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Date: January 28, 2000
Refer to: E/ER:00-025

Mr. John Kieling
NMED-HRMB
P.O. Box 26110
Santa Fe, NM 87502

HWA LANL 5/1144/49

SUBJECT: MATERIAL DISPOSAL AREA (MDA) AB MOISTURE MONITORING

Dear Mr. Kieling:

Pursuant to our meeting with Ms. Lee Winn of your staff, this letter amends Section 6.0 of the "Stabilization Plan for Implementing Interim Measures and Best Management Practices at Potential Release Sites 49-001(b, c, d, and g)," and the contingency plan, which is Attachment A of our response to your request for supplemental information (RSI) on September 10, 1998 (EM/ER:98-336). The stabilization plan was submitted to the New Mexico Environment Department Hazardous and Radioactive Materials Bureau (NMED-HRMB) on August 30, 1999, (ER Catalog # 19990054).

Section 6.0 of the stabilization plan is amended by the enclosed "MDA AB Moisture Monitoring Fact Sheet," which was provided to NMED-HRMB on January 7, 2000, and subsequently discussed with Ms. Winn on January 19, 2000. The moisture monitoring plan presented in the fact sheet calls for the replacement and abandonment of the two boreholes (49-2906 and 49-2907) on the current cap, which were determined to be inadequate for monitoring; the installation of replacement boreholes to be located directly adjacent to boreholes 49-2906 and 49-2907; and the installation of a new borehole at a location in the eastern portion of the cap. All three boreholes will be advanced to a nominal depth of 15 feet beneath present ground surface. Moisture content in these three boreholes will be measured with a neutron probe. In addition, horizontal and vertical time domain reflectometry (TDR) arrays will be installed adjacent to the new borehole in the eastern portion of the cap and adjacent to borehole 49-2906. TDR is considered one of the most promising new technologies for in situ moisture sensing and utilizes a data logger, which can be set to record moisture content at any specified time interval. Detailed information describing TDR is provided in the fact sheet. Moisture data from both monitoring technologies will be compared and correlated in the annual reports. This information will be utilized to evaluate future monitoring plans for engineered covers at LANL.

Monthly monitoring will be conducted over the entire length of each of the three boreholes in the cap and the eight existing boreholes located around the cap at 1-foot intervals, as described in the fact sheet. Additional monitoring may be performed to investigate the effects of selected storm events and rainfall patterns. Monitoring results will be reported to NMED-HRMB in the Environmental Restoration (ER) Project quarterly reports with trends provided in an annual moisture monitoring report for MDA AB.

The contingency plan provided as Attachment A to our response (EM/ER:98-336) to your RSI on September 10, 1998, describes supplemental measures that will be taken if a progressive, significant increase in moisture content is observed in the fill materials and underlying soil beneath the cap. It has been revised in accordance with comments from your staff and is provided as Enclosure 1.

As agreed to in our January 19, 2000, meeting with NMED-HRMB, we are providing a tentative schedule for the implementation of the moisture monitoring plan described in the fact sheet. This schedule is contingent on the timing of the contract award for this project. We anticipate the first monthly monitoring data will be collected in March 2000. We will keep NMED-HRMB apprised of any changes to this proposed schedule.

Los Alamos National Laboratory would like to thank Ms. Winn for taking the time to meet with ER Project personnel to discuss our proposed approach to moisture monitoring at MDA AB to determine the effectiveness of stabilization activities. We look forward to continued interaction with you and your staff as the moisture monitoring plan is implemented and moisture data are collected and analyzed.

If you have any questions, please call Dave McInroy (505) 667-0819 or Joe Mose at (505) 667-5808.

Sincerely,

Julie A. Canepa, Program Manager
Los Alamos National Laboratory
Environmental Restoration

Sincerely,

Theodore J. Taylor, Program Manager
Department of Energy
Los Alamos Area Office

JC/TT/MB/ev

Enclosures:
1) Response to Request for Supplemental Information for the Stabilization Plan for Implementing Interim Measures and Best Management Practices at PRSs 49-001 (b, c, d, and g) (Attachment A)
2) MDA AB Moisture Monitoring Project Schedule
3) MDA AB Moisture Monitoring Fact Sheet

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Revision 1 of Response to Request for Supplemental Information for the Stabilization Plan (SP) for Implementing Interim Measures and Best Management Practices at PRSs 49-001 (b, c, d, and g) Los Alamos National Laboratory (LANL) EPA I.D. NM0890010515

INTRODUCTION

To facilitate review of this response, the New Mexico Environment Department's (NMED's) comments are included verbatim. Los Alamos National Laboratory's (LANL's) responses, which follow each NMED comment, address the general comments on the stabilization plan. Those comments were presented in NMED's Attachment A. NMED's comments on the Storm Water Pollution Prevention (SWPP) Plan, which were presented in NMED's Attachment B, will be incorporated into the SWPP Plan, as required under the National Pollutant Discharge Elimination System Baseline General Permit. These comments will be included as part of the annual site compliance evaluation currently scheduled to be completed in September.

GENERAL COMMENTS

NMED Comment

1. *LANL shall submit an as built certification report verifying the work that was completed and what deviations from the approved plan were made.*

LANL Response

1. LANL will submit two as-built certification reports to NMED, one addressing the best management practices aspects of the stabilization and a second addressing the interim measures aspects. These reports will be prepared during the first quarter of fiscal year 1999, following completion of the respective activities, and each will be certified for accuracy by LANL's Material Disposal Area AB project leader.

NMED Comment

2. *LANL shall provide a sampling schedule for the moisture content beneath the temporary cover, including fill and clay, to determine if the cover is effective.*

LANL Response

2. A sampling schedule is provided in the contingency document (Attachment A) requested in NMED's third comment (below). This schedule provides an elaboration of the monitoring program information provided in Section 6.0 of the stabilization plan and calls for a three-part monitoring effort. First, monitoring will be performed in the surface soils and the soil/tuff interface on a monthly basis at selected locations to determine if an increase in moisture content is occurring. Second, monitoring will be performed on a monthly basis over the entire length of each monitoring hole in all monitoring wells at the site, as stated in the stabilization plan. Third, additional monitoring will be performed to investigate the effects of selected storm events and rainfall patterns to obtain a better understanding of those climatic events that affect stormwater percolation and consequent changes in soil moisture content. The conditions to be studied under this additional monitoring program will be identified by

LANL. To facilitate efficient implementation of the monitoring program as well as a rapid response of monitoring personnel to specific storm events, a dedicated neutron probe is planned to be acquired and maintained at Technical Area 49.

NMED Comment

3. *LANL shall provide a contingency plan (with schedule) that describes an alternate solution if an increase in moisture content under the temporary cover, including fill and clay, occurs.*

LANL Response

3. A contingency document has been prepared as requested (Attachment A).

NMED Comment

4. *Attachment 1, Evaluation of Potential Surface Water Concerns. AP 4.5 changes will be initiated by the Surface Water Quality Bureau and the Surface Water Assessment Team (SWAT).*

LANL Response

4. No Attachment 1 was included in NMED's comments. The site-specific surface water assessment process (formerly referred to as AP 4.5) is being developed as an Environmental Restoration Project standard operating procedure. Revisions or changes to surface water assessment scores can be initiated by the Surface Water Assessment Team or, if through further review another site visit and assessment are deemed appropriate, by LANL. The Surface Water Quality Bureau will be copied by ESH-18 on all revisions to surface water assessment scores. If there are any questions or concerns, please contact Mike Alexander (665-4752) or Steve Veenis (662-0606).

ATTACHMENT A
CONTINGENCIES FOR REDUCING SOIL MOISTURE CONTENT AT POTENTIAL RELEASE SITES 49-001(b,c,d, and g)

1.0 INTRODUCTION

The contingencies described in this document are supplemental measures that can be taken, if needed, to control soil moisture content at Los Alamos National Laboratory's (Laboratory's) Potential Release Sites (PRSs) 49-001(b,c,d, and g). These measures would be implemented if future moisture contents are found to progressively increase despite the interim measures that were implemented to reduce moisture levels. PRSs 49-001(b,c,d, and g) are located in the Laboratory's Technical Area (TA) 49 and include Areas 2, 2A, and 2B of Material Disposal Area (MDA) AB. These areas are collectively known as the asphalt pad site, and their locations are shown in Figure 1-1.

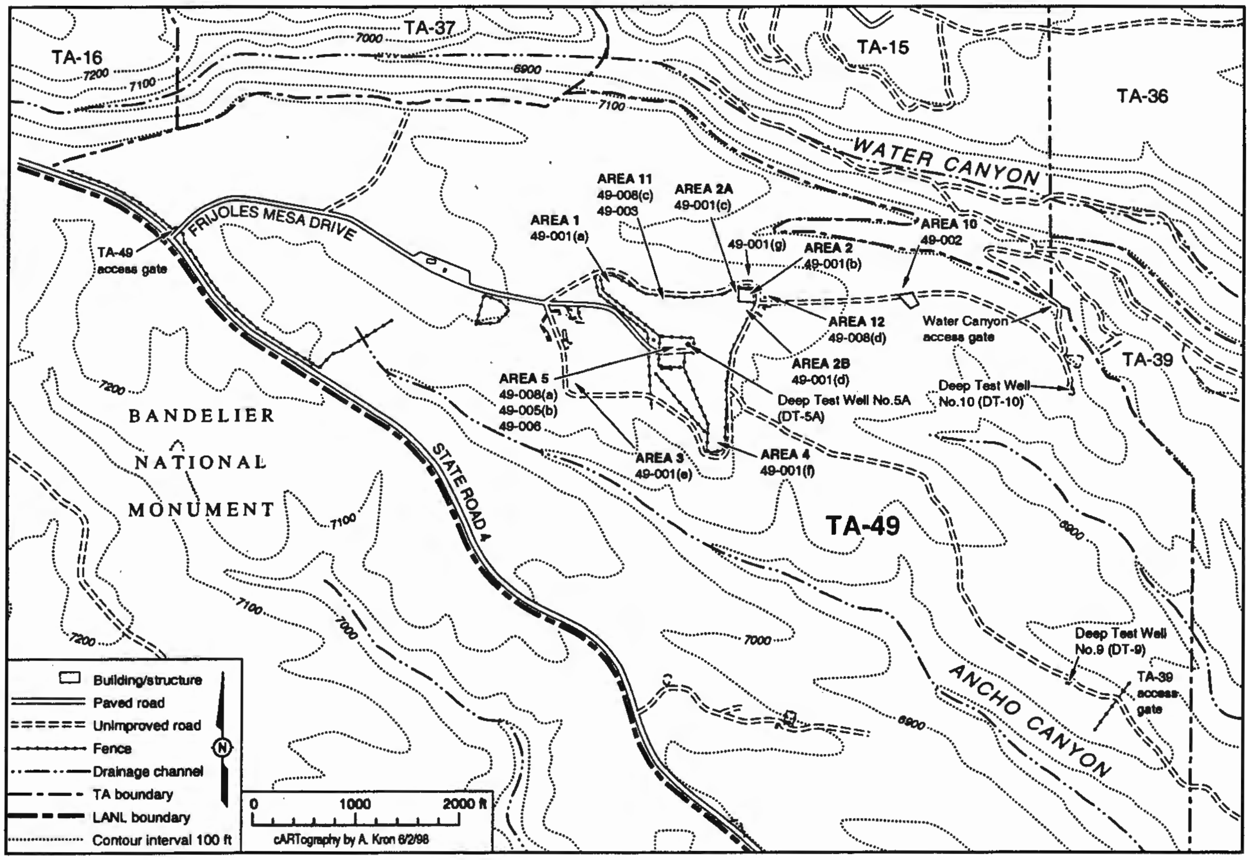


Figure 1-1. **Map of TA-49**

Interim measures intended to induce a long-term reduction in moisture content at the site have been implemented and are described in the report, "Stabilization Plan for Implementing Interim Measures and Best Management Practices at PRSs 49-001(b,c,d, and g)" (LANL 1999, 63918). The stabilization measures include diverting surface water run-on before it reaches the site, removing the asphalt pad to enhance soil moisture evaporation, regrading the site to improve drainage by eliminating surface ponding, and revegetating the site with shallow-rooting grasses to enhance evapotranspiration. The stabilization measures will restore the site to more natural conditions, and over a period of years, the moisture content of the near-surface soil and fill materials is expected to drop. However, in the unlikely event that climatic conditions result in a series of years with high recharge and low evaporation, temporary increases in soil moisture may be observed. The following paragraphs describe the soil moisture monitoring program that will be used to determine the effectiveness of the best management practices, introduce the decision methodology, and provide preliminary action alternatives in the event that a significant, progressive increase in soil moisture content occurs.

This document has been prepared in response to a request by the Hazardous and Radioactive Materials Bureau (HRMB) of the New Mexico Environment Department (NMED).

2.0 SOIL MOISTURE MONITORING PROGRAM

The proposed monitoring program described in Section 6.0 of the stabilization plan (LANL 1999, 63918) will be supplemented, as described below, to obtain the information necessary to determine the need for implementing contingency actions. This monitoring plan calls for the replacement and abandonment of the two boreholes (49-2906 and 49-2907) determined to be inadequate for monitoring. Two-in.-diameter aluminum casing will be installed in the replacement boreholes, which will be located directly adjacent to abandoned boreholes 49-2906 and 49-2907 (Figure 2-1), to a nominal depth of 15 ft beneath the present ground surface. A new borehole will also be installed at a location to be agreed to by the NMED HRMB (2-in.-diameter aluminum casing driven to a nominal depth of 15 ft beneath the present ground surface). The proposed location for this borehole is shown in Figure 2-1 (new hole). Moisture content will be measured in these three boreholes with a neutron probe.

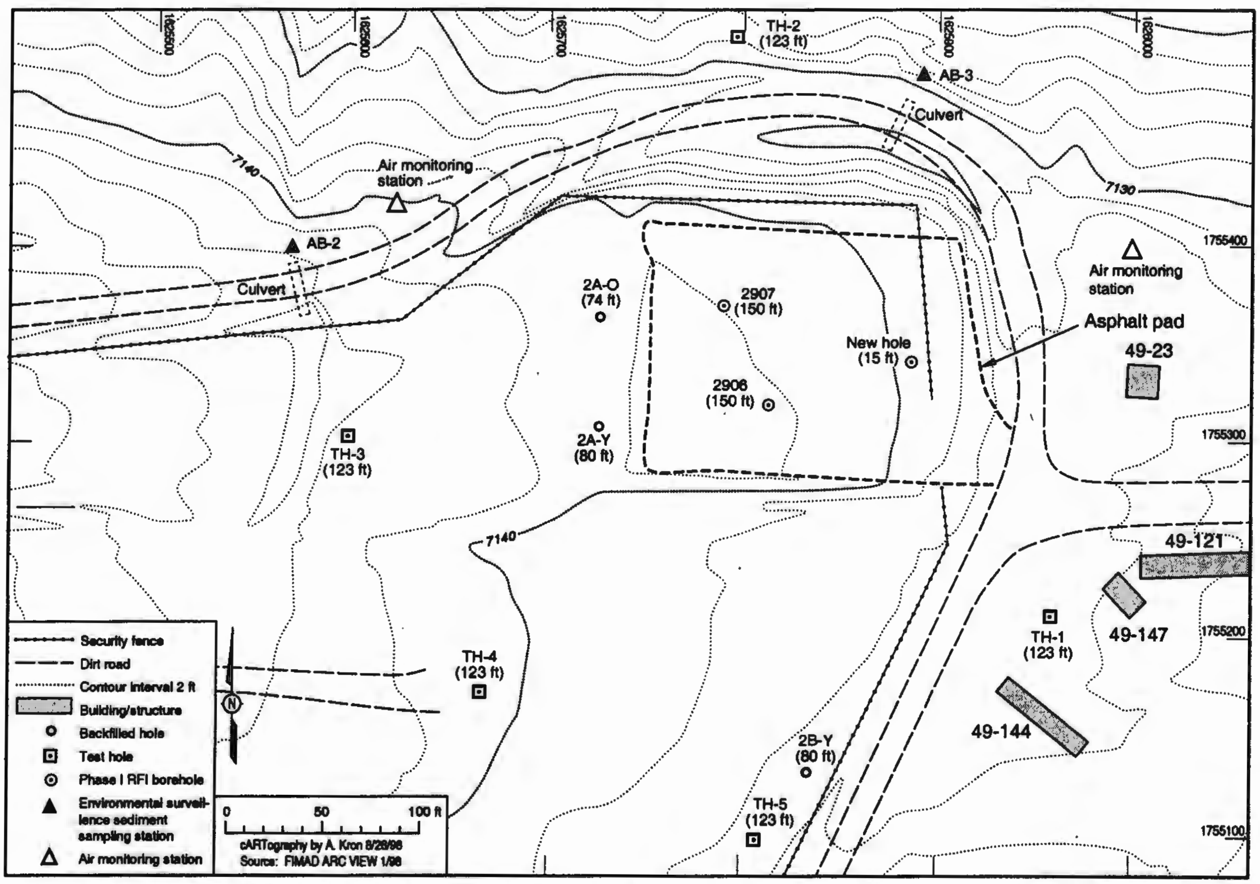


Figure 2-1. **Monitoring hole locations at Area 2**

Moisture monitoring will be performed in the surface soils and the soil/tuff interface on a monthly basis in the two replacement boreholes 49-2906 and 49-2907, in the new hole, and in existing boreholes TH-1 through TH-5, 2A-O, 2A-Y, and 2B-Y. Monthly monitoring will be conducted over the entire length of each borehole at 1-ft intervals. Monitoring results will be reported to NMED-HRMB in the Environmental Restoration Project quarterly report in accordance with our request for supplemental information response dated September 10, 1998 (EM/ER:98-336). A list of borehole depths is provided in Table 2-1.

Table 2-1
Borehole Descriptions

Borehole Number	Casing Type	Borehole Diameter (in.)	Borehole Depth (ft)
TH-3	4-in. schedule 40 PVC at surface only	5	112
TH-4	4-in. schedule 40 PVC at surface only	5	92
TH-5	4-in. schedule 40 PVC at surface only	5	107
2B-Y	2-in. schedule 40 PVC at surface only	2	33
2A-Y	2-in. schedule 40 PVC at surface only	2	28
2A-O	2-in. schedule 40 PVC at surface only	2	62
TH-2	4-in. schedule 40 PVC at surface only	5	106
TH-1	4-in. schedule 40 PVC at surface only	5	114

Of the three monitoring holes on the pad, replacement borehole 49-2907 is located in the northwestern, upgradient part of the pad, replacement borehole 49-2906 is located in the south-central part of the pad, and the proposed site of the new hole is located in the east-central, downgradient part of the pad. Holes 49-2906 and 49-2907 are located approximately 25 ft from the nearest shafts where no concrete caps are believed to be present and may therefore be in areas of better vertical drainage where the moisture content of the fill materials beneath the asphalt is lower. The new hole is located downgradient of shaft 2-O where standing water was found above a concrete cap at a depth of 24 in. during the Resource Conservation and Recovery Act facility investigation (RFI) sampling in April 1998. The concrete cap may impede vertical drainage, and the new hole may be in an area where the moisture content of the fill materials is higher. These three holes are appropriate for conservatively determining representative average conditions because less than a third of the pad is believed to be underlain by concrete caps. The moisture content of the native soil underlying the fill materials and concrete caps is expected to be elevated throughout the pad.

Because of their geographic spread, their locations relative to known concrete shaft caps, and their upgradient, central, and downgradient sites on the pad, the three monitoring holes on the pad are expected to provide adequate information on the range of moisture conditions in the fill materials, native soils, and soil/tuff contact zone beneath the pad. Monitoring is not planned for holes into test shafts beneath the pad because of the potential for encountering contamination and because moisture measurements in the shaft sand backfill would not provide information typical of the surrounding soils. Monitoring through direct measurement of standing water levels in shallow wells in the fill material above concrete caps is also not planned because the open wells may provide a pathway for enhanced vertical moisture migration, the appropriate well depth in a perched water zone of varying thickness over time would be difficult to determine, and the masking effects of slow flow transients in the clayey fill would be difficult to assess.

The five TH holes that will be monitored are located off the pad in areas where more natural mesa-top moisture conditions prevail. Information from these holes will provide a basis for comparing changes in moisture conditions at the pad with changes in natural soil moisture to help evaluate the effects of the pad fill materials on soil moisture conditions.

The moisture monitoring will be conducted using a calibrated neutron probe. Neutron probes have been extensively studied by the Laboratory and have been found to be effective tools for measuring soil moisture content at Los Alamos (Nyhan et al. 1994, 44015). Radioactive constituents in the fill, soil, and tuff around the existing monitoring holes are within the background range and will not interfere with the probe measurements. Measurements will be taken according to the following specifications.

- Volumetric field moisture measurements of the fill, soil, and tuff material around each borehole will be taken every foot to a depth of 3 ft beneath the soil/tuff contact.
- Measurements will be made in a manner that allows quantitative comparison to volumetric moisture content data previously obtained from holes at the site.
- Field logs will be maintained documenting each monitoring round.
- An annual monitoring report will be prepared describing the results of each monitoring round, interpreting the results, and documenting any identified trends.

In addition to the neutron probe, horizontal and vertical time domain reflectometry (TDR) arrays will be installed adjacent to the new borehole and adjacent to borehole 49-2906. The most promising emerging technology for in situ moisture sensing is TDR, which when connected to a data logger can be set to record moisture content at any time interval. Two TDR sensors will be installed at each of the two monitoring points (new hole and 49-2906). One sensor will be positioned horizontally just below the bottom of the top soil in the crushed tuff layer of the new cap, and one vertical probe will be placed just below the new cap into the old cover material to detect any progressive downward migration of a wetting front. The proposed design will allow comparison and correlation of moisture monitoring data using neutron probes and TDR arrays. If data show that the two moisture monitoring techniques are comparable, then the TDRs can be used to continuously monitor transient events and potentially replace use of neutron probes.

Monitoring to support contingency decisions will be conducted on a monthly basis for at least the first two years following completion of the stabilization measures to provide a comprehensive database that can be analyzed for seasonal trends. A two-year base period has been selected for supporting contingency decisions to defray the potential of reacting to false positives. Limited historical data collected by the Laboratory on percolation of surface runoff into the soil indicates that although climatic conditions may favor substantial percolation in a given year (Wilcox et al. 1997, 57577), the likelihood that such conditions will persist for two years in a row is small. Additionally, the significant 1200-ft depth to groundwater at the site would substantially attenuate short-term pulses in near-surface moisture supply, and minimal incremental risk would be associated with one or two years of high moisture conditions in the fill and underlying soil. Seasonal variations in moisture level are anticipated, such that two full years of data are expected to be necessary to identify differences between seasonal variability and actual long-term changes in moisture content. Although the supplemental monitoring program will be continued until a final corrective measure is completed at the site, after the first two years, the program will be reviewed and modified as appropriate.

In addition to the monthly measurements, additional measurements may be taken to investigate the effects of selected storm events and rainfall patterns to obtain a better understanding of those climatic events that affect stormwater percolation and consequent changes in soil moisture content. To facilitate efficient implementation of the monitoring program as well as the rapid response of monitoring personnel to specific storm events, a dedicated neutron probe is planned to be acquired and maintained at TA-49. This would eliminate delays related to transporting the neutron source over public highways.

Moisture measurements have historically been taken in the asphalt pad monitoring holes on an occasional basis, and baseline measurements were made in all holes in July 1998 before removing the asphalt.

3.0 CRITERIA FOR IMPLEMENTING CONTINGENCY ACTIONS

Contingency actions will be implemented if a progressive, significant increase in moisture content is observed in the fill materials and underlying soil at the pad. A *significant increase* will be determined on the basis of projected risk. Significant moisture content is defined as the amount that would result in a projected human health risk by way of the groundwater pathway above 1 x 10-6 within 1000 years. This determination is nominally expected to be made after two years of monitoring data are collected and is expected to be based on average moisture trends in the three monitored wells on the pad. However, if significant increases in moisture content are observed after the first year of monitoring that are not related to short-term causes (such as unusual climatic conditions), the determination to implement contingency actions may be made earlier.

Linking contingency action implementation to health risk provides a rational, quantitative basis for evaluating the significance of any moisture increases that are observed. It would not be appropriate to expend resources on additional site stabilization if an increase in moisture content had only negligible consequences. Because the determination to implement contingency actions involves an analysis of the consequences of increased moisture content, it will necessarily be based on model predictions of contaminant mobilization and transport. The model will be based on site-specific data and will be available for use in the fall of 1999. This schedule will provide timely model availability and the associated implementation trigger values for the consequence analysis when the first year of monitoring data will have been collected.

Because the site information and monitoring database available at the time the consequence analysis would be conducted will be more comprehensive than what is available today, it would be premature to define in detail the methods and approach that would be used in the consequence analysis. In addition, the Laboratory's MDA core document, currently under development, will provide a comprehensive approach to addressing corrective measures at MDAs. It is expected that information on the extent, rate, and significance of contaminant migration in the vadose zone beneath the site will be available from

- monitoring in Phase II RFI slant boreholes planned to be drilled beneath the asphalt pad site in fiscal year 2001 (LANL 1992, 7670, Section 7.6.6),
- modeling studies of the rates of contaminant migration, and
- an assessment of the associated risk.

If the increase in moisture content is found to be significant in terms of the human health risk criterion described above, the next step would be to determine the appropriate contingency actions. If the increase in moisture content is not found to potentially cause this criterion to be exceeded, no contingency action would be required.

4.0 ALTERNATIVE CONTINGENCY ACTIONS

Three alternative classes of contingency actions are described in the following subsections. They consist of

- implementing in whole or in part the final corrective measures to be developed for the site through the corrective measures study (CMS) process,
- implementing temporary measures designed to address infiltration from direct precipitation on the site, or
- implementing temporary measures designed to address surface run-on and subsurface interflow entering the site.

The appropriate contingency actions would be implemented if the foregoing consequence analysis indicates that the observed increase in moisture content may significantly reduce the ability of the site to isolate the waste. The actual contingency actions that would be implemented will be selected at the time that the need for such actions is determined. Because knowledge of site conditions and available remedial techniques is expected to increase over the two or more year period before the need for contingency actions is determined, measures designed today would not be expected to be as effective as those designed at a later date.

Selection of the appropriate contingency action will depend on the source of the excess moisture identified at the site. If contingency action is required, analysis of moisture levels will focus on the horizons where moisture peaks have typically been observed beneath the asphalt. As shown in Figure 4-1, these are in the fill materials directly beneath the asphalt and in the native soils underlying those fill materials. The three potential findings are significant increases in moisture levels in the upper horizon, in the lower horizon, or in both horizons.

Because the upper horizon of fill materials is higher than the local ground surface, a finding of significant increases in moisture levels in that horizon could only result from increases in the net infiltration of direct precipitation on the site. One alternative contingency action must therefore address control of direct precipitation. Increases in moisture levels in the lower horizon could result from three principal sources:

- increases in downward migration of moisture from the overlying fill materials,
- increases in surface water run-on originating in the upgradient area between the existing surface water diversion channel and the pad, and
- increases in potential subsurface interflow onto the site beneath the existing surface water diversion channel.

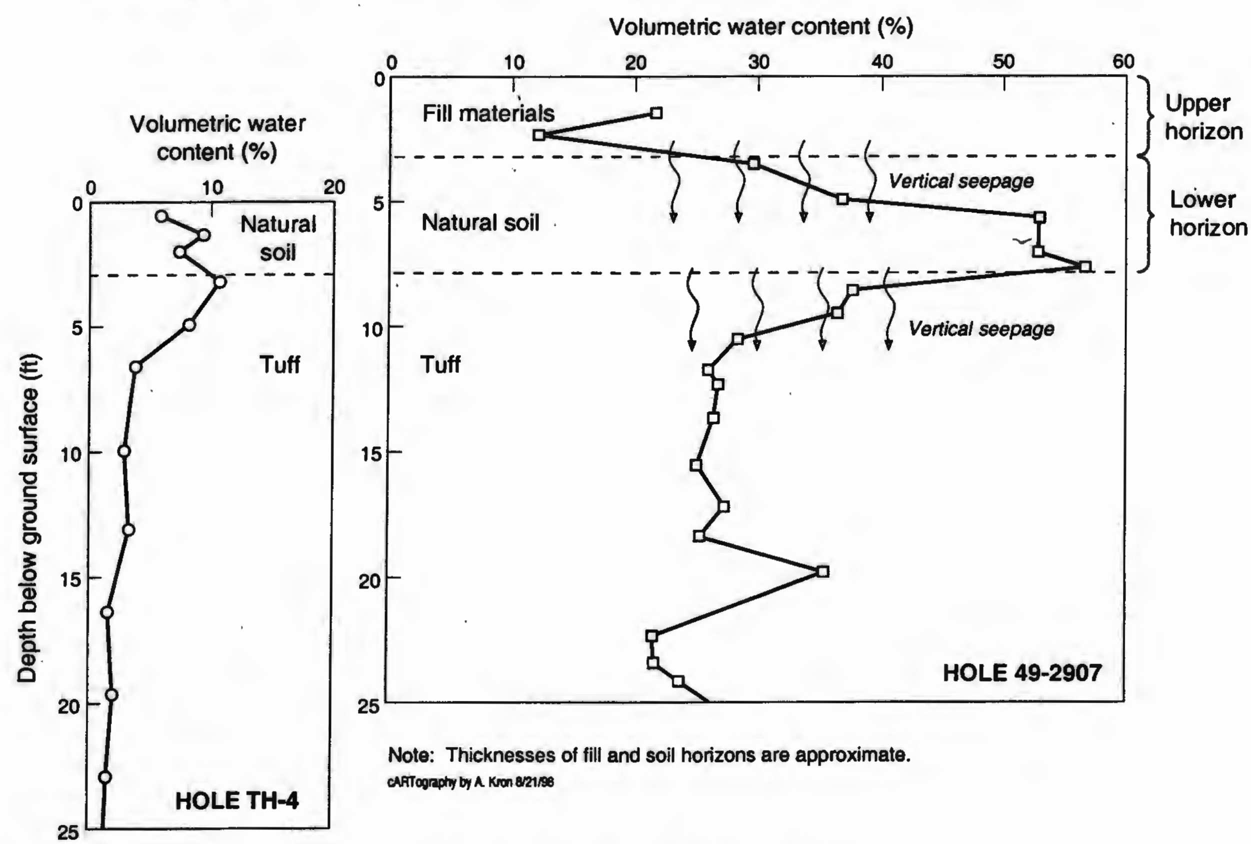


Figure 4-1. **Upper and lower horizons for soil moisture monitoring**

These sources are illustrated in Figures 4-1 and 4-2. Additional alternative contingency actions must therefore address control of potential interflow and supplemental surface run-on.

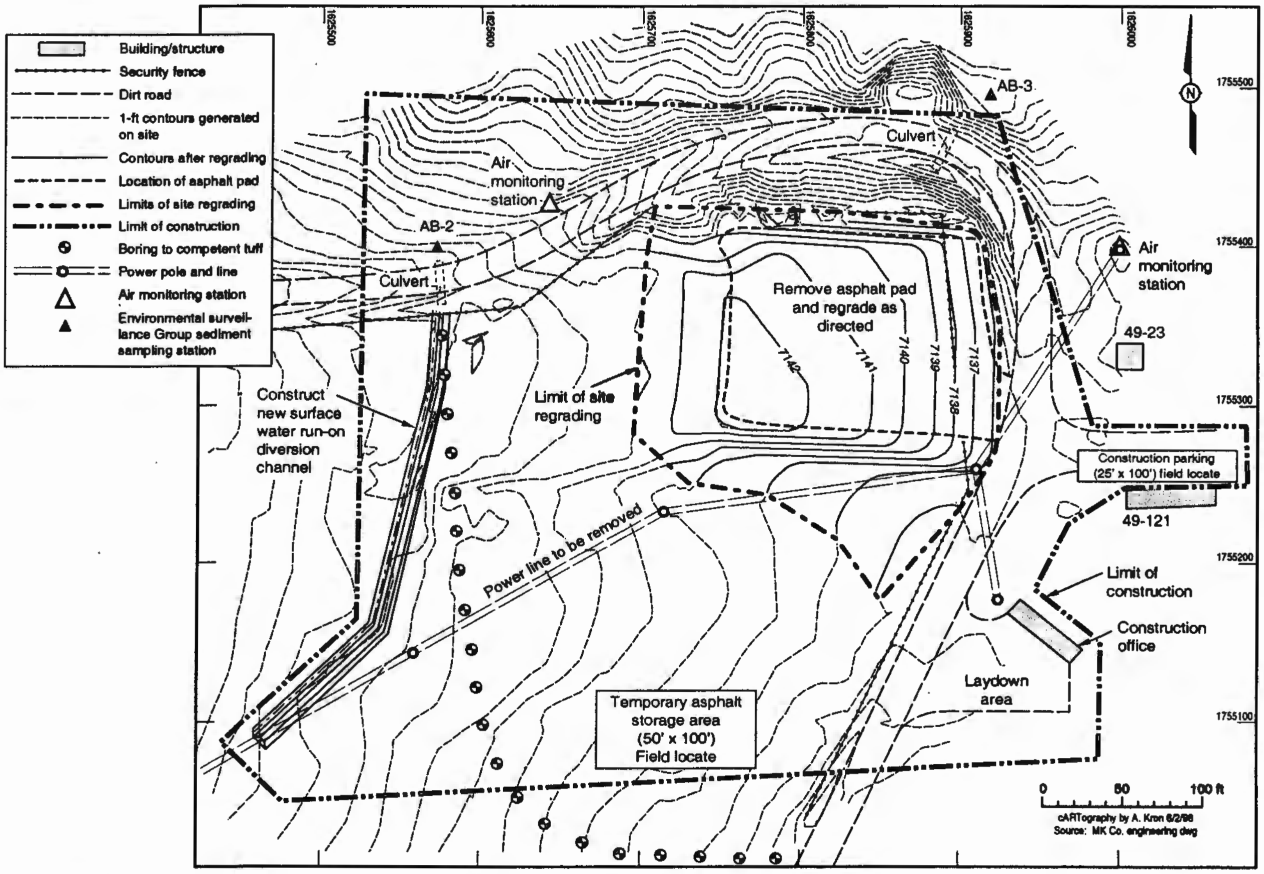


Figure 4-2. Approximate area of supplemental surface water collection and run-on

The following alternative contingency actions are intended to provide examples of effective steps that might be taken but are not necessarily descriptive of the actual contingency actions that would be implemented.

4.1 Implement Full Final Corrective Measure

The first alternative contingency action is to implement the full final corrective measure for stabilizing Areas 2, 2A, and 2B. Selection of this alternative would address all additional sources of moisture at the site. It would have the advantage of avoiding additional expenditure of funds on interim stabilization measures but has the disadvantage of likely being more costly and requiring additional design time. Because of the magnitude of the source term and the importance of the site, the final corrective measure would be designed to meet performance criteria developed to help ensure adequate isolation of the source term for the necessary duration of time. It is anticipated that these criteria will be developed by the Laboratory in conjunction with NMED.

A decision to implement the final corrective measure as the contingency action will depend on the timing of the planned corrective measure implementation (CMI), when the need for contingency action is determined, the urgency of the contingency action, and the availability of funding. If implementation of the final corrective measure has been planned for a later date, consideration could be given to expediting completion of the CMS/CMI process. If expediting implementation of the full final corrective measure is not feasible, then staged implementation of the final measure or implementation of a temporary corrective action could be considered.

4.2 Implement Control of Direct Precipitation

Controlling direct precipitation on the site would address moisture increases in the upper horizon as well as increases in vertical seepage from the upper to the lower horizon (Figure 4-1). One method for temporarily controlling direct precipitation on the site would be to construct a structure over the site that would shed all direct precipitation until the final corrective measure is implemented. Alternatively, if the final corrective measure involves an engineered cover, direct precipitation on the site could be controlled by construction of that cover. Either approach could be used and illustrate that effective corrective actions to control direct precipitation, if needed, are feasible and readily available.

4.3 Implement Control of Supplemental Run-on

Although most surface water run-on is currently diverted by an upgradient channel, a small but possibly important volume of supplemental stormwater run-on could occur from precipitation falling on the upgradient area between the site and the diversion channel. This area is shown in Figure 4-2. Because of differences in elevation, supplemental run-on could only contribute to increases in moisture content in the lower horizon shown in Figure 4-1. Although most of this supplemental run-on will flow around the site as a result of the regrading that was performed as an interim measure, some will percolate into the ground and could add to any subsurface interflow that originates upgradient of the diversion channel. One method for temporarily diverting the supplemental surface water run-on would be to construct a second, smaller diversion channel near the limit of the regraded area. If needed, seepage from the bottom of both diversion channels and potential accretions to subsurface interflow could be reduced by the addition of low permeability layers in the bottoms of the channels. Although excavation of a second diversion channel may not be the actual remedy selected to control supplemental run-on, it illustrates that effective corrective actions to control supplemental run-on, if needed, are feasible and readily available.

4.4 Implement Control of Interflow

Subsurface interflow is the last potentially significant contributor to moisture buildup beneath the site. As with supplemental run-on, because of differences in elevation, interflow could only contribute to increases in moisture content in the lower horizon shown in Figure 4-1. Contributions to interflow could occur from percolation of surface stormwater at locations upgradient of either the existing stormwater diversion channel or the smaller channel described in Section 4.3. One method for controlling potential interflow would be to construct a trench extending to the soil-tuff interface at an upgradient location that would intercept and divert interflow from the site. The closer this trench is to the site, the more interflow it would potentially intercept. If a temporary trench is needed, it could be collocated with the small diversion channel. Alternatively, potential interflow could be controlled by a low-permeability curtain installed from ground surface to competent tuff around the upgradient perimeter of the site. If an interflow interceptor trench is needed as part of the final corrective measure for the site, interflow could be controlled by constructing that trench. Although the foregoing examples may not include the actual remedy that may be selected to control interflow, these options illustrate that effective corrective actions to control interflow, if needed, are feasible and readily available.

5.0 ENHANCED POSTCONTINGENCY MONITORING AND MAINTENANCE

If contingency action is found to be required to address significant increases in moisture contents at the site, the adequacy of the presently planned supplemental monitoring program will be reviewed in light of the observed increases, and the need for modifications will be evaluated. Similarly, the adequacy of the presently planned maintenance program, described in Section 7.0 of the stabilization plan (LANL 1999, 63918), will also be evaluated and modified as needed. An increase in soil moisture content at the site that could potentially result in an unacceptable health risk would be viewed by the Laboratory as a serious issue that would require rapid correction and may also require enhanced site monitoring and maintenance.

REFERENCES

LANL (Los Alamos National Laboratory), August 1999. "Stabilization Plan for Implementing Interim Measures and Best Management Practices at Potential Release Sites 49-001 (b, c, d, and g)," Los Alamos National Laboratory report LA-UR-98-1534, Los Alamos, New Mexico. (LANL 1999, 63918)

LANL (Los Alamos National Laboratory), May 1992. "RFI Work Plan for Operable Unit 1144," Los Alamos National Laboratory report LA-UR-92-900, Los Alamos, New Mexico. (LANL 1992, 7670)

Nyhan, J. W., J. L. Martinez, and G. J. Langhorst, October 1994. "Calibration of Neutron Moisture Gauges and their Ability to Spatially Determine Soil Water Content in Environmental Studies.," Los Alamos National Laboratory report LA-12831-MS, Los Alamos, New Mexico. (Nyhan et al. 1994, 44015)

Wilcox, B. P., B. D. Newman, D. Brandes, D. W. Davenport, and K. Reid, October 1997. "Runoff from a Semiarid Ponderosa Pine Hillslope in New Mexico," *Water Resources Research* 33 (10), pp. 2301–2314. (Wilcox et al. 1997, 57577)

MATERIAL DISPOSAL AREA AB MOISTURE MONITORING FACT SHEET

INTRODUCTION

Technical Area 49 was the location of underground nuclear safety and related tests performed during 1960 and 1961. In 1961, the entire surface of Area 2 [Potential Release Site 49-001(b)] was covered with fill and an asphalt pad after it was determined that plutonium contamination resulting from an accidental release was present in the surface soils. It was subsequently determined that moisture was accumulating between the asphalt and tuff surface and that there was a potential for surface water to pond at Area 2. In 1998, a stabilization plan (LA-UR-98-1534) was written and implemented to reduce the potential for deep subsurface migration of contaminants by reducing moisture infiltration. Best management practices and interim measures detailed in the plan consisted of constructing a run-on diversion channel upgradient of the site, removing the asphalt pad, and regrading the site to eliminate surface water ponding.

Section six of the plan identified routine moisture monitoring at the site to determine the effectiveness of the stabilization activities. The plan called for the use of neutron probes in existing boreholes to acquire this information on a quarterly basis for two years. The New Mexico Environment Department (NMED) issued a Request for Supplemental Information (RSI) after reviewing the plan. The RSI asked that a sampling schedule and contingency plan be developed for the site. Los Alamos National Laboratory's response to the RSI included a contingency plan, as Attachment A, which provided this information. The contingency plan was designed to supplement section six of the stabilization plan and proposed additional monitoring requirements. The additional requirements include increasing the monitoring frequency to monthly, added monitoring in two off-cap boreholes, and installation of a new borehole on the cap.

After partial implementation of the proposed plan, it was determined that construction of the existing boreholes on the cap was inadequate for the collection of moisture monitoring data. The following section describes a new monitoring plan which will adequately collect the moisture monitoring data needed to assess the effectiveness of the stabilization activities.

PROPOSED MONITORING PLAN

This proposed monitoring plan calls for the replacement and abandonment of the two boreholes determined to be inadequate for monitoring (49-2906 and 49-2907). Two-inch-diameter aluminum casing will be installed in replacement boreholes to be located directly adjacent to boreholes 49-2906 and 49-2907 to a nominal depth of 15 feet beneath the present ground surface (Figure 1). A new borehole will also be installed at a location to be agreed to by the NMED Hazardous and Radioactive Materials Bureau (HRMB) (2-inch-diameter aluminum casing driven to a nominal depth of 15 feet beneath the present ground surface). The proposed location for this borehole is shown in Figure 1 (new hole). Moisture content will be measured in these three boreholes with a neutron probe. In addition, horizontal and vertical time domain reflectometry (TDR) arrays would be installed adjacent to the new borehole and adjacent to borehole 49-2906. The most promising emerging technology for in situ moisture sensing is TDR, which when connected to a data logger can be set to record moisture content at any time interval. Two TDR sensors would be installed at each of the two monitoring points (new hole and 49-2906). One sensor would be positioned horizontally just below the bottom of the top soil in the crushed tuff layer of the new cap, and one vertical probe would be placed just below the new cap into the old cover material (Figures 2 and 3) to detect any progressive downward migration of a wetting front. The proposed design will allow comparison and correlation of moisture monitoring data using neutron probes and TDR arrays. If data show that the two moisture monitoring techniques are comparable, then the TDRs can be used to continuously monitor transient events and potentially replace use of neutron probes.

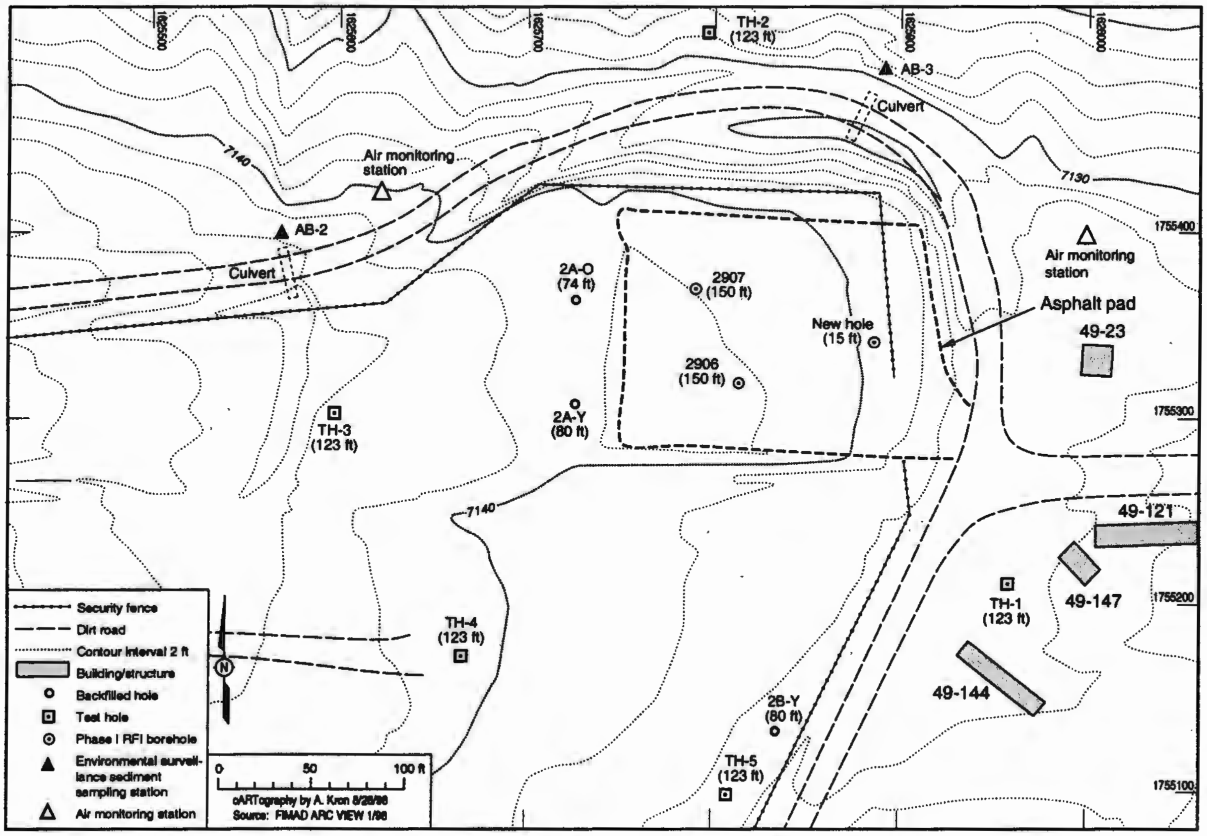


Figure 1. Monitoring hole locations at Area 2

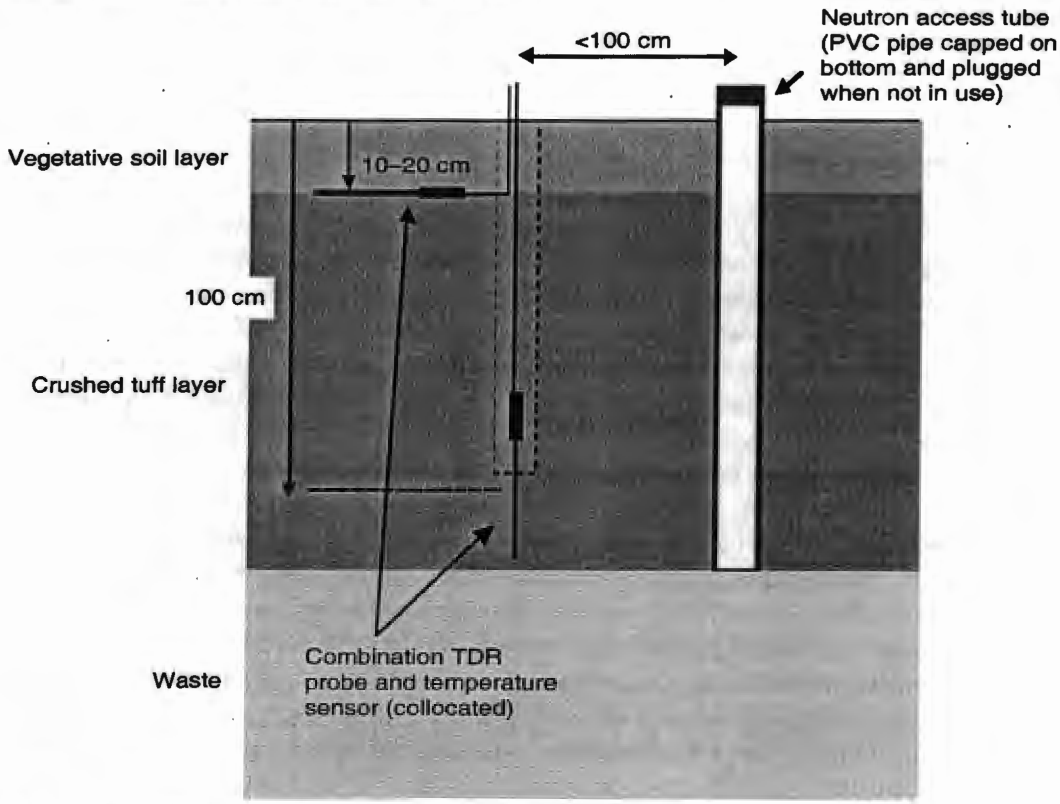


Figure 2. TDR arrays

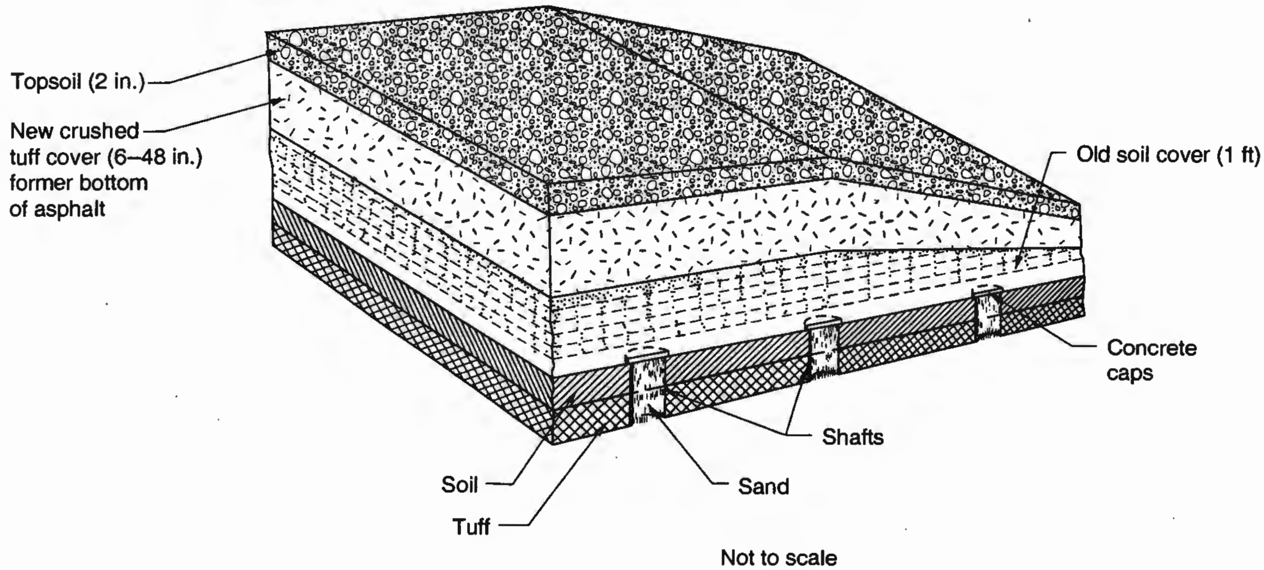


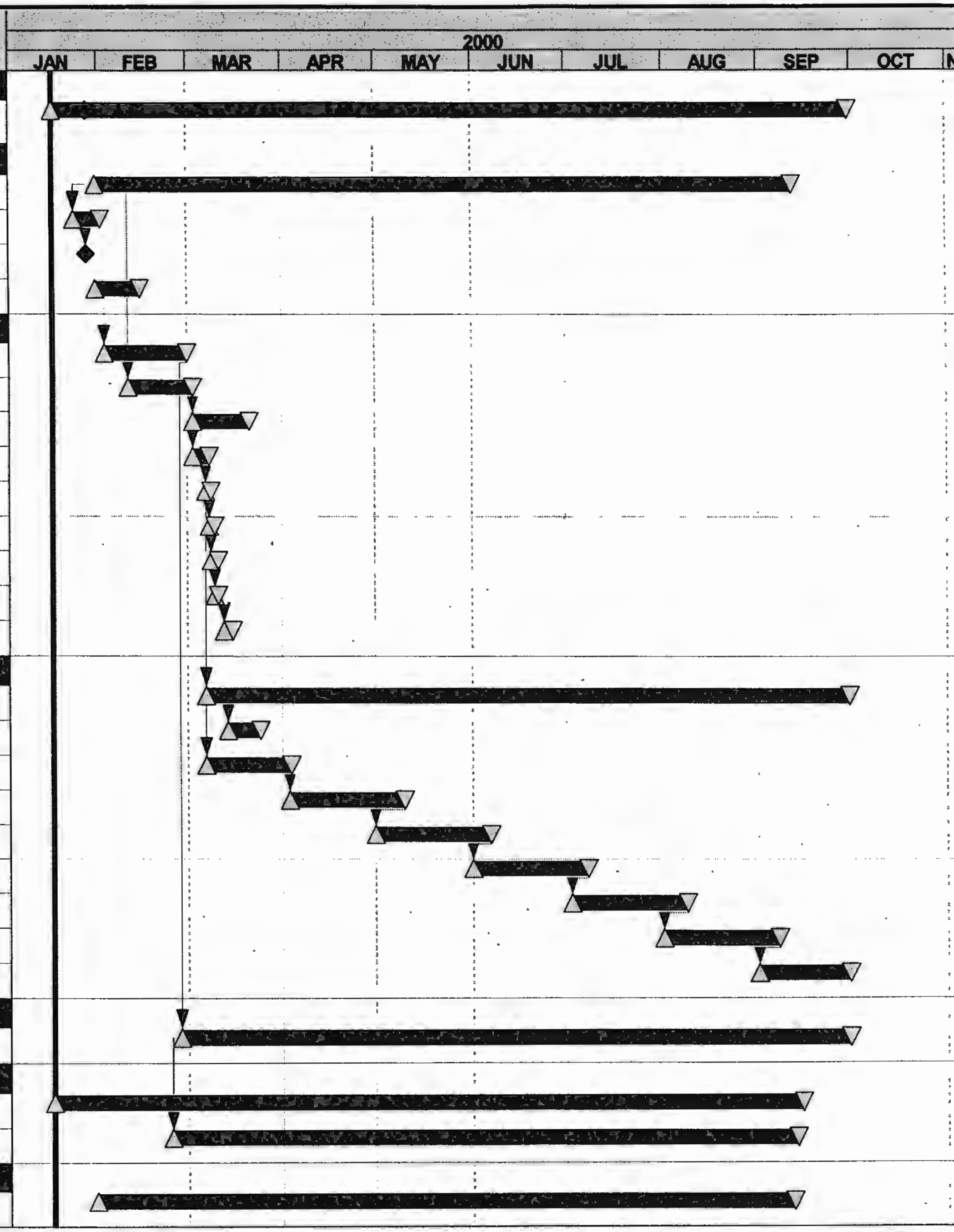
Figure 3. Schematic of subsurface geology

Moisture monitoring will be performed in the surface soils and the soil/tuff interface on a monthly basis in the two locations adjacent to boreholes 49-2906 and 49-2907, in the new borehole on the pad, and in existing boreholes TH-1 through TH-5, 2A-O, 2A-Y, and 2B-Y. Monthly monitoring will be conducted over the entire length of each borehole at 1-foot intervals. Monitoring results will be reported to NMED-HRMB in the Environmental Restoration Project quarterly report in accordance with our request for supplemental information response dated September 10, 1998 (EM/ER:98-336). A list of borehole depths is provided in Table 1.

Table 1
Borehole Descriptions

Borehole Number	Casing Type	Borehole Diameter (in.)	Borehole Depth (ft)
TH-3	4-inch schedule 40 PVC at surface only	5	112
TH-4	4-inch schedule 40 PVC at surface only	5	92
TH-5	4-inch schedule 40 PVC at surface only	5	107
2B-Y	2-inch schedule 40 PVC at surface only	2	33
2A-Y	2-inch schedule 40 PVC at surface only	2	28
2A-O	2-inch schedule 40 PVC at surface only	2	62
TH-2	4-inch schedule 40 PVC at surface only	5	106
TH-1	4-inch schedule 40 PVC at surface only	5	114

Activity ID	Activity Description	Orig Dur	Early Start	Early Finish
TA-49 Moisture Monitoring Project				
Subtotal		185	17JAN00	29SEP00
[illegible]				
1.1	Subtask 1.A: Field Preparation Activities	161	31JAN00*	11SEP00
1.1.1	Project Startup Activities	7	24JAN00	01FEB00
1.1.1.1	Notification of Contract Award	0	28JAN00	
1.1.3	Prepare or Update Plans and Permits	11	31JAN00*	14FEB00
[illegible]				
1.2	Subtask 2: Installation of Equipment	19	03FEB00	29FEB00
1.2.1	Procure Equipment	15	11FEB00	02MAR00
1.2.2	Construct Data Logger Facility	12	03MAR00	20MAR00
1.2.3	Install Moist Monit Facilit Adjacent BH 49-2906	3	03MAR00	07MAR00
1.[illegible]	Install Moist Monit Facilit 20 ft E of Shaft 2-0	2	07MAR00	08MAR00
1.2.5	Install Moist Monit Facilit Adj to BH 49-2907	2	08MAR00	09MAR00
1.2.6	Abandon BH 49-2907	2	09MAR00	10MAR00
1.2.7	Abandon BH 49-2906	1	10MAR00	10MAR00
1.2.8	Demobilize/Restore Site	3	13MAR00	15MAR00
[illegible]				
1.3	Subtask 1.B: Moisture Monitoring Fieldwork	149	07MAR00	29SEP00
1.3.1	Monitor Existing Boreholes - Mar 2000	9	14MAR00	24MAR00
1.3.2	Monitor Boreholes - Mar 2000	20	07MAR00	03APR00
1.3.3	Monitor Boreholes - Apr 2000	27	03APR00	09MAY00
1.3.4	Monitor Boreholes - May 2000	27	01MAY00	06JUN00
1.3.5	Monitor Boreholes - Jun 2000	27	01JUN00	07JUL00
1.3.6	Monitor Boreholes - Jul 2000	27	03JUL00	08AUG00
1.3.7	Monitor Boreholes - Aug 2000	27	01AUG00	06SEP00
1.[illegible]	Monitor Boreholes - Sep 2000	21	01SEP00	29SEP00
[illegible]				
1.4	Subtask 1.C: Moisture Monitoring Support FW	155	28FEB00	29SEP00
[illegible]				
1.5	Subtask 3: Quarterly and Annual Reports	174	17JAN00	14SEP00
1.5.1	Technical Reports (Quarterly and Annual)	143	25FEB00	12SEP00
[illegible]				
1.6	Subtask 4: Cover Maintenance	161	31JAN00*	11SEP00



Start Date	17JAN00
Finish Date	29SEP00
Data Date	17JAN00
Run Date	27JAN00 14:45

Early Bar
Progress Bar
Critical Activity

TA49 Sheet 1 of 1

MDA AB Moisture Monitoring Project