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From:(Senders - Organization) *(separate multiple values with semicolons)*	1)PEGGY RENEAU, IT CORPORATION JENNIFER GRIFFIN, IT CORPORATION LTR(2)-JOSEPH C. VOZELLA, DOE
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91327

April 26, 2002

Mr. Gian Bacigalupa
ESH-19, MS K490
Los Alamos National Laboratory
P. O. Box 1663
Los Alamos, NM 87545

Project No. 819592.20

Transmittal
Closure/Post-Closure Plans for Technical Area 54 Area L and Area G Landfills and Compliance Demonstration with 40 CFR 264, Subparts G and F under Corrective Action Procedures for Material Disposal Area H at Technical Area 54
Contract No. 003CT0008-8L
Task Order 7

Dear Mr. Bacigalupa:

IT Corporation (IT) is pleased to provide you with 16 hard copies and one electronic copy of each of the following documents:

- Closure/Post-Closure Plan for the Technical Area 54 Area L Landfill (Shafts 1, 13-17, and 19-34 and Impoundments B and D)
- Closure/Post-Closure Plan for the Technical Area 54 Area G Landfill (Pit 29 and Shaft 124)
- Compliance Demonstration with 40 CFR 264, Subparts G and F under Corrective Action Procedures for Material Disposal Area H at Technical Area 54

These documents are for distribution to the following:

- EPA (1 hard copy of each document)
- UC Legal (1 hard copy of each document)
- DOE (2 hard copies of each document)
- FWO/SWO (2 hard copies of each document)
- ER (3 hard copies of each document)
- SWRC (4 hard copies and 1 electronic copy of each document)
- ESH-18/Charlie Nylander (1 hard copy of each document)
- RRES Division Office (1 hard copy of each document)
- Associate Director of Operations Office/James Holt (1 hard copy of each document)

Department of Energy
Albuquerque Operations Office
Office of Los Alamos Site Operations
Los Alamos, New Mexico 87544

APR 25 2002

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

Mr. Carl Will
Permits Management Program
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Building 1
Santa Fe, New Mexico 87505-6303

Dear Mr. Will:

Subject: Response to Determination of Incompleteness for:
1) "Closure and Post Closure Plans for TA-54-Area G Landfill," September 1985;
2) "TA-54 Area H & Area L Landfill Closure and Post-Closure Plan," November 1986;
3) "Closure Plan for Technical Area 54, Material Disposal Area L" (Revision 1.0), March 1998; and
4) "Closure Plan for Technical Area 54, Material Disposal Area H" (Revision 1.0), March 1998.

Los Alamos National Laboratory EPA ID# NM0890010515

The purpose of this letter is to provide the Department of Energy (DOE) and University of California (UC) response to the subject Determination of Incompleteness (DOI) issued by the New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB) on December 21, 2001, as clarified by the HWB in its March 13 and 20, 2002 letters. DOE received the DOI on December 26, 2001. The DOI required that DOE and UC provide new or revised closure and post-closure plans for the Technical Area (TA)-54 Areas G, H, and L hazardous waste disposal units to replace those listed above as part of the renewal of the DOE/UC hazardous waste facility permit. This submittal responds to that requirement within the extended time allowed by your letter of March 13, 2002.

This submittal consists of separate documents for the three areas that contain hazardous waste disposal units. Two closure/post-closure plans for Areas L and G are included. The titles of the documents are the *"Closure/Post-Closure Plan for the Technical Area 54 Area G Landfill (Pit 29 and Shaft 124)"* and the *"Closure/Post-Closure Plan for the Technical Area 54 Area L Landfill (Shafts 1, 13-17, and 19-34 and Impoundments B and D)."* The response for Area H includes a regulatory crosswalk that illustrates how corrective action activities under the Corrective Action Chapter of the permit, which are being implemented as alternative requirements, meet the applicable substantive requirements of the Resource Conservation and Recovery Act (RCRA) for

and G site characterization activities completed to date (SWMU Nos. 54-006 and 54-013(b)-99 respectively). Continued corrective action activities are subject to NMED approval through the RCRA corrective action process.

If you should have any questions or concerns regarding this submittal, please feel free to contact Gene Turner, DOE, at 667-5794 or Gian Bacigalupa, UC, at 667-1579.

Sincerely,

Joseph C. Vozella
Associate Director
Office of Facility Operations

Enclosures

cc w/enclosures:
Linda King, Chief (6PD-N)
New Mexico/Federal Facilities Section
Environmental Protection Agency – Region 6
1445 Ross Avenue, Suite 1200
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D. McInroy, RRES-ER, LANL, MS-M992
J. Ellvinger, RRES-SWRC, LANL, MS-K490
G. Bacigalupa, RRES-SWRC, LANL, MS-K490

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J. Ellvinger, RRES-SWRC, LANL, MS-K490
G. Bacigalupa, RRES-SWRC, LANL, MS-K490

Closure/Post-Closure Plan for the Technical Area 54 Area L Landfill
(Shafts 1, 13-17, and 19-34 and Impoundments B and D)

LA-UR-02-2304
April 2002

Prepared by:
Los Alamos National Laboratory
Solid Waste and Regulatory Compliance Group (SWRC)
Los Alamos, New Mexico 87545

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ATTACHMENT	TITLE
A	MDA L: Operating Unit Regulations for Ground Water/Closure/Post-Closure Care and Corresponding HSWA Activities
B	Geology, Hydrology, and Groundwater Characterization at Technical Area 54, Area L
C	Nature and Extent of Releases and Present-Day Risk Assessment for Technical Area 54, Material Disposal Area L

CLOSURE/POST-CLOSURE PLAN FOR THE TECHNICAL AREA 54 AREA L LANDFILL (SHAFTS 1, 13-17, AND 19-34 AND IMPOUNDMENTS B AND D)

This closure/post-closure plan describes the activities necessary to achieve closure and post-closure of the Area L landfill at Los Alamos National Laboratory (LANL) Technical Area (TA) 54. The Area L landfill is an "active" unit comprised of Shafts 1, 13-17, and 19-34 and Impoundments B and D because they received hazardous waste after November 19, 1980. Hereinafter, the phrase "Area L landfill" is used to denote the active unit. The Area L landfill is also a "regulated unit," as defined in the New Mexico Administrative Code, Title 20, Chapter 4, Part 1 (20.4.1 NMAC) § 264.90(a)(2), revised June 14, 2000 [6-14-00]. The information provided in this plan is submitted to address the applicable closure and post-closure requirements specified in 20.4.1 NMAC § 270.14(b)(13); 20.4.1 NMAC, Subpart V, Part 264, Subparts F and G; and 20.4.1 NMAC § 264.310 [6-14-00].

The Area L landfill is located within the TA-54 Area L treatment and storage facility, which will continue to operate. The Area L landfill will be closed in place without removing the waste and is co-located with land disposal units that comprise solid waste management unit (SWMU) No. 54-006 managed under the LANL corrective action program. The closure and post-closure activities for the Area L landfill will be addressed through alternative requirements, as allowed by 20.4.1 NMAC § 264.110(c), to meet closure and post-closure care requirements. Alternative requirements are discussed further in Sections 1.3 and 3.2. Closure of the landfill will ensure that the existing asphalt cover and wastes and/or waste residues that remain in place are stabilized, as described in Section 2.0 of this plan. The cover will minimize the need for further maintenance and be protective of human health. Post-closure care will include monitoring, maintenance, and reporting, as described in Section 4.0 of this plan. These activities will occur in conjunction with and subject to the investigation and potential remediation efforts of the LANL corrective action program, as allowed by the alternative requirements process. Therefore, the final remedy for the Area L landfill will be part of the corrective measure for Area L as a whole when operations cease and will be implemented in accordance with the Corrective Action Chapter of this permit. An aid in demonstrating the proposed corrective action activities that will meet the applicable post-closure requirements for the regulated unit at Material Disposal Area (MDA) L is presented in Attachment A (MDA L: Operating Unit Regulations for Ground Water/Closure/Post-Closure Care and Corresponding HSWA Activities) of this plan.

A "Closure and Post-Closure Plan for TA-54 Area H and Area L Landfill at Los Alamos National

documentation on the closure status of each unit, including all previous partial clean closures as well as land-based units that have been or are being addressed via alternative closure requirements. Final closure will be deemed complete when the closure certification has been submitted to the NMED and the NMED has approved the final closure.

1.2 Closure Performance Standard [20.4.1 NMAC § 264.111]

The Area L landfill (Shafts 1, 13-17, and 19-34 and Impoundments B and D) will be closed to meet the following performance standards:

- Minimize the need for further maintenance
- Control, minimize, or eliminate, to the extent necessary to protect human health and the environment, the post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products to the ground or surface waters or atmosphere
- Comply with the applicable closure and post-closure requirements of 20.4.1 NMAC, Subpart V, Part 264, Subpart G and 20.4.1 NMAC § 264.310 [6-14-00].

To meet the above closure performance standards and the closure requirements in 20.4.1 NMAC § 264.310(a), the existing covers on the specified shafts and impoundments that comprise the Area L landfill have been designed and constructed to:

- Minimize migration of liquids through the closed unit
- Function with minimum maintenance
- Promote drainage and minimize erosion or abrasion of the cover
- Accommodate settling and subsidence so that the cover's integrity is maintained, and
- Have a permeability that is less than or equal to the permeability of the natural subsoils present.

1.3 Closure Activities and Alternative Requirements

Closure activities for the Area L landfill will be addressed under alternative requirements, pursuant to 20.4.1 NMAC §264.118(b)(4). This allowable option is defined in 20.4.1 NMAC § 264.110(c) when a regulated unit is located among other SWMUs, releases potentially originating from both the regulated unit and the SWMU(s) have or are likely to have occurred, and the alternative requirements will meet the closure performance standards set forth in 20.4.1 NMAC § 264.111. At Area L, the impoundments and shafts identified as the regulated unit are in close proximity to (i.e., co-located with) similar disposal units (included in SWMU No. 54-006) to be addressed under the LANL corrective action program. A subsurface volatile organic compound (VOC) vapor-phase plume

LANL will submit a written request for a permit modification with a copy of the amended closure plan at least 60 days prior to the proposed change in unit design or operation or no later than 60 days after an occurrence of an unexpected event that affects the closure plan. If the unexpected event occurs during closure, the permit modification will be requested within 30 days of the occurrence. The Secretary of the NMED may request a modification of the closure plan under the conditions presented in the bulleted items above. LANL will submit the modified plan in accordance with the request within 60 days of notification, or within 30 days of notification if a change in facility condition occurs during the closure process.

1.6 Closure Cost Estimate, Financial Assurance, and Liability Requirements [20.4.1 NMAC § 264.140(c)]

In accordance with 20.4.1 NMAC § 264.140(c) [6-14-00], LANL, as a federal facility, is exempt from the requirements of 20.4.1 NMAC, Subpart V, Part 264, Subpart H [6-14-00] to provide a cost estimate, financial assurance mechanism, and liability insurance for closure actions.

1.7 Closure Certification [20.4.1 NMAC § 264.115]

Within 60 days after completion of closure activities for the Area L landfill, LANL will submit to the Secretary of the NMED, via certified mail, a certification that the unit has been closed in accordance with the approved closure plan. The certification will be signed by the appropriate DOE and LANL officials and by an independent, registered professional engineer, in accordance with 20.4.1 NMAC § 264.115 [6-14-00]. Documentation supporting the independent, registered engineer's certification will be furnished to the Secretary of the NMED upon request, as specified in 20.4.1 NMAC § 264.115 [6-14-00]. A copy of the certification and supporting documentation will be maintained by both the DOE/OLASO and the SWRC Group.

1.8 Security

Because of the ongoing nature of waste management operations at TA-54, security and administrative controls for the Area L landfill will be maintained by the DOE or another authorized federal agency for as long as necessary to prohibit public access. The security fence at TA-54 will be maintained to ensure that public access into Area L is prevented.

1.9 Closure Report

Upon completion of the closure activities at the Area L landfill, a closure report will be prepared and, upon request, provided to the Secretary of the NMED. The report will document the closure and contain, for example, the following:

- A copy of the certification described in Section 1.7 of this plan

on the nature and extent of releases at MDA L, as well as a brief assessment of present-day risk.

2.1 TA-54 Description

TA-54 is located on top of Mesita del Buey, an east-west trending mesa that is bordered on the north by Cañada del Buey and on the south by Pajarito Canyon. The elevation at TA-54 is approximately 6,800 feet (ft). TA-54 is used primarily for waste management. It includes four MDAs (one each at Areas G, H, J, and L) (Figure 1), hazardous/mixed waste storage and treatment areas, and numerous supporting offices. The Radioassay and Nondestructive Testing Facility is located in the western part of TA-54 (TA-54 West).

2.2 Area L and MDA L Description

Area L is a 2.58-acre site in the north-central portion of TA-54 (Figure 2). The irregularly-shaped area, located on the north side of Mesita del Buey Road, is surrounded by an 8-ft-high chain-link security fence with barbed wire or razor wire at the top. The fence is inspected weekly and repairs made, if necessary. Area L is kept locked at all times, with entrance to the area restricted to authorized and/or escorted personnel. Historically, MDA L was used for disposal of chemical wastes in 34 shafts, 3 impoundments, and 1 pit. MDA L is designated as SWMU No. 54-006. Disposal no longer occurs at MDA L. The surface of Area L is presently used for hazardous waste storage and treatment, and for mixed waste storage.

Near Area L, Cañada del Buey is roughly 100 ft below the north mesa rim, and Pajarito Canyon is approximately 140 ft below the south mesa rim. Runoff at Area L is primarily from sheet flow, which is channeled northward into a drainage that is a tributary of Cañada del Buey. Erosion controls at Area L divert water away from MDA L; these include an asphalt cover, asphalt curbing, and asphalt drainage channels.

The following are descriptions of the subsurface shafts, impoundments, and pit at MDA L. The descriptions were taken from the "RFI Work Plan for Operable Unit 1148" (LANL, 1992a) and the "Closure Report: Technical Area 54 Waste Oil Storage Tanks" (LANL, 1992b).

Between 1975 and 1985, 34 chemical waste disposal shafts at Area L were dry-drilled with an auger into the Bandelier Tuff. The shafts, located at the east and west ends of Area L, have all been capped with concrete and are no longer in use. Backfill was added around some of the shafts, where necessary, and the surface covered with asphalt. Only Shafts 1, 13-17, and 19-34 (Figure 2) received hazardous waste after November 19, 1980, making them subject to regulation under

disposed of in these shafts. After 1981, no noncontainerized wastes were disposed of in the shafts. From November 1982 until February 1985, wastes were accumulated on site and packaged in drums until sufficient quantities had amassed to facilitate subsequent emplacement. The drums were lowered by crane into a shaft through doors in the steel cap and arranged in layers. Layers in 3-ft and 4-ft diameter shafts contain 1 drum, layers in 6-ft diameter shafts contain 4 to 5 drums, and layers in 8-ft diameter shafts contain 6 drums. The space around the drums was filled with crushed tuff, and a 6-inch layer of crushed tuff was placed between each layer of drums. The crushed tuff provides structural support to help prevent failure of drums in the bottom of the shafts (LANL, 1992a). When the use period for these disposal shafts ended, they were backfilled with crushed tuff and approximately the uppermost 3 ft of each shaft was plugged with concrete, which was rounded at the surface to form a dome (LANL, 1986).

2.2.2 Impoundments B and D

Impoundment B was excavated in 1978. It is approximately 60 ft long, 18 ft wide, and 10 ft deep. Impoundment B was used from January 1979 through June 1985. This 7,560-cubic-ft capacity impoundment was used to evaporate batch-treated salt solutions (e.g., ammonium bifluoride) and electroplating wastes (e.g., chromium wastes). The impoundment capacity was calculated assuming it was to be filled to within 3 ft of the surface. The treated aqueous waste was discharged into the impoundment, where it pooled and was left to evaporate. Impoundment B was backfilled with clean fill and later covered with asphalt.

Impoundment D was used to treat small batch quantities of lithium hydride by reacting it with water. The neutralized liquid from this treatment was then allowed to evaporate. This practice, which began in 1972, was discontinued in 1984 for safety reasons. The approximately 75-ft-long, 18-ft-wide, 10-ft-deep impoundment was not used for disposal of any other hazardous wastes. Air photos indicate that Impoundment D was backfilled with clean fill and covered with asphalt in the late 1980s (LANL, 1992a).

After treatment of lithium hydride was discontinued, a rectangular 5,650-gallon steel waste-oil storage tank was placed in the 9,450-cubic-ft capacity impoundment (LANL, 1992a). The impoundment capacity was calculated assuming it was to be filled to within 3 ft of the surface. A 5,086-gallon waste-oil tanker truck was parked at the surface adjacent to and just west of Impoundment D, and four 771-gallon fiberglass waste-oil storage tanks were stored at the surface adjacent to and just east of the impoundment. When the six waste-oil storage tanks were closed, it was decided that closure would not include removal of any associated contaminated soil; rather, the soil would be addressed during closure and corrective actions at Area L. Prior to backfilling the

the natural subsoils present, in accordance with 20.4.1 NMAC § 264.310(a). In addition, the asphalt provides run-on and runoff control, pursuant to 20.4.1 NMAC § 264.112(b)(5).

2.3.2 Impoundments B and D Closure Procedures

When it was determined that an impoundment would no longer be used for treatment or disposal, it was backfilled with clean fill and later covered with asphalt. Prior to placement of Storage Dome 215, this asphalt layer was broken up and left in place as a base coarse, upon which approximately four ft of clean fill was placed and compacted in lifts and graded. The new clean fill was then covered with an approximate 3-inch-thick asphalt pad. The original backfill helps to stabilize the waste residues in the impoundments, and the subsequent backfill helps to accommodate settling and subsidence so that the asphalt cover's integrity is maintained. The existing asphalt (further described below) helps to minimize infiltration of precipitation to the closed impoundments. The existing asphalt cover over the Area L landfill will be inspected and repaired (as necessary), as described in Section 4.2.1.

The asphalt cover slopes gently to the northeast and channels surface runoff to the area's discharge point. The gently sloping asphalt, which also covers the surrounding areas, will also help to minimize infiltration of precipitation, as well as function with minimum maintenance, promote drainage and minimize erosion or abrasion of the cover, and have a permeability less than that of the natural subsoils present, in accordance with 20.4.1 NMAC § 264.310(a). In addition, the asphalt provides run-on and runoff control, pursuant to 20.4.1 NMAC § 264.112(b)(5).

3.0 GENERAL POST-CLOSURE INFORMATION

This section is prepared in accordance with the requirements of 20.4.1 NMAC §270.14(b)(13); 20.4.1 NMAC, Subpart V, Part 264, Subparts G and H; and 20.4.1 NMAC § 264.310 [6-14-00], as applicable.

3.1 Closure Performance Standard

Post-closure of the Area L landfill (Shafts 1, 13-17, and 19-34 and Impoundments B and D) will meet the following performance standards:

- Minimize the need for further maintenance
- Control, minimize, or eliminate, to the extent necessary to protect human health and the environment, the post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products to the ground or surface waters or atmosphere
- Comply with the applicable closure and post-closure requirements of 20.4.1 NMAC, Subpart V, Part 264, Subparts G and N [6-14-00].

requirements of 20.4.1 NMAC, Subpart V, Part 264, Subpart F and 20.4.1 NMAC § 264.310, as described in Section 4.0. As described in Section 2.3 of this plan, the landfill is covered by the existing asphalt. The integrity and effectiveness of the cover will be maintained, including conducting inspections and making necessary repairs to correct the effects of settling, erosion, water damage, or other events.

A RCRA Facility Investigation (RFI) is currently ongoing at MDA L. NMED will determine whether a RCRA Corrective Measures Study (CMS) is required, based on the findings of the RFI. Vadose zone monitoring of the Area L landfill will be performed in accordance with the findings of the RFI regarding the current monitoring system. Groundwater monitoring will be developed for TA-54 as an aggregate under the LANL "Hydrogeologic Workplan" (LANL, 1998b) and implemented as appropriate by LANL's Groundwater Protection Program, as described in Section 4.1.2.

If further corrective measures at the Area L landfill are deemed necessary to protect human health and the environment, they will be analyzed, selected, and implemented during the CMS process according to the requirements of the Corrective Action Chapter of LANL's renewed Hazardous Waste Facility Permit and the most current and approved Installation Work Plan for the ER Project. The selected corrective measure will include alternative requirements for post-closure of the Area L landfill in a manner that complies with the requirements of 20.4.1 NMAC §264.110(c)(2), and the selection and implementation must be approved by the NMED as a permit modification.

An aid in demonstrating the proposed corrective action activities that will meet the applicable post-closure requirements for the regulated unit at MDA L is presented in Attachment A of this plan.

3.3 Amendment of the Post-Closure Plan

In accordance with 20.4.1 NMAC §264.118(d)(1) [6-14-00], LANL may submit a written notification of or request for a permit modification to authorize a change in the approved post-closure plan at any time during the active life of the facility or during the post-closure care period. In accordance with 20.4.1 NMAC §264.118(d)(2) [6-14-00], LANL will submit a written notification of or request for a permit modification to authorize a change in the approved post-closure plan whenever:

- There are changes in operating plans or facility design that affect the approved post-closure plan
- There is a change in the expected year of final closure, if applicable
- Events which occur during the active life of the facility, including partial and final closures, affect the approved post-closure plan

LANL will submit to the Secretary of the NMED, by registered mail, a certification that the post-closure care period for the unit was performed in accordance with the approved post-closure plan. The certification will be signed by the appropriate DOE and LANL officials and by an independent, registered professional engineer. Documentation supporting the independent, registered professional engineer's certification will be furnished to the Secretary of the NMED upon request. A copy of the certification and supporting documentation will be maintained by DOE/OLASO. The supporting documentation may include, for example, the following:

- Any significant variance from the approved activities and the reason for the variance
- A summary of all sampling results
- A quality assurance/quality control statement on analytical data validation
- The location of the file of supporting documentation
- Storage or disposal location of hazardous/mixed waste resulting from post-closure activities.

3.6 Security

Because of the ongoing nature of waste management operations at TA-54, security and administrative controls for the Area L landfill will be under the care of the DOE or another authorized federal agency during the post-closure care period. The security fence at TA-54 will be maintained during that period to prohibit public access into Area L.

3.7 Survey Plat and Post-Closure Requirements [20.4.1 NMAC §264.116 and §264.117 through §264.120]

As stated in Section 1.10, a survey plat prepared in accordance with 20.4.1 NMAC §264.116 [6-14-00] will be filed with the appropriate authorities at certification of closure. No later than 60 days after certification of closure of the Area L landfill, LANL will submit to the County of Los Alamos and other authorized agencies and to the Secretary of the NMED a record of the type, location, and quantity of hazardous wastes disposed of within the unit. For hazardous wastes disposed of before January 12, 1981, LANL will identify the type, location, and quantity of the hazardous wastes to the best of their knowledge and in accordance with any records that have been kept.

Post-closure care pursuant to 20.4.1 NMAC §264.117 through §264.120 [6-14-00] will begin after closure of a disposal unit. Post-closure notices will be filed with appropriate authorities within 60 days of certification of closure of the first disposal unit and within 60 days of certification of closure of the last disposal unit, as described in 20.4.1 NMAC §264.119 [6-14-00]. To meet that requirement, DOE will file a "Land Use Restriction Notice" or equivalent document with the County

4.1.1 Vadose Zone

Vadose zone monitoring at MDA L has been ongoing since the mid-1980s. As reported in Appendix C of the "Quarterly Technical Report July-September 2001" (ER Project, 2001), the VOC vapor-phase plume (as represented by 1,1,1-trichloroethane [TCA] screening data) has been measured to be near a steady condition since the first quarter of Fiscal Year (FY) 99. As indicated by the screening results, the 10-parts per million by volume contour remained relatively constant at depth, approximately 650 ft above the regional groundwater table. The report also indicated that the maximum TCA concentrations have been measured to remain relatively steady since FY 99.

As concluded in the "Subsurface Vapor-Phase Transport of TCA at MDA L: Model Predictions" (Stauffer et al., 2000), the observed site data and site numerical modeling results also indicate that, currently, the vapor-phase plume at MDA L is at a near steady condition, both in concentration and size. The authors also concluded that the current location of the vapor-phase plume is not expected to spread any closer to White Rock or to the deep aquifer. In addition, because there is no evidence of liquid migration and it has been determined that saturated flow through the tuff is not a viable transport mechanism, it is not anticipated that VOCs can migrate as liquids to the uppermost aquifer (Stauffer et al., 2000; IT Corporation, 1987). It is predicted that the plume size will begin to decrease when the contaminant source is depleted (likely before the year 2060), based on estimates of a conservative TCA source. The site numerical model will provide a useful tool in the future to explore the effects of potential corrective measures (e.g., passive venting, optimized passive venting) (Stauffer et al., 2000).

The pore-gas monitoring program has been successful in defining both the nature and extent of the vapor-phase plume at MDA L, as indicated by the agreement of the numerical model with pore-gas and surface flux data. Both the current and future plume growth over the next 50 years are anticipated to be quite small, according to the simulations (e.g., by the year 2050, the simulation results for the 50 parts per million by volume TCA contour show very little lateral growth) (Stauffer et al., 2000). The modeling results indicate that pore-gas monitoring could be performed less frequently than the current quarterly regime, and less frequent monitoring is supported by the recent observations of slowly changing pore-gas concentrations. It is believed that annual monitoring would be sufficient to identify any significant changes in the plume, as demonstrated by the simulation of catastrophic drum failure that predicts that such an event would be captured in the monitoring data for several years. Overall, annual monitoring is believed to be capable of assessing the current rate of plume growth as well as detecting a large perturbation to the system (e.g., a drum failure) (Stauffer et al., 2000).

providing information to determine potential future locations for additional monitoring wells. The well data will be entered into the well inventory module of the Water Quality Database. This database will be available to LANL and external stakeholders. Data customers (e.g., regulators, LANL personnel, or other stakeholders) can then examine the information and, if appropriate and necessary, request samples, measurements, or other data to be collected from any well. Under the Groundwater Protection Program, all water sampling, water-level measurements, and other testing will be implemented consistent with laws, regulations, and DOE orders, and in consultation with the data customers.

Consistent with the site characterization and following a determination of the need for monitoring, the detection-type monitoring prescribed in 20.4.1 NMAC § 264.98 will be initiated. Detection is defined in 20.4.1 NMAC § 264.91(a)(1) as statistically significant evidence of contamination, as described in 20.4.1 NMAC 264.98(f). A monitoring system and compliance period as described in Attachment A consistent with 20.4.1 NMAC §§ 264.96 and 264.97 will be utilized. In accordance with 20.4.1 NMAC § 264.98(f), LANL will determine whether there is statistically significant evidence of contamination for any chemical parameter or hazardous constituent. An appropriate frequency for sample collection and statistical analysis will be proposed to the NMED that will be capable of determining statistically significant evidence of contamination, as required by 20.4.1 NMAC § 264.98(d). Data will be collected that are appropriate for the statistical methodology applied, sufficient in sample size, and utilizing sampling procedures and frequencies of sample collection established by the Groundwater Protection Program to ensure that potential contaminant release(s) to groundwater from the regulated unit can be detected, in accordance with 20.4.1 NMAC § 264.97. For TA-54, the point of compliance is the boundary of Aggregate 2. If a more comprehensive monitoring program is established, as described in Attachment A consistent with 20.4.1 NMAC § 264.99, and an increase in contamination is indicated, a program that takes action to address the increase will be implemented. Descriptions of each proposed activity equivalent to operating unit regulations for groundwater are presented in Attachment A.

4.2 Maintenance and Frequency

Pursuant to 20.4.1 NMAC § 264.118(b)(2), the planned maintenance activities and the frequencies at which they will be performed are discussed in the following sections. Planned maintenance will include inspections at prescribed frequencies and potential resulting maintenance activities consistent with 20.4.1 NMAC § 264.310. The planned maintenance will also ensure the function of the monitoring equipment consistent with 20.4.1 NMAC, Subpart V, Part 264, Subpart F and 20.4.1 NMAC § 264.310.

be inspected to verify that the location identification number remains clearly imprinted on the monument. If the well is in an area where vehicle traffic might pose a hazard, the guard or bumper posts will be inspected to ensure their integrity is maintained. Maintenance will be performed on an as-needed basis when the necessity is indicated as a result of inspections.

Surveyed benchmarks used in accordance with 20.4.1 NMAC § 264.309 will be protected and maintained throughout the post-closure period, pursuant to 20.4.1 NMAC § 264.310(b)(6). If a benchmark is in an area where vehicle traffic might pose a hazard, guard or bumper posts will be installed to provide protection. The condition of the surveyed benchmarks will be inspected for legibility and to identify any potential maintenance needs. Maintenance will be performed on an as-needed basis when the necessity is indicated as a result of inspections.

4.3 Reporting

Post-closure care will also include reporting consistent with 20.4.1 NMAC, Subpart V, Part 264, Subpart F and 20.4.1 NMAC § 264.310, as appropriate.

As described in Attachment A consistent with 20.4.1 NMAC § 264.98, LANL will notify the Secretary of the NMED if, under the detection monitoring program, it is determined [in accordance with 20.4.1 NMAC § 264.98(f)] that there is statistically significant evidence of contamination for chemical parameters or hazardous constituents at any of the Aggregate 2 monitoring wells. This notification will be provided in writing within seven days of the determination. The notification will indicate what chemical parameters or hazardous constituents have shown statistically significant evidence of contamination.

If a more comprehensive monitoring program is established as described in Attachment A consistent with 20.4.1 NMAC § 264.99, LANL will analyze samples from the Aggregate 2 monitoring wells for all 20.4.1 NMAC, Subpart V, Part 264, Appendix IX constituents at least annually, in accordance with 20.4.1 NMAC § 264.99(g). This analysis will be used to determine whether additional hazardous constituents are present in the uppermost aquifer and, if so, at what concentration, pursuant to the procedures in 20.4.1 NMAC § 264.98(f). If LANL finds Appendix IX constituents in the groundwater that are not identified as monitoring constituents in the permit, LANL may resample within one month and repeat the Appendix IX analysis. If the presence of new hazardous constituents is confirmed by the second analysis, LANL will report the concentration of these additional constituents to the Secretary of the NMED within seven days after completion of the second analysis. If LANL decides not to resample, the concentrations of the additional hazardous constituents will be reported to the

U.S. Department of Energy

National Nuclear Security Administration

Office of Los Alamos Site Operations

528 35th Street

Los Alamos, New Mexico

87544

505-667-5105

5.0 REFERENCES

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Table 2

Dates of Use, Dimensions, Capacities, and Contents of Shafts 1, 13-17, and 19-34 at Technical Area 54 Area L Landfill

Shaft No.	Start Date of Use	End Date of Use	Depth (feet)	Diameter (feet)	Capacity (cubic feet)	Waste Contents
1	4/80	8/83	60	3	424	Organics
13	6/79	4/82	60	8	3016	Inorganics
14	6/79	4/82	60	3	424	Reactives
15	6/79	4/82	60	3	424	Reactives
16	6/79	4/82	60	3	424	Gas Cylinders
17	6/79	4/82	60	3	424	Organics
19	4/80	4/82	60	8	3016	Waste Oil
20	3/82	8/83	60	3	424	Inorganics
21	3/82	12/85	60	3	424	Gas Cylinders
22	3/82	8/83	60	3	424	Organics
23	4/82	2/84	60	4	754	Waste Oil
24	4/82	3/84	60	4	754	Organics & Waste Oil
25	9/82	4/85	60	6	1696	Inorganics
26	9/82	2/84	60	6	1696	Organics
27	1/83	1/85	60	4	754	Special Waste[a]
28	1/82	4/85	60	4	754	Special Waste
29	12/83	7/84	65	6	1838	Organics
30	12/83	4/84	65	6	1838	Organics
31	12/83	8/84	61	6	1725	Organics
32	3/84	8/84	15	4	188	Organics
33	3/84	1/85	65	6	1838	Organics
34	2/85	4/85	63	6	1781	Organics

[a] Used for miscellaneous wastes requiring greater isolation.

ATTACHMENT A

MDA L

OPERATING UNIT REGULATIONS FOR GROUND WATER/CLOSURE/POST-CLOSURE CARE AND CORRESPONDING HSWA ACTIVITIES

Operating Unit Regulations for Ground Water/Closu. ost-Closure Care and Corresponding HSWA Activities

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.90(b)(4)	The Secretary finds that there is no potential for migration of liquid from a regulated unit to the uppermost aquifer during the active life of the regulated unit (including the closure period) and the post-closure care period specified under §264.117. This demonstration must be certified by a qualified geologist or geotechnical engineer. In order to provide an adequate margin of safety in the prediction of potential migration of liquid, the owner or operator must base any predictions made under this paragraph on assumptions that maximize the rate of liquid migration.	Should sufficient information support this exemption for a regulated unit in the future, the HSWA activity would be equivalent to that prescribed by the exemption.	
§264.90(b)(5)	He designs and operates a pile in compliance with §264.250(c).	NA	NA
§264.90(c)	The regulations under this subpart apply during the active life of the regulated unit (including the closure period). After closure of the regulated unit, the regulations in this subpart:		NA
§264.90(c)(1)	Do not apply if all waste, waste residues, contaminated containment system components, and contaminated subsurface soils removed or decontaminated at closure;	For MDA L, a CMS report will be developed and will address this issue. If appropriate, the report will include a general description of an excavation alternative corrective measure (equivalent to clean closure). If the excavation corrective measure is selected, details will be provided in the approved CMI Plan following permit modification.	
§264.90(c)(2)	Apply during post-closure care period if owner/operator is conducting a detection monitoring program under §264.98; or	The probable corrective measure to be implemented at MDA L will include monitoring in the vadose zone beneath MDA L. The LANL hydrogeologic characterization program (as implemented through the LANL Hydrogeologic Workplan) proposes the locations for characterization wells for TA-54 that after four sampling events will be included in LANL Environmental Surveillance Program, and may, if appropriate, be used as repetitive monitoring wells for TA-54 as a whole.	
§264.90(c)(3)	Apply during compliance period under §264.96 if the owner/operator is conducting a compliance monitoring program under §264.99 or a corrective action program under §264.100.	If monitoring indicates a more comprehensive program is needed to adequately comply with ground water protection standards in 264.91 and 264.92, additional characterization and/or well installation will occur, if appropriate.	
§264.90(d)	Regulations in this subpart may apply to miscellaneous units when necessary to comply with §§264.601-603.	NA	NA

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.91(a)(4)	In all other cases, owner/operator must institute a detection monitoring program under §264.98.	TA-54 characterization wells will be sampled and analyzed as repetitive monitoring wells as appropriate through the LANL Environmental Surveillance Program.	
§264.91(b)	The Secretary will specify in the facility permit the specific elements of the monitoring and response program. The Secretary may include one or more of the programs identified in paragraph (a) of this section in the facility permit as may be necessary to protect human health and the environment and will specify the circumstances under which each of the programs will be required. In deciding whether to require the owner or operator to be prepared to institute a particular program, the Secretary will consider the potential adverse effects on human health and the environment that might occur before final administrative action on a permit modification application to incorporate such a program could be taken.	See above.	
§264.92	The owner/operator must comply with conditions specified in the facility permit that are designed to ensure that hazardous constituents under §264.93 detected in the ground water from a regulated unit do not exceed the concentration limits under §264.94 in the uppermost aquifer underlying the waste management area beyond the point of compliance under §264.95 during the compliance period under §264.96. The Secretary will establish this ground-water protection standard in the facility permit when hazardous constituents have been detected in the ground water.	Should "detection" consistent with the definition in §264.91(a)(1) occur, LANL will comply with concentration limits established through a process similar to that described in §264.94.	
§264.93	Hazardous constituents		
§264.93(a)	The Secretary will specify in the facility permit the hazardous constituents to which the ground-water protection standard of §264.92 applies. Hazardous constituents are constituents identified in appendix VIII of part 261 of this chapter that have been detected in ground water in the uppermost aquifer underlying a regulated unit and that are reasonably expected to be in or derived from waste contained in a regulated unit, unless the Secretary has excluded them under paragraph (b) of this section.	For any of the following information that is not already available or developed, it will be prepared and included in a manner consistent with §264.93 in corresponding corrective action/HSWA activity documents.	
§264.93(b)	The Secretary will exclude an Appendix VIII constituent from the list of hazardous constituents specified in the facility permit if he finds that the constituent is not capable of posing a substantial present or potential hazard to human health or the environment. In deciding whether to grant an exemption, the Secretary will consider the following:	Concentration limits established for hazardous constituents following "detection" will not include those incapable of posing a substantial present or potential hazard to human health or the environment considering the following:	
§264.93(b)(1)	Potential adverse effects on groundwater quality, considering:	Potential adverse effects on groundwater quality considering:	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.93(b)(1)(vii)	Potential health risks caused by human exposure to waste constituents;	A present day human health risk screening assessment was completed and is presented in Attachment C of the Area L closure/post-closure plan. Results indicate no unacceptable risk to human receptors. The CMS Report for MDA L will provide results of a future human health risk assessment, including potential for contaminant migration and the site conceptual model.	Attachment C
§264.93(b)(1)(viii)	Potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents;	A present day ecological risk screening assessment was completed and is presented in Attachment C of the Area L closure/post-closure plan. Results indicate no unacceptable risk to ecological receptors. The CMS Report for MDA L will provide results of a future ecological risk assessment, including potential for contaminant migration and the site conceptual model.	Attachment C
§264.93(b)(1)(ix)	Persistence and permanence of the potential adverse effects; and	RFI and CMS Reports for MDA L will be developed and will address this issue.	
§264.93(b)(2)	Potential adverse effects on hydraulically-connected surface water quality, considering:	Potential adverse effects on hydraulically-connected surface water quality, considering:	
§264.93(b)(2)(i)	Volume and physical and chemical characteristics of the waste in the regulated unit;	RFI and CMS Reports for MDA L will be developed and will address this issue.	
§264.93(b)(2)(ii)	Hydrogeologic characteristics of the facility and surrounding land;	While additional information regarding the hydrogeologic characterization of the facility and surrounding land is being developed through the implementation of the Hydrogeologic Work Plan, information for MDA L can also be found in the Performance Assessment, the Hydrogeologic Assessment of TA-54, Areas G and L, and will be presented in the MDA L RFI and CMS Reports.	
§264.93(b)(2)(iii)	Quantity and quality of groundwater, and the direction of groundwater flow;	Information to be obtained through implementation of the LANL Hydrogeologic Workplan.	

Operating Unit Regulations for Ground Water/Closu. Post-Closure Care and Corresponding HSWA Activities

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.94(b)	The Secretary will establish an alternate concentration limit for a hazardous constituent if he finds that the constituent will not pose a substantial present or potential hazard to human health or the environment as long as the alternate concentration limit is not exceeded. In establishing alternate concentration limits, the Secretary will consider the following factors:	See above.	
§264.94(b)(1)	Potential adverse effects on groundwater quality, considering:		
§264.94(b)(1)(i)	Physical and chemical characteristics of the waste in the regulated unit, including its potential for migration;	RFI and CMS Reports for MDA L will be developed and will address this issue.	
§264.94(b)(1)(ii)	Hydrogeological characteristics of the facility and surrounding land;	While this information regarding the hydrogeologic characterization in facility and surrounding land is being developed through the implementation of the Hydrogeologic Workplan, site-specific information for MDA L will be found in the MDA L RFI Report and CMS Report.	
§264.94(b)(1)(iii)	Quantity of groundwater and direction of groundwater flow;	Information to be obtained through implementation of the LANL Hydrogeologic Workplan.	
§264.94(b)(1)(iv)	Proximity and withdrawal rates of groundwater users;	Information regarding the proximity and withdrawal rates of ground-water users can be obtained in the annual water supply reports (with location maps) published by ESH-18, in sections 270.14(e), 264(b)(1)(iv) and 264.601(a)(5) of the LANL permit, or in previous LANL waiver documentation.	
§264.94(b)(1)(v)	Current and future uses of groundwater in the area;	Information regarding current and future users of groundwater in the area will be developed.	
§264.94(b)(1)(vi)	Existing quality of groundwater, including other sources of contamination and their cumulative impact on groundwater quality;	Four sampling events for each well installed in the vicinity of TA-54 pursuant to the Hydrogeologic Workplan will occur in addition to ongoing monitoring of Environmental Surveillance Program wells and ER Project site characterization efforts.	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.94(b)(2)(vi)	Current and future uses of surface waters in the area and any water quality standards established for those surface waters;	Information regarding surface water use, if not already described, will be developed.	
§264.94(b)(2)(vii)	Existing surface water quality, including other sources of contamination and their cumulative impact on surface water quality;	The evaluation of LANL's surface water quality standards are considered in the evaluation of surface water and springs by the LANL Environmental Surveillance Program multi-sector CWA permit, as well as through ER Project characterization activities.	
§264.94(b)(2)(viii)	Potential for health risks caused by human exposure to waste constituents;	A present day human health risk screening assessment was completed and is presented in Attachment C of the Area L closure/post-closure plan. Results indicate no unacceptable risk to human receptors. The CMS Report for MDA L will provide results of a future human health risk assessment, including potential for contaminant migration and the site conceptual model.	
§264.94(b)(2)(ix)	Potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents; and	A present day ecological risk screening assessment was completed and is presented in Attachment C of the Area L closure/post-closure plan. Results indicate no unacceptable risk to ecological receptors. The CMS Report for MDA L will provide results of a future ecological risk assessment, including potential for contaminant migration and the site conceptual model.	
§264.94(b)(2)(x)	Persistence and permanence of potential adverse effects.	RFI and CMS Reports for MDA L will be developed and will address this issue.	
§264.94(c)	In making any determination under paragraph (b) of this section about the use of ground water in the area around the facility the Secretary will consider any identification of underground sources of drinking water and exempted aquifers made under §144.8 of this chapter.	NA	

Operating Unit Regulations for Ground Water/Closu 'ost-Closure Care and Corresponding HSWA Activities

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.97	The owner/operator must comply with following requirements for any groundwater monitoring program developed to satisfy §264.98, §264.99, or §264.100:	Alternative requirements will be met there.	
§264.97(a)	The groundwater monitoring system must consist of sufficient number of wells, installed at appropriate locations and depths to yield groundwater samples from the uppermost aquifer that:	All groundwater monitoring wells will be sufficient in number and placed at appropriate locations and depths in the uppermost aquifer as determined by characterization efforts performed during implementation of the Hydrogeologic Workplan.	
§264.97(a)(1)	Represent the quality of background water that has not been affected by leakage from a regulated unit;	Background wells will be placed in an upgradient locations determined to be unaffected by potential releases from the waste management area.	
§264.97(a)(1)(i)	A determination of background quality may include sampling of wells that are not hydraulically upgradient of the waste management area where:	Should existing conditions preclude the location of background wells upgradient, other wells will be used. These wells will be capable of determining background quality passing the aggregate boundary. This determination will be made in part by ongoing characterization efforts establishing groundwater gradient, flow directions, potential transport mechanisms, and waste-specific migration characteristics.	
§264.97(a)(1)(i)(A)	Hydrogeologic conditions do not allow the owner/operator to determine what wells are hydraulically upgradient; and	See above.	
§264.97(a)(1)(i)(B)	Sampling at other wells will provide an indication of background groundwater quality that is representative or more representative than that provided by the upgradient wells; and	See above.	
§264.97(a)(2)	Represent the quality of groundwater passing the point of compliance.	The above-mentioned geologic, hydrologic, and waste characteristics will be considered in determining the representativeness of the groundwater passing the downgradient aggregate boundary and the monitoring system's capability of detecting contamination if hazardous waste or hazardous constituents migrate from the aggregate to the uppermost aquifer.	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
		The cap should consist of concrete blending into an apron extending at least three feet from the outer edge of the borehole. Remaining annular space should be sealed with expanding cement. A suitable threaded or flanged cap or compression seal should then be placed and locked. A quarter-inch vent hole pipe will allow gas to escape, and bumper guards should be placed around the well to prevent damage by vehicles.	
§264.97(d)	The groundwater monitoring program must include consistent sampling and analysis procedures that are designed to ensure monitoring results provide a reliable indication of groundwater quality below the waste management area. At a minimum, the program must include procedures and techniques for:	Groundwater sampling and analysis procedures will be in written form and will address the following:	
§264.97(d)(1)	Sample collection;	1) Groundwater level measurements will be determined prior to collection of sample in accordance with a written procedure describing level of accuracy, measurement reference points, required equipment decontamination, and time period measured. 2) Water collection will occur in accordance with a written procedure describing sampling devices and procedures for use and decontamination, well evacuation volumes and procedures, field measurements, and appropriate sample container types.	
§264.97(d)(2)	Sample preservation and shipment;	*SW-846* requirements will be followed to ensure appropriate preservation and temperature controls are utilized.	
§264.97(d)(3)	Analytical procedures; and	*SW-846* or other approved analytical methods, holding times, and approved QA/QC analytical procedures will be used.	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.97(h)	Owner/operator will specify one of the following statistical methods to be used in evaluating ground-water monitoring data for each hazardous constituent which will be specified in the unit permit. The statistical test chosen shall be conducted separately for each hazardous constituent in each well. Where practical quantification limits (pql's) are used in any of the following statistical procedures to comply with §264.97(i)(5), the pql must be proposed by the owner or operator and approved by the Secretary. Use of any of the following statistical methods must be protective of human health and the environment and must comply with the performance standards outlined in paragraph (i) of this section.	One of the statistical methods described in §264.97(h) or an alternative approved by the Secretary will be chosen to evaluate groundwater monitoring data. It is premature at this time to prescribe a specific method until adequate characterization has been performed.	
§264.97(h)(1)	A parametric analysis of variance (ANOVA) followed by multiple comparisons procedures to identify statistically significant evidence of contamination. The method must include estimation and testing of the contrasts between each compliance well's mean and the background mean levels for each constituent.	See above.	
§264.97(h)(2)	An analysis of variance (ANOVA) based on ranks followed by multiple comparisons procedures to identify statistically significant evidence of contamination. The method must include estimation and testing of the contrasts between each compliance well's median and the background median levels for each constituent.	See above.	
§264.97(h)(3)	A tolerance or prediction interval procedure in which an interval for each constituent is established from the distribution of the background data, and the level of each constituent in each compliance well is compared to the upper tolerance or prediction limit.	See above.	
§264.97(h)(4)	A control chart approach that gives control limits for each constituent.	See above.	
§264.97(h)(5)	Another statistical test method submitted by the owner or operator and approved by the Secretary.	See above.	
§264.97(i)	Any statistical method chosen under §264.97(h) for specification in the unit permit shall comply with the following performance standards, as appropriate:	The appropriate performance standard used for the statistical method applied will be consistent with those prescribed in §264.97(i).	
§264.97(i)(1)	The statistical method used to evaluate ground-water monitoring data shall be appropriate for the distribution of chemical parameters or hazardous constituents. If the distribution of the chemical parameters or hazardous constituents is shown by the owner or operator to be inappropriate for a normal theory test, then the data should be transformed or a distribution-free theory test should be used. If the distributions for the constituents differ, more than one statistical method may be needed.	See above.	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.98(a)	The owner/operator must monitor for indicator parameters (e.g., specific conductance, total organic carbon, or total organic halogen), waste constituents, or reaction products that provide a reliable indication of the presence of hazardous constituents in ground water. The Secretary will specify the parameters or constituents to be monitored in the facility permit, after considering the following factors:	As a result of sampling performed during the four events following well installation under the Hydrogeologic Workplan, indicator parameters, waste constituents, or reaction products will be prescribed that consider the following:	
§264.98(a)(1)	The types, quantities, and concentrations of constituents in wastes managed at the regulated unit;	Waste information has been obtained and reviewed, identifying hazardous constituents, concentrations, and waste volumes during the RFI/CMS process.	
§264.98(a)(2)	The mobility, stability, and persistence of waste constituents or their reaction products in the unsaturated zone beneath the waste management area;	Further refinement of the hydrogeologic regime at TA-54 and the behavior of hazardous constituents in the unsaturated zone will be developed and reported through the Hydrogeologic Workplan activities and the RFI/CMS process. Substantial information regarding these issues has already been provided in the "Hydrogeologic Assessment of Technical Area 54, Areas G and L", the "Performance Assessment and Composite Analysis for Los Alamos National Laboratory Material Disposal Area G", and the "RFI Report for Material Disposal Areas G, H and L at Technical Area 54".	
§264.98(a)(3)	The detectability of indicator parameters, waste constituents, and reaction products in ground water; and	Based on data collected during the four sampling events following well installation under the Hydrogeologic Workplan, detectability of indicator parameters, waste constituents, and reaction products will be established using *SW-846* or Secretary-approved methodologies and detection limits.	

Operating Unit Regulations for Ground Water/Closu. .Post-Closure Care and Corresponding HSWA Activities

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.98(d)	The Secretary will specify the frequencies for collecting samples and conducting statistical tests to determine whether there is statistically significant evidence of contamination for any parameter or hazardous constituent specified in the permit under paragraph (a) of this section in accordance with §264.97(g). A sequence of at least four samples from each well (background and compliance wells) must be collected at least semi-annually during detection monitoring.	An appropriate frequency for sample collection and statistical analysis will be proposed that will be capable of determining statistically significant evidence of contamination as described in §264.98(d).	
§264.98(e)	The owner/operator must determine the ground-water flow rate and direction in the uppermost aquifer at least annually.	Groundwater flow rate and direction in the upper-most aquifer will be determined and reevaluated annually.	
§264.98(f)	The owner/operator must determine whether there is statistically significant evidence of contamination for any chemical parameter of hazardous constituent specified in the permit pursuant to paragraph (a) of this section at a frequency specified under paragraph (d) of this section.	Collect and analyze samples, evaluate data using appropriate statistical methodology and compare groundwater quality between the upgradient and downgradient wells at the aggregate boundary to determine whether statistically significant evidence of contamination exists within a reasonable timeframe.	
§264.98(f)(1)	In determining whether statistically significant evidence of contamination exists, the owner/operator must use the method(s) specified in the permit under §264.97(h). These method(s) must compare data collected at the compliance point(s) to the background ground-water quality data.	See above.	
§264.98(f)(2)	The owner/operator must determine whether there is statistically significant evidence of contamination at each monitoring well as the compliance point within a reasonable period of time after completion of sampling. The facility permit will specify what period of time is reasonable, based on the complexity of the statistical test and the availability of laboratory facilities to perform the analysis of ground-water samples.	See above.	
§264.98(g)	If the owner/operator determines pursuant to paragraph (f) of this section that there is statistically significant evidence of contamination for chemical parameters or hazardous constituents specified pursuant to paragraph (a) of this section at any monitoring well at the compliance point, he or she must:	If statistically significant evidence of contamination for established chemical parameters or hazardous constituents exists, notification will be made and ground water wells will be sampled for Appendix IX constituents. If present and confirmed with a second analysis within the timeframes described in §264.98(g), these constituents will be used in a more comprehensive monitoring program.	
§264.98(g)(1)	Notify the Secretary of this finding in writing within seven days. The notification must indicate what chemical parameters or hazardous constituents have shown statistically significant evidence of contamination;	See above.	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.98(g)(5)(ii)	An engineering feasibility plan for a corrective action program necessary to meet the requirement of §264.100, unless:	A feasibility plan for a groundwater corrective action program will be developed during the CMS/CMI process unless:	
§264.98(g)(5)(ii)(A)	All hazardous constituents identified under paragraph (g)(2) of this section are listed in Table 1 of §264.94 and their concentrations do not exceed the respective values given in that Table; or	Concentrations of hazardous constituents are not greater than MCLs; or	
§264.98(g)(5)(ii)(B)	The owner or operator has sought an alternate concentration limit under §264.94(b) for every hazardous constituent identified under paragraph (g)(2) of this section.	An ACL demonstration has been submitted for all constituents found.	
§264.98(g)(6)	If the owner/operator determines that, pursuant to paragraph (f) of this section, there is a statistically significant difference for chemical parameters or hazardous constituents specified pursuant to paragraph (a) of this section at any monitoring well at the compliance point, he/she demonstrate that a source other than a regulated unit caused the contamination or that the detection is an artifact caused by an error in sampling, analysis, or statistical evaluation or natural variation in the ground water. The owner/operator may make a demonstration under this paragraph in addition to, or in lieu of, submitting a permit modification application under paragraph (g)(4) of this section; however, owner/operator is not relieved of the requirement to submit a permit modification application within the time specified in paragraph (g)(4) of this section unless the demonstration made under this paragraph successfully shows that a source other than a regulated unit caused the increase, or that the increase resulted from error in sampling, analysis, or evaluation. In making a demonstration under this paragraph, the owner or operator must:	If contamination is detected but thought to have migrated from somewhere other than the TA-54 aggregate, was caused by sampling and analysis and/or statistical artifacts, or natural variations in groundwater, notification will be provided to the Secretary that a demonstration will be made, a demonstration report submitted, and any necessary modifications to the enforceable document requested to address appropriate changes to the monitoring program. Timeframes for submittals will be consistent with those established in §264.98(g)(6) and monitoring will continue.	
§264.98(g)(6)(i)	Notify the Secretary in writing within seven days of determining statistically significant evidence of contamination at the compliance point that he intends to make a demonstration under this paragraph;	See above.	
§264.98(g)(6)(ii)	Within 90 days, submit a report to the Secretary which demonstrates that a source other than a regulated unit caused the contamination or that the contamination resulted from error in sampling, analysis, or evaluation;	See above.	
§264.98(g)(6)(iii)	Within 90 days, submit to the Secretary an application for a permit modification to make any appropriate changes to the detection monitoring program facility; and	See above.	
§264.98(g)(6)(iv)	Continue to monitor in accordance with the detection monitoring program established under this section.	See above.	
§264.98(h)	If the owner/operator determines that the detection monitoring program no longer satisfies the requirements of this section, he/she must within 90 days submit an application for a permit modification to make any appropriate changes to the program.	A modification to the enforceable document will be requested if the monitoring prescribed in this program is no longer appropriate.	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.99(c)	The Secretary will specify the sampling procedures and statistical methods appropriate for the constituents and the facility, consistent with §264.97 (g) and (h).	Samples will be collected and analyzed for all relevant chemical parameters and hazardous constituents in such form as is appropriate for determination of statistical significance using appropriate sampling procedures and statistical methods.	
§264.99(c)(1)	The owner/operator must conduct a sampling program for each chemical parameter or hazardous constituent in accordance with §264.97(g).	See above.	
§264.99(c)(2)	The owner/operator must record ground-water analytical data as measured and in form necessary for the determination of statistical significance under §264.97(h) for the compliance period of the facility.	See above.	
§264.99(d)	The owner/operator must determine whether there is statistically significant evidence of increased contamination for any chemical parameter or hazardous constituent specified in the permit, pursuant to paragraph (a) of this section, at a frequency specified under paragraph (f) under this section.	Collect and analyze samples, evaluate data using appropriate statistical methodology and compare groundwater quality between the upgradient and downgradient wells at the aggregate boundary to determine whether statistically significant evidence of increased contamination exists within a reasonable timeframe.	
§264.99(d)(1)	In determining whether statistically significant evidence of increased contamination exists, owner/operator must use the method(s) specified in the permit under §264.97(h). The methods(s) must compare data collected at the compliance point(s) to a concentration limit developed in accordance with §264.94.	See above.	
§264.99(d)(2)	The owner/operator must determine whether there is statistically significant evidence of increased contamination at each monitoring well at the compliance point within a reasonable time period after completion of sampling. The Secretary will specify that time period in the facility permit, after considering the complexity of the statistical test and the availability of analytical laboratories to perform the analysis of ground-water samples.	See above.	
§264.99(e)	The owner/operator must determine the ground-water flow rate and direction in the uppermost aquifer at least annually.	Groundwater flow rate and direction in the uppermost aquifer will be determined and reevaluated annually.	
§264.99(f)	The Secretary will specify the frequencies for collecting samples and conducting statistical tests to determine statistically significant evidence of increased contamination in accordance with §264.97(g). A sequence of at least four samples from each well (background and compliance wells) must be collected at least semi-annually during the compliance period of the facility.	An appropriate frequency for sample collection and statistical analysis will be proposed that will be capable of determining statistically significant evidence of increased contamination as described in §264.99(f).	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.99(h)(2)(i)	A detailed description of corrective actions that will achieve compliance with the ground-water protection standard specified in the permit under paragraph (a) of this section; and	See above.	
§264.99(h)(2)(ii)	A plan for a ground-water monitoring program that will demonstrate the effectiveness of the corrective action. Such a ground-water monitoring program may be based on a compliance monitoring program developed to meet the requirements of this section.	See above.	
§264.99(i)	If the owner/operator determines, pursuant to paragraph (d) of this section, that the ground-water concentration limits under this section are being exceeded at any monitoring well at the point of compliance, may demonstrate that a source other than a regulated unit caused the contamination or that the detection is an artifact caused by an error in sampling, analysis, or statistical evaluation or natural variation in the ground water. In making a demonstration under this paragraph, the owner/operator must:	If contamination is detected but thought to have migrated from somewhere other than the TA-54 aggregate, was caused by sampling and analysis and/or statistical artifacts, or natural variations in groundwater, notification will be provided to the Secretary that a demonstration will be made, a demonstration report submitted, and any necessary modifications to the enforceable document requested to address appropriate changes to the monitoring program. Timeframes for submittals will be consistent with those established in §264.99(i) and monitoring will continue.	
§264.99(i)(1)	Notify the Secretary in writing within seven days that he intends to make a demonstration under this paragraph;	See above.	
§264.99(i)(2)	Within 90 days, submit a report to the Secretary which demonstrates that a source other than a regulated unit caused the standard to be exceeded or that the apparent noncompliance with the standards resulted from error in sampling, analysis, or evaluation;	See above.	
§264.99(i)(3)	Within 90 days, submit an application for a permit modification to the Secretary to make any appropriate changes to the compliance monitoring program at the facility; and	See above.	
§264.99(i)(4)	Continue to monitor in accord with the compliance monitoring program established under this section.	See above.	
§264.99(j)	If the owner/operator determines that the compliance monitoring program no longer satisfies the requirements of this section, must, within 90 days, submit an application for a permit modification to make any appropriate changes to the program.	A modification to the enforceable document will be requested if the monitoring prescribed in this program is no longer appropriate.	

Operating Unit Regulations for Ground Water/Closu ost-Closure Care and Corresponding HSWA Activities

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.100(d)	In conjunction with a corrective action program, owner/operator must establish and implement a ground-water monitoring program to demonstrate the effectiveness of the corrective action program. Such a monitoring program may be based on the requirements for a compliance monitoring program under §264.99 and must be as effective as that program in determining compliance with the ground-water protection standard under §264.92 and in determining the success of a corrective action program under paragraph (e) of this section, where appropriate.	A groundwater monitoring program to demonstrate the effectiveness of the corrective action will be established and implemented. It will be based on considerations identified in the corrective action program and capable of detecting statistically significant exceedances in previously established hazardous constituent concentration limits. Additional monitoring wells may be installed and sampled if necessary.	
§264.100(e)	In addition to the other requirements of this section, owner/operator must conduct a corrective action program to remove or treat in place any hazardous constituents under §264.93 that exceed concentration limits under §264.94 in groundwater:	The corrective action will also address hazardous constituents that exceed the concentration limits between the downgradient aggregate boundary and the downgradient property boundary, and off-site. Removal or in situ treatment of such constituents will occur in a reasonable time period, and, if off site, where necessary to protect human health and the environment. Corrective action can cease once limits are no longer exceeded.	
§264.100(e)(1)	Between the compliance point under §264.95 and the downgradient property boundary; and	See above.	
§264.100(e)(2)	Beyond the facility boundary, where necessary to protect human health and the environment, owner/operator demonstrates to the satisfaction of the Secretary that, despite the owner's or operator's best efforts, the owner or operator was unable to obtain the necessary permission to undertake such action. The owner/operator is not relieved of all responsibility to clean up a release that has migrated beyond the facility boundary where off-site access is denied. On-site measures to address such releases will be determined on a case-by-case basis.	See above.	
§264.100(e)(3)	Corrective action measures under this paragraph must be initiated and completed within a reasonable period of time considering the extent of contamination.	See above.	
§264.100(e)(4)	Corrective action measures under this paragraph may be terminated once the concentration of hazardous constituents under §264.93 is reduced to levels below their respective concentration limits under §264.94.	See above.	

Operating Unit Regulations for Ground Water/Closure/Post-Closure Care and Corresponding HSWA Activities

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.110(c)	The Secretary may replace all or part of the requirements of this subpart (and the unit-specific standards referenced in §264.111(c) applying to a regulated unit), with alternative requirements set out in a permit or enforceable document, where the Secretary determines that:	The CMS report to be prepared for MDA L will provide a general description of how the proposed corrective measure will meet the closure and post-closure care requirements of 264.111 - 264.120. The CMI plan to also be prepared for MDA L will describe in detail how the selected corrective measure will meet closure/post-closure care requirements. Enforceable documents include Module VIII of LANL's Hazardous Waste Facility Permit and the CMS report and CMI plan for MDA L once they are approved .	Sections 1.0, 2.0, 3.0, and 4.0
§264.110(c)(1)	The regulated unit is situated among SWMUs or AOCs, a release has occurred, and both the regulated unit and one or more SWMUs or AOCs are likely to have contributed to the release; and	MDA L meets the criteria for alternative requirements because the existing land-based unit (Shafts 1, 13-17, and 19-34 and Impoundments B and D) is situated among SWMUs, a release has occurred, and the origin of the release is uncertain.	Sections 1.0 and 3.0, Attachment C
§264.110(c)(2)	It is not necessary to apply the closure requirements of this subpart (and those referenced herein) because the alternative requirements will protect human health and the environment and will satisfy the closure performance standard of §264.111(a) and (b).	The CMS report to be prepared for MDA L will provide a general description of how the proposed corrective measure will meet applicable closure and post-closure care requirements of §264.111 - 264.120; details will be provided in the CMI Plan.	Sections 1.0 and 3.0
§264.111	Closure Performance Standard: Owner/operator must close the facility in a manner that:	For MDA L, the alternative requirements specified in the CMS report and ultimately detailed in the CMI plan will protect human health and the environment by meeting the intent of closure performance standards.	Section 1.2
§264.111(a)	Minimizes the need for further maintenance; and	For MDA L, the alternative requirements specified in the CMS report and ultimately detailed in the CMI plan will protect human health and the environment by meeting the intent of closure performance standards.	Sections 1.0, 2.0, and 3.0
§264.111(b)	Controls, minimizes or eliminates, to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated run-off, or hazardous waste decomposition products to the ground or surface waters or to the atmosphere.	For MDA L, the alternative requirements specified in the CMS report and ultimately detailed in the CMI plan will protect human health and the environment by meeting the intent of closure performance standards.	Sections 1.0, 2.0, and 3.0

Operating Unit Regulations for Ground Water/Clos ost-Closure Care and Corresponding HSWA Activities

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.112(b)(4)	A detailed description of the steps needed to remove or decontaminate all hazardous waste residues and contaminated containment system components, equipment, structures, and soils during partial and final closure, including, but not limited to, procedures for cleaning equipment and removing contaminated soils, methods for sampling and testing surrounding soils, and criteria for determining the extent of decontamination required to satisfy the closure performance standard; and	NA	Section 2.3
§264.112(b)(5)	A detailed description of other activities necessary during the closure period to ensure that all partial closures and final closure satisfy the closure performance standards, including, but not limited to, ground-water monitoring, leachate collection, and run-on and run-off control; and	NA	Section 2.3
§264.112(b)(6)	A schedule for closure of each hazardous waste management unit and for final closure of the facility. The schedule must include, at a minimum, the total time required to close each hazardous waste management unit and the time required for intervening closure activities which will allow tracking of the progress of partial and final closure. (For example, in the case of a landfill unit, estimates of the time required to treat or dispose of all hazardous waste inventory and of the time required to place a final cover must be included.)	NA	Section 1.4
§264.112(b)(7)	For facilities that use trust funds to establish financial assurance under §264.143 or §264.145 and that are expected to close prior to the expiration of the permit, an estimate of the expected year of final closure.	NA	Section 1.6
§264.112(b)(8)	For facilities where the Secretary has applied alternative requirements at a regulated unit under §264.90(f), §264.110(c), and/or §264.140(d), either the alternative requirements applying to the regulated unit, or a reference to the enforceable document containing those alternative requirements.	The closure of MDA L will utilize alternative requirements, which allows transfer of closure activities to the corrective action process. The CMS report to be prepared for MDA L will provide a general description of how the proposed corrective measure will meet closure requirements. The CMI plan to also be prepared for MDA L will describe in detail how the selected corrective measure will meet closure requirements. Enforceable documents include Module VIII of LANL's Hazardous Waste Facility Permit and the CMS report and CMI plan for MDA L once they are approved.	Section 1.3
§264.112(c)	The owner/operator must submit a written notification of or request for a permit modification to authorize a change in operating plans, facility design, or the approved closure plan in accordance with the applicable procedures in Parts 124 and 270. The written notification or request must include a copy of the amended closure plan for review or approval by the Secretary.	NA	Section 1.5

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.112(d)(2)(i)	No later than 30 days after the date on which any hazardous waste management unit receives the known final volume of hazardous wastes, or if there is a reasonable possibility that the hazardous waste management unit will receive additional hazardous wastes, no later than one year after the date on which the unit received the most recent volume of hazardous wastes. If the owner/operator of a hazardous waste management unit can demonstrate to the Secretary that the hazardous waste management unit or facility has the capacity to receive additional hazardous wastes and it has taken all steps to prevent threats to human health and the environment, including compliance with all applicable permit requirements, the Secretary may approve an extension to this one-year limit; or	NA	
§264.112(d)(2)(ii)	For units meeting the requirements of §264.113(d), no later than 30 days after the date on which the hazardous waste management unit receives the known final volume of non-hazardous wastes, or if there is a reasonable possibility that the hazardous waste management unit will receive additional non-hazardous wastes, no later than one year after the date on which the unit received the most recent volume of non-hazardous wastes. If the owner/operator can demonstrate to the Secretary that the hazardous waste management unit has the capacity to receive additional non-hazardous wastes and it has taken, and will continue to take, all steps to prevent threats to human health and the environment, including compliance with all applicable permit requirements, the Secretary may approve an extension to this one-year limit.	NA	
§264.112(d)(3)	If the facility's permit is terminated, or if the facility is otherwise ordered, by judicial decree or final order under section 3008 of RCRA, to cease receiving hazardous wastes or to close, then the requirements of this paragraph do not apply. However, the owner/operator must close the facility in accordance with the deadlines established in §264.113.	NA	
§264.112(e)	Nothing in this section shall preclude the owner/operator from removing hazardous wastes and decontaminating or dismantling equipment in accordance with the approved partial or final closure plan at any time before or after notification of partial or final closure.	NA	NA
§264.113	Closure; Time allowed for closure		
§264.113(a)	Within 90 days after receiving the final volume of hazardous wastes, or the final volume of non-hazardous wastes if the owner/operator complies with all applicable requirements in paragraphs (d) and (e) of this section, at a hazardous waste management unit or facility, the owner/operator must treat, remove from the unit or facility, or dispose of on-site, all hazardous wastes in accordance with the approved closure plan. The Secretary may approve a longer period if the owner/operator complies with all applicable requirements for requesting a modification to the permit and demonstrates that:	NA	NA

Operating Unit Regulations for Ground Water/Clos ost-Closure Care and Corresponding HSWA Activities

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.113(c)(1)	The demonstrations in paragraph (a)(1) of this section must be made at least 30 days prior to the expiration of the 90-day period in paragraph (a) of this section; and	NA	NA
§264.113(c)(2)	The demonstration in paragraph (b)(1) of this section must be made at least 30 days prior to the expiration of the 180-day period in paragraph (b) of this section, unless the owner/operator is otherwise subject to the deadlines in paragraph (d) of this section.	NA	NA
§264.113(d)	The Secretary may allow an owner/operator to receive only non-hazardous wastes in a landfill, land treatment, or surface impoundment unit after the final receipt of hazardous wastes at that unit if:	NA	NA
§264.113(d)(1)	The owner or operator requests a permit modification in compliance with all applicable requirements in parts 270 and 124 of this title and in the permit modification request demonstrates that:	NA	NA
§264.113(d)(1)(i)	The unit has the existing design capacity as indicated on the part A application to receive non-hazardous wastes; and	NA	NA
§264.113(d)(1)(ii)	There is a reasonable likelihood that the owner or operator or another person will receive non-hazardous wastes in the unit within one year after the final receipt of hazardous wastes; and	NA	NA
§264.113(d)(1)(iii)	The non-hazardous wastes will not be incompatible with any remaining wastes in the unit, or with the facility design and operating requirements of the unit or facility under this part; and	NA	NA
§264.113(d)(1)(iv)	Closure of the hazardous waste management unit would be incompatible with continued operation of the unit or facility; and	NA	NA
§264.113(d)(1)(v)	The owner or operator is operating and will continue to operate in compliance with all applicable permit requirements; and	NA	NA
§264.113(d)(2)	The request to modify the permit includes an amended waste analysis plan, ground-water monitoring and response program, human exposure assessment required under RCRA section 3019, and closure and post-closure plans, and updated cost estimates and demonstrations of financial assurance for closure and post-closure care as necessary and appropriate, to reflect any changes due to the presence of hazardous constituents in the non-hazardous wastes, and changes in closure activities, including the expected year of closure if applicable under § 264.112(b)(7), as a result of the receipt of non-hazardous wastes following the final receipt of hazardous wastes; and	NA	NA
§264.113(d)(3)	The request to modify the permit includes revisions, as necessary and appropriate, to affected conditions of the permit to account for the receipt of non-hazardous wastes following receipt of the final volume of hazardous wastes; and	NA	NA

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.117(a)(1)	Post-closure care for each hazardous waste management unit subject to the requirements of §§ 264.117 through 264.120 must begin after completion of closure of the unit and continue for 30 years after that date and must consist of at least the following:	A post-closure plan for MDA L is included in this submittal. The post-closure of MDA L will utilize alternative requirements, which allows transfer of closure activities to the corrective action process. The CMS report to be prepared for MDA L will provide a general description of how the proposed corrective measure will meet the post-closure care requirements of 264.117-120. The CMI plan to also be prepared for MDA L will describe in detail how the selected corrective measure will meet post-closure care requirements.	Section 3.2
§264.117(a)(1)(i)	Monitoring and reporting in accordance with the requirements of subparts F, K, L, M, N, and X of this part; and	The CMS report to be prepared for MDA L will provide a general description of how the proposed corrective measure will meet the post-closure care requirements of 264.117-120. The CMI plan to also be prepared for MDA L will describe in detail how the selected corrective measure will meet post-closure care requirements.	Sections 4.1 and 4.3
§264.117(a)(1)(ii)	Maintenance and monitoring of waste containment systems in accordance with the requirements of subparts F, K, L, M, N, and X of this part.	See above.	Sections 4.1 and 4.2
§264.117(a)(2)	Any time preceding partial closure of a hazardous waste management unit subject to post-closure care requirements or final closure, or any time during the post-closure period for a particular unit, the Secretary may, in accordance with the permit modification procedures in parts 124 and 270:		
§264.117(a)(2)(i)	Shorten the post-closure care period applicable to the hazardous waste management unit, or facility, if all disposal units have been closed, if he finds that the reduced period is sufficient to protect human health and the environment (e.g., leachate or ground-water monitoring results, characteristics of the hazardous wastes, application of advanced technology, or alternative disposal, treatment, or re-use techniques indicate that the hazardous waste management unit or facility is secure); or	NA	Section 3.2
§264.117(a)(2)(ii)	Extend the post-closure care period applicable to the hazardous waste management unit or facility if he finds that the extended period is necessary to protect human health and the environment (e.g., leachate or ground-water monitoring results indicate a potential for migration of hazardous wastes at levels which may be harmful to human health and the environment).	NA	Section 3.2

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.118(b)(1)	A description of the planned monitoring activities and frequencies at which they will be performed to comply with subparts F, K, L, M, N, and X of this part during the post-closure care period; and	See above.	Section 4.1
§264.118(b)(2)	A description of the planned maintenance activities, and frequencies at which they will be performed, to ensure:	See above.	Section 4.2
§264.118(b)(2)(i)	The integrity of the cap and final cover or other containment systems in accordance with the requirements of subparts F, K, L, M, N, and X of this part; and	See above.	Section 4.2.1
§264.118(b)(2)(ii)	The function of the monitoring equipment in accordance with the requirements of subparts, F, K, L, M, N, and X of this part; and	See above.	Section 4.2.2
§264.118(b)(3)	The name, address, and phone number of the person or office to contact about the hazardous waste disposal unit or facility during the post-closure care period.		Section 4.5
§264.118(b)(4)	For facilities where the Secretary has applied alternative requirements at a regulated unit under §§264.90(f), 264.110(c), and/or §§264.140(d), either the alternative requirements that apply to the regulated unit, or a reference to the enforceable document containing those requirements.		Section 3.2
§264.118(c)	Until final closure of the facility, a copy of the approved post-closure plan must be furnished to the Secretary upon request, including request by mail. After final closure has been certified, the person or office specified in §264.188(b)(3) must keep the approved post-closure plan during the remainder of the post-closure period.		Introduction
§264.118(d)	The owner/operator must submit a written notification of or request for a permit modification to authorize a change in the approved post-closure plan in accordance with the applicable requirements in parts 124 and 270. The written notification or request must include a copy of the amended post-closure plan for review or approval by the Secretary.		Section 3.3
§264.118(d)(1)	The owner/operator may submit a written notification or request to the Secretary for a permit modification to amend the post-closure plan at any time during the active life of the facility or during the post-closure care period.		Section 3.3
§264.118(d)(2)	The owner/operator must submit a written notification of or request for a permit modification to authorize a change in the approved post-closure plan whenever:		Section 3.3
§264.118(d)(2)(i)	Changes in operating plans or facility design affect the approved post-closure plan, or		Section 3.3
§264.118(d)(2)(ii)	There is a change in the expected year of final closure, if applicable, or		Section 3.3
§264.118(d)(2)(iii)	Events which occur during the active life of the facility, including partial and final closures, affect the approved post-closure plan.		Section 3.3
§264.118(d)(2)(iv)	The owner/operator requests the Secretary to apply alternative requirements to a regulated unit under §264.90(f), §264.110(c), and/or §264.140(d).		Section 3.3

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.119(b)(2)	Submit a certification, signed by the owner/operator, that he has recorded the notation specified in paragraph (b)(1) of this section, including a copy of the document in which the notation has been placed, to the Secretary.		Section 3.7
§264.119(c)	If the owner/operator or any subsequent owner/operator of the land upon which a hazardous waste disposal unit is located wishes to remove hazardous wastes and hazardous waste residues, the liner, if any, or contaminated soils, it must request a modification to the post-closure permit in accordance with the applicable requirements in parts 124 and 270. The owner/operator must demonstrate that the removal of hazardous wastes will satisfy the criteria of §264.117(c). By removing hazardous waste, the owner/operator may become a generator of hazardous waste and must manage it in accordance with all applicable requirements of this chapter. If it is granted a permit modification or otherwise granted approval to conduct such removal activities, the owner/operator may request that the Secretary approve either:		Section 3.3
§264.119(c)(1)	The removal of the notation on the deed to the facility property or other instrument normally examined during title search; or		Section 3.3
§264.119(c)(2)	The addition of a notation to the deed or instrument indicating the removal of the hazardous waste.		Section 3.3
§264.120	No later than 60 days after completion of the established post-closure care period for each hazardous waste disposal unit, the owner/operator must submit to the Secretary, by registered mail, a certification that the post-closure care period for the hazardous waste disposal unit was performed in accordance with the specifications in the approved post-closure plan. The certification must be signed by the owner/operator and an independent registered professional engineer. Documentation supporting the independent registered professional engineer's certification must be furnished to the Secretary upon request until he releases the owner or operator from the financial assurance requirements for post-closure care under §264.145(i).		Section 3.5
§264.310	Closure and post-closure care for landfills.	A post-closure plan for MDA L is included in this submittal. The post-closure of MDA L will utilize alternative requirements, which allows transfer of closure activities to the corrective action process. The CMS report to be prepared for MDA L will provide a general description of how the proposed corrective measure will meet the post-closure care requirements of 264.117-120. The CMI plan to also be prepared for MDA L will describe in detail how the selected corrective measure will meet post-closure care requirements.	

ATTACHMENT B

GEOLOGY, HYDROLOGY, AND GROUNDWATER CHARACTERIZATION AT TECHNICAL AREA 54, AREA L

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LIST OF ABBREVIATIONS/ACRONYMS

bgs	below ground surface
CA	composite analysis
cm	centimeter(s)
cm^2	square centimeters
cm/hr	centimeters per hour
cm/sec	centimeters per second
cm/yr	centimeters per year
DQO	Data Quality Objective
EP	Extraction Procedure
ER	Environmental Restoration
FEHM	Finite Element Heat and Mass
ft	feet (foot)
ft/d	feet per day
ft/yr	feet per year
FY	Fiscal Year
HE	high explosives
in.	inch(es)
in./yr	inches per year
LANL	Los Alamos National Laboratory
m	meter(s)
MCL	maximum concentration level
MDA	material disposal area
µg/L	micrograms per liter
mg/L	milligrams per liter

GEOLOGY, HYDROLOGY, AND GROUNDWATER CHARACTERIZATION AT TECHNICAL AREA 54, AREA L

1.0 GEOLOGY AND HYDROLOGY AT TECHNICAL AREA 54, AREA L

Numerous investigations of the geology and hydrology at Technical Area (TA) 54 have been conducted at Los Alamos National Laboratory (LANL). The following sections describe the extensive studies conducted at TA-54 in the past, and present information on future characterization activities and hydrologic modeling. LANL's TA-54, Area L, is located on Mesita del Buey, an east-west trending mesa bordered on the north by Cañada del Buey and on the south by Pajarito Canyon.

1.1 Geology and Stratigraphy

The following information on the geology and stratigraphy at TA-54 was obtained from borehole core logs. Unit 2 of the Tshirege Member of the Bandelier Tuff is at the surface of Mesita del Buey. This moderately welded ash-flow tuff forms nearly vertical cliffs on the sides of mesas, and at Area L is approximately 45 to 50 feet (ft) thick. A series of thin, discontinuous surge beds mark the base of Unit 2. Tshirege Member Unit 1v underlies Unit 2. This vapor-phase altered cooling unit forms sloping outcrops, and is further divided into Units 1vu and 1vc. Unit 1vu is a poorly welded ash-flow tuff. At TA-54, the thickness of Unit 1vu ranges from about 90 ft near Material Disposal Area (MDA) H to about 46 ft near MDA G. Unit 1vc is a moderately to poorly welded ash-flow tuff and ranges from 49 ft thick at the western end of Mesita del Buey to 23-26 ft thick at the eastern end. At the base of Unit 1v is Tshirege Member Unit 1g, which is a vitric, pumiceous, nonwelded ash-flow tuff. This unit is about 150 ft thick at MDA H, and thins to about 49 ft thick at the eastern end of MDA G. A distinctive pumice-poor surge deposit forms the base of Unit 1g. Beneath Unit 1g is the Tsankawi Pumice Bed, which at Area L is a thin (about 3-ft-thick) bed of gravel-sized pumice. It is the basal air fall deposit of the Tshirege Member. The Cerro Toledo interval is stratigraphically beneath the Tsankawi Pumice Bed; it separates the Tshirege and Otowi Members of the Bandelier Tuff, and averages about 40 ft thick at Area L. The Otowi Member is a massive, nonwelded, pumice-rich ash-flow tuff. At Area L, it ranges from about 64 to 109 ft thick. At the base of the Otowi Member is the Guaje Pumice Bed. At Area L, this basal air fall deposit averages about 9 ft thick. Beneath the Guaje Pumice Bed are the Cerros del Rio basalts. It is inferred that these basalts exist beneath Mesita del Buey, based on borehole data at Area L,

that the alluvium in Cañada del Buey contained no perched water (Devaurs and Purtymun, 1985).

Three test wells were also installed in Pajarito Canyon in 1985; they are PCO-1, PCO-2, and PCO-3 (Purtymun, 1995). These 3 wells are sampled for radionuclides, metals, general inorganics, and organics. Sampling results are compiled annually in environmental surveillance reports and submitted to the New Mexico Environment Department (NMED). To ensure that the alluvial aquifer in Pajarito Canyon did not extend northward beneath Mesita del Buey, 4 test holes were drilled in the canyon floor north of the intermittent stream channel in 1985 (Devaurs and Purtymun, 1985). These 4 test holes, designated PCM-1, PCM-2, PCM-3, and PCM-4, were dry. They were completed for use as moisture-access holes (Purtymun, 1995). It was concluded that perched water in Pajarito Canyon is confined to the alluvium in the stream channel and does not extend to the flank of the canyon (Purtymun, 1995). As stated in the "Hydrogeologic Workplan" (LANL, 1998), no perched groundwater has been identified beneath Mesita del Buey.

In addition to the seven test holes drilled in Pajarito Canyon in 1985, two test holes were drilled in 1950 as part of a water-supply study (Griggs, 1964; Purtymun, 1975). These holes are identified as T-5 and T-6; they were drilled to depths of 263 ft and 300 ft, respectively, and completely penetrated the Bandelier Tuff beneath the floor of Pajarito Canyon. No water was encountered. The same holes were dry when measured in 1985 (Devaurs and Purtymun, 1985).

Two mesa-top test holes at Area G were drilled to depths that were equivalent to up to 40 ft beneath the base of the alluvium in Pajarito Canyon, and three mesa-top test holes at Area L were drilled to depths that were equivalent to up to 48 ft beneath the Pajarito Canyon allluvium. None of these test holes encountered perched water (IT Corporation, 1987).

Five observation wells were installed in Cañada del Buey, mostly up-gradient from Area L, as part of a 1992 investigation for a proposed sanitary wastewater treatment plant. These wells, installed to study the effect of effluent release on the environment in the canyon, are CDBO-5, CDBO-6, CDBO-7, CDBO-8, and CDBO-9. In addition, two moisture-access holes (CDBM-1 and CDBM-2) were drilled north of Area L in 1992. Perched water was encountered in the

hydraulic head were measured to calculate seepage velocity and rates of moisture flux. Second, the moisture content of the tuff was measured after precipitation events to determine changes in moisture content with depth.

Hydrologic testing was performed in the boreholes and on borehole core samples in the laboratory to allow calculation of seepage velocity and moisture flux rates in the tuff. Intrinsic permeability was measured in boreholes through air injection and vacuum tests. Laboratory tests included the Dynamic Method to measure gas-water relative permeability, and gas injection with correction for slippage. Intrinsic permeability ranged from about 10^{-8} to 10^{-9} square centimeters (cm^2) for fractured and unfractured intervals. Similar results were obtained from a water injection test performed to verify the results of the air injection tests. Vacuum tests performed in the same boreholes yielded slightly lower permeability values; however, they also averaged in the 10^{-8} to 10^{-9} cm^2 range. In the laboratory tests, intrinsic permeability yielded values in the low 10^{-9} cm^2 range. Because discontinuities that occur in the rock intersected by the borehole are not typically present in laboratory-tested cores, lower intrinsic permeability values are expected for laboratory tests.

Laboratory measurements were conducted for gravimetric moisture content, soil-moisture characteristic curves, and unsaturated hydraulic conductivity of borehole tuff samples. The gravimetric moisture content generally ranged from 2 to 4%, with isolated intervals that ranged up to 10 to 28%. Soil moisture characteristic curves were determined for 20 tuff samples, and moisture content was determined for capillary pressures in the range of -0.03 to -0.34 bar. Attempts to measure moisture contents at lower capillary pressures were not successful because samples disaggregated. Hence, moisture characteristic curves could only be determined for volumetric moisture contents above 22%, which is considerably higher than the values observed from testing core samples of field measurements. From the characteristic curve data, it was concluded that moisture retention values of the tuff are extremely high, and ranged up to 80% (60% volumetric moisture). The moisture retention value of 80% indicates that no liquid transport can occur at moisture content below this value. Because all of the moisture content measurements for the tuff were significantly below 80%, it was concluded that capillary transport of liquids does not contribute to moisture movement and vapor transport is clearly the major mechanism of water transport. Unsaturated flow is not likely to be a major factor in liquid transport at these moisture content levels.

performed using measured hydraulic conductivity values for the tuff and hydraulic head data from the psychrometers to determine maximum rates of moisture movement in the tuff. A maximum downward flux (using average measured hydraulic conductivity) of 0.254 ft per year (ft/yr) and a maximum upward flux of 0.198 ft/yr were calculated using average measured hydraulic conductivity for Area L. Because only hydraulic conductivity values at higher percentages of saturation than those actually observed in the field were available, the calculated flux rates very likely overestimate the moisture flux values. Because hydraulic conductivity in the vadose zone typically increases with increases in percent saturation, the measured hydraulic conductivity values are greater than the actual field conditions. If calculated (rather than measured) hydraulic conductivity values are used, lower flux rate values (by approximately an order of magnitude) are predicted. The moisture flux values, though highly conservative, show that very long periods of time would be required for water and contaminants to move by unsaturated flow from the MDAs to the groundwater. In summary, there is no evidence to suggest that saturation of the tuff and subsequent transport of contaminants by saturated flow is likely.

Based on the data collected in the 1985/1986 investigation, the following conclusions were made regarding the hydrologic characterization of the vadose zone and potential aqueous phase migration of contaminants:

- The Bandelier Tuff is characterized by very low moisture content (typically in the range of 2 to 5%). This value is well below the porosity; thus, moisture movement by unsaturated flow processes predominate over saturated flow.
- The tuff has high moisture retention properties and is very porous, averaging 50% porosity.
- Intrinsic permeability tests (both field and laboratory) indicate average permeability of the tuff to be 10^{-8} to 10^{-9} cm^2.
- Permeability tests conducted in the field do not indicate increased permeability in zones adjacent to fractures in boreholes. Aperture, trace, and degree of fracture filling is variable, however, and permeability along fractures may vary significantly.
- The tuff's unsaturated hydraulic conductivity was determined to be approximately 10^{-8} centimeters per second at approximately 20 to 40% moisture content, determined by measured effective permeability and using van Genuchten's model. Actual moisture conditions and unsaturated hydraulic conductivity are likely lower than these values.

Twenty-three sampling ports were installed in seven boreholes to allow collection of pore-gas at various depths (Devaurs and Bell, 1986). The pore-gas samples were collected by pumping air from the sampling port through charcoal adsorption tubes. The volatile organics were then extracted from the charcoal for analysis. The analytical results indicated that VOCs in the pore gas were present in ppm concentrations at depths up to approximately 100 ft, the approximate depths of the holes.

The core analyses and the pore-gas data suggested that volatile organic constituents from the wastes disposed of at MDA L have migrated into the tuff. It was determined that, based on the vadose zone characterization studies, vapor diffusion is the predominant mechanism for migration.

As noted in the hydrogeologic assessment prepared in 1987 (IT Corporation), the regional aquifer was encountered at a depth of approximately 875 ft just west of Areas G and L. Calculations using the hydraulic gradient of the Tesuque Formation (0.015) predicted depths to the regional aquifer beneath Area L as 950 ft.

Water samples collected from the wells in Pajarito Canyon (described in Section 1.4) were analyzed for VOCs, selected metals, and radionuclides. No VOCs were detected in these samples, and metal and radionuclide concentrations were found to be below drinking water standards. It was concluded that there appears to be no discernable effect on water quality in Pajarito Canyon from disposal operations at Area L.

Based on the hydrogeologic investigations performed at Mesita del Buey in 1985 and 1986 and on other previous work, several specific conclusions were reached regarding the characteristics of Areas G and L and the potential for contaminant migration from the waste disposal units there. These conclusions are:

- The stratigraphy of the Bandelier Tuff at Areas G and L is similar to that throughout the western portion of the Pajarito Plateau.
- Vertical and near-vertical cooling fractures are common in the tuff at Mesita del Buey.
- No major fault zones are known to exist at or near Areas G and L that could serve as conduits from the shallow subsurface to the regional groundwater.

to the near-surface drying, evaporation appears to occur along the sides of the mesa and in fractures and surge beds, which are layers within the mesa that appear to allow air flow. The relative absence of moisture nearly eliminates the possibility that contaminants will be transported through the tuff to the regional aquifer (LANL, 1997).

The PA/CA was supported by a fairly complete set of data and observations to characterize the uppermost 60 m (200 ft) of the Tshirege Member of the Bandelier Tuff beneath MDA G. Unit 2 of the Bandelier Tuff is the caprock that forms the top of Mesita del Buey. This unit is extensively fractured as a result of contraction upon post-depositional cooling. The cooling-joint fractures, which are mostly vertical, generally dissipate at the bottom of Unit 2, which at Area G is about 12 m (39 ft) thick. Mean spacing between fractures is about 1 m (3.3 ft), and fracture widths range from less than 1 millimeter (mm) to 13 mm (<0.03 to 0.51 inches [in.]) with a median of 3 mm (0.12 in.). Typically, fractures are filled with smectite clays to a depth of about 3 m (10 ft). Smectite clays (e.g., montmorillonite) are known for their tendency to swell when water is present and for their ability to strongly bind certain elements. Both of these properties have implications for transport of contaminants in fractures (LANL, 1997). Typically, fractures in Unit 2 do not extend into Unit 1vu. Only the more prominent cooling fractures originating in Unit 2 continue into the more welded upper section of Unit 1 vu; however, they die out in the less consolidated lower section.

The degree of welding and devitrification are two properties of the tuff that influence fluid flow. In welded, devitrified tuff, there are several competing effects that determine moisture content and fluid flux. Welded tuffs tend to be more fractured than non-welded tuffs. Although water moves slowly through an unsaturated tuff matrix, it can move relatively rapidly through fractures only if nearly saturated conditions exist (LANL, 1997). As indicated by modeling studies, moisture is absorbed into the matrix when fractures disappear at contacts between stratigraphic subunits, when fracture fills are encountered, or when coatings are interrupted. Because fractures are open to the passage of both air and water, they can have both wetting and drying effects, depending on the relative abundance of water in the fractures and matrix (LANL, 1997).

As a rule, the Tshirege Member of the Bandelier Tuff is very dry and does not readily transmit moisture. Most of the pore spaces in the tuff are small enough to be of capillary size and have

10^{-10} cm/sec at 5% volumetric moisture content. This also illustrates the effects of the physical characteristics discussed above. The slopes of the conductivity curves generally level out when the moisture content reaches 7% and indicate that the hydraulic conductivity remains relatively constant over a wide range of moisture content (between 10 and 30%). The conductivity curves steepen again when the moisture content exceeded 34%; however, the high moisture contents were obtained under experimental conditions and are not expected *in situ* except under very localized conditions (LANL, 1997).

The rate of moisture movement beneath Mesita del Buey is perhaps the most important parameter in modeling the subsurface transport of contaminants (LANL, 1997). Moisture movement largely controls the minimum time required for contaminants to potentially be transported from MDA G through the vadose zone into the regional aquifer. The moisture movement through the undisturbed vadose zone is complex and is further complicated at MDA G by man-made disturbances associated with waste management activities.

Three moisture-content zones are consistently shown within the subsurface at MDA G (LANL, 1997). The volumetric moisture content in the top few meters varies between about 3 and 12% and reflects the seasonal effects of precipitation and evapotranspiration. Between mid-mesa depths of about 8 and 23 m (25 and 75 ft), volumetric moisture content is quite low, from 0.5 to 2%. Below 25 m (80 ft), moisture content increases to between 9 and 19%. The mid-mesa dry zone occurs consistently near the surge beds at the base of Unit 2 of the Tshirege Member. Based on unsaturated hydraulic conductivity estimates, estimates of flux rates through the low moisture content region are negligible (LANL, 1997). Water-pressure profiles estimated beneath the mesa, using hydraulic properties from cores, suggest that moisture moves toward the base of Unit 2 from above and below. These observations are consistent with a hypothesis that the mesa is dried out to a significant extent by evaporation and air movement along surge beds and fractures that are prevalent near this horizon (LANL, 1997).

Different rates of moisture movement corresponding to the three moisture-content zones are inferred by several independent analyses. Although the analyses invoke simplifying assumptions, they provide consistent qualitative evidence of variable rates of moisture movement within and across Mesita del Buey (LANL, 1997). The inferred zones include:

Tuff. It was found that near the surface, the best fit to the field moisture data to a depth of approximately 5 m (15 ft) corresponds to a moisture movement rate between 0.01 and 10 mm/yr (0.0004 and 0.4 in./yr). In Unit 2 and Unit 1vu, the apparent moisture movement rate that matches the field moisture data is between 0 and 0.1 mm/yr (0 and 0.004 in./yr). In Units 1vc and 1g, a moisture movement rate of 1 mm/yr (0.04 in./yr) best matches the field data. The Tsankawi-Cerro Toledo and Otowi Member stratigraphic layers match field moisture data with a much larger apparent moisture movement rate on the order of 10 mm/yr (0.4 in./yr). These estimated rates support the hypothesis that moisture movement is not steady state, or that significant changes in movement of moisture occur at depths (LANL, 1997). One explanation that accounts for the results of this analysis is that water may be removed at intermediate depths by evaporation and vapor-phase diffusion.

The unit-gradient approximation was also used to identify depths within Mesita del Buey where moisture may be lost to evaporation or vapor-phase diffusion (LANL, 1997). A moisture profile analysis was performed, and the rates of moisture movement calculated as the gradient of moisture were plotted, as was the gradient of the vertical flux. The results suggest a downward flux and a source of moisture to depths of about 7 m (23 ft). Below this, to depths near 28 m (92 ft), the average vertical flux is small but downward and the source is very small. The average local flux in this low-moisture zone is -0.017 mm/yr (-0.0007 in./yr) and the average moisture source is -0.0013 mm/yr (-0.005 in./yr). A moisture peak at 30 m (100 ft) occurs at the vapor-phase notch (the base of Unit 1vc). Overall, the average rate of moisture movement near the surface is about 10 mm/yr (0.4 in./yr), with a large standard deviation suggesting high variability. The average rate of moisture movement through the middle depths of the mesa is very small, and in the vapor-phase notch portion is relatively large (0.73 mm/yr). Although increased moisture at the vapor-phase notch at MDA G may be interpreted as a moisture source from the relatively wet canyons, this hypothesis does not explain high moisture content values (10 to 20% volumetric) observed at the vapor-phase notch at other locations across the Laboratory where the notch is not coincident with a canyon bottom or other moisture source.

Another study to understand the potential influence of water moving within and out of the mesa in the vapor phase was conducted by analyzing the vapor flux through the mesa (LANL, 1997). Analyses were performed on neutron-probe moisture measurements from several boreholes at

approximately 8%. Using the unit approximation, the average rate of moisture movement through Pit 37 is 5 mm/yr (0.2 in./yr) at the average (mean) pit moisture content (LANL, 1997).

In 1976, horizontal boreholes were drilled approximately 1 m (3.3 ft) beneath a pit at MDA G that was closed in 1966. Moisture measurements at the same boreholes were made in 1992 with a neutron probe. The volumetric moisture content values beneath the pit were in the range of 1 to 4%, and were generally 1 to 2% higher beneath the pit than moisture content values away from the pit. These data suggest that pit excavation has a small effect on moisture contents beneath the pits (LANL, 1997).

1.6 Groundwater

The most recent projected depth to groundwater at Area L, based on currently available data, is approximately 1,000 ft (LANL, 2001a). Additional information on groundwater at TA-54 is provided in the "Characterization Well R-22 Completion Report" (LANL, 2002); the "Supplement to Quarterly Technical Report April-June 2001" (ER Project, 2001); and the "Quarterly Technical Report October-December 2001" (ER Project, 2002). The following are summaries of the information in those reports.

Well R-22 is located on Mesita del Buey, east of TA-54, and was funded and installed by LANL's Environmental Restoration (ER) Project. This well is one of the 11 regional aquifer (R) wells drilled to date as part of the "Hydrogeologic Workplan" (LANL, 1998) in support of the "Groundwater Protection Management Program Plan" (LANL, 1996). Well R-22 is the first of five planned regional aquifer wells at or in the vicinity of TA-54. This well was designed primarily to provide water-quality and water-level data for potential intermediate-depth perched zones and for the regional aquifer downgradient of TA-54. In addition, it was designed to collect geologic, hydrologic, and geochemical data that will contribute to the understanding of the vadose zone and regional aquifer in this area of LANL. Although the location of well R-22 was originally proposed for installation in Pajarito Canyon, just south of Mesita del Buey, its final location was changed to the mesa top in order to be in closer proximity to and more directly downgradient of TA-54 and to be better suited for a future monitoring well.

Well R-22 was drilled to a total depth of 1,489 ft in 2000. A multiscreen well containing five screened intervals that can be sampled individually was installed. In descending order, the

Extensive borehole geophysical data were collected during drilling. Borehole video and natural gamma radiation surveys were conducted, and a suite of borehole geophysical logs was obtained. The surveys were conducted in cased hole from the surface to a depth of 1,330 ft. Below 1,330 ft, the surveys were conducted in open hole. Geophysical logging in open hole included caliper, resistivity, natural gamma radiation, spontaneous potential, lithodensity, magnetic resonance, borehole color video, epithermal neutron, neutron porosity, and spectral natural radiation. Volumetric water content beyond the casing in the vadose zone was measured using a Compensated Neutron Tool as a means to evaluate moist/porous zones and to estimate porosity in the saturated zone. Overall and spectral natural gamma ray activity was measured using a Hostile Natural Gamma Spectroscopy tool as a means to evaluate geology and lithology and the presence of clay versus sand. As a means to characterize mineralogy, lithology, and water content of the formation, concentrations of hydrogen, silicon, calcium, sulfur, iron, potassium, titanium, and gadolinium were measured using an Elemental Capture Spectroscopy tool. To measure bulk density and photoelectric effect as a means to estimate total porosity and characterize lithology, a Litho-Density Tool was used. Calibrated gross gamma ray readings were recorded to match the depth of the logging runs. The log results indicated that at the time of logging, a well-water level of 995 ft below ground surface (bgs) was recorded and that the probable regional groundwater level was 886 ft bgs. The log results also showed increased vadose zone moisture content (an average of 5%) in the intervals between 50 and 180 ft bgs, and 10% or greater between 350 and 715 ft bgs. In addition, in the interval from 1,405 to 1,478 ft (the total log depth), log data indicated an increased saturated zone porosity (greater than 40%) corresponding to the Lower Puye Formation. Clearly defined stratigraphic/lithologic boundaries were also indicated from the spectral gamma and geochemical logs.

During drilling, samples of groundwater were collected from depths of 883 ft and 1,489 ft. The potential contaminants of concern at the well R-22 location include VOCs, perchloric acid, tritium, and other radionuclides (LANL, 2002). The samples were analyzed for major anions, VOCs, semivolatile organic compounds, high explosives (HE), radionuclides, and stable isotopes. Samples collected for major anions analysis were filtered; nonfiltered samples were collected for the remainder of the analyses. Due to the presence of drilling fluids, the borehole water samples are not representative of groundwater.

As previously mentioned, the following compounds are not subject to regulation under the hazardous waste program; however, data are provided herein for informational purposes only. Tritium was present at an activity of 109 picocuries per liter (pCi/L); this screening value suggests that the age of the tritium is less than 60 years old. More recent sampling shows lower tritium levels. During the first round of groundwater sampling in March 2001, tritium levels ranged from 2 to 77 pCi/L. During the second round of sampling in June 2001, tritium levels continued to decrease and ranged from 1 to 14 pCi/L. (The Drinking Water maximum concentration level [MCL] for tritium is 20,000 pCi/L.) Activities of americium-241, plutonium-238, plutonium-239/-240, and strontium-90 were less than detection. Activities of uranium-234, uranium-235, and uranium-238 were at levels of 1.48, 0.126, and 1.41 pCi/L, respectively. Nitrogen isotopes were analyzed for the water sample collected at 1,489 ft to evaluate the source(s) of nitrate at well R-22. The $\delta^{15}N(NO_3)$ value was +9.6 permil, which suggests that the water sample is enriched with nitrogen-15.

The Cerros del Rio lavas at well R-22 were nearly three times thicker than predicted (983 ft vs. 339 ft). The most significant hydrogeologic impact of this thick set of lavas is that the regional water table is within these lavas rather than within Puye Formation fanglomerates. Therefore, all flow and transport within the upper ~300 ft of the regional aquifer is within basaltic fractures and interflow rubble rather than through Puye Formation pore spaces. This difference in stratigraphy implies different flow rates and pathways, and the lavas provide an environment in which certain constituents (e.g., ferrous iron) can influence water chemistry.

Several features contribute to the peculiarities of the as-drilled stratigraphy at well R-22. It is believed that the exceptional thickness of the Cerros del Rio lavas and cinder indicate fill within a paleocanyon. The absence of axial river gravels at the base of the Cerros del Rio volcanics suggests that the paleocanyon was not a through-going drainage ancestral to the modern Rio Grande. Because cuttings were not returned from some key intervals beneath the Cerros del Rio lavas, it is possible that axial river gravels may have been present within 5 ft of the base of the lavas but were not sampled. Therefore, the orientation of the paleocanyon (east-west vs. north-south) is uncertain.

The first round of groundwater sampling at well R-22 was conducted in March 2001 and the

The primary purpose of the "Hydrogeologic Workplan" is to gain an understanding of the hydrogeologic setting that is adequate to design a detection monitoring network capable of detecting water quality threats to the regional aquifer. As stated in the Executive Summary of the workplan, the expected outcomes of implementing the plan's activities are:

- A "refined understanding of the hydrogeologic framework at the Laboratory, including recharge areas, hydraulic interconnections, flow paths, and flow rates, synthesized by modeling simulations;
- Information sufficient either to design and implement a detection monitoring program that meets applicable requirements and/or to demonstrate that groundwater monitoring requirements can be waived; and
- Defined areas of existing or potential groundwater contamination, and the potential pathways of contaminant transport from the surface to the regional aquifer, with predictions of directions and rates of movement and risk based on modeling simulations."

A series of decisions established in the plan were intended to focus data collection activities on information important to a better understanding of the hydrogeologic regime as well as monitoring design. Areas with the highest potential for contaminant impacts are where hydrogeologic data collection is more focused. The potential pathways and rates of contaminant migration can be determined using the resulting data and analyses. One workplan objective is to identify areas of groundwater contamination. Determining the extent of contamination and risk posed by that contamination is conducted by LANL's ER Project because investigation of contaminant plumes is not within the scope of the "Hydrogeologic Workplan" (LANL, 1998).

The "Hydrogeologic Workplan" provides for an iterative process of gaining understanding from each activity, especially from installed wells. This iterative process is then used in guiding the succeeding DQOs and the location and data collection of subsequent wells. Although the interpretive process is not as highly visible as data collection, it is equally as important as the well installation and data collection. A primary tool used to interpret data collected from drilling and testing in the wells is numerical modeling. When sufficient new data and data interpretation have been accomplished to change the conceptual understanding, the iteration process is conducted. The data collection and modeling reached a level of maturity in Fiscal Year (FY) 01 to allow iteration of the DQOs. The FY 01 DQO iteration process began with a

presence of contaminants within the zones that could indicate actively occurring contaminant transport. As noted in Section 1.6, well R-22 was installed in 2000 on the mesa top just east of the TA-54 disposal areas. The location of this well was changed from its original siting in Pajarito Canyon to determine if perched zones are present beneath Mesita del Buey and to better understand the hydrogeologic conditions just east of the disposal areas at TA-54. Other proposed R wells for Pajarito Canyon included wells R-17, R-18, and R-19, which would provide information about sources in other aggregates upgradient of Aggregate 2; they are not discussed further in this attachment. Also in the initial workplan, one R well (R-21) was proposed for installation on Mesita del Buey near MDA L. The purpose of this proposed well is to evaluate and monitor hydrologic and geochemical conditions in the regional aquifer beneath MDA L. Data from well R-21 will be compared to data from well R-20, just northwest of Aggregate 2, to evaluate migration of organic contaminants, potential pathway behavior, and potential contaminant movement toward supply well PM-2. Recently, it was determined that an additional well (well R-23) be included in Aggregate 2. Well R-23 is proposed to be located in Potrillo Canyon, approximately 3,700 ft south of Area G. This well will provide water-quality and water-level data for potential intermediate perched zones and the regional aquifer. It will also provide data that may be used to calibrate the potential for a southeasterly groundwater flow direction, evaluate recharge, and determine the presence of perched zones and the influence of the regional aquifer in the area of a hydrologic sink. It should be noted that the locations of the four additional R wells associated with Aggregate 2 (wells R-16, R-20, R-21, and R-23) are subject to change as the DQO iteration process continues.

3.0 REGIONAL AQUIFER HYDROLOGIC MODELING

A hydrologic model for the Pajarito Plateau beneath LANL is an important tool for protecting groundwater that could potentially be impacted by past Laboratory operations. The purpose of modeling the regional aquifer is two-fold. First, the model can be used to synthesize hydrologic, geochemical, and geologic data relevant to the regional aquifer. Second, the model can be used to predict flow directions and velocities as well as technically defensible estimates of uncertainty in the predictions.

A numerical groundwater model for the Pajarito Plateau beneath LANL was developed in 1998 and has been refined continuously as new groundwater data are collected. From the detailed

in alluvium in some canyons; (2) perched intermediate groundwater (groundwater above a less permeable layer that is separated from the underlying groundwater by an unsaturated zone at intermediate depths (150-400 ft); and (3) the regional aquifer, which is separated from the upper groundwater by hundreds of ft of tuff, basalts, and volcanic sediments in the western portion of the Laboratory, with the vadose zone becoming thinner to the east. The regional aquifer beneath the Pajarito Plateau provides the community and Laboratory water supply.

Hydrologic models have two parts that work together: the conceptual model and the numeric model. The conceptual model is the synthesis of all the known geologic and hydrologic data, which provides the estimated input parameters for the numeric model. The numeric model uses mathematical equations to translate the rock and water properties to numbers. A model is "calibrated" when the numbers that result from the numeric model match reasonably well to actual observations (e.g., water levels in wells). The process of calibrating a model involves revising the conceptual and numeric models consistent with the known data until there is reasonable match between model outputs and observed data. After calibration, the regional aquifer model is used for sensitivity analyses. Sensitivity analyses are a tool to evaluate the uncertainty of the model by testing how much each of the inputs affects the outcome of the model. Those inputs that have a big effect on the model outcome are considered "sensitive" and the input values should be based on appropriate site-specific data. Those inputs that do not affect model outcomes are "insensitive" and are not as important to site-specific data.

3.3 Model Code Selection

The numeric model is the computer code that runs calculations with the input parameters provided. The numeric model selected by the Laboratory is the Finite Element Heat and Mass (FEHM) computer code. It was developed at the Laboratory for the High-Level Radioactive Waste Repository Program. It simulates the flow of water and air and the transport of heat or substances in water through saturated or partially saturated rock. It can simulate flow or transport in either 2-dimensions or 3-dimensions. It was selected because it has been rigorously tested and certified for use in radioactive waste disposal and because its capabilities match the specific investigation needs at the Laboratory. For example, FEHM can be used for both unsaturated and saturated flow modeling, both of which are important at the Laboratory. This computer code is publicly available from LANL.

At the outset of the modeling effort, the decision was made to develop a regional-scale model

- Lower boundary is the basement rocks of the Española Basin, which are metamorphic rocks that can also be seen in the Sangre de Cristo Mountains
- The upper boundary is the water table of the regional aquifer.

Of the boundary conditions, the upper boundary is considered the most important because that is where all the recharge occurs. The other boundaries represent hydrologic divides, where little water enters or exits the basin. The upper boundary surface is the water table of the regional aquifer. The grid nodes on the upper boundary surface are assigned one of three kinds of boundary conditions. The first kind of boundary condition is for nodes that occur in one of the major rivers (Rio Grande or Rio Chama). The boundary condition for the nodes in the rivers allows water to either flow into or out of the river, depending on if the water table is higher than (water flows out of the aquifer into the river) or lower than (water flows out of the river and into the aquifer) the river. The elevation of the river grid nodes was set at the elevation of the river.

The second kind of boundary condition for the upper model boundary is the higher elevation where recharge occurs. These grid nodes are set to allow a specific amount of water into the regional aquifer. The amount of water at each grid node was calculated based on the elevation of the land surface. This approach was taken because a graph of actual precipitation measurements at stations of different elevation in the Española Basin shows a linear relationship - the higher the elevation, the higher the precipitation. It was also assumed that the percent of precipitation reaching the water table increases with increasing elevation. This assumption is based on the observation that at higher elevations, the temperature and vegetation cover are both less, so the evaporation and transpiration (use of water by plants) are both expected to be lower; thus, more water is available to infiltrate the ground surface. In the numerical model, for every node above the threshold elevation of 6,000 ft (the elevation at which evaporation is greater than precipitation, so no water recharges), the amount of precipitation assumed was based on the linear trends of increasing precipitation and infiltration with elevation.

The third type of boundary condition on the upper boundary of the 1998 model were assigned to nodes that had elevation of less than 6,000 ft and were not in the river channels. These nodes were assigned a no-flow condition, because water is not expected to enter or exit the regional aquifer in these areas.

lower Los Alamos, and Santa Clara Pueblo, Tesuque Pueblo). On the Pajarito Plateau, vertical gradients have been measured in a number of wells. The measured vertical gradients are shown in Table 3.

The **aquifer properties**, primarily permeability, are assumed to be controlled by the geologic characteristics of the rocks. The Española Basin gradually accumulated sedimentary rocks formed by sediments eroded from surrounding high areas and volcanic rocks erupted from different volcanic centers. The sedimentary rocks generally contain the regional aquifer within the Española Basin. For the regional aquifer model, 20 layers representing different types of rock units (hydrostratigraphic zones) were used (Table 4). In addition, vertically-oriented hydrostratigraphic units representing fault zones were included in the model. Each layer was assigned hydraulic properties based largely on hydrologic data that have been collected and the geologic character of the layer where no data are available.

Aquifer **recharge**, the amount of water entering the aquifer, is a generalized recharge model, assuming that the first order control on recharge rates is elevation. The conceptual model of recharge is that most water recharging the aquifer originates in stream channel bottoms. For major channels in the basin, this is modeled explicitly. However, for most of the model domain, recharge is applied uniformly within any given elevation range ("diffuse" recharge), making no distinction between canyons and mesas. This effectively "spreads" the focused recharge occurring in canyon bottoms over a larger area. This approximation is appropriate for estimating the total amount of water recharging the system in various elevation ranges, for estimating baseflow discharge to rivers, and for estimating hydraulic gradients in the regional aquifer at scales of kilometers.

Groundwater **discharge** to rivers is an extremely important constraint on the regional aquifer model. Surface water flow data from twelve rivers in the basin are used to determine the baseflow. Quantified downstream increases in baseflow are attributed to regional aquifer discharge.

3.5 Regional Aquifer Modeling Calibration and Results

The regional aquifer model has been calibrated in two modes: steady-state and transient. Since 1945, the water levels in the Pajarito Plateau area have declined due to extensive development of the aquifer. The steady-state mode is calibrated using "pre-development"

Table 1: Grid Spacing in Española Basin-scale Model and the Pajarito Plateau Portion of the Model				
Model	**North- South (X)**	**East-West (Y)**	**Vertical (Z)**	**# Nodes**
Española Basin-scale model	1000 m	1055 m	50 m above 1300 m depth	277,951
	1000 m	1055 m	500 m below 1300 m depth	
Pajarito Plateau portion	250 m	264 m	12.5 m above 1550 m elevation	172,741
	250 m	264 m	50 m above 1100 m depth	
	250 m	264 m	500 m below 1100 m depth	

Table 2: Horizontal Gradients on the Pajarito Plateau

Upgradient Well	Water Level Elevation (m)	Down-gradient Well	Water Level Elevation (m)	E-W Distance (m)	Gradient (m/m)
R-25	1836	CdV-15-3	1833	2189	0.02884
CdV-15-3	1833	R-19	1795	4710	0.02149
DT-10	1805	R-22	1747	5195	0.01121
R-15	1785	R-12	1738	3684	0.01283

Table 4:	Hydrostratigraphic Units		
Rock Type	**Hydrostratigraphic Layer**	**Volume (10^{10} m^3)**	**Permeability (m^2)**
Crystalline Rock	Deep Basement (Precambrian	400.8	5.00×10^{-16}
	Fractured Paleozoic/Mesozoic	214.2	
	Paleozoic/Mesozoic	181.7	2.00×10^{-17}
	Cerros del Rio Basalts	0.4	1.00×10^{-15}
	Cerros del Rio Basalts - southern	2.2	1.00×10^{-16}
	Tschicoma Formation	57.1	7.10×10^{-16}
Fault Zones	Pajarito	17.6	2.13×10^{-15}
	Agua Fria	0.1	4.49×10^{-15}
Sedimentary Rocks	Santa Fe Group east	47.4	2.07×10^{-13} horizontal 2.07×10^{-15} Vertical
	Santa Fe Group west	171.2	1.4×10^{-13} horizontal 1.4×10^{-15} Vertical
	Ancha Formation	3.4	1.34×10^{-13} horizontal 1.34×10^{-15} Vertical
	Santa Fe Group north	90.3	1.50×10^{-14}
	Ojo Caliente sandstone	61	2.20×10^{-14}
	Peñasco Embayment	38.5	4.67×10^{-13}
	Santa Fe Group - deep	162.4	1.21×10^{-14}
	Santa Fe Group- near airport	8.2	1.00×10^{-11} horizontal 1.00×10^{-13} Vertical
	Santa Fe Group - Chaquehui Formation	2.6	1.00×10^{-13}
	Puye - fanglomerate	0.4	2.38×10^{-13}
	Puye - totavi lentil	0.5	1.00×10^{-13}
	Bandelier Tuff	0.1	3.95×10^{-14}
Total Model Volume		**1620**	

regional aquifer beneath the Pajarito Plateau.

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ATTACHMENT C

NATURE AND EXTENT OF RELEASES AND PRESENT-DAY RISK ASSESSMENT FOR TECHNICAL AREA 54, MATERIAL DISPOSAL AREA L

SWMU 54-006

Administrative Authority NMED
Technical Area TA-54
Has ER Sampled the Site? Yes
Structure Number N/A

Material Disposal Area (MDA L) (all subsurface units such as Pit A, SI B,C,D, Shafts 1-28, 29-34)
Former Operable Unit OU 1148
Dates of Operation 1959-1986
ER Remedial Action Conducted? No
Other Remedial Action Conducted? No

Unit Description

SWMU 54-006 (also called MDA L) is included in Module VIII of LANL's Hazardous Waste Facility Permit. Area L is a 2.5-acre fenced area that includes MDA L, which consists of 1 subsurface disposal pit (pit A); 3 subsurface treatment and disposal impoundments (impoundments B, C, and D); and 34 disposal shafts (shafts 1 through 34). Only impoundments B and D and shafts 1, 13-17, and 19-34 (although no longer in use) are considered active impoundments until RCRA closure is certified and approved. The entire fenced surface area of Area L is an active RCRA-permitted hazardous waste management unit.

Disposal pit A is located in the eastern portion of Area L beneath Dome 54-215. The pit is 200 ft long x 12 ft wide x 12 ft deep. It received chemical waste from the late 1950s until December 1978. Initial waste disposal practices included disposal of uncontainerized chemical wastes and liquids in drums without added sorbents. The pit also was used as an evaporative pit. Pit A was filled with waste to within approximately three feet of the surface between 1964 and 1978, and then was covered with crushed, consolidated tuff.

The three surface impoundments (impoundments B, C, and D) are located northwest of pit A. Impoundment B was excavated in 1978 and is 60 ft long x 18 ft wide x 10 ft deep. It had a capacity of 7,560 ft^3 and operated from January 1979 to June 1985 to evaporate treated salt solutions and electroplating wastes. Impoundment C was closed in 1978. This impoundment, which is 35 ft long x 12 ft wide x 10 ft deep, was used for the same disposal purposes as impoundment B. Impoundment C had a capacity of 2,940 ft^3. Impoundment D is approximately 75 ft long x 18 ft wide x 10 ft deep and had a capacity of 9,450 ft^3. It was used to treat small quantities of lithium hydride by reaction with water. This practice began in 1972 and was discontinued in 1984. Impoundment D later was used as secondary containment for used oil storage tanks (see SWMU 54-021). The capacities of the impoundments were calculated assuming they were filled to within three feet of the surface. All three impoundments are covered with crushed tuff followed by asphalt.

The 34 disposal shafts at MDA L were drilled directly into the subsurface tuff. Shafts 1 through 28 are located south of pit A. Shafts 29 through 34 are located northwest of impoundments B, C and D. Three feet of crushed tuff were placed in the bottom of each shaft to fill cracks and joints. The shafts range from 15 ft to 65 ft deep and vary in diameter from 3 ft to 8 ft. Groups of shafts were constructed as needed. When in use, the shafts were covered with a steel cap that could be opened or removed, depending on design, to allow placement of waste. The operational dates of the shafts vary, but

Present-day risks posed by MDA L to human and ecological receptors were characterized using a human health risk assessment and an ecological screening assessment. The risk assessment presented in the preliminary RFI report concluded that surface contamination at the site posed no unacceptable present-day risk to human health. No radionuclides or inorganic chemicals were detected in sediment samples collected at the site. Methoxychlor was detected but at concentrations similar to those found to pose no unacceptable present-day risk at MDA G. Results of ambient air risk assessment for VOCs indicated carcinogenic risks that were about equal to or below the lower end of EPA's acceptable risk range. Potential doses from tritium are below those shown to pose an acceptable risk in the MDA G risk assessment. The ecological screening assessment found that chemicals did not have the potential to cause adverse ecological impacts to receptors at MDA L. The results of the present-day risk assessment indicate that no action is necessary to address exposure of on-site workers to VOCs or tritium in air at MDA L. The risks, dose, and hazards associated with exposure to soil contaminants at MDA L were lower than those from exposure to VOCs and tritium in air and were below acceptable limits. The present-day ecological risk screening assessment at MDA L indicated no COPECs.

Quarterly pore-gas sampling of the vapor phase VOC plume at MDA L is ongoing; sampling results are reported in the ER quarterly reports. At the request of NMED, the RFI report for MDA L is being rewritten to incorporate additional recent information on the nature and extent of contamination.

References

RFI Report for Material Disposal Areas G, H, and L at Technical Area -54 LA-UR Number: 00-1140

Modification to Resource Conservation and Recovery Act Facility Investigation (RFI) Work Plan for Operable Unit (OU) 1148, Field Unit 5 LA-UR Number: No LA-UR

RFI Report for Channel Sediment Pathways from MDAs G, H, J and L, at TA-54 (located in former Operable Unit 1148) LA-UR Number: 96-0110

Proposed Action Plan Drilling Near Area [MDA] L, TA-54, OU 1148 LA-UR Number: No LA-UR

RFI Work Plan for Operable Unit 1148 LA-UR Number: 92-0855

CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

James L. Holt
Associate Director, Operations
Los Alamos National Laboratory
Operator

4/25/02
Date Signed

E. Dennis Martinez
Acting Director
U.S. Department of Energy
National Nuclear Security Administration
Office of Los Alamos Site Operations
Owner/Operator

4/25/02
Date Signed