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Nevada Test Site Environmental Report

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2008

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Editor: Cathy Wills

Technical Editor: Sierra Cory
Graphic Design/Desktop Publisher Specialist: Elaine Forbes
Geographic Information System Specialist: Ashley Burns

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Prepared for:
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National Nuclear Security Administration
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Prepared by:
National Security Technologies, LLC
P. O. Box 98521
Las Vegas, NV 89193-8521

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Executive Summary

The *Nevada Test Site Environmental Report* (NTSER) *2008* was prepared to meet the information needs of the public and the requirements and guidelines of the U.S. Department of Energy (DOE) for annual site environmental reports. It was prepared by National Security Technologies, LLC (NSTec), for the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO). This and previous years' NTSERs are posted on the NNSA/NSO website at http://www.nv.doe.gov/library/publications/aser.aspx.

Purpose and Scope of the NTS Environmental Report

This NTSER was prepared to satisfy DOE Order DOE O 231.1A, "Environment, Safety and Health Reporting." Its purpose is to (1) report compliance status with environmental standards and requirements, (2) present results of environmental monitoring of radiological and nonradiological effluents, (3) report estimated radiological doses to the public from releases of radioactive material, (4) summarize environmental incidents of noncompliance and actions taken in response to them, (5) describe the NNSA/NSO Environmental Management System and characterize its performance, and (6) highlight significant environmental programs and efforts.

This NTSER summarizes data and compliance status for calendar year 2008 at the Nevada Test Site (NTS) and its two support facilities, the North Las Vegas Facility (NLVF) and the Remote Sensing Laboratory (RSL)–Nellis. It also addresses environmental restoration (ER) projects conducted at the Tonopah Test Range (TTR). Through a Memorandum of Agreement, NNSA/NSO is responsible for the oversight of TTR ER projects, and the Sandia Site Office of NNSA (NNSA/SSO) has oversight of all other TTR activities. NNSA/SSO produces the TTR annual environmental report available at http://www.sandia.gov/news/publications/environmental/index.html.

Major Site Programs and Facilities

NNSA/NSO directs the management and operation of the NTS and six sites across the nation. The NTS is located about 105 kilometers (km) (65 miles [mi]) northwest of Las Vegas. The six sites include two in Nevada (NLVF and RSL-Nellis) and four sites in other states (RSL-Andrews in Maryland, Livermore Operations in California, Los Alamos Operations in New Mexico, and Special Technologies Laboratory in California). Los Alamos, Lawrence Livermore, and Sandia National Laboratories are the principal organizations that sponsor and implement the nuclear weapons programs at the NTS. NSTec is the current Management and Operating (M&O) contractor accountable for the successful execution of work and ensuring that work is performed in compliance with environmental regulations. The six sites all provide support to enhance the NTS as a location for weapons experimentation and nuclear test readiness. The three major NTS missions include National Security, Environmental Management, and Stewardship of the NTS.

Facilities that support the National Security mission of keeping the U.S. stockpile of nuclear weapons safe and reliable include the U1a Facility, Big Explosives Experimental Facility (BEEF), Device Assembly Facility (DAF), and Joint Actinide Shock Physics Experimental Research (JASPER) Facility. Facilities that support the Homeland Security program include the new Radiological/Nuclear Countermeasures Test and Evaluation Complex that became operational in 2009.

Other Key Initiatives

Apart from the major site programs, other NTS activities include demilitarization activities; controlled spills of hazardous material at the Nonproliferation Test and Evaluation Complex (NPTEC) for research purposes; processing of waste destined for the Waste Isolation Pilot Plant in Carlsbad, New Mexico, or the Idaho National Laboratory in Idaho Falls, Idaho; disposal of radioactive and mixed waste; and environmental research.

Environmental Performance Measures Programs

During the conduct of the major programs and other key initiatives mentioned above, NNSA/NSO complies with applicable environmental and public health protection regulations and strives to manage the land and facilities at the NTS as a unique and valuable national resource. For the identification of NTS environmental initiatives, NSTec relies upon their Integrated Safety Management System (ISMS), contractual requirements, and the Environmental Management System (EMS). The ISMS is designed to ensure the systematic integration of environment, safety, and health concerns into management and work practices so that NTS missions are accomplished safely and in a manner that protects the environment. NNSA/NSO oversees ISMS implementation through the Integrated Safety Management Council.

The NSTec EMS is designed to incorporate concern for environmental performance throughout the organization, with the ultimate goal being continual reduction of the organization's impact on the environment. Specific objectives and targets to reduce environmental impacts are identified through the EMS process and are tracked annually. On June 21, 2008, NSTec's EMS was awarded ISO 14001 Certification (Section 17.2). ISO stands for the International Organization for Standardization. The certification represents an external third-party organization review and approval of the EMS as an effective and efficient system to ensure environmental compliance and to conform with NNSA/NSO environmental policy.

Performance Measures

Performance measures are used to evaluate the achievement of organization or process goals and to identify the need to institute changes in an organization or process. The NTS performance measures defined in the NSTec Prime Contract relate to protection of the environment and the public from effects of NTS operations. These performance measures apply to several programs and processes. They include (1) the potential radiological dose received by the public; (2) the identification, notification, and mitigation of spills and releases to the environment; (3) the reduction in the generation of wastes; and (4) compliance with applicable environmental protection regulations. The performance measures tracked by each process or program (e.g., air quality protection) are consolidated and presented in this report in Section 2.0, Compliance Summary. As part of implementing the EMS, objectives and targets to reduce environmental impacts are also identified and tracked on a fiscal year (FY) schedule (October 1 through September 30). The objectives and targets for FY 2008 were reviewed and approved by the Executive Leadership Council. They included increasing the use of alternative fuels, reducing the use of electrical energy, plugging unneeded boreholes, increasing material recycling, and using only environmentally friendly electronics. All FY 2008 targets were met or exceeded by the end of 2008 (Section 17.2.4).

Offsite Monitoring for Radiological Releases into Air

An offsite radiological air monitoring program is run by the Community Environmental Monitoring Program (CEMP) and is coordinated by the Desert Research Institute (DRI) of the Nevada System of Higher Education under contract with NNSA/NSO (Section 6.0). It is a non-regulatory public informational and outreach program, and its purpose is to provide monitoring for radionuclides that might be released from the NTS. A network of 29 CEMP stations, located in selected towns and communities within a 160,000 square kilometer (61,776 square mile) area of southern Nevada, southeastern California, and southwestern Utah, was operated during 2008. The CEMP stations monitored gross alpha and beta radioactivity in airborne particulates using low-volume particulate air samplers, penetrating gamma radiation using thermoluminescent dosimeters (TLDs), gamma radiation exposure rates using pressurized ion chamber (PIC) detectors, and meteorological parameters using automated weather instrumentation.

No airborne radioactivity related to historic or current NTS operations was detected in any of the samples from the CEMP particulate air samplers during 2008. TLD and PIC detectors measure gamma radiation from all sources: natural background radiation from cosmic and terrestrial sources and man-made sources. The offsite TLD and PIC results remained consistent with previous years' background levels and are well within background levels observed in other parts of the United States.

Onsite Monitoring and Estimating of Radiological Releases into Air

Estimates of radionuclide emissions on the NTS in 2008 were made for the following sources: (1) tritium (^{3}H) gas released during operations at the Dense Plasma Focus Facility in Area 11; (2) the evaporation of tritiated water discharged from E Tunnel in Area 12; (3) the evaporation of ^{3}H from lined containment sumps at three post-shot wells in Areas 2, 4, and 19; (4) the evaporation of tritiated water removed from the basement of Building A-1 at the NLVF and transported to the NTS for disposal in the Area 5 Sewage Lagoon; (5) the evaporation and transpiration of tritiated water from soil and vegetation, respectively, from the Area 3 Radioactive Waste Management Site (RWMS), the Area 5 RWMS, the Schooner crater in Area 20, and the Sedan crater in Area 10; (6) the release of tritium and aerosolized depleted uranium (DU) during high explosives experiments at the BEEF; and (7) the resuspension of americium-241 (^{241}Am), plutonium-238 (^{238}Pu), and plutonium-239+240 ($^{239+240}Pu$) from past nuclear testing from soil deposits on the NTS across all NTS areas. A network of 19 air sampling stations and a network of 109 TLDs were used to monitor diffuse onsite radioactive emissions in 2008. Total radiological atmospheric releases for 2008 (Section 3.1.9) are shown in the table below. The methods used to estimate these quantities include the use of annual field air and water monitoring data, historical soil inventory data, and accepted soil resuspension and air transport models.

Total NTS Radiological Atmospheric Releases for 2008 (Curies per year)

^{3}H	^{85}Kr	Noble Gases (T1/2<40 days)	Short-Lived Fission and Activation Products (T1/2<3 hr)	Fission and Activation Products (T1/2>3 hr)	Total Radio-iodine	Total Radio-strontium	Total Depleted Uranium	Plutonium	Other Actinides	Other
440	0	0	0	0	0	0	0.060	0.050 (^{238}Pu) 0.29 ($^{239+240}Pu$)	0.047 (^{241}Am)	0

Offsite Radiological Monitoring of Water

Offsite water monitoring conducted by the M&O contractor and by DRI (through the CEMP) verifies that there has been no offsite migration of man-made radionuclides from NTS underground contamination areas.

In 2008, NSTec conducted radiological monitoring of 10 offsite non-potable NNSA/NSO wells drilled for hydrogeologic investigations including groundwater flow modeling. Most were wells in Oasis Valley. The DRI, through the CEMP, sampled 28 offsite water locations in 2008 for tritium. They included 4 springs, 21 wells, and 3 surface water bodies located in selected towns and communities within 373 km (232 mi) of the NTS (Section 6.2.1). The NSTec offsite water samples were analyzed for tritium as well as man-made gamma-emitting radionuclides and gross alpha and gross beta radioactivity.

CEMP results in 2008, as in past years, continue to verify that no contaminated groundwater has migrated beyond the NTS boundaries into surrounding water supplies used by the public. Tritium concentrations for all the spring and surface water samples were either below or barely above laboratory background levels except those from the municipal water systems of Boulder City and Henderson where tritium was found at the low levels of 24.1 ± 1.6 picocuries per liter (pCi/L) and 23.2 ± 1.5 pCi/L, respectively (Section 6.2.3). Boulder City and Henderson municipal water systems both obtain water from Lake Mead, which has documented levels of residual tritium persisting in the environment that originated from global atmospheric nuclear testing.

Similarly, the 2008 NSTec data indicate that groundwater at the 10 offsite NNSA/NSO wells has not been impacted by past NTS nuclear testing operations. Tritium was not detected above its MDC in these wells. Gross alpha and gross beta radioactivity were detected, however, in most of the well samples, but none of the measured levels met or exceeded the U.S. Environmental Protection Agency (EPA) maximum contaminant level (MCL) of 15 pCi/L for gross alpha, or the EPA Level of Concern of 50 pCi/L for gross beta. They likely represent natural radiation sources.

Onsite Radiological Monitoring of Water

In 2008, 5 potable and 4 non-potable water supply wells, 14 monitoring wells, 1 tritiated water containment pond system, and 2 sewage lagoons were sampled for man-made radiological contaminants. The 2008 data continue to indicate that underground nuclear testing has not impacted the NTS potable water supply network. None of the onsite water supply wells had detectable concentrations of tritium or detectable concentrations of man-made gamma-emitting radionuclides (Section 4.1.8). Tritium values ranged from -19.5 ± 12.6 to 10.6 ± 12.9 pCi/L. The gross alpha and gross beta radioactivity detected in potable water supply wells represent the presence of naturally occurring radionuclides and did not exceed EPA limits.

All the monitoring wells measured for gross alpha and gross beta had detectable levels, most likely from natural sources. None of the monitoring wells had gamma-emitting radionuclides above their respective MDCs. Ten of the 14 onsite monitoring wells had levels of tritium below their MDCs. Four of the 14 monitoring wells had detectable levels of tritium above their MDCs that ranged from 31 ± 13 to 356 ± 59 pCi/L (Section 4.1.9). These wells (PM-1, UE-7NS, WW A, and U-19BH) are each within 1 km (0.6 mi) of an historical underground nuclear test; all have consistently had detectable levels of tritium in past years. Their tritium levels are still less than 3 percent of the EPA MCL for drinking water of 20,000 pCi/L, and no trend of rising tritium concentrations in these wells has been observed since 2000.

Five constructed basins collect and hold water discharged from E Tunnel in Area 12 where nuclear testing was conducted in the past. Tunnel effluent water was analyzed for tritium, gross alpha, and gross beta in accordance with a wastewater discharge permit. Tritium in tunnel effluent water was 577,000 ± 88,100 pCi/L, lower than the limit allowed under the discharge permit (1,000,000 pCi/L). Gross alpha and gross beta values in 2008 were also less than their permitted limits (Section 4.1.10).

Neither of the two onsite permitted sewage lagoons had detectable levels of tritium. Gross alpha and gross beta activity in the lagoon waters were both below their permitted limits (Section 4.1.11).

The Underground Test Area (UGTA) Sub-Project pumps tritiated water into lined sumps during studies conducted at contaminated post-shot or near-cavity wells on the NTS. Four of these types of contaminated wells were sampled in 2008. An additional well that is associated with the N-Tunnel complex on Rainier Mesa was also sampled. The tritium levels in these wells ranged from 260,000 ± 10,000 to 21,000,000 ± 1,000,000 pCi/L (Section 4.1.12).

Radiation Dose to the Public from the NTS

Background Gamma Radiation – Mean background gamma radiation exposure rates on the NTS are measured at ten TLD stations located away from radiologically contaminated sites. These ranged from 63 to 159 mR/yr during 2008 (Section 5.3). This equates to an annual estimated background external dose of 63 to 159 millirem per year (mrem/yr) to a hypothetical person residing at those locations all year. In comparison, DRI measured background radiation in 2008 at offsite locations using TLDs that ranged from 71 mR/yr at Pahrump, Nevada, to 148 mR/yr at Twin Springs, Nevada (Section 6.1.2).

Public Dose from Drinking Water – Man-made radionuclides from past nuclear testing have not been detected in offsite groundwater in the past or during 2008 (Section 4.1). The offsite public does not receive a radiation dose from NTS operations from drinking water.

Public Dose from Inhalation – The radiation dose limit to the general public via just the air transport pathway is established by the National Emission Standards for Hazardous Air Pollutants (NESHAP) under the Clean Air Act to be 10 mrem/yr. The EPA, Region IX, has approved the use of six air sampling stations on the NTS (called "critical receptor" stations) to verify compliance with the NESHAP dose limit. The following radionuclides were detected at four or more of the critical receptor samplers: ^{241}Am, ^{238}Pu, $^{239+240}$Pu, $^{233+234}$U, $^{235+236}$U, ^{238}U, and ^{3}H (Section 3.1.5). Concentrations of these radionuclides at each of the stations indicated that the NESHAP dose limit to the public was not exceeded. The Schooner station in the far northwest corner of the NTS experienced the highest concentrations of radioactive air emissions (Section 3.1.5), yet an individual residing at this station would experience a dose from air emissions of only 1.9 mrem/yr, 19 percent of the admissible dose limit. No one resides at this location, and the dose at offsite populated locations 20–80 km (12–50 mi) from the Schooner station would be much lower due to wind dispersion.

Public Dose from Direct Radiation – The radiation dose limit to the general public via all possible transport pathways (over and above background dose) established by DOE is 100 mrem/yr. This includes internal and external dose. Areas accessible to the public had direct external gamma radiation exposure rates in 2008 comparable to natural background rates. The TLD location on the west side of the parking area at Gate 100, the NTS entrance gate, had an estimated annual mean exposure that ranged from 65.1 mR/yr to 114 mR/yr during the first and second quarters of 2008, respectively. It is likely that low-level radioactive waste shipments intermittently parked there prior to entering the NTS are responsible for such quarter-to-quarter variation.

Military or other personnel on the Nevada Test and Training Range (NTTR) could be exposed to direct radiation from legacy sites in Frenchman Lake playa. A TLD location near the NTS boundary with NTTR in the playa had an estimated annual exposure of 349 mR (Section 5.3.1). This represents an above-background dose of 190 to 286 mrem/yr (depending on which background radiation value is used), which would exceed the 100 mrem/yr dose limit to a member of the public. However, there are no living quarters or full-time personnel in that area.

Public Dose from Ingestion of Radionuclides in Game Animals – Game animals from different contaminated NTS sites are trapped each year and analyzed for their radionuclide content to estimate the dose to hunters who might consume these animals if the animals moved off the NTS. In 2008, one mourning dove and two cottontail rabbits were sampled from near the Schooner Crater in Area 20. Based on tissue analyses from these samples, the highest annual dose to a member of the public consuming NTS game animals was estimated to be 0.47 mrem (Section 8.1.3, Table 8-1).

Public Dose from Release of Property Containing Radioactive Material – No items were released from the NTS in 2008 that had residual radioactivity in excess of the default authorized limits specified in DOE O 5400.5, "Radiation Protection of the Public and the Environment." The NNSA/NSO contribution to the total public dose from this source was therefore negligible in 2008.

Public Dose from All Pathways – Existing 2008 radiological monitoring data indicate that the dose to the public living in communities surrounding the NTS is not expected to be significantly higher than the previous 10 years. The public dose from all pathways in 2008 was estimated to be 2.37 mrem/yr. This is less than 3 percent of the 100 mrem/yr dose limit and about 0.6 percent of the total dose the maximally exposed individual receives from natural background radiation (340 mrem/yr) (Section 8.1.7).

Nonradiological Releases into Air

The release of air pollutants is regulated on the NTS under a Class II air quality operating permit. Class II permits are issued for minor sources where annual emissions must not exceed 100 tons of any one criteria pollutant, or 10 tons of any one of the 189 hazardous air pollutants (HAPs), or 25 tons of any combination of HAPs. Criteria pollutants include sulfur dioxide (SO_2), nitrogen oxides (NO_X), carbon monoxide (CO), particulate matter (PM), and volatile organic compounds (VOCs). The NTS facilities regulated by the permit include (1) over 15 facilities/185 pieces of equipment in Areas 1, 3, 5, 6, 12, 23, and 27; (2) the NPTEC; (3) Site-Wide Chemical Release Areas; (4) the BEEF; and (5) the Explosives Ordnance Disposal Unit.

An estimated 6.05 tons of criteria air pollutants were released on the NTS in 2008 (Section 3.2.1). The majority were NO_x from diesel generators. Total HAPs emissions from permitted operations was only 190 pounds (Section 3.2.1). Lead emissions from non-permitted activities, such as soldering and weapons use, are reported to the EPA, and this quantity in 2008 was 4.56 pounds (Section 10.3). No emission limits for any criteria air pollutants or HAPS were exceeded.

One test, consisting of 28 releases of hazardous chemicals at the Area 5 NPTEC facility and 6 releases at the Test Cell C NPTEC facility in Area 25, was conducted in 2008 (Section 3.2.5). An annual report of the types and amounts of chemicals released and the test plans and final analysis reports for each chemical release were submitted to the State of Nevada. No ecological monitoring was performed since each test posed a very low level of risk to the environment and biota.

Nonradiological Releases into Water

There are no liquid discharges to navigable waters, offsite surface water drainage systems, or publicly owned treatment works resulting from operations on the NTS. Therefore, no Clean Water Act National Pollutant Discharge Elimination System (NPDES) permits are required for operations on the NTS.

Industrial discharges on the NTS are limited to two operating sewage lagoon systems, the Area 6 Yucca Lake and Area 23 Mercury systems. Liquid discharges to these sewage lagoons are tested quarterly for biological oxygen demand, pH, and total suspended solids. Annually, sewage lagoon pond waters are sampled for a suite of toxic

Pollution Prevention/Waste Minimization (P2/WM) Activities

P2/WM activities result in reductions to the volume and/or toxicity of waste actually generated on site (Section 11.3). A reduction of 268.5 metric tons (mtons) (295 tons) of hazardous wastes was realized in 2008. The largest proportion of this reduction came from shipments of lead acid batteries (105.0 mtons [115.5 tons]), bulk used oil (76.4 mtons [84 tons]), and lead scrap metal (73.5 mtons [80.8 tons]) to offsite vendors for recycling.

A reduction of 311.2 mtons (342.3 tons) of solid wastes was realized in 2008. The largest proportion of this reduction came from shipping 161.0 mtons (177.1 tons) of mixed paper and cardboard and 84.2 mtons (92.6 tons) of ferrous scrap metal to a vendor for recycling and shipping 44.6 mtons (49.1 tons) of food wastes from the NTS cafeterias to a local pig farm.

Compliance with Environmental Laws, Regulations, and Policies

A summary of NNSA/NSO's compliance with over 100 applicable environmental laws, regulations, and policies is presented in Chapter 2. The following table shows those categories for which compliance was not 100 percent.

Noncompliance Incidents in 2008
Air Quality
Two cooling towers at RSL-Nellis were being operated and were not on the air permit (Appendix A, Section A.2.2).
Water Quality
Quarterly sampling of drinking water from the Area 23 and 6 Public Water System was not initiated immediately after xylene was measured above the EPA-specified detection level (Section 4.2.1.2).
Pollution Prevention and Waste Minimization
The Executive Order 13423 goal to have 100 percent of purchases of items from the EPA-designated list contain recycled materials at the specified minimum content was not met; only 56 percent of purchases met the criteria (Section 11.1).
Conservation and Protection of Biota and Wildlife Habitat
Six out of ten accidental bird deaths were attributable to NTS activities (e.g., killed by vehicular traffic); those killed represented five species protected from harm as migratory birds (Section 13.3.2.3).
Accidental/Unplanned Environmental Releases
(1) Radiologically contaminated debris at Test Cell C, Area 25 was dispersed outside the boundaries of a controlled Contamination Area by high winds, (2) radiologically contaminated debris was found in Area 3 outside an adjacent Contamination Area, and (3) a fuel/lube truck leaked 329 gallons of oil in Area 6, contaminating a 60 square foot area adjacent to Road 6-05 (Section 2.11.1).

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Chapter Authors and Contributors

Executive Summary

Cathy A. Wills, NSTec

1.0 Introduction

Charles B. Davis, EnviroStat
Cathy A. Wills, NSTec

2.0 Compliance Summary

Colleen M. Beck, DRI
Elizabeth C. Calman, NSTec
Andrea L. Gile, NSTec
Cirilo C. Gonzales, NSTec
Sydney J. Gordon, NSTec
Diana J. Mendel, NSTec
W. Kent Ostler, NSTec
Phyllis M. Radack, NSTec
Glenn Richardson, NSTec
David D. Rudolph, NSTec
Gregory T. Schmett, NSTec
Carlton Soong, NSTec
Tammy H. Wallace, NSTec
Ronald W. Warren, NSTec

3.0 Radiological and Nonradiological Air Monitoring

Elizabeth C. Calman, NSTec
Charles B. Davis, EnviroStat
Robert F. Grossman, NSTec
Diana J. Mendel, NSTec
Tammy H. Wallace, NSTec
Ronald W. Warren, NSTec

4.0 Radiological and Nonradiological Water Monitoring

Charles B. Davis, EnviroStat
Sigmund L. Drellack, NSTec
David L. Finnegan, LANL
Phyllis M. Radack, NSTec
Theodore J. Redding, NSTec
David D. Rudolph, NSTec
Ronald W. Warren, NSTec

5.0 Direct Radiation Monitoring

Charles B. Davis, EnviroStat
Ronald W. Warren, NSTec

6.0 Oversight Radiological Monitoring of Air and Water

William T. Hartwell, DRI
Charles E. Russell, DRI
Craig Shadel, DRI

7.0 Radiological Biota Monitoring

Ronald W. Warren, NSTec

8.0 Radiological Dose Assessment

Robert F. Grossman, NSTec
Mark McMahon, NSTec
Ronald W. Warren, NSTec

9.0 Waste Management and Environmental Restoration

Pat Arnold, NSTec
Carol F. Dinsman, NNSA/NSO
Cirilo C. Gonzales, NSTec
Sydney J. Gordon, NSTec

9.0 Waste Management and Environmental Restoration (continued)

David B. Hudson, NSTec
Glenn Richardson, NSTec
Gregory T. Schmett, NSTec
Carlton Soong, NSTec

10.0 Hazardous Materials Control and Management

Orin L. Haworth, NSTec
Carlton Soong, NSTec
Tammy H. Wallace, NSTec

11.0 Pollution Prevention

Orin L. Haworth, NSTec

12.0 Historic Preservation and Cultural Resources Management

Colleen M. Beck, DRI
Barbara A. Holz, DRI

13.0 Ecological Monitoring

David C. Anderson, NSTec
Paul D. Greger, NSTec
Derek B. Hall, NSTec
Dennis J. Hansen, NSTec
W. Kent Ostler, NSTec

14.0 Underground Test Area Sub-Project

Sigmund L. Drellack, NSTec

15.0 Groundwater Protection Programs, Projects, and Activities

Robert P. Graves, USGS
Bruce W. Hurley, NNSA/NSO
Curtis Obi, NSTec

16.0 Meteorological Monitoring

Walter Schalk, ARL/SORD

17.0 Environmental Management System

Orin L. Haworth, NSTec

18.0 Compliance Quality Assurance Program

Elizabeth Burns, NSTec
Charles B. Davis, EnviroStat
Theodore J. Redding, NSTec

19.0 Oversight Quality Assurance Program

Craig Shadel, DRI

Appendix A: Offsite Facilities

Sigmund L. Drellack, NSTec
David D. Rudolph, NSTec
Carlton Soong, NSTec
Tammy H. Wallace, NSTec
Ronald W. Warren, NSTec

NSTec ETS Support Staff

The following individuals within ETS are responsible for the numerous tasks that are integral to the collection, quality assurance, and quality control of much of the environmental data reported in this report.

Coordination of Field Sampling Operations for Routine Radiological Environmental Monitoring Plan (RREMP), Clean Water Act (CWA) and Safe Drinking Water Act (SDWA) Projects:

Terrence P. Sonnenburg

Field Sampling for RREMP, CWA, and SDWA Projects:

Melissa A. Cabble
Martin D. Cavanaugh
Rebecca T. Fish
Paul D. Greger
George H. Juniel
Matthew O. Weaver

Laboratory Operations Supporting RREMP Screening and Sample Processing:

Lynn N. Jaussi

Sample Management Supporting the NSTec Subcontracting of Environmental Analytical Services:

Catherine D. Castaneda
Theodore J. Redding

RREMP Data Verification, Validation, and Review:

Elizabeth Burns
Theodore J. Redding
Ronald W. Warren

Quality Assurance Oversight of the RREMP:

Elizabeth Burns
Theodore J. Redding

Administration of the Bechtel Environmental Integrated Data Management System for RREMP, CWA, and SDWA Projects:

Elizabeth Burns
Robert G. Peppard

Report Production and Distribution Support Personnel

The following individuals were responsible for improving the quality, appearance, and timely production and distribution of this report:

Ashley Burns of NSTec Spatial Sciences worked with all the authors to produce the high-quality Geographic Information System (GIS)-generated maps and figures.

Sierra Cory of Directives Management & Publications (DM&P) provided a thorough review of this document to ensure spelling, format, grammar, references, tables, figures, acronyms, table of contents, etc., were all in order.

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Tom Fitzmaurice of NSTec Environmental Restoration provided his artistic talents to produce the drawing of possible pathways of radiological exposure to the public presented in the NTSER Summary.

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David Wieand of Public Affairs and Community Relations designed the report cover.

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1.0 Introduction and Helpful Information

1.1 Site Location

The U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) directs the management and operation of the Nevada Test Site (NTS), which is located in Nye County in south-central Nevada (Figure 1-1). The southeast corner of the NTS is about 88 kilometers (km) (55 miles [mi]) northwest of the center of Las Vegas in Clark County. By highway, it is about 105 km (65 mi) from the center of Las Vegas to Mercury. Mercury, located at the southern end of the NTS, is the main base camp for worker housing and administrative operations for the NTS.

The NTS encompasses about 3,561 square kilometers (km^2) (1,375 square miles [mi^2]). It varies from 46 to 56 km (28 to 35 mi) in width from west to east and from 64 to 88 km (40 to 55 mi) from north to south. The NTS is surrounded on all sides by federal lands (Figure 1-1). It is bordered on the southwest corner by the Yucca Mountain Project Area, on the west and north by the Nevada Test and Training Range (NTTR), on the east by an area used by both the NTTR and the Desert National Wildlife Range, and on the south by Bureau of Land Management lands. The combination of the NTTR and the NTS represents one of the larger unpopulated land areas in the United States, comprising some 14,200 km^2 (5,470 mi^2).

1.2 Environmental Setting

The NTS is located in the southern part of the Great Basin, the northern-most sub-province of the Basin and Range Physiographic Province. The NTS terrain is typical of much of the Basin and Range Physiographic Province, characterized by generally north-south trending mountain ranges and intervening valleys. These mountain ranges and valleys, however, are modified on the NTS by very large volcanic calderas (Figure 1-2).

The principal valleys within the NTS are Frenchman Flat, Yucca Flat, and Jackass Flats (Figure 1-2). Both Yucca and Frenchman Flat are topographically closed and contain dry lake beds, or playas, at their lowest elevations. Jackass Flats is topographically open, and surface water from this basin flows off the NTS via the Fortymile Wash. The dominant highlands of the NTS are Pahute Mesa and Rainier Mesa (high volcanic plateaus), Timber Mountain (a resurgent dome of the Timber Mountain caldera complex), and Shoshone Mountain. In general, the slopes of the highland areas are steep and dissected, and the slopes in the lowland areas are gentle and less eroded. The lowest elevation on the NTS is 823 meters (m) (2,700 feet [ft]) in Jackass Flats in the southeast, and the highest elevation is 2,341 m (7,680 ft) on Rainier Mesa in the north-central region.

The topography of the NTS has been altered by historic U.S. Department of Energy (DOE) actions, particularly underground nuclear testing. The principal effect of testing has been the creation of numerous collapse sinks (craters) in Yucca Flat basin and a lesser number of craters on Pahute and Rainier Mesas. Shallow detonations that created surface disruptions were also performed during Project Plowshare to determine the potential uses of nuclear devices for large-scale excavation.

The reader is directed to *Attachment A: Nevada Test Site Description,* a separate file on the compact disc of this report, where the geology, hydrology, climatology, ecology, and cultural resources of the NTS are described.

1.3 Site History

The history of the NTS, as well as its current missions, directs the focus and design of the environmental monitoring and surveillance activities on and near the site. Between 1940 and 1950, the area now known as the NTS was under the jurisdiction of Nellis Air Force Base and was part of the Nellis Bombing and Gunnery Range. The NTS was established in 1950 to be the primary location for testing the nation's nuclear explosive devices and supported nuclear testing from 1951 to 1992. Fact sheets on many of the historical tests and projects mentioned below can be found at <http://www.nv.doe.gov/library/factsheets.aspx>. The NTS currently conducts only subcritical nuclear experiments.

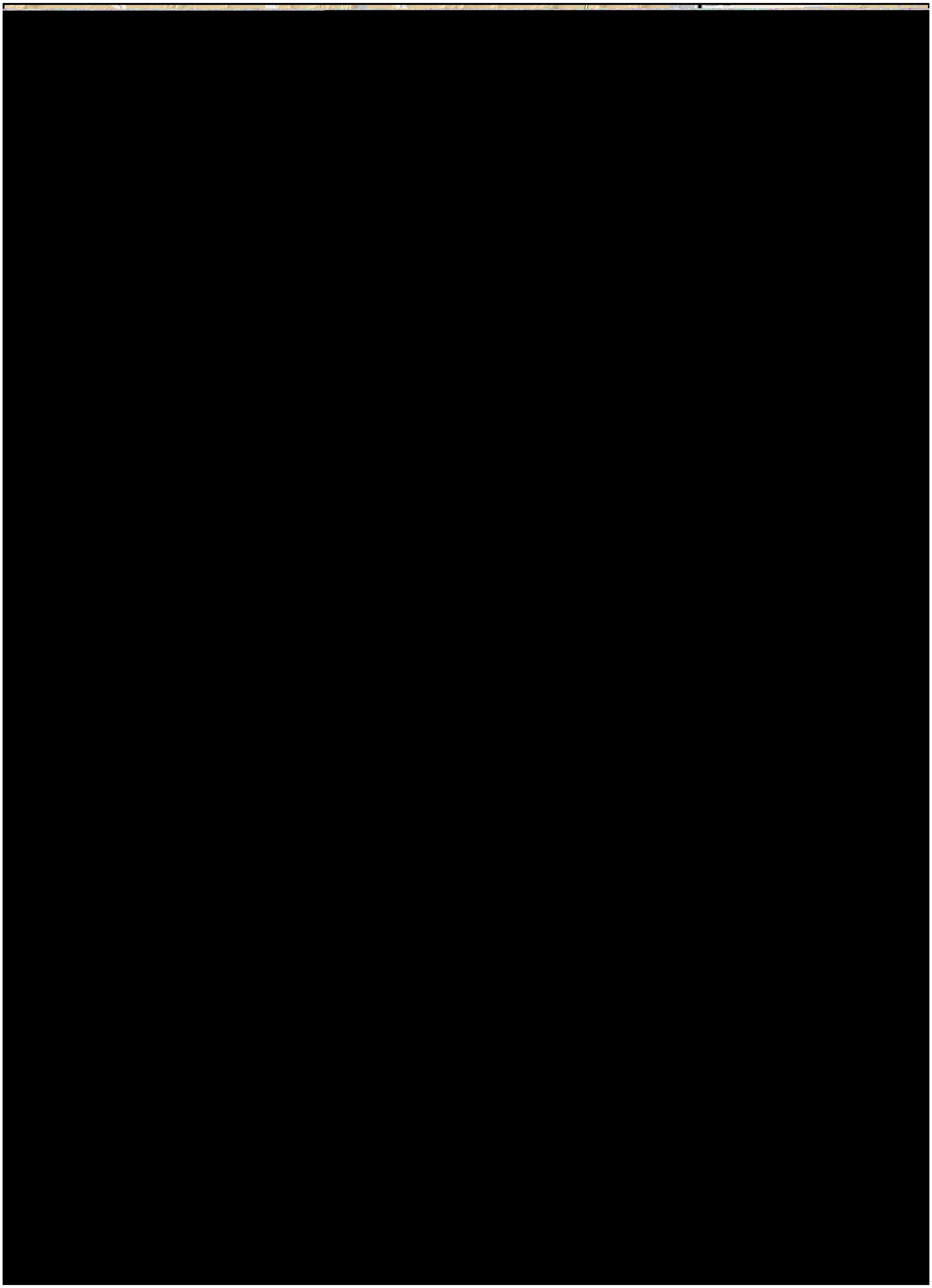

Figure 1-1. NTS vicinity map

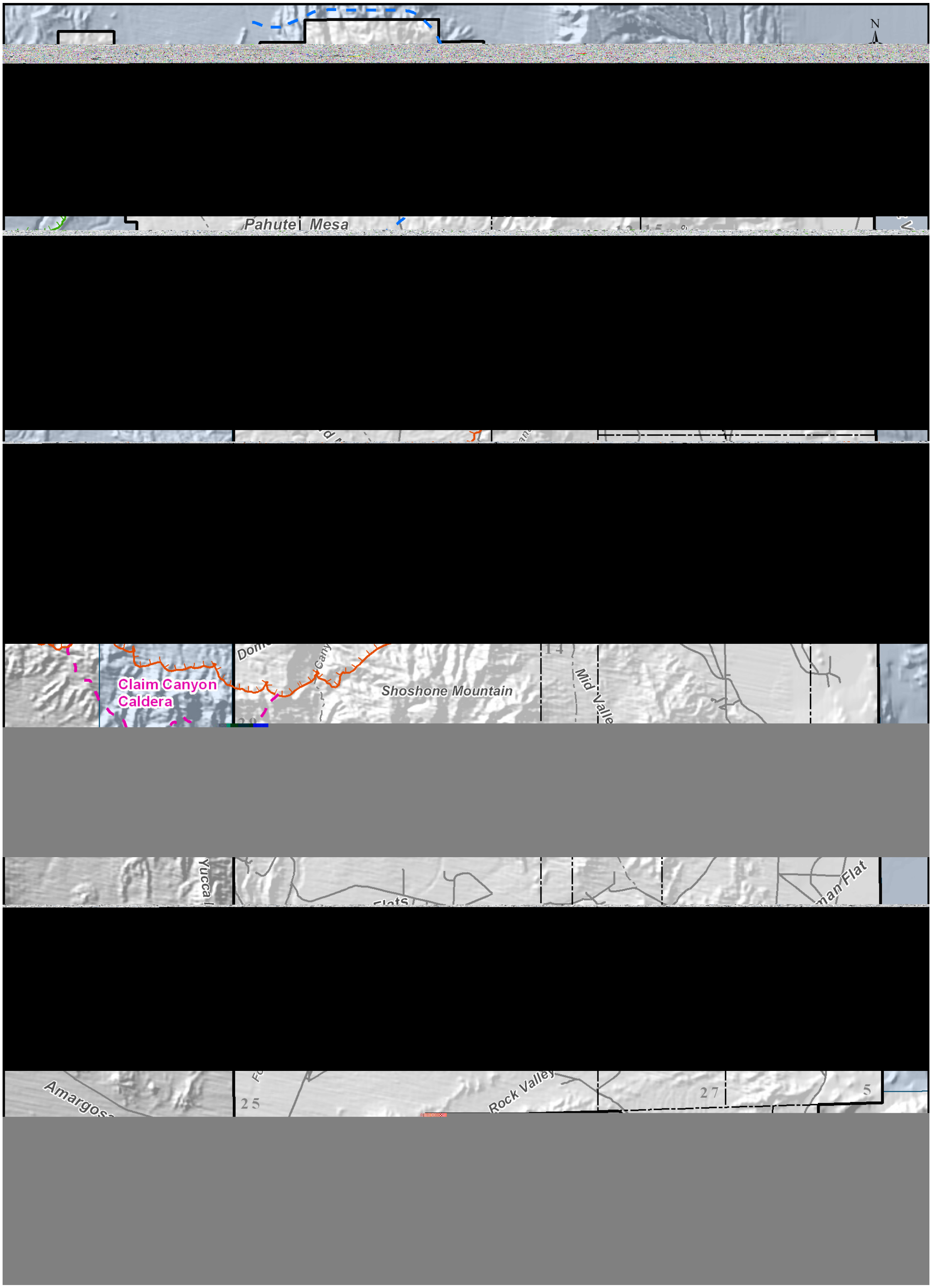

Figure 1-2. Major topographic features and calderas of the NTS

Atmospheric Tests – Tests conducted through the 1950s were predominantly atmospheric tests. These tests involved a nuclear explosive device detonated while on the ground surface, on a steel tower, suspended from tethered balloons, dropped from an aircraft, or placed on a rocket. Several tests were categorized as "safety experiments" and "storage-transportation tests," involving the destruction of a nuclear device with non-nuclear explosives. Some of these tests resulted in the dispersion of plutonium in the test vicinity. One of these test areas lies just north of the NTS boundary at the south end of the NTTR, and four others involving storage-transportation tests are at the north end of the NTTR. These test areas have been monitored for radionuclides in the past (1996–2000) in support of remediation projects, two of which were completed. The three remaining sites will be monitored again once restoration of these sites begins. All nuclear device tests are listed in *United States Nuclear Tests, July 1945 through September 1992* (U.S. Department of Energy, Nevada Operations Office, 2000).

Underground Tests – The first underground test, a cratering test, was conducted in 1951. The first totally contained underground test was in 1957. Testing was discontinued during a bilateral moratorium that began October 31, 1958, but was resumed in September 1961 after the Union of Soviet Socialist Republics resumed nuclear testing. After late 1962, nearly all tests were conducted in sealed vertical shafts drilled into Yucca Flat and Pahute Mesa or in horizontal tunnels mined into Rainier Mesa. From 1951 to 1992, a total of 828 underground nuclear tests were conducted at the NTS. Approximately one-third of these tests was detonated near or below the water table; this has resulted in the contamination of groundwater in some areas. In 1996, DOE, the U.S. Department of Defense (DoD), and the State of Nevada entered into a Federal Facility Agreement and Consent Order, which established Corrective Action Units on the NTS that delineated and defined areas of concern for groundwater contamination.

Cratering Tests – Five earth-cratering (shallow-burial) tests were conducted from 1962 through 1968 as part of the Plowshare Program that explored peaceful uses of nuclear explosives. The first and highest yield Plowshare crater test, Sedan (U.S. Public Health Service, 1963), was detonated at the northern end of Yucca Flat on the NTS. The second-highest yield crater test was Schooner, located in the northwest corner of the NTS. From these tests, mixed fission products, tritium, and plutonium were entrained in the soil ejected from the craters and deposited on the ground surrounding the craters.

Other Tests – Other nuclear-related experiments at the NTS have included the BREN [Bare Reactor Experiment - Nevada] series in the early 1960s conducted in Area 4. These tests were performed with a 14-million electron volt neutron generator mounted on a 465-m (1,527-ft) steel tower to produce neutron and gamma radiation for the purpose of estimating the radiation doses received by survivors of Hiroshima and Nagasaki. The tower was moved in 1966 to Area 25 and used for conducting Operation HENRE [High-Energy Neutron Reactions Experiment], jointly funded by the DoD and the Atomic Energy Commission (AEC) to provide information for the AEC's Division of Biology and Medicine. From 1959 through 1973, a series of open-air nuclear reactor, nuclear engine, and nuclear furnace tests were conducted in Area 25, and a series of tests with a nuclear ramjet engine were conducted in Area 26. Erosion of metal cladding on the reactor fuel released some fuel particles that caused negligible deposition of radionuclides on the ground. Most of the radiation released from these tests was gaseous in the form of radio-iodines, radio-xenons, and radio-kryptons.

1.4 Site Mission

NNSA/NSO directs the management and operation of the NTS and six sites across the nation. Los Alamos National Laboratory, Lawrence Livermore National Laboratory, and Sandia National Laboratories are the principal organizations that sponsor and implement the nuclear weapons programs at the NTS. National Security Technologies, LLC, is the current Management and Operating (M&O) contractor accountable for the successful execution of work and ensuring that work is performed in compliance with environmental regulations. The six sites include the North Las Vegas Facility (NLVF), Remote Sensing Laboratory (RSL)–Nellis, RSL–Andrews, Livermore Operations, Los Alamos Operations, and Special Technologies Laboratory. These sites all provide support to enhance the NTS as a site for weapons experimentation and nuclear test readiness. The three major NTS missions include National Security, Environmental Management, and Stewardship of the NTS. The programs that support these missions include Stockpile Stewardship, Homeland Security, Test Readiness, Environmental Restoration, Waste Management, and Facilities and Infrastructure.

NTS Missions and Programs

National Security

Stockpile Stewardship Program – Conducts high-hazard operations in support of defense-related nuclear and national security experiments.

Homeland Security Program – Provides support facilities, training facilities, and capabilities for government agencies involved in counterterrorism activities, emergency response, first responders, national security technology development, and nonproliferation technology development.

Test Readiness Program – Maintains the capability to resume underground nuclear weapons testing, if directed.

Environmental Management

Environmental Restoration Program – Characterizes and remediates the environmental legacy of nuclear weapons and other testing at the NTS and at offsite locations, and develops and deploys technologies that enhance environmental restoration.

Waste Management – Manages and safely disposes of low-level waste received from DOE- and DoD-approved facilities throughout the U.S. and mixed low-level waste generated in Nevada by NNSA/NSO, and safely manages and characterizes hazardous and transuranic wastes for offsite disposal.

Stewardship of the NTS

Facilities and Infrastructure – Maintains the buildings, roads, utilities, and facilities required to support all NTS programs and to provide a safe environment for NTS workers.

1.5 Primary Facilities and Activities

NTS activities in 2008 continued to be diverse, with the primary one being to help ensure that the U.S. stockpile of nuclear weapons remains safe and reliable. Facilities that support this national security mission include the U1a Facility, Big Explosives Experimental Facility, Device Assembly Facility, and Joint Actinide Shock Physics Experimental Research (JASPER) Facility (Figure 1-3). The Radiological/Nuclear Countermeasures Test and Evaluation Complex (RNCTEC) (Figure 1-3) is a new facility to support the Homeland Security Program, which became operational in 2009. Facilities that support the Waste Management Program include the Area 5 Radioactive Waste Management Complex (RWMC) and the Area 3 Radioactive Waste Management Site (RWMS) (Figure 1-3). Other NTS activities include demilitarization activities; controlled spills of hazardous material at the Nonproliferation Test and Evaluation Complex (NPTEC) (Figure 1-3); remediation of industrial sites; processing of waste destined for the Waste Isolation Pilot Plant in Carlsbad, New Mexico, or the Idaho National Laboratory in Idaho Falls, Idaho; disposal of radioactive and mixed waste; and environmental research. Land use by each of the NTS missions occurs within zones designated by the land-use map shown in Figure 1-4. It is the resultant Record of Decision land-use map for the 1996 programmatic NTS Environmental Impact Statement (DOE, 1996), as depicted in the NTS Resource Management Plan (U.S. Department of Energy, Nevada Operations Office [DOE/NV], 1998).

1.6 Scope of Environmental Report

This report summarizes data and the compliance status of the environmental protection and monitoring programs for calendar year (CY) 2008 at the NTS and its two support facilities, the NLVF and RSL-Nellis. This report also addresses environmental restoration (ER) projects conducted at the Tonopah Test Range (TTR) (see Figure 1-1). Through a Memorandum of Agreement, NNSA/NSO is responsible for the oversight of TTR ER projects, and the Sandia Site Office of NNSA (NNSA/SSO) has oversight of all other TTR activities. NNSA/SSO produces the TTR annual site environmental reports (e.g., Sandia National Laboratories, 2008), which are posted at http://www.sandia.gov/news/publications/environmental/index.html.

Figure 1-3. NTS operational areas, principal facilities, and past nuclear testing areas

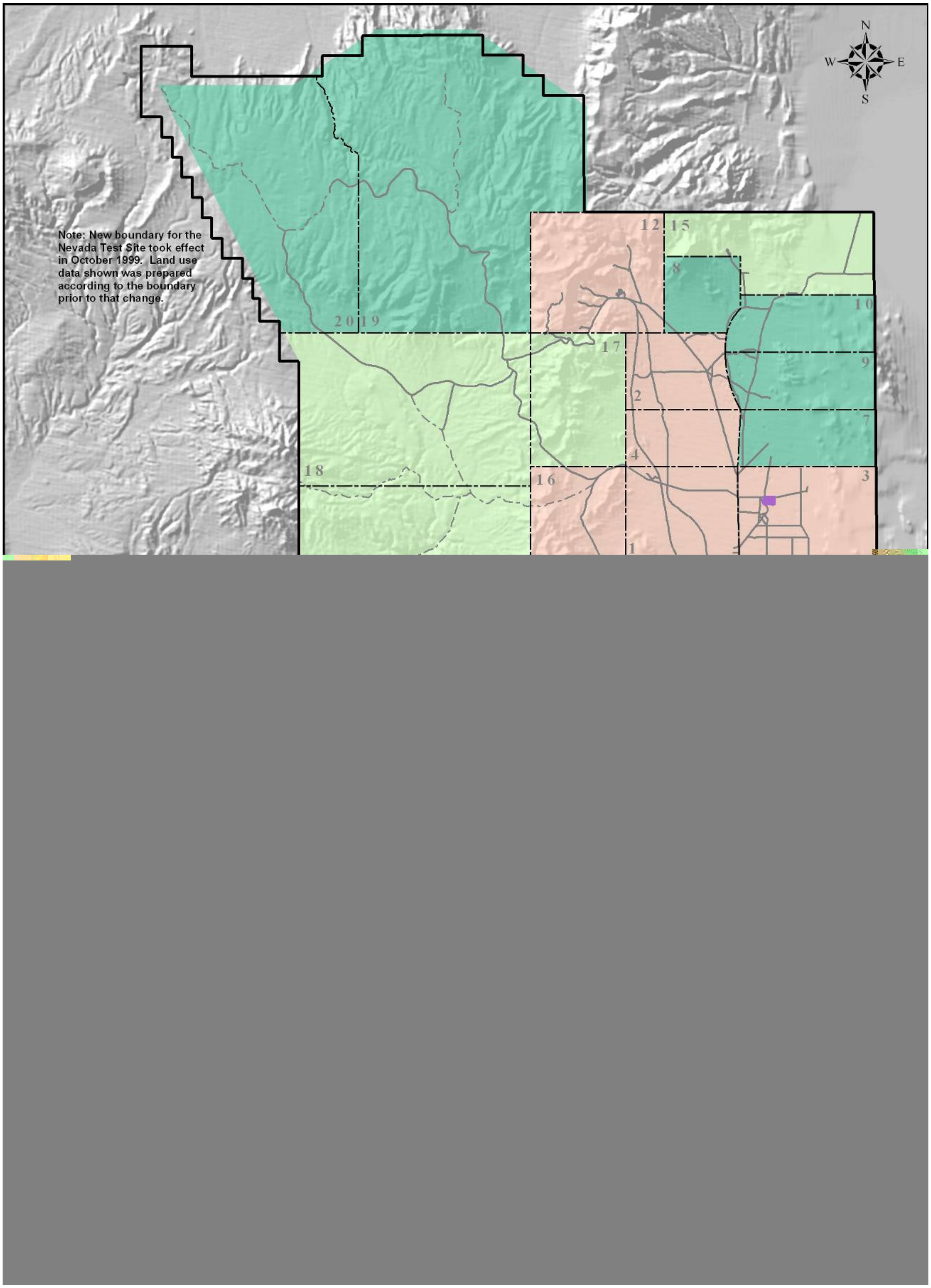

Figure 1-4. NTS land-use map (Source: DOE/NV, 1998)

1.7 Populations near the NTS

The population of the area surrounding the NTS (see Figure 1-1) is predominantly rural. Population estimates for Nevada communities are provided by the Nevada State Demographer's Office (Hardcastle, 2009). The 2008 population estimate for Nye County is 47,370, and the largest Nye County community is Pahrump (38,882), located approximately 80 km (50 mi) south of the NTS Control Point facility near the center of the NTS. Other Nye County communities include Tonopah (2,628), Amargosa (1,521), Beatty (1,024), Round Mountain (850), Gabbs (332), and Manhattan (138). Lincoln County to the east of the NTS includes a few small communities including Caliente (1,089), Pioche (791), Panaca (595), and Alamo (427). Clark County, southeast of the NTS, is the major population center of Nevada and has an estimated population of 1,867,716. The total annual population estimate for all Nevada counties, cities, and unincorporated towns is 2,783,733.

The Mojave Desert of California, which includes Death Valley National Park, lies along the southwestern border of Nevada. This area is still predominantly rural; however, tourism at Death Valley National Park swells the population to more than 5,000 on any particular day during holiday periods when the weather is mild.

The extreme southwestern region of Utah is more developed than the adjacent portion of Nevada. The population estimates for Utah communities are based on projections for the year 2006 by the Utah Population Estimates Committee (2009) of the Governor's Office of Planning and Budget. The largest community is St. George, located 220 km (137 mi) east of the NTS, with an estimated population of 67,614. The next largest town, Cedar City, is located 280 km (174 mi) east-northeast of the NTS and has an estimated population of 25,665.

The northwestern region of Arizona is mostly rangeland except for that portion in the Lake Mead recreation area. In addition, several small communities lie along the Colorado River. The largest towns in the area are Bullhead City, 165 km (103 mi) south-southeast of the NTS, with an estimated population of 41,187, and Kingman, 280 km (174 mi) southeast of the NTS, with an estimated population of 28,823 (Arizona Workforce Informer, 2009).

1.8 Understanding Data in this Report

1.8.1 Scientific Notation

Scientific notation is used in this report to express very large or very small numbers. A very small number is expressed with a negative exponent, for example 2.0×10^{-5}. To convert this number from scientific notation to a more traditional number, the decimal point must be moved left by the number of places equal to the exponent (5 in this case). The number thus becomes 0.00002.

Very large numbers are expressed in scientific notation with a positive exponent. The decimal point should be moved to the right by the number of places equal to the exponent. The number 1,000,000,000 could be presented in scientific notation as 1.0×10^{9}.

1.8.2 Unit Prefixes

Units for very small and very large numbers are commonly expressed with a prefix. The prefix signifies the amount of the given unit. For example, the prefix k, or kilo-, means 1,000 of a given unit. Thus 1 kg (kilogram) is 1,000 g (grams). Other prefixes used in this report are listed in Table 1-1.

Table 1-1. Unit prefixes

Prefix	Abbreviation	Meaning
mega-	M	1,000,000 (1×10^{6})
kilo-	k	1,000 (1×10^{3})
centi-	c	0.01 (1×10^{-2})
milli-	m	0.001 (1×10^{-3})
micro-	µ	0.000001 (1×10^{-6})
nano-	n	0.000,000,1 (1×10^{-9})
pico-	p	0.000,000,000,0001 (1×10^{-12})

1.8.3 Units of Radioactivity

Much of this report deals with levels of radioactivity in various environmental media. The basic unit of radioactivity used in this report is the curie (Ci) (Table 1-2). The curie describes the amount of radioactivity present, and amounts are usually expressed in terms of fractions of curies in a given mass or volume (e.g., picocuries per liter). The curie is historically defined as the rate of nuclear disintegrations that occur in 1 g of the radionuclide radium-226, which is 37 billion nuclear disintegrations per second. For any other radionuclide, 1 Ci is the quantity of the radionuclide that decays at this same rate. Nuclear disintegrations produce spontaneous emissions of alpha or beta particles, gamma radiation, or combinations of these.

Table 1-2. Units of radioactivity

Symbol	Name
Ci	curie
cpm	counts per minute
mCi	millicurie (1 x 10^{-3} Ci)
µCi	microcurie (1 x 10^{-6} Ci)
nCi	nanocurie (1 x 10^{-9} Ci)
pCi	picocurie (1 x 10^{-12} Ci)
aCi	attocurie (1 x 10^{-18} Ci)

1.8.4 Radiological Dose Units

The amount of ionizing radiation energy absorbed by a living organism is expressed in terms of radiological dose. Radiological dose in this report is usually written in terms of effective dose equivalent and reported numerically in units of millirem (mrem) (Table 1-3). Millirem is a term that relates ionizing radiation to biological effect or risk to humans. A dose of 1 mrem has a biological effect similar to the dose received from an approximate one-day exposure to natural background radiation. An acute (short-term) dose of 100,000 to 400,000 mrem can cause radiation sickness in humans. An acute dose of 400,000 to 500,000 mrem, if left untreated, results in death approximately 50 percent of the time. Exposure to lower amounts of radiation (1,000 mrem or less) produces no immediate observable effects, but long-term (delayed) effects are possible. The average person in the United States receives an annual dose of approximately 300 mrem from exposure to naturally produced radiation. Medical and dental X-rays, air travel, and tobacco smoking add to this total.

Table 1-3. Units of radiological dose

Symbol	Name
mrad	millirad (1 x 10^{-3} rad)
mrem	millirem (1 x 10^{-3} rem)
R	roentgen
mR	milliroentgen (1 x 10^{-3} R)
µR	microroentgen (1 x 10^{-6} R)

The unit "rad," for radiation absorbed dose, is also used in this report. The rad is a measure of the energy absorbed by any material, whereas a "rem," for roentgen equivalent man, relates to both the amount of radiation energy absorbed by humans and its consequence. A roentgen (R) is a measure of radiation exposure. Generally speaking, 1 R of exposure will result in an effective dose equivalent of 1 rem. Additional information on radiation and dose terminology can be found in the Glossary (Appendix B).

1.8.5 International System of Units for Radioactivity and Dose

In some instances in this report, radioactivity and radiological dose values are expressed in other units in addition to Ci and rem. These units are the becquerel (Bq) and the sievert (Sv), respectively. The Bq and Sv belong to the International System of Units (SI), and their inclusion in this report is mandated by DOE. SI units are the internationally accepted units and may eventually be the standard for reporting both radioactivity and radiation dose in the United States. One Bq is equivalent to one nuclear disintegration per second.

The unit of radiation absorbed dose (rad) has a corresponding SI unit called the gray (Gy). The roentgen measure of radiation exposure has no SI equivalent. Table 1-4 provides the multiplication factors for converting to and from SI units.

Table 1-4. Conversion table for SI units

To Convert From	To	Multiply By
becquerel (Bq)	picocurie (pCi)	27
curie (Ci)	becquerel (Bq)	3.7 x 10^{10}
gray (Gy)	rad	100
mrem	msievert (mSv)	0.01
msievert (mSv)	mrem	100
picocurie (pCi)	becquerel (Bq)	0.03704
rad	gray (Gy)	0.01
sievert (Sv)	rem	100

1.8.6 Radionuclide Nomenclature

Radionuclides are frequently expressed with the one- or two-letter chemical symbol for the element. Radionuclides may have many different isotopes, which are shown by a superscript to the left of the symbol. This number is the atomic weight of the isotope (the number of protons and neutrons in the nucleus of the atom). Radionuclide symbols, many of which are used in this report, are shown in Table 1-5 along with the half-life of each radionuclide. The half-life is the time required for one-half of the radioactive atoms in a given amount of material to decay. For example, after one half-life, half of the original atoms will have decayed; after two half-lives, three-fourths of the original atoms will have decayed; and after three half- lives, seven-eighths of the original atoms will have decayed, and so on. The notation $^{236+238}$Ra and similar notations in this report (e.g., $^{239+240}$Pu) are used when the analytical method does not distinguish between the isotopes, but reports the total amount of both.

Table 1-5. Radionuclides and their half-lives

Symbol	Radionuclide	Half-Life [(a)]
^{241}Am	americium-241	432.2 yr
^{7}Be	beryllium-7	53.44 d
^{14}C	carbon-14	5,730 yr
^{134}Cs	cesium-134	2.1 yr
^{137}Cs	cesium-137	30 yr
^{51}Cr	chromium-51	27.7 d
^{60}Co	cobalt-60	5.3 yr
^{152}Eu	europium-152	13.3 yr
^{154}Eu	europium-154	8.8 yr
^{155}Eu	europium-155	5 yr
^{3}H	tritium	12.35 yr
^{129}I	iodine-129	1.6 x 10^7 yr
^{131}I	iodine-131	8 d
^{40}K	potassium-40	1.3 x 10^8yr
^{85}Kr	krypton-85	10^7 yr
^{212}Pb	lead-212	10.6 hr
^{238}Pu	plutonium-238	87.7 hr
^{239}Pu	plutonium-239	2.4 x 10^4 yr
^{240}Pu	plutonium-240	6.5 x 10^3 yr
^{241}Pu	plutonium-241	14.4 yr
^{226}Ra	radium-226	1.62 x 10^3 yr
^{228}Ra	radium-228	5.75 yr
^{220}Rn	radon-220	56 s
^{222}Rn	radon-222	3.8 d
^{103}Ru	ruthenum-103	39.3 d
^{106}Ru	ruthenum-106	368.2 d
^{125}Sb	antimony-125	2.8 yr
^{113}Sn	tin-113	115 d
^{90}Sr	strontium-90	29.1 yr
^{99}Tc	technetium-99	2.1 x 10^5 yr
^{232}Th	thorium-232	1.4 x 10^{10} yr
U [(b)]	uranium total	- - - [(c)]
^{234}U	uranium-234	2.4 x 10^5 yr
^{235}U	uranium-235	7 x 10^8 hr
^{238}U	uranium-238	4.5 x 10^9 yr
^{65}Zn	zinc-65	243.9 d
^{95}Zr	zirconium-95	63.98 d

(a) From Shleien, 1992
(b) Total uranium may also be indicated by U-natural (U-nat) or U-mass
(c) Natural uranium is a mixture dominated by ^{238}U; thus, the half-life is approximately 4.5 x 10^9 years

1.8.7 Units of Measurement

Both metric and non-metric units of measurement are used in this report. Metric system and U.S. customary units and their respective equivalents are shown in Table 1-6 on the following page.

1.8.8 Measurement Variability

There is always uncertainty associated with the measurement of environmental contaminants. For radioactivity, a major source of uncertainty is the inherent randomness of radioactive decay events.

Uncertainty in analytical measurements is also the consequence of variability related to collecting and analyzing the samples. This variability is associated with reading or recording the result, handling or processing the sample, calibrating the counting instrument, and numerical rounding.

The uncertainty of a measurement is denoted by following the result with an uncertainty value which is preceded by the plus-or-minus symbol, ±. This uncertainty value gives information on what the measurement might be if the same sample were analyzed again under identical conditions. The uncertainty value implies that approximately 95 percent of the time, the average of many measurements would give a value somewhere between the reported value minus the uncertainty value and the reported value plus the uncertainty value.

If the reported concentration of a given constituent is smaller than its associated uncertainty (e.g., 40 ± 200), then the sample may not contain that constituent. Such low concentration values are considered to be below detection, meaning the concentration of the constituent in the sample is so low that it is undetected by the method and/or instrument.

Table 1-6. Metric and U.S. customary unit equivalents

Metric Unit	U.S. Customary Equivalent Unit	U.S. Customary Unit	Metric Equivalent Unit
Length			
1 centimeter (cm)	0.39 inches (in.)	1 inch (in.)	2.54 centimeters (cm)
1 millimeter (mm)	0.039 inches (in.)		25.4 millimeters (mm)
1 meter (m)	3.28 feet (ft)	1 foot (ft)	0.3048 meters (m)
	1.09 yards (yd)	1 yard (yd)	0.9144 meters (m)
1 kilometer (km)	0.62 miles (mi)	1 mile (mi)	1.6093 kilometers (km)
Volume			
1 liter (L)	0.26 gallons (gal)	1 gallon (gal)	3.7853 liters (L)
1 cubic meter (m^3)	35.32 cubic feet (ft^3)	1 cubic foot (ft^3)	0.028 cubic meters (m^3)
	1.35 cubic yards (yd^3)	1 cubic yard (yd^3)	0.765 cubic meters (m^3)
Weight			
1 gram (g)	0.035 ounces (oz)	1 ounce (oz)	28.6 gram (g)
1 kilogram (kg)	2.21 pounds (lb)	1 pound (lb)	0.373 kilograms (kg)
1 metric ton (mton)	1.10 short ton (2,000 lb)	1 short ton (2,000 lb)	0.90718 metric ton (mton)
Geographic area			
1 hectare	2.47 acres	1 acre	0.40 hectares
Radioactivity			
1 becquerel (Bq)	2.7×10^{-11} curie (Ci)	1 curie (Ci)	3.7×10^{-10} becquerel (Bq)
Radiation dose			
1 rem	0.01 sievert (Sv)	1 sievert (Sv)	100 rem
Temperature			
°C = (°F – 32)/1.8		°F = (°C x 1.8) + 32	

1.8.9 Mean and Standard Deviation

The mean of a set of data is the usual average of those data. The standard deviation (SD) of sample data relates to the variation around the mean of a set of individual sample results; it is defined as the square root of the average squared difference of individual data values from the mean. This variation includes both measurement variability and actual variation between monitoring periods (weeks, months, or quarters, depending on the particular analysis). The sample mean and standard deviation are estimates of the average and the variability that would be seen in a large number of repeated measurements. If the distribution shape were “normal” (i.e., shaped as ), about 67 percent of the measurements would be within the mean ± SD, and 95 percent would be within the mean ± 2 SD.

1.8.10 Standard Error of the Mean

Just as individual values are accompanied by counting uncertainties, mean values (averages) are accompanied by uncertainty. The standard deviation of the distribution of sample mean values is known as the standard error of the mean (SE). The SE conveys how accurate an estimate the mean value is based on the samples that were collected and analyzed. The ± value presented to the right of a mean value is equal to 2 x SE (2 multiplied by the SE). The ± value implies that approximately 95 percent of the time the average of many calculated means will fall somewhere between the reported value minus the 2 x SE value and the reported value plus the 2 x SE value.

1.8.11 Median, Maximum, and Minimum Values

Median, maximum, and minimum values are reported in some sections of this report. A median value is the middle value when all the values are arranged in order of increasing or decreasing magnitude. For example, the median value in the series of numbers, 1 2 3 3 4 5 5 5 6, is 4. The maximum value would be 6 and the minimum value would be 1.

1.8.12 Less Than (<) Symbol

The "less than" (<) symbol is used to indicate that the measured value is smaller than the number given. For example, <0.09 would indicate that the measured value is less than 0.09. In this report, < is often used in reporting the amounts of nonradiological contaminants in a sample when the measured amounts are less than the analytical laboratory's reporting limit for that contaminant in that sample. For example, if a measurement of benzene in sewage lagoon pond water is reported as <0.005 milligrams per liter, this implies that the measured amount of benzene present, if any, was not found to be above this level, given the sample and analysis methods used. For some constituents the notation "ND" is also used to indicate that the constituent in question was not detected. For organic constituents, in particular, this could mean that the compound could not be clearly identified, the level (if any) was lower than the reporting limit, or (as often happens) both. The measurements of radionuclide concentrations are reported whether or not they are below the usual reporting limit (the minimum detectable concentration [see Glossary, Appendix B]).

1.8.13 Negative Radionuclide Concentrations

There is always a small amount of natural radiation in the environment. The instruments used in the laboratory to measure radioactivity in environmental media are sensitive enough to measure the natural, or background, radiation along with any contaminant radiation in a sample. To obtain an unbiased measure of the contaminant level in a sample, the natural, or background, radiation level must be subtracted from the total amount of radioactivity measured by an instrument. Because of the randomness of radioactive emissions and the very low concentrations of some contaminants, it is possible to obtain a background measurement that is larger than the actual contaminant measurement. When the larger background measurement is subtracted from the smaller contaminant measurement, a negative result is generated. The negative results are reported because they are useful when conducting statistical evaluations of the data.

1.8.14 Understanding Graphic Information

Some of the data graphed in this report are plotted using logarithmic (log) scales. Log scales are used in plots where the values are of widely different magnitudes at different locations and/or different times. Log scales use equal distances to represent equal *ratios* of values, whereas in linear scales equal distances represent equal *differences* in values. For example, a log scale would use the same distance to represent a change from 2 to 4 as a change from 10 to 20 or a change from 700 to 1,400.

For example, Figure 1-5 is the same as Figure 3-9 in Chapter 3, which shows long-term trends in annual tritium (^{3}H) concentrations in air samples at locations with extended histories, using the original scale. In order to allow the Schooner data to be represented on the same plot as the data from the other stations with lower concentrations, the Schooner data are divided by 10 and the reference line is one percent of the compliance level (CL) (see Glossary, Appendix B). The alternate presentation in Figure 1-6 uses a log scale, which allows all stations to be represented at their actual measured values and the actual CL to be included.

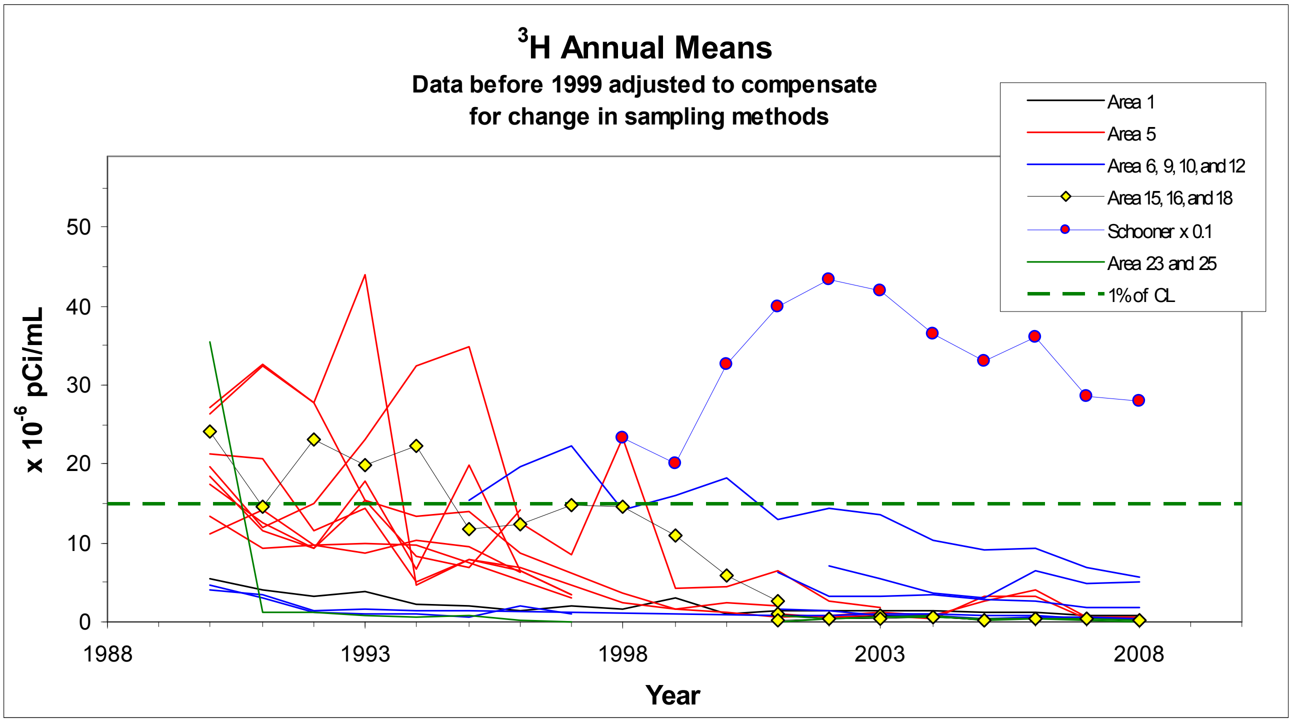

Figure 1-5. Data plotted using a linear scale

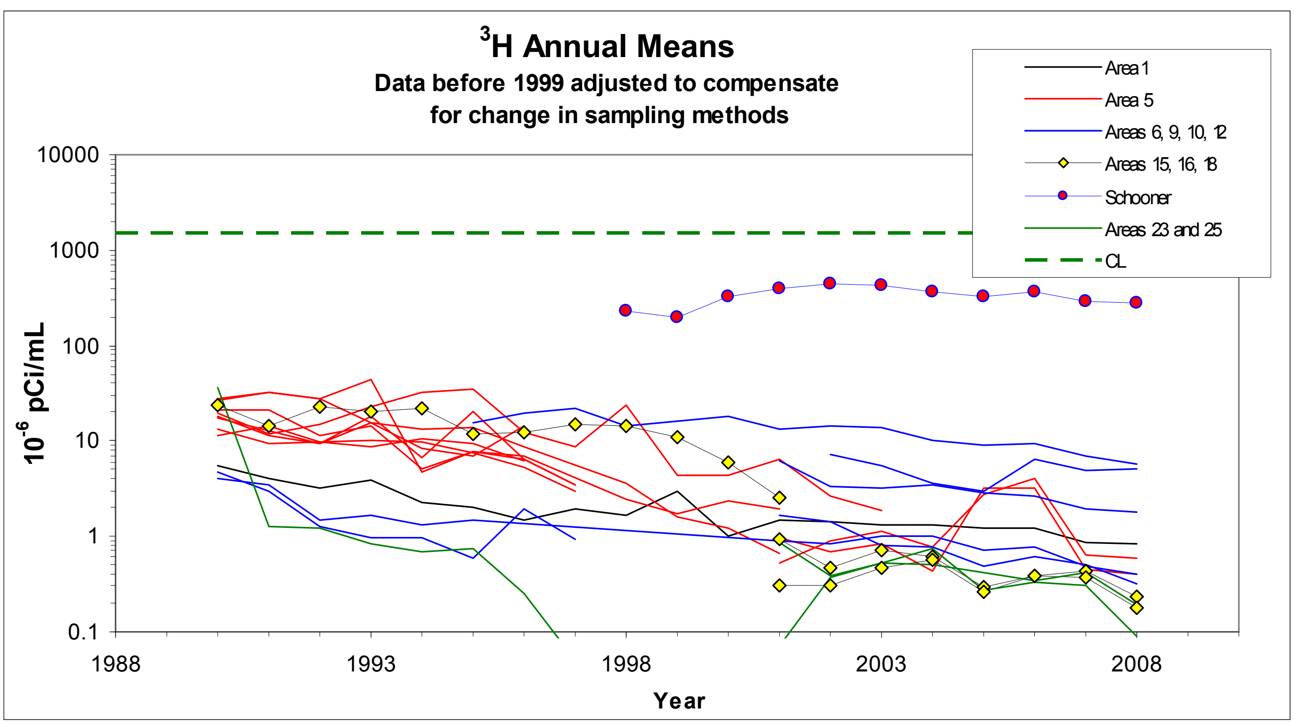

Figure 1-6. Data plotted using a log scale

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2.0 Compliance Summary

Environmental regulations pertinent to operations on the Nevada Test Site (NTS), the North Las Vegas Facility (NLVF), and the Remote Sensing Laboratory (RSL)–Nellis are listed in this chapter. They include federal and state laws, state permit requirements, Executive Orders (EOs), U.S. Department of Energy (DOE) orders, and state agreements. They dictate how the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) conducts operations on and off the NTS to ensure the protection of the environment and the public. The regulations are grouped by topic, and each topical subsection contains a summary description of noncompliance incidents, if any, a listing of compliance reports generated during or for the reporting year, and a compliance status table. Each table lists those measures or actions that are tracked or performed to ensure compliance with a regulation. A description of the field monitoring efforts, actions, and results that support the data in each table is found in subsequent chapters of this document, as noted in the "Reference Section" column of each table. At the end of this chapter, Table 2-11 presents the list of all environmental permits issued for the NTS and the two Las Vegas area facilities.

2.1 Air Quality

2.1.1 Applicable Regulations

Clean Air Act (CAA), National Emission Standards for Hazardous Air Pollutants (NESHAP) – Title III of the CAA establishes NESHAP to control those pollutants that might reasonably be anticipated to result in either an increase in mortality or an increase in serious irreversible or incapacitating but reversible illness. Industry-wide national emissions standards were developed for 22 of 189 designated hazardous air pollutants (HAPs). Radionuclides and asbestos are among the 22 HAPs for which standards were established. NNSA/NSO NESHAP compliance activities are limited to radionuclide air monitoring and reporting/notification of asbestos abatement.

CAA, National Ambient Air Quality Standards (NAAQS) – Title I of the CAA establishes the NAAQS to limit levels of pollutants in the air for six "criteria" pollutants: sulfur dioxide, nitrogen oxides, carbon monoxide, ozone, lead, and particulate matter. Title V of the CAA authorizes states to implement permit programs to regulate emissions of these pollutants. At the NTS, there is one main air quality permit. The permit's emission limits (except ozone and lead) are based on published emission values for other similar industries and on operational data specific to the NTS. Emissions from operations at the NTS are calculated and submitted each year to the State. Lead emissions are reported to the State as part of the total HAPs emissions. The NTS air permit also specifies visible emissions (opacity) limits for equipment/facilities as well as requirements for recordkeeping, performance testing, opacity field monitoring, particulate monitoring, and monitoring personnel certification. NLVF and RSL-Nellis operate under air quality permits that require annual reporting of hours of operation, emission quantities of criteria pollutants and HAPs, and summaries of significant malfunctions and repairs.

CAA, New Source Performance Standards (NSPS) –Title I of the CAA establishes the NSPS to set minimum nationwide emission limitations for air pollutants from various industrial categories of facilities. NSPS pollutants are acid mist, carbon monoxide, particulate matter, fluorides, hydrogen sulfide in acid gas, lead, nitrogen oxides, sulfur oxides, total reduced sulfur, and volatile organic compounds. The NSPS impose more stringent standards, including a reduced allowance of visible emissions (opacity), than under NAAQS. On the NTS, some screens, conveyor belts, and bulk fuel storage tanks are subject to the NSPS, which Nevada regulates under Nevada Administrative Code (NAC) 445B. No offsite facilities are subject to the NSPS.

CAA, Stratospheric Ozone Protection – Title VI of the CAA establishes production limits and a schedule for the phase-out of ozone-depleting substances (ODS). The U.S. Environmental Protection Agency (EPA) has established regulations for ODS recycling during servicing and disposal of air conditioning and refrigeration equipment, for repairing leaks in such equipment, and for safe ODS disposal. While there are no reporting requirements, recordkeeping to document the usage of ODS and technician certification is required, and the EPA may conduct random inspections to determine compliance. At the NTS, ODS are mainly used in air conditioning units in vehicles, buildings, refrigerators, drinking water fountains, vending machines, and laboratory equipment.

Other Air Quality Requirements –Title V, Part 70 of the CAA requires owners or operators of air emission sources to pay annual state fees. Fees are based on a source's "potential to emit" and range from $500 for a Class II source that may emit less than 25 tons per year of any regulated air pollutant except carbon monoxide, to a maximum of $5,000 per year for a Class II source that may emit 80–100 tons or more of any regulated air pollutant except carbon monoxide. NTS operations are subject to these fees. In addition, NNSA/NSO must allow Nevada's Bureau of Air Pollution Control (BAPC) to conduct inspections of permitted NTS facilities and allow the Clark County Department of Air Quality and Environmental Management (DAQEM) to conduct inspections of NLVF and RSL-Nellis permitted equipment.

Section VII of the NTS Class II Air Quality Operating Permit requires implementation of an ongoing program to control fugitive dust using the best practicable methods.

Nevada regulations prohibit the open burning of combustible refuse and other materials unless specifically exempted by an authorized variance (NAC 445B.22067). At the NTS, Open Burn Variances are routinely obtained for various fire training and emergency management exercises.

2.1.2 Compliance Issues

In November 2008, NNSA/NSO received a Letter of Noncompliance from the Clark County DAQEM. DAQEM personnel inspected the RSL-Nellis facility and determined that two cooling towers were being operated without an air permit. An application to modify the permit to add the cooling towers was submitted to Clark County DAQEM on December 16, 2008 (see Appendix A, Section A.2.2).

2.1.3 Compliance Reports

The following reports were generated for 2008 NTS operations in compliance with air quality regulations:

- *National Emission Standards for Hazardous Air Pollutants, Calendar Year 2008*, submitted to EPA Region IX (Warren and Grossman, 2009)
- *Annual Asbestos Abatement Notification Form*, submitted to EPA Region IX
- *Calendar Year 2008 Actual Production/Emissions Reporting Form,* submitted to the Nevada Division of Environmental Protection (NDEP)
- Quarterly Class II Air Quality Reports, submitted to NDEP
- Nonproliferation Test and Evaluation Complex (NPTEC) Pre-test and Post-test Reports, submitted to NDEP

The following reports were generated for 2008 operations at offsite facilities in compliance with air quality regulations:

- *Clark County Air Emission Inventory for North Las Vegas Facility,* submitted to Clark County DAQEM
- *Clark County Air Emissions Inventory for Remote Sensing Laboratory,* submitted to Clark County DAQEM

Table 2-1. NTS compliance status with applicable air quality regulations

Compliance Measure/Actions	Compliance Limit	2008 Compliance Status	Section Reference [(a)]
Clean Air Act – NESHAP			
Annual dose equivalent from all radioactive air emissions	10 mrem/yr [(b)] (0.1 mSv/yr)	Compliant	3.1.5
Notify EPA Region IX if the number of linear feet (ft) or square feet (ft^2) of asbestos to be removed from a facility exceeds limit	260 linear ft or 160 ft^2 [(c)]	Compliant	3.2.8
Maintain asbestos abatement plans, data records, activity/ maintenance records	For up to 75 years	Compliant	3.2.8
Clean Air Act – NAAQS			
Submit quarterly reports of calculated emissions at the NTS to the State	Due 30 days after end of quarter	Compliant	3.2.1
Submit annual report of calculated emissions at the NTS to the State	Due March 1	Compliant	3.2.1
Tons of emissions of each criteria pollutant produced by permitted equipment/facility at the NTS based on calculations	PTE [(d)] varies	Compliant	3.2.1; Table 3-14
Conduct and pass performance emission tests on permitted equipment	Test after 100 hours of operation, emission limits vary	Compliant	3.2.2
Number of gallons of fuel used, hours of operation, and rate of aggregate/concrete production by permitted equipment/facility at the NTS	Limit varies [(e)]	Compliant	3.2.3
Conduct opacity readings from permitted equipment/facility	Quarterly	Compliant	3.2.4
Percent opacity of emissions from permitted equipment/facility at the NTS	20%	Compliant	3.2.4
Conduct particulate monitoring for NPTEC and BEEF releases/detonations	Per test	Compliant	3.2.5
Submit test plans/final analysis reports for each chemical release test at NPTEC or elsewhere on NTS	Test plans due ≥ 30 days prior to test. Final reports due ≤ 30 days from end of each quarter	Compliant	3.2.5; Table 3-16; Table 3-17
Submit annual report of calculated emissions at the NLVF and the RSL-Nellis to Clark County	Due March 31	Compliant	Appendix A, A.1.3; A.3.2
Tons of emissions of each criteria pollutant produced by permitted equipment/facility at NLVF and RSL-Nellis based on calculations	PTE [(d)] varies	Compliant	Appendix A, Table A-5; Table A-9

Table 2-1. NTS compliance status with applicable air quality regulations (continued)

Compliance Measure/Actions	Compliance Limit	2008 Compliance Status	Section Reference[a]
Clean Air Act - NSPS			
Conduct opacity readings from permitted equipment/facility	Quarterly	Compliant	3.2.4
Percent opacity of emissions from permitted equipment/facility	10%	Compliant (No permitted equipment used)	3.2.4
Clean Air Act - Stratospheric Ozone Protection			
Maintain ODS technician certification records, approvals for ODS-containing equipment recycling/recovery, and applicable equipment servicing records	NA[f]	Compliant	3.2.7
Other Nevada Air Quality Permit Regulations			
Control fugitive dust for land disturbing activities	NA	Compliant	3.2.9
Allow Nevada BAPC personnel access to the NTS and Clark County DAQEM personnel access to the NLVF and RSL-Nellis to conduct inspections of facilities and operations regulated by state air permits	NA	Clark County DAQEM inspection resulted in a Letter of Noncompliance for operating two cooling towers not included in RSL-Nellis air permit	3.2.2; Appendix A, Section A.2.2

(a) The section(s) within this document that describe how compliance summary data were collected

(b) mrem/yr = millirem per year; mSv/yr = millisievert per year

(c) 260 linear ft or 160 ft^2 = 79.3 linear meters (m) or 14.9 m^2

(d) Potential to emit (PTE) = quantities of criteria pollutants that each facility/piece of equipment would emit annually if it were operated for the maximum number of hours specified in the state air permit

(e) Compliance limit is specific for each piece of permitted equipment/facility

(f) Not applicable

2.2 Water Quality and Protection

2.2.1 Applicable Regulations

Clean Water Act (CWA) – The CWA sets national water quality standards for contaminants in surface waters. It prohibits the discharge of contaminants from point sources to waters of the U.S. without a National Pollutant Discharge Elimination System (NPDES) permit. At the NTS, CWA regulations are followed through compliance with permits issued by NDEP for wastewater discharges. NTS operations do not require any NPDES permits. At the NLVF, an NPDES permit regulates the discharge of pumped groundwater (see Appendix A, Section A.1.1.2).

Safe Drinking Water Act (SDWA) – The SDWA protects the quality of drinking water in the United States and authorizes the EPA to establish safe standards of purity. It requires all owners or operators of public water systems (PWSs) to comply with National Primary Drinking Water Standards (health standards). State governments are authorized to set Secondary Standards related to taste, odor, and visual aspects. NAC 445A ensures that PWSs meet both primary and secondary water quality standards. The SDWA standards for radionuclides currently apply only to PWSs designated as community water systems. The PWSs on the NTS are permitted by the state as non-community water systems. However, all potable water supply wells are monitored on the NTS for radionuclides in compliance with DOE Order DOE O 5400.5, "Radiation Protection of the Public and the Environment" (see Section 2.3).

NAC 445A - Water Controls (Public Water Systems) – Enforces the SDWA requirements and sets standards for permitting, design, construction, operation, maintenance, certification of operators, and water quality of PWSs. The NTS has three PWSs and two potable water hauler trucks, which NDEP regulates through the issuance of permits.

NAC 444 and 445A - Water Controls (Water Pollution Control) – Regulates the collection, treatment, and disposal of wastewater and sewage at the NTS. The requirements of this state regulation are issued in permits to NNSA/NSO for the E-Tunnel Waste Water Disposal System, 2 active and 9 inactive sewage lagoons, 23 septic tanks, 5 septic tank pumpers, and 1 septic tank pumping contractor's license. NNSA/NSO also obtains underground injection control (UIC) permits from NDEP for tracer tests in Underground Test Area (UGTA) Sub-Project characterization wells.

NAC 534 - Nevada Division of Water Resources Regulations for Water Well and Related Drilling – This NAC regulates the drilling, construction, and licensing of new wells and the reworking of existing wells to prevent the waste of underground waters and their contamination. NNSA/NSO complies with this NAC as a matter of comity, holding to the position that state licensing requirements do not apply to the federal government and its contractors as a matter of law under the principle of federal supremacy and associated case law. Two current operations that voluntarily comply with this NAC are the UGTA Sub-Project, which drills new wells and reworks old wells, and the Borehole Management Project, which plugs abandoned NTS boreholes.

UGTA Fluid Management Plan - UGTA Sub-Project wells are regulated by the State through an agreement between NNSA/NSO and the NDEP called the UGTA Fluid Management Plan. The plan is followed in lieu of following separate state-issued water pollution control permits for each UGTA characterization well. Such permits ensure compliance with the CWA. The plan prescribes the methods of disposing groundwater pumped from UGTA wells during drilling, development, and testing based on the levels of radiological contamination. This plan is Attachment I of the UGTA Sub-Project Waste Management Plan (U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office, 2002)

2.2.2 Compliance Issues

In June 2007, xylene was detected in a water sample from the Mercury North Tank, a point of entry for the Area 23 and 6 PWS. The detection, above 0.0005 milligrams per liter (mg/L), should have triggered quarterly sampling to determine if the xylene concentration reflected a real presence of the contaminant or an anomalous analytical result. Quarterly monitoring was not initiated until June 2008. Quarterly sampling continued throughout the remainder of 2008 and into January 2009. Xylene was undetectable or below 0.0005 mg/L in all of the additional samples. NDEP determined that the failure to initiate quarterly sampling in 2007 did not warrant issuing a Notice of Alleged Violation and/or imposing fines (see Section 4.2.1.2).

2.2.3 Compliance Reports

The following reports were generated for NTS operations in 2008 in compliance with water quality regulations:

- *Quarterly Monitoring Report for Nevada Test Site Sewage Lagoons*, submitted to NDEP
- Results of water quality analyses for PWS were sent to the State throughout the year as they were obtained from the laboratory
- *Water Pollution Control Permit NEV 96021, Quarterly Monitoring Report* (for first, second, and third quarters of 2008 for E Tunnel effluent monitoring), submitted to NDEP
- *Water Pollution Control Permit NEV 96021, Quarterly Monitoring Report and Annual Summary Report for E-Tunnel Waste Water Disposal System* (National Security Technologies, LLC [NSTec], 2009a)

The following reports were generated for operations at the two offsite facilities in 2008 in compliance with water quality regulations:

- *Self-Monitoring Report for the National Nuclear Security Administration's North Las Vegas Facility: Permit VEH-112*, submitted to the City of North Las Vegas
- Quarterly reports titled *Remote Sensing Laboratory Self Monitoring Report - Permit No. CCWRD-080*, submitted to the Clark County Water Reclamation District
- Two monitoring reports titled *Remote Sensing Laboratory Additional Monitoring Reports - Permit No. CCWRD-080*, submitted to the Clark County Water Reclamation District

Table 2-2. NTS compliance status with applicable water quality and protection regulations

Compliance Measure/Action	Compliance Limit	2008 Compliance Status	Section Reference[(a)]
Safe Drinking Water Act and Nevada Water Controls (NAC 445A - Water Controls - Public Water Systems)			
Number of water samples containing coliform bacteria	1 per month per PWS	Compliant	4.2.1; Table 4-10
Concentration of inorganic, organic, and microbial contaminants and disinfection byproducts in permitted NTS PWSs	Limit varies	Compliant	4.2.1; Table 4-10
Adhere to design, construction, maintenance, and operation regulations specified by permits	NA[(d)]	Compliant	- -
Allow NDEP access to conduct inspections of PWS and water hauling trucks	NA	Compliant	4.2.1
Clean Water Act - NPDES/State Pollutant Discharge Elimination System Permits			
Measure and report volume of pumped groundwater discharged at the NLVF	NA	Compliant	Appendix A, A.1.1.2; Table A-3
Clean Water Act and Nevada Water Pollution Controls - Sewage Disposal (NAC 444 – Sewage Disposal)			
Adhere to all design/construction/operation requirements for new systems and those specified in septic system permits, septic tank pump truck permits, and septic tank pumping contractor permit	NA	Compliant	4.2.2; 4.2.3
Clean Water Act and Nevada Water Pollution Controls (NAC 445A - Water Pollution Controls)			
Value of 5-day biological oxygen demand (BOD_5), total suspended solids (TSS), and pH in one sewage lagoon water sample sampled quarterly	BOD_5: varies TSS: no limit pH: 6.0–9.0 S.U.	Compliant	4.2.3.1; Table 4-11
Concentration of 29 contaminants in the filtrate from one sewage lagoon sample collected annually from each of two permitted facilities	Limit varies	Compliant	4.2.3.2; Table 4-12
Inspection by operator of active sewage lagoon systems	Weekly	Compliant	4.2.3.3
Inspection by operator of inactive sewage lagoon systems	Quarterly	Compliant	4.2.3.3
Submit quarterly monitoring reports for 2 active sewage lagoons (for Areas 6 and 23)	Due end of January, April, July, and October	Compliant	- -
Allow NDEP access to conduct inspections of active sewage lagoon systems	NA	Compliant	4.2.3.3

Table 2-2. NTS compliance status with applicable water quality and protection regulations (continued)

Compliance Measure/Action	Compliance Limit	2008 Compliance Status	Section Reference[(a)]
Clean Water Act and Nevada Water Pollution Controls (NAC 445A - Water Pollution Controls) (continued)			
Concentrations of tritium (^{3}H), gross alpha (α), gross beta (β), (in picocuries per liter [pCi/L]), and 14 nonradiological contaminants/water quality parameters in E Tunnel effluent water samples collected quarterly	^{3}H: 1,000,000 pCi/L α: 35 pCi/L β: 100 pCi/L Non-rad: Limit varies	Compliant	4.1.8; Table 4-5
Concentrations of ^{3}H, α, β, and 17 water chemistry parameters in well ER-12-1 water samples collected every 24 months	^{3}H: 20,000 pCi/L α: 15 pCi/L β: 50 pCi/L Non-rad: Limit varies	Compliant	4.1.8, Table 4-5; 4.2.4; Table 4-13
Concentrations of 18 contaminants in water samples from three NLVF sewage outfalls and all sludge and liquid samples from the NLVF sand/oil interceptor	Limit varies	Compliant	Appendix A, A.1.1.1; Table A-2
Concentrations of 12 contaminants in water samples from sewage outfall at the RSL-Nellis	Limit varies	Compliant	Appendix A, A.2.1; Table A-8
NAC 534 - Nevada Division of Water Resources Regulations for Water Well and Related Drilling and UGTA Fluid Management Plan			
Maintain state well-drilling license for personnel supervising well construction/reconditioning	NA	Compliant	14.1
For UGTA well drilling fluids, monitor tritium (in pCi/L) and lead levels (in mg/L), manage the fluids, and notify NDEP as required based on the decision criteria limits in the UGTA Fluid Management Plan	Decision Criteria Limits: ^{3}H > 200,000 pCi/L, Lead > 5 mg/L	Compliant	14.1
File notices of intent and affidavits of responsibility for plugging	NA	Compliant	- -
Adhere to well construction requirements/waivers	NA	Compliant	15.3.1
Maintain required records and submit required reports	NA	Compliant	15.3.1

(a) The section(s) within this document that describe how compliance summary data were collected
(b) Not detectable
(c) Compliance limit is specific for each contaminant; see referenced tables for specific limits
(d) Not applicable

2.3 Radiation Dose Protection

2.3.1 Applicable Regulations

Clean Air Act (CAA), National Emission Standards for Hazardous Air Pollutants (NESHAP) – NESHAP (Title 40 Code of Federal Regulations [CFR] Part 61 Subpart H) establishes a radiation dose limit of 10 millirem per year (mrem/yr) (0.1 millisievert per year [mSv/yr]) to individuals in the general public from the air pathway. NESHAP also specifies "Concentration Levels for Environmental Compliance" (abbreviated as compliance levels [CLs]) for radionuclides in air. A CL is the annual average concentration of a radionuclide that could deliver a dose of 10 mrem/yr. The CLs are provided for facilities, such as the NTS, which use air sampling at offsite receptor locations to demonstrate compliance with the NESHAP public radiation dose limit. Sources of radioactive air emissions on the NTS include containment ponds, Area 5 Radioactive Waste Management Complex, Sedan crater, Schooner crater, calibration of analytical equipment, and contaminated soil at nuclear device safety test and atmospheric test locations.

Safe Drinking Water Act (SDWA) – The National Primary Drinking Water Regulations (40 CFR 141), promulgated by the SDWA, require that the maximum contaminate level goal for any radionuclide be zero. But, when this is not possible (e.g., in groundwater containing naturally occurring radionuclides), the SDWA specifies that the concentration of one or more radionuclides should not result in a whole body or organ dose greater than 4 mrem/yr (0.04 mSv/yr). Sources of radionuclide contamination in groundwater at the NTS are the underground nuclear tests detonated near or below the water table.

DOE O 450.1A, "Environmental Protection Program" – Requires federal facilities to (1) conduct environmental monitoring to detect, characterize, and respond to releases from DOE activities, (2) assess impacts, (3) estimate dispersal patterns in the environment, (4) characterize the pathways of exposure to members of the public, (5) characterize the exposures and doses to individuals and to the population, and (6) evaluate the potential impacts to the biota in the vicinity of a DOE activity. Such releases, exposures, and doses apply to radiological contaminants.

DOE O 5400.5, "Radiation Protection of the Public and the Environment" – This order and its flow-down procedural standards establish requirements for (1) measuring radioactivity in the environment, (2) applying the ALARA [as low as reasonably achievable] process to all operations, (3) using mathematical models for estimating radiation doses, (4) releasing property having residual radioactive material, and (5) maintaining records to demonstrate compliance with the requirements. This order sets a radiation dose limit of 100 mrem/yr (1 mSv/yr) above background levels to individuals in the general public from all pathways of exposure combined. It also provides the Derived Concentration Guides (DCGs) for all radionuclides. The DCGs are the annual average concentrations of a radionuclide that could deliver a dose of 100 mrem/yr.

DOE Standard DOE-STD-1153-2002, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota" – Provides methods, computer models, and guidance in implementing a graded approach to evaluating the radiation doses to populations of aquatic animals, terrestrial plants, and terrestrial animals residing on DOE facilities. Dose limits of 1 rad per day (rad/d) (10 milligray [mGy]/d) for terrestrial plants and aquatic animals, and of 0.1 rad/d (1 mGy/d) for terrestrial animals are specified by this DOE standard. Dose rates below these levels are believed to cause no measurable adverse effects to populations of plants and animals.

DOE O 435.1, "Radioactive Waste Management" – Ensures that all DOE radioactive waste is managed in a manner that is protective of the worker, public health and safety, and the environment. It directs how radioactive waste management operations are conducted on the NTS. These requirements are summarized in Section 2.4. The manual for this order (DOE M 435.1-1) specifies that operations at the Area 3 and Area 5 Radioactive Waste Management Sites (RWMSs) must not contribute a dose to the general public in excess of 25 mrem/yr.

2.3.2 Compliance Reports

In compliance with NESHAP under the CAA, the report *National Emission Standards for Hazardous Air Pollutants, Calendar Year 2008*, was submitted to EPA Region IX in June 2009 (Warren and Grossman, 2009). This *Nevada Test Site Environmental Report 2008* was generated to report 2008 compliance with DOE O 5400.5 and DOE-STD-1153-2002.

Table 2-3. NTS compliance status with regulations for radiation protection of the public and the environment

Compliance Measure	Compliance Limit	2008 Compliance Status	Section Reference[a]
Clean Air Act - NESHAP			
Annual dose to the general public from all radioactive air emissions	10 mrem/yr	Compliant	3.1.5
Safe Drinking Water Act			
Annual dose to the general public from drinking water	4 mrem/yr	Compliant[b]	4.1.4; Table 4-1
DOE O 5400.5, "Radiation Protection of the Public and the Environment"			
Annual dose above background levels to the general public from all pathways	100 mrem/yr	Compliant	8.1.7; Table 8-3; Appendix A, A.1.5; Table A-5
Total residual surface contamination of property released offsite (in disintegrations per minute per 100 square centimeters [dpm/100 cm^2])	300–15,000 dpm/100 cm^2 depending on the radionuclide	Compliant	8.1.6
DOE STD 1153-2002, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota"			
Absorbed radiation dose to terrestrial plants	1 rad/d	Compliant	8.2
Absorbed radiation dose to aquatic animals	1 rad/d	Compliant	8.2
Absorbed radiation dose to terrestrial animals	0.1 rad/d	Compliant	8.2
DOE O 435.1, "Radioactive Waste Management"			
Annual dose to the general public due to RWMS operations	25 mrem/yr	Compliant[c]	5.3.2
DOE O 450.1A, "Environmental Protection Program"			
Conduct radiological environmental monitoring	NA[d]	Compliant	3.1; 4.1; 5.0; 6.0; 7.0
Detect and characterize radiological releases	NA	Compliant	3.1; Table 3-13; 4.1; 5.0; 6.0
Characterize pathways of exposure to the public	NA	Compliant	8.1.1
Characterize exposures and doses to individuals, the population, and biota	NA	Compliant	8.1; 8.2

(a) The section(s) within this document that describe how compliance summary data were collected
(b) Migration of radioactivity in groundwater to offsite wells has never been detected
(c) Nearest populations to the Area 3 and 5 RWMSs are Amargosa Valley at 55 kilometers [km] (34 miles [mi]) away and Cactus Springs at 36 km (22 mi) away, respectively. They are too distant to receive any radiation exposure from operations at the sites.
(d) Not applicable

2.4 Radioactive and Nonradioactive Waste Management and Environmental Restoration

2.4.1 Applicable Regulations

10 CFR 830: Nuclear Safety Management – Establishes requirements for the safe management of work at DOE's nuclear facilities. It governs the possession and use of special nuclear and byproduct materials. It also covers activities at facilities where no nuclear material is present, such as facilities that prepare the non-nuclear components of nuclear weapons, but which could cause radiological damage at a later time. It governs the conduct of the management and operating contractor and other persons at DOE nuclear facilities, including facility visitors. When coupled with the Price-Anderson Amendments Act (PAAA) of 1988, it provides DOE with authority to assess civil penalties for violation of rules, regulations, or orders relating to nuclear safety by contractors, subcontractors, and suppliers who are indemnified under PAAA.

DOE O 435.1, "Radioactive Waste Management" – Ensures that all DOE radioactive waste is managed in a manner that is protective of the worker, public health and safety, and the environment. Activities conducted on the NTS subject to this order include (1) characterization of low-level radioactive waste (LLW) and low-level mixed radioactive waste (LLMW) generated by DOE within the state of Nevada; (2) disposal of LLW and LLMW at the Area 3 and Area 5 RWMSs; (3) characterization, visual examination, and repackaging of transuranic (TRU) waste at the Waste Examination Facility south of the Area 5 RWMS; and (4) loading of TRU waste at the Area 5 RWMS for shipment to Idaho National Environmental Engineering Laboratory.

Atomic Energy Act (AEA) of 1954 (42 United States Code Sect. 2011 et seq.) – Ensures the proper management of source, special nuclear, and byproduct material. At the NTS, AEA regulations are followed through compliance with DOE O 435.1 and 10 CFR 830.

Resource Conservation and Recovery Act (RCRA) - 40 CFR Parts 239–282 – RCRA is the nation's primary law governing the management of solid and hazardous waste (HW). RCRA regulates the storage, transportation, treatment, and disposal of such wastes to prevent contaminants from leaching into the environment from landfills, underground storage tanks (USTs), surface impoundments, and hazardous waste disposal facilities. The EPA authorizes the State of Nevada to administer and enforce RCRA regulations. RCRA also requires generators of HWs to have a program in place to reduce the volume or quantity and toxicity of HWs generated. Such NTS programs are addressed in Sections 2.7 and 11.0 on Pollution Prevention and Waste Minimization.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)/Superfund Amendments and Reauthorization Act (SARA) – Provides a framework for the cleanup of waste sites containing hazardous substances and an emergency response program in the event of a release of a hazardous substance to the environment. No HW cleanup operations on the NTS are regulated under CERCLA; they are regulated under RCRA instead. The applicable requirements of CERCLA pertain to an emergency response program for hazardous substance releases (see Emergency Planning and Community Right-to-Know Act in Section 2.5) and to how state laws concerning the removal and remediation of hazardous substances apply to federal facilities (specifically, implementation of the Federal Facility Agreement and Consent Order discussed below).

Federal Facility Compliance Act (FFCA) – Extends the full range of enforcement authorities in federal, state, and local laws for management of HWs to federal facilities. The FFCA of 1992, signed by NNSA/NSO and the State of Nevada, requires the identification of existing quantities for mixed waste, the proposal of methods and technologies of mixed waste treatment and management, the creation of enforceable timetables, and the tracking and completion of deadlines.

Federal Facility Agreement and Consent Order (FFACO), as amended (February 2008) – Pursuant to Section 120(a)(4) of CERCLA and to Sections 6001 and 3004(u) of RCRA, this consent order, agreed to by the state of Nevada, DOE Environmental Management, the U.S. Department of Defense, and DOE Legacy

Management became effective in May 1996. It addresses the environmental restoration of historically contaminated sites at the NTS, parts of Tonopah Test Range, parts of the Nevada Test and Training Range (NTTR), the Central Nevada Test Area, and the Project SHOAL Area. Under the FFACO, hundreds of sites have been identified for cleanup and closure. An individual site is called a Corrective Action Site (CAS). Multiple CASs are often grouped into Corrective Action Units (CAUs). NNSA/NSO is responsible for the CASs included in the UGTA Sub-Project, the Soils Sub-Project and the Industrial Sites Sub-Project, while DOE Legacy Management is responsible for the CASs at the Central Nevada Test Area and the Project SHOAL Area.

Settlement Agreement for Mixed Transuranic Waste – This agreement between NNSA/NSO and the State of Nevada requires NNSA/NSO to operate the Area 5 TRU Storage Pad in accordance with 40 CFR 264 Subpart I. Mixed TRU is stored in compliance with RCRA requirements and weekly inspections are conducted.

Mutual Consent Agreement – This agreement between NNSA/NSO and the State of Nevada covers the storage and management of mixed waste on the NTS that was generated or identified after March 1996. It requires NNSA/NSO to develop and submit specific treatment and disposal plans for mixed waste within nine months of identification.

NAC 444.850–444.8746 - Disposal of Hazardous Waste – Regulates the operation of HW disposal facilities on the NTS to comply with federal RCRA regulations. Through this NAC, a RCRA Part B Permit (NEV HW0021) regulates the operation of the Hazardous Waste Storage Unit (HWSU) in Area 5, the Explosive Ordnance Disposal Unit (EODU) in Area 11, and the disposal of LLMW received from DOE offsite facilities into the Pit 3 Mixed Waste Disposal Unit (P03U). The state permit requires groundwater monitoring of three wells down-gradient of P03U, prescribes post-closure monitoring for HW sites that were closed under RCRA prior to enactment of the FFACO, and requires preparation of an EPA Biennial Hazardous Waste Report of all HW volumes generated annually at NTS and the NLVF.

NAC 444.570–444.7499 - Solid Waste Disposal Controls – This Nevada regulation sets standards for solid waste management systems, including the storage, collection, transportation, processing, recycling, and disposal of solid waste. The NTS has one inactive and four active permitted landfills. Active units include the Area 5 Asbestiform Low-Level Solid Waste Disposal Unit (P06U), Area 6 Hydrocarbon Disposal Site, Area 9 U10c Solid Waste Disposal Site, and Area 23 Solid Waste Disposal Site. These landfills are designed, constructed, operated, maintained, and monitored in adherence to the requirements of their state-issued permits. The Area 5 Asbestiform Low-Level Solid Waste Disposal Unit P07U is inactive.

NAC 459.9921–459.999 - Storage Tanks – Enforces the federal regulations under RCRA pertaining to the maintenance and operation of fuel tanks (including underground fuel storage tanks) so as to prevent environmental contamination. The NTS has five USTs and RSL-Nellis has four USTs. The tanks are either (1) fully regulated under RCRA and registered with the State, (2) regulated under RCRA and registered with the State but deferred from leak detection requirements, or (3) excluded from federal and state regulation. At RSL-Nellis, NDEP allows Clark County to enforce this NAC with the issuance of county permits to NNSA/NSO.

2.4.2 Compliance Reports

The following reports were prepared in 2008 or 2009 to comply with environmental regulations for waste management and environmental restoration operations conducted on the NTS in 2008. All CAU/CAS reports prepared in 2008 as per the FFACO schedule are presented in Table 9-4 of Section 9.4.1.

- *Area 5 Asbestiform Low-Level Solid Waste Disposal Annual Report for CY 2007*, submitted to NDEP
- Quarterly LLW/LLMW Disposal Reports (for all active LLW and LLMW disposal cells), submitted to NDEP each quarter
- *2007 EPA Biennial Hazardous Waste Report for the Nevada Test Site and North Las Vegas Facility*, submitted to NDEP

- *Conditionally Exempt Small Quantity Generator 2008 Hazardous Waste Report* (for the NTS and NLVF), submitted to NDEP
- *Annual Transportation Report for Radioactive Waste Shipments to and from the Nevada Test Site – Fiscal Year 2008* (NNSA/NSO, 2009)
- *Biannual Neutron Monitoring Report for the Nevada Test Site Area 9 10c and Area 6 Hydrocarbon Landfills*
- *Nevada Test Site 2008 Data Report: Groundwater Monitoring Program Area 5 Radioactive Waste Management Site* (NSTec, 2009b)
- *Nevada Test Site 2008 Waste Management Monitoring Report, Area 3 and Area 5 Radioactive Waste Management Sites* (NSTec, 2009c)
- Post-closure monitoring reports for RCRA Part B Permit-identified CAUs
- *January-June 2008 Biannual Solid Waste Disposal Site Report for the Nevada Test Site Area 23 Sanitary Landfill*
- *July-December 2008 Biannual Solid Waste Disposal Site Report for the Nevada Test Site Area 23 Sanitary Landfill*
- *2008 Annual Solid Waste Disposal Site Report for the NTS Area 6 Hydrocarbon Landfill and Area 9 U10c Landfills*

Table 2-4. NTS compliance status with applicable waste management and environmental restoration regulations

Compliance Measure/Action	Compliance Limit	2008 Compliance Status	Section Reference[(a)]
10 CFR 830: Nuclear Safety Management			
Completion and maintenance of proper conduct of operations documents required for Class II Nuclear Facility for disposal/characterization/storage of radioactive waste	Six types of guiding documents required	Compliant	9.1.1; Table 9-1
DOE O 435.1, "Radioactive Waste Management"			
Establishment of Waste Acceptance Criteria for radioactive wastes received for disposal/storage at Area 3 and 5 RWMSs	NA[(b)]	Compliant	9.1.1; Table 9-1

Table 2-4. NTS compliance status with applicable waste management and environmental restoration regulations (continued)

Compliance Measure/Action	Compliance Limit	2008 Compliance Status	Section Reference[a]
Resource Conservation and Recovery Act (as enforced through permits issued by the State of Nevada) (continued)			
Conduct vadose zone monitoring for RCRA closure site U3ax/bl Subsidence Crater	Continuous monitoring using TDR[f] sensors	Compliant	9.4.2
Periodic post-closure site inspection of five historic RCRA closure sites (CAU 90, 91, 92, 110, 112)	NA	Compliant	9.4.2
Upgrade, remove, and report on USTs at NTS and RSL-Nellis	NA	Compliant	9.3; Appendix A, A.2.4
Federal Facility Agreement and Consent Order			
Adherence to calendar year work scope for site characterization, remediation, and closures	23 CAUs identified for some phase of action	Compliant	9.4.1; Table 9-5
Post-closure monitoring and inspections of closed sites	44 CAUs required monitoring/ inspecting	Compliant	9.4.2; Table 9-7
NAC 444.750-8396 - Solid Waste Disposal Controls			
Track weight and volume of waste disposed each calendar year	Area 5 P06U - No limit Area 6 - No limit Area 9 - No limit Area 23 - 20 tons/day	Compliant	9.5.1; Table 9-8
Monitor vadose zone for the Area 6 Hydrocarbon and Area 9 U10c Solid Waste disposal sites	Annually using neutron logging through access tubes	Compliant	9.5.1

(a) The section(s) within this document that describe how compliance summary data were collected
(b) Not applicable
(c) mmhos/cm = micromhos (a measure of conductance) per centimeter
(d) mg/L = milligram per liter
(e) µg/L = micrograms per liter
(f) Time domain reflectometry

2.5 Hazardous Materials Control and Management

2.5.1 Applicable Regulations

Toxic Substances Control Act (TSCA) – Requires testing and regulation of chemical substances that enter the consumer market. Since the NTS does not produce chemicals, compliance is primarily directed toward the management of polychlorinated biphenyls (PCBs). At the NTS, remediation activities and maintenance of fluorescent lights can result in the disposal of PCB-contaminated waste and light ballasts. Disposal of these items and recordkeeping requirements for PCB activities are regulated on the NTS by the State of Nevada.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) – Sets forth procedures and requirements for pesticide registration, labeling, classification, devices for use, and certification of applicators. The use of certain pesticides (called "restricted-use pesticides") is regulated. The use of non-restricted-use pesticides (as available in consumer products) is not regulated. On the NTS, only non-restricted-use pesticides are applied under the direction of a State of Nevada certified applicator. Pesticide applications in food service facilities are

NAC 555 - Control of Insects, Pests, and Noxious Weeds – Provides the regulatory framework for certification of several classifications of registered pesticide and herbicide applicators in the state of Nevada. The Nevada Department of Agriculture (NDOA) administers this program and has the primary role to enforce FIFRA in Nevada. Inspections of pesticide/herbicide applicator programs are carried out by NDOA.

NAC 444 - Polychlorinated Biphenyls (PCBs) – This code enforces the federal requirements for the handling, storage, and disposal of PCBs and contains record-keeping requirements for PCB activities.

State of Nevada Chemical Catastrophe Prevention Act – This act directed NDEP to develop and implement a program called the Chemical Accident Prevention Program (CAPP). The act requires registration of facilities storing EHSs above listed thresholds. NNSA/NSO submits a CAPP report to NDEP if any storage quantity thresholds are exceeded.

2.5.2 Compliance Reports

The following reports were generated for 2008 NNSA/NSO operations on the NTS and at the two offsite facilities in compliance with hazardous materials control and management regulations:

- *Nevada Combined Agency Report - Calendar Year 2008,* submitted to state and local agencies
- *Toxic Release Inventory Report, Form R for CY2008 Operations,* submitted to the EPA and the State
- *Calendar Year (CY) 2008 Polychlorinated Biphenyls (PCBs) Report for the Nevada Test Site (NTS)*, submitted to NNSA/NSO (no longer required to be submitted to the EPA)
- *2008 Chemical Accident Prevention Program Report*, submitted to NDEP

Table 2-5. NTS compliance status with applicable regulations for hazardous substance control and management

Compliance Measure/Action	Compliance Limit	2008 Compliance Status	Section Reference[a]
Toxic Substances Control Act (TSCA) and NAC 444 - Polychlorinated Biphenyls			
Storage and offsite disposal of PCB materials	Required if >50 ppm[b] PCBs	Compliant	10.1
Storage and onsite disposal of PCB materials	Allowed if <50 ppm PCBs	No onsite storage or disposal	10.1
Disposal of bulk product waste containing PCBs generated by remediation and site operations	Case-by-case approval by NDEP	No such bulk product wastes were generated	10.1
Generate report of quantities of PCB liquids and materials disposed offsite during previous calendar year	Due July 1 of following year	Compliant	10.1
Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and NAC 555 - Control of Insects, Pests, and Noxious Weeds			
Application of restricted-use pesticides is conducted under the direct supervision of a state-certified applicator	NA[c]	Compliant	10.2
Maintain state certification of onsite pesticide and herbicide applicator	NA	Compliant	10.2
Emergency Planning and Community Right-to-Know Act (EPCRA)			
Section 302–303 - Planning Notification	NCA Report due in March for previous calendar year	Compliant	10.3; A.1.4; A.3.3
Section 304 - EHS Release Notification	Notification Report due immediately after a release	Compliant (No releases occurred)	10.3; A.1.4; A.3.3
Section 311–312 - MSDS/Chemical Inventory	NCA Report due in March for previous calendar year	Compliant	10.3; A.1.4; A.3.3
Section 313 - TRI Reporting	TRI Report, Form R due July 1 for previous calendar year	Compliant	10.3; A.1.4; A.3.3
State of Nevada Chemical Catastrophe Prevention Act			
Registration of NTS with the state if EHSs are stored above listed threshold quantities	NDEP-CAPP[d] Report due June 21, 2009	Compliant	10.4

(a) The section(s) within this document that describe how compliance summary data were collected
(b) ppm = parts per million
(c) Not applicable
(d) Chemical Accident Prevention Program

2.6 Pollution Prevention/Waste Minimization (P2/WM) and Renewable Energy and Transportation Management

2.6.1 Applicable Regulations

Resource Conservation and Recovery Act (RCRA) – Under RCRA, generators of hazardous waste are required to have a program in place to reduce the volume or quantity and toxicity of such waste to the degree determined by the generator to be economically practicable. The EPA was required to develop a list of types of commercially available products (e.g., copy machine paper, plastic desktop items) and then specify that a certain minimum percentage of the product type's content be composed of recycled materials if they are to be purchased by a federal agency. It then requires federal facilities to have a procurement process in place to ensure that they purchase product types which satisfy the EPA-designated minimum percentages of recycled material.

EO 13423, "Strengthening Federal Environmental, Energy, and Transportation Management" – Requires federal facilities to begin establishing goals to improve efficiency in energy and water use, procure goods and services that use sustainable environmental practices, reduce amounts of toxic materials acquired and maintain a cost-effective waste prevention and recycling program, ensure construction and major renovation of buildings that incorporate sustainable practices, reduce use of petroleum products in motor vehicles and increase use of alternative fuels, and acquire and dispose of electronic products using environmentally sound practices. These goals are to be incorporated into the Environmental Management System (EMS) of each federal facility (see Section 2.10). NNSA/NSO complies with this EO through adherence to DOE O 430.2B.

DOE O 430.2B, "Departmental Energy, Renewable Energy and Transportation Management" – Provides requirements and responsibilities for DOE or NNSA sites to assist DOE in meeting its energy efficiency goals and objectives in electricity, water, and thermal consumption, conservation, and savings, including goals and objectives contained in EO 13423. This order requires sites to develop an energy management program and to have an Executable Plan for the program in place by December 31, 2008. The Executable Plan must be integrated with a site's Ten Year Site Plan.

DOE O 450.1A, "Environmental Protection Program" – Requires federal facilities to implement an EMS (see Section 2.10) that includes P2/WM goals and objectives.

NDEP Hazardous Waste Permit Number NEV HW0021 – This state permit requires NNSA/NSO to maintain an Annual Waste Minimization Summary Report in the Facility Operating Records. This report should include a description of the efforts taken during the year to reduce the volume and toxicity of waste generated as per RCRA, as well as a description of the changes in volume and toxicity of waste actually achieved during the year in comparison to previous years to the extent such information is available for the years prior to 1984.

2.6.2 Compliance Reports

The following reports were generated for 2008 NNSA/NSO operations on the NTS and at the two offsite facilities in compliance with P2/WM.

- *FY 2009 NNSA/NSO Energy Executable Plan*
- *FY 2008 Waste Generation and Pollution Prevention Progress Report*, submitted to DOE Headquarters (HQ)
- *CY 2008 Waste Minimization Summary Report*, submitted to NDEP

Table 2-6. NTS compliance status with P2/WM and renewable energy and transportation management regulations

Compliance Measure/Action	Compliance Limit/Goal	2008 Compliance Status	Section Reference[(a)]
Resource Conservation and Recovery Act (RCRA)			
Have a program in place to reduce the volume or quantity and toxicity of generated hazardous waste to the degree it is economically practicable	NA[(b)]	Compliant	11.1
Have a process in place to ensure that EPA-designated list products are purchased containing the minimum content of recycled materials	NA	Compliant	11.1
EO 13423, "Strengthening Federal Environmental, Energy and Transportation Management"			
Percent of all purchased items that contain the minimum content of recycled material as specified on the EPA-designated product list	100%	Noncompliant 56%	11.2
DOE O 430.2B, "Departmental Energy, Renewable Energy and Transportation Management"			
Prepare an Energy Executable Plan integrated with the Ten Year Site Plan	Due December 31, 2008	Compliant	17.3
Incorporate renewable energy and transportation management goals and objectives into EMS that help meet goals of the order	NA	Compliant	17.2.4
DOE O 450.1A, "Environmental Protection Program"			
Submit a fiscal year Waste Generation and Pollution Prevention Progress Report to DOE/HQ	Due December 31, 2008	Compliant	11.2
NDEP Hazardous Waste Permit Number NEV HW0021			
Submit a 2008 calendar year Waste Minimization Summary Report to NDEP	Due by March 1, 2009	Compliant	11.2

(a) The section(s) within this document that describe how compliance summary data were collected
(b) Not applicable

2.7 National Environmental Policy Act

Before any project or activity is initiated at the NTS, it must be evaluated for possible impacts to the environment. Under the National Environmental Policy Act (NEPA), federal agencies are required to consider environmental effects and values and reasonable alternatives before making a decision to implement any major federal action that may have a significant impact on the human environment. NNSA/NSO uses four levels of documentation to demonstrate compliance with NEPA:

- Environmental Impact Statement (EIS) – a full disclosure of the potential environmental effects of proposed actions and the reasonable alternatives to those actions
- Environmental Assessment (EA) – a concise discussion of proposed actions and alternatives and the potential environmental effects to determine if an EIS is necessary
- Supplement Analysis (SA) – a collection and analysis of information for an action already addressed in an existing EIS or EA used to determine whether a supplemental EIS or EA should be prepared, a new EIS or EA should be prepared, or no further NEPA documentation is required
- Categorical Exclusion (CX) – a category of actions that do not have a significant adverse environment impact based on similar previous activities and for which, therefore, neither an EA nor an EIS is required

A NEPA Environmental Evaluation Checklist (Checklist) is required for all proposed projects or activities on the NTS. The Checklist is reviewed by the NNSA/NSO NEPA Compliance Officer to determine whether the activity's environmental impacts have been addressed in existing NEPA documents. If a proposed project has not been covered under any previous NEPA analysis and it does not qualify as a CX, then a new NEPA analysis is performed. The NEPA analysis may result in preparation of a new EA or a new SA to the existing programmatic NTS EIS (DOE, 1996). The NEPA Compliance Officer must approve each Checklist before a project proceeds. During 2008, a draft programmatic SA to the 1996 NTS EIS was prepared and sent to DOE/HQ for review and approval. A decision was made, however, to proceed with a new EIS instead of approving the draft SA. Work on the EIS will start in 2009. Table 2-7 presents a summary of how NNSA/NSO complied with NEPA in 2008 for 54 projects.

Table 2-7. NTS NEPA compliance activities conducted in 2008

Results of NEPA Checklist Reviews / NEPA Compliance Activities
6 projects were exempted from further NEPA analysis because they were of CX status.
44 projects were exempted from further NEPA analysis due to their inclusion under previous analysis in the NTS EIS (DOE, 1996) and its Record of Decision.
1 project was exempted from further NEPA analysis due to its inclusion under previous analysis in the *Final Environmental Impact Statement for the Proposed Relocation of Technical Area 18 Capabilities and Materials at the Los Alamos National Laboratory* (DOE, 2002) and under previous analysis in the NTS EIS (DOE, 1996).
1 project was exempted from further NEPA analysis due to its inclusion under previous analysis in the *Environmental Assessment for Radiological/Nuclear Countermeasures Test and Evaluation Complex, Nevada Test Site* (NNSA/NSO, 2004a).
2 projects were exempted from further NEPA analysis due to its inclusion under previous analysis in the *Final Environmental Assessment for Activities Using Biological Simulants and Releases of Chemicals at the Nevada Test Site* (NNSA/NSO, 2004b).

2.8 Historic Preservation and Cultural Resource Protection

2.8.1 Applicable Regulations

National Historic Preservation Act of 1966, as amended – This act presents the goals of federal participation in historic preservation and delineates the framework for federal activities. Section 106 requires federal agencies to take into account the effects of their undertakings on properties included in, or eligible for inclusion in, the National Register of Historic Places (NRHP) and to consult with interested parties. The Section 106 process involves the agency reviewing background information, identifying eligible properties for the NRHP within the area of potential effect through consultation with the Nevada State Historic Preservation Office (SHPO), making a determination of effect (when applicable), and developing a mitigation plan when an adverse effect is unavoidable. Determinations of eligibility, effect, and mitigation are conducted in consultation with the SHPO and, in some cases, the federal Advisory Council on Historic Preservation. Section 110 sets out the broad historic preservation responsibilities of federal agencies and is intended to ensure that historic preservation is fully integrated into the ongoing programs of all federal agencies. It requires federal agencies to develop and implement a Cultural Resources Management Plan, to identify and evaluate the eligibility of historic properties for long-term management as well as for future project-specific planning, and to maintain archaeological collections and their associated records at professional standards. At the NTS, a long-term management strategy includes (1) monitoring NRHP-listed and eligible properties to determine if environmental or other actions are negatively affecting the integrity or other aspects of eligibility and (2) taking corrective actions if necessary.

EO 11593, "Protection and Enhancement of the Cultural Environment" – Reinforces the obligation of federal agencies to conduct adequate surveys to locate any and all sites of historic value under their jurisdiction.

Archaeological Resources and Protection Act of 1979 – The purpose of this act is to secure, for the present and future benefit of the American people, the protection of archaeological resources and sites that are on public and Indian lands, and to address the irreplaceable heritage of archaeological sites and materials. It requires the issuance of a federal archaeology permit to qualified archaeologists for any work that involves excavation or removal of archaeological resources on federal and Indian lands and notification to Indian tribes of these activities. Unauthorized excavation, removal, damage, alteration, or defacement of archaeological resources is prohibited, as is the sale, purchase, exchange, transport, receipt of, or offer for sale of such resources. Criminal and civil penalties apply to such actions. Information concerning the nature and location of any archaeological resource may not be made available to the public unless the federal land manager determines that the disclosure would not create a risk of harm to the resources or site. The Secretary of the Interior is required to submit an annual report at the end of each fiscal year to Congress that reports the scope and effectiveness of all federal agencies' efforts on the protection of archaeological resources, specific projects surveyed, resources excavated or removed, damage or alterations to sites, criminal and civil violations, the results of permitted archaeological activities, and the costs incurred by the federal government to conduct this work. All archaeologists working at the NTS must have qualifications that meet federal standards and must work under a permit issued by NNSA/NSO. In the event of vandalism, NNSA/NSO would need to investigate the actions.

American Indian Religious Freedom Act of 1978 – This law established the government policy to protect and preserve for American Indians their inherent right of freedom to believe, express, and exercise the traditional religions, including but not limited to access to sites, use and possession of sacred objects, and the freedom to worship through ceremonials and traditional rites. Locations exist on the NTS that have religious significance to Western Shoshone and Southern Paiute; visits to these places involve prayer and other activities. Access is provided by NNSA/NSO as long as there are no safety or health hazards.

Native American Graves Protection and Repatriation Act (NAGPRA) of 1990 – This act requires federal agencies to identify Native American human remains, funerary objects, sacred objects, and objects of cultural patrimony in their possession. Agencies are required to prepare an inventory of human remains and associated funerary objects, as well as a summary with a general description of sacred objects, objects of cultural patrimony, and unassociated funerary objects. Through consultation with Native American tribes, the affiliation of the remains and objects are determined and the tribes can request repatriation of their cultural items. The agency is required to publish a notice of inventory completion in the Federal Register. The law also protects the physical location where human remains are placed during a death rite or ceremony. The NTS artifact collection is subject to NAGPRA, and the locations of American Indian human remains at the NTS must be protected from NTS activities.

2.8.2 Reporting Requirements

NNSA/NSO submits Section 106 cultural resources inventory reports and historical evaluations to the Nevada SHPO for review and concurrence. Mitigation plans and mitigation documents are also submitted to the Nevada SHPO, and some types of documents go to the Advisory Council on Historic Preservation and the National Park Service. Reports containing restricted data on site locations are not available to the public. Some technical reports, however, are available to the public upon request and can be obtained from the National Technical Information Service. The 2008 reports submitted to agencies are discussed in Chapter 12.

Table 2-8. NTS compliance status with historic preservation regulations

Compliance Action	2008 Compliance Status	Section Reference[(a)]
National Historic Preservation Act of 1966 and EO 11593, "Protection and Enhancement of the Cultural Environment"		
Maintain and implement NTS Cultural Resources Management Plan	Compliant	- -
Conduct cultural resources inventories and evaluations of historic structures	Compliant	12.1; Table 12-1
Make determinations of eligibility to the National Register	Compliant	12.1.2; Table 12-1
Make assessments of impact to eligible properties	Compliant	12.1.2
Manage artifact collection as per required professional standards	Compliant	12.2
Archaeological Resources and Protection Act of 1979		
Conduct archaeological work by qualified personnel	Compliant	- -
Determine if archaeological sites have been damaged	Compliant	12.1.3.2
Complete and submit Secretary of the Interior Archaeology Questionnaire	Compliant	12.1.3.3
American Indian Religious Freedom Act of 1978		
Allow American Indians access to NTS locations for ceremonies and traditional use	Compliant	12.3
Native American Graves Protection and Repatriation Act		
Consult with affiliated Native American Indian tribes regarding repatriation of cultural items	Completed	12.2
Protect Native American Indian burial locations on NTS	Compliant	12.2
Overall Requirement		
Consult with tribes regarding various cultural resources issues	Compliant	12.3

(a) The section(s) within this document that describe how compliance summary data were collected

2.9 Conservation and Protection of Biota and Wildlife Habitat

2.9.1 Applicable Regulations

Endangered Species Act (ESA) – Section 7 of this act requires federal agencies to ensure that their actions do not jeopardize the continued existence of federally listed endangered or threatened species or their critical habitat. The threatened desert tortoise is the only animal protected under the ESA that may be impacted by NTS operations. NTS activities within tortoise habitat are conducted so as to comply with the terms and conditions of Biological Opinions issued by the U.S. Fish and Wildlife Service (FWS) to NNSA/NSO.

Migratory Bird Treaty Act (MBTA) – Prohibits the harming of any migratory bird, their nest, or eggs without authorization by the Secretary of the Interior. All but five of the 239 bird species observed on the NTS (Wills and Ostler, 2001) are protected under this act. Biological surveys are conducted for projects to prevent direct harm to protected birds, nests, and eggs.

Bald Eagle Protection Act – Prohibits the capture or harming of bald and golden eagles without special authorization. Both bald and golden eagles occur on the NTS. Biological surveys are conducted for projects to prevent direct harm to eagles and their nests and eggs.

Clean Water Act (CWA), Section 404, Wetlands Regulations – Regulates land development affecting wetlands by requiring a permit obtained from the U.S. Army Corps of Engineers (USACE) to discharge dredged or fill material into waters of the United States, which includes most wetlands on public and private land. NTS projects are evaluated for their potential to disturb wetlands and their need for a Section 404 permit application. Based on recent rulings, no natural NTS wetland may meet the criteria of a "jurisdictional" wetland subject to Section 404 regulations. However, final determination from the USACE regarding the status of NTS wetlands has yet to be received.

National Wildlife Refuge System Administration Act – Forbids a person to knowingly disturb or injure vegetation or kill vertebrate or invertebrate animals or their nests or eggs on any National Wildlife Refuge lands unless permitted by the Secretary of the Interior. The boundary of the Desert National Wildlife Refuge (DNWR), land administered within this system, is approximately 5 km (3.1 mi) downwind of the NPTEC in Area 5. Biological monitoring is conducted to verify that tests conducted at the NPTEC do not disperse toxic chemicals that could harm biota on the DNWR.

EO 11990, "Protection of Wetlands" – Requires governmental agencies to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities, including managing federal lands and facilities. Projects are evaluated for their potential to disturb the more than 20 natural water sources on the NTS. NTS wetlands are monitored to document their status and use by wildlife, even though they may not meet the criteria for "jurisdictional" status under the CWA.

EO 11988, "Floodplain Management" – Ensures protection of property and human well-being within a floodplain and protection of floodplains themselves. The Federal Emergency Management Agency publishes guidelines and specifications for assessing alluvial fan flooding. NNSA/NSO generally satisfies EO 11988 through DOE O 420.1, "Facility Safety", and invoked standards. DOE O 420.1 and the associated implementation guide for mitigation of natural phenomena hazards call for a graded approach to assessing risk to all facilities (structures, systems, and components [SSC]) from potential natural hazards. Chapter 4 of DOE Standard 1020 (DOE-STD-1020-2002) provides flood design and evaluation criteria for SSC. Evaluations of flood hazards at the NTS are generally conducted to ensure protection of property and human well-being.

EO 13186, "Responsibilities of Federal Agencies to Protect Migratory Birds" – Directs federal agencies to take certain actions to further implement the MBTA if agencies have, or are likely to have, a measurable negative effect on migratory bird populations. It also directs federal agencies to support the conservation intent of the MBTA and conduct actions, as practicable, to benefit the health of migratory bird populations. NTS projects are evaluated for their potential to impact such bird populations.

EO 13112, "Invasive Species" – Directs federal agencies to act to prevent the introduction of, or to monitor and control, invasive (non-native) species; to provide for restoration of native species; and to exercise care in taking actions that could promote the introduction or spread of invasive species. Land-disturbing activities on the NTS have resulted in the spread of numerous invasive plant species. Habitat reclamation and other controls are evaluated and conducted, when feasible, to control such species and meet the purposes of this EO.

Wild Free-Roaming Horse and Burro Act – Requires the protection, management, and control of wild horses and burros on public lands and calls for the management and protection of these animals in a manner that is designed to achieve and maintain a thriving natural ecological balance. Wild horses on the NTS may wander off the NTS onto public lands and therefore are protected under this act. This act makes it unlawful to harm wild horses and burros.

DOE O 450.1A, "Environmental Protection Program" – Requires federal facilities to address the protection of site resources from wildland and operational fires and the protection of the environment and biota from site activities through the integration of an EMS into each site's Integrated Safety Management System (ISMS) (see Section 2.10). Annual surveys of vegetation fuel hazards, ecosystem mapping, surveys for protected and important species, and habitat revegetation are conducted to meet the intent of this order.

Five-Party Cooperative Agreement – Agreement between NNSA/NSO, NTTR, FWS, Bureau of Land Management (BLM), and the State of Nevada Clearinghouse that calls for cooperation in conducting resource inventories and developing resource management plans for wild horses and burros and to maintain favorable habitat on federally withdrawn lands for these animals. BLM considers NTS a zero herd-size management area. NNSA/NSO consults with BLM regarding any issue of NTS horse management. Biologists conduct periodic horse census surveys on the NTS.

NAC 503.010–503.104 - Protection of Wildlife – Identifies Nevada animal species, both protected and unprotected, and prohibits the harm of protected species without special permit. Over 200 bird species and 1 bat species on the NTS are state-protected. Biological surveys are conducted for projects to prevent direct harm to protected birds, nests, eggs, and protected bats.

NAC 527.270 - Protection of Flora – Requires that the State Forester Firewarden determine the protective status of Nevada plants and prohibits removal or destruction of protected plants without special permit. Currently, no state-protected plants are known to occur on the NTS. Annual reviews of the status of NTS plants are conducted.

2.9.2 Compliance Issues

Six deaths recorded among migratory birds in 2008 were related to NTS activities (see Table 13-4). One mitigation action was taken to reduce future accidental bird mortality; a barbed wire fence in which a great-horned owl became entangled and died was removed.

2.9.3 Compliance Reports

The following reports were prepared in 2008 or 2009 to meet regulation requirements or to document compliance for all activities conducted in 2008:

- *Annual Report of Actions Taken Under Authorization of the Biological Opinion on NTS Activities* (File No. 1-5-96-F-33) *– January 1, 2008 Through December 31, 2008*
- *Annual Report for Handling Permit S29157*, submitted to Nevada Division of Wildlife
- *Annual Report for Federal Migratory Bird Scientific Collecting Permit MB008695-0*, submitted to FWS Portland Office
- *Annual Report for Federal Migratory Bird Special Purpose Possession Permit (Dead Permit) MB037277-1,* submitted to FWS Portland Office

Table 2-9. NTS compliance status with applicable biota and wildlife habitat regulations

Compliance Measure/Action	Compliance Limit	2008 Compliance Status	Section Reference[a]
Endangered Species Act – 1996 Opinion for NTS Programmatic Activities			
Number of tortoises accidentally injured or killed due to NTS activities, per year	3	Compliant	13.1
Number of tortoises captured and displaced from project sites, per year	10	Compliant	13.1
Number of tortoises taken since 1992 by way of injury or mortality on NTS paved roads by vehicles other than those in use during a project	Unlimited	Compliant	13.1
Number of total acres (ac) of desert tortoise habitat disturbed during NTS project construction since 1992	3,015 ac	Compliant	13.1
Follow the 23 terms and conditions of the Biological Opinion during construction and operation of NTS projects	NA[b]	Compliant	13.1
Conduct biological surveys at proposed project sites to assess presence of protected species	NA	Compliant	13.2
Migratory Bird Treaty Act; Bald Eagle Protection Act; and EO 13186, "Responsibilities of Federal Agencies to Protect Migratory Birds"			
Number of birds/nests/eggs harmed by NTS project activities	0	Noncompliant 6 bird deaths	13.3.2.3; Table 13-4
National Wildlife Refuge System Administration Act			
Number of animals, their nests, or eggs killed and amount of vegetation disturbed or injured on System lands (the DNWR) as a result of NTS activities	0	Compliant	13.6
Wild Free-Roaming Horse and Burro Act and Five-Party Cooperative Agreement			
Number of horses harassed or killed due to NTS activities	0	Compliant	13.3.2.6
Cooperate in conducting resource inventories and developing resource management plans for horses on the NTS, NTTR, and DNWR	NA	Compliant	13.3.2.6; Table 13-5
EO 11988, Floodplain Management"			
Conduct flood hazard assessments	NA	NA – No floodplain projects	- -
Clean Water Act, Section 404 -Wetlands Regulations and EO 11990, "Protection of Wetlands"			
Number of wetlands disturbed by NTS activity	NA	0	13.3.4
EO 13112, "Invasive Species"			
Evaluate feasibility of conducting habitat reclamation and other controls to control spread of invasive species	NA	Compliant	13.1, 13.4
NAC 503.010–503.104 and NAC 527.270 - Nevada Protective Measures for Wildlife and Flora			
Number of state-protected animals harmed or killed and number of state-protected plants collected or harmed due to NTS activities	0	Noncompliant 6 bird deaths	13.3.2.3; Table 13-4

(a) The sections within this document that describe how compliance summary data were collected
(b) Not applicable

2.10 Environmental Management System

2.10.1 Applicable Regulations

DOE O 450.1A, "Environmental Protection Program" – Requires each DOE facility to implement an EMS, which is a continuing cycle of planning, implementing, evaluating, and improving processes and actions undertaken to achieve environmental goals. The objectives are to implement sound stewardship practices that are protective of the air, water, land, and other natural and cultural resources impacted by DOE operations, by which DOE cost-effectively meets or exceeds compliance with applicable environmental, public health, and resource protection laws, regulations, and DOE requirements. The EMS must be fully integrated into the site ISMS. The EMS must include pollution prevention goals and objectives. Subsequent DOE orders (e.g., DOE O 430.2B) require integration of other types or goals and objectives into a site's EMS.

2.10.2 Compliance Status

In 2008, NSTec tracked environmental measures for those environmental aspects, objectives, targets, and goals that had been identified through the EMS (see Chapter 17 for a full description). The *2008 Facility EMS Annual Report Data* were entered into the DOE computer database as required by NNSA/NSO.

2.11 Occurrences, Unplanned Releases, and Continuous Releases

2.11.1 Applicable Regulations

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) – Continuous release reporting under Section 103 requires that a non-permitted hazardous substance release that is equal to or greater than its reportable quantity be reported to the National Response Center. The EPA requires all facilities that release a hazardous substance meeting the Section 103(f) requirements to report annually to EPA and perform an annual evaluation of releases. CERCLA requirements applicable to NTS operations also pertain to an emergency response program for hazardous substance releases to the environment (see discussion of EPCRA in Section 2.5).

Emergency Planning and Community Right-to-Know Act (EPCRA) – This act is described in Section 2.5. See Table 2-5 for summary of compliance to EPCRA pertaining to unplanned environmental releases of hazardous substances.

40 CFR 302.1–302.8: Designation, Reportable Quantities, and Notification – Requires facilities to notify federal authorities of spills or releases of certain hazardous substances designated under CERCLA and the CWA. It specifies what quantities of hazardous substance spills/releases must be reported to authorities and delineates the notification procedures for a release that equals or exceeds the reportable quantities.

DOE O 231.1A, "Environment, Safety, and Health Reporting" – This order includes the requirement for reporting environmental occurrences. Along with DOE M 231.1-2, "Occurrence Reporting and Processing of Operations Information," it requires the establishment and maintenance of a system for reporting operations information related to DOE-owned and leased facilities, for processing that information to identify the root causes of environmental occurrences, and for providing appropriate corrective action for such occurrences.

NAC 445A.345–445.348 - Notification of Release of Pollutant – Requires state notification for the unplanned or accidental releases of specified quantities of pollutants, hazardous wastes, and contaminants.

Water Pollution Control General Permit GNEV93001 – This general wastewater discharge permit issued by the State to the NTS specifies that no petroleum products will be discharged into treatment works without first being processed through an oil/water separator or other approved methods. It also specifies how NNSA/NSO shall report each bypass, spill, upset, overflow, or release of treated or untreated sewage.

Other NTS Permits/Agreements – As with General Permit GNEV93001, other state permits and agreements are cited in previous subsections of this chapter (e.g., FFACO) that specify that accidents or events of non-compliance must be reported. These include events that may create an environmental hazard.

2.11.2 Compliance Status

There are no continuous releases on the NTS or at the two offsite facilities.

In 2008, four reportable environmental occurrences happened. They included radioactive material blown outside a radiological Contamination Area (CA) in Area 25 by high winds, legacy contaminated debris found outside a CA in Area 3, cooling towers at RSL-Nellis operating without a Clark County air permit, and a spill of spent oil in Area 6. All four are described in Table 2-10.

Table 2-10. Environmental occurrences in 2008

Description of Occurrence	Reporting Criteria[(a)]	Corrective Actions Taken
ORPS Number/Date of Occurrence: EM--NVSO-NST-NTS-2008-0002, February 19, 2008		
On February 18, high winds shut down work during packaging of contaminated debris at CAU 127 at Test Cell C in Area 25. Two transportainers were loaded with debris when the wind increased to over 40 miles per hour. Workers left the CA without covering the transportainers because of unsafe working conditions. On February 19, Radiological Control Technicians (RCTs) found pieces of contaminated tarp and tape downwind outside the CA. Radiological instrument (direct) readings on the debris ranged from 5,000 to 140,000 dpm of beta/gamma (where maximum removable limit is 350 dpm beta/gamma).	6B(3) - Identification of onsite radioactive contamination greater than 10 times the total contamination values in 10 CFR 835 Appendix D and that is found outside of the following locations: Contamination Areas, High Contamination Areas, Airborne Radioactivity Areas, Radiological Buffer Areas, and areas controlled in accordance with 10 CFR 835.1102(c). For tritium, the reporting threshold is 10 times the removable contamination values in 10 CFR Part 835, Appendix D.	The nearby road was blocked off and the Duty Manager was notified. The roadway and area were searched for additional contaminated debris, which was bagged for proper disposal. A critique was performed and a determination was made to only generate highly contaminated waste if it can be packaged for disposal immediately and to ensure that Environmental Restoration personnel are trained/briefed to maintain awareness of the radiological hazards of waste staging in the field.
ORPS Number/Date of Occurrence: NA--NVSO-NST-NTS-2008-0007, April 10, 2008		
On April 10, during a Soils Sub-Project preliminary assessment in Area 3, RCTs identified four locations of contaminated debris outside a radiological CA. Debris had readings from 3,000 to 3 million dpm/100 cm^2 total alpha. On April 30, RCTs performed a verification survey of the area. Two survey points showed removable alpha contamination that ranged from 38 to 288 dpm/100 cm^2 and total contamination levels that ranged from 126,000 to 200,000 dpm/100 cm^2. The alpha spectroscopy confirmed the presence of transuranics (^{239}Pu).	6B(4) - Identification of onsite legacy radioactive contamination greater than 10 times the total contamination values in 10 CFR 835 Appendix D and that is found outside of the following locations: Contamination Areas, High Contamination Areas, Airborne Radioactivity Areas, Radiological Buffer Areas, and areas controlled in accordance with 10 CFR 835.1102(c). For tritium, the reporting threshold is 10 times the removable contamination values in 10 CFR Part 835, Appendix D.	The locations of contaminated debris were temporarily marked with pin flags and posted. After verification survey, RCTs extended the current CA boundary to include the area of contamination.
ORPS Number/Date of Occurrence: NA--NVSO-NST-RSL-2008-0004, November 13, 2008		
NNSA/NSO received a Letter of Noncompliance from the Clark County DAQEM, dated November 18, 2008. On November 13, 2008, DAQEM personnel inspected the RSL-Nellis facility and determined that two cooling towers were being operated without an air permit.	9(2) - Any written notification from an outside regulatory agency that a site/facility is considered to be in noncompliance with a schedule or requirement (e.g., Notice of Violation, Notice of Intent to Sue, Notice of Noncompliance, Warning Letter, Finding of Violation, Finding of Alleged Violation, Administrative Order, or a similar type of notification or enforcement action).	

2.12 Environment, Safety, and Health Reporting

2.12.1 Applicable Regulations

DOE O 231.1A, "Environment, Safety and Health Reporting" – This order calls for the "timely collection, reporting, analysis, and dissemination of information on environment, safety, and health issues as required by law or regulations or as needed to ensure that the DOE and the NNSA are kept fully informed on a timely basis about events that could adversely affect the health and safety of the public or the workers, the environment, the intended purpose of DOE facilities, or the credibility of the Department." The order specifically requires DOE and NNSA sites to prepare an annual calendar year report, referred to as the Annual Site Environmental Report (ASER).

DOE M 231.1-1A Chg 2, "Environment, Safety and Health Reporting Manual" – This manual provides detailed requirements for implementing DOE O 231.1A.

The data to be included in an ASER are air emissions, effluent releases, environmental monitoring, and estimated radiological doses to the public from releases of radioactive material at DOE or NNSA sites. The annual report must also summarize environmental occurrences and responses reported during the calendar year, confirm compliance with environmental standards and requirements, and highlight significant programs and efforts. Environmental performance indicators and/or performance measures programs are to be included. The breadth and detail of this reporting should reflect the size and extent of programs at a particular site. The ASER for the calendar year is to be completed and made available to the public by October 1 of the following year. DOE's Office of Analysis is to issue annual guidance to all field elements regarding the preparation of the report.

For NNSA/NSO, reporting is accomplished through the publication of the NTS ASER, which is titled the Nevada Test Site Environmental Report (NTSER).

2.12.2 Compliance Status

The 2007 NTSER was published and posted on the NNSA/NSO, NSTec, and DOE Office of Scientific and Technical Information Web sites by September 12, 2008. The 2007 NTSER was mailed to all recipients (on a compact disc accompanied by a 25-page summary) on September 22, 2008.

2.13 Summary of Permits

Table 2-11 presents the complete list of all federal and state permits active during calendar year 2008 that were issued to NNSA/NSO and to NSTec for NTS, NLVF, and RSL-Nellis operations, and which have been referenced in previous subsections of this chapter. The table includes those pertaining to air quality monitoring, operation of drinking water and sewage systems, hazardous materials and hazardous waste management and disposal, and endangered species protection. Reports associated with these permits are submitted to the appropriate designated state or federal office. Copies of reports may be obtained upon request.

Table 2-11. Environmental permits required for NTS and NTS site facility operations

Permit Number	Description	Expiration Date	Reporting
Air Quality	**NTS**		
AP9711-0549.01	NTS Class II Air Quality Operating Permit	June 25, 2009	Annually
08-29	NTS Burn Variance (Various Locations)	March 14, 2009	None
08-30	NTS Open Burn Variance, NTS, A-23, Facility #23-T00200 (NTS Fire & Rescue Training Center)	March 14, 2009	None
	NLVF		
Facility 657, Mod. 3	Clark County Authority to Construct/Operating Permit for a Testing Laboratory	None	March
	RSL-Nellis		
Facility 348, Mod. 2	Clark County Authority to Construct/Operating Permit for a Testing Laboratory	None	March
NTS Drinking Water			
NY-0360-12NTNC	Areas 6 and 23	September 30, 2009	None
NY-4098-12NC	Area 25	September 30, 2009	None
NY-4099-12NC	Area 12	September 30, 2009	None
NY-0835-12NP	NTS Water Hauler #84846	September 30, 2009	None
NY-0836-12NP	NTS Water Hauler #84847	September 30, 2009	None
NTS Septic Systems and Pumpers			
NY-1054	Septic System, Area 3 (Waste Management Offices)	None	None
NY-1069	Septic System, Area 18 (820th Red Horse Squadron)	None	None
NY-1076	Septic System, Area 6 (Airborne Response Team Hangar)	None	None
NY-1077	Septic System, Area 27 (Baker Compound)	None	None
NY-1079	Septic System, Area 12 (U12g Tunnel)	None	None
NY-1080	Septic System, Area 23 (Building 1103)	None	None
NY-1081	Septic System, Area 6 (Control Point-170)	None	None
NY-1082	Septic System, Area 22 (Building 22-01)	None	None
NY-1083	Septic System, Area 5 (Radioactive Material Management Site)	None	None
NY-1084	Septic System, Area 6 (Device Assembly Facility)	None	None
NY-1085	Septic System, Area 25 (Central Support Area)	None	None
NY-1086	Septic System, Area 25 (Reactor Control Point)	None	None
NY-1087	Septic System, Area 27 (Able Compound)	None	None
NY-1089	Septic System, Area 12 (Camp)	None	None
NY-1090	Septic System, Area 6 (Los Alamos National Laboratory Construction Camp Site)	None	None
NY-1091	Septic System, Area 23 (Gate 100)	None	None

Table 2-12. Environmental permits required for NTS and NTS site facility operations (continued)

Permit Number	Description	Expiration Date	Reporting
NTS Septic Systems and Pumpers (cont.)			
NY-1103	Septic System, Area 22 (Desert Rock Airport)	None	None
NY-1106	Septic System, Area 5 (Hazmat Spill Center)	None	None
NY-1110-HAA-A	Individual Sewage Disposal System, A-12, Building 12-910	None	None
NY-1112	Commercial Sewage Disposal System, U1a, Area 1	None	None
NY-1113	Commercial Sewage Disposal System, Area 1, Building 121	None	None
NY-1124	Commercial Individual Sewage Disposal System, NTS, Area 6	None	None
NY-1128	Commercial Individual Sewage Disposal System, NTS, Area 6, Yucca Lake Project	None	None
NY-17-03313	Septic Tank Pumper E 106785	July 31, 2009	None
NY-17-03315	Septic Tank Pumper E 107105	July 31, 2009	None
NY-17-03317	Septic Tank Pumper E-105918	July 31, 2009	None
NY-17-03318	Septic Tank Pumping Contractor (one unit)	July 31, 2009	None
NY-17-06838	Septic Tank Pumper E-105919	July 31, 2009	None
NY-17-06839	Septic Tank Pumper E-107103	July 31, 2009	None
Wastewater Discharge	**NTS**		
GNEV93001	Water Pollution Control General Permit	August 5, 2010	Quarterly
NEV96021	Water Pollution Control for E-Tunnel Waste Water Disposal System and Monitoring Well ER-12-1	October 1, 2013	Quarterly
	NLVF		
VEH-112	NLVF Wastewater Contribution Permit	December 31, 2013	Annually
NV0023507	North Las Vegas National Pollutant Discharge Elimination System Permit	November 2, 2011	Quarterly
	RSL-Nellis		
CCWRD-080	Industrial Wastewater Discharge Permit	June 30, 2009	Quarterly
Hazardous Materials	**NTS**		
2287-5146	NTS Hazardous Materials	February 28, 2009	Annually
2287-5147	Nonproliferation Test and Evaluation Complex	February 28, 2009	Annually
	NLVF		
2287-5144	NLVF Hazardous Materials Permit	February 28, 2009	Annually
	RSL-Nellis		
2287-5145	RSL Hazardous Materials Permit	February 28, 2009	Annually
NTS Hazardous Waste			
NEV-HW0021	NTS Hazardous Waste Management Permit (RCRA)	December 1, 2010	Biennially
0510003453	Utah Generator Site Access Permit	November 1, 2008	None
NTS Waste Management			
U1576-33N-01	RSL-Nellis Waste Management Permit-Underground Storage Tank	December 31, 2008	None

Table 2-12. Environmental permits required for NTS and NTS site facility operations (continued)

Permit Number	Description	Expiration Date	Reporting
NTS Disposal Sites			
SW 13 000 01	Area 5 Asbestiform Low-Level Solid Waste Disposal Site	Post-closure[(a)]	Annually
SW 13 097 02	Area 6 Hydrocarbon Disposal Site	Post-closure	Annually
SW 13 097 03	Area 9 U10c Solid Waste Disposal Site	Post-closure	Annually
SW 13 097 04	Area 23 Solid Waste Disposal Site	Post-closure	Biannually
Endangered Species/Wildlife/Special Use			
File No. 1-5-96-F-33	U.S. Fish and Wildlife Service – Desert Tortoise Incidental Take Authorization (Biological Opinion for Programmatic NTS Activities)	December 31, 2008	Annually
MB008695-0	U.S. Fish and Wildlife Service – Migratory Bird Scientific Collecting Permit	March 31, 2009	Annually
MB037277-1	U.S. Fish and Wildlife Service – Migratory Bird Special Purpose Possession – Dead Permit	March 31, 2009	Annually
S29157	Nevada Division of Wildlife – Scientific Collection of Wildlife Samples	December 31, 2008	Annually

(a) Permit expires 30 years after closure of the landfill

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3.0 Radiological and Nonradiological Air Monitoring

Section 3.1 presents the results of radiological air monitoring conducted on the Nevada Test Site (NTS) to verify compliance with radioactive air emission standards (see Section 2.1). Sources of radioactive air emissions from the NTS include evaporation of tritiated water from containment ponds; diffusion of tritiated water vapor from the soil at Area 3 and Area 5 Radioactive Waste Management Sites (RWMSs), Sedan crater, and Schooner crater; release of tritium gas during equipment calibrations; and resuspension of plutonium and americium from contaminated soil at historical nuclear device safety test locations and atmospheric test locations. Radiological air monitoring is conducted by National Security Technologies, LLC (NSTec), Environmental Technical Services. Measurements of radioactivity in air samples are used to assess radiological dose to the general public in the vicinity of the NTS. The assessed dose to the public from all exposure pathways (air, water, direct radiation exposure, and consumption of game animals) is presented in Chapter 8.

The U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) has also established an air monitoring program to monitor radionuclides in air within communities adjacent to the NTS. This independent program, the Community Environmental Monitoring Program, is managed by the University of Nevada's Desert Research Institute (DRI) of the Nevada System of Higher Education. DRI's 2008 offsite air monitoring results are presented in Chapter 6.

Section 3.2 presents the results of nonradiological air quality assessments conducted on the NTS to ensure compliance with current air quality permits (see Section 2.1). NTS operations that are potential sources of nonradiological air pollution include aggregate production, surface disturbance (e.g., construction), release of fugitive dust from driving on unpaved roads, use of fuel-burning equipment, open burning, venting from bulk fuel storage facilities, explosives detonations, and releases of various chemicals during testing at the Nonproliferation Test and Evaluation Complex (NPTEC) or at other release areas. Air quality assessments are conducted by NSTec Environmental Services (ES).

3.1 Radiological Air Monitoring

The U.S. Department of Energy (DOE) Order DOE O 5400.5, "Radiation Protection of the Public and the Environment," and the Clean Air Act (CAA) National Emission Standards for Hazardous Air Pollutants (NESHAP) require air monitoring for radiological emissions at the NTS. Radiological air monitoring is conducted to ensure that no significant emission source that contributes to calculable offsite exposures is ignored and that the NTS remains in compliance with the requirements of DOE O 5400.5 and the CAA. To accomplish this, an air surveillance network consisting of air particulate and atmospheric moisture samplers has been established. The objectives and design of the network are described in detail in the Routine Radiological Environmental Monitoring Plan (Bechtel Nevada, 2003a). The network monitors airborne radioactivity near NTS sites at which radioactivity from past nuclear testing was deposited on and in the soil, at NTS operating facilities that may produce radioactive air emissions, and along the NTS boundaries.

Diffuse radionuclide sources from historic nuclear testing activities on the Tonopah Test Range (TTR) (Clean Slate 1, 2, and 3) are reported by Sandia National Laboratories (SNL) in the TTR annual environmental report (SNL, 2008). In July 2008, NNSA/NSO began conducting environmental and radiological monitoring at Clean Slate 3. The purpose is to assess current site conditions in preparation for monitoring when active site remediation begins. These monitoring efforts will be reported by SNL in the TTR annual environmental report, beginning calendar year 2009. Historic sites on the Nevada Test and Training Range (NTTR) (Double Tracks and Project 57) are currently not being monitored; however, air sampling was conducted at Double Tracks during 1996–1999 in support for its remediation and at Project 57 in 1997–2000 for surveillance purposes. NTTR air sampling results were reported in past NTS Annual Site Environmental Reports available at <http://www.nv.doe.gov/library/publications/environmental.aspx>.

Data from all current sampling stations are analyzed to meet the specific goals listed below. Also listed below are the analytes monitored in order to perform dose assessments. These are the radionuclides most likely to be present in the air as a result of past or current NTS operations, selected based on NTS inventories of radionuclides in surface soil (McArthur, 1991) and upon their volatility and availability for resuspension; half-lives for these radionuclides are found in Table 1-5. Uranium is included on this list because depleted uranium (see Glossary, Appendix B) ordnance is used during exercises in Areas 20 and 25. Air samples from selected sampling locations in the vicinity of these areas only are analyzed for uranium. Also, gross alpha and gross beta readings are used in air monitoring as a rapid screening measure.

Radiological Air Monitoring Goals	***Analytes Monitored***
Measure radionuclide concentrations in air at or near historic or current operation sites that have the potential to release airborne radioactivity to (1) detect and identify local and site-wide trends, (2) identify radionuclides emitted to air, and (3) detect accidental and unplanned releases. Determine if radioactive air emissions from past or present NTS activities result in a radiation dose, called the committed effective dose equivalent (CEDE) (see Glossary, Appendix B), to any member of the public that exceeds the NESHAP standard of 10 millirem per year (mrem/yr) (0.1 millisievert per year [mSv/yr]). Provide point source operational monitoring as required under NESHAP for any facility that has the potential to emit radionuclides into the air and cause a dose greater than 0.1 mrem/yr (0.001 mSv/yr) to any member of the public. Provide data to determine if radioactive air emissions from past or present NTS activities result in a radiation dose to any member of the public from all pathways (air, water, food) that exceeds the DOE O 5400.5 standard of 100 mrem/yr (1 mSv/yr).	Americium-241 (^{241}Am) Cesium-137 (^{137}Cs) Tritium (^{3}H) Plutonium-238 (^{238}Pu) Plutonium-239+240 ($^{239+240}Pu$) Uranium-233+234 ($^{233+234}U$) Uranium-235+236 ($^{235+236}U$) Uranium-238 (^{238}U) Gross alpha radioactivity Gross beta radioactivity $^{239+240}Pu$, $^{233+234}U$, and $^{235+236}U$ are reported as the sum of isotope concentrations since the analytical method cannot readily distinguish the individual isotopes.

3.1.1 Monitoring System Design

Environmental Samplers – There are 19 sampling stations referred to as environmental samplers. They include 3 stations that have only low-volume air particulate samplers, 1 that has only a tritium sampler, and 15 that have both air particulate and tritium samplers (Figure 3-1). They are located throughout the NTS in or near the highest diffuse radiation sources. Predominant winds were a factor in station placement (for NTS wind rose data, see Section A.3 of Attachment A: Site Description, included as a separate file on the compact disc of this report). The sources include areas with (1) radioactivity in surface soil that can be resuspended by the wind, (2) tritium that transpires or evaporates from plants and soil at the sites of past nuclear tests, and (3) tritium that evaporates from ponds receiving tritiated water either pumped from contaminated wells or directed from tunnels that cannot be sealed shut. Sampling and analysis of air particulates and tritium were performed at these stations as described in Section 3.1.2. Radionuclide concentrations measured at these stations are used for trending, determining ambient background concentrations in the environment, and monitoring for unplanned releases of radioactivity. Air concentrations approaching 10 percent of the NESHAP Concentration Levels for Environmental Compliance (compliance levels [CLs]) (second column of Table 3-1) are investigated for causes that may be mitigated to avoid exceeding regulatory dose limits.

Critical Receptor Samplers – Six of the 15 sampling stations with both air particulate and tritium samplers, near the boundaries and the center of the NTS, are approved by the U.S. Environmental Protection Agency (EPA) Region IX as critical receptor samplers (Figure 3-1). Radionuclide concentrations measured at these stations are used to assess compliance with the NESHAP dose limit to the public of 10 mrem/yr (0.1 mSv/yr). The annual average concentrations from each station were compared with the concentration limits listed in Table 3-1. Compliance with NESHAP is demonstrated when the sum of the fractions, determined by dividing each radionuclide's concentration by its concentration limit and then adding the fractions together, is less than 1.0 at all stations.

Figure 3-1. Radiological air sampling network on the NTS in 2008

Table 3-1. Regulatory concentration limits for radionuclides in air

Radionuclide	Concentration (x 10^{-15} microcuries/milliliter [µCi/mL]) NESHAP Concentration Level for Environmental Compliance (CL)[(a)]	10% of Derived Concentration Guide (DCG)[(b)]
^{241}Am	1.9	2
^{137}Cs	19	40,000
^{3}H	1,500,000	10,000,000
^{238}Pu	2.1	3
^{239}Pu	2	2
^{233}U	7.1	9
^{234}U	7.7	9
^{235}U	7.1	10
^{236}U	7.7	10
^{238}U	8.3	10

Note: Both the CL values and 10% of the DCG values represent the annual average concentration that with elapsed time meters at a flow rate of about 566 cubic centimeters per minute (1.2 ft^3 per hour). The total volume sampled is determined from the product of the sampling period and the flow rate (about 11 m^3 [14.4 cubic yards] over a two-week sampling period). The HTO was removed from the airstream by two molecular sieve columns connected in series (one for routine collection and a second to indicate if breakthrough occurred through the first column during collection). These columns were exchanged biweekly. An aliquot of the total moisture collected was extracted from the first column and analyzed for tritium by liquid scintillation counting. In all cases, measured activity in units per sample is converted to units per volume of air prior to reporting in the following sections.

Routine quality control air samples (e.g., duplicates, blanks, and spikes) are also incorporated into the analytical suites on a frequent basis. Chapter 18 contains a discussion of quality assurance/quality control protocols and procedures utilized for radiological air monitoring.

3.1.3 Presentation of Air Sampling Data

The annual average concentration for each radionuclide at each station is presented in the following sections. The annual average concentration for each radionuclide was calculated from uncensored analytical results for individual samples; i.e., values less than the sample-specific MDC were included in the calculation. A column is included in each table indicating the percentage of the analytical results that were greater than their analysis-specific MDCs.

Annual average concentrations are also expressed in the tables as percentages of the CL (the second column of Table 3-1). In graphs of concentration data, the CL or some percentage of the CL is included as a green horizontal line. The CL for each radionuclide is used instead of the DCG, as it is the lesser of the two for those radionuclides for which these limits differ. The CL or fraction thereof is shown in graphs for reference only and not to demonstrate compliance with NESHAP dose limits, since assessment of compliance is based upon annual average concentrations, not upon the single measurement results shown in the graphs.

For convenience in reporting, values shown in the tables in the following result sections are frequently formatted to a greater number of significant digits than can be justified by the accuracy of the measurements, which is typically two significant figures (e.g., 2500, 25, 2.5, or 0.025).

3.1.4 Air Sampling Results from Environmental Samplers

All elevated radionuclide concentrations in the 2008 air samples shown in the tables and graphs are attributed to the resuspension of legacy contamination in surface soils and to the upward flux of tritium from the soil at sites of past nuclear tests and of low-level radioactive waste burial.

Monitoring results for the point-source station at JASPER are included in the tables in this section. These results are not included in NTS-wide averages of air concentrations, as they are generally based on rather small air volumes and are consequently of rather lower precision than the data from the environmental air samplers.

3.1.4.1 Americium-241

During 2008, 28.5 percent of ^{241}Am measurements exceeded their MDCs (Table 3-2). This is about the same as 2007 (26.5 percent) and somewhat lower than 2006 and 2005 (40 and 35 percent, respectively). The mean concentration over all environmental sampler stations was 4.5 x 10^{-18} µCi/mL, similarly lower than preceding years including 2007. The highest concentrations are found sporadically at U-3ah/at S in Area 3 and at Bunker 9-300 in Area 9 (Figure 3-2), located within areas of known soil contamination from past nuclear tests. The annual mean concentrations at U-3ah/at S and Bunker 9-300 were 17.5 and 11.6 x 10^{-18} µCi/mL, 0.9 and 0.6 percent of the CL, respectively.

Table 3-2. Concentrations of ^{241}Am in air samples collected in 2008

NTS Area	Sampling Station	Number of Samples	^{241}Am (x 10^{-18} µCi/mL) Mean	% of CL [(a)]	Median	SD [(b)]	Min [(c)]	Max [(d)]	Mean MDC	% > MDC
1	BJY	12	3.36	0.2	2.19	4.67	-2.27	11.65	9.46	29.2
3	U-3ah/at N	12	4.42	0.2	3.79	4.91	-2.89	13.19	7.66	25.0
3	U-3ah/at S	12	17.54	0.9	10.44	23.64	-1.50	82.81	8.43	58.3
3	U-3bh N	12	5.57	0.3	4.81	7.37	-4.93	18.76	8.32	33.3
3	U-3bh S	12	10.37	0.5	3.93	12.29	-1.11	34.56	8.75	50.0
5	DoD	12	1.86	0.1	2.14	2.72	-2.47	6.74	8.33	20.8
5	Sugar Bunker N	12	0.57	0.0	0.75	3.17	-4.50	5.83	9.15	8.3
6	Yucca	12	4.49	0.2	2.58	9.09	-6.44	30.95	8.89	16.7
9	Bunker 9-300	12	11.64	0.6	11.16	12.18	0.40	46.09	8.08	66.7
10	Gate 700 S	12	2.37	0.1	1.73	4.81	-7.24	12.37	7.56	41.7
10	Sedan N	12	5.56	0.3	5.14	6.32	-4.05	17.57	7.82	33.3
16	3545 Substation	12	0.59	0.0	0.64	4.36	-4.43	11.57	9.15	8.3
18	Little Feller 2 N	12	4.16	0.2	4.61	3.82	-1.06	9.58	7.28	25.0
20	Gate 20-2P	12	-0.07	0.0	1.59	3.59	-8.28	3.56	9.10	8.3
20	Schooner	12	4.52	0.2	2.94	8.15	-2.62	27.73	6.65	41.7
23	Mercury Track	12	1.37	0.1	2.13	2.68	-3.55	6.03	7.98	16.7
25	Gate 510	12	0.74	0.0	1.71	4.01	-7.35	7.99	8.66	16.7
27	ABLE Site	12	2.60	0.1	2.36	2.60	-1.26	6.21	8.99	12.5
All Environmental Samplers		**216**	**4.54**	**0.2**	**2.58**	**9.18**	**-8.28**	**82.81**	**8.35**	**28.5**
27	JASPER Stack	12	43.25	2.3	27.27	47.24	-16.07	124.44	198.71	0.0

Blue-shaded locations are EPA-approved critical receptor sampler stations.
The orange-shaded location is a point-source sampler station.
Non-shaded locations are environmental sampler stations.
Green shading indicates that some percentage of samples had concentrations above the sample-specific MDC.
(a) CL is the NESHAP Concentration Level for Environmental Compliance (see Table 3-1).
(b) Standard deviation (c) Minimum (d) Maximum
Note: The CL for ^{241}Am is 1,900 x 10^{-18} µCi/mL.

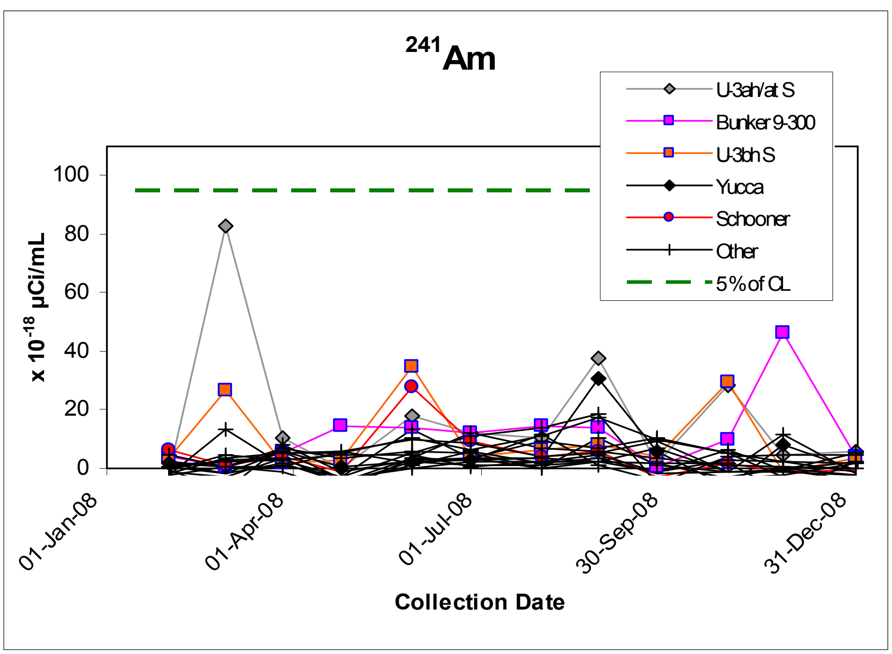


Figure 3-2. Concentrations of ^{241}Am in air samples collected in 2008

3.1.4.2 Cesium-137

No ^{137}Cs measurement exceeded its MDC during 2008 (Table 3-3). Mean values for all environmental samplers were near or below zero. No plot is provided because of the low measurement levels.

Table 3-3. Concentrations of ^{137}Cs in air samples collected in 2008

			^{137}Cs (x 10^{-17} µCi/mL)							
NTS Area		**Number of Samples**	**Mean**	**% of CL [(a)]**	**Median**	**SD [(b)]**	**Min [(c)]**	**Max [(d)]**	**Mean MDC**	**% > MDC**
1	BJY	11	-4.18	-0.2	-1.44	14.73	-42.49	14.35	58.60	0.0
3	U-3ah/at N	11	0.30	0.0	-0.86	22.36	-34.31	39.60	69.18	0.0
3	U-3ah/at S	12	-7.04	-0.4	-11.27	27.88	-48.05	54.00	64.63	0.0
3	U-3bh N	12	14.54	0.8	-1.15	48.26	-47.32	140.63	72.47	0.0
3	U-3bh S	12	3.84	0.2	0.18	21.55	-19.97	43.80	69.32	0.0
5	DoD	11	4.99	0.3	8.93	27.48	-36.84	56.55	67.99	0.0
5	Sugar Bunker N	12	14.06	0.7	11.33	20.70	-13.12	61.37	59.85	0.0
6	Yucca	12	-4.07	-0.2	-2.43	14.99	-32.46	15.60	58.27	0.0
9	Bunker 9-300	11	-1.96	-0.1	-1.40	18.93	-40.73	28.51	61.85	0.0
10	Gate 700 S	11	-4.13	-0.2	-6.83	16.85	-33.59	26.63	61.09	0.0
10	Sedan N	10	2.74	0.1	0.97	14.88	-14.89	32.27	60.04	0.0
16	3545 Substation	12	-6.31	-0.3	-8.08	18.70	-41.16	23.45	66.48	0.0
18	Little Feller 2 N	12	-2.86	-0.2	-8.56	19.40	-30.11	39.40	64.07	0.0
20	Gate 20-2P	11	6.14	0.3	1.82	24.46	-27.95	45.44	66.07	0.0
20	Schooner	12	0.25	0.0	5.54	19.60	-35.50	22.97	55.43	0.0
23	Mercury Track	12	1.32	0.1	2.32	13.81	-24.54	21.70	59.87	0.0
25	Gate 510	11	-10.12	-0.5	-15.16	18.77	-33.78	17.35	60.13	0.0
27	ABLE Site	12	-4.42	-0.2	-4.03	22.49	-50.90	26.37	60.86	0.0
All Environmental Samplers		**207**	**0.20**	**0.0**	**-0.87**	**22.90**	**-50.90**	**140.63**	**63.14**	**0.0**
27	JASPER Stack	12	318.31	16.8	-119.88	1319.68	-391.59	4396.07	1464.44	0.0

Blue-shaded locations are EPA-approved critical receptor sampler stations.
The orange-shaded location is a point-source sampler station.
Non-shaded locations are environmental sampler stations.
(a) CL is the NESHAP Concentration Level for Environmental Compliance (see Table 3-1).
(b) Standard deviation
(c) Minimum
(d) Maximum
Note: The CL for ^{137}Cs is 1,900 x 10^{-17}µCi/mL.

3.1.4.3 Plutonium Isotopes

During 2008 7.8 percent of ^{238}Pu measurements exceeded their MDCs (Table 3-4), somewhat fewer than during 2007, 2006, and 2005. The overall mean concentration (2.27 x 10^{-18} µCi/mL) was similar to that of the three prior years. No one station appears to be consistently higher than the rest; see Figure 3-3. The highest mean concentrations at the stations were only 0.2 percent of the CL.

Plutonium isotopes $^{239+240}$Pu (analytical methods cannot readily distinguish between ^{239}Pu and ^{240}Pu) are of greater abundance and hence greater interest. Overall, 48 percent of measurements exceeded their MDCs (Table 3-5). The overall mean of 22 x 10^{-18} µCi/mL is considerably lower than in 2006 and 2005 (138 and 148 x 10^{-18} µCi/mL, respectively) but similar to levels seen in other recent years (39, 48, 38, and 55 x 10^{-18} µCi/mL in 2007, 2004, 2003, and 2002, respectively). The locations with the highest means are U-3ah/at S and Bunker 9-300, with annual means of 91 and 73 x 10^{-18} µCi/mL, respectively; these are 4.6 and 3.7 percent of the CL (see Table 3-5

Table 3-4. Concentrations of ^{238}Pu in air samples collected in 2008

NTS Area	Sampling Station	Number of Samples	^{238}Pu (x 10^{-18} µCi/mL) Mean	% of CL [(a)]	Median	SD [(b)]	Min [(c)]	Max [(d)]	Mean MDC	% > MDC
1	BJY	12	1.35	0.1	0.85	2.42	-2.34	6.53	8.85	0.0
3	U-3ah/at N	11	0.88	0.0	0.66	2.83	-4.56	5.90	16.58	0.0
3	U-3ah/at S	12	4.98	0.2	3.36	5.48	-0.77	14.30	10.54	16.7
3	U-3bh N	11	1.71	0.1	0.53	3.23	-1.13	9.34	8.74	0.0
3	U-3bh S	11	3.50	0.2	2.26	3.74	-0.67	12.28	8.85	9.1
5	DoD	11	1.82	0.1	1.63	3.06	-3.07	6.45	9.72	9.1
5	Sugar Bunker N	12	3.47	0.2	0.28	7.23	-2.03	23.01	11.14	8.3
6	Yucca	12	3.02	0.1	0.89	7.17	-3.51	22.75	12.24	12.5
9	Bunker 9-300	12	2.37	0.1	2.12	4.10	-5.65	10.25	7.44	16.7
10	Gate 700 S	12	1.65	0.1	1.27	1.93	-1.39	5.00	11.62	8.3
10	Sedan N	12	2.08	0.1	2.29	4.47	-10.81	7.25	10.95	16.7
16	3545 Substation	12	0.48	0.0	0.00	3.16	-5.88	7.17	8.81	0.0
18	Little Feller 2 N	12	0.97	0.0	0.75	1.60	-1.16	4.08	10.10	8.3
20	Gate 20-2P	12	3.74	0.2	1.47	5.99	-0.89	18.40	10.20	0.0
20	Schooner	12	5.11	0.2	1.88	7.15	-1.22	22.88	9.02	16.7
23	Mercury Track	12	-0.75	0.0	0.00	3.25	-10.32	2.48	7.48	0.0
25	Gate 510	12	2.70	0.1	1.92	3.34	-0.67	9.68	8.67	16.7
27	ABLE Site	11	1.68	0.1	0.00	3.65	-2.27	8.41	11.85	0.0
	All Environmental Samplers	**211**	**2.27**	**0.1**	**1.13**	**4.54**	**-10.81**	**23.01**	**10.13**	**7.8**
27	JASPER Stack	12	57.20	2.7	10.18	146.11	-23.64	514.30	167.54	0.0

Blue-shaded locations are EPA-approved critical receptor sampler stations.
The orange-shaded location is a point-source sampler station.
Non-shaded locations are environmental sampler stations.
Green shading indicates that some percentage of samples had concentrations above the sample-specific MDC.
(a) CL is the NESHAP Concentration Level for Environmental Compliance (see Table 3-1).
(b) Standard deviation (c) Minimum (d) Maximum
Note: The CL for ^{238}Pu is 2,100 x 10^{-18}µCi/mL.

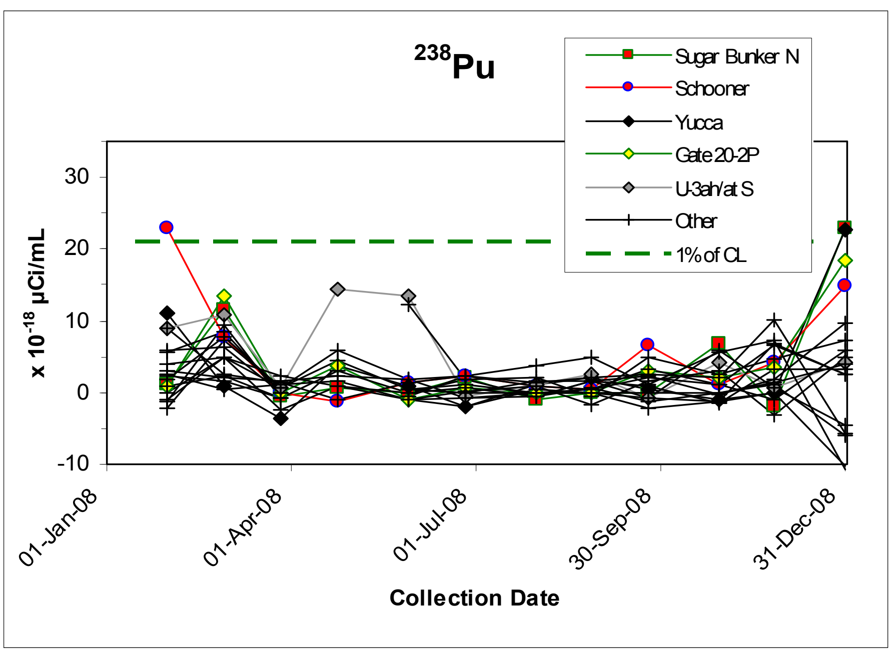


Figure 3-3. Concentrations of ^{238}Pu in air samples collected in 2008

and Figure 3-4). The relatively high plutonium values observed at these stations are due to diffuse sources of radionuclides from historical nuclear testing in Areas 3 and 9 and in surrounding Areas 4 and 7.

The temporal patterns for ^{241}Am and $^{239+240}$Pu at U-3ah/at S and Bunker 9-300 shown in Figures 3-2 and 3-4 are correlated. This is because ^{241}Am is the long-lived daughter product obtained when ^{241}Pu (a short-lived isotope created along with the more common Pu isotopes) decays by beta emission. Hence, $^{239+240}$Pu and ^{241}Am (and also ^{238}Pu to some extent) tend to be found together in particles of Pu remaining from past nuclear tests. The half-life of ^{241}Pu is 14.4 years, whereas that of ^{241}Am is 432 years; consequently, concentrations of ^{241}Am in NTS soils should gradually increase for about 80 years and then decrease. These isotopes become airborne by soil disturbances.

Table 3-5. Concentrations of $^{239+240}$Pu in air samples collected in 2008

			$^{239+240}$Pu (x 10^{-18} µCi/mL)							
NTS Area	**Sampling Station**	**Number of Samples**	**Mean**	**% of CL [(a)]**	**Median**	**SD [(b)]**	**Min [(c)]**	**Max [(d)]**	**Mean MDC**	**% > MDC**
1	BJY	12	28.60	1.4	16.44	43.89	1.28	161.07	8.30	70.8
3	U-3ah/at N	12	27.42	1.4	26.23	20.41	1.79	58.26	9.38	66.7
3	U-3ah/at S	12	91.24	4.6	43.18	141.09	-0.99	511.39	14.35	83.3
3	U-3bh N	12	32.36	1.6	23.41	30.67	-0.02	100.33	8.45	83.3
3	U-3bh S	12	55.44	2.8	21.03	88.82	3.30	259.19	6.24	66.7
5	DoD	12	3.05	0.2	2.57	3.84	-2.40	12.40	6.26	37.5
5	Sugar Bunker N	12	4.97	0.2	5.30	3.99	-2.00	10.91	9.31	33.3
6	Yucca	12	24.82	1.2	8.18	57.66	0.00	206.91	8.09	58.3
9	Bunker 9-300	12	73.18	3.7	48.27	84.04	13.93	327.49	6.21	100.0
10	Gate 700 S	12	6.78	0.3	4.92	7.12	1.49	28.75	8.77	37.5
10	Sedan N	12	26.66	1.3	17.41	26.80	-2.08	85.50	9.72	66.7
16	3545 Substation	12	1.67	0.1	1.99	6.50	-15.62	12.58	8.71	25.0
18	Little Feller 2 N	12	7.65	0.4	6.10	6.08	1.36	24.56	8.09	50.0
20	Gate 20-2P	12	2.14	0.1	1.62	4.33	-9.19	7.38	9.57	12.5
20	Schooner	12	3.54	0.2	1.95	6.39	-3.69	20.73	8.04	16.7
23	Mercury Track	12	3.56	0.2	2.08	4.33	-1.29	12.75	7.61	20.8
25	Gate 510	12	1.60	0.1	1.28	2.98	-3.23	8.77	9.25	8.3
27	ABLE Site	12	3.97	0.2	3.03	4.50	-0.04	16.32	8.70	29.2
All Environmental Samplers		**216**	**22.15**	**1.1**	**6.00**	**53.34**	**-15.62**	**511.39**	**8.61**	**48.1**
27	JASPER Stack	11	32.48	1.6	15.94	34.33	0.00	106.25	130.55	0.0

Blue-shaded locations are EPA-approved critical receptor sampler stations.
The orange-shaded location is a point-source sampler station.
Non-shaded locations are environmental sampler stations.
Green shading indicates that some percentage of samples had concentrations above the sample-specific MDC.
(a) CL is the NESHAP Concentration Level for Environmental Compliance (see Table 3-1).
(b) Standard deviation
(c) Minimum
(d) Maximum
Note: The CL for $^{239+240}$Pu is 2,000 x 10^{-18} µCi/mL.

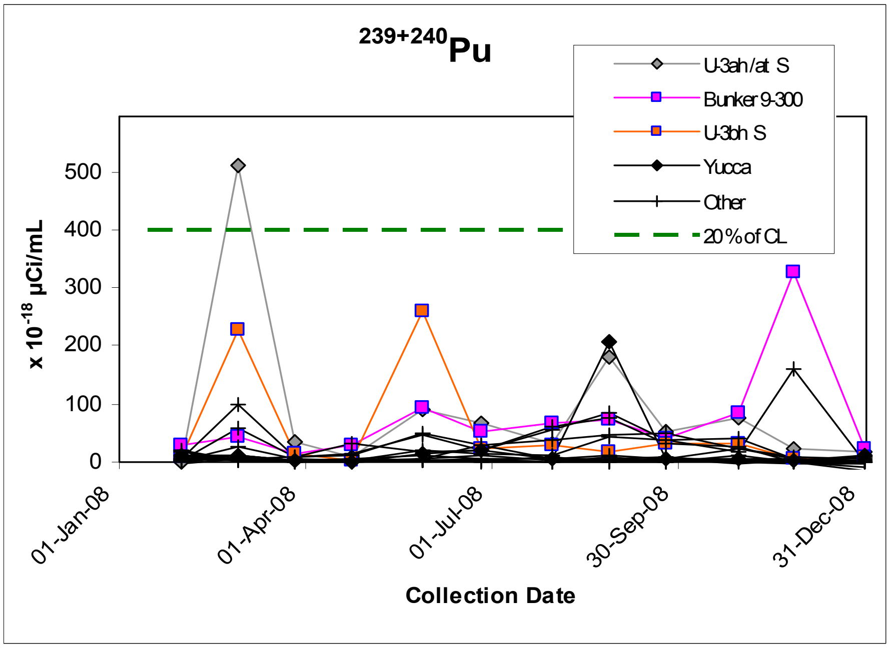


Figure 3-4. Concentrations of $^{239+240}Pu$ in air samples collected in 2008

Figure 3-5 shows long-term trends in $^{239+240}Pu$ annual mean concentrations at locations with at least 15-year data histories since 1970. Rather than showing the time histories for all 42 locations, Figure 3-5 shows the annual highest mean for any station in its "area group" (geographically contiguous group of NTS Areas). The estimated average annual rates of decline for the area groups range from 2.9 percent (Areas 1 and 3) and 4.0 percent (Areas 7, 9, 10, and 15) to 17.7 percent (Areas 19 and 20). These rates are all considerably faster than can be attributed to radioactive decay, as the half-lives of ^{239}Pu and ^{240}Pu are 24,110 and 6,537 years, respectively. The decreases are therefore attributed to immobilization of Pu particles in soil and/or decrease in activities resulting in soil resuspension. The half-life of the less abundant ^{238}Pu is 88 years. Figure 3-6 shows the average (geometric mean) trend lines by area group for all stations with at least 15-year histories in that area group.

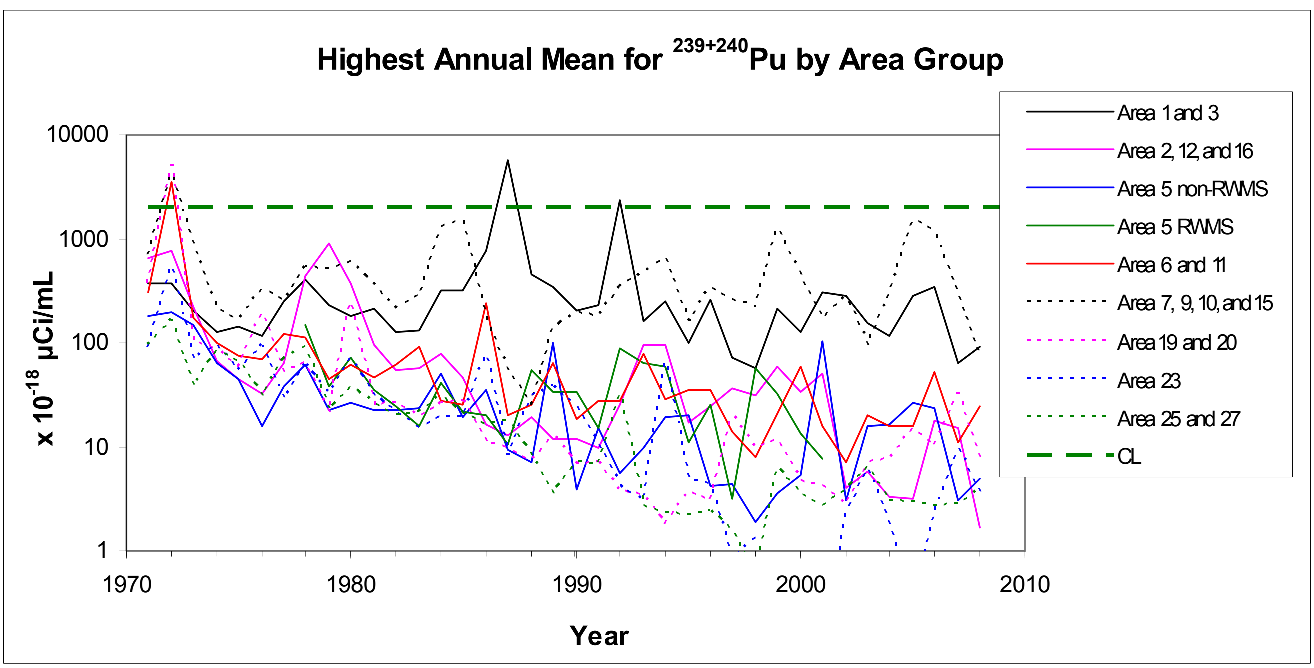


Figure 3-5. Highest annual mean concentrations of $^{239+240}Pu$ in air samples for each NTS area group, 1971–2008

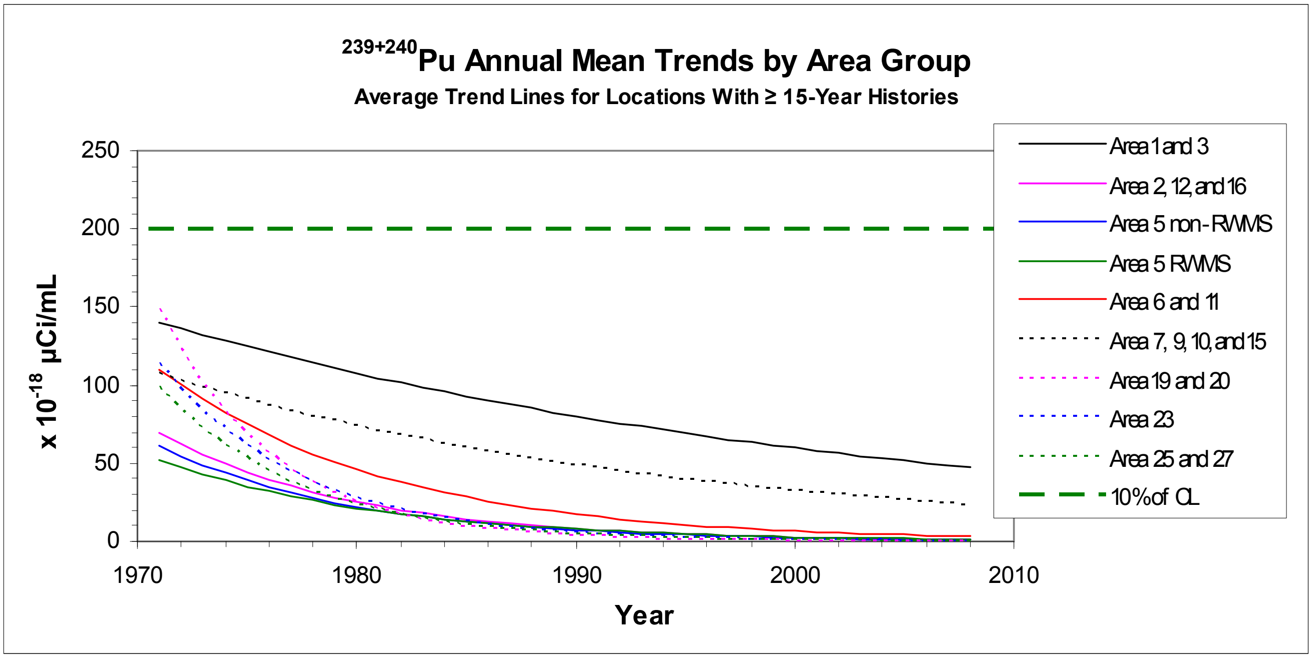


Figure 3-6. Fitted average trends in $^{239+240}$Pu geometric-means of air samples by NTS area group, 1971–2008

3.1.4.4 Uranium Isotopes

Uranium analyses by radiochemistry were performed for samples from five stations. Exercises using depleted uranium ordnance have been conducted in the past in Areas 20 and 25. The annual mean concentrations are shown in Table 3-6; note that the scale factor in Table 3-6 is the same for $^{233+234}$U and ^{238}U, but an order of magnitude lower for $^{235+236}$U. All but one of the $^{233+234}$U and ^{238}U measurements exceeded their MDCs, whereas 32 percent of measurements exceeded the MDC for $^{235+236}$U. Mean concentrations of all isotopes are similar to those for 2007. These mean concentrations remain around 2–4 percent of the CLs for $^{233+234}$U and ^{238}U and at most 0.2 percent of the CL for $^{235+236}$U. No substantial or statistically significant differences were observed between stations.

Table 3-6. Concentrations of uranium isotopes in air samples collected in 2008

NTS Area	Sampling Station	Number of Samples	Mean	% of CL (a)	Median	SD (b)	Min (c)	Max (d)	Mean MDC	% > MDC
			$^{233+234}$U (x 10^{-17} µCi/mL)							
6	Yucca	12	18.45	2.6	19.09	3.49	11.21	24.00	2.02	100.0
16	3545 Substation	12	28.91	4.1	19.15	34.12	2.25	135.35	2.76	100.0
20	Gate 20-2P	12	17.47	2.5	16.54	3.60	11.79	25.30	1.90	100.0
25	Gate 510	12	21.83	3.1	18.22	13.13	14.14	62.04	2.24	100.0
27	ABLE Site	12	18.16	2.6	18.01	2.98	13.10	22.97	2.43	100.0
	All Stations	**60**	**20.96**	**3.0**	**18.89**	**16.55**	**2.25**	**135.35**	**2.27**	**100.0**
			$^{235+236}$U (x 10^{-18} µCi/mL)							
6	Yucca	12	7.21	0.1	6.54	7.14	-0.29	26.05	16.39	20.8
16	3545 Substation	12	15.16	0.2	10.59	21.93	1.31	81.09	14.11	50.0
20	Gate 20-2P	12	7.98	0.1	7.07	6.35	0.98	19.34	13.57	41.7
25	Gate 510	12	9.75	0.1	9.91	6.56	0.25	20.68	13.28	29.2
27	ABLE Site	12	7.66	0.1	5.89	7.19	-1.53	19.04	17.80	16.7
	All Stations	**60**	**9.55**	**0.1**	**7.36**	**11.54**	**-1.53**	**81.09**	**15.03**	**31.7**

Table 3-6. Concentrations of uranium isotopes in air samples collected in 2008 (continued)

			^{238}U (x 10^{-17} µCi/mL)							
NTS Area	**Sampling Station**	**Number of Samples**	**Mean**	**% of CL [(a)]**	**Median**	**SD [(b)]**	**Min [(c)]**	**Max [(d)]**	**Mean MDC**	**% > MDC**
6	Yucca	12	17.44	2.1	17.84	3.07	11.33	22.73	1.90	100.0
16	3545 Substation	12	17.97	2.2	19.24	5.73	1.63	22.35	2.19	91.7
20	Gate 20-2P	12	19.11	2.3	19.62	1.81	15.90	21.96	1.59	100.0
25	Gate 510	12	18.11	2.2	17.01	3.30	13.45	24.72	1.86	100.0
27	ABLE Site	12	19.73	2.4	20.54	3.64	13.29	24.47	1.94	100.0
	All Stations	**60**	**18.47**	**2.2**	**18.66**	**3.70**	**1.63**	**24.72**	**1.90**	**98.3**

Blue-shaded locations are EPA-approved critical receptor sampler stations.
Non-shaded locations are environmental sampler stations.
Green shading indicates that some percentage of samples had concentrations above the sample-specific MDC.
(a) CL is the NESHAP Concentration Level for Environmental Compliance (see Table 3-1).
(b) Standard deviation
(c) Minimum
(d) Maximum
Note: The CL for $^{233+234}$U is about 710 x 10^{-17} µCi/mL.
The CL for $^{235+236}$U is about 7,100 x 10^{-18} µCi/mL.
The CL for ^{238}U is 830 x 10^{-17} µCi/mL.

The ratios of the uranium isotope concentrations are given in Table 3-7, and Table 3-8 presents the values expected of those ratios for uranium from different sources. Because of the high proportion of $^{235+236}$U measurements below their MDCs, including negative values, these ratios are computed in terms of $^{233+234}$U/^{238}U and $^{235+236}$U/^{238}U, a departure from reports over the past five years that used ratios with ^{238}U in the numerator. The median $^{235+236}$U/^{238}U ratio is consistent with a source of natural U, whereas the median $^{233+234}$U/^{238}U ratio is below the target values for both natural and depleted U. There was one anomalous sample in April from 3545 Substation, which had uranium ratios more suggestive of enriched U. No other sample during 2008 supported evidence of an enriched uranium source at that location.

Table 3-7. Observed values of uranium isotope ratios in 2008

	Isotope Ratio Values $^{233+234}$U / ^{238}U	$^{235+236}$U / ^{238}U
Median (95% CI)	1.00 (0.92, 1.05)	0.043 (0.033, .058)

Table 3-8. Expected ratios of uranium isotopes by type of source

Source	**Expected Isotope Ratios** $^{233+234}$U / ^{238}U	$^{235+236}$U / ^{238}U
Natural	~1.29	~0.047
Enriched	~6.8	~0.19
Depleted	~1.13	~0.016

3.1.4.5 Tritium

Measurements of tritium (^3H) in air vary widely across monitoring stations on the NTS. Overall 35 percent of atmospheric moisture samples have ^3H concentrations above their MDCs (Table 3-9); this proportion of detections ranges from 100 percent at Schooner and E Tunnel Pond to less than 10 percent at several stations.

As in past years, the highest mean concentration was at the Schooner station (280 x 10^{-6} picocuries per milliliter [pCi/mL]). The next highest were 5.6 x 10^{-6} pCi/mL at Sedan N and 5.0 x 10^{-6} pCi/mL at E Tunnel Pond 2; all of these values were similar to those from 2007. Figure 3-7 shows these data; note that the Schooner values are plotted at one-tenth of their actual values in order to allow the variation at other locations to be visible. The Schooner annual mean was 19 percent of the CL. The mean concentrations at other locations were at most 0.4 percent of the CL.

Table 3-9. Concentrations of ^3H in air samples collected in 2008

			^3H Concentration (x 10^{-6} pCi/mL)							
NTS Area	**Sampling Station**	**Number of Samples**	**Mean**	**% of CL [(a)]**	**Median**	**SD [(b)]**	**Min [(c)]**	**Max [(d)]**	**Mean MDC**	**% > MDC**
1	BJY	26	0.85	0.1	0.78	0.74	-0.14	3.20	1.02	34.6
3	U-3ah/at S	26	1.06	0.1	0.86	0.85	-0.20	2.98	1.02	46.2
3	U-3bh N	24	1.02	0.1	0.57	1.17	-0.03	4.97	1.05	29.2
5	DoD	25	0.40	0.0	0.30	0.48	-0.34	1.53	1.02	18.0
5	Sugar Bunker N	25	0.59	0.0	0.54	0.46	-0.29	1.72	1.07	16.0
6	Yucca	25	0.32	0.0	0.34	0.32	-0.51	1.01	1.08	0.0
9	Bunker 9-300	26	1.79	0.1	1.52	1.41	0.01	5.01	1.02	69.2
10	Gate 700 S	25	0.41	0.0	0.26	0.58	-0.33	2.36	1.02	12.0
10	Sedan N	26	5.62	0.4	4.32	5.35	-0.01	17.60	1.02	92.3
12	E Tunnel Pond 2	25	5.01	0.3	4.04	3.13	0.96	10.70	1.02	100.0
16	3545 Substation	26	0.24	0.0	0.16	0.39	-0.41	1.03	1.00	7.7
18	Little Feller 2 N	26	0.18	0.0	0.14	0.29	-0.33	0.74	1.00	3.8
20	Gate 20-2P	26	0.23	0.0	0.30	0.32	-0.55	0.98	0.95	11.5
20	Schooner	26	279.87	18.7	179.50	282.83	9.30	817.00	1.32	100.0
23	Mercury Track	26	0.20	0.0	0.23	0.35	-0.61	0.93	1.08	5.8
25	Gate 510	25	0.09	0.0	0.10	0.34	-0.74	0.74	1.13	8.0
	All Environmental Samplers	**408**	**18.96**	**1.3**	**0.53**	**97.79**	**-0.74**	**817.00**	**1.05**	**34.8**

Blue-shaded locations are EPA-approved critical receptor sampler stations.
Non-shaded locations are environmental sampler stations.
Green shading indicates that some percentage of samples had concentrations above the sample-specific MDC
(a) CL is the NESHAP Concentration Level for Environmental Compliance (see Table 3-1).
(b) Standard deviation
(c) Minimum
(d) Maximum
Note: The CL for ^3H is 1,500 x 10^{-6} pCi/mL.

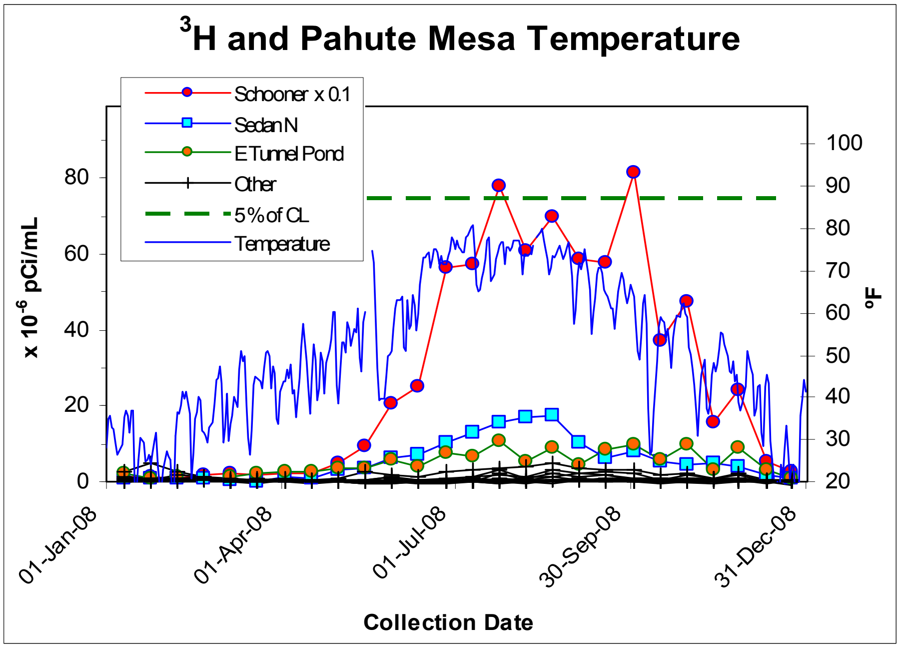


Figure 3-7. Concentrations of ^{3}H in air samples collected in 2008 and Pahute Mesa air temperature

The tritium found at Schooner, Sedan N, and E Tunnel Pond 2 comes from past nuclear tests. Tritium associated with these tests quickly oxidized into tritiated water, which remains in the surrounding soil and rubble until it moves to the surface and evaporates. Higher tritium concentrations in air are generally observed during the summer months. For the E Tunnel Pond station, this increase is due to the rate of evaporation increasing as the temperature increases during the summer months. For the Schooner and Sedan stations, increased tritium emissions are likely due to the movement of relatively deep soil moisture (> 2 m) containing relatively high concentrations of tritium to the surface when temperatures are the highest and when shallow (< 2 m) soil moisture is the lowest. Rainfall can temporarily suppress these emissions by diluting the shallow soil moisture. Figure 3-7 shows the relationship between ^{3}H measurements and the average daily temperature at Pahute Mesa, where Schooner is located; Figure 3-8 shows the time and amount of precipitation events in that area.

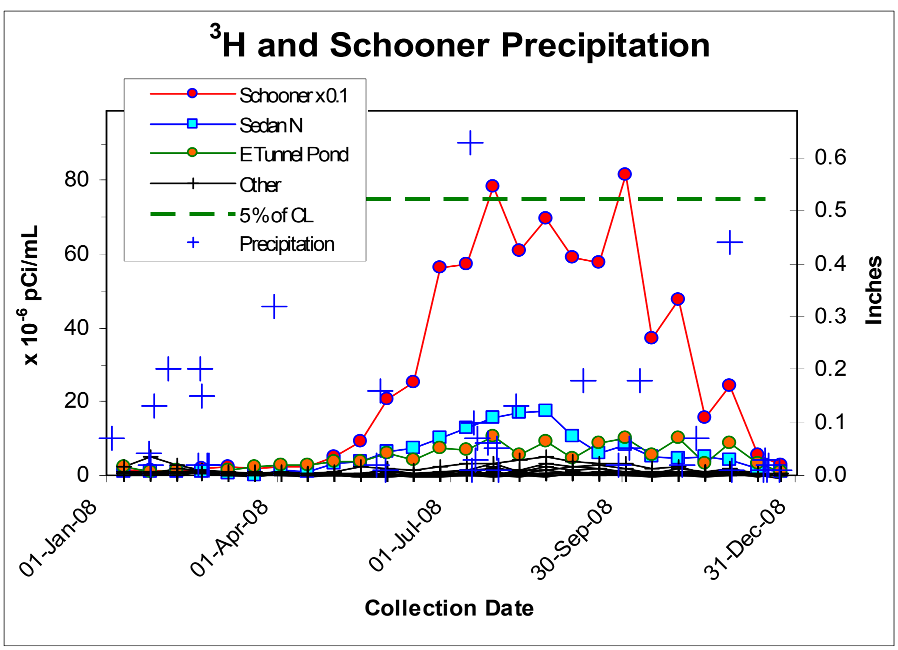


Figure 3-8. Concentrations of ^{3}H in air samples collected in 2008 and Pahute Mesa precipitation

Figure 3-9 shows long-term trends for the annual mean tritium levels at locations with at least seven-year histories since 1990, color-coded by NTS Area. At most locations, the ^{3}H measurements have been decreasing fairly rapidly from year to year; the average decline rate is around 14 percent per year across all locations excluding Schooner. These figures and patterns differ slightly from those in the 2007 NTS environmental report (NSTec, 2008a), as E Tunnel Pond now has enough history to be included in the "≥ 7 years" category.

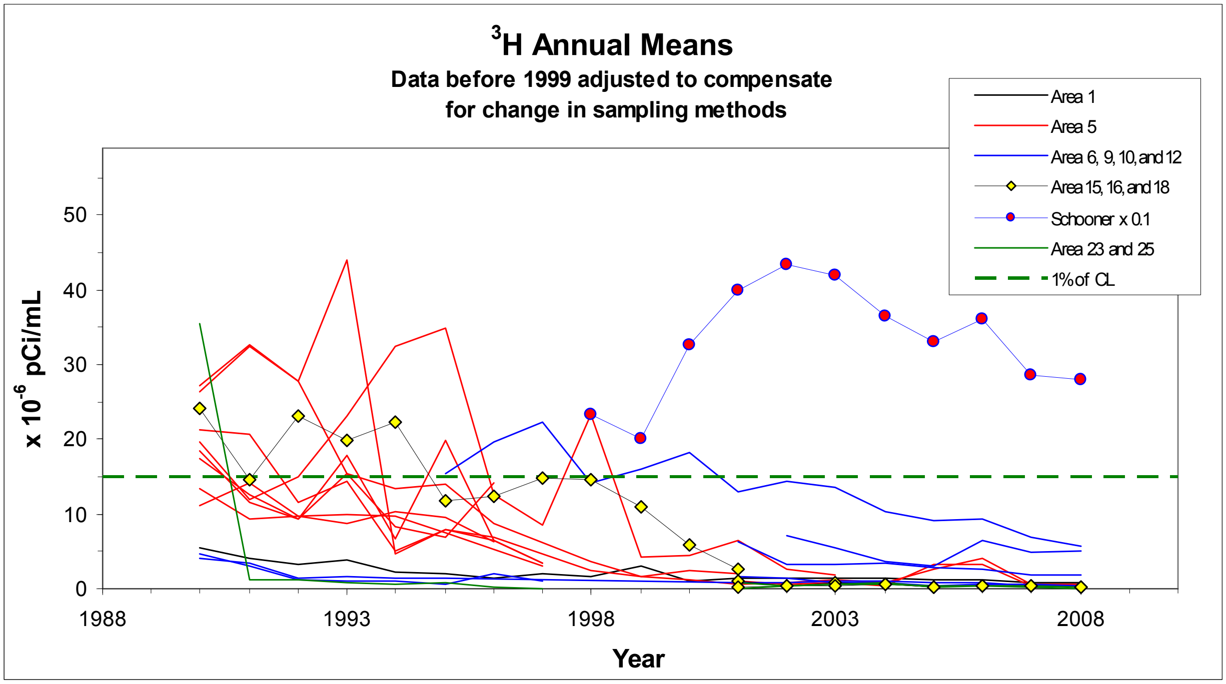


Figure 3-9. Annual mean concentrations of ^{3}H in air samples, 1990–2008

The exception to the generally decreasing trend occurs at Schooner. As Figure 3-10 shows, Schooner ^{3}H data do not show a consistent trend; rather, ^{3}H emissions appear to be related to the temperatures on Pahute Mesa during the summer months. The data suggest that there may be influences due to seasonal precipitation and recharge as well.

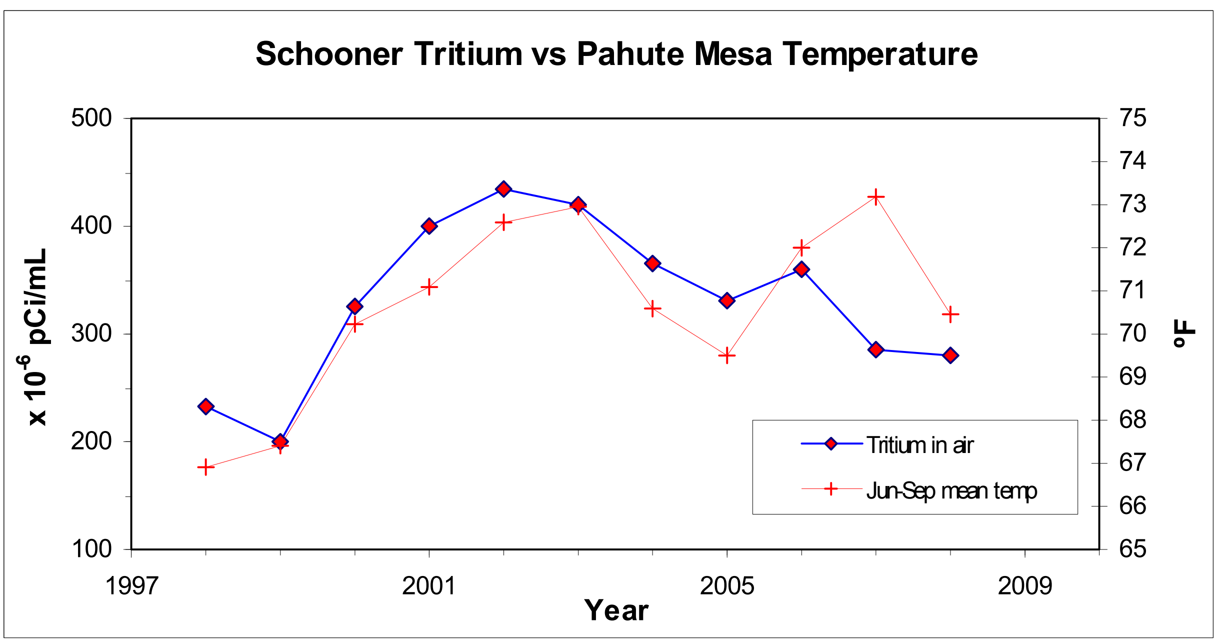


Figure 3-10. Concentrations of ^{3}H at Schooner and June–September mean temperatures at Pahute Mesa, 1998–2008

3.1.4.6 Gross Alpha and Gross Beta

The gross alpha and gross beta radioactivity in air samples collected in 2008 are shown in Tables 3-10 and 3-11 and Figures 3-11 and 3-12. Since these radioactivity measurements include naturally occurring radionuclides (e.g., ^{40}K, ^{7}Be, uranium, thorium, and the daughter isotopes of uranium and thorium) in uncertain proportions, a meaningful CL cannot be constructed. These analyses are useful in that they can be performed just five days after sample collection to identify any increases requiring investigation.

Overall, 26 percent of gross alpha measurements exceeded their MDCs, comparable to 2007 and somewhat lower than 2006 and 2005. The distribution of measurement means across the network is also similar to that of 2007, and the overall mean is comparable with those of the past few years. Figure 3-11 shows these measurements; the predominant features are the few isolated high values at U-3ah/at S, U3-bh S, and Sugar Bunker N, along with the general parallelism of the week-to-week variation in the measurements.

The gross beta measurements in 2008 resembled those of prior years: all data exceeded their MDCs, the mean values are similar, and there are no stations with data standing out from the others. The most prominent feature in Figure 3-12, as in past years, is the week-to-week parallel variation between sampling locations. This is much more pronounced with gross beta than with gross alpha or other analytes.

Table 3-10. Gross alpha radioactivity in air samples collected in 2008

NTS Area	Sampling Station	Number of Samples	Gross Alpha (x 10^{-16} µCi/mL) Mean	Median	SD (a)	Min (b)	Max (c)	Mean MDC	% > MDC
1	BJY	53	18.90	18.93	11.70	-1.08	42.94	29.38	19.8
3	U-3ah/at N	53	19.42	19.12	12.31	-5.54	51.79	28.92	28.3
3	U-3ah/at S	52	20.16	18.04	16.70	-5.69	105.55	28.49	23.1
3	U-3bh N	49	18.09	18.55	11.93	-6.77	44.65	29.78	18.4
3	U-3bh S	50	24.39	24.36	16.53	-3.55	94.05	28.54	40.0
5	DoD	52	16.37	15.65	11.14	-7.63	46.36	28.84	19.2
5	Sugar Bunker N	53	31.62	29.44	19.80	-6.61	86.24	29.63	58.5
6	Yucca	53	23.34	24.07	12.91	-13.41	49.27	28.68	37.7
9	Bunker 9-300	52	23.14	21.34	13.82	-12.32	67.61	28.69	34.6
10	Gate 700 S	52	16.29	14.90	9.73	0.00	41.93	28.93	16.3
10	Sedan N	53	17.49	14.83	13.15	-5.64	43.40	28.73	28.3
16	3545 Substation	51	19.15	18.74	12.22	-5.39	53.61	29.22	23.5
18	Little Feller 2 N	53	17.47	16.58	11.27	-7.87	46.16	28.68	17.0
20	Gate 20-2P	52	17.74	17.26	12.64	-7.98	45.52	29.27	21.2
20	Schooner	53	17.64	18.88	10.47	-11.05	39.38	28.70	20.8
23	Mercury Track	53	17.95	19.21	10.81	-6.63	39.31	29.01	13.2
25	Gate 510	53	18.55	16.80	12.60	-10.94	48.99	28.91	24.5
27	ABLE Site	53	16.08	16.69	11.24	-6.68	40.53	28.93	14.2
	All Environmental Samplers	**940**	**19.65**	**18.72**	**13.47**	**-13.41**	**105.55**	**28.96**	**25.5**
27	JASPER Stack	48	-72.41	-33.09	312.49	-769.93	776.65	737.24	2.1

Blue-shaded locations are EPA-approved critical receptor sampler stations.
The orange-shaded location is a point-source sampler station.
Non-shaded locations are environmental sampler stations.
Green shading indicates that some percentage of samples had concentrations above the sample-specific MDC.
(a) Standard deviation
(b) Minimum
(c) Maximum

Table 3-11. Gross beta radioactivity in air samples collected in 2008

NTS Area	Sampling Station	Number of Samples	Gross Beta (x 10^{-15} µCi/mL) Mean	Median	SD (a)	Min (b)	Max (c)	Mean MDC	% > MDC
1	BJY	53	20.27	20.10	6.59	7.95	51.66	4.25	100.0
3	U-3ah/at N	53	20.33	19.85	6.45	9.54	50.01	4.18	100.0
3	U-3ah/at S	52	21.16	20.20	6.16	11.49	49.53	4.13	100.0
3	U-3bh N	49	21.02	20.48	6.92	7.80	51.58	4.35	100.0
3	U-3bh S	50	20.84	20.27	6.62	8.37	50.10	4.15	100.0
5	DoD	52	21.49	21.28	6.79	9.67	55.78	4.17	100.0
5	Sugar Bunker N	53	22.94	22.56	7.05	10.35	55.26	4.28	100.0
6	Yucca	53	21.43	20.74	7.16	10.79	57.06	4.15	100.0
9	Bunker 9-300	52	20.18	19.63	6.10	9.35	49.10	4.16	100.0
10	Gate 700 S	52	20.03	19.01	6.44	8.11	50.13	4.18	100.0
10	Sedan N	53	19.80	18.85	6.41	7.73	49.47	4.15	100.0
16	3545 Substation	51	19.91	19.17	7.04	8.48	50.32	4.25	100.0
18	Little Feller 2 N	53	19.17	19.20	6.16	6.18	43.97	4.15	100.0
20	Gate 20-2P	52	19.38	19.40	5.97	9.14	44.13	4.23	100.0
20	Schooner	53	19.53	18.62	6.41	7.49	46.93	4.15	100.0
23	Mercury Track	53	20.94	21.09	6.40	8.62	50.10	4.20	100.0
25	Gate 510	53	21.68	21.30	7.02	10.18	56.40	4.17	100.0
27	ABLE Site	53	20.24	19.34	6.88	8.79	54.80	4.18	100.0
	All Environmental Samplers	**940**	**20.57**	**20.09**	**6.60**	**6.18**	**57.06**	**4.19**	**100.0**
27	JASPER Stack	48	4.38	3.13	27.33	-75.09	93.08	96.60	0.0

Blue-shaded locations are EPA-approved critical receptor sampler stations.
The orange-shaded location is a point-source sampler station.
Non-shaded locations are environmental sampler stations.
Green shading indicates that some percentage of samples had concentrations above the sample-specific MDC.
(a) Standard deviation
(b) Minimum
(c) Maximum

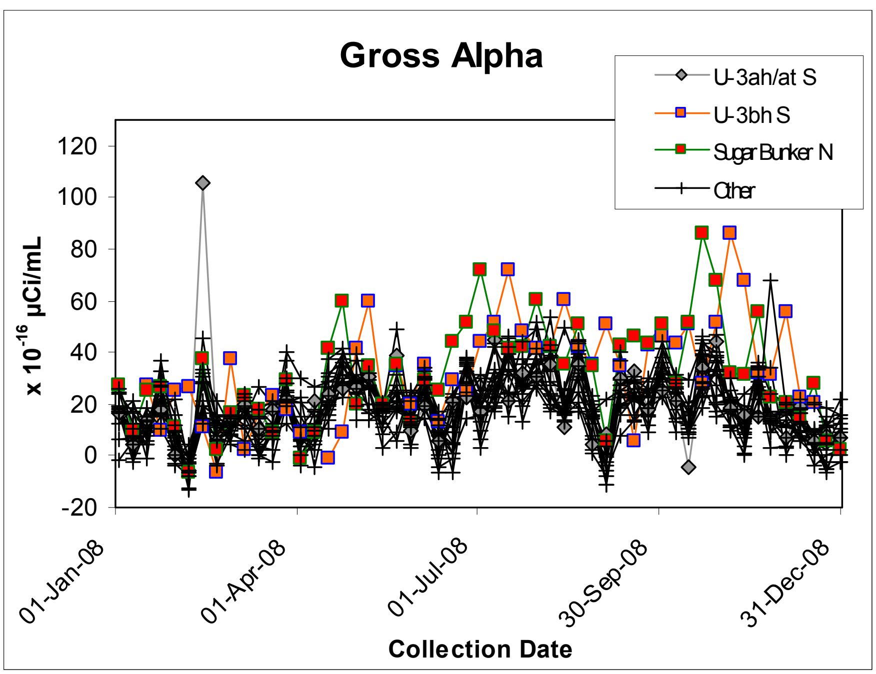


Figure 3-11. Gross alpha radioactivity in air samples collected in 2008

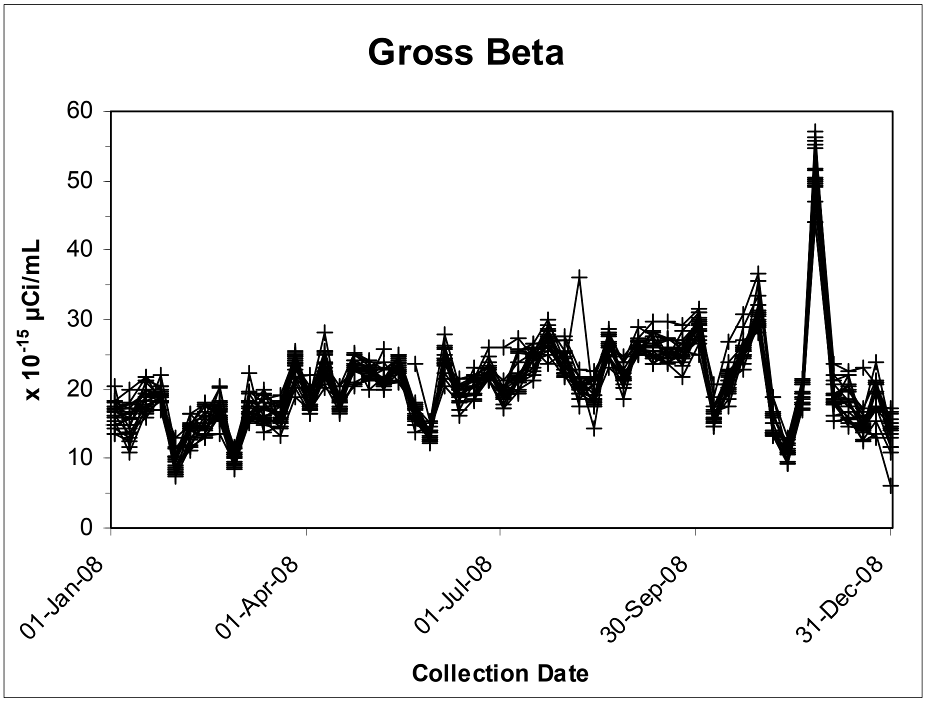


Figure 3-12. Gross beta radioactivity in each air sample collected in 2008

3.1.5 Air Sampling Results from Critical Receptor Samplers

The following radionuclides were detectable at three or more of the critical receptor samplers: ^{241}Am, ^{238}Pu, $^{239+240}$Pu, $^{233+234}$U, $^{235+236}$U, ^{238}U, and ^{3}H (see Tables 3-2, 3-4, 3-5, 3-6, and 3-9, respectively). All measured concentrations of these radionuclides were well below their CLs during 2008. The uranium isotopes have been attributed to naturally occurring uranium, and hence have been monitored only at selected locations (see Section 3.1.4.4). The concentration of each measured radionuclide (excluding uranium) at each of the six critical receptor stations was divided by its respective CL (see Table 3-1) to obtain a "percent of CL." These were then summed for each station. The sum of these fractions at each critical receptor sampler is far less than 1.0, demonstrating that the NESHAP dose limit (10 mrem/yr) at these critical receptor locations was not exceeded. The highest radiation dose (CEDE) at a critical receptor location would be approximately 1.93 mrem/yr for a hypothetical individual residing at Schooner.

Table 3-12. Sum of fractions of compliance levels for man-made radionuclides at critical receptor samplers

Radionuclides Included in Sum of Fractions[(a)]	NTS Area	Sampling Station	Sum of Fractions of Compliance Levels (CLs)[(b)]
^{241}Am, ^{238}Pu, $^{239+240}$Pu, ^{3}H	6	Yucca	0.016
	10	Gate 700 S	0.006
	16	3545 Substation	0.002
	20	Schooner	0.193[(b)]
	23	Mercury	0.003
	25	Gate 510	0.003

(a) $^{233+234}$U, $^{235+236}$U, and ^{238}U are not included in sum of fractions. Uranium detected in air particulate samples has previously been determined to be naturally occurring, based on the isotopic ratios. If uranium is included as well, the sum of fractions increases to 0.064, 0.066, and 0.056 for Yucca, 3545 Substation, and Gate 510, respectively. Isotopic uranium analyses have not been performed at the other critical receptor locations; presumably the increases in the sum of fractions would be comparable, around 0.05.

(b) This equates to a hypothetical receptor at this location receiving a CEDE of 1.9 mrem/yr.

3.1.6 Air Sampling Results from Point-Source (Stack) Sampler

Analyses of the 2008 air samples from the stack sampler at the JASPER facility contained no measurements of man-made radionuclides above their MDCs (see Tables 3-2 through 3-5). The HEPA filters at the facility appeared to function as intended; no radionuclide emission rate or offsite dose was calculated for this potential NTS radiation source (see Chapter 8).

3.1.7 Emission Evaluations for Planned Projects

No new construction or modifications were conducted on the NTS that increased the rate of radionuclide emissions to air. Two projects, however, were evaluated during 2008 to determine if they have the potential to release airborne radionuclides that would expose the public to a dose equal to or greater than 0.1 mrem/yr. For any project or facility with this potential, the EPA requires point-source operational monitoring. The projects evaluated in 2008 included:

- High explosives experiments conducted at the Big Explosives Experimental Facility (BEEF) using depleted uranium (DU)
- Evacuation of unfiltered air from the confinement chamber at the JASPER

The evaluations were considered periodic confirmatory measurements, as required by 40 CFR Section 61.93 (b) (4)(i), to ensure an emission source is still a minor source; these were performed using the EPA-approved atmospheric diffusion model called the Clean Air Package 1988, Version 3.0 (CAP88-PC). CAP88-PC computes the CEDE for an offsite maximally exposed individual (MEI) from air emissions in mrem/yr. The CEDE to the MEI for each evaluated project were well below the limit of 0.1 mrem/yr. The detailed air emission dose evaluations for each project are reported separately in Warren and Grossman (2009).

3.1.8 Unplanned Releases

No unplanned radionuclide releases occurred on the NTS during 2008.

3.1.9 Total NTS Radiological Atmospheric Releases

Each year existing operations, new construction projects, and modifications to existing facilities that have the potential for airborne emissions of radioactive materials are reviewed. The following quantities are measured or calculated to obtain the total annual quantity of radiological atmospheric releases from the NTS:

- The quantity of ^{3}H gas released during laboratory or facility operations
- The quantity of ^{3}H released through evaporation from ponds or open tanks, estimated from the measured ^{3}H concentrations in water discharged into them and assuming that all water is completely evaporated during the year
- The quantity of ^{3}H released from the Area 3 and Area 5 RWMSs and from Schooner and Sedan crater sites, estimated using (1) the EPA-approved atmospheric diffusion model called CAP88-PC and (2) the annual mean concentration of ^{3}H in air measured by environmental air samplers at locations near these sources
- The quantity of other radionuclides released during environmental restoration, waste management, or research operations/activities estimated using predicted volumes of material to be moved or released, radionuclide concentrations in those materials, and emission factors supplied by the EPA (Eastern Research Group, 2004)
- The quantity of other radionuclides resuspended in air from areas of known soil contamination, calculated from an inventory of radionuclides in surface soil determined by the Radionuclide Inventory and Distribution Program (McArthur, 1991), a resuspension model (U.S. Nuclear Regulatory Commission [NRC], 1983), and equation parameters derived at the NTS (U.S. Department of Energy, Nevada Operations Office [DOE/NV], 1992)

3.2 Nonradiological Air Quality Assessment

Nonradiological air quality assessments are conducted to document compliance with the current State of Nevada air quality permit that regulates specific operations or facilities on the NTS. The State of Nevada has adopted the CAA standards, which include NESHAP, National Ambient Air Quality Standards (NAAQS), and New Source Performance Standards (NSPS) (see Section 2.1). Specifically omitted from this section is NESHAP compliance for radionuclide emissions, which is presented in Section 3.1. Data collection, opacity readings, recordkeeping, and reporting activities related to air quality on the NTS are conducted by NSTec ES personnel to meet the program goals and to track the compliance measures summarized in the table below.

Air Quality Assessment Program Goals	*Compliance Measures*
Ensure that NTS operations comply with all the requirements of the current air quality permit issued by the State of Nevada. Ensure that air emissions of criteria pollutants (sulfur dioxide [SO_2]), nitrogen oxides [NO_X], carbon monoxide [CO], volatile organic compounds [VOCs], and particulate matter) do not exceed limits established under NAAQS. Ensure that emissions of permitted NTS equipment meet the opacity criteria to comply with NSPS. Ensure that NTS operations comply with the asbestos abatement reporting requirements under NESHAP. Document usage of ozone-depleting substances (ODS) to comply with Title VI of the CAA.	Tons of emissions of criteria pollutants produced annually Gallons of fuel burned annually Hours of operation of equipment per year Rate at which aggregate and concrete is produced Quarterly opacity readings on specified equipment Pounds of chemicals released from NPTEC facilities Amount of asbestos in existing structures removed or scheduled for removal Maintenance of ODS usage, disposition, and certification records

NNSA/NSO maintains a Class II Air Quality Operating Permit (AP9711-0549.01) for NTS activities. State of Nevada Class II permits are issued for sources of air pollutants considered “minor”, i.e., where annual emissions must not exceed 100 tons of any one criteria pollutant (see Glossary, Appendix B), or 10 tons of any one hazardous air pollutant (HAP), or 25 tons of any combination of HAPs. The NTS facilities regulated by this permit include:

- Over 15 facilities/185 pieces of equipment in Areas 1, 3, 5, 6, 12, 23, and 27
- NPTEC in Area 5
- Site-Wide Chemical Release Areas
- BEEF in Area 4
- Explosives Ordnance Disposal Unit in Area 11

The NTS air permit was modified in May 2008, to increase the emission limits of particulate matter (PM) and PM equal to or less than 10 microns in diameter (PM10) for the Area 27 Baker and JASPER generators. In December 2008, an extensive modification package was submitted to the Nevada Division of Environmental Protection (NDEP) in advance of the 2009 permit renewal application. The modification application included updates to equipment listings and operating parameters, revised NTS maps, facility diagrams, and air dispersion modeling. NDEP requires that all updates be incorporated into the existing permit prior to its renewal. The modified NTS air permit is expected to be issued in 2009.

3.2.1 Emissions of Criteria Air Pollutants and Hazardous Air Pollutants

A source's regulatory status is determined by the maximum number of tons of criteria pollutants and nonradiological HAPs it may emit in a 12-month period if it were operated for the maximum number of hours and at the maximum production amounts specified in the source's air permit. This maximum emission quantity, known as the potential to emit (PTE), is specified in an Air Emissions Inventory of all permitted NTS facilities and equipment. Each year, the State issues to NNSA/NSO *Actual Production/Emissions Reporting Forms* for the NTS air permit. They are used to report the actual hours of operation, gallons of fuel burned, etc., for each permitted facility/piece of equipment. Using these data, emissions of the criteria pollutants and HAPs are calculated and reported. The forms are completed by ES personnel and returned to NNSA/NSO for submittal to the State. The State uses the submitted information to determine annual maintenance and emissions fees and to document that calculated emission quantities do not exceed the PTEs. Because lead is considered a HAP as well as a criteria pollutant, NTS lead emissions for permitted operations are reported to the State as part of the total HAPs emissions. Lead emissions from non-permitted activities, such as soldering and weapons use, are covered under the Emergency Planning and Community Right-to-Know Act and are reported to the EPA (see Section 10.3).

In 2008, examination of records for permitted facilities and equipment indicated that all operational parameters were being properly tracked. A total of 6.05 tons (5.48 metric tons [mtons]) of criteria pollutants were emitted from NTS permitted facilities and equipment in 2008 (Table 3-14). No PTEs were exceeded. The majority of the emissions were NO_x from diesel generators. Only 190 pounds (0.095 tons [0.086 mtons]) of HAPs were released in 2008 (Table 3-15). The *Calendar Year 2008 Actual Production/Emissions Reporting Form* was submitted to NDEP on February 12, 2009. Table 3-15 shows the calculated tons of air pollutants released on the NTS since 1998.

Field measurements (versus calculated emissions) of particulate matter equal to or less than 10 microns in diameter (PM10) are required for two permitted facilities: BEEF and NPTEC. A minimum of one portable PM10 sampler is required to be located at each facility. The sampling systems must operate and record ambient PM10 concentrations at least each day a detonation or chemical release occurs. The PM10 emissions are reported to the State in reports specific to each series of detonations or chemical releases (see Section 3.2.5).

Table 3-14. Tons of criteria air pollutant emissions released on the NTS from permitted facilities operational in 2008

	Calculated Tons[(a)] of Emissions									
	Particulate Matter (PM10)[(b)]		Carbon Monoxide (CO)		Nitrogen Oxides (NO_X)		Sulfur Dioxide (SO_2)		Volatile Organic Compounds (VOC)	
Facility	**Actual**	**PTE[(c)]**	**Actual**	**PTE**	**Actual**	**PTE**	**Actual**	**PTE**	**Actual**	**PTE**
Wet Aggregate Plant	0.07	8.54	NA[(d)]	NA	NA	NA	NA	NA	NA	NA
Concrete Batch Plant	0.02	4.21	NA	NA	NA	NA	NA	NA	NA	NA
Cementing Services Equipment	0.001	0.41	NA	NA	NA	NA	NA	NA	NA	NA
Portable Bins (Area 6)	0.001	0.51	NA	NA	NA	NA	NA	NA	NA	NA
BEEF	0.01	8.0	0.17	0.54	0	0.07	0	0.003	0.001	0.007
Diesel Fired Generators	0.12	0.92	0.76	5.77	3.36	25.44	0.06	0.49	0.13	0.96
Bulk Gasoline Storage Tank	NA	NA	NA	NA	NA	NA	NA	NA	0.34	3.92
Bulk Diesel Fuel Storage Tank	NA	NA	NA	NA	NA	NA	NA	NA	0.01	0.02
NPTEC	0	3.00	0.01	3.26	0.001	3.02	0	3.00	0.12	10.0
Total by Pollutant	**0.22**	**25.59**	**0.94**	**9.57**	**3.36**	**28.53**	**0.06**	**3.49**	**0.60**	**14.91**
Total Emissions	**6.05 Actual, 82.09 PTE**									

(a) For metric tons (mtons), multiply tons by 0.9072
(b) Particulate matter equal to or less than 10 microns in diameter
(c) Potential to emit: the quantity of criteria pollutant that each facility/piece of equipment would emit annually if it were operated for the maximum number of hours at the maximum production rate specified in the air permit
(d) Not applicable: the facility does not emit the specified pollutant(s), therefore there is no emission limit set forth in the air permit

Table 3-15. Criteria air pollutants and HAPS released on the NTS since 1998

	Total Emissions (tons/yr)[(a)]										
Pollutant	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Particulate Matter (PM10)[(b)]	1.11	1.7	1.46	2.05	3.61	2.39	0.94	0.84	0.69	0.54	0.22
Carbon Monoxide (CO)	1.85	1.87	2.76	4.84	4.6	1.79	0.24	0.15	0.43	0.51	0.94
Nitrogen Oxides (NO_x)	7.57	8.07	12.75	22.23	21.09	8.11	1.01	0.69	2.02	1.21	3.36
Sulfur Dioxide (SO_2)	0.37	0.42	0.98	1.68	1.62	0.76	0.12	0.04	0.03	0.01	0.06
Volatile Organic Compounds (VOC)	11.76	1.99	1.89	2.01	2.1	1.21	4.60	1.94	1.40	1.14	0.60
Hazardous Air Pollutants (HAPs)	NR	NR	0.01	0.03	0.01	0	0.41	0.05	1.87	0.02	0.09[(d)]

(a) For mtons, multiply tons by 0.9072
(b) Particulate matter equal to or less than 10 microns in diameter
(c) Not reported
(d) 95 percent of HAPs were emitted during chemical spill tests at NPTEC

Unless specifically exempted, the open burning of any combustible refuse, waste, garbage, or oil, or for salvage operations, is prohibited. Open burning for other purposes, including personnel training, is allowed if approved in advance by the State (Nevada Administrative Code 445B.22067). Approval is denoted by the issuance of an Open Burn Variance prior to each burn. Exceptions to this include the Open Burn Variances issued to NNSA/NSO for fire extinguisher training at the NTS and for support-vehicle live-fire training evolutions. These Open Burn Variances are renewed annually and require 24-hour advance notification to the State prior to each burn. There were 12 fire extinguisher training sessions and 36 vehicle burns conducted in 2008. Quantities of criteria pollutants produced by open burns are not required to be calculated.

3.2.2 Performance Emission Testing and State Inspection

The NTS air permit requires performance emission testing of equipment that vents emissions through stacks (called “point sources”). The tests must be conducted once during the five-year life of the NTS air permit for each specified source. Once a source accumulates 100 hours of operation (since issuance of the permit in June 2002) it must be tested within 90 days. Testing is conducted by inserting a probe into the stack while the equipment is operating. Visible emissions readings must also be conducted by a certified evaluator during the tests (see Section 3.2.4). One performance emission test was conducted in 2008. Emissions from the diesel generator located at the Area 27 Baker Facility were within the specified NTS air permit limits. There were no State inspections of facilities regulated by the NTS air permit in 2008.

3.2.3 Production Rates/Hours of Operation

Compliance with operational parameters such as production rates and hours of operation is verified through an examination of the data generated for the annual report to the State. The number of hours that equipment operates throughout a year is determined either by meter readings or by recording the operating hours in a logbook each time the equipment is operated. Permit requirements specific to each piece of equipment dictate the frequency in which readings are obtained. Production rates for construction facilities such as the aggregate-producing plant are calculated using the hours of operation and amount of material produced. Logbooks are maintained to record this information. Gallons of fuel used are calculated preferably by recording tank levels each time that the tank is filled. If this is not possible, then calculations are performed by using industry standards and the hours of operation. In 2008, production rates, hours of operation, and gallons of fuel used all were within the specified permit limits and were used to calculate the tons of air pollutants emitted (see Table 3-14).

3.2.4 Opacity Readings

Under 40 CFR 60, personnel that conduct visible emissions evaluations must be certified semiannually by a qualified organization. A form similar to one appearing in 40 CFR 60 for conducting visible emissions evaluations is used to record and document the readings. Visual readings are taken every 15 seconds. A minimum of 24 consecutive readings is required for a valid reading. The average of the 24 readings must not exceed the permit-specified limit (20 percent for NAAQS, 10 percent for NSPS). The NTS air permit requires that readings be obtained once each quarter that the equipment is used and be kept on file. This applies to construction equipment only. Readings are taken for all other permitted facilities and equipment periodically but are not always recorded.

During 2008, four NSTec employees were certified by Carl Koontz Associates to conduct visible emissions evaluations. Readings were taken for the following NTS facilities regulated under the NAAQS opacity limit of 20 percent: Area 1 Concrete Batch Plant, Area 1 Wet Aggregate Plant, Area 6 Storage Silos, Area 23 Building 650 Diesel Generator, and the Area 27 Baker Generator. Readings for these facilities ranged from 0 to 10 percent. NTS equipment that is regulated by the 10 percent opacity limit under the NSPS includes miscellaneous conveyor belts, screens and hoppers, and the Area 1 pugmill. None of this equipment was used in 2008.

3.2.5 NPTEC and BEEF Reporting

In addition to annual reporting, the NTS air quality operating permit for the NPTEC and the site-wide chemical releases requires the submittal of test plans and final analysis reports to the State for each chemical release or release series. For the BEEF, quarterly test plans and final reports must be submitted for the types and weights of explosives used and estimated emissions that may be released.

In 2008, the Tarantula II chemical test was conducted at the Area 5 NPTEC and consisted of 28 releases. Six releases were also conducted at the Test Cell C Facility as part of the Tarantula II test series. A completion report was submitted to NNSA/NSO for transmittal to NDEP's Bureau of Air Pollution Control at the conclusion of each test. Tables 3-16 and 3-17 summarize the total quantities of all chemicals released during tests.

The majority of BEEF activities involve sensitive or classified information. To protect confidentiality of data, summary reports are submitted on a quarterly basis rather than for each test or test series. Table 3-18 is a summary of the general types and weights of explosives detonated during tests conducted in 2008. Emissions generated from these releases are summarized in Table 3-14.

Table 3-16. Chemicals released during tests conducted at the Area 5 NPTEC in 2008

Chemical	Total Released (kg)	Total Released (lb)[(a)]
Acetone	36.04	79.04
Ammonia	26.99	59.19
Chlorine	1.60	3.51
Dimethylamine	15.03	32.96
Dinitrogen Tetroxide	4.08	8.95
Dimethyl Methylphosphonate	2.32	5.09
Ethylene	11.56	25.35
Freon 134a	19.34	42.41
Hydrazine	4.56	10.00
Hydrogen Fluoride	24.40	53.51
Kerosene	8.25	18.09
Methane	9.26	20.31
Monomethyl Hydrazine	3.71	8.14
Nitrogen Dioxide	2.00	4.39
Nitrous Oxide	21.51	47.17
Propylene	34.85	76.43
Sulfur Hexafluoride	36.77	80.64
TM185	2.97	6.51
UDMH	3.35	7.35

(a) 1 pound (lb) = 0.456 kilograms (kg)

Table 3-17. Chemicals released during tests conducted at the Test Cell C Facility in 2008

Chemical	Total Released (kg)	Total Released (lb)[(a)]
Hydrogen Fluoride	4.67	10.24
Sulfur Hexafluoride	5.56	12.19

(a) 1 lb = 0.456 kg

Table 3-18. Types and weights of explosives detonated at BEEF in 2008

Type of Explosive	Total Released (kg)	Total Released (lb)[(a)]
TNT Based	1579.94	3464.77
Detonator materials	0.19	0.42
Nitramine/binder	473.81	1039.06
Nitramine/binder with fluorine or chlorine	0.005	0.01
Pure Compound	68.02	149.17

(a) 1 lb = 0.456 kg

3.2.6 Tactical Demilitarization Development (TaDD) Project Reporting

The TaDD project facility is located in Area 11. It was developed as a prototype of a portable burn facility to dispose of unneeded Shillelagh tactical military rocket motors. TaDD was added to the NTS air permit because of the emissions generated during each burn. Permit requirements include reporting hours of operation and emissions and an opacity limit of 20 percent. This facility has not been used due to lack of funding. It is listed in the NTS air permit with zero allowable operating hours. Its removal from the NTS air permit was requested in a permit modification submitted in late 2008.

3.2.7 ODS Recordkeeping

At the NTS, refrigerants containing ODS are mainly used in air conditioning units in vehicles, buildings, refrigerators, drinking water fountains, vending machines, and laboratory equipment. Halon 1211 and 1301, now classified as ODS, have been used in the past in fire extinguishers. There are no reporting requirements for ODS, but recordkeeping to document the usage of ODS and technician certification is required. ODS recordkeeping requirements applicable to NTS operations include maintaining, for a minimum of three years, evidence of technician certification, recycling/recovery equipment approval, and servicing records for appliances containing 22.7 kg (50 lb) or more of refrigerant. Compliance with recordkeeping and certification requirements for the use and disposition of ODS is verified through periodic self assessments. The assessments include a records review and interviews with managers and technicians associated with the use, disposition, and purchase of refrigerants. The EPA may conduct random inspections to determine compliance with ODS regulations under the CAA. In December 2008, an internal assessment of the NTS ODS program was conducted and resulted in no findings and one recommendation to consolidate recordkeeping for equipment containing 50 pounds or more of ODS.

3.2.8 Asbestos Abatement

A NESHAP notification is submitted annually to the EPA for the next calendar year. It provides an estimate of the quantities of asbestos-containing materials that are expected to be removed from small projects: removal of less than 80 linear m (260 linear ft), 15 square meters (m^2) (106 square feet [ft^2]), or 1 m^3 (35 ft^3). These projections are submitted to the EPA in an Annual Asbestos Abatement Notification Form. A Notification of Demolition and Renovation Form is also submitted to the EPA at least 10 working days prior to the start of each project if (1) a facility is scheduled for demolition and has no asbestos present, or (2) quantities of asbestos-containing materials to be removed are estimated to equal or exceed 80 linear m, 15 m^2, or 1 m^3.

The recordkeeping requirements for asbestos abatement activities include maintaining air and bulk sampling data records, abatement plans, and operations and maintenance activity records for up to 75 years and maintaining location-specific records of asbestos-containing materials for a minimum of 75 years. Compliance is verified through periodic internal assessments. The assessments include a records review and interviews with managers and technicians associated with asbestos abatement. NNSA/NSO informal reviews are performed periodically.

An Annual Asbestos Abatement Notification Form was submitted to the EPA on November 7, 2007, which projected that 45.7 linear m (250 linear ft), 23.2 m^2 (150 ft^2) and 1 m^3 (30 ft^3) of asbestos-containing material would be removed from small projects from NTS facilities in 2008. However, asbestos abatement projects that were larger than projected arose in 2008. A Notification of Demolition and Renovation Form was submitted to the EPA within 10 working days prior to the start of each project. One project was the demolition of multiple rail cars for which 1,015 m^2 (10,920 ft^2) of asbestos-containing materials were designated as "Non-friable Asbestos Material not to be removed" during demolition. The railcars were cut in half, which kept the top halves, containing the asbestos, intact for burial. Wet methods were used and air quality monitoring was conducted during this project. Another project was the removal of 111.9 linear m (367 linear ft) and 473.8 m^2 (5,100 ft^2) of asbestos-containing materials from two buildings scheduled for demolition. Four smaller projects were also conducted in 2008 for which a combined total of 102 linear m (335 linear ft) of insulation and 84 m^2 (900 ft^2) of vinyl asbestos tile were removed from buildings to be demolished. The remainder of the asbestos abatement activities throughout the NTS complex were minor in scope, involving the removal of amounts below the reporting threshold. Asbestos-containing materials were buried in both the Area 9 U10c and Area 23 solid waste disposal sites. Asbestos abatement records continue to be maintained as required.

3.2.9 Fugitive Dust Control

The NTS Class II Air Quality Operating Permit states that the best practical methods should be used to prevent particulate matter from becoming airborne prior to the construction, repair, demolition, or use of unpaved or untreated areas. Methods and materials that are typically used to control fugitive dust include presoaking, water spraying, using dust palliatives, gravelling or paving haul routes, revegetating, reducing vehicle speeds, and either covering stockpiles or watering them. At the NTS, the main method of dust control is the use of water sprays.

During 2008, NSTec personnel conducted several fugitive dust readings of operations throughout the NTS that included the Area 1 Aggregate Plant, the Radiological/Nuclear Countermeasures Test and Evaluation Complex, and the Area 1 Concrete Batch Plant. No excessive fugitive dust was noted.

3.2.10 Environmental Impact

During 2008, NTS activities produced a total of only 6.05 tons of criteria pollutants and 0.095 tons of HAPs. These small quantities had little, if any, impact to air quality on the NTS and at offsite locations. Emissions of pollutants for 2008 were significantly less than those generated during the heightened activity that occurred in the years prior to the nuclear weapons testing moratorium.

Impacts of the chemical release tests at the NPTEC are minimized by controlling the amount and duration of each release. Biological monitoring at the NPTEC is performed whenever there is a risk of significant exposure to downwind plants and animals from the planned tests (see Section 13.6). NSTec biologists review all chemical release test plans to determine the level of field monitoring needed for each test. To date, chemical releases at the NPTEC have used such small quantities (when dispersed into the air) that downwind test-specific monitoring has not been necessary. No measurable impacts to downwind plants or animals have been observed.

4.0 Radiological and Nonradiological Water Monitoring

This chapter presents radiological and nonradiological monitoring results for surface water and groundwater from on and off the Nevada Test Site (NTS). This monitoring program is directed by the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO). Surface water and groundwater includes natural springs, drinking water, non-potable groundwater, and water discharged into domestic and waste-water systems on the NTS. Water monitoring is conducted to comply with applicable state and federal regulations (see Section 2.2) as well as to address the concerns of stakeholders who reside in the vicinity of the NTS.

In 2008, several programs or projects were involved in water monitoring. These included (1) routine radiological monitoring conducted by National Security Technologies, LLC (NSTec), Environmental Technical Services (ETS) under the *Routine Radiological Environmental Monitoring Plan* (RREMP) (Bechtel Nevada [BN], 2003a); (2) water quality assessments of permitted water systems conducted by NSTec Environmental Services; and (3) water sampling and analysis conducted by NSTec under the Underground Test Area (UGTA) Sub-Project (see Chapter 14 for a description of all UGTA Sub-Project activities conducted in 2008). In addition, the Community Environmental Monitoring Program, established by NNSA/NSO, annually performs independent monitoring of offsite springs and water supply systems in communities surrounding the NTS. This independent community outreach program is managed by the Desert Research Institute (DRI).

Section 4.1 presents the concentrations of radioactivity in all water samples collected in 2008. These data are used to calculate radiological doses to the general public residing near the NTS and to biota residing on the NTS; these results are provided in Chapter 8 (Radiological Dose Assessment). Section 4.2 presents the results of nonradiological monitoring of drinking water and domestic and industrial wastewaters on the NTS. DRI's 2008 monitoring results for offsite surface and groundwater are presented in Chapter 6 (Section 6.2).

4.1 Radiological Surface Water and Groundwater Monitoring

The purpose of radiological water monitoring under the RREMP (BN, 2003a) is to determine whether concentrations of radionuclides in groundwater and surface water bodies at the NTS and its vicinity pose a threat to public health or the environment. Toward this end, the monitoring program collects and analyzes water samples to meet the goals shown below. UGTA Sub-Project goals are provided in detail in Chapter 14.

Radiological Surface Water and Groundwater Monitoring Program Goals	*Analytes Monitored*
Determine if radionuclide concentrations of offsite and onsite water supply wells exceed the safe drinking water standards established under the Safe Drinking Water Act or the dose limits to the general public set by U.S. Department of Energy (DOE) Order DOE O 5400.5, "Radiation Protection of the Public and the Environment." Determine if radionuclide concentrations in NTS surface waters expose animals to doses that exceed those set by DOE Standard DOE-STD-1153-2002, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota" to protect wildlife populations. Determine if permitted facilities on the NTS are in compliance with permit discharge limits for radionuclides. Determine if radionuclide concentrations in onsite and offsite natural springs and non-potable water wells (monitoring wells) indicate that NNSA/NSO activities have had an impact on the environment. Strict drinking water standards are often used as a monitoring action level for this determination.	Tritium (^{3}H) Gross alpha radioactivity Gross beta radioactivity Gamma-emitting radionuclides Plutonium-238 (^{238}Pu) Plutonium-239+240 ($^{239+240}Pu$) Carbon-14 (^{14}C) Strontium-90 (^{90}Sr) Technetium-99 (^{99}Tc)

4.1.1 Areas of Radiological Groundwater Contamination

The NTS is located in a complex hydrogeologic setting (see *Attachment A: Nevada Test Site Description* included on the compact disc version of this report). Within this setting, a total of 828 underground nuclear tests were conducted between 1951 and 1992. Approximately one-third of these tests were detonated near or below the water table (DOE, 1996; U.S. Department of Energy, Nevada Operations Office, 2000), resulting in contamination of groundwater in some areas. The Federal Facility Agreement and Consent Order established Corrective Action Units (CAUs) that delineate areas of concern for groundwater contamination on the NTS (DOE, 1996). Figure 4-1 shows the locations of historic underground nuclear tests and the areas of potential groundwater contamination designated as CAUs.

4.1.2 Water Monitoring Locations

The RREMP (BN, 2003a) identifies a groundwater monitoring network of 78 wells located on and off the NTS to be sampled at frequencies ranging from once every three months to once every three years. Ten additional wells (seven offsite and three onsite), not identified in the 2003 RREMP, have been added to the network and are sampled opportunistically or at the suggestion of NNSA/NSO. Of these 88 wells, 72 have been sampled at least once since 1999. These 72 include 33 offsite wells, 10 onsite water supply wells, and 29 onsite monitoring wells (Figure 4-2). Some of the wells monitored under the RREMP are managed by the UGTA Sub-Project (see Chapter 14, Figure 14-2). Those wells not sampled since 1999, but identified in the RREMP, include 15 onsite monitoring wells and 1 offsite well. They are not sampled for one or more of the following reasons: they are not accessible, are used for other purposes, are blocked, provide water samples that are of poor quality or are contaminated (disqualifying them from monitoring), or contain waters with known high levels of radiological contamination that are not expected to change.

Natural springs are sampled at intervals from once a year to once every three years, and the RREMP identifies one containment pond system and three sewage lagoons that may be sampled quarterly or annually. Only two of the three sewage lagoons are currently active.

In 2008, priority was given to sampling 10 offsite NNSA/NSO wells, particularly those managed by the UGTA Sub-Project in Oasis Valley to the west of the NTS (see Figure 4-2). Offsite community water supply wells were therefore not sampled in 2008, but are scheduled for 2009 sampling. Also, none of the offsite or onsite springs in the monitoring network were sampled in 2008 because many were sampled within recent years (Figure 4-3). A total of 33 groundwater locations (Figure 4-2) and 3 surface water locations (Figure 4-3) were sampled in 2008:

- 10 offsite non-potable NNSA/NSO wells
- 9 onsite water supply wells (5 potable, 4 non-potable)
- 14 onsite monitoring wells
- 1 NTS permitted containment pond system (E Tunnel ponds)
- 2 onsite sewage lagoons

Six UGTA Sub-Project wells were sampled for tritium by sub-project participants in 2008. The results are discussed briefly in Section 4.1.12 below.

4.1.3 Analytes Monitored

The selection of analytes for groundwater monitoring under the RREMP is based on the radiological source term from historical nuclear testing, regulatory/permit requirements, and characterization needs. The isotopic inventory remaining from nuclear testing is presented in the 1996 environmental impact statement for NTS activities (DOE, 1996) and in a Los Alamos National Laboratory (LANL) document (Bowen et al., 2001). Many of the radioactive species generated from subsurface testing have very short half-lives, sorb strongly onto the solid phase, or are bound into what is termed “melt glass” and are not available for groundwater transport in the near term (Smith, 1993; Smith et al., 1995). Tritium (^{3}H) is the radioactive species created in the greatest quantities and is widely believed to be the most mobile. Tritium is therefore the primary target analyte; every water sample is analyzed for this radionuclide. It will represent the greatest concern to users of groundwater on and around the

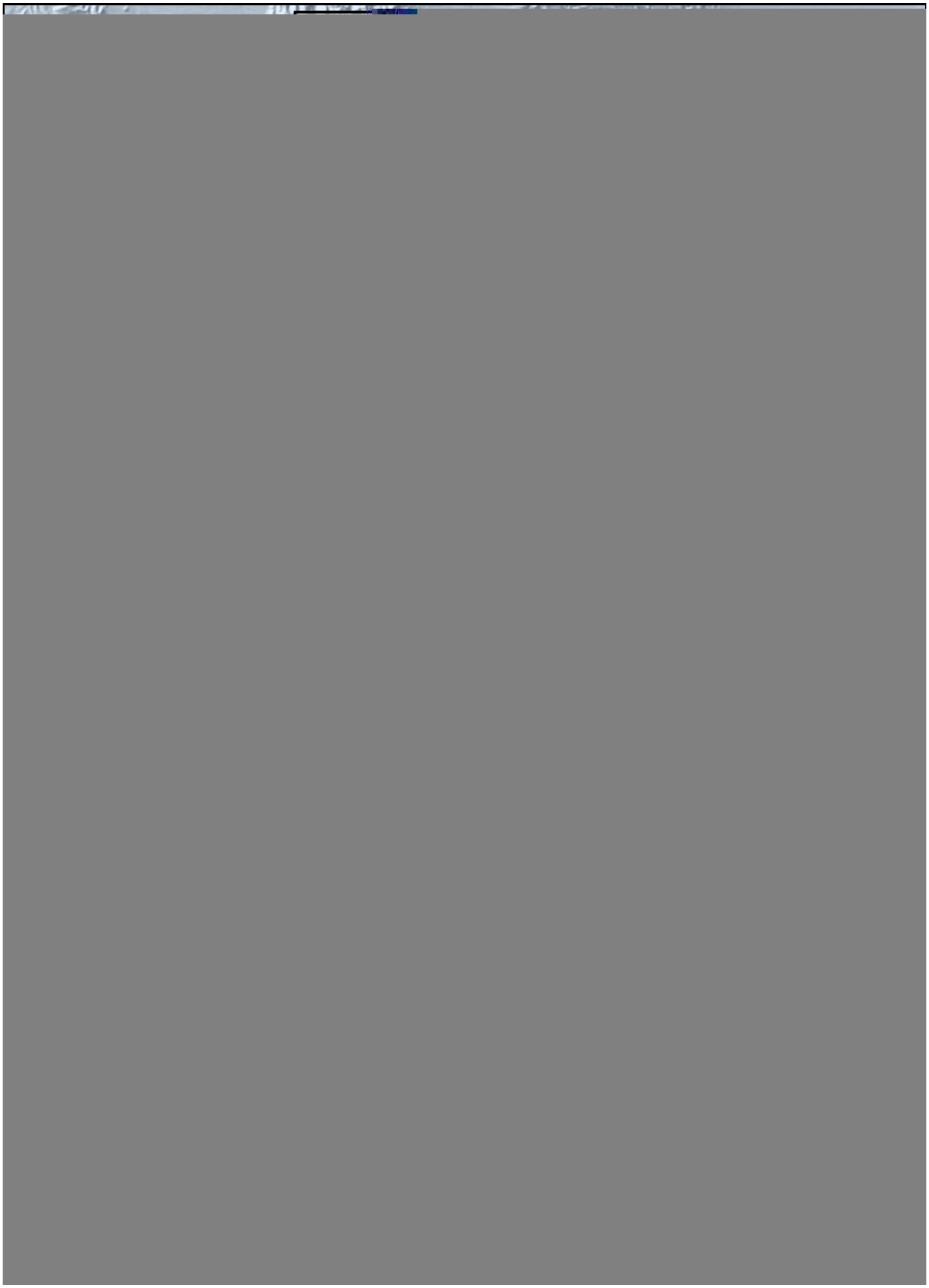


Figure 4-1. Areas of potential groundwater contamination on the NTS

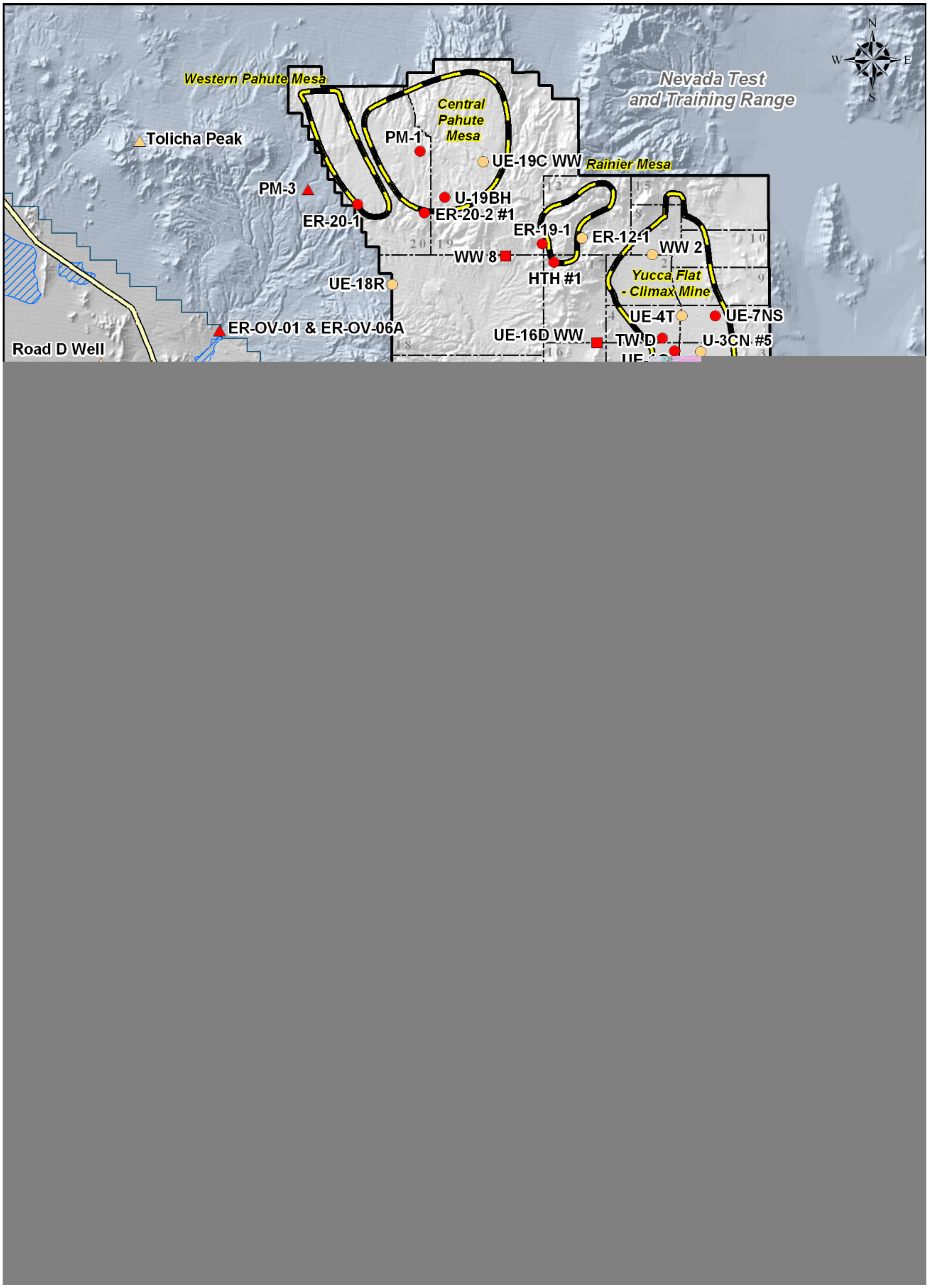


Figure 4-2. RREMP well monitoring locations sampled on and off the NTS in 2008

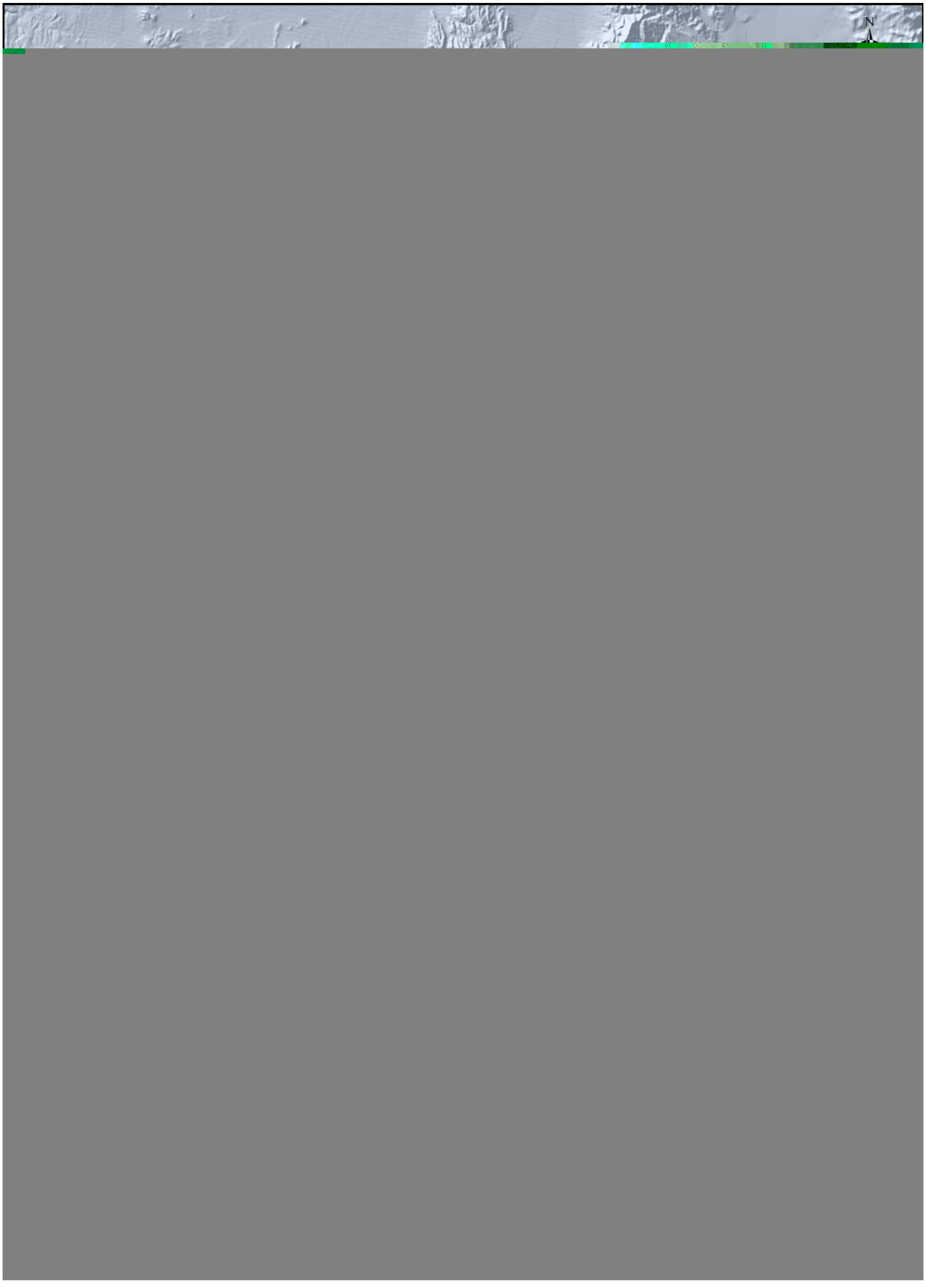


Figure 4-3. Surface water monitoring locations sampled on the NTS in 2008 and in recent years

NTS for at least the next 100 years due to its high mobility and concentration (DOE, 1996; International Technology Corporation, 1997).

Gross alpha and gross beta radioactivity analyses are also conducted on water samples from all locations in the monitoring network, but less frequently than tritium analyses at some locations. Gross alpha and gross beta radioactivity can include activity from both natural and man-made radionuclides, if any are present. Naturally occurring minerals in the water can contribute to both alpha radiation (e.g., isotopes of uranium and radium-226 [^{226}Ra]) and beta radiation (e.g., radium-228 [^{228}Ra] and potassium-40 [^{40}K]). Gamma spectroscopy analysis is also performed on water samples; this can identify the presence of specific man-made radionuclides (e.g., americium-241 [^{241}Am], cesium-137 [^{137}Cs], cobalt-60 [^{60}Co], and europium-152 and -154 [^{152}Eu and ^{154}Eu]) as well as natural radionuclides (e.g., actinium-228 [^{228}Ac], lead-212 [^{212}Pb], ^{40}K, uranium-235 [^{235}U], and thorium-234 [^{234}Th]). Specific analyses for ^{238}Pu, $^{239+240}$Pu, ^{14}C, ^{90}Sr, ^{99}Tc, ^{241}Am, and uranium isotopes are performed on selected water samples to help characterize sampled locations. Specific radium analyses were discontinued in 2005, since previous analyses indicated that ^{226}Ra and ^{228}Ra are not major contributors to gross alpha or gross beta activity, respectively. Water analyses also include chemical parameters to assist in characterizing groundwater chemistry and hydrology; these data are not presented in this report.

4.1.4 Water Sampling and Analysis Methods

Water sampling methods are based, in part, on the characteristics and configurations of the sample locations. For example, wells with dedicated pumps may be sampled from the associated plumbing (e.g., spigots) at the wellhead, while wells without pumps may be sampled via a wireline bailer or a portable pumping system. Six of the monitoring wells are constructed to allow for sampling different horizons of the penetrated hydrostratigraphic units. The sample depths for these six wells are:

HTH #1
- 590 meters (m) (1,935 feet[ft]) below ground surface (bgs)
- 622 m (2,040 ft) bgs
- 649 m (2,130 ft) bgs
- 701 m (2,300 ft) bgs

UE-18R
- 518 m (1,700 ft) bgs
- 649 m (2,130 ft) bgs

PM-3
- 475 m (1,560 ft) bgs
- 608 m (1,994 ft) bgs

ER-19-1
- 826 m (2,710 ft) bgs
- 1,000 m (3,280 ft) bgs

Ash-B
- Piezometer #2 - 114 m (375 ft) bgs
- Piezometer #1 - 312 m (1,025 ft) bgs

ER-6-1
- 615 m (2,017 ft) bgs
- 679 m (2,228 ft) bgs

Of these, wells HTH #1, PM-3, and ER-19-1 were sampled in 2008; the other 30 wells were sampled at single depths.

Sampling frequencies and analyses for routine radiological water monitoring are based on location and type of sampling point as defined in the RREMP. As usual, tritium analyses were performed on all samples obtained. Other analyses were performed on specific samples based primarily on the RREMP schedule.

Most tritium analyses were conducted after the samples were enriched. The enrichment process concentrates tritium in a sample to provide low minimum detectable concentrations (MDCs) (see Glossary, Appendix B) for the laboratory analyses. Sample-specific MDCs for laboratory analysis, reported in each results table, range from 18 to 34 picocuries per liter (pCi/L) with an average of 23.2 pCi/L. The MDCs for standard (non-enriched) tritium analyses typically range from 200 to 400 pCi/L. For comparison, the U.S. Environmental Protection Agency (EPA) maximum contaminant level (MCL) for tritium in drinking water is 20,000 pCi/L.

Routine quality control samples (e.g., duplicates, blanks, and spikes) are also incorporated into the analytical streams frequently. Section 18.0 discusses the quality assurance/quality control protocols and procedures used for radiological water monitoring.

4.1.5 Presentation and Statistical Analysis of Water Sampling Data

The following sections present only concentrations that were above their MDCs for man-made gamma-emitting radionuclides (i.e., ^{137}Cs), plutonium, ^{14}C, ^{90}Sr, and ^{99}Tc. Concentration values of gross alpha, gross beta, and tritium are presented for all water samples in the data tables, whether above or below their MDCs. Most of the values in the tables in the following sections are formatted with two significant digits.

The uncertainty values presented in the data tables represent the uncertainty ("error") of the analytical method. This does not include the uncertainty associated with sample collection or the tritium enrichment process. A statistical analysis of water supply well samples analyzed between July 1999 and December 2008 was conducted to obtain an estimate of the tritium decision level (L_C). The analysis suggests an L_C (see Glossary, Appendix B) for tritium of approximately 19.6 pCi/L, where L_C is a 99 percent prediction limit for any individual measurement based on the background water supply well data. Alternately, a 95 percent prediction limit for all enriched tritium measurements (PLall), based on the background water supply well data, is 27.2 pCi/L. This takes into account the total number of tritium measurements made annually under the current implementation of the RREMP (82 during 2008, 103 on average). If all monitoring locations produced data from the same distribution as the water supply wells, there would be a 5 percent chance of obtaining one or more values exceeding this PLall anywhere during any one year.

Formal statistical trend analyses have been performed on the gross alpha, gross beta, and tritium data for the offsite wells, offsite springs, and NTS water supply wells. In each of these, a p-value and observed rate of change are determined. The p-value is the "observed significance level"; this is the chance that a trend at least as large as that observed (either increasing or decreasing) would result simply from random variation in the data. It is common to consider trends with $p < 0.05$ to be "statistically significant"; however, one must recognize that these do occur just by chance in around five percent of such analyses. In the following sections the results of 125 such analyses are reported; one would expect therefore around 6.25 "statistically significant" trends to be found due to chance variation in the data, and in fact seven were found. Another way to approach the issue of multiple tests is to adjust the criterion used for the total number of analyses performed. Using this approach, one would not consider a result to be "statistically significant" unless its p-value were less than 0.05 divided by the number of analyses, which would be 0.05/125 = 0.0004 here. The smallest p-value reported in the following sections is 0.005, rather larger than that critical value.

4.1.6 Results from Offsite Wells

The 2008 data indicate that groundwater at the offsite NNSA/NSO well locations has not been impacted by past NTS nuclear testing operations. Tritium was not detected above its MDC in any of the offsite wells sampled (Table 4-1). Gross alpha and gross beta radioactivity were detected, however, in most of the well samples (Table 4-1). None of the 2008 gross alpha or beta results met or exceeded the EPA MCL of 15 pCi/L (gross alpha) or the EPA Level of Concern of 50 pCi/L (gross beta). These levels likely represent natural radiation sources.

Samples from wells ER-OV-01, ER-OV-02, ER-OV-03C, ER-OV-03C2, and ER-OV-06A were also analyzed for gamma-emitting radionuclides, ^{238}Pu, and $^{239+240}$Pu. PM-3 was analyzed for ^{14}C, $^{89+90}$Sr, and ^{99}Tc. No man-made radionuclides were detected.

Table 4-1. Gross alpha, gross beta, and tritium analysis results for offsite non-potable NNSA/NSO wells in 2008

Offsite Well	Date Sampled	Gross α ± Uncertainty[a] (MDC) (pCi/L)[b]	Gross β ± Uncertainty (MDC) (pCi/L)[c]	^{3}H ± Uncertainty (MDC) (pCi/L)[d]
ER-OV-01	5/19/2008	NS[e]	NS	-1.6 ± 13.5 (24)
	5/19/2008 FD [f]	NA[g]	NA	5.1 ± 13.7 (24)
	10/27/2008	10.3 ± 2.2 (1.1)	10.0 ± 2.1 (2.1)	-9.2 ± 13.7 (25)
ER-OV-02	5/20/2008	NS	NS	2.5 ± 13.8 (24)
	10/28/2008	11.6 ± 2.5 (1.7)	9.5 ± 2.2 (2.5)	1.5 ± 13.8 (24)
ER-OV-03A	10/27/2008	NS	NS	9.1 ± 14.6 (25)
ER-OV-03A3	10/28/2008	NS	NS	3.3 ± 14.2 (25)
ER-OV-03C	10/28/2008	7.1 ± 2.2 (1.8)	1.2 ± 1.4 (2.9)	-10.5 ± 14.1 (26)
ER-OV-03C2	10/28/2008	6.2 ± 2.0 (1.6)	2.6 ± 1.6 (3.2)	-10.8 ± 13.4 (24)
	10/28/2008 FD	NA	NA	4.8 ± 14.2 (24)
ER-OV-04A	10/29/2008	NS	NS	-8.4 ± 14.4 (26)
ER-OV-05	10/29/2008	NS	NS	4.2 ± 14.0 (24)
ER-OV-06A	5/19/2008	NS	NS	

well as the PLall discussed in Section 4.1.5. In formal statistical trend tests, there are statistically significant increases in tritium in wells ER-OV-02 ($p = 0.013$, estimated increase = 1.38 pCi/L/year) and PM-3 ($p = 0.019$, estimated increase = 3.24 pCi/L/year) out of the 26 wells with enough data to perform this analysis. One well (Tolicha Peak) has a statistically significant decreasing trend in gross alpha ($p = 0.005$, estimated decrease = 0.36 pCi/L/year), of 25 wells with enough data to perform this analysis. No statistically significant trends were found with gross beta. (Using the conventional five percent significance level, one would expect to see 3.8 statistically significant trends in these 76 analyte/well combinations just due to random variation.)

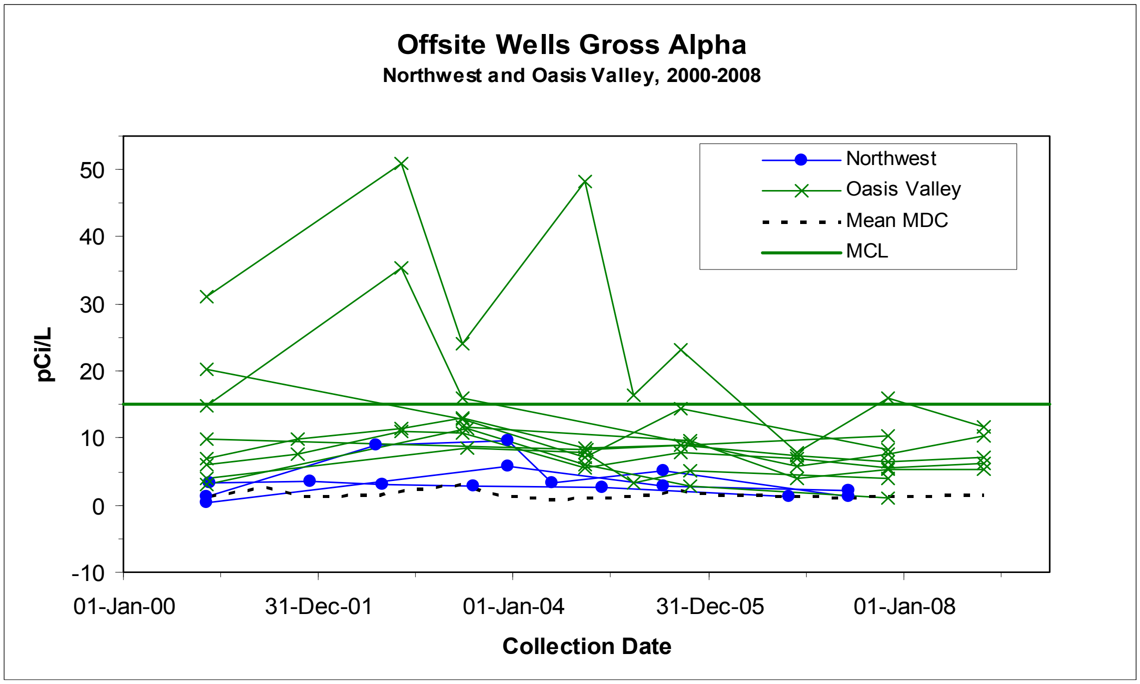


Figure 4-4. Gross alpha levels in wells that are in and north of Oasis Valley from 2000 to 2008

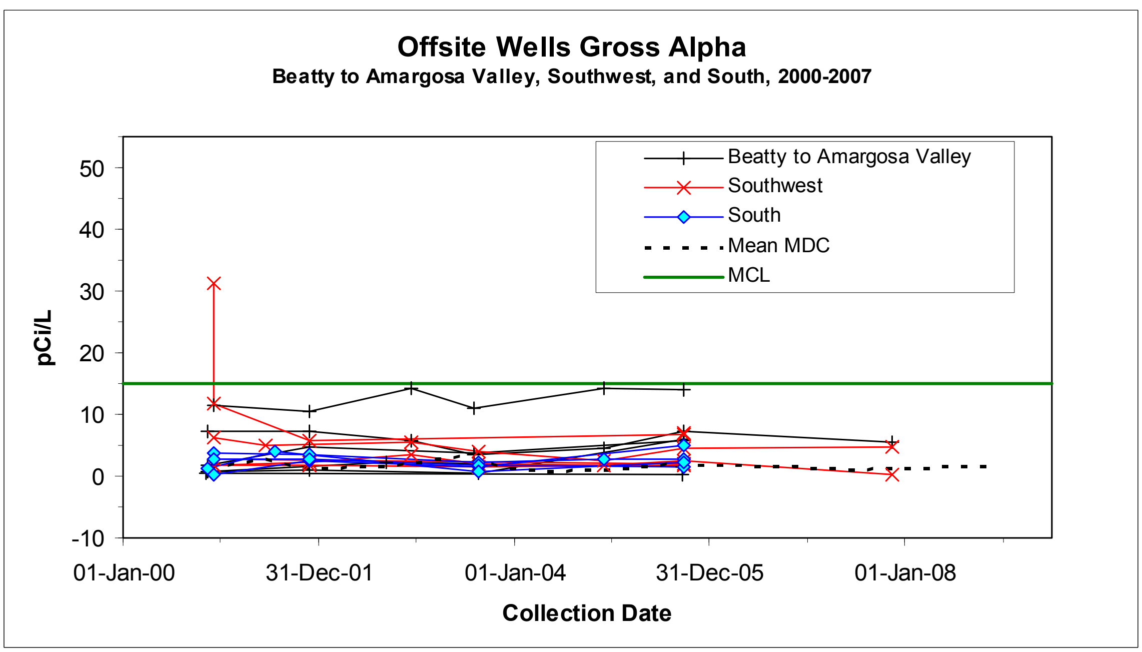


Figure 4-5. Gross alpha levels in wells in areas west, southwest, and south of the NTS from 2000 to 2007 (these wells were not sampled in 2008)

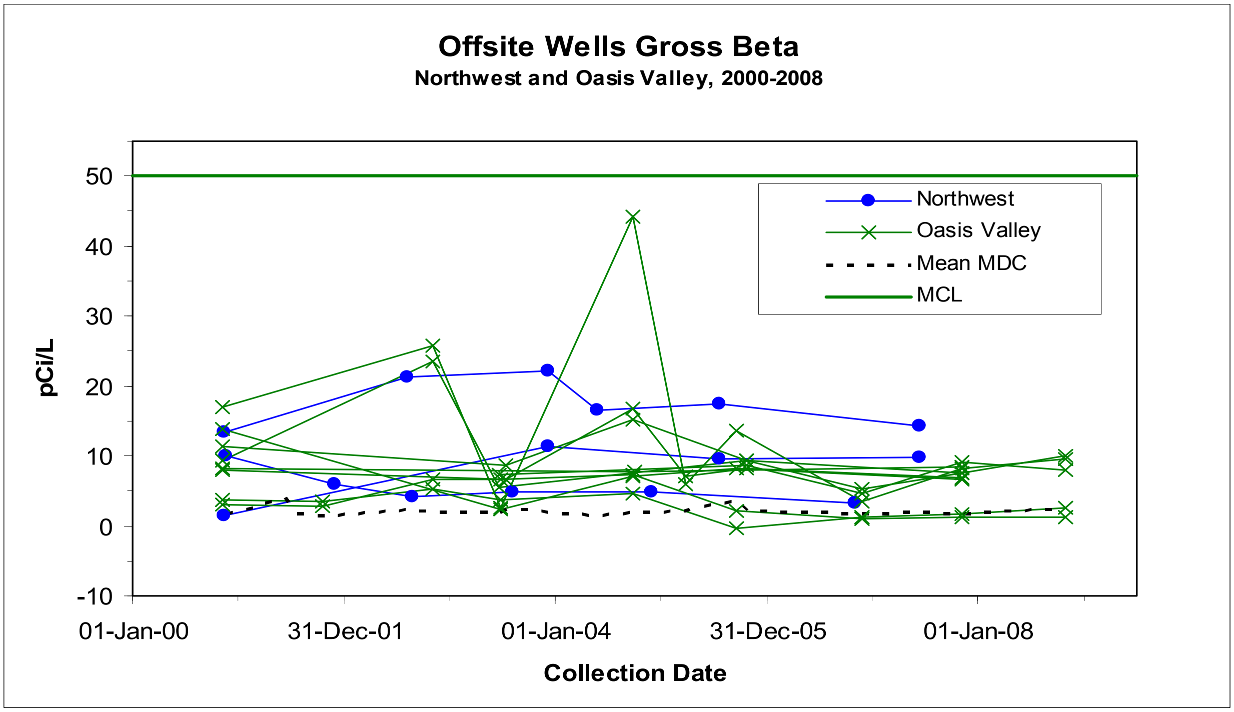


Figure 4-6. Gross beta levels in wells that are in and north of Oasis Valley from 2000 to 2008

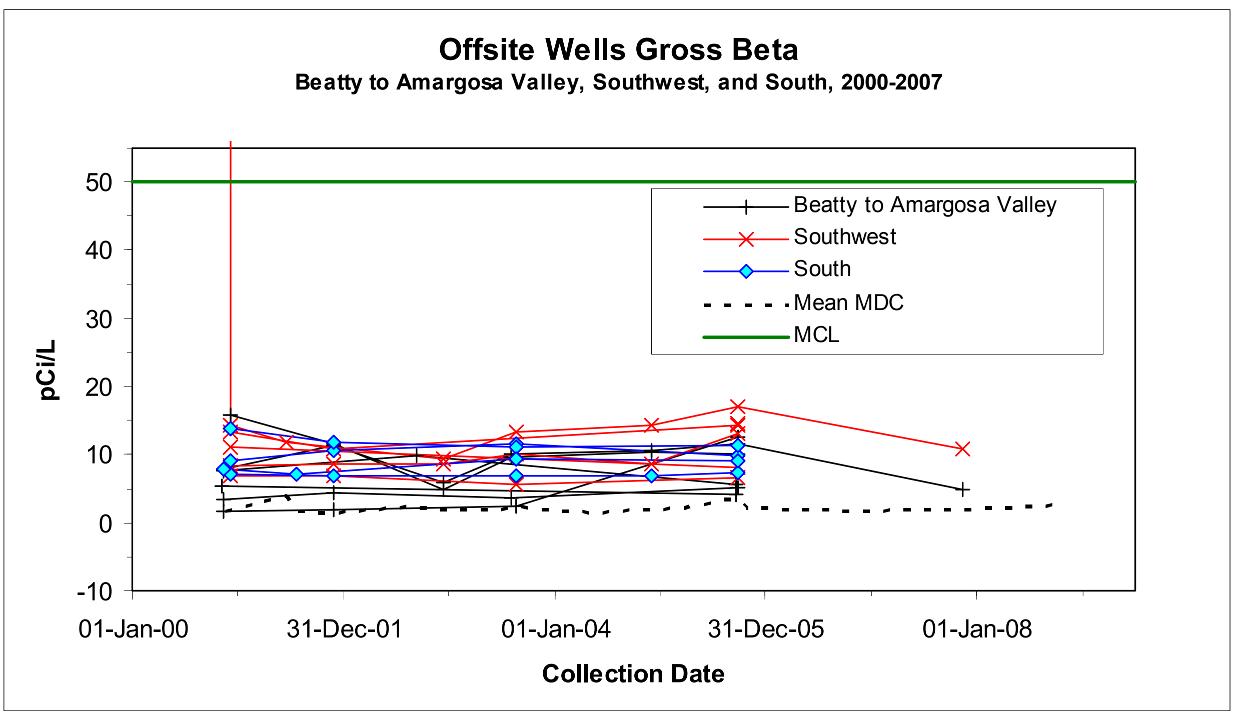


Figure 4-7. Gross beta levels in wells in areas west, southwest, and south of the NTS from 2000 to 2007 (these wells were not sampled in 2008)

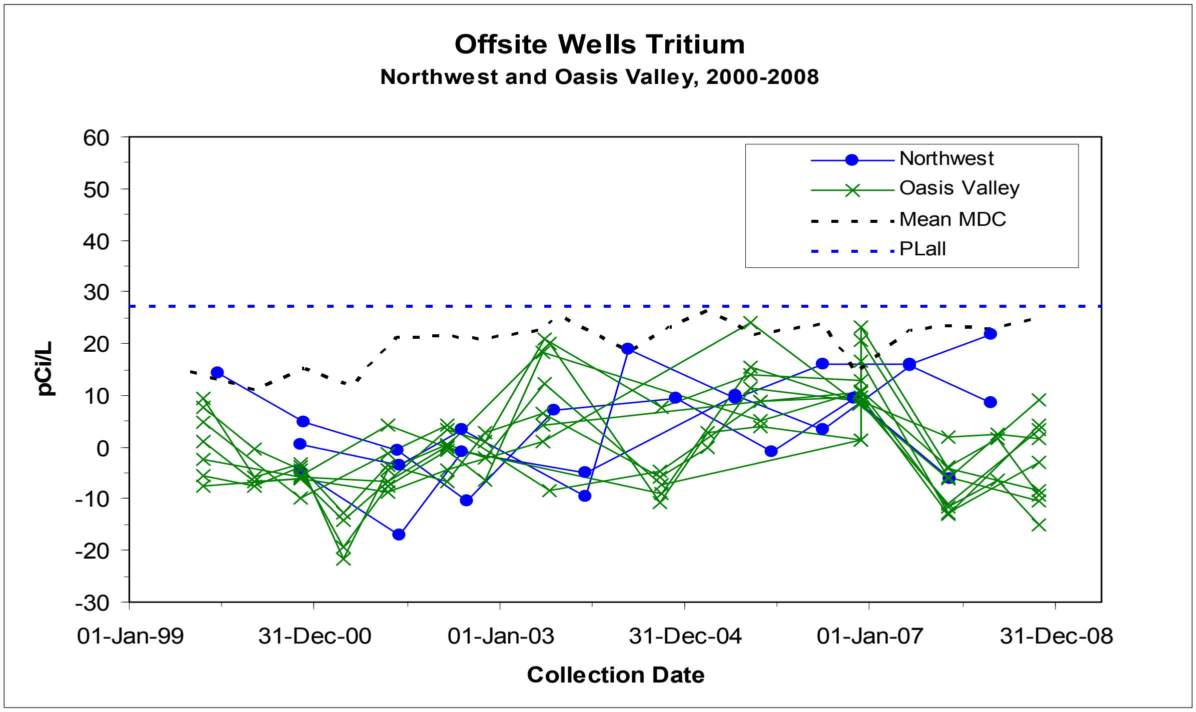


Figure 4-8. Tritium levels in wells that are in and north of Oasis Valley from 2000 to 2008

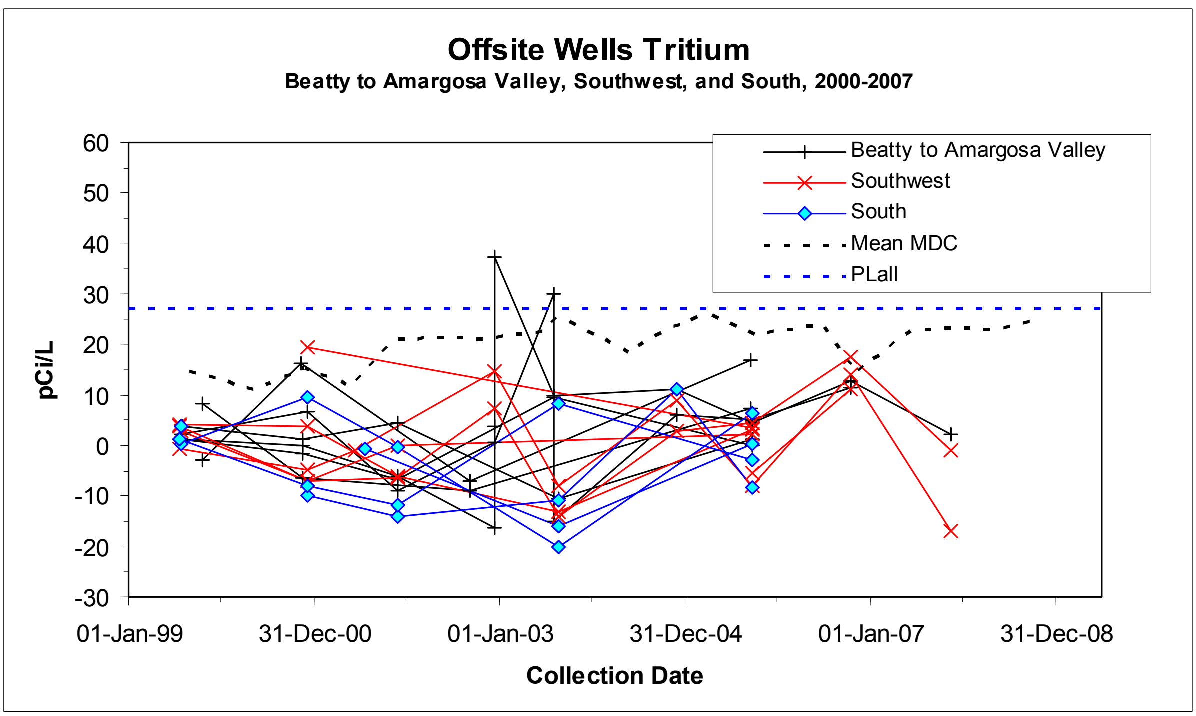


Figure 4-9. Tritium levels in wells in areas west, southwest, and south of the NTS from 2000 to 2007 (these wells were not sampled in 2008)

4.1.7 Results from Offsite Springs

The offsite springs (see Figure 4-3) were not sampled in 2008 due to their planned frequency in the RREMP and to the priority given to the offsite NNSA/NSO wells in Oasis Valley. Figures 4-10 through 4-12 repeat the data as shown in the *Nevada Test Site Environmental Report 2007* (NSTec, 2008a). During 2007, no detectable

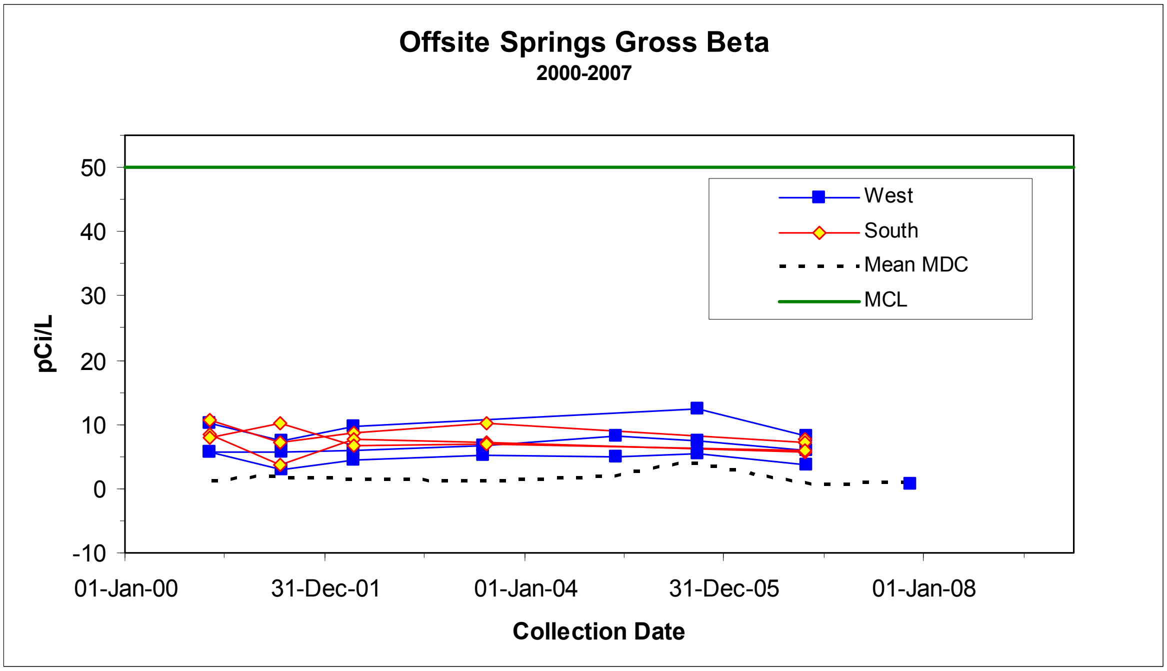


Figure 4-11. Gross beta levels in offsite springs from 2000 to 2007 (springs not sampled in 2008)

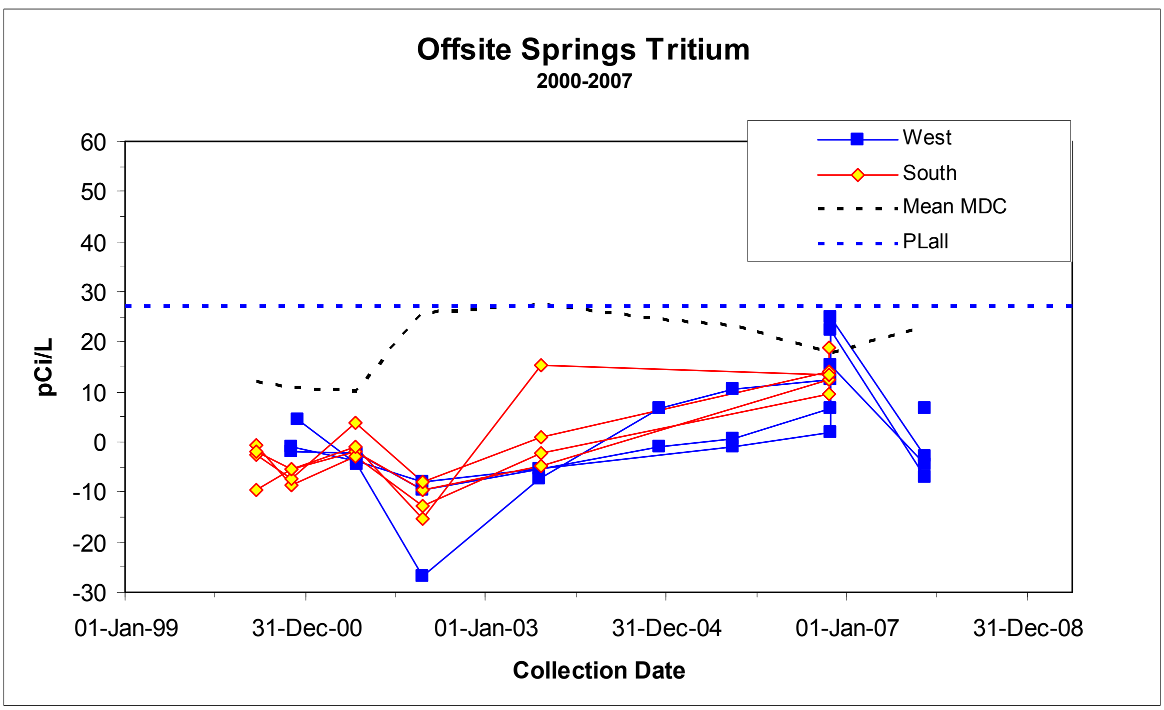


Figure 4-12. Tritium concentrations in offsite springs from 2000 to 2007 (springs not sampled in 2008)

4.1.8 Results from NTS Water Supply Wells

Five of six permitted wells that supply the potable water needs of NTS operations were sampled in 2008. The sixth, J-13 WW, is currently inoperable. Four onsite water wells supply non-potable water to support NTS activities (e.g., dust suppression). Results from these nine wells continue to indicate that nuclear testing has not impacted the NTS water supply network. Tritium was not detected above its MDC in any of the water wells sampled (Table 4-2).

Nearly all detections of radiological analytes in the NTS water supply wells involved gross alpha and gross beta radioactivity (Table 4-2). These likely represent the presence of naturally occurring radionuclides, since corresponding man-made radionuclides were not found in the samples. None of the gross alpha or gross beta activity concentrations exceeded the EPA-established MCL (gross alpha) or Level of Concern (gross beta) for drinking water (Table 4-2).

All nine wells were also monitored for gamma radionuclides and $^{239+240}$Pu, and all but Army #1 Water Well were monitored for ^{14}C, $^{89+90}$Sr, and ^{99}Tc. Analysis of the WW C-1 sample for $^{89+90}$Sr resulted in a reported value slightly above MDC. Due to the lack of confirmatory data (no detection of tritium, plutonium, ^{99}Tc, fission or activation products), this value is considered to be erroneous. No man-made radionuclides were otherwise detected in the water supply well samples.

These wells have been sampled routinely since 1999. Trend graphs for gross alpha, gross beta, and tritium are shown in Figures 4-13 through 4-15. Army #1 WW and WW #4A show mildly statistically significant decreasing trends in gross alpha; the estimated magnitudes of the decreases are 0.22 and 0.30 pCi/L/year (p = 0.028 and 0.034, respectively). One mildly statistically significant increasing trend (p = 0.045) is found with tritium in Army #1 WW; the estimated increase is 0.84 pCi/L/year. Otherwise, no statistically significant trends are found in these data. (Using the common 5 percent significance level, one would expect to see 1½ statistically significant trends just from random variation in the data among these 30 analyte/well combinations.) WW C-1 had a history of tritium detections prior to 1994 because this well was injected with approximately 0.1 to 0.2 curies of tritium in 1962 by a researcher conducting a tracer test (Lyles, 1990). Since 1995, annually averaged tritium concentrations in WW C-1 have remained below the effective analytical MDC despite wide variations seen in individual sample values (e.g., in 2002) (Figure 4-15).

The Nevada State Health Division's Bureau of Health Care Quality and Compliance (HCQC) (formerly the Bureau of Health Protection Services [BHPS]) is allowed access to the NTS to independently sample the NTS water supply wells. In 2008, however, HCQC did not perform any sampling or analysis of onsite water wells. HCQC personnel last accompanied ETS personnel in January 2007 to sample all the water wells except WW 5B. The HCQC sample results from 2007 indicated that man-made radionuclides are at or below their MDCs and that naturally occurring radioactive materials such as thorium and uranium decay chain radionuclides were within normal ranges (BHPS, 2007). HCQC personnel did, however, accompany ETS personnel to observe one sampling event at a monitoring well in Oasis Valley in 2008.

Table 4-2. Gross alpha, gross beta, and tritium analysis results for NTS water supply wells in 2008

Water Supply Well (NTS Area)	Date Sampled	Gross α ± Uncertainty[(a)] (MDC) (pCi/L)[(b)]	Gross β ± Uncertainty[(a)] (MDC) (pCi/L)[(c)]	^{3}H ± Uncertainty[(a)] (MDC) (pCi/L)[(d)]
Permitted Potable Wells				
J-12 WW (Area 25)	1/16/2008	-0.9 ± 1.1 (1.8)	4.3 ± 0.6 (0.7)	-7.6 ±12.9 (24)
	4/29/2008	2.4 ± 1.5 (2.1)	5.9 ± 2.0 (2.2)	-6.8 ±12.5 (21)
	7/15/2008	2.7 ± 1.7 (1.6)	5.7 ± 2.0 (2.0)	0.7 ±13.3 (22)
	10/21/2008	1.0 ± 0.7 (1.2)	5.4 ± 1.6 (2.5)	-9.2 ±13.7 (25)
WW #4 (Area 6)	1/16/2008	9.5 ± 2.3 (1.9)	4.9 ± 0.9 (0.8)	3.3 ±11.3 (20)
	4/29/2008	7.4 ± 2.7 (1.9)	6.7 ± 2.5 (3.2)	-4.8 ±13.5 (23)
	4/29/2008 FD	6.9 ± 2.7 (2.0)	6.4 ± 2.2 (2.4)	-3.8 ±13.8 (23)
	7/15/2008	6.7 ± 2.3 (1.9)	7.7 ± 1.8 (1.2)	-5.2 ±13.6 (23)
	10/21/2008	5.2 ± 1.6 (1.4)	5.4 ± 1.7 (2.6)	-6.0 ±13.0 (23)

Table 4-2 Gross alpha, gross beta, and tritium analysis results for NTS water supply wells in 2008 (continued)

Water Supply Well (NTS Area)	Date Sampled	Gross α ± Uncertainty (MDC)[(a)] (pCi/L)[(b)]	Gross β ± Uncertainty (MDC) (pCi/L)[(c)]	^{3}H ± Uncertainty (MDC) (pCi/L)[(d)]
Permitted Potable Wells (continued)				
WW #4A (Area 6)	1/16/2008	9.2 ± 2.3 (1.8)	5.5 ± 0.9 (0.97)	-0.9 ± 13.2 (23)
		6.7 ± 2.4 (2.0)	5.6 ± 2.2 (2.9)	-2.1 ± 13.4 (23)
		6.2 ± 2.5 (1.8)	8.2 ± 2.1 (1.5)	7.3 ± 13.5 (22)
		7.5 ± 3.0 (1.9)	7.4 ± 2.0 (1.5)	0.6 ± 13.6 (23)
		6.1 ± 1.4 (1.0)	7.0 ± 1.6 (1.7)	-5.0 ± 12.9 (23)
WW 5B (Area 5)	1/16/2008	4.9 ± 1.7 (1.9)	11.0 ± 1.0 (0.8)	-0.9 ± 13.4 (24)
	4/29/2008	2.2 ± 1.5 (2.0)	10.9 ± 2.9 (2.4)	-5.1 ± 13.6 (23)
	7/15/2008	3.7 ± 1.7 (2.0)	11.4 ± 2.4 (1.5)	-0.2 ± 12.4 (21)
	10/21/2008	2.9 ± 0.9 (0.9)	9.9 ± 2.0 (1.9)	-2.7 ± 13.2 (23)
	10/21/2008 FD	2.6 ± 0.9 (1.0)	13.1 ± 2.5 (2.1)	-2.2 ± 13.4 (23)
WW 8 (Area 18)	1/16/2008	1.4 ± 1.2 (1.8)	4.9 ± 1.2 (1.1)	-4.5 ± 12.6 (23)
	1/16/2008 FD	1.2 ± 1.2 (1.9)	3.7 ± 1.0 (1.0)	0.4 ± 13.2 (23)
	4/29/2008	-1.0 ± 0.9 (2.1)	3.1 ± 1.7 (2.4)	4.8 ± 14.0 (23)
	7/15/2008	0.0 ± 0.6 (1.6)	2.9 ± 1.4 (1.6)	-0.8 ± 12.7 (21)
	10/21/2008	1.6 ± 1.0 (1.6)	4.5 ± 1.7 (3.0)	2.2 ± 18.3 (32)
Non-Potable Wells				
Army #1 WW (Area 22)	1/16/2008	0.6 ± 1.1 (2.0)	3.2 ± 0.7 (0.9)	3.8 ± 13.3 (23)
	4/29/2008	3.8 ± 1.7 (2.0)	7.6 ± 2.3 (2.4)	-9.0 ± 13.8 (23)
	7/15/2008	4.6 ± 2.4 (1.8)	5.1 ± 1.7 (1.4)	3.1 ± 13.5 (23)
	10/21/2008	3.3 ± 1.2 (1.2)	5.9 ± 1.7 (2.6)	-0.9 ± 13.7 (24)
UE-16D WW (Area 16)	1/16/2008	2.7 ± 1.3 (2.0)	4.8 ± 0.6 (0.8)	-19.5 ± 12.6 (24)
	4/29/2008	7.3 ± 2.7 (2.0)	11.4 ± 3.0 (2.4)	2.6 ± 13.1 (22)
	7/15/2008	6.8 ± 2.9 (1.9)	6.7 ± 2.0 (1.7)	-1.0 ± 12.8 (22)
	10/21/2008	6.1 ± 1.4 (1.0)	7.4 ± 1.6 (1.7)	7.0 ± 13.8 (24)
WW 5C (Area 5)	1/16/2008	12.0 ± 2.4 (1.9)	5.4 ± 1.0 (1.0)	-5.2 ± 12.2 (22)
	4/29/2008	6.4 ± 2.4 (2.0)	5.5 ± 2.0 (2.5)	-3.2 ± 13.7 (23)
	7/15/2008	5.2 ± 2.5 (1.6)	6.3 ± 1.9 (1.5)	3.8 ± 12.6 (21)
	10/21/2008	5.6 ± 1.4 (1.2)	7.9 ± 2.0 (2.5)	5.1 ± 14.2 (24)
WW C-1 (Area 6)	1/16/2008	11.4 ± 2.0 (2.0)	10.5 ± 1.0 (1.1)	-2.6 ± 13.0 (23)
	4/29/2008	8.2 ± 3.1 (2.0)	14.5 ± 3.3 (2.5)	10.6 ± 12.9 (21)
	7/15/2008	5.5 ± 2.8 (2.0)	13.2 ± 3.1 (1.6)	3.1 ± 12.4 (21)
	10/21/2008	12.9 ± 2.6 (1.3)	14.4 ± 3.0 (2.9)	-5.6 ± 13.4 (24)

Green shaded results are considered detected (result is greater than the sample specific MDC)

(a) ±2 standard deviations
(b) The EPA established MCL in drinking water for gross alpha (α) is 15 pCi/L
(c) The EPA "Level of Concern" in drinking water for gross beta (β) is 50 pCi/L
(d) The EPA established MCL in drinking water for tritium (^{3}H) is 20,000 pCi/L
(e) FD = field duplicate sample

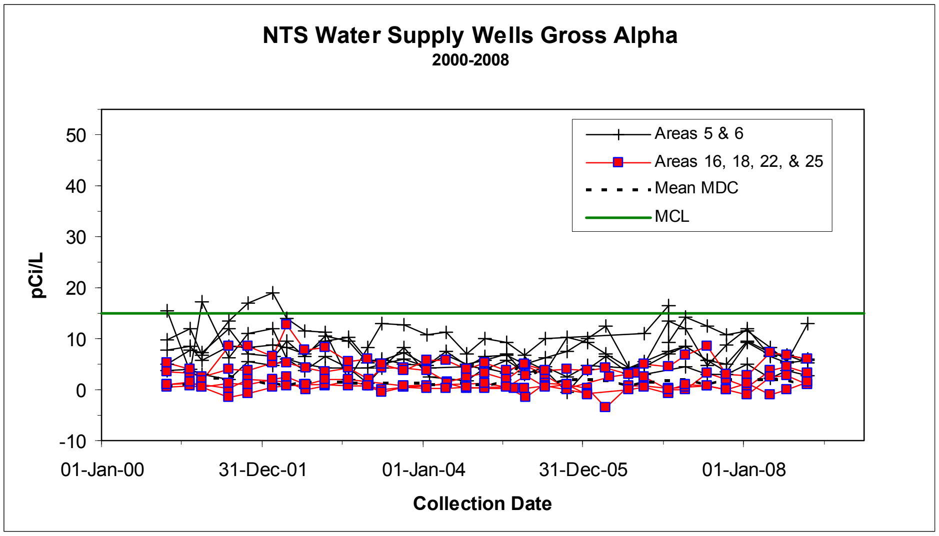


Figure 4-13. Gross alpha levels in NTS water supply wells from 2000 to 2008

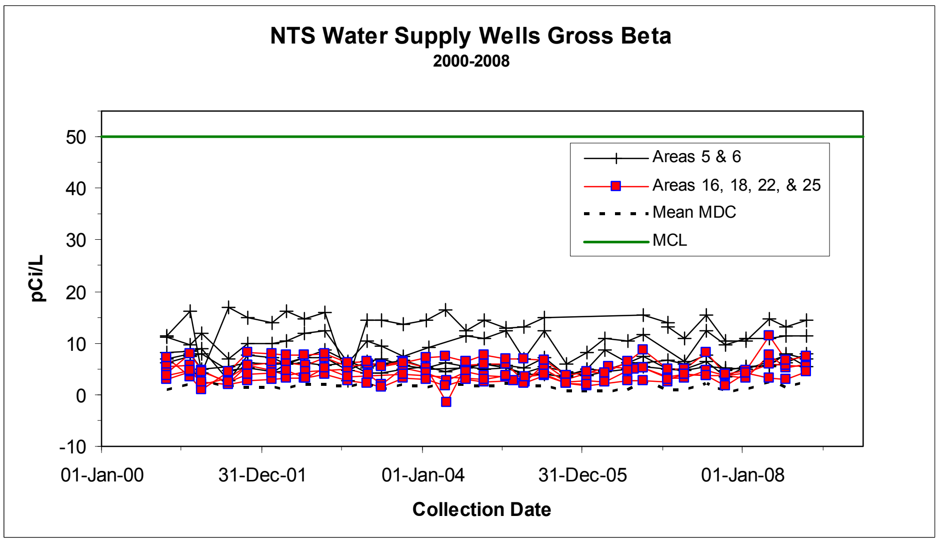


Figure 4-14. Gross beta levels in NTS water supply wells from 2000 to 2008

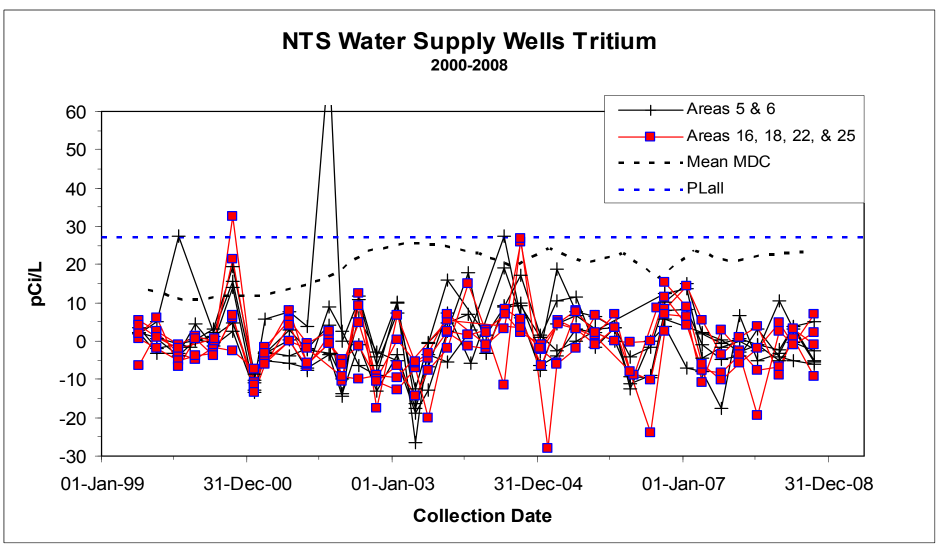


Figure 4-15. Tritium concentrations in NTS water supply wells from 2000 to 2008

4.1.9 Results from NTS Monitoring Wells

Analytical results from the network of onsite RREMP monitoring wells (see Figure 4-2) indicate that migration of radionuclides from the underground test areas is not significant. Four NTS monitoring wells (PM-1, U-19BH, UE-7NS, and WW A) are known to have detectable concentrations of tritium, although they are all well below the EPA drinking water MCL of 20,000 pCi/L. Each is located within 1 kilometer (km) (0.6 miles [mi]) of an historical underground nuclear test. They are discussed below, and their historic tritium concentrations are shown in Figure 4-16. Other than for these four wells, tritium was not detectable in other samples from onsite RREMP monitoring wells during 2008 (Table 4-3), and there were no statistically significant trends in the measured tritium levels (Figure 4-15).

PM-1 – This well is located in the Central Pahute Mesa CAU. It is constructed with unslotted casing from the surface to 2,300 m (7,546 ft) bgs and is an open hole from 2,300 to 2,356 m (7,546 to 7,730 ft) bgs. Results from depth profile sampling below the static water level in 2001 show a decreasing tritium concentration with depth, indicating that tritium is entering the borehole near the static water level at approximately 643 m (2,109 ft) bgs. Potential sources include the underground nuclear tests FARM (U-20ab), GREELEY (U-20g), and KASSERI (U-20z). The FARM test is closest to PM-1 but is believed to be down-gradient. GREELY and KASSERI tests are both upgradient from PM-1 at distances of 2,429 m (7,969 ft) and 1,196 m (3,924 ft), respectively.

U-19BH – This well is located in the Central Pahute Mesa CAU. It is an unexpended emplacement borehole. Several nuclear detonations were conducted near U-19BH, but the source of the tritium in the borehole is unclear. Previous investigations suggest that the water in the well originates from a perched aquifer, but identifying the likely source of tritium is difficult due to a lack of data regarding the perched system (Brikowski et al., 1993). The results from a tracer test conducted in the well indicate that there is minimal flow across the borehole (Brikowski et al., 1993). The lack of measurable flow in the well suggests that the chemistry of the water sampled from the borehole may not be representative of the aquifer. The tritium concentrations measured since 1999 at U-19BH show a downward trend (Figure 4-16).

UE-7NS – This well is located in the Yucca Flat CAU and was drilled 137 m (449 ft) from the BOURBON underground nuclear test (U-7n), which was conducted in 1967. This well was routinely sampled between 1978 and 1987, with the resumption of sampling in 1991. Tritium levels in this well have been decreasing in recent years (Figure 4-16). UE-7NS is the second known location on the NTS where the regionally important lower carbonate aquifer (LCA) has been impacted by radionuclides from nuclear testing (Smith et al., 1999). The first location where the LCA was known to be impacted by radionuclides from nuclear testing is Well UE-2CE located less than 200 m (656 ft) from the NASH test conducted in Yucca Flat in 1967. Well UE-2CE is not configured for routine sampling.

WW A – This well is completed in alluvium in the Yucca Flat CAU. It is located within 1 km (0.6 mi) of 14 underground nuclear tests, most of which appear to be up-gradient of the well. The well has had measurable tritium since the late 1980s. The marked increase between 1985 and 1999 suggests inflow of tritium to this well from the HAYMAKER underground nuclear test (U-3aus) conducted in 1962, 524 m (1,720 ft) north of WW A. This well, which supplied non-potable water for construction, was shut down in the early 1990s. The tritium concentrations measured since 2000 at WW A indicate a slight downward trend (Figure 4-16).

Detectable concentrations of gross alpha and gross beta were present in water collected from NTS onsite monitoring wells in 2008 (Table 4-3). These low measurable levels are likely from natural sources. The high levels of gross alpha and gross beta activity in U-19BH are likely due to contamination. Analysis of the U-19BH sample for ^{14}C resulted in a reported value slightly above MDC (232 pCi/L ± 147 pCi/L, MDC = 231 pCi/L), but the laboratory duplicate (an aliquot taken from the same sample container) was below the MDC. In addition, due to the lack of other indicators (no detection of tritium, plutonium, ^{99}Tc, other fission or activation products) that would confirm its presence, this value is considered to be an anomaly. No man-made radionuclides were otherwise confirmed as detected at concentrations above their respective MDCs in any of the NTS monitoring wells in 2008.

Table 4-3. Gross alpha, gross beta, and tritium analysis results for NTS monitoring wells in 2008

Monitoring Well	Date Sampled	Gross α ± Uncertainty[(a)] (MDC) (pCi/L)[(b)]	Gross β ± Uncertainty (MDC) (pCi/L)[(c)]	^{3}H ± Uncertainty (MDC) (pCi/L)[(d)]
ER-19-1 (2710 ft bgs)	3/18/2008	NS[(e)]	NS	7.5 ± 10.4 (18)
(2710 ft bgs)	3/18/2008 FD[(f)]	NA[(g)]	NA	5.5 ± 10.6 (18)
(3280 ft bgs)	3/18/2008	NS	NS	3.2 ± 10.9 (19)
ER-20-1	5/13/2008	NS	NS	-1.7 ± 13.6 (24)
	5/13/2008 FD	NA	NA	-6.2 ± 13.3 (24)
ER-20-2 #1	5/14/2008	NS	NS	1.4 ± 13.5 (24)
	5/14/2008 FD	NA	NA	-5.6 ± 13.2 (24)
HTH #1 (1935 ft bgs)	2/26/2008	3.2 ± 1.9 (1.9)	2.0 ± 1.2 (1.6)	-0.3 ± 14.0 (23)
(2040 ft bgs)	2/26/2008	2.2 ± 1.6 (1.9)	1.2 ± 1.1 (1.7)	-0.6 ± 14.0 (23)
(2130 ft bgs)	2/26/2008	2.0 ± 1.6 (2.0)	1.1 ± 1.1 (1.7)	4.2 ± 15.1 (25)
(2130 ft bgs)	2/26/2008 FD	NA	NA	-2.6 ± 13.8 (23)
(2300 ft bgs)	2/26/2008	3.6 ± 2.0 (2.0)	3.7 ± 1.4 (1.5)	0.2 ± 14.2 (24)
SM-23-1	10/8/2008	2.2 ± 1.0 (1.5)	9.6 ± 2.1 (2.4)	1.9 ± 14.0 (24)
	10/8/2008 FD	NA	NA	7.2 ± 14.7 (25)
U-19BH	3/17/2008	80 ± 13 (1.7)	92 ± 15 (2.6)	31 ± 13 (19)
	3/17/2008 FD	NA	NA	37 ± 13 (19)
UE-1Q	3/5/2008	5.2 ± 1.0 (0.6)	9.9 ± 1.8 (1.1)	-0.7 ± 10.7 (19)
	3/5/2008 FD	5.6 ± 1.2 (0.6)	9.0 ± 1.8 (1.6)	NA
UE5PW-1[(h)]	3/11/2008	NS	NS	6.8 ± 11.1 (19)
	3/11/2008 FD	NA	NA	3.8 ± 11.0 (19)
	9/10/2008	NA	NA	-2.6 ± 13.3 (22)
	9/10/2008 FD	NA	NA	11.7 ± 13.0 (21)
UE5PW-2[(h)]	3/11/2008	NS	NS	3.2 ± 10.8 (19)
	3/11/2008 FD	NA	NA	12.1 ± 11.2 (18)
	9/10/2008	NA	NA	-2.2 ± 12.8 (22)
	9/10/2008 FD	NA	NA	-1.9 ± 13.1 (22)
UE5PW-3[(h)]	3/11/2008	NS	NS	-2.5 ± 10.6 (19)
	3/11/2008 FD	NA	NA	-0.3 ± 10.8 (19)
	9/10/2008	NA	NA	0.7 ± 13.1 (22)
	9/10/2008 FD	NA	NA	-10.7 ± 12.8 (22)
UE-7NS	2/27/2008	1.8 ± 1.4 (1.9)	1.9 ± 1.1 (1.5)	90 ± 24 (30)
	2/27/2008 FD	NA	NA	84 ± 22 (28)
TW D	3/5/2008	2.7 ± 0.7 (0.6)	9.4 ± 1.7 (0.97)	3.1 ± 10.8 (19)

Table 4-3. Gross alpha, gross beta, and tritium analysis results for NTS monitoring wells in 2008 (continued)

Monitoring Location	Date Sampled	Gross α ± Uncertainty[(a)] (MDC) (pCi/L)[(b)]	Gross β ± Uncertainty (MDC) (pCi/L)[(c)]	^{3}H ± Uncertainty (MDC) (pCi/L)[(d)]
WW A	2/12/2008	2.0 ± 0.5 (0.4)	6.3 ± 1.2 (1.1)	356 ± 59 (28)
	2/12/2008 FD	NA	NA	344 ± 59 (34)
WELL PM-1	4/23/2008	NS	NS	127 ± 25 (23)
	4/23/2008 FD	NA	NA	130 ± 25 (22)

Green shaded results are considered detected (result is greater than the sample specific MDC)
Yellow shaded results are any that are equal to or greater than the EPA-designated levels shown below for each analyte:
(a) ±2 standard deviations
(b) The EPA established MCL in drinking water for gross alpha (α) is 15 pCi/L
(c) The EPA Level of Concern in drinking water for gross beta (β) is 50 pCi/L
(d) The EPA established MCL in drinking water for tritium (^{3}H) is 20,000 pCi/L
(e) NS = Not scheduled for gross alpha/beta analysis in 2008, analysis run once every 2–3 years, last analyzed in 2007
(f) FD = Field duplicate sample
(g) NA = Specific analysis was not run on the sample
(h) Compliance well for validation of waste pit P03U at Area 5 RWMS (see Section 9.1.6)

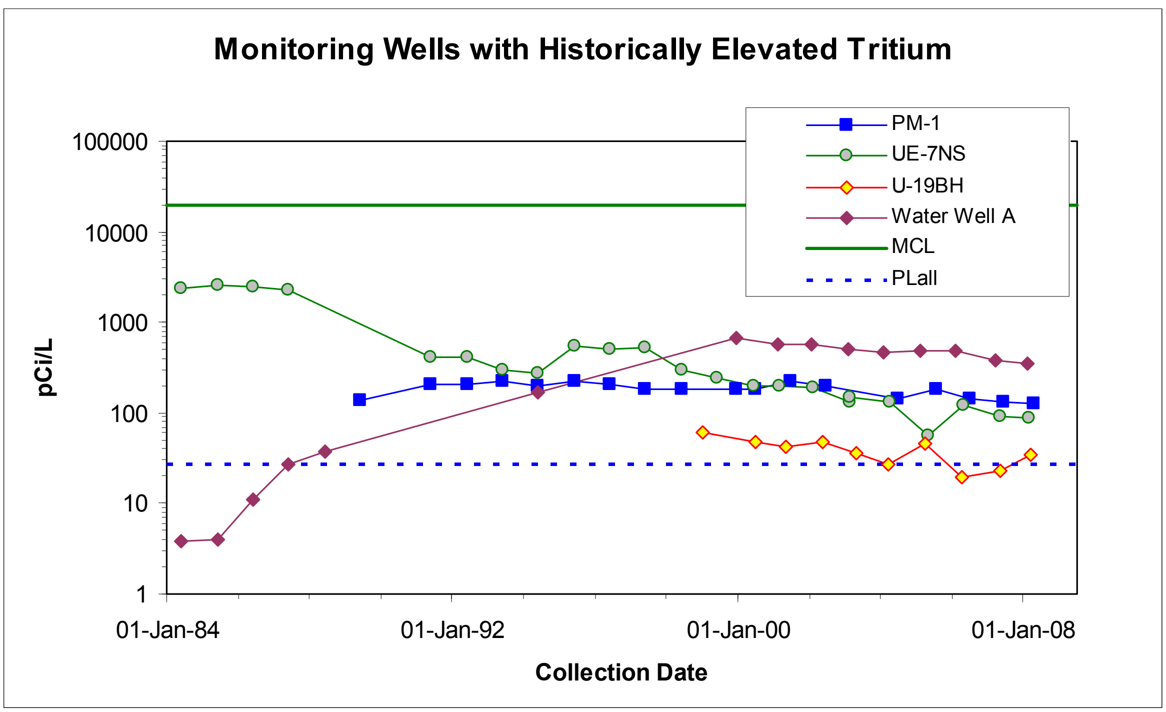
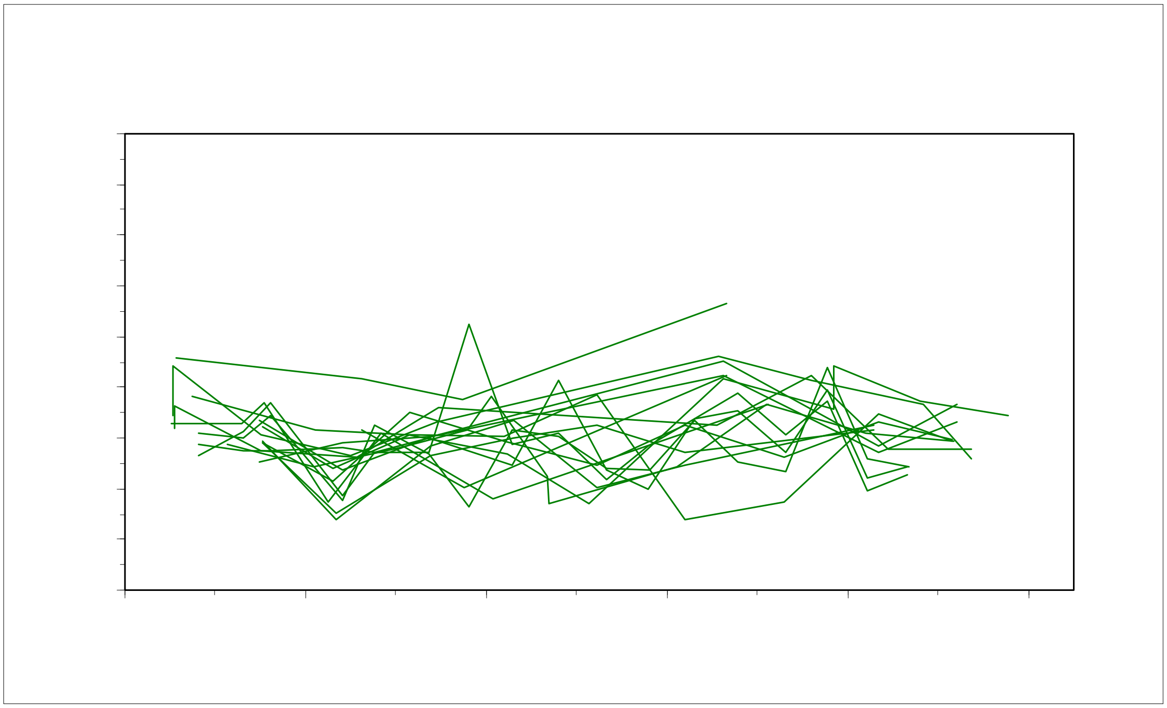


Figure 4-16. Concentrations of tritium in wells with a history of detectable levels



Through 2007, NSTec ETS sampled E Tunnel effluent, water from the ponds, and sediments from the ponds for the primary purpose of assessing the dose to NTS aquatic and terrestrial biota living in or using the ponds. Results from radiological analyses of these samples were reported in previous years' NTS environmental reports (e.g., NSTec, 2007a; 2008a). Concentrations of tritium in these effluent and pond water samples were generally similar to those measured in effluent samples for permit compliance (Figure 4-18). Both samples show tritium concentrations decreasing over time. Tritium levels in pond water samples were generally lower than in the tunnel effluent samples, which is likely due to precipitation diluting tritium concentrations in the ponds. Concentrations of man-made radionuclides in pond sediments, which were sampled from 2002 to 2007, are displayed in Figure 4-19. They were consistently above their MDCs, but did not appear to have increasing trends. Because inputs of man-made radionuclides to the tunnel system ended with the halt of nuclear weapons testing, radionuclides in tunnel effluents are expected to continue their decrease through time.

The potential dose to NTS biota from the E Tunnel ponds was assessed using the graded approach in DOE Standard DOE-STD-1153-2002, the RESRAD-BIOTA computer model (DOE, 2004b), and the radionuclide concentrations measured in E Tunnel pond water and sediments. Results demonstrated that the doses to biota were much less than the limits set to protect plant and animal populations (BN, 2004a; NSTec, 2008a). Sampling of tunnel effluent, pond waters, and sediments were discontinued in 2008 as these samples are in excess of ETDS permit compliance and are no longer needed for biota dose monitoring objectives. Plants and animals near the ponds will continue to be sampled under RREMP monitoring to directly verify low potential radiological doses to them and to humans potentially consuming them.

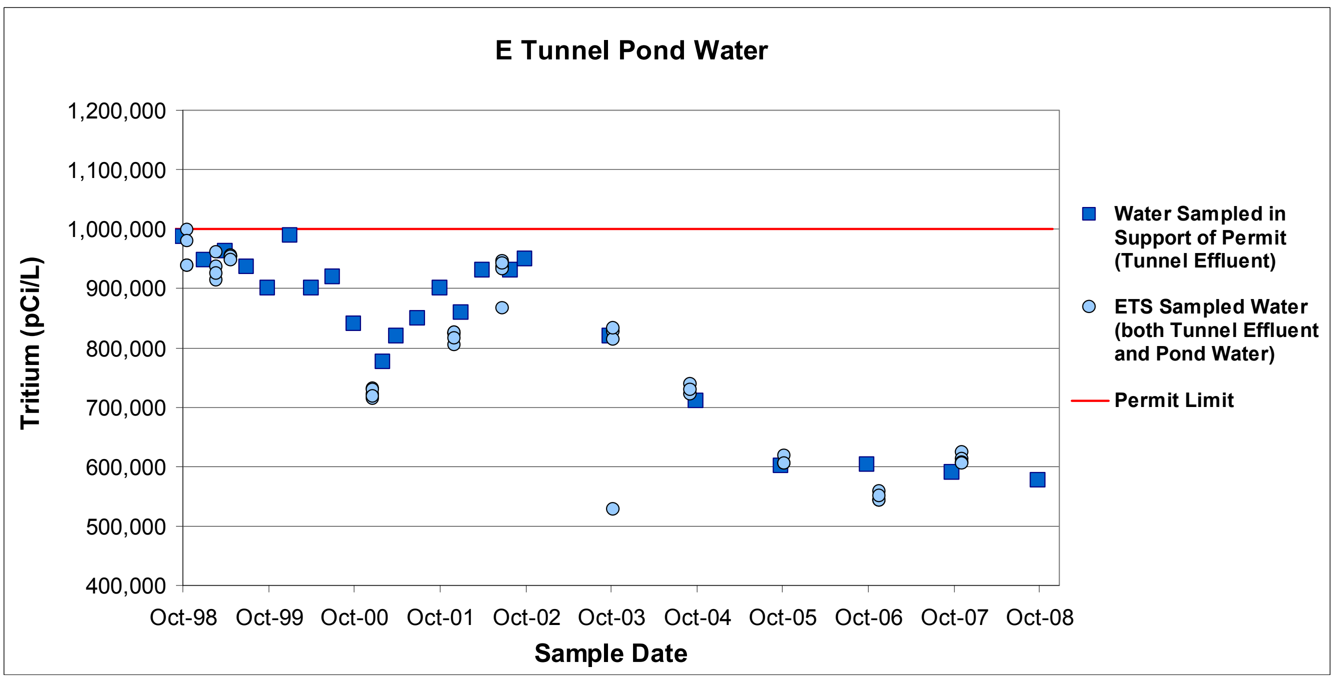


Figure 4-18. Tritium concentration in E Tunnel effluent and ponds from 1999 to 2008

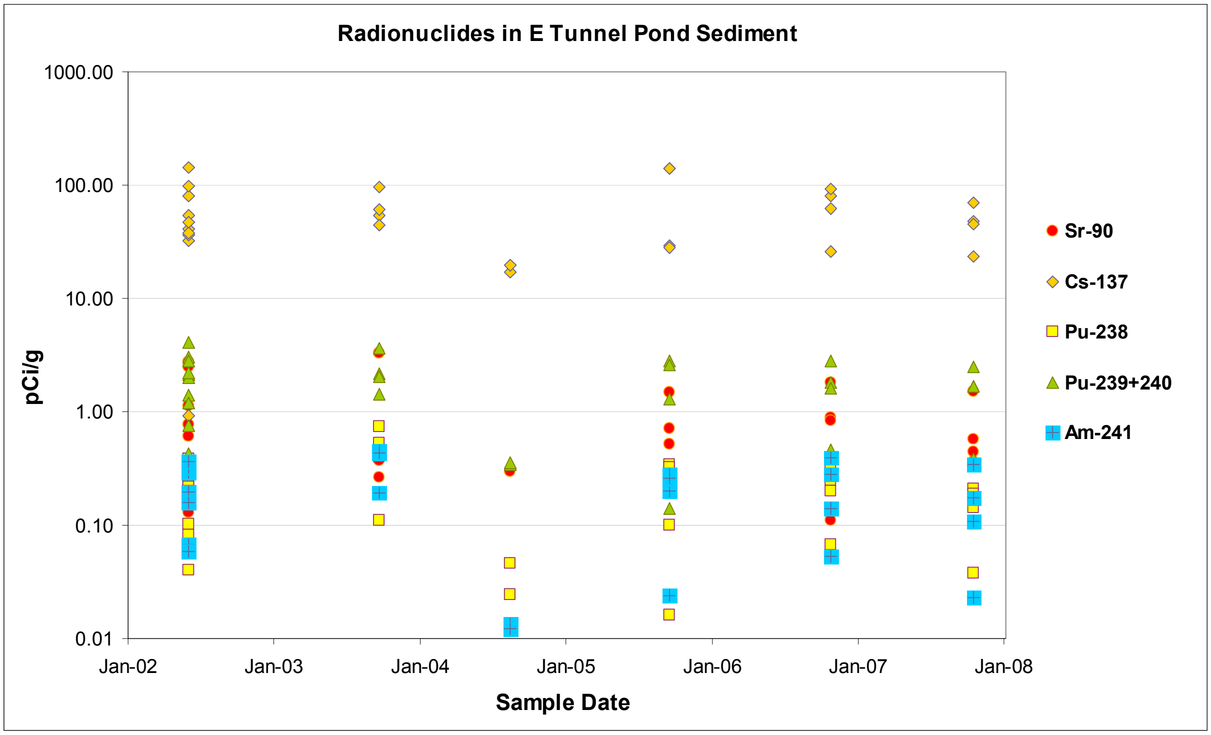


Figure 4-19. Concentrations of man-made radionuclides in E Tunnel pond sediments from 2002 to 2007

4.1.11 Results from NTS Sewage Lagoons

Each sewage lagoon at the NTS is part of a closed system used for the evaporative treatment of sanitary sewage. Sewage storage and treatment at the NTS has transitioned from lagoons to septic systems at several locations in recent years. Two permitted sewage lagoons, operated under the Water Pollution Control General Permit GNEV93001, remain: Area 6 Yucca and Area 23 Mercury (see Figure 4-3).

In July 2008, NSTec Solid Waste Operations collected annual samples to demonstrate permit compliance for gross alpha, gross beta, and tritium (Table 4-5). To more completely demonstrate the proper management of effluents on the NTS, gamma spectroscopy analyses were also conducted for these lagoons under the RREMP (BN, 2003a); no man-made gamma-emitting radionuclides were detected.

Until 2008, permit GNEV93001 required annual monitoring of gross alpha, gross beta, and tritium radioactivity. The permit was revised on November 20, 2008, and the requirement for annual monitoring changed. The lagoons will be sampled for gross alpha, gross beta, tritium, and 29 organic and inorganic contaminants only in the event of specific or accidental discharges of potential contaminants. Quarterly monitoring of 5-day biochemical oxygen demand, total suspended solids, and pH continue to be permit requirements (see Section 4.2.3.1).

Table 4-5. Radiological results for sewage lagoon effluent pertaining to permit GNEV 93001

Monitoring Location	Date Sampled	Gross α ± Uncertainty[a] (MDC) (pCi/L)	Gross β ± Uncertainty (MDC) (pCi/L)	^{3}H ± Uncertainty (MDC) (pCi/L)
Area 6 Yucca	7/08/2008	4.7 ± 1.3 (1.3)	23.8 ± 4.1 (2.0)	136 ± 225 (370)
Area 23 Mercury	7/08/2008	3.8 ± 1.3 (1.5)	27.7 ± 5.0 (3.3)	35 ± 222 (370)
	Permit Limit	15	50	20,000

Green shaded results are considered detected (results greater than the sample-specific MDC)

(a) ± 2 standard deviations

4.1.12 UGTA Wells

The UGTA Sub-Project (see Chapter 14) pumped and collected groundwater samples from six wells in 2008. Three of these wells are associated with underground nuclear tests and are classified as contaminated (UE-2ce, U-4u PS#2A, and U-19ad PS#1A), two are characterization wells located on Rainier Mesa (ER-12-3 and ER-12-4), and one is associated with the N-Tunnel complex on Rainier Mesa (U-12n.10 Vent Hole) (see Chapter 14, Figure 14-2). All of these wells except for the U-12n.10 Vent Hole were purged using downhole electric submersible pumps prior to the collection of samples. The U-12n.10 Vent Hole was sampled using a bailer on a wireline. A multi-agency team consisting of personnel from LANL and Lawrence Livermore National Laboratory collected the groundwater samples and analyzed them for tritium and other radionuclides. The resultant tritium concentrations are shown in Table 4-6.

Table 4-6. LANL radiochemistry results from UGTA well samples in 2008

UGTA Well	Date Sampled	^{3}H ± Uncertainty[(a)] (MDC) pCi/L
UE-2ce	7/2/08	260,000 ± 10,000 (400)
U-4u PS #2a	2/6/08	21,000,000 ± 1,000,000 (400)
U-19ad PS #1a	5/1/08	11,000,000 ± 400,000 (400)
U-12n.10 Vent Hole	8/20/08	6,200,000 ± 300,000 (400)
ER-12-3	9/17/08	<400
ER-12-4	9/24/08	<400

(a) ±2 standard deviations

4.1.13 Environmental Impact

The 2008 tritium data provide no evidence that man-made radionuclides have traveled significant distances from underground testing areas to offsite NNSA/NSO monitoring wells in Oasis Valley. None of the offsite NNSA/NSO monitoring wells sampled had levels of tritium consistently above MDCs. Previous years' tritium data from offsite water supply wells and springs indicate the same findings. Even on the NTS, groundwater monitoring results indicate that migration of radionuclides from the underground test areas is not significant. Groundwater from four monitoring wells on the NTS is known to consistently have tritium at levels above detection, and they are each within 1 km (0.6 mi) of an historical underground nuclear test. Their concentrations of tritium are still less than 3 percent of the EPA MCL for drinking water of 20,000 pCi/L, and no trend of rising tritium concentrations in these wells has been observed since 2000.

The radiological impact to water resources from current and past activities on the NTS is groundwater contamination from man-made radionuclides within the UGTA Sub-Project CAUs shown in Figure 4-1. The NDEP-approved method of containing tritium-contaminated waters in lined sumps (as for the UGTA Sub-Project post-shot wells) and in the E Tunnel ponds exposes NTS wildlife to tritium in their drinking water or aquatic habitat. The potential dose to NTS biota from the E Tunnel ponds has been assessed, and the results demonstrated that the doses to biota were much less than the limits set to protect plant and animal populations (BN, 2004a; NSTec, 2008a). The effect on wildlife to NTS radiological sources is addressed in Section 8.2 of this report.

4.2 Nonradiological Drinking Water and Wastewater Monitoring

The quality of drinking water and wastewater on the NTS is regulated by federal and state laws. The design, construction, operation, and maintenance of many of the drinking water and wastewater systems are regulated under state permits. NSTec is tasked with ensuring that such systems meet the applicable water quality standards and permit requirements (see Section 2.2). The NTS nonradiological water monitoring goals are shown below. NSTec Environmental Services (ES) personnel met these goals by conducting field water sampling and analyses, performing assessments, and maintaining documentation. This section describes the results of 2008 activities. Information about radiological monitoring of drinking water on and off the NTS is presented in Sections 4.1.4 and 4.1.6.

Nonradiological Water Monitoring Goals	*Compliance Measures/Actions*
Ensure that the operation of NTS public water systems (PWSs) and private water systems provide high-quality drinking water to workers and visitors of the NTS.	Number of PWS samples containing coliform bacteria
Determine if NTS PWS are operated in accordance with the requirements in Nevada Administrative Code (NAC) 445A under permits issued by the State.	Inorganic Phase II and V chemicals, volatile organic Phase I, II, and V chemicals, disinfection by-products, and Secondary Standards contaminants in PWS samples
Determine if the operation of commercial septic systems to process domestic wastewater on the NTS meets operational standards in accordance with the requirements NAC 445A under permits issued by the State.	5-day biological oxygen demand (BOD_5), total suspended solids (TSS), pH, and 29 organic and inorganic contaminants in sewage lagoon water Inspection of sewage lagoon systems
Determine if the operation of industrial wastewater systems on the NTS meets operational standards of federal and state regulations as prescribed under the GNEV93001 state permit.	Flow rate, pH, temperature, specific conductance, and 14 contaminants (mostly metals) in E Tunnel effluent water

4.2.1 Drinking Water Monitoring

Six permitted wells supply the potable water needs of NTS operations. These are grouped into three PWSs that were operated by NSTec in 2008 (Figure 4-20). The largest PWS (Area 23 and 6) serves the main work areas of the NTS. The PWSs are designed, operated, and maintained in accordance with the requirements in NAC 445A under permits issued by the NDEP Bureau of Safe Drinking Water (BSDW). PWS permits are renewed annually. The three PWSs must meet water quality standards for National Primary and Secondary Drinking Water Standards. They are sampled according to a nine-year monitoring cycle, which identifies the specific classes of contaminants to monitor for each drinking water source and the frequency of their monitoring.

For work locations at the NTS that are not part of a PWS, NNSA/NSO hauls potable water in two water tanker trucks. The trucks are permitted by the BSDW to hau

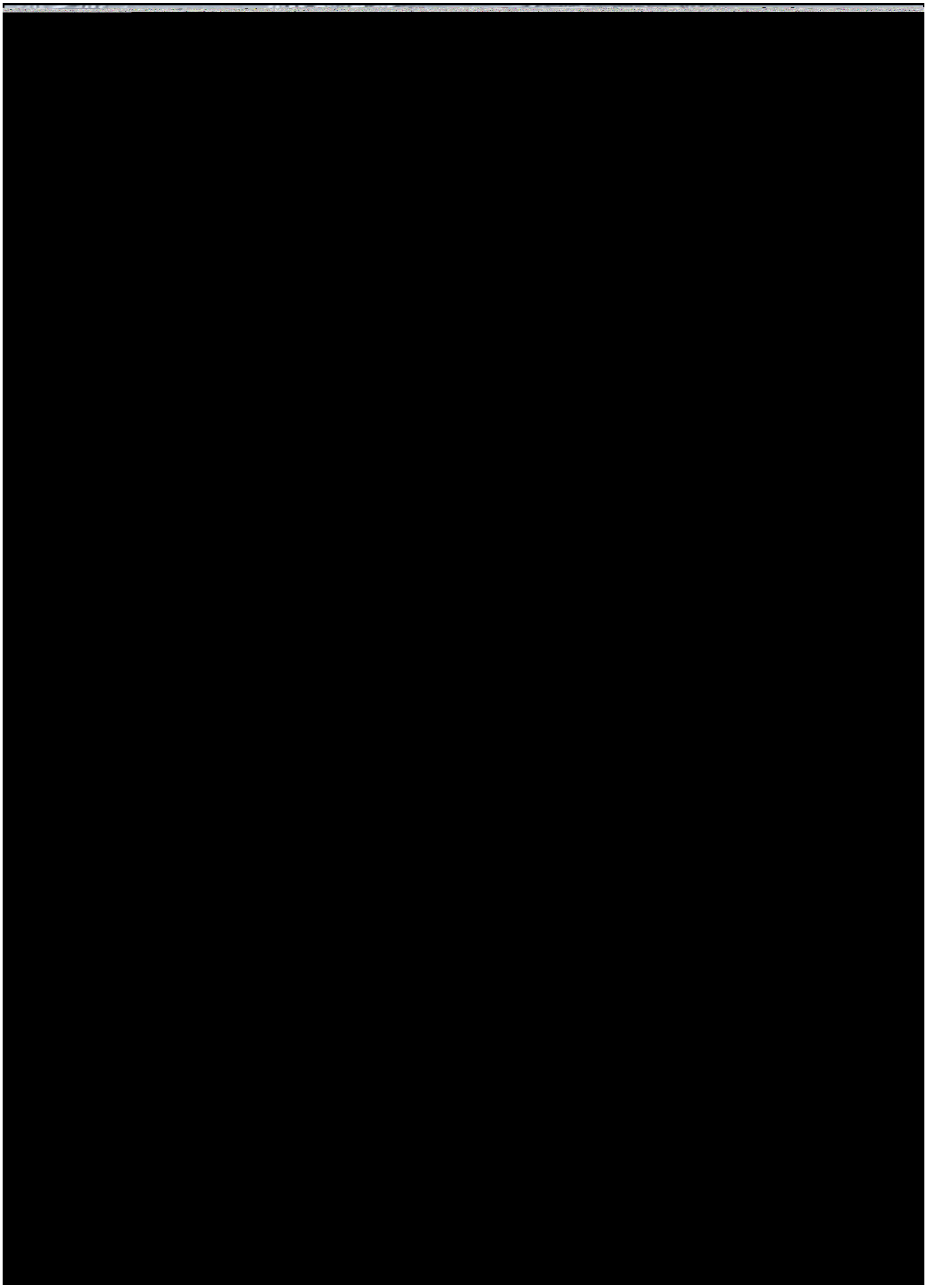


Figure 4-20. Water supply wells and drinking water systems on the NTS

Table 4-7. Monitoring parameters and sampling design for NTS PWSs and permitted water-hauling trucks

PWS	Contaminant	2008 Monitoring Requirement Samples/Frequency	Monitoring Locations
Area 23 and 6	Coliform Bacteria	36 samples (3 buildings per month, 4 samples per building)	Buildings 5-7, U1H restroom, 6-609, 6-900, 22-1, 23-180, 23-701, 23-777, 23-1103
	Inorganic Phase II Chemicals: Nitrate	1 sample (1 per entry point per year)	Two entry points: 4/4A S. Tank, Mercury N. Tank
	Inorganic Phase V Chemicals: Arsenic	1 sample (1 per entry point every 3 years)	
	Lead and copper	1 sample (1 per building every 3 years)	Buildings 5-7, 23-117, 23-143, CP-41, CP-214, 23-531, 23- 532, 23- 535, 23-614, 23-652
	Disinfection By-products: Trihalomethanes, haloacetic acids	1 sample (1 per building every 3 years)	Buildings 23-180, 22-1, 6-900
Area 12	Coliform Bacteria	4 samples (1 per quarter)	Building 12-30
	Inorganic Phase II Chemicals: Fluoride, nitrate, nitrite	1 sample (1 per entry point every 3 years)	One entry point: Area 12 S. Tank
	Secondary Standards: 11 contaminants (Table 4-8)	1 sample (1 per entry point every 3 years)	
Area 25	Coliform Bacteria	4 samples (1 per quarter)	Building 25-4320 or 25-4221
	Inorganic Phase II Chemicals: Fluoride and nitrate	1 sample (1 per entry point every 3 years)	One entry point: J-11 Tank
Water-Hauling Truck			
Truck 84846 and Truck 84847	Coliform Bacteria	12 samples (1 per month for each truck)	From water tank on each truck after filling at Area 6 potable water fill stand

All water samples were collected in accordance with accepted practices and the analyses were performed by state-approved laboratories. Approved analytical methods listed in NAC 445A and Title 40 Code of Federal Regulations (CFR) Part 141 were used by the laboratories.

In 2008, monitoring results indicated that the PWSs and the permitted water-hauling trucks complied with National Primary Drinking Water Quality Standards and Secondary Standards (Table 4-8). In June 2008, ten buildings in the Area 23 and 6 PWS (see Table 4-7) that have copper (Cu) pipes with lead (Pb) solder were sampled for these two metals. Pb and Cu were not detected above their reporting limits of 0.015 milligrams per liter (mg/L) (Pb) and 1.3 mg/L (Cu). In July 2008, three buildings within the Area 23 and 6 PWS (see Table 4-7) were sampled for total trihalomethanes (TTHM) and haloacetic acids (HAA), which are disinfection by-products. None of the samples exceeded the reporting limits of 0.08 mg/L for TTHM and 0.06 mg/L for HAA.

Table 4-8. Water quality analysis results for NTS PWSs and permitted water-hauling trucks

Contaminant	Maximum Contaminant Level (mg/L)	2008 Results (mg/L)		
		Area 23 and 6 PWS	Area 12 PWS	Area 25 PWS
Coliform Bacteria	Coliforms present in 1 sample/month	Present in 1 sample in January	Absent in all samples	Absent in all samples
Inorganic Chemicals – Phase II				
Fluoride	2.0	NA[(a)]	0.756	1.89-1.90
Nitrate	10 (as nitrogen)	3.25-3.77	1.20	1.9
Nitrite	1 (as nitrogen)	NA[(a)]	ND [(b)]	NA

Table 4-8. Water quality analysis results for NTS PWSs and permitted water-hauling trucks (continued)

Contaminant	Maximum Contaminant Level (mg/L)	2008 Results (mg/L)		
		Area 23 and 6 PWS	Area 12 PWS	Area 25 PWS
Inorganic Chemicals – Phase V				
Arsenic	10	7.8–9.1	NA	10
Secondary Standards				
Aluminum	0.2	NA	ND	NA
Chloride	400.0	NA	9.61	NA
Copper	1.0	NA	ND	NA
Foaming Agents	0.5	NA	ND	NA
Iron	0.6	NA	0.17	NA
Magnesium	150.0	NA	0.84	NA
Manganese	0.1	NA	0.0086	NA
Silver	0.1	NA	ND	NA
Sulfate	500.0	NA	18.1	NA
Total Dissolved Solids (TDS)	1000.00	NA	94	NA
Zinc	5.0	NA	ND	NA

(a) NA = Not applicable, not required to be sampled in 2008
(b) ND = Not detectable

Periodically, NDEP conducts a sanitary survey of the permitted NTS PWSs. It consists of an inspection of the wells, tanks, and other visible portions of each PWS to ensure that they are maintained in a sanitary configuration. As non-community water systems, the minimum survey frequency is once every five years. NDEP performed a sanitary survey of the PWSs in November 2008, and there were no significant findings.

NDEP inspects the two water-hauling trucks annually at the time of permit renewal to make sure they still meet the requirements of NAC 445A. Inspections were performed in June 2008 and permits were renewed.

4.2.1.2 Xylene Monitoring at Mercury North Tank

In June 2007, the organic contaminant xylene was detected in a water sample from the Mercury N. Tank point of entry into the Area 23 and 6 PWS (see Figure 4-20). The sample concentration was above 0.0005 mg/L but well below the MCL of 10 mg/L (Table 4-10 of NSTec, 2008a). To comply with the Safe Drinking Water Act, any regulated organic contaminant that is detected at a level exceeding 0.0005 mg/L in any sample, must trigger the initiation of quarterly monitoring at each sampling point that resulted in a detection [40 CFR 141.24 (f)(11)(i)]. NSTec did not initiate quarterly monitoring for xylene at the Mercury N. Tank immediately. NSTec discovered this oversight during routine data review and initiated quarterly sampling at the Mercury N. Tank in June 2008. Samples were collected on June 25, July 14, and November 5, 2008. The last quarterly sample was collected on January 29, 2009. Xylene was not detected (i.e., concentrations were <0.005 mg/L) in the subsequent quarterly samples.

In September 2008, NDEP determined that the failure to initiate quarterly sampling in 2007 did not warrant issuing a Notice of Alleged Violation (NOAV) and/or imposing fines. In lieu of issuing an NOAV, NDEP directed NNSA/NSO to implement specific changes in their sampling, administrative, and quality assurance programs (NDEP, 2008). NSTec complied with all requested changes by the end of 2008. In March 2009, NDEP notified NNSA/NSO that quarterly monitoring for xylene could be discontinued and that the routine annual sampling for xylene could be resumed (NDEP, 2009).

4.2.2 Domestic Wastewater Monitoring

A total of 23 permitted septic systems for domestic wastewater are being used on the NTS (Figure 4-21). These septic systems are permitted to handle 5,000 gallons of wastewater per day. Of the 23 permitted systems, 7 systems are under the direct control of the Solid Waste Department; the remaining 16 systems fall under the supervision and management of the building's Facility Manager. The permitted septic systems are inspected periodically for sediment loading and are pumped as required. A state-permitted septic pumping contractor is used. The State conducts onsite inspections of pumper trucks and pumping contractor operations. ES personnel perform management assessments of the permitted systems and services to determine and document adherence to permit conditions. The assessments are performed according to existing directives and procedures.

In 2008, the following compliance actions relating to domestic wastewater on the NTS occurred:

- During the second quarter of 2008, the inactive Area 12 lagoon received an unplanned discharge of approximately 4,000 gallons of potable water. Water used for a fire suppression test was inadvertently sent to the lagoon instead of the septic system because a by-pass plug was dislodged.
- A septic tank pumping contractor permit (NY-17-03318), septic tank pump truck permits (NY-17-03313, NY-17-03315, NY-17-03317, NY-17-06838), and a septic tanker permit (NY-17-06839) were approved by the State and renewed in July 2008.

The design and construction application for the Area 6 Criticality Experiments Facility septic system was terminated due to budget constraints. This new proposed system would have connected into the existing permitted Device Assembly Facility septic system. It would have assisted in managing the additional sewage flow generated from an increase number of workers when a new training and laboratory complex are constructed.

4.2.3 Industrial Wastewater Monitoring

Industrial discharges on the NTS are limited to two operating sewage lagoon systems: Area 6 Yucca Lake and Area 23 Mercury (these lagoon systems also receive domestic wastewater) (Figure 4-21). The Area 6 Yucca Lake system consists of two primary lagoons and two secondary lagoons. All lagoons in this system are lined with compacted native soils that meet the State of Nevada requirements for transmissivity (10^{-7}centimeters per second).

The Area 23 Mercury system consists of one primary lagoon, a secondary lagoon, and an infiltration basin. The primary and secondary lagoons in this system have a geosynthetic clay liner and a high-density polyethylene liner. The lining of the ponds allows Area 23 lagoons to operate as a fully contained, evaporative, non-discharging system.

Both sewage systems are monitored quarterly for influent quality and annually for influent toxicity. The locations where water samples are collected for analysis within each sewage system include the following:

- Each influent headwork for systems where there is direct access to influent flows
- Each pond near the lagoon's inlet for systems where there is no direct access to influent flows
- Each infiltration basin at a place where a sample most closely representing the infiltrating wastewater can be collected

In 2008, composite samples were collected over a period of 8 hours at the Area 6 Yucca Lake and Area 23 Mercury systems. All water samples were collected in accordance with accepted practices, and the analyses were performed by state-approved laboratories. Approved analytical methods listed in NAC 445A and Title 40 CFR 141 were used by the laboratories.

4.2.3.1 Quarterly Analysis of Sewage Lagoon Influent Water Quality

A composite sample from each influent headwork was collected quarterly. The composite sample was analyzed for three parameters: 5-day biological oxygen demand (BOD_5, see Glossary, Appendix B), total suspended solids (TSS), and pH (Table 4-9). The compliance limits for these parameters, established under Water Pollution

Figure 4-21. Active permitted sewage disposal systems on the NTS

Control General Permit GNEV93001, are shown in Table 4-9. All quarterly monitoring results for BOD_5, TSS, and pH for sewage system influent waters were within permit limits in 2008.

Table 4-9. Water quality analysis results for NTS sewage lagoon influent waters in 2008

		Minimum and Maximum Values from Quarterly Samples	
Parameter	**Units**	**Area 6 Yucca Lake**	**Area 23 Mercury**
BOD_5	mg/L	42-270	66-250
BOD_5 Permit Limit		No Limit	No Limit
BOD_5 Mean Daily Load [(a)]	kg/d	0.18-1.06	8.31-45.21
BOD_5 Mean Daily Load Limit		8.66	115.4
TSS	mg/L	118-248	98.6-160
TSS Permit Limit		No Limit	No Limit
pH	S.U. [(b)]	8.15-8.77	7.69-8.46`
pH Permit Limit		6.0–9.0	6.0–9.0

(a) BOD_5 Mean Daily Load in kilograms per day (kg/d) = (mg/L BOD x liters per day (L/d) average flow x 3.785)/10^6
(b) Standard units of pH

4.2.3.2 Annual Analysis of Toxicity of Sewage Lagoon Pond Waters

A grab sample from the Area 23 Mercury primary lagoon and an equal-volume composite sample from the two Area 6 Yucca Lake primary lagoons were collected in July. Each grab and composite sample was filtered, the solids discarded, and the filtrate analyzed directly, using methods of analysis cited in EPA (1986). Each sample was analyzed for the contaminants listed in Table 4-10. The limits for these contaminants are specified under the GNEV93001 permit; they are the same limits specified in 40 CFR 261.24, Table 1, Maximum Concentration of Contaminants for the Toxicity Characteristic. Annual monitoring showed that no contaminants exceeded permit limits (Table 4-10). As mentioned in Section 4.1.11, the permit's requirement for annual monitoring of the lagoons changed in November 2008. The lagoons will only be sampled for the contaminants in Table 4-10 in the event of specific or accidental discharges of potential contaminants.

Table 4-10. Water toxicity analysis results for NTS sewage lagoon pond water in 2008

Contaminant	Limit[(a)] (mg/L)	Area 6 Yucca (mg/L)	Area 23 Mercury (mg/L)
Benzene	0.5	ND[(b)]	ND
Carbon Tetrachloride	0.5	ND	ND
Chlorobenzene	100	ND	ND
Chloroform	6.0	ND	ND
Cresol (Total)	200	ND	ND
2,4-D	10	ND	ND
1,4-Dichlorobenzene	7.5	ND	ND
1,2-Dichloroethane	0.5	ND	ND
1,1-Dichlorethylene	0.7	ND	ND
2,4-Dinitrotoluene	0.13	ND	ND
Hexachlorobenzene	0.13	ND	ND
Hexachlorobutadiene	0.5	ND	ND
Hexachloroethane	3.0	ND	ND
Methylethyl Ketone	200	ND	ND
Nitrobenzene	2.0	ND	ND
Pentachlorophenol	100	ND	ND

Table 4-10. Water toxicity analysis results for NTS sewage lagoon pond water in 2008 (continued)

Contaminant	Limit[a] (mg/L)	Area 6 Yucca (mg/L)	Area 23 Mercury (mg/L)
Pyridine	5.0	ND	ND
Trichloroethylene	0.5	ND	ND
2,4,5-Trichlorophenol	400	ND	ND
2,4,6-Trichlorophenol	2.0	ND	ND
Vinyl Chloride	0.2	ND	ND
Arsenic	5.0	ND	ND
Barium	100	0.0411	0.0631
Cadmium	1.0	ND	ND
Chromium	5.0	ND	ND
Lead	5.0	ND	ND
Mercury	0.2	ND	ND
Selenium	1.0	ND	ND
Silver	5.0	0.0060	0.0085

(a) Source: 40 CFR 261.24, Table 1

(b) Not detected - results of laboratory analysis were below the lab's minimum detection limits

4.2.3.3 Sewage System Inspections

The sewage system operators inspect active systems weekly and inactive lagoon systems quarterly. NDEP inspects both active and inactive NTS lagoon systems annually. Onsite operators inspect for abnormal conditions, weeds, algae blooms, pond color, abnormal odors, dike erosion, burrowing animals, discharge from ponds or lagoons, depth of staff gauge, crest level, excess insect population, maintenance/repairs needed, and general conditions. Weekly and quarterly inspections were conducted by NSTec throughout the year, and NDEP conducted its annual inspection in May 2008. The inspection covered field maintenance programs, lagoons, sites, and access roads functional to operations. There were no notable findings from the onsite and NDEP inspections.

4.2.4 E-Tunnel Waste Water Disposal System (ETDS) Monitoring

The NNSA/NSO manages and operates the ETDS in Area 12 under a separate water pollution control permit (NEV 96021) issued by the NDEP BFF. The permit governs the management of radionuclide-contaminated wastewater that drains from the E Tunnel portal into a series of holding ponds. The permit requires Well ER-12-1 groundwater and ETDS discharge waters to be monitored for radiological parameters (see Section 4.1.10, Table 4-4) and for the nonradiological parameters listed below in Table 4-11. Monthly monitoring of the ETDS is also conducted during which personnel measure the flow rate, pH, temperature, and specific conductance of the discharge water and the total volume and structural integrity of the holding ponds. Well and ETDS monitoring data are reported to the NDEP BFF in annual and quarterly reports, respectively.

Until September 30, 2008, DTRA held the NEV 96021 permit and conducted the permit monitoring. NSTec assumed management and operating responsibility for the ETDS on October 1, 2008. In 2008, all nonradiological parameters in the annual ETDS sample were within the threshold limits specified by the permit (Table 4-11). The Well ER-12-1 groundwater sample, collected in July 2007, was also within permit limits for these parameters (Table 4-11). All 2008 monthly measurements and observations demonstrated compliance with permit limits and specifications.

Prior to September 2008, DTRA determined that the E Tunnel containment pond system needed modification and received approval for the modification from NDEP. Two earthen berms were constructed across Pond 6 to restore the pond's original holding capacity and reduce the risk of an uncontrolled release from the ETDS. The construction subdivided Pond 6 into three sections. The new numbering system for the impoundments is Ponds 4, 5, 6a, 6b, and 6c. Construction of the berms was completed on January 15, 2009.

Table 4-11. Nonradiological results for Well ER-12-1 groundwater and ETDS discharge samples

Nonradiological Parameter	Well ER-12-1 Groundwater (Sampled July 2007)		ETDS Discharge Water (Sampled October 2008)	
	Threshold (mg/L)	Measured Value (mg/L)	Threshold (mg/L)	Measured Value (mg/L)
Cadmium	0.005	0.002	0.045	0.00025[a]
Chloride	250	15.4	360	9.4
Chromium	0.09	0.006	0.09	0.0021
Copper	1.2	0.006	1.2	0.001[a]
Fluoride	3.6	0.243	3.6	0.25[a]
Iron	5.0	2.59	5.0	1.42
Lead	0.014	0.003	0.014	0.0015[a]
Magnesium	135	60.5	135	1.35
Manganese	0.25	0.145	0.25	0.0163
Mercury	0.0018	0.0002	0.0018	0.00006[a]
Nitrate nitrogen	9	0.104	9	1.13
Selenium	0.045	0.003	0.045	0.003[a]
Sulfate	450	328	450	15.8
Zinc	4.5	0.091	4.5	0.022

(a) Estimated quantity based on the minimum detection limit

Source: (NSTec, 2008a)

4.2.5 Environmental Impact

The results of all drinking water and wastewater monitoring in 2008 were within permit limits. In the past, some drinking water standards in NTS water supply wells or PWSs have been exceeded (e.g., arsenic in Army #1 WW and WW 5C, lead in the Area 12 PWS, elevated total dissolved solids and hardness in WW C-1). However, all were determined to have been due to natural causes or the condition of the water distribution systems themselves; they have not been the result of the release of contaminants into the groundwater from site operations. Non-radiological contamination of groundwater from NTS operations is expected to be co-located with the radiological contamination that has occurred from historic underground nuclear testing within the UGTA Sub-Project CAUs. It is expected to be minor, however, in comparison to the radiological contamination. For nuclear tests above the water table, potential nonradiological contaminants are not likely to reach groundwater because of their negligible advective and dispersive transport rates through the thick vadose zone. Water samples from UGTA Sub-Project wells, which include hot wells, have not had elevated levels of nonradiological man-made contaminants.

Well drilling, waste burial, chemical storage, and wastewater management are the only current NTS activities that have the potential to contaminate groundwater with nonradiological contaminants. This potential is very low, however, due to engineered and operational deterrents and natural environmental factors. Current drilling operations include the containment of drilling muds and well effluents in sumps (see Chapter 14). Well effluents are monitored for nonradiological contaminants (predominantly lead) to ensure that lined sumps are used when necessary. The Area 3 and 5 RWMSs and the solid waste landfills are designed and monitored to ensure that contaminants do not reach groundwater (see Chapter 9). In addition, the potential for mobilization of contaminants from all these sources to groundwater is negligible due to the arid climate, the extensive depth to groundwater (thickness of the vadose zone), and the proven behavior of liquid and vapor fluxes in the vadose zone (primarily upward liquid movement towards the ground surface).

The Environmental Restoration program, through the Soils Project and Industrial Sites Project, conducts cleanup and closures of historic surface and shallow subsurface contamination sites, some of which have nonradiological contaminants like metals, petroleum hydrocarbons, hazardous organic and inorganic chemicals, and unexploded ordnance (see Chapter 9). The potential for mobilization of these contaminants to groundwater is negligible due to the same regional climatic, soil, and hydrogeologic factors mentioned above.

No past or present NNSA/NSO operations are known to have contaminated natural springs or ephemeral surface waters on the NTS.

5.0 Direct Radiation Monitoring

U.S. Department of Energy (DOE) Order DOE O 5400.5, "Radiation Protection of the Public and the Environment," and DOE O 435.1, "Radioactive Waste Management," have requirements to protect the public and environment from exposure to radiation (see Section 2.3). Energy from radionuclides present in the Nevada Test Site (NTS) environment could potentially be deposited inside humans and animals through inhalation and ingestion. Section 3.1 and Section 4.1 present the results of monitoring radionuclides in air and water on the NTS; those results are used to estimate potential internal radiation dose to the public via inhalation and ingestion. Energy absorbed from radioactive materials outside of the body results in an external dose. During 2008, external dose was measured under the Direct Radiation Monitoring Program of National Security Technologies, LLC (NSTec), Environmental Technical Services. External dose comes from direct ionizing radiation on the NTS from all sources, including natural radioactivity from cosmic or terrestrial sources as well as man-made radioactive sources. This chapter presents the data obtained through this program.

Direct radiation monitoring is conducted to assess the state of the external radiation environment, detect changes in that environment, and measure gamma radiation levels near potential exposure sites. DOE O 450.1A, "Environmental Protection Program," states that environmental monitoring should be conducted to detect, characterize, and respond to releases from DOE activities, assess impacts, and estimate dispersal patterns in the environment. In addition, DOE O 5400.5 states that "it is also an objective that potential exposures to members of the public be as low as is reasonably achievable (ALARA)."

Direct Radiation Monitoring Program Goals
Assess the proportion of dose to the public that comes from background radiation versus NTS operations.
Measure the potential external dose to a member of the public in order to determine if the total dose (internal and external) exceeds 100 millirem per year (mrem/yr) (1 millisievert [mSv]/yr), the dose limit of DOE O 5400.5.
Determine if radiation levels from the Radioactive Waste Management Sites (RWMSs) are likely to result in a dose exceeding the 25 mrem/yr (0.25 mSv/yr) dose limit to members of the public as specified in DOE Manual DOE M 435.1-1, "Radioactive Waste Management Manual."
Monitor operational activities involving radioactive material, radiation-generating devices, or accidental releases of radioactive material to ensure exposure to members of the public are kept ALARA as stated in DOE O 5400.5.
Determine if the absorbed radiation dose (in a unit of measure called a rad [see Glossary, Appendix B]) from external radiation exposure to NTS terrestrial plants and aquatic animals is less than 1 rad per day (1 rad/d) (0.01 gray [Gy]/d), and if the absorbed radiation dose to NTS terrestrial animals is less than 0.1 rad/d (1 milligray [mGy]/d) (limits prescribed by DOE O 5400.5 and DOE Standard DOE-STD-1153-2002, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota").
Determine the patterns of exposure rates through time at various soil contamination areas to fulfill the requirements of DOE O 450.1A to characterize releases in the environment.

An offsite monitoring program has been established by the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office to monitor direct radiation within communities adjacent to the NTS. The Desert Research Institute (DRI) conducts this monitoring as part of its Community Environmental Monitoring Program (CEMP). DRI's 2008 direct radiation monitoring results are presented in Sections 6.1.2 and 6.1.3; see also Figure 5-2 of this chapter.

5.1 Measurement of Direct Radiation

Direct radiation is exposure to electromagnetic (gamma and X-ray) radiation. Electromagnetic radiation can travel long distances through air and penetrate living tissue causing ionization within the body tissues. By contrast, alpha and beta particles do not travel far in air (a few centimeters for alpha and about 10 meters (m) (33 feet [ft]) for beta particles). Alpha particles deposit only negligible energy externally; they rarely penetrate the outer dead layer of skin. Beta particles are generally absorbed in the layers of skin immediately below the outer layer.

Direct radiation exposure is usually reported in the unit milliroentgen (mR), which is a measure of exposure in terms of numbers of ionizations in air. The dose in human tissue resulting from an exposure from the most common external radionuclides can generally be approximated by equating a 1 mR exposure with a 1 millirem (mrem) (0.01 millisievert [mSv]) dose.

5.2 Thermoluminescent Dosimetry Surveillance Network Design

Monitoring is performed on the NTS because some NTS areas have elevated radiation levels resulting from historical weapons testing, current and past radioactive waste management activities, and/or current operations involving radioactive material or radiation-generating devices. A surveillance network of thermoluminescent dosimeter (TLD) sampling locations has been established on the NTS. The objectives and design of the network are described in detail in the *Routine Radiological Environmental Monitoring Plan* (RREMP) (BN, 2003a).

TLDs measure ionizing radiation exposure from all sources, including both natural and man-made radioactivity. The TLD used is the Panasonic UD-814AS, which consists of four elements housed in an air-tight, water-tight, ultraviolet-light-protected case. A slightly shielded lithium borate element can be used to check low-energy radiation levels. The average of three calcium sulfate elements is used to measure penetrating gamma radiation.

A pair of TLDs is placed at 1.0 ± 0.3 m (28 to 51 inches [in.]) above the ground at each monitoring location; these are exchanged for analysis quarterly. The quarterly analysis of TLDs is performed using automated TLD readers that are calibrated and maintained by the NSTec Radiological Control Department (RCD). Reference TLDs are exposed to 100 mR from a cesium-137 radiation source under tightly controlled conditions. These are then read along with TLDs collected from the environment to calibrate their response.

In 2008, there were 109 active environmental TLD locations on the NTS (Figure 5-1). They include the following numbers and types of locations:

- Background (B) – 10 locations where radiation effects from NTS operations are negligible.
- Environmental 1 (E1) – 41 locations where there is no measurable radioactivity from past operations but which are of interest due to the presence of personnel or the public in the area and/or the potential for receiving radiation exposure from a current operation.
- Environmental 2 (E2) – 35 locations where there is measurable added radioactivity from past operations and the locations are of interest due to the potential for personnel to be in the area and/or the need to monitor exposure trends in the area. Some locations fitting this description are grouped with the waste operations category below.
- Waste Operations (WO) – 17 locations in and around the Area 3 and Area 5 RWMS.
- Control (C) – 5 locations in Building 652 and 1 location in Building 650 in Mercury. Control TLDs are kept in stable environments and are used as a quality check on the TLDs and the analysis process.

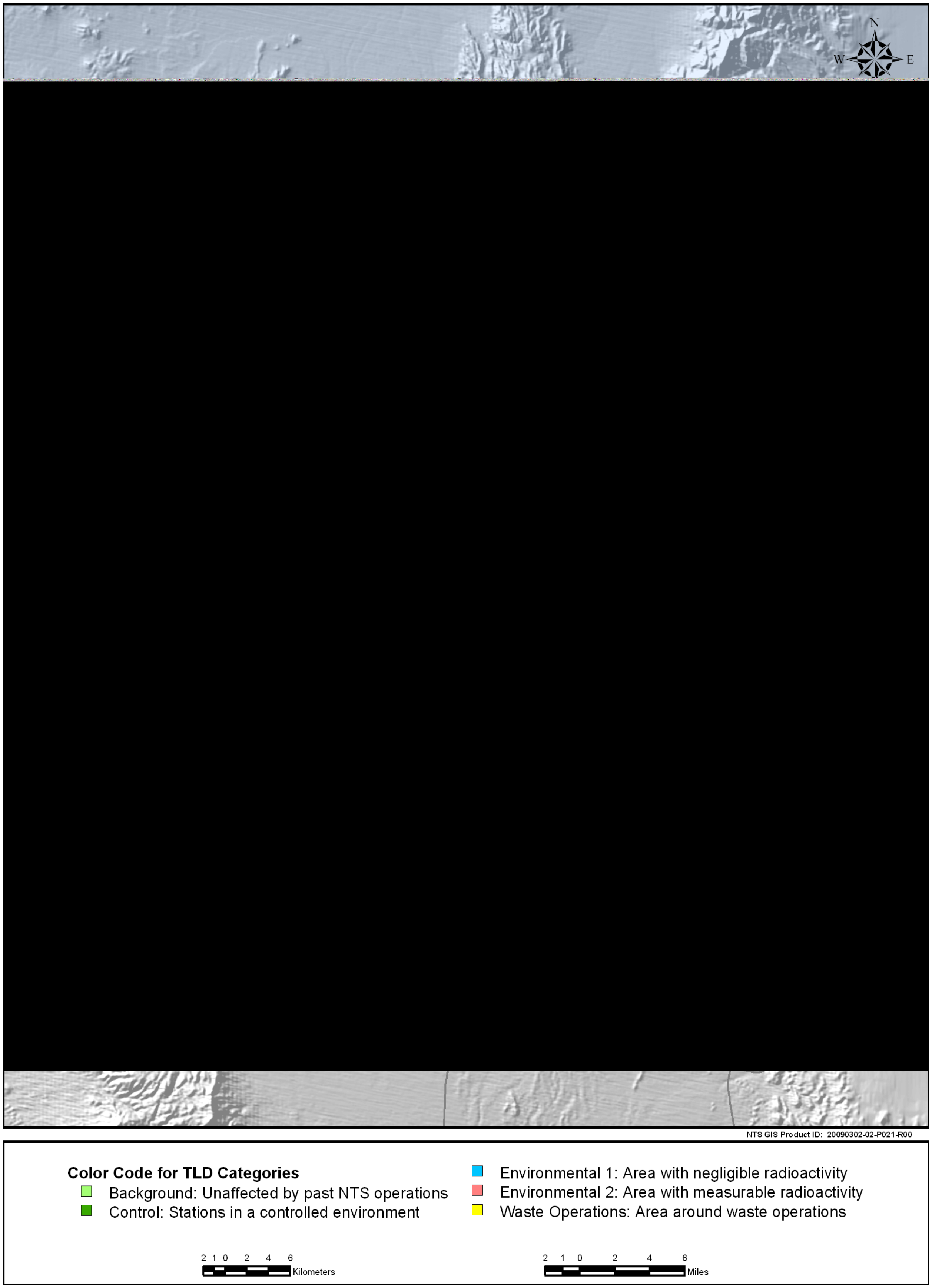

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Figure 5-1. Location of TLDs on the NTS

5.2.1 Data Quality

Quality assurance procedures for TLD monitoring of ambient radiation involve comparing the data from paired TLDs to estimate measurement precision, and reviewing data from the TLDs in the control locations. Five of the six control locations are shielded; the sixth is unshielded, but located in Mercury in Building 650. These locations allow one to detect and estimate any systematic quarter-to-quarter variation that might be introduced by the measurement process itself.

Some amount of systematic quarter-to-quarter variation is typical in the measurement process. When the TLD data for 2008 were examined, however, it was found that the third quarter data for virtually all stations exhibited atypical patterns. It has been determined that these patterns were due to improper "annealing" (essentially, resetting the TLDs to zero exposure) between subsequent deployments. The third quarter data were therefore discarded and steps have been taken to avoid this sort of anomaly in the future (e.g., screening steps programmed in software that controls anneal results). Unless stated otherwise, the results reported in this chapter are based on the TLD measurements made during the first, second, and fourth quarters.

Of the 327 possible pairs of TLD measurements, four were not available either because the TLDs were found on the ground or were missing. Agreement between results provided by the paired TLDs was very good, with an average relative percent difference between measurements of 2.2 percent for 2008. The quarter-to-quarter coefficient of variation (CV, identical to the relative standard deviation) ranged from 0.4 to 7.7 percent (median = 2.8 percent) except at the Gate 100 Truck Parking #1 and Stake TH-48 locations (see Sections 5.3.1 and 5.3.2). The quarter-to-quarter CVs were also a bit higher for control locations, ranging from 3.4 to 9.4 percent. For comparison, CV values for control locations have ranged from 1.2 to 10.0 percent in recent years. (CVs at control locations tend to be higher than those at environmental locations since the exposure rates are much lower due to shielding.)

At a programmatic level, quality assurance and quality control (QA/QC) protocols, including Data Quality Objectives, have been developed and are maintained as essential elements of direct radiation monitoring, as directed by the RREMP. The QA/QC requirements established for the monitoring program include the use of sample packages to thoroughly document each sampling event, rigorous management of databases, and completion of essential training. The RCD maintains certification through the U.S. Department of Energy Laboratory Accreditation Program for dosimetry.

5.2.2 Data Reporting

Direct radiation is reported as exposure per unit time. TLD analysis results are maintained in a database as milliroentgen per day (mR/d), calculated by dividing the measured mR exposure per quarter for each TLD by the number of days the TLD was exposed at its measurement location in the quarter. For annual reporting purposes, these are multiplied by 366 (since 2008 was a leap year). The estimated annual exposure is the average of the quarterly annualized values; this is used to determine compliance with federal annual direct radiation exposure limits.

5.3 Results

Estimated annual exposures for all TLD locations are summarized in Table 5-1; summary statistics for the five location types are given in Table 5-2. During 2008, the average of the estimated annual exposures at background locations was 116 mR; these ranged from 63 to 159 mR over the ten background locations (Table 5-2). These values are slightly lower than those from 2007. A 95 percent prediction interval (PI) for annual exposures based on background location annual mean values for 2008 is 39.5 to 192.3 mR (the "95% PI from B" shown in Figures 5-2, 5-3, and 5-4). This is a spatial prediction for mean values to be expected at new B locations; prediction limits for values to be expected at existing locations based on their own histories would be considerably narrower.

For comparison, the CEMP-estimated annual exposure in Las Vegas, Nevada (at 622 m [2,040 ft] elevation) was 94 mR during 2008 (see Table 6-3). Estimated exposures at CEMP locations ranged from 71 mR at Pahrump (777 m [2,550 ft] elevation) to 148 mR at Twin Springs (1,541 m [5,055 ft] elevation). There is generally an increasing relationship between exposure and elevation, with a correlation coefficient around 0.45. For comparison, the NTS background locations with lowest and highest exposures are at elevations 1,087 m (3,568 ft) (for the station named “Area 5, 3.3 Mi SE of Aggregate Pit”) and 1,737 m (5,700 ft) (for the station named “Area 20, Stake A-112”), respectively. Exposure estimates at all locations include the contribution from natural sources. Dose limits prescribed by DOE orders only apply to exposures above background levels.

Table 5-1. Annual direct radiation exposure rates measured at TLD locations on the NTS in 2008

				Estimated Annual Exposure (mR)[a]				
NTS Area	**Station**	**Location Type[b]**	**Number of Quarters**	**Mean[c]**	**SD[c]**	**Min[c]**	**Median[b]**	**Max[c]**
5	3.3 Mi SE of Aggregate Pit	B	3	63	2	61	64	64
14	Mid-Valley	B	3	142	5	138	141	148
16	Stake P-3	B	3	116	4	112	117	120
20	Stake A-112	B	3	159	4	154	159	163
20	Stake A-118	B	3	152	5	149	149	158
22	Army #1 Water Well	B	3	82	3	78	84	85
25	Gate 25-4-P	B	2	129	5	126	129	133
25	Gate 510	B	3	126	5	123	124	132
25	Jackass Flats & A-27 Roads	B	3	81	3	79	82	84
25	Skull Mtn Pass	B	3	108	4	104	108	111
23	Building 650 Dosimetry	C	3	59	2	57	59	61
23	Lead Cabinet, 1	C	3	26	2	24	25	28
23	Lead Cabinet, 2	C	3	27	2	24	26	29
23	Lead Cabinet, 3	C	3	27	2	25	26	29
23	Lead Cabinet, 4	C	3	27	2	25	27	29
23	Lead Cabinet, 5	C	3	26	2	25	26	28
1	BJY	E1	3	117	4	114	115	121
1	Sandbag Storage Hut	E1	3	112	2	110	113	114
1	Stake C-2	E1	3	117	1	117	117	118
2	Stake M-140	E1	3	131	2	129	133	133
2	Stake TH-58	E1	3	94	3	90	95	96
3	LANL Trailers	E1	2	120	4	117	120	123
3	Stake OB-20	E1	3	89	3	86	88	92
3	Well ER 3-1	E1	3	124	3	121	126	126
4	Stake TH-41	E1	3	111	2	109	110	112
4	Stake TH-48	E1	3	140	43	115	116	189
5	Water Well 5B	E1	3	113	6	106	114	118
6	CP-6	E1	3	70	2	68	71	72
6	DAF East	E1	3	96	1	95	96	97
6	DAF North	E1	3	103	3	100	105	106
6	DAF South	E1	3	135	3	131	136	138
6	DAF West	E1	3	84	3	80	84	86
6	Decon Facility NW	E1	3	129	4	126	128	133
6	Decon Facility SE	E1	3	134	5	129	134	138
6	Stake OB-11.5	E1	3	126	3	122	128	128
6	Yucca Compliance	E1	3	93	3	90	94	96

Table 5-1. Annual direct radiation exposure rates measured at TLD locations on the NTS in 2008 (continued)

NTS Area	Station	Location Type[(b)]	Number of Quarters	Estimated Annual Exposure (mR)[(a)] Mean[(c)]	SD[(c)]	Min[(c)]	Median[(c)]	Max[(c)]
6	Yucca Oil Storage	E1	3	99	3	97	98	102
7	Reitmann Seep	E1	3	125	2	124	125	128
7	Stake H-8	E1	3	126	3	122	125	129
9	Papoose Lake Road	E1	3	88	2	86	89	89
9	U-9CW South	E1	3	102	1	101	102	103
9	V & G Road Junction	E1	3	113	3	111	114	116
10	Gate 700 South	E1	3	131	4	127	130	135
11	Stake A-21	E1	3	129	4	124	131	131
12	Upper N Pond	E1	3	129	4	126	127	133
16	3545 Substation	E1	3	137	4	135	135	141
18	Stake A-83	E1	3	145	6	141	142	152
18	Stake F-11	E1	3	143	6	140	140	150
19	Stake P-41	E1	3	161	3	158	160	164
20	Stake J-41	E1	3	138	4	135	137	143
23	Gate 100 Truck Parking 1	E1	3	83	27	65	71	114
23	Gate 100 Truck Parking 2	E1	3	63	3	61	63	66
23	Mercury Fitness Track	E1	3	59	4	54	59	63
25	HENRE	E1	3	123	5	119	123	128
25	NRDS Warehouse	E1	3	124	3	120	123	127
27	Cafeteria	E1	3	113	2	111	114	115
27	JASPER-1	E1	3	114	4	110	116	117
1	Bunker 1-300	E2	3	122	2	121	121	124
1	T1	E2	3	271	4	267	272	275
2	Stake L-9	E2	3	166	4	162	168	168
2	Stake N-8	E2	3	515	9	508	512	526
3	Stake A-6.5	E2	3	139	1	138	138	141
3	T3	E2	3	366	10	355	367	376
3	T3 West	E2	3	351	7	343	354	356
3	T3A	E2	3	395	12	382	400	404
3	T3B	E2	2	496	7	491	496	501
3	U-3co North	E2	3	186	5	183	184	191
3	U-3co South	E2	3	144	1	142	144	145
4	Stake A-9	E2	3	643	10	631	647	650
5	Frenchman Lake	E2	3	349	12	335	351	360
7	Bunker 7-300	E2	3	234	4	230	234	238
7	T7	E2	3	115	1	114	115	115
8	BANEBERRY 1	E2	3	367	5	362	370	370
8	Road 8-02	E2	3	123	5	120	122	129
8	Stake K-25	E2	3	104	3	102	102	107
8	Stake M-152	E2	3	162	2	161	161	165
9	B9A	E2	3	131	5	127	130	137
9	Bunker 9-300	E2	3	121	1	121	121	122
9	T9B	E2	3	516	14	501	516	529
10	Circle & L Roads	E2	3	121	1	121	121	122
10	Sedan East Visitor Box	E2	3	132	3	128	133	134

Table 5-1. Annual direct radiation exposure rates measured at TLD locations on the NTS in 2008 (continued)

NTS Area	Station	Location Type[(b)]	Number of Quarters	Estimated Annual Exposure (mR)[(a)]
				Mean

5.3.1 Potential Exposure to the Public along the NTS Boundary

Most of the NTS is not accessible to the public, as only the southern portion of the NTS boundary borders public land. Therefore, the only place the public has potential for exposure to direct radiation from the NTS is along the southern boundary.

Gate 100 is the primary entrance point to the NTS. The outer parking areas are accessible to the public. Trucks hauling radioactive materials, primarily low-level radioactive waste destined for disposal in the RWMSs, often park outside Gate 100 while waiting for entry to the NTS. Two TLD locations were established in October 2003 to monitor this truck parking area. The TLD on the north end of the parking area (Gate 100 Truck Parking 2) had an estimated annual exposure of 63 mR, with quarterly estimates varying between 61 and 66 mR, at the lower end of the range of background exposures observed at the NTS.

The TLD location on the west side of the parking area (Gate 100 Truck Parking 1) has had somewhat elevated exposure levels at various times throughout its history, as documented in previous annual NTS environmental reports. The most recent high value was 268 mR, during the third quarter of 2007. The first quarter 2008 value (114.4 mR) is still descending from that peak. The second and fourth quarter values (65.1 and 71.2 mR, respectively) have returned to levels similar to those of Gate 100 Truck Parking 2 and the lower end of the range of NTS background values. The first quarter 2008 value is itself well within the range of NTS background values, although not at the low end of that range.

After the source of the problems with the third quarter data was identified, an informal adjustment of the third quarter data was made for the purpose of identifying any anomalies that might have occurred during that quarter. Gate 100 Truck Parking 1 again appeared mildly elevated during that quarter; its adjusted annualized value estimated at 115.4 mR, about the same as the first quarter. Again, this is high compared with expected values at this location, but well within the range of NTS background values.

While the public has access only to the southern portions of the NTS borders, other people may have access to other boundaries of the NTS. The great majority of the NTS is bounded by the Nevada Test and Training Range (NTTR). Military or other personnel on the NTTR who are not classified as radiation workers would also be subject to the 100 mrem/yr public dose limit. Nuclear tests on the NTTR (Double Tracks and Project 57) consisted of experiments where weapons were conventionally exploded without going critical (safety experiments). These areas, therefore, have primarily alpha-emitting radionuclides that do not contribute significantly to external dose.

The only place a radiological boundary extends beyond the NTS is in the Frenchman Lake region of Area 5 along the southeast boundary of the NTS. This region was a location of atmospheric weapons testing in the 1950s. A TLD location was established in July 2003 near the NTS boundary in the Frenchman Lake playa. The estimated annual exposure at Frenchman Lake during 2008 was 349 mR (down from 369 mR in 2007, 379 mR in 2006, 391 mR in 2005, and 411 mR in 2004). The resulting above-background dose of approximately 190 to 286 mrem, depending on which background value is used, would exceed the 100 mrem dose limit to a person residing year-round at this location; however, there are no living quarters or full-time workers in this vicinity.

5.3.2 Exposures from NTS Operational Activities

During 2008, there were 41 TLDs in locations where there is negligible radioactivity from past operations but where monitoring is of interest due either to the presence of personnel or the public in the area and/or due to the potential for receiving radiation exposure from current operations (E1 locations). The estimated mean annual exposure at these locations was 114 mR, approximately the same as the mean estimated annual exposure at background locations (see Table 5-2). Overall, annual exposures were not different between B (background) and E1 locations (Figure 5-2); the estimated annual exposures at all E1 locations were within the background-based PIs. These were also comparable with the off-NTS exposures reported by the CEMP stations.

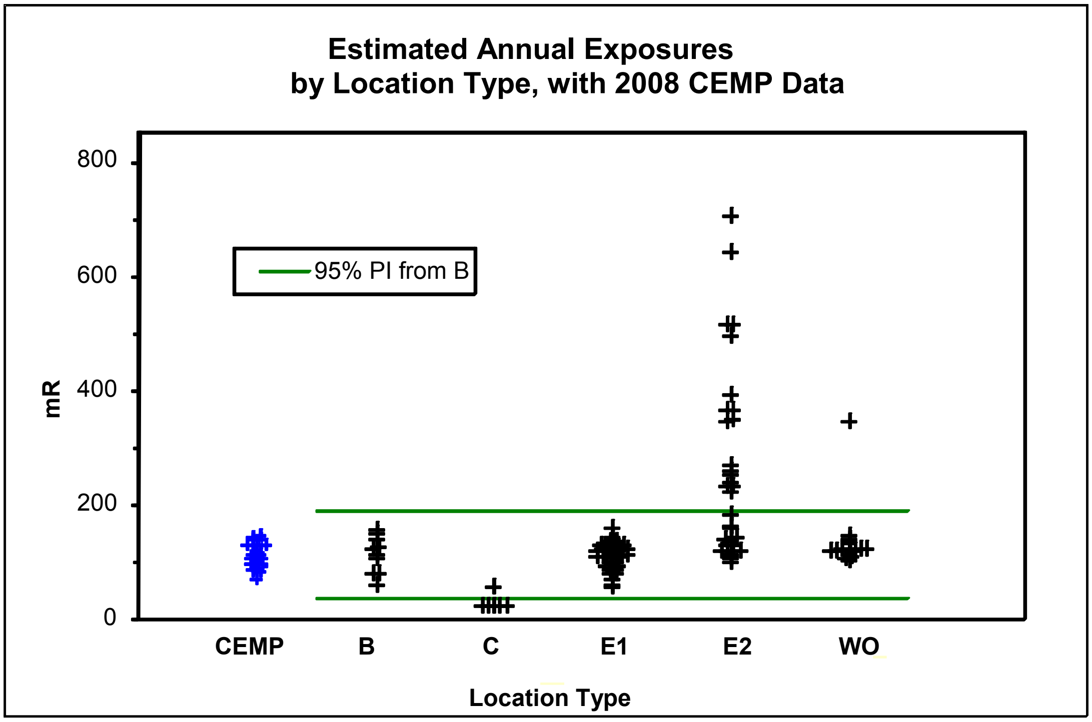

Figure 5-2. 2008 annual exposure rates on the NTS, by location type, and off the NTS (CEMP stations)

As noted in Section 5.2.1, there was a large between-quarter variation at Station TH-48 in Area 4. The first quarter measurements were around 63 percent higher than those of other quarters, including the adjusted third quarter values. The high first quarter values (averaging 189.2 mR) are barely within the background-station-based prediction limits shown in Figure 5-2. Values nearly as high have been measured a couple of times at that station from 1989 through 1993, but since then, values have been in the 100–140 mR range. The source of this inconsistent measurement is not known. Other than the anomalies noted here and at Gate 100 Truck Parking 1, all other exposure rate measurements were similar to, or decreasing from, values measured in past years.

5.3.3 Exposure Rates at RWMSs

DOE M 435.1-1, "Radioactive Waste Management Manual," states that low-level waste disposal facilities shall be operated, maintained, and closed so that a reasonable expectation exists that annual dose to members of the public shall not exceed 25 mrem. Given that the RWMSs are located well within the NTS boundaries, no members of the public could access these areas for significant periods of time. Exposures are still measured by TLDs located at the RWMSs to show the potential dose to a hypothetical person residing year-round at each RWMS.

The Area 3 RWMS is located in Yucca Flat. Between 1952 and 1972, 60 nuclear weapons tests were conducted within 400 m of the Area 3 RWMS boundary. Fourteen of these tests were atmospheric tests that left radionuclide-contaminated surface soil and, therefore, elevated radiation exposures across the area. Waste pits in the Area 3 RWMS are subsidence craters from seven subsurface tests, which are being filled with low-level radioactive waste. These are then covered with clean soil, resulting in lower exposures inside the Area 3 RWMS compared with the average exposures at the fence line or in Area 3 outside the fence line.

Annual exposures during 2008 in and around the Area 3 RWMS are shown in Figure 5-3. The exposures measured inside the Area 3 RWMS and three of four measurements at the boundary were within the range of background exposures. The estimated exposure above the range of NTS background levels at one location on the RWMS boundary is associated with historic aboveground nuclear weapon test locations. Under these conditions, current Area 3 RWMS operations would have contributed negligible external exposure to a hypothetical person residing at the Area 3 RWMS boundary during 2008.

The Area 5 RWMS is located in the northern portion of Frenchman Flat. Between 1951 and 1971, 25 nuclear weapons tests were conducted within 6.3 kilometers (km) (3.9 miles [mi]) of the Area 5 RWMS. Fifteen of these were atmospheric tests, and of the remaining ten, nine released radioactivity to the surface, which contributes to exposures in the area. No nuclear weapons testing occurred within the boundaries of the Area 5 RWMS. During 2008, estimated annual exposures at Area 5 RWMS TLD locations were within the range of exposures measured at NTS background locations (Figure 5-4). The one exposure rate measured outside the RWMS in Area 5 that was higher than background levels was within 0.5 km (0.3 mi) of six atmospheric tests in Frenchman Lake Playa.

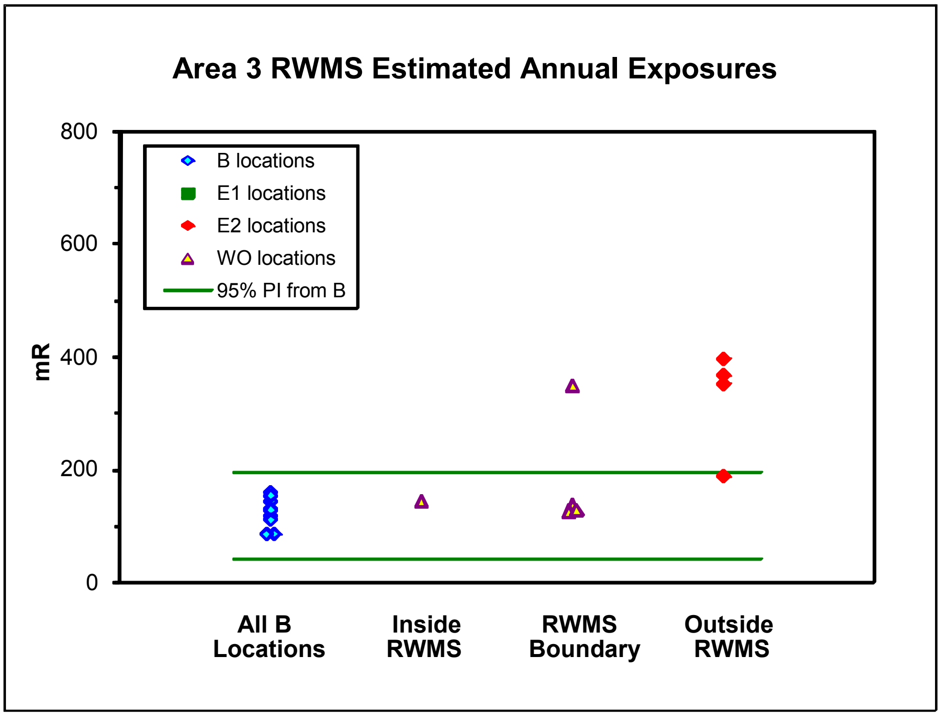

Figure 5-3. 2008 annual exposure rates in and around Area 3 RWMS and at background locations

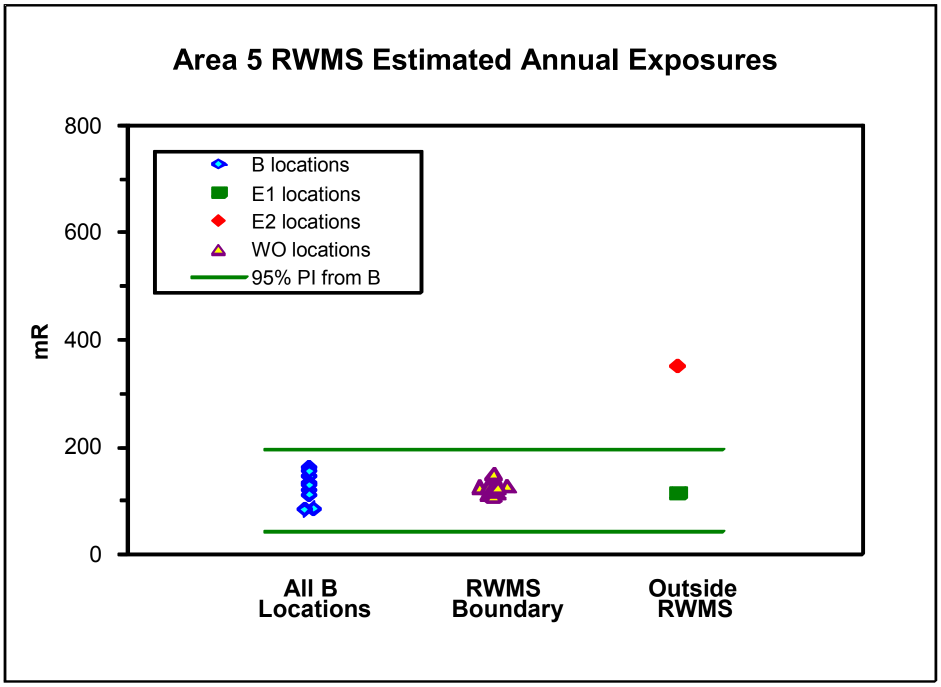

Figure 5-4. 2008 annual exposure rates around Area 5 RWMS and at background locations

5.3.4 Exposure to NTS Plants and Animals

The highest exposure rate measured at any TLD location during 2008 was 729 mR/yr at the Schooner-1 location (see Table 5-1). This was measured during the first quarter and equates to an exposure rate of 1.99 mR/d. Given such a large area source, there is very little difference between the exposure measured at 1-m (3.3-ft) height and that measured at an elevation near the ground (e.g., 3 centimeters [1.2 in.]) where small plants and animals reside. Therefore, the daily exposure rate near the ground surface at the Schooner-1 location would be approximately two percent of the most stringent total dose rate to biota, which is the 0.1 rad/d (approximately 100 mR/d) limit to terrestrial animals mandated by DOE-STD-1153-2002. Hence, doses to plants and animals from external radiation exposure at NTS monitoring locations are low compared with the mandated dose limit. Dose to biota from both internal and external radionuclides is discussed in Chapter 8.

5.3.5 Exposure Rate Patterns in the Environment over Time

DOE O 450.1A states that environmental monitoring should be conducted to characterize releases from DOE activities. Continued monitoring of exposures at locations of past releases on the NTS helps to do this. Small quarter-to-quarter changes are normally seen in exposure rates from all locations. In 2008, inter-quarter CVs averaged 2.8 percent (excluding Gate 100 Truck Parking 1 and Stake TH-48). The control locations tended to have larger quarter-to-quarter relative differences, which suggests that systematic analytical variability is a major, but not the only, contributing factor to the observed quarter-to-quarter variation.

Long-term trends are displayed in Figure 5-5 by location type for locations that have been monitored for at least ten years. As expected, the C and B locations show virtually no net change through time due to the protected locations and lack of added man-made radionuclides. Over all locations with at least 10-year data histories, the exposure rate at E1 locations decreased 0.4 percent per year; the E2 locations decreased 2.0 percent per year on average, and the WO locations decreased 0.7 percent per year on average. Those E2 and WO locations whose 2008 estimated exposures were above the background-based prediction limits decreased 3.8 percent per year on average.

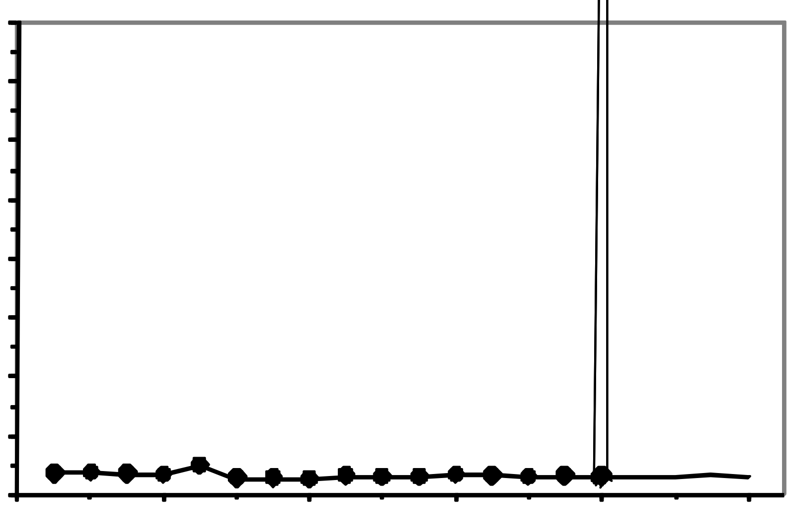

Figure 5-5. Trends in direct radiation exposure measured at TLD locations

Note that the Schooner-1 TLD location, which has the highest exposure of any current NTS location, is not included in Figure 5-5 because it was established in 2003. The two highest exposures shown in Figure 5-5, Stake A-9 in Area 4 and Stake N-8 in Area 2, are decreasing by 4.0 and 4.9 percent per year, respectively; these correspond to half-lives of about 17 and 14 years. The next highest exposures shown in Figure 5-5 are at the WO location RWMS South in Area 3; these are decreasing an average 3.7 percent per year. The observed decreases are due to a combination of natural radioactive decay and the dispersal of radionuclides in the environment.

5.4 Environmental Impact

Direct radiation exposure to the public from NTS operations in 2008 was negligible. Radionuclides historically released to the environment on the NTS have resulted in localized elevated exposures. These areas of elevated exposure are not open to the public, nor do personnel work in these areas full-time. Overall exposures at the RWMSs appear to be generally lower inside or at the boundary compared with those outside the RWMSs. This is likely due to the presence of radionuclides released from historical testing distributed throughout the area around the RWMSs compared with the clean soil used inside the RWMSs to cap waste pits. The external dose to plants and animals at the location with the highest measured exposure was a small fraction of the dose limit to biota; hence no detrimental effects to biota from external radiation exposure are expected at the NTS.

6.0 Oversight Radiological Monitoring of Air and Water

Community oversight for the Nevada Test Site (NTS) is provided through the Community Environmental Monitoring Program (CEMP) whose mission is to monitor and communicate environmental data that are relevant to the safety and well-being of participating communities and their surrounding areas. Previously, the CEMP network functioned as a first line of offsite detection of potential radiation releases from underground nuclear tests at the NTS, and it can be outfitted to fulfill this role again should underground testing resume. It currently exists as a non-regulatory public informational and outreach program, although quarterly reporting of monitoring data is furnished to the Nevada Division of Environmental Protection and the U.S. Environmental Protection Agency Region IX as a supplemental requirement to NTS onsite monitoring. The CEMP is sponsored by the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO), and is administered and operated by the Desert Research Institute (DRI) of the Nevada System of Higher Education.

Monitored and collected data include, but are not necessarily limited to, background and airborne radiation data, meteorological data, and tritium concentrations in community and ranch drinking water. Network stations, located in Nevada, Utah, and California, are managed by local citizens, many of them high school science teachers, whose routine tasks are to ensure equipment is operating normally and to collect air filters and route them to the DRI for analysis. These Community Environmental Monitors (CEMs) are also available to discuss the monitoring results with the public and to speak to community and school groups. DRI's responsibilities include maintaining the physical monitoring network through monthly visitations by environmental radiation monitoring specialists, who also participate in training and interfacing with CEMs and interacting with other local community members and organizations to provide information related to the monitoring data. DRI also provides public access to the monitoring data through maintenance of a project Web site at <http://www.cemp.dri.edu/>. A detailed informational background narrative about of the CEMP can be found at <http://www.cemp.dri.edu/cemp/moreinfo.html> along with more detailed descriptions of the various types of sensors found at the stations and on outreach activities conducted by the CEMP.

6.1 Offsite Air Monitoring

During 2008, 29 CEMP stations managed by DRI comprised the Air Surveillance Network (ASN) (Figure 6-1). The ASN stations include various equipment as described below. The Mesquite, Nevada CEMP station is shown in Figure 6-2.

CEMP Low-Volume Air Sampling Network – During 2008, the CEMP ASN included continuously operating low-volume particulate air samplers located at 27 of the 29 CEMP station locations. No low-volume air samplers were located at Medlin's Ranch or Warm Springs Summit, Nevada, during 2008. Duplicate air samples were collected from up to three ASN stations each week. The duplicate samplers are operated at randomly selected stations for three months (one calendar quarter) before being moved to a new location.

Glass-fiber filters from the low-volume particulate samplers are collected by the CEMs and mailed to DRI, where they are prepared and forwarded to an independent laboratory to be analyzed for gross alpha and gross beta activity. Samples are held for a minimum of seven days after collection to allow for the decay of naturally occurring radon progeny. Upon completion of the gross alpha/beta analyses, the filters are returned to DRI to be composited on a quarterly basis for gamma spectroscopy analysis.

CEMP Thermoluminescent Dosimetry Network – Thermoluminescent dosimetry is another of the essential components of environmental radiological assessments. This is used to determine both individual and population external exposure to ambient radiation from natural and artificial sources. In 2008, this network consisted of fixed environmental thermoluminescent dosimeters (TLDs) at 28 of the 29 CEMP stations (see Figure 6-1). A TLD is not currently deployed at Warm Springs Summit due to limited access during the winter months. The TLD used is a Panasonic UD-814AS. Within the TLD, a slightly shielded lithium borate element is used to check low-energy radiation levels while three calcium sulfate elements are used to measure penetrating gamma radiation. For quality assurance (QA) purposes, duplicate TLDs are deployed at three randomly selected

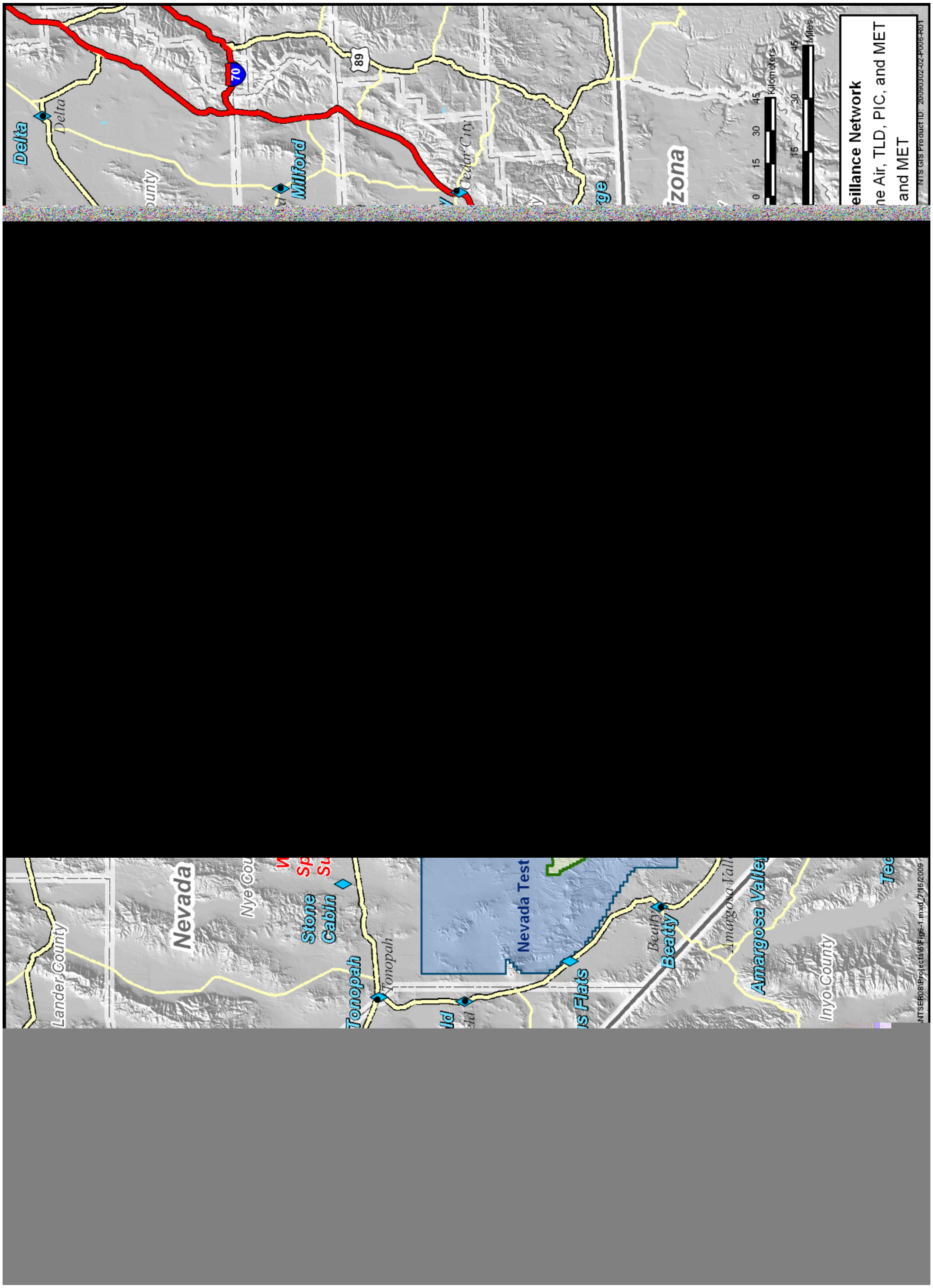

Figure 6-1. 2008 CEMP Air Surveillance Network

Figure 6-2. CEMP station at Mesquite, Nevada

environmental stations. An average daily exposure rate was calculated for each quarterly exposure period. The average of the quarterly values was multiplied by 365.25 days to obtain the total annual exposure for each station.

CEMP Pressurized Ion Chamber (PIC) Network – The PIC detector measures gamma radiation exposure rates, and because of its sensitivity may detect low-level exposures that go undetected by other monitoring methods. PICs are in place at all 29 stations in the CEMP network (see Figure 6-1). The primary function of the PIC network is to detect changes in ambient gamma radiation due to human activities. In the absence of such activities, ambient gamma radiation rates vary naturally among locations, reflecting differences in altitude (cosmic radiation), radioactivity in the soil (terrestrial radiation), and slight variations at a single location due to weather patterns. Because a full suite of meteorological data is recorded at each CEMP station, variations in PIC readings caused by weather events such as precipitation or changes in barometric pressure are more readily identified. These variations can be easily viewed by selecting the Time Series Graph link from the CEMP home page, <http://www.cemp.dri.edu/>, after selecting a desired station and then selecting the desired variables.

CEMP Meteorological (MET) Network – Because changing weather conditions can have a significant effect on measurable levels of background radiation, meteorological instrumentation is in place at each of the 29 CEMP stations. The MET network includes sensors that measure air temperature, humidity, wind speed and direction, solar radiation, barometric pressure, precipitation, and soil temperature and moisture data. All of these data can be observed real-time at the onsite station display, and archived data are accessible by accessing the CEMP home page at <http://www.cemp.dri.edu/>.

6.1.1 Air Particulate Sampling Results

For the first three quarters of 2008, samples of airborne particulates from CEMP ASN stations were collected by drawing air through a 5-centimeter (2-inch) diameter glass-fiber filter at a constant flow rate of 56.6 liters per minute (2 cubic feet [ft^3] per minute) at standard temperature and pressure. The actual flow rate and volume were measured and recorded with an in-line air-flow calibrator. The particulate filter is mounted in a filter holder that faces downward at a height of 1.5 meters (m) (5 feet [ft]) above the ground. The total actual volume collected ranges from approximately 538 to 793 cubic meters (m^3) (19,000 to 28,000 ft^3), depending on the elevation of the station and changes in air temperature and/or pressure. Beginning in October 2008, DRI began using a bi-weekly air sample collection routine. This routine required a reduction in the flow rate of the air sampler to compensate for increased particle loading on the filter. The current rate used is 49.5 liters per minute (1.75 ft^3 per minute). The total actual volume collected currently ranges from approximately 1,030 to 1,290 m^3 (36,000 to 45,000 ft^3).

6.1.1.1 Gross Alpha and Gross Beta

Analyses of gross alpha and beta in airborne particulate samples are used to screen for long-lived radionuclides in the air. The mean annual gross alpha activity across all sample locations was 1.61 ± 0.43 x 10^{-15} microcuries per milliliter (µCi/mL) (5.95 ± 1.59 x 10^{-5} Becquerels [Bq]/m^3) (Table 6-1). Most of the results for 2008 exceeded the analytical minimum detectable concentration (MDC) (see Glossary, Appendix B) and, overall, are similar to results from previous years. Figure 6-3 shows the long-term maximum, mean, and minimum alpha trend for the CEMP stations as a whole. The data for the Duckwater, Nevada station represents the first full year of sample collection since its installation. In addition, a three month gap in data for the Tecopa, California station occurred due to difficulties in finalizing permitting for the electrical infrastructure at the site.

Table 6-1. Gross alpha results for the CEMP offsite ASN in 2008

Sampling Location	Number of Samples	Concentration (x 10^{-15} µCi/mL [3.7 x 10^{-5} Bq/m^3])			
		Mean	Standard Deviation	Minimum	Maximum
Alamo	44	1.93	0.92	0.47	4.15
Amargosa Valley	46	1.58	0.58	0.69	3.64
Beatty	46	1.88	0.75	0.62	3.76
Boulder City	46	2.07	0.82	0.66	3.86
Caliente	46	2.27	0.99	0.77	4.30
Cedar City	46	1.31	0.56	0.36	3.04
Delta	46	1.35	0.50	0.43	3.56
Duckwater	42	1.30	0.49	0.46	2.67
Ely	45	1.24	0.52	0.34	2.74
Garden Valley	46	1.24	0.32	0.39	1.93
Goldfield	45	1.41	0.50	0.69	2.66
Henderson	43	1.48	0.49	0.37	2.73
Indian Springs	44	1.28	0.42	0.64	2.34
Las Vegas	46	2.94	0.89	0.69	4.71
Mesquite	44	1.66	0.69	0.86	4.19
Milford	46	1.59	0.84	0.65	6.08
Nyala Ranch	46	1.04	0.31	0.46	1.91
Overton	46	2.04	0.88	0.76	4.35
Pahrump	46	1.62	0.71	0.52	3.92
Pioche	44	1.27	0.49	0.59	3.29
Rachel	45	1.65	0.62	0.57	3.64
Sarcobatus Flats	46	2.35	1.09	0.83	4.78
Stone Cabin Ranch	46	1.38	0.44	0.64	2.82
St. George	46	1.41	0.42	0.43	2.23
Tecopa	34	1.52	0.64	0.55	3.36
Tonopah	45	1.39	0.45	0.51	2.41
Twin Springs	45	1.29	0.41	0.55	2.05
Network Mean = 1.61 ± 0.43 x 10^{-15} µCi/mL					
Mean MDC = 0.47 x 10^{-15} µCi/mL		**Standard Error of Mean MDC = 0.07 x 10^{-15} µCi/mL**			

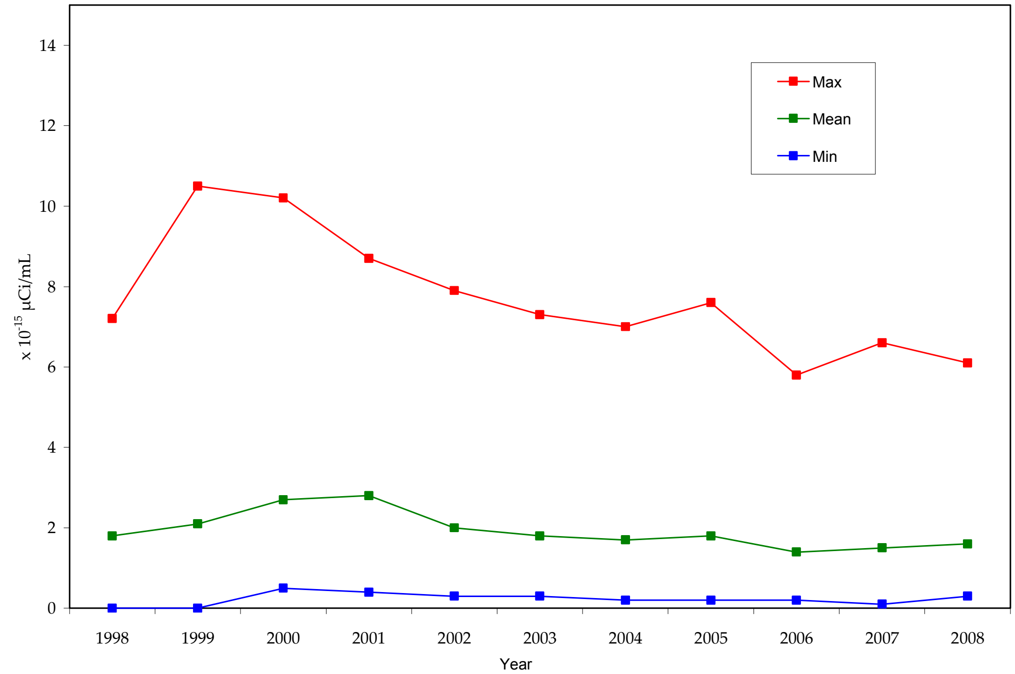

Figure 6-3. Historical trend for gross alpha analysis for all CEMP stations

The mean annual gross beta activity across all sample locations (Table 6-2) was 2.09 ± 0.16 x 10^{-14} µCi/mL (7.73 ± 0.59 x 10^{-4} Bq/m^3). Most of these results also exceeded the MDC, and are similar to previous years' data. Figure 6-4 shows the long-term maximum, mean, and minimum beta trend for the CEMP stations as a whole.

Table 6-2. Gross beta results for the CEMP offsite ASN in 2008

		Concentration (x 10^{-14} µCi/mL [3.7 x 10^{-4} Bq/m^3])			
Sampling Location	**Number of Samples**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**
Alamo	44	2.12	0.59	0.96	4.46
Amargosa Valley	46	2.07	0.43	1.11	2.87
Beatty	46	2.14	0.49	1.07	3.06
Boulder City	46	2.22	0.43	1.06	3.55
Caliente	46	2.23	0.50	1.04	3.09
Cedar City	46	1.92	0.51	0.99	2.92
Delta	46	2.09	0.53	0.86	3.43
Duckwater	42	1.99	0.50	1.03	3.04
Ely	45	1.91	0.49	1.11	3.44
Garden Valley	46	2.01	0.43	1.36	2.94
Goldfield	45	1.89	0.40	1.16	2.85
Henderson	43	2.15	0.51	0.90	3.27
Indian Springs	44	1.94	0.41	1.04	2.76
Las Vegas	46	2.35	0.48	1.26	3.82
Mesquite	44	2.28	0.54	1.15	3.65
Milford	46	2.18	0.55	0.93	3.65
Nyala Ranch	46	1.72	0.41	1.01	3.16
Overton	46	2.21	0.46	1.33	3083
Pahrump	46	2.06	0.49	0.99	3.08
Pioche	44	1.90	0.53	0.79	3.69

Table 6-2. Gross beta results for the CEMP offsite ASN in 2008 (continued)

Sampling Location	Number of Samples	Concentration (x 10^{-14} µCi/mL [3.7 x 10^{-4} Bq/m^3]) Mean	Standard Deviation	Minimum	Maximum
Rachel	45	2.23	0.58	1.17	4.57
Sarcobatus Flats	46	2.30	0.56	1.33	3.42
Stone Cabin	46	2.03	0.52	1.08	3.22
St. George	46	2.30	0.52	1.29	4.16
Tecopa	34	2.23	0.57	1.13	4.00
Tonopah	45	1.90	0.44	0.91	2.72
Twin Springs	45	2.12	0.63	0.95	4.21
Network Mean = 2.09 ± 0.16 x 10^{-14} µCi/mL					
Mean MDC = 0.09 x 10^{-14} µCi/mL		**Standard Error of Mean MDC = 0.02 x 10^{-14} µCi/mL**			

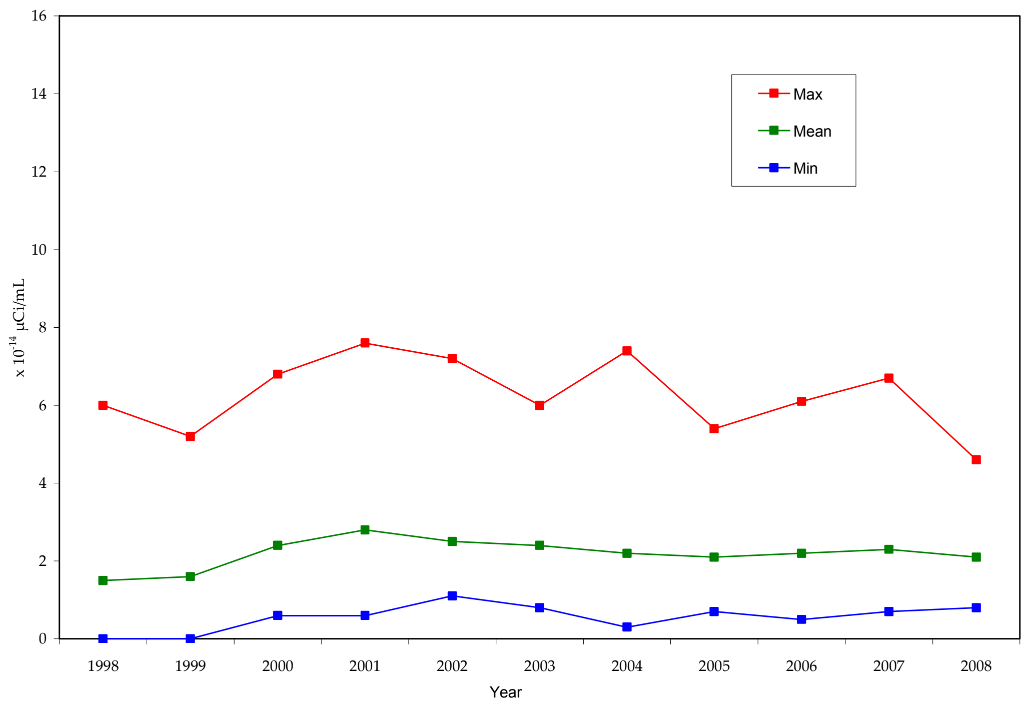

Figure 6-4. Historical trend for gross beta analysis for all CEMP stations

The mean gross alpha results show a generally increasing trend from 1998 to 2001 before slightly trending downward the last seven years. Likewise, the gross beta results show a similar trend beginning in 1998, although the downward trend is not as pronounced. These trends are also reflected by most of the stations on an individual basis. This trend is most likely explained as being a result of persistent drought conditions throughout the southwest and Great Basin states. Drought in these regions has existed to varying degrees since 1996. These dry conditions could be directly responsible for an increase in suspended air particles collected by the air-sampling network. The slight decrease in mean values since 2001 may indicate a minor change in the severity of drought conditions, but overall remain greater than pre-drought values (not shown).

6.1.1.2 Gamma Spectroscopy

Gamma spectroscopy analysis was performed on all samples from the low-volume air sampling network. The filters were composited by station on a quarterly basis after gross alpha/beta analysis. As in previous years, all samples were gamma-spectrum negligible with respect to man-made radionuclides (i.e., gamma-emitting radionuclides were not detected). In most of the samples, naturally occurring beryllium-7 (^{7}Be) was detected above the analytical MDC. This radionuclide is produced by cosmic ray interaction with nitrogen in the atmosphere. The mean annual activity for ^{7}Be for the sampling network was $1.04 \pm 0.21 \times 10^{-13}$ μCi/mL.

6.1.2 TLD Results

TLDs measure ionizing radiation from all sources, including natural radioactivity from cosmic or terrestrial sources and from man-made radioactive sources. The TLDs are mounted in a plexiglass holder approximately 1 m above the ground and are exchanged quarterly. TLD results are not presented for the Warm Springs Summit, Nevada station at this time since its access is limited in the winter months. This does not allow for a proper quarterly change of the TLD as required. The total annual exposure for 2008 ranged from 71 milliroentgens (mR) (0.71 millisieverts [mSv]) at Pahrump, Nevada, to 148 mR (1.48 mSv) at Twin Springs, Nevada, with a mean annual exposure of 112 mR (1.12 mSv) for all operating locations. Results are summarized in Table 6-3 and are consistent with previous years' data. Figure 6-5 shows the long-term trend for the CEMP stations as a whole.

Table 6-3. TLD monitoring results for the CEMP offsite ASN in 2008

Daily Exposure (mR)

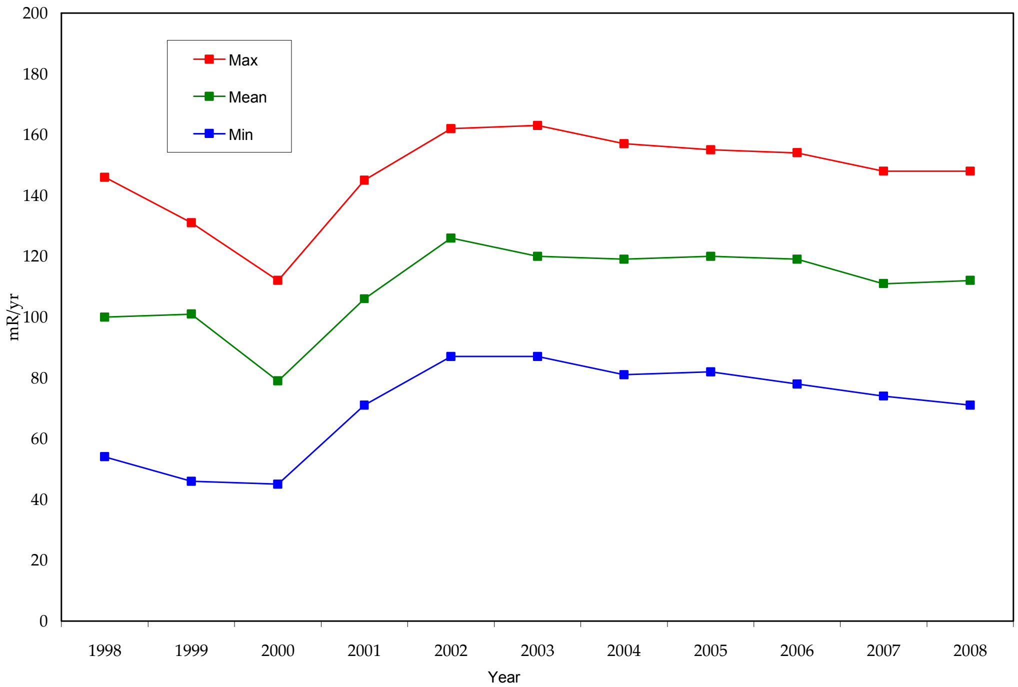

Figure 6-5. Historical trend for TLD analysis for all CEMP stations

With the exception of the dip in 2000, the TLD data also show a generally increasing trend from 1998 to 2002 before showing a slight decrease the last six years. The TLD trends generally mirror those for gross alpha and beta analyses. This again may be consistent with minor changes in drought conditions observed in the regions around the monitoring network as described in Section 6.1.1.1.

6.1.3 PIC Results

The PIC data presented in this section are based on daily averages of gamma exposure rates from each station. Table 6-4 contains the maximum, minimum, and standard deviation of daily averages (in microroentgens per hour [µR/hr]) for the periods during 2008 when telemetry data were available. It also shows the average gamma exposure rate for each station during the year (in µR/hr) as well as the total annual exposure (in milliroentgens per year [mR/yr]). The exposure rate ranged from 72.71 mR/yr (0.72 mSv/yr) in Pahrump, Nevada to 175.64 mR/yr (1.76 mSv/yr) in Warm Springs Summit, Nevada. Background levels of environmental gamma exposure rates in the United States (from combined effects of terrestrial and cosmic sources) vary between 49 and 247 mR/yr (BEIR III, 1980). Averages for selected regions of the United States were compiled by the U.S. Environmental Protection Agency and are shown in Table 6-5. The annual exposure levels observed at the CEMP stations in 2008 are well within these United States background levels.

Table 6-4. PIC monitoring results for the CEMP offsite ASN in 2008

Sampling Location	Daily Average Gamma Exposure Rate (µR/hr) Mean	Standard Deviation	Minimum	Maximum	Annual Exposure (mR/yr)
Alamo	13.65	0.25	12.8	14.5	119.57
Amargosa Valley	12.50	0.14	12.0	13.0	109.50
Beatty	16.95	0.21	16.3	17.6	148.48
Boulder City	15.45	0.14	14.8	16.1	135.34
Caliente	16.20	0.61	14.8	17.6	141.91
Cedar City	11.10	0.28	10.2	12.0	97.24
Delta	12.35	0.56	11.2	13.5	108.19
Duckwater	14.10	0.40	11.3	16.9	123.52
Ely	12.20	0.32	11.2	13.2	106.87
Garden Valley	17.85	0.54	16.0	19.7	156.37
Goldfield	15.10	0.39	13.8	16.4	132.28
Henderson	14.85	0.55	12.6	17.1	130.09
Indian Springs	11.30	0.22	10.7	11.9	98.99
Las Vegas	10.65	0.15	10.1	11.2	93.29
Medlin's Ranch	16.90	0.30	15.4	18.4	148.04
Mesquite	11.90	0.16	11.3	12.5	104.24
Milford	17.45	1.52	15.8	19.1	152.86
Nyala Ranch	13.95	0.36	12.8	15.1	122.20
Overton	10.20	0.21	9.5	10.9	89.35
Pahrump	8.30	0.15	7.8	8.8	72.71
Pioche	13.80	0. 46	12.1	15.5	120.89
Rachel	15.50	0.27	14.4	16.6	135.78
Sarcobatus Flats	17.75	0.24	16.9	18.6	155.49
Stone Cabin Ranch	16.90	0.77	15.1	18.7	148.04
St. George	9.45	0. 21	8.6	10.3	82.78
Tecopa	15.35	0.29	14.2	16.5	134.47
Tonopah	16.15	0.31	15.2	17.1	141.47
Twin Springs	19.35	0.50	17.6	21.1	169.51
Warm Springs Summit	20.05	0.45	18.9	21.2	175.64

Table 6-5. Average natural background radiation for selected U.S. cities (excluding radon)

City	Radiation (mR/yr)
Denver, CO	164.6
Fort Worth, TX	68.7
Las Vegas, NV	69.5
Los Angeles, CA	73.6
New Orleans, LA	63.7
Portland, OR	86.7
Richmond, VA	64.1
Rochester, NY	88.1
St. Louis, MO	87.9
Tampa, FL	63.7
Wheeling, WV	111.9

Source: <http://www.wrcc.dri.edu/cemp/Radiation.html.> "Radiation in Perspective," August 1990 (Access Date: 4/2/2009)

6.1.4 Environmental Impact

Results of analyses conducted on data obtained from the CEMP network of low-volume particulate air samplers, TLDs, and PICs showed no measurable evidence at CEMP station locations of offsite impact from radionuclides originating on the NTS. Activity observed in gross alpha and beta analyses of low-volume air sampler filters was consistent with previous years' results and are within the range of activity found in other communities of the United States that are not adjacent to man-made radiation sources. Also, no man-made gamma-emitting radionuclides were detected. Likewise, TLD and PIC results remained consistent with previous years' background levels and are well within average background levels observed in other parts of the United States (see Table 6-5).

Occasional elevated gamma readings (10–50 percent above normal average background) in 2008 were always associated with precipitation events and/or low barometric pressure. Low barometric pressure can result in the release of naturally occurring radon and its daughter products from the surrounding soil and rock substrates. Precipitation events can result in the "rainout" of globally distributed radionuclides occurring as airborne particulates in the upper atmosphere. Figure 6-6, generated from the CEMP Web site, illustrates an example of this phenomenon.

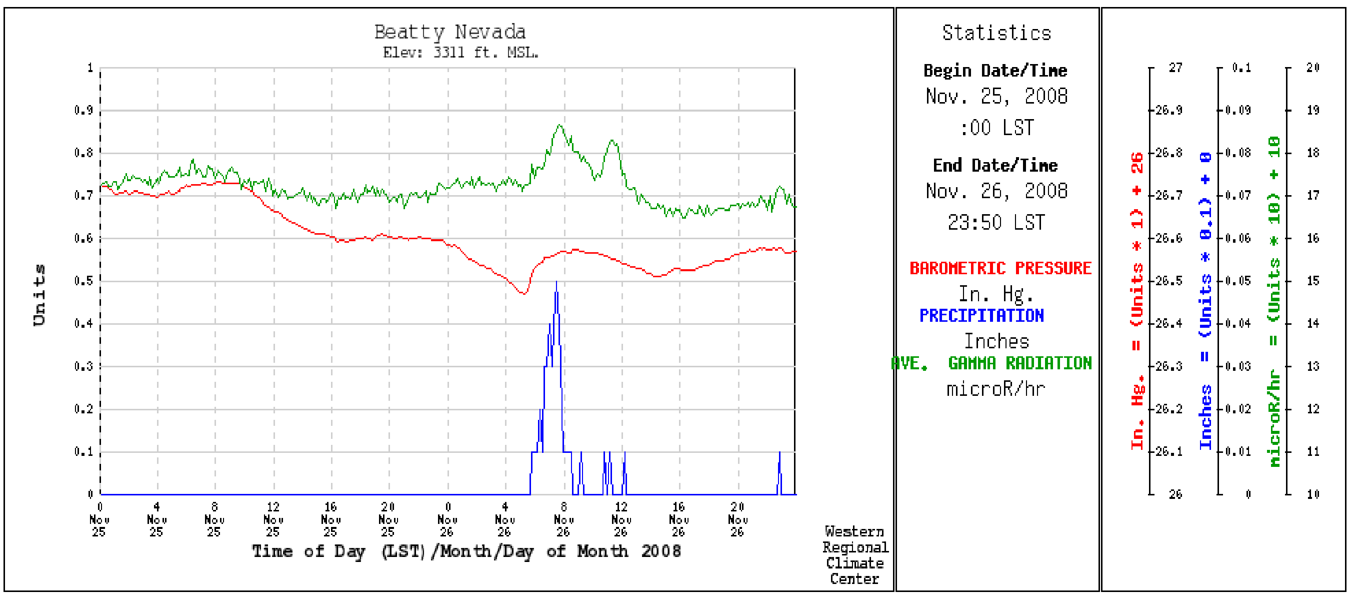

Figure 6-6. The effect of meteorological phenomena on background gamma readings

6.2 Offsite Surface and Groundwater Monitoring

During 2008, DRI was tasked by NNSA/NSO to provide independent verification of the tritium activity within some of the offsite groundwater wells, surface waters, and springs used for water supplies in areas surrounding the NTS. Samples collected by DRI personnel provide, in some years, a direct comparison to the results obtained by National Security Technologies, LLC (NSTec), under the *Routine Radiological Environmental Monitoring Plan*. In 2008, however, DRI and NSTec did not sample from the same offsite water sources (see Section 4.1).

The sole analyte for this project was tritium. Tritium is one of the most abundant radionuclides generated by an underground nuclear test and, since it is a constituent of the water molecule itself, it is also one of the most mobile.

6.2.1 Sample Locations and Methods

During the period of June 17 to September 11, 2008, DRI sampled 4 springs, 21 wells, and 3 surface water bodies either directly or through municipal water supply systems. Sample locations were selected based upon input from the CEMs and local ranch owners participating in the CEMP project. All wells were sampled utilizing downhole submersible pumps. Samples from surface water bodies were obtained via discharge from a faucet or valve connected to the water supply system that pumps that body of water. Springs were sampled by hand along surface drainage that emanates from the spring orifice, or from the water supply system connected to the spring discharge. Each well was pumped a minimum of 5 to 15 minutes prior to sampling to purge water from the pump tubing and well annulus. This process ensured that the resultant sample was representative of local groundwater. Table 6-6 lists all of the sample points, their locations, the date they were sampled, and the sampling method. The locations of the sample points are shown in Figure 6-7.

6.2.2 Procedures and Quality Assurance

DRI utilized several methods to ensure that radiological results reported herein conform to current QA protocols (see Section 19.0 for a detailed description of the CEMP QA program). This was achieved through the use of standard operating procedures, field QA samples, and laboratory QA procedures. DRI's standard operating procedures are detailed procedures that describe the method and materials, using step-by-step instructions, which are required to collect field water quality samples and protect the samples from tampering and environmental conditions that may alter their chemistry.

The second tier of QA utilized on this project consisted of field QA samples, specifically field blanks, duplicates, and spiked samples. The intent of field blanks was to provide direct measures of the contribution of radioactive material that was derived from the bottles, sampling equipment, and the environment to the activity of tritium measured within the samples. Duplicate samples were collected to establish a measure of the repeatability of the analysis. Spiked samples consisted of samples that had the appearance of being routine CEMP samples, yet actually consisted of water containing a known quantity of tritium in it. Sixteen samples (36 percent of the sample load) were collected for the purposes of meeting field QA requirements. The third tier of QA utilized on this project were laboratory QA controls, which consisted of the utilization of published laboratory techniques for the analysis of tritium, method blanks, laboratory control samples, and laboratory duplicates. The laboratory QA samples provide a measure of the accuracy and the confidence of the reported results.

Samples collected in 2008 were analyzed using enriched gas proportional counting at the University of Miami. CEMP tritium samples taken prior to 2008 were analyzed using gas proportional counting. The enrichment process significantly lowers the detection limit, improving confidence in the reported results, especially for those samples containing little or no tritium. The decision level (L_C) (see Glossary, Appendix B) for enriched gas proportional counting was 0.5 picocuries per liter (pCi/L). The L_C is the result that must be exceeded before there is a 95 percent confidence that the sample contains radioactive material above laboratory background. The MDC (see Glossary, Appendix B) for tritium was approximately 1.0 pCi/L.

6.2.3 Results of Surface Water and Spring Discharge Monitoring

Measured tritium (^3H) concentrations from the springs and surface waters sampled in 2008 ranged from below MDC to 24.1 pCi/L (Table 6-7). All samples yielded results that were distinguishable from background (i.e., $\geq L_C$). The Stone Cabin Ranch sample was above background, yet the activity was too low to quantitatively distinguish from background at 95 percent confidence (i.e., < MDC). The remaining surface water and spring discharge samples contained sufficient tritium to quantify above background with 95 percent confidence (i.e., ≥ MDC). This is a change from results of previous years where many samples were less than the MDC. The difference is due to an improved analytical method that significantly lowered MDC rather than to a real increase in the tritium of surface waters and springs sampled as part of the CEMP project. The greatest activities were detected in samples from Boulder City and Henderson, which originated from Lake Mead. Slightly elevated tritium activities in Lake Mead are documented in previous annual NTS environmental reports (e.g., Bechtel Nevada [BN], 2004a; 2005a; BN and NSTec, 2006; NSTec, 2007a; 2008a) and are due to residual tritium persisting in the environment that originated from global atmospheric nuclear testing. All tritium results were well below the safe drinking water limit of 20,000 pCi/L.

Table 6-6. CEMP water monitoring locations sampled in 2008

Monitoring Location Description	Latitude	Longitude	Date Sampled	Sample Collection Method
Adaven Springs	38 08.25	-115 36.20	7/15/2008	By hand from stream discharging from spring orifice.
Alamo city water supply system - source of water is municipal well field	37 21.84	-115 10.13	6/17/2008	By hand from municipal water well.
Amargosa Valley school well	36 34.16	-116 27.66	9/09/2008	By hand at wellhead at the school.
Beatty Water and Sewer municipal water distribution system	36 50.00	-116 49.44	7/29/2008	By hand at holding tank containing municipal well water at corner of Rhyolite and Bullfrog. Coordinates refer to location of well supplying water to the holding tank.
Boulder City municipal water distribution system	35 59.74	-114 49.90	7/09/2008	By hand from a drinking fountain inside Hemingway Park; water originates from Lake Mead.
Caliente municipal water supply well	37 36.93	-114 30.98	6/17/2008	By hand at well in municipal well field.
Cedar City municipal water supply well about 11 kilometers (km) (7 miles [mi]) west of town	37 39.84	-113 13.03	6/19/2008	By hand at wellhead.
Delta municipal well	39 21.59	-112 34.65	6/18/2008	By hand at wellhead.
Duckwater water supply well	38 55.41	-115 41.99	7/16/2008	By hand at faucet inside pump house.
Ely municipal water source	39 13.80	-114 54.01	7/16/2008	By hand from sump located in spring discharge area. Springs are used as municipal water supply.
Goldfield municipal water supply well about 18 km (11 mi) north of town	37 52.41	-117 14.96	7/29/2008	By hand at wellhead; sampled new well location this year.
Henderson municipal water distribution system	36 00.43	-114 57.95	7/09/2008	By hand from faucet inside building of College of Southern Nevada; water originates from Lake Mead.
Indian Springs municipal well	36 34.41	-115 40.1	9/09/2008	By hand at wellhead.
Las Vegas Valley Water District #103	36 13.94	-115 15.13	9/11/2008	By hand at wellhead.
Medlin's Ranch - spring 10 mi west of ranch house	37 24.10	-115 32.25	7/30/2008	By hand at kitchen faucet; water originates from spring 16 km (10 mi) west of ranch.
Mesquite municipal water supply well 3 km (2 mi) S.E. of town	36 46.40	-114 03.26	9/11/2008	By hand at wellhead.
Milford municipal well	38 22.88	-112 59.78	6/18/2008	By hand at wellhead.
Nyala Ranch water well	38 14.93	-115 43.72	7/15/2008	By hand from front yard hose faucet at house.
Overton water well located at Arrow Canyon approximately 32 km (20 mi) west of town	36 44.06	-114 44.87	9/11/2008	By hand at wellhead.

Table 6-6. CEMP water monitoring locations sampled in 2008 (continued)

Monitoring Location Description	Latitude	Longitude	Date Sampled	Sample Collection Method
Pahrump municipal water system	36 11.29	-115 57.95	9/09/2008	By hand at wellhead, location is different than last year.
Pioche municipal well	37 56.98	-114 25.78	6/17/2008	By hand at wellhead.
Rachel - Little Ale Inn well	37 38.79	-115 44.75	7/30/2008	By hand from faucet inside Lil Ale Inn Restaurant.
Sarcobatus Flats well	37 16.78	-117 01.92	7/29/2008	By hand at wellhead.
St. George municipal water distribution system	37 10.47	-113 23.92	6/19/2008	By hand at water treatment plant; water originates from Quail Creek Reservoir.
Stone Cabin Ranch	38 12.45	-116 37.99	7/16/2008	By hand from outside house faucet; water originates from spring
Tecopa Residential Well	35 57.59	-116 15.71	9/09/2008	By hand at wellhead.
Tonopah public utilities well field located approximately 19 km (12 mi) from town	38 11.68	-117 04.70	7/30/2008	By hand at wellhead.
Twin Springs Ranch Well	38 12.21	-116 10.53	7/15/2008	By hand from wellhead.

Note: Coordinates reported last year for Alamo City well head were slightly in error. Coordinates reported this year are accurate.

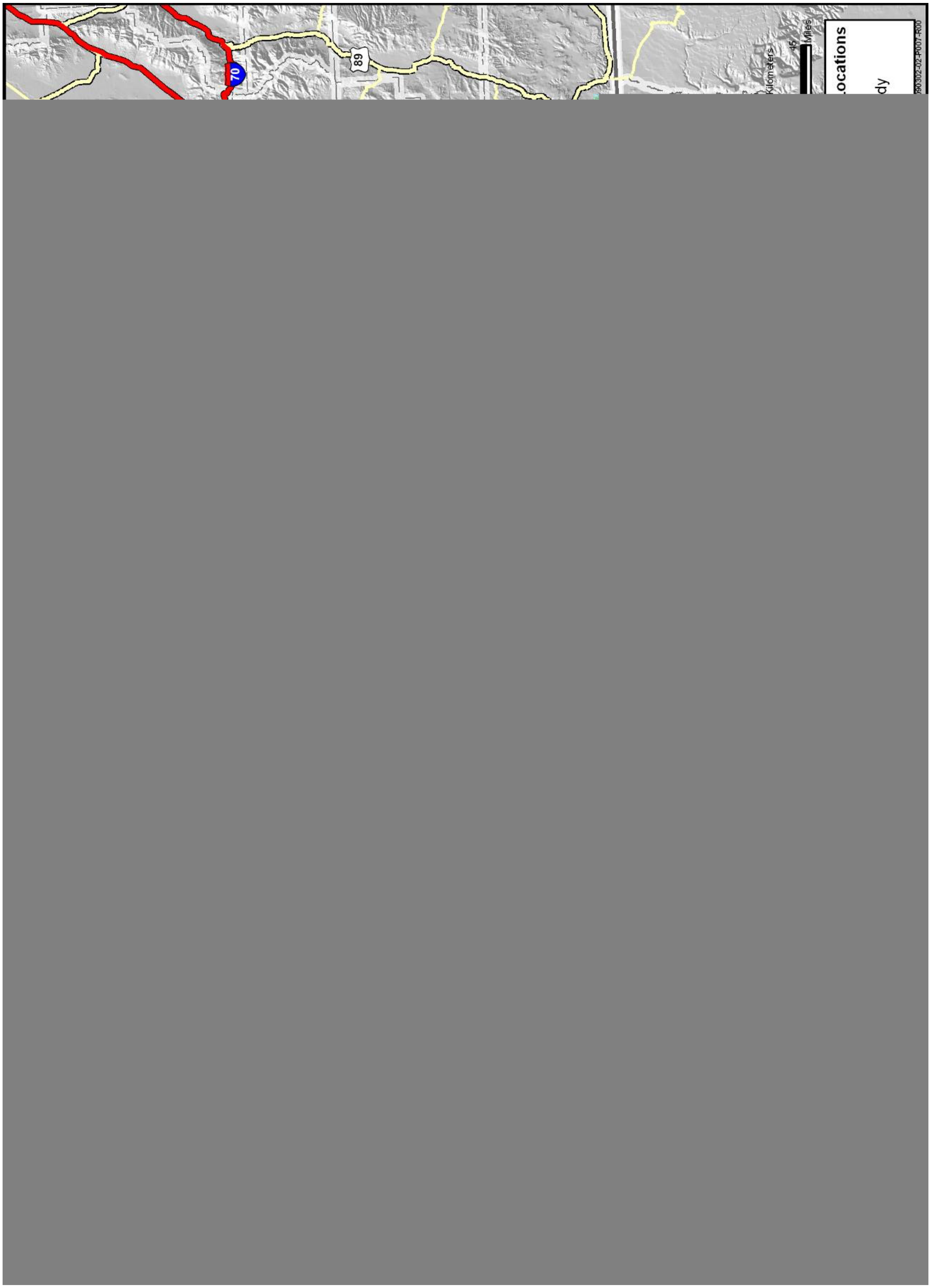

Figure 6-6. 2008 CEMP water monitoring locations

All samples were analyzed for the presence of trends with respect to samples collected in previous years. All samples indicated a presence of tritium in the water as opposed to previous years where tritium was generally not detected. This is due to the use of an improved analytical method rather than any real change in the activity of the water being monitored.

Table 6-7. Tritium results for CEMP offsite surface water and spring discharges in 2008

Monitoring Location	^{3}H ± Uncertainty [(a)] (pCi/L)
Adaven Springs	10.7 ± 0.7
Ely municipal water source	2.8 ± 0.6
Medlin's Ranch	5.1 ± 0.6
Stone Cabin Ranch	0.8 ± 0.6
Boulder City municipal water distribution system	24.1 ± 1.6
Henderson municipal water distribution system	23.2 ± 1.5
St. George municipal water distribution system	9.4 ± 0.6

(a) ± 2 standard deviations
L_C = 0.5 pCi/L; MDC = 1.0 pCiL for all samples

6.2.4 Results of Groundwater Monitoring

The results for the 21 groundwater tritium analyses from the University of Miami Tritium Laboratory are presented in Table 6-8. The measured activities ranged from -0.3 to 5.4 pCi/L. Most of the samples yielded results that were statistically indistinguishable from laboratory background (≤L_C). The exceptions were samples obtained from Alamo City, Caliente, Las Vegas, and Nyala Ranch. Of these samples, only one exceeded the MDC (1.0 pCi/L). This sample was from Caliente (5.4 ± 0.6 pCi/L). The tritium activities for Caliente exhibited detectable tritium for the first time. This is most likely due to the use of an improved methodology for the detection of tritium rather than any real increase in tritium in water from Caliente over time. All groundwater samples were well below the safe drinking water limit of 20,000 pCi/L.

Table 6-8. Tritium results for CEMP offsite wells in 2008

Monitoring Location	^{3}H ± Uncertainty [(a)] (pCi/L)
Alamo City	0.8 ± 0.6
Amargosa Valley	0.0 ± 0.6
Beatty	-0.2 ± 0.6
Caliente	5.4 ± 0.6
Cedar City	0.2 ± 0.6
Delta	-0.1 ± 0.6
Duckwater	0.3 ± 0.6
Goldfield	0.4 ± 0.6
Indian Springs	0.1 ± 0.6
Las Vegas	0.8 ± 0.6
Mesquite	-0.0 ± 0.6
Milford	-0.3 ± 0.6
Nyala Ranch	0.5 ± 0.6
Overton	-0.1 ± 0.6
Pahrump	0.1 ± 0.6
Pioche	0.1 ± 0.6
Rachel	-0.2 ± 0.6
Sarcobatus Flats	0.1 ± 0.6
Tecopa	-0.2 ± 0.6
Tonopah	-0.1 ± 0.6
Twin Springs Ranch	-0.1 ± 0.6

± 2 standard deviations
L_C = 0.5 pCi/L; MDC = 1.0 pCiL for all samples

6.2.5 Environmental Impact

Results of the CEMP tritium analyses conducted on selected offsite groundwater wells and water supply systems surrounding the NTS showed no evidence of tritium migration off site via groundwater. Detectable activities (≥MDC) were most often found in surface waters and in spring discharge emananting from small local groundwater systems located in recharge areas. Most of the groundwater samples analyzed were below the L_C for tritium (see Table 6-8). The greatest observed activity, 5.4 pCi/L for Caliente, is upgradient of the NTS and may be due to localized recharge.

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7.0 Radiological Biota Monitoring

Historical atmospheric nuclear weapons testing, outfalls from underground nuclear tests, and radioactive waste disposal sites provide sources of potential radiation contamination and exposure to Nevada Test Site (NTS) plants and animals (biota). U.S. Department of Energy (DOE) Order DOE O 5400.5, "Radiation Protection of the Public and the Environment," requires that all DOE sites monitor radioactivity in the environment to ensure that the public does not receive a radiological dose greater than 100 millirems per year (mrem/yr) from all pathways of exposure, including the ingestion of contaminated plants and animals. The DOE also requires monitoring to determine if the radiological dose to aquatic and terrestrial biota on site exceeds DOE-established limits expressed in rad (for radiation absorbed dose, see Glossary, Appendix B) per day (rad/d).

Current NTS land use precludes the harvest of plants or plant parts (e.g., pine nuts and wolf berries) for direct consumption by humans. Therefore, the ingestion of game animals is the primary potential biotic pathway for radionuclide contamination from the NTS to the public. Game animals that occur on the NTS may travel off the site and become available, through hunting, for consumption by the public. Game animals are therefore monitored under the *Routine Radiological Environmental Monitoring Plan* (RREMP) (Bechtel Nevada, 2003a). In 2008, National Security Technologies, LLC, Environmental Technical Services conducted the monitoring.

Plants and game animals are sampled annually from contaminated sites on the NTS to estimate hypothetical doses to hunters (i.e., the public), measure the potential for radionuclide transfer through the food chain, and determine if NTS biota are exposed to radiation levels harmful to their own populations. Biota are also sampled from Radioactive Waste Management Sites (RWMSs) as a measure of potential contact with the waste (integrity of waste containment). This chapter describes the biota monitoring program designed to meet public and environmental radiation protection regulations (see Section 2.3) and presents the field sampling and analyses results from 2008. Analyses results were used to estimate the dose to humans consuming game animals from the NTS and to biota found in contaminated areas of the NTS. These dose estimates are presented in Section 8.0.

Radiological Biota Monitoring Goals	***Analytes Measured in Plant and Animal Tissues***
Determine if the potential dose to humans consuming game animals from the NTS is less than 100 mrem/yr, the limit set by DOE O 5400.5. Demonstrate that projected releases of radionuclides to the environment from the Area 3 and Area 5 RWMSs shall be maintained as per Performance Assessments required by DOE O 435.1, "Radioactive Waste Management." Determine if the absorbed radiation dose to NTS biota is less than the limits set by DOE O 5400.5 and DOE Standard DOE-STD-1153-2002, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota:" $<$ 1 rad/d for terrestrial plants and aquatic animals $<$ 0.1 rad/d for terrestrial animals	Americium-241 (^{241}Am) Cesium-137 (^{137}Cs) Cobalt-60 (^{60}Co) Europium-152 (^{152}Eu) Europium-154 (^{154}Eu) Tritium (^{3}H) Plutonium-239+240 ($^{239+240}$Pu) Strontium-90 (^{90}Sr)

7.1 Species Selection

The goal for vegetation monitoring is to sample the most contaminated plants within the NTS environment. They are generally found inside demarcated radiological areas near the "ground zero" locations of historical above-ground nuclear tests. The species selected for sampling represent the most dominant life forms (e.g., trees, shrubs, herbs, or grasses) at these sites. Woody vegetation (i.e., shrubs versus forbs or grasses) is sampled because it is reported to have deeper penetrating roots and higher concentrations of ^{3}H (Hunter and Kinnison, 1998). Woody vegetation also is a major source of browse for game animals that might potentially migrate off site. Grasses and forbs are also sampled when present, however, because they are also a source of food for wildlife. Plant parts collected for analysis represent new growth over the past year.

The game animals monitored to assess the potential dose to the public had to meet three criteria: (1) have a relatively high probability of entering the human food chain; (2) have a home range that overlaps a contaminated site and, as a result, have the potential for relatively high radionuclide body burdens from exposure to contaminated soil, air, water, or plants at the contaminated site; and (3) be sufficiently abundant at a site to acquire an adequate tissue sample for laboratory analysis. These criteria limited the candidate game animals to those listed in Table 7-1. Mule deer and pronghorn antelope are only collected as the opportunity arises if they are found dead on the NTS (e.g., from accidentally being hit by a vehicle). Tissues from other game species, such as predators, or species analogous to big game, such as feral horses, may be collected opportunistically as well.

The goal of sampling animals for the purpose of determining potential dose to biota is to select species that are most exposed and most sensitive to effects from radiation. In general, mammals and birds are more sensitive to radiation than fish, amphibians, or invertebrates (DOE-STD-1153-2002). Because of this, and because no native fish or amphibians are found on the NTS, the species in Table 7-1 are also used to assess potential dose to animals.

The animal species monitored to assess the integrity of radioactive waste containment had to meet three criteria: (1) is fossorial (i.e., burrows and lives predominantly underground), (2) has a home range small enough to ensure it resides for most of its time on the waste disposal site, and (3) is sufficiently abundant at a site to acquire an adequate tissue sample for laboratory analysis. These criteria limited the animals to those listed in Table 7-1.

Table 7-1. NTS animals monitored for radionuclides

Small Mammals	Large Mammals	Birds
Game Animals Monitored for Dose Assessments		
Cottontail rabbit (*Sylvilagus audubonii*)	Mule deer (*Odocoileus hemionus*)	Mourning dove (*Zenaida macroura*)
Jackrabbit (*Lepus californicus*)	Pronghorn antelope (*Antilocapra americana*)	Chukar (*Alectoris chukar*)
		Gambel's quail (*Callipepla gambelii*)
Animals Monitored for Integrity of Radioactive Waste Containment		
Kangaroo rats (*Dipodomys sp.*)		
Mice (*Peromyscus sp.*)		
Desert woodrat (*Neotoma lepida*)		

7.2 Site Selection

The monitoring design focuses on sampling sites that have the highest concentrations of radionuclides in other media (e.g., soil and surface water) and have relatively high densities of candidate animals. The RREMP identifies five contaminated sites and their associated control sites at which biota are sampled once every five years. They are E Tunnel Ponds, Palanquin Crater, Sedan Crater, T2, and Plutonium Valley (Figure 7-1), and each is associated with one type of a legacy contamination area (see bulleted list below). The control site selected for each contaminated site has similar biological and physical features. Control sites are sampled to document the radionuclide levels representative of background.

- **Runoff areas or containment ponds associated with underground or tunnel test areas.** Contaminated water draining from test areas can form surface water sources that are important given the limited availability of surface water on the NTS. Therefore, they have a high potential for transferring radionuclides to plants and wildlife seeking surface water. The associated monitoring site is E Tunnel Ponds below Rainier Mesa. It was last sampled in 2007.
- **Plowshare sites in alluvial fill at lower elevations with high surface contamination.** Subsurface nuclear detonations at these sites have distributed contaminants over a wide area, usually in the lowest precipitation areas of the NTS. The associated monitoring site is Sedan Crater in Yucca Flat. It was last sampled in 2005.
- **Plowshare sites in bedrock or rocky fill at higher elevations with high surface contamination.** Subsurface nuclear detonations at these sites distributed contaminants over a wide area, usually in the highest precipitation areas of the NTS. Through 2007, the associated monitoring site was Palanquin Crater. It was last sampled in 2003. Schooner Crater was added as a biota sampling site and sampled in 2008.

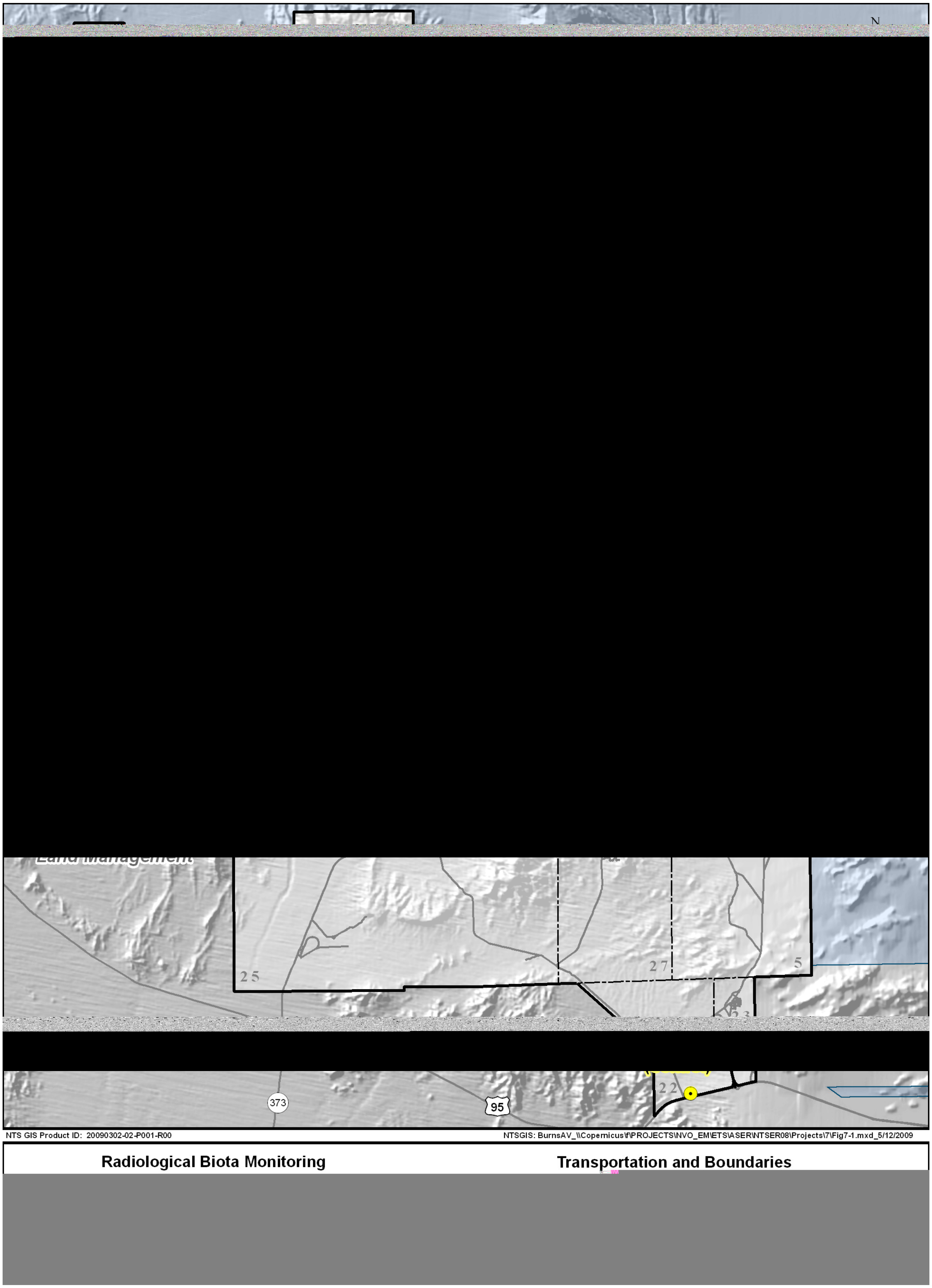

Figure 7-1. Radiological biota monitoring sites on the NTS and sites sampled in 2008

- **Atmospheric test areas.** These sites have highly disturbed soils due to the removal of topsoil during historical cleanup efforts and to the sterilization of soils from heat and radiation during testing. The same areas were often used for multiple nuclear tests. The associated monitoring site is T2 in Yucca Flat. It was last sampled in 2006.
- **Aboveground safety experiment sites.** These areas are typified by current radioactive soil contamination, primarily in the form of plutonium and uranium. The associated monitoring site is Plutonium Valley in Area 11. It was last sampled in 2004.

Biota sampling is also conducted periodically at the Area 5 RWMS and the Area 3 RWMS (Figure 7-1) to assess whether fossorial small mammals are being exposed to buried wastes and, therefore, whether the integrity of waste containment is compromised. These sites contain subsurface radioactively contaminated materials at depths equal to or greater than 2 meters (m) (6.6 feet [ft]). At least one of these sites is sampled about every two years. Both were last sampled in 2007. Other sites may be monitored if new sites become radiologically contaminated or if contamination conditions change (e.g., through the addition of water pumped from contaminated groundwater or from soil disturbance).

7.3 Biota Sampling and Analysis at Schooner Crater

In 2008, Schooner Crater was sampled. It represents a Plowshare site in bedrock or rocky fill at high elevation. The Schooner test was conducted on December 8, 1968, on Pahute Mesa in Area 20 at about 1,700 m (5,577 ft) elevation to demonstrate the ability of a nuclear device to excavate large amounts of earth in an igneous rock-dominated location. Contaminants resulting from this test were primarily tritium (^{3}H), strontium-90 (^{90}Sr), cesium-137 (^{137}Cs), plutonium-239+240 ($^{239+240}$Pu), and americium-241 (^{241}Am). The control area for the Schooner Crater is located about 12 kilometers (km) (7.5 miles [mi]) southeast of the crater in similar habitat (partially disturbed) in Area 20 (Figure 7-1). Aerial surveys of the area indicate radionuclide dispersion from the Schooner test was generally in a northerly direction (Hendricks and Riedhauser, 1999). Vegetation was therefore sampled along a transect to the northeast and, for comparison, along a generally southern transect. Because of the mobility of animals, samples were taken relatively close to the crater in a relatively accessible location.

7.3.1 Plants

Plant sampling at Schooner Crater and the control site occurred on July 16, 2008. Sixteen samples were collected at distances ranging from about 100 to 950 m (330 to 3,100 ft) north and south of the crater (Figure 7-2). Four samples were collected at the control site. The species sampled represent the dominant shrubs at each site (Table 7-2). Each sample consisted of about 150 to 500 grams (5.3 to 17.6 ounces) of fresh-weight plant material and was a composite of material from many plants of the same species found generally within 5 m (16 ft) of each other. Leaves and stems were hand-plucked and stored in airtight plastic bags. Rubber gloves were used by samplers and changed between each composite sample.

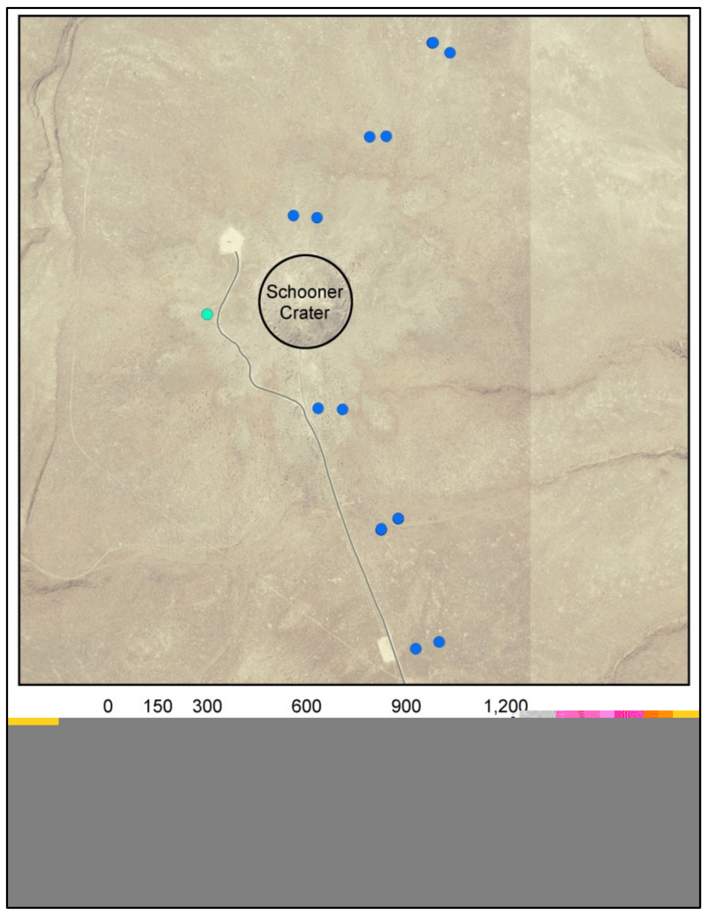

Figure 7-2. Plant and animal sampling locations near Schooner Crater in 2008

Table 7-2. Plant species sampled at Schooner Crater and its control site in 2008

Common Name	Scientific Name	Name Abbreviation	Schooner Crater	Control Site
Black sagebrush	*Artemisia nova*	ARNO	X	X
Basin big sagebrush	*Artemisia tridentata*	ARTR	X	
Yellow rabbitbrush	*Chrysothamnus viscidiflorus*	CHVI	X	
Rubber rabbitbrush	*Ericameria nauseosus*	ERNA	X	X

Samples were labeled and stored in an ice chest. Within 4 hours of collection, the samples were delivered to the laboratory. Water was separated from plant samples by distillation. Water and dried plant tissues were submitted to a commercial laboratory for analysis of radionuclides. Water from plants was analyzed for ^{3}H and dried plant tissue was analyzed for gamma-emitting radionuclides, ^{90}Sr, uranium, plutonium, and ^{241}Am.

All plant samples from the Schooner Crater location had detectable concentrations of man-made radionuclides (Table 7-3). Activity in samples was dominated by ^{3}H but also included ^{90}Sr, ^{137}Cs, and $^{239+240}$Pu with relatively smaller concentrations of ^{152}Eu, ^{238}Pu, and ^{241}Am. The samples with the highest concentrations of tritium were in rubber rabbitbrush (ERNA) located closest to the crater (Figure 7-3). No man-made radionuclides were detected in plant samples from the control location.

These results differ from the Palanquin Crater plant sampling results from 2003. The average concentrations of ^{3}H, ^{137}Cs, and ^{152}Eu across all plant samples from the Schooner Crater were higher than those observed at the Palanquin Crater (Figure 7-4). ^{3}H and ^{152}Eu were not detected in any plant samples near the Palanquin Crater, while ^{238}Pu, $^{239+240}$Pu, ^{241}Am, and ^{90}Sr in the Palanquin samples tended to be slightly higher.

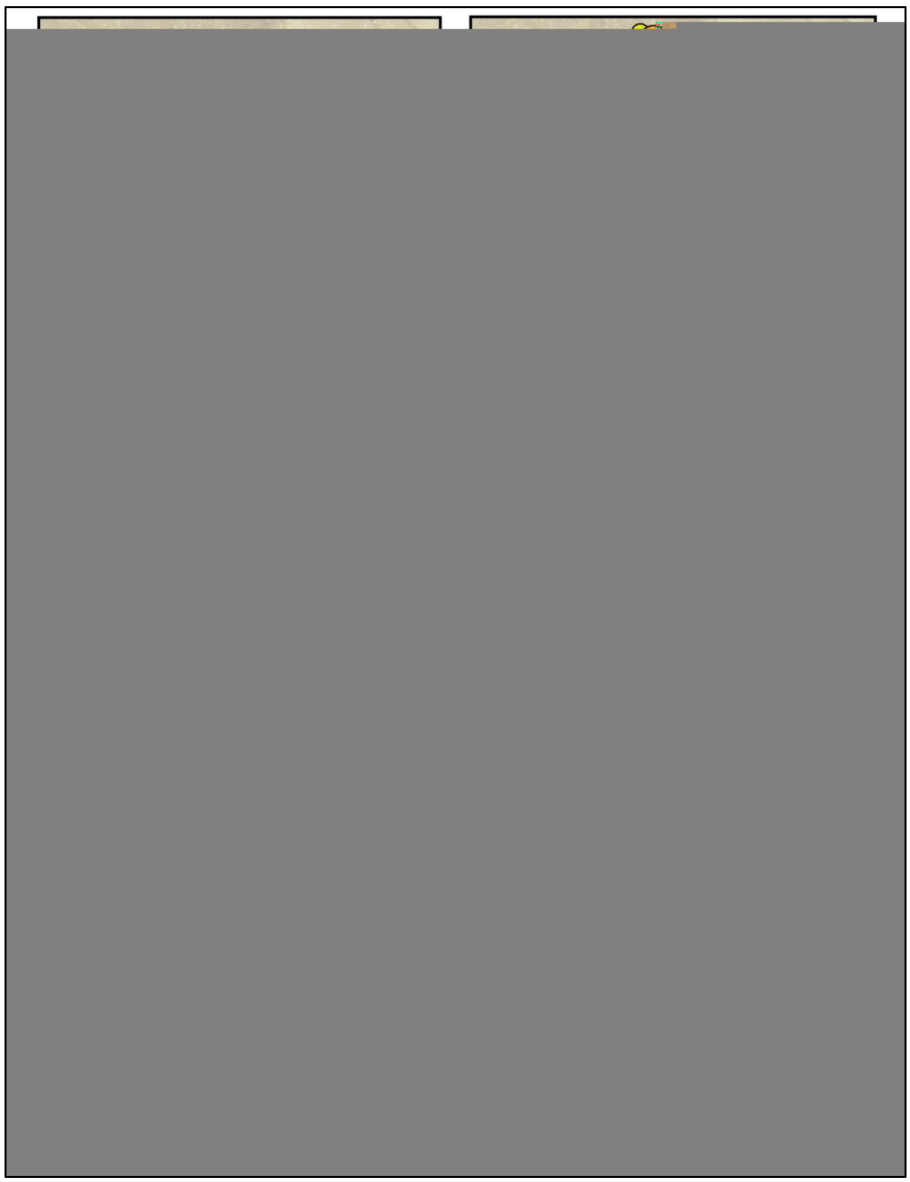

Figure 7-3. Concentrations of man-made radionuclides in plant samples at varying distances from Schooner Crater in 2008

Table 7-3. Concentrations of man-made radionuclides in plants sampled near Schooner Crater in 2008

	Radionuclide Concentrations ± Uncertainty[a]						
	^{3}H[b]	^{90}Sr[c]	^{137}Cs[c]	^{152}Eu[c]	^{238}Pu[c]	$^{239+240}$Pu[c]	^{241}Am[c]
Schooner Crater							
ARNO #1	3,090 ± 419	0.04 ± 0.03	0.05 ± 0.06	0.02 ± 0.18	0.008 ± 0.009	0.002 ± 0.005	-0.001 ± 0.005
ARNO #2	6,990 ± 795	0.02 ± 0.04	0.07 ± 0.08	0.07 ± 0.19	0.004 ± 0.009	0.017 ± 0.015	0.009 ± 0.010
ARNO #3	667 ± 206	0.03 ± 0.03	0.03 ± 0.09	0.37 ± 0.35	0.002 ± 0.005	0.010 ± 0.010	-0.001 ± 0.005
ARNO #4	853 ± 262	0.05 ± 0.04	0.08 ± 0.07	0.01 ± 0.21	-0.001 ± 0.005	0.007 ± 0.009	0.001 ± 0.006
ARTR #1	8,820 ± 979	0.09 ± 0.04	-0.01 ± 0.07	0.01 ± 0.17	0.012 ± 0.011	1.080 ± 0.152	0.072 ± 0.029
ARTR #2	6,920 ± 794	-0.06 ± 0.05	0.02 ± 0.05	0.27 ± 0.24	0.007 ± 0.010	-0.001 ± 0.006	-0.003 ± 0.006
CHVI #1	2,390 ± 351	0.08 ± 0.06	0.05 ± 0.07	-0.15 ± 0.17	0.008 ± 0.009	0.005 ± 0.007	0.005 ± 0.007
CHVI #2	8,760 ± 971	0.20 ± 0.07	0.15 ± 0.09	0.32 ± 0.27	0.049 ± 0.023	0.038 ± 0.020	0.033 ± 0.019
CHVI #3	3,040 ± 415	0.12 ± 0.05	0.00 ± 0.11	0.20 ± 0.28	0.001 ± 0.006	0.008 ± 0.009	0.007 ± 0.009
CHVI #4	4,510 ± 556	0.01 ± 0.03	0.01 ± 0.08	0.19 ± 0.20	0.002 ± 0.007	0.007 ± 0.008	0.003 ± 0.006
ERNA #1	9,980,000 ± 997,000	0.35 ± 0.09	1.34 ± 0.23	0.04 ± 0.36	-0.001 ± 0.006	0.002 ± 0.006	-0.001 ± 0.005
ERNA #2	3,800,000 ± 380,000	0.39 ± 0.10	0.46 ± 0.14	0.26 ± 0.25	0.000 ± 0.007	0.000 ± 0.007	0.002 ± 0.005
ERNA #3	148,000 ± 14,800	0.14 ± 0.05	0.03 ± 0.11	-0.05 ± 0.24	0.006 ± 0.009	0.008 ± 0.010	-0.003 ± 0.006
ERNA #4	618,000 ± 61,800	0.04 ± 0.04	0.00 ± 0.09	0.12 ± 0.25	-0.001 ± 0.005	0.000 ± 0.005	0.002 ± 0.006
ERNA #5	287,000 ± 28,700	0.05 ± 0.04	0.22 ± 0.10	0.15 ± 0.17	-0.001 ± 0.005	0.000 ± 0.005	-0.001 ± 0.005
ERNA #6	1,060,000 ± 106,000	0.04 ± 0.04	0.24 ± 0.10	-0.06 ± 0.19	-0.001 ± 0.005	-0.001 ± 0.005	-0.003 ± 0.006
% Above MDC [d] (Average MDC)	**100% (292)**	**38% (0.06)**	**31% (0.12)**	**13% (0.30)**	**13% (0.013)**	**19% (0.012)**	**13% (0.010)**

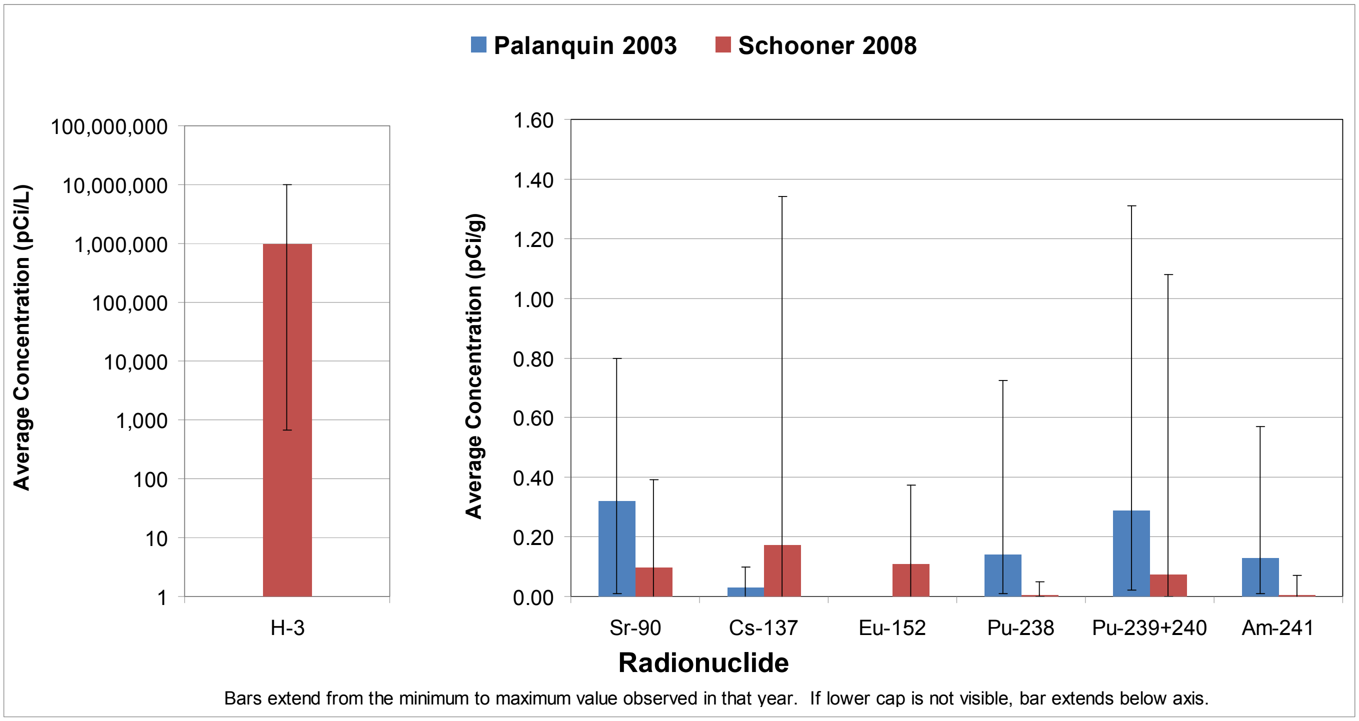

Figure 7-4. Average concentrations of detected man-made radionuclides in plants from representative Plowshare sites in bedrock or rocky fill at higher elevations

7.3.2 Animals

State and federal permits were secured to trap specific small mammals and birds in 2008 and to sample road-killed, large mammals. Animal trapping took place July through August. One mourning dove and two cottontail rabbits were trapped near the Schooner Crater (see Figure 7-2). No animals were successfully trapped at the control site. No large mammals were sampled due to a lack of road-kills or other mortalities.

In the laboratory, samples were individually homogenized. Past results have shown that radionuclide concentrations are generally higher in the skin, bone, and viscera compared with muscle. Though muscle is usually the only portion consumed by humans, whole animals were homogenized to give a more conservative (higher) estimate of potential dose to someone consuming the animals (see Section 8.1.3). Water was distilled from the samples and submitted to a laboratory for ^{3}H analysis, and the dried tissue samples were submitted for analysis of gamma-emitting radionuclides, ^{90}Sr, uranium, plutonium, and ^{241}Am.

Man-made radionuclides were detected in all three animals trapped near Schooner Crater (Table 7-4). Activity levels were dominated by ^{3}H. Radionuclide levels were generally higher in the Cottontail #2 sample, but only concentrations of ^{60}Co, ^{152}Eu, and ^{154}Eu were significantly higher than those of Cottontail #1. These results differ from the Palanquin Crater sampling results from 2003 (Figure 7-5). Concentrations of $^{239+240}$Pu and ^{241}Am were higher in animals collected near Palanquin Crater, but ^{3}H concentrations were much higher in animals trapped near Schooner Crater.

Table 7-4. Concentrations of man-made radionuclides in animals sampled near Schooner Crater in 2008

	Radionuclide Concentrations ± Uncertainty[(a)]			
	Cottontail #1	Cottontail #2	Mourning Dove	% Above MDC (Average MDC)
^{3}H [(b)]	562,000 ± 56,400	532,000 ± 53,300	6,250 ± 828	100 (395)
^{60}Co [(c)]	0.04 ± 0.03	0.13 ± 0.03	0.00 ± 0.04	33 (0.05)
^{90}Sr [(c)]	1.91 ± 0.41	1.11 ± 0.26	0.05 ± 0.04	67 (0.07)
^{137}Cs [(c)]	0.53 ± 0.07	0.53 ± 0.08	0.00 ± 0.03	67 (0.04)
^{152}Eu [(c)]	0.03 ± 0.08	0.99 ± 0.12	0.07 ± 0.09	33 (0.11)
^{154}Eu [(c)]	0.05 ± 0.12	0.73 ± 0.15	0.03 ± 0.10	33 (0.14)
^{238}Pu [(c)]	0.006 ± 0.008	0.018 ± 0.018	-0.001 ± 0.005	33 (0.012)
$^{239+240}Pu$ [(c)]	-0.001 ± 0.006	0.018 ± 0.018	-0.001 ± 0.005	33 (0.013)
^{241}Am [(c)]	0.006 ± 0.010	0.019 ± 0.016	-0.003 ± 0.007	33 (0.014)

Green-shaded results are considered detected (results greater than the sample-specific MDC).

(a) ± 2 standard deviations

(b) picocuries per liter (pCi/L) water from sample

(c) picocuries per gram (pCi/g) dry weight of sample

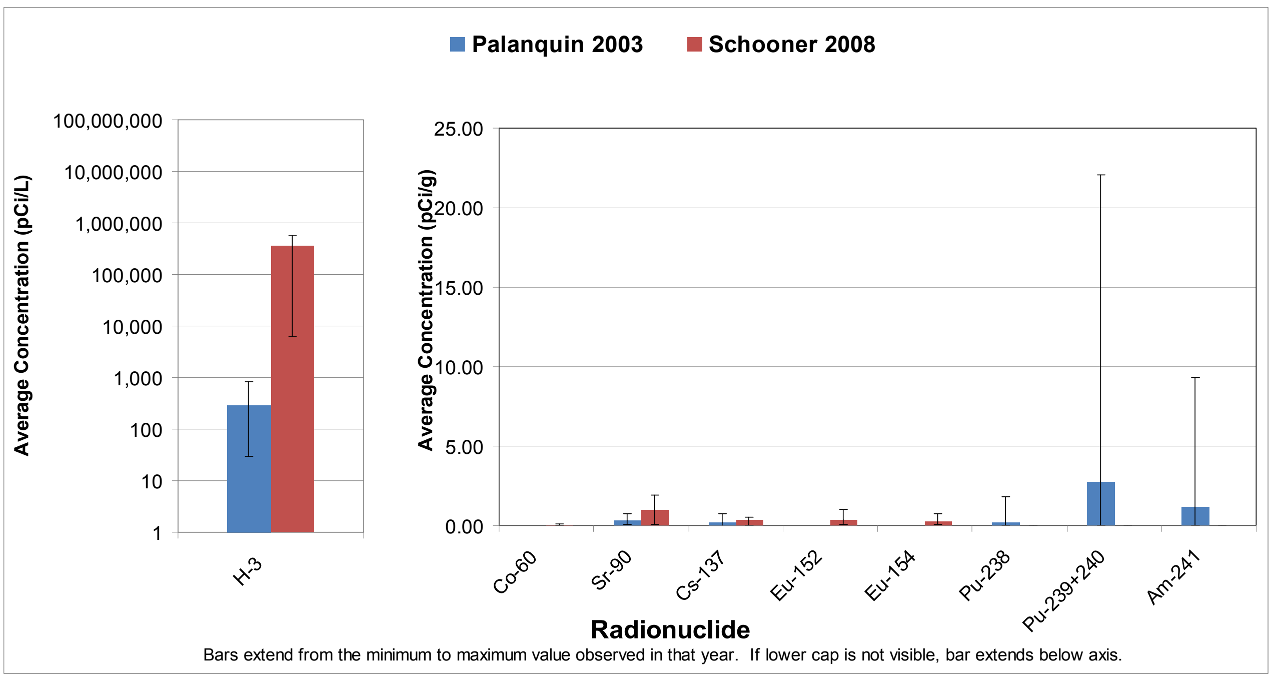

Figure 7-5. Average concentrations of detected man-made radionuclides in animals from representative Plowshare sites in bedrock or rocky fill at higher elevations

7.4 Data Assessment

As expected, higher concentrations of radionuclides were detected in plants from Schooner Crater than in those from the control site. Schooner Crater biota samples tended to have much higher activities of tritium and of certain fission and activation products, while the Palanquin Crater samples tended to have higher concentrations of plutonium isotopes and ^{241}Am. The levels of radionuclides detected pose negligible risk to humans and biota. The potential dose to a person hunting and consuming these animals is well below dose limits to members of the public (see Section 8.1.4). Also, radionuclide concentrations were below levels considered harmful to the health of the plants or animals; the dose resulting from observed concentrations were less than 1 percent of dose limits set to protect populations of plants and animals (see Section 8.2).

8.0 Radiological Dose Assessment

The U.S. Department of Energy (DOE) requires DOE facilities to estimate the radiological dose to the general public and to plants and animals in the environment caused by past or present facility operations. These requirements are specified in DOE Order DOE O 450.1A, "Environmental Protection Program," and DOE O 5400.5, "Radiation Protection of the Public and the Environment" (see Section 2.3). To estimate these radiological doses, mathematical models are used along with data gathered annually on the Nevada Test Site (NTS) by National Security Technologies, LLC (NSTec), and existing data from past inventories of the radionuclide content of NTS surface soils. The 2008 data used are presented in Sections 3.0 through 7.0 of this report and include the results for onsite compliance monitoring of air, water, direct radiation, and biota, and the offsite monitoring results of air, direct radiation, and water reported by the Community Environmental Monitoring Program (CEMP). The specific goals for the dose assessment component of radiological monitoring are shown below along with the compliance measures that are calculated in order to accomplish these assessment goals.

Radiological Dose Assessment Goals	*Compliance Measures*
Determine if the maximum radiation dose to a member of the general public from airborne radionuclide emissions at the NTS is less than the Clean Air Act, National Emission Standards for Hazardous Air Pollutants (NESHAP) limit of 10 millirems per year (mrem/yr) (0.1 millisieverts [mSv]/yr).	Annual average concentrations of radionuclides at six NTS critical-receptor air sampling locations compared to the Concentration Levels for Environmental Compliance, Table 2, Appendix E, Title 40 Code of Federal Regulations Part 61 (NESHAP)
Determine if the total radiation dose to a member of the general public from all possible pathways (direct exposure, inhalation, ingestion of water and food) as a result of NTS operations is less than the limit of 100 mrem/yr established by DOE O 5400.5.	Committed effective dose equivalent (CEDE) for an offsite resident from all pathways, in mrem/yr (or mSv/yr)
Determine if the radiation dose (in a unit of measure called a rad [see Glossary, Appendix B]) to NTS biota is less than the following limits set by DOE O 5400.5 and DOE Standard DOE-STD-1153-2002, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota": < 1 rad per day (rad/d) for terrestrial plants and aquatic animals < 0.1 rad/d for terrestrial animals	Absorbed dose to onsite plants and animals, in rad/d

8.1 Radiological Dose to the Public

Several steps are taken to compute radiological dose to the public from all pathways. This section briefly describes these steps, identifies how field monitoring data interface with other NTS data sources (e.g., radionuclide inventory data) to provide input to the dose estimates, and presents the results of each step.

8.1.1 Possible Exposure Pathways to the Public

As prescribed in the *Routine Radiological Environmental Monitoring Plan* (Bechtel Nevada [BN], 2003s), NSTec routinely samples air, groundwater, and biota to document the amount of radioactivity in these media and to provide data that can be used to assess the radiation dose received by the general public from several pathways. The potential pathways by which a member of the general public residing off site might receive a radiation dose resulting from past or present NTS operations include the following:

- Inhalation of, ingestion of, or direct external exposure to airborne radionuclide emissions transported off site by wind
- Ingestion of meat from wild game animals that drink from surface waters and eat vegetation containing NTS-related radioactivity
- Drinking contaminated water from underground aquifers containing radionuclides that have migrated from the sites of past underground nuclear tests
- Exposure to direct radiation along the borders of the NTS
- Exposure to direct radiation from the release of property (e.g., equipment, building materials) containing residual radioactive material

In 2008, only the wind transport pathway and the ingestion of wild game were credible pathways of exposure to the public residing off site. The subsections below address all of the potential pathways and their contribution to public dose estimated for 2008.

8.1.2 Dose to the Public from NTS Air Emissions

Six air particulate and tritium (^{3}H) sampling stations located near the boundaries and the center of the NTS are approved by the U.S. Environmental Protection Agency Region IX as critical receptor samplers to demonstrate compliance with the NESHAP public dose limit of 10 mrem/yr from air emissions. Analysis of air particulate and ^{3}H data obtained at these six stations was performed in 2008 (Section 3.1.5). To be in compliance with NESHAP, the annual average concentration of an airborne radionuclide must be less than its NESHAP Concentration Level for Environmental Compliance (abbreviated as compliance level [CL]) (see Table 3-1 of Section 3.1.1). The CL for each radionuclide represents the annual average concentration of that radionuclide in air that would result in a CEDE of 10 mrem/yr. If multiple radionuclides are detected at a station, then compliance with NESHAP is demonstrated when the sum of the fractions (determined by dividing each radionuclide's concentration by its CL and then adding the fractions together) is less than 1.0.

The following radionuclides were detected at four or more of the critical receptor samplers: americium-241 (^{241}Am), plutonium-238 (^{238}Pu), plutonium-239+240 ($^{239+240}$Pu), uranium-233+234 ($^{233+234}$U), uranium-235+236 ($^{235+236}$U), uranium-238 (^{238}U), and ^{3}H (Section 3.1.5). All concentrations of these radionuclides were well below their CLs. The uranium isotopes are attributed to naturally occurring uranium. The concentration of each measured radionuclide (excluding uranium, since it has been determined to be of natural origin) at each of the six critical receptor samplers was divided by its respective CL to obtain a "fraction of CL." These fractions were then summed for each location and all were less than 1.0 (see Table 3-12, Section 3.1.5). As in previous years, the 2008 data from the six critical receptor samplers show that the NESHAP dose limit to the public of 10 mrem/yr was not exceeded. The Schooner critical receptor station in the far northwest corner of the NTS had the highest concentrations of radioactive air emissions, yet an individual residing at this station would experience a dose from air emissions of only 1.9 mrem/yr, 19 percent of the admissible dose limit. No one resides at this location, and the dose at offsite populated locations 20–80 kilometers (km) (12–50 miles [mi]) from the Schooner station would be much lower due to wind dispersion.

In previous years (1992–2004), the air transport model called Clean Air Package 1988 (CAP88-PC) was used to calculate the dose to the public from NTS air emissions, including diffuse emissions from legacy soil contamination. Beginning in 2005, CAP88-PC was no longer used. The air sampling data from the critical receptor stations, now used to calculate public dose, provides a more conservative estimate of potential dose to the public. See Sections 3.1 and 8.0 of the *Nevada Test Site Environmental Report 2005* (BN and NSTec, 2006) for discussions on this change in dose assessment methods. The CAP88-PC model is used, however, to evaluate new projects and activities for NESHAP compliance (see Sections 3.1.7–3.1.9). In 2008, no unplanned releases occurred and airborne emissions from planned projects and new activities resulted in an emission less than ten percent of that estimated from legacy soil contamination (Warren and Grossman, 2009).

8.1.3 Dose to the Public from Ingestion of Wild Game from the NTS

Two game species, mule deer and mourning doves, have been shown to travel off of the NTS, making them available to hunters. The movements of NTS mule deer herds were studied with a combined use of visual marking and radio-telemetry in the 1980s (Giles and Cooper, 1985). Although the majority of NTS deer studied did not migrate off federal lands onto public lands, two deer (1.7 percent of marked deer) did. One radio-collared buck captured on Echo Peak was harvested by a hunter near Kawich Peak about 120 km (75 mi) northwest of the NTS, and one visually marked doe was observed twice in the Barley Creek area of central Nevada, approximately 200 km (125 mi) northwest of her capture location during the following summer.

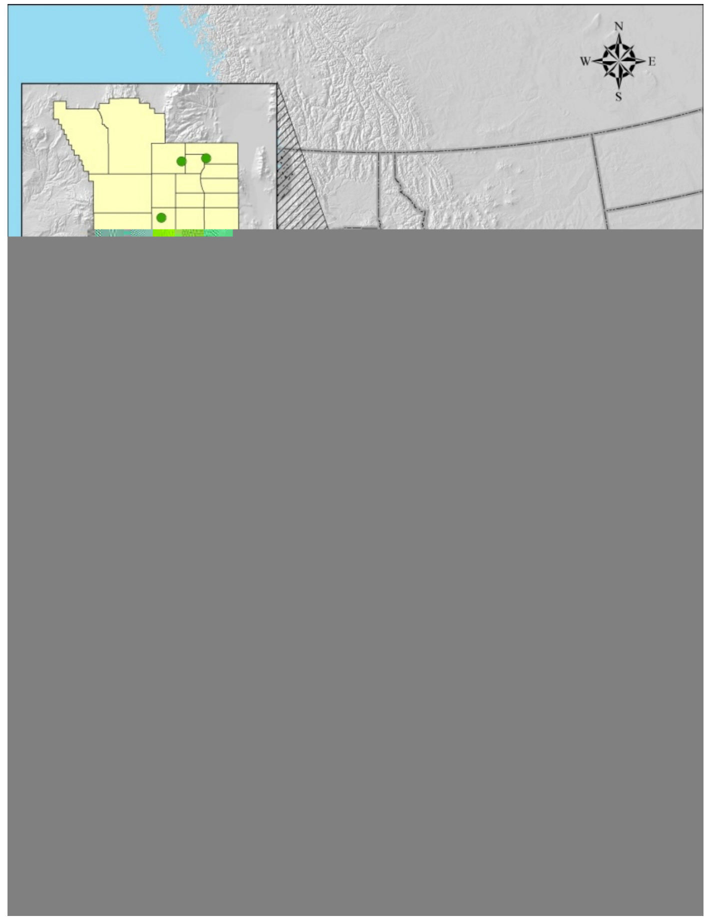

Figure 8-1. Locations of mourning doves banded on the NTS from 1961–1977 and of bands recovered by dove hunters

Data on banded mourning doves indicate that they may be more commonly available to offsite hunters than mule deer. Between 1961 and 1977, 586 mourning doves were reported banded on the NTS, based on data retrieved from the USGS Patuxent Wildlife Research Center, Bird Banding Laboratory, North American Bird Banding Program. Of these, ten bands were recovered by hunters outside of Nevada (Figure 8-1). Assuming there are no differences between behaviors of banded doves and all other doves on the NTS, and that the number of bands reported by hunters range from 30 to 60 percent of those actually collected (Tomlinson, 1968; Reeves, 1979; Otis et al., 2008;), the percent of doves potentially collected by hunters for this time period was 3 to 6 percent of mourning doves using the NTS.

Game animals on the NTS are sampled annually near known radiologically contaminated areas as a conservative (worst case) estimate of the levels of radionuclides that hunters may consume if these animals leave the NTS and are harvested. In 2008, one mourning dove and two cottontail rabbits were sampled from near the Schooner Crater in Area 20 and analyzed for radionuclide content (see Section 7.3.2, Table 7-4 for analysis results). The potential dose to an individual from consuming these game animals was calculated using the following assumptions:

- An individual consumes 20 doves and 20 rabbits over the year (these numbers are the possession limits set for these species by the Nevada Division of Wildlife).
- An individual consumes a total of 600 grams (g) of dove breast meat (30 g per dove) and 4,000 g of cottontail rabbit meat (200 g per rabbit).
- Each consumed dove and rabbit contains the average concentration of radionuclides that was detected in the muscle tissue of the dove and rabbits sampled.
- The moisture content of meat consumed is 75 percent.

The CEDE was calculated using dose conversion factors (DOE, 1988) multiplied by the total activity estimated to be consumed for each of the detected radionuclides. The resultant potential doses are shown in Table 8-1. The highest estimated CEDE was 0.47 mrem (0.0047 mSv) from consuming cottontail rabbits from Schooner, which is only 0.47 percent of the annual dose limit for members of the public. If someone were to consume just one cottontail rabbit from the near the Schooner Crater, the potential dose would be only about 0.023 mrem (0.00023 mSv). The dose from consuming 20 doves from near the Schooner Crater, based on the 2008 sample, would be much lower at about 0.0002 mrem (0.000002 mSv).

The radionuclide contributing most to dose was ^{90}Sr (42 percent) followed by ^{3}H (22 percent), plutonium (18 percent), and ^{241}Am (12 percent) in the cottontail rabbits. ^{3}H was present at much higher concentrations than other nuclides but contributes relatively little to the dose because it only emits low energy beta particles and has a short biological half-life.

To put these potential doses in perspective, the dose from naturally occurring cosmic radiation received during a 1-hour airplane flight at 39,000 feet is about 0.5 mrem (0.005 mSv). This is about the same as the CEDE from consuming 20 cottontail rabbits and about 2,500 times higher than consuming 20 doves like those sampled from Schooner Crater in 2008.

Table 8-1. Hypothetical dose to a human consuming NTS cottontail rabbits and doves based on 2008 samples from Schooner Crater

Radionuclide	Average Concentration (a)	Dose Conversion Factor (mrem/pCi ingested)(b)	CEDE (mrem)	Sum of CEDE (mrem)
Cottontail Rabbit	**(Assumed weight of muscle consumed = 4,000 g)**			0.47
^{3}H	547,000 pCi/L	0.000000063	0.103	
^{60}Co	0.08 pCi/g	0.000026000	0.002	
^{90}Sr	1.51 pCi/g	0.000130000	0.196	
^{137}Cs	0.53 pCi/g	0.000050000	0.027	
^{152}Eu	0.51 pCi/g	0.000006000	0.003	
^{154}Eu	0.39 pCi/g	0.000009100	0.004	
^{238}Pu	0.012 pCi/g	0.003800000	0.045	
$^{239+240}$Pu	0.009 pCi/g	0.004300000	0.037	
^{241}Am	0.012 pCi/g	0.004500000	0.056	
Mourning Dove	**(Assumed weight of muscle consumed = 600 g)**			0.0002
^{3}H	6,250 pCi/L	0.000000063	0.0002	

(a) Negative values were set to zero prior to averaging. Radionuclides not detected in a species were not included in dose estimate.
(b) Dose conversion factors for human ingestion are from DOE (1988).

8.1.4 Dose to the Public from Drinking Contaminated Groundwater

The migration of radioactivity in groundwater has not been detected off site in the past, nor was it detected in 2008 (see Section 4.1). Therefore, drinking contaminated groundwater is not a possible pathway of exposure to the public residing off site.

8.1.5 Dose to the Public from Direct Radiation Exposure along NTS Borders

The direct exposure pathway from gamma radiation to the public is monitored annually (see Section 5.0). In 2008, the only place where the public had the potential to be exposed to direct radiation along the NTS borders was at Gate 100, the primary entrance to the site on the southern NTS border. Trucks hauling radioactive materials, primarily low-level radioactive waste being shipped for disposal at the Area 3 and 5 Radioactive Waste Management Sites, park outside Gate 100 while waiting for entry approval. Only during these times is there a potential for exposure to the public on the NTS. However, no member of the public resides or remains full-time at the Gate 100 truck parking area.

8.1.6 Dose to the Public from Release of Property Containing Residual Radioactive Material

The release of property off the NTS that contains residual radioactive material is another type of release to the environment and potential contributor to the dose received by the public. No vehicles, equipment, structures, or other materials can be released from the NTS unless the amount of radiological contamination on such items is less than the authorized limits specified in the *NV/YMP Radiological Control Manual* (Table 8-2) (U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office [NNSA/NV], 2004) as specified in DOE O 5400.5. Items proposed for unrestricted release must be surveyed to document compliance with the release criteria.

In 2000, DOE placed a moratorium on the release of scrap material from radiological areas for recycling. This moratorium is still in effect. Government vehicles and equipment are routinely released or excessed when they are no longer needed by NTS projects or if they are required to be replaced. They are permitted to be released based on a combination of process knowledge and direct and indirect surveys such that the release criteria of Table 8-2 are met.

Some building structures and items on the NTS house uncontained radioactive materials. NSTec has no plans to release such structures and items off the NTS. If, in the future, there are plans to do so, approval of alternate authorized limits specific for this release would be requested from DOE in accordance with DOE O 5400.5. No items with residual radioactivity in excess of the default authorized limits specified in Table 8-2 were released from the NTS in 2008. The contribution to public dose from released items from the NTS was therefore negligible in 2008.

Table 8-2. Allowable total residual surface contamination for property released off NTS

	Residual Surface Contamination (dpm/100 cm^2)$^{(a)}$		
Radionuclide	**Removable**	**Average$^{(b)}$ (Fixed & Removable)**	**Maximum Allowable$^{(c)}$ (Fixed & Removable)**
Transuranics, ^{125}I, ^{129}I, ^{226}Ra, ^{227}Ac, ^{228}Ra, ^{228}Th, ^{230}Th, ^{231}Pa	20	100	300
Th-natural, ^{90}Sr, ^{126}I, ^{131}I, ^{133}I, ^{223}Ra, ^{224}Ra, ^{232}U, ^{232}Th	200	1,000	3,000
U-natural, ^{235}U, ^{238}U and associated decay products, alpha emitters	1,000	5,000	15,000
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except ^{90}Sr and others noted above	1,000	5,000	15,000

(a) Disintegrations per minute per 100 square centimeters

(b) Averaged over an area of not more than 1 square meter

(c) Applicable to an area of not more than 100 cm^2

Source: NNSA/NV (2004)

8.1.7 Total Offsite Dose to the Public from all Pathways

DOE O 5400.5 establishes a radiation dose limit to a member of the general public from all possible pathways as a result of DOE facility operations. This limit is 100 mrem/yr (1 mSv/yr) over and above background radiation and includes the air transport pathway, ingestion pathway, and direct exposure pathway. For 2008, the only possible pathways of public exposure to man-made radionuclides from current or past NTS activities included the air transport pathway and the ingestion of game animals. The doses from these pathways are combined below to present an estimate of the total 2008 dose to the maximally exposed individual (MEI) (see Glossary, Appendix B) residing off site.

The dose estimate for an offsite MEI from radionuclides in air is expected to be no greater than 1.9 mrem/yr (0.019 mSv) (see Section 3.1.5). If the offsite MEI is assumed to eat 20 cottontail rabbits from near the Schooner Crater, this individual may receive an estimated additional 0.47 mrem/yr (0.0047 mSv/yr) dose (see Table 8 -1). The total CEDE to this hypothetical MEI would be 2.37 mrem/yr (0.024 mSv/yr) (Table 8-3). The total dose of 2.37 mrem/yr is 2.37 percent of the DOE limit of 100 mrem/yr and about 0.6 percent of the total dose the MEI receives from natural background radiation (340 mrem/yr) (Figure 8-2).

Table 8-3. Estimated radiological dose to a hypothetical maximally exposed member of the general public from 2008 NTS operations

Pathway	Dose to MEI (mrem/yr)	(mSv/yr)	Percent of DOE 100-mrem/yr Limit
Air [(a)]	1.9	0.019	1.9
Water [(b)]	0	0	0
Wildlife [(c)]	0.47	0.0047	0.47
Property Containing Radioactive Material [(d)]	0	0	0
Direct [(e)]	0	0	0
All Pathways	2.37	0.024	2.37

(a) Based on maximum observed annual average concentrations at compliance stations on the NTS, 2008 (Section 3.1.5)
(b) Based on all offsite groundwater sampling in 2008 (Sections 4.1 and 5.2)
(c) Assumes that the MEI consumes 20 cottontail rabbits from near the Schooner Crater (Table 8-1)
(d) Based on 2008 property release tracking (Section 8.1.6)
(e) Based on 2008 gamma radiation monitoring data (Section 5.0)

Natural background radiation consists of cosmic radiation, terrestrial radiation, radiation from radionuclides within the composition of the human body (primarily potassium-40), and radiation from the inhalation of naturally occurring radon and its progeny. The cosmic and terrestrial components of background radiation shown in Figure 8-2 were estimated from the annual mean radiation exposure rate measured with a pressurized ion chamber (PIC) at Indian Springs by the CEMP (98 milliroentgens per year [mR/yr], see Table 6-4 in Section 6.0). The radiation exposure in air measured by the PIC in units of mR/yr is approximately equivalent to the unit of mrem/yr for tissue. The portion of the background dose from the internally deposited, naturally occurring radionuclides, and from the inhalation of radon and its daughters shown in Figure 8-2 were estimated at 40 mrem/yr and 200 mrem/yr, respectively, using the approximations by the National Council on Radiation Protection (NCRP) (NCRP, 1996).

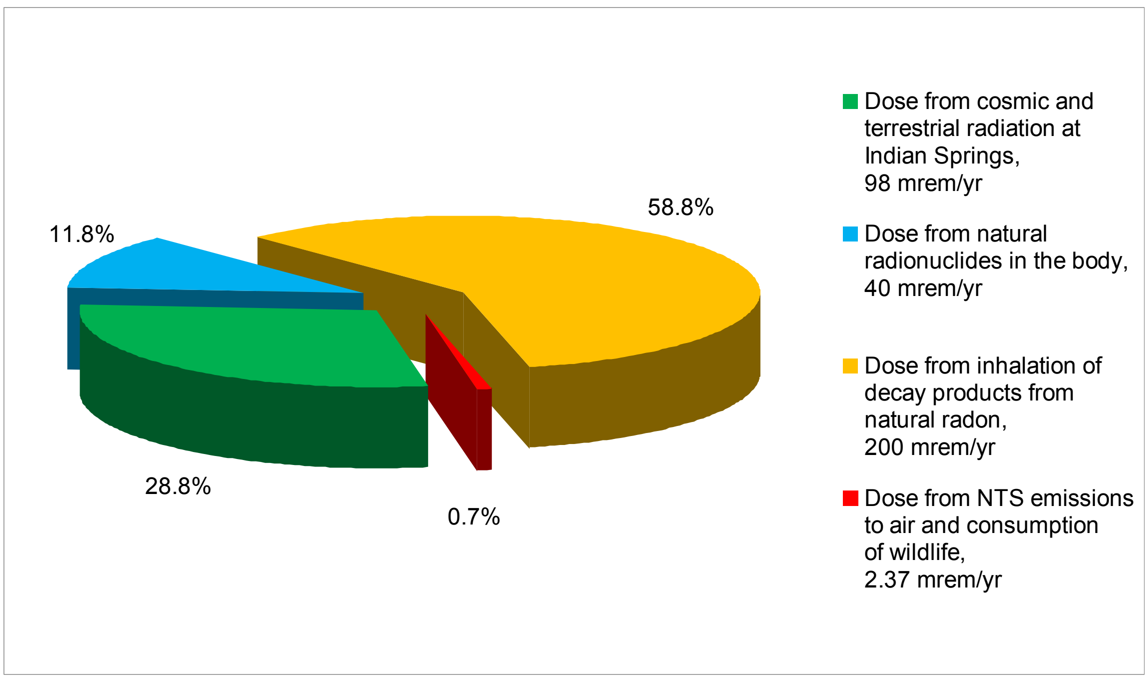

Figure 8-2. Comparison of radiation dose to the MEI from the NTS and natural background (percent of total)

8.1.8 Collective Population Dose

The collective population dose to residents within 80 km (50 mi) of the NTS emission sources was not estimated in 2008 because this assessment depends upon CAP88-PC estimations, which were not calculated. The collective population dose has been below 0.6 person-rem/yr for the period 1992 to 2004 (Figure 8-3). The DOE approved the discontinuance of reporting collective population dose because it is so low for the NTS. The DOE recommended, however, that the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office should consider reporting it once again if ever it exceeds 1.0 person-rem/yr (DOE, 2004a).

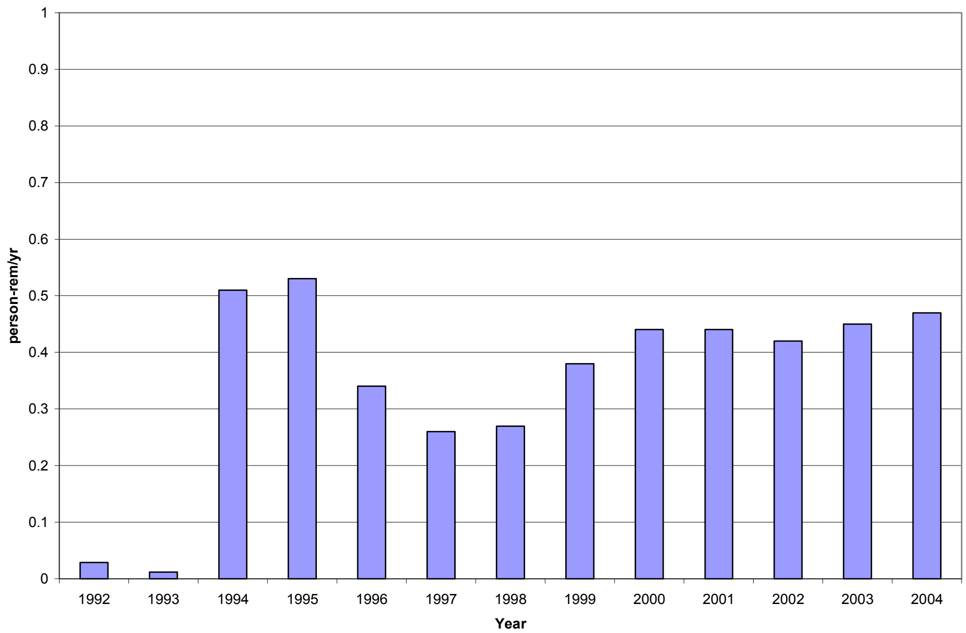

Figure 8-3. Collective population dose within 80 km of NTS emission sources from 1992 to 2004

8.2 Dose to Aquatic and Terrestrial Biota

DOE O 450.1A requires DOE facilities to evaluate the potential impacts of radiation exposure to biota in the vicinity of DOE activities. To assist in such an evaluation, DOE's Biota Dose Assessment Committee developed DOE-STD-1153-2002. This standard established the following radiological dose limits for plants and animals. Dose rates equal to or less than these are expected to have no direct, observable effect on plant or animal reproduction:

- 1 rad/d (0.01 grays per day [Gy/d]) for aquatic animals
- 1 rad/d (0.01 Gy/d) for terrestrial plants
- 0.1 rad/d (1 milligrays per day) for terrestrial animals

DOE-STD-1153-2002 also provides concentration values for radionuclides in soil, water, and sediment that are to be used as a guide for determining if biota are potentially receiving radiation doses that exceed the limits. These concentrations are called the Biota Concentration Guide (BCG) values. They are defined as the minimum concentration of a radionuclide that would cause dose limits to be exceeded using very conservative uptake and exposure assumptions.

NSTec biologists utilize the graded approach described in DOE-STD-1153-2002. The approach is a three-step process consisting of a data assembly step, a general screening step, and an analysis step. The analysis step consists of site-specific screening, site-specific analysis, and site-specific biota dose assessment. The following information is required by the graded approach:

- Identification of terrestrial and aquatic habitats on the NTS that have radionuclides in soil, water, or sediment
- Identification of terrestrial and aquatic biota on the NTS that occur in contaminated habitats and are at risk of exposure
- Measured or calculated radionuclide concentrations in soil, water, and sediment in contaminated habitats on the NTS that can be compared to BCG values to determine the potential for exceeding biota dose limits
- Measured radionuclide concentrations in NTS biota, soil, water, and sediment in contaminated habitats on the NTS to estimate site-specific dose to biota

A comprehensive biota dose assessment for the NTS using the graded approach was reported in the *Nevada Test Site Environmental Report 2003* (Bechtel Nevada, 2004a). This dose assessment demonstrated that the potential radiological dose to biota on the NTS was not likely to exceed dose limits. No data exist to suggest that NTS surface contamination conditions have changed; therefore, the terrestrial biota dose evaluation conclusion remains the same for 2008.

8.2.1 2008 Site-Specific Biota Dose Assessment

The site-specific biota dose assessment phase of the graded approach centers on the actual collection and analysis of biota. To obtain a predicted dose to biota at the sites sampled near Schooner Crater in 2008, the RESRAD-BIOTA, Version 1.21 computer model (DOE, 2004b) was used. Input to the model included the average concentrations of radionuclides in soil, as estimated from decay corrected radionuclide inventories (McArthur, 1991), and the maximum measured concentrations in animals and plants sampled from the monitoring site (see Tables 7-3 and 7-4). Internal dose is calculated using measured concentrations in biota tissue, and external dose is predicted from the average soil concentrations.

Dose to biota near the Schooner Crater in 2008 was estimated to be 0.01 rad/d for plants and 0.002 rad/d for cottontail rabbits (Table 8-4). External dose accounted for about 95 percent of the total dose to rabbits, with europium (Eu) isotopes and ^{60}Co dominating. Both Eu and ^{60}Co are activation products in the soil from nuclear weapons testing. External dose only accounted for about 27 percent of the total dose to plants due to relatively high concentrations of plutonium, ^{241}Am, and ^{3}H in the plant tissue. The total estimated dose rates are 2 percent or less than dose limits for terrestrial plants and animals.

Table 8-4. Site-specific dose assessment for terrestrial plants and animals sampled in 2008

	Estimated Radiological Dose (rad/d)					
	To Plants[(a)]			To Animals[(a)]		
Location	**Internal**	**External**	**Total**	**Internal**	**External**	**Total**
Schooner Crater	0.008	0.003	0.01	0.0001	0.002	0.002
DOE Dose Limit:			**1**			**0.1**

(a) For information on plants and animals sampled, see Section 7.0

8.2.2 Environmental Impact

Radionuclides in the environment from past or present NTS activities do not contribute significant dose to the public or biota. The estimated worst case dose to the MEI for 2008 was only 2.37 percent of the limits set to protect human health. Dose to biota at the NTS sites monitored during 2008 were 2 percent, or less, than the dose limits set to protect plant and animal populations. Based on the low potential doses from NTS radionuclides, impacts from those radionuclides are expected to be negligible.

9.0 Waste Management and Environmental Restoration

Several federal and state regulations govern the safe management, storage, and disposal of radioactive, hazardous, and solid wastes generated or received on the Nevada Test Site (NTS) for the purpose of protecting the environment and the public (see Section 2.4). This section describes both the waste management and environmental restoration operations conducted under the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) Environmental Management Program and summarizes the activities performed in 2008 to meet all environmental/public safety regulations. The goals of the program are shown below. The compliance measures and actions tracked and taken to meet the program goals are also listed.

Waste Management and Environmental Restoration Goals	***Compliance Measures/Actions***
Manage and safely dispose of the following wastes generated by NNSA/NSO, other U.S. Department of Energy (DOE), and U.S. Department of Defense (DoD) operations: Low-level radioactive waste (LLW) Low-level radioactive mixed waste (LLMW) Hazardous waste (HW) Continue to characterize, inspect, repackage, load, and ship transuranic (TRU) wastes stored on an interim basis at the NTS to either the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico, or to the Idaho National Laboratory (INL). Characterize and remediate historic sites contaminated by NNSA/NSO testing activities. Manage and safely dispose of solid/sanitary wastes generated by NNSA/NSO.	Completion/maintenance of documents required for a Class II Non-reactor Nuclear Facility established for waste disposal Acceptance criteria for radioactive wastes received for disposal Volume of disposed LLW Volume of stored nonradioactive HW Volume of disposed LLMW Weight of approved explosive ordnance wastes detonated Vadose zone monitoring Groundwater monitoring Site characterization, remediation, closure, and post-closure site monitoring Weight and volume of solid waste disposed

9.1 Radioactive Waste Management

DOE Order DOE O 435.1, "Radioactive Waste Management," requires that DOE radioactive waste management activities be systematically planned, documented, executed, and evaluated. Radioactive waste is managed to protect the public, the environment, and workers from exposure to radiation from radioactive materials and to comply with all applicable federal, state, and local laws and regulations; Executive Orders; and DOE directives. The major tasks within Radioactive Waste Management include:

- Verifying that NTS waste acceptance criteria are met for waste received
- Characterization of LLW and LLMW that has been generated by DOE projects within the State of Nevada
- Disposal of LLW and LLMW at the Radioactive Waste Management Complex (RWMC), which consists of the Area 3 Radioactive Waste Management Site (RWMS) and the Area 5 RWMS (the Area 3 RWMS is currently not being utilized but is being maintained for future use, as needed)
- Characterization, visual examination, and repackaging of legacy TRU waste at the Waste Examination Facility (WEF) at the RWMC
- Loading of legacy TRU waste at the Area 5 RWMS for shipment to either the WIPP or INL

9.1.1 Maintenance of Key Documents

Table 9-1 lists the key documents that must be current and in place for RWMS disposal operations to occur. In 2008, all of these key documents were maintained, one was revised, and one new document was prepared.

Table 9-1. Key documents required for Area 3 RWMS and Area 5 RWMS operations

Disposal Authorization Statement
Disposal Authorization Statement for Area 5 RWMS, December 2000
Disposal Authorization Statement for Area 3 RWMS, October 1999
Performance Assessment
Addendum 2 to Performance Assessment for Area 5 RWMS, Revision 2.1, September 2005
Performance Assessment/Composite Analysis for Area 3 RWMS, Revision 2.1, October 2000
Composite Analysis
Composite Analysis for Area 5 RWMS, September 2001
Performance Assessment/Composite Analysis for Area 3 RWMS, Revision 2.1, October 2000
NTS Waste Acceptance Criteria
NTS Waste Acceptance Criteria, Revision 7, June 2008
Integrated Closure and Monitoring Plan
Closure Plan for the Area 3 RWMS at the NTS, September 2007
Closure Plan for the Area 5 RWMS at the NTS, September 2008
Auditable Safety Analysis
Documented Safety Analysis for the NTS Area 5 RWMC, Revision 3, November 2007
Documented Safety Analysis for the NTS Area 3 RWMS, Revision 2, March 2006
Technical Safety Requirements for the Area 5 RWMC LLW Activities, Revision 5, October 2007
Technical Safety Requirements for the Area 5 RWMC TRU Waste Activities, Revision 5, October 2007
Technical Safety Requirements for the Area 3 RWMS, Revision 2, March 2006
Authorization Agreement for Area 5 RWMC, January 2007

9.1.2 Characterization of LLW and LLMW

Waste Generator Services (WGS) characterizes LLW and LLMW generated by the DOE primarily at the NTS but also at selected offsite DOE locations. Characterization is performed utilizing either knowledge of the generating process or sampling and analysis. Following the characterization of a waste stream, a Waste Profile is completed for approval by an appropriate disposal facility. The Waste Profile delineates the pedigree of the waste, including but not limited to a description of the waste generating process, physical and chemical characteristics, radioactive isotopes and their quantities, and detailed packaging information. WGS then packs and ships approved waste streams in accordance with U.S. Department of Transportation requirements to the Area 5 RWMS or to an offsite treatment, storage, or disposal facility.

In 2008, LLW and LLMW were characterized by WGS for the following general waste stream categories:

- Lead Solids
- Sealed Sources
- Miscellaneous Debris
- Depleted Uranium
- Carbon flecks
- Contaminated Asbestos Waste
- Compactable Trash
- Contaminated Soils
- Contaminated Liquids
- Hazardous Soils
- Contaminated Sludges
- Contaminated Polychlorinated Biphenyl (PCB) Waste

9.1.3 Disposal of LLW and LLMW

The RWMC, which includes the Area 3 and Area 5 RWMSs, operates as a Category II Non-reactor Nuclear Facility. The RWMC is designed and operated to perform three functions:

- Dispose of LLW and LLMW from NNSA/NSO activities performed on and off the NTS and from offsite generators located in the State of Nevada.
- Dispose of DOE LLW and LLMW from around the DOE Complex, primarily from the cleanup of sites associated with the manufacture of weapons components.
- Dispose of LLMW from around the DOE Complex.

All generators of waste streams must demonstrate eligibility to ship waste to the NTS for disposal, submit profiles characterizing specific waste streams, meet the NTS Radioactive Waste Acceptance Criteria, and receive programmatic approval from NNSA/NSO. The NNSA/NSO assesses and predicts the long-term performance of LLW disposal sites by conducting a Performance Assessment (PA) and a Composite Analysis (CA). A PA is a systematic analysis of the potential risks posed by a waste disposal site to the public and to the environment. A CA is an assessment of the risks posed by all wastes disposed in a LLW disposal site and by all other sources of residual contamination that may interact with the disposal site. The RWMC receives LLW generated within the DOE complex from numerous DOE sites across the United States, LLW from DoD sites that carry a national security classification, and LLMW generated within the DOE complex for disposal.

The Area 5 RWMS includes 81 hectares (ha) (200 acres [ac]) of existing and proposed disposal cells for burial of both LLW and LLMW, and approximately 202 ha (500 ac) of land available for future radioactive disposal cells. Waste disposal at the Area 5 RWMS has occurred in a 37 ha (92 ac) portion of the site since the early 1960s. This part of the Area 5 RWMS (commonly referred to as the “92-Acre Area”) consists of 31 disposal cells (pits and trenches) and 13 Greater Confinement Disposal (GCD) boreholes (listed below). This site is used for disposal of waste in drums, soft sided containers, large cargo containers, and boxes. The 92-Acre Area is expected to be filled and closed by 2011, and new cells extending to the north and west are expected to close after 2027. LLW and LLMW disposal services are expected to continue at the Area 5 RWMS as long as the DOE complex requires the disposal of wastes from the weapons program. Onsite disposal services for LLMW generated on and off site will continue through November 2010 or until a total volume of 20,000 cubic meters is received, whichever occurs first.

31 Disposal Cells at Area 5 RWMS:

6 active that receive standard LLW

1 active and permitted to receive asbestiform LLW (P06UA)

1 active and permitted to receive LLMW (P03U)

11 operationally closed containing LLW

11 cells operationally closed containing LLW
and LLMW (Corrective Action Unit [CAU] 111)

1 operationally closed containing asbestiform LLW (P07U)

13 GCD Boreholes at Area 5 RWMS:

4 inactive (open but have not received waste)

4 closed containing TRU waste

5 closed containing LLW

Disposal operations at the Area 3 RWMS began in the late 1960s. The Area 3 RWMS consists of seven subsidence craters configured into five disposal cells. Each subsidence crater was created by an underground weapons test. Until July 1, 2006, when the site was placed into inactive status, the site was used for disposal of bulk LLW waste, such as soils or debris, and waste in large cargo containers. The site consists of the following seven craters:

3 Disposal Cells (Inactive Status):	2 Closed Cells:	2 Undeveloped Cells:
U-3ah/at	U-3ax/bl (CAU 110)	U-3az
U-3bh		U-3bg

In calendar year 2008, the Area 5 RWMS received shipments containing a total of 37,722 cubic meters (m^3) (1,332,130 cubic feet [ft^3]) of radioactive wastes for disposal (Table 9-2). The majority of disposed LLW and LLMW were received from offsite generators. Only 1,160 m^3 (40,952 ft^3) of the LLW disposed in 2008 were generated on site. Fiscal year 2008 (October 1–September 30) volumes of waste shipments are reported in NNSA/NSO (2009).

Table 9-2. Radioactive waste received and disposed at the Area 5 RWMS

Waste Type	Disposal Cell(s)	Permitted Limit (m^3)	2008 Quantities Received and Disposed	
			m^3 (ft^3) [(a)]	tons [(b)]
LLW	P10C, P12C, P13U, P14U, P15U, P16C	NA[(c)]	36,368 (1,284,319)	NA
LLMW [(d)]	P03U	20,000	1,312 (46,330)	1,880.5
Asbestiform LLW	P06UA	NA	41.9 (1,481)	5.79
2008 Totals			**37,722 (1,332,130)**	**1,886.5**

(a) LLW disposal is regulated by DOE and totals reported are based on volume (m^3).
(b) Fees paid to Nevada for HW generated at NTS and LLMW wastes received for disposal are based on weight (tons).
(c) Not applicable.
(d) LLMW contains a hazardous component that is regulated by Nevada (see Section 9.2.1).

9.1.4 TRU Waste Operations

The TRU-Pad/Transuranic Pad Cover Building (TPCB) at the Area 5 RWMC is a Resource Conservation and Recovery Act (RCRA) Part B interim status facility designed for the safe storage of TRU waste generated by Lawrence Livermore National Laboratory and other small-quantity sites. The TPCB accepts TRU waste from NTS generators including the Joint Actinide Shock Physics Experimental Research facility. The TPCB stores TRU waste until it is characterized at the WEF at the Area 5 RWMC. Once characterized, the TRU waste is loaded at the mobile loading unit for shipment either to the WIPP at Carlsbad, New Mexico, for disposal or to an interim site for further characterization. Current agreements between NNSA/NSO and WIPP plan for TRU waste shipments to be completed by July 31, 2009. In 2008, TRU waste stored at the TPCB continued to be characterized, visually inspected, repackaged, and prepared for shipment.

9.1.5 Assessments

In 2008, assessments were conducted at the RWMC in accordance with National Security Technologies, LLC (NSTec), procedures. Schedules for management self-assessments (MSAs) are developed for the RWMC. In addition to the MSAs performed internally at the RWMC, assessments were performed periodically by other NSTec organizations, NNSA/NSO, and the Defense Nuclear Facilities Safety Board. The results of each assessment and any required corrective action(s) were logged for NNSA/NSO in the companywide issues tracking system known as CaWeb.

9.1.6 Groundwater Monitoring for Mixed Waste Disposal Unit (Pit P03U)

P03U is operated according to RCRA Interim Status standards for the disposal of mixed LLW. Title 40 Code of Federal Regulations (CFR) Part 265 (Groundwater Monitoring) Subpart F (40 CFR 265.92) requires groundwater monitoring to verify the performance of P03U to protect groundwater from buried radioactive wastes. Wells UE5 PW-1, UE5 PW-2, and UE5 PW-3 are monitored for this purpose; these wells comprise 3 of the 14 onsite monitoring wells sampled periodically for radionuclide analyses of groundwater (see Section 4.1.7). Investigation levels (ILs) for five indicators of groundwater contamination (Table 9-3) were established by NNSA/NSO and the Nevada Division of Environmental Protection (NDEP) for these three wells in 1998. Further groundwater analyses will be required if the results from all replicate samples exceed a parameter's IL. None of the samples collected semi-annually from the wells had contaminant levels above their ILs (Table 9-3). General water chemistry parameters are also monitored. All sample analysis results are presented in NSTec (2009b). Table 4-4 of Section 4.1.7 presents the tritium results for UE5 PW-1, UE5 PW-2, and UE5 PW-3.

Table 9-3. Results of groundwater monitoring of UE5 PW-1, UE5 PW-2, and UE5 PW-3 in 2008

Parameter	Investigation Level (IL)	Sample Levels
pH	< 7.6 or > 9.2 S.U.[(a)]	8.00 to 8.17 S.U.
Specific conductance (SC)	0.440 mmhos/cm[(b)]	0.360 to 0.386 mmhos/cm
Total organic carbon (TOC)	1 mg/L[(c)]	<0.5 to 0.65 mg/L
Total organic halides (TOX)	50 µg/L[(d)]	< 5.2 to 6.4 µg/L
Tritium (^{3}H)	2,000 pCi/L[(e)]	-10.7 to 12.1 pCi/L

(a) S.U. = standard unit(s) (for measuring pH) (b) mmhos/cm = millimhos per centimeter Source: NSTec (2009b)
(c) mg/L = milligrams per liter (d) µg/L = microgram(s) per liter (e) pCi/L = picocuries per liter

9.1.7 Vadose Zone Monitoring

Monitoring of the vadose zone (unsaturated zone above the water table) is conducted at the RWMC to demonstrate (1) that the PA assumptions at the RWMSs are valid regarding the hydrologic conceptual models used, including soil water contents, and upward and downward flux rates and (2) that there is negligible infiltration of precipitation into zones of buried waste at the RWMSs. Vadose zone monitoring (VZM) offers many advantages over groundwater monitoring, including detecting potential problems long before groundwater resources would be impacted, allowing corrective actions to be made early, and being less expensive than groundwater monitoring.

The components of the VZM program include (1) the Drainage Lysimeter Facility northwest of the U-3ax/bl, (2) the Area 5 Weighing Lysimeter Facility southwest of the Area 5 RWMS, (3) automated monitoring systems in the operational covers on Pits P03U, P04U, and P05U; the floor of P05U underneath the waste; and the vegetated closure cover on U-3ax/bl, (4) tritium monitoring via soil gas sampling at Well GCD-05U (one of the 13 GCD boreholes at the Area 5 RWMS), and (5) radon flux monitoring on the U-3ax/bl cover at the Area 3 RWMS and on the P01U cover at the Area 5 RWMS. Descriptions of these components and the results of monitoring in 2008 can be found in the *Nevada Test Site 2008 Waste Management Monitoring Report Area 3 and Area 5 Radioactive Waste Management Sites* (NSTec, 2009c). All VZM conducted in 2008 continued to demonstrate that there is negligible infiltration of precipitation into zones of buried waste at the RWMC and that the perform-ance criteria of the waste disposal cells are being met to prevent contamination of groundwater and the environment.

9.2 Hazardous Waste Management

Hazardous wastes regulated under RCRA are generated at the NTS from a broad range of activities including onsite laboratories, paint shops, vehicle maintenance, communications and photo operations, and environmental restoration of historic contaminated sites (see Section 9.3). The RCRA Part B Permit (NEV HW0021) regulates the operation of three HW facilities on the NTS: P03U at the Area 5 RWMS, the Hazardous Waste Storage Unit (HWSU) in Area 5, and the Explosive Ordnance Disposal Unit (EODU) in Area 11. Quarterly reports are submitted to the State of Nevada that document the weight of HW received each quarter at each of these HW units for management (i.e., for disposal, temporary storage, or detonation). Quarterly fees are paid to the State based on the weights of HW received. Also, Part II.K.2 of the permit requires preparation of a U.S. Environmental Protection Agency Biennial Hazardous Waste Report of all hazardous waste volumes generated at the NTS and at the North Las Vegas Facility (NLVF) during a year. This report is prepared for odd-numbered years only. No report, therefore, was prepared for 2008.

9.2.1 Pit P03U

Pit P03U began receiving LLMW from offsite DOE facilities in April 2006. The RCRA Part B Permit, NEV HW002, authorizes the disposal of LLMW received from DOE offsite facilities into P03U through November 2010 or until a total of 20,000 m^3 is received, whichever occurs first. P03U received a total of 1,880.5 tons (1,312 m^3) in 2008 (Table 9-4).

9.2.2 HWSU and Waste Accumulation Areas

The HWSU is a pre-fabricated, rigid-steel-framed, roofed shelter that is permitted to store a maximum of 61,600 liters (16,280 gallons) of approved waste at a time. HW generated at NSTec environmental restoration sites off the NTS (e.g., at the Tonopah Test Range [TTR]) or generated at the NLVF are direct-shipped to approved disposal facilities. HW generated on the NTS is also direct-shipped if the sites generate bulk, non-packaged HW that is not accepted at the HWSU for storage. HW would also be direct-shipped in the unlikely case when the waste volume capacity of the HWSU is approaching its permitted limits. Satellite Accumulation Areas (SAAs) and 90-day Hazardous Waste Accumulation Areas (HWAAs) are used at the NTS for the temporary storage of HW prior to direct shipment off site or to the HWSU.

In 2008, 8.96 tons of HW was received for storage at the HWSU (Table 9-4). In addition, the HWSU received and stored drums of lamp ballasts and debris contaminated with PCBs totaling 0.98 tons, and eight drums totaling 0.82 tons of PCB material were shipped off site (see Section 10.1). In 2008, no HW was direct-shipped from NTS SAAs nor from HWAAs (Table 9-4). No storage limits were exceeded. Quarterly reports of applicable waste quantities were submitted on time to NDEP.

9.2.3 EODU

Conventional explosive wastes are generated at the NTS from tunnel operations, the NTS firing range, the resident national laboratories, and other activities. The permit allows NNSA/NSO to treat explosive ordnance wastes at the EODU by open detonation of no more than 45.4 kilograms (100 pounds) of approved waste at a time, not to exceed one detonation event per hour. In 2008, no explosive ordnance were detonated (Table 9-4).

Table 9-4. Hazardous waste managed at the NTS in 2008

Permitted Unit	Total Waste Managed (tons) [a]
P03U	1,880.5
HWSU	8.96
HWSU – PCB Waste	0.98
SAAs and HWAAs	0 [b]
EODU	0

(a) Fees paid to Nevada for hazardous wastes generated at NTS and LLMW wastes received for disposal are based on weight (tons).
(b) Tons shipped directly off site from SAAs and/or HWAAs.

9.3 Underground Storage Tank (UST) Management

NNSA/NSO operates one deferred UST and three excluded USTs at the Device Assembly Facility. NNSA/NSO also maintains a fully regulated UST at the Area 6 helicopter pad, which is not in service. No new USTs were installed or closed in 2008. In 2008, NDEP did not conduct any inspections of these USTs.

9.4 Environmental Restoration - Remediation of Historic Contaminated Sites

In April 1996, the DOE, DoD, and the State of Nevada entered into a Federal Facility Agreement and Consent Order (FFACO) to address the environmental restoration of historic contaminated sites at the NTS, parts of TTR, parts of the Nellis Air Force Range (now known as the Nevada Test and Training Range), the Central Nevada Test Area, and the Project Shoal Area. These sites, known as Corrective Action Sites (CASs), may be contaminated with both radioactive and nonradioactive wastes. Appendix VI of the FFACO, as amended (February 2008), describes the strategy that will be employed to plan, implement, and complete environmental corrective actions at facilities where nuclear-related operations were conducted. Stoller-Navarro Joint Venture conducted most site characterization activities, while the NTS Management and Operating contractor (NSTec) conducted site restoration, soil remediation, and some facility decontamination and decommissioning activities in 2008.

9.4.1 Corrective Actions

The corrective action strategy is based on four steps: (1) identifying the CASs, (2) grouping the CASs into CAUs, (3) prioritizing the CAUs for funding and work, and (4) implementing the corrective action investigations (CAIs) and/or corrective actions, as applicable. CASs are broadly organized into the following four categories based on the source of contamination:

- Industrial Sites – CASs located on the NTS and TTR where activities were conducted that supported nuclear testing activities
- Underground Test Area (UGTA) Sites – CASs located where underground nuclear tests have resulted or might result in local or regional impacts to groundwater resources
- Soils Sites – CASs where tests have resulted in extensive surface and/or shallow subsurface contamination
- Nevada Off-Sites – Additional CASs associated with underground nuclear testing at the Project Shoal Area and the Central Nevada Test Area, located in northern and central Nevada, respectively

Identifying CASs – The first step in the strategy is to identify CASs potentially requiring CAIs and/or corrective actions. As CASs are identified, a literature search may be completed and each CAS is verified on aerial photographs or in the field to confirm its location and site condition. A data repository has been created containing or referencing all information currently available for each CAS.

Grouping CASs into CAUs – A CAU may have several CASs or only one. In addition to the four categories noted above, criteria for grouping CASs into CAUs include the following:

- Potential source of contamination
- Agency responsible for cleanup of the CAS
- Function of the CAS and the nature of the contamination
- Geographic proximity of CASs to one another
- Potential for investigation or cleanup of grouped CASs to be accomplished within a similar time frame

Implementing CAIs and/or Corrective Actions – When a CAU is assigned priority and funding, environmental restoration activities follow a formal work process beginning with a Data Quality Objectives (DQO) meeting with NNSA/NSO, NDEP, and contractors. If existing information about the nature and extent of contamination at the CASs is insufficient to evaluate and select preferred corrective actions, a CAI will be conducted. A Corrective Action Investigation Plan (CAIP) is prepared that provides a conceptual model of the site and defines how the site is to be characterized in conformance with the DQO process.

Site characterization is performed and then documented in a Corrective Action Decision Document (CADD). The CADD provides the information that either confirms or modifies the preliminary conceptual model. If suitable information is available to make a decision, a remedial action alternative is selected that best provides site closure. In some instances, additional site characterization may be required before the CADD can be prepared.

If a site requires a closure action, a Corrective Action Plan (CAP) is prepared that will implement the recommended remedial action/closure alternative. A CAP is composed of the following elements for site closure: a detailed scope of work, target field schedule, quality control measures, waste management strategy, design specifications/ drawings (when applicable), verification sampling strategies (for clean closures), and other information necessary for satisfying the specific closure requirements. Some sites also require a Post-Closure Plan as the site or parts of the site are closed in place. Information on field inspections, types of monitoring, monitoring frequency, and maintenance/repairs are provided in an Annual Post-Closure Monitoring Report.

Once the closure is completed, a Closure Report (CR) is prepared. The CR provides information on the scope of work performed, results of verification sampling, as-built drawings, waste management, and post-closure requirements for closed-in-place sites, etc. Some sites are closed under the Streamlined Approach for Environmental Restoration (SAFER) process identified in the FFACO. These sites typically have enough information available to remediate the site within a shorter duration. For such sites, a SAFER plan is prepared that will implement the plan for site closure. After closure, a SAFER CR is prepared that documents the scope of work performed.

NDEP is a participant throughout the remediation process, and the Community Advisory Board (CAB) is kept informed of the progress made. The CAB's comments are strongly considered before final prioritization of corrective actions. A public participation working group of representatives from NNSA/NSO, the State of Nevada, and the CAB meets twice a year to discuss quarterly progress, upcoming environmental restoration activities, priority-setting activities established under the FFACO, and the level of public involvement required.

Table 9-5 lists the CAUs for which some step of the site remediation process was completed in calendar year 2008. All 2008 milestones were met. A total of 70 CASs were closed, either under the SAFER process or the complex closure process.

Table 9-5. Environmental restoration activities conducted in 2008

CAU	CAU Description	Number of CASs	Milestone	Due Date	Date Submitted	Date NDEP Approved
	Defense Threat Reduction Agency/DOE Industrial Sites[(a)]					
481	Area 12 T-Tunnel Conditional Release Storage Yard	1	Closure Report to State	12/31/08	11/28/08	12/29/08
	DOE Industrial Sites – Defense Project					
556	Dry Wells and Surface Release Points	4	CADD/CR to State	9/30/08	9/10/08	9/17/08
557	Spills and Tank Sites	4	CAIP to State	7/31/08	7/3/08	7/14/08
560	Septic Systems	7	CAIP to State	5/31/08	5/6/08	5/12/08
563	Septic Systems	4	CADD to State	3/31/08	2/29/08	3/7/08
	DOE Industrial Sites – Environmental Restoration Project (ERP)					
121	Storage Tanks and Miscellaneous Sites	3	Closure Report to State	9/30/08	9/22/08	9/29/08
124	Storage Tanks	5	Closure Report to State	2/29/08	1/22/08	1/30/08
127	Areas 25 and 26 Storage Tanks	12	Closure Report to State	2/29/08	2/21/08	3/6/08
130	Storage Tanks	7	SAFER Plan to State	8/31/08	6/18/08	7/3/08
134	Aboveground Storage Tanks	4	SAFER Plan to State	5/31/08	5/29/08	6/17/08
145	Wells and Storage Holes	6	Closure Report to State	6/30/08	2/21/08	3/6/08
151	Septic Systems and Discharge Area	8	Closure Report to State	4/30/08	4/15/08	5/1/08
190	Contaminated Waste Sites	4	CADD/CR to State	3/17/08	3/10/08	3/27/08
234	Mud Pits, Cellars, and Mud Spills	12	CADD/CR to State	9/30/08	5/19/08	6/2/08
543	Liquid Disposal Units	7	Closure Report to State	1/31/08	1/22/08	1/28/08
545	Dumps, Waste Disposal Sites, and Buried Radioactive Materials	8	CADD/CR to State	9/30/08	4/10/08	4/29/08
546	Injection Well and Surface Releases	2	CAIP to State	4/30/08	3/6/08	3/14/08
	DOE Soil Sites					
107	Low Impact Soil Sites	15	SAFER Plan to State	9/30/08	9/29/08	10/28/08
370	T-4 Atmospheric Test Site	1	CAIP to State	4/30/08	4/25/08	5/7/08
	DOE UGTA Sites					
99	Rainier Mesa/Shoshone Mountain	66	Phase I Transport Parameters	3/5/08	3/5/08	4/8/08
99	Rainier Mesa/Shoshone Mountain	66	Phase I Hydrology Documentation Package	3/5/08	3/5/08	4/8/08
99	Rainier Mesa/Shoshone Mountain	66	Phase I Model Approach Strategy	4/4/08	4/3/08	7/30/08

Table 9-5. Environmental restoration activities conducted in 2008 (continued)

CAU	CAU Description	Number of CASs	Milestone	Due Date	Date Submitted	Date NDEP Approved
			DOE UGTA Sites (continued)			
99	Rainier Mesa/Shoshone Mountain	66	Complete Well Development, Testing, & Sampling for ER-16-1	4/16/08	4/10/08	4/23/08
101	Central Pahute Mesa	64	Phase I Transport Model	10/1/08	9/29/08	3/11/09
102	Western Pahute Mesa	18	Phase I Transport Model	10/1/08	9/29/08	3/11/09
101	Central Pahute Mesa	64	CAIP Phase II to State	12/3/08	12/1/08	AP[(b)]
102	Western Pahute Mesa	18	CAIP Phase II to State	12/3/08	12/1/08	AP
			Nevada Off-Sites			
443	Central Nevada Test Area - Subsurface	3	Final CADD/CAP Addendum	1/11/08	1/9/08	1/17/08

(a) In 2008, the responsible authority for this site was transferred from the Defense Threat Reduction Agency (DTRA) to NSTec. This site is currently managed under the Environmental Restoration (ER) Project, Industrial Sites Sub-Project.
(b) Approval pending with NDEP, as of July 29, 2009.

9.4.2 Post-Closure Monitoring and Inspections

The RCRA Part B Permit for the NTS prescribes quarterly or semi-annual post-closure monitoring for five of eight hazardous waste sites that were closed under RCRA prior to enactment of the FFACO (Table 9-6). One of the sites, the Area 3 U-3ax/bl Subsidence Crater (CAU 110), also requires VZM. The U-3ax/bl Subsidence Crater engineered cover cap is designed to limit infiltration into the disposal unit and is monitored using time-domain reflectometry soil water content sensors buried at various depths within the waste cover to provide water content profile data. The soil water content profile data are used to demonstrate whether the cover is performing as expected. The cover cap was also revegetated with native vegetation and is periodically monitored for revegetation success (see Section 13.4).

Table 9-6. Historic RCRA closure sites

CAU	Remediation Site	Post Closure Requirements
90	Area 2 Bitcutter Containment	Semi-annual site inspection
91	Area 3 U-3fi Injection Well	Semi-annual site inspection
92	Area 6 Decon Pond	Quarterly site inspection
93	Area 6 Steam Cleaning Effluent Ponds	None
94	Area 23 Building 650 Leachfield	None
109	Area 2 U-2bu Subsidence Crater	None
110	Area 3 U-3ax/bl Subsidence Crater	Quarterly site inspection, VZM of cover
112	Area 23 Hazardous Waste Trenches	Quarterly site inspection

Under the FFACO, the CRs for many of the closed remediation sites specify that post-closure monitoring or inspections be performed. In 2008, all required post-closure monitoring and inspections were conducted as specified by RCRA permit or by site CRs. VZM results for CAU 110 indicated that surface water is not migrating into buried wastes and that the cover is functioning as designed. The 44 CAUs for which physical inspections were conducted during the 2008 post-closure inspection period are listed in Table 9-7. Some CAUs originally listed have been updated and no longer require monitoring, maintenance, or inspections. This is the result of a risk-based evaluation between current use-restriction data and final threshold contamination limits. An annual monitoring report combining all RCRA closure sites was prepared and submitted to NDEP. Similarly, a combined annual monitoring report for non-RCRA closure sites was also prepared and submitted to NDEP.

Table 9-7. Remediation sites inspected in 2008

CAU	Remediation Site	CAU	Remediation Site
005	Landfills	357	Mud Pits and Waste Dump
90	Area 2 Bitcutter Containment	383	Area 12 E-Tunnel Sites (formerly DTRA)[(a)]
91	Area 3 U-3fi Injection Well	400	Bomblet Pit and Five Points Landfill (TTR)
92	Area 6 Decon Pond Facility	404	Roller Coaster Lagoons and Trench (TTR)
110	Area 3 U-3ax/bl Subsidence Crater	407	Roller Coaster RadSafe Area (TTR)
112	Area 23 Hazardous Waste Trenches	423	Area 3 Underground Discharge Point, Building 0360 (TTR)
113	Area 25 R-MAD Facility	424	Area 3 Landfill Complexes (TTR)
115	Area 25 Test Cell A Facility	426	Cactus Spring Waste Trenches (TTR)
118	Area 27 Super Kukla Facility	427	Area 3 Septic Waste Systems 2, 6 (TTR)
137	Waste Disposal Sites	453	Area 9 UXO Landfill (TTR)
140	Waste Dumps, Burn Pits, and Storage Area	476	Area 12 T-Tunnel Muckpile (formerly DTRA)[(a)]
143	Area 25 Contaminated Waste Dumps	477	Area 12 N-Tunnel Muckpile (formerly DTRA)[(a)]
165	Area 25 and 26 Dry Well and Washdown Areas	478	Area 12 T-Tunnel Ponds (formerly DTRA)
168	Area 25 and Area 26 Contaminated Materials and Waste Dumps	482	Area 15 U15a/e Muckpiles and Ponds (formerly DTRA)[(a)]
204	Storage Bunkers	487	Thunderwell Site (TTR)
254	Area 25 Reactor Maintenance, Assembly, and Disassembly Decontamination Facility	528	Polychlorinated Biphenyls Contamination
261	Area 25 Test Cell A Leachfield	529	Area 25 Contaminated Materials
262	Area 25 Septic Systems and UDP	542	Disposal Holes
309	Area 12 Muckpiles	551	Area 12 Muckpiles
322	Areas 1 and 3 Release Sites and Injection Wells	552	Area 12 Muckpiles and Ponds
333	U-3auS Disposal Site (not required until 2011)	554	Area 23 Release Sites
339	Area 12 Fleet Operations Steam Cleaning Effluent	559	T-Tunnel Compressor/Blower Pad (formerly DTRA)[(a)]

(a) In 2008, the responsible authority for this site was transferred from the Defense Threat Reduction Agency (DTRA) to NSTec. This site is currently managed under the Industrial Sites ER Post Closure Monitoring program.

9.5 Solid and Sanitary Waste Management

9.5.1 Landfills

The NTS has three landfills for solid waste disposal that were operated by NSTec Waste Management in 2008. The landfills are regulated and permitted by the State of Nevada (see Table 2-11 for list of permits). No liquids, hazardous waste, or radioactive waste are accepted in these landfills. They include:

- Area 6 Hydrocarbon Disposal Site – accepts hydrocarbon-contaminated wastes, such as soil and absorbents.
- Area 9 U10c Solid Waste Disposal Site – designated for industrial waste such as construction and demolition debris.
- Area 23 Solid Waste Disposal Site – accepts municipal-type wastes such as food waste and office waste. Regulated asbestos-containing material is also permitted in a special section. The permit allows disposal of no more than an average of 20 tons/day at this site.

These landfills are designed, constructed, operated, maintained, and monitored in adherence to the requirements of their state-issued permits. NDEP visually inspects the landfills and checks the records on an annual basis to ensure compliance with the permits.

The vadose zone is monitored at two of the permitted sanitary landfills: the Area 6 Hydrocarbon Disposal Site and the Area 9 U10c Solid Waste Disposal Site. VZM is performed once annually in lieu of groundwater monitoring to demonstrate that contaminants from the landfills are not leaching into the groundwater. VZM in 2008 indicated that there was no soil moisture migration and, therefore, no waste leachate migration to the water table.

The amount of waste disposed of in each solid waste landfill in 2008 is shown in Table 9-8. An average of 2.75 tons/day was disposed at the Area 23 landfill, well within permit limits. State inspections of the three permitted landfills were conducted in April 2008. No out-of-compliance issues were noted.

Table 9-8. Quantity of solid wastes disposed in NTS landfills in calendar year 2008

Metric Tons (Tons) of Waste		
Area 6 Hydrocarbon Disposal Site	**Area 9 U10c Solid Waste Disposal Site**	**Area 23 Solid Waste Disposal Site**
17.2 (19)	4,144.1 (4,569)	519.7 (573)

9.5.2 Sewage Lagoons

The NTS also has two state-permitted sewage lagoons that were operated by NSTec Waste Management in 2008. They are the Area 6 Yucca Lake and Area 23 Mercury lagoons. The operations and monitoring requirements for these sewage lagoons are specified by Nevada water pollution control regulations. Because of this, the discussion of their operations and compliance monitoring are presented in Section 4.2.3.

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10.0 Hazardous Materials Control and Management

Hazardous materials used or stored on the Nevada Test Site (NTS) are controlled and managed through the use of a Hazardous Substance Inventory database. All contractors and subcontractors of the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) utilize this database if they use or store hazardous materials. They are required to comply with the operational and reporting requirements of the Toxic Substances Control Act (TSCA); the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA); the Emergency Planning and Community Right-to-Know Act (EPCRA); and the Nevada Chemical Catastrophe Act (see Section 2.5). Chemicals to be purchased are subject to a requisition compliance review process. Environmental Services (ES) personnel with National Security Technologies, LLC (NSTec), reviewed each chemical purchase in 2008 to ensure that toxic chemicals and products were not purchased when less hazardous substitutes were commercially available. Requirements and responsibilities for the use and management of hazardous/toxic chemicals were provided in company documents and were aimed at meeting the goals shown below. The reports and activities prepared or performed in 2008 to document compliance with hazardous materials regulations are presented below.

Hazardous Materials Control and Management Goals	*Compliance Activities/Reports*
Minimize the adverse effects of improper use, storage, or management of hazardous/toxic chemicals. Ensure compliance with applicable federal and state environmental regulations related to hazardous materials.	Use of Hazardous Substance Inventory database Annual TSCA report FIFRA management assessments Annual Nevada Combined Agency (NCA) Report Annual EPCRA Toxic Release Inventory (TRI) Report, Form R Nevada Division of Environmental Protection (NDEP) Chemical Accident Prevention Program Annual Registration Form Use of electronic Hazardous Materials Notification System (known as HAZTRAK) for tracking the movements of such materials

10.1 TSCA Program

There are no known pieces of polychlorinated biphenyl (PCB)-containing electrical equipment (transformers, capacitors, or regulators) at the NTS; however, sometimes during demolition activities, old hydraulic systems are found to contain PCB liquids. The TSCA program consists mainly of properly characterizing, storing, and disposing of various PCB wastes generated through remediation activities and maintenance of fluorescent lights. The remediation waste is generated by NSTec and Stoller-Navarro Joint Venture at Corrective Action Sites during environmental restoration activities (see Section 9.4) and during maintenance activities and building decontamination and decommissioning activities performed by NSTec. These activities can generate PCB-contaminated fluids and bulk product waste containing PCBs.

Waste classified as bulk product waste generated on the NTS by remediation and site operations can be disposed of on site in the U10c landfill with prior State of Nevada approval. PCB-containing light ballasts removed during normal maintenance can also go to an onsite landfill, but when remediation or upgrade activities generate several ballasts, these must be disposed of off site at an approved PCB disposal facility. Soil and other materials contaminated with PCBs must also be sent off site for disposal.

During 2008, eight drums of PCB light ballasts were generated from remediation, demolition, and renovation activities and sent off site for disposal in one shipment. On May 19, 2009, an Annual Report was generated for PCB management activities during 2008. There were no TSCA inspections by outside regulators performed at the NTS in 2008.

10.2 FIFRA Program

ES personnel performed the following oversight functions to ensure FIFRA compliance: (1) screened all purchase requisitions for restricted-use pesticides; (2) reviewed operating procedures for handling, storing, and applying pesticide products; and (3) conducted facility inspections for unauthorized pesticide storage/use. On the NTS, pesticides are applied under the direction of a State of Nevada certified applicator. This service was provided by Solid Waste Operations (SWO). SWO maintained appropriate Commercial Category (Industrial) certifications for applying restricted-use pesticides, but only non-restricted pesticides were used. Pesticide applications in food service facilities are subcontracted to state-certified vendors.

SWO did not purchase any restricted-use pesticides during 2008. Training was provided to affected personnel. Certifications were kept current in 2008 for Industrial Category application(s) of restricted-use pesticides. Facility inspections were conducted and indicated that there were no restricted-use pesticides being used or stored in violation of federal/state requirements.

10.3 EPCRA Program

EPCRA requires that federal, state, and local emergency planning authorities be provided information regarding the presence and storage of hazardous substances and their planned and unplanned environmental releases, including provisions and plans for responding to emergency situations involving hazardous materials. NNSA/NSO prepares and submits reports in compliance with EPCRA pursuant to Sections 302, 303, 304, 311, 312, and 313 of the Superfund Amendments and Reauthorization Act, Title III (see Section 2.5.1).

In response to the EPCRA requirements, all chemicals that are purchased are entered into a hazardous substance inventory database and assigned specific hazard classifications (e.g., corrosive liquid, flammable, diesel fuel). Annually, this database is updated to show the maximum amounts of chemicals that were present in each building at the NTS, the Nonproliferation Test and Evaluation Complex (NPTEC), the North Las Vegas Facility (NLVF) (see Section A.1.4), and the Remote Sensing Laboratory (RSL)–Nellis (see Section A.2.3). This information is then used to complete the NCA Report (Table 10-1). The NCA Report provides information to the State of Nevada, community, and local emergency planning commissions on the maximum amount of any chemical, based on its hazard classification, present at any given time during the preceding year. The State Fire Marshall then issues permits to store hazardous chemicals on the NTS, as well as at RSL-Nellis and NLVF. The 2008 chemical inventory for NTS facilities was updated and submitted to the State of Nevada in the NCA Report on February 26, 2009. No accidental or unplanned release of an extremely hazardous substance occurred on the NTS in 2008.

The hazardous substance inventory database is also used to complete the TRI Report, Form R (Table 10-1). This report provides the U.S. Environmental Protection Agency (EPA) and the State Emergency Response Commission information on any toxic chemical that enters the environment above a given threshold. It also provides these agencies with the amounts of toxic chemicals that are recycled. NNSA/NSO submitted this report for calendar year 2008 to EPA on June 11, 2009. Lead was the only listed toxic chemical released into the NTS environment in 2008 that was reportable (Table 10-2). The total amount of lead released into the air was 4.56 pounds (lb). Lead that is recovered during site remediation activities or is excess to NTS operational needs (e.g., lead bricks, lead shielding) is either sent off site for recycling or is sent off site for proper disposal. Lead acid batteries that are recycled (see Chapter 11, Table 11-1) are exempt from inclusion in the TRI Report, Form R. In 2008, 1,318 lbs of lead were sent off site for disposal.

No EPCRA inspections were performed by outside regulators at the NTS in 2008.

Table 10-1. EPCRA compliance reporting at the NTS in 2008

Section of the Act	Activity Regulated	Notification/Report Submitted per Applicable Requirement
Section 302–303	Planning Notification	NCA Report
Section 304	Extremely Hazardous Substance Release Notification	Not applicable (no releases occurred)
Section 311–312	Material Safety Data Sheet/Chemical Inventory	NCA Report
Section 313	TRI Reporting	TRI Report

Table 10-2. EPCRA reportable releases of toxic chemicals in 2008

Toxic Chemical	Source	Quantity (lb)
Lead – solid	Ammunition - Mercury Firing Range	7,606
Lead – air release	Ammunition - Mercury Firing Range	4.56
Lead – air release	Solder	0.01

HAZTRAK is a tracking system that monitors hazardous materials while they are in transit. When a truck transporting hazardous material enters the NTS, all information concerning the load is entered into the tracking system. Once the delivery is complete, the information provided at the time of entry is removed from the tracking system.

10.4 Nevada Chemical Catastrophe Prevention Act

If extremely hazardous substances (EHSs) are stored in quantities that exceed threshold quantities established by NDEP, then NNSA/NSO submits a report notifying the State of Nevada. From June 1, 2008, through May 31, 2009, NPTEC in Area 5 stored two EHS (nitrogen dioxide and sulfur dioxide) in quantities that required state notification. A Nevada Chemical Accident Prevention Program Report was prepared regarding June 1, 2008, through May 31, 2009, NTS operations and was submitted to NDEP on June 11, 2009.

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11.0 Pollution Prevention and Waste Minimization

The U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) has pollution prevention and waste minimization (P2/WM) initiatives that establish a process to reduce the volume and toxicity of waste generated by NNSA/NSO on the Nevada Test Site (NTS) and its satellite facilities. They also ensure that proposed methods of treatment, storage, and disposal of waste minimize potential threats to human health and the environment. These initiatives address the requirements of several federal and state regulations applicable to operations on the NTS (see Section 2.7). The following information provides an overview of the P2/WM goals, major accomplishments during the reporting year, and a description of efforts undertaken by National Security Technologies, LLC (NSTec), in 2008 to reduce the volume and toxicity of waste generated.

11.1 P2/WM Goals and Components

It is the priority of NNSA/NSO to minimize the generation, release, and disposal of pollutants to the environment by implementing cost-effective P2 technologies, practices, and policies. A commitment to P2 minimizes the impact on the environment, improves the safety of operations, improves energy efficiency, and promotes the sustainable use of natural resources. This commitment includes providing adequate administrative and financial materials on a continuing basis to ensure goals are achieved. When economically feasible, source reduction is the preferred method of handling waste, followed by reuse and recycling, treatment, and as a last resort, landfill disposal.

Source Reduction – Source reduction is the minimization or elimination of waste before it is generated by a project or operation. Examples of source reduction include chemical substitution, process modification, and segregation. NNSA/NSO's Integrated Safety Management System requires that every project/operation address waste minimization issues during the planning phase and ensure that adequate funds are allocated to perform any identified waste minimization activities.

To minimize the generation of waste, project managers are required to incorporate waste minimization into the planning phase of their projects. Waste-generating processes must be assessed to determine if the waste can be economically reduced or eliminated. Waste minimization activities that are determined to be cost-effective should be incorporated into the project plan and adequate funding allocated to ensure their implementation.

Recycling – For wastes that are generated, an aggressive recycling program is maintained. Items recycled through the NNSA/NSO recycling program in 2008 included paper, cardboard, aluminum cans, toner cartridges, inkjet cartridges, used oil, food waste from the cafeteria, plastic, scrap metal, computer equipment, rechargeable batteries, lead-acid batteries, fluorescent light bulbs, mercury lamps, metal hydride lamps, and sodium lamps.

An effective method for reuse is the coordination of the Material Exchange Program. Created in 1998, the Material Exchange Program diverts supplies, chemicals, and equipment from landfills. Unwanted chemicals, supplies, and equipment are made available through electronic mail or postings on the intranet Material Exchange Database so that individuals in need can obtain the items at no cost. These materials are destined for disposal, either as solid or hazardous waste, as a result of process modification, discontinued use, or shelf-life expiration. Rather than disposing of these items, the majority of them are provided to other employees for their intended purpose, thus avoiding disposal costs and costs for new purchases. If items are not placed with another user, they can be returned to the vendor for recycle/reuse, or given to other U.S. Department of Energy (DOE) sites, other government agencies, or local schools.

Affirmative Procurement – As required by Resource Conservation and Recovery Act (RCRA), Section 42 United States Code (USC) 6962, NNSA/NSO maintains an Affirmative Procurement process that stimulates a market for recycled content products and closes the loop on recycling. RCRA Section 42 USC 6962 requires the U.S. Environmental Protection Agency (EPA) to develop a list of items containing recycled materials that should be purchased. The EPA is also required to determine what the minimum content of recycled material should be for each item. Federal facilities are required to ensure that a process is in place for purchasing the EPA-designated items containing the minimum content of recycled materials. Executive Order (EO) 13423, "Strengthening Federal Environmental, Energy and Transportation Management," goes one step further and requires federal facilities to ensure, where possible, that 100 percent of purchases of items from the EPA-designated list contain recycled materials at the specified minimum content. Of these items NNSA/NSO purchased from the EPA-designated list in 2008, about 56 percent contained recycled materials at the specified minimum content.

Employee and Public Awareness – The NNSA/NSO P2 and WM initiatives also include an employee and public awareness program. Awareness of P2/WM issues is accomplished by dissemination of articles through electronic mail, contractor and NNSA/NSO newsletters, the maintenance of a P2/WM intranet Web site, employee training courses, and participation at employee and community events. These activities are intended to increase awareness of P2/WM and environmental issues and highlight the importance of P2/WM for improving environmental conditions in the workplace and community.

Establishing P2/WM Related Goals – EO 13423, "Strengthening Federal Environmental, Energy, and Transportation Management," requires federal facilities to begin establishing goals to improve efficiency in energy and water use, procure goods and services that use sustainable environmental practices, reduce amounts of toxic materials acquired, maintain a cost-effective waste prevention and recycling program, ensure construction and major renovation of buildings that incorporate sustainable practices, reduce use of petroleum products in motor vehicles and increase use of alternative fuels, and acquire and dispose of electronic products using environmentally sound practices.

11.2 Major P2/WM Accomplishments

The following six accomplishments were reported to DOE Headquarters for 2008:

The North Las Vegas Facility (NLVF) is regulated under RCRA as a conditionally exempt small quantity generator (CESQG) of hazardous waste (HW). By definition, a CESQG generates less than 100 kilograms (kg) (220 pounds [lb]) of HW, or less than 1 kg (2.2 lb) of acute HW per month, or less than 100 kg of spill residue per month. When an activity arose at the NLVF that would generate two 55-gallon drums of lead-contaminated rags, it was noted that this would necessitate a change in generator status as well as an unscheduled HW pickup for the facility. It was determined that paper towels could be used instead of the rags; thus keeping the total weight of waste at the NLVF to less than 100 kg and eliminating the need to change the generator status of the facility, dispose of the two 55-gallon drums of lead-contaminated rags, and pay for a special HW collection. The total cost savings was estimated to be $8,000.

NSTec had a fiscal year (FY) 2008 (October 1, 2007–September 31, 2008) environmental target, in accordance with EO 13423, to increase the use of non-petroleum-based fuel by 10 percent over its use in FY 2007. Through good employee awareness and management support, an increase of 35 percent was achieved.

NSTec successfully completed a commitment to obtain International Organization for Standardization (ISO) 14001 Certification within a two-year time frame. Part of the ISO Certification process was to establish the environmental objectives and targets program. Several of the targets successfully met in FY 2008 were in the area of pollution prevention.

A cleanup project at the T-Tunnel Laydown Yard in Area 12 could have resulted in large amounts of potentially radiologically contaminated metal being buried in an onsite landfill. However, by careful segregation and a minimal amount of costly radiological characterization, over 227 metric tons (mtons) (250 tons) of material (34 percent) was able to be designated for recycling.

The Information Services Department of NSTec developed a database for listing software that ordinarily would have been excessed and either recycled or disposed. The database allows employees to search for needed software, which is provided to them at no cost. This process allows software to be redeployed and reused by employees, therefore avoiding the cost of recycle/disposal and the purchase of new software.

Thirty-four oversize locomotive and forklift batteries, weighing about 7,893 kg (174,000 lb), were no longer required and needed to be removed from the NTS. A search was made for a local recycling vendor who could accept the batteries and a suitable one was found. This avoided the onsite storage of a large quantity of HW at the Hazardous Waste Storage Unit in Area 5 and the associated costs of onsite storage and offsite disposal.

Per NSTec's Environmental Management System (EMS), the Material Exchange Program is continually striving for improvement. Articles were published in newsletters and disseminated to employees in all organizations within the NNSA/NSO complex to raise the level of awareness of the program and its Web site. The Material Exchange Program diverted 3.4 mtons (3.7 tons) of chemicals, office supplies, and equipment from solid and HW landfills in 2008, bringing the total of usable materials diverted from such landfills since the program's inception in 1998 to 194 mtons (213 tons).

A number of P2/WM goals were identified and tracked in 2008. These goals are integrated into the NSTec EMS and are presented in Chapter 17 (see Table 17-1).

On November 26, 2008, NSTec completed the FY 2008 Waste Generation and Pollution Prevention Progress Report for the NTS. This was done by entering the site's data, including annual recycling totals and waste minimization accomplishments, into the DOE Headquarters electronic database. NSTec also submitted the calendar year 2008 Waste Minimization Summary Report to NNSA/NSO in February 2009 for its subsequent transmittal to the Nevada Division of Environmental Protection.

11.3 Waste Reductions

P2/WM techniques and practices are implemented for all activities that may generate waste. These P2/WM activities result in reductions to the volume and/or toxicity of waste generated on site. Table 11-1 shows a summary of the waste reduction activities accomplished during 2008. Estimated reductions of 268.5 mtons (295 tons) of HW (including RCRA, Toxic Substance Control Act, and state-regulated HW) and 311.2 mtons (342 tons) of solid waste (sanitary waste) occurred in 2008, all from recycling and reuse. Table 11-2 compares the amounts of radioactive, hazardous, and solid wastes reduced in 2008 to the amounts in prior years.

Table 11-1. Waste reduction activities in 2008

Activity	Reduction (mtons)[a]
Hazardous Waste	
Bulk used oil was sent to an offsite vendor for recycling	76.4
Lead acid batteries were shipped to an offsite vendor for recycling	178.5
Computer equipment was returned to the vendor where it is refurbished and sold for reuse	12.1
Spent fluorescent light bulbs, mercury lamps, metal hydride lamps, and sodium lamps were sent to an offsite vendor for recycling	1.3

Table 11-2. Quantities of waste reduced through P2/WM activities by waste type and year

Calendar Year	Radioactive (m^3)[(a)]	Hazardous (mtons)[(b)]	Solid (mtons)
2008	28.9	268	311
2007	0	167	1,698
2006	0	149	803
2005	0	13,992	1,194
2004	0	115	1,438
2003	40.0	207	1,547
2002	63.2	177	904

(a) 1 cubic meter (m^3) = 1.3 cubic yards
(b) 1 mton = 1.1 ton

12.0 Historic Preservation and Cultural Resources Management

The historic landscape of the Nevada Test Site (NTS) contains archaeological sites, buildings, structures, and places of importance to American Indians and others. These are referred to as "cultural resources." U.S. Department of Energy (DOE) Order DOE O 450.1A, "Environmental Protection Program," requires that NTS activities and programs comply with all applicable cultural resources regulations (see Section 2.8) and that such resources on the NTS be monitored. The Cultural Resources Management (CRM) program has been established and is implemented by the Desert Research Institute (DRI) on the NTS to meet this requirement. The CRM program is designed to meet the specific goals shown below.

Cultural Resources Management Program Goals
Ensure compliance with all regulations pertaining to cultural resources on the NTS (see Section 2.8).
Inventory and manage cultural resources on the NTS.
Provide information that can be used to evaluate the potential impacts of proposed projects and programs to cultural resources on the NTS and mitigate adverse effects.
Curate archaeological collections in accordance with Title 36 Code of Federal Regulations (CFR) Part 79.
Conduct American Indian consultations related to places and items of importance to the Consolidated Group of Tribal Organizations.

In order to achieve the program goals and meet federal and state requirements, the CRM program is multifaceted and contains the following major components: (1) inventories and historical evaluations, (2) curation of archaeological collections, and (3) the American Indian Program. The guidance for the CRM program work is provided in the *Cultural Resources Management Plan for the Nevada Test Site* (Drollinger et al., 2002). Historic preservation personnel and archaeologists of DRI who meet the qualification standards set by the Secretary of the Interior conduct the work, and the archaeological efforts are permitted under the Archaeological Resources Protection Act (ARPA).

A brief description of the CRM program components and their 2008 accomplishments is provided in this chapter. The methods used to conduct inventories and historical evaluations in support of NTS operations were summarized in the 2003 NTS Environmental Report (Bechtel Nevada, 2004a). The reader is directed to a separate file called *Nevada Test Site Description* on the compact disc of this 2008 report. The *Nevada Test Site Description* contains a summary of the known human occupation and use of the NTS from the Paleo-Indian Period, about 12,000 years ago, until the mining and ranching period of the twentieth century, just before NTS lands were withdrawn for federal use.

12.1 Cultural Resources Inventories, Historical Evaluations, and Associated Activities

Cultural resources inventories are conducted at the NTS to meet the requirements of the National Historic Preservation Act (NHPA) and the ARPA. The inventories are completed prior to proposed projects that may disturb or otherwise alter the environment. The following information is maintained in databases:

- Number of cultural resources inventories conducted
- Location of each inventory
- Number of acres surveyed at each project location

- Types of cultural resources identified at each project location
- Number of cultural resources determined eligible to the National Register of Historic Places (NRHP)
- Eligible properties avoided by project activities
- Cultural resources requiring mitigation to address an adverse effect
- Final report on results

12.1.1 Cultural Resources Inventories

In 2008, six cultural resources inventories were conducted for proposed projects: (1) the Firing Range in Area 23, (2) the Underground Test Area (UGTA) ER-20-7 Well Pad and Access Road in Area 20, (3) the UGTA ER-20-8 Well Pad and Access Road in Area 20, (4) the UGTA Borrow Pit Expansion in Area 20, (5) the UGTA ER-EC-11 Well Pad and Access Road on Range EC South Nevada Test and Training Range (NTTR), and (6) the UGTA ER-EC-11 Well Pad Relocation on Range EC South NTTR. One site was identified during these surveys. As summarized in Table 12-1, a total of 25.02 hectares (62.09 acres) was examined during cultural resources inventories. Three self-assessments were performed for the inventories associated with the UGTA Sub-Project.

Table 12-1. Summary data for cultural resources inventories completed in 2008

Inventory	Prehistoric/ Historic Sites Found	Cultural Resources Evaluated	Cultural Resources Determined NRHP Eligible	Area Surveyed	
				Hectares	Acres
Firing Range	0	0	0	3.8	9.4
UGTA ER-20-7 Well Pad and Access Road	0	0	0	8.7	12.0
UGTA ER-20-8 Well Pad and Access Road	0	0	0	4.39	10.9
UGTA Borrow Pit Expansion, Area 20	0	0	0	3.6	8.9
UGTA ER-EC-11 Well Pad and Access Road	1	1	1	5.04	12.52
UGTA ER-EC-11 Relocation Sites	0	0	0	3.39	8.37
Totals	**1**	**1**	**0**	**25.02**	**62.09**

12.1.2 Evaluations of Historic Structures

Three historical evaluations of nuclear testing related locations were in progress at the end of 2008. The historical evaluation report for the U12t Tunnel was submitted for technical review. Archival research and fieldwork were completed for the U12n Tunnel with the report in development. For the Structural Response Safety Program Structures, fieldwork was completed with a report pending.

12.1.3 Associated Cultural Resources Activities

12.1.3.1 General Reconnaissance/Archival Research

Five field projects and ten archival research projects were conducted in 2008. The first field project was the annual site monitoring program for which 15 sites were monitored. The NHPA requires federal agencies to identify and maintain the integrity of historic properties under their jurisdiction. Historic properties are cultural resources that have been determined eligible to the NRHP through consultation between the NNSA/NSO and the Nevada State Historic Preservation Office. The purpose of the monitoring program is to periodically document that the historic properties, traditional cultural properties, and American Indian sacred sites on the NTS retain their integrity and NRHP eligibility. Monitoring the condition of cultural resources is an integral part of the NNSA/NSO historic preservation program. In terms of field efforts, the monitoring of archaeological sites of diverse site types is yielding interesting data that can ultimately be used to develop models for predicting retention of site integrity. The 2008 monitoring project focused on 15 properties eligible to the NRHP. The sites monitored were five temporary camps, three dual component camps (prehistoric and historic), three historic structures, one historic cabin, one prehistoric processing locality, one cave site, and one historic residential base. The monitoring provided the opportunity to update site information, evaluate the condition of site locations and make further recommendations for the protection of the sites. Of the 15 sites monitored, only two sites, both dual component sites, were moderately affected by visitor traffic. The remaining 13 sites were all in a good state of preservation, though sustaining normal weathering.

Two field projects focused on the photo-documentation of structures in Areas 3 and 23. Two other field projects were site visits to three tower locations in Areas 2 and 3 and four nuclear test locations in Areas 18 and 20. Four archival research projects involved conducting research on the history of the test locations Russet, Raritan, Little Feller II, and T-4.

Archival research was conducted for six proposed projects. Four of these projects are a Wackenhut training area to be built in one of multiple proposed locations, a concentrating solar power plant in Area 22, the proposed removal of old electrical panels in multiple NTS areas, and a buried fiber-optic line from the NTS to Indian Springs. There also was archival research for a pending Environmental Impact Statement for one of the locations in the United States that is in consideration for a new low-level waste facility. At the NTS, the location proposed is in Area 5 near the RWMS. The last archival research project involved gathering photographs of Native American structures on the NTS**.**

12.1.3.2 Reports

Six inventory reports (SR), seven letter reports (LR) and one monitoring report (MR) were completed in 2008 and are listed in Table 12-2. Site location information is protected from public distribution; reports containing such data are not available to the public. The data on NTS archaeological activities also were provided to DOE Headquarters in the formal Archeology Questionnaire for transmittal to the Secretary of the Interior and, ultimately, to the U.S. Congress as part of the Secretary of the Interior's Annual Archeology Report to Congress.

Table 12-2. Reports prepared in 2008

Project	Report Author(s)	Report No.	Citation
Proposed Nevada Test Site Firing Range	Robert C. Jones	SR031008-1	Jones, 2008a
Proposed UGTA ER-20-7 Well Pad and Access Road	Robert C. Jones	SR090308-1	Jones, 2008b
Proposed UGTA ER-20-8 Well Pad and Access Road	Robert C. Jones	SR090408-1	Jones, 2008c
Proposed UGTA ER-EC-11 Well Pad and Access Road	Robert C. Jones	SR091708-1	Jones, 2008d
Proposed UGTA Borrow Pit Expansion	Robert C. Jones	SR092908-1	Jones, 2008e
Proposed UGTA ER-EC-11 Well Pad Relocation	Robert C. Jones	SR102108-1	Jones, 2008f
Fiscal Year (FY) 2008 Cultural Resources Monitoring of Cane Spring	Barbara A. Holz	LR030508-2	Holz, 2008a
FY 2008 Cultural Resources Monitoring of Japanese Village	Barbara A. Holz	LR030608-1	Holz, 2008b
FY 2008 Cultural Resources Monitoring of Wahmonie	Barbara A. Holz	LR031808-1	Holz, 2008c
FY 2008 Cultural Resources Monitoring of Rice Grass Village	Barbara A. Holz	LR032508-1	Holz, 2008d
FY 2008 Cultural Resources Monitoring of Bower Cabin	Barbara A. Holz	LR043008-1	Holz, 2008e
Curation Compliance Annual Progress Report	Harold Drollinger	LR090508-1	Drollinger, 2008
Soils Project Pre-Task Cultural Resources Visit	Robert C. Jones and Colleen M. Beck	LR102808-1	Jones and Beck, 2008
FY 2008 Cultural Resources Monitoring Program	Barbara A. Holz	MR030508-1	Holz, 2008f

12.2 Curation

The NHPA requires that archaeological collections and associated records be maintained at professional standards; the specific requirements are delineated in 36 CFR Part 79, *Curation of Federally-Owned and*

Administered Archeological Collections. The NTS Archaeological Collection currently contains over 400,000 artifacts and is curated in accordance with 36 CFR 79. The requirements for curation of the NTS Archaeological Collection include the following:

- Maintain a catalog of the items in the NTS collection
- Package the NTS collection in materials that meet archival standards (e.g., acid-free boxes)
- Store the NTS collection and records in a facility that is secure and has environmental controls
- Establish and follow curation procedures for the NTS collection and facility
- Comply with the Native American Graves Protection and Repatriation Act

In the 1990s, NNSA/NSO completed the required inventory and summary of NTS cultural materials accessioned into the NTS Archaeological Collection and distributed the inventory list and summary to the tribes affiliated with the NTS and adjacent lands. Consultations followed, and all artifacts the tribes requested were repatriated to them. This process was completed in 2002; it will be repeated for new additions to the collection in the future. Known NTS locations of American Indian human remains continued to be protected from NTS activities in 2008.

NNSA/NSO is in the process of obtaining NTS archaeological materials that currently are curated at other artifact repositories in Nevada in order to assemble the entire NTS collection in the NNSA/NSO facility. In the early years of the NTS, various archaeologists worked there and these collections have been stored for decades at facilities that existed at that time. In 2008, 3,876 artifacts that are part of an NTS archaeological collection from the 1960s were transferred to the NNSA/NSO. These artifacts were inventoried with analysis pending.

The ongoing effort to upgrade the storage materials used to house the entire archaeological collection was completed in 2008, and now all the artifacts are stored in current archival-quality materials. Although the work schedule in the curation facility is variable, the state of this collection is monitored weekly to ensure that the materials remain in good condition. The curation facility was audited by the U.S. General Services Administration in 2008, and no corrective actions were recommended. For records curation, 30 years of archaeological survey reports, technical reports, and site records were scanned and linked to a searchable Geographical Information System that has been developed for these data.

12.3 American Indian Program

NNSA/NSO has had an active American Indian Program since the late 1980s. The function of the program is to conduct consultations between NNSA/NSO and NTS-affiliated American Indian tribes. Such consultation occurs through the Consolidated Group of Tribes and Organizations (CGTO). The CGTO is composed of 16 groups of Southern Paiute, Western Shoshone, and Owens Valley Paiute-Shoshone, along with the Las Vegas Indian Center, a Pan-Indian organization. The 16 groups of the CGTO are listed in previous NTS environmental reports (e.g., National Security Technologies, LLC, 2008a). A history of this program is contained in *American Indians and the Nevada Test Site, A Model of Research and Consultation* (Stoffle et al., 2001). The goals of the program are to:

- Provide a forum of the CGTO to express and discuss issues of importance.
- Provide the CGTO with opportunities to actively participate in decisions that involve places and locations that hold significance for them.
- Involve the CGTO in the curation and display of American Indian artifacts.
- Enable the CGTO and its constituency to practice their religious and traditional activities.

In 2008, the American Indian Program Coordinator worked to update the information from the various tribes and to develop future activities for the program. This effort is the groundwork for a CGTO meeting in the near future. There was one activity that resulted in consultation with the tribes, identifying a site of special importance. There were no new proposals for artifact displays and no requests by tribes or tribal members to conduct religious ceremonies.

13.0 Ecological Monitoring

U.S. Department of Energy (DOE) Order DOE O 450.1A, "Environmental Protection Program," requires ecological monitoring and biological compliance support for activities and programs conducted at DOE facilities. The National Security Technologies, LLC (NSTec), Ecological Monitoring and Compliance (EMAC) Program provides this support for the Nevada Test Site (NTS). The major sub-programs and tasks within EMAC include (1) the Desert Tortoise Compliance Program, (2) biological surveys at proposed construction sites, (3) monitoring important species and habitats, (4) the Habitat Restoration Program, (5) wildland fire hazard assessment, and (6) biological impact monitoring at the Nonproliferation Test and Evaluation Complex (NPTEC). Brief descriptions of these sub-programs and their 2008 accomplishments are provided in this chapter. More detailed information may be found in the most recent annual EMAC report (Hansen et al., 2009). EMAC annual reports are available at <http://www.osti.gov/bridge>.

Ecological Monitoring and Compliance Program Goals
Ensure compliance with all state and federal regulations and stakeholder commitments pertaining to NTS flora, fauna, wetlands, and sensitive vegetation and wildlife habitats (see Section 2.9). Delineate NTS ecosystems. Provide ecological information that can be used to evaluate the potential impacts of proposed projects and programs on NTS ecosystems and important plant and animal species.

13.1 Desert Tortoise Compliance Program

The desert tortoise inhabits the southern one-third of the NTS (Figure 13-1). It is listed as threatened under the Endangered Species Act. Activities conducted in desert tortoise habitat on the NTS must comply with the terms and conditions of a Biological Opinion (Opinion) issued to the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) by the U.S. Fish and Wildlife Service (FWS). The Opinion is effectively a permit to conduct activities in desert tortoise habitat in a specific manner. It authorizes the incidental "take" (accidental killing, injury, harassment, etc.) of tortoises that may occur during the activities which, without the Opinion, would be illegal and subject to civil or criminal penalties. The first Opinion was issued to NNSA/NSO in August 1996 (FWS, 1996) and was valid through December 31, 2007. In July 2007, NNSA/NSO received a one-year extension of the Opinion. On July 2, 2008, NNSA/NSO provided FWS with a Biological Assessment of anticipated activities on the NTS for the next ten years and entered into formal consultation with the FWS to obtain a new Opinion. FWS issued a draft Opinion to NNSA/NSO on December 6, 2008, and asked NNSA/NSO to provide comments. NSTec biologists and NNSA/NSO met with FWS personnel and negotiated changes to the draft Opinion. FWS issued the new final Opinion to NNSA/NSO in February 2009.

Both the 1996 and 2009 Opinions state that proposed NTS activities are not likely to jeopardize the continued existence of the Mojave population of the species and that no critical habitat would be destroyed or adversely modified. They establish compliance limits for the numbers of accidentally injured and killed tortoises, captured and displaced tortoises, and the acres of tortoise habitat that can be disturbed. They also establish mitigation requirements for habitat loss. The Desert Tortoise Compliance Program was developed to implement the Opinion's terms and conditions, document compliance actions taken, and assist NNSA/NSO in FWS consultations.

In 2008, biologists conducted surveys for 18 projects that were within the distribution range of the desert tortoise. All of the proposed projects were covered under the 1996 Opinion. No desert tortoises were accidentally injured or killed, nor were any found, captured, or displaced from project sites. No desert tortoises were killed along roads in 2008.

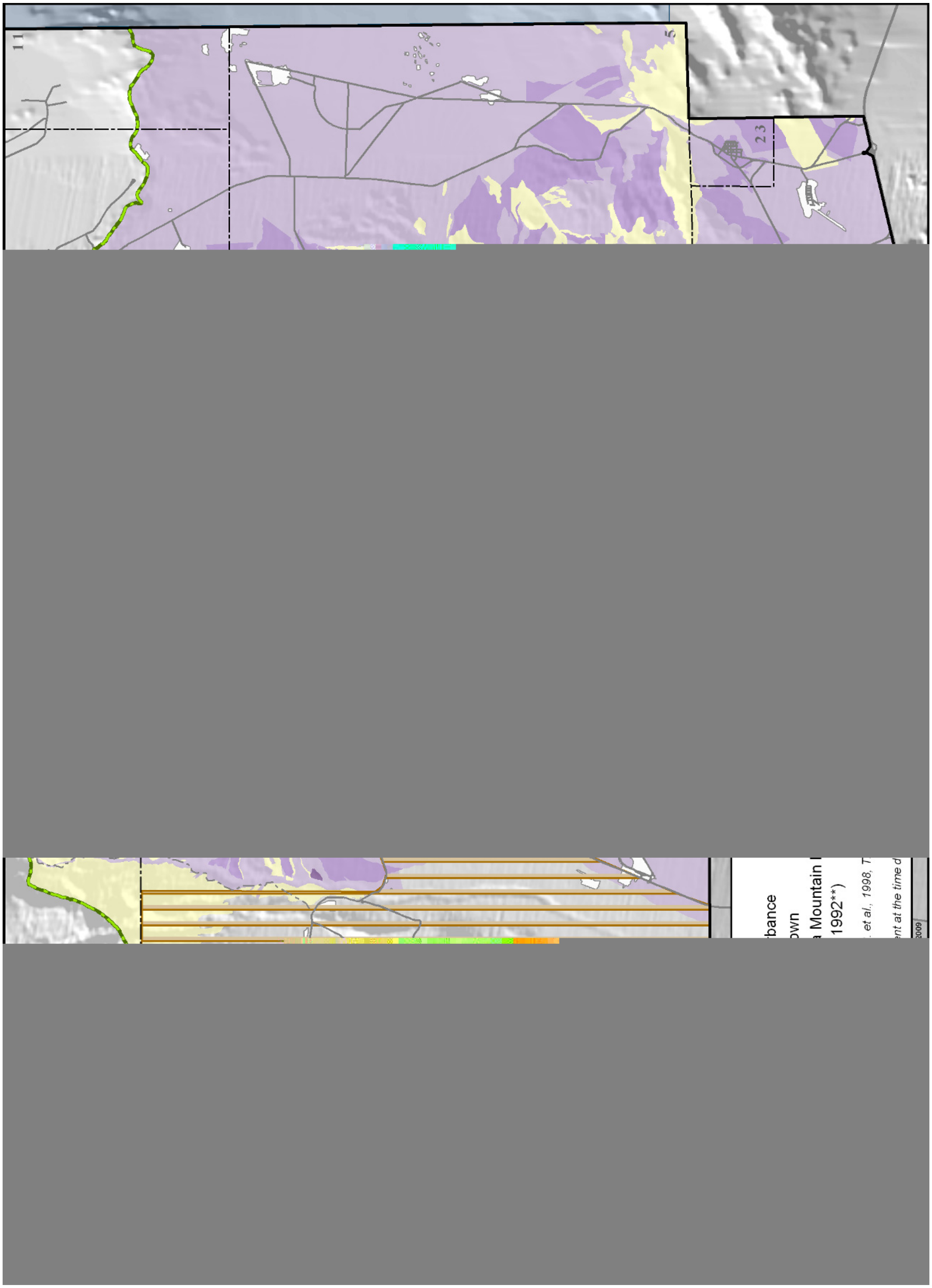

Figure 13-1. Desert tortoise distribution and abundance on the NTS

Table 13-2. Important plants known to occur on or adjacent to the NTS (continued)

SENSITIVE PLANT SPECIES		
Moss Species	**Common Name**	**Status[a]**
Entosthodon planoconvexus	Planoconvex entosthodon	S, 5 years
PROTECTED/REGULATED PLANT SPECIES		
Cactaceae	Cacti (18 species)	CY
Agavaceae	Yucca (3 species), Agave (1 species)	CY
Pinus monophylla/Juniperus osteosperma	Pinyon/Juniper	CY

(a) Status Codes:

State of Nevada

S - Listed on the Nevada Natural Heritage Program (NNHP) Nevada Animal and Plant At-Risk Tracking List, March 2007

CY - Protected as a cactus, yucca, or Christmas tree from unauthorized collection on public lands. Such plants are not protected from harm on private lands or on withdrawn public lands such as the NTS

Long-term Sensitive Plant Monitoring Status under EMAC

5 years - Monitor a minimum of once every 5 years

10 years - Monitor a minimum of once every 10 years

Table 13-3. Important animals known to occur on or adjacent to the NTS

Mollusk Species	**Common Names**	**Status [a]**
Pyrgulopsis turbatrix	Southeast Nevada pyrg	S, A
Reptile Species		
Eumeces gilberti rubricaudatus	Western red-tailed skink	S, E
Gopherus agassizii	Desert tortoise	LT, NPT, S, IA
Bird Species[b]		
Accipiter gentilis	Northern goshawk	NPS, S, IA
Alectoris chukar	Chukar	G, IA
Aquila chrysaetos	Golden eagle	EA, NP, IA
Buteo regalis	Ferruginous hawk	NP, S, IA
Callipepla gambelii	Gambel's quail	G, IA
Coccyzus americanus	Western yellow-billed cuckoo	C, NPS, S, IA
Falco peregrinus anatum	Peregrine falcon	NPE, S, IA
Haliaeetus leucocephalus leucocephalus	Bald eagle	EA, NPE, S, IA
Ixobrychus exillis hesperis	Western least bittern	NP, S, IA
Lanius ludovicianus	Loggerhead shrike	NPS, IA
Oreoscoptes montanus	Sage thrasher	NPS, IA
Phainopepla nitens	Phainopepla	NP, S, IA
Spizella breweri	Brewer's sparrow	NPS
Toxostoma bendirei	Bendire's thrasher	NP, S, IA
Toxostoma lecontei	LeConte's thrasher	NP, S, IA
Mammal Species		
Antilocapra americana	Pronghorn antelope	G, IA
Antrozous pallidus	Pallid bat	NP, M, A
Corynorhinus townsendii pallescens	Townsend's big-eared bat	NPS, S, H, A
Equus asinus	Burro	HB, IA
Equus caballus	Horse	HB, A
Euderma maculatum	Spotted bat	NPT, S, M, A

Table 13-3. Important animals known to occur on or adjacent to the NTS (continued)

Mammal Species (continued)	Common Names	Status [(a)]
Lasionycteris noctivagans	Silver-haired bat	M, A
Lasiurus blossevillii	Western red bat	NPS, S, H, A
Lasiurus cinereus	Hoary bat	M, A
Lynx rufus	Bobcat	F, IA
Microdipodops megacephalus	Dark kangaroo mouse	NP, A
Microdipodops pallidus	Pale kangaroo mouse	NP, S, A
Myotis californicus	California myotis	M, A
Myotis ciliolabrum	Small-footed myotis	M, A
Myotis evotis	Long-eared myotis	M, A
Myotis thysanodes	Fringed myotis	NP, S, H, A
Myotis yumanensis	Yuma myotis	M, A
Ovis canadensis nelsoni	Desert bighorn sheep	G, IA
Odocoileus hemionus	Mule deer	G, A
Pipistrellus hesperus	Western pipistrelle	M, A
Puma concolor	Mountain lion	G, A
Sylvilagus audubonii	Audubon's cottontail	G, IA
Sylvilagus nuttallii	Nuttall's cottontail	G, IA
Tadarida brasiliensis	Brazilian free-tailed bat	NP, A
Urocyon cinereoargenteus	Gray fox	F, IA
Vulpes velox macrotis	Kit fox	F, IA

(a) Status Codes:

U.S. Fish and Wildlife Service, Endangered Species Act

LT - Listed Threatened
PD - Proposed for delisting
PT - Proposed for listing as Threatened
C - Candidate for listing

U.S. Department of Interior

EA - Protected under Bald and Golden Eagle Act
HB - Protected under Wild Free Roaming Horses and Burros Act

State of Nevada

F - Regulated as fur-bearer species
G - Regulated as game species
NPE - Species protected as endangered under Nevada Administrative Code (NAC) 503
NPT - Species protected as threatened under NAC 503
NPS - Species protected as sensitive under NAC 503
NP - Species listed as protected under NAC 503
S - Listed on NNHP's Nevada Animal and Plant At-Risk Tracking List, March 2007

Revised Nevada Bat Conservation Plan (Bradley et al., 2005) – Bat Species Risk Assessment Designations

H - High: species imperiled or at high risk of imperilment and having the highest priority for funding, planning, and conservation actions
M - Moderate: species that warrant closer evaluation, more research, and conservation actions and lacking meaningful information to adequately assess species' status

Long-term Sensitive Animal Monitoring Status under EMAC

A - Active: currently included in long-term population monitoring activities
E - Evaluate: species for which more information on distribution, abundance, and susceptibilities to threats on the NTS must be gathered before deciding to include in long-term monitoring activities
IA - Inactive: not currently included in long-term population monitoring activities

(b) All wild bird species on the NTS are protected by the Migratory Bird Treaty Act except for the following five species: Gambel's quail, chukar, English house sparrow, rock dove, and European starling. Also, the State of Nevada protects all wild birds that are protected by federal laws in addition to the species listed in this table.

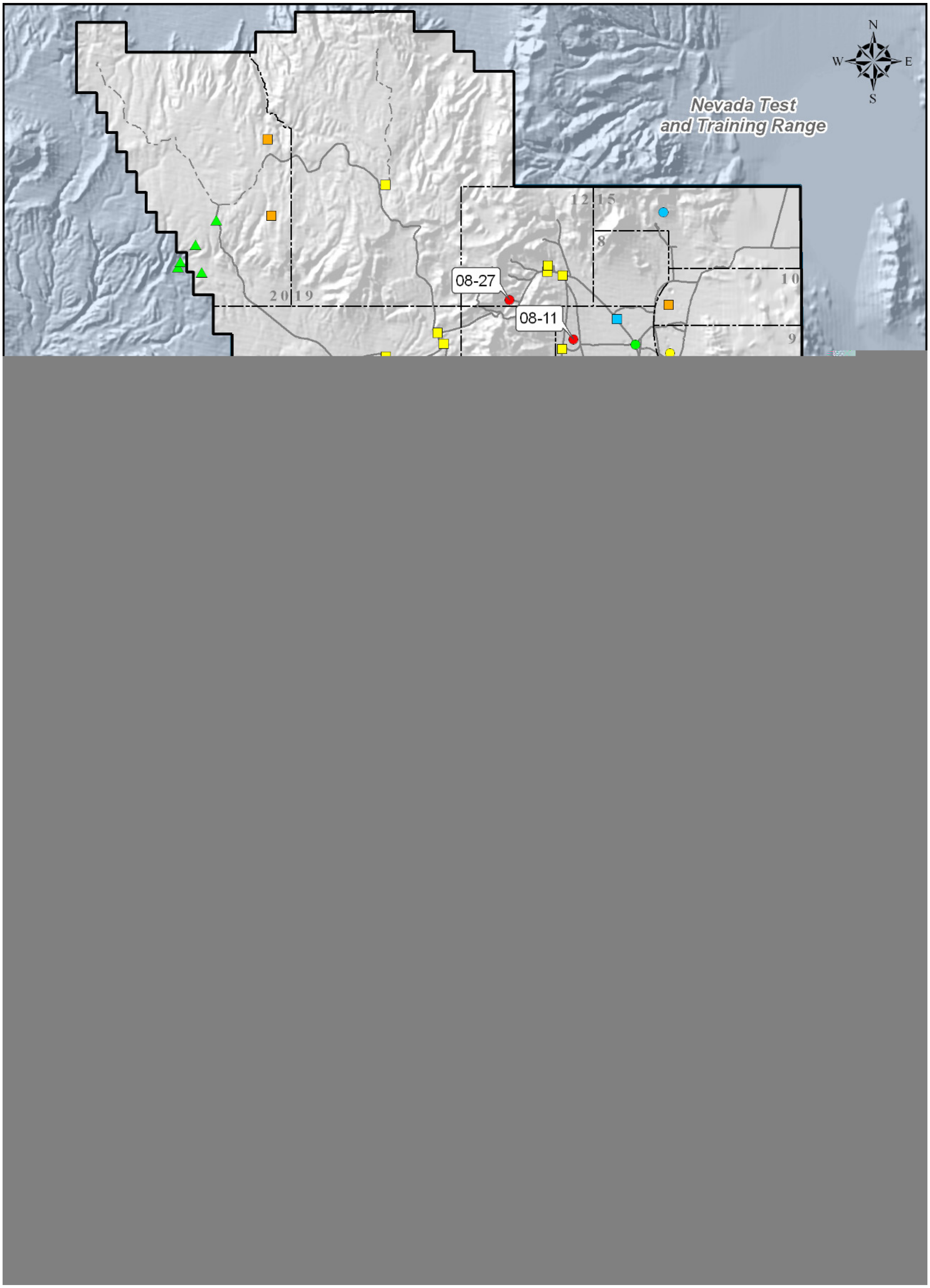

Figure 13-2. Location of biological surveys conducted on the NTS in 2008

13.3 Important Species and Habitat Monitoring

Over the last three decades, NNSA/NSO has taken an active role in collecting or supporting the collection of information on the status of important plants and animals and their habitat on the NTS and has produced numerous documents reporting their occurrence, distribution, and susceptibility to threats on the NTS (see *Ecology of the Nevada Test Site: An Annotated Bibliography* [Wills and Ostler, 2001]). In 1998, NNSA/NSO prepared a Resource Management Plan (U.S. Department of Energy, Nevada Operations Office, 1998). One of the natural resources goals stated in the plan is to protect and conserve sensitive plant and animal species found on the NTS and to minimize cumulative impacts to those species as a result of NNSA/NSO activities. In 2008, the major accomplishments under this EMAC task are presented below. Detailed descriptions of these actions and results can be found in Hansen et al. (2009).

13.3.1 Sensitive Plants

The current list of sensitive plants on the NTS (Table 13-2) represents a significant effort by botanists over the last three decades. The list is reviewed annually and modifications are made as necessary. The only modification made in 2008 was the removal of *Lathyrus hitchockianus*, Bullfrog Hills peavine. Although it is found about 3.2 kilometers (km) (2 miles [mi]) west of the NTS boundary, it has not yet been found on the NTS.

Field surveys were conducted in 2008 for *Eriogonum heermannii* var. *clokeyi* to better define the range of this species on the NTS. They were conducted along the north slope of Red Mountain and the slopes of Mercury Ridge. Both of these hills are located just north of the town site of Mercury in Area 23. Over 5,000 plants were observed, and the known species distribution was increased to 178 ha (439 ac), more than seven times the 26 ha (64 ac) reported previously. Field surveys were conducted for the Gold Meadows population of *Frasera pahutensis* with the same objective. Approximately 1,000 individual *F. pahutensis* plants were observed over 9 ha (21 ac). This is ten times the size of the population originally identified in 1997. A map of all the known sensitive plant populations on the NTS was updated in 2008. It is the culmination of several years of work and replaces a similar map prepared in 1994. It is available on the NNSA/NSO Internet Web site at http://www.nv.doe.gov/library/publications/Environmental/Figures/Fig11-3.pdf.

13.3.2 Important Animals

13.3.2.1 Western Red-tailed Skink

Surveys for the western red-tailed skink *(Eumeces gilberti rubricaudatus)* continued in 2008. Eight western red-tailed skinks, including one hatchling (Figure 13-3), were captured from 4 sites during 6,099 trap days at 31 sites. A total of 267 reptiles representing 10 of the 16 known lizards and 7 of the 17 known snake species on the NTS were captured or observed in 2008. Current NTS distributions of western red-tailed skinks are presented in Hansen et al. (2009). NTS biologists collaborated with Dr. Jonathan Richmond of Cornell University to provide specimens for genetic testing.

Figure 13-3. Hatchling western red-tailed skink captured near Schooner, Area 20 (Photo by D. B. Hall, July 31, 2008)

13.3.2.2 Western Burrowing Owl

Western burrowing owls *(Athene cunicularia hypugaea)* were trapped on the NTS in 2008 as part of a collaborative effort with Dr. Courtney Conway to evaluate the genetic relatedness and migratory status of this species in western North America. Dr. Conway is funded by the Department of Defense Legacy Project. Nine owls (seven adults and two juveniles) were captured and banded (Figure 13-4). No recaptures from previous years were documented. The current total of documented western burrowing owl locations on the NTS is 164 (47 owl sightings [no burrow located] and 117 burrow sites).

13.3.2.3 Raptor Monitoring and Bird Mortality

Raptors are sensitive species and all are protected or regulated under the Migratory Bird Treaty Act or Nevada state law (see Table 13-3). Nine raptor species are known to breed on the NTS. Field surveys for active raptor nests are conducted at least once every five years. They were not conducted in 2008. Opportunistic sightings of raptors were uncommon in 2008 and were recorded in a raptor sighting database.

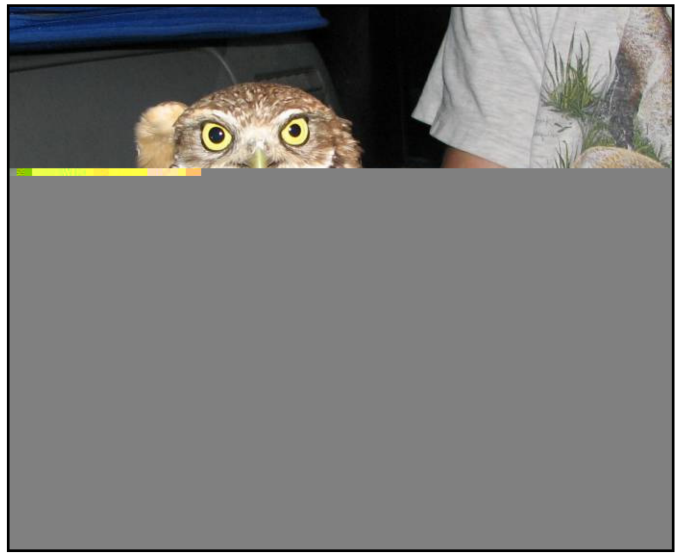

Figure 13-4. Western burrowing owl with identification bands (Photo by W. K. Ostler, June 20, 2007)

Bird mortality is a measure of the impacts of NNSA/NSO activities on protected birds. Ten bird mortalities were recorded in 2008, and six can be attributed to NNSA/NSO activities (Table 13-4). One mitigation action was taken to reduce bird mortality; NSTec biologists removed the barbed wire fence in which a great-horned owl had become entangled and died. The fence surrounded a solar panel array used to power the air sampling station at Schooner crater in Area 20. NNSA/NSO activities have a low impact on protected birds. Since 1990, an average of 13 bird mortalities has been reported each year, which includes deaths caused naturally and those caused by NNSA/NSO activities (Figure 13-5).

Table 13-4. Records of bird mortality on the NTS in 2008

	Cause of Death			
Species	**Electrocution**	**Vehicle**	**Tangled in Barbed Wire**	**Unknown**
Barn owl *(Tyto alba)*				2
Common raven *(Corvus corax)*				1
Great-horned owl *(Bubo virginianus)*			1	
Horned lark *(Eremophila alpestris)*		1		
Prairie falcon *(Falco mexicanus)*		1		1
Red-tailed hawk *(Buteo jamaicensis)*	1	1		
Sabine's gull *(Xema sabini)*		1		
Total	**1**	**4**	**1**	**4**

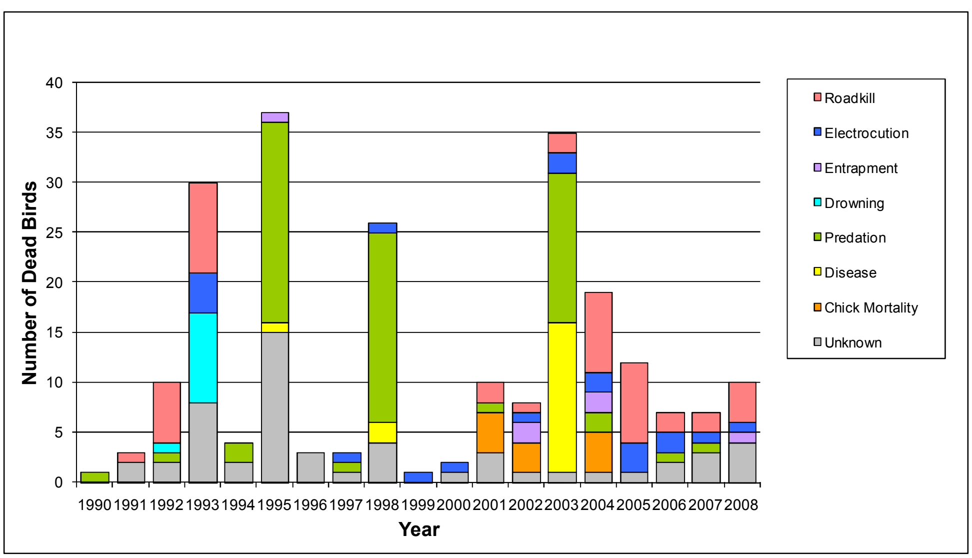

Figure 13-5. Number of bird deaths recorded on the NTS by year and cause

13.3.2.4 State-Protected Small Mammals

In 2005, the dark kangaroo mouse *(Microdipodops megacephalus)* and the pale kangaroo mouse *(M. pallidus)* were added to the list of Nevada Protected species under NAC 503 (see Table 13-2). Small mammal trapping was initiated in 2005 to help assess these species' distribution and abundance on the NTS. Trapping continued in 2008; however, these two species were not captured.

13.3.2.5 Sensitive Bats

In 2008, acoustic (bat vocalization) data and concurrent climate data were collected from Camp 17 Pond, 16A Tunnel was monitored for bat use, and bat roosts in buildings were documented. The acoustic data collected have not yet been analyzed. Monitoring results from 16A Tunnel indicated it was being used by five sensitive bat species (see Table 13-3) as a day roost or night roost/foraging site; therefore, installation of a bat-compatible closure was recommended and installed. Future surveys will assess whether bats continue to use this tunnel. Bats were found in nine NTS buildings. Four were found dead and five were removed and relocated.

13.3.2.6 Wild Horses

An annual horse census is conducted by driving selected NTS roads and using cameras to record individual markings of animals. Total numbers have dropped from 42 in 2007 to 35 in 2008 (Table 13-5). Their estimated range of 213 square kilometers (km^2) in 2008 was very similar in size to the horse range in 2007 (NSTec, 2008). Camp 17 Pond and Gold Meadows Spring continue to be important summer water sources for horses.

Table 13-5. Number of individual horses observed on the NTS by age class, gender, and year

Age Class	Years															
	2001		2002		2003		2004		2005		2006		2007		2008	
Foals	11		5		6		5		5		8		8		9	
Yearlings	2		0		9 (a)		9		6		8		1		0	
	Gender (b)															
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
2-Year Olds	2	2	0	2	0	0	4	4	5	4	3	3	2	3	0	0
3-Year Olds	0	0	2	2	0	2	0	0	4	4	4	4	1	3	1	1
(>3-Year Olds)	11	20	8	19	8	20	6	21	5	21	7	24	5	27	6	27
Total (c)	**37**		**33**		**38**		**44**		**49**		**53**		**42**		**35**	

(a) 1 of the 9 was found dead (b) M=Male, F=Female (c) Excludes foals and dead horses

13.3.2.7 Mule Deer

Mule deer *(Odocoileus hemionus)* abundance has been measured on the NTS during most years since 1989 by counting the number of deer sighted at night while driving along a prescribed census route. Deer counts have fluctuated from a low of 9.0 deer/night in 1999 to a high of 62.1 deer/night in 2006. The average number of deer counted in 2008 was 45.5 deer/night. In 2008, deer density was calculated along different sections of the route and along the total route using Program Capture, Version 5.0 (Thomas et al., 2006). Deer density on the Rainier Mesa route segment was 4.0 deer/km

awto a hito a a324.-3.6(-3. crs210.9(rou)1232)1851.0.9-032 mammals). Noteworthy images included a video clip of a mature male mountain lion at Topopah Spring in Area 29 and a photograph of three mountain lions on Rainier Mesa, possibly an adult female with two yearlings (Figure 13-6). The adult female may be the same lactating female captured on film in October 2007 (NSTec, 2008a). A photograph was also taken of a mountain lion within 1.5 km of buildings at CP6, evidence that they occur near active facilities. Further information about distribution, abundance, and temporal activity can be found in Hansen et al. (2009).

Figure 13-6. Possible adult female (far right) with two yearlings, Dick Adams Cutoff Road, Area 12 (Photo by motion-activated camera, August 28, 2008)

13.3.2.9 Natural and Man-Made Water Sources

Natural wetlands on the NTS are monitored and protected when feasible as unique and important habitats for plants and wildlife per the intent of Executive Order (EO) 11990, "Protection of Wetlands." Characterization of these mesic habitats and periodic monitoring of their hydrologic and biotic parameters was started in 1997 to help identify natural fluctuations and ranges in measured parameters. Twelve wetlands were monitored in 2008 to document water surface area, surface flow, observed disturbances, and wildlife use and mortality. The surface areas (in square meters [m^2]) and flow rates (in liters per minute [L/min]) were moderately low at the natural springs in 2008 (0.1–600 m^2 and 0.020–1.5 L/min where flow was measurable, respectively) (Hansen et al., 2009). No wetlands were damaged by NTS activities. A sensitive species of springsnail *(Pyrgulopsis turbatrix)* was present in 2008 at Cane Spring, its only natural habitat on the NTS. Since the Pleistocene, this population has been isolated from others that occur in the Spring Mountains 80 km (50 mi) to the south.

Man-made water sources were monitored in 2008 for wildlife use and mortality. They included 34 plastic-lined sumps and 2 radioactive containment ponds. No dead animals were observed in the sumps or ponds. Sediment ramps, previously constructed in the plastic-lined sumps, are either working to prevent entrapment of deer and other animals, or else animals did not enter any of these sumps in 2008.

13.3.3 West Nile Virus Surveillance

West Nile virus (WNV) surveillance on the NTS continued in 2008 for the fifth consecutive year in cooperation with Southern Nevada Health District (SNHD) personnel. Ten sites were sampled during 12 surveys. NSTec personnel took captured mosquitoes to SNHD personnel for species identification and WNV testing. A total of 89 individuals representing three species were captured and analyzed. All specimens tested for WNV were negative. No new species of mosquitoes were detected in 2008.

13.4 Habitat Restoration Monitoring Program

Native habitat disturbed by NNSA/NSO activities or by wildfires is sometimes revegetated by seeding and/or planting native plant species. NNSA/NSO evaluates revegetation as a potential method to stabilize soils based on site size, future use, nature of soils, annual precipitation, slope, aspect, and site location. Revegetation supports the intent of EO 13112, "Invasive Species" to prevent the introduction and spread of non-native species and restore native species to disturbed sites. The majority of NNSA/NSO projects for which revegetation has been pursued are wildland fire sites and abandoned industrial or nuclear test support sites characterized and remediated under the Environmental Restoration (ER) Project. The ER Program has also revegetated soil closure covers (or cover caps) to protect against soil erosion and water percolation into buried waste.

In 2008, the Habitat Restoration Monitoring Program surveyed eight sites revegetated in 1999 or 2000. Four of the sites are staging areas for cleanup activities at Corrective Action Units (CAUs) on the Tonopah Test Range (TTR): CAU 400 (Five Points Landfill and the Bomblet Pit), CAU 404 (Rollercoaster Sewage Lagoon), and CAU 426 (Cactus Spring Waste Trenches). The other four sites are cover caps, three at TTR (CAU 404, CAU 426, and CAU 407 [Rollercoaster Radsafe]) and one on the NTS (CAU 110 [U-3ax/bl Subsidence Crater]).

Plant cover, averaged over the four TTR staging areas, was 10 percent higher in 2008 than in 2007, due mainly to the increased abundance of annual plants that were not seeded. The density of forbs fluctuates over the years, and in 2008, some of the highest forb densities recorded to date were observed. The majority of the forbs were seeded species. The density of the seeded perennial plants has not changed significantly year to year since 2004. At the three TTR sites cover caps, total plant cover and perennial plant density were similar to those of the previous few years. The density of forbs was the highest observed to date. At the cover cap for U-3ax/bl, total plant cover was the highest it has ever been observed. Perennial plant cover, all from shrubs, was higher than in 2007, and annual plant cover was more than four times higher than in previous years.

Overall, both plant cover and density were higher in 2008 than in previous years, primarily due to the increase in annual forbs. There were no significant declines in the cover or density of those perennial shrubs and forbs that were seeded at any of the eight sites monitored in 2008.

13.5 Wildland Fire Hazard Assessment

DOE O 450.1A requires protection of site resources from wildland and operational fires. An annual vegetation survey to determine wildland fire hazards is conducted on the NTS each spring. Survey findings are submitted to the NTS Fire Marshal and summarized in the annual EMAC report (Hansen et al., 2009). In April and May, NSTec biologists visited 211 NTS roadside sampling stations to assess a fuel index that can range from 0 to 10 (lowest to highest risk of wildfires) based on the presence of fine fuels and woody fuels. Fine fuels refer to fine-textured fuels, typically invasive non-native and native grasses and forbs. Woody fuels refer mainly to shrubs. Mean precipitation in 2008 was about 50 percent of average at the NTS rain gauges operated by the Air Resources Laboratory, Special Operations and Research Division. The mean combined fuels index for all 211 sampling stations was 4.81, compared to 4.77, 5.26, 5.64, and 4.88 in 2007, 2006, 2005, and 2004, respectively. Most of the biomass in 2008 was biomass persisting from 2007 and 2006. The roadside areas that had the highest risk of wildland fires were in Areas 29 and 30. In 2008, there were 20 wildland fires, but less than 1 ha (2.5 ac) was burned. Most fires were confined to a single tree or shrub.

13.6 Biological Monitoring of the NPTEC Complex

Biological monitoring at the NPTEC in Area 5 is performed whenever there is a risk of significant exposure to downwind plants and animals from planned test releases of hazardous materials. The Desert National Wildlife Refuge (DNWR) lies just east of the NTS border, approximately 5 km (3 mi) from the NPTEC. The National Wildlife Refuge System Administration Act forbids the disturbance or injury of native vegetation and wildlife on any National Wildlife Refuge System lands unless permitted by the Secretary of the Interior. The DNWR is administered within this System. Biological monitoring is conducted to verify that approved tests do not disperse toxic chemicals that harm biota on DNWR. This is also a requirement of NPTEC's Programmatic Environmental Assessment (U.S. Department of Energy, Nevada Operations Office, 2002). Monitoring involves sampling established transects both downwind and upwind of the NPTEC and recording (1) the number and type of dead animals observed, (2) the number and type of wildlife observed, and (3) the presence of observed vegetation damage.

In 2008, chemical release test plans for two activities on Frenchman Lake playa, Tarantula III and Black Widow 151, were reviewed. Chemicals were released at such low volumes or low toxicity that there was no need to monitor downwind transects for biological impacts. Baseline monitoring was not conducted at established control-treatment transects near the NPTEC in 2008 due to budget and personnel constraints.

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14.0 Underground Test Area Sub-Project

From 1951 to 1992, more than 800 underground nuclear tests were conducted at the Nevada Test Site (NTS) (U.S. Department of Energy, Nevada Operations Office, 2000). Most were conducted hundreds of feet above groundwater; however, over 200 were within or near the water table. The Underground Test Area (UGTA) Sub-Project, the largest component of the Environmental Restoration Project, investigates areas where local or regional groundwater contamination has occurred. These areas have been organized into five UGTA Corrective Action Units (CAUs) which are directly related to the geographical and hydrologic areas of past NTS underground testing (Figure 14-1). UGTA CAUs are included in the Federal Facility Agreement and Consent Order (FFACO) (as amended February 2008) between the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) and the Nevada Division of Environmental Protection (NDEP). Completing the schedule of FFACO corrective actions for UGTA CAUs is among the highest mission priorities of NNSA/NSO.

The UGTA Sub-Project gathers information regarding the hydrology and geology of each CAU and gathers data to define groundwater flow rates and direction to determine the nature and location of aquifers. Hydrogeologic studies use existing data from past testing and data obtained from drilling and testing newly constructed deep wells and from recompleting or rehabilitating existing wells. Figure 14-2 shows the new and historic wells that are managed under the UGTA Sub-Project. UGTA wells that are not designated as source term characterization wells are made available for routine radiological monitoring (see Section 4.1.2).

Data from studies are used to produce hydrogeologic models that will be used to predict groundwater flow and contaminant transport. Numerous surface and subsurface investigations and computer modeling are performed by various participating organizations including National Security Technologies, LLC (NSTec); Los Alamos National Laboratory (LANL); Lawrence Livermore National Laboratory (LLNL); the U.S. Geological Survey (USGS); the Desert Research Institute (DRI); and Stoller-Navarro Joint Venture (SNJV).

Surface investigations include:

- Evaluating discharges from springs located downgradient of the NTS
- Assessing surface geology

Subsurface investigations include:

- Drilling deep wells to access groundwater hundreds to thousands of feet below the surface
- Sampling groundwater to test for radioactive contaminants
- Assessing NTS hydrology and subsurface geology to determine possible groundwater flow paths and direction

Hydrogeologic modeling includes:

- Developing a regional three-dimensional computer groundwater model (International Technology Corporation [IT], 1996) to identify any immediate risk and to provide a basis for developing more detailed CAU-specific models
- Developing CAU-specific models of groundwater flow and contaminant transport that geographically cover the six former NTS underground nuclear testing areas
- Developing smaller scale (“sub-CAU scale”) models to investigate specific geographic areas and for sensitivity analysis to identify key uncertainties and data needs
- Identifying, through the CAU-specific models, contaminant boundaries based on the extent of contaminant migration at specified regulatory limits

The final product for each UGTA CAU will be an analytical model that includes a predicted contaminant boundary and a negotiated compliance boundary. A monitoring well network will be designed and installed for each CAU and used for monitoring to ensure public health and safety (NNSA/NSO, 2006). Closure-in-place with monitoring is considered to be the only feasible corrective action because cost-effective groundwater technologies have not been developed to effectively remove or stabilize deep subsurface radiological contaminants.

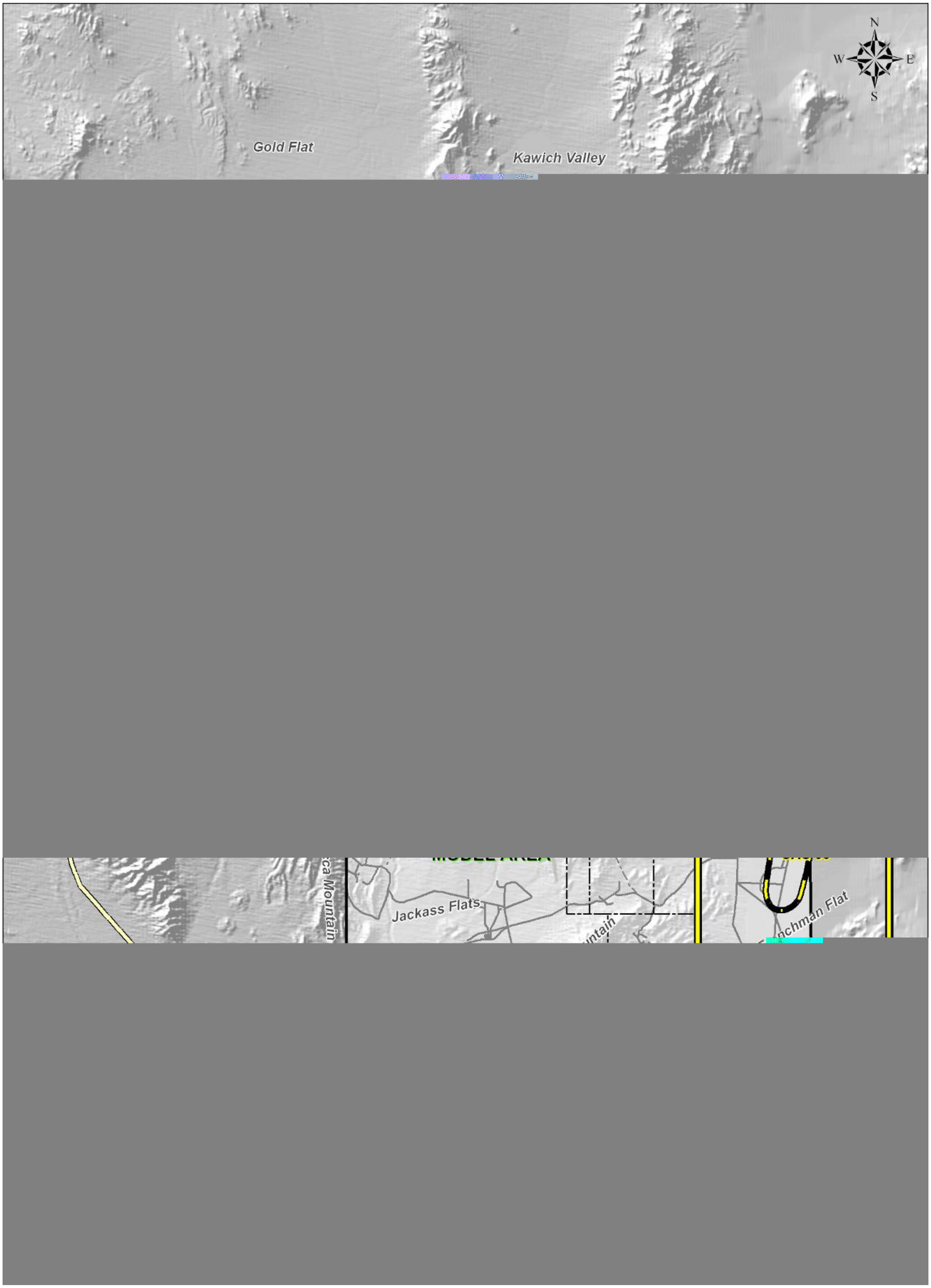

Figure 14-1. Location of UGTA Sub-Project CAUs and model areas

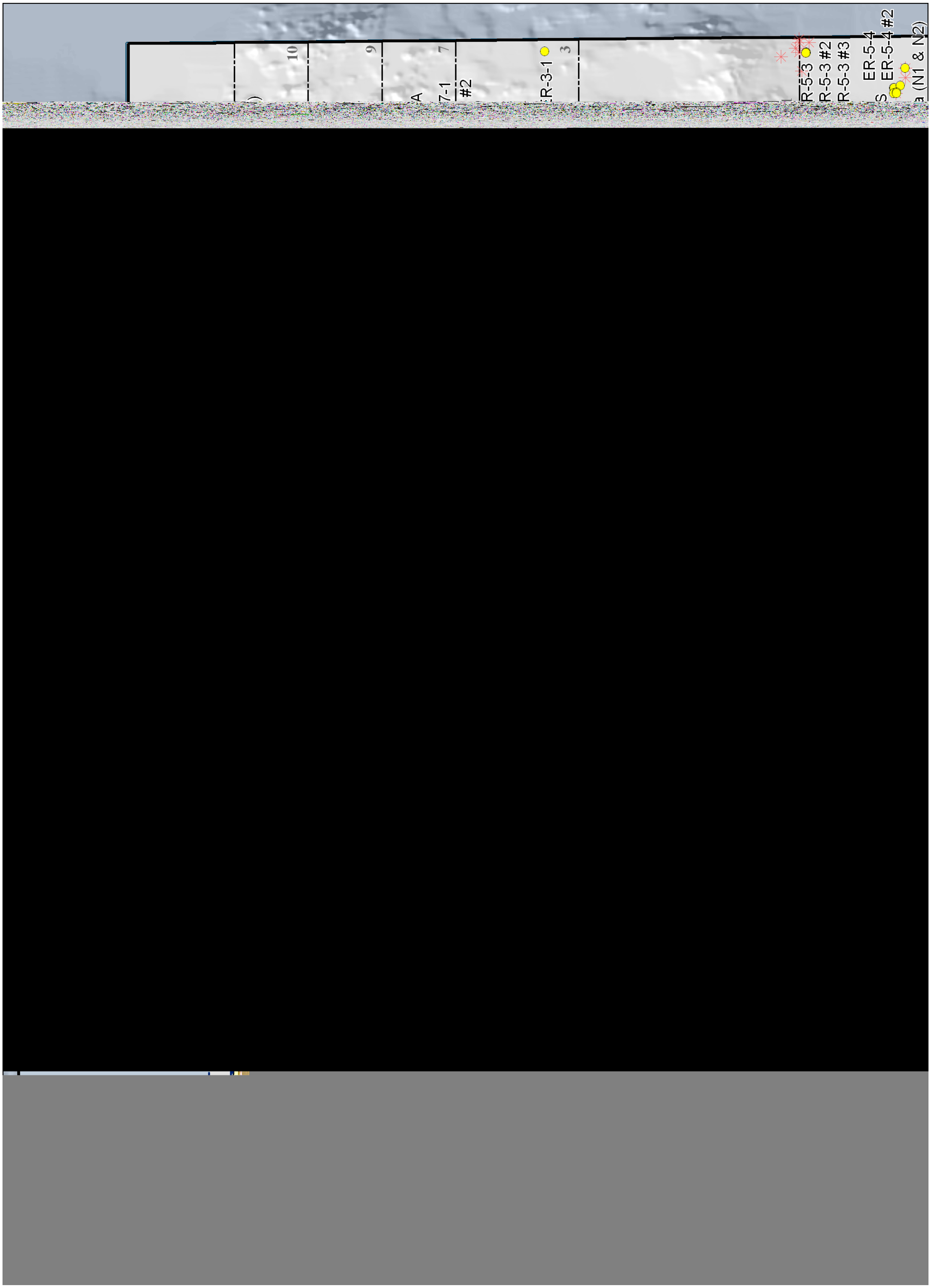

Figure 14-2. Existing and proposed UGTA Sub-Project drill holes

14.1 2008 Subsurface Investigations

The UGTA Sub-Project pumped and collected groundwater samples from six wells in 2008 (Figure 14-2). Three of the wells are associated with underground nuclear tests and are classified as contaminated, two are characterization wells located on Rainier Mesa, and one is associated with the N-Tunnel complex at Rainier Mesa:

Contaminated Wells	Characterization Wells	N-Tunnel
UE-2ce	ER-12-3	U-12n.10 Vent Hole
U-4u PS#2A	ER-12-4	
U-19ad PS#1A		

All of these wells, except for the U-12n.10 Vent Hole, were purged using downhole electric submersible pumps prior to the collection of samples. The U-12n.10 Vent Hole was sampled using a bailer on a wireline. A multi-agency team consisting of personnel from LANL and LLNL collected the groundwater samples and analyzed them for tritium and other radionuclides. The groundwater from these wells, except the U-12n.10 Vent Hole, was discharged into nearby lined sumps in accordance with the Decision Criteria Limits specified in the UGTA Fluid Management Plan (Attachment I of U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office, 2002). The limited amount of water recovered from bailing operations at the U-12n.10 Vent Hole was containerized on location. The tritium concentrations were below detection limits in the characterization wells and ranged from 260,000 to 21,000,000 picocuries per liter among the other five wells. Tritium concentrations are presented in Section 4.1.10 (see Table 4-8). Groundwater data are maintained by SNJV in the UGTA Sub-Project geochemical database (SNJV, 2008a).

In anticipation of drilling new characterization wells in 2009 (see Section 14.2.1 below), land and ecological surveys of proposed access roads and drill sites for the first three wells (ER-20-7, ER-EC-11, and ER-20-8) were completed. Work on the access road and drill-pad for the first well, ER-20-7, was started.

NSTec personnel who support UGTA well drilling operations renewed their State of Nevada well drilling operations licenses in 2008.

14.2 2008 Hydrogeologic Modeling and Supporting Studies

Construction of CAU-specific groundwater-flow and contaminant-transport models requires a hydrostratigraphic framework that depicts the character and extent of hydrostratigraphic units in three dimensions. Four hydrostratigraphic framework models, also referred to as geologic models, have been built (see the color-coded model areas in Figure 14-1). The four model areas encompass the five UGTA CAUs:

- Pahute Mesa-Oasis Valley, CAUs 101 and 102 (Bechtel Nevada [BN], 2002)
- Rainier Mesa-Shoshone Mountain, CAU 99 (NSTec, 2007b)
- Frenchman Flat, CAU 98 (BN, 2005b)
- Yucca Flat-Climax Mine, CAU 97 (BN, 2006)

In 2008, work was conducted for all four model areas.

14.2.1 Pahute Mesa-Oasis Valley Model Area

The final draft of the Phase I flow and transport model for the Central and Western Pahute Mesa CAUs (CAUs 101 and 102) was completed near the end of 2008 and is documented in SNJV (2009a). A formal review and assessment of the Phase I model was conducted in 2008 by the Technical Working Group Pahute Mesa Phase II Corrective Action Investigation Plan (CAIP) ad hoc Subcommittee, which included the NNSA/NSO UGTA Sub-Project director, subject matter experts consisting of UGTA Sub-Project participants (NSTec, DRI, LLNL, LANL, SNJV, USGS), a representative from NDEP, and two representatives of the Community Advisory

Board. Based on the review, additional work activities (Phase II) were proposed in the Central and Western Pahute Mesa CAIP.

Both the Phase I Central and Western Pahute Mesa Transport Model and the CAIP support the statements released in the 1997 regional groundwater flow and tritium transport report (U.S. Department of Energy, Nevada Operations Office, 1997) stating that radioactively contaminated groundwater is predicted to travel off the northwestern boundary of the NTS. The flow and transport model predicts the migration of tritium and carbon-14 off the NTS within 50 years of the first nuclear detonation (1966) in the Pahute Mesa-Oasis Valley Model Area. The model predicts that contamination above the Safe Drinking Water Act standard for tritium of 20,000 pCi/L should be present off the NTS (Figure 14-3). However, well sampling results have not detected the presence of man-made radionuclides downgradient of Pahute Mesa in any of the seven UGTA wells on the Nevada Test and Training Range (ER-EC-1, -2A, -4, -5, -6, -7, -8; see Figure 14-3).

The Subcommittee reviewed the state of knowledge supporting the Phase I flow and transport model, identified data needs, identified further analysis work to support Phase II modeling, and prioritized proposed drilling locations for new wells (SNJV, 2009b). The CAIP will outline a new well drilling campaign which will involve drilling nine wells during the next three years to gather further data regarding the establishment of a long-term monitoring system. The UGTA Sub-Project has selected 12 proposed locations for these new Phase II wells (Figure 14-2). This well drilling campaign began in May 2009. Continued well drilling and data collection will improve and refine the transport model for this area. Scientific objectives, predicted geology and hydrology, expected drilling conditions, and well construction and completion designs for the proposed Phase II wells are summarized in a well drilling and completion document to be published in 2009 by SNJV.

Upon completion of the final draft Phase I Central and Western Pahute Mesa Transport Model at the end of 2008, NNSA/NSO began preparing a public presentation of the model predictions and the current state of knowledge of contaminant migration off the NTS based on offsite well monitoring. This presentation was completed in February 2009 when the transport model was published (SNJV, 2009a) and was given at an open house on February 18, 2009, at the Beatty Community Center in Beatty, Nevada. Links to the regional transport model, to the Phase I Central and Western Pahute Mesa Transport Model, and to the posters presented at the open house can be found at the NNSA/NSO web page http://www.nv.doe.gov/emprograms/environment/restoration/ugta.htm. Figure 14-3 is adapted from one of the posters presented at the open house.

14.2.2 Rainier Mesa-Shoshone Mountain Model Area

The compilation, analysis, and documentation of all hydrologic and transport parameters that will be used to build the flow model for the Rainier Mesa-Shoshone Mountain CAU were completed (SNJV, 2008b; 2008c) and a modeling strategy for this CAU was developed (SNJV, 2008d). Sub-CAU-scale models were constructed for the N-Tunnel area by LANL, and for the T-Tunnel area by DRI.

14.2.3 Frenchman Flat Model Area

The Phase II flow model (SNJV, 2006) and transport model (publication in preparation) for the Frenchman Flat CAU have been completed and are being used by the SNJV and LANL modeling team for transport analysis. The transport analysis work is scheduled to be completed and published in late 2009 by SNJV. The total assemblage of models and documentation packages will be submitted for formal external peer review in 2010. Work on the development of objectives and criteria for the long-term monitoring well network for the Frenchman Flat CAU began in late 2008.

14.2.4 Yucca Flat-Climax Mine Model Area

UGTA Sub-Project participants continued in 2008 toward developing flow and transport models for the Yucca Flat-Climax Mine CAU. LLNL participants continued to work on a source-term model. Studies are being conducted regarding radionuclide transport through NTS volcanic rocks, including the distribution of reactive minerals and their radionuclide sorption properties (Carle et al., 2008).

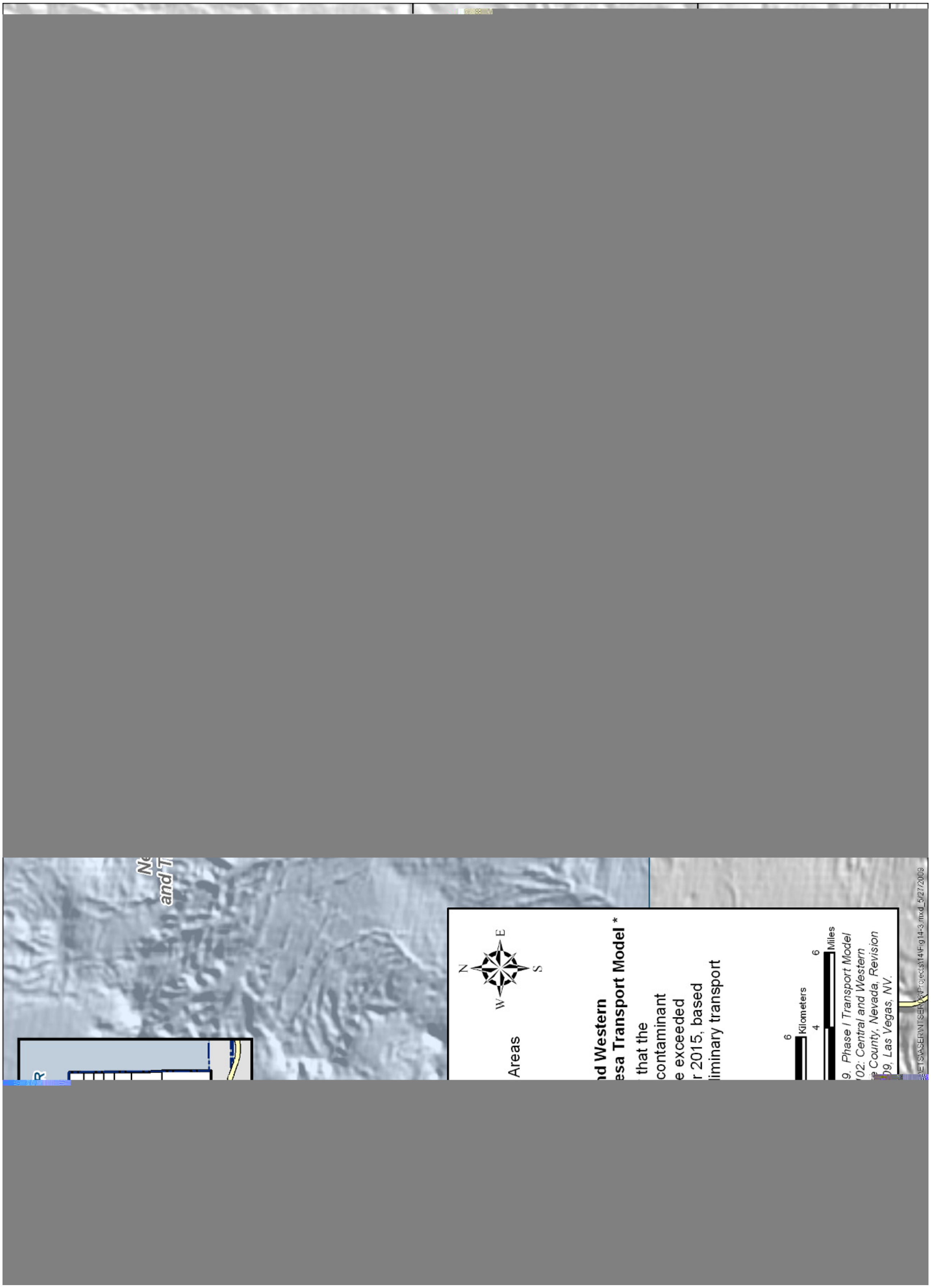

Figure 14-3. Results of Phase I Central and Western Pahute Mesa transport model

14.2.5 Other UGTA Sub-Project Modeling and Studies

UGTA studies not related to a particular CAU were also conducted. In 2008, three focused hydrogeologic investigations were completed:

- Documentation of the hydrostratigraphic system for modeling groundwater at the NTS
- Identification and characterization of NTS hydrogeologic units using geophysical logs
- Hydrogeologic characterization of NTS faults

The resultant draft reports will be finalized and published by NSTec in 2009. All UGTA Sub-Project reports and publications that were completed in 2008 and were subsequently released by June 2009 are listed in Table 14-1. The list includes collaborative work with other programs and organizations. Some of the published technical reports can be obtained from DOE's Office of Scientific and Technical Information (OSTI) at <http://www.osti.gov/bridge>, and the OSTI identification number (ID) for those reports is provided. The hydrogeologic modeling deliverables that were submitted in 2008 to NDEP as FFACO deliverables are presented in Chapter 9, Table 9-4).

Compiling, evaluating, and updating the various databases is an ongoing effort. The water chemistry and fracture databases were expanded and updated in 2008. Efforts to compile petrographic, mineralogical, and chemical data from outcrops, tunnels, and drill cuttings samples continued and will be included in updates of *A Petrographical, Geochemical, and Geophysical Database and Framework for the Southwestern Nevada Volcanic Field* (Warren et al., 2003).

Table 14-1. UGTA Sub-Project publications completed in 2008 and released prior to June 2009

Report	Reference
Spatial Variability of Reactive Mineral and Radionuclide K_d Distributions in the Tuff Confining Unit: Yucca Flat, Nevada Test Site (OSTI ID 926431)	Carle et al., 2008
Hydrologic Resources Management Program and Underground Test Area Project FY 2006 Progress Report (OSTI ID 945573)	Culham et al., 2008
Letter Report: Yucca Fracture Mapping	Dickerson and Hand, 2008
Predevelopment Water-Level Contours for Aquifers in the Rainier Mesa and Shoshone Mountain Area of the Nevada Test Site, Nye County, Nevada (OSTI ID 932993)	Fenelon et al., 2008
Geochemical and Isotopic Evaluation of Groundwater Movement in Corrective Action Unit 99: Rainier Mesa and Shoshone Mountain, Nevada Test Site.	Hershey et al., 2008
Actinide Sorption in Rainier Mesa Tunnel Waters from the Nevada Test Site (OSTI ID 926020)	Pihong et al., 2008
Analysis of Fractures in Cores from the Tuff Confining Unit Beneath Yucca Flat, Nevada Test Site (OSTI ID 92885)	Prothro, 2008
Geochem08.mdb and User Guide to the Comprehensive Water Quality Database for Groundwater in the Vicinity of the Nevada Test Site	SNJV, 2008a
Phase I Hydrologic Data for the Groundwater Flow and Contaminant Transport Model of Corrective Action Unit 99: Rainier Mesa/Shoshone Mountain, Nevada Test Site, Nye County, Nevada (OSTI ID 932406)	SNJV, 2008b
Phase I Contaminant Transport Parameters for the Groundwater Flow and Contaminant Transport Model of Corrective Action Unit 99: Rainier Mesa/Shoshone Mountain, Nevada Test Site, Nye County, Nevada (OSTI ID 932410)	SNJV, 2008c
Modeling Approach/Strategy for Corrective Action Unit 99: Rainier Mesa and Shoshone Mountain, Nevada Test Site, Nye County, Nevada (OSTI ID 943562)	SNJV, 2008d
Phase I Transport Model of CAUs 101 and 102: Central and Western Pahute Mesa, Nevada Test Site, Nye County, Nevada (OSTI ID 948559)	SNJV, 2009a

Table 14-1. UGTA Sub-Project publications completed in 2008 and released prior to June 2009 (continued)

Report	Reference
Phase II Corrective Action Investigation Plan for Corrective Action Units 101 and 102: Central and Western Pahute Mesa, Nevada Test Site, Nye County, Nevada	SNJV, 2009b
Documentation Report for Rainier Mesa Test Information Compiled for the UGTA Project	Townsend, 2008
Completion Report for the Well ER-6-2 Site, Corrective Action Unit 97: Yucca Flat-Climax Mine (OSTI ID 928812)	NNSA/NSO, 2008a
Analysis of the Variability of Classified and Unclassified Radiological Source Term Inventories in the Frenchman Flat Area, Nevada Test Site (OSTI ID 945617)	Zhao and Zavarin, 2008a
Analysis of the Variability of Classified and Unclassified Radiological Source Term Inventories in the Rainier Mesa/Shoshone Mountain Area, Nevada Test Site (OSTI ID 945619)	Zhao and Zavarin, 2008b
On the Appropriate "Equivalent Aperture" for the Description of Solute Transport in Single Fractures: Laboratory-scale Experiments	Zheng et al., 2008

15.0 Groundwater Protection Programs, Projects, and Activities

This chapter presents other U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) programs and 2008 activities related to the protection of groundwater which have not been discussed in previous chapters of this report (Chapter 4, Chapter 6 [Section 6.2], Chapter 9 [Sections 9.1.6 and 9.1.7], and Chapter 14).

It is the policy of NNSA/NSO to prevent pollutants, both from past and current Nevada Test Site (NTS) activities, from impacting the local groundwater. The groundwater protection goals of NNSA/NSO are to (1) prevent future groundwater contamination, (2) control existing contamination, and (3) protect groundwater quality and availability for current and future NTS missions. NNSA/NSO acknowledges that the greatest potential for environmental impact at the NTS is the resumption of underground testing of nuclear devices and their components. If such testing were resumed in the future, the groundwater protection policy of the NNSA/NSO would be to minimize, rather than eliminate, the impacts of testing.

In 2008, the NNSA/NSO Hydrology Program Manager directed the revision of the *Groundwater Protection Program Plan for the National Nuclear Security Administration Nevada Site Office* (NNSA/NSO, 2008b). With the aid of this internal plan, the Hydrology Program Manager communicates and helps facilitate furtherance of the NNSA/NSO groundwater protection policy and goals and helps integrate site-wide groundwater-related activities across the multiple NNSA/NSO programs.

15.1 Hydrologic Resources Management Program

The Hydrologic Resources Management Program (HRMP) is a groundwater program that is currently unfunded. Up until 2007, its function has been to provide NNSA/NSO with hydrologic data and information on groundwater supplies to support ongoing and future activities at the NTS. It has provided a sound technical basis for NTS groundwater use decisions and assessments of the potential impacts of large-scale water withdrawals from or near NTS groundwater basins. The HRMP has provided long-term support to NNSA/NSO through studies of the occurrence, distribution, and movement of radionuclides in groundwater at the NTS and in characterizing groundwater recharge of the region. When funded, participants in the HRMP include Los Alamos National Laboratory, Lawrence Livermore National Laboratory, the U.S. Geological Survey (USGS), and the Desert Research Institute. The HRMP may be reinstated at a future time, should adequate funding again become available.

15.2 Water Level, Temperature, and Usage Monitoring by the USGS

The USGS Nevada Water Science Center collects, compiles, stores, and reports hydrologic data used in determining the local and regional hydrogeologic conditions in and around the NTS. Hydrologic data are collected quarterly or semi-annually from wells within two monitoring networks: an onsite and an offsite network (wells located on and off of the NTS).

By the end of 2008, the USGS monitored water levels in 187 wells. This included 92 wells on the NTS and 95 wells off the NTS. Also during 2008, annual temperature data were collected from wells at 1.5 and 16.8 meters (5 and 55 feet) below the water surface. All water-level and temperature data are posted on the USGS/ Department of Energy (DOE) Cooperative Studies in Nevada Web page at <http://nevada.usgs.gov/doe%5Fnv/>. The water-level data are also published in the *USGS Nevada Water Science Center Annual Water-Resources Data Report* available at <http://nevada.usgs.gov/>.

Groundwater use from water-supply wells on the NTS is collected using flow meters that are read monthly by the NTS Management and Operating subcontractor and then reported to the USGS Nevada Water Science Center. The principal water supply wells monitored during 2008 included J-12 WW, UE-16d WW, WW #4, WW #4A, WW 5B, WW 5C, WW 8, and WW C-1. The USGS compiles the annual water-use data and reports annual withdrawals in millions of gallons. Discharge data from these wells for 2008 have been compiled, processed, and entered onto the USGS/DOE Cooperative Studies in Nevada Web site at <http://nevada.usgs.gov/doe_nv/wateruse/wu_map.htm>. Discharge from these wells during 2008 was approximately 170.5 million gallons (Figure 15-1).

Water-use data are also published in the USGS Nevada Water Science Center Annual Water-Resources Data Report on a water-year calendar (October–September). The Water-Year 2008 report is available at <http://nevada.usgs.gov/> and will include monthly water-use data for each well listed from October 2007 through September 2008.

The USGS also continued to maintain and develop the Death Valley Regional Groundwater Flow System Model and manage the NTS well hydrologic and geologic information database.

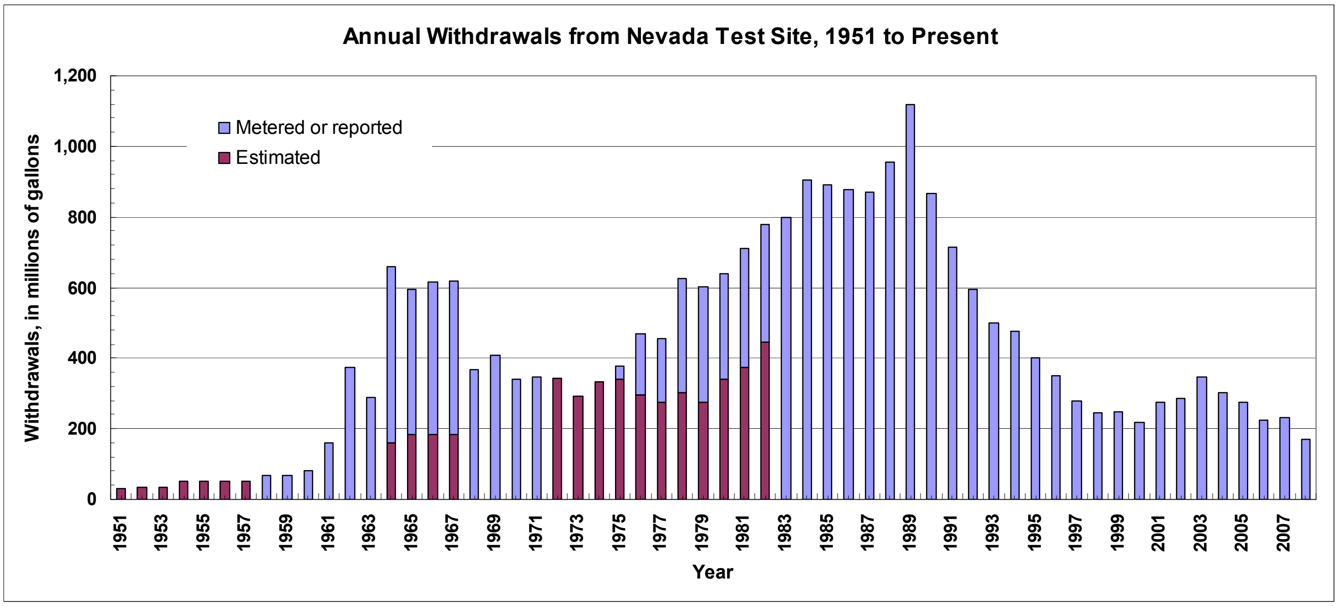

Figure 15-1. Annual withdrawals from the NTS, 1951 to present

15.3 Wellhead Protection

NNSA/NSO seeks to protect groundwater from the infiltration or introduction of contaminants at the wellhead through a variety of procedures and programs. Wellhead protection areas on the NTS have been identified by the State for NTS water supply wells, and inventories and assessments of potential contaminant sources within these areas have been performed. Wellheads are routinely surveyed to identify potential new contaminant sources. Wellheads are protected from public access by locked well caps and by the prohibition of public access onto NTS land enforced by site security. NNSA/NSO wells that are sampled are protected through adherence to proper groundwater sampling procedures developed by each NTS contractor or tenant organization. These procedures must be identified and implemented as a condition of well access authorization under an NNSA/NSO permit called a Real Estate/Operations Permit. Also, the Borehole Management Program protects groundwater "at the wellhead" for boreholes that have been abandoned. These boreholes are plugged to prevent possible aquifer contamination. This program and their 2008 activities are described below.

15.3.1 Borehole Management Program

More than 4,000 boreholes were drilled on and off the NTS in support of nuclear testing. They include emplacement holes for nuclear devices, post-shot investigation boreholes, exploratory holes, instrument holes, potable water wells, construction water supply wells, monitoring wells, and other special purpose boreholes. The Borehole Management Program has identified 871 unneeded boreholes and has plugged 617 of them (as of

January 2009). Of the unneeded boreholes, 151 are believed to penetrate groundwater and underground nuclear test cavities. Of these 151, 93 have been plugged (as of January 2009). Plugging may reduce the potential for boreholes to act as conduits for contaminants transported down the borehole from the surface or from contaminated aquifers to non-contaminated aquifers. They are plugged by National Security Technologies, LLC (NSTec), according to Nevada Administrative Code 534.420–534.427 requirements, to the extent possible. The database of boreholes is maintained by NSTec. A fiscal year progress report is sent annually to the Nevada Division of Water Resources. In April and May of 2008, a total of 40 boreholes were plugged (Table 15-1).

Table 15-1. NTS boreholes plugged in 2008

NTS Area	Borehole	Year Constructed	Hole Size (in.)	Original Depth (ft)	Surface Casing Size (in.)	Surface Casing Depth (ft)	Depth Plugged From to Surface (ft)
2	U-2gg PS #1A	1989	9.875	2035	10.75	110	1521
2	U-2cj PS #1A	1969	9.875	1340	10.75	90	45
3	UE-3ct	1975	12.25	1230	20	120	120
3	U-3gh PPS #1A	1968	12.25	72	7.625	69	69
3	U-3kb PS #1D	1975	9.875	1813	13.375	117	33
3	U-3ek PS #1V	1966	12.25	886	13.375	47	287
3	U-3bi	1967	42	890	29	870	23
3	U-3bm PS #4	1962	6.125	875	7.625	32	40
3	U-3bm PS #1	1962	9.625	872	10.75	40	504
3	U-3bm PS #2	1962	9.625	870	10.75	40	277
3	U-3ap PS #2	1962	6.125	1200	7	950	964
3	U-3bd PS #1	1962	9.625	1511	4.5	1490	970
3	U-3bs PS #1D	1966	9.875	1991	13.375	805	805
4	U-4c PPS #1D	1966	9.875	1194	13.375	1147	100
4	U-4q PS #1A	1984	9.875	2449	10.75	123	17
4	U-4ah PS #1A	1978	9.875	1351	10.75	112	1028
4	U-4t PS #1A	1986	9.875	2404	13.375	120	1736
4	U-4t PS #2A	1986	9.875	1863	10.750	109	1751
7	U-7m PPS #1D	1966	9.875	875	13.375	835	95
7	U-7s PPS #1D	1966	9.875	980	13.375	938	74
7	U-7s PS #2D	1972	9	2181	13.375	60	31
8	UE-8d	1970	9.625	1246	10.75	80	1167
8	UE-8i	1973	12.25	1200	13.375	119	813
9	U-9cr PS #1A	1981	9.625	1432	10.75	108	1051
9	U-9cr PS #2A	1981	9.875	1109	10.75	110	1077
9	U-9cn PS #1A	1982	9.875	1158	10.75	119	930
9	U-9u PS #1A	1962	9.875	643	10.75	40	382
9	U-9cg PS #1A	1977	9.875	1213	10.75	125	1124
9	U-9ce PS #1A	1966	9.875	1635	10.75	108	670
9	U-9cl PS #1A	1975	9.875	1267	10.75	131	911
9	U-9cq PS #1A	1981	9.875	1304	10.75	112	199
10	U-10am #2 PS #1A	1969	9.875	850	10.75	114	423
12	Whiterock Springs 3a	1959	5.75	10	none	none	6
12	Whiterock Springs 3	1959	5.75	41	none	none	26
26	Pluto 1	1962	NA	778	4.5	24	21
26	Pluto 3	1962	NA	263	4.5	24	23
26	Pluto 6	1962	NA	1000	3.5	NA[a]	124
26	Pluto 7	1962	NA	NA	4.0	NA	113
26	Pluto 10	1962	NA	802	3.5	NA	36
26	Pluto 11	1962	NA	800	3.5	NA	88

(a) Not available

15.4 Spill Prevention and Management

NSTec has established procedures for the prevention, control, cleanup, and reporting of spills of hazardous and toxic materials, or any other regulated material, into the environment. Spills include releases from underground

16.0 Meteorological Monitoring

16.1 Meteorological Monitoring Goals

Meteorological and climatological data are collected on the Nevada Test Site (NTS) by the Air Resources Laboratory, Special Operations and Research Division (ARL/SORD). Data are collected through the Meteorological Data Acquisition (MEDA) system, a network of over 30 mobile meteorological towers located primarily on the NTS. The MEDA system became operational in 1981, replacing an older system. MEDA is used to measure, transmit, and display vital meteorological data to SORD meteorologists and U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) customers. These data are used daily for operational support to a wide variety of projects on the NTS and form the climatological database for the NTS. The data are also used in safety analysis reports, emergency response activities, radioactive waste remediation projects, environmental reports, and consequence assessments. The NTS Site Description, Section 3.0, presents descriptive NTS climatological data collected by the MEDA system. The NTS Site Description is included as a separate file on the compact disc of this 2008 report for easy reference.

16.2 MEDA Station Locations

A standard MEDA unit consists of an enclosed trailer, a portable 10-meter (m) (32.8-feet [ft]) tower, meteorological instrumentation, a microprocessor, and a microwave radio transmitter powered by a battery and solar recharge system (Figure 16-1). Locations of the MEDA stations are shown in Figure 16-2. All towers were sited according to standards set by the Federal Meteorological Handbook No. 1 (National Oceanic and Atmospheric Administration, 1995]) and the World Meteorological Organization, 2002) so as not to be influenced by natural or man-made obstructions or by heat dissipation and generation systems. MEDA station locations are based on the following criteria: (1) access by road, (2) line-of-sight to a microwave repeater, and (3) project support. A primary goal of the network is to provide details in the surface wind field for emergency response activities related to the transport and dispersion of hazardous materials. Another primary goal is to provide data used in computing offsite radiological dose estimates.

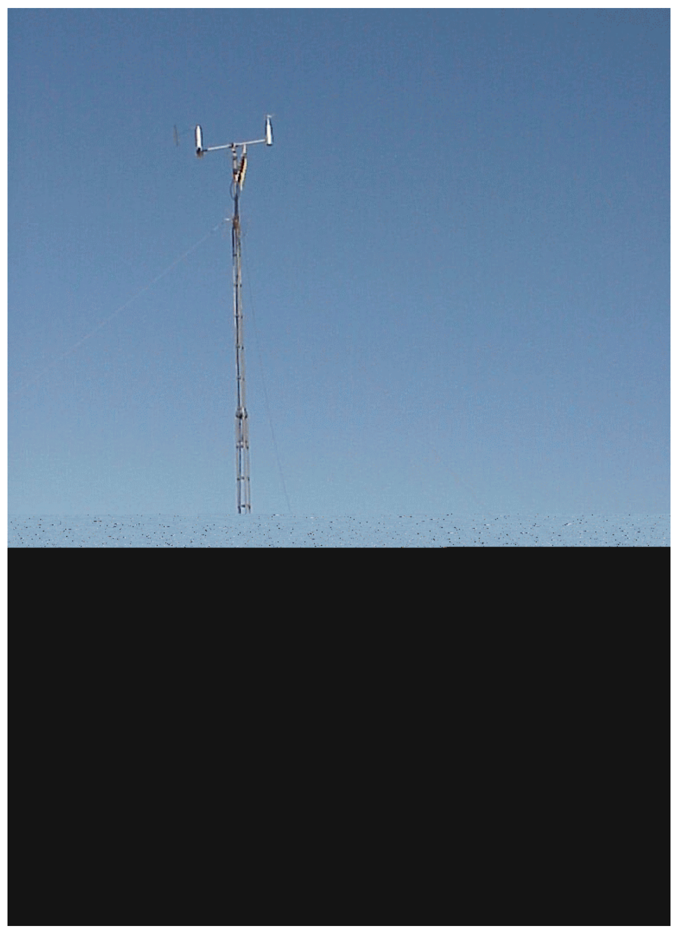

Figure 16-1. Example of a typical MEDA station with a 10-meter tower

16.3 MEDA Station Instrumentation

MEDA station instrumentation is located on top of the tower and on booms oriented into the prevailing wind direction and at a minimum distance of two tower widths from the tower. Wind direction and speed are measured at the 10-m (32.8-ft) level, in accordance with the American National Standard for Determining Meteorological Information at Nuclear Facilities (American Nuclear Society, 2005) specifications.

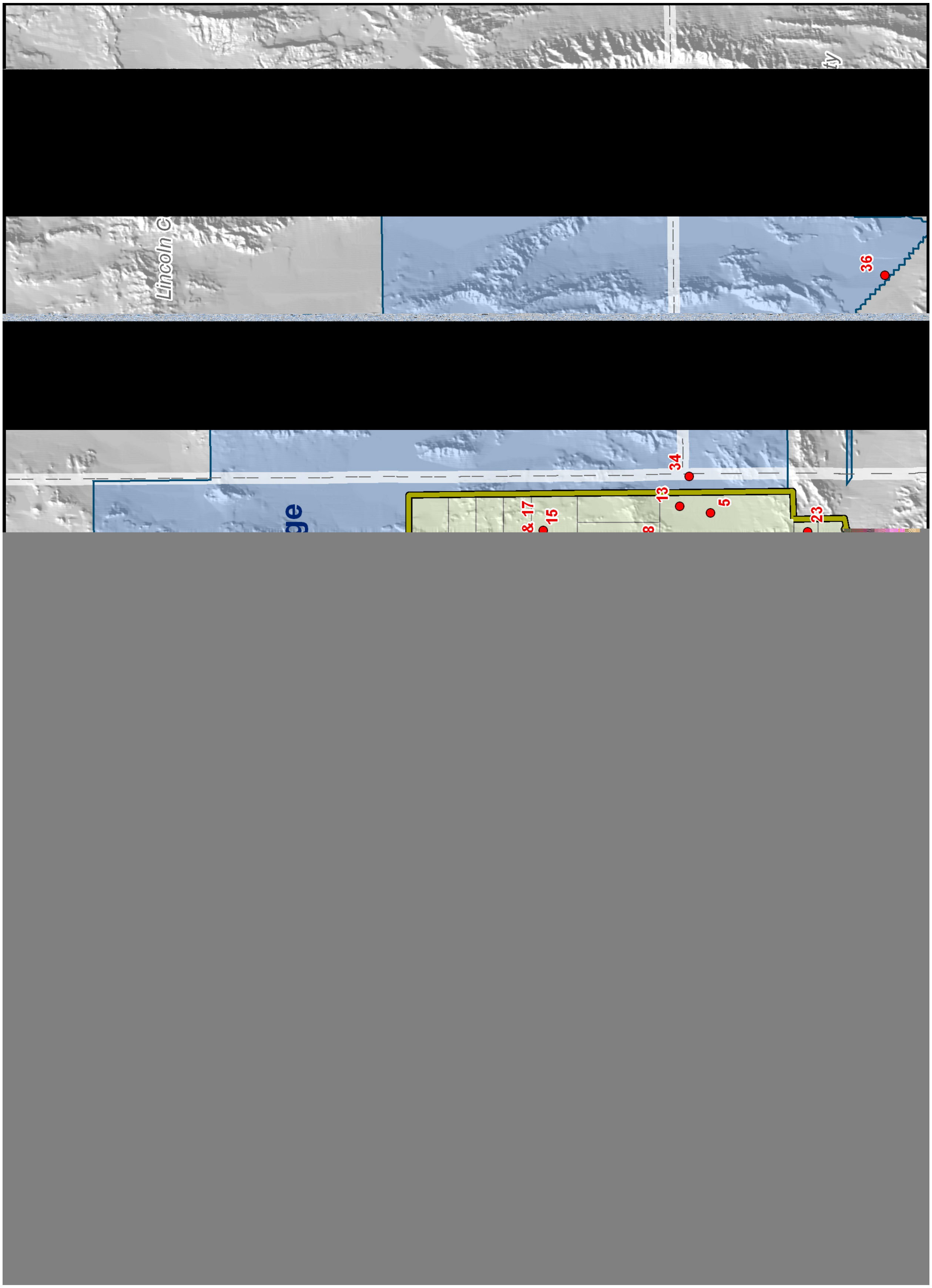

Figure 16-2. MEDA station locations on and near the NTS

Ambient temperature, relative humidity, and atmospheric pressure measurements are taken at approximately the 2-m (6.6-ft) level so as to be within the surface boundary layer. Observations are collected and transmitted every 15 minutes on the quarter hours. Wind data are 5-minute averages of speed and direction. The peak wind speed is the fastest instantaneous gust measured within the 15-minute time interval. Temperature, relative humidity, and pressure are instantaneous measurements.

16.4 Rain Gauge Network

ARL/SORD also operates and maintains a climatological rain gauge network on the NTS (Figure 16-3). This network consists of 16 Belford Series 5-780 Universal Precipitation Gauges and one Vaisala 44A Tipping Bucket Precipitation Gauge. The 16 Belford gauges are strip chart recorders that are read at least once every 30 days. The Vaisala gauge is part of the MEDA network and reports data every fifteen minutes to the weather database. Once read and checked, the data are entered into the SORD precipitation climatological database. Data are recorded as daily totals. Under special circumstances, 1- to 3-hour totals can be obtained.

16.5 Data Access

The meteorological parameters measured at each station, along with other information, are listed on the SORD Web site <http://www.sord.nv.doe.gov>. MEDA data are also processed and archived in the ARL/SORD climatological database. Climatological data summaries are posted on the ARL/SORD Web site under the Climate section. SORD meteorologists provide specially tailored climatological summaries by request through NNSA/NSO. For new NTS projects and facility modifications that may produce radiological emissions, wind data from the MEDA stations are used to calculate potential radiological doses to members of the public residing near the NTS (see Section 3.1.7).

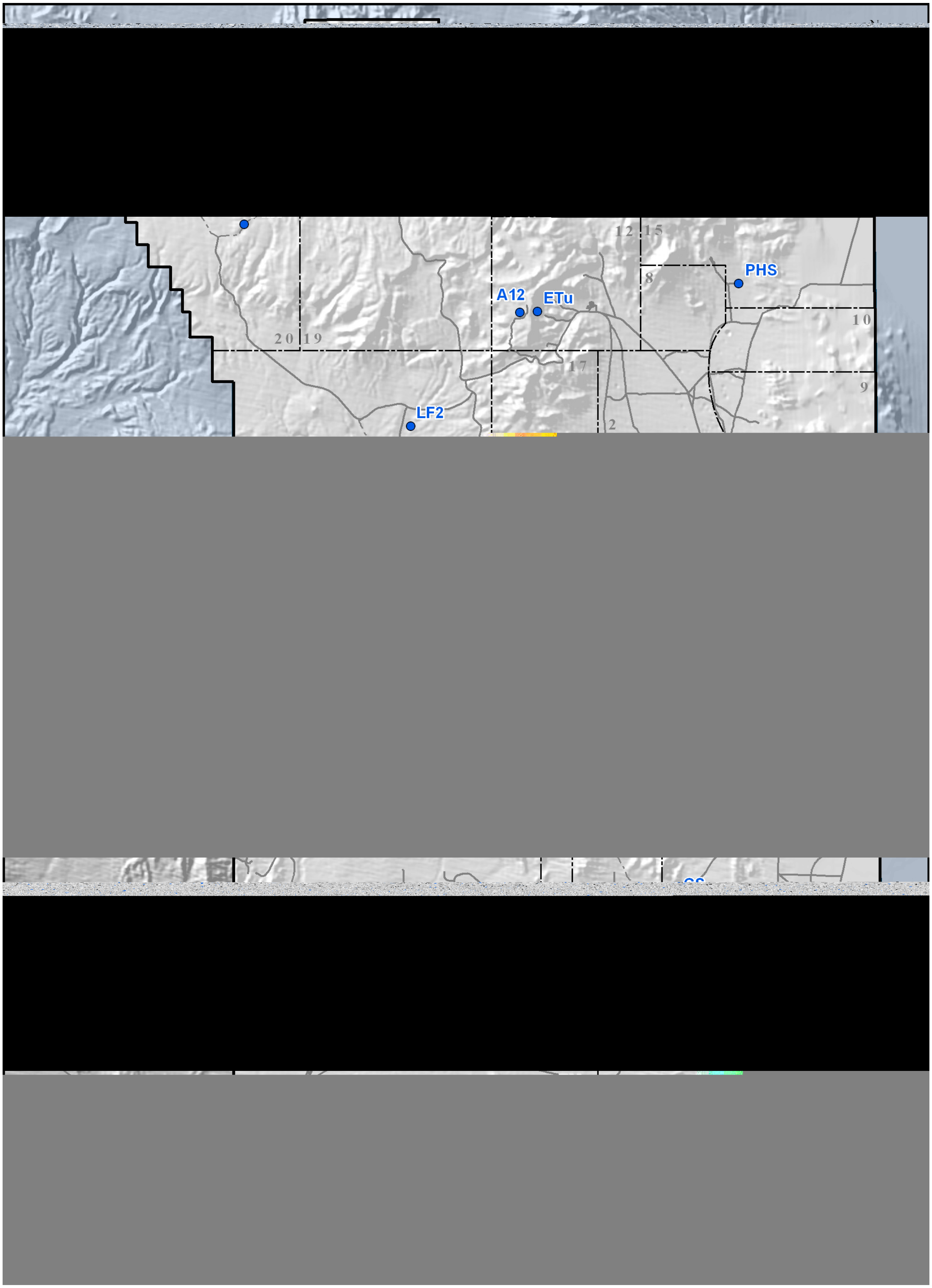

Figure 16-3. Climatological rain gauge network on the NTS

17.0 Integrated Safety Management System and Environmental Management System

A plan to integrate environment, safety, and health (ES&H) management programs at the Nevada Test Site (NTS) was developed and initiated at the NTS in 1996. The NTS Integrated Safety Management System (ISMS) is designed to ensure the systematic integration of ES&H concerns into management and work practices so that missions are accomplished safely. The term *safety* is used synonymously with *environment, safety, and health* throughout the NTS ISMS implementation policies to encompass protection of the public, the workers, and the environment. The seven guiding principles of ISMS and the five core functions are shown below.

Seven Guiding Principles	***Five Core Functions***
Line management is directly responsible for the protection of the public, the workers, and the environment. Clear roles and responsibilities for ES&H are established and maintained. Personnel competence is commensurate with their responsibilities. Resources are effectively allocated to address ES&H, programmatic, and operational considerations with balanced priorities. ES&H standards and requirements are established that ensure adequate protection of the employees, the public, and the environment. Administrative and engineering controls to prevent and mitigate ES&H hazards are tailored to the work being performed. Operations are authorized.	Define the scope of work. Identify and analyze the hazards and environmental aspects associated with the work. Develop and implement hazard and aspect controls. Perform work within the controls. Provide feedback on the adequacy of the controls for continuous improvement.

The use of an ISMS helps ensure that (1) all levels of program organizations are accountable for environmental protection, (2) all projects are planned with ES&H concerns in mind, and (3) continuous improvements in program implementation occur.

In 2000, Executive Order (EO) 13148, "Greening the Government Through Leadership in Environmental Management," was issued. It required all federal agencies to adopt an Environmental Management System (EMS). It applied to most of the U.S. Department of Energy, National Nuclear Security Administration (NNSA) and to U.S. Department of Energy (DOE) and NNSA contractors. An EMS is a business management practice that allows an organization to strategically address its ES&H matters. EMSs are designed to incorporate concern for environmental performance throughout an organization, with the ultimate goal being continual reduction of the organization's impact on the environment. EMS implementation reflects accepted quality management principles based on the "Plan, Do, Check, Act" model, using a standard process to identify goals, implement them, determine progress, and make improvements to ensure continual improvement.

In January 2003, DOE O 450.1, "Environmental Protection Program" was issued. This order implemented the requirements of EO 13148, requiring DOE and NNSA facilities to have an EMS that is fully integrated into each site's ISMS by December 31, 2005.

In January 2007, EO 13423, "Strengthening Federal Environmental, Energy, and Transportation Management," was issued and EO 13148 was revoked. EO 13423 requires federal facilities to begin establishing goals to improve efficiency in energy and water use, procure goods and services that use sustainable environmental practices, reduce the amount of toxic materials acquired, maintain a cost-effective waste prevention and recycling program, ensure construction and major renovation of buildings, incorporate sustainable practices, reduce the use of petroleum products and increase the use of alternative fuels in motor vehicles, and acquire and dispose of electronic products using environmentally sound practices.

In February 2008, DOE Order DOE O 430.2B, "Departmental Energy, Renewable Energy and Transportation Management," was issued. The requirements and goals in this order are similar to those in EO 13423 and are discussed in Section 17.3.

In June 2008, DOE O 450.1 was superceded by DOE O 450.1A of the same title. The updated order establishes requirements for implementing EO 13423 and achieving DOE sustainable environmental stewardship goals. This chapter presents integrated EMS status and activities for 2008 that flow from compliance with DOE O 450.1A.

17.1 Scope of Chapter

This chapter reflects the status of EMS and ISMS in 2008 under National Security Technologies, LLC (NSTec), the current Management and Operating (M&O) contractor. Work in previous years on the M&O's EMS and ISMS integration can be found in previous *Nevada Test Site Environmental Reports.*

17.2 Elements and Status of the NTS EMS

In 2006, a commitment was made by NSTec to pursue ISO 14001 Certification (ISO stands for the International Organization for Standardization) as the method of satisfying the requirement of DOE O 450.1 to have an EMS, and to have it audited by a qualified outside party. NSTec committed in their contract proposal to obtain the certification by June 30, 2009. An internal management assessment had been performed in December 2006 to evaluate the existing environmental program against the requirements of the ISO 14001:2004 Standard. The assessment showed that the 2006 program was mature and effective, but that improvements had to be made in some of the elements to satisfy all the rigorous ISO 14001 requirements. In 2007, an Implementation Strategy was developed to address the identified deficiencies, and an Environmental Working Group (EWG) representing all operating parts of the company was formed to direct the implementation strategy. Monthly meetings were held, at which the environmental staff reviewed implementation progress with the Executive Leadership Council NSTec President and his direct reports. Lloyd's Register Quality Assurance (LRQA) was contracted to be NSTec's ISO 14001 certifying company, and the NSTec stretch goal was to obtain the certification by June 30, 2008. In June of 2008, LRQA performed the certification assessment and awarded NSTec with ISO 14001 certification. The 2008 status of each ISO element is discussed in the subsections below.

17.2.1 NTS Environmental Policy

The Environmental Protection Policy is a statement of NSTec's intentions and principles regarding overall ES&H performance. It provides a framework for planning and action. The policy was streamlined in an April 28, 2008, revision and is posted on the NSTec Programs Internet Website (http://www.nstec.com/programs/index.htm) available to the public. The policy contains the following key goals and commitments:

- Protect environmental quality and human welfare by implementing EMS practices.
- Identify and comply with all applicable DOE orders and federal, state, and local environmental laws and regulations.
- Identify and mitigate environmental aspects early in project planning.
- Establish environmental objectives, targets, and performance measures.
- Collaborate with employees, customers, subcontractors, and key suppliers on sustainable development and pollution prevention efforts.
- Communicate and instill an organizational commitment to environmental excellence in company activities through processes of continual improvement.

17.2.2 Environmental Aspects

When operations have an environmental aspect, NSTec implements the EMS to minimize or eliminate any potential impact. NSTec evaluates its operations by performing a Hazard Assessment (HA), identifies the aspects of operations that can impact the environment, and determines the appropriate mitigation actions. The HA requires the activity manager to go through a series of questions that identify potential environmental impacts.

The assessment also lists available mitigations, such as training and applicable procedures and guidance. The completed HA is then reviewed and, when approved by the NSTec Environment, Safety, Health, and Quality (ESH&Q) Division, becomes part of the authorization basis for performing the work. National Environmental Policy Act documents, Health and Safety Plans, and Execution Plans also identify aspects that can have potential impacts. Each of these documents then requires that mitigation actions be identified to minimize the risk of adverse impacts. In 2008, the EWG updated the list of aspects for fiscal year (FY) 2009 (October 1, 2008, through September 30, 2009) and applied a risk matrix to determine which aspects were significant. NSTec has determined that the following aspects of its operations have the potential to affect the environment:

Significant aspects:

- Air quality
- Drinking water quality
- Energy and fuel use
- Environmental restoration
- Groundwater protection
- Hazardous, radioactive, and mixed waste generation and management
- Wastewater management (generation and disposal)

Other aspects:

- Building construction and renovation
- Building demolition
- Electronics stewardship
- Industrial chemical storage and use
- Non-hazardous waste generation and management
- Purchase of materials and equipment
- Recycling and management of surplus property and materials
- Resource protection (cultural, biological, and raw materials)
- Surface water and storm water runoff
- Water usage

17.2.3 Legal and Other Requirements

To implement the compliance commitments of the Environmental Protection Policy and to meet its legal requirements, NSTec monitors changes in federal, state, or local environmental regulations and DOE orders. Changes are communicated to affected parts of the company, along with recommended actions to satisfy the new requirements. The changes frequently require amendments to operating permits, modifications to record-keeping or hours of operation, revisions to procedures, and upgrades to training. Execution Plans identify requirements applicable to each NSTec-managed facility, project, and work activity by referencing the requirements in the NSTec Prime Contract that apply to that plan. Execution Plans are reviewed annually and updated as necessary.

17.2.4 Objectives, Targets, and Programs

Objectives and targets are developed by NSTec on an FY (versus calendar year) basis. NSTec first evaluates which aspects are considered significant, and then, with senior management input, sets objectives to improve performance with respect to those aspects. Finally, targets to meet the objectives are established by the operating organizations and their member of the EWG. Targets can also come from goals identified in DOE orders. The potential objectives and targets are then presented to the Executive Leadership Council for final selection and approval. Organizations within NSTec are assigned responsibility for each target, develop action plans detailing how they will achieve their objectives and targets, and commit the necessary resources to successfully implement them. A company directive outlines the responsibilities of all organizations involved in establishing, tracking, and reporting progress on environmental targets. Objectives and targets established and implemented for FY 2008 are described in Table 17-1. The objectives and targets established in 2008 for FY 2009 are described in Table 17-2.

NSTec also works with U.S Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) to clearly define expectations and performance measures that directly address NNSA/NSO priorities and concerns. These activities, which are associated with award and incentive fees, are tracked by the NSTec Prime Contract Office.

Several environmental management programs exist throughout NSTec. These programs are discussed in sequential chapters of this report.

Table 17-1. FY 2008 EMS objectives and targets

Environmental Aspect	Objective	Target	Result
Air Quality	Increase the percentage of alternate fuel use relative to overall fuel consumption.	Increase alternative fuel use at the NTS by at least 10% over FY 2007 usage.	**Exceeded Target –** A 35% increase in amount of alternative fuel use was achieved.
Energy Use	Reduce energy use.	Reduce electrical energy use per gross square foot by 3% in comparison to the FY 2007 2% reduction goal baseline.	**Exceeded Target –** Reduced use by 11%.
		Retrofit/install 200 individual building-smart electrical meters at the NTS to identify those buildings where improvements can be made.	**Partially Met Target –** Unable to shut power off at some buildings to meet the FY 2008 schedule, but all were installed by December.
Groundwater Protection	Protect groundwater quality.	Prepare 45 unneeded boreholes for plugging and plug 40.	**Met Target.**
Non-hazardous Waste Generation and Management	Increase recycling.	At the T-Tunnel cleanup site, recycle or salvage 30% by weight of material that is nonradioactive.	**Exceeded Target –** 34.5% of material removed was sent off site for recycling.
Purchase of Material and Equipment	Lease environmentally friendly electronics.	Lease only computers that are Electronic Product Environmental Assessment Tool (EPEAT)-registered as existing ones are replaced. By end of FY 2008, have 100% of leased desktops and 90% of leased laptops be EPEAT-registered.	**Exceeded Target –** 100% of leased desktops and 100% of leased laptops are now EPEAT-registered.

Table 17-2. FY 2009 proposed objectives and targets

Environmental Aspect	Objective	Target
Air Quality	Reduce hazardous emissions.	Replace three fuel burning boilers with high efficiency electric boilers.
Drinking Water Quality	Upgrade water system to stabilize pressures and reduce maintenance.	Replace approximately 823 meters (2,700 feet) of waterline in Area 6.
Energy and Fuel Use	Reduce energy use.	Reduce electrical energy use per gross square foot by 3% in comparison to the FY 2008 baseline.
	Increase the percentage of alternate fuel use relative to overall fuel consumption.	Increase alternative fuel use at the NTS by at least 10% over FY 2008 usage.
Environmental Restoration	Close/remediate sites identified in the Federal Facility Agreement and Consent Order.	Complete closures of four Corrective Action Units.
Groundwater Protection	Protect groundwater quality.	Prepare 80 unneeded boreholes for plugging and plug 74.
Hazardous, Radioactive, and Mixed Waste Generation and Management	Reduce environmental contamination risk at vulnerable sites.	Take identified corrective actions to mitigate top priorities from the Vulnerable Sites List. This is a prioritized list of sites that need some type of identified corrective action to remove or reduce the risk of an environmental problem (usually a chemical release).
Non-hazardous Waste Generation and Management	Reuse excavated soil from excavation of a new disposal cell in Area 5.	Reuse 100% of the soil excavated from Pit 17 as cover material in other Area 5 disposal cells.
	Reuse pavement removed from roads.	Use a process that removes existing pavement and some subsurface, grinds up the material, and then applies the material as replacement subsurface.
Water Usage	Reduce water usage.	Reduce water usage by 2% below FY 2008 usage.

17.2.5 Resources, Roles, Responsibilities, and Authorities

All employees at NSTec have specific roles and responsibilities in key areas, including environmental protection. These are identified in company procedures and work packages. Employee-stop-work authority applies to potential environmental issues as well as health and safety problems. Job-specific environmental training is identified for workers and included on their company-required training matrix. NSTec Environmental Services (ES) technical support personnel assist the line organizations with developing and meeting their environmental responsibilities.

17.2.6 Competence, Training, and Awareness

Extensive training on NSTec's EMS requirements has been provided to staff whose responsibilities include environmental protection. The training program includes general environmental awareness for all employees, regulatory compliance training for selected staff, and specific courses for managers, internal assessors, and operations personnel whose work can impact the environment. In May 2007, all members of the EWG and other key environmental people attended a one-week training course on ISO 14001 Implementation and Auditing. In 2008, all upper and mid-level managers received a 4-hour ISO awareness briefing from an outside subcontractor, and all employees received an awareness briefing specific to the NSTec ISO 14001 program. EMS awareness is also part of the training that all new employees receive.

17.2.7 Communication

NSTec communicates environmental issues to employees through e-mails, articles in newsletters, safety meetings, new-hire orientations, job hazard analyses, pre-task briefings, and company procedures. Energy issues are communicated through the intranet employee publication, *The Joule*. NSTec assists NNSA/NSO in soliciting input from interested external parties such as community members, activists, civic organizations, Indian tribes, elected officials, and regulators. This is accomplished primarily through Community Advisory Board (CAB) meetings. The CAB consists of 10–15 volunteer Nevada citizens who represent rural and urban areas. CAB meetings occur monthly and focus on the Environmental Management program and projects on site. Environmental Management also sponsors a Speakers Bureau, which provides representatives a chance to give presentations to schools, groups, or organizations and sponsors community exhibits and displays for communicating NTS environmental issues and interacting one-on-one with the public. All external communications are coordinated through NNSA/NSO.

17.2.8 Documentation

NSTec has comprehensive environmental documents as part of the EMS that detail information on regulatory requirements, site-wide operating procedures, and work control procedures on how to control processes and perform work in a way that protects the environment. The current "Environmental Management System Description" was updated in July 2008 to incorporate the program improvements made in pursuit of ISO Certification.

17.2.9 Control of Documents

The NSTec document control system ensures effective management of procedures and other requirements documents. When facilities require additional procedures to control their work, document control protocols are implemented to ensure that workers have access to the most current versions of procedures. Documents of long-term NNSA/NSO or NSTec interest are archived and are destroyed according to schedules mandated by federal laws.

17.2.10 Operational Control

Operations are evaluated through HAs and work packages for the adequacy of current controls to prevent or minimize impacts to the environment. Task-specific procedures or work plans are developed when needed. Additional administrative or engineered controls are identified, and plans for upgrades and improvements are developed and implemented. Assessments are currently being performed to make sure that all environmental issues identified in upper-tier documents like HAs are rolled down to the work level plans. Lessons learned and critiques are incorporated into work processes to continually improve environmental performance.

17.2.11 Emergency Preparedness and Response

NSTec has an emergency preparedness and response program and specialized onsite staff to provide timely response to hazardous materials releases or other environmental emergencies. There is a comprehensive NSTec Emergency Management Plan, and many facilities have a facility Emergency Management Plan where all credible scenarios are evaluated. These emergency plans are tested and evaluated at least annually, and improvements are made to the plans. This program includes procedures for preventing, as well as responding to, emergencies. Agreements are in place with outside emergency response agencies to support non-NTS facilities.

17.2.12 Monitoring and Measurement

NSTec has an extensive network of environmental compliance programs with defined monitoring, surveillance, and compliance and performance measures tracking (see Section 2.0, Compliance Summary). These programs help ensure the effectiveness of controls, adherence to regulatory requirements, and timely identification and implementation of corrective measures for all work performed by NSTec for NNSA/NSO. In addition to the monitoring programs, an independent program called the Community Environmental Monitoring Program, established by NNSA/NSO, monitors air and groundwater within communities adjacent to the NTS. Onsite and offsite monitoring and surveillance results are reported to regulatory agencies and are summarized annually in this report. Many of these monitoring activities are required by state or federal environmental operating permits. In addition, NSTec tracks and trends its progress and performance in achieving environmental objectives/targets and performance measures which are not strictly compliance-driven (see Table 17-1).

17.2.13 Evaluation of Compliance

NSTec has procedures for periodically evaluating its compliance with relevant environmental regulations. Line managers and facility managers periodically inspect their operations and facilities. NSTec ES and NNSA/NSO personnel also perform regulatory inspections and assessments in a particular topical area to verify the compliance status of multiple organizations, or a comprehensive assessment of a particular organization. Lastly, external regulatory agencies and/or technical experts frequently conduct independent audits of compliance.

17.2.14 Nonconformity and Corrective and Preventive Actions

NSTec continues to improve processes that identify and correct problems. Critiques, root cause analyses, and lessons learned are used in an attempt to prevent recurrences of environmental problems and promote continual improvement. Any deficiencies resulting from incidents or assessments are entered into an electronic Web-based system, where corrective actions are identified and tracked until completed.

17.2.15 Control of Records

EMS-related records, including audit and training records, permits, waste manifests, waste characterization, and inspections are maintained according to federal standards and a formal NSTec records control procedure is followed to ensure integrity, facilitate retrieval, and protect them from loss.

17.2.16 Internal Audit

NSTec has used internal staff and subcontractors to identify the EMS elements that are fully implemented and those that still require strengthening. This is an ongoing activity intended to continually improve the environmental program. A comprehensive audit of the environmental program against the ISO 14001 requirements was started in December 2007 and completed in February 2008. This audit was conducted by the EWG under the direction of a lead auditor, and served as the last internal audit or assessment prior to the arrival of the ISO registrar in February 2008. Annual audits of various parts of the EMS program will continue to be performed by internal audit groups. In addition, compliance with regulatory requirements is verified through routine inspections, operational evaluations, and periodic audits.

17.2.17 Management Review

The NSTec Senior Manager for ESH&Q will ensure periodic review of the EMS to ensure its continuing suitability, adequacy, and effectiveness. The review process is scheduled in the NSTec ESH&Q Execution Plan and documented. A management review of the EMS program is conducted monthly by the environmental staff and the Executive Leadership Council. Environmental issues are discussed and action items are assigned. This is a proceduralized process, and meeting minutes are kept to document continual improvement in the EMS.

17.3 DOE O 430.2B Implementation

The purpose of DOE O 430.2B is to meet, lead, or exceed the goals of all applicable laws, EOs, and federal regulations with respect to energy, buildings and fleets. In particular, the goals in EO 13423 are applied through this Order. NSTec identified key employees in various organizations affected by the Order and formed an Energy Management Council to evaluate the level of effort and cost to fully implement the requirements (goals) in the Order. In December 2008, the *FY 2009 NNSA/NSO Energy Executable Plan* was developed. The Executable Plan serves as a contract between NNSA/NSO and NNSA Headquarters in terms of how to meet DOE O 430.2B. It is organized into five goals (Table 17-3) and discusses each goal in terms of current NNSA/NSO status; site-specific goals as negotiated between NSTec, DOE, and NNSA/NSO; description of projects and activities; funding plan; and milestones. Table 17-3 summarizes the initial implementation status of each goal as reported in the Executable Plan. The EMS mirrors annual energy goals in the Executable Plan to ensure consistency.

Table 17-3. FY 2009 NNSA/NSO Executable Plan goals summary

Goal	Executable Plan's Status with Meeting Goal
Energy Efficiency	On track to meet goal of reducing energy intensity by 30% by 2015, with certain facilities excluded by waiver.
Renewable Energy	Pursuing construction of an onsite Concentrating Solar Power (CSP) plant to achieve goal of having 7.5% of NTS's annual electricity and thermal consumption from an onsite renewable energy source by 2010. Meeting this goal is dependent on acquiring funding for construction of CSP.
Water	Pursuing installation of needed water meters, use of Best Management Practices for Water Efficiency, and conducting water study in 2009 to baseline potential water reduction and identify water reduction projects. On track to reduce potable water use by 16% by 2015 relative to 2007 usage.
Transportation/ Fleet Management	On track to exceed goals of reducing fleet's total consumption of petroleum products by 2% annually by 2015 and increase non-petroleum-based fuel consumption by 10% annually. Goal to use plug-in hybrid (PIH) vehicles currently unfeasible due to excessive summer heat and PIH air conditioning limitations.
High Performance Sustainable Buildings (HPSB)	Plan meets goal for new buildings. An HPSB Plan is being developed to meet the August 1, 2009, deadline. Approximately 30 retro-commissioning audits are scheduled each FY from FY 2009–FY 2015 to ensure 15% of buildings can be classified as HPSB by the end of FY 2015, if sufficient funding is provided to correct energy issues identified by the audits.

18.0 Compliance Quality Assurance

The National Security Technologies, LLC (NSTec), Quality Assurance Program (QAP) documents the process used by NSTec to ensure that quality is integrated into work performed under Prime Contract DE-AC52-06NA25946. It establishes and communicates the program requirements for compliance with (1) Title 10 Code of Federal Regulations (CFR) Part 830, Subpart A, Quality Assurance Requirements; (2) U.S. Department of Energy (DOE) Order DOE O 414.1C, "Quality Assurance;" and (3) other relevant requirements documents for the operation, process, or program to which they apply. The ten criteria established in 10 CFR 830 Subpart A and DOE O 414.1C that are required as part of a quality program are shown in the box below. The NSTec QAP requires a graded approach to quality for determining the level of rigor that effectively provides assurance of performance and conformance to requirements.

Required Criteria of a Quality Program
• Quality assurance program • Personnel training and qualification • Quality improvement process • Documents and records • Established work processes • Established standards for design and verification • Established procurement requirements • Inspection and acceptance testing • Management assessment • Independent assessment

The Data Quality Objectives (DQO) process developed by the U.S. Environmental Protection Agency (EPA) is generally used to provide the quality assurance (QA) structure for designing, implementing, and improving upon environmental monitoring efforts when environmental sampling and analysis are involved. Sampling and Analysis Plans are developed prior to performing an activity to ensure complete understanding of the data use objectives. Personnel are trained and qualified in accordance with company and task-specific requirements. Access to sampling locations is coordinated with organizations conducting work at or having authority over those locations in order to avoid conflicts in activities and to communicate hazards to better ensure successful execution of the work and protection of the safety and health of sampling personnel. Sample collection activities adhere to organization instructions and/or procedures that are designed to ensure that samples are representative and data are reliable and defensible. Sample shipments on site and to offsite laboratories are conducted in accordance with the U.S. Department of Transportation and International Air Transport Association regulations, as applicable. Quality control (QC) in the analytical laboratories is maintained through adherence to standard operating procedures that are based on methodologies developed by nationally recognized organizations such as the EPA, DOE, and ASTM International. Key quality-affecting procedural areas cover sample collection, preparation, instrument calibration, instrument performance checking, testing for precision and accuracy, and laboratory data review. NSTec data users perform reviews as required by the project-specific objectives before the data are used to support decision making.

The key elements of environmental monitoring process work flow are listed below. Each of these elements is designed to ensure the applicable QA requirements are implemented. A discussion of these elements follows.

- A **Sampling and Analysis Plan** (SAP) is developed using the EPA DQO process to ensure that clear goals and objectives are established for the environmental monitoring activity. The SAP is implemented in accordance with EPA, DOE, and other requirements addressing environmental, safety, and health concerns.
- **Environmental Sampling** is performed in accordance with the SAP and site work controls to ensure defensibility of the resulting data products and protection of the workers and the environment.
- **Laboratory Analyses** are performed to ensure that the resultant data meet DOE-, NSTec-, and regulation-defined requirements.
- **Data Review** is done to ensure that the SAP DQOs have been met, and thereby determine whether the data are suitable for their intended purpose.

- **Assessments** are employed to ensure that monitoring operations are conducted accordingly and that analytical data quality requirements are met in order to identify nonconforming items, investigate causal factors, implement corrective actions, and monitor for corrective action effectiveness.

18.1 Sampling and Analysis Plan

Most environmental monitoring is specifically mandated to demonstrate compliance with a variety of requirements including federal and state regulations and DOE orders and standards. Developing the SAP using the DQO approach ensures those requirements are considered in the planning stage. The following statistical concepts and controls are vital in designing and evaluating the system design and implementation.

18.1.1 Precision

Precision is the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves. Precision is a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms (DOE, 2008).

Practically, precision is determined by comparing the results obtained from performing analyses on split or duplicate samples taken at the same time from the same location or locations very close to one another, maintaining sampling and analytical conditions as nearly identical as possible.

18.1.2 Accuracy

Accuracy refers to the degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components that are due to sampling and analytical operations. Accuracy is a data quality indicator (DOE, 2008). Accuracy related to laboratory operations is monitored by performing measurements and evaluating results of control samples containing known quantities of the analytes of interest.

18.1.3 Representativeness

Representativeness is the degree to which a measurement is truly representative of the sampled medium or population (i.e., the degree to which measured analytical concentrations represent the concentrations in the medium being sampled) (Stanley and Verner, 1985).

At each sampling point in the sampling and analysis process, subsamples of the medium of interest are obtained. The challenge is to ensure that each subsample maintains the character of the larger sampled population. From a field sample collection standpoint, representativeness is managed through sampling plan design and execution. Representativeness related to laboratory operations concerns the ability to appropriately subsample and characterize for analytes of interest. For example, in order to ensure representative characterization of a heterogeneous matrix (soil, sludge, solids, etc.), the sampling and/or analysis process should evaluate whether homogenization or segregation should be employed prior to sampling or analysis. Water samples are generally considered homogeneous unless observation suggests otherwise. Each air monitoring station's continuous operation at a fixed location results in representatively sampling the ambient atmosphere. Field sample duplicate analyses are additional controls allowing evaluation of representativeness and heterogeneity.

18.1.4 Comparability

Comparability refers to "the confidence with which one data set can be compared to another" (Stanley and Verner, 1985). Comparability from an overall monitoring perspective is ensured by consistent execution of the sampling design concerning sample collection and handling, laboratory analyses, and data review. This is ensured through adherence to established procedures and standardized methodologies. Ongoing data evaluation compares data collected at the same locations from sampling events conducted over multiple years and produced by numerous laboratories to detect any anomalies that might occur.

18.2 Environmental Sampling

Environmental samples are collected in support of various environmental programs. Each program executes the field sampling activities in accordance with the SAP to ensure usability and defensibility of the resulting data. The key elements supporting the quality and defensibility of the sampling process and products include:

- Training and qualification
- Procedures and methods
- Field documentation
- Inspection and Acceptance testing

18.2.1 Training and Qualification

The environmental programs ensure that personnel are properly trained and qualified prior to doing the work. In addition to procedure-specific and task-specific qualifications for performing work, training addresses environment, safety, and health aspects to ensure protection of the workers, the public, and the environment. Recurrent training is also conducted as appropriate to maintain proficiency.

18.2.2 Procedures and Methods

Sampling is conducted in accordance with established procedures to ensure consistent execution and continuous comparability of the environmental data. The methods to be used for sample analyses are also consulted in order to ensure that viable samples are obtained.

18.2.3 Field Documentation

Field documentation is generated for each sample collection activity, and may include chain of custody, sampling procedures, analytical methods, equipment and data logs, maps, Material Safety Data Sheets, and other materials needed to support the safe and successful execution and defense of the sampling effort. Chain of custody practices are employed from point of generation through disposal (cradle-to-grave); these are critical to the defensibility of the decisions made as a result of the sampling and analysis. Sampling data and documentation are stored and archived so that they are readily retrievable for use at a later date. In many cases the data are managed in electronic data management systems. Routine assessments or surveillances are performed to ensure that sampling activities are performed in accordance with applicable requirements. Deficiencies are noted, causal factors are determined, corrective actions are implemented, and follow-up assessments are performed to ensure effective resolution. This data management approach ensures the quality and defensibility of the decisions made using analytical environmental data.

18.2.4 Inspection and Acceptance Testing

Sample collection data are reviewed for appropriateness, accuracy, and fit with historical measurements. In the case of groundwater sampling, real-time field measurements are monitored during purging to determine when parameters have stabilized, thereby indicating that the purge water is generally representative of the aquifer, at which time sampling may begin. After a sampling activity is complete, data are reviewed to ensure the samples were collected in accordance with the SAP. Samples are further inspected to ensure that their integrity has not been compromised, either physically (leaks, tears, breakage, custody seals) or administratively (labeled incorrectly) and that they are valid for supporting the intended analyses. If concerns are raised at any point during collection, the data user, in consideration of data usability, is consulted for direction on proceeding with or canceling the subsequent analyses.

18.3 Laboratory Analyses

Samples are transported to a laboratory for characterization. Several NSTec organizations maintain measurement capabilities that are generally considered "screening" operations, and may be used to support planning or preliminary decision-making activities. However, unless specifically authorized by the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office or the regulator, all data used for reporting purposes are generated by a DOE and NSTec-qualified laboratory whose services have been obtained through subcontracts. Ensuring the quality of procured laboratory services is accomplished through focus on three specific areas: (1) procurement, (2) initial and continuing assessment, and (3) data evaluation.

18.3.1 Procurement

Laboratory services are procured through the use of the DOE Integrated Contractor Purchasing Team (ICPT) Analytical Services Basic Ordering Agreement (BOA). The ICPT was put in place to pursue strategic sourcing opportunities that represent procurement-leveraged spending, which results in a lower total cost of ownership for DOE Complex-wide Site and Facility Contractors. Agreements placed by the ICPT have met all applicable requirements of the Competition in Contracting Act, the Federal Acquisition Regulation, the DOE Acquisition Regulations, prime contractor terms and conditions for subcontracting, and other relevant policies and procedures. As such, no further requirements apply pertaining to competition, further price analysis/justification, additional review of the terms and conditions, etc., which also saves time and effort.

The Analytical Services BOA was initially developed in 1998 by a team of contractor subject matter experts (both technical and procurement) from across the DOE complex, and BOAs were established with numerous laboratories beginning in 1999. The analytical services technical basis was initially contained in the BOA. It has been revised over the years and is currently codified in the DOE Quality Systems for Analytical Services (QSAS), revision 2.4, October 2008 (DOE, 2008). The QSAS is based on the National Environmental Laboratory Accreditation Conference Chapter 5, *Quality Systems, 2003*, as implemented in 2005, based on International Organization for Standardization (ISO) 17025, *General Requirements for the Competence of Testing and Calibration Laboratories*. Prior to a laboratory being issued a BOA, it must be assessed to be in compliance with the QSAS. Once a BOA is issued, the laboratory is routinely audited under the DOE Consolidated Audit Program (DOECAP).

Because of the rigor involved with the ICPT BOA process, rather than issuing a Request for Proposal to several laboratories and investing the time to evaluate the proposals received, NSTec awards subcontracts to laboratories that already hold a BOA. The NSTec subcontracts cite the BOA as the base requirement and address site-specific conditions.

The process for obtaining an ICPT BOA requires significant effort both on the laboratory and DOE's part. Consequently, BOA-holding laboratories are primarily those providing a wide range of analytical services to the DOE. NSTec obtains services not available from a BOA laboratory either through an NSTec subcontract laboratory's subcontracting of the work (i.e., lower-tier subcontractor) or by subcontracting directly with the laboratory. In either case, DOE and NSTec requirements for laboratory services are established with those laboratories as well for the specific services provided.

The subcontract places numerous requirements on the laboratory, including:

- Maintaining the following documents:

- The ability to generate data deliverables, both hard copy reports and electronic files
- Responding to all data quality questions in a timely manner
- Mandatory participation in proficiency testing programs
- Maintaining specific licenses, accreditations, and certifications
- Conducting internal audits of laboratory operations, as well as audits of vendors
- Allowing external audits by the DOECAP and NSTec, and providing copies of other audits considered by NSTec to be comparable and applicable

18.3.2 Initial and Continuing Assessment

An initial assessment is made during the request for proposal process above, including a pre-award audit. If an acceptable audit has not been performed within the past year, NSTec will consider performing an audit (or participating in a DOECAP audit) of those laboratories awarded the contract. NSTec will not initiate work with a laboratory without authorized approval of those NSTec personnel responsible for ensuring vendor acceptability.

A continuing assessment consists of the ongoing monitoring of a laboratory's performance against contract terms and conditions, of which the technical specifications are a part. Tasks supporting continuing assessment are:

- Conducting regular audits or participating in evaluation of DOECAP audit products
- Monitoring for continued successful participation in proficiency testing programs such as:
  - National Institute of Standards and Technology Radiochemistry Intercomparison Program
  - Studies that support certification by the State of Nevada or appropriate regulatory authority for analyses performed in support of compliance monitoring
- Monitoring of the laboratory's adherence to the QA requirements

18.3.3 Data Evaluation

Data products are continuously evaluated for compliance with contract terms and specifications. This primarily involves review of the data against the specified analytical method to determine the laboratory's ability to adhere to the QA/QC requirements, as well as an evaluation of the data against the DQOs. This activity is discussed in further detail in Section 18.4. Any discrepancies are documented and resolved with the laboratory, and continuous assessment tracks the recurrence and efficacy of corrective actions.

18.4 Data Review

A systematic approach to thoroughly evaluating the data products generated from an environmental monitoring effort is essential for understanding and sustaining the quality of data collected under the program. This allows the programs to determine whether the DQOs established in the planning phase were achieved and whether the monitoring design performed as intended or requires review.

Because decisions are based on environmental data, and the effectiveness of operations is measured at least in part by environmental data, reliable, accurate, and defensible records are essential. Detailed records that must be kept include temporal, spatial, numerical, geotechnical, chemical, and radiological data, and all sampling, analytical, and data review procedures used. Failure to maintain these records in a secure but accessible form may result in exposure to legal challenges and the inability to respond to demands or requests from regulators and other interested organizations.

An electronic data management system is a key tool used by many programs for achieving standardization and integrity in managing environmental data. The primary objective is to store and manage in an easily and efficiently retrievable form unclassified environmental data that are directly or indirectly tied to monitoring events. This may include information on monitoring system construction (groundwater wells, ambient air monitoring), analytical, geotechnical, and field parameters at the Nevada Test Site. Database integrity and security are enforced through the assignment of varying database access privileges commensurate with an employee's database responsibilities.

18.4.1 Data Verification

Data verification is defined as a subcontract compliance and completeness review to ensure that all laboratory data and sample documentation are present and complete. Additional critical sampling and analysis process information is also reviewed at this stage, which may include, but is not limited to, sample preservation and temperature, defensible chain-of-custody documentation and integrity, and analytical hold-time compliance. Data verification also ensures that electronic data products correctly represent the sampling and/or analyses performed and includes evaluation of QC sample results.

18.4.2 Data Validation

Data validation supplements verification and is a more thorough process of analytical data review to better determine if the data meet the analytical and project requirements. Data validation ensures that the reported results correctly represent the sampling and analyses performed, determines the validity of the reported results, and assigns data qualifiers (or "flags"), if required.

18.4.3 Data Quality Assessment (DQA)

DQA is a scientific and statistical evaluation to determine if the data obtained from environmental operations are of the right type, quality, and quantity to support their intended use. The DQA includes reviewing data for accuracy, representativeness, and fit with historical measurements to ensure that the data will support their intended uses.

18.5 Assessments

The overall effectiveness of the environmental program is determined through routine surveillance and assessments of work execution as well as review of the program requirements. Deficiencies are identified, causal factors are investigated, corrective actions are developed and implemented, and follow-on monitoring is performed to ensure effective resolution. The assessments discussed below are broken down into general programmatic and focused measurement data areas.

18.5.1 Programmatic

Assessments and audits under this category include evaluations of the work planning, execution, and performance activities. Personnel independent of the work activity perform the assessments to evaluate compliance with established requirements and report on the identified deficiencies. Organizations responsible for the activity are required to develop and implement corrective actions, with the concurrence of the deficiency originator or recognized subject matter expert. NSTec maintains the companywide issues tracking system (called CaWeb) to manage assessments, findings, and corrective actions.

18.5.2 Measurement Data

This type of assessment includes routine evaluation of data generated from analyses of QC samples. QC sample data are used to monitor the analytical control on a given batch of samples and are indicators over time of potential biases in laboratory performance. Discussion of the 2008 results for field duplicates, laboratory control samples, blank analysis, and inter-laboratory comparison studies are provided and summary tables are included below.

18.5.2.1 Field Duplicates

Samples obtained at approximately the same locations and times as initial samples are termed field duplicates and are used to evaluate the overall precision of the measurement process, including small-scale heterogeneity in the medium (air, soil, water, etc.) being sampled as well as analytical and sample preparation variation. The relative error ratio (RER) compares the absolute difference of initial and field duplicate measurements to a measure of the analytical uncertainty. The absolute relative percent difference (RPD) compares the absolute difference of initial and field duplicate measurements with the average of the two measurements; it is computed only from pairs for which both values are above their respective minimum detectable concentrations (MDCs). These are provided in Table 18-1.

The values in Table 18-1 fall in typical ranges. The highest RPD (63.5 percent) is found with $^{239+240}$Pu; this is due mostly to one air sampler intercepting a particle with high Pu while the other sampler in the pair had a typical background value. The RER is also affected by this pair. The second highest RPD (45.7 percent) occurred with $^{235+236}$U; values of this analyte tend to be rather low on the whole, which tends to inflate variability measured in relative terms.

18.5.2.2 Laboratory Control Samples (LCSs)

An LCS is a sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes. It is generally used to establish intra-laboratory or analyst-specific precision and bias or to assess the performance of all or a portion of the measurement system (DOE, 2008).

The results are calculated as a percentage of the true value, and must fall within established control limits (or percentage range) to be considered acceptable. If the LCS recovery falls outside control limits, evaluation for potential sample data bias is necessary. The numbers of 2008 LCSs analyzed and within control limits are summarized in Table 18-2.

18.5.2.3 Blank Analysis

In general terms, a blank is a sample that has not been exposed to the analyzed sample stream, and is analyzed in order to monitor contamination during sampling, transport, storage, or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results (DOE, 2008).

Laboratory method blank data are summarized in Table 18-3. A method blank is a sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses (DOE, 2008).

18.5.2.4 Proficiency Testing Program Participation

Laboratories are required to participate in Proficiency Testing Programs. Laboratory performance supports decisions on work distribution and may also be a basis for state certifications. Table 18-4 presents the 2008 results for the Mixed Analyte Performance Evaluation Program (MAPEP) administered by the Radiological and Environmental Sciences Laboratory of the Idaho National Laboratory.

Table 18-5 shows the summary of inter-laboratory comparison sample results for the NSTec Radiological Health Dosimetry Group. This internal evaluation was based on National Voluntary Laboratory Accreditation Program (NVLAP) criteria. The Dosimetry Group participated in the Battelle Pacific Northwest National Laboratory performance evaluation study program during the course of the year.

Table 18-1. Summary of field duplicate samples for compliance monitoring in 2008

Analyte	Medium	Number of Duplicate Pairs[(a)]	Number of Pairs > MDC[(b)]	Average Absolute RPD[(c)] of Pairs > MDC	Average Absolute RER[(d)] of All Pairs
Gross Alpha	Air	105	13	10.4	0.70
Gross Beta	Air	105	105	7.9	0.73
Tritium	Air	50	19	23.5	1.04
^{241}Am	Air	24	2	27.7	1.19
^{7}Be[(e)]	Air	24	24	7.5	0.96
^{40}K[(e)]	Air	21	10	32.7	0.82
^{238}Pu	Air	23	0	-	0.74
$^{239+240}$Pu	Air	24	7	63.5	1.69
$^{233+234}$U	Air	13	13	18.5	0.79
$^{235+236}$U	Air	13	4	45.7	0.75
^{238}U	Air	13	13	20.8	0.96
^{137}Cs	Air	24	0	-	0.99
^{235}U (gamma)	Air	24	0	-	0.72
Gross Alpha	Water	5	4	11.4	0.44
Gross Beta	Water	5	5	16.1	1.01
Tritium	Water	22	4	7.4	0.58
TLD	Ambient Radiation	323[(f)]	NA	2.2	0.26

(a) Represents the number of field duplicates reported for the purpose of monitoring precision. If an associated field sample was not processed, the field duplicate was not included in this table.

(b) Represents the number of field duplicate-field sample result sets with both values above their minimum detectable concentrations (MDC). The MDC does not apply to thermoluminescent dosimeter (TLD) measurements. If either the field sample or its duplicate was reported below the MDC, the RPD was not determined.

(c) Reflects the average absolute RPD calculated as follows:

$$Absolute\ \ RPD = \frac{|D - S|}{(D + S)/2}\ X\ \ 100$$

Where: S = Sample result
D = Duplicate result

(d) Relative error ratio (RER) determined by the following equation is used to determine whether a sample result and the associated field duplicate result differ significantly when compared to their respective one sigma uncertainties. The RER is calculated for all sample and field duplicate pairs reported without regard to the MDC.

$$Absolute\ \ RER = \frac{|S - D|}{\sqrt{(TPU_S)^2 + (TPU_D)^2}}$$

Where: S = Sample result
D = Duplicate result
TPU_S = one-sigma total propagated uncertainty of the field sample
TPU_D = one-sigma total propagated uncertainty of the field duplicate

(e) ^{7}Be and ^{40}K are naturally occurring analytes included for quality assessment of the gamma spectroscopy analyses.

(f) Third quarter TLD data are omitted; see Chapter 5 discussion.

Table 18-2. Summary of LCSs for 2008

Analysis	Matrix	Number of LCS Results Reported	Number Within Control Limits	Control Limits (%)
Radiological Analyses				
Tritium	Air	34	34	70-130
^{60}Co	Air	30	30	70-130
^{137}Cs	Air	30	30	70-130
$^{239+240}$Pu	Air	39	39	70-130
^{241}Am	Air	64	64	70-130
Gross Alpha	Water	12	12	70-130
Gross Beta	Water	12	12	70-130
Tritium	Water	62	62	70-130
^{60}Co	Water	11	11	70-130
^{90}Sr	Water	10	10	70-130
^{137}Cs	Water	11	11	70-130
$^{239+240}$Pu	Water	14	14	70-130
^{241}Am	Water	10	10	70-130
^{60}Co	Soil	3	3	70-130
^{90}Sr	Soil	4	4	70-130
^{137}Cs	Soil	3	3	70-130
$^{239+240}$Pu	Soil	2	2	70-130
^{241}Am	Soil	5	5	70-130
Nonradiological Analyses				
Metals	Water	178	178	80-120
Volatiles	Water	375	369	70-130
Semi Volatiles	Water	115	110	Laboratory specific
Miscellaneous	Water	321	320	80-120
Metals	Soil	9	9	75-125
Volatiles	Soil	26	25	70-130
Semi Volatiles	Soil	71	68	Laboratory specific

Table 18-3. Summary of laboratory blank samples for 2008

Analysis	Matrix	Number of Blank Results Reported	Number of Results < MDC
Radiological Analyses			
Tritium	Air	31	29
^{7}Be	Air	30	30
^{60}Co	Air	30	29
^{137}Cs	Air	30	30
^{238}Pu	Air	28	27
$^{239+240}$Pu	Air	28	23
^{241}Am	Air	54	50
Gross Alpha	Water	24	24
Gross Beta	Water	24	23
Tritium	Water	55	54
^{60}Co	Water	11	11
^{90}Sr	Water	8	8
^{137}Cs	Water	11	11
^{238}Pu	Water	8	8
$^{239+240}$Pu	Water	8	8
^{241}Am	Water	11	11
^{60}Co	Soil	3	3
^{90}Sr	Water	8	8
^{137}Cs	Water	11	11
^{238}Pu	Water	8	8
$^{239+240}$Pu	Water	8	8
^{241}Am	Water	11	11
^{60}Co	Soil	3	3
^{90}Sr	Soil	3	3
^{137}Cs	Soil	3	3
^{238}Pu	Soil	4	4
$^{239+240}$Pu	Soil	4	4
^{241}Am	Soil	5	5
Nonradiological Analyses			**Number of Results < Reporting Limit**
Metals	Water	183	168
Volatiles	Water	171	168
Semi Volatiles	Water	80	79
Miscellaneous	Water	243	242
Metals	Soil	19	16
Volatiles	Soil	30	29
Semi Volatiles	Soil	49	49

Table 18-4. Summary of 2008 radiological MAPEP reports

Analysis	Matrix	Number of Blank Results Reported	Number of Results < MDC
Radiological Analyses			
Tritium	Air	31	29
^{7}Be	Air	30	30
^{60}Co	Air	30	29
^{137}Cs	Air	30	30
^{238}Pu	Air	28	27
$^{239+240}$Pu	Air	28	23
^{241}Am	Air	54	50
Gross Alpha	Water	24	24
Gross Beta	Water	24	23
Tritium	Water	55	54
^{60}Co	Water	11	11
^{90}Sr	Water	8	8
^{137}Cs	Water	11	11
^{238}Pu	Water	8	8
$^{239+240}$Pu	Water	8	8
^{241}Am	Water	11	11
^{60}Co	Soil	3	3
^{90}Sr	Soil	3	3
^{137}Cs	Soil	3	3
^{238}Pu	Soil	4	4
$^{239+240}$Pu	Soil	4	4
^{241}Am	Soil	5	5
Nonradiological Analyses			**Number of Results < Reporting Limit**
Metals	Water	183	168
Volatiles	Water	171	168
Semi Volatiles	Water	80	79
Miscellaneous	Water	243	242
Metals	Soil	19	16
Volatiles	Soil	30	29
Semi Volatiles	Soil	49	49

Table 18-5. Summary of inter-laboratory comparison TLD samples for the subcontract dosimetry group in 2008

Analysis	Matrix	Number of Results Reported	Number Within Control Limits[(a)]
TLD	Ambient Radiation	29	29

(a) Based upon NVLAP criteria; absolute value of the bias plus one standard deviation < 0.3

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19.0 Quality Assurance Program for the Community Environmental Monitoring Program

The Community Environmental Monitoring Program (CEMP) Quality Assurance Program Plan (QAPP) was followed for the collection and analysis of radiological air and water data presented in Section 6.0 of this report. The CEMP QAPP ensures compliance with U.S. Department of Energy (DOE) Order DOE O 414.1C, "Quality Assurance," which implements a quality management system ensuring the generation and use of quality data. This QAPP addresses the following items previously defined in Section 18.0:

- Data Quality Objectives (DQOs)
- Sampling plan development appropriate to satisfy the DQOs
- Environmental health and safety
- Sampling plan execution
- Sample analyses
- Data review
- Continuous improvement

19.1 Data Quality Objectives

The DQO process is a strategic planning approach that is used to plan data collection activities. It provides a systematic process for defining the criteria that a data collection design should satisfy. These criteria include when and where samples should be collected, how many samples to collect, and the tolerable level of decision errors for the study. DQOs are unique to the specific data collection or monitoring activity, and are further explained in Appendices A through E of the *Routine Radiological Environmental Monitoring Plan* (BN, 2003a).

19.2 Measurement Quality Objectives (MQOs)

The MQOs are basically equivalent to DQOs for analytical processes. The MQOs provide direction to the laboratory concerning performance objectives or requirements for specific method performance characteristics. Default MQOs are established in the subcontract with the laboratory, but may be altered in order to satisfy changes in the DQOs. The MQOs for the CEMP project are described in terms of precision, accuracy, representativeness, completeness, and comparability requirements. These terms are defined and discussed in Section 18.1 for onsite activities.

19.3 Sampling Quality Assurance Program

Quality Assurance (QA) in field operations for the CEMP includes sampling assessments, surveillances, and oversight of the following supporting elements:

- The sampling plan, DQOs, and field data sheets accompanying the sample package
- Database support for field and laboratory results, including systems for long-term storage and retrieval
- A training program to ensure that qualified personnel are available to perform required tasks

Sample packages include the following items:

- Station manager checklist confirming all observable information pertinent to sample collection
- An Air Surveillance Network Sample Data Form documenting air sampler parameters, collection dates and times, and total sample volumes collected
- Chain-of-custody forms

This managed approach to sampling ensures that the sampling is traceable and enhances the value of the final data available to the project manager. The sample package also ensures that the station manager Community Environmental Monitor (CEM) (see Section 6.0 for description of CEMs) has followed proper procedures for sample collection. The CEMP Project Manager or QA Officer routinely performs assessments of the station managers and field monitors to ensure that standard operating procedures and sampling protocol are being followed properly.

Data obtained in the course of executing field operations are entered in the documentation accompanying the sample package during sample collection and in the CEMP database along with analytical results upon their receipt and evaluation.

Completed sample packages are kept as hard copy in file archives. Analytical reports are kept as hard copy in file archives as well as on read-only compact disks by calendar year. Analytical reports and databases are protected and maintained in accordance with the Desert Research Institute's (DRI's) Computer Protection Program.

19.4 Laboratory QA Oversight

CEMP ensures that DOE O 414.1C requirements are met with respect to laboratory services through review of the vendor laboratory policies formalized in a Laboratory Quality Assurance Plan (LQAP). CEMP is assured of obtaining quality data from laboratory services through a multifaceted approach involving specific procurement protocols, the conduct of quality assessments, and requirements for selected laboratories to have an acceptable QA program. These elements are discussed below.

19.4.1 Procurement

Laboratory services are procured through subcontracts. The subcontract establishes the technical specifications required of the laboratory and provides the basis for determining compliance with those requirements and evaluating overall performance. The subcontract is awarded on a "best value" basis as determined by pre-award audits. The prospective vendor is required to provide a review package to CEMP that includes the following items:

- All procedures pertinent to subcontract scope
- Environment, Safety, and Health Plan
- LQAP
- Example deliverables (hard copy and/or electronic)
- Proficiency testing (PT) results from the previous year from recognized PT programs
- Resumes
- Facility design/description
- Accreditations and certifications
- Licenses
- Audits performed by an acceptable DOE program covering comparable scope
- Past performance surveys
- Pricing

CEMP evaluates the review package in terms of technical capability. Vendor selection is based solely on these capabilities and not biased by pricing.

19.4.2 Initial and Continuing Assessment

An initial assessment of a laboratory is managed through the procurement process above, including a pre-award audit. Pre-award audits are conducted by CEMP (usually by the CEMP QA Officer). In no instance shall CEMP initiate work with a laboratory without approval of the CEMP Program Manager.

A continuing assessment of a selected laboratory involves ongoing monitoring of a laboratory's performance against the contract terms and conditions, of which technical specifications are a part. Tasks supporting continuing assessment are:

- Tracking schedule compliance
- Review of analytical data deliverables
- Monitoring of the laboratory's adherence to the LQAP
- Conducting regular audits
- Monitoring for continued successful participation in approved PT programs

19.4.3 Laboratory QA Program

The laboratory policies and approach to the implementation of DOE O 414.1C must be verified in a LQAP prepared by the laboratory. The elements of a LQAP required for the CEMP are similar to those required by National Security Technologies, LLC, for onsite monitoring, and are described in Section 18.3.3.

19.5 Data Review

Essential components of process-based QA are data checks, verification, validation, and data quality assessment to evaluate data quality and usability.

Data Checks – Data checks are conducted to ensure accuracy and consistency of field data collection operations prior to and upon data entry into CEMP databases and data management systems.

Data Verification – Data verification is defined as a subcontract compliance and completeness review to ensure that all laboratory data and sample documentation are present and complete. Sample preservation, chain-of-custody, and other field sampling documentation shall be reviewed during the verification process. Data verification ensures that the reported results entered in CEMP databases correctly represent the sampling and/or analyses performed and includes evaluation of quality control (QC) sample results.

Data Validation – Data validation is the process of reviewing a body of analytical data to determine if it meets the data quality criteria defined in operating instructions (OIs). Data validation ensures that the reported results correctly represent the sampling and/or analyses performed, determines the validity of the reported results, and assigns data qualifiers (or "flags"), if required. The process of data validation consists of:

- Evaluating the quality of the data to ensure that all project requirements are met
- Determining the impact on data quality of those requirements if they are not met
- Verifying compliance with QA requirements
- Checking QC values against defined limits
- Applying qualifiers to analytical results in the CEMP databases for the purposes of defining the limitations in the use of the reviewed data

OIs, procedures, applicable project specific work plans, field sampling plans, QAPPs, analytical method references, and laboratory statements of work may all be used in the process of data validation. Documentation of data validation includes checklists, qualifier assignments, and summary forms.

Data Quality Assessment – Data Quality Assessment (DQA) is the scientific evaluation of data to determine if the data obtained from environmental data operations are of the right type, quality, and quantity to support their intended use. DQA review is a systematic review against pre-established criteria to verify that the data are valid for their intended use.

19.6 QA Program Assessments

The overall effectiveness of the QA program is determined through management and independent assessment as defined in the CEMP QAPP. These assessments evaluate the plan execution work-flow (sampling plan development and execution, chain-of-custody, sample receiving, shipping, subcontract laboratory analytical activities, and data review) as well as program requirements as it pertains to the organization.

19.7 2008 Sample QA Results

QA procedures were performed by the CEMP, including the laboratories responsible for sample analyses. These assessments ensure that sample collection procedures, analytical techniques, and data provided by the subcontracted laboratories comply with CEMP requirements. Data were provided by Testamerica Laboratories and the University of Nevada, Las Vegas Radiation Services Laboratory (gross alpha/beta and gamma spectroscopy data), Global Dosimetry Solutions (thermoluminescent dosimeter [TLD] data), and the University of Miami Tritium Laboratory (tritium data). A brief discussion of the 2008 results for field duplicates, laboratory control samples, blank analyses, and inter-laboratory comparison studies is provided along with summary tables within this section. The 2008 CEMP radiological air and water monitoring data are presented in Section 6.0.

19.7.1 Field Duplicates (Precision)

A field duplicate is a sample collected, handled, and analyzed following the same procedures as the primary sample. The relative percent difference (RPD) between the field duplicate result and the corresponding field sample result is a measure of the variability in the process caused by the sampling uncertainty (matrix heterogeneity, collection variables, etc.) and measurement uncertainty (field and laboratory) used to arrive at a final result. The average absolute RPD, expressed as a percentage, was determined for the calendar year 2008 samples and is listed in Table 19-1. An RPD of zero indicates a perfect duplication of results of the duplicate pair, whereas an RPD greater than 100 percent generally indicates that a duplicate pair falls beyond QA requirements and are not considered valid for use in data interpretation. These samples are further evaluated to determine the reason for QA failure and if any corrective actions are required. Overall, the RPD values for all analyses indicate very good results, with only nine alpha duplicates exceeding an RPD of 100 percent.

Table 19-1. Summary of field duplicate samples for oversight monitoring in 2008

Analysis	Matrix	Number of Samples Reported[(a)]	Number of Samples Reported above MDC[(b)]	Average Absolute RPD of those above MDC (%)[(c)]
Gross Alpha	Air	117	117	66.1
Gross Beta	Air	117	117	32.2
Gamma - Beryllium-7	Air	12	12	12.2
Tritium	Water	7	4	1.9
TLDs	Ambient Radiation	11	11	5.0

(a) Represents the number of field duplicates reported for the purpose of monitoring precision. If an associated field sample was not processed, the field duplicate was not included in this table.

(b) Represents the number of field duplicate-field sample result sets reported above the minimum detectable concentration (MDC) (MDC is not applicable for TLDs). If either the field sample or its duplicate was reported below the detection limit, the precision was not determined.

(c) Reflects the average absolute RPD calculated for those field duplicates reported above the MDC. The absolute RPD calculation is as follows:

$$Absolute\ RPD = \frac{|FD - FS|}{(FD + FS)/2}\ X\ 100\%$$

Where: FD = Field duplicate result
FS = Field sample result

19.7.2 Laboratory Control Samples (Accuracy)

Laboratory control samples (LCSs) (also known as matrix spikes) are performed by the subcontract laboratory to evaluate analytical accuracy, which is the degree of agreement of a measured value with the true or expected value. Samples of known concentration are analyzed using the same methods as employed for the project samples. The results are determined as the measured value divided by the true value, expressed as a percent. To be considered valid, the results must fall within established control limits (or percentage range) for further analyses to be performed. The LCS results obtained for 2008 are summarized in Table 19-2. The LCS results were satisfactory with only 3 percent of the alpha and beta control samples falling outside of control parameters for the air sample matrix.

Table 19-2. Summary of laboratory control samples (LCS) for oversight monitoring in 2008

Analysis	Matrix	Number of LCS Results Reported	Number Within Control Limits[(a)]
Gross Alpha	Air	95	92
Gross Beta	Air	95	93
Gamma	Air	8	8
Tritium	Water	5	5

(a) Control limits are as follows: 80 to 120 percent for gross alpha, 80 to 120 percent for gross beta, 80 to 114 percent for gamma (^{137}Cs, ^{60}Co, ^{241}Am), 80 to 120 percent for tritium.

19.7.3 Blank Analysis

Laboratory blank sample analyses are essentially the opposite of control samples discussed in Section 19.7.2. These samples do not contain any of the analyte of interest. Results of these analyses are expected to be "zero," or more accurately, below the MDC of a specific procedure. Blank analysis and control samples are used to evaluate overall laboratory procedures, including sample preparation and instrument performance. The laboratory blank sample results obtained for 2008 are summarized in Table 19-3. The laboratory blank results were satisfactory with less than 5 percent of the alpha and beta blank samples outside of control parameters for the air sample matrix.

Table 19-3. Summary of laboratory blank samples for oversight monitoring in 2008

Analysis	Matrix	Number of Blank Results Reported	Number Within Control Limits[(a)]
Gross Alpha	Air	95	90
Gross Beta	Air	95	92
Gamma	Air	8	8
Tritium	Water	5	4

(a) Control limit is less than the MDC.

19.7.4 Inter-laboratory Comparison Studies

Inter-laboratory comparison studies are conducted by the subcontracted laboratories to evaluate their performance relative to other laboratories providing the same service. These types of samples are commonly known as "blind' samples, in which the expected values are known only to the program conducting the study. The analyses are evaluated and, if found satisfactory, the laboratory is certified that its procedures produce reliable results. The inter-laboratory comparison sample results obtained for 2008 are summarized in Tables 19-4 and 19-5.

Table 19-4 shows the summary of inter-laboratory comparison sample results for the Subcontract Radiochemistry Laboratories. The Laboratories participated in either the Quality Assurance Program administered by

Environmental Research Associates (ERA), the Mixed Analyte Performance Evaluation Program (MAPEP) for gross alpha, gross beta, and gamma analyses, and/or the International Atomic Energy Agency (IAEA) tritium inter-laboratory comparison study. The subcontractors performed very well during the year by passing all of the parameters analyzed.

Table 19-5 shows the summary of the in-house performance evaluation results conducted by the Subcontract Dosimetry Group. This internal evaluation was based on National Voluntary Laboratory Accreditation Program (NVLAP) criteria and was performed biannually. The Dosimetry Group performed very well during the year passing 20 out of 20 TLDs analyzed.

Table 19-4. Summary of inter-laboratory comparison samples of the subcontract radiochemistry laboratory for oversight monitoring in 2008

Analysis	Matrix	Number of Results Reported	Number Within Control Limits[(a)]
		MAPEP, ERA and IAEA Results	
Gross Alpha	Air	2	2
Gross Beta	Air	2	2
Gamma	Air	2	2
Tritium	Water	6	6

(a) Control limits are determined by the individual inter-laboratory comparison study.

Table 19-5. Summary of inter-laboratory comparison TLD samples of the subcontract dosimetry group for oversight monitoring in 2008

Analysis	Matrix	Number of Results Reported	Number Within Control Limits[(a)]
TLDs	Ambient Radiation	20	20

(a) Based upon NVLAP criteria; absolute value of the bias plus one standard deviation < 0.3.

Appendix A

Offsite Facilities

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Appendix A: Offsite Facilities

The U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) manages two facilities in Clark County, Nevada, that support NNSA/NSO missions on and off the Nevada Test Site (NTS). They include the North Las Vegas Facility (NLVF) and the Remote Sensing Laboratory (RSL)–Nellis (Figure A-1). This appendix describes all environmental monitoring and compliance activities conducted in 2008 at these offsite facilities.

A.1 North Las Vegas Facility

The NLVF is a fenced complex composed of 31 buildings that house much of the NTS project management, diagnostic development and testing, design, engineering, and procurement. The 32-hectare (80-acre) facility is located along Losee Road, a short distance west of Interstate 15 (Figure A-1). The facility is buffered on the north, south, and east by general industrial zoning. The western border separates the property from fully developed, single-family residential-zoned property. The NLVF is a controlled-access facility.

Environmental compliance and monitoring activities associated with this facility in 2008 included the maintenance of one wastewater permit, one National Pollutant Discharge Elimination System (NPDES) permit, one air quality operating permit, one hazardous materials permit (Table A-1), and the monitoring of tritium in air and ambient gamma-emissions to comply with radiation protection regulations.

Table A-1. Environmental permits for NLVF in 2008

Permit Number	Description	Expiration Date	Reporting
Wastewater Discharge			
VEH-112	NLVF Wastewater Contribution Permit	December 31, 2013	Annually
NV0023507	NLVF NPDES Permit	November 2, 2011	Quarterly
Air Quality			
Source 657, Modification (Mod.) 2/ Mod.3	Clark County Authority to Construct/Operating Permit for a Testing Laboratory (Mod 2.)/for a Nonmajor Commercial Building (Mod 3.)	None	March
Hazardous Materials			
2287-5144	NLVF Hazardous Materials Permit	February 28, 2009	Annually

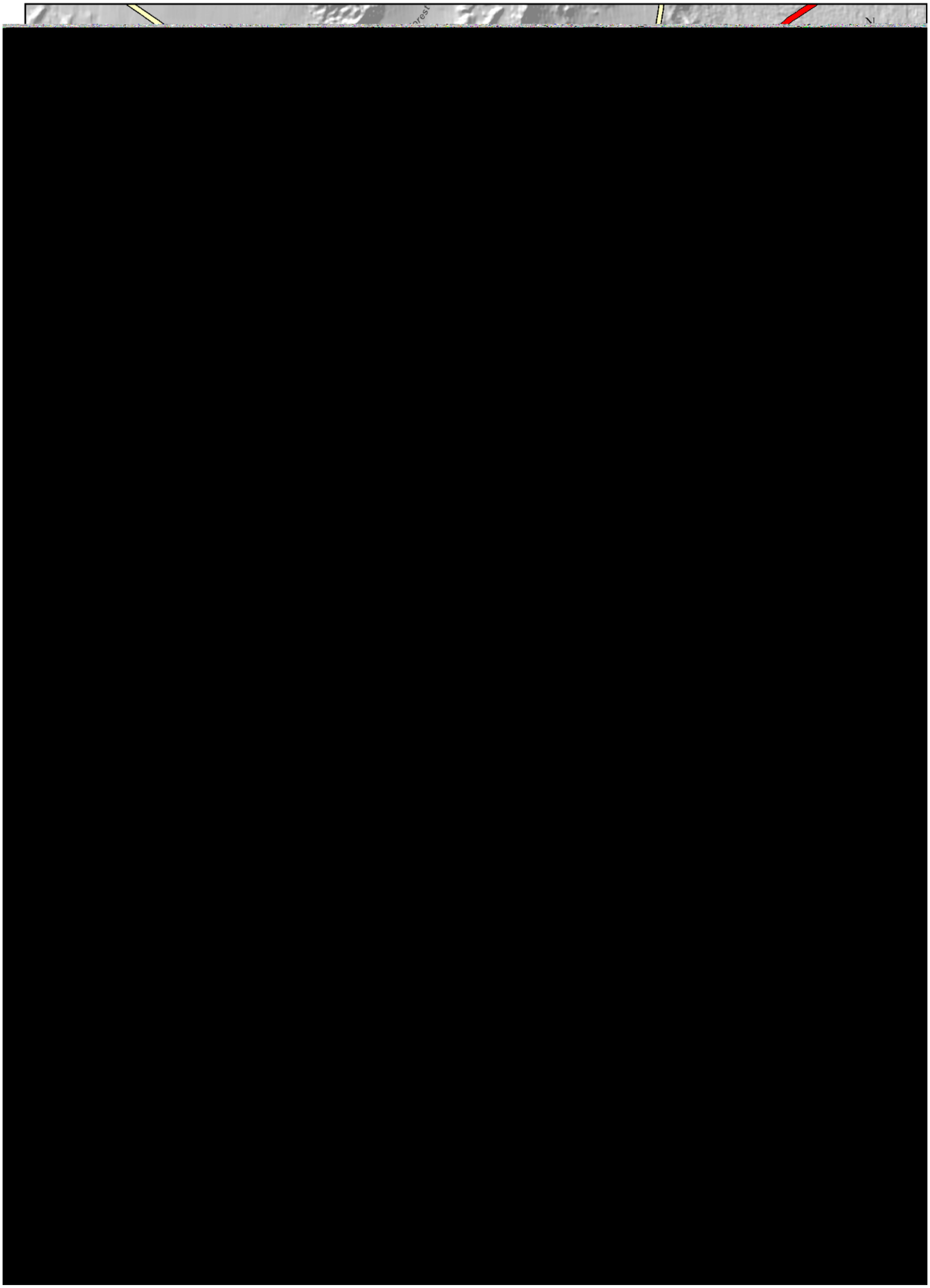
A.1.1 Compliance with Water Permits

Wastewater permits in 2008 for NLVF included a Class II Wastewater Contribution Permit with the City of North Las Vegas (CNLV) for sewer discharges and an NPDES permit issued by the U.S. Environmental Protection Agency (EPA) used in dewatering operations to control rising groundwater levels that surround the facility.

Discharges of sewage and industrial wastewater from NLVF are required to meet permit limits set by the CNLV. These limits support the permit limits for the Publicly Owned Treatment Works (POTW) operated by the City of Las Vegas. Regulations for wastewater discharges are codified in the municipal codes for both cities.

A.1.1.1 Wastewater Contribution Permit VEH-112

This permit specifies concentration limits for contaminants in domestic and industrial wastewater discharges. Self-monitoring and reporting of the levels of nonradiological contaminants in sewage and industrial outfalls is conducted. In 2008, contaminant concentrations (in milligrams per liter [mg/L]) were below the established permit limits in all water samples from the NLVF outfalls sampled (Table A-2). In compliance with this permit, a



[redacted]

Figure A-1. Location of NTS offsite facilities in Las Vegas and North Las Vegas

report summarizing wastewater monitoring was generated for NLVF operations and was submitted on October 27, 2008 to CNLV. The report is titled *Self-Monitoring Report for the National Nuclear Security Administration's North Las Vegas Facility: Permit VEH-112.*

Table A-2. Results of 2008 monitoring at NLVF for Wastewater Contribution Permit VEH-112

Contaminant	Permit Limit (mg/L)	Outfall A (mg/L)	Outfall B (mg/L)
Ammonia	61.0	12.2	20.0
Arsenic	2.3	0.0038	<0.0025
Barium	13.1	0.144	0.151
Beryllium	0.02	<0.00025	<0.00025
Cadmium	0.15	<0.00025	<0.00025
Chromium (hexavalent)	0.10	0.0003	0.0003
Chromium (total)	5.60	0.0012	0.0016
Copper	0.60	0.171	0.251
Cyanide (total)	19.9	<0.010	<0.0114
Lead	0.20	< 0.0015	<0.0015
Mercury	0.001	<0.00006	<0.00006
Nickel	1.10	0.0044	0.0041
Oil & Grease (animal or vegetable)	250	1.5	<1.0
Oil & Grease (mineral or petroleum)	100	<1.0	<1.0
Organophosphorus or carbamate compounds	1.0	<0.1	<0.1
pH (Standard Units)	5.0–11.0	8.22	8.17
Phenols	33.6	0.0083	0.0323
Phosphorus (total)	0.50	0.0045	0.0057
Selenium	2.70	< 0.0005	< 0.0005
Silver	8.20	0.255	0.224
Zinc	13.1	0.144	0.151

A.1.1.2 National Pollution Discharge Elimination System Permit NV0023507

An NPDES permit (NV0023507) covers the dewatering operation conducted at the NLVF (see Section A.1.2). Dewatering wells (NLVF-13s, -15, -16, -17) pump groundwater into a 39,747 liter (L) (10,500 gallon [gal]) storage tank (Figure A-2). The permit allows for the discharge of water from the storage tank to the groundwater of the state via percolation, when used for landscape irrigation and dust suppression, and into the Las Vegas Wash via direct discharge into the CNLV storm water drainage system. The permit defines the discharge source via percolation as "Outfall 001" and via the storm water drainage system as "Outfall 002." Water produced from the dewatering wells may also be used for purposes that do not require a groundwater discharge or an NPDES permit (e.g., evaporative cooling). In accordance with the permit, chemistry analyses are performed quarterly, annually, and biennially for water samples collected from the storage tank (Table A-3). The total quantities of groundwater produced and discharged and the results of groundwater chemistry analyses are reported quarterly to Nevada Division of Environmental Protection Bureau of Water Pollution Control.

In 2008, the four dewatering wells produced a total of about 9,664 L (2,553 gal) per day that were directed into the storage tank (Figure A-2). The pumping rates varied from 2.7 liters per minute (Lpm) (0.72 gallons per minute [gpm]) at Well NLVF-13s to 0.9 Lpm (0.24 gpm) at Wells NLVF-15 and NLVF-16. The average combined discharge from all four wells was about 295,000 L (78,000 gal) per month. Discharge rates did not exceed the NPDES permit limits (Table A-3). Quarterly and annual water samples from the holding tank had total petroleum hydrocarbons, total suspended solids, total dissolved solids, total inorganic nitrogen (as nitrogen [N]), pH, and tritium levels that were all below permit limits (Table A-3). Biennial water sampling for the presence of over 100 analytes (listed in Attachment A of the permit) began in January 2007. Therefore, no sampling for these analytes was conducted in 2008.

Figure A-2. **Location of dewatering and monitoring wells around Building A-1**

Table A-3. NPDES Permit NV0023507 monitoring requirements and 2008 sampling results

Parameter	Monitoring Requirements Sample Frequency	Monitoring Requirements Sample Type	Permit Discharge Limits Daily Maximum	Sample Results 1st Quarter	Sample Results 2nd Quarter	Sample Results 3rd Quarter	Sample Results 4th Quarter
Daily Maximum Flow (MGD) [(a)]	Continuous	Flow Meter	0.005184	0.002523	0.002647	0.002467	0.002595
Total Petroleum Hydrocarbons (mg/L)	Annually (4th Qtr)	Discrete	1.0	NS [(b)]	NS	NS	< 0.017*
Total Suspended Solids (mg/L)	Quarterly	Discrete	135	ND [(c)]	6	< 5*	< 5*
Total Dissolved Solids (mg/L)	Quarterly	Discrete	1900	760	966	917	879
Total Inorganic Nitrogen as N (mg/L)	Quarterly	Discrete	20.0	0.81	0.76	0.82	0.71
pH (S.U.) [(d)]	Quarterly	Discrete	6.5–9.0	7.58	7.63	8.25	8.09
Tritium (picocuries per liter [pCi/L])	Annually (4th Qtr)	Discrete	MR [(d)]	NS	NS	NS	< 13.1*
Permit Attachment A Analytes (mg/L):							
46 Base Neutral Extractables	Biennial	Discrete	MR	These analytes were not sampled in 2008. They were sampled in January 2007 (National Security Technologies, LLC [NSTec], 2008a) and in January 2009. The 2009 sample results will be reported in the 2009 NTS Environmental Report.			
12 Acid Extractables	Biennial	Discrete	MR				
28 Volatile Organics	Biennial	Discrete	MR				
25 Pesticides/PCBs [(e)]	Biennial	Discrete	MR				
Dioxins	Biennial	Discrete	MR				
13 Metals	Biennial	Discrete	MR				
Cyanide	Biennial	Discrete	MR				
Asbestos	Biennial	Discrete	MR				

(a) MGD = million gallons per day

(b) NS = not required to be sampled that quarter

(c) ND = not detected

(d) S.U. = Standard Unit

(d) MR = monitor and report

(e) PCBs = Polychlorinated biphenyls

*Values were less than the laboratory detection limits.

A.1.2 Groundwater Control and Dewatering Operation

During 2008, the groundwater control and dewatering project at the NLVF continued efforts to reduce the intrusion of groundwater below Building A-1. Since its inception in 2002, the project has transitioned from initial groundwater investigations and characterization phases to a long-term/permanent dewatering operational project. A review of the rising groundwater situation and past efforts to understand and remediate the problem is presented in previous reports (Bechtel Nevada [BN], 2003b; 2004b; 2005c; National Security Technologies, LLC [NSTec], 2006; 2008a).

Groundwater monitoring for this operation includes taking periodic water-level measurements at 29 NLVF monitoring wells, taking continuous water-level measurements at the A-1 Basement Sump well, measuring the total volume of discharged groundwater, and conducting groundwater chemistry analyses in accordance with the NPDES permit (see Section A.1.1.2). Groundwater data are assessed quarterly or as new data become available. This information is used to help characterize the groundwater situation, validate the conceptual hydrologic model, and evaluate the dewatering operation. The presence or absence of particular constituents or overall chemical signature could suggest or confirm source(s) of the rising near-surface groundwater. Water monitoring data are maintained in the NSTec Environmental Integrated Data Management System database.

In 2008, about 295,000 L (78,000 gal) per month were pumped from the dewatering wells. Groundwater also continued to be pumped from the A-1 Basement Sump well (Figure A-2), totaling about 935,235 L (247,070 gal) in 2008. When the A-1 Basement Sump well pump is active, the water level directly beneath Building A-1 is about 50 centimeters (cm) (20 inches [in.]) (below the basement floor, as measured in a monitoring tube installed outside a nearby elevator shaft. When the pump is active, water within the A-1 Basement Sump well itself is about 244 cm (96 in.) below the basement floor. When the A-1 Basement Sump well pump is turned off for short periods of three to six days, the water in the elevator shaft-monitoring tube rises 33 cm (13 in.), to 18 cm (7 in.) below the basement floor, and water in the A-1 Basement Sump well itself rises to within 76 cm (30 in.) of the basement floor. These water level measurements reflect a drop of roughly 61 cm (24 in.) in the local water table beneath Building A-1 since full-scale dewatering operations began in 2006.

However, the general trend in the 29 NLVF monitoring wells shows rising water levels, about 0.9 meters (3 feet) higher than levels obtained over the past three to five years. The dewatering efforts must counter this rising groundwater trend. Water levels in the closest monitoring well, NLVF-12s (Figure A-2), seem to be decreasing, however, presumably reflecting drawdown of the local water table due to the dewatering operations at Building A-1.

A.1.2.1 Discharge of Groundwater from Building A-1 Sump Well

During 2001, the sump well was installed in the basement of Building A-1 and used in operations to remediate tritium contamination in the basement that occurred in 1999 (BN, 2000). The discharge water, containing tritium, was disposed of at the NTS. The sump well was turned off after the remedial operations were completed. However, beginning in early 2003, the sump well has been used intermittently to help control the encroaching water below Building A-1. The water contains some residual tritium (1,900 pCi/L or about one-tenth of the Safe Drinking Water Act limit of 20,000 pCi/L) and it is kept separate with its own disposal process. The discharge is transported to the NTS during the winter, but during the warm months, the discharge is evaporated with an exterior array of evaporative units on the north side of Building A-1. In 2008, about 363,000 L (95,900 gal) were transported to the NTS for disposal during the winter and about 572,230 L (151,170 gal) were evaporated at the NLVF during the summer months. These measured quantities of water released through evaporation and the measured tritium concentrations in these waters allowed estimates of total curies released to the atmosphere in 2008 at the NTS (see Section 3.1.9, Table 3-13) and at the NLVF (see Section A.1.5.1).

A.1.3 Compliance with Air Quality Permits

Sources of air pollutants at the NLVF were regulated in 2008 by the Source 657 Authority to Construct/ Operating Permit for the emission of criteria pollutants (see Glossary, Appendix B) and hazardous air pollutants (HAPs). These pollutants include sulfur dioxide (SO_2), nitrogen oxide (NO_X), carbon monoxide (CO), particulate matter (PM), volatile organic compounds (VOCs), and any of 189 defined HAPs. The regulated sources of emissions at the NLVF include an aluminum sander, an abrasive blaster, emergency generators, and a spray paint booth.

An application to modify the permit by removing a diesel generator from it that had been previously stationed outside of Building B-3 was submitted to Clark County in March 2008. The modified permit was issued in April 2008. Another application to modify the permit by adding five cooling towers and two boilers was submitted to Clark County at the end of 2008. The Clark County Department of Air Quality and Environmental Management (DAQEM) requires submittal of an annual emissions inventory. The emissions inventory for 2008 was submitted to DAQEM on March 24, 2009. The estimated quantities of criteria air pollutants and HAPs emitted in 2008 are shown in Table A-4.

Table A-4. Tons of criteria air pollutant and HAPs emissions estimated for NLVF in 2008

Criteria Pollutant (Tons/yr)[a]					HAPs (Tons/yr)
CO	NO_x	PM10[b]	SO_2	VOC	
0.082	0.365	0.027	0.016	0.021	0.0002
Total Emissions = 0.511					

(a) 1 ton equals 0.91 metric tons
(b) Particulate matter equal to or less than 10 microns in diameter

A.1.4 Compliance with Hazardous Materials Regulations

In 2008, the chemical inventory at NLVF was updated and submitted to the State in the Nevada Combined Agency (NCA) Report on February 26, 2009, as per the requirements of the Hazardous Materials Permit 2287-5144 (see Section 2.5, Emergency Planning and Community Right-to-Know Act for description of content, purpose, and federal regulatory driver behind the NCA Report). No accidental or unplanned release of an extremely hazardous substance (EHS) occurred at NLVF in 2008. Also, no annual usage quantities of toxic chemicals kept at NLVF exceeded specified thresholds (see Section 2.5 concerning Toxic Chemical Release Inventory, Form R).

A.1.5 Compliance with Radiation Protection Regulations

A.1.5.1 National Emission Standards for Hazardous Air Pollutants (NESHAP)

In compliance with NESHAP of the Clean Air Act, NSTec assessed the radionuclide air emissions from the NLVF in 2008 and the resultant radiological dose to the public surrounding the facility. NESHAP establishes a dose limit for the general public to be no greater than 10 millirems per year (mrem/yr) from all radioactive air emissions. Building A-1's basement was contaminated with tritium in 1995 when a container of tritium foils was opened, emitting about 1 curie of tritium (U.S. Department of Energy, Nevada Operations Office, 1996). Complete cleanup of the tritium was unsuccessful due to the tritium being absorbed into the building materials. This has resulted in a continuous but decreasing release of tritium into the basement air space, which is ventilated to the outdoors. Since 1995, a dose assessment has been performed every year for this building.

In 2008, groundwater containing detectable levels of tritium were pumped from the sump well in the basement and allowed to evaporate from the array of evaporative units on the north side of the building during the summer months (see Figure A-2). The tritium concentration levels in the groundwater and the volume of groundwater diverted to the evaporative units were known and were used to compute total annual tritium emissions from the evaporative units. Also, two air samples were collected from the basement (from April 14 to 21 and from September 8 to 16) in order to compute average tritium emissions from the basement. A calculated annual total of 11.1 millicuries (mCi) were released from both the evaporative units (1.1 mCi) and the basement air being vented to the outside (10 mCi). Based on this emission rate, the calculated radiation dose to the nearest member of the general public from the NLVF, located about 100 m northwest of Building A-1, was very low at 0.00006 mrem/yr (Warren and Grossman, 2009). This is the same low public dose that was estimated in 2007 (NSTec, 2008a).

A.1.5.2 DOE O 5400.5

U.S. Department of Energy (DOE) Order DOE O 5400.5, "Radiation Protection of the Public and the Environment," specifies that the radiological dose to a member of the public from radiation from all pathways must not exceed 100 mrem/yr as a result of DOE activities. This dose limit does not include the dose contribution from natural background radiation. The Atlas A-1 Source Range Laboratory and the Building C-3 High Intensity Source Building are two NLVF facilities that use radioactive sources or where radiation-producing operations are conducted that have the potential to expose the general population or non-project personnel to direct radiation. NSTec's Environmental Technical Services (ETS) conducts direct radiation monitoring at these locations. ETS utilizes thermoluminescent dosimeters (TLDs) to monitor external gamma radiation exposure near the boundaries of these facilities. The methods of TLD use and data analyses are described in Section 5.0 of this report.

In 2008, radiation exposure was measured at two locations along the perimeter fence and at one control location. Annual exposure rates estimated from measurements at those NLVF locations are summarized in Table A-5. The radiation exposure in air measured by the TLDs in units of milliroentgens per year (mR/yr) is approximately equivalent to the unit of mrem/yr for tissue. These exposures include contributions from background radiation and are similar to the TLD measurement of 94 mR/yr for total annual exposure reported by the Desert Research Institute from their Las Vegas air monitoring station (see Section 6.1.2, Table 6-3). The NLVF TLD results indicate that facility activities do not contribute a radiological dose to the surrounding public that can be distinguished from that of background radiation.

Table A-5. Results of 2008 direct radiation exposure monitoring at NLVF

		Gamma Exposure (milliroentgens per year [mR/yr])			
Location	**Number of Samples**	**Mean**	**Median**	**Minimum**	**Maximum**
Control (along west fence of Building C-1)	4	91	93	83	97
North Fence of Building A-1	4	92	93	83	97
North Fence of Building C-3	4	92	93	83	97

A.2 Remote Sensing Laboratory-Nellis

RSL-Nellis is approximately 13.7 kilometers (km) (8.5 miles [mi]) northeast of the Las Vegas city center, and approximately 11.3 km (7 mi) northeast of NLVF. It occupies six facilities on approximately 14 secured hectares (35 acres) at the Nellis Air Force Base. The six NNSA/NSO facilities were constructed on property owned by the U.S. Air Force (USAF). There is a Memorandum of Agreement between the USAF and the NNSA/NSO whereby the land belongs to the USAF, but is under lease to the NNSA/NSO for 25 years (as of 1989) with an option for a 25-year extension. The facilities are owned by NNSA/NSO. RSL-Nellis provides emergency response resources for weapons-of-mass-destruction incidents. The laboratory also designs and field tests counterterrorism/intelligence technologies and has the capability to assess environmental and facility conditions using complex radiation measurements and multi-spectral imaging technologies.

Environmental compliance and monitoring activities at RSL-Nellis in 2008 included maintenance of a wastewater contribution permit, an air quality permit, a hazardous materials permit, and a waste management permit (Table A-6). Sealed radiation sources are used for calibration at RSL-Nellis, but the public has no access to any area that may have elevated gamma radiation emitted by the sources. Therefore, no environmental TLD monitoring is conducted. However, dosimetry monitoring to ensure protection of personnel who work within the facility is performed.

Table A-6. Environmental permits for RSL-Nellis in 2008

Permit Number	Description	Expiration Date	Reporting
Wastewater Discharge			
CCWRD-080	Industrial Wastewater Discharge Permit	June 30, 2008	March, May, September, December
Air Quality			
Facility 348, Mod. 2	Clark County Authority to Construct/Operating Permit for a Testing Laboratory	None	March
Hazardous Materials			
2287-5145	RSL-Nellis Hazardous Materials Permit	February 28, 2009	Annually
Waste Management			
U1576-33N-01	RSL-Nellis Waste Management Permit-Underground Storage Tank	December 31, 2008	None

A.2.1 Compliance with Wastewater Contribution Permit CCWRD-080

Discharges of wastewater from RSL-Nellis are required to meet permit limits set by the Clark County Water Reclamation District (CCWRD). These limits support the permit limits for the POTW operated by Clark County. The wastewater permit for this facility requires quarterly monitoring and reporting. Table A-7 presents the mean concentration of outfall measurements collected once per quarter in 2008. All contaminants in the outfall samples were below permit limits. Quarterly reports were submitted on March 12, May 14, September 15, and December 11, 2008, to the CCWRD. The CCWRD also conducted two inspections of RSL-Nellis in 2008. The inspections resulted in no findings or corrective actions for the facility.

Table A-7. Mean concentration of outfall measurements at RSL-Nellis in 2008

Contaminant/Measure	Permit Limit (mg/L)	Outfall (mg/L)
Ammonia	NL[(a)]	19.25
Cadmium	0.35	0.00053
Chromium (Total)	1.7	0.0017
Copper	3.36	0.276
Cyanide (Total)	1	0.015
Lead	0.99	0.002
Nickel	10.08	0.0048
Phosphorus	NL[(a)]	3.90
Silver	6.3	0.0008
TDS	NL[(a)]	1,585
TSS	NL[(a)]	162.3
Zinc	23.06	0.467
pH (Standard Units)	5.0–11.0	8.38
Temperature (Degrees Fahrenheit)	140	74.0

(a) No limit listed on permit

A.2.2 Compliance with Air Quality Permits

Sources of air pollutants at RSL-Nellis are regulated by the Facility 348 Authority to Construct/Operating Permit for the emission of criteria pollutants and HAPs (see Glossary, Appendix B). The regulated sources include boilers, water heaters, emergency generators, a spray paint booth, and a vapor degreaser. On November 13, 2008, the DAQEM conducted an inspection of the equipment regulated by the permit. The inspector was pleased with the records and logbooks maintained by RSL-Nellis; however, it was noted that two cooling towers were not included in the permit. A letter of noncompliance was issued by DAQEM on November 18, 2008, which required NNSA/NSO to modify the permit to add the cooling towers. No monetary fines or violations were issued. An application to modify the permit was submitted to DAQEM on December 16, 2008. The new permit was issued July 21, 2009. The DAQEM requires submittal of the annual emissions inventory. The estimated quantities of criteria air pollutants and HAPs emitted at RSL-Nellis in 2008 are presented in Table A-8. Natural gas consumption is also reported as per the requirements of the consolidated air permit issued for RSL-Nellis. The emissions inventory for 2008 was submitted to DAQEM on March 24, 2009.

Table A-8. Summary of air emissions for RSL-Nellis in 2008

Criteria Pollutant (Tons/yr)[(a)]					HAPs (Tons/yr)	Natural Gas Consumption (ft^3) [(c)]
CO	**NO_x**	**PM10[(b)]**	**SO_2**	**VOC**		
0.217	0.426	0.025	0.009	0.023	0.004	3,777,100
Total Emissions of Pollutants = 0.704						

(a) 1 ton equals 0.91 metric tons
(b) Particulate matter equal to or less than 10 microns in diameter
(c) Cubic feet

A.2.3 Compliance with Hazardous Materials Regulations

In 2008, the chemical inventory at RSL-Nellis was updated and submitted to the state in the NCA Report on February 26, 2009, as per the requirements of the Hazardous Materials Permit 2287-5145 (see Section 2.5 of this report for description of content, purpose, and federal regulatory driver behind the NCA Report). No accidental or unplanned release of an EHS occurred at RSL-Nellis in 2008. Also, no annual usage quantities of toxic chemicals kept at RSL-Nellis exceeded specified thresholds (see Section 2.5 concerning Toxic Chemical Release Inventory, Form R).

A.2.4 Compliance with Waste Management Regulations

The underground storage tank program at RSL-Nellis consists of two active permitted tanks (gasoline/diesel fuel), one inactive tank (empty used oil tank), one deferred tank (as per Title 40 Code of Federal Regulations Part 280.10(d)) for emergency power generation, and three unregulated tanks. The permitted and deferred tanks are located at Building 2211. The fuel tanks were retrofitted with spill/overflow protection in 1998. They are inspected annually by the Southern Nevada Health District. No deficiencies were noted during the 2008 health district's inspection at RSL-Nellis. As-built engineering drawings of the permitted tanks were provided to the health district at their request.

Appendix B: Glossary of Terms

A **Absorbed dose:** the amount of energy imparted to matter by ionizing radiation per unit mass of irradiated material, in which the absorbed dose is expressed in units of rad or gray (l rad equals 0.01 gray).

Accuracy: the closeness of the result of a measurement to the true value of the quantity measured.

Action level: defined by regulatory agencies, the level of pollutants which, if exceeded, requires regulatory action.

Alluvium: a sediment deposited by flowing water.

Alpha particle: a positively charged particle emitted from the nucleus of an atom, having mass and charge equal to those of a helium nucleus (two protons and two neutrons), usually emitted by transuranic elements.

Analyte: the specific component measured in a chemical analysis.

Aquifer: a saturated layer of rock or soil below the ground surface that can supply usable quantities of groundwater to wells and springs, and be a source of water for domestic, agricultural, and industrial uses.

Atom: the smallest particle of an element capable of entering into a chemical reaction.

B **Background:** as used in this report, background is the term for the amounts of chemical constituents or radioactivity in the environment that are not caused by Nevada Test Site operations.

Becquerel (Bq): the International System of Units unit of activity of a radionuclide, equal to the activity of a radionuclide having one spontaneous nuclear transition per second.

Beta particle: a negatively charged particle emitted from the nucleus of an atom, having charge, mass, and other properties of an electron, emitted from fission products such as cesium-137.

Biological oxygen demand (BOD): a measure of the amount of dissolved oxygen that microorganisms need to break down organic matter in water; used as an indicator of water quality.

C **CAP88-PC:** a computer code required by the U.S. Environmental Protection Agency for modeling air emissions of radionuclides.

Code of Federal Regulations (CFR): a codification of all regulations promulgated by federal government agencies.

Collective population dose: the sum of the total effective dose equivalents of all individuals within a defined population. The unit of collective population dose is person-rem or person-sievert. Collective population dose may also be referred to as "collective effective dose equivalent" or simply "population dose."

Committed dose equivalent: the dose equivalent to a tissue or organ over a 50-year period after an intake of a radionuclide into the body. Committed dose equivalent is expressed in units of rem or sievert.

Committed effective dose equivalent (CEDE): the sum of the committed dose equivalents to various tissues in the body, each multiplied by an appropriate weighting factor representing the relative vulnerability of different parts of the body to radiation. Committed effective dose equivalent is expressed in units of rem or sievert.

Compliance Level (CL): the Clean Air Act National Emission Standards for Hazardous Air Pollutants Concentration Level for Environmental Compliance. The CL value represents the annual average concentration that would result in a dose of 10 millirem per year, which is the federal dose limit to the public from all radioactive air emissions.

Cosmic radiation: radiation with very high energies originating outside the earth's atmosphere; it is one source contributing to natural background radiation.

Criteria pollutants: those air pollutants designated by the U.S. Environmental Protection Agency as potentially harmful and for which National Ambient Air Quality Standards under the Clean Air Act have been established to protect the public health and welfare. These pollutants include sulfur dioxide (SO_2), nitrogen oxides (NO_X), carbon monoxide (CO), ozone, lead, and particulate matter equal to or less than 10 microns in diameter (PM10). The State of Nevada, through an air quality permit, establishes emission limits on the Nevada Test Site for SO_2, NO_X, CO, PM10, and volatile organic compounds (VOCs). Ozone is not regulated by the permit as an emission as it is formed in part from NO_X and VOCs. Lead is considered a hazardous air pollutant (HAP) as well as a criteria pollutant, and lead emissions on the Nevada Test Site are reported as part of the total HAP emissions. Lead emissions above a specified threshold are also reported under Section 313 of the Emergency Planning and Community Right-to-Know Act.

Curie (Ci): a unit of measurement of radioactivity, defined as the amount of radioactive material in which the decay rate is 3.7×10^{10} disintegrations per second or 2.22×10^{12} disintegrations per minute; one Ci is approximately equal to the decay rate of one gram of pure radium.

D **Daughter nuclide:** a nuclide formed by the radioactive decay of another nuclide, which is called the parent.

Decision level: the counts of radioactivity (or concentration level of a radionuclide) in a sample that must be exceeded before there is a specified level of confidence (typically 95 or 99 percent) that the sample contains radioactive material above the background; also known as the Critical Level (L_C).

Depleted uranium: uranium having a lower proportion of the isotope ^{235}U than is found in naturally occurring uranium. The masses of the three uranium isotopes with atomic weights 238, 235, and 234 occur in depleted uranium in the weight-percentages 99.8, 0.2, and 5×10^{-4}, respectively; see Table 3-7 and related discussion.

Derived Concentration Guide (DCG): concentrations of radionuclides in water and air that could be continuously consumed or inhaled for one year and not exceed the U.S. Department of Energy primary radiation dose limit to the public of 100 millirem per year effective dose equivalent.

Dose: the energy imparted to matter by ionizing radiation; the unit of absorbed dose is the rad, equal to 0.01 joules per kilogram for irradiated material in any medium.

Dose equivalent: the product of absorbed dose in rad (or gray) in tissue and a quality factor representing the relative damage caused to living tissue by different kinds of radiation, and perhaps other modifying factors representing the distribution of radiation, etc., expressed in units of rem or sievert.

Dosimeter: a portable detection device for measuring the total accumulated exposure to ionizing radiation.

Dosimetry: the theory and application of the principles and techniques of measuring and recording radiation doses.

E **Effective dose equivalent (EDE):** an estimate of the total risk of potential effects from radiation exposure; it is the summation of the products of the dose equivalent and weighting factor for each tissue. The weighting factor is the decimal fraction of the risk arising from irradiation of a selected tissue to the total risk when the whole body is irradiated uniformly to the same dose equivalent. These factors permit dose equivalents from non-uniform exposure of the body to be expressed in terms of an EDE that is numerically equal to the dose from a uniform exposure of the whole body that entails the same risk as the internal exposure. The EDE includes the committed effective dose equivalent from internal deposition of radionuclides and the EDE caused by penetrating radiation from sources external to the body, and is expressed in units of rem or sievert.

Effluent: used in this report to refer to a liquid discharged to the environment.

Emission: used in this report to refer to a vapor, gas, airborne particulate, or radiation discharged to the environment via the air.

Environmental Impact Statement (EIS): a detailed report, required by the National Environmental Policy Act, on the environmental impacts from a federally approved or funded project. An EIS must be prepared by a federal agency when a "major" federal action that will have "significant" environmental impacts is planned.

F

Federal facility: a facility that is owned or operated by the federal government, subject to the same requirements as other responsible parties when placed on the Superfund National Priorities List.

Federal Register: a document published daily by the federal government containing notification of government agency actions, including notification of U.S. Environmental Protection Agency and U.S. Department of Energy decisions concerning permit applications and rule-making.

Fiscal year: the U.S. Department of Energy, National Nuclear Security Agency Nevada Site Office's fiscal year is from October 1 through September 30.

G

Gamma ray: high-energy, short-wavelength, electromagnetic radiation emitted from the nucleus of an atom, frequently accompanying the emission of alpha or beta particles.

Gray (Gy): the International System of Units unit of measure for absorbed dose; the quantity of energy imparted by ionizing radiation to a unit mass of matter, such as tissue. One gray equals 100 rads, or 1 joule per kilogram.

Gross alpha: the measure of radioactivity caused by all radionuclides present in a sample that emit alpha particles. Gross alpha measurements reflect alpha activity from all sources, including those that occur naturally. Gross measurements are used as a method to screen samples for relative levels of radioactivity.

Gross beta: the measure of radioactivity caused by all radionuclides present in a sample that emit beta particles. Gross beta measurements reflect beta activity from all sources, including those that occur naturally. Gross measurements are used as a method to screen samples for relative levels of radioactivity.

H

Half-life: the time required for one-half the radioactive atoms in a given amount of material to decay; for example, after one half-life, half of the atoms will have decayed; after two half-lives, three-fourths; after three half-lives, seven-eighths; and so on, exponentially.

Hazardous waste: hazardous wastes exhibit any of the following characteristics: ignitability, corrosivity, reactivity, or Extraction Procedure toxicity (yielding excessive levels of toxic constituents in a leaching test), but other wastes that do not necessarily exhibit these characteristics have been determined to be hazardous by the U.S. Environmental Protection Agency (EPA). Although the legal definition of hazardous waste is complex, according to EPA, the term generally refers to any waste that, if managed improperly, could pose a threat to human health and the environment.

High-efficiency particulate air (HEPA) filter: a throwaway, extended-media, dry-type filter used to capture particulates in an air stream; HEPA collection efficiencies are at least 99.97 percent for 0.3-micrometer diameter particles.

Hydrology: the science dealing with the properties, distribution, and circulation of natural water systems.

I

Inorganic compounds: compounds that either do not contain carbon or do not contain hydrogen along with carbon, including metals, salts, various carbon oxides (e.g., carbon monoxide and carbon dioxide), and cyanide.

Instrument detection limit (IDL): the lowest concentration that can be detected by an instrument without correction for the effects of sample matrix or method-specific parameters such as sample preparation. IDLs are explicitly determined and generally defined as three times the standard deviation of the mean noise level. This represents 99 percent confidence that the signal is not random noise.

Interim status: a legal classification allowing hazardous waste incinerators or other hazardous waste management facilities to operate while the U.S. Environmental Protection Agency considers their permit applications, provided that they were under construction or in operation by November 19, 1980, and can meet other interim status requirements.

International System of Units (SI): an international system of physical units that includes meter (length), kilogram (mass), kelvin (temperature), becquerel (radioactivity), gray (radioactive dose), and sievert (dose equivalent). The abbreviation, SI, comes from the French term Système International d'Unités.

Isotopes: forms of an element having the same number of protons in their nuclei, but differing numbers of neutrons.

L **L_C:** the counts of radioactivity (or concentration level of a radionuclide) in a sample that must be exceeded before there is a specified level of confidence (typically 95 or 99 percent) that the sample contains radioactive material above the background; called the Critical Level (L_C) or the decision level.

Less than detection limits: a phrase indicating that a chemical constituent or radionuclide was either not present in a sample, or is present in such a small concentration that it cannot be measured as significantly different from zero by a laboratory's analytical procedure and, therefore, is not identified at the lowest level of sensitivity.

Low-level radioactive waste (LLW): waste, defined by U.S. Department of Energy Order DOE O 435.1 that contains transuranic nuclide concentrations less than 100 nanocuries per gram.

Lower limit of detection: the smallest concentration or amount of analyte that can be detected in a sample at a 95-percent confidence level.

Lysimeter: an instrument for measuring the water percolating through soils and determining the dissolved materials.

M **Maximally exposed individual (MEI):** a hypothetical member of the public at a fixed location who, over an entire year, receives the maximum effective dose equivalent (summed over all pathways) from a given source of radionuclide releases to air. Generally, the MEI is different for each source at a site.

Maximum contaminant level (MCL): the highest level of a contaminant in drinking water that is allowed by U.S. Environmental Protection Agency regulation.

Minimum detectable concentration (MDC): also known as the lower limit of detection, the smallest amount of radioactive material in a sample that can be quantitatively distinguished from background radiation in the sample with 95 percent confidence.

Metric units: metric units, U.S. customary units, and their respective equivalents are shown in Table 1-6. Except for temperature for which specific equations apply, U.S. customary units can be determined from metric units by multiplying the metric units by the U.S. customary equivalent. Similarly, metric units can be determined from U.S. customary equivalent units by multiplying the U.S. customary units by the metric equivalent.

Mixed waste (MW): waste that has the properties of both hazardous and radioactive waste.

N **National Emission Standards for Hazardous Air Pollutants (NESHAP):** standards found in the Clean Air Act that set limits for hazardous air pollutants.

National Pollutant Discharge Elimination System (NPDES): a federal regulation under the Clean Water Act that requires permits for discharges into surface waterways.

Nuclide: any species of atom that exists for a measurable length of time. A nuclide can be distinguished by its atomic mass, atomic number, and energy state.

O **Offsite:** for effluent releases or in the nuclear testing area, any place outside the Nevada Test Site and adjacent Nevada Test and Training Range.

Onsite: for effluent releases or in the nuclear testing area, any place inside the Nevada Test Site and adjacent Nevada Test and Training Range.

P **Part B Permit:** the second, narrative section submitted by generators in the Resource Conservation and Recovery Act permitting process that covers in detail the procedures followed at a facility to protect human health and the environment.

Parts per million (ppm): a unit of measure for the concentration of a substance in its surrounding medium; for example, one million grams of water containing one gram of salt has a salt concentration of 1 ppm.

Perched aquifer: an aquifer that is separated from another water-bearing stratum by an impermeable layer.

Performance standards (incinerators): specific regulatory requirements established by the U.S. Environmental Protection Agency limiting the concentrations of designated organic compounds, particulate matter, and hydrogen chloride in incinerator emissions.

pH: a measure of hydrogen ion concentration in an aqueous solution. Acidic solutions have a pH from 0 to 7, basic solutions have a pH greater than 7, and neutral solutions have a pH of 7.

PM10: a fine particulate matter with an aerodynamic diameter equal to or less than 10 microns.

Point source: any confined and discrete conveyance (e.g., pipe, ditch, well, or stack).

Q **Quality assurance (QA):** a system of activities whose purpose is to provide the assurance that standards of quality are attained with a stated level of confidence.

Quality control (QC): procedures used to verify that prescribed standards of performance are attained.

Quality factor: the factor by which the absorbed dose (rad) is multiplied to obtain a quantity that expresses (on a common scale for all ionizing radiation) the biological damage to exposed persons, usually used because some types of radiation, such as alpha particles, are biologically more damaging than others. Quality factors for alpha, beta, and gamma radiation are in the ratio 20:1:1.

R **Rad:** the unit of absorbed dose and the quantity of energy imparted by ionizing radiation to a unit mass of matter such as tissue; equal to 0.01 joule per kilogram, or 0.01 gray.

Radioactive decay: the spontaneous transformation of one radionuclide into a different nuclide (which may or may not be radioactive), or de-excitation to a lower energy state of the nucleus by emission of nuclear radiation, primarily alpha or beta particles, or gamma rays (photons).

Radioactivity: the spontaneous emission of nuclear radiation, generally alpha or beta particles, or gamma rays, from the nucleus of an unstable isotope.

Radionuclide: an unstable nuclide. See nuclide and radioactivity.

Rem: a unit of radiation dose equivalent and effective dose equivalent describing the effectiveness of a type of radiation to produce biological effects; coined from the phrase "roentgen equivalent man," and the product of the absorbed dose (rad), a quality factor (Q), a distribution factor, and other necessary modifying factors. One rem equals 0.01 sievert.

Risk assessment: the use of established methods to measure the risks posed by an activity or exposure by evaluating the relationship between exposure to radioactive substances and the subsequent occurrence of health effects and the likelihood for that exposure to occur.

Roentgen (R): a unit of measurement used to express radiation exposure in terms of the amount of ionization produced in a volume of air.

S **Sanitary waste:** most simply, waste generated by routine operations that is not regulated as hazardous or radioactive by state or federal agencies.

Saturated zone: a subsurface zone below which all rock pore-space is filled with water; also called the phreatic zone.

Sensitivity: the capability of methodology or instrumentation to discriminate between samples having differing concentrations or containing varying amounts of analyte.

Sievert (Sv): the International System of Units unit of radiation dose equivalent and effective dose equivalent, that is the product of the absorbed dose (gray), quality factor, distribution factor, and other necessary modifying factors; 1 Sv equals 100 rem.

Source term: the amount of a specific pollutant emitted or discharged to a particular medium, such as the air or water, from a particular source.

Specific conductance: the measure of the ability of a material to conduct electricity; also called conductivity.

Subcritical experiment: an experiment using high explosives and nuclear weapon materials (including special nuclear materials like plutonium) to gain data used to maintain the nuclear stockpile without conducting nuclear explosions banned by the Comprehensive Test Ban Treaty.

T **Thermoluminescent dosimeter (TLD):** a device used to measure external beta or gamma radiation levels, and which contains a material that, after exposure to beta or gamma radiation, emits light when processed and heated.

Total dissolved solids (TDS): the total mass of particulate matter per unit volume that is dissolved in water and that can pass through a very fine filter.

Total organic carbon (TOC): the sum of the organic material present in a sample.

Total organic halides (TOX): the sum of the organic halides present in a sample.

Total suspended solids (TSS): the total mass of particulate matter per unit volume suspended in water and wastewater discharges that is large enough to be collected by a very fine filter.

Transpiration: a process by which water is transferred from the soil to the air by plants that take the water up through their roots and release it through their leaves and other aboveground tissue.

Tritium: a radioactive isotope of hydrogen, containing one proton and two neutrons in its nucleus, which decays at a half-life of 12.3 years by emitting a low-energy beta particle.

Transuranic (TRU) waste: material contaminated with alpha-emitting transuranium nuclides that have an atomic number greater than 92 (e.g., ^{239}Pu), half-lives longer than 20 years, and are present in concentrations greater than 100 nanocuries per gram of waste.

U **Uncertainty:** the parameter associated with a sample measurement that characterizes the range of the measurement that could reasonably be attributed to the sample. Used in this report, the uncertainty value is established at ± 2 standard deviations.

Unsaturated zone: that portion of the subsurface in which the pores are only partially filled with water and the direction of water flow is vertical; is also referred to as the vadose zone.

V **Vadose zone:** the partially saturated or unsaturated region above the water table that does not yield water to wells.

Volatile organic compound (VOC): liquid or solid organic compounds that have a high vapor pressure at normal pressures and temperatures and thus tend to spontaneously pass into the vapor state.

W **Waste accumulation area (WAA):** an officially designated area that meets current environmental standards and guidelines for temporary (less than 90 days) storage of hazardous waste before offsite disposal.

Wastewater treatment system: a collection of treatment processes and facilities designed and built to reduce the amount of suspended solids, bacteria, oxygen-demanding materials, and chemical constituents in wastewater.

Water table: the water-level surface below the ground at which the unsaturated zone ends and the saturated zone begins, and the level to which a well that is screened in the unconfined aquifer would fill with water.

Weighting factor: a tissue-specific value used to calculate dose equivalents that represents the fraction of the total health risk resulting from uniform, whole-body irradiation that could be contributed to that particular tissue. The weighting factors used in this report are recommended by the International Commission on Radiological Protection.

Wind rose: a diagram that shows the frequency and intensity of wind from different directions at a specific location.

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Appendix C: Acronyms and Abbreviations

ac	acre(s)
AEA	Atomic Energy Act
AEC	Atomic Energy Commission
ALARA	as low as reasonably achievable
^{241}Am	americium-241
AP	air particulate
ARL/SORD	Air Resources Laboratory, Special Operations and Research Division
ARPA	Archaeological Resources Protection Act
ASER	Annual Site Environmental Report
ASN	Air Surveillance Network
ATM	Atomic Testing Museum
B	background
BAPC	Bureau of Air Pollution Control
BCG	Biota Concentration Guide
Be	beryllium
BEEF	Big Explosives Experimental Facility
BFF	Bureau of Federal Facilities
bgs	below ground surface
BHPS	Bureau of Health Protection Services
BLM	Bureau of Land Management
BN	Bechtel Nevada
BOA	Basic Ordering Agreement
BOD	biological oxygen demand
Bq	Becquerel
Bq/m^3	Becquerels per cubic meter
BREN	Bare Reactor Experiment - Nevada
BSDW	Bureau of Safe Drinking Water
C	control
$^{\circ}C$	degree(s) Celsius
^{14}C	carbon-14
CA	Composite Analysis
CAA	Clean Air Act
CAB	Community Advisory Board
CADD	Corrective Action Decision Document
CAI	corrective action investigation
CAIP	Corrective Action Investigation Plan
CAP	Corrective Action Plan
CAPP	Chemical Accident Prevention Program
CAP88-PC	Clean Air Package 1988
CAS	Corrective Action Site
CAU	Corrective Action Unit
CCWRD	Clark County Water Reclamation District
CEDE	committed effective dose equivalent
CEM	Community Environmental Monitor
CEMP	Community Environmental Monitoring Program
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CESGQ	conditionally exempt small quantity generator
CFR	Code of Federal Regulations
CGTO	Consolidated Group of Tribes and Organizations
Ci	curie(s)
Ci/yr	curie(s) per year
CL	compliance level (used in text for the Clean Air Act National Emission Standards for Hazardous Pollutants Concentration Level for

DNWR	Desert National Wildlife Refuge
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOECAP	U.S. Department of Energy Consolidated Audit Program
DOE/HQ	U.S. Department of Energy Headquarters
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
DQA	Data Quality Assessment
DQO	Data Quality Objectives
DRI	Desert Research Institute
DTRA	Defense Threat Reduction Agency
DU	depleted uranium
EA	Environmental Assessment
EDE	effective dose equivalent
EHS	extremely hazardous substance
EIS	Environmental Impact Statement
EMAC	Ecological Monitoring and Compliance
EMS	Environmental Management System
EO	Executive Order
EODU	Explosive Ordnance Disposal Unit
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EPEAT	Electronic Product Environmental Assessment Tool
ER	Environmental Restoration
ERA	Environmental Research Associates
ERP	Environmental Restoration Project
ES	Environmental Services
ES&H	Environment, Safety, and Health
ESA	Endangered Species Act
ESH&Q	Environment, Safety, Health, and Quality
ETDS	E-Tunnel Waste Water Disposal System
ETS	Environmental Technical Services
Eu	europium
EWG	Environmental Working Group
°F	degree(s) Fahrenheit
FD	field duplicate
FFACO	Federal Facility Agreement and Consent Order
FFCA	Federal Facility Compliance Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
ft	foot or feet
ft^2	square feet
ft^3	cubic feet
FWS	U.S. Fish and Wildlife Service
FY	fiscal year
g	gram(s)
gal	gallon(s)
GCD	Greater Confinement Disposal
GIS	Geographic Information System
gpm	gallon(s) per minute
Gy	gray(s)
Gy/d	gray(s) per day
^3H	tritium
ha	hectare(s)
HA	Hazard Assessment
HAA	haloacetic acid
HAP	hazardous air pollutant
HCQC	Bureau of Health Care Quality and Compliance
HENRE	High-Energy Neutron Reactions Experiment
HEPA	high-efficiency particulate air
HPSB	High Performance Sustainable Building
hr	hour(s)
HRMP	Hydrologic Resources Management Program
HTO	tritiated water
HW	hazardous waste
HWAA	Hazardous Waste Accumulation Area
HWSU	Hazardous Waste Storage Unit
ICPT	Integrated Contractor Purchasing Team
ID	identification number
IDL	instrument detection limit
IL	investigation level
in.	inch(es)
INL	Idaho National Laboratory
ISMS	Integrated Safety Management System
ISO	International Organization for Standardization

IT	International Technology Corporation
JASPER	Joint Actinide Shock Physics Experimental Research
K	potassium
kg	kilogram(s)
kg/d	kilogram(s) per day
km	kilometer(s)
km^2	square kilometer(s)
L	liter(s)
LANL	Los Alamos National Laboratory
lb	pound(s)
L_C	Critical Level (synonymous with Decision Level)
LCA	lower carbonate aquifer
LCS	laboratory control sample
L/d	liter(s) per day
LLMW	low-level radioactive mixed waste
LLNL	Lawrence Livermore National Laboratory
LLW	low-level radioactive waste
L/min	liter(s) per minute
log	logarithmic
Lpm	liter(s) per minute
LQAP	Laboratory Quality Assurance Plan
LRQA	Lloyd's Register Quality Assurance
µCi	microcurie(s)
µCi/mL	microcurie(s) per milliliter
µg/L	microgram(s) per liter
µR	microroentgen(s)
µR/hr	microroentgen(s) per hour
m	meter(s)
m^2	square meter(s)
m^3	cubic meter(s)
M&O	Management and Operating
MAPEP	Mixed Analyte Performance Evaluation Program
MBTA	Migratory Bird Treaty Act
mCi	millicurie(s)
MCL	maximum contaminant level
MDC	minimum detectable concentration
MEDA	Meteorological Data Acquisition
MEI	maximally exposed individual
MET	meteorological
MGD	million gallons per day
mGy/d	milligray(s) per day
mg/L	milligram(s) per liter
mi	mile(s)
mi^2	square mile(s)
mm	millimeter(s)
mmhos/cm	millimhos per centimeter
MQO	Measurement Quality Objectives
mR	milliroentgen(s)
mR/d	milliroentgen(s) per day
mR/yr	milliroentgen(s) per year
mrad	millirad(s)
mrem	millirem(s)
mrem/yr	millirem(s) per year
MSA	management self-assessments
MSDS	Material Safety Data Sheet
mSv	millisievert(s)
mSv/yr	millisievert(s) per year
mton	metric ton(s)
MW	mixed waste
N	nitrogen
NAAQS	National Ambient Air Quality Standards
NAC	Nevada Administrative Code
NAGPRA	Native American Graves Protection and Repatriation Act
NCA	Nevada Combined Agency
NCRP	National Council on Radiation Protection
NDEP	Nevada Division of Environmental Protection
NDOA	Nevada Department of Agriculture
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act
NLVF	North Las Vegas Facility
NNHP	Nevada Natural Heritage Program
NNSA	U.S. Department of Energy, National Nuclear Security Administration
NNSA/NSO	U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office
NNSA/SSO	U.S. Department of Energy, National Nuclear Security Administration Sandia Site Office
NO_x	nitrogen oxides

NPDES	National Pollutant Discharge Elimination System
NPTEC	Nonproliferation Test and Evaluation Complex
NRC	U.S. Nuclear Regulatory Commission
NRHP	National Register of Historic Places
NRS	Nevada Revised Statutes
NSPS	New Source Performance Standards
NSHD	Nevada State Health Division
NSTec	National Security Technologies, LLC
NTS	Nevada Test Site
NTSER	Nevada Test Site Environmental Report
NTTR	Nevada Test and Training Range
NVLAP	National Voluntary Laboratory Accreditation Program
ODS	ozone-depleting substance
OSTI	Office of Scientific and Technical Information
oz	ounce(s)
P03U	Pit 3 Mixed Waste Disposal Unit
P06U	Area 5 Asbestiform Low-Level Solid Waste Disposal Unit
P2	pollution prevention
P2/WM	pollution prevention/waste minimization
PA	Performance Assessment
PAAA	Price-Anderson Amendments Act
Pb	lead
PCB	polychlorinated biphenyl
pCi	picocurie(s)
pCi/g	picocurie(s) per gram
pCi/L	picocurie(s) per liter
pCi/mL	picocurie(s) per milliliter
PI	prediction interval
PIC	pressurized ion chamber
PIH	plug-in hybrid
PLall	prediction limit for all enriched tritium measurements
PM	particulate matter
PM10	particulate matter equal to or less than 10 microns in diameter
POTW	Publicly Owned Treatment Works
ppm	part(s) per million
PT	proficiency testing
PTE	potential to emit
Pu	plutonium
PWS	public water system
QA	quality assurance
QAP	Quality Assurance Program
QAPP	Quality Assurance Program Plan
QA/QC	quality assurance and quality control
QC	quality control
QSAS	Quality Systems for Analytical Services
R	roentgen(s)
rad	radiation absorbed dose (a unit of measure)
rad/d	rad(s) per day
RCD	Radiological Control Department
RCRA	Resource Conservation and Recovery Act
RCT	radiological control technician
rem	roentgen equivalent man (a unit of measure)
RER	relative error ratio
RNCTEC	Radiological/Nuclear Countermeasures Test and Evaluation Complex
RPD	relative percent difference
RREMP	Routine Radiological Environmental Monitoring Plan
RSL	Remote Sensing Laboratory
RWMC	Radioactive Waste Management Complex
RWMS	Radioactive Waste Management Site
s	second(s)
SA	Supplement Analysis
SAA	Satellite Accumulation Area
SAFER	Streamlined Approach for Environmental Restoration
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SC	specific conductance
SD	standard deviation
SDWA	Safe Drinking Water Act
SE	standard error of the mean
SHPO	State Historic Preservation Office
SI	International System of Units
SNHD	Southern Nevada Health District

SNJV	Stoller-Navarro Joint Venture
SNL	Sandia National Laboratories
SORD	Special Operations and Research Division
SO_2	sulfur dioxide
Sr	strontium
SSC	structures, systems, and components
S.U.	standard unit(s) (for measuring pH)
Sv	sievert(s)
SWO	Solid Waste Operations
TaDD	Tactical Demilitarization Development Project
Tc	technetium
TDR	time domain reflectometry
TDS	total dissolved solids
Th	thorium
TLD	thermoluminescent dosimeter
TOC	total organic carbon
TOX	total organic halides
TPCB	Transuranic Pad Cover Building
TRI	Toxic Release Inventory
TRU	transuranic
TSCA	Toxic Substances Control Act
TSS	total suspended solids
TTHM	total trihalomethane
TTR	Tonopah Test Range
U	uranium
UGTA	Underground Test Area
U.S.	United States
USACE	U.S. Army Corps of Engineers
USAF	U.S. Air Force
USC	United States Code
USGS	U.S. Geological Survey
UST	underground storage tank
VOC	volatile organic compounds
VZM	vadose zone monitoring
WAA	Waste Accumulation Area
WEF	Waste Examination Facility
WGS	Waste Generator Services
WIPP	Waste Isolation Pilot Plant
WM	waste minimization
WNV	West Nile virus
WO	Waste Operations
WW	water well
yd	yard(s)
yd^3	cubic yard(s)
yr	year(s)

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References

American Nuclear Society, 2005. American National Standard for Determining Meteorological Information at Nuclear Facilities, ANSI/ANS-3.11-2005, American Nuclear Society, 555 North Kensington Avenue, La Grange Park, IL.

Arizona Workforce Informer, 2009. *July 1, 2008 Population Estimates for Arizona's Counties, Incorporated Places and Balance of County.* Available at http://www.azcommerce.com/doclib/econinfo/FILES/2008AZestimates.pdf, as accessed on April 20, 2009.

Bechtel Nevada, 2000. *Characterization Report - Building A- I at the U.S. Department of Energy, Nevada Operations Office, North Las Vegas Facility,* DOE/NV/11718--413, Las Vegas, NV.

Bechtel Nevada, 2002. *A Hydrostratigraphic Framework Model of the Pahute Mesa - Oasis Valley Area, Nye County, Nevada,* DOE/NV/11718--646, Las Vegas, NV. OSTI ID: 790074

Bechtel Nevada, 2003a. *Routine Radiological Environmental Monitoring Plan,* DOE/NV/11718--804, Las Vegas, NV, prepared for U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office.

Bechtel Nevada, 2003b. *Summary Report for the U.S. Department of Energy National Nuclear Security Administration Nevada Site Office FY02/FY03 Groundwater Control Study at the North Las Vegas Facility*, September 2003, prepared by the Bechtel Nevada Geotechnical Sciences Group.

Bechtel Nevada, 2004a. *Nevada Test Site Environmental Report 2003,* DOE/NV/11718--971, Las Vegas, NV, prepared for U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office.

Bechtel Nevada, 2004b. *Summary Report for the U.S. Department of Energy National Nuclear Security Administration Nevada Site Office Groundwater Control at Building A-1 North Las Vegas Facility,* Las Vegas, NV.

Bechtel Nevada, 2005a. *Nevada Test Site Environmental Report 2004,* DOE/NV/11718--1080, Las Vegas, NV, prepared for U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office.

Bechtel Nevada, 2005b. *A Hydrostratigraphic Framework Model and Alternatives for the Groundwater Flow and Contaminant Transport Model of Corrective Action Unit 98: Frenchman Flat, Clark, Lincoln and Nye Counties, Nevada,* DOE/NV/11718--1064, Las Vegas, NV, prepared for U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office.

Bechtel Nevada, 2005c. *FY 2005 Mid-Year Status Report for the U.S. Department of Energy National Nuclear Security Administration Nevada Site Office Groundwater Control at Building A-1 North Las Vegas Facility*, Las Vegas, NV.

Bechtel Nevada, 2006. *A Hydrostratigraphic Framework Model and Alternatives for the Groundwater Flow and Contaminant Transport Model of Corrective Action Unit 97: Yucca Flat-Climax Mine, Lincoln and Nye Counties, Nevada,* DOE/NV/11718--1119, Las Vegas, NV.

Bechtel Nevada and National Security Technologies, LLC, 2006. U.S. Department of Energy, 2006a. *Nevada Test Site Environmental Report 2005,* DOE/NV/11718--1214 and DOE/NV/25946--007, National Security Technologies, LLC, Las Vegas, NV, prepared for U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. OSTI ID: 892135

BEIR III, 1980. *The Effects on Populations of Exposure to Low Levels of Ionizing Radiation: 1980,* Committee on the Biological Effects of Ionizing Radiation III, National Academy Press, Washington, D.C.

BHPS, see Nevada State Health Division, Bureau of Health Protection Services.

BN, see Bechtel Nevada.

BN and NSTec, see Bechtel Nevada and National Security Technologies, LLC.

Bowen, S. M., D. L. Finnegan, J. L. Thompson, C. M. Miller, P. L. Baca, L. F. Olivas, C. G. Geoffrion, D. K. Smith, W. Goishi, B. K. Esser, J. W. Meadows, N. Namboodiri, and J. F. Wild, 2001. *Nevada Test Site Radionuclide Inventory, 1951–1992.* LA-13859-MS, Los Alamos National Laboratory, Los Alamos, NM.

Bradley, P. V., J. J. O'Farrell, J. A. Williams, and J. E. Newmark (Editors), 2005. *The Revised Nevada Bat Conservation Plan,* Nevada Bat Working Group, Reno, NV.

Brikowski, T. H., J. B. Chapman, B. F. Lyles, and S. Hokett, 1993. *Origin of Elevated Water Levels Encountered in Pahute Mesa Emplacement Boreholes: Preliminary Investigations*, Desert Research Institute Publication No. 45123, Las Vegas, NV. OSTI ID: 10164133

Carle, S. F., M. Zavarin, and G. A. Pawloski, 2008. *Spatial Variability of Reactive Mineral and Radionuclide* K_d *Distributions in the Tuff Confining Unit: Yucca Flat, Nevada Test Site,* LLNL-TR-402227-DRAFT, Lawrence Livermore National Laboratory, Livermore, CA. OSTI ID: 926431

Culham, H. W., G. F. Eaton, V. Genetti, Q. Hu, A. B. Kersting, R. E. Lindvall, J. E. Moran, G. A. Blasiyh Nuño, B. A. Powell, T. P. Rose, M. J. Singleton, R. W. Williams, M. Zavarin, and P. Zhao, 2008. *Hydrologic Resources Management Program and Underground Test Area Project FY 2006 Progress Report*. M. Zavarin, A. B. Kersting, R. E. Lindvall, and T. P. Rose (eds.), LLNL-TR-404620, Lawrence Livermore National Laboratory, Livermore, CA. OSTI ID: 945573

Dickerson, R., and J. S. Hand, 2008. Letter Report: *Yucca Fracture Mapping,* Stoller-Navarro Joint Venture, Las Vegas, NV.

DOE, see U.S. Department of Energy.

DOE/NV, see U.S. Department of Energy, Nevada Operations Office.

Drollinger, H., 2008. *Fiscal Year 2008 Curation Compliance Annual Progress Report,* Desert Research Institute, Division of Earth and Ecosystems Sciences Letter Report No. LR090508-1, Las Vegas, NV.

Drollinger, H., C. M. Beck, and R. Furlow, 2002. *Cultural Resources Management Plan for the Nevada Test Site,* DOE/NV/11508--47, Desert Research Institute, Division of Earth and Ecosystems Sciences, Las Vegas, NV.

Eastern Research Group, 2004. *Methods for Estimating Fugitive Air Emissions of Radionuclides from Diffuse Sources at DOE Facilities,* prepared for the U.S. Environmental Protection Agency by Eastern Research Group, Inc., Morrisville, NC.

EPA, see U.S. Environmental Protection Agency.

Fenelon, J. M., R. J. Laczniak, and K. J. Halford, 2008. *Predevelopment Water-Level Contours for Aquifers in the Rainier Mesa and Shoshone Mountain Area of the Nevada Test Site, Nye County, Nevada,* Scientific Investigations Report 2008-5044, U.S. Geological Survey, Las Vegas, NV. OSTI ID: 932993

FWS, see U.S. Fish and Wildlife Service.

Giles, K. R. and J. Cooper, 1985. *Characteristics and Migration Patterns of Mule Deer on the Nevada Test Site,* EPA 600/4-85-030 (DOE/DP/00539-054), U.S. Environmental Protection Agency, Las Vegas, NV.

Hansen, D. J., D. C. Anderson, D. B. Hall, P. D. Greger, and W. K. Ostler, 2009. *Ecological Monitoring and Compliance Program 2008 Report,* DOE/NV/25946--704, National Security Technologies, LLC, April 2009, Las Vegas, NV. OSTI ID: 960405

Hardcastle, J., 2009. *2008 Estimates by County*. Prepared by Nevada State Demographer's Office for Nevada Department of Taxation, Nevada Small Business Development Center, from Internet URL: http://www.nsbdc.org/what/data_statistics/demographer/pubs/pop_increase/, as accessed on April 20, 2009.

Hendricks, T. J., and S. R. Riedhauser, 1999. *An Aerial Radiological Survey of the Nevada Test Site,* DOE/NV/11718--324, U.S. Department of Energy, Nevada Operations Office, Las Vegas, NV.

Hershey, R. L., J. B. Paces, M. J. Singleton, E. M. Kwicklis, D. L. Decker, W. M. Fryer, and S. Earman, 2008. *Geochemical and Isotopic Evaluation of Groundwater Movement in Corrective Action Unit 99: Rainier Mesa and Shoshone Mountain, Nevada Test Site*, DOE/NV/26383-10, Desert Research Institute Publication No. 45229, Las Vegas, NV.

Holz, B. A., 2008a. *Fiscal Year 2008 Site Monitoring, Cane Spring, Site 26NY4, Areas 5 and 27, Nevada Test Site, Nye County, Nevada,* Desert Research Institute, Division of Earth and Ecosystems Sciences Short Report No. SR030508-2, Las Vegas, NV.

Holz, B. A., 2008b. *Fiscal Year 2008 Site Monitoring Japanese Village Component of Site 26NY8765, Area 4, Nevada Test Site, Nye County, Nevada,* Desert Research Institute, Division of Earth and Ecosystems Sciences Short Report No. SR030608-1, Las Vegas, NV.

Holz, B. A., 2008c. *Fiscal Year 2008 Site Monitoring Wahmonie Component of Site 26NY9843, Area 26, Nevada Test Site, Nye County, Nevada,* Desert Research Institute, Division of Earth and Ecosystems Sciences Short Report No. SR031808-1, Las Vegas, NV.

Holz, B. A., 2008d. *Fiscal Year 2008 Site Monitoring, Rice Grass Village, Site 26NY2, Area 18, Nevada Test Site, Nye County, Nevada,* Desert Research Institute, Division of Earth and Ecosystems Sciences Short Report No. SR032508-1, Las Vegas, NV.

Holz, B. A., 2008e. *Fiscal Year 2008 Site Monitoring, Bower Cabin at Site 26NY8806, Area 15, Nevada Test Site, Nye County, Nevada,* Desert Research Institute, Division of Earth and Ecosystems Sciences Short Report No. SR043008-1, Las Vegas, NV.

Holz, B. A., 2008f. *Fiscal Year 2008 Cultural Resources Site Monitoring, Nevada Test Site, Nye County, Nevada,* Desert Research Institute, Division of Earth and Ecosystems Sciences Monitoring Report No. MR030508-1, Las Vegas, NV.

Hunter, R. B., and R. R. Kinnison, 1998. *Tritium in Vegetation on the Nevada Test Site,* United States Department of Energy, December 1998, In: *Nevada Test Site Routine Radiological Environmental Monitoring Plan, Appendices*, DOE/NV/11718--244. Bechtel Nevada, Las Vegas, NV.

International Technology Corporation, 1996. *Regional Geologic Model Data Documentation Package (Phase I, Data Analysis Documentation, Volume I, Parts 1 and 2),* ITLV/10972-181, Las Vegas, NV.

International Technology Corporation, 1997. *Groundwater Flow Model Documentation Package (Phase I, Data Analysis Documentation, Volume VI),* Las Vegas, NV.

IT, see International Technology Corporation.

Jones, R. C., 2008a. *A Class III Cultural Resources Inventory of the Proposed Firing Range, Area 23, Nevada Test Site, Nye County, Nevada,* Desert Research Institute, Division of Earth and Ecosystems Sciences Short Report No. SR031008-1, Las Vegas, NV.

Jones, R. C., 2008b. *A Class III Cultural Resources Inventory of the Proposed Underground Test Area ER-20-7 Well Pad and Access Road, Area 20, Nevada Test Site, Nye County, Nevada,* Desert Research Institute, Division of Earth and Ecosystems Sciences Short Report No. SR090308-1, Las Vegas, NV.

Jones, R. C., 2008c. *A Class III Cultural Resources Inventory of the Proposed Underground Test Area ER-20-8 Well Pad and Access Road, Area 20, Nevada Test Site, Nye County, Nevada,* Desert Research Institute, Division of Earth and Ecosystems Sciences Short Report No. SR090408-1, Las Vegas, NV.

Jones, R. C., 2008d. *A Class III Cultural Resources Inventory of the Proposed Underground TestArea ER-EC-11 Well Pad and Access Road, Range EC South, Nevada Test and Training Range, Nye County, Nevada,* Desert Research Institute, Division of Earth and Ecosystems Sciences Short Report No. SR091708-1, Las Vegas, NV.

Jones, R. C., 2008e. *A Class III Cultural Resources Inventory of the Proposed Underground Test Area Borrow Pit Expansion, Area 20, Nevada Test Site, Nye County, Nevada,* Desert Research Institute, Division of Earth and Ecosystems Sciences Short Report No. SR092908-1, Las Vegas, NV.

Jones, R. C., 2008f. *A Class III Cultural Resources Inventory of the Relocation of the Proposed Underground Test Area ER-EC-11 Well Pad, Range EC South, Nevada Test and Training Range, Nye County, Nevada,* Desert Research Institute, Division of Earth and Ecosystems Sciences Short Report No. SR092908-1, Las Vegas, NV.

Jones, R, C., and C. M. Beck, 2008. *Soils Project Pre-Task Cultural Resources Visit to Schooner, Palanquin, Cabriolet, and Johnnie Boy Event Locations, Areas 18 and 20, Nevada Test Site, Nye County, Nevada,* Desert Research Institute, Division of Earth and Ecosystems Sciences Short Report No. SR102808-1, Las Vegas, NV.

Lyles, B. F., 1990. *Tritium Variations in Groundwater on the Nevada Test Site,* Desert Research Report 45086, DOE/NV/10384--380.

McArthur, R. D., 1991. *Radionuclides in Surface Soil at the Nevada Test Site,* DOE/NV/10845-02, Water Resources Center Publication #45077, Desert Research Institute, Las Vegas, NV.

National Council on Radiation Protection, 1996. *A Guide for Uncertainty Analysis in Dose and Risk Assessments Related to Environmental Contamination,* NCRP Commentary No. 14, Bethesda, MD.

National Oceanic and Atmospheric Administration, 1995. *Surface Weather Observations and Reports*, FCM-H1-1995, U.S. Department of Commerce, Washington, D.C.

National Security Technologies, LLC, 2006. *U.S. Department of Energy National Nuclear Security Administration Nevada Site Office Groundwater Control at Building A-1, North Las Vegas Facility Enhanced Dewatering Initiative*. Las Vegas, NV.

National Security Technologies, LLC, 2007a. *Nevada Test Site Environmental Report 2006,* DOE/NV/25946--259, Las Vegas, NV, prepared for U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. OSTI ID: 915233

National Security Technologies, LLC, 2007b. *A Hydrostratigraphic Model and Alternatives for the Groundwater Flow and Contaminant Transport Model of Corrective Action Unit 99: Rainier Mesa-Shoshone Mountain, Nye County, Nevada.* DOE/NV/25946--146. Las Vegas, NV. OSTI ID: 934454

National Security Technologies, LLC, 2008a. *Nevada Test Site Environmental Report 2007,* DOE/NV/25946--543, Las Vegas, NV, prepared for U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. OSTI ID: 936844

National Security Technologies, LLC, 2008b. *FY 2009 NNSA/NSO Energy Executable Plan*, Las Vegas, NV, December 2008.

National Security Technologies, LLC, 2009a. *Water Pollution Control Permit NEV 96021, Quarterly Monitoring Report and Annual Summary Report for E Tunnel Waste Water Disposal System,* Las Vegas, NV.

National Security Technologies, LLC, 2009b. *Nevada Test Site 2008 Data Report: Groundwater Monitoring Program Area 5 Radioactive Waste Management Site*, DOE/NV/25946--619, Las Vegas, NV. OSTI ID: 946167

National Security Technologies, LLC, 2009c. *Nevada Test Site 2008, Waste Management Monitoring Report, Area 3 and Area 5 Radioactive Waste Management Sites,* DOE/NV/25946--736, Las Vegas, NV. OSTI ID: 960411

NCRP, see National Council on Radiation Protection.

NDEP, see Nevada Division of Environmental Protection.

Nevada State Health Division, Bureau of Health Protection Services, 2007. *State of Nevada Report HDAIP 30*, Sanford Cohen & Associates ID 6614, Las Vegas, NV.

Nevada Division of Environmental Protection, 2008. Letter from T. H. Murphy (Chief, Bureau of Federal Facilities) to J. L. Appenzeller-Wing (Acting Assistant Manager for Environmental Management, NNSA/NSO), September 19, 2008.

Nevada Division of Environmental Protection, 2009. Letter from C. D. Andres (Supervisor, Bureau of Federal Facilities) to L. A. Plummer (Acting Team Leader Environmental Protection Team, NNSA/NSO), March 17, 2009.

NNSA/NSO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office.

NNSA/NV, see U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office.

NRC, see U.S. Nuclear Regulatory Commission.

NSTec, see National Security Technologies, LLC.

Otis, D. L., J. H. Schulz, and D. P. Scott. 2008. *Mourning Dove (Zenaida macroura) Harvest and Population Parameters Derived from a National Banding Study,* U.S. Fish and Wildlife Service Biological Technical Publication-BTP-R3010-2008, Washington, D.C.

Pihong, Z., M. Zavarin, R. Leif, B. Powell, M. Singleton, R. Lindvall, and A. Kersting, 2008. *Actinide Sorption in Rainier Mesa Tunnel Waters from the Nevada Test Site,* LLNL-TR-400273, Lawrence Livermore National Laboratory, Livermore, CA. OSTI ID: 926020

Prothro, L. B., 2008. *Analysis of Fractures in Cores from the Tuff Confining Unit Beneath Yucca Flat, Nevada Test Site*, DOE/NV/25946--351, National Security Technologies, LLC, Las Vegas, NV. OSTI ID: 92885

Reeves, H. M., 1979. Estimating of Reporting Rate for Mourning Dove Bands, *Journal of Wildlife Management* 43:36–42.

Sandia National Laboratories, 2008. *Annual Site Environmental Report Tonopah Test Range, Nevada & Kauai Test Facility, Hawaii*, SAND2008-5070P, Albuquerque, NM, prepared for U.S. Department of Energy, National Nuclear Security Administration Sandia Site Office.

Shleien, B. (ed.), 1992. *The Health Physics and Radiological Health Handbook, Revised Edition,* Scinta, Inc., Silver Spring, MD.

Smith, D. K., 1993. *A Review of Literature Pertaining to the Leaching and Sorption of Radionuclides Associated with Nuclear Explosive Melt Glasses,* UCRL-ID-113370, Lawrence Livermore National Laboratory, Livermore, CA.

Smith, D. K., B. K. Esser, and J. L. Thompson, 1995. *Uncertainties Associated with the Definition of a Hydrologic Source Term for the Nevada Test Site,* UCRL-ID-120322, Lawrence Livermore National Laboratory, Livermore, CA.

Smith, D. K., S. B. Kersting, J. M. Keneally, T. P. Rose, G. B. Hudson, and G. F. Eaton, 1999. *Radionuclide Migration Studies: FY 1998 Progress Report,* Lawrence Livermore National Laboratory, Livermore, CA.

SNJV, see Stoller-Navarro Joint Venture.

SNL, see Sandia National Laboratories.

Stanley, T. W., and S. S. Verner, 1985. The U.S. Environmental Protection Agency's Quality Assurance Program, in: J. K. Taylor and T. W. Stanley (eds.), *Quality Assurance for Environmental Measurements*, ASTM STP-867, Philadelphia, PA.

Stoffle, R. W., M. N. Zedeno, and D. B. Halmo, 2001. *American Indians and the Nevada Test Site, A Model of Research and Consultation,* U.S. Government Printing Office, Washington, D.C.

Stoller-Navarro Joint Venture. 2006. *Phase II Groundwater Flow Model of Corrective Action Unit 98: Frenchman Flat, Nevada Test Site, Nye County, Nevada*, S-N/99205--074, Las Vegas, NV. OSTI ID: 891955

Stoller-Navarro Joint Venture, 2008a. *Geochem08.mdb and User Guide to the Comprehensive Water Quality Database for Groundwater in the Vicinity of the Nevada Test Site,* Rev. 3, S-N/99205--059-Rev. 3, Las Vegas, NV.

Stoller-Navarro Joint Venture, 2008b. *Phase I Hydrologic Data for the Groundwater Flow and Contaminant Transport Model of Corrective Action Unit 99: Rainier Mesa/Shoshone Mountain, Nevada Test Site, Nye County, Nevada,* S-N/99205--103, Las Vegas, NV. OSTI ID: 932406

Stoller-Navarro Joint Venture, 2008c. *Phase I Contaminant Transport Parameters for the Groundwater Flow and Contaminant Transport Model of Corrective Action Unit 99: Rainier Mesa/Shoshone Mountain, Nevada Test Site, Nye County, Nevada*, Rev. 1, S-N/99205--102, Las Vegas, NV. OSTI ID: 932410

Stoller-Navarro Joint Venture, 2008d. *Modeling Approach/Strategy for Corrective Action Unit 99: Rainier Mesa and Shoshone Mountain, Nevada Test Site, Nye County, Nevada*, Rev. 1, S-N/99205--106, Las Vegas, NV. OSTI ID: 943562

Stoller-Navarro Joint Venture, 2009a. *Phase I Transport Model of Corrective Action Units 101 and 102: Central and Western Pahute Mesa, Nevada Test Site, Nye County, Nevada*, Revision No. 1, S-N/99205--111, February 2009, Las Vegas, NV. OSTI ID: 948559

Stoller-Navarro Joint Venture, 2009b. *Phase II Corrective Action Investigation Plan for Corrective Action Units 101 and 102: Central and Western Pahute Mesa, Nevada Test Site, Nye County, Nevada*, Rev. 1, DOE/NV--1312, Las Vegas, NV.

Thomas, L., J. L. Laake, S. Strindberg, F. F. C. Marques, S. T. Buckland, D. L. Borchers, D. R. Anderson, K. P. Burnham, S. L. Hedley, J. H. Pollard, J. R. B. Bishop, and T. A. Marques, 2006. *Distance 5.0. Release 1*. Research Unit for Wildlife Population Assessment, University of St. Andrews, UK.

Tomlinson, R. E., 1968. Reward banding to determine reporting rate of recovered Mourning Dove bands, *Journal of Wildlife Management* 32:6–11.

Townsend, D. R., 2008. *Documentation Report for Rainier Mesa Test Information Compiled for the UGTA Project*, Wastren Advantage, Incorporated, Las Vegas, NV.

U.S. Department of Energy, 1988. Internal Dose Conversion Factors for Calculation of Dose to the Public, DOE/EH-0071, Washington, D.C.

U.S. Department of Energy, 1996. *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada*, Volume 1, Chapters 1–9, DOE/EIS--0243, Las Vegas, NV, August 1996.

U.S. Department of Energy, 2002. *Final Environmental Impact Statement for the Proposed Relocation of Technical Area 18 Capabilities and Materials at the Los Alamos National Laboratory,* DOE/EIS-0319, Washington, D.C.

U.S. Department of Energy, 2004a. E-mail from Gustavo Vazquez, DOE/EH-41, to Bruce W. Hurley, U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office, dated April 1, 2004.

U.S. Department of Energy, 2004b. *Users Guide, Version 1; RESRAD-BIOTA: A Tool for Implementing A Graded Approach To Biota Dose Evaluation,* DOE/EH-0676 (also Interagency Steering Committee on Radiation Standards [ISCORS] Technical Report 2004-02), Washington D.C.

U.S. Department of Energy, 2008. *Quality Systems for Analytical Services, Revision 2.4*, October 2008.

U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office, 2002. *Underground Test Area Project Waste Management Plan*, DOE/NV--343, Rev. 2, Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office, 2004. *NV/YMP Radiological Control Manual*, DOE/NV/11718--079, Rev. 5, Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, 2004a. *Environmental Assessment for Radiological/Nuclear Countermeasures Test and Evaluation Complex, Nevada Test Site*, DOE/EA-1499, Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, 2004b. *Final Environmental Assessment for Activities Using Biological Simulants and Releases of Chemicals at the Nevada Test Site*, DOE/EA-1494, Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, 2006. *Nevada Test Site Environmental Management End State Vision*, DOE/NV--958, Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, 2008a. *Completion Report for the Well ER-6-2 Site, Corrective Action Unit 97: Yucca Flat-Climax Mine*, DOE/NV--1270, Las Vegas, NV. OSTI ID: 928812

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, 2008b. *Groundwater Protection Program Plan for the National Nuclear Security Administration Nevada Site Office*, DOE/NV/25946--557, Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, 2009. *Annual Transportation Report for Radioactive Waste Shipments to and from the Nevada Test Site – Fiscal Year 2008*, DOE/NV--1309, Las Vegas, NV, February 2009. OSTI ID: 946803

U.S. Department of Energy, Nevada Operations Office, 1992. *Summary of the Nevada Applied Ecology Group and Correlative Programs,* DOE/NV--357, Las Vegas, NV. OSTI ID: 10191695

U.S. Department of Energy, Nevada Operations Office, 1996. *National Emission Standards for Hazardous Air Pollutants Submittal – 1995*, DOE/NV/11718--032, Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office, 1997. *Regional Groundwater Flow and Tritium Transport Modeling and Risk Assessment of the Underground Test Area, Nevada Test Site, Nevada,* DOE/V--477, October 1997, Las Vegas, NV. OSTI ID: 788792

U.S. Department of Energy, Nevada Operations Office, 1998. *Nevada Test Site Resource Management Plan*, DOE/NV--518, Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office, 2000. *United States Nuclear Tests, July 1945 through September 1992*, DOE/NV--209, Rev. 15, Las Vegas, NV. Available at: http://www.nv.doe.gov/library/publications/historical/DOENV_209_REV15.pdf, as accessed on August 31, 2009.

U.S. Department of Energy, Nevada Operations Office, 2002. *Environmental Assessment for Hazardous Materials Testing at the Hazardous Materials Spill Center*, *Nevada Test Site*, DOE/EA-0864, Las Vegas, NV.

U.S. Environmental Protection Agency, 1986 and Subsequent Updates. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, *EPA PublicationSW-846.* Available at http://www.epa.gov/SW-846/main.htm, as accessed on July 8, 2009.

U.S. Fish and Wildlife Service, 1996. *Final Programmatic Biological Opinion for Nevada Test Site Activities,* File No. 1-5-96-F-33, August 22, 1996, Reno, NV.

U.S. Nuclear Regulatory Commission, 1983. *Radiological Assessment.* Report NUREG/CR-3332, J. E. Till and H. R. Meyer, Editors, Office of Nuclear Reactor Regulation, Washington, D.C.

U.S. Public Health Service, 1963. *Project SEDAN, Final Off-Site Report,* AEC Report PNE-200F, Offsite Radiological Safety Organization, Las Vegas, NV.

Utah Population Estimates Committee, 2009. *Subcounty Population Projections (Total Population)*, Governor's Office of Planning and Budget. Available at http://governor.utah.gov/dea/popprojections.html, as accessed on April 20, 2009.

Warren, R. G., D. A. Sawyer, F. M. Byers, Jr., and J. C. Cole, 2003. *A Petrographic/Geochemical and Geophysical Database, and Stratigraphic Framework for the Southwestern Nevada Volcanic Field.* LANL Report LA-UR-03-1503, Los Alamos, NM.

Warren, R. W., and R. F. Grossman, 2009. *National Emission Standards for Hazardous Air Pollutants, Calendar Year 2008*. DOE/NV/25946--742, U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, Las Vegas, NV.

Wills, C. A., and W. K. Ostler, 2001. *Ecology of the Nevada Test Site*: *An Annotated Bibliography, with Narrative Summary, Keyword Index, and Species List.* DOE/NV/11718--594, Bechtel Nevada, Ecological Services, Las Vegas, NV. OSTI ID: 901998

Woodward, R., K. R. Rautenstrauch, D. B. Hall, and W. K. Ostler, 1998. *The Relative Abundance of Desert Tortoises on the Nevada Test Site Within Ecological Landform Units*, DOE/NV/11718--245, Bechtel Nevada, Las Vegas, NV. OSTI ID: 901934

World Meteorological Organization, 2002. *Manual on the Global Observing System, Vol. 1*, WMO No. 55, Secretariat of the World Meteorological Organization, Geneva, Switzerland.

Zhao, P., and M. Zavarin, 2008a. *Analysis of the Variability of Classified and Unclassified Radiological Source Term Inventories in the Frenchman Flat Area, Nevada Test Site,* LLNL-TR-404694, Lawrence Livermore National Laboratory, Livermore, CA. OSTI ID: 945617

Zhao, P., and M. Zavarin, 2008b. *Analysis of the Variability of Classified and Unclassified Radiological Source Term Inventories in the Rainier Mesa/Shoshone Mountain Area, Nevada Test Site*, LLNL-TR-404695, Lawrence Livermore National Laboratory, Livermore, CA. OSTI ID: 945619

Zheng, Q., S. E. Dickson, and Y. Guo, 2008. On the Appropriate "Equivalent Aperture" for the Description of Solute Transport in Single Fractures: Laboratory-scale Experiments, *Water Resources Research* 44:9.

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