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Nevada National Security Site Environmental Report 2013

September 2014

National Nuclear Security Administration

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Nevada National Security Site Environmental Report 2013

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Executive Summary

This report 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 Field Office (NNSA/NFO) (formerly designated as the Nevada Site Office [NNSA/NSO]). The new field office designation occurred in March 2013. Published reports cited in this 2013 report, therefore, may bear the name or authorship of NNSA/NSO. This and previous years' reports, called Annual Site Environmental Reports (ASERs), Nevada Test Site Environmental Reports (NTSERs), and, beginning in 2010, Nevada National Security Site Environmental Reports (NNSSERs), are posted on the NNSA/NFO website at http://www.nv.energy.gov/library/publications/aser.aspx.

Purpose and Scope of the NNSSER

This NNSSER was prepared to satisfy DOE Order DOE O 231.1B, "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/NFO Environmental Management System and characterize its performance, and (6) highlight significant environmental programs and efforts.

This NNSSER summarizes data and compliance status for calendar year 2013 at the Nevada National Security Site (NNSS) (formerly the Nevada Test Site) and its two support facilities, the North Las Vegas Facility (NLVF) and the Remote Sensing Laboratory–Nellis (RSL-Nellis). It also addresses environmental restoration (ER) projects conducted at the Tonopah Test Range (TTR) and the Nevada Test and Training Range (NTTR). Through a Memorandum of Agreement, NNSA/NFO is responsible for the oversight of these ER projects, and the Sandia Field Office of NNSA (NNSA/SFO) has oversight of all other TTR and NTTR activities. NNSA/SFO produces the TTR annual environmental report, which is available at http://www.sandia.gov/news/publications/environmental/index.html.

Major Site Programs and Facilities

NNSA/NFO directs the management and operation of the NNSS and six sites across the nation. The six sites include two in Nevada (NLVF and RSL-Nellis) and four 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 NNSS. NSTec is the current Management and Operating 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 NNSS as a location for weapons experimentation and nuclear test readiness.

The three major NNSS missions include National Security/Defense, Environmental Management, and Nondefense. The major programs that support these missions are Stockpile Stewardship and Management, Nonproliferation and Counterterrorism, Nuclear Emergency Response, Work for Others, Environmental Restoration, Waste Management, Conservation and Renewable Energy, Other Research and Development, and Infrastructure. The major facilities that support the programs include the U1a Facility, Big Explosives Experimental Facility (BEEF), Device Assembly Facility, Dense Plasma Focus Facility, Joint Actinide Shock Physics Experimental Research Facility, Radiological/Nuclear Countermeasures Test and Evaluation Complex, Nonproliferation Test and Evaluation Complex (NPTEC), Radiological/Nuclear Weapons of Mass Destruction Incident Exercise Site (known as the T-1 Site), Area 5 Radioactive Waste Management Complex (RWMC), and the Area 3 Radioactive Waste Management Site (RWMS).

Other Key Environmental Initiatives

In addition to the environmental restoration efforts to clean up legacy contamination from historical nuclear testing activities, NNSA/NFO pursues several other environmental key initiatives. They are components of the Nondefense mission of NNSA/NFO to prevent pollution, minimize waste generation, conserve water, advance energy efficiency, reduce fossil fuel use, pursue renewable energy sources, and support the federal goals within all of these areas promulgated through executive orders and DOE orders. These initiatives are pursued through the Energy Management Program and the Pollution Prevention and Waste Minimization (P2/WM) Program discussed below.

Environmental Performance Measures Programs

During the conduct of the major programs mentioned above, NNSA/NFO complies with applicable environmental and public health protection regulations and strives to manage the NNSS as a unique and valuable national resource. To identify NNSS environmental initiatives, NNSA/NFO implements an Integrated Safety Management System (ISMS) and an 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 NNSS missions are accomplished safely and in a manner that protects the environment. NNSA/NFO oversees ISMS implementation through the Integrated Safety Management Council.

The EMS is designed to incorporate concern for environmental performance throughout all site programs and activities, with the ultimate goal being continual reduction of program impacts on the environment. The NNSS attained International Organization for Standardization (ISO) 14001 certification for its EMS in 2008, and continues to maintain certification. In addition to ISMS and EMS, two programs, the Energy Management Program and the P2/WM Program, operate specifically to support some of the key environmental initiatives.

Environmental Management System

An Environmental Working Group helps determine what EMS objectives and targets will be implemented to address specific environmental aspects of NNSA/NFO operations. These are determined on a fiscal year (FY) (October 1 through September 30) basis. The FY 2013 targets were all met or exceeded and are summarized in Section 2.2 of Chapter 3.

The ISO 14001 certifying organization, Lloyd’s Register Quality Assurance (LRQA) recertified the EMS for another 3 years in March 2012. LRQA conducts semi-annual surveillances on focused portions of the EMS, and findings and recommendations are tracked in the companywide issues tracking system, caWeb. LRQA conducted EMS surveillances in January and July of 2013, and a 2013 internal independent audit was conducted by NSTec. Minor issues were found and entered into caWeb for tracking until the issues are corrected. Also, 8 internal management assessments and 86 compliance evaluations were conducted to promote continual improvement.

The 2013 Facility EMS Annual Report Data for the NNSS was entered into the DOE Headquarters EMS database on the www.FedCenter.gov website. The report includes a scorecard section that is a series of questions regarding a site’s EMS effectiveness in meeting the objectives of federal EMS directives. The NNSS scored “green” (the highest score).

Energy Management

The NNSA/NFO Energy Management Program supports the goals of DOE’s annual Strategic Sustainability Performance Plan (SSPP). The program advances energy efficiency, water conservation, and the use of solar and other renewable energy sources at the NNSS, NLVF, and RSL-Nellis. In 2013, the FY 2014 NNSA/NFO Site Sustainability Plan (SSP) was prepared, which describes the program, planning, and budget assumptions as well as each DOE SSPP goal, NNSA/NFO’s current performance status for each DOE SSPP goal, and planned actions to meet each goal. Thus far, the Energy Management Program is on track to meet the DOE long-term goals of reducing energy intensity, water intensity, and petroleum fuel use, and of increasing alternative fuel use and the acquisition of alternative fuel vehicles. The 2013 status of all the NNSA/NFO SSPs goals is summarized in Table 3-1 of Chapter 3.

Pollution Prevention and Waste Minimization

The P2/WM Program has initiatives to eliminate or reduce the generation of waste, the release of pollutants to the environment, and the use of Class I ozone-depleting substances. These initiatives are pursued through source reduction, re-use, segregation, and recycling, and by procuring recycled-content materials and environmentally preferable products and services. In 2013, the P2/WM Program was compliant with the requirements for implementing P2/WM processes. The 2013 P2/WM activities resulted in reductions to the volume and/or toxicity of waste generated by NNSA/NFO activities. In 2013, 35% of non-hazardous solid waste and 43% of construction waste was diverted from disposal in NNSS landfills through re-use and recycling.

Environmental Awards

NNSA awarded four Sustainability Awards for innovation and excellence to the NNSS in 2013. They included two in the Best in Class category and two in the Environmental Stewardship category. The 2013 award recipients were selected by a panel of judges from NNSA headquarters and from DOE/NNSA sites who reviewed and scored the nominations in 11 award categories. Eighteen awards were presented overall, with 11 for Best in Class and 7 for Environmental Stewardship.

The NNSS awards included Best in Class awards for NNSS Fleet Management Initiatives and for NNSS Water Loss Mitigation and Environmental Stewardship awards for Sustainable Communications: The Green Reaper and Greenhouse Gas Scope 1 and 2: NNSS Offsite Transport of Sulfur Hexafluoride. These four awards are described in Section 3.8 of Chapter 3.

Compliance

One measure of the effectiveness of the EMS is the degree of compliance with applicable environmental laws, regulations, and policies that protect the environment and the public from the effects of NNSA/NFO operations. In 2013, NNSA/NFO complied with all federal statutes, as shown below and in more detail in Chapter 2.

Federal Statute	What it Covers	2013 Status
Radiation Protection		
DOE O 458.1, "Radiation Protection of the Public and the Environment" (and its predecessor of the same name, DOE O 5400.5)	Measuring radioactivity in the environment and estimating radiological dose to the public due to NNSA/NFO activities	Radiological monitoring was conducted by NNSA/NFO at 20 onsite air stations, 3 offsite and 22 onsite groundwater sources, and 109 stations measuring direct gamma radiation. A total of 12 plant samples from 6 study locations, 7 animal samples from 3 study locations, 15 opportunistic samples of large mammal carcasses, 1 mountain lion blood sample, and 6 mountain lion scat samples were collected to monitor biota. The total annual dose to the maximally exposed individual (MEI) from all exposure pathways due to NNSA/NFO activities was estimated to be 0.55 millirems per year (mrem/yr), well below the DOE limit of 100 mrem/yr.
Atomic Energy Act (through compliance with DOE O 435.1, "Radioactive Waste Management")	Management of low-level waste (LLW) and mixed low-level waste (MLLW) generated or disposed on site	1,125,523 cubic feet of radioactive wastes including LLW, MLLW, and non-radioactive classified items were received and disposed on site. All volumes and weights of disposed radiological wastes for permitted disposal units were within permit limits. All vadose zone and groundwater monitoring continued to verify that disposed LLW and MLLW are not migrating to groundwater or threatening biota or the environment.
Air Quality and Protection		
Clean Air Act: National Emission Standards for Hazardous Air Pollutants (NESHAP)	Air quality and emissions into the air from facility operations	There are no major sources of criteria air pollutants or hazardous air pollutants at the NNSS, NLVF, or RSL-Nellis. Nonradiological air emissions from all permitted equipment/facilities were below permit emission and opacity limits.

Federal Statute	What it Covers	2013 Status
Air Quality and Protection (continued)		
Clean Air Act: National Ambient Air Quality Standards (NAAQS) New Source Performance Standards (NSPS) Stratospheric Ozone Protection	Air quality and emissions into the air from facility operations	No air permit exceedances, Notices of Violation, or other air quality noncompliances occurred. The 20 onsite continuous air sampling stations detected man-made radionuclides at levels comparable to previous years and well below the regulatory dose limit for air emissions to the public of 10 mrem/yr. The estimated dose from all 2013 NNSS air emissions to the MEI is 0.02 mrem/yr.
Water Quality and Protection		
Clean Water Act (CWA)	Water quality and effluent discharges from facility operations	All required maintenance, monitoring, and reporting were conducted for permitted wastewater systems and monitoring wells. All domestic and industrial wastewater systems and groundwater monitoring well samples were within permit limits for regulated water contaminants and water chemistry parameters. Pumped groundwater samples at the NLVF were all within National Pollutant Discharge Elimination System (NPDES) permit limits. NNSS operations do not require any NPDES permits.
Safe Drinking Water Act (SDWA)	Quality of drinking water	All concentrations of regulated water contaminants in drinking water from the three permitted public water systems on the NNSS were below state and federal permit limits.
Waste and Hazardous Materials Management and Environmental Restoration		
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)/Superfund Amendments and Reauthorization Act (SARA)	Cleanup of waste sites containing hazardous substances	No hazardous waste (HW) cleanup operations on the NNSS are regulated under CERCLA or SARA; they are regulated under the Resource Conservation and Recovery Act (RCRA) instead. The requirements of CERCLA applicable to the NNSS pertain to an emergency response program for hazardous substance releases (see Emergency Planning and Community Right-to-Know Act [EPCRA] below) 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 [FFACO]).
Federal Facility Agreement and Consent Order (FFACO)	Cleanup of waste sites containing hazardous substances	All 2013 milestones established under the FFACO with the State of Nevada were met for conducting corrective actions and closures of historical contaminated sites called corrective action sites (CASs). A total of 32 CASs were closed in accordance with state-approved corrective action plans.
Resource Conservation and Recovery Act (RCRA)	Generation, management, and/or disposal of HW and MLLW and cleanup of inactive, historical waste sites	A total of 1,911 tons of MLLW were disposed in Cell 18, 2.96 tons of HW and 1.13 tons of polychlorinated biphenyl (PCB) waste were received for onsite storage, and 2.11 tons of HW and 0.43 tons of PCB waste were shipped for offsite disposal, all in accordance with state permits. No HW was shipped directly off site from Satellite or Hazardous Waste Accumulation Areas, and no waste explosive ordnance were detonated on site. Semiannual water samples from three groundwater monitoring wells at the Area 5 RWMC confirmed that buried MLLW remains contained. All vadose zone monitoring and post-closure inspections of historical RCRA closure sites confirmed the sites' integrity to contain HW.

Federal Statute	What it Covers	2013 Status
Waste and Hazardous Materials Management and Environmental Restoration (continued)		
National Environmental Policy Act (NEPA)	Projects are evaluated for environmental impacts	NNSA/NFO evaluated 22 projects. A Record of Decision for the final *Site-Wide Environmental Impact Statement for the Nevada National Security Site and Offsite Locations in Nevada* is expected to be published in 2014.
Toxic Substances Control Act (TSCA)	Management and disposal of PCBs	Six drums of PCB-contaminated materials were shipped off site to permitted disposal and treatment facilities. Their contents included fluorescent light ballasts, a large capacitor, and absorbed oil.
Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	Storage and use of pesticides and herbicides	Only non-restricted-use pesticides were used in 2013 and were applied by State of Nevada–certified personnel. Storage and use of pesticides were in compliance with federal and state regulations.
Emergency Planning and Community Right-to-Know Act (EPCRA)	The public's right to know about chemicals released into the community	No accidental or unplanned release of an extremely hazardous substance occurred at the NNSS, NLVF, or RSL-Nellis in 2013. The chemical inventory for NNSS, NLVF, and RSL-Nellis was updated and submitted to the State of Nevada. As part of routine activities and cleanup operations, reportable quantities of lead and mercury were released at the NNSS in 2013 and reported to the U.S. Environmental Protection Agency. Releases included onsite disposal, offsite disposal, and offsite recycling and totaled 223,827.73 pounds (lb) for lead and 1,435.62 lb for mercury.
Other Environmental Statutes		
Endangered Species Act (ESA)	Threatened or endangered species of plants and animals	Field surveys for 10 proposed projects in desert tortoise habitat and 3 projects in other habitats on the NNSS were conducted; 11.97 acres of tortoise habitat were disturbed, and no tortoises were harmed at or displaced from project sites. Two tortoises were accidentally killed by vehicles on paved roads, and seven were moved off of roads out of harm's way. All actions were in compliance with the U.S. Fish and Wildlife Service's requirements for work conducted in desert tortoise habitat.
National Historic Preservation Act (NHPA)	Identifying and preserving historic properties	NNSA/NFO maintained compliance with the NHPA. Archival research for 40 proposed projects was conducted, and 1,061 acres were surveyed for ten of the projects; 11 historic sites and 3 historic districts were identified.
Migratory Bird Treaty Act (MBTA)	Protecting migratory birds, nests, and eggs from harm	During biological surveys for proposed projects, no migratory bird nests, eggs, or young were found in harm's way. However, 5 accidental bird deaths due to human activities were documented.

Occurrences and Unplanned Releases

No unplanned airborne releases and no unplanned releases of radioactive liquids occurred from the NNSS, NLVF, or RSL-Nellis in 2013. There were two reportable environmental occurrences in 2013: 50 gallons of jet fuel were spilled at the crash site of an unmanned aerial vehicle immediately after launch in Area 25, and 20 gallons of sewage were released at the Area 6 Sewage Lift Station due to disabled pumps. The State was notified of both incidents, and both were cleaned up. Nineteen other spills occurred at the NNSS, none of which met regulatory agency reporting criteria. They consisted of small-volume releases either to containment areas or to other surfaces and did not exceed a reportable quantity. All these minor spills were cleaned up.

Radiation Dose to the Public

Background Gamma Radiation – Mean background gamma radiation exposure rates on the NNSS are estimated using ten thermoluminescent dosimeter (TLD) stations located away from radiologically contaminated sites. The average mean exposure rate among these ten stations in 2013 was 124 milliroentgen per year (mR/yr) and ranged from 70 to 167 mR/yr (Section 6.3.1). The Desert Research Institute (DRI) used TLDs at offsite locations in 2013, and these measurements ranged from 82 mR/yr at Pahrump, Nevada, to 149 mR/yr at Sarcobatus Flats, Nevada (Section 7.1.5).

Public Dose from Direct Radiation – Areas accessible to the public had direct external gamma radiation exposure rates in 2013 comparable to natural background rates. The TLD locations on the west and north sides of the parking area at Gate 100, the NNSS entrance gate, had estimated annual mean exposures of 79 and 69 mR/yr, respectively, similar to the range of background exposures observed on the NNSS (Section 6.3.2). Military or other personnel on the NTTR could be exposed to direct radiation from legacy sites on Frenchman Lake playa. A TLD location in the playa and near the NNSS boundary with NTTR had an estimated annual exposure of 290 mR (Section 6.3.2). This represents an above-background exposure of 128 to 225 mrem/yr (depending on which background radiation value is subtracted), which would exceed the 100 mrem/yr dose limit if a member of the public were to reside at this location. However, there are no living quarters or full-time personnel in that area. Because the nearest resident does not live in close proximity of the site, there is no dose contribution from external gamma radiation from NNSS operations to the public.

Public Dose from Drinking Water – Man-made radionuclides from past nuclear testing have not been detected in offsite drinking water supply wells or springs in the past or during 2013 (Section 5.1.2). Therefore, there is no dose contribution from drinking water to the public due to NNSS operations.

Public Dose from Inhalation – The radiation dose limit to the public via the air transport pathway is established by NESHAP under the Clean Air Act to be 10 mrem/yr. The U.S. Environmental Protection Agency (EPA), Region IX, has approved the use of six air sampling stations on the NNSS to verify compliance with this dose limit. 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, uranium-235+236, uranium-238, and tritium (^{3}H) (Section 4.1.4). 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 NNSS experienced the highest concentrations of radioactive air emissions (Section 4.1.5). The Gate 510 sampler, however, is the closest station to a public receptor (3.5 kilometers [km] [2.2 miles (mi)]). The estimated effective dose equivalent from air emissions for a hypothetical individual living year-round at the Gate 510 sampler would be 0.02 mrem/yr.

Public Dose from Ingestion of Radionuclides in Game Animals – Game animals and small mammals (used as models for small game animals) are analyzed for their radionuclide content to estimate the dose to the public who might consume these animals if the animals were to move off the NNSS. In 2013, tissue samples from two cottontail rabbits from each of the Palanquin and Schooner historical Plowshare sites and their control site, one jackrabbit from the Palanquin site, and opportunistic tissue samples from the carcasses of two pronghorn antelope killed by vehicles, and three bighorn sheep and nine mule deer killed by a mountain lion were collected. An individual who consumes one animal of each game species sampled on the NNSS in 2013, each having the average radionuclide concentrations of these samples, may receive an estimated 0.53 mrem/yr dose (Section 9.1.1.2).

Public Dose from All Pathways – 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. The 2013 radiological monitoring data indicate that the dose to the public living in communities surrounding the NNSS is not expected to be significantly higher than the previous 10 years. The public dose from all pathways in 2013 was estimated to be 0.55 mrem/yr. This is 0.55% of the 100 mrem/yr dose limit and about 0.15% of the total dose the MEI receives from natural background radiation (360 mrem/yr) (Section 9.1.3).

Monitoring of Radiological Releases into Air

Offsite – An offsite radiological air monitoring program is run by the Community Environmental Monitoring Program (CEMP) and is coordinated by DRI of the Nevada System of Higher Education under contract with NNSA/NFO (Chapter 7). 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 NNSS. A network of 24 CEMP stations monitor gross alpha and beta radioactivity in airborne particulates using low-volume particulate air samplers, penetrating gamma radiation using TLDs, gamma radiation exposure rates using pressurized ion chamber (PIC) detectors, and meteorological parameters using automated weather instrumentation. The stations are located in selected towns and communities of southern Nevada, southeastern California, and southwestern Utah. DRI also manages four stations having only automated weather instrumentation that are located on private ranches.

As in previous years, no airborne radioactivity related to historical or current NNSS operations was detected in any of the samples from the CEMP particulate air samplers during 2013. 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 attributable to NNSS operations remained consistent with previous years' background levels and are well within background levels observed in other parts of the United States.

Onsite – Radionuclide emissions on the NNSS are from the following sources: (1) evaporation of tritiated water from containment ponds; (2) diffusion of tritiated water vapor from soil at the Area 3 Radioactive Waste Management Site (RWMS), the Area 5 Radioactive Waste Management Complex (RWMC), and historical surface or near-surface nuclear device test locations (particularly Sedan and Schooner Craters); (3) resuspension of contaminated soil at historical surface or near-surface nuclear device test locations; and (4) release of radionuclides from current operations. A network of 20 air sampling stations and a network of 109 TLDs on the NNSS were used to monitor onsite radioactive emissions.

Total radiological atmospheric releases from the NNSS in curies (Ci) for 2013 (Section 4.1.8) are shown in the table below. An estimated 0.003 Ci of tritium were released at the NLVF.

^{3}H	^{85}Kr	Noble Gases (T½* <40 days)	Short-Lived Fission and Activation Products (T½ <3 hr)	Fission and Activation Products (T½ >3 hr)	Total Radio-iodine	Total Radio-strontium	Plutonium	Other Actinides
42	0	377	4,749	2.0206	0	0	0.050 (^{238}Pu) 0.29 ($^{239+240}Pu$)	0.047 (^{241}Am)

* T ½ = half-life

The mean tritium concentration in air samples from across all tritium sampling stations was 9.41×10^{-6} picocuries per milliliter (pCi/mL) and ranged from below detection to 407.98×10^{-6} pCi/mL at the Schooner crater station (Section 4.1.4.5). The mean annual exposure rate for direct gamma radiation at the 41 TLDs located near active projects, working personnel, and public access areas was 120 mR, approximately the same as the mean for the 10 background radiation stations of 124 mR (Section 6.3).

New NNSS Integrated Groundwater Sampling Plan

During the last quarter of 2013, NNSA/NFO implemented a new NNSS Integrated Groundwater Sampling Plan. The plan was developed over the past 2 years (2011–2013) to ensure coordinated sampling efforts at those wells that meet the objectives of Underground Test Area (UGTA) activities under the FFACO and the environmental monitoring and surveillance requirements under DOE O 458.1. The plan ensures integration between all organizations participating in groundwater sampling and in obtaining water-level measurements. A final draft of the plan was prepared in July 2013, and its implementation began in October 2013.

The Plan identifies an integrated well sampling network of 73 wells, categorized into five different types based on their current use, water quality, and downgradient proximity to historical underground nuclear tests (Section 5.1). The Plan's sampling network includes (1) 28 Characterization wells (8 on the NTTR, 20 on the NNSS) used to support groundwater characterization and contaminant flow modeling objectives, (2) 20 Source/Plume wells on the NNSS that contain contaminated groundwater verified to originate from NNSS underground nuclear testing and that are within the detonation cavity or are downgradient of the detonation at the plume edge, (3) 10 Early Detection wells (2 on the NTTR, 8 on the NNSS) that contain no radiological contaminants above background levels but are the first wells downgradient of an underground nuclear test or a Source/Plume well, (4) 7 Distal wells (1 on the NTTR and 6 on the NNSS) that are farther downgradient from Early Detection wells, and (5) 8 Community water sources southwest of the NNSS that are on BLM or private lands and that are either community, business, or private water sources or are near such sources. No wells upgradient from any of the UGTA corrective action units (areas of known groundwater contamination from historical underground nuclear testing) are included in the sampling plan. The NNSS Integrated Goundwater Sampling Plan also identifies the sampling frequency and analytical procedures for each well type. NNSA/NFO also samples annually six permitted NNSS public water system (PWS) wells and five locations called Compliance wells/surface waters, which are monitored to demonstrate compliance with specific federal/state regulations or NNSS permits. One of the PWS wells and one of the Compliance wells are also classified as Distal wells.

Monitoring of Radionuclides in Water

Offsite – Offsite water monitoring conducted in 2013 and over the past decade continues to verify that there are no man-made radionuclides from NNSS underground contamination areas in any public or private water supply wells or springs being monitored. In 2013, DRI through the CEMP sampled 23 offsite private or community water supply locations (1 spring, 3 surface water bodies, and 19 wells) for tritium (Section 7.2).Tritium concentrations for all the CEMP spring and surface water samples ranged from below detection to 23.3 picocuries per liter (pCi/L), well below the safe drinking water limit of 20,000 pCi/L (Section 7.2.3). The greatest activities were detected in samples from Boulder City and Henderson, where Lake Mead is the original water source. Slightly elevated tritium activities in Lake Mead are due to residual tritium persisting in the environment that originated from global atmospheric nuclear testing. Among the 19 offsite wells sampled under the CEMP, tritium was detectable in only one sample at very low levels (4.3 pCi/L), believed to be due to the presence of some combination of natural atmospheric production and global atmospheric testing (Section 7.2.5).

In 2013, NNSA/NFO sampled two new Characterization wells and one Early Detection well on the NTTR for tritium. Tritium was detected at low levels (249 pCi/L) only in the Early Detection well PM-3, confirming the presence of tritium detected in this well in 2011 and 2012 (Section 5.1.3.3). Hydrogeologic data west of the NNSS are sparse, and thus groundwater flow predictions are uncertain. Sample results collected to date, along with future sampling of PM-3 and modeling will be used to further develop flow and transport contamination models of the area.

In December 2013, NNSA/NFO held the Fifth Annual Groundwater Open House for the public in Beatty, Nevada. NNSA/NFO shared current information on UGTA groundwater monitoring activities. A series of 21 posters were prepared for the open house. Links to the posters can be found at the NNSA/NFO Groundwater Open House web page (http://www.nv.energy.gov/emprograms/gwopenhouse.aspx).

Onsite – In 2013, the six NNSS PWS wells were sampled for tritium and for gross alpha and gross beta radioactivity. Onsite water monitoring continues to indicate that underground nuclear testing has not impacted the NNSS potable water supply network. None of the PWS wells had detectable concentrations of tritium (Section 5.1.3.6). Detectable gross alpha and gross beta radioactivity found in many of the PWS well samples likely represents the presence of naturally occurring radionuclides, and none exceeded their EPA allowable limits for drinking water.

NNSA/NFO sampled four Characterization, four Early Detection, and five Distal wells on NNSS for tritium in 2013. Of these, one Characterization well (ER-20-11) had detectable tritium at 191,000 pCi/L (Section 5.1.3.1). ER-20-11 is believed to lie along a groundwater flowpath potentially impacted by the two nuclear detonations, TYBO and BENHAM.

In 2013, the five onsite Compliance wells/surface waters were sampled for tritium and for gross alpha and gross beta radioactivity. All water samples were within their permit limits for these analytes (Section 5.1.3.7). Groundwater and drilling fluids discharged from UGTA wells in 2013 were also sampled and found to be below the fluid management criteria limits for radiological and non-radiological parameters monitored (Section 5.1.3.7).

Release of Property Containing Residual Radioactive Material

No property can be released from the NNSS unless the amount of residual radioactivity on the property is less than the authorized limits, which are consistent with DOE O 458.1. Items proposed for unrestricted release are either surveyed (physically sampled), or a process knowledge evaluation is conducted to verify that the material has not been exposed to radioactive material or beams of radiation capable of generating radioactive material. In 2013, 424 pieces of laboratory equipment, 18 vehicles, and 14 pieces of heavy equipment were released off site to the public (Section 9.1.5). In addition, an estimated 1,105 tons of waste were released to vendors for recycling or reuse. No released items had residual radioactivity in excess of the authorized limits.

Onsite Nonradiological Releases into Air

The release of air pollutants is regulated on the NNSS 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, 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, nitrogen oxides (NO_x), carbon monoxide, particulate matter, and volatile organic compounds. The NNSS facilities regulated by the permit include (1) approximately 14 facilities and 150 pieces of equipment throughout the NNSS, (2) NPTEC, (3) Site-Wide Chemical Release Areas, (4) the BEEF, (5) the Explosives Ordnance Disposal Unit, and (6) Explosives Activities Sites in Areas 5, 14, 25, 26, and 27.

An estimated 10.29 tons of criteria air pollutants were released on the NNSS in 2013 (Section 4.2.3). The majority was NO_x from diesel generators. Total HAPs emissions from permitted operations was 0.23 tons. Lead air emissions from non-permitted activities, such as weapons use, are reported to the EPA, and this quantity in 2013 was 1.6 lb (Section 12.3). No emission limits for any criteria air pollutants or HAPs were exceeded.

Two chemical test series were conducted in 2013, consisting of 38 releases of chemicals at the Area 5 NPTEC facility (Section 4.2.6). The majority of the chemicals released were neither HAPs nor criteria pollutants, and no permit limits were exceeded. No ecological monitoring was performed because each test posed a very low level of risk to the environment and biota. In 2013, explosives were detonated at Port Gaston, and no permit limits were exceeded.

Onsite 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 NNSS. Therefore, no Clean Water Act NPDES permits are required for operations on the NNSS. Industrial discharges on the NNSS are limited to two operating sewage lagoon systems, the Area 6 Yucca Lake and Area 23 Mercury systems. Sewage lagoon waters are sampled for a suite of toxic chemicals only in the event of specific or accidental discharges of potential contaminants. There were no such discharges that warranted sampling in 2013, and all water quality parameters monitored quarterly from lagoon samples were within permit limits (Section 5.2.3.1). E Tunnel effluent, sampled for nonradiological contaminants (mainly metals), had levels of contaminants below permit limits (Section 5.2.4).

Nonradiological Releases into Air and Water at NLVF and RSL-Nellis

Sources of air pollutants at the NLVF and RSL-Nellis are regulated by permits from the Clark County Department of Air Quality. The regulated sources of air emissions include sanders, sand-blasters, diesel and gasoline generators, fire pumps, cooling towers, and boilers. The calculated total emissions of criteria pollutants at NLVF and RSL-Nellis were 1.68 and 4.41 tons per year, respectively (Appendix A, Sections A.1.1 and A.2.1). HAPs calculated emissions at RSL-Nellis were 0.08 tons per year. HAPs emissions are minor and are not regulated at the NLVF.

Water discharges at the NLVF are regulated by a permit with the City of North Las Vegas (CNLV) for sewer discharges and by an NPDES discharge permit issued by the Nevada Division of Environmental Protection for dewatering operations to control rising groundwater levels that surround the facility. The NPDES permit authorizes the discharge of pumped groundwater to the groundwater of the state via percolation and to the Las Vegas Wash via the CNLV storm drain system. Self-monitoring and reporting of the levels of nonradiological contaminants in sewage and industrial outfalls is conducted. In 2013, contaminant measurements were below established permit limits in all water samples from the NLVF sewage outfalls sampled (Appendix A, Section A.1.2.1). In 2013, the discharge from pumped groundwater at the NLVF did not exceed NPDES permit limits, and quarterly, annual, and biennial water samples of the pumped groundwater analyzed in 2013 had water quality measurements that were all below permit limits (Appendix A, Section A.1.2.2).

Water discharges at RSL-Nellis were required to meet permit limits set by the Clark County Water Reclamation District (CCWRD) during the first half of 2013, and all contaminants in the sewage outfall samples were below the limits (Appendix A, Section A.2.2). During the permit renewal process in 2013, CCWRD determined that a discharge permit would no longer be necessary at RSL-Nellis because no industrial wastewaters were being discharged. A Zero Discharge Form was submitted to CCWRD, and the permit was not renewed.

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Acknowledgements

Contributing Organizations

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More than 30 subject matter experts from across the multiple organizations identified above either authored or contributed information needed for the compilation of this report. They are identified at the beginning of each chapter.

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Chapter 1: Introduction and Helpful Information

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1.1 Site Location

The U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office (NNSA/NFO) (designated as the Nevada Site Office [NNSA/NSO] prior to March 2013) directs the management and operation of the Nevada National Security Site (NNSS). The NNSS is located in Nye County in south-central Nevada (Figure 1-1). The southeast corner of the NNSS 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. Located at the southern end of the NNSS, Mercury is the main base camp for worker housing and administrative operations for the NNSS.

The NNSS encompasses about 3,522 square kilometers (km^2) (1,360 square miles [mi^2]) based on the most recent land survey. 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 NNSS is surrounded on all sides by federal lands (Figure 1-1). It is bordered on the southwest corner by the former Yucca Mountain Site, 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 NNSS represents one of the largest unpopulated land areas in the United States, comprising some 14,200 km^2 (5,470 mi^2).

1.2 Environmental Setting

The NNSS is located in the southern part of the Great Basin, the northern-most sub-province of the Basin and Range Physiographic Province. The NNSS 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 NNSS by very large volcanic calderas (Figure 1-2). The principal valleys 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 NNSS via the Fortymile Wash. The dominant highlands 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 NNSS 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 NNSS has been altered by historical 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: Site Description*, a file on the compact disc of this report, where the geology, hydrology, climatology, ecology, and cultural resources of the NNSS are described.

1.3 Site History

The history of the NNSS, 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 known as the NNSS was under the jurisdiction of Nellis Air Force Base and was part of the Nellis Bombing and Gunnery Range. The site was established in 1950 to be the primary location for testing the nation’s nuclear explosive devices. It was

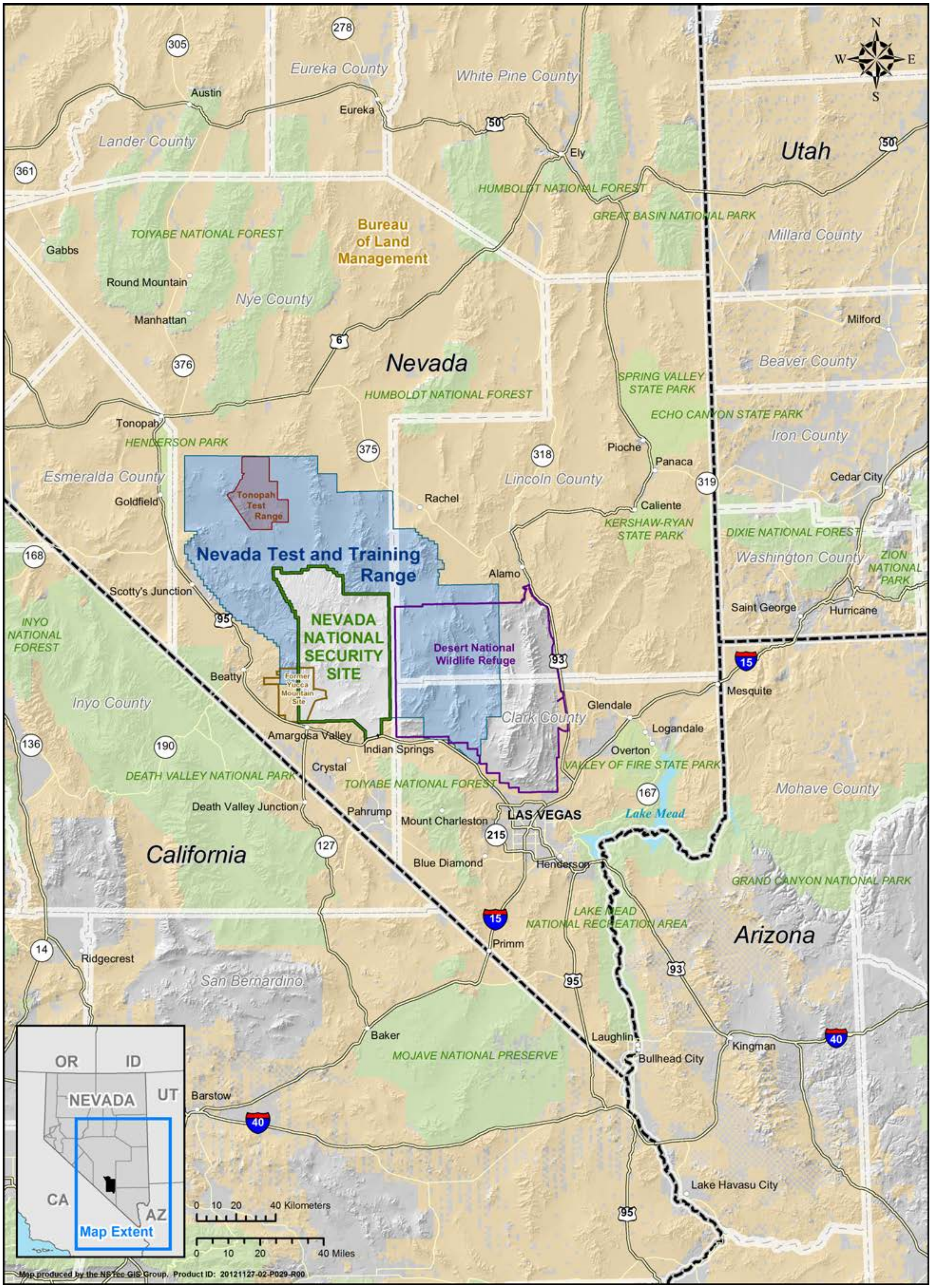


Figure 1-1. NNSS vicinity map

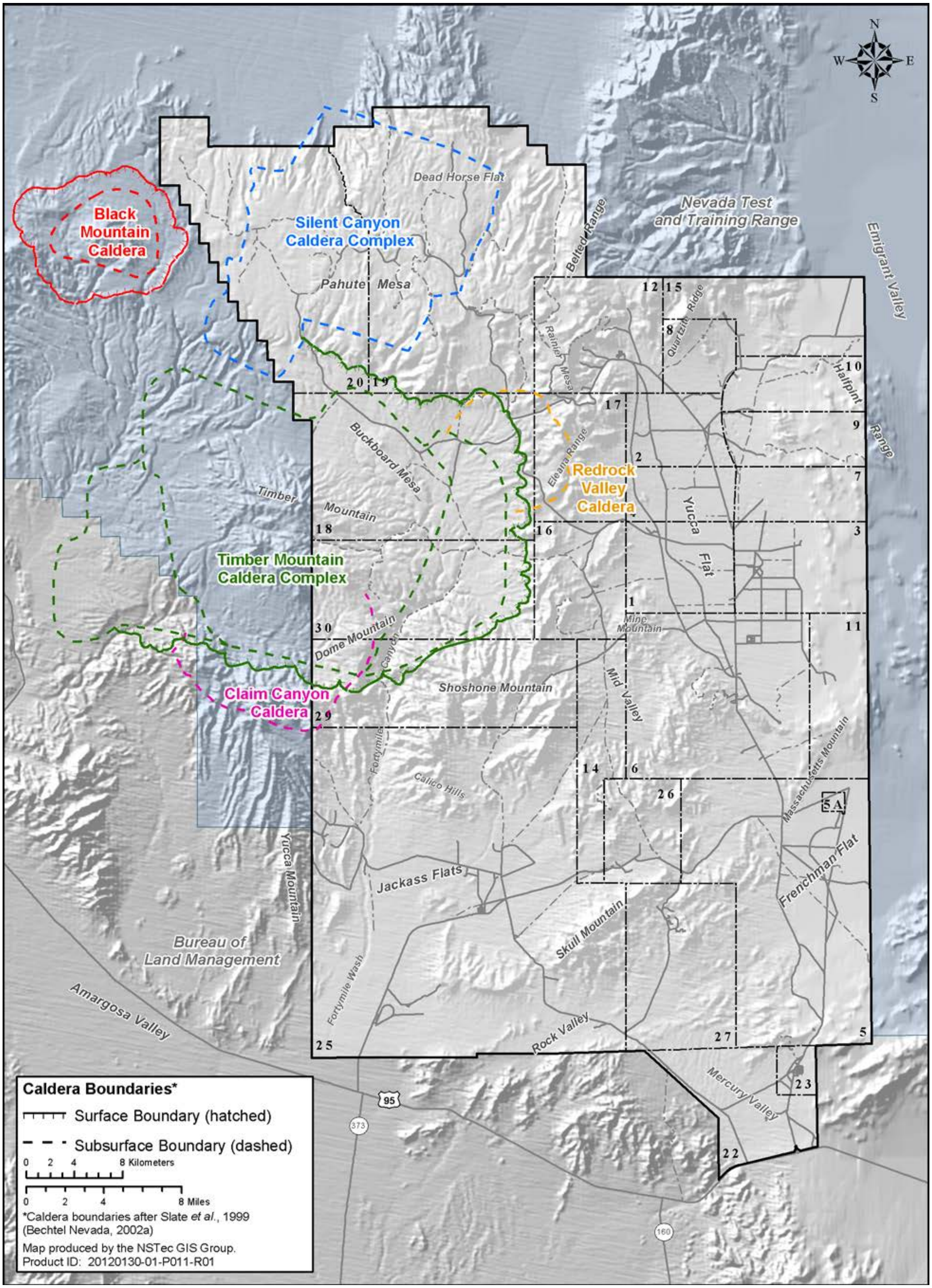


Figure 1-2. Major topographic features and calderas of the NNSS

named the Nevada Test Site (NTS) in 1951 and supported nuclear testing from 1951 to 1992. The types of tests conducted during this period are briefly described below. On August 23, 2010, the NTS was named the NNSS to reflect the diversity of nuclear, energy, and homeland security activities now conducted at the site. Nuclear experiments conducted at the NNSS are currently limited to subcritical experiments.

Atmospheric Tests – Tests conducted through the 1950s were predominantly atmospheric tests. They involved a nuclear explosive device detonated while either 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 NNSS boundary at the south end of the NTTR, and four others are at the north end of the NTTR.

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 NNSS. Approximately one-third of them were detonated near or in the saturated zone (see Glossary, Appendix B).

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 NNSS. The second-highest yield crater test was Schooner, located in the northwest corner of the NNSS. 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 NNSS 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 U.S. Department of Defense (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 was conducted in Area 25, and a series of tests with a nuclear ramjet engine was 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.

Fact sheets on many of the historical tests mentioned above can be found at http://www.nv.energy.gov/library/factsheets.aspx. 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).

1.4 Site Mission

NNSA/NFO directs the facility management and program operations at the NNSS, North Las Vegas Facility (NLVF), and Remote Sensing Laboratory–Nellis (RSL-Nellis) in Nevada and directs selected operations at four sites outside of Nevada that include RSL-Andrews in Maryland, Livermore Operations in California, Los Alamos Operations in New Mexico, and the Special Technologies Laboratory in California. 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 NNSS. National Security Technologies, LLC, is the current Management and Operations contractor accountable for the successful execution of work and ensuring that work is performed in compliance with environmental regulations. The three major NNSS missions include National Security/Defense, Environmental Management, and Nondefense. The programs that support these missions are listed in the text box below.

NNSS Missions and Programs

National Security/Defense Missions

Stockpile Stewardship and Management Program – Conducts high-hazard operations in support of defense-related nuclear and national security experiments and maintains the capability to resume underground nuclear weapons testing, if directed.

Nuclear Emergency Response, Nonproliferation, and Counterterrorism Programs – Provides support facilities, training facilities, and capabilities for government agencies involved in emergency response, nonproliferation technology development, national security technology development, and counterterrorism activities.

Work for Others Program – Provides support facilities and capabilities for other DOE programs and federal agencies/organizations involved in defense-related activities.

Environmental Management Missions

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

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

Nondefense Missions

General Site Support and Infrastructure Program – Maintains the buildings, roads, utilities, and facilities required to support all NNSS programs and to provide a safe environment for NNSS workers.

Conservation and Renewable Energy Programs – Operates the pollution prevention program and supports renewable energy and conservation initiatives at the NNSS.

Other Research and Development – Provides support facilities and NNSS access to universities and organizations conducting environmental and other research unique to the regional setting.

1.5 Primary Facilities and Activities

The NNSS facilities or centers that support the National Security/Defense missions include the U1a Complex, Big Explosives Experimental Facility, Device Assembly Facility (DAF), Dense Plasma Focus Facility (located within the Los Alamos Technical Facility), Joint Actinide Shock Physics Experimental Research (JASPER) Facility, Nonproliferation Test and Evaluation Complex (NPTEC), the National Criticality Experiments Research Center (located within the DAF), the Radiological/Nuclear Countermeasures Test and Evaluation Complex (RNCTEC), and the Radiological/Nuclear Weapons of Mass Destruction Incident Exercise Site (known as the T-1 Site). NNSS facilities that support Environmental Management missions include the currently active Area 5 Radioactive Waste Management Complex (RWMC) and the Area 3 Radioactive Waste Management Site (RWMS), which is in cold standby (Figure 1-3).

The primary NNSS activity in 2013 was helping to ensure that the U.S. stockpile of nuclear weapons remains safe and reliable. Other 2013 NNSS activities included weapons of mass destruction first responder training; the controlled release of hazardous material at NPTEC; remediation of legacy contamination sites; processing of waste destined for the Waste Isolation Pilot Plant in Carlsbad, New Mexico, or the Idaho National Laboratory in Idaho Falls, Idaho; and disposal of low-level and mixed low-level radioactive waste. Land use by each of the NNSS missions occurs within designated zones (Figure 1-4).

1.6 Scope of Environmental Report

This report summarizes data and the compliance status of the NNSA/NFO environmental protection and monitoring programs for calendar year 2013 at the NNSS and at 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).

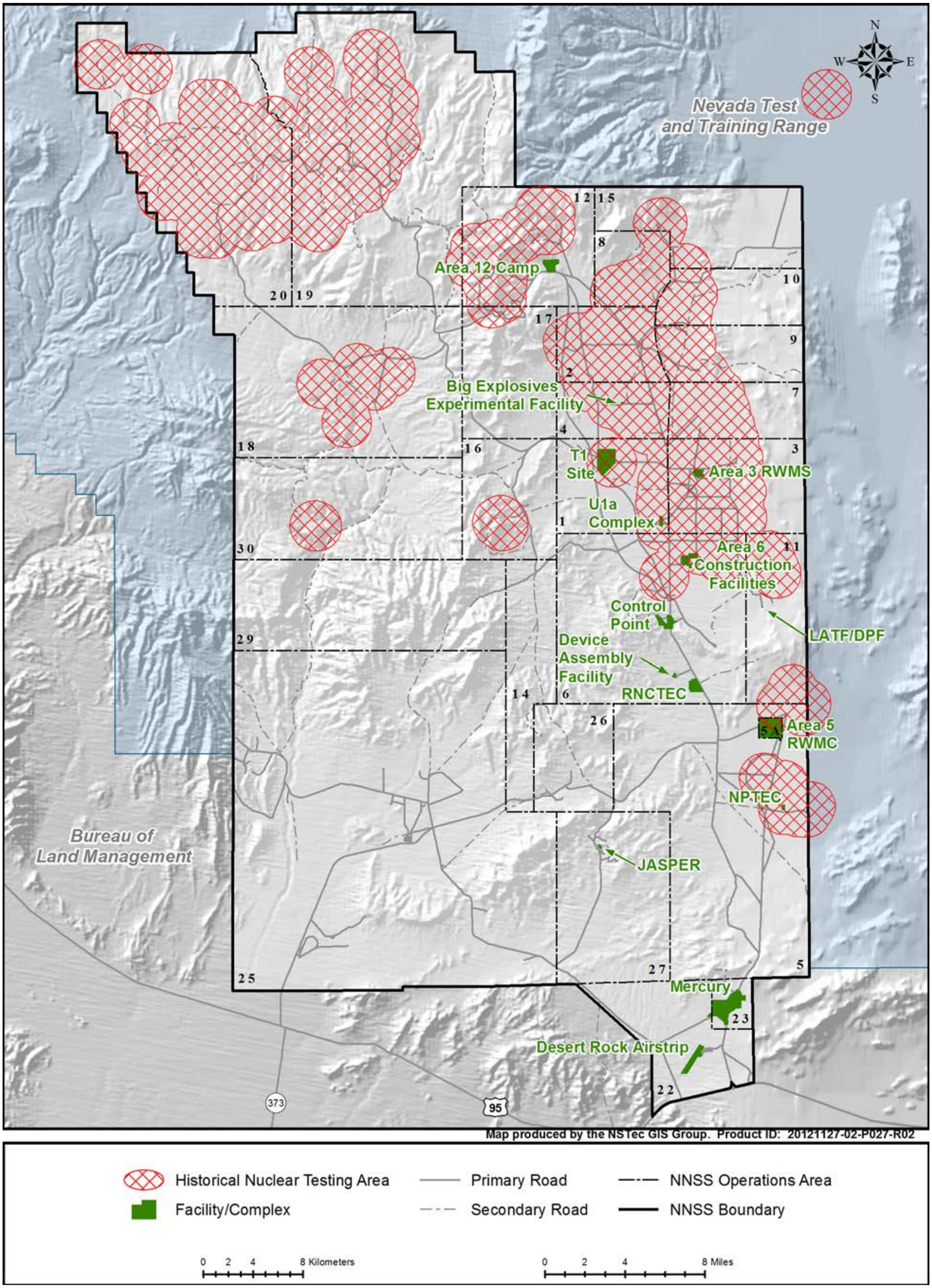


Figure 1-3. NNSS operational areas, principal facilities, and past nuclear testing areas

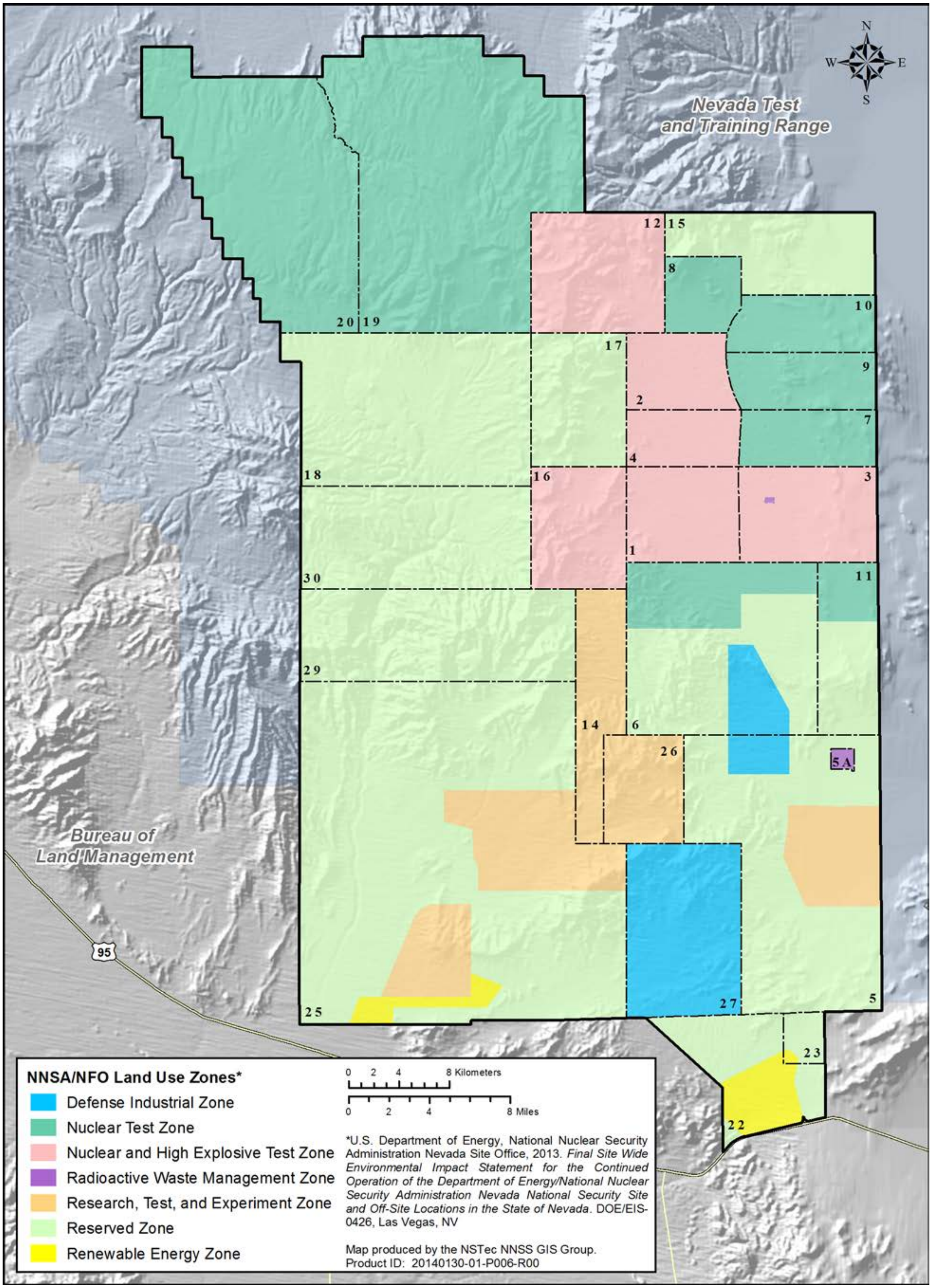


Figure 1-4. NNSS land-use map

Through a Memorandum of Agreement, NNSA/NFO is responsible for the oversight of TTR ER projects, and the U.S. Department of Energy, National Nuclear Security Administration Sandia Field Office (NNSA/SFO) has oversight of all other TTR activities. NNSA/SFO produces the TTR annual site environmental reports, which are posted at http://www.sandia.gov/news/publications/environmental/index.html.

1.7 Populations near the NNSS

The population of the area surrounding the NNSS (see Figure 1-1) is predominantly rural. Population estimates for Nevada communities are provided by the Nevada State Demographer's Office (2014). The most recent population estimate for Nye County is 44,749, and the largest Nye County community is Pahrump (37,030), located approximately 80 km (50 mi) south of the NNSS Control Point facility near the center of the NNSS. Other Nye County communities include Tonopah (2,593), Amargosa (1,342), Beatty (966), Round Mountain (822), Gabbs (259), and Manhattan (124). Lincoln County to the east of the NNSS includes a few small communities including Caliente (1,068), Pioche (790), Panaca (811), and Alamo (583). Clark County, southeast of the NNSS, is the major population center of Nevada and has an estimated population of 2,031,723. The total annual population estimate for all Nevada counties, cities, and unincorporated towns is 2,800,967.

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 latest population estimates for Utah communities are taken from the U.S. Census Bureau (2014) of the U.S. Department of Commerse. Southern Utah's largest community is St. George, located 220 km (137 mi) east of the NNSS, with an estimated population of 75,561. The next largest town, Cedar City, is located 280 km (174 mi) east-northeast of the NNSS and has an estimated population of 29,118.

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 NNSS, with an estimated population of 39,495, and Kingman, 280 km (174 mi) southeast of the NNSS, with an estimated population of 28,476 (Arizona Department of Administration 2014).

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 to the 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	0.000000001 (1×10^{-9})
pico-	p	0.000000000001 (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 gram 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 (1×10^{-3} Ci)
μCi	microcurie (1×10^{-6} Ci)
nCi	nanocurie (1×10^{-9} Ci)
pCi	picocurie (1×10^{-12} 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 1-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% 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 (1×10^{-3} rad)
mrem	millirem (1×10^{-3} rem)
R	roentgen
mR	milliroentgen (1×10^{-3} R)
μR	microroentgen (1×10^{-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)	3.7×10^{10}
gray (Gy)	rad	100
millirem (mrem)	millisievert (mSv)	0.01
millisievert (mSv)	millirem (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
^{36}Cl	chlorine-36	3.01×10^5 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	1.6×10^7 yr
^{131}I	iodine-131	8 d
^{40}K	potassium-40	1.3×10^8yr
^{85}Kr	krypton-85	10^7 yr
^{212}Pb	lead-212	10.6 hr
^{238}Pu	plutonium-238	87.7 yr
^{239}Pu	plutonium-239	2.4×10^4 yr
^{240}Pu	plutonium-240	6.5×10^3 yr
^{241}Pu	plutonium-241	14.4 yr
^{226}Ra	radium-226	1.62×10^3 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	2.1×10^5 yr
^{232}Th	thorium-232	1.4×10^{10} yr
U [b]	uranium total	- - - [c]
^{234}U	uranium-234	2.4×10^5 yr
^{235}U	uranium-235	7×10^8 hr
^{238}U	uranium-238	4.5×10^9 yr
^{65}Zn	zinc-65	243.9 d
^{95}Zr	zirconium-95	63.98 d

(a) From Shleien (1992), except for ^{36}Cl (Browne et al. 1986)

(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 4.5×10^9 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.

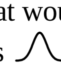
Uncertainty in analytical measurements is also the consequence of variability related to collecting and analyzing the samples. This variability is associated with reading or recording the result, handling or processing the sample, calibrating the counting instrument, and numerical rounding.

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% 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.

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)
	1.31 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)	28.35 gram (g)
1 kilogram (kg)	2.21 pounds (lb)	1 pound (lb)	0.454 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 × 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% of the measurements would be within the mean ± SD, and 95% 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 × SE. The ± value implies that approximately 95% of the time, the average of many calculated means will fall somewhere between the reported value minus the 2 × SE value and the reported value plus the 2 × 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.

1.9 References

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Chapter 2: Compliance Summary

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Environmental regulations pertinent to operations on the Nevada National Security Site (NNSS), the North Las Vegas Facility (NLVF), and the Remote Sensing Laboratory–Nellis (RSL-Nellis) are listed in this chapter. They include federal and state laws, state and local 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 Field Office (NNSA/NFO) conducts operations on and off the NNSS to ensure the protection of the environment and the public. The regulations are grouped by topic, and each topical subsection contains a brief description of the applicable regulations, a summary 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 compliance status 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 2-12 presents the list of all environmental permits issued for the NNSS and the two Las Vegas area facilities.

2.1 Environmental Management and Sustainability

2.1.1 Applicable Regulations

EO 13423, "Strengthening Federal Environmental, Energy, and Transportation Management" – This EO requires federal facilities to establish 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. NNSA/NFO complies with this EO through adherence to DOE O 436.1, "Departmental Sustainability."

EO 13514, "Federal Leadership in Environmental, Energy, and Economic Performance" – This EO expands upon the energy reduction and environmental performance requirements of EO 13423. It requires all federal agencies to establish an integrated sustainability plan towards reducing greenhouse gas (GHG) emissions, using water more efficiently, promoting pollution prevention and eliminating waste, constructing high performance sustainable buildings, purchasing energy efficient and environmentally preferred products, and reducing the use of fossil fuels through improved fleet management. The GHGs targeted for emission reductions in the EO are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. The EO establishes GHG emission reductions as an overarching, integrating performance metric for all federal agencies. The Secretary of Energy issued a memorandum in March 2010 creating DOE goals pertaining to EO 13514. The DOE goals were first published in the 2010 Strategic Sustainability Performance Plan (SSPP) (DOE 2010). It commits DOE to a 28% reduction in agency GHG emissions by fiscal year (FY) 2020.The SSPP is updated each year to reflect changes in schedule, milestones, and approaches. Site-specific goals for the NNSS that support DOE's SSPP and compliance with this EO are incorporated into NNSA/NFO's EMS.

DOE O 436.1, "Departmental Sustainability" – This order incorporates and implements the requirements of EO 13514 and EO 13423 and requires each DOE site to set goals to achieve the DOE SSPP goals, use their EMS as the platform for establishing site-specific sustainability programs with objectives and measureable targets, develop and implement Site Sustainability Plans (SSPs) to put established sustainability objectives and targets into action, and use alternative financing to the maximum extent possible for sustainability projects.

Resource Conservation and Recovery Act (RCRA) – Under RCRA, generators of hazardous waste (HW) 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 U.S. Environmental Protection Agency (EPA) developed a list of types of commercially available products (e.g., copy machine paper, plastic desktop items) and specified 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. Federal facilities must have a procurement process in place to ensure that they purchase product types that satisfy the EPA-designated minimum percentages of recycled material.

Nevada Division of Environmental Protection (NDEP) Hazardous Waste Permit NEV HW0101 – This state permit requires NNSA/NFO to generate an Annual Summary Report, which includes waste minimization information. This report should include a description of the efforts taken during the year to reduce the volume and toxicity of waste generated in accordance with 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.

2.1.2 Compliance Reports

The following reports were generated in 2013 for NNSA/NFO operations on the NNSS and at the two offsite facilities in compliance with regulations related to environmental protection; renewable energy and transportation management; environmental, energy, and economic performance; and pollution prevention and waste minimization:

- *FY 2014 NNSA/NFO Site Sustainability Plan* (National Security Technologies, LLC [NSTec], 2013a)
- *RCRA Permit for a Hazardous Waste Management Facility Permit Number NEV HW0101- Annual Summary/Waste Minimization Report Calendar Year 2013, Nevada National Security Site, Nevada*, submitted to NDEP (NSTec 2014a)
- *FY 2013-0 EMS Annual Report*, submitted to DOE Headquarters (HQ) via entry into DOE HQ database

Table 2-1. NNSS compliance status with environmental management and sustainability regulations

Requirement	2013 Compliance Status	Section Reference[(a)]
DOE O 436.1, "Departmental Sustainability"; EO 13423, "Strengthening Federal Environmental, Energy and Transportation Management"; and EO 13514, "Federal Leadership in Environmental, Energy, and Economic Performance"		
Annually update and implement an SSP to meet sustainability targets and goals.	Compliant	3.3.1; Table 3-1
Implement a validated EMS, which is certified to or conforming to International Organization for Standardization (ISO) 14001:2004.	Compliant	3.6
Include objectives and targets in the EMS that contribute to achieving the DOE Sustainable Environmental Stewardship goals.	Compliant	3.3
Monitor EMS progress and make such information available annually through the EMS Compliance Reporting using the Fed Center DOE HQ database.	Compliant	3.3; Table 3-1; 3.7
Resource Conservation and Recovery Act (RCRA)		
Have a program to reduce volume/quantity and toxicity of generated HW to the degree it is economically practicable.	Compliant	3.3.2
Have a process to ensure that EPA-designated list products are purchased containing the minimum content of recycled materials.	Compliant	3.3.2
NDEP Hazardous Waste Permit NEV HW0101		
Submit a calendar year Annual Summary/Waste Minimization Report to NDEP due March 1.	Compliant	3.3.2.1

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

2.2 Air Quality and Protection

2.2.1 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 187 designated hazardous air pollutants (HAPs). Radionuclides and asbestos are among the 22 HAPs for which standards were established. NNSA/NFO NESHAP compliance activities include radionuclide air monitoring; reporting/notification of asbestos abatement; monitoring/reporting of emissions from generators, boilers, and management of gasoline and diesel storage tanks. At the NNSS, NESHAP requirements are mainly met through adherence to State of Nevada Class II Air Quality Operating Permit (AP9711-2557); all approvals, notifications, requests for additional information, and reports required under the CAA are submitted to the State, Clark County, and the EPA Region IX in accordance with federal requirements. At NLVF and RSL-Nellis, NESHAP requirements are met through adherence to a Clark County Minor Source Permit and a Clark County Synthetic Minor Source Permit, respectively.

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. For the NNSS, there is one state-issued Class II Air Quality Operating 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 NNSS. Emissions from NNSS operations are calculated and submitted to the State each year. Lead emissions are reported to the State as part of the total HAPs emissions. The NNSS 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 semi-annual and annual reporting of hours of operation, emission quantities of criteria pollutants and HAPs, opacity for all operating equipment, certification of personnel who monitor opacity, 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 include the six criteria pollutants plus other pollutants known as "designated pollutants." A designated pollutant is any pollutant regulated by NSPS that is not a criteria pollutant. Examples of these are acid mist, fluorides, hydrogen sulfide in acid gas, and total reduced sulfur. The NSPS impose more stringent standards, including a reduced allowance of visible emissions (opacity), than under NAAQS. On the NNSS, some screens, a pugmill, conveyor belts, bulk fuel storage tanks, and generators are subject to the NSPS, which Nevada regulates through the Class II Air Quality Operating Permit. One diesel generator located at the NLVF is also regulated by 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 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 NNSS, ODS are mainly used in air conditioning units in vehicles, buildings, refrigerators, drinking water fountains, vending machines, and laboratory equipment.

Nevada Administrative Code NAC 445B, "Air Controls" – In addition to enforcing the CAA regulations mentioned above, NAC 445B.22037 requires fugitive dust to be controlled. At the NNSS, the Class II Air Quality Operating Permit includes a provision for site-wide surface disturbances and therefore requires implementation of an ongoing control program using the best practicable methods. Off the NNSS, and excluding Clark County, all NNSA/NFO surface-disturbing activities that cover 5 or more acres are regulated by stand-alone Class II Surface Area Disturbance (SAD) permits issued by the State. NAC 445B.22067 prohibits the open burning of combustible refuse and other materials unless specifically exempted by an authorized variance. At the NNSS, Open Burn Variances are routinely obtained for various fire training and emergency management exercises.

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 NNSS operations are subject to these fees. In addition, NNSA/NFO must allow Nevada's Bureau of Air Pollution Control to conduct inspections of permitted NNSS facilities and allow the Clark County Department of Air Quality (DAQ) to conduct inspections of NLVF and RSL-Nellis permitted equipment.

2.2.2 Compliance Reports

The following reports were generated for 2013 NNSS operations in compliance with air quality regulations:

- *National Emission Standards for Hazardous Air Pollutants – Radionuclide Emissions, Calendar Year 2013*, submitted to EPA Region IX (NSTec 2014b)
- *Annual Asbestos Abatement Notification Form*, submitted to NDEP and to EPA Region IX
- *Calendar Year 2013 Actual Production/Emissions Reporting Form*, submitted to 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
- Explosive Ordnance Disposal Unit (EODU) Detonation Proposal and Analysis Results, submitted to NDEP

The following reports were generated for 2013 operations at offsite facilities in compliance with air quality regulations:

- *Department of Air Quality Annual Emission Inventory Reporting Form for North Las Vegas Facility*, submitted to Clark County DAQ
- *Department of Air Quality Semi-Annual Report for Remote Sensing Laboratory*, submitted to Clark County DAQ
- *Department of Air Quality Annual Emission Inventory Reporting Forms for Remote Sensing Laboratory*, submitted to Clark County DAQ

Table 2-2. NNSS compliance status with applicable air quality regulations

Requirement	Compliance Limit	2013 Compliance Status	Section Reference[(a)]
Clean Air Act – NESHAP			
Estimate annual dose equivalent from all radioactive air emissions	10 millirem per year	Compliant	9.1.1.1
Submit notification of compliance for small area source boilers subject to tune-ups to NDEP	Due July 19, biennially	Compliant	--
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	Compliant	4.2.8
Maintain asbestos abatement plans, data records, activity/ maintenance records	For up to 75 years	Compliant	4.2.8
Clean Air Act – NAAQS			
Submit annual and quarterly reports of calculated emissions at the NNSS to the State	Due March 1 and 30 days after end of each quarter, respectively	Compliant	4.2.3
Submit annual report of calculated emissions at NLVF and RSL-Nellis to Clark County	Due March 31	Compliant	A.1.1; A.2.1
Track tons of emissions of each criteria pollutant produced by permitted equipment/facility at the NNSS, NLVF, and RSL-Nellis based on calculations and actual operating information	PTE[(b)] varies	Compliant	4.2.3; Table 4-11; A.1.1; A.2.1
Submit semi-annual report of operating hours and throughputs for permitted equipment used at RSL-Nellis to Clark County	Due January 31 and July 31	Compliant	A.2.1
Track number of gallons of fuel used, hours of operation, and rate of aggregate/concrete production by permitted equipment/facility at the NNSS	Limit varies[(c)]	Compliant	4.2.3
Conduct opacity readings when in use for selected permitted equipment/facility at the NNSS, NLVF, and RSL-Nellis	Quarterly for NNSS, weekly for NLVF, daily for RSL-Nellis	Compliant	4.2.5; A.1.1; A.2.1
Measure percent opacity of emissions from permitted equipment/facility at the NNSS, NLVF, and RSL-Nellis	20%	Compliant	4.2.5; A.1.1; A.2.1
Conduct particulate monitoring for chemical releases/detonations at permitted chemical release and detonation sites on the NNSS	Monitoring report due ≤ 30 days from end of each quarter	Compliant	4.2.6
Submit test plans/final analysis reports to the State for each chemical release test or test series and for each detonation at permitted chemical release/detonation sites on the NNSS	Test plans due ≥ 30 days prior to tests, final reports due ≤ 30 days from end of each quarter	Compliant	4.2.6
Track rate and quantity of chemicals released at permitted chemical release sites and of explosives detonated at permitted detonation sites on the NNSS	Pounds per hour and tons per year; limits vary by chemical	Compliant	4.2.6
Track tons of criteria pollutant emissions and hazardous air pollutants at permitted chemical release sites and detonation sites on the NNSS	PTE[(b)] varies	Compliant	4.2.3; Table 4-11
Clean Air Act – NSPS			
Conduct opacity readings from permitted equipment/facility	Quarterly	Compliant	4.2.5
Measure percent opacity of emissions from permitted equipment/facility	10%	Compliant	4.2.5
Clean Air Act – Stratospheric Ozone Protection			
Maintain ODS technician certification records, approvals for ODS-containing equipment recycling/recovery, and applicable equipment servicing records	NA[(d)]	Compliant	4.2.7
Other Nevada Air Quality Permit Regulations			
Control fugitive dust for land-disturbing activities	NA	Compliant	4.2.9

(a) The section(s) within this document that describe how compliance summary data were collected
(b) Potential to emit = quantities of criteria pollutants that each facility/piece of equipment would emit annually if it were operated for the maximum hours specified in the air permit
(c) Compliance limit is specific for each piece of permitted equipment/facility
(d) Not applicable

2.3 Water Quality and Protection

2.3.1 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 United States without a National Pollutant Discharge Elimination System (NPDES) permit. At the NNSS, CWA regulations are followed through compliance with permits issued by NDEP for wastewater discharges. Because there are no wastewater discharges to surface waters on or off site, there are no NPDES permits for the NNSS. At the NLVF, an NPDES permit regulates the discharge of pumped groundwater (see Appendix A, Section A.1.1.2). NPDES compliance is summarized in a format requested by DOE in Table 2-3 below. The EPA also requires the NLVF and RSL-Nellis to maintain and implement a Spill Prevention, Control, and Countermeasure (SPCC) Plan to ensure that petroleum and non-petroleum oil products do not pollute waters of the United States via discharge into the Las Vegas Wash.

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) (see Glossary, Appendix B) 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, "Water Controls," requires 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, and the PWSs on the NNSS are permitted by the State as noncommunity water systems (see Glossary, Appendix B). Although not required under the SDWA, all potable water supply wells are monitored on the NNSS for radionuclides in compliance with DOE O 458.1, "Radiation Protection of the Public and the Environment" (see Section 2.4).

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

NACs 444, "Sanitation" (Sewage Disposal) and 445A, "Water Controls" (Water Pollution Control) – These NACs regulate the collection, treatment, and disposal of wastewater and sewage at the NNSS. The requirements of these state regulations are issued in permits to NNSA/NFO for the E Tunnel Waste Water Disposal System, active and inactive sewage lagoons, septic tanks, septic tank pumpers, and a septic tank pumping contractor's license. NNSA/NFO also obtains underground injection control (UIC) permits from NDEP, as required under NAC 445A.810–925, for various investigations. In 2012, a UIC permit was obtained for a noble gas migration study at borehole U20az PS#1A in Area 20. The permit was still active in 2013.

NAC 534, "Underground Water and Wells" – This NAC regulates the drilling, construction, and licensing of new wells and the reworking of existing wells to prevent the waste and contamination of underground waters. NNSA/NFO 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. Only one NNSA/NFO operation, the UGTA activity, complies with this NAC; which drills new wells and reworks old wells.

UGTA Fluid Management Plan – UGTA wells are regulated by the State through an agreement between NNSA/NFO and 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 Waste Management Plan (U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office [NNSA/NSO] 2009).

2.3.2 Compliance Reports

The following reports were generated for NNSS operations in 2013 in compliance with water quality regulations:

- *Quarterly Monitoring Reports for Nevada National Security Site Sewage Lagoons*, submitted to NDEP
- Results of water quality analyses for PWSs, sent to the State throughout the year as they were obtained from the analytical laboratory
- *Water Pollution Control Permit NEV 96021, Quarterly Monitoring Report* (for first, second, and third quarters of 2013 for E Tunnel effluent monitoring), submitted to NDEP
- *Water Pollution Control Permit NEV 96021, Quarterly Monitoring Report and Annual Summary Report for E Tunnel Wastewater Disposal System, Biennial Groundwater Monitoring Report* (NSTec 2014c), submitted to NDEP

The following reports were generated for operations at the two offsite facilities in 2013 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 for first and second quarters titled *Remote Sensing Laboratory Self Monitoring Report - Permit No. CCWRD-080*, submitted to the Clark County Water Reclamation District
- One monitoring report titled *Remote Sensing Laboratory Additional Monitoring Reports - Permit No. CCWRD-080*, submitted to the Clark County Water Reclamation District

Table 2-3. Summary of NPDES permit compliance at NLVF in 2013

Permit Type	Outfall	Parameter[(a)]	Number of Permit Exceedances	Number of Samples Taken	Number of Compliant Samples	Percent Compliance	Date(s) Exceeded	Description/ Solution
NV0023507	001 and 002	Daily maximum flow	0	365 (continuous)	365	100	NA[(b)]	NA
		TPH	0	1 (1/year)	1	100	NA	NA
		TSS	0	4 (1/quarter)	4	100	NA	NA
		TDS	0	4 (1/quarter)	4	100	NA	NA
		N	0	4 (1/quarter)	4	100	NA	NA
		pH	0	4 (1/quarter)	4	100	NA	NA
		Tritium	MR[(c)]	1 (1/year)	1	100	NA	NA

(a) TPH = total petroleum hydrocarbons, TSS = total suspended solids, TDS = total dissolved solids, N = total inorganic nitrogen
(b) NA = not applicable
(c) MR = monitor and report, no specified daily maximum or 30-day average limit, just the requirement that there shall be no discharge of substances that would cause a violation of state water quality standards

Table 2-4. NNSS compliance status with applicable water quality and protection regulations

Requirement	Compliance Limit	2013 Compliance Status	Section Reference[(a)]
Safe Drinking Water Act and NAC 445A, "Water Controls" (Public Water Systems)			
Monitor number of water samples containing coliform bacteria	1 per month per PWS	Compliant	5.2.1.1; Table 5-7
Measure concentration of inorganic and organic chemical contaminants and disinfection byproducts in permitted NNSS PWSs	Limit varies[(b)]	Compliant	5.2.1.1; Table 5-7
Allow NDEP access to conduct inspections of PWS and water hauling trucks	NA[(c)]	Compliant	5.2.1.2
Clean Water Act - NPDES/State Pollutant Discharge Elimination System Permits and SPCC Plan			
Monitor water chemistry parameters quarterly and annually and monitor over 100 contaminants biennially in pumped groundwater at the NLVF	Limit varies	Compliant	A.1.2.2; Table A-3
Maintain and implement the SPCC Plan for the NLVF	NA	Compliant	A.1.2.5
Clean Water Act and NAC 444, "Sanitation" (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	5.2.2
Clean Water Act and NAC 445A, "Water Controls" (Water Pollution Control)			
Monitor quarterly the 5-day biological oxygen demand (BOD_5), total suspended solids (TSS), and pH in sewage lagoon	BOD_5: varies TSS: no limit pH: 6.0–9.0 S.U.	Compliant	5.2.3.1; Table 5-8
Monitor for 29 contaminants in permitted sewage lagoons only if specific or accidental discharges of potential contaminants occur	Limit varies	Compliant	5.2.3.1
Submit quarterly monitoring reports for two active sewage lagoons (for Areas 6 and 23)	Due end of April, July, October, January	Compliant	5.2.3.1
Inspection by operator of active and inactive sewage lagoon systems	Weekly and quarterly	Compliant	5.2.3.2
Monitor quarterly concentrations of tritium (^3H), gross alpha (α), gross beta (β) (in picocuries per liter [pCi/L]); and 14 nonradiological contaminants/water parameters; and monitor monthly the flow rate, pH, and specific conductance (SC) from E Tunnel discharge water samples	^3H: 1,000,000 pCi/L α: 35 pCi/L β: 100 pCi/L Non-rad: Limit varies	Compliant – All contaminants were within permit limits. One water quality indicator, SC, was below permissible limits	5.1.3.7.2; Table 5-4; 5.2.4; Table 5-9
Monitor every 24 months the concentrations of ^3H, α, β, and 16 nonradiological contaminants/water quality parameters in Well ER-12-1 water samples	^3H: 20,000 pCi/L α: 15 pCi/L; β: 50 pCi/L Non-rad: Limit varies	Compliant	5.1.3.7.2; Table 5-4; 5.2.4; Table 5-9
Monitor annually concentrations of 20 contaminants in samples from NLVF sewage outfalls	Limit varies	Compliant	A.1.2.1; Table A-2
Monitor quarterly concentrations of 12 contaminants in samples from the RSL-Nellis sewage outfall	Limit varies	Compliant	A.2.2; Table A-6
Adhere to NDEP UIC permit requirements for noble gas migration study in Area 20	NA	Compliant	—
NAC 534, "Underground Water and Wells," and UGTA Fluid Management Plan			
Maintain State well-drilling license for personnel supervising well construction/reconditioning	NA	Compliant	—
For UGTA well drilling fluids, monitor tritium and lead levels (in milligrams per liter [mg/L]), manage fluids, notify NDEP as required based on decision criteria limits	^3H >200,000 pCi/L, Lead >5 mg/L	Compliant	5.1.3.7.3
Adhere to well construction requirements/waivers, maintain records, submit required reports	NA	Compliant	—

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

(b) Compliance limit is specific for each contaminant; see referenced tables for specific limits

(c) NA = Not applicable

2.4 Radiation Protection

2.4.1 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 (0.1 mSv/yr). The CLs are provided for facilities, such as the NNSS, which use air sampling at offsite receptor locations to demonstrate compliance with the NESHAP public radiation dose limit. Sources of NNSS radioactive air emissions include containment ponds, Area 5 Radioactive Waste Management Complex (RWMC), Sedan and Schooner craters, 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 contaminant 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 NNSS are the underground nuclear tests detonated near or below the water table (see Glossary, Appendix B).

DOE O 458.1, "Radiation Protection of the Public and the Environment" – DOE O 458.1 requires DOE sites to establish and document an environmental radiological protection program. The order establishes requirements for (1) measuring radioactivity in the environment, (2) documenting the ALARA [as low as reasonably achievable] process for operations, (3) using mathematical models for estimating radiation doses, (4) releasing property having residual radioactive material, and (5) maintaining records to demonstrate compliance. DOE O 458.1 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. The order calls for the protection of populations of terrestrial plants and aquatic and terrestrial animals from radiological impacts through the use of DOE Standard DOE-STD-1153-2002, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota."

DOE-STD-1196-2011, "Derived Concentration Technical Standard" – This standard, issued in April 2011, defines the Derived Concentration Standards (DCSs) (see Glossary, Appendix B) used in the design and conduct of radiological environmental protection programs at DOE facilities and sites. DCSs represent the concentration of a given radionuclide in either water or air that results in a member of the public receiving 100 mrem (1 mSv) effective dose following continuous exposure for 1 year via each of the following pathways: ingestion of water, submersion in air, and inhalation. They replace the Derived Concentration Guides (DCGs), which were previously published by DOE in 1993 in DOE O 5400.5, "Radiation Protection of the Public and the Environment." Previous versions of this report used DCGs to evaluate environmental monitoring results. With the issuance of DOE O 458.1 and DOE-STD-1196-2011, this report will now report environmental monitoring results according to the corresponding DCSs.

DOE-STD-1153-2002, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota" – This standard 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 per day [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" – This order requires that all DOE radioactive waste be 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 NNSS. The Area 3 Radioactive Waste

Management Site (RWMS) and the Area 5 RWMC operate as Category II Non-Reactor Nuclear Facilities. They are designed and operated to manage and safely dispose of low-level waste (LLW), mixed low-level waste (MLLW), and HW generated by NNSA/NFO, other DOE, or selected U.S. Department of Defense (DoD) operations and to manage and safely store transuranic (TRU) and mixed transuranic (MTRU) wastes generated on site for eventual shipment to the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico. The manual for this order (DOE M 435.1-1) specifies that operations at NNSS radioactive waste management facilities must not contribute a dose to the general public in excess of 25 mrem/yr.

2.4.2 Compliance Reports

- *National Emission Standards for Hazardous Air Pollutants – Radionuclide Emissions, Calendar Year 2013,* submitted to EPA Region IX (NSTec 2014b)
- This document, the *Nevada National Security Site Environmental Report 2013*, was generated to report 2013 compliance with DOE O 458.1 and DOE-STD-1153-2002.

Table 2-5. NNSS compliance status with regulations for radiation protection of the public and the environment

Requirement	Compliance Limit	2013 Compliance Status	Section Reference[(a)]
Clean Air Act – NESHAP			
Estimate annual dose above background levels to the general public from radioactive air emissions	10 mrem/yr	Compliant	9.1.1.1
Safe Drinking Water Act			
Estimate annual dose to the general public from drinking water	4 mrem/yr	Compliant[(b)]	9.1.1.4
DOE O 458.1, "Radiation Protection of the Public and the Environment"			
Estimate annual dose above background level to the general public from all pathways	100 mrem/yr	Compliant	9.1.3
Determine total residual surface contamination of property released off site (in disintegrations per minute per 100 square centimeters [dpm/100 cm^2])	300–15,000 dpm/100 cm^2 depending on the radionuclide	Compliant	9.1.5
DOE-STD-1153-2002, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota"			
Estimate absorbed radiation dose to terrestrial plants and aquatic animals	1 rad/d	Compliant	9.2
Estimate absorbed radiation dose to terrestrial animals	0.1 rad/d	Compliant	9.2
DOE O 435.1, "Radioactive Waste Management"			
Estimate annual dose to the general public due to waste management operations	25 mrem/yr	Compliant	9.1.2

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

(b) Migration of radioactivity in groundwater to offsite public or private drinking water wells has never been detected

2.5 Waste Management and Environmental Restoration

2.5.1 Applicable Regulations

Atomic Energy Act (AEA) of 1954 – The AEA ensures the proper management of source, special nuclear, and byproduct material. At the NNSS, AEA regulations are followed through compliance with DOE O 435.1 and 10 CFR 830, "Nuclear Safety Management."

10 CFR 830, "Nuclear Safety Management" – This CFR 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 that 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 the 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" – This order requires that all DOE radioactive waste be managed in a manner that is protective of the worker, public health and safety, and the environment. On the NNSS, the Area 3 RWMS and the Area 5 RWMC operate as Category II Non-Reactor Nuclear Facilities. They are designed and operated to manage and safely dispose of LLW, MLLW, and hazardous waste generated by NNSA/NFO, other DOE, or selected DoD operations and to manage and safely store TRU and MTRU wastes generated on site for eventual shipment to the WIPP in Carlsbad, New Mexico.

Resource Conservation and Recovery Act (RCRA) – 40 CFR 239–282 – RCRA is the nation's primary law governing the management of solid waste and 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 HW disposal facilities. The EPA authorizes the State of Nevada to administer and enforce RCRA regulations. RCRA also requires generators of HW to have a program in place to reduce the volume or quantity and toxicity of HW generated. Such NNSS programs are addressed in Sections 2.6 and 3.3.2 on Pollution Prevention and Waste Minimization.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)/Superfund Amendments and Reauthorization Act (SARA) – These acts provide 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 NNSS 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 2.6) 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).

Federal Facility Agreement and Consent Order (FFACO), as amended – 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 NNSS, parts of the 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/NFO is responsible for the CASs included in the UGTA, Soils, and Industrial Sites activities, while DOE Legacy Management is responsible for the CASs at the Central Nevada Test Area and the Project Shoal Area.

NAC 444.850–444.8746, "Disposal of Hazardous Waste" – This NAC regulates the operation of HW disposal facilities on the NNSS to comply with federal RCRA regulations. Through this NAC, RCRA Part B Permit NEV HW0101 regulates the operation of the Hazardous Waste Storage Unit (HWSU) in Area 5, the Explosive Ordnance Disposal Unit (EODU) in Area 11, the storage of onsite and offsite MLLW in designated Area 5 locations prior to treatment and/or disposal, and the disposal of MLLW received from DOE offsite facilities into Cell 18, the permitted Mixed Waste Disposal Unit. The state permit requires groundwater monitoring of three wells downgradient of the MLLW disposal cells, prescribes post-closure monitoring for HW sites that were closed under RCRA prior to enactment of the FFACO, and requires preparation of an EPA Hazardous Waste Report of all HW and MLLW volumes generated and disposed annually at NNSS and all HW generated annually at the NLVF.

NAC 444.570–444.7499, "Solid Waste Disposal" – This NAC sets standards for solid waste management systems, including the storage, collection, transportation, processing, recycling, and disposal of solid waste. The NNSS has one inactive and four active permitted landfills. Active units include the Area 5 Asbestiform Low-Level Solid Waste Disposal Unit (P06), 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 P07 is inactive.

NAC 459.9921–459.999, "Storage Tanks" – This NAC 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 NNSS has five USTs and RSL-Nellis has seven 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 the Southern Nevada Health District to enforce this NAC with the issuance of county permits to NNSA/NFO.

2.5.2 Compliance Reports

The following reports were prepared and submitted to NDEP to comply with environmental regulations for waste management and environmental restoration operations conducted on the NNSS in 2013.

- *Nevada National Security Area 5 Solid Waste Disposal Annual Report for CY 2013*, January 2014
- NNSS Quarterly Volume Reports (for all active LLW and MLLW disposal cells), April, July, and October 2013, and January 2014
- *Annual Transportation Report for Radioactive Waste Shipments to and from the Nevada National Security Site – Fiscal Year 2013,* March 2014 (NNSA/NFO 2014a)
- *RCRA Permit for a Hazardous Waste Management Facility Permit Number NEV HW0101 – Annual Summary/Waste Minimization Report Calendar Year 2013,* February 2014 (NSTec 2014a)
- *Nevada National Security Site 2013 Data Report: Groundwater Monitoring Program Area 5 Radioactive Waste Management Site,* February 2014 (NSTec 2014d)
- *Nevada National Security Site 2013 Waste Management Monitoring Report - Area 3 and Area 5 Radioactive Waste Management Site* (NSTec 2014e)
- *Post-Closure Report for Closed Resource Conservation and Recovery Act Corrective Action Units, Nevada National Security Site, Nevada, for Fiscal Year 2013 (October 2012–September 2013),* January 2014 (NNSA/NFO 2014b)
- *Post-Closure Inspection Letter Report for Corrective Action Units on the Nevada National Security Site,* May 2014 (NNSA/NFO 2014c)
- *Post-Closure Inspection Report for the Tonopah Test Range, Nevada, for Calendar Year 2013*, January 2014 (NNSA/NFO 2014d)

- *Annual Soil Moisture Monitoring Report for the Area 9 U10c Landfill*, Nevada National Security Site, Nevada, for the Period March 2012 – February 2013, April 2013
- *January–June 2013 Biannual Solid Waste Disposal Site Report for the Nevada National Security Site Area 23 Sanitary Landfill*, July 2014
- *July–December 2013 Biannual Solid Waste Disposal Site Report for the Nevada National Security Site Area 23 Sanitary Landfill*, January 2014
- *Annual Soil Moisture Monitoring Report for the Area 6 Hydrocarbon Landfill, Nevada National Security Site, Nevada, for the Period March 2012–February 2013*, April 2013

The following Environmental Restoration reports/presentations for CAUs were submitted to NDEP in 2013 in accordance with the FFACO schedule.

- *CAU 97: Yucca Flat/Climax Mine –Phase I Flow and Transport Model Presentation #2*
- *CAU 97: Yucca Flat/Climax Mine – Phase I Flow and Transport Model Document, Revision 0*
- *CAUs 101 and 102: Central Pahute Mesa and Western Pahute Mesa – Completion Report for Well ER-20-11*
- *CAUs 101 and 102: Central Pahute Mesa and Western Pahute Mesa – Completion Report for Well ER-EC-14*
- *CAUs 101 and 102: Central Pahute Mesa and Western Pahute Mesa – Completion Report for Well ER-EC-14, Errata Sheet*
- *CAUs 101 and 102: Central Pahute Mesa and Western Pahute Mesa – Phase II Drilling Operations Presentation #3*
- *CAUs 101 and 102: Central Pahute Mesa and Western Pahute Mesa – Well Development, Testing, Sampling and Well Observation Presentation #1*
- *CAU 104: Area 7 Yucca Flat Atmospheric Test Sites – Closure Report*
- *CAU 105: Area 2 Yucca Flat Atmospheric Test Sites – Corrective Action Decision Document/Closure Report*
- *CAU 366: Area 11 Plutonium Valley Dispersion Sites – Corrective Action Plan*
- *CAU 366: Area 11 Plutonium Valley Dispersion Sites – Closure Report*
- *CAU 567: Miscellaneous Soil Sites – Corrective Action Investigation Plan*
- *CAU 569: Area 3 Yucca Flat Atmospheric Test Sites – Corrective Action Decision Document/Closure Report*
- *CAU 569: Area 3 Yucca Flat Atmospheric Test Sites – Corrective Action Decision Document/Closure Report, Record of Technical Change (ROTC) 1*
- *CAU 570: Area 9 Yucca Flat Atmospheric Test Sites – Corrective Action Decision Document/Closure Report*
- *CAU 571: Area 9 Yucca Flat Plutonium Dispersion Sites – Corrective Action Investigation Plan*

Table 2-6. NNSS compliance status with applicable waste management and environmental restoration regulations

Requirement	Compliance Limit	2013 Compliance Status	Section Reference[(a)]
10 CFR 830, "Nuclear Safety Management"			
Complete and maintain proper conduct of operations documents required for Class II Nuclear Facility for disposal/characterization/storage of radioactive waste	6 types of guiding documents required	Compliant	10.1.6; Table 10-2
DOE O 435.1, "Radioactive Waste Management"			
Establish/maintain Waste Acceptance Criteria for radioactive wastes received at Area 3 and 5 RWMSs	NA[(b)]	Compliant	10.1.5
Track annual volume of LLW and MLLW disposed at Area 3 and Area 5 RWMSs (in cubic meters [m^3])	NA	Compliant	10.1.1; Table 10-1
Vadose zone monitoring at Area 3 and Area 5 RWMSs, not required by order, but performed to validate performance assessment criteria of RWMSs	NA	Conducted	10.1.8
Resource Conservation and Recovery Act (as enforced through permits issued by the State of Nevada)			
Monitor semi-annually the pH, specific conductance (SC), total organic carbon (TOC), total organic halides (TOX), and tritium (^3H) and 11 general water chemistry parameters in groundwater from Wells UE5 PW-1, UE5 PW-2, and UE5 PW-3 to verify performance of Cell 18, the new Area 5 MWDU[(c)]	pH: 7.6 to 9.2 SC: 0.440 mmhos/cm[(d)] TOC: 1 mg/L[(e)]; TOX: 50 µg/L[(f)] H^3: 2,000 pCi/L	Compliant	10.1.7
Track the volume of MLLW disposed in Cell 18 (the Area 5 MWDU)	25,485 m^3 (899,994 ft^3)	Compliant	10.1.1; Table 10-1
Track the volume of nonradioactive HW stored at the HWSU	61,600 liters (16,280 gallons)	Compliant	10.2.1; Table 10-5
Track the weight of approved explosive ordnance wastes detonated at the EODU (in kilograms [kg] or pounds [lb])	45.4 kg (100 lb) at a time, not to exceed 1 detonation event/hour	Compliant	10.2.1; Table 10-5
Submit quarterly and annual reports to the State of Nevada for volumes in m^3 of HW wastes received at the Area 5 MWSU[(g)], HWSU, EODU, and Cell 18.	Due April, July, October, January; annual report due March 1	Compliant	10.2.1
Submit Annual Hazardous Waste Report for NNSS and NLVF to the State of Nevada	Due the following February	Compliant	10.2.1
Conduct vadose zone monitoring for RCRA closure site U-3ax/bl Subsidence Crater	Continuous monitoring using TDR[(h)] sensors	Compliant	10.1.8; 11.4; Table 11-4
Conduct periodic post-closure site inspections of five historic RCRA closure sites (CAUs 90, 91, 92, 110, 112)	NA	Compliant	11.4; Table 11-4
Upgrade, remove, and report on USTs at NNSS and RSL-Nellis	NA	Compliant	10.3
Federal Facility Agreement and Consent Order			
Adhere to calendar year work scope for site characterization, remediation, closures, and post-closure monitoring and inspection	14 CAUs identified for some phase of action in 2013	Compliant	11.1; 11.2; 11.3
NAC 444.750-8396, "Solid Waste Disposal"			
Track weight and volume of waste disposed each calendar year	Areas 6 and 9 – No limit Area 23 – 20 tons/day	Compliant	10.4.1; Table 10-6
Monitor vadose zone for the Area 6 Hydrocarbon and Area 9 U10c Solid Waste disposal sites	Annually using neutron logging through access tubes	Compliant	10.4.1

(a) The section(s) within this document that describe how compliance summary data were collected
(b) Not applicable
(c) MWDU = Mixed Waste Disposal Unit
(d) mmhos/cm = micromhos (a measure of conductance) per centimeter
(e) mg/L = milligram per liter
(f) µg/L = microgram per liter
(g) MWSU = Mixed Waste Storage Unit
(h) Time domain reflectometry

2.6 Hazardous Materials Control and Management

2.6.1 Applicable Regulations

Toxic Substances Control Act (TSCA) – This act requires testing and regulation of chemical substances that enter the consumer market. Because the NNSS does not produce chemicals, compliance is primarily directed toward the management of polychlorinated biphenyls (PCBs). At the NNSS, remediation activities and maintenance of fluorescent lights can result in the onsite disposal of PCB-contaminated waste and light ballasts or the offsite disposal of larger quantities of such PCB waste at an approved PCB disposal facility. NNSS also receives radioactive waste for disposal that may contain regulated levels of PCBs. When received, the TSCA requires the NNSS disposal facility to issue a Certificate of Disposal for PCBs to the waste-generating facility. These certificates are issued under the NNSS Waste Management program (see Section 10.1.1). The onsite disposal of all PCB wastes and recordkeeping requirements for PCB activities are regulated on the NNSS by the State of Nevada.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) – This act 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 NNSS, both restricted-use and non-restricted–use pesticides are applied under the direction of a State of Nevada–certified applicator.

Emergency Planning and Community Right-to-Know Act (EPCRA) – This act is a provision of the 1986 SARA Title III amendments to CERCLA. It 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. EO 13514 requires all federal facilities to report in accordance with the requirements of Sections 301 through 313 of EPCRA. NNSA/NFO is required to submit reports pursuant to Sections 302, 303, 304, 311, 312, and 313 of SARA Title III described below. Compliance with these EPCRA reporting requirements is summarized in Table 2-7.

- **Section 302–303, Planning Notification** – Requires the state emergency response commission and the local emergency planning committee to be notified when an extremely hazardous substance (EHS) is present at a facility in excess of the threshold planning quantity. An inventory of the location and amounts of all hazardous substances stored on the NNSS and at the two offsite facilities is maintained. Inventory data are included in an annual report called the Nevada Combined Agency (NCA) Report. Also, NNSA/NFO monitors hazardous materials while they are in transit on the NNSS through a hazardous materials notification system called HAZTRAK.
- **Section 304, Extremely Hazardous Substances Release Notification** – Requires the local emergency planning committee and state emergency response agencies to be notified immediately of accidental or unplanned releases of an EHS to the environment. Also, the national response center is notified if the release exceeds the CERCLA reportable quantity for the particular hazardous substance.
- **Section 311–312, Material Safety Data Sheet/Safety Data Sheet (MSDS/SDS)/Chemical Inventory –** Requires facilities to provide applicable emergency response agencies with MSDSs/SDSs, or a list of MSDSs/SDSs for each hazardous chemical stored on site. This is essentially a one-time reporting unless chemicals or products change. Any new MSDSs/SDSs are provided annually in the NCA Report. Section 312 requires facilities to report maximum amounts of chemicals on site at any one time. This report is submitted to the State Emergency Response Commission, the Local Emergency Planning Committee, and the local fire departments.
- **Section 313, Toxic Release Inventory (TRI) Reporting** – Requires facilities to submit an annual report titled "Toxic Chemical Release Inventory, Form R" to the EPA and to the State of Nevada if annual usage quantities of listed toxic chemicals exceed specified thresholds. Toxic chemical releases on the NNSS above threshold limits are reported to the EPA and the State Emergency Response Commission in the TRI, Form R report.

NAC 555, "Control of Insects, Pests, and Noxious Weeds" – This NAC 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, "Sanitation" – Polychlorinated Biphenyls (PCBs) – This code enforces the federal requirements for the handling, storage, and disposal of PCBs and contains recordkeeping 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 highly hazardous substances above listed thresholds. NNSA/NFO submits an annual CAPP registration report to NDEP.

2.6.2 Compliance Reports

The following reports were generated for 2013 NNSA/NFO operations on the NNSS and at the two offsite facilities in compliance with hazardous materials control and management regulations:

- *Nevada Combined Agency Hazmat Facility Report – Calendar Year (CY) 2013*, submitted to state and local agencies
- *Toxic Release Inventory Report, Form R for CY 2013*, submitted to the EPA and the State
- *Calendar Year (CY) 2013 Polychlorinated Biphenyls (PCBs) Report for the Nevada National Security Site (NNSS)*, submitted to NNSA/NFO
- *Chemical Accident Prevention Program 2013 Registration*, submitted to NDEP

Table 2-7. Status of EPCRA reporting

EPCRA Section	Description of Reporting	2013 Status(a)
Section 302	Emergency Planning Notification	Yes
Section 304	EHS Release Notification	No
Section 311–312	MSDS/Chemical Inventory	Yes
Section 313	TRI Reporting	Yes

(a) "Yes" indicates that NNSA/NFO reported under the requirements of the EPCRA section specified (see Section 12.3, Table 12-1).

Table 2-8. NNSS compliance status with applicable regulations for hazardous substance control and management

Requirement	Compliance Limit	2013 Compliance Status	Section Reference[a]
Toxic Substances Control Act (TSCA) and NAC 444, "Sanitation" – Polychlorinated Biphenyls			
Store and dispose PCB materials off site	Required if >50 ppm[b] PCBs	Compliant	12. 1
Store and dispose PCB materials on site	Allowed if <50 ppm PCBs	No onsite storage or disposal	12. 1
Dispose on site bulk product waste containing PCBs generated by remediation and site operations	Case-by-case approval by NDEP	No bulk product wastes were generated for onsite disposal	12. 1
Generate report of quantities of PCB liquids and materials disposed off site during previous calendar year	Due July 1 of following year	Compliant	12. 1
Issue a Certificate of Disposal for PCBs to the waste-generating facility bringing radioactive waste containing regulated levels of PCBs to the NNSS for disposal	Due within 30 days after receipt of waste	Compliant	10.1.1
Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and NAC 555, "Control of Insects, Pests, and Noxious Weeds"			
Use restricted-use pesticides under the direct supervision of an individual who is a state-certified applicator	NA[c]	Compliant	12. 2
Maintain state certification of onsite pesticide and herbicide applicator	NA	Compliant	12. 2
Emergency Planning and Community Right-to-Know Act (EPCRA)			
Adhere to reporting requirements	Varies by EPCRA section[d]	Compliant	12. 3
	Routine reports: NCA Report due March 1 for previous CY; TRI Report, Form R due July 1 for previous CY		
State of Nevada Chemical Catastrophe Prevention Act			
Registration of NNSS with the State if highly hazardous substances are stored above listed threshold quantities	NDEP CAPP[e] Report due June 21 for previous period of June 1 through May 31	Compliant	12. 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) Reporting criteria varies across EPCRA Sections (i.e., 302–304 and 311–313). See Table 2-7; Section 12.3, Table 12-1.

(e) CAPP = Chemical Accident Prevention Program

2.7 National Environmental Policy Act

DOE O 451.1B, "National Environmental Policy Act Program," establishes DOE requirements and responsibilities for implementing the National Environmental Policy Act of 1969 (NEPA), the Council on Environmental Quality Regulations Implementing the Procedural Provisions of NEPA (40 CFR 1500–1508), and the DOE NEPA Implementing Procedures (10 CFR 1021). Under 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. Before any project or activity is initiated at the NNSS, it is evaluated for possible impacts to the environment. NNSA/NFO 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. An EIS must be prepared by a federal agency when a "major" federal action that will have "significant" environmental impacts is planned. For large multi-program or multiple facility sites, a programmatic EIS is prepared.
- 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 environmental 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 NNSS. The Checklist is reviewed by the NNSA/NFO NEPA Compliance Officer to determine if 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, a determination is made to initiate the appropriate level of NEPA analysis and documentation. The analysis may result in preparation of a new EA, EIS, or supplemental document to the existing programmatic NNSS EIS (U.S. Department of Energy, Nevada Operations Office [DOE/NV] 1996). The NEPA Compliance Officer must approve each Checklist before a project proceeds. Table 2-9 presents a summary of how NNSA/NFO complied with NEPA in 2013.

In 2013, NNSA/NFO (then the Nevada Site Office [NSO]) completed the final *Site-Wide Environmental Impact Statement for the Nevada National Security Site and Offsite Locations in Nevada* (NNSS SWEIS) (NNSA/NSO 2013). The final NNSS SWEIS identifies NNSA's preferred alternative as a hybrid alternative comprising various programs, capabilities, projects, and activities selected from among the three alternatives. A Record of Decision will likely be published in mid-2014. The final NNSS SWEIS will replace the current programmatic NNSS EIS (DOE/NV 1996) and address impacts from NNSA/NFO operations in Nevada for the 10-year period beginning when the Record of Decision is published.

In 2013, NNSA/NFO completed the *NNSA/NFO NEPA Annual Planning Document*, which was submitted to DOE HQ on January 3, 2014. It provides the status of all EAs and EISs being developed or planned in the next 12–24 months and the budget and major milestone information for the NNSS SWEIS.

Table 2-9. NNSS NEPA compliance activities conducted in 2013

Results of NEPA Checklist Reviews/NEPA Compliance Activities
3 projects were exempted from further NEPA analysis because they were of CX status.
19 projects were exempted from further NEPA analysis due to their inclusion under previous analysis in the NNSS EIS (DOE/NV 1996a) and its Record of Decision.

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 NNSS, 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" – This EO directs the federal agencies to inventory their cultural resources and establish policies and procedures to ensure the protection, restoration, and maintenance of federally owned sites, structures, and objects of historical, architectural, or archaeological significance.

DOE Policy DOE P 141.1, "Department of Energy Management of Cultural Resources" – The purpose of this policy is to ensure that DOE programs, including the NNSA, integrate cultural resources management into their missions and activities.

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 American 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 inventory, excavation or removal of archaeological resources on federal and American Indian lands and notification to American 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 NNSS must have qualifications that meet federal standards and must work under a permit issued by NNSA/NFO. In the event of vandalism, NNSA/NFO 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 ceremonial and traditional rites. Locations exist on the NNSS that have religious significance to Western Shoshone and Southern Paiute; visits to these places involve prayer and other activities. Access is provided by NNSA/NFO 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 is 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 NNSS artifact collection is subject to NAGPRA.

2.8.2 Reporting Requirements

NNSA/NFO 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 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 Office of Scientific and Technical Information. The 2013 reports submitted to agencies are discussed in Chapter 14.

Table 2-10. NNSS compliance status with applicable historic preservation regulations

Requirement	2013 Compliance Status	Section Reference[(a)]
National Historic Preservation Act of 1966; EO 11593, “Protection and Enhancement of the Cultural Environment”; and DOE P 141.1, “Department of Energy Management of Cultural Resources”		
Maintain and implement NNSS Cultural Resources Management Plan	Compliant	14.0
Conduct cultural resources inventories and evaluations of historic structures	Compliant	14.1; 14.2; Table 14-1; Table 14-2
Make determinations of eligibility to the National Register	Compliant	14.1; Table 14-1
Make assessments of impact to eligible properties	Compliant	14.1
Manage artifact collection in accordance with required professional standards	Compliant	14.5
Archaeological Resources and Protection Act of 1979		
Conduct archaeological work by qualified personnel	Compliant	14.0
Document occurrences of damage to archaeological sites	Compliant	14.1
Complete and submit Secretary of the Interior Archaeology Questionnaire	Compliant	14.4
American Indian Religious Freedom Act of 1978		
Allow American Indians access to NNSS locations for ceremonies and traditional use	Compliant	14.6
Native American Graves Protection and Repatriation Act		
Consult with affiliated American Indian tribes regarding repatriation of cultural items	Compliant	14.6
Overall Requirement		
Consult with tribes regarding various cultural resources issues	Compliant	14.6

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 NNSS operations. NNSS 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/NFO (FWS 2009).

Migratory Bird Treaty Act (MBTA) – This act prohibits the harming of any migratory bird, their nest, or eggs without authorization by the Secretary of the Interior. All but 5 of the 239 bird species observed on the NNSS are protected under this act. Biological surveys are conducted for projects to prevent direct harm to protected birds, nests, and eggs. Biologists periodically collect game birds for radiological analysis under a federal migratory bird collection permit.

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

Wild Free-Roaming Horse and Burro Act – This act makes it unlawful to harm wild horses and burros. It requires the U.S. Bureau of Land Management (BLM) to protect, manage, and control wild horses and burros within designated herd management areas (HMAs) in a manner that is designed to achieve and maintain a thriving natural ecological balance. Although the NNSS is not within an active HMA, a Five-Party Cooperative Agreement exists between NNSA/NFO, NTTR, FWS, 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 maintaining favorable habitat for them on federally withdrawn lands. BLM considers the NNSS a zero herd-size management area. NNSA/NFO consults with BLM regarding any issue of NNSS horse management. Biologists conduct periodic horse census surveys on the NNSS.

Clean Water Act (CWA), Section 404, Wetlands Regulations – This act 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. NNSS projects are evaluated for their potential to disturb wetlands and their need for a Section 404 permit application. Based on recent rulings, no natural NNSS wetland may meet the criteria of a “jurisdictional” wetland subject to Section 404 regulations. However, final determination from the USACE regarding the status of NNSS wetlands has yet to be received.

National Wildlife Refuge System Administration Act – This 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 kilometers (3.1 miles) 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” – This EO 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 natural water sources on the NNSS. NNSS 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” – This EO 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/NFO generally satisfies EO 11988 through DOE O 420.1B, “Facility Safety,” and invoked standards. DOE O 420.1B 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-STD-1020-2002, "Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities," provides flood design and evaluation criteria for SSC. Evaluations of flood hazards at the NNSS are generally conducted to ensure protection of property and human well-being.

EO 13186, "Responsibilities of Federal Agencies to Protect Migratory Birds" – This EO 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. NNSS projects are evaluated for their potential to impact such bird populations.

EO 13112, "Invasive Species" – This EO 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 NNSS 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.

DOE O 458.1, "Radiation Protection of the Public and the Environment" – This order, approved in June 2011, requires the establishment and implementation of procedures and practices to ensure that populations of terrestrial plants and aquatic and terrestrial animals within local ecosystems are protected. This order specifically addresses their protection from any radiological impacts of DOE/NNSA activities (see Section 2.4.1). Ecosystem mapping and surveys for protected and important species are conducted on the NNSS to identify the biota and ecosystems that may be impacted by both radiological and other NNSS activities.

NAC 503.010–503.104, "Protection of Wildlife" – This code identifies Nevada animal species, both protected and unprotected, and prohibits the harm of protected species without special permit. Biologists periodically conduct live trapping and release of bats, rodents, reptiles, and desert tortoises under a state wildlife handling permit. Over 200 bird species, 1 reptile species, 6 bat species, and 2 small mammal species on the NNSS are state-protected. Biological surveys are conducted for projects to prevent direct harm to protected birds, nests, eggs, and protected animals.

NAC 527, "Protection and Preservation of Timbered Lands, Trees and Flora" – This code 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 NNSS. Annual reviews of the status of NNSS plants are conducted.

2.9.2 Compliance Reports

The following reports were prepared in 2013 or 2014 to meet regulation requirements or to document compliance for all activities conducted in 2013:

- *Annual Report of Actions Taken under Authorization of the Biological Opinion on NNSS Activities (File Nos. 84320-2008-F-0416 and 84320-2008-B-0015) – January 1, 2013, through December 31, 2013,* submitted to FWS Las Vegas Office
- *Annual Report for Handling Permit S36422,* submitted to Nevada Division of Wildlife
- *Annual Report for Federal Migratory Bird Scientific Collecting Permit SCCL-008695-0,* submitted to FWS Sacramento Office

Table 2-11. NNSS compliance status with applicable biota and wildlife habitat regulations

Requirement	Compliance Limit	2013 Compliance Status	Section Reference[(a)]
Endangered Species Act – 1996 Opinion for NNSS Programmatic Activities			
Track the number of tortoises accidentally injured or killed due to NNSS activities and the number captured and displaced from project sites	Limit varies by project/activity	Compliant	15.1; Table 15-1
Track the number of tortoises taken by way of injury or mortality on NNSS paved roads by vehicles other than those in use during a project	4 per year not to exceed 15 by 2019	Compliant	15.1; Table 15-1
Track the number of total acres (ac) of desert tortoise habitat disturbed during NNSS project construction from 2009 to 2019	2,710 ac	Compliant	15.1; Table 15-1
Follow all terms and conditions of the Biological Opinion during construction and operation of NNSS projects	NA[(b)]	Compliant	15.1
Conduct biological surveys at proposed project sites to assess presence of protected species	NA	Compliant	15.2
Migratory Bird Treaty Act			
Prevent the harm of migratory birds, their nests, and their eggs from NNSS project activities	0	5 accidental bird deaths	15.3; Table 15-2; Figure 15-2
National Wildlife Refuge System Administration Act			
Avoid killing or destroying animals, their nests, or eggs and disturbing or injuring vegetation on System lands (the DNWR) as a result of NNSS activities	0	Compliant	4.2.10
Wild Free-Roaming Horse and Burro Act and Five-Party Cooperative Agreement			
Avoid harassing or killing wild horses due to NNSS activities	0	Compliant	15.3; Table 15-2
Cooperate in conducting resource inventories and developing resource management plans for horses on the NNSS, NTTR, and DNWR	NA	Compliant	15.3; Table 15-2
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"			
Track the number of wetlands disturbed by NNSS activity	NA	0	15.3; Table 15-2
EO 13112, "Invasive Species"			
Evaluate feasibility of conducting habitat reclamation and other controls to control spread of invasive species	NA	Compliant	15.5
NAC 503.010–503.104 and NAC 527 – Nevada Protective Measures for Wildlife and Flora			
Track the number of state-protected animals harmed, killed, or collected and the number of state-protected plants harmed or collected due to NNSS activities	Without special permit: 0 Under permit: 10 collections each per year of jackrabbits, cottontail rabbits, mourning doves, chukar, quail, and 15 of selected bat species Unlimited capture/releases of bats, rodents, reptiles	7 capture/sacrifice of rabbits; 30 capture/releases of reptiles, birds, and bats	15.3; Table 15-2

(a) The sections within this document that discuss the compliance summary data

(b) Not applicable

2.10 Occurrences, Unplanned Releases, and Continuous Releases

2.10.1 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 the EPA and perform an annual evaluation of releases. CERCLA requirements applicable to NNSS 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 a summary of compliance to EPCRA pertaining to unplanned environmental releases of hazardous substances.

40 CFR 302.1–302.8, "Designation, Reportable Quantities, and Notification" – This CFR 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 232.2, "Occurrence Reporting and Processing of Operations Information" – This order requires that DOE and NNSA be informed about events within ten operational categories (Operational Emergencies, Personnel Safety and Health, Environmental, Contamination Radiation Control, etc.) that could adversely affect the health and safety of the public, workers, environment, DOE missions, or the credibility of the DOE. Within the Environmental category, it sets reporting criteria for unplanned environmental releases of pollutants, hazardous substances, extremely hazardous substances, petroleum products, and sulfur hexafluoride at DOE/NNSA sites/facilities. Within the Noncompliance Notifications category, it also requires sites/facilities to report to DOE/NNSA any written notification received from an outside regulatory agency that the site/facility is in noncompliance with a schedule or requirement.

NAC 445A.345–445.348, "Notification of Release of Hazardous Substance" – This NAC 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 NNSS specifies that no petroleum products will be discharged into treatment works without first being processed through an oil/water separator or other approved method. It also specifies how NNSA/NFO shall report each bypass, spill, upset, overflow, or release of treated or untreated sewage.

Other NNSS 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.

2.10.2 Compliance Status

There are no continuous releases on the NNSS or at the NLVF and RSL-Nellis. On February 9, 2013, 50 gallons of jet fuel were released from an unmanned aerial vehicle that crashed immediately after launch in Area 25. NDEP was notified immediately (NDEP Spill No. 130209-02), the spill was cleaned up, confirmatory sampling of the cleanup area was performed in April 2013, and NDEP was provided a detailed spill report in May 2013 (NSTec 2013b). A second reportable environmental occurrence was discovered on March 20, 2013, at the NNSS Area 6 Sewage Lift Station (ORPS Number NA-NVSO-NST-NTS-2013-003). Approximately 20 gallons of sewage were released at the station due to disabled pumps. NDEP was notified, the affected area was disinfected, and the pumps were enabled. During 2013, there were 19 additional spills at the NNSS, none of which met regulatory agency reporting criteria. They consisted of small-volume releases either to containment areas or to other surfaces. All spills were cleaned up.

2.11 Environment, Safety, and Health Reporting

2.11.1 Applicable Regulations

DOE O 231.1B, "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).

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/NFO, reporting is accomplished through the publication of the NNSS ASER, which is titled the Nevada National Security Site Environmental Report (NNSSER).

2.11.2 Compliance Status

In 2013, the NNSSER was published under the title *Nevada National Security Site Environmental Report 2012* (NSTec 2013c). It was published and posted on the NNSA/NFO and DOE Office of Scientific and Technical Information websites by September 16, 2013. The 2012 NNSSER was mailed to all recipients (on a compact disc accompanied by a 24-page summary) by September 27, 2013, and a subset of individuals on distribution also received a hard copy of the full 2012 NNSSER.

2.12 Summary of Permits

Table 2-12 presents the complete list of all federal and state permits active during CY 2013 for NNSS, NLVF, and RSL-Nellis operations and that 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 HW management and disposal, and endangered species protection. Some 2013 permit names retain the "NTS" acronym for the NNSS because they have not been officially changed with the regulatory agencies. Reports associated with permits are submitted to the appropriate designated state or federal office. Copies of reports may be obtained upon request.

Table 2-12. Environmental permits required for NNSA/NFO operations at NNSS, NLVF, and RSL-Nellis

Permit Number	Permit Name or Description	Expiration Date	Reporting
Air Quality	**NNSS**		
AP9711-2557	NNSS Class II Air Quality Operating Permit	June 25, 2014	Annually
12-38 and 13-47	NNSS Open Burn Variance, Fire Extinguisher Training (Various Locations)	March 17, 2013/ March 19, 2014	None
12-39 and 13-48	NNSS Open Burn Variance, NNSS, A-23, Facility #23-T00200 (NNSS Fire & Rescue Training Center)	March 17, 2013/ March 19, 2014	None
	UGTA Offsite		
AP9711-2622	NTTR Class II Air Quality Operating Permit, Surface Area Disturbance, Well ER-EC-12	November 4, 2014	Annually

Table 2-12. Environmental permits required for NNSA/NFO operations at NNSS, NLVF, and RSL-Nellis (continued)

Permit Number	Permit Name or Description	Expiration Date	Reporting
Air Quality	**NNSS**		
AP9711-2659	NTTR Class II Air Quality Operating Permit, Surface Area Disturbance, Wells ER-EC-13 and ER-EC-15	March 5, 2015	Annually
	NLVF		
Source 657	Clark County Minor Source Permit	November 1, 2015	Annually
	RSL-Nellis		
Source 348	Clark County Synthetic Minor Source Permit	July 5, 2017	Semi-annually and annually
Drinking Water	**NNSS**		
NY-0360-12NTNC	Areas 6 and 23	September 30, 2013/2014	None
NY-4098-12NC	Area 25	September 30, 2013/2014	None
NY-4099-12NC	Area 12	September 30, 2013/2014	None
NY-0835-12NP	NNSS Water Hauler #84846	September 30, 2013/2014	None
NY-0836-12NP	NNSS Water Hauler #84847	September 30, 2013/2014	None
Septic Systems/Pumpers	**NNSS**		
NY-1054	Septic System, Area 3 (Waste Management Offices)	None	None
NY-1069	Septic System, Area 18 (820th Red Horse Squadron)	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
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, NNSS, Area 6	None	None
NY-1128	Commercial Individual Sewage Disposal System, NNSS, Area 6, Yucca Lake Project	None	None
NY-1130	Commercial Individual Sewage Disposal System, NTS, Area 6, Fire Station #2	None	None
NY-17-06839	Septic Tank Pumper E 106785	July 31, 2013/2014	None
NY-17-06839	Septic Tank Pumper E 107105	July 31, 2013/2014	None
NY-17-06839	Septic Tank Pumper E-105918	July 31, 2013/2014	None
NY-17-06839	Septic Tank Pumping Contractor (one unit)	July 31, 2013/2014	None
NY-17-06839	Septic Tank Pumper E-106169	July 31, 2013/2014	None
NY-17-06839	Septic Tank Pumper E-107103	July 31, 2013/2014	None

Table 2-12. Environmental permits required for NNSA/NFO operations at NNSS, NLVF, and RSL-Nellis (continued)

Permit Number	Permit Name or Description	Expiration Date	Reporting
Wastewater Discharge	**NNSS**		
GNEV93001	Water Pollution Control General Permit	August 5, 2015	Quarterly
NEV96021	Water Pollution Control for E Tunnel Waste Water Disposal System and Monitoring Well ER-12-1	October 1, 2013/ October 1, 2018	Quarterly
	NLVF		
VEH-112	NLVF Wastewater Contribution Permit	December 31, 2016	Annually
NV0023507	North Las Vegas National Pollutant Discharge Elimination System Permit	June 24, 2017	Quarterly
	RSL-Nellis		
CCWRD-080	Industrial Wastewater Discharge Permit	June 30, 2012/2013	Quarterly
	Permit cancelled April 2013; replaced by annual certification statement of zero discharge		
Underground Injection Control	**NNSS**		
UNEV2012203	NNSS Underground Injection Control Permit	July, 6, 2017	Semi-annually
Hazardous Materials	**NNSS**		
20214	NNSS Hazardous Materials	February 28, 2012/2013	Annually
20215	Nonproliferation Test and Evaluation Complex	February 28, 2012/2013	Annually
	NLVF		
20212	NLVF Hazardous Materials Permit	February 28, 2012/2013	Annually
	RSL-Nellis		
20208	RSL-Nellis Hazardous Materials Permit	February 28, 2012/2013	Annually
Hazardous Waste	**NNSS**		
NEV HW0101	RCRA Permit for NNSS Hazardous Waste Management (Area 5 Mixed Waste Disposal Unit, Area 5 Mixed Waste Storage Unit, Hazardous Waste Storage Unit, and Explosive Ordnance Disposal Unit)	April 20, 2016	Biennially and annually
Waste Management	**NNSS**		
SW 523	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
	RSL-Nellis		
PR0064276	RSL-Nellis Waste Management Permit-Underground Storage Tank	December 31, 2013	None
Endangered Species/Wildlife			
File Nos. 84320-2008-F-0416 and 84320-2008-B-0015	U.S. Fish and Wildlife Service – Desert Tortoise Incidental Take Authorization (Biological Opinion for Programmatic NNSS Activities)	February 12, 2019	Annually
SCCL-008695-0	U.S. Fish and Wildlife Service – Migratory Bird Scientific Collecting Permit	March 31, 2016	Annually
MB037277-1	U.S. Fish and Wildlife Service – Migratory Bird Special Purpose Possession – Dead Permit	March 31, 2010 (permit renewal requested)	Annually
S36422	Nevada Division of Wildlife – Scientific Collection of Wildlife Samples	December 31, 2014	Annually

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

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Chapter 3: Environmental Management System

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National Security Technologies, LLC

The U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office (NNSA/NFO) conducts activities on the Nevada National Security Site (NNSS) while ensuring the protection of the environment, the worker, and the public. This is accomplished, in part, through the implementation of an Environmental Management System (EMS). An EMS is a business management practice that incorporates concern for environmental performance throughout an organization, with the ultimate goal being continual reduction of the organization's impact on the environment. An EMS ensures that environmental issues are systematically identified, controlled, and monitored, and it provides mechanisms for responding to changing environmental conditions and requirements, reporting on environmental performance, and reinforcing continual improvement. National Security Technologies, LLC (NSTec), the current Management and Operating contractor for the NNSS, designed an EMS to meet the 17 requirements of the globally recognized International Organization for Standardization (ISO) 14001:2004 Environmental Management Standard, and in 2008 the EMS obtained ISO 14001:2004 re-certification. In June 2011, it was re-certified again for another 3-year period.

The EMS incorporates environmental stewardship goals that are identified in federal EMS directives applicable to all U.S. Department of Energy (DOE) and U.S. Department of Energy, National Nuclear Security Administration (NNSA) sites. In 2013, they included DOE Order DOE O 436.1A, "Departmental Sustainability"; Executive Order EO 13423, "Strengthening Federal Environmental, Energy, and Transportation Management"; and EO 13514, "Federal Leadership in Environmental, Energy, and Economic Performance" (see Section 2.1). This chapter describes the 2013 progress made towards improving overall environmental performance and meeting sustainable environmental stewardship goals. Reported progress applies to operations on the NNSS as well as support activities conducted at the NNSA/NFO-managed North Las Vegas Facility (NLVF) and Remote Sensing Laboratory–Nellis (RSL-Nellis). NNSA/NFO uses this annual environmental report as the mechanism to communicate to the public the components and status of the EMS, which is a requirement for ISO 14001:2004 certification.

3.1 Environmental Policy

The NSTec environmental policy, approved by NNSA/NFO, 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.

3.2 Environmental Aspects

Operations are evaluated to determine if they have an environmental aspect, and the EMS is implemented to minimize or eliminate any potential impacts. Operations are evaluated by performing Hazard Assessments, preparing Health and Safety Plans and Execution Plans, and preparing and reviewing National Environmental Policy Act documents. A list of aspects is compiled, and they are ranked in order of importance to determine which aspects are significant. The factors that are considered during ranking are the potential to cause adverse environmental impact; the potential for noncompliance with regulations; the ability to meet permit requirements, contract and performance objectives, and DOE order requirements; and the potential to result in bad publicity. The likelihood of occurrence and severity of each of these factors is considered. The significant aspects compose approximately the top half of the list. This process is done annually to account for changing activities, regulations/DOE orders, and management priorities. For 2013, the following list of environmental aspects were identified.

Significant aspects:

- Air emissions
- Drinking water system maintenance
- Energy and fuel use
- Environmental restoration
- Industrial chemical storage and use
- Greenhouse gas emissions
- Groundwater protection
- Hazardous, radioactive, and mixed waste management (generation, storage, and disposal)
- Wastewater management (generation and disposal)
- Resource protection (cultural, biological, and raw materials)

Other aspects:

- Building construction and renovation
- Electronics stewardship
- Nonhazardous waste management (generation, storage, and disposal)
- Purchase of materials and equipment
- Recycling and management of surplus property and materials
- Water use
- Surface water and stormwater runoff

3.3 Environmental Objectives, Targets, and Sustainability Goals

To address the identified significant environmental aspects of NNSA/NFO operations, an Environmental Working Group (EWG) selects objectives and targets that are determined on a fiscal year (FY) (October 1 through September 30) basis. Targets are tracked by the various responsible operational groups, and reported quarterly to NNSA/NFO. The majority of objectives and targets identified each FY are identical to the environmental sustainability goals of DOE O 436.1A, EO 13514, and EO 13423 (Table 3-1), which are tracked by the Energy Management Program (EMP) and the Pollution Prevention and Waste Minimization (P2/WM) Program, each described in the subsections below.

In FY 2013, two EMS targets were identified in addition to the sustainability goals presented in Table 3-1. One was to meet all FY 2013 milestones identified in the Federal Facility Agreement and Consent Order (FFACO) for the cleanup and closure of historically contaminated sites. All FY 2013 FFACO milestones were met (see Chapter 11 and Chapter 2, Section 2.5). The second additional target was to identify ten products for purchase that meet Environmentally Preferable Purchasing (EPP) standards that are substitutes for non-EPP products currently being used. This target was also met in FY 2013.

3.3.1 Energy Management Program

The EMP strives to ensure continuous life-cycle, cost-effective improvements to increase energy efficiency; increase the effective management of energy, water, and transportation fleets; and increase the use of clean energy sources for NNSA/NFO operations. NNSA/NFO currently uses electricity, fuel oil, and propane at the NNSS and RSL-Nellis facilities. At the NLVF, electricity, fuel oil, and natural gas are used. NNSA/NFO vehicles and equipment are powered by unleaded gasoline, diesel, bio-diesel, E-85, and jet fuel. All water used at the NNSS is groundwater, and water used at the NLVF and RSL-Nellis is predominately surface water from Lake Mead.

Each FY, the EMP produces an NNSA/NFO Site Sustainability Plan (SSP) (NSTec 2013) that identifies how NNSA/NFO will help meet the DOE complex-wide goals identified in DOE's Strategic Sustainability Performance Plan (SSPP) (DOE 2013), which is also updated annually. The SSP also satisfies the requirement of EO 13423 for an Energy Management Plan. The SSP describes the program, planning, and budget assumptions as well as each DOE SSPP goal, NNSA/NFO's current performance status for each DOE SSPP goal, and planned actions to meet each goal. To implement the SSP, an Energy Management Council (EMC) meets monthly to discuss the requirements and track and facilitate their completion. The EMC and the EWG coordinate to ensure that all EMS-tracked objectives and targets mirror overlapping annual goals in the SSP. Table 3-1 includes a summary of the DOE SSPP goals and the status in FY 2013 of reaching them.

Table 3-1. Environmental sustainability goals and FY 2013 performance status

DOE Agency SSPP Goal[(a)] (from DOE 2013)	NNSA/NFO Performance Status (from NSTec 2013)
Goal 1: Greenhouse Gas (GHG) Reduction	
28% reduction of Scope 1 and 2 GHG emissions[(b)] by FY 2020, from an FY 2008 baseline	FY 2013 emissions were 48,494 $MtCO_2e$[(c)], a 2% increase from the FY 2008 baseline of 47,454 $MtCO_2e$.
13% reduction in Scope 3[(b)] GHG emissions by FY 2020, from an FY 2008 baseline	FY 2013 emissions were determined to be 6,694 $MtCO_2e$, a 54% reduction from the FY 2008 baseline of 14,398 $MtCO_2e$, exceeding this goal.
Goal 2: Sustainable Buildings	
30% reduction of energy intensity (BTUs per square foot of building space) by FY 2015, from an FY 2003 baseline *(Also identified as an NNSA/NFO EMS target)*	Energy intensity was reduced overall by 29.5% from the FY 2003 baseline.
Energy and water assessments conducted for 25% of all facilities covered under Section 432 of the Energy Independence and Security Act to ensure that 100% of covered facilities are assessed every 4 years.	In FY 2013, 77 energy audits/assessments were conducted, meeting this goal; the audits/assessments identified energy conservation measures for several buildings at the NNSS and NLVF.
Metering of individual buildings or processes for 90% of electricity (by October 2012) and for 90% of steam, natural gas, and chilled water (by October 2015)	94.4% of electricity is metered, 75.5% of natural gas is metered[(d)], 0% of chilled water is metered[(e)], 20.8% of water is metered, and no steam is used.
Cool roofs (see Glossary, Appendix B), unless determined uneconomical, for roof replacements; new roofs must have a thermal resistance of at least R-30	Two buildings totaling 23,267 gross square feet (gsf) of space had cool roofs installed in FY 2013, bringing the total building space under cool roofs to 607,742 gsf, which represents 23% of operational NNSA/NFO buildings (by gsf).
All new construction, major renovations, and alterations of buildings larger than 5,000 gsf to comply with the Guiding Principles (GPs) for Federal Leadership in High Performance Sustainable Buildings design (referred to hereafter as GPs) (Interagency Sustainability Working Group 2008); all buildings for which such work is greater than $5 million are to achieve the U.S. Green Building Council's Leadership in Energy and Environmental Design Gold certification (unless determined not to be cost effective by the Senior Acquisition Official).	No such construction or major renovations occurred in FY 2013, and no new construction/renovations are planned for FY 2014.
15% of existing buildings larger than 5,000 gsf to be compliant with the GPs by FY 2015	NNSA/NFO operates 120 enduring buildings larger than 5,000 gsf, 18 of them (15%) have been identified for modifications to meet the goal; 4 of the 120 (3.3%) currently meet the GPs, and the other 14 range from 69% to 86% complete toward meeting the GPs.
Goal 3: Fleet Management	
10% annual increase in fleet alternative fuel consumption by FY 2015, relative to an FY 2005 baseline (FY 2013 target is 114% cumulative increase) *(Also identified as an NNSA/NFO EMS target)*	Alternative fuel consumption in FY 2013 was 368,942 gallons (gal), a 195% increase above the FY 2005 baseline of 125,089 gal, exceeding the goal.
2% annual reduction in fleet petroleum consumption by FY 2015, relative to an FY 2005 baseline (FY 2013 target is 16% cumulative decrease) *(Also identified as an NNSA/NFO EMS target)*	Petroleum consumption in FY 2013 was 534,354 gal, a 60% reduction from the FY 2005 baseline of 1,328,957 gal, exceeding this goal.
75% of light duty vehicle purchases must consist of alternative fuel vehicles (AFVs) by FY 2000 and therafter through FY 2014, 100% beginning in FY 2015	100% of all light duty vehicle acquisitions (118) in FY 2013 were AFVs, exceeding this goal.
Reduce fleet inventory by 35% by FY 2015 relative to an FY 2005 baseline; however, NNSA's complex-wide goal, agreed to by the Secretary of Energy, is to reduce the fleet by 15% by FY 2015 relative to the FY 2005 baseline	Fleet inventory was 938 vehicles in FY 2013, a 13.4% reduction from the FY 2005 baseline of 1,083 vehicles.

Table 3-1. NNSA/NFO Site Sustainability Plan goals and FY 2013 performance status (continued)

DOE Agency SSPP Goal[(a)] (from DOE 2013)	NNSA/NFO Performance Status (from NSTec 2013)
Goal 4: Water Use Efficiency and Management	
26% reduction in water intensity (gallons per square foot [gal/ft^2]) by FY 2020 from an FY 2007 baseline *(Also identified as an NNSA/NFO EMS target)*	Water intensity[(f)] across all NNSA/NFO facilities was 39.09 gal/ft^2 in FY 2013, a 57% reduction from the FY 2007 baseline of 90.95 gal/ft^2, exceeding this goal.
20% reduction in water consumption of industrial, landscaping, and agricultural water by FY 2020 from an FY 2010 baseline	Non-potable water production[(f)] was 10,992,600 gal in FY 2013, an 80% reduction from the FY 2010 baseline of 54,913,300 gal, exceeding this goal.
Goal 5: Pollution Prevention and Waste Minimization	
Divert at least 50% of non-hazardous solid waste, excluding construction and demolition materials and debris, from disposal by the end of FY 2015	35% of non-hazardous solid waste was diverted from disposal.
Divert at least 55% of construction and demolition materials and debris from disposal by the end of FY 2015	43% of construction waste was diverted from disposal.
Goal 6: Sustainable Acquisition	
Procurements to meet sustainability requirements and include sustainable acquisition provisions and clauses	Requirements for sustainable acquisition have been incorporated into all applicable subcontracts and company procurement procedures; procurements are reviewed for sustainability requirements to reduce hazardous material use, chemical inventory, GHG emissions, and energy use.
Goal 7: Electronic Stewardship and Data Centers	
Meter 100% of data centers by FY 2015 in order to measure the monthly Power Utilization Effectiveness (PUE)[(g)]	Goal was met in FY 2011; all data centers are metered.
Attain a maximum annual weighted average PUE for data centers of 1.4 by FY 2015 (an ideal PUE is 1.0)	PUE for the Building C-1 (NLVF) data center and the Building 23-725 (Mercury) data center was 1.5 and 1.1, respectively, meeting the goal for Building 23-725.
100% of eligible personal computers, laptops, and monitors with power management actively implemented and in use by FY 2012	All leased computers and monitors have power management capabilities that are implemented and in use, meeting this goal.
Goal 8: Renewable Energy	
7.5% of a site's annual electricity consumption from renewable sources by FY 2013; 20% by FY 2020	1% of power produced on site is from renewable sources; renewable energy credits were purchased, representing 8% of NNSA/NFO's annual electrical consumption, allowing NNSA/NFO to meet the FY 2013 goal.
Goal 9: Climate Change Resilience	
Address the 2012 DOE Climate Change Adaptation Plan[(h)] goals to better understand climate change effects, impacts, vulnerabilities, and risk to DOE programs or sites and to address them (DOE 2012). EO 13514 requires each federal agency to evaluate agency climate change risks and vulnerabilities to identify and manage the effects of climate change on the agency's operations and mission in both the short and long term.	Regional risks to facilities currently identified include drought and flooding. Existing emergency management plans cover flood contingencies. Evaluations of site plans will continue to ensure they are climate change resilient.

(a) These are department-wide goals of the DOE, which NNSA/NFO (or any single DOE site) is not required to specifically meet. NNSA/NFO is committed, however, towards striving to meet these department-wide target goals.

(b) The GHGs targeted for emission reductions are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride (SF_6). Scope 1 GHG emissions include direct emissions from sources that are owned or controlled by a federal agency. Scope 2 includes direct emissions resulting from the generation of electricity, heat, or steam purchased by a federal agency. Scope 3 includes emissions from sources not owned or directly controlled by a federal agency but related to agency activities, such as vendor supply chains, delivery services, employee business air and ground travel, employee commuting, contracted solid waste disposal, contracted waste water discharge, and transmission and distribution losses related to purchased electricity. Fugitive GHG emissions are uncontrolled or unintentional releases from equipment leaks, storage tanks, loading, and unloading.

(c) $MtCO_2e$ = metric tons of carbon dioxide equivalents.

Table 3-1. NNSA/NFO Site Sustainability Plan goals and FY 2013 performance status (continued)

(d) The percent of natural gas metered was reported as 98% in 2012. The drop in percent is due to some previously installed gas meters not functioning correctly and the addition of two buildings that changed from standby to operational status. The two buildings require natural gas but are not currently metered for it.

(e) All chilled water systems are equipped with BTU meters, and this goal was reported as 100% complete in 2012. However, the goal actually relates to building level utility metering, not system level. Three buildings lack the utility metering to account for chilled water consumption; therefore, this goal was changed to 0% in 2013. The goal will be met when the three buildings are appropriately metered.

(f) Water consumption data for all facilities at the NNSS are not available because only a few of the NNSS facilities have water meters installed. Instead, water well production, which is tracked with flow meters on each well, is used to estimate consumption on the NNSS. The NLVF and RSL-Nellis buildings all have water meters.

(g) PUE is determined by dividing the amount of power entering a data center by the power used to run the computer infrastructure within it. PUE is expressed as a ratio; efficiency improves as the quotient approaches 1.

(h) This plan is Appendix A of the DOE 2012 Strategic Sustainability Performance Plan (DOE 2012).

3.3.2 Pollution Prevention and Waste Minimization

The P2/WM Program has initiatives to eliminate or reduce the generation of waste, the release of pollutants to the environment, and the use of Class I ozone-depleting substances (ODS). These initiatives are pursued through source reduction, reuse, segregation, and recycling, and by procuring recycled-content materials and environmentally preferable products and services. 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 DOE SSPP goals and the requirements of DOE orders, federal laws, and state regulations applicable to operations at the NNSS, NLVF, and RSL-Nellis (see Section 2.6). The following strategies are employed to meet P2/WM goals:

Source Reduction – The preferred method of waste minimization is source reduction, i.e., to minimize or eliminate waste before it is generated by a project or operation. NNSA/NFO'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.

Source reduction was the strategy used to implement a requirement under EO 13423 to reduce ODS at all DOE sites. By the end of 2009, NNSA/NFO had discontinued the procurement of Class I ODS for all non-exempted uses, and halon-containing fire extinguishers and equipment were removed from the NNSS and NLVF facilities by 2010. All halons have been removed from RSL-Nellis, with the exception of halon fire extinguishers in the aircraft. Since 2009, only environmentally preferable alternatives to Class I ODS are purchased. All procurement of refrigerants containing ODS (referred to as ODS refrigerants) are approved by the environmental oversight organization, which verifies that only approved products are purchased. Existing ODS refrigerants in equipment are being phased out as equipment is drained for repair or replaced by new equipment with approved alternative refrigerants.

Recycling – For some recyclable waste streams generated, NNSA/NFO maintains a recycling program. Items recycled in 2013 included cardboard, mixed paper (office paper, shredded paper, newspaper, magazine, color print, glossy paper), plastic bottles, plastic grocery bags, elastic/plastic stretch pack, milk jugs, Styrofoam, tin and aluminum cans, glass containers, toner cartridges, cafeteria food waste, computers, software, scrap metal, rechargeable batteries, lead-acid batteries, electric lamps (fluorescent, mercury vapor, metal halide, and high-pressure sodium), used oil, antifreeze, and tires. There is also an Excess Property Program that provides excess property to NNSA/NFO employees or subcontractors, laboratories, other DOE sites, other federal agencies, state and local government agencies, and local schools. If new users are not found, excess property is made available to the public for recycle/reuse through periodic Internet sales. In 2013, an estimated 1,215.5 metric tons (1,105 tons) of waste were diverted from NNSS landfills and disposal facilities, all through recycling and reuse.

Environmentally Preferable Purchasing (EPP) – The Resource Conservation and Recovery Act (RCRA), as amended, requires federal agencies to develop and implement an affirmative procurement program (APP). NNSA/NFO maintains an APP that stimulates a market for recycled-content products and closes the loop on recycling. The U.S. Environmental Protection Agency (EPA) maintains a list of items containing recycled materials that should be purchased. The EPA determines what the minimum content of recycled material should be for each item. Federal facilities must have a process in place for purchasing the EPA-designated items containing the minimum content of recycled materials. EO 13423 requires federal facilities to ensure, where possible, that 100% of purchases of items on the EPA-designated list contain recycled materials at the specified minimum content. The U.S. Department of Agriculture designates types of materials that have a required minimum amount of bio-based chemicals. Products that meet this requirement are being added to procurement lists, and the percentage of those that are purchased will be tracked in 2014.

3.3.2.1 WM Reporting

In December 2013 NNSA/NFO submitted the *RCRA Permit for a Hazardous Waste Management Facility Permit Number NEV HW0101 - Annual Summary/Waste Minimization Report Calendar Year 2013, Nevada National Security Site, Nevada* (NSTec 2014) to the Nevada Division of Environmental Protection on February 19, 2014.

3.3.2.2 Major P2/WM Accomplishments

The major P2/WM accomplishments for 2013 included:

- A recycling innovation known as the Clean Burn System was installed at Warehouse 160 in Mercury to replace infrared heaters that were costly to operate and replace. The system includes four clean-burning furnaces, which use recycled oil generated through NSTec's Fleet, Fuel, and Equipment preventive maintenance program, and four large high-volume low-speed fans to circulate the warmed air. Used oil generated at the NNSS is normally shipped off site for reuse or disposal. The cost savings from not having to test and ship the oil will average $12,000 to $15,000 a year. The furnaces can also burn some oils from decommissioned transformers, which is too costly to ship off site and is normally disposed of on site. One gallon of recycled oil generates the same amount of energy as 18 kilowatt hours of electricity. The energy cost savings to heat Warehouse 160 will be approximately $58,000 a year.
- A new process was implemented in 2013 to reduce the amount of scrap metal being disposed of on site. As part of the process improvement effort, expectations and metrics were developed in order to define and track success. In FY 2013, the process resulted in 1,118 tons of scrap metal being diverted from the NNSS solid waste landfill and earning $308,766 in revenue from their sale to offsite vendors/recyclers.
- In July 2013, the NLVF Parking Lot Lighting Replacement project was completed. A total of 25 old lights, which were mercury vapor and high pressure sodium lamps ranging from 250 watts (W) to 462W, were replaced with 200W light emitting diode (LED) lights. The total energy savings is estimated to be $1,971 per year.

3.3.3 Environmental Programs

Multiple programs that serve to protect public health and the environment are implemented on the NNSS (Table 3-2). They address the environmental protection actions supported under the EMS as specified in DOE orders and federal environmental protection statutes. Work conducted in calendar year 2013 by these programs is summarized throughout various chapters of this report (see Table 3-2, "Section Reference" column).

Table 3-2. Major environmental programs of NNSA/NFO

NNSA/NFO Environmental Program	Environmental Protection Action Addressed	Program Description	Section Reference[(a)]
National Environmental Policy Act Compliance	Assess environmental impacts of NNSA/NFO activities	Assesses the environmental effects, values, and reasonable alternatives of proposed projects before deciding to implement any major NNSA/NFO action	Chapter 2: Section 2.7
Routine Radiological Environmental Monitoring Program	Conduct environmental monitoring to detect releases from DOE activities	Monitors direct ambient radiation and monitors man-made radionuclides in air, groundwater, surface water, and biota samples	Chapter 4: Section 4.1, Chapter 5: Section 5.1, Chapters 6, 8, and 9
	Estimate contaminant dispersal patterns in the environment	Identifies pathways of exposure to the public	

Table 3-2. Major environmental programs of NNSA/NFO (continued)

NNSA/NFO Environmental Program	Environmental Protection Action Addressed	Program Description	Section Reference[(a)]
Routine Radiological Environmental Monitoring Program (continued)	Characterize the pathways of exposure to members of the public Estimate the exposures and doses to individuals and nearby populations	Estimates dose to public from NNSA/NFO air emissions, groundwater contamination, direct radiation, and ingestion of NNSS game animals	Chapter 4: Section 4.1, Chapter 5: Section 5.1, Chapters 6, 8, and 9
Environmental Restoration – Underground Test Area Sites	Conduct environmental monitoring to detect, characterize, and respond to releases to groundwater from DOE activities Estimate contaminant dispersal patterns in the environment	Characterizes radiological groundwater contamination from past NNSS activities and develops contaminant flow models needed to design a network of long-term monitoring wells for the protection of public and private water supply wells	Chapter 11: Section 11.1
Environmental Restoration – Industrial Sites	Conduct environmental monitoring to detect, characterize, and respond to releases from DOE activities	Characterizes and remediates contamination from radiological and hazardous wastes or materials located at past NNSS industrial sites	Chapter 11: Section 11.2
Environmental Restoration – Soils	Conduct environmental monitoring to detect, characterize, and respond to releases from DOE activities	Characterizes and remediates radiological soil contamination from past NNSS activities	Chapter 11: Section 11.3
Community Environmental Monitoring Program	Conduct environmental monitoring to detect releases from DOE activities	Monitors ambient gross alpha and beta radio-activity, gamma radiation, and gamma-emitting radionuclides in offsite community air sampling stations and tritium in offsite water supply sources	Chapter 7
Radiological Waste Management	Public health and environmental protection and compliance	Manages and safely disposes of low-level waste and mixed low-level waste generated by NNSA/NFO, other DOE, and selected U.S. Department of Defense operations	Chapter 10: Section 10.1
Air Quality Protection (Non-radiological)	Conduct environmental monitoring to detect releases from DOE activities Conform to Nevada's air quality implementation plan to attain and maintain national ambient air quality standards	Collects and reports air quality data to ensure that NNSA/NFO operations comply with all air quality permits and federal, state, and local standards	Chapter 4: Section 4.2
Water Quality Protection (Non-radiological)	Conduct environmental monitoring to detect releases from DOE activities Comply with water quality standards	Collects and reports drinking water and wastewater quality to ensure that NNSA/NFO operations comply with all water quality permits and federal, state, and local standards	Chapter 5: Section 5.2
Groundwater Protection Program	Implement a site-wide approach for groundwater protection	Integrates site-wide groundwater-related activities across multiple programs	Chapter 13
Hazardous Materials Management	Assist in meeting the chemical emergency planning, release, and reporting requirements of the Emergency Planning and Community Right-to-Know Act and the Pollution Prevention Act of 1990	Safely manages hazardous materials used and stored for NNSA/NFO activities	Chapter 12
Hazardous and Solid Waste Management	Public health and environmental protection and compliance	Safely manages and disposes of hazardous and solid wastes generated by NNSA/NFO operations	Chapter 10: Section 10.2, 10.3, 10.4
Cultural Resources Management Program and Historic Preservation	Assess environmental impacts of NNSA/NFO activities Identify and protect cultural resources	Collects and provides information used to evaluate and mitigate potential impacts of proposed projects on NNSS cultural resources and ensures compliance with all state and federal requirements pertaining to cultural resources on the NNSS	Chapter 14

Table 3-2. Major environmental programs of NNSA/NFO (continued)

NNSA/NFO Environmental Program	Environmental Protection Action Addressed	Program Description	Section Reference[(a)]
Ecological Monitoring and Compliance Program	Assess environmental impacts of NNSA/NFO activities Evaluate the potential impacts to biota in the vicinity of a DOE activity Protect natural resources	Collects ecological information used to evaluate and mitigate potential impacts of proposed projects on NNSS ecosystems and biota and ensures compliance with all state and federal requirements to protect NNSS biota and habitats	Chapter 15
Emergency Services and Operations Support – Wildland Fire Management	Protect site resources from wildland fires	Minimizes the vulnerability of NNSS personnel, property, and wildlife to wildland fire damage	Chapter 15: Section 15.5
Meteorological Monitoring	Public health and environmental protection	Conducted by the Air Resources Laboratory, Special Operations and Research Division (SORD) of the National Oceanic and Atmospheric Administration; provides air dispersion and atmospheric sciences support to NNSA/NFO operations at the NNSS and elsewhere, as needed	Section A.3 of *Attachment A: Site Description* (electronic file included on compact disc of this report); see also SORD website http://www.sord.nv.doe.gov
Quality Assurance Program	Ensure that analytical work for environmental and effluent monitoring supports data quality objectives, using a documented approach for collecting, assessing, and reporting environmental data	Ensures that quality is integrated into the environmental monitoring data collected and analyzed	Chapters 16 and 17

(a) The section(s) within this document that present environmental protection and compliance activities of the listed program

3.4 Legal and Other Requirements

NNSA/NFO and its contractors comply with all applicable laws and regulations. Baseline laws and regulations are supplemented on an activity-specific basis as needed. Operating directives and procedures are developed to meet all legal requirements through controlled processes. Company planning documents, policies, and procedures implement the directives, as applicable. Procedures exist at both the company and organization levels. These documents integrate legal, regulatory, and other company-accepted standards and operating practices into daily work planning and execution activities. Programs conforming to company business management, quality assurance, and environment, safety, and health management processes have been established to ensure that standards are implemented, business objectives are achieved, and the workers, public, and environment are protected.

NNSA/NFO and its contractors operate within the constraints of various federal, state, and local environmental permits. These permits often prescribe operational controls, records management, and monitoring and measuring requirements. Approved operations and maintenance plans may also exist to comply with permit and non-permit regulatory requirements. There are regulatory agreements, agreements in principle between NNSA/NFO and the State of Nevada, memoranda of understanding, and tenant support agreements that are considered in planning and executing work.

3.5 EMS Competence, Training, and Awareness

EMS awareness is included as part of the orientation training required for all new NSTec employees. Ongoing EMS awareness is accomplished by publishing environmental articles in electronic employee newsletters. Focused environmental briefings are given at tail-gate meetings in the field prior to work with high or non-routine environmental risk.

The NNSA/NFO P2/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/NFO newsletters, the maintenance of a P2/WM intranet website, 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.

3.6 Audits and Operational Assessments

The ISO 14001 certifying organization conducts semi-annual surveillances on focused portions of the EMS. Findings and recommendations are tracked in the companywide issues tracking system, caWeb. Corrective actions taken to close the issues help to continually improve the EMS program. In 2013, surveillances were conducted in January and July. The EMS Description document states that an independent internal audit of portions of the EMS program will be performed each year. The internal audit conducted by NSTec in 2013 found a few minor issues, and these were entered into caWeb for tracking until the issues are closed.

Additionally, NSTec's Environment, Safety, Health, and Quality Division conducts internal management assessments and compliance evaluations on focused portions of the EMS program. These assessments and evaluations determine the extent of compliance with environmental regulations and identify areas for overall improvement. In 2013, NSTec conducted 8 internal management assessments and 86 compliance evaluations.

3.7 EMS Effectiveness and Reporting

The ISO 14001:2004 certification of the EMS program has enabled NNSA/NFO to declare that they have met executive and DOE order requirements. The ISO 14001:2004 certifying organization stated after the March, 2011 recertification assessment that the EMS program remains effective, and the EMS program's certification was renewed in June 2011 for another three years.

EMS training and awareness has improved the overall environmental knowledge of the workforce. Many times the operational workers in the company identify problems and recommend preventive or corrective actions. These actions, driven by the EMS program, have improved performance and reduced costs.

The establishment of annual environmental EMS targets assists in reducing water, fuel, and energy usage; avoiding waste production; recycling wastes generated from environmental restoration activities; purchasing EPP products; and making infrastructure improvements on environmental systems such as water lines and boilers.

One of the benefits of the EMS program is monthly communication between NSTec and NNSA/NFO regarding current environmental issues and the status of EMS objectives and targets. NSTec prepares and distributes by email a monthly EMS slide presentation to facilitate communication and support, and topics include assessment findings, status of corrective actions, emerging concerns, environmental metrics, and opportunities for improvement. The EMS program is continuously being evaluated and improvements are implemented and documented. A summary report is presented to senior management annually, documenting performance and improvements, documenting the determination that the program continues to be suitable, adequate and effective.

On December 4, 2013, the 2013 Facility EMS Annual Report Data for the NNSS was entered into the DOE Headquarters EMS database accessed through the FedCenter.gov website (http://www.fedcenter.gov/programs/ems/). This database gathers information in several EMS areas from all DOE sites to produce a combined report reflecting DOE's overall performance compared to other federal agencies. The report includes a score card section, which is a series of questions regarding a site's EMS effectiveness in meeting the objectives of federal EMS directives. The NNSS scored "green," the highest score.

3.8 Awards and Recognition

In 2013, NNSA awarded NSTec with four Sustainability Awards for innovation and excellence. They included two in the Best in Class category and two in the Environmental Stewardship category, as described below.

Best in Class Sustainability Award: NNSS Fleet Management Initiatives – The NNSA/NFO is one of only five locations across the nation to be selected to participate in the Plug-in Electric Vehicle (PEV) Pilot Program, the first of its kind sponsored by the General Services Administration and vehicle manufacturers. The NNSS and NSTec were selected to demonstrate PEV technology for possible wider use in federal fleets nationwide. In 2012, NSTec received 11 Chevy Volts. Five PEV charging stations are installed at NLVF, and in 2013, two charging stations were installed at the NNSS without the use of additional funding, bringing the total number of NNSS charging stations to ten. NNSS is an ideal testing location because it challenges the vehicles in a wide variety of driving conditions.

Fleet Services purchased and installed two closed-loop vehicle oil change machines that protect the environment and reduce the time taken to change oil on trucks and vehicles. Fleet Services also expanded the availability of E-85 fuel at the Area 6 Service Station by installing two dispensers capable of fueling four vehicles at once, allowing for an increase in the use of alternative fuel on the NNSS. The engine run time for the premier NNSS security vehicles was increased by 50% by installing synthetic oil in them and using oil analysis to determine the frequency of oil changes.

Best in Class Sustainability Award: NNSS Water Loss Mitigation – A water loss mitigation project completed in 2012 at the NNSS resulted in the closure of several earthen sumps, the installation of several wildlife water troughs, and replacement of the sumps with aboveground storage of water used for construction that eliminated water losses due to soil infiltration. The project resulted in a 20% reduction in water use.

Environmental Stewardship Award: Sustainable Communications: NNSS – The Green Reaper – Manager Dawn Starrett of NSTec was given this award for her creation of the cartoon character, The Green Reaper. The Green Reaper in used in announcements, newletters, and other literature to encourage workers to conserve energy. In FY 2013, the Green Reaper character was translated into a costume for use during community outreach presentations at local elementary schools.

Environmental Stewardship Award: Greenhouse Gas Scope 1 and 2: NNSS Offsite Transport of Sulfur Hexafluoride – NSTec initiated a program to remove excess bottles of SF_6 gas, which is used in gas circuit breakers and diagnostic equipment at the NNSS. By returning dozens of unused or surplus cylinders to their supplier, and by introducing new methods for monitoring equipment containing SF_6, fugitive emissions of this GHG are expected to be significantly reduced.

3.9 References

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Chapter 4: Air Monitoring

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The first part of this chapter (Section 4.1) presents the results of radiological air monitoring conducted on the Nevada National Security Site (NNSS) by the U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office (NNSA/NFO) to verify compliance with radioactive air emission standards. Measurements of radioactivity in air are also used to assess the radiological dose to the general public from inhalation. The assessed dose to the public from all exposure pathways is presented in Chapter 9. Section 4.2 then presents the results of nonradiological air quality assessments that are conducted to ensure compliance with NNSS air quality permits.

NNSA/NFO has also established an independent Community Environmental Monitoring Program to monitor radionuclides in air in communities adjacent to the NNSS. It is managed by the University of Nevada's Desert Research Institute (DRI) of the Nevada System of Higher Education. DRI's offsite air monitoring results are presented in Chapter 7.

4.1 Radiological Air Monitoring

The sources of radioactive air emissions on the NNSS include the following: (1) evaporation of tritiated water from containment ponds; (2) diffusion of tritiated water vapor from soil at the Area 3 Radioactive Waste Management Site (RWMS), the Area 5 Radioactive Waste Management Complex (RWMC), and historical surface or near-surface nuclear device test locations (particularly Sedan and Schooner Craters); (3) resuspension of contaminated soil at historical surface or near-surface nuclear device test locations; and (4) release of radionuclides from current operations (Figure 4-1). The NNSS air monitoring network consists of samplers placed near sites of soil contamination, at facilities that may produce radioactive air emissions, and along the NNSS boundaries. The objectives and design of the network are described in the *Routine Radiological Environmental Monitoring Plan* (Bechtel Nevada 2003).

Data from NNSS sampling stations are analyzed to meet the specific goals listed below. The analytes monitored include radionuclides most likely to be present in air as a result of past or current NNSS operations, based on inventories of radionuclides in surface soil (McArthur 1991) and on the volatility and availability of radionuclides for resuspension (see Table 1-5 for the half-lives of these radionuclides). Uranium is included because depleted uranium (DU) either has been, or currently is, used during exercises in specific areas of the NNSS. Samples from stations near these areas are analyzed for uranium. Gross alpha and gross beta readings are used in air monitoring as a relatively rapid screening measure.

Radiological Air Monitoring Goals	*Analytes Monitored*
Monitor air at or near historical or current operation sites to (1) detect and identify local and site-wide trends, (2) quantify radionuclides emitted to air, and (3) detect accidental and unplanned releases. Conduct point-source operational monitoring required under NESHAP for any facility that has the potential to emit radionuclides to the air and cause a dose greater than 0.1 millirem per year (mrem/yr) (0.1 millisievert per year [mSv/yr]) to any member of the public. Determine if the air pathway dose to the public from past or current NNSS activities complies with the Clean Air Act (CAA) National Emission Standards for Hazardous Air Pollutants (NESHAP) standard of 10 mrem/yr (0.1 mSv/yr) (see Chapter 9). Determine if the total radiation dose to the public from all pathways (air, water, food) complies with the 100 mrem/yr standard set by U.S. Department of Energy (DOE) Order DOE O 458.1, "Radiation Protection of the Public and the Environment" (see Chapter 9).	Americium-241 (^{241}Am) Gamma ray emitters (includes 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

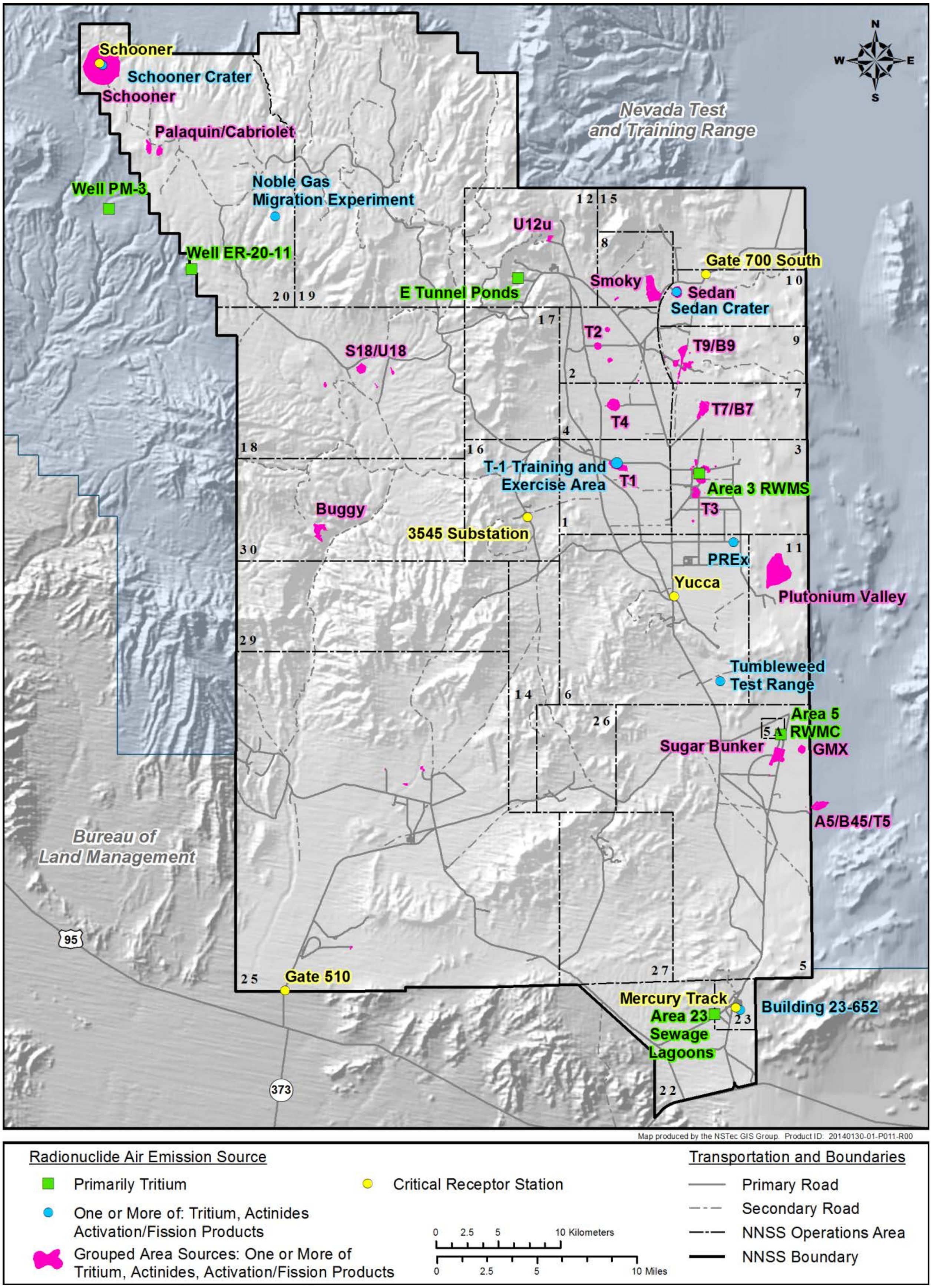

Figure 4-1. Sources of radiological air emissions on the NNSS in 2013

4.1.1 Monitoring System Design

Environmental Samplers – A total of 20 environmental sampling stations operated on the NNSS at some time during 2013 (Figure 4-2). Sampling ended at Sugar Bunker North (Area 5) on January 31, 2013, and ended at both E Tunnel Pond (Area 12) and Gate 20-2P (Area 20) on April 25, 2013. Sampling began at a new station, RWMS 5 Lagoons (Area 5) on January 31, 2013, and began at U-20U South (Area 20) on April 30, 2013. By the end of 2013, 17 environmental sampling stations were operating; 15 have both air particulate and tritium (atmospheric moisture) samplers, 1 has only an air particulate sampler, and 1 has only a tritium sampler (Figure 4-2). The NNSS air samplers are positioned in predominant downwind directions from sources of radionuclide air emissions (for NNSS wind rose data, see Section A.3 of *Attachment A: Site Description*, included as a separate file on the compact disc of this report) and/or are positioned between NNSS contaminated locations and potential offsite receptors. Most radionuclide air emission sources are diffuse sources that include areas with (1) radioactivity in surface soil that can be resuspended by the wind, (2) tritium in water (tritiated water) transpiring or evaporating from plants and soil at the sites of past nuclear tests, and (3) tritiated water evaporating from ponds receiving water either from contaminated wells or from tunnels that cannot be sealed. Sampling and analysis of air particulates and tritium were performed at these stations as described in Section 4.1.2. Radionuclide concentrations measured at these stations are used for trending, determining ambient background concentrations in the environment, and monitoring for unplanned releases of radioactivity.

Critical Receptor Samplers – Six of the environmental sampling locations that have both air particulate and tritium samplers are approved by the U.S. Environmental Protection Agency (EPA) Region IX as critical receptor samplers. They are located near the boundaries and center of the NNSS (Figure 4-2). Radionuclide concentrations measured at these stations are used to assess compliance with the NESHAP public dose limit of 10 mrem/yr (0.1 mSv/yr). The annual average concentrations from each station are compared with the NESHAP Concentration Levels for Environmental Compliance (compliance levels [CLs]) listed in Table 4-1. 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 at all stations.

Table 4-1. Regulatory concentration limits for radionuclides in air

	Concentration (× 10^{-15} microcuries/milliliter [μCi/mL])	
Radionuclide	**NESHAP Concentration Level for Environmental Compliance (CL)[a]**	**10% of Derived Concentration Standard (DCS)[b]**
^{241}Am	1.9	4.1
^{137}Cs	19	9,800
^{3}H	1,500,000	1,400,000
^{238}Pu	2.1	3.7
^{239}Pu	2	3.4
^{233}U	7.1	39
^{234}U	7.7	40
^{235}U	7.1	45
^{236}U	7.7	44
^{238}U	8.3	47

(a) From Table 2, Appendix E of Title 40 Code of Federal Regulations (CFR) Part 61, 2010

(b) From DOE-STD-1196-2011, "Derived Concentration Technical Standard"

In addition to CLs, air concentrations measured at all locations are also compared with Derived Concentration Standard (DCS) values. They represent the annual average air concentrations that would result in a total effective dose equivalent (TEDE) (see Glossary, Appendix B) of 100 mrem/yr (the federal dose limit to the public from all radiological exposure pathways). Ten percent of the DCS (third column of Table 4-1) represents a 10 mrem/yr dose and is analogous to the CLs. Differences between the CL and 10% of the DCS are due to the fact that they are computed using different dose models. Generally, the more conservative of the two are the CLs used to demonstrate compliance. Air concentrations approaching 10% of the CLs are investigated for causes that may be mitigated in order to ensure regulatory dose limits are not exceeded.

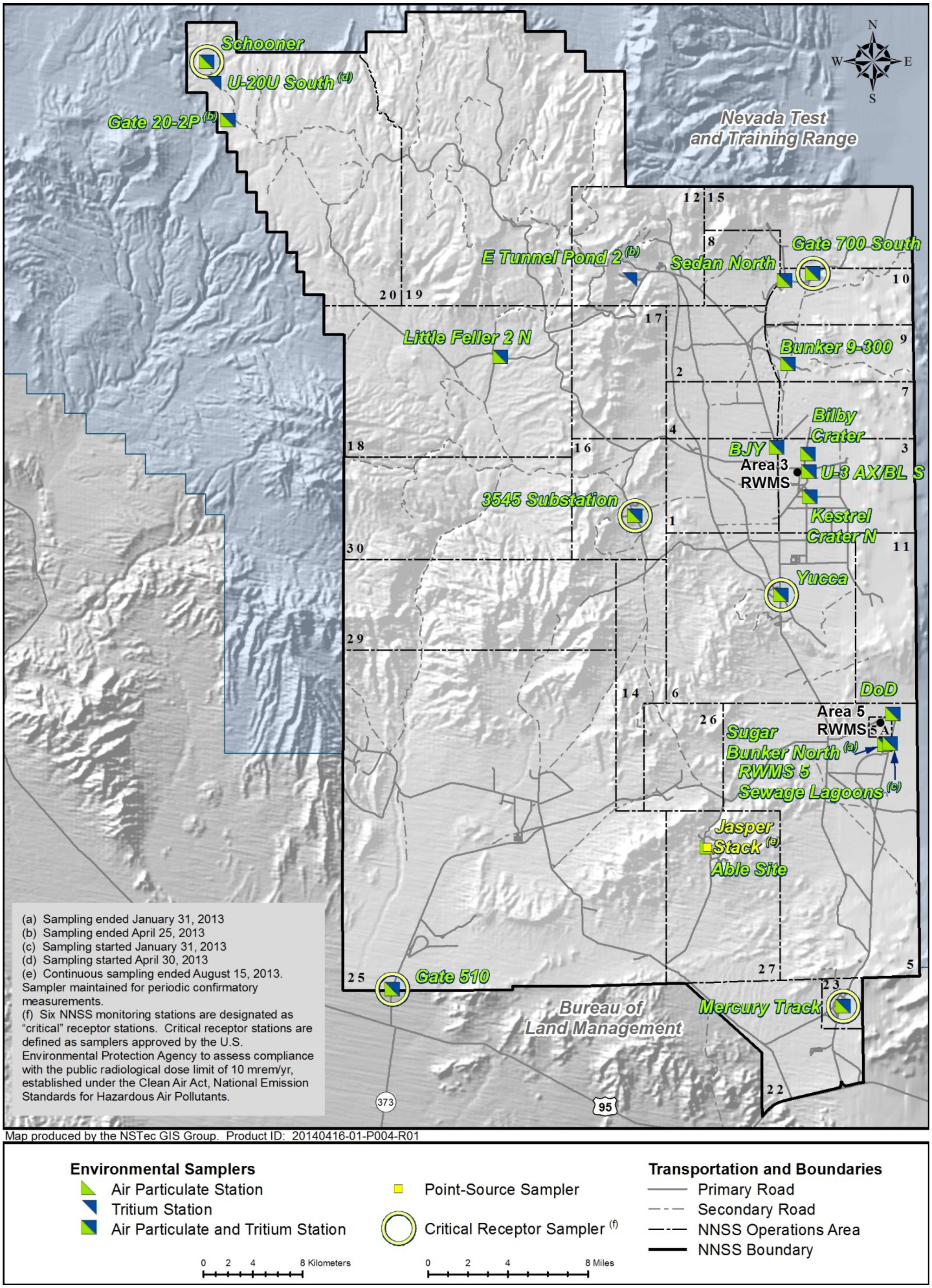

Figure 4-2. Radiological air sampling network on the NNSS in 2013

Point-Source (Stack) Sampler – One facility on the NNSS, the Joint Actinide Shock Physics Experimental Research (JASPER) facility in Area 27 (Figure 4-2), had required stack monitoring during operations. However, during 2013, the potential air emissions from the facility were re-evaluated and determined to result in a potential dose that is much less than the 0.1 mrem/yr threshold at which stack monitoring is required. The last sample from JASPER was collected August 15, 2013. While continuous air monitoring was halted, the sampler will be maintained in order to conduct periodic confirmatory measurements.

4.1.2 Air Particulate and Tritium Sampling Methods

A sample is collected from each air particulate sampler by drawing air through a 10-centimeter (cm) (4-inch [in.]) diameter glass-fiber filter at a flow rate of about 85 liters per minute (L/min) (3 cubic feet [ft^3] per minute). The particulate filter is mounted in a filter holder that faces downward at a height of 1.5 meters (m) (5 feet [ft]) above ground. A timer measures the operating time. The run time multiplied by the flow rate yields the volume of air sampled, which is about 860 cubic meters (m^3) (30,000 ft^3) during a typical 7-day sampling period. The air sampling rates are measured using mass-flow meters that are calibrated annually. The filters are collected every 2 weeks at the stations in Area 3 and Area 5 and weekly at all other stations.

The filters are analyzed for gross alpha and gross beta radioactivity after a 5-day holding time to allow for the decay of naturally occurring radon progeny. These filters are then composited at regular intervals for each station. The composite samples are analyzed for gamma-emitting radionuclides (including ^{137}Cs) by gamma spectroscopy and for ^{238}Pu, $^{239+240}$Pu, and ^{241}Am by alpha spectroscopy after chemical separation. Samples from stations relatively near potential sources of uranium emissions are also analyzed for uranium isotopes by alpha spectroscopy. These stations are Sugar Bunker North and RWMS 5 Lagoons (Area 5), Yucca (Area 6), Gate 700 S (Area 10), 3545 Substation (Area 16), Gate 20-2P (Area 20), Gate 510 (Area 25), and Able Site (Area 27). Until March 2012, the Area 3 and Area 5 station filters were composited monthly, similar to all other stations. After that time, however, they have been composited quarterly. This extended schedule (i.e., quarterly versus monthly) for the Area 3 and Area 5 stations is intended to increase the volume of air sampled and thereby increase the amount of radioactivity that would be deposited on the filters. This was done to enhance the ability to measure lower concentrations.

Tritiated water vapor in the form of $^3H^3HO$ or ^3HHO (collectively referred to as HTO) is sampled continuously over 2-week periods at each tritium sampling station. Tritium samplers are operated 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 2-week sampling period). The HTO is removed from the airstream by a molecular sieve desiccant. The desiccant is exchanged biweekly. An aliquot of the total moisture collected is extracted from the desiccant 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.

Quality control air samples (e.g., duplicates, blanks, and spikes) are also routinely incorporated into the analytical suites. Chapter 16 contains a discussion of quality assurance/quality control protocols and procedures used for radiological air monitoring.

4.1.3 Presentation of Air Sampling Data

The 2013 annual average radionuclide concentrations at each air sampling station are presented in the following sections. The annual average concentration for each radionuclide is estimated from uncensored analytical results for individual samples; i.e., values less than their analysis-specific minimum detectable concentrations (MDCs; see Glossary, Appendix B) were included in the calculation. $^{239+240}$Pu, $^{233+234}$U, and $^{235+236}$U are reported as the sum of isotope concentrations because the analytical method cannot readily distinguish the individual isotopes. Where field duplicate measurements are available, plots and summaries use the average of the regular and field duplicate measurements.

In graphs of concentration data, the CL (second column of Table 4-1) or a fraction of the CL is included as a dashed green horizontal line. For graphs displaying individual measurements, the CL or fraction thereof is shown for reference only, because assessment of NESHAP compliance is based on annual average concentrations rather than individual measurements.

For the summary row titled "All Environmental Locations" in each of the tables below, the Sugar Bunker N, Gate 20-2P, and E Tunnel Pond station results are omitted because these stations were sampled for less than half the year, and their results are therefore not representative of the entire year. Also, the annual mean values for the Area 3 and Area 5 stations that had fewer measurements with longer compositing periods were weighted equally with those from other stations by including each of their sample results three times. For example, the single result for a three-month composited sample is included three times to represent that value for each month. This gives all stations equal weight for the annual "All Environmental Locations" mean.

The single point-source sampler (JASPER Stack) is not included in the summary tables or discussed in the following results section because it does not measure ambient air and its results for specific radionulcides were either less than the MDC or the range of the result, based on its uncertainty, overlapped zero and was therefore considered not detected.

4.1.4 Air Sampling Results

Radionuclide concentrations in the 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 low-level radioactive waste burial.

4.1.4.1 Americium-241

The mean ^{241}Am concentration for environmental sampler stations is 10.09 × 10^{-18} μCi/mL. This is not a significant change from recent years as it is slightly lower than in 2012 (12.74 × 10^{-18} μCi/mL) and 2011 (15.99 × 10^{-18} μCi/mL) but somewhat higher than in 2010 (6.99 × 10^{-18} μCi/mL) and 2009 (6.33 × 10^{-18} μCi/mL). The 2013 average concentration is less than 1% of the CL. As usual, the highest concentrations are detected at the Bunker 9-300 sampling station in Area 9 (Table 4-2, Figure 4-3). This sampler is located within areas of known soil contamination from past nuclear tests. The annual mean concentration at Bunker 9-300 is 78.43 × 10^{-18} μCi/mL, 4.1% of the CL. In Figures 4-3 through 4-5, the measurements at Bunker 9-300 are shown individually. The plots also show the mean monthly concentrations at other stations, with vertical bars extending from the lowest to highest measurements at the other stations.

Table 4-2. Concentrations of ^{241}Am in air samples collected in 2013

			^{241}Am (× 10^{-18} μCi/mL)			
Area	**Sampling Station**	**Number of Samples**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**
1	BJY	12	7.03	9.62	0.00	34.80
3	Bilby Crater	4	5.69	4.01	2.77	11.54
3	Kestrel Crater N	4	11.98	5.42	5.14	18.26
3	U-3ax/bl S	4	23.46	36.75	1.42	78.43
5	DoD	4	1.71	2.71	0.00	5.72
5	RWMS 5 Lagoons	4	1.63	2.23	−1.02	4.02
5	Sugar Bunker N	1	3.41	----	3.41	3.41
6	Yucca[a]	12	1.85	4.52	−4.83	12.75
9	Bunker 9-300	12	78.43	62.25	10.45	200.18
10	Gate 700 S[a]	12	5.92	9.88	−2.97	22.47
10	Sedan N	12	11.19	11.98	−1.35	41.78
16	3545 Substation[a]	12	2.49	6.45	−5.62	16.72
18	Little Feller 2 N	12	2.26	5.17	−3.87	12.77
20	Gate 20-2P	4	1.19	1.75	−0.63	3.33
20	Schooner[a]	12	2.67	4.95	−2.91	15.80
23	Mercury Track[a]	12	2.61	4.56	−3.58	14.01
25	Gate 510[a]	12	0.39	3.81	−4.39	8.46
27	ABLE Site	12	2.11	5.91	−3.94	17.92
All Environmental Locations[b]		**192**	**10.09**	**25.78**	**−5.62**	**200.18**
CL = 1900 × 10^{-18} μCi/mL						

(a) EPA-approved Critical Receptor Station

(b) For these summary data, Sugar Bunker N and Gate 20-2P results are omitted (see Section 4.1.3) and each quarterly composited result for the Area 3 and Area 5 stations are included three times to give all station results equal weight

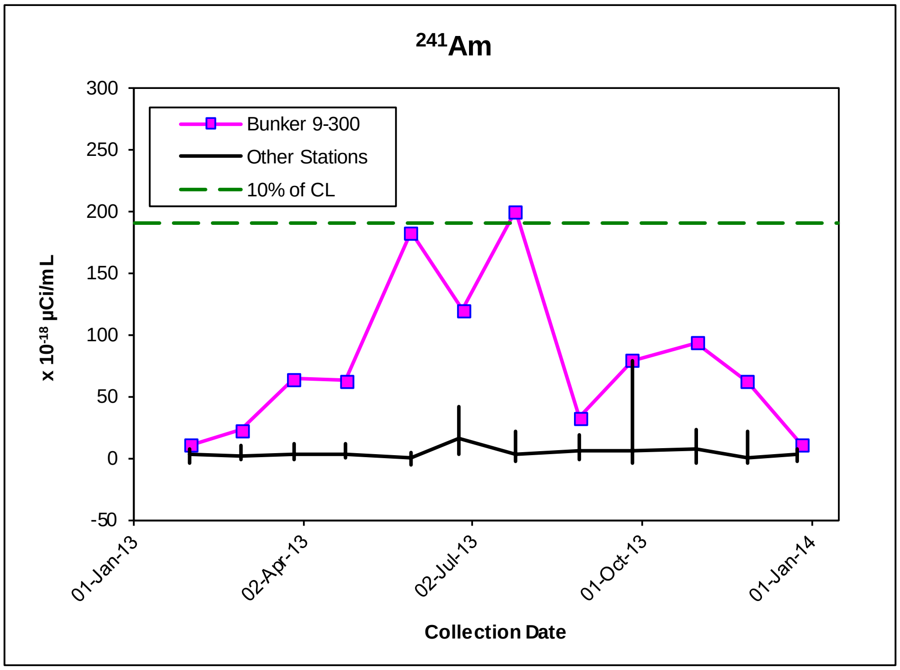

Figure 4-3. Concentrations of ^{241}Am in air samples collected in 2013

4.1.4.2 Cesium-137

During 2013, ^{137}Cs was not detected at any of the environmental sampling stations or at the JASPER Stack point-source sampler.

4.1.4.3 Plutonium Isotopes

The overall mean concentration for ^{238}Pu at environmental stations during 2013 (2.71×10^{-18} µCi/mL) is within the range of values observed in recent years (2.20×10^{-18} µCi/mL in 2012, 3.72×10^{-18} µCi/mL in 2011, 1.88×10^{-18} µCi/mL in 2010, and 1.15×10^{-18} µCi/mL in 2009). Average Bunker 9-300 (Area 9) measurements are again higher than those of other stations (Table 4-3, Figure 4-4), although less prominently so in comparison with ^{241}Am (Figure 4-3) and $^{239+240}$Pu (Figure 4-5). The highest mean concentration at environmental stations is 0.5% of the CL.

Plutonium isotopes $^{239+240}$Pu are of greater abundance and hence greater interest. The overall mean of 61.7×10^{-18} µCi/mL is with the range of values measured over the past 8 years. The location with the highest mean, as expected, is Bunker 9-300 (593×10^{-18} µCi/mL, 29.6% of the CL; see Table 4-4 and Figure 4-5). The higher plutonium values at this station are due to diffuse sources of radionuclides from historical nuclear testing in Area 9 and surrounding Areas 4 and 7.

The temporal patterns for ^{241}Am, $^{239+240}$Pu, and to some extent ^{238}Pu at Bunker 9-300, shown in Figures 4-3, 4-5, and 4-4, respectively, 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, the amount of ^{241}Am will gradually increase as ^{241}Pu decays; then it will decrease by half every 432 years.

Figure 4-6 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 44 locations, Figure 4-6 shows the average (geometric mean) trend lines for Areas 1 and 3; Area 5; Areas 7, 9, 10, and 15; and the other areas. Areas 1, 3, 7, 9, 10, and 15, in the northeast portion of the NNSS, have a legacy of soil contamination from surface and atmospheric nuclear tests and safety shots. The average annual rates of decline for these groups range from 2.1% (Areas 1 and 3) and 3.1% (Areas 7, 9, 10, and 15) to over 12% (“Other Areas” group). This equates to an

Table 4-3. Concentrations of ^{238}Pu in air samples collected in 2013

			^{238}Pu (× 10^{-18} µCi/mL)			
Area	**Sampling Station**	**Number of Samples**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**
1	BJY	12	2.48	3.67	-5.01	6.51
3	Bilby Crater	4	1.38	0.45	0.99	1.97
3	Kestrel Crater N	4	1.65	0.83	0.47	2.25
3	U-3ax/bl S	4	4.21	4.43	0.00	10.39
5	DoD	4	0.25	0.28	0.00	0.51
5	RWMS 5 Lagoons	4	1.09	0.59	0.57	1.70
5	Sugar Bunker N	1	−3.30	----	−3.30	−3.30
6	Yucca[(a)]	12	0.78	2.98	−2.97	6.33
9	Bunker 9-300	12	11.54	9.62	0.00	33.09
10	Gate 700 S[(a)]	12	1.54	4.54	−9.87	7.57
10	Sedan N	12	5.51	3.49	0.00	10.52
16	3545 Substation[(a)]	12	2.70	2.82	−1.14	8.60
18	Little Feller 2 N	12	2.51	3.29	−2.35	7.85
20	Gate 20-2P	4	1.55	1.09	0.00	2.56
20	Schooner[(a)]	12	3.07	2.39	0.00	6.66
23	Mercury Track[(a)]	12	0.61	2.91	−6.06	4.90
25	Gate 510[(a)]	12	1.53	3.44	−3.81	9.13
27	ABLE Site	12	2.43	2.94	−2.29	8.16
All Environmental Locations[(b)]		**192**	**2.71**	**4.42**	**−9.87**	**33.09**
		CL = 2100 × 10^{-18} µCi/mL				

(a) EPA-approved Critical Receptor Station

(b) For these summary data, Sugar Bunker N and Gate 20-2P results are omitted (see Section 4.1.3) and each quarterly composited result for the Area 3 and Area 5 stations are included three times to give all station results equal weight

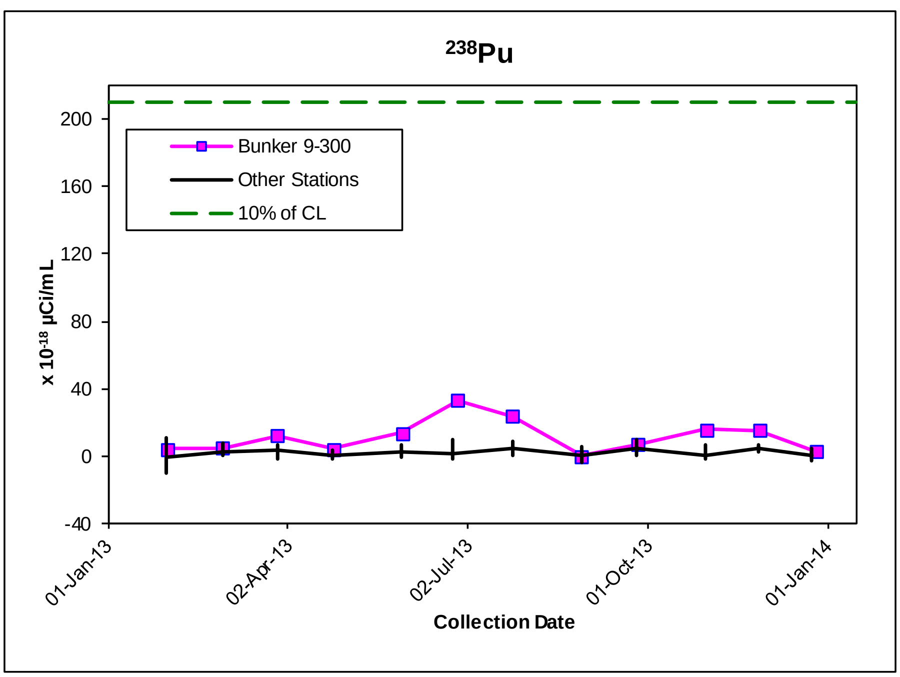

Figure 4-4. Concentrations of ^{238}Pu in air samples collected in 2013

Table 4-4. Concentrations of $^{239+240}Pu$ in air samples collected in 2013

Area	Sampling Station	Number of Samples	$^{239+240}$Pu (× 10^{-18} µCi/mL) Mean	Standard Deviation	Minimum	Maximum
1	BJY	12	20.90	19.15	1.25	61.38
3	Bilby Crater	4	38.78	13.67	24.21	54.74
3	Kestrel Crater N	4	52.53	22.89	32.72	77.43
3	U-3ax/bl S	4	173.84	208.21	22.39	480.29
5	DoD	4	5.72	8.03	1.14	17.74
5	RWMS 5 Lagoons	4	3.00	1.96	0.89	5.23
5	Sugar Bunker N	1	3.30	----	3.30	3.30
6	Yucca[a]	12	10.62	8.35	0.00	24.57
9	Bunker 9-300	12	592.52	439.26	58.31	1369.19
10	Gate 700 S[a]	12	22.70	43.42	0.00	157.03
10	Sedan N	12	42.72	43.09	8.75	140.98
16	3545 Substation[a]	12	2.86	2.78	−1.15	7.94
18	Little Feller 2 N	12	6.79	5.58	−1.54	20.07
20	Gate 20-2P	4	4.12	3.54	−0.91	7.34
20	Schooner[a]	12	5.12	5.86	−4.46	20.38
23	Mercury Track[a]	12	3.12	5.10	−3.03	16.23
25	Gate 510[a]	12	2.52	4.68	−10.65	7.38
27	ABLE Site	12	3.62	2.60	0.72	10.04
All Environmental Locations[b]		**192**	**61.71**	**184.46**	**−10.65**	**1369.19**
		CL = 2000 × 10^{-18} µCi/mL				

(a) EPA-approved Critical Receptor Station

(b) For these summary data, Sugar Bunker N and Gate 20-2P results are omitted (see Section 4.1.3) and each quarterly composited result for the Area 3 and Area 5 stations are included three times to give all station results equal weight

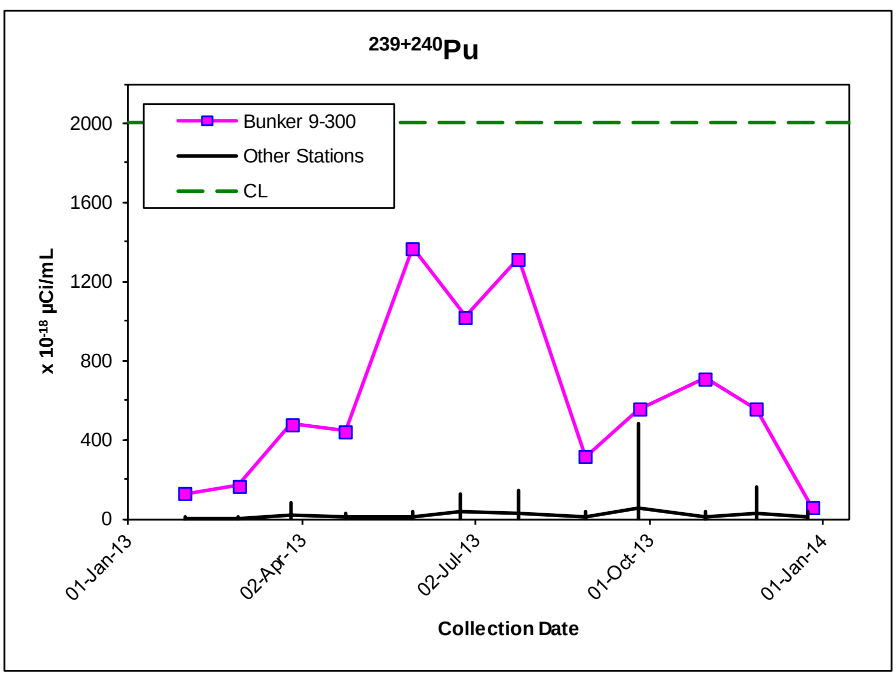

Figure 4-5. Concentrations of $^{239+240}Pu$ in air samples collected in 2013

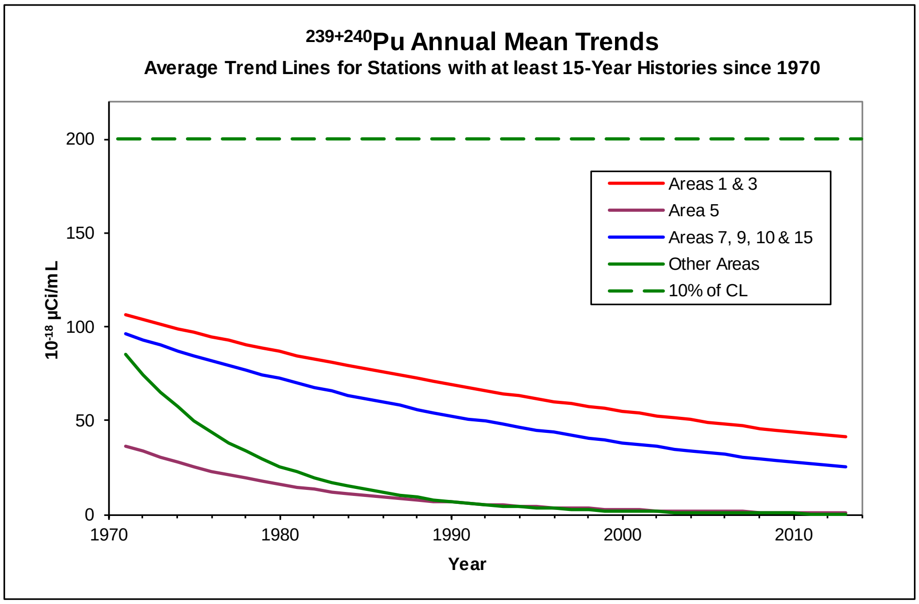

Figure 4-6. Average trends in $^{239+240}$Pu in air annual means, 1971–2013

environmental half-life for $^{239+240}$Pu in air of 30.7 years for Areas 1 and 3; 22.0 years for Areas 7, 9, 10, and 15; 7.5 years for Area 5; and 5.2 years for the "Other Areas" group. Declining rates are not attributed to radioactive decay, as the physical half-lives of ^{239}Pu and ^{240}Pu are 24,110 and 6,537 years, respectively. The decreases are primarily due to immobilization and dilution of Pu particles in soil, resulting in reduced concentrations suspended in air. The half-life of the less abundant ^{238}Pu is 88 years.

4.1.4.4 Uranium Isotopes

Uranium analyses were performed for samples from eight stations during 2013. Two of the stations were discontinued during the year, and six continued to be used for uranium analysis because exercises using uranium (predominately DU) have been conducted relatively near them. In the past, isotopic ratios have been calculated and reported for the purpose of attempting to identify the source (natural, depleted, or enriched) of any uranium found on filters. This uranium was attributed to the NNSS environment. However, recent analyses of blank filters have identified background levels of uranium that basically negate any environmental contribution. Both the quantities of the isotopes and their ratios on environmental samples are very similar for the blank filters. Accordingly, we must conclude that amounts of uranium found in the field samples are negligible.

4.1.4.5 Tritium

Measurements of tritium in air vary widely across monitoring stations on the NNSS (Table 4-5). The highest mean concentration was detected at the Schooner station (143×10^{-6} picocuries per milliliter [pCi/mL]). The next highest are 2.1×10^{-6} pCi/mL at Sedan and 1.8×10^{-6} pCi/mL at E Tunnel Pond; the latter was last sampled April 25, 2013. Figure 4-7 shows these data with the Schooner data plotted at one-tenth of their actual values to allow the variation at other locations to be visible. The Schooner annual mean is 9.5% of the CL; mean concentrations at other locations are less than 0.2% of the CL.

The tritium found at Schooner, Sedan N, and E Tunnel Pond comes from past nuclear tests. At Schooner and Sedan, tritium associated with these tests quickly oxidizes into tritiated water, which remains in the surrounding soil and rubble until it moves to the surface and evaporates. At E Tunnel, the tritium remains in the soil and rubble within the tunnel and is washed out by groundwater moving out of the tunnel. Higher tritium concentrations in air are generally observed during the summer months. At E Tunnel Pond, this increase is predominantly due to the rate of evaporation increasing as the temperature increases. At Schooner and Sedan, increased tritium emissions

Table 4-5. Concentrations of ^3H in air samples collected in 2013

Area	Sampling Station	Number of Samples	^3H Concentration (× 10^{-6} pCi/mL) Mean	Standard Deviation	Minimum	Maximum
1	BJY	26	0.37	0.64	−1.61	1.85
3	Bilby Crater	26	0.30	0.46	−0.30	1.62
3	Kestrel Crater N	26	0.33	0.59	−1.05	1.72
3	U-3ax/bl S	26	0.34	0.38	−0.34	1.40
5	DoD	26	0.22	0.46	−0.46	1.49
5	RWMS 5 Lagoons	23	0.33	0.51	−0.32	2.04
5	Sugar Bunker N	3	−0.11	0.31	−0.42	0.20
6	Yucca[a]	26	0.12	0.44	−0.99	0.78
9	Bunker 9-300	26	0.64	0.74	−0.79	2.73
10	Gate 700 S[a]	26	0.18	0.31	−0.67	0.78
10	Sedan N	25	2.12	2.08	−0.30	6.65
12	E Tunnel Pond	9	1.80	0.79	0.72	2.86
16	3545 Substation[a]	26	0.36	0.41	−0.64	1.29
18	Little Feller 2 N	25	0.13	0.32	−0.52	0.75
20	Gate 20-2P	9	0.14	0.27	−0.24	0.65
20	Schooner[a]	26	142.70	139.14	5.27	407.98
20	U-20U South	17	0.75	0.68	−0.79	1.74
23	Mercury Track[a]	26	0.10	0.55	−1.97	0.93
25	Gate 510[a]	26	0.04	0.35	−0.69	0.67
All Environmental Locations[b]		**411**	**9.41**	**48.82**	**−1.97**	**407.98**
CL = 1500 × 10^{-6} pCi/mL						

(a) EPA-approved Critical Receptor Station

(b) Sugar Bunker N and E Tunnel Pond are omitted from these summaries (see Section 4.1.3)

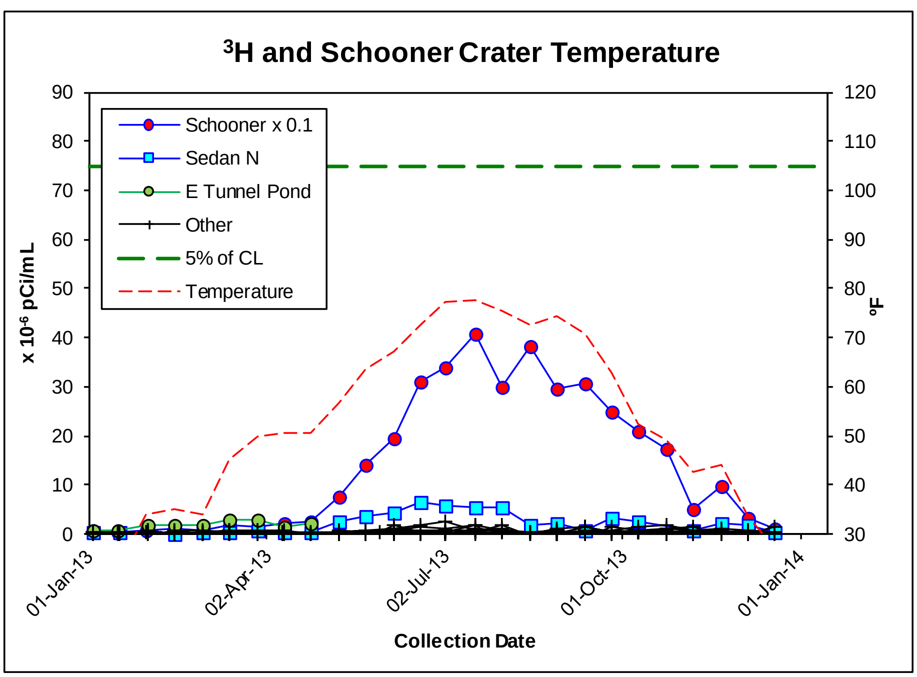

Figure 4-7. Concentrations of ^3H in air samples collected in 2013 with Schooner Crater average air temperature per collection period

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 tritium in the atmosphere and in the shallow soil moisture. Figure 4-7 shows the relationship between tritium and average daily temperature at Schooner Crater. Figure 4-8 shows the amount of precipitation occurring during monitoring periods in and around Pahute Mesa; note the dip in tritium emissions following the rains of mid-July and early September.

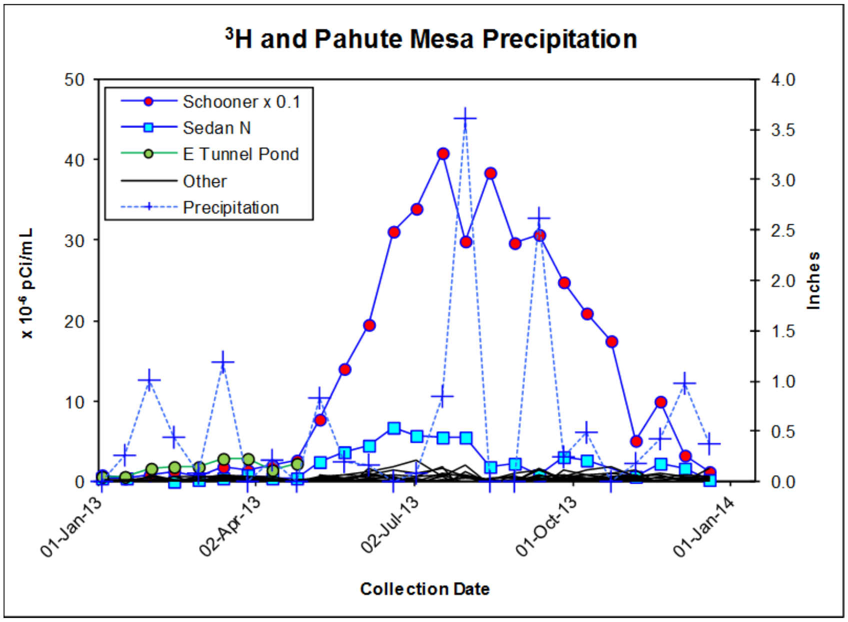

Figure 4-8. Concentrations of ^{3}H in air samples collected in 2013 with Pahute Mesa precipitation

Figure 4-9 shows average (geometric mean) long-term trends for the annual mean tritium levels at locations with at least 7-year histories since 1989. Tritium measurements have been decreasing fairly rapidly at most locations; the overall average decline rate for stations other than Schooner is around 16% per year. The decline rate for Schooner is about 10% per year since 2002.

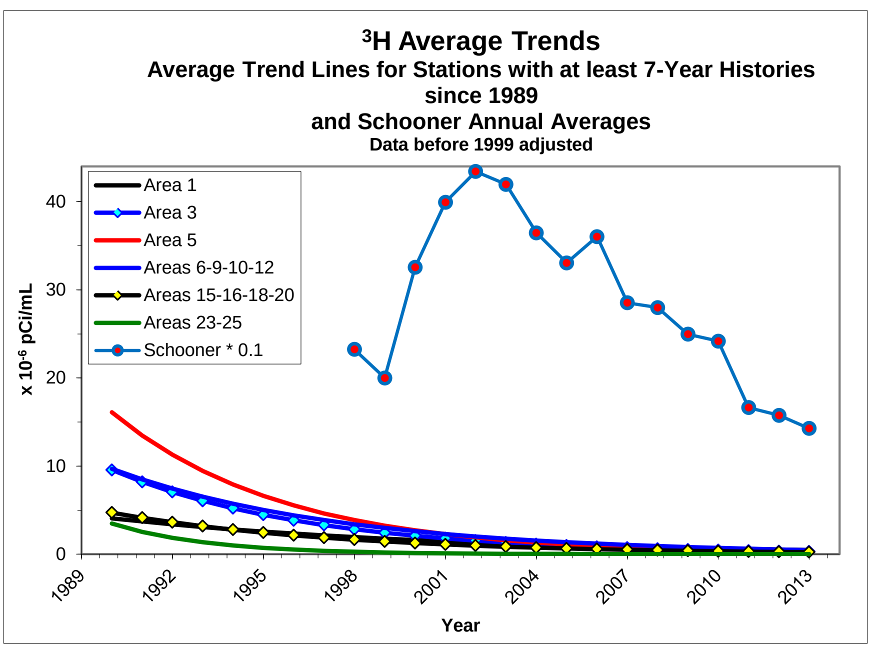

Figure 4-9. Trends in annual mean ^{3}H air concentrations for Area groups and Schooner Crater annual means, 1990–2013

4.1.4.6 Gross Alpha and Gross Beta

The gross alpha and gross beta radioactivity in air samples collected in 2013 are summarized in Tables 4-6 and 4-7. Because these radioactivity measurements include naturally occurring radionuclides (such as potassium-40, beryllium-7, 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 5 days after sample collection to identify any increases requiring investigation.

Overall, the distribution of mean gross alpha results across the network is comparable with those of the past few years. The gross beta measurements also resembled those of prior years (excluding the briefly elevated values in March 2011 due to the Fukushima Daiichi nuclear power plant event). The mean gross beta values are similar, and there are no stations with data that stand out from the rest.

Table 4-6. Gross alpha radioactivity in air samples collected in 2013

			Gross Alpha (× 10^{-16} μCi/mL)			
Area	**Sampling Station**	**Number of Samples**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**
1	BJY	52	20.33	11.18	−10.61	52.75
3	Bilby Crater	26	22.19	8.05	3.71	41.01
3	Kestrel Crater N	26	25.91	10.34	7.58	43.86
3	U-3ax/bl S	26	26.61	18.68	5.45	102.12
5	DoD	26	23.71	9.91	8.00	43.47
5	RWMS 5 Lagoons	23	23.94	10.31	5.48	43.46
5	Sugar Bunker N	3	24.68	6.38	18.69	31.39
6	Yucca[a]	52	19.42	16.27	−66.24	47.95
9	Bunker 9-300	52	37.15	25.22	−12.84	98.51
10	Gate 700 S[a]	52	18.35	11.68	−13.93	50.35
10	Sedan N	52	19.45	11.02	−7.52	43.27
16	3545 Substation[a]	52	16.27	11.56	−5.78	39.01
18	Little Feller 2 N	52	18.29	11.35	−5.75	47.72
20	Gate 20-2P	16	12.92	12.72	−8.09	33.77
20	Schooner[a]	51	18.60	9.89	−12.87	41.16
23	Mercury Track[a]	52	17.64	10.64	−7.68	48.61
25	Gate 510[a]	52	20.67	10.37	0.64	37.29
27	ABLE Site	52	17.08	11.94	−9.49	45.13
All Environmental Locations[b]		**825**	**21.59**	**13.88**	**−66.24**	**102.12**

(a) EPA-approved Critical Receptor Station

(b) For these summary data, Sugar Bunker N and Gate 20-2P results are omitted (see Section 4.1.3) and each quarterly composited result for the Area 3 and Area 5 stations are included twice to give all station results equal weight

Table 4-7. Gross beta radioactivity in air samples collected in 2013

			Gross Beta (× 10^{-15} μCi/mL)			
Area	**Sampling Station**	**Number of Samples**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**
1	BJY	52	22.11	6.14	11.63	36.11
3	Bilby Crater	26	22.03	5.11	14.19	32.94
3	Kestrel Crater N	26	23.59	5.40	14.82	35.85
3	U-3ax/bl S	26	22.11	4.93	14.66	35.40
5	DoD	26	23.84	5.77	14.95	39.50
5	RWMS 5 Lagoons	23	23.51	5.55	16.39	37.86
5	Sugar Bunker N	3	24.29	4.22	19.64	27.89
6	Yucca[a]	52	22.81	6.12	11.68	36.68
9	Bunker 9-300	52	21.58	6.10	11.34	35.87
10	Gate 700 S[a]	52	21.74	6.49	9.18	35.27

Table 4-8. Gross beta radioactivity in air samples collected in 2013 (continued)

Area	Sampling Station	Number of Samples	Gross Beta ($\times 10^{-15}$ µCi/mL) Mean	Standard Deviation	Minimum	Maximum
10	Sedan N	52	21.71	5.59	11.13	33.65
16	3545 Substation[(a)]	52	20.22	5.79	8.65	33.84
18	Little Feller 2 N	52	19.99	5.66	9.99	32.36
20	Gate 20-2P	16	17.42	5.60	10.47	29.26
20	Schooner[(a)]	51	21.48	5.74	9.39	33.60
23	Mercury Track[(a)]	52	22.13	5.65	12.74	35.47
25	Gate 510[(a)]	52	22.51	6.17	11.38	36.69
27	ABLE Site	52	21.46	5.70	10.00	32.86
All Environmental Locations[(b)]		**825**	**22.04**	**5.79**	**8.65**	**39.50**

(a) EPA-approved Critical Receptor Station

(b) For these summary data, Sugar Bunker N and Gate 20-2P results are omitted (see Section 4.1.3) and each quarterly composited result for the Area 3 and Area 5 stations are included twice to give all station results equal weight

4.1.5 Air Sampling Results from Critical Receptor Samplers

The following radionuclides from NNSS-related activities were detected at one or more of the critical receptor samplers: ^{241}Am, ^{238}Pu, $^{239+240}$Pu, and ^{3}H. All measured concentrations of these radionuclides were well below their CLs during 2013. No man-made uranium was detected above background levels (see Section 4.1.4.4). The concentration of each measured man-made radionuclide at each of the six critical receptor stations is divided by its respective CL (see Table 4-1) to obtain a "percent of CL." These are then summed for each station. The sum of these fractions at each critical receptor sampler is far less than 1, demonstrating that the NESHAP dose limit (10 mrem/yr) at these critical receptor locations was not exceeded (Table 4-8). The highest radiation TEDE (see Glossary, Appendix B) at a critical receptor location would be approximately 1.01 mrem from air to a hypothetical individual residing at Schooner for the entire calendar year. A more realistic estimate of dose to the offsite public would come from using the 0.002 sum of fractions from the Gate 510 sampler, which is closest to the nearest public receptor (about 3.5 kilometers [km] or 2.2 miles (mi)]). The estimated TEDE from air emissions for a hypothetical individual living year-round at the Gate 510 sampler would be 0.02 mrem/yr.

Table 4-9. Sum of fractions of compliance levels for man-made radionuclides at critical receptor samplers

Radionuclides Included in Sum of Fractions	NNSS Area	Sampling Station	Sum of Fractions of Compliance Levels (CLs)
^{241}Am, ^{238}Pu, $^{239+240}$Pu, and ^{3}H	6	Yucca	0.007
	10	Gate 700 S	0.015
	16	3545 Substation	0.004
	20	Schooner	0.101
	23	Mercury Track	0.003
	25	Gate 510	0.002

4.1.6 Emission Evaluations for Planned Projects

During 2013, two NESHAP evaluations were conducted. The first was to estimate a worst case dose resulting from the resupsension of radiologically contaminated soil during the planned detonation of unexploded ordnance (for disposal purposes) near Buggy, a Project Plowshare site (see Chapter 1, Section 1.3) in Area 30. The second evaluation was in support of the planned Noble Gas Migration Experiment at the existing drill hole U20az in Area 20. Gas samples, collected from the drill hole, were to be transported to an offsite facility and analyzed for a non-radioactive tracer gas. Because the samples may contain radioactive noble gases, a NESHAP evaluation was done to estimate the offsite dose to the public from potential emissions.

Both evaluations were conducted to determine if the projects had 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 approval prior to operation and point-source operational monitoring. The predicted dose at the nearest NNSS boundary for each planned project was much less than the 0.1 mrem/yr level specified in 40 CFR 61.96. Therefore, it was concluded that these activities constituted minor sources and did not require point-source operational monitoring. The detailed air emission dose evaluations for each project are reported in the NESHAP annual report for 2013 (National Security Technologies, LLC [NSTec], 2014).

4.1.7 Unplanned Releases

There were no known unplanned radionuclide releases in 2013. Three small wildland fires, totaling 1 acre, did occur on the NNSS in 2013, but the fires were not in radiologically contaminated areas.

4.1.8 Estimate of Total NNSS Radiological Atmospheric Releases in 2013

Each year, existing operations, new construction projects, and modifications to existing facilities that have the potential for airborne emissions of radioactive materials are reviewed. Quantities of radionuclides released during these operations and from legacy contamination sites are measured or calculated to obtain the total annual quantity of radiological atmospheric releases from the NNSS. The methods used are described in detail in NSTec (2014). The 2013 emission sources are presented in Table 4-9. Their locations in relation to critical receptor air monitoring locations are shown in Figure 4-1.

In 2013, argon-37 (^{37}Ar) and xenon-127 (^{127}Xe) were emitted as part of the Noble Gas Migration Project, and lanthanum-140 (^{140}La) and gold-198 (^{198}Au) were emitted as part of the Particulate Release Experiment (PREx). These radionuclides are short-lived (40-hour to 36-day half-life) and were released as relatively large particulates (^{140}La and ^{198}Au) or deep underground (^{37}Ar and ^{127}Xe), so only negligible amounts could be available for transport offsite. A number of other short-lived radionuclides were released in 2013 at the Tumbleweed Test Range and the T1 Training and Exercise Area: beryllium-7 (^{7}Be), carbon-11 (^{11}C), nitrogen-13 (^{13}N), oxygen-15 (^{15}O), chlorine-38 (^{38}Cl), chlorine-39 (^{39}Cl), argon-41 (^{41}Ar), and metastable technetium-99 (^{99m}Tc). All but ^{7}Be have half-lives ranging from 10 minutes (^{13}N) to 6 hours (^{99m}Tc). They decay away very quickly and are not available to contribute dose to the public at the 31 to 62 km (19 to 38 mi) distances over which they have to travel. ^{7}Be has a 54-day half-life but is emitted in quantities much lower than the concentrations of ^{7}Be produced in the atmosphere by naturally occurring cosmic radiation.

In 2013, an estimated 5,170 Ci of radionuclides were released as air emissions. Of this amount, 95.3% (4,928 Ci) is from activation products with very short half-lives discussed above; 42 Ci were tritium (Table 4-10). Descriptions of the methods used for estimating the quantities shown in Table 4-9 are reported in NSTec (2014).

Table 4-10. Radiological atmospheric releases from the NNSS for 2013

Emission Source[(a)]	Type of Emissions Control	Radionuclide	Annual Quantity (Ci)
Legacy Weapon Test and Plowshare Crater Locations			
Sedan	None	^{3}H	17.4
Schooner	None	^{3}H	4.2
Grouped Area Sources – All NNSS Ops Areas	None	^{241}Am	0.047
	None	^{238}Pu	0.050
	None	$^{239+240}$Pu	0.29
Emanation from Building Materials			
Building A-01, basement ventilation, NLVF	None	^{3}H	0.0023
Groundwater Characterization/Control or Remediation			
E Tunnel Ponds	None	^{3}H	6.1
UGTA Well Sump ER-20-11	None	^{3}H	7.7
UGTA Well Sump PM-3	None	^{3}H	0.000047
NLVF Groundwater Control – Area 23 Sewage Lagoons	None	^{3}H	0.00025

Table 4-11. Radiological atmospheric releases from the NNSS for 2013 (continued)

Emission Source[(a)]	Type of Emissions Control	Radionuclide	Annual Quantity (Ci)
Defense, Security, and Stockpile Stewardship			
Noble Gas Migration Project	None	^{37}Ar	100
	None	^{127}Xe	100
PREx	None	^{140}La	1
	None	^{198}Au	1
T1 Training and Exercise Area	None	^{99m}Tc	0.02
Tumbleweed Test Range	None	^{7}Be	0.0006
	None	^{11}C	51
	None	^{13}N	1808
	None	^{15}O	2866
	None	^{38}Cl	2
	None	^{39}Cl	22
	None	^{41}Ar	177
Radioactive Waste Management			
Area 3 RWMS	Soil cover over	^{3}H	1.3
Area 5 RWMC	Soil cover over	^{3}H	5.1
Support Facility Operations			
Building 23-652	None	^{3}H	0.000042

(a) All locations are on the NNSS except for Building A-01

Table 4-12. Total estimated NNSS radionuclide emissions for 2013

Radionuclide	Total Quantity (Ci)	Half-Life[(a)]
^{3}H	42	12.3 years (yr)
^{7}Be	0.0006	53.2 days (d)
^{11}C	51	20.4 minutes (min)
^{13}N	1808	10.0 min
^{15}O	2866	122.2 seconds
^{37}Ar	100	35.0 d
^{38}Cl	2	37.2 min
^{39}Cl	22	55.6 min
^{41}Ar	177	109.6 min
^{99m}Tc	0.02	6.0 hours
^{127}Xe	100	36.4 d
^{140}La	1	1.7 d
^{198}Au	1	2.7 d
^{238}Pu	0.050	87.7 yr
$^{239+240}Pu$	0.29	24,110 yr
^{241}Am	0.047	432.2 yr

(a) Source: International Commission on Radiological Protection (2008)

4.1.9 Environmental Impact

The concentrations of man-made radionuclides in air on the NNSS are all less than the regulatory concentration limits specified by federal regulations. Also, air monitoring data at the six critical receptor samplers indicate that the radiological dose to the general public from the air pathway is below the NESHAP standard of 10 mrem/yr (see Chapter 9 for a discussion of dose to the public from all pathways). Nearly all radionuclides detected by environmental air samplers in 2013 appear to be from two sources: (1) legacy deposits of radioactivity on and in the soil from past nuclear tests and (2) the upward flux of tritium from the soil at sites of past nuclear tests and low-level radioactive waste burial. Long-term trends of $^{239+240}Pu$ and tritium in air continue to show a decline with time. Radionuclide concentrations in plants and animals on the NNSS and their potential impact are discussed in Chapter 8.

4.2 Nonradiological Air Quality Assessment

NNSS operations that are potential sources of 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 to document compliance with the current State of Nevada air quality permit that regulates specific operations or facilities on the NNSS. The assessments predominately address nonradiological air pollutants. 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 2.2). NESHAP compliance with radionuclide emissions monitoring and with the air pathway public dose limits are presented in Section 4.1 of this chapter. Compliance with all other CAA air quality standards is addressed in this section. Data collection, opacity readings, recordkeeping, and reporting activities on the NNSS are conducted to meet the specific program goals in the table below.

Air Quality Assessment Program Goals
Ensure that NNSS operations comply with all the requirements of the current air quality permit issued by the State of Nevada.
Ensure that emissions of criteria air pollutants (sulfur dioxide [SO_2]), nitrogen oxides [NO_X], carbon monoxide [CO], volatile organic compounds [VOCs], and particulate matter) and emissions of hazardous air pollutants do not exceed limits established under NAAQS and NESHAP, respectively.
Ensure that emissions of permitted NNSS equipment meet the opacity criteria to comply with NAAQS and NSPS.
Ensure that NNSS 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.

4.2.1 Permitted NNSS Facilities

NNSA/NFO maintains a Class II Air Quality Operating Permit (AP9711-2557) for NNSS 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), 10 tons of any one hazardous air pollutant (HAP; see Glossary, Appendix B), or 25 tons of any combination of HAPs. The NNSS facilities regulated by permit AP9711-2557 include the following:

- Approximately 14 facilities/150 pieces of equipment in Areas 1, 5, 6, 12, 23, 25, 26, 27, and 29
- Chemical Releases at NPTEC in Area 5 and in Port Gaston in Area 26
- Site-Wide Chemical Releases (conducted throughout the NNSS)
- Big Explosives Experimental Facility (BEEF) in Area 4
- Explosives Ordnance Disposal Unit (EODU) in Area 11
- Explosives Activities Sites at NPTEC in Area 5; High Explosives Simulation Test (HEST) in Area 14; Test Cell C, Calico Hills, and Army Research Laboratory (ARL) in Area 25; Port Gaston in Area 26; and Baker in Area 27

4.2.2 Permit Maintenance Activities

The NNSS air permit (AP9711-2557) was modified once in 2013. In May 2013, the Nevada Division of Environmental Protection (NDEP) issued the following permit modifications:

- Eight diesel-fired generators were reclassified from non-emergency to emergency generators.
- 19 pieces of construction equipment (conveyors, hoppers, a pugmill and one screen), 6 diesel-fired generators, and 7 mud and concrete pumps were removed from the permit.
- One diesel-fired generator and two propane-fired generators were added to the permit.
- Recordkeeping requirements for seven remotely located fuel-fired generators were revised.
- The requirement to report the Community Environmental Monitoring Program offsite air monitoring results was removed from the permit.

In addition, a request was made in the modification application to eliminate the performance emissions test ("stack test") requirement for five diesel-fired generators and for the eight baghouses associated with the aggregate plant, batch plant, and cementing services facilities. Stack testing has been conducted for these facilities since issuance of the permit in 2009, and it is anticipated that it will not continue to be required for the referenced equipment when the permit is renewed in 2014.

4.2.3 Emissions of Criteria Air Pollutants and Hazardous Air Pollutants

A source's regulatory status is determined by the maximum number of tons of criteria air 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 emission units. Each year, NNSA/NFO submits Actual Production/Emissions Reporting Forms to NDEP as required by the NNSS air permit. These forms are used to report the operational information and the calculated emissions of the criteria air pollutants and HAPs for permitted emission units. The State uses the information to determine permit fees and to verify that emissions do not exceed the PTEs. Quarterly reports of emission quantities were submitted to NDEP in April, July, and October 2013, and January 2014. The Calendar Year 2013 Actual Production/ Emissions Reporting Form was submitted in February 2014.

Records examined in 2013 for permitted facilities and equipment indicated that all operational parameters were being properly tracked and no PTEs were exceeded. An estimated 10.29 tons of criteria air pollutants were released (Table 4-11). The majority of the emissions were NO_X from diesel generators. An estimated 0.225 tons of HAPs were released in 2013. Table 4-12 shows the calculated tons of air pollutants released on the NNSS over the past 10 years. Tons of emissions for most pollutants generally decreased from 2001 through 2007, increased from 2008 through 2012, and decreased (with the exception of HAPs) in 2013. The decreases may be due to reduced project activities and less use of large diesel generators that emit large quantities of pollutants. In recent years, additional generators have been added to the permit to either support project activities or to provide backup electrical power, which could account for an increase in emissions. The fluctuation in VOC and HAPs emissions over the past 10 years is mainly due to variations in NPTEC chemical releases.

Field measurements of particulate matter equal to or less than 10 microns in diameter (PM10) are required for all permitted explosives activities. 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.

Unless specifically exempted, the open burning of any combustible refuse, waste, garbage, or oil is prohibited. Open burning for other purposes is allowed if approved in advance by the State through issuance of an Open Burn Variance prior to each burn. Open Burn Variances must be renewed annually. At the NNSS, they are issued for fire extinguisher training and for support-vehicle live-fire training activities. In 2013, 22 fire extinguisher training sessions and 4 vehicle burns were conducted at the NNSS. Quantities of criteria air pollutants produced by open burns are not required to be calculated or reported.

Table 4-11. Tons of criteria air pollutant emissions released on the NNSS from permitted facilities operational in 2013

	Calculated Tons[(a)] per Year of Emissions									
	Particulate Matter (PM10)[(b)]		Carbon Monoxide (CO)		Nitrogen Oxides (NO_X)		Sulfur Dioxide (SO_2)		Volatile Organic Compounds (VOCs)	
Facility	**Actual**	**PTE[(c)]**	**Actual**	**PTE**	**Actual**	**PTE**	**Actual**	**PTE**	**Actual**	**PTE**
Construction Equipment										
Wet Aggregate Plant	0.11	6.80	NA[(d)]	NA	NA	NA	NA	NA	NA	NA
Concrete Batch Plant	0.018	3.64	NA	NA	NA	NA	NA	NA	NA	NA
Cementing Services Equipment	<0.00	23.18	NA	NA	NA	NA	NA	NA	NA	NA
Portable Bins (Area 6)	<0.00	0.64	NA	NA	NA	NA	NA	NA	NA	NA
Paint Spray Booth	NA	NA	NA	NA	NA	NA	NA	NA	0.003	0.21
Fuel Burning/Storage										
Diesel Fired Generators	0.29	3.45	1.33	13.45	5.99	61.09	0.22	2.85	0.32	3.80
Gasoline Fired Generators	0.02	0.12	0.17	1.17	0.27	1.85	0.01	0.10	0.37	2.52
Propane Generator	<0.00	0.02	0.005	0.95	<0.00	1.44	<0.000	0.001	<0.00	0.20
Boilers	0.01	0.34	0.03	0.84	0.12	3.36	0.00	0.01	0.01	0.10
Bulk Gasoline Storage Tank	NA	NA	NA	NA	NA	NA	NA	NA	0.98	1.25
Bulk Diesel Fuel Storage Tank	NA	NA	NA	NA	NA	NA	NA	NA	0.01	0.02
Chemical Releases										
NPTEC	<0.00	3.00	<0.00	3.26	<0.00	3.02	<0.00	3.00	<0.00	10.00
Detonations										
Port Gaston	<0.00	0.21	0.00	1.49	<0.000	0.085	<0.00	0.01	0.00	0.01
Total by Pollutant	**0.45**	**41.40**	**1.54**	**21.16**	**6.38**	**70.85**	**0.23**	**5.97**	**1.69**	**18.11**
Total Emissions	**10.29 Actual, PTE 157.49**									

(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 air 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 established in the air permit

Table 4-12. Criteria air pollutants and HAPs released on the NNSS over the past 10 years

	Total Emissions (tons/yr)[(a)]									
Pollutant	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Particulate Matter (PM10)[(b)]	0.94	0.84	0.69	0.54	0.22	0.49	1.09	2.40	6.51	0.45
Carbon Monoxide (CO)	0.24	0.15	0.43	0.51	0.94	0.55	1.33	3.70	2.38	1.54
Nitrogen Oxides (NO_X)	1.01	0.69	2.02	1.21	3.36	2.45	6.09	16.15	10.51	6.38
Sulfur Dioxide (SO_2)	0.12	0.04	0.03	0.01	0.06	0.10	0.36	1.20	1.14	0.23
Volatile Organic Compounds (VOCs)	4.60	1.94	1.40	1.14	0.60	0.71	0.33	1.68	1.08	1.69
Hazardous Air Pollutants (HAPs)[(c)]	0.41	0.05	1.87	0.02	0.09	0.30	0.02	0.04	0.03	0.23[(d)]

(a) For mtons, multiply tons by 0.9072

(b) Particulate matter equal to or less than 10 microns in diameter

(c) The site-wide PTE for HAPs is 8 tons per individual HAP and 23.3 tons for all HAPs combined

(d) Total HAPs came predominantly from chemical tests at NPTEC (0.21 tons/yr)

4.2.4 Performance Emission Testing and State Inspection

The NNSS air permit requires performance emission testing of equipment that vents emissions through stacks (called "point sources"). The tests must be conducted once during the 5-year life of the NNSS 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. No performance emission tests were conducted in 2013. No state air inspections were conducted in 2013.

4.2.5 Opacity Readings

Visual opacity readings are conducted in accordance with permit and regulatory requirements. Personnel that take opacity readings are certified semiannually. In 2013, four employees on the NNSS were certified. Readings were taken for the following NNSS facilities regulated under the NAAQS opacity limit of 20%: Area 1 Concrete Batch Plant, Area 1 Wet Aggregate Plant, Area 6 Storage Silos, and several diesel generators located in Areas 18 and 23. Readings for these facilities ranged from 0% to 25%. Although one reading at the Batch Plant exceeded the 20% limit, the average opacity (used to determine compliance) was only 13%. NNSS equipment that is regulated by the 10% opacity limit under the NSPS includes miscellaneous conveyor belts, screens and hoppers, and the Area 1 Pugmill. None of this equipment was used in 2013. Because this equipment has not been used in many years, these items were all removed from the air permit in 2013.

4.2.6 Chemical Releases and Detonations Reporting

The NNSS air permit regulates the release of chemicals at specific locations under three separate "systems": NPTEC in Area 5 (System 29), Site-Wide Releases throughout the NNSS (System 81), and Port Gaston in Area 26 (System 95). The types and amounts of chemicals that may be released vary depending on the system. In 2013, the Tarantula VIII chemical test series was conducted at the Area 5 NPTEC. For this series, 36 chemical releases were conducted. Another chemical test series was conducted at NPTEC by the United States Marine Corps for the Chemical Biological Incident Response Force and included 2 chemical releases. The majority of the chemicals released were neither HAPS nor criteria pollutants, with the exception of VOCs, which were released at NPTEC (see Table 4-11). No permit limits were exceeded.

Near-surface explosives detonations can take place at nine locations on the NNSS (BEEF in Area 4; EODU in Area 11; NPTEC in Area 5; Port Gaston in Area 26; HEST in Area 14; Test Cell C, Calico Hills, and ARL in Area 25; and Baker in Area 27). BEEF is permitted to detonate large quantities of explosives (up to 41.5 tons per detonation with a limit of 50.0 tons per 12-month period), while the other locations are limited to much smaller quantities (1 ton per detonation with a limit of 10 tons per 12-month period). Permitted limits exist also for the amounts of criteria air pollutant and HAP emissions generated by the detonations. In 2013, explosives were detonated only at Port Gaston, and no permit limits were exceeded (see Table 4-11).

PM10 monitoring was conducted for each chemical release test and detonation at NPTEC and Port Gaston in 2013. Monitoring was conducted in accordance with the permit and met calibration and performance audit requirements.

In addition to annual reporting, the NNSS air quality operating permit requires the submittal of test plans and final analysis reports to the State for detonations and chemical releases or release series. For 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. Completion reports are submitted at the end of each calendar quarter for all chemical releases and detonations.

4.2.7 ODS Recordkeeping

At the NNSS, 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, classified as ODS, have been used in the past in fire extinguishers and deluge systems, but all known occurrences of these halons have been removed from the NNSS. ODS recordkeeping requirements applicable to NNSS operations include maintaining evidence of technician certification for 3 years, recycling/recovery equipment approval, and servicing records for appliances containing 22.7 kilograms (50 pounds) or more of refrigerant.

4.2.8 Asbestos Abatement

A Notification of Demolition and Renovation Form is submitted to the EPA at least 10 working days prior to the start of a demolition or renovation project if the quantities of asbestos-containing material (ACM) to be removed are estimated to equal or exceed 260 linear feet, 160 square feet, or 1 m^3. Small asbestos abatement projects are conducted throughout the year consisting of the removal of lesser quantities of ACM within a single facility per project, and a Notification of Demolition and Renovation Form is not required for these projects.

Two Notification of Demolition and Renovation Forms were submitted during 2013. Both were renovation projects. Each project was performed in a closely supervised and rigidly controlled environment, and personal air monitoring and/or environmental air sampling were conducted. The remaining asbestos abatement activities throughout the NNSS complex were minor in scope, involving the removal of quantities of ACM less than the reporting threshold per facility. ACM was buried in both the Area 9 U10c and Area 23 solid waste disposal sites. Asbestos abatement records continued to be maintained as required.

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 ACM for a minimum of 75 years. Compliance is verified through periodic internal assessments.

4.2.9 Fugitive Dust Control

The NNSS 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. At the NNSS, the main method of dust control is the use of water sprays. During 2013, personnel observed operations throughout the NNSS that included the Area 1 Batch Plant and various trenching and digging activities at other locations. Water sprays were used to control dust at these locations.

Off the NNSS, all NNSA/NFO surface-disturbing activities that cover 5 or more acres are regulated by stand-alone Class II Surface Area Disturbance (SAD) permits issued by the State. Current SADs exist for the operation of three Underground Test Area (UGTA) wells on the Nevada Test and Training Range: ER-EC-13, ER-EC-14, and ER-EC-15. No excessive fugitive dust from these well sites was noted in 2013, and all requirements of the SADs were met.

4.2.10 Environmental Impact

During 2013, NNSS activities produced a total of 10.29 tons of criteria air pollutants and 0.23 tons of HAPs. These small quantities had little, if any, impact on air quality on or around the NNSS. NNSS air pollutant emissions are very low compared to the estimated daily releases from point sources in Clark County, Nevada. For example, the average annual projected emissions of NO_X in Clark County for base year 2002 through projected year 2018 is 37,549 tons per year compared to the estimated annual release from the NNSS in 2013 of 6.38 tons, 0.02% of Clark County’s projected annual emissions of NO_X (Pollack 2007).

Impacts of the chemical release tests at NPTEC are minimized by controlling the amount and duration of each release. Biological monitoring at NPTEC is performed if there is a risk of significant exposure to downwind plants and animals from the planned tests (see Section 15.2). To date, chemical releases at 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.

4.3 References

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Chapter 5: Water Monitoring

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This chapter presents the most recent results of water monitoring conducted by the U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office (NNSA/NFO) on and adjacent to the Nevada National Security Site (NNSS). NNSA/NFO monitors groundwater to ensure that drinking water for NNSS workers and visitors is safe, that NNSS groundwater is protected from contamination from current activities, and to take corrective actions to protect the public and the environment from areas of known underground radiological contamination resulting from historical nuclear testing. Monitoring is conducted to comply with all applicable state and federal water quality and water protection regulations, U.S. Department of Energy (DOE) directives, and the Federal Facility Agreement and Consent Order (FFACO) between the U.S. Department of Energy (DOE), the U.S. Department of Defense, and the State of Nevada (see Section 2.2).

The Nevada State Health Division's Bureau of Health Care Quality and Compliance is allowed access to the NNSS to independently sample onsite water supply wells at its discretion. Monitoring results from the State's independent sampling and analysis are also presented in this chapter, if the State performed sampling during the reporting year.

The Community Environmental Monitoring Program (CEMP), established by NNSA/NFO, also performs annual, independent radiological monitoring of water supply systems in communities surrounding the NNSS and emphasizes community involvement. This independent outreach program is managed by the Desert Research Institute (DRI). The reader is directed to Chapter 7 for the presentation of CEMP's water monitoring activities in 2013.

5.1 Radiological Monitoring

Radionuclides have been detected in the groundwater in some areas of the NNSS as a result of historical underground nuclear tests. Between 1951 and 1992, 828 of these tests were conducted, and approximately one-third were detonated near or in the saturated zone (U.S. Department of Energy, Nevada Operations Office 1996, 2000). The FFACO (as amended) established corrective action units (CAUs) that geographically group the underground nuclear tests on the NNSS (Figure 5-1). *Attachment A: Site Description*, included on the compact disc of this report, provides a thorough description of the complex hydrogeological environment in which underground nuclear testing was conducted.

NNSA/NFO is tasked, under the FFACO, with developing CAU-specific models of groundwater flow and radionuclide transport. These models are used to develop contaminant boundaries within which radiological contaminants are forecasted to exceed the Safe Drinking Water Act (SDWA) limits at any time within a 1,000-year period. The current status of the CAU-specific models of groundwater flow and contaminant transport is discussed in Section 11.1.2 of Chapter 11 of this report. Groundwater sampling and analyses support the development and evaluation of the CAU-specific models of groundwater flow and radionuclide transport and demonstrate that there is no impact to public water sources as a result of underground nuclear testing. Other NNSS wells and surface waters are monitored by NNSA/NFO to demonstrate compliance with State-issued water discharge permits, with DOE Order DOE O 458.1, "Radiation Protection of the Public and the Environment," with protection of groundwater from ongoing radiological waste disposal activities, and to demonstrate the radiological safety of onsite drinking water.

In 2013, the NNSS Integrated Groundwater Sampling Plan (NNSA/NFO 2014), referred to hereafter as the Plan, was designed to provide a comprehensive, integrated approach for collecting and analyzing groundwater samples that would meet NNSA/NFO's radiological water monitoring objectives associated with underground nuclear testing (see text box on page 5-3). The Plan produced changes to the overall number of NNSA/NFO groundwater sampling locations, their sampling frequency, and the analytical procedures performed. The Plan will increase efficiencies and cost savings and standardize sampling methods and analyses performed for NNSA/NFO by

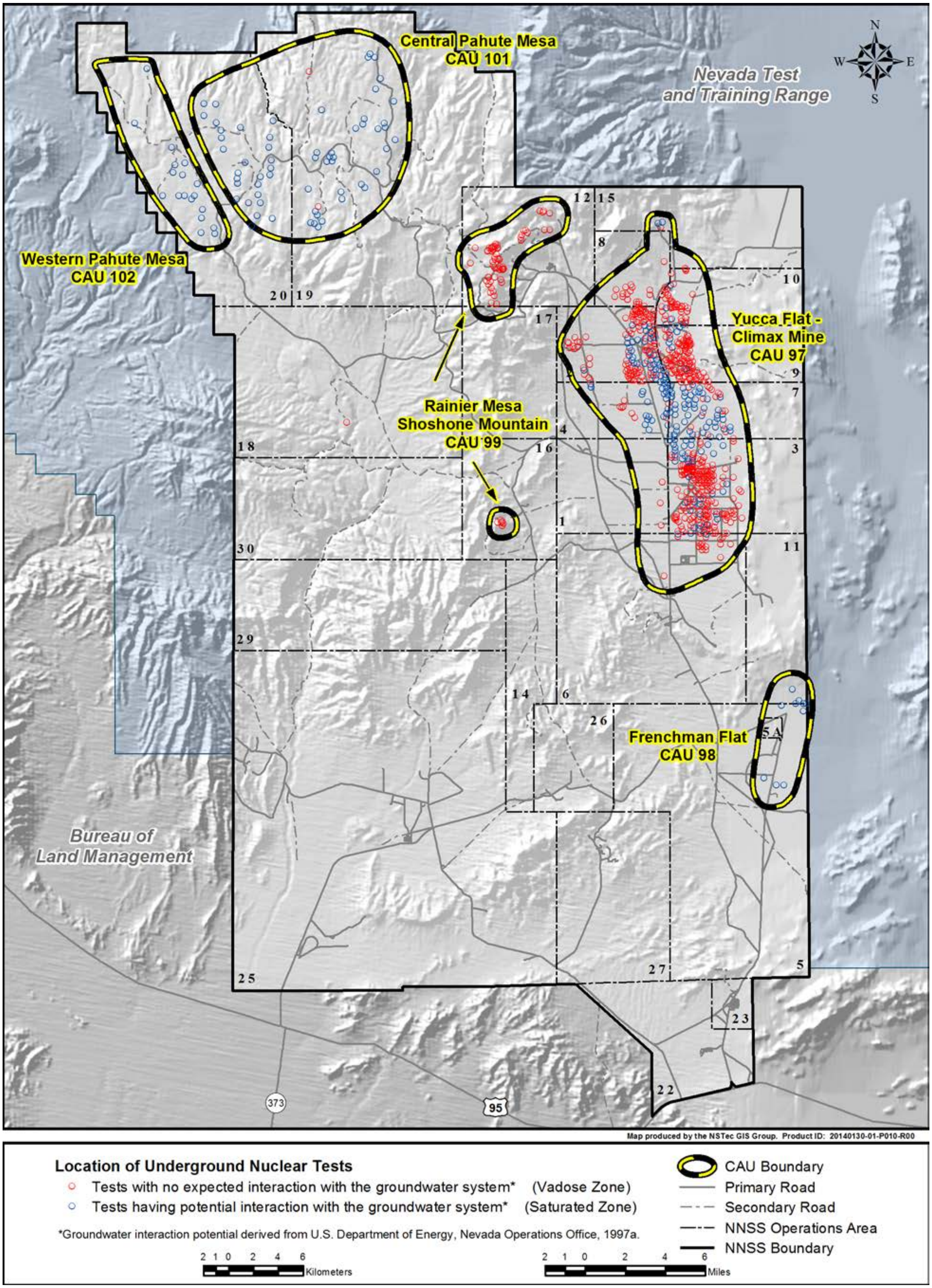

Figure 5-1. Locations of underground nuclear tests and UGTA CAUs on the NNSS

numerous organizations, contractors, and subcontractors. The Plan also ensures routine sampling of wells that are critical to understanding contaminant transport near the underground nuclear testing areas. Transition to Plan implementation began in Spring 2013. This chapter presents the Plan's design, the most recent tritium analysis results for wells sampled under the Plan, and other 2013 water analysis results related to meeting NNSA/NFO's radiological water monitoring objectives.

Radiological Water Monitoring Objectives
Provide data to complete corrective actions prescribed under the FFACO to protect the public from groundwater contaminated by historical underground nuclear testing (see Table 5-1 for objectives specific to each type of sampling location). Determine if radionuclides from underground nuclear testing are present at levels near the U.S. Environmental Protection Agency's (EPA) Safe Drinking Water Act (SDWA) maximum contaminant levels (MCLs) in wells outside institutional controls. Identify and evaluate trends in radionuclide concentrations in onsite water supply wells. Determine compliance with the dose limits to the general public set by DOE O 458.1 via the water pathway (see Chapter 9 for estimates of public dose). Determine compliance with wastewater discharge permit limits for radionuclides at permitted NNSS facilities. Monitor wells downgradient of an NNSS radioactive waste disposal unit in accordance with a Resource Conservation and Recovery Act (RCRA) permit to ensure wastes do not impact groundwater.

5.1.1 Groundwater Sampling and Analyses

The radiological water sampling network consists of 84 sample locations, categorized into seven different types. Table 5-1 defines each sample source type and the monitoring objectives, analytes, and sample frequency associated with each. Some locations are sampled to meet multiple objectives. The sampling network is shown in Figure 5-2.

Wells upgradient from the underground test area (UGTA) CAUs are not included in the sampling network. Also, no NNSS springs are included in the network. Ten NNSS springs have been monitored periodically and reported in past annual environmental reports. They include Cane, Captain Jack, Cottonwood, Gold Meadows, John's, Tipipah, Topopah, Tub, Twin, and Whiterock springs; see Figure A-4 of *Attachment A: Site Description* included on the compact disc of this report for the location of NNSS springs and seeps. The groundwater that feeds these onsite springs is locally derived and is not hydrologically connected the aquifers that may be impacted by underground nuclear tests. Detectable man-made radionuclides in onsite springs are primarily from historical atmospheric testing activities, including global radioactive fallout.

Table 5-1. Type definitions and objectives for NNSA/NFO radiological water sample locations

Sample Source Type	Definition	Objective	Analytes	Frequency
Characterization	Used for system characterization or model evaluation	• Support flow and transport model development and/or evaluation • Identify groundwater flow paths • Establish the presence or absence of groundwater contaminants of concern (COCs) and contaminants of potential concern (COPCs) • Estimate travel time of contaminants • To be reclassified and sampled according to its new type when above objectives are met	Specific to UGTA Strategy stage (FFACO, as amended) for each UGTA CAU (may include general chemistry, metals, gamma emitters, age and migration parameters, gross alpha, gross beta, and radioisotopes)	2–3 years, as needed

Table 5-1. Type definitions and objectives for NNSA/NFO radiological water sampling locations (continued)

Sample Source Type	Definition	Objective	Analytes	Frequency
Source/Plume	Located within the plume from an underground nuclear test (i.e., test-related contamination present)	• Support flow and transport model development and/or evaluation • Identify COCs for downgradient wells • Monitor contaminant migration • Monitor natural attenuation	Radiological COCs and CAU-specific COPCs (see Table 5-2)	4 years
Early Detection	Located downgradient of an underground test and no radio-isotopes detected above standard detection levels	• Support flow and transport model development and/or evaluation • Detect and monitor plume edge	Tritium (^{3}H) (low level)	2–5 years
Distal	Outside the Early Detection area	• Monitor COC (^{3}H) below SDWA 1,000 pCi/L detection limit • Support flow and transport model development and/or evaluation	^{3}H (standard)	5 years
Community	Located on BLM or private land; used as a water supply source or is near one	• Monitor COC (^{3}H) below SDWA 1,000 pCi/L detection limit	^{3}H (standard)	5 years
NNSS PWS	Permitted water supply well that is part of a State-designated noncommunity public water system (PWS) on the NNSS	• Monitor to demonstrate safety of NNSS drinking water (radiological monitoring is not required by the State for noncommunity PWSs)	^{3}H (low level), gross alpha, gross beta	Quarterly
Compliance	Sampled to comply with specific federal/state regulations or permits	• Determine if radiological COCs are within permit limits	As specified by permit	As specified by permit

5.1.1.1 Analytes

An inventory of 43 radionuclides produced by NNSS underground nuclear tests is presented in Bowen et al. (2001). Many of these radionuclides are relatively immobile because they are bound within the melt glass produced during nuclear detonation or have chemical properties that cause them to bind strongly to solid particles in the aquifer. Those radionuclides that are most mobile in groundwater and are present produced in high abundance from nuclear testing have the greatest potential for impacting groundwater quality.

A single contaminant of concern (COC) and, at some locations, additional contaminants of potential concern (COPCs) were identified based on the Bowen et al. (2001) inventory, an understanding of the radionuclide's relative mobility, previous sampling and analysis data, and modeling results (Table 5-2). Tritium has been identified as the single COC for all sample locations based on extensive groundwater characterization data from wells throughout each CAU. The Plan therefore prescribes tritium analysis for all sampling locations at frequencies that range from every 2 to 5 years (Table 5-1). NNSS public water system (PWS) wells are sampled quarterly, and Compliance well sampling is consistent with the applicable permit requirements.

For all CAUs except Rainier Mesa/Shoshone Mountain, tritium is the only radionuclide included in the inventory that is known to have exceeded its SDWA MCL of 20,000 picocuries per liter (pCi/L) in sampling locations away from the nuclear test cavity (Navarro-Intera, LLC, 2013). Although plutonium (Pu) has been reported above its SDWA MCL of 15 pCi/L in T Tunnel, located in Rainier Mesa (Zavarin 2009), it has not been detected in downgradient wells at concentrations above 10% of its SDWA MCL. Pu has therefore been identified as a contaminant of potential concern (COPC) for the Rainier Mesa/Shoshone Mountain CAU and is analyzed for in all Characterization and Source/Plume well samples. Similarly, the other CAU-specific COPCs (Table 5-2) may have exceeded their SDWA MCLs in samples collected from the test cavity but have generally not exceeded 10% of their MCLs in downgradient locations.

Groundwater characterization data have shown that COPCs, if present, are at insignificant levels (i.e., < 0.1% of their MCL) unless tritium is present at concentrations that exceed its 20,000 pCi/L MCL. Therefore, COPCs are only analyzed in Source/Plume wells, where tritium exceeds the detection limit for standard tritium analysis (300 pCi/L). Instrumentation capable of detecting COPCs at levels well below their MCLs are used for analysis of

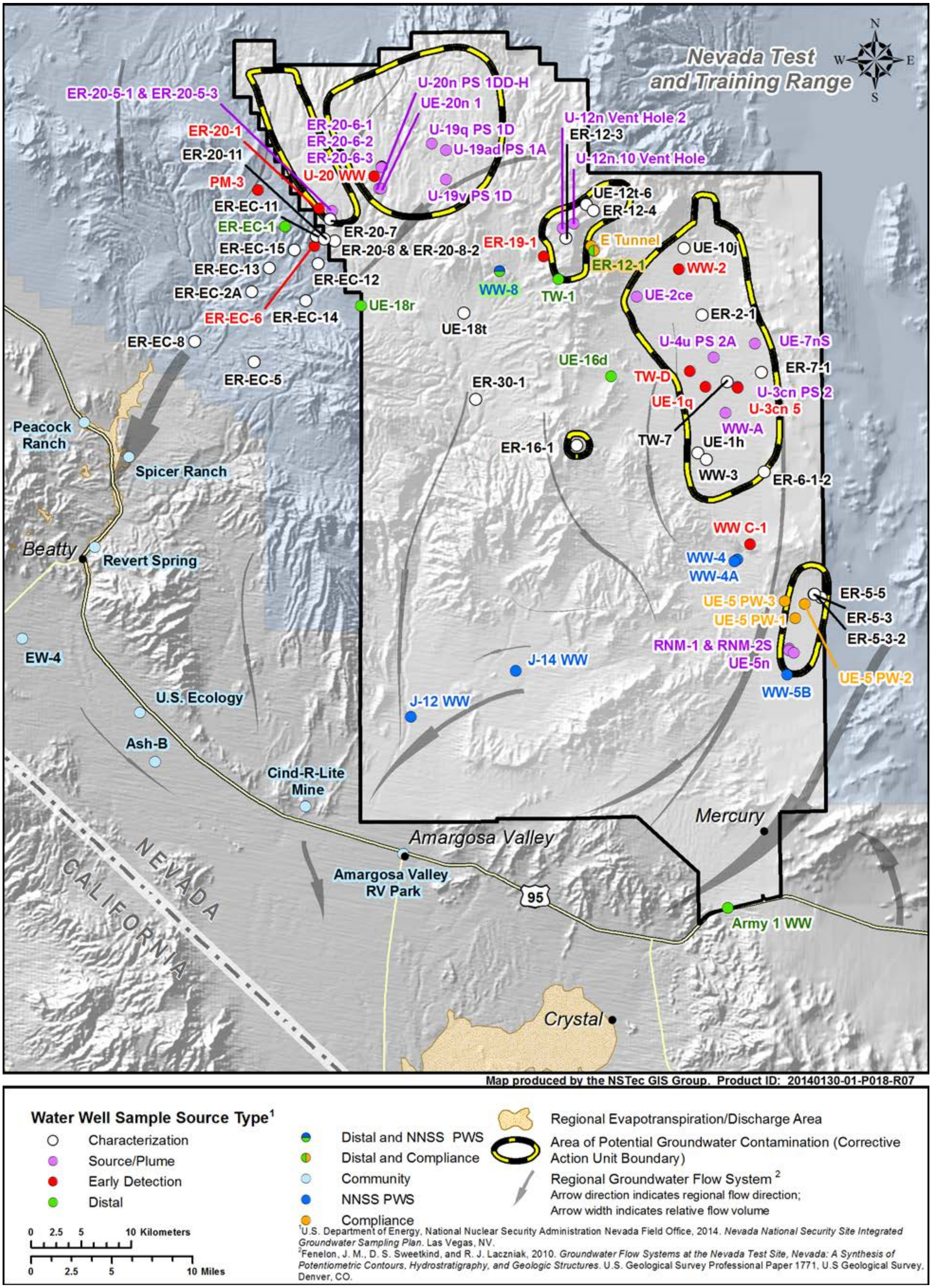

Figure 5-2. NNSA/NFO water sampling network

Source/Plume and Characterization well samples. This ensures that COPCs will be detected early and that trends can be evaluated to determine whether a COPC should be reclassified as a COC and monitored in Early Detection wells. Samples collected from Characterization wells are analyzed for many of the immobile radionuclides listed in Bowen et al. (2001). These radionuclides have not been found in any of the samples, which continues to confirm that they are not present in groundwater in or downgradient of the underground nuclear test cavities.

Table 5-2. CAU-specific COCs and COPCs

CAU	COC[(a)]	COPC[(b)]
Frenchman Flat	^{3}H	^{14}C, ^{36}Cl, ^{99}Tc, and ^{129}I
Pahute Mesa	^{3}H	^{14}C, ^{36}Cl, ^{99}Tc, and ^{129}I
Rainier Mesa/Shoshone Mountain	^{3}H	^{14}C, ^{36}Cl, ^{90}Sr, ^{99}Tc, ^{129}I, and Pu
Yucca Flat/Climax Mine	^{3}H	^{14}C, ^{36}Cl, ^{99}Tc, and ^{129}I (and ^{90}Sr and ^{137}Cs in the lower carbonate aquifer samples)

(a) A radionuclide that has exceeded its SDWA MCL in sampling locations downgradient from a nuclear test cavity.

(b) A radionuclide that has the potential to become a COC based either on historical analytical data and/or on model results. COPCs may have exceeded SDWA MCLs in samples from a nuclear test cavity but have generally not exceeded 10% of their MCLs in sampling locations downgradient from a test cavity.

Gross alpha (α) and gross beta (β) radioactivity and gamma spectroscopy analyses have been conducted for some groundwater samples in the past according to a prescribed sampling schedule (see Table 5-1 of National Security Technologies, LLC [NSTec], 2012). During development of the Plan, a decision was made to analyze for gross alpha and gross beta radioactivity at Characterization wells to establish a baseline. They continue to be monitored for NNSS PWS wells and for certain Compliance water sampling locations, as required.

5.1.1.2 Sample Collection Methods

Water sampling methods are based, in part, on the characteristics and configurations of 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. The majority of wells sampled are single-zone completion wells where samples are collected from one depth. Some wells, however, are multiple-completion wells that are sampled at multiple depths (e.g., ER-EC-11, -12, -13, -14, and -15). All water samples are collected in a manner that ensures they represent ambient formation water following the sampling methods described in standard operating procedures. This may involve purging the well until the stability of certain water quality parameters (e.g., pH, temperature, electrical conductivity) is achieved.

5.1.1.3 Detection Limits

Samples collected from all NNSS PWS and Early Detection wells and from some Characterization wells, are enriched before being analyzed for tritium. The enrichment process concentrates tritium in a sample to provide lower minimum detectable concentrations (MDCs) (see Glossary, Appendix B). For samples with expected levels of tritium above the laboratory's standard detection capability, or when the objective is to monitor for SDWA compliance, tritium enrichment is not performed. The MDCs for the laboratory analysis of enriched (or low-level) tritium samples range from 2.1 to 32 pCi/L depending on the laboratory performing the enrichment process. The MDCs for non-enriched (or standard) tritium analyses typically range from 300 to 400 pCi/L. Both MDCs are well below the EPA's SDWA required detection limit of 1,000 pCi/L for tritium. Standard methods are used for analysis of COPCs and are performed by State of Nevada certified commercial laboratories. The MDCs must be at or below the SDWA MCL. The MDCs for gross alpha and beta radioactivity are 2 and 4 pCi/L, respectively, and satisfy their EPA SDWA required detection limits of 3 and 4 pCi/L, respectively.

Highly sensitive instrumentation at Lawrence Livermore National Laboratory (LLNL) is used to analyze tritium concentrations in Characterization and Early Detection wells, when standard methods are not sufficient (i.e., tritium is expected to be present but at levels less than the 300 pCi/L MDC for the standard method). LLNL's instrumentation is capable of detecting tritium at concentrations less than 1 pCi/L. Similarly, LLNL uses highly sensitive methods for COPC analyses for samples from Source/Plume and Characterization wells. These methods are capable of measuring natural levels of some COPCs (^{14}C and ^{36}Cl) in the groundwater.

Analytical methods routinely include quality control samples such as duplicates, blanks, and spikes. Chapter 16 discusses in more detail the quality assurance and control procedures used for sampling groundwater.

5.1.2 Presentation of Water Sampling Data

The maximum tritium concentrations in samples from the Characterization, Source/Plume, Early Detection, Distal, and Community sampling locations are presented in Table 5-3. The locations are grouped by CAU. When tritium was not detected, the value is reported as less than the sample's MDC (i.e., <MDC). For wells at which multiple samples were collected and analyzed during a single year, Table 5-3 presents the result for the sample that had the highest tritium concentration. Similarly, for wells that are sampled at multiple depths during a single year, Table 5-3 presents the result for the depth sample that had the highest tritium. Table 5-3 will always present the maximum tritium concentration found in a well sample that is still believed to be accurate and will not always present the results of the current year's sample analysis. For example, for a well found to have tritium levels >1,000 pCi/L from a deep depth sampled in 2009, but found to have tritium levels <300 pCi/L from a shallow depth sampled in 2013, Table 5-3 will present the maximum tritium value as >1,000 pCi/L and show the year last sampled as 2009. The results section text, however, would report the 2013 analysis results from the shallow depth sample. Well ER-EC-11 is one such well that applies to this scenario (see Section 5.1.3.1).

Table 5-3. Tritium results for Characterization, Source/Plume, Early Detection, Distal, and Community Sampling Locations

Sampling Locations	Land Management or NNSS Operations Area	Sample Year	Maximum Tritium Concentration (pCi/L)
	Frenchman Flat		
Characterization Wells			
ER-5-3	Area 5	2001	< 1.5[(a)]
ER-5-5	Area 5	2013	1.1
Source/Plume Wells			
RNM-1	Area 5	2007	866
RNM-2S	Area 5	2007	104,000
UE-5n	Area 5	2010	186,000
	Pahute Mesa (Central and Western)		
Characterization Wells			
ER-20-7	Area 20	2010	19,100,000
ER-20-8	Area 20	2011	3,020
ER-20-8-2	Area 20	2009	1,280
ER-20-11	Area 20	2013	191,000
ER-EC-2A	NTTR	2010	< 270
ER-EC-5	NTTR	2003	<320
ER-EC-8	NTTR	2010	<340
ER-EC-11	NTTR	2009	10,600[(b)]
ER-EC-12	NTTR	2012	4.2
ER-EC-13	NTTR	2013	< 2.2
ER-EC-14	NTTR	Not yet sampled	NA[(c)]
ER-EC-15	NTTR	2013	< 2.1
Source/Plume Wells			
ER-20-5-1	Area 20	2011	30,100,000
ER-20-5-3	Area 20	2011	96,200
ER-20-6-1	Area 20	1998	3,200
ER-20-6-2	Area 20	1997	71,000
ER-20-6-3	Area 20	1998	1,110
U-19ad PS 1A	Area 19	2008	12,900,000
U-19q PS 1D	Area 19	2003	11,000,000

Table 5-3. Tritium results for Characterization, Source/Plume, Early Detection, Distal, and Community Sampling Locations (continued)

Sampling Location	Land Management or NNSS Operations Area	Sample Year	Maximum Tritium Concentration (pCi/L)
Pahute Mesa (Central and Western) (continued)			
Source/Plume Wells (continued)			
U-19v PS 1D	Area 19	2009	84,900,000
U-20n PS 1DD-H	Area 20	2005	33,300,000
UE-20n 1	Area 20	2012	55,500,000
Early Detection Wells			
ER-20-1	Area 20	2012	< 21
PM-3	NTTR	2013	249
ER-EC-6	NTTR	2009	1.7
U-20 WW	Area 20	1999	< 29
Distal Wells/Locations			
ER-EC-1	NTTR	2009	<1
UE-18r	Area 18	2007	<21
Community Wells/Springs			
Amargosa Valley RV Park	BLM	2012	<24
Ash B	BLM	2009	<29
Cind-R-Lite Mine	BLM	2012	<24
EW-4	Private land	2011	<30
Peacock Ranch	Private land	2012	<21
Revert Spring	Private land	2012	<22
Spicer Ranch	Private land	2012	<21
U.S. Ecology	BLM	2012	<22
Rainier Mesa/Shoshone Mountain			
Characterization Wells			
ER-12-3	Area 12	2008	< 94
ER-12-4	Area 12	2008	< 94
ER-16-1	Area 16	2008	< 340
ER-30-1	Area 30	1996	< 215
UE-12t-6	Area 12	Not yet sampled	NA
UE-18t	Area 18	1999	144
Source/Plume Wells			
U-12n.10 Vent Hole	Area 12	2005	6,260,000
U-12n Vent Hole 2	Area 12	2011	1,030,000
Early Detection Wells			
ER-19-1	Area 19	2013	<30
Distal Wells			
ER-12-1[(d)]	Area 12	2013	<366
TW-1	Area 17	2013	<11
UE-16d	Area 16	2013	<31
WW-8[(e)]	Area 18	2013	<31
Yucca Flat/Climax Mine			
Characterization Wells			
ER-2-1	Area 2	2003	228
ER-5-3-2	Area 5	2001	<1.5
ER-6-1-2	Area 6	2004	<370
ER-7-1	Area 7	2003	<350
TW-7	Area 7	1994	<55
UE-1h	Area 1	1993	10.9

Table 5-3. Tritium results for Characterization, Source/Plume, Early Detection, Distal, and Community Sampling Locations (continued)

Sampling Location	Land Management or NNSS Operations Area	Sample Year	Maximum Tritium Concentration (pCi/L)
	Yucca Flat/Climax Mine (continued)		
Characterization Wells (continued)			
UE-10j	Area 8	1997	<210
WW-3	Area 3	1972	ND[(f)]
Source/Plume Wells			
U-3cn PS 2	Area 3	2007	7,680,000
U-4u PS 2A	Area 4	2008	24,100,000
UE-2ce	Area 2	2008	267,000
UE-7nS	Area 7	2012	94.2
WW-A	Area 3	2012	355
Early Detection Wells			
TW-D	Area 4	2013	<27
U-3cn 5	Area 3	2011	< 6.5
UE-1q	Area 1	2013	<15
WW C-1	Area 6	2010	<29
WW-2	Area 2	2006	< 1
Distal Wells			
Army 1 WW	Area 22	2013	<32

Yellow shaded results exceed the EPA MCL for tritium in drinking water of 20,000 pCi/L.

(a) Concentration reported is less than (<) its sample-specific MDC.

(b) 13,180 pCi/L was reported for ER-EC-11 in NSTec (2010) based on drilling fluid samples collected October 3-4, 2009, and analyzed by LLNL. A bailed sample, considered more representative, collected October 9, 2009 and analyzed by a State-certified commercial laboratory, yielded 10,600 pCi/L, and this result was entered into the NNSA/NFO groundwater database. It is the highest tritium concentration from the most representative sample from this location.

(c) Not applicable.

(d) ER-12-1 is also a Compliance well (see Table 5-4).

(e) WW-8 is also a NNSS PWS well (see Table 5-4).

(f) Original 1972 result was reported as not detected; no measured value or MDC was entered in the database.

The tritium, gross alpha, and gross beta levels for water samples collected and analyzed in 2013 for the NNSS PWS and Compliance sampling locations are presented in Table 5-4. The results of analyses for those radionuclides identified as COPCs (Table 5-2) are not tabulated in this report but can be acquired upon request from NNSA/NFO.

Table 5-4. Sample analysis results from NNSS PWS wells and Compliance wells/surface waters

Sampling Location	NNSS Operations Area	Date Sampled	Sample Concentration (pCi/L) ^3H	α	β
NNSS PWS Wells					
J-12 WW	Area 25	1/29/13	<30[(a)]	2.9	5.2
		4/23/13	<25	2.5	2.7
		7/16/13	<28	<1.9	2.3
		11/05/13	<17	<1.4	4.0
J-14 WW	Area 25	1/29/13	<32	2.6	9.4
		1/29/13 FD[(b)]	<29	NA[(c)]	NA
		4/24/13	<24	2.0	10
		4/24/13 FD	<24	NA	NA
		7/16/13	<28	4.5	6.3
		7/16/13 FD	<27	NA	NA
		11/19/13	<17	4.2	8.2
		11/19/13 FD	<17	NA	NA

Table 5-4. Sample analysis results from NNSS PWS wells and Compliance wells/surface waters (continued)

Sampling Location	NNSS Operations Area	Date Sampled	Concentration (pCi/L) ^{3}H	α	β
NNSS PWS Wells (continued)					
WW-4	Area 6	1/29/13	<30	11	7.0
		4/23/13	<25	6.7	4.0
		7/16/13	<27	6.8	6.6
		11/05/13	<17	6.9	5.3
WW-4A[(d)]	Area 6	4/23/13	<24	7.3	5.3
		7/16/13	<27	12	5.6
		11/05/13	<17	8.4	4.6
WW-5B	Area 5	1/29/13	<31	6.2	11
		1/29/13 FD	<31	NA	NA
		4/23/13	<25	3.8	13
		7/16/13	<27	4.5	8.2
		11/05/13	<17	6.8	9.6
WW-8	Area 18	1/30/13	<31	<1.5	2.7
		4/23/13	<24	<1.9	3.0
		4/23/13 FD	<24	NA	NA
		7/16/13	<28	<1.9	2.3
		11/05/13	<17	<1.3	1.8
Compliance Wells/Surface Waters					
UE-5 PW-1	Area 5	3/5/13	<30	NA	NA
		3/5/13 FD	<31	NA	NA
		8/13/13	<28	NA	NA
		8/13/13 FD	<28	NA	NA
UE-5 PW-2	Area 5	3/5/13	<31	NA	NA
		3/5/13 FD	<31	NA	NA
		8/13/13	<28	NA	NA
		8/13/13 FD	<28	NA	NA
UE-5 PW-3	Area 5	3/5/13	<32	NA	NA
		3/5/13 FD	<31	NA	NA
		8/13/13	<28	NA	NA
		8/13/13 FD	<26	NA	NA
ER-12-1	Area 12	4/18/13	<366	14	6.7
		4/18/13 FD	<365	13	6.5
E Tunnel Waste Water Disposal System	Area 12	10/15/13	391,000	11	31
		10/15/13 FD	420,000	12	35

(a) Concentration reported is less than (<) its sample-specific MDC.
(b) FD = field duplicate sample.
(c) NA = not applicable, analysis was not performed.
(d) WW-4A was being repaired in January 2013 and was not sampled that month.

The wells in Table 5-3 were classified into four concentration levels (Table 5-5) to provide the visual presentation of tritium results. The categories represent tritium levels in terms of their percentage of the 20,000 pCi/L SDWA MCL. Figure 5-3 shows the current color-coded category for each well in the Plan's sampling network.

Table 5-5. Tritium concentration categories

Tritium Concentration (X) in pCi/L	Percent of SDWA MCL
X < 1,000	< 5
1,000 < X < 10,000	5–50
10,000 < X < 20,000	50–100
X > 20,000	> 100 (Exceeds SDWA MCL)

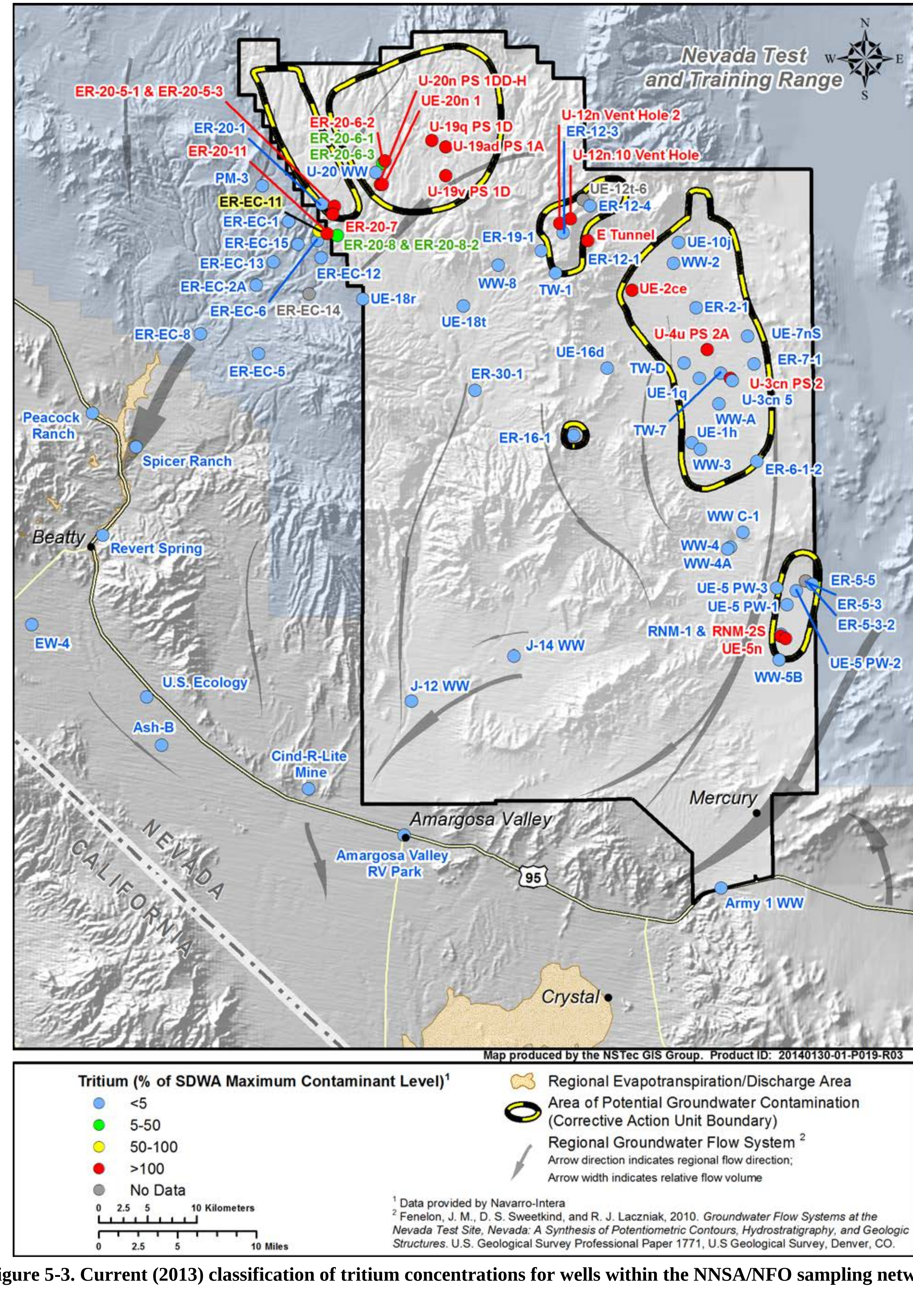

Figure 5-3. Current (2013) classification of tritium concentrations for wells within the NNSA/NFO sampling network

5.1.3 Discussion of 2013 Sample Results

The following subsections discuss the analytical results for the seven well types that comprise the radiological water sampling network. As illustrated in Figure 5-2, all Characterization, Source/Plume, Early Detection, and Distal wells are located on government-owned property. All Community wells or springs are located on BLM or private land. As reflected in Table 5-3 and presented in the sections below, no test-related radionuclides are present in the Distal or Community wells. Consistent with the definition of Early Detection wells (tritium < 300 pCi/L), low concentrations of tritium at a few locations have been detected in these wells. Sampling results from PWS wells located on the NNSS indicate that water sources used by NNSS personnel are not affected by underground nuclear tests. In addition, all regulatory requirements associated with the Compliance well samples were satisfied.

5.1.3.1 Characterization Wells

Twenty-eight Characterization wells are currently included in the sampling network. They are either new wells, or wells that require additional radionuclide data to establish a baseline and/or to ensure that the current list of COCs and COPCs (Table 5-2) is accurate for the CAU. Once a baseline has been developed, each Characterization well will be reclassified and sampled according to its new type (Source/Plume, Early Detection, Distal, or Community).

Two Characterization wells are present in the Frenchman Flat CAU (Table 5-3). In 2013, priority was placed on developing, hydraulic testing, and sampling two new model evaluation wells in this CAU, ER-5-5 and ER 11-2. They were drilled in 2012 near detonation cavities with the objective to evaluate the Phase II flow and contaminant transport models (see Section 11.1.2.1). In 2013, low-level tritium was detected in ER-5-5 (1.1 pCi/L, Table 5-3), which was forecasted by the models (Navarro Nevada Environmental Services, LLC, 2010), although no tritium was detected in ER-11-2. Based on extensive data and model reviews, ER-11-2 was dropped from the sampling network (see Section 11.1.2.1). ER-5-3, the one other Characterization well in Frenchman Flat, is located nearest to five underground tests (UGTs). It was last sampled in 2001, and no tritium was detected. Both ER-5-3 and ER-5-5 will serve as Early Detection wells after characterization.

Twelve Characterization wells are associated with the Pahute Mesa (Central and Western) CAUs (Table 5-3). Most of these wells were drilled in 2009 through 2012 as part of the Phase II corrective action investigation for this CAU (see Section 11.1.2.2). Tritium was detected in six of the wells (ER-20-7, ER-20-8, ER-20-8-2, ER-EC-6, ER-EC-11, ER-EC-12, and ER-20-11), which is believed to originate from two UGTs, TYBO and BENHAM. The greatest tritium concentration was observed in 2010 at Well ER-20-7 (19,100,000 pCi/L). This well is located 960 m (3,150 ft) and 2,100 m (6,890 ft) from the detonation points (U-20y and U-20c) for the TYBO and BENHAM UGTs, respectively. In 2009, sampling of Well ER EC-11, 716.3 m (2,350 ft) west of the NNSS boundary, confirmed the presence of tritium at elevated levels but below the SDWA MCL (Table 5-3; Figure 5-3). This was the first time that radionuclides from NNSS UGTs had been detected in groundwater beyond NNSS boundaries. Casing had been installed in ER-EC-11 below the depth where the high tritium was observed in order to prevent cross contamination to the deeper aquifers open to this well, but also prevented developing and further sampling this depth. Recently, technology has become available for sampling narrow diameter piezometers previously installed for water-level measurements. As a result, additional sampling is now planned for the near future to further characterize the radionuclides, including tritium, at the depth associated with the elevated tritium level in ER-EC-11. Groundwater samples collected at Well ER-EC-6 in 2009 and Well ER-EC-12 in 2012 contained very low tritium (1.7 and 4.2 pCi/L, respectively). Additional sampling and analyses is needed to confirm these marginally measureable amounts of tritium. Tritium was not detected in the other Characterization wells within the Pahute Mesa CAUs; these wells will be categorized as Early Detection or Distal wells depending on their proximity to the UGTs and Source/Plume wells once characterization is complete.

Six Characterization wells are located within the Rainier Mesa/Shoshone Mountain CAU, and eight are located within the Yucca Flat/Climax Mine CAU (Table 5-3). None were sampled in 2013. Based on the tritium concentrations previously reported, which are either near or below sample-specific MDCs, these wells will likely be re-categorized as Early Detection or Distal wells depending on their relative proximity to the UGTs once characterization is complete.

5.1.3.2 Source/Plume Wells

Twenty Source/Plume wells are included in the sampling network. They have detectable radionuclides from NNSS underground nuclear testing and vary in location from within a test cavity where radionuclide concentrations are high, to downgradient of the detonation where radionuclide concentrations can be relatively low, in comparison to SDWA MCLs. Samples are collected every 4 years (three samples per one tritium half-life) and analyzed for tritium and CAU-specific COPCs (Table 5-2). No Source/Plume wells were sampled in 2013.

Three Source/Plume wells are located in Frenchman Flat, two of which exceed the 20,000 pCi/L MCL for tritium (Table 5-3; Figure 5-3). Well RNM-1 was drilled directly into a test cavity, and RNM-2S was drilled 91 m (300 ft) south of the center of the cavity. To evaluate radionuclide migration, groundwater flow from the detonation point to Well RNM-2S was induced by pumping Well RNM-2S from 1975 to 1991 (Bryant 1992).Tritium concentrations decreased in RNM-1 and increased in RNM-2S as a result of the pumping experiment (Stoller-Navarro Joint Venture [SNJV] 2005). Well UE-5n is located approximately 560 m (1,840 ft) southeast of RNM-1 within an unlined discharge ditch that was used to transport large volumes (approximately 1.7 x 10^7 cubic meters) of water pumped during the experiment (Finnegan and Thompson, 2002). Radionuclides detected in UE-5n waters are thought to reflect infiltration of water from the unlined ditch rather than groundwater transport from the test cavity (Rose et al. 2003). While groundwater samples from RNM-1 have exceeded the MCL for a few radionuclides (^{90}Sr, ^{137}Cs, and ^{129}I), only tritium has exceeded its MCL in groundwater from RNM-2S and UE-5n. In fact, two of the radionuclides, ^{90}Sr and ^{137}Cs, were not detected in RNM-2S even after 16 years of pumping (SNJV 2005) and are therefore not COPCs for this CAU.

Ten Source/Plume wells, associated with six different UGTs, occur within the Pahute Mesa CAUs (Table 5-3). The groundwater in all but two wells (ER-20-6-1 and ER-20-6-3) exceed the tritium MCL (Table 5-3; Figure 5-3). A few radionuclides (^{90}Sr, ^{137}Cs, ^{129}I, and Pu) exceed their SDWA MCLs (8, 200, 1, and 15 pCi/L, respectively) in samples from wells drilled directly into a test cavity (U-19ad PS 1A, U-19v PS 1D, and U-20n PS 1DD-H). They have not, however, exceeded their MCLs in wells located away from the test cavity, even when the wells are within 300 m of the cavity (U-19q PS 1D and UE-20n 1) and when high levels of tritium were detected (Table 5-3). In samples from U-19q PS 1D and UE-20n 1, only ^{14}C was found at levels ≥10% of its SDWA MCL of 2,000 pCi/L.

Two Source/Plume locations are monitored within the Rainier Mesa/Shoshone Mountain CAU (Table 5-3). Two vent holes are sampled to monitor radionuclides within the N Tunnels. While tritium was observed above the MCL in these locations (Table 5-3), no other radionuclides were observed above their MCL. In these Source/Plume locations, ^{90}Sr, ^{129}I, and Pu are within 10% of the SDWA MCL.

Five Source/Plume wells occur within the Yucca Flat/Climax Mine CAU (Table 5-3). Two of the wells are drilled directly into a test cavity (U-3cn PS 2 and U-4u PS 2A); groundwater from these wells exceed the 20,000 pCi/L MCL for tritium. Two other Source/Plume wells (UE-2ce and UE-7nS) are located within 200 m (655 ft) from detonation cavities, but groundwater from only Well UE-2ce exceeds the tritium MCL. Well WW-A is located approximately 520 m (1,705 ft) from a test cavity. Tritium was detected in WW-A in the late 1980s, peaked at ~700 pCi/L in 1999, and declined to 355 pCi/L by 2012 (Table 5-3). The combined presence of four radionuclides (^{14}C, ^{90}Sr, ^{137}Cs, and ^{129}I) in Well U-4u PS 2A exceeds the SDWA MCL for beta- and photon-emitting radionuclides allowed in drinking water, which is the combined concentration of such emitters that would result in an exposure of 4 mrem/yr. No other radionuclides in samples from Source/Plume wells in this CAU exceed the SDWA MCL. No radionuclides have been found at levels ≥10% of their SDWA MCLs in wells located away from a test cavity within the Yucca Flat/ Climax Mine CAU, except for ^{90}Sr in Well UE-2ce.

5.1.3.3 Early Detection Wells

Ten Early Detection wells are included in the sampling network (Table 5-3). These wells are the next wells downgradient of a UGT or Source/Plume well and have tritium concentrations less than the MDCs for standard tritium analyses (i.e., < 300 pCi/L). In the absence of tritium, no other test-related radionuclides are present in historically sampled groundwater; therefore, Early Detection Wells are monitored solely for low levels of tritium using enriched tritium analysis. Most of these wells are sampled every 2 years to ensure that the plume front is detected in a reasonable time frame and that a time trend for tritium is established early. In some cases (e.g., for Frenchman Flat Early Detection wells, once they are identified), the sampling frequency will be once every

5 years because of the low groundwater velocity within this CAU and the resulting slow change in radionuclide concentration with time.

Three Early Detection wells were sampled in 2013: PM-3, ER-19-1, and UE-1q. Groundwater samples collected using depth-discrete bailers from PM-3 in 2012 at depths of 475.5 m (1,560 ft) and 607.8 m (1,994 ft) were found to contain very low concentrations of tritium (64.6 and 52.9 pCi/L, respectively). In 2013, a pump was installed in PM-3 and a total of 82,518 gallons of groundwater was purged in order to develop the well. Samples were collected once the water quality parameters stabilized. The results confirmed the presence of tritium from the depth-discrete bailed water samples collected in 2012. The 2013 samples from the shallow interval had tritium levels ranging from 225 to 249 pCi/L and from the deep interval ranging from 37 to 44 pCi/L (this highest 2013 value of 249 pCi/L is shown in Table 5-3). Tritium was not detected in the Early Detection Wells ER-19-1 and UE-1q (Table 5-3).

5.1.3.4 Distal Wells

Seven Distal wells occur within the sampling network (Table 5-3). Distal Wells are analyzed for tritium using a standard EPA method. Samples are collected at a 5-year frequency. The sampling objective for these wells is to ensure that tritium is not present downgradient of UGTs at levels above the SDWA-required minimum detection limit of 1,000 pCi/L. These wells also support the development and evaluation of the flow and contaminant transport models. Five Distal wells (ER-12-1, TW-1, UE-16d, WW-8, and Army 1WW) were sampled in 2013. No tritium was detected (Table 5-3).

5.1.3.5 Community Wells/Springs

Eight Community sampling locations occur within the sampling network (Table 5-3). These wells and springs are either used as private, business, or community water supply sources or are near such sources, and they are sampled for tritium every 5 years. Samples are analyzed using a standard EPA method. The objective is the same as for Distal Wells: to ensure that tritium is not present downgradient of UGTs at levels above the SDWA-required minimum detection limit of 1,000 pCi/L. No Community wells or springs were sampled in 2013. Well Ash B was last sampled in 2009, Well EW-4 was last sampled in 2011, and the other six Community sampling locations were last sampled in 2012. No tritium has been detected (Table 5-3).

5.1.3.6 NNSS PWS Wells

Results from the NNSS water wells sampled quarterly in 2013 continue to indicate that historical underground nuclear testing has not impacted the NNSS water supply network. No tritium measurements were above their MDCs (Table 5-4). Gross alpha and gross beta radioactivity were found at concentrations slightly greater than their MDCs in most 2013 samples and are believed to represent the presence of naturally occurring radionuclides. However, no water supply samples had gross alpha measurements that exceeded the EPA MCL (15 pCi/L) or gross beta measurements that exceeded the EPA level of concern (50 pCi/L).

5.1.3.7 Compliance Wells/Groundwater Discharges

5.1.3.7.1 RCRA Permitted Wells for the Area 5 Mixed Waste Disposal Unit

Wells UE-5 PW-1, UE-5 PW-2, and UE-5 PW-3 are sampled semi-annually for tritium as well as for numerous nonradiological parameters. They are monitored to verify the performance of the Area 5 Mixed Waste Disposal Unit (Cell 18), which is operated under a RCRA permit (see Section 10.1.7). In 2013, all water samples from these three wells had non-detectable levels of tritium (Table 5-4), indicating that Cell 18 radioactive wastes have not contaminated local groundwater. Table 10-3 in Section 10.1.7 presents the 2013 sampling results for four additional indicators of groundwater contamination, and all 2013 sample analysis results for these three wells are presented in NSTec (2014a).

5.1.3.7.2 NDEP Permitted E Tunnel Waste Water Disposal System (ETDS)

NNSA/NFO manages and operates the ETDS in Area 12 under a water pollution control permit (NEV 96021) issued by the Nevada Division of Environmental Protection (NDEP) Bureau of Federal Facilities. The permit governs the management of radionuclide-contaminated wastewater that drains from the E Tunnel portal into a series of holding ponds (the E Tunnel Ponds). The permit requires Well ER-12-1 groundwater to be monitored once every 24 months and E Tunnel discharge waters (retained in the E Tunnel Ponds) to be monitored once every 12 months for tritium, gross alpha, and gross beta as well as for numerous nonradiological parameters (see Section 5.2.4, Table 5-9).

On October 15, 2013, annual sampling of ETDS discharge water was performed, and on April 18, 2013, biennial sampling of Well ER-12-1 was performed. The permissible limits for tritium, gross alpha, and gross beta in the tunnel discharge waters are 1,000,000, 35.1, and 101 pCi/L, respectively. The permissible limits for Well ER-12-1 are identical to the EPA SDWA limits of 20,000, 15, and 50 pCi/L, respectively. All samples collected and analyzed in 2013 for Well ER-12-1 and for E Tunnel Ponds were below these limits allowed under the permit (Table 5-4).

5.1.3.7.3 UGTA Well Discharged Groundwater and Fluids

UGTA wells are regulated by the State through an agreement between NNSA/NFO and NDEP called the UGTA Fluid Management Plan (Attachment 1 of U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office [2009]) in lieu of having separate State-issued water pollution control permits for each well. The plan prescribes the methods of disposing groundwater and fluids pumped from UGTA wells during drilling, development, and testing based on the levels of radiological contamination. Discharge water and drilling fluids having ≥400,000 pCi/L of tritium are diverted to lined sumps; otherwise they are diverted to unlined sumps. Samples of the discharge water from the wellhead or bailer are analyzed for gross alpha, gross beta, tritium, and RCRA-regulated metals to ensure discharged water is below the established fluid management criteria for these parameters. When discharge water and drilling fluids are ≥400,000 pCi/L of tritium, lead is monitored in the field to ensure that the RCRA limit for lead of 5 milligrams per liter (mg/L) is not exceeded; exceeding this level may result in the generation of a hazardous or mixed waste in a sump and in the suspension of drilling operations. Well discharges are retained until they evaporate.

In 2013, well development and testing was conducted at ER-5-5, ER-11-2, ER-20-11, ER-EC-13, ER-EC-15, and PM-3, and pumped groundwater was directed to unlined sumps at all locations in accordance with the fluid management plan. Fluids in excess of sump capacity were allowed to gravity flow from the sumps to designated surface infiltration areas. Grab samples from the sumps were below the fluid management criteria limits for all analyzed parameters.

5.1.4 Environmental Impact

The potential radiological impact to water resources from past activities on the NNSS is the migration of radionuclides in the groundwater downgradient from the UGTA CAUs. Currently, sampling and analysis data indicate that underground nuclear testing only within the Pahute Mesa CAUs has impacted groundwater off the NNSS. Current data indicate, however, that the distance over which radionuclides have migrated from underground nuclear testing in the Pahute Mesa CAUs is not significant. Several wells intercept a contaminant plume of tritium believed to originate from the TYBO and BENHAM UGTs. Well sampling to date has not detected the presence of man-made radionuclides downgradient of Pahute Mesa in nine other UGTA wells on the NTTR. As presented in previous annual reports, samples from offsite monitoring wells in Oasis Valley, farther downgradient of Pahute Mesa, also contain no detectable man-made radionuclides. These sampling results are consistent with UGTA's Phase I Pahute Mesa flow and transport model (SNJV 2009), which forecasts migration of tritium off the NNSS within 50 years of the first nuclear detonation (1965) from the Central and Western Pahute Mesa CAUs (see Section 11.1.2.2, Figure 11-4).

Currently, groundwater contaminated from historical UGTs does not impact the public or NNSS workers who drink water from wells located off or on the NNSS. However, NNSS wildlife are exposed to tritium in their drinking water or aquatic habitats from the NDEP-approved method of containing contaminated waters in the E Tunnel ponds and in sumps that may be used to contain pumped groundwater from UGTA wells. The potential dose to NNSS biota from these water sources is assessed annually (see Section 9.2), and the results demonstrate that the doses to biota are below the limits set to protect plant and animal populations (Bechtel Nevada 2004; NSTec 2008).

5.2 Nonradiological Drinking Water and Wastewater Monitoring

The quality of drinking water and wastewater on the NNSS 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. NNSA/NFO ensures that such systems meet the applicable water quality standards and permit requirements (see Section 2.2). The NNSS nonradiological water monitoring goals are shown below. They are met by conducting field water sampling and analyses, performing assessments, and maintaining documentation. This section describes the results of 2013 activities. Information about radiological monitoring of drinking water on and off the NNSS and wastewater on the NNSS is presented in Sections 5.1.3.5 through 5.1.3.7.

Nonradiological Water Monitoring Goals
Ensure that the operation of NNSS public water systems (PWSs) and private water systems (see Glossary, Appendix B) provides high-quality drinking water to workers and visitors of the NNSS. Determine if NNSS PWSs are operated in accordance with the requirements in Nevada Administrative Code NAC 445A, "Water Controls," under permits issued by the State. Determine if the operation of commercial septic systems that process domestic wastewater on the NNSS meets operational standards in accordance with the requirements NAC 445A under permits issued by the State. Determine if the operation of industrial wastewater systems on the NNSS meets operational standards of federal and state regulations as prescribed under the GNEV93001 state permit.

5.2.1 Drinking Water Monitoring

Seven permitted wells supply the potable water needs of NNSS operations. These are grouped into three PWSs (Figure 5-4). The largest PWS (Area 23 and 6) serves the main work areas of the NNSS. 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 9-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 NNSS that are not part of a PWS, NNSA/NFO hauls potable water in two water tanker trucks. The trucks are permitted by the BSDW to haul water to a PWS, and the water they carry is subject to water quality standards for coliform bacteria. Normal use of these trucks, however, involves hauling to private water systems (see Glossary, Appendix B) and to hand-washing stations at construction sites, activities not subject to permitting. NNSA/NFO renews the permits for these trucks annually, however, in case of emergency.

5.2.1.1 PWS and Water-Hauling Truck Monitoring

Table 5-6 lists the water quality parameters monitored in 2013, sample frequencies, and sample locations. At all building locations, the sampling point for coliform bacteria is a sink within the building. Samples for the chemical contaminants were collected at the four points of entry to the PWSs. Although not required by regulation or permit, the private water systems were monitored quarterly for coliform bacteria to ensure safe drinking water.

All water samples were collected in accordance with accepted practices, and the analyses were performed by State-approved laboratories. The laboratories used approved analytical methods listed in NAC 445A and Title 40 Code of Federal Regulations (CFR) Part 141, "National Primary Drinking Water Standards."

In 2013, monitoring results indicated that the PWSs complied with National Primary Drinking Water Quality Standards and Secondary Standards (Table 5-7). Also, all water samples from the water-hauling trucks were negative for coliform bacteria in 2013.

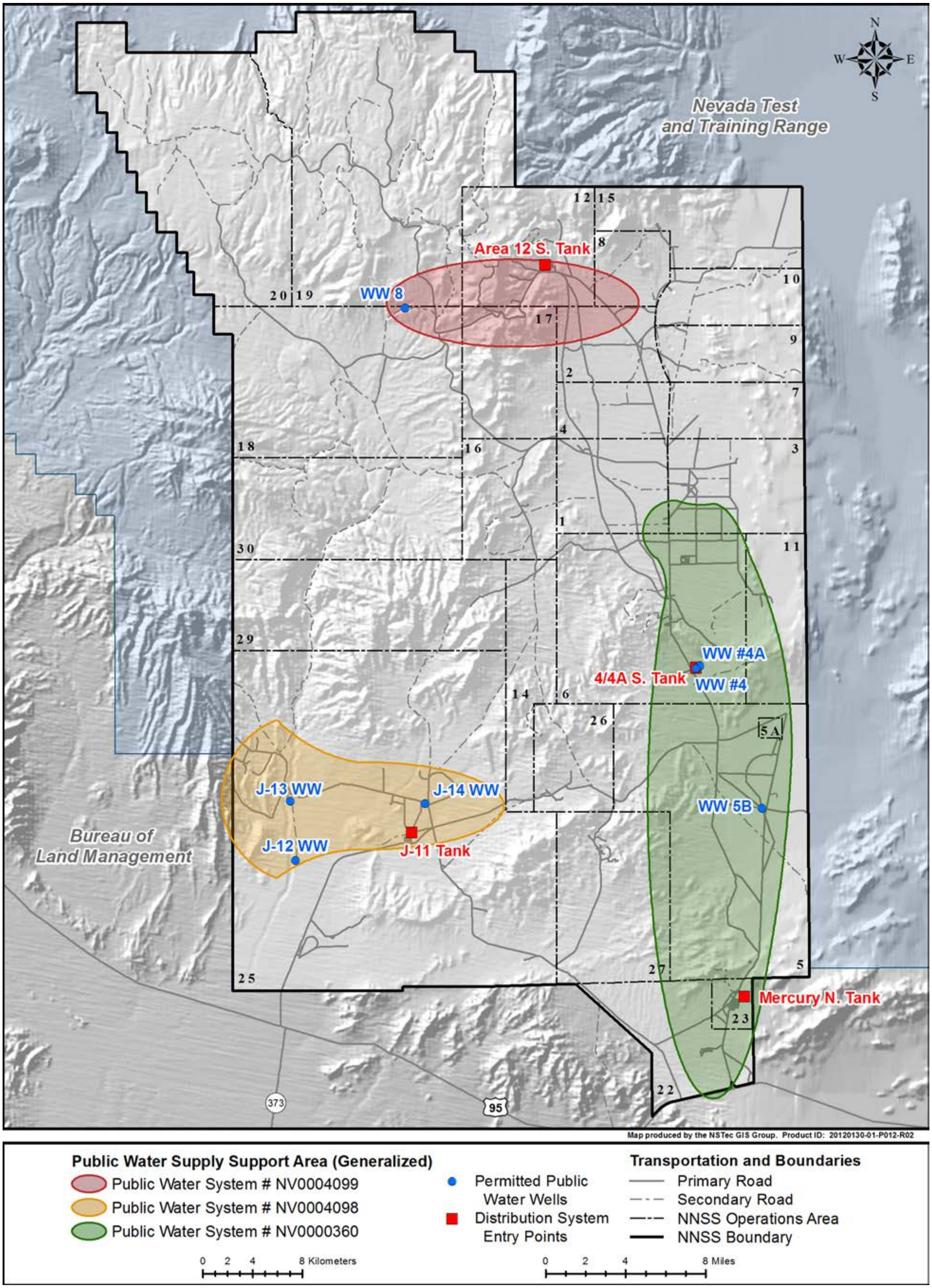

Figure 5-4. Water supply wells and drinking water systems on the NNSS

Table 5-6. Monitoring parameters and sampling design for NNSS PWSs and permitted water-hauling trucks

PWS	Contaminant	2013 Monitoring Requirements Samples/Frequency	Monitoring Locations
Area 23 and 6	Coliform Bacteria	24 samples/ 2 buildings per month	Buildings 5-7, U1H restroom, 6-609, 6-900, 22-1, 23-180, 23-701, 23-777, and 23-1103
	Inorganic Chemicals: Nitrate	2 samples/ 1 per entry point annually	Entry points: Mercury N. Tank and 4/4A S. Tank
	Fluoride	2 samples/ 1 per entry point every 3 years	
	Secondary Inorganic Chemicals	2 samples/ 1 per entry point every 3 years	Entry points: Mercury N. Tank and 4/4A S. Tank
	Volatile Organic Chemicals Phase 2 and 5	2 samples/ 1 per entry point every 3 years	Entry points: Mercury N. Tank and 4/4A S. Tank
Area 12	Coliform Bacteria	4 samples/ 1 per quarter	Building 12-909
	Inorganic Chemicals: Nitrate	1 sample/ annually	Entry point Area 12 S. Tank
Area 25	Coliform Bacteria	4 samples/ 1 per quarter	Building 25-3123 or 25-4222
	Inorganic Chemicals: Nitrate	2 samples/ 1 per entry point annually	Entry points: J-11 Booster Station and J-14 Pumphouse
	Secondary Inorganic Chemicals	1 sample/every 3 years	J11 Booster Station
Water-Hauling Truck			
Truck 84846 and Truck 84847	Coliform Bacteria	24 samples/ 1 per month for each truck	From water tank on each truck after filling at Area 6 potable water fill stand

Table 5-7. Water quality analysis results for NNSS PWSs

Contaminant	Maximum Contaminant Level (mg/L)	2013 Results (mg/L)		
		Area 23 and 6 PWS	Area 12 PWS	Area 25 PWS
Coliform Bacteria	Coliforms present in 1 sample/month	Absent in all samples	Absent in all samples	Absent in all samples
Inorganic Chemicals				
Nitrate	10 mg/L (as nitrogen)	3.07 and 4.21	1.20	1.95 and 0.87
Secondary Standards				
Aluminum	0.2	ND[a] and ND	NA[b]	0.0735
Chloride	400	21.5 and 11.1	NA	7.60
Copper	1.3	ND and ND	NA	ND
Foaming Agents	0.5	ND and ND	NA	ND
Iron	0.6	0.032 and 0.03	NA	0.113
Magnesium	150	2.84 and 7.6	NA	1.2
Manganese	0.1	ND and ND	NA	0.0063
Silver	0.1	ND and ND	NA	ND
Sulfate	500	57.7 and 41.7	NA	25.2
Total Dissolved Solids	1,000	340 and 280	NA	220
Zinc	5	ND and ND	NA	0.044
Fluoride	2	0.934 and 0.919	NA	2.14
Color	15 units	0-5 and 0-5	NA	0-5
Odor	3	NOO[c] and NOO	NA	NOO
pH	6.5 to 8.5	8.44 and 7.97	NA	8.29
Volatile Organic Chemicals				
Benzene	0.005	< 0.0005	NA	NA
Carbon tetrachloride	0.005	< 0.0005	NA	NA
o-Dichlorobenzene	0.6	< 0.0005	NA	NA
1, 2-Dichloroethane	0.005	< 0.0005	NA	NA

Table 5-7. Water quality analysis results for NNSS PWSs (continued)

Contaminant	Maximum Contaminant Level (mg/L)	2013 Results (mg/L)		
		Area 23 and 6 PWS	Area 12 PWS	Area 25 PWS
Volatile Organic Chemicals (continued)				
para-Dichlorobenzene	0.075	< 0.0005	NA	NA
cis-1, 2-Dichloroethylene	0.07	< 0.0005	NA	NA
1, 1-Dichloroethylene	0.007	< 0.0005	NA	NA
trans-1, 2-Dichloroethylene	0.1	< 0.0005	NA	NA
Methylene chloride	0.005	0.00031[(d)] and 0.00022[(d)]	NA	NA
1, 2-Dichloropropane	0.005	< 0.0005	NA	NA
Ethylbenzene	0.7	< 0.0005	NA	NA
Chlorobenzene	0.1	< 0.0005	NA	NA
Styrene	0.1	< 0.0005	NA	NA
Tetrachloroethylene	0.005	< 0.0005	NA	NA
Toluene	1	< 0.0005	NA	NA
1,2,4-trichlorobenzene	0.7	< 0.0005	NA	NA
1, 1, 1-Trichloroethane	0.2	< 0.0005	NA	NA
1,1,2-trichloroethane	0.005	< 0.0005	NA	NA
Trichloroethylene	0.005	< 0.0005	NA	NA
Vinyl chloride	0.002	< 0.0005	NA	NA
Xylenes (total)	10	< 0.0015	NA	NA

(a) ND = Not detected
(b) NA = Not applicable
(c) NOO = No odor observed
(d) Sample blank was reported as contaminated, the reported value was estimated

5.2.1.2 State Inspections

Periodically, NDEP conducts a sanitary survey of the permitted NNSS 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 5 years. In 2013, NDEP did not perform a sanitary survey of the PWSs. The last survey was conducted in 2011, and there were no significant findings then.

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 2013, and permits were renewed.

5.2.2 Domestic Wastewater Monitoring

A total of 23 permitted septic systems for domestic wastewater are being used on the NNSS (Figure 5-5). These septic systems are permitted to handle up to 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 buildings' facility manager. The permitted septic systems are inspected periodically for sediment loading and are pumped as required. The NNSS Management and Operations contractor maintains a septic pumping contractor permit issued by the State. The State conducts onsite inspections of pumper trucks and pumping contractor operations. NNSS 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 2013, there were no compliance actions relating to domestic wastewater on the NNSS.

A septic tank pumping contractor permit (NY-17-03318), four 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 2013.

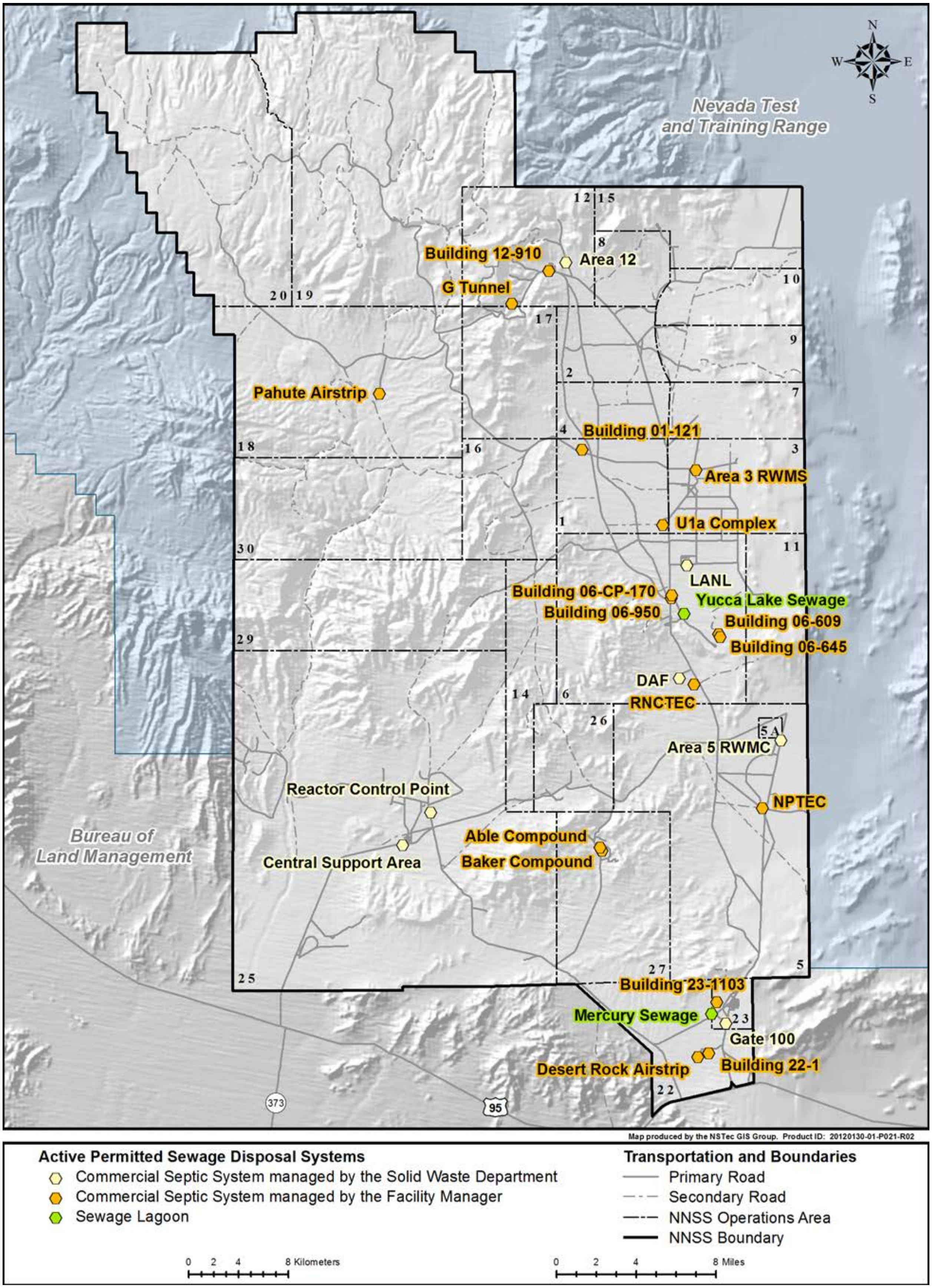

Figure 5-5. Active permitted sewage disposal systems on the NNSS

5.2.3 Industrial Wastewater Monitoring

Industrial discharges on the NNSS are limited to two operating sewage lagoon systems: Area 6 Yucca Lake and Area 23 Mercury (these lagoon systems also receive domestic wastewater) (Figure 5-5). 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 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.

5.2.3.1 Quarterly and Annual Influent Monitoring

Both sewage systems are monitored quarterly for influent quality. Composite samples from each system are collected over a period of 8 hours and in accordance with accepted practices. The analyses are performed by State-approved laboratories. The laboratories used approved analytical methods listed in NAC 445A and 40 CFR 141. The composite samples are analyzed for three parameters: 5-day biological oxygen demand (BOD_5, see Glossary, Appendix B), total suspended solids (TSS), and pH. In 2013, all results for BOD_5, TSS, and pH for sewage system influent waters were within the limits established under Water Pollution Control General Permit GNEV93001 (Table 5-8). Quarterly monitoring reports of these results were submitted to NDEP in April, July, and October 2013 and in January 2014.

Table 5-8. Water quality analysis results for NNSS sewage lagoon influent waters in 2013

Parameter	Units	Minimum and Maximum Values from Quarterly Samples: Area 6 Yucca Lake	Area 23 Mercury
BOD_5	mg/L	44.4–118	222–479
Permit Limit		None	None
BOD_5 Mean Daily Load[(a)]	kg/d	0.39–1.27	17.67–36.65
Permit Limit		34.43	124.31
TSS	mg/L	40–94	181–379
Permit Limit		None	None
pH	S.U.[(b)]	8.02–8.45	8.06–8.80
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 × liters per day (L/d) average flow × 3.785)/10^6

(b) Standard units of pH

Toxicity monitoring of influent waters of the lagoons was not conducted in 2013. The permit requires that the lagoons be sampled and analyzed for the 29 contaminants shown in Table 4-10 of the *Nevada Test Site Environmental Report 2008* (NSTec 2009) only in the event of specific or accidental discharges of potential contaminants. There were no such discharges that warranted sampling in 2013.

5.2.3.2 Sewage System Inspections

NNSS personnel inspect active systems weekly and inactive lagoon systems quarterly. NDEP inspects both active and inactive NNSS lagoon systems annually. NNSS personnel 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. NNSS personnel conducted weekly and quarterly inspections throughout the year. They cover field maintenance programs, lagoons, sites, and access roads functional to operations. There were no notable findings from the onsite inspections. NDEP performed an annual inspection in 2013, and there was one minor finding. An inactive lagoon utilized as a drying bed for portable toilet waste had a deep rooting plant that was required to be removed.

5.2.4 ETDS Monitoring

NNSA/NFO manages and operates the ETDS in Area 12 under a separate water pollution control permit (NEV 96021) issued by the NDEP Bureau of Federal Facilities. 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 ETDS discharge waters to be monitored every 12 months for radiological parameters (see Table 5-4 and Section 5.1.3.7.2) and for the nonradiological parameters listed in Table 5-9. It also requires Well ER-12-1 to be sampled for the same parameters but at a frequency of once every 24 months. The ETDS is also monitored monthly for flow rate, pH, temperature, and specific conductance (SC) of the discharge water and the total volume and structural integrity of the holding ponds. Monitoring data are reported to the NDEP Bureau of Federal Facilities in annual and quarterly reports.

On October 15, 2013, monitoring personnel sampled the ETDS discharge water, and all nonradiological parameters were within the threshold limits specified by the permit (Table 5-10), with the exception of SC measurements at the ETDS discharge point. SC measures for the first three quarters of 2013 were below the lower permit limit of 400 microsiemens per centimeter (µS/cm), ranging from 375.3 to 395.5 µS/cm. NDEP determined, after evaluating NNSA/NFO's study of this parameter that these measurements should continue to be collected. NDEP suspended the permit requirement for follow-on monitoring and reevaluated the permit limits for SC when the permit was renewed in 2013. The new permit, issued on October 1, 2013, no longer has a lower limit for SC.

On April 18, 2013, Well ER-12-1 was sampled, and the sample was within permit limits for all nonradiological parameters except SC, which was slightly higher than the permissible limit (Table 5-9). The upper limit was raised in the new permit issued October 1, 2013.

Table 5-9. Nonradiological results for Well ER-12-1 groundwater and ETDS discharge samples

	ETDS Discharge Water Sampled Every 12 Months (October 2013)		Well ER-12-1 Groundwater Sampled Every 24 Months (April 2013)	
Nonradiological Parameter	**Threshold (mg/L)**	**Measured Value (mg/L)**	**Threshold (mg/L)**	**Measured Value (mg/L)**
Cadmium	0.045	< 0.00012	0.005	< 0.00009
Chloride	360	9.6	250	17
Chromium	0.09	< 0.0005	0.09	< 0.0005
Copper	1.2	< 0.003	1.2	< 0.003
Fluoride	3.6	0.17	3.6	0.31
Iron	5.0	1.3	5.0	4.7
Lead	0.014	0.00099	0.014	< 0.00015
Magnesium	135	0.86	135	58
Manganese	0.25	0.015	0.25	0.14
Mercury	0.0018	< 0.00006	0.0018	< 0.00006
Nitrate nitrogen	9	0.35	9	< 0.2
Selenium	0.045	<0.0005	0.045	< 0.0003
Sulfate	450	16	450	350
Zinc	4.5	0.028	4.5	< 0.003
Flow Rate (liters/minute)	MR[(a)]	28.2[(d)]	NA	NA
pH (S.U.)[(b)]	6.0–9.0	7.3[(d)]	6.5–8.5	7.55
Specific conductance (µS/cm)[(c)]	400–500[(e)]	379[(d)]	400–1,000[(e)]	1,023

(a) Permit requires NNSA/NFO to monitor and report; there are no threshold limits

Sources: (NSTec 2014b; 2014c)

(b) S.U. = standard unit(s) (for measuring pH)

(c) µS/cm = microsiemens per centimeter

(d) Average of 12 monthly measures

(e) The permit issued in October 2013 set a limit of <1,500 µS/cm for both ETDS discharge and ER-12-1 water samples

5.2.5 Environmental Impact

The results of all drinking water and wastewater monitoring in 2013 were within permit limits. In the past, some drinking water standards in NNSS 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. If present, nonradiological contamination of groundwater from NNSS operations would likely be co-located with the radiological contamination that has occurred from historical underground nuclear testing within UGTA 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 investigation wells, which include highly contaminated wells, have not had elevated levels of nonradiological man-made contaminants.

Well drilling, waste burial, chemical storage, and wastewater management are the only current NNSS 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 procedures include the containment of drilling muds and well effluents in sumps (see Section 5.1.3.7.3). Well effluents are monitored for nonradiological contaminants (predominantly lead) to ensure that lined sumps are used when necessary. The Area 3 and Area 5 Radioactive Waste Management Sites and the solid waste landfills are designed and monitored to ensure that contaminants do not reach groundwater (see Chapter 10). 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, for the Soils and Industrial Sites, conducts cleanup and closures of historical 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 Sections 11.2 and 11.3). 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/NFO operations are known to have contaminated natural springs or ephemeral surface waters on the NNSS.

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Chapter 6: Direct Radiation Monitoring

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U.S. Department of Energy (DOE) Orders DOE O 458.1, "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 absorbed from radioactive materials outside of the body results in an external dose. External dose comes from direct ionizing radiation from all sources on the Nevada National Security Site (NNSS), including natural radioactivity from cosmic and terrestrial sources as well as man-made radioactive sources. This chapter presents the data obtained to assess external dose during 2013. Chapters 4, 5, and 8 present the monitoring results of radioactivity from NNSS activities in air, water, and biota, respectively. Those results are used to estimate potential internal radiation dose to the public via inhalation and ingestion. The total estimated dose, both internal and external, from NNSS activities is presented in Chapter 9.0.

Direct radiation monitoring is conducted to assess the external radiation environment, detect changes in that environment, respond to releases from U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office (NNSA/NFO) activities, and measure gamma radiation levels near potential exposure sites. In addition, DOE O 458.1 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 external dose that comes from background radiation versus NNSS operations.
Measure external radiation in order to assess the potential external dose to a member of the public from all NNSA/NFO operations at the NNSS and determine if the total dose (internal and external) complies with the 100 millirem per year (mrem/yr) (1 millisievert [mSv]/yr) dose limit of DOE O 458.1 (see Chapter 9 for estimates of public dose).
Measure external radiation in order to assess the potential external dose to a member of the public from operations at the Area 3 and Area 5 Radioactive Waste Management Sites (RWMSs) and determine if the total dose complies with the 25 mrem/yr (0.25 mSv/yr) dose limit to members of the public specified in DOE Manual DOE M 435.1-1, "Radioactive Waste Management Manual" (see Chapter 9 for estimates of public dose).
Monitor operational activities involving radioactive material, radiation-generating devices, and accidental releases of radioactive material to ensure exposure to members of the public are kept ALARA as stated in DOE O 458.1.
Determine if the absorbed radiation dose (in a unit of measure called a rad [see Glossary, Appendix B]) from external radiation exposure to NNSS terrestrial plants and aquatic animals is less than 1 rad per day (1 rad/d) (0.01 gray/d), and if the absorbed radiation dose to NNSS terrestrial animals is less than 0.1 rad/d (1 milligray/d) (limits prescribed by DOE O 458.1 and DOE Standard DOE-STD-1153-2002, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota") (see Section 9.2 for biota dose assessments).
Determine the patterns of exposure rates through time at various soil contamination areas in order to characterize releases in the environment.

An offsite monitoring program has been established by NNSA/NFO to monitor direct radiation in communities adjacent to the NNSS. The Desert Research Institute (DRI) conducts this monitoring as part of its Community Environmental Monitoring Program (CEMP). DRI's 2013 direct radiation monitoring results are presented in Sections 7.1.2 and 7.1.3 and are compared with those from onsite thermoluminescent dosimeters (TLDs) in this chapter (see Figures 6-2 and 6-3).

6.1 Measurement of Direct Radiation

Direct (or external) radiation exposure can occur when alpha particles, beta particles, or electromagnetic (gamma and X-ray) radiation interact with living tissue. Electromagnetic radiation can travel long distances through air and penetrate living tissue, causing ionization within the body tissues. For this reason, electromagnetic radiation is one of the greater concerns of direct radiation exposure. 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 to living tissue as they rarely penetrate the outer dead layer of skin, and they cannot penetrate thin plastic. 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 radionuclides can be approximated by equating a 1 mR exposure with a 1 mrem (0.01 mSv) dose.

6.2 Thermoluminescent Dosimetry Surveillance Network Design

A surveillance network of TLD sampling locations has been established on the NNSS to monitor those NNSS areas that have elevated radiation levels resulting from historical nuclear weapons testing, current and past radioactive waste management activities, and/or current operations involving radioactive material or radiation-generating devices. The objectives and design of the network are described in detail in the *Routine Radiological Environmental Monitoring Plan* (RREMP) (Bechtel Nevada 2003).

TLDs have the capability to measure exposure from all sources of ionizing radiation, but, with normal use, the TLD will only detect electromagnetic radiation, high-energy beta particles, and in some special cases neutrons. This is due to the penetrative abilities of the radiation. The TLD currently used for environmental sampling is the Panasonic UD-814AS, which has three calcium sulfate elements housed in an air-tight, water-tight, ultraviolet-light–protected case. Measurements from the three calcium sulfate elements are averaged to assess 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 quarterly for analysis. Analysis of TLDs is performed using automated TLD readers calibrated and maintained by the Radiological Control Department. Reference TLDs are exposed to a 100 mR cesium-137 source under tightly controlled conditions. These are read along with TLDs collected from the network to calibrate their responses.

There were 103 active environmental TLD locations on the NNSS (Figure 6-1) during 2013 and six control locations. They include the following numbers and types:

- Background (B) – 10 locations where radiation effects from NNSS operations are negligible.
- Environmental 1 (E1) – 41 locations where there is no measurable radioactivity from past operations but are of interest due to the presence of people in the area and/or the potential for increased radiation exposure from a current operation.
- Environmental 2 (E2) – 35 locations where there is measurable added radioactivity from past operations; these locations are of interest to monitor direct radiation 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 RWMSs.
- Control (C) – 5 locations in Building 652 and 1 location in Building 650 (both buildings are in Area 23). Control TLDs are kept in stable environments. Both locations are shielded to some degree. The TLDs in Building 652 are well shielded inside a lead cabinet, and the TLDs in Building 650 are shielded by just the building itself. These TLDs are used as a quality check on the TLDs and the analysis process.

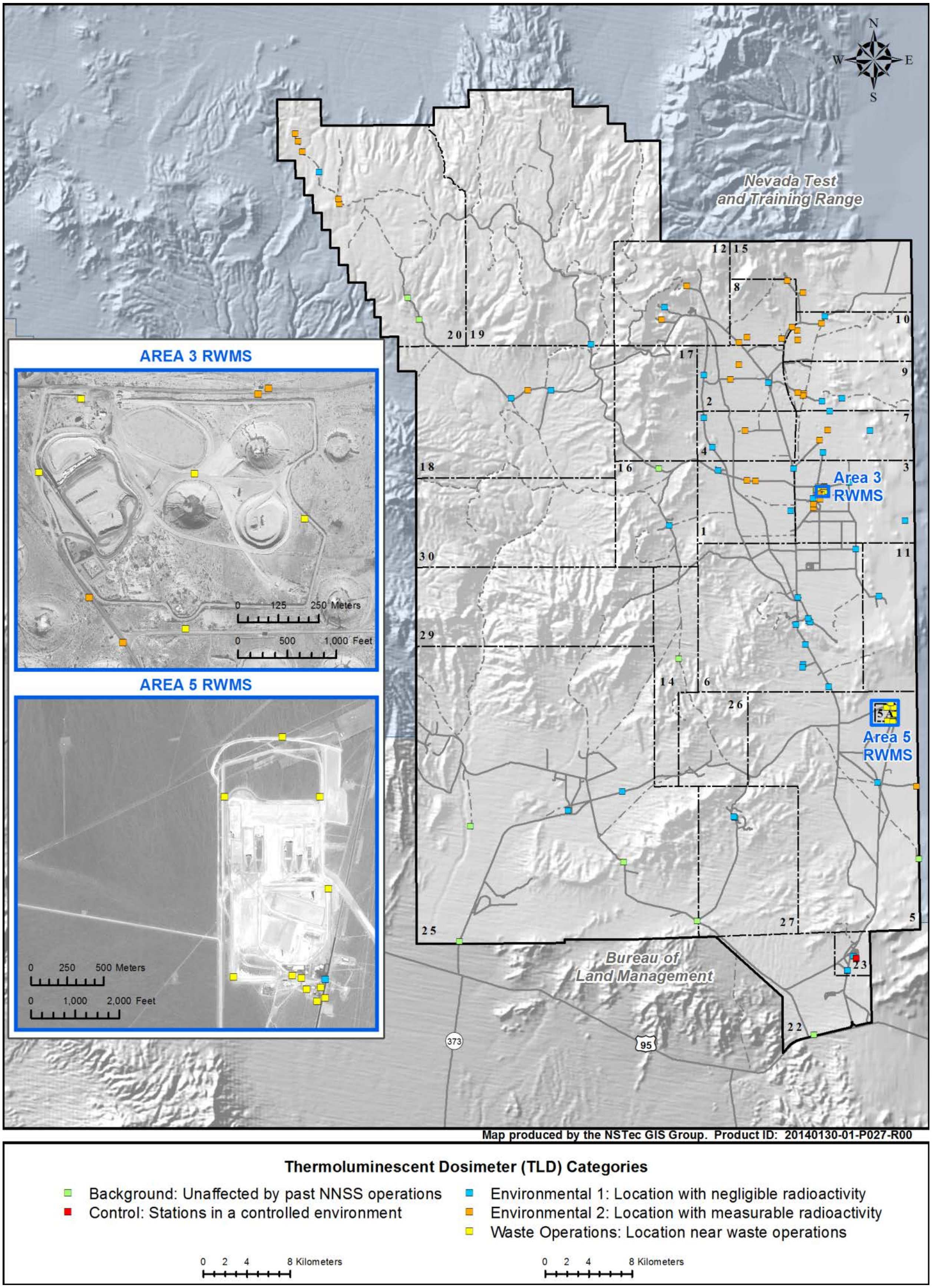

Figure 6-1. Location of TLDs on the NNSS

6.2.1 Data Quality

Quality assurance (QA) procedures for direct radiation monitoring involve comparing the data from the paired TLDs at each location to estimate the measurement and its precision, comparing current and past data measurements at each TLD location, and reviewing data from the TLDs in the control locations. Five of the six control locations are shielded; the sixth is unshielded and located in Mercury in Building 650. These locations provide the detection and estimation of any systematic variations that might be introduced by the measurement process itself.

As directed by the RREMP, QA and quality control (QC) protocols (including Data Quality Objectives) have been developed and are maintained as essential elements of direct radiation monitoring. 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 (see Chapter 16). The Radiological Control Department maintains certification through the U.S. Department of Energy Laboratory Accreditation Program for dosimetry.

6.2.2 Data Reporting

Direct radiation is recorded as exposure per unit time in milliroentgens per day (mR/d), calculated by dividing the measured exposure per quarter for each TLD by the number of days the TLD was exposed at its measurement location. These are multiplied by 365.25 to obtain annualized values. The estimated annual exposure is the average of the quarterly annualized values; this is the metric used to determine compliance with federal annual dose limits.

6.3 Results

Estimated annual exposures for all TLD locations are given in Table 6-1. Summary statistics for the five location types are given in Table 6-2 and Figure 6-2. Data were successfully obtained from all TLDs during all quarters of 2013. Agreement between the results provided by the paired TLDs was quite good, with an average relative percent difference between measurements of 3.7%. The quarter-to-quarter coefficient of variation (CV, i.e., the relative standard deviation) ranged from 0.8% to 10.3% (median = 3.8%) over all locations excluding the two Gate 100 Truck Parking locations (see the discussion in Section 6.3.2).

6.3.1 Background Exposure

During 2013, the average of the estimated annual exposures among the 10 background locations was 124 mR, ranging from 70 to 167 mR (Table 6-2). A 95% prediction interval (PI) for annual exposures based on the 2013 estimated mean annual exposures at the background locations (denoted “95% PI from B” in the plots) is 45.0 to 203.1 mR. This interval predicts mean annual background exposures at locations where radiation effects from NNSS operations are negligible.

For comparison, the CEMP’s estimated annual exposure in Las Vegas, Nevada (at 617 m [2,025 ft] elevation), was 98 mR during 2013 (see Table 7-3). Estimated exposures at CEMP locations ranged from 77 mR at Pahrump, Nevada (804 m [2,639 ft] elevation), to 139 mR at Beatty, Nevada (930 m [3,216 ft] elevation). There is a general increasing relationship between natural background exposure and elevation (Figure 6-3). The NNSS background locations with lowest and highest exposures are at elevations 1,087 m (3,568 ft) (Area 5, 3.3 miles [mi] southeast [SE] of Aggregate Pit) and 1,737 m (5,700 ft) (Area 20, Stake A-112), respectively.

Exposure estimates at all locations include contributions from natural sources. It is important to note that the DOE dose limits to the public are for dose over and above what may be received from natural sources.

Table 6-1. Annual direct radiation exposures measured at TLD locations on the NNSS in 2013

NNSS Area	Station	Location Type[(b)]	Number of Quarters	Estimated Annual Exposure (mR)[(a)] Mean[(c)]	Minimum[(c)]	Maximum[(c)]
5	3.3 mi SE of Aggregate Pit	B	4	70	66	75
14	Mid-Valley	B	4	153	149	158
16	Stake P-3	B	4	122	115	130
20	Stake A-112	B	4	167	162	175
20	Stake A-118	B	4	162	156	170
22	Army #1 Water Well	B	4	89	80	95
25	Gate 25-4-P	B	4	139	128	148
25	Gate 510	B	4	135	129	143
25	Jackass Flats & A-27 Roads	B	4	88	85	93
25	Skull Mtn Pass	B	4	114	106	122
23	Building 650 Dosimetry	C	4	65	59	70
23	Lead Cabinet, 1	C	4	26	24	27
23	Lead Cabinet, 2	C	4	25	24	27
23	Lead Cabinet, 3	C	4	28	26	32
23	Lead Cabinet, 4	C	4	26	25	28
23	Lead Cabinet, 5	C	4	28	27	30
1	BJY	E1	4	123	118	125
1	Sandbag Storage Hut	E1	4	123	112	138
1	Stake C-2	E1	4	128	115	146
2	Stake M-140	E1	4	136	134	140
2	Stake TH-58	E1	4	102	98	103
3	LANL Trailers	E1	4	129	123	143
3	Stake OB-20	E1	4	94	88	103
3	Well ER 3-1	E1	4	134	129	147
4	Stake TH-41	E1	4	118	116	120
4	Stake TH-48	E1	4	123	120	125
5	Water Well 5B	E1	4	117	113	124
6	CP-6	E1	4	76	67	82
6	DAF East	E1	4	104	100	110
6	DAF North	E1	4	107	102	116
6	DAF South	E1	4	140	135	146
6	DAF West	E1	4	89	83	95
6	Decon Facility NW	E1	4	133	125	139
6	Decon Facility SE	E1	4	139	136	142
6	Stake OB-11.5	E1	4	136	131	143
6	Yucca Compliance	E1	4	97	94	100
6	Yucca Oil Storage	E1	4	104	97	108
7	Reitmann Seep	E1	4	132	128	136
7	Stake H-8	E1	4	131	126	135
9	Papoose Lake Road	E1	4	92	87	98
9	U-9CW South	E1	4	107	101	113
9	V & G Road Junction	E1	4	118	112	123
10	Gate 700 South	E1	4	129	126	132
11	Stake A-21	E1	4	136	127	147
12	Upper N Pond	E1	4	136	133	140
16	3545 Substation	E1	4	145	140	151
18	Stake A-83	E1	4	153	145	161
18	Stake F-11	E1	4	153	149	159
19	Stake P-41	E1	4	169	168	172

Table 6-2. Annual direct radiation exposures measured at TLD locations on the NNSS in 2013 (continued)

NNSS Area	Station	Location Type[b]	Number of Quarters	Estimated Annual Exposure (mR)[a] Mean[c]	Minimum[c]	Maximum[c]
20	Stake J-41	E1	4	145	141	148
23	Gate 100 Truck Parking 1	E1	4	79	68	93
23	Gate 100 Truck Parking 2	E1	4	69	63	80
23	Mercury Fitness Track	E1	4	64	58	70
25	HENRE	E1	4	129	125	133
25	NRDS Warehouse	E1	4	129	120	135
27	Cafeteria	E1	4	118	113	123
27	JASPER-1	E1	4	120	111	125
1	Bunker 1-300	E2	4	125	123	126
1	T1	E2	4	240	230	246
2	Stake L-9	E2	4	168	158	175
2	Stake N-8	E2	4	431	418	440
3	Stake A-6.5	E2	4	140	135	144
3	T3	E2	4	314	310	322
3	T3 West	E2	4	303	301	308
3	T3A	E2	4	335	325	359
3	T3B	E2	4	445	439	454
3	U-3co North	E2	4	184	173	191
3	U-3co South	E2	4	149	143	156
4	Stake A-9	E2	4	510	442	561
5	Frenchman Lake	E2	4	290	279	300
7	Bunker 7-300	E2	4	207	202	213
7	T7	E2	4	118	114	121
8	BANEBERRY 1	E2	4	340	337	344
8	Road 8-02	E2	4	128	125	130
8	Stake K-25	E2	4	100	96	104
8	Stake M-152	E2	4	166	161	172
9	B9A	E2	4	131	127	137
9	Bunker 9-300	E2	4	124	120	130
9	T9B	E2	4	448	439	457
10	Circle & L Roads	E2	4	120	117	123
10	Sedan East Visitor Box	E2	4	135	132	142
10	Sedan West	E2	4	220	215	226
10	T10	E2	4	238	235	241
12	T-Tunnel #2 Pond	E2	4	245	240	251
12	Upper Haines Lake	E2	4	113	107	117
15	EPA Farm	E2	4	114	112	116
18	JOHNNIE BOY North	E2	4	154	148	166
20	PALANQUIN	E2	4	220	205	229
20	SCHOONER-1	E2	4	561	547	574
20	SCHOONER-2	E2	4	245	240	249
20	SCHOONER-3	E2	4	148	145	152
20	Stake J-31	E2	4	168	159	181
3	A3 RWMS Center	WO	4	144	142	149
3	A3 RWMS East	WO	4	136	131	143
3	A3 RWMS North	WO	4	131	123	139
3	A3 RWMS South	WO	4	307	290	319
3	A3 RWMS West	WO	4	130	125	135

Table 6-3. Annual direct radiation exposures measured at TLD locations on the NNSS in 2013 (concluded)

NNSS Area	Station	Location Type[b]	Number of Quarters	Estimated Annual Exposure (mR)[a] Mean[c]	Minimum[c]	Maximum[c]
5	Building 5-31	WO	4	108	104	112
5	A5 RWMS East Gate	WO	4	107	103	114
5	A5 RWMS Expansion NE	WO	4	143	138	152
5	A5 RWMS Expansion NW	WO	4	152	149	158
5	A5 RWMS NE Corner	WO	4	130	126	138
5	A5 RWMS South Gate	WO	4	112	105	122
5	A5 RWMS SW Corner	WO	4	129	125	137
5	A5 RWMS North	WO	4	147	144	152
5	WEF East	WO	4	130	127	138
5	WEF North	WO	4	122	117	130
5	WEF South	WO	4	129	125	139
5	WEF West	WO	4	127	122	137

(a) To obtain daily exposure rates, divide exposure measures by 365.25.
(b) Location types:
- B: Background locations
- C: Control locations
- E1: Environmental locations with exposure rates near background but monitored for potential for increased exposure rates due to NNSS operations
- E2: Environmental locations with measurable radioactivity from past operations, excluding those designated WO
- WO: Locations in or near waste operations

(c) Mean, minimum, and maximum values from quarterly estimates. Each quarterly estimate is the average of two TLD readings per location.

Table 6-4. Summary statistics for 2013 mean annual direct radiation exposures by TLD location type

Location Type	Number of Locations	Estimated Annual Exposure (mR) Mean	Minimum	Maximum
Background (B)	10	124	70	167
Environmental 1 (E1)	41	120	64	169
Environmental 2 (E2)	35	231	100	561
Waste Operations (WO)	17	140	107	307
Control, Building 652 (C)	5	27	25	28
Control, Building 650 (C)	1	65	65	65

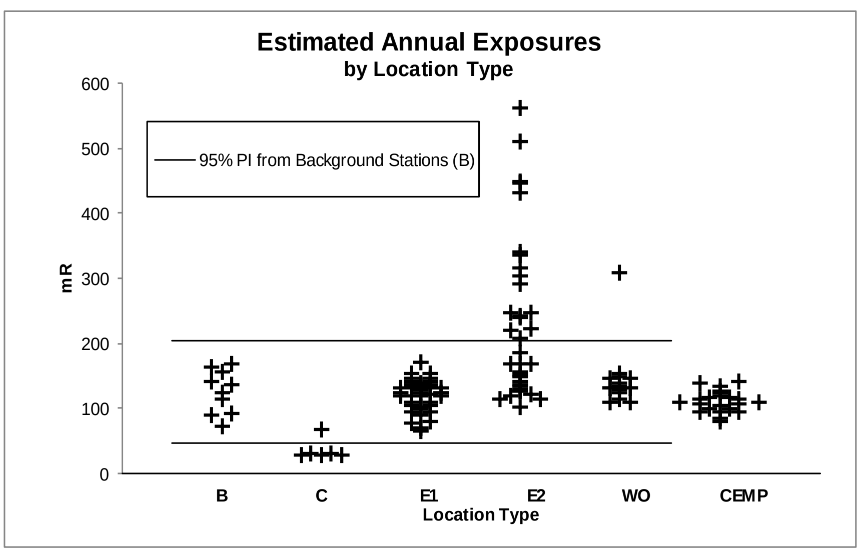

Figure 6-2. 2013 annual exposures on the NNSS, by location type, and off the NNSS at CEMP stations

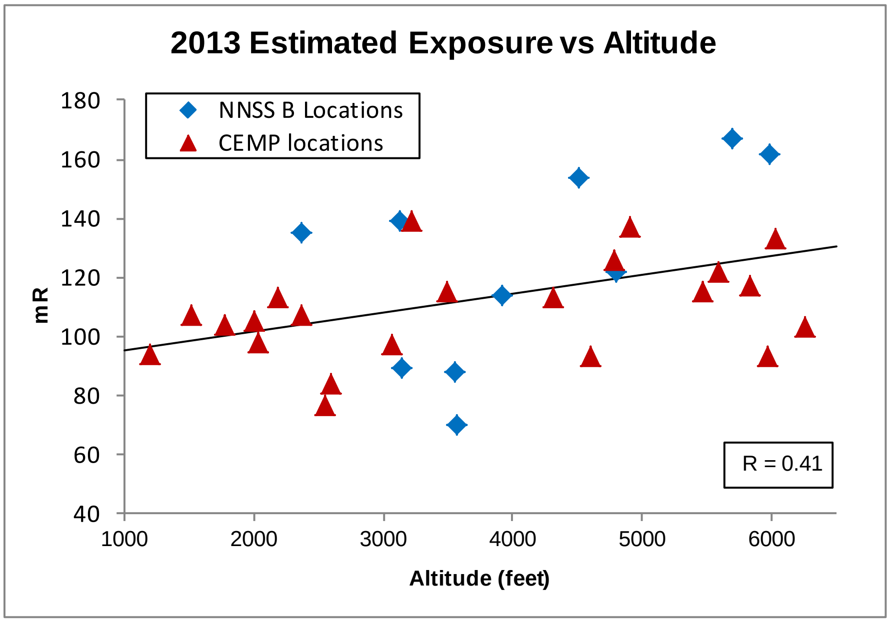

Figure 6-3. Correlation between 2013 annual exposures at NNSS Background and CEMP TLD locations and altitude

6.3.2 Potential Exposure to the Public along the NNSS Boundary

Most of the NNSS is not accessible to the public, as only the southern portion of the NNSS borders public land. Therefore, the only place the public has limited access is along the southern end of the NNSS. Gate 100 is the primary entrance point to the NNSS. The outer parking areas are accessible to the public. Trucks hauling radioactive materials, primarily low-level waste (LLW) destined for disposal in the RWMSs, often park outside Gate 100 while waiting to enter the NNSS. Two TLD locations were established in October 2003 to monitor this truck parking area.

The TLDs at the north end of the parking area (Gate 100 Truck Parking 2) had an estimated annual exposure of 69 mR, with quarterly estimates of 63, 64, 70, and 80 mR. The TLD location on the west side of the parking area (Gate 100 Truck Parking 1) has had elevated exposure levels at various times in its history, likely due to exposure to waste shipments. Its average value for 2013 was 79 mR, with quarterly estimates of 68, 69, 86, and 93 mR. For both truck parking locations, results are all within the range of background variation; however, the third and fourth quarter values are higher than those at the nearby Mercury Fitness Track station, likely due to exposure to waste shipments.

While the public has limited access to the NNSS at Gate 100 along its southern border, others may have access to other boundaries of the NNSS. Most of the NNSS 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 (1 mSv/yr) public dose limit. Nuclear tests on the NTTR (Double Tracks and Project 57) consisted of experiments where weapons were exploded conventionally without going critical (safety experiments). These areas, therefore, have primarily alpha-emitting radionuclides that do not contribute significantly to external dose. Historical nuclear testing activities also occurred on the Tonopah Test Range (TTR) (Clean Slate I, II, and III) located in the northwest portion of the NTTR. Radiation exposure rates are measured on and around the TTR, and the results are reported by Sandia National Laboratories (SNL) in the TTR annual environmental report (SNL 2014).

A radioactive material area boundary extends beyond the NNSS in the Frenchman Lake region of Area 5 along the southeast boundary of the NNSS. This region was a location of atmospheric weapons testing in the 1950s and is inaccessible to the public. A TLD location was established there in July 2003 to characterize direct radiation levels from this legacy soil contaminated area and to assess the external dose to personnel not classified as radiation workers who may visit the area. The estimated annual exposure to a hypothetical person at the Frenchman Lake TLD location during 2013 was 290 mR. This has been consistently declining over time, down from 411 mR in 2004. The resulting estimated above-background dose during 2013 would be approximately 128 to 225 mrem, depending on which background value is subtracted. This would exceed the 100 mrem dose limit to a person residing year-round at this location, but there are no living quarters or full-time non-radiation workers in this vicinity. Workers specially trained and outfitted as radiation workers, although they do not work in the vicinity, have a higher allowable dose limit of 5,000 mrem per year, which would not be exceeded in the vicinity of the Frenchman Lake TLD.

Based on these results, the potential external dose to a member of the public due to past or present operations at the NNSS does not exceed 100 mrem/yr (1 mSv/yr) and exposures are kept ALARA, as required by DOE O 458.1.

6.3.3 Exposures from NNSS Operational Activities

Forty-one TLDs are in locations where workers or the public have the potential to receive radiation exposure from current operations (E1 locations). E1 locations have negligible radioactivity from past operations. The mean estimated annual exposure at these locations was 120 mR, approximately the same as the mean estimated annual exposure at background locations (see Table 6-2). Overall, annual exposures were not different between B and E1 locations (Figure 6-2); the estimated annual exposures at all E1 locations are well within the 95% PI of B locations. E1 location exposures were also comparable with the offsite exposures reported by the CEMP stations, as shown in Figure 6-2.

6.3.4 Exposures from RWMSs

DOE M 435.1-1 states that LLW 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 from all exposure pathways combined. Given that the RWMSs are located well within the NNSS boundaries that are patrolled by security personnel, no member of the public could access these areas for significant periods of time. However, TLDs are placed at the RWMSs to show the potential dose from external radiation 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 (1,312 ft) 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 have been filled with LLW and then covered with clean soil. As a result, exposures inside the Area 3 RWMS are low when compared with average exposures at the fence line or in Area 3 outside the fence line.

Annual exposures during 2013 in and around the Area 3 RWMS are shown in Figure 6-4. The exposures measured inside the Area 3 RWMS and three of four measurements at the boundary were within the range of background exposures. The one location on the RWMS boundary (A3 RWMS South) that has an estimated exposure above the range of NNSS background is 160 m (525 ft) from where two atmospheric nuclear weapon tests occurred. The three E2 TLD locations outside the RWMS that are also above the range of NNSS background (Figure 6-4) are a similar distance from the same atmospheric test location but on the other side, farther from the RWMS boundary. Based on these measurements, it does not appear that waste buried at the Area 3 RWMS would have contributed external exposure to a hypothetical person residing at the Area 3 RWMS boundary during 2013.

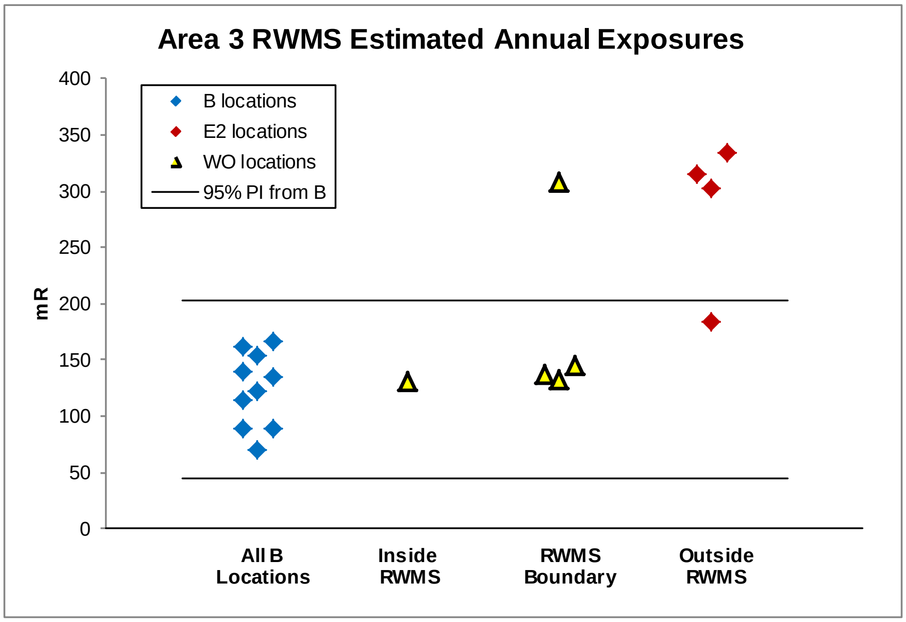

Figure 6-4. 2013 annual exposures in and around the Area 3 RWMS and at background locations

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 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 2013, estimated annual exposures at Area 5 RWMS TLD locations were within the range of exposures measured at NNSS background locations (Figure 6-5). The one location outside the Area 5 RWMS (Frenchman Lake) that has an estimated exposure above background levels is within 0.5 km (0.3 mi) of six atmospheric tests in Frenchman Lake Playa. Based on these results, the potential external dose to a member of the public from operations at the Area 3 and Area 5 RWMSs does not exceed the 25 mrem/yr (0.25 mSv/yr) dose limit to members of the public, specified in DOE M 435.1-1. See Section 9.1.2 of this report for a summary of the potential dose to the public from the RWMSs from all exposure pathways.

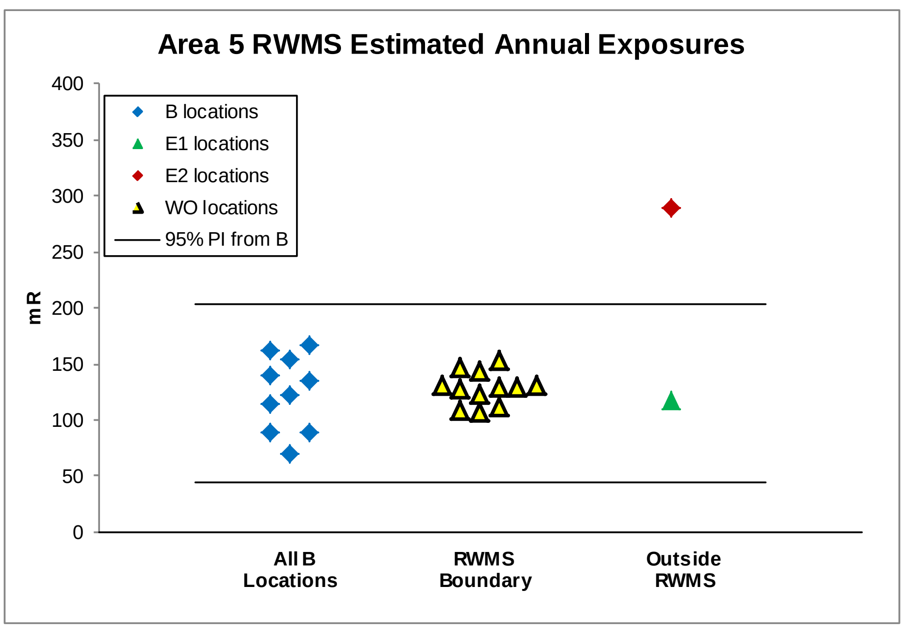

Figure 6-5. 2013 annual exposures around the Area 5 RWMS and at background locations

6.3.5 *Exposures to NNSS Plants and Animals*

The highest exposure rate measured at any TLD location during 2013 was 574 mR/yr (1.57 mR/d), at the Schooner-1 location during the third quarter (Table 6-1). Given such a large area source, there is very little difference between the exposure measured at a height of 1 m (3.3 ft) and that measured near the ground (e.g., 3 centimeters [1.2 in.]) where small plants and animals reside. The daily exposure rate near the ground surface would be less than 2% of the 0.1 rad/d (approximately 100 mR/d or 36,500 mR/yr) total dose rate limit to terrestrial animals, as stated in DOE-STD-1153-2002. Hence, doses to plants and animals from external radiation exposure at NNSS monitoring locations are very low compared with the dose limit. Dose to biota from both internal and external radionuclides is presented in Chapter 9.

6.3.6 *Exposure Patterns in the Environment over Time*

Direct radiation monitoring is conducted to help characterize releases from NNSA/NFO activities. Continued monitoring of exposures at locations of past releases on the NNSS helps to accomplish this. Small quarter-to-quarter changes are normally seen in exposure rates from all locations. During 2013, the CVs for measurements between quarters averaged 3.8%. Only the CVs for Stake C-2 in Area 1 (10.2%) and Gate 100 Truck Parking 2 (11.6%) and Truck Parking 1 (15.6%) were above 10.0%.

Long-term trends are displayed in Figure 6-6 by location type for locations that have been monitored for at least 10 years. As expected, the B and C locations show virtually no net change through time due to the protected locations and lack of added man-made radionuclides. Among all locations with at least 10-year data histories, the annual exposures at E1 locations decreased an average of 0.24% per year, those at E2 locations decreased 1.92% per year on average, and those at WO locations decreased 0.66% per year on average. Annual exposures decreased 3.14% per year on average at those locations with significant added man-made radiation, which are the E2 and WO locations, with 2013 estimated exposures higher than the 95% PI of B locations. These average rates of decay are very similar to those measured from 2008 through 2012. The observed decreases are due to a combination of natural radioactive decay, dispersal, and dilution in the environment.

The two highest exposures shown in Figure 6-6, Schooner-1 in Area 20 and Stake A-9 in Area 4, are decreasing at a rate of about 50% every 16 and 17 years, respectively.

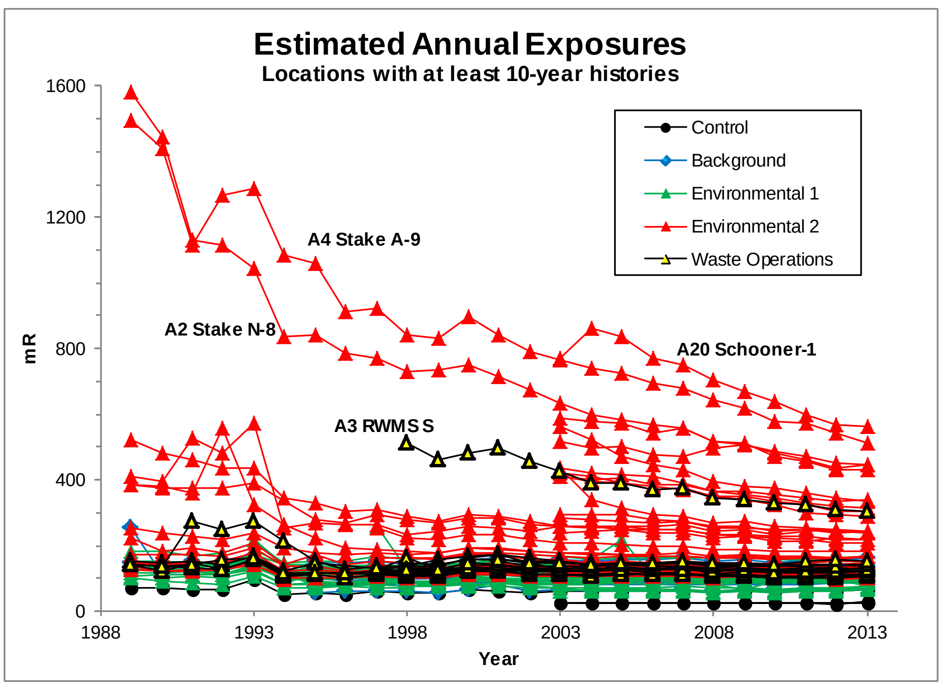

Figure 6-6. Trends in direct radiation exposure measured at TLD locations

6.4 Environmental Impact

Direct radiation exposure to the public from NNSS operations during 2013 was negligible. Radionuclides historically released to the environment on the NNSS 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 and at the boundary than 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 NNSS.

6.5 References

Bechtel Nevada, 2003. *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.

Sandia National Laboratories, 2014. *Calendar Year 2013 Annual Site Environmental Report Tonopah Test Range, Nevada & Kauai Test Facility, Hawaii*. SAND2014-16456R, Albuquerque, NM, prepared for U.S. Department of Energy, National Nuclear Security Administration Sandia Field Office, posted at http://www.sandia.gov/news/publications/environmental/index.html.

SNL, see Sandia National Laboratories.

Chapter 7: Community Environmental Monitoring Program

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Independent environmental monitoring for the Nevada National Security Site (NNSS) is provided through the Community Environmental Monitoring Program (CEMP), whose mission is to provide data to the public regarding the release of man-made radionuclides off site that could be the result of current operations or past nuclear testing on the NNSS. Initially, the CEMP network functioned as a first line of offsite detection of potential radiation releases from underground nuclear tests at the NNSS. It currently exists as a non-regulatory public informational and outreach program. The CEMP is sponsored by the U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office (NNSA/NFO), 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 air monitoring 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 website at http://www.cemp.dri.edu/. A detailed informational background narrative about 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.

CEMP Goals
Monitor offsite environmental conditions and communicate environmental data relevant to past and continuing activities at the NNSS
Engage the public hands-on in monitoring environmental conditions in their communities relative to activities at the NNSS
Communicate environmental monitoring data to the public in a transparent and accessible manner
Provide an educated, trusted, local resource for public inquiries and concerns regarding past and present activities at the NNSS

7.1 Offsite Air Monitoring

7.1.1 2013 Station Evaluations and Changes

In 2013, DRI managed 24 CEMP stations, which compose the Air Surveillance Network (ASN) (Figure 7-1). The ASN stations include various types of equipment used to monitor airborne radiation and meteorological conditions, as described in Section 7.1.2. In addition, DRI managed 4 meteorological (MET) stations located on ranches not visited by CEMs, as described below.

In 2013, NNSA/NFO and DRI continued the process of evaluating the design of the ASN to address the monitoring issues of greatest public concern in different communities, better align monitoring with the current NNSS mission and site activities, allocate funding which meets the needs of the respective communites while bringing value to the DOE, and increase public outreach in participating communities. CEMs provided valuable input to the evaluation process at the annual CEMP Workshop held in the summer of 2013 in Tonopah, Nevada.

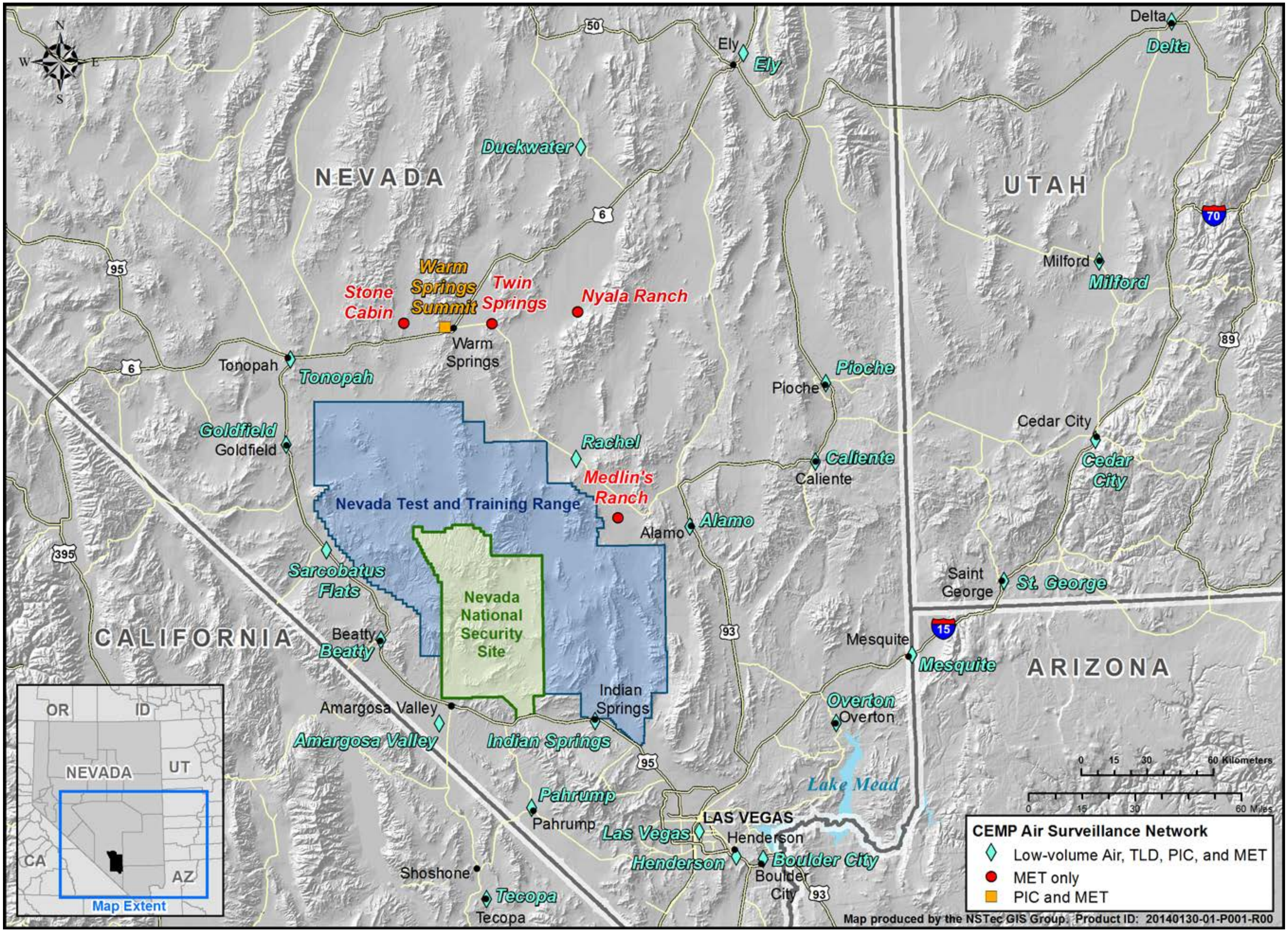

Figure 7-1. 2012 CEMP Air Surveillance Network

The 2013 evaluation resulted in changes in the sampling frequency at 11 CEMP stations as described in Section 7.1.3. Beginning in October 2013, the sampling frequency at stations either farthest from the NNSS or most frequently upwind from the NNSS was reduced to quarterly collections of a single 2-week air sample. These 11 stations include Duckwater, Ely, Delta, Milford, Boulder City, Henderson, Las Vegas, Indian Springs, Pahrump, Tecopa, and Amargosa Valley. The remainder of the stations maintained continuously running air samplers with a bi-weekly collection schedule. Air samples scheduled to be collected during October 2013 were affected by a Stop Work order issued for the CEMP as a result of the government shutdown.

As reported in 2012 (National Security Technologies, LLC 2013), the CEMP stations located on ranches without CEM support were reconfigured or decommissioned. The four remaining CEMP ranch stations have no radiation monitoring equipment, but are visited quarterly for routine maintenance of their meteorological and communication equipment. Ranchers remain on the mail distribution list and are welcome to continue participation in the program through attendance at CEMP workshops. All historical data from the four ranch stations, including radiological data, continue to be accessible online at the CEMP website.

7.1.2 Air Monitoring Equipment

CEMP Low-Volume Air Sampler Network – During 2013, the CEMP ASN included continuously operating low-volume particulate air samplers at 23 of the 24 CEMP stations; Warm Springs Summit, Nevada, is the one station where this type of sampler is not located. Duplicate air samples were collected from up to three ASN stations for each sampling period. The duplicate samplers are operated at randomly selected stations for 3 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 7 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 used to measure both individual and population external exposure to ambient radiation from natural and artificial sources. In 2013, this network consisted of fixed environmental TLDs at 23 of the 24 CEMP stations (see Figure 7-1). 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 and three calcium sulfate elements are used to measure penetrating gamma radiation. For quality assurance (QA) purposes, duplicate TLDs are deployed at three randomly selected 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 24 stations in the CEMP ASN (see Figure 7-1). 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. Variations can be easily viewed by selecting a station location on the Graph link from the CEMP home page, http://www.cemp.dri.edu/, then selecting the desired variables.

CEMP Meteorological (MET) Network – Changing weather conditions can have an effect on measurable levels of background radiation; therefore, meteorological instrumentation is in place at each of the 24 CEMP stations and at the four ranch MET stations that do not monitor airborne radiation: Stone Cabin, Twin Springs, Nyala Ranch, and Medlin's Ranch.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 available by accessing the CEMP home page at http://www.cemp.dri.edu/.

The CEMP station in Beatty, Nevada, which has all of the air monitoring equipment described above is shown in Figure 7-2.

Figure 7-2. CEMP Station in Beatty, Nevada

7.1.3 Air Sampling Methods

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 49.5 liters (1.75 cubic feet [ft^3]) per minute at standard temperature and pressure. The actual flow rate and total volume were measured with an in-line air-flow calibrator. The filter is mounted in a holder that faces downward at a height of approximately 1.5 meters (m) (5 feet [ft]) above the ground. The total volume of air collected ranged from approximately 1,030 to 1,290 cubic meters (m^3) (36,000 to 45,000 ft^3), depending on the elevation of the station and changes in air temperature and/or pressure.

During most of 2013, CEMP air samples were collected on a bi-weekly basis. This sampling frequency results in the possible collection of 26 samples per year from each station. As noted in Section 7.1.1, beginning in October 2013, samples were collected on a quarterly basis (one 2-week sample per quarter) from 11 of the stations. In addition, the Stop Work Order, issued because of the government shutdown in October 2013, resulted in three other sets of samples at all stations that were either not collected or were deemed invalid. Therefore, for 2013, a maximum of 23 samples were collected from the 12 full-time stations and 20 samples from the 11 stations that were converted to the quarterly schedule.

7.1.4 Air Sampling Results

7.1.4.1 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 $1.20 \pm 0.25 \times 10^{-15}$ microcuries per milliliter (µCi/mL) ($4.44 \pm 0.93 \times 10^{-5}$ becquerels [Bq]/m^3) (Table 7-1). Gross alpha was detectable in all of the 2013 air samples, and overall, gross alpha levels of activity were similar to results from previous years. Figure 7-3 shows the long-term maximum, mean, and minimum alpha trend for the CEMP stations as a whole.

Table 7-1. Gross alpha results for the CEMP offsite ASN in 2013

Sampling Location	Number of Samples	Concentration (× 10^{-15} µCi/mL [3.7 × 10^{-5} Bq/m^3]) Mean	Standard Deviation	Minimum	Maximum
Alamo	23	1.60	1.07	0.43	4.26
Amargosa Valley[(a)]	20	1.15	0.42	0.52	2.22
Beatty	23	0.97	0.46	0.39	2.44
Boulder City[(a)]	20	1.43	0.71	0.33	3.05
Caliente	22	1.65	0.99	0.45	4.14
Cedar City	22	0.68	0.28	0.26	1.42
Delta[(a)]	20	1.06	0.99	0.39	4.32
Duckwater[(a)]	20	1.22	0.52	0.63	2.19
Ely[(a)]	20	1.09	0.41	0.47	2.11
Goldfield	22	1.06	0.46	0.51	2.11
Henderson[(a)]	20	1.17	0.41	0.62	1.86
Indian Springs[(a)]	20	1.18	0.34	0.61	2.01
Las Vegas	23	1.22	0.68	0.49	3.54
Mesquite	23	1.67	0.92	0.46	4.71
Milford[(a)]	20	1.11	0.76	0.41	3.31
Overton[(a)]	19	1.18	0.50	0.37	2.24
Pahrump[(a)]	20	1.07	0.36	0.47	1.89
Pioche	23	1.22	0.56	0.51	2.48
Rachel	23	1.00	0.40	0.52	1.96
Sarcobatus Flats	23	1.70	1.07	0.63	4.52
St. George	23	1.04	0.59	0.39	2.43
Tecopa[(a)]	20	1.10	0.49	0.46	2.01
Tonopah	23	1.05	0.37	0.45	1.67

Network Mean = 1.20 ± 0.25 × 10^{-15} µCi/mL
Mean Minimum Detectable Concentration (MDC; see Glossary, Appendix B) = 0.27 × 10^{-15} µCi/mL
Standard Error of Mean MDC = 0.04 × 10^{-15} µCi/mL

(a) Stations converted to quarterly sampling in October 2013

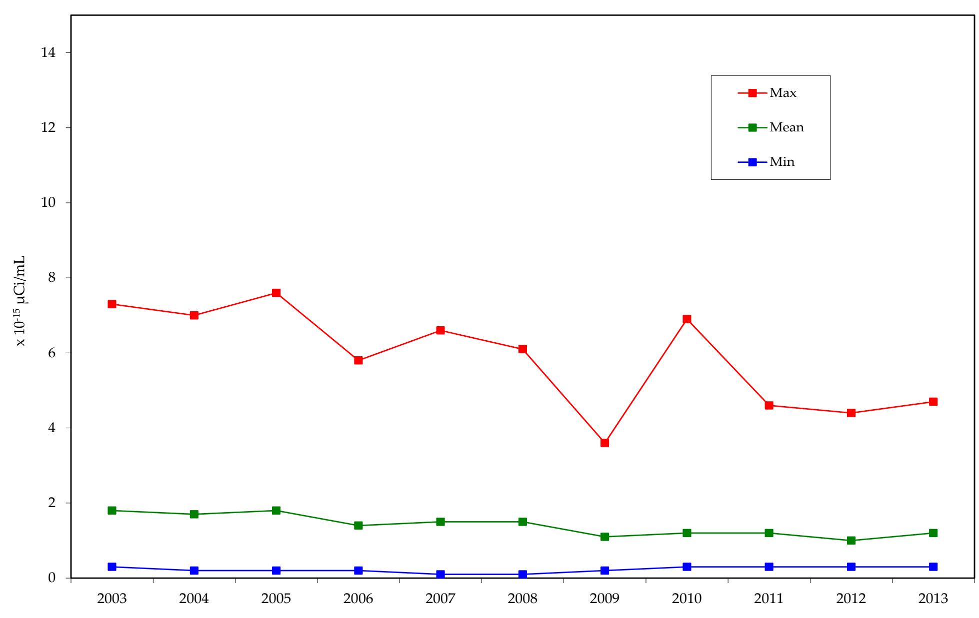

Figure 7-3. Historical trend for gross alpha analysis for all CEMP stations

The mean annual gross beta activity across all sample locations (Table 7-2) was $1.93 \pm 0.18 \times 10^{-14}$ µCi/mL ($7.14 \pm 0.67 \times 10^{-4}$ Bq/m^3). Gross beta activity was detected in all air samples and, overall, was similar to previous years' levels. The spike evident in the maximum data for 2011, which also had some effect on the mean data, was due to the tsunami-damaged Fukushima Nuclear Power Plant accident in Japan. Figure 7-4 shows the long-term maximum, mean, and minimum beta trend for the CEMP stations as a whole.

Table 7-2. Gross beta results for the CEMP offsite ASN in 2013

Sampling Location	Number of Samples	Concentration (× 10^{-14} µCi/mL [3.7 × 10^{-4} Bq/m^3]) Mean	Standard Deviation	Minimum	Maximum
Alamo	23	1.84	0.44	1.22	3.22
Amargosa Valley[a]	20	2.01	0.34	1.49	2.61
Beatty	23	1.83	0.41	1.24	2.90
Boulder City[a]	20	1.91	0.48	1.26	2.89
Caliente	22	1.96	0.62	1.06	3.62
Cedar City	22	1.51	0.38	1.04	2.78
Delta[a]	20	2.05	1.53	1.15	6.54
Duckwater[a]	20	1.91	0.57	0.67	3.02
Ely[a]	20	1.66	0.36	0.58	2.23
Goldfield	22	1.86	0.58	1.04	3.03
Henderson[a]	20	1.95	0.58	0.93	3.44
Indian Springs[a]	20	1.99	0.36	1.21	2.81
Las Vegas	23	1.97	0.43	1.45	3.05
Mesquite	23	2.37	0.63	1.46	3.50
Milford[a]	20	2.06	1.30	1.25	6.87
Overton[a]	19	2.25	0.54	1.31	3.42
Pahrump[a]	20	1.70	0.49	0.50	2.78
Pioche	23	1.98	0.56	1.16	3.49
Rachel	23	1.86	0.63	1.06	3.46
Sarcobatus Flats	23	1.96	0.50	1.16	2.96
St. George	23	2.04	0.74	1.28	3.72
Tecopa[a]	20	1.89	0.51	1.35	3.16
Tonopah	23	1.73	0.42	1.05	2.56

Network Mean = $1.93 \pm 0.18 \times 10^{-14}$ µCi/mL
Mean MDC = 0.04×10^{-14} µCi/mL **Standard Error of Mean MDC = 0.004×10^{-14} µCi/mL**

(a) Stations converted to quarterly sampling in October 2013

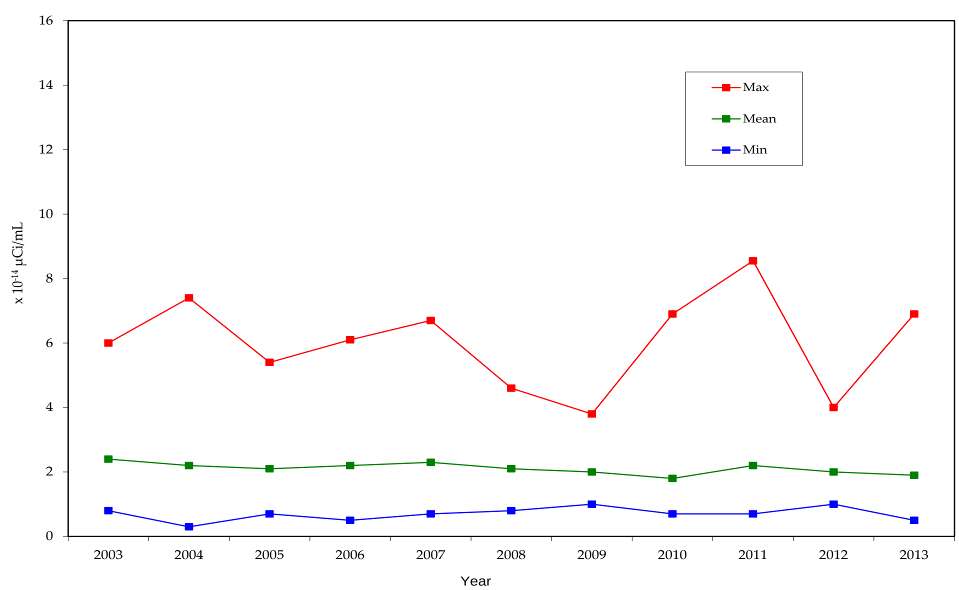

Figure 7-4. Historical trend for gross beta analysis for all CEMP stations

The mean gross alpha results show a generally decreasing trend for the past 10 years from 2003 to 2013. Except for the increase in the mean and maximum values in 2011 data due to the Japan nuclear accident, the gross beta results have been essentially level for the same time period. These trends are also reflected by most of the stations on an individual basis.

7.1.4.2 Gamma Spectroscopy

Gamma spectroscopy analysis was performed on all samples from the low-volume air sampling network. Generally, the filters were composited by station on a quarterly basis after gross alpha/beta analysis. As in previous years, man-made gamma-emitting radionuclides were not detected in any samples. In most of the samples, naturally occurring beryllium-7 (^{7}Be) was detectable. 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 $0.36 \pm 0.09 \times 10^{-13}$ μCi/mL.

7.1.5 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 (3.3 ft) above the ground and are exchanged quarterly. TLD results are not presented for the Warm Springs Summit station at this time because 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 2013 ranged from 72 milliroentgens (mR) (0.72 millisieverts [mSv]) at Pahrump, Nevada, to 149 mR (1.49 mSv) at Sarcobatus Flats, Nevada, with a mean annual exposure of 115 mR (1.15 mSv) for all operating locations. Results are summarized in Table 7-3 and are consistent with previous years' data. Figure 7-5 shows the long-term trend for the CEMP stations as a whole.

Table 7-3. TLD monitoring results for the CEMP offsite ASN in 2013

Sampling Location	Number of Quarters	Estimated Annual Exposure (mR)[a] Mean[b]	Minimum[b]	Maximum[b]
Alamo	4	115	112	119
Amargosa Valley	4	105	100	109
Beatty	4	139	137	142
Boulder City	4	107	105	109
Caliente	4	113	106	119
Cedar City	4	93	88	100
Delta	4	93	90	97
Duckwater	4	115	107	119
Ely	4	103	99	105
Goldfield	4	122	116	128
Henderson	4	113	111	119
Indian Springs	4	97	92	100
Las Vegas	4	98	95	101
Mesquite	4	104	100	109
Milford	4	137	133	142
Overton	4	94	89	100
Pahrump	4	77	72	82
Pioche	4	117	110	120
Rachel	4	126	119	130
Sarcobatus Flats	4	144	141	149
St. George	4	84	79	87
Tecopa	4	107	104	110
Tonopah	4	133	128	136

(a) To obtain daily exposure rates, divide annual exposure rates by 365
(b) Mean, minimum, and maximum values are from quarterly estimates

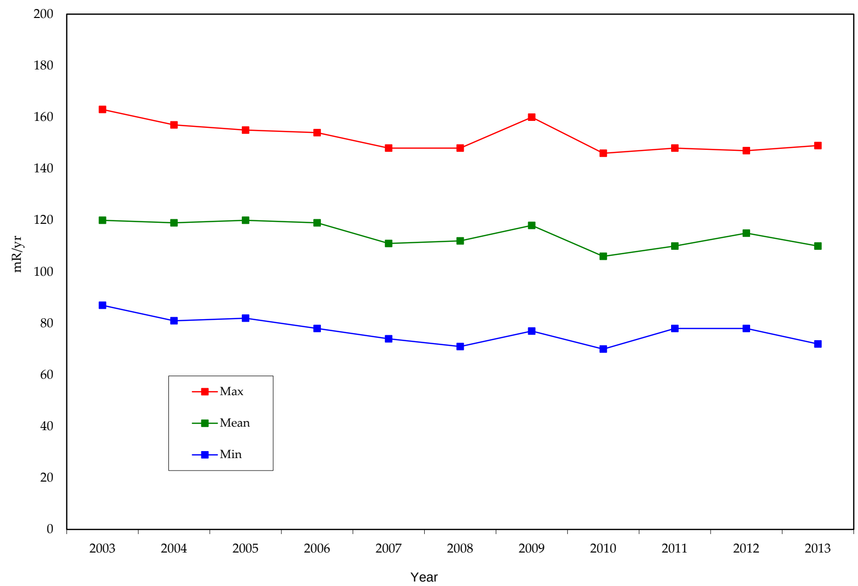

Figure 7-5. Historical trend for TLD analysis for all CEMP stations

Overall, the TLD data show a generally decreasing trend for the past 10 years from 2003 to 2013. The 2013 results are slightly lower than 2012, but continue to be consistent with previous data. The TLD trends generally mirror those for gross alpha and beta analyses.

7.1.6 PIC Results

The PIC data presented in this section are based on daily averages of gamma exposure rates from each station. Table 7-4 contains the maximum, minimum, and standard deviation of daily averages (in microroentgens per hour [µR/hr]) for the periods during 2013 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 71.83 mR/yr (0.72 mSv/yr) in Pahrump, Nevada, to 173.01 mR/yr (1.73 mSv/yr) at Warm Springs, 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 7-5. The annual exposure levels observed at the CEMP stations in 2013 are well within these United States background levels, and are consistent with previous years' exposure rates. Increases of greater than 10% in annual averages relative to the averages for 2012 at the Delta and Tecopa stations are attributable to the replacement of PICs at both those stations during the latter half of 2012. Sensitivity differences of 10%–15% between calibrated PICs are not unusual when measuring ionizing radiation at very low environmental levels.

Table 7-4. PIC monitoring results for the CEMP offsite ASN in 2013

	Daily Average Gamma Exposure Rate (µR/hr)				Annual Exposure (mR/yr)
Sampling Location	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**	
Alamo	13.80	0.04	12.5	15.1	120.89
Amargosa Valley	11.65	0.21	10.8	12.50	102.05
Beatty	17.30	0.27	15.80	18.8	151.55
Boulder City	16.70	0.41	14.9	18.5	146.29
Caliente	16.00	0.27	15.1	16.9	140.16
Cedar City	11.10	0.27	10.1	12.1	97.24
Delta	12.60	0.29	11.5	13.7	110.38
Duckwater	14.75	0.50	13.4	16.1	129.21
Ely	12.40	0.33	11.1	13.7	108.62

Table 7-4. PIC monitoring results for the CEMP offsite ASN in 2013 (continued)

	Daily Average Gamma Exposure Rate (µR/hr)				Annual Exposure (mR/yr)
Sampling Location	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**	
Goldfield	15.30	0.42	14.0	16.6	134.03
Henderson	14.65	0.26	13.7	15.6	128.33
Indian Springs	11.45	0.25	10.6	12.3	100.30
Las Vegas	11.65	0.22	10.8	12.5	102.05
Mesquite	11.95	0.18	11.3	12.6	104.68
Milford	17.50	0.45	15.9	19.1	153.30
Overton	12.30	0.22	11.5	13.1	107.75
Pahrump	8.20	0.17	7.7	8.7	71.83
Pioche	14.85	0.37	13.6	16.1	130.09
Rachel	15.80	0.41	14.5	17.1	138.41
Sarcobatus Flats	16.90	0.21	16.2	17.6	148.04
St. George	10.15	0.23	9.3	11.0	88.91
Tecopa	13.20	0.20	12.7	13.7	115.63
Tonopah	16.10	0.29	15.2	17.0	141.04
Warm Springs Summit	19.75	0.42	18.6	20.9	173.01

Table 7-5. Average natural background radiation for selected U.S. cities (excluding radon)

City	Annual Exposure (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: 3/17/2014)

7.1.7 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 impacts from radionuclides from NNSA/NFO activities. Activity observed in gross alpha and beta analyses of low-volume air sampler filters was consistent with previous years' results and is within the range of activity found in other communities of the United States that are not adjacent to man-made radiation sources. Likewise, no man-made gamma-emitting radionuclides were detected. 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 7-5).

Occasional elevated gamma readings (10%–50% above normal average background) detected by the PICs in 2013 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 7-6, generated from the CEMP website, illustrates an example of this phenomenon.

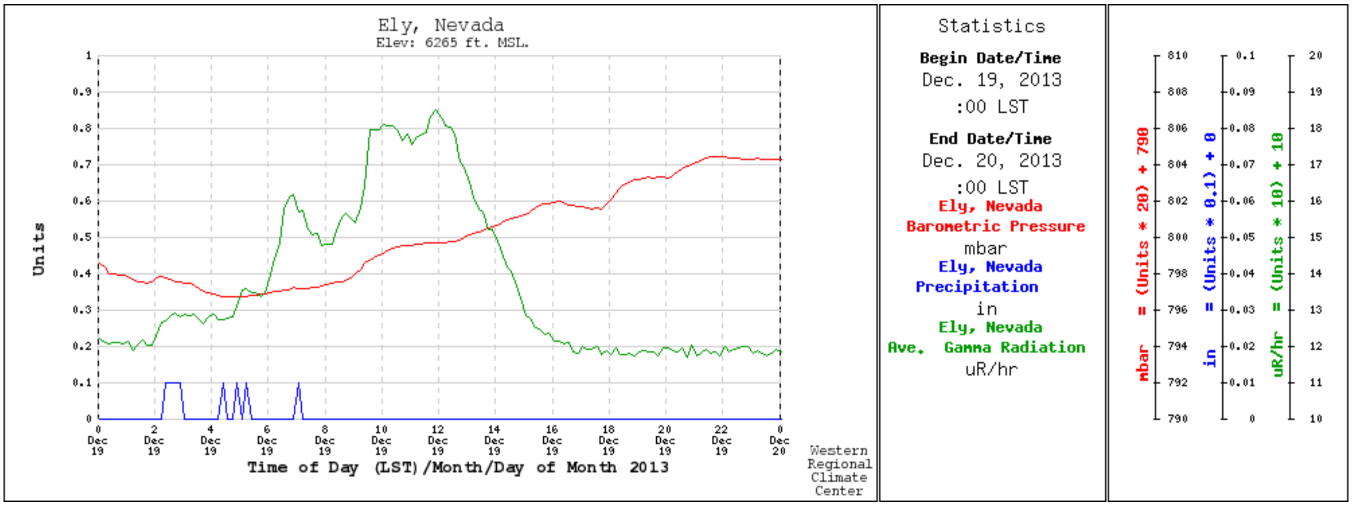

Figure 7-6. The effect of meteorological phenomena on background gamma readings

7.2 Offsite Surface and Groundwater Monitoring

The CEMP monitors offsite groundwater wells, surface waters, and springs used for water supplies in areas surrounding the NNSS. Like the CEMP air monitoring program, CEMP water monitoring is a non-regulatory public informational and outreach program. It provides the public with data regarding the presence of man-made radionuclides that could be the result of past nuclear testing on the NNSS. Water samples are collected by DRI personnel and analyzed for tritium. Tritium is one of the most abundant radionuclides generated by an underground nuclear test, and because it is a constituent of the water molecule itself, it is also one of the most mobile. DRI provides public access to water monitoring data through CEMP's website at http://www.cemp.dri.edu/.

7.2.1 2013 Sample Location Evaluations and Changes

As mentioned in Section 7.1.1, all radiation monitoring equipment was removed from the CEMP ranch stations in 2012. Concurrently, radiological monitoring at water sources identified by ranchers at these sites was discontinued, making 2012 the final year that the three springs (Adaven Springs, Medlin's Ranch, Stone Cabin Ranch) and two wells (Nyala Ranch and Twin Springs Ranch) associated with these sites were sampled. All of these locations are in areas that occur up-gradient from the NNSS and therefore do not receive groundwater flowing from any of the historical underground testing areas on the NNSS (see Figure 7-7, which depicts the general direction and relative volume of the groundwater flow systems beneath the NNSS).

Discussions began in 2013 with the CEMs to solicit their input on the proposal to discontinue water sampling in all other locations that are up-gradient of the NNSS and to focus on locations that may receive groundwater flowing downgradient from the NNSS (see Figure 7-7). This proposal will consider increasing future water sampling activities in more relevant areas such as Beatty and Amargosa Valley, which are down-gradient of the NNSS. It is expected that these changes will be implemented in 2014.

7.2.2 Sample Locations and Methods

During the period of June 5 to September 9, 2013, DRI sampled 1 spring (Ely), 3 surface water bodies either directly or through municipal water supply systems (Boulder City, Henderson, and St. George), and 19 wells (Table 7-6). Sample locations were selected based upon input from the CEMs participating in the CEMP project and the relative location of the public water source to the NNSS. All wells were sampled using 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 7-6 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 7-7.

Table 7-6. CEMP water monitoring locations sampled in 2013

Monitoring Location Description	Latitude	Longitude	Date Sampled	Sample Collection Method
Alamo city water supply system—source of water is municipal well field	37°21.35"	−115°10.24"	8/07/2013	By hand from municipal water well #007 Sandhill, different than 2012.
Amargosa Valley school well	36°34.16"	−116°27.66"	8/29/2013	By hand at wellhead at the school.
Beatty Water and Sewer municipal water distribution system	36°54.56"	−116°45.39"	6/10/2013	By hand at wellhead at Well #1, backup well. Different than 2012.
Boulder City municipal water distribution system	35°59.74"	−114°49.90"	6/05/2013	By hand from a drinking fountain inside Hemenway Park; water originates from Lake Mead.
Caliente municipal water supply well	37°37.01"	−114°30.44"	6/17/2013	By hand at well in municipal well field.
Cedar City municipal water supply well about 12 kilometers (km) (7.5 miles [mi]) west of town	37°39.21"	−113°13.58"	6/18/2013	By hand at wellhead.
Delta municipal well	39°20.73"	−112°32.34"	6/18/2013	By hand at wellhead.
Duckwater water supply well	38°55.41"	−115°41.99"	8/22/2013	By hand at faucet inside pump house.
Ely municipal water supply	39°14.10"	−114°53.71"	8/22/2013	Sampled from municipal water supply. Springs are origin of municipal water supply. Location different than 2012.
Goldfield municipal water supply well about 18 km (11 mi) north of town	37°52.41"	−117°14.75"	8/19/2013	By hand at wellhead, Klondike #2.
Henderson municipal water distribution system	36°00.43"	−114°57.95"	6/11/2013	By hand from faucet inside building of College of Southern Nevada; water originates from Lake Mead.
Indian Springs municipal well	36°34.19"	−115°40.08"	8/05/2013	By hand at wellhead.
Las Vegas Valley Water District #103	36°13.94"	−115°15.13"	7/31/2013	By hand at wellhead.
Mesquite municipal water supply well 3 km (2 mi) southeast of town	36°46.40"	−114°03.26"	8/14/2013	By hand at wellhead.
Milford municipal well	38°22.88"	−112°59.78"	9/09/2013	By hand at wellhead.
Overton water well located at Arrow Canyon approximately 32 km (20 mi) west of town	36°44.06"	−114°44.87"	8/14/2013	By hand at wellhead.
Pahrump municipal water system	36°11.29"	−115°57.95"	8/29/2013	By hand at wellhead.
Pioche municipal well	37°56.97"	−114°25.76"	6/17/2013	By hand at wellhead.
Rachel—Little A'Le'Inn well	37°38.79"	−115°44.75"	6/28/2013	By hand from faucet inside Little A'Le'Inn Restaurant.
Sarcobatus Flats well	37°16.76"	−117°01.10"	8/19/2013	By hand at wellhead.
St. George municipal water distribution system	37°10.47"	−113°23.92"	6/19/2013	By hand at water treatment plant; water originates from Quail Creek Reservoir.
Tecopa residential well	35°50.52"	−116°13.38"	8/05/2013	By hand at residential source. Location different than 2012.
Tonopah public utilities well field located approximately 19 km (12 mi) from town	38°11.68"	−117°04.70"	7/24/2013	By hand at wellhead.

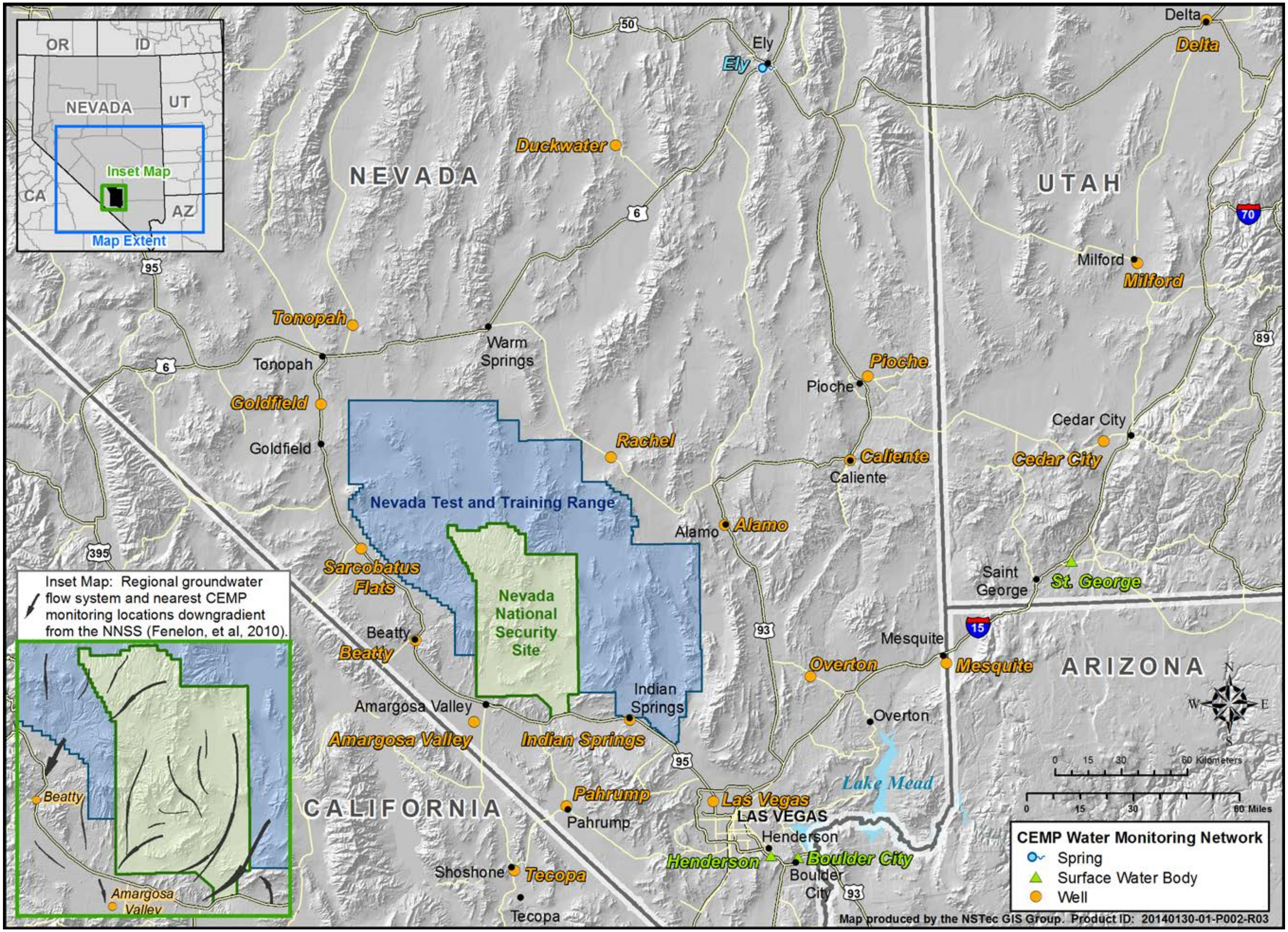

Figure 7-7. 2013 CEMP water monitoring locations

Samples collected in 2013 were analyzed using enriched gas proportional counting at the University of Miami Tritium Laboratory. Samples taken prior to 2008 were analyzed using gas proportional counting or enriched liquid scintillation counting. Enriched gas proportional counting significantly lowers the detection limit, improving confidence in the reported results, especially for samples containing little or no tritium. The decision level (L_C) (see Glossary, Appendix B) for this counting process was 0.65 picocuries per liter (pCi/L). The L_C is established solely based on the variability of multiple measures of samples used to establish laboratory background. If a sample exceeds this threshold, then it is considered to be distinguishable from background. The MDC (see Glossary, Appendix B) for tritium was approximately 1.12 pCi/L and is a more rigorous threshold that dictates that the sample be distinguishable from background at a confidence of 95%. The MDC considers both the variability associated with multiple measures of the background as well as the variability associated with multiple measures of the sample itself. Chapter 17 discusses the quality assurance and control procedures used for sampling groundwater.

7.2.3 Results of Surface Water and Spring Discharge Monitoring

Measured tritium concentrations from the spring and surface waters sampled in 2013 ranged from 2.7 to 23.3 pCi/L (Table 7-7). All samples yielded results that were quantifiably above background (i.e., ≥ MDC). 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 NNSS environmental reports (http://www.nv.energy.gov/library/publications/aser.aspx) and are due to a combination of the natural production of tritium in the upper atmosphere and the 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.All samples were analyzed for the presence of trends with respect to samples collected in previous years. The results are consistent with samples collected and analyzed using enriched gas proportional counting over the period of 2008 through 2013. The major difference between 2012 and 2013 was tritium results from Ely declined by 2 pCi/L. The sample location for Ely was moved in 2013, which may be partially contributing to the difference in the reported tritium activity. The 2008 through 2013 results differ from those of previous years due to the use of an improved analytical method (enriched gas proportional counting) rather than to any real change in the activity of the water being monitored. Public access to the monitoring data is available on the DRI CEMP website at http://www.cemp.dri.edu/.

Table 7-7. Tritium results for CEMP offsite surface water and spring discharges in 2013

Monitoring Location	^{3}H (pCi/L)
Ely municipal water source	2.7
Boulder City municipal water distribution system	21.9
Henderson municipal water distribution system	23.3
St. George municipal water distribution system	7.8

MDC = 1.12 pCi/L for all samples

7.2.4 Results of Groundwater Monitoring

Tritium analyses from the University of Miami Tritium Laboratory for the 19 groundwater samples yielded results that were quantifiably below background (≤ the MDC of 1.12 pCi/L) in all but one sample from Caliente (Table 7-8). The tritium activity for Caliente is slightly less than the long-term average for the period of 2008 through 2012 (4.7 pCi/L). These results indicate that tritium present in water samples from Caliente is likely due to the presence of some combination of natural atmospheric production of tritium and tritium originating from global atmospheric testing in waters that have recharged sometime over the last 68 years (since 1945).

Table 7-8. Tritium results for CEMP offsite wells in 2013

Monitoring Location	^{3}H (pCi/L)
Alamo City	<1.12
Amargosa Valley	<1.12
Beatty	<1.12
Caliente	4.32
Cedar City	<1.12
Delta	<1.12
Duckwater	<1.12
Goldfield	<1.12
Goldfield	<1.12
Indian Springs	<1.12
Las Vegas	<1.12
Mesquite	<1.12
Milford	<1.12
Overton	<1.12
Pahrump	<1.12
Pioche	<1.12
Rachel	<1.12
Sarcobatus Flats	<1.12
Tecopa	<1.12
Tonopah	<1.12

MDC = 1.12 pCi/L for all samples

7.2.5 Environmental Impact

As in previous years, the wells and water supply systems within the CEMP monitoring network showed no evidence of tritium contamination from past underground nuclear testing on the NNSS. However, in 2009, tritium was detected off site in the Underground Test Area characterization well, ER-EC-11, which is approximately 700 m (2,297 ft) west of the NNSS on the Nevada Test and Training Range (see Section 11.1.4.2). The nearest CEMP water monitoring locations that are downgradient of the NNSS nuclear testing areas are Amargosa Valley and Beatty, approximately 67 km (42 mi) and 38 km (24 mi), respectively, southwest of Well ER-EC-11.

Among the CEMP offsite water monitoring locations, detectable tritium activities were most often found in surface waters that appear to be impacted by some combination of ongoing natural atmospheric production of tritium and contribution of atmospheric tritium to groundwater systems through recharge that occurred sometime over the last 60 years. This groundwater must then be contributing to the surface water body being sampled. Spring discharge or wells containing tritium are likely accessing groundwater systems that may have some component of recharge that has occurred sometime over the last 60 years. Most of the groundwater samples analyzed were below the L_C for tritium (see Table 7-8). The single groundwater sample from Caliente that exceeded the MDC is part of a groundwater flow system separate from the systems beneath the NNSS.

7.3 References

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.

National Security Technologies, LLC, 2013. *Nevada National Security Site Environmental Report 2012*. DOE/NV/25946--1856, prepared for U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office, Las Vegas, NV. OSTI ID: 1092497

Chapter 8: Radiological Biota Monitoring

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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 National Security Site (NNSS) plants and animals (biota). U.S. Department of Energy (DOE) Order DOE O 458.1, "Radiation Protection of the Public and the Environment," requires that 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. DOE O 458.1 also requires monitoring to ensure aquatic and terrestrial plant and animal (biota) populations are protected from excessive radiological dose.

Current NNSS land use practices discourage the harvest of plants or plant parts (e.g., pine nuts and wolf berries) for direct consumption by humans. Some edible plant material may be taken off site and consumed, but this is generally not allowed and, if it does occur, is very limited. Game animals on the NNSS may travel off the site and become available through hunting for consumption by the public, which makes the ingestion of game animals the primary potential biotic pathway for potential dose to the public.

Plants and game animals are monitored under the *Routine Radiological Environmental Monitoring Plan* (RREMP) (Bechtel Nevada [BN] 2003). They are sampled annually from contaminated NNSS sites to estimate doses to persons potentially consuming them, to measure the potential for radionuclide transfer through the food chain, and to determine if NNSS biota are exposed to radiation levels harmful to their own populations. Biota and soil samples from the Radioactive Waste Management Sites (RWMSs) are also periodically collected to assess the integrity of waste disposal cells. 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 analysis results from 2013. The estimated dose to humans potentially consuming NNSS plants and animals and the dose to biota from these radionuclides are presented in Chapter 9.

Radiological Biota Monitoring Goals
Collect and analyze biota samples for radionuclides to estimate the potential dose to humans who may consume plants or game animals from the NNSS (see Chapter 9 for the estimates of dose to humans).
Collect and analyze biota samples for radionuclides to estimate the absorbed radiation dose to NNSS biota (see Chapter 9 for the estimates of dose to NNSS plants and animals).
Collect and analyze soil samples at the Area 3 and Area 5 RWMSs to provide evidence that the burrowing activities of fossorial animals have or have not compromised the integrity of the soil covered waste disposal units.

8.1 Species Selection

The goal for vegetation monitoring is to sample the plants most likely to have the highest contamination within the NNSS environment. They are generally found inside demarcated radiological areas near the "ground zero" locations of historical aboveground or near-surface 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 tritium (^{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 sampled when present because they are also a source of food for wildlife. Plant parts collected for analysis represent new growth over the past year. Pine nuts from singleleaf pinyon pine trees, which may be consumed by humans, are also sampled periodically.

The game animals monitored to assess the potential dose to the public meet three criteria: (1) they have a relatively high probability of entering the human food chain; (2) they 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) they are sufficiently abundant at a site to acquire an adequate tissue sample for laboratory analysis. These criteria limit the candidate game animals to those listed in Table 8-1. Mule deer, pronghorn antelope, and predatory game animals such as mountain lions are only collected as the opportunity arises if they are found dead on the NNSS (e.g., from accidentally being hit by a vehicle). Tissues from species analogous to big game, such as feral horses, may be collected opportunistically as well. If game animals are not sufficiently abundant at a particular site or at a particular time, non-game small mammals may be used as an analog (Table 8-1).

A mountain lion radio-telemetry study is being conducted on the NNSS (see Chapter 15, Table 15-2). Tissue samples from the carcasses of game animals killed by the radio-tracked mountain lions are analyzed for radionuclides whenever possible, and blood collected from captured mountain lions before they are released with radio-collars are analyzed for ^{3}H. Mountain lion fecal samples (scat) are collected near sites where they had made a kill, if available. The scat are analyzed for ^{3}H to determine if the mountain lion had been exposed to ^{3}H. Soil near the scat is also sampled and analyzed for ^{3}H to determine if it could have contaminated the fecal sample.

When determining the potential dose to biota, the goal of sampling is to select species that are most exposed and most sensitive to the effects of radiation. In general, mammals and birds are more sensitive to radiation than fish, amphibians, or invertebrates (DOE Standard DOE-STD-1153-2002, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota"). Because of this, and because no native fish or amphibians are found on the NNSS, the species in Table 8-1 are used to assess potential dose to animals.

The sampling strategy used to assess the integrity of radioactive waste containment includes sampling plants, animals, and soil excavated by ants or small mammals on top of waste covers. Plants are generally selected by size with preference for larger shrubs under the assumption that they have deeper roots and therefore would be more likely to penetrate waste. Small mammals selected for sampling meet three criteria: (1) they are fossorial (i.e., they burrow and live predominantly underground), (2) they have a home range small enough to ensure that they reside a majority of the time on the waste disposal site, and (3) they are sufficiently abundant at a site to acquire an adequate tissue sample for laboratory analysis. These criteria limit the animals to those listed in Table 8-1. Soils excavated by ants or small mammals are also selected for sampling on the basis of size, with preference for larger ant mounds and animal burrow sites under the assumption that these burrows are deeper and have a higher potential for penetrating waste.

Table 8-1. NNSS animals monitored for radionuclides

Small Mammals	Large Mammals	Birds
Game Animals Monitored for Dose Assessments		
Cottontail rabbit (*Sylvilagus audubonii*) Jackrabbit (*Lepus californicus*)	Mule deer (*Odocoileus hemionus*) Pronghorn antelope (*Antilocapra americana*) Mountain lion (*Puma concolor*) Bighorn sheep (*Ovis canadensis nelsoni*) Bobcat (*Lynx rufus*)	Mourning dove (*Zenaida macroura*) Chukar (*Alectoris chukar*) Gambel's quail (*Callipepla gambelii*)
Animals Monitored for Integrity of Radioactive Waste Containment or as Game Animal Analogs		
Kangaroo rats (*Dipodomys* spp.) Mice (*Peromyscus* spp.) Antelope ground squirrel (*Ammospermophilus leucurus*) Desert woodrat (*Neotoma lepida*)		

8.2 Site Selection

The monitoring program 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. Each year, biota from one or two of these sites is sampled, and each of the five sites is sampled once every 5 years. They are E Tunnel Ponds, Palanquin/ Schooner Crater, Sedan Crater, T2, and Plutonium Valley (Figure 8-1), and each is associated with one type of a legacy contamination area (see 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.

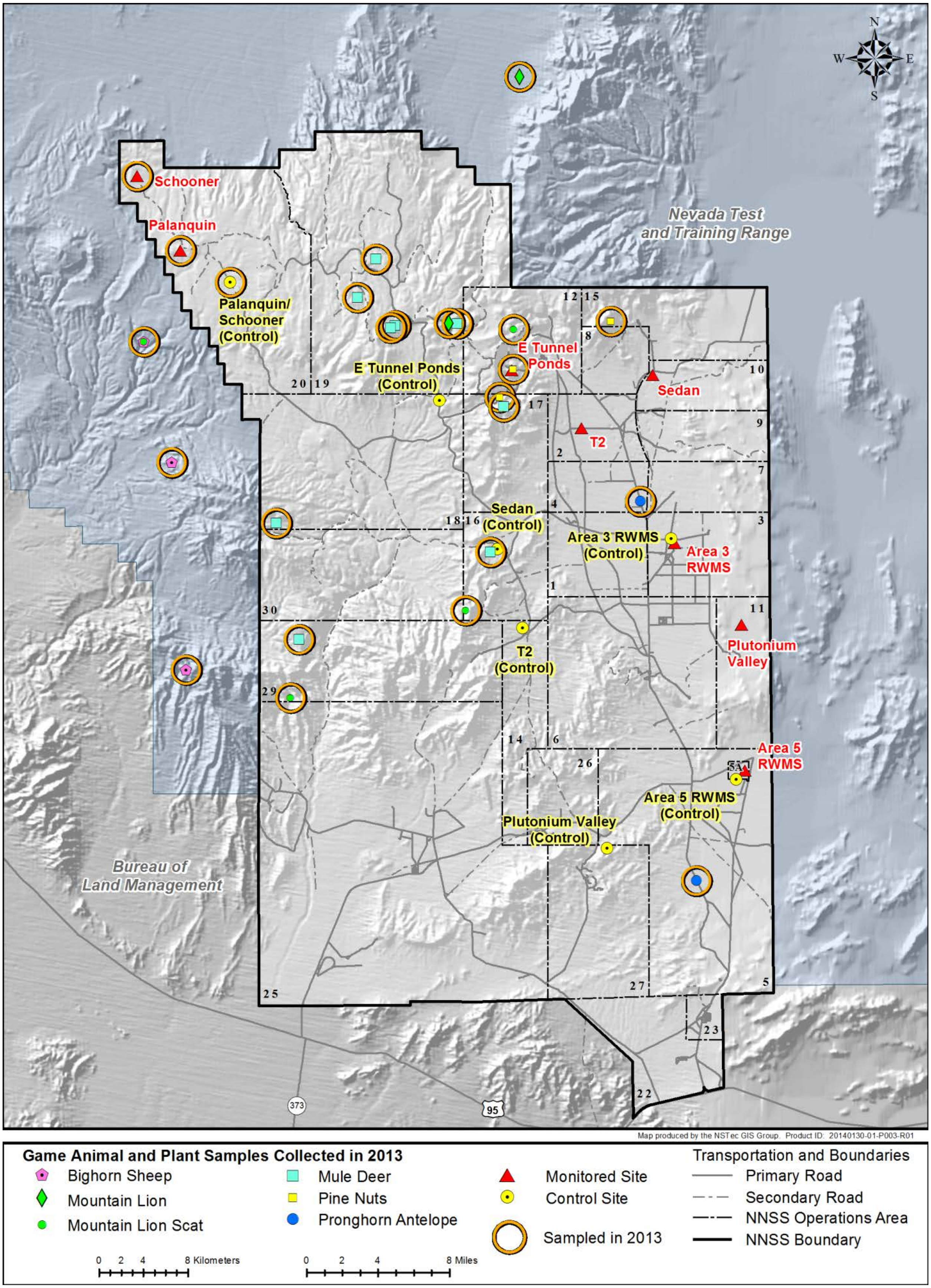

Figure 8-1. Radiological biota monitoring sites on the NNSS

- **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 NNSS. 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 2012.
- **Plowshare sites in alluvial fill at lower elevations with high surface contamination.** The historical Plowshare program, conducted throughout the NNSS, explored the potential use of nuclear weapons for peaceful purposes. Subsurface nuclear detonations at these alluvial, low elevation sites have distributed contaminants over a wide area, usually in the lowest precipitation areas of the NNSS. The associated monitoring site is Sedan Crater in Yucca Flat. It was last sampled in 2010.
- **Plowshare sites in bedrock or rocky fill at higher elevations with high surface contamination.** Subsurface nuclear detonations at these Plowshare program sites distributed contaminants over a wide area, usually in the highest precipitation areas of the NNSS. Two monitored sites are in this category: Palanquin Crater and Schooner Crater. Both sites were sampled in 2013.
- **Atmospheric test areas.** These sites have highly disturbed soils due to the removal of topsoil during historical cleanup efforts and due 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 2011.
- **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 for biota in 2009.

Soil sampling is also conducted periodically at radioactive waste disposal locations on the NNSS to assess whether fossorial small mammals are being exposed to buried wastes and, therefore, whether the integrity of waste containment is compromised. Two radioactive waste disposal facilities are sampled:

- **Area 3 RWMS.** Waste disposal cells within the Area 3 RWMS are subsidence craters resulting from underground nuclear testing. Two closed cells containing bulk low-level radioactive waste are craters U-3ax and U-3bl, which were combined to form the U-3ax/bl disposal unit (Corrective Action Unit 110). U-3ax/bl is covered with a vegetated, native alluvium closure cover that is at least 2.4 meters (m) (8 feet [ft]) thick. It was last sampled in 2009.
- **Area 5 RWMS.** Waste disposal has occurred at the Area 5 RWMS since the early 1960s. There are 11 closed disposal cells containing bulk low-level radioactive waste. The cells are unlined pits and trenches that range in depth from 4.6 to 15 m (15 to 48 ft). The unvegetated soil cover caps for the pits and trenches are approximately 2.4 m (8 ft) thick. Three pits and one trench were last sampled in 2009.

8.3 2013 Biota Sampling and Analysis

In 2013, the Palanquin and Schooner craters were sampled as representative Plowshare program sites in bedrock or rocky fill at higher elevation (Figure 8-1). Both craters are located in Area 20 in the northwest portion of the NNSS and are the result of near-surface detonations used to test if nuclear weapons could be used to excavate large volumes of soil. The soils at these sites are contaminated with fission and activation products as well as plutonium and americium. The control site used for these locations is about 12 kilometers (7.5 miles) southeast of the Schooner Crater. It is in similar habitat (partially disturbed) in Area 20. Any one of the candidate game species is likely to be present at the crater and control sites.

Three additional locations were sampled for pine nuts in 2013 that included stands of singleleaf pinyon pine trees at the E Tunnel Ponds and in portions of Area 15 and Area 17 (Figure 8-1).

In 2013, no biota or soil sampling was conducted at the Area 3 or Area 5 RWMSs. The last sampling of the RWMSs in 2009 did not suggest that burrowing animals had come into contact with buried waste (NSTec 2010).

8.3.1 Plants

On June 26, 2013, three composite plant samples were collected from each of the Palanquin, Schooner, and control locations. On August 29, 2013, a composite pine nut sample was collected from each of three locations: E Tunnel Ponds, Area 15, and Area 17 (Figure 8-1). Sampled species represent the dominant vegetation at each site (Table 8-2). All samples consisted of about 150 to 500 grams (5.3 to 17.6 ounces) of fresh-weight plant material collected from many plants of the same species found along meandering transects about 100 to 250 m long.

Plant leaves and stems from plants at the Palanquin, Schooner, and control sites as well as pinyon pine cones and nuts (seeds) from near the E Tunnel Ponds and in Areas 15 and 17 were hand-picked and stored in airtight Mylar bags. Rubber gloves were used by samplers and changed between each composite sample. 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 the samples by distillation, and the water and dried plant tissues were submitted to a commercial laboratory for analysis. Water from plants was analyzed for ^{3}H. Dried plant tissue was submitted for analysis of americium-241 (^{241}Am), strontium-90 (^{90}Sr), plutonium-238 (^{238}Pu), plutonium-239+240 ($^{239+240}$Pu), and gamma emitting radionuclides (including cesium-137 [^{137}Cs]).

Table 8-2. Plant samples collected in 2013

Common Name	Scientific Name	Name Code	Palanquin	Schooner	Palanquin/ Schooner Control	E Tunnel Ponds	Area 15	Area 17
Indian ricegrass	*Achnatherum hymenoides*	ACHY	X	X	X			
Basin big sagebrush	*Artemisia tridentata*	ARTR	X		X			
Rubber rabbitbrush	*Ericameria nauseosus*	ERNA		X	X			
Hoary tansyaster	*Machaeranthera canescens*	MACA	X					
Singleleaf pinyon (pine nuts)	*Pinus monophylla*	PIMO				X	X	X
Desert globe mallow	*Sphaeralcea ambigua*	SPAM		X				

As expected, concentrations of man-made radionuclides were higher in samples from the Palanquin and Schooner sites compared with the control site (Table 8-3). The Schooner site had much higher ^{3}H concentrations, and to a lesser extent higher ^{90}Sr concentrations, in plants than at the Palanquin site. The opposite was true for ^{238}Pu, $^{239+240}$Pu, and ^{241}Am. Concentrations of these were much higher in plants from the Palanquin site compared with the Schooner site. The only man-made radionuclide detected (i.e., radionuclide concentration greater than the laboratory-reported minimum detectable concentration [MDC]; see Glossary, Appendix B) at the control site was ^{90}Sr in the basin big sagebrush (ARTR) sample. Though detected, the concentration was very low and is consistent with global fallout levels.

Table 8-3. Concentrations of man-made radionuclides in plants sampled in 2013

Sample	Radionuclide Concentrations ± Uncertainty[(a)] ^{3}H (pCi/L)[(b)]	^{90}Sr (pCi/g)[(c)]	^{137}Cs (pCi/g)[(c)]	^{238}Pu (pCi/g)[(c)]	$^{239+240}$Pu (pCi/g)[(c)]	^{241}Am (pCi/g)[(c)]
Palanquin						
ACHY	1,440 ± 306	0.30 ± 0.09	0.03 ± 0.22	0.034 ± 0.014	0.047 ± 0.016	0.020 ± 0.011
ARTR	429 ± 224	0.37 ± 0.08	0.11 ± 0.11	0.051 ± 0.015	0.064 ± 0.017	0.027 ± 0.017
MACA	42 ± 196	0.17 ± 0.05	0.54 ± 0.41	0.063 ± 0.019	0.332 ± 0.047	0.149 ± 0.031
Average Concentration	637	0.28	0.23	0.049	0.147	0.065
Average MDC[(d)]	345	0.06	0.41	0.010	0.012	0.016

Table 8-4. Concentrations of man-made radionuclides in plants sampled in 2013 (continued)

	Radionuclide Concentrations ± Uncertainty[a]					
Sample	^{3}H (pCi/L)[b]	^{90}Sr (pCi/g)[c]	^{137}Cs (pCi/g)[c]	^{238}Pu (pCi/g)[c]	$^{239+240}$Pu (pCi/g)[c]	^{241}Am (pCi/g)[c]
Schooner						
ACHY	13,800 ± 1,500	0.23 ± 0.08	0.05 ± 0.16	0.011 ± 0.013	0.005 ± 0.013	0.002 ± 0.010
ERNA	500,000 ± 50,000	0.47 ± 0.11	0.14 ± 0.16	−0.003 ± 0.008	0.011 ± 0.009	0.007 ± 0.008
SPAM	11,500 ± 1,280	0.69 ± 0.14	0.24 ± 0.12	0.045 ± 0.020	0.018 ± 0.014	0.029 ± 0.014
Average Concentration	175,100	0.46	0.14	0.017	0.011	0.013
Average MDC[d]	375	0.06	0.24	0.011	0.015	0.013
Control						
ACHY	−192 ± 184	0.03 ± 0.05	−0.02 ± 0.11	0.000 ± 0.009	0.004 ± 0.011	0.003 ± 0.008
ARTR	−140 ± 183	0.11 ± 0.04	0.10 ± 0.09	0.009 ± 0.013	0.000 ± 0.009	−0.001 ± 0.007
ERNA	−262 ± 174	0.00 ± 0.02	−0.04 ± 0.12	−0.002 ± 0.004	0.002 ± 0.004	0.003 ± 0.008
Average Concentration	−198	0.05	0.01	0.003	0.002	0.002
Average MDC[d]	345	0.05	0.18	0.015	0.014	0.014
E Tunnel Ponds						
PIMO	46,300 ± 4,840	−0.02 ± 0.05	0.05 ± 0.07	−0.001 ± 0.005	0.005 ± 0.009	0.004 ± 0.012
Area 15						
PIMO	−48 ± 123	−0.05 ± 0.05	0.02 ± 0.07	0.001 ± 0.007	0.003 ± 0.008	0.004 ± 0.008
Area 17						
PIMO	−11 ± 132	−0.04 ± 0.04	0.04 ± 0.05	−0.001 ± 0.005	0.000 ± 0.005	−0.003 ± 0.007
Average MDC[d]	257	0.11	0.12	0.013	0.009	0.018

(a) ± 2 standard deviations
(b) picocuries per liter water from sample
(c) picocuries per gram dry weight of sample
(d) the average sample-specific MDC for the radionuclide

8.3.2 Animals

State and federal permits were secured to trap specific small mammals and birds in 2013 and to opportunistically sample large mammal mortalities (e.g., from vehicles or from predation) on the NNSS. Small mammal and bird trapping occurred July through August. Only rabbits were captured (Table 8-4). No game birds (dove, quail, or chukar) were captured. Two cottontail rabbits were collected from each of the Palanquin, Schooner, and control sites. One jackrabbit was also collected from the Palanquin site. Two pronghorn antelope killed by vehicles on the NNSS were also sampled during 2013 (Table 8-4). Though muscle is usually the only portion consumed by humans, the rabbits were homogenized to give a more conservative (higher) estimate of potential dose to someone consuming them (see Section 9.1.1.2). Water was distilled from the homogenized samples and submitted to a laboratory for ^{3}H analysis, and the remaining tissue samples were submitted for ^{90}Sr, ^{238}Pu, $^{239+240}$Pu, ^{241}Am, and gamma spectroscopy analysis.

In addition, game animal and mountain lion samples were collected in conjunction with an ongoing mountain lion study (see Chapter 15, Table 15-2) to supplement the mountain lion habitat use and diet study with information on their exposure to radionuclides. One female mountain lion, NNSS4, was captured and radio-collared in 2012 but was found dead from apparently natural causes in 2013. A muscle tissue sample was taken from this animal. After NNSS4 died, only one other collared male mountain lion remained in the study, NNSS7. NNSS7 was recaptured on June 1 to replace the batteries of his radio collar, and a blood sample was collected for radionuclide analysis at that time. Numerous sites where NNSS7 had made a kill (called kill sites) were visited, and tissue samples from the remains of his prey were sampled whenever possible. Prey species sampled included three bighorn sheep and nine mule deer (Table 8-4). Such tissue samples were generally quite small; therefore, the only analysis conducted on most of them was ^{3}H in water distilled from the sample; these samples are listed as “water” samples in

Table 8-4 under the Sample Description column. In four instances, there was enough muscle tissue available for analysis of ^{3}H, ^{90}Sr, ^{238}Pu, $^{239+240}Pu$, ^{241}Am, and gamma-emitting radionuclides. Six fecal samples (scat) from NNSS7 and six paired soil samples (taken as background for the scat samples) were collected at NNSS7 kill sites (Table 8-4). Only at two kill sites (NNSS7-78 and NNSS7-84) were both adequate prey tissue and mountain lion scat samples found together and sampled.

Table 8-4. Animal samples collected in 2013

Routine Monitoring Samples			
Location	**Sample**	**Collection Date**	**Sample Description**
Palanquin			
	Cottontail rabbit #1	7/11/2013	Whole body
	Cottontail rabbit #2	7/18/2013	Whole body
	Jackrabbit	7/18/2013	Whole body
Schooner			
	Cottontail rabbit #1	7/11/2013	Whole body
	Cottontail rabbit #2	7/11/2013	Whole body
Control			
	Cottontail rabbit #1	7/11/2013	Whole body
	Cottontail rabbit #2	7/17/2013	Whole body
Opportunistic/Mountain Lion Study Samples			
Sample	**Location / Kill Site**	**Collection Date**	**Sample Description**
Pronghorn antelope			
	Area 4	6/3/2013	Muscle tissue from an adult female killed by a vehicle
	Area 5	6/17/2013	Muscle tissue from an adult female killed by a vehicle
Bighorn sheep			
	NTTR / NNSS7-34	2/5/2013	Water from lower leg found at kill site
	NTTR / NNSS7-84	12/3/2013	Water from skull and fur found at kill site
	NTTR / NNSS7-86	12/18/2013	Muscle tissue from leg found at kill site
Mule deer			
	Area 17 / NNSS7-54	7/17/2013	Water from intestine tissue found at kill site
	Area 19 / NNSS7-61	8/13/2013	Water from muscle tissue found at kill site
	Area 19 / NNSS7-62	8/13/2013	Water from lower leg found at kill site
	Area 19 / NNSS7-60	8/15/2013	Water from lower leg found at kill site
	Area 19 / NNSS7-70	9/10/2013	Water from lower leg found at kill site
	Area 16 / NNSS7-73	10/1/2013	Muscle tissue from leg found at kill site
	Area 19 / NNSS7-78	10/28/2013	Water from skull and fur remains found at kill site
	Area 29 / NNSS7-80	11/19/2013	Water from lower leg found at kill site
	Area 18 / NNSS7-87	12/17/2013	Muscle tissue from upper leg found at kill site
Mountain lion NNSS4	NTTR	3/9/2013	Muscle tissue from hind quarter sampled after being found dead from apparently natural causes
Mountain lion NNSS7	Area 19	6/1/2013	Water from blood collected from anesthetized lion at re-capture location
	Area 12 / NNSS7-49	6/20/2013	Water from scat collected near mule deer kill site
	Area 19 / NNSS7-78	10/28/2013	Water from scat and soil collected near mule deer kill site
	Area 29 / NNSS7-82	11/20/2013	Water from scat and soil collected (no prey remains found)
	Area 16 / NNSS7-83	11/27/2013	Water from scat and soil collected near mule deer kill site
	NTTR / NNSS7-84	12/3/2013	Water from scat and soil collected near bighorn sheep kill site
	Area 18 / NNSS7-87	12/17/2013	Water from scat and soil collected near mule deer kill site

Results of the routine animal monitoring are listed in Table 8-5. The same general patterns exist for animal samples from the Palanquin, Schooner, and control sites as observed for plants. Tritium dominated at Schooner, and ^{238}Pu, $^{239+240}$Pu, and ^{241}Am was higher at Palanquin. Man-made radionuclides were detected in both pronghorn antelope sampled during 2013. The pronghorn antelope sampled in Area 4 had elevated ^{3}H, and the pronghorn sampled in Area 5 had a low level of $^{239+240}$Pu, similar to that observed in cottontail rabbits at the control site.

Concentrations of man-made radionuclides in samples collected in conjunction with the mountain lion study are listed in chronological order, by mountain lion, in Table 8-6. Cesium-137 was only detected at low concentrations in the muscle tissue of mountain lion NNSS4. It is uncertain if this is from NNSS operations or from global fallout. Cesium-137 was one of the radionuclides detected on the NNSS after the Fukushima accident in Japan. Tritium was the only man-made radionuclide detected in samples associated with male mountain lion NNSS7. No ^{3}H was observed in the blood sample taken from this animal on June 1, but there was ^{3}H in the scat sample collected on June 20. Between June 1 and June 20, he was known to have preyed on two mule deer fawns and one mature mule deer buck but no samples were collected from these kill sites. Given his locations and the ^{3}H in his scat on June 20, it is likely it came from one of these deer. About a month later (July 17), he preyed on a mule deer with elevated ^{3}H concentrations. That was the last evidence during 2013 that mountain lion NNSS7 was exposed to radionuclides from the NNSS.

Table 8-5. Concentrations of man-made radionuclides in animals sampled during routine monitoring in 2013

	Radionuclide Concentrations ± Uncertainty[(a)]					
Sample	**^{3}H** (pCi/L)[(b)]	**^{90}Sr** (pCi/g)[(c)]	**^{137}Cs** (pCi/g)[(c)]	**^{238}Pu** (pCi/g)[(c)]	**$^{239+240}$Pu** (pCi/g)[(c)]	**^{241}Am** (pCi/g)[(c)]
Palanquin (Area 20)						
Cottontail rabbit #1	215 ± 199	0.12 ± 0.05	0.01 ± 0.06	0.012 ± 0.005	0.031 ± 0.010	0.012 ± 0.005
Cottontail rabbit #2	136 ± 193	0.15 ± 0.05	0.03 ± 0.06	0.033 ± 0.010	0.121 ± 0.026	0.042 ± 0.013
Jackrabbit #1	−10 ± 189	0.13 ± 0.05	0.08 ± 0.07	0.005 ± 0.004	0.016 ± 0.006	0.004 ± 0.004
Average Concentration	114	0.13	0.04	0.017	0.056	0.019
Average MDC[(d)]	318	0.07	0.11	0.003	0.002	0.006
Schooner (Area 20)						
Cottontail rabbit #1	557,000 ± 85,000	0.33 ± 0.09	0.04 ± 0.07	0.022 ± 0.007	0.010 ± 0.005	0.003 ± 0.004
Cottontail rabbit #2	1,240,000 ± 189,000	0.26 ± 0.07	0.11 ± 0.07	0.020 ± 0.007	0.012 ± 0.005	0.012 ± 0.006
Average Concentration	898,500	0.29	0.07	0.021	0.011	0.008
Average MDC[(d)]	1,630	0.07	0.11	0.003	0.003	0.006
Control (Area 20)						
Cottontail rabbit #1	−44 ± 189	0.10 ± 0.05	0.06 ± 0.06	0.009 ± 0.005	0.023 ± 0.008	0.003 ± 0.004
Cottontail rabbit #2	−44 ± 189	0.08 ± 0.04	0.08 ± 0.07	0.002 ± 0.003	0.000 ± 0.003	−0.001 ± 0.002
Average Concentration	−44	0.09	0.07	0.006	0.012	0.001
Average MDC[(d)]	319	0.07	0.09	0.003	0.004	0.006
Roadkill Opportunistic Samples						
Pronghorn antelope (Area 4)	1,370 ± 396	0.02 ± 0.04	−0.01 ± 0.04	0.000 ± 0.008	0.003 ± 0.011	0.004 ± 0.008
Pronghorn antelope (Area 5)	−1 ± 199	0.02 ± 0.03	−0.07 ± 0.06	0.002 ± 0.002	0.010 ± 0.005	0.003 ± 0.005
Average MDC[(d)]	352	0.07	0.11	0.008	0.012	0.010

(a) ± 2 standard deviations
(b) picocuries per liter water from sample
(c) picocuries per gram wet weight of sample

Table 8-6. Man-made radionuclide concentrations in samples collected in 2013 in conjunction with the mountain lion study (samples listed in chronological order for each mountain lion)

			Radionuclide Concentrations ± Uncertainty[(a)] (MDC)	
Area / Kill Site	**Prey / Sample**	**Collection Date**	**^{3}H (pCi/L)[(b)]**	**^{137}Cs (pCi/g)[(c)]**
Mountain Lion NNSS4				
NTTR	Mt lion muscle	3/9/2013	152 ± 179 (300)	0.106 ± 0.053 (0.075)
Mountain Lion NNSS7				
NTTR / NNSS7-34	Bighorn sheep	2/5/2013	−40 ± 215 (364)	NM[(d)]
Area 19	Mt lion blood	6/1/2013	−151 ± 374 (810)	NM
Area 12 / NNSS7-49	Mt lion scat	6/20/2013	48,300 ± 4,910 (288)	NM
Area 17 / NNSS7-54	Mule deer	7/17/2013	79,700 ± 12,200 (490)	NM
Area 19 / NNSS7-61	Mule deer	8/13/2013	−37 ± 206 (348)	NM
Area 19 / NNSS7-62	Mule deer	8/13/2013	74 ± 213 (354)	NM
Area 19 / NNSS7-60	Mule deer	8/15/2013	−18 ± 206 (347)	NM
Area 19 / NNSS7-70	Mule deer	9/10/2013	−38 ± 130 (266)	NM
Area 16 / NNSS7-73	Mule deer	10/1/2013	−10 ± 128 (252)	0.006 ± 0.023 (0.043)
Area 19 / NNSS7-78	Mule deer	10/28/2013	868 ± 868 (1,406)	NM
Area 19 / NNSS7-78	Mt lion scat	10/28/2013	−33 ± 207 (350)	NM
Area 19 / NNSS7-78	Soil near scat	10/28/2013	163 ± 793 (1,324)	NM
Area 29 / NNSS7-80	Mule deer	11/19/2013	−87 ± 171 (311)	NM
Area 29 / NNSS7-82	Mt lion scat	11/20/2013	−10 ± 193 (342)	NM
Area 29 / NNSS7-82	Soil near scat	11/20/2013	−255 ± 186 (353)	NM
Area 16 / NNSS7-83	Mt lion scat	11/27/2013	−135 ± 171 (316)	NM
Area 16 / NNSS7-83	Soil near scat	11/27/2013	152 ± 207 (350)	NM
NTTR / NNSS7-84	Bighorn sheep	12/3/2013	−104 ± 199 (338)	NM
NTTR / NNSS7-84	Mt lion scat	12/3/2013	−36 ± 212 (358)	NM
NTTR / NNSS7-84	Soil near scat	12/3/2013	23 ± 215 (360)	NM
Area 18 / NNSS7-87	Mule deer	12/17/2013	348 ± 241 (380)	−0.005 ± 0.008 (0.014)
Area 18 / NNSS7-87	Mt lion scat	12/17/2013	75 ± 219 (364)	NM
Area 18 / NNSS7-87	Soil near scat	12/17/2013	175 ± 215 (351)	NM
NTTR / NNSS7-86	Bighorn sheep	12/18/2013	40 ± 209 (349)	0.012 ± 0.017 (0.029)

(a) ± 2 standard deviations
(b) picocuries per liter of water from sample
(c) picocuries per gram wet-weight
(d) not measured

8.4 Data Assessment

Biota sampling results confirm that man-made radionuclide concentrations are generally higher at the selected biota monitoring locations identified in Section 8.2 compared with their control locations or other locations distant from operational activities. This was observed in 2013 at both the Schooner and Palanquin craters. Though certain radionuclides are elevated, the levels detected pose negligible risk to humans and biota. The potential dose to a person consuming these animals is well below dose limits to members of the public (see Section 9.1.1.2). Also, radionuclide concentrations were below levels considered harmful to the health of the plants or animals; the dose resulting from observed concentrations was less than 1% of dose limits set to protect populations of plants and animals (see Section 9.2.1).

8.5 References

Bechtel Nevada, 2003. *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.

Hunter, R. B., and R. R. Kinnison, 1998. *Tritium in Vegetation on the Nevada Test Site*, U.S. Department of Energy, December 1998, In: *Nevada Test Site Routine Radiological Environmental Monitoring Plan, Appendices*. DOE/NV/11718--244. Bechtel Nevada, Las Vegas, NV.

National Security Technologies, LLC, 2010. *Nevada Test Site Environmental Report 2009*. DOE/NV/25946--1067, prepared for U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, Las Vegas, NV. OSTI ID: 988193

Chapter 9: Radiological Dose Assessment

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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 Orders DOE O 435.1, “Radioactive Waste Management,” and DOE O 458.1, “Radiation Protection of the Public and the Environment” (see Section 2.3). To estimate these radiological doses, radionuclide concentration data gathered on the Nevada National Security Site (NNSS) are used along with dose conversion factors based on the biokinetic models of Federal Guidance Report Number 13 (U.S. Environmental Protection Agency [EPA] 1999). The 2013 data used are presented in Chapters 4 through 8 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.

Radiological Dose Assessment Goals
Determine if the maximum radiation dose to a member of the general public from airborne radionuclide emissions at the NNSS complies with the Clean Air Act, National Emission Standards for Hazardous Air Pollutants (NESHAP) limit of 10 millirems per year (mrem/yr) (0.1 millisieverts per year [mSv/yr]).
Determine if radiation levels from the Radioactive Waste Management Sites (RWMSs) comply with 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.”
Determine if the total radiation dose (total effective dose equivalent [TEDE], see Glossary, Appendix B) to a member of the general public from all possible pathways (direct exposure, inhalation, ingestion of water and food) as a result of NNSS operations complies with the limit of 100 mrem/yr (1 mSv/yr) established by DOE O 458.1.
Determine if the radiation dose (in a unit of measure called a rad [see Glossary, Appendix B]) to NNSS biota complies with the following limits set by 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

9.1 Dose to the Public

This section identifies the possible pathways by which the public could be exposed to radionuclides due to past or current NNSS activities. It describes how field monitoring data are used with other NNSS data sources (e.g., radionuclide inventory data) to provide input to the dose estimates and presents the estimated 2013 public dose attributable to U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office (NNSA/NFO) activities from each pathway and all pathways combined. The public dose due to radioactive waste operations on the NNSS is also assessed, and a description of the program that controls the release of NNSS materials having residual radioactivity into the public domain is provided.

9.1.1 Dose from Possible Exposure Pathways

As prescribed in the *Routine Radiological Environmental Monitoring Plan* (Bechtel Nevada [BN] 2003), air, groundwater, and biota are routinely sampled 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 NNSS operations include the following:

- Inhalation of, ingestion of, or direct external exposure to airborne radionuclide emissions transported off site by wind
- Ingestion of wild game animals that drink from surface waters and/or eat vegetation containing NNSS-related radioactivity
- Ingestion of plants containing radioactivity from NNSS-related activities
- Drinking water from underground aquifers containing radionuclides that have migrated from the sites of past underground nuclear tests or waste management sites
- Exposure to direct radiation along the borders of the NNSS

The subsections below address all of the potential pathways and their contribution to public dose estimated for 2013.

9.1.1.1 Dose from NNSS Air Emissions

Six air particulate and tritium (^{3}H) sampling stations located near the boundaries and the center of the NNSS are approved by the EPA Region IX as critical receptor samplers to demonstrate compliance with the NESHAP public dose limit of 10 mrem/yr (0.1 mSv/yr) from air emissions. 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 4-1 of Section 4.1.1). The CL for each radionuclide represents the annual average concentration of that radionuclide in air that would result in a TEDE 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 critical receptor sampling stations can be thought of as worst case for an offsite receptor because these samplers are much closer to emissions sources. Table 9-1 displays the distances between the critical receptor monitoring stations and points where members of the public potentially live, work, and/or go to school. The distance between the sampling location and the closest onsite emission location is also listed.

Table 9-1. Distance between critical receptor air monitoring stations and nearest points of interest

Critical Receptor Station	Distance[(a)] and Direction[(b)] to Nearest Offsite Locations and Onsite Emission Location			
	Residence	Business/Office	School	NNSS Emission Source
Area 6, Yucca	47 km SW Amargosa Valley	38 km SSE American Silica	54 km SE Indian Springs	6.5 km NE Area 6
Area 10, Gate 700	49 km ENE Medlin's Ranch	56 km NNE Rachel	77 km ENE Alamo	2.4 km WSW Area 10
Area 16, Substation 3545	46 km SSW Amargosa Valley	46 km SSW Amargosa Valley	58 km SSW Amargosa Valley	14 km ENE Area 3
Area 20, Schooner	36 km WSW Sarcobatus Flat	20 km WSW Tolicha Peak	56 km SSW Beatty	0.2 km SE Area 20
Area 23, Mercury Track	24 km SW Crystal	6.0 km SE American Silica	31 km SSW Indian Springs	1.0 km WSW Area 23
Area 25, Gate 510	4 km S Amargosa Valley	3.5 km S Amargosa Valley	15 km SW Amargosa Valley	5.1 km NE Area 25

(a) Distance is shown in kilometers (km). For miles, multiply by 0.62.
(b) N=north, S=south, E=east, W=west in all direction combinations shown

In 2013, the man-made radionuclides detected in samples from at least one of the six critical receptor air monitoring stations included ^{3}H, americium-241 (^{241}Am), plutonium-238 (^{238}Pu), and plutonium-239+240 ($^{239+240}Pu$) (see Section 4.1.4). The annual average concentrations of these radionuclides were well below their CLs, and the sum of fractions for each location were all less than 1.0 (see Section 4.1.5, Table 4-8). As in previous years, the 2013 data from the six critical receptor samplers show that the NESHAP dose limit to the public of 10 mrem/yr was not exceeded.

The shortest distance between where a member of the public resides and a critical receptor monitoring station is 4 km (2.5 miles [mi]): between the Gate 510 sampler in the southwest corner of the NNSS and the northern edge of the community of Amargosa Valley. Because it is the closest, the results from the Gate 510 sampler (see Table 4-8) are believed to be most representative of air concentrations to which the public is continuously exposed. Scaling the 0.002 sum of fractions for the Gate 510 station to the 10 mrem/yr limit gives an estimated dose of 0.02 mrem/yr from radionuclides in air. More detailed information regarding the estimation of the dose to the public from airborne radioactivity in 2013 from all activities conducted by NNSA/NFO on the NNSS and its Nevada support facilities is reported in National Security Technologies, LLC (NSTec) (2014).

9.1.1.2 Dose from Ingestion of Game Animals from the NNSS

Two game species, mule deer and mourning doves, have been shown to travel off the NNSS and be available to hunters (Giles and Cooper 1985; NSTec 2009). Because of this, game animals on the NNSS are sampled annually near known radiologically contaminated areas to give conservative (worst-case) estimates of the level of radionuclides that hunters may consume if these animals are harvested off of the NNSS. In 2013, the following animals were sampled (see Chapter 8, Figure 8-1 and Tables 8-4, 8-5, and 8-6):

- Two cottontail rabbits and one jackrabbit from near Palanquin Crater (Area 20)
- Two cottontail rabbits from near Schooner Crater (Area 20)
- Two cottontail rabbits from a control location about 12 kilometers (km) (7.5 miles [mi]) southeast of the Schooner Crater (Area 20)
- Two pronghorn antelope (one from Area 4 and one from Area 5)
- Three bighorn sheep from the Nevada Test and Training Range (NTTR)
- Two mountain lions – each part of a research study (post mortem tissue sample from one animal found on the NTTR and multiple scat samples from a second study animal at locations across the NNSS)
- Eight mule deer (five from Area 19 and one each from Areas 16, 17, and 18)

The potential committed effective dose equivalent (CEDE; see Glossary, Appendix B) to an individual from consuming game animals was calculated using only locations where animals sampled in 2013 had concentrations of man-made radionuclides above the minimum detectable concentration (MDC; see Glossary, Appendix B). No man-made radionuclides were detected in the bighorn sheep from the NTTR; the mule deer from Areas 16, 18, and 19; and the mountain lion sampled on the NTTR. No dose was calculated, therefore, for those animals/locations. Also, no dose was calculated for consumption of rabbits from the control location because radionuclide concentrations were lower than monitored locations. For locations where animals had elevated man-made radionuclides, the following parameters were used to estimate dose to someone consuming them:

- An individual consumes all meat from one rabbit (250 grams [g]), one pronghorn antelope (21.7 kilograms [kg]), one mountain lion (18.1 kg), or one mule deer (41.7 kg) during the year.
- The moisture content of muscle tissue is 70%.
- Dose coefficients for a reference person as defined by DOE-STD-1196-2011 (DOE 2011) are used. These dose coefficients are for a hypothetical person representing an aggregate of individuals in the United States population.
- The entire committed dose is considered to be received during the calendar year.

Dose coefficients (mrem per picocurie [pCi] ingested), based on values listed in DOE-STD-1196-2011, were multiplied by the amount of radioactivity (pCi) potentially ingested to obtain the potential dose (CEDE) (Table 9-2).

Two CEDEs were calculated, one using the average radionuclide concentrations and one using the maximum concentrations for 2013 samples from each location. Based on the 2013 samples, an individual who consumes one of each animal having the average radionuclide concentrations shown in Table 9-2 may receive an estimated 0.53 mrem (0.0053 mSv) dose. To put this dose in perspective, the dose from naturally occurring cosmic radiation received during a 2-hour airplane flight at 39,000 feet is about 1 mrem (0.01 mSv).

Table 9-2. Hypothetical CEDE from ingesting game animals sampled in 2013 that contained detectable radionuclides

Location[(a)] and Game Animal	Radionuclide Concentration (pCi/g)[(b)]		Dose Conversion Factor (mrem/pCi ingested)[(c)]		Committed Effective Dose Equivalent (CEDE) (mrem)
Palanquin (Area 20)					
Rabbit[(d)] (Average)	**^{90}Sr**	0.13	0.000133200		0.004
	^{238}Pu	0.02	0.000973100		0.004
	$^{239+240}$Pu	0.06	0.001065600		0.015
	^{241}Am	0.02	0.000880600		0.004
				Total:	**0.028**
Rabbit[(d)] (Maximum)	**^{90}Sr**	0.15	0.000133200		0.005
	^{238}Pu	0.03	0.000973100		0.008
	$^{239+240}$Pu	0.12	0.001065600		0.032
	^{241}Am	0.04	0.000880600		0.009
				Total:	**0.054**
Schooner (Area 20)					
Cottontail Rabbit (Average)	**^{3}H**	629	0.000000078		0.012
	^{90}Sr	0.29	0.000133200		0.010
	^{137}Cs	0.07	0.000049210		0.001
	^{238}Pu	0.02	0.000973100		0.005
	$^{239+240}$Pu	0.01	0.001065600		0.003
	^{241}Am	0.01	0.000880600		0.002
				Total:	**0.032**
Cottontail Rabbit (Maximum)	**^{3}H**	868	0.000000078		0.017
	^{90}Sr	0.33	0.000133200		0.011
	^{137}Cs	0.11	0.000049210		0.001
	^{238}Pu	0.02	0.000973100		0.005
	$^{239+240}$Pu	0.01	0.001065600		0.003
	^{241}Am	0.01	0.000880600		0.003
				Total:	**0.040**
Control (Area 20)					
Cottontail Rabbit (Average)	**^{90}Sr**	0.09	0.000133200		0.003
	^{238}Pu	0.01	0.000973100		0.001
	$^{239+240}$Pu	0.01	0.001065600		0.003
				Total:	**0.008**
Cottontail Rabbit (Maximum)	**^{90}Sr**	0.10	0.000133200		0.003
	^{238}Pu	0.01	0.000973100		0.002
	$^{239+240}$Pu	0.02	0.001065600		0.006
				Total:	**0.012**
Opportunistic Sampling					
Area 4 Pronghorn (Area 4)	**^{3}H**	1.0	0.000000078		0.002
Area 5 Pronghorn (Area 5)	**$^{239+240}$Pu**	0.01	0.001065600		0.231
Mountain Lion (Area 12)	**^{3}H**	33.81	0.000000078		0.048
Mule Deer (Area 17)	**^{3}H**	55.79	0.000000078		0.181
CEDE from consuming one animal with average concentrations from each location = 0.53 mrem					

(a) Only sample locations where man-made radionuclides were detected are included
(b) pCi/g is per gram wet weight; water content = 70% by weight for meat
(c) Dose conversion factors for ingestion by reference person, from DOE-STD-1196-2011 (DOE 2011)
(d) At this location, result from one jackrabbit and two cottontail rabbits were combined

It is theoretically possible for someone to consume more than one animal coming from various locations on the NNSS; therefore, Table 9-3 presents the hypothetical CEDE for humans consuming various species of NNSS wildlife based on animals sampled from 2001 through 2013. The two dose columns show bounding estimates. The first (CEDE High Estimate) is based on eating the number of animals equal to the State possession limit, and the second CEDE is based on eating just one animal. Eating one animal from the NNSS is a more realistic assumption, but including large numbers of animals consumed ensures an understanding of a worst-case scenario.

The average CEDE from consuming just one animal of a single species ranges from 0.0028 mrem for mourning doves to 0.189 mrem for mule deer (Table 9 3, last column). The highest CEDE overall for any one species and location is 4.5 mrem (0.045 mSv) from consuming 20 or jackrabbits from Plutonium Valley (NSTec 2010). This represents 4.5% of the annual dose limit for members of the public. If an individual were to consume just one jackrabbit from Plutonium Valley having similar tissue radionuclide levels, the potential dose would be 0.22 mrem (0.0022 mSv), which is 0.22% of the annual dose limit for members of the public and 22% of the dose one would receive from naturally occurring cosmic radiation during a 2-hour airplane flight at 39,000 feet. If an individual were to consume one animal of each species with the average concentrations shown in Table 9-3, they would receive an estimated 0.47 mrem/yr (0.0047 mSv/yr) dose.

Table 9-3. Hypothetical CEDEs from ingesting NNSS game animals sampled from 2001–2013

Game Animal	Sample Location	Year Sampled	Sample Size	Number of Animals Presumed to be Consumed by an Individual (State of Nevada Possession Limit) – Used for CEDE High Estimate	CEDE – Consumption of State Limit (mrem)	CEDE – Consumption of One Animal (mrem)
Bobcat	Area 25	2012	1	1 (all muscle tissue)	**0.032**	**0.032**
Chukar	E Tunnel	2001	2	12 (breast meat only)	**0.070**	**0.0058**
Cottontail rabbit	Schooner Crater	2008	2	20 (all muscle tissue)	0.47	0.024
	Palanquin Crater[(a)]	2013	2		0.56	0.028
	Schooner Crater	2013	2		0.65	0.032
				Average	**0.56**	**0.028**
Gambel's quail	T2	2002	2	20 (all muscle tissue)	**0.080**	**0.0040**
Jackrabbit	Area 3 RWMS	2009	3[(b)]	20 (all muscle tissue)	0.59	0.030
	Area 5 RWMS	2009	2[(b)]		0.15	0.0075
	Plutonium Valley	2009	1		4.5	0.22
	Sedan	2005	3	20 (all muscle tissue)	0.32	0.016
	Sedan	2010	2		1.7	0.083
	T2	2002	1		0.11	0.0055
	T2	2006	3		0.040	0.0020
	T2	2011	2		0.030	0.0015
	Palanquin Crater[(a)]	2013	1		0.55	0.028
				Average	**0.89**	**0.044**
Mourning dove	E Tunnel	2000	1	20 (all muscle tissue)	0.16	0.0080
	E Tunnel	2002	5		0.020	0.0010
	E Tunnel	2003	3		0.015	0.00075
	E Tunnel	2007	2		0.0095	0.00048
	E Tunnel	2012	2		0.003	0.00015
	Palanquin	2003	3		0.013	0.00065
	Pu-Valley	2004	2		0.005	0.00025
	Schooner Crater	2008	1		0.0002	0.00001
	Sedan	2005	3		0.0098	0.00049
	U-19ad Sump	2005	4		0.082	0.0041
	Well U-20n PS#1DDH[(c)]	2003	3		0.30	0.01495
				Average	**0.056**	**0.0028**
Mountain lion	Areas 8, 12, 30	2010	3	1 (all muscle tissue)	0.0010	0.0010
	Areas 12, 19, NTTR	2012	5		0.003	0.003
	Area 12	2013	1		0.048	0.048
				Average	**0.017**	**0.017**

Table 9-3. Hypothetical CEDEs from ingesting NNSS game animals sampled from 2001–2013 (continued)

Game Animal	Sample Location	Year Sampled	Sample Size	Number of Animals Presumed to be Consumed by an Individual (State of Nevada Possession Limit) – Used for CEDE High Estimate	CEDE – Consumption of State Limit (mrem)	CEDE – Consumption of One Animal (mrem)
Mule deer	Area 19	2011	1	1 (all muscle tissue)	0.31	0.31
	Areas 12, 18, 19	2012	10		0.077	0.077
	Area 17	2013	1		0.181	0.181
				Average	**0.189**	**0.189**
Pronghorn antelope	Area 5	2003	1	1 (all muscle tissue)	0.064	0.064
	Area 5	2007	1		0.091	0.091
	Area 4	2013	1		0.002	0.002
	Area 5	2013	1		0.231	0.231
				Average	**0.129**	**0.129**
CEDE from consuming one of each game species that has the average dose for that species = 0.47 mrem						

(a) Cottontail rabbits and jackrabbit were combined during 2013 for the Palanquin Crater location so dose estimates from these species are the same.
(b) Samples were composites of kangaroo rats and antelope ground squirrels used as analogs for jackrabbits.
(c) This location is labeled Palanquin Control in the Nevada Test Site Environmental Report 2003 (BN 2004).

9.1.1.3 Dose from Ingestion of Plants from the NNSS

Current NNSS land use practices discourage the harvest of plants or plant parts for direct consumption by humans. However, it is possible that individuals with access may collect and consume edible plant material. One species in particular, the pinyon pine tree, produces pine nuts that are harvested and consumed across the western United States. Pinyon pine trees grow in multiple locations on the NNSS. During 2013, pine nuts were sampled from three locations in Area 15, Area 17, and in Area 12 near the E Tunnel Ponds. Tritium was the only man-made radionuclide detected, and it was only in the Area 12 sample from near the E Tunnel Ponds (see Section 8.3.1, Table 8-2).

The potential dose to an individual from consuming these pine nuts was estimated to be 0.00056 mrem (0.0000056 mSv), based on the following assumptions and methods:

- An individual consumes 1 pound (453.6 g) over the year.
- Consumed pine nuts contain the average concentration of tritium detected in collected samples.
- The moisture content of consumed pine nuts is 34%, which is the average moisture content of samples collected during 2010 (moisture measurements were not made on samples collected in 2013).
- Dose coefficients for a reference person from DOE-STD-1196-2011 (DOE 2011) were used (Section 9.1.1.2, Table 9-2).

To put the dose from consuming pine nuts in perspective, one receives about 0.003 mrem from wearing a luminous liquid crystal display watch for a year. This is over five times the dose from consuming a pound of pine nuts.

9.1.1.4 Dose from Drinking Contaminated Groundwater

The 2013 groundwater monitoring data indicate that groundwater from offsite private and community wells and springs has not been impacted by past NNSS nuclear testing operations (see Sections 5.1.3.5, 7.2.4, and 7.2.5). No man-made radionuclides have been detected in any wells accessible to the offsite public or in private wells or springs. Therefore, drinking water from underground aquifers containing radionuclides is not a possible pathway of exposure to the public residing off site.

9.1.1.5 Dose from Direct Radiation Exposure along NNSS Borders

The direct exposure pathway from gamma radiation to the public is monitored annually (see Chapter 6). In 2013, the only place where the public had the potential to be exposed to direct radiation from NNSS operations is at Gate 100, the primary entrance to the site on the southern NNSS border. Trucks hauling radioactive materials, primarily low-level waste (LLW) being shipped for disposal at the Area 3 and Area 5 RWMSs, park outside Gate 100 while waiting for entry approval. Only during these times is there a potential for exposure to the public due to NNSS activities. However, no member of the public resides or remains full-time at the Gate 100 truck parking area. Therefore, dose from direct radiation is not included as a possible pathway of exposure to the public residing off site.

9.1.2 Dose from Waste Operations

DOE M 435.1-1 states that LLW 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 10 mrem through the air pathway and 25 mrem through all pathways for a 1,000-year compliance period after closure of the disposal units. Given that the RWMSs are located well within the NNSS boundaries, no members of the public could access these areas for significant periods of time. However, for purposes of documenting potential impacts, the possible pathways for radionuclide movement from waste disposal facilities are monitored.

During 2013, external radiation from waste operations measured near the boundaries of the Area 3 and Area 5 RWMSs could not be distinguished from background levels at those locations (see Section 6.3.3). Area 3 and Area 5 RWMS operations would have contributed negligible external exposure to a hypothetical person residing near the boundaries of these sites and no dose to the offsite public.

The dose from the air pathway can be estimated from air monitoring results from stations near the RWMSs (see Chapter 4, Figure 4-1). Mean concentrations of radionuclides in air at the Area 3 and Area 5 environmental sampler locations were, at the most, only 10% of their CLs. Scaling this to the 10 mrem dose that the CL represents would be 1 mrem to a hypothetical person residing near the boundaries of the RWMS, and the dose would be much lower to the offsite public. There is no exposure, and therefore no dose, to the public from groundwater beneath waste disposal sites on the NNSS. Groundwater monitoring indicates that no man-made radionuclides have been detected in wells accessible to the offsite public or in private wells or springs (see Sections 5.1.3.5, 7.2.4, and 7.2.5). Also, groundwater and vadose zone monitoring at the RWMSs, conducted to verify the performance of waste disposal facilities, have not detected the migration of radiological wastes into groundwater (see Section 10.1.7 and 10.1.8). Based on these results, potential doses to members of the public from LLW disposal facilities on the NNSS from all pathways are negligible.

9.1.3 Total Offsite Dose to the Public from all Pathways

The DOE-established radiation dose limit to a member of the general public from all possible pathways as a result of DOE facility operations is 100 mrem/yr (1 mSv/yr) excluding background radiation, while considering air transport, ingestion, and direct exposure pathways. For 2013, the only plausible pathways of public exposure to man-made radionuclides from current or past NNSS activities included the air transport pathway and the ingestion of game animals and plants. The doses from these pathways are combined below to present an estimate of the total 2013 dose to the maximally exposed individual (MEI) (see Glossary, Appendix B) residing off site.

In the recent past, the MEI for the air pathway was considered to be a hypothetical person residing at the critical receptor station with the highest dose (Schooner). However, in an effort to give a more realistic estimate, the 0.02 mrem/yr (0.0002 mSv/yr) dose estimate for the Gate 510 critical receptor station is used for the dose estimate for an offsite MEI (see Section 4.1.1.1). If the offsite MEI is assumed to also eat wildlife from the NNSS, additional dose would be received. The additional dose may be 0.53 mrem (0.0053 mSv) (Table 9-2) or 0.47 mrem (0.0047 mSv) (Table 9-3), depending on the consumption scenario used (Section 9.1.1.2). Based on the higher of these scenarios (0.53 mrem), if all dose from consuming wildlife were received in one year, the total effective dose equivalent (TEDE) to this hypothetical MEI from all exposure pathways combined and solely due to NNSA/NFO activities would be 0.55 mrem/yr (0.0055 mSv/yr) (Table 9-4).

Table 9-4. Estimated radiological dose to a hypothetical MEI of the general public from 2013 NNSS operations

Pathway	Dose to MEI (mrem/yr)	(mSv/yr)	Percent of DOE 100 mrem/yr Limit
Air[(a)]	0.02	0.0002	0.02
Water[(b)]	0	0	0
Wildlife[(c)]	0.53	0.0053	0.53
Direct[(d)]	0	0	0
All Pathways	**0.55**	**0.0055**	**0.55**

(a) Based on annual average concentrations at the compliance station nearest the offsite public (Section 4.1.5, Table 4-8)
(b) Based on all offsite groundwater sampling conducted by NNSA/NFO to date (Section 5.1)
(c) Based on consuming one animal sampled from each sample location in 2013 that has the average radionuclide concentrations shown in Table 9-2
(d) Based on 2013 gamma radiation monitoring data at the NNSS entrance (Section 6.3.1)

The total dose of 0.55 mrem/yr to the hypothetical MEI is 0.55% of the DOE limit of 100 mrem/yr and about 0.15% of the total dose that the MEI receives from natural background radiation (360 mrem/yr) (Figure 9-1). 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 9-1 were estimated from the annual mean radiation exposure rate measured with a pressurized ion chamber (PIC) at Indian Springs by the CEMP (100.3 milliroentgens per year [mR/yr], rounded to 100 mR/yr; see Chapter 7, Table 7-4). 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 were estimated at 31 mrem/yr and 229 mrem/yr, respectively, as shown in Figure 9-1, using the approximations by the National Council on Radiation Protection and Measurements (2006).

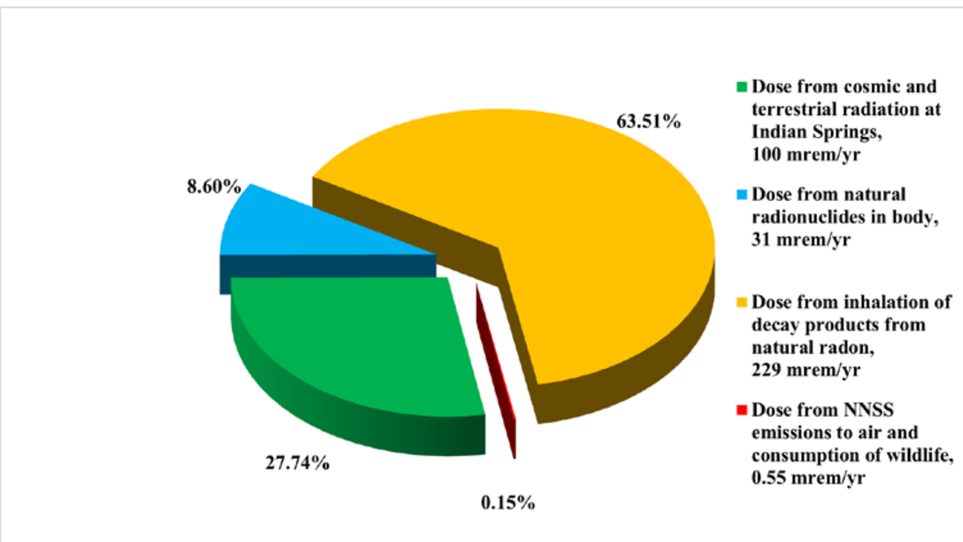

Figure 9-1. Comparison of radiation dose to the MEI from the NNSS and natural background (percent of total)

9.1.4 Collective Population Dose

The collective population dose to residents within 80 km (50 mi) of the NNSS emission sources was not estimated in 2013. DOE approved the discontinuance of reporting collective population dose from NNSS operations after 2004 because it is so low for the NNSS. It has been below 0.6 person-rem/yr for the period from 1992, when it was first calculated and reported to DOE, through 2004 (Figure 9-2). The relatively large increase in collective population dose seen in 1994 in Figure 9-2 was due to two changes. The first was the inclusion of plutonium resuspension in air from soils across all areas of the NNSS instead of from soils from only a few areas of the NNSS in 1992 and 1993. The second was a large increase in the surrounding population in 1994, as Pahrump's population increased by 7,000 and the population of Tonopah (4,200) was added to the calculation.

DOE recommended that NNSA/NFO should consider reporting collective population dose once again if ever it exceeds 1.0 person-rem/yr (DOE 2004). It will be recalculated when either the radionuclide emissions from NNSS activities or the population within 80 km (50 mi) of the NNSS increase significantly (e.g., ≥ 50%), both of which are estimated annually (see Section 1.7 for population estimates).

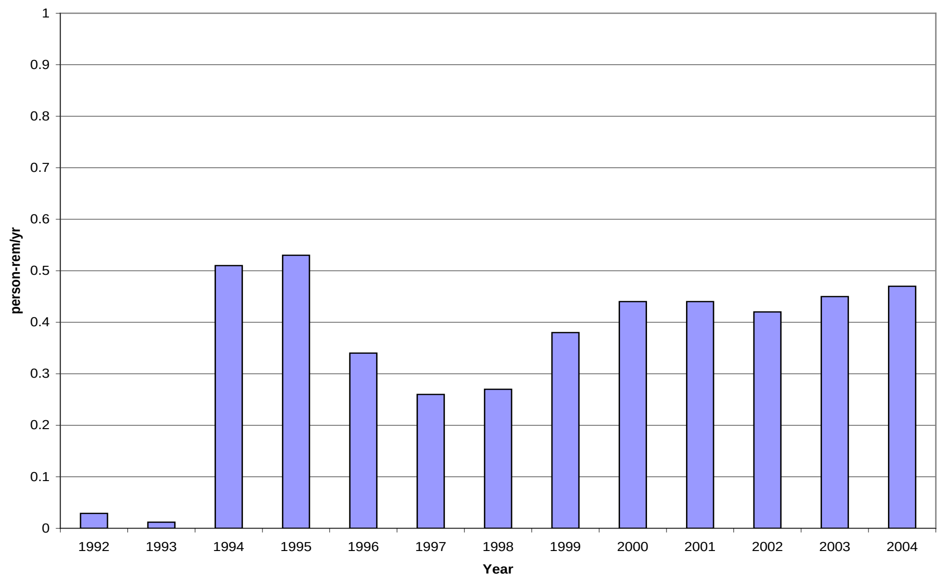

Figure 9-2. Collective population dose within 80 km (50 mi) of NNSS emission sources from 1992 to 2004

9.1.5 Release of Property Containing Residual Radioactive Material

In addition to discharges to the environment, the release of DOE property containing residual radioactive material is a potential contributor to the dose received by the public. The release of property off the NNSS is controlled. No vehicles, equipment, structures, or other materials can be released from the NNSS for unrestricted public use unless the amount of residual radioactivity on such items is less than the authorized limits. The default authorized limits are specified in the *Nevada Test Site Radiological Control Manual* (Radiological Control Manager's Council 2012) and are consistent with the limits set by DOE O 458.1. These limits are shown in Table 9-5.

All NNSA/NFO contractors use a graded approach for release of material and equipment for unrestricted public use. Items are either surveyed prior to release to the public, or a process knowledge evaluation is conducted to verify that the material has not been exposed to radioactive material or beams of radiation capable of generating radioactive material. In some cases, both a radiological survey and a process knowledge evaluation are performed (e.g., a radiological survey is conducted on the outside of the item, and a process knowledge form is signed by the custodian to address inaccessible surfaces). Items are evaluated/surveyed prior to shipment to the NNSA/NFO property/excess warehouse. All contractors also complete material surveys prior to release and transport to the Area 23 landfill. The only exception is for items that could be internally contaminated; these items are submitted to Waste Generator Services for disposal using one of the facilities that can accept LLW. Excessed items that can be free-released are either donated to interested state agencies, federal agencies, or universities; redeployed to other onsite users; or sold on an auction website.

In 2013, 424 pieces of laboratory equipment, 18 vehicles, and 14 pieces of heavy equipment were released off site to the public by these means. An estimated 1,105 tons of waste were diverted from NNSS landfills, mainly by being released to vendors for recycling. No released items had residual radioactivity in excess of the limits specified in Table 9-5.

In 2013, over 3,000 reels of wire cable were excessed, but the process knowledge evaluation could not confirm that the reels were free of any residual contamination, nor was it feasible to unspool each reel to conduct radiological surveys. The reels were therefore auctioned to a recycling company licensed by the Nuclear Regulatory Commission to possess radioactive material. The recycling company performed the radiological surveys and were able to release the wire for recycling through their Material Release Program.

Independent verification of radiological surveys and process knowledge evaluations performed by NSTec (the Management and Operating contractor) is achieved through NNSA/NFO program oversight and through audits. DOE O 458.1, which includes the process of releasing property to the public, has been incorporated into the site's Radiological Control Managers' Council Internal Audit Schedule. An audit of DOE O 458.1 was performed in 2013 and found that the NNSS is in full compliance with the order.

Table 9-5. Allowable total residual surface contamination for property released off the NNSS

	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 (α)	1,000 α	5,000 α	15,000 α
Beta (β)-gamma (γ) emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except ^{90}Sr and others noted above	1,000 β+γ	5,000 β+γ	15,000 β+γ
^{3}H and tritiated compounds	10,000	N/A	N/A

(a) Disintegrations per minute per 100 square centimeters (cm^2)
(b) Averaged over an area of not more than 100 cm^2
(c) Applicable to an area of not more than 100 cm^2

Source: Radiological Control Manager's Council (2012)

9.2 Dose to Aquatic and Terrestrial Biota

DOE requires that their facilities 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 milligray 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.

NNSS biologists use 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 NNSS that have radionuclides in soil, water, or sediment
- Identification of terrestrial and aquatic biota on the NNSS 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 NNSS that can be compared to BCG values to determine the potential for exceeding biota dose limits
- Measured radionuclide concentrations in NNSS biota, soil, water, and sediment in contaminated habitats on the NNSS to estimate site-specific dose to biota

A comprehensive biota dose assessment for the NNSS using the graded approach was reported in the *Nevada Test Site Environmental Report 2003* (BN 2004). This dose assessment demonstrated that the potential radiological dose to biota on the NNSS was not likely to exceed dose limits. Data from monitoring air, water, and biota across the NNSS do not suggest that NNSS surface contamination conditions have worsened; therefore, this biota dose evaluation conclusion remains the same for 2013.

9.2.1 2013 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 internal dose to biota sampled in 2013, the RESRAD-BIOTA, Version 1.5, computer model (DOE 2004) was used. Maximum concentrations of man-made radionuclides detected in plant and animal tissue (see Section 8.3.1, Table 8-3, and Section 8.3.2, Table 8-5) were used as input to the model. External dose was based on the annual exposure rate measured based on the maximum quarterly thermoluminescent dosimeter (TLD) measurement made near the biota sampling site (Table 6-1). This is an overestimate because it also includes natural radiation. The TLD location used for each location is shown in Table 9-6. Details of direct radiation measurements used for determining external dose can be found in Chapter 6.

The 2013 site-specific estimated dose rates to biota were all below the DOE limits for both plants and animals (Table 9-6). The highest internal dose was predicted for plants near Schooner Crater followed by the animals near the Palanquin Crater, both in Area 20. External dose accounted for 70% to almost 100% of the total dose in all locations except near Palanquin and Schooner Craters. Samples from these locations were elevated, which resulted in higher internal dose but still much less than dose limits.

Table 9-6. Site-specific dose assessment for terrestrial plants and animals sampled in 2013

Location [(a)]	TLD Location	Estimated Radiological Dose (rad/d) Internal [(b)]	External [(c)]	Total
Terrestrial Plants				
Palanquin (Area 20) (3 species)	Palanquin	0.0002917	0.00063	0.00092
Schooner (Area 20) (3 species)	Schooner 1	0.0018831	0.00157	0.00346
Control (Area 20) (3 species)	Stake A-118	0.0000183	0.00047	0.00048
E Tunnel Ponds (Area 12) (pine nuts)	Upper Haines Lake	0.0000067	0.00032	0.00033
			DOE Dose Limit:	**1**
Terrestrial Animals				
Area 20 Palanquin (2 cottontail rabbits/1 jackrabbit)	Palanquin	0.0010763	0.00063	0.00170
Area 20 Schooner (2 cottontail rabbits)	Schooner 1	0.0005323	0.00157	0.00210
Area 20 control site (2 cottontail rabbits)	Stake A-118	0.0001817	0.00047	0.00065
Area 4 (1 pronghorn antelope)	BJY-ETLD	0.0000003	0.00034	0.00034
Area 5 (1 pronghorn antelope)	3.3 Mi SE of Aggregate Pit	0.0000540	0.00020	0.00026
Area 12 (1 mountain lion)[(d)]	T Tunnel #2 Pond	0.0000099	0.00069	0.00070
Area 17 (1 mule deer)	Upper Haines Lake	0.0000163	0.00032	0.00034
			DOE Dose Limit:	**0.1**

(a) For information on plants and animals sampled, see Chapter 8, Tables 8-3 and 8-5
(b) Based on maximum concentrations of each man-made radionuclide detected in plants and animals sampled at that location
(c) Based on maximum TLD measured exposure rates at or near the sample location, see Chapter 6
(d) Tritium concentration in animal was set equal to that measured in scat

9.2.2 Dose Assessment Summary

Radionuclides in the environment from past or present NNSS activities result in a potential dose to the public or biota much lower than dose limits set to protect health and the environment. The estimated dose to the MEI for 2013 was 0.55 mrem/yr, which is 0.55% of the dose limit set to protect human health. Dose to biota at the NNSS sites sampled in 2013 were less than 3% of dose limits set to protect plant and animal populations. Based on the low potential doses from NNSS radionuclides, impacts from those radionuclides are expected to be negligible.

9.3 References

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Chapter 10: Waste Management

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Several federal and state regulations govern the safe management, storage, and disposal of radioactive, hazardous, and solid wastes generated or received on the Nevada National Security Site (NNSS) (see Section 2.5). This chapter describes the waste management operations conducted by Environmental Management of the U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office (NNSA/NFO) and summarizes the activities performed in 2013 to meet all environmental/public safety regulations. The goals of the program are shown below.

Waste Management Goals
Manage and safely dispose of low-level waste (LLW), mixed low-level waste (MLLW), and non-radioactive classified waste/matter, which are generated by NNSA/NFO, other U.S. Department of Energy (DOE) approved generators, or selected U.S. Department of Defense (DoD) operations.
Manage and safely store transuranic (TRU) and mixed transuranic (MTRU) wastes generated on site for eventual shipment to the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico.
Manage, safely store, and ship hazardous wastes generated on the NNSS to approved treatment/storage/disposal facilities, and treat by open detonation explosive ordnance wastes generated on the NNSS.
Ensure that wastes received for disposal meet NNSS waste acceptance criteria.
Evaluate, design, construct, maintain, and monitor closure covers for radioactive waste disposal units at the Area 3 and Area 5 Radioactive Waste Management Sites (RWMSs).
Manage radiation doses from the Area 3 RWMS and the Area 5 Radioactive Waste Management Complex (RWMC) to the levels specified in DOE Manual DOE M 435.1-1, "Radioactive Waste Management Manual."
Manage and safely dispose of solid/sanitary wastes generated by NNSA/NFO operations.
Manage underground storage tanks (USTs) to prevent environmental contamination.
Ensure that disposal systems meet performance objectives.

10.1 Radioactive Waste Management

The NNSS Radioactive Waste Management facilities include the Area 5 RWMC (see Glossary, Appendix B) and the Area 3 RWMS. They operate as Category II non-reactor nuclear facilities. The Area 5 RWMC is composed of the Area 5 RWMS and the Waste Examination Facility (WEF). This section describes the facilities and processes that comprise the safe receipt, storage, disposal, and disposal unit monitoring of radioactive wastes at the NNSS.

10.1.1 Area 5 RWMS

The Area 5 RWMS is an NNSA/NFO-owned radioactive waste disposal facility. It is approximately 740 acres (ac), which includes 200 ac of historical and active disposal cells used for burial of both LLW and MLLW, and approximately 540 ac of land available for future radioactive disposal cells. Waste disposal at the Area 5 RWMS occurred in a 92 ac portion of the site starting in the early 1960s. This "92-Acre Area" consists of 31 disposal cells and 13 Greater Confinement Disposal (GCD) boreholes, and was used for disposal of waste in drums, soft-sided containers, large cargo containers, and boxes. The 92-Acre Area was filled and permanently closed in 2011. Closure covers for the 92-Acre Area were seeded in the fall of 2011, and seedlings became established in 2012. Three new cells were developed immediately north and west of the 92-Acre Area and have been receiving wastes since 2010.

They include two LLW cells (Cells 19 and 20) and a MLLW cell (Cell 18). All active Area 5 RWMS cells can accept radioactive waste contaminated with regulated polychlorinated biphenyl (PCB) bulk product waste. Cell 18 can accept waste contaminated with PCB remediation waste as well as asbestos-contaminated MLLW. Cells 19 and 20 can accept asbestos-contaminated LLW. All disposal cells at the Area 5 RWMS that were active in 2013 are shown in Table 10-1. MLLW disposal services are expected to continue at the Area 5 RWMS until the remaining needs of the DOE complex are met.

Disposal Cell 18 is operated under a Resource Conservation and Recovery Act (RCRA) Part B Permit (NEV HW0101), which authorizes the disposal of up to 25,485 cubic meters (m^3) (899,994 cubic feet [ft^3]) of MLLW. In 2013, Cell 18 received 2,807.5 m^3 (99,144 ft^3) of MLLW totaling 1,911 tons (Table 10-1). A cumulative total of 7,397.8 m^3 (261,250 ft^3) of MLLW has been disposed in Cell 18 through the end of 2013. Quarterly reports were submitted to the State of Nevada in 2013 to document the weight of MLLW disposed each quarter in Cell 18.

In 2012, NNSS received approval from the State of Nevada to accept for disposal non-radioactive waste/matter that is considered classified by DOE. This approval extended to non-hazardous waste/matter and to waste/matter containing a hazardous constituent, and it identified two disposal cells that could accept one or the other type for disposal. The non-hazardous waste/matter is herein referred to as non-radioactive classified and the hazardous waste/matter is referred to as non-radioactive classified hazardous.

In 2013, the Area 5 RWMS received shipments containing a total of 31,843 m^3 (1,124,523 ft^3) of radioactive waste for disposal (Table 10-1), which included both the non-radioactive classified and the non-radioactive classified hazardous waste/matter. The majority of waste disposed was received from offsite generators. The total number of waste shipments during fiscal year (FY) 2013 (October 1, 2012–September 30, 2013) were reported in an annual transportation report (NNSA/NFO 2014). In 2013, all offsite waste generators delivering MLLW for disposal in Cell 18 that contained regulated quantities of PCBs were issued Certificates of Disposal, as required under the Toxic Substances Control Act (see Section 2.6, Table 2-8).

Table 10-1. Total waste volumes received and disposed at the Area 5 RWMS in calendar year 2013

Waste Type	Disposal Cell(s)	Permitted Limit in m^3	Volume Received and Disposed in m^3 (ft^3)	
LLW, non-radioactive classified	Cells 12,14,16, 17, 19, 20, 21, Trench 13	NA[(a)]	29,035.5	(1,025,379)
MLLW, non-radioactive classified hazardous	Cell 18	25,485	2,807.5	(99,144); 1,911 tons[(b)]
		Total	31,843	(1,125,523)

(a) Not applicable

(b) Fees paid to the State of Nevada for hazardous waste generated at the NNSS and MLLW wastes received for disposal are based on weight (tons)

10.1.2 WEF

The operational units of the WEF include the TRU Pad, TRU Pad Cover Building (TPCB), TRU Loading Operations Area, WEF Yard, WEF Drum Holding Pad, Sprung Instant Structure, and the Visual Examination and Repackaging Building. The WEF was used for the staging, characterization, repackaging, and offsite shipment of legacy TRU wastes that had been stored for many years at the NNSS. This activity was completed in 2009.

Currently, The TRU Pad and TPCB are authorized for the safe storage of TRU and MTRU waste under the current RCRA Permit (NEV HW0101). The TPCB accepts TRU/MTRU waste from NNSS generators including the Joint Actinide Shock Physics Experimental Research (JASPER) facility. The TPCB stores the waste until it is characterized for disposal at the WIPP in Carlsbad, New Mexico. In 2013, the TRU waste remaining in storage at the TPCB consisted of two experimental spheres from Lawrence Livermore National Laboratory and 25 standard waste boxes from JASPER.

10.1.3 Area 3 RWMS

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, such as soils or debris, and waste in large cargo containers. The site consists of the following seven craters:

2 Disposal Cells (Inactive Status):	1 Closed Cell:	2 Undeveloped Cells:
U-3ah/at U-3bh	U-3ax/bl (Corrective Action Unit 110)	U-3az U-3bg

10.1.4 Waste Characterization

All generators of waste streams must demonstrate eligibility for waste to be disposed at the NNSS, submit profiles characterizing specific waste streams, meet the NNSS Radioactive Waste Acceptance Criteria, and receive programmatic approval from NNSA/NFO for their site waste certification programs.

Characterization is performed by approved NNSA/NFO waste generators using knowledge of the generating process, sampling and analysis, or non-destructive analysis. Following the characterization of a waste stream, the approved NNSA/NFO waste generator develops a waste profile. 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 isotope activity and quantity, and packaging information. The waste profile is reviewed by the Waste Acceptance Review Panel for eventual approval or disapproval by NNSA/NFO. The approved waste generator then packages 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 2013, LLW and MLLW were characterized by approved waste generators for the following general waste stream categories:

- Lead Solids
- Sealed Sources
- Miscellaneous Debris
- Hazardous Soils
- Contaminated PCB Waste
- Compactable Trash
- Contaminated Soils
- Depleted Uranium
- Contaminated Asbestos Waste
- Classified Components

10.1.5 Verification of Waste Acceptance Criteria

Waste verification is an inspection process that confirms the waste stream data supplied by approved waste generators before MLLW or non-radioactive classified hazardous waste is accepted for disposal at the NNSS. Verification uses Real-Time Radiography (RTR), visual inspection, and/or chemical screening on a designated percentage of MLLW or non-radioactive classified hazardous waste. The objectives of waste verification include identifying prohibited waste forms, verifying that certain MLLW or hazardous waste treatment objectives are met, confirming that waste containers do not contain free liquids, and ensuring that waste containers are at least 90% full, per RCRA and State of Nevada requirements. Offsite generated waste is verified either when the waste is received at the NNSS or when it is still at a generator facility or a designated treatment, storage, or disposal facility.

In 2013, visual inspections were completed off site on 47 MLLW packages from six separate waste streams and on eight non-radioactive classified hazardous waste packages from three separate waste streams. Chemical screening was completed off site on one MLLW package from one waste stream. No onsite visual inspections or onsite RTR was conducted on MLLW or non-radioactive classified hazardous waste packages in 2013, and no MLLW or non-radioactive classified hazardous waste packages were rejected during 2013.

10.1.6 Performance Assessments, Analyses, and Annual Reviews

To assess and predict the long-term performance of NNSS disposal sites, NNSA/NFO conducts a Performance Assessment (PA) and a Composite Analysis (CA). A PA is a systematic analysis of the potential risks posed by a waste disposal facility to the public and to the environment for LLW disposed after 1988. A CA is an assessment of the risks posed by all wastes disposed in a LLW disposal facility and by all other sources of residual contamination that may interact with the disposal site. NNSA/NFO maintains current PAs and CAs for the Area 3 and Area 5 RWMSs (Table 10-2). The *Maintenance Plan for the Performance Assessments and Composite Analyses for the Area 3 and Area 5 Radioactive Waste Management Sites at the NNSS* (National Security Technologies, LLC [NSTec], 2007) requires an annual review to assess the adequacy of the PAs and CAs, and results are submitted annually to the DOE Office of Environmental Management. The Disposal Authorization Statements for the Area 3 and Area 5 RWMSs also require that annual reviews be made and that secondary or minor unresolved issues be tracked and addressed as part of the maintenance plan.

NNSA/NFO performed an annual review of the Area 3 and Area 5 RWMS PAs and CAs for FY 2013. Operational factors (e.g., waste forms and containers, facility design), closure plans, monitoring results, and research and development activities in or near the facilities were also reviewed. Because the Area 3 RWMS has been in inactive status since July 1, 2006, a special analysis was prepared in FY 2012 to update the PA and CA results for the Area 3 RWMS. The FY 2013 annual summary report to DOE (NSTec 2014a) presented data and conclusions that verified the adequacy of both the Area 3 and Area 5 PAs and CAs. Table 10-2 lists the key documents that must be current and in place for RWMS disposal operations to occur. In 2013, all of these key documents were maintained and one was revised.

Table 10-2. Key documents required for Area 3 RWMS and Area 5 RWMS disposal 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, June 2006
Performance Assessment/Composite Analysis for Area 3 RWMS, Revision 2.1, October 2000
2013 Annual Summary Report for Area 3 and 5 RWMSs at NNSS (Review of Performance Assessments and Composite Analyses), March 2014
Composite Analysis
Composite Analysis for Area 5 RWMS, September 2001
Performance Assessment/Composite Analysis for Area 3 RWMS, Revision 2.1, October 2000
NNSS Waste Acceptance Criteria
NNSS Waste Acceptance Criteria, Revision 10, June 2013
Integrated Closure and Monitoring Plan
Closure Plan for the Area 3 RWMS at the NNSS, September 2007
Closure Plan for the Area 5 RWMS at the NNSS, September 2008
Documented Safety Analysis
Documented Safety Analysis (DSA) for the NNSS Area 3 and 5 Radioactive Waste Facilities, Revision 5, Change Notice 4, May 2012
Safety Evaluation Report (SER) Addendum C, Revision 0, for the Visual Examination and Repackaging Building Addendum to the Area 5 RWMC DSA and Technical Safety Requirements (TSR) for the Area 5 RWMC TRU Waste Activities, November 2008
Visual Examination and Repackaging Building Addendum to the Area 5 RWMC DSA, Revision 0, Change Notice 3, November 2008
SER Addendum C, Revision 0, for the NNSS Area 3 and 5 Radioactive Waste Facility DSA, Revision 5, Change Notice 3, and TSR Revision 7, Change Notice 3, January 2012
TSR for the Area 5 RWMC TRU Waste Activities, Revision 10, Change Notice 4, May 2012
TSR for the Area 3 and 5 RWMS LLW Activities, Revision 7, Change Notice 4, May 2012

10.1.7 Groundwater Monitoring

Disposal Cell 18 is operated according to RCRA standards for the disposal of MLLW. 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 Cell 18 to protect groundwater from buried radioactive wastes. Wells UE5 PW-1, UE5 PW-2, and UE5 PW-3 are monitored for this purpose. Investigation levels (ILs) for five indicators of groundwater contamination (Table 10-3) were established by NNSA/NFO and the Nevada Division of Environmental Protection (NDEP) for these three wells in 1998. Samples collected semiannually in 2013 from the wells had contaminant levels below their ILs (Table 10-3). Static levels and general water chemistry parameters are also monitored. All sample analysis results are presented in NSTec (2014b). Table 5-4 of Section 5.1.2 presents the tritium results for each water sample collected in 2013 from UE5 PW-1, UE5 PW-2, and UE5 PW-3.

Table 10-3. Results of groundwater monitoring of UE5 PW-1, UE5 PW-2, and UE5 PW-3 in 2013

Parameter	Investigation Level (IL)	Sample Levels[(a)]
pH	< 7.6 or > 9.2 S.U.[(b)]	7.80 to 8.30 S.U.
Specific conductance (SC)	0.440 mmhos/cm[(c)]	0.352 to 0.374 mmhos/cm
Total organic carbon (TOC)	1 mg/L[(d)]	0.41 to 0.57 mg/L
Total organic halides (TOX)	50 µg/L[(e)]	<3.3 to 7.6 µg/L
Tritium (^{3}H)	2,000 pCi/L[(f)]	−23.0 to −7.54 pCi/L

(a) Levels shown are the lowest and highest values of the averages for each well for each sample date. Source: NSTec (2014b)

(b) S.U. = standard unit(s) (for measuring pH) (c) mmhos/cm = millimhos per centimeter

(d) mg/L = milligrams per liter (e) µg/L = microgram(s) per liter (f) pCi/L = picocuries per liter

10.1.8 Vadose Zone Monitoring

Monitoring of the vadose zone (unsaturated zone above the water table) is conducted at the RWMC to demonstrate that (1) 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) 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 the Drainage Lysimeter Facility northwest of U-3ax/bl and the Area 5 Weighing Lysimeter Facility southwest of the Area 5 RWMS. Descriptions of the VZM components and the results of monitoring in 2013 are reported in NSTec (2014c). All VZM results in 2013 continued to demonstrate that there is negligible infiltration of precipitation into zones of buried waste at the RWMC and that the performance criteria of the waste disposal cells are being met to prevent contamination of groundwater and the environment.

10.1.9 Assessment of Radiological Dose to the Public

DOE M 435.1-1 states that LLW 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 10 millirem (mrem) through the air pathway and 25 mrem through all pathways for a 1,000-year compliance period after closure of the disposal units. Given that the RWMSs are located well within the NNSS boundaries, no members of the public can currently access these areas for significant periods of time to acquire a dose exceeding the 10 or 25 mrem annual limit. To document compliance with DOE M 435.1-1, however, the possible pathways for radionuclide movement from waste disposal facilities are monitored. Long-term compliance with the DOE M 435.1-1 dose limits is evaluated by performance assessment modeling.

10.1.9.1 Dose from Air and Direct Radiation

Air samplers operate continuously to collect air particulates and atmospheric moisture near each RWMS. These samples are analyzed for radionuclides, and results are used to assess potential dose. Details of the air sampling and a summary of the analysis results can be found in Chapter 4. A total of three environmental sampling stations operated in/near the Area 3 RWMS during 2013 (U-3ax/bl S, Bilby Crater, and Kestrel Crater N). Three air monitoring stations operated near the Area 5 RWMS during 2013; sampling at one of them (Sugar Bunker) ended January 31, 2013, and sampling began at the new station, RWMS 5 Sewage Lagoons, on the same day. The DoD air sampler operated unchanged all year. The dose from the air pathway was estimated based on results from the five stations that operated for the larger portion of the year (U-3ax/bl S, Bilby Crater, Kestrel Crater N, DoD, and RWMS 5 Sewage Lagoons).

Mean concentrations of radionuclides in air at the Area 3 and Area 5 RWMS environmental sampler locations were far below the established National Emission Standards for Hazardous Air Pollutants (NESHAP) Concentration Levels for Environmental Compliance (CLs) (Table 10-4). The highest fraction of the CL of any radionuclide among the RWMS air sampler locations was 0.087 for $^{239+240}$Pu at U-3ax/bl S. Summing the fractions of CLs gives 0.10, which is only 10% of the limit in this worst-case scenario. Scaling this to the 10 mrem dose that the CLs represent would mean that a hypothetical person residing near the RWMS would receive an annual dose of about 1 mrem/yr from the air pathway.

Table 10-4. Concentrations of radionuclides in Area 3 and Area 5 RWMS air samples collected in 2013

	Concentration (× 10^{-15} microcuries/milliliter [μCi/mL])		
Radionuclide	**NESHAP Concentration Level for Environmental Compliance (CL)$^{(a)}$**	**Highest Annual Mean Concentration Among RWMS Samplers**	**RWMS Sampler with Highest Concentration**
^{241}Am	1.9	0.0235	U-3ax/bl S
^{3}H	1,500,000	344.0	U-3ax/bl S
^{238}Pu	2.1	0.00421	U-3ax/bl S
^{239}Pu	2	0.174 ($^{239+240}$Pu)	U-3ax/bl S

Note: The CL values represent an annual average concentration that would result in a total effective dose equivalent of 10 mrem/yr, the federal dose limit to the public from all radioactive air emissions.

(a) From Table 2, Appendix E of 40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," 1999.

Thermoluminescent dosimeters (TLDs) are used to measure ionizing radiation exposure in and around each RWMS. These TLDs have three calcium sulfate elements used to measure the total exposure rate from penetrating gamma radiation that includes background radiation. The penetrating gamma radiation makes up the deep dose, which is compared to the 25 mrem/yr limit when background exposure is subtracted. Details of the direct radiation monitoring can be found in Chapter 6. During 2013, the external radiation measured near the boundaries of the Area 3 and Area 5 RWMSs could not be distinguished from background levels (see Section 6.3.3). Area 3 and Area 5 RWMS operations would have contributed negligible external exposure to a hypothetical person residing near the boundaries of these sites and no dose to the offsite public.

10.1.9.2 Dose from Groundwater

Groundwater and VZM at the RWMSs is conducted to verify the performance of waste disposal facilities. Such monitoring has not detected the migration of radiological wastes into groundwater (see Sections 10.1.7 and 10.1.8). Also, the results of monitoring offsite public and private wells and springs (see Chapter 5, Table 5-4) indicate that man-made radionuclides have not been detected in any public or private water supplies. Based on these results, potential doses to members of the public from LLW disposal facilities on the NNSS from groundwater, and from all pathways combined, are negligible.

10.2 Hazardous Waste Management

Hazardous waste regulated under RCRA is generated at the NNSS from a broad range of activities, including onsite laboratories, site and vehicle maintenance, communications operations, and environmental restoration of historical contaminated sites (see Chapter 11). The RCRA Part B Permit NEV HW0101 regulates the operation of the Area 5 Mixed Waste Disposal Unit (or Cell 18), the Hazardous Waste Storage Unit (HWSU), and the Explosive Ordnance Disposal Unit (EODU) facilities. Included in the RCRA Part B permit is authorization for the storage of MLLW at the Mixed Waste Storage Unit (MWSU) composed of the following four facilities at the Area 5 RWMC: the TPCB and TRU Pad, the Sprung Instant Structure Building, the Visual Examination and Repackaging Building, and the Drum Holding Pad.

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. Hazardous waste generated at NNSA/NFO environmental restoration sites off the NNSS (e.g., at the Tonopah Test Range) or generated at the North Las Vegas Facility are direct-shipped to approved disposal facilities. Hazardous waste generated on the NNSS is also direct-shipped if the sites generate bulk, non-packaged hazardous waste that is not accepted at the HWSU for storage. Hazardous waste 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 NNSS for the temporary storage of hazardous waste prior to direct shipment off site or to the HWSU.

The EODU is permitted to treat explosive ordnance wastes by open detonation of not more than 45.4 kilograms (100 pounds) of approved waste at a time, not to exceed one detonation event per hour. Conventional explosive wastes are generated at the NNSS from explosive operations at construction and experiment sites, the NNSS firing range, the resident national laboratories, and other activities.

10.2.1 2013 Hazardous Waste Activities

The RCRA permit requires preparation of a U.S. Environmental Protection Agency Biennial Hazardous Waste Report of all hazardous waste volumes generated and disposed or stored at the NNSS. This report is prepared for odd-numbered years only. It was prepared for 2013 and submitted to the State of Nevada on February 20, 2014. An annual waste volume report (NSTec 2014d) was also prepared and submitted to the State of Nevada on February 27, 2014. It includes the volumes of wastes received in calendar year 2013 at the Area 5 MWSU, HWSU, EODU, and Cell 18.

In 2013, 0.46 tons of MLLW generated either on or off site were managed (received, stored, or treated) at the Area 5 MWSU (Table 10-5) and subsequently disposed at the Area 5 RWMS. Of the 2.96 tons of hazardous waste and 1.13 tons of PCB waste received at the HWSU in 2013 (Table 10-5), 2.11 tons of hazardous waste and 0.43 tons of PCB were shipped off site from the HWSU in 2013. The shipped PCB waste included six drums (one of hazardous waste/PCB-absorbed oil, one of a large PCB-capacitor, and four of fluorescent light ballasts containing PCBs). In 2013, no hazardous waste was direct-shipped from NNSS SAAs or HWAAs. No storage limits were exceeded at any NNSS SAAs or HWAAs. Quarterly 2013 hazardous waste volume reports were submitted on time to NDEP.

No waste explosive ordnance were detonated at the EODU in 2013 (Table 10-5).

Table 10-5. Hazardous waste managed at the NNSS in 2013

Permitted Unit	Total Waste Treated, Stored, and/or Disposed (tons)
Cell 18	1,911
MWSU	0.46
HWSU	2.96
HWSU – PCB Waste	1.13
SAAs and HWAAs	0
EODU	0

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10.3 Underground Storage Tank (UST) Management

RCRA regulates the storage, transportation, treatment, and disposal of hazardous wastes to prevent contaminants from leaching into the environment from USTs. Nevada Administrative Code NAC 459.9921–459.999, “Storage Tanks,” enforces the federal regulations under RCRA pertaining to the maintenance and operation of USTs and the regulated substances contained in them so as to prevent environmental contamination. NNSA/NFO operates one deferred UST and three excluded USTs at the Device Assembly Facility; one fully regulated UST at the Area 6 Helicopter pad, which is not in service; and three fully regulated USTs, one deferred UST, and three excluded

USTs at the Remote Sensing Laboratory–Nellis (RSL-Nellis). The Southern Nevada Health District (SNHD) has oversight authority of USTs in Clark County. In 2013, SNHD inspected the fully regulated and deferred USTs at RSL-Nellis. No deficiencies were noted, and no USTs were upgraded or removed.

In 2013, NDEP inspected the fully regulated UST and one excluded UST at the NNSS. No deficiencies were noted, and no USTs were upgraded or removed.

10.4 Solid and Sanitary Waste Management

10.4.1 Landfills

The NNSS has three landfills for solid waste disposal that were operated in 2013. The landfills are regulated and permitted by the State of Nevada (see Table 2-12 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 and asbestos waste under certain circumstances.
- 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 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 2013 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 is shown in Table 10-6. An average of 2.48 tons/day was disposed at the Area 23 landfill, well within permit limits. State inspections of the three permitted landfills were conducted in 2013, and no non-compliance issues were noted.

Table 10-6. Quantity of solid wastes disposed in NNSS landfills in 2013

Waste Disposed in Landfills in Metric Tons (Tons)		
Area 6	**Area 9**	**Area 23**
1.8 (2.0)	1,168 (1,288)	450 (496)

10.4.2 Sewage Lagoons

The NNSS also has two state-permitted sewage lagoons that were operated in 2013. 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 5.2.3.

10.5 References

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NNSA/NFO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office.

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Chapter 11: Environmental Restoration

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Environmental Restoration (ER) evaluates and implements corrective actions on those portions of the Nevada National Security Site (NNSS), the Nevada Test and Training Range (NTTR), and the Tonopah Test Range (TTR) that have been impacted by atmospheric and underground nuclear tests conducted from 1951 to 1992. These sites are referred to as corrective action sites (CASs). ER is the responsibility of Environmental Management (EM) of the U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office (NNSA/NFO). Cleanup strategies and corrective actions are developed based on the nature and extent of contamination and the risks posed by that contamination. ER is responsible for approximately 3,000 CASs in Nevada.

CASs are broadly organized into four categories based on the source of contamination: Underground Test Area (UGTA) sites, Industrial Sites, Soils sites, and Nevada Offsites. Multiple CASs are grouped into corrective action units (CAUs) according to location, physical and geological characteristics, and/or contaminants. UGTA is the largest component of NNSA/NFO's EM Operations and includes five CAUs that are directly related to the geographical areas of past underground nuclear testing. Industrial Sites are facilities and land that may have become contaminated as a result of activities conducted in support of nuclear testing, and include disposal wells, inactive tanks, contaminated waste sites, inactive ponds, muck piles, spill sites, drains and sumps, and ordnance sites. Soils sites are where nuclear tests have resulted in extensive surface and/or shallow subsurface contamination that include radioactive materials as well as possibly oils, solvents, heavy metals, and contaminated instruments and test structures used during testing activities. Nevada Offsites are associated with underground nuclear testing at the Project Shoal Area and the Central Nevada Test Area, located in northern and central Nevada, respectively. Nevada Offsites are managed by the U.S. Department of Energy (DOE) Office of Legacy Management.

In April 1996, the DOE, the U.S. Department of Defense, and the State of Nevada entered into a Federal Facility Agreement and Consent Order (FFACO) to address the environmental restoration of CASs. Appendix VI of the FFACO (as amended), describes the strategy that will be employed to plan, implement, and complete environmental corrective actions (i.e., to "close" the CASs). ER activities follow a formal work process described in the FFACO. The State of Nevada is a participant throughout the closure process, and the Nevada Site Specific Advisory Board (NSSAB) is kept informed of the progress made. The NSSAB is a formal volunteer group of interested citizens and representatives who provide informed recommendations to NNSA/NFO EM. The NSSAB's comments are strongly considered throughout the corrective action process. This section summarizes actions taken by ER towards the closure of UGTA, Industrial, and Soils sites in 2013.

Environmental Restoration Objectives for All Sites
Characterize sites contaminated by NNSA/NFO nuclear testing activities.
Remediate contaminated sites in accordance with FFACO-approved planning documents.
Conduct post-closure monitoring of sites in accordance with FFACO closure documents.

11.1 UGTA Sites

From 1951 to 1992, more than 800 underground nuclear tests were conducted at the NNSS (U.S. Department of Energy, Nevada Operations Office [DOE/NV] 2000). Most were conducted hundreds of feet above groundwater;

however, over 200 were within or near the water table. The test locations (i.e., CASs) are grouped into five CAUs based primarily on geographically distinct areas of underground testing (Figure 11-1). Closure-in-place with institutional controls and monitoring is considered to be the only feasible corrective action for these sites because cost-effective groundwater technologies have not been developed to effectively remove or stabilize deep subsurface radiological contaminants. This corrective action includes an evaluation of each CAU that starts with data collection and analysis and is followed by the development of models of the hydrogeological setting, the radiological source term, and flow and contaminant transport. The spatial extent of these models for each CAU is presented in Figure 11-2. These models are used to improve understanding of potential contaminant transport from the underground nuclear tests and, ultimately, to design monitoring well networks and land-use restrictions that are protective of the public.

Water levels are routinely measured in wells throughout the NNSS and surrounding area and are evaluated to determine groundwater flow directions (e.g., Fenelon et al. 2010) (Figure 11-3). Regional three-dimensional groundwater flow models have also been developed (International Technology Corporation 1996; Belcher and Sweetkind 2010). The characterization studies, water-level monitoring data, and regional models provide the basis for developing groundwater flow and contaminant transport models for each CAU. The groundwater flow and contaminant transport models for four of the five UGTA CAUs will be used to identify contaminant boundaries that forecast areas that potentially could exceed the Safe Drinking Water Act (SDWA) maximum contaminant levels for radionuclides over the next 1,000 years. Contaminant boundary forecasts are not required for the Rainier Mesa/Shoshone Mountain CAU model (NNSA/NFO 2013). For the Rainier Mesa/Shoshone Mountain CAU, the models must demonstrate that institutional controls will not be challenged by radionuclides emanating from underground tests conducted in the CAU within the 1,000-year compliance period.

As required under the FFACO, the following items are sequentially identified/defined for each CAU in agreement between DOE and NDEP: a regulatory boundary objective statement, regulatory boundary(ies), and use-restriction boundaries. UGTA corrective actions are expected to be completed by fiscal year 2030 (October 1, 2029–September 30, 2030).

The 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 Navarro-Intera, LLC (N-I).

Environmental Restoration Objectives for UGTA Sites
Develop a regional three-dimensional computer groundwater model to identify immediate risks and provide a basis for developing more detailed CAU-specific models.
Develop CAU-specific models of groundwater flow and contaminant transport that geographically cover the five former NNSS underground nuclear testing areas.
Identify contaminant boundaries[(a)] (which support regulatory decision-making processes) where contaminants are forecasted to exceed the SDWA limits at any time within a 1,000-year compliance period.
Negotiate regulatory boundaries to protect the public and environment from the effects of radioactive contaminant migration.
Negotiate use-restriction boundaries to restrict access to contaminated groundwater.
Develop a long-term closure monitoring network to verify consistency with the flow and transport models, compliance to the regulatory boundary, and protection of human health and the environment.
(a) The identification of contaminant boundaries are objectives for all UGTA CAUs except for the Rainier Mesa/Shoshone Mountain CAU, for which it must be demonstrated that institutional controls will not be challenged by radionuclides from underground tests conducted in the CAU within the 1,000-year compliance period.

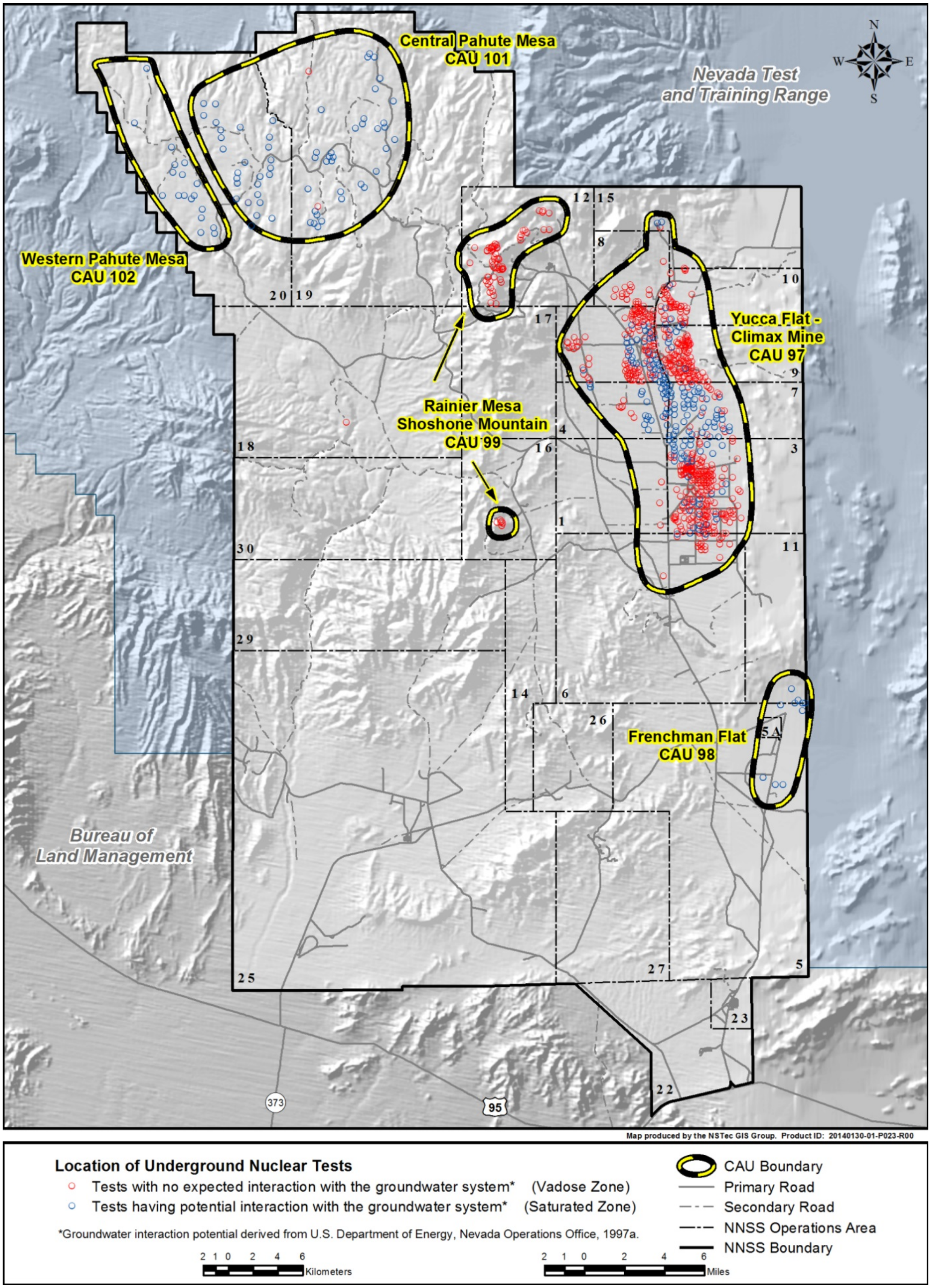


Figure 11-1. UGTA CAUs on the NNSS

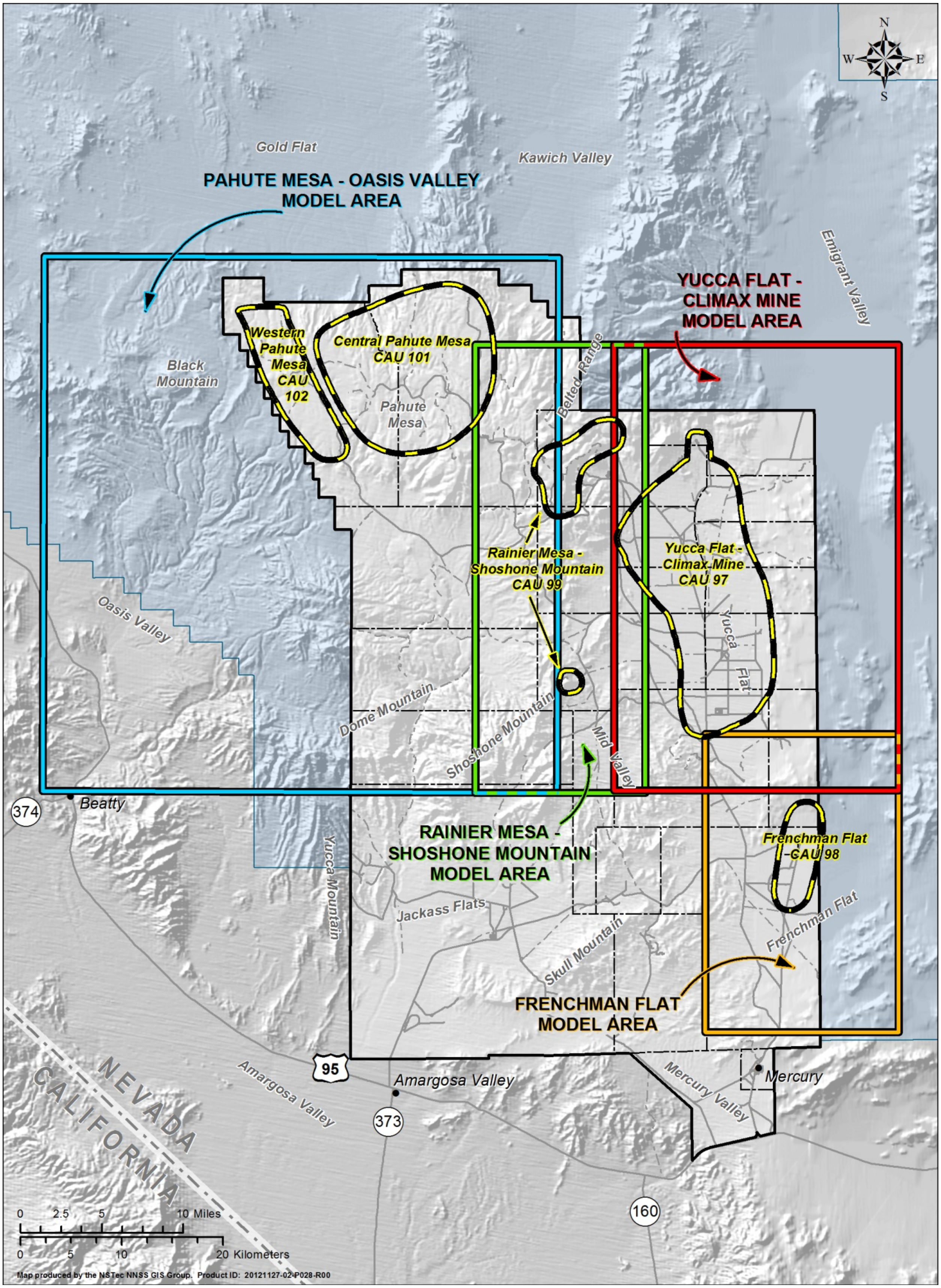
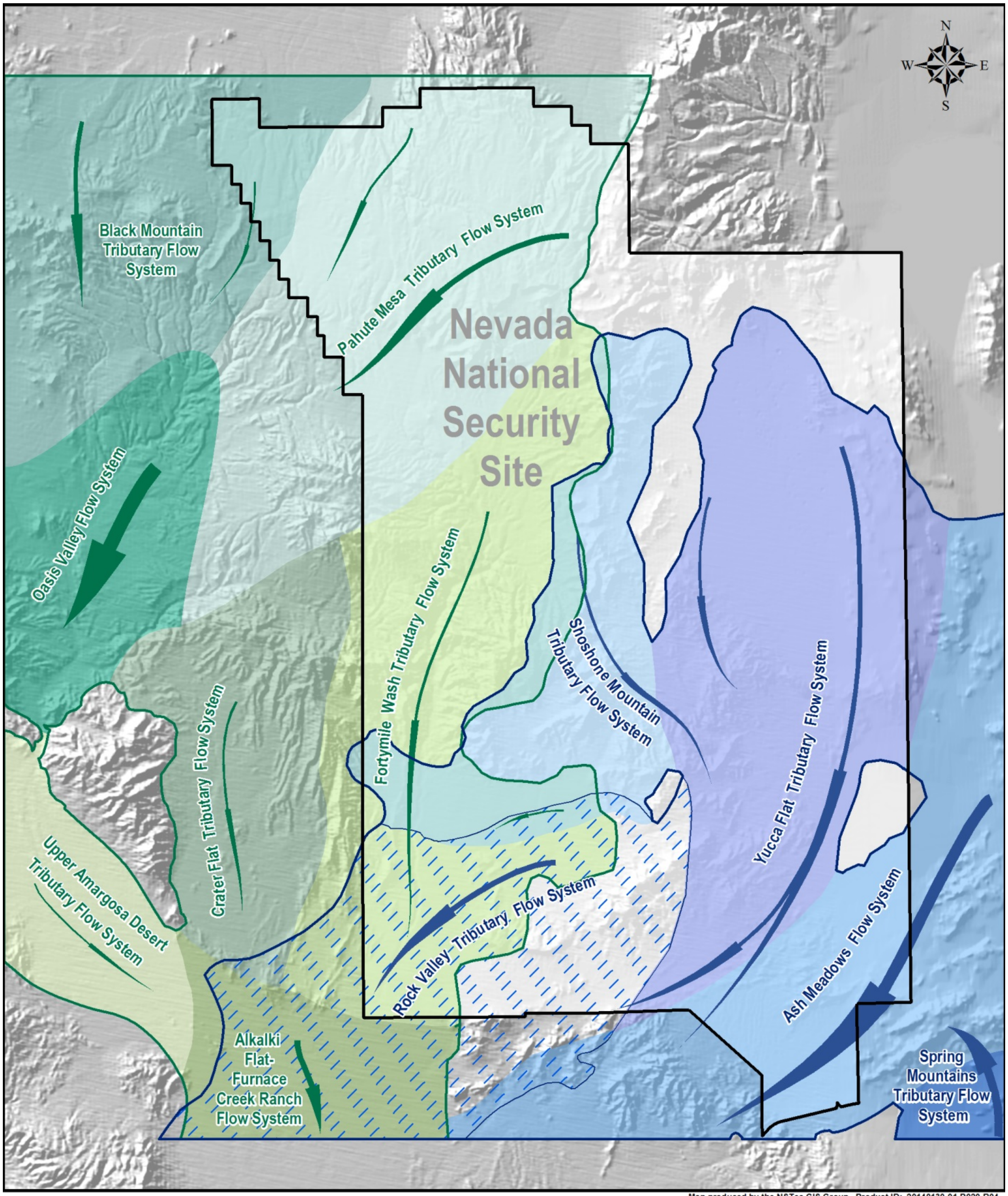


Figure 11-2. Location of UGTA model areas



Regional groundwater flow systems – Green hues denote the alluvial-volcanic flow systems; blue hues denote the carbonate flow systems[1]. Arrow direction indicates regional groundwater flow direction and width indicates relative groundwater flow volume[1]. Rock Valley Tributary Carbonate Flow System boundary is represented by a dashed-fill to indicate that the aquifer extends eastward beneath the extent of the Ash Meadows Carbonate Flow System. The Belted Range and Sarcobatus Flat Tributary Flow Systems are not shown.

[1] Modified from Fenelon, J. M., D. S. Sweetkind, and R. J. Laczniak, 2010. *Groundwater Flow Systems at the Nevada Test Site, Nevada: A Synthesis of Potentiometric Contours, Hydrostratigraphy, and Geologic Structures*. U.S. Geological Survey Professional Paper 1771, U.S Geological Survey, Denver, CO.

0 2.5 5 10 Kilometers

0 2.5 5 10 Miles

Figure 11-3. Groundwater flow systems of the NNSS

11.1.1 Development of the NNSS Integrated Groundwater Sampling Plan

An NNSS Integrated Groundwater Sampling Plan, referred to hereafter as the Plan, was developed in 2013 (NNSA/NFO 2014a). The Plan is a collaborative effort between participants of the UGTA activity and of the groundwater monitoring activity conducted under the *Routine Radiological Environmental Monitoring Plan* (RREMP) (Bechtel Nevada [BN] 2003). The Plan provides a comprehensive, integrated approach for collecting and analyzing groundwater samples and water-level measurements relevant to evaluating and monitoring groundwater potentially downgradient of underground nuclear testing. The Plan was designed to comply with the FFACO and is expected to provide a seamless transition to long-term monitoring by ensuring that adequate analytical and water-level baseline data are available as each CAU enters the Closure Report stage identified in the FFACO.

The transition to Plan implementation began in spring 2013. To support the implementation, a committee of field operations experts explored technologies for improving well purging and sampling methods. One particular goal is to provide a technology capable of sampling narrow diameter wells (i.e., piezometer strings) that were primarily installed for water-level measurements. More details will be provided in future reports.

The reader is directed to Section 5.1 in Chapter 5 of this report for a description of the Plan's sampling network and the most current tritium analysis results (Table 5-3) for wells in the network.

11.1.2 UGTA CAU Corrective Action Activities

The UGTA CAU closure strategy is essentially a process of conducting characterization and modeling studies (investigation stage) needed to acquire NDEP's approval of each CAU flow and transport model so that each CAU can move to its model evaluation stage and then to its closure stage. The closure stage is the initiation of a long-term monitoring program to protect the public from consuming potentially contaminated groundwater. The five UGTA CAUs are in various stages of the process. The following subsections provide a brief history of the actions taken to date towards the closure-in-place of each CAU. NNSA/NFO expects to complete all groundwater flow and contaminant transport models by 2023.

11.1.2.1 Frenchman Flat CAU

The Frenchman Flat CAU is the first of the five UGTA CAUs at the NNSS to complete a formal independent peer review for the CAU flow and transport model and supporting data and investigations. In 2010, the Phase II Transport Model was published (Navarro Nevada Environmental Services, LLC, 2010). In 2010, NDEP approved the Frenchman Flat flow and transport model, and the external peer review panel recommended advancement to the next stage in the closure process (N-I 2010). In 2011, a Corrective Action Decision Document/Corrective Action Plan (CADD/CAP) was prepared to describe the path forward for evaluating the groundwater flow and transport models. Initial use-restriction boundaries and a Regulatory Boundary Objective were established and are presented in the CADD/CAP (U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office [NNSA/NSO] 2011). The CADD/CAP was approved by NDEP in 2011.

A model evaluation drilling program was initiated and completed in 2012 as part of the CADD/CAP. Two model evaluation wells (ER-5-5 and ER-11-2), placed near two underground nuclear test cavities, were drilled in the summer of 2012, as described in the well drilling and completion criteria document (N-I 2012). Completion reports for ER-5-5 and ER-11-2 were published in January 2013 (NNSA/NSO 2013a; 2013b). Well development, hydrologic testing, and sampling of these two wells were conducted in the spring/summer of 2013. All sampling data were compared to the existing framework models and modeling forecasts. The data and models indicate that the local geology disrupts the flow path of contaminants away from the PIN STRIPE nuclear test cavity (borehole U-11b) near which ER-11-2 is located, and that the test cavity can no longer be considered a source of radionuclide contamination to any downgradient aquifers. Therefore, ER-11-2 was dropped from the sampling network; ER-5-5 is currently classified as a Characterization well within the network (see Table 5-3, Chapter 5).

As part of this data evaluation process, four reviews by a panel of experts (preemptive review committee) familiar with the UGTA project, but not directly associated with the data collection activities, were conducted in 2013. The committee evaluated the survey (geospatial location) data, new geology data, aquifer test data, and water-level data for all wells within the Frenchman Flat model area (Figure 11-2). Nine wells located within Frenchman Flat Areas 5 and 11 were resurveyed in September 2013 (NSTec 2013). The accuracy of the existing survey data for the nine wells was in question because of inadequate survey documentation. The new survey data were used to reduce the uncertainty in the water-level data and thus improve the basis for determining groundwater flow directions.

11.1.2.2 Western and Central Pahute Mesa CAUs

The Western and Central Pahute Mesa CAUs are in the middle of the investigation stage of the closure process. In 2009, a Phase I Central and Western Pahute Mesa Transport Model (Stoller-Navarro Joint Venture 2009) was completed for the Pahute Mesa–Oasis Valley model area. An additional phase of data collection and model development (Phase II) was needed in order to establish the necessary confidence to move forward with the closure process. Phase II data collection activities were recommended by an ad hoc subcommittee that included the NNSA/NFO UGTA Federal Activity Lead, UGTA participants (NSTec, DRI, LLNL, LANL, N-I, and USGS), a representative from NDEP, and two representatives of the NSSAB.

A Phase II Central and Western Pahute Mesa Corrective Action Investigation Plan (CAIP) was completed in 2009 (NNSA/NSO 2009a) that outlines the field investigation program that is currently being implemented. The program's objective is to institute a second phase of data collection to test the assumptions of the Phase I groundwater flow and contaminant transport models, improve the quality of data used in the models, and increase confidence in the transport model results used to forecast contaminant boundaries. Twelve locations for new wells were proposed, 10 of which were selected for drilling. Phase II drilling began in May 2009 and was completed in 2012.

The Phase I Central and Western Pahute Mesa Transport Model forecasts that tritium and carbon-14 may migrate off the NNSS from the Central and Western Pahute Mesa CAUs within 50 years of the first nuclear detonation (1965) and that offsite concentrations of tritium may be above the SDWA limit of 20,000 pCi/L within the 1,000-year compliance period (Figure 11-4). Consistent with this flow and transport model forecast, tritium was detected at 10,600 pCi/L (see Table 5-3, Chapter 5) in Well ER-EC-11 on the NTTR in 2009 (NSTec 2010. It is the first offsite well in which radionuclides from underground nuclear testing activities at the NNSS were detected. Well ER-EC-11 is located approximately 716.3 m (2,350 ft) west of the NNSS boundary (see Figure 5-2, Chapter 5) and approximately 3.2 km (2 mi) from the nearest underground nuclear tests, BENHAM and TYBO, which were conducted in 1968 and 1975, respectively. In 2010, a deeper zone of Well ER-EC-11 was sampled, and low tritium (31 pCi/L) was detected. This was not unexpected, as the aquifer sampled is isolated from the overlying contaminated aquifer by a confining unit (see Glossary, Appendix B).

Tritium detected in Well ER-20-11 (see Table 5-3, Chapter 5) is believed to represent the downgradient extension of the BENHAM-TYBO contaminant plume. This contaminant plume was first encountered at ER-20-5 (DOE/NV 1997b) and further defined by Well ER-20-7 (NNSA/NSO 2010a) and peripheral Wells ER-EC-11 (NNSA/NSO 2010b) and ER-20-8/20-8#2 (NNSA/NSO 2011). This cluster of contaminated wells is increasing the understanding of flow and transport of radionuclides from underground tests on Pahute Mesa. The discovery of tritium at Well ER-20-11 indicates that the contaminant plume forecasted by Phase I flow and transport modeling may be more southerly (ER-20-5 to ER-20-7 to ER-20-11) than previously modeled. Phase II flow and transport modeling will include the new data from the Phase II drilling initiative and will reflect the recent tritium measurements.

As part of the Phase II activities at Pahute Mesa, the Phase I hydrostratigraphic framework model (BN 2002) was rebuilt in 2013. This new model incorporates new Phase II data from the 10 additional characterization wells. Other refinements include subdividing composite units (hydrostratigraphic units composed of both aquifers and non-aquifers) into their respective hydrogeologic components.

In 2013, further analysis of faults and fracture characteristics and of hydraulic properties of selected hydrostratigraphic units was also conducted. These studies are still in progress. However, to date, this information is being used to enhance conceptual models for the Phase II hydrostratigraphic framework model, as well as provide attributes for specific aquifers on and immediately downgradient of Pahute Mesa.

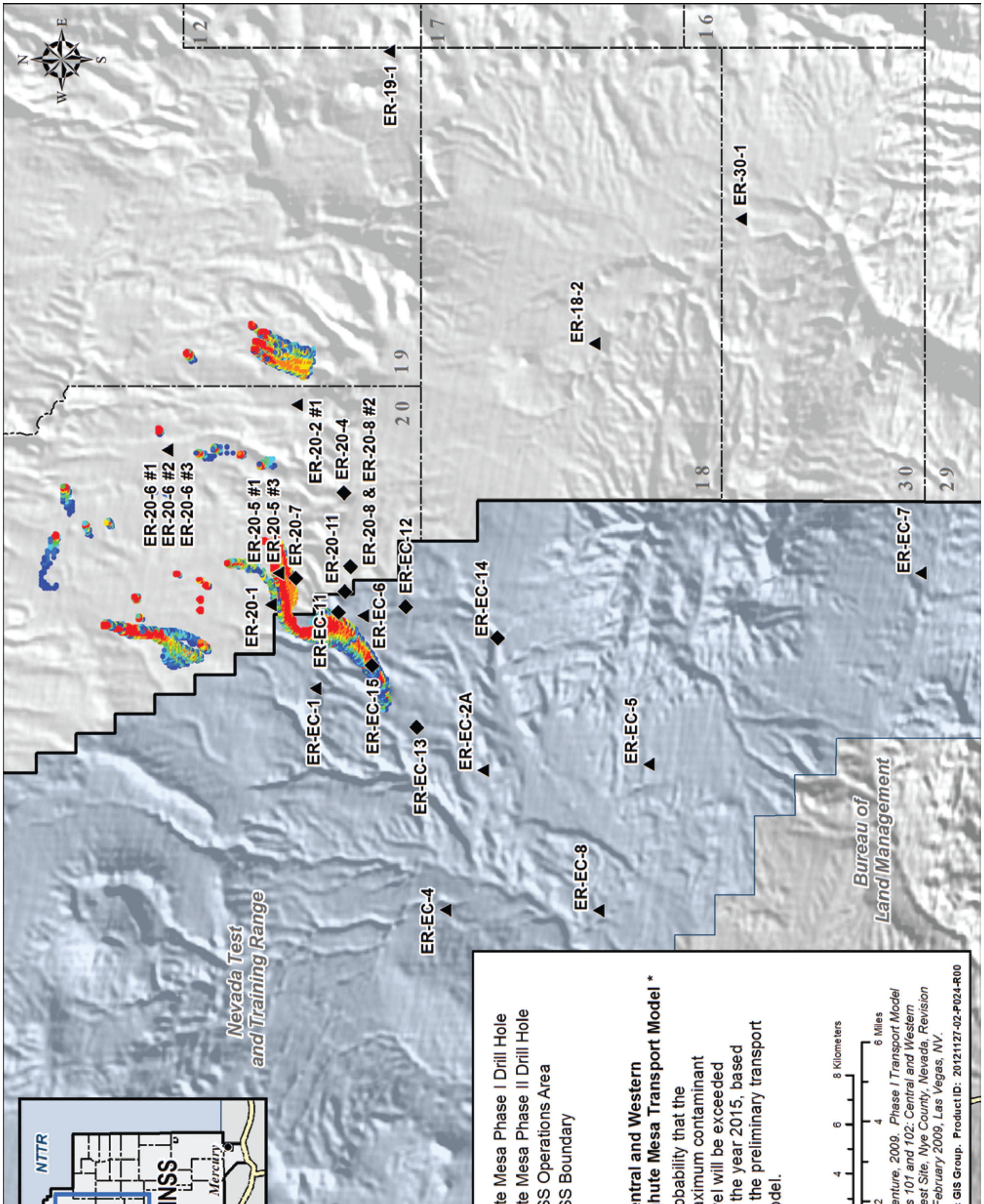


Figure 11-4. Results of Phase I Central and Western Pahute Mesa Transport Modeling

11.1.2.3 Rainier Mesa/Shoshone Mountain CAU

The Rainier Mesa/Shoshone Mountain CAU is in the investigation stage of the closure process. In 2007, the hydrogeologic model for this CAU was completed (NSTec 2007) and in 2013, the draft groundwater flow and contaminant transport models were completed. The ensemble of models was subjected to several cycles of internal reviews and summary presentations to NDEP. Compilation of attendant data packages and writing of the draft flow and transport model document were completed in 2013. Efforts to develop a more robust conceptual model for the unsaturated zone began in 2013. To facilitate this effort, the initial hydrostratigraphic framework model (NSTec 2007) is being rebuilt. This rebuild effort began in late 2013 and is scheduled to be completed in 2014.

11.1.2.4 Yucca Flat/Climax Mine CAU

The Yucca Flat/Climax Mine CAU is in the latter part of the investigation stage of the closure process. All data collection and modeling activities have been completed. The final groundwater flow and contaminant transport model (N-I 2013a) was reviewed internally and by NDEP. All comments were addressed, and the final Phase I Flow and Transport Model report was completed in September 2013 (N-I 2013b). Preparations began for an external peer review scheduled for April 2014.

11.1.3 Quality Assurance

The UGTA Quality Assurance Plan (QAP) (NNSA/NSO 2012) provides the overall quality assurance requirements and general quality practices that are applied to UGTA drilling, laboratory analyses, and modeling. The UGTA QAP complies with DOE Order DOE O 414.1D, “Quality Assurance”; *Guidance for Quality Assurance Project Plans for Modeling* (U.S. Environmental Protection Agency [EPA] 2002); and *Guidance on the Development, Evaluation, and Application of Environmental Models* (EPA 2009). UGTA work is conducted under the UGTA QAP in conjunction with other UGTA participants’ quality assurance programs. Chapter 16 discusses in more detail the quality assurance and quality control procedures used for collecting and analyzing groundwater samples.

11.1.4 Public Outreach

In December 2013, NNSA/NFO held the Fifth Annual Groundwater Open House for the public in Beatty, Nevada. Each year, NNSA/NFO conducts an open house to share current information on UGTA groundwater monitoring activities. A series of 21 posters was prepared for the December open house. They presented an overview of the groundwater monitoring program, the current sampling results for tritium and other radionuclides, the status of model development for each CAU model area, and the various investigation and decision/action stage activities that are planned for each CAU. Attendees of the open house, in addition to the public, included representatives from NNSA/NFO, the State of Nevada, NSTec, N-I, DRI, USGS, Nye County, and members of the NSSAB. EM maintains a public outreach web page specific to NNSS groundwater characterization activities at http://www.nv.energy.gov/emprograms/groundwater.aspx. Summary brochures and detailed documents on project activities (such as the Phase I Central and Western Pahute Mesa Transport Model) can be found at this website. Links to the posters presented at the 2013 public meeting can be found at the NNSA/NFO Groundwater Open House web page (http://www.nv.energy.gov/emprograms/gwopenhouse.aspx).

11.1.5 Other Activities and Studies

Compiling, evaluating, and updating the various databases continued as an ongoing effort. The water chemistry and fracture databases were expanded and updated in 2013. Efforts to compile petrographic, mineralogical, and chemical data from drill cutting samples continued and will be included in updates of A Petrographic, Geochemical, and Geophysical Database and Framework for the Southwestern Nevada Volcanic Field (Warren et al. 2003) and other UGTA databases. The USGS continued their efforts in 2013 to establish a sample photo archive related to UGTA investigations and continued their water-level monitoring program. The photo archive, water levels, and other pertinent NNSS information and data sets can be accessed through the USGS/U.S. Department of Energy Cooperative Studies in Nevada website at http://nevada.usgs.gov/doe_nv/.

11.1.6 UGTA Publications

All reports and publications that were completed in 2013 and published by June 2014 are listed in Table 11-1. 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.

Table 11-1. 2013 UGTA publications published in 2013 or prior to June 2014

Report	Reference
Estimation of Groundwater Recharge at Pahute Mesa Using the Chloride Mass-Balance Method (OSTI ID: 1113247)	Cooper et al. 2013
Dating Groundwater Using Dissolved Organic Carbon and Estimating Flow Path Travel Times in Southern Nevada Aquifers	Fereday 2013
Detecting Drawdowns Masked by Environmental Stresses with Water-Level Models	Garcia et al. 2013
Evapotranspirative Water Losses from Sagebrush and Pinyon-Pine/Juniper Ecosystems at Pahute Mesa, Nevada National Security Site, 2011–2012	Jasoni et al. 2013
Timber Mountain Precipitation Monitoring Station: 2012 Annual Report	Lyles et al. 2013
Yucca Flat/Climax Mine CAU Flow and Transport Model, Nevada National Security Site, Nye County, Nevada	N-I 2013a
Phase I Flow and Transport Model Document for Corrective Action Unit 97: Yucca Flat/Climax Mine, Nevada National Security Site, Nye County, Nevada (OSTI ID: 1094979)	N-I 2013b
Well Pahute Mesa #3 (PM-3) Well Development and Sampling Data Report, Preliminary	N-I 2014
Nevada National Security Site Integrated Groundwater Sampling Plan	NNSA/NFO 2013b
Underground Test Area Fiscal Year 2013 Annual Quality Assurance Report, Nevada National Security Site, Nevada (OSTI ID: 1113803)	NNSA/NFO 2014b
Completion Report for Model Evaluation Well ER-5-5, Corrective Action Unit 98: Frenchman Flat (OSTI ID: 1060268)	NNSA/NSO 2013a
Completion Report for Model Evaluation Well ER-11-2, Corrective Action Unit 98: Frenchman Flat (OSTI ID: 1060273)	NNSA/NSO 2013b
Completion Report for Well ER-20-11, Corrective Action Units 101 and 102: Central and Western Pahute Mesa (OSTI ID: 1063990)	NNSA/NSO 2013c
Completion Report for Well ER-EC-14, Corrective Action Units 101 and 102: Central and Western Pahute Mesa (OSTI ID: 1067490)	NNSA/NSO 2013d
Evaluation of Pleistocene Groundwater Flow through Fractured Tuffs Using a U-series Disequilibrium Approach, Pahute Mesa, Nevada, USA	Paces 2013
Colloid-Facilitated Radionuclide Transport in Fractured Carbonate Rock from Yucca Flat, Nevada National Security Site (OSTI ID: 1079666)	Zavarin et al. 2013

11.2 Industrial Sites

NNSA/NFO has identified 1,861 Industrial Sites CASs on and off the NNSS for which they are responsible for characterization and closure under the FFACO. As of December 31, 2013, 1,853 of these sites have been closed and approved by the State. Closure strategies include removal of debris, excavation of soil, decontamination and decommissioning, and closure-in-place with subsequent monitoring. Radioactive materials removed from sites were either disposed as low-level waste (LLW) or mixed low-level waste (MLLW) at the Area 5 Radioactive Waste Management Site (see Section 10.1). Hazardous waste (HW) removed from the CASs was shipped to approved offsite treatment and disposal facilities (see Section 10.2) or recycled (see Section 3.3.2.2). Beyond remediation, the Industrial Sites Activity ensures that long-term monitoring programs are in place to protect the safety of the public and the environment.

In 2013, no Industrial Sites CAUs were closed, and no interim work related to closure was conducted at any Industrial Sites CASs. Only two Industrial Sites CAUs remained to be closed at the end of 2013: CAU 114, Area 25 Engine Maintenance, Assembly, and Disassembly (EMAD) Facility and CAU 572, Test Cell C Ancillary Buildings and Structures. They comprise the final eight Industrial Sites CASs to be closed. Their closure will occur prior to the end of the NNSS Environmental Restoration Activity, which is currently planned for 2030.

11.3 Soils

NNSA/NFO has identified 134 Soils CASs on and off the NNSS for which they are responsible for characterization and closure under the FFACO. This number increased from 130 to 134 in 2013 because three new CASs were created in CAU 567, Miscellaneous Soil Sites. As of December 31, 2013, 79 of these sites have been closed and approved by the State. Corrective actions range from removal of soil to closure-in-place with restricted access controls. Historical research and the preparation of summary reports have been completed for all 134 CASs. In 2013, 32 Soils CASs from 4 CAUs on the NNSS were closed (Table 11-2), and work was conducted towards closure at 53 CASs in 11 CAUs (Table 11-3). CASs on the TTR and NTTR require negotiation with the State of Nevada and the U.S. Department of Defense. The anticipated date for Soils closure is fiscal year 2027 (October 1, 2026–September 30, 2027); 55 Soils CASs remain to be formally closed.

Table 11-2. Soils Sites closed in 2013

CAU	CAU Description	Number of CASs	Corrective Actions	Wastes Generated[a]
104	Area 7 Yucca Flat Atmospheric Test Site	15	Clean closure[b]	MLLW, Sanitary
567	Miscellaneous Soil Sites	2	Transferred to CAU 5000[c]	Not applicable
569	Area 3 Yucca Flat Atmospheric Test Sites	9	Closure-in-place with use restrictions[d]	MLLW, LLW, Sanitary
570	Area 9 Yucca Flat Atmospheric Test Sites	6	Clean closure and closure-in-place with use restrictions	LLW, Sanitary

(a) In addition to wastes, recyclable materials were recovered from all three CAUs.
(b) Clean closure is the removal of pollutants, contaminants, and waste at a CAS in accordance with Corrective Action Plans.
(c) CAU 5000, Archived Corrective Action Sites, contains sites that were once identified as unique CASs, but are currently found to be either active, non-existent, or duplicative of other identified CASs. CASs transferred to CAU 5000 are approved by the State and are considered closed.
(d) Closure-in-place with use restrictions is the isolation of contamination with restricted access controls.

Table 11-3. Other Soils Sites where work was conducted in 2013

CAU	CAU Description	Number of CASs	Activity	Wastes Generated
105	Area 2 Yucca Flat Atmospheric Test Sites	5	Investigation of nature and extent of contamination and closure activities	MLLW, LLW, and Sanitary
366	Area 11 Plutonium Valley Dispersion Sites	6	Closure activities	LLW
411	Double Tracks Plutonium Dispersion (Nellis)	1	Preliminary investigation	None
412	Clean Slate I Plutonium Dispersion (TTR)	1	Preliminary investigation	None
413	Clean Slate II Plutonium Dispersion (TTR)	1	Preliminary investigation	None
414	Clean Slate II Plutonium Dispersion (TTR)	1	Rocket body removal	LLW and Sanitary
541	Small Boy	2	Preliminary investigation	None
550	Smoky Contamination Area	19	Investigation of nature and extent of contamination	LLW
567	Miscellaneous Soil Sites	5	Preliminary investigation	None
568	Area 3 Plutonium Dispersion Sites	6	Preliminary investigation	None
571	Area 9 Yucca Flat Plutonium Dispersion Sites	5	Preliminary investigation	None
573	Alpha Contaminated Sites	2	Preliminary investigation	None

11.3.1 Monitoring Activities at Soils CAUs

NNSA/NFO monitors airborne radiation and meteorological parameters on the TTR and NTTR to determine if there is wind transport of man-made radionuclides from the contaminated Operation Roller Coaster CAUs: Double Tracks Plutonium Dispersion (Nellis) (CAU 411), and the Clean Slate I, II, and III Plutonium Dispersion (TTR)

CAUs (412, 413, and 414, respectively). In 2008, NNSA/NFO established air monitoring stations at Clean Slate III and the Range Operations Center. In 2011, a third air monitoring station was installed at Clean Slate I. The design of these stations is similar to that used in the CEMP (see Chapter 7, Section 7.1). These monitoring efforts are not required under the FFACO, and they are reported by Sandia National Laboratories (SNL) in the TTR annual environmental report (SNL 2014). In 2013, no man-made radionuclides were detected in any of the air samples collected from these stations. Only naturally occurring radionuclides were identified (SNL 2014).

NNSA/NFO monitors meteorological and surface runoff data from two Soils CAUs on the NNSS: Smoky Contamination Area (CAU 550) in Area 8 and Area 11 Plutonium Valley Dispersion Sites (CAU 366). In 2011, one meteorological station and a flume to measure channelized runoff were installed at CAU 550, and two meteorological stations and an instrument station to collect surface water runoff and transported suspended and bedload sediments were installed at CAU 366. These stations are also similar in design and function to those used in the CEMP with the exception of not including air filter monitoring or pressurized ion chambers. The equipment at both sites collects data to develop an understanding of meteorological conditions that contribute to contaminated soil transport. These monitoring efforts are not required under the FFACO but are conducted to aid in developing closure designs and post-closure monitoring requirements.

During fiscal year (FY) 2013 (October 1, 2012–September 30, 2013), data from the CAU 550 meteorological station, the flume, and visual observations of sediment transport were summarized monthly and evaluated. Surface water flowed along the monitored channel during one or more precipitation events at CAU 550, and measurable transport of radionuclide-contaminated soil occurred during one of these events. All data collected in FY 2013 are reported in Miller et al. (2014a). In FY 2013, air monitoring data collected at CAU 366 identified wind speed conditions that resulted in increased dust transport and, thus, the potential re-suspension of contaminated soils. However, no surface water runoff events occurred that were of sufficient volume to collect suspended or bedload transport samples for radiological analyses in FY 2013. The FY 2013 findings for CAU 366 are summarized in Miller et al. (2014b).

11.4 Post-Closure Monitoring and Inspections

All nine of the historical waste management units on the NNSS identified for closure under the Resource Conservation and Recovery Act (RCRA) (see Section 2.5) have been closed (Table 11-4). The RCRA Part B Permit for the NNSS prescribes post-closure monitoring requirements for six of these sites (Table 11-4). CAU 110 and CAU 111 require vadose zone monitoring (VZM) of the engineered covers over the craters/waste pits. The covers were designed to limit infiltration into the disposal units and are monitored using time-domain reflectometry soil water content sensors buried at various depths in the waste covers to provide water content profile data. The data are used to demonstrate whether the covers are performing as expected. The covers were vegetated with native vegetation and are monitored for vegetation success. In 2013, VZM results for CAU 110 and CAU 111 indicated that surface water is not migrating into buried wastes and that the covers are functioning as designed (NSTec 2014a). For CAU 111, external radiation measures from thermoluminescent dosimeters (TLDs), air and groundwater sample analyses for radionuclides, and radon flux measurements indicate that the closure covers are performing within expectations and parameter assumptions of performance assessment models and there is no impact on the surrounding environment (NSTec 2014a; 2014b). One report for all RCRA closure sites monitored in FY 2013 was prepared and submitted to NDEP in January 2014 (NNSA/NFO 2014c).

Table 11-4. Historical RCRA closure sites and their post-closure monitoring requirements

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 Facility	Quarterly site inspection Inspection if precipitation >0.5 inches/24-hour period
93	Area 6 Steam Cleaning Effluent Ponds	None
94	Area 23 Building 650 Leachfield	None
109	Area 2 U-2bu Crater	None

Table 11-4. Historical RCRA closure sites and their post-closure monitoring requirements (continued)

CAU	Remediation Site	Post-closure Requirements
110	Area 3 WMD U-3ax/bl Crater	Quarterly site inspection VZM of the engineered cover caps Biennial subsidence survey Annual vegetation survey
111	Area 5 WMD Retired Mixed Waste Pits	Quarterly site inspection Inspection if precipitation >0.5 inches/24-hour period Annual subsidence survey Annual vegetation survey Quarterly TLD readings Tritium air analyses Gamma-emitting and isotopic radionuclide air analyses Annual measurements of radon flux Groundwater monitoring of Wells UE5 PW-1, -2, and -3 VZM of the engineered cover caps
112	Area 23 Hazardous Waste Trenches	Quarterly site inspection

Post-closure inspections are also required for many of the closed remediation sites managed under the FFACO. In 2013, physical inspections were conducted at 152 closed CASs on the NNSS and TTR managed under the FFACO. Several CASs that do not require inspections were inspected as a best management practice to ensure that the signs are intact. A 2013 annual monitoring report for non-RCRA post-closure sites on the NNSS was prepared and submitted to NDEP in May 2014 (NNSA/NFO 2014d). A 2013 annual monitoring report for post-closure sites on the TTR was prepared and submitted to NDEP in March 2014 (NNSA/NFO 2014e).

11.5 Restoration Progress under the FFACO

In 2013, NNSA/NFO closed 32 CASs and completed all 2013 FFACO milestones. Figure 11-5 depicts the progress made since 1996 in the remediation of all historically contaminated sites managed under the FFACO. A total of 2,075 of the 3,021 sites have been closed; they include 143 sites that have been closed by the DOE Office of Legacy Management, the Defense Threat Reduction Agency, or other owners. Of the remaining 946 CASs yet to be closed under the FFACO (941 of which are the responsibility of NNSA/NFO), 878 (93%) of them are UGTA CASs, which will be closed in place with monitoring in perpetuity. The public can view an interactive map that shows all CASs on the NNSS, NTTR, and TTR at the following NNSS Remediation Sites website: http://nnssremediation.dri.edu/. The website identifies all CASs that have been closed and those that are still open.

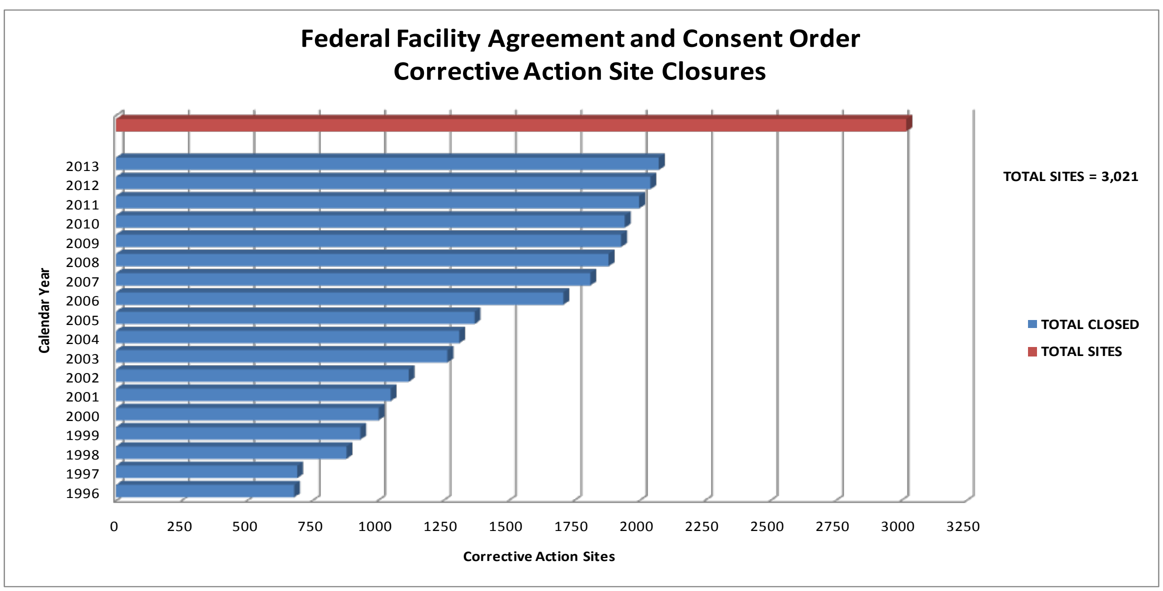


Figure 11-5. Annual cumulative totals of FFACO CAS closures

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Chapter 12: Hazardous Materials Control and Management

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Hazardous materials used or stored on the Nevada National Security Site (NNSS) 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 Field Office (NNSA/NFO) use 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 2.6). Chemicals to be purchased are subject to a requisition compliance review process. Hazardous substance purchases are reviewed 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 are provided in company documents and are aimed at meeting the goals shown below. The reports and activities prepared or performed in 2013 to document compliance with hazardous materials regulations are presented below.

Hazardous Materials Control and Management Goals
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.

12.1 TSCA Program

There are no known pieces of polychlorinated biphenyl (PCB)–containing electrical equipment (transformers, capacitors, or regulators) at the NNSS. However, sometimes during demolition activities, old hydraulic systems or contaminated soils 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 at corrective action sites during environmental restoration activities (see Chapter 11) and during maintenance activities and building decontamination and decommissioning activities. These activities can generate PCB-contaminated fluids and soil, along with bulk product waste containing PCBs.

Waste classified as bulk product waste that is generated on the NNSS by remediation and site operations can be disposed of on site in the Area 9 U10 Solid Waste Disposal Site with prior State of Nevada approval. PCB-containing light ballasts removed during normal maintenance can also go to this 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 2013, three activities generated PCB regulated waste:

- Remediation and renovation activities generated two drums of PCB waste weighing a total of 67 kilograms (kg) (146 pounds [lb]): one of absorbed PCB oil, and one with a PCB large capacitor; both were sent off site from the Hazardous Waste Storage Unit (HWSU) for disposal.
- Renovation activities generated six drums of PCB light ballasts weighing 448 kg (979 lb), one of which was shipped off site from the HWSU for disposal.
- Maintenance activities at the NNSS generated five drums of PCB light ballasts weighing 506 kg (1,111 lb), three of which were shipped off site from the HWSU for disposal.

Onsite PCB records continue to be maintained as required by the U.S. Environmental Protection Agency (EPA), and PCB management activities are documented herein annually. If any generated PCB wastes that are above threshold levels are released, they are also reported in the Toxic Release Inventory (TRI) Report (see Section 12.3). The EPA did not conduct any TSCA inspections at the NNSS in 2013.

The onsite disposal of radioactive waste received from offsite waste generator facilities that contain regulated quantities of PCBs is managed by Waste Management (see Section 10.1.1)

12.2 FIFRA Program

Several oversight functions are performed each year to ensure FIFRA compliance. They include the screening of all purchase requisitions for restricted-use pesticides/herbicides; the review of operating procedures for handling, storing, and applying pesticide/herbicide products; and monthly inspections of stored pesticides/herbicides. On the NNSS, pesticides and herbicides are applied under the direction of a State of Nevada–certified applicator. This service is provided by Solid Waste Operations (SWO). Pesticide applications in NNSS food service facilities are also conducted by SWO. Only one restricted-use chemical is used on the NNSS, which is an herbicide for vegetation control along the edges of paved roads. It is the same herbicide used by the State of Nevada along highway shoulders. SWO maintains the appropriate Commercial Category (Industrial) certification for applying this herbicide. It was not used, however, in 2013. All other pesticides/herbicides used are categorized as non-restricted-use (i.e., available for purchase and application by the general public). Monthly inspections in 2013 found that all pesticides/herbicides were stored in accordance with their labeling. The State of Nevada did not conduct an inspection of pesticide storage facilities in 2013.

12.3 EPCRA Program

EPCRA requires that federal, state, and local emergency planning authorities be provided information regarding the presence and storage of hazardous substances and extremely hazardous substances (EHSs) and their planned and unplanned environmental releases, including provisions and plans for responding to emergency situations involving hazardous materials. NNSA/NFO prepares and submits reports in compliance with EPCRA pursuant to Sections 302, 304, 311, 312, and 313 of the Superfund Amendments and Reauthorization Act, Title III (Table 12-1).

Table 12-1. Reporting criteria of the Emergency Planning and Community Right-to-Know Act

Section	CFR Section	Reporting Criteria	Agencies Receiving Report
302	40 CFR 355: Emergency Planning Notifications	The presence of an EHS in a quantity equal to or greater than the threshold planning quantity at any one time.	SERC[(a)], LEPC[(b)]
		Change occurring at a facility that is relevant to emergency planning.	LEPC
304	40 CFR 355: Emergency Release Notifications	Release of an EHS or a CERCLA hazardous substance[(c)] in a quantity equal to or greater than the reportable quantity.	SERC, LEPC
311	40 CFR 370: Material Safety Data Sheet Reporting	The presence at any one time at a facility of an OSHA hazardous chemical[(d)] in a quantity equal to or greater than 4,500 kg (10,000 lb) or an EHS in a quantity equal to or greater than the threshold planning quantity or 230 kg (500 lb), whichever is less.	SERC, LEPC, Local Fire Departments
312	40 CFR 370: Tier Two Report	Same as Section 311 reporting criteria above.	SERC, LEPC, Local Fire Departments
313	40 CFR 372: Toxic Release Inventory Report	Manufacture, process, or otherwise use at a facility, any listed TRI chemical in excess of its threshold amount during the course of a calendar year. Thresholds are 11,300 kg (25,000 lb) for manufactured or processed or 4,500 kg (10,000 lb) for otherwise used, except for persistent, bio-accumulative, toxic chemicals, which have thresholds of 45 kg (100 lb) or less.	EPA, SERC

(a) SERC = State Emergency Response Commission
(b) LEPC = Local Emergency Planning Commission
(c) Hazardous substance as defined in the Comprehensive Environmental Response, Compensation, and Liability Act, 40 CFR 302.4
(d) Hazardous chemical as defined in the Occupational Safety and Health Act, 29 CFR 1910.1200

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, toxic). Annually, this database is updated to show the maximum amounts of chemicals that were present in each building at the NNSS, North Las Vegas Facility (NLVF) (see Section A.1.5), and the Remote Sensing Laboratory–Nellis (RSL-Nellis) (see Section A.2.4). This information is then used to complete the Nevada Combined Agency (NCA) Report. 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 Marshal then issues permits to store hazardous chemicals on the NNSS as well as at RSL-Nellis and NLVF. The 2013 chemical inventory for NNSS facilities was updated and submitted to the State of Nevada in the NCA Report on February 12, 2014. The NCA Report satisfies EPCRA Section 302, 311, and 312 reporting requirements. No EPCRA Section 304 reporting was required in 2013 because no accidental or unplanned release of an EHS occurred at the NNSS, NLVF, or RSL-Nellis.

The hazardous substance inventory database is also a data source for the TRI Report. This database provides quantities of TRI chemicals that were used at the NNSS as part of normal business operations throughout the previous year. Toxic chemicals included in the TRI Report are typically released to the environment through air emissions, landfill disposal, and recycling. Reuse of a material, however, does not constitute a release to the environment. TRI toxic chemicals that are recovered during NNSS remediation activities or become “excess” to operational needs (e.g., lead bricks, lead shielding) are sent off site for recycling, reuse, or proper disposal. Mixed wastes generated at other DOE facilities and sent to the NNSS for disposal may contain TRI toxic chemicals that must be reported in the TRI Report.

In 2013, lead and mercury, released as a result of NNSS activities, were determined to be reportable under EPCRA Section 313. PCB wastes, which were generated and released for offsite and onsite disposal in 2013 (see Section 12.1) did not exceed threshold levels requiring reporting in the TRI Report. No release activities at NLVF or RSL-Nellis exceeded reportable thresholds in 2013. Table 12-2 lists the 2013 NNSS release quantities by type of activity for the two reportable TRI toxic chemicals. In June 2014, NNSA/NFO submitted the TRI Report for calendar year 2013 to the EPA and the State Emergency Response Commission.

Table 12-2. Summary of 2013 reported releases under EPCRA Section 313

	Quantity[(a)] (pounds [lb])	
Reported Release	**Lead**	**Mercury**
Air Emissions[(b)]	1.6	0
Onsite Disposal[(c)]	64,002	1,435.6
Onsite Release[(d)]	2,680	0
Offsite Recycling[(e)]	156,942.9	0.012
Offsite Disposal[(f)]	66.82	0.011
Cleanup Activities or One-time Events[(g)]	134.41	0
Totals	**223,827.73**	**1,435.62**
EPCRA Reporting Thresholds	**100**	**10**

(a) The weight of the chemical released, not the weight of the waste material containing the toxic chemical.
(b) Airborne releases of lead during firing at the Mercury Firing Range.
(c) Mixed low level waste or hazardous waste containing lead or mercury that was disposed in Cell 18 at the Area 5 Radioactive Waste Management Site (RWMS) (see Section 10.1.1).
(d) Spent ammunition left on the ground during firing at the Mercury Firing Range. When the firing range is closed, ammunition will be collected for recycling.
(e) Lead is from three waste streams: 124,500 lb of scrap metal, 32,410 lb of lead-acid batteries, and 32.9 lb of miscellaneous lead items. Mercury is from fluorescent lamps.
(f) Lead waste generated from lead paint removal and other routinely generated waste. Mercury waste is from cirduit board debris.
(g) Lead waste generated at the NNSS and other DOE facilities and disposed of off site.

In February 2014, NNSA/NFO submitted revised TRI Reports for calendar years 2011 and 2012 to the EPA and the State Emergency Response Commission. The revisions contained the quantities of PCBs released during those years which exceeded reportable thresholds under EPCRA Section 313, which had been incorrectly reported. The originally reported and revised release quantities are documented in Table 12-3.

No EPCRA inspections were performed by outside regulators in 2013.

Table 12-3. Revised quantities of reportable releases of PCBs for 2011 and 2012

		Quantity[a] (lb)	
Year	**Release**	**Originally Reported**	**Correctly Reported in 2014**
2011	Onsite Disposal[b]	5,048	5,068
	Offsite Disposal	3.98	0
	Cleanup Activities or One-time Events	0	3.98
	Totals	**5,051.98**	**5,071.98**
2012	Onsite Disposal[b]	0	20.035
	Offsite Recycling[c]	0	0.0002
	Offsite Disposal[d]	0	0.036
	Cleanup Activities or One-time Events[e]	0	0.0384
	Totals	**0**	**20.110**

(a) The weight of the chemical released, not the weight of the waste material containing the toxic chemical.

(b) PCBs disposed in Cell 18 at the Area 5 RWMS.

(c) Generated from disposed light ballasts.

(d) Generated from PCB contaminated oil.

(e) Generated at the NNSS and other DOE facilities and disposed of off site.

12.4 Nevada Chemical Catastrophe Prevention Act

The Nonproliferation Test and Evaluation Complex in Area 5 of the NNSS is registered as a Nevada Chemical Accident Prevention Program (CAPP) facility. NNSA/NFO is required to submit an annual CAPP Registration report to the State of Nevada whether or not a threshold was exceeded. The CAPP Registration report for operations from June 2012 through May 2013 was submitted to NDEP on June 12, 2013. No highly hazardous substances were stored in quantities that exceeded reporting thresholds.

Chapter 13: Groundwater Protection

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This chapter presents other programs and activities of the U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office (NNSA/NFO) that are related to the protection of groundwater that have not been discussed in previous chapters of this report (Chapter 5, Water Monitoring; Chapter 7, Section 7.2, Offsite Surface and Groundwater Monitoring; Chapter 10, Section 10.1.7, Groundwater Monitoring, and Section 10.1.8, Vadose Zone Monitoring; and Chapter 11, Section 11.1, UGTA Sites).

It is the policy of NNSA/NFO to prevent pollutants, both from past and current Nevada National Security Site (NNSS) activities, from impacting the local groundwater. Groundwater-related activities, under current NNSA/NFO missions, focus on preventing groundwater contamination, protecting the public and environment from past contamination, and protecting groundwater quality and availability for current and future NNSS missions. NNSA/NFO acknowledges that the greatest potential for environmental impact at the NNSS 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 NNSA/NFO would be to minimize, rather than eliminate, the impacts of testing.

Groundwater Protection Program Goals
Prevent the degradation of water quality due to NNSA/NFO activities that would be harmful to the public, the environment, or biota. Conduct research and monitoring to prevent public exposure to drinking water contaminated by past nuclear testing activities. Protect water availability for current and future NNSS activities.

13.1 Wellhead Protection

NNSA/NFO 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 NNSS have been identified by the State of Nevada for NNSS 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 NNSS land enforced by site security. NNSA/NFO wells that are sampled are protected through adherence to proper groundwater sampling procedures developed by each NNSS contractor or tenant organization. These procedures must be identified and implemented as a condition of well access authorization under an NNSA/NFO permit called a Real Estate Operations Permit.

13.2 Spill Prevention and Management

Procedures for the prevention, control, cleanup, and reporting of spills of hazardous and toxic materials, or any other regulated material, into the environment are established for all NNSA/NFO-managed facilities. Spills include releases from underground tanks, aboveground tanks, containers, equipment, or vehicles. All users of the NNSS are instructed to prevent, control, and report spills. NNSA/NFO ensures that spills are reported to proper federal, state, and county regulatory agencies, if required, and are properly mitigated by removing and disposing the contaminated media. All federal and state regulations concerning spills under the Clean Water Act, the Resource Conservation and Recovery Act, Superfund Amendments and Reauthorization Act, Emergency Planning and Community Right-to-Know Act, and state-specific requirements are followed.

Spill Prevention, Control, and Countermeasure (SPCC) plans are in place for the North Las Vegas Facility (NLVF) and the Remote Sensing Laboratory–Nellis (RSL-Nellis) to prevent discharges of petroleum products and non-petroleum oils and greases into the Las Vegas Wash. The plans were prepared in accordance with the Clean Water Act and cover petroleum storage areas and petroleum-containing equipment, including transformers and machine tools. The NNSS does not have an SPCC because the NNSS oil storage areas do not have the potential to impact any protected waterways. Established procedures for users of the NNSS as well as the NLVF and RSL-Nellis ensure that surface spills or subsurface releases of contaminants do not infiltrate groundwater or flow into surface waters. There was one reportable spill in 2013 (see Section 2.10.2).

13.3 Water Level, Temperature, and Usage Monitoring by the USGS

The U.S. Geological Survey (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 NNSS. Hydrologic data are collected quarterly or semi-annually from wells on and off the NNSS. The USGS also maintains and develops the Death Valley Regional Groundwater Flow System Model (Belcher and Sweetkind 2010) and manages the NNSS well hydrologic and geologic information database.

During 2013, the USGS monitored water levels in 221 wells, which included 109 on the NNSS and 112 off the NNSS. A map showing the location of monitored wells and all water-level data are posted on the USGS/ U.S. Department of Energy (DOE) Cooperative Studies in Nevada web page at http://nevada.usgs.gov/doe_nv/.

Groundwater use data are collected from water supply wells on the NNSS using flow meters, and are reported monthly. The principal NNSS water supply wells monitored during 2013 included J-12 WW, J-14 WW, UE-16d WW, WW #4, WW #4A, WW 5B, and WW 8 (see Chapter 5, Figure 5-2). The USGS compiles the annual water-use data and reports annual withdrawals in millions of gallons. Discharge data from these wells for 2013 have been compiled, processed, and entered onto the USGS/DOE Cooperative Studies in Nevada website at http://nevada.usgs.gov/doe_nv/wateruse/wu_map.cfm. Discharge from these wells during 2013 was approximately 99.3 million gallons (Figure 13-1).

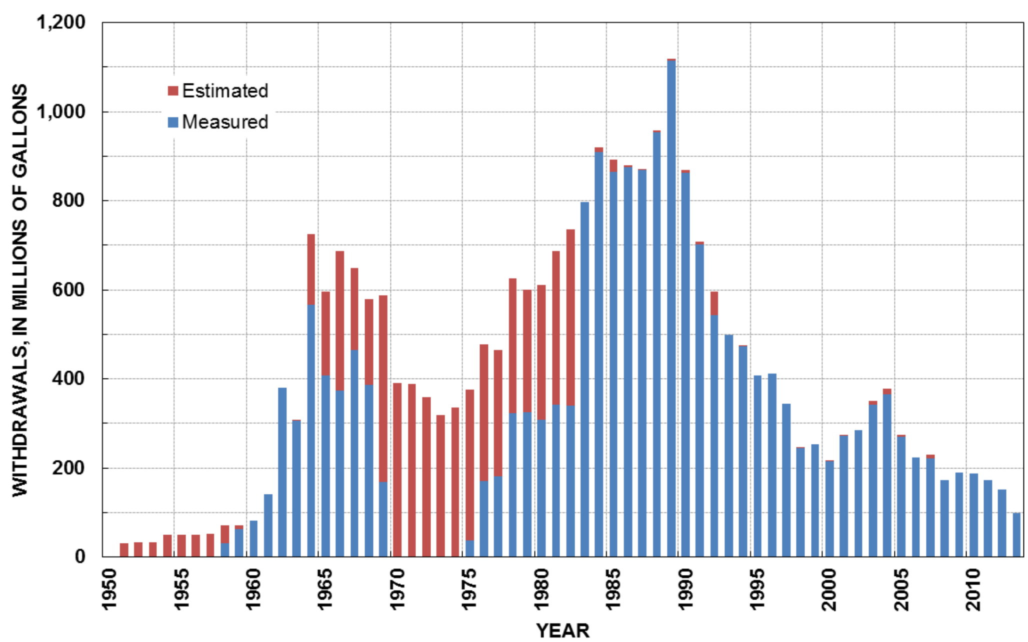

Figure 13-1. Annual withdrawals from the NNSS, 1951 to 2013

13.4 Groundwater Conservation

All water used at the NNSS is groundwater. NNSA/NFO takes actions to conserve groundwater by addressing the water efficiency and water management goals presented in DOE's Strategic Sustainability Performance Plan (DOE 2013) and in the fiscal year (FY) 2014 NNSA/NFO Site Sustainability Plan (National Security Technologies, LLC [NSTec], 2013). These goals include reducing both potable and non-potable water use (see Section 3.3.1, Energy Management Program, Table 3-2, Goal 4). As shown in Figure 13-1, current water usage is approaching levels that have not been seen since the early 1960s due to changes in site operations and to recent conservation actions.

A Water Management Plan for the NNSS, developed in 2011 (The Delphi Groupe, Inc. [Delphi] 2011), includes a water metering plan, a comprehensive plan to reduce groundwater usage and losses on site, a water system configuration improvement plan, and water efficiency practices implemented on the NNSS. Below are listed the groundwater conservation actions of this plan that were accomplished in FY 2013 (October 1, 2012, through September 30, 2013) (NSTec 2013):

- The closure in FY 2012 of four earthen sumps (NSTec 2013) resulted in the conservation of 24 million gallons of groundwater at the NNSS during FY 2013.
- Potable water production on the NNSS for FY 2013 was reduced by 41% from the FY 2007 baseline.
- WaterSense labeled products continued to be purchased and installed to replace standard faucets and toilets on an as-needed basis. Rebates from the Southern Nevada Water Authority for the installation of water-saving devices continued to be sought and, when obtained, will be used to fund additional water-saving initiatives.

Since the water use efficiency and management goals established by DOE were exceeded by NNSA/NFO in FY 2013 (see Section 3.3.1, Table 3-2, Goal 4), future water saving projects will be limited to routine maintenance until additional funding is acquired. The replacement of aging waterlines in Area 23 and throughout the NNSS remains to be implemented as an identified conservation action under the Water Management Plan (Delphi 2011).

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Chapter 14: Historic Preservation and Cultural Resources Management

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The historic landscape of the Nevada National Security Site (NNSS) 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 436.1, "Departmental Sustainability," requires the development and maintenance of policies and directives for the conservation and preservation of cultural resources. On the NNSS, cultural resources are monitored, and site activities and projects comply with applicable federal and state regulations related to their protection (see Section 2.8). The Cultural Resources Management (CRM) program at the NNSS has been established and is implemented by the Desert Research Institute (DRI) to aid in the conservation and preservation of cultural resources that may be impacted by U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office (NNSA/NFO) activities. 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 NNSS (see Section 2.8).
Inventory and manage cultural resources on the NNSS.
Provide information that can be used to evaluate the potential impacts of proposed projects and programs to cultural resources on the NNSS and mitigate adverse effects.
Curate archaeological collections in accordance with Title 36 Code of Federal Regulations (CFR) Part 79, "Curation of Federally-Owned and Administered Archeological Collections."
Conduct American Indian consultation related to places and items of importance to the Consolidated Group of Tribes and 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) archival research, inventories, and historical evaluations; (2) curation of archaeological collections; and (3) the American Indian Consultation Program. The guidance for the CRM program work is provided in the *Cultural Resources Management Plan for the Nevada Test Site* (Drollinger and Beck 2010). Historical 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 2013 accomplishments is provided in this chapter. The methods used to conduct inventories and historical evaluations in support of NNSS operations were summarized in the *Nevada Test Site Environmental Report 2003* (Bechtel Nevada 2004). The reader is directed to the *Nevada National Security Site Environmental Report 2013 Attachment A: Site Description*. It is a separate file on the compact disc of this report and is also accessible on the NNSA/NFO web page http://www.nv.energy.gov/library/publications/aser.aspx. Attachment A summarizes cultural resource inventories of the NNSS and describes prehistoric and historic artifacts found there. It also contains a summary of the known human occupation and use of the NNSS from the Paleo-Indian Period, about 12,000 years ago, until the mining and ranching period of the 20th century, just before NNSS lands were withdrawn for federal use.

14.1 Cultural Resources Inventories and Historical Evaluations

Cultural resources inventories are field surveys that are conducted at the NNSS 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. Historical evaluations are completed to evaluate historic resources for eligibility to the National Register of Historic Places (NRHP). The following types of information collected during inventories and historical evaluations, or produced based on them, are 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 NRHP
- Eligible properties avoided by project activities
- Cultural resources requiring mitigation to address an adverse effect
- Occurrences of damage to archaeological sites
- Final report on results

In 2013, DRI conducted archival research for 40 proposed NNSA/NFO projects that had the potential to impact cultural resources on the NNSS. The archival research results led archeologists to conduct six field inventories and two historical evaluations, which are listed in Tables 14-1 and 14-2. Two of the six inventories and one of the historical evaluations were completed through the report phase (Table 14-1), and one historic site was identified in these areas. The other cultural resources inventories and the historical evaluations were completed through the field work phase (Table 14-2) and resulted in the identification of ten historic sites and three Historic Districts. A total of 429.6 hectares (1,061.4 acres) was examined during the inventories and historical evaluations (Tables 14-1 and 14-2).

In 2013, there were no reported occurrences of damage to archaeological sites.

Table 14-1. 2013 cultural resources inventories and historical evaluations for which final reports were completed

Inventories/Evaluations	NNSS Area	Prehistoric/ Historic Sites Found	Cultural Resources Evaluated	Cultural Resources Determined NRHP Eligible	Area Surveyed Hectares	Acres
Jackass Flats Road Repair	25	0	0	0	3.7	9.1
New Access Road between Two Detonation Pads	26	0	0	0	0.4	0.9
U16a Historical Evaluation	16	1	1	1	16.7	41.3
Totals		**1**	**1**	**1**	**20.8**	**51.3**

Table 14-2. 2013 cultural resources inventories and historical evaluations for which final reports and cultural resource evaluations to determine NRHP eligibility are pending

Inventories/Evaluations	NNSS Area	Prehistoric/ Historic Sites Found	Historic District	Area Surveyed Hectares	Acres
Access Road #2 Neptune 5a	26	0	0	0.4	0.9
Corrective Maintenance DDL and DAE Power Lines	2, 3, 4, 6, 8, 12	5	0	77	190.3
Corrective Maintenance of the DDK Power Line	5	1	0	20	49.4

Table 14-2. 2013 cultural resources inventories and historical evaluations for which final reports and cultural resource evaluations to determine NRHP eligibility are pending (continued)

Inventories/Evaluations	NNSS Area	Prehistoric/ Historic Sites Found	Historic District	Area Surveyed Hectares	Area Surveyed Acres
Corrective Maintenance of the DDP and DDR Power Lines	5	0	0	18	44.5
U15 Complex Historical Evaluation	15	1	1	113	279.3
Shasta Historical Evaluation	2, 4, 8	1	1	14	34.5
Smoky Historical Evaluation	8	2	1	166.4	411.2
Totals		**10**	**3**	**408.8**	**1,010.1**

14.2 Evaluations of Historic Structures

In 2013, archival research and fieldwork were completed for the historical evaluations of the U15 Complex in Area 15 and the Shasta atmospheric test location in Areas 2, 4, and 8 of the NNSS. The U15 Complex was in operation from 1959 to 1967 for the Hard Hat, Tiny Tot, and Pile Driver underground nuclear tests. The objective of these tests was to monitor the response of ground shock and various structure types to a nuclear explosion in order to design and construct underground facilities, such as command centers, that would be impervious to a direct nuclear attack (Drollinger et al. 2013). Subsequent to these tests, the complex was used for underground nuclear fuel storage experiments by the Lawrence Livermore National Laboratory for the DOE from 1978 to 1985. No major projects have been conducted at the site since then.

The Shasta location was used in 1957 as one of the mid-series tests of Operation Plumbbob. The primary objectives of the test were to evaluate newly designed devices, to evaluate the nuclear yield and blast of the Shasta device, and to investigate thermal and nuclear radiation phenomena. The Shasta device was detonated from the top of a 152.4-meter (500-foot) steel tower, named T2a. Cultural materials within the site area are features, artifacts, and structures related to the test (King 2013a).

Also completed in 2013 was one damage assessment of Resource No. S89, a wooden structure at Yucca Lake in Area 6. The structure was originally recorded in 2004 and at that time not enough information was available to make a National Register Determination. It was likely, however, that the structure was associated with atmospheric nuclear testing during the 1950s, so it was being treated as eligible until a determination could be made. In recent years, noticeable changes from weathering have been apparent. By 2010, one wall of the structure had collapsed inward; by late 2013, the other three walls collapsed during a wind storm (Drollinger 2013a).

14.3 General Reconnaissance

Three field activities and five preliminary assessments were conducted in 2013. One of the field activities was to monitor the grading of the Dead Horse Flat Road into the U-19ax location.The remaining field activities were to accompany construction and seismic personnel to the Rock Valley Seismic locations U-27 RTPP and U-27 RVEE to monitor the placement of seismic equipment. The preliminary assessments were for Corrective Action Units (CAUs) 541, 567, and 571. These CAUs are focused on atmospheric nuclear test sites, underground nuclear test sites, and miscellaneous nuclear testing-related features and facilities. DRI provided recommendations regarding the presence and protection of cultural resources at the CAUs.

14.4 Cultural Resources Reports

Eight cultural resources reports were completed and finalized in 2013 (Table 14-3). NNSA/NFO submitted the inventory reports and historical evaluations to the Nevada State Historic Preservation Office for their review and concurrence. Specific site location information and reports containing such data are not available to the public.

The data on NNSS 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 14-3. Cultural resources reports approved and finalized in 2013

Project	Reference
Inventory Reports	
Valley Electric Association, Inc. Transmission Line	Jones et al. 2013
Jackass Flats Road Repair, Area 25	Menocal 2013
Damage Assessment of Resource No. S89, a Wooden Structure at Yucca Lake	Drollinger 2013a
New Access Road between Two Detonation Pads, Area 26	Drollinger 2013b
Preliminary Assessment Letter Reports	
Corrective Action Unit 541, Area 5	Jones 2013
Corrective Action Site 05-23-07, Corrective Action Unit 567, Area 5	King 2013b
Corrective Action Site 20-23-08, Corrective Action Unit 567, Area 20	King 2013c
Corrective Action Unit 571 Walk Down, Area 9	King 2013d
Corrective Action Unit 571, Area 9	King 2013e

14.5 Curation

The NHPA requires that archaeological collections and associated records be maintained at professional standards; the specific requirements are delineated in 36 CFR 79. The NNSS Archaeological Collection currently contains over 400,000 artifacts and is curated in accordance with 36 CFR 79. Curation requirements for the NNSS Archaeological Collection include:

- Maintain a catalog of the items in the NNSS collection.
- Package the NNSS collection in materials that meet archival standards (e.g., acid-free boxes).
- Store the NNSS collection and records in a facility that is secure and has environmental controls.
- Establish and follow curation procedures for the NNSS collection and facility.
- Comply with the Native American Graves Protection and Repatriation Act (NAGPRA).

In the 1990s, the U.S. Department of Energy, Nevada Operations Office completed the required inventory and summary of NNSS cultural materials accessioned into the NNSS Archaeological Collection and distributed the inventory list and summary to the tribes affiliated with the NNSS 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.

In 2013, the NNSA/NFO artifact collection and documents for the cultural resources studies conducted on the NNSS were maintained by DRI. The NNSA/NFO collection is arranged on the shelving according to site provenience, and the collection is stored in a manner that meets or surpasses archival standards (Falvey 2013). This involved oversight of the collections and documents in the curation facility, management of project records, and maintenance of the databases. The objective for 2013 was to finalize an accession database for the artifact collection. This effort started during 2011 and was completed midway through fiscal year 2013. The accession database consists of 1,281 entries and documents the number of boxes and types of artifacts collected for each project. The artifact catalog, which contains records for individual artifacts in the collection, is linked to the accession record table in a Microsoft Access database file. These files can now be cross-referenced in order to get information on collections at the project, site, or artifact level (Falvey 2013). Several items from the collection have been loaned to the Atomic Testing Museum and are on display there.

All artifacts in the collection are stored in current archival-quality materials, and 35 years of archaeological survey reports, technical reports, and site records are linked to a Geographical Information System. Although the work schedule in the curation facility is variable, the state of the collection is monitored weekly to ensure that the materials remain in good condition.

14.6 American Indian Consultation Program

NNSA/NFO has had an active American Indian Consultation Program since the late 1980s. The function of the program is to conduct consultations between NNSA/NFO and 16 NNSS-culturally affiliated American Indian tribes that are collectively organized into the Consolidated Group of Tribes and Organizations (CGTO). The CGTO represents Southern Paiute, Western Shoshone, and Owens Valley Paiute-Shoshone. The 16 groups are listed in previous NNSS environmental reports (e.g., National Security Technologies, LLC, 2008). 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 government-to-government forum for the CGTO to interface directly with NNSA/NFO and discuss issues of importance.
- Provide the CGTO with opportunities to actively participate in decisions that involve culturally significant places and locations on the NNSS.
- Involve the CGTO in the curation, display, and protection of American Indian artifacts.
- Enable the CGTO and its constituency to practice and participate in religious and traditional activities within the boundaries of the NNSS.
- Provide an opportunity for subgroups of the CGTO to participate in the review and evaluation of program documents and provide guidance in the interim between regularly scheduled meetings.
- Include the CGTO in the development of text in the agency's National Environmental Policy Act documents.

Following last year's meeting on January 25, 2012, with the Acting DOE Deputy Assistant Secretary for Environmental Management, actions were taken on June 4, 2013, to appoint the CGTO Spokesperson to the State Tribal Government Working Group (STGWG). This involvement joins 10 other tribes currently serving from New Mexico, Idaho, Washington, Oregon, and New York. Specifically, these tribes work closely with various sites within the DOE Complex and focus on Environmental Management activities and enhanced communications at all levels within DOE along with those states and tribes affected by DOE sites and activities.

During 2013, the CGTO Spokesperson attended six meetings, each supported by NNSA/NFO to encourage increased tribal involvement and understanding about DOE's role in national activities. Included were meetings with the Assistant Secretary for Nuclear Energy on March 20, 2013, in Washington, D.C., and two STGWG meetings, one at the Fernald Site in Cincinnati, Ohio, June 3–5, 2013, and the other in New Orleans, Louisiana, October 28–30, 2013. A special meeting, the 1st Tribal Leaders Dialogue, followed with the DOE Assistant Secretary of Nuclear Energy and selected individuals. This forum provided an opportunity for the CGTO Spokesperson and other tribal leaders to engage in discussions with the Assistant Secretary and develop methods for increasing tribal involvement through expanded communications on a national level. Other meetings included DOE's National Transportation Stakeholders Forum in Buffalo, New York, May 14–16, 2013, and its Tribal Caucus participation in two State Regional Groups including the Western Interstate Energy Board on October 15, 2013, in San Diego, California, and the Midwestern Council of State Governments, on December 4–5, 2013, in Kansas City, Kansas. During the weeks of July 15 and 22, 2013, the CGTO Spokesperson accompanied DOE Headquarters personnel and other subject matter experts to visit six shutdown nuclear power plants in Oregon, California, Illinois, Wisconsin, and Michigan. This involvement provided insight into the decommissioning process and allowed DOE to identify other culturally affiliated tribes with those locations to expand tribal interactions in the future.

On August 21, 2013, the CGTO Spokesperson was formally appointed to the Nevada Site Specific Advisory Board (NSSAB) to serve as a Liaison giving advisory insight into activities conducted on the NNSS. This appointment provides an opportunity to share the perspectives conveyed by the 16 American Indian Tribes that are culturally affiliated to the NNSS while becoming more interactive with NSSAB recommendations made to the DOE and NNSA/NFO.

In 2013, NNSA/NFO did not receive any requests from NNSS-culturally affiliated tribes to access the NNSS for ceremonial or traditional use. CGTO interest continues to focus on expanding tribal involvement in traditional management activities and conducting further ethnographic studies to document traditional ecological knowledge relating to land use and cultural resource protection and preservation. NNSA/NFO continues to protect culturally important American Indian sites and conducts periodic monitoring, providing updates to culturally affiliated tribes upon request.

In the 1990s, NNSA/NFO initiated NAGPRA consultations with NNSS-culturally affiliated tribes regarding artifacts maintained in the NNSS artifact collection. The final repatriation of tribally identified cultural items from the collection occurred in 2002 and marked the conclusion of NAGPRA consultations for NNSA/NFO. NNSA/NFO remains committed to providing opportunities for the CGTO to evaluate the NNSA/NFO artifact collection for compliance with curation standards and ensuring positive relations continue to exist between the NNSA/NFO and the tribes (Arnold 2013).

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Chapter 15: Ecological Monitoring

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The Ecological Monitoring and Compliance (EMAC) Program provides ecological monitoring and biological compliance support for activities and programs conducted at the Nevada National Security Site (NNSS). The major sub-programs and tasks within EMAC include (1) the Desert Tortoise Compliance Program, (2) biological surveys at proposed project/activity sites, (3) monitoring important species and habitats, (4) the Habitat Restoration Program, and (5) wildland fire hazard assessment. Brief descriptions of these sub-programs and their 2013 accomplishments are provided in this chapter. Detailed information may be found in the most recent annual EMAC report (Hall et al. 2014). EMAC annual reports are available at http://www.nv.energy.gov/library/publications/emac.aspx. The reader is also directed to *Attachment A: Site Description*, a separate file on the compact disc of this report, where the ecology of the NNSS is described.

Ecological Monitoring and Compliance Program Goals
Ensure compliance with all state and federal regulations and stakeholder commitments pertaining to NNSS flora, fauna, wetlands, and sensitive vegetation and wildlife habitats (see Section 2.9). Delineate NNSS ecosystems. Provide ecological information that can be used to evaluate the potential impacts of proposed projects and programs on NNSS ecosystems and important plant and animal species.

15.1 Desert Tortoise Compliance Program

The desert tortoise is federally protected as a threatened species under the Endangered Species Act, and it inhabits the southern one-third of the NNSS (Figure 15-1). Activities conducted in desert tortoise habitat on the NNSS 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 Field Office (NNSA/NFO) by the U.S. Fish and Wildlife Service (FWS) (FWS 2009). 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 Opinion states that proposed NNSS 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. It sets compliance limits for the acres of tortoise habitat that can be disturbed, the number of accidentally injured and killed tortoises, and the number of captured, displaced, or relocated tortoises (Table 15-1). It also establishes 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/NFO in FWS consultations.

15.1.1 Surveys and Compliance Documentation

In 2013, biologists conducted surveys for 10 projects that were within the distribution range of the desert tortoise on or near the NNSS. A total of 11.97 acres of desert tortoise habitat were disturbed in 2013, and no compliance limits of the Opinion were exceeded (Table 15-1). Remuneration fees for the compensation of habitat disturbance were paid and deposited into a Desert Tortoise Public Lands Conservation Fund, as required by the Opinion.

In 2013, two desert tortoises were killed by vehicles on paved roads and seven were moved out of harm's way off of roads. Seven desert tortoises were captured and fitted with radio transmitters for a study approved by the FWS. The study will collect movement data through 2014 from up to 20 desert tortoises found near NNSS roads for the purpose of developing a strategy to minimize road mortalities. At project sites, no desert tortoises were accidentally injured or killed, nor were any found, captured, or displaced from the project sites. In January 2014,

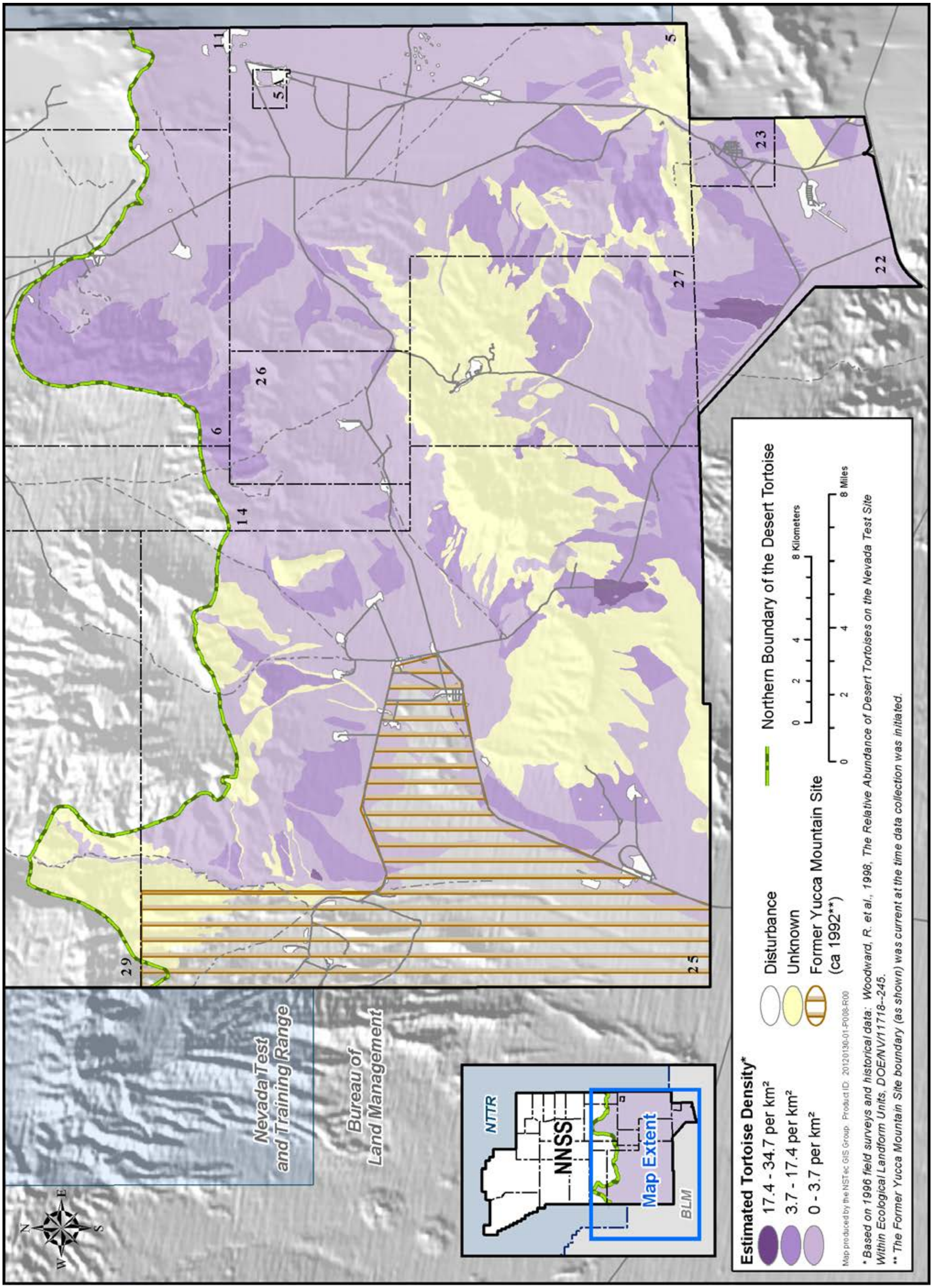

Figure 15-1. Desert tortoise distribution and abundance on the NNSS

NNSA/NFO submitted a report to the FWS Southern Nevada Field Office that summarizes tortoise compliance activities conducted on the NNSS from January 1 through December 31, 2013.

Table 15-1. Annual totals (2013), cumulative totals (2009–2013), and compliance limits for take of acres and tortoises

Program/Activity	Acres Impacted			Tortoises Killed or Injured			Other Incidental Take[a]		
	Annual Total	Cumulative Total	Permit Limit	Annual Total	Cumulative Total	Permit Limit	Annual Total	Cumulative Total	Permit Limit
Defense	0	5.61	500	0	0	1	0	0	10
Waste Management	0	0	100	0	0	1	0	0	2
Environmental Restoration	0	0	10	0	0	1	0	0	2
Nondefense Research and Development	0	0	1,500	0	0	2	0	0	35
Work for Others	5.36	30.53[b]	500	0	0	1	0	0	10
Infrastructure Development	6.61	8.25	100	0	0	1	0	0	10
Vehicle Traffic on Roads	-	-	-	2	7	15[c]	14	59	125
Totals	11.79	44.39	2,710	2	7	22	14	59	194

(a) The number of desert tortoises that a qualified biologist can take by capture, displacement, relocation, or disruption of behavior if desert tortoises are found in harm's way within a project area or on a heavily trafficked road.

(b) The Radiological/Nuclear Countermeasures Test and Evaluation Complex (RNCTEC) began an expansion project in 2011 and pre-paid mitigation fees for the disturbance of 118 acres, of which, 104.28 acres have not yet been disturbed.

(c) No more than 4 desert tortoises killed during any calendar year and 15 during the term of the Opinion (2009–2019).

15.1.2 Desert Tortoise Conservation Projects

Three desert tortoise projects on the NNSS have been approved by the FWS and are being conducted solely or in part by NNSS biologists. They include (1) a tortoise movements study of up to 20 tortoises found along paved NNSS roads, (2) a study of the fate of 60 juvenile tortoises translocated in 2012 from captivity at the Desert Tortoise Conservation Center (DTCC) located near Las Vegas, Nevada, to undisturbed tortoise habitat in Area 22 of the NNSS by staff and volunteers from the San Diego Zoo Institute for Conservation Research (ICR), and (3) a collaborative behavioral/health study of up to 20 translocated tortoises within each of three existing fenced enclosures in Rock Valley (Area 25) led by the U.S. Geological Survey (USGS) in collaboration with the FWS, the ICR, and Penn State University.

NNSS biologists use radiotelemetry to document the location and condition of tortoises included in these three studies. In November 2013, the FWS approved NNSS biologists to conduct/support these studies in lieu of paying mitigation fees for habitat loss for NNSS projects that were not under the Work for Others Program (see Table 15-1, first column). The mitigation fees paid to date have provided no protection benefits to onsite tortoise populations; they have been used to support the operation of the DTCC operated by the ICR. The studies were approved because they are anticipated to reduce onsite tortoise road mortality and enhance tortoise conservation and regional recovery of the species.

In 2013, an additional seven desert tortoises were radiotagged for inclusion in the tortoise roadside movements study, bringing the total number of tortoises in the study to 18. Analysis of the movement data and resultant recommendations to reduce road mortality are expected to be completed in 2015. Monitoring of the 60 juvenile tortoises was transferred from ICR personnel to NNSS biologists in the fall of 2013. NNSS biologists will continue to monitor the translocated juveniles for the next 2 to 4 years. At the Rock Valley enclosures, NNSS biologists assisted in weekly monitoring during the initial release of 15 tortoises into each enclosure in the spring of 2013, and will provide support to USGS biologists as requested.

15.2 Biological Surveys at Proposed Project Sites

Biological surveys are performed at proposed project sites where land disturbance will occur or where significant impacts to plants and animals might occur (e.g., during the demolition of structures that may contain bird nests or the release of toxic chemicals into habitat of protected species). The goal is to minimize the adverse effects of land disturbance and other impacts on important plants and animals (see Section 15.3), their associated habitat, and important biological resources. Important biological resources include such things as cover sites, nest/burrow sites, roost sites, wetlands, or water sources that are vital to important species.

During 2013, biological surveys for 13 projects were conducted on or near the NNSS. Three of the projects had multiple sites that were surveyed. Biologists surveyed a total of 1,197 acres. Biologists provided to project managers written summary reports of all survey findings and mitigation recommendations, which are summarized by project in Hall et al. (2014). No important species or important biological resources were harmed by project activities in 2013, although accidental bird mortalities occurred (Table 15-2). No chemical or biological simulant release tests at NPTEC or Port Gaston required biological monitoring due to the very small quantities of chemicals/simulants released.

15.3 Important Species and Habitat Monitoring

NNSA/NFO strives to protect and conserve sensitive plant and animal species found on the NNSS and to minimize cumulative impacts to those species as a result of NNSA/NFO activities. Important species known to occur on the NNSS include 18 sensitive plants, 1 mollusk, 2 reptiles, 236 birds, and 27 mammals. They are identified in Table A-11 of *Attachment A: Site Description* (see file on the compact disc of this document). They are classified as important due to their sensitive, protected, and/or regulatory status with state or federal agencies, and they are evaluated for inclusion in long-term monitoring activities on the NNSS.

Over the past several decades, NNSA/NFO has produced numerous documents reporting the occurrence, distribution, and susceptibility to threats for predominately sensitive species on the NNSS (Wills and Ostler 2001). Field monitoring activities in 2013 that related to important NNSS plants, animals, and habitats are listed in Table 15-2. A description of the methods and a more detailed presentation of the results of these activities are reported in Hall et al. (2014). A map of all the known sensitive plant populations on the NNSS is available at http://www.nv.energy.gov/library/publications/Environmental/Figures/Fig11-3.pdf.

Table 15-2. Activities conducted in 2013 for important species and habitats of the NNSS

Sensitive Plants
• Field surveys for Beatley's milkvetch (*Astragalus beatleyae*) were conducted in areas adjacent to the NNSS, and one new population was documented.
Migratory Birds
• Biologists ensure that migratory birds and active nests are not harmed by proposed projects and ongoing activities. During biological surveys for proposed projects conducted in 2013, no migratory bird nests, eggs, or young were found.
• Eleven bird mortalities were documented (Figure 15-2), five of which were due to human activities: two birds were electrocuted, two were killed by vehicles, and one died from accidental entrapment. The remaining six deaths could not be attributed to NNSA/NFO activities: one bird was killed by a predator, one appeared to have been diseased, and four died from unknown causes.
Mountain Lions (*Puma concolor*)
• A collaborative effort with Dr. David Mattson of the USGS to investigate the movements, habitat use, and food habits of mountain lions on the NNSS using radio-collared individuals continued in 2013. Of the four mountain lions captured and collared in 2012, the female NNSS6 died of apparent natural causes in August 2012, the radiocollar on the male NNSS5 stopped working in mid-November 2012, and the male NNSS4 was found dead in February 2013 in Kawich Valley north of the NNSS, apparently due to natural causes. The remaining collared male, NNSS7, was recaptured and fitted with a new radiocollar in June 2013. NNSS biologists visited suspected kill sites to determine the lions' food habits. NNSS4 had eaten two coyotes (*Canis latrans*) and a golden eagle (*Aquila chrysaetos*) during January and February. NNSS7 was tracked all year and consumed 30 mule deer (*Odocoileus hemionus*), 12 desert bighorn sheep (*Ovis canadensis nelsoni*), and 1 badger (*Taxidea taxus*).
• A collaborative effort with Erin Boydston of the USGS continued to investigate mountain lion distribution and abundance on the NNSS using remote, motion-activated cameras. Cameras collected a total of 56 photographs/video clips of mountain lions from 12 of 32 camera sites. At least two un-collared lions have been photographed in addition to the one radio-collared lion.

Table 15-2. Activities conducted in 2013 for important species and habitats of the NNSS (continued)

Wild Horses (*Equus caballus*)

- The annual horse census was conducted, and approximately 30 individuals were counted, not including foals (Figure 15-4). Based on observations and photographs, at least 11 foals were born in 2013. Mountain lion NNSS4 killed five horse foals during 2012. With NNSS4's death, recruitment of foals may increase and the horse population may expand. The estimated size of the wild horse range on the NNSS was 238 square kilometers (km^2) (92 square miles [mi^2]). Camp 17 Pond and Gold Meadows Spring continue to be important summer water sources for horses.

Mule Deer (*Odocoileus hemionus*)

- Mule deer surveys were conducted on Pahute and Rainier mesas, and the average number of deer counted was 30 deer/night, 50% more than in 2012. Deer density averaged 0.9 and 2.3 deer/km^2 (0.3 and 0.9 deer/mi^2) on Pahute Mesa and Rainier Mesa routes, respectively. Deer counts and density over the last 8 years have fluctuated and shown no distinctive trends.

Bats

- Bat vocalizations and climatic data (e.g., temperature, humidity, wind, barometric pressure) at Camp 17 Pond were recorded. Analysis of vocalizations to identify bat species will be conducted as funding is available.
- One dead California myotis (*Myotis californicus*), one live California myotis caught in a glue trap used for insect control, one dead pallid bat (*Antrozous pallidus*), and one live pallid bat were found at four separate NNSS buildings, three in Mercury and one in Area 6. The building day roost sites were recorded, the two dead bats were removed, the live pallid bat was relocated, and the trapped California myotis was rescued and cleaned but later died. Pallid bats are State-protected species (see Table A-11 of Attachment A).
- Bat monitoring was conducted at four water troughs to evaluate how bats were using these artificial water sources installed to help mitigate the loss of perennial water at well ponds that were closed in 2012. Bats were detected at each of the troughs. The troughs are providing a valuable resource for several bat species, several of which are State protected (see Table A-11 of Attachment A).

Reptiles

- Surveys for road-killed reptiles were conducted, and 65 individuals, representing 8 snake and 7 lizard species, were detected.
- Funnel traps were set at eight sites throughout the NNSS for a total trap effort of 250 trap nights (number of traps × number of nights they were open); 15 captures of four species were made, further expanding or refining the known distributions of NNSS reptiles.

Natural and Man-made Water Sources

- Two new natural water sources were discovered on the NNSS: a seep (given the name Upper Gap Wash Seep) and a natural formation of rock tanks (given the name Paintbrush Canyon Tanks) (see Figure A-20 of Attachment A). An old metal drum with a faucet was found at the seep.
- Five wildlife watering troughs installed in 2012 to mitigate the loss of well sumps closed in 2012 were monitored with motion-activated cameras to document wildlife use. A total of 10 mammal species and 12 bird species have been documented using the troughs.
- Eleven natural NNSS wetlands were monitored to document water surface area, surface flow, observed disturbances, and wildlife use and mortality. No wetlands were damaged by NNSS activities in 2013. As in previous years, a sensitive species of springsnail (*Pyrgulopsis turbatrix*) was present at Cane Spring, which is this species' only natural habitat on the NNSS.
- Man-made water sources were monitored for wildlife use and mortality and included 37 plastic-lined sumps. No wildlife mortality was observed at any water source in 2013.

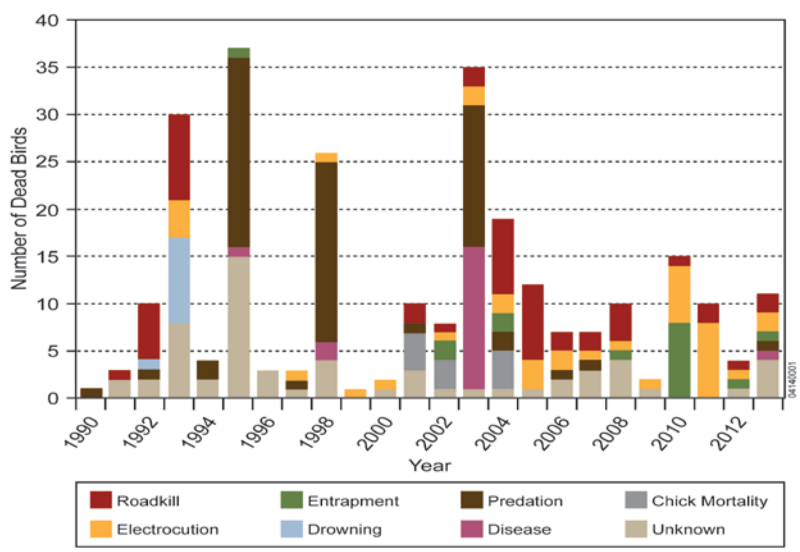

Figure 15-2. Number of bird deaths recorded on the NNSS by year and cause

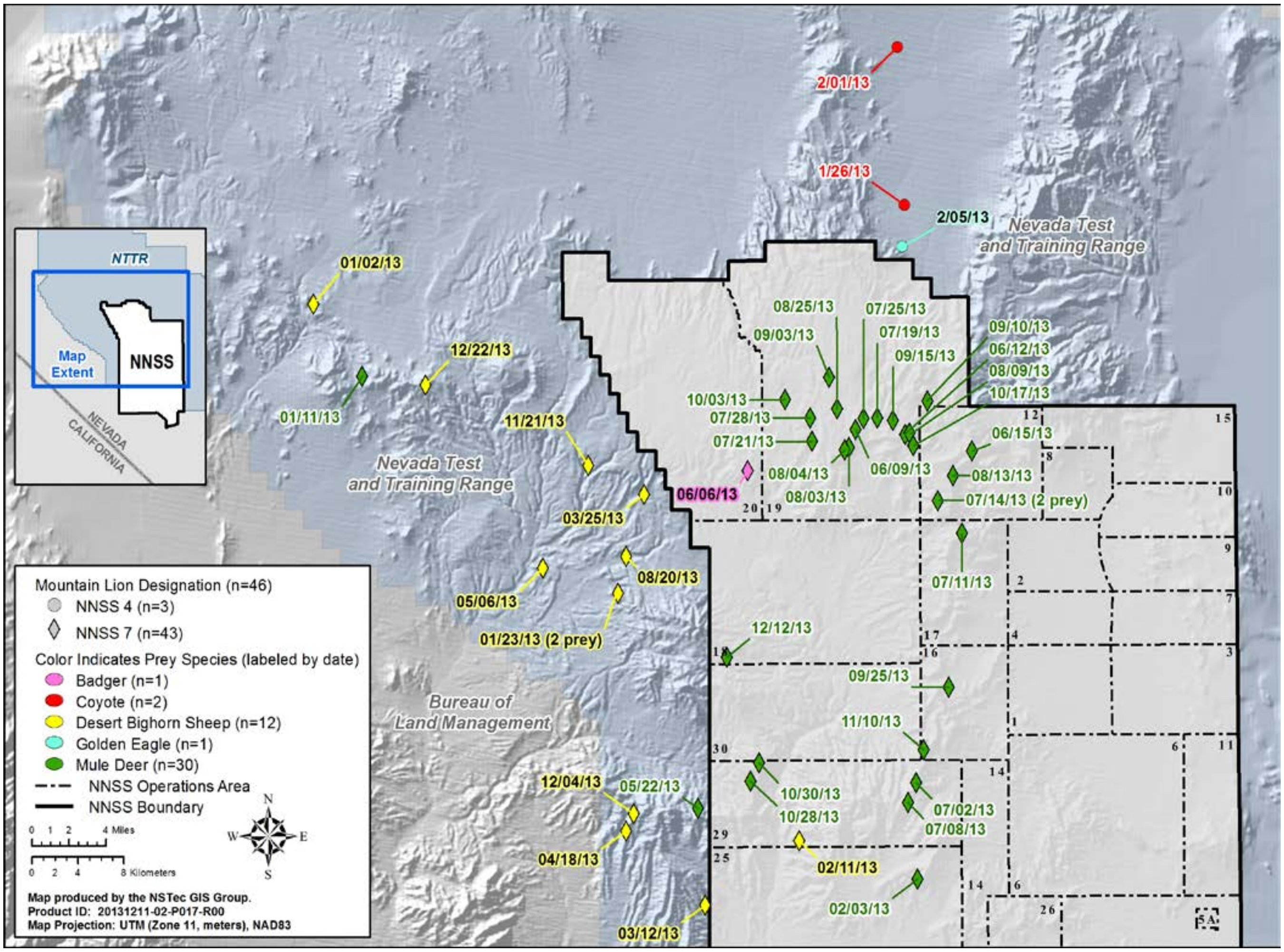

Figure 15-3. Kill sites of two radio-collared mountain lions documented in 2013

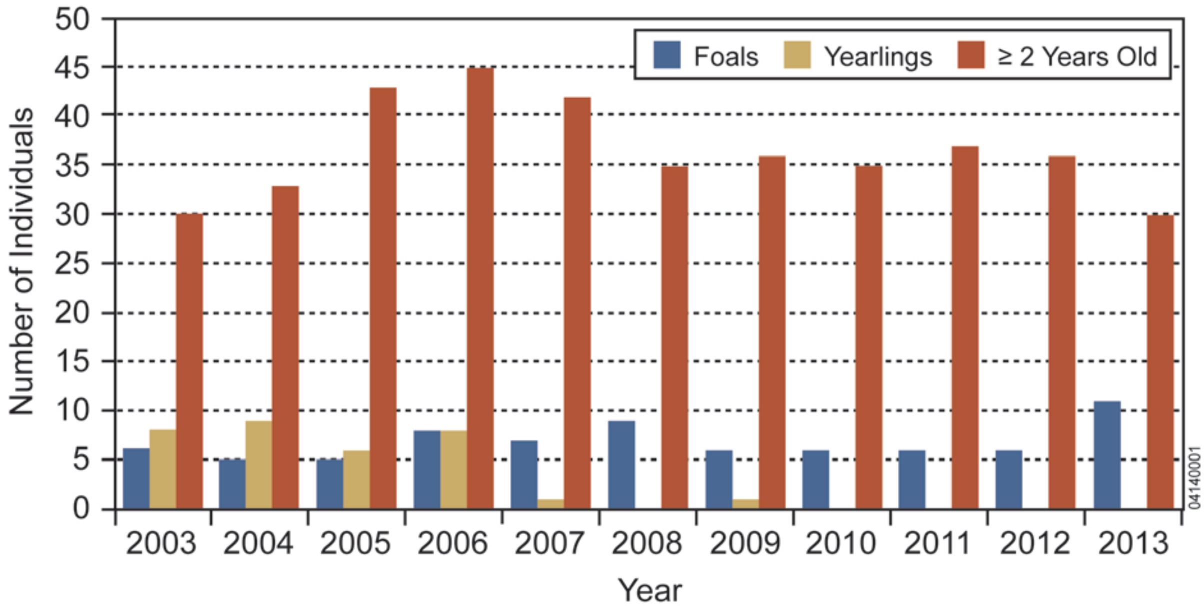

Figure 15-4. Trends in age structure of the NNSS horse population from 2003 to 2013

15.4 Habitat Restoration Program

The Habitat Restoration Program involves the revegetation of disturbances and the evaluation of previous revegetation efforts. Sites that have been revegetated are periodically sampled, and the information obtained is used to develop site-specific revegetation plans for future restoration efforts on the NNSS. Revegetation supports the intent of Executive Order EO 13112, "Invasive Species," to prevent the introduction and spread of non-native species and restore native species to disturbed sites. Revegetation also may qualify as mitigation for the loss of desert tortoise habitat under the current Opinion. NNSA/NFO projects for which revegetation has been pursued are lands disturbed in desert tortoise habitat, wildland fire sites, and abandoned industrial or nuclear test support sites characterized and remediated under NNSA/NFO Environmental Restoration (ER). ER has also revegetated soil closure covers to protect against soil erosion and water percolation into buried waste.

Two previously revegetated sites on the NNSS and two on the Tonopah Test Range (TTR) were monitored in 2013. The cover cap on the U-3ax/bl disposal unit (Corrective Action Unit [CAU] 110), revegetated in 2000, and the "92-Acre Site" at the Area 5 Radioactive Waste Management Complex, revegetated in 2011, were monitored on the NNSS. The Five Points Landfill site (CAU 400), revegetated in 1997, and the Rollercoaster RADSAFE site (CAU 407), revegetated in 2000, were the restoration sites monitored on the TTR. Plant cover and density were recorded at the sites, where applicable reclamation success standards were evaluated. Monitoring results are reported in Hall et al. (2014).

Remedial revegetation on a small portion of the 92-Acre Site was implemented in 2013. Different techniques were evaluated including broadcast seeding, hydroseeding, and hydromulching at different rates. Supplemental irrigation was applied in November to increase germination success.

15.5 Wildland Fire Hazard Assessment

A Wildland Fire Management Plan is maintained, which requires protection of site resources from wildland and operational fires. An annual vegetation survey to determine wildland fire hazards is conducted on the NNSS each spring. Survey findings are submitted to the NNSS Fire Marshal and summarized in the annual EMAC report (Hall et al. 2014). In April and May 2013, NNSS biologists visited 104 roadside sampling stations to assess a fuel index that can range from 0 to 10 (lowest to highest risk of wildfires). The mean combined fuels index for all 104 sampling stations was 4.52. In 2013, three wildland fires were ignited by lightning, but only burned a total of 1 acre (0.4 hectares).

15.6 West Nile Virus Surveillance

NNSA/NFO has collaborated with the Southern Nevada Health District (SNHD) since 2004 to determine if mosquitoes on the NNSS carry West Nile virus (WNV). WNV is a potentially serious illness that spreads to humans and other animals through mosquito bites. It was first detected in southern Nevada in 2004. NNSS biologists are trained by SNHD personnel in the proper sampling protocol and establish sampling locations throughout the NNSS using traps provided by SNHD. Mosquitoes are sampled annually by NNSS biologists and identified and tested for WNV by SNHD personnel.

In 2013, 10 sites were sampled during 15 surveys from May to September. A total of 39 mosquitoes were trapped including 38 *Culex tarsalis* and 1 *Anopheles franciscanus*. All were negative for WNV. Mosquito species known to carry the virus occur on the NNSS. To date, WNV has not been detected conclusively on the NNSS; however, two samples were suspect for WNV in 2005 and 2006 (Bechtel Nevada 2006; National Security Technologies, LLC, 2007). This exchange of labor (sample collection by NNSS biologists) for analysis (by SNHD) assists NNSA/NFO in monitoring the potential health risks to NNSS biota as well as to workers. This collaboration benefits SNHD by avoiding the added costs of sampling this region of southern Nevada.

15.7 References

Hall, D. B., D. C. Anderson, P. D. Greger, and W. K. Ostler, 2014. *Ecological Monitoring and Compliance Program 2013 Report*. DOE/NV/25946--2045, National Security Technologies, LLC, July 2014, Las Vegas, NV.

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U.S. Fish and Wildlife Service, 2009. *Final Programmatic Biological Opinion for Implementation of Actions Proposed on the Nevada Test Site, Nye County, Nevada.* File Nos. 84320-2008-F-0416 and B-0015, February 12, 2009, 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

Chapter 16: Quality Assurance Program

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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 environmental monitoring work performed for the U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office (NNSA/NFO) is performed in accordance with the Quality Assurance Program (QAP) established by the current Management and Operations (M&O) contractor, National Security Technologies, LLC (NSTec), and with the Underground Test Area (UGTA) QAP. Both QAPs describe the methods used to ensure that quality is integrated into the monitoring work. Both QAPs comply with Title 10 Code of Federal Regulations (CFR) Part 830, Subpart A, "Quality Assurance Requirements," and with U.S. Department of Energy (DOE) Order DOE O 414.1D, "Quality Assurance." The 10 criteria of a quality program specified by these regulations are shown in the box above. The QAPs require a graded approach to quality for determining the level of rigor that effectively provides assurance of performance and conformance to requirements.

The Data Quality Objective (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, obtaining a measurement, and laboratory data review. Data users perform reviews as required by the project-specific objectives before the data are used to support decision making.

The key elements of the environmental monitoring process work flow are listed below. Each element 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 (as the current M&O contractor), and UGTA 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.

16.1 Sampling and Analysis Plan

Sampling 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 that 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.

16.1.1 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 and is usually expressed as standard deviation, variance, or range, in either absolute or relative terms (DOE 2013).

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.

16.1.2 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 2013). Accuracy is monitored by performing measurements and evaluating results of control samples containing known quantities of the analytes of interest.

16.1.3 Representativeness

Representativeness is the degree to which measured analytical concentrations represent the concentrations in the medium being sampled (Stanley and Verner 1985).

At each 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.

16.1.4 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.

16.2 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 the following:

- Training and qualification
- Procedures and methods
- Field documentation
- Inspection and acceptance testing

16.2.1 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.

16.2.2 Procedures and Methods

Sampling is conducted in accordance with established procedures to ensure consistent execution and continuous comparability of the environmental data. The analytical methods to be used are also consulted in order to ensure that, as methods are revised, sample collection is performed appropriately and that viable samples are obtained.

16.2.3 Field Documentation

Field documentation is generated for each sample collection activity. This may include chain of custody, sampling procedures, analytical methods, equipment and data logs, maps, Material Safety Data Sheets, 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 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.

16.2.4 Inspection and Acceptance Testing

Sample collection data are reviewed for appropriateness, accuracy, and fit with historical measurements. In the case of groundwater sampling, water quality parameters are monitored during purging. Stabilization of these parameters generally indicates that the water is representative of the aquifer, at which time sample collection 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.

16.3 Laboratory Analyses

Samples are transported to a laboratory for analysis. Several DOE contractor organizations maintain measurement capabilities that may be used to support planning or decision-making activities. However, unless specifically authorized by NNSA/NFO 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.

16.3.1 Procurement

Laboratory services are procured through subcontracts in accordance with the Competition in Contracting Act, the Federal Acquisition Regulations, the DOE Acquisition Regulations, contractor terms and conditions for subcontracting, and other relevant policies and procedures. The analytical services technical basis is codified in the DOE Quality Systems for Analytical Services (QSAS) (DOE 2013). The QSAS is based on the National Environmental Laboratory Accreditation Conference Chapter 5, "Quality Systems," as implemented in 2005, based on International Organization for Standardization Standard ISO 17025, "General Requirements for the Competence of Testing and Calibration Laboratories." Subcontracted laboratories must be assessed to be in compliance with the QSAS and are routinely audited under the DOE Consolidated Audit Program (DOECAP).

A request for proposal (RFP) is posted to the government website, laboratory responses are evaluated, and subcontracts awarded. The RFP cites the QSAS and DOECAP participation as base requirements and addresses site-specific conditions. Multiple laboratories may receive a subcontract through one RFP.

The laboratories are primarily those providing a wide range of analytical services to DOE. Other services can be subcontracted by the laboratory (i.e., lower-tier subcontractor) or contracted directly from a vendor. In either case, requirements are established for the specific services provided.

The subcontract places numerous requirements on the laboratory, including the following:

- Maintaining the following documents:
  - A Quality Assurance Plan and/or Manual describing the laboratory's policies and approach to the implementation of QA requirements
  - An Environment, Safety, and Health Plan
  - A Waste Management Plan
  - Procedures pertinent to subcontract scope
- 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 DOECAP and NNSA/NFO contractors and providing copies of other audits considered by NSTec to be comparable and applicable

16.3.2 Initial and Continuing Assessment

An initial assessment is made during the RFP process, 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 as follows:

- 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
- Routine ongoing monitoring of the laboratory's adherence to the quality requirements

16.3.3 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 16.4. Any discrepancies are documented and resolved with the laboratory, and continuous assessment tracks the recurrence and efficacy of corrective actions.

16.4 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 as well as 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), and analytical, geotechnical, and field parameters at the Nevada National Security Site. Database integrity and security are enforced through the assignment of varying database access privileges commensurate with an employee's database responsibilities.

16.4.1 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.

16.4.2 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.

16.4.3 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.

16.5 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.

16.5.1 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. NNSA/NFO contractors maintain companywide issues tracking systems to manage assessments, findings, and corrective actions.

16.5.2 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. Discussions of the 2013 results for field duplicates, laboratory control samples, blank analyses, matrix spikes, and proficiency testing programs are provided, and summary tables are included below.

16.5.2.1 Field Duplicates

Samples obtained at nearly the same locations and times as initial samples are termed field duplicates. These are used to evaluate the overall precision of the measurement process, including small-scale heterogeneity in the medium (air, water, or direct radiation) 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 the laboratory’s reported 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). The summary of field duplicate samples is provided in Table 16-1.

The values in Table 16-1 generally fall in ranges typical for prior years. The higher average RPDs are associated with two types of phenomena. RPDs for actinides in air in particular, and consequently gross alpha, can be elevated when one sampler of a pair intercepts a particle with high americium (Am) or plutonium (Pu) while the other sampler in the pair had a typical background value (for example, 22.5% in gross alpha in 2013). Also, higher average RPDs are often associated with relatively few pairs having both values above their MDCs, as low-level measurements are typically “noisier” than higher-level measurements (40.9% for $^{235+236}$U, 58.2% for ^{40}K, and 87.6% for ^{238}Pu in air in 2013). The average RER can also be affected by particulates, as with ^{241}Am and $^{239+240}$Pu in air (average RER = 1.12 and 1.57, respectively, in 2013). Also, both averages can be variable when there are smaller numbers of pairs overall.

Table 16-1. Summary of field duplicate samples for 2013

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
Environmental Monitoring Samples					
Gross alpha	Air	105	15	22.5	0.68
Gross beta	Air	105	105	7.2	0.71
Tritium	Air	52	11	7.1	0.56
^{241}Am	Air	21	0	–	1.12
^{238}Pu	Air	21	1	87.6	0.85
$^{239+240}$Pu	Air	21	4	36.8	1.57
$^{233+234}$U	Air	14	14	15.6	0.91
$^{235+236}$U	Air	14	6	40.9	0.73
^{238}U	Air	14	14	14.0	0.89
^{7}Be(e)	Air	21	21	9.4	1.12
^{137}Cs	Air	21	0	–	0.62
^{40}K(e)	Air	21	5	58.2	1.03
Gross alpha	Water	2	2	7.2	0.54
Gross beta	Water	2	2	8.1	0.65
Tritium	Water	14	1	7.2	0.54
TLD	Ambient Radiation	436	NA(f)	3.7	0.33
Underground Test Area (UGTA) Samples					
Gross alpha	Water	17	11	18.4	1.00
Gross beta	Water	17	12	19.0	1.11
Tritium	Water	25	6	11.5	0.55

(a) Represents the number of field duplicates reported for evaluating precision.

(b) Represents the number of field duplicate–field sample pairs with both values above their MDCs. If either the field sample or duplicate was below the MDC, the RPD was not determined. This does not apply to thermoluminescent dosimeter (TLD) measurements; because TLDs virtually always detect ambient background radiation, MDCs are not computed.

(c) Represents the average absolute RPD calculated as follows:

$$Absolute\ RPD = \frac{|S - D|}{(D + S)/2}\ X\ \ 100$$

Where: S = Sample result
D = Duplicate result

(d) Represents the absolute RER, determined by the following equation, which is used to determine whether a sample result and the associated field duplicate result differ significantly when compared to their respective 1 sigma uncertainties (i.e., measurement standard deviation). The RER is calculated for all sample and field duplicate pairs reported without regard to the MDC.

$$Absolute\ \ RER = \frac{|S - D|}{\sqrt{(SD_S)^2 + (SD_D)^2}}$$

Where: S = Sample result
D = Duplicate result
SD_S Standard deviation of the sample result
SD_D = Standard deviation of the duplicate result

(e) ^{7}Be and ^{40}K are naturally occurring analytes included for quality assessment of the gamma spectroscopy analyses.

(f) Not applicable

16.5.2.2 Laboratory Control Samples (LCSs)

An LCS is prepared from a sample matrix verified to be free from the analytes of interest, and then spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes. The LCS 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 2013).

The results are calculated as a percentage of the true value (i.e., percent recovery), and must fall within established control limits to be considered acceptable. If the LCS recovery falls outside control limits, evaluation for potential sample data bias is necessary. The numbers of the 2013 LCSs analyzed and within control limits are summarized in Table 16-2. There were no systemic issues identified in 2013 by LCS recovery data, and no failures invalidating the associated sample data.

Table 16-2. Summary of LCSs for 2013

Analyte	Matrix	Number of LCS Results Reported	Number Within Control Limits	Control Limits (%)
Environmental Monitoring Samples				
Tritium	Air	68	68	75–125
^{60}Co	Air	19	19	75–125
^{137}Cs	Air	19	19	75–125
$^{239+240}$Pu	Air	26	26	75–125
^{241}Am	Air	45	45	75–125
Gross alpha	Water	14	14	75–125
Gross beta	Water	14	14	75–125
Tritium	Water	29	29	75–125
^{60}Co	Water	1	1	75–125
^{90}Sr	Water	1	1	75–125
^{137}Cs	Water	1	1	75–125
$^{239+240}$Pu	Water	1	1	75–125
^{241}Am	Water	1	1	75–125
Tritium	Soil	4	4	75–125
^{60}Co	Soil	7	7	75–125
^{90}Sr	Soil	9	9	75–125
^{137}Cs	Soil	7	7	75–125
$^{239+240}$Pu	Soil	7	7	75–125
^{241}Am	Soil	14	14	75–125
^{60}Co	Vegetation	1	1	75–125
^{90}Sr	Vegetation	2	2	75–125
^{137}Cs	Vegetation	1	1	75–125
$^{239+240}$Pu	Vegetation	2	2	75–125
^{241}Am	Vegetation	3	3	75–125
Metals	Water	158	158	80–120
Volatiles	Water	290	290	70–130
Semi volatiles	Water	572	565	Laboratory specific
Miscellaneous	Water	112	112	80–120
UGTA Samples				
Gross alpha	Water	9	9	70–130
Gross beta	Water	9	9	70–130
Tritium	Water	21	18	70–130

16.5.2.3 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 that might be introduced 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 2013). Blanks are processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures. The following discusses the blanks routinely used during environmental monitoring activities.

- A trip blank is a sample of analyte-free media taken from the laboratory to the sampling site and returned to the laboratory unopened. A trip blank is used to document contamination attributable to shipping and field handling procedures. This type of blank is useful in documenting contamination of volatile organics samples (DOE 2013).
- An equipment blank is a sample of analyte-free media that has been used to rinse common sampling equipment to check effectiveness of decontamination procedures (DOE 2013).

- A field blank is prepared in the field by filling a clean container with purified water (appropriate for the target analytes) and appropriate preservative, if any, for the specific sampling activity being undertaken. The field blank is used to indicate the presence of contamination due to sample collection and handling (DOE 2013).
- A method blank is a sample of a matrix similar to the associated sample batch in which no target analytes or interferences are present at concentrations that would impact the sample analyses results (DOE 2013). Method blank data are summarized in Table 16-3.

There were no systemic issues and no failures that required invalidating the associated sample data identified in 2013 by the blank data.

Table 16-3. Summary of laboratory blank samples for 2013

Analyte	Matrix	Number of Blank Results Reported	Number of Results < MDC
Environmental Monitoring Samples			
Tritium	Air	68	68
^{7}Be	Air	19	19
^{60}Co	Air	12	12
^{137}Cs	Air	19	18
^{238}Pu	Air	17	15
$^{239+240}$Pu	Air	17	14
^{241}Am	Air	29	29
Gross alpha	Water	13	11
Gross beta	Water	13	11
Tritium	Water	28	27
^{60}Co	Water	1	1
^{90}Sr	Water	1	1
^{137}Cs	Water	1	1
^{238}Pu	Water	1	1
$^{239+240}$Pu	Water	1	1
^{241}Am	Water	1	1
Tritium	Soil	4	4
^{60}Co	Soil	2	2
^{90}Sr	Soil	8	8
^{137}Cs	Soil	7	7
^{238}Pu	Soil	7	7
$^{239+240}$Pu	Soil	7	7
^{241}Am	Soil	9	9
^{60}Co	Vegetation	NA	NA
^{90}Sr	Vegetation	2	2
^{137}Cs	Vegetation	1	1
^{238}Pu	Vegetation	2	2
$^{239+240}$Pu	Vegetation	2	2
^{241}Am	Vegetation	2	2
Metals	Water	158	135
Volatiles	Water	466	405
Semi volatiles	Water	385	317
Miscellaneous	Water	141	129
UGTA Samples			
Gross alpha	Water	9	9
Gross beta	Water	9	9
Tritium	Water	15	15

16.5.2.4 Matrix Spike Analysis

A matrix spike is a sample spiked with a known concentration of analyte. This spike sample is subjected to the same sample preparation and analysis as the original environmental sample. The matrix spike is used to indicate if the matrix (e.g., soil, water with sediment) interfers with the analytical results. Matrix spike analyses were conducted for UGTA water samples in 2013, and there were no issues identified by the analysis data (Table 16-4).

Table 16-4. Summary of UGTA matrix spike samples for 2013

Analyte	Matrix	Number of Matrix Spikes Reported	Number Within Control Limits	Control Limits (%)
Gross alpha	Water	10	9	60–140
Gross beta	Water	10	10	60–140
Tritium	Water	20	20	60–140

16.5.2.5 Proficiency Testing Program Participation

All contracted 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 16-5 presents the 2013 results for the laboratory performance in the March and August studies of the Mixed Analyte Performance Evaluation Program (MAPEP) (http://www.id.energy.gov/resl/mapep/mapepreports.html) administered by the Radiological and Environmental Sciences Laboratory of the Idaho National Laboratory.

Table 16-6 shows the summary of inter-laboratory comparison sample results for the NSTec Radiological Health Dosimetry Group. The DOE Standard DOE-STD-1095-2011, "Department of Energy Laboratory Accreditation for External Dosimetry," establishes the methodology for determining acceptable performance testing of dosimeter systems. It also establishes the technical basis for performance testing and the testing categories and performance criteria, which are outlined in the American National Standards Institute/Health Physics Society (ANSI/HPS) N13.11-2009, "American National Standard for Dosimetry–Personnel Dosimetry Performance–Criteria for Testing," and in ANSI/HPS N13.32-2008, "An American National Standard, Performance Testing of Extremity Dosimeters." The Dosimetry Group participated in the Battelle Pacific Northwest National Laboratory proficiency testing program during the course of the year.

Table 16-5. Summary of 2013 MAPEP reports

Analyte	Matrix	Number of Results Reported	Number within Control Limits[(a)]
Environmental Monitoring Samples			
Gross alpha	Filter	5	4
Gross beta	Filter	5	5
^{60}Co	Filter	5	5
^{137}Cs	Filter	5	5
^{238}Pu	Filter	5	5
$^{239+240}$Pu	Filter	5	5
^{241}Am	Filter	5	5
Gross alpha	Water	5	5
Gross beta	Water	5	5
Tritium	Water	5	5
^{60}Co	Water	5	5
^{90}Sr	Water	5	5
^{137}Cs	Water	5	5
^{238}Pu	Water	5	5
$^{239+240}$Pu	Water	5	5
^{241}Am	Water	5	5
^{60}Co	Vegetation	5	5
^{90}Sr	Vegetation	5	5
^{60}Co	Vegetation	5	5
^{90}Sr	Vegetation	5	5
^{137}Cs	Vegetation	5	5
^{238}Pu	Vegetation	5	5
^{60}Co	Soil	5	5
^{90}Sr	Soil	5	5
^{137}Cs	Soil	5	5
^{238}Pu	Soil	5	5
$^{239+240}$Pu	Soil	5	5
^{241}Am	Soil	5	5

Table 16-5. Summary of 2013 MAPEP reports (continued)

Analyte	Matrix	Number of Results Reported	Number within Control Limits[a]
Environmental Monitoring Samples (continued)			
Metals	Water	95	93
Organics	Water	391	384
Metals	Soil	100	91
Organics	Soil	368	366

(a) Based upon MAPEP criteria

Table 16-6. Summary of inter-laboratory comparison TLD samples (UD-802 dosimeters) for the subcontract dosimetry group in 2013

Analysis	Matrix	Number of Results Reported	Number within Control Limits[a]
TLD	Ambient Radiation	90	90

(a) Based upon ANSI/HPS N13.11-2009 criteria

16.6 References

DOE, see U.S. Department of Energy.

Stanley, T. W., and S. S. Verner, 1985. The U.S. Environmental Protection Agency's Quality Assurance Program. In: Taylor, J. K., and T. W. Stanley (eds.), *Quality Assurance for Environmental Measurements*, ASTM STP-867, Philadelphia, PA.

U.S. Department of Energy, 2013. *DOE Quality Systems for Analytical Services Version 3.0*, July 2013.

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Chapter 17: Quality Assurance Program for the Community Environmental Monitoring Program

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The Community Environmental Monitoring Program (CEMP) Quality Assurance Management and Assessment Plan (QAMAP) (Desert Research Institute 2009) was followed for the collection and analysis of radiological air and water data presented in Chapter 7 of this report. The CEMP QAMAP ensures compliance with U.S. Department of Energy (DOE) Order DOE O 414.1D, "Quality Assurance," which implements a quality management system, ensuring the generation and use of quality data. This QAMAP addresses the following items previously defined in Chapter 16.

- 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

17.1 Data Quality Objectives (DQOs)

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 follow similar guidelines for onsite activities where applicable as discussed in Chapter 16.

17.2 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 16.1 for onsite activities.

17.3 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 Community Environmental Monitor (CEM) station manager (see Section 7.1 for a 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 protocols 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 discs by calendar year. Analytical reports and databases are protected and maintained in accordance with the Desert Research Institute's Computer Protection Program.

17.4 Laboratory QA Oversight

The CEMP ensures that DOE O 414.1D requirements are met with respect to laboratory services through review of the vendor laboratory policies formalized in a Laboratory Quality Assurance Plan (LQAP) (Testamerica, Inc., 2012. The 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.

17.4.1 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 the 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
- Résumés
- 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.

17.4.2 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 the CEMP (usually by the CEMP QA Officer). The CEMP does not 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. The following tasks support continuing assessment:

- Tracking schedule compliance
- Reviewing analytical data deliverables
- Monitoring the laboratory's adherence to the LQAP
- Conducting regular audits
- Monitoring for continued successful participation in approved PT programs

17.4.3 Laboratory QA Program

The laboratory policies and approach to the implementation of DOE O 414.1D must be verified in an LQAP prepared by the laboratory. The elements of an LQAP required for the CEMP are similar to those required by National Security Technologies, LLC, for onsite monitoring, and are described in Section 16.3.

17.5 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. 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 the following:

- 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

Operating instructions, procedures, applicable project-specific work plans, field sampling plans, QA plans, 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 (DQA) – 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.

17.6 QA Program Assessments

The overall effectiveness of the QA Program is determined through management and independent assessments as defined in the CEMP QAMAP. These assessments evaluate the plan execution workflow (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.

17.7 2013 Sample QA Results

QA assessments 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); Mirion Technologies (thermoluminescent dosimeter [TLD] data); and the University of Miami Tritium Laboratory (tritium data). A brief discussion of the 2013 results for field duplicates, laboratory control samples, blank analyses, and inter-laboratory comparison studies is provided along with summary tables within this section. The 2013 CEMP radiological air and water monitoring data are presented in Chapter 7.

17.7.1 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 2013 samples and is listed in Table 17-1. An RPD of zero indicates a perfect duplication of results of the duplicate pair, whereas an RPD greater than 100% generally indicates that a duplicate pair falls beyond QA requirements and is 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 four alpha duplicates exceeding an RPD of 100%.

Table 17-1. Summary of field duplicate samples for CEMP monitoring in 2013

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	64	64	67.1
Gross Beta	Air	64	64	26.4
Gamma – Beryllium-7	Air	11	7	63.3
Tritium	Water	4	0	N.A
TLDs	Ambient Radiation	12	NA	2.6

(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

17.7.2 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 percentage. To be considered valid, the results must fall within established control limits (or percentage ranges) for further analyses to be performed. The LCS results obtained for 2013 are summarized in Table 17-2. The LCS results were satisfactory, with all samples falling within control parameters for the air sample matrix.

Table 17-2. Summary of laboratory control samples (LCSs) for CEMP monitoring in 2013

Analysis	Matrix	Number of LCS Results Reported	Number Within Control Limits[(a)]
Gross Alpha	Air	51	51
Gross Beta	Air	51	51
Gamma	Air	8	8
Tritium	Water	4	4

(a) Control limits are as follows: 78% to 115% for gross alpha, 87% to 115% for gross beta, 90% to 115% for gamma (^{137}Cs, ^{60}Co, ^{241}Am), and 80% to 120% for tritium.

17.7.3 Blank Analysis

Laboratory blank sample analyses are essentially the opposite of LCSs discussed in Section 17.7.2. 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 2013 are summarized in Table 17-3. The laboratory blank results were satisfactory with less than 4% of the alpha and beta blank samples outside of control parameters for the air sample matrix.

Table 17-3. Summary of laboratory blank samples for CEMP monitoring in 2013

Analysis	Matrix	Number of Blank Results Reported	Number within Control Limits[(a)]
Gross Alpha	Air	51	50
Gross Beta	Air	51	48
Gamma	Air	8	8
Tritium	Water	4	4

(a) Control limit is less than the MDC.

17.7.4 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 2013 are summarized in Tables 17-4 and 17-5.

Table 17-4 shows the summary of inter-laboratory comparison sample results for the subcontract radiochemistry laboratories. The laboratories participated in either the QA Program administered by Environmental Research Associates (ERA) and/or the Mixed Analyte Performance Evaluation Program (MAPEP) for gross alpha, gross beta, and gamma analyses. The subcontract tritium laboratory participated in 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 17-4. Summary of inter-laboratory comparison samples of the subcontract radiochemistry and tritium laboratories for CEMP monitoring in 2013

		MAPEP, ERA, and IAEA Results	
Analysis	**Matrix**	**Number of Results Reported**	**Number Within Control Limits[(a)]**
Gross Alpha	Air	4	4
Gross Beta	Air	4	4
Gamma	Air	6	6
Tritium	Water	6	6

(a) Control limits are determined by the individual inter-laboratory comparison study.

Table 17-5 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 15 out of 15 TLDs analyzed.

Table 17-5. Summary of inter-laboratory comparison TLD samples of the subcontract dosimetry group for CEMP monitoring in 2013

Analysis	Matrix	Number of Results Reported	Number Within Control Limits[(a)]
TLDs	Ambient Radiation	15	15

(a) Based upon NVLAP criteria; absolute value of the bias plus one standard deviation < 0.3.

17.8 References

Desert Research Institute, 2009. *DOE NNSA/NSO Community Environmental Monitoring Program Quality Assurance Management and Assessment Plan*, July 2009.

Testamerica, Inc., 2012. *Quality Assurance Manual*. Version 6.0. November 2012.

Appendix A

Las Vegas Area Support Facilities

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Appendix A: Las Vegas Area Support Facilities

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National Security Technologies, LLC

The U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office (NNSA/NFO) manages two facilities in Clark County, Nevada, that support NNSA/NFO missions on and off the Nevada National Security Site (NNSS). They include the North Las Vegas Facility (NLVF) and the Remote Sensing Laboratory–Nellis (RSL-Nellis) (Figure A-1). This appendix describes all environmental monitoring and compliance activities conducted in 2013 at these support facilities.

A.1 North Las Vegas Facility

The NLVF is a fenced complex composed of 31 buildings that house much of the NNSS project management, diagnostic development and testing, design, engineering, and procurement personnel. 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 2013 included the maintenance of one air quality operating permit, one wastewater permit, one National Pollutant Discharge Elimination System (NPDES) permit, one Spill Prevention, Control, and Countermeasure (SPCC) Plan, and one hazardous materials permit (see Chapter 2, Table 2-12 for a list of all NNSA/NFO permits). NNSA/NFO also monitors tritium in air and ambient gamma-emissions to comply with federal radiation protection regulations, although this monitoring is not required by any city or state permits.

A.1.1 Air Quality and Protection

Sources of air pollutants at the NLVF are regulated by the Source 657 Minor Source Permit issued by the Clark County Department of Air Quality (DAQ) for the emission of criteria pollutants (see Glossary, Appendix B). These pollutants include sulfur dioxide (SO_2), nitrogen oxide (NO_X), carbon monoxide (CO), particulate matter (PM), and volatile organic compounds (VOCs). Because the NLVF is considered a "true minor source", there is no requirement to report hazardous air pollutants (HAPs; see Glossary, Appendix B). The regulated sources of emissions at the NLVF include an abrasive blaster, diesel generators, a fire pump, cooling towers, and boilers. The DAQ requires an annual emissions inventory of criteria air pollutants. The 2013 emissions inventory, which reported the estimated quantities shown in Table A-1, was submitted to the DAQ on March 24, 2014.

Table A-1. Summary of air emissions for the NLVF in 2013

	Criteria Pollutant (Tons/yr)[(a)]					
Parameter	**CO**	**NO_x**	**PM10[(b)]**	**PM2.5[(c)]**	**SO_2**	**VOC**
PTE[(d)]	1.63	8.08	0.96	0.32	0.34	0.35
Actual[(e)]	0.27	1.09	0.15	0.06	0.05	0.06
Total Emissions = 1.68 Actual, 11.68 PTE						

(a) 1 ton equals 0.91 metric tons
(b) Particulate matter equal to or less than 10 microns in diameter
(c) Particulate matter equal to or less than 2.5 microns in diameter
(d) Potential to emit: The quantity of criteria air pollutant that facilities/pieces of equipment would emit annually if they were operated for the maximum number of hours at the maximum production rate specified in the air permit
(e) Emissions based on calculations using actual hours of operation for each piece of equipment

Clark County air regulations specify that the opacity from any emission unit may not exceed the Clean Air Act National Ambient Air Quality Standards (NAAQS) opacity limit of 20% for more than 6 consecutive minutes. The NLVF air permit requires that at least one visual emissions observation be performed each week for the boilers, generators, emergency fire pump, emergency generator, and the cooling towers. There are other emission units at the

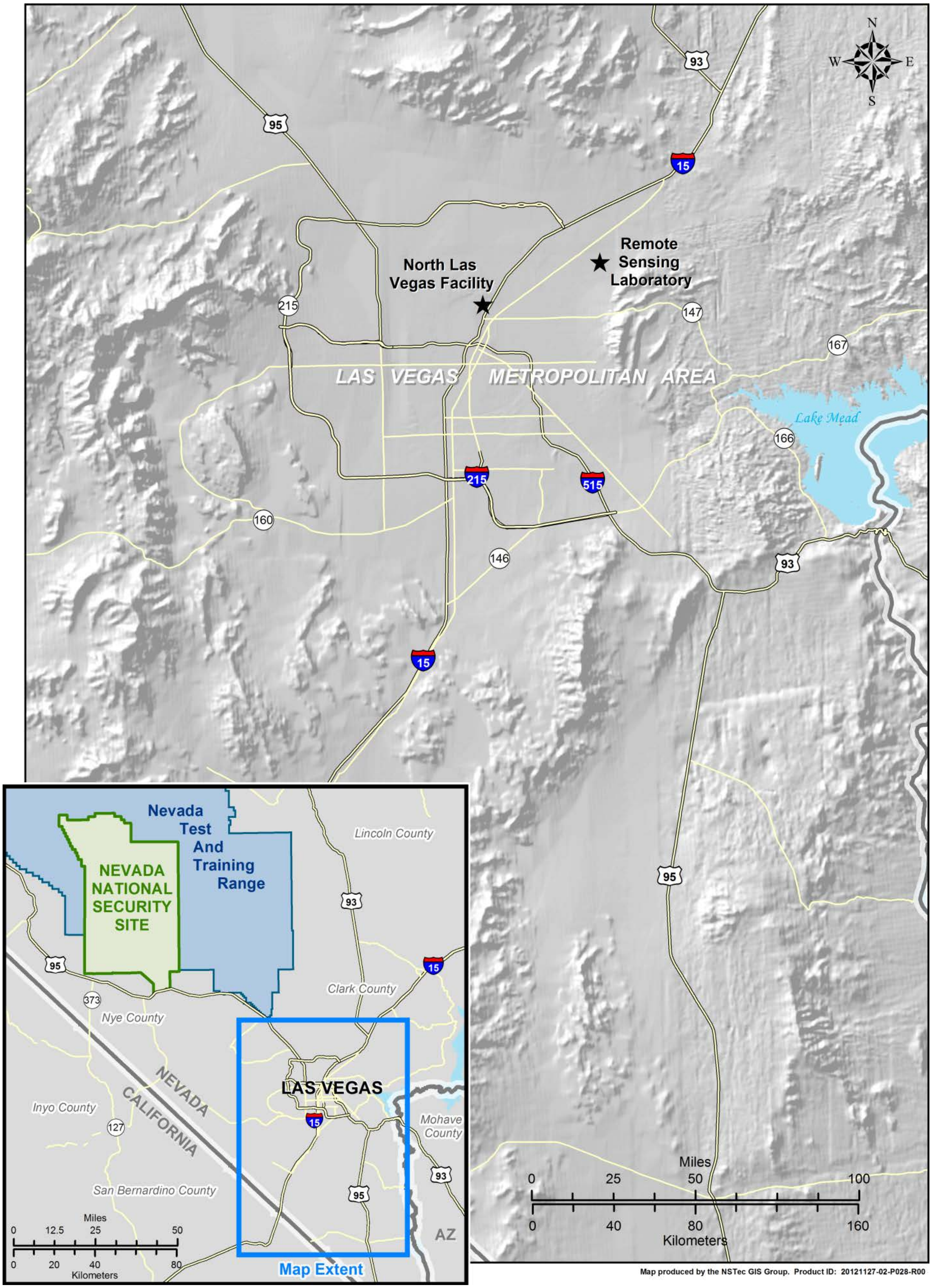

Figure A-1. Location of NNSS offsite facilities in Las Vegas and North Las Vegas

NLVF for which the observation frequency is not specified. If emissions are observed, then U.S. Environmental Protection Agency (EPA) Method 9 opacity readings are recorded by a certified visible emissions evaluator. If visible emissions appear to exceed the limit, corrective actions must be taken to minimize emissions. In 2013, two NLVF personnel were recertified to conduct opacity readings. In 2013, readings were taken for generators; emissions were well below the NAAQS opacity limit of 20%.

At NLVF, a verbal notification to the City of North Las Vegas (CNLV) Fire Department is required before each for fire extinguisher training. In 2013, two hot work live fire extinguisher training sessions were conducted at the NLVF. Quantities of criteria air pollutants produced by the open burns during training are not required to be calculated or reported.

A.1.2 Water Quality and Protection

Water used at the NLVF is supplied by the CNLV and meets or exceeds federal drinking water standards. Water quality permits issued to NNSA/NFO are for wastewaters discharged from the NLVF. NLVF wastewater permits in 2013 included a Class II Wastewater Contribution Permit from the CNLV for sewer discharges, and an NPDES permit issued by the Nevada Division of Environmental Protection (NDEP) for dewatering operations to control rising groundwater levels at the facility. Discharges of sewage and industrial wastewater from the NLVF are required to meet permit limits set by the CNLV. These limits support the permit limits for the Publicly Owned Treatment Works operated by the City of Las Vegas.

A.1.2.1 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 the outfalls of sewage and industrial wastewater is conducted. In 2013, contaminant concentrations (in milligrams per liter [mg/L]) were below the established permit limits in annual water samples taken from the two NLVF outfalls (Table A-2). In compliance with this permit, a report summarizing wastewater monitoring was generated for NLVF operations and was submitted to the CNLV on October 10, 2013.

Table A-1. Results of 2013 monitoring at the NLVF for Wastewater Contribution Permit VEH-112

Contaminant	Permit Limit (mg/L)	Outfall A (mg/L)	Outfall B (mg/L)
Ammonia	61.0	13.7	37.3
Arsenic	2.3	0.00182[(a)]	<0.00166
Barium	13.1	0.133	0.159
Beryllium	0.02	<0.0002	<0.0002
BOD_5[(b)]	600	241	351
Cadmium	0.15	0.000066[(a)]	0.000161
Chromium (hexavalent)	0.10	<0.0165	<0.033
Chromium (total)	5.60	0.00195[(a)]	0.00307
Copper	0.60	0.139	0.336
Cyanide (total)	19.9	0.00351[(a)]	0.0081
Lead	0.20	0.00112[(a)]	0.00108[(a)]
Mercury	0.001	<0.000067	0.000261
Nickel	1.10	0.00665	0.00978
Oil and Grease (animal or vegetable)	250	4.42[(a)]	5.56
Oil and Grease (mineral or petroleum)	100	<1.47	2.57[(a)]
Organophosphorus or carbamate compounds	1.0	<0.01	<0.01
pH (Standard Units)	5.0–11.0	8.12	8.44
Phenols	33.6	0.0213	0.0496
Phosphorus (total)	14	3.65	11.8
Selenium	2.70	<0.0015	<0.0015
Silver	8.20	<0.0002	0.000259[(a)]

Table A-2. Results of 2013 monitoring at the NLVF for Wastewater Contribution Permit VEH-112 (continued)

Contaminant	Permit Limit (mg/L)	Outfall A (mg/L)	Outfall B (mg/L)
TDS(c)	1200	853	1070
TSS(d)	750	85.5	446
Zinc	13.1	0.182	0.380

(a) Estimated concentration, the concentration between the method detection limit and the method reporting limit.
(b) 5-day biological oxygen demand (see Glossary, Appendix B)
(c) Total dissolved solids (d) Total suspended solids

A.1.2.2 National Pollution Discharge Elimination System Permit NV0023507

An NPDES permit (NV0023507) covers the dewatering operation conducted at the NLVF (see Section A.1.2.3). Dewatering wells (NLVF-13s, -15, -16, -17) pump groundwater into a 37,854-liter (L) (10,000-gallon [gal]) storage tank (Figure A-2). The permit allows for the discharge of water from the storage tank to groundwater 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 permit or an NPDES permit (e.g., evaporative cooling). 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 NDEP's Bureau of Water Pollution Control.

In 2013, the four dewatering wells produced a total of about 9,464 L (2,500 gal) per day that were directed into the storage tank (Figure A-2). The average pumping rates varied from 2.5 liters per minute (Lpm) (0.67 gallons per minute [gpm]) at Well NLVF-13s to 0.68 Lpm (0.18 gpm) at Well NLVF-16. The average combined discharge from all four wells was about 285,420 L (75,400 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) was done in January 2013. Regulatory and permit limits were not exceeded. Most of the required analytes were not detected (less than the laboratory detection limits). The results are summarized in Table A-3.

A.1.2.3 Groundwater Control and Dewatering Operation

During 2013, the groundwater control and dewatering project at the NLVF continued efforts to reduce the intrusion of groundwater below Building A-1. The project has transitioned from initial groundwater investigations and characterization phases in 2002 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] 2003, 2004; NSTec 2006). Groundwater monitoring for this operation includes taking periodic water-level measurements at 24 accessible wells out of the 27 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. Groundwater data are assessed quarterly or as new data become available. This information is used to help characterize groundwater conditions, validate the conceptual hydrologic model, and evaluate the dewatering operation.

In 2013, about 285,420 L (75,400 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 113,941 L (30,100 gal) per month in 2013. When the A-1 Basement Sump well pump is active, the water level directly beneath Building A-1 is about 19.1 centimeters (cm) (7.5 inches [in.]) below the basement floor, as measured in a monitoring tube installed in a nearby elevator shaft. This water level reflects a drop of roughly 40.6 cm (16 in.) in the local water table beneath Building A-1 since full-scale dewatering operations began in 2006. However, the general trend in the 24 accessible NLVF monitoring wells shows rising water levels that are about 1.5 meters (5 feet) higher than levels obtained over the past 10 years. The dewatering efforts must counter this rising groundwater trend.

Figure A-2. Location of dewatering and monitoring wells around Building A-1

Table A-3. NPDES Permit NV0023507 monitoring requirements and 2013 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	0.0052	0.0024	0.0025	0.0023	0.0023
Total Petroleum Hydrocarbons (mg/L)	Annually (4th Qtr)	Discrete	1.0	NS[b]	NS	NS	ND[c]
Total Suspended Solids (mg/L)	Quarterly	Discrete	135	ND	ND	ND	ND
Total Dissolved Solids (mg/L)	Quarterly	Discrete	1900	1170	1250	1200	1500
Total Inorganic Nitrogen as N (mg/L)	Quarterly	Discrete	20	1.28	1.16	1.3	1.2
pH (Standard Units)	Quarterly	Discrete	6.5–9.0	7.83	8.08	8.04	7.94
Tritium (picocuries per liter [pCi/L])	Annually (4th Qtr)	Discrete	MR[d]	NS	NS	NS	ND
Permit Attachment A Analytes (mg/L):							
46 Base Neutral Extractables	Biennial	Discrete	MR	NS	NS	NS	ND
12 Acid Extractables	Biennial	Discrete	MR	NS	NS	NS	ND
31 Volatile Organics*	Biennial	Discrete	MR	NS	NS	NS	ND
Chloroform				NS	NS	NS	0.00167
Tetrachloroethylene				NS	NS	NS	0.00061[e]
24 Pesticides/PCBs[f]	Biennial	Discrete	MR	NS	NS	NS	ND
Dioxins	Biennial	Discrete	MR	NS	NS	NS	ND
13 Metals**	Biennial	Discrete	MR	NS	NS	NS	ND
Arsenic				NS	NS	NS	0.0146
Cadmium				NS	NS	NS	0.000204[e]
Chromium				NS	NS	NS	0.00118
Copper				NS	NS	NS	0.0101
Selenium				NS	NS	NS	0.00443[e]
Zinc				NS	NS	NS	0.0114
Cyanide	Biennial	Discrete	MR	NS	NS	NS	ND
Asbestos	Biennial	Discrete	MR	NS	NS	NS	<0.2

(a) MGD = million gallons per day
(b) NS = not required to be sampled that quarter
(c) ND = not detected; values were less than the laboratory detection limits
(d) MR = monitor and report; no specified daily maximum or 30-day average limit, just the requirement that there shall be no discharge of substances that would cause a violation of state water quality standards
(e) Estimated concentration, the concentration between the method detection limit and the method reporting limit.
(f) PCBs = Polychlorinated biphenyls
* All 31 volatile organics were ND except chloroform and tetrachloroethylene as shown
** All 13 metals were ND except for arsenic, cadmium, chromium, copper, selenium, and zinc as shown

A.1.2.4 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 between 1994 and 1995 (BN 2000). The discharge water, which contained tritium, was disposed of at the NNSS. The sump well was turned off after the remedial operations were completed. However, beginning in early 2003, the sump well has been used to help control the encroaching water below Building A-1. The water contains some residual tritium, and it is segregated from the uncontaminated water from the dewatering operation through its own disposal process. The amount of tritium in the sump well water has decreased over the last 10 years from about 1,900 pCi/L to about 193 pCi/L (average of two analyses) in 2013 (less than 1/100th of the Safe Drinking Water Act limit of 20,000 pCi/L). A total of 1,367,908 L (361,363 gal) of water were pumped from the sump well and transported to the NNSS for disposal in 2013. The measured tritium concentrations of the transported water were used to estimate total curies released to the atmosphere at the NNSS (see Section 4.1.9, Table 4-12) and at the NLVF (see Section A.1.3.1).

A.1.2.5 Oil Pollution Prevention

The NLVF has an SPCC Plan that was prepared in accordance with the Clean Water Act to minimize the potential discharge of petroleum products, animal fats and vegetable oils, and other non-petroleum oils and greases into waters of the U.S. (i.e., the Las Vegas Wash). The EPA requires SPCC Plans for non-transportation–related facilities having the potential to pollute waters of the U.S. and having an aggregate aboveground oil storage capacity of more than 4,997 L (1,320 gal). Oil storage facilities at the NLVF include 9 aboveground tanks, 18 transformers, 14 pieces of oil-filled machining equipment (e.g., lathes, elevators), and numerous 55 gal drums that are used to store new and used oils. These facilities/pieces of equipment are located within approved spill and storm water runoff containment structures. The SPCC specifies procedures for removing storm water from containment structures and identifies discharge countermeasures, disposal methods for recovered materials, and discharge reporting requirements.

In 2013, quarterly inspections of tanks, transformers, oil-filled equipment, and drums were conducted on March 20 and 28, June 20, September 16, and December 5. Throughout 2013, all NLVF employees who handle oil received their required annual spill prevention and management training. A small quantity (about 3.5 gallons) of oil leaked from a personal vehicle driven onto the NLVF and was cleaned up. No spills occurred in 2013 that met regulatory agency reporting criteria.

A.1.3 Radiation Protection

A.1.3.1 National Emission Standards for Hazardous Air Pollutants (NESHAP)

In compliance with NESHAP of the Clean Air Act, the radionuclide air emissions from the NLVF and the resultant radiological dose to the public surrounding the facility were assessed. 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 2013, groundwater containing detectable levels of tritium was pumped from the sump well in the basement and transported to the NNSS for disposal. Potential emissions from this activity were estimated by applying the emission factor for liquids listed in Title 40 Code of Federal Regulations Appendix D to Part 61, "Methods for Estimating Radionuclide Emissions," to the total amount of tritium handled (tritium concentration in the groundwater multiplied by the volume). Also, the tritium emission in air coming from the building was determined by taking two air samples from the basement (April 8–15 and September 9–16) in order to compute average tritium emissions from the basement. A calculated annual total of 2.27 millicuries were released, virtually all from the basement air that was vented to the outside. Based on this emission rate, the 2013 calculated radiation dose to the nearest member of the general public from the NLVF was very low: 0.000011 mrem/yr (NSTec 2014).

The nearest public place is 100 meters (328 feet) northwest of Building A-1. This annual public dose is well below the regulatory limit of 10 mrem/yr and continues to decrease. It is currently less than half of that estimated for 2010 (NSTec 2011).

A.1.3.2 DOE O 458.1

U.S. Department of Energy (DOE) Order DOE O 458.1, "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. Direct radiation monitoring is conducted using 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 Chapter 6 of this report.

In 2013, radiation exposure was measured at two locations along perimeter fences for Buildings A-1 and C-3 and at one control location along the west fence of Building C-1. Annual exposure rates estimated from measurements at those locations are summarized in Table A-4. The radiation exposure in air measured by the TLDs is in the unit of milliroentgens per year (mR/yr), which is considered equivalent to the unit of mrem/yr for tissue. These exposures include contributions from background radiation and are similar to the TLD measurement of 100 mR/yr for total annual exposure reported by the Desert Research Institute from their Las Vegas air monitoring station (see Section 7.1.5, Table 7-3). The NLVF TLD results indicate that facility activities do not contribute a radiological dose to the surrounding public that can be distinguished from the dose due to background radiation.

Table A-4. Results of 2013 direct radiation exposure monitoring at the NLVF

Location	Number of Samples	Gamma Exposure (mR/yr) Mean	Median	Minimum	Maximum
West Fence of Building C-1 (Control)	4	95	95	92	101
North Fence of Building A-1	4	67	66	64	72
North Fence of Building C-3	4	68	67	64	79

A.1.4 Hazardous Waste Management

Hazardous wastes (HWs) generated at the NLVF include such items as non-empty aerosol cans, lead debris, and oily rags. HWs are stored temporarily in satellite accumulation areas until they are direct-shipped to approved disposal facilities. The NLVF is a Conditionally Exempt Small Quantity Generator; therefore, no HW permit is required by the State of Nevada. However, once a year, the Southern Nevada Health District (SNHD) conducts an onsite audit to validate proper handling and storage. SNHD personnel conducted the annual audit on May 9, 2013, and found existing HW procedures acceptable.

A.1.5 Hazardous Materials Control and Management

In 2013, the chemical inventory at the NLVF was updated and submitted to the State in the Nevada Combined Agency (NCA) Report on February 12, 2014. The inventory data were submitted in accordance with the requirements of the Hazardous Materials Permit 26779 (see Section 2.6, Emergency Planning and Community Right-to-Know Act, for a description of the content, purpose, and federal regulatory driver behind the NCA Report). No accidental or unplanned release of an extremely hazardous substance (EHS) occurred at the NLVF in 2013. Also, the quantities of toxic chemicals kept at the NLVF that are used annually did not exceed the specified reporting thresholds (see Section 2.6 concerning Toxic Chemical Release Inventory, Form R).

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 the NLVF. It occupies six facilities on approximately 14 secured hectares (35 acres) at the Nellis Air Force Base. The six NNSA/NFO facilities were constructed on property owned by the U.S. Air Force (USAF). There is a Memorandum of Agreement between the USAF and NNSA/NFO whereby the land belongs to the USAF but is under lease to the NNSA/NFO for 25 years (as of 1989) with an option for a 25-year extension. The facilities are owned by NNSA/NFO. RSL-Nellis provides emergency response resources for weapons-of-mass-destruction incidents. The laboratory also designs and conducts field tests of 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 2013 included maintenance of an air quality permit, a wastewater discharge permit, a hazardous materials permit, and a waste management permit (see Chapter 2, Table 2-12 for a list of all NNSA/NFO permits). 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 is performed to ensure protection of personnel who work within the facility.

A.2.1 Air Quality and Protection

Sources of air pollutants at RSL-Nellis are regulated by the Synthetic Minor Source Permit 348 for the emission of criteria pollutants and HAPs issued by the Clark County DAQ. The regulated sources of emissions at RSL-Nellis include an aluminum sander, an abrasive blaster, spray paint booth, diesel generators, a fire pump, cooling towers, and boilers. The 2013 emissions inventory of criteria air pollutants and HAPs was submitted to the DAQ on March 24, 2014, and is shown in Table A-5.

Table A-5. Summary of air emissions for RSL-Nellis in 2013

	Criteria Pollutant (Tons/yr)[(a)]						
Parameter	**CO**	**NO_x**	**PM10[(b)]**	**PM2.5[(c)]**	**SO_2**	**VOC**	**HAPs (Tons/yr)**
PTE[(d)]	2.97	9.35	1.02	0.60	0.43	1.06	0.39
Actual[(e)]	0.96	2.72	0.24	0.16	0.09	0.15	0.08
Total Emissions = 4.40 Actual, 15.82 PTE							

(a) 1 ton equals 0.91 metric tons
(b) Particulate matter equal to or less than 10 microns in diameter
(c) Particulate matter equal to or less than 2.5 microns in diameter
(d) Potential to emit: The quantity of criteria air pollutant that facilities/pieces of equipment would emit annually if they were operated for the maximum number of hours at the maximum production rate specified in the air permit
(e) Emissions based on calculations using actual hours of operation for each piece of equipment

Clark County air regulations specify that the opacity from any emission unit may not exceed the Clean Air Act NAAQS opacity limit of 20% for more than 6 consecutive minutes. The RSL-Nellis air permit requires that equipment be observed each day it is operated. If visible emissions are observed, then EPA Method 9 opacity readings are recorded by a certified visible emissions evaluator. If visible emissions appear to exceed the limit, corrective actions must be taken to minimize emissions. In 2013, two RSL-Nellis personnel were recertified to conduct opacity readings. Readings were taken for generators, a paint booth, aluminum sander, and sand blaster. Emissions for all equipment were well below the Clean Air Act NAAQS opacity limit of 20%.

Twice a year, the operating hours and throughputs for each permitted piece of equipment must be submitted to Clark County. These semi-annual reports were submitted on July 25, 2013 for the period January through June and on January 27, 2014 for the period July through December.

A.2.2 Water Quality and Protection

Water used at RSL-Nellis is supplied by the CNLV and meets or exceeds federal drinking water standards. The only 2013 water quality permit for RSL-Nellis was Wastewater Contribution Permit CCWRD-080, issued by the Clark County Water Reclamation District (CCWRD) for wastewaters discharged from the facility. During the permit renewal process, CCWRD determined that a discharge permit would no longer be necessary since no industrial wastewaters were being discharged. A Zero Discharge Form was submitted to CCWRD, and the permit was not renewed. The permit was active, however, for the first half of 2013 and required quarterly monitoring and reporting. Table A-6 presents the mean concentration of outfall measurements collected once per quarter during the first two quarters of 2013. All contaminants in the outfall samples were below permit limits. Quarterly reports were submitted to the CCWRD on March 14 and May 9, 2013. The CCWRD conducted one inspection of RSL-Nellis in May 2013 and no findings or corrective actions for the facility were identified.

Table A-6. Mean concentration of outfall measurements at RSL-Nellis in 2013

Contaminant/Measure	Permit Limit (mg/L)	Outfall (mg/L)
Ammonia	NL[(a)]	31.8
Cadmium	0.35	0.000371
Chromium (Total)	1.7	0.00189
Copper	3.36	0.267
Cyanide (Total)	1	<0.005
Lead	0.99	0.00123
Nickel	10.08	0.00540
Oil and Grease as SGT-HEM[(b)]	100	10.35
Phosphorus	NL	12.05
Silver	6.3	0.001097
Total Dissolved Solids	NL	971
Total Suspended Solids	NL	305
Zinc	23.06	0.229
pH (Standard Units)	5.0–11.0	8.51
Temperature (degrees Fahrenheit)	140	64.7

(a) No limit listed on permit
(b) Silica Gel Treated N-Hexane Extractable Material

A.2.2.1 Oil Pollution Prevention

An SPCC Plan is in place for RSL-Nellis. Similar to the NLVF (see Section A.1.3), the SPCC Plan is required because the facility has an aggregate aboveground oil storage capacity of more than 4,997 L (1,320 gal) and spills could potentially enter the Las Vegas Wash. Oil storage facilities at RSL-Nellis include nine aboveground tanks, four transformers, and two pieces of oil-filled machining equipment (e.g., elevators). These facilities and pieces of equipment are located within approved spill and storm water runoff containment structures. The SPCC specifies procedures for removing storm water from containment structures and identifies discharge countermeasures, disposal methods for recovered materials, and discharge reporting requirements.

In 2013, quarterly inspections of tanks, transformers, and oil-filled equipment were conducted on February 14, May 9, August 1, and October 31. Throughout 2013, all RSL-Nellis employees who handle oil received their required annual spill prevention and management training. A small quantity (about 0.25 gallons) of oil leaked from the Aircraft Power Unit and was cleaned up. No spills occurred in 2013 that met regulatory agency reporting criteria.

A.2.3 Underground Storage Tank Management

The underground storage tank program at RSL-Nellis consists of three fully regulated tanks (one for unleaded gasoline, one for diesel fuel, and one for used oil), one deferred tank (in accordance with Title 40 Code of Federal Regulations Part 280.10[d]) for emergency power generation, and three excluded tanks. The active tanks are inspected annually by SNHD. No deficiencies were noted during the 2013 inspection.

A.2.4 Hazardous Materials Control and Management

In 2013, the chemical inventory at RSL-Nellis was updated and submitted to the State in the NCA Report on February 12, 2014, in accordance with the requirements of the Hazardous Materials Permit 26781 (see Section 2.6 of this report for a description of the content, purpose, and federal regulatory driver behind the NCA Report). No accidental or unplanned release of an EHS occurred at RSL-Nellis in 2013. Also, no annual usage quantities of toxic chemicals kept at RSL-Nellis exceeded specified thresholds (see Section 2.6 concerning Toxic Chemical Release Inventory, Form R).

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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 that, 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.

Area 5 Radioactive Waste Management Complex (RWMC): the complex in Area 5 of the Nevada National Security Site at which low-level waste (LLW) and mixed low-level waste (MLLW) may be received, examined, packaged, stored, or disposed. Limited quantities of onsite-generated transuranic waste (TRU) are also stored temporarily at the RWMC. The RWMC is composed of the Area 5 Radioactive Waste Management Site (RWMS) and the Waste Examination Facility (WEF) and supporting administrative buildings, parking areas, and utilities. The operational units of the Area 5 RWMS include active, inactive, and closed LLW and MLLW cells and a Real Time Radiography Building. The operational units of the WEF include the TRU Pad, TRU Pad Cover Building, TRU Loading Operations Area, WEF Yard, WEF Drum Holding Pad, Sprung Instant Structure, and the Visual Examination and Repackaging Building.

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 National Security Site operations. In the broader context outside this report, background radiation refers to radiation arising from natural sources always present in the environment, including solar and cosmic radiation from outer space and naturally radioactive elements in the atmosphere, the ground, building materials, and the human body.

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.

Community water system: as defined in Nevada Revised Statute 445A.808, it is a public water system that has at least 15 service connections used by year-round residents of the area served by the system; or regularly serves at least 25 year-round residents of the area served by the system.

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.

Confining unit: a geologic unit of relatively low permeability that impedes the vertical movement of groundwater.

Cool roof: a low-sloped roof (pitch less than or equal to 2:12) that is designed and installed with a minimum 3-year aged solar reflectance of 0.55 and a minimum 3-year aged thermal emittance of 0.75, or with a minimum 3-year aged solar reflectance index (SRI) of 64. Cool steep-sloped roofs (pitch exceeding 2:12) have a 3-year SRI of 29 or higher.

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 National Security 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 National Security 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.

Critical Level (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.

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} (37 billion) disintegrations per second; 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): previously published standard in U.S. Department of Energy (DOE) Order DOE O 5400.5 from 1993, which was the concentration of a given radionuclides in water or air that could be continuously consumed or inhaled for 1 year and not exceed the DOE primary radiation dose limit to the public of 100 millirem per year effective dose equivalent. DCGs were replaced in 2011 by Derived Concentration Standards (DCSs).

Derived Concentration Standard (DCS): concentration of a given radionuclide in either water or air that results in a member of the public receiving 100 millirem (1 millisievert) effective dose following continuous exposure for one year via each of the following pathways: ingestion of water, submersion in air, and inhalation. They replace the DCGs previously published by the U.S. Department of Energy (DOE) in 1993 in DOE Order DOE O 5400.5. Since 1993, the radiation protection framework on which DCSs are based has evolved with more sophisticated biokinetic and dosimetric information provided by the International Commission on Radiological Protection (ICRP), thus enabling consideration of age and gender. DOE-STD-1196-2011 establishes DCS values that reflect the current state of knowledge and practice in radiation protection. These DCSs are based on age-specific effective dose coefficients, revised gender specific physiological parameters for the Reference Man (ICRP 2002), and the latest information on the energies and intensities of radiation emitted by radionuclides (ICRP 2008).

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 to radiation discharged to the environment via the air.

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 Administration Nevada Field 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 of 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 air pollutants (HAPs): Toxic air pollutants that are known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental effects. The U.S. Environmental Protection Agency has set emission standards for 22 of the 187 designated HAPs. Examples of toxic air pollutants include benzene, which is found in gasoline; perchloroethylene, which is emitted from some dry cleaning facilities; and methylene chloride, which is used as a solvent and paint stripper by a number of industries. Examples of other listed air toxics include dioxin, asbestos, toluene, and metals such as cadmium, mercury, chromium, and lead compounds.

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 the 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 disposable, 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:** see Critical Level (L_C).

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 waste (LLW): defined by U.S. Department of Energy Manual DOE M 435.1-1, "Radioactive Waste Management Manual," as radioactive waste that is not high-level radioactive waste, spent nuclear fuel, transuranic waste, byproduct material (as defined in section 11e.(2) of the Atomic Energy Act of 1954, as amended), or naturally occurring radioactive material.

Lower limit of detection: the smallest concentration or amount of analyte that can be detected in a sample at a 95-percent confidence level; also known as minimum detectable concentration.

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 low-level waste (MLLW): waste containing both radioactive and hazardous components.

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.

Non-community water system: as defined in Nevada Revised Statute 445A.828, it is a public water system that is not a community water system. Private water system: on the NNSS, a water system that is not a public water system and is not regulated under State of Nevada permits.

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.

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.

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).

Private water system: a water system that is not a public water system, as defined in Nevada Revised Statute 445A.235, and is not regulated under State of Nevada permits.

Public water system (PWS): as defined in Nevada Revised Statute 445A.235, it is a system, regardless of ownership, that provides the public with water for human consumption through pipes or other constructed conveyances, if the system has 15 or more service connections, as defined in NRS 445A.843, or regularly serves 25 or more persons. The three PWSs on the NNSS are permitted by the State of Nevada as non-community water systems.

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." 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.

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.

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 Nuclear 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 effective dose equivalent (TEDE): The sum of the external exposures and the committed effective dose equivalent (CEDE) for internal exposures.

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; 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; also referred to as the unsaturated zone.

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 underground boundary between saturated and unsaturated soils or rock. It is the point beneath the surface of the ground at which natural ground water is found. It is the upper surface of a zone of saturation where the body of groundwater is not confined by an overlying impermeable formation. Where an overlying confining formation exists, the aquifer in question has no water table.

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.

Appendix C: Acronyms and Abbreviations

ac	acre(s)
Ac	actinium
ACM	asbestos-containing material
AEA	Atomic Energy Act
AEC	Atomic Energy Commission
AFV	alternative fuel vehicle
AICP	American Indian Consultation Program
ALARA	as low as reasonably achievable
Am	americium
APP	affirmative procurement program
ARL/SORD	Air Resources Laboratory, Special Operations and Research Division
ARPA	Archaeological Resources Protection Act
ASER	Annual Site Environmental Report
ASN	Air Surveillance Network
B	Background
BCG	Biota Concentration Guide
Be	beryllium
BEEF	Big Explosives Experimental Facility
BFF	Bureau of Federal Facilities
bgs	below ground surface
BLM	Bureau of Land Management
BN	Bechtel Nevada
BOA	Basic Ordering Agreement
BOD_5	5-day biological oxygen demand
Bq	Becquerel
BREN	Bare Reactor Experiment–Nevada
BSDW	Bureau of Safe Drinking Water
BTU	British thermal unit
C	carbon
CA	Composite Analysis
CAA	Clean Air Act
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
CFR	Code of Federal Regulations
CGTO	Consolidated Group of Tribes and Organizations
Ci	curie(s)
CL	compliance level (used in text for the Clean Air Act National Emission Standards for Hazardous Pollutants Concentration Level for Environmental Compliance)
cm	centimeter(s)
cm^2	square centimeter(s)
CNLV	City of North Las Vegas
Co	cobalt
CO	carbon monoxide
CR	Closure Report
CRM	Cultural Resources Management
Cs	cesium
CV	coefficient of variation
CWA	Clean Water Act
CX	Categorical Exclusion
CY	calendar year
3D	Directives and Documents Department
DAF	Device Assembly Facility
DAQ	Department of Air Quality (Clark County)
DCG	Derived Concentration Guide
DCS	Derived Concentration Standard
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/NV	U.S. Department of Energy, Nevada Operations Office

dpm	disintegrations per minute
DQA	Data Quality Assessment
DQO	Data Quality Objective
DRI	Desert Research Institute
DTCC	Desert Tortoise Conservation Center
DSA	Documented Safety Analysis
DU	depleted uranium
E1	Environmental 1
E2	Environmental 2
EA	Environmental Assessment
E&EM	Ecological and Environmental Monitoring
EDE	effective dose equivalent
EHS	extremely hazardous substance
EIS	Environmental Impact Statement
EM	Environmental Management
EMAC	Ecological Monitoring and Compliance
EMAD	Engine Maintenance, Assembly, and Disassembly
EMC	Energy Management Council
EMP	Energy Management Program
EMS	Environmental Management System
EO	Executive Order
EODU	Explosive Ordnance Disposal Unit
EP	Environmental Programs
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EPEAT	Electronic Product Environmental Assessment Tool
EPP	Environmentally Preferable Purchasing
ER	Environmental Restoration
ERA	Environmental Research Associates
ESA	Endangered Species Act
ETDS	E-Tunnel Waste Water Disposal System
Eu	europium
EWG	Environmental Working Group
EWO	Environmental Waste Operations
F&I	Facility and Infrastructure
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
GHG	greenhouse gas
GIS	Geographic Information System
gpm	gallon(s) per minute
gsf	gross square feet
Gy	gray(s)
Gy/d	gray(s) per day
^3H	tritium
ha	hectare(s)
HAP	hazardous air pollutant
HENRE	High-Energy Neutron Reactions Experiment
HEPA	high-efficiency particulate air
HEST	High Explosives Simulation Test
HMA	Herd Management Area
HQ	Headquarters
HTO	tritiated water
HW	hazardous waste
HWAA	Hazardous Waste Accumulation Area
HWSU	Hazardous Waste Storage Unit
I	iodine
IAEA	International Atomic Energy Agency
ICPT	Integrated Contractor Purchasing Team
ICR	San Diego Zoo Institute for Conservation Research
ID	identification number
IH	Industrial Hygiene
IL	investigation level
in.	inch(es)
ISO	International Organization for Standardization
ISWG	Interagency Sustainability Working Group
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
LEED	Leadership in Energy and Environmental Design
LLNL	Lawrence Livermore National Laboratory
LLW	low-level waste
Lpm	liter(s) per minute
LoC	Level of Concern
log	logarithmic
lpm	liter(s) per minute
LQAP	Laboratory Quality Assurance Plan
LRQA	Lloyd's Register Quality Assurance
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
MEI	maximally exposed individual
MET	meteorological
MGD	million gallons per day
mg/L	milligram(s) per liter
mGy/d	milligray(s) per day
mi	mile(s)
mi^2	square mile(s)
MLLW	mixed low-level waste
mm	millimeter(s)
mmhos/cm	millimhos per centimeter
Mod.	Modification
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
MSDS	Material Safety Data Sheet
mSv	millisievert(s)
mSv/yr	millisievert(s) per year
$mTCO_2e$	metric ton(s) of carbon dioxide equivalent
mton	metric ton(s)
MTRU	mixed transuranic
MWDU	Mixed Waste Disposal Unit
MWSU	Mixed Waste Storage Unit
µCi/mL	microcurie(s) per milliliter
µg/L	microgram(s) per liter
µR/hr	microroentgen(s) per hour
µS/cm	microseimen(s) per centimeter
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
N-I	Navarro-Intera, LLC
NLVF	North Las Vegas Facility
NNES	Navarro Nevada Environmental Services, LLC
NNHP	Nevada Natural Heritage Program
NNSA	U.S. Department of Energy, National Nuclear Security Administration
NNSA/NFO	U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office

NNSA/NSO	U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office
NNSA/SFO	U.S. Department of Energy, National Nuclear Security Administration Sandia Field Office
NNSS	Nevada National Security Site
NNSSER	Nevada National Security Site Environmental Report
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
NSSAB	Nevada Site Specific Advisory Board
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)
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
PEV	plug-in electric vehicle
PI	prediction interval
PIC	pressurized ion chamber
PLall	prediction limit for all enriched tritium measurements
PM	particulate matter
PM10	particulate matter equal to or less than 10 microns in diameter
PT	proficiency testing
PTE	potential to emit
Pu	plutonium
PUE	Power Utilization Effectiveness
PWS	public water system
QA	quality assurance
QAP	Quality Assurance Program
QAPP	Quality Assurance Program Plan
QC	quality control
QPID	Quality and Performance Improvement Division
QSAS	Quality Systems for Analytical Services
R	roentgen(s)
Ra	radium
rad	radiation absorbed dose (a unit of measure)
rad/d	rad(s) per day
RC	Radiological Control
RCRA	Resource Conservation and Recovery Act
rem	roentgen equivalent man (a unit of measure)
RER	relative error ratio
RMA	Radioactive Material Area
RNCTEC	Radiological/Nuclear Countermeasures Test and Evaluation Complex
RPD	relative percent difference
RREMP	Routine Radiological Environmental Monitoring Plan
RSL	Remote Sensing Laboratory
RTR	Real-Time Radiography
RW	Radioactive Waste
RWAP	Radioactive Waste Acceptance Program
RWMC	Radioactive Waste Management Complex
RWMS	Radioactive Waste Management Site
SA	Supplement Analysis
SAA	Satellite Accumulation Area
SAD	surface area disturbance
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
SER	Safety Evaluation Report
SF_6	Sulfur hexafluoride
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
SPCC	Spill Prevention, Control, and Countermeasure
Sr	strontium
SSC	structures, systems, and components
SSP	Site Sustainability Plan
SSPP	Strategic Sustainability Performance Plan
STGWG	State Tribal Government Working Group
S.U.	standard unit(s) (for measuring pH)
Sv	sievert(s)
SWEIS	Site-Wide Environmental Impact Statement
SWO	Solid Waste Operations
T½	half-life
Tc	technetium
TDS	total dissolved solids
TEDE	total effective dose equivalent
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
TSR	Technical Safety Requirements
TSS	total suspended solids
TTR	Tonopah Test Range
U	uranium
UGT	underground test
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 compound
VZM	vadose zone monitoring
W&W	Waste and Water
WEF	Waste Examination Facility
WIPP	Waste Isolation Pilot Plant
WNV	West Nile virus
WO	Waste Operations
WW	water well
yr	year(s)

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