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Documented Safety Analysis for the Removal, Characterization, and Restoration of Material Disposal Area B Nuclear Environmental Site

Los Alamos NATIONAL LABORATORY EST. 1943

Prepared by
Environmental Programs–Environment and Remediation Support Services

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1.0 INTRODUCTION

Los Alamos National Laboratory (LANL or the Laboratory) prepared this documented safety analysis (DSA) for the removal, characterization, and restoration (RCR) of Nuclear Environmental Site (NES) Technical Area (TA) 21, Material Disposal Area (MDA) B (Solid Waste Management Unit [SWMU] 21-015) in accordance with 10 CFR 830, Subpart B, "Safety Basis Requirements." This NES is not active now and will not serve as an active disposal facility in the future.

The U.S. Department of Energy (DOE)/National Nuclear Security Administration (NNSA) approved a DSA (LANL 2004, 87651) to provide safety basis coverage for ongoing surveillance and maintenance (S&M) activities at MDA B and nine other NES, to ensure that site contaminants do not migrate from their current location. This DSA evaluates the hazards and identifies needed controls for the RCR of MDA B. Upon approval of this DSA will serve as the only safety authorization basis for MDA B.

The purpose of this RCR DSA is to evaluate the hazards and identify the appropriate controls that will ensure workers, the public, and the environment are protected from the radiological, chemical, and other hazardous materials/substances associated with the RCR of MDA B. Section 1 provides the background and requirements for the DSA and describes site characteristics, locations, and area features. General site characteristics and those that apply specifically to MDA B are discussed. An operational history of MDA B and its current status are also presented. Section 2 describes the MDA B RCR site layout along with the activities and tasks evaluated in this RCR DSA. Section 3 provides the safety assessment for the RCR of MDA B. Technical safety requirements (TSRs) for the activities in this DSA are described, per 10CFR830 Subpart B, in a separate stand-alone document titled "Technical Safety Requirements for Removal, Characterization, and Restoration of Material Disposal Area B Nuclear Environmental Site" (LANL 2006a).

1.1 Background

DOE administers, and Los Alamos National Security (LANS) operates, the Laboratory and the 32 TAs currently active within the Laboratory boundaries. Figure 1.1-1 shows the location of TA-21 and MDA B with respect to other Laboratory technical areas and surrounding land. For more than 60 years, the Laboratory has been the location for experimental nuclear weapons and science programs. MDA B is a legacy site associated with the disposal of materials related to these programs.

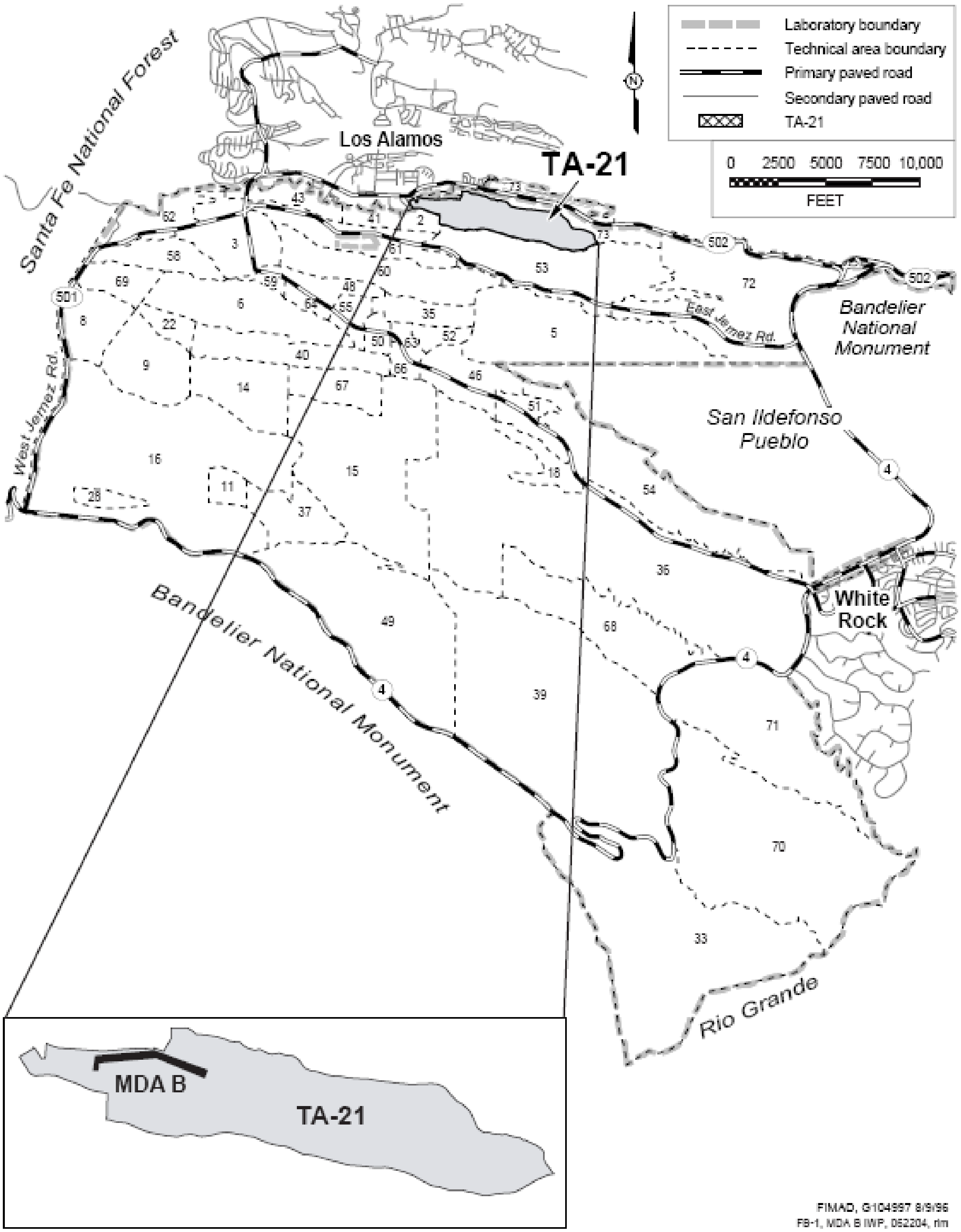


Figure 1.1-1. Location of TA-21 and MDA B

1.2 Requirements

The Laboratory compiled this DSA in accordance with the following codes and standards:

- 10 CFR 830, "Nuclear Safety Management"
- DOE Standard 1120-2005, "Integration of Environment, Safety, and Health into Facility Disposition Activities, Volume 1 of 2: Documented Safety Analysis for Decommissioning and Environmental Restoration Projects"
- DOE Standard 1120-2005, "Integration of Environment, Safety, and Health into Facility Disposition Activities, Volume 2 of 2: Appendices"
- 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response" (HAZWOPER)

1.3 Approach

In accordance with 10 CFR 830 Subpart B, Appendix A Table 2 the basis for developing a Documented Safety Analysis (DSA) for a type 6 nuclear facility is the methodology in DOE Standard 1120-2005 and the provisions of 29 CFR 1910.120.

The RCR of MDA B involves potential hazards primarily associated with intrusion into buried waste inventory that includes both radionuclide and chemical contamination. The hazard analysis for activities that involved exposure to these chemicals and radionuclides followed a rigorous qualitative method for evaluation of potential impacts and the identification of appropriate safety controls to prevent or mitigate potential consequences.

A Target-Barrier-Hazard-Analysis method was used to evaluate the hazards associated with MDA B RCR activities. A barrier analysis provides the appropriate and adequate basis for the safety assessment of MDA RCR activities for the DSA. The barrier analysis methodology provides an adequate means of determining the physical and administrative barriers needed to ensure protection of workers, the public, and the environment. The results of the barrier analysis for the evaluation of identified hazards is then relied upon to identify the appropriate type, level, and number of safety controls.

1.4 Site Description

1.4.1 Geography

The Laboratory and the residential and industrial areas associated with the townsite of Los Alamos (inclusive of the White Rock community) are located in Los Alamos County in north-central New Mexico, approximately 96.6 km (60 mi) north-northeast of Albuquerque and 40 km (25 mi) northwest of Santa Fe (Figure 1.4-1). The area surrounding the Laboratory, including portions of Los Alamos, Sandoval, Rio Arriba, and Santa Fe Counties, is largely undeveloped. Santa Fe National Forest, the Bureau of Land Management, Bandelier National Monument, the General Services Administration, and Los Alamos County own and/or manage large tracts of land north, west, and south of the Laboratory. Thirteen Native American pueblos are located within an 80-km (50-mi) radius of the Laboratory. San Ildefonso Pueblo borders the Laboratory to the east.

The 111-km^2 (43-mi^2) Laboratory site and the adjacent communities are situated on the Pajarito Plateau, a shelf approximately 16 to 24 km (10 to 15 mi) wide and 72 km (45 mi) long. The Pajarito Plateau consists of a series of east-trending finger-like mesas separated by deep canyons cut by streams. The mesa tops range in elevation from approximately 2400 m (7800 ft) on the flanks of the Jemez Mountains to about 1900 m (6200 ft) at their eastern termination above the Rio Grande Valley. The Laboratory is located at altitudes ranging from 1800 to 2500 m (6000 to 8000 ft) on the eastern slopes of the Jemez Mountains.

1.4.1.1 Location of MDA B

MDA B is located within TA-21 between Delta Prime (DP) Canyon and Los Alamos Canyon, south of DP Road, and west of the main TA-21 complex. MDA B is located at the western edge of TA-21, approximately 488 m (1600 ft) east of the intersection of DP Road and Trinity Drive. The northern, fenced boundary of MDA B is within approximately 1.5 m (5 ft) of DP Road. MDA B covers approximately 24,400 m^2 (6.03 acre).

1.4.1.2 Public Exclusion Areas and Access Control Areas

MDA B is within a DOE-controlled area, although public access to DP Road is not currently controlled. DOE has delegated authority to LANS to close DOE-controlled roads at LANL for transporting hazardous and radioactive materials (Bellows 1993). Authority for road closure extends to emergencies as well.

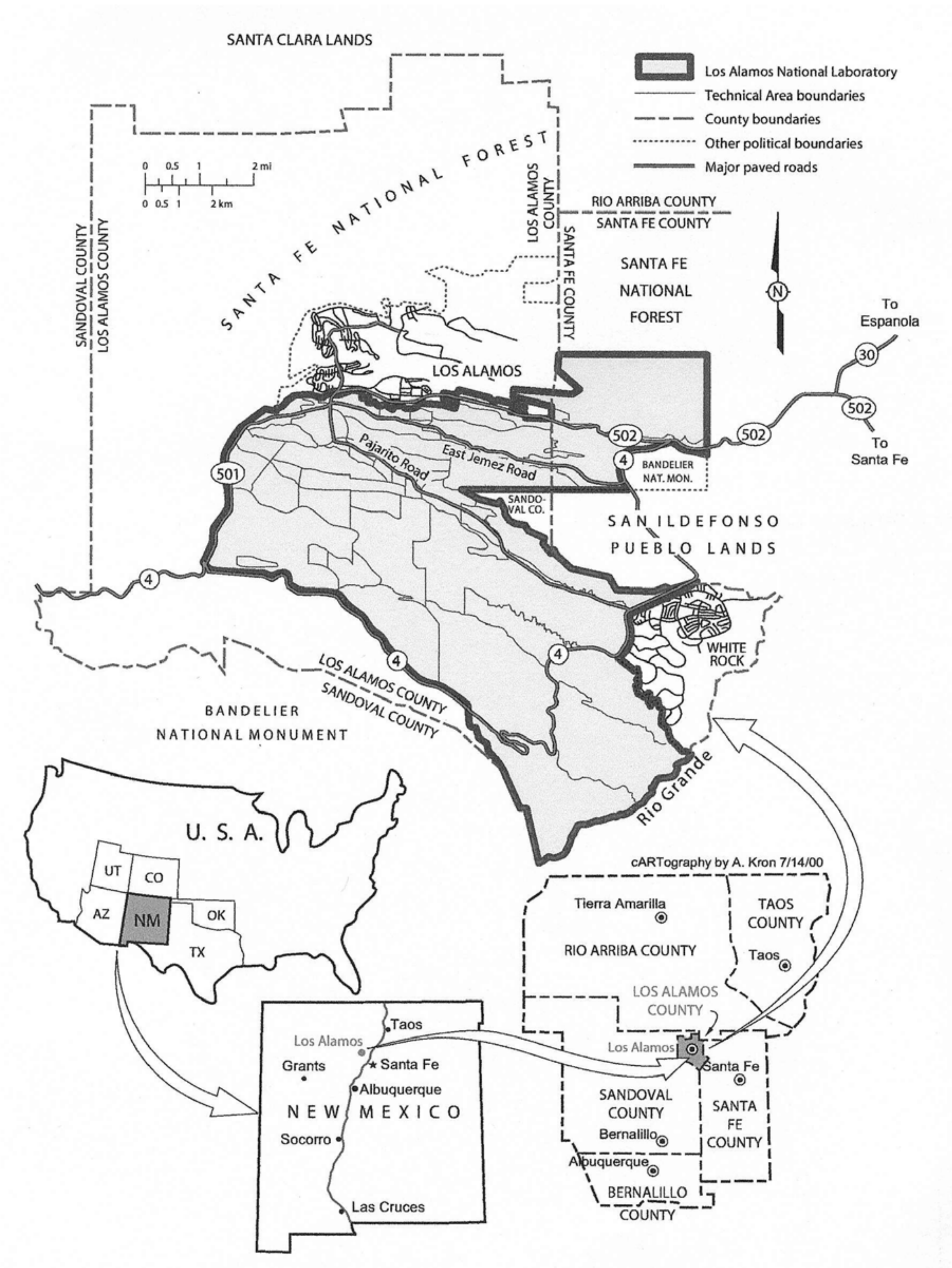


Figure 1.4-1. Location of LANL

1.4.1.3 Receptor Locations

Table 1.4-1 provides the distance to the LANL site boundary in each of the 16 cardinal directions. The nearest public receptor is located at businesses approximately 20 m (65 ft) to the north of MDA B, across DP Road. Due to the recent transfer of land from DOE to Los Alamos County (tracts A-8, A-15-1, and A-15-2), MDA B is within 200 m (650 ft) of the LANL site boundary in all 16 cardinal directions.

Table 1.4-1
Nearest Site Boundary Distances

16 Cardinal Directions	Distance to Site Boundary (m)
N	22.3
NNE	22.3
NE	22.3
ENE	24.4
E	32.5
ESE	63
SE	166.6
SSE	130.1
S	113.8
SSW	113.8
SW	119.9
WSW	140.2
W	83.3
WNW	40.6
NW	26.4
NNW	22.3

1.4.1.4 Roads and Vehicular Access

Three state highways and the Los Alamos Airport allow vehicular access to the Laboratory and the townsite of Los Alamos. State Highway 502 enters Los Alamos from Pojoaque and areas to the southeast of Los Alamos and is the main access route for commuters from outlying communities. State Highways 4 and 501 enter Los Alamos from the Jemez Mountains to the west and southwest. Traffic on State Highway 502 is moderate to heavy on workdays during the peak morning and evening commute. During off-hours and weekends, traffic is typically light to moderate on all three roads. Access to MDA B is by way of DP Road.

1.4.1.5 Airports and Air Traffic

The Los Alamos Airport runway is located approximately 0.48 km (0.3 mi) north of MDA B, adjacent to and north of State Highway 502. The airport consists of a single east-west runway and primarily serves the general public, with some occasional commercial or military traffic. Generally, air traffic enters from and exits to the east due to local atmospheric conditions and airspace restrictions.

Los Alamos Airport has the capacity to handle 500 to 600 private flights and 200 to 300 commercial flights per month. Data obtained in 1997 for frequency of aircraft operations at the airport recorded approximately 4860 general-aviation and 1980 commercial takeoffs and an equal number of landings per year (Heindel 1998). Data obtained in 2006 (effective December 22, 2005) for airport operational statistics recorded an average of 55 aircraft operations per day, with 75% due to local general aviation, 17% due to transient general aviation, 7% due to air taxi, and less than 1% due to military aviation (AirNav 2006).

1.4.2 Demography

The total population within 80 km (50 mi) of the Laboratory in 2004 was approximately 280,000 (LANL 2005b). Santa Fe is the largest city in the area, with a population of about 66,476 (U.S. Census Bureau 2006). The Albuquerque metropolitan area, which is approximately 97 km (60 mi) to the south-southwest, has an estimated population of 471,856 (U.S. Census Bureau 2006).

Los Alamos County has an estimated population of 18,796 individuals (U.S. Census Bureau 2006). The Los Alamos community has an estimated population of 11,400 persons. The White Rock area (including the residential areas of White Rock, La Senda, and Pajarito Acres) has approximately 6800 residents. A few permanent residents reside at the Bandelier National Monument, but during summer operational hours the population at the Monument can be as high as 1000. Approximately 12,350 LANS and subcontractor employees work within Laboratory boundaries.

1.5 Environmental Description

1.5.1 Meteorology

Los Alamos County has a semiarid, temperate mountain climate. “Los Alamos Climatology” (Bowen 1990, 06899) and “Los Alamos Climatology Summary Including Latest Normals from 1961-1990” (Bowen 1992, 12016) provide detailed discussion of the Los Alamos climate and include frequency analyses of extreme climatologic events.

1.5.1.1 Wind Speed and Direction

Five meteorological monitoring stations measure wind speed and direction around the Laboratory. Los Alamos is considered a light-wind site, with surface winds (measured at 11 to 12 m above ground level [AGL]) at the Laboratory averaging 3.1 m/s (7 mph). Wind speeds are strongest from March through June and weakest in December and January. Sustained winds exceeding 11 m/s (25 mph) with peak wind gusts exceeding 22 m/s (50 mph) are common during the spring. The strongest winds are generally southwesterly through northwesterly and occur in the afternoon or evening. Wind distribution varies with location, height above ground, and time of day. The highest recorded wind gusts in recent history were 34 m/s (77 mph) on November 15, 1988, at East Gate. Thunderstorms also produced 34 m/s (76 mph) peak gusts at both East Gate and Area G on May 9 and 27, 1989, respectively (Bowen 1992, 12016).

No tornadoes have been reported to touch down in the Los Alamos area in recent history. However, a funnel cloud was reported near White Rock on August 23, 1983. In addition, numerous funnel clouds were reported near Santa Fe on August 24 and 25, 1987, and a tornado touched down in Albuquerque on September 20, 1985.

1.5.1.2 Temperature

Summer afternoon temperatures in Los Alamos County typically range between 21 and 32ºC (70 and 90ºF) and only infrequently reach 32ºC (90ºF). Nighttime temperatures typically range between 10 and 15ºC (50 and 59ºF) (Bowen 1992, 12016). Typical winter temperatures are between –1 and 10ºC (30 to 50ºF) in the daytime and between –9 and –4ºC (15ºF and 25ºF) at night. Winter temperatures occasionally drop to –18ºC (0ºF) or below (Bowen 1992, 12016).

1.5.1.3 Precipitation

Annual average precipitation at Los Alamos is about 48 cm (19 in.), with about 36% occurring as brief, intense thunderstorms during July and August (Bowen 1992, 12016). Hail can be frequent and severe during the thunderstorms. Most hailstones have diameters of about 0.64 cm (0.25 in.). Snowfall is greatest from December through March, with heavy snowfall infrequent in other months. Annual snowfall averages about 150 cm (59 in.). Variations in precipitation from year to year can be quite large, and annual precipitation extremes in Los Alamos ranged from 17 cm (6.8 in.) to 77 cm (30.3 in.) over a 71-year period (Bowen 1992, 12016). Daily rainfall extremes of 2.54 cm (1 in.) or greater occur in most years, and the estimated 100-year daily rainfall extreme is about 6.4 cm (2.5 in.). Precipitation generally increases westward toward the Jemez Mountains.

1.5.1.4 Lightning

Lightning associated with thunderstorms in Los Alamos can be frequent and dense. The National Oceanic and Atmospheric Administration provides a lightning-density map for the U.S. on its website. The density in the Los Alamos area shown on this map is four to eight strikes per square km per year (National Weather Service Lightning Safety 2006).

1.5.2 Atmospheric Dispersion

The terrain at Los Alamos is irregular and affects atmospheric turbulence and dispersion both favorably and unfavorably. Increased dispersion promotes greater dilution of contaminants released into the atmosphere. The complex terrain and forests create an aerodynamically rough surface, forcing increased horizontal and vertical turbulence and dispersion. However, dispersion is greatly restricted within the area’s canyons. Also, dispersion generally decreases at lower elevations, where the terrain becomes smoother and less covered in vegetation. The frequent clear skies and light winds cause good vertical daytime dispersion, especially during the warm season. Daytime heating during the summer can force strong vertical mixing to 1200 to 2400 m (4000 to 8000 ft) AGL. The generally light winds have a limited effect on the horizontal dilution of contaminants (Bowen 1992, 12016).

The clear skies and light winds have a negative effect on dispersion at night, causing strong, shallow surface inversions to form. These inversions can severely restrict near-surface vertical and horizontal dispersion. The inversions are especially strong during the winter. Shallow drainage winds can fill lower areas with cold air, thereby creating deeper inversions. A deeper inversion is common toward White Rock and the Rio Grande Valley on clear nights with light winds. Canyons also can limit dispersion by channeling airflow. A large-scale inversion during the winter can limit vertical mixing to under 3050 m (10,000 ft) above sea level (Bowen 1992, 12016).

Dispersion is generally greatest during the spring, when winds are strongest. However, deep vertical mixing is greatest during summer, when the atmosphere is unstable up to 1500 m (5000 ft) or more AGL (Bowen 1992, 12016). Low-level dispersion is generally the least during summer and autumn, when winds are light.

1.5.3 Geology

1.5.3.1 Topology and Soils

Consolidated ash (tuff) from two major volcanic eruptions in the Jemez Mountains that took place about 1.61 and 1.22 million years ago forms the Pajarito Plateau. These eruptions produced widespread, massive deposits known as the Otowi and Tshirege Members of the Bandelier Tuff. Smaller eruptions that occurred between the two major events produced an interbedded sequence of silica-rich (rhyolitic) tuffs and sediments that occur commonly, but not uniformly, between the Otowi and Tshirege Members.

Surface sediments across the Pajarito Plateau are composed of thin soils developed on the mesa top, alluvial (water-deposit) and colluvial (slope-deposit) residues on the mesa flanks, and alluvial deposition in the canyon bottoms. The sediments consist of coarse-grained colluvium on steep hill slopes and fine-grained materials on the flatter mesa tops. Alluvial deposits in the canyons are composed of loose (unconsolidated) fine and coarse sands of quartz, sanidine crystal fragments, and broken pumice fragments that are weathered and transported from the mesa top and sides. The slopes between the mesa tops and canyon bottoms often consist of rocky outcrops and patches of undeveloped colluvial soil. South-facing canyon walls are steep and sometimes have no soils, but north-facing walls generally have areas of very shallow, dark soils (DOE 1999).

1.5.3.2 Seismicity and Volcanism

Seismic source zones at Los Alamos include the Rio Grande Rift, the Jemez Volcanic Province, the Colorado Plateau Transition Zone, the Southern Rocky Mountains, and the Great Plains Provinces.

The Laboratory is situated near the western edge of, and within, the Rio Grande Rift, a tectonically, volcanically, and seismically active province in the western U.S. The instrumental and historical records of earthquakes in New Mexico extend back only about 100 years.

The most recent volcanic activity within the Jemez volcanic field occurred about 50,000 to 60,000 years ago. Studies have found more evidence for recurring seismic activity along the Pajarito Fault System than for recurring volcanic activity in the Jemez volcanic field (Reneau et al. 1996, 57002; Olig et al. 1996, 57574). The three most significant and closest fault zones to the Laboratory are the Pajarito, Guaje Mountain, and Rendija Canyon Faults, which are accompanied by numerous smaller secondary faults. Surface offsets at some locations clearly express the larger faults; geologists have inferred their presence at other locations from geologic evidence (Wong et al. 1995, 70097).

The Woodward-Clyde study evaluated the seismic measurements recorded by the Laboratory from 1973 to 1992 (Wong et al. 1995, 70097). Only one well-located earthquake has occurred near the Laboratory or the three local faults. The maximum depth of seismic activity in the northern Rio Grande Rift is about 12 km (7.5 mi), which is consistent with elevated temperatures in the crust. Focal mechanisms show normal and strike-slip faulting generally on northerly striking planes. Consistent with the Rio Grande Rift zone, an approximately east-to-west extension characterizes the tectonic stress field.

The Pajarito Fault is thought to mark the currently active western boundary fault of the Española Basin (Carter and Gardner 1995). This fault forms the western boundary of the Pajarito Plateau and is easily visible above West Jemez Road as an east-facing escarpment about 91 m (300 ft) high. The Rendija Canyon and Guaje Mountain Faults are shorter than the Pajarito Fault. All three faults are geologically young and are capable of producing earthquakes.

The Pajarito Fault zone trends north along the western boundary of the Laboratory. The Rendija Canyon Fault zone is located 3.2 km (2 mi) east of the Pajarito Fault zone and trends north to south across the Laboratory. The Guaje Mountain Fault zone is located 1.6 to 2.4 km (1 to 1.5 mi) east of the Rendija Canyon Fault zone and trends north to south. Maximum magnitudes for the random earthquakes within these provinces range from 6.0 to 6.5 Mw (Wong et al. 1995, 70097). Table 1.5-1 lists the approximate length, type, most recent movement, and maximum earthquake for each fault.

Table 1.5-1
Major Faults in the Laboratory Area

Name	Approximate Length (km/mi)	Type[a]	Most Recent Movement	Maximum Earthquake (Mw)[b]
Pajarito	26/16.3	Normal, east side down	100,000 to 200,000 years ago, multiple in the past	6.9
Rendija Canyon	9.6/6	Normal, west side down	8000 to 9000 years ago	6.5
Guaje Mountain	8/5	Normal, west side down	4000 to 6000 years ago	6.5

[a] "Normal Fault" describes a steep to moderately steep fault for which the movement is downward for the rocks above the fault zone.

[b] "Mw" denotes the moment magnitude scale, which is physically based and calibrated to the Richter local magnitude scale at the lower values.

1.5.4 Hydrology

1.5.4.1 Surface Flow

Springs on the flanks of the Jemez Mountains supply base flow into the upper reaches of some canyons on the Pajarito Plateau. Runoff from summer storms on the Pajarito Plateau reaches maximum discharge in less than 2 hours and generally lasts less than 24 hours (Devaurs and Purtymun 1985, 07415; Purtymun and Kennedy 1970, 04798). High-discharge rates can transport large masses of both suspended and bed sediments for long distances down the canyons. Spring snowmelt runoff occurs over several weeks to several months at a low discharge rate.

Surface flow in Pueblo Canyon is perennial in the form of effluent from the Los Alamos townsite. Runoff from heavy thunderstorms or heavy snowmelt reaches the Rio Grande several times a year. Large-scale flooding is not common in New Mexico. However, flash floods from heavy thunderstorms are possible in susceptible areas, such as arroyos and canyons. Although severe flooding has never been observed in Los Alamos, flooding from a heavy thunderstorm could occur in canyons or low spots (Bowen 1990, 06899). Drainages from the watersheds above Los Alamos, burned by the Cerro Grande fire of May 2000, are at extreme risk of flash flooding, under even normal rainfall patterns. Most of the Laboratory TAs, including TA-21, are located on top of the finger mesas near drainage divides in areas that are not subject to flooding.

MDA B is located on DP Mesa at an elevation of approximately 2192 m (7190 ft). There are no streams on DP Mesa; storm water and snowmelt generally run off the mesa as sheet flow and in small drainages off the mesa sides into DP Canyon to the north and Los Alamos Canyon to the south. Contour lines run in an east-west direction, and the slope is gradual. The contour lines north and south of MDA B are 2188 m (7180 ft), which means that MDA B is slightly higher than its surroundings.

Surface water has the potential to erode the cover from, infiltrate into, or destabilize MDA B. Evaporation, transpiration, and infiltration generally deplete surface flow in the upper reaches of the canyons of the Pajarito Plateau before it can flow across the Laboratory and the NES. Some storm or snowmelt events could provide sufficient runoff for short periods (days or weeks) to initiate flow across MDA B (Devaurs and Purtymun 1985, 07415; Purtymun and Kennedy 1970, 04798). The potential for surface water runoff to impact MDA B is considered to be low or moderate (LANL 2004, 87651), depending upon site conditions and cover thickness.

1.5.4.2 Groundwater

Groundwater in the Laboratory area occurs in shallow alluvial systems in canyons; in perched zones beneath some canyons and along the Jemez Mountains within the Bandelier Tuff, the Cerros del Rio Basalt, and the upper part of the Puye Formation; and in the regional aquifer. The regional aquifer is the only groundwater source that can serve as a municipal and industrial water supply. Eighteen deep aquifer wells, located in Otowi and Guaje Canyons and on the Pajarito Plateau, supply water to the Laboratory and the townsite of Los Alamos (inclusive of the White Rock community). The average saturated thickness of the aquifer penetrated by the Pajarito Field wells is 550 m (1800 ft). Regional aquifer waters date to a few thousand years to more than 40,000 years, with the most recent waters in the western portions of the aquifer and the oldest in portions to the east.

The principal recharge to the main aquifer is from the intermountain basin of the Valles Caldera in the Jemez Mountains west of Los Alamos. The integrity of the aquifer results from its confinement below ground; compromise from flooding, earthquakes, or volcanic eruption is unlikely. Water in the aquifer moves from the major recharge area east toward the Rio Grande, where the water discharges as seeps and springs in White Rock Canyon (Purtymun et al. 1980, 06048). The Rio Grande is the principal groundwater discharge for the regional aquifer, with annual discharge to an 18-km (11-mi) reach of the Rio Grande in White Rock Canyon of about 6.8 million m^3 (5500 acre-ft) (LANL 1995, 50276).

The aquifer extends to the south into Bandelier National Monument, where water movement trends more southerly than easterly. North of Frijoles Canyon, the aquifer surface is slightly above river level; south of the canyon, the aquifer surface is below river level (Purtymun et al. 1980, 06048).

Depth to groundwater on DP Mesa is approximately 350 m (1150 ft) beneath the mesa top.

1.6 Description of MDA B

MDA B was a radioactive and chemical waste-disposal facility from approximately 1944 to 1948; currently the site is inactive. MDA B was the first common disposal area for radioactive waste generated at the Laboratory. MDA B is comprised of ten (10) discrete pits or trenches where chemical and radioactive waste materials were buried. The overall length of the MDA waste disposal areas is approximately 594 meters (1,950 feet) and an overall width that ranges between 22 m (75 feet) and 91 m (300 feet). The cover at MDA B consists of asphalt and soil overburden. The estimated asphalt coverage is 0.1 to 0.15 m (4 to 6 in.) over approximately 75% of the site. Estimated soil overburden is 0.15 m (6 in.) in the asphalted area. The Laboratory resurfaced the unpaved portion of MDA B with a variety of cover systems during a pilot study in the early 1980s. The total cover thickness on this portion of MDA B is approximately 2 m (6.5 ft).

Inventory at MDA B exists in trenches and pits separated by undisturbed bedrock and covered with fill and/or asphalt, as previously described. Interstitial fill material may be present in some areas.
Figure 1.6-1 shows the location of MDA B relative to DP Road and area businesses.

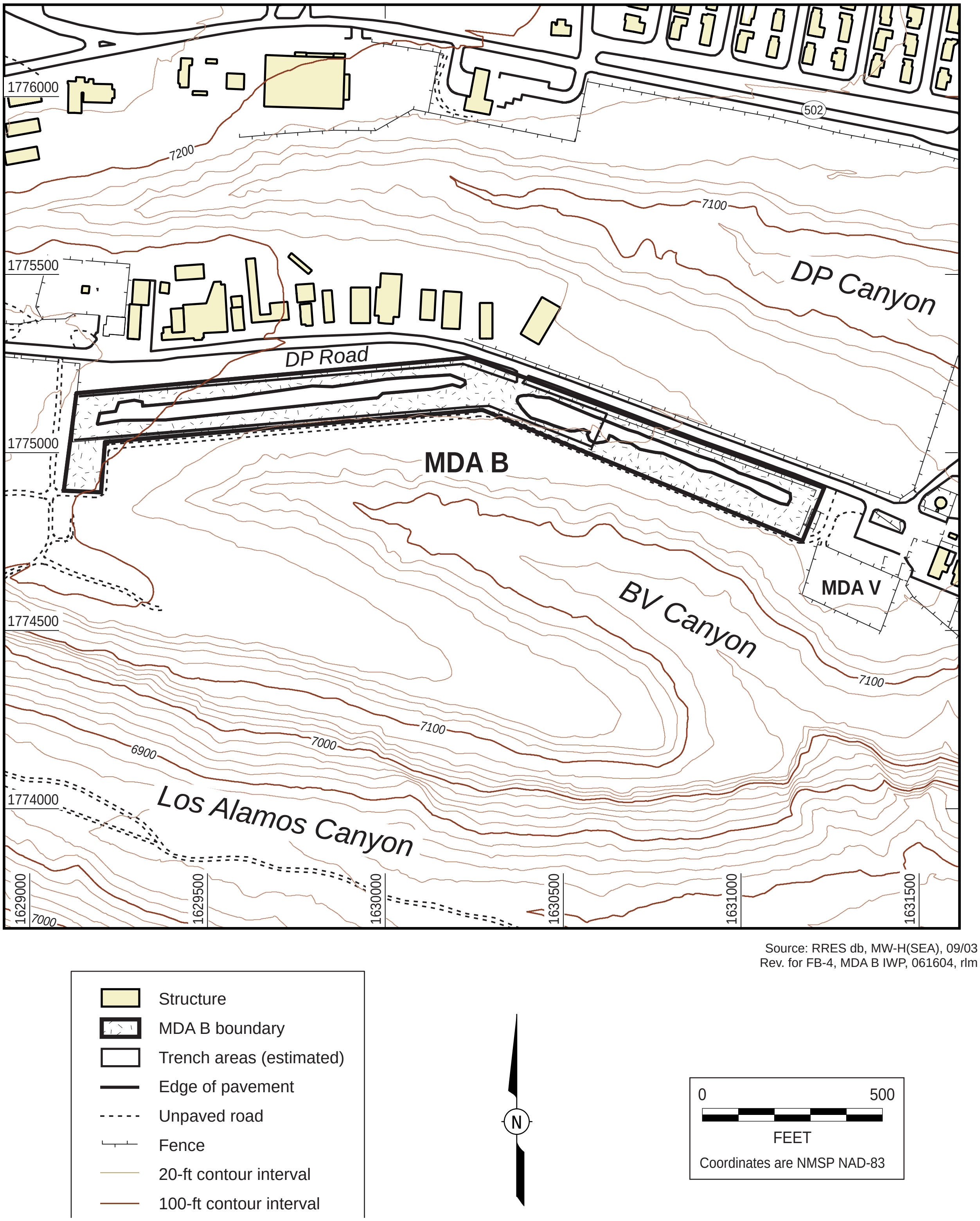


Figure 1.6-1. MDA B location

1.6.1 Operational History

Understanding the context of historical operations at MDA B (known in the 1940s as the "contaminated dump") is essential for establishing a framework for the analysis of hazards associated with the excavation and removal of the waste contents. A partial foundation for the history of MDA B is provided in the 1977 Los Alamos Scientific Laboratory (LASL) informational report "History and Environmental Setting of LASL Near-Surface Land Disposal Facilities for Radioactive Wastes (Areas A, B, C, D, E, F G, and T)" by Margaret Anne Rogers (LASL 1977, 05707; LASL 1977, 05708). This informational report focused primarily on the history of MDA B with respect to location, physical design, modes of disposal, general waste types, and significant events (e.g., fires and results of post-closure studies). The "Investigation Work Plan for Material Disposal Area B at Technical Area 21, Solid Waste Management Unit 21-015" (LANL 2004, 87290) provided a historical investigation report for MDA B that summarized what was initially known about the operational history and the results of environmental sampling. An extensive literature review of historical documentation has subsequently been conducted to establish a more detailed profile of historical operations at MDA B and the process operations that MDA B supported.

MDA B was actively used for the disposal of radioactively contaminated wastes between April 1944 and June 1948:

- MDA B was apparently opened about April 1944. In 1945, pits at MDA A were reportedly filled at such a rate that additional waste disposal pits were necessary. MDA B was a favorable location because sufficient space was available. In April 1945, an 80-ft by 150-ft trench existed at what is now known as MDA B, which was used to dump boxes of contaminated items (Tribby 1945, 33817). A memorandum by Kershaw (1945, 01770) reported overfilling of the activated refuse material pit that had been provided on South Point, just southeast of the coal storage piles, about a year before. In July 1945, it was suggested that a trench 15 ft wide by 300 ft long be bulldozed as deep as practical before hard rock was encountered, starting just east of the newly covered Chemistry and Metallurgy (CM) Division disposal pits located southeast of the coal storage yard, and running parallel to, and about 40 ft to 50 ft north, of the DP power line. This trench once had a parking bumper along its northern edge with a graveled 20-ft clearing for truck access, and of course a fence surrounding the whole area (Dow 1945, 00525). It was further suggested that the excavation of this waste pit was to be continued until a depth of 12 ft was reached or until September 1, 1945, whichever came sooner (LASL 1977, 05707; LASL 1977, 05708).
- Other memoranda indicated additional pits. In 1952, Meyer (36622) noted that letters in the CMR-12 Group's file, in what after September 1945 had become the Chemistry and Metallurgy Research (CMR) Division, indicated that sometime in 1944 a pit was in use that was located in the fenced area between the Trailer Court (former coal storage yard) and the "CMR laundry." When this pit was filled, two more were dug in the area then known as the General's Tank area (now known as MDA A). When these were filled in 1945, three more pits were dug in the area between the trailer court and CMR laundry and that space was exhausted by 1948. Personal testimony and reference to common Laboratory practice at the time suggested that four disposal pits 300 ft long, 15 ft wide, and 12 ft deep were located parallel to the fence line along DP Road and that two pits of uncertain length were located in the north-south leg of MDA B at the site's western end (LASL 1977, 05707; LASL 1977, 05708).
- Rogers (LASL 1977, 05707; LASL 1977, 05708) also noted that several other sources indicated that additional trenches for chemical disposal were located at the easternmost part of MDA B. A 1964 memorandum apparently stated that a covered shallow trench 2 ft wide by 40 ft long by 3 ft deep was located at the extreme eastern end of MDA B. Another source indicated that several small slit trenches, 3 ft to 4 ft deep, 2 ft wide, and less than 40 ft long, had been reportedly dug in this area for chemical disposal.

- Two separate fires occurred at MDA B while it was being used as a landfill. The first fire occurred in November 1946, the second one in May of 1948. Both fires were interpreted to be the result of chemically induced spontaneous combustion within the landfill matrix. Documented observations of the fires indicated that conditions were "conducive" to spontaneous combustion and brought into question waste disposal practices.
- As a result of the May 1948 fire, another contaminated disposal site was selected on Pajarito Road, now known as MDA C, and operations started there on June 10, 1948 (LASL 1977, 05705; LASL 1977, 05708).

Rogers (LASL 1977, 05707; LASL 1977, 05708) indicates wastes were emplaced by the truckload in piles filling the entire trench depth and width rather than in vertical layers. Using a bulldozer, workers subsequently covered the material weekly with fill dirt. No effort was reportedly made to keep routine waste types or loads separate (Meyer 1952, 36622). The U.S. Army Manhattan Engineering District (MED) controlled operations at Los Alamos until the formation of the Atomic Energy Commission (AEC) in January 1947. The large, rectangular pits on the western end were filled and covered during the MED's control of the Laboratory, and the irregular pits on the eastern end were filled and covered after January 1947. The chemical pits on the far eastern end are now interpreted to have resulted from focused burials of residual plutonium recovery solutions, possibly in 1948 and possibly later in the early 1950s.

No specific MDA B disposal records have been found. Additional classified documents and reports from the operating groups were reviewed for this report and provide insights into the processes that generated radiologically contaminated equipment and materials from key operational sites. Based on this evidence, this historical context is presented with the assertion that the current inventory within MDA B reflects a period in the history of the Laboratory when operations were driven by scientific research, bench-scale operations, and the start-up and refinement of plutonium and uranium production operations. The need to conserve and recover all radioactive materials is demonstrated to be the central theme in this period of Laboratory operations.

During the period 1945 to 1948, several operational and experimental sites throughout the Laboratory were the sole contributors to the waste inventory that is currently located at MDA B. These historic operational and experimental sites included

- D Building and the original technical area (then informally referred to as the "Tech Area," now known as TA-01),
- DP Site,
- the "contaminated laundry" facility,
- Bayo Canyon (radioactive lanthanum [RaLa] program),
- Omega Site (the "water boiler"), and
- other technical areas of the Laboratory (S Site, Anchor Ranch, and Sandia Site).

The vast majority of information about the potential inventory of MDA B comes from reports and memoranda generated by historic Laboratory organizations working at these sites. These sources provide evidence that the management of materials disposed of at MDA B was largely the responsibility of the waste-generation sites. The only site-specific documentation consisted of waste pick-up log books that started in 1947. The notebooks were to record the trips each day, including the buildings served, types of materials such as trash, solutions, chemicals, and property, as well as the drivers' names, their protective clothing, and their radiation exposure data. The log books were issued to the drivers of what was then referred to as the "contaminated truck" (this was the truck that hauled contaminated trash). Los Alamos Scientific Laboratory Notebook No. 1743 (LASL 1948) was maintained from January 1947 through

November 1948, the period that includes the last part of the MDA B operations. The log book provides strong support for the assumption that the operations of these sites and associated waste streams define the current waste inventory within MDA B.

The historic record of the operational processes clearly documents the following aspects of waste disposal at MDA B:

- No high explosives or high-explosive residues were buried at MDA B but were entirely confined to Anchor Ranch and S Site.
- Obsolete wooden laboratory furniture and other demolition debris from contaminated areas were released for disposal after wipe-down.
- Reusable laboratory apparatus and equipment required decontamination before returning them to stockroom or other laboratory areas.
- Materials that did not meet tolerance limits after decontamination were disposed.
- Uranium and plutonium purification and reduction solutions, equipment, and materials were required to be returned to recovery processes.
- Uranium and plutonium recovery solutions had criteria for retrievable storage or disposal.
- The large volume of basic plutonium recovery residues was placed in storage in the General's Tanks.
- By 1947, laboratories had established waste disposal procedures that required laboratory and salvage wastes to be boxed, sealed, wrapped with paper or placed in wooden crates, and tagged to indicate waste status.

Although the Laboratory did not maintain formal waste inventory records, process knowledge is provided by the historical documents and memoranda that suggest that the vast majority of waste was primarily radioactively contaminated, routine laboratory waste, including contaminated glassware and obsolete equipment, demolition debris, building materials, clothing, glassware, paper, trash, and minor chemicals from the laboratory areas. Property items required release from the property office, but no property records have been located to date.

The large volumes of basic solutions from the recovery processes were stored in the General's Tanks. These two, 50,000-gal., underground tanks were constructed by General Leslie Groves in late 1945 to store basic recovery residues from plutonium operations at DP West. The residues contained small concentrations (<1 mg/L) that were considered too great to discard without further investigation. Other solutions from the plutonium and americium recovery operations were reportedly stored in large glass bottles in DP West. Investigations and recovery of the residual plutonium solutions, including the basic solutions in the tanks, and other stored residues continued into the early 1950s. Some of the bottles of stored solutions are believed to have been placed in at least one chemical disposal trench at the eastern end of MDA B. By analogy with known operations, the concentrations of plutonium in the bottles would be approximately 1 mg/L of plutonium, a concentration considered too precious to discard at the time, or too concentrated to release to the environment. The concentrations of americium in these solutions would have been much less than 1 mg/L, as the processes for separation and purification of americium were in the early stages. The total number and type of bottles buried is unknown, but probably included bottles of 4-L, 9-L, or 20-L capacity, as these were common at the time. The volume of residues stored in the large glass bottles was relatively small, probably a few hundred gallons, by comparison with the thousands of gallons of basic solutions stored in the General's Tanks. Because the routine wastes sent to the dump consisted of radiologically contaminated materials and trash from the laboratory areas, the residual recovery residues probably contain the largest fraction of the radiological inventory of plutonium at MDA B.

Residual chemicals may include cleaning solutions and strong oxidizers, such as acids and possibly anhydrous hydrogen fluoride, although no evidence exists that hydrogen fluoride tanks were disposed of in the contaminated dump. Other documented wastes that did not pass decontamination requirements included empty gas cylinders that typically would have been used to store oxygen, neon, helium, argon, and nickel carbonyl.

1.6.1.1 Post-Closure

The western two-thirds of MDA B was fenced and compacted in 1966 and leased by DOE to Los Alamos County for trailer storage. The former location of the storage area is indicated by the paved area. Los Alamos County was asked to vacate use of this site as a trailer storage area by September 30, 1990.

Surface stabilization of the eastern end of MDA B began on July 6, 1982, and was completed by October 15, 1982. The fence was moved outward by 10 ft, surfaces were decontaminated, vegetation was removed, and the area was covered with soil, compacted, and reseeded. Capping studies were initiated on the eastern end of MDA B in 1987 to evaluate alternative cover designs.

Some post-closure subsidence has been observed at MDA B. The subsidence is consistent with what is observed at legacy landfill sites that included previously boxed wastes. During a small mammal field investigation in the early 1980s, a member of one of the Laboratory’s environmental studies groups (H-6) fell through the surface and into a hollow area of MDA B in the eastern portion of the landfill. During the very brief time the individual was in the bottom of the collapsed area, he observed multiple stacks of 2- to 5-gal. glass bottles containing liquids. The containers were stacked 2 ft to 3 ft high on a pallet, with an open area between pallets approximately 2 ft wide, 6 ft long, and 5 ft deep assumed to be created by either subsidence or arching of the cap material, but the open area could have originally been an aisle between the pallets. The employee was not injured, climbed out of the hole unassisted, and was monitored by a radiological control technician before leaving the area. No contamination was detected on the person or his clothing. The hole was carefully backfilled and regraded.

1.6.2 Current Condition

MDA B can be divided into the following three main areas:

- The small soil-covered, unpaved area at the extreme western end of MDA B (approximately 32 m/105 ft by 46 m/150 ft)
- The large asphalt-paved area occupying the long western leg and the central portion of the site (approximately 457 m/1500 ft long by 37m/120 ft wide)
- The unpaved area occupying the eastern leg of MDA B (approximately 183 m/600 ft long by 46m/150 ft wide)

The three areas currently have no surface structures, and galvanized-steel chainlink fencing encloses the entire site. Vegetation has penetrated through cracks in the asphalt pavement, and trees line a portion of the northern and southern boundary of the site.

The Laboratory has conducted numerous surface and subsurface environmental investigations at and near MDA B beginning in 1966 (LANL 2004, 87290). Early (non-Resource Conservation and Recovery Act [RCRA] facility investigation [RFI]) activities focused on collecting data to support site stabilization efforts at the disposal area. RFIs have focused on defining the nature and extent of contamination migration outside of the disposal trench areas following the cessation of waste disposal and the subsequent installation of both asphalt and soil covers over the disposal area. The Laboratory conducted the most recent investigation in 2001. Review of data from the field investigations of MDA B indicates the data were of sufficient quality and quantity to support the following statements:

- Some radionuclides and metals are present at concentrations greater than background values in surface soils along the perimeter of the site in areas not covered by asphalt or the 1982 cover.
- Investigators detected volatile organic compounds (VOCs) in the subsurface soil pore gas in the seven angled boreholes drilled beneath the disposal area in 1998.
- Tritium, plutonium-239, uranium, and lead are present at concentrations above background values in three of the seven boreholes drilled beneath the disposal area in 1998.
  Note*:* Tritium concentrations are mesa-wide and are the result of atmospheric releases from DP East.
- Investigators detected other inorganic compounds above background values.
- The average moisture content in soils beneath the asphalt (10.6 wt%) is elevated compared with the surrounding surface soils (5.1 wt%) and subsurface materials (5.6 wt%).
- Investigators detected elevated radionuclides, organic chemicals, and inorganic chemicals in some surface soil samples.

Surface releases appear to be related to past disposal operations that distributed primarily isotopic plutonium to the surface soils along the perimeter of MDA B. The cessation of disposal operations and the placement of an interim cover of soil and asphalt have prevented additional releases. Current soil contamination is available for additional migration by wind entrainment and surface water runoff.

A subsurface release to tuff of low concentrations of contaminants is limited in extent. The primary subsurface contaminants are tritium (as noted above) and VOCs in the vapor phase. Additionally, some limited aqueous phase releases occurred based on borehole detections of isotopic-plutonium. However, the vertical extent of these releases is very limited, indicating that this release mechanism is minor and not active and that the distribution of contamination was the result of disposal practices, which may have included liquid disposal. The sources of subsurface contamination appear to be limited to past disposal practices at the trenches, diffusion of vapor-phase tritium from a DP East atmospheric release, and VOCs in low concentration from the disposed waste.

In workshops conducted during 2004, as documented in the “Preliminary Documented Safety Analysis Package for Material Disposal Area B” (LANL 2004b), subject matter experts (SMEs) divided MDA B into 10 sections (or cells) for investigation. Figure 1.6-2 shows the locations of those 10 sections.

The 1998 TA-21 MDA B geophysical survey locations map (Plot ID: G107140), estimated trench depths, and historical aerial photos were used to estimate the waste volume in each of the 10 sections. Table 1.6-1 provides the results of the waste estimates.

Table 1.6-1
Estimated Waste Volume by Section at MDA B

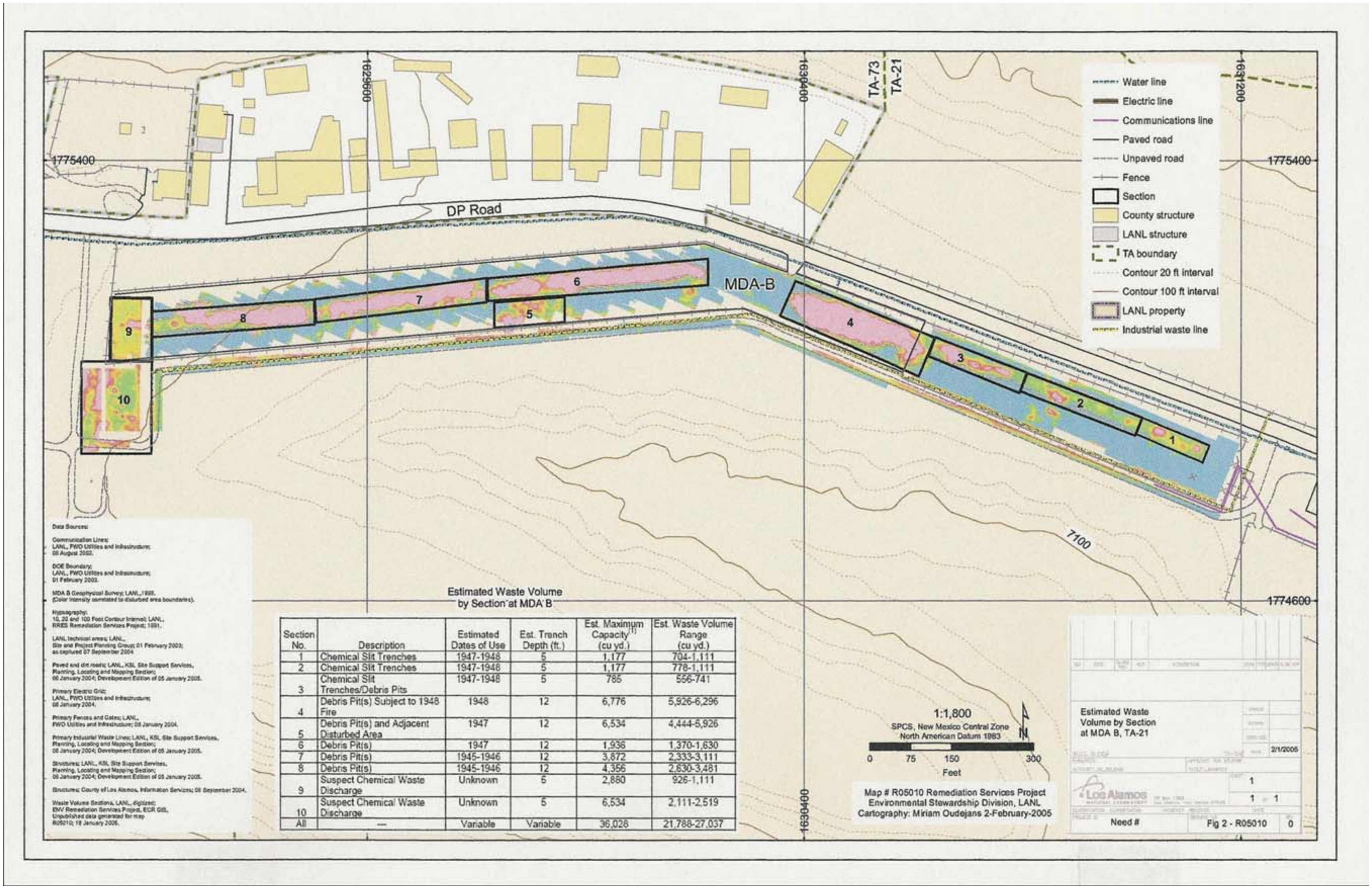
Section	Description	Estimated Dates of Use	Estimated Trench Depth (ft)	Estimated Maximum Capacity[a] (yd^3)	Estimated Waste Volume Range (yd^3)
1	Chemical slit trenches	1947–1948	5	1177	704–1111
2	Chemical slit trenches	1947–1948	5	1177	778–1111
3	Chemical slit trenches/debris pits	1947–1948	5	785	556–741
4	Debris pit(s) subject to 1948 fire	1948	12	6776	5926–6296
5	Debris pit(s) and adjacent disturbed area	1947	12	6534	4444–5926
6	Debris pit(s)	1947	12	1936	1370–1630
7	Debris pit(s)	1945–1946	12	3872	2333–3111
8	Debris pit(s)	1945–1946	12	4356	2630–3481
9	Suspect chemical waste discharge	unknown	5	2880	926–1111
10	Suspect chemical waste discharge	unknown	5	6534	2111–2519

[a] Maximum volume is estimated from the boundaries of geophysical disturbance and projected depth of disposal trenches in section. Additional waste volume could be encountered in adjacent side walls and in underlying tuff.

1.6.2.1 Summary of Inventory Characterization

As previously described, historical evidence indicates that the principal radioactive contaminants consist of the types of radioactive materials used at the time: plutonium, polonium, uranium, americium, curium, radioactive lanthanum, actinium, and waste products from the water boiler reactor (Meyer 1952, 36622). Approximately 90% of the waste consisted of radioactively contaminated paper, rags, rubber gloves, glassware, and small metal apparatuses placed in cardboard boxes by the waste originator and sealed with masking tape. The remainder of the material consisted of metal, including air ducts and large metal apparatuses. The latter type of material is in wood boxes or wrapped with paper (Meyer 1952, 36622). Historical evidence also indicates that bottled liquid recovery residues are present. At least one truck, contaminated with fission products from the Trinity test, is believed to be buried in MDA B (DOE 1986, 08657).

Prior to the addition of cover material over the eastern portion of the site in 1982, the Laboratory conducted a biota-sampling project at MDA B (Wenzel et. al. 1987, 58214). This project included the removal of some trees and shrubs and their roots. Investigators found exposed contaminated debris beneath a ponderosa pine tree, and an investigation of the tree roots confirmed that the roots were in contact with contaminated debris. Debris included electrical conduit, copper and electrical wires, a mass of rubber gloves, Duroglass bottles still filled with liquid, rubber tubing, plaster, and metal tubing that had been painted. Investigators did not find cardboard or wood materials in the area beneath the tree probably due to the decay of cardboard and wood and consumption by soil arthropods. There was also indication that some waste material was dumped in the trench without previous packaging. Investigators sampled for and identified scandium, cesium-137, uranium, and plutonium-239/240 in the tree, shrub, and soil samples.



Section No.	Description	Estimated Dates of Use	Est. Trench Depth (ft.)	Est. Maximum Capacity[1] (cu yd.)	Est. Waste Volume Range (cu yd.)
1	Chemical Slit Trenches	1947-1948	5	1,177	704-1,111
2	Chemical Slit Trenches	1947-1948	5	1,177	778-1,111
3	Chemical Slit Trenches/Debris Pits	1947-1948	5	785	556-741
4	Debris Pit(s) Subject to 1948 Fire	1948	12	6,776	5,926-6,296
5	Debris Pit(s) and Adjacent Disturbed Area	1947	12	6,534	4,444-5,926
6	Debris Pit(s)	1947	12	1,936	1,370-1,630
7	Debris Pit(s)	1945-1946	12	3,872	2,333-3,111
8	Debris Pit(s)	1945-1946	12	4,356	2,630-3,481
9	Suspect Chemical Waste Discharge	Unknown	5	2,880	926-1,111
10	Suspect Chemical Waste Discharge	Unknown	5	6,534	2,111-2,519
All	—	Variable	Variable	36,028	21,788-27,037

Figure 1.6-2. MDA B investigative sections/cells

There are some indications that hazardous chemicals may be present at MDA B. Drager (1948, 00552), commenting on the 1948 fire, reported there was some evidence chemicals had been disposed of in the dump in an unauthorized manner (i.e., in cardboard containers used for the regular disposal of common laboratory waste). In the fire, several cartons of waste caused minor explosions, and on one occasion, a cloud of pink gas arose from the debris in the dump. Documented employee interviews (DOE 1986, 08657) stated chemical disposal occurred at the eastern end of MDA B. Chemicals disposed of included old bottles of organic chemicals, including perchlorate, ethers, and solvents. The 1986 DOE document also stated lecture bottles, mixtures of spent chemicals, old chemicals, and corrosive gases may be at the eastern end of MDA B (DOE 1986, 08657).

SMEs estimate the following waste types make up the waste volume at MDA B:

- Industrial waste—debris, clean soil, asphalt, and recycle material
- Low-level radioactive waste (LLW)—soil, debris, and radioactively contaminated asbestos
- Mixed low-level radioactive waste (MLLW)—soil, liquids, and debris
- Hazardous waste/RCRA waste—soil, acid carboys, lab packs, lecture bottles, debris, repackaged liquids, gas cylinders, and shock-sensitive containers
- Toxic Substances Control Act (TSCA) waste—asbestos-containing material and polychlorinated biphenyls (PCBs)

Initial categorization of MDA B used the inventory reported in a 1971 memorandum from Meyer (Meyer 1971, 00557). According to the Meyer inventory, the maximum plutonium-239 inventory in MDA B is 100 g: ”At the time they were in use, Pu was scarce and only that which was present as contamination was buried. I would estimate that the entire pit area contains no more than 100 grams of ^{239}Pu.”

According to “Initial Categorization of Environmental Sites” (LANL 2003, 90176), very little sampling data exists to describe the radioactive material content buried in MDA B. Categorization of MDA B was based on some surface and shallow-depth sampling data from areas adjacent to MDA B for strontium-90, cesium-134, thorium-228, and plutonium-239, and on the bounding plutonium-239 quantity referred to in the Meyer memo. Table 1.6-2 presents the radionuclide inventory estimates for MDA B.

Recently identified historical evidence, as discussed in section 1.6.1, indicates that the 100 g of plutonium-239 estimated by Meyer, and used for the purposes of initial categorization, is a conservative number.

Table 1.6-2
MDA B Inventory

Radionuclide	Inventory (Ci)	Inventory (g)
strontium-90	2.85E-01	2.09E-03
cesium-134	5.49E-03	4.26E-06
thorium-228	1.82E-01	2.22E-04
plutonium-239	6.22E+00	1.00E+02

1.7 Features Near MDA B

In addition to the general site characteristics of the Laboratory, this DSA considers several specific site characteristics relative to safety and inventory isolation at MDA B. These characteristics include facilities and potential energy sources, the proximity of MDA B to utilities and roads, and vegetation relative to fuel loading. The following subsections discuss these characteristics of MDA B.

1.7.1 Energy Sources and Facilities with Proximity to MDA B

A natural gas line (46 m/150 ft east); a 100,000-gal. water tower; and overhead electric power lines are located in the vicinity of MDA B. Vehicular traffic and buried county utilities are also nearby. Commercial businesses are located north of DP Road, directly opposite the center and western sections of MDA B. This DSA addresses other energy sources associated with RCR activities with the description of those activities in section 2 and with the hazard analysis in section 3.

1.7.2 Proximity to Roads and Utilities

MDA B lies along DP Road, which is a public road. There is a natural gas line along the western half of the site to north of DP Road. A sewer line runs northwest and north of DP Road. An abandoned underground radioactive liquid waste line, which served other LANL facilities, runs along the southern boundary of the site outside the fence line. A Los Alamos County sanitary sewer lift station is outside the fence near the southeastern corner of the site. Buried water and communications lines are located under the area between the north fence and DP Road. A water hydrant is located inside the northwestern corner of the fence and an air-monitoring station is located on the outside of the east fence. This DSA does not consider the radioactive liquid waste line and utilities as part of MDA B. Overhead electric power lines run along the eastern and western ends of MDA B.

1.7.3 Vegetation

The Laboratory site and surrounding areas are generally forested and have high fuel loadings. MDA B borders forested areas containing indigenous evergreen trees and wild vegetation. To the south, Los Alamos Canyon separates MDA B from large forested areas with high fuel loadings. A thinly forested canyon to the north separates State Highway 502 from MDA B. The urban Los Alamos townsite separates MDA B from the Jemez Mountains to the west. Native vegetation covers, and is immediately adjacent to, MDA B.

2.0 SITE LAYOUT AND ACTIVITIES

2.1 Introduction

This section describes the MDA B site and the broad set of MDA B RCR activities included within the scope of this DSA and required to achieve the following objectives:

- Removal of buried waste from MDA B
- Management of resulting waste
- Characterization of the remaining soil and bedrock (tuff) to determine the nature and extent of any residual contamination
- Characterization of any potential remaining human health or ecological risk associated with the site
- Assessment of the need for future corrective action

The descriptions contained in this section are part of the basis for analyzing hazards and, along with other information presented in this DSA, provide sufficient detail for developing the appropriate type, level, and number of controls.

2.2 Site Layout

The MDA B site includes an excavation area, exterior staging areas, and an equipment decontamination area. There are additional support facilities (e.g., offices, lunchroom, etc.) located outside of the MDA B site boundary/fence line.

2.2.1 MDA B Site

Excavation and initial material screening, classification, stabilization, and packaging take place within the site boundary/fence line. To accommodate RCR activities, the original site boundary/fence line of MDA B is extended to within approximately 6 m (20 ft) of DP Road to the north; approximately 12 m to 21 m (40 ft to 70 ft) to the south, as the site topography permits; and approximately 91 m (300 ft) to the west. The additional 91 m (300 ft) located on the western end of MDA B is used for staging procured clean fill material and as a buffer area. Additionally, the eastern fence line is extended.

2.2.2 Excavation and Exterior Staging Areas

Excavation and exterior staging areas are located within the boundary of MDA B and delineate where the specific activities associated with excavation and staging can occur. The excavation area limits the total area within which excavation and removal activities can occur and the exterior staging areas delineate the location for stockpiled uncontaminated overburden and layback material. Material is staged pending receipt of laboratory sample analyses necessary to demonstrate compliance with the applicable regulations for reuse as fill material or transportation off-site. The exact location of the exterior staging area at any given time is determined based on the location of the excavation area.

The exterior staging areas may be lined and bermed in areas for staging of uncontaminated overburden and layback material. Exterior staging areas where waste packages are staged awaiting transport to an off-site location may also include a gravel bed.

2.3 Description of Activities

The RCR of MDA B includes

- mobilization;

- preliminary surface characterization and surveys;
- comprehensive excavation operations;
- closure and stabilization of the site;
- demobilization; and
- surveillance and maintenance.

2.3.1 Mobilization

Mobilization is the start of fieldwork at MDA B. Mobilization prepares the site for RCR activities and includes

- clearing and grubbing of vegetative material, debris, and obstructions;
- installation of new fencing and removal of old fencing;
- preparation of equipment and material staging areas;
- modification of existing haul and access roads;
- construction of a decontamination area;
- installation of administrative facilities;
- installation of run-on diversion structures to minimize storm water impacts to the site and prevent migration of site contaminants;
- completion of pre-fieldwork surveys, including land surveys, radiological surveys, and biological surveys;
- collection of supplemental background samples for comparison of underlying tuff contaminant concentrations;
- installation of area and perimeter monitoring systems, alarms, and communication equipment; and
- execution of mockup drills and emergency response drills with MDA B site personnel.

Site preparation will be performed as necessary to support operations including an setup of the excavation and the exterior staging areas. The surface area associated with each waste cell will be cleared prior to excavation to support surveys, monitoring, and sampling as necessary. The area above and around each waste cell is cleared of shrubs, vegetation, and debris. A staging/buffer area on the western end of MDA B, and the exterior staging areas, may also require some clearing. Equipment may include miscellaneous hand tools and cutters, chain saws, tractors with fixed or adjustable cutting attachments, weed-line or blade trimmers, push mowers, tractors with fixed or adjustable (hydraulic) mower decks, and trucks and transport vehicles, including cherry picker hydraulic lifts, graders, front-end loaders, or bobcats. Installation of fences, gates, and roads will be performed as necessary to support operations

2.3.1.1 Preliminary Surface Characterization and Surveys

Preliminary surface characterization may include soil sampling, biota sampling, and vapor sampling. Preliminary surveys may include general surveying, radiological surveys, geophysical surveys, and geologic mapping. Preliminary surface characterization and surveys are used to verify/further delineate the geophysical boundaries of the waste cells.

2.3.2 Comprehensive Excavation Operations

Comprehensive excavation operations involve the removal of waste materials from MDA B cells 1 through 10 (as identified in Figure 1.6-2), side walls, and underlying tuff to a minimum depth of 3.7 m (12 ft) below grade, as necessary. Comprehensive excavation operations are estimated to include the removal of approximately 18,350 m^3 (24,000 yd^3) of material, including waste cell contents and adjacent contaminated materials. Material removed from MDA B sections is characterized and prepared for off-site disposal. Uncontaminated overburden and layback material may be staged for reuse as fill material. Personnel will remove, store, sample, and process for disposal any water present in the excavation because of run-on or infiltration. Verification-sampling program on exposed base and wall surfaces is implemented as necessary.

2.3.2.1 Excavation of Waste Cells

Locations of waste cells are identified based on geophysical characteristics and are shown in Figure 1.6-2. Prior to waste cell excavation, a wet saw or other similar tool is used for scoring asphalt. As excavation proceeds, waste material and debris can be placed/staged for radiological and chemical monitoring and analyses. A front-end loader handles material removed from the excavation and may assist in excavation operations. Site personnel perform additional surveys on the material to determine a material classification. Once personnel initially classify the material, the waste material is containerized as appropriate for movement to support operations areas. Following excavation operations, project personnel backfill and compact the excavation to original grade with clean fill material. Other vehicles/equipment used to transport material may include a forklift, pickup truck, dump truck, flatbed trucks, and small four- or six-wheeled vehicles.

2.3.2.2 Material Screening and Classification

The excavation equipment operator performs an initial survey of newly exposed material (dig face) for high radiation or other hazardous conditions using instruments mounted on the excavator bucket or arm. Various screening tools are used to monitor for radiological and chemical constituents and identify physical attributes. The heat of waste cell contents is regularly monitored using a handheld infrared thermometer.

Representative samples of excavated overburden and layback material (i.e., material that does not come from the waste cells but has been excavated only to facilitate the safe removal of the waste cell contents) are collected to make an initial determination about whether the material must be handled as waste. The samples are analyzed for target analyte list (TAL) metals, semivolatile organic compounds (SVOCs), VOCs, and alpha- and gamma-emitting radionuclides. Material that is initially determined to be uncontaminated is stockpiled in an exterior staging area for use as backfill. If the results of this initial screening on overburden and layback material indicate either inorganic or radionuclide constituents above background or detected organic chemicals, the material is handled as waste and containerized prior to moving it to an exterior staging area.

Waste and chemicals in containers may be moved to a support operations area within the excavation site where they are staged, opened, and tested. Types of equipment/methods that personnel may use for material screening and classification purposes include sodium iodide detectors, neutron dose rate meters, a hazard characterization (HazCat) kit, Product Acoustic Signature System (PASS) liquid identifications, a photoionization detector (PID), a flame ionization detector (FID), magnetometer, combustible gas indicators, Micro R meter, ion chambers, ion mobility spectrometer, colorimetric test kit/swipes, x-ray fluorescence (XRF), thermal neutron detector, multi-gas meter, scaler/rate meter, NaI(Ti) detector, Geiger-Mueller (GM) pancake, Field Instrument for Detecting Low Energy Radiation (FIDLER), Drager and Sensidyne tubes, pH paper/litmus, HAPSITE monitor, alpha detector, gamma spectrometry, liquid scintillation counter, and smears.

Laboratory personnel attempt to provide definitive identification of material removed from the excavation with these additional analyses. Personnel also collect laboratory analytical samples. Material that personnel cannot identify using these screening and classification methods will be transported off-site for additional characterization.

2.3.2.3 Material Packaging

Laboratory personnel segregate material based on initial screening and classification of the material at the excavation. Segregated material may be containerized in drums, boxes, roll-off bins, or other appropriate containers. Size reduction of debris (i.e., compaction) may be performed if appropriate.

2.3.3 Closure and Stabilization of the Site

Following excavation, the Laboratory will provide for the placement of topsoil/native seed mix at MDA B to stabilize the site. The Laboratory will provide additional barriers, roads, and paths, as determined necessary. Laboratory personnel will install drainage controls, as necessary, to prevent, retard, or contain soil and sediment erosion. Site restoration will include raking and recontouring of disturbed areas, mulching, and reseeding with approved mixtures of seed to stabilize disturbed areas.

2.3.4 Demobilization

Demobilization will occur following excavation activities and will include

- confirmation that site perimeter fencing has not been damaged and that all gates are secure and functional;
- decontamination of heavy equipment;
- containment of decontamination fluids and water;
- processing of decontamination and water for unrestricted discharge or hazardous/radioactive disposal;
- removal of temporary facilities and utility hookups that are unlikely to be used in future remediation and redevelopment activities;
- removal of support and heavy equipment not anticipated to be reused within three months.

2.3.4.1 Equipment Decontamination

Equipment involved in excavation, drilling, and other material-removal/handling activities, are handled decontaminated in accordance with specified requirements. Methods may include dry decontamination including the use of wire brushes and scrapers, to remove residual material adhering to equipment. High-pressure sprayer, along with long-handled brushes and rods, can be used to more effectively remove contaminated material from equipment. It is anticipated that decontamination of heavy equipment will occur during demobilization. However, decontamination may occur during excavation if there is a need to remove equipment from the site for repair and maintenance or another reason.

2.3.5 Surveillance and Maintenance

The Laboratory performs S&M of those portions of MDA B that are not involved in immediate excavation activities. Additionally, the Laboratory will perform S&M of MDA B in the event that RCR activities are temporarily suspended.

2.3.5.1 Vegetation Maintenance

MDA B vegetation may require maintenance. This activity involves tasks such as mowing, clearing brush, removing debris, and removing trees. Vegetation maintenance is expected to be ongoing throughout the RCR of MDA B, particularly during mobilization.

2.3.5.2 Erosion Control and Cover Maintenance

Erosion control and cover maintenance includes maintaining the surface and near-surface soil, overburden, and cap layers that isolate the MDA B contents from the near-surface environment. Erosion control and maintenance also may include implementing and maintaining additional erosion controls and water diversions. Cover augmentation or other small repairs in response to erosion or biological actions (e.g., animal burrows) are completed as necessary. Erosion control and cover maintenance may involve light site preparation and addition and compaction of clean fill material.

Erosion controls may include adding fill material, repairing surfaces and replacing soils associated with erosion control devices, placing hay bales or straw as barriers, placing gabions and sand bags, installing or placing silt fences and rip-rap, installing concrete culverts and drainages, or driving posts and anchors for erosion controls.

2.3.5.3 Access Control and Maintenance

Access control and maintenance includes the repair and upkeep of roads, parking and storage areas, and walkways; filling potholes and other areas that require minor repair; and the maintenance of drainages, road barriers, and rights-of-way. Access control and maintenance also include visual inspection, replacement of damaged or poorly visible signage, and repair of fencing and posts.

Removal of snow, mud, and other debris may be necessary to keep access areas clear and can entail the use of graders, front-end loaders, bobcats, or other heavy equipment. Repairing fences and installing signage can involve minor site preparation, such as light scraping and removal of vegetation, and can include digging holes, placing concrete, setting posts, and using a “come along” or other suitable light equipment to stretch fencing materials.

3.0 HAZARD-BARRIER ANALYSIS

3.1 Introduction

This section provides the hazard-barrier analysis for the RCR of MDA B. The hazard-barrier analysis includes the identification of hazards that may be present during MDA B RCR as well as the identification of barriers intended to prevent and/or mitigate those hazards. The hazard-barrier analysis incorporates the following three elements related to safety management:

- Identification of hazards
- Identification and evaluation of barriers to prevent and/or mitigate hazards
- Analysis of actual and potential accident sequences to obtain insights into effective accident prevention

Analysts identified hazards for the RCR of MDA B using the checklist approach. An experience-based checklist was used to identify known types of hazards. Analysts identified and evaluated both preventive and mitigative barriers to ensure the hazards are effectively controlled. Analysts postulated hazard scenarios to ensure that a complete and effective set of barriers was identified.

The barriers described in this section form the control sets that are implemented through the TSRs. For each barrier, analysts established qualitative expectations to guide implementation of the control sets. These expectations form the basis for the development of implementing programs and procedures, which specifically define the acceptance criteria for each of the controls.

Section 3.2 provides the hazardous material/energy sources identified for MDA B RCR. Section 3.3 presents the hazard categorization for MDA B. Section 3.4 describes the barriers identified for MDA B RCR. Analysts postulated and evaluated potential hazard scenarios for those hazards not screened from further consideration. Appendix B presents those hazard scenarios along with the barriers identified for the prevention/mitigation of each scenario in the form of hazard-barrier matrixes.

3.2 Hazard Identification

Analysts used a hazard identification checklist to identify hazards (hazardous materials and energy sources) associated with MDA B RCR. Analysts identified hazards specific to each of the following RCR activities or groups of activities:

- Mobilization, preliminary surface characterization and surveys, restoration, and demobilization (including decontamination)
- Removal of overburden
- Removal of buried waste
- Additional characterization
- Staging of fill material and waste in exterior staging areas

The hazard identification and evaluation tables are organized by these activities/groups of activities, which encompass the activities that will be conducted during MDA B RCR as described in section 2. Figure 3.2-1 presents a flow block diagram, which illustrates the major functional steps associated with each activity/group of activities. The figure is consistent with the activity descriptions provided in section 2 and provides the basis for the identification and evaluation of hazards.

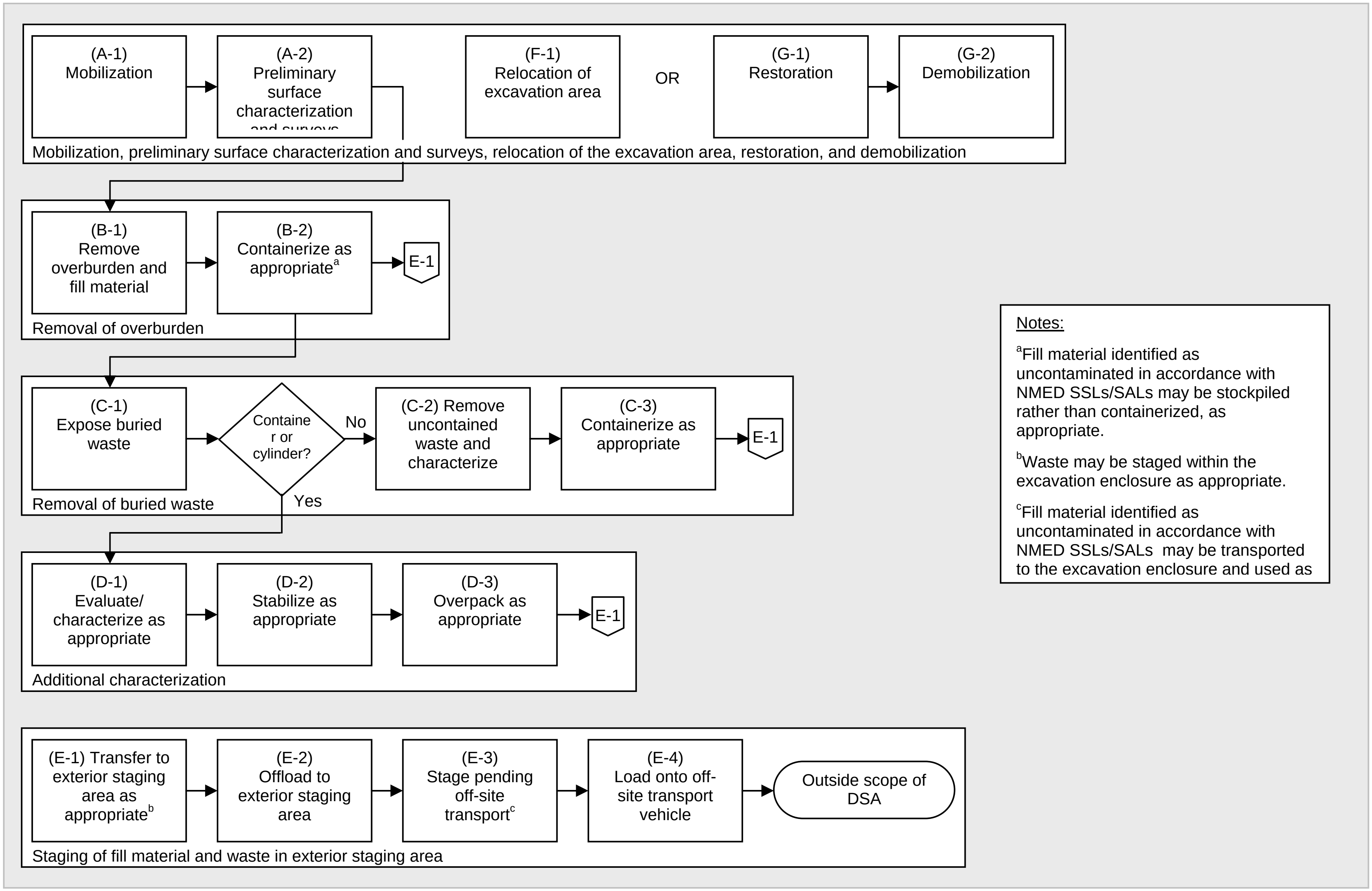


Figure 3.2-1. Functional flow block diagram for MDA B RCR

Accidents/hazardous events occurring during a facility's operating history may also provide a perspective on potential future facility hazards. The following three known accidents/hazardous events have occurred during MDA B's history:

- A chemical fire occurred at MDA B in 1946. That fire lasted approximately two hours. An incident report (Drager 1946) described the fire as more of a chemical reaction than a fire. The fire department controlled the fire with water; however, when application of water was stopped, the chemical reaction resumed. Bulldozers pushing dirt over the affected area ultimately extinguished the fire. There were no known injuries.
- A fire occurred at MDA B in 1948 (Drager 1948, 00552). The fire was estimated to have lasted two hours, had great intensity, and covered a waste area of 232 m^2 (2500 ft^2). The probable cause was spontaneous combustion of mixed chemicals in waste, probably containing plutonium, americium, and fission products. In the fire, several cartons of waste caused minor explosions, and on one occasion, a cloud of pink gas arose from the debris in the dump. The location of this fire is not well known. Based on historical accounts, SMEs suspect that the fire occurred in the area of cell 4. Dense smoke forced the evacuation of personnel in areas east and west of the site. There were no known injuries.
- During an inspection of MDA B in the 1980s, a LANL employee fell through a weak ground area into a void in one of the waste cells. The employee was not injured.

Analysts searched the Occurrence Reporting and Processing System (ORPS) database for applicable accidents/hazardous events that have occurred at other DOE sites to broaden the perspective on potential future facility hazards. Table 3.2-1 provides applicable accidents/hazardous events identified through a search of the ORPS database. Applicable accidents/hazardous events that occurred at MDA B and other DOE sites provided additional input to the hazard identification checklist.

Analysts evaluated in the hazard-barrier analysis only those hazards that could result in a radiological and/or chemical spill or release during MDA B RCR. Analysts eliminated from further consideration those hazards considered to be SIHs only. SIHs are hazards that are routinely encountered in general industry and construction, and for which national consensus codes and/or standards (e.g., Occupational Safety and Health Administration [OSHA], transportation safety) exist to guide safe design and operation, thus eliminating the need for special analysis to devise safe design and/or operational parameters. Analysts considered SIHs in the hazard analysis only to the extent that they may be initiators and/or contributors to a radiological and/or chemical spill or release.

While fissile material is identified in the hazard identification tables, criticality is screened from further consideration in the hazard evaluation. The maximum quantity of plutonium-239 buried in MDA B is 100 g. In accordance with DOE STD 1027 quantities below 450 grams for 239Pu criticality is precluded and criticality controls are not required. Therefore, criticality is not considered a credible scenario during MDA B RCR.

Tables 3.2-2 through 3.2-6 provide the results of the hazard identification process. The first column, Hazard Type, of each table lists the specific checklist items used to facilitate the identification of hazardous material/energy sources (second column) specific to MDA B RCR.

Table 3.2-1
Applicable Scenarios from the ORPS Database

Report Number	Event Description	Safety Significance/Lessons Learned
Loss of Containment or Confinement		
EM-RL--WHC-WHC600EM-1991-0213	As part of scheduled work activities, a drum that contained liquids was unearthed at a burial ground. This drum was in an area thought to be outside the boundary of the disposal trench where digging was being conducted to slope the sides of the excavation to a level suitable for personnel entry. During the excavation, the drum was breached by the backhoe, resulting in two small holes on the top of the drum and a small volume of liquid (less than 2 gal.) spilling into the burial ground soils.	Since contingency plans were in place to deal with spills, no adverse environmental effects were realized. Releases from deteriorated waste containers are anticipated to occur. Site operations at remediation sites must prepare for material releases by having contingencies in place.
EM-ALO--GEO-GJO-1996-0006	While two employees were weighing sources in preparation for packaging them for transportation to a disposal facility, an exempt quantity carbon-14 source in nonvolatile liquid form was dropped on the floor and broken. The source contained 50 µCi of carbon-14 in 1 mL of liquid in a glass ampoule.	The process of weighing the sources, including the source that was dropped, was a new and nonroutine operation, which the involved individuals had just begun. The design of the work area layout was awkward and contributed to the incident. Handling of small items lends itself to the potential for dropping and breaking. It is important that precautions be taken, not only for precluding inadvertent dropping of the item, but also for minimizing the possibility of breakage of the item if it is dropped.
DP-ALO-LA-LANL-RADIOCHEM-1996-0008	A 2-L glass bottle ruptured, dispersing glass fragments up to 7 or 8 ft and cutting the fingers of two nearby employees. The bottle contained legacy waste that had been shipped to TA-48 for a waste treatability study. Later investigation determined that the unvented bottle contained a waste solution of Nochromix glass cleaner in sulfuric acid. The manufacturer and the Laboratory's vender of Nochromix both advise against storing this solution in an airtight container.	The rupture of the bottle was caused by an excess buildup of pressure generated by the stored solution. The pressure buildup occurred because, when the waste was disposed of several years ago, the waste generator did not store the solution in a vented container. Experiments that involve materials that may be incompletely characterized must be analyzed with a great deal of rigor. Careful planning can mitigate problems and provide for a safe work place.

Table 3.2-1 (continued)

Report Number	Event Description	Safety Significance/Lessons Learned
EM-SR--WSRC-SW&I-1998-0008	While preparing to remove the lid of an 85-gal. drum, the lid blew off, apparently as a result of overpressurization. Several of these waste containers, known to contain 1,1,1-Trichlorethane, were being sampled for waste characterization at the time of this incident. An operator near the drum was potentially exposed to the chemicals in the drum.	The cause of the overpressurization of the hazardous waste drum was due to the buildup of gases from the chemical reaction between trichloroethane and water producing hydrochloric acid, and the hydrochloric acid with carbon steel. A contributing cause was less than adequate review of the potential hazards associated with obtaining samples from this waste drum.
EM-SR--WSRC-SW&I-1999-0013 (Similar occurrence report: EM-SR--WSRC-SW&I-1999-0009)	While performing routine inspections, personnel discovered a polyethylene container in storage that was pressurized and appeared to be leaking through the drum bung. The polyethylene container contained a mixture of paints and solvents. There was no personnel injury or contamination as a result of this incident.	The drum pressurization was believed to be the result of placing incompatible wastes into the same container. Generators must ensure that waste and storage containers are compatible. Procedures must be in place to ensure proper containerization of waste. Personnel must be observant at all times to ensure situations like this are promptly identified.
EM-ID—BBWI-LANDLORD-2004-0006	During the process of moving six legacy hydrogen fluoride (HF) gas cylinders (that were buried during the early 1950s) from a staging area to a temporary exclusion area, site personnel discovered a leak in the last cylinder to be moved and a Site Area Emergency was declared.	The leak was due to equipment deterioration. It was determined that the planning, foresight, and execution of the contingency plan for this emergency was exceptional. Recognizing and promoting the value of good contingency planning proved to be worthwhile.
EM-ID--BBWI-LANDLORD-2004-0009	During a surveillance of a hydrofluoric acid container that was inside an overpack at the CPP-84 Buried Cylinder Remediation Site, subcontract personnel determined that the acid container was leaking. A Site Area Emergency was declared.	The cause of the leak was determined to be failure of the pressure gauge due to corrosion (as a result of moisture reacting with the hydrogen fluoride gas and forming hydrofluoric acid). It is important to maintain a questioning attitude with regard to the compatibility of systems and processes to new chemicals.
Fire		
EM-RL--PHMC-SOLIDWASTE-1997-0009	A grass fire occurred in burial ground 218-E-10. The burned area is posted as an Underground Radioactive Material Area. No radioactive material was involved in the fire.	The fire began along a route that a Caterpillar tractor was using to exit the burial ground after completing backfilling operations. The cause of the fire was a spark caused by one of the tracks on the Caterpillar tractor striking a rock. The spark ignited dried vegetation, which smoldered for an unknown

Table 3.2-1 (continued)

Report Number	Event Description	Safety Significance/Lessons Learned
		time before flaring up. Using heavy equipment in burial grounds during fire season can cause fires that do not flare up until after the operations are completed and personnel leave the area. To prevent fires, dried vegetation should be removed. A fire watch should be maintained for a time after operations are completed to ensure that there are no smoldering fires.
EM-ORO--BJC-X10ENVRES-2005-0012	During excavation work, a pyrophoric chemical reaction unexpectedly engulfed the excavator bucket in flames, which shot up about 6–7 ft and lasted about 5 seconds. Subsequently, the operator emptied the bucket's contents onto the source of the fire, extinguishing the flame, and swung the bucket out of the origin of the fire to minimize damage to the excavator.	While the limited process knowledge prior to this event indicated that it could be pyrophoric, the magnitude of this pyrophoric event came as a surprise to the project team. Although pyrophorics were expected, more information about the potential for highly energetic reactions could have led to a different or improved approach. Worst-case events must be taken into consideration during planning.
Explosions		
EM-ID--CWI-RWMC-2005-0009 (Note: Although no explosion occurred, this incident could have resulted in an explosion.)	A propane leak at the Radioactive Waste Management Complex, Accelerated Retrieval Project led to declaration of an Operational Emergency and a facility evacuation. No abnormal lower explosive limit (LEL) readings were identified.	The cause of the propane leak was settlement of the tank, which caused a small rotation of the tank, tension in the liquid discharge piping, overstressing of the excess flow valve, and valve failure. The fact that this system was being installed in an area of unstable soil was not compensated for adequately.
EM-ID--CWI-RWMC-2005-0012	After placing two drums into a pit 13 ft below grade, the second drum exploded approximately five seconds after being set down by the equipment operator. This explosion created a fireball approximately 8 ft high and 4 ft wide, and engulfed the first drum, causing it to also catch on fire. The fire was extinguished by smothering it with soil. There were no personnel injuries, and contamination levels were not elevated as a result of the event.	Explosions as a result of overpressurized containers, chemical reactions, etc., are anticipated to occur during such operations. Site operations at remediation sites must prepare for such occurrences by having contingencies (e.g., soil to smother a fire) in place.

Table 3.2-1 (continued)

Report Number	Event Description	Safety Significance/Lessons Learned
Exposure		
EM-RL--BHI-REMACT-2004-0018	While performing radiological surveys in a High Contamination Area containing stockpiled soils from the 618-2 burial grounds, two radiological control technicians were potentially exposed to airborne alpha contamination.	There is the potential for airborne radioactivity near contaminated soil.
EM-OH-FN-FFI-REMP-2000-0023	The results from radiological air samplers collected at a radiological control point indicated airborne radioactivity levels that would probably exceed airborne radioactivity guidelines for the week. The air sampler was located in the control point trailer adjacent to the material handling building at the Waste Pits Remedial Action Project. The material handling building contains stockpiles of uranium-contaminated soil.	The airborne radioactivity was likely the result of the two buildings sharing the same atmosphere, to a certain extent (e.g., doors being open simultaneously). There is the potential for airborne radioactivity near contaminated soil.
Natural Phenomena		
EM-ID--WVNS-NDA-1991-1001	Four roll-offs containing contaminated soil generated from the Nuclear Regulatory Commission Licensed Disposal Area (NDA) Interceptor Trench construction were found to have radioactive contamination levels on the ground (underneath the roll-off door) that were above the release criteria.	Rainwater and snow resulted in water collecting in the roll-offs and eventually leaking out. The tarp chosen to cover the roll-offs and protect them from the weather was not adequate. The intensity of inclement weather and its effects must be considered in the design of outdoor storage areas.
EM-SR--WSRC-SW&I-1992-0003 (Similar occurrence report: EM-ID--WVNS-NDA-1990-0001)	An environmental subcontractor employee reported that a container was observed partially protruding from the surface of the slope of a drainage ditch in the Old Burial Ground. Investigation revealed that the container was a 55-gal. drum that had a small segment exposed because the ditch was eroded.	The direct cause of this occurrence was rainfall which caused erosion and exposed the waste. The contributing cause was a procedure which did not have sufficient detail to allow identification of the exposed waste, given the size of the facility being inspected. Workers must be diligent in identifying areas in the landfill where inventory may be unintentionally exposed. Procedures must be specific about when inspections are to take place, what to look for, and how to make inspections.

Table 3.2-1 (continued)

Report Number	Event Description	Safety Significance/Lessons Learned
EM-ID--WVNS-NDA-1993-0001	An operator discovered the electrical cords for fans inside a sprung structure and the outlets they were plugged into were charred and burned. An inspection of the electrical system concluded that the damage most likely occurred due to a lightning strike during the previous night.	Actions to preclude lightning strikes must be considered.
EM-RL--PHMC-SOLIDWASTE-2002-0014	As a loaded tractor and trailer were backing away from a temporary staging area at the 218-W-5 low-level burial ground, the driver’s side rear wheel of the trailer fell into an undetected subsidence located near the edge of a backfilled trench.	Rainfall supersaturated the soil of the burial grounds, which increased the potential for a subsidence. Heavy rainfall can reduce the effectiveness of controls established to prevent/mitigate a subsidence. Types and sizes of equipment and vehicles that may be used must be considered when establishing controls to prevent a subsidence.
EM-ID--CWI-ICDF-2005-0005	While unloading waste storage boxes from a shipment, one box slid off the forklift tines and landed on its side. As the waste box was uprighted, a forklift tine punctured the box.	The forklift tines were covered with ice and snow. This incident demonstrates the need for extra precautions when working under adverse weather conditions.
EM-ID--CWI-RWMC-2006-0001	During snow removal activities at the Subsurface Disposal Area, a dump truck slid off the roadway and inadvertently contacted energized overhead power lines as the driver attempted to back up and return to the roadway.	This incident demonstrates the need for extra precautions when working under adverse weather conditions.
External Events		
DP-ALO-LA-LANL-DPWEST-1997-0001	An estimated 500 to 1500 gal. of potable water was released when a chilled water tower overflowed. Water entered MDA T but did not flow off the MDA or into any stream courses. The water infiltrated the ground of the MDA. No known impact to the environment was caused.	The cause was determined to be an end-of-life failure of the water tower. There is the potential for water intruding on operations as the result of water tower failure.
DP-ALO-LA-LANL-LANL-2000-0003	A wildfire (the Cerro Grande fire), initiated by a controlled burn, caused a general emergency at LANL with site-wide suspension of operations and extensive property damage.	There is the potential for wildfires affecting operations. Operations must prepare for wildfires by having contingencies in place.

Table 3.2-1 (continued)

Report Number	Event Description	Safety Significance/Lessons Learned
FE--NETL-GOPE-NETLPIT-2006-0001	An underground 8-in. potable-water supply line ruptured, causing the spilled water to leak to the surface and enter the site's storm sewer catch basin before flowing into a stream through a permitted outfall.	The pipe failure was caused by corrosion, wear, and aging. There is the potential for water intruding on operations as the result of an underground water line rupture.
Transportation		
EM-SR--WSRC-SW&I-1992-0008	Approximately 700 lbs of hazardous waste soil was spilled from a B-25 as a forklift operator was attempting to relocate the B-25 from a stack that was too high. The B-25 contacted another stack of stationary B-25s and was pulled from the forklift even after the operator attempted to return the B-25 to its original position.	The condition was a result of a temporary inattention to detail and a need for further planning before a recovery attempt.
EM-SR--WSRC-SGCP-2005-0003	A roll-off box fell from the rear of a roll-off truck as it approached E Road along a gravel road in the Burial Ground. The empty box (cap. 30 yd^3) fell to the ground without any damage to the box or surrounding area and without causing any injuries.	The subcontractor's checklists did not contain items that required the drivers to identify whether the cable system or latching dogs were operating properly to ensure the box was safely attached to the roll-off truck. Proper load securement is essential to the transport of hazardous materials/substances.

Table 3.2-2
Hazard Identification—Mobilization, Preliminary Surface Characterization and Surveys, Restoration, and Demobilization

Hazard Type	Hazardous Material/Energy Source
Acceleration (Kinetic Energy) • Inadvertent motion • Sloshing of liquids • Translation of loose objects	• On-site moving vehicles and equipment (SIH only) • Mowers (SIH only) • Loading/unloading of heavy equipment from trucks/trailers (SIH only)
Chemical Reaction (non-fire) • Disassociation, product reverts to separate components • Corrosion, rust, etc. • Combination, new product formed from mixture	Not applicable (N/A)
Deceleration (Kinetic Energy) • Impacts (sudden stops) • Failure of brakes, wheels, tires, etc. • Fragments or missiles	• On-site moving vehicles and equipment (SIH only) • Loading/unloading of heavy equipment from trucks/trailers (SIH only)
Electrical • Shock • Burns • Overheating • Ignition of combustibles • Inadvertent activation • Explosion, electrical • Static, electrostatic electricity	• Electrical components of vehicles/equipment • Backup generators • Alternating current (AC) electrical connections to service lines • Live overhead electric wires • Electric utility pole
External Events • Natural phenomena • Other external events	• Earthquake • Lightning • Heavy snowfall • High winds • Heavy rain • Hail • Extremely high temperatures • Freezing temperatures • Vehicles moving on nearby roadway • Aircraft crash • Wildland fire
Flammability and Fires • Presence of fuel—solid, liquid, gas • Presence of strong oxidizer—oxygen, peroxide, etc. • Presence of strong ignition force—welding torch, heaters	• Equipment/vehicle fuel (e.g., gasoline, diesel) • Cutting torch; welding torch • Spark from equipment track • Batteries used in vehicles/equipment

Table 3.2-2 (continued)

Hazard Type	Hazardous Material/Energy Source
Heat and Temperature • Source of heat, non-electrical • Hot surface burns • Very cold surface burns • Increased gas pressure caused by heat • Increased flammability caused by heat • Increased volatility caused by heat • Increased activity caused by heat	• Equipment/vehicle exhaust • Heat from engine (catalytic converter)
Leak of Material • Flammable • Toxic • Corrosive • Slippery	• Equipment/vehicle fuel (e.g., gasoline, diesel) and engine fluids
Mechanical • Sharp edges or points • Rotating equipment • Reciprocating equipment • Pinch points • Weights to be lifted • Stability/toppling frequency • Ejected parts or fragments	• Loads to be lifted by a crane (SIH only) • Loading/unloading of heavy equipment from trucks/trailers (SIH only)
Potential Energy • Elevated work surfaces • Lifts, scaffolds, ladders • Stacked material • Heavy masses over weak ground areas • Equipment booms and lifts	• Heavy equipment staged or operating over weak ground area • Worker working over weak ground area • Suspended loads • Ladders, scaffolding, etc. (SIH only)
Pressure • Compressed gas • Compressed air tool • Pressurized system exhaust • Objects propelled by pressure • Water hammer • Flex hose whipping	• Pressure washer in decontamination area

Table 3.2-2 (continued)

Hazard Type	Hazardous Material/Energy Source
Radiation • Ionizing radiation • Ultraviolet light • High-intensity visible light • Infrared radiation • Electromagnetic radiation • Laser radiation	• Surface-contaminated landfill • Calibration sources (SIH only) • Survey equipment (SIH only) • XRF (SIH only)
Toxicity • Gas or liquid • Asphyxiant • Irritant • Systemic poison • Carcinogen • Mutagen • Combination product • Combustion product	• Surface-contaminated landfill
Vibration • Vibrating tools • High noise level source • Metal fatigue • Flow or jet vibration • Supersonics	• Moving transportation vehicles and heavy equipment • Ventilation system motors • Jackhammer

Table 3.2-3
Hazard Identification—Removal of Overburden

HAZARD TYPE	HAZARDOUS MATERIAL/ENERGY SOURCE
Acceleration (Kinetic Energy)	• On-site moving vehicles and equipment
Chemical Reaction (non-fire)	N/A
Deceleration (Kinetic Energy)	• On-site moving vehicles and equipment • Operation of cutting equipment (e.g., wet saw)
Electrical	• Electrical components of vehicles/equipment • Backup generators • AC electrical connections to service lines • Live overhead electric wires • Electric utility pole
External Events	• Earthquake • Lightning • Heavy snowfall • High winds • Heavy rain • Hail • Extremely high temperatures • Freezing temperatures • Vehicles moving on nearby roadway • Aircraft crash • Wildland fire
Flammability and Fires	• Equipment/vehicle fuel (e.g., gasoline, diesel) • Cutting torch; welding torch • Spark from equipment track • Batteries used in vehicles/equipment
Heat and Temperature	• Equipment/vehicle exhaust • Heat from engine (catalytic converter)
Leak of Material	• Equipment/vehicle fuel (e.g., gasoline, diesel) and engine fluids
Mechanical	• Wet saw • Excavator bucket/thumb • Forklift tines • Front-end loader bucket
Potential Energy	• Heavy equipment staged or operating over weak ground area • Heavy equipment operating near excavation • Worker working over weak ground area • Worker working near excavation • Ladders, scaffolding, etc. (SIH only) • Hydraulic drum lift • Lifting equipment (e.g., forklift, crane, etc.) used to move containers (e.g., intermodal container) • Equipment (mechanical arm) in up position • Subsurface work (potential for tools, other items to fall/roll into open excavation) • Suspended tools/equipment (e.g., lighting, camera)

Table 3.2-3 (continued)

HAZARD TYPE	HAZARDOUS MATERIAL/ENERGY SOURCE
Pressure	• Hydraulic drum lift • Hydraulic attachments/accessories for excavator
Radiation	• Surface-contaminated landfill debris • Calibration sources (SIH only) • Survey equipment (SIH only) • XRF (SIH only)
Toxicity	• Surface-contaminated landfill debris
Vibration	• Vibrating equipment (e.g., excavator) • Moving transportation vehicles • Ventilation system motor

Table 3.2-4
Hazard Identification—Removal of Buried Waste

Hazard Type	Hazardous Material/Energy Source
Acceleration (Kinetic Energy)	• On-site moving vehicles and equipment • Operation of sampling equipment (e.g., drum spikes, hot taps)
Chemical Reaction (non-fire)	• Incompatible materials (e.g., materials that react to water, air, metal, etc.) in excavation • Incompatible materials (e.g., materials that react to water, air, metal, etc.) processed/staged above ground • Rusted containers in excavation
Deceleration (Kinetic Energy)	• On-site moving vehicles and equipment
Electrical	• Electrical components of vehicles/equipment • Backup generators • AC electrical connections to service lines • Live overhead electric wires • Electric utility pole
External Events	• Earthquake • Lightning • Heavy snowfall • High winds • Heavy rain • Hail • Extremely high temperatures • Freezing temperatures • Vehicles moving on nearby roadway • Aircraft crash • Wildland fire
Flammability and Fires	• Equipment/vehicle fuel (e.g., gasoline, diesel) • Shock-sensitive material (e.g., crystalline ethyl ether, perchlorate in canisters) • Pyrophoric materials • Flammable waste in excavation • Flammable waste processed/staged above ground • Spark from equipment track • Batteries used in vehicles/equipment
Heat and Temperature	• Equipment/vehicle exhaust • Incompatible materials (e.g., materials that react to water, air, metal, etc.) in excavation • Incompatible materials (e.g., materials that react to water, air, metal, etc.) processed/staged above ground • Hot tap equipment • Liquid argon/nitrogen (SIH only) • Heat from engine (catalytic converter)
Leak of Material	• Low-integrity containers in excavation • Low-integrity containers processed/staged above ground • Treatment/transfer equipment • Equipment/vehicle fuel (e.g., gasoline, diesel) and engine fluids

Table 3.2-4 (continued)

Hazard Type	Hazardous Material/Energy Source
Mechanical	• Broken glass containers • Excavator bucket/thumb • Forklift tines • Front-end loader bucket
Potential Energy	• Heavy equipment staged or operating over weak ground area • Heavy equipment operating near excavation • Worker working over weak ground area • Worker working near excavation • Worker handling radiological or chemical materials • Ladders, scaffolding, etc. (SIH only) • Hydraulic drum lift • Lifting equipment (e.g., forklift, crane, etc.) used to move containers (e.g., intermodal container) • Equipment (mechanical arm) in up position • Subsurface work (potential for tools, other items to fall/roll into open excavation) • Suspended tools/equipment (e.g., lighting, camera)
Pressure	• High-pressure cylinders • Hot tap equipment • Hydraulic drum lift • Hydraulic attachments/accessories for excavator • Acids (hydrogen gas buildup) • Pneumatic equipment
Radiation	• Diffuse, volume-contaminated radioactive waste in excavation • Diffuse, volume-contaminated radioactive waste processed/staged above ground • Surface-contaminated landfill debris • Concentrated radioactive sources/material in containers • Fissile material • Calibration sources (SIH only) • Survey equipment (SIH only) • XRF (SIH only)
Toxicity	• Diffuse, volume-contaminated chemical waste in excavation • Diffuse, volume-contaminated chemical waste processed/staged above ground • Surface-contaminated landfill debris • Concentrated chemical sources/material in containers
Vibration	• Vibrating equipment (e.g., excavator) • Moving transportation vehicles • Ventilation system motor

Table 3.2-5
Hazard Identification—Additional Characterization within Excavation Area

Hazard Type	Hazardous Material/Energy Source
Acceleration (Kinetic Energy)	• On-site moving vehicles and equipment • Operation of sampling equipment (e.g., drum spikes, hot taps)
Chemical Reaction (non-fire)	• Incompatible materials (e.g., materials that react to water, air, metal, etc.) in excavation • Incompatible materials (e.g., materials that react to water, air, metal, etc.) processed/staged above ground • Rusted containers in excavation • Chemicals used for stabilization
Deceleration (Kinetic Energy)	• On-site moving vehicles and equipment
Electrical	• Electrical components of vehicles/equipment • Backup generators • AC electrical connections to service lines • Live overhead electric wires • Electric utility pole
External Events	• Earthquake • Lightning • Heavy snowfall • High winds • Heavy rain • Hail • Extremely high temperatures • Freezing temperatures • Vehicles moving on nearby roadway • Aircraft crash • Wildland fire
Flammability and Fires	• Equipment/vehicle fuel (e.g., gasoline, diesel) • Shock-sensitive material (e.g., crystalline ethyl ether, perchlorate in canisters) • Pyrophoric materials • Flammable waste in excavation • Flammable waste processed/staged above ground • Spark from equipment track • Batteries used in vehicles/equipment • Chemicals used for stabilization
Heat and Temperature	• Equipment/vehicle exhaust • Incompatible materials (e.g., materials that react to water, air, metal, etc.) in excavation • Incompatible materials (e.g., materials that react to water, air, metal, etc.) processed/staged above ground • Hot tap equipment • Liquid argon/nitrogen (SIH only) • Heat from engine (catalytic converter) • Chemicals used for stabilization

Table 3.2-5 (continued)

Hazard Type	Hazardous Material/Energy Source
Leak of Material	• Low-integrity containers in excavation • Low-integrity containers processed/staged above ground • Treatment/transfer equipment • Equipment/vehicle fuel (e.g., gasoline, diesel) and engine fluids • Chemicals used for stabilization
Mechanical	• Broken glass containers • Excavator bucket/thumb • Forklift tines • Front-end loader bucket
Potential Energy	• Heavy equipment staged or operating over weak ground area • Heavy equipment operating near excavation • Worker working over weak ground area • Worker working near excavation • Worker handling radiological or chemical materials • Ladders, scaffolding, etc. (SIH only) • Hydraulic drum lift • Lifting equipment (e.g., forklift, crane, etc.) used to move containers (e.g., intermodal container) • Suspended tools/equipment (e.g., lighting, camera)
Pressure	• High-pressure cylinders • Hot tap equipment • Hydraulic drum lift • Hydraulic attachments/accessories for excavator • Acids (hydrogen gas buildup) • Pneumatic equipment
Radiation	• Diffuse, volume-contaminated radioactive waste in excavation • Diffuse, volume-contaminated radioactive waste processed/staged above ground • Surface-contaminated landfill debris • Concentrated radioactive sources/material in containers • Fissile material • XRF (SIH only) • Calibration sources (SIH only) • Survey equipment (SIH only)
Toxicity	• Diffuse, volume-contaminated chemical waste in excavation • Diffuse, volume-contaminated chemical waste processed/staged/ stored above ground • Surface-contaminated landfill debris • Concentrated chemical sources/material in containers • Chemicals used for stabilization
Vibration	• Vibrating equipment (e.g., excavator) • Moving transportation vehicles • Ventilation system motor

Table 3.2-6
Hazard Identification—Staging of Fill Material and Waste in Exterior Staging Areas

Hazard Type	Hazardous Material/Energy Source
Acceleration (Kinetic Energy)	• On-site moving vehicles and equipment
Chemical Reaction (non-fire)	• Incompatible materials (e.g., materials that react to water, air, metal, etc.) processed/staged above ground
Deceleration (Kinetic Energy)	• On-site moving vehicles and equipment
Electrical	• Electrical components of vehicles/equipment • Backup generators • AC electrical connections to service lines • Live overhead electric wires • Electric utility pole
External Events	• Earthquake • Lightning • Heavy snowfall • High winds • Heavy rain • Hail • Extremely high temperatures • Freezing temperatures • Vehicles moving on nearby roadway • Aircraft crash • Wildland fire
Flammability and Fires	• Equipment/vehicle fuel (e.g., gasoline, diesel) • Spark from equipment track • Batteries used in vehicles/equipment
Heat and Temperature	• Equipment/vehicle exhaust • Heat from engine (catalytic converter)
Leak of Material	• Equipment/vehicle fuel (e.g., gasoline, diesel) and engine fluids
Mechanical	• Forklift tines
Potential Energy	• Heavy equipment staged or operating over weak ground area • Worker working over weak ground area • Hydraulic drum lift • Lifting equipment (e.g., forklift, crane, etc.) used to move containers (e.g., intermodal container) • Equipment (mechanical arm) in up position
Pressure	• Hydraulic drum lift • Acids (hydrogen gas buildup)
Radiation	• Surface-contaminated landfill • Calibration sources (SIH only) • Survey equipment (SIH only) • XRF (SIH only)
Toxicity	• Surface-contaminated landfill
Vibration	• Moving transportation vehicles • Ventilation system motor

3.3 Hazard Categorization

Analysts based the initial categorization of MDA B on the inventory reported in a 1971 memorandum from Meyer (00557). Meyer estimated the maximum plutonium-239 inventory in MDA B to be 100 g. In accordance with the categorization methodology described in DOE-STD-1027-92, Change Notice 1, analysts categorized MDA B as an HC3 site based on the total radionuclide inventory. Since the inventory is 100 grams of plutonium-239 equivalent (239Pu-EQ) the MDA B Nuclear Environmental Site (NES) is categorized as a HC 3 nuclear facility in accordance with DOE STD 1027-92 CN.

3.4 Hazard-Barrier Analysis

Hazard scenarios based on the identified hazards for each activity/group of activities were postulated. Appendix B provides the postulated hazard scenarios (in the form of hazard-barrier matrixes) for which barriers were identified to prevent and/or mitigate a hazardous material/substance spill or release. The inventory buried within MDA B is a combination of surface-contaminated solid waste, recovery residue solutions, and chemicals. The maximum quantity of material at risk MAR in MDA B is is 100 g ^{239}Pu-EQ;.

To ensure the safety of the public, workers, and the environment during MDA B RCR activities, analysts identified barriers that will contribute to the prevention and/or mitigation of the postulated hazard scenarios. The term “barrier” is used to describe systems, components, structures, procedures, and human actions. The term “barrier” is roughly equivalent to the term “control.” Barriers may provide physical separation between hazards and potential receptors or administratively control hazards associated with tasks. Table 3.4-1 presents the barriers identified for the prevention and mitigation of hazards associated with the RCR of MDA B. Sections 3.4.1 and 3.4.2 provide additional information necessary for the derivation of TSRs. The hazard-barrier matrixes provided in Appendix B identify the specific scenarios that each of the barriers has been selected to prevent and/or mitigate.

The primary barrier selected for the mitigation of consequences in the event of a radiological material spill or release during RCR operations is the control of the available MAR. Controlling the available MAR is accomplished by controlling the excavation and removal of waste material. This ensures that excavation of the waste cells proceeds in a controlled manner and that the total quantity of radiological material exposed within the open excavation and staged above ground is less than the Hazard Category 3 (HC 3) threshold quantity of ^{239}Pu.. This control, coupled with the inventory isolation system for unexcavated waste cells ensures that there is no significant off-site impact during MDA B RCR operations. The control of the MAR in an excavation area is incorporated in the TSRs as a Limiting Condition of Operation (LCO).

To put this control (and the potential risk during MDA B RCR) into perspective, total volume of material to be removed, including waste cell contents and adjacent contaminated materials, is approximately 18,350 m^3 (24,000 yd^3). If the radiological constituent (primarily plutonium-239) is assumed to be uniformly distributed throughout MDA B in the form of surface-contaminated solid waste and contaminated soil, there are approximately 5.5 mg/m^3 (4.2 mg/yd^3) of plutonium-239. If the radiological constituent is largely found in recovery residue solutions, historical evidence indicates that the solutions will contain, at most, 5 mg plutonium-239 per liter. One 5-gal. carboy will contain, at most, approximately 100 mg. Therefore, using conservative measurement assumptions, the removal of waste cell contents during MDA B RCR can be accomplished at a safe and efficient rate.

Defense-in-depth (DID) is a safety design concept or strategy that is based on the premise that no one layer of protection is completely relied upon to ensure safe operation (DOE Guide 420.1-1). By applying this safety strategy during MDA B RCR, the Laboratory will achieve the objective of providing multiple layers of protection to prevent or mitigate an unintended release of hazardous materials/substances to the public, workers, and the environment. Therefore, to compensate for potential human and mechanical failures, analysts based DID for the RCR of MDA B on several layers of protection with successive barriers to prevent or mitigate the release of hazardous materials/substances. These barriers consist of primarily administrative controls (ACs). The hazard-barrier matrixes provided in Appendix B demonstrate the layers of DID provided for MDA B RCR.

Waste packaging and an excavation cover over the exposed waste in the open excavation were evaluated for providing protection to the workers during operations. Waste packaging minimizes the potential for waste to become involved in a fire, should one initiate, and prevents waste from adding to the combustible loading. Waste packaging also minimizes exposure to workers during handling. The excavation cover acts as a barrier to inadvertent release or resuspension of contamination during periods without excavation and removal.

No safety-class (SC) SSCs for MDA B RCR were identified. While the total inventory, form, and degree to which it is dispersed throughout the site are somewhat uncertain, the radiological material excavation control ensures that a spill or release during MDA B RCR do not challenge the EG at the site boundary. Radiological material excavation control is provided here as a scenario-defining assumption and does not constitute a mitigated analysis in that the consequence evaluation must be bounded by some limit to be meaningful (OST 300-00-06).

TSRs define the performance requirements of SSCs and identify the safety management programs (SMPs) used by personnel to ensure safety. TSRs are aimed at confirming the ability of the SSCs and personnel to perform their intended safety functions under normal, abnormal, and accident conditions (DOE Guide 423.1-1). Analysts recognize program commitments (e.g., radiation protection, maintenance, quality assurance) as being important to safety for the RCR of MDA B. The discipline imposed by SMPs is an integral part of DID. Table 3.4-1 identifies those barriers requiring TSR coverage and commitments to SMPs. Section 3.4.3 describes additional commitments to SMPs not specifically identified in Table 3.4-1.

Table 3.4-1
MDA B Barriers

Barrier		Description	Safety Designation
Barriers necessary to prevent/mitigate the release of exposed/excavated hazardous materials/substances:			
SSC	Excavation cover (P, M)	The excavation cover provides a barrier over the exposed waste in the open excavation when excavation operations are stopped at the end of a shift to minimize worker exposure.	TSR AC Program Element,
SSC	Waste packaging (P, M)	Waste packaging provides passive confinement of the excavated waste, minimizes the potential for waste to add to the combustible loading in the event of a fire, minimizes the potential for rapid combustion or overpressurization, and protects contents from fires.	TSR AC Program Element
AC	Limit on total MAR during excavation operations	This barrier establishes the limit on total MAR that can be in any defined excavation area to minimize consequences to workers and the public in the event of a release.	TSR LCO
AC	Radiological & Chemical Waste material excavation control (M)	This barrier establishes criteria for the excavation of radiological material to minimize consequences to workers and the public in the event of an accident.	TSR AC Program
SMP—Hazardous Material and Waste Management Program	Other hazardous material/substance control (P, M)	The management of nonradiological hazardous materials/substances complies with applicable state and federal regulations consistent with LANL implementing requirements.	TSR programmatic AC
	Stacking of waste containers prohibited (P, M)	Filled or partially filled waste containers are not stacked.	
SMP—Safety and Health Program (as required by HAZWOPER)	Exposure monitoring and air sampling (M)	The exposure monitoring and air-sampling program provides for the identification and quantification of airborne levels of potentially hazardous substances as required by HAZWOPER to ensure controls are appropriate to minimize worker exposure.	TSR programmatic AC
	Use of spotters during excavation operations (P)	Spotters are used (either at the excavation or at a remote location using a camera) as appropriate during excavation operations.	
	Observation of unsecured open excavation (P)	Observation of an unattended (i.e., between shifts) open excavation is conducted as applicable.	

Table 3.4-1 (continued)

Barrier		Description	Safety Designation
	Spill-control plan (M)	A spill-control plan consistent with LANL implementing requirements provides for worker response, as applicable, to spills of hazardous materials/substances that occur outside of the excavation (i.e., during waste handling or staging above ground) to minimize the consequences of the spill.	
	Use of spotters during equipment/vehicle movement (P)	Spotters are used as applicable during vehicle/heavy equipment movement to minimize inadvertent impacts to staged hazardous materials/substances.	
	Use of personal protective equipment (PPE) (M)	Site personnel use PPE as required by the site-specific health and safety plan (SSHASP), radiological work permit (RWP), and integrated work document (IWD), and consistent with LANL implementing requirements to minimize exposure to hazardous materials/substances.	
	Site control plan (P, M)	The site control plan identifies the requirements necessary to ensure that only authorized personnel and personnel with the required qualifications and training are present at the MDA B site.	
	Emergency response plan (M)	The emergency response plan provides for safe and effective responses to emergencies in accordance with HAZWOPER and consistent with LANL implementing requirements.	
	Dust control (P)	Dust control is used as applicable to minimize the potential for contamination (e.g., on the surface of buried containers, in the soil, in asphalt) to become airborne.	
SMP—Fire Protection Program (FPP)	Control of vegetation (P)	Vegetation exterior to the excavation area is maintained/controlled to limit the opportunity for a wildfire to propagate to the excavation area and external staging area.	TSR programmatic AC
	Minimization of transient combustibles in the excavation area (P)	Transient combustibles are minimized to the extent possible within the excavation area to limit the opportunity for a fire to propagate and involve waste materials.	
	Site personnel trained to respond to fires (M)	MDA B field personnel are trained to respond to incipient fires.	
	Fire response equipment and/or material is on hand and available for use (M)	Fire response equipment and/or material, as applicable, is on hand and available for use to control incipient fires and minimize the propagation of a fire.	

Table 3.4-1 (continued)

Barrier		Description	Safety Designation
Barriers necessary to prevent/mitigate the release of hazardous materials/substances from unexcavated waste cells:			
SSC	Inventory isolation system (M)	The inventory isolation system (i.e., the depth of burial, cover material/cap, and distribution of buried waste within the geophysical boundaries of the waste cells), as described in the NES S&M DSA (LANL 2004, 87651), provides passive confinement and protection to buried waste in unexcavated waste cells.	TSR DF
SMP—Surveillance and Maintenance Program	Erosion control and cover maintenance (P)	Measures, including the maintenance of vegetation, surface and near-surface soil, overburden, cover material/caps, and the use of water diversions are implemented as needed to minimize erosion within the geophysical boundaries of the unexcavated waste cells.	TSR programmatic AC
	Visual inspections (P)	Visual inspections are conducted as necessary within the geophysical boundaries of the unexcavated waste cells to assess the condition of the inventory isolation system.	
	Controls to support vehicle/heavy equipment weight over waste cells (P)	The movement of vehicles/heavy equipment within the geophysical boundaries of unexcavated waste cells is controlled as applicable to minimize the potential for cave-in over waste cells.	
	Near-surface earthwork control (P)	Near-surface earthwork within the geophysical boundaries of unexcavated waste cells is controlled as applicable to minimize the potential to disturb buried inventory.	

3.4.1 Bases for MAR and Excavation Control

The total estimated radiological inventory for Material Disposal Area (MDA) B is 100 grams of plutonium-239 equivalent (^{239}Pu-EQ) or 6.2 plutonium-239 equivalent curies (^{239}PE-Ci). Table 1.6-2 provides the estimated radiological inventory for specific radionuclides. This inventory is based on historical information and that the total radiological inventory is distributed over the entire volume of MDA B. Because of the relatively short distances to the site boundary it is recognized that a total release of the entire inventory would result in elevated concentrations outside of the MDA B boundary. For this reason it is essential to limit the total amount of waste material that can be acted on in any particular excavation operation. This assumption takes into account the uncertainty in both the total inventory and the degree to which it is dispersed throughout the MDA B site as well as the close proximity of potential off-site receptors (approximately 20 m/66 ft).

Therefore, the identified safety controls include both a limit on the total MAR and a radiological material excavation control program. These administrative controls are implemented as technical safety requirements (TSRs) for the RCR of MDA B to prevent or mitigate the consequences of a potential release of radioactive or chemical contamination, and also to prevent or mitigate the consequences of fires or smoldering associated with potentially flammable chemical waste material. These TSR Administrative Controls place a limit on the total amount of material exposed within the excavation area and staged above ground such that the total amount of MAR is less than the Hazard Category 3 threshold of 8.4 grams for ^{239}Pu. These controls then limit the total amount of material that is available for release thereby limiting the exposure to both workers and the public.

3.4.2 Methodology and Approach

Recognizing that off-site receptors may be as close as 20 meters to the excavation area during active remediation of MDA B it was imperative that the total MAR available for the identified potential release scenarios be limited to quantities that are less than the Hazard Category 3 threshold of 8.4 grams for ^{239}Pu. Because the total inventory of the MDA B, which covers an area of nearly six acres (approximately 24,281 square meters), is conservatively estimated to be 100 grams ^{239}Pu-EQ, then it is recognized that the assumption that a single receptor could be exposed to the entire inventory at distances less than 50 meters is not feasible. The length of the MDA B site compared to the nearest off-site distances precludes a receptor from being exposed to the entire inventory. As distances increase the consequences from exposure from a total release are reduced due to dispersion. In addition, it is recognized that a total release of the entire inventory of 100 grams from MDA B is not credible from excavation activities alone. There is no credible scenario where the entire 24,000 square meter area could be excavated in a single operation. Because of these realities the approach used for the development of the safety controls for excavation activities at MDA B was based on a detailed hazard barrier analysis (described previously) and the ability to limit the total amount of MAR available for release.

DOE Standard 1027 "Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports" provides threshold limits for radionuclide inventories for determining the preliminary hazard categorization. The HC 3 thresholds are based on the potential for significant localized consequences from an unmitigated release. The assumptions for the HC 3 presume that at the threshold value of 8.4 grams of ^{239}Pu a receptor at a distance of 30 meters would receive approximately 10 rem. Therefore keeping the total MAR at values less than 8.4 grams during excavation activities at MDA B ^{239}Pu would minimize the consequences to the MEOI.

3.4.3 Bases for MAR Control

Calculating the average concentration of radionuclides in the excavated materials and then estimating the size of a “Hot Spot” for purposes of the controlling the total MAR determine the calculation of the “excavation area.”

The total inventory of 100 grams of ^{239}Pu-EQ is taken to be the conservative upper bound for the entire MDA B. The total available waste volume for MDA B is provided in Figure 3.4-1 (See below). Minimum waste volume = 21,778 yd^3 = 16,650 m^3.

The minimum waste volume will provide the greatest average concentrations of radionuclides per volume of waste materials. Using the minimum waste volume incorporates a measure of conservatism to the estimates for identifying “Hot Spots” which could contain significantly greater concentrations than the average.

Using the minimum waste volumes the average ^{239}Pu-Eq concentration is calculated to be approximately 6×10^{-3} g/m^3.

For purposes of the evaluation of the excavation area a “Hot Spot” is defined as 100 times greater than the average concentration or 6×10^{-1} g/m^3 (0.6 grams in a cubic meter of waste). [Note: a cubic meter is nearly 31% greater than a cubic yard]

It is anticipated that nominal excavation would not likely exceed an area of 100 m^2, which could include volumes on the order of 100 to 300 cubic meters (average depth of a waste area is 8.5 ft or 2.6 m).

3.4.4 CALCULATION OF THE SIZE OF THE “HOT SPOT”

There is no means by which the size of the “Hot Spot” can be determined until the excavation along with sampling and analysis has collected data. The primary safety control to mitigate or prevent adverse consequences to the worker or the public is through rigorous MAR control. The control of the MAR to less than Hazard Category 3 Threshold limits will ensure that the workers and the public are adequately protected. The MAR is implemented via a control on the excavation. The total MAR exposed during any phase of the excavation of MDA B will be controlled in accordance with the Excavation Control Program description (TSR AC) and will be appropriately monitored in accordance with the radiological control and chemical management programs (TSR ACs).

Specific details of the program implementation are left to the TSR implementing documents, however, the concept of the excavation control is provided here to illustrate the effectiveness of the program to ensure that the MAR limit will not be exceeded.

A standard statistical approach is used to determine the maximum size of a “Hot Spot” based on a specified excavation area and a defined sampling grid. This approach ensures an overall low probability that the “Hot Spot” will not be missed.

The method employed to calculate the size of a “Hot Spot” is adapted from (R. O. Gilbert, 1987: “Statistical Methods for Environmental Pollution Monitoring”) and is based on the approach developed by Singer using nomographs developed by Zirschky and Gilbert. The method is used to identify the minimum dimensions of a “Hot Spot” that can be detected with a specified level of confidence. The definition of the “Hot Spot” only needs to be clear and unambiguous. In other words the difference between the average concentration and the “Hot Spot” is easily discernable with field methods. In this way the sampling can be accomplished in real time.

Using a method such as that prescribed by Gilbert (Gilbert, 1987) and assuming that the excavation area is on the order of 100 m^2 (10 m x 10 m) with ‘G’ being equal to 2 meters the maximum size of the “Hot Spot” that would have a 95% chance of being identified with as little as 25 samples (e.g., real-time radiological surveys) can be determined. A conceptual sampling grid is presented in Figure 3.4-1. The curves presented in Figure 3.4-2 illustrate the elliptical shape of a “Hot Spot” of dimension ‘L’ based on an prescribed beta (β), which is the error rate that the “Hot spot” would be missed assuming a square sampling grid of dimension ‘G.’ An S value of unity represents a circular “Hot Spot” and a value of S less than unity represents varying elliptical areas.

In this case assigning a value of 0.05 to β would result in an L/G value of 0.6 (see Figure 3.4-1from Gilbert, 1987) indicating that the radius of the circular “Hot Spot” would be 1.2 m and is given by:

$$L = G * 0.6$$

Where:

L = the radius of the “Hot Spot”

G = Grid dimension (2 meters)

The dimension ‘L’ then provides the minimum size of a “Hot Spot” that would be detected with a 95% confidence level based on the sampling grid dimension and the identified number of samples. This information is then used to guide the excavation activities such that as material is sampled and removed the upper bound limit on the MAR can be determined.

The application of this approach is presented here as an illustration of the effectiveness of the MAR control and the control on excavation. For example assume that an excavation area of 100 square meters is defined and survey data is collected based on the method described above. In this case there would be sufficient information to identify with high confidence a minimum size “Hot Spot” (an area where the detected concentration is significantly greater than the average) of 4.5 m^2. Then depending on the levels that are detected the depth of the excavation can be controlled to ensure that the maximum MAR is always below the specified limit.

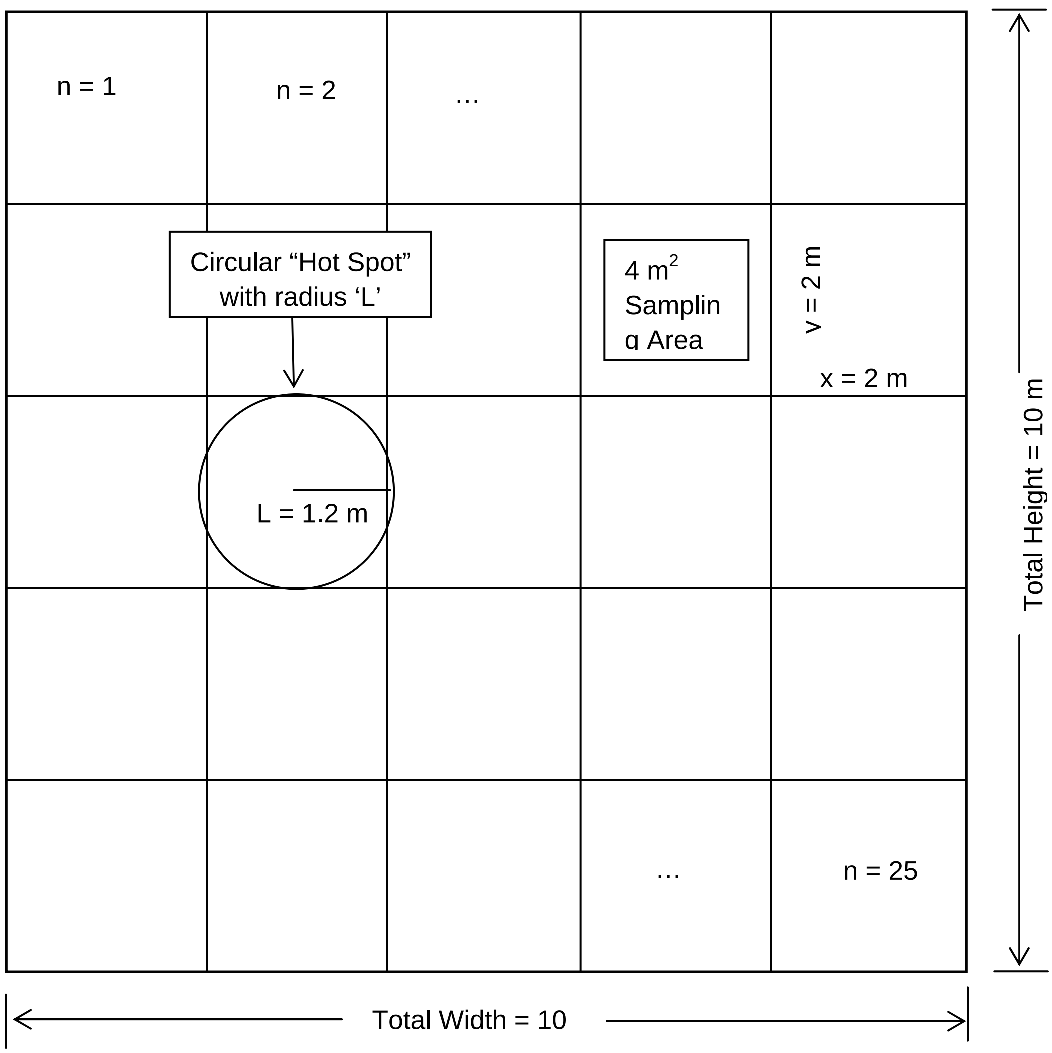
The excavation depth may vary from as little as a half meter to a maximum of 3.7 meters. The volume of the “Hot Spot” can be determined by calculating the circular area with a radius ‘L’ (in this example the radius is1.2 meters) multiplied by the excavation depth. For this example a resulting “Hot Spot” volume (based on the average depth of a waste unit being approximately 2.6 meters) could be as much as 12 m^3. In this case the MAR in the “Hot Spot” would be approximately 7 grams ^{239}Pu-EQ.

The total amount of MAR available in any particular “Hot Spot” is dependent on the actual distribution of the radionuclides within the specified volume and the chosen depth of the excavation. Provided the assumption is made that the “Hot Spot” occupies a large portion of the defined volume and the detected concentration that is up to 100 times greater than the average then the “Hot Spot” volume could represent a MAR range of up to 8 grams of ^{239}Pu-EQ. Using a sampling approach such as this would be an effective method for ensuring a MAR limit of 8 grams would not be exceeded during excavation activities.

The implementation of the LCO for MAR and conducting the excavation and monitoring in accordance with the Excavation Control Program will ensure that the total amount of radionuclides available for release is maintained below the Hazard Category 3 threshold of 8.4 grams for ^{239}Pu. This will ensure that both the worker and the public are adequately protected.

Assuming an average concentration of 6 x 10^{-3} g/m^3 the total MAR (grams ^{239}Pu-Eq) that is available for release in the excavation area is on the order of 2.2 grams, which will keep any potential exposure to the worker of the public to manageable levels. DOE STD 1027 establishes Hazard Category 3 thresholds for radionuclide inventory.

Figure 3.4-1. Conceptual Sampling Grid



Grid spacing 'G' is defined as 2 meters on a square lattice that generates a grid for n = 25 samples each located at the center of a lattice cell

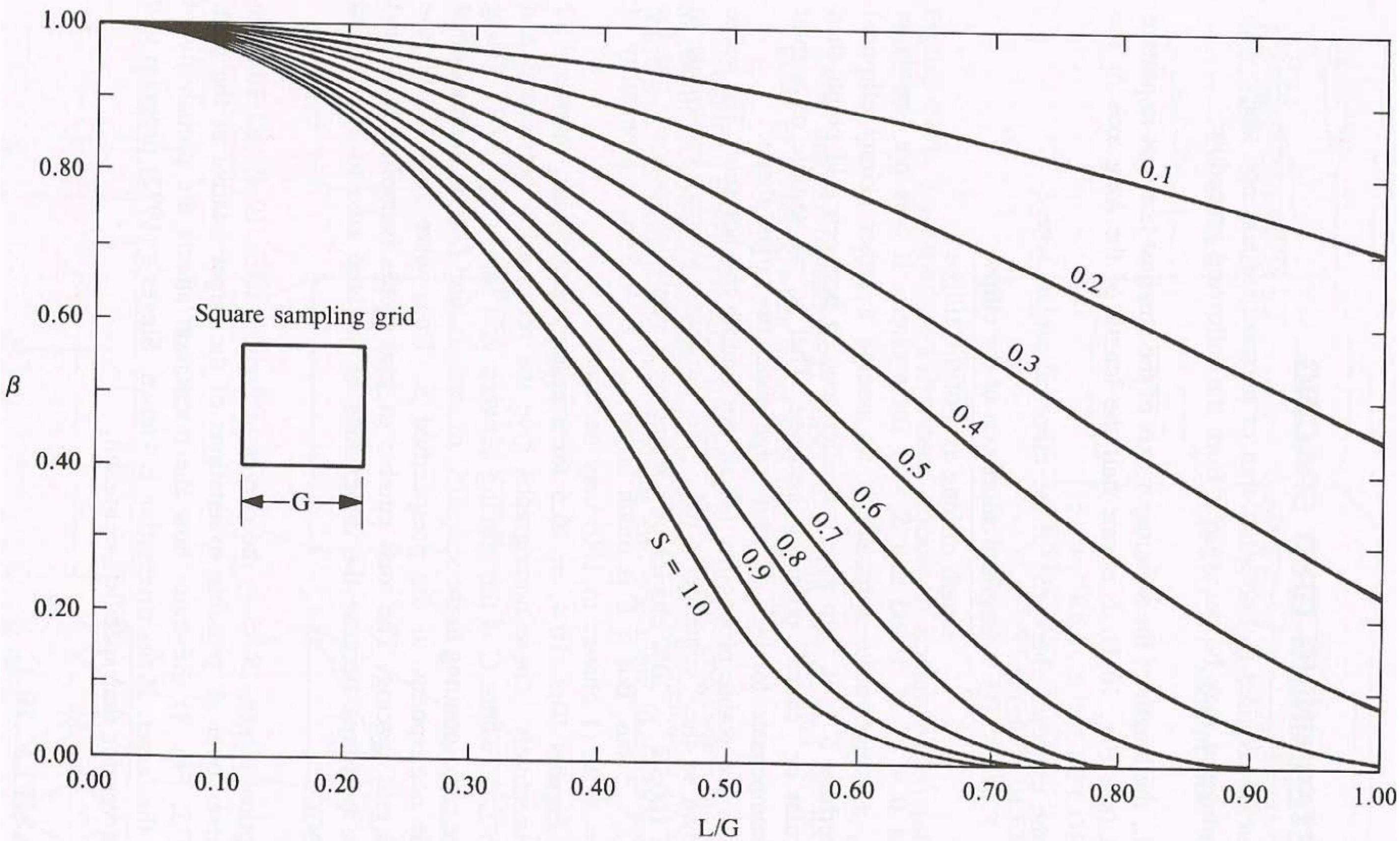


Figure 10.3 Curves relating *L/G* to consumer's risk, β, for different target shapes when sampling is on a square grid pattern (after Zirschky and Gilbert, 1984, Fig. 3).

Figure 3.4-2: Estimating the Dimensions of a "Hot Spot" Based on the Sampling

3.5 CONTROL SELECTION

3.5.1 Engineering Controls

3.5.1.1 Excavation Cover

Analysts designated the excavation cover as a SS SSC. The excavation cover provides a continuous[a] cover and can consist of a soil (or other similar fill material) cover of at least 6 in. thick, or be another mechanism to provide an equivalent level of performance. The excavation cover is addressed as a TSR AC Program element in section 5 of the TSR document

3.5.1.2 Inventory Isolation System

The inventory isolation system (i.e., the depth of burial, cover material/cap, and distribution of buried waste), as described in the NES S&M DSA (LANL 2004, 87651), provides passive confinement and protection to buried waste in unexcavated waste cells.

The depth of burial provides protection to waste from surface activities and other external forces. Most of the waste in MDA B is contained well below the surface.

Distribution (rather than concentration) of the inventory primarily serves as a barrier to the release of significant amounts of hazardous materials/substances. At MDA B, inventory is distributed throughout pits and trenches over approximately 6 acres, mitigating the amount of material that could be released in the event that the MDA B cover material is inadvertently breached in any one location.

The thickness and characteristics of the MDA B cover material and cap vary. An asphalt cap with soil underneath covers approximately three-quarters of the site. The remaining one-quarter of the site has been resurfaced with a variety of cover systems up to 2 m (6.5 ft) thick. These covers will provide an additional barrier to the inadvertent release of material.

The inventory isolation system is maintained within the geophysical boundaries of unexcavated waste cells to ensure that it can continue to perform its safety function. The inventory isolation system is not applicable to waste cells that have been excavated or are in the process of being excavated. The inventory isolation system is addressed in the DFs section of the TSR document.

3.5.1.3 Waste Packaging

Analysts designated waste packaging as a SS SSC. The waste packages provide passive confinement of excavated waste, minimize the potential for waste to add to the combustible loading in the event of a fire, minimize the potential for rapid combustion or overpressurization, and protect waste from small fires.

Waste packaging is addressed as a TSR AC Program element in section 5 of the TSR document.

3.5.2 Administrative Controls

3.5.2.1 Excavation Control Program

An Excavation Control Program will be established and documented in approved TSR implementing plans, procedures, or other appropriate mechanisms. The excavation control program will provide the basis and support for controlling the MAR during active waste material removal. Elements of the excavation control program include:

- Describes the methods and processes for defining the boundaries and extent of the excavation area;

- Ascertaining the minimum monitoring, sampling, and verification protocols and methods necessary to adequately estimate the MAR in the excavation area;
- Defining the “Hot Spot” along with the use and application for ensuring that the MAR Limit will not be exceeded;
- Establishes the constraints that limit the size and total concentration of any potential “Hot Spot”;
- Provides the methods and processes to determine the probability of encountering a “Hot spot”; and
- Defines the processes for modification of the EXCAVATION AREA, sampling and monitoring procedures and other aspects necessary to ensure that the MAR limit is not exceeded.

Specific criteria and details of the Excavation Control Program for the MDA B RCR are implemented in appropriate reviewed and approved facility-specific procedure or other implementing documents.

The administrative control program to effectively limit the total volume of material excavated from MDA B at any particular time is the primary mechanism for ensuring that the total MAR available is limited to less than HC 3 levels. In this manner the potential consequences from an inadvertent release are effectively mitigated or prevented.

3.5.2.2 Surveillance and Maintenance Program

The S&M Program is necessary to maintain current waste-isolation characteristics within the geophysical boundaries of unexcavated waste cells and to evaluate changes in the physical setting at MDA B that could significantly affect those waste-isolation characteristics. The MDA B S&M Program includes a subset of the S&M activities described in the NES S&M DSA (LANL 2004, 87651) as the primary controls for preserving the integrity of the inventory isolation system. Specific criteria necessary to implement the requirements of the S&M Program are established, using a graded approach, in a facility-specific procedure or procedures or other implementing document. Analysts identified the following specific S&M Program requirements for the prevention and/or mitigation of hazards associated with unexcavated waste cells during MDA B RCR:

- Erosion control measures, including the maintenance of vegetation, surface and near-surface soil, overburden, and cover material/caps and the use of water diversions are implemented as needed.
- Visual inspections are conducted as necessary within the geophysical boundaries of the unexcavated waste cells.
- The movement of vehicles/heavy equipment within the geophysical boundaries of unexcavated waste cells is controlled as applicable.
- Near-surface earthwork within the geophysical boundaries of unexcavated waste cells is controlled as applicable.

The S&M Program is addressed in the ACs section of the TSR document.

3.5.2.3 Safety and Health Program

The Safety and Health Program, as required by HAZWOPER, controls worker safety and health hazards and provides for emergency response. The controls in place to protect the workers also, in many cases, protect the public. A Safety and Health Program consistent with HAZWOPER and LANL implementing requirements is implemented and maintained for MDA B RCR. Specific criteria are established, using a graded approach, in a facility-specific procedure or procedures or other implementing document. Analysts identified the following specific Safety and Health Program requirements for the prevention and/or mitigation of hazards associated with MDA B RCR:

- An exposure monitoring and air-sampling program is established.
- Spotters are used as applicable during excavation operations.
- Observation of an unattended (i.e., between shifts) open excavation is conducted as applicable.
- A spill-control plan provides for worker response, as applicable, to spills of hazardous materials/substances that occur outside of the excavation (i.e., during waste handling or staging above ground).
- Spotters are used as applicable during vehicle/heavy equipment movement.
- Site personnel use PPE as required by the SSHASP, RWP, and IWD.
- A site control plan is established.
- An emergency response plan is established.
- Dust control is used as applicable.

The Safety and Health Program is addressed in the ACs section of the TSR document.

3.5.2.4 Fire Protection Program

A Fire Protection Program is implemented and maintained for MDA B RCR consistent with LANL implementing requirements. Specific criteria necessary to implement the requirements of the Fire Protection Program are established, using a graded approach, in a facility-specific procedure or procedures or other implementing document. Analysts identified the following MDA B RCR-specific Fire Protection Program requirements for the prevention and/or mitigation of hazards associated with MDA B RCR:

- Vegetation is maintained/controlled.
- Transient combustibles are minimized.
- MDA B field personnel are trained to respond to incipient fires.
- Fire response equipment and/or material, as applicable, is on hand and available for use.

The Fire Protection Program is addressed in the ACs section of the TSR document.

3.5.2.5 Hazardous Material and Waste Management Program

The LANL Hazardous Material and Waste Management Program has been established to manage waste and aid in meeting the requirements of DOE orders, federal and state regulations, and Laboratory permits. A Hazardous Material and Waste Management Program is implemented and maintained for MDA B RCR consistent with LANL implementing requirements. Specific criteria necessary to implement the requirements of the Hazardous Material and Waste Management Program are established, using a graded approach, in a facility-specific procedure or procedures or other implementing document. Analysts identified the following MDA B RCR-specific Hazardous Material and Waste Management Program requirements for the prevention and/or mitigation of hazards associated with MDA B RCR:

- The management of nonradiological hazardous materials/substances complies with applicable state and federal regulations.
- Filled or partially filled waste containers are not stacked.

The Hazardous Material and Waste Management Program is addressed in the ACs section of the TSR document.

3.5.3 Additional Safety Management Programs

The Laboratory has designed its SMPs to ensure that a facility/activity is operated/conducted in a manner that adequately protects the public, workers, and the environment. The Laboratory relies upon SMPs to provide additional DID to MDA B RCR activities and to further ensure the safety of the public, workers, and the environment. These additional LANL SMPs are also addressed in the ACs section of the TSR document. Specific criteria necessary to implement the requirements of each SMP are established, using a graded approach, in facility-specific procedures or other implementing document.

3.5.3.1 Abnormal Events Reporting Program

An Abnormal Events Reporting Program is implemented and maintained for MDA B RCR consistent with LANL implementing requirements. This program will ensure that site personnel report and evaluate injuries or illnesses, environmental incidents, radiological incidents, property damage, and any other reportable occurrences according to the required method set forth by LANL.

3.5.3.2 Calibration Program

A Calibration Program is implemented and maintained as applicable consistent with LANL implementing requirements to ensure the proper control, use, and calibration of tools and equipment necessary for the RCR of MDA B.

3.5.3.3 Chemical Management Program

The purpose of LANL's Chemical Management Program is to protect worker health and safety, assist Emergency Management and Response (EM&R), protect the environment, and minimize waste by controlling chemical activities. LANL's Chemical Management Program ensures that only workers qualified through education, training, and experience work with chemicals. A Chemical Management Program is implemented and maintained for MDA B RCR consistent with LANL implementing requirements.

3.5.3.4 Conduct of Operations Program

By identifying the risks to operations and developing and implementing the controls needed to perform the work safely and securely, the LANL Conduct of Operations Program ensures that conduct of operations is integrated into the Laboratory's processes for accepting and performing work. The Conduct of Operations Program ensures that the depth of detail required and the magnitude of resources expended for operations are commensurate with each facility's programmatic importance and potential environment, safety, health, and security impact. A Conduct of Operations Program is implemented and maintained for MDA B RCR consistent with LANL implementing requirements.

3.5.3.5 Configuration Management Program

Configuration management (CM) is an integrated management program that establishes consistency among design requirements, physical configuration, and facility documentation, and maintains this consistency throughout the life of the facility as changes occur. The LANL CM Program consists of CM functions associated with program management, design requirements, document control, change control, and assessments.

A CM Program is implemented and maintained for MDA B RCR consistent with LANL implementing requirements to ensure that changes to the technical baseline are properly identified, developed, assessed, approved, scheduled, implemented, and documented using a formal process. This program additionally ensures the use of a systematic, rigorous process to document, review, and approve changes to the barriers that the Laboratory relies upon to protect the public, workers, and environment.

3.5.3.6 Emergency Management and Response Program

The LANL Emergency Management and Response Program addresses emergency preparedness planning, activation of emergency organizations, assessment actions, notification processes, emergency facilities and equipment, protective actions, training and exercises, and recovery actions. The EM&R Group is responsible for assisting Laboratory personnel by administering a comprehensive emergency management program. A MDA B RCR-specific emergency response plan is implemented and maintained consistent with LANL implementing requirements.

3.5.3.7 Integrated Work Management Program

The LANL Integrated Work Management (IWM) Program defines requirements and processes for doing work in a safe, secure, environmentally responsible manner. The program defines the requirements for the implementation of the five-step process associated with Integrated Safety Management (ISM) and Integrated Safeguards and Security Management (ISSM) and directly supports the LANL Environmental Management System at the activity level. The core functions of ISM and ISSM include the following tasks:

- Define the work
- Identify and analyze hazards
- Develop and implement controls
- Perform the work
- Ensure performance

While implementing the five-step ISM process, IWM emphasizes the following criteria:

- Management and worker accountability
- Applying the worker’s knowledge and experience
- Providing integrated, worker-friendly documentation that includes defined work tasks/steps that are linked to specific hazards and unambiguous controls
- Identifying a single person-in-charge for each work activity
- Providing independent oversight and facility coordination
- Formally validating, releasing, and closing out work activities
- Feedback and continuous improvement

The most important aspects of this process are the direct involvement of workers in controlling the risks and the accountability of responsible division leaders and of responsible line managers for safety, security, and environmental protection. As the level of risk posed by the hazards and work complexity increases, IWM requires a more rigorous process and documentation. For moderate- and high-hazard and complex activities, the work process, hazards, and controls must be documented in an IWD. The IWD consists of the following four parts:

- Activity-specific information

- Work-area information
- Validation and release information (followed by work execution)
- Close-out information

An IWM Program is implemented and maintained for MDA B RCR consistent with LANL implementing requirements to ensure that appropriate controls are in place and that work is authorized so that no increase in risk to the workers, public, or environment is created. Additionally, this program ensures the use of a systematic, rigorous process to document, review, and approve changes to the barriers that the Laboratory relies upon to protect the public, workers, and environment.

3.5.3.8 Maintenance Management Program

A Maintenance Management Program is implemented and maintained for MDA B RCR consistent with LANL implementing requirements. This program ensures the effective performance and reliability of SSCs.

3.5.3.9 Quality Assurance Program

LANL's Institutional Quality Management Program (IQMP) assigns roles, responsibilities, authorities and accountabilities; defines policies and requirements; provides for the performance and assessment of work; and ensures the identification and application of improvement initiatives. Through the implementation of the IQMP, LANL

- enhances the formality of operations;
- reduces work-related risk and hazards to the public and workers;
- improves responsibility and accountability for material, process, and product control;
- improves work-control processes through the integration of quality and safety principles in a single work-control process that uses consensus codes and standards ;
- provides guidance for tailoring and simplifying the approach to meet requirements;
- institutionalizes the ISSM System;
- communicates an integrated corporate approach to business systems management;
- minimizes rework and improves efficiency and effectiveness in work productivity;
- provides the means to ensure continued ability to meet customer needs and institutional goals; and
- increases facility availability to support national science and stockpile stewardship missions.

A Quality Assurance Program is implemented and maintained for MDA B RCR consistent with LANL implementing requirements and in support of the LANL IQMP to achieve and improve quality through the identification of problems and the recommendation and initiation of improvements during MDA B RCR. This program will ensure that MDA B RCR maintains quality requirements that address the needs of sampling, surveying, mapping, excavating, other applicable activities, and personnel.

3.5.3.10 Radiation Protection Program

A Radiation Protection Program is implemented and maintained during MDA B RCR consistent with LANL implementing requirements for radiological survey issues related directly to worker safety and to unrestricted release as described in 10 CFR 835. The LANL Radiation Protection Program includes the following elements that, combined, accomplish the as-low-as-reasonably-achievable (ALARA) principle and ensure personnel health and safety:

- Areas with potential radiological hazards are identified and designated with postings.
- Radioactive contamination is managed and controlled to minimize personnel exposure and to limit inadvertent transfer beyond area boundaries.
- External and internal radiation doses to personnel are monitored and ensured not to exceed annual or lifetime limits.
- Instrumentation used to make radiation measurements is calibrated and maintained to ensure accurate results.
- Areas and activities requiring PPE are identified.
- Personnel are given training in radiation protection.

3.5.3.11 Records Management Program

Records include information created and received in the course of conducting LANL programs and business. A Records Management Program is implemented and maintained for MDA B RCR consistent with LANL implementing requirements to ensure that records created in the normal course of business are maintained and protected from unauthorized destruction or removal.

3.5.3.12 Training and Qualification Program

A Training and Qualification Program is implemented and maintained for MDA B RCR consistent with LANL implementing requirements. This program ensures that personnel responsible for facility operations, process operations, vehicle operations, maintenance, and technical support are trained and qualified/certified, as applicable, to accomplish their safety-related responsibilities.

3.5.3.13 Unreviewed Safety Question Program

The unreviewed safety question (USQ) process facilitates the ability to make changes to support day-to-day operations. The USQ process also provides a mechanism for keeping the safety basis current by reviewing potential USQs, reporting USQs to DOE, and obtaining approval from DOE before taking any action that involves a USQ. The USQ process is required for

- all temporary or permanent physical changes at a facility;
- all temporary or permanent changes to procedures at a facility;
- all activities, operations, tests, or experiments that are new to a facility; and
- discoveries of potential inadequacies in the existing DSA.

The USQ process not only applies to changes within the boundary of a facility, but also to changes outside the boundary, when those changes have the potential to affect the safety of the operations within the boundaries.

A USQ Program is implemented and maintained for MDA B RCR consistent with LANL implementing requirements to ensure that any changes to MDA B's planned activities are analyzed against the DSA with respect to frequency, consequences, and safety margin to determine if the change falls within the existing safety envelope or if it requires approval through the USQ process. The USQ Program thereby ensures that controls remain effective and that analysts identify any additional controls necessary to the safety basis of MDA B RCR.

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Copies of the master reference set are maintained at NMED's Hazardous Waste Bureau; DOE-LASO; EPA, Region 6; and EP-ERSS. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.

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Appendix A

Acronyms/Abbreviations and Glossary

A-1.0 ACRONYMS AND ABBREVIATIONS

AC	administrative control
AEC	Atomic Energy Commission
AGL	above ground level
ALARA	as low as reasonably achievable
CM	Chemistry and Metallurgy
CM	configuration management
CMR	Chemistry and Metallurgy Research
CMR-11	DP West production group
Consent Order	Compliance Order on Consent
DF	design feature
DID	defense-in-depth
DOE	Department of Energy (U.S.)
DP	Delta Prime
DSA	documented safety analysis
EC	engineering control
EG	Evaluation Guideline
EM&R	emergency management and response
EP	Environmental Programs (a LANL directorate)
EPA	Environmental Protection Agency (U.S.)
ER	environmental restoration
ES&H	environment, safety, and health
ERSS	Environment and Remediation Support Services
FID	flame ionization detector
FIDLER	Field Instrument for Detecting Low Energy Radiation
FPP	Fire Protection Program
GM	Geiger-Mueller
GPR	ground-penetrating radar
H-6	environmental studies groups (LANL)
HazCat	hazard category
HAZWOPER	hazardous waste operations and emergency response
HC	hazard category
HF	hydrogen fluoride
HYPO	High Power Water Boiler
IQMP	Institutional Quality Management Program
ISM	Integrated Safety Management
ISSM	Integrated Safeguards and Security Management
IWD	integrated work document
IWM	Integrated Work Management
LANL	Los Alamos National Laboratory
LANS	Los Alamos Nuclear Security
LASL	Los Alamos Scientific Laboratory (now Los Alamos National Laboratory)

LASO	Los Alamos Site Office (DOE)
LEL	lower explosive limit
LOPO	Low Power Water Boiler
M	mitigative
MAR	material-at-risk (Ci)
MDA	material disposal area
MED	Manhattan Engineering District (U.S. Army)
MEOI	maximally exposed off-site individual
N/A	not applicable
NDA	Nuclear Regulatory Commission Licensed Disposal Area
NES	nuclear environmental site
NMED	New Mexico Environment Department
NNSA	National Nuclear Security Administration
ORPS	Occurrence Reporting and Processing System
OSHA	Occupational Safety and Health Administration
OST	operational support tool
P	preventive
PASS	Product Acoustic Signature System
PCB	polychlorinated biphenyl
PE-Ci	plutonium-239 equivalent curie
PID	photoionization detector
PPE	personal protective equipment
RaLa	radioactive lanthanum
RCR	removal, characterization, and restoration
RCRA	Resource Conservation and Recovery Act
RF	respirable factor
RFI	RCRA facility investigation
RPF	Records Processing Facility (an EP-ERSS archive)
RWP	radiological work permit
S&M	surveillance and maintenance
SAC	specific administrative control
SAL	screening action level
SBO	safety basis office
SC	safety-class
SIH	standard industrial hazard
SME	subject matter expert
SMP	safety management program
SS	safety-significant
SSC	structure, system, or component
SSHASP	site-specific health and safety plan
SSL	soil screening level
ST	source term
SUPO	Super Power Water Boiler

SVOC	semivolatile organic compound
SWMU	solid waste management unit
TA	technical area
TAL	target analyte list (EPA)
TSCA	Toxic Substances Control Act
TSR	technical safety requirement
USQ	unreviewed safety question
VOC	volatile organic compound
XRF	x-ray fluorescence

A-2.0 GLOSSARY

administrative controls—Nonphysical or nonengineered mechanisms for managing risks to human health and the environment.

area of contamination— As defined by the U.S. Environmental Protection Agency, certain areas of generally dispersed contamination that could be equated to a Resource Conservation and Recovery Act (RCRA) landfill. The movement of hazardous wastes within those areas would not be considered land disposal and would not trigger RCRA land-disposal restrictions. An area of contamination may be designated by the Environmental Programs-Environment and Remediation Support Services as part of a corrective action for waste management purposes, subject to approval by the administrative authority.

as low as reasonably achievable (ALARA)—(1) An approach to radiation protection for controlling or managing exposure (both individual and collective) to the work force and the general public. (2) An approach for controlling or managing releases of radioactive material to the environment at levels as low as social, technical, economic, practical, and public-policy considerations permit. ALARA is not a dose limit.

design features—The design features of a nuclear facility specified in the technical safety requirements that, if altered or modified, would have a significant effect on safe operation.

field screening sample—A sample that may be collected and analyzed on-site and may be used for health and safety analysis, preliminary waste assay and segregation, and temporary handling and storage control.

graded approach—A management tool used to evaluate the importance and relative risk of an item, activity, or service in the working process.

hazardous material/substance—Includes any substance designated or reflected in 29 CFR 1910.120, to which exposure may result in adverse affects to the worker, public, or environment including : (1) any substance defined under section 101(14) of CERCLA; (2) any biological agent and other disease-causing agent that after release into the environment and upon exposure, ingestion, inhalation, or assimilation into any person, either directly from the environment or indirectly by ingestion through food chains, will or may reasonably be anticipated to cause death, disease, behavioral abnormalities, cancer, genetic mutation, physiological malfunctions (including malfunctions in reproduction), or physical deformations in such persons or their offspring; (3) any substance listed by the DOT as hazardous materials under 49 CFR 172.101 and appendixes; and (4) hazardous waste (i.e., a waste or combination of wastes as defined in 40 CFR 261.3 or substances defined as hazardous waste in 49 CFR 171.8).

overburden—Any material that may be present over the contents of the MDA B waste cells, but is not contained within. May include but is not limited to, soils, miscellaneous fill, gravel, or stone or concrete rip rap. The overburden may or may not be contaminated.

release—Any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing of hazardous waste or hazardous constituents into the environment (including the abandonment or discarding of barrels, containers, and other closed receptacles that contain any hazardous wastes or hazardous constituents).

safety-significant structure, system, and components (SS SSCs)—Structures, systems, and components which are not designated as safety-class SSCs but whose preventive or mitigative function is a major contributor to defense in depth and/or worker safety as determined from safety analyses. (As a general rule of thumb, safety-significant SSC designations based on worker safety are limited to those systems, structures, or components whose failure is estimated to result in a prompt worker fatality or serious injuries or significant radiological or chemical exposures to workers. The term, serious injuries, as used in this definition, refers to medical treatment for immediately life-threatening or permanently disabling injuries [e.g., loss of eye, loss of limb].)

screening action level (SAL)—A radionuclide's medium-specific concentration level; it is calculated by using conservative criteria below which it is generally assumed that no potential exists for a dose that is unacceptable to human health. The derivation of a SAL is based on conservative exposure and on land-use assumptions. However, if an applicable regulatory standard exists that is less than the value derived, it is used in place of the SAL.

soil screening level (SSL)—The concentration of a chemical (inorganic or organic) below which no potential for unacceptable risk to human health exists. The derivation of an SSL is based on conservative exposure and land-use assumptions, and on target levels of either a hazard quotient of 1.0 for a noncarcinogenic chemical or a cancer risk of 10^{-5} for a carcinogenic chemical.

specific administrative control (SAC)—An AC that provides a specific preventive or mitigative function for accident scenarios identified in the DSA where the safety function has importance similar to, or the same as, the safety function of a safety SSC (e.g., discrete operator actions, combustible loading program limits, hazardous material limits protecting hazard analyses or facility categorization).

unrestricted release criteria—Concentrations of residual chemical and radiological constituents, when weighted against one another, present an acceptable residual risk. Attainment of these concentrations is necessary prior to any permanent backfill, stabilization, and restoration operations.

verification sample—A sample transferred off-site for laboratory analyses and related to material left in place at the close of trench investigation (i.e., tuff) and/or material packaged and transported off-site for waste disposal. Verification samples are used to demonstrate compliance with unrestricted release criteria.