

**Nevada National Security Site Environmental Remediation
Progress toward Closure of Contaminated Sites – 11153**

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ABSTRACT

The Environmental Restoration activities at the U.S. Department of Energy (DOE), National Nuclear Security Administration Nevada Site Office assess the environmental impacts that resulted from atmospheric and underground nuclear tests conducted from 1951 to 1992 on the Nevada National Security Site and Nevada Test and Training Range (which includes the Tonopah Test Range). The goal is to protect public health and the environment through investigations and corrective actions.

The *Federal Facility Agreement and Consent Order* (FFACO), established in 1996 between the State of Nevada Division of Environmental Protection (NDEP), DOE, and the U.S. Department of Defense, serves as the cleanup agreement for the Environmental Restoration activities and provides the framework for identifying, prioritizing, investigating, remediating, and monitoring contaminated sites. This agreement satisfies the corrective action requirements of the *Resource Conservation and Recovery Act*. To ensure efficiency in managing these corrective actions, the sites are grouped according to location, physical and geological characteristics, and/or contaminants. These groups, called corrective action units, are prioritized based on potential risk to workers and the public, available technology, future land use, agency and stakeholder concerns, and other criteria. Environmental Restoration activities include: Industrial Sites, Soils, and Underground Test Area.

Nearly 15 years have passed since the FFACO was established, and during this time, more than 3,000 sites have been identified as requiring investigation or corrective actions. To date, approximately 1,945 sites have been investigated and closed through no further action, clean closure, or closure in place. Another 985 sites are currently being investigated or are in the remediation phase, leaving approximately 80 contaminated sites yet to be addressed.

INTRODUCTION

The Environmental Management (EM) Program was established in 1989 at U.S. Department of Energy (DOE) offices around the country to address the environmental liabilities associated with more than 50 years of nuclear weapons production and testing. More than 20 years later, EM has the world's largest environmental cleanup effort. As part of that effort, the DOE, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) is responsible for remediating portions of the Nevada National Security Site (NNSS) and the Nevada Test and Training Range (NTTR), which includes the Tonopah Test Range (TTR).

The NNSS and the NTTR played important roles in advancing the nation’s nuclear testing program. Some of the facilities and land were used in direct support of nuclear testing, resulting in environmental contamination and subsequent hazardous and radioactive waste generation. Cleanup activities include identifying the nature and extent of contamination, determining its potential risk to the public and environment, and performing the necessary corrective actions in compliance with guidelines and requirements.

ENVIRONMENTAL RESTORATION

The *Federal Facility Agreement and Consent Order* (FFACO), established in 1996 between the Nevada Division of Environmental Protection (NDEP), DOE, and the U.S. Department of Defense (DoD), outlines the cleanup and monitoring commitments for sites and requires State of Nevada approval for the remediation activities selected to achieve closure [1]. The FFACO outlines a schedule of cleanup and monitoring commitments as follows:

- Formalizes relationships among the State of Nevada, DOE, and the DoD.
- Identifies sites of potential historic contamination and prioritizes them for cleanup.
- Defines the regulations the State of Nevada will use to direct and enforce corrective action activities.
- Establishes a corrective action strategy for cleanup activities.
- Provides public involvement opportunities.

The FFACO, with its six appendices, is a legally binding document. The appendices describe the Nevada facilities; identify the contaminated sites; list and prioritize milestones, due dates, and deadlines; outline a corrective action strategy; and detail the public involvement process. The Agreement also satisfies the corrective action requirements of the *Resource Conservation and Recovery Act* (RCRA).

Once the State has approved closure, a public notice of completion is issued to mark the end of the closure process. Individual releases or sites that have been identified as potentially needing remediation are referred to as corrective action sites (CASs). More than 3,000 CASs have been identified as requiring investigation or corrective actions since the FFACO was established.

To facilitate the implementation of the corrective action program, Environmental Restoration activities are divided into three areas:

- Industrial Sites
- Soils
- Underground Test Area (UGTA)

INDUSTRIAL SITES

The Industrial Sites activities address sites at the NNSS and NTTR facilities, such as gas stations, motor pools, worker housing, and research buildings, used in direct support of nuclear testing. Activities conducted at these facilities resulted in some environmental contamination

and subsequent hazardous and radioactive waste generation. Other miscellaneous areas include disposal wells, inactive tanks; contaminated waste sites, inactive ponds, muck piles, spill sites, drains and sumps, and ordnance sites. The contaminants of concern may include hazardous chemicals, unexploded ordnance, and low-level radionuclides.

Over the past few years, the focus of Industrial Sites has included the decontamination and decommissioning of facilities with no active mission and in which contamination exists. The goal of decontamination is to reduce residual radioactivity to limit risks to site workers, the public, and the environment, as well as the long-term cost of surveillance and maintenance. Decommissioning simply means to remove from service, which in most cases involves dismantling, or demolishing the facilities and properly disposing of the generated waste.

Approximately 1,854 industrial sites have been identified, verified, and inventoried for characterization, closure, and/or restoration. Of these, more than 1,780 sites have been formally closed.

SOILS

The Soils activities include land areas where atmospheric nuclear tests, nuclear safety experiments, and evaluation tests for peaceful uses of nuclear explosives (i.e., Plowshare tests) conducted at the NNSS, NTTR, and TTR resulted in the radioactive contamination of surface soils.

The NNSA/NSO performs characterization activities at each Soils CAS to establish the nature and extent of contamination and to determine potential risk to site workers, the public, and the environment. Information obtained through these activities is used to select corrective action strategies, such as removal of soil or closure in place with restricted access controls. Corrective actions performed must comply with the guidelines and requirements of the FFACO [1].

There are a total of 128 Soils CASs, all of which have undergone preliminary characterizations. Soils sites include two sites on the NTTR that have undergone interim remediation and twenty sites on the NNSS that have been formally closed. Sites will continue to undergo further characterization, and will be cleaned, fenced, posted, and/or monitored as deemed necessary. For sites where contamination is left in place, use restrictions will be maintained. These sites will continue to be managed by NNSA/NSO in accordance with all applicable requirements.

UNDERGROUND TEST AREA

From 1951 to 1992, the U.S. government conducted 828 underground nuclear tests at the NNSS at depths ranging from approximately 30 to 1,500 meters below ground surface. About one-third of these tests occurred near, below, or in the water table, resulting in some radioactive contamination of the area's groundwater.

Faced with the reality that no proven, feasible method existed then or now for remediating deep groundwater contamination, the UGTA team has adopted a three-pronged strategy of developing computer models of groundwater flow and contaminant transport, developing an effective long-

term groundwater monitoring system, and establishing institutional controls to limit access to contaminated groundwater.

The complex geology and hydrology of the NNSS presents unusual challenges in understanding velocity, volume, and direction of groundwater flow and the movement of contaminants. To meet these challenges, the UGTA team has developed a process that includes estimating the releasable source term; characterizing the subsurface geology and hydrology by drilling, testing, and sampling monitoring wells; characterizing contaminants; developing and evaluating computer models of flow and transport; and establishing institutional controls.

With these components in mind, the UGTA team designed a phased approach. The team has completed a regional evaluation exploring the groundwater pathways over the entire NNSS. Currently, the team is in the process of determining contaminant movement and boundaries unique to each of the UGTA corrective action units. The objective is to develop model forecasts of contaminant migration over a 1,000-year period.

A key component of the UGTA strategy is the continuing development of contaminant transport models. These models are three-dimensional computerized models that forecast where and how quickly radioactive contamination is moving in the groundwater. The models use data collected from drilling related to past underground nuclear testing and the sampling of groundwater wells. The NNSA/NSO expects that these groundwater models will be completed by 2023, with an additional four years to implement monitoring plans.

Once NNSA/NSO and the State of Nevada find the contaminant transport models developed by the UGTA team acceptable, the State will approve completion of UGTA characterization activities and authorize the NNSA/NSO to proceed to the corrective action stage, which includes model evaluation. Once the model evaluation is complete, NNSA/NSO will then move to closure and implement a long-term monitoring program using new and existing wells.

ENVIRONMENTAL MANAGEMENT BOTTOM LINE

The NNSA/NSO Environmental Restoration Program is accelerating cleanup of the contaminated sites to reduce risk to workers, the public, and the environment. The NNSA/NSO is committed to working cooperatively with State regulators and other stakeholders, and keeping the public informed of its activities. The implementation of NNSA/NSO Environmental Restoration activities has resulted in a sound, technically feasible approach to closure of complex contaminated sites. This has resulted in a cooperative working relationship between NNSA/NSO and the State and local communities while reducing the EM environmental liability associated with the NNSS.

REFERENCES

1. FEDERAL FACILITY AGREEMENT AND CONSENT ORDER, agreed to by the State of Nevada; U.S. Department of Energy, Environmental Management; U.S. Department of Defense; and U.S. Department of Energy, Legacy Management (1996; as amended March 2010).

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