ERRATA SHEET

Issue Date: August 2014

Corrections Apply to: **Nevada National Security Site Environmental Report 2012**

DOE Document Number: **DOE/NV/25946--1856**

Document Date: **September 2013**

Chapter 4:

Page 4-14, Table 4-9: The sampling stations Bunker 9-300 and Gate 700 S were not listed, and some other stations were listed out of order. The corrected table is shown below.

Page 4-15, Table 4-10: The sampling stations Gate 510 and ABLE Site were not listed, and some other stations were listed out of order. The corrected table is shown below.

Table 4-1. Gross alpha radioactivity in air samples collected in 2012

Area	Sampling Station	Number of Samples[(a)]	Gross Alpha ($\times 10^{-16}$ μCi/mL) Mean	Standard Deviation	Minimum	Maximum
1	BJY	51	21.23	14.90	−12.77	77.46
3	Bilby Crater[(b)]	19	26.86	6.96	14.01	39.46
3	Kestrel Crater N[(b)]	18	33.29	30.85	7.73	152.06
3	U-3ah/at N[(c)]	13	17.79	9.76	3.52	31.27
3	U-3ah/at S[(c)]	13	17.31	12.00	0.00	39.60
3	U-3ax/bl S[(b)]	19	28.03	9.39	16.31	46.45
3	U-3bh N[(c)]	13	17.25	9.44	4.56	36.62
3	U-3bh S[(c)]	13	16.81	12.01	3.48	38.39
5	DoD	32	22.82	9.82	0.59	38.40
5	Sugar Bunker N	32	26.15	10.73	4.65	50.36
6	Yucca*	52	20.73	12.69	−15.49	47.80
9	Bunker 9-300	51	38.12	26.71	5.90	172.02
10	Gate 700 S*	52	16.74	11.39	−4.78	46.11
10	Sedan N	52	19.63	12.67	−4.54	50.06
16	3545 Substation*	52	16.21	10.55	−7.23	41.42
18	Little Feller 2 N	52	20.38	16.32	−10.79	107.57
20	Gate 20-2P	52	16.26	11.79	−8.96	43.27
20	Schooner*	52	20.13	9.20	−1.16	45.31
23	Mercury Track*	52	18.34	9.73	−5.25	38.98
25	Gate 510*	52	19.78	12.75	3.02	71.11
27	ABLE Site	52	17.74	11.05	−9.30	52.61
All Environmental Locations		**794**	**21.16**	**14.90**	**−15.49**	**172.02**
27	JASPER Stack	39	−363.46	9,543.27	−50,198.77	30,543.73

*** EPA-approved Critical Receptor Station**

(a) Differences in the number of samples across stations are due to the number of weeks a station operated in 2012 and/or to different sample collection schedules (e.g., weekly versus every 2 weeks; see Section 4.1.2).

(b) Sampling station was added at end of March 2012.

(c) Sampling station was removed at end of March 2012.

Table 4-2. Gross beta radioactivity in air samples collected in 2012

			Gross Beta (× 10^{-15} µCi/mL)			
Area	**Sampling Station**	**Number of Samples[a]**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**
1	BJY	51	21.95	6.32	10.92	46.76
3	Bilby Crater[b]	19	23.00	6.10	14.88	39.69
3	Kestrel Crater N[b]	18	22.54	5.91	14.68	38.69
3	U-3ah/at N[c]	13	19.85	6.31	11.12	33.59
3	U-3ah/at S[c]	13	20.58	6.09	13.34	33.79
3	U-3ax/bl S[b]	19	22.62	5.82	14.32	37.75
3	U-3bh N[c]	13	20.53	6.86	11.23	38.13
3	U-3bh S[c]	13	20.32	6.04	11.22	33.98
5	DoD	32	22.95	6.52	12.36	41.83
5	Sugar Bunker N	32	23.86	6.52	12.31	39.34
6	Yucca*	52	23.10	6.72	10.83	47.33
9	Bunker 9-300	51	21.98	6.77	10.43	46.41
10	Gate 700 S*	52	21.74	6.73	9.95	45.35
10	Sedan N	52	21.56	6.56	10.45	47.68
16	3545 Substation*	52	20.22	6.58	9.88	44.17
18	Little Feller 2 N	52	20.43	6.24	9.89	42.53
20	Gate 20-2P	52	20.54	6.55	9.40	43.90
20	Schooner*	52	21.61	7.03	9.74	46.04
23	Mercury Track*	52	22.02	6.77	9.50	42.73
25	Gate 510*	52	22.39	6.80	10.40	42.94
27	ABLE Site	52	20.83	6.62	10.46	41.22
All Environmental Locations		**794**	**21.68**	**6.57**	**9.40**	**47.68**
27	JASPER Stack	40	−6.27	312.43	−1,181.66	1,267.87
*** EPA-approved Critical Receptor Station**						

(a) Differences in the number of samples across stations are due to the number of weeks a station operated in 2012 and/or to different compositing schedules (e.g., weekly versus every 2 weeks; see Section 4.1.2).

(b) Sampling station was added at end of March 2012.

(c) Sampling station was removed at end of March 2012.

DOE/NV/25946--1856

Nevada National Security Site Environmental Report 2012

September 2013

National Nuclear Security Administration

National Security Technologies LLC
Vision • Service • Partnership

Document Availability

Available for sale to the public from:

U.S. Department of Commerce
National Technical Information Service
5301 Shawnee Road
Alexandria, Virginia 22312

Phone: **1-800-553-6847**
Fax: **(703) 605-6900**
E-mail: **orders@ntis.gov**
Online ordering: **http://www.ntis.gov/help/ordermethods.aspx**

Available electronically at **http://www.osti.gov/bridge**

Available for a processing fee to the U.S. Department of Energy and its contractors, in paper, from:

U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, Tennessee 37831-0062

Phone: **(865) 576-8401**
Fax: **(865) 576-5728**
E-mail: **reports@adonis.osti.gov**

Disclaimer

Front cover photographs ...

Wyoming Indian paintbrush *(Castilleja linarifolia)*

New Mexico thistle *(Cirsium neomexicanum)* (on left)

Virgin River brittlebush *(Encelia virginensis)* (on right)

Desert milkweed *(Asclepias erosa)*

Fremont's dalea *(Psorothamnus fremontii)*

Redspined fishhook cactus *(Sclerocactus polyancistrus)*

Wishbone-bush *(Mirabilis laevis)*

Title page photograph ...

Stansbury cliffrose *(Purshia stansburiana)*

Back cover photograph ...

Joshua tree *(Yucca brevifolia)*

DOE/NV/25946--1856

Nevada National Security Site Environmental Report 2012

Editor: **Cathy Wills**

Technical Editor: **Sierra Cory**

Graphic Designer: **Katina Loo**

Geographic Information System Specialist: **Ashley Burns**

September 2013

Work performed under contract number:

DE-AC52-06NA25946

This report was prepared for:

U.S. Department of Energy
National Nuclear Security Administration
Nevada Field Office

By:

National Security Technologies, LLC
P.O. Box 98521
Las Vegas, Nevada 89193-8521

THIS PAGE LEFT INTENTIONALLY BLANK

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 2012 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 2012 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 Site Office of NNSA (NNSA/SSO) has oversight of all other TTR and NTTR activities. NNSA/SSO produces the TTR annual environmental report available at http://www.sandia.gov/news/publications/environmental/index.html.

Major Site Programs and Facilities

NNSA/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, 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, several other environmental key initiatives are pursued. 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. For the identification of 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 2012 targets were all met or exceeded and are summarized in Tables 3-1 and 3-2 of Chapter 3.

Surveillances in January and June and a recertification assessment in March were performed in 2012 by the ISO 14001 certifying organization, Lloyd's Register Quality Assurance (LRQA). The EMS program was found to meet all the requirements of the ISO 14001 standard with no major nonconformances, and in March 2012, LRQA recertified the EMS for another 3 years. A 2012 internal independent audit found minor issues that were corrected. Also, 5 internal management assessments and 86 compliance evaluations were conducted to promote continual improvement.

The 2012 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 score card 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 Program

The NNSA/NFO Energy Management Program supports the goals of the DOE's Strategic Sustainability Performance Plan (SSPP) (DOE 2011) that have been set to meet the requirements of 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." The program accomplishes this by advancing energy efficiency, water conservation, and the use of solar and other renewable energy sources at the NNSS, NLVF, and RSL-Nellis. In 2012, the *FY 2013 NNSA/NSO Site Sustainability Plan* (SSP) (NSTec 2012a) 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 2012 status of all the NNSA/NFO SSPs goals is summarized in Table 3-2 of Chapter 3.

P2/WM Program

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 2012, the P2/WM Program was compliant with the requirements for implementing P2/WM processes but failed to meet one goal under EO 13423. Only 53.8% of qualified items purchased by NNSA/NFO in 2012 contained the minimum amount of recycled materials instead of the 100% required, if possible, under EO 13423.

The 2012 P2/WM activities resulted in reductions to the volume and/or toxicity of waste generated by NNSA/NFO activities. A reduction of 75 metric tons (mtons) (83 tons) of hazardous waste (HW) was realized in 2012. The largest proportion of this reduction came from shipments of lead acid batteries (35 mtons [38 tons]) and scrap lead (23 mtons [25 tons]) to offsite vendors for recycling. A reduction of 1,279 mtons (1,410 tons) of solid waste was realized in 2012. The largest proportion of this reduction came from 821 mtons (905 tons) of ferrous and nonferrous metal sold as scrap for recycling and 308 mtons (340 tons) of mixed paper/cardboard/aluminum cans/plastic shipped from the NLVF and the NNSS to offsite vendors for recycling.

Environmental Awards

DOE Environmental Management Headquarters awarded NNSA/NFO with an Honorable Mention 2012 Sustainability Award for the Pluto Facility demolition in Area 26. An aggressive waste minimization approach was used to improve safety, minimize environmental impact, reduce schedule, and save approximately $1.35 million in demolition, waste containers, transportation, and oversight costs.

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 2012, NNSA/NFO complied with all federal statutes, as shown below and in more detail in Chapter 2.

Federal Statute	What it Covers	2012 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	Routine radiological monitoring was conducted at 22 onsite air stations, 22 offsite and 25 onsite groundwater sources, and 108 stations measuring direct gamma radiation. A combined total of 14 plant samples from 2 locations and 20 animal samples from 19 locations 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 0.54 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	806,544 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.

Federal Statute	What it Covers	2012 Status
Air Quality and Protection		
Clean Air Act: National Emission Standards for Hazardous Air Pollutants (NESHAP) National Ambient Air Quality Standards (NAAQS) New Source Performance Standards (NSPS) Stratospheric Ozone Protection	Air quality and emissions into the air from facility operations	There are no major sources of criteria air pollutants and hazardous air pollutants at the NNSS, NLVF, or RSL-Nellis. Nonradiological air emissions from all permitted equipment and facilities were calculated and were all below permit emission limits; emissions from permitted equipment were all below opacity limits. No air permit exceedances, Notices of Violation, or other air quality noncompliances occurred. The 19 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 2012 NNSS air emissions to the MEI is 0.17 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 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 2012 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 43 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 1,355 tons of MLLW were disposed in Cell 18, 6.14 tons of HW were received for onsite storage, 35.79 tons of HW were shipped directly off site, 0.28 tons of polychlorinated biphenyl (PCB) wastes were shipped to an offsite disposal facility, and 0.39 tons of waste explosive ordnance were detonated on site, all in accordance with state permits. 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	2012 Status
Waste and Hazardous Materials Management and Environmental Restoration (continued)		
National Environmental Policy Act (NEPA)	Projects are evaluated for environmental impacts	NNSA/NFO prepared the final *Site-Wide Environmental Impact Statement for the Nevada National Security Site and Offsite Locations in Nevada*, incorporating public comments. It evaluates current and future NNSA/NFO operations in Nevada during the 10-year period beginning when the Record of Decision is published.
Toxic Substances Control Act (TSCA)	Management and disposal of PCBs	Four drums of PCB-contaminated materials were shipped off site to permitted disposal and treatment facilities. Their contents included fluorescent light ballasts, oil, absorbed oil, and expired calibration standards, all containing PCBs.
Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	Storage and use of pesticides and herbicides	Only nonrestricted-use pesticides were used in 2012 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 2012. 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 2012 and reported to the U.S. Environmental Protection Agency. Releases included onsite disposal, offsite disposal, and offsite recycling and totaled 170,486 lb for lead and 268 lb for mercury. The majority of both lead and mercury releases were from the onsite disposal of cleanup and building demolition materials that were received from other DOE facilities or generated on site.
Other Environmental Statutes		
Endangered Species Act (ESA)	Threatened or endangered species of plants and animals	Field surveys for 15 proposed projects were conducted, 15.21 acres of tortoise habitat were disturbed, and no tortoises were harmed at or displaced from project sites. One tortoise was injured by a vehicle on a paved road, and seven were moved off of roads. 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 34 proposed projects was conducted, and 510 acres were surveyed for 9 of the projects; 2 prehistoric sites, 2 historical sites, and 1 historic district 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, four accidental bird mortalities were documented. The NNSS Power Utilities group modified a power pole in 2012 to prevent raptor electrocution.

Occurrences and Unplanned Releases

There were no reportable environmental occurrences in 2012. No unplanned airborne releases and no unplanned releases of radioactive liquids occurred from the NNSS, NLVF, or RSL-Nellis in 2012. Thirty-three 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 impermeable surfaces and did not exceed a reportable quantity.

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 2012 was 120 milliroentgen per year (mR/yr) and ranged from 66 to 165 mR/yr (Section 6.3). The Desert Research Institute (DRI) used TLDs at offsite locations in 2012 to measure background radiation, and these measurements ranged from 78 mR/yr at Pahrump, Nevada, to 147 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 2012 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 94 and 68 mR/yr, respectively, similar to the range of background exposures observed on the NNSS (Section 6.3.1). Military or other personnel on the NTTR could be exposed to direct radiation from legacy sites on Frenchman Lake playa. A TLD location near the NNSS boundary with NTTR in the playa had an estimated annual exposure of 295 mR (Section 6.3.1). This represents an above-background exposure of 130 to 229 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. Since 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 2012 (Section 5.1.5). 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 0.17 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 2012, tissue samples from two mourning doves captured at E Tunnel Ponds in Area 12; opportunistic tissue samples from the carcasses of 10 mule deer, 2 horses, 1 bobcat, 1 mountain lion; and blood samples from four live mountain lions were collected. An individual who consumes one animal of each game species sampled on the NNSS from 2001 to 2012, having the average radionuclide concentrations of these samples, may receive an estimated 0.38 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 2012 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 2012 was estimated to be 0.54 mrem/yr. This is 0.54% 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).

Offsite Monitoring of Radiological Releases into Air

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 29 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 within a 160,000 square kilometer (61,776 square mile) area of southern Nevada, southeastern California, and southwestern Utah. The network was reduced in size, however, by the end of September 2012. DRI removed air samplers, PICs, and TLDs from five private ranch stations in coordination with the participating ranchers in order to provide more resources for public outreach in participating communities in future years.

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 2012. 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.

Offsite Monitoring of Radionuclides in Water

Routine offsite water monitoring conducted under the *Routine Radiological Environmental Monitoring Plan* (RREMP) (Bechtel Nevada 2003a) and conducted by DRI through the CEMP 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. Under the RREMP, 22 offsite locations (11 community water supply wells, 4 NNSA/NFO monitoring wells, and 7 springs) were sampled for tritium. Man-made gamma-emitting radionuclides and gross alpha and gross beta radioactivity analyses were also conducted for 1 of the NNSA/NFO monitoring wells. The DRI sampled 28 offsite private or community water supply locations (4 springs, 21 wells, and 3 surface water bodies) for tritium.

Tritium was detected at low levels (≤73 picocuries per liter [pCi/L]) for the third year in a row at RREMP monitoring well PM-3, a NNSA/NFO monitoring well located west of the NNSS on the NTTR. Hydrogeologic data west of the NNSS are sparse, and thus groundwater flow predictions are uncertain. PM-3 will continue to be monitored to determine the tritium source. Tritium was not detected in the remainder of the offsite wells and springs sampled under the RREMP in 2012 (Section 5.1.5).

Tritium concentrations for all the CEMP spring and surface water samples ranged from below detection to 22.5 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 have been documented in previous annual NNSS environmental reports and are due to residual tritium persisting in the environment that originated from global atmospheric nuclear testing. Among the 21 offsite wells sampled under the CEMP, tritium ranged from −0.4 to 3.9 pCi/L (Section 7.2.4). Most samples yielded results that were statistically indistinguishable from laboratory background.

The Underground Test Area (UGTA) activity continued their groundwater characterization work, sampling two offsite wells, ER-EC-12 and ER-EC-13 on the NTTR. Tritium was not detected in Well ER-EC-13 and was found just above the detection limit in ER-EC-12, at 4.2 pCi/L (Section 11.1.1.2). Groundwater analyses to date have detected and confirmed tritium in one offsite well on NTTR, Well ER-EC-11 (in 2009). This well is 3.2 km (2 mi) downgradient from the underground nuclear tests, BENHAM and TYBO. No man-made radionuclides have been detected off site farther downgradient of Pahute Mesa in any of the other UGTA or RREMP monitoring wells on the NTTR or in Oasis Valley. The presence of marginally measureable tritium in ER-EC-12 needs to be confirmed with additional sampling and analyses over the next few years.

In September 2012, NNSA/NFO gave a fourth public presentation of the current state of knowledge of contaminant migration off the NNSS at the Beatty Community Center in Beatty, Nevada. Links to the posters presented at the 2012 public meeting as well as to the regional transport model and the Phase I Central and Western Pahute Mesa Transport Model can be found at the NNSA/NFO Groundwater Characterization web page (http://www.nv.energy.gov/emprograms/groundwater.aspx).

Onsite Monitoring of Radiological Releases into Air

Radionuclide emissions on the NNSS in 2012 were from the following sources: (1) the evaporation and transpiration of tritiated water from soil and vegetation, respectively, from the Area 3 and Area 5 RWMSs, the Schooner crater in Area 20, and the Sedan crater in Area 10; (2) the evaporation of tritiated water discharged from E Tunnel in Area 12; (3) the evaporation of tritium from pumped groundwater at two UGTA wells in Area 20; (4) the resuspension of ^{241}Am, ^{238}Pu, and $^{239+240}$Pu from past nuclear testing from soil deposits on the NNSS; (5) the suspension of depleted uranium (DU) during experiments conducted at NPTEC in Area 5 and at the BEEF in Area 4; (6) the evaporation of tritiated water removed from the basement of Building A-1 at the NLVF and transported to the NNSS for disposal in the Area 23 Sewage Lagoon; (7) the release of tritium from laboratory operations at Building 23-652 in Mercury; and (8) the release of beryllium-7, carbon-11, nitrogen-13, oxygen-15, chlorine-38, chlorine-39, argon-41, and metastable technetium-99 in Area 6 during a special research project. A network of 22 air sampling stations and a network of 108 TLDs on the NNSS were used to monitor diffuse onsite radioactive emissions.

Total radiological atmospheric releases from the NNSS in curies (Ci) for 2012 (Section 4.1.9) are shown in the table below. An estimated 0.0047 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
228	0	0	0	4,926**	0	0	0.050 (^{238}Pu) 0.29 ($^{239+240}$Pu)	0.047 (^{241}Am) 0.061 (DU)

* T ½ = half-life

** Quantity represents products having a T ½ <6 hr, which were released during a research project in Area 6. They are not available to contribute dose to the public at the distances over which they have to travel. This category also includes other fission and activation products such as cobalt-60, strontium-90, cesium-137, and europium-152, -154, and -155, which are in soil in various areas on the NNSS; however, their concentrations in air samples are generally below detection levels and collectively contribute less than 10% to the total dose from all radionuclide emissions based on resuspension calculations.

The mean tritium concentration from across all tritium sampling stations was 9.41×10^{-6} pCi/mL and ranged from below detection to 456.18×10^{-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 117 mR, approximately the same as the mean for the 10 background radiation stations of 120 mR (Section 6.3).

Onsite Radiological Monitoring of Water

In 2012, 6 potable and 4 non-potable water supply wells, 14 monitoring wells, and 1 tritiated water containment pond system were sampled for man-made radiological contaminants. The 2012 data indicate that underground nuclear testing has not impacted the NNSS potable water supply network. None of the onsite water supply wells had detectable concentrations of tritium (Section 5.1.7). None of the annual mean values for tritium and gross alpha, exceeded their EPA maximum contaminant levels, and none of the annual means values for gross beta exceeded the EPA level of concern. Detectable gross alpha and gross beta radioactivity likely represents the presence of naturally occurring radionuclides.

Of the 14 onsite monitoring wells, 11 had levels of tritium below detection and 3 had detectable levels ranging from 94 to 355 pCi/L (Section 5.1.7). These wells (PM-1, UE-7NS, and WW A) are each within 1 km (0.6 mi) of a historical underground nuclear test; all have consistently had detectable levels of tritium in past years. Their tritium levels are still less than 2% of the EPA maximum contaminant level for drinking water of 20,000 pCi/L, and tritium concentrations in these wells has been decreasing since 1999. All monitoring wells measured for gross alpha and gross beta had detectable levels of one or both, most likely from natural sources.

Five constructed basins collect and hold water discharged from E Tunnel in Area 12 where nuclear testing was conducted in the past. E Tunnel effluent water was sampled in 2012 in accordance with the wastewater discharge permit for the site. Effluent waters contained 419,000 pCi/L of tritium, lower than the 1,000,000 pCi/L limit allowed. Effluent water samples also had gross alpha and gross beta values less than their permitted limits (Section 5.1.8).

The UGTA activity pumps tritiated water into lined sumps during studies conducted at contaminated post-shot or near-cavity wells on the NNSS. One of these types of wells, Well UE-20n#1, was sampled in 2012. The tritium concentration in this well was 47,400,000 pCi/L (Section 11.1.1.2). Preliminary tritium analyses of water samples were conducted in 2012 from two new Pahute Mesa–Oasis Valley Phase II wells, ER-20-11 and ER-EC-14, and two new Frenchman Flat model evaluation wells, ER-5-5 and ER-11-2. Analyses results indicated elevated tritium of 186,000 pCi/L in ER-20-11, which is believed to be down-gradient of the contaminant plume from the BENHAM-TYBO underground nuclear test.

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 2012, 591 pieces of laboratory equipment, 28 vehicles, and 16 pieces of heavy equipment were released off site to the public (Section 9.1.5). In addition, over 75 mtons of hazardous materials and over 1,200 mtons of non-hazardous materials were released to vendors for recycling or reuse (Section 3.3.2.2). 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 21.62 tons of criteria air pollutants were released on the NNSS in 2012 (Section 4.2.3). The majority was NO_x from diesel generators. Total HAPs emissions from permitted operations was 0.03 tons. Lead air emissions from non-permitted activities, such as weapons use, are reported to the EPA, and this quantity in 2012 was 3.4 lb (Section 12.3). No emission limits for any criteria air pollutants or HAPs were exceeded.

Two chemical test series were conducted in 2012, consisting of 50 releases of chemicals at the Area 5 NPTEC facility and 9 releases at the Port Gaston Facility in Area 25 (Section 4.2.7). 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 2012, explosives were detonated at three locations on the NNSS, 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 2012, 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 1.42 and 5.97 tons per year, respectively. HAPs calculated emissions at RSL-Nellis were 0.11 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 2012, contaminant measurements were below established permit limits in all water samples from the NLVF sewage outfalls sampled (Appendix A, Section A.1.1.2). Water discharges at RSL-Nellis are required to meet permit limits set by the Clark County Water Reclamation District, and all contaminants in the outfall samples were below the limits (Appendix A, Section A.2.1).

Table of Contents

List of Figures

List of Tables

1.0 Introduction and Helpful Information

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 within the NNSS 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 of the NNSS 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 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.

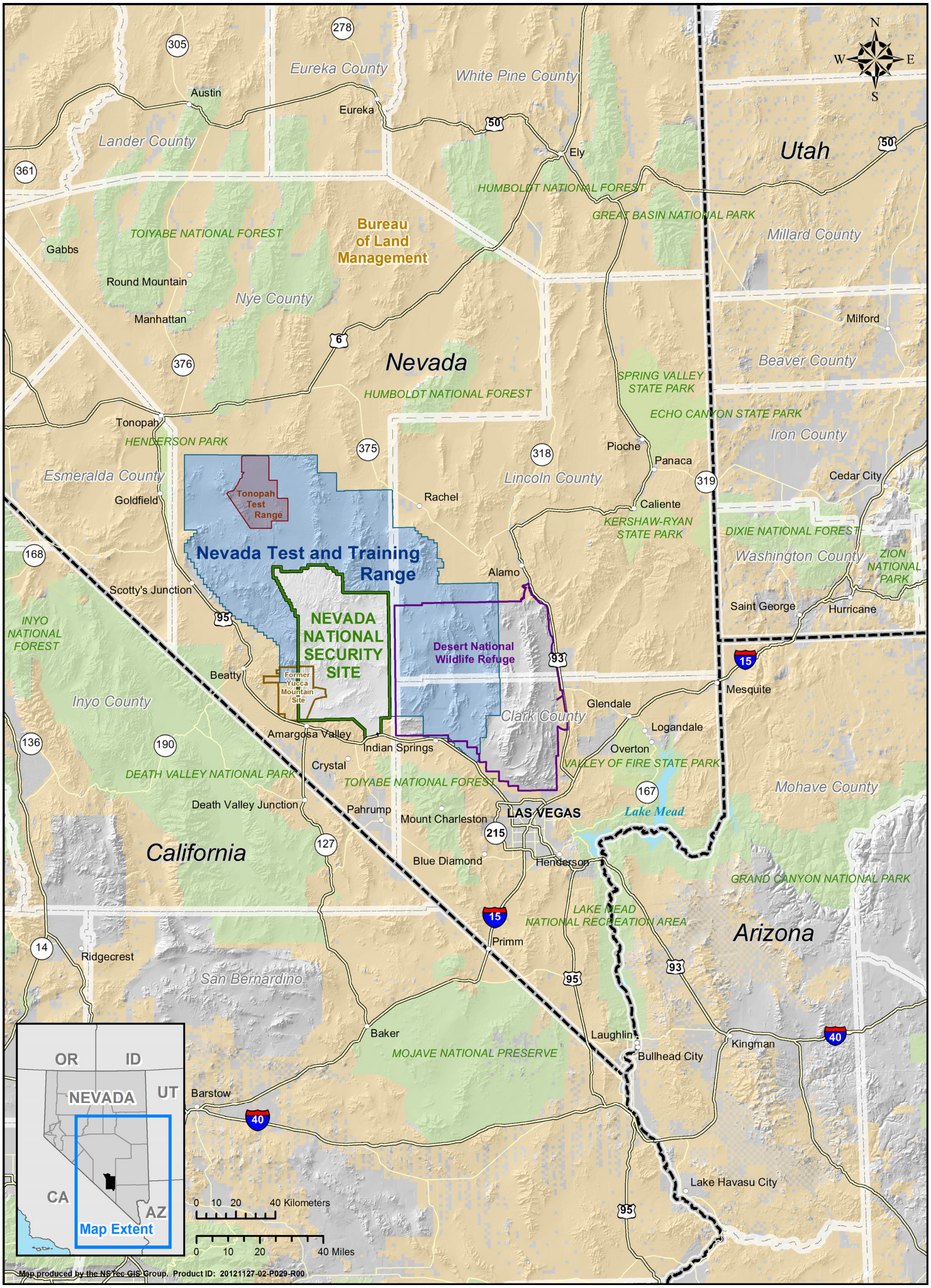


Figure 1-1. NNSS vicinity map

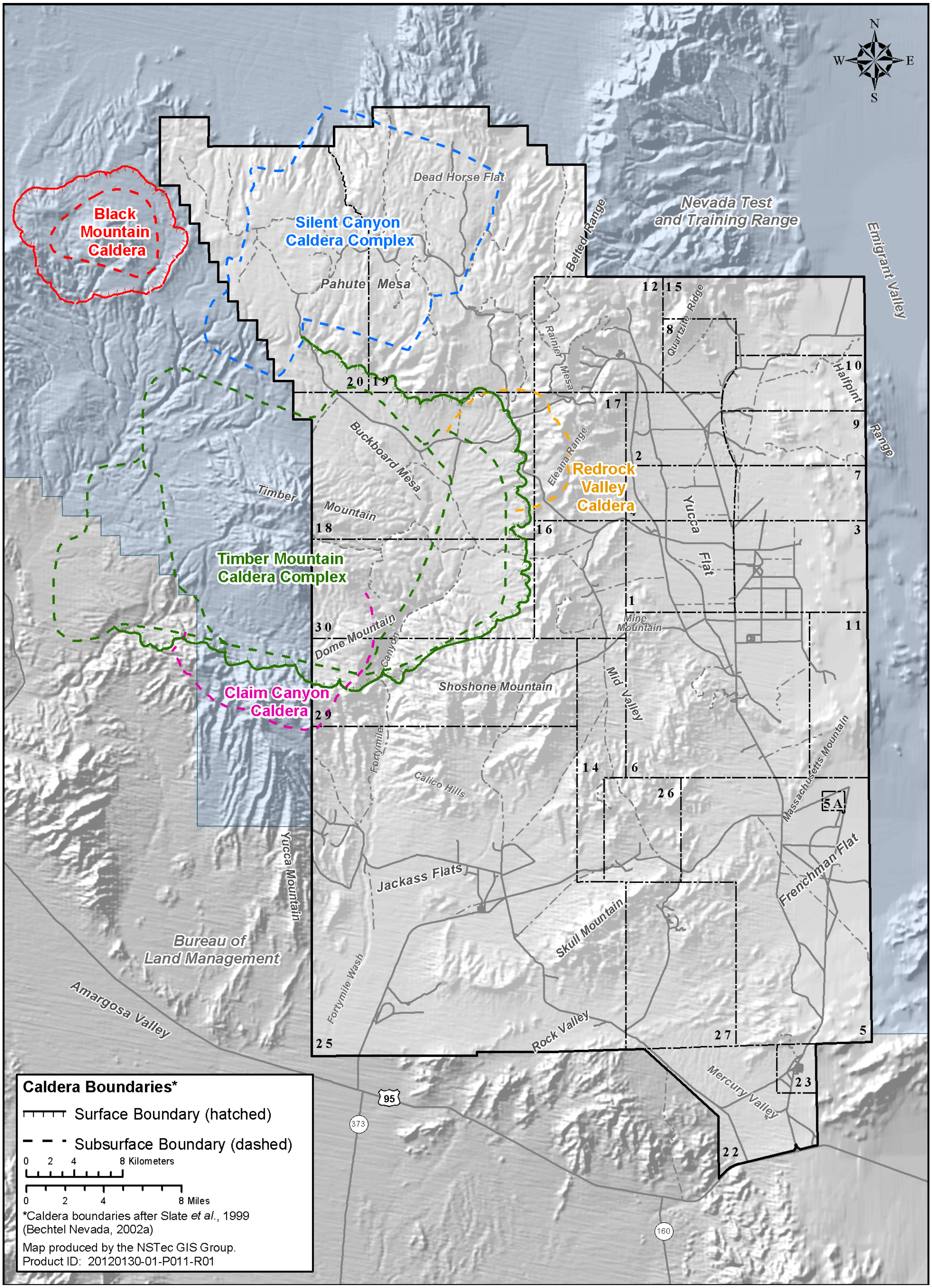


Figure 1-2. Major topographic features and calderas of the NNSS

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 2012 was helping to ensure that the U.S. stockpile of nuclear weapons remains safe and reliable. Other 2012 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 2012 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).

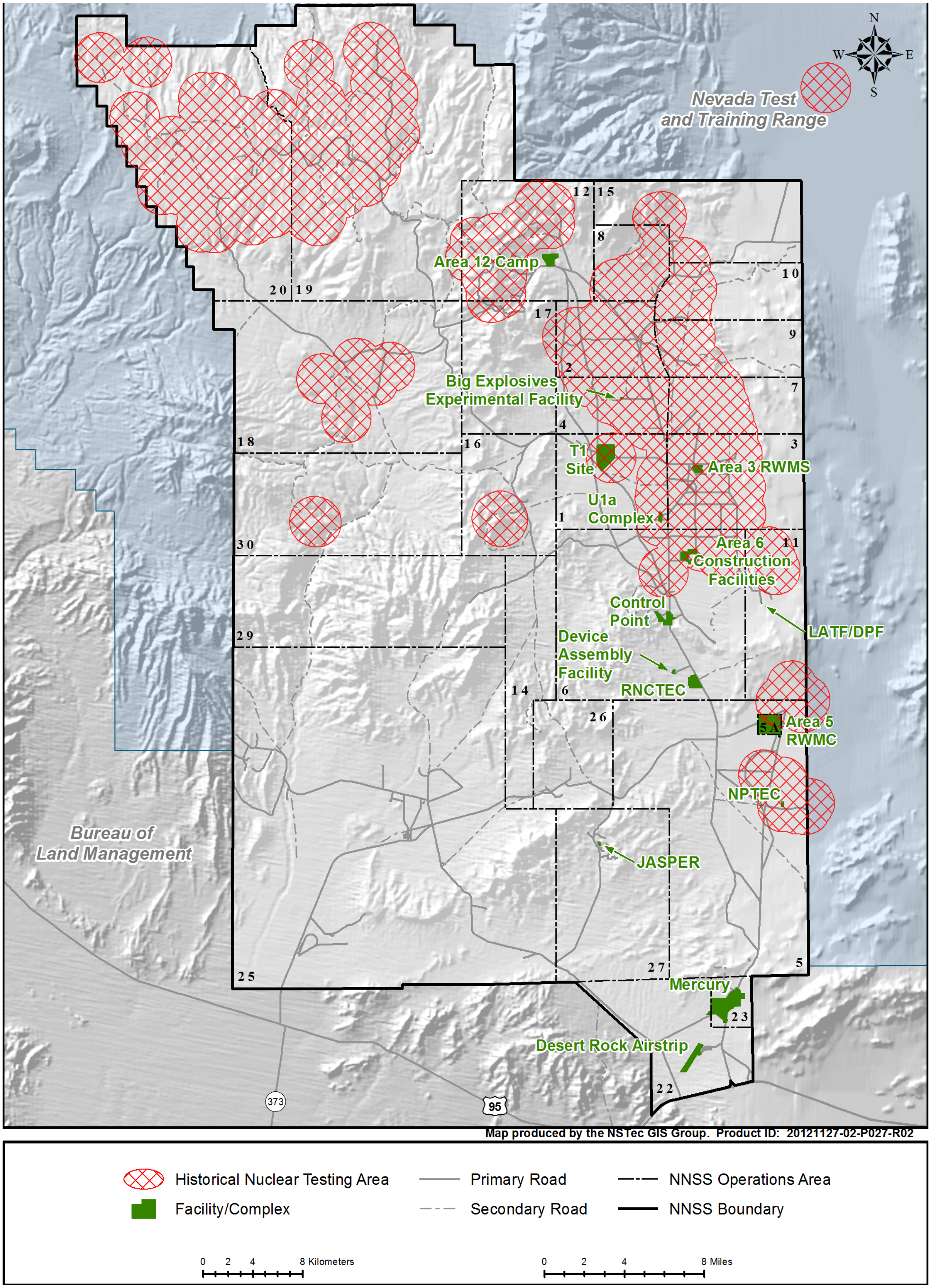


Figure 1-3. NNSS operational areas, principal facilities, and past nuclear testing areas

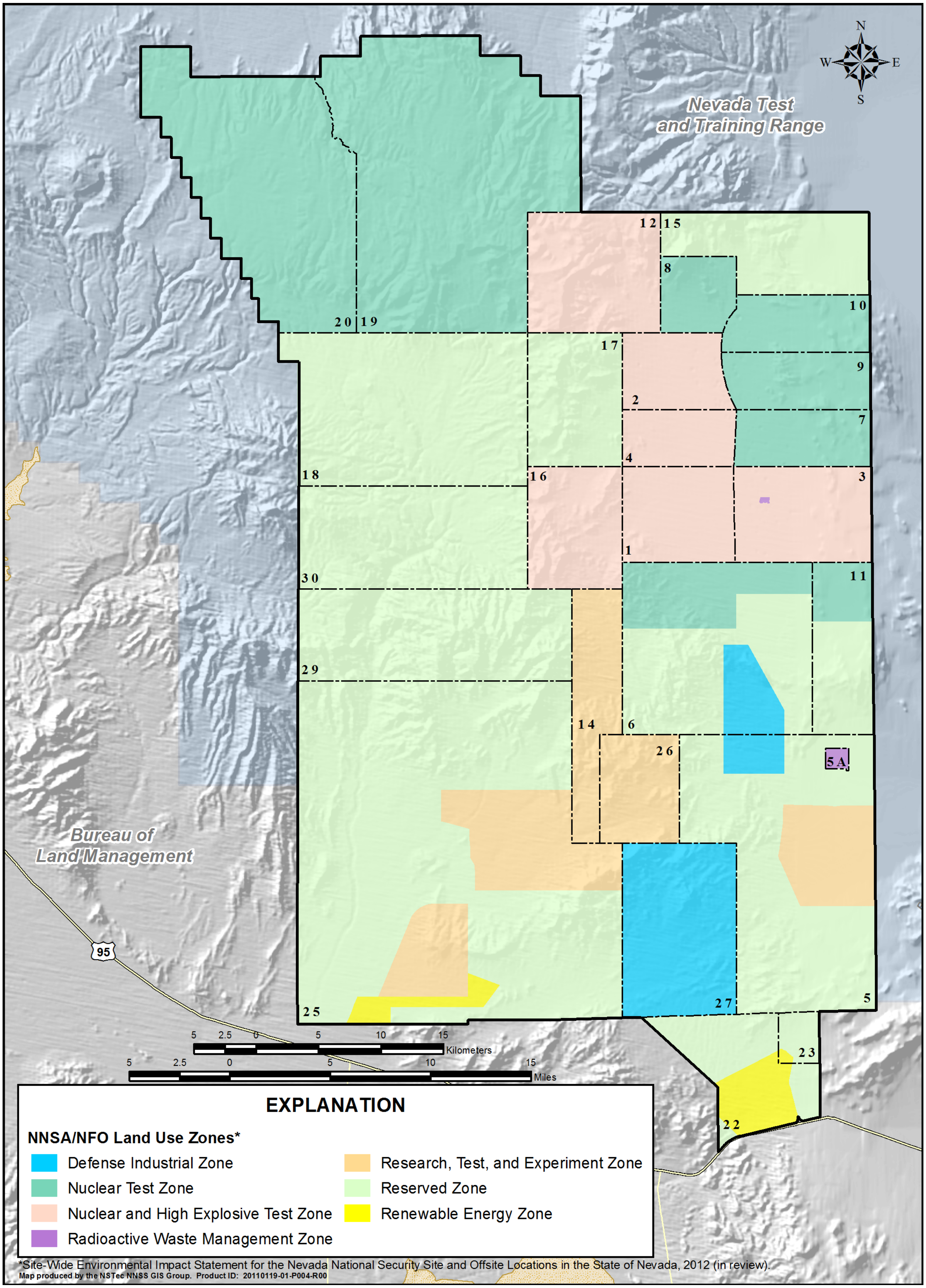


Figure 1-4. NNSS land-use map

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 Site Office (NNSA/SSO) has oversight of all other TTR activities. NNSA/SSO produces the TTR annual site environmental reports (e.g., Sandia National Laboratories 2013), 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 (2013). The most recent population estimate for Nye County is 44,292, and the largest Nye County community is Pahrump (36,593), 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 (2,552), Amargosa (1,353), Beatty (1,011), Round Mountain (809), Gabbs (271), and Manhattan (125). Lincoln County to the east of the NNSS includes a few small communities including Caliente (1,089), Pioche (810), Panaca (832), and Alamo (563). Clark County, southeast of the NNSS, is the major population center of Nevada and has an estimated population of 1,988,195. The total annual population estimate for all Nevada counties, cities, and unincorporated towns is 2,750,217.

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 from the 2010 census conducted by the U.S. Census Bureau, as prepared by the State of Utah Governor's Office of Planning and Budget (2013). Southern Utah's largest community is St. George, located 220 km (137 mi) east of the NNSS, with an estimated population of 72,897. The next largest town, Cedar City, is located 280 km (174 mi) east-northeast of the NNSS and has an estimated population of 28,857.

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 39,516, and Kingman, 280 km (174 mi) southeast of the NNSS, with an estimated population of 28,335 (Arizona Department of Administration 2013).

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	0.000,000,1 (1×10^{-9})
pico-	p	0.000,000,000,0001 (1×10^{-12})

1.8.3 Units of Radioactivity

Much of this report deals with levels of radioactivity in various environmental media. The basic unit of radioactivity used in this report is the curie (Ci) (Table 1-2). The curie describes the amount of radioactivity present, and amounts are usually expressed in terms of fractions of curies in a given mass or volume (e.g., picocuries per liter). The curie is historically defined as the rate of nuclear disintegrations that occur in 1 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
^{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 hr
^{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)

(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.

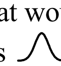
Uncertainty in analytical measurements is also the consequence of variability related to collecting and analyzing the samples. This variability is associated with reading or recording the result, handling or processing the sample, calibrating the counting instrument, and numerical rounding.

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.

1.8.14 Understanding Graphic Information

Some of the data graphed in this report are plotted using logarithmic (log) scales. Log scales can be used in plots where the values are of widely different magnitudes at different locations and/or different times. In log scales equal distances represent equal ratios of values, whereas in linear scales equal distances represent equal differences in values. In a log scale an increase from 2 to 4 is shown by the same distance as an increase from 10 to 20 or from 700 to 1,400.

For example, Figure 1-5 (Figure 5-8 in Chapter 5) shows the annual means for tritium in groundwater samples from selected NNSS onsite monitoring wells using the log scale. Figure 1-6 shows the same data using a linear scale. The linear scale plot emphasizes the difference between the high early values in Well UE-7NS through 1987 and the rather lower values starting in 1991. The log scale plot de-emphasizes those high values and expands the portion of the plot containing lower values; in particular, it allows one to see the initial increase in Well WW A beginning in 1986 more clearly.

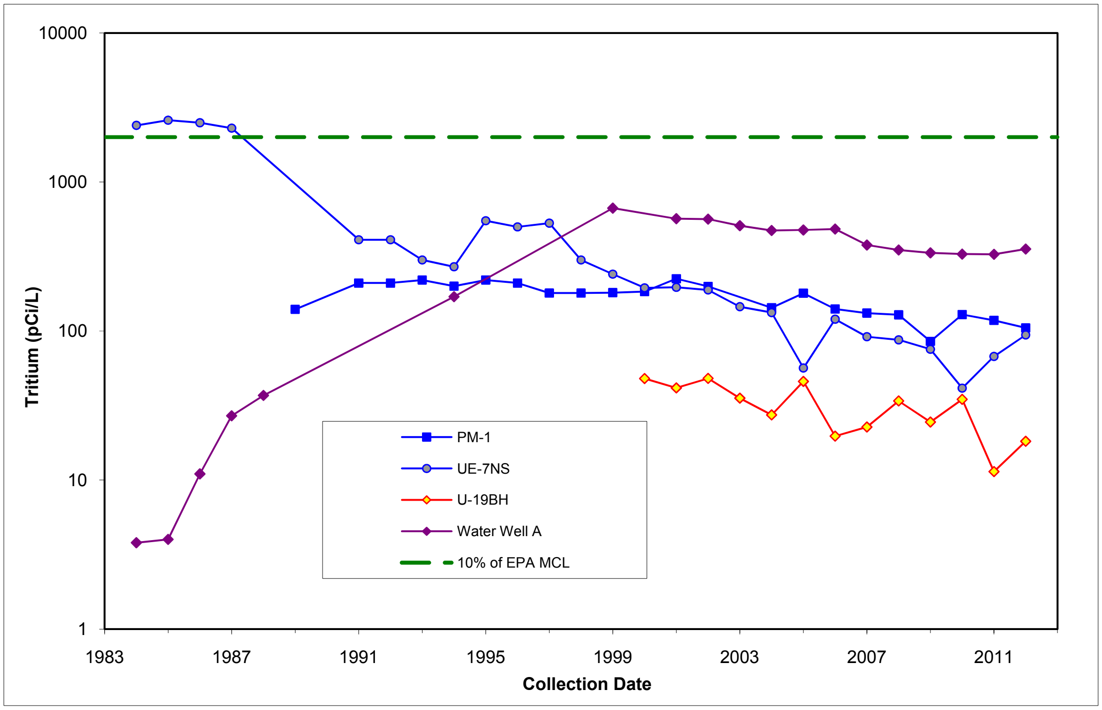


Figure 1-5. Data plotted using a log scale (tritium annual means for NNSS monitoring wells with histories of elevated concentrations)

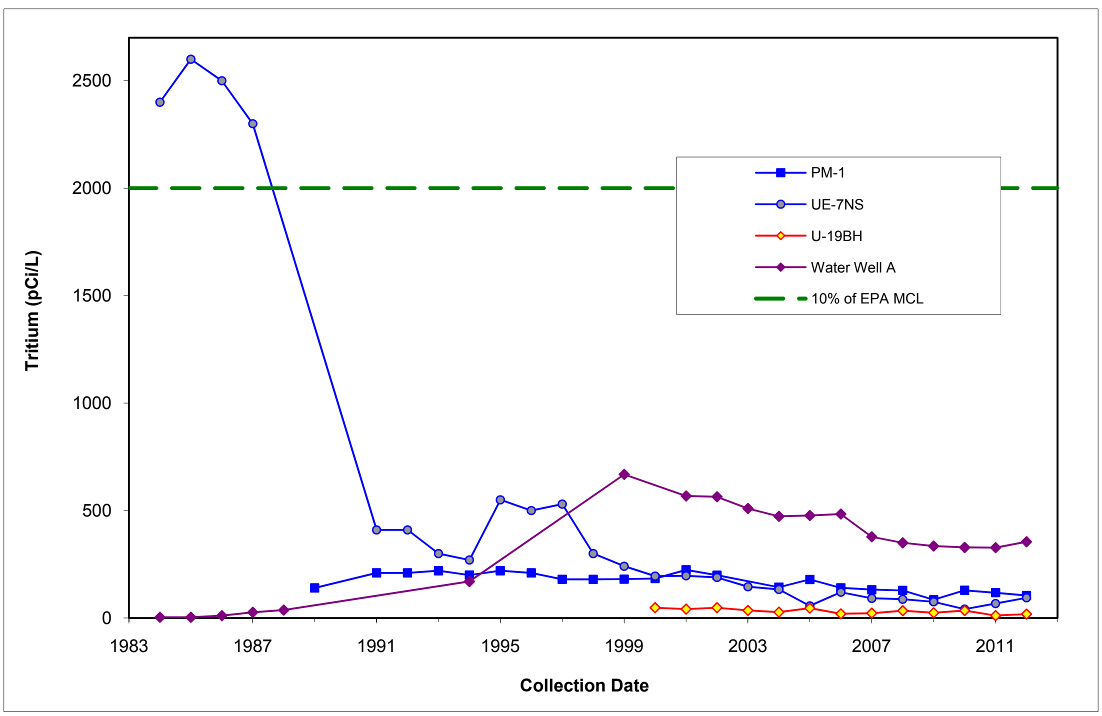


Figure 1-6. Data plotted using a linear scale (tritium annual means for NNSS monitoring wells with histories of elevated concentrations)

THIS PAGE INTENTIONALLY LEFT BLANK

2.0 Compliance Summary

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 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 new order, approved in May 2011, consolidates and streamlines the requirements of the cancelled DOE O 450.1A, "Environmental Protection Program," and the cancelled DOE O 430.2B, "Departmental Energy, Renewable Energy and Transportation Management." It 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 2012 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 2013 NNSA/NSO Site Sustainability Plan* (National Security Technologies, LLC [NSTec], 2012a)
- *FY 2012 Waste Generation and Pollution Prevention Progress Report*, submitted to DOE Headquarters (HQ) via entry into DOE HQ database
- *RCRA Permit for a Hazardous Waste Management Facility Permit Number NEV HW0101- Annual Summary/Waste Minimization Report Calendar Year 2012, Nevada National Security Site, Nevada*, submitted to NDEP (NSTec 2013a)
- *FY 2012-0 EMS Annual Report*, submitted to DOE HQ via entry into DOE HQ database

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

Requirement	2012 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 3-2
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
Submit an FY Waste Generation and Pollution Prevention Progress Report (electronic) to DOE HQ by December 31.	Compliant	3.3.2.3
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	3.3.2.2; Tables 3-3 and 3-4
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	3.3.2.3

(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 as per 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 each year to the State. 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 an 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. The Class II Air Quality Operating Permit requires implementation of an ongoing control program at the NNSS using the best practicable methods. 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. 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 2012 NNSS operations in compliance with air quality regulations:

- *National Emission Standards for Hazardous Air Pollutants – Radionuclide Emissions, Calendar Year 2012*, submitted to EPA Region IX (NSTec 2013b)
- *Annual Asbestos Abatement Notification Form*, submitted to NDEP and to EPA Region IX
- *Calendar Year 2012 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 Detonation (EODU) Proposal and Analysis Results, submitted to NDEP

The following reports were generated for 2012 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
- *Calendar Year 2012 Actual Production/Emissions Reporting Form*, submitted to NDEP for Underground Test Area (UGTA) SAD Permits AP9711-2622 and AP9711-2659

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

Requirement	Compliance Limit	2012 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	4.2.9
Maintain asbestos abatement plans, data records, activity/ maintenance records	For up to 75 years	Compliant	4.2.9
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.1.3; A.2.2
Track tons of emissions of each criteria pollutant produced by permitted equipment/facility at the NNSS, NLVF, and RSL-Nellis based on calculations	PTE[b] varies	Compliant	4.2.3; Table 4-14; A.1.3; A.2.2
Submit semi-annual report of operating hours, throughputs, and quantities of paints used at RSL-Nellis to Clark County	Due January 31 and July 31	Compliant	A.1.3; A.2.2
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	4.2.5
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	4.2.6; A.1.3; A.2.2
Measure percent opacity of emissions from permitted equipment/facility at the NNSS, NLVF, and RSL-Nellis	20%	Compliant	4.2.6; A.1.3; A.2.2
Conduct particulate monitoring for releases/detonations at permitted chemical release and detonation sites on the NNSS	Monitoring report due ≤ 30 days from end of each quarter	Compliant	4.2.7
Submit test plans/final analysis reports to the State for each chemical release test at permitted chemical release sites on the NNSS	Test plans due ≥ 30 days prior to tests, final reports due ≤ 30 days from end of each quarter	Compliant	4.2.7
Track rate and quantity of chemicals released at permitted chemical release sites on the NNSS	Pounds per hour and tons per year; limits vary by chemical	Compliant	4.2.7
Track tons of criteria pollutant emissions at permitted chemical release sites on the NNSS	PTE[b] varies	Compliant	4.2.7; Table 4-14
Clean Air Act – NSPS			
Conduct opacity readings from permitted equipment/facility	Quarterly	Compliant	4.2.6
Measure percent opacity of emissions from permitted equipment/facility	10%	Compliant	4.2.6
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	4.2.8
Other Nevada Air Quality Permit Regulations			
Control fugitive dust for land-disturbing activities	NA	Compliant	4.2.10

(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 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 NAC regulates the collection, treatment, and disposal of wastewater and sewage at the NNSS. The requirements of this state regulation 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.

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. Two operations that voluntarily comply with this NAC are the UGTA activity, which drills new wells and reworks old wells, and the Borehole Management Project, which plugged abandoned NNSS boreholes and was completed in September 2012.

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, Nevada Operations Office 2002).

2.3.2 Compliance Reports

The following reports were generated for NNSS operations in 2012 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 PWS, 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 2012 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* (NSTec 2013c), submitted to NDEP

The following reports were generated for operations at the two offsite facilities in 2012 in compliance with water quality regulations:

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

Table 2-3. Summary of NPDES permit compliance at NLVF in 2012

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	2012 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	Appendix A, A.1.1.2; Table A-3
Maintain and implement the SPCC Plan for the NLVF	NA	Compliant	Appendix A, 1.1.3
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 (^{3}H), 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	^{3}H: 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	5.1.8; Table 5-5; 5.2.4; Table 5-9
Monitor every 24 months the concentrations of ^{3}H, α, β, and 16 nonradiological contaminants/water quality parameters in Well ER-12-1 water samples	^{3}H: 20,000 pCi/L α: 15 pCi/L; β: 50 pCi/L Non-rad: Limit varies	Compliant	5.1.8; 5.2.4
Monitor annually concentrations of 20 contaminants in samples from NLVF sewage outfalls	Limit varies	Compliant	A.1.1.1; Table A-2
Monitor quarterly concentrations of 12 contaminants in samples from the RSL-Nellis sewage outfall	Limit varies	Compliant	A.2.1; Table A-7
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	11.1.1.1
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	^{3}H >200,000 pCi/L, Lead >5 mg/L	Compliant	11.1.2
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 and DOE O 5400.5, "Radiation Protection of the Public and the Environment" – DOE O 458.1, approved in June 2011, supersedes DOE O 5400.5 and provides for an 18-month period from the time of issuance for full implementation. During 2012, NNSA/NFO continued radiation protection compliance under the requirements of DOE O 5400.5 that establish 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. Both DOE O 5400.5 and the new DOE O 458.1 set 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. Both orders call 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 O 458.1 includes a new requirement for DOE sites to establish and document an environmental radiological protection program.

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 one 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. 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 is managed in a manner that is protective of the worker, public health and safety, and the environment. It directs how radioactive waste management operations are conducted on the 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 2012,* submitted to EPA Region IX (NSTec 2013b)
- This document, the *Nevada National Security Site Environmental Report 2012,* was generated to report 2012 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	2012 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 and 5400.5, "Radiation Protection of the Public and the Environment"			
Estimate annual dose above background levels 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
(c) Not applicable

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 is 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 Compliance Act (FFCA) – The FFCA of 1992 extends the full range of enforcement authorities in federal, state, and local laws for the management of hazardous waste to federal facilities. In 1996, NNSA/NFO and the State of Nevada signed a FFCA Consent Order (CO) that required the identification of existing quantities of MLLW being managed at the NNSS, the proposal of methods and technologies to treat and manage MLLW, the creation of enforceable time tables, and the tracking and completion of deadlines. NNSA/NFO satisfied all terms and conditions of the FFCA CO in 2010, and the State of Nevada officially terminated the FFCA CO in April 2012.

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 2012.

- *Nevada National Security Area 5 Solid Waste Disposal Annual Report for CY 2012,* January 2013
- NNSS Quarterly Volume Reports (for all active LLW and MLLW disposal cells), April, July, and October 2012, and January 2013
- *2012 Nevada Division of Environmental Protection and Environmental Protection Agency Biennial Report for the Nevada National Security Site*, February 2012
- *Annual Transportation Report for Radioactive Waste Shipments to and from the Nevada National Security Site – Fiscal Year 2012,* August 2013 (U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office [NNSA/NSO] 2013a)
- *RCRA Permit for a Hazardous Waste Management Facility Permit Number NEV HW0101 – Annual Summary/Waste Minimization Report Calendar Year 2012,* February 2013 (NSTec 2013a)
- *Nevada National Security Site 2012 Data Report: Groundwater Monitoring Program Area 5 Radioactive Waste Management Site,* February 2013 (NSTec 2013d)

- *Nevada National Security Site 2012 Waste Management Monitoring Report - Area 3 and Area 5 Radioactive Waste Management Site* (NSTec 2013e)
- *Post-Closure Report for Closed Resource Conservation Recovery Act Corrective Action Units, Nevada National Security Site, Nevada, for Fiscal Year 2012 (October 2011–September 2012)*, January 2013 (NNSA/NSO 2013b)
- *Post-Closure Inspection Letter Report for Corrective Action Units on the Nevada National Security Site*, May 2012 (NNSA/NSO 2013c)
- *Post-Closure Inspection Report for the Tonopah Test Range, Nevada, for Calendar Year 2012*, January 2013 (NNSA/NSO 2013d)
- *Annual Neutron Monitoring Report for the Nevada National Security Site Area 9 U10c and Area 6 Hydrocarbon Landfills*, June 2012
- *January–June 2012 Biannual Solid Waste Disposal Site Report for the Nevada National Security Site Area 23 Sanitary Landfill*, July 2012
- *July–December 2012 Biannual Solid Waste Disposal Site Report for the Nevada National Security Site Area 23 Sanitary Landfill*, January 2013
- *2012 Annual Solid Waste Disposal Site Report for the NNSS Area 6 Hydrocarbon Landfill and Area 9 U10c Landfill*, January 2013

The following Environmental Restoration reports/presentations for CAUs were submitted to NDEP in 2012 in accordance with the FFACO schedule.

- *CAU 98: Frenchman Flat – Model Evaluation Well Drilling Presentation #1*
- *CAU 99: Rainier Mesa/Shoshone Mountain – Phase I Flow and Transport Model Presentation #2*
- *CAU 99: Rainier Mesa/Shoshone Mountain – Technical Basis Agreement, Rev 0*
- *CAU 104: Area 7 Yucca Flat Atmospheric Test Sites – Corrective Action Decision Document/Corrective Action Plan (CADD/CAP)*
- *CAU 105: Area 2 Yucca Flat Atmospheric Test Sites – Corrective Action Investigation Plan (CAIP)*
- *CAU 111: Area 5 WMD Retired Mixed Waste Pits – Closure Report (CR)*
- *CAU 366: Area 11 Plutonium Valley Dispersion Sites – CADD*
- *CAU 417: Central Nevada Test Area – Surface – Draft 2012 Post-Closure Inspection and Monitoring Report*
- *CAU 443: Central Nevada Test Area – Subsurface – Draft 2011 Monitoring Report*
- *CAU 447: Project Shoal Area – Subsurface – Draft 2011 Monitoring Report*
- *CAU 465: Hydronuclear – CR*
- *CAU 547: Miscellaneous Contaminated Waste Sites – CR*
- *CAU 548: Areas 9, 10, 18, 19, and 20 Housekeeping Sites – CR*
- *CAU 550: Smoky Contamination Area – CAIP*
- *CAU 562: Waste Systems – CR*
- *CAU 569: Area 3 Yucca Flat Atmospheric Test Sites – CAIP*
- *CAU 570: Area 9 Yucca Flat Atmospheric Test Sites – CAIP*
- *CAU 574: Neptune – CR*

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

Requirement	Compliance Limit	2012 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
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	10.1.4; Table 10-2
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 (^{3}H) 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	10.2.2; Table 10-4
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	10.2.3; Table 10-4
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
Submit Annual Hazardous Waste Report for NNSS and NLVF to the State of Nevada	Due the following February	Compliant	10.2
Conduct vadose zone monitoring for RCRA closure site U-3ax/bl Subsidence Crater	Continuous monitoring using TDR[(h)] sensors	Compliant	10.1.8
Conduct periodic post-closure site inspections of five historic RCRA closure sites (CAUs 90, 91, 92, 110, 112)	NA	Compliant	11.1.1
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	26 CAUs identified for some phase of action in 2012	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
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, 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 that the state emergency response commission and the local emergency planning committee 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 that the local emergency planning committee and state emergency response agencies 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 (MSDS)/Chemical Inventory – Requires facilities to provide applicable emergency response agencies with MSDSs, or a list of MSDSs for each hazardous chemical stored on site. This is essentially a one-time reporting unless chemicals or products change. Any new MSDSs 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 entitled "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 2012 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) 2012*, submitted to state and local agencies
- *Toxic Release Inventory Report, Form R for CY 2012*, submitted to the EPA and the State
- *Calendar Year (CY) 2012 Polychlorinated Biphenyls (PCBs) Report for the Nevada National Security Site (NNSS)*, submitted to NNSA/NFO
- *Chemical Accident Prevention Program 2012 Registration*, submitted to NDEP

Table 2-7. Status of EPCRA reporting

EPCRA Section	Description of Reporting	2012 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	2012 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)] Routine reports: NCA Report due March 1 for previous CY; TRI Report, Form R due July 1 for previous CY	Compliant	12. 3
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[(d)] 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] 1996a). 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 2012.

In 2012, NNSA/NFO prepared the final *Site-Wide Environmental Impact Statement for the Nevada National Security Site and Offsite Locations in Nevada* (NNSS SWEIS) and *Record of Decision* (NNSA/NSO 2013e). 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. It will replace the current programmatic NNSS EIS (DOE/NV 1996a) and address impacts from NNSA/NFO operations in Nevada for the 10-year period beginning when the Record of Decision is published.

On January 10, 2013, NNSA/NFO submitted to DOE HQ the *NNSA/NSO NEPA Annual Planning Document*. 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 2012

Results of NEPA Checklist Reviews/NEPA Compliance Activities
5 projects were exempted from further NEPA analysis because they were of CX status.
24 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.
1 project was exempted from further NEPA analysis due to its inclusion under previous analysis in the *Environmental Assessment for Radiological/Nuclear Countermeasures Test and Evaluation Complex, Nevada Test Site* (NNSA/NSO 2004b).
1 project was exempted from further NEPA analysis due to its inclusion under previous analysis in the *Final Environmental Assessment for Aerial Operations Facility, Nevada Test Site,* DOE/EA-1512, December 2000.

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 excavation or removal of archaeological resources on federal and American Indian lands and notification to Indian tribes of these activities. Unauthorized excavation, removal, damage, alteration, or defacement of archaeological resources is prohibited, as is the sale, purchase, exchange, transport, receipt of, or offer for sale of such resources. Criminal and civil penalties apply to such actions. Information concerning the nature and location of any archaeological resource may not be made available to the public unless the federal land manager determines that the disclosure would not create a risk of harm to the resources or site. The Secretary of the Interior is required to submit an annual report at the end of each fiscal year to Congress that reports the scope and effectiveness of all federal agencies' efforts on the protection of archaeological resources, specific projects surveyed, resources excavated or removed, damage or alterations to sites, criminal and civil violations, the results of permitted archaeological activities, and the costs incurred by the federal government to conduct this work. All archaeologists working at the 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 law also protects the physical location where human remains are placed during a death rite or ceremony. The NNSS artifact collection is subject to NAGPRA, and the locations of American Indian human remains at the NNSS must be protected from NNSS activities.

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 restricted data on site locations are not available to the public. Some technical reports, however, are available to the public upon request and can be obtained from the Office of Scientific and Technical Information. The 2012 reports submitted to agencies are discussed in Chapter 14.

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

Requirement	2012 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 as per 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
Protect American Indian burial locations on NNSS	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.

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 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" – 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 2012 or 2013 to meet regulation requirements or to document compliance for all activities conducted in 2012:

- *Annual Report of Actions Taken under Authorization of the Biological Opinion on NNSS Activities (File Nos. 84320-2008-F-0416 and B-0015) – January 1, 2012, through December 31, 2012*, submitted to FWS Las Vegas Office
- *Annual Report for Handling Permit S33994*, submitted to Nevada Division of Wildlife
- *Annual Report for Federal Migratory Bird Scientific Collecting Permit MB008695-0*, submitted to FWS Portland Office

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

Requirement	Compliance Limit	2012 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
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
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
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	10 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	15.7
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	480 capture/releases of reptiles; collection of 5 skinks	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" – In January 2012, this order became effective, replacing DOE M 231.1-2 of the same name. It requires that DOE and NNSA are 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. During 2012, there were 33 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 impermeable surfaces that did not exceed a reportable quantity.

During 2012, no environmental violations, Notices of Violation, Notices of Deficiency, Notices of Intent to Sue, or other types of enforcement actions were issued to the site.

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 2012, the NNSSER was published under the title *Nevada National Security Site Environmental Report 2011* (NSTec 2012b). It was published and posted on the NNSA/NFO and DOE Office of Scientific and Technical Information websites by September 18, 2012. The 2011 NNSSER was mailed to all recipients (on a compact disc accompanied by a 24-page summary) by September 27, 2012, and a subset of individuals on distribution also received a hard copy of the full 2011 NNSSER.

2.12 Summary of Permits

Table 2-12 presents the complete list of all federal and state permits active during calendar year 2012 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 2012 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 NNSS and NNSS site facility operations

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
11-23 and 12-38	NNSS Open Burn Variance, Fire Extinguisher Training (Various Locations)	March 16, 2012/ March 17, 2013	None
11-24 and 12-39	NNSS Open Burn Variance, NNSS, A-23, Facility #23-T00200 (NNSS Fire & Rescue Training Center)	March 16, 2012/ March 17, 2013	None
12-40	NNSS Open Burn Variance, Cat Canyon Training Exercise (Areas 18 & 30)	March 30, 2012	None
	UGTA Offsite		
AP9711-2622	NTTR Class II Air Quality Operating Permit, Surface Area Disturbance, Well ER-EC-12	November 4, 2014	Annually
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, 2011/2012	None
NY-4098-12NC	Area 25	September 30, 2011/2012	None
NY-4099-12NC	Area 12	September 30, 2011/2012	None
NY-0835-12NP	NNSS Water Hauler #84846	September 30, 2011/2012	None
NY-0836-12NP	NNSS Water Hauler #84847	September 30, 2011/2012	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-1076	Septic System, Area 6 (Airborne Response Team Hangar)	None	None
NY-1077	Septic System, Area 27 (Baker Compound)	None	None
NY-1079	Septic System, Area 12 (U12g Tunnel)	None	None
NY-1080	Septic System, Area 23 (Building 1103)	None	None
NY-1081	Septic System, Area 6 (Control Point-170)	None	None
NY-1082	Septic System, Area 22 (Building 22-01)	None	None
NY-1083	Septic System, Area 5 (Radioactive Material Management Site)	None	None
NY-1084	Septic System, Area 6 (Device Assembly Facility)	None	None
NY-1085	Septic System, Area 25 (Central Support Area)	None	None
NY-1086	Septic System, Area 25 (Reactor Control Point)	None	None
NY-1087	Septic System, Area 27 (Able Compound)	None	None
NY-1089	Septic System, Area 12 (Camp)	None	None
NY-1090	Septic System, Area 6 (Los Alamos National Laboratory Construction Camp Site)	None	None
NY-1091	Septic System, Area 23 (Gate 100)	None	None
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

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

Permit Number	Permit Name or Description	Expiration Date	Reporting
Septic Systems/Pumpers (cont.)	**NNSS**		
NY-1128	Commercial Individual Sewage Disposal System, NNSS, Area 6, Yucca Lake Project	None	None
NY-17-06839	Septic Tank Pumper E 106785	July 31, 2012/2013	None
NY-17-06839	Septic Tank Pumper E 107105	July 31, 2012/2013	None
NY-17-06839	Septic Tank Pumper E-105918	July 31, 2012/2013	None
NY-17-06839	Septic Tank Pumping Contractor (one unit)	July 31, 2012/2013	None
NY-17-06839	Septic Tank Pumper E-106169	July 31, 2012/2013	None
NY-17-06839	Septic Tank Pumper E-107103	July 31, 2012/2013	None
Wastewater Discharge	**NNSS**		
GNEV93001	Water Pollution Control General Permit	August 5, 2010/2015	Quarterly
NEV96021	Water Pollution Control for E Tunnel Waste Water Disposal System and Monitoring Well ER-12-1	October 1, 2013	Quarterly
	NLVF		
VEH-112	NLVF Wastewater Contribution Permit	December 31, 2013	Annually
NV0023507	North Las Vegas National Pollutant Discharge Elimination System Permit	November 2, 2011/ June 24, 2017	Quarterly
Underground Injection Control	**NNSS**		
UNEV2012203	NNSS Underground Injection Control Permit	July, 6, 2017	Semi-annually
	RSL-Nellis		
CCWRD-080	Industrial Wastewater Discharge Permit	June 30, 2012/2013	Quarterly
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, 2012	None
Endangered Species/Wildlife			
File Nos. 84320-2008-F-0416 and B-0015	U.S. Fish and Wildlife Service – Desert Tortoise Incidental Take Authorization (Biological Opinion for Programmatic NNSS Activities)	February 12, 2019	Annually
MB008695-0	U.S. Fish and Wildlife Service – Migratory Bird Scientific Collecting Permit	March 31, 2016	Annually

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

Permit Number	Permit Name or Description	Expiration Date	Reporting
Endangered Species/Wildlife (continued)			
MB037277-1	U.S. Fish and Wildlife Service – Migratory Bird Special Purpose Possession – Dead Permit	March 31, 2010 (permit renewal requested)	Annually
S33994	Nevada Division of Wildlife – Scientific Collection of Wildlife Samples	December 31, 2014	Annually

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

3.0 Environmental Management System

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 2012, 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 2012 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 then compiled, and weighting factors are used to determine which aspects are significant. The first weighting factor considers the potential to adversely impact the environment, compliance with regulations and permits, fulfillment of contract or performance objectives, and compliance with DOE orders. The second weighting factor considers the likelihood of such an adverse occurrence and its severity. These two factors are multiplied and scored. The aspects having the highest scores are considered significant. This process is done annually to account for changing activities, regulations/DOE orders, and management priorities. For 2012, the following environmental aspects were identified:

Significant aspects:

- Air emissions
- Drinking water system maintenance
- Energy and fuel use
- Environmental restoration
- Non-hazardous waste management (generation, storage, and disposal)
- Greenhouse gas emissions
- Groundwater protection
- Hazardous, radioactive, and mixed waste management (generation, storage, and disposal)
- Wastewater management (generation and disposal)
- Water Use

Other aspects:

- Building construction and renovation
- Electronics stewardship
- Industrial chemical storage and use
- Purchase of materials and equipment
- Building demolition
- Recycling and management of surplus property and materials
- Resource protection (cultural, biological, and raw materials)
- Surface water and stormwater runoff

3.3 Environmental Objectives, Targets, and Programs

To address the identified significant environmental aspects of NNSA/NFO operations, an Environmental Working Group (EWG) selects objectives and targets (Table 3-1), which are determined on a fiscal year (FY) (October 1 through September 30) basis. The targets are tracked by the various responsible operational groups, and reported quarterly to NNSA/NFO and NSTec senior management. Those EMS targets that are identical to the sustainability goals of DOE O 436.1A, EO 13514, and EO 13423 are identified in Table 3-2. The Energy Management Program (EMP) and the Pollution Prevention and Waste Minimization (P2/WM) Program address the specific efficiency and sustainability goals of these orders.

Table 3-1. FY 2012 EMS objectives and targets status and FY 2013 targets to be tracked

FY 2012 Objective	FY 2012 Target	FY 2012 Target Status	FY 2013 Target
Groundwater protection.	Prepare 14 boreholes for plugging and plug 19 boreholes.	14 boreholes were prepped and 19 were plugged.	None; no candidate boreholes remain to be plugged.
Remediate sites identified in the Federal Facility Agreement and Consent Order (FFACO).	Meet FY 2012 FFACO deadlines: submit completed Closure Report to NNSA/NFO by July 31, 2012, for Corrective Action Unit (CAU) 547, by August 10, 2012, for CAU 548, and by August 17, 2012, for CAU 562.	All milestones were met.	Complete the FFACO milestone for CAU 366 scheduled for FY 2013.
Purchase products that meet DOE Environmentally Preferable Purchasing (EPP) standards (see Section 3.3.2).	Identify 10 products for purchase that meet EPP standards that are substitutes for non-EPP products currently being used.	10 products that meet EPP standards were added to the NSTec list of approved products for purchase.	Identify 10 more products for purchase that meet EPP standards.
Reduce energy use.	Install British thermal unit (BTU) sub-meters on boilers and chillers.	34 BTU sub-meters were installed on boilers and chillers.	Perform high-performance sustainable audits on 25% of enduring buildings.
	Perform upgrades and submit at least one building for Energy Star status.	NNSS buildings 6-902 and 6-906 were Energy Star certified.	
Decrease use of petroleum-based fuels.	Modify the Area 6 Gas Station to be able to dispense E-85 fuel.	Construction was completed.	Meet the DOE cumulative goals of 16% reduction of petroleum-based fuel usage and 93% increase in renewable fuel usage compared to the FY 2005 baselines.

3.3.1 Energy Management Program

NNSA implements DOE's Strategic Sustainability Performance Plan (SSPP) goals by reducing the use of energy and water at NNSA/NFO facilities. The EMP is performance oriented and strives to ensure continuous life-cycle, cost-effective improvements to increase energy efficiency and effective management of energy, water, and transportation fleets, while increasing the use of clean energy sources. NNSA/NFO currently uses electricity, fuel oil, and propane at 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. Water consumption data for the specific 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.

The *FY 2013 NNSA/NFO Site Sustainability Plan* (SSP) was completed in December 2012 (NSTec 2012a). The SSP serves as a contract between NNSA/NFO and NNSA Headquarters in terms of how to meet the goals of DOE's SSPP and 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 3-2 includes a summary of the SSP goals and the status in FY 2012 of reaching them.

Table 3-2. NNSA/NFO Site Sustainability Plan goals and FY 2012 performance status

DOE Agency SSPP Goal[a]	NNSA/NFO Performance Status
Greenhouse Gas (GHG) Emissions	
28% reduction of Scope 1 and 2 GHG emissions[b] by FY 2020, from an FY 2008 baseline	A baseline inventory for fugitive GHG emissions[b] and a system for their quantification and inclusion in each year's Scope 1 and 2 emission inventory was established in FY 2012; FY 2012 emissions were 47,922 $mTCO_2e$[c], a 0.98% increase from the FY 2008 baseline of 47,454 $mTCO_2e$, which did not include fugitive GHG emissions. Onsite inventory of sulfur hexafluoride was reduced by 80%, reducing the risk of fugitive GHG emissions.
13% reduction in Scope 3[b] GHG emissions by FY 2020, from an FY 2008 baseline	FY 2012 emissions were determined to be 10,102 $mTCO_2e$, a 29.8% reduction from the FY 2008 baseline of 14,398 $mTCO_2e$.
Energy Efficiency And Management	
30% reduction of energy intensity in buildings (BTUs per square foot of building space) by FY 2015, from an FY 2003 baseline *(Also identified as an NNSA/NFO EMS target)*	Reduced energy intensity overall by 31% from the baseline; FY 2012 actions included installation of air curtains in a warehouse, use of reflective paint, and lowering hot water heater temperatures.
Metering of individual buildings or processes for 90% of electricity (by October 2012) and for 90% of steam, natural gas, and chilled water[d] (by October 2015)	94% of electricity is metered; 100% of natural gas is metered; all boilers and chilled water systems have BTU meters; FY 2012 actions included installation of 19 BTU meters, 34 BTU sub-meters, and 32 advanced electrical meters; advanced electrical meters will continue to be installed as funding permits.
Cool roofs (see Glossary, Appendix B), unless determined uneconomical, for roof replacements, and new roofs must have a thermal resistance of at least R-30	Cool roofs have been installed on buildings since FY 2005; five cool roof replacements were made in FY 2012; as of the end of FY 2012, 584,475 gross square feet (gsf) of building space is under cool roofs[e], representing 23% of all NNSA/NFO building gsf.
7.5% of a site's annual electricity consumption from renewable sources by FY 2013 (or 3.75% if electricity is produced from renewable sources on site)	0.5% of power produced on site is from 153 photovoltaic and 25 wind turbine systems that provide power to environmental air samplers and remote communications sites; renewable energy credits were purchased, representing 8% of NNSA/NFO's annual electrical consumption, allowing NNSA/NFO to meet this goal.

Table 3-2. NNSA/NFO Site Sustainability Plan goals and FY 2012 performance status (continued)

DOE Agency SSPP Goal[(a)]	NNSA/NFO Performance Status
Fleet Management	
10% annual increase in fleet alternative fuel consumption by FY 2015, relative to an FY 2005 baseline (i.e., FY 2012 increase should be 70% above the FY 2005 baseline) *(Also identified as an NNSA/NFO EMS target)*	Alternative fuel consumption in FY 2012 was 118% above the FY 2005 baseline. All diesel fuel used by NNSA/NFO fleet vehicles contains 20% bio-fuel and 80% petroleum, and the E-85 fuel contains 85% ethanol and 15% petroleum. A second E-85 fueling station was installed on the NNSS in Area 6 in FY 2012.
2% annual reduction in fleet petroleum consumption by FY 2015, relative to an FY 2005 baseline (i.e., FY 2012 consumption should be 14% less than the FY 2005 baseline) *(Also identified as an NNSA/NFO EMS target)*	Consumption in FY 2012 was 50% less than the FY 2005 baseline. Participated in a General Services Administration pilot program for Plug-in Electric Vehicles (PEVs); 13 charging stations at NNSS and NLVF were installed and 11 Chevrolet Volt PEVs were acquired.
75% of light duty vehicle purchases must consist of alternative fuel vehicles (AFVs) by FY 2000 and thereafter, 100% beginning in FY 2015	100% of all light duty vehicle acquisitions (109) in FY 2012 were AFVs.
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	The FY 2005 baseline is 1,083 vehicles; a reduction of 21.7% in fleet inventory has occurred from FY 2005 through FY 2012.
High Performance Sustainable Buildings	
All new construction and major renovations greater than $5 million are to achieve the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) Gold certification. Buildings less than $5 million must meet the Guiding Principles for Federal Leadership in High Performance Sustainable Buildings design (Interagency Sustainability Working Group [ISWG] 2008)	No such construction or major renovations occurred in FY 2012, and no new construction is planned for FY 2013.
15% of existing buildings larger than 5,000 gsf to be compliant with the Guiding Principles for Federal Leadership in High Performance Sustainable Buildings design (ISWG 2008) by FY 2015	3.4% of NNSA/NFO enduring buildings over 5,000 gsf meet the Guiding Principles; 10% (by gsf) meet the Guiding Principles. The Nevada Support Facility at the NLVF achieved LEED Gold certification in August 2012.
Water Use Efficiency And Management	
26% reduction in water intensity[(f)] by FY 2020 from an FY 2007 baseline *(Also identified as an NNSA/NFO EMS target)*	Water intensity across all NNSA/NFO facilities was 59.08 gallons in FY 2012, a 35% reduction from the FY 2007 baseline; NNSS water production was reduced by 23% from the FY 2007 baseline; four NNSS well sumps were closed and are expected to reduce NNSS water production by an additional 14% (see Section 13.4, Groundwater Conservation, for more details).
20% reduction in water consumption of industrial, landscaping, and agricultural water by FY 2020 from an FY 2010 baseline	Non-potable water production was reduced by 14% from the FY 2010 baseline; end point leaks in NNSS water systems were repaired in FY 2012.
Pollution Prevention/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	39% of non-hazardous solid waste was diverted from disposal through recycling (see Section 3.3.2.2). Meeting this goal by the end of FY 2015 will require increased employee awareness and participation in waste stream segregation.
Divert at least 55% of construction and demolition materials and debris from disposal by the end of FY 2015	A process to track this goal was established, and 42% of construction waste was recycled and diverted from the landfill.
Reduce and minimize the quantity of toxic and hazardous chemicals and materials acquired, used, and disposed of	Four clean-burning waste oil furnaces were purchased to replace 172 infrared heaters in an NNSS warehouse, diverting the oil from recycling, but reducing electricity usage. The infrared heaters remain in the warehouse to be used only as backup heaters.

Table 3-2. NNSA/NFO Site Sustainability Plan goals and FY 2012 performance status (continued)

DOE Agency SSPP Goal[(a)]	NNSA/NFO Performance Status
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.
Electronic Stewardship And Data Centers	
Meter 100% of data centers by FY 2015 in order to measure the monthly Power Utilization Effectiveness (PUE)	Goal met; all data centers are metered.
Attain a maximum annual weighted average PUE for data centers of 1.4 by FY 2015	PUE for the Building C-1 data center at the NLVF was 2.1; best practices will continue to be implemented to improve the PUE; a PUE will be calculated for the data center in Building 23-725 (Mercury) in FY 2013.
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.
Innovation And Government-Wide Support	
Innovation to enhance efficiency gains, expand clean energy, evolve sustainable campuses, and engage employees and the DOE community	A cartoon character called the Green Reaper was developed as part of the EMP to promote the reduction of energy use. A spokesperson in a Green Reaper costume is also used as part of a community outreach program to teach elementary school children what they can do to save energy and water at home.

(a) These are department-wide goals of the DOE (DOE 2011), 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 target goals.

(b) The GHGs targeted for emission reductions are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. 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.

(d) Chilled water in this goal refers to having BTU meters on systems that deliver chilled water to air conditioning coils to cool buildings.

(e) For 2011, it was reported that the total area under cool roofs was 863,322 gsf (NSTec 2012b). This erroneously included four buildings that have been removed from this current total of gsf (Building B-3 at the NLVF, the Device Assembly Facility on the NNSS, and the two new fire stations on the NNSS).

(f) Water use intensity is potable gallons consumed per total gross square footage of facility space.

3.3.2 Pollution Prevention and Waste Minimization Program

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., the minimization or elimination of 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.

Recycling – For some recyclable waste streams generated, NNSA/NFO maintains a recycling program. Items recycled in 2012 included cardboard, office paper, shredded paper, mixed 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.

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. Of these items that NNSA/NFO purchased in 2012, about 53.8% contained 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 2013.

3.3.2.1 Reduction of Ozone-Depleting Substances

The EMS includes practices to maximize the use of safe alternatives to ODS. EO 13423 has a requirement to reduce ODS at all DOE sites and to phase out the procurement of Class I ODS for all non-exempted uses by the end of 2010. The NNSS achieved this procurement phase-out in 2009. In 2012, only environmentally preferable alternatives to Class I ODS were purchased. All procurement of refrigerants containing ODS (referred to as ODS refrigerants) are to be 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. Drained ODS refrigerants can be reused if needed for existing, operating equipment. Halon-containing fire extinguishers and equipment were removed from the NNSS and NLVF facilities by February 9, 2010. All halons have been removed from RSL-Nellis, with the exception of halon fire extinguishers in the aircraft.

3.3.2.2 Reduction of Wastes

Table 3-3 shows a summary of the routine waste reduction activities during 2012. An estimated 75.2 mtons (83 tons) of hazardous wastes (including RCRA, Toxic Substance Control Act, and state-regulated hazardous wastes) and 1,279.2 mtons (1,410 tons) of solid waste (sanitary waste) were diverted from disposal facilities in 2012 from these activities, all through recycling and reuse. Table 3-4 compares the amounts of radioactive, hazardous, and solid wastes reduced in 2012 to the amounts in prior years.

Table 3-3. Waste reduction activities in 2012

Activity	Reduction (mtons)[(a)]
Hazardous Waste	
Bulk used oil sent to an offsite vendor for recycling	2.5
Lead acid batteries shipped to an offsite vendor for recycling	34.9
Electronic equipment, including computer towers, monitors, laptops, and televisions, sent to an offsite vendor for recycling	13.4
Scrap lead sent to an offsite vendor for recycling	23.1

Table 3-3. Waste reduction activities in 2012 (continued)

Activity	Reduction (mtons)[a]
Hazardous Waste (continued)	
Rechargeable batteries sent to an offsite vendor for recycling	0.31
Spent fluorescent light bulbs, mercury lamps, metal hydride lamps, and sodium lamps sent to an offsite vendor for recycling	0.77
Refrigerant sent to an offsite vendor for recycling	0.17
Alkaline batteries sent to an offsite vendor for recycling	0.02
Total	**75.2**
Solid Waste	
Single stream mixed paper/cardboard/cans/plastic sent off site for recycling	246.1
Mixed paper and cardboard sent off site for recycling	62.2
Mixed paper and electronic media from Shred Day activities sent off site for recycling	32.9
Food waste from the NNSS cafeterias sent off site to be used as compost	43.6
Tires sent off site for recycling	23.5
Shipping materials including pallets, Styrofoam, bubble wrap, and shipping containers reused	8.2
Aluminum cans and plastic sent off site for recycling	0.31
Ferrous and nonferrous metal sold as scrap for recycling	821.1
Spent toner cartridges sent off site for recycling	1.6
Lithium bromide diverted from landfill disposal and reused by onsite contractor	0.9
Sulfur hexafluoride (SF_6) sent off site for recycling	1.2
Diesel fuel sent off site to local government agency for reuse	11.2
Electronic equipment sold for reuse	21
Communication devices returned to vendor for reuse	1.8
Office equipment and supplies recycled on site through the Material Exchange Program	0.05
Spent brass from shooting range returned to vendor	3.5
Total	**1,279.2**

(a) 1 mton = 1.1 ton

Table 3-4. Quantities of waste reduced through P2/WM activities by waste type and year

	Waste Reduction		
Calendar Year	Radioactive (mtons)[a]	Hazardous (mtons)	Solid (mtons)
2012	0	75.2	1,279.2
2011	0.07	121.0	760.5
2010	0	138.8	648.5
	Radioactive (m^3)[b]		
2009	45.2	114.0	153.5
2008	28.9	268	311
2007	0	167	1,698
2006	0	149	803
2005	0	13,992	1,194
2004	0	115	1,438
2003	40.0	207	1,547
2002	63.2	177	904

Note: The unit of measure for the quantity of radioactive waste reduced was changed in 2010 from cubic meter to metric ton

(a) 1 mton = 1.1 ton

(b) 1 cubic meter (m^3) = 1.3 cubic yards

3.3.2.3 P2/WM Reporting

In December 2012, NNSA/NFO submitted the FY 2012 Waste Generation and Pollution Prevention Progress Report for the NNSS, NLVF, and RSL-Nellis to DOE by entering the sites' data, including annual recycling totals and waste minimization accomplishments, into the DOE Headquarters Pollution Prevention Tracking and Reporting System electronic database. NNSA/NFO also submitted the *RCRA Permit for a Hazardous Waste Management Facility Permit Number NEV HW0101 - Annual Summary/Waste Minimization Report Calendar Year 2012, Nevada National Security Site, Nevada* (NSTec 2013c) to the Nevada Division of Environmental Protection on February 28, 2013.

3.3.2.4 Major P2/WM Accomplishments

The major P2/WM accomplishments for 2012, which were reported in NSTec (2013c) included:

- The Nevada Support Facility (NSF) at the NLVF achieved LEED Gold certification.
- The historic BREN (Bare Reactor Experiment–Nevada) Tower (see Chapter 1, Section 1.3), located in Area 25, was demolished on May 23, 2012. It became the world's tallest structure of its kind to collapse in a planned demolition. The majority of the tower was recycled as scrap metal. A total of 326 mtons, mostly steel, were sent off site to a scrap metal recycler.
- The NNSS Water and Waste Department determined they could meet the 2020 SSP goal for water use efficiency and management (see Table 3.2) by draining and closing four sumps on the NNSS that receive water from potable water wells. Their closure eliminated water loss through evaporation, infiltration, and transpiration and has significantly reduced the use of potable water on the NNSS (see Section 13.4, Groundwater Conservation).
- NNSA/NFO participated in a General Services Administration pilot program for Plug-in Electric Vehicles (PEVs). Thirteen PEV charging stations at various locations throughout the NNSS and the NLVF were installed, and 11 Chevrolet Volt PEVs were acquired. Since the project began greenhouse gases have been reduced by approximately 12,290 kilograms (kg).
- Four clean-burning waste oil furnaces were purchased to replace one-third of the infrared heaters inside an NNSS warehouse. The waste oil furnaces burn used motor oils generated by cars, trucks, heavy equipment, and the stockpile of transformer/dielectric oil generated at the NNSS. Burning the waste oil produces cost-free heat and reduces the risk of spills and/or contamination to the environment if the oils were instead being transported to an offsite recycle or disposal facility.
- Approximately 900 kg of lithium bromide, a desiccant, was averted from the landfill and was reused on site by another contractor. This waste reduction also saved approximately $36,000 by avoiding the purchase of new lithium bromide.
- Approximately 2,700 pounds of sulfur hexafluoride (SF_6), a potent greenhouse gas, was transported off the NNSS for recycling. This was an 80% reduction in the onsite inventory and a reduction in the risk of fugitive gas emissions from the NNSS. SF_6 is commonly used as an electric insulator (dielectric medium) in accelerators, switchgear, and high-voltage power supplies. Fugitive emissions result from maintenance, equipment failure, and gas seepage.
- The Energy Management Improvement Program obtained $660K to aid in the installation of 32 advanced electrical meters and 19 BTU meters for a mercury switch project. The project exceeded its goal to install 18 advanced electrical and 12 BTU meters. The new meters will ultimately be read by a building automation system as part of an approach to reduce energy costs.
- An onsite contractor sent 11.11 mtons of lead and 3.47 mtons of spent brass shell casings off of the NNSS for recycling, which resulted in the contractor receiving credit toward the purchase of new ammunition and saving approximately $2,500 in disposal costs.

3.3.3 Environmental Programs

Multiple programs that serve to protect public health and the environment are implemented on the NNSS (Table 3-5). 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 2012 by these programs is summarized throughout various chapters of this report (see Table 3-5, "Section Reference" column).

Table 3-5. 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	Section 2.7
Routine Radiological Environmental Monitoring Program	Conduct environmental monitoring to detect releases from DOE activities Estimate contaminant dispersal patterns in the environment Characterize the pathways of exposure to members of the public Estimate the exposures and doses to individuals and nearby populations	Monitors direct ambient radiation and monitors man-made radionuclides in air, groundwater, surface water, and biota samples Identifies pathways of exposure to the public Estimates dose to public from NNSA/NFO air emissions, groundwater contamination, direct radiation, and ingestion of NNSS game animals	Sections 4.1, 5.1, 6.0, 8.0, 9.1
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	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	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	Section 11.3
Community Environmental Monitoring Program	Conduct environmental monitoring to detect releases from DOE activities	Monitors ambient gross alpha and beta radioactivity, gamma radiation, and gamma-emitting radionuclides in offsite community air sampling stations and tritium in offsite water supply sources	Section 7.0
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	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	Section 4.2

Table 3-5. Major environmental programs of NNSA/NFO (continued)

NNSA/NFO Environmental Program	Environmental Protection Action Addressed	Program Description	Section Reference[(a)]
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	Section 5.2
Groundwater Protection Program	Implement a site-wide approach for groundwater protection	Integrates site-wide groundwater-related activities across multiple programs	Section 13.0
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	Section 12.0
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	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	Section 14.0
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	Section 15.0
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	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	Sections 16.0 and 17.0

(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 newsletters and in a printed newsletter that is mailed to NSTec employees' homes. 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 in those reports are also entered and tracked in the companywide issues tracking system, caWeb. Corrective actions taken to close the issues help to continually improve the EMS program. In 2012, 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. A 2012 independent audit conducted by NSTec's Quality and Performance Improvement Division 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 compliance and identify areas for overall improvement. In 2012, NSTec conducted 5 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 recertification assessment that the EMS program remains effective and that certification is renewed.

The EMS training and awareness discussed in Section 3.5 have improved the overall environmental knowledge of the workforce. Many times the operational workers in the company, rather than the environmental organization, identify problems and recommend preventive or corrective actions. These actions driven by the EMS program have improved performance and reduced costs frequently.

The establishment of annual environmental EMS targets assists in reducing water, fuel, and energy usages; avoiding waste production; recycling wastes generated from environmental restoration activities; purchasing environmentally preferable 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 senior management regarding current environmental issues and the status of EMS objectives and targets. The NSTec environmental organization that coordinates the EMS prepares and distributes by email a monthly slide presentation to facilitate communication and support. Presentation topics also include assessment findings, status of corrective actions, emerging concerns, environmental metrics, and opportunities for continual improvement. The EMS program is continuously being evaluated, and improvements are implemented and documented. A summary report is prepared and presented to NSTec senior management annually, documenting performance and improvements, which allows the determination that the program continues to be suitable, adequate and effective.

On December 4, 2012, the 2012 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

DOE Environmental Management Headquarters awarded NNSA/NFO with an Honorable Mention 2012 Sustainability Award for the Pluto Facility demolition. An aggressive waste minimization approach was used to improve safety, minimize environmental impact, reduce schedule, and save approximately $1.35 million in demolition, waste containers, transportation, and oversight costs.

4.0 Air Monitoring

Section 4.1 presents the results of radiological air monitoring conducted on the Nevada National Security Site (NNSS) to verify compliance with radioactive air emission standards. Measurements of radioactivity in air samples are also used to assess radiological dose to the general public. The assessed dose to the public from all exposure pathways is presented in Chapter 9. Section 4.2 presents the results of nonradiological air quality assessments that are conducted to ensure compliance with NNSS air quality permits.

The U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office (NNSA/NFO) has also established an independent Community Environmental Monitoring Program to monitor radionuclides in air within 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

NNSS sources of radioactive air emissions include evaporation of tritiated water from containment ponds; 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); resuspension of contaminated soil at historical surface or near surface nuclear device test locations; and release of radionuclides from current facility 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 2003a).

Data from NNSS sampling stations are analyzed to meet the specific goals listed below. The analytes monitored to perform dose assessments are also listed; these include the radionuclides most likely to be present in the 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***
Measure radionuclide concentrations in air at or near historical or current operation sites that have the potential to release airborne radioactivity to (1) detect and identify local and site-wide trends, (2) quantify radionuclides emitted to air, and (3) detect accidental and unplanned releases. Measure radionuclide concentrations in air to determine if the air pathway dose to any member of 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 millirem per year (mrem/yr) (0.1 millisievert per year [mSv/yr]) (see Chapter 9 for the estimate of public dose from the air pathway). Provide point-source operational monitoring as required under NESHAP for any facility that has the potential to emit radionuclides into the air and cause a dose greater than 0.1 mrem/yr (0.1 mSv/yr) to any member of the public. Provide the inhalation exposure pathway data to determine if the total radiation dose to any member of 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 for estimates of dose from all pathways).	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 $^{239+240}$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.

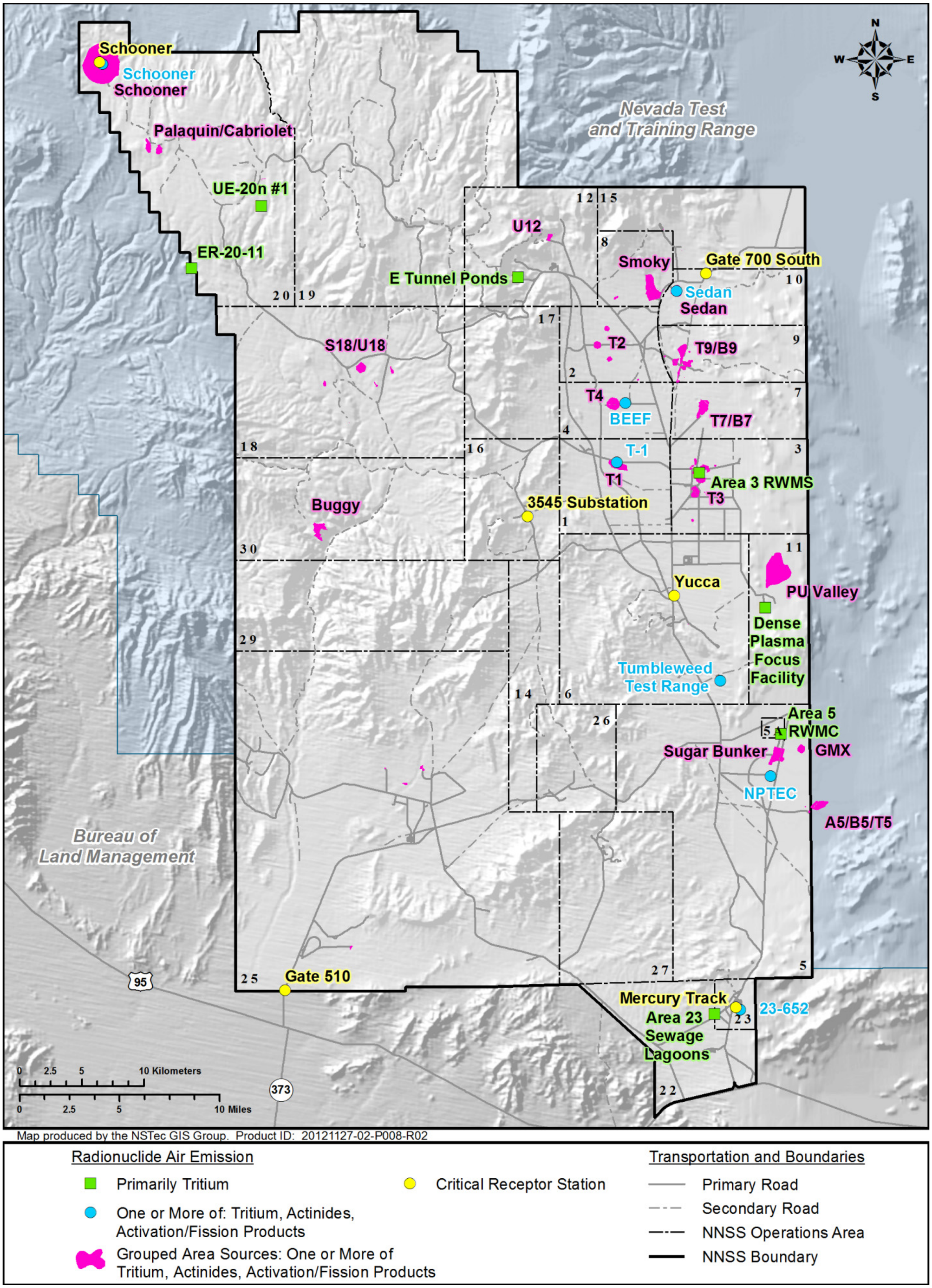


Figure 4-1. Sources of radiological air emissions on the NNSS in 2012

4.1.1 Monitoring System Design

Environmental Samplers – A total of 22 environmental sampling stations operated on the NNSS at some time during 2012 (Figure 4-2). Sampling at four monitoring locations (U-3bh N, U-3bh S, U-3ah/at N, and U-3ah/at S) ended March 29, 2012, and sampling at three new stations (U-3ax/bl South, Bilby Crater, and Kestrel Crater N) started the same day. These changes were made to improve the network's sensitivity to possible releases of radionuclides from the Area 3 RWMS. By the end of 2012, 18 environmental sampling stations were operating; 16 have both air particulate and tritium (atmospheric moisture) samplers, 1 has only an air particulate sampler, and 1has 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. Air concentrations approaching 10% of the NESHAP Concentration Levels for Environmental Compliance (compliance levels [CLs]) (second column of Table 4-1) are investigated for causes that may be mitigated in order to ensure regulatory dose limits are not exceeded.

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 were compared with the 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.

Point-Source (Stack) Sampler – One facility on the NNSS, the Joint Actinide Shock Physics Experimental Research (JASPER) facility in Area 27 (Figure 4-2), requires stack monitoring while operating because inital assessments conservatively determined it has the potential to emit airborne radionuclides that could result in an offsite radiation dose exceeding 0.1 mrem/yr.

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

	Concentration ($\times 10^{-15}$ 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

Note: Both the CL values and 10% of the DCS values represent an annual average resulting in a total effective dose equivalent (TEDE) of 10 mrem/yr, the federal dose limit to the public from radioactive air emissions. They are computed using different dose models; the generally more conservative CLs are used in this report.

(a) From Table 2, Appendix E of Title 40 Code of Federal Regulations (CFR) Part 61, 1999

(b) From DOE-STD-1196-2011, "Derived Concentration Technical Standard"; see Glossary, Appendix B for DCS definition

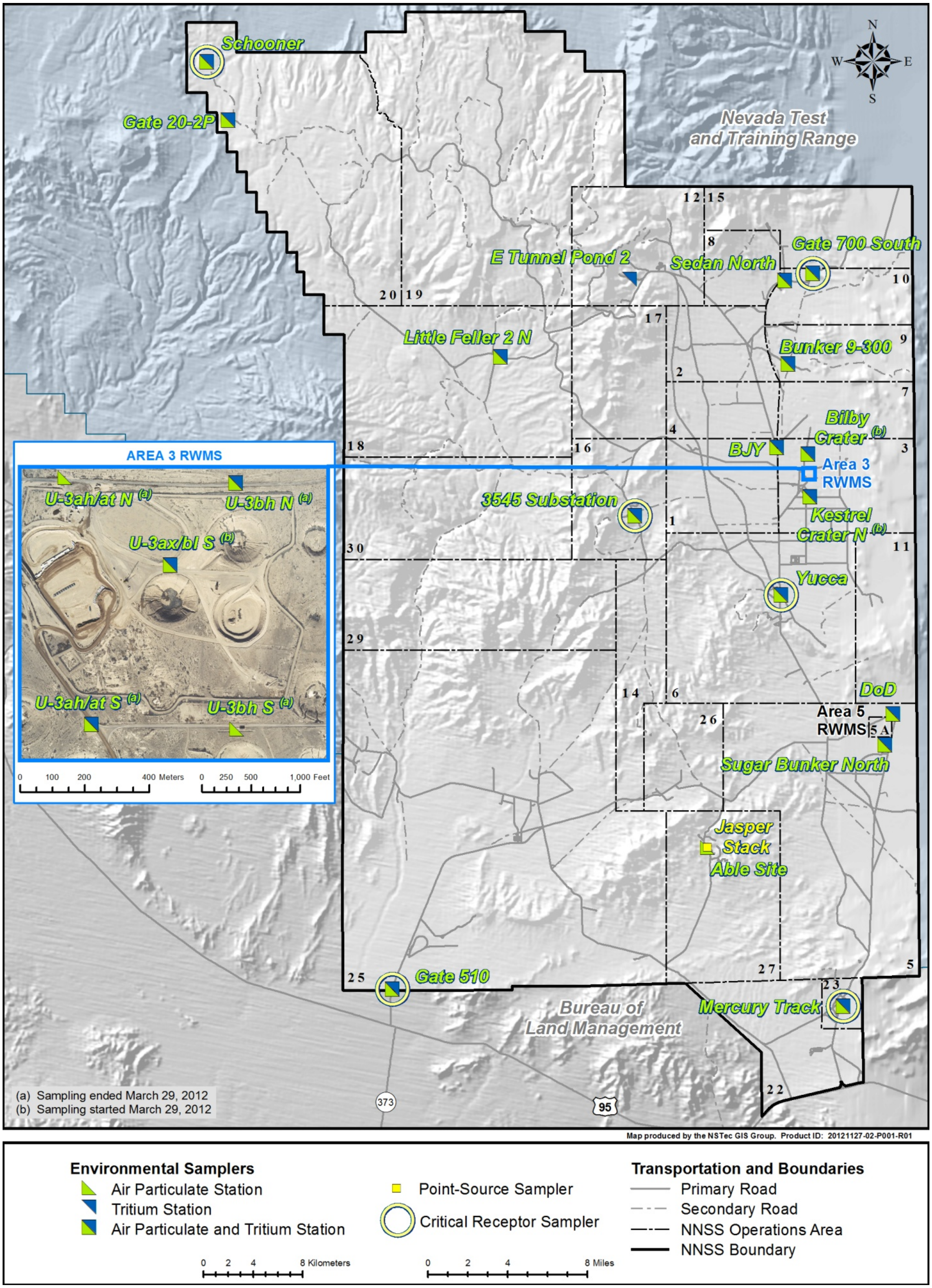


Figure 4-2. Radiological air sampling network on the NNSS in 2012

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 (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). Up until March 2012, the Area 3 and Area 5 station filters were composited monthly, similar to all other stations. After March, however, the Area 3 and Area 5 station filters were 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.

Routine quality control air samples (e.g., duplicates, blanks, and spikes) are also frequently incorporated into the analytical suites. Chapter 16 contains a discussion of quality assurance/quality control protocols and procedures used for radiological air monitoring. Measurement values presented in this chapter are averages of the regular measurements and field duplicate measurements where the latter are available.

4.1.3 Presentation of Air Sampling Data

The 2012 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.

In graphs of concentration data, the CL (second column of Table 4-1) or a fraction of the CL is included as a 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 convenience in reporting, values shown in the tables in the following sections are frequently formatted to a greater number of significant digits than can be justified by the inherent accuracy of the measurements, which is typically two significant figures (e.g., 2500, 25, 2.5, or 0.025).

4.1.4 Air Sampling Results from Environmental Samplers

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 12.74 × 10^{-18} µCi/mL, less than in 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 2012 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 103.57 × 10^{-18} µCi/mL, 5.5% of the CL. In Figure 4-3 and several other figures, the measurements at Bunker 9-300 are shown individually. The plot also shows 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 2012

			^{241}Am (× 10^{-18} µCi/mL)			
Area	**Sampling Station**	**Number of Samples[(a)]**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**
1	BJY	12	11.58	15.45	−2.96	42.58
3	Bilby Crater[(b)]	3	6.13	3.29	3.86	9.91
3	Kestrel Crater N[(b)]	3	64.39	88.55	12.96	166.63
3	U-3ah/at N[(c)]	3	12.07	14.79	0.00	28.57
3	U-3ah/at S[(c)]	3	13.02	10.06	5.44	24.44
3	U-3ax/bl S[(b)]	3	8.29	3.89	4.44	12.22
3	U-3bh N[(c)]	3	7.85	4.10	3.41	11.50
3	U-3bh S[(c)]	3	8.91	1.61	7.76	10.75
5	DoD	6	1.25	1.90	−0.98	3.77
5	Sugar Bunker N	6	6.53	11.31	0.00	29.46
6	Yucca*	12	2.15	3.88	−5.10	9.75
9	Bunker 9-300	12	103.57	90.85	14.71	356.77
10	Gate 700 S*	12	1.22	3.09	−2.39	5.91
10	Sedan N	12	4.80	4.68	−1.01	14.08
16	3545 Substation*	12	2.86	3.76	−1.50	8.16
18	Little Feller 2 N	12	12.75	39.02	−3.73	136.43
20	Gate 20-2P	12	1.29	2.50	−2.85	6.01
20	Schooner*	12	4.99	4.01	0.00	11.00
23	Mercury Track*	12	3.26	3.26	−1.09	10.44
25	Gate 510*	12	3.66	6.32	−2.47	20.93
27	ABLE Site	12	1.74	3.82	−6.55	6.70
All Environmental Locations		**177**	**12.74**	**37.53**	**−6.55**	**356.77**
27	JASPER Stack[(d)]	12	185.52	333.57	−20.40	1,153.29

CL = 1900 × 10^{-18} µCi/mL

*** EPA-approved Critical Receptor Station**

(a) Differences in the number of samples across stations are due to the number of months a station operated in 2012 and/or to different compositing schedules (e.g., quarterly versus monthly; see Section 4.1.2).

(b) Sampling station was added at end of March 2012.

(c) Sampling station was removed at end of March 2012.

(d) None of the JASPER Stack results were considered detected due to the result being less than the MDC and/or the high uncertainty associated with the result.

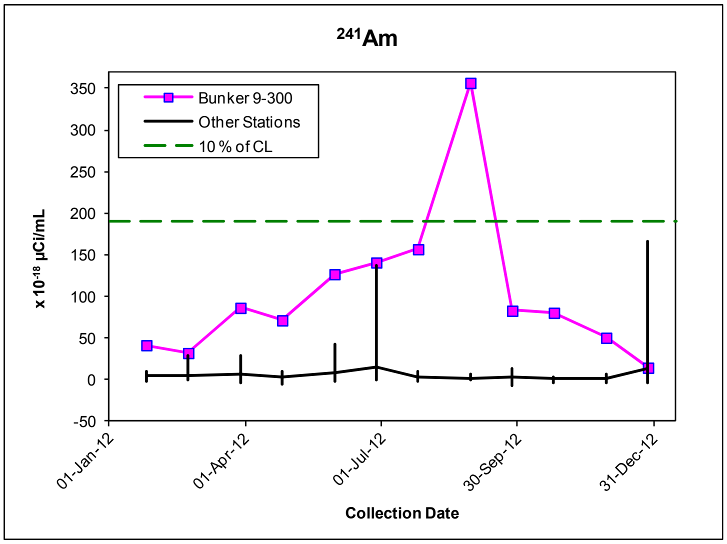


Figure 4-3. Concentrations of ^{241}Am in air samples collected in 2012

4.1.4.2 Cesium-137

During 2012, no ^{137}Cs was detected at any of the environmental sampling stations or at the JASPER Stack point-source sampler. There were no ^{137}Cs results higher than the MDC, and the mean value across all environmental samplers was less than zero.

4.1.4.3 Plutonium Isotopes

The overall mean concentration for ^{238}Pu at environmental stations during 2012 (2.20×10^{-18} µCi/mL) is within the range of values observed in recent years (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). Bunker 9-300 (Area 9) measurements are again slightly higher than those of other stations (Table 4-3), although not so prominently as is the case with ^{241}Am and $^{239+240}$Pu (see Figure 4-4). The highest mean concentration at environmental stations is only 0.4% of the CL.

Plutonium isotopes $^{239+240}$Pu (analytical methods cannot readily distinguish between ^{239}Pu and ^{240}Pu) are of greater abundance and hence greater interest. The overall mean of 76.2×10^{-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 (698×10^{-18} µCi/mL, 34.9% 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.

Table 4-3. Concentrations of ^{238}Pu in air samples collected in 2012

			^{238}Pu (× 10^{-18} µCi/mL)			
Area	Sampling Station	Number of Samples[a]	Mean	Standard Deviation	Minimum	Maximum
1	BJY	12	1.04	4.48	−7.74	7.40
3	Bilby Crater[b]	3	3.25	2.28	1.49	5.82
3	Kestrel Crater N[b]	3	5.19	7.45	−1.16	13.39
3	U-3ah/at N[c]	3	2.40	6.85	−4.92	8.67
3	U-3ah/at S[c]	3	1.16	3.39	−2.66	3.81

Table 4-3. Concentrations of ^{238}Pu in air samples collected in 2012 (continued)

Area	Sampling Station	Number of Samples[(a)]	^{238}Pu (× 10^{-18} µCi/mL) Mean	Standard Deviation	Minimum	Maximum
3	U-3ax/bl S[(b)]	3	1.99	0.63	1.50	2.70
3	U-3bh N[(c)]	3	2.30	3.39	−1.15	5.63
3	U-3bh S[(c)]	3	−1.97	3.38	−4.37	1.89
5	DoD	6	0.28	3.73	−6.87	2.98
5	Sugar Bunker N	6	0.19	3.45	−4.84	5.09
6	Yucca*	12	0.32	5.42	−12.52	5.83
9	Bunker 9-300	12	9.35	10.11	−3.32	35.44
10	Gate 700 S*	12	1.52	3.13	−3.51	6.09
10	Sedan N	12	3.95	4.21	−2.32	12.53
16	3545 Substation*	12	1.99	2.46	−2.32	6.73
18	Little Feller 2 N	12	2.83	3.98	−3.01	11.62
20	Gate 20-2P	12	2.08	2.39	−0.86	6.71
20	Schooner*	12	2.39	4.32	−6.74	9.09
23	Mercury Track*	12	1.35	2.74	−2.26	5.49
25	Gate 510*	12	1.06	3.05	−2.97	6.65
27	ABLE Site	12	0.77	4.55	−10.39	7.28
All Environmental Locations		**177**	**2.20**	**4.89**	**−12.52**	**35.44**
27	JASPER Stack[(d)]	12	114.98	205.71	−219.15	545.26

CL = 2100 × 10^{-18} µCi/mL

*** EPA-approved Critical Receptor Station**

(a) Differences in the number of samples across stations are due to the number of months a station operated in 2012 and/or to different compositing schedules (e.g., quarterly versus monthly; see Section 4.1.2).

(b) Sampling station was added at end of March 2012.

(c) Sampling station was removed at end of March 2012.

(d) None of the JASPER Stack results were considered detected due to the result being less than the MDC and/or the high uncertainty associated with the result.

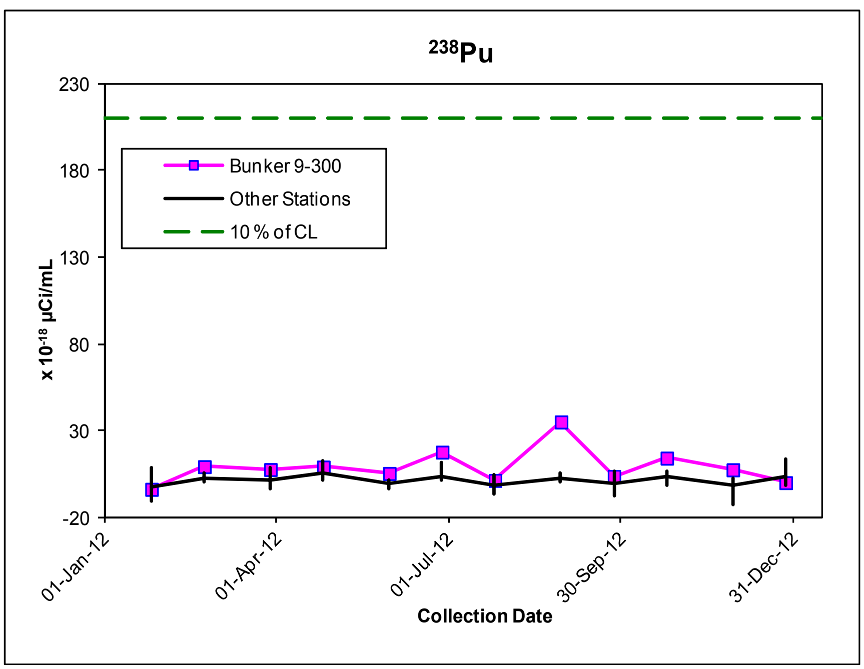


Figure 4-4. Concentrations of ^{238}Pu in air samples collected in 2012

Table 4-4. Concentrations of $^{239+240}$Pu in air samples collected in 2012

Area	Sampling Station	Number of Samples(a)	$^{239+240}$Pu (× 10^{-18} µCi/mL) Mean	Standard Deviation	Minimum	Maximum
1	BJY	12	75.70	109.75	2.20	295.66
3	Bilby Crater(b)	3	49.58	30.84	23.11	83.44
3	Kestrel Crater N(b)	3	328.19	392.15	69.46	779.38
3	U-3ah/at N(c)	3	77.60	70.23	35.45	158.67
3	U-3ah/at S(c)	3	99.06	68.07	36.50	171.55
3	U-3ax/bl S(b)	3	59.97	27.28	31.12	85.33
3	U-3bh N(c)	3	25.88	18.67	11.46	46.97
3	U-3bh S(c)	3	49.45	21.52	35.05	74.18
5	DoD	6	2.24	1.40	0.98	4.71
5	Sugar Bunker N	6	30.16	65.97	0.00	164.78
6	Yucca*	12	7.01	7.51	−1.14	23.05
9	Bunker 9-300	12	698.36	610.38	63.62	2402.26
10	Gate 700 S*	12	8.22	6.02	1.01	19.17
10	Sedan N	12	28.53	28.64	5.79	104.38
16	3545 Substation*	12	3.31	2.82	−2.84	7.66
18	Little Feller 2 N	12	73.44	239.46	−9.61	833.57
20	Gate 20-2P	12	2.66	2.93	−2.36	7.38
20	Schooner*	12	3.73	2.30	0.10	8.58
23	Mercury Track*	12	3.94	2.47	1.21	8.42
25	Gate 510*	12	27.87	86.06	0.00	300.99
27	ABLE Site	12	2.53	3.22	−3.47	7.65
All Environmental Locations		**177**	**76.20**	**246.45**	**−9.61**	**2402.26**
27	JASPER Stack(d)	12	150.00	363.68	−235.83	1,226.28

CL = 2000 × 10^{-18} µCi/mL

*** EPA-approved Critical Receptor Station**

(a) Differences in the number of samples across stations are due to the number of months a station operated in 2012 and/or to different compositing schedules (e.g., quarterly versus monthly; see Section 4.1.2).

(b) Sampling station was added at end of March 2012.

(c) Sampling station was removed at end of March 2012.

(d) None of the JASPER Stack results were considered detected due to the result being less than the MDC and/or the high uncertainty associated with the result.

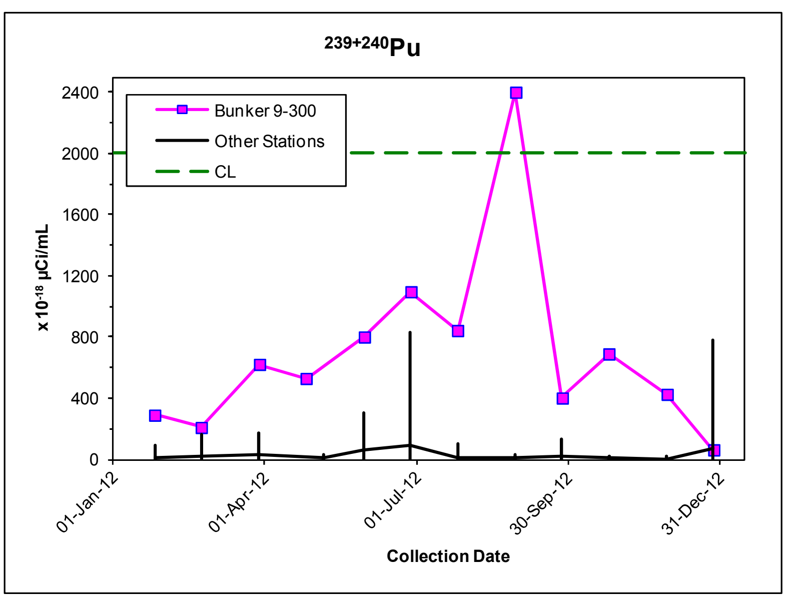


Figure 4-5. Concentrations of $^{239+240}$Pu in air samples collected in 2012

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 environmental half-life for $^{239+240}$Pu in air of 32.9 years for Areas 1 and 3; 22.2 years for Areas 7, 9, 10, and 15; and about 5 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.

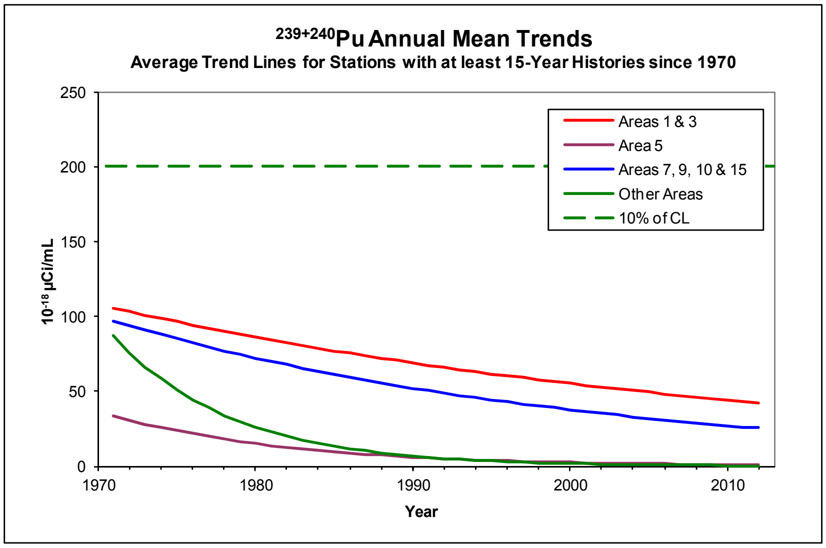


Figure 4-6. Average trends in $^{239+240}$Pu in air annual means, 1971–2012

4.1.4.4 Uranium Isotopes

Uranium analyses are performed for samples from seven stations, since exercises using uranium [predominately DU] have been conducted relatively near these samplers. The annual mean concentrations for 2012 are shown in Table 4-5; note that the scale factor in Table 4-5 is the same for $^{233+234}$U and ^{238}U but an order of magnitude lower for $^{235+236}$U. Mean concentrations of $^{233+234}$U and ^{238}U are somewhat higher than in 2009 and 2010; the mean concentration of $^{235+236}$U remains about the same.

Table 4-5. Concentrations of uranium isotopes in air samples collected in 2012

			$^{233+234}$U by Radiochemistry ($\times 10^{-17}$ µCi/mL)			
Area	**Sampling Station**	**Number of Samples[(a)]**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**
5	Sugar Bunker N	6	19.58	6.81	13.14	30.77
6	Yucca*	12	23.35	2.60	19.28	26.81
10	Gate 700 S*	12	22.13	2.51	18.58	27.10
16	3545 Substation*	12	23.78	3.31	18.35	29.26
20	Gate 20-2P	12	24.08	2.23	21.09	28.52
25	Gate 510*	12	22.55	2.62	18.89	26.84
27	ABLE Site	12	22.17	2.34	18.08	25.51
All Environmental Locations		**78**	**22.74**	**3.21**	**13.14**	**30.77**
			CL = 710 $\times 10^{-17}$ µCi/mL			

Table 4-5. Concentrations of uranium isotopes in air samples collected in 2012 (continued)

Area	Sampling Station	Number of Samples[(a)]	Mean	Standard Deviation	Minimum	Maximum
			$^{235+236}U$ by Radiochemistry ($\times 10^{-18}$ µCi/mL)			
5	Sugar Bunker N	6	9.45	6.78	−1.13	17.87
6	Yucca*	12	13.70	2.77	6.85	16.84
10	Gate 700 S*	12	10.83	7.40	0.00	24.04
16	3545 Substation*	12	11.72	4.21	5.17	17.33
20	Gate 20-2P	12	12.91	4.11	5.45	20.51
25	Gate 510*	12	13.57	6.18	1.48	23.08
27	ABLE Site	12	11.65	6.29	3.55	23.51
All Environmental Locations		**78**	**12.17**	**5.45**	**−1.13**	**24.04**
CL = 7100 $\times 10^{-18}$ µCi/mL						
			^{238}U by Radiochemistry ($\times 10^{-17}$ µCi/mL)			
5	Sugar Bunker N	6	17.83	3.07	13.91	21.06
6	Yucca*	12	23.67	2.30	19.74	27.28
10	Gate 700 S*	12	22.25	2.12	18.90	25.49
16	3545 Substation*	12	23.70	2.68	18.35	27.89
20	Gate 20-2P	12	24.63	2.57	21.35	29.10
25	Gate 510*	12	23.89	2.01	21.62	28.19
27	ABLE Site	12	23.71	2.29	19.99	27.49
All Environmental Locations		**78**	**23.19**	**2.86**	**13.91**	**29.10**
CL = 830 $\times 10^{-17}$ µCi/mL						
*** EPA-approved Critical Receptor Station**						

(a) Sugar Bunker N had three monthly composite samples from January through March and then three quarterly composite samples for the remainder of the year; all other stations had monthly samples.

The ratios of the uranium isotope concentrations are given in Table 4-6. Table 4-7 presents the values expected of those ratios for uranium from different sources. Natural uranium is believed to be the predominant source of uranium in air samples based on the mean $^{235+236}U/^{238}U$ ratio being most consistent with natural uranium, although the mean $^{233+234}U/^{238}U$ ratio is below the target values for both natural and depleted uranium. Though the uranium observed on air filters is believed to be natural, should they be conservatively presumed to be from NNSS activities, their concentrations are less than 4% of CL values for all uranium isotopes.

Table 4-6. Observed values of uranium isotope ratios in 2012

Mean Isotope Ratio Values (95% CI)	
$^{233+234}U$ / ^{238}U	$^{235+236}U$ / ^{238}U
0.98 (0.96–1.01)	0.053 (0.048–0.059)

Table 4-7. Expected ratios of uranium isotopes by type of source

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

4.1.4.5 Tritium

Measurements of tritium in air vary widely across monitoring stations on the NNSS (Table 4-8). The highest mean concentration was detected at the Schooner station (158 × 10^{-6} picocuries per milliliter [pCi/mL]). The next highest are 4.8 × 10^{-6} pCi/mL at E Tunnel Pond and 3.3 × 10^{-6} pCi/mL at Sedan. 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 10.5% of the CL; mean concentrations at other locations are less than 0.3% of the CL.

Table 4-8. Concentrations of ^{3}H in air samples collected in 2012

Area	Sampling Station	Number of Samples[(a)]	^{3}H Concentration (× 10^{-6} pCi/mL) Mean	Standard Deviation	Minimum	Maximum
1	BJY	26	0.52	0.44	−0.12	1.58
3	Bilby Crater[(b)]	19	0.21	0.40	−0.39	1.09
3	Kestrel Crater N[(b)]	19	0.51	0.45	−0.63	1.33
3	U-3ah/at S[(c)]	7	0.13	0.15	−0.03	0.42
3	U-3ax/bl S[(b)]	19	0.44	0.38	−0.23	1.14
3	U-3bh N[(c)]	7	0.23	0.12	0.10	0.48
5	DoD	26	0.17	0.42	−0.52	1.21
5	Sugar Bunker N	26	0.63	0.80	−0.37	2.48
6	Yucca*	26	0.22	0.36	−0.36	1.64
9	Bunker 9-300	26	0.75	0.69	−0.78	2.01
10	Gate 700 S*	26	0.26	0.36	−0.49	1.07
10	Sedan N	26	3.33	2.49	0.66	9.88
12	E Tunnel Pond	24	4.84	2.91	0.86	10.89
16	3545 Substation*	26	0.18	0.46	−0.88	1.74
18	Little Feller 2 N	25	0.24	0.44	−0.27	1.64
20	Gate 20-2P	26	0.19	0.31	−0.37	0.85
20	Schooner*	26	157.57	151.93	15.60	456.18
23	Mercury Track*	26	0.24	0.56	−0.41	2.42
25	Gate 510*	26	0.21	0.52	−0.89	1.70
All Environmental Locations		**473**	**9.41**	**50.04**	**−0.89**	**456.18**
			CL = 1500 × 10^{-6} pCi/mL			
			*** EPA-approved Critical Receptor Station**			

(a) Differences in the number of samples across stations are due to the number of weeks a station operated in 2012.
(b) Sampling station was added at end of March 2012.
(c) Sampling station was removed at end of March 2012.

The tritium found at Schooner, Sedan N, and E Tunnel Pond 2 comes from past nuclear tests. Tritium associated with these tests quickly oxidized into tritiated water, which remains in the surrounding soil and rubble until it moves to the surface and evaporates. Higher tritium concentrations in air are generally observed during the summer months. At E Tunnel Pond, this increase is due to the rate of evaporation increasing as the temperature increases. At Schooner and Sedan, increased tritium emissions are likely due to the movement of relatively deep soil moisture (>2 m) containing relatively high concentrations of tritium to the surface when temperatures are the highest and when shallow (< 2 m) soil moisture is the lowest. Rainfall can temporarily suppress these emissions by diluting the shallow soil moisture. Figure 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 August and again in the second week of October.

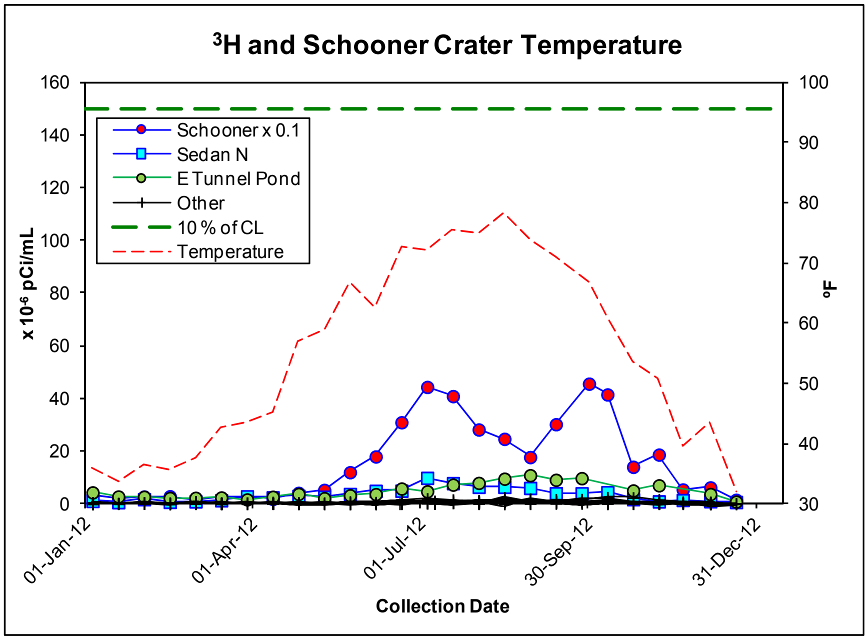


Figure 4-7. Concentrations of ^{3}H in air samples collected in 2012 with Schooner Crater average air temperature per collection period

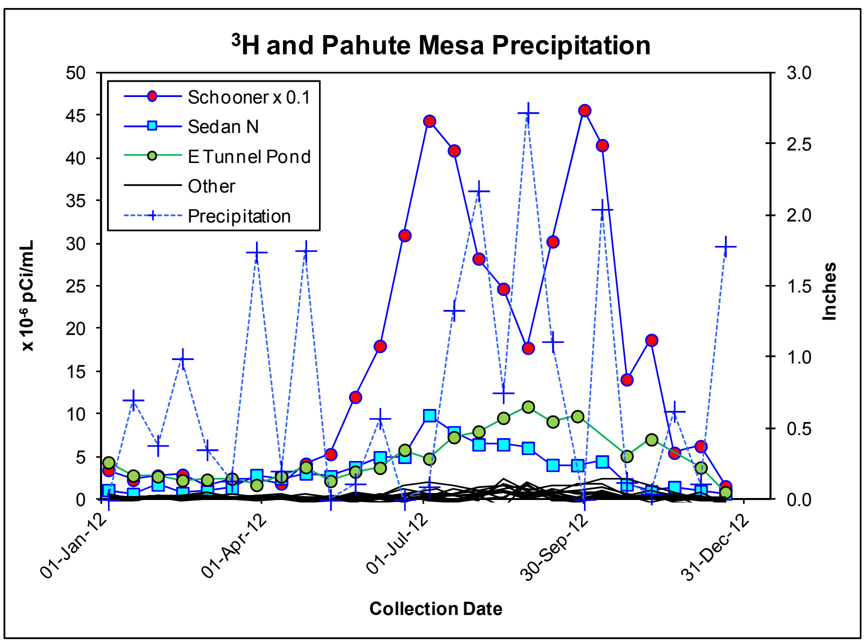


Figure 4-8. Concentrations of ^{3}H in air samples collected in 2012 with Pahute Mesa precipitation

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 15% per year. The decline rate for Schooner is about 9 % per year since 2002.

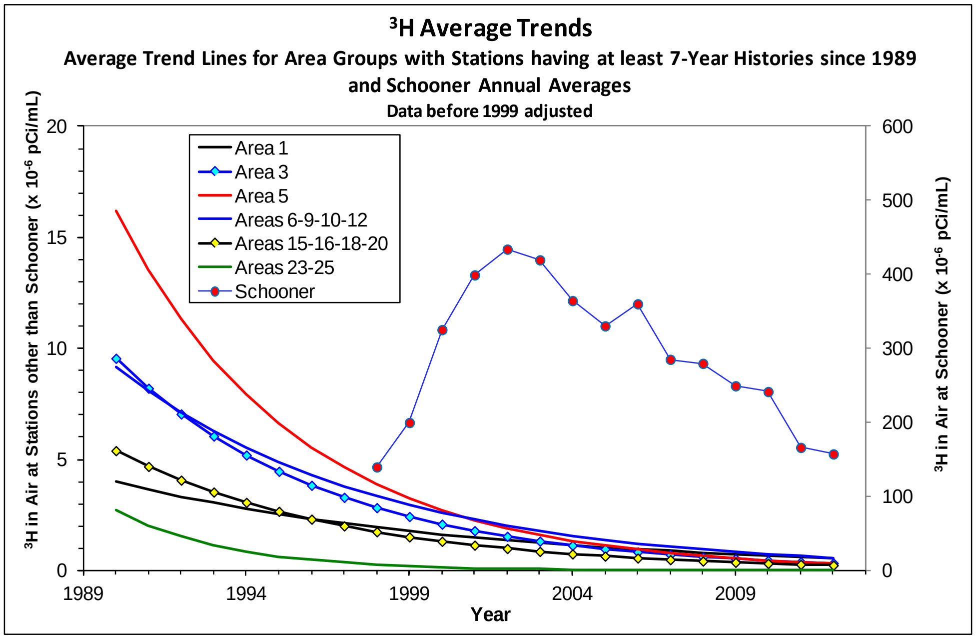


Figure 4-9. Trends in annual mean ^{3}H air concentrations for Area groups and Schooner Crater, 1990–2012

4.1.4.6 Gross Alpha and Gross Beta

The gross alpha and gross beta radioactivity in air samples collected in 2012 are summarized in Tables 4-9 and 4-10. Because these radioactivity measurements include naturally occurring radionuclides (e.g., 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 4-9. Gross alpha radioactivity in air samples collected in 2012

			Gross Alpha ($\times 10^{-16}$ µCi/mL)			
Area	Sampling Station	Number of Samples[a]	Mean	Standard Deviation	Minimum	Maximum
1	BJY	51	21.23	14.90	−12.77	77.46
3	Bilby Crater[b]	19	26.86	6.96	14.01	39.46
3	Kestrel Crater N[b]	18	33.29	30.85	7.73	152.06
3	U-3ah/at N[c]	13	17.79	9.76	3.52	31.27
3	U-3ah/at S[c]	13	17.31	12.00	0.00	39.60
3	U-3ax/bl S[b]	19	28.03	9.39	16.31	46.45
3	U-3bh N[c]	13	17.25	9.44	4.56	36.62
3	U-3bh S[c]	13	16.81	12.01	3.48	38.39
5	DoD	32	22.82	9.82	0.59	38.40
5	Sugar Bunker N	32	26.15	10.73	4.65	50.36
6	Yucca*	52	20.73	12.69	−15.49	47.80
9	Bunker 9-300	51	38.12	26.71	5.90	172.02
10	Gate 700 S*	52	16.74	11.39	−4.78	46.11
10	Sedan N	52	19.63	12.67	−4.54	50.06
16	3545 Substation*	52	16.21	10.55	−7.23	41.42

Table 4-9. Gross alpha radioactivity in air samples collected in 2012 (continued)

Area	Sampling Station	Number of Samples[(a)]	Gross Alpha (× 10^{-16} µCi/mL) Mean	Standard Deviation	Minimum	Maximum
18	Little Feller 2 N	52	20.38	16.32	−10.79	107.57
20	Gate 20-2P	52	16.26	11.79	−8.96	43.27
20	Schooner*	52	20.13	9.20	−1.16	45.31
23	Mercury Track*	52	18.34	9.73	−5.25	38.98
25	Gate 510*	52	19.78	12.75	3.02	71.11
27	ABLE Site	52	17.74	11.05	−9.30	52.61
All Environmental Locations		**794**	**21.16**	**14.90**	**−15.49**	**172.02**
27	JASPER Stack	39	−363.46	9,543.27	−50,198.77	30,543.73

*** EPA-approved Critical Receptor Station**

(a) Differences in the number of samples across stations are due to the number of weeks a station operated in 2012 and/or to different sample collection schedules (e.g., weekly versus every 2 weeks; see Section 4.1.2).

(b) Sampling station was added at end of March 2012.

(c) Sampling station was removed at end of March 2012.

Table 4-10. Gross beta radioactivity in air samples collected in 2012

Area	Sampling Station	Number of Samples[(a)]	Gross Beta (× 10^{-15} µCi/mL) Mean	Standard Deviation	Minimum	Maximum
1	BJY	51	21.95	6.32	10.92	46.76
3	Bilby Crater[(b)]	19	23.00	6.10	14.88	39.69
3	Kestrel Crater N[(b)]	18	22.54	5.91	14.68	38.69
3	U-3ah/at N[(c)]	13	19.85	6.31	11.12	33.59
3	U-3ah/at S[(c)]	13	20.58	6.09	13.34	33.79
3	U-3ax/bl S[(b)]	19	22.62	5.82	14.32	37.75
3	U-3bh N[(c)]	13	20.53	6.86	11.23	38.13
3	U-3bh S[(c)]	13	20.32	6.04	11.22	33.98
5	DoD	32	22.95	6.52	12.36	41.83
5	Sugar Bunker N	32	23.86	6.52	12.31	39.34
6	Yucca*	52	23.10	6.72	10.83	47.33
9	Bunker 9-300	51	21.98	6.77	10.43	46.41
10	Gate 700 S*	52	21.74	6.73	9.95	45.35
10	Sedan N	52	21.56	6.56	10.45	47.68
16	3545 Substation*	52	20.22	6.58	9.88	44.17
18	Little Feller 2 N	52	20.43	6.24	9.89	42.53
20	Gate 20-2P	52	20.54	6.55	9.40	43.90
20	Schooner*	52	21.61	7.03	9.74	46.04
23	Mercury Track*	52	22.02	6.77	9.50	42.73
25	Gate 510*	52	22.39	6.80	10.40	42.94
27	ABLE Site	52	20.83	6.62	10.46	41.22
All Environmental Locations		**794**	**21.68**	**6.57**	**9.40**	**47.68**
27	JASPER Stack	40	−6.27	312.43	−1,181.66	1,267.87

*** EPA-approved Critical Receptor Station**

(a) Differences in the number of samples across stations are due to the number of weeks a station operated in 2012 and/or to different compositing schedules (e.g., weekly versus every 2 weeks; see Section 4.1.2).

(b) Sampling station was added at end of March 2012.

(c) Sampling station was removed at end of March 2012.

4.1.5 Air Sampling Results from Critical Receptor Samplers

The following NNSS-related radionuclides were detectable 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 2012. The uranium isotopes have been attributed to naturally occurring uranium (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 4-11). The highest radiation total effective dose equivalent (TEDE) (see Glossary, Appendix B) at a critical receptor location would be approximately 1.11 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 0.017 sum of fractions from the Gate 510 sampler, which is closest to the nearest public receptor (about 3.5 kilometers [km] [2.2 miles (mi)]). The estimated TEDE from air emissions for a hypothetical individual living year-round at the Gate 510 sampler would be 0.17 mrem/yr.

Table 4-11. Sum of fractions of compliance levels for man-made radionuclides at critical receptor samplers

Radionuclides Included in Sum of Fractions[(a)]	NNSS Area	Sampling Station	Sum of Fractions of Compliance Levels (CLs)
^{241}Am, ^{238}Pu, $^{239+240}$Pu, ^{3}H	6	Yucca	0.005
	10	Gate 700 S	0.006
	16	3545 Substation	0.004
	20	Schooner	0.111[(b)]
	23	Mercury Track	0.004
	25	Gate 510	0.017

(a) $^{233+234}$U, $^{235+236}$U, and ^{238}U are not included in sum of fractions. If they were, the sum of fractions increases to 0.068, 0.068, and 0.079 for Yucca, 3545 Substation, and Gate 510, respectively.

(b) This equates to a hypothetical receptor at this location receiving a TEDE of 1.11 mrem from air.

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

No man-made radionuclides were detected in JASPER stack samples. All analytical results were less than the MDC and/or had high uncertainties associated with them. JASPER stack monitoring is scheduled to be discontinued in 2013.

4.1.7 Emission Evaluations for Planned Projects

During 2012, NESHAP evaluations were completed for four research projects conducted in 2012 or planned for the future. They included a linear accelerator project in Area 6, use of non-radiological explosives in Area 25, a radio-tracer particulate dispersion experiment in Area 6, and emergency response training for first responders in Area 1. The evaluations were completed in order to determine if these projects have the potential to release airborne radionuclides that would expose the public to a dose equal to or greater than 0.1 mrem/yr. For any project or facility with this potential, the EPA requires approval prior to operation and point-source operational monitoring. The predicted dose at the nearest NNSS boundary for each potential release was less than the 0.1 mrem/yr level specified in 40 CFR 61.96. It was therefore concluded that these activities constituted minor sources. The detailed air emission dose evaluations for each project are reported separately in the NESHAP annual report for 2012 (National Security Technologies, LLC [NSTec], 2013b). All projects evaluated were determined to be minor emission sources.

4.1.8 Unplanned Releases

There were no unplanned radionuclide releases in 2012. Multiple wildland fires did occur on the NNSS in 2012, but results from routine air monitoring throughout the year were not significantly elevated, so radionuclide emissions from these fires were negligible.

4.1.9 Estimate of Total NNSS Radiological Atmospheric Releases in 2012

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

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

NNSS emission sources identified in 2012 are presented in Table 4-12. Their locations in relation to critical receptor air monitoring locations are shown in Figure 4-1. The amounts of ^{241}Am, ^{238}Pu, and $^{239+240}$Pu emissions from soil resuspension are the sum of emission rates computed for each area of the NNSS with surface contamination (Areas 1–13, 15–20, and 30). Other radionuclides (cobalt-60, strontium-90, ^{137}Cs, europium-152, europium-154, and europium-155), although found in surface soils during past radiation surveys, were not included because, combined, they contributed less than 10% to the total dose to the public.

A number of short-lived radionuclides were released in 2012 during a special research project at the Tumbleweed Test Range in Area 6. They are 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 (^{99}mTc). All but one of these activation products (^{7}Be) have short half-lives ranging from 10 minutes (^{13}N) to 6 hours (^{99}mTc). This means that they decay away very quickly so 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 2012, an estimated 5,154 Ci of radionuclides were released as air emissions; 95.6% of this (4,926 Ci) is from activation products with very short half-lives discussed above and 228 Ci were tritium (Table 4-13). Descriptions of the methods used for estimating the quantities shown in Tables 4-12 and 4-13 are reported in NSTec (2013b).

Table 4-12. Radiological atmospheric releases from the NNSS for 2012

Emission Source[(a)]	Type of Emissions Control	Radionuclide	Annual Quantity (Ci)
Legacy Weapon Test and Plowshare Crater Locations			
Sedan	None	^{3}H	24.4
Schooner	None	^{3}H	92
Grouped Area Sources – All NNSS Ops	None	^{241}Am	0.047
	None	^{238}Pu	0.050
	None	$^{239+240}$Pu	0.29
Groundwater Characterization/ Control or Remediation			
E Tunnel Ponds	None	^{3}H	6.7
UGTA Well Sump UE-20n #1	None	^{3}H	2.6
UGTA Well Sump ER-20-11	None	^{3}H	0.12
NLVF Groundwater Control – Area 23	None	^{3}H	0.00045

Table 4-12. Radiological atmospheric releases from the NNSS for 2012 (continued)

Emission Source[a]	Type of Emissions Control	Radionuclide	Annual Quantity (Ci)
Defense, Security, and Stockpile Stewardship			
BEEF	None	DU	0.06
DPF	None	^{3}H	95
NPTEC	None	DU	0.00082
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
T1 Training and Exercise Area	None	^{99m}Tc	0.0002
Emanation from Building Materials			
Building A-01, basement ventilation, NLVF	None	^{3}H	0.0047
Radioactive Waste Management			
Area 3 RWMS	Soil cover over	^{3}H	5.7
Area 5 RWMC	Soil cover over	^{3}H	1.8
Support Facility Operations			
Building 23-652	None	^{3}H	0.000042

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

Table 4-13. Total estimated NNSS radionuclide emissions for 2012

Radionuclide[a]	Total Quantity (Ci)
^{3}H	228
^{7}Be	0.0006
^{11}C	51
^{13}N	1808
^{15}O	2866
^{38}Cl	2
^{39}Cl	22
^{41}Ar	177
^{99m}Tc	0.0002
^{238}Pu	0.050
$^{239+240}Pu$	0.29
DU	0.061
^{241}Am	0.047

4.1.10 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 2012 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 nonradiological air pollution include aggregate production, surface disturbance (e.g., construction), release of fugitive dust from driving on unpaved roads, use of fuel-burning equipment, open burning, venting from bulk fuel storage facilities, explosives detonations, and releases of various chemicals during testing at NPTEC or at other release areas. Nonradiological air quality assessments are conducted to document compliance with the current State of Nevada air quality permit that regulates specific operations or facilities on the NNSS. 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). Specifically omitted from this section is NESHAP compliance for radionuclide emissions, which is presented in Section 4.1. Data collection, opacity readings, recordkeeping, and reporting activities related to air quality on the NNSS are conducted to meet the 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 air emissions of criteria pollutants (sulfur dioxide [SO_2]), nitrogen oxides [NO_X], carbon monoxide [CO], volatile organic compounds [VOCs], and particulate matter) do not exceed limits established under NAAQS.
Ensure that emissions of permitted 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 the Nonproliferation Test and Evaluation Complex (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 2012. In May 2012, the Nevada Division of Environmental Protection (NDEP) issued a modification that included the addition of four generators as permitted sources. Operating hours were revised for three groups of generators. Boundaries were also expanded for the Port Gaston chemical releases. Emissions were revised for the chemical releases at NPTEC and EODU. Four propane boilers, four used oil furnaces, fourteen propane space heaters, and three propane tanks were added as insignificant sources.

In 2012, the Class II Surface Area Disturbance (SAD) permit for the Underground Test Area (UGTA) Well ER-EC-12 drill site and access road was cancelled due to completion of drilling activities at this location.

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 2012, and January 2013. The Calendar Year 2012 Actual Production/ Emissions Reporting Form was submitted in February 2013.

Records examined in 2012 for permitted facilities and equipment indicated that all operational parameters were being properly tracked and no PTEs were exceeded (Table 4-14). The majority of the emissions were NO_X from diesel generators. A total of 0.089 tons of HAPs were released in 2012. Table 4-15 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, but increased from 2008 through 2012. The decrease may be due to reduced project activities and less use of large diesel generators that emitted 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 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. In 2012, a deviation from the air permit requirements occurred when the Area 5 NPTEC PM10 monitor failed to operate. An Excess Emissions Report noting the deviation was sent to the State, and the PM10 monitoring equipment was altered to prevent a similar failure.

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 2012, 20 fire extinguisher training sessions and 27 vehicle burns were conducted. Quantities of criteria air pollutants produced by open burns are not required to be calculated or reported.

Table 4-14. Tons of criteria air pollutant emissions released on the NNSS from permitted facilities operational in 2012

	Calculated Tons[(a)] 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	5.06	6.80	NA[(d)]	NA	NA	NA	NA	NA	NA	NA
Concrete Batch Plant	0.46	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

Table 4-14. Tons of criteria air pollutant emissions released on the NNSS from permitted facilities operational in 2012 (continued)

	Calculated Tons[a] 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 (continued)										
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	<0.00	0.21
Fuel Burning/Storage										
Diesel Fired Generators	0.97	3.45	2.30	13.45	10.47	61.09	1.13	2.85	1.01	3.80
Gasoline Fired Generators	0.02	0.12	0.02	1.17	0.04	1.85	<0.00	0.10	0.05	2.52
Propane Generator	<0.00	0.02	<0.00	0.95	<0.00	1.44	<0.000	0.001	<0.00	0.20
Boilers	<0.00	0.34	<0.00	0.84	<0.00	3.36	0.01	0.01	<0.00	0.10
Bulk Gasoline Storage Tank	NA	NA	NA	NA	NA	NA	NA	NA	<0.00	1.25
Bulk Diesel Fuel Storage Tank	NA	NA	NA	NA	NA	NA	NA	NA	<0.00	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
Port Gaston	NR[e]	NR	NR	NR	NR	NR	NR	NR	<0.00	10.00
Detonations										
BEEF	<0.00	1.80	0.05	1.99	<0.00	0.50	<0.00	0.04	0.01	0.03
Port Gaston	<0.00	0.21	0.01	1.49	<0.000	0.085	<0.00	0.01	<0.00	0.01
EODU	<0.00	1.68	<0.00	0.21	<0.00	0.07	<0.00	0.01	<0.00	0.01
Total by Pollutant	**6.51**	**44.88**	**2.38**	**23.36**	**10.51**	**71.42**	**1.14**	**6.02**	**1.08**	**28.15**
Total Emissions	**21.62 Actual, PTE 173.83**									

(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
(e) Not released: the chemicals released did not include the specified pollutant and, therefore, no emission limit for the pollutant was established for the test.

Table 4-15. Criteria air pollutants and HAPs released on the NNSS over the past 10 years

	Total Emissions (tons/yr)[a]									
Pollutant	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Particulate Matter (PM10)[b]	2.39	0.94	0.84	0.69	0.54	0.22	0.49	1.09	2.40	6.51
Carbon Monoxide (CO)	1.79	0.24	0.15	0.43	0.51	0.94	0.55	1.33	3.70	2.38
Nitrogen Oxides (NO_X)	8.11	1.01	0.69	2.02	1.21	3.36	2.45	6.09	16.15	10.51
Sulfur Dioxide (SO_2)	0.76	0.12	0.04	0.03	0.01	0.06	0.10	0.36	1.20	1.14
Volatile Organic Compounds (VOCs)	1.21	4.60	1.94	1.40	1.14	0.60	0.71	0.33	1.68	1.08
Hazardous Air Pollutants (HAPs)[c]	0	0.41	0.05	1.87	0.02	0.09	0.30	0.02	0.04	0.03[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 (0.02 tons/yr) and from generators (0.01 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 2012. No state air inspections were conducted in 2012.

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 2012, 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 diesel generators located in Areas 6 and 12. Readings for these facilities ranged from 0% to 10%. 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 2012.

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 2012, the Tarantula VII chemical test series was conducted at the Area 5 NPTEC and the Area 26 Port Gaston Facility. For this series, 38 chemical releases were conducted at NPTEC and 5 were conducted at Port Gaston. Another chemical test series was conducted at NPTEC and Port Gaston by the United States Marine Corps for the Chemical Biological Incident Response Force and included 12 chemical releases at NPTEC and 4 at Port Gaston. The majority of the chemicals released were neither HAPS nor criteria pollutants, with the exception of VOCs, which were released at Port Gaston (see Table 4-14). 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 2012, explosives were detonated at BEEF, EODU, and Port Gaston, and no permit limits were exceeded (see Table 4-14).

PM10 monitoring was conducted for each chemical release test and detonation at NPTEC, Port Gaston, EODU and BEEF in 2012. Monitoring was conducted in accordance with the permit, with the possible exception of meeting certain calibration and performance audit requirements. This issue will be resolved in 2013.

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 for 3 years evidence of technician certification, 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.

A total of four Notification of Demolition and Renovation Forms were submitted during 2012. This included one demolition project and three 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 were 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 2012, 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 SAD permits issued by the State. In 2009, 2010, and 2011 SADs were issued for the construction and operation of UGTA wells on the Nevada Test and Training Range: ER-EC-12, ER-EC-13, ER-EC-14, and ER-EC-15. The SAD for ER-EC-12 was cancelled in 2012. No excessive fugitive dust from these well sites was noted in 2012, and all requirements of the SADs were met.

4.2.10 Environmental Impact

During 2012, NNSS activities produced a total of 21.62 tons of criteria air pollutants and 0.089 tons of HAPs. These small quantities had little, if any, impact on air quality on or around the NNSS.

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 whenever there is a risk of significant exposure to downwind plants and animals from the planned tests (see Section 15.7). Biologists review all chemical release test plans to determine the level of field monitoring needed for each test. 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.

THIS PAGE INTENTIONALLY LEFT BLANK

5.0 Water Monitoring

This chapter presents the results of radiological and nonradiological water monitoring on and adjacent to the Nevada National Security Site (NNSS). The U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office (NNSA/NFO) monitors water to comply with applicable state and federal water quality and water protection regulations and U.S. Department of Energy (DOE) directives (see Section 2.2) and to address the concerns of stakeholders residing in the vicinity of the NNSS. Waters routinely monitored include surface water and groundwater, including natural springs, drinking water wells, non-potable groundwater wells, and water discharged into domestic and wastewater systems on the NNSS. In addition to the annual onsite monitoring conducted by NNSA/NFO, 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. The Community Environmental Monitoring Program, established by NNSA/NFO, also performs independent monitoring of offsite springs and water supply systems in communities surrounding the NNSS. This independent community outreach program is managed by the Desert Research Institute (DRI). The reader is directed to Chapter 7 for the presentation of this program's water monitoring activities in 2012.

5.1 Radiological Surface Water and Groundwater 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 [DOE/NV] 1996a, 2000). The Federal Facility Agreement and Consent Order (FFACO) established corrective action units (CAUs) that delineate areas of concern for radiological groundwater contamination on the NNSS (DOE/NV 1996a). Figure 5-1 shows the locations of underground nuclear tests and the identified CAUs. *Attachment A: Site Description,* included on the compact disc version of this report, provides a thorough description of the complex hydrogeological conditions in which underground nuclear testing was conducted.

The Underground Test Area (UGTA) activity is tasked with developing CAU-specific models of groundwater flow and transport of radionuclides. The UGTA activity will also identify contaminant boundaries where the presence of radiological contaminants exceed the Safe Drinking Water Act limits or are likely to exceed those limits at any time within a 1,000-year period. Section 11.1 of this report describes UGTA's goals and progress towards reaching them and presents the results of 2012 UGTA groundwater sampling. As a complement to UGTA, routine radiological monitoring of some existing available groundwater wells and surface waters has been conducted under the *Routine Radiological Environmental Monitoring Plan* (RREMP) (Bechtel Nevada [BN] 2003a) to meet the goals shown below.

RREMP Monitoring Goals
Measure radionuclide concentrations in offsite and onsite water supply wells to (1) monitor for trends, (2) compare concentrations with the safe drinking water standards established by the U.S. Environmental Protection Agency (EPA) under the Safe Drinking Water Act, and (3) provide data to determine compliance with the dose limits to the general public set by DOE Order DOE O 458.1, "Radiation Protection of the Public and the Environment" (see Chapter 9 for the estimate of public dose from the water pathway).
Measure radionuclide concentrations in surface waters on the NNSS to determine if surface waters expose animals to doses less than those set by DOE Standard DOE-STD-1153-2002, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota" to protect wildlife populations (see Section 9.2 for biota dose estimates).
Determine if permitted facilities on the NNSS are in compliance with permit discharge limits for radionuclides.
Determine if radionuclide concentrations in natural springs and non-potable water wells (monitoring wells) indicate that NNSA/NFO activities have had an impact on the environment.

The RREMP well monitoring objectives are becoming more integrated, however, with those of UGTA as groundwater characterization and contaminant transport studies provide a scientific basis on where to focus sampling to ensure protection of the public and community groundwater sources. An integrated sampling program will result in a better use of resources without duplicating efforts while meeting the objectives of both RREMP and UGTA.

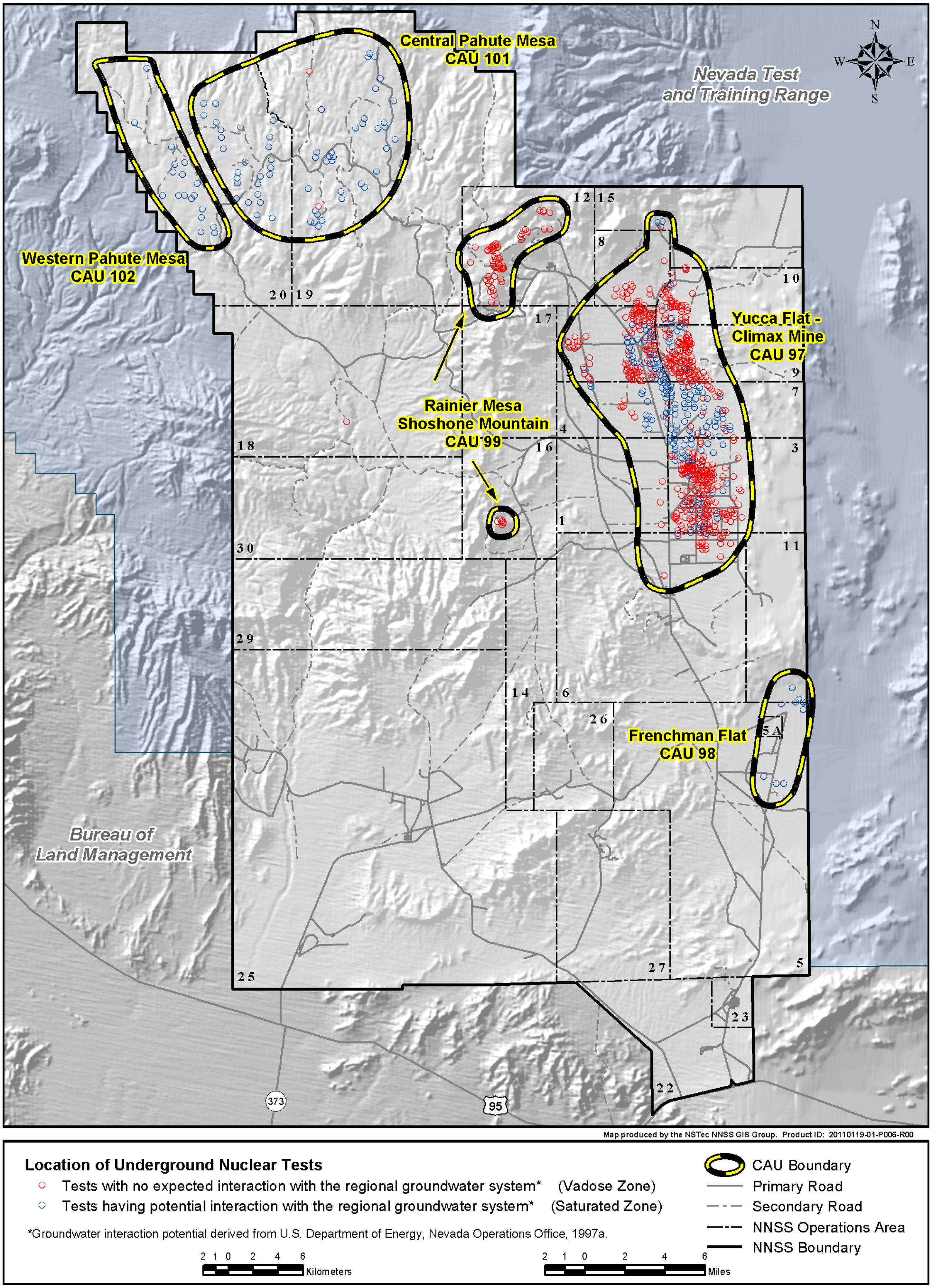


Figure 5-1. Areas of potential groundwater contamination on the NNSS

Beginning in March 2012, NNSA/NFO held multiple meetings with RREMP and UGTA participants. Meeting discussions focused on identifying wells of mutual interest for shared objectives, increasing collaborative efficiencies between the two programs, and the development of an NNSS Integrated Groundwater Sampling Plan. As a result of the 2012 integration meetings, some changes were made in RREMP sampling and analyses in 2012, which are identified in the sections below. The NNSS Integrated Groundwater Sampling Plan will replace the RREMP as the technical basis for most radiological groundwater monitoring conducted by the NNSA/NFO. The first draft of the plan was completed at the end of May 2013. It is expected to be finalized and approved by NNSA/NFO and the Nevada Division of Environmental Protection (NDEP) by the start of 2014. The 2013 NNSS environmental report will describe the NNSS Integrated Groundwater Sampling Plan and its implementation status.

5.1.1 RREMP Water Monitoring Locations

The RREMP monitoring well network includes onsite and offsite wells selected from those drilled in support of nuclear testing or other site missions that have met specific criteria based on monitoring objectives. It also includes some offsite private/community drinking water wells and offsite springs. Selection criteria include well condition, the ability to obtain representative water samples of acceptable quality, and well access. Sometimes UGTA characterization wells were added to the RREMP network over the years when they were no longer needed for current UGTA investigations, if they did not have high concentrations of radionuclides, and if they met all other selection criteria. As mentioned previously, the RREMP monitoring network was not designed to meet the requirements of the FFACO for a long-term monitoring network for the closure of UGTA CAUs (see Section 11.1). Wells in the RREMP network will be evaluated as candidate elements of the long-term monitoring program as UGTA CAUs proceed to closure.

Water sources that have been sampled under the RREMP have included 54 wells and 8 springs or surface waters (see Table 5-1 of National Security Technologies, LLC [NSTec] [2012b]). Water sources have been sampled at frequencies ranging from once every 3 months to once every 3 years for specified radiological and water chemistry parameters. During the 2012 groundwater sampling integration meetings, several RREMP monitoring wells were identified for possible elimination from the sampling network in 2013 because they are not beneficial in assessing flow and radionuclide transport, based on models and data collected under the UGTA activity.

Onsite springs have been sampled for radionuclides only on request by NNSA/NFO. 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 to any of 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 radioactive fallout.

During 2012, 47 locations were sampled (Figures 5-2 and 5-3), which included:

- 4 offsite non-potable NNSA/NFO wells
- 11 offsite community water supply wells
- 7 offsite springs
- 10 onsite water supply wells (6 potable, 4 non-potable or inactive)
- 14 onsite monitoring wells
- 1 onsite discharge system (E Tunnel)

5.1.2 RREMP Analytes Monitored

The selection of analytes for groundwater monitoring under the RREMP has been based on the radiological source term from historical nuclear testing, regulatory and permit requirements, and characterization needs. The isotopic inventory remaining from nuclear testing is presented in the 2013 site-wide environmental impact statement for NNSS activities (U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office 2013e) and in a Los Alamos National Laboratory document (Bowen et al. 2001). Many of the radioactive species generated from subsurface testing have very short half-lives, sorb strongly onto the solid phase, or are bound into what is termed “melt glass,” and are therefore not available for groundwater transport in the near term

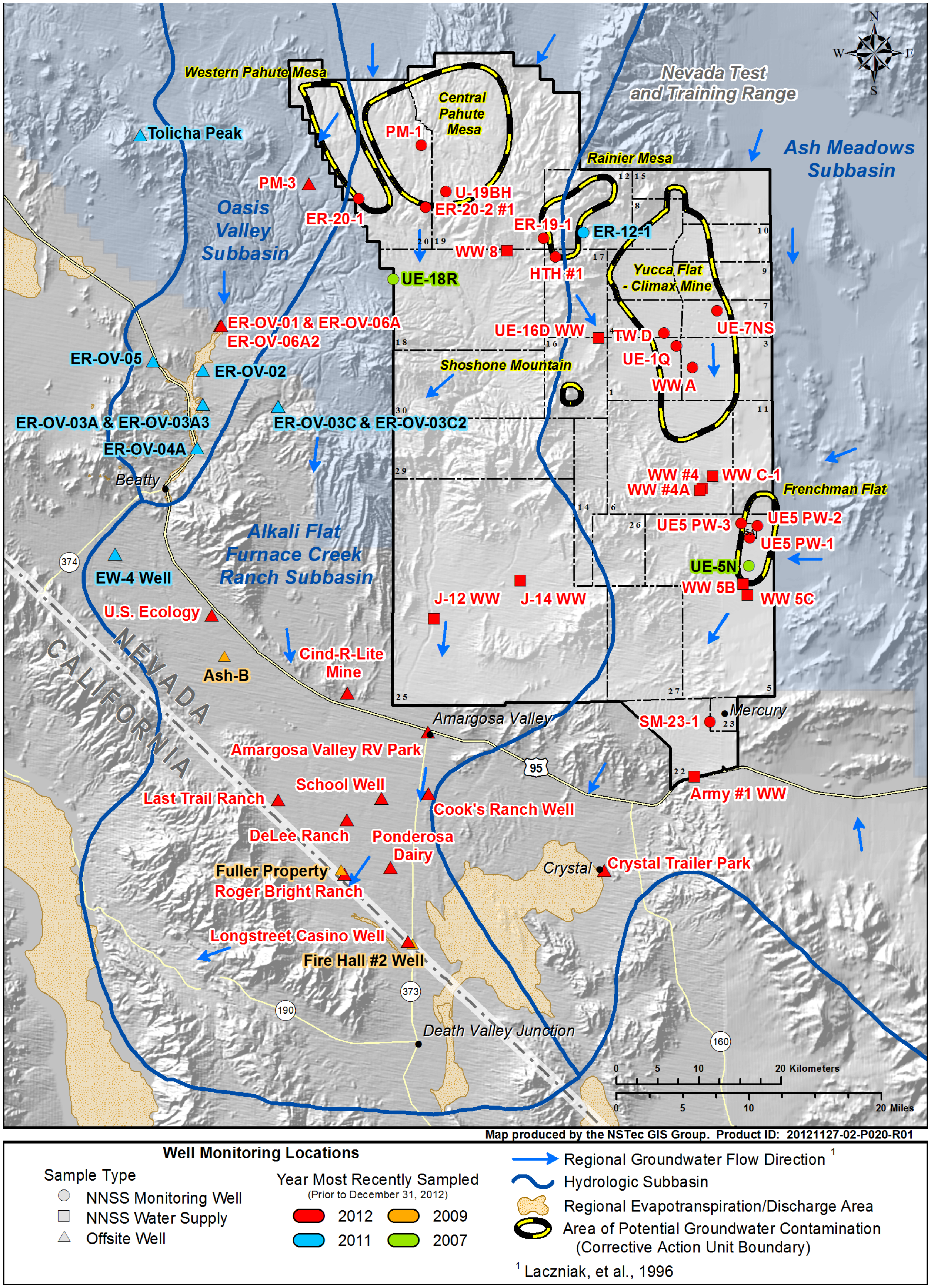


Figure 5-2. 2012 RREMP well monitoring network

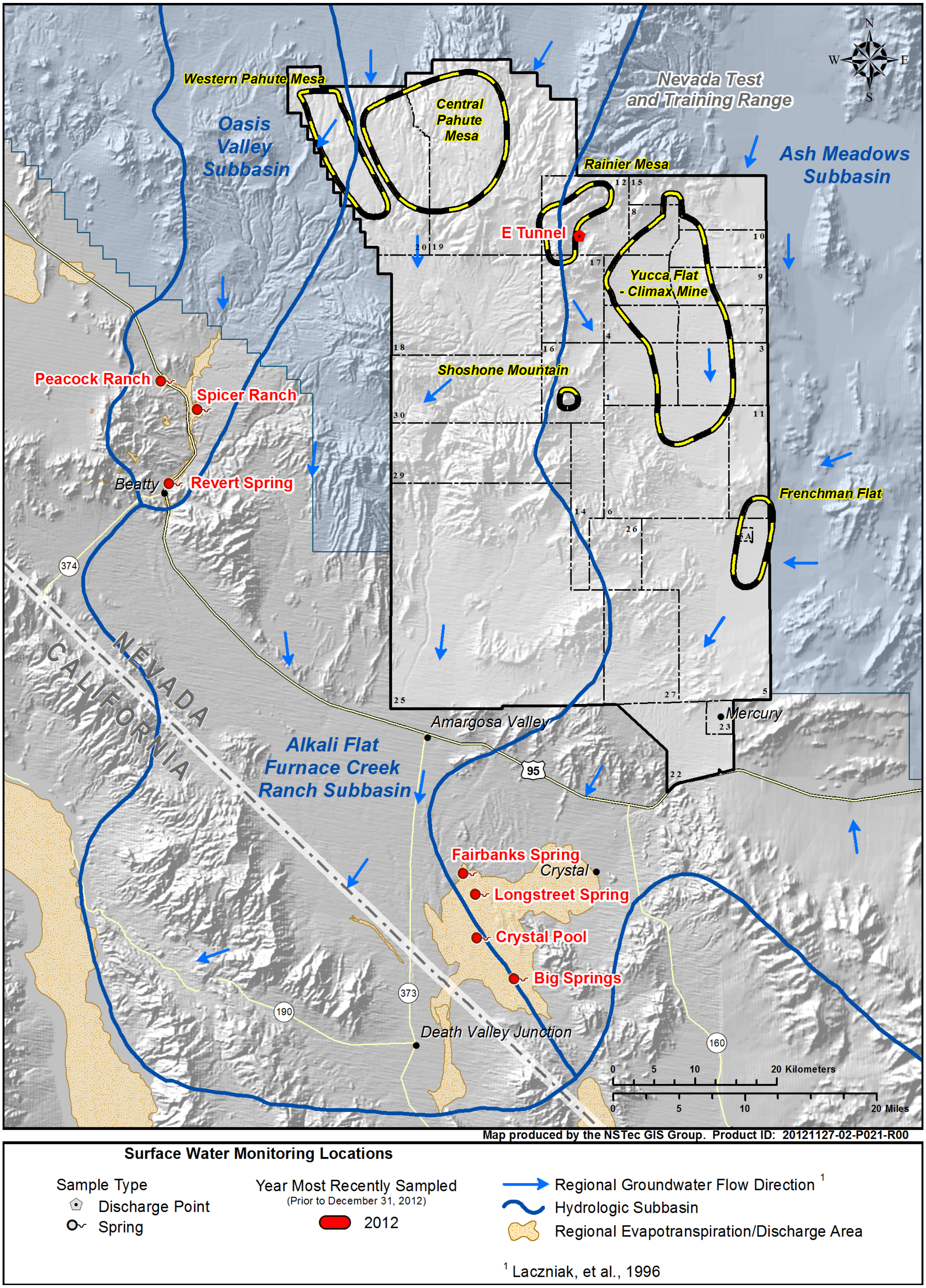


Figure 5-3. 2012 RREMP surface water monitoring network

(Smith 1993; Smith et al. 1995). Tritium (^{3}H) is the radioactive species created in the greatest quantities, it is highly mobile, and it is nonreactive. Tritium is therefore the primary target analyte; every water sample is analyzed for this radionuclide.

Gross alpha and gross beta radioactivity and gamma spectroscopy analyses have been conducted for RREMP water samples according to a prescribed sampling schedule (see Table 5-1 of NSTec [2012b]). Gross alpha and gross beta radioactivity can include activity from both natural and man-made radionuclides, if any are present. Naturally occurring minerals in the water can contribute to both alpha radiation (e.g., isotopes of uranium and radium-226 [^{226}Ra]) and beta radiation (e.g., radium-228 [^{228}Ra] and potassium-40 [^{40}K]). Gamma spectroscopy analysis can identify the presence of specific man-made radionuclides (e.g., americium-241 [^{241}Am], cesium-137 [^{137}Cs], cobalt-60 [^{60}Co], and europium-152 and -154 [^{152}Eu and ^{154}Eu]), as well as natural radionuclides (e.g., actinium-228 [^{228}Ac], lead-212 [^{212}Pb], ^{40}K, uranium-235 [^{235}U], and thorium-234 [^{234}Th]).

During the 2012 meetings with NNSA/NFO RREMP and UGTA participants, a decision was made to analyze samples collected from RREMP wells for only tritium because sufficient background data have been gathered in the past from most wells for gross alpha, gross beta, gamma emitting isotopes, plutonium, strontium-89+90 ($^{89+90}Sr$), carbon-14 (^{14}C), technetium-99 (^{99}Tc), and general water chemistry measures, and at this time, tritium is the only radionuclide of concern at these wells. However, some of the 2012 sample analyses for these analytes were performed prior to the decision to discontinue their analyses. As a result, in 2012, gross alpha and gross beta radioactivity analyses were conducted on water samples from one Oasis Valley monitoring well (ER-OV-06A2) and from all of the onsite RREMP monitoring and drinking water supply wells, and gamma spectroscopy analysis was performed for only the Oasis Valley monitoring well ER-OV-06A2.

If water samples exceed Safe Drinking Water Act (SDWA) standards, such as the EPA maximum contaminant level (MCL) for gross alpha (15 picocuries per liter [pCi/L]) and the EPA level of concern (LoC) for gross beta (50 pCi/L), then NNSA/NFO considers numerous factors in determining how to proceed, some of which include:

- If the well is a drinking water well, further analyses may be performed; the associated analytes may be more closely monitored to determine whether the exceedance was an anomaly and if the source is natural or a result of NNSA/NFO activities.
- SDWA standards for radionuclides apply only to public water systems (PWSs) designated as community water systems, and the PWSs on the NNSS are permitted by the State as non-community water systems; exceeding an MCL or LoC does not require action in accordance with the SDWA.
- If the well is not a drinking water well, then human health is not at risk, and further action may not be taken.

5.1.3 RREMP Water Sampling/Analysis Methods

Water sampling methods are based, in part, on the characteristics and configurations of the sample locations. For example, wells with dedicated pumps may be sampled from the associated plumbing (e.g., spigots) at the wellhead, while wells without pumps may be sampled via a wireline bailer or a portable pumping system. Sampling frequencies and analyses for routine radiological water monitoring have been based on location and type of sampling point as defined in the RREMP and on discussions with UGTA participants. When implemented in 2014, the NNSS Integrated Groundwater Sampling Plan will likely identify sampling frequencies for the single analyte, tritium, as once every 1 to 5 years depending on the well type (e.g., offsite monitoring well, onsite water supply well).

All RREMP tritium analyses (with the exception of those for E Tunnel) were conducted after the samples were enriched. The enrichment process concentrates tritium in a sample to provide low minimum detectable concentrations (MDCs) (see Glossary, Appendix B). For samples with expected levels of tritium that are much higher than the laboratory's standard detection capability (i.e., E Tunnel), or when the program goal is not to monitor for low-level concentrations of tritium (i.e., UGTA wells), tritium enrichment is not performed. Sample-specific MDCs for laboratory analysis of enriched samples ranged from 17.8 to 32.5 pCi/L. The MDCs for standard (non-enriched) tritium analyses typically range from 300 to 400 pCi/L. By comparison, the EPA MCL for tritium in drinking water is 20,000 pCi/L and required detection limit is 1,000 pCi/L, and the RREMP's informal "action level" (with no formal action required by regulation) is 10% of the drinking water standard, or 2,000 pCi/L.

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 monitoring.

5.1.4 Presentation of Water Sampling Data

The following sections present values of tritium, gross alpha, and gross beta analyses along with the measurement uncertainty. The "±" values presented in the data tables are the laboratory's stated 2–standard deviation "uncertainty" for each particular analysis. This does not include the uncertainty associated with sample collection or the tritium enrichment process. A statistical analysis of water supply well samples analyzed between July 1999 and December 2010 was conducted to obtain an estimate of the tritium decision level (L_C) (see Glossary, Appendix B). The analysis suggests an L_C for tritium of 22.2 pCi/L, where L_C is a 99% prediction limit for any individual measurement based on background water supply well data. Alternately, a 95% prediction limit for all enriched tritium measurements (PLall), based on that background water supply well data, is 31.0 pCi/L. This takes into account the total number of enriched tritium measurements made annually under the current implementation of the RREMP (99 during 2012). In comparison to the analysis uncertainty (i.e., the uncertainty associated with only the laboratory measurements for an individual sample), PLall implicitly incorporates all uncertainties in the sampling and analysis process over multiple years of water monitoring. If all monitoring locations produced data from the same distribution as the water supply wells, there would be a 5% chance of obtaining one or more values exceeding PLall anywhere during any single year.

Figures 5-4 through 5-9 show trends over time in tritium levels and in gross alpha and gross beta radioactivity among the RREMP sample locations that have been sampled routinely. In preparing these figures, the annual mean analyte concentration for each RREMP location was first computed for each year. These were averaged across locations within groups (offsite wells, offsite springs, onsite water supply wells, and onsite monitoring wells), and the annual "means of means" were plotted and connected. The vertical bars in the figures extend from the minimum to the maximum annual mean for any well or spring for each year in each group of locations.

5.1.5 Results from RREMP Offsite Wells and Springs

The 2012 and prior data indicate that groundwater sampled at offsite private/community wells (Figure 5-2) and at offsite springs (Figure 5-3) has not been impacted by past NNSS underground nuclear testing operations. These results are consistent with the data and model forecasts conducted under the UGTA program. Tritium levels in these water sources were all below their MDCs in 2012 (Tables 5-1 and 5-2). In the offsite NNSA/NFO wells (Figure 5-2), tritium was found to be above its MDCs but far below the EPA MCL in only one well, PM-3, for both depths (Table 5-1). UGTA sampled Well PM-3 in 2011 and obtained similar results (NSTec 2012b). UGTA determined that additional study of this well is warranted, and has scheduled this well for 2013 sampling. In all offsite springs sampled, tritium was below the MDCs (Table 5-2). Figure 5-4 shows the trend over time in tritium levels among the offsite wells and springs that have been sampled routinely.

Gross alpha and gross beta radioactivity were measured only in one offsite well, ER-OV-06A2, in order to obtain needed baseline information (Table 5-1). The results likely represent the presence of naturally occurring radionuclides. This one well was also analyzed for additional man-made radionuclides with gamma spectroscopy, and no gamma-emitting radionuclides were detected above their respective MDCs. The 2011 NNSS annual environmental report (NSTec 2012b) presents graphs of the trends in annual mean gross alpha and gross beta radioactivity in all RREMP offsite wells and springs that were sampled routinely for these analytes from 2000 through 2011.

Table 5-1. Gross alpha, gross beta, and tritium in offsite wells in 2012

Location	Date Sampled	Concentration ± Uncertainty[a] (pCi/L)		
		Gross Alpha	Gross Beta	Tritium
Non-potable NNSA/NFO Wells				
ER-OV-01	10/24	NA[b]	NA	−12.5 ± 16.9
ER-OV-06A	10/24	NA	NA	−0.19 ± 16.9
ER-OV-06A2	10/24	5.3 ± 1.6	8.6 ± 2.1	−15.7 ± 18.9
	10/24 FD[c]	NA	NA	−26.0 ± 19.0

Table 5-1. Gross alpha, gross beta, and tritium in offsite wells in 2012 (continued)

Location	Date Sampled	Concentration ± Uncertainty[(a)] (pCi/L) Gross Alpha	Gross Beta	Tritium
Non-potable NNSA/NFO Wells				
PM-3 (1,560 ft)	3/13	NA	NA	64.6 ± 18.3
	3/13 FD	NA	NA	73.4 ± 18.4
(1,994 ft)	3/13	NA	NA	52.9 ± 17.4
	3/13 FD	NA	NA	39.0 ± 15.1
Private/Community Drinking Water Wells				
Amargosa Valley RV Park	11/6	NA	NA	2.9 ± 12.4
Cind-R-Lite Mine	11/6	NA	NA	-4.9 ± 10.8
Cook's Ranch Well	11/5	NA	NA	0.3 ± 12.1
Crystal Trailer Park	11/6	NA	NA	-0.9 ± 10.3
DeLee Ranch	11/5	NA	NA	-11.6 ± 9.3
Last Trail Ranch	11/5	NA	NA	5.1 ± 11.9
Longstreet Casino Well	11/5	NA	NA	-3.5 ± 10.9
Ponderosa Dairy	11/5	NA	NA	-1.9 ± 15.0
Roger Bright Ranch	11/5	NA	NA	−9.8 ± 7.9
School Well	11/5	NA	NA	-4.3 ± 9.5
U.S. Ecology	11/6	NA	NA	-4.5 ± 9.9

Mean MDCs were 1.8, 2.4, and 24.6 pCi/L for gross alpha, gross beta, and tritium, respectively.
(a) ± 2 standard deviations
(b) NA = Analysis not performed based on decisions made during 2012 groundwater sampling integration meetings
(c) FD = Field duplicate sample

Table 5-2. Tritium in offsite springs in 2012

Location	Date Sampled	Concentration ± Uncertainty[(a)] (pCi/L)
Big Springs	11/5	3.7 ± 11.5
Crystal Pool	11/5	3.0 ± 12.6
Fairbanks Spring	11/5	-10.1 ± 9.4
Longstreet Spring	11/5	-3.6 ± 11.0
Peacock Ranch	11/6	2.6 ± 11.1
Revert Spring	11/6	0.3 ± 10.9
Spicer Ranch	11/6	-2.0 ± 10.2

Mean MDC for tritium was 23.2 pCi/L
(a) ± 2 standard deviations

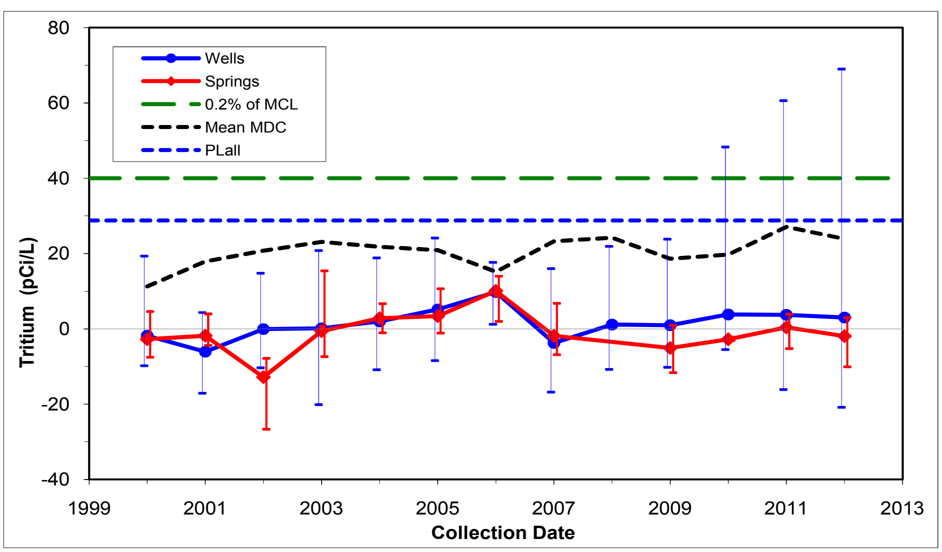


Figure 5-4. Tritium annual means for offsite wells and springs from 2000 through 2012

5.1.6 Results from RREMP NNSS Water Supply Wells

Results from the NNSS water wells sampled quarterly in 2012 (see Figure 5-2) continue to indicate that nuclear testing has not impacted the NNSS water supply network. No tritium measurements were above their MDCs and were far below the EPA MCL (Table 5-3). Gross alpha and gross beta radioactivity were found at concentrations slightly greater than their MDCs in most 2012 samples (Table 5-3). Two permitted potable wells, WW #4A and WW C-1, were not operational during the fourth quarter, and were therefore not sampled in October 2012.

Nine of the ten water supply wells have been sampled routinely since 1999, and J-14 WW, completed in 2011, was added to the sampling network in 2012. None of the annual mean values shown in Figures 5-5 through 5-7 exceed the EPA MCLs for tritium and gross alpha or the EPA LoC for gross beta. A few gross alpha quarterly values did exceed the MCL (attributed to natural occurring radionuclides); no gross beta quarterly measurements have exceeded the LoC.

Table 5-3. Gross alpha, gross beta, and tritium in NNSS water supply wells in 2012

Location	Date Sampled	Concentration ± Uncertainty[(a)] (pCi/L) Gross Alpha	Gross Beta	Tritium
Permitted Potable Wells				
J-12 WW	1/18	1.7 ± 0.9	4.0 ± 1.2	5.7 ± 14.0
	4/17	0.3 ± 0.9	3.2 ± 1.3	5.2 ± 11.7
	7/17	0.5 ± 1.1	3.8 ± 2.0	0.2 ± 11.7
	10/17	1.6 ± 1.4	3.5 ± 1.4	-11.9 ± 16.9
J-14 WW	1/18	2.7 ± 1.7	7.3 ± 1.7	-11.8 ± 13.2
	5/8	2.8 ± 1.8	8.6 ± 2.1	5.2 ± 14.1
	5/8 FD[(b)]	4.6 ± 2.1	2.0 ± 1.1	-1.1 ± 12.8
	7/17	2.3 ± 1.7	11.9 ± 3.1	-3.0 ± 11.5
	10/17	3.3 ± 2.0	4.9 ± 1.7	6.0 ± 19.4
	10/17 FD	NA[(c)]	NA	-17.9 ± 18.7
WW #4	1/18	6.2 ± 2.1	5.2 ± 1.5	-7.7 ± 13.5
	4/17	7.0 ± 2.9	5.3 ± 1.7	14.2 ± 14.0
	7/17	11.2 ± 3.6	6.5 ± 2.4	-5.7 ± 9.8
	10/17	9.7 ± 3.2	6.0 ± 1.8	-23.4 ± 19.0
	10/17 FD[(b)]	NA	NA	-16.0 ± 19.0
WW #4A	1/18	9.2 ± 2.8	7.0 ± 1.8	1.7 ± 13.7
	1/18 FD	NA	NA	-0.6 ± 13.1
	4/17	6.0 ± 1.8	10.0 ± 2.7	6.6 ± 12.9
	7/17	7.1 ± 2.5	9.4 ± 2.3	-4.7 ± 10.3
WW 5B	1/18	5.8 ± 2.2	10.7 ± 2.6	5.6 ± 13.8
	4/17	4.8 ± 2.1	10.4 ± 2.3	7.0 ± 13.7
	4/17 FD	NA	NA	9.0 ± 13.4
	7/17	5.1 ± 2.3	10.0 ± 2.7	-12.5 ± 9.6
	7/17 FD	NA	NA	-2.7 ± 10.2
	10/17	4.3 ± 2.1	9.4 ± 2.3	0.3 ± 17.2
WW 8	1/18	1.1 ± 0.8	3.1 ± 1.2	3.9 ± 13.3
	4/17	0.0 ± 0.7	2.1 ± 1.3	4.7 ± 12.8
	7/17	0.3 ± 1.0	2.8 ± 1.9	3.3 ± 11.8
	10/17	0.9 ± 1.2	3.4 ± 1.6	-11.6 ± 17.4
Non-potable and Inactive Wells				
Army #1 WW	1/18	6.5 ± 2.7	6.8 ± 1.9	3.3 ± 13.6
	4/17	3.4 ± 2.1	1.7 ± 1.3	6.4 ± 12.5
	7/17	5.3 ± 2.3	5.2 ± 2.1	0.2 ± 11.4
	10/17	3.0 ± 1.8	2.8 ± 1.2	-7.0 ± 17.0
UE-16D WW	1/18	9.8 ± 3.3	7.3 ± 2.1	3.4 ± 13.6
	4/17	7.2 ± 2.9	6.9 ± 1.9	3.3 ± 12.2
	7/17	3.7 ± 2.0	7.6 ± 2.4	-2.1 ± 10.3
	10/17	5.8 ± 2.4	5.0 ± 1.6	-21.1 ± 18.6
WW 5C	1/18	14.8 ± 4.2	6.9 ± 1.8	-4.0 ± 14.0
	4/17	3.4 ± 2.0	8.3 ± 2.0	11.3 ± 13.8
	7/17	7.0 ± 2.8	7.1 ± 2.3	-3.9 ± 10.1
	10/17	3.1 ± 1.9	4.4 ± 1.5	-10.9 ± 16.9

Table 5-3. Gross alpha, gross beta, and tritium in NNSS water supply wells in 2012 (continued)

Location	Date Sampled	Concentration ± Uncertainty[(a)] (pCi/L) Gross Alpha	Gross Beta	Tritium
Non-potable and Inactive Wells (continued)				
WW C-1	1/18	11.2 ± 3.5	14.0 ± 3.3	-8.4 ± 13.7
	4/17	10.3 ± 2.9	13.0 ± 2.7	11.6 ± 15.8
	7/17	16.6 ± 4.4	15.6 ± 4.2	-4.3 ± 11.2

Mean MDCs were 1.9, 1.9, 23.8 pCi/L for gross alpha, gross beta, and tritium, respectively.
The yellow shaded result exceeds the EPA MCL for gross alpha (15 pCi/L).
(a) ± 2 standard deviations (b) FD = Field duplicate sample (c) NA = Analysis not performed on this sample

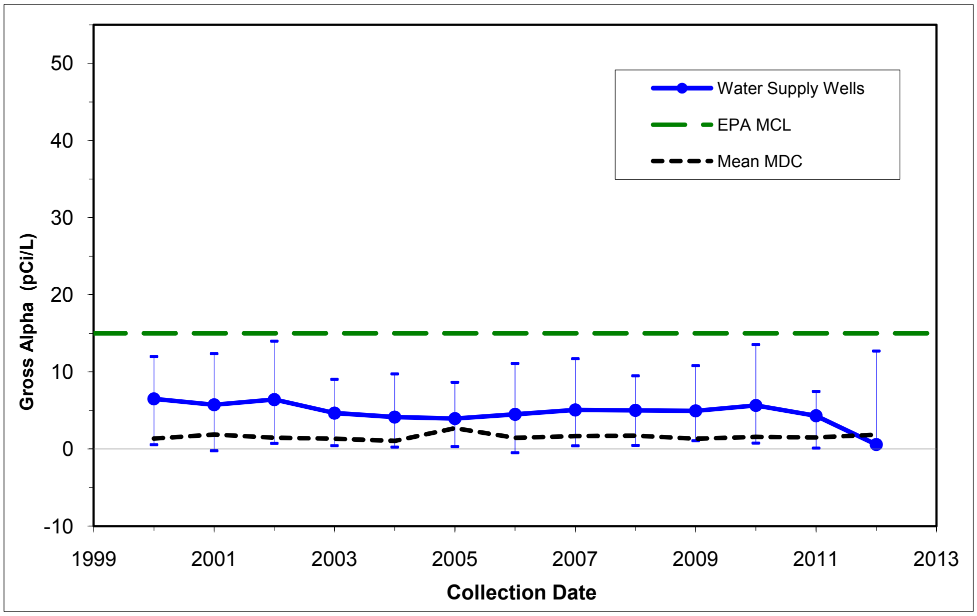


Figure 5-5. Gross alpha annual means for NNSS water supply wells from 2000 through 2012

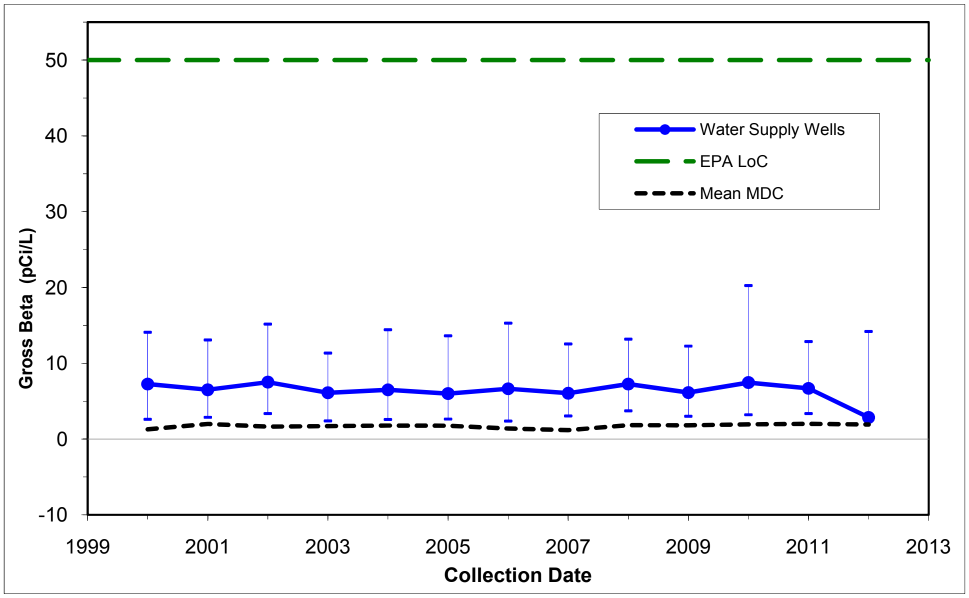


Figure 5-6. Gross beta annual means for NNSS water supply wells from 2000 through 2012

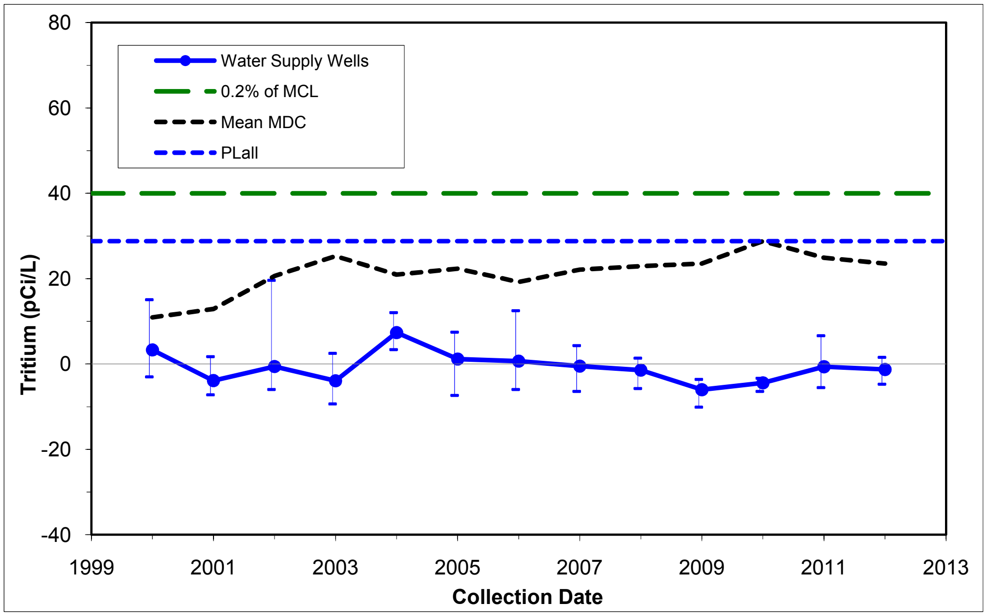


Figure 5-7. Tritium annual means for NNSS water supply wells from 2000 through 2012

5.1.7 Results from RREMP NNSS Monitoring Wells

In 2012, tritium was detected in three RREMP onsite monitoring wells (PM-1, UE-7NS, and WW A) (Table 5-4). Well U-19BH has also historically had concentrations above the MDC but far below the EPA MCL. These four wells are known to have, or have had, detectable concentrations of tritium, as reported in previous annual NNSS environmental reports. They are each located within 1 kilometer (km) (0.6 miles [mi]) of a historical underground nuclear test, as discussed below. Tritium concentrations in samples from these wells have been decreasing in recent years (Figure 5-8). Since 1999, estimated annual rates of decrease are 5.3%, 9.9%, 7.9%, and 5.6% for PM-1, U-19BH, UE-7NS, and WW A, respectively. These decreasing trends are statistically significant, with p-values of 0.001, 0.012, 0.000, and 0.000, respectively.

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

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

UE-7NS – This well is located in the Yucca Flat CAU and was drilled 137 m (449 ft) from the BOURBON underground nuclear test (U-7n), which was conducted in 1967. This well was routinely sampled between 1978 and 1987, with the resumption of sampling in 1991. Tritium levels in this well have been decreasing in recent years (Figure 5-8). UE-7NS is the second known location on the NNSS where the regionally important lower carbonate aquifer (LCA) has been impacted by radionuclides from nuclear testing (Smith et al. 1999).

Table 5-4. Gross alpha, gross beta, and tritium in NNSS monitoring wells in 2012

Location	Date Sampled	Concentration ± Uncertainty[a] (pCi/L) Gross Alpha	Gross Beta	Tritium
ER-19-1 (2,710 ft)	5/11	NA[b]	NA	6.3 ± 14.2
(3,280 ft)	5/11	NA	NA	1.0 ± 11.5
ER-20-1	6/12	NA	NA	-4.3 ± 13.2
	6/12 FD[c]	NA	NA	-3.4 ± 11.6
ER-20-2 #1	7/2	NA	NA	-4.4 ± 11.3
	7/2 FD	NA	NA	-7.6 ± 11.1
HTH #1 (1,935 ft)	2/29	1.9 ± 1.4	0.9 ± 1.0	2.7 ± 16.3
(2,040 ft)	2/29	0.7 ± 1.0	1.2 ± 1.0	14.6 ± 18.7
(2,130 ft)	2/29	0.7 ± 1.0	1.2 ± 1.1	3.1 ± 18.8
(2,300 ft)	2/29	3.6 ± 1.9	0.5 ± 1.0	5.8 ± 16.8
PM-1	3/13	NA	NA	105.0 ± 22.0
SM-23-1	9/18	NA	NA	-7.8 ± 19.1
TW D	2/7	2.0 ± 1.6	5.7 ± 1.7	4.7 ± 18.4
U-19BH	5/8	NA	NA	18.2 ± 17.7
UE-1Q	2/7	7.9 ± 3.0	11.1 ± 2.5	4.4 ± 16.4
UE5 PW-1[d]	3/21	NA	NA	-0.3 ± 14.5
	3/21 FD	NA	NA	3.4 ± 14.4
	8/7	NA	NA	-9.4 ± 19.1
	8/7 FD	NA	NA	18.1 ± 18.7
UE5 PW-2[d]	3/21	NA	NA	6.2 ± 13.0
	3/21 FD	NA	NA	5.9 ± 14.5
	8/7	NA	NA	14.4 ± 19.4
	8/7 FD	NA	NA	-0.7 ± 18.3
UE5 PW-3[d]	3/21	NA	NA	-0.05 ± 14.3
	3/21 FD	NA	NA	4.7 ± 14.2
	8/7	NA	NA	4.1 ± 17.3
	8/7 FD	NA	NA	5.3 ± 18.1
UE-7NS	2/14	0.7 ± 1.0	3.2 ± 1.4	94.2 ± 23.6
WW A	2/8	1.5 ± 1.4	5.9 ± 2.0	355.0 ± 44.7

The mean MDCs were 1.7, 1.7, and 26.9 for gross alpha, gross beta, and tritium respectively.
(a) ± 2 standard deviations
(b) NA = Analysis not performed based on decisions made during 2012 groundwater sampling integration meetings
(c) FD = field duplicate sample
(d) Compliance well for mixed low-level waste disposal cells at Area 5 RWMS (see Section 10.1.7)

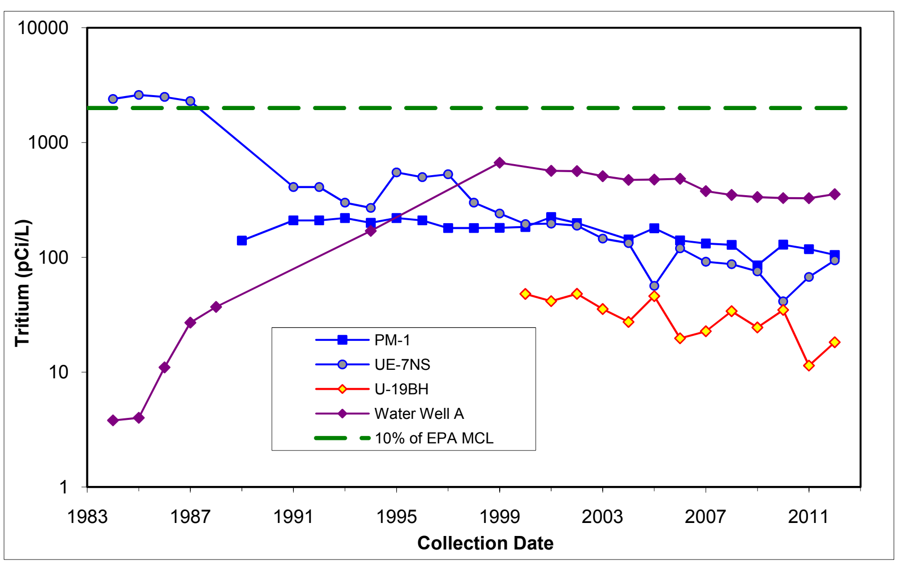


Figure 5-8. Tritium annual means for NNSS monitoring wells with histories of elevated concentrations

The first location where the LCA has been impacted by radionuclides from nuclear testing is Well UE-2CE, located less the 200 m (656 ft) from the NASH test conducted in Yucca Flat in 1967. Well UE-2CE is not configured for routine sampling, however.

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

Tritium was not detected in samples from the other RREMP onsite monitoring wells during 2012 (Table 5-4). Tritium histories for these other wells are shown in Figure 5-9.

Detectable concentrations of gross alpha and gross beta were present in water collected from the five NNSS onsite monitoring wells sampled in 2012 (Table 5-4). The gross alpha and gross beta radioactivity in most of these wells is likely from natural sources. The 2011 NNSS annual environmental report (NSTec 2012b) presents graphs of the trends in annual mean gross alpha and beta radioactivity in all RREMP onsite monitoring wells that were sampled routinely for these analytes from 2000 through 2011.

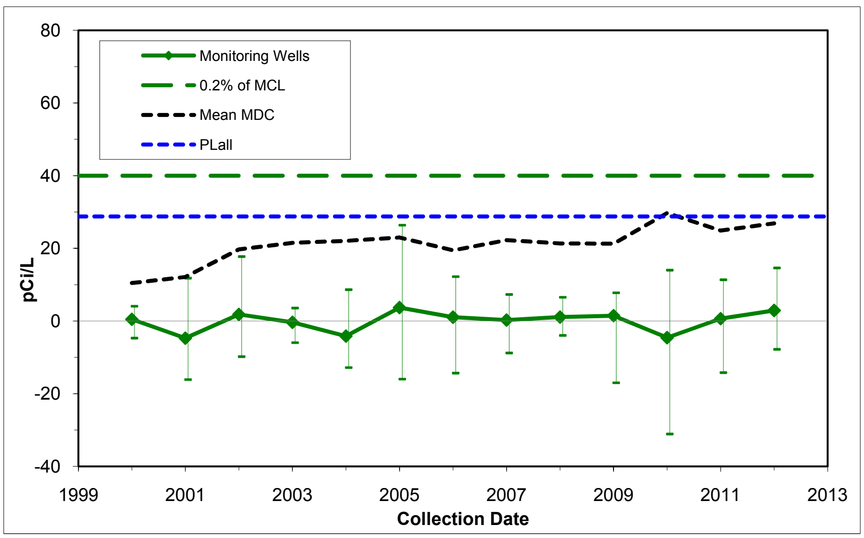


Figure 5-9. Tritium annual means for NNSS monitoring wells without histories of elevated concentrations

5.1.8 Results from E Tunnel Waste Water Disposal System (ETDS) Monitoring

NNSA/NFO manages and operates the ETDS in Area 12 under a 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 E Tunnel Ponds). The permit requires Well ER-12-1 groundwater to be monitored once every 24 months and E Tunnel discharge waters 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 8, 2012, the annual sampling of the ETDS discharge water was performed. Tritium, gross alpha, and gross beta levels for all samples were below the limits allowed under the permit (Table 5-5). Well ER-12-1 was last sampled in 2011 (NSTec 2012b), so it was not sampled in 2012.

Table 5-5. Gross alpha, gross beta, and tritium in ETDS discharge water samples in 2012

Radiological Parameter	Concentration ± Uncertainty[(a)] (pCi/L)	
	Permissible Limit	Measured Value
Tritium	1,000,000	419,000 ± 63,900
Gross Alpha	35.1	8.79 ± 1.66
Gross Beta	101	32.6 ± 5.32

(a) ± 2 standard deviations

5.1.9 Environmental Impact

The radiological impact to water resources from past activities on the NNSS is from man-made radionuclides in the groundwater within UGTA CAUs (Figure 5-1) and the migration of these radionuclides downgradient from the CAUs. In 2009, sampling of UGTA well ER-EC-11, 716.3 m (2,350 ft) west of the NNSS boundary (Section 11.1.4.2, Figure 11-8), confirmed the presence of tritium at elevated levels around 66% of the EPA drinking water MCL. This was the first time that radionuclides from NNSS underground tests (UGTs) had been detected in groundwater beyond NNSS boundaries. Those sampling results were consistent with UGTA's Pahute Mesa transport model, which predicts migration of tritium off the NNSS within 50 years of the first nuclear detonation (1965) from the Central and Western Pahute Mesa CAUs (Section 11.1.4.2, Figure 11-5). Tritium was not found in a deeper horizon in ER-EC-11 in the 2010 sampling, and this well was not sampled in 2011 or 2012. However, additional characterization sampling is planned for the near future.

Well sampling results to date have not detected the presence of man-made radionuclides downgradient of Pahute Mesa in 10 other UGTA wells on the Nevada Test and Training Range (ER-EC-1, -2A, -4, -5, -6, -7, -8, -13, -14, and -15; see Section 11.1, Figure 11-4). However, groundwater samples collected at Well ER-EC-12 in 2012 contained very low levels of tritium (4.2 pCi/L). Additional sampling and analyses is needed to confirm this marginally measureable amount of tritium. Samples from offsite RREMP monitoring wells in Oasis Valley, farther downgradient of Pahute Mesa, also contain no detectable man-made radionuclides. The groundwater samples collected in March 2012 under the RREMP from PM-3 at a depth 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). These concentration levels are far lower than the EPA MCL of 20,000 pCi/L and the RREMP action level of 2,000 pCi/L. PM-3 is 3,261 m (10,700 ft) west of the NNSS border. Hydrogeologic data west of the NNSS are sparse, and thus groundwater flow predictions are uncertain. The 2011 UGTA sample analysis results from PM-3 (NSTec 2012b) confirmed the presence of tritium in the well at these very low levels that were first noticed in May 2010. Currently there are several developing hypotheses to explain the occurrence of tritium at PM-3. UGTA also has additional sampling activities planned for the near future following procurement of appropriate pumping hardware. Results from a more comprehensive suite of water analyses are expected to provide the necessary information to identify the source of the tritium.

On the NNSS and immediately downgradient of Pahute Mesa, groundwater monitoring results indicate that the migration of radionuclides from UGTs is not significant in distance. UGTA Wells ER-EC-11 and ER-20-11, completed in 2009 and 2012 respectively, intercepted a contaminant plume of tritium believed to originate from two UGTs, TYBO and BENHAM, which are about 2,987 m (9,800 ft) and 4,084 m (13,400 ft) from both ER-EC-11 and ER-20-11, respectively. As mentioned above, Well ER-EC-12 with 4.2 pCi/L of tritium (if confirmed), may be at the front edge of this same plume. Well ER-EC-12 is located 5.6 km (3.5 mi) and 6.7 km (4.1 mi) southwest of the possible sources TYBO and BENHAM, respectively. Groundwater from the four RREMP monitoring wells on the NNSS with detectable tritium levels (PM-1, U-19bh, UE-7nS, and WW A) are each within about 1,000 m (3,300 ft) of a UGT. Since 1999, their tritium concentrations have all been less than 3% of the EPA MCL for drinking water (20,000 pCi/L) and are low and/or statistically significantly decreasing, as discussed in Section 5.1.7.

The NDEP-approved method of containing tritium-contaminated waters in UGTA Activity's lined sumps and in the E Tunnel ponds exposes NNSS wildlife to tritium in their drinking water or aquatic habitat. 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 (BN 2004a; 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 2012 activities. Information about radiological monitoring of drinking water on and off the NNSS and wastewater on the NNSS is presented in Sections 5.1.5, 5.1.6, and 5.1.8.

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 5-10). 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 2012, 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 2012, 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 2012.

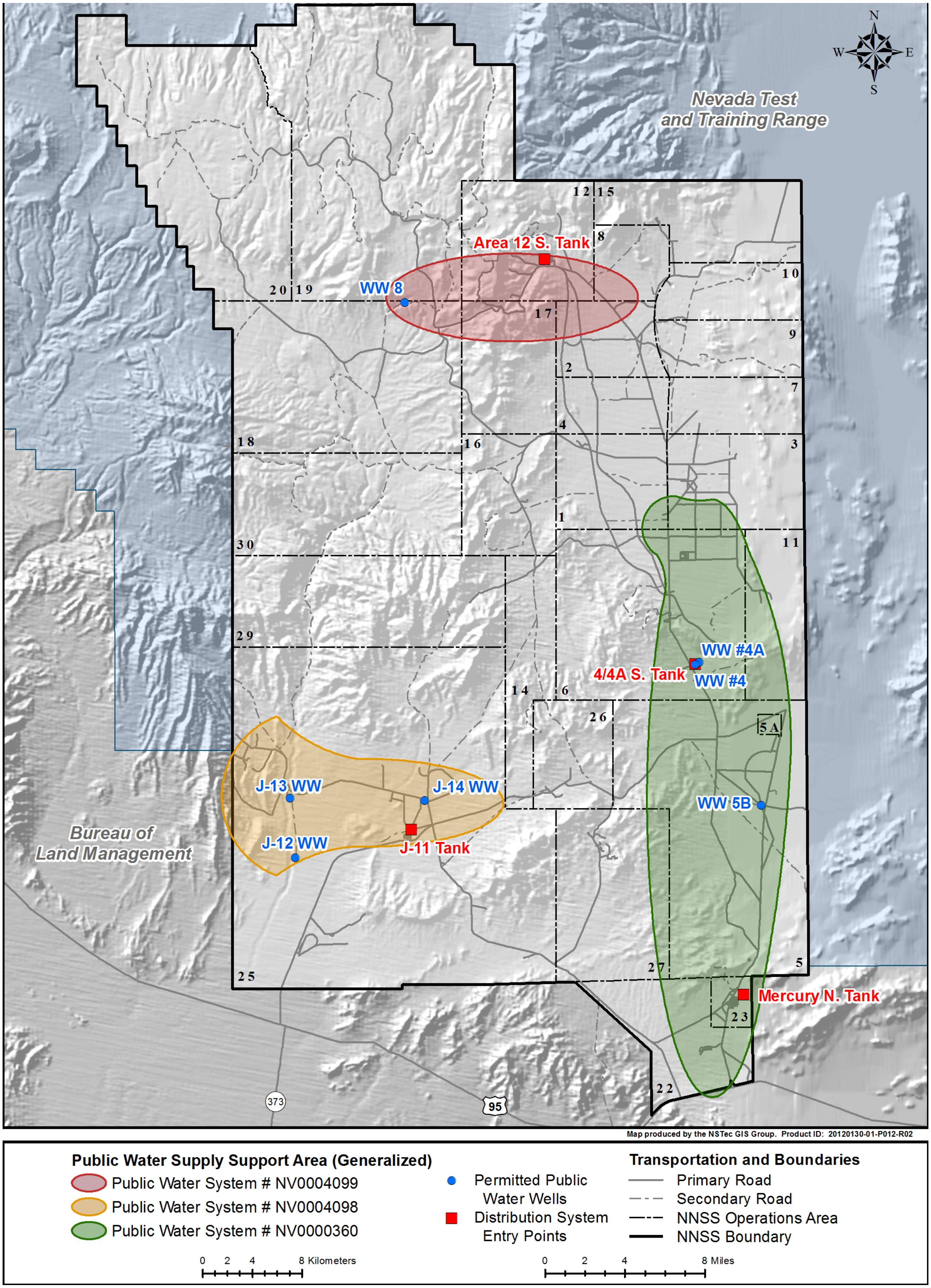


Figure 5-10. Water supply wells and drinking water systems on the NNSS

Table 5-6. 2012 monitoring parameters and sampling design for NNSS PWSs and permitted water-hauling trucks

PWS	Contaminant	2012 Monitoring Requirements Samples/Frequency	Monitoring Locations
Area 23 and 6	Coliform Bacteria	36 samples/ 3 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
	Nitrite	2 samples/ 1 per entry point every 3 years	
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	8 samples/ 2 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
	Nitrite	1 sample/ every 3 years	J-11 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	2012 Results (milligrams per liter [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)	3.80 and 2.80	1.10	1.80 and 1.10
Nitrite	1 mg/L (as nitrogen)	0.10 and 0.10	NA	0.10

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 2012, 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 2012, 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 5-11). 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 2012, there were no compliance actions relating to domestic wastewater on the NNSS.

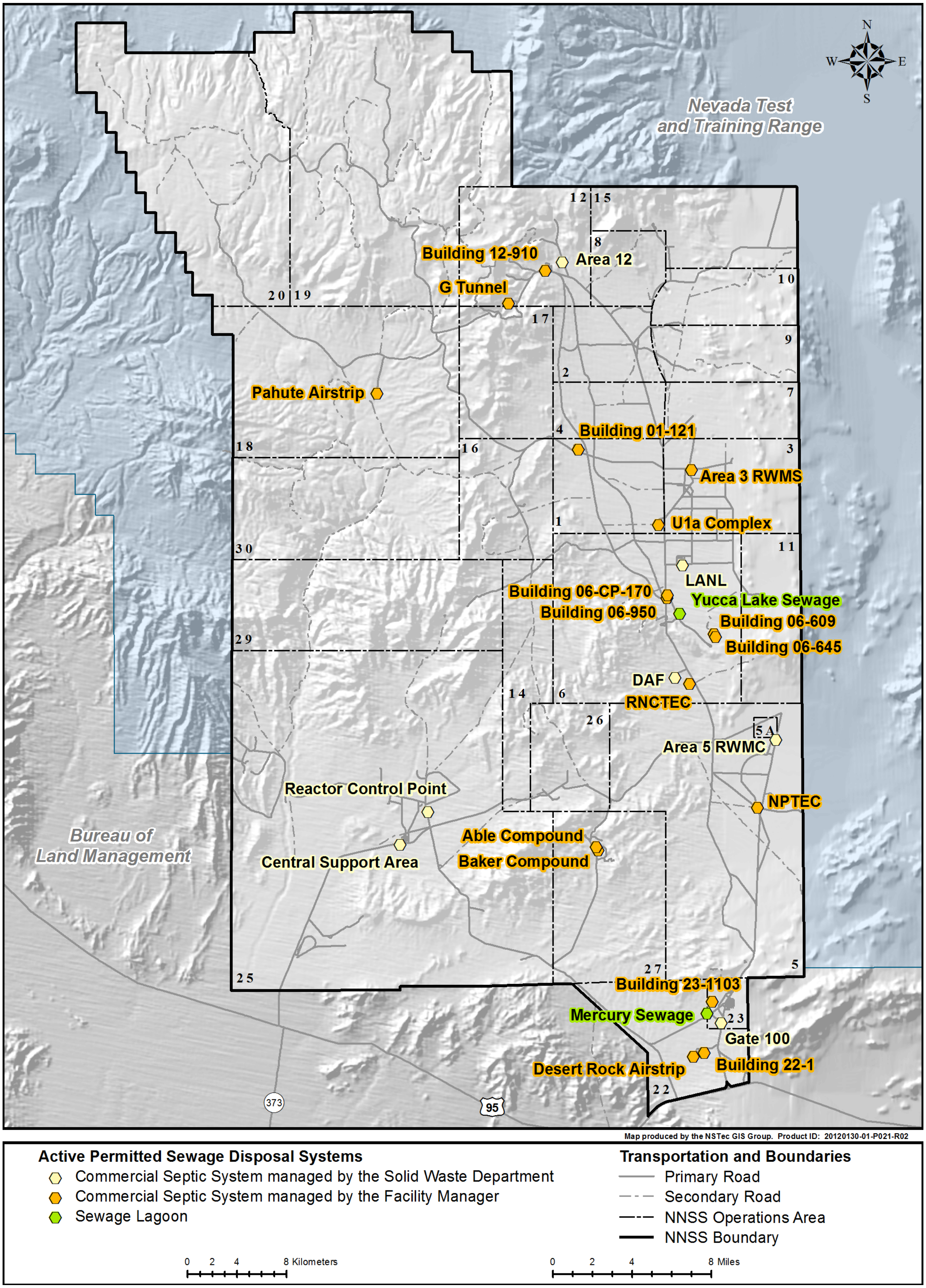


Figure 5-11. Active permitted sewage disposal systems on the NNSS

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 2012.

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 5-11). 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 2012, 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 2012 and in January 2013.

Table 5-8. Water quality analysis results for NNSS sewage lagoon influent waters in 2012

		Minimum and Maximum Values from Quarterly Samples	
Parameter	**Units**	**Area 6 Yucca Lake**	**Area 23 Mercury**
BOD_5	mg/L	20–177	36.9–182
Permit Limit		None	None
BOD_5 Mean Daily Load[(a)]	kg/d	0.19–2.33	3.49–23.13
Permit Limit		8.66	115.4
TSS	mg/L	60–1130	75–293
Permit Limit		None	None
pH	S.U.[(b)]	7.94–8.27	8.53–8.80
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 2012. 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 2012.

5.2.3.2 Sewage System Inspections

The sewage system operators inspect active systems weekly and inactive lagoon systems quarterly. NDEP inspects both active and inactive NNSS lagoon systems annually. Onsite operators inspect for abnormal conditions, weeds, algae blooms, pond color, abnormal odors, dike erosion, burrowing animals, discharge from ponds or lagoons, depth of staff gauge, crest level, excess insect population, maintenance/repairs needed, and general conditions. 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 did not conduct an annual inspection in 2012.

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 (BFF). The permit governs the management of radionuclide-contaminated wastewater that drains from the E Tunnel portal into a series of holding ponds. The permit requires ETDS discharge waters to be monitored every 12 months for radiological parameters (see Section 5.1.8, Table 5-5) 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 BFF in annual and quarterly reports.

On October 8, 2012, monitoring personnel sampled the ETDS discharge water, and all nonradiological parameters were within the threshold limits specified by the permit (Table 5-9). All 2012 monthly measurements and observations demonstrated compliance with permit limits and specifications, with the exception of SC measurements at the ETDS discharge point. All 2012 monthly SC measures were below the lower permit limit of 400 microsiemens per centimeter (μS/cm), ranging from 345.1 to 390.8 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 will reevaluate the permit limits for SC when the permit is renewed in 2013.

Well ER-12-1 was not sampled in 2012. It was last sampled in 2011 and is scheduled for sampling in 2013.

Table 5-9. Nonradiological results for ETDS discharge samples

Nonradiological Parameter	Concentration (mg/L) Threshold	Concentration (mg/L) Measured Value
Cadmium	0.045	0.000271[a]
Chloride	360	9.11
Chromium	0.09	0.000790[a]
Copper	1.2	0.00209[a]
Fluoride	3.6	< 0.50
Iron	5.0	2.20
Lead	0.014	< 0.001
Magnesium	135	1.15
Manganese	0.25	0.0262
Mercury	0.0018	< 0.00006
Nitrate nitrogen	9	1.29
Selenium	0.045	< 0.003
Sulfate	450	16.6
Zinc	4.5	0.111
pH (S.U.)[b]	6.0–9.0	7.39
Specific conductance (μS/cm)[c]	400–500	386.9

(a) Estimated quantity based on the minimum detection limit
(b) S.U. = standard unit(s) (for measuring pH)
(c) μS/cm = microsiemens per centimeter

Sources: (NSTec 2013c)

5.2.5 Environmental Impact

The results of all drinking water and wastewater monitoring in 2012 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 11.1.2). 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.

THIS PAGE INTENTIONALLY LEFT BLANK

6.0 Direct Radiation Monitoring

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). Radionuclides present in the Nevada National Security Site (NNSS) environment could potentially be deposited in humans and animals through inhalation and ingestion. Chapters 4, 5, and 8 present the results of monitoring radionuclides in air, water, and biota, respectively, on the NNSS; those results are used to estimate potential internal radiation dose to the public via inhalation and ingestion. Energy absorbed from radioactive materials outside of the body results in an external dose. External dose comes from direct ionizing radiation from all sources on the 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 2012.

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 2012 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 2003a).

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 108 active environmental TLD locations on the NNSS (Figure 6-1) during 2012. They include the following numbers and types of locations:

- 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. These include one new location called A5 RWMS North, which replaces the location named A5 RWMS NW Corner which was decommissioned after 2011.
- Control (C) – 5 locations in Building 652 and 1 location in Building 650 in Mercury. Control TLDs are kept in stable environments and are used as a quality check on the TLDs and the analysis process.

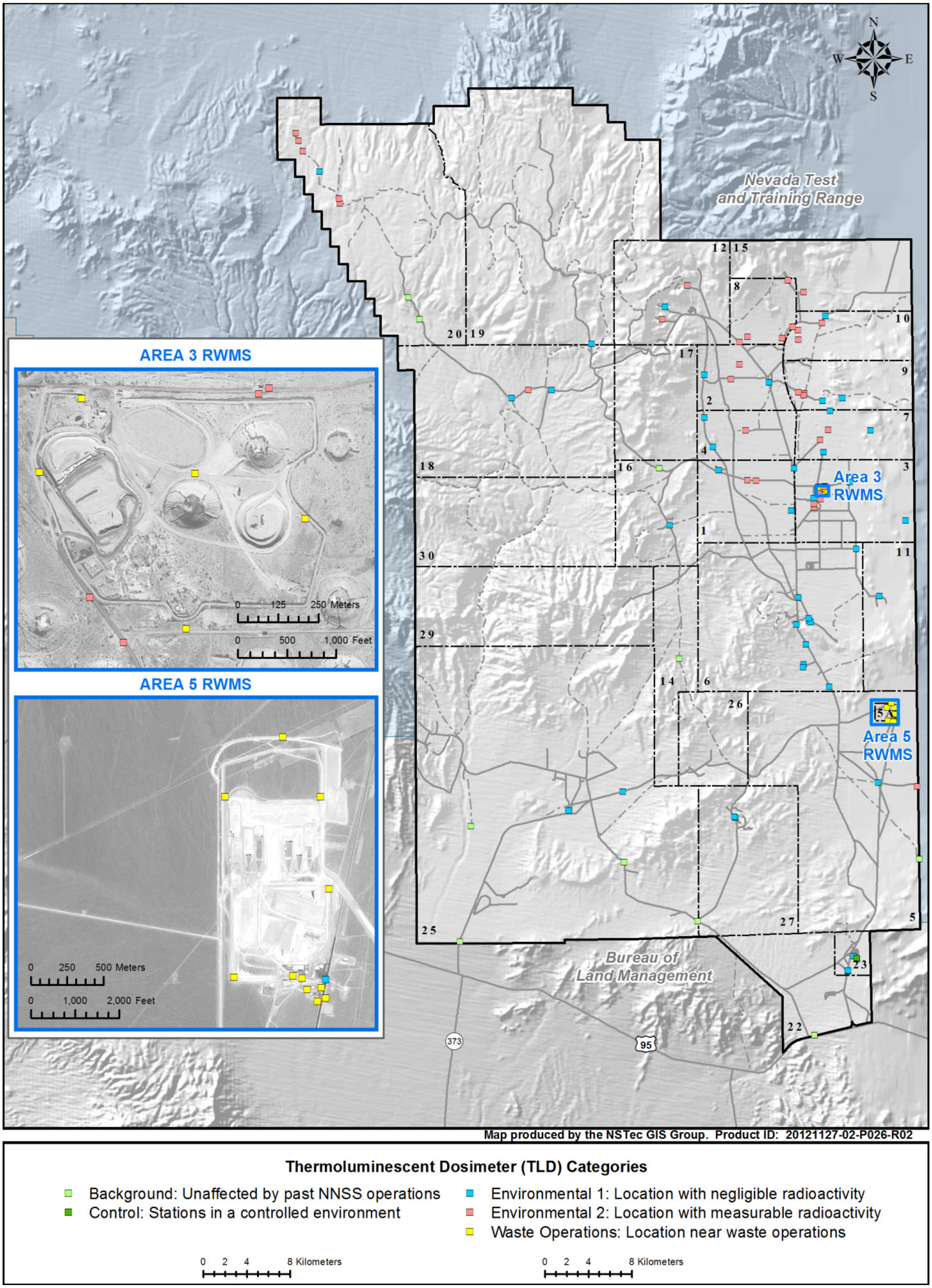


Figure 6-1. Location of TLDs on the NNSS

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. TLD processing and collection errors occurred in 2012; data for the first quarter from all locations were lost due to a read error during TLD processing, and the TLDs in the five shielded locations were not collected at the end of the second quarter due to a collection error. Agreement between the results provided by the paired TLDs successfully collected over the year was quite good, with an average relative percent difference between measurements of 3.5%. The quarter-to-quarter coefficient of variation (CV, identical to the relative standard deviation) ranged from 0.2% to 9.6% (median = 2.8%) over all locations excluding Gate 100 Truck Parking 1 (see the discussion in Section 6.3.1).

During 2012, the average of the estimated annual exposures among the 10 background locations was 120 mR, ranging from 66 to 165 mR (Table 6-2). A 95% prediction interval for annual exposures based on the 2012 estimated mean annual exposures at the background locations (denoted “95% PI from B” in the plots) is 43.2 to 196.8 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 100 mR during 2012 (see Table 7-3). Estimated exposures at CEMP locations ranged from 78 mR at Pahrump, Nevada (804 m [2,639 ft] elevation), to 147 mR at Sarcobatus Flats, Nevada (1,223 m [4,015 ft] elevation). There is a slight 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 2012

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	3	66	62	69
14	Mid-Valley	B	3	149	147	152
16	Stake P-3	B	3	120	119	120
20	Stake A-112	B	3	165	162	168
20	Stake A-118	B	3	152	148	156
22	Army #1 Water Well	B	3	89	80	97
25	Gate 25-4-P	B	3	135	125	142
25	Gate 510	B	3	131	130	132
25	Jackass Flats & A-27 Roads	B	3	85	80	88
25	Skull Mtn Pass	B	3	109	108	113
23	Building 650 Dosimetry	C	3	62	61	64
23	Lead Cabinet, 1	C	2	24	23	25
23	Lead Cabinet, 2	C	2	25	25	25
23	Lead Cabinet, 3	C	2	26	26	26
23	Lead Cabinet, 4	C	2	25	25	25
23	Lead Cabinet, 5	C	2	24	23	24
1	BJY	E1	3	119	117	120
1	Sandbag Storage Hut	E1	3	117	114	119
1	Stake C-2	E1	3	113	105	117
2	Stake M-140	E1	3	135	129	138
2	Stake TH-58	E1	3	98	91	105
3	LANL Trailers	E1	3	122	115	132
3	Stake OB-20	E1	3	91	89	94
3	Well ER 3-1	E1	3	127	125	129
4	Stake TH-41	E1	3	115	109	121
4	Stake TH-48	E1	3	122	116	130
5	Water Well 5B	E1	3	115	111	118
6	CP-6	E1	3	72	70	75
6	DAF East	E1	3	99	97	102
6	DAF North	E1	3	105	99	108
6	DAF South	E1	3	138	136	141
6	DAF West	E1	3	86	85	86
6	Decon Facility NW	E1	3	128	124	133
6	Decon Facility SE	E1	3	135	131	140
6	Stake OB-11.5	E1	3	132	130	137
6	Yucca Compliance	E1	3	95	92	98
6	Yucca Oil Storage	E1	3	101	99	105
7	Reitmann Seep	E1	3	123	121	124
7	Stake H-8	E1	3	128	124	131
9	Papoose Lake Road	E1	3	89	86	92
9	U-9CW South	E1	3	104	98	107
9	V & G Road Junction	E1	3	114	111	117
10	Gate 700 South	E1	3	128	122	132
11	Stake A-21	E1	3	134	132	136
12	Upper N Pond	E1	3	133	127	137
16	3545 Substation	E1	3	142	137	147

Table 6-1. Annual direct radiation exposures measured at TLD locations on the NNSS in 2012 (continued)

NNSS Area	Station	Location Type[b]	Number of Quarters	Estimated Annual Exposure (mR)[a] Mean[c]	Minimum[c]	Maximum[c]
18	Stake A-83	E1	3	151	147	155
18	Stake F-11	E1	3	151	146	158
19	Stake P-41	E1	3	165	158	173
20	Stake J-41	E1	3	143	138	148
23	Gate 100 Truck Parking 1	E1	3	94	75	132
23	Gate 100 Truck Parking 2	E1	3	68	62	75
23	Mercury Fitness Track	E1	3	63	62	64
25	HENRE	E1	3	127	124	131
25	NRDS Warehouse	E1	3	127	125	129
27	Cafeteria	E1	3	120	116	123
27	JASPER-1	E1	3	118	114	124
1	Bunker 1-300	E2	3	121	120	122
1	T1	E2	3	248	245	251
2	Stake L-9	E2	3	163	159	169
2	Stake N-8	E2	3	433	427	441
3	Stake A-6.5	E2	3	137	133	141
3	T3	E2	3	318	311	326
3	T3 West	E2	3	307	302	314
3	T3A	E2	3	347	345	349
3	T3B	E2	3	434	427	444
3	U-3co North	E2	3	181	177	185
3	U-3co South	E2	3	140	137	145
4	Stake A-9	E2	3	541	521	560
5	Frenchman Lake	E2	3	295	291	298
7	Bunker 7-300	E2	3	210	204	213
7	T7	E2	3	114	110	119
8	Baneberry 1	E2	3	335	330	344
8	Road 8-02	E2	3	125	123	127
8	Stake K-25	E2	3	99	94	101
8	Stake M-152	E2	3	156	154	158
9	B9A	E2	3	132	129	135
9	Bunker 9-300	E2	3	125	122	128
9	T9B	E2	3	451	439	464
10	Circle & L Roads	E2	3	117	113	120
10	Sedan East Visitor Box	E2	3	135	133	138
10	Sedan West	E2	3	220	220	220
10	T10	E2	3	244	236	250
12	T-Tunnel #2 Pond	E2	3	247	234	254
12	Upper Haines Lake	E2	3	113	106	117
15	EPA Farm	E2	3	112	107	116
18	Johnnie Boy North	E2	3	153	151	155
20	Palanquin	E2	3	223	219	226
20	Schooner-1	E2	3	570	569	571
20	Schooner-2	E2	3	241	238	246
20	Schooner-3	E2	3	141	139	143
20	Stake J-31	E2	3	159	156	162

Table 6-1. Annual direct radiation exposures measured at TLD locations on the NNSS in 2012 (continued)

NNSS Area	Station	Location Type[b]	Number of Quarters	Estimated Annual Exposure (mR)[a] Mean[c]	Minimum[c]	Maximum[c]
3	A3 RWMS Center	WO	3	140	136	143
3	A3 RWMS East	WO	3	140	131	152
3	A3 RWMS North	WO	3	127	123	129
3	A3 RWMS South	WO	3	311	306	315
3	A3 RWMS West	WO	3	130	126	135
5	A5 RWMS East Gate	WO	3	103	101	104
5	A5 RWMS Expansion NE	WO	3	138	135	143
5	A5 RWMS Expansion NW	WO	3	155	152	160
5	A5 RWMS NE Corner	WO	3	126	121	132
5	A5 RWMS North	WO	3	146	143	148
5	A5 RWMS South Gate	WO	3	110	106	113
5	A5 RWMS SW Corner	WO	3	126	120	130
5	Building 5-31	WO	3	105	101	108
5	WEF East	WO	3	124	120	129
5	WEF North	WO	3	118	113	126
5	WEF South	WO	3	127	125	130
5	WEF West	WO	3	123	120	128

(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. In general, each quarterly estimate is the average of two TLD readings per location.

Table 6-2. Summary statistics for 2012 mean annual direct radiation exposures by TLD location type

Location Type	Number of Locations	Estimated Annual Exposure (mR) Mean	Minimum	Maximum
Background (B)	10	120	66	165
Control (C)	6	25	24	26
Environmental 1 (E1)	41	117	63	165
Environmental 2 (E2)	35	231	99	570
Waste Operations (WO)	17	138	103	311

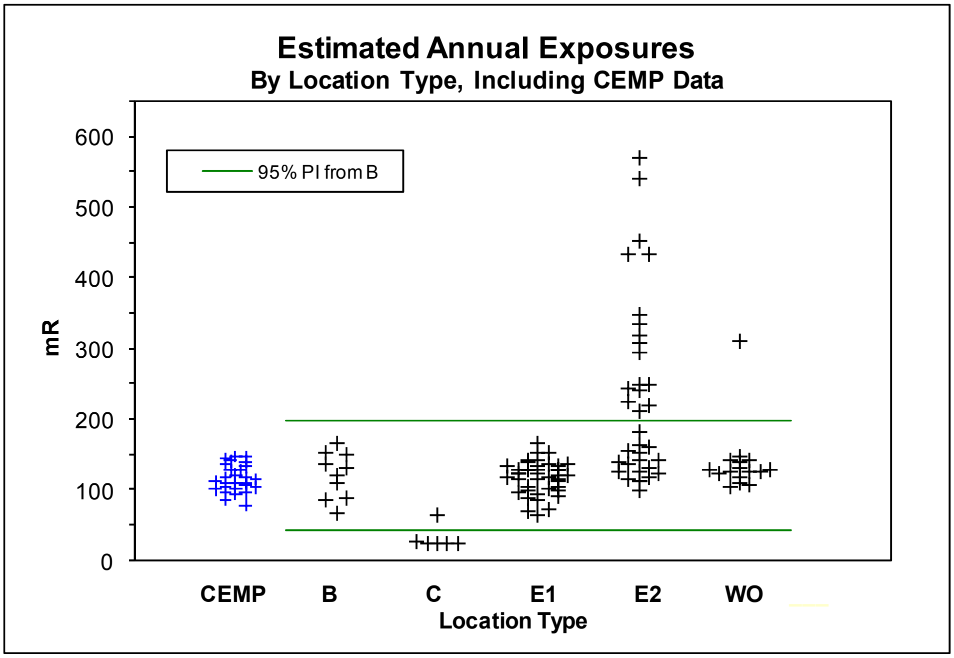


Figure 6-2. 2012 annual exposures on the NNSS, by location type, and off the NNSS at CEMP stations

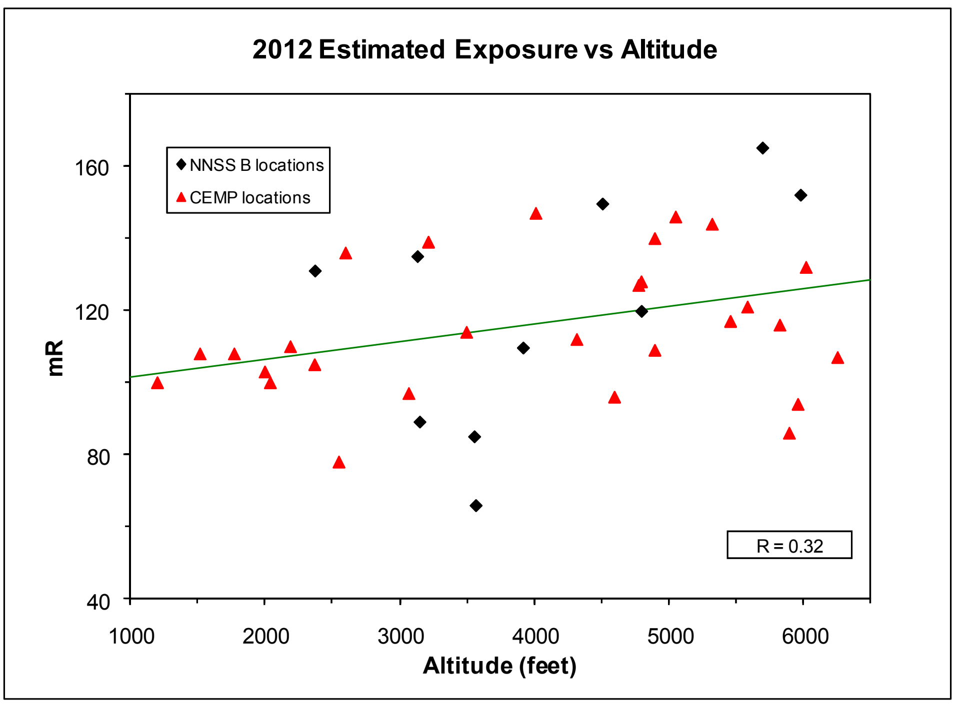


Figure 6-3. Correlation between 2012 annual exposures at NNSS Background and CEMP TLD locations and altitude

6.3.1 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 68 mR, with quarterly estimates varying between 62 and 75 mR. These values are similar to the lower end of the range of background exposures observed at the NNSS.

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, as documented in previous annual environmental reports. Its average value for 2012 was 94 mR, with quarterly estimates of 75, 132, and 75 mR. These are all within the range of background variation; however, the third quarter values are higher than those at Truck Parking 2 and the nearby Mercury Fitness Track station, likely due to exposure to waste shipments. Also, the relative percent difference between the two TLDs at that location was 21.6% for the third quarter, rather high when compared to other locations.

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 2013).

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 2012 was 295 mR. This has been consistently declining over time, down from 411 mR in 2004. The resulting estimated above-background dose during 2012 would be approximately 130 to 229 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.

6.3.2 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 117 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.

6.3.3 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 which 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 2012 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 2012.

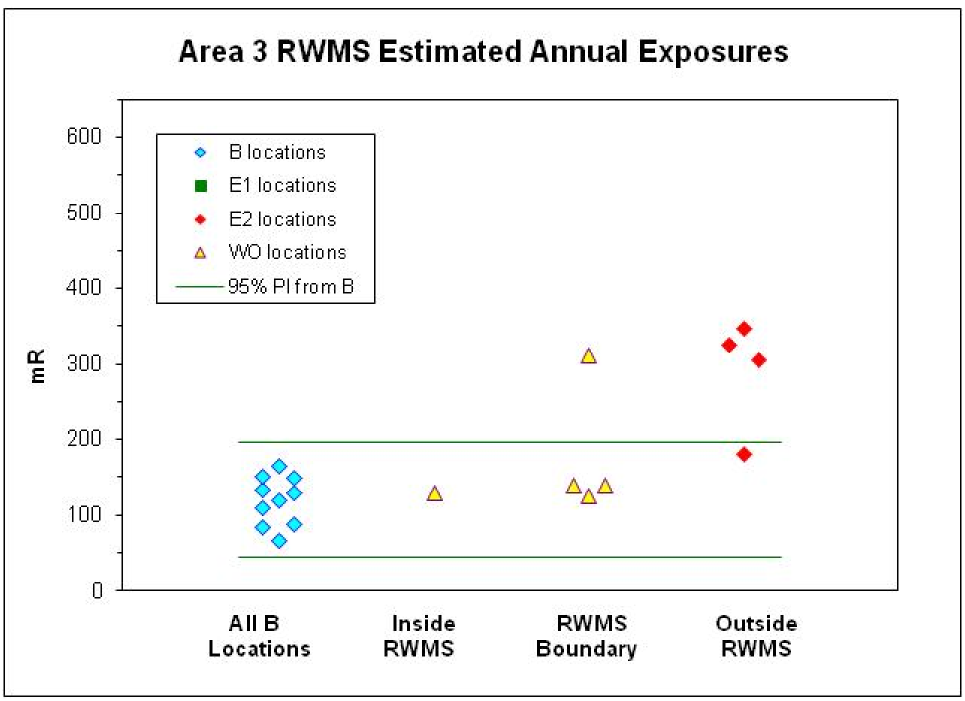


Figure 6-4. 2012 annual exposures in and around the Area 3 RWMS and at background locations

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 2012, 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.

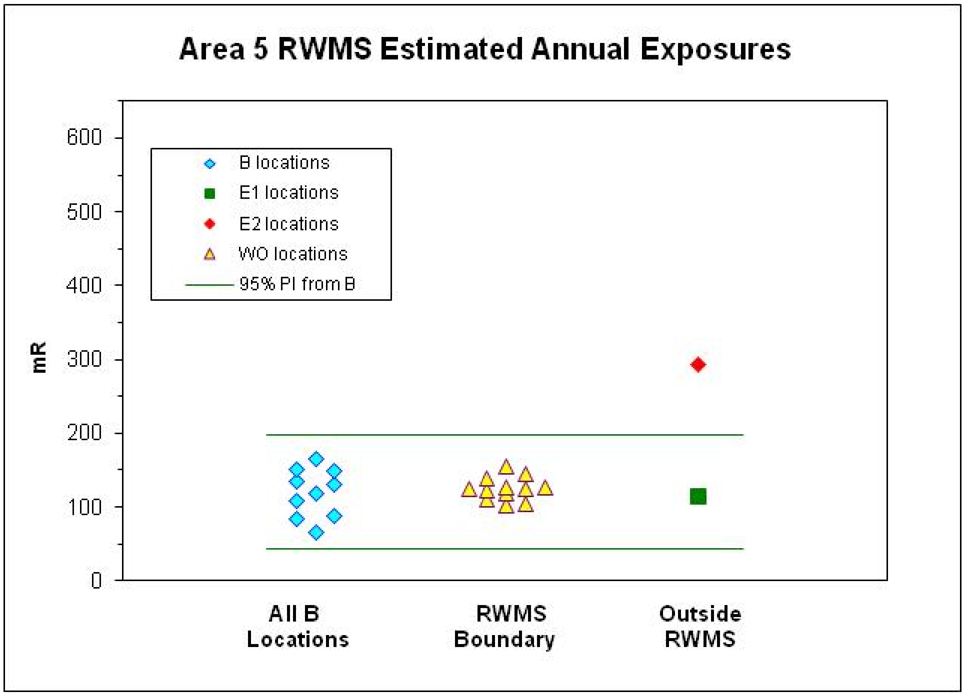


Figure 6-5. 2012 annual exposures around the Area 5 RWMS and at background locations

6.3.4 Exposures to NNSS Plants and Animals

The highest exposure rate measured at any TLD location during 2012 was 571 mR/yr (1.56 mR/d), at the Schooner-1 location during the second 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.

6.3.5 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 2012, the CVs for measurements between quarters averaged 3.4%. Only the CV for the Gate 100 Truck Parking 1 location (35.0%) was 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 0.31% per year, those at E2 locations decreased 2.01%

per year on average, and those at WO locations decreased 0.71% per year on average. Annual exposures decreased 3.22% per year on average at those locations with significant added man-made radiation, which are the E2 and WO locations with 2012 estimated exposures higher than the 95% PI of B locations. These average rates of decay are very similar to those measured from 2008 through 2011. 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 both decreasing at a rate of about 50% every 13 and 17 years, respectively.

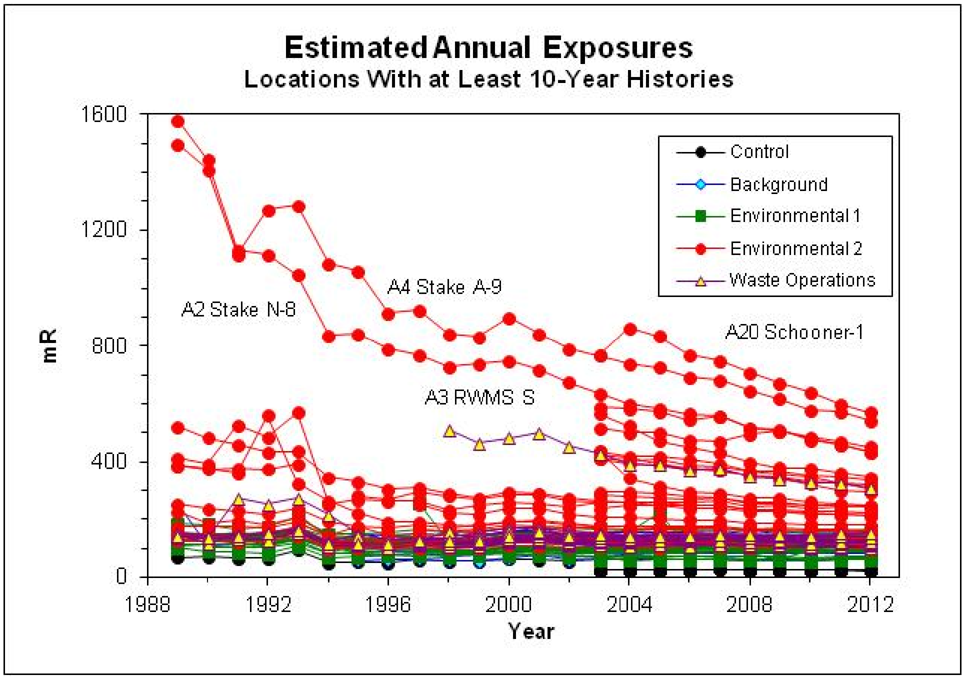


Figure 6-6. Trends in direct radiation exposure measured at TLD locations

6.4 Environmental Impact

Direct radiation exposure to the public from NNSS operations during 2012 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.

7.0 Community Environmental Monitoring Program

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 offsite 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 2012 Station Evaluations and Changes

In 2012 and for the previous 13 years, DRI managed 29 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, which are described in Section 7.1.2 below. In 2012, NNSA/NFO and DRI began evaluating the possibility of removing the radiation monitoring equipment from those CEMP air monitoring stations located on ranches without CEMs in order to provide a gradual transition of the CEMP toward a vision of increased public outreach in participating communities. These ranch stations include Stone Cabin, Twin Springs, Nyala Ranch, Medlin's Ranch, and Garden Valley, and they represent the greatest relative cost to the CEMP in terms of the need for personnel to visit the stations on a bi-weekly schedule to collect air filter samples. They are also perceived as having the least public benefit in terms of public visibility and educational outreach. There are no CEMs associated with these stations, and there is little or no participation in the CEMP workshops by the ranchers who live on these ranches.

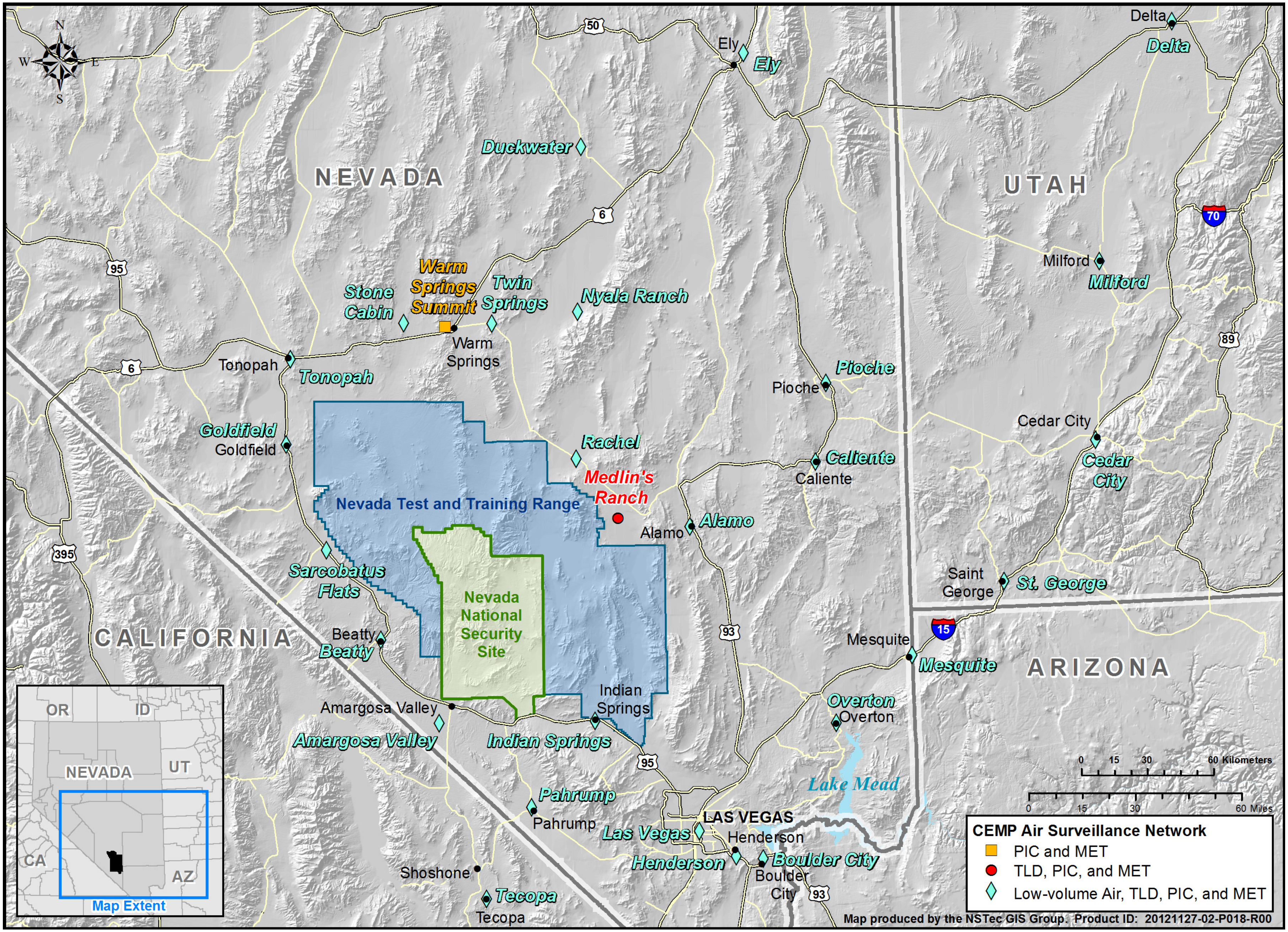


Figure 7-1. 2012 CEMP Air Surveillance Network

DRI conducted informal notifications to participating ranchers, followed by formal written notification detailing the justifications for the removal of the equipment and providing opportunity to meet with representatives of NNSA/NFO and DRI to discuss concerns or questions about the process. A final written notification and opportunity to provide written feedback was provided following meetings. As a result, air samplers, pressurized ion chambers (PICs), and thermoluminescent dosimeters (TLDs) were removed from the five ranch stations previously mentioned by the end of September 2012. Meteorological and communications equipment were left in place unless ranchers requested otherwise. Garden Valley was the only station to be completely decommissioned. Quarterly maintenance visits continue to be planned for 2013. Leaving this infrastructure in place will make it easy to re-install other equipment at a later date in the event the mission of the NNSS changes. Ranchers will remain on the mail distribution list unless requested otherwise, and will be welcome to continue participation in the program through attendance at CEMP workshops. All archived data from the ranch stations will continue to be accessible online at the CEMP website.

7.1.2 Air Monitoring Equipment

CEMP Low-Volume Air Sampler Network – During 2012, the CEMP ASN included continuously operating low-volume particulate air samplers located at 27 of the 29 CEMP station locations. No low-volume air samplers were located at Medlin's Ranch or Warm Springs Summit, Nevada, during 2012. Duplicate air samples were collected from up to three ASN stations each week. 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 2012, this network consisted of fixed environmental TLDs at 28 of the 29 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 environmental stations. An average daily exposure rate was calculated for each quarterly exposure period. The average of the quarterly values was multiplied by 365.25 days to obtain the total annual exposure for each station.

CEMP Pressurized Ion Chamber (PIC) Network – The PIC detector measures gamma radiation exposure rates and, because of its sensitivity, may detect low-level exposures that go undetected by other monitoring methods. PICs are in place at all stations in the CEMP network (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 – Because changing weather conditions can have an effect on measurable levels of background radiation, meteorological instrumentation is in place at each of the 29 CEMP stations. The MET network includes sensors that measure air temperature, humidity, wind speed and direction, solar radiation, barometric pressure, precipitation, and soil temperature and moisture data. All of these data can be observed real-time at the onsite station display, and archived data are available by accessing the CEMP home page at http://www.cemp.dri.edu/.

The CEMP station in Beatty, Nevada, is shown in Figure 7-2.

Figure 7-2. CEMP Station in Beatty, Nevada

7.1.3 Air Sampling Methods

During 2012, CEMP air samples were collected on a bi-weekly basis. This sampling frequency results in the possible collection of 26 samples per year for each station. In 2012, however, due to equipment removal from the ranch stations, only 19 samples were collected from the four ranch stations at which low-volume air samplers had been located. 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.

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 $1.03 \pm 0.29 \times 10^{-15}$ microcuries per milliliter (μCi/mL) ($3.81 \pm 1.07 \times 10^{-5}$ becquerels [Bq]/m^3) (Table 7-1). Gross alpha was detectable in all of the 2012 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.

The mean annual gross beta activity across all sample locations (Table 7-2) was $1.98 \pm 0.21 \times 10^{-14}$ μCi/mL ($7.33 \pm 0.77 \times 10^{-4}$ 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 7-1. Gross alpha results for the CEMP offsite ASN in 2012

Sampling Location	Number of Samples	Concentration (× 10^{-15} µCi/mL [3.7 × 10^{-5} Bq/m^3]) Mean	Standard Deviation	Minimum	Maximum
Alamo	26	1.78	0.67	0.67	3.42
Amargosa Valley	26	1.06	0.42	0.47	2.28
Beatty	26	1.13	0.61	0.56	3.29
Boulder City	26	1.33	0.70	0.37	3.91
Caliente	26	1.60	0.74	0.63	3.25
Cedar City	26	0.63	0.24	0.26	1.41
Delta	26	0.77	0.22	0.52	1.27
Duckwater	26	0.97	0.32	0.54	2.03
Ely	26	0.87	0.22	0.46	1.54
Garden Valley	19	0.93	0.32	0.51	1.78
Goldfield	26	1.05	0.50	0.31	2.58
Henderson	26	1.08	0.39	0.40	2.12
Indian Springs	26	0.84	0.28	0.26	1.46
Las Vegas	26	1.00	0.35	0.38	1.91
Mesquite	26	1.32	0.78	0.46	4.23
Milford	26	0.97	0.36	0.51	2.34
Nyala Ranch	19	1.03	0.39	0.49	1.88
Overton	26	1.76	1.17	0.43	4.46
Pahrump	26	1.06	0.39	0.50	1.87
Pioche	26	0.94	0.38	0.33	2.04
Rachel	26	1.03	0.35	0.56	1.66
Sarcobatus Flats	26	1.83	1.20	0.51	4.61
Stone Cabin Ranch	19	0.91	0.35	0.47	1.99
St. George	26	1.05	0.42	0.34	2.41
Tecopa	26	1.09	0.45	0.62	2.31
Tonopah	26	1.08	0.45	0.41	2.14
Twin Springs	19	0.95	0.28	0.53	1.81

Network Mean = 1.03 ± 0.29 × 10^{-15} µCi/mL
Mean Minimum Detectable Concentration (MDC; see Glossary, Appendix B) = 0.26 × 10^{-15} µCi/mL
Standard Error of Mean MDC = 0.03 × 10^{-15} µCi/mL

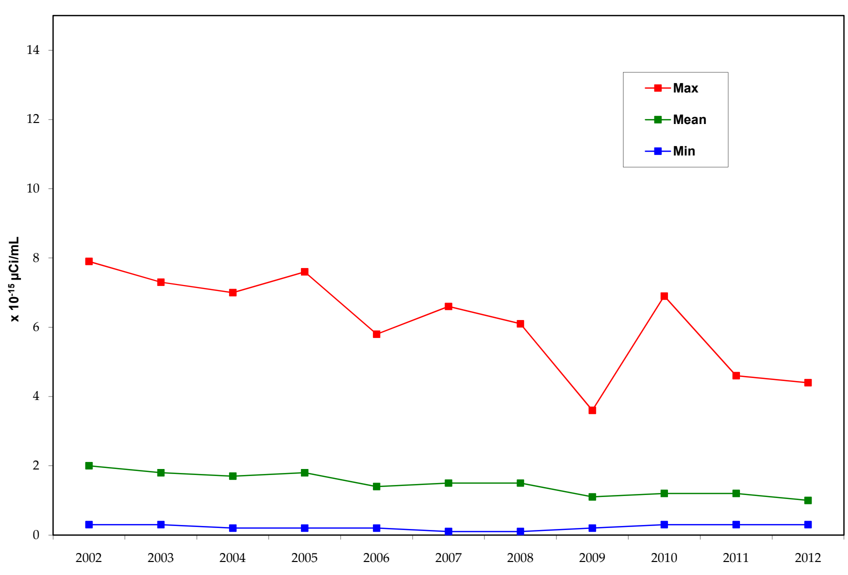


Figure 7-3. Historical trend for gross alpha analysis for all CEMP stations

Table 7-2. Gross beta results for the CEMP offsite ASN in 2012

Sampling Location	Number of Samples	Concentration (× 10^{-14} µCi/mL [3.7 × 10^{-4} Bq/m^3])			
		Mean	Standard Deviation	Minimum	Maximum
Alamo	26	2.27	0.53	1.46	3.43
Amargosa Valley	26	2.05	0.57	1.09	3.77
Beatty	26	1.93	0.54	1.16	3.44
Boulder City	26	2.17	0.63	1.41	3.70
Caliente	26	2.11	0.49	1.31	3.56
Cedar City	26	1.53	0.38	0.99	2.73
Delta	26	1.95	0.52	1.13	3.33
Duckwater	26	1.86	0.49	1.24	3.34
Ely	26	1.76	0.44	1.20	3.14
Garden Valley	19	1.92	0.55	1.31	3.45
Goldfield	26	1.88	0.47	1.12	3.13
Henderson	26	2.08	0.53	1.35	3.49
Indian Springs	26	2.01	0.55	1.22	3.80
Las Vegas	26	2.11	0.53	1.35	3.43
Mesquite	26	2.55	0.62	1.49	3.51
Milford	26	2.09	0.55	1.36	3.54
Nyala Ranch	19	1.53	0.52	1.01	2.75
Overton	26	2.42	0.62	1.55	4.02
Pahrump	26	1.98	0.54	1.33	3.37
Pioche	26	1.81	0.46	1.20	3.05
Rachel	26	1.87	0.41	1.08	2.58
Sarcobatus Flats	26	2.11	0.61	1.29	3.90
Stone Cabin	19	1.74	0.36	1.21	2.75
St. George	26	2.21	0.60	1.40	3.54
Tecopa	26	2.07	0.50	1.18	3.09
Tonopah	26	1.82	0.47	1.20	3.42
Twin Springs	19	1.81	0.40	1.19	3.06

Network Mean = 1.98 ± 0.21 × 10^{-14} µCi/mL
Mean MDC = 0.04 × 10^{-14} µCi/mL **Standard Error of Mean MDC = 0.004 × 10^{-14} µCi/mL**

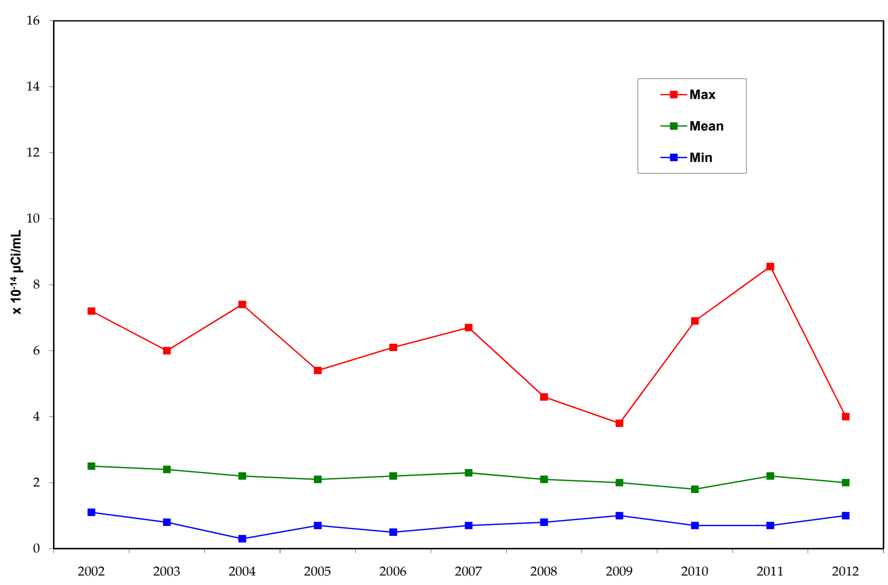


Figure 7-4. Historical trend for gross beta analysis for all CEMP stations

The mean gross alpha results show a generally decreasing trend for the past 10 years from 2002 to 2012. Likewise, except for the increase in the mean and maximum values in 2011 data due to the Japan nuclear accident, the gross beta results show a similar trend for the same time period. Although the downward trend in the mean data since 2002 for gross beta is not as pronounced, even arguably level, the maximum values suggest a downward trend. These trends are also reflected by most of the stations on an individual basis. Their explanation is currently unknown, but hypothetically may be related to drought conditions.

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 (^7Be) was detectable. This radionuclide is produced by cosmic ray interaction with nitrogen in the atmosphere. The mean annual activity for ^7Be for the sampling network was $0.76 \pm 0.33 \times 10^{-13}$ 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 2012 ranged from 78 milliroentgens (mR) (0.78 millisieverts [mSv]) at Pahrump, Nevada, to 147 mR (1.47 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 2012

Sampling Location	Number of Quarters	Estimated Annual Exposure (mR)[a] Mean[b]	Minimum[b]	Maximum[b]
Alamo	4	114	104	122
Amargosa Valley	4	103	97	113
Beatty	4	139	130	144
Boulder City	4	105	99	110
Caliente	4	112	104	117
Cedar City	4	94	83	104
Delta	4	96	86	104
Duckwater	4	117	108	139
Ely	4	107	92	123
Garden Valley	3	144	130	154
Goldfield	4	121	112	130
Henderson	4	110	99	117
Indian Springs	4	97	93	109
Las Vegas	4	100	95	104
Medlin's Ranch	3	128	117	139
Mesquite	4	108	103	110
Milford	4	140	127	152
Nyala Ranch	3	109	99	123
Overton	4	100	96	106
Pahrump	4	78	71	87
Pioche	4	116	101	135
Rachel	4	127	119	135

Table 7-3. TLD monitoring results for the CEMP offsite ASN in 2012 (continued)

Sampling Location	Number of Quarters	Estimated Annual Exposure (mR)[a] Mean[b]	Minimum[b]	Maximum[b]
Sarcobatus Flats	4	147	138	157
Stone Cabin Ranch	3	136	127	144
St. George	4	86	71	96
Tecopa	4	108	101	117
Tonopah	4	132	123	144
Twin Springs	3	146	139	149

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

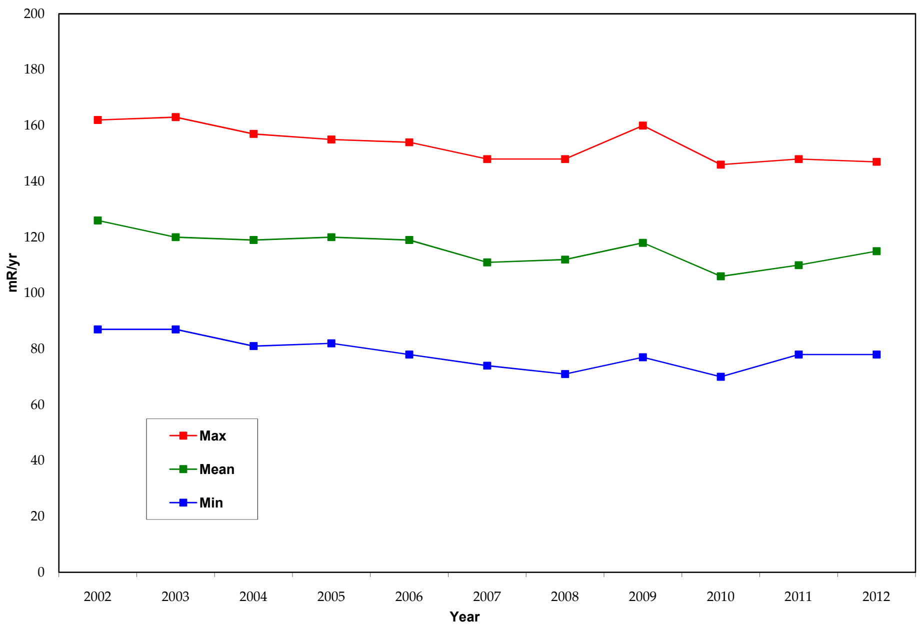


Figure 7-5. Historical trend for TLD analysis for all CEMP stations

Overall, the TLD data show a generally decreasing trend for the past 10 years from 2002 to 2012. The 2012 results are slightly higher than 2011, 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 2012 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 173.89 mR/yr (1.74 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 2012 are well within these United States background levels, and are consistent with previous years' exposure rates.

Table 7-4. PIC monitoring results for the CEMP offsite ASN in 2012

Sampling Location	Daily Average Gamma Exposure Rate (μR/hr) Mean	Standard Deviation	Minimum	Maximum	Annual Exposure (mR/yr)
Alamo	13.45	0.35	12.5	14.4	117.82
Amargosa Valley	11.40	0.16	10.9	11.9	99.86
Beatty	16.85	0.25	16.0	17.7	147.61
Boulder City	15.20	0.15	14.7	15.7	133.15
Caliente	15.85	0.22	15.1	16.6	138.85
Cedar City	11.10	0.24	10.2	12.0	97.24
Delta	10.65	0.98	7.2	14.1	93.29
Duckwater	15.30	0.27	14.2	16.4	134.03
Ely	12.30	0.31	11.3	13.3	107.75
Garden Valley[a]	18.35	0.47	17.1	19.6	160.75
Goldfield	15.10	0.41	14.1	16.1	132.28
Henderson	14.05	0.15	13.5	14.6	123.08
Indian Springs	11.20	0.23	10.6	11.8	98.11
Las Vegas	11.25	0.21	10.7	11.8	98.55
Medlin's Ranch[a]	16.55	0.41	15.50	17.6	144.98
Mesquite	11.70	0.18	11.1	12.3	102.49
Milford	17.60	0.35	16.4	18.8	154.18
Nyala Ranch[a]	15.20	0.36	13.9	16.5	133.15
Overton	12.05	0.21	11.2	12.9	105.56
Pahrump	8.20	0.16	7.6	8.8	71.83
Pioche	14.95	0.36	13.3	16.6	130.96
Rachel	15.30	0.39	14.2	16.4	134.03
Sarcobatus Flats	16.55	0.20	15.8	17.3	144.98
Stone Cabin Ranch[a]	13.75	0.22	9.4	18.1	120.45
St. George	10.10	0.22	9.4	10.8	88.48
Tecopa	15.05	1.12	12.8	17.3	131.84
Tonopah	16.15	0.34	15.2	17.1	141.47
Twin Springs[a]	19.50	0.63	17.7	21.3	170.82
Warm Springs Summit	19.85	0.62	18.1	21.6	173.89

(a) Values from these locations are based on approximately 9 months of data collected through September 2012

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: 4/4/2013)

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 originating on the NNSS. 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 2012 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.

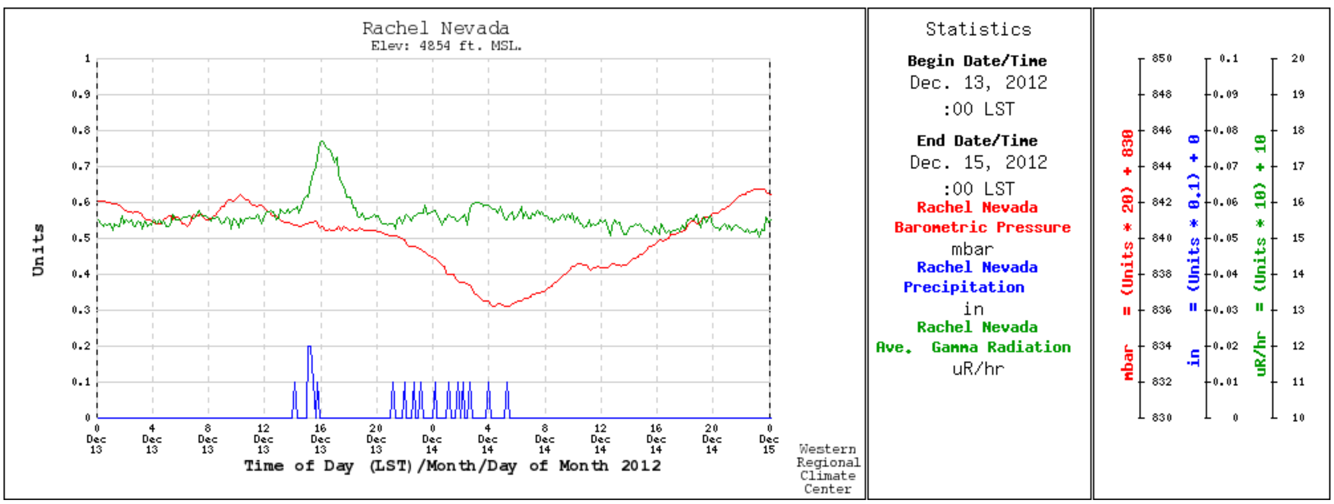


Figure 7-6. The effect of meteorological phenomena on background gamma readings

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 Sample Locations and Methods

During the period of June 1 to September 4, 2012, DRI sampled 4 springs, 21 wells, and 3 surface water bodies either directly or through municipal water supply systems. Sample locations were selected based upon input from the CEMs and local ranch owners participating in the CEMP project. All wells were sampled 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.

7.2.2 Procedures and Quality Assurance

DRI used several methods to ensure that radiological results reported herein conform to current QA protocols (see Chapter 17 for a detailed description of the CEMP QA program). This was achieved through the use of standard operating procedures, field QA samples, and laboratory QA procedures. DRI's standard operating procedures use step-by-step instructions to describe the method and materials that are required to collect field water quality samples and to protect the samples from tampering and environmental conditions that may alter their chemistry.

The second tier of QA used on this project consisted of field QA samples, specifically field blanks, duplicates, and spiked samples. The intent of field blanks was to provide direct measures of the contribution of radioactive material that was derived from the bottles, sampling equipment, and the environment to the activity of tritium measured within the samples. Duplicate samples were collected to establish a measure of the repeatability of the analysis. Spiked samples consisted of samples that had the appearance of being routine CEMP samples, yet actually consisted of water containing a known quantity of tritium. Twelve samples (30% of the sample load) were collected for the purposes of meeting field QA requirements. The third tier of QA used on this project was laboratory QA controls, which consisted of the utilization of published laboratory techniques for the analysis of tritium, method blanks, laboratory control samples, and laboratory duplicates. The laboratory QA samples provide a measure of the accuracy and the confidence of the reported results.

Samples collected in 2012 were analyzed using enriched gas proportional counting at the University of Miami Tritium Laboratory. CEMP tritium samples taken prior to 2008 were analyzed using gas proportional counting or enriched liquid scintillation counting. The enriched gas proportional counting process significantly lowers the detection limit, improving confidence in the reported results, especially for those samples containing little or no tritium. The decision level (L_C) (see Glossary, Appendix B) for enriched gas proportional counting was 0.73 picocuries per liter (pCi/L). The L_C is the sample activity required such that 95% of the laboratory's repeated measures of background are exceeded. 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 1.21 pCi/L. The MDC 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.

Table 7-6. CEMP water monitoring locations sampled in 2012

Monitoring Location Description	Latitude	Longitude	Date Sampled	Sample Collection Method
Adaven Springs	38°08.25"	−115°36.20"	7/17/2012	By hand from stream discharging from spring orifice.
Alamo city water supply system—source of water is municipal well field	37°21.84"	−115°10.20"	7/26/2012	By hand from municipal water well.
Amargosa Valley school well	36°34.16"	−116°27.66"	7/20/2012	By hand at wellhead at the school.
Beatty Water and Sewer municipal water distribution system	36°54.33"	−116°45.52"	7/25/2012	By hand at wellhead in City Park. Sample collected from a different well than in 2011.
Boulder City municipal water distribution system	35°59.74"	−114°49.90"	6/01/2012	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"	8/07/2012	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"	8/08/2012	By hand at wellhead. Sample collected from a different well than in 2011.
Delta municipal well	39°20.73"	−112°32.34"	8/08/2012	By hand at wellhead.
Duckwater water supply well	38°55.41"	−115°41.99"	9/04/2012	By hand at faucet inside pump house.
Ely Residence	39°14.10"	−114°53.71"	9/04/2012	By hand from residence in Ely. Source of water is the municipal supply system. Springs are origin of municipal water supply.
Goldfield municipal water supply well about 18 km (11 mi) north of town	37°52.41"	−117°14.75"	7/25/2012	By hand at wellhead.
Henderson municipal water distribution system	36°00.43"	−114°57.95"	6/01/2012	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"	6/13/2012	By hand at wellhead. Sample collected from a different well than in 2011.
Las Vegas Valley Water District #103	36°13.94"	−115°15.13"	6/18/2012	By hand at wellhead.
Medlin's Ranch—spring 16 km (10 mi) west of ranch house	37°24.10"	−115°32.25"	8/01/2012	By hand at kitchen faucet; water originates from spring 16 km (10 mi) west of ranch.
Mesquite municipal water supply well 3 km (2 mi) southeast of town	36°46.40"	−114°03.26"	6/14/2012	By hand at wellhead.
Milford municipal well	38°22.88"	−112°59.78"	8/08/2012	By hand at wellhead.
Nyala Ranch water well	38°14.93"	−115°43.72"	7/17/2012	By hand from front yard hose faucet at house.

Table 7-6. CEMP water monitoring locations sampled in 2012 (continued)

Monitoring Location Description	Latitude	Longitude	Date Sampled	Sample Collection Method
Overton water well located at Arrow Canyon approximately 32 km (20 mi) west of town	36°44.06"	−114°44.87"	6/14/2012	By hand at wellhead.
Pahrump municipal water system	36°11.29"	−115°57.95"	6/08/2012	By hand at wellhead.
Pioche municipal well	37°56.97"	−114°25.76"	8/07/2012	By hand at wellhead.
Rachel—Little A'Le'Inn well	37°38.79"	−115°44.75"	7/26/2012	By hand from faucet inside Little A'Le'Inn Restaurant.
Sarcobatus Flats well	37°16.76"	−117°01.10"	7/25/2012	By hand at wellhead.
St. George municipal water distribution system	37°10.47"	−113°23.92"	8/09/2012	By hand at water treatment plant; water originates from Quail Creek Reservoir.
Stone Cabin Ranch	38°12.45"	−116°37.99"	7/18/2012	By hand from outside house faucet; water originates from spring.
Tecopa residential well	35°57.59"	−116°15.71"	6/08/2012	By hand at wellhead.
Tonopah public utilities well field located approximately 19 km (12 mi) from town	38°11.68"	−117°04.70"	7/26/2012	By hand at wellhead.
Twin Springs Ranch well	38°12.21"	−116°10.53"	7/18/2012	By hand at wellhead.

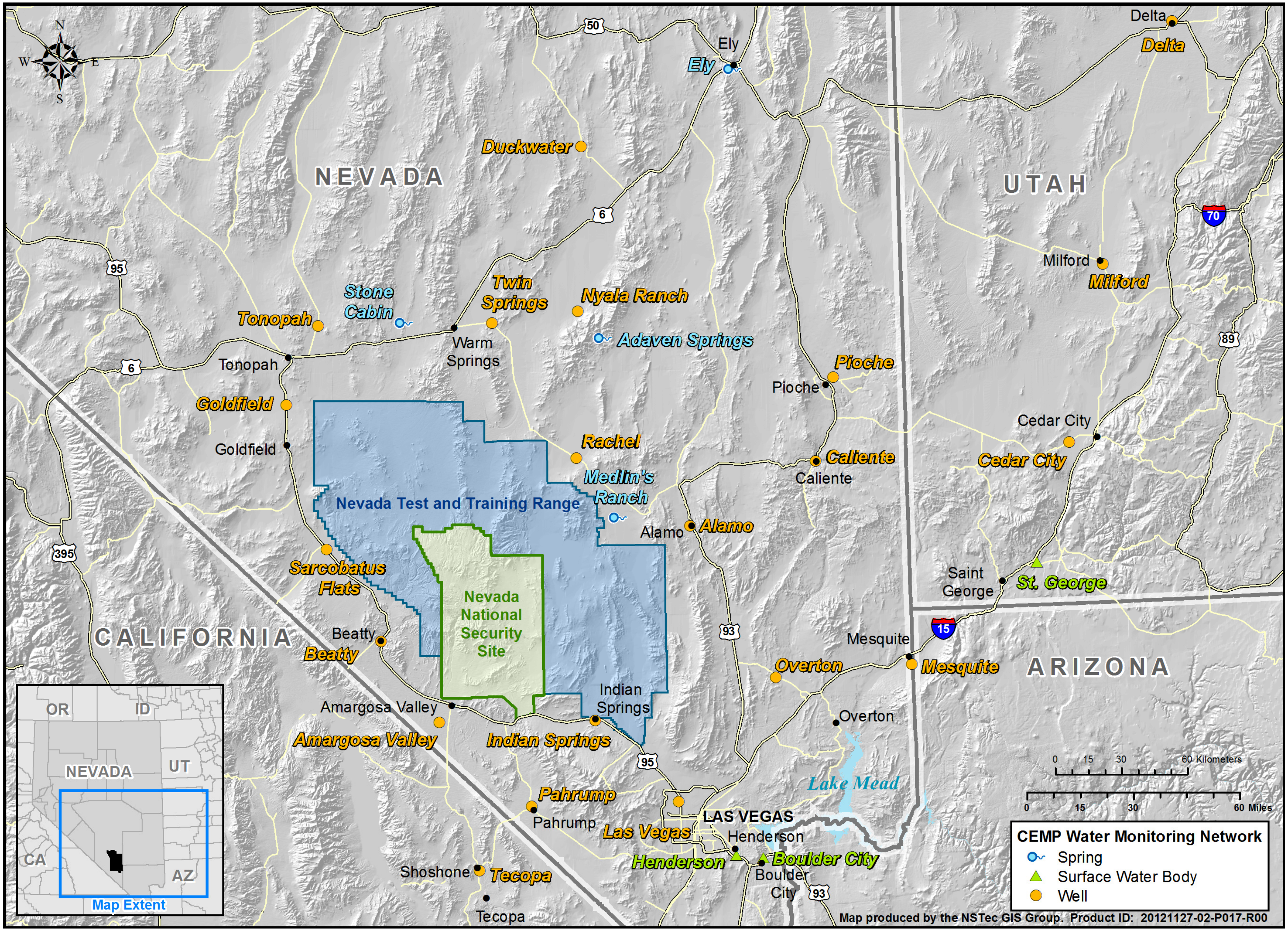


Figure 7-7. 2012 CEMP water monitoring locations

7.2.3 Results of Surface Water and Spring Discharge Monitoring

Measured tritium concentrations from the springs and surface waters sampled in 2012 ranged from below background to 22.5 pCi/L (Table 7-7). Almost all samples yielded results that were quantifiably above background (i.e., ≥ MDC), with the exception of Stone Cabin Ranch, which had tritium activities indistinguishable from background. 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 2012, with all samples declining in activity relative to samples collected in 2011. The 2008 through 2012 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 2012

Monitoring Location	^{3}H ± Uncertainty [(a)] (pCi/L)		
Adaven Springs	11.00	±	0.7
Ely municipal water source	2.1	±	0.6
Medlin's Ranch	5.8	±	0.6
Stone Cabin Ranch	0.4	±	0.6
Boulder City municipal water distribution system	21.9	±	1.4
Henderson municipal water distribution system	22.5	±	1.5
St. George municipal water distribution system	9.9	±	0.6

(a) ± 2 standard deviations
L_C = 0.73 pCi/L; MDC = 1.21 pCi/L for all samples

7.2.4 Results of Groundwater Monitoring

The results for the 21 groundwater tritium analyses from the University of Miami Tritium Laboratory are presented in Table 7-8. The measured activities ranged from −0.4 to 3.9 pCi/L. Most of the samples yielded results that were statistically indistinguishable from laboratory background (≤ L_C). Three exceptions were the samples obtained from Beatty (0.8 ± 0.6 pCi/L), Caliente (3.9 ± 0.6 pCi/L), and Nyala Ranch (2.9 ± 0.6 pCi/L). The tritium activity for Beatty marginally exceeds the L_C, indicating that there may be tritium in the water above background. The tritium activity for Caliente is slightly less than that detected from 2008 through 2011 (5.4, 4.7, 4.7, and 4.8 pCi/L). Results for Nyala Ranch continued to trend slightly upward relative to the period from 2008 to 2011 (0.5, 0.5, 0, and 1.16 pCi/L). Both Caliente and Nyala Ranch results exceeded the MDC. These results indicate that tritium present in water samples from Caliente and Nyala Ranch are 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 60 years. All groundwater samples were well below the safe drinking water limit of 20,000 pCi/L.

Table 7-8. Tritium results for CEMP offsite wells in 2012

Monitoring Location	^{3}H ± Uncertainty [(a)] (pCi/L)		
Alamo City	0.6	±	0.6
Amargosa Valley	-0.2	±	0.6
Beatty	0.8	±	0.6
Caliente	3.9	±	0.6
Cedar City	0.1	±	0.6
Delta	0.0	±	0.6
Duckwater	0.0	±	0.6
Goldfield	−0.1	±	0.6
Indian Springs	0.0	±	0.6
Las Vegas	0.2	±	0.6
Mesquite	0.1	±	0.6
Milford	0.2	±	0.6
Nyala Ranch	2.9	±	0.6
Overton	−0.4	±	0.6
Pahrump	−0.1	±	0.6
Pioche	0.0	±	0.6
Rachel	−0.2	±	0.6
Sarcobatus Flats	0.2	±	0.6
Tecopa	0.3	±	0.6
Tonopah	0.0	±	0.6
Twin Springs Ranch	0.2	±	0.6

(a) ± 2 standard deviations
L_C = 0.73 pCi/L; MDC = 1.21 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). This is the first offsite well in which radionuclides from underground nuclear testing activities at the NNSS have been detected. 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). All observed tritium in groundwater that exceeded the MDC were either up-gradient of the NNSS or part of a groundwater flow system separate from the systems beneath the NNSS. The sample obtained from Beatty is downgradient of the NNSS. However, the tritium activities were so low that the actual amount of tritium in the sample cannot be quantified.

8.0 Radiological Biota Monitoring

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

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 likely 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] 2003a). They are sampled annually from contaminated NNSS sites to estimate hypothetical doses to persons 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 2012. Analysis results used to estimate the dose to humans consuming NNSS plants and animals and the dose to biota found in contaminated areas of the NNSS 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, which may be consumed by humans, were last sampled in 2010; information regarding their dose to the public can be in found in the 2010 NNSS environmental monitoring report (National Security Technologies, LLC [NSTec], 2011b).

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. 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 newly-captured mountain lions before they are released with radio-collars are analyzed for ^{3}H.

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*)	Mule deer (*Odocoileus hemionus*)	Mourning dove (*Zenaida macroura*)
Jackrabbit (*Lepus californicus*)	Pronghorn antelope (*Antilocapra americana*)	Chukar (*Alectoris chukar*)
	Mountain lion (*Puma concolor*)	Gambel's quail (*Callipepla gambelii*)
	Bighorn sheep (*Ovis canadensis nelsoni*)	
	Bobcat (*Lynx rufus*)	
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 are 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 bulleted list below). The control site selected for each contaminated site has similar biological and physical features. Control sites are sampled to document the radionuclide levels representative of background.

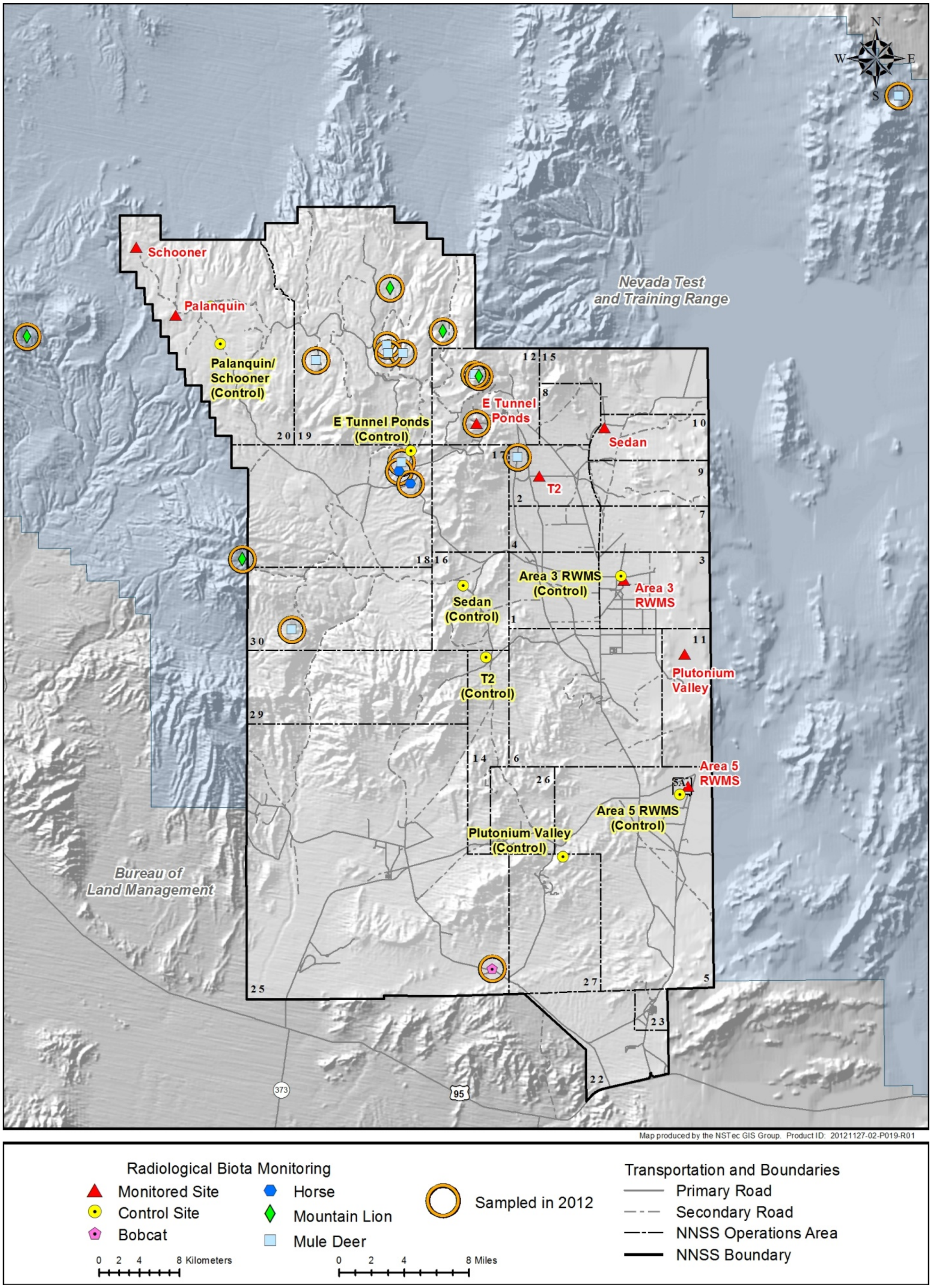


Figure 8-1. Radiological biota monitoring sites on the NNSS

- **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 sampled in 2012.
- **Plowshare sites in alluvial fill at lower elevations with high surface contamination.** Subsurface nuclear detonations at these sites have distributed contaminants over a wide area, usually in the lowest precipitation areas of the 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 sites distributed contaminants over a wide area, usually in the highest precipitation areas of the NNSS. Through 2007, the associated monitoring site was Palanquin Crater. It was last sampled in 2003. Schooner Crater was added as a biota sampling site and was last sampled in 2008.
- **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 2012 Biota Sampling and Analysis

In 2012, the E Tunnel Ponds site was sampled for plants and animals, and the E Tunnel control site (Whiterock Spring) was sampled for plants (Figure 8-1).

The E Tunnel Ponds are located just southeast of Rainier Mesa in Area 12 in the northern part of the NNSS (Figure 8-1). Radionuclide-contaminated water and soils occur at this site. The ponds were constructed to collect and hold contaminated water (mainly from ^{3}H), which drains out of E Tunnel where nuclear testing was conducted. The water is perched groundwater that has percolated through fractures in the tunnel system.

In 2012, 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 19, 2012, six plant samples were collected from the E Tunnel Ponds site, and on June 20, 2012, eight plant samples were collected from the control site. 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 and were composites of material from many plants of the same species found generally within 5 m (16 ft) of each other.

Plant leaves and stems from the sites 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 (includes cesium-137 [^{137}Cs]).

Table 8-2. Plant species sampled in 2012

Common Name	Scientific Name	Name Code	E Tunnel Ponds	E Tunnel Ponds Control
White sagebrush	*Artemisia ludoviciana*	ARLU		X
Rubber rabbitbrush	*Ericameria nauseosus*	ERNA	X	X
Baltic rush	*Juncus balticus*	JUBA		X
Desert almond	*Prunus fasciculata*	PRFA	X	
Narrowleaf willow	*Salix exigua*	SAEX		X
Southern cattail	*Typha domingensis*	TYDO	X	

As expected, concentrations of certain man-made radionuclides, specifically ^{3}H and ^{137}Cs, were higher in samples from the E Tunnel Ponds site compared with the control site (Table 8-3). The E Tunnel Ponds site had positive detections (i.e., radionuclide concentrations greater than their laboratory-reported minimum detectable concentrations [MDCs]; see Glossary, Appendix B) of ^{3}H, ^{90}Sr, ^{137}Cs, ^{238}Pu, and $^{239+240}$Pu. Concentrations of ^{90}Sr, ^{238}Pu, and $^{239+240}$Pu were relatively low and not significantly different from the control site.

Table 8-3. Concentrations of man-made radionuclides in plants sampled in 2012

	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)]**
E Tunnel Ponds					
ERNA#1	350,000 ± 53400	0.03 ± 0.02	0.33 ± 0.28	0.0010 ± 0.0019	0.0064 ± 0.0039
ERNA#2	318,000 ± 48500	0.02 ± 0.03	0.76 ± 0.35	0.0013 ± 0.0028	0.0047 ± 0.0039
PRFA#1	344,000 ± 52500	0.05 ± 0.03	−0.24 ± 0.35	0.0036 ± 0.0033	0.0023 ± 0.0031
PRFA#2	226,000 ± 34600	0.05 ± 0.03	0.23 ± 0.47	0.0018 ± 0.0018	0.0019 ± 0.0018
TYDO#1	398,000 ± 60800	0.08 ± 0.04	1.06 ± 0.58	0.0025 ± 0.0025	0.0015 ± 0.0023
TYDO#2	395,000 ± 60300	0.16 ± 0.06	1.25 ± 0.63	0.0000 ± 0.0041	0.0031 ± 0.0041
Average Concentration	338,500	0.07	0.57	0.0017	0.0033
Average MDC[(d)]	1,026	0.06	0.62	0.0027	0.0036
E Tunnel Ponds Control					
ARLU#1	19 ± 227	0.03 ± 0.03	0.13 ± 0.44	0.0009 ± 0.0032	0.0024 ± 0.0032
ARLU#2	93 ± 235	0.00 ± 0.02	0.00 ± 0.42	0.0039 ± 0.0030	0.0047 ± 0.0035
ERNA#1	26 ± 229	0.01 ± 0.03	0.05 ± 0.18	0.0018 ± 0.0038	0.0078 ± 0.0062
ERNA#2	119 ± 233	0.01 ± 0.02	−0.03 ± 0.28	0.0006 ± 0.0021	0.0057 ± 0.0038
JUBA#1	84 ± 225	0.05 ± 0.03	0.21 ± 0.43	0.0023 ± 0.0026	0.0021 ± 0.0026
JUBA#2	207 ± 232	0.03 ± 0.02	0.08 ± 0.19	0.0051 ± 0.0042	0.0017 ± 0.0031
SAEX#1	175 ± 230	0.04 ± 0.03	0.08 ± 0.40	0.0014 ± 0.0030	0.0039 ± 0.0038
SAEX#2	100 ± 230	0.13 ± 0.05	−0.10 ± 0.25	0.0017 ± 0.0044	−0.0015 ± 0.0044
Average Concentration	103	0.04	0.05	0.0022	0.0034
Average MDC[(d)]	382	0.06	0.62	0.0036	0.0046

(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 2012 and to opportunistically sample large mammal mortalities (e.g., from vehicles or from predation) on the NNSS. Permission was also obtained to acquire samples of blood from radio-collared mountain lions. Attempts were made to trap small mammals and birds at the E Tunnel Ponds and E Tunnel Pond control locations from June 19 through September 13, 2013. Two mourning doves were trapped from the E Tunnel Ponds site, and no animals were collected from the control site (Table 8-4). Tissue samples were opportunistically collected from 13 large mammals: 10 mule deer (1 accidentally hit by a vehicle and 9 preyed upon by mountain lions), 2 horses killed by a mountain lion, and 1 bobcat hit by a vehicle. Water was also collected from blood or tissue samples from four radio-collared mountain lions captured on or near the NNSS during 2012. In one case, a water sample was collected from Mountain Lion #3 when it was captured, and another sample was collected from the same animal after it had died of natural causes. Because of the mobility of these large game animals, samples were collected on neighboring Nevada Test and Training Range (NTTR) land when the opportunity arose (Figure 8-1, Table 8-4).

Table 8-4. Animal samples collected in 2012

Location	Sample	Collection Date	Sample Description
E Tunnel Ponds	Mourning Dove #1	9/13/2012	Whole body
	Mourning Dove #2	9/13/2012	Whole body
Opportunistic Sampling			
Area 25	Bobcat	3/19/2012	Muscle tissue from an adult male bobcat killed by a vehicle
Area 19	Mountain Lion #1 (NNSS4)[a]	5/23/2012	Blood sample from mountain lion that was captured and released
Area 12	Mountain Lion #2 (NNSS5)[a]	6/3/2012	Blood sample from mountain lion that was captured and released
Area 19	Mountain Lion #3 (NNSS6)[a]	6/10/2012	Blood sample from mountain lion that was captured and released
NTTR	Mountain Lion #4 (NNSS7)[a]	6/17/2012	Blood sample from mountain lion that was captured and released
Area 19	Mule Deer #1	7/19/2012	Water from lower leg of mule deer killed by Mountain Lion #1
Area 19	Mule Deer #2	7/19/2012	Water from lower leg of mule deer killed by Mountain Lion #4
Area 12	Mule Deer #3	7/31/2012	Water from lower leg of mule deer killed by Mountain Lion #2
NTTR	Mountain Lion #3 (post mortem)	8/12/2012	Water from Mountain Lion #3, which died of natural causes
Area 18	Mule Deer #4	8/29/2012	Muscle tissue from mule deer killed by Mountain Lion #1
NTTR	Mule Deer #5	9/15/2012	Water from lower leg of mule deer killed by Mountain Lion #2
Area 19	Mule Deer #6	10/8/2012	Muscle tissue from mule deer killed by Mountain Lion #4
Area 19	Mule Deer #7	10/9/2012	Water from lower leg of mule deer killed by Mountain Lion #4
Area 2	Mule Deer #8	10/24/2012	Muscle tissue from mule deer killed by a vehicle
Area 18	Horse #1	10/30/2012	Water from lower leg of a young horse killed by Mountain Lion #1
Area 18	Mule Deer #9	11/27/2012	Water from lower leg of mule deer killed by Mountain Lion #4
Area 18	Mule Deer #10	11/27/2012	Water from lower leg of mule deer killed by Mountain Lion #4
Area 18	Horse #2	12/12/2012	Muscle tissue collected from a young horse killed by Mountain Lion #1

(a) Identification number used for this animal in radiotelemetry study (see Section 15.3, Table 15-2)

Blood samples from captured mountain lions were only analyzed for ^3H content due to the small volumes of blood. Similarly, due to the small sample sizes of tissues available for analysis from the carcasses of mountain lion kills and the relatively high potential for cross-contamination between them and the surrounding soil, only water was distilled from the carcass tissue and analyzed for ^3H content. In three mountain lion kills (Mule Deer #4, Mule Deer #6, and Horse #2), there was sufficient fresh tissue on the carcass to obtain a muscle sample. Any adequate muscle tissue samples from large mammals were homogenized, as were the whole bodies of each mourning dove. Past results have shown that radionuclide concentrations are generally higher in the skin, bone, and viscera compared with muscle. Though muscle is usually the only portion consumed by humans, the mourning doves 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 ^{241}Am, ^{90}Sr, plutonium, and gamma spectroscopy analysis.

Tritium was detected in both mourning doves collected at the E Tunnel Ponds, in Mountain Lion #2, and in four mule deer (#1, #2, #3, and #8) (Table 8-5). Because the mourning doves were collected adjacent to a ^{3}H source (the E Tunnel Ponds), it is likely that this is the source of their intake. For the deer and mountain lion, however, their source of ^{3}H is not as clear because they were sampled at relatively large distances (e.g., 4–12 kilometers [km]) from known NNSS ^{3}H sources. Mule Deer #2 is of particular interest due to its relatively high ^{3}H concentration of 425,000 picocuries per liter (pCi/L). This is about the same concentration that was in the E Tunnel Ponds (419,000 pCi/L; Section 5.1.8, Table 5-5), but it is unlikely that the deer would be in equilibrium with the ponds given it was sampled 12 km from them. Groundwater pumped from Well UE-20n #1 and retained in its plastic-lined sump during sampling operations is another possible source (see Sections 11.1.1.2 and 11.1.2). The groundwater had a ^{3}H concentration of 47,400,000 pCi/L (see Section 11.1.1.2, Table 11-1), which is about 100 times greater than that measured in Mule Deer #2. Given the ^{3}H concentration and the location of the well sump in a deer migration area, it is believed that it is the source of ^{3}H for Mule Deer #2. Tritium was detected in animal samples coming from Areas 2, 12, and 19, but no ^{3}H was detected in animals sampled from Area 18 or on the NTTR. Continuing to monitor tritium concentrations in mountain lions and their kills will likely give a better understanding of animal movement patterns from NNSS tritium sources. ^{137}Cs was the only other detected man-made radionuclide, and it was only at concentrations above the MDC in the one bobcat sample (Table 8-5).

Table 8-5. Concentrations of man-made radionuclides in animals sampled in 2012

Sample	Radionuclide Concentration ± Uncertainty[a] (MDC) ^{3}H (pCi/L)[b]	^{137}Cs (pCi/g)[c]
E Tunnel Ponds		
Mourning Dove #1	101,000 ± 10,300 (191)	0.001 ± 0.030 (0.051)
Mourning Dove #2	75,600 ± 7,770 (194)	0.021 ± 0.020 (0.031)
Opportunistic Sampling		
Bobcat	116 ± 156 (266)	0.170 ± 0.101 (0.123)
Mountain Lion #1	611 ± 757 (1,274)	NA[d]
Mountain Lion #2	14,491 ± 3,025 (1,886)	NA
Mountain Lion #3	−299 ± 542 (1,253)	NA
Mountain Lion #4	69 ± 562 (1,114)	NA
Mule Deer #1	1,190 ± 362 (334)	NA
Mule Deer #2	425,000 ± 43,100 (462)	NA
Mule Deer #3	26,300 ± 2,970 (329)	NA
Mountain Lion #3	−80 ± 204 (369)	NA
Mule Deer #4	−78 ± 177 (328)	−0.003 ± 0.031 (0.054)
Mule Deer #5	0 ± 394 (705)	NA
Mule Deer #6	514 ± 1,000 (1,820)	0.041 ± 0.038 (0.062)
Mule Deer #7	70 ± 114 (202)	NA
Mule Deer #8	365 ± 176 (230)	0.011 ± 0.024 (0.043)
Horse #1	70 ± 128 (227)	NA
Mule Deer #9	67 ± 213 (356)	NA
Mule Deer #10	303 ± 227 (359)	NA
Horse #2	−84 ± 204 (368)	0.032 ± 0.036 (0.065)

(a) ± 2 standard deviations
(b) picocuries per liter of water from sample
(c) picocuries per gram, wet weight, of tissue from sample
(d) not analyzed; small sample size and condition did not allow for ^{137}Cs analysis of muscle tissue

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 2012 at the E Tunnel Ponds and its control site. 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).

9.0 Radiological Dose Assessment

The U.S. Department of Energy (DOE) requires DOE facilities to estimate the radiological dose to the general public and to plants and animals in the environment caused by past or present facility operations. These requirements are specified in DOE 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 mathematical models and Federal Guidance Report Number 11 dose coefficients (EPA-520/1-88-029). The 2012 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 2012 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 2003a), 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 NNSS-related radioactivity
- 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 2012.

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 U.S. Environmental Protection Agency (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. Analysis of air particulate and ^{3}H data obtained at these six stations was performed in 2012 (see Chapter 4, Sections 4.1.4 and 4.1.5). 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	10 km N Area 3
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

The shortest distance between where a member of the public resides and a critical receptor monitoring station is 4 km (2.5 miles [mi]). This is between the Gate 510 sampler, in the southwest corner of the NNSS, and Amargosa Valley. Because it is the closest, the results from the Gate 510 sampler are believed to be most representative of air concentrations to which the public is continuously exposed. The shortest distance between an NNSS radionuclide emission source and a critical receptor sampling station is 0.2 km (0.1 mi). This is between the Schooner sampler, in the northwest corner of the NNSS, and the Schooner Crater. Because this sampler is actually within the area physically affected by the nuclear test, it generally has the highest radionuclide concentrations of all of the six critical receptor stations. It also, therefore, represents the most extreme potential dose to a (pseudo) member of the public. The distance from the Schooner sampler to the closest member of the public (Tolicha Peak) is 20 km (12.4 mi), which is 100 times farther than it is from the emission source.

The following man-made radionuclides were detected in samples from at least one of the six critical receptor air monitoring stations: ^{3}H, americium-241 (^{241}Am), plutonium-238 (^{238}Pu), and plutonium-239+240 ($^{239+240}$Pu) (see Section 4.1.4). 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 4-12). As in previous years, the 2012 data from the six critical receptor samplers show that the NESHAP dose limit to the public of 10 mrem/yr was not exceeded.

The Schooner critical receptor station had the highest sum of fractions for critical receptor locations, 0.11 (Table 4-12). Scaling this 0.11 sum of fractions to the 10 mrem/yr limit gives an estimated TEDE of 1.10 mrem/yr from radionuclides in air. This can be thought of as a highly conservative dose to a hypothetical maximally exposed individual (MEI; see Glossary, Appendix B) at this station. Air concentrations drop relatively quickly with distance from contaminated locations. The Gate 20-2P sampler, which is 5.0 km (3.1 mi) south-southeast of the Schooner sampler, had a sum of fractions of only 0.003. The more representative dose to the public would be from the Gate 510 station, which is closest to the nearest public receptor (about 3.5 km [2.2 mi]). Scaling the 0.016 sum of fractions for the Gate 510 station to the 10 mrem/yr limit gives an estimated dose of about 0.16 mrem/yr from radionuclides in air. More detailed information regarding the estimation of the airborne dose to the public in 2012 from all activities conducted by NNSA/NFO on the NNSS and its Nevada support facilities are reported in National Security Technologies, LLC (NSTec) (2013b).

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 2012, animals sampled from contaminated locations, or sampled animals potentially visiting contaminated locations, consisted of 2 mourning doves from E Tunnel Ponds; 4 mountain lions from Areas 12, 19, and the Nevada Test and Training Range (NTTR); 10 mule deer from Areas 2, 12, 18, 19, and NTTR; 2 horses from Area 18; and 1 bobcat from Area 25 (see Chapter 8, Figure 8-1 and Tables 8-4 and 8-5).

The potential committed effective dose equivalent (CEDE; see Glossary, Appendix B) to an individual from consuming game animals was calculated using only those species sampled in 2012 that had concentrations of man-made radionuclides that were above the minimum detectable concentration (MDC; see Glossary, Appendix B) and using the following assumptions:

- An individual consumes 20 mourning doves over the year (the possession limit set for this species by the Nevada Division of Wildlife), each having 30 grams (g) of meat.
- An individual consumes all meat from one mule deer (41.7 kilograms [kg]) during the year.
- An individual consumes all meat from one mountain lion (18.1 kg) during the year.
- An individual consumes all meat from one bobcat (3.8 kg) during the year.
- The moisture content of the mourning doves is 52%, and the moisture content of the large game animal meat is 70%.

Two CEDEs were calculated: one using the average radionuclide concentration of the 2012 samples, and one using the maximum concentration. Dose conversion factors for human ingestion, taken from Federal Guidance Report No. 11 (EPA 1988), were multiplied by the total radioactivity estimated to be consumed for each detected radionuclide for each species. The resultant potential doses (CEDEs) are shown in Table 9-2. The highest CEDE was 0.794 mrem (0.00794 mSv) from eating one mule deer with the maximum observed concentration. This was a deer sampled in Area 19 which that had a relatively high tritium concentration believed to have come from ingesting tritiated groundwater retained in an onsite plastic-lined sump (see Section 8.3.2). The second highest CEDE (0.077 mrem [0.00077 mSv]) was from consuming a mule deer with average tritium concentrations. The potential dose from consuming 20 mourning doves with average and maximum radionuclide concentrations was 0.002 mrem (0.00002 mSv) and 0.003 mrem (0.00003 mSv), respectively. If an individual consumed just one mourning dove from the E Tunnel Ponds that contained the maximum tritium concentration detected in 2012, the potential CEDE would be about 0.00015 mrem (0.0000015 mSv). To put these potential doses 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). This is higher than the dose that would result from consuming the mule deer from Area 19.

Table 9-2. Hypothetical CEDE from ingesting game animals sampled in 2012 that contained detectable radionuclides

Game Animal	Sample Size		Radionuclide Concentration (pCi/L)[(a)] Average[(c)]	Radionuclide Concentration (pCi/L)[(a)] Maximum	Dose Conversion Factor (mrem/pCi ingested)[(b)]	CEDE (mrem) Using Average Concentrations	CEDE (mrem) Using Maximum Concentrations
Mourning dove	2	^{3}H	88,300	101,000	0.000000064	0.002	0.003
Mountain lion	4	^{3}H	3,793	14,491	0.000000064	0.003	0.012
Mule deer	10	^{3}H	41,255	425,000	0.000000064	0.077	0.794
			(pCi/g)[(d)]				
Bobcat	1	^{137}Cs	0.170		0.000050000	0.032	
CEDE from consumption of all species[(b)] using average concentrations = 0.114 mrem							

(a) pCi/L is the concentration in water from the animal; water content is 52% by weight for mourning doves and 70% for all other muscle samples.
(b) Meat from 20 mourning doves (30 g each), one bobcat (3.8 kg), one mountain lion (18.1 kg), and one adult male mule deer (41.7 kg) was assumed to be ingested; dose conversion factors for human ingestion are from EPA (1988).
(c) For the average values, negative results were set to zero.
(d) pCi/g is per gram wet weight.

Table 9-3 presents the hypothetical CEDE for humans consuming various species of NNSS wildlife based on animals sampled from 2001 through 2012. 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, therefore, this CEDE is what is discussed. The average CEDE by species ranges from 0.002 mrem/yr for mountain lions to 0.92 mrem/yr for jackrabbits. The highest estimated CEDE for any one species and location is 4.47 mrem (0.0447 mSv) from Plutonium Valley jackrabbits, as estimated from 2009 samples (NSTec 2010). This represents 4.47% 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 about 0.22 mrem (0.0022 mSv), which is 0.22% of the annual dose limit for members of the public, or approximately 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 just one animal of each species with average concentrations based on samples collected from 2000 through 2012, this individual may receive an estimated 0.38 mrem/yr (0.0038 mSv/yr) dose (Table 9-3).

Table 9-3. Hypothetical CEDEs from ingesting NNSS game animals sampled from 2001–2012

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 - High Estimate (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**
Gambel's quail	T2	2002	2	20 (all muscle tissue)	0.080	**0.0040**
Jackrabbit	Area 3 RWMS	2009	3[(a)]	20 (all muscle tissue)	0.59	0.030
	Area 5 RWMS	2009	2[(a)]		0.15	0.0075
	Plutonium Valley	2009	1		4.5	0.22

Table 9-3. Hypothetical CEDEs from ingesting NNSS game animals sampled from 2001–2012 (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 - High Estimate (mrem)	CEDE - Consumption of One Animal (mrem)
Jackrabbit (continued)	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
				Jackrabbit Average	0.92	**0.046**
				Minimum	0.030	0.0015
				Maximum	4.5	0.22
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[(b)]	2003	3		0.30	0.01495
				Mourning Dove Average	0.056	**0.0028**
				Minimum	0.0002	0.00001
				Maximum	0.3	0.015
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
				Mountain Lion Average	0.002	**0.002**
				Minimum	0.001	0.001
				Maximum	0.003	0.003
Mule deer	Area 19	2011	1	1 (all muscle tissue)	0.31	0.31
	Areas 12, 18, 19	2012	10		0.077	0.077
				Mule Deer Average	0.19	**0.19**
				Minimum	0.077	0.077
				Maximum	0.31	0.31
Pronghorn antelope	Area 5	2003	1	1 (all muscle tissue)	0.064	0.064
	Area 5	2007	1		0.091	0.091
				Pronghorn Antelope Average	0.078	**0.078**
				Minimum	0.064	0.064
				Maximum	0.091	0.091
	Total (from consumption of one of each game species having individual doses shown in bold)					**0.38**

(a) Samples were composites of kangaroo rats and antelope ground squirrels used as analogs for jackrabbits

(b) This location is labeled Palanquin Control in the *Nevada Test Site Environmental Report 2003* (Bechtel Nevada 2004a)

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 may be possible that individuals with access do collect and consume edible plant material. One species in particular, the pinyon tree, produces pine nuts that are harvested and consumed across the western United States. Pinyon trees grow in multiple locations on the NNSS. NNSS pine nuts were sampled and analyzed in 2010. The estimated dose from consuming them was shown to be extremely low and a negligible contribution to the total potential dose to a member of the public (NSTec 2011b). No other edible plant or plant materials have been collected for analysis on the NNSS in recent history, and no edible plants were sampled in 2012.

9.1.1.4 Dose from Drinking Contaminated Groundwater

The 2012 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 5.1.5, 7.2.3, and 7.2.4). 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 2012, 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 2012, 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 20% of their CLs. Scaling this to the 10 mrem dose that the CL represents would be 2 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 5.1.5, 7.2.3, and 7.2.4). 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 2012, 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. The doses from these pathways are combined below to present an estimate of the total 2012 dose to the MEI residing off site.

In the recent past, the MEI from 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 0.16 mrem/yr (0.0016 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. Based on radionuclide levels in 2012 samples and the assumption that this person consumes 20 mourning doves, one bobcat, one mountain lion, and one mule deer, all with average concentrations, this individual may receive an estimated additional 0.11 mrem/yr (0.0011 mSv/yr) dose (Table 9-2). If this person consumed one animal of each game species with average concentrations based on samples collected from 2000 to 2012, this individual may receive an estimated additional 0.38 mrem/yr (0.0038 mSv/yr) dose (Table 9-3). Both wildlife consumption scenarios are conservative estimates. Based on the second conservative scenario, if all dose from consuming wildlife were received in one year, the total effective dose equivalent (TEDE) (see Glossary, Appendix B) to this hypothetical MEI from all exposure pathways combined and solely due to NNSA/NFO activities would be 0.54 mrem/yr (0.0054 mSv/yr) (Table 9-4).

Table 9-4. Estimated radiological dose to a hypothetical MEI of the general public from 2012 NNSS operations

Pathway	Dose to MEI (mrem/yr)	Dose to MEI (mSv/yr)	Percent of DOE 100 mrem/yr Limit
Air[(a)]	0.16	0.0016	0.16
Water[(b)]	0	0	0
Wildlife[(c)]	0.38	0.0028	0.38
Direct[(d)]	0	0	0
All Pathways	0.54	0.0054	0.54

(a) Based on annual average concentrations at the compliance station nearest the offsite public (Section 4.1.5, Table 4-12).
(b) Based on all offsite groundwater sampling in 2012 (Section 5.1.5).
(c) Assumes the MEI consumes one of each species sampled on the NNSS that each have average radionuclide concentrations shown in Table 9-2.
(d) Based on 2012 gamma radiation monitoring data at the NNSS entrance (Section 6.3.1).

The total dose of 0.54 mrem/yr to the hypothetical MEI is 0.54% 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 (98.11 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).

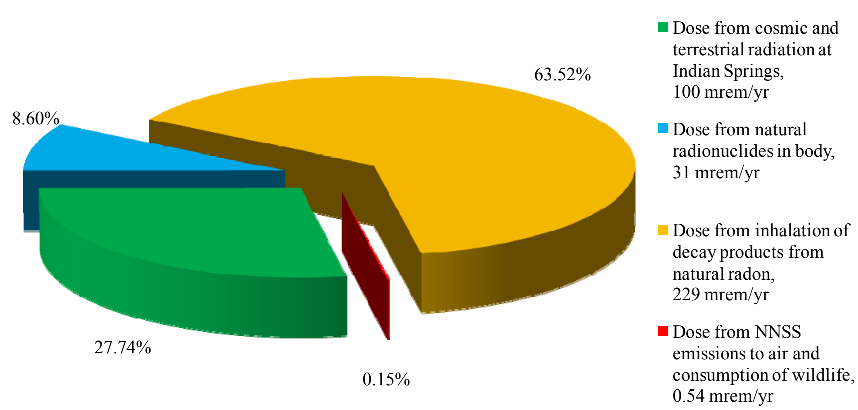


Figure 9-1. Comparison of radiation dose to the MEI from the NNSS and natural background (percent of total)

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 2012 because this assessment depends upon CAP88-PC estimations, which were not calculated. 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 2004a). 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).

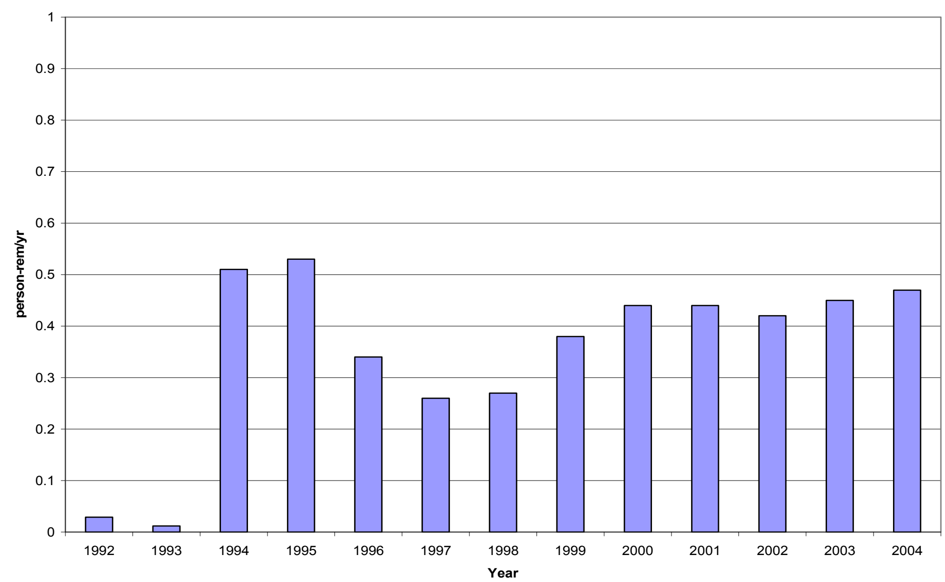


Figure 9-2. Collective population dose within 80 km (50 mi) of NNSS emission sources from 1992 to 2004

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 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 2012, 591 pieces of laboratory equipment, 28 vehicles, and 16 pieces of heavy equipment were released off site to the public by these means. In addition, over 75 metric tons (mtons) of hazardous materials and over 1,200 mtons of non-hazardous materials were released to vendors for recycling or reuse (see Table 3-3 of Section 3.3.2.2 for a list of these materials). No released items had residual radioactivity in excess of the limits specified in Table 9-5. 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 has been incorporated into the site's Radiological Control Managers' Council Internal Audit Schedule. The schedule calls for the audit of DOE O 458.1, which includes the process of releasing property to the public, to be performed in 2013.

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
(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* (Bechtel Nevada 2004a). 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 2012.

9.2.1 2012 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 2012, the RESRAD-BIOTA, Version 1.21, computer model (DOE 2004b) 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 absolute value of the difference between the average exposure rate measured by a thermoluminescent dosimeter (TLD) near the biota sampling site and the average background exposure rate. The *Stake TH-58* TLD site was used for the mule deer sampled in Area 2; the *Upper Haines Lake* TLD site was used for plants and mourning doves sampled at the E Tunnel Ponds; the *T Tunnel #2 Pond* TLD site was used for the mule deer and mountain lion in Area 12; the *Stake P-41* TLD Site was used for the mule deer in Area 19; and the *Jackass Flats & A-27 Roads* TLD site was used for the bobcat in Area 25 (see Chapter 6, Table 6-1).

The 2012 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 the E Tunnel Ponds in Area 12 followed by the Area 19 mule deer. Higher external dose in Area 12 drove the highest total dose predicted to the mountain lion and mule deer in Area 12.

Table 9-6. Site-specific dose assessment for terrestrial plants and animals sampled in 2012

	Estimated Radiological Dose (rad/d)		
Location	**Internal**	**External (TLD site)**	**Total**
Terrestial Plants[(a)]			
Area 12, E Tunnel Ponds (rubber rabbitbrush, desert almond, southern cattail)	0.00013	0.00002	0.00015
		DOE Dose Limit:	**0.1**
Terrestrial Animals[(a)]			
Area 2 (Mule Deer #8)	0.0000001	0.00006	0.00006
Area 12 (Mourning Doves at E Tunnel Ponds)	0.0000153	0.00002	0.00004
Area 12 (Mountain Lion #2)	0.0000029	0.00035	0.00035
Area 12 (Mule Deer #3)	0.0000053	0.00035	0.00036
Area 19 (Mule Deer #1 and #2)	0.0000864	0.00012	0.00021
Area 25 (Bobcat)	0.0000074	0.00010	0.00011
		DOE Dose Limit:	**0.1**

(a) For information on plants and animals sampled, see Chapter 8. Maximum concentrations used. Man-made radionuclides were not detected in animals sampled from Area 18 or the NTTR.

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 worst-case dose to the MEI for 2012 was 0.54% of the dose limit set to protect human health. Dose to biota at the NNSS sites sampled in 2012 were less than 1% 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.

10.0 Waste Management

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 2012 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 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 2012 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 2012, Cell 18 received 1,861.4 m^3 (65,736 ft^3) of MLLW totaling 1,355 tons (Table 10-1). A cumulative total of 4,095.8 m^3 (144,640 ft^3) of MLLW has been disposed in Cell 18 through the end of 2012. Quarterly reports were submitted to the State of Nevada in 2012 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 2012, the Area 5 RWMS received shipments containing a total of 22,838.8 m^3 (806,544 ft^3) of radioactive wastes for disposal,(Table 10-1), including both the non-radioactive classified and the non-radioactive classified hazardous waste matter. The majority of waste disposed was received from offsite generators. The volumes and numbers of waste shipments during fiscal year (FY) 2012 (October 1–September 30) were reported in an annual transportation report (U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office [NNSA/NSO] 2013a). In 2012, 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 (TSCA) (see Section 2.6, Table 2-8).

Table 10-1. Total waste volumes received and disposed at the Area 5 RWMS in calendar year 2012

Waste Type	Disposal Cell(s)	Permitted Limit in m^3	Volume Received and Disposed in m^3 (ft^3)	
LLW	Cells 12,14,16, 17, 19, 20, 21, Trench 13	NA[(a)]	20,977.4	(740,808)
MLLW	Cell 18	25,485	1,861.4	(65,736); 1,355 tons[(b)]
		Total	22,838.8	(806,544)

(a) Not applicable
(b) Fees paid to the State of Nevada for HW generated at 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 WEFwas 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 2012, the TRU waste remaining in storage at the TPCB consisted of two experimental spheres from Lawrence Livermore National Laboratory and 22 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 isotopes activity and quantity, and packaging information. The waste profile is reviewed by the Waste Acceptance Review Panel (WARP) 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 2012, 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 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. The objectives of waste verification include identifying prohibited waste forms, verifying that certain MLLW 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 2012, visual inspections were completed off site on 127 MLLW packages from 15 separate waste streams. Chemical screening was completed off site on nine MLLW packages from four separate waste streams. Onsite visual inspections were completed on two packages from one onsite waste stream and on one package from one offsite waste stream. No onsite RTR was conducted on MLLW packages in 2012, and no MLLW packages were rejected during 2012.

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], 2007a) 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 2012. 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 2012 annual summary report to DOE (NSTec 2013f) 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 2012, all of these key documents were maintained and five were 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
2012 Annual Summary Report for Area 3 and 5 RWMSs at NNSS (Review of Performance Assessments and Composite Analyses), March 2013
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 2012 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 (2013d). Table 5-4 of Section 5.1.7 presents the tritium results for 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 2012

Parameter	Investigation Level (IL)	Sample Levels
pH	< 7.6 or > 9.2 S.U.[(a)]	8.24 to 8.39 S.U.
Specific conductance (SC)	0.440 mmhos/cm[(b)]	0.362 to 0.383 mmhos/cm
Total organic carbon (TOC)	1 mg/L[(c)]	<0.2 to 0.35 mg/L
Total organic halides (TOX)	50 µg/L[(d)]	8.2 to <20 µg/L
Tritium (^3H)	2,000 pCi/L[(e)]	1.57 to 6.84 pCi/L

(a) S.U. = standard unit(s) (for measuring pH) (b) mmhos/cm = millimhos per centimeter Source: NSTec (2013d)
(c) mg/L = milligrams per liter (d) µg/L = microgram(s) per liter (e) 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 2012 are reported in NSTec (2013e). All VZM results in 2012 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 six environmental sampling stations operated in/near the Area 3 RWMS during 2012. Sampling at four monitoring locations (U-3bh N, U-3bh S, U-3ah/at N, and U-3ah/at S) ended March 29, 2012, and sampling at three new stations (U-3ax/bl S, Bilby Crater, and Kestrel Crater N) started the same day. Two air monitoring stations, DoD and Sugar Bunker, operated at the Area 5 RWMS during 2012. 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 Sugar Bunker).

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 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 0.16 for $^{239+240}$Pu at Kestrel Crater N. Summing the fractions of CLs gives 0.20, which is only 20% 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 boundaries of the RWMS would receive an annual dose of about 2 mrem/yr from the air pathway.

Table 10-4. Concentrations of radionuclides in Area 3 and Area 5 RWMS air samples collected in 2012

	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	0.0648	Kestrel Crater N
^{3}H	1,500,000	627.4	Sugar Bunker
^{238}Pu	2.1	0.00519	Kestrel Crater N
^{239}Pu	2	0.328 ($^{239+240}$Pu)	Kestrel Crater N

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.

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 2012, 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 Sections 5.1.5 and 7.2) 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

HW 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. HW 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. HW generated on the NNSS is also direct-shipped if the sites generate bulk, non-packaged HW that is not accepted at the HWSU for storage. HW would also be direct-shipped in the unlikely case when the waste volume capacity of the HWSU is approaching its permitted limits. Satellite Accumulation Areas (SAAs) and 90-day Hazardous Waste Accumulation Areas (HWAAs) are used at the NNSS for the temporary storage of HW 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 2012 HW Activities

The RCRA permit requires preparation of a U.S. Environmental Protection Agency Biennial Hazardous Waste Report of all HW volumes generated and disposed or stored at the NNSS. This report is prepared for odd-numbered years only. It was prepared for 2011 and submitted to the State of Nevada on February 14, 2012. An annual waste volume report (NSTec 2013c) was prepared and submitted to the State of Nevada in February 2013. It includes the volumes of wastes received in calendar year 2012 at the Area 5 MWSU, HWSU, EODU, and Cell 18 as well as waste minimization accomplishments in 2012 (see Section 3.3.2).

In 2012, 33.42 tons of MLLW generated on site were managed (received, stored, or treated) at the Area 5 MWSU (Table 10-5) and subsequently disposed at the Area 5 RWMS. Three drums of PCB wastes (one of HW/PCB-contaminated oil, one of expired HW/PCB-contaminated calibration standards, and one of fluorescent light ballasts containing PCBs), totaling 0.28 tons, were shipped off site in 2012. In 2012, 35.79 tons of HW were direct-shipped from NNSS HWAAs. No storage limits were exceeded at any NNSS SAAs or HWAAs. Quarterly 2012 hazardous waste volume reports were submitted on time to NDEP.

In 2012, 0.39 tons of waste explosive ordnance were detonated at the EODU (Table 10-5). No more than 100 pounds at a time were detonated, and no more than one detonation event per hour occurred.

Table 10-5. Hazardous waste managed at the NNSS in 2012

Permitted Unit	Total Waste Treated, Stored, and/or Disposed (tons)
Cell 18	1,355
MWSU	33.42
HWSU	6.14
HWSU – PCB Waste	0.45
SAAs and HWAAs	35.79[(a)]
EODU	0.39

(a) Tons shipped directly off site from SAAs and/or HWAAs.

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 underground storage tanks 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 2012, SNHD inspected the fully regulated and deferred USTs at RSL-Nellis. No deficiencies were noted, and no USTs were upgraded or removed.

An amendment to NAC 459.9921–459.999 became effective August 8, 2012. It added a UST operator training component mandated by the federal Energy Policy Act of 2005. The training requirements ensure that persons responsible for USTs receive proper training in all relevant aspects of operation, maintenance, and regulation. All responsible operators of NNSA/NFO USTs completed the training by the August 8 effective date of the amended NAC.

10.4 Solid and Sanitary Waste Management

10.4.1 Landfills

The NNSS has three landfills for solid waste disposal that were operated in 2012. The landfills are regulated and permitted by the State of Nevada (see Table 2-12 for list of permits). No liquids, HW, 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 2012 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 2.14 tons/day was disposed at the Area 23 landfill, well within permit limits. State inspections of the three permitted landfills were conducted in 2012, and no non-compliance issues were noted.

Table 10-6. Quantity of solid wastes disposed in NNSS landfills in 2012

Waste Disposed in Landfills in Metric Tons (Tons)		
Area 6	**Area 9**	**Area 23**
0 (0)	1,516 (1,671)	389 (428)

10.4.2 Sewage Lagoons

The NNSS also has two state-permitted sewage lagoons that were operated in 2012. 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.

11.0 Environmental Restoration

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 includes five CAUs in which radionuclides have been detected in groundwater and are directly related to the geographical and hydrologic 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 DOE Office of Legacy Management (LM).

In April 1996, the U.S. Department of Energy (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). Environmental restoration 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 closure process. This section summarizes actions taken by ER towards the closure of UGTA, Industrial, and Soils sites in 2012.

Environmental Restoration Goals – All Sites
Characterize and remediate sites contaminated by NNSA/NFO nuclear testing activities.
Remediate sites in accordance with FFACO-approved planning documents.
Conduct post-closure monitoring of sites in accordance with FFACO site closure documents.
UGTA Sites
Develop a regional three-dimensional computer groundwater model to identify any 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 (which support regulatory decision-making processes) where contaminants exceed, or are likely to exceed, the Safe Drinking Water Act (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.

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. UGTA has identified areas where radionuclides have been detected in the groundwater and has organized them into five UGTA CAUs (Figure 11-1). UGTA gathers information regarding the hydrology and geology of each CAU. Hydrogeologic studies use data from past testing, data obtained from drilling and testing newly constructed deep wells, and data from recompleting or rehabilitating existing wells. Data from these studies are used to produce hydrogeologic models for specific UGTA model areas that will be used to predict groundwater flow and contaminant transport and, ultimately, to design monitoring well networks and land-use restrictions.

A regional three-dimensional computer groundwater model was developed (International Technology Corporation [IT] 1996; Belcher and Sweetkind 2010) to provide a basis for developing more detailed groundwater flow models for each UGTA model area. Figure 11-2 shows the regional groundwater subbasins and general flow directions based on the regional model and CAU models developed to date. Figure 11-3 shows the UGTA model areas, and Figure 11-4 shows the new and historical wells that are managed under UGTA. UGTA wells that are not designated as source-term characterization wells are made available for routine radiological monitoring (see Chapter 5).

Groundwater flow and contaminant transport models for each UGTA CAU include, or will include, a contaminant boundary forecast. As required under the FFACO, the following items will be sequentially identified/defined for each individual CAU through an iterative process: a regulatory boundary objective statement, a regulatory boundary, and a use-restriction boundary. Monitoring well networks will be designed consistent with FFACO requirements, installed, and used for monitoring the individual CAUs (U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office [NNSA/NSO] 2006). Closure-in-place with institutional controls and monitoring is considered to be the only feasible corrective action because cost-effective groundwater technologies have not been developed to effectively remove or stabilize deep subsurface radiological contaminants. UGTA is the largest component of NNSA/NFO's EM Operations and is expected to be completed in FY 2027.

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).

11.1.1 Subsurface Investigations

Most subsurface investigations conducted by UGTA include the construction of wells that are designed to provide the maximum amount of hydrogeologic information to support the refinement of existing hydrostratigraphic framework models and to support groundwater flow and contaminant transport modeling. Of particular interest is the characterization of specific pathways (i.e., faults, fractured aquifers) along which radionuclides could migrate from individual underground nuclear tests away from the NNSS. Also of interest is determining the hydraulic properties of the volcanic aquifers in the model areas and along potential flow paths downgradient. Some of these initial characterization wells may also be used as long-term monitoring wells.

UGTA initiated a Phase II hydrogeologic investigation for the Pahute Mesa–Oasis Valley Model Area (Figure 11-3) in 2009. The investigation is part of the Corrective Action Investigation Plan (CAIP) for the Central and Western Pahute Mesa CAUs, 101 and 102, respectively (NNSA/NSO 2009a) and is described in Section 11.1.3.2. A model evaluation drilling program was initiated in 2012 as part of the Corrective Action Decision Document (CADD)/Corrective Action Plan (CAP) for Frenchman Flat CAU 98 (NNSA/NSO 2011a). No drilling has been conducted in Yucca Flat or Rainier Mesa in recent years. A description of the physiography, overall geology, structural setting, and hydrogeology of all of the UGTA CAUs is found in Section A.2.5 of *Attachment A: Site Description*, which is included on the compact disc of this report.

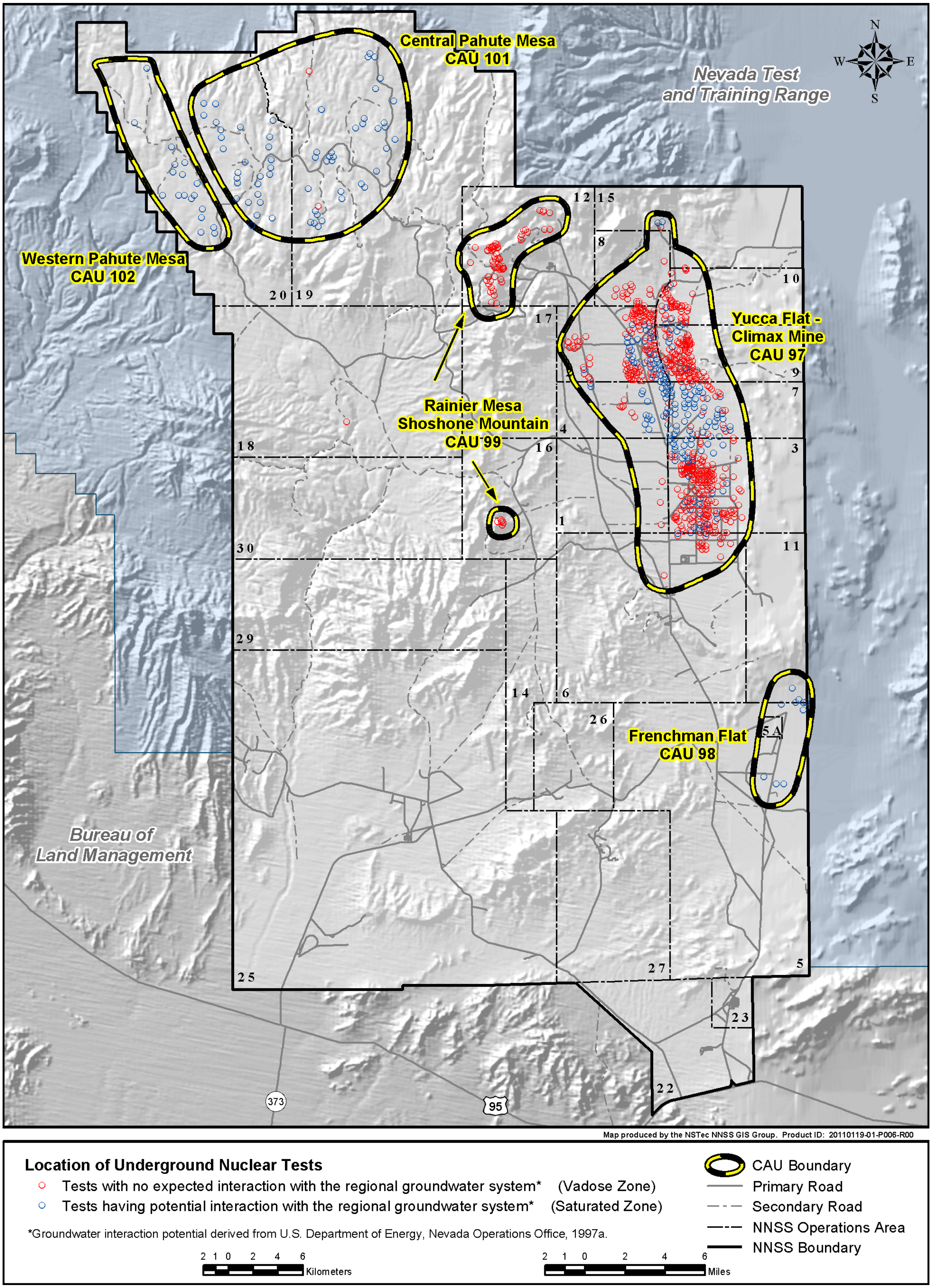


Figure 11-1. UGTA CAUs on the NNSS

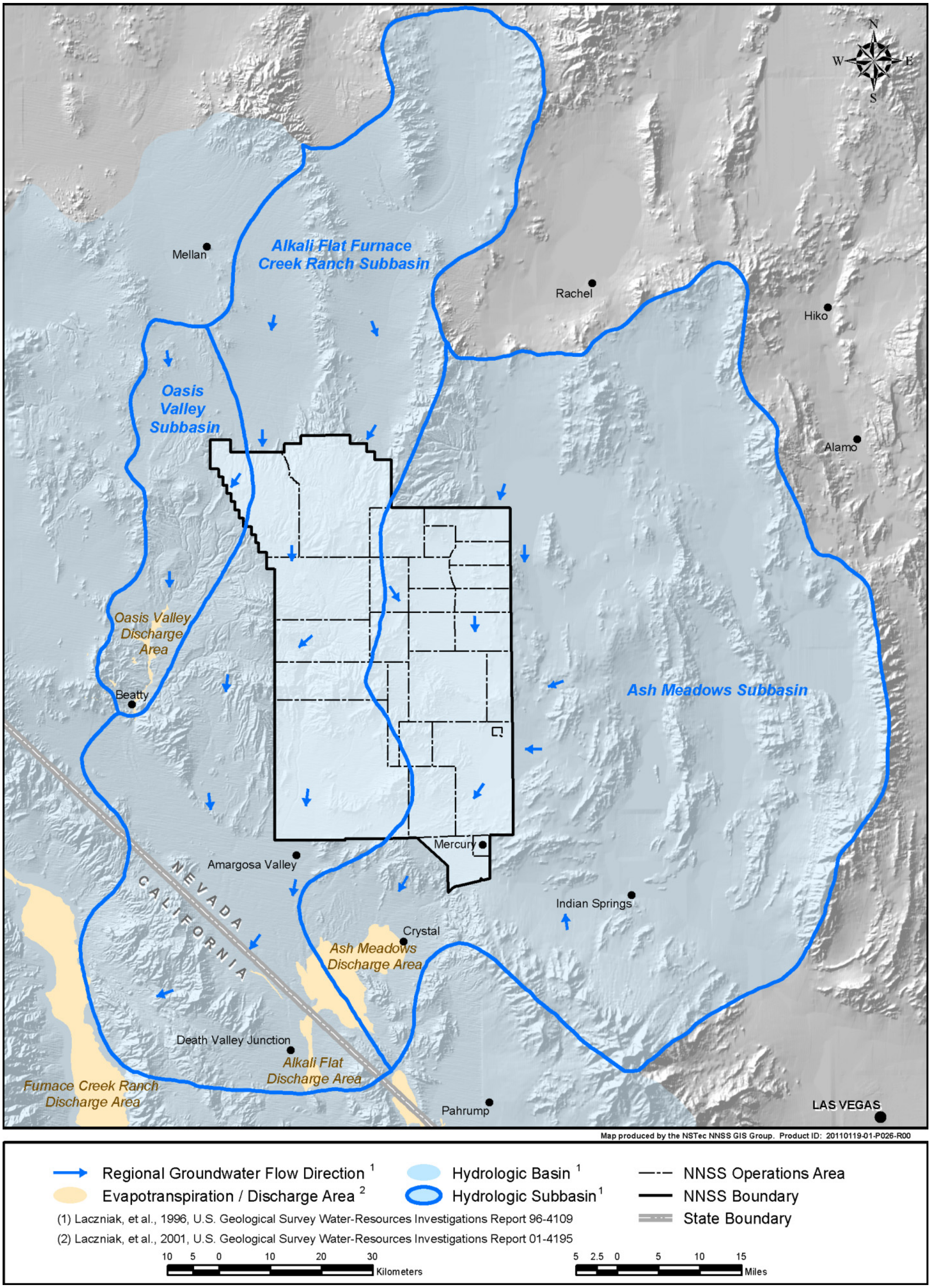


Figure 11-2. Groundwater subbasins of the NNSS and vicinity

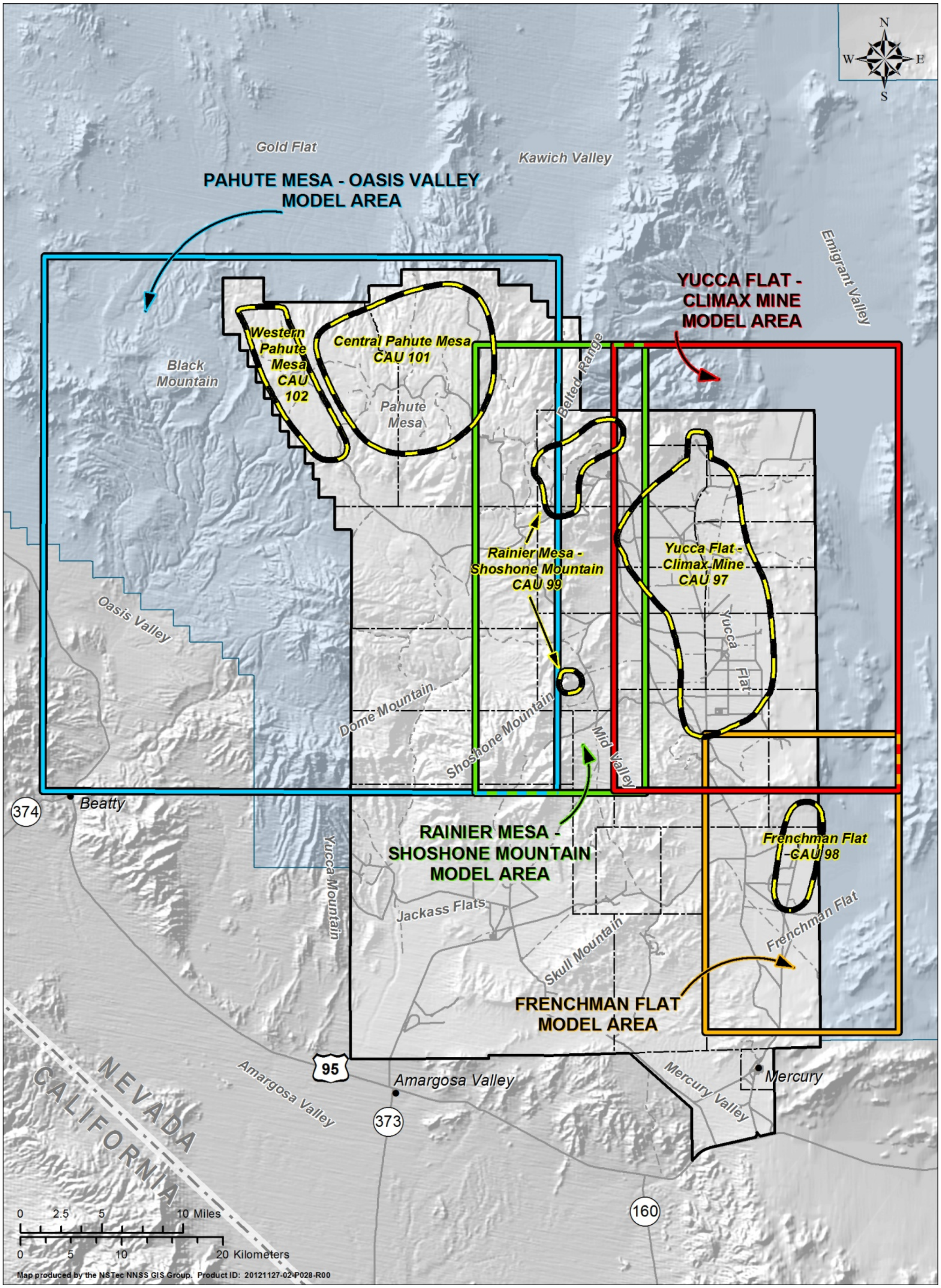


Figure 11-3. Location of UGTA model areas

11.1.1.1 Well Drilling

UGTA completed four new wells in 2012. They included two Pahute Mesa Phase II characterization wells (ER-20-11 in Area 20 and ER-EC-14 on the NTTR) and two Frenchman Flat model evaluation wells (ER-5-5 and ER-11-2 located in northern Frenchman Flat) (Figure 11-4). Preliminary evaluations of the data show that these four wells are providing quality information and fulfilling their intended scientific objectives. Well construction data for these wells were published in individual well completion reports that were started in 2012 and finished in 2013.

The primary purpose of ER-20-11 is to investigate the nature and extent of radionuclide-contaminated groundwater encountered in nearby UGTA Wells ER-EC-11 (NNSA/NSO 2010a) and ER-20-8/ER-20-8#2 (NNSA/NSO 2011b) and to obtain detailed hydrologic information for the contaminated Benham aquifer (N-I 2011a). Tritium, exceeding the Safe Drinking Water Act of 20,000 picocuries per liter (pCi/L), and other radionuclides were detected in this well (NNSA/NSO 2013f).

The primary purpose of ER-EC-14 is to provide detailed hydrogeologic information for volcanic aquifers in the shallow-to-intermediate-depth Tertiary volcanic section in the Timber Mountain moat area. The information obtained from this well will support Phase II efforts, including rebuilding the Phase I hydrostratigraphic framework model of the Pahute Mesa–Oasis Valley (PM-OV) area (Bechtel Nevada [BN] 2002) and subsequent flow and transport modeling. No man-made radionuclides were detected in this well (NNSA/NSO 2013g).

The primary purpose of Wells ER-5-5 and ER-11-2 is to provide detailed geologic, hydrogeologic, chemical, and radiological data that can be used to evaluate the accuracy of the Frenchman Flat CAU flow and transport models and resultant model forecasts. In particular, Well ER-5-5 is intended to capture possible radionuclides from the up-gradient underground nuclear test MILK SHAKE, conducted in Emplacement Hole U-5k. No man-made radionuclides were detected in Well ER-5-5 (NNSA/NSO 2013h). Well ER-11-2 is intended to capture possible radionuclides from the up-gradient underground nuclear test PIN STRIPE conducted in Emplacement Hole U-11b. No man-made radionuclides were detected in Well ER-11-2 (NNSA/NSO 2013i).

Personnel who have responsibility for UGTA well drilling renewed their State of Nevada well drilling operations licenses in 2012.

11.1.1.2 Groundwater Sampling

In 2012, UGTA pumped and collected groundwater characterization samples from three UGTA wells: UE-20n#1 on Pahute Mesa and ER-EC-12 and ER-EC-13 southwest of Pahute Mesa on NTTR (Figure 11-4). Wells ER-EC-12 and ER-EC-13 are within 5.6 kilometers (km) (3.5 miles [mi]) of the NNSS boundary. These three wells were purged using downhole electric submersible pumps prior to the collection of samples to ensure that the samples represent the natural groundwater condition. A multi-agency team collected the groundwater samples and analyzed them for water chemistry parameters and radionuclides. Samples were analyzed by LANL and LLNL and by a certified commercial laboratory. For ER-EC-12, an even more sensitive method was used, $^{3}He/^{4}He$ ratio, yielding an MDC in the low single digits. For UE-20n#1, standard (non-enriched) tritium analyses were performed, and because of the high activity, the MDCs were correspondingly much higher. All groundwater data are maintained in the UGTA geochemical database. Tritium analysis results for these three wells are shown in Table 11-1.

Also included in Table 11-1 are preliminary analyses of water samples from the two new PM-OV Phase II Wells ER-20-11 and ER-EC-14 and the two new Frenchman Flat model evaluation Wells ER-5-5 and ER-11-2. Samples from these four wells were collected during or immediately after drilling operations and prior to well development. These measurements may reflect perturbations due to drilling and consequently may not fully represent the in situ groundwater of the aquifer. The results are used for operation and fluid management decisions, but are useful as general information. These four wells will be sampled again at a later date after further well development and hydraulic testing activities.

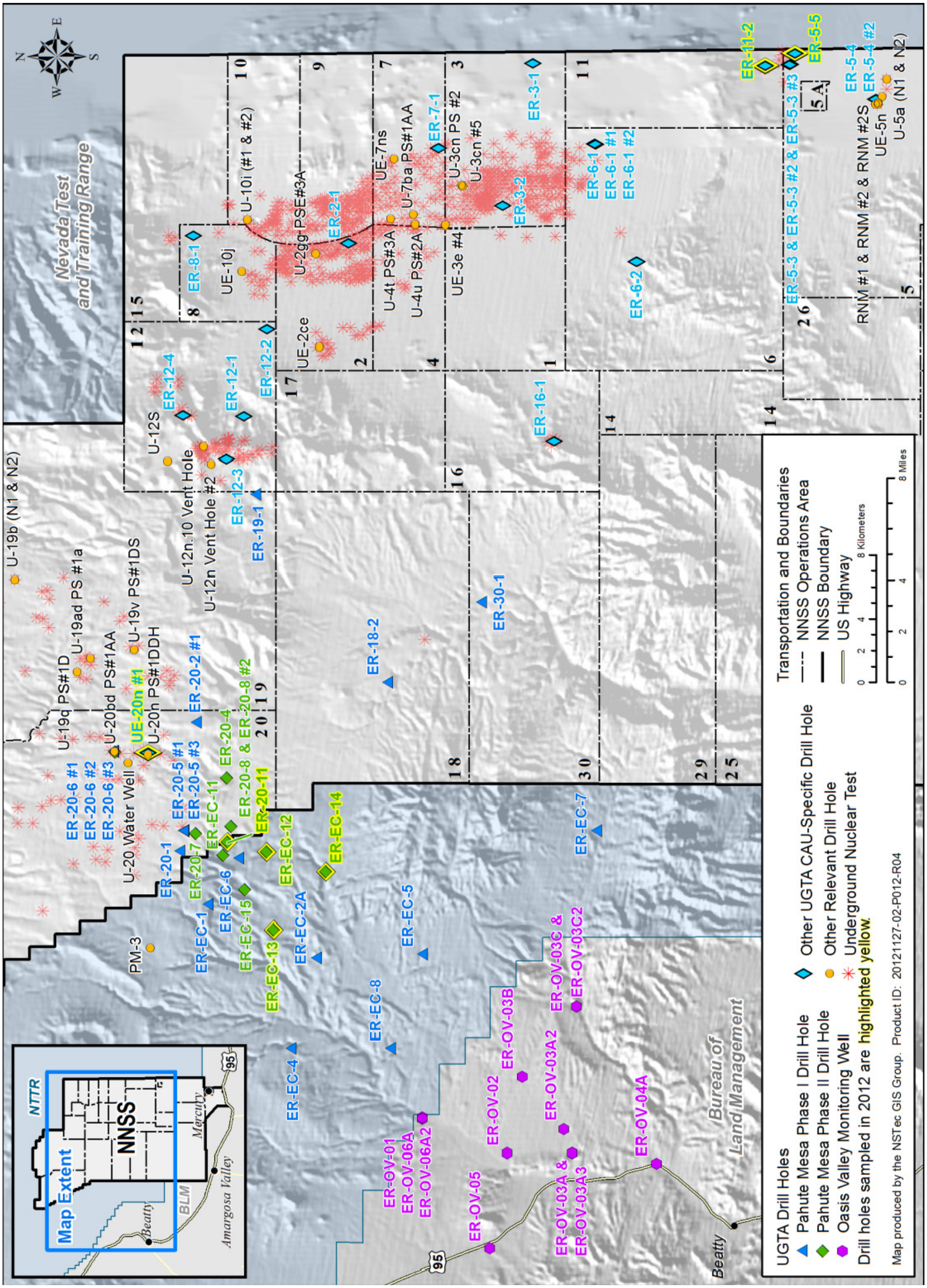


Figure 11-4. Existing UGTA-managed drill wells

Table 11-1. Tritium results from UGTA wells sampled in 2012

UGTA Well, Location	Sample Depth (ft bgs)[(a)]	Date Sampled	Tritium Concentration ± Uncertainty[(b)] (pCi/L)
Groundwater Characterization Sampling			
UE-20n#1, Area 20	2,280–2,824	5/24	47,400,000 ± 7,200,000
ER-EC-12, NTTR	3,259–3,719	3/26	4.20 ± 1.92
ER-EC-13, NTTR	1,888–2,097	7/13	<MDC[(e)] of 2.0
Preliminary Sampling[(c)]			
ER-5-5, Area 5	Entire borehole[(d)]	During drilling	<MDC of 1,385
ER-11-2, Area 11	Entire borehole[(d)]	During drilling	<MDC of 1,845
ER-20-11, Area 20	2,810[(f)]	9/11	186,000 ± 1,000
ER-EC-14, NTTR	Entire borehole[(d)]	During drilling	<MDC of 1,480

(a) feet below ground surface
(b) ± 2 standard deviations
(c) Samples from these wells were collected and analyzed during or immediately after drilling operations and prior to well development; therefore, they may not fully represent the natural groundwater
(d) Flow-line grab samples taken through the duration of drilling
(e) MDC = minimum detectable concentration. Mean MDC varies per analysis (e.g., 2 pCi/L at ER-EC-12 to 2,115 pCi/L at ER-20-11)
(f) Depth-discrete bailer

The tritium detected at Well UE-20n#1 (47,400,000 pCi/L) is associated with a known contaminant plume from a nearby underground nuclear test, CHESHIRE (U-20n) (Marsh 1992) (Figure 11-4). The moderately low tritium measured at Well ER-20-11 (186,000 pCi/L) also was not unexpected (N-I 2011b) and is believed to be the downgradient extension of the BENHAM-TYBO plume. The contaminant plume was first encountered at Well ER-20-5 (DOE/NV 1997b) and further defined by Well ER-20-7 (NNSA/NSO 2010b) and peripheral Wells ER-EC-11 (NNSA/NSO 2010a) and ER-20-8/20-8#2 (NNSA/NSO 2011b). This cluster of contaminated wells is increasing the understanding of flow and transport of radionuclides from underground tests (UGTs) on Pahute Mesa. The extremely low tritium values at ER-EC-12 (more than 4,700 times below the Safe Drinking Waster Act limit) and the absence of tritium at ER-EC-13 (Table 11-1) is generally consistent with Phase I flow and transport models for Pahute Mesa. The tritium analysis results for ER-EC-12 will be investigated by performing additional sampling over the next several years in order to determine if this concentration is a false-positive. The discovery of tritium at ER-20-11 indicates that the contaminant plume forecasted by Phase I flow and transport modeling should be directed more southerly (ER-20-5 to ER-20-7 to ER-20-11). Phase II flow and transport modeling scheduled for the near future will include the new data from the Phase II drilling initiative and will more accurately reflect the recent tritium measurements. See Section 11.1.3.2 for further discussion of wells within the PM-OV Area and their sampling results.

Beginning in March 2012, NNSA/NFO held multiple meetings with participants of the UGTA activity and of the groundwater monitoring activity conducted under the *Routine Radiological Environmental Monitoring Plan* (RREMP) (Bechtel Nevada [BN] 2003a; see Section 5.1). Meeting discussions focused on identifying wells of mutual interest for shared objectives, increasing collaborative efficiencies between the two programs, and the development of an NNSS Integrated Groundwater Sampling Plan. The purpose of this new plan will be to provide a comprehensive, integrated approach for collecting and analyzing groundwater samples and water levels, primarily to meet the needs and the objectives of the UGTA activity. The Plan will be designed to comply with the FFACO and to coordinate with the NNSA/NFO RREMP program and the Community Environmental Monitoring Program (CEMP; see Chapter 7). It 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. Work on the first draft of the plan began in 2012. It is expected to be finalized and approved by NNSA/NFO and the Nevada Division of Environmental Protection (NDEP) by the start of 2014.

11.1.2 Drilling Fluid and Well Sump Sampling

Discharge fluids from UGTA characterization wells being drilled are routinely sampled for tritium and lead. Fluids having ≥400,000 pCi/L of tritium (≥20 times the Nevada Drinking Water Standards) are diverted to lined sumps, and fluids having <400,000 pCi/L of tritium are diverted to unlined sumps in accordance with the Decision Criteria Limits specified in the *UGTA Fluid Management Plan* (Attachment I of NNSA/NSO [2009]). Discharge fluids having ≥3 milligrams per liter (mg/L) of lead (approaching the 5 mg/L Resource Conservation and Recovery Act [RCRA] concentration for hazardous waste) could result in the suspension of drilling operations.

Four UGTA characterization wells were drilled in 2012. Drilling fluids from ER-5-5 and ER-11-2 were directed to lined sumps, and drilling fluids from ER-20-11 and ER-EC-14 were directed to unlined sumps. Water produced during well purging operations prior to sampling (e.g., for UE-20n#1 in 2012) is also typically directed to existing sumps in accordance with the *UGTA Fluid Management Plan*. These sumps were routinely sampled for RCRA-regulated metals as well as for gross alpha/beta and tritium. In addition to grab samples collected during well purging, a composite water sample was collected from the sumps. Test results for lead and metals were all negative. Tritium results are shown in Table 11-1.

11.1.3 Hydrogeologic Modeling and Supporting Studies

Construction of CAU-specific groundwater-flow and contaminant-transport models requires a hydrostratigraphic framework that depicts the character and extent of hydrostratigraphic units in three dimensions. Four hydrostratigraphic framework models, also referred to as hydrogeologic models, have been built (Figure 11-3):

- Frenchman Flat, CAU 98 (BN 2005)
- Pahute Mesa–Oasis Valley, CAUs 101 and 102 (BN 2002)
- Rainier Mesa–Shoshone Mountain, CAU 99 (NSTec 2007b)
- Yucca Flat–Climax Mine, CAU 97 (BN 2006)

The following subsections provide a brief history and current status of work on each model area.

11.1.3.1 Frenchman Flat Model Area

In 2010, NDEP accepted the Frenchman Flat flow and transport models, and a Model Evaluation Plan was prepared that describes a path forward and the evaluation of the flow and transport model forecasts for the Frenchman Flat CAU. The objectives and criteria for the Frenchman Flat CAU model evaluation wells were also developed. In 2012, a well drilling and completion criteria document (N-I 2012a) was prepared for the new model evaluation Wells ER-5-5 and ER-11-2 that were drilled in the summer of 2012 (see Table 11-1 for preliminary tritium analyses of groundwater samples conducted during their drilling). Completion reports for ER-5-5 and ER-11-2 were begun in 2012 and published in January 2013 (NNSA/NSO 2013h, 2013i). Well development, hydrologic testing, and sampling of these two wells are planned for the spring/summer of 2013. These data will then be compared to the existing framework models and modeling forecasts. The Frenchman Flat CAU is the first of the five UGTA CAUs at the NNSS to progress to the model-evaluation stage.

11.1.3.2 Pahute Mesa–Oasis Valley Model Area

The Central and Western Pahute Mesa CAIP (NNSA/NSO 2009a) outlines a campaign to drill additional characterization wells to gather more data needed for the establishment of a long-term groundwater monitoring system. UGTA identified 12 proposed locations for new Phase II wells as part of the campaign, 10 of which were selected for drilling (see Figure 11-4). The drilling campaign began in May 2009. Four wells were drilled in 2009 (ER-20-7, ER-20-8, ER-20-8#2, and ER-EC-11), four were drilled in 2010 (ER-EC-12, ER-20-4, ER-EC-13, and ER-EC-15), and the final two wells were drilled in 2012 (ER-20-11 and ER-EC-14). In 2012, well development, testing, and sampling were accomplished as planned for ER-EC-12, ER-EC-13, and UE-20n#1, and preliminary groundwater samples were collected from ER-20-11 and ER-EC-14 (see Sections 11.1.1.1 and 11.1.1.2).

The Phase I Central and Western Pahute Mesa Transport Model (Stoller Navarro Joint Venture 2009), which supersedes the 1997 regional groundwater flow and tritium transport report (DOE/NV 1997c), predicts that radionuclides in groundwater could travel off the northwestern boundary of the NNSS. The transport model forecasts the migration of tritium and carbon-14 off the NNSS within 50 years of the first nuclear detonation (1965) from the Central and Western Pahute Mesa CAUs and that offsite concentrations of tritium will be above the SDWA limit of 20,000 pCi/L (Figure 11-5). Consistent with this flow and transport model forecast, tritium was detected in Well ER-EC-11 (13,180 pCi/L) on the NTTR in 2009 (NSTec, 2010). It is the first offsite well in which radionuclides from underground nuclear testing activities at the NNSS have been detected. Well ER-EC-11 is located approximately 716.3 m (2,350 ft) west of the NNSS boundary (Figure 11-4) 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 no tritium 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). Well ER-EC-11 was not sampled in 2011 or 2012. As mentioned in Section 11.1.1.2, tritium was found in 2012 in Well ER-20-11 and is believed to represent the downgradient extension of the BENHAM-TYBO contaminant plume. Also, a marginally measureable amount of tritium was reported for the March 2012 sampling of ER-EC-12 (4.2 pCi/L; Table 11-1). The presence of tritium at this location needs to be confirmed with additional sampling and analyses over the next few years. Well sample analyses to date have not detected the presence of man-made radionuclides farther downgradient from Pahute Mesa in the other 10 nearby UGTA wells on the NTTR (ER-EC-1, -2A, -4, -5, -6, -7, -8, -13, -14, and -15; see Figure 11-4).

In September 2012, NNSA/NFO gave a fourth public presentation in Amargosa Valley, Nevada, of the model forecasts and the current state of knowledge of radionuclide migration off the NNSS. Links to the posters presented at the 2012 public meeting as well as to the regional transport model and the Phase I Central and Western Pahute Mesa Transport Model can be found at the NNSA/NFO Groundwater Characterization web page (http://www.nv.energy.gov/emprograms/groundwater.aspx).

In 2012, further analysis of faults and fracture characteristics and of hydraulic properties of selected hydrostratigraphic units was conducted to support Phase II modeling. This further analysis had been recommended in 2009 by the Technical Working Group Pahute Mesa Phase II CAIP ad hoc subcommittee. The subcommittee includes the NNSA/NFO UGTA Federal Activity Lead, subject matter experts consisting of UGTA participants (NSTec, DRI, LLNL, LANL, N-I, and USGS), a representative from NDEP, and two representatives of the NSSAB. 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.

11.1.3.3 Rainier Mesa–Shoshone Mountain Model Area

Planned work on the Rainier Mesa–Shoshone Mountain CAU-scale and sub-CAU-scale models was completed in 2012 and included completion of the following specific items:

- CAU-scale source-term model
- CAU-scale flow and transport model
- Shoshone Mountain sub-CAU-scale model
- Sub-CAU-scale models for the UGTs CLEARWATER and WINESKIN
- Sub-CAU-scale models for the N Tunnel and T Tunnel areas
- Sub-CAU-scale models for the E Tunnel, N Tunnel, and T Tunnel ponds
- CAU-scale surface water infiltration model

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 flow and transport model document began in 2012.

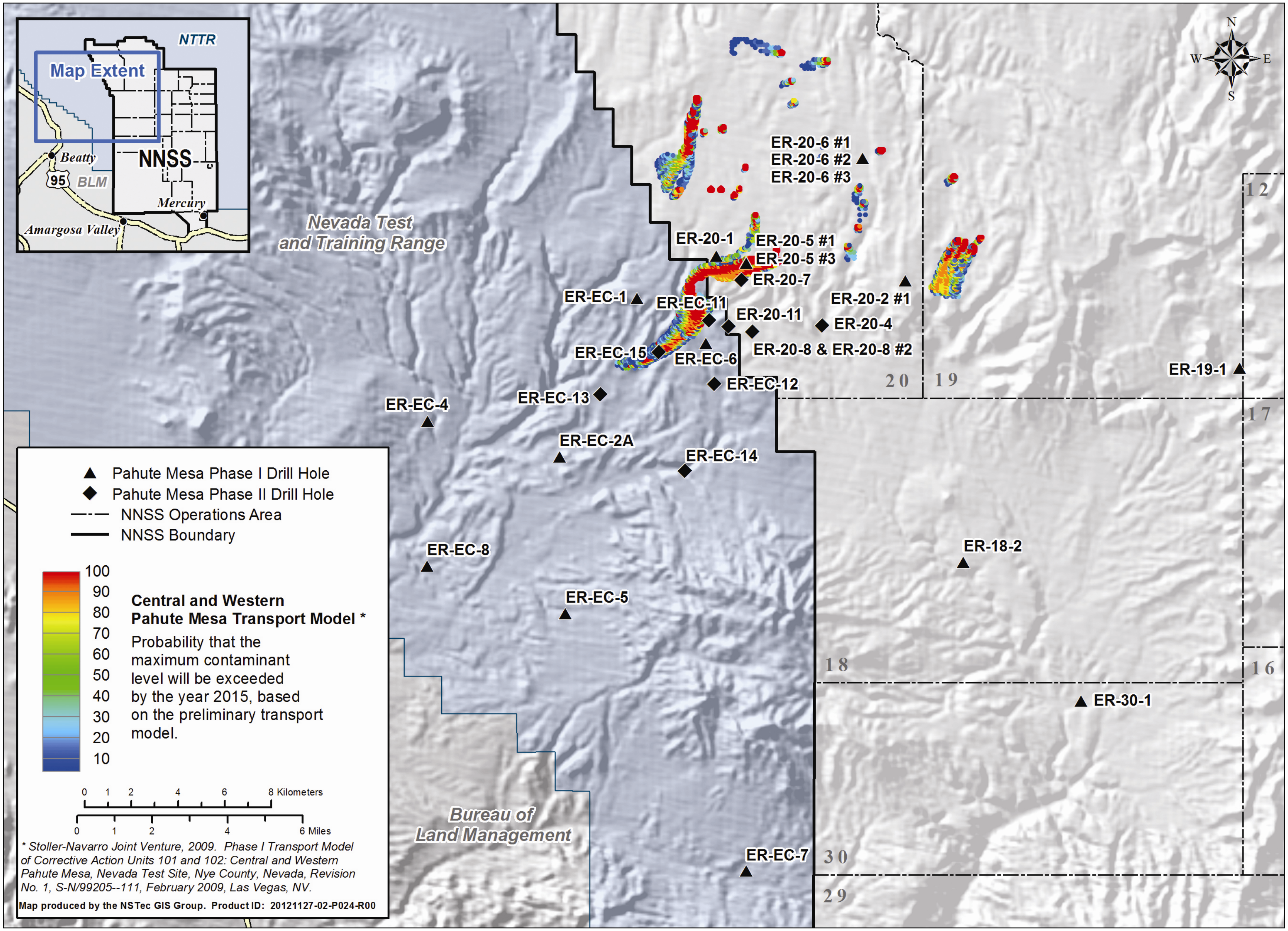


Figure 11-5. Results of Phase I Central and Western Pahute Mesa Transport Modeling

11.1.3.4 Yucca Flat–Climax Mine Model Area

The compilation of the Yucca Flat–Climax Mine CAU flow and transport model document was the main focus of work in 2012 for this UGTA Model Area. The draft document was completed in 2012 for internal review. It is expected to be reviewed by NDEP by the end of 2013.

11.1.4 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 2012. 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 2012 to establish a sample photo archive related to UGTA investigations.

11.1.5 UGTA Publications

All reports and publications that were completed in 2012 and published by June 2013 are listed in Table 11-2. 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 11-2. UGTA publications completed in 2012 and published prior to June 2013

Report	Reference
Frenchman Flat Model Evaluation Wells Drilling and Completion Criteria	N-I 2012a
Pahute Mesa Well Development and Testing Analyses for Wells ER-20-8 and ER-20-4, Nevada National Security Site, Nye County, Nevada	N-I 2012b
Underground Test Area Fiscal Year 2011 Annual Quality Assurance Report	NNSA/NSO 2012
Approaches to Quantify Potential Contaminant Transport in the Lower Carbonate Aquifer from Underground Nuclear Testing at Yucca Flat, Nevada National Security Site, Nye County, Nevada	Andrews et al. 2012
A Multiple-Point Geostatistical Method for Characterizing Uncertainty of Subsurface Alluvial Units and Its Effects on Flow and Transport	Cronkite-Ratcliff et al. 2012
Database of Groundwater Levels and Hydrograph Descriptions for the Nevada Test Site Area, Nye County, Nevada	Elliott and Fenelon 2012
Conceptualization of the Predevelopment Groundwater Flow System and Transient Water-Level Responses in Yucca Flat, Nevada National Security Site	Fenelon et al. 2012
Transient Effects on Groundwater Chemical Compositions from Pumping of Supply Wells at the Nevada National Security Site, Nye County, Nevada, 1951–2008	Paces et al. 2012
Completion Report for Well ER-20-11, Corrective Action Units 101 and 102: Central and Western Pahute Mesa (OSTI ID: 1063990)	NNSA/NSO 2013f
Completion Report for Well ER-EC-14, Corrective Action Units 101 and 102: Central and Western Pahute Mesa (OSTI ID: 1067490)	NNSA/NSO 2013g
Completion Report for Model Evaluation Well ER-5-5, Corrective Action Unit 98: Frenchman Flat (OSTI ID: 1060268)	NNSA/NSO 2013h
Completion Report for Model Evaluation Well ER-11-2, Corrective Action Unit 98: Frenchman Flat (OSTI ID: 1060273)	NNSA/NSO 2013i
Underground Test Area Fiscal Year 2012 Annual Quality Assurance Report Nevada National Security Site, Nevada	NNSA/NSO 2013j
Yucca Flat/Climax Mine CAU Flow and Transport Model, Nevada National Security Site, Nye County, Nevada	N-I 2013

11.2 Industrial Sites

NNSA/NFO identified 1,861 Industrial Sites for which they were responsible to safely close. Closure strategies have included the removal and disposal of debris, complete excavation of the site, decontamination and decommissioning activities, closure in place (see footnote a of Table 11-3), no further action, and subsequent monitoring. Radioactive materials removed from Industrial Sites are 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) or recycled (see Section 3.3.2.2). Hazardous wastes (HWs) generated at the CASs are either direct-shipped to approved disposal facilities or are temporarily stored at the NNSS prior to shipment off site (see Section 10.2). Beyond remediation, the ultimate goal of the Industrial Sites Activity is to ensure that any necessary long-term surveillance and maintenance programs are in place to protect the safety of the public and the environment.

In 2012, 37 Industrial Sites CASs from 4 CAUs were closed (Table 11-3), and interim work was conducted at 1 CAS (Table 11-4). Only two Industrial Sites CAUs remain to be closed: CAU 114, the Area 25 Engine Maintenance, Assembly, and Disassembly (EMAD) Facility, and CAU 572, the Test Cell C Ancillary Buildings and Structures. They represent 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 2027. As of December 31, 2012, closures of 1,853 Industrial Sites CASs have been approved by the State in accordance with the FFACO.

Table 11-3. Industrial Sites closed in 2012

CAU	CAU Description	Number of CASs	Corrective Actions	Wastes Generated
111	Area 5 WMD Retired Mixed Waste Pits	1	Closure in place[(a)] with use restrictions	None
547	Miscellaneous Contaminated Waste Sites	3	Closure in place with use restrictions	LLW, Asbestiform[(b)] LLW, HW, Sanitary
548	Areas 9, 10, 18, 19, and 20 Housekeeping Sites	20	Clean closure[(c)] and no further action	LLW, MLLW, Hydrocarbon, HW, Sanitary
562	Waste Systems	13	Clean closure and no further action	HW, Sanitary

(a) Closure in place is the stabilization or isolation of pollutants, HWs, and solid wastes, with or without partial treatment, removal activities, and/or post-closure monitoring, in accordance with corrective action plans.
(b) Waste with asbestos-containing material.
(c) Clean closure is the removal of pollutants, HWs, and solid wastes at a CAS in accordance with corrective action plans.

Table 11-4. Other Industrial Sites where work was conducted in 2012

CAU	CAU Description	Number of CASs	Activity	Wastes Generated
114	Area 25 EMAD Facility	1	Removal of contaminated equipment in hot cells, investigation of pits and vaults	LLW, MLLW, HW, Sanitary

11.3 Soils

There are 131 Soils CASs for which NNSA/NFO is responsible for characterizing, managing, and closing under the FFACO. Corrective actions range from removal of soil to closure in place with restricted access controls. Historical research and the preparation of short summary reports of research findings have been completed for all 131 CASs. In 2012, 6 Soils CASs from 2 CAUs on the NNSS were closed (Table 11-5) and 69 CASs from 12 CAUs were investigated as progress towards closure (Table 11-6). 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 2022; 84 Soils CASs remain to be formally closed. As of December 31, 2012, closures of 47 Soils CASs have been approved by the State in accordance with the FFACO.

Table 11-5. Soils Sites closed in 2012

CAU	CAU Description	Number of CASs	Corrective Actions	Wastes Generated
465	Hydronuclear	4	Close in place with use restrictions	LLW, HW, Sanitary
574	Neptune	2	Close in place with use restrictions	None

Table 11-6. Other Soils Sites where work was conducted in 2012

CAU	CAU Description	Number of CASs	Activity	Wastes Generated
104	Area 7 Yucca Flat Atmospheric Test Site	15	Investigate nature and extent of contamination	LLW, MLLW, Sanitary
105	Area 2 Yucca Flat Atmospheric Test Sites	5	Preliminary investigations	LLW, Sanitary
366	Area 11 Plutonium Valley Dispersion Sites	6	Investigate nature and extent of contamination	LLW, Sanitary
411	Double Tracks Plutonium Dispersion (NTTR)	1	Preliminary investigations	LLW
412	Clean Slate I Plutonium Dispersion (TTR)	1	Preliminary investigations	LLW
413	Clean Slate II Plutonium Dispersion (TTR)	1	Preliminary investigations	LLW
414	Clean Slate III Plutonium Dispersion (TTR)	1	Preliminary investigations	LLW
415	Project 57 No. 1 Plutonium Dispersion (NTTR)	1	Demarcation effort	LLW
550	Smoky Contamination Area	19	Preliminary investigations	LLW, Sanitary
567	Miscellaneous Soil Sites	4	Preliminary investigations	Sanitary
569	Area 3 Yucca Flat Atmospheric Test Sites	9	Preliminary investigations	HW, LLW, Sanitary
570	Area 9 Yucca Flat Atmospheric Test Sites	6	Preliminary investigations	LLW, Sanitary

11.3.1 Monitoring Activities at Soils CAUs

NNSA/NFO monitors airborne radiological contaminants and meteorological parameters on the TTR to determine if there is wind transport of man-made radionuclides from the contaminated Operation Roller Coaster Soil 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 (ROC), and 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 2013). In 2012, no man-made radionuclides were detected in any of the air samples collected from the Clean Slate I, Clean Slate III, and ROC monitoring stations. Only naturally occurring radionuclides were identified (SNL 2013).

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

From July 2011 to September 2012, data from the Smoky Contamination Area 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 the Smoky CA. All data from the site collected in fiscal year 2012 are reported in Miller et al. (2012). From November 2011 to December 2012, air monitoring data collected at the Area 11 Plutonium Valley Dispersion Sites identified wind speed conditions that resulted in increases in dust transport (and potentially in the re-suspension of contaminated soils). However, no surface water runoff events occurred that were of sufficient volume to collect samples for radiological analyses in 2012. The 2012 study findings for the Area 11 Plutonium Valley Dispersion Sites are summarized in Miller et al. (2013).

11.4 Post-Closure Monitoring and Inspections

All nine of the historical waste management units on the NNSS identified for closure under RCRA (see Section 2.5) have been closed (Table 11-7). The ninth site, CAU 111, the Area 5 Retired Mixed Waste Pits, was closed in 2012. The RCRA Part B Permit for the NNSS prescribes various post-closure monitoring requirements for six of these sites (Table 11-7). CAU 110 and CAU 111 both require vadose zone monitoring (VZM) of the engineered covers of 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 within 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 also revegetated with native vegetation and are monitored for revegetation success. In 2012, 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 2013e). 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 2013d, 2013e). One report for all RCRA closure sites monitored in fiscal year (FY) 2012 (October 1–September 30) was prepared and submitted to NDEP in January 2013 (NNSA/NSO 2013b).

Table 11-7. 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	Quarterly site inspections 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 Subsidence Crater	None
110	Area 3 U-3ax/bl Subsidence Crater	Quarterly site inspections VZM of the engineered cover caps Biennial subsidence survey Annual vegetation survey
111	Area 5 Retired Mixed Waste Pits	Quarterly site inspections 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 2012, physical inspections were conducted at 144 closed CASs 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 2012 annual monitoring report for non-RCRA closure sites on the NNSS was prepared and submitted to NDEP in May 2013 (NNSA/NSO 2013c). A 2012 annual monitoring report for closure sites on the TTR was prepared and submitted to NDEP in January 2013 (NNSA/NSO 2013d).

11.5 Restoration Progress under the FFACO

In 2012, 43 CASs were closed and all 2012 FFACO milestones were completed. Figure 11-6 depicts the progress made since 1996 in the remediation of historically contaminated sites. A total of 2,043 of the 3,018 sites have been closed, and 90% (878) of the remaining 975 CASs are UGTA CASs, for which closure in place with monitoring in perpetuity is the corrective action. 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.

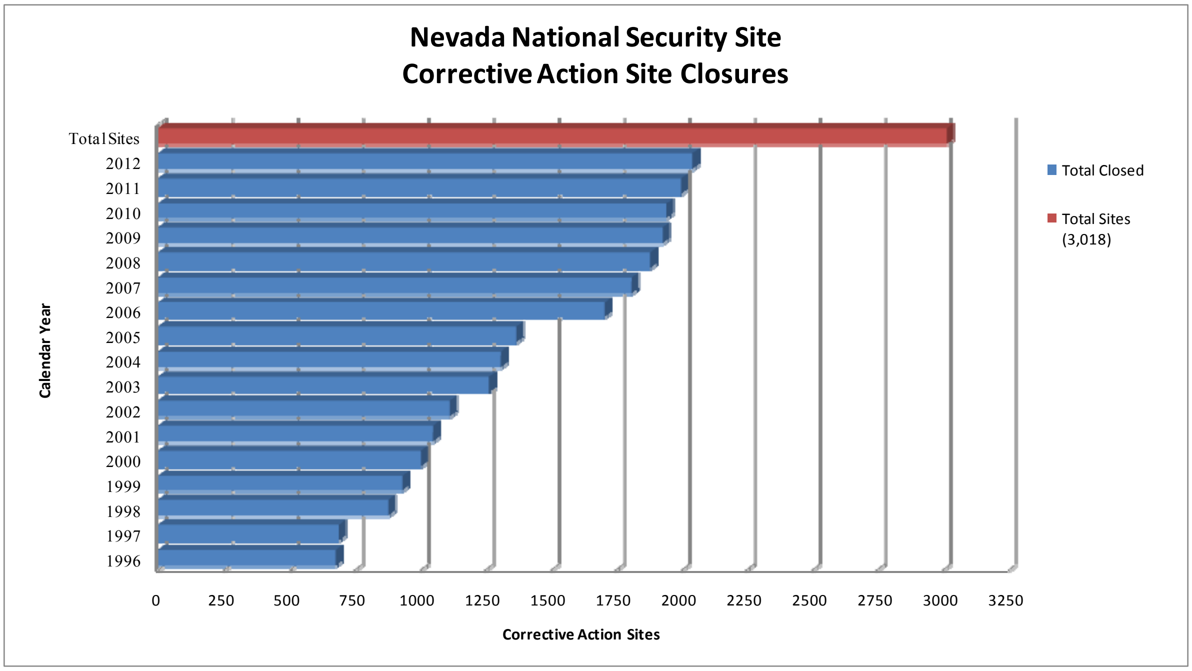


Figure 11-6. Annual cumulative totals of FFACO CAS closures

12.0 Hazardous Materials Control and Management

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 2012 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 (CASs) 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 2012, three activities generated PCB regulated waste:

- Remediation and renovation activities generated three drums of PCB waste weighing a total of 230 kilograms (kg) (507 pounds [lb]): one of PCB oil, one of absorbed PCB oil, and one of mix kits (expired calibration standards); all were sent off site from the Hazardous Waste Storage Unit (HWSU) for disposal.
- Remediation, demolition, and renovation activities generated one drum of PCB light ballasts weighing 11 kg (24 lb), which was received at the Area 5 HWSU for disposal.
- Maintenance activities at the NNSS generated four drums of PCB light ballasts weighing 354 kg (780 lb), one of which was 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. Generated PCB wastes that are above threshold levels are also reported in the Toxic Release Inventory (TRI) Report (see Section 12.3). There were no TSCA inspections by the EPA performed at the NNSS in 2012.

The onsite disposal of radioactive wastes 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

In 2012, the following oversight functions were performed to ensure FIFRA compliance: (1) screened all purchase requisitions for restricted-use pesticides/herbicides and (2) reviewed operating procedures for handling, storing, and applying pesticide/herbicide products. On the NNSS, pesticides and herbicides are applied under the direction of a State of Nevada–certified applicator. This service is provided by Water and Waste (W&W). 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. W&W maintains the appropriate Commercial Category (Industrial) certification for applying this herbicide. It was not used, however, in 2012. All other pesticides/herbicides used are categorized as non-restricted-use (i.e., available for purchase and application by the general public). Pesticide applications in NNSS food service facilities are also conducted by W&W. The State of Nevada did not conduct an inspection of pesticide storage facilities in 2012.

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, 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 2012 chemical inventory for NNSS facilities was updated and submitted to the State of Nevada in the NCA Report on February 21, 2013. The NCA Report satisfies EPCRA Section 302, 311, and 312 reporting requirements. No EPCRA Section 304 reporting was required in 2012 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. Lead and mercury, released as a result of NNSS activities, were determined to be reportable in 2012 under EPCRA Section 313. PCB wastes, which were generated and released for offsite and onsite disposal in 2012 (see Section 12.1) did not exceed threshold levels requiring reporting in the TRI Report, and no release activities at NLVF or RSL-Nellis exceeded reportable thresholds in 2012. Table 12-2 lists the 2012 NNSS release quantities by type of activity for the two reportable TRI toxic chemicals. In June 2013, NNSA/NFO submitted the TRI Report for calendar year 2012 to the EPA and the State Emergency Response Commission.

No EPCRA inspections were performed by outside regulators in 2012.

Table 12-2. EPCRA-reported NNSS releases of toxic chemicals in 2012

Toxic Chemical	Activity	Quantity[(a)] (pounds [lb])
Lead	Routine Activities	
	Onsite disposal/releases	5,626[(b)]
	Offsite disposal/releases	462[(c)]
	Offsite recycling	71,767[(d)]
	Cleanup Activities or One-time Events	92,630[(e)]
	Total Quantity (reporting threshold = 100 lb)	**170,486**
Mercury	Routine Activities	
	Offsite disposal/releases	0.001[(f)]
	Offsite recycling	0.021[(g)]
	Cleanup Activities or One-time Events	268.25[(h)]
	Total Quantity (reporting threshold = 10 lb)	**268.27**

(a) The weight of the chemical released, not the weight of the waste material containing the toxic chemical.

(b) Represents spent ammunition left on the ground and airborne releases of lead during firing at the Mercury Firing Range. When the firing range is closed, ammunition will be collected for recycling.

(c) Represents offsite disposal of lead waste generated from lead paint removal and other routinely generated waste.

(d) Represents lead from two waste streams: 71,407 lb of lead acid batteries and 360.5 lb of broken lead-acid batteries.

(e) Represents lead waste generated from cleanup activities/building demolitions at the NNSS and other DOE facilities: 58,561 lb generated off site and 3,448 lb generated on site and disposed in onsite landfills; 6,121 lb of onsite contaminated soil disposed at offsite facilities; and 24,500 lb of onsite lead bricks sent off site for recycling.

(f) Represents offsite disposal of circuit board debris.

(g) Represents recycled mercury in fluorescent lamps.

(h) Represents mercury waste generated at other DOE facilities and disposed on site.

12.4 Nevada Chemical Catastrophe Prevention Act

The Nonproliferation Test and Evaluation Complex in Area 5 of the NNSS is a Nevada Chemical Accident Prevention Program (CAPP) registered 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.

13.0 Groundwater Protection

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 of Closure Covers; and Chapter 11, Section 11.1, UGTA Activity).

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.

The NNSA/NFO Hydrology Program Manager communicates and helps facilitate furtherance of the NNSA/NFO groundwater protection policy and goals. In conjunction with the *Groundwater Protection Program Plan for the National Nuclear Security Administration Nevada Site Office* (U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office [NNSA/NSO] 2008), NNSA/NFO integrates site-wide groundwater-related activities across the multiple NNSA/NFO programs mentioned below and in previous chapters of this report.

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. Also, the Borehole Management Program protects groundwater "at the wellhead" for boreholes that have been abandoned.

13.1.1 Borehole Management Program

More than 4,000 boreholes were drilled on and off the NNSS in support of nuclear testing. They include emplacement holes for nuclear devices, post-shot investigation boreholes, exploratory holes, instrument holes, potable water wells, construction water supply wells, monitoring wells, and other special purpose boreholes. In 2000, the Borehole Management Program identified 1,238 legacy boreholes as candidates for closure (plugging).

Of these, 160 penetrated the groundwater and underground nuclear test cavities. Plugging may reduce the potential for boreholes to act as conduits for contaminants transported down the borehole from the surface or from contaminated aquifers to non-contaminated aquifers. They are plugged in accordance with Nevada Administrative Code NAC 534.420–534.427 requirements, to the extent possible. Since 2000, some boreholes have been removed from the plugging candidate list as they were determined to be outside the scope of the Borehole Management Program (for example, already plugged or saved for other uses), and a number of partially plugged or previously unknown boreholes have been added to the list.

In calendar year 2012, 13 boreholes were plugged (Table 13-1), 1 of which originally penetrated the groundwater and nuclear test cavities. As of the end of 2012, a total of 822 boreholes have been plugged, 142 of which penetrated groundwater and test cavities, and no candidate boreholes remain on the list. The Borehole Management Program was therefore closed in September 2012. The final fiscal year (FY) progress report (for October 1, 2011 through September 30, 2012) was sent to the Nevada Division of Water Resources in October 2012. During FY 2012, 19 boreholes were plugged.

Table 13-1. NNSS boreholes plugged in 2012

Borehole	Year Constructed	Hole Size (in.)	Original Depth (ft)	Surface Casing Size (in.)	Surface Casing Depth (ft)	Depth Plugged From to Surface (ft)
UE-15j #1	1970	3.75	1250	4	20	835
UE-15j A-5	1969	6.75	745	7.625	6	719
UE-15j C-5	1969	6.75	336	7.625	6	331
UE-15j D-1	1969	6.75	498	7.625	6	500
U-16a-1 Vent	1962	17.5	416	13.375	416	405
U-20g PS #1D	1967	9.875	4546	10.75	2916	652
BLM (HTH)	1951	NA	587	6.625	NA	568
UE-na	1969	12.25	223	13.375	15	55
UE-nb	1969	6.125	950	13.375	144	8
U-na (Assembly)	1969	86	20	66	20	19
USGS HTH #10	1963	12.5	1301	16	995	775
USGS HTH #4	1962	7.625	1500	13.375	760	610
Well 1	1950	NA	870	12	5	35

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 were no reportable spills in 2012.

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 et al. 2004) and manages the NNSS well hydrologic and geologic information database.

By the end of 2012, the USGS monitored water levels in 216 wells, which included 103 on the NNSS and 113 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%5Fnv/.

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 2012 included J-12 WW, J-14 WW, UE-16d WW, WW #4, WW #4A, WW 5B, WW 5C, WW 8, and WW C-1 (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 2012 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 2012 was approximately 152.4 million gallons (Figure 13-1).

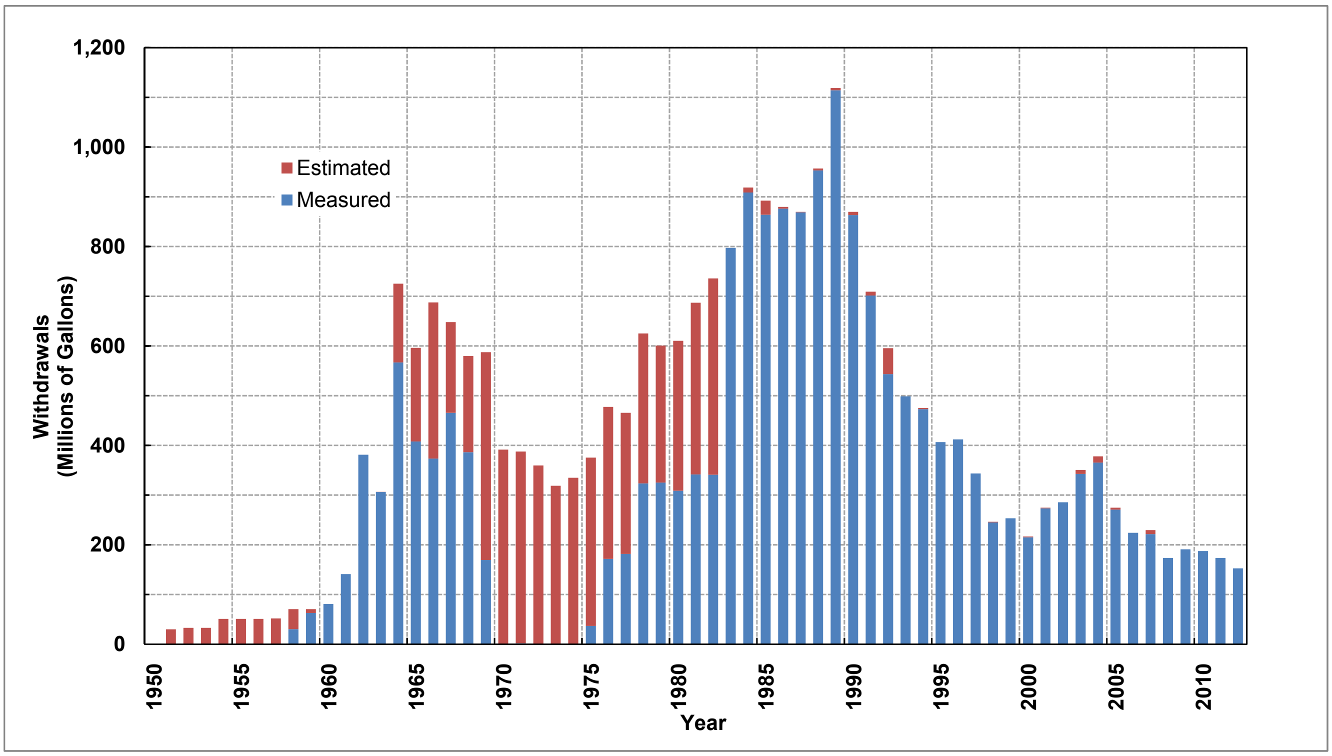


Figure 13-1. Annual withdrawals from the NNSS, 1951 to present

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 2011) and in the *FY 2013 NNSA/NSO Site Sustainability Plan* (National Security Technologies, LLC, 2012a). These goals include reducing both potable and non-potable water use (see Section 3.3.1, Energy Management Program, Table 3-2). 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, 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 2012:

- Potable water consumption was reduced by 23% from the FY 2007 baseline.
- The NNSS Water and Waste Department determined that the largest sources of water usage were five earthen water sumps that store water for site work activities and wildlife use. About 28 million gallons of water per year were pumped to these sumps from potable water supply wells. Approximately 11 million gallons (40%) were used for construction operations or dust control. The remaining 17 million gallons were used as drinking water for wildlife and lost due to evaporation and soil infiltration. Over time, the growth of plants has breached the compacted soil lining of the sumps and increased soil infiltration. A Water Loss Mitigation Team was established to evaluate the potential impact of eliminating these sumps. Site operations for construction, drilling, dust control, and fire fighting, as well as wildlife requirements, were considered. The goal was to achieve responsible water management at the sumps while supporting the water needs of site operations and NNSS wildlife. NNSS biologists worked closely with the team. The following actions were taken, which are expected in 2013 to reduce overall water production on the NNSS by 14% from 2012 production volumes:
  - Well J-11 Sump (Area 25). Groundwater from Well J-12 is pumped to this sump (Well J-11 is not in operation). The sump water was not being used for any operations. Pumping water to this sump was discontinued, and to offset the loss of drinking water available to wildlife in the area, a 600-gallon metal water trough equipped with escape ramps was installed at each of the two nearest natural springs: Topopah Spring, 10.5 miles to the north, and Cane Spring, 10.5 miles to the east.
  - Well 5b Sump (Area 5). The sump water was used for dust control when needed for construction, earth moving, or soil compaction. The sump was closed and the existing fill stand for water trucks was disconnected from the sump and connected to the existing water line. A wildlife water trough was installed and connected to the existing water line at the Well 5b booster station to mitigate for the loss of the sump.
  - Area 6 Construction Yard Sump. The sump water, which can be pumped from Wells 4, 4A, or C-1, was used for dust control. The sump was closed, and the existing water truck fill stand and a new wildlife water trough, installed to replace the sump, were connected to an existing water line.
  - Well C1 Sump (Area 6). The sump water was used for dust control when needed and to transfer water from Well C1 to the Area 6 Construction Yard Sump. The sump was closed, the existing fill stand was removed, and a wildlife water trough was installed by tapping into a water line at the Well C-1 booster station.
  - Camp 17 Pond (Area 18). The sump water is used during drilling operations and as backup for fighting wildfire. It is the largest sump by size and has the greatest documented usage by wildlife. Water is pumped to the sump from Well 8. Water flow into this pond was reduced by approximately 25%. It was not closed due to its importance to wildlife.
- Continued to purchase and install WaterSense labeled products.

14.0 Historic Preservation and Cultural Resources Management

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 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 2012 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 2004a). The reader is directed to the *Nevada National Security Site Environmental Report 2012 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 historical artifacts found on the NNSS. 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

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.

The following information is maintained in databases:

- Number of cultural resources inventories conducted
- Location of each inventory
- Number of acres surveyed at each project location
- Types of cultural resources identified at each project location
- Number of cultural resources determined eligible to the National Register of Historic Places (NRHP)
- Eligible properties avoided by project activities
- Cultural resources requiring mitigation to address an adverse effect
- Occurrences of damage to archaeological sites
- Final report on results

In 2012, DRI conducted archival research for 34 proposed NNSA/NFO projects that had the potential to impact cultural resources on the NNSS. The archival research results led archeologists to conduct eight field inventories and one historical evaluation, which are listed in Tables 14-1 and 14-2. Seven of the eight inventories were completed through the report phase (Table 14-1), resulting in the identification of two prehistoric sites. The other cultural resources inventory and the historical evaluation were completed through the field work phase (Table 14-2) and resulted in the identification of 2 historical sites and one Historic District. A total of 206.5 hectares (510.1 acres) was examined during the inventories and historic evaluation.

In 2012, there were no reported occurrences of damage to archaeological sites.

Table 14-1. 2012 cultural resources inventories and historic evaluations for which final reports were completed

Inventories	NNSS Area	Prehistoric/ Historical Sites Found	Cultural Resources Evaluated	Cultural Resources Determined NRHP Eligible	Area Surveyed Hectares	Area Surveyed Acres
Neptune 2	26	0	0	0	1.0	2.5
PDSE Fiber Optic Line	4	0	0	0	8.6	21.2
Desert Rock Airstrip	22	0	0	0	5.3	13.0
Detonation Pad Area 25	25	0	0	0	0.1	0.2
Neptune-Leo Projects #1 and #2	26	0	0	0	0.6	1.4
Bare Reactor Experiment–Nevada (BREN) Powerline Repair	25	2	2	0	5.1	12.7
Neptune 5a	26	0	0	0	2.8	7.0
Totals		**2**	**2**	**0**	**23.5**	**58.0**

Table 14-2. 2012 cultural resources inventories and historic evaluations for which final reports and cultural resource evaluations to determine NRHP eligibility are pending

Inventories	NNSS Area	Prehistoric/ Historical Sites Found	Historical District	Area Surveyed Hectares	Area Surveyed Acres
P Tunnel Fiber Optic Line	12	0	0	16.6	41.0
Smokey Historical Evaluation	8	2	1	166.4	411.1
Totals		**2**	**1**	**183.0**	**452.1**

14.2 Evaluations of Historic Structures

In 2012, archival research and fieldwork were completed for the historical evaluation of the 1957 Smoky atmospheric test location in Area 8 of the NNSS. Smoky was a nuclear weapons related test in the Plumbbob series and part of the Department of Defense military exercises Desert Rock VII and VIII. The Smoky test location is the most intact atmospheric nuclear testing site on the NNSS and possibly in the world. During the fieldwork, the archaeologists identified two nuclear-related archaeological sites containing 1,308 artifacts and 14 features from the test. In the same area is a nuclear testing historic district that contains 1 building and 37 structures.

14.3 General Reconnaissance

Three field activities and five preliminary assessments were conducted in 2012. Two of the field activities were to monitor the placement of wildlife watering troughs at Cane and Topopah Springs (see Section 13.4). The third activity involved DRI and NNSA/NFO personnel visiting Tunnel U16a to monitor vegetation removal around the edge of the tunnel pad. The preliminary assessments were for Corrective Action Units (CAUs) 105, 465, 550, 567, and 570. The 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

Twenty-eight cultural resources reports were completed in either late 2011 or in 2012 and were approved and finalized in 2012 (Table 14-3). NNSA/NFO submitted all inventory reports and historical evaluations to the Nevada State Historic Preservation Office (SHPO) 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 2012

Project	Reference
Inventory Reports	
BREN Powerline Repair, Area 25	DeMaio 2012
Vegetation Stress Experiment Location, Area 8	DeMaio and Holz 2012
Well Pad, Trailer Pad and Access Road for the Source Physics Experiment, Areas 8 and 15	Drollinger 2011a
Pele Experiment Test Area, Area 4	Drollinger 2011b
Neptune 5a Detonation Pad and Access Road, Area 26	Drollinger 2012a
Hangar and Leach Field, Desert Rock Airstrip, Area 22	Drollinger and Edwards 2012
Chicken Little Project, Area 18	Holz 2012a
Hill 200 Power-line Upgrade, Area 5	Holz 2012b
Improvements to U12u Tunnel, Area 12	Holz 2012c
Generator Pad and Bore Hole Project Area, Area 12	Holz 2012d
Generator Pad Extension and Borrow Pit, Area 12	Holz 2012e
Five Proposed Rotary Percussion Sounding System Drill Holes, Area 15	Holz 2012f
Neptune 2 Project, Area 26	Holz 2012g
Blast Pad, Area 25	Holz 2012h
Neptune – Leo Projects #1 and #2, Area 26	Holz 2012i
Fiber Optic Line from Mercury to Area 6 Control Point, Areas 5, 6, and 23	Holz and Drollinger 2012a
Fiber Optic Line from Mercury Highway to Yucca Lake, Area 6	Holz and Drollinger 2012b
PDSE Fiber Optic Line, Area 4	Jones 2012a
U12u Powerline in Support of the ITD-1, Area 12	Rowland-Fleischmann et al. 2011

Table 14-3. Cultural resources reports approved and finalized in 2012 (continued)

Project	Reference
Historical Evaluations	
Railroad Lines in Areas 25 and 26	Drollinger 2012a
Pluto Compressor Building, Area 26	Drollinger and Vanderslice 2012
Structural Response Safety Program Structures in Areas 1, 3, 12, and 19	Jones 2011
Preliminary Assessment Letter Reports	
Corrective Action Unit 104, Area 7	Jones 2012b
Corrective Action Unit 465, Area 27	Jones 2012c
Corrective Action Unit 550, Smoky Test Location, Area 8	Jones 2012d
Corrective Action Unit 105, Area 9	King 2012a
Corrective Action Unit 567, Areas 1, 2, 3, and 7	King 2012b
Corrective Action Unit 570, Area 9	King and Jones 2012

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 2012, 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 and Drollinger 2012). The objective in 2012 for the artifact collection was to continue the development of the accession record database. This database will be linked to the existing artifact catalog. Towards this goal, data were entered into the accession form template and linked to a Microsoft Office Access database. Artifacts are being accessioned according to site number and the date they entered the collections. In order to do this, the year and month of collection are being recorded from the original artifact provenience tags stored in the curation facility. The dates for approximately 70% of the collection have been compiled (Falvey and Drollinger 2012).

All artifacts in the collection are stored in current archival-quality materials, and 30 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 (AICP) 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 and display 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.

On January 25, 2012, a meeting between the CGTO Spokesperson and Dave Huizenga, acting DOE Deputy Assistant Secretary for Environmental Management (EM) was held. The meeting, arranged by NNSA/NFO, occurred in response to a 2011 CGTO recommendation requesting an opportunity to provide background information about the CGTO and the collaborative efforts between 16 tribes and NNSA/NFO. The meeting focused on CGTO participation in EM activities on the NNSS and involvement in DOE/EM State Tribal Government Work Group (STGWG) meetings. Members of STGWG are composed of tribes that work with DOE sites throughout the United States. The CGTO Spokesperson attended four more meetings in 2012, each supported by NNSA/NFO to encourage increased tribal involvement and understanding about DOE's role in national and international activities. They included DOE's National Transportation Stakeholders Forum on May 14–17, in Knoxville, Tennessee, and two STGWG meetings, one in Denver, Colorado, on June 18–20, and the other in New Orleans, Louisiana, on December 11–14. At these three meetings, the CGTO Spokesperson shared cultural and tribal perspectives as it relates to the AICP. The CGTO is an integral part of these DOE and STGWG meetings, as they bring pertinent information and related experience into DOE and tribal discussions. As such, the CGTO continues to work closely with DOE/EM in identifying potential mechanisms for securing additional support for the NNSA/AICP. The fourth meeting was the International Conference of Geologic Repositories held in Ontario, Canada, on September 30–October 4. DOE's Office of Nuclear Energy and the U.S. Nuclear Regulatory Commission invited the CGTO Spokesperson to be a guest speaker at this international conference. This forum allowed the CGTO Spokesperson to represent American Indian perspectives for the United States in tandem with three First Nations representatives who shared their unique perspectives about geologic repositories and the importance of tribal interactions.

In 2012, NNSA/NFO did not receive any requests from NNSS-culturally affiliated tribes to access the NNSS for ceremonial or traditional use. CGTO interest still remains in expanding tribal involvement in traditional management activities and conducting a traditional pine nut harvest in the future on the NNSS.

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. Although NAGPRA consultation has been completed, NNSA/NFO continues to protect an onsite American Indian burial site and other culturally important sites while maintaining location information and conducting periodic monitoring and providing updates to culturally affiliated tribes upon request. 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 2012).

THIS PAGE INTENTIONALLY LEFT BLANK

15.0 Ecological Monitoring

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 construction sites, (3) monitoring important species and habitats, (4) the Habitat Restoration Program, (5) wildland fire hazard assessment, and (6) biological impact monitoring at the Nonproliferation Test and Evaluation Complex (NPTEC). Brief descriptions of these sub-programs and their 2012 accomplishments are provided in this chapter. Detailed information may be found in the most recent annual EMAC report (Hall et al. 2013). 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 numbers 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 2012, biologists conducted surveys for 15 projects that were within the distribution range of the desert tortoise on or near the NNSS. A total of 15.21 acres (ac) of desert tortoise habitat were disturbed in 2012, 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 2012, one desert tortoise was injured by a vehicle on a paved road and seven were moved out of harm’s way off of roads. Eleven 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 2013, 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, 2012.

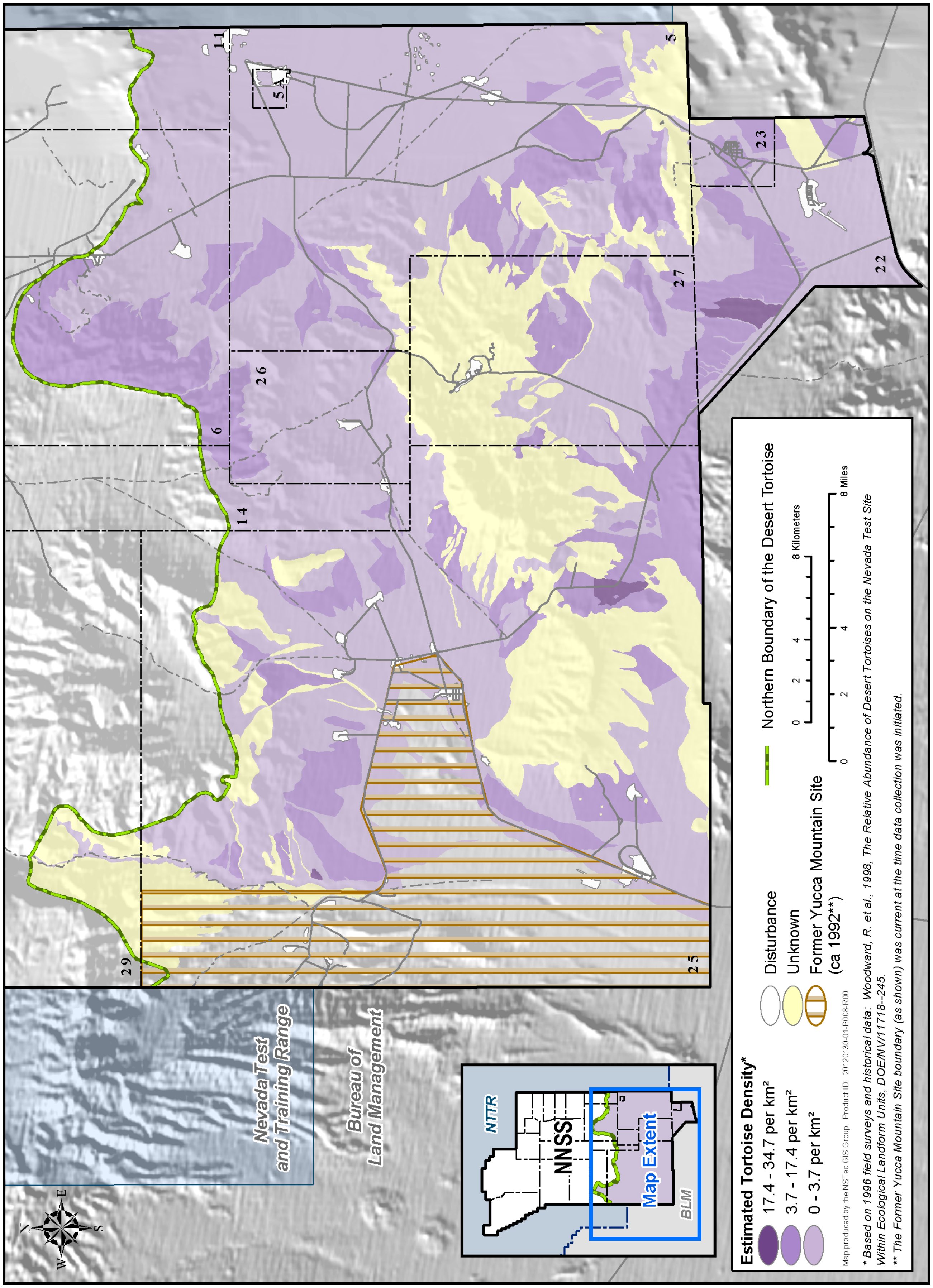


Figure 15-1. Desert tortoise distribution and abundance on the NNSS

Table 15-1. Annual totals (2012), cumulative totals (2009–2012), and compliance limits for take of acres and tortoises

	Acres Impacted			Tortoises Killed or Injured			Other Incidental Take[a]		
Program/Activity	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	13.72	25.17[b]	500	0	0	1	0	0	10
Infrastructure Development	1.49	1.64	100	0	0	1	0	0	10
Vehicle Traffic on Roads	-	-	-	1	5	15[c]	18	45	125
Totals	15.21	32.42	2,710	1	5	22	18	45	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 2011and 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 Roadside Tortoise Movements Study

Since 1992, when the first Opinion was issued to NNSA/NFO, nearly $300,000 of NNSA/NFO project funds have been paid as mitigation for the disturbance of desert tortoise habitat, and 14 tortoises have been accidentally killed on paved roads (although no tortoises have been killed at new project sites). Tortoise deaths on the NNSS are minimized by worker education, posted road signs, and workers who move tortoises off paved roads out of harm's way. The mitigation fees provide no protection benefits to onsite tortoise populations; they are used to support the operation of the Desert Tortoise Conservation Center (DTCC) located near Las Vegas, Nevada, and operated by the San Diego Zoo Institute for Conservation Research (ICR).

To assess ways of minimizing road mortalities, site biologists developed a proposal to study roadside tortoise movements and requested funds from the FWS to conduct the study, as allowed under the Opinion. A successful collaboration agreement was finalized in February 2012 with the FWS and the San Diego Zoo ICR. The agreement offered NNSS lands as a needed translocation research site for tortoises being held and cared for at the DTCC in exchange for funds to purchase radiotelemetry equipment needed for the NNSS roadside tortoise movements study. The NNSS radiotelemetry study began in May 2012, and site biologists are currently collecting movement data from 11 adult tortoises (Hall et al. 2013).

15.2 Biological Surveys at Proposed Project Sites

Biological surveys are performed at proposed project sites where land disturbance will occur. The goal is to minimize the adverse effects of land disturbance 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 2012, biological surveys for 20 projects were conducted on or near the NNSS. One of the projects had multiple sites that were surveyed. Biologists surveyed a total of 358.72 ac. A total of 15 projects were within the range of the desert tortoise. Biologists provided to project managers written summary reports of all survey findings and mitigation recommendations, which are summarized by project in Hall et al. (2013).

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 2012 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. (2013). 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 2012 for important species and habitats of the NNSS

Sensitive Plants

- Field surveys for rock purpusia (*Ivesia arizonica* var. *saxosa*) and white bearpoppy (*Arctomecon merriamii*) were conducted, and new NNSS populations of both species were documented.
- Specimens of Kingston Mountains bedstraw (*Galium hilendiae* ssp. *kingstonense*), collected on the NNSS in 2011, were sent to taxonomic experts, and the subspecies was confirmed to be *kingstonense*. Two new NNSS populations of this plant were documented.
- Several new locations of Pahute green gentian (*Frasera pahutensis*) were documented during other monitoring activities.

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, no migratory bird nests, eggs, or young were found in 2012.
- Mitigation actions were taken to minimize raptor electrocutions. The NNSS Power Utilities group installed extra insulation on the energized drop down lines to the transformer boxes on a power pole that were 1–1.5 meters from a previously-occupied red-tailed hawk nest. This action may be taken at other power poles on the NNSS that have raptor nests.
- Four bird mortalities were documented (Figure 15-2). A common raven (*Corvus corax*) was electrocuted by power lines, a great horned owl (*Bubo virginianus*) was killed by a vehicle, a brown-headed cowbird (*Molothrus ater*) died from accidental entrapment in a glue trap used for pest control, and a sharp-shinned hawk (*Accipiter striatus*) was found dead of unknown cause.

Mountain Lions (*Puma concolor*)

- A collaborative effort with Erin Boydston of the U.S. Geological Survey (USGS) continued to investigate mountain lion distribution and abundance on the NNSS using remote, motion-activated cameras. Cameras collected a total of 124 photographs/video clips of mountain lions from 22 of 33 camera sites. Two un-collared lions have been photographed in addition to the four collared lions.
- 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 2012. Three males and one female were captured and collared in May and June 2012. NNSS biologists visited suspected kill sites to determine the lions' food habits. Combining data from all four mountain lions, a total of 54 kills of prey species were found on the NNSS (Figure 15-3). The female mountain lion was found dead during early August 2012; the cause of death is unknown but may be disease-related.

Wild Horses (*Equus caballus*)

- The annual horse census was conducted, and 35 individuals were counted, not including foals. Based on observations and photographs, at least six foals were born in 2012, and four foals are known to be killed by a radio-collared mountain lion. The NNSS horse population in 2012 is stable at about 35 individuals (Figure 15-4).The estimated size of the wild horse range on the NNSS was 206 square kilometers (km^2) (80 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 20 deer/night, 50% fewer than in 2011. Deer density ranged from 0.2 to 2.1 deer/km^2 (0.08–0.82 deer/mi^2) between different segments of the survey routes. Deer counts and density over the last 7 years have fluctuated and show no distinctive trends.

Table 15-2. Activities conducted in 2012 for important species and habitats of the NNSS (continued)

Bats

- Bat vocalizations and climatic data (e.g., temperature, humidity, wind, barometric pressure) at Camp 17 Pond were recorded, but no analysis was performed due to a limited budget.
- One dead and five live bats were found and documented at five NNSS buildings in Mercury. Building day roost sites were recorded and the bats were removed; all live bats were released.

Reptiles

- Funnel traps were set at 20 sites throughout the NNSS for a total trap effort of 1,520 trap nights (number of traps × number of nights they were open); 102 captures of nine species and direct observation of seven additional species were made, further expanding or refining the known distributions of NNSS reptiles.

Natural and Man-made Water Sources

- Eight new natural water sources were discovered on the NNSS during mountain lion monitoring. They include one seep, which appears to be a permanent water source, and seven rock tanks, which collect surface water flow after precipitation events and hold water from a few weeks to several months. Old metal pipes were found at the seep.
- Five new wildlife watering troughs were installed to mitigate for the loss of well sumps closed in 2012 (see Section 13.4). Motion-activated cameras were set up at each trough in September and November to document wildlife use.
- 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. 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. They included 23 plastic-lined sumps and 1 radioactive containment pond. No wildlife mortality was observed at any water source.

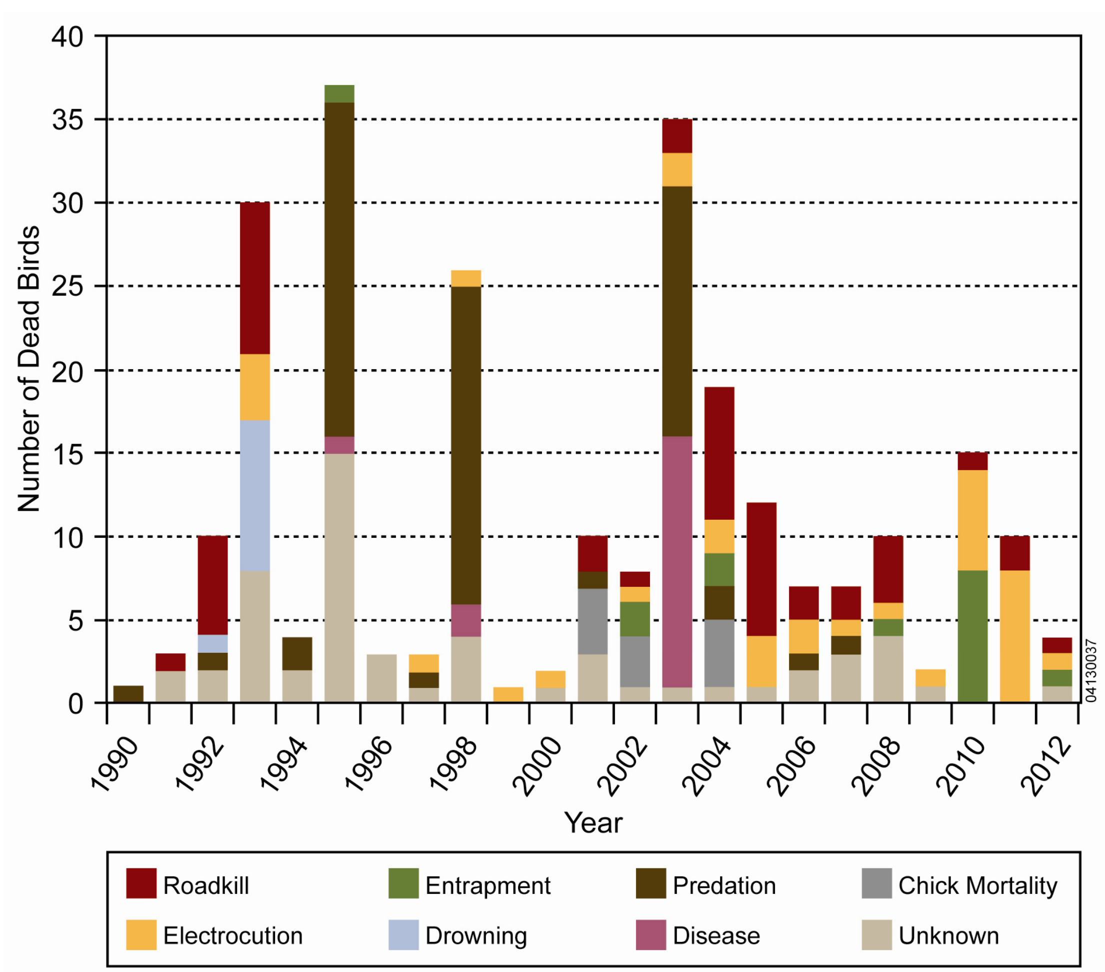


Figure 15-2. Number of bird deaths recorded on the NNSS by year and cause

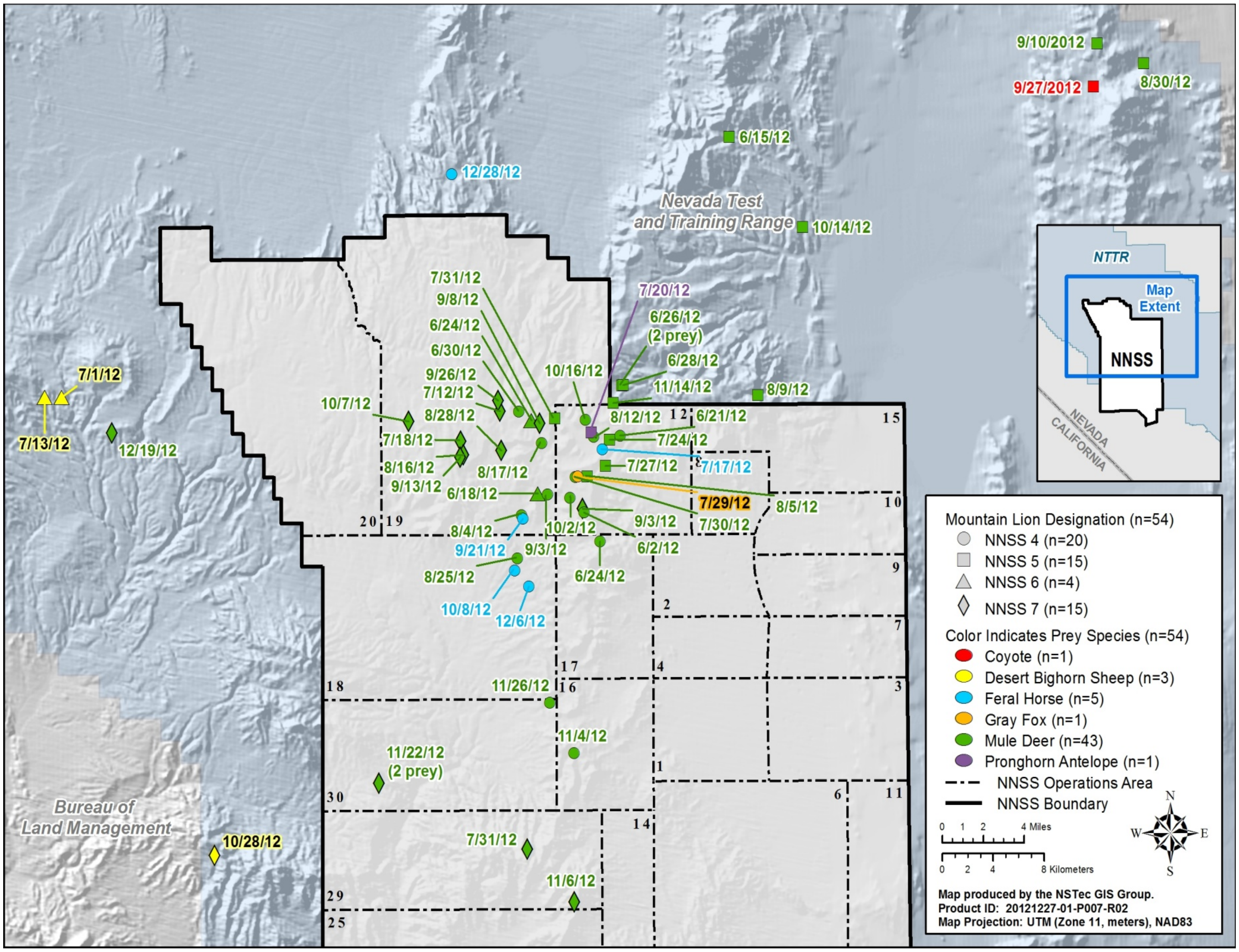


Figure 15-3. Kill sites of four radio-collared mountain lions documented in 2012

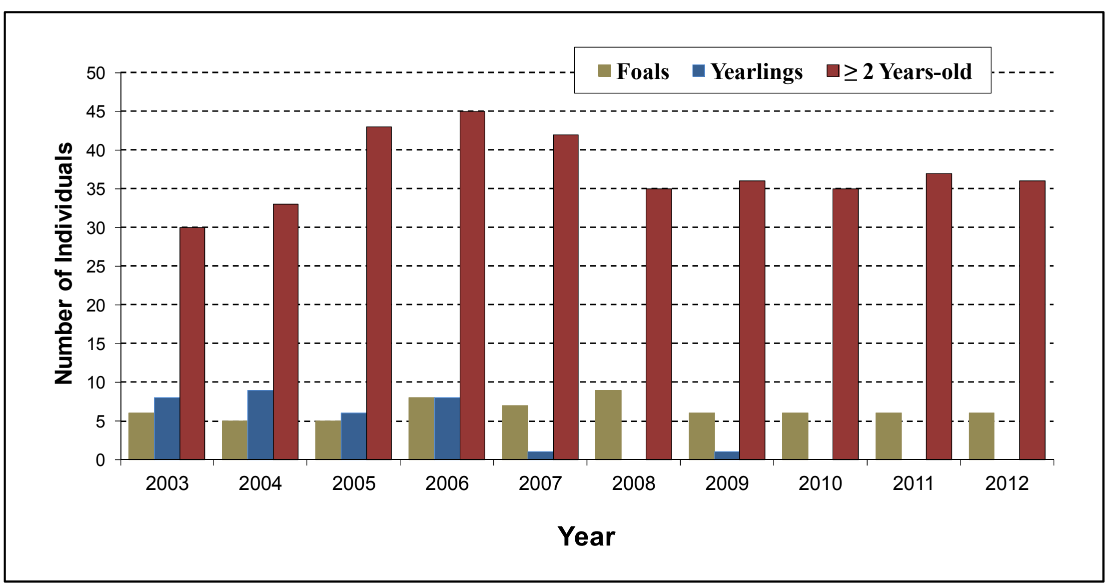


Figure 15-4. Trends in age structure of the NNSS horse population from 2003 to 2012

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 2012. The cover cap on the U-3ax/bl disposal unit (Corrective Action Unit [CAU] 110), revegetated in 2000, and the Control Point waterline, revegetated in 2009, were the restoration sites 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. (2013).

The "92-Acre Site" at the Radioactive Waste Management Complex (see Section 10.1.1) was revegetated in late 2011 to establish an evapotranspirative cover over buried waste. Revegetation included site preparation, seeding, mulching, crimping, and setting up an irrigating system on four areas at the site, which totaled 18 ha (44.5 ac). To date, this is the largest revegetation effort at the NNSS. The irrigation system was designed and constructed to provide a means of supplementing natural precipitation to promote seed germination and enhance plant establishment and was completed in January 2012. Between January and December 2012, 109 mm or 14,020,750 liters of supplemental watering was applied to the four areas within the 92-Acre Site. Natural precipitation provided 56 mm of water to the site. No plant monitoring was conducted in 2012.

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. 2013). In April and May 2012, NNSS biologists visited 106 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 106 sampling stations was 4.17. In 2012, 11 wildland fires burned a total of 216.9 ha (535.9 ac). Seven were caused by lightning (206 ha [509 ac]), two by ordnance (6.5 ha [16.1 ac]), one by high winds that caused high voltage lines to arc (4 ha [9.8 ac]), and one by a vehicle (0.4 ha [1 ac]).

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 2012, 15 samples were collected from seven sites. Nine traps contained no mosquitoes, and the other six traps contained mosquitoes but they were moldy and unable to be identified or tested for WNV. Mosquito species known to carry the virus occur on the NNSS; however, to date, WNV has not been detected conclusively on the NNSS, although two samples were suspect for WNV in 2005 and 2006 (Bechtel Nevada 2006b; National Security Technologies, LLC, 2007b). Trapping will continue next year. This exchange of labor for analysis results 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 Biological Monitoring of NPTEC

Biological monitoring at NPTEC in Area 5 is performed when there is a risk of significant exposure to downwind plants and animals from planned test releases of hazardous materials. The Desert National Wildlife Refuge (DNWR) lies east of the NNSS border, approximately 5 kilometers (3 miles) from NPTEC. The National Wildlife Refuge System Administration Act forbids the disturbance or injury of native plants and wildlife on any National Wildlife Refuge System lands unless permitted by the Secretary of the Interior. Biological monitoring is conducted to verify that NPTEC tests do not disperse toxic chemicals that harm biota on the DNWR. This is also a requirement of NPTEC's Programmatic Environmental Assessment (U.S. Department of Energy, Nevada Operations Office 2002). Monitoring involves sampling established transects downwind and upwind of NPTEC and recording dead animals and vegetation damage. In 2012, NNSS biologists reviewed one test plan. Baseline monitoring was not conducted at established control-treatment transects near the NPTEC in 2012 because it was determined that the small quantities and low concentration levels planned for the test would pose no significant impact to downwind biota.

16.0 Quality Assurance Program

The National Security Technologies, LLC (NSTec), Quality Assurance Program (QAP) describes the system used by NSTec to ensure that quality is integrated into the environmental monitoring work performed for the U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office (NNSA/NFO). The NSTec QAP complies 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 below. The NSTec QAP requires a graded approach to quality for determining the level of rigor that effectively provides assurance of performance and conformance to requirements.

Required Criteria of a Quality Program

- Quality assurance program
- Personnel training and qualification
- Quality improvement process
- Documents and records
- Established work processes
- Established standards for design and verification
- Established procurement requirements
- Inspection and acceptance testing
- Management assessment
- Independent assessment

The Data Quality 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. NSTec data users perform reviews as required by the project-specific objectives before the data are used to support decision making.

The key elements of 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-, and regulation-defined requirements.
- **Data Review** is done to ensure that the SAP DQOs have been met and thereby determine whether the data are suitable for their intended purpose.
- **Assessments** are employed to ensure that monitoring operations are conducted accordingly and that analytical data quality requirements are met in order to identify nonconforming items, investigate causal factors, implement corrective actions, and monitor for corrective action effectiveness.

16.1 Sampling and Analysis Plan

Most environmental monitoring is specifically mandated to demonstrate compliance with a variety of requirements including federal and state regulations and DOE orders and standards. Developing the SAP using the DQO approach ensures 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. Precision is usually expressed as standard deviation, variance, or range, in either absolute or relative terms (DOE 2012).

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 2012). Accuracy related to laboratory operations 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 a measurement is truly representative of the sampled medium or population (i.e., the degree to which measured analytical concentrations represent the concentrations in the medium being sampled) (Stanley and Verner 1985).

At each sampling point in the sampling and analysis process, subsamples of the medium of interest are obtained. The challenge is to ensure that each subsample maintains the character of the larger sampled population. From a field sample collection standpoint, representativeness is managed through sampling plan design and execution. Representativeness related to laboratory operations concerns the ability to appropriately subsample and characterize for analytes of interest. For example, in order to ensure representative characterization of a heterogeneous matrix (soil, sludge, solids, etc.), the sampling and/or analysis process should evaluate whether homogenization or segregation should be employed prior to sampling or analysis. Water samples are generally considered homogeneous unless observation suggests otherwise. Each air monitoring station's continuous operation at a fixed location results in representatively sampling the ambient atmosphere. Field sample duplicate analyses are additional controls allowing evaluation of representativeness and heterogeneity.

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, 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, real-time field measurements are monitored during purging to determine when field parameters have stabilized, thereby indicating that the purge water is generally 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 characterization. Several NSTec organizations maintain measurement capabilities that are generally considered “screening” operations, and may be used to support planning or preliminary decision-making activities. However, unless specifically authorized by 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 the use of the DOE Integrated Contractor Purchasing Team (ICPT) Analytical Services Basic Ordering Agreement (BOA). The ICPT was put in place to pursue strategic sourcing opportunities that represent procurement-leveraged spending, which results in a lower total cost of ownership for DOE complex-wide site and facility contractors. Agreements placed by the ICPT have met all applicable requirements of the Competition in Contracting Act, the Federal Acquisition Regulation, the DOE Acquisition Regulations, prime contractor terms and conditions for subcontracting, and other relevant policies and procedures. As such, no further requirements apply pertaining to competition, further price analysis/justification, additional review of the terms and conditions, etc., which also saves time and effort.

The Analytical Services BOA was initially developed in 1998 by a team of contractor subject matter experts (both technical and procurement) from across the DOE complex, and BOAs were established with numerous laboratories beginning in 1999. The analytical services technical basis was initially contained in the BOA. It has been revised over the years and is currently codified in the DOE Quality Systems for Analytical Services (QSAS) (DOE 2012). 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." Prior to a laboratory being issued a BOA, it must be assessed to be in compliance with the QSAS. Once a BOA is issued, the laboratory is routinely audited under the DOE Consolidated Audit Program (DOECAP).

Because of the rigor involved with the ICPT BOA process, rather than issuing a Request for Proposal to several laboratories and investing the time to evaluate the proposals received, NSTec awards subcontracts to laboratories that already hold a BOA. The NSTec subcontracts cite the BOA as the base requirement and address site-specific conditions.

The process for obtaining an ICPT BOA requires significant effort on the part of both the laboratory and DOE. Consequently, BOA-holding laboratories are primarily those providing a wide range of analytical services to DOE. NSTec obtains services not available from a BOA laboratory either through an NSTec subcontract laboratory's subcontracting of the work (i.e., lower-tier subcontractor) or by subcontracting directly with the laboratory. In either case, DOE and NSTec requirements for laboratory services are established with those laboratories as well for the specific services provided.

The subcontract places numerous requirements on the laboratory, including 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 NSTec, 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 request for proposal process above, including a pre-award audit. If an acceptable audit has not been performed within the past year, NSTec will consider performing an audit (or participating in a DOECAP audit) of those laboratories awarded the contract. NSTec will not initiate work with a laboratory without authorized approval of those NSTec personnel responsible for ensuring vendor acceptability.

A continuing assessment consists of the ongoing monitoring of a laboratory's performance against contract terms and conditions, of which the technical specifications are a part. Tasks supporting continuing assessment are 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
- Monitoring of the laboratory's adherence to the QA 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. NSTec maintains the companywide issues tracking system (called caWeb) 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. Discussion of the 2012 results for field duplicates, laboratory control samples, blank analyses, and inter-laboratory comparison studies 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 fall in ranges typical for prior years. The higher average RPDs are associated with two types of phenomena. RPDs for actinides in particular, and consequently for 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, 24.2% in gross alpha in 2012). 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 (37.4% for $^{235+236}U$, 47.7% for ^{40}K, and 24.2% for gross alpha in air in 2012). The average RER can also be affected by particulates, as with ^{241}Am and $^{239+240}Pu$ in air (average RER = 1.36 and 1.77 respectively in 2012). Also, both averages can be variable when there are smaller numbers of pairs overall, as is particularly the case with the water duplicate pairs in 2012.

Table 16-1. Summary of field duplicate samples for compliance monitoring in 2012

Analyte	Medium	Number of Duplicate Pairs[(a)]	Number of Pairs > MDC[(b)]	Average Absolute RPD[(c)] of Pairs > MDC	Average Absolute RER[(d)] of All Pairs
Gross alpha	Air	122	17	24.2	0.79
Gross beta	Air	122	120	7.5	0.81
Tritium	Air	51	13	12.8	0.68
^{241}Am	Air	22	0	–	1.36
^{238}Pu	Air	22	1	16.7	0.65
$^{239+240}Pu$	Air	22	4	17.7	1.77
$^{233+234}U$	Air	13	13	8.1	0.51
$^{235+236}U$	Air	13	4	37.4	0.73
^{238}U	Air	13	13	11.6	0.75
^{7}Be[(e)]	Air	22	22	7.1	0.81
^{137}Cs	Air	22	0	–	0.74
^{40}K[(e)]	Air	22	6	47.7	0.78
Gross alpha	Water	2	2	30.2	1.07
Gross beta	Water	2	2	63.1	2.88
Tritium	Water	18	3	16.1	0.70
TLD	Ambient Radiation	334	NA[(f)]	3.7	0.34

(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 pairs with both values above their minimum detectable concentrations (MDCs). If either the field sample or its duplicate was reported below the MDC, the RPD was not determined. This does not apply to thermoluminescent dosimeter (TLD) measurements; since TLDs virtually always detect ambient background radiation, MDCs are not computed.

(c) Reflects the average absolute RPD calculated as follows:

$$Absolute\ RPD = \frac{|D - S|}{(D + S)/2}\ X\ 100$$

Where: S = Sample result
D = Duplicate result

(d) Relative error ratio (RER), determined by the following equation, is used to determine whether a sample result and the associated field duplicate result differ significantly when compared to their respective 1 sigma uncertainties. The RER is calculated for all sample and field duplicate pairs reported without regard to the MDC.

$$Absolute\ RER = \frac{|S - D|}{\sqrt{(SD_S)^2 + (SD_D)^2}}$$

Where: S = Sample result
D = Duplicate result
SD_S = uncertainty standard deviation of the field sample
SD_D = uncertainty standard deviation of the field duplicate

(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. It is generally used to establish intra-laboratory or analyst-specific precision and bias or to assess the performance of all or a portion of the measurement system (DOE 2012).

The results are calculated as a percentage of the true value, and must fall within established control limits (or percentage range) to be considered acceptable. If the LCS recovery falls outside control limits, evaluation for potential sample data bias is necessary. The numbers of the 2012 LCSs analyzed and within control limits are summarized in Table 16-2. There were no systemic issues identified in 2012 by LCS recovery data, and no failures required invalidating the associated sample data.

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 2012). 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 2012).
- 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 2012).
- 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 2012).
- A method blank is a sample of a matrix similar to the batch of associated samples that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses (DOE 2012). The laboratory method blank data are summarized in Table 16-3.

There were no systemic issues identified in 2012 by any of the blank data, and no failures that required invalidating the associated sample data.

16.5.2.4 Proficiency Testing Program Participation

Laboratories are required to participate in Proficiency Testing Programs. Laboratory performance supports decisions on work distribution and may also be a basis for state certifications. Table 16-4 presents the 2012 results for the laboratory performance in the August study 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. Data from the March study have not been made publically available due to extenuating circumstances.

Table 16-5 shows the summary of inter-laboratory comparison sample results for the NSTec Radiological Health Dosimetry Group. This internal evaluation was based on National Voluntary Laboratory Accreditation Program (NVLAP) criteria. The Dosimetry Group participated in the Battelle Pacific Northwest National Laboratory performance evaluation study program during the course of the year.

Table 16-2. Summary of LCSs for 2012

Analyte	Matrix	Number of LCS Results Reported	Number Within Control Limits	Control Limits (%)
Radiological Analyses				
Tritium	Air	81	80	70–130
^{60}Co	Air	22	22	70–130
^{137}Cs	Air	22	22	70–130
$^{239+240}Pu$	Air	28	28	70–130
^{241}Am	Air	53	53	70–130
Gross alpha	Water	14	14	70–130
Gross beta	Water	14	14	70–130
Tritium	Water	23	23	70–130
^{60}Co	Water	6	6	70–130
^{90}Sr	Water	6	6	70–130
^{137}Cs	Water	6	6	70–130
$^{239+240}Pu$	Water	4	4	70–130
^{241}Am	Water	9	9	70–130
^{60}Co	Soil	2	2	70–130
^{90}Sr	Soil	2	2	70–130
^{137}Cs	Soil	2	2	70–130
$^{239+240}Pu$	Soil	2	2	70–130
^{241}Am	Soil	2	2	70–130
Nonradiological Analyses				
Metals	Water	106	106	80–120
Volatiles	Water	131	130	70–130
Semi volatiles	Water	127	127	Laboratory specific
Miscellaneous	Water	161	158	80–120
Metals	Soil	16	16	75–125
Volatiles	Soil	59	59	70-130
Semi volatiles	Soil	50	50	Laboratory specific

Table 16-3. Summary of laboratory blank samples for 2012

Analyte	Matrix	Number of Blank Results Reported	Number of Results < MDC
Radiological Analyses			
Tritium	Air	73	73
^{7}Be	Air	22	22
^{60}Co	Air	14	14
^{137}Cs	Air	22	22
^{238}Pu	Air	19	19
$^{239+240}Pu$	Air	19	19
^{241}Am	Air	34	34
Gross alpha	Water	14	14
Gross beta	Water	14	14
Tritium	Water	21	21
^{60}Co	Water	5	5
^{90}Sr	Water	2	2
^{137}Cs	Water	5	5
^{238}Pu	Water	4	4
$^{239+240}Pu$	Water	4	4
^{241}Am	Water	5	5
^{60}Co	Vegetation	3	3
^{90}Sr	Vegetation	7	7
^{137}Cs	Vegetation	7	7
^{238}Pu	Vegetation	7	7
$^{239+240}Pu$	Vegetation	7	7
^{241}Am	Vegetation	8	8

Table 16-3. Summary of laboratory blank samples for 2012 (continued)

Analyte	Matrix	Number of Blank Results Reported	Number of Results < MDC
Nonradiological Analyses			
Metals	Water	122	119
Volatiles	Water	167	167
Semi volatiles	Water	132	132
Miscellaneous	Water	154	148
Metals	Soil	40	37
Volatiles	Soil	97	97
Semi volatiles	Soil	102	100

Table 16-4. Summary of 2012 MAPEP reports

Analyte	Matrix	Number of Results Reported	Number within Control Limits(a)
Radiological Analyses			
Gross alpha	Filter	2	1
Gross beta	Filter	2	2
^{60}Co	Filter	2	2
^{137}Cs	Filter	2	2
^{238}Pu	Filter	2	2
$^{239+240}$Pu	Filter	2	2
^{241}Am	Filter	2	2
Gross alpha	Water	2	2
Gross beta	Water	2	2
Tritium	Water	2	2
^{60}Co	Water	2	2
^{90}Sr	Water	2	2
^{137}Cs	Water	2	2
^{238}Pu	Water	2	2
$^{239+240}$Pu	Water	2	2
^{241}Am	Water	2	2
^{60}Co	Vegetation	2	2
^{90}Sr	Vegetation	2	1
^{137}Cs	Vegetation	2	2
^{238}Pu	Vegetation	2	2
$^{239+240}$Pu	Vegetation	2	2
^{241}Am	Vegetation	2	2
^{60}Co	Soil	2	2
^{90}Sr	Soil	2	2
^{137}Cs	Soil	2	2
^{238}Pu	Soil	2	2
$^{239+240}$Pu	Soil	2	2
^{241}Am	Soil	2	2
Nonradiological Analyses			
Metals	Water	52	52
Organics	Water	207	207
Metals	Soil	55	55
Organics	Soil	218	217

(a) Based upon MAPEP criteria

Table 16-5. Summary of inter-laboratory comparison TLD samples for the subcontract dosimetry group in 2012

Analysis	Matrix	Number of Results Reported	Number within Control Limits(a)
TLD	Ambient Radiation	29	29

(a) Based upon NVLAP criteria

17.0 Quality Assurance Program for the Community Environmental Monitoring Program

The Community Environmental Monitoring Program (CEMP) Quality Assurance Program Plan (QAPP) was followed for the collection and analysis of radiological air and water data presented in Chapter 7 of this report. The CEMP QAPP 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 QAPP 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 are further explained in Appendices A through E of the *Routine Radiological Environmental Monitoring Plan* (Bechtel Nevada 2003a).

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 station manager Community Environmental Monitor (CEM) (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). 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, QAPPs, analytical method references, and laboratory statements of work may all be used in the process of data validation. Documentation of data validation includes checklists, qualifier assignments, and summary forms.

Data Quality Assessment (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 QAPP. 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 2012 Sample QA Results

QA procedures were performed by the CEMP, including the laboratories responsible for sample analyses. These assessments ensure that sample collection procedures, analytical techniques, and data provided by the subcontracted laboratories comply with CEMP requirements. Data were provided by Testamerica Laboratories and the University of Nevada, Las Vegas, Radiation Services Laboratory (gross alpha/beta and gamma spectroscopy data); Mirion Technologies (thermoluminescent dosimeter [TLD] data); and the University of Miami Tritium Laboratory (tritium data). A brief discussion of the 2012 results for field duplicates, laboratory control samples, blank analyses, and inter-laboratory comparison studies is provided along with summary tables within this section. The 2012 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 2012 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 2012

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	75	74	74.4
Gross Beta	Air	75	75	30.9
Gamma – Beryllium-7	Air	9	9	43.4
Tritium	Water	4	1	0.04
TLDs	Ambient Radiation	12	NA	2.0

(a) Represents the number of field duplicates reported for the purpose of monitoring precision. If an associated field sample was not processed, the field duplicate was not included in this table.

(b) Represents the number of field duplicate–field sample result sets reported above the minimum detectable concentration (MDC) (MDC is not applicable for TLDs). If either the field sample or its duplicate was reported below the detection limit, the precision was not determined.

(c) Reflects the average absolute RPD calculated for those field duplicates reported above the MDC.

The absolute RPD calculation is as follows:

$$Absolute\ \ RPD = \frac{|FD - FS|}{(FD + FS)/2}\ X\ \ 100\,\%$$

Where: FD = Field duplicate result
FS = Field sample result

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 2012 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 2012

Analysis	Matrix	Number of LCS Results Reported	Number Within Control Limits[(a)]
Gross Alpha	Air	57	57
Gross Beta	Air	57	57
Gamma	Air	10	10
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 2012 are summarized in Table 17-3. The laboratory blank results were satisfactory with less than 3% 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 2012

Analysis	Matrix	Number of Blank Results Reported	Number within Control Limits[(a)]
Gross Alpha	Air	57	55
Gross Beta	Air	57	56
Gamma	Air	10	10
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 2012 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 2012

Analysis	Matrix	Number of Results Reported	Number Within Control Limits(a)
		MAPEP, ERA, and IAEA Results	
Gross Alpha	Air	6	6
Gross Beta	Air	6	6
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 20 out of 20 TLDs analyzed.

Table 17-5. Summary of inter-laboratory comparison TLD samples of the subcontract dosimetry group for CEMP monitoring in 2012

Analysis	Matrix	Number of Results Reported	Number Within Control Limits(a)
TLDs	Ambient Radiation	20	20

(a) Based upon NVLAP criteria; absolute value of the bias plus one standard deviation < 0.3.

Appendix A

Las Vegas Area Support Facilities

THIS PAGE INTENTIONALLY LEFT BLANK

Table of Contents

List of Figures

List of Tables

THIS PAGE INTENTIONALLY LEFT BLANK

Appendix A: Las Vegas Area Support Facilities

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 2012 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 2012 included the maintenance of one waste-water permit, one National Pollutant Discharge Elimination System (NPDES) permit, one Spill Prevention, Control, and Countermeasure (SPCC) Plan, one air quality operating permit, and one hazardous materials permit (Table A-1), and the monitoring of tritium in air and ambient gamma-emissions to comply with radiation protection regulations.

Table A-1. Environmental permits and plans for the NLVF in 2012

Permit Number	Description	Expiration Date	Reporting
Wastewater Discharge			
VEH-112	NLVF Wastewater Contribution Permit	December 31, 2013	Annually
NV0023507	NLVF NPDES Permit	June 24, 2017	Quarterly
Oil Pollution Prevention			
National Security Technologies, LLC (NSTec), PLN-1089	SPCC Plan for North Las Vegas Complex	None	None
Air Quality			
Source 657	Clark County Department of Air Quality Minor Source Permit	November 1, 2015	Annually
Hazardous Materials			
20212	NLVF Hazardous Materials Permit	February 28, 2012/2013	Annually

A.1.1 Compliance with Water Permits

NLVF wastewater permits in 2012 included a Class II Wastewater Contribution Permit from the City of North Las Vegas (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 (POTW) operated by the City of Las Vegas. Regulations for wastewater discharges are codified in the municipal codes for both cities.

A.1.1.1 Wastewater Contribution Permit VEH-112

This permit specifies concentration limits for contaminants in domestic and industrial wastewater discharges. Self-monitoring and reporting of the levels of nonradiological contaminants in the outfalls of sewage and industrial wastewater is conducted. In 2012, 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 18, 2012.

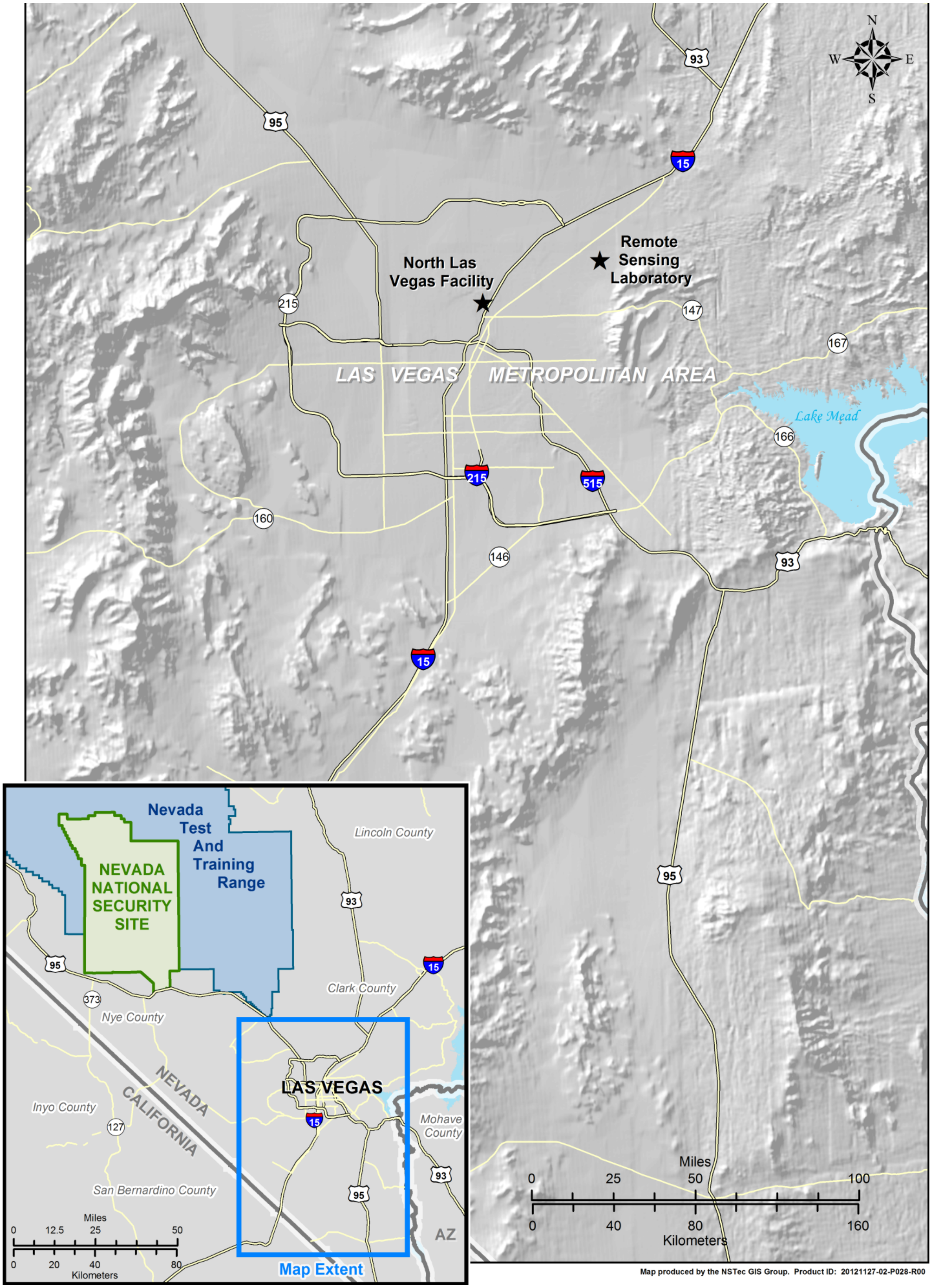


Figure A-1. Location of NNSS offsite facilities in Las Vegas and North Las Vegas

Table A-2. Results of 2012 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	37.2	21.6
Arsenic	2.3	0.00318[(a)]	0.00354[(a)]
Barium	13.1	0.141	0.169
Beryllium	0.02	<0.00025	<0.00025
BOD_5[(b)]	600	254	242
Cadmium	0.15	<0.0025	<0.0025
Chromium (hexavalent)	0.10	<0.02	<0.02
Chromium (total)	5.60	0.00193[(a)]	<0.0015
Copper	0.60	0.264	0.443
Cyanide (total)	19.9	<0.00505	<0.005
Lead	0.20	0.002066[(a)]	0.00269[(a)]
Mercury	0.001	<0.0001	<0.0001
Nickel	1.10	<0.020	<0.020
Oil and Grease (animal or vegetable)	250	<10.0	<10.0
Oil and Grease (mineral or petroleum)	100	<10.0	<10.0
Organophosphorus or carbamate compounds	1.0	<0.01	<0.01
pH (Standard Units)	5.0–11.0	8.41	8.44
Phenols	33.6	0.0911	0.151
Phosphorus (total)	14	6.84	9.68
Selenium	2.70	0.00372[(a)]	0.00332[(a)]
Silver	8.20	<0.001	<0.001
TDS[(c)]	1200	861	981
TSS[(d)]	750	388	223
Zinc	13.1	0.381	0.530

(a) Estimated concentration, the concentration between the method detection limit and the method reporting
(b) 5-day biological oxygen demand (see Glossary, Appendix B)
(c) Total dissolved solids (d) Total suspended solids

A.1.1.2 National Pollution Discharge Elimination System Permit NV0023507

An NPDES permit (NV0023507) covers the dewatering operation conducted at the NLVF (see Section A.1.2). Dewatering wells (NLVF-13s, -15, -16, -17) pump groundwater into a 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 the groundwater of the State via percolation, when used for landscape irrigation and dust suppression, and into the Las Vegas Wash via direct discharge into the CNLV storm water drainage system. The permit defines the discharge source via percolation as "Outfall 001" and via the storm water drainage system as "Outfall 002." Water produced from the dewatering wells may also be used for purposes that do not require a groundwater discharge permit or an NPDES permit (e.g., evaporative cooling). In accordance with the permit, chemistry analyses are performed quarterly, annually, and biennially for water samples collected from the storage tank (Table A-3). The total quantities of groundwater produced and discharged and the results of groundwater chemistry analyses are reported quarterly to NDEP's Bureau of Water Pollution Control.

In 2012, the four dewatering wells produced a total of about 9,085 L (2,400 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) (0.66 gallons per minute [gpm]) at Well NLVF-17 to 0.57 Lpm (0.15 gpm) at Well NLVF-15. The average combined discharge from all four wells was about 277,849 L (73,400 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 May 2011. Therefore, sampling for these analytes will not be done again until 2013.

Figure A-2. Location of dewatering and monitoring wells around Building A-1

Table A-3. NPDES Permit NV0023507 monitoring requirements and 2012 sampling results

Parameter	Monitoring Requirements Sample Frequency	Monitoring Requirements Sample Type	Daily Maximum Permit Discharge Limits	Quarterly Sampling Results 1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Daily Maximum Flow (MGD)[(a)]	Continuous	Flow Meter	0.0052	0.0022	0.0024	0.0025	0.0025
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	1090	1180	1340	1300
Total Inorganic Nitrogen as N (mg/L)	Quarterly	Discrete	20	1.15	1.20	1.28	1.15
pH (Standard Units)	Quarterly	Discrete	6.5–9.0	7.82	7.95	8.02	7.93
Tritium (picocuries per liter [pCi/L])	Annually (4th Qtr)	Discrete	MR[(d)]	NS	NS	NS	ND

(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

A.1.2 Groundwater Control and Dewatering Operation

During 2012, 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] 2003b, 2004b; 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 the groundwater situation, validate the conceptual hydrologic model, and evaluate the dewatering operation.

In 2012, about 277,849 L (73,400 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 111,670 L (29,500 gal) per month in 2012. When the A-1 Basement Sump well pump is active, the water level directly beneath Building A-1 is about 25.4 centimeters (cm) (10 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 47.0 cm (18.5 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. Water levels in the monitoring wells nearest to the actively pumping wells (NLVF-1s, NLVF-2d, NLVF-12d, and NLVF-13d) (Figure A-2) seem to be holding steady or decreasing slightly, presumably reflecting drawdown of the local water table due to the dewatering operations at Building A-1.

A.1.2.1 Discharge of Groundwater from Building A-1 Sump Well

During 2001, the sump well was installed in the basement of Building A-1 and used in operations to remediate tritium contamination in the basement that occurred 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 9 years from about 1,900 pCi/L to about 330 pCi/L (average of two analyses) in 2012 (about 1/60th of the Safe Drinking Water Act limit of 20,000 pCi/L). A total of 1,340,236 L (354,053 gal) of water were pumped from the sump well and transported to the NNSS for disposal in 2012. 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 4-13) and at the NLVF (see Section A.1.7.1).

A.1.3 Oil Pollution Prevention

An SPCC Plan is in place for the NLVF, which 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 U.S. Environmental Protection Agency (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 2012, quarterly inspections of tanks, transformers, oil-filled equipment, and drums were conducted on March 22, June 20, September 11 and 19, and December 20. Throughout 2012, all NLVF employees who handle oil received their required annual spill prevention and management training. No spills were reported in 2012.

A.1.4 Compliance with Air Quality Permits

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). Hazardous air pollutants (HAPs; see Glossary, Appendix B) are not required to be reported for true minor sources, which NLVF is. The regulated sources of emissions at the NLVF include an aluminum sander, an abrasive blaster, diesel generators, a fire pump, cooling towers, and boilers. In 2012, an aluminum sander was removed from the permit. Also, one portable generator was added to the permit as an insignificant source. The DAQ requires an annual emissions inventory of criteria air pollutants. The 2012 emissions inventory was submitted to the DAQ on March 27, 2013, which reported the estimated quantities shown in Table A-4.

Table A-4. Summary of air emissions for the NLVF in 2012

	Criteria Pollutant (Tons/yr)[(a)]					
Parameter	**CO**	**NO_x**	**PM10[(b)]**	**PM2.5[(c)]**	**SO_2**	**VOC**
PTE[(d)]	1.63	8.08	1.26	0.32	0.34	0.35
Actual[(e)]	0.22	0.90	0.15	0.05	0.05	0.05
Total Emissions = 1.42 Actual, 11.98 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 NLVF for which the observation frequency is not specified. If 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 2012, two NLVF personnel were recertified to conduct opacity readings. In 2012, readings were taken for generators and an aluminum sander; emissions were well below the NAAQS opacity limit of 20%.

A.1.5 Compliance with Hazardous Materials Regulations

In 2012, the chemical inventory at the NLVF was updated and submitted to the State in the Nevada Combined Agency (NCA) Report on February 21, 2013. The inventory data were submitted in accordance with the requirements of the Hazardous Materials Permit 20212 (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 2012. 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.1.6 Southern Nevada Health District Audit of Hazardous Waste

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 October 10, 2012, and found existing HW procedures acceptable.

A.1.7 Compliance with Radiation Protection Regulations

A.1.7.1 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 1996b). 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 2012, 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 (from March 27 to April 3 and from September 10 to 17) in order to compute average tritium emissions from the basement. A calculated annual total of 4.74 millicuries were released, virtually all from the basement air that was vented to the outside. Based on this emission rate, the 2012 calculated radiation dose to the nearest member of the general public from the NLVF was very low: 0.000024 mrem/yr (NSTec 2013b). 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. It is the same as that estimated for 2011 and 25% lower than the public dose estimated for 2010 (NSTec 2011).

A.1.7.2 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 2012, 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-5. 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-5. Results of 2012 direct radiation exposure monitoring at the NLVF

Location	Number of Samples[(a)]	Gamma Exposure (mR/yr)			
		Mean	Median	Minimum	Maximum
West Fence of Building C-1 (Control)	3	100	101	97	103
North Fence of Building A-1	3	72	67	61	87
North Fence of Building C-3	3	68	66	65	72

(a) TLDs are collected and read quarterly; however, the first quarter data were lost due to a TLD processing error.

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 the 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 2012 included maintenance of a wastewater discharge permit, air quality permit, hazardous materials permit, and a waste management permit (Table A-6). Sealed radiation sources are used for calibration at RSL-Nellis, but the public has no access to any area that may have elevated gamma radiation emitted by the sources. Therefore, no environmental TLD monitoring is conducted. However, dosimetry monitoring is performed to ensure protection of personnel who work within the facility.

Table A-6. Environmental permits for RSL-Nellis in 2012

Permit Number	Description	Expiration Date	Reporting
Wastewater Discharge			
CCWRD-080	Industrial Wastewater Discharge Permit	June 30, 2012/2013	Quarterly
Oil Pollution Prevention			
NSTec PLN-RSL-B100.003	SPCC Plan for RSL-Nellis	None	None
Air Quality			
Source 348	Clark County Synthetic Minor Source Permit	July 5, 2017	Annually and Semi-Annually
Hazardous Materials			
20208	RSL-Nellis Hazardous Materials Permit	February 28, 2011/2013	Annually
Waste Management			
PR0064276	RSL-Nellis Waste Management Permit – Underground Storage Tank	December 31, 2012	None

A.2.1 Compliance with Wastewater Contribution Permit CCWRD-080

Discharges of wastewater from RSL-Nellis are required to meet permit limits set by the Clark County Water Reclamation District (CCWRD). These limits support the permit limits for the POTW operated by Clark County. The wastewater permit for this facility requires quarterly monitoring and reporting. Table A-7 presents the mean concentration of outfall measurements collected once per quarter in 2012. All contaminants in the outfall samples were below permit limits. Quarterly reports were submitted to the CCWRD on March 1, May 3, September 6, and December 5, 2012. The CCWRD conducted one inspection of RSL-Nellis in 2012. No findings or corrective actions for the facility were identified.

Table A-7. Mean concentration of outfall measurements at RSL-Nellis in 2012

Contaminant/Measure	Permit Limit (mg/L)	Outfall (mg/L)
Ammonia	NL[a]	30.5
Cadmium	0.35	0.00251
Chromium (Total)	1.7	0.01222
Copper	3.36	0.739
Cyanide (Total)	1	0.008
Lead	0.99	0.00918
Nickel	10.08	0.015
Oil and Grease as SGT-HEM[b]	100	<5.3
Phosphorus	NL	8.32
Silver	6.3	0.001545
Total Dissolved Solids	NL	1113
Total Suspended Solids	NL	562
Zinc	23.06	0.772
pH (Standard Units)	5.0–11.0	8.4
Temperature (degrees Fahrenheit)	140	76.7

(a) No limit listed on permit
(b) Silica Gel Treated N-Hexane Extractable Material

A.2.2 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 eight 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 2012, quarterly inspections of tanks, transformers, and oil-filled equipment were conducted on September 18 and November 8. Throughout 2012, all RSL-Nellis employees who handle oil received their required annual spill prevention and management training. No spills were reported in 2012.

A.2.3 Compliance with Air Quality Permits

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, diesel generators, a fire pump, cooling towers, and boilers. The 2012 emissions inventory of criteria air pollutants and HAPs was submitted to the DAQ on March 27, 2013, and are shown in Table A-8.

Table A-8. Summary of air emissions for RSL-Nellis in 2012

	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	1.60	0.43	1.06	0.60
Actual[(e)]	1.10	4.04	0.25	0.18	0.11	0.18	0.11
Total Emissions = 5.97 Actual, 16.03 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 2012, 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 of the equipment were well below the Clean Air Act NAAQS opacity limit of 20%.

A.2.4 Compliance with Hazardous Materials Regulations

In 2012, the chemical inventory at RSL-Nellis was updated and submitted to the State in the NCA Report on February 21, 2013, in accordance with the requirements of the Hazardous Materials Permit 20208 (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 2012. 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).

A.2.5 Compliance with Waste Management Regulations

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 2012 inspection.

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 reflecting 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 sir 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
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
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/SSO	U.S. Department of Energy, National Nuclear Security Administration Sandia Site 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
POTW	Publicly Owned Treatment Works
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
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)

THIS PAGE INTENTIONALLY LEFT BLANK

References

Andrews, R. W., T. R. Birdie, B. Mukhopadhyay, and W. R. Wilborn, 2012. *Approaches to Quantify Potential Contaminant Transport in the Lower Carbonate Aquifer from Underground Nuclear Testing at Yucca Flat, Nevada National Security Site, Nye County, Nevada.* DOE/NV--1468. Presentation given at the 2013 Waste Management Symposium, Phoenix, AZ.

Arizona Department of Administration, 2013. *July 1, 2012 Population Estimates for Arizona's Counties, Incorporated Places and Balance of Count*. Office of Employment and Population Statistics. Available at http://www.workforce.az.gov/population-estimates.aspx, as accessed on February 12, 2013.

Arnold, R., 2012. *American Indian Consultation Program Annual Progress Report, FY 2012*. Cultural Resources Letter Report No. LR091112-2, Desert Research Institute, Las Vegas, NV.

Bechtel Nevada, 2000. *Characterization Report - Building A-1 at the U.S. Department of Energy, Nevada Operations Office, North Las Vegas Facility*. DOE/NV/11718--413, Las Vegas, NV.

Bechtel Nevada, 2002. *A Hydrostratigraphic Model and Alternatives for the Groundwater Flow and Contaminant Transport Model of Corrective Action Units 101 and 102: Central and Western Pahute Mesa, Nye County, Nevada*. DOE/NV/11718--706, Las Vegas, NV.

Bechtel Nevada, 2003a. *Routine Radiological Environmental Monitoring Plan*. DOE/NV/11718--804, Las Vegas, NV, prepared for U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office.

Bechtel Nevada, 2003b. *Summary Report for the U.S. Department of Energy National Nuclear Security Administration Nevada Site Office FY02/FY03 Groundwater Control Study at the North Las Vegas Facility*. Las Vegas, NV.

Bechtel Nevada, 2004a. *Nevada Test Site Environmental Report 2003*. DOE/NV/11718--971, Las Vegas, NV, prepared for U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office.

Bechtel Nevada, 2004b. *Summary Report for the U.S. Department of Energy National Nuclear Security Administration Nevada Site Office Groundwater Control at Building A-1 North Las Vegas Facility*. Las Vegas, NV.

Bechtel Nevada, 2005. *A Hydrostratigraphic Framework Model and Alternatives for the Groundwater Flow and Contaminant Transport Model of Corrective Action Unit 98: Frenchman Flat, Clark, Lincoln and Nye Counties, Nevada*. DOE/NV/11718--1064, Las Vegas, NV, prepared for U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office.

Bechtel Nevada, 2006. *A Hydrostratigraphic Framework Model and Alternatives for the Groundwater Flow and Contaminant Transport Model of Corrective Action Unit 97: Yucca Flat-Climax Mine, Lincoln and Nye Counties, Nevada*. DOE/NV/11718--1119, Las Vegas, NV.

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.

Belcher, W. R. and D. S. Sweetkind, eds., 2010. *Death Valley Regional Groundwater Flow System, Nevada and California–Hydrogeologic Framework and Transient Groundwater Flow Model*. U.S. Geological Survey Professional Paper 1711, U.S. Geological Survey, Denver, CO.

BN, see Bechtel Nevada.

Bowen, S. M., D. L. Finnegan, J. L. Thompson, C. M. Miller, P. L. Baca, L. F. Olivas, C. G. Geoffrion, D. K. Smith, W. Goishi, B. K. Esser, J. W. Meadows, N. Namboodiri, and J. F. Wild, 2001. *Nevada Test Site Radionuclide Inventory, 1951–1992.* LA-13859-MS, Los Alamos National Laboratory, Los Alamos, NM.

Brikowski, T. H., J. B. Chapman, B. F. Lyles, and S. Hokett, 1993. *Origin of Elevated Water Levels Encountered in Pahute Mesa Emplacement Boreholes: Preliminary Investigations*. Desert Research Institute Publication No. 45123, Las Vegas, NV. OSTI ID: 10164133

Cronkite-Ratcliff, C., G. A. Phelps, and A. Boucher, 2012. *A Multiple-Point Geostatistical Method for Characterizing Uncertainty of Subsurface Alluvial Units and Its Effects on Flow and Transport.* U.S. Geological Survey Open-File Report 2012-1065, Reston, VA.

DeMaio, J., 2012. *A Class III Cultural Resources Inventory of the Bare Reactor Experiment Nevada (BREN) Powerline Repair, Area 25, Nevada National Security Site, Nye County, Nevada.* Cultural Resources Inventory Short Report No. SR072512-1, Desert Research Institute, Las Vegas, NV.

DeMaio, J., and B. A. Holz, 2012. *A Class III Cultural Resources Inventory of a Proposed Vegetation Stress Experiment Location, Area 8, Nevada National Security Site, Nye County, Nevada.* Cultural Resources Inventory Short Report No. SR091311-1, Desert Research Institute, Las Vegas, NV.

DOE, see U.S. Department of Energy.

DOE/NV, see U.S. Department of Energy, Nevada Operations Office.

Drollinger, H., 2011a. *A Cultural Resources Inventory of a Proposed Well Pad, Trailer Pad and Access Road for the Source Physics Experiment, Areas 8 and 15, Nevada National Security Site, Nye County, Nevada.* Cultural Resources Inventory Short Report No. SR052510-1, Desert Research Institute, Las Vegas, NV.

Drollinger, H., 2011b. *A Cultural Resources Inventory of the Pele Experiment Test Area, Area 4, Nevada National Security Site, Nye County, Nevada.* Cultural Resources Inventory Short Report No. SR080310-1, Desert Research Institute, Las Vegas, NV.

Drollinger, H., 2012a. *A Class III Cultural Resources Inventory of the Neptune 5a Detonation Pad and Access Road, Area 26, Nevada National Security Site, Nye County, Nevada*. Cultural Resources Inventory Short Report No. SR101112-1, Desert Research Institute, Las Vegas, NV.

Drollinger, H., 2012b. *A Historical Evaluation of the Railroad Lines in Areas 25 and 26, Nevada National Security Site, Nye County, Nevada.* Historical Evaluation Short Report HE072610-1, Desert Research Institute, Las Vegas, NV.

Drollinger, H., and C. M. Beck, 2010. *Cultural Resources Management Plan for the Nevada National Security Site*. Cultural Resources Technical Report No. 108, Desert Research Institute, Las Vegas, NV.

Drollinger, H., and S. R. Edwards, 2012. *A Class III Cultural Resources Inventory of a Proposed Hangar and Leach Field, Desert Rock Airstrip, Area 22, Nevada National Security Site, Nye County, Nevada*. Cultural Resources Inventory Short Report No. SR020612-1, Desert Research Institute, Las Vegas, NV.

Drollinger, H., and A. Vanderslice, 2012. *A Historical Evaluation of the Pluto Compressor Building, Area 26, Nevada National Security Site, Nye County, Nevada*. Historical Evaluation Short Report HE083109-1, Desert Research Institute, Las Vegas, NV.

Eastern Research Group, 2004. *Methods for Estimating Fugitive Air Emissions of Radionuclides from Diffuse Sources at DOE Facilities*. Prepared for the U.S. Environmental Protection Agency, Morrisville, NC.

Elliott, P. E., and J. M. Fenelon, 2012. *Database of Groundwater Levels and Hydrograph Descriptions for the Nevada Test Site Area, Nye County, Nevada*. U.S. Geological Survey Data Series 533, Version 3.0. Reston, VA.

EPA, see U.S. Environmental Protection Agency.

Falvey, L., and H. Drollinger, 2012. *Curation Compliance Annual Progress Report, FY 2012.* Cultural Resources Letter Report No. LR091112-1, Desert Research Institute, Las Vegas, NV.

Fenelon, J. M., D. S. Sweetkind, P. E. Elliot, and R. J. Laczniak, 2012. *Conceptualization of the Predevelopment Groundwater Flow System and Transient Water-Level Responses in Yucca Flat, Nevada National Security Site.* U.S. Geological Survey Scientific Investigations Report 2012-5196. Reston, VA.

FWS, see U.S. Fish and Wildlife Service.

Hall, D. B., D. C. Anderson, P. D. Greger, W. K. Ostler, and D. J. Hansen, 2013. *Ecological Monitoring and Compliance Program 2012 Report*. DOE/NV/25946--1776, National Security Technologies, LLC, July 2012, Las Vegas, NV.

Holz, B. A., 2012a. *A Class III Cultural Resources Inventory of the Proposed Chicken Little Project, Area 18, Nevada National Security Site, Nye County, Nevada.* Cultural Resources Inventory Short Report No. SR071006-1 (Revision 2), Desert Research Institute, Las Vegas, NV.

Holz, B. A., 2012b. *A Class III Cultural Resources Inventory of the Proposed Hill 200 Power-line Upgrade, Area 5, Nevada National Security Site, Nye County, Nevada*. Cultural Resources Inventory Short Report No. SR061311-1, Desert Research Institute, Las Vegas, NV.

Holz, B. A., 2012c. *A Class III Cultural Resources Inventory of the Proposed Improvements to U12u Tunnel, Area 12, Nevada National Security Site, Nye County, Nevada*. Cultural Resources Inventory Short Report No. SR062211-1, Desert Research Institute, Las Vegas, NV.

Holz, B. A., 2012d. *A Class III Cultural Resources Inventory of the Proposed Generator Pad and Bore Hole Project Area, Area 12, Nevada National Security Site, Nye County, Nevada.* Cultural Resources Inventory Short Report No. SR070511-1, Desert Research Institute, Las Vegas, NV.

Holz, B. A., 2012e. *A Class III Cultural Resources Inventory of the Proposed Generator Pad Extension and Borrow Pit, Area 12, Nevada National Security Site, Nye County, Nevada.* Cultural Resources Inventory Short Report No. SR080311-2, Desert Research Institute, Las Vegas, NV.

Holz, B. A., 2012f. *A Class III Cultural Resources Inventory of the Five Proposed Rotary Percussion Sounding System Drill Holes, Area 15, Nevada National Security Site, Nye County, Nevada.* Cultural Resources Inventory Short Report No. SR083111-1, Desert Research Institute, Las Vegas, NV.

Holz, B. A., 2012g. *A Class III Cultural Resources Inventory of the Proposed Neptune 2 Project, Area 26, Nevada National Security Site, Nye County, Nevada.* Cultural Resources Inventory Short Report No. SR101811-1, Desert Research Institute, Las Vegas, NV.

Holz, B. A., 2012h. *A Class III Cultural Resources Inventory of the Proposed Blast Pad, Area 25, Nevada National Security Site, Nye County, Nevada.* Cultural Resources Inventory Short Report No. SR052912-1, Desert Research Institute, Las Vegas, NV.

Holz, B. A., 2012i. *A Class III Cultural Resources Inventory of the Proposed Neptune – Leo Projects #1 and #2, Area 26, Nevada National Security Site, Nye County, Nevada.* Cultural Resources Inventory Short Report No. SR080612-1, Desert Research Institute, Las Vegas, NV.

Holz, B. A., and H. Drollinger, 2012a. *A Class III Cultural Resources Inventory of a Proposed Fiber Optic Line from Mercury to Area 6 Control Point, Areas 5, 6, and 23, National Nuclear Security Site, Nye County, Nevada.* Cultural Resources Inventory Short Report No. SR062110-1, Desert Research Institute, Las Vegas, NV.

Holz, B. A., and H. Drollinger, 2012b. *A Class III Cultural Resources Inventory of a Proposed Fiber Optic Line from Mercury Highway to Yucca Lake, Area 6, Nevada National Security Site, Nye County, Nevada*. Cultural Resources Inventory Short Report No. SR121310-1, Desert Research Institute, Las Vegas, NV.

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.

ICRP, see International Commission on Radiological Protection.

Interagency Sustainability Working Group, 2008. *High Performance and Sustainable Buildings Guidance.* Available at http://www.fedcenter.gov/_kd/Items/actions.cfm?action=Show&item_id=11130&destination=ShowItem, as accessed on July 26, 2011.

International Commission on Radiological Protection, 2002. *Basic Anatomical and Physiological Data for Use in Radiological Protection*. ICRP Publication 89, Pergamon Press, Oxford.

International Commission on Radiological Protection, 2008. *Nuclear Decay Data for Dosimetric Calculations*. ICRP Publication 107, Pergamon Press, Oxford.

International Technology Corporation, 1996. *Regional Geologic Model Data Documentation Package (Phase I, Data Analysis Documentation, Volume I, Parts 1 and 2)*. ITLV/10972-181, Las Vegas, NV.

ISWG, see Interagency Sustainability Working Group.

IT, see International Technology Corporation.

Jones, R. C., 2011. *A Historical Evaluation of Structural Response Safety Program Structures in Areas 1, 3, 12, and 19, Nevada National Security Site, Nye County, Nevada*. Cultural Resources Inventory Short Report No. HE060507-1, Desert Research Institute, Las Vegas, NV.

Jones, R. C., 2012a. *A Class III Cultural Resources Inventory of the Proposed PDSE Fiber Optic Line, Area 4, Nevada National Security Site, Nye County, Nevada*. Cultural Resources Short Report No. SR012512-1, Desert Research Institute, Las Vegas, NV.

Jones, R. C., 2012b. *Cultural Resources Preliminary Assessment of Corrective Action Unit 104, Area 7, Nevada National Security Site, Nye County, Nevada*. Cultural Resources Letter Report No. LR110811-1, Desert Research Institute, Las Vegas, NV.

Jones, R. C., 2012c. *Cultural Resources Preliminary Assessment of Corrective Action Unit 465, Area 27, Nevada National Security Site, Nye County, Nevada.* Cultural Resources Assessment Letter Report LR022312-1, Desert Research Institute, Las Vegas, NV.

Jones, R. C., 2012d. *Cultural Resources Preliminary Assessment of Corrective Action Unit 550, Smoky Test Location, Area 8, Nevada National Security Site, Nye County, Nevada*. Cultural Resources Assessment Letter Report LR031412-1, Desert Research Institute, Las Vegas, NV.

King, M. L., 2012a. *Cultural Resources Preliminary Assessment of Corrective Action Unit 105, Area 9, Nevada National Security Site, Nye County, Nevada*. Cultural Resources Assessment Letter Report No. LR062612-1, Desert Research Institute, Las Vegas, NV.

King, M. L., 2012b. *Cultural Resources Preliminary Assessment of Corrective Action Unit 567, Areas 1, 2, 3, and 7, Nevada National Security Site, Nye County, Nevada*. Cultural Resources Assessment Letter Report No. LR091712-1, Desert Research Institute, Las Vegas, NV.

King, M. L., and R. C. Jones, 2012. *Cultural Resources Preliminary Assessment of Corrective Action Unit 570, Area 9, Nevada National Security Site, Nye County, Nevada.* Cultural Resources Assessment Letter Report LR051712-1, Desert Research Institute, Las Vegas, NV.

Marsh, K.V., 1992. *Hydrology and Radionuclide Migration Program 1988 Progress Report*. UCRL--53779-88, Lawrence Livermore National Laboratory. Livermore, CA.

McArthur, R. D., 1991. *Radionuclides in Surface Soil at the Nevada Test Site*. DOE/NV/10845-02, Water Resources Center Publication #45077, Desert Research Institute, Las Vegas, NV.

Miller, J. J., S. A. Mizell, G. McCurdy, and S. A. Campbell, 2012. *Monitoring Potential Transport of Radioactive Contaminants in Shallow Ephemeral Channels:Ephemeral Channels: FY 2012*. DOE/NV/0000939-07, Publication #45249, Desert Research Institute, Las Vegas, NV.

Miller, J. J., S. A. Mizell, G. Nikolich, G. McCurdy, and S. Campbell, 2013. *NNSS Soils Monitoring: Plutonium Valley (CAU 366) FY2012*. DOE/NV/0000939-004, Publication #45246, Desert Research Institute, Las Vegas, NV.

National Council on Radiation Protection and Measurements, 2006. *Ionizing Radiation Exposure of the Population of the United States*. NCRP Report Number 160, National Council on Radiation Protection and Measurements, Bethesda, MD.

National Security Technologies, LLC, 2006. *Groundwater Control at Building A-1, North Las Vegas Facility Enhanced Dewatering Initiative*. Las Vegas, NV.

National Security Technologies, LLC, 2007a. *Maintenance Plan for Performance Assessments and Composite Analyses of the Area 3 and Area 5 Radioactive Waste Management Sites at the Nevada Test Site*. DOE/NV/25946--091, Las Vegas, NV. OSTI ID: 914419

National Security Technologies, LLC, 2007b. *A Hydrostratigraphic Model and Alternatives for the Groundwater Flow and Contaminant Transport Model of Corrective Action Unit 99: Rainier Mesa-Shoshone Mountain, Nye County, Nevada*. DOE/NV/25946--146. Las Vegas, NV. OSTI ID: 934454

National Security Technologies, LLC, 2008. *Nevada Test Site Environmental Report 2007*. DOE/NV/25946--543, prepared for U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, Las Vegas, NV. OSTI ID: 936844

National Security Technologies, LLC, 2009. *Nevada Test Site Environmental Report 2008*. DOE/NV/25946--790, prepared for U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, Las Vegas, NV. OSTI ID: 963883

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

National Security Technologies, LLC, 2011. *National Emission Standards for Hazardous Air Pollutants - Radionuclide Emissions Calendar Year 2010*. DOE/NV/25946--1243, U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, Las Vegas, NV. OSTI ID: 1026857

National Security Technologies, LLC, 2012a. *FY 2013 NNSA/NSO Site Sustainability Plan*. Prepared for U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, Las Vegas, NV.

National Security Technologies, LLC, 2012b. *Nevada National Security Site Environmental Report 2011*. DOE/NV/25946--1604, prepared for U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, Las Vegas, NV. OSTI ID: 1050519

National Security Technologies, LLC, 2013a. *RCRA Permit for a Hazardous Waste Management Facility Permit Number NEVHW0101- Annual Summary/Waste Minimization Report, Calendar Year 2012, Nevada National Security Site, Nevada.* DOE/NV/25946--1707, Las Vegas, NV, February 2013.

National Security Technologies, LLC, 2013b. *National Emission Standards for Hazardous Air Pollutants - Radionuclide Emissions Calendar Year 2012*. DOE/NV/25946--1796, U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, Las Vegas, NV.

National Security Technologies, LLC, 2013c. *Water Pollution Control Permit NEV 96021, Quarterly Monitoring Report and Annual Summary Report for the E Tunnel Waste Water Disposal System*. Las Vegas, NV.

National Security Technologies, LLC, 2013d. *Nevada National Security Site 2012 Data Report: Groundwater Monitoring Program Area 5 Radioactive Waste Management Site*. DOE/NV/25946--1683, Las Vegas, NV. OSTI ID: 1062673

National Security Technologies, LLC, 2013e. *Nevada National Security Site 2012 Waste Management Monitoring Report - Area 3 and Area 5 Radioactive Waste Management Site*. DOE/NV/25946--11858, U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, Las Vegas, NV.

National Security Technologies, LLC, 2013f. *2012 Annual Summary Report for the Area 3 and 5 Radioactive Waste Management Sites at the Nevada National Security Site (Review of Performance Assessments and Composite Analyses)*. DOE/NV/25946--1717, U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, Las Vegas, NV.

Navarro-Intera, LLC, 2011a. *Pahute Mesa Well Development and Testing Analyses for Wells ER-20-7, ER-20-8 #2, and ER-EC-11*. N-I/28091--037, Revision 1. Las Vegas, NV. OSTI ID 1031914

Navarro-Intera, LLC, 2011b. *Addendum #2 to the Central and Western Pahute Mesa Phase II Hydrogeologic Investigation Wells Drilling and Completion Criteria for Investigation Wells ER-EC-14 and ER-20-11*. N-I/28091--015-ADD 2. Las Vegas, NV.

Navarro-Intera, LLC, 2012a. *Frenchman Flat Model Evaluation Wells Drilling and Completion Criteria.* N-I/28091--051, Revision 0. Las Vegas, NV.

Navarro-Intera, LLC, 2012b. *Pahute Mesa Well Development and Testing Analyses for Wells ER-20-8 and ER-20-4, Nevada National Security Site, Nye County, Nevada.* N-I/28091--061, Revision 0. Las Vegas, NV. OSTI ID: 1052206

Navarro-Intera, LLC, 2013. *Yucca Flat/Climax Mine CAU Flow and Transport Model, Nevada National Security Site, Nye County, Nevada.* N-I/28091--065, Revision 0. Las Vegas, NV.

NCRP, see National Council on Radiation Protection and Measurements.

NDEP, see Nevada Division of Environmental Protection.

Nevada State Demographer's Office, 2013. *2012 Estimates, Estimates by County, City, and Unincorporated Town*. Nevada State Demographer, College of Business, the Business Services Group. Available at: http://nvdemography.org/data-and-publications/estimates/estimates-by-county-city-and-unincorporated-towns/, as accessed on May 16, 2013.

N-I, see Navarro-Intera, LLC.

NNES, see Navarro Nevada Environmental Services, LLC.

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

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

NRC, see U.S. Nuclear Regulatory Commission.

NSTec, see National Security Technologies, LLC.

Paces, J. B., P. E. Elliott, J. M. Fenelon, R. J. Laczniak, and M. T. Moreo, 2012. *Transient Effects on Groundwater Chemical Compositions from Pumping of Supply Wells at the Nevada National Security Site, Nye County, Nevada, 1951–2008*. U.S. Geological Survey Scientific Investigations Report 2012-5023. Reston, VA.

Radiological Control Manager's Council, 2012. *Nevada Test Site Radiological Control Manual*. DOE/NV/25946--801, Rev. 2, Las Vegas, NV. OSTI ID: 1036978

Rowland-Fleischmann, S. L., R. C. Jones, and H. Drollinger, 2011. *A Class III Cultural Resource Inventory for the Proposed U12u Powerline in Support of the ITD-1, Area 12, Nevada National Security Site, Nye County, Nevada* (Revised). Cultural Resources Inventory Short Report No. SR112210-1, Desert Research Institute, Las Vegas, Nevada.

Sandia National Laboratories, 2013. *Calendar Year 2012 Annual Site Environmental Report Tonopah Test Range, Nevada & Kauai Test Facility, Hawaii*. Albuquerque, NM, prepared for U.S. Department of Energy, National Nuclear Security Administration Sandia Site Office.

Shleien, B. (ed.), 1992. *The Health Physics and Radiological Health Handbook, Revised Edition.* Scinta, Inc., Silver Spring, MD.

Smith, D. K., 1993. *A Review of Literature Pertaining to the Leaching and Sorption of Radionuclides Associated with Nuclear Explosive Melt Glasses.* UCRL-ID-113370, Lawrence Livermore National Laboratory, Livermore, CA.

Smith, D. K., B. K. Esser, and J. L. Thompson, 1995. *Uncertainties Associated with the Definition of a Hydrologic Source Term for the Nevada Test Site.* UCRL-ID-120322, Lawrence Livermore National Laboratory, Livermore, CA.

Smith, D. K., S. B. Kersting, J. M. Keneally, T. P. Rose, G. B. Hudson, and G. F. Eaton, 1999. *Radionuclide Migration Studies: FY 1998 Progress Report.* Lawrence Livermore National Laboratory, Livermore, CA.

SNL, see Sandia National Laboratories.

Stanley, T. W., and S. S. Verner, 1985. The U.S. Environmental Protection Agency's Quality Assurance Program. In: J. K. Taylor and T. W. Stanley (eds.), *Quality Assurance for Environmental Measurements*, ASTM STP-867, Philadelphia, PA.

State of Utah Governor's Office of Planning and Budget, 2013. *Census Brief: Cities and Counties of Utah*. Available at http://www.governor.utah.gov/dea/Census/Census%20Briefs/2010/2010CitiesandCounties.pdf, as accessed on May 16, 2013.

Stoffle, R. W., M. N. Zedeno, and D. B. Halmo, 2001. *American Indians and the Nevada Test Site, A Model of Research and Consultation*. U.S. Government Printing Office, Washington, D.C.

Stoller-Navarro Joint Venture, 2009. *Phase I Transport Model of Corrective Action Units 101 and 102: Central and Western Pahute Mesa, Nevada Test Site, Nye County, Nevada*. S-N/99205--111 Rev.1, Las Vegas, NV. OSTI ID: 948559

U.S. Department of Energy, 2004a. E-mail from G. Vazquez, DOE/EH-41, to B. W. Hurley, U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office, dated April 1, 2004.

U.S. Department of Energy, 2004b. *Users Guide, Version 1; RESRAD-BIOTA: A Tool for Implementing A Graded Approach To Biota Dose Evaluation.* DOE/EH-0676 (also Interagency Steering Committee on Radiation Standards [ISCORS] Technical Report 2004-02), Washington D.C.

U.S. Department of Energy, 2010. *Strategic Sustainability Performance Plan, Discovering Sustainable Solutions to Power and Secure America's Future*. Report to The White House Council on Environmental Quality and Office of Management and Budget, September 2010. Available at: http://www.energy.gov/media/DOE_Sustainability_Plan_2010.pdf, as accessed on July 28, 2011.

U.S. Department of Energy, 2011. *2011 Strategic Sustainability Performance Plan.* Report to the White House Council on Environmental Quality. Available at: http://www1.eere.energy.gov/sustainability/pdfs/doe_sspp_2011.pdf, as accessed on April 10, 2012.

U.S. Department of Energy, 2012. *Quality Systems for Analytical Services*. Revision 2.8, January 2012.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, 2006. *Nevada Test Site Environmental Management End State Vision*. DOE/NV--958, Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, 2008. *Groundwater Protection Program Plan for the National Nuclear Security Administration Nevada Site Office*. DOE/NV/25946--557, Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, 2009a. *Phase II Corrective Action Investigation Plan for Corrective Action Units 101 and 102: Central and Western Pahute Mesa, Nevada Test Site, Nye County, Nevada*. DOE/NV--1312 Rev. 2, Las Vegas, NV. OSTI ID: 968999

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, 2009b. Attachment 1, "Fluid Management Plan for the Underground Test Area Project," Revision 5, DOE/NV--370. In: *Underground Test Area Project Waste Management Plan*, Revision 3, DOE/NV--343. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, 2010a. *Completion Report for Well ER-EC-11, Corrective Action Units 101 and 102: Central and Western Pahute Mesa.* DOE/NV--1435. Prepared by National Security Technologies, LLC, Las Vegas, NV. OSTI ID: 1003755

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, 2010b. *Completion Report for Well ER-20-7, Corrective Action Units 101 and 102: Central and Western Pahute Mesa*. DOE/NV--1386, Las Vegas, NV. OSTI ID: 977585

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, 2011a. *Corrective Action Decision Document/Corrective Action Plan for Corrective Action Unit 98: Frenchman Flat Nevada National Security Site, Nevada*. DOE/NV--1455. Las Vegas, NV. OSTI ID: 1022621

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, 2011b. *Completion Report for Wells ER-20-8 and ER-20-8#2, Corrective Action Units 101 and 102: Central and Western Pahute Mesa*. DOE/NV--1440, Las Vegas, NV. OSTI ID: 1012655

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, 2012. *Underground Test Area Fiscal Year 2011 Annual Quality Assurance Report.* DOE/NV--1471. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, 2013a. *Annual Transportation Report for Radioactive Waste Shipments to and from the Nevada Test Site – Fiscal Year 2012*. DOE/NV--1507, Las Vegas, NV, August 2013.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, 2013b. *Post-Closure Report for Closed Resource Conservation Recovery Act Corrective Action Units, Nevada National Security Site, Nevada, for Fiscal Year 2012 (October 2011-September 2012)*. DOE/NV--1493, Rev. 0, Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, 2013c. *Post-Closure Inspection Letter Report for Corrective Action Units on the Nevada National Security Site*, from R. Boehlecke (NNSA/NSO) to T. Murphy (NDEP), May 28, 2013.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, 2013d. *Post-Closure Inspection Report for the Tonopah Test Range, Nevada, for Calendar Year 2012* DOE/NV--1495, Rev. 0, Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, 2013e. *Final Site-Wide Environmental Impact Statement for the Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada National Security Site and Off-Site Locations in the State of Nevada*. DOE/EIS-0426, Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, 2013f. *Completion Report for Well ER-20-11, Corrective Action Units 101 and 102: Central and Western Pahute Mesa.* DOE/NV--1498. Prepared by National Security Technologies, LLC, Las Vegas, NV. OSTI ID: 1063990

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, 2013g. *Completion Report for Well ER-EC-14, Corrective Action Units 101 and 102: Central and Western Pahute Mesa.* DOE/NV--1499. Prepared by National Security Technologies, LLC, Las Vegas, NV. OSTI ID: 1067490

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, 2013h. *Completion Report for Model Evaluation Well ER-5-5, Corrective Action Unit 98: Frenchman Flat.* DOE/NV--1496. Prepared by National Security Technologies, LLC, Las Vegas, NV. OSTI ID: 1060268

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, 2013i. *Completion Report for Model Evaluation Well ER-11-2, Corrective Action Unit 98: Frenchman Flat.* DOE/NV--1497. Prepared by National Security Technologies, LLC, Las Vegas, NV. OSTI ID: 1060273

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, 2013j. *Underground Test Area Fiscal Year 2012 Annual Quality Assurance Report Nevada National Security Site, Nevada.* DOE/NV--1494. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office, 1992. *Summary of the Nevada Applied Ecology Group and Correlative Programs.* DOE/NV--357, Las Vegas, NV. OSTI ID: 10191695

U.S. Department of Energy, Nevada Operations Office, 1996a. *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada*. Volume 1, Chapters 1–9, DOE/EIS--0243, Las Vegas, NV, August 1996.

U.S. Department of Energy, Nevada Operations Office, 1996b. *National Emission Standards for Hazardous Air Pollutants Submittal – 1995*. DOE/NV/11718--032, Las Vegas, NV. OSTI ID: 436417

U.S. Department of Energy, Nevada Operations Office, 1997a. *Shaft and Tunnel Nuclear Detonations at the Nevada Test Site: Development of a Primary Database for the Estimation of Potential Interactions with the Regional Groundwater System*. DOE/NV--464, Las Vegas, Nevada.

U.S. Department of Energy, Nevada Operations Office, 1997b. *Completion Report for Well Cluster ER-20-5*. DOE/NV--466, Las Vegas, Nevada. OSTI ID: 631143

U.S. Department of Energy, Nevada Operations Office, 1997c. *Regional Groundwater Flow and Tritium Transport Modeling and Risk Assessment of the Underground Test Area, Nevada Test Site, Nevada.* DOE/NV--477, October 1997, Las Vegas, NV. OSTI ID: 788792

U.S. Department of Energy, Nevada Operations Office, 2000. *United States Nuclear Tests, July 1945 through September 1992*. DOE/NV--209, Rev. 15, Las Vegas, NV. Available at http://www.nv.energy.gov/library/publications/historical/DOENV_209_REV15.pdf, as accessed on August 31, 2009.

U.S. Department of Energy, Nevada Operations Office, 2002. *Underground Test Area Project Waste Management Plan*. DOE/NV--343, Rev. 2, Las Vegas, NV.

U.S. Environmental Protection Agency, 1988. *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion.* Federal Guidance Report No. 11, EPA-520/1-88-020. Oak Ridge National Laboratory, Oak Ridge, TN, and U.S. Environmental Protection Agency, Office of Radiation Programs, Washington, D.C.

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.

U.S. Nuclear Regulatory Commission, 1983. *Radiological Assessment.* Report NUREG/CR-3332, J. E. Till and H. R. Meyer, Editors, Office of Nuclear Reactor Regulation, Washington, D.C.

U.S. Public Health Service, 1963. *Project SEDAN, Final Off-Site Report.* AEC Report PNE-200F, Offsite Radiological Safety Organization, Las Vegas, NV.

Warren, R. G., D. A. Sawyer, F. M. Byers, Jr., and J. C. Cole, 2003. *A Petrographic, Geochemical, and Geophysical Database, and Stratigraphic Framework for the Southwestern Nevada Volcanic Field*. LANL Report LA-UR-03-1503, Los Alamos, NM.

Wills, C. A., and W. K. Ostler, 2001. *Ecology of the Nevada Test Site*: *An Annotated Bibliography, with Narrative Summary, Keyword Index, and Species List.* DOE/NV/11718--594, Bechtel Nevada, Ecological Services, Las Vegas, NV. OSTI ID: 901998

Woodward, R., K. R. Rautenstrauch, D. B. Hall, and W. K. Ostler, 1998. *The Relative Abundance of Desert Tortoises on the Nevada Test Site Within Ecological Landform Units.* DOE/NV/11718--245, Bechtel Nevada, Las Vegas, NV. OSTI ID: 901934

Library Distribution List

Libraries in this list will be mailed a hard copy of this full report (NNSSER), a hard copy of the *Nevada National Security Site Environmental Report Summary 2012* (SUM), and a compact disc (CD) containing the NNSSER, SUM, and *Attachment A: Site Description,* unless otherwise indicated. All versions are uncontrolled.

Alamo Branch Library, P.O. Box 239, Alamo, NV 89001

Amargosa Valley Library District, HCR 69-2, P.O. Box 401-T, Amargosa Valley, NV 89020

Beatty Library District, P.O. Box 129, Beatty, NV 89003

Boulder City Library, 701 Adams Blvd., Boulder City, NV 89005

Caliente Branch Library, P.O. Box 306, Caliente, NV 89009

Cedar City Public Library, 303 N. 100 E., Cedar City, UT 84720-2610

Delta City Library, 76 N. 200 W., Delta, UT 84624-9440

Goldfield Public Library, P.O. Box 430, Goldfield, NV 89013

Henderson District Public Library, 280 Water Street, Henderson, NV 89015

Indian Springs Library, P.O. Box 629, Indian Springs, NV 89018

Library of Congress, c/o John Chin, U.S./Anglo Division, U.S. Government Documents Section, 101 Independence Avenue, SI, STOP 4274, Washington, DC 20540-4274

Lincoln County Library, P.O. Box 330, Pioche, NV 89043

Milford Public Library, P.O. Box 579, Milford, UT 84751-0579

Moapa Valley Library, P.O. Box 397, Overton, NV 89040

Pahrump Library District, 2101 E. Calvada Boulevard, Pahrump, NV 89048

Tonopah Library District, P.O. Box 449, Tonopah, NV 89049

UNLV Library Government Documents, University of Nevada-Las Vegas, P.O. Box 457013, Las Vegas, NV 89154-7013

University of Nevada Libraries, c/o Alisa Huckle, Business & Government Information Center/322, 1664 North Virginia Street, Reno, NV 89557-0044

U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office, Public Reading Facility c/o Nuclear Testing Archive, P.O. Box 98521, M/S 400, Las Vegas, NV 89193-8521 (2 CDs)

U.S. Department of Energy, Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831-0062 (1 electronic copy NNSSER/SUM/Attachment A)

Washington County Library, 50 S. Main Street, St. George, UT 84770-3490

White Pine County Library, 950 Campton Street, Ely, NV 89301

THIS PAGE INTENTIONALLY LEFT BLANK

National Nuclear Security Administration

For more information, contact:

U.S. Department of Energy
National Nuclear Security Administration
Nevada Field Office
Office of Public Affairs
P.O. Box 98518
Las Vegas, Nevada 89193-8518

Phone: (702) 295-3521
Fax: (702) 295-0154
E-mail: nevada@nnsa.doe.gov

http://www.nv.energy.gov

06130007