DOE/NV--952

U.S. DEPARTMENT OF ENERGY

Gnome-Coach Site
ENVIRONMENTAL MANAGEMENT
END STATE VISION
Final

Executive Summary

The Environmental Management End State Vision is to be used as the primary tool for communicating the individual site end state to the involved parties (e.g., U.S. Department of Energy [DOE], regulators, public stakeholders, Tribal Nations). The end state document is not a decisional document. If the DOE decides to seek changes to the current compliance agreements, decisions, or statutory/regulatory requirements, those changes will be made in accordance with applicable requirements (DOE/EM, 2003).

Restoration activities have been conducted on the surface of the Gnome-Coach Site; however, an investigation of subsurface contamination has not yet been completed. Therefore, the surface and subsurface end states are treated separately within this document.

The Gnome-Coach Site is located on the Mescalero pediment of the Pecos River in southern Eddy County, New Mexico. The Pecos River is 11 miles west of the Gnome-Coach Site, and the town of Carlsbad is 25 miles northwest. Ranching, farming, oil and gas production, potash mining, and tourism associated with the Carlsbad Caverns have historically provided the dominant commercial interests in this region of New Mexico. Construction and use of the DOE Waste Isolation Pilot Plant has brought additional federal spending to the regional economy.

The Gnome test was the first nuclear test conducted in the Plowshare Program, under the direction of the U.S. Atomic Energy Commission (AEC) (predecessor agency to the DOE). The Plowshare Program focused on developing peaceful uses for nuclear explosives. The Gnome test, conducted on December 10, 1961, involved a 3-kiloton nuclear device that was detonated at a depth of 1,184 feet below ground surface in a thick, bedded salt deposit within the Salado Formation.

The Coach test, the second planned experiment, was to be located within the Salado Formation near the Gnome test, and was initially scheduled for 1963. Construction of a horizontal drift was completed for the Coach test, but the test was canceled.

Major surface restoration activities at the Gnome-Coach Site were conducted from 1968 to 1969, and again from 1977 to 1979. This restoration included disposing of equipment, construction materials, and radioactive materials down the emplacement shaft; pumping radioactive salt slurry into the test cavity; decontaminating all salvageable equipment; removing all uncontaminated buildings and equipment to off-site locations; and plugging many of the AEC wells and drill

holes. In 1972, an area reconnaissance revealed that the salt muckpile from mining operations was eroding, exposing blasting materials and spreading surface contamination associated with the muckpile. A second major clean-up effort occurred from 1977 to 1979, and included excavating contaminated soils and burying them in the shaft, removing concrete pads, general housekeeping activities, and extensive post clean-up sampling (NNSA/NV, 2002). The emplacement shaft was also filled with contaminated material to within 7 feet of the surface, backfilled with uncontaminated gravel and soil to the surface, and sealed with a concrete pad to form a permanent plug to inhibit any migration.

In 2002, the DOE Nevada Operations Office (now the DOE Nevada Site Office [DOE/NSO]) completed a site characterization plan and a corrective action investigation for the surface area of the Gnome-Coach Site. This investigation characterized surface and shallow subsurface soils for contamination. No soil remains above acceptable clean-up levels and the report recommends no further action for clean closure of the site surface under the New Mexico Voluntary Remediation Program (VRP). The Corrective Action Investigation Report detailing the activities of the 2002 site characterization has been completed and is pending State approval.

The planned subsurface investigation for the Gnome-Coach Site is detailed in the *Site Characterization Work Plan for the Gnome-Coach Site, New Mexico*, approved by the State of New Mexico (NNSA/NV, 2002). Based on the historic use of the site and characterizations conducted at similar sites, contaminants of concern associated with the Gnome test are expected to include radioactive fission products, plutonium, and uranium. Existing information will be used to determine if ingestion of contaminated groundwater is a viable exposure pathway. If a groundwater exposure pathway exists, then the DOE will define a contaminant boundary at the Gnome-Coach Site and monitor groundwater to ensure that contamination does not migrate past the contaminant boundary. The location of monitoring wells to verify modeling results and the contaminant boundary will be determined through negotiation and concurrence with the State of New Mexico. Well locations will be based on best available knowledge of the most likely direction and pathways for groundwater migration. In the event that contaminants migrate past the contaminant boundary, the monitoring system and groundwater model will be re-evaluated to determine if the drilling restriction area and associated institutional controls need to be changed. This approach will be protective because, though it is not technologically feasible to remediate the contamination associated with an underground nuclear test, the use (withdrawal) of and exposure to contaminated groundwater will be precluded by implementation of institutional controls restricting the drilling of wells within the contaminant boundary.

In 1963, the U.S. Geological Survey conducted a tracer test by injecting radioactive isotopes into the Culebra Aquifer. The tracer test left radiological constituents within the formation that are not associated with the Gnome test (NNSA/NV, 2002). This test left tritium, strontium-90, and cesium-137 in contact with Culebra Formation groundwater. The tracer test area investigation will begin with a Data Decision Analysis, building on previous modeling to evaluate the cost-benefit of additional data collection. If necessary, additional data will be collected. Contaminant transport of the tracer test constituents will be calculated and used to define a contaminant boundary and to evaluate subsurface intrusion restrictions and monitoring needs related to the tracer test.

The end state envisions returning the surface area of the Gnome-Coach Site to the U.S. Department of the Interior, Bureau of Land Management for administration, with deed restrictions on the site to prevent access to the subsurface areas. The DOE/NSO expects to achieve clean closure for the site surface in fiscal year (FY) 2004. Upon completion of closure activities for the surface, all New Mexico Environment Department comments on the closure report will have been addressed, and all VRP-required documentation filed. At that time, the DOE/NSO will request a certificate of completion for the surface area at the Gnome-Coach Site (NNSA/NSO, 2003). The site surface is in the end state. The DOE/NSO plans to transfer future stewardship of the site subsurface to the DOE Office of Legacy Management (LM). Subsurface closure of the site is expected to be completed in FY 2014. The LM will continue long-term stewardship activities for the subsurface contamination, including determination of appropriate long-term monitoring, if technically warranted, on and near the site. The DOE-imposed deed restrictions are currently in place to isolate subsurface contamination from potential receptors in perpetuity (DOE/EM, 2001). The current state of the subsurface, with monitoring and intrusion restrictions, is foreseen as the end state.

The DOE/NSO developed a public participation plan for the Gnome-Coach Site Environmental Management End State Vision. The plan provided a draft copy of this document, an information sheet, and a letter soliciting feedback by July 1, 2004, to involved parties and stakeholders. All written comments that were submitted to the DOE/NSO received comment resolution.

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List of Acronyms and Abbreviations

AEC	U.S. Atomic Energy Commission
bgs	Below ground surface
BLM	U.S. Department of the Interior, Bureau of Land Management
Ci	Curie(s)
COC	Contaminant(s) of concern
Cs	Cesium
CSM	Conceptual site model
°F	Degrees Fahrenheit
DOE	U.S. Department of Energy
DOE/NSO	U.S. Department of Energy, Nevada Site Office
EM	U.S. Department of Energy, Environmental Management Program
EPA	U.S. Environmental Protection Agency
ft	Foot (feet)
FY	Fiscal year
kt	Kiloton(s)
LM	U.S. Department of Energy, Office of Legacy Management
LTHMP	Long-Term Hydrologic Monitoring Program
mg/L	Milligrams per liter
mi	Mile(s)
NTS	Nevada Test Site
SGZ	Surface ground zero
Sr	Strontium
USGS	U.S. Geological Survey
VRP	Voluntary Remediation Program
WIPP	Waste Isolation Pilot Plant

1.0 Introduction

The Environmental Management End State Vision is to be used as the primary tool for communicating the individual site end state to the involved parties (e.g., U.S. Department of Energy [DOE], regulators, public stakeholders, Tribal Nations). The end state document is not a decisional document. If the DOE decides to seek changes to the current compliance agreements, decisions, or statutory/regulatory requirements, those changes will be made in accordance with applicable requirements (DOE/EM, 2003).

The Environmental Management End State Vision juxtaposes land use with remediation requirements, establishing a conceptual completion goal (or end state) that is both realistic and protective of human health and the environment. The purpose of the vision is to identify where and how potentially harmful exposures to hazardous or radioactive contaminants might occur under projected future conditions, and to determine what actions will be necessary to minimize the potential for harm under those conditions. Consistent with the objectives of cleanup, the vision conceptualizes specific end state conditions that will minimize the potential for harm in the future.

The July 2003 DOE Policy 455.1, "Use of Risk-Based End States," requires DOE Environmental Management Program (EM) sites to define and document a risk-based end state vision that is acceptable to regulators and stakeholders, and then to revise clean-up program plans as necessary to achieve that end state in the most efficient manner (DOE, 2003). The policy is a formal mandate for EM sites to implement risk-based corrective action programs as described in numerous DOE and U.S. Environmental Protection Agency (EPA) publications, American Society of Testing and Materials Standard Guides, and National Research Council recommendations.

Environmental corrective action is an application of standard scientific, engineering, and mathematical principles, enabling steady progress in solving even very complex clean-up problems. The complexities of cleanup at a typical EM site are generally similar: multiple contaminants distributed in multiple environmental media, released over long periods of time and over large areas of land. Uncertainties in source(s), nature, extent, transport, and fate of contaminants are very large and can never be absolutely eliminated. Corrective action provides an objective means of managing uncertainties to the degree necessary and sufficient to make defensible decisions about effective clean-up actions.

The end state vision describes clean-up goals that would be protective under planned future uses. Proposed corrective actions based on risk and other factors associated with land use are presented, negotiated, and agreed to by the State of New Mexico and DOE.

The DOE's risk-based end state initiative is fully consistent with the EPA's recent endorsement of systematic planning, which uses risk-based decision methods to ensure objectivity, defensibility, and cost-effectiveness in corrective action programs (EPA, 2001). The DOE Nevada Site Office (DOE/NSO) will collaborate with its stakeholders to revise the proposed environmental management end state vision, as needed, to define clear goals for completion of its EM-sponsored clean-up work.

The DOE/NSO developed a public participation plan for the Gnome-Coach Site End State Vision. The plan provided a draft copy of this document, an information sheet, and a letter soliciting feedback by July 1, 2004, to involved parties and stakeholders. All written comments that were submitted to the DOE/NSO received comment resolution.

Restoration activities have been conducted on the surface of the Gnome-Coach Site; however, an investigation of subsurface contamination has not yet been completed. Therefore, the surface and subsurface end states are treated separately within this document.

The Gnome-Coach Site is located on the Mescalero pediment of the Pecos River in southern Eddy County, southeastern New Mexico. The Mescalero pediment is a region of gently rolling plains, stabilized sand dunes, and wind-blown deflation basins. This area is characterized by immature drainage basins and local karst topography covered by plains and semi-desert grasses, as well as Chihuahuan desert scrub. The Pecos River is 11 miles (mi) west of the Gnome-Coach Site, and the town of Carlsbad is located 25 mi northwest. Ranching, farming, oil and gas production, and tourism associated with the Carlsbad Caverns have historically provided the dominant commercial interests in this part of New Mexico (NNSA/NV, 2002). The Gnome-Coach Site is administered by the U.S. Department of the Interior, Bureau of Land Management (BLM) Carlsbad Field Office, which has granted a grazing permit to a local rancher on an annual basis.

In preparation for the Gnome test, a 10-foot (ft) diameter vertical emplacement shaft was mined to a depth of 1,216 ft and a horizontal drift was mined 1,116 ft to the northeast. On December 10, 1961, a 3-kiloton (kt) nuclear device was detonated at a depth of 1,184 ft below ground surface (bgs). Immediately following the test, radioactive gases from the test cavity vented to

the atmosphere through the emplacement shaft. Construction of a horizontal drift was completed for a scheduled second test, the Coach test, but this test was cancelled (NNSA/NV, 2002).

The *Site Characterization Work Plan for the Gnome-Coach Site, New Mexico*, Rev. 1 (NNSA/NV, 2002) documented the operational history, initial clean-up activities, secondary clean-up activities, site status, and characterization strategies for both the surface and subsurface. The *Surface Corrective Action Investigation Report for the Gnome-Coach Site, New Mexico* (NNSA/NSO, 2003) has recently been completed but has not been released to the public. The investigation characterized surface and shallow subsurface contamination. This report recommended no further action for clean closure of the site surface under the New Mexico Voluntary Remediation Program (VRP). Upon completion of closure activities for the surface, all New Mexico Environment Department comments on the closure report will have been addressed, and all VRP-required documentation filed. At that time, the DOE will request a certificate of completion for the surface area at the Gnome-Coach Site (NNSA/NSO, 2003). The surface at the Gnome-Coach Site is in the end state. According to the Lifecycle Baseline Revision 5, subsurface closure of the site will be complete in fiscal year (FY) 2014. The DOE will retain long-term stewardship of the subsurface at the Gnome-Coach Site due to the presence of residual contamination in the test cavity and in the Culebra Aquifer at, and downgradient of, the tracer test (DOE/EM, 2001). Groundwater monitoring data from Gnome-Coach is included in the *Annual Water Sampling and Analysis, Calendar Year 2002* (EPA, 2002).

As noted above, the site characterization plan includes the strategy to be followed for the Gnome-Coach Site subsurface contaminant sources. *Scoping Calculations for Groundwater Transport of Tritium From the Gnome Site, New Mexico* (Pohlmann and Andricevic, 1994) evaluated migration from the tracer test contaminants, and was followed by *Evaluation of the Radionuclide Tracer Test Conducted at the Project Gnome Underground Nuclear Test Site, New Mexico* (Pohll and Pohlmann, 1996). An assessment of possible release mechanisms from the underground test and the tracer test was included in *Assessment of Hydrologic Transport of Radionuclides From the Gnome Underground Nuclear Test Site, New Mexico* (Earman et al., 1996). The risk associated with transport from the tracer test and surface sources is presented in *A Preliminary Human Health Risk Assessment of the Gnome Site, New Mexico* (Conrad et al., 1998).

1.1 Organization of the Report

The Gnome-Coach Site Environmental Management End State Vision is organized into five sections. Since the current state and the end state are the same for the Gnome-Coach Site, only one map is presented for each subsection.

Section 1.0 introduces the site, including a brief discussion of past, present, and future site missions. This section also briefly discusses site hazards, the extent of environmental contamination, past remediation work, and any planned future clean-up work.

Section 2.0 describes the regional context end state. This section examines physical and surface interface and human and ecological land use in the regional context. A map showing the current state and the end state is also included for each subsection.

Section 3.0 describes the site-specific end state. This section examines physical and surface interface and human and ecological land use for the site and immediately adjacent lands. Legal ownership and demographics are also presented, and each subsection includes a map showing the current state and the end state.

Section 4.0 discusses specific site hazards including the nature of each hazard, potential impacts on human health and the environment, and any hazard mitigation identified. This section includes a current site-wide hazard map in addition to a current state/end state map for each specific hazard. A conceptual site model (CSM) is also included in this section. This model shows the current state/end state for each hazard. The CSM is used to show the known and potential contaminant pathways, potential receptors, and barriers that have been put in place to minimize exposure to contamination.

Section 5.0 provides references used to develop the Gnome-Coach Site Environmental Management End State Vision.

Attachment A provides a report table detailing that there are no variances between the end state vision and current remediation plans for this site.

1.2 Site Mission

The Gnome test was the first test in the Plowshare Program, which focused on developing peaceful uses for nuclear devices, and was the first underground test conducted off the Nevada Test Site (NTS). The purpose of the test was to study the possibility of converting the energy from nuclear explosions into electricity, to investigate the production and retrieval of radioactive isotopes, and to collect data on the characteristics of nuclear explosions in salt formations. For the Gnome test, a 10-ft diameter vertical emplacement shaft was mined to a depth of 1,216 ft, and a horizontal adit was mined 1,116 ft to the northeast. On December 10, 1961, a 3-kt nuclear device was detonated at a depth of 1,184 ft bgs. Immediately following the test, radioactive gases from the test cavity vented to the atmosphere through the emplacement shaft. Post-test activities included drilling numerous holes into the test cavity and emplacement adits, mucking out the adits, and reentering the cavity. A second horizontal adit was drilled in preparation for the Coach test; however, this test was cancelled (NNSA/NV, 2002).

During surface clean-up activities from 1968 to 1969 and from 1977 to 1979, slurry contaminated with radionuclides was pumped into the test cavity and adits, and they were filled to capacity (NNSA/NSO, 2003). The emplacement shaft was also filled with contaminated material to within 7 ft of the surface, backfilled with uncontaminated gravel and soil to the surface and sealed with a concrete pad to form a permanent plug to inhibit any migration. Surface characterization sampling and analysis performed in 2002 did not indicate any migration of contaminants from the shaft. Based on the historic use of the site and characterizations conducted at similar sites, the contaminants of concern (COCs) for the subsurface are expected to include radioactive fission products, plutonium, uranium, and tritium. Table 1.1 shows the representative source term for the Gnome test.

In 1963, the U.S. Geological Survey (USGS) conducted a tracer test at the Gnome-Coach Site by injecting radioactive isotopes into the Culebra Aquifer. The tracer test left radiological constituents within the formation that are not associated with the Gnome test (NNSA/NV, 2002). The COCs for the tracer test include tritium, strontium-90 (Sr^{90}) and cesium-137 (Cs^{137}). Table 1.2 shows the representative source term for the USGS tracer test.

Table 1.1 Representative Source Term for the Gnome-Coach Site

Mean radionuclide inventory for 76 nuclear tests detonated below or within 328 ft of the water table in Areas 19 and 20 at the NTS, with values decay corrected to January 1, 1994 (Smith, 2001). Unclassified site-specific mass estimates for the Gnome test are substituted where available from Gardner and Sigalove (1970).

Radionuclide	Isotope Symbol	Half life ($t_{1/2}$; year)	Estimated Inventory (Ci) *
Tritium	H-3	1.23E+01	7.1E+02**
Carbon-14	C-14	5.73E+03	4.9E-05**
Aluminum-26	Al-26	7.30E+05	1.18E-04
Chlorine-36	Cl-36	3.01E+05	5.6E-01**
Argon-39	Ar-39	2.69E+02	9.1E-01**
Potassium-40	K-40	1.28E+09	3.85E-07**
Calcium-41	Ca-41	1.03E+05	8.4E-04**
Nickel-59	Ni-59	7.60E+04	5.25E-01
Nickel-63	Ni-63	1.00E+02	5.6E-05**
Krypton-85	Kr-85	1.07E+01	4.5E+01**
Strontium-90	Sr-90	2.91E+01	2.4E+02**
Zirconium-93	Zr-93	1.50E+06	5.49E-01
Niobium-93m	Nb-93m	1.61E+01	9.99E+01
Niobium-94	Nb-94	2.00E+04	7.0E-06**
Technetium-99	Tc-99	2.13E+05	8.75E-02**
Paladium-107	Pd-107	6.50E+06	1.28E-06**
Cadmium-113m	Cd-113m	1.41E+01	1.19E-02**
Tin-121m	Sn-121m	5.50E+01	5.67E+01
Tin-126	Sn-126	1.00E+05	6.47E-01
Iodine-129	I-129	1.57E+07	5.6E-04**
Cesium-135	Cs-135	2.30E+06	7.82E-14**
Cesium-137	Cs-137	3.02E+01	7.0E+02**
Samarium-151	Sm-151	9.00E+01	3.1E+01**
Europium-150	Eu-150	3.60E+01	1.46E+01
Europium-152	Eu-152	1.35E+01	3.9E+01**
Europium-154	Eu-154	8.59E+00	9.94E+00**
Holmium-166m	Hm-166m	1.20E+03	5.89E-01
Thorium-232	Th-232	1.40E+10	7.68E-04
Uranium-232	U-232	7.00E+01	3.36E+00
Uranium-233	U-233	1.59E+05	2.25E+00
Uranium-234	U-234	2.46E+05	1.62E+00
Uranium-235	U-235	7.04E+08	2.18E-02
Uranium-236	U-236	2.34E+07	6.22E-02
Uranium-238	U-238	4.47E+09	2.88E-02
Neptunium-237	Np-237	2.14E+06	4.80E-01
Plutonium-238	Pu-238	8.77E+01	9.42E+01
Plutonium-239	Pu-239	2.41E+04	2.54E+02
Plutonium-240	Pu-240	6.56E+03	8.16E+01
Plutonium-241	Pu-241	1.44E+01	1.18E+03
Plutonium-242	Pu-242	3.75E+05	4.42E-02
Americium-241	Am-241	4.33E+02	6.14E+01
Americium-243	Am-243	7.37E+03	2.36E-03
Curium-244	Cm-244	1.81E+01	3.91E+01

*Except where noted, value is from the mean unclassified radionuclide inventory for 76 nuclear tests detonated below or within 328 ft of the water table in Areas 19 and 20 of the NTS.
**Value is an unclassified estimate for the Gnome test specifically, from Gardner and Sigalove (1970).

Table 1.2
Tracer Test Radionuclide Inventory

Initial Injected Activity in Year 1963		Injected Activity Decayed to Year 2000	
H^3	18.5 curies (Ci)	H^3	2.3 Ci
Cs^{137}	10.0 Ci	Cs^{137}	4.25 Ci
I^{131}	4.0 Ci	I^{131}	Essentially zero
Sr^{90}	10.0 Ci	Sr^{90}	4.10 Ci

The results of the 2002 investigation showed that Cs^{137} residual contamination from venting and post-test activities is present in the surface and shallow subsurface; however, the concentrations do not exceed risk-based action levels or the dose criteria of 25 millirem/year for either of the receptors evaluated. All other detected constituents are below applicable clean-up levels following investigation activities (NNSA/NV, 2002).

1.3 Status of Clean-up Program

The original cleanup associated with the Gnome-Coach Site was conducted between 1968 and 1969. During this phase, radioactive sludge from holding tanks and liquid from evaporation ponds was pumped into the test cavity, contaminated equipment and solid waste were disposed of in the emplacement shaft, all salvageable equipment was decontaminated, all uncontaminated buildings and equipment were moved off site, and all U.S. Atomic Energy Commission test wells and drill holes were plugged and abandoned. In 1972, an area reconnaissance revealed that the salt muckpile from mining operations was eroding, exposing blasting materials, and surface contamination associated with the muckpile was spreading. The second major cleanup occurred from 1977 to 1979 and included excavating contaminated soils and burying them in the shaft, removing concrete pads, general housekeeping activities, and extensive post clean-up sampling. During these operations, the test cavity and horizontal adits were filled to capacity, and remaining contaminated material was removed and transported to the NTS (NNSA/NV, 2002).

In 2002, the DOE completed a corrective action investigation for the surface area of the Gnome-Coach Site under the *Site Characterization Work Plan for the Gnome-Coach Site, New Mexico,* Rev. 1 (NNSA/NV, 2002). These studies included sampling and surveying of surface and shallow subsurface soils to a depth of 20 ft bgs. Several radiological hotspots were identified, but in each instance, the concentration levels of Cs^{137} did not exceed risk-based clean-up levels.

As a result, the DOE is currently negotiating with the State of New Mexico to clean close the surface of the Gnome-Coach Site, with unrestricted surface use.

The EPA annually monitors ten wells and two municipal water supplies in the vicinity of the site as part of the Long-Term Hydrologic Monitoring Program (LTHMP) (EPA, 2002). The site has been part of the LTHMP since 1972. The Gnome-Coach Site Wells LRL7 and DD-1; USGS Wells 1, 4, and 8; and several nearby wells used for stock watering and public water supplies are in the monitoring network. The only contaminated wells within the network are USGS 4 and USGS 8, which were used during the radioactive tracer test, Well DD-1, which was drilled into the Project Gnome test cavity, and Well LRL-7, which was drilled into the Coach test chamber/tunnel. The Desert Research Institute has assessed the radionuclide transport from the site and performed two evaluations of transport related to the tracer study (NNSA/NSO, 2003).

No remediation has been conducted on the subsurface; however, the planned subsurface investigation for the Gnome-Coach Site is detailed in the *Site Characterization Work Plan for the Gnome-Coach Site, New Mexico,* approved by the State of New Mexico (NNSA/NV, 2002). COCs associated with the Gnome test are expected to include radioactive fission products, plutonium, and uranium. Existing information will be used to determine if ingestion of contaminated groundwater related to the underground nuclear test is a viable exposure pathway. If a groundwater exposure pathway exists, then the DOE will define a contaminant boundary at the Gnome-Coach Site, and monitor groundwater to ensure that contamination does not migrate past the contaminant boundary. The location of monitoring wells to verify modeling results and the contaminant boundary will be determined through negotiation and concurrence with the State of New Mexico. Well locations will be based on best available knowledge of the most likely direction and pathways for groundwater migration. In the event that contaminants migrate past the contaminant boundary, the monitoring system and groundwater model will be re-evaluated to determine if the drilling restrictions and associated institutional controls need to be changed. This approach will be protective because, though it is not technologically feasible to remediate the contamination associated with an underground nuclear test, the use (withdrawal) of and exposure to contaminated groundwater will be precluded by implementation of institutional controls restricting the drilling of wells within the contaminant boundary.

The second subsurface source, the tracer test, left tritium, Sr^{90}, and Cs^{137} in contact with Culebra Formation groundwater. The tracer test investigation will begin with a Data Decision Analysis, building on previous modeling to evaluate the cost-benefit of additional data collection. If necessary, additional data will be collected. Contaminant transport of the tracer test constituents

will be calculated and used to define a contaminant boundary and to evaluate subsurface intrusion restrictions and monitoring needs related to the tracer test. Subsurface investigations and modeling are scheduled to be completed in FY 2014.

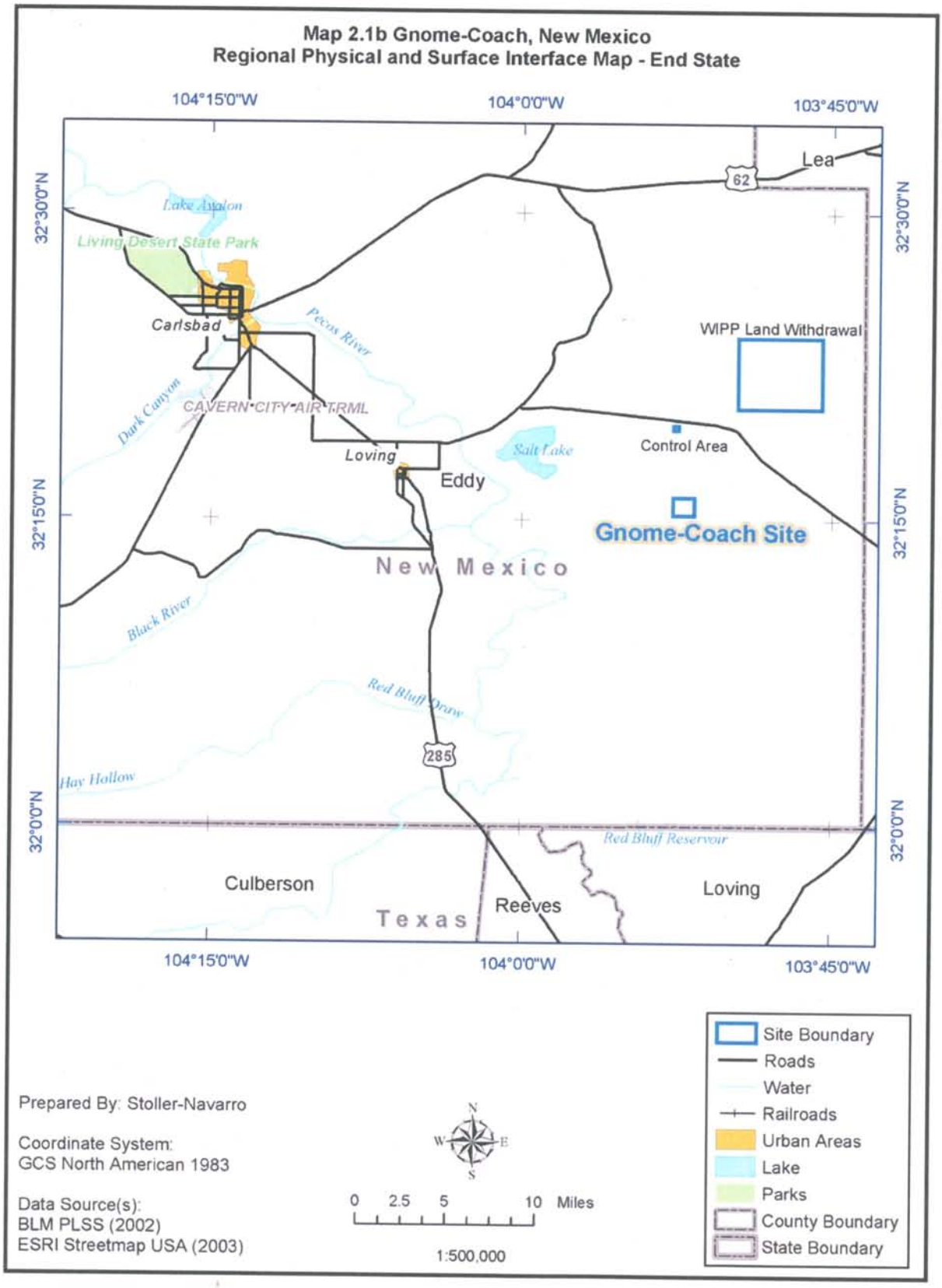
2.0 Regional Context End State Description

This section examines physical and surface interface and human and ecological land use in the regional context. This section also provides a discussion of current and planned future land use for the region surrounding the Gnome-Coach Site.

2.1 Regional Physical and Surface Interface

The Gnome-Coach Site is located on the Mescalero pediment of the Pecos River in southeastern New Mexico (Map 2.1b). The elevation at the site is approximately 3,400 ft above mean sea level, and topographic relief at the site is less than 100 ft. The Mescalero pediment is a region of gently rolling plains, stabilized sand dunes, and wind-blown deflation basins. The area is characterized by immature drainage basins and local karst topography covered by grasses and desert scrub. The Pecos River is 11 mi west of the test site. There is no surface water at the Gnome-Coach Site, and storm runoff drains into dry arroyos and flows to the Pecos River via the Nash Draw, east of the site.

The Gnome-Coach Site is in the northern part of the Delaware Basin, a 283 billion square foot structural basin containing over 16,400 ft of limestone, shale, and evaporites that accumulated in a slowly sinking shallow sea. The basin is well defined by the Capitan Limestone, a late Permian-age reef deposit. The basin is tilted to the east so that formations outcropping along the western edge occur at increasing depths below land surface to the east. The Delaware Basin has great economic value, primarily from oil and gas deposits, but also from mining of evaporites (potash) and waste disposal activities. As a result, the geology and structure of the basin are well known.


Map 2.1b Gnome-Coach, New Mexico
Regional Physical and Surface Interface Map - End State
104°15'0"W
104°0'0"W
103°45'0"W
32°30'0"N
32°15'0"N
32°0'0"N
Lea
62
Lake Avalon
Living Desert State Park
Carlsbad
Pecos River
WIPP Land Withdrawal
Dark Canyon
CAVERN CITY AIR TRML
Loving
Eddy
Salt Lake
Control Area
Gnome-Coach Site
New Mexico
Black River
Red Bluff Draw
285
Hay Hollow
Red Bluff Reservoir
Culberson
Texas
Reeves
Loving
Site Boundary
Roads
Water
Railroads
Urban Areas
Lake
Parks
County Boundary
State Boundary
Prepared By: Stoller-Navarro
Coordinate System:
GCS North American 1983
Data Source(s):
BLM PLSS (2002)
ESRI Streetmap USA (2003)
N
W
E
S
0 2.5 5 10 Miles
1:500,000

The Gnome test was conducted in the bedded salt of the Salado Formation (Figure 2.1). Immediately below the Salado Formation is a thick sequence of evaporites (anhydrite and halite) of the Castile Formation, which overlies the Bell Canyon Formation and others, representing sedimentary deposition in deeper seas. Although these deeper formations are targets of oil and gas exploration, they are not relevant to contaminant transport concerns at the Gnome-Coach Site. The Salado Formation is approximately 1,640 ft thick at the site. Over 75 percent of the formation is halite, with the remainder comprised of potassium minerals (polyhalite) and minor thin sandstone, siltstone, shale, anhydrite, and gypsum lenses. The test occurred about 525 ft below the top of the Salado Formation, at a depth of 1,184 ft bgs.

The contact between the Salado Formation and the overlying Rustler Formation is marked by a leached member of interlayered gypsum and sandstone residual from halite dissolution. The Rustler Formation is comprised principally of anhydrite/gypsum, siltstone, and sandstone. Two carbonate members of the Rustler, Magenta, and Culebra Dolomites are the only significant water-bearing units in the formation. The Magenta Formation is unsaturated in the Gnome-Coach area so that the Culebra Formation is the only aquifer at the site. The overlying Dewey Lake (Pierce Canyon) Redbeds and Gatuna Formations are also unsaturated in the area.

The Culebra Formation is a fractured, grayish-white dolomite. It is approximately 29 ft thick at the Gnome-Coach Site, 499 ft bgs and 669 ft above the location of the Gnome test. The Culebra Formation is saturated and confined in the area. The potentiometric surface is about 75 ft above the top of the dolomite. Although the recharge area is essentially unknown, it is believed to be generally to the east, while the discharge is along Malaga Bend at the Pecos River.

The water quality in the Culebra Dolomite is marginal at best, but supply wells have been drilled into it and the water is used principally for stock. Cooper and Glanzman (1971) identified four supply wells completed in the Culebra Formation that were in use in the late 1950s and early 1960s. The water from these wells ranged in total dissolved solids content from 3,260 to 6,960 milligrams per liter (mg/L), with sulfate concentrations over 2,000 mg/L.

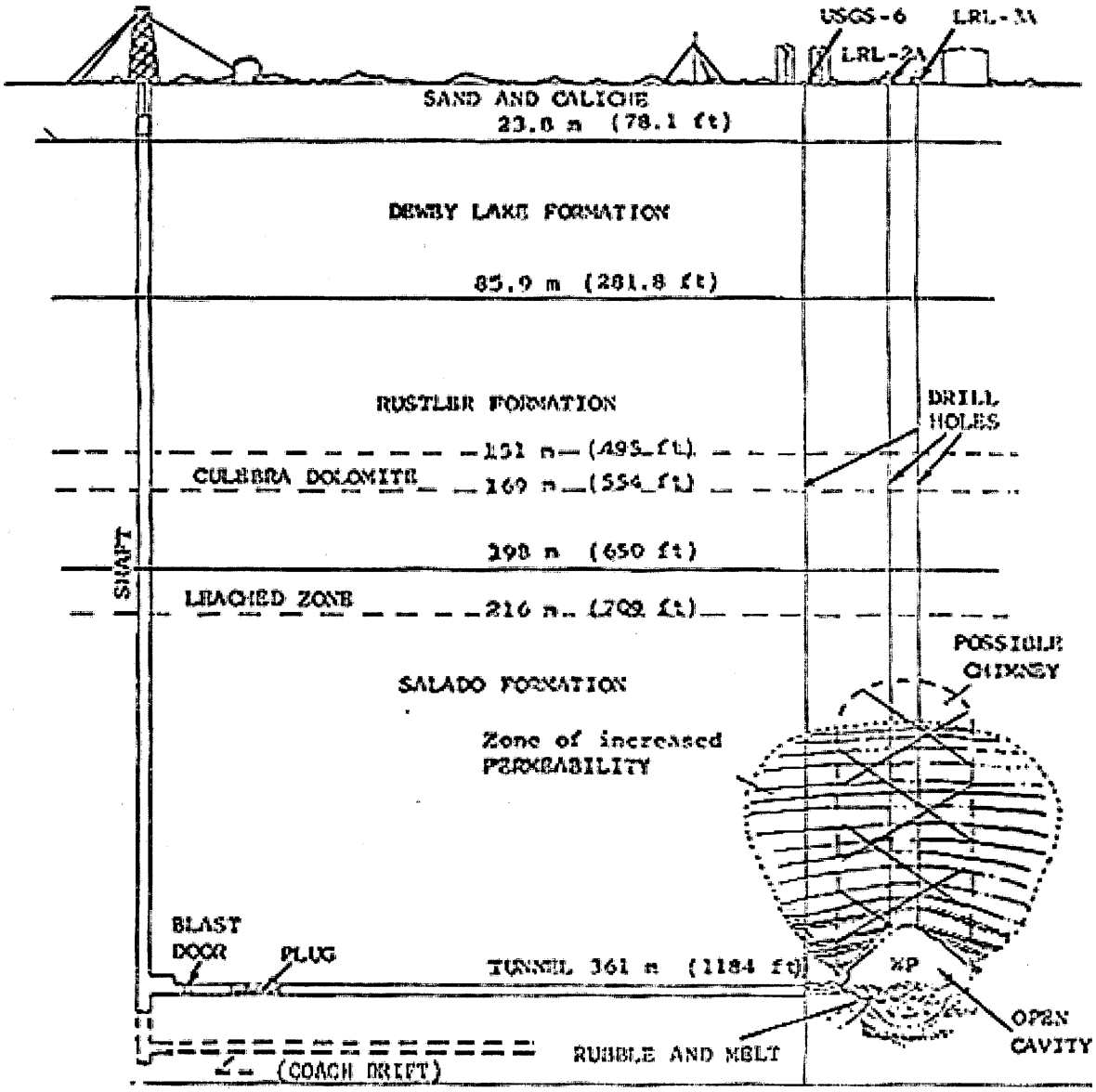


Figure 2.1

Diagrammatic Cross Section of the Gnome-Coach Site

2.2 Regional Human and Ecological Land Use

Human Land Use

The current land use for the region surrounding the Gnome-Coach Site is primarily for cattle grazing. The future land use for the site and surrounding area is expected to remain the same. The future roles and responsibilities of the DOE, landowners, and other federal and state agencies are documented in Table 2.1 (Johnston, 2003b).

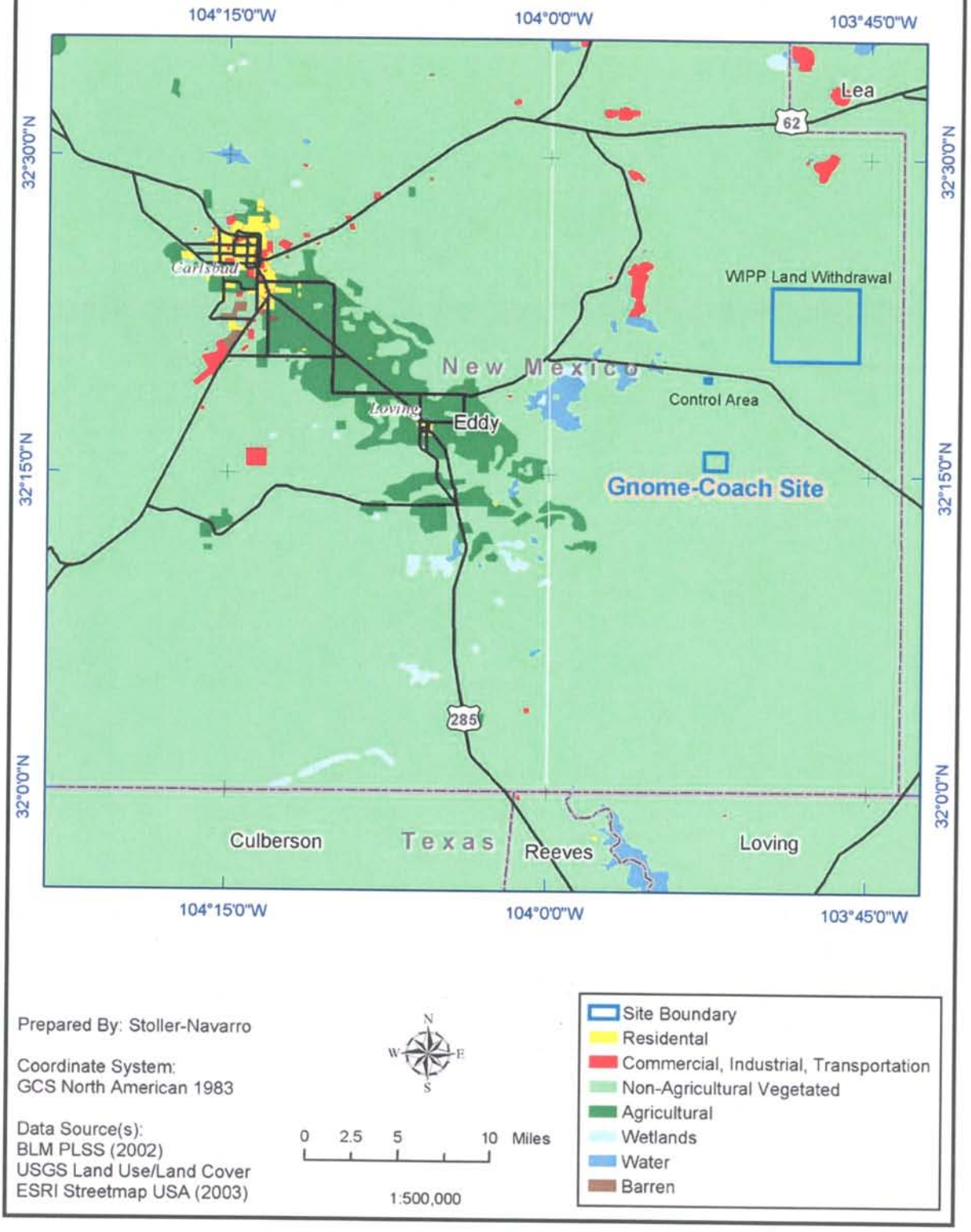
Table 2.1
DOE/NSO Land Status

Landlord	Surface Steward	Subsurface Steward	Withdrawal Order/Law	Specific Restriction Record	Oil/Gas Owner and Leases	Water Well Permits	Mineral Rights	Grazing Rights
DOE (BLM)	BLM DOE/ NSO	**Current:** DOE/NSO **Future:** DOE Office of Legacy Management	**Surface:** Public Land Order 2526 **Subsurface:** Public Land Order 2526	Second Plaque located at site	BLM No Leases	DOE/ NSO USGS	DOE/ NSO	BLM Issued to Private

Ranching, farming, oil and gas production, potash mining, and tourism associated with the Carlsbad Caverns have historically provided the dominant commercial interests in this part of New Mexico (Map 2.2b). There are oil and gas leases on the land surrounding the Gnome-Coach Site. The DOE Waste Isolation Pilot Plant (WIPP) is approximately 15 mi northeast of the site. Construction and use of the WIPP Site have brought additional federal spending to the regional economy. The town of Carlsbad lies 25 mi northwest of the Gnome-Coach Site, and the Mobley Ranch, which is approximately 6 mi from the site, is the nearest residential location (NNSA/NV, 2002).

As part of the LTHMP, the EPA regularly samples wells surrounding the Gnome-Coach Site. Routine sampling sites include 10 monitoring wells in the vicinity of surface ground zero (SGZ) and the municipal supplies at Loving and Carlsbad. Elevated tritium has been detected in 4 of the 12 monitoring well sampling locations. The four wells showing tritium, Cs^{137}, and Sr^{90} detections (DD-1, LRL-7, USGS 4 and USGS 8) are located in the test cavity, in the adit, or were used in the tracer study. No radioactive materials attributable to the Gnome test were detected in samples collected in the off-site areas during the June 2002 sampling effort (EPA, 2002).

Map 2.2b Gnome-Coach, New Mexico
Regional Human and Ecological Land Use Map - End State



Ecological Land Use

The climate in the area of the Gnome-Coach Site is semi-arid, receiving about 12 inches of annual precipitation. The rainy season is May through October, when 70 percent of the annual precipitation falls. Temperatures fluctuate between –24 degrees Fahrenheit (°F) in January to 107°F in July and August. Diurnal temperature fluctuations of 40°F are not uncommon. The Gnome-Coach Site lies on the boundary between the Warm Temperate and the Cold Temperate climate zones and exhibits a mix of plant and animal species from both zones. Three types of plant communities are represented in the area, including Plains Grassland (Oak-Grass Series), Semi-Desert Grassland (Black Grama Series), and Chihuahuan Desert Scrub. Twenty species of raptors and hawks have been noted in the region, as well as 14 other bird species and 5 species of reptiles. The wood rat, jackrabbit, cottontail, and mule deer are the only mammals noted in the area of the test site. No threatened or endangered species have been observed at the Gnome-Coach Site (DOE/NV, 1993). The flora and fauna currently found in the region surrounding the site are anticipated to continue as the species in the region for the foreseeable future.

3.0 Site-Specific End State Description

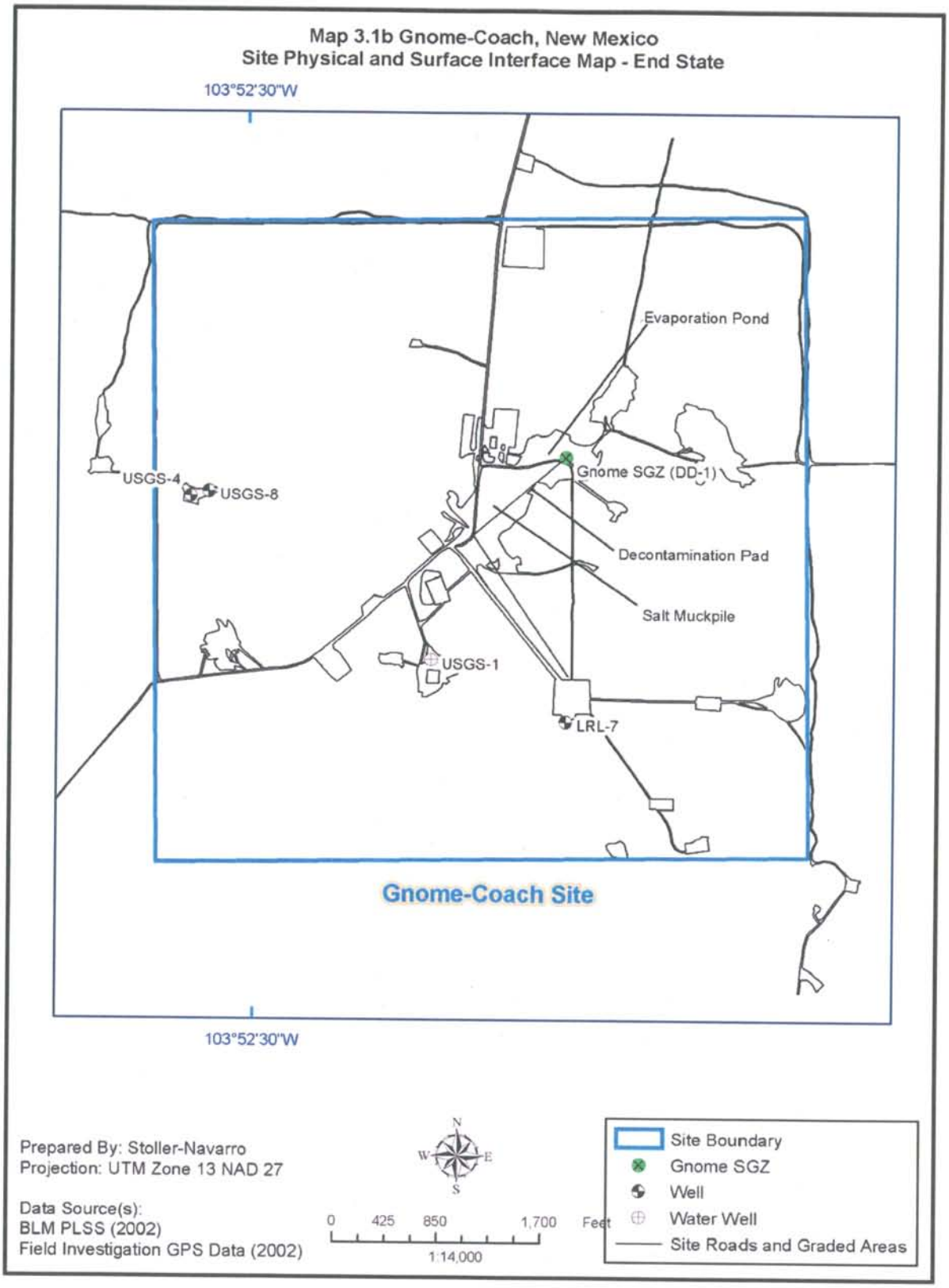
This section examines physical and surface interface and human and ecological land use in the site-specific context. This section also provides a discussion of current and planned future land use for the site, legal ownership of the site and immediately adjacent lands, and demographics for the area.

3.1 Site Physical and Surface Interface

The Gnome-Coach Site is located on the Mescalero pediment of the Pecos River, at an elevation of 3,400 ft. The southern part of the area was the location of the Gnome test activities (Map 3.1b). This area encompasses the historical operational areas, including the Gnome emplacement shaft and SGZ, an evaporation pond and waste tank, Area 57, a salt muckpile, storage areas, a decontamination pad, lab facilities, a contamination waste dump, a salvage yard, and drill holes/wells. All drill holes except USGS-1, USGS-4, USGS-8, DD-1, and LRL-7 have been plugged and abandoned, and the mud pits have been reclaimed. One of the LTHMP monitoring wells, USGS-1, is also used to furnish water for livestock on the permitted grazing allotment in Section 34.

The DOE has recommended that the Gnome-Coach Site receive clean closure of the site surface with no further action (NNSA/NSO, 2003). Upon completion of closure activities for the surface, all New Mexico Environment Department comments on the closure report will have been addressed, and all VRP-required documentation filed. At that time, the DOE will request a certificate of completion for the surface area at the Gnome-Coach Site (NNSA/NSO, 2003). The land surface of the Gnome-Coach Site is in the end state.

The Gnome test cavity, emplacement shaft, and adits have the potential to impact groundwater quality with contamination from radionuclides. The emplacement shaft cuts across the Culebra Aquifer and connects the surface with the adit and test cavity. Tritium analytical results greater than minimum detectable concentrations were reported from four locations in the immediate vicinity of SGZ. None of these wells are used for potable water. Two of these wells were completed in the test cavity and drift, and two were used in the USGS tracer test and thus, reflect contamination from that test. Radioactive isotopes of Cs^{137} and/or Sr^{90} were also detected in these four on-site monitoring wells.


Map 3.1b Gnome-Coach, New Mexico
Site Physical and Surface Interface Map - End State
103°52'30"W
Evaporation Pond
Gnome SGZ (DD-1)
USGS-4
USGS-8
Decontamination Pad
Salt Muckpile
USGS-1
LRL-7
Gnome-Coach Site
103°52'30"W
Prepared By: Stoller-Navarro
Projection: UTM Zone 13 NAD 27
Data Source(s):
BLM PLSS (2002)
Field Investigation GPS Data (2002)
N
W
E
S
0
425
850
1,700
Feet
1:14,000
Site Boundary
Gnome SGZ
Well
Water Well
Site Roads and Graded Areas

The planned subsurface investigation for the Gnome-Coach Site is detailed in the *Site Characterization Work Plan for the Gnome-Coach Site, New Mexico,* approved by the State of New Mexico (NNSA/NV, 2002). Contaminants associated with the Gnome test are expected to include radioactive fission products, plutonium, and uranium. Existing information will be used to determine if consumption of contaminated groundwater related to the underground nuclear test is a viable exposure pathway. If a groundwater exposure pathway exists, then the DOE will define a contaminant boundary at the Gnome-Coach Site, and monitor groundwater to ensure that contamination does not migrate past the contaminant boundary. The location of monitoring wells to verify modeling results and the contaminant boundary will be determined through negotiation and concurrence with the State of New Mexico. Well locations will be based on best available knowledge of the most likely direction and pathways for groundwater migration. In the event that contaminants migrate past the contaminant boundary, the monitoring system and groundwater model will be re-evaluated to determine if the drilling restriction area and associated institutional controls need to be changed. This approach will be protective because, though it is not technologically feasible to remediate the contamination associated with an underground nuclear test, the use (withdrawal) of and exposure to contaminated groundwater will be precluded by implementation of institutional controls restricting the drilling of wells within the contaminant boundary.

The second subsurface source, the tracer test, left tritium, Sr^{90}, and Cs^{137} in contact with Culebra Formation groundwater. The tracer test investigation will begin with a Data Decision Analysis, building on previous modeling to evaluate the cost benefit of additional data collection. If necessary, additional data will be collected. Contaminant transport of the tracer test constituents will be calculated and used to define a contaminant boundary and to evaluate subsurface intrusion restrictions and monitoring needs related to the tracer test.

3.2 Human and Ecological Land Use

Human Land Use

The entire region around the Gnome-Coach Site is zoned for grazing. Principal land use in the area is livestock grazing, oil and gas exploration and production, and recreation (Map 3.2b). The Gnome-Coach Site is administered by the BLM Carlsbad Field Office, which has granted a grazing permit to a local rancher on an annual basis. USGS –1, a monitoring well for groundwater quality sampling purposes, is also used to water stock that are permitted to graze on the site (Johnston, 2003a). A network of water pipelines associated with this well is present throughout the section. Although there are active oil and gas leases surrounding the land withdrawn for the Gnome-Coach Site, such leases are not permitted on the site (DOE/EM, 2001). Future use of the site is anticipated to remain the same.

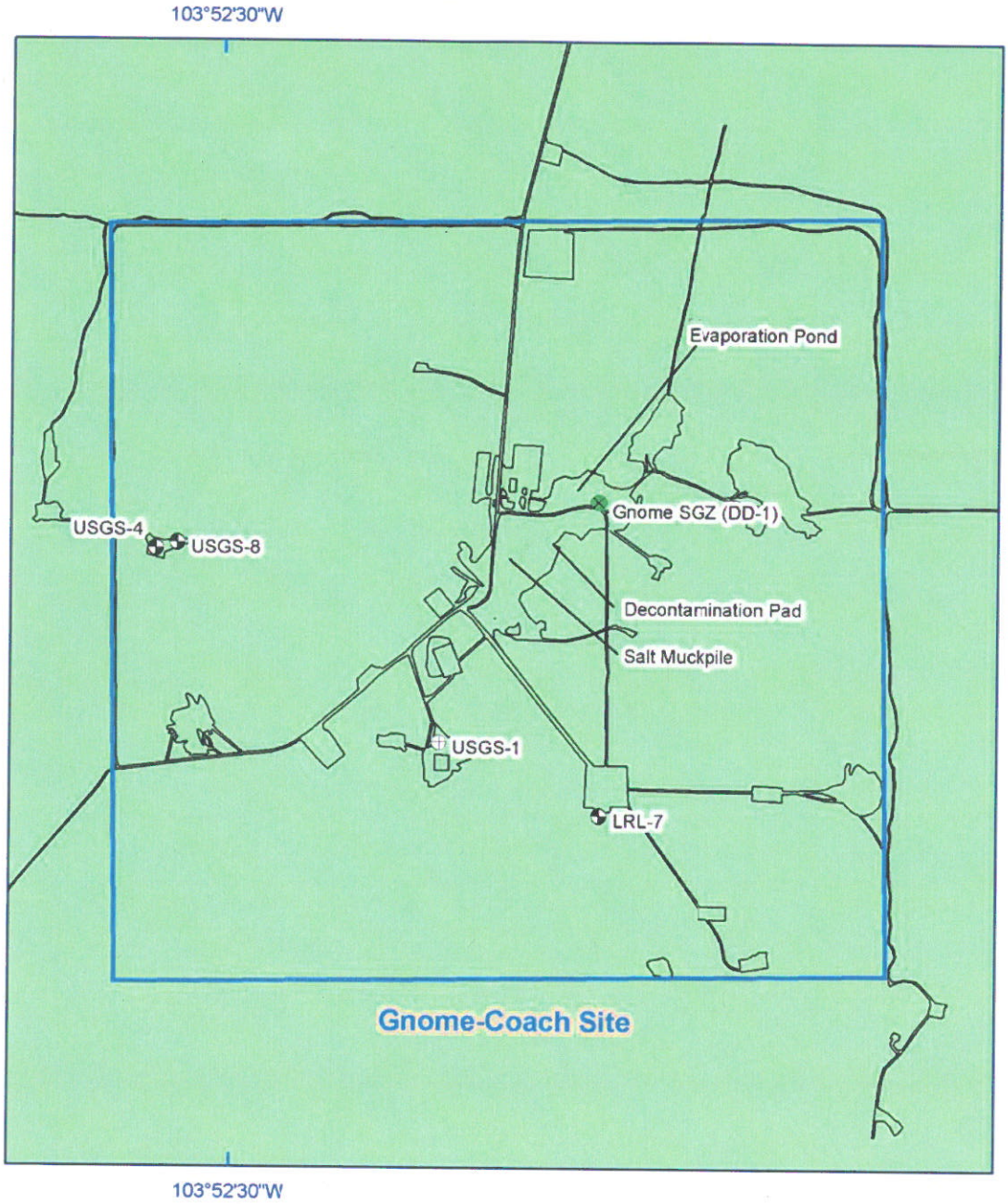
Subsurface use restrictions in the vicinity of the Gnome-Coach Site are expected to continue in perpetuity. A plaque on the SGZ monument at the site details historical information about the test (Johnston, 2003a). The plaque at SGZ indicates historical information about the site as follows:

"UNITED STATES ATOMIC ENERGY COMMISSION
DR. GLENN T. SEABORG, CHAIRMAN
PROJECT GNOME
December 10, 1961

> The first nuclear detonation in the Plowshare Program to develop peaceful uses for nuclear explosives was conducted below this spot at a depth of 1,216 feet in a stratum of rock salt. The explosive, equivalent to 3,100 tons of TNT, was detonated at the end of a horizontal passage leading from a vertical shaft located 1,116 feet southwest of this point. Among the many objectives was the production and recovery of useful radioactive isotopes, the study of heat recovery, the conduct of neutron physics experiments, and the provision of a seismic source for geophysical studies."

A second plaque at the site states that "...no excavation and/or drilling is permitted to penetrate Section 34, T23S, R30E, New Mexico Principal Meridian, at any depth between the surface and 457 m (1,500 ft) below the land surface" (DOE/NV, 1996).

Map 3.2b Gnome-Coach, New Mexico
Site Human and Ecological Land Use Map - End State



Prepared By: Stoller-Navarro
Projection: UTM Zone 13 NAD 27

Data Source(s):
BLM PLSS (2002)
BLM Land Cover/Land Use (2003)
Field Investigation GPS Data (2002)

N W E S

0 445 890 1,780 Feet
1:14,000

- Site Boundary
- Gnome SGZ
- Well
- Water Well
- Non-Agricultural Vegetated

The DOE/NSO developed a public participation plan for the Gnome-Coach Site End State Vision. The plan provided a draft copy of this document, an information sheet, and a letter soliciting feedback by July 1, 2004, to involved parties and stakeholders. All written comments that were submitted to the DOE/NSO received comment resolution.

Ecological Land Use

The clean-up activities associated with abandonment of the Gnome-Coach Site resulted in the excavation and disposal of the salt muckpile, excavation and disposal of contaminated soil and other material into the shaft and test cavity, and regrading and reclamation of the mud pits and evaporation pond. Native grasses have reestablished themselves over much of the site except where excessive concentrations of salt are present. The access roads have been maintained for use by the USGS, EPA, and ranchers holding the grazing permits (NNSA/NV, 2002). Shinnery oak, yucca, honey mesquite, and several grasses thrive in the sand dune parts of the site and stabilize the sand. Grama grass, sand sage, and javelina bush are the dominant plants over most of the site. Creosote bush and whitethorn acacia thrive in the eastern part of the site, adjacent to Nash Draw. No threatened or endangered species have been observed at the Gnome-Coach Site. However, the area is considered biologically sensitive due to the high use by raptors and the presence of gypsiferous soils (DOE/NV, 1993).

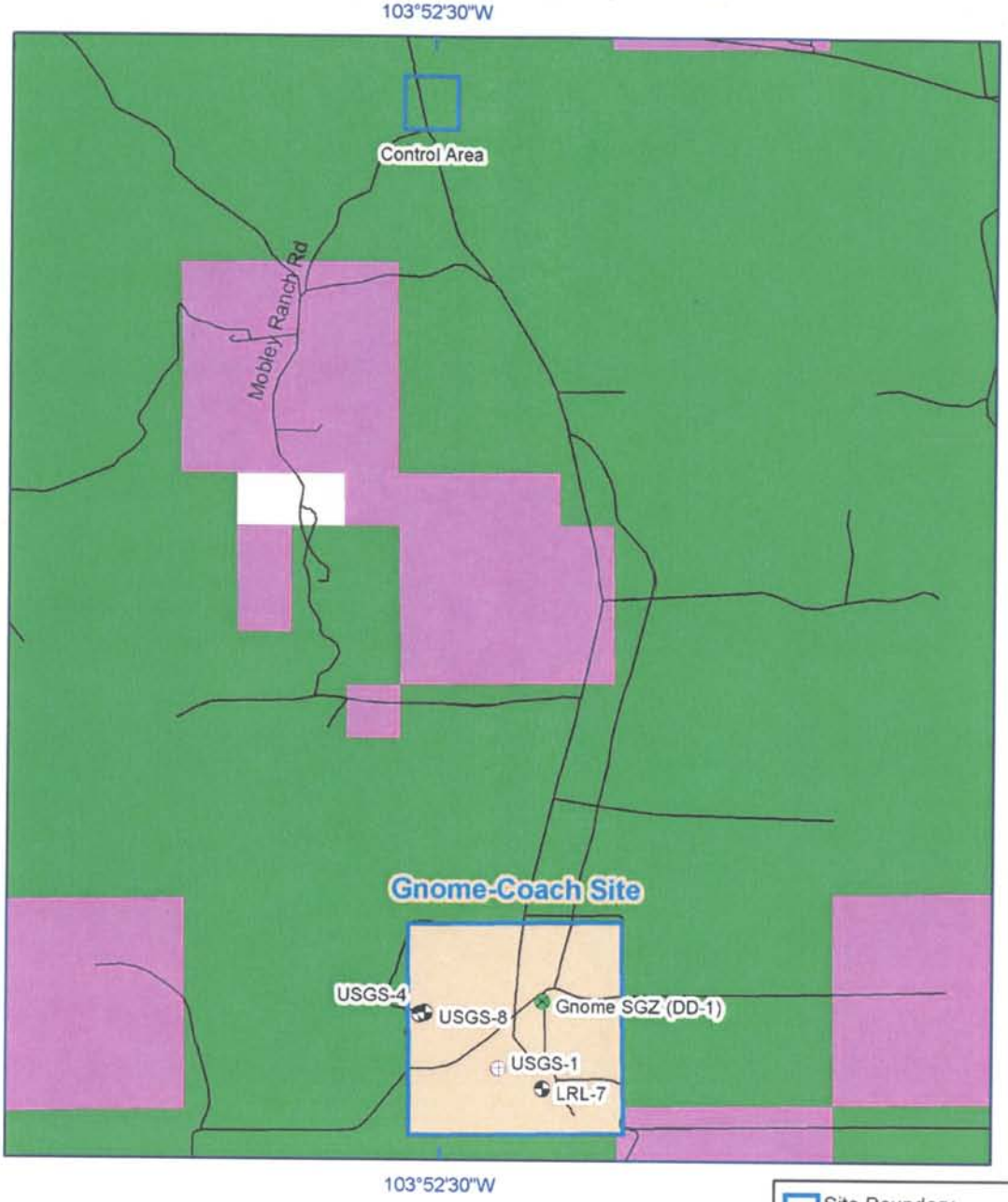
3.3 Site Context Legal Ownership

Two parcels of land totaling 680 acres were withdrawn from the Public Domain for the Gnome-Coach Site under Public Land Order 2526, as noted in the *Federal Register*, Doc. 61-10429, dated November 1, 1961 (*Federal Register*, 1961). The first parcel, Section 34, Township 23 S, Range 30 E, is the land where the Gnome test was conducted (Map 3.3b). The second parcel, the NW ¼ of the NW ¼ of Section 10, Township 23 S, Range 30 E, was used for the base camp Control Area during the test. The Gnome-Coach Site is withdrawn from all forms of disposition under the public land laws, including U.S. mining laws, and leasing under mineral leasing laws. According to the Master Title Plat provided by the BLM Carlsbad Field Office, all of Section 34 is closed to oil and gas leasing. The BLM administers surface activities that are limited to grazing. Although grazing permits are normally issued on a 10-year basis, the grazing permit for Section 34 is issued on an annual basis. Jay Mobley, a rancher, is the current grazing permit holder for Section 34 (Johnston, 2003a).

3.4 Site Context Demographics

The Gnome-Coach Site is in the southern part of Eddy County, in southeastern New Mexico. The population of Eddy County (Map 3.4b) was 51,655 in the 2000 census, which represented a 6 percent increase from 1990. The town of Carlsbad lies 25 mi northwest of the Gnome-Coach Site and has a population of 25,625 (U.S. Census Bureau, 2000). Farming, ranching, oil and gas production, and tourism dominate the local economy. The area surrounding the Gnome-Coach Site is zoned for grazing (DOE/EM, 2001). It is not anticipated that the human population near the Gnome-Coach Site will increase significantly in the foreseeable future.

Map 3.3b Gnome-Coach, New Mexico
Site Legal Land Ownership Map - End State



Prepared By: Stoller-Navarro
Projection: UTM Zone 13 NAD 27

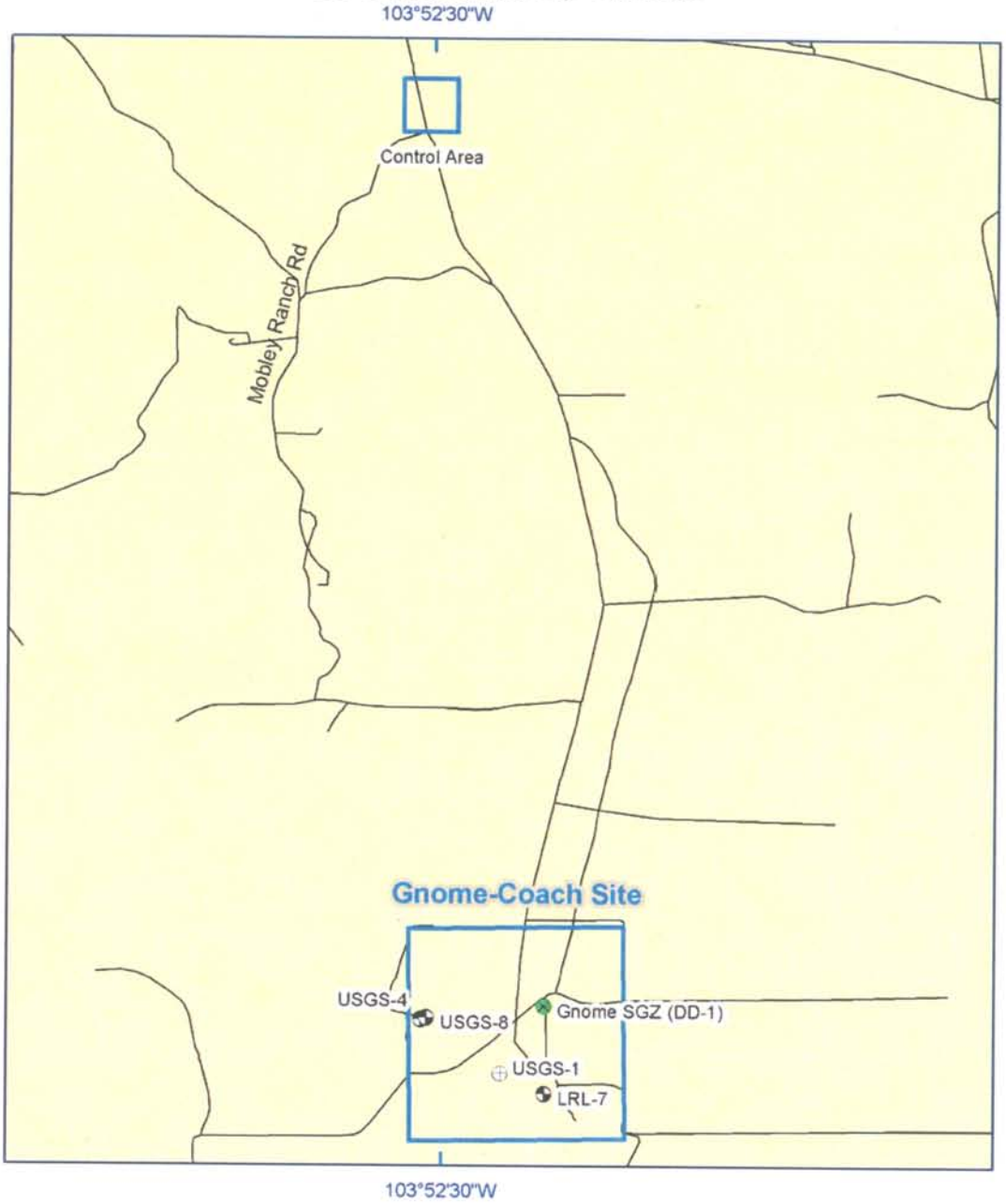
Data Source(s):
BLM PLSS (2002)
BLM Land Cover/Land Use (2003)
Field Investigation GPS Data (2002)

N W E S

0 0.25 0.5 1 Miles
1:50,000

- Site Boundary
- Gnome SGZ
- Well
- Water Well
- Federal Government
- State Government
- Private
- No Oil or Gas Drilling

Map 3.4b Gnome-Coach, New Mexico
Site Demographics Map - End State



Prepared By: Stoller-Navarro
Projection: UTM Zone 13 NAD 27

Data Source(s):
BLM PLSS (2002)
ESRI Streetmap USA (2003)
Field Investigation GPS Data (2002)

N W E S

0 0.25 0.5 1 Miles
1:50,000

Site Boundary
Gnome SGZ
Well
Water Well
Population Density (per Square Mile)
0 - 150

4.0 Hazard Specific Discussion

The Gnome-Coach Site currently consists of two source areas (Map 4.0b). Clean-up activities conducted from 1968 to 1969, and from 1977 to 1979, included the excavation and burial of the salt muckpile, excavation and disposal of contaminated soil and other contaminated material into the shaft and test cavity, and regrading and reclamation of the mud pits and evaporation pond. Soils that contained total petroleum hydrocarbons above clean-up levels were removed during the 2003 investigation (NNSA/NSO, 2003). Based on the corrective action investigation, the Gnome-Coach Site surface source area contains arsenic at background levels, Cs^{137} below risk-based action levels, and two locations with detectable plutonium at less than 20 percent of the preliminary action level. Therefore, the surface of the site is no longer considered a hazard area. Upon completion of closure activities for the surface, all New Mexico Environment Department comments on the closure report will have been addressed, and all VRP-required documentation filed. At that time, the DOE will request a certificate of completion for the surface area of the Gnome-Coach Site (NNSA/NSO, 2003). The surface of the Gnome-Coach Site is in the end state.

The two remaining hazards at the Gnome-Coach Site are the subsurface near SGZ and the Culebra Aquifer at and downgradient of the tracer test at USGS 4 and USGS 8. Table 4.0 summarizes the remaining hazards and risks associated with the site (DOE/NV, 2000). The planned subsurface investigation for the Gnome-Coach Site is detailed in the *Site Characterization Work Plan for the Gnome-Coach Site, New Mexico*, approved by the State of New Mexico (NNSA/NV, 2002). Based on the historic use of the site and characterization conducted at similar sites, the COCs associated with the Gnome test are expected to include radioactive fission products, plutonium, and uranium. Existing information will be used to determine if consumption of contaminated groundwater related to the underground nuclear test is a viable exposure pathway. If a groundwater exposure pathway exists, then the DOE will define a contaminant boundary at the Gnome-Coach Site, and monitor groundwater to ensure that contamination does not migrate past the contaminant boundary. The location of monitoring wells to verify modeling results and the contaminant boundary will be determined through negotiation and concurrence with the State of New Mexico. Well locations will be based on best available knowledge of the most likely direction and pathways for groundwater migration. In the event that contaminants migrate past the contaminant boundary, the monitoring system and groundwater model will be re-evaluated to determine if the drilling restrictions and associated institutional controls need to be changed. This approach will be protective because, though it is not technologically feasible to remediate the contamination associated with an underground

nuclear test, the use (withdrawal) of and exposure to contaminated groundwater will be precluded by implementation of institutional controls restricting the drilling of wells within the contaminant boundary.

The second subsurface source, the tracer test, left tritium, Sr^{90}, and Cs^{137} in contact with Culebra Formation groundwater. The tracer test investigation will begin with a Data Decision Analysis, building on previous modeling to evaluate the cost benefit of additional data collection. If necessary, additional data will be collected. Contaminant transport of the tracer test constituents will be calculated and used to define a contaminant boundary and to evaluate subsurface intrusion restrictions and monitoring needs related to the tracer test.

A CSM for the site is provided in Figure 4.0. The CSM illustrates the relationship between the identified potential sources of contamination, the mechanisms for release and migration away from the potential source, the pathways the contamination would follow once released, the exposure routes by which potential contamination would affect receptors, and the receptors that would be impacted by potential contamination (NNSA/NV, 2002).

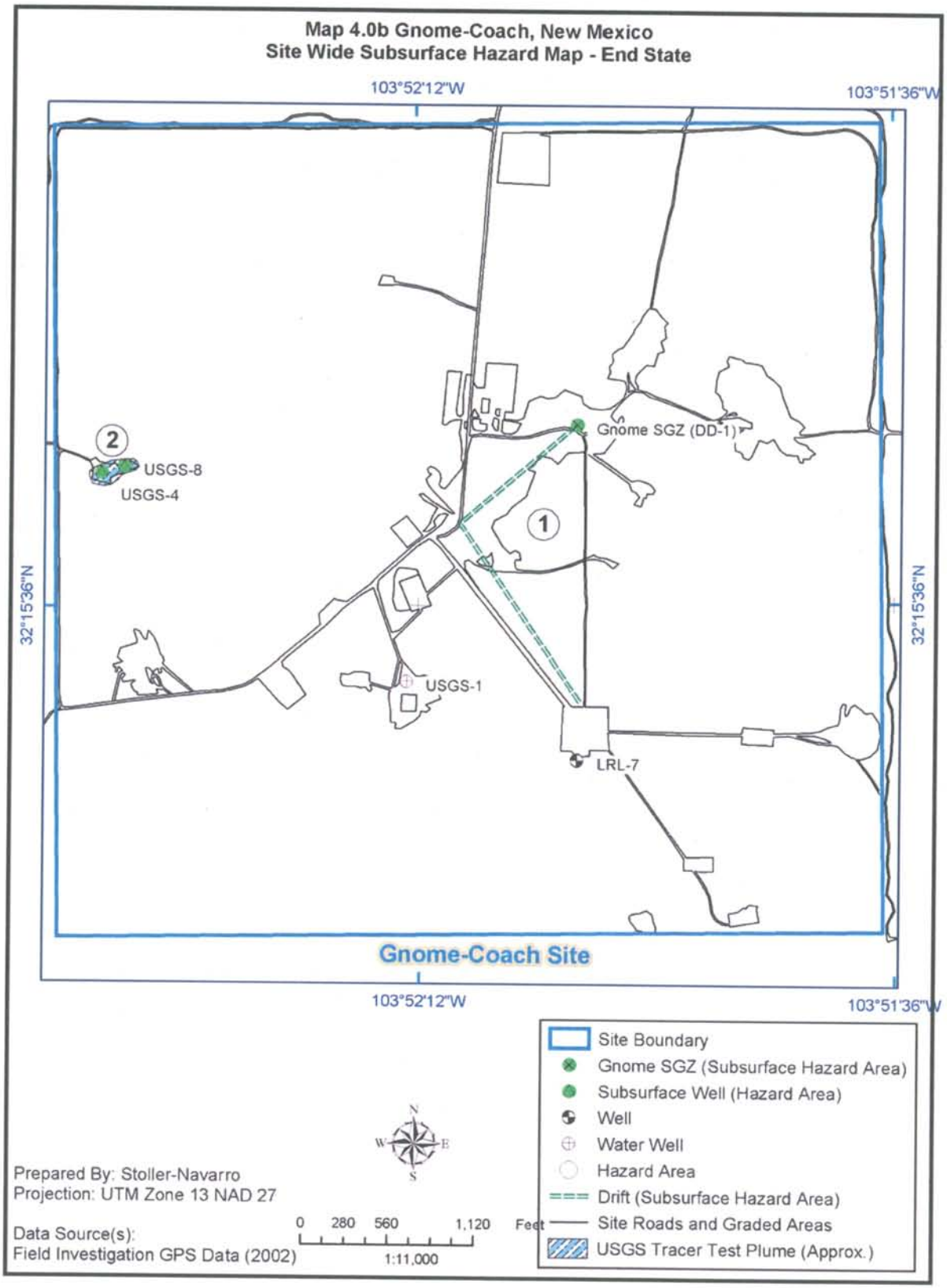

Map 4.0b Gnome-Coach, New Mexico
Site Wide Subsurface Hazard Map - End State
103°52'12"W
103°51'36"W
32°15'36"N
2
USGS-8
USGS-4
Gnome SGZ (DD-1)
1
USGS-1
LRL-7
Gnome-Coach Site
Site Boundary
Gnome SGZ (Subsurface Hazard Area)
Subsurface Well (Hazard Area)
Well
Water Well
Hazard Area
Drift (Subsurface Hazard Area)
Site Roads and Graded Areas
USGS Tracer Test Plume (Approx.)
N
W
E
S
Prepared By: Stoller-Navarro
Projection: UTM Zone 13 NAD 27
Data Source(s):
Field Investigation GPS Data (2002)
0 280 560 1,120 Feet
1:11,000

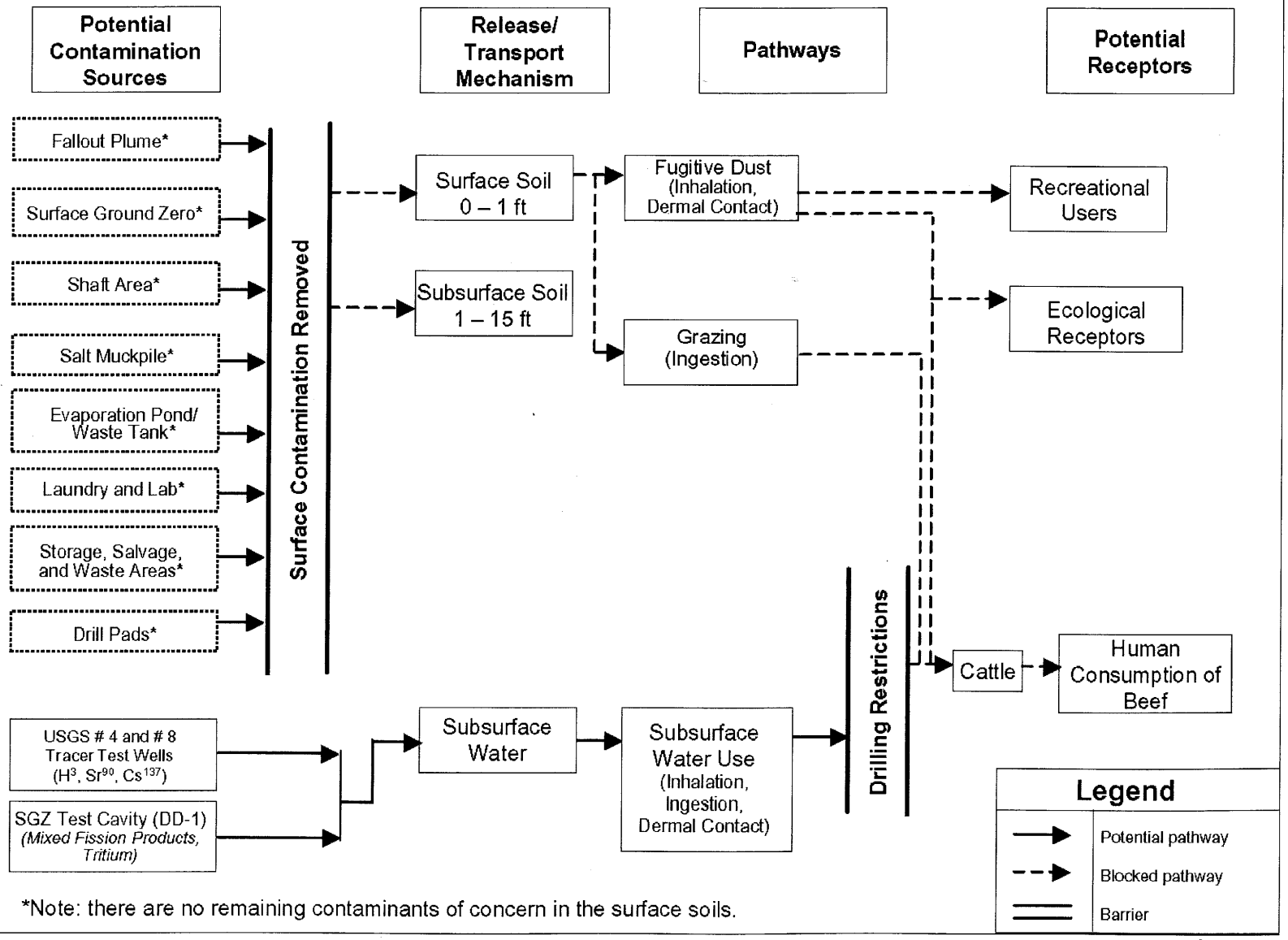
Table 4.0
Gnome-Coach Site Hazards and Risks
(Page 1 of 2)

Material Category	Nature of Hazard	Nature of Potential Risk	Status of Current Management	Planned Risk-Reduction Control	Anticipated Risk-Reduction Progress	End-State Disposition and Risk
Deep (>500 ft bgs) groundwater and test cavity	Groundwater in the immediate vicinity of the test cavity is contaminated with radionuclides (tritium and mixed fission products). Migratory potential of the contaminants via groundwater from the test cavity will be modeled. Migratory potential of the radionuclides injected into an overlying nonpotable aquifer will also be modeled.	Migratory potential of radionuclides in groundwater is minimal. Existing monitoring data from surrounding wells have not indicated radionuclide contamination. If contaminant migration is verified, the most probable exposure scenarios would be via inhalation of, ingestion of, and dermal contact with groundwater.	Site surface characterization, risk analysis, and contaminant migration modeling activities are ongoing. Site subsurface access is restricted.	Subsurface restrictions and institutional controls are in place and maintained. The subsurface risk-based compliance boundary will be refined based on subsurface modeling results. A refined long-term monitoring program will be implemented, if required and if technically feasible.	Currently, there is no feasible or cost-effective corrective action technology to address test cavities and associated subsurface contamination that will prevent risk.	Subsurface restrictions and institutional controls will be maintained and long-term hydrologic monitoring will be implemented, based on the risk assessment and groundwater modeling results.
Deep (>500 ft bgs) groundwater and tracer test plume	Groundwater in the immediate vicinity of the tracer test wells, USGS-4 and USGS-8, is contaminated with radionuclides (tritium and mixed fission products). Migratory potential of the contaminants via groundwater from the tracer test plume will be modeled.	The tracer test was conducted in 1963 within an overlying nonpotable aquifer. The aquifer is used for livestock. Potential exposure is via direct human contact and ingestion of contaminated beef.	Site surface characterization, risk analysis, and contaminant migration modeling activities are ongoing. Site subsurface access is restricted.	Subsurface restrictions and institutional controls are in place and maintained. The subsurface risk-based compliance boundary will be refined based on subsurface modeling results. A refined long-term monitoring program will be implemented, if required and if technically feasible.	Currently, there is no feasible or cost-effective corrective action technology to address subsurface contamination that will prevent risk.	Subsurface restrictions and institutional controls will be maintained and long-term hydrologic monitoring will be implemented, based on the risk assessment and groundwater modeling results.

Table 4.0
Gnome-Coach Site Hazards and Risks
(Page 2 of 2)

Material Category	Nature of Hazard	Nature of Potential Risk	Status of Current Management	Planned Risk-Reduction Control	Anticipated Risk-Reduction Progress	End-State Disposition and Risk
Surface Soil	Site decommissioning records indicate radioactive material was disposed of in the test cavity and shaft or removed from the site, leaving minimal residual surface contamination. Confirmation of site characterization is planned for regulatory approved site closure.	A human health risk assessment for the surface has indicated that the risk from exposure to contaminants is below regulatory limits.	Previous site cleanup confirmed.	No further action required for surface soils.	No further action required for surface soils.	The anticipated future surface land use will be unrestricted surface use as open range.

Figure 4.0 - Gnome–Coach Site Conceptual Site Model - Current State and End State

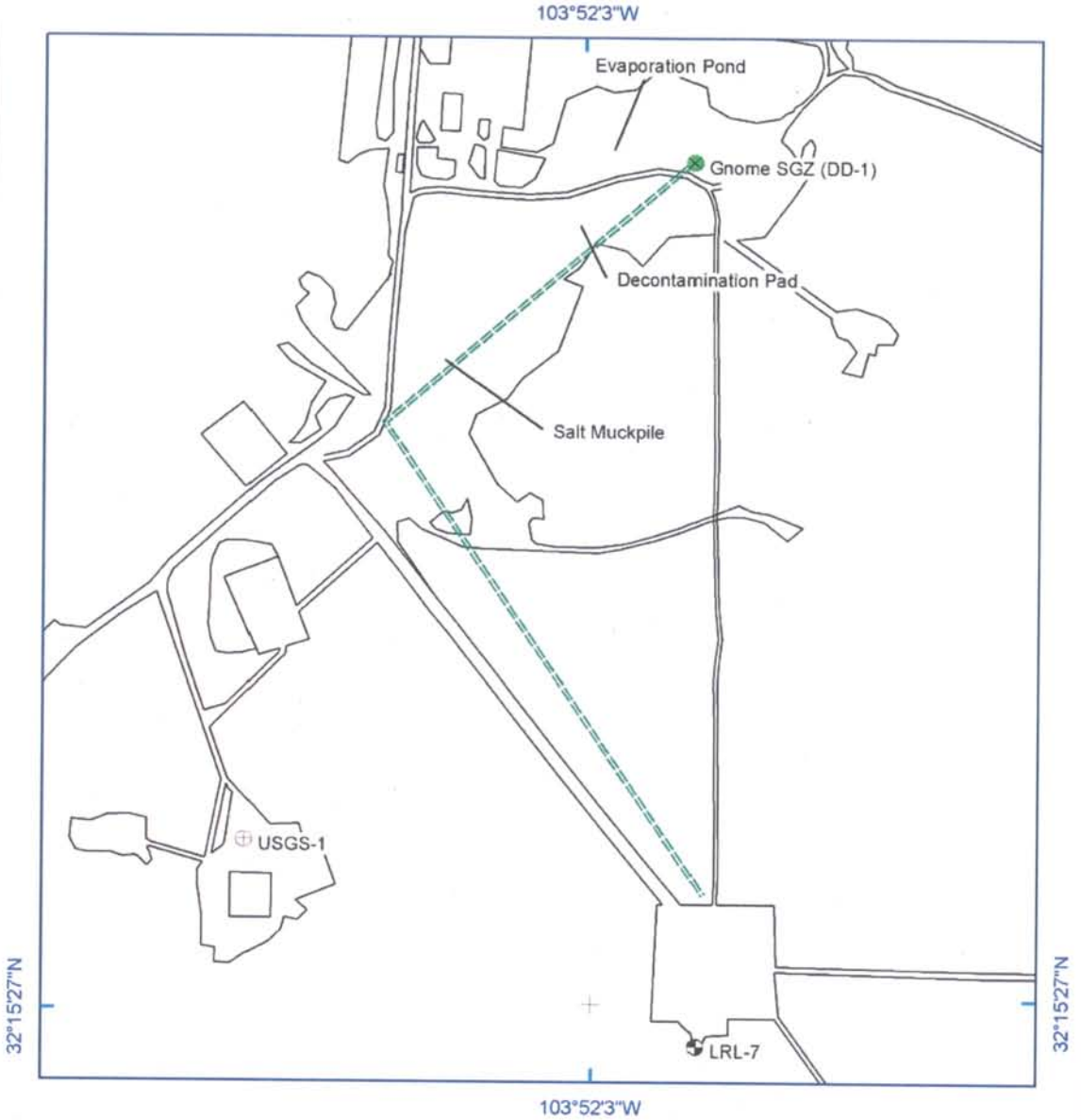


*Note: there are no remaining contaminants of concern in the surface soils.

4.1 Subsurface Source Area 1

The Gnome underground test cavity, emplacement shaft, and drift have the potential to impact groundwater quality with contamination from radionuclides (Map 4.1b1). The test cavity and placement adit are in a salt formation 685 ft below the aquifer in the Culebra Dolomite, but the emplacement shaft cuts across the aquifer and connects the surface with the adit and test cavity, both of which are filled with contaminated material. The DOE does not plan to remediate the subsurface contamination at the Gnome-Coach Site because of the lack of feasible technologies (NNSA/NSO, 2003). The hazard extent has not been defined; however, the DOE/NSO will continue to investigate and model subsurface contamination (DOE/EM, 2001). According to the Life-Cycle Baseline Revision 5, subsurface closure of the Gnome-Coach Site is scheduled to be completed in FY 2014.

Map 4.1b1 Gnome-Coach, New Mexico
SGZ and Drift Subsurface Hazard Area 1 Map - End State



Prepared By: Stoller-Navarro
Projection: UTM Zone 13 NAD 27

Data Source(s):
Field Investigation GPS Data (2002)

N W E S

0 145 290 580 Feet
1:5,000

- Site Boundary
- Gnome SGZ (Subsurface Hazard Area)
- Well
- Water Well
- Drift (Subsurface Hazard Area)
- Site Roads and Graded Areas

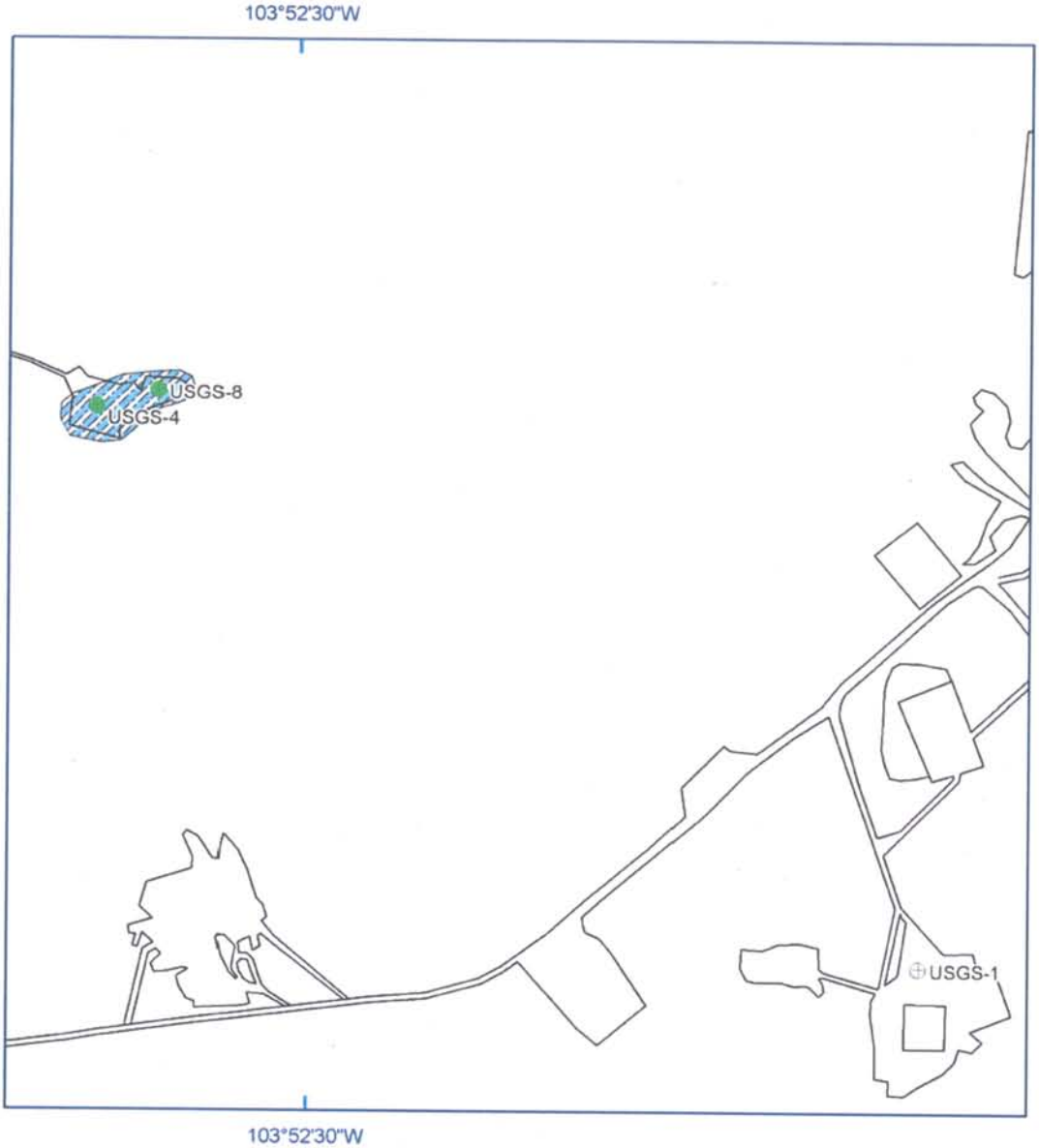
4.2 Subsurface Source Area 2

The radioactive tracers from the tracer test at USGS-4 and USGS-8 were left in the Culebra Aquifer at the conclusion of the test (Map 4.1b2). Analyses performed to date (Pohlmann and Andricevic, 1994; Pohll and Pohlmann, 1996; Earman et al., 1996) indicate the potential for migration of the tracer test radionuclides beyond the area of subsurface control. A risk assessment determined risk through a beef ingestion pathway to be less than 1×10^{-4} but greater than 1×10^{-6}. Risk via drinking water was not evaluated due to poor water quality, though the State of New Mexico considers the Culebra Aquifer a drinking water resource (Conrad et al., 1998).

The tracer test investigation will begin with a Data Decision Analysis, building on previous modeling to evaluate the cost benefit of additional data collection. If necessary, additional data will be collected. Contaminant transport of the tracer test constituents will be calculated and used to define a contaminant boundary and to evaluate subsurface intrusion restrictions and monitoring needs related to the tracer test.

At the present time, the hazard extent has not been defined; however, the DOE/NSO will continue to investigate and model subsurface contamination (DOE/EM, 2001). According to the Life-Cycle Baseline Revision 5, subsurface closure of the Gnome-Coach Site is scheduled to be completed in FY 2014.

Map 4.1b2 Gnome-Coach, New Mexico
USGS 4 and 8 with Plume Subsurface Hazard Area 2 Map - End State



Prepared By: Stoller-Navarro
Projection: UTM Zone 13 NAD 27

Data Source(s):
Field Investigation GPS Data (2002)

N
W E
S

0 155 310 620 Feet
1:5,000

Site Boundary
Subsurface Well (Hazard Area)
Water Well
Site Roads and Graded Areas
USGS Tracer Test Plume (Approx.)

5.0 References

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Attachment A – Discussion of Variances

The following variance report table is provided in accordance with Appendix D of the Environmental Management End State Vision Development Guidance dated September 11, 2003. The table below does not identify any variances, but does provide information clarifying why there are no perceived differences between the various plans and agreements governing activities at the site. There are no negative impacts in terms of scope, cost, schedule, and risk, and no known barriers to achieving the end state. Based on the above noted belief, the next steps are identified for future activities associated with the Gnome-Coach Site. There are no maps provided, as there are no differences between the end state based on the current requirements and the end state based on the end state vision. The maps within the main body of the end state document sufficiently identify pertinent information related to the Gnome-Coach Site.

Gnome-Coach Site Variance Report				
ID No.	**Description of Variances**	**Impacts (in Terms of Scope, Cost, Schedule, and Risk)**	**Barriers in Achieving the End State**	**Recommendations**
N/A	There are no known variances between the end state, the current Offsites baseline, the Nevada Site Office Performance Management Plan, and/or regulatory agreements.	Clean-up decisions made for the Gnome-Coach Site are consistent with planned future use as public use land (cattle grazing). The State of New Mexico is predicted to concur on recent surface remediation activities and issue a no further action determination for surface remediation under the State's Voluntary Remediation Program. The State is aware of the future subsurface characterization activities and understands issues associated with the residual contamination.	None at this time.	Concur on the closure of the Gnome-Coach Site surface, support completion of future subsurface plans and documents, and prepare the necessary long-term stewardship information for transfer of the management responsibility of the site subsurface to the Office of Legacy Management.