2.0 Description of Proposed Action and Alternatives

This section discusses the Proposed Action and a No Action Alternative. Section 2.1 describes the site and characteristics of MDA H and includes summary information about site investigations and characterization and the waste inventory at MDA H. Section 2.2 describes the Long-Term Environmental Stewardship Program. Section 2.3 describes the No Action Alternative as a baseline for comparison with the consequences of implementing the Proposed Action. Section 2.4 describes the Proposed Action for the EA that would allow NNSA to meet its purpose and need for agency action. The Proposed Action, implementing a corrective measure at MDA H, has five corrective measure options. There are three containment corrective measure options, discussed in Section 2.4.1, and two excavation and removal corrective measure options, discussed in Section 2.4.2.

Because the MDA H RFI report (LANL 2001a) identified no unacceptable present-day risks to human health or the environment and no unacceptable dose levels from radiological contaminants at MDA H, the potential need for corrective action at MDA H is based on future potential for releases that might create unacceptable risks or doses to human health or the environment. Thus, the proposed corrective measure options emphasize confirmation of continuing absence of releases, controlling the sources that could contribute to releases, and providing containment that would ensure the magnitude of potential future releases would be within acceptable risk and dose levels.

As stated earlier, the final selection of a corrective measure option would be made by the NMED, which has been delegated RCRA corrective action authority from the EPA. NMED is not obligated to select any one of the five corrective measure options analyzed in this EA, but could choose a combination of corrective measures or a totally different corrective measure option. The corrective measure options analyzed in this EA address a range of potential containment and excavation options and are intended to be representative of corrective measures that could be implemented at MDA H. This EA analyzes the potential environmental consequences of implementing corrective measure options consistent with RCRA requirements, EPA guidance, the HSWA permitting process, DOE policy, and other applicable regulations. In accordance with HSWA requirements, corrective measure options selected for this analysis are based on the information developed in the RFI and are intended to provide a bounding analysis of the potential environmental effects of implementing any corrective measure option at MDA H.

This EA incorporates, by reference, the MDA H RFI Report (LANL 2001a) and Addendum (LANL 2002a, 2001a), the CMS Plan (LANL 2001b), and the CMS Report (LANL 2003) submitted to NMED by DOE and UC at LANL. Detailed information on the MDA H investigation, site characteristics, waste inventory, corrective measures screening process, corrective measure options, and waste handling procedures can be found in the MDA H RFI Report (LANL 2001a) and Addendum (LANL 2002a, 2001a) and in the CMS Report (LANL 2003). Copies of these reports may be reviewed in Los Alamos, New Mexico, at the DOE Reading Room in the Community Relations Office located at 1619 Central Avenue, and in Santa Fe, New Mexico, at the Northern New Mexico Citizens Advisory Board located at 1660 Old Pecos Trail, Suite B. Information pertinent to the analysis of the environmental consequences of the Proposed Action is included in this EA. Should the corrective measure chosen by NMED prove to have environmental effects that are not bounded by this EA analysis, DOE will pursue an additional NEPA compliance review.

2.1 Site Description and Characteristics of MDA H

As previously stated, TA-54 is located in the east-central portion of LANL on Mesita del Buey between Pajarito Canyon (south) and Cañada del Buey (north). Access to TA-54 and Pajarito Road is restricted. MDA H, designated SWMU 54-004 under the RCRA corrective action process, is a 70-ft (21-m) by 200-ft (60 m) fenced area (0.3-ac [0.12 ha]) (Figure 4). The site is not located near any existing structures or paved vehicle parking areas. The area near MDA H is considered to be a developed area with unpaved access roads and unpaved parking areas. No floodplains, wetlands, or sensitive species habitat areas are located nearby. A complete description of the natural characteristics of the MDA H setting is provided in Appendix B of the MDA H RFI Report (LANL 2001a).

MDA H consists of nine inactive vertical disposal shafts arranged in a row about 15 ft (4.5 m) inside its southern fence (see Figure 3). Each shaft is cylindrical with a diameter of 6 ft (1.8 m) and a depth of 60 ft (18 m). Shafts at MDA H are located more than 90 ft (27 m) from the south rim of Mesita del Buey, which puts them outside the zone of increased susceptibility for mesa edge failure (see Geology, Section 3.5). One shaft, shaft 9, has an existing 6-ft (1.8-m) concrete cap; the remaining shafts are capped with 3 ft (0.9 m) of concrete covered with 3 ft (0.9 m) of crushed tuff[8] material. The entire MDA site, including the shafts and caps, is covered

Figure 4. Material Disposal Area H at TA-54. (The mound of soil in the right forefront of the photo is clean fill remaining after the excavation of the last shaft.)

[8] "Tuff" is locally available consolidated (or "welded") volcanic ash that covers the Pajarito Plateau. Tuff is a relatively soft, porous rock varying in size from fine sand to coarse gravel and is usually formed by the compaction and cementation of volcanic ash or dust.

with a layer of soil. The concrete caps were brought to grade level with crushed tuff placed above the caps. The exact condition and the calculated life span of the caps over the MDA H shafts have not been determined. There are many factors that affect the performance of concrete and its life span of service; concrete actually cures harder over years of existence. The concrete shaft caps at MDA H are buried under about 3 ft (0.9 m) of tuff and soil so their exposure to weathering events and circumstances is very limited or not present. Prior to the initiation of any of the corrective measures that would leave wastes in place at Area G, the covering soil would be removed and the condition of the caps would be assessed. If the caps need to be replaced, they would be replaced with high performance concrete caps.

The surface of MDA H (including the shaft caps) is vegetated with native[9] grasses and herbaceous plants that stabilize the soil against erosion. In addition, the surface is contoured to redirect storm water runoff around the site and into a single surface drainage feature to Pajarito Canyon. No saturated ground conditions were encountered during installation of the shafts. The shafts were used between 1960 and 1986 for the disposal of classified solid-form waste generated by LANL operations. MDA H contains both radioactive and hazardous wastes including, but not limited to, plutonium, tritium, uranium, metals, and HE.

The site-specific aspects of the natural setting of MDA H (discussed in more detail in Chapter 3 of this EA) that are important to assessing the potential future impacts posed by releases of contamination to surface and subsurface media include the following:

- A very thick, relatively dry, unsaturated zone helps to limit downward migration of dissolved inorganic contaminants (metals and radionuclides, excluding tritium) in the liquid phase through the vadose zone (the zone of aeration in the earth's crust above the groundwater level where water in vapor form may be located) to the regional aquifer. The deepest borehole adjacent to MDA H is 300 ft (90 m) and no saturated conditions have been encountered. The regional aquifer is about 1,000 ft (300 m) below MDA H based on data from regional well R-20, located in Pajarito Canyon about 0.5 mi (0.8 km) southeast of MDA H;
- A semiarid climate with low precipitation and a high evapotranspiration (ET)[10] rate limits the amount of moisture percolating into the disposal units, subsequently limiting the amount of water available to leach[11] radionuclides or hazardous constituents; and
- Infrequent soaking rains and episodic rainfall events.

2.1.1 Site Investigation and Characterization

The nature and extent of contamination in the vicinity of MDA H were characterized during the RFI Report (LANL 2001a) and addendum (LANL 2002a, 2001a). During the RFI, samples of tuff and pore gas were collected from boreholes around the disposal shafts, and sediment

[9] The resident plant species that evolved within, or naturally dispersed to, various vegetation zones at LANL are "native" or "indigenous" species.
[10] ET is the combined discharge of water from the earth's surface to the atmosphere by evaporation from lakes, streams, and soil surfaces, and by transpiration (giving off water vapor) from plants.
[11] Leach, as used in this EA, refers to a material or element being dissolved by and carried away with liquid water into the surrounding environment.

samples were collected from the drainage channel receiving runoff from the site. The results of the RFI indicate there have been no releases of radionuclides or hazardous constituents associated with runoff from the site or infiltration of water through the disposal shafts. The RFI results, however, indicate subsurface releases of radioactive tritium (in the form of water vapor) and trace amounts of volatile organic compounds (VOCs) from the shafts associated with vapor phase transport. The levels of tritium and VOCs detected during the RFI were extremely low and do not pose a potential current risk to human health and the environment. The extent of this contamination was found to be limited to the immediate vicinity of the disposal shafts.

A CMS was requested by the NMED-Hazardous Waste Bureau (Young 2000) to ensure future potential impacts from the site remain low. DOE and UC at LANL submitted a CMS Plan (LANL 2001b) to NMED proposing approaches to determine the need for and the features of corrective measures options. As part of the CMS, contaminant fate and transport modeling was performed to evaluate the expected performance of corrective measure Option 1. The result of this modeling was that no transport of contaminants from the disposal shafts to surface water or groundwater would be likely over a 1,000-year evaluation period. It was concluded by inference that results for corrective measure Options 2 and 3 would be even better. The CMS Plan was approved by DOE and NMED in December 2001 (Young 2001).

A 1,000-yr performance period was evaluated for corrective measure options consistent with the performance assessment requirements for LLW disposal sites contained in DOE Order 435.1. The worker risk and dose assessments in the CMS Report (LANL 2003) are based on the projection that DOE would maintain institutional control of MDA H for the next 100 years, thereby limiting potential exposures to people living outside DOE's controlled area. It is possible that DOE may not maintain institutional control beyond a timeframe of 100 years. Therefore, the MDA H human health risk assessment also considers the potential for people to be exposed on or near MDA H once 100 years have elapsed. The potential for the loss of institutional controls after 100 years is consistent with performance assessment requirements for LLW disposal sites contained in DOE Order 435.1.

2.1.2 Estimated Inventory

A review of logbook and process descriptions along with personnel interviews was performed during the CMS to improve the accuracy of the estimated inventory in MDA H. These efforts resulted in a revised estimate of the waste inventory (LANL 2003, Omicron 2003). The approximate percentages by weight of material disposed of in the shafts at MDA H are shown in Figure 5.

About 33 percent of the MDA H waste inventory is metal objects including beryllium, copper, and enriched uranium fuel elements. As described in the logbook entries, DU comprises about 24 percent of the total waste inventory. Radioactive materials, other than DU, make up an additional 24 percent of the inventory. Radionuclides listed in the logbook entries include tritium; uranium-234, -235, -236, and -238; and plutonium-238, -239, -240, -241, and -242. Potentially reactive materials, such as lithium compounds and HE, each represent less than 1 percent of the inventory; these materials potentially meet the RCRA definition of characteristic hazardous waste. Graphite represents about 9 percent of the inventory. Additional materials, including plastics and recording media (such as paper documents, film, slides, and magnetic computer tapes), account for about 9 percent of the inventory (LASL 1960, Omicron 2003).

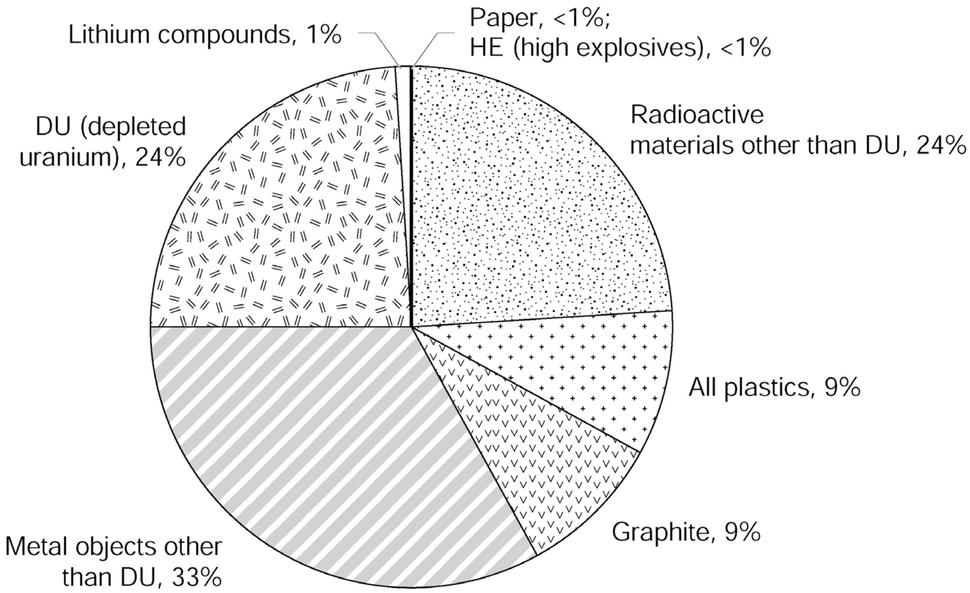

Figure 5. Breakdown of identified waste material disposed in shafts (approximate percentages by weight).

Potentially hazardous waste constituents not listed in logbook entries are anticipated to be present at MDA H based on process knowledge. These materials (barium, cadmium, chromium, lead, mercury, and silver) were used for shielding, solders, parts, or coatings. VOCs were not listed in the logbook entries but were detected in trace amounts in vapor phase sampling in the MDA H RFI boreholes (LANL 2002a).

2.2 Long-Term Environmental Stewardship Program

Depending on the corrective measure option ultimately selected and approved by the NMED, residual contamination could remain onsite after closure. For those options involving in-place containment of wastes (corrective measure Options 1, 2, and 3 and the No Action Alternative), physical controls (engineered barriers, such as caps and containment barriers) and institutional controls (such as access restrictions) would be required for generations to come. Because of the long-lived and hazardous nature of plutonium and other contaminants onsite, the risks posed by the breakdown or malfunction of an engineered barrier or institutional control could be potentially high. Consequently, one of the major challenges that has surfaced during the CMS process is incorporating long-term environmental stewardship requirements into the remedy decision-making process.

One of the key characteristics of the stewardship components is their interdependence. For example, physical controls would almost always require that the institutional or administrative controls designed to support them remain operational and functional. Likewise, monitoring and maintenance of both the physical controls and the institutional or administrative controls would be required to assess and ensure their performance. Information would need to be maintained about the physical and institutional or administrative controls, as well as the monitoring and maintenance records. Comprehensive periodic assessments would be conducted by examining well-kept records about stewardship controls and related monitoring and maintenance records.

The controlling authority (NMED) would likely require NNSA and UC at LANL to ensure that the stewardship controls remain in place, that they are maintained, that the necessary information is collected, and that the periodic assessment program is implemented and subsequent corrective actions are taken. As these examples show, no part of the stewardship program should be considered by itself.

The specific details of each stewardship component would necessarily depend on the corrective measure option selected. Therefore, details of the Long-Term Environmental Stewardship Program are not developed during the CMS, but the stewardship components are qualitatively

Components of a Long-Term Environmental Stewardship Program

These components of a **Long-Term Environmental Stewardship Program** work individually and collectively to ensure that the chosen corrective measure option remain protective of human health and the environment:

1. **Physical controls**: Physical controls include, but are not limited to, containment structures such as caps, water diversion and treatment systems, and access barriers such as fences, guards, and signs. These controls physically reside at the site of, or close to, the actual contamination.

2. **Institutional or Administrative Controls**: This category of controls includes governmental controls such as zoning, permits, and use restrictions; proprietary controls such as easements and covenants; legal enforcement tools such as administrative orders and consent decrees; and informational devices such as deed notices, registries, and advisories.

3. **Monitoring and Maintenance**: These components include periodic monitoring and maintenance of the selected corrective measure option and corresponding stewardship controls (whether physical or institutional and administrative).

4. **Information Management**: A successful stewardship program is dependent on retaining all necessary records about the site's history and residual contamination. Information that must be retained should include history of the site, the contaminants of concern, the selected corrective measure option, the use of controls along with their monitoring and maintenance records, and any other information judged necessary for succeeding generations to understand the nature and extent of the residual contamination.

5. **Periodic Assessment**: Periodic assessments are performed to determine whether the selected corrective measure option and stewardship controls continue to operate as designed, and to ascertain whether new technologies might exist to eliminate remaining residual contamination in a safe and cost-effective manner.

6. **Controlling Authority**: Long-term protection of human health and the environment necessitates that a controlling authority be established with responsibility for overall stewardship program management and guidance.

discussed together with the proposed option. Further guidance would be provided by the NMED as part of the Permit Modification decision in which an option is selected. Details of the final Long-Term Environmental Stewardship Program would then be developed by NNSA and UC at LANL as part of the CMI Plan for the selected option, which must be submitted to the NMED for approval.

2.3 No Action Alternative

The No Action Alternative, which in this case would be a continuation of the status quo, provides a description of current conditions to compare to the potential effects of the Proposed Action. The No Action Alternative is required by law and must be considered even if NNSA is under a court order or legislative command to act (10 CFR 1021.31[c]).

The CMS Report (LANL 2003) identified that the current design of the MDA H cover has been reliable and effective in preventing releases of wastes (with the exception of subsurface vapor releases of VOCs and tritium) from the shafts at MDA H. This cover has had minimal maintenance in its 40-year lifetime. If properly maintained, the existing cover should adequately perform its intended containment function. Contaminant transport modeling of the effectiveness of the existing cover demonstrated that no contaminants would be likely to reach the regional groundwater table beneath MDA H during the 1,000-year evaluation period.

Under the No Action Alternative, none of the corrective measure Options 1 through 5 described in Sections 2.4.1 through 2.4.2.2, would be undertaken at this site, although a Long-Term Environmental Stewardship Program would be implemented at the site. There would be only limited control of the amount of water that could percolate into the shafts and contribute to potential subsurface contaminant transport. Enhanced erosion controls to limit direct exposure of the waste and further minimize surface transport of contaminants would not be implemented. There would be a continuing potential for contaminant mobilization due to biotic intrusion of deep-rooting plants and burrowing animals and, potentially, human intrusion. Vapor-phase waste migration would continue to occur until all vapor phase waste were depleted and vapors were vented to the atmosphere, were bioconverted or decayed, or were diluted over time.

The need for implementation of a corrective measure at MDA H is based on future potential for releases that might create unacceptable risks or doses to human health or the environment. DOE is required by NMED through Module VIII of LANL's Hazardous Waste Facility Permit (EPA 1994, 1990) to perform site characterization and cleanup. Under the No Action Alternative, DOE, NNSA would not implement site remediation and would not comply with the requirements of Module VIII of LANL's Hazardous Waste Facility Permit. In addition, NNSA and UC at LANL activities would not comply with the requirements of Sections 3004(u) and (v) of RCRA, the *Atomic Energy Act of 1954*, and other applicable laws, regulations, and DOE orders.

2.4 Proposed Action

The Proposed Action is to implement a corrective measure at MDA H within TA-54. The CMS Report identified five corrective measure options (Table 1), each of which would meet the CMS

Table 1. Corrective Measure Options for the Proposed Action

Containment Corrective Measure Options
Corrective Measure Option 1: Upgrade Existing Surface
Corrective Measure Option 2: Replacement of the Existing Surface with an Engineered ET Cover
Corrective Measure Options 3 a and b: Partial or Complete Encapsulation and Use of Engineered Caps and an Engineered ET Cover
Excavation and Removal Corrective Measure Options
Corrective Measure Option 4: Complete Excavation with Maximal Offsite Disposal
Corrective Measure Option 5: Complete Excavation with Maximal Onsite Disposal

Plan's corrective action objectives[12] (see text box); these five corrective measure options range from the relatively simple to implement to the more complex actions with correspondingly increased cost and more complex implementation requirements. This EA analyzes effects for three waste containment corrective measure options and two conceptual waste excavation and removal corrective measure options as part of the Proposed Action. The corrective measure options analyzed in this EA address a range of potential containment and excavation options and are intended to provide a bounding analysis of the potential environmental effects of implementing any corrective measure option at MDA H. The corrective measure option preferred by DOE is corrective measure Option 2, Replacement of the Existing Surface with an engineered ET cover. This corrective measure option was proposed for implementation to the State in the draft CMS Report (LANL 2003).

Corrective Action Objectives Identified in the CMS Plan

In accordance with Module VIII of LANL's Hazardous Waste Facility Permit (EPA 1990, 1994) and the MDA H CMS Plan, any corrective measure option considered for implementation at MDA H must satisfy the following **corrective action objectives** established in the CMS Plan:

- protect human health,
- protect the environment,
- attain action levels (provide reasonable assurance that the potential migration of contaminants would not result in contaminant concentrations in the environment high enough to warrant an action),
- control the source of potential contamination to reduce or eliminate releases that may pose a threat to human health or the environment, and
- comply with all applicable waste management requirements.

General Measures

Work at MDA H for any of the five corrective measure options could require the use of heavy equipment such as drill rigs, cranes, cement trucks, dump trucks, trackhoes, excavators, front-end loaders, and backhoes. Corrective measure options involving waste excavation could also require the use of a conveyor system and remote-handling equipment. Equipment would operate primarily during the daylight hours and would be left onsite over night. During site activities, space in the immediate vicinity would be required for vehicle parking,

[12] The corrective action objectives listed in the text box in Section 2.3 of this EA must be satisfied for any corrective measure option developed for MDA H. The corrective measure action objectives were based on the EPA RCRA Corrective Action Plan (EPA 1994) and the DOE RCRA Corrective Action Plan Program Guide (DOE 1993c).

equipment storage, and material staging. Existing site controls (such as fencing) would limit unauthorized public access.

Before the start of any construction activities, utilities along Mesita del Buey Road would be modified. The water lines supplying Areas G and L would be upgraded by the addition of pressure sensors and automatic shutoff valves to the two subsurface water lines located north of MDA H. If a loss in pressure were detected by the pressure sensor, the line would automatically be shut off, thereby minimizing the potential for flooding of the MDA H shafts in the event of a water line break nearby along Mesita del Buey Road.

After the utilities have been upgraded, a single construction trailer for use by site workers would be placed within the staging area. The staging area for heavy equipment, vehicles, and the construction trailer (office) would be installed near the MDA H work site and would cover about 7,500 square feet (ft^2) (675 square meters [m^2]). Utilities would be made available to the construction site by hooking up to the existing water and electric utilities along Mesita del Buey and Pajarito roads. Portable toilets would be installed near the construction trailer in the staging area and next to the sorting and declassification facility that would be installed if an excavation and removal corrective measure option was selected. Office waste generated by site workers would be disposed of at the Los Alamos County Landfill or its replacement facility. Sanitary waste would be trucked offsite and disposed of by the company supplying the portable toilets.

Site activities at MDA H have the potential to generate dust. Standard dust suppression methods would be used onsite to minimize the generation of dust during site activities; such methods could include water spraying or the use of other types of dust suppression materials. New Mexico Ambient Air Quality Standards and the National Ambient Air Quality Standards (NAAQS) for total suspended particulate emissions[13] would be met throughout any corrective measure activities by maintaining particulate emissions below the 24-hour permissible level of 150 micrograms per cubic meter and below the annual perimeter level of 50 micrograms per cubic meter in ambient air.

Site work would be planned and managed to ensure standard worker safety goals are met and work would be performed in accordance with good management practices, regulations promulgated by the Occupational Safety and Health Administration (OSHA), and applicable DOE orders involving worker and site safety practices. Onsite workers would park their personal vehicles either in existing parking lots nearby or in other designated parking areas at MDA H. All site construction contractors would be required to submit and adhere to a Construction Health and Safety Plan. Applicable safety and health training and monitoring, personal protective equipment (PPE), and work-site hazard controls would be required for workers at MDA H. A peak staff level of about 10 to 85 workers would be actively involved in activities such as site preparation, earthmoving, and heavy equipment work, depending on the final corrective measure option chosen and the overall sequencing of construction, excavation, and sorting activities. Site corrective measure implementation activities could begin as early as 2004 and take between six and forty-eight months to complete, depending on the corrective

[13] Total suspended particulate emissions are now referred to as PM_{10}; PM_{10} is particulate matter of 10 microns or less in diameter.

measure option chosen. Potential exposures to various physical, chemical, HE, and radiation hazards or injuries would be possible during these activities.

All corrective measure options of the Proposed Action would be conducted in accordance with LANL's requirements for waste management (LANL 1998a) specifying that the generation of any operational waste shall be reduced as much as technically and economically feasible. Generated and recovered wastes would be segregated, recycled, and reduced to the greatest practical extent.

For corrective measure options that include waste excavation and removal, the most efficient, safe, and appropriate means of handling waste would be determined. Site activities would be conducted in accordance with DOE Orders 435.1, "Radioactive Waste Management," 5400.5, "Radiation Protection of the Public and the Environment," and 10 CFR 830, "Nuclear Safety Management," which defines the requirements for Document Safety Analysis (DSA) approval by DOE before UC staff at LANL could excavate MDA H. Remote handling and other appropriate site waste removal technologies and techniques would be employed at MDA H.

Best management practices (BMPs) for soil erosion control purposes would be implemented, as necessary, for any site remediation activities involving soil disturbance. BMPs could include runon and runoff controls, such as straw bales, silt fencing, ditching, and similar storm water flow controls. Special air pollution control technologies would be applied as necessary and appropriate. A National Pollutant Discharge Elimination System (NPDES) General Permit Notice of Intent would be filed, if required, based on the corrective measure option chosen for implementation. A Storm Water Pollution Prevention Plan would be required for the construction activity.

2.4.1 Containment Corrective Measure Options

Containment corrective measure Options 1, 2, and 3 would leave the waste undisturbed within the MDA H shafts and would make changes to the disposal area cover[14] and individual shaft caps.[15] Construction activities would be confined to the immediate area surrounding MDA H. The following elements are common to corrective measure Options 1, 2, and 3:

- All three corrective measure options would rely on the use of ET;
- the existing waste inventory would remain undisturbed in the shafts;
- the MDA H site would remain fenced to provide a measure of protection against disturbance of the caps, existing cover, and vegetated surface for a period of at least 100 years; and
- the MDA H site would have regular monitoring and maintenance inspections for at least 100 years, including periodic examination of the surface for any excessive erosion or gullying, ponding of water, and condition of the vegetative cover. Maintenance would be performed, as necessary, to maintain the required site surface condition.

[14] "Cover" refers to a soil layer placed over the entire disposal area.
[15] "Cap" refers to concrete seals or plugs placed at the tops of the shafts.

The useful life of a new cover could be extended indefinitely if the cover were maintained properly and if site access was restricted. Even with loss of institutional controls (fences and human access restrictions), 3-ft- (0.9-m-) thick concrete caps and ET covers would not be expected to erode away over a 1,000-year evaluation period (corrective measure Options 2 and 3) according to containment modeling estimates.

2.4.1.1 Corrective Measure Option 1: Upgrade Existing Surface

Corrective measure Option 1 would include a minor upgrade to the existing MDA H surface and implementation of a Long-Term Environmental Stewardship Program, as described in Section 2.2. The existing concrete and tuff shaft caps that provide a barrier to intrusion by plants or animals (biointrusion) would be retained. The existing soil surface cover would be regraded and recontoured for improved storm water runon and runoff control. The surface of MDA H would be upgraded with the placement of about 6 inches (in.)[16] (15 centimeter [cm]) of gravel and soil mix on top of the existing soil surface and revegetated with shallow-rooting native grasses and herbaceous plants.

Implementation of this corrective measure option would take about six months and would cost about $214,000. Upgrades to the existing cover would be easily constructed. Regrading the site would be routine. The topsoil and gravel mulch that make up the cover would be easily obtainable nearby and relatively easy to install. A vegetative cover could be established within two years. The gravel and soil admixture would serve to control erosion of the cover while the vegetative cover was establishing itself in the topsoil beneath the gravel. Thereafter, the vegetative cover would provide additional erosion control and decrease infiltration of moisture through the cover by the process of ET. The topsoil would promote maximal plant coverage.

LANL personnel would provide monitoring and maintenance of site surface features that protect against severe erosion. Subsurface monitoring would be performed below the cover down to a depth of about 260 ft (78 m). The subsurface monitoring program would be designed to identify changes in soil and substrate moisture content. Monitoring would be performed using sensors placed at three depths below the cover in small-diameter shafts that would be bored at predetermined locations. These sensors would be used to determine whether moisture was moving through the cover. The moisture content in the tuff below the shafts would also be monitored using existing site boreholes. The site would have regular inspections and maintenance to ensure that the integrity of the vegetative cover is adequate to prevent excessive erosion of the surface cover, gullying, or ponding of water. Regrading, recontouring, and revegetation with shallow-rooting native grasses and plants would be performed, as necessary, to maintain the effectiveness of the surface cover.

2.4.1.2 Corrective Measure Option 2: Replacement of the Existing Surface with an Engineered ET Cover

Corrective measure Option 2 would include the installation of an engineered ET cover with the implementation of a Long-Term Environmental Stewardship Program as described in Section 2.2. The design objectives of an engineered ET cover would be to 1) reduce the amount of water

[16] The actual cover thickness would be determined during final design based on estimates of the water holding or storage capacity of the soil and the amount of infiltrated water that has to be stored (Dwyer 2002).

that could percolate into shafts to further reduce the potential for subsurface contaminant transport over time; 2) further reduce erosion potential to limit risk of direct exposure of the waste; 3) further minimize surface transport of contaminants over the next 1,000 years; and 4) further reduce intrusion potential for deep-rooting plants and most burrowing animals.

The conceptual design of an engineered ET cover corrective measure option for MDA H is illustrated in Figure 6. The design is based on research conducted at LANL and Sandia National Laboratories/NM on engineered ET covers (LANL 1998b, Dwyer 2002). The vegetated ET cover was developed explicitly for landfills located in arid and semi-arid climates like Los Alamos. ET covers have been installed at over 36 landfill sites in the southwestern U.S. under the review of the EPA's Technology Innovation Office (the World Wide Web address is http://cluin.org/products/altcovers/usersearch/ lf_search.cfm) and have been found to be a superior alternative to conventional landfill covers in arid and semi-arid climates.

ET covers have been demonstrated to be reliable because they use "natural" climatic and vegetation ET conditions at the site to minimize downward water movement. The proposed engineered ET cover would consist of a topsoil and gravel layer planted with dense, shallow-rooting vegetation to reduce erosion and facilitate soil moisture removal by ET. The non-clay soil would absorb and hold moisture near the surface so that it could be evaporated or transpired. The thin layer of topsoil and gravel would control erosion without compromising the features of the ET cover. The topsoil and gravel mixture would also promote initial plant growth on the cover, further reducing runoff and erosion. Underneath this top layer would be a thick layer (about 3 ft [0.9 m]) of crushed tuff material. Biointrusion barriers, as shown in Figure 6, would be constructed of various materials, including cobbles (about 1 ft [0.3 m] in depth) or a single layer of metal chain-link fencing as has been effectively used before. The biobarrier would be placed immediately over the existing cap of the shafts at MDA H. A cobble barrier would be effective in inhibiting intrusion from most burrowing animals and most deep-rooted plants, whereas metal fencing would be effective against burrowing animals only. The functionality of the existing shaft caps would not be compromised by differential settlement or localized erosion. The engineered ET cover could be easily maintained by adding more topsoil and gravel mixture to areas that settle or erode over time.

Implementation of this corrective measure option would take about five months to implement and would cost about $348,000. An engineered ET cover would be easily constructed. The equipment and material required to construct the engineered ET cover are common construction materials that are readily available. It is estimated that the engineered ET cover could be designed and approved in three months while construction of the cover is estimated to take about two months. As with corrective measure Option 1, a vegetative cover could be established within two years.

2.4.1.3 Corrective Measure Option 3: Partial or Complete Encapsulation and Use of Engineered Caps and an Engineered ET Cover

Corrective measure Option 3 of the Proposed Action would include partial or complete encapsulation of the disposal shafts with the addition of new, engineered shaft caps and an engineered ET cover, along with the implementation of a Long-Term Environmental Stewardship Program as described in Section 2.2. This corrective measure option would enhance the existing shaft caps with additional concrete thickness and utilize currently available