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RECEIVED MAR 2007 NMED Hazardous Waste Bureau

Date: March 16, 2007
Refer To: EP2007-0155

Mr. James Bearzi
NMED-Hazardous Waste Bureau
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505-6303

Subject: Response to the Approval with Modifications for the Investigation Work Plan for Cañon de Valle Aggregate Area, Los Alamos National Laboratory, EPA ID #NM0890010515, HWB-LANL-06-021, Dated February 9, 2007

Dear Mr. Bearzi:

To facilitate review of this response, the New Mexico Environment Department's (NMED's) comments requiring a response are included verbatim. Los Alamos National Laboratory's (LANL's or the Laboratory's) responses follow each NMED comment. A meeting held between LANL and NMED on March 9, 2007, addressed a number of NMED comments. Responses are provided to those comments where NMED indicated a response is necessary.

I.9 Schedule of Investigation Report Submittals:

NMED Comment

I.9 NMED concurs with the proposed submittal of multiple investigation reports for the Cañon de Valle Aggregate Area (one report for the TA-16 subaggregate, one for the TA-15 subaggregate, and one for the TA-14 subaggregate). NMED suggests that the submittals be staggered to expedite the review with due dates of January 15, June 15, and December 15, 2012 for the Investigation Reports for TA-16, TA-15 and TA-14, respectively.

The Permittees must confirm their agreement to modify the Order schedule in writing within 30 days of the receipt of this letter. NMED will adjust the Order schedule upon receipt of written agreement.

In addition, NMED recommends that the Permittees submit the risk assessments for the investigations following approval of the investigation Reports. This will eliminate the need to revise the risk assessment if additional work is required to define nature and extent of contamination.

LANL Response

I.9. LANL agrees to the submission of multiple investigation reports and requests the following schedule for delivery, as discussed during the meeting of March 9, 2007:

- TA-14, due January 15, 2012
- TA-15, due June 15, 2012
- TA-16, due December 15, 2012

II.1. References Missing from Administrative Record:

NMED Comment

II.1 The following references included in the Plan were not found in the Administrative Record:

a. LANL, May 2004. "Final Well CdV-16-3(i) Completion Report," Los Alamos National Laboratory, Los Alamos, New Mexico. (LANL 2004, 87645)

b. LANL, September 1997. "Voluntary Corrective Action Completion Report for Potential Release Sites 14-002(a) Firing Site 010 Sump Field Unit 2," Los Alamos National Laboratory document, Los Alamos, New Mexico. (LANL 1997, 56611)

c. USAF (U.S. Air Force), November 22, 1958. TA-9 and TA-6 Aerial Photograph, Los Alamos National Laboratory Environmental Programs Records Processing Facility, Los Alamos, New Mexico. (USAF 1958, 05855)

The Permittees must submit the above documents to NMED within 30 days of the receipt of this letter to be included in the Administrative Record.

LANL Response

II.1 The requested references are provided on the CD that accompanies this response.

- Note that the correct reference for the final well CdV-16-3(i) completion report is as follows: Kleinfelder, May 2004, "Final Borehole CdV-16-3(i) Status Report, Los Alamos National Laboratory, Los Alamos, New Mexico," report prepared Los Alamos National Laboratory, Project No. 37151/11.12, Albuquerque, New Mexico. (Kleinfelder 2004, 087845).

- Note that the correct ER ID number for the TA-09 and TA-06 aerial photograph is 015855.

II.2 Section 2.2 Surface Water, page 7, paragraph 2:

Permittees' Statement

II.2 "HE...and RDX...were also detected at gauging stations E256, E257, and E262 (LANL 2006, 92600, Attachment 2, Table A9). RDX did not exceed the wSAL, no wSAL is available for the other HE.... "

NMED Comment

II.2 Table A-9 of the Storm Water Pollution Prevention Plan (SWPP vol. 1) reports that RDX was detected at the gauging stations listed above, but Table A9 does not have a column for wSALs. Table 3-3 (p. 3-9 of the SWPP vol. 1) provides a summary of LANL Storm Water Screening Action levels (wSALs), but does not include RDX. The permittees must submit a copy of the appropriate table in the SWPP or other applicable document within the 30 days of receipt of this letter.

LANL Response

II.2 Table 3-3 in volume 1 of the Stormwater Pollution Prevention Plan (SWPPP) includes RDX (see p. 3-11, the third page of Table 3-3).

II.3 Section 2.5.1, Site Description and Operational History, page 17, paragraphs 1-3:

NMED Comment

II.3 A report prepared by Border Demolition and Environmental, Inc. (2005, 92461) has been provided as a reference for removal of buildings 16-224, 16-226 and 16-220. The Report documents work performed at TA-15, not TA-16. The Permittees must provide the correct reference that includes work at TA-16 within 30 days of receipt of this letter.

LANL Response

II.3 The correct reference to this report, which is included on the attached CD, is as follows: LANL, October 2003. "TA-16-220 Complex D&D Demolition Completion Report," Los Alamos National Laboratory document, Los Alamos, New Mexico. (LANL 2003, 092460)

If you have any questions, please contact John McCann at (505) 665-1091 or (jmccann@lanl.gov).

Sincerely,

Carolyn A. Mangeng, Acting Associate Director
Environmental Programs
Los Alamos National Laboratory

Sincerely,

George J. Rael, Assistant Manager
Department of Energy
Los Alamos Site Office

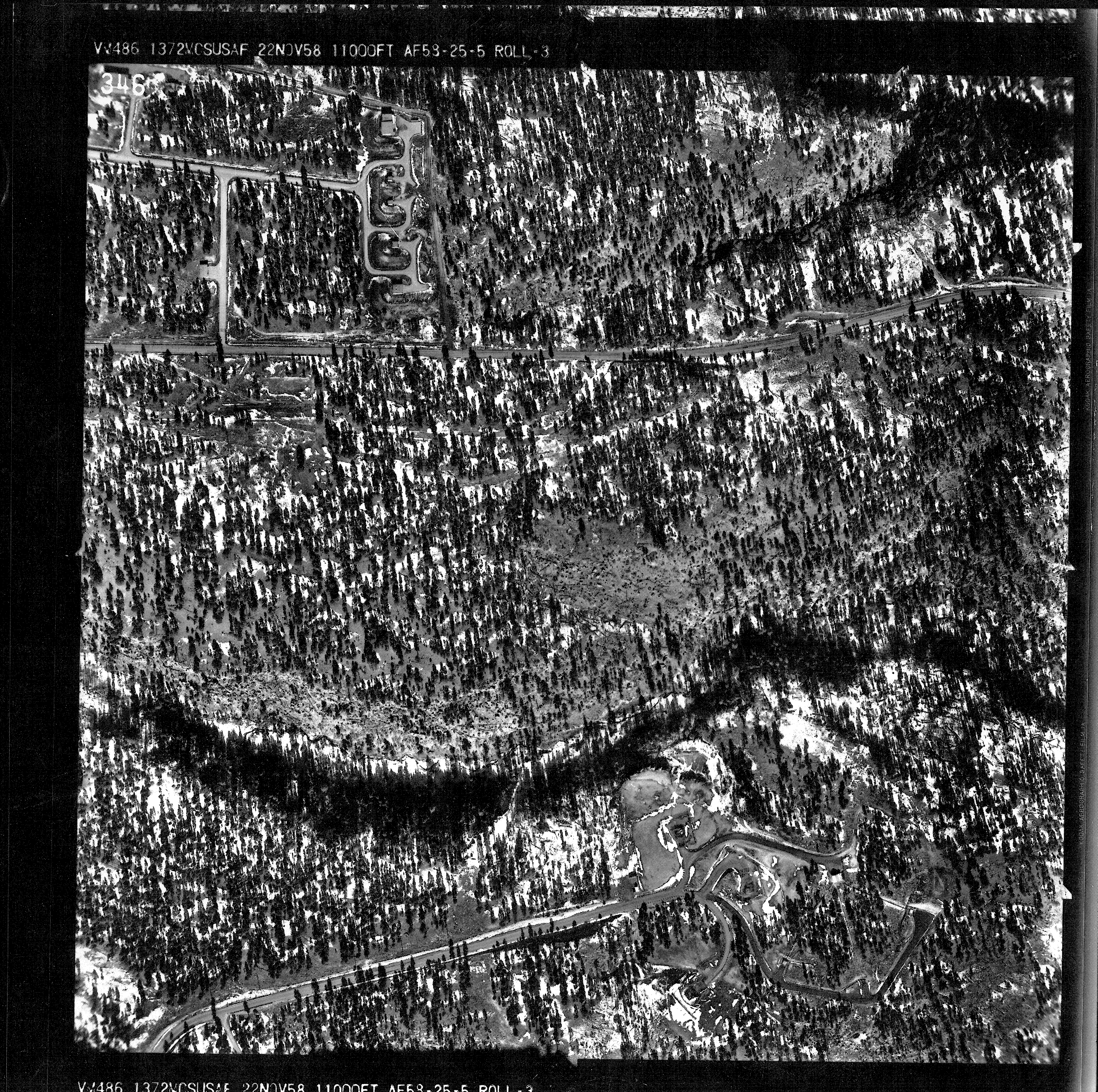
CAM/GJR/JM:ew

Attachment: CD of requested references

Cy: (w/att.):
G. Rael, DOE-LASO, MS A316 (w/CD)
D. Gregory, DOE LASO, MS A316 (w/CD)
R. Navarez, OST, Service Center-1 (w/CD)
J. McCann, EP-CAP, MS M992 (w/CD)
EP-CAP File, MS M992 (w/CD)
RPF, MS M707 (w/two CDs)

Cy: (letter and CD only)
L. King, EPA Region 6
P. Reneau, EP-ERSS, MS M992

Cy: (w/o att.)
T. Skibitski, NMED OB
C. Mangeng, ADEP, MS J591
A. Dorries, EP-ERSS, MS M992
P. Reneau, EP-ERSS, MS M992
G. Dover, EP-CAP, MS M992
D. McInroy, EP-CAP, MS M992
ADEP File, MS J591
IRM-RMMSO, MS A150
Public Reading Room, MS J591



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VV486 1372VCSUSAF 22NOV58 11000FT AF58-25-5 ROLL-3

Los Alamos Environmental Restoration Records Processing Facility

ER I.D.# 0056611

LOS ALAMOS NATIONAL LABORATORY
ENVIRONMENTAL RESTORATION
Records Processing Facility
ER Records Index Form

ER ID NO. 56611 *Date Received:* 9/17/97 *Processor:* YCA *Page Count:* 25

Privileged: (Y/N) N *Record Category:* P *Record Package No:* 0

FileFolder: N/A

Correction: (Y/N) N *Corrected No.* 0 *Corrected By Number:* 0

Administrative Record: (Y/N) Y

Refilmed: (Y/N) N *Old ER ID Number:* 0 *New ER ID Number:* 0

Miscellaneous Comments:
N/A

THIS FORM IS SUBJECT TO CHANGE. CONTACT THE RPF FOR LATEST VERSION. (JUNE 1997)

25

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Los Alamos
NATIONAL LABORATORY
memorandum

Earth and Environmental Science Division
EES-15, Environmental Science Group
Los Alamos, New Mexico 87545

To/MS: Distribution
From/MS: T.E. Gould, EES-15, MS J495 N. Riebe for
Phone/FAX: 5-4348/5-1976
Symbol: EES-15: ER-97-060
Date: September 12, 1997

SUBJECT: EXTERNAL REVIEW - VOLUNTARY CORRECTIVE ACTION COMPLETION REPORT FOR POTENTIAL RELEASE SITES (PRSs) 14-002(a) AND 14-010

The VCA completion report for PRSs 14-002(a) and 14-010 is attached. Please review this document and return your comments to Nancy Riebe by September 17, 1997. (Comment resolution forms are attached.) Appendix C and F will be provided in the final version.

If you have any questions regarding the technical content of this report please contact Ken Towery at 661-5273.

TEG/nar

Attachments: (1) VCA Report
(2) Comment resolution forms

Distribution:
- Mike Gilgosch, LAAO, MS A316, w/Attachments 1 and 2
- Dave Bradbury, EM/ER, MS M992, w/Attachments 1 and 2
- Pat Shanley, ESH-19, MS K498, w/Attachments 1 and 2
- Joe Rochelle, LC-GEN, MS A187, w/Attachments 1 and 2
- Tom Fogg, ICF/KE, MS M892, w/Attachment 1
- Ken Towery, ICF/KE, MS M892, w/Attachment 1
- Tracy McFarland, ICF/KE, MS J495, w/Attachment 1
- VCA File w/Attachment 1
- RPF, MS M707, w/Attachment 1
- EES-15 Files w/o Attachments

Voluntary Corrective Action Completion Report for

Potential Release Sites
14-002(a), Firing Site
14-010, Sump

Field Unit 2

Environmental
Restoration
Project

September 1997

A Department of Energy
Environmental Cleanup Program

Los Alamos
NATIONAL LABORATORY

LA-UR-97-xxxx

TABLE OF CONTENTS

VOLUNTARY CORRECTIVE ACTION COMPLETION REPORT FOR POTENTIAL RELEASE SITES 14-002(a) - FIRING SITE AND 14-010 - SUMP

1.0 INTRODUCTION

The two potential release sites (PRSs) at Los Alamos National Laboratory (the Laboratory) addressed in this Voluntary Corrective Action (VCA) Completion Report are located in the western portion of Technical Area (TA)-14, also called Q-Site (see Appendix F for site map). These PRSs have been determined to be in or near a watercourse listed with the New Mexico Environment Department (NMED). PRSs 14-002(a) and 14-010 are also listed in Table A of the Hazardous and Solid Waste Amendments (HSWA) Module of the Laboratory's RCRA permit. This report serves as the mechanism to request concurrence to remove these PRSs from the HSWA Module of the Laboratory's RCRA operating permit in a Class 3 permit modification.

PRS 14-002(a)

PRS 14-002(a) was a high-explosive (HE) firing chamber located at Building TA-14-2. This structure was built in October 1944 and is located as shown in Appendix F. The closed, decommissioned chamber was removed in early 1970 because a new HE facility was planned for the area where the chamber was located. PRS 14-002(a) was a heavily reinforced concrete structure 16 ft by 21.6 ft by 13 ft with a steel plate lining (LANL 1993, 21-0077). It was used extensively for HE tests, many of which involved uranium, low-order detonation, or both. This PRS is discussed in Section 5.3 of the OU 1085 Work Plan (LANL 1994, 1156).

The notice of deficiency (NOD) response (October 31, 1994) to the RCRA Facility Investigation (RFI) Work Plan (LANL 1994, 1156) describes ruptured sandbags southeast of Building TA-14-39. In response to the NOD, the sandbags, which are all that remains of PRS 14-002(a), were sampled. The results of the Phase I sampling, as presented in the VCA Plan (ER Project 1997, ER ID No. 55678), indicated that depleted uranium was present at concentrations above the screening action level (SAL) of 130 mg/kg.

Based on the chemical of potential concern (COPC), uranium, and on the fact that the site is in or near a drainage area, remediation of this PRS was recommended. The corrective action for PRS 14-002(a) included the removal of the contaminated sand, the deteriorated sandbags, and the underlying soil to the extent of contamination.

PRS 14-010

PRS 14-010 was a decommissioned explosive waste sump located south of and adjacent to Building TA-14-2, as shown in Appendix F. A drain extended from the sump across the road (Courtwright 1973, ER ID No. 5081). The sump and drainline around the base of the floor slab at Building TA-14-2 were excavated by hand and removed (Courtwright 1973, 21-0067). The sump may have contained HE and toxic chemicals (Ortiz 1973, ER ID No. 55598). The contents of the sump were removed and disposed of by Group WX-2 in the early 1970s (Russo, 1973, ER ID No. 5088). This PRS is discussed in Section 5.3 of the RFI Work Plan (LANL 1994, 1156). PRS 14-010 now consists of the drainline from PRS 14-001(f) and its associated drainage area.

Based on the COPC, uranium, and on the fact that the site is in a drainage area, remediation of this PRS was recommended. The corrective action for PRS 14-010 included the excavation and removal of contaminated surface soil from the drainage area.

2.0 SITE CHARACTERIZATION PRIOR TO REMOVAL

2.1 Field Activities

The Phase I sampling at PRSs 14-002(a) and 14-010 was conducted in July 1995 in accordance with the approved RFI work plan (LANL 1994, 1156). The objectives of sampling were to determine whether contamination existed. The sandbags at PRS 14-002(a) are located in a small area approximately 6 m^2, and are approximately 7 inches deep. One surface sample was collected from this area using the approved spade and scoop technique (LANL-ER-SOP 6.09). The sample was submitted to a fixed analytical laboratory for analyses of target analyte list (TAL) metals, uranium, and HE.

PRS 14-010 was an explosive waste sump next to Building 14-2 with a drainline that extended into a relatively small drainage area (approximately 538 ft^2). Four surface soil samples (one 0-4 in.; three 0-6 in.) and one subsurface soil sample (14-20 in.) were collected from the drainage area. The surface soil samples were collected using the approved spade and scoop technique (LANL-ER-SOP 6.09), and the subsurface soil sample was collected using the approved hand auger technique (LANL-ER-SOP 6.10). The five samples collected were submitted to a fixed laboratory for analysis by gamma spectroscopy in addition to analyses for uranium, HE, and TAL metals.

The analytical results for PRSs 14-002(a) and 14-010 indicated that uranium was present at concentrations above the SAL for depleted uranium (130 mg/kg). The RFI screening assessments identified uranium as a COPC at these PRSs based on human health concerns. As a result, a cleanup was recommended for both PRSs, based on the presence of the COPC and the fact that the PRSs are in or near a drainage area (ER Project 1996, 1394). The data quality assessment and results of the 1995 Phase I sampling are presented in the VCA Plan. A summary of the analytical results for each PRS is presented below.

PRS 14-002(a)

- Four inorganics (chromium, copper, nickel, and uranium) were detected above background UTLs.

- Three analytes (chromium, copper, and nickel) had concentrations below their respective SALs and were submitted to a multiple chemical evaluation (MCE) for noncarcinogenic effects. The sum of the maximum normalized concentrations was 0.1, which is less than the target value of one, indicating that potential adverse health effects were unlikely. Therefore, these three inorganics were eliminated from further evaluation.

- Uranium was detected at a concentration greater than its inorganic SAL (based on systemic effects) of 230 mg/kg and was retained as a COPC.

- Uranium-238 and uranium were detected at concentrations above their respective background UTLs and SALs [67 pCi/g and 130 mg/kg (DU SAL for uranium)]. Since uranium-238 is a primary constituent of total uranium, uranium is the COPC for which a preliminary remediation goal (PRG) was calculated. Uranium-235 was detected above background but below its SAL (10 pCi/g), but because it was the only analyte in the radionuclide effects category above background and is also a constituent of uranium, it was not submitted to an MCE and was not retained as a COPC.

- No HE was detected at this PRS.

The results of the RFI screening assessment at PRS 14-002(a) indicated that uranium (inclusive of uranium-238 and uranium-235) was a COPC.

PRS 14-010

- Ten inorganics (chromium, cobalt, copper, lead, nickel, silver, selenium, thallium, uranium, and zinc) were detected above background UTLs in the surface soil.

- Nine inorganics (chromium, cobalt, copper, lead, nickel, silver, selenium, thallium, and zinc) were detected at concentrations below their respective SALs and were submitted to an MCE for noncarcinogenic effects. The sum of the maximum normalized concentrations was 0.6, which is less than the target value of one, indicating adverse health effects from exposure would be unlikely. Therefore, chromium, cobalt, copper, lead, nickel, silver, selenium, thallium, and zinc were eliminated from further evaluation.

- Uranium was detected at concentrations greater than its inorganic SAL (based on systemic effects) of 230 mg/kg in two samples and was retained as a COPC.

- Uranium-238 and uranium were detected at concentrations above their respective background UTLs and SALs of [67 pCi/g and 130 mg/kg (DU SAL for uranium)]. Since uranium-238 is a primary constituent of total uranium, uranium was the COPC for which a PRG was calculated. Uranium-235 was detected above background but below its SAL (10 pCi/g), but because it was the only analyte in the radionuclide effects category above background and is also a constituent of uranium, it was not submitted to an MCE and was not retained as a COPC.

- One high explosive compound, HMX, was detected in the surface soil (40.8 mg/kg) and in the drainline (14.5 mg/kg) below its SAL of 3300 mg/kg, and was included in the MCE for noncarcinogenic effects. This compound was not retained as a COPC because it was below SAL and the sum of the normalized concentrations in the MCE (0.6) was below the target value of 1.0.

The results of the RFI screening assessment at PRS 14-010 indicated that uranium (inclusive of uranium-238 and uranium-235) was a COPC.

2.2 Nature and Extent of Contamination

The purpose of the Phase I sampling was to determine the presence of contamination from the sandbags at PRS 14-002(a) and along the drainage at PRS 14-010. The Phase I sampling identified depleted uranium as the only COPC at these PRSs. The sampling indicated that contamination existed along the drainage course in the surface soil. The objective of the sampling proposed as part of the VCA activities at this PRS was to determine whether the area encompassed by these PRSs was successfully remediated and whether the contamination extended beyond the drainage.

The extent of the contamination at PRS 14-002(a) was associated with the sandbags, as well as the underlying soil and the immediate area around the sandbags, including the paved area. Radiological screening of the pavement and visual observations indicated that depleted uranium was present. The pavement was subsequently vacuumed and pieces of DU removed by hand as part of the VCA. Screening and confirmatory sampling determined that the extent of the contamination at this PRS did not go beyond this area.

The extent of the contamination at PRS 14-010 was the drainage area extending approximately 75 ft down the drainage, which is located approximately 35 ft from Building 14-2. Screening and confirmatory sampling determined that the extent of the contamination at this PRS did not go beyond this area.

2.3 Risk Calculations and/or Cleanup Level Derivation

PRSs 14-002(a) and 14-010 lie within DOE-owned land and are removed from public access roads. The anticipated future land use is expected to be exclusively for Laboratory operations (i.e., industrial land use only).

A PRG for the COPC retained from the human health screening assessment, i.e., uranium, was calculated based on the expected land use at these sites. The PRG was calculated to be 1230 mg/kg or 493 pCi/g (Table 2.3-1). The derivation of the PRG was calculated using RESRAD 5.70, and is based on an exposure limit of 15 mrem/yr. LANL site-specific exposure input parameters were used in the model (LANL 1996) and were presented in the VCA Plan (ER Project 1997, ER ID No. 55678).

TABLE 2.3-1

PRG FOR PRSs 14-002(a) AND 14-010

COPC	Sample Value		PRG*		Rationale
	14-002(a)	14-010			
Uranium	2010 mg/kg 804 pCi/g	1370 mg/kg 548 pCi/g	1,230 mg/kg	493 pCi/g	Radionuclide (based on a dose of 15 mrem/yr)

*Based on an industrial scenario

Based on the sample results, the maximum detected concentration of uranium at both PRSs exceeded the PRG.

3.0 REMEDIAL ACTIVITIES AND RESULTS OF CONFIRMATORY SAMPLING

3.1 Remedial Implementation

The VCA was generally conducted in accordance with the approved VCA Plan (ER Project 1997, ER ID No. 55678). Deviations from the approved plan included screening and removal of contaminated asphalt pavement, and the plugging of the drainage pipe from the bullet test facility [PRS 14-001(f)], which had previously been remediated. Another deviation included collecting confirmatory samples for HE, since HE positive results from the HE spot test were recorded. The remediation for PRS 14-002(a) included the removal of the sandbags and the underlying soil down to approximately 6 inches. The remediation at PRS 14-010 involved the removal of the surface soil in the drainage down to approximately 6-12 inches. The VCA activities began on June 17, 1997 and were completed on July 17, 1997.

PRS 14-002(a)

The loose sand, sandbags, and soil were removed by hand shoveling and were placed in a B-25 container. Two confirmatory samples from two sample locations in the area beneath the sandbags were submitted to the analytical laboratory for analysis of uranium and HE (Figure 3.1-1). Asphalt in the immediate vicinity of the sandbags had visible depleted uranium as well as high radiological readings from the 44-9 pancake probe (over 5000 cpm) at twelve locations. The asphalt was subsequently vacuumed using a Spoil Vac SPU 500 Supersucker™ to remove the loose contaminated soil. The asphalt from the twelve locations with the high radiological readings was removed by chipping and the pieces placed in a B-25 container. Following removal of the contaminated asphalt, the underlying surface was tested with a pancake probe and found to have readings below background.

The asphalt pavement 5-20 ft northwest of the sandbags towards the bullet test facility [PRS 14-001(f)], and outside of PRS 14-002(a) boundaries, was also found to be contaminated with depleted uranium.

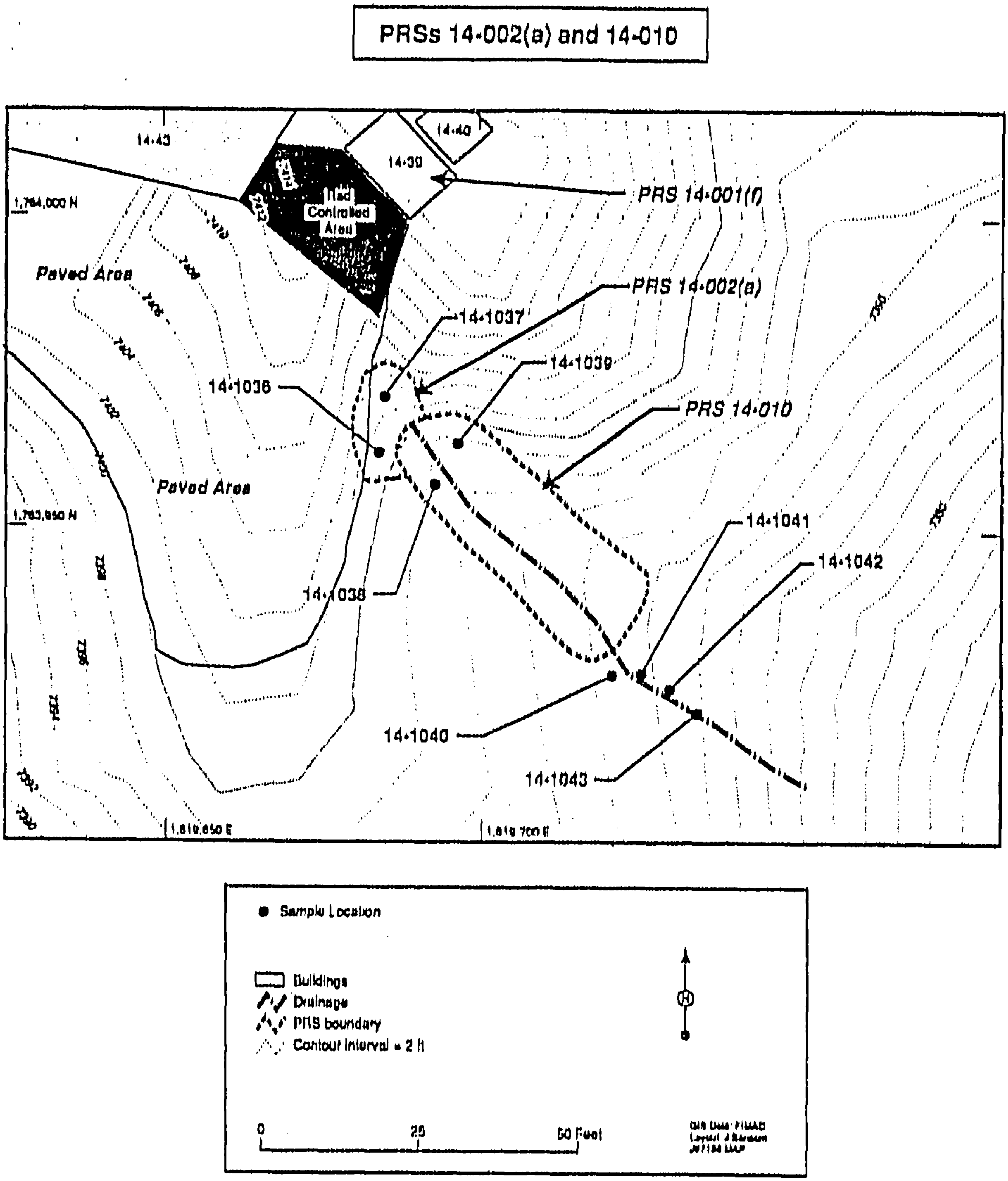

Figure 3.1-1 PRSs 14-002(a) and 14-010, Site map of sample locations

based on visual observations and high radiological readings. This area was also vacuumed with the Spoil Vac SPU 500 Supersucker™ to remove the loose contaminated soil. The area was then cordoned off and designated as a Radiation Controlled Area (Figure 3.1-1).

PRS 14-010

The top six inches of soil was removed by hand shoveling from an area approximately 12 ft wide and 75 ft long (Figure 3.1-1). At the beginning of the drainage, visible depleted uranium and HE resulted in soil being removed down to approximately 12 inches. A 4-inch drainage pipe from the bullet test facility [PRS 14-001(f)] was uncovered during the soil removal and was subsequently plugged with mortar to prevent any leakage of material. Following the soil removal, 2 ft by 2 ft grids were laid out across the 12 ft by 75 ft PRS. Radiological readings were measured from the center of each grid using a sodium iodide detector. The areas to the east and west of the drainage area were also screened for radiation using either a sodium iodide detector or a pancake probe. Screening confirmed that cleanup had been performed to the level specified in the VCA Plan. Two confirmatory samples were collected from two separate locations that had the highest radiological readings and submitted to the analytical laboratory for uranium and HE analyses (Figure 3.1-1). In addition, confirmatory samples were collected from the surface soil at 5 ft, 10 ft, 15 ft, and 20 ft along the drainage and downgradient from the clean-up area at PRS 14-010, and submitted to the analytical laboratory for uranium and HE analyses (Figure 3.1-1).

3.2 Confirmatory Sampling

Data Quality Assessment

Samples were collected, processed, and analyzed in accordance with the ER Project Quality Assurance Project Plan Requirements for Sampling and Analysis (QAPP) (LANL 1996, 1292). The QA/QC samples used to determine the quality and usability of the soil data generated from the confirmatory samples included method blanks, calibration blanks, laboratory duplicates, surrogates, spikes, laboratory control samples, and internal standards. These samples were analyzed according to the frequency outlined in EPA's functional guidelines for organic and inorganic data review (EPA 1994, 1205 and 1206). A review of the technical quality of the data (baseline validation) requires that the data be compared to numerical acceptance criteria established either by the analytical laboratory or EPA for the QA samples mentioned above. The data that do not meet these criteria are qualified to indicate to the data user those sample results that have potential issues associated with sample handling and analysis.

The QA/QC data associated with the confirmatory samples from this investigation indicated that 100% of the data are acceptable and defensible. None of the data are qualified as estimated undetected (UJ), estimated (J), or unusable (R). The data are of good quality and are suitable for decision-making purposes. The QA/QC mechanisms were effective in ensuring the reliability of measured data within expected limits of sampling and analytical error.

Eight confirmatory soil samples [two from 14-002(a) and six from 14-010] were collected in accordance with the sampling described in the VCA Plan. These samples were analyzed for HE and isotopic uranium. The results of the data quality evaluation performed on the sample results associated with this report are summarized below. The QA/QC problems are presented in Appendix A (Table A-1) according to request number, sample ID, and analytical suite, respectively.

- Seven samples from one request number had QA/QC problems associated with the radionuclide data. The minimum detection limit (MDA) was greater than the estimated quantitation limit (EQL) for uranium-235. The uranium-235 results in five samples [two from 14-002(a) and three from 14-010] were less than the MDA and EQL and are qualified as U. The uranium-235 results in two samples from 14-010 were less than the MDA but greater than the EQL and are qualified as U. All U qualified data are usable as nondetects.

- The HE data from PRSs 14-002(a) and 14-010 had no QA/QC problems associated with the analyses. The data are usable as reported.

Summary of Analytical Results

Confirmatory samples were collected from eight sample locations [two from PRS14-002(a) and six from PRS 14-010] and analyzed for HE and isotopic uranium. All samples were collected from the surface soil (0-6 in.) following removal of the contaminated soil. The two samples at PRS 14-002(a) were collected from east of the pavement. The six confirmatory samples at PRS 14-010 were collected from the drainage area. The sample locations and analyte detections are presented in Figure 3.2-1 and the results are summarized below.

PRS 14-002(a)

- Uranium-234 was detected above its background UTL of 1.94 pCi/g in one of two confirmatory samples, but below its SAL of 13 pCi/g in all samples (Table 3.2-1).

- Uranium-235 was detected above its background UTL of 0.084 pCi/g in one of two confirmatory samples, but below its SAL of 10 pCi/g in all samples (Table 3.2-1).

- Uranium-238 was detected above its background UTL of 1.82 pCi/g in both confirmatory samples, but below its SAL of 67 pCi/g in all samples (Table 3.2-1).

- The total uranium activity concentrations (derived by adding up the isotopic activity values) ranged from 5.0 pCi/g to 23.8 pCi/g, which are below the PRG of 493 pCi/g (Table 3.2-1).

- HMX was detected in the surface soil in two samples at concentrations of 47.5 mg/kg and 20.9 mg/kg (Table 3.2-2). These concentrations were below the SAL of 3300 mg/kg and an MCE was not conducted because HMX is the only noncarcinogen detected. Therefore, HMX was not evaluated further and no other HE compounds were detected in the soil at this PRS.

PRS 14-010

- Uranium-234 was detected above its background UTL of 1.94 pCi/g in two of six confirmatory samples, but below its SAL of 13 pCi/g in all samples (Table 3.2-1).

- Uranium-235 was detected above its background UTL of 0.084 pCi/g in one of six confirmatory samples, but below its SAL of 10 pCi/g in all samples (Table 3.2-1).

- Uranium-238 was detected above its background UTL of 1.82 pCi/g in five of six confirmatory samples, but below its SAL of 67 pCi/g in all samples (Table 3.2-1).

- The total uranium activity concentrations (derived by adding up the isotopic activity values) ranged from 2.5 pCi/g to 27.7 pCi/g, which are below the PRG of 493 pCi/g (Table 3.2-1).

- HMX was detected in the surface soil in six samples and 2,4,6-trinitrotoluene was detected in surface soil in three samples (Table 3.2-2). The concentrations for HMX ranged from 1.0 mg/kg to 94.3 mg/kg and the concentrations for 2,4,6-trinitrotoluene ranged from 0.9 mg/kg to 0.16 mg/kg. These detected concentrations were below the SALs of 3300 mg/kg for HMX and 15 mg/kg for 2,4,6-trinitrotoluene. An MCE for these analytes was not conducted because HMX was the only noncarcinogen and 2,4,6-trinitrotoluene was the only carcinogen detected in the soil. Therefore, HMX and 2,4,6-trinitrotoluene were not evaluated further and no other HE compounds were detected in the soil at this PRS.

PRSs 14-002(a) and 14-010

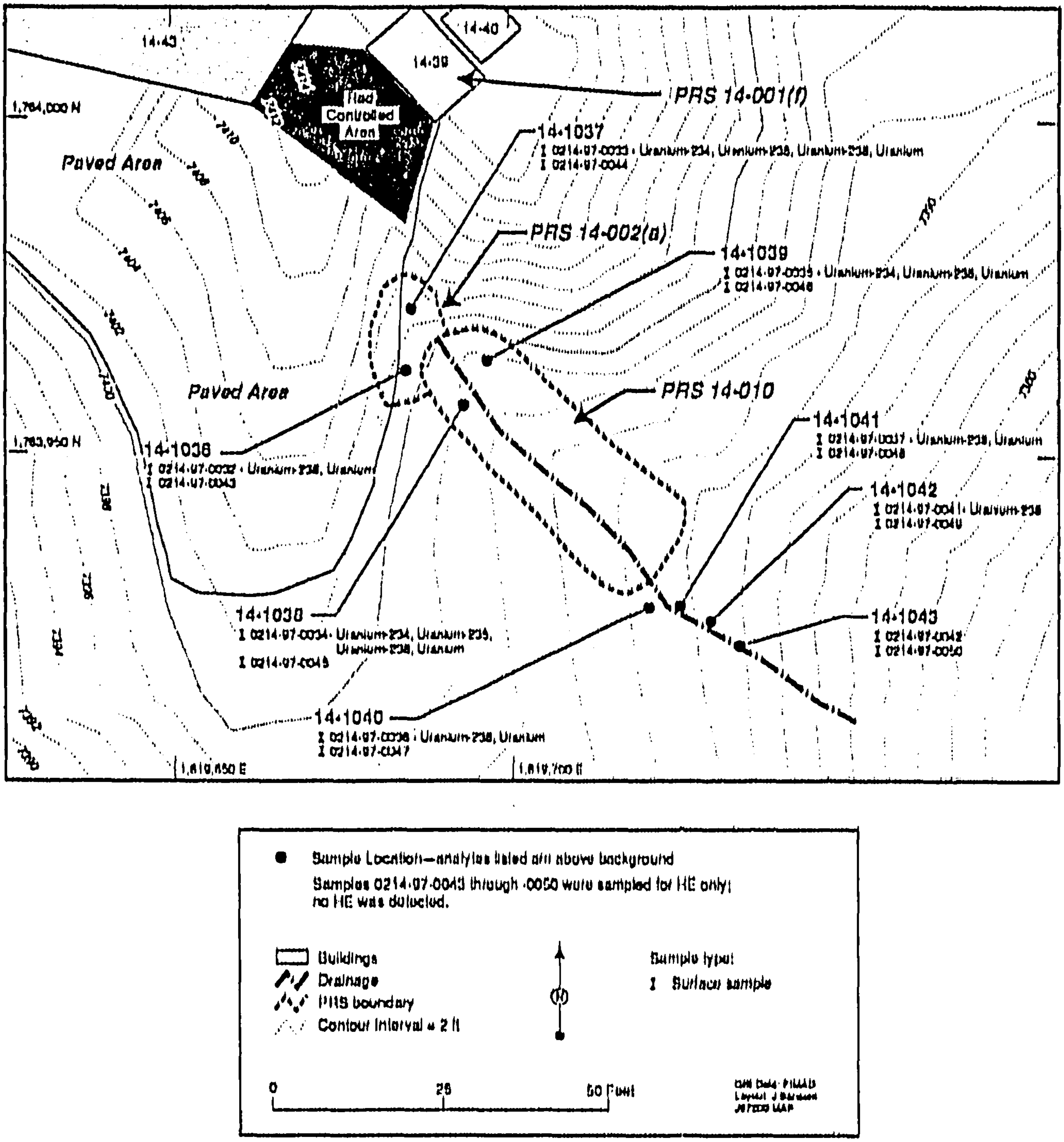

Figure 3.2-1 PRSs 14-002(a) and 14-010; Site map of sample locations with detected analytes

TABLE 3.2-1

RADIONUCLIDES WITH CONCENTRATIONS AT OR ABOVE BACKGROUND SCREENING VALUES FOR PRSs 14-002(a) AND 14-010

Sample ID	Location ID	Depth (in)	Uranium-234 (pCi/g)	Uranium-235 (pCi/g)	Uranium-238 (pCi/g)	Uranium[a] (pCi/g)
SAL	N/A[b]	N/A[b]	13	10	67	52[c]
soil UTL	N/A[b]	N/A[b]	1.94	0.084	1.82	3.84
PRS 14-002(a)						
0214-97-0032	14-1036	0-6	1.2	0.06(U)	3.8	5.0
0214-97-0033	14-1037	0-6	3.3	0.3	20.2	23.8
PRS 14-010						
0214-97-0034	14-1038	0-6	3.4	0.3	24.0	27.7
0214-97-0035	14-1039	0-6	2.3	0.2(U)	12.0	14.5
0214-97-0036	14-1040	0-6	1.1	0.07(U)	2.2	3.4
0214-97-0037	14-1041	0-6	1.8	0.07(U)	3.4	5.2
0214-97-0041	14-1042	0-6	1.3	0.1(U)	2.3	3.7
0214-97-0042	14-1043	0-1	0.8	0.004(U)	1.7	2.5

[a]The total uranium values were estimated by applying the appropriate conversion factor for each sample.
[b]Not applicable
[c]SAL for uranium in pCi/g was derived by multiplying the depleted uranium SAL of 130 mg/kg by 0.4.
Note: Boxes with darkened borders are values greater than background.

TABLE 3.2-2

ORGANICS DETECTED AT PRSs 14-002(a)/010

Sample ID	Location ID	Depth (in)	HMX (mg/kg)	2,4,6-Trinitrotoluene (mg/kg)
SAL	N/A[a]	N/A[a]	3,300	15
EQL	N/A[a]	N/A[a]	0.16	0.09
PRS 14-002(a)				
0214-97-0043	14-1036	0-6	47.5	0.09(U)
0214-97-0044	14-1037	0-6	29.9	0.09(U)
PRS 14-010				
0214-97-0045	14-1038	0-6	94.3	0.09
0214-97-0046	14-1039	0-6	61.9	0.09(U)
0214-97-0047	14-1040	0-6	1.0	0.09(U)
0214-97-0048	14-1041	0-6	2.2	0.09(U)
0214-97-0049	14-1042	0-6	1.3	0.16
0214-97-0050	14-1043	0-6	1.4	0.18

Not applicable
Note: Boxes with darkened borders are detected values.

The results of the confirmatory sampling indicated that there were no analytes detected at these PRSs above either SALs or industrial PRGs. The COPC identified in the Phase I investigation, uranium, was detected at concentrations that were not a concern to human health (i.e., below background or below SALs and industrial PRGs) following remediation. The concentrations of uranium from the drainage area were between 1% and 6% of the industrial PRG (Table 2.3-1). The concentrations of HMX were approximately three to four orders of magnitude below the industrial PRG (34,000 mg/kg) and 2,4,6-trinitrotoluene concentrations were more than two orders of magnitude below the industrial PRG (64 mg/kg). Therefore, based on the results of the confirmatory sampling, the remedial activities at PRSs 14-002(a) and 14-010 were successful in reducing the levels of the COPC to below the risk-based cleanup value and the sites are recommended for no further action (NFA). The PRSs have been successfully remediated and best management practices (BMPs) in the form of sandbags and hay bales have been put in place to control run-on and runoff from the sites.

4.0 WASTE MANAGEMENT

4.1 Estimated Types and Volumes of Waste

PRS 14-002(a)

The VCA Plan (ER Project 1997, ER ID No. 55678) estimated that the volume of waste generated at PRS 14-002(a) would be less than one B-25 container (<3 cu. yds of soil). The volume of waste collected as a result of the VCA activities was approximately two B-25 containers or 6 cu. yds. of soil. The difference was due to additional soil removal beneath the sand bags and the inclusion of the contaminated asphalt in the vicinity of the PRS.

The waste in the B-25 containers was characterized by collecting grab samples from each 5-gallon bucket that was emptied into the containers. The grab samples were placed in a stainless steel bowl and homogenized. A representative soil sample from each bowl was collected and submitted to the fixed laboratories for analyses of Toxicity Characteristic Leaching Procedure (TCLP) metals, HE, isotopic uranium, SVOCs, and VOCs. The analytical results of the waste samples indicated that the B-25 containers from PRS 14-002(a) were low-level radioactive waste (Table 4.2.2-1). The low-level radioactive waste will be disposed of at the Laboratory's low-level radioactive storage facility at TA-54.

PRS 14-010

The VCA Plan (ER Project 1997, ER ID No. 55678) estimated that the volume of waste generated at PRS 14-010 would be approximately three B-25 containers (9 cu. yds of soil). The volume of waste collected as a result of the VCA activities was approximately two B-25 containers or 6 cu. yds. of soil. The difference was due to less soil being removed than anticipated.

The waste in the B-25 containers was characterized by collecting grab samples from each 5-gallon bucket that was emptied into the containers. The grab samples were placed in a stainless steel bowl and homogenized. A representative soil sample from each bowl was collected and submitted to the fixed laboratories for analyses of TCLP metals, HE, isotopic uranium, SVOCs, and VOCs. The analytical results of the waste samples indicated that the B-25 containers from PRS 14-010 were mixed waste (Table 4.2.2-2). The mixed waste generated by the VCA will be temporarily stored at the Laboratory's low-level radioactive storage facility at TA-54 until an approved treatment, storage, and disposal (TSD) facility for the waste can be determined.

4.2 Waste Characterization Data

4.2.1 Data Quality Assessment of Waste Characterization Data

The results of the laboratory analyses on the waste samples from PRS 14-002(a) are the final data; the waste characterization data for PRS 14-010 are preliminary results. Because these waste samples are used for the purpose of waste disposition and are not used to determine whether the VCA activities were effective, the use of preliminary data does not affect the decision of whether or not the PRS has been successfully remediated. The waste characterization data for PRS 14-010 will be reevaluated once the final data packages are received. A summary of the data quality assessment and the analytical results for PRS 14-010 will be included as an addendum to the VCA Completion Report.

The QA/QC samples used to determine the quality and usability of the waste characterization data generated from the analyses of the soil in the B-25 containers included method blanks, calibration blanks, laboratory duplicates, surrogates, spikes, laboratory control samples, and internal standards. These samples were analyzed according to the frequency outlined in EPA's functional guidelines for organic and inorganic data review (EPA 1994, 1205 and 1206). A review of the technical quality of the data (baseline validation) requires that the data be compared to numerical acceptance criteria established either by the analytical laboratory or EPA for the QA samples mentioned above. The data that do not meet these criteria are qualified to indicate to the data user those sample results that have potential deficiencies associated with sample handling and analysis. As mentioned previously, the waste characterization data for PRS 14-010 are preliminary data, and a data quality assessment is presented below based on a review of the preliminary data packages. Those data that did not have any accompanying descriptions of the laboratory QA/QC were not evaluated for data quality in this report. The QA/QC problems are presented in Appendix A (Tables A-1 and A-2) according to request number, sample ID, and analytical suite, respectively.

PRS 14-002(a)

- The inorganic data had no QA/QC problems associated with the analyses. The data are usable as reported.
- The radionuclide data had no QA/QC problems associated with the analyses. The data are usable as reported.
- The HE data had no QA/QC problems associated with the analyses. The data are usable as reported.
- Acetone was detected in the method blank associated with two samples. The sample values for this analyte were less than 10X the blank value, indicating presence may be due to contamination (EPA 1994, 1206). The analyte is qualified as U and is usable as a nondetect.
- Two soil samples from one request number had QA/QC problems associated with the VOC internal standard area counts. The area count for 1,4-dichlorobenzene was more than a factor of 2 below the lower limit for both samples. The data for all nondetects are qualified as UJ, and data for all detects are qualified as JPM. The data are usable because area counts are between 27-48%, are not extremely low (<10%), and do not drop off abruptly, which would indicate a loss of sensitivity (EPA 1994, 1205). Although the data are potentially biased low, the instrument is still able to detect and quantify the analytes because its sensitivity and responsiveness were not compromised. In addition, the continuing calibrations, the internal standard retention times, the other internal standard area counts, and the other QA/QC samples were acceptable for these samples.
- Two samples from one request number had QA/QC problems associated with the VOC surrogate recoveries. The percent recoveries for bromofluorobenzene were below the established lower limit of

74%. Analytes that were undetected are qualified as UJ, and detected analytes are qualified as J-. The data are usable because the recoveries of 73% and 72% are only slightly below the limit and were within the range of 10-73%, which results in acceptable, but potentially biased low data (EPA 1994, 1206). The recoveries were, therefore, sufficient to detected and quantify the analytes if they were present, and the detected analyte, methylene chloride, was more than two orders of magnitude below its SAL.

PRS 14-010

- The inorganic data had no QA/QC problems associated with the analyses. The data are usable as reported.
- The preliminary isotopic uranium data had no QA/QC problems associated with the analyses. The data are usable as reported.
- The preliminary HE data package did not have any QA/QC information.
- Two soil samples from one request number had QA/QC problems associated with the VOC internal standard area counts. The area count for 1,4-dichlorobenzene was more than a factor of 2 below the lower limit for one sample, while the area counts for d4-1,4-dichlorobenzene were more than a factor of 2 below the lower limit for both samples. The data for all nondetects should be qualified as UJ, and data for all detects should be qualified as JPM. The data are usable because area counts are between 13-41%, are not extremely low (<10%), and do not drop off abruptly, which would indicate a loss of sensitivity (EPA 1994, 1205). Although the data are potentially biased low, the instrument is still able to detect and quantify the analytes because its sensitivity and responsiveness were not compromised. In addition, the continuing calibrations, the internal standard retention times, the other internal standard area counts, and the other QA/QC samples were acceptable for these samples.
- The SVOC data had no QA/QC problems associated with the analyses. The data are usable as reported.

The results of the data quality evaluation performed on the waste characterization sample results are summarized in Table A-2.

4.2.2 Summary of Waste Characterization Data

Tables 4.2.2-1 and 4.2.2-2 present the analytical results of the waste characterization samples from PRSs 14-002(a) and 14-010, respectively. Analytes listed were those detected in the individual waste characterization samples collected from the B-25 containers.

TABLE 4.2.2-1

WASTE CHARACTERIZATION SAMPLES FOR PRS 14-002(a)

Sample ID	Compound	Result	Units	Qualifier
0214-97-0027	Barium	0.9	mg/L	
	Cadmium	0.008	mg/L	
	Lead	0.3	mg/L	
	HMX	21.1	mg/kg	
	RDX	5.1	mg/kg	
	Uranium-234	15.4	pCi/g	
	Uranium-235	1.9	pCi/g	
	Uranium-238	115	pCi/g	
	Methylene chloride	0.01	mg/kg	
0214-97-0028	Barium	1.1	mg/L	
	Cadmium	0.008	mg/L	
	Lead	0.3	mg/L	
	HMX	52.7	mg/kg	
	RDX	5.0	mg/kg	
	Uranium-234	17.7	pCi/g	
	Uranium-235	2.2	pCi/g	
	Uranium-238	132	pCi/g	
	Methylene chloride	2	mg/kg	

TABLE 4.2.2-2

WASTE CHARACTERIZATION SAMPLES FOR PRS 14-010

Sample ID	Compound	Result	Units	Qualifier
0215-97-0029	Barium	900	µg/L	
	Acetone	0.04	mg/kg	
	HMX	280	mg/kg	
	Uranium-234	5.8	pCi/g	
	Uranium-235	0.9	pCi/g	
	Uranium-238	37.6	pCi/g	
0215-97-0030	Barium	600	µg/L	
	Butylbenzylphthalate	16	mg/kg	
	Acetone	0.05	mg/kg	
	Toluene	0.009	mg/kg	
	HMX	32	mg/kg	
	Uranium-234	11.7	pCi/g	
	Uranium-235	1.5	pCi/g	
	Uranium-238	78.7	pCi/g	

5.0 REFERENCES

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APPENDIX A

QUALITY ASSURANCE/QUALITY CONTROL EVALUATION

TABLE A-1

DATA QUALITY EVALUATION OF CONFIRMATORY SAMPLES COLLECTED FROM PRSs 14-002(a) AND 14-010

Request Number	Sample ID	Suite	Comments
PRS 14-002(a)			
3365R	0214-97-0032, -0033	Radionuclides	The MDA was greater than the EQL for uranium-235. These results were less than the MDA and EQL and are qualified as U. All U qualified data are usable as nondetects.
PRS 14-010			
3365R	0214-97-0036, -0037, -0042	Radionuclides	The MDA was greater than the EQL for uranium-235. These results were less than the MDA and EQL and are qualified as U. All U qualified data are usable as nondetects.
	0214-97-0035, -0041		The MDA was greater than the EQL for uranium-235. The result was greater than the MDA but less than the EQL and is qualified as U. All U qualified data are usable as nondetects.

TABLE A-2

DATA QUALITY EVALUATION OF WASTE CHARTACTERIZATION SAMPLES COLLECTED FROM PRSs 14-002(a) AND 14-010

Request Number	Sample ID	Suite	Comments
			PRS 14-002(a)
3244R	0214-97-0027, -0028	VOCs	Acetone was detected in the method blank associated with two samples. The sample values for this analyte were less than 10X the blank value, indicating presence may be due to contamination. The analyte is qualified as U and is usable as a nondetect.
	0214-97-0027, -0028		The area counts for the internal standard 1,4-dichlorobenzene were more than a factor of 2 below the lower limit for both samples. The data for all nondetects are qualified as UJ, data for all detects are qualified as JPM. The data are usable because area counts are between 27-48% and are not extremely low (<10%) and do not drop off abruptly, which would indicate a loss of sensitivity. Although the data are potentially biased low, the instrument is still able to detect and quantify the analytes because its sensitivity and responsiveness were not compromised. In addition, the continuing calibrations, the internal standard retention times, the other internal standard area counts, and the other QA/QC samples were acceptable.
	0214-97-0027, -0028		The percent recoveries for the surrogate bromofluorobenzene were below the established lower limit of 74%. Analytes that were undetected are qualified as UJ; detected analytes are qualified as J-. The data are usable because the recoveries of 73% and 72% are only slightly below the limit and were within the range of 10-73%, which results in acceptable, but potentially biased low data. The recoveries were sufficient to detect and quantify the analytes if they were present and the detected analyte, methylene chloride, was more than two orders of magnitude below its SAL.
			PRS 14-010
3471R	0214-97-0029, -0030	VOCs	The area count for the internal standard 1,4-dichlorobenzene was more than a factor of 2 below the lower limit for one sample, while the area counts for d4-1,4-dichlorobenzene were more than a factor of 2 below the lower limit for both samples. The data for all nondetects should be qualified as UJ, data for all detects should be qualified as JPM. The data are usable because area counts are between 13-41% and are not extremely low (<10%) and do not drop off abruptly, which would indicate a loss of sensitivity. Although the data are potentially biased low, the instrument is still able to detect and quantify the analytes because its sensitivity and responsiveness were not compromised. In addition, the continuing calibrations, the internal standard retention times, the other internal standard area counts, and the other QA/QC samples were acceptable for these samples.

APPENDIX B

RFI ANALYTICAL RESULTS

The data from the RFI Phase I Investigation have been edited and validated. These data are available via the Facility Information Management and Display (FIMAD) database and will be provided upon request.

APPENDIX C

ESTIMATED AND ACTUAL COST COMPARISON

APPENDIX D

CONFIRMATORY SAMPLING RESULTS

The data provided in this section are preliminary data from the quick-turnaround laboratory analysis. As such, these data have not undergone baseline validation and are not yet available in the FIMAD database. While the analytical results are not expected to change, these data will be re-evaluated upon receipt of the final data packages. Once the data have been uploaded into the FIMAD database, a printout will be provided and inserted into the report in place of the preliminary data.

APPENDIX E

CERTIFICATION OF COMPLETION

I certify that all the work pertaining to the voluntary corrective action PRSs 14-002(a) and 14-010 has been completed in accordance with the Department of Energy approved VCA plan entitled VCA Plan for Potential Release Site 14-002(a) and 14-010, Decommissioned Firing Chamber and Decommissioned Sump. Based on my personal involvement or inquiry of the person or persons who managed this cleanup, a review of all data gathered and a visit to the site, to the best of my knowledge and belief, all criteria of the plan have been met or exceeded. I believe that the completion of this VCA is protective of both human health and the environment. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

____________________________________ __________________

Field Unit 2, Field Project Leader
Environmental Restoration Project
Los Alamos National Laboratory

Date Signed

APPENDIX F

SITE MAP OF TA-14 AND PRSs 14-002(a) AND 14-010

8 7 8 4 5	***ERID#:*** 87845	***LOS ALAMOS NATIONAL LABORATORY*** ***ENVIRONMENTAL RESTORATION (RRES-R)*** ***Records Processing Facility*** ***ER Records Index Form***

Date Received: 3/18/2005 ***Processor:*** NMV ***Page Count:*** 41

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Record Documents:

Start Pg	*Doc Type*	*Doc Date*	*Title*	*Box*	*Package*
1	STATUS REPORT	5/18/2004	FINAL BOREHOLE CdV-16-3(i) STATUS REPORT LOS ALAMOS NATIONAL LABORATORY LOS ALAMOS, NEW MEXICO PROJECT NUMBER 37151/11.12 37151/11.12 N/A N/A		
13	APPENDIX A	5/18/2004	GROUNDERWATER ANALYTICAL RESULTS 37151/11.12 N/A N/A		
16	APPENDIX C	5/18/2004	APPENDIX C SCHLUMBERGER GEOPHYSICAL REPORT AND MONTAGES 37151/11.12 N/A N/A		
29	APPENDIX D	5/18/2004	APPENDIX D LITHOLOGY 37151/11.12 N/A N/A		
38	APPENDIX E	5/18/2004	APPENDEX E NMED DISCHARGE APPROVAL 37151/11.12 N/A N/A		

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FINAL
BOREHOLE CdV-16-3(i) STATUS REPORT
LOS ALAMOS NATIONAL LABORATORY
LOS ALAMOS, NEW MEXICO
PROJECT NO. 37151/11.12

Prepared for:

The United States Department of Energy and the
National Nuclear Security Administration through the
United States Army Corps of Engineers
Sacramento District

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May 18, 2004

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LIST OF ACRONYMS AND ABBREVIATIONS

AITH	array induction tool, version H
amsl	above mean sea level
ASTM	American Society for Testing and Materials
bgs	below ground surface
°C	degrees Celsius
CD	compact disc
CMR™	Combinable Magnetic Resonance
CNTG	compensated neutron tool, model G
CQMP	Contractor Quality Management Program
DOE	Department of Energy
DP	Drilling Plan
DTH	down-the-hole
DTW	depth to water
DVD	digital video disc
EES	Earth and Environmental Sciences
EnviroWorks	EnviroWorks, Inc
FMI	formation microimager
ft	feet
gal	gallon
GPS	global positioning system
g	grams
HSA	hollow-stem auger
ID	inner diameter
in	inches
KA	Kleinfelder, Inc.
KBr	potassium bromide
LANL	Los Alamos National Laboratory
MDL	Method Detection Limit
mil	1/1000 of an inch
NAD	North American Datum
NGS	natural gamma spectroscopy
NGVD	National Geodetic Vertical Datum
NMED	New Mexico Environment Department
NOI	Notice of Intent
NTU	nephelometric turbidity unit
OD	outer diameter
PMP	Project Management Plan
psi	pounds per square inch
SSHASP	Site-Specific Health and Safety Plan
TD	total depth
TLD	triple detector lithodensity
TOC	Total Organic Carbon
USACE	United States Army Corps of Engineers
µS/cm	microsiemens per centimeter
WDC	WDC Exploration & Wells

ABSTRACT

Borehole CdV-16-3(i) is being installed by the Department of Energy (DOE) as part of the Addendum to Corrective Measures Study (CMS) Plan for Potential Release Site (PRS) 16-021(c) Revision 1 (LA-UR-02-7366, 2003). This borehole is located on a ridge south of the Technical Area (TA)-16 Burning Ground, between Fish Ladder Seep and Martin Spring, within TA-16 of Los Alamos National Laboratory (the Laboratory, or LANL). This borehole is intended to be used to identify potential contamination in the deep perched and regional aquifers that may be associated with effluents containing high explosives (HE) that were discharged from TA-16 and possibly other nearby sites. Borehole CdV-16-3(i) is currently an open-hole completion.

Information obtained from this borehole will be used (1) to determine how fast the contamination, if confirmed to be present, is moving downgradient toward the Pajarito well field or other potential exposure points such as Bandelier National Monument; (2) assess the presence and direction of groundwater flow; and (3) determine the hydraulic gradient of the regional aquifer and any deep perched saturated zones in the southwest part of the Laboratory. The data obtained from drilling this borehole will be used with similar data from other wells in the area to improve the conceptual model for geology, hydrogeology, and hydrochemistry, as well as to provide constraints on numerical models that address contaminant migration in the vadose (unsaturated) zone and the regional aquifer.

Construction for the drill pad and cuttings pit occurred in phases from October 16 to December 10, 2003. Borehole drilling was conducted from December 20, 2003 to January 15, 2004. Corehole drilling was not included in the scope of work for CdV-16-3(i). The well borehole was drilled using air and fluid-assisted air-rotary methods to a total depth of 1,405 ft bgs. No groundwater was observed during drilling. The borehole was advanced 121 ft past the predicted depth of the regional water table. DOE and LANL subsequently decided to monitor water levels in the open borehole to determine if water was slowly recharging the drill hole; but the borehole made little groundwater, possibly due to the impermeable nature of dacitic lavas that make up the aquifer at this location. Samples of drill cuttings were collected at regular intervals for stratigraphic, petrographic, and geochemical analysis. The stratigraphy encountered during borehole drilling included, in descending order, ash-flow tuffs of the Tshirege Member of the Bandelier Tuff, Cerro Toledo interval, ash-flow tuffs and Guaje Pumice Bed of the Otowi Member of the Bandelier Tuff, Puye Formation, Tschicoma lava/breccia, and massive Tschicoma lavas.

On January 20, 2004, NMED approved an open-hole completion for CdV-16-3(i) to allow for continued observations of the presence of groundwater. Well screen and casing were not installed in CdV-16-3(i) due to the apparent absence of water. No well development or aquifer testing could be conducted at CdV-16-3(i).

A bimonthly water level monitoring program has been implemented; on March 12 and 26, 2004, depth to water was measured at 1,350.2 and 1,350.50 ft bgs, respectively. Total depth of the borehole was measured on March 26, 2004 at 1391.5 ft bgs. On April 13 and April 23, depth to water was measured at 1,350.56 and 1,350.51, respectively. Depth to water measurements will continue for the purpose of gathering information to support a final borehole completion decision.

1.0 INTRODUCTION

This status report summarizes borehole drilling and related activities conducted from October 16, 2003 through Spring 2004 for borehole CdV-16-3(i). CdV-16-3(i) was drilled for LANL's Risk Reduction and Environmental Stewardship Remediation Services (RRES-RS) as part of the Addendum to Corrective Measures Study (CMS) Plan for Potential Release Site (PRS) 16-021(c) Revision 1 (LA-UR-02-7366, 2003). The CdV-16-3(i) investigation was funded and directed by the Department of Energy (DOE). Kleinfelder, Inc. (KA), under contract to the US Army Corps of Engineers (USACE), was responsible for executing the drilling, installation, testing, and sampling activities, with technical assistance from LANL.

The information presented in this report was compiled from field reports and activity summaries generated by KA, LANL, and subcontractor personnel. All original source documents are on file in the KA Albuquerque office. Results of the field activities are discussed briefly and shown in tables and figures contained in this report. Detailed analysis and interpretation of geologic, geochemical, and hydrologic data will be included in separate technical documents prepared by LANL.

CdV-16-3(i) is located within Technical Area (TA)-16 on a high ridge south of the TA-16 Burning Ground, as shown in Figure 1.0-1. CdV-16-3(i) was designed as an intermediate well to target the thick perched zones of groundwater observed in other nearby wells. This borehole is intended to be used to identify potential contamination in the deep perched and regional aquifers. Effluents containing high explosives have been discharged at TA-16 and possibly other nearby sites.

Data from CdV-16-3(i) will be evaluated in conjunction with data from other area wells and boreholes to form the technical basis for the design of a groundwater monitoring system, if needed. Water quality, geochemical, hydrologic, and geologic information obtained from CdV-16-3(i) will augment knowledge of regional subsurface characteristics and distribution of contaminants downgradient of potential release sites.

2.0 PRELIMINARY ACTIVITIES

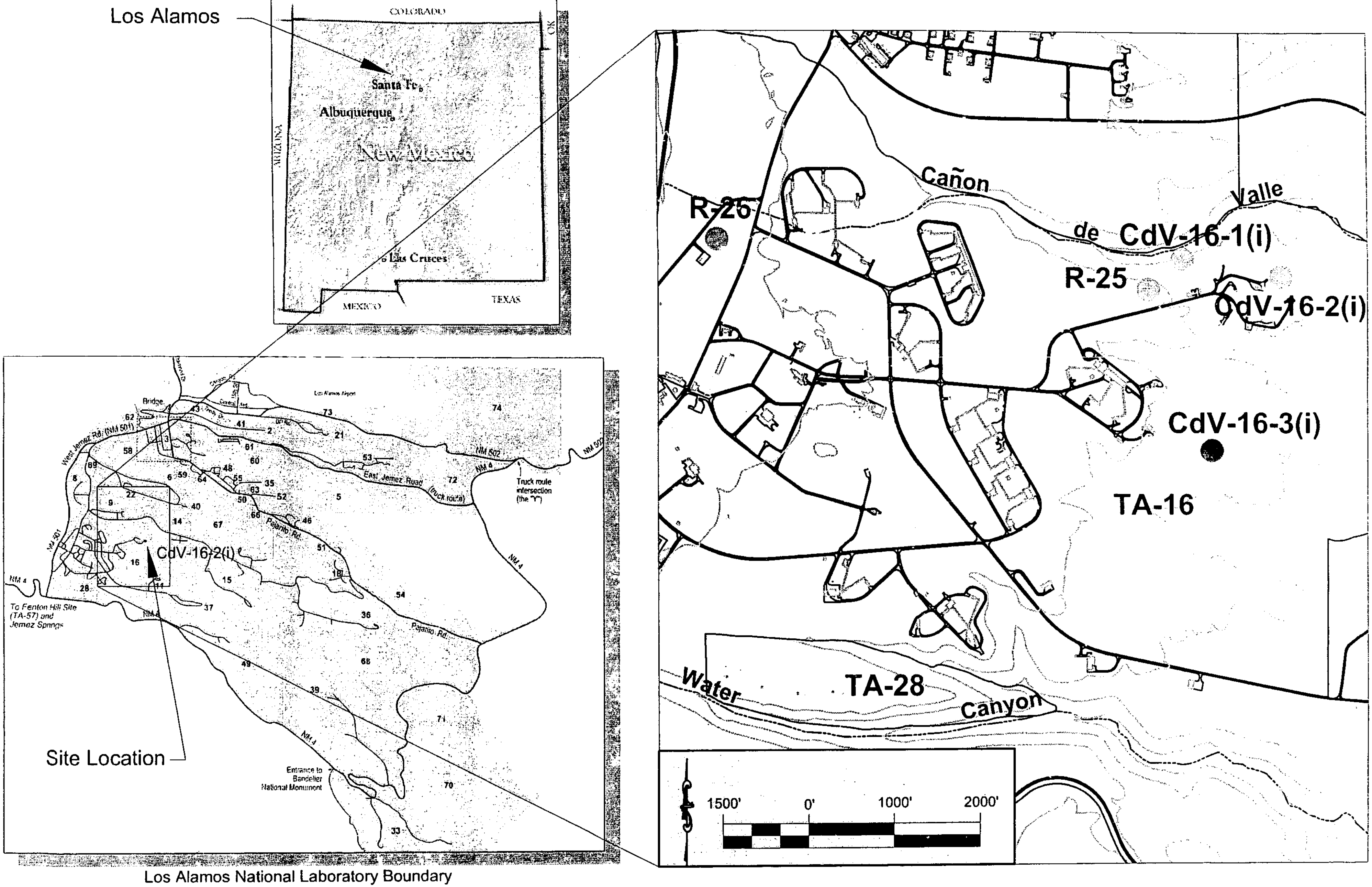
Preliminary activities at CdV-16-3(i) included administrative and site preparation.

Administrative Preparation

KA received contractual authorization to start administrative preparation tasks in the form of a notice to proceed on July 11, 2003. As part of this preparation, KA developed a Project Management Plan (PMP), a Contractor's Quality Management Program (CQMP), a Site-Specific Health and Safety Plan (SSHASP) and a Drilling Plan (DP) for the work at CdV-16-3(i). The LANL host facility was Engineering Sciences and Applications (ESA), a division of LANL. Necessary permits and access agreements were obtained prior to beginning fieldwork.

Site Preparation

EnviroWorks, Inc. (EnviroWorks) was subcontracted by KA to conduct site preparation. Activities included site clearing, access road improvement, construction of the drill pad, construction of a lined borehole-cuttings containment area, and installation of silt and safety fencing. Site preparation began on October 16, 2003 and was completed on December 10, 2003.



KLEINFELDER		SITE LOCATION MAP Completed Borehole CdV-16-3(i) LANL Well Program Los Alamos National Laboratory Los Alamos, New Mexico	FIGURE 1.0-1
Drawn By: C. Landon	Date: April 2004		
Project No.: 37151	Filename: FIGURE 1.0-1		
Scale: 1" = 2000'	Revision: 0		

Note: CdV-16-3(i) Well Identification Modified from Proposed R Characterization Well Location Map Provided by Los Alamos National Laboratory

Site preparation began with repairing Nakamu Road, the road leading to the site location. The CdV-16-3(i) drill pad was cleared of vegetation and graded with a front-end loader. A primary layer of base-course gravel was distributed over the drill pad. Drill pad construction was completed with an additional graded layer of base-course gravel. EnviroWorks constructed a 20 ft wide by 60 ft long by 7 ft high, lined containment area for drilling fluids and borehole cuttings. Enviroworks imported fill to build up the berm for the containment area due to the hard rock surface of the site location. Safety barriers and signs were installed at the site entrance and around the borehole-cuttings containment area. Office and supply trailers, generators, and safety lighting equipment were moved to the site during subsequent mobilization of drilling equipment.

Sediment from site preparation work was controlled on-site through the use of silt fences and straw bales as per the storm water pollution prevention plan (SWPP).

Potable water was provided by a canvas fire hose connected to a fire hydrant (hydrant no. 593) located adjacent to the old water treatment plant, approximately 800 feet to the west of the drill site. A backflow prevention system was installed at the hydrant.

3.0 SUMMARY OF DRILLING ACTIVITIES

Borehole drilling activities at the CdV-16-3(i) site were completed between December 20, 2003 and January 15, 2004. Objectives were to collect cuttings of intersected geologic formations, collect groundwater samples from perched water zones and the regional aquifer, and provide a borehole for geophysical logging and installation of a monitoring well. The planned TD of the CdV-16-3(i) borehole was approximately 900 ft below ground surface (bgs) to investigate perched zones at intermediate depths. If the perched zone was not encountered before reaching the proposed total depth (TD) the borehole could be advanced into the regional aquifer, estimated to occur at approximately 1284 ft bgs.

Drilling activities were performed generally in one 12-hour shift per day, 7-days per week by the drill crew and two site geologists. DTW measurements were taken at the beginning and end of every shift to check for the presence of water. Drilling equipment was removed from the borehole at the end of each shift to facilitate measurement of possible groundwater.

Figure 3.0-1 summarizes drilling data and graphically depicts groundwater and geologic conditions encountered during drilling at CdV-16-3(i). Table 3.0-1 details the chronology of drilling and other on-site activities at CdV-16-3(i). Section 3.1 discusses specific borehole drilling activities.

cation: South of Burning Ground,
Adjacent to Nakamu Road, TA-16

:scription: Borehole - Drill Casing
rthing: 17262434.9
isting: 1615981.6
evation: 7486.80

ring: None

illing:
- (12' - 1238') 12-1/4" Tri-Cone
  - (12'-105') Air Rotary
  - (105' - 1238') Fluid-Assisted Air Rotary
- (1238' - 1405') 12-1/4" DTH Hammer
  - (1238' - 1405') Fluid-Assisted Air Rotary

ata Collection:
- Cuttings submitted for geochemical and contaminant characterization
- Open borehole fluid samples submitted
  - 1/16/04 (1400.5') - sample not analyzed per EES-6 personnel
  - 1/20/04 (1385') - sample not analyzed per EES-6 personnel

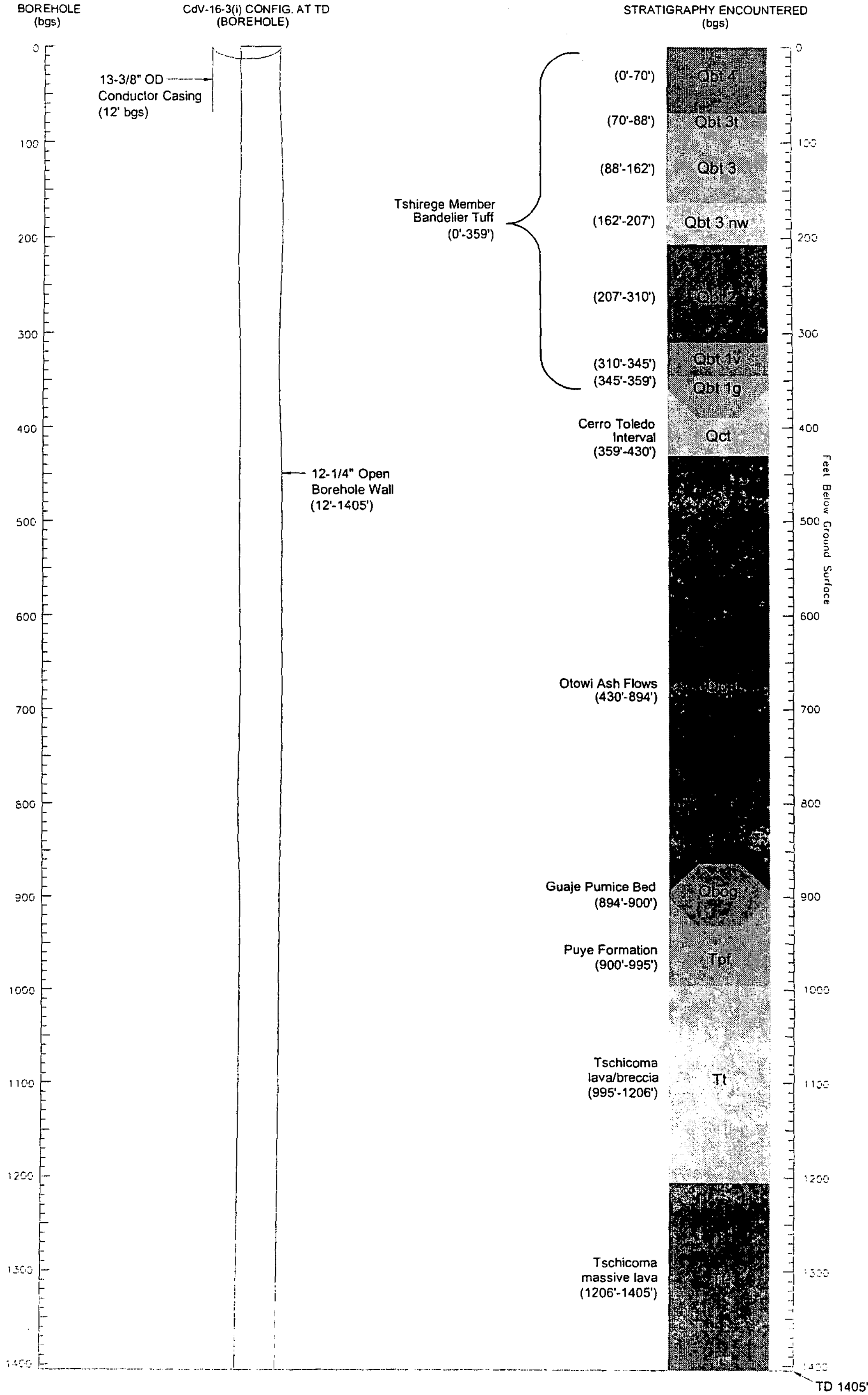
eologic Properties:
Minerology, petrography, and chemistry: 7

orehole Logs:
- Lithologic: 0' - 1405'
- Video (LANL tool): 0' - 1385'
- Schlumberger logs:
  - Compensated Neutron Log: Open Hole: 14'-1404'
  - Triple Litho-Density: Open Hole: 14'-1404'
  - Array Induction Tool: Open Hole: 14'-1398'
  - Elemental Capture Sonde: Open Hole: 14'-1399'
  - Natural GR Spectroscopy: Open Hole: 14'-1382'
  - Combinable Magnetic Resonance: Open Hole: 14'-1386'
  - Gamma Ray: Open Hole: 14'-1386'
  - Fullbore Formation Micro Imager: (FMI) Open Hole: FMI not performed

Rotary Drilling Completed: 12/20/03 - 1/15/04
Contract Geophysics: 1/16/04
Borehole Video: 1/17/04

Temporary Surface Completion: 1/23/04

Geologic contacts for CdV-16-3(i) were determined from cuttings, borehole video, and geophysical logs.



Notes:

1. All depths are below ground surface (bgs).
2. Qbt 1v, Qbt 1g, Qbt 2, Qbt 3nw, Qbt 3, Qbt 3t and Qbt4 are cooling units of the Tshirege Member of the Bandelier Tuff.
3. Based on results of borehole video and preliminary borehole geophysics, perched water is not encountered and the regional saturation is slowly returning to equilibrium.
4. Fluids present in borehole suspected as being drilling fluids.
5. Due to the lack of groundwater, the well has not been constructed. A metal plate with an access port has been welded atop the conductor casing. A temporary 3'x3'x6" concrete well pad was constructed. Occurrence of groundwater is being monitored on a routine basis.

KLEINFELDER

Drawn By: C. London	Date: April 2004
Project No.: 37151	Filename: Figure 3.0-1
Scale: Not-To-Scale	Revision: 0
Reviewed By: F. Schelby	Approved By: B. Bockisch

Well Summary Data Sheet for Completed Borehole CdV-16-3(i)
Los Alamos National Laboratory
Los Alamos, New Mexico

FIGURE **3.0-1**

Table 3.0-1 Operations Chronology for Borehole CdV-16-3(i)

TASK DESCRIPTIONS	DATE						
	Oct-03	Nov-03	Dec-03	Jan-04	Feb-04	Mar-04	Apr-04
SITE PREPARATION ACTIVITIES	10/16-12/10						
BOREHOLE DRILLING AND SAMPLING							
Mobilization			12/17				
Air-Rotary				12/20, 1/6-1/7			
Fluid Assisted Air-Rotary				1/7-1/15			
Groundwater Screening Sampling				1/16 and 1/20			
BOREHOLE GEOPHYSICS							
Schlumberger Logging				1/16			
LANL Video				1/17			
LANL Geophysics				Not Conducted			
WELL DESIGN AND CONSTRUCTION				Open Hole Completion			
WELL DEVELOPMENT	*Not Applicable*						
GROUNDWATER WELL SAMPLING	*Not Applicable*						
HYDROLOGIC TESTING	*Not Applicable*						
SITE RESTORATION							Activities began April 2004

NOTES: NMED discharge approval was received in an email dated March 18, 2004. Site restoration activities began in April 2004.

3.1 Borehole Drilling Activities

Drilling was performed by WDC Exploration & Wells (WDC) using a Star 50-CH Failing/Speedstar air/mud rotary drill rig equipped with conventional circulation drilling rods, tricone bits, down-the-hole (DTH) hammer bits, and support equipment. Drilling fluid mixing and circulation equipment included a mixing tank and pump assembly, and a generator to power the mixing unit. Drilling fluids were used as needed to improve borehole stability, minimize fluid loss, and facilitate cuttings removal from the borehole. Drilling fluids consisted of potable water with QUIK-FOAM® (surfactant) and EZ-MUD® (polymer).

From December 17 to 19, 2003, WDC mobilized the drill rig and equipment to the CdV-16-3(i) site. On December 20, 2003, WDC advanced 13³/₈-in outside-diameter (OD) conductor casing to a depth of 9 ft bgs using a 12¼-in button-tooth tricone bit and air-rotary methods. Drilling continued open-hole to 22 ft bgs. Drilling activities were suspended from December 21, 2003, through January 4, 2004, for the Christmas and New Year holidays.

On January 5, 2004, equipment mobilization and drill site setup resumed. The following day, site setup was completed and the 13³/₈-in conductor casing was advanced and set at 12 ft bgs. On January 7, 2004, drilling resumed from 22 ft bgs using a 12¼-in button-tooth tricone bit and air-rotary methods. The borehole was advanced through the Tshirege Member of the Bandelier Tuff to 105 ft bgs, where WDC began adding water to the borehole for dust suppression. Drilling continued in the Tshirege Member to 223 ft bgs. Forty-five minutes after drilling stopped for the day, a depth-to-water (DTW) measurement was attempted with an electronic sounder. No water was detected.

On the morning of January 8, 2004, an attempt to measure water in the borehole was made; none was detected. Fluid-assisted air-rotary drilling was initiated at 223 ft bgs to clear cuttings from the borehole. Potassium bromide (KBr) was added to the fluids as a tracer to aid in determining the occurrence of groundwater saturation. Drilling continued through the Tshirege Member, the Cerro Toledo interval, and into the Otowi Member of the Bandelier Tuff, to 523 ft bgs.

Attempts to measure groundwater in the borehole at the end of shift on January 8, and on the morning of January 9, 2004, indicated the borehole was dry. The borehole was advanced through the Otowi Member to 743 ft bgs and an attempt to measure DTW was again made; no water was detected.

The borehole was subsequently advanced through the Otowi Member, Guaje Pumice Bed, Puye Formation, and into the Tschicoma Formation at 995 ft bgs, to 1000 ft bgs. Drilling stopped to monitor for groundwater in the borehole at 1000 ft bgs. After waiting one and a half hours, fluid in the borehole was measured at 940 ft bgs. However, on the morning of January 11, 2004 a DTW measurement indicated the borehole was dry. The borehole was advanced in Tschicoma dacite to 1163 ft bgs where DTW measurements ranged from 1020 ft to 1050 ft bgs, however it appears that DTW indications were due to interference from drilling foam.

On the morning January of 12, 2004, 15 hours after drilling activities had ceased the night before, a DTW measurement was made, which indicated once again that the borehole was dry. WDC mobilized additional drill rods and three 3000-gal. poly tanks to the site to continue drilling to a deeper footage and to provide additional storage capacity for drilling fluids. On the morning of January 13, 2004, 40 hours after drilling stopped, a DTW measurement was made.

No water was indicated. The borehole was then advanced in the Tschicoma Formation from 1163 ft to 1238 ft bgs.

On January 14, 2004, another DTW measurement was made. No water was detected, thus WDC switched to a 12¼-in down-the-hole hammer drill bit to penetrate the more resistant Tschicoma lava flows, and drilled to 1405 ft bgs by the end of shift on January 15, 2004. On January 16, 2004, DTW was measured at 1400.5 ft bgs and a 1-liter sample of borehole fluid was collected from the borehole (Sample ID # GW3i-04-52951). TD was declared at 1405 ft bgs, after advancing 121 feet beyond the predicted depth to regional groundwater. After reaching TD, the borehole was prepared for geophysical logging. On January 20, 2004, a second sample (Sample ID # GW3i-04-52952) of borehole fluids was collected in an attempt to obtain a more representative sample of potential ground water.

Table 3.2-1 shows the total amount of fluids introduced and recovered from the borehole during drilling at CdV-16-3(i).

Table 3.2-1
Introduced and Recovered Fluids

Material	Amount (Gallons)
QUIK-FOAM®	48
EZ-MUD®	14
Potable water for Drilling	26,300
Recovered Fluids[a]	19,340

[a] Recovered fluids represents approximate quantity of fluids recovered during drilling.

4.0 SAMPLING AND ANALYSIS OF CUTTINGS AND GROUNDWATER

During drilling at CdV-16-3(i), samples of cuttings and borehole fluids were collected according to the Scope of Services (GSA Task Order 9T3N163PG). Samples of cuttings and borehole fluids were submitted to LANL for analysis. Cuttings collected from CdV-16-3(i) may be analyzed for mineralogic, petrographic, and geochemical properties by LANL. Borehole fluids were submitted for analysis of metals, anions, and HE compounds, but were not considered to be representative samples of groundwater.

Cuttings Sampling

As borehole drilling conditions permitted, a sufficient quantity of cuttings was collected from the discharge line at 5-ft intervals. A portion of the cuttings were sieved (at >#10 and >#35 mesh or >#35 and >#60 for finer-grained samples) and placed in chip-trays along with an unsieved whole rock portion. These chip trays were studied to determine the lithology of the borehole. A detailed lithologic log was prepared for CdV-16-3(i). The remaining cuttings were sealed in Ziploc® bags, labeled and archived in core boxes. Up to seven samples may be removed by LANL for mineralogic, petrographic, and geochemical analyses. No cuttings samples were submitted for contaminant characterization analysis.

Sample analysis results will be included in a future LANL investigation report for Cañon de Valle.

Groundwater Sampling

A groundwater-screening sample was collected on January 16, 2004 from CdV-16-3(i) at a depth of 1400.5 ft bgs. This sample (Sample ID # GW3i-04-52951) was collected from the open borehole using disposable and stainless steel bailers. An additional sample (Sample ID # GW3i-04-52952) was collected on January 20, 2004 from a depth of 1385-1388 ft bgs. The current total depth of the borehole was determined to be at 1391.5 ft bgs on March 26, 2004 due to slough in the bottom of the hole. These samples were submitted to LANL for analysis of metals, anions, and HE compounds. However, according to Pat Longmire, representative for LANL, these samples were determined to consist of drilling fluids and do not represent groundwater. Sample ID # GW3i-04-52951 was therefore not analyzed. Sample ID # GW3i-04-52952 was analyzed for inorganic constituents; these results are provided in Appendix A.

5.0 BOREHOLE GEOPHYSICS

Using LANL-owned and subcontractor-owned tools, KA and Schlumberger performed borehole geophysics logging operations at CdV-16-3(i).

Schlumberger Geophysical Logging

Schlumberger personnel conducted geophysical logging in the CdV-16-3(i) borehole on January 16, 2004. The primary purpose of the Schlumberger logging was to characterize the conditions in the hydrogeologic units penetrated by the CdV-16-3(i) borehole, with emphasis on gathering moisture distribution data, identifying the potential presence of water zones, measuring capacity for flow (porosity and moisture), and obtaining lithologic/stratigraphic data. Secondary objectives included evaluating borehole geometry and determining the degree of drilling fluid invasion along the borehole wall.

Schlumberger personnel performed a suite of geophysical logging in the cased and uncased portions of the borehole; the suite included the following tools:

- Combinable Magnetic Resonance (CMR™) measures the nuclear magnetic resonance response of the formation, which is used to evaluate total and effective water-filled porosity of the formation and to estimate pore size distribution and in situ hydraulic conductivity.
- Array Induction Tool, version H (AITH™) measures formation electrical resistivity and borehole fluid resistivity, thus evaluating the drilling fluid invasion into the formation, the presence of moist zones away from the borehole wall, and the presence of clay-rich zones.
- Triple Detector Litho-Density (TLD™) measures formation bulk density related to porosity, photoelectric effect related to lithology, and borehole diameter using a single-arm caliper.
- Natural Gamma Spectroscopy (NGS™) measures spectral and overall natural gamma ray activity, indicating potassium, thorium, and uranium concentrations, thus evaluating geology and lithology.

- Elemental Capture Spectroscopy (ECS™) measures concentrations of hydrogen, silicon, calcium, sulfur, iron, aluminum, potassium, titanium, chlorinity, and gadolinium to characterize mineralogy, lithology, and water content of the formations.
- Epithermal Compensated Neutron Tool, model G (CNTG™) measures volumetric water content beyond the casing to evaluate formation moisture content and porosity.

Additionally, a calibrated natural gamma tool was used to record gross natural gamma-ray activity with each logging method (except the NGS™ run) to correlate depth runs between each of the surveys conducted.

Important results from the processed geophysical logs in CdV-16-3(i) include the following:

1. No substantial standing was present at the time of the January 16, 2004 logging – although several logs indicate there may have been a small quantity of fluid (possibly just accumulated water from the drilling foam used) at the very bottom of the borehole that was rising during the logging operation (1392–1405 ft bgs).
2. There are no clear indications that CdV-16-3(i) penetrates a fully water-saturated zone at the bottom of the borehole section that was logged (maximum depth of 1,405 ft bgs). The estimated pore volume water saturation computed from the integrated log analysis does not read consistently above 60% (% of pore volume occupied by water) anywhere below 900 ft. The rock formation in the interval 1214–1405 ft is very dense, having an estimated total porosity of 10% or less of total rock volume and water-filled porosity is very low – only approximately 5% of total rock volume. The interval 900–1214 ft has higher, much more variable, total porosity (mostly 15–50%) – as well as water-filled porosity (mostly 5–20%) – than the bottom section of the borehole, but an estimated water saturation of only 20–30%.
3. The processed logs do not indicate any significant fully water-saturated (perched) zones across the entire logged interval (13–1,405 ft). The estimated water saturation never reaches above 75% and mostly stays below 50%. The highest water content (44% of total rock volume), moveable water content (30% of total rock volume), and water saturation (72% of pore volume) occurs in the 894–900 ft depth interval.
4. The processed logs indicate a dense, low porosity silica-rich volcanic formation (likely lava flow(s)) exists across the interval 1,213–1,405 ft.
5. The processed logs indicate a highly altered, heterogeneous siliceous volcanic material (possibly a brecciated flow or rubble zone) exists across the interval 900–1,213 ft. The borehole condition is highly rugose and washed out across this interval and the estimated total porosity is highly variable (15–50%).
6. The geophysical log response in the zone 894–900 ft, overlying the likely siliceous volcanic flow material, is characteristic of the bottom of the Guaje Pumice Bed, with very high total porosity (48–61%) and the highest total and moveable water content in the borehole. The logs above 894 ft to the near the top of the log interval (13 ft) are characteristic of the Bandelier Tuff.
7. The processed logs indicate that varying amounts of clay are present in the following zones: 20–470 ft, 900–994 ft, and 1,135–1,405 ft.

Table 5.1-1 summarizes geophysical well logging conducted in CdV-16-3(i) by KA/LANL and Schlumberger. Schlumberger's report is presented in Appendix C along with the geophysical logs, compiled as a montage, (on the CD in Appendix C) of the final CdV-16-3(i) report.

Table 5.1-1
Borehole Logging Surveys Conducted in CdV-16-3(i)

Operator	Date	Method	Cased Footage (ft bgs)	Open-hole Interval (ft bgs)	Remarks
Schlumberger	January 16, 2004	Logging suite[a]	0-12	14-1,404[b]	Schlumberger borehole logging conducted prior to open-hole completion
KA/LANL	January 17, 2004	Video	0-12	12-1,385	Open-borehole video

[a] Schlumberger suite of borehole logging surveys included triple detector litho-density, array induction tool, epithermal compensated neutron tool, elemental capture spectroscopy, natural gamma spectroscopy, and combinable magnetic resonance.
[b] Variable effective depths, see Figure 3.0-1 and Appendix C

Kleinfelder-Supported Geophysical and Video Logging

On January 17, 2004, video logging was performed in the CdV-16-3(i) borehole using downhole tools provided by LANL. The video logs were used to identify possible evidence for perched-water zones and to aid in lithologic contact identification. No saturated zones were observed in the borehole, with the exception of fluid at the bottom of the hole. The video log of the open borehole was digitized onto a digital video disc (DVD) and is included as Appendix B.

6.0 LITHOLOGY

A preliminary assessment of the hydrogeologic features encountered during drilling operations at CdV-16-3(i) is presented below. Included are summary descriptions of geologic units identified during characterization of the cuttings samples. LANL EES-6 staff provided preliminary identification of geologic contacts. Groundwater occurrences are discussed based on drilling evidence, open-hole video logging, geophysical logging, and water-level measurements.

Stratigraphy and Lithologic Logging

Rock units and stratigraphic relations are interpreted from the visual examination of CdV-16-3(i) cuttings samples and preliminary interpretation of geophysical and video camera survey data. Units are briefly discussed in order of younger to older occurrence. The interpretations presented below are preliminary and may be revised upon future analysis of petrographic, geochemical, mineralogical, and geophysical logging data. A lithologic log for CdV-16-3(i) containing detailed descriptions that identify texture and composition of sample intervals is presented in Appendix D.

Tshirege Member of the Bandelier Tuff, Qbt (0 ft to 359 ft bgs)

Rhyolitic ash flows of the Tshirege Member of the Bandelier Tuff have been divided into four separate cooling units in the general region of the Pajarito Plateau (Broxton and Reneau, 1995). The drilled CdV-16-3(i) section from 0 ft to 359 ft bgs is interpreted to represent Units 1, 2, 3, and 4. Units 1 and 3 are further subdivided, as indicated below.

Unit 4 (Qbt 4) was intersected from 0 ft to 70 ft bgs. Cuttings indicated that Unit 4 is a crystal-rich tuff that is moderately welded. Samples in this interval contain widely varying amounts of three main constituents: welded tuff fragments, quartz and sanidine crystals, and intermediate volcanic lithics that include hornblende-dacite.

The interval from 70 ft to 207 ft bgs is subdivided into upper Unit 3t (Qbt 3t), a unit having chemical properties that are transitional between Qbt 3 and Qbt 4, middle Unit 3 (Qbt 3), and lower nonwelded Unit 3 nw (Qbt 3 nw). Qbt 3t was intersected in the CdV-16-3(i) borehole from 70 ft to 88 ft bgs. Subunits Qbt 3 and Qbt 3 nw occur from 88 ft to 162 ft bgs and from 162 ft to 207 ft bgs, respectively. All three subunits are composed of moderately welded to nonwelded crystal-rich tuff and appear to be mineralogically and texturally similar. The coarse-fraction (i.e., plus No. 10 sieved size) of most cuttings samples contains abundant welded crystal-rich tuff fragments (with the exception of Qbt 3 nw which contain less than 10% tuff fragments due to pulverization and loss of fine ash), generally 50% or more quartz and sanidine crystals, and minor lithics of intermediate volcanic composition.

Cuttings indicated that Unit 2 (Qbt 2), occurring in the section from 207 ft to 310 ft bgs, is a crystal-rich tuff that is moderately welded. Samples are generally made up of greater than 50% by volume crystal-rich tuff fragments, up to 50% quartz and sanidine crystals, and minor volcanic lithics of intermediate composition.

The basal cooling unit of the Tshirege Member is divided into upper devitrified (Qbt 1v) and lower glassy (Qbt 1g) subunits (Broxton and Reneau, 1995). The CdV-16-3(i) borehole intersected Unit 1v from 310 ft to 345 ft bgs. Samples of Qbt 1v are made up of welded tuff fragments, quartz and sanidine crystals, and intermediate volcanic lithic fragments that occur in widely varying abundances. Unit 1g occurs in the interval from 345 ft to 359 ft bgs. Cuttings from Unit 1g contain variable percentages of tuff fragments, white vitric pumices, quartz and sanidine crystals, and lithic fragments of intermediate volcanic composition.

Cerro Toledo Interval, Bandelier Tuff, Qct (359 ft to 430 ft bgs)

Volcaniclastic sedimentary and tephra deposits of the Cerro Toledo interval regionally separate the Tshirege and Otowi Members of the Bandelier Tuff. Preliminary interpretation of geophysical logs suggests that the Cerro Toledo interval occurs in borehole CdV-16-3(i) from 359 ft to 430 ft bgs.

Cuttings in the Qct interval indicate weakly cemented fine-grained deposits of silt, silty sand, and well-graded sand. The coarse fraction of most samples contains subangular to subrounded detrital constituents that generally include more than 50% intermediate to felsic volcanic lithics, up to 50% pumice, and up to 15% quartz and sanidine crystals. Varied lithic fragments commonly include dacite, hornblende-dacite, rhyolite, and vitrophyre. Pumices are generally vitric and white in color.

Otowi Member of the Bandelier Tuff, Qbo (430 ft to 894 ft bgs)

Rhyolitic ash-flow tuff representing the Otowi Member of the Bandelier Tuff was intersected in CDV-16-3(i) from 430 ft to 894 ft bgs. Cuttings from this interval indicated that the Otowi Member is lithic bearing, partly pumiceous, and weakly welded. The coarse fraction of most cuttings samples throughout the section is made up of varying amounts of pumice fragments (generally less than 50% by volume) and volcanic lithics that represent xenolithic inclusions.

Lithic constituents (up to 90% by volume due to pulverization and loss of fine ash) include porphyritic dacite, andesite, and vitrophyre. Pumice fragments are generally glassy, fibrous, and orange, white, or brown to gray in color. Fine-fraction (i.e., plus No. 35 sieved size) cuttings samples are made up dominantly of quartz and sanidine crystals with subordinate amounts of volcanic lithics and pumice.

Guaje Pumice Bed, Bandelier Tuff, Qbog (894 ft to 900 ft bgs)

The Guaje Pumice Bed is made up of air-fall tephra that regionally form a thin stratigraphic interval at the base of the Bandelier Tuff. The Guaje Pumice Bed was intersected in the CdV-16-3(i) borehole from 894 ft to 900 ft bgs. Unsieved whole rock cuttings samples from this interval contain up to 50% white vitric pumice fragments and subordinate abundances of intermediate volcanic lithics plus quartz and sanidine crystals.

Puye Formation, Tpf (900 ft to 995 ft bgs)

The Puye Formation intersected in CdV-16-3(i) is made up of volcaniclastic sand and gravel deposits occurring from 900 ft to 995 ft bgs. Cuttings indicated that this sedimentary section is made up of poorly cemented, fine to coarse detritus representing a range of intermediate to felsic volcanic lithologies. Volcanic constituents include hornblende-dacite, rhyodacite, andesite, vitrophyre, and minor local pumice. Sample chips are commonly subrounded and/or broken, indicating an abundance of gravel-size clasts consistently throughout the section.

Tschicoma Formation, Tt (995 ft to 1405 ft bgs)

Dacite lava flows and intercalated breccias of the Tschicoma Formation were intersected from 995 ft to the bottom of the CdV-16-3(i) borehole at 1405 ft bgs. The Tschicoma section is informally divided into upper and lower intervals based on evidence from video log survey information.

The upper Tt interval, from 995 ft to 1206 ft bgs, consists of a monolithologic breccia that is interpreted as a flow breccia of dacite composition. Drill cuttings from this interval contain gray and pink-colored porphyritic dacite with aphanitic groundmass that locally exhibits moderate hydrothermal alteration. Phenocrysts occupy as much as 20% by volume and include coarse, anhedral to resorbed plagioclase, euhedral hornblende, biotite, and minor pyroxene. Groundmass is commonly altered, bleached, and has a pitted or corroded appearance. Porphyritic dacite with glassy groundmass was noted in the interval from 1070 ft to 1130 ft bgs.

The lower Tt section, intersected from 1206 ft to 1405 ft bgs, consists of massive dacite lava that appears less hydrothermally altered than dacite in the upper part of the section. Cuttings in the interval are mostly monolithologic, consisting of coarsely porphyritic dacite with dark green pyoxene. Pyroxene, observed as individual stubby phenocrysts, in cumulophyric clusters, and as intergrowths with plagioclase, becomes more abundant and exceeds hornblende as the dominant accessory ferromagnesian constituent with depth. Aphanitic groundmass is generally fresh or weakly altered. Local sample intervals contain as much as 20% by volume rounded (i.e., milled during drilling) fragments of yellowish tan siltstone with dark-colored ferromagnesian sand grains. Because the video log shows no siltstone horizons, it is believed that these represent fracture fills or patchy interflow sediments.

Groundwater Occurrences and Characteristics

The Scope of Services required that perched groundwater zones be identified and sampled if encountered in the upper 900 ft of the stratigraphic section at CdV-16-3(i). Regional groundwater was anticipated to occur at a projected depth of approximately 1284 ft bgs.

Throughout the drilling of CdV-16-3(i), numerous attempts were made to measure DTW whenever drillers suspected water might have been encountered. DTW readings using an electric sounder were made on January 8, 2004, with the borehole advanced to 523 ft bgs, and again the following day with the borehole depth at 743 ft bgs; however, no water was present. Similarly, drillers stopped to measure DTW on January 11 and 12, 2004, when the borehole had been advanced to 995 and 1020 ft bgs, respectively. On these occasions also, electric sounder measurements indicated no accumulated water in the borehole. A water level reading again indicated no water present on January 13, 2004, with the borehole at a depth of 1163 ft bgs. Results of sampling and analysis for KBr in drilling fluids indicated no saturated zones down to 960 ft bgs. A comparison of the inflow KBr concentration and the KBr concentration in the cuttings fluid is shown in Figure 6.2-1. At 960 feet, the probe was inadvertently moved in and out of the output fluid and is depicted as continuous monitoring points on the figure. These data are not indicative of ground water in the borehole.

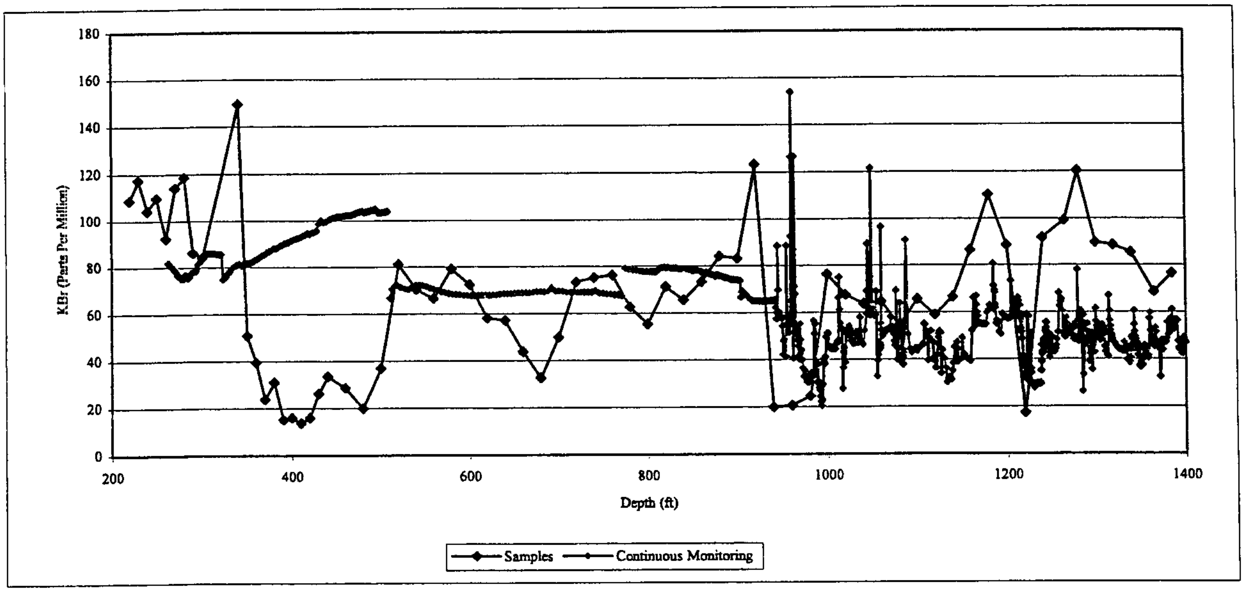


Figure 6.2-1. KBr Concentrations in Borehole at CdV-16-3(i)

On January 16, upon completion of CdV-16-3(i) drilling at a total depth of 1405 ft bgs, a DTW of 1400.5 ft bgs was measured and a 1-liter water sample collected. Also, on January 20, 2004, a second sample of borehole fluids was collected in an attempt to obtain a more representative sample of potential ground water. However, samples were determined by LANL to be introduced drilling fluid and one sample was analyzed for inorganic content (refer to Section 4.2). A video camera survey conducted on January 17, 2004 (refer to Section 5.2), showed no evidence of groundwater saturation either as a perched zone or the regional aquifer.

On January 20 and January 22, 2004, depth to water was measured at 1,376.5 ft bgs and 1,367 ft bgs, respectively. On March 12 and March 26, 2004, depth to water was measured at 1,350.52 ft bgs and 1,350.50 ft bgs, respectively. Total depth of the borehole was again measured on March

26, 2004 at 1391.5 ft bgs. On April 13 and April 23, depth to water was measured at 1,350.56 and 1,350.51, respectively. Depth to water measurements will continue on a bi-monthly schedule for the purpose of gathering information to support a final well completion decision and to monitor for changes in the observed water level in the borehole. This information will be used to help support a final decision on whether to complete the borehole as a well. It should be noted that the depth to water observed in CdV-16-3(i) is at a similar elevation to the static water level observed (1196.7 ft bgs) in the nearby well CdV-R-37-2, which is considered to be representative of the regional zone of saturation.

Detailed results of geophysical logging relating to water occurrence and logs for all Schlumberger surveys are presented in Appendix C. Electronic copies of logging files are stored on the CD attached to the back cover of this report.

7.0 COMPLETION ACTIVITIES

Well screen and casing was not installed in CdV-16-3(i) due to the apparent absence of groundwater. The NMED approved an open-hole completion for CdV-16-3(i) to allow continued observations for the presence of water. Figure 7.0-1 is a schematic diagram of the current CdV-16-3(i) borehole.

Wellhead Completion

The surface completion for CdV-16-3(i) was finished on January 23, 2004 and involved placing a reinforced (2,500 psi) concrete pad, 3-ft by 3-ft by 6-in. thick, around the 13-3/8" conductor casing. A mag nail was placed in the northwest corner of the pad for surveying purposes. A flush-mount screw-in cap was mounted in the conductor casing. This cap is equipped with two holes to allow the well to breathe. The surrounding base course was sloped away from the pad to allow for drainage.

Geodetic Survey

On March 29, 2004, Lynn Engineering and Surveying, Inc. determined the location of Well CdV-16-3(i) using a Leica TCR303 electronic total station. Coordinates and elevations were obtained from a mag nail placed in the concrete pad and the steel cover plate using a Static Global Positioning System (GPS). The coordinates shown are in New Mexico State Plane Grid Coordinates, Central Zone (North American Datum, 1983 [NAD 83]), expressed in feet. Elevation is expressed in ft amsl relative to the National Geodetic Vertical Datum of 1929 (NGVD 29). The original geodetic survey is on file in the KA Albuquerque office.

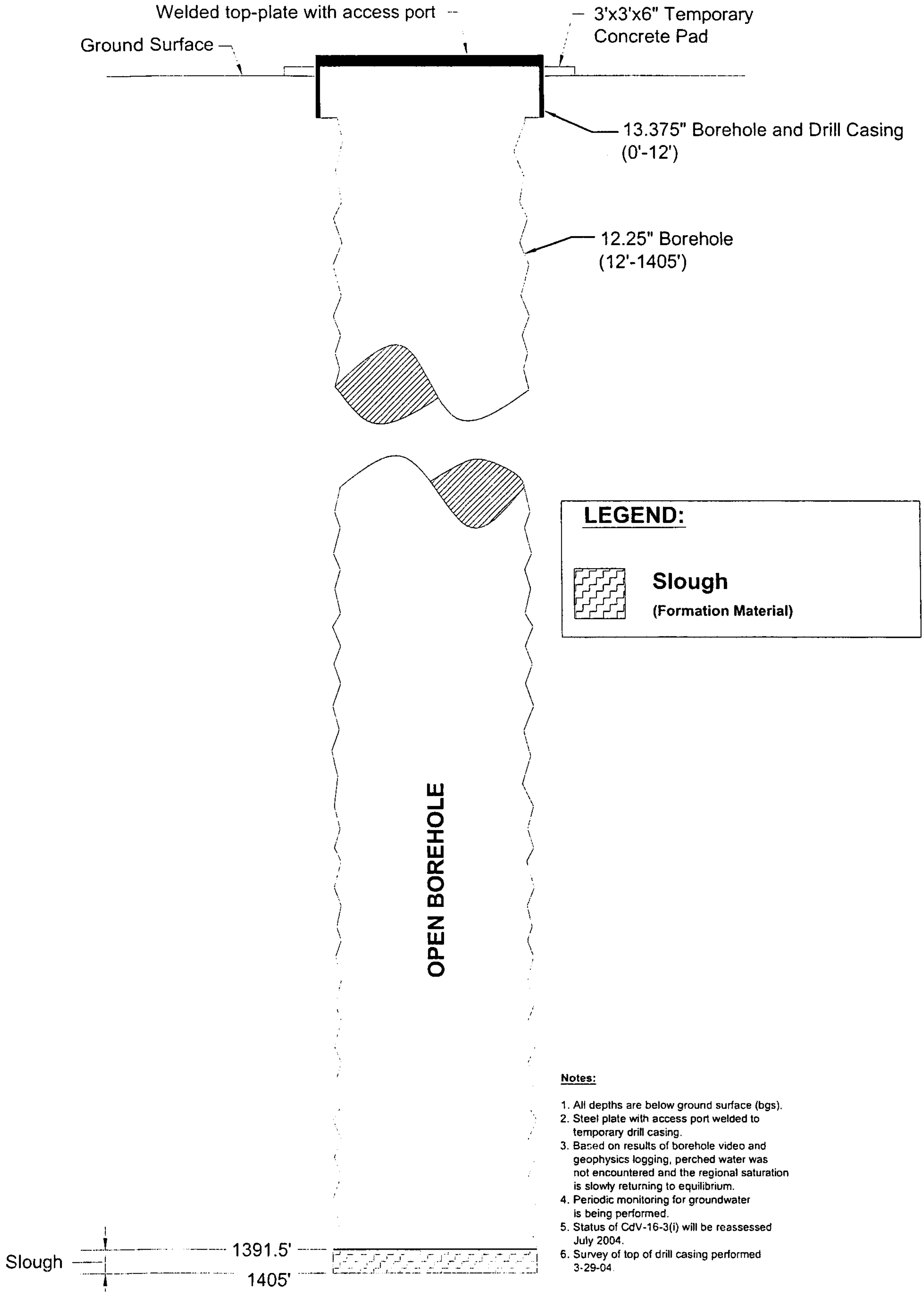
Table 7.2-1
Geodetic Data for CdV-16-3(i)

Description	Northing	Easting	Elevation [a]
Mag Nail in CdV-16-3(i) Pad	1762434.9	1615980.5	7486.40
Top of Steel Cover	1762434.52	1615981.6	7486.80

[a] Measured in ft amsl relative to the National Geodetic Vertical Datum of 1929.

Site Restoration

Fluids and cuttings produced during drilling and development were sampled in accordance with the Notice of Intent (NOI) to Discharge, Hydrogeologic Workplan Wells, and filed with the



Notes:

1. All depths are below ground surface (bgs).
2. Steel plate with access port welded to temporary drill casing.
3. Based on results of borehole video and geophysics logging, perched water was not encountered and the regional saturation is slowly returning to equilibrium.
4. Periodic monitoring for groundwater is being performed.
5. Status of CdV-16-3(i) will be reassessed July 2004.
6. Survey of top of drill casing performed 3-29-04.

KLEINFELDER

Drawn By: C. London	Date: April 2004
Project No.: 37151	Filename: Figure 7.2-1
Scale: Not-To-Scale	Revision: 0
Reviewed By: F. Schelby	Approved By: B. Bockisch

Schematic Diagram of Borehole CdV-16-3(i)
Los Alamos National Laboratory
Los Alamos, New Mexico

FIGURE **7.0-1**

NMED. Approval to discharge drilling and development water was received via e-mail from the NMED on March 18, 2004. A copy of the NMED discharge approval is included in Appendix E; and the sample analysis is included on the CD attached to the back of this report. Silt fencing and straw bales have been left in place to minimize possible sediment impacts from future precipitation.

Site restoration activities began in April 2004. These activities include: (1) removal and land application of water from the borehole-cuttings containment area, (2) removal of the polyethylene liner and borehole cuttings from the borehole-cuttings containment, (3) removal of containment area berms, and (4) backfilling and grading the containment area. The imported fill, used to build up the berm for the containment area during site preparation, was hauled away and stored off-site for re-use at other sites. The cuttings will be managed in accordance with the DOE-NMED letter, which states that the cuttings will be used to backfill the cuttings pit after the liner is removed. Site re-seeding will be performed in the Spring of 2004.

8.0 DEVIATIONS FROM THE CDV-16-3(i) SCOPE OF SERVICES

Appendix F compares the actual characterization activities performed at CdV-16-3(i) with the planned activities described in the "Addendum to Corrective Measures Study (CMS) Plan for Potential Release Site (PRS) 16-021(c) Revision 1 (LA-UR-02-7366, 2003)" and the Scope of Services. For the most part, drilling, and sampling at CdV-16-3(i) was performed as specified in the Scope. The main deviations from planned activities are summarized as follows:

- Planned borehole depth – the Scope anticipated that the deep borehole would be drilled to a TD of 900 ft bgs, approximately 50 ft below the estimated depth of perched saturation, projected to occur at 850 ft bgs. If no perched zone was encountered, the borehole could be advanced to 1284 ft bgs, into the regional aquifer. The completed CdV-16-3(i) borehole was drilled to 1405 ft bgs TD, about 121 ft below the predicted depth of the regional water table at 1284 ft bgs.
- Water Sample Field Measurements - Carbonate alkalinity, pH, specific conductance, temperature, and turbidity were specified in the Scope of Services. No field quality measurements were collected.
- Well Installation – A well was planned for CdV-16-3(i); however, saturated zones producing sufficient quantities to support a decision to install well screens have not been identified to date.
- Hydraulic Testing – Injection straddle packer tests were required for all screens below the regional water table. No well has been installed and no hydraulic testing was performed.

9.0 ACKNOWLEDGEMENTS

E. Tow, P. Schuh, and R. Lawrence of Tetra Tech EM, Inc., Albuquerque, NM, contributed to the preparation of this report.

EnviroWorks, Inc provided site preparation and restoration activities.

Lynn Engineering & Surveying, Inc. provided the final geodetic survey of the borehole location.

N. Clayton of Schlumberger provided processing and interpretation of borehole geophysical data.

Tetra Tech EM, Inc. provided support for well site geology, sample collection, and hydrologic testing.

WDC Exploration & Wells provided rotary drilling services.

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Appendix A

Groundwater Analytical Results

SAMPLING AND ANALYSIS OF DRILL CORE AND GROUNDWATER AT CDV-16-3(i) INTERMEDIATE WELL

During drilling operations at borehole CdV-16-3(i), alluvial groundwater and perched groundwater within the upper saturated zone were not encountered. Drilling fluid accumulated in the borehole and groundwater was not present in significant quantities, based on visual and olfactory observations. The foam-rich fluid was analyzed for inorganic constituents and results are provided in Table A.1-1.

Core samples were not collected from the alluvium and Tshirege Member of the Bandelier Tuff at CdV-16-3(i) because a corehole was not advanced.

GEOCHEMISTRY OF SAMPLED WATERS FROM WELL CDV-16-3(i)

On January 20, 2004, a fluid sample was collected from a depth of 1385-1388 ft bgs from the open borehole using a bailer. Analytical results for this groundwater sample are provided in Table A.1-1. Aliquots of the samples were filtered through a 0.45-μm Gelman filter. Samples were acidified with analytical-grade HNO_3 to a pH of 2.0 or less for metal and major cation analyses at EES-6. Alkalinity was determined at EES-6 using standard titration techniques.

The fluid sample was analyzed by EES-6 using techniques specified in the US Environmental Protection Agency (EPA) SW-846 manual. Ion chromatography (IC) was the analytical method for bromide, chloride, fluoride, nitrate, nitrite, oxalate, perchlorate, phosphate, and sulfate. The method detection limit (MDL) for perchlorate using IC is 0.002 ppm or mg/L (2 ppb or 2 μg/L). Inductively coupled (argon) plasma emission spectroscopy (ICPES) was used for calcium, magnesium, potassium, silica, and sodium. Aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, silver, thallium, vanadium, uranium, and zinc were analyzed by inductively coupled (argon) plasma mass spectrometry (ICPMS). The precision limits (analytical error) for major ions and trace elements were generally less than ±10% using ICPES and ICPMS.

Table A.1-1
Hydrochemistry of Fluid Sample Collected at Borehole CdV-16-3(i) (filtered sample)

Depth (ft)	**1385-1388**
Geologic Unit	**Tschicoma Massive Lava**
Date Sampled	**01/20/04**
pH (Lab)	6.61
Temperature (°C)	Not reported
Specific Conductance (μS/cm)	Not reported
Turbidity (NTU)	Not reported
Alkalinity (ppm $CaCO_3$/L)	58.9
Al (ppm)	6.78
Sb (ppm)	[0.001], U
As (ppm)	0.0103
B (ppm)	0.021
Ba (ppm)	0.081

Be (ppm)	[0.001], U
HCO_3 (ppm)	71.9
Br (ppm)	13.6
Cd (ppm)	[0.001], U
Ca (ppm)	24.7
Cl (ppm)	7.98
ClO_4 (ppm) (IC)	[0.002], U
Cr (ppm)	0.0036
Co (ppm)	0.005
Cu (ppm)	0.0079
F (ppm)	0.13
Fe (ppm)	2.32
Pb (ppm)	0.0015
Mg (ppm)	7.31
Mn (ppm)	0.15
Hg (ppm)	0.00059
Mo (ppm)	0.020
Ni (ppm)	0.0051
NO_3 (ppm) (as N)	0.01
NO_2 (ppm) (as N)	0.10
C_2O_4 (ppm) (oxalate)	0.18
PO_4 (ppm) (as P)	[0.01], U
K (ppm)	5.91
Se (ppm)	[0.001], U
Ag (ppm)	[0.0002], U
Na (ppm)	15.7
SiO_2 (ppm)	78.3
Sr (ppm)	0.17
SO_4 (ppm)	24.1
Tl (ppm)	[0.001], U
U (ppm)	0.0007
V (ppm)	0.007
Zn (ppm)	0.24
TDS (calculated)	261

Note: U = not detected. Silica concentrations were calculated from measured silicon (ICPES). Bicarbonate concentrations were calculated from measured alkalinity. TDS = total dissolved solids.

Appendix B

Borehole Video
(DVDs included)

Appendix C

Schlumberger Geophysical Report and Montages
(CD included)

TABLE OF CONTENTS

1.0 SUMMARY

This report describes the borehole geophysical logging measurements acquired in characterization well CdV-16-3(i) by Schlumberger, logged in January 2004 prior to well completion. The report (1) summarizes the technology, measurements, and procedures employed, and (2) presents the processed results from these measurements and discusses their interpretation. The logging suite was acquired from 7 ft to 1,405 ft bgs, when the borehole was open below 14 ft, drilled with 12.25 in diameter bit size, and contained 13.375 in outer diameter freestanding steel casing above 14 ft.

The primary purpose of the geophysical logging was to characterize the geologic/hydrogeologic section intersected by the well with emphasis on determining regional aquifer groundwater level, perched groundwater zones, moisture content, capacity for flow, and the stratigraphy/mineralogy of geologic units. A secondary purpose of the geophysical logging was to evaluate the borehole conditions such as borehole diameter versus depth and degree of drilling fluid invasion. These objectives were accomplished by measuring, nearly continuously, along the length of the well: (1) total and effective water-filled porosity and pore size distribution, from which an estimate of effective water hydraulic conductivity is made, (2) bulk density (sensitive to total water- plus air-filled porosity), (3) bulk electrical resistivity at multiple depths of investigation, (4) bulk concentrations of a number of important mineral-forming elements, (5) spectral natural gamma ray, including potassium, thorium, and uranium concentrations, and (6) borehole diameter.

Preliminary results of these measurements were generated in the logging truck at the time the geophysical services were performed and are documented in field logs provided on-site. However, the measurements presented in the field results are not fully corrected for borehole conditions and are provided as separate, individual logs. The field results were reprocessed by Schlumberger to (1) correct/improve the measurements, as best as possible, for borehole/formation environmental conditions, (2) perform an integrated analysis of the log measurements so that they are all coherent, and (3) combine the logs in a single presentation, enabling integrated interpretation. The reprocessed log results provide better quantitative property estimates that are consistent for all applicable measurements, as well as estimates of properties that otherwise could not be reliably estimated from the single measurements alone (e.g. total porosity inclusive of all water and air present, water saturation, mineralogy).

The geophysical log measurements from Well CdV-16-3(i) provide good quality results that are consistent with each other through most of the borehole. The quality of some measurements was degraded across intervals where the borehole contains large washouts and/or rugose hole. The measurements most affected by the adverse borehole conditions were ones that have a shallow depth of investigation and require close contact to the borehole wall—the bulk density, photoelectric effect, and the porosity measurements. The greatest impact on the log processing was erroneously high estimated porosity in the problem zones. Through the integrated analysis and interpretation of all the logs, the individual shortcomings of the specific measurements are reduced. Thus, the integrated log analysis results (e.g. the optimized water-filled porosity log) are the most robust single representation of the geophysical log results—providing a wealth of valuable high resolution information on the geologic and hydrogeologic environment of the CdV-16-3(i) locale.

Important results from the processed geophysical logs in CdV-16-3(i) include the following:

1 No substantial standing was present at the time of the January 16, 2004 logging – although several logs indicate there may have been a little bit of fluid (possibly just accumulated water from the drilling foam used) at the very bottom of the borehole that was rising during the logging operation (1392–1405 ft bgs).

2 There are no clear indications that CdV-16-3(i) penetrates a fully water-saturated zone at the bottom of the borehole section that was logged (maximum depth of 1,405 ft bgs). The estimated pore volume water saturation computed from the integrated log analysis does not read consistently above 60% (% of pore volume occupied by water) anywhere below 900 ft. The rock formation in the interval 1214–1405 ft is very dense, having an estimated total porosity of 10% or less of total rock volume and water-filled porosity is very low – only approximately 5% of total rock volume. The interval 900–1214 ft has higher, much more variable, total porosity (mostly 15–50%) – as well as water-filled porosity (mostly 5–20%) – than the bottom section of the borehole, but an estimated water saturation of only 20–30%.

3 The processed logs do not indicate any significant fully water saturated (perched) zones across the entire logged interval (13–1,405 ft). The estimated water saturation never reaches above 75% and mostly stays below 50%. The highest water content (44% of total rock volume), moveable water content (30% of total rock volume), and water saturation (72% of pore volume) occurs in the 894–900 ft depth interval.

4 The processed logs indicate a dense, low porosity silica-rich volcanic formation (likely lava flow(s)) exists across the interval 1,213–1,405 ft.

5 The processed logs indicate a highly altered, heterogeneous siliceous volcanic material (possibly a brecciated flow or rubble zone) exists across the interval 900–1,213 ft. The borehole condition is highly rugose and washed out across this interval and the estimated total porosity is highly variable (15–50%).

6 The geophysical log response in the zone 894–900 ft, overlying the likely siliceous volcanic flow material, is characteristic of the bottom of the Guaje Pumice Bed, with very high total porosity (48–61%) and the highest total and moveable water content in the borehole. The logs above 894 ft to the near the top of the log interval (13 ft) are characteristic of the Bandelier Tuff.

7 The processed logs indicate that varying amounts of clay are present in the following zones: 20–470 ft, 900–994 ft, and 1,135–1,405 ft.

2.0 INTRODUCTION

Geophysical logging services were performed in characterization well CdV-16-3(i) by Schlumberger in January 2004, prior to initial well completion. The purpose of these services was to acquire in situ measurements that help characterize the borehole, near-borehole, and abutting geologic formation environment. The primary objective of the geophysical logging was to provide in situ evaluation of formation properties (hydrogeology and geology) intersected by the well. This information was (and is) used by scientists, engineers, and project managers in the

Los Alamos Characterization and Monitoring Well Project to design the well completion, better understand subsurface site conditions, and assist in overall decision-making.

The primary geophysical logging services performed by Schlumberger in well CdV-16-3(i) were the:

- Combinable Magnetic Resonance (CMR*) tool to measure the nuclear magnetic resonance response of the formation, which is used to evaluate total and effective water-filled porosity of the shallow formation and to estimate pore size distribution and in-situ hydraulic conductivity;
- Compensated Neutron Tool (CNT*) to measure volumetric water content of the formation, which is used to evaluate moist/porous zones;
- Triple detector Litho-Density (TLD*) tool to measure formation bulk density and photoelectric factor, which are used to estimate total porosity and lithology;
- Array Induction Tool, (AIT*) to measure formation electrical resistivity at five depths of investigation and borehole fluid resistivity, which is used to evaluate drilling fluid invasion into the formation (an indicator of relative permeability and water saturation), presence of moist zones far from the borehole wall, and presence of clay-rich zones;
- Natural Gamma Spectroscopy (NGS) tool to measure gross natural gamma and spectral natural gamma ray activity, including potassium, thorium, and uranium concentrations, which is used to evaluate geology/lithology, particularly the amount of clay and potassium-bearing minerals;
- Elemental Capture Spectroscopy (ECS*) tool to measure elemental weight percent concentrations of a number of elements – used to characterize mineralogy and lithology of the formation

In addition, calibrated gross gamma ray (GR) was recorded with every service except the NGS, for the purpose of depth matching the logging runs to each other. Table 2.1 summarizes the geophysical logging runs performed in CdV-16-3(i).

Table 2.1
Geophysical logging services, their combined tool runs and intervals logged, as performed by Schlumberger in borehole CdV-16-3(i)

Date of Logging	Borehole Status	Run #	Tool 1	Tool 2	Tool 3	Depth Interval (ft)
16-Jan-2004	Open hole below 14 ft. Bit size of 12.25 in. Steel casing above 14 ft. Casing OD of 13.375 in.	1	TLD	CNT	GR	10–1,405 ft
Same	Same	2	AITH	NGS		12–1,405 ft
Same	Same	3	ECS	CMR	GR	34–1,405 ft

A description of these geophysical logging tools can be found on the Schlumberger website (http://www.hub.slb.com/index.cfm?id=id11618).

*Mark of Schlumberger

3.0 METHODOLOGY

This section describes the methods employed by Schlumberger for performed geophysical logging services in Well CdV-16-3(i), including the following stages/tasks:

- Measurement acquisition at the well site
- Quality assessment of logs
- Reprocessing of field data

3.1 Acquisition Procedure

Once the well drilling project team notified Schlumberger that CdV-16-3(i) was ready for geophysical well logging, the Schlumberger district in Farmington, NM, mobilized a wireline logging truck, the appropriate wireline logging tools and associated equipment, and crew to the job site. Upon arriving at the LANL site, the crew completed site entry paperwork and received a site-specific safety briefing.

After arriving at the well site, the crew proceeded to rig up the wireline logging system, including:

- Parking and stabilizing the logging truck in a position relative to the borehole that is best for performing the surveys;
- Setting up a lower and an upper sheave wheel (the latter attached to, and hanging above, the borehole from the drilling rig/mast truck);
- Threading the wireline cable through the sheaves; and
- Attaching the appropriate sonde(s) for the first run to the end of the cable.

Next, pre-logging checks and any required calibrations were performed on the logging sondes and the tool string was lowered into the borehole. If any of the tools required active radioactive sources (in this case a neutron and gamma source for the CNT/ECS and TLD, respectively), just prior to lowering the tool string the sources were taken out of their carrying shields and placed in the appropriate tool source-holding locations using special source handling tools. The tool string was lowered to the bottom of the borehole and brought up at the appropriate logging speed as measurements were made. At least two logging runs (one main and one repeat) were made with each tool string.

Upon reaching the surface any radioactive sources were removed from the tools and returned to their appropriate storage shields, thus eliminating any radiation hazards. Any post-logging measurement checks were performed as part of log quality control and assurance. The tool string was cleaned as it was pulled out of the hole, separated, and disconnected.

The second tool string was attached to the cable for another logging run, followed by subsequent tool strings and logging runs. After the final logging run was completed the cable and sheave wheels were rigged down.

Before departure, the logging engineer printed field logs for on site distribution and sent the data via satellite to the Schlumberger data archiving center. The Schlumberger data processing center was alerted that the data were ready for post-acquisition processing.

3.2 Log Quality Control and Assessment

Schlumberger has a thorough set of procedures and protocols for ensuring that the geophysical logging measurements are of very high quality. This includes full calibration of tools when they are first built, regular recalibrations and tool measurement/maintenance checks, and real-time monitoring of log quality as measurements are made. Indeed, one of the primary responsibilities of the logging engineer is to ensure, before and during acquisition, that the log measurements meet prescribed quality criteria.

A tool specific base calibration that directly relates the tool response to the physical measurement using the designed measurement principle is performed on all Schlumberger logging tools when first assembled in the engineering production centers. This is accomplished through a combination of computer modeling and controlled measurements in calibration models with known physical parameters.

The base calibration is augmented through regular "master calibrations" for most Schlumberger tools – typically performed every one to six months in local Schlumberger shops (such as Farmington, NM), depending on tool design. Master calibrations consist of controlled measurements using specially designed calibration tanks/jigs and internal calibration devices that are built into the tools. The measurements are used to fine-tune the tool's calibration parameters and to verify that the measurements are valid.

In addition, on every logging job, on-site before and after "calibrations" are executed for most Schlumberger tools directly before/after lowering/removing the tool string from the borehole. For most tools these represent a measurement verification instead of an actual calibration – used to confirm the validity of the measurements directly before acquisition and to ensure that they have not drifted or been corrupted during the logging job.

All Schlumberger logging measurements have a number of associated depth-dependent quality control (QC) logs and flags to assist with identifying and determining the magnitude of log quality problems. These QC logs are monitored in real-time by the logging engineer during acquisition and are used in the post-acquisition processing of the logs to determine the best processing approach for optimizing the overall validity of the property estimates derived from the logs.

Additional information on specific tool calibration procedures can be found on the Schlumberger web page (http://www.hub.slb.com/index.cfm?id=id11618).

3.3 Processing Procedure

After the geophysical logging job was completed in the field and the data archived, the data were downloaded to the Schlumberger processing center. There the data were processed, in the order below, to (1) correct the measurements for near-wellbore environmental conditions and redo the raw measurement field processing for certain tools using better processing algorithms, (2) depth match the log curves from different logging runs, and (3) model the near-wellbore substrate lithology/mineralogy and pore fluids through integrated log analysis. Separately, the FMI electrical image was processed to produce scaled and normalized high-resolution images that were interpreted to identify geologic features and compute fracture apertures. Afterwards an integrated log montage was built to combine and compile all the processed log results.

Environmental Corrections and Raw Measurement Reprocessing

If required, the field log measurements were processed to correct for conditions in the well, including fluid type (drilling mud or air) and (to a much lesser extent) pressure, temperature, and water salinity. Basically these environmental corrections entail subtracting from the measurement response the known influences of the set of prescribed borehole conditions. In CdV-16-3(i) the log measurements requiring these corrections are the CNT porosity and NGS spectral gamma ray logs.

Two CNT neutron porosity measurements are available – one that measures thermal ("slow") neutrons and one that measures epithermal ("fast") neutrons. Measurement of epithermal neutrons is required to make neutron porosity measurements in air-filled hole. Only the epithermal neutron porosity measurement was made in CdV-16-3(i) since the borehole was entirely air-filled. Epithermal neutron porosity was processed at the field site for borehole fluid type (air) and other environmental conditions, and didn't require any further processing. For further processing and analysis (e.g. ELAN analysis) the field processed epithermal neutron porosity log was used.

The raw ECS elemental yield measurements include the contribution of hydrogen from fluid in the borehole. The processing consists of subtracting this unwanted contribution from the raw normalized yields, then performing the normal elemental yields-to-weight fraction processing. The contribution to subtract is a constant baseline amount (or zoned constant values if there are bit/casing size changes), usually determined by comparing the normalized raw yields in zones directly below/above the borehole fluid change. Information from the driller and the results from the neutron porosity and borehole fluid resistivity logs indicate no apparent water in CdV-16-3(i). However, the raw ECS logs exhibit a significant increase in hydrogen content at the bottom of the borehole – 1392 ft to the bottom of the log (1405 ft). The increased hydrogen reading could result from the accumulation at the bottom of the borehole of foam/mist used in drilling, possibly with the addition of small amounts of water seeping into the borehole. (The ECS was part of the last logging suite run.) This apparent borehole contribution to the ECS hydrogen log response below 1392 ft was corrected for by applying a baseline borehole hydrogen correction determined from the difference between the hydrogen yield above and below this depth. No correction was applied above this depth.

The NGS spectral gamma ray are affected by the material (fluid, air, casing) in the borehole because different types and amounts of these materials have different gamma ray shielding properties; the NGS measures incoming gamma rays emitted by radioactive elements in the formation surrounding the borehole. The processing algorithms try to correct for the damping influence of the borehole material. The NGS logs from CdV-16-3(i) were reprocessed to fully account for the environmental effects of the borehole fluid (air) and hole size.

The measurements cannot be fully corrected for borehole washouts or rugosity since the specific characteristics of these features (e.g., geometry) are unknown and their effects on the measurements often too significant to account for. Thus, the compromising effects of these conditions on the measurements, especially borehole washouts, should be accounted for in the interpretation of the log results.

Depth-Matching

Once the logs were environmentally corrected for the conditions in the borehole and the raw measurement reprocessing was completed, the logs from different tool runs were depth-matched to each other using the AIT-NGS tool run as the base reference. Gamma ray was used as the common correlation log measurement for depth-matching the different runs.

Integrated Log Analysis

An integrated log analysis, using as many of the processed logs as possible, was performed to model the near-wellbore substrate lithology/mineralogy and pore fluids. This analysis was performed using the Elemental Log Analysis (ELAN*) program (Mayer and Sibbit, 1980; Quieren et al, 1986) – a petrophysical interpretation program designed for depth-by-depth quantitative formation evaluation from borehole geophysical logs. ELAN estimates the volumetric fractions of user-defined rock matrix and pore constituents at each depth based on the known log measurement responses to each individual constituent by itself[1]. ELAN requires an a priori specification of the volume components present within the formation—fluids, minerals, and rocks. For each component, the relevant response parameters for each measurement are also required. For example, if one assumes that quartz is a volume component within the formation and the bulk density tool is used, then the bulk density parameter for this mineral is well known to be 2.65 g/cc.

The logging tool measurements, volume components, and measurement response parameters used in the ELAN analysis for CdV-16-3(i) are provided in Table 3.1. The final results of the analysis – an optimized mineral-fluid volume model – are shown on the integrated log montage (see CD attached to back of this report), 3rd track from the right (inclusive of the depth track). To make best use of all the measurement data and to perform the analysis across as much of the well interval as possible (13–1405 ft), as many as possible of the processed logs were included in the analysis, with less weighting applied to less robust logs. Not all the tool measurements shown in Table 3.1 are used for the entire interval analyzed, as not all the measurements are available, or of good quality, across certain sections of the borehole. To accommodate fewer tool measurements certain model constituents are removed from the analysis in some intervals. Most notably, at the top of the log interval (above 35 ft) a number of the minerals, and capillary bound water, had to be removed from the model due to the absence of many of the logs.

The ELAN analysis was performed with as few constraints or prior assumptions as possible. A considerable effort was made to choose a set of minerals or mineral types for the model that is representative of Los Alamos area geology and it's volcanic origins. For the ELAN analysis, the log interval above 900 ft was assumed to be within the Bandelier Tuff and a mineral suite considered representative of this volcanic tuff was used (primary "minerals" silica glass, quartz, sanidine, and montmorillinite with accessory minerals augite, calcite, and pyrite). In addition, the results of laboratory analyses of Bandelier Tuff core samples from around the LANL site were used to constrain the proportion of quartz versus glass in the ELAN analysis (as well as to

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*Mark of Schlumberger

[1]Mathematically this corresponds to an inverse problem – solving for constituent volume fractions from an (over)determined system of equations relating the measured log results to combinations of the tool measurement response to individual constituents

determine the representative primary mineral suites). No assumptions about formation type were made for the log interval below 900 ft and, thus, a wide range of possible minerals were included – reflective of the area's volcanism.

No prior assumption is made about water saturation—where the boundary between saturated and unsaturated zones lies (e.g. the depth to the top of the regional aquifer or perched zones). Thus, the presence and amount of air in the pore space is unconstrained. Total porosity and water-filled porosity are also left unconstrained throughout the analysis interval. Thus, interpretations should be made from the ELAN results with the understanding that the mineral-fluid model represents a mathematically optimized solution that is not necessarily a physically accurate representation of the native geologic formation. Within this context, the ELAN model is a robust estimate of the bulk mineral-fluid composition that accounts for the combined response from all the geophysical measurements.

Table 3.1
Tool measurements, volumes, and respective parameters used in the CdV-16-3(i) ELAN analysis.

Volume / Tool Measurement	Air	Capillary Bound Water	Water	Hornblende	Hypersthene	Labradorite	Silica Glass	Heavy Mafic Minerals	Augite	Montmorillinite	Pyrite	Orthoclase / Sanidine	Calcite	Quartz
Bulk density (g/cc)	-0.19	1.00	1.00	3.11	3.55	2.65	2.33	4.0	3.08	2.1	4.99	2.58 2.56		2.64
Epithermal neutron porosity (ft^3/ft^3)	0.0	1.00	1.00	0.05	0.01	-0.01	0.0	0.02	-0.01	0.6	0.17	-0.01	0.0	-0.048
Volumetric photoelectric effect	0	0	0.40	12	20.2	7	4.2	65	23.8	4.4	82.1	7.3 7.0	14.1	4.8
Total CMR water-filled porosity (ft^3/ft^3)	0	1.0	1.0	0	0	0	0	0	0	0.425	0	0	0	0
CMR bound fluid volume (ft^3/ft^3)	0	1.0	0	0	0	0	0	0	0	0.425	0	0	0	0
Resistivity (ohm-m)	Very high	36	36	Very high	Very high	Very high	Very high	Very high	Very high	1.41	Very high	Very high	Very high	Very high
Dry weight silicon (lbf / lbf)	0.0	0.0	0.0	0.21	0.24	0.24	0.47	0.18	0.23	0.26	0	0.3 0.38	0	0.47
Dry weight calcium (lbf / lbf)	0.0	0.0	0.0	0.09	0.0	0.09	0.0	0.0	0.10	0.01	0.0	0.0	0.405	0.0
Dry weight iron (lbf / lbf)	0.0	0.0	0.0	0.08	0.20	0.02	0.0	0.22	0.11	0.04	0.47	0.02	0.0	0.0
Dry weight sulfur (lbf / lbf)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.53	0.0	0.0	0.0
Dry weight titanium (lbf / lbf)	0.0	0.0	0.0	0.005	0.01	0.0	0.0	0.0	0.048	0.0	0.0	0.0	0.0	0.0
Dry weight aluminum (lbf / lbf)	0.0	0.0	0.0	0.07	0.0	0.16	0.0	0.0	0.02	0.11	0.0	0.10	0.0	0.0
Wet weight potassium (lbf / lbf)	0.0	0.0	0.0	0.01	0.0	0.0	0.0	0.0	0.003	0.005	0.0	0.102	0.0	0.0
Weight hydrogen (lbf / lbf)	0.0	0.11	0.11	0.0	0.0	0.0	0.01	0.0	0.0	0.025	0.0	0.0	0.0	0.0
Wet weight thorium (ppm)	0.0	0.0	0.0	50	25	3	2	4	20	24	0	5.5	0.0	2
Clay bound water volume (ft^3/ft^3)	0	0	0	0	0	0	0	0	0	0.425	0	0		0
Magnetic mineral indicator (mT)	0	0	0	0	0	0	0	2	0	0	0.5	0		0

4.0 RESULTS

Preliminary results from the wireline geophysical logging measurements acquired by Schlumberger in CdV-16-3(i) were generated in the logging truck at the time the geophysical services were performed and are documented in field logs provided on-site. However, the measurements presented in the field results are not fully corrected for undesirable (from a measurement standpoint) borehole and geologic conditions and are provided as separate, individual logs. The field log results have been processed (1) to correct/improve the measurements, as best as possible, for borehole/formation environmental conditions and (2) to depth-match the logs from different tool runs in the well. Additional logs were generated from integrated analysis of processed measured logs, providing valuable estimates of key geologic and hydrologic properties.

The processed log results are presented as continuous curves of the processed measurement versus depth and are displayed as (1) one page, compressed summary log displays for selected directly related sets of measurements (see Figures 4.1, 4.2, and 4.3) and (2) an integrated log montage that contains all the key processed log curves, on depth and side by side (see CD). The summary log displays address specific characterization needs, such as moisture content, water saturation, and lithologic changes. The purpose of the integrated log montage is to present, side by side, all the most salient reprocessed logs and log-derived models, depth-matched to each other, so that correlations and relationships between the logs can be identified.

Important results from the processed geophysical logs in CdV-16-3(i) are described below.

Well Water Level

The geophysical logs indicate no substantial standing water in CdV-16-3(i) at the time of the January 16, 2004 logging – although several logs suggest there may have been a little bit of fluid (possibly just accumulated drilling foam) at the very bottom of the borehole. The borehole fluid resistivity log (measured by the AIT tool) seems to indicate fluid with a resistivity of 33 ohm-m (typical of standing water in other LANL monitoring wells) below 1405 ft. The uncorrected ECS hydrogen content log, acquired after the borehole fluid resistivity log, indicates a sharp increase in hydrogen content below 1392 ft – likely associated with water-based fluid in the borehole. It is possible the borehole was very slowly filling with fluid over the course of the logging, although the fluid could just be water derived from the drilling process (e.g. from the breakdown of drilling foam/mist).

Regional Aquifer

There are no clear indications, solely from the processed geophysical log results, that CdV-16-3(i) penetrates a fully water-saturated zone at the bottom of the primary log interval (1405 ft). The estimated pore volume water saturation[2] computed from the ELAN integrated log analysis does not read consistently above 60% anywhere below 900 ft. The processed logs suggest that the rock type in this interval (900–1405 ft) is likely silica-rich extrusive volcanic rock. Estimated water saturation computed directly from bulk density and water content – over the

[2] Water saturation is defined in this report as the volumetric fraction of the total pore space occupied by water – the rest being occupied by air.

likely maximum possible range of grain density for the silica-rich volcanic rock (2.65–3.05 g/cc) – also does not consistently read 100% across any significant zones in this interval. The rock formation in the interval 1214–1405 ft (bottom of log interval) is very dense, having an estimated total porosity of 10% or less of total rock volume. The estimated water-filled porosity is very low – only approximately 5% of total rock volume. The interval 900–1214 ft has higher, much more variable, total porosity (mostly 15–50%) – as well as water-filled porosity (mostly 5–20%). This interval appears to have the same mineralogy as the dense silica-rich volcanic material below 1214 ft – possibly the same rock type, but heavily weathered and broken up to form a breccia-like or rubble material. The average water saturation across this interval is even lower than the dense rock below (around 20–30%), although much more variable – suggesting the regional groundwater level is not crossed.

The moveable water content estimated from the ELAN integrated log analysis averages around 3% of total rock volume in the 1134–1405 ft interval and approximately 4–6% in the 900–1134 ft interval. Hydraulic conductivity, as estimated from the ELAN analysis results, is mostly below 0.1 gal/min/ ft^2 across the entire interval – highest in 900–1134 ft zone.

Vadose Zone Perched Water

There are no clear indications, solely from the processed geophysical log results, that any significant perched (fully water-saturated) zones are intersected by CdV-16-3(i). The ELAN-estimated water saturation never reaches above 75% and mostly stays below 50%. Hydrogeologic observations and interpretations from the processed logs are provided below for the logged interval above 900 ft, from bottom to top.

894–900 ft:
The 894–900 ft depth interval has very high ELAN estimated total porosity (48–61%), high water-filled porosity (21–44%), and relatively high water saturation (50–72%) – characteristic of the log response in the bottom of the Guaje Pumice Bed. Moveable water content is also high (10–30%). The ELAN results indicate that the zone is underlain by a relatively clay-rich geologic sequence – possibly acting as a low permeability barrier that causes pooling of water in the highly porous pumice bed above. This zone has the highest total and moveable water content in the entire log interval, as well as the highest estimated hydraulic conductivity (~30 gal/min/ ft^2).

852–894 ft:
The 852–894 ft depth interval, assumed to be in the Bandelier Tuff (solely based on the logs), has high total porosity (40–50%) and relatively high, uniform water-filled porosity (18–22%), resulting in a water saturation of 42–48%. Moveable water content ranges 3–5%.

843–852 ft:
This zone is characterized by a significant decrease in total porosity to 28%, along with a decrease in water-filled porosity to 13% and moveable water content to 3%.

798–843 ft:
The 798–852 ft interval, assumed to be in the Bandelier Tuff (solely based on the logs), has similar characteristics as the 852–894 ft interval: high total porosity (average 45%), water-filled porosity of 20–23%, and moveable water content of about 5%.

615–798 ft:
The processed logs across the 615–798 ft interval exhibit a sharp decrease in total and water-filled porosity at 798 ft (to 40% and 17%, respectively), compared to the zone below. Above 798 ft total porosity gradually increases in the upward direction, reaching 43% at 625 ft. Water-filled porosity gradually increases to a maximum of 20% at 660 ft, then decreases to 17% at 615 ft. Moveable water content is consistent – uniformly decreasing in the upwards from 4% at 798 ft to around 2% at 615 ft. Water saturation ranges 40–45%.

586–615 ft:
This interval is characterized by lower total and water-filled porosity (41% and 10%, respectively), but slightly higher moveable water content (4%) than directly below.

412–586 ft:
Total and water-filled porosity is more variable across this interval than the section below, ranging 36–53% and 8–17%, respectively. Moveable water content mostly varies between 3–5% and water saturation 25–40%.

340–412 ft:
The 340–412 ft interval is characterized by highly variably total and water-filled porosity (27–55% and 7–24%, respectively). Moveable water content averages about 4%, reaching a maximum of 7% at 395 ft.

312–340 ft:
Water-filled porosity decreases significantly above 340 ft, lowering to 5% at 325 ft, while total porosity remains relatively high (mostly 30–35%). Moveable water content is no more than 4%.

214–312 ft:
Total porosity decreases significantly above 312 ft, decreasing from 20% at 311 ft to 8% at 225 ft. Water-filled porosity varies between 5–10% and moveable water content averages about 3%.

162–214 ft:
Total porosity increases significantly above 214 ft, reaching 37% at 200 ft. Water-filled porosity varies between 4–11% and moveable water content averages about 3%. There is a large washout across the 170–214 ft interval that may be causing elevated total porosity values.

127–162 ft:
Total porosity decreases to 8–12% across this interval, with water-filled porosity and moveable water content relatively stable at 6% and 3%, respectively.

13–127 ft:
The total porosity increases considerably in this interval (compared to zone below), generally increasing in the upward direction – reaching 52% at 30 ft. However, the porosity increases are correlated with large washouts. Water-filled porosity averages around 7% across the interval 40–127 ft and 12% across the interval 13–40 ft.

Geology

The processed geophysical log results delineate the geologic material and many of the formation contacts intersected by CdV-16-3(i). The generalized geologic stratigraphy observed from the logs, independent of any other information, across the logged interval is as follows (depth bgs):

- **13–75 ft: Very porous volcanic tuff (possibly not volcanic tuff at top)** – characterized by very high total porosity (40–50% of total rock volume), high sanidine and silica glass/mineral content, and trace clay content
- **75–88 ft: Low porosity volcanic tuff** – characterized by relatively low total porosity (20–25% of total rock volume), high sanidine and silica glass/mineral content
- **88–132 ft: Lower porosity, clay-rich volcanic tuff** – characterized by relatively lower total porosity (20–35% of total rock volume), high sanidine and silica glass/mineral content, and the presence of clay throughout (maximum 10% of total rock volume)
- **132–162 ft: Low porosity volcanic tuff** – characterized by relatively low total porosity (17% of total rock volume), high sanidine and silica glass/mineral content, and small amounts of clay
- **162–214 ft: Porous volcanic tuff** – characterized by relatively high total porosity (28–37% of total rock volume), high sanidine and silica glass/mineral content, and trace clay content
- **214–312 ft: Low porosity volcanic tuff** – characterized by relatively low total porosity increasing downwards (8–20% of total rock volume), high sanidine and silica glass/mineral content, and trace clay content
- **312–343 ft: Porous volcanic tuff** – characterized by relatively high total porosity (30–35% of total rock volume), high sanidine and silica glass/mineral content, and minor presence of clay
- **343–346 ft: Low porosity volcanic tuff** – characterized by relatively low total porosity (23% of total rock volume), high sanidine and silica glass/mineral content, moderate augite mineral content, and minor presence of clay
- **346–357 ft: Very porous volcanic tuff**– characterized by very high total porosity (53% of total rock volume), high sanidine and silica glass/mineral content, and possibly trace pyrite content
- **357–360 ft: Lower porosity volcanic tuff** – characterized by relatively lower total porosity (30% of total rock volume), high sanidine and silica glass/mineral content, moderate augite mineral content, and minor presence of clay
- **360–412 ft: Very porous, heterogeneous volcanic tuff (possibly re-worked)**– characterized by very high and variable total porosity (30–57% of total rock volume), high sanidine and silica glass/mineral content, minor to moderate augite mineral content, and trace amounts of clay
- **412–620 ft: Porous, relatively heterogeneous volcanic tuff** – characterized by high total porosity (36–53% of total rock volume), high sanidine and silica glass/mineral content, and minor to moderate augite mineral content
- **620–798 ft: Porous volcanic tuff** – characterized by very high total porosity (40–43% of total rock volume), high sanidine and silica glass/mineral content
- **798–843 ft: Very porous volcanic tuff**– characterized by very high total porosity (45% of total rock volume), high sanidine and silica glass/mineral content
- **843–852 ft: Lower porosity volcanic tuff** – characterized by relatively lower total porosity (28% of total rock volume), high sanidine and silica glass/mineral content, moderate augite mineral content, and minor presence of clay
- **852–894 ft: Very porous volcanic tuff**– characterized by very high total porosity (40–50% of total rock volume), high sanidine and silica glass/mineral content

- <u>894–900 ft</u>: **Extremely porous volcanic tuff/pumice** – characterized by extremely high total porosity (48–61% of total rock volume), high water-filled porosity (21–44%), high sanidine content, and moderate silica glass/mineral content
- <u>900–994 ft</u>: **Clay-rich, highly altered, heterogeneous siliceous volcanic material (possibly brecciated flow or rubble zone)** – characterized by highly variable total porosity (15–50% of total rock volume); moderate quartz, potassium feldspar, and plagioclase feldspar content; moderate clay content; and considerable presence of heavy mafic minerals
- <u>994–1213 ft</u>: **Highly altered, heterogeneous siliceous volcanic material (possibly brecciated flow or rubble zone)** – characterized by highly variable total porosity (15–50% of total rock volume); moderate quartz, potassium feldspar, and plagioclase feldspar content; considerable presence of heavy mafic minerals; and variable, trace amounts of clay
- <u>1213–1405 ft</u>: **Dense, low porosity siliceous volcanic material (likely unaltered lava flow)** – characterized by very low total porosity (10% or less of total rock volume); moderate quartz, potassium feldspar, and plagioclase feldspar content; considerable presence of heavy mafic minerals; and variable, minor amounts of clay

4.1 Summary Logs

Three summary log displays have been generated for CdV-16-3(i) to highlight the key hydrogeologic and geologic information provided by the processed geophysical log results:

- <u>Porosity summary log</u> showing continuous hydrogeologic property logs, including total and moveable water content and water saturation – to highlight hydrologic information obtained from the integrated log results (Figure 4.1)
- <u>Density and clay content summary</u> showing a continuous logs of formation bulk density and estimated grain density, as well as photoelectric factor (sensitive to mineralogy) and estimated clay volume – to highlight key geologic rock matrix information obtained from the log results (Figure 4.2)
- <u>Spectral natural gamma ray and lithology summary</u> showing a high vertical resolution, continuous volumetric analysis of formation mineral and pore fluid composition (based on an integrated analysis of the logs) and key lithologic/stratigraphic correlation logs from the spectral gamma ray measurement (concentrations of gamma-emitting elements) – to highlight the geologic lithology, stratigraphy and correlation information obtained from the log results (Figure 4.3)

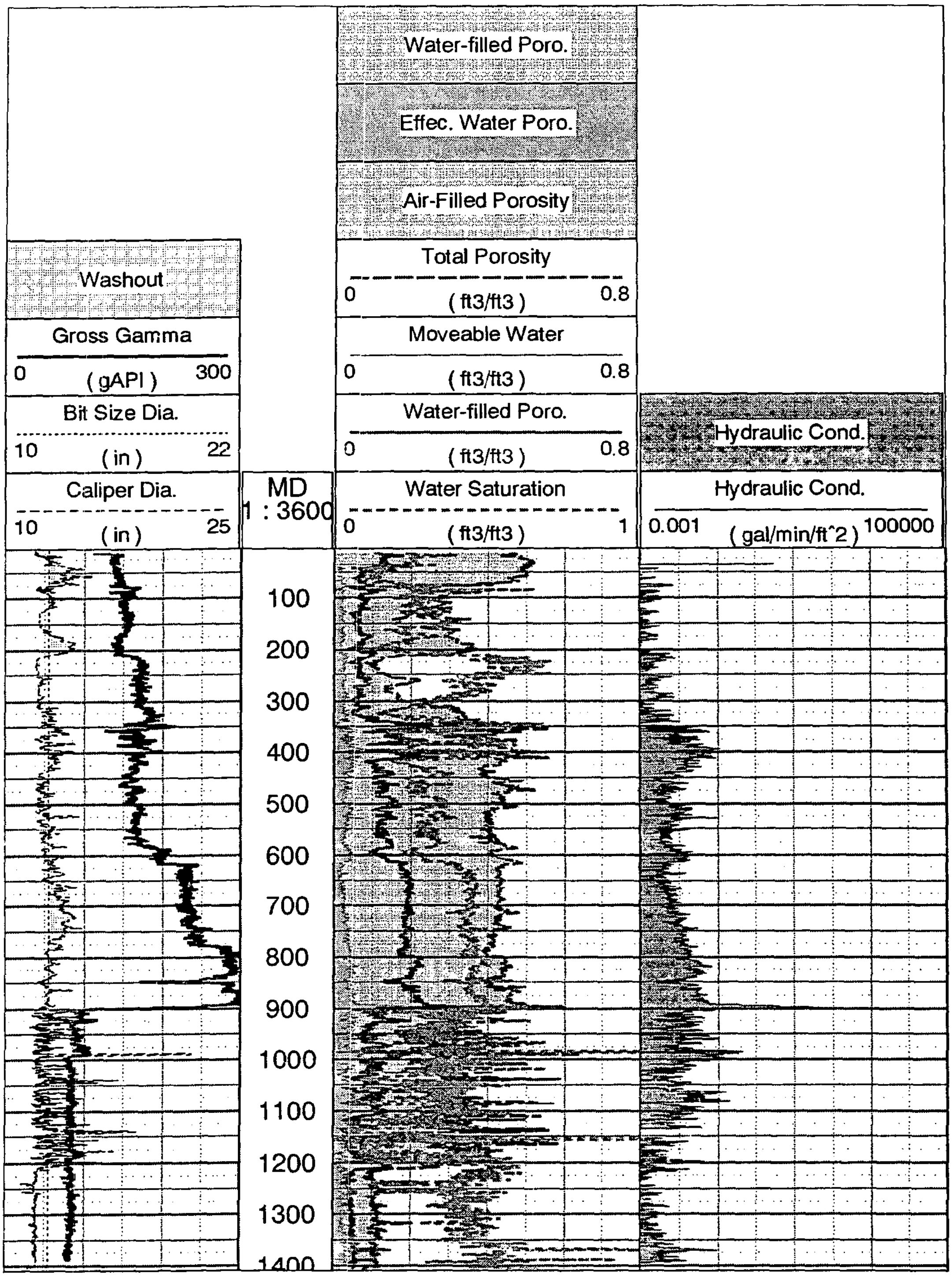

Figure 4.1. **Summary porosity logs in CdV-16-3(i) borehole from processed geophysical logs, interval 13–1405 ft, with caliper, gross gamma, water saturation, and water hydraulic conductivity logs. Porosity, water saturation, and hydraulic conductivity logs are derived from the ELAN integrated log analysis.**

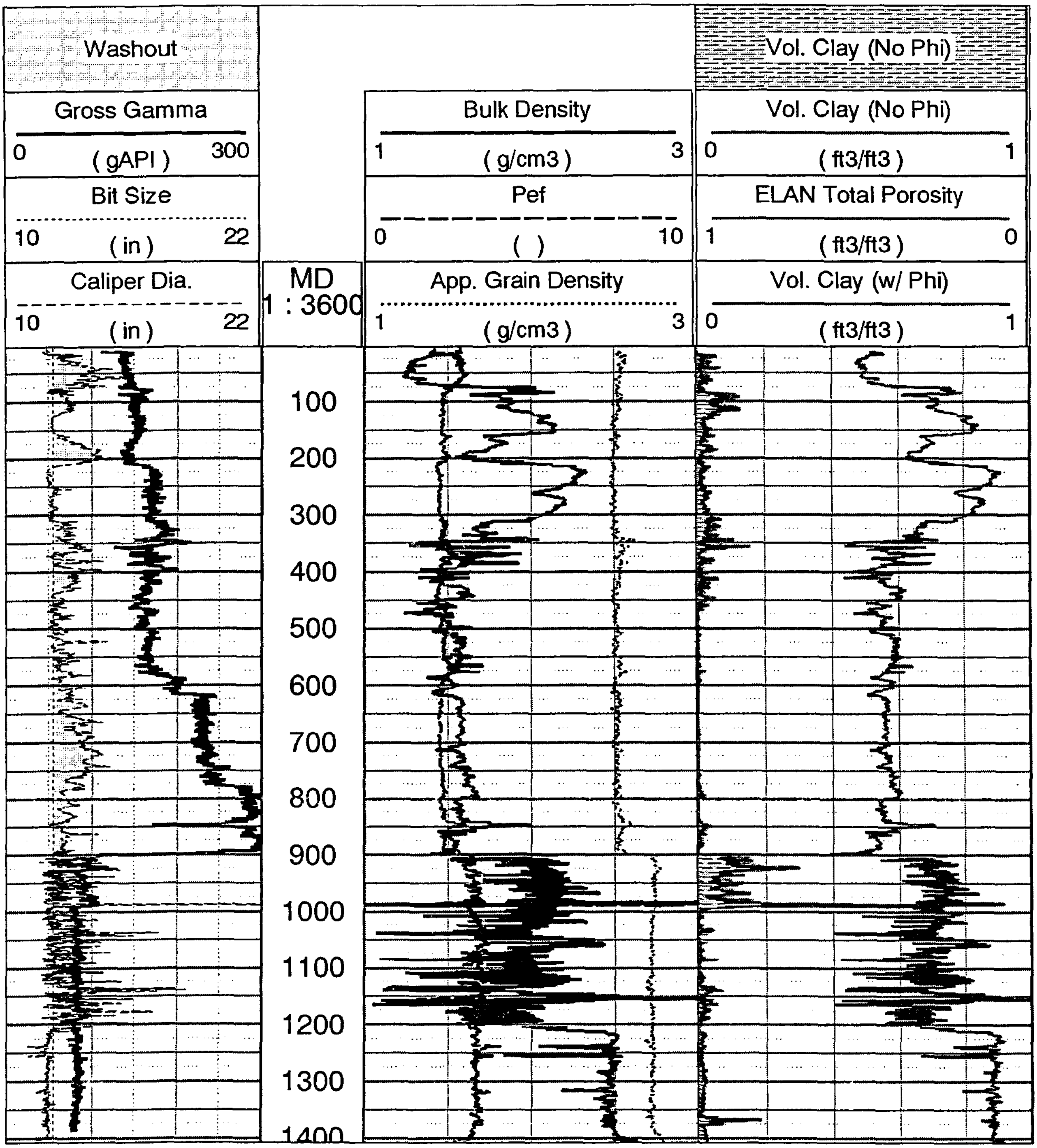

Figure 4.2. **Summary bulk density and volume clay logs in CdV-16-3(i) borehole from processed geophysical logs, interval 13–1405 ft. Also shown – caliper, gross gamma, apparent grain density, and total porosity logs (the latter two derived from the ELAN analysis).**

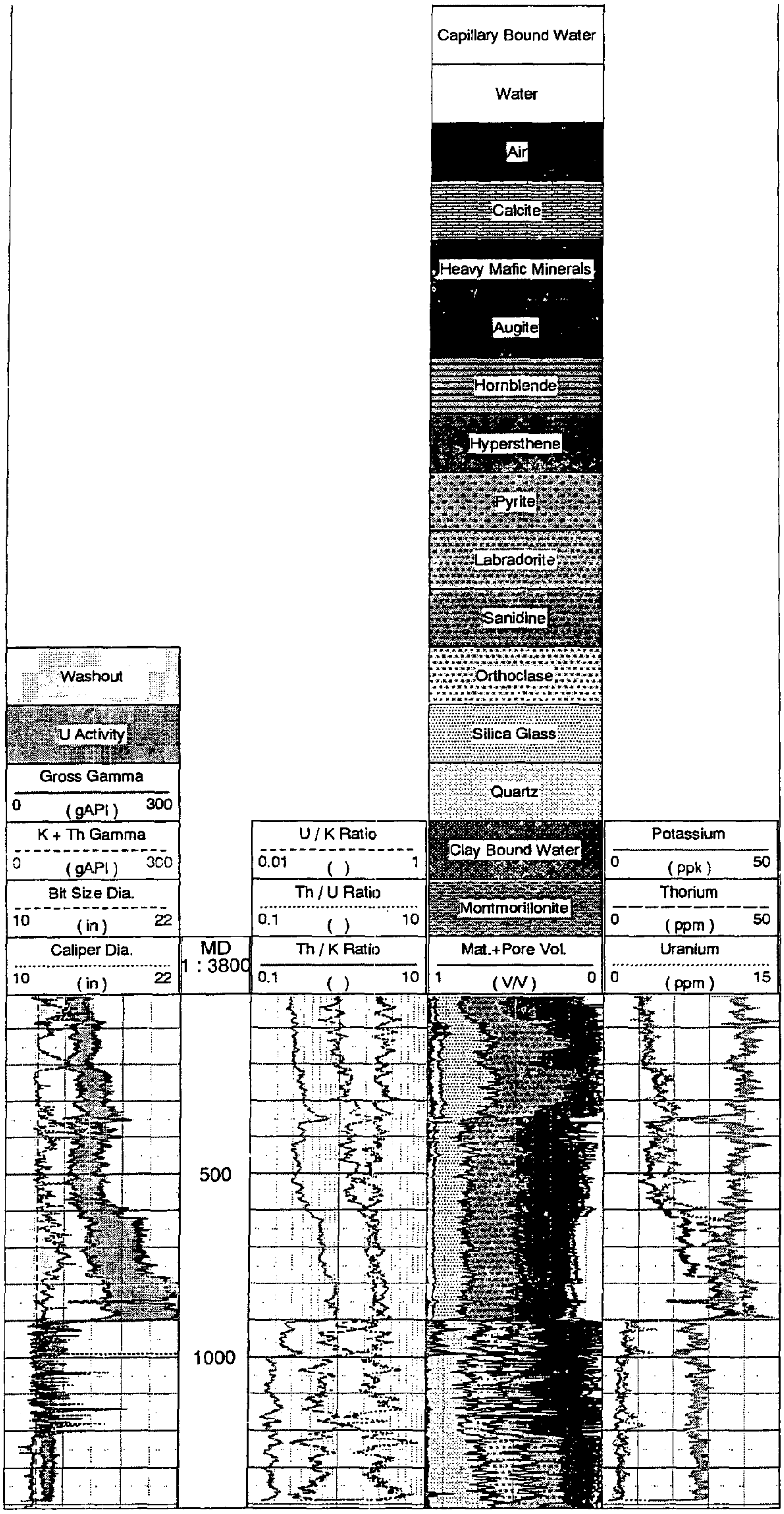

Figure 4.3. Summary spectral natural gamma ray logs and ELAN mineralogy/lithology and pore fluid model from CdV-16-3(i) borehole, interval 13–1405 ft. Caliper log is also shown.

4.2 Integrated Log Montage

This section summarizes the integrated geophysical log montage for CdV-16-3(i). The montage is provided on a CD in the back of this report. A description of each log curve in the montage follows—organized under the heading of each track, starting from track 1 on the left-hand side of the montage. Note that the descriptions in this section focus on what the curves are and how they are displayed; the specific characteristics and interpretations of the CdV-16-3(i) geophysical logs are provided in the previous section.

Track 1-Depth

The first track on the left contains the depth bgs in units of feet, as measured by the geophysical logging system during the AIT logging run. All the geophysical logs are depth-matched to the spectral gross gamma measurement run with the AIT.

Track 2-Basic Logs

The second track on the left (inclusive of the depth track) presents basic curves:

- gamma ray (thick black), recorded in API units and displayed on a scale of 0 to 300 API units;
- caliper borehole diameter from the TLD (thin solid pink) with bit size as a reference (dashed-dotted black) to show washout (pink shading), recorded as hole diameter in inches and displayed on a scale of 11 to 26 in.;

Two gamma ray curves from the NGS are presented:

- total gross gamma (thick solid black curve) and
- gross gamma minus the contribution of uranium (dashed black).

Track 3-Resistivity

The third track displays the resistivity measurements from the AIT, spanning most of the open hole section. All the resistivity logs are recorded in units of ohmmeters and displayed on a logarithmic scale of 2 to 2000 ohm-m.

Six electrical resistivity logs from the AIT are displayed:

- Borehole fluid resistivity (solid orange curve)–only valid in water-filled hole
- Bulk electrical resistivity at five median depths of investigation–10 in. (black solid), 20 in. (long-dashed blue), 30 in. (short-dashed red), 60 in. (dashed-dotted green), and 90 in. (solid purple)–each having a two-foot vertical resolution.

The area between the 10 in. and 90 in. resistivity curves, representing radial variations in bulk resistivity (potentially from invasion of drilling fluids), is shaded:

- blue when the 10 in. resistivity is greater than the 90 in. resistivity (labeled "resistive invasive") and
- yellow when the 90 in. resistivity is greater than the 10 in. resistivity (labeled "conductive invasive").

Track 4-Porosity

The fourth track displays the primary porosity log results. All the porosity logs are recorded in units of volumetric fraction and displayed on a linear scale of 0.75 (left side) to negative 0.1 (right side). Specifically, these logs consist of

- CNT epithermal neutron porosity (solid sky blue curve)–epithermal neutron porosity processed for both air-filled and water-filled hole;
- CMR total water-filled porosity (short-dashed black);
- CMR effective water-filled porosity (long-dashed green);
- CMR bound water porosity (light blue area shading)–representing by the area between the CMR total and effective water-filled porosities;
- Total porosity derived from bulk density and neutron water-filled porosity using a grain density of 2.65/3.05 g/cc (dotted red curve), 2.45/2.85 g/cc (long-dashed red curve), and 2.25/2.65 g/cc (dashed red curve)–with red shading between the 2.25/2.65 and 2.65/3.05 g/cc porosity curves to show the range (the higher grain density range used across the siliceous volcanic flow interval below 900 ft); and
- ELAN water-filled porosity (dashed-dotted cyan)–derived from the ELAN integrated analysis of all log curves to estimate optimized matrix and pore volume constituents.

Track 5-Density

The fifth track displays the:

- bulk density (thick solid maroon curve) on a scale of 1 to 3 grams per cubic centimeter (g/cc);
- Pe (long-dashed black curve) on a scale of 0 to 10 non-dimensional units;
- density correction (dashed orange curve) on a scale of -0.75 to 0.25 g/cc; and
- apparent grain density (dashed-dotted brown curve), derived from the ELAN analysis, on a scale of 1 to 3 g/cc.

Grey area shading is shown where the Pe increases above 3 (indicating the presence of heavy, possibly mafic, minerals) and orange shading is shown where the density correction is greater than the absolute value of 0.25 (indicating the density processing algorithm had to perform a major correction to the bulk density calculation).

Track 6-NGS Spectral Gamma

The sixth track from the left displays the spectral components of the NGS measurement results as wet weight concentrations:

- potassium (solid green curve) in units of parts per thousand (ppk) and on a scale of -50 to 50 ppk;
- thorium (dashed brown) in units of parts per million (ppm) and on a scale of 50 to -50 ppm; and
- uranium (dotted blue) in units of parts per million (ppm) and on a scale of 20 to 0 ppm.

Track 7-CMR Porosity

Track 7 displays various CMR water-filled porosities along with measurement quality flags–valid only in the open hole section. The porosity and measurement quality logs are presented on a scale of 0.5 to zero volume fraction and discrete blocks originating from the left side, respectively. Specifically, the CMR logs shown in this track are:

- Total water-filled porosity (solid black curve)–representing the total water volume fraction measured by the CMR;
- Three millisecond (ms) porosity (short-dashed brown)–representing the water volume fraction corresponding to the portion of the CMR measured T2 distribution that is above 3 ms, a cutoff that is considered to be representative of the break between clay-bound water (less than 3 ms) and all other types of water (greater than 3 ms);
- Effective water-filled, or free fluid, porosity (solid pink)–representing the water volume fraction that is moveable (can flow), based on a T2 distribution cutoff that is considered representative of the break between bound water and moveable water;
- Clay-bound water (brown area shading between total and 3 ms porosity logs)–representing the water volume fraction that is bound within clays;
- Capillary-bound water (pink area shading between 3 ms and effective porosity logs)–representing the water volume fraction that is bound within matrix pores by capillary forces;
- CMR magnetic field variation (dotted yellow)–representing the variation in the measured magnetic field versus the baseline magnetic field used for the logging (used as an indicator of the presence of magnetic minerals which requires a lower T2 cutoff)
- CMR wait-time flag (red area shading)–activates when there is significant measurement response at late T2 times, corresponding to large amounts of completely free ("bathtub") water and often associated with washouts or very large pores;
- CMR measurement noise flag (yellow and orange area shading)–activates when there is potentially detrimental amounts of measurement noise detected by the tool, at moderate (yellow) and high (orange) levels.

Track 8 –Pore Size Distribution

Track 8 displays the water-filled pore size distribution as determined by the CMR–shown as binned water-filled porosities and valid only in the open hole section. The binned porosity logs are presented on a scale of 0.5 to zero volume fraction with colored area shading corresponding to the different bins:

- Clay-bound water–brown area shading;
- Micro pore and small pore water (the sum comprising capillary-bound water)–gray and blue area shading, respectively;
- Medium pore, large pore, and late decay (the sum comprising effective water-filled porosity)–yellow, red, and green area shading, respectively.

Track 9–CMR T2 Distribution (Waveforms)

The CMR T2 distribution is displayed in Track 9 as green waveform traces at discrete depths. The horizontal axis, corresponding to relaxation time in milliseconds, is on a logarithmic scale from 0.3 to 3000 ms. Also plotted are the:

- T2 logarithmic mean (solid blue curve) and
- T2 cutoff time used for differentiating between bound and free water (solid red line).

Track 10–CMR T2 Distribution (Heated Amplitude)

Track 10 displays the T2 distribution in another way–on a heated color scale where progressively "hotter" color (green to yellow to red) corresponds to increasing T2 amplitude. The remaining aspects of the display are the same as in Track 9, except that the T2 logarithmic mean is shown as a solid white curve and the T2 cutoff is not displayed.

Track 11–CMR Hydraulic Conductivity

Track 11 displays several estimates of hydraulic conductivity (K) derived from the CMR measurement and the ELAN integrated log analysis (the latter primarily sensitive to the CMR measurement of moveable water), presented on a logarithmic scale of 10^{-4} to 10^{6} gallons per day per feet squared (gal/day/ft2):

- A K versus depth estimate derived from using the SDR permeability equation applied to the processed CMR results, converted to hydraulic conductivity (dashed purple curve);
- A K versus depth estimate derived from using the Timur-Coates permeability equation with total and moveable water content derived from the ELAN analysis, converted to hydraulic conductivity (solid blue curve); and
- An intrinsic K versus depth estimate (assuming full saturation) using the Timur-Coates permeability equation with total and effective porosity values derived from the ELAN analysis, converted to hydraulic conductivity (dotted cyan).

Tracks 12 to 16 – Geochemical Elemental Measurements

The narrow tracks 12 to 16 present the geochemical measurements iron (Fe) and silicon (Si), sulfur (S) and calcium (Ca), potassium (K) and estimated aluminum (Al), titanium (Ti) and gadolinium (Gd), and hydrogen (H) and bulk chlorinity (Cl) —from left to right respectively, in units of dry matrix weight fraction (except H wet weight fraction, Cl and K in ppk).

Track 17–ELAN Mineralogy Model Results (Dry Weight Fraction)

Track 17 displays the results from the ELAN integrated log analysis (the matrix portion)–presented as dry weight fraction of mineral types chosen in the model:

- Montmorillonite clay (brown/tan)
- Quartz (yellow with small black dots)
- Silica glass (orange)
- Orthoclase or other potassium feldspar (lavender)
- Sanidine (violet)

- Labradorite or other plagioclase feldspar (pink)
- Hypersthene (purple)
- Hornblende (forest green)
- Augite (maroon)
- Heavy mafic/ultramafic minerals, such as magnetite or olivine (dark green)
- Pyrite (cross-hatched red).

Track 18–ELAN Mineralogy-Pore Space Model Results (Wet Volume Fraction)

Track 18 displays the results from the ELAN integrated log analysis–presented as wet mineral and pore fluid volume fractions:

- Montmorillonite clay (brown/tan)
- Clay-bound water (checkered gray-black)
- Quartz (yellow with small black dots)
- Silica glass (yellow with large black dots)
- Orthoclase or other potassium feldspar (lavender)
- Sanidine (violet)
- Labradorite or other plagioclase feldspar (pink)
- Pyrite (tan with large black squares).
- Hypersthene (purple)
- Hornblende (forest green)
- Augite (maroon)
- Heavy mafic minerals, such as magnetite (dark army green)
- Air (red)
- Moveable water (white)
- Capillary-bound water (light blue).

Track 19-Summary Logs

Track 19, the second track from the right, displays several summary logs that describe the fluid and air-filled volume measured by the geophysical tools, including water saturation:

- Optimized estimate of total volume fraction water from the ELAN analysis (solid dark blue curve and area shading);
- Optimized estimate of moveable volume fraction water (effective porosity in fully saturated conditions) from the ELAN analysis (dashed cyan curve and green area shading);
- Optimized estimate of total volume fraction of air-filled porosity from the ELAN analysis (solid red curve and dotted red area shading);

- Optimized estimate of water saturation (percentage of pore space filled with water) from the ELAN analysis (dashed-dotted purple curve);
- Water saturation as calculated directly from the bulk density and geochemical estimated porosity using a grain density of 2.65/3.05 g/cc (dotted light blue curve), 2.45/2.85 g/cc (long-dashed light blue curve), and 2.25/2.65 g/cc (dashed light blue curve)–with light blue shading between the 2.25/2.65 and 2.65/3.05 g/cc saturation curves to show the range (the higher grain density range used across the siliceous volcanic flow interval below 900 ft);
- Integrated estimated relative water flow from the CMR log that mimics a flow meter (spinner) acquired under flowing conditions (solid green line coming from left-hand side at bottom of logged interval);
- Potential for water flow indicator from the CMR log (block cyan coming from the right-hand side of the track).

The porosity curves scale from 0 to 1 total volume fraction, left to right; the water saturation scales from 0 to 1 volume fraction of pore space, from left to right. The relative water flow is on a scale of 0 to 1 relative volumetric flow rate from left to right. The flow indicator is a binary-valued flag that rises to halfway through the first division from the right on the x-axis when the CMR measurement indicates a potential for flow.

Track 20-Depth

The final track on the right, same as the first track on the left, displays the depth below ground surface in units of feet, as measured by the geophysical logging system during the AIT-NGT logging run.

5.0 REFERENCES

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Appendix D

Lithology Log

Lithologic Descriptions of Drill Cuttings from Borehole CdV-16-3(i)

Geologic Unit	Lithologic Description	Sample Interval (ft)	Elevation Range (ft above msl)
Qbt 4, Tshirege Member of the Bandelier Tuff	Volcanic tuff, grayish orange pink (5YR 7/2), weakly to moderately welded. WR (i.e., unsieved whole rock sample): fine ash with 15% sand-size grains. +10F (i.e. sample fraction retained by the No. 10 sieve): composed of 60-70% vitric pumice and welded tuff fragments (up to 2 cm), 30-40% rounded intermediate volcanic (dacite) lithic fragments (up to 1.5 cm).	0-23	7486.4-7463.4
	Volcanic tuff, very light gray (N8), weakly to moderately welded. WR: very fine ash with 10-15% tuff fragments, and quartz and sanidine crystals. +10F: composed of 80-90% welded tuff fragments (made up of 3-5% crystals, 3-5% pumice, 90-95% ash), 5-10% volcanic lithic fragments, 5-10% clay fragments. +35F (i.e., sample fraction retained by the No. 35 sieve): 5% volcanic lithics, 70-75% quartz and sanidine crystals, 15-20% welded tuff fragments.	23-38	7463.4-7448.4
	Volcanic tuff, grayish orange pink (5YR 7/2), weakly to moderately welded. WR: very fine ash with trace tuff fragments, and quartz and sanidine crystals. +10F: composed of 20-30% welded tuff fragments and pumice (up to 8 mm), 25-30% euhedral quartz and sanidine crystals, 45-50% angular to subrounded volcanic (mostly dacite) lithic fragments (up to 6 mm). +35F: 10-15% volcanic lithics, 50% quartz and sanidine crystals, 35-40% pumice, and welded tuff fragments.	38-53	7448.4-7433.4
	Volcanic tuff, grayish orange pink (10YR 7/2), weakly to moderately welded. WR: very fine ash with trace pumice, and quartz and sanidine crystals. +10F: composed of 65-70% subangular to subrounded, intermediate volcanic (hornblende-dacite noted) lithic fragments (up to 2 cm); 30-35% euhedral quartz and sanidine crystals; trace pumice and welded tuff fragments. +35F: 95-98% quartz and sanidine crystals, 1-2% pumice, 1-3% volcanic lithics. Note: the lower contact between subunit Qbt 4 and underlying Qbt 3t is interpreted to occur at 70 ft bgs based on geophysical logging data.	53-70	7433.4-7416.4
Qbt 3t, Tshirege Member of the Bandelier Tuff	Volcanic tuff, very pale orange (10YR 8/2), weakly welded or weathered. WR: very fine ash with trace tuff fragments, and quartz and sanidine crystals. +10F: composed of 70-75% intermediate volcanic (predominantly dacite) lithic fragments (up to 2 cm); 25-30% euhedral quartz and sanidine crystals. +35F: 1-2% volcanic lithics, 98% quartz and sanidine crystals, 1-2% pumice and tuff fragments.	70-80	7416.4-7406.4

Geologic Unit	Lithologic Description	Sample Interval (ft)	Elevation Range (ft above msl)
	Volcanic tuff, light brownish gray (5YR 6/1) to light brown (5YR 6/4). WR: fine ash with 15% tuff fragments, and quartz and sanidine crystals. +10F: poor sample returns of this size fraction. +35F: 1-2% volcanic lithics, 98% quartz and sanidine crystals, 1-2% pumice. Note: the lower contact between subunit Qbt 3t and underlying Qbt 3 is interpreted to occur at 88 ft bgs based on geophysical logging data.	80-88	7406.4-7398.4
Qbt 3, Tshirege Member of the Bandelier Tuff	Volcanic tuff, light brown (5YR 6/4) to grayish orange (10YR 7/4), moderately welded. WR: fine ash with trace tuff volcanic lithics, and quartz and sanidine crystals. +10F: 100% crystal-rich welded tuff fragments (up to 7 mm) containing sparse relict pumice. +35F: 2-3% volcanic lithics, 95-98% quartz and sanidine crystals, 1-2% pumice and tuff fragments.	88-105	7398.4-7381.4
	Volcanic tuff, grayish orange (10YR 7/4), weakly to moderately welded. WR: fine ash with trace quartz and sanidine crystals. +10F: 95-98% quartz and sanidine crystals, 2-5% altered tuff fragments (up to 3 mm). Note: poor sample returns of the +10F size fraction in the intervals 110-115 ft bgs and 120-125 ft bgs.	105-125	7381.4-7361.4
	Volcanic tuff, light brownish gray (5YR 6/1), weakly to moderately welded. WR: 75-80% quartz and sanidine crystals, 10-15% fine ash, 1-2% lithics, 2-3% tuff fragments. +10F: 40-45% crystal-rich welded tuff fragments (up to 2 mm), 40-45% quartz and sanidine crystals, 5-8% volcanic lithics (up to 3-mm). +35F: 90-95% quartz and sanidine crystals, 5-10% tuff fragments.	125-145	7361.4-7341.4
	Volcanic tuff, light brownish gray (5YR 6/1), weakly to moderately welded. WR: 80-85% quartz and sanidine crystals, 5-10% fine ash, 5-10% tuff fragments. +10F: 90-95% crystal-rich welded tuff fragments (up to 3 mm), 5-10% quartz and sanidine crystals. +35F: 25-30% quartz and sanidine crystals, 70-75% tuff fragments. Note: the contact between subunit Qbt 3 and underlying Qbt 3 nw is interpreted to occur at 162 ft bgs based on geophysical logging data.	145-165	7341.4-7321.4
Qbt 3 nw, Tshirege Member of the Bandelier Tuff	Volcanic tuff, light brownish gray (5YR 6/1), weakly welded. WR: 90-95% quartz and sanidine crystals, 5-10% fine ash. +10F: composed of 80-85% quartz and sanidine crystals, 10-15% welded tuff fragments, 5-10% volcanic lithics. +35F: 95-98% quartz and sanidine crystals, and 2-5% tuff fragments.	165-185	7321.4-7301.4
	Volcanic tuff, grayish orange (10YR 7/4) to pale yellowish brown (10YR 6/2), weakly welded. +10F: composed of 90-95% quartz and sanidine crystals, 2-5% welded tuff fragments, 2-5% volcanic lithics. +35F: 98% quartz and sanidine crystals, and 2% tuff fragments. Note: the contact between subunit Qbt 3 nw and underlying Qbt 2 is interpreted to occur at 207 ft bgs based on geophysical logging data.	185-210	7301.4-7276.4

Geologic Unit	Lithologic Description	Sample Interval (ft)	Elevation Range (ft above msl)
Qbt 2, Tshirege Member of the Bandelier Tuff	Volcanic tuff, light brownish gray (5YR 6/1), weakly to moderately welded. WR: 80-85% quartz and sanidine crystals, 10-15% fine ash, 2-5% volcanic lithics (up to 2 mm). +10F: composed of 80-85% quartz and sanidine crystals, 5-10% welded tuff fragments (up to 2 mm) and 10-15% volcanic lithic fragments. +35F: 95-98% quartz and sanidine crystals, 2-3% tuff fragments, and 1-2% volcanic lithics.	210-220	7276.4-7266.4
	Volcanic tuff, light brownish gray (5YR 6/1), moderately welded. +10F: composed of 50% quartz and sanidine crystals, 50% welded tuff fragments and volcanic lithic fragments. +35F: 60-65% quartz and sanidine crystals, and 35-40% tuff fragments.	220-225	7266.4-7261.4
	Volcanic tuff, light brownish gray (5YR 6/1), moderately welded. +10F: composed of 1% quartz and sanidine crystals, 99% welded tuff fragments. +35F: 60-65% quartz and sanidine crystals and 35-40% tuff fragments.	225-230	7261.4-7256.4
	Volcanic tuff, light brownish gray (5YR 6/1), moderately welded. WR: quartz and sanidine crystals, and varying percentages of fine ash. +10F: 88-90% crystal-rich welded tuff fragments (up to 3 mm), 6-7% quartz, sanidine, and ferromagnesian crystals. +35F: 25-30% quartz and sanidine crystals, 70-75% tuff fragments.	230-250	7256.4-7236.4
	Volcanic tuff, light brownish gray (5YR 6/1), moderately welded. WR: 90-95% fine ash, 2-5% quartz and sanidine crystals, 2-5% tuff fragments (up to 3 mm). +10F: poor returns of this size sample fraction, composition similar to that in the interval 230-250 ft bgs. +35F: 50-60% quartz and sanidine crystals, 40-50% tuff fragments.	250-265	7236.4-7221.4
	Volcanic tuff, light brownish gray (5YR 6/1), moderately welded. WR: 15-40% quartz and sanidine crystals, 55-80% fine ash, 5% volcanic lithics (up to 4 mm). +10F: composed of 88-90% welded tuff fragments, 5-7% quartz and sanidine crystals, and 5% volcanic lithic fragments. +35F: 65-70% tuff fragments and 30-35% quartz and sanidine crystals.	265-285	7221.4-7201.4
	Volcanic tuff, light brownish gray (5YR 6/1), moderately welded. +10F: composed dominantly of welded tuff fragments containing 10-15% quartz and sanidine crystals, and 10-15% dacitic lithics; abundant elongate Fe-oxide-stained volcanic lithic fragments (up to 3 mm). +35F: 60-65% tuff fragments and 35-40% quartz and sanidine crystals.	285-310	7201.4-7176.4
Qbt 1v, Tshirege Member of the	No sample recovery; no cuttings available for examination in this interval. Note: the contact between Qbt 2 and underlying Qbt 1v is interpreted to occur at 310 ft bgs based on geophysical logging data.	310-315	7176.4-7171.4

Geologic Unit	Lithologic Description	Sample Interval (ft)	Elevation Range (ft above msl)
Bandelier Tuff	Volcanic tuff, light brownish gray (5YR 6/1) to grayish orange pink (5YR 7/2), moderately to weakly welded. +10F: composed of varying abundances of welded tuff fragments, quartz and sanidine crystals, and volcanic lithics. +35F: 70-80% quartz and sanidine crystals, 20-30% tuff fragments and lithics.	315-330	7171.4-7156.4
	Volcanic tuff, light brownish gray (5YR 6/1), weakly welded, crystal-rich. WR: fine ash, 7-10% quartz and sanidine crystals, and tuff fragments (up to 2 mm). +10F: poor returns of this size sample fraction. +35F: 60-70% quartz and sanidine crystals, and 30-40% tuff and volcanic lithic fragments. Note: the contact between subunit Qbt 1v and underlying Qbt 1g is interpreted to occur at 345 ft bgs based on geophysical logging data.	330-345	7156.4-7141.4
Qbt 1g, Tshirege Member of the Bandelier Tuff	Volcanic tuff, grayish orange pink (5YR 7/2), weakly welded, crystal-rich. WR: 25-30% quartz and sanidine crystals, tuff fragments, and fine ash. +10F: very poor returns of this size fraction, predominantly quartz and sanidine crystals. +35F: 85-90% quartz and sanidine crystals and 10-15% tuff and lithic fragments, trace pinkish pumice(?) fragments.	345-350	7141.4-7136.4
	Volcanic tuff, grayish orange pink (5YR 7/2) to light brown (5YR 6/4), weakly welded, crystal-rich. WR: quartz and sanidine crystals, lithic fragments, and fine ash. +10F: very poor returns of this sample fraction, composed dominantly of white vitric pumice, minor quartz and sanidine crystals, and lithics. +35F: 70-80% quartz and sanidine crystals, 5% pumice, and 5-10% tuff and lithic fragments. Note: the contact between Qbt 1g and underlying Qct is interpreted to occur at 359 ft bgs based on geophysical logging data.	350-365	7136.4-7121.4
Qct, Cerro Toledo Interval	Volcaniclastic sediments, silty sand (SM), moderate orange pink (5YR 8/4), very fine to coarse sand, grains subangular to subrounded. +10F: detrital constituents (up to 15 mm) composed of 40-50% varied volcanic (dacite, rhyolite, obsidian, and other intermediate lithologies) lithics, 30-35% white fibrous, vitric pumice, 10-15% quartz and sanidine crystals. +35F: grains made up of 20-25% quartz and sanidine crystals, 20-25% pumice, and 50-60% volcanic lithics.	365-385	7121.4-7101.4
	Volcaniclastic sediments, well-graded sand (SW) with silt, moderate orange (5YR 8/4), fine to coarse sand, grains subangular. +10F: detrital constituents composed of 80-85% varied volcanic (hornblende-dacite, rhyolite, vitrophyre) lithics, 5-10% white fibrous, vitric pumice, 5-10% quartz and sanidine crystals. +35F: composition similar to that of the +10F size sample.	385-405	7101.4-7081.4

Geologic Unit	Lithologic Description	Sample Interval (ft)	Elevation Range (ft above msl)
	Volcaniclastic sediments, silty sand (SM), very pale orange (10YR 8/2). WR: fine to coarse sand, grains subangular to subrounded, 30-40% silt. +10F: detrital constituents composed of 45-50% varied volcanic (hornblende-dacite, vitrophyre) lithics (up to 4 mm), 45-50% white fibrous, vitric pumice, 1-2% quartz and sanidine crystals. +35F: grains made up of 40-45% pumice, 40-45% intermediate volcanic lithics, 10% quartz and sanidine crystals.	405-410	7081.4-7076.4
	Volcaniclastic sediments, well-graded sand (SW) with silt, very pale orange (10YR 8/2) to moderate orange pink (10YR 8/4). +10F: detrital constituents (up to 6 mm) composed of 90% varied volcanic (dominantly dacite) lithics, 5-7% white vitric pumice, trace quartz and sanidine crystals. +35F: grains made up of 30-35% pumice, 30-35% intermediate volcanic lithics, 30-35% quartz and sanidine crystals.	410-414	7076.4-7072.4
	Volcaniclastic sediments/volcanic tuff, well-graded sand (SW) with silt, very pale orange (10YR 6/2). WR: abundant fine ash with 20-40% volcanic lithics (up to 4 mm), quartz and sanidine crystals, and pumice fragments. +10F: composed of 70-75% intermediate volcanic (predominantly dacite) lithics, 25-27% white fibrous, vitric pumice, and 3-5% quartz and sanidine crystals. +35F: 10-15% pumice, 70-75% quartz and sanidine crystals and 10-15% volcanic lithics. Note: the contact between Qct and underlying Qbo is interpreted to occur at 430 ft bgs based on geophysical logging data.	414-430	7072.4-7056.4
Qbo, Otowi Member of the Bandelier Tuff	No cuttings returns; no sample available for examination in this interval.	430-435	7056.4-7051.84
	Volcanic tuff, moderate orange pink (5YR 8/4) to light brown (5YR 6/4), weakly welded. WR: fine ash with 10-15% tuff fragments and quartz and sanidine crystals. +10F: very poor returns of this sample fraction. +35F: 30-35% pumice, 60-70% quartz and sanidine crystals and 5-10% volcanic lithics.	435-440	7051.4-7046.4
	Volcanic tuff, moderate orange pink (5YR 8/4), weakly welded. WR: fine ash with 10-15% tuff fragments and quartz and sanidine crystals. +10F: composed of varying percentages of crystal-poor tuff fragments, quartz and sanidine crystals, orange pink to olive black vitric and nonvitric pumices. +35F: 50% pumice and lithics, 50% quartz and sanidine crystals.	440-465	7046.4-7021.4
	Volcanic tuff, moderate orange pink (5YR 8/4), weakly welded. WR: fine ash with 30-35% quartz and sanidine crystals, 5-10% tuff fragments (up to 2 mm). +10F: composed of 98-99% tuff fragments, 1-2% light brown, pale orange, and olive black vitric pumices. +35F: 50% pumice and lithics, 50% quartz and sanidine crystals.	465-485	7021.4-7001.4

Geologic Unit	Lithologic Description	Sample Interval (ft)	Elevation Range (ft above msl)
	Volcanic tuff, pale yellowish brown (10YR 6/2), weakly welded. WR: fine ash with 70-75% quartz and sanidine crystals, lithics and pumice (up to 1 mm). +10F: composed of 20% crystal-poor tuff fragments, 30% pale orange and olive black vitric pumices, 50% varieties of intermediate volcanic lithics. +35F: 10-15% pumice, 5-10% volcanic lithics, 65-70% quartz and sanidine crystals, 5-10% tuff fragments.	485-500	7001.4-6986.4
	Volcanic tuff, grayish orange pink (5YR 7/2), weakly welded. WR: fine ash with 10% quartz and sanidine crystals, 1-2% lithics, and 5% pumice and tuff fragments (up to 2 mm). +10F: very poor returns of this sample fraction. +35F: 10-15% vitric pumice, 5-10% volcanic lithics, 80% quartz and sanidine crystals.	500-510	6986.4-6976.4
	Volcanic tuff, pale yellowish brown (10YR 6/2), weakly welded. WR: fine ash with 5% quartz and sanidine crystals, 5 % volcanic lithics, 5% pumice (up to 1 mm). +10F: poor sample returns of this size fraction; composed of 95% varied aphyric, aphanitic intermediate volcanic lithics (up to 2 mm), 2-5% varicolored vitric pumice, 1-2% quartz and sanidine crystals. +35F: 95-98% quartz and sanidine crystals; and 2-5% volcanic lithics and pumice.	510-515	6976.4-6971.4
	No cuttings returns; no sample available for examination in this interval.	515-520	6971.4-6966.4
	Volcanic tuff, grayish orange pink (5YR 7/2), weakly welded. WR: fine ash with 2-5% quartz and sanidine crystals, 2-5% volcanic lithics and tuff fragments. +10F: composed of 30% aphyric and porphyritic intermediate volcanic (hornblende-dacite noted), lithics (up to 7 mm), 50% orange, white, and olive black, fibrous, vitric pumice, 18-20% tuff fragments, 1-2% quartz and sanidine crystals. +35F: 90-95% quartz and sanidine crystals; 2-5% volcanic lithics, and 5-7% pumice.	520-530	6966.4-6956.4
	Volcanic tuff, grayish orange pink (5YR 7/2) to moderate orange pink (5YR 8/4), weakly welded. WR: fine ash with 2-5% quartz and sanidine crystals, 1-2% volcanic lithics. +10F: composed of 98% aphyric, aphanitic intermediate volcanic lithics (andesite, dacite, and vitrophyre), 1-2% tuff fragments. +35F: 80-85% quartz and sanidine crystals; 2-5% volcanic lithics, and 5-10% vitric pumice.	530-540	6956.4-6946.4
	Volcanic tuff, very pale orange (10YR 8/2) to pale yellowish brown (10YR 6/2), weakly welded. WR: fine ash with 20-25% quartz and sanidine crystals, 10-15% volcanic lithics (up to 5 mm). +10F: composed of 95-97% varied aphyric and porphyritic intermediate volcanics (hornblende-dacite, andesite, vitrophyre), 2-5% orange and olive black pumice. +35F: 95-98% quartz and sanidine crystals and 2-5% vitric pumice fragments.	540-565	6946.4-6921.4
	No cuttings returns; no sample available for examination in this interval.	565-570	6921.4-6916.4

Geologic Unit	Lithologic Description	Sample Interval (ft)	Elevation Range (ft above msl)
	Volcanic tuff, grayish orange pink (5YR 7/2) to pale yellowish brown (10YR 6/2), weakly welded. WR: fine ash with 30-40% quartz and sanidine crystals, 5-10% volcanic lithics (up to 5 mm). +10F: composed of 100% varied aphyric and porphyritic intermediate volcanic (hornblende-biotite-dacite, andesite, vitrophyre) lithics (up to 4 mm). +35F: 90-95% quartz and sanidine crystals 5% volcanic lithics, and 2-5% vitric pumice fragments.	570-585	6916.4-6901.4
	Volcanic tuff, very pale orange (10YR 8/2), weakly welded. WR: fine ash with 20-25% quartz and sanidine crystals, 5-10% volcanic lithics (up to 3 mm). +10F: composed predominantly of varied aphyric and porphyritic intermediate volcanic (hornblende-dacite, andesite, vitrophyre) lithics (up to 5 mm). +35F: 95-98% quartz and sanidine crystals 2-5% volcanic lithics, and 1% vitric pumice fragments.	585-605	6901.4-6881.4
	Volcanic tuff, very pale orange (10YR 8/2) to grayish orange pink (5YR 7/2), weakly welded. WR: fine ash with 10-15% quartz and sanidine crystals, 5-10% volcanic lithics (up to 4 mm). +10F: composed of 98% aphyric, aphanitic dacite lithics (up to 1 cm); 2% orange pumices. +35F: 95-98% quartz and sanidine crystals; 2-5% volcanic lithics.	605-610	6881.4-6876.4
	Volcanic tuff, very pale orange (10YR 8/2) to grayish orange pink (5YR 7/2), weakly welded. WR: fine ash with 10-15% quartz and sanidine crystals, 5-10% volcanic lithics (up to 4 mm). +10F: composed of 40% intermediate volcanic lithics (up to 5 mm), 60% orange and light brown, fibrous, vitric pumice and tuff fragments. +35F: 98-99% quartz and sanidine crystals; 1-2% volcanic lithics.	610-625	6876.4-6861.4
	Volcanic tuff, light brown (5YR 6/4), weakly welded. WR: fine ash with 5-10% quartz and sanidine crystals, 1-2% volcanic lithics (up to 1 mm). +10F: poor returns of this size sample fraction, composed of 30% intermediate volcanic lithics (up to 3 mm), 70% pumice and tuff fragments. +35F: 98% quartz and sanidine crystals; 2% volcanic lithics.	625-630	6861.4-6856.4
	Volcanic tuff, grayish orange pink (5YR 7/2) to very pale orange (10YR 8/2), weakly welded. +10F: very poor returns of this size sample fraction, composed of 100% intermediate volcanic lithics (up to 4 mm). +35F: 98% quartz and sanidine crystals; 1-2% volcanic lithics.	630-640	6856.4-6846.4
	Volcanic tuff, moderate orange pink (5YR 8/4) to very pale orange (10YR 8/2), weakly welded. +10F: very poor returns of this size sample fraction, composed of 98% varied aphyric and porphyritic intermediate volcanic (hornblende-dacite noted) lithics. +35F: 98% quartz and sanidine crystals; 1-2% volcanic lithics.	640-650	6846.4-6836.4

Geologic Unit	Lithologic Description	Sample Interval (ft)	Elevation Range (ft above msl)
	Volcanic tuff, grayish orange pink (5YR 7/2), weakly welded. +10F: poor returns of this size sample fraction, composed of 100% varied intermediate volcanic lithics. +35F: 98% quartz and sanidine crystals; 1-2% volcanic lithics.	650-660	6836.4-6826.4
	Volcanic tuff, very pale orange (10YR 8/2), weakly welded. +10F: composed of 98% varied aphyric and porphyritic intermediate volcanic (hornblende-dacite, andesite) lithics, 1-2% pumices. +35F: 80-85% quartz and sanidine crystals, 10-12% volcanic lithics, 5-10% pumice.	660-670	6826.4-6816.84
	Volcanic tuff, grayish orange (10YR 7/4), weakly welded. +10F: composed of 95-98% varied intermediate volcanic (dacite noted) lithics, 2-5% vitric pumices. +35F: 60-65% quartz and sanidine crystals; 35-40% volcanic lithics.	670-680	6816.4-6806.4
	Volcanic tuff, grayish orange pink (5YR 7/2) to very pale orange (10YR 8/2), weakly welded. +10F: composed of 99% varied aphyric, aphanitic intermediate volcanic (dacite, vitrophyre) lithics (up to 7 mm); trace pumice. +35F: 50-60% quartz and sanidine crystals, 30-40% volcanic lithics, 5-10% pumice.	680-700	6806.4-6786.4
	Volcanic tuff, grayish orange pink (5YR 7/2), weakly welded. +10F: very poor returns of this size sample fraction, composed dominantly of intermediate volcanic lithics (up to 4 mm). +35F: 80-85% quartz and sanidine crystals; 15-20% volcanic lithics.	700-725	6786.4-6761.4
	No cuttings returns; no sample available for examination in this interval.	725-735	6761.4-6751.4
	Volcanic tuff, very pale orange (10YR 8/2), weakly welded. +10F: very poor returns of this size sample fraction, composed of 50% intermediate volcanic lithics; 50% pumice and tuff fragments. +35F: 99% quartz and sanidine crystals, 1% volcanic lithics.	735-745	6751.4-6741.4
	Volcanic tuff, grayish orange pink (5YR 7/2) to very pale orange (10YR 7/4), weakly welded. +10F: poor returns of this size sample fraction, composed of 50% white, fibrous vitric pumice with Mn-oxide spots; 50% intermediate volcanic (hornblende-dacite noted) lithics (up to 4 mm), angular to subrounded. +35F: 30-40% quartz and sanidine crystals; 30-40% volcanic lithics, 20-30% pumice.	745-760	6741.4-6726.4
	Volcanic tuff, very pale orange (10YR 7/4), weakly welded. +10F: composed of 50% white, vitric pumice with Mn-oxide spots; 50% intermediate volcanic (hornblende-dacite noted) lithics, angular to subrounded. +35F: 80-85% quartz and sanidine crystals, 5-10% volcanic lithics, 5-10% white vitric pumice.	760-785	6726.4-6701.4
	Volcanic tuff, very pale orange (10YR 7/4), weakly welded. +10F: poor returns of this size sample fraction, composed of 95-98% intermediate volcanic (hornblende-dacite noted) lithics (up to 1 cm), angular to subrounded; 2-5% white fibrous, vitric pumice with Mn-oxide spots (up to 5 mm). +35F: 50-80% quartz and sanidine crystals, 10-25% volcanic lithics, 10-25% pumice.	785-800	6701.4-6686.4

Geologic Unit	Lithologic Description	Sample Interval (ft)	Elevation Range (ft above msl)
	Volcanic tuff, very pale orange (10YR 7/4), weakly welded. +10F: composed of varying percentages of intermediate volcanic (hornblende-dacite, andesite noted) lithics (up to 7 mm) and white fibrous, vitric pumice (up to 1 cm). +35F: 90-95% quartz and sanidine crystals, 2-5% volcanic lithics, 5-8% pumice.	800-815	6686.4-6671.4
	Volcanic tuff, very pale orange (10YR 7/4), weakly welded. +10F: composed of 30-50% varied intermediate volcanic lithics (up to 5 mm), angular to subangular; 50-70% white fibrous, vitric pumice (up to 6 mm). +35F: 50-80% quartz and sanidine crystals, 10-25% volcanic lithics, 10-25% pumice.	815-830	6671.4-6656.4
	No cuttings returns; no sample available for examination in this interval.	830-840	6656.4-6646.4
	Volcanic tuff, very pale orange (10YR 7/4), weakly welded. +10F: composed of 90-95% varied intermediate volcanic (dacite, andesite) lithics (up to 1 cm), angular to subangular, local oxide staining; 5-10% white fibrous, vitric pumice. +35F: 35-40% quartz and sanidine crystals, 10-20% volcanic lithics, 45-50% pumice.	840-865	6646.4-6621.4
	Volcanic tuff, medium light gray (N6), weakly welded. +10F: composed of 100% varied intermediate volcanic (hornblende-dacite, minor andesite) lithics, angular to subangular, trace Fe-oxide (possible limonite) staining. +35F: 5-10% quartz and sanidine crystals; 80-85% volcanic lithics, 5-10% pumice.	865-870	6621.4-6616.4
	No cuttings returns; no sample available for examination in this interval.	870-875	6616.4-6611.4
	Volcanic tuff, very pale orange (10YR 7/4), weakly welded. WR: fine ash with 50% fragments (up to 5 mm) of pumice, quartz and sanidine crystals, and volcanic lithics. +10F: composed of 70% intermediate volcanic (hornblende-dacite, andesite) lithics (up to 7 mm), angular to subangular; 30% white vitric pumice. +35F: 30-35% quartz and sanidine crystals, 30-35% volcanic lithics, 30-35% pumice.	875-890	6611.4-6596.4
	No cuttings returns; no sample available for examination in this interval. Note: the contact between Qbo and underlying Qbog is interpreted to occur at 894 ft bgs based on geophysical logging data.	890-895	6596.4-6591.4
Qbog, Guaje Pumice Bed	Volcanic tuff/tephra, very pale orange (10YR 7/4) to white (N9), weakly welded. WR: fine ash with 50% pumice (up to 1 cm), 45% intermediate volcanic lithics (up to 3 mm), and 5% quartz and sanidine crystals (up to 1 mm). +10F: composed of 90-95% intermediate volcanic lithics (up to 4 mm), angular to subangular; 5-10% white vitric pumice (up to 3 mm). +35F: 20-25% quartz and sanidine crystals, 35-40% volcanic lithics, 35-40% pumice. Note: the base of Qbog and contact with Tpf is placed at 900 ft bgs.	895-900	6591.4-6586.4

Geologic Unit	Lithologic Description	Sample Interval (ft)	Elevation Range (ft above msl)
Tpf, Puye Formation	Tephra/volcaniclastic sediments, well-graded gravel (GW), very pale orange (10YR 8/2) to white (N9). WR: made up of 95% vitric pumice fragments (up to 8 mm), 2-5% volcanic lithics, 2-5% quartz and sanidine crystals. +10F: composed of 25-30% intermediate volcanic clasts (up to 7 mm), 65-70% white vitric pumice (up to 3 mm), 5-10% quartz and sanidine crystals. +35F: 80-85% pumice, 10-15% quartz and sanidine crystals, 2-5% volcanic lithics.	900-905	6586.4-6581.4
	Volcaniclastic sediments, well-graded gravel (GW), very pale orange (10YR 8/2), up to 2.5 cm. +10F: composed of 100% intermediate volcanics (hornblende-dacite and andesite noted) clasts (up to 2.5 cm), angular to subrounded.	905-915	6581.4-6571.4
	Volcaniclastic sediments, well-graded gravel (GW), very pale orange (10YR 8/2). +10F: detrital clasts (up to 2 cm) composed of 100% intermediate volcanics (hornblende-dacite and andesite), angular to subrounded. +35F: 95-98% volcanic clasts, 1-2% pumice, 2-3% quartz and sanidine crystals.	915-935	6571.4-6551.4
	Volcaniclastic sediments, well-graded gravel (GW), grayish orange pink (5YR 7/2), gravel clasts up to 3 cm. +10F: detrital clasts composed of 100% intermediate volcanics (hornblende-dacite, andesite, and rhyolite), angular to subangular. +35F: 95-98% volcanic clasts, 2-3% tuff and pumice fragments, 1-2% quartz and sanidine crystals.	935-950	6551.4-6536.4
	Volcaniclastic sediments, well-graded sand (SW) with gravel, grayish orange pink (5YR 7/2). +10F: detrital clasts (up to 2.5 cm) composed of 100% intermediate volcanics (including hornblende-dacite and andesite), angular to subrounded. +35F: 95-98% volcanic clasts, 2-3% tuff and pumice fragments, 1-2% quartz and sanidine crystals.	950-985	6536.4-6501.4
	Volcaniclastic sediments, well-graded sand (SW) with silt and gravel, reddish brown (10R 5/4). +10F: partly subrounded detrital clasts (up to 1.8 cm) composed of 100% hornblende-biotite-dacite (dacite consists of 5-7% phenos of plagioclase, hornblende, biotite, plus pyroxene[?]). +35F: 88-90% dacite fragments, 10-12% free feldspar, hornblende, and biotite.	985-995	6501.4-6491.4
Tt Tschicoma Formation (lava/ breccia)	Dacite lava/breccia, medium gray (N5). +10F: chips (up to 2.5 cm) made up of 100% gray to white (bleached) dacite, porphyritic with aphanitic groundmass, phenocrysts (8-12% by volume) of anhedral/resorbed plagioclase, euhedral hornblende, biotite, and minor pyroxene (?); groundmass is partly bleached. +35F: 2-4% feldspar and ferromagnesian crystals, 96-98% gray and white hornblende-dacite fragments.	995-1000	6491.4-6486.4
	No cuttings returns; no sample available for examination in this interval.	1000-1015	6486.4-6471.4

Geologic Unit	Lithologic Description	Sample Interval (ft)	Elevation Range (ft above msl)
	Dacite lava/breccia, medium gray (N5) to very light gray (N8). +10F: chips (up to 1.7 cm) made up of 100% hornblende-dacite, porphyritic with aphanitic groundmass, phenocrysts (10-20% by volume) of anhedral/resorbed plagioclase, euhedral hornblende, and minor pyroxene(?). +35F: 3-4% feldspar and ferromagnesian crystals, 96-97% gray and pink-colored hornblende-dacite fragments. WR: 5% moderately cemented sandstone/siltstone fragments in the interval 1025-1030 ft bgs.	1015-1030	6471.4-6456.4
	No cuttings returns; no sample available for examination in this interval.	1030-1035	6456.4-6451.4
	Dacite lava/breccia, brownish gray (5YR 4/1). +10F: chips (up to 2.0 cm) made up of 100% hornblende-dacite, porphyritic with aphanitic groundmass, phenocrysts (7-15% by volume) of anhedral/resorbed plagioclase and euhedral hornblende; groundmass partly altered, oxidized (pink) or bleached and commonly pitted with corroded appearance. +35F: 3-4% feldspar and ferromagnesian crystals, 96-97% gray and pink-colored hornblende-dacite fragments. WR: 5% moderately cemented sandstone/siltstone fragments in the interval 1025-1030 ft bgs.	1035-1045	6451.4-6441.4
	No cuttings returns; no sample available for examination in this interval.	1045-1055	6441.4-6431.4
	Dacite lava/breccia, massive, very light gray (N8) to pale red (5YR 6/2). +10F/+35F: chips made up of 100% pinkish to white (bleached) hornblende-dacite, porphyritic with aphanitic groundmass, phenocrysts (10-15% by volume) of anhedral/resorbed plagioclase, hornblende, and pyroxene(?); groundmass moderately altered, commonly pitted and having a corroded appearance.	1055-1060	6431.4-6426.4
	Dacite lava/breccia, massive, medium light gray (N6). +10F/+35F: chips (up to 1.3 cm) made up of 100% hornblende-dacite, porphyritic with aphanitic groundmass, phenocrysts (8-12% by volume) of anhedral/resorbed plagioclase and hornblende; groundmass fresh to weakly oxidized, locally with vuggy texture.	1060-1070	6426.4-6416.4
	Dacite lava/breccia, massive, pale red (5R 6/2) to mottled pink and dark gray (N3). +10F/+35F: chips made up of 100% pinkish to white (bleached) hornblende-dacite, porphyritic with aphanitic and glassy (i.e., local vitrophyre) groundmass, phenocrysts (10-15% by volume) of anhedral/resorbed plagioclase, hornblende; groundmass moderately to strongly altered and or oxidized; pinkish groundmass exhibits corroded, vuggy appearance.	1070-1090	6416.4-6396.4

Geologic Unit	Lithologic Description	Sample Interval (ft)	Elevation Range (ft above msl)
	Dacite lava/breccia, massive, very dark gray (N3) and pale red (5R 6/2). +10F: chips made up of varieties of porphyritic pink (oxidized) and dark-colored glassy dacite (the former appears to be altered vitrophyre); phenocrysts (8-10% by volume) of plagioclase and hornblende; groundmass altered aphanitic or glassy. +35F: 1-2% plagioclase, ferromagnesian, and possible quartz (?) crystals, 98-99% pink (altered) and black vitrophyric dacite fragments.	1090-1105	6396.4-6381.4
	No cuttings returns; no sample available for examination in this interval.	1105-1110	6381.4-6376.4
	Dacite lava/breccia, massive, pale red (5R 6/2) to medium light gray (N6). +10F/+35F: chips made up of 98-99% varieties of porphyritic pink (oxidized) and gray (fresh) dacite; aphanitic groundmass, phenocrysts (10-15% by volume) of plagioclase and hornblende; groundmass weak to moderately altered, locally glassy; 1-2% rounded fragments of volcanic siltstone to fine -grained sandstone.	1110-1130	6376.4-6356.4
	Dacite lava/breccia, massive, pale red (5R 6/2) to medium light gray (N6). +10F/+35F: chips made up of varieties of pink (oxidized) and gray dacite; porphyritic with aphanitic groundmass, phenocrysts (15-20% by volume) of plagioclase, pyroxene, and hornblende; groundmass generally weakly altered. Note: dark green stubby crystals of pyroxene are more abundant downward in the section, commonly seen in cumulophyric clots with plagioclase.	1130-1150	6356.4-6336.4
	Dacite lava/breccia, massive, medium light gray (N6). +10F/+35F: chips (up to 1. 5 cm) made up of monolithologic gray dacite, porphyritic with aphanitic groundmass, phenocrysts (8-12% by volume) of plagioclase, euhedral hornblende, and minor pyroxene; groundmass fresh to weakly altered.	1150-1170	6336.4-6316.4
	No cuttings returns; no sample available for examination in this interval.	1170-1175	6316.4-6311.4
	Dacite lava/breccia, massive, medium light gray (N6). +10F/+35F: chips (up to 2.5 cm) made up of varieties of hornblende- and hornblende-pyroxene-dacite; porphyritic with aphanitic groundmass, phenocrysts (7-10% by volume) of plagioclase, hornblende and pyroxene (commonly in cumulophyric clusters); groundmass generally weakly altered. Note: mafic xenolithic inclusion (vesicular, approximately 1 cm) at 1180-1185 ft bgs.	1175-1190	6311.4-6296.4
	Dacite lava/breccia, massive, medium light gray (N6) to light gray (N7). +10F/+35F: chips (up to 7 mm) made up of gray dacite; weakly porphyritic with aphanitic groundmass, phenocrysts (3-7% by volume) of plagioclase and fine hornblende; groundmass fresh to moderately bleached.	1190-1200	6296.4-6286.4

Geologic Unit	Lithologic Description	Sample Interval (ft)	Elevation Range (ft above msl)
Tt Tschicoma Formation (massive lava)	Dacite, massive lava, medium light gray (N6) and grayish orange (10YR 7/4). +10F/+35F: chips made up of 98-99% hornblende-dacite, porphyritic with aphanitic groundmass, phenocrysts (2-5% by volume) of plagioclase and fine hornblende; groundmass commonly bleached and pitted, having a corroded appearance; 1-2% rounded fragments of yellowish tan siltstone with fine-grained sand (suggesting possible sedimentary interlayers). Note: the base of Tt lava/breccia section and contact with underlying Tt massive lavas is placed at 1206 ft bgs based on video log survey data and geophysical logs.	1200-1220	6286.4-6266.4
	Dacite, massive lava, medium light gray (N6). +10F/+35F: monolithologic chips (up to 2.0 cm) made up of gray dacite, porphyritic with aphanitic groundmass, phenocrysts (10-12% by volume) of plagioclase, pyroxene, and hornblende; groundmass weakly altered. WR: 2-5% rounded fragments of yellowish siltstone in the interval 1230-1235 ft bgs.	1220-1240	6266.4-6246.4
	Dacite, massive lava, medium light gray (N6). +10F/+35F: monolithologic chips (up to 1.0 cm) made up of porphyritic dacite with aphanitic groundmass, phenocrysts (12-15% by volume) of anhedral plagioclase, green pyroxene, and euhedral hornblende; groundmass weakly altered to fresh, partly bleached. Note: pyroxene phenocrysts, commonly in cumulophyric clusters, are generally more abundant with depth.	1240-1255	6246.4-6231.4
	Dacite lava/fine-grained sediments, medium light gray (N6) and moderate orange (5YR 8/4). +10F/+35F: chips made up of 80% weakly porphyritic dacite with aphanitic groundmass, phenocrysts (5-7% by volume) of plagioclase and hornblende; groundmass generally fresh; 20% rounded fragments (up to 1.5 cm) siltstone with fine mafic mineral sand grains.	1255-1260	6231.4-6226.4
	Dacite, massive lava, medium light gray (N6). +10F: monolithologic chips (up to 1.5 cm) made up of weakly porphyritic dacite with aphanitic groundmass, phenocrysts (8-10% by volume) of plagioclase, green pyroxene, and hornblende; groundmass generally fresh. +35F: composition similar to that of the +10F sample fraction, trace tan-colored siltstone fragments.	1260-1265	6226.4-6221.4
	Dacite lava/fine-grained sediments, medium light gray (N6) and moderate orange (5YR 8/4). +10F/+35F: chips (up to 2.0 cm) made up of 85-95% weakly porphyritic dacite with aphanitic groundmass, phenocrysts (5-8% by volume) of plagioclase and hornblende; groundmass generally fresh; 5-15% rounded fragments of volcanic(?) siltstone with fine sand grains.	1265-1280	6221.4-6206.4
	Dacite, massive lava, medium light gray (N6). +10F/+35F: monolithologic chips (up to 1.5 cm) made up of porphyritic dacite with aphanitic groundmass, phenocrysts (8-12% by volume) of plagioclase, green pyroxene, and hornblende; groundmass generally fresh, partly bleached.	1280-1295	6206.4-6191.4

Geologic Unit	Lithologic Description	Sample Interval (ft)	Elevation Range (ft above msl)
	Dacite lava/fine-grained sediments, medium light gray (N6) and moderate orange (5YR 8/4). +10F/+35F: chips made up of 75% weakly porphyritic dacite with aphanitic groundmass, phenocrysts (5-8% by volume) of plagioclase, pyroxene, and hornblende; groundmass generally fresh; 25% rounded fragments (up to 2.0 cm) of volcanic (?) siltstone with fine sand grains.	1295-1300	6191.4-6186.4
	Dacite, massive lava, medium light gray (N6). +10F: monolithologic chips (up to 1.5 cm) made up of porphyritic dacite with aphanitic groundmass, phenocrysts of plagioclase, green pyroxene, and hornblende; groundmass generally fresh.	1300-1305	6186.4-6181.4
	Dacite lava/fine-grained sediments, medium light gray (N6) and moderate orange (5YR 8/4). WR/+10F: chips made up of 70% porphyritic dacite with aphanitic groundmass, phenocrysts of plagioclase, pyroxene, and hornblende; groundmass generally fresh; 30% rounded (i.e., milled by drilling) fragments (up to 2.3 cm) of volcanic (?) siltstone with fine sand grains.	1305-1310	6181.4-6176.4
	Dacite, massive lava, medium light gray (N6). WR/+10F: poor cuttings returns, monolithologic chips made up of weakly porphyritic dacite with aphanitic groundmass, phenocrysts (7-10% by volume) of plagioclase, green pyroxene, and hornblende; groundmass generally fresh.	1310-1315	6176.4-6171.4
	Dacite lava/fine-grained sediments, medium light gray (N6) and moderate orange (5YR 8/4). WR/+10F: chips made up of 95% porphyritic dacite with aphanitic groundmass, phenocrysts (10-15% by volume) of subhedral plagioclase, dark green pyroxene (as single crystals, in cumulophyric clots, and as intergrowths with plagioclase), and hornblende; groundmass generally fresh; 5% rounded fragments (up to 5 mm) of volcanic (?) siltstone with fine sand grains.	1315-1325	6171.4-6161.4
	Dacite, massive lava, medium light gray (N6). WR/+10F: monolithologic chips made up of weakly porphyritic dacite with aphanitic groundmass, phenocrysts (10-15% by volume) of plagioclase, green pyroxene, and hornblende; groundmass fresh to weakly altered; Fe-oxide-stained altered dacite in the interval 1335-1340 ft bgs. Poor sample recovery in the interval 1325-1335 ft bgs.	1325-1340	6161.4-6146.4
	Dacite lava/fine-grained sediments, medium light gray (N6) and moderate orange (5YR 8/4). WR/+10F: chips made up of 90% porphyritic dacite with aphanitic groundmass, phenocrysts (12-17% by volume) of plagioclase, dark green pyroxene (commonly as intergrowths with plagioclase), and euhedral hornblende; groundmass generally fresh; 10% rounded fragments (up to 1 cm) of volcanic(?) siltstone with fine sand grains.	1340-1345	6146.4-6141.4

Geologic Unit	Lithologic Description	Sample Interval (ft)	Elevation Range (ft above msl)
	Dacite, massive lava, medium light gray (N6). WR/+10F: monolithologic chips made up of porphyritic dacite with aphanitic groundmass, phenocrysts (15-20% by volume) of plagioclase, green pyroxene (commonly as intergrowths with plagioclase), and hornblende; groundmass fresh to weakly altered; locally up to 2 % siltstone fragments.	1345-1365	6141.4-6121.4
	Dacite, massive lava, medium light gray (N6). WR/+10F: monolithologic chips (up to 5 mm) made up of porphyritic dacite with aphanitic groundmass, phenocrysts (10-15% by volume) of anhedral plagioclase, pyroxene (generally more abundant than hornblende), and hornblende; groundmass fresh to weakly altered.	1365-1385	6121.4-6101.4
	Dacite, massive lava, light gray (N7). WR/+10F: monolithologic chips (up to 5 mm) made up of porphyritic dacite with aphanitic groundmass, phenocrysts (15-20% by volume) of anhedral plagioclase, pyroxene, and minor hornblende; groundmass moderately to strongly altered, partly bleached.	1385-1405	6101.4-6081.4
	TOTAL BOREHOLE DEPTH (TD) IS AT 1405 FT BGS.		

Note: Descriptions presented in this lithology log are based on those made during visual examination of cuttings samples collected at 5-ft intervals while drilling the CdV-16-3(i) borehole from 0 to 1405 ft bgs.

Note: ASTM standards were used in describing the texture of drill chip samples for sedimentary rocks such as alluvium and the Puye Fanglomerate. ASTM method D 2488-90 incorporates the Unified Soil Classification System (USCS) as a standard for field examination and description of soils. The following is a glossary of standard USCS symbols used in the CdV-16-1 lithlog.

GW	Well graded gravel
SP	Poorly graded sand
SM	Silty Sand
SP-SC	Poorly graded sand with clay to clayey sand (gradational)
ML	Silt
ML-CL	Sandy silt to sandy clay (gradational)
SW	Well graded sand
SW-ML	Well-graded sand with silt to silt (gradational)
SW-SC	Well-graded sand with clay to sand clay (gradational)
SW-SM	Well-graded sand with silt to silty sand (gradational)

Note: Cuttings were collected at nominal 5-ft intervals and divided into three sample splits: (1) unsieved, or whole rock (WR), sample; (2) +10F sieved fraction (No. 10 sieve equivalent to 2.0 mm); and (3) +35F sieved fraction (No. 35 sieve equivalent to 0.50 mm).

Note: The term "per cent" (%), as used in the above descriptions, refers to relative abundance by volume for a given sample component.

Note: Contact locations are based on cuttings retrieval. There is general agreement between this borehole log and the geophysics report.

REFERENCE:

ASTM D 2488-90. Standard Practice and Identification of Soils (Visual-Manual Procedure)

Geologic Society of America, 1995, Rock-color chart with genuine Munsell color chips, 8th printing.

Appendix E

NMED Discharge Approval
(Discharge Media Analytical Results included on CD)

Bob:

This email confirms NMED approval for the discharge of drilling and development water from Workplan Well CdV-16-3(i) (described below). The
drilling and development water must be discharged as described in the Hydrogeologic Workplan NOI dated July 16, 2002.

Curt Frischkorn
NMED Ground Water Quality Bureau

-----Original Message-----
From: Enz, Robert D. [mailto:renz@doeal.gov]
Sent: Thursday, March 18, 2004 8:49
To:
'curt_Frischkorn@nmenv.state.nm.us';'john_young@nmenv.state.nm.us'
Cc: 'bbeers@lanl.gov'; 'bbockisch@kleinfelder.com'; Whitacre, Thomas; Johansen, Mathew
Subject: Land Application of Drilling and Development Water From CdV-16-3(i)

Dear Curt and John,

I am transmitting the analytical screening data from the sampling of Workplan Well CdV-16-3(i) drilling and development water. Workplan Well CdV-16-3(i) is located on the mesa top at TA-16, southeast of R-25.

Approximately 33,000 gallons of drilling and development water was recently produced during the construction of CdV-16-3(i). The details are as follows.

Pit Water Approximately 33,000 gallons of drilling and development water are being stored in a lined pit at the CdV-16-3(i) drill site. Screening
analysis of the pit water produced the following results:

1) No PCBs were detected at concentrations greater than Method Detection Limits.
2) No VOAs were detected with the exception of 1-Methlynaphthalene (1300 ppb) and 2-Methlynaphthalene (2000 ppb). Hall Environmental Analysis Laboratory (HEAL) believes that the observed methylnaphthalene concentrations were likely carried over from previous unrelated samples that were analyzed prior to our samples. The presence of foam in the samples caused the lab to use a relatively high sample dilution factor. This helped to prevent the sample

from foaming during extraction. If a small amount of contaminant was carried over from a previous sample, the quantified concentration would look much bigger due to the large dilution factor. This appears to be substantiated because the results of the 8270 SVOC analysis did not indicate the presence of methylnaphthalenes at a much lower PQL and a dilution factor of 1.

3) No SVOAs were detected in the sample with the exception of Bis(2-ethylhexyl)phthalate at 200 ppb. HEAL stated that this contaminate typically originates from using latex gloves during sample collection. Kleinfelder did use latex gloves during sample collection since this is their standard operating procedure.
4) Gross alpha activity is 6.31 pCi/L (+/-1.84 pCi/L), below the EPA drinking water MCL of 15 pCi/L.
5) Tritium results were non detect (DL=408 pCi/L).
6) Perchlorate results are still pending. However, no perchlorate is expected at this location since both CdV-16-1(i) and CdV-16-2(i) were non detect.
7) Screening results show that no contaminants exceeded NM WQCC Regulation 3103 ground water standards with the exception of the following:

Al=10.1 ppm (ground water std=5.0 ppm)
Fe=5.6 ppm (ground water std=1.0 ppm)
Mn=0.97 ppm (ground water std=0.2 ppm)

DOE proposes to land apply the CdV-16-3(i) drilling and development water along the sides of the paved roads in the vicinity of the burning grounds and the roads located to the west of the Nakamu Road. This water would be spray applied to the unpaved ground located adjacent to the roads. The application will be conducted in accordance with the terms and conditions of the Hydrogeologic Workplan NOI.

Please contact me at 667-7640 or Bob Beers at 667-7969 (office) or 699-2342 (cell) should you have any questions regarding this notification. This notification will be formally transmitted to you via a letter signed by Mat Johansen, DOE Ground Water Compliance Manager.

Bob Enz

Activity	Addendum to CMS Plan for PRS 16-021 (c)[1]	Scope of Services for CdV-16-3(i) GSA Task Order 9T3N163PG	CdV-16-3(i) Actual Work
Planned Depth	Approximately 800 ft - 1000 ft bgs or into the top of the deep perched zone where present.	Planned TD of 900 ft bgs, approximately 50 ft below the anticipated perched water zone, assumed to be at 850 ft bgs. If perched zone is not encountered, the borehole will be advanced into the regional water table estimated at 1284 ft bgs.	CdV-16-3(i) drilled to 1405 ft bgs TD, approximately 550 feet into the predicted deep-perched zone.
Drilling Method	Methods may include, but are not limited to HSA, air-rotary/Odex/Stratex, air-rotary/Barber rig, and mud-rotary drilling	Not specified in the Scope of Services.	CdV-16-3(i) drilled using fluid-assisted, open-hole, air- rotary methods.
Amount of Core	10% of the borehole	No coring was required in the Scope of Services for CdV-16-3(i).	No coring was performed at CdV-16-3(i)
Lithologic Log	Log to be prepared from core, cuttings and drilling performance	Log to be prepared from data provided by cuttings, geophysical logs, and drilling performance.	The CdV-16-3(i) lithlog was prepared from cuttings samples in the interval 0-1405 ft. Interpretation of geophysical logs and determination of unit contacts was provided by LANL EES-6.
Number of Water Samples Collected for Contaminant Analysis	Not specified.	If perched water is encountered in the unsaturated zone, ground water samples to be collected from each perched zones for screening analysis. Groundwater samples from the regional aquifer were not specified in the Scope of Services.	No water samples were obtained from the vadose zone because no perched zones were encountered. One (1) screening sample collected at 1400.5 ft bgs (no analysis performed). A second screening sample was collected at 1385 ft bgs and was analyzed for inorganic constituents.
Water Sample Analysis	HE, metals, anions (nitrate, sulfate, perchlorate) fluoride, chloride, bromide, HCO_3 (bicarbonate), Volatile organic compounds, Gross alpha/beta	Analytes not specified in the Scope of Services.	Two (2) water samples were collected but neither were analysed for the specified analytes per LANL personnel. One sample was analyzed for inorganic constituents.
Water Sample Field Measurements	Alkalinity, pH, specific conductance, temperature, turbidity	Carbonate alkalinity, pH, specific conductance, temperature, turbidity	No field parameters measured.
Number of Core/Cuttings Samples Collected for Contaminant Analysis	Not specified.	No coring was required in the Scope of Services for CdV-16-3(i).	No core/cuttings samples were collected for contaminant analysis.
Core/Cuttings Sample Analytes	HE, metals, anions (nitrate, sulfate, perchlorate) fluoride, chloride, bromide, HCO_3 (bicarbonate), Volatile organic compounds, Gross alpha/beta	No coring was required in the Scope of Services for CdV-16-3(i).	No core/cuttings samples were collected for contaminant analysis.
Laboratory Hydraulic-Property Tests	Physical properties analyses will be conducted on 5 core samples and will typically include: moisture content, porosity, particle density, bulk density, saturated hydraulic conductivity, and water retention characteristics.	Not specified in the Scope of Services.	No Laboratory Hydraulic-Property Tests were performed.
Geology	Ten samples of core or	The geology task leader to determine	Seven (7) samples of cuttings were

Activity	Addendum to CMS Plan for PRS 16-021 (c)[1]	Scope of Services for CdV-16-3(i) GSA Task Order 9T3N163PG	CdV-16-3(i) Actual Work
	cuttings will be collected for petrographic, X-ray fluorescence (XRF) and X-ray diffraction (XRD) analyses.	the number of samples for characterization of mineralogy, petrography, and geochemistry based on geologic and hydrologic conditions encountered during drilling.	collected and submitted for analysis for mineralogy, petrography, and geochemistry
Geophysics	In general, open-hole geophysics includes caliper, electromagnetic induction, natural gamma, magnetic susceptibility, borehole color videotape (axial and sidescan), fluid temperature (saturated), single-point resistivity (saturated), and spontaneous potential (saturated). In general, cased-hole geophysics includes: gamma-gamma density, natural gamma, and thermal neutron.	Typical wireline logging service as planned: open-hole geophysics includes array induction imager, triple lithodensity, combinable magnetic resonance tool, natural gamma, natural gamma ray spectrometry, epithermal compensated neutron log, caliper, full-bore formation micro-imager, elemental capture spectrometer and borehole video. In general, cased-hole geophysics includes triple lithodensity, natural gamma, natural gamma spectrometry, epithermal compensated neutron log, elemental capture spectrometer.	Schlumberger geophysical logging surveys conducted at CdV-16-3 (i) included: Compensated Neutron Tool: *Cased: none* *Open Hole: 14 – 1404 ft bgs* Triple Litho-Density: *Cased: none* *Open Hole: 14 – 1404 ft bgs* Array Induction Tool: *Cased: none* *Open Hole: 14 – 1098 ft bgs* Elemental Capture Spectroscopy: Cased: none *Open Hole: 14 – 1399 ft bgs* Natural Gamma Spectroscopy: Cased: none *Open hole: 14 – 1382 ft bgs* Combinable Magnetic Resonance: Cased: none *Open Hole: 14 – 1386 ft bgs* *Gamma Ray:* Cased: none *Open Hole: 14 – 1386 ft bgs* *Full-bore Fm Micro-imager:* Cased: none *Open Hole: none, no water*
Water-Level Measurements	Not specified	Water levels will be determined for each saturated zone by water-level meter or by pressure transducer.	Electric water level meter (sounder) used to measure zones of perched and regional saturation (i.e., attempted measurements)
Field Hydraulic-Property Tests	Not specified.	Slug or pumping tests may be conducted in saturated intervals once the well is completed.	No field hydraulic-property tests were performed at tests at CdV-16-3(i). A January 17, 2004, video log performed in the open CdV-16-3(i) borehole indicated no water entering, or accumulated in, the borehole. Groundwater is currently being monitored in the open CdV-16-3(i) borehole.
Shallow Piezometers	Not specified.	Not specified.	A shallow piezometer was not installed at CdV-16-3 (i).
Surface Casing	Approximately 16-in. outer diameter (OD) extends from land surface to 10-ft depth in underlying competent layer and grouted in place.	Not specified.	13 $^{3}/_{8}$-in. OD steel casing was installed to 12 ft bgs and remains in place. The borehole is currently capped with a steel top plate fitted with an access port.
Minimum Well Casing Size	5.56-in. OD	4-in. diameter, 304 grade stainless steel casing.	No well casing installed.
Well Screen	Number and length of screens to be determined on	4-in. diameter, 304 grade stainless steel well screen, estimated to be 10 ft	No well installed.

Activity	Addendum to CMS Plan for PRS 16-021 (c)[1]	Scope of Services for CdV-16-3(i) GSA Task Order 9T3N163PG	CdV-16-3(i) Actual Work
	a site-specific basis and proposed to NMED	long.	
Sump Backfill	Stainless-steel casing with an end cap Uncontaminated drill cuttings below sump and bentonite above sump	Not specified. Not specified.	No well installed. No well installed.
Filter Material	Filter pack shall be sized based on formation grain size and characteristics and extend no more than 2 ft above and 2 ft below the screened interval.	Not specified.	No well installed.
Transition Seal	Not specified.	Not specified.	No well installed.
Bentonite Seal	Not specified.	Not specified.	No well installed.
Concrete Backfill	Not specified.	Not specified.	No well installed.

Los Alamos
NATIONAL LABORATORY

October 2003

TA-16-220 COMPLEX D&D
Demolition Completion Report

Project Leader: Dan Broughton

Team Leader: Gilbert Montoya

Deactivation and Decommissioning (D&D) Program
Demolition of TA-16-220 Complex

FINAL REPORT

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The TA16-220 Complex D&D Project consisted of the removal of eighteen (18) stucco/masonry structures comprising a total of 51,489 square feet. These facilities occupied space at Technical Area 16 (TA-16). Re-vegetation, site contouring, site drainage, and soil stabilization were accomplished upon completion of the demolition activity.

Key project points:

1. The authorized funding level, acquired through Facilities & Infrastructure Re-capitalization Program (FIRP), was $4,650,000. Total Project Cost was $4,120,000. An RPA was submitted for the $530,000 delta.
2. There were no accidents, incidents, or occurrences during execution of the project.
3. The Project recycled 7,107 cu yd of recyclable materials and various reuse materials through the demolition subcontractor (see appendix A).
4. Demolition began on December 04, 2002. All physical work, including punch-list corrections, concluded on July 09, 2003. This completed the project execution phase.

1.0 INTRODUCTION

The complex is on the eastern slopes of the Jemez Mountains in northern New Mexico at an elevation of 7500 to 7600 feet. The complex is behind a security area as well as the controlled High Explosives area. The security stations control access to the site and the HE access control office at TA-16 Building 202. The area is lightly wooded with Ponderosa pine with some burned areas from the Cerro Grande Fire that occurred in 2000.

The TA16-220 complex encompasses approximately 23 acres and eight buildings. Seven buildings were constructed in the early 50's to work on High Explosives (HE). HE components were brought into the rest houses and taken to the x-ray buildings for radiographic. The x-ray film was then processed at the dark building. In the 1990's, a boiler was constructed at the complex to replace the steam generated by the main steam plant (TA-16-540).

The complex is designed like a hub and spokes, the hub being the film development building, spokes being the passageways, and the rest houses and x-ray buildings at the end of passageways or at the rim. To protect and direct accidental explosions, earthen barriers are constructed next to the buildings. Various utilities are networked throughout the complex to service the buildings. The buried steam lines and manholes were abandoned when a steam boiler was constructed to service this complex in the 1990's. Asphalt paved roadways and parking areas existed to service this complex.

2.0 SCOPE OF WORK

The definitive scope of work for this project was identified in the "Excess Facilities Program Project Baseline; Demolition of TA16-220 Complex", submitted to the LANL Program Office on March 29, 2002, for submission to DOE.

3.0 SAFETY

There were no safety incidents during the project.

4.0 PROJECT MANAGEMENT & OVERSIGHT

This project was managed by the Facility & Waste Operations Division Solid Waste Operations–Deactivation & Decommissioning team (SWO-D&D). Scientech, Inc. and their subcontractors were responsible for performing the actual demolition of the facility.

Responsible individuals on this project included:

SWO-D&D Group Leader	Ray Hahn
SWO-D&D Team Leader	Gilbert Montoya
SWO-D&D Project Leader	Dan Broughton
HSR-5, Health & Safety	Robert Baran
Waste Management Coordinator	Vince Rodriquez
Scientech Inc., Project Manager	Barry Sims
Scientech Inc., Project Superintendent	Pat Horkman
Scientech Inc., Project Safety Officer	Darren Merrill

5.0 WASTE OPERATIONS

Waste streams generated and managed during this project included:

- Friable ACM removed was thermal systems insulation (TSI).
- Non-friable ACM removed was built-up roofing.
- Wood trim and entry/exit doors contaminated with lead-based paint.
- Concrete debris.
- Wood debris.
- Scrap metals.
- PCBs.

Appendix A contains a detailed description of estimated and actual waste materials, recycled/reused materials, and excess equipment disposition.

6.0 FINAL SITE CONDITION

The site was returned to prevailing local grade, seeded, and left as "open space." See *Appendix C*. (NOTE: Additional photographs are attached containing site preparation and demolition phase activities).

7.0 COSTS

The contract did not meet Davis-Bacon Act criterion. This project falls under the Service Contract Act, therefore a labor breakdown by the contractor(s) was not required. However, the following table identifies LANL costs for pre-planning, planning (including SHPO, RCT, High Explosive (HE) SME/Certifying Official (CO), Estimating, Project Controls, Utility Mapping, As-Built Drawing retrieval, etc.), characterization/analytical results, project management/oversight, and close-out. (NOTE: Project management included the following personnel/support from planning through close out: Project Leader (PL), IH/Safety, HE SME/Certifying Official, project controls, budget analysts, and illustrator).

LABOR CATEGORIES	K$$
PROJECT MANAGEMENT (INCLUDES PL AND ADMIN SUPPORT FOR 02/03 PLUS 02 SUPPORT FROM PROJECT CONTROLS/STORM WATER GROUP/ECO GROUP/SSS ENG/).	400K
PROJECT CONTROLS	45K
*STORM WATER POLLUTION PREVENTION PROGRAM/INSPECTIONS	47K
HEALTH PHYSICISTS	NO COST
SITE HISTORICAL PRESERVATION (SHPO)	62K
* CHARACTERIZATION/ANALYTICAL	130K
INDUSTRIAL HYGIENE/SAFETY SUPPORT	88K
RADIOLOGICAL CONTROL TECHNICIANS	5K
WASTE MANAGEMENT COORDINATORS	NO COST
* QUALITY ASSURANCE SPECIALISTS (ONE TIME COST TO BUILD QA PROGRAM FOR FUTURE PROJECTS)	190K
BUDGET ANALYST/COST CONTROL	10K
ILLUSTRATOR	58K
* ESTIMATORS	50K
** ENGINEERS (VARIOUS DISCIPLINES)	100K
** UTILITY DISCONNECTS (PRE EXECUTION PHASE)	180K
** SITE PREP (TEMP UTILITY HOOK-UPS FOR CONTRACTOR'S FIELD OFFICE & CREW TRAILER)	100K
** SITE DE-MOBILIZATION (REMOVE TEMP SVC)	100K
* FENCE CONTRACT (BUBBLED-OUT SECURITY AREA)	120K
TOTAL	1,685K

* Contracted support. ** Support Service Sub-Contractor (In-house)

The Project Final Report is in progress at this time. Project cost breakdown to date:

TOTAL EST COST:	$4,650,000.00 (With 10% contingency – $465K)
TOTAL COSTS TO DATE:	$4,120,000.00 (**Includes LANL** Cost & FY02)
CONTRACTOR COST:	$2,434,652.58 (Demolition Contract/Execution Phase)
DELTA (RPA Pending):	$530,000.00 (Includes 10% contingency - $465K)

8.0 CHANGE ORDER DESCRIPTION

There was one change order for a reduction in contract costs. This reduction was based on a decision to leave earthen blast berms in place. As identified in the as-built drawings, the top six (6) inch layer of the blast berms were saturated with clean motor oil, suspected as an erosion and stabilization measure. Disturbing the berms would have created a hazardous waste stream and would have added removal and disposal costs to the project. Since the oil was part of an engineered design, left intact the soil does not pose an environmental concern. This cost change resulted in a reduction of ~$25,000 from the original contract award.

9.0 PROJECT SCHEDULE PERFORMANCE

The execution phase, primarily the contractor's planned and actual performance schedule, are attached (see Appendix B).

10.0 LESSONS LEARNED

- Clearly identify within the Statement of Work (SOW) the type, number, and frequency of personal and area monitoring requirements associated with industrial hygiene hazards. Ensure the requirements are incorporated into the contractor's Site Specific Health and Safety Plan (SSHASP).
- Readiness review items with a post-operational date must be met, or a stop work clause imposed for non-compliance, without cost to the customer.
- Characterization of frame structures should identify hanta virus hazards within the framing. This framing is typically inaccessible during non-destructive characterization activity. The likelihood of hanta virus is very high based on the location of these old abandoned facilities.
- As a means of continuous communication between project supervision and teamsters/drivers, ensure two-way radios or cellular telephones are provided to the teamsters/drivers during off-site hauling activities.
- Incorporate hold points, with verification and approvals, in contractor's Task Hazard Analyses (THA) and/or Activity Hazard Analyses (AHA) for critical and/or life-threatening activities.

11.O ACKNOWLEDGEMENTS

We would like to thank the following companies and personnel for their work and efforts during the project:

Contractors – JCNNM, KSL, Scientech Inc., SG Western,
Keers Abatement and their employees.
Technical Assistance – Taunia Wilde, Stoller Corporation
Illustrations – Patricia Leyba
Safety – Dr. Robert Baran
Project Controls – Denise Borrego, Fernando Quintana, Peter Stillwell
Budget Analysis – Angelic Trujillo

12.0 APPENDICES

Appendix A: Waste Streams

Appendix B: Schedules

Appendix C: Site Restoration with Additional Phase Photos

APPENDIX A

Waste Materials

WASTE STREAM	ESTIMATED VOLUME	ACTUAL VOLUME	DISPOSAL FACILITY
Clean ACM	300 CY	635 CY	Keers Environmental Monofill
Hazardous Waste	16 – 55 gallon drums	None	NA
Demolition Debris	1500 CY	732 CY	LA Co. Landfill

The significant difference between the estimated and actual volume of ACM waste is attributed to the unexpected presence of multiple layers of ACM roofing materials. Waste from Building 222 chemical trench decontamination was sampled and found to be non-hazardous, accounting for the significant reduction in estimated hazardous waste volume. Reduction in demolition debris is attributed to waste minimization practices imposed during the demolition process. The types and quantities of recycled-reused materials are listed in the following table.

Recycled and Reused Materials

ITEM	ESTIMATED AMOUNT	ACTUAL AMOUNT	DISPOSITION
Scrap Metal	2000 CY	2000 CY	Recycled by Ace Metals
Concrete	5047 CY	5,047 CY	Crushed and reused by LANL as roadway material
Oak Planking	10,000 LF	10,000 LF	Reused for barns, corrals and cabinets
Mineral Oil	250 gallons	250 gallons	Recycled at Houstiens Oil
Building 1482	20 ft x 20 ft	20 ft x 20 ft	Disassembled and donated to SG Western employee
Asphalt	60 CY	60 CY	Milled and reused by SG Western as roadway material
Utility Poles	Originally estimated as waste.	24	Donated to Los Alamo Ski Hill and White Rock Skate Board Park
Pre-existing control Fencing around transformer pads.	Originally estimated as waste.	~200 LF	Donated to SG Western employee for Wolf Pen
Work benches, desks, shelves, metal cabinets, and metal doors		4 benches, 8 desks, 200sf shelving, 10 metal doors.	Donated to Habitat for Humanity

EXCESS EQUIPMENT DISPOSITION

The following excess equipment was salvaged for donation to Habitat for Humanity:

- Three Electric Hoists
- Six air compressors
- Four 110 v water heaters
- Interior and exterior lighting

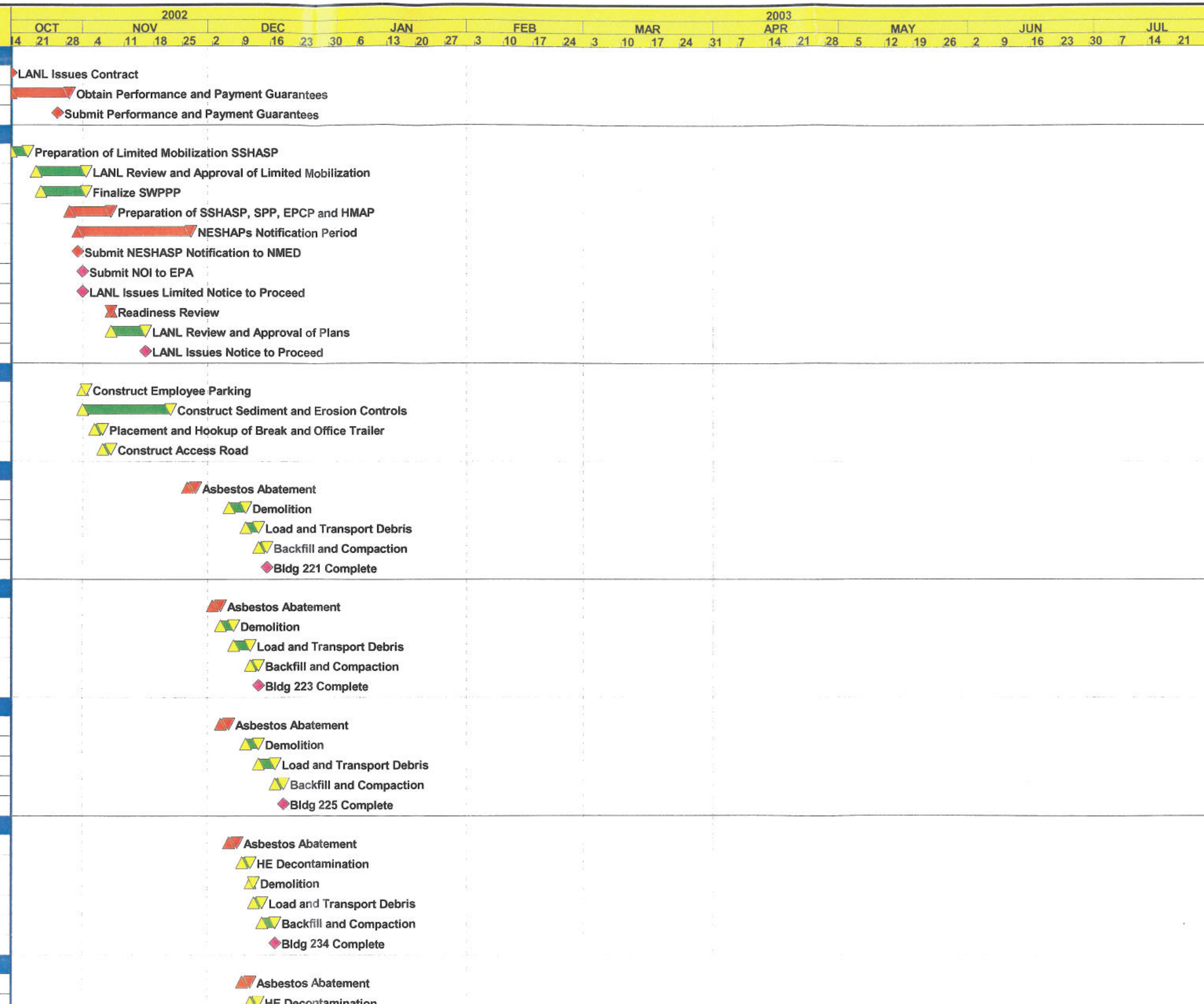
NOTE: The project was nominated, and received, a 2003 Pollution Prevention (P2) Award for significant contributions to waste minimization through recycling/re-use processes.

APPENDIX B

Schedules (attached)

220 COMPLEX D&D
Figure 2 - Planned Schedule

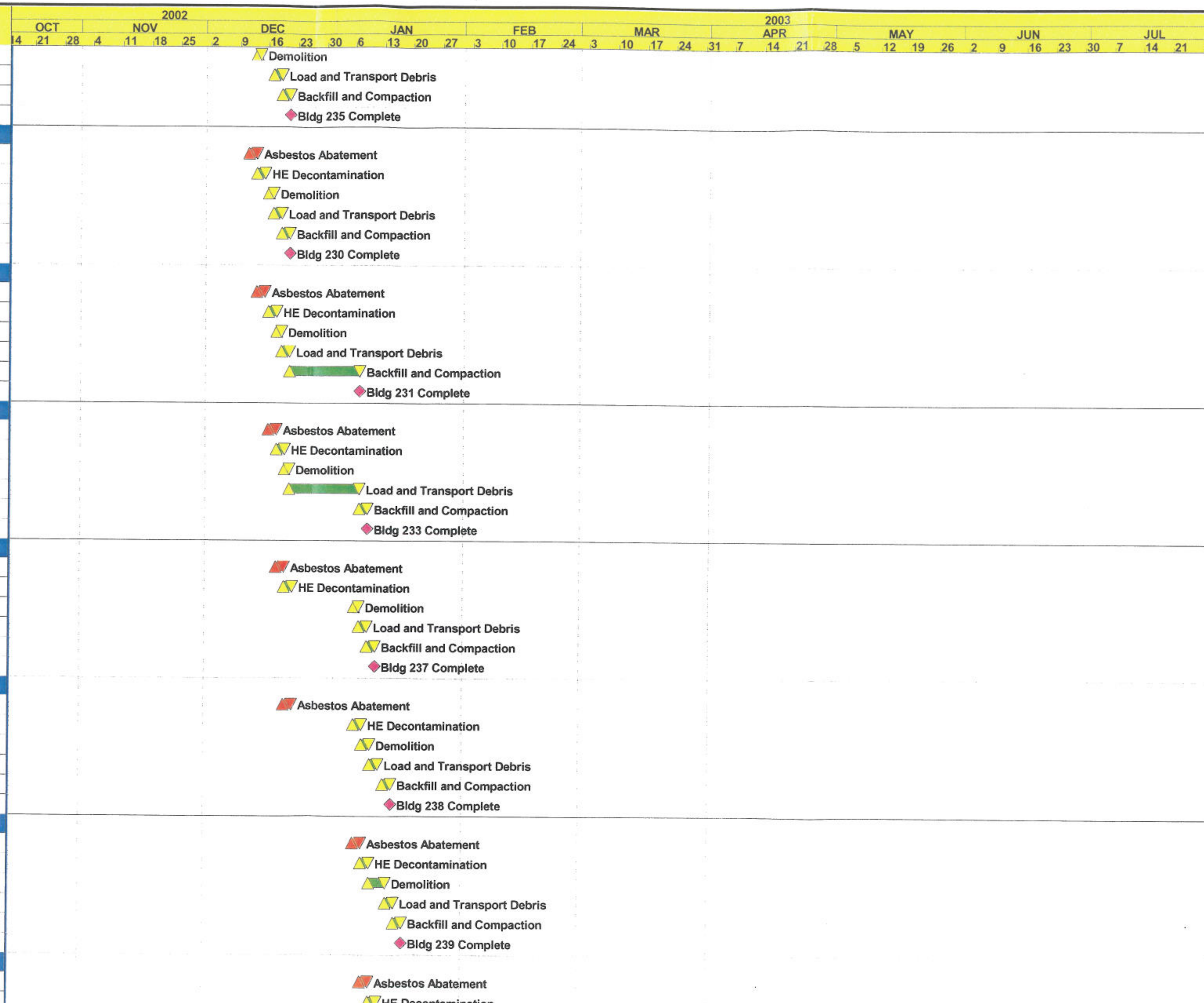
Activity ID	Activity Description	Orig Dur	Early Start	Early Finish
Project Start-up Activities				
0001	LANL Issues Contract	0	15OCT02*	
0002	Obtain Performance and Payment Guarantees	10	15OCT02	28OCT02
0003	Submit Performance and Payment Guarantees	0		25OCT02
Preparation and Approval of Plans				
0004	Preparation of Limited Mobilization SSHASP	4	15OCT02	18OCT02
0005	LANL Review and Approval of Limited Mobilization	10	21OCT02	01NOV02
0006	Finalize SWPPP	9	22OCT02	01NOV02
0011	Preparation of SSHASP, SPP, EPCP and HMAP	8	29OCT02	07NOV02
0010	NESHAPs Notification Period	21	31OCT02	26NOV02
0020	Submit NESHASP Notification to NMED	0	31OCT02	
0007	Submit NOI to EPA	0		31OCT02
0008	LANL Issues Limited Notice to Proceed	0		31OCT02
0013	Readiness Review	0	08NOV02	07NOV02
0012	LANL Review and Approval of Plans	6	08NOV02	15NOV02
0014	LANL Issues Notice to Proceed	0		15NOV02
Site Mobilization				
0018	Construct Employee Parking	1	01NOV02	01NOV02
0019	Construct Sediment and Erosion Controls	16	01NOV02	21NOV02
0016	Placement and Hookup of Break and Office Trailer	2	04NOV02	05NOV02
0017	Construct Access Road	2	06NOV02	07NOV02
Building 221 - Rest House				
0022	Asbestos Abatement	2	26NOV02	27NOV02
0023	Demolition	3	06DEC02	09DEC02
0024	Load and Transport Debris	3	10DEC02	12DEC02
0025	Backfill and Compaction	2	13DEC02	14DEC02
0026	Bldg 221 Complete	0		14DEC02
Building 223 - Rest House				
0028	Asbestos Abatement	2	02DEC02	03DEC02
0029	Demolition	3	04DEC02	06DEC02
0030	Load and Transport Debris	3	07DEC02	10DEC02
0031	Backfill and Compaction	2	11DEC02	12DEC02
0032	Bldg 223 Complete	0		12DEC02
Building 225 - Rest House				
0034	Asbestos Abatement	2	04DEC02	05DEC02
0035	Demolition	3	10DEC02	12DEC02
0036	Load and Transport Debris	3	13DEC02	16DEC02
0037	Backfill and Compaction	2	17DEC02	18DEC02
0038	Bldg 225 Complete	0		18DEC02
Building 234 - Passageway				
0040	Asbestos Abatement	2	06DEC02	07DEC02
0041	HE Decontamination	2	09DEC02	10DEC02
0042	Demolition	1	11DEC02	11DEC02
0043	Load and Transport Debris	2	12DEC02	13DEC02
0044	Backfill and Compaction	2	14DEC02	16DEC02
0045	Bldg 234 Complete	0		16DEC02
Building 235 - Passageway				
0047	Asbestos Abatement	2	09DEC02	10DEC02
0048	HE Decontamination	2	11DEC02	12DEC02



SCIENTECH, Inc

Run Date 07JUL03 16:54

Activity ID	Activity Description	Orig Dur	Early Start	Early Finish
0049	Demolition	1	13DEC02	13DEC02
0050	Load and Transport Debris	2	17DEC02	18DEC02
0051	Backfill and Compaction	2	19DEC02	20DEC02
0052	Bldg 235 Complete	0		20DEC02
Building 230 - Passageway				
0054	Asbestos Abatement	2	11DEC02	12DEC02
0055	HE Decontamination	2	13DEC02	14DEC02
0056	Demolition	1	16DEC02	16DEC02
0057	Load and Transport Debris	2	17DEC02	18DEC02
0058	Backfill and Compaction	2	19DEC02	20DEC02
0059	Bldg 230 Complete	0		20DEC02
Building 231 - Passageway				
0061	Asbestos Abatement	2	13DEC02	14DEC02
0062	HE Decontamination	2	16DEC02	17DEC02
0063	Demolition	1	18DEC02	18DEC02
0064	Load and Transport Debris	2	19DEC02	20DEC02
0065	Backfill and Compaction	2	21DEC02	06JAN03
0066	Bldg 231 Complete	0		06JAN03
Building 233 - Passageway				
0068	Asbestos Abatement	2	16DEC02	17DEC02
0069	HE Decontamination	2	18DEC02	19DEC02
0070	Demolition	1	20DEC02	20DEC02
0071	Load and Transport Debris	2	21DEC02	06JAN03
0072	Backfill and Compaction	2	07JAN03	08JAN03
0073	Bldg 233 Complete	0		08JAN03
Building 237 - Passageway				
0075	Asbestos Abatement	2	18DEC02	19DEC02
0076	HE Decontamination	2	20DEC02	21DEC02
0077	Demolition	1	06JAN03	06JAN03
0078	Load and Transport Debris	2	07JAN03	08JAN03
0079	Backfill and Compaction	2	09JAN03	10JAN03
0080	Bldg 237 Complete	0		10JAN03
Building 238 - Passageway				
0082	Asbestos Abatement	2	20DEC02	21DEC02
0083	HE Decontamination	2	06JAN03	07JAN03
0084	Demolition	2	08JAN03	09JAN03
0085	Load and Transport Debris	2	10JAN03	11JAN03
0086	Backfill and Compaction	2	13JAN03	14JAN03
0087	Bldg 238 Complete	0		14JAN03
Building 239 - Passageway				
0089	Asbestos Abatement	2	06JAN03	07JAN03
0090	HE Decontamination	2	08JAN03	09JAN03
0091	Demolition	3	10JAN03	13JAN03
0092	Load and Transport Debris	2	14JAN03	15JAN03
0093	Backfill and Compaction	2	16JAN03	17JAN03
0094	Bldg 239 Complete	0		17JAN03
Building 232 - Elevated Passageway				
0096	Asbestos Abatement	2	08JAN03	09JAN03
0097	HE Decontamination	2	10JAN03	11JAN03



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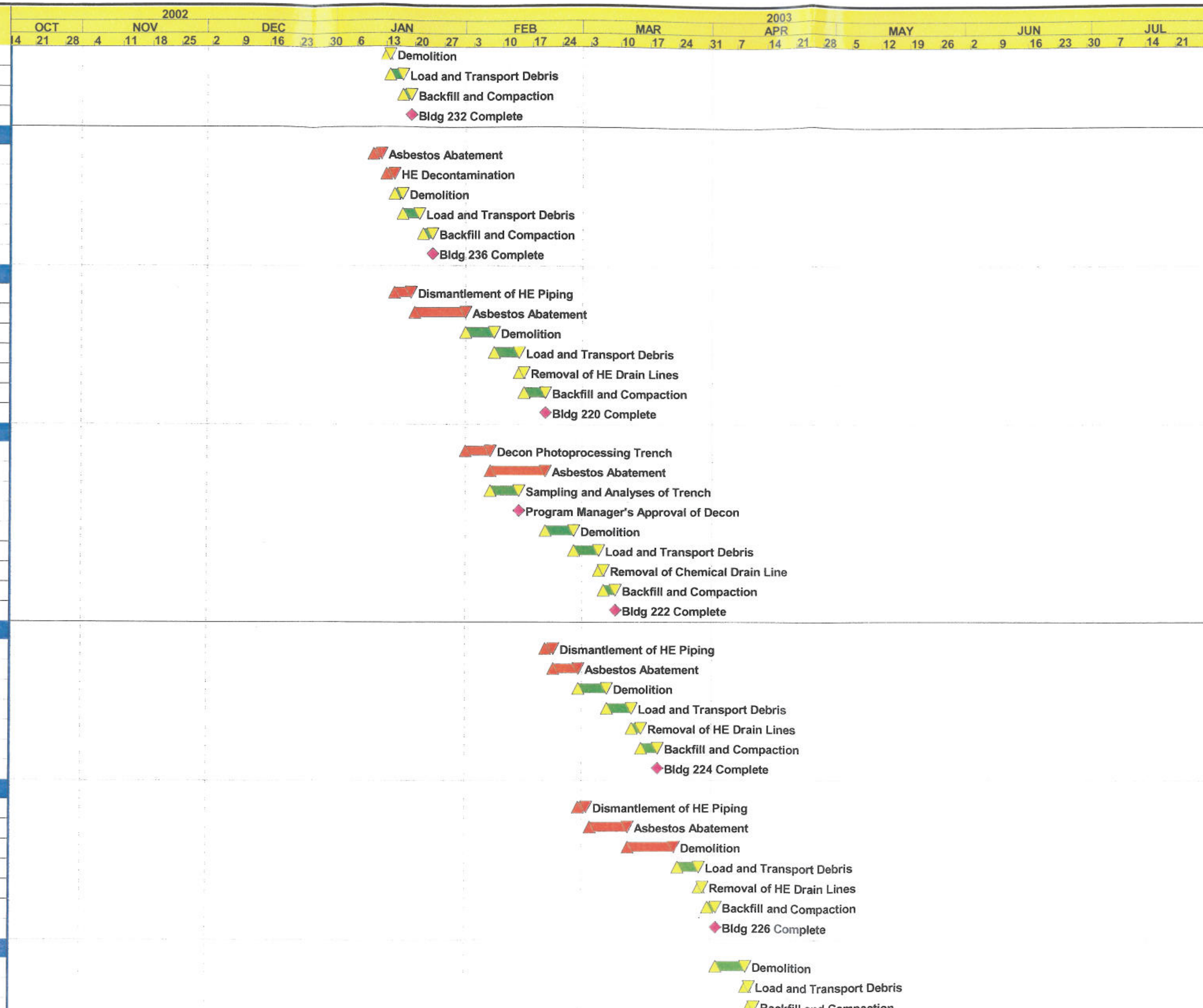
220 COMPLEX D&D

Figure 2 - Planned Schedule

Run Date 07JUL03 16:54

Activity ID	Activity Description	Orig Dur	Early Start	Early Finish
0098	Demolition	1	13JAN03	13JAN03
0099	Load and Transport Debris	3	14JAN03	16JAN03
0100	Backfill and Compaction	2	17JAN03	18JAN03
0101	Bldg 232 Complete	0		18JAN03
Building 236 - Elevated Passageway				
0103	Asbestos Abatement	2	10JAN03	11JAN03
0104	HE Decontamination	2	13JAN03	14JAN03
0105	Demolition	2	15JAN03	16JAN03
0106	Load and Transport Debris	3	17JAN03	20JAN03
0107	Backfill and Compaction	2	22JAN03	23JAN03
0108	Bldg 236 Complete	0		23JAN03
Building 220 - X-Ray				
0110	Dismantlement of HE Piping	4	15JAN03	18JAN03
0111	Asbestos Abatement	10	20JAN03	31JAN03
0112	Demolition	6	01FEB03	07FEB03
0113	Load and Transport Debris	5	08FEB03	13FEB03
0114	Removal of HE Drain Lines	1	14FEB03	14FEB03
0115	Backfill and Compaction	3	15FEB03	19FEB03
0116	Bldg 220 Complete	0		19FEB03
Building 222 - Darkroom				
0118	Decon Photoprocessing Trench	5	01FEB03	06FEB03
0121	Asbestos Abatement	10	07FEB03	19FEB03
0119	Sampling and Analyses of Trench	6	07FEB03	13FEB03
0120	Program Manager's Approval of Decon	0	14FEB03	
0122	Demolition	6	20FEB03	26FEB03
0123	Load and Transport Debris	5	27FEB03	04MAR03
0124	Removal of Chemical Drain Line	1	05MAR03	05MAR03
0125	Backfill and Compaction	3	06MAR03	08MAR03
0126	Bldg 222 Complete	0		08MAR03
Building 224 - X-Ray				
0128	Dismantlement of HE Piping	2	20FEB03	21FEB03
0129	Asbestos Abatement	5	22FEB03	27FEB03
0130	Demolition	6	28FEB03	06MAR03
0131	Load and Transport Debris	5	07MAR03	12MAR03
0132	Removal of HE Drain Lines	2	13MAR03	14MAR03
0133	Backfill and Compaction	3	15MAR03	18MAR03
0134	Bldg 224 Complete	0		18MAR03
Building 226 - X-Ray				
0136	Dismantlement of HE Piping	2	28FEB03	01MAR03
0137	Asbestos Abatement	8	03MAR03	11MAR03
0138	Demolition	10	12MAR03	22MAR03
0139	Load and Transport Debris	5	24MAR03	28MAR03
0140	Removal of HE Drain Lines	1	29MAR03	29MAR03
0141	Backfill and Compaction	2	31MAR03	01APR03
0142	Bldg 226 Complete	0		01APR03
Building 1482 - Morgan Building				
0144	Demolition	6	02APR03	08APR03
0145	Load and Transport Debris	1	09APR03	09APR03
0146	Backfill and Compaction	1	10APR03	10APR03



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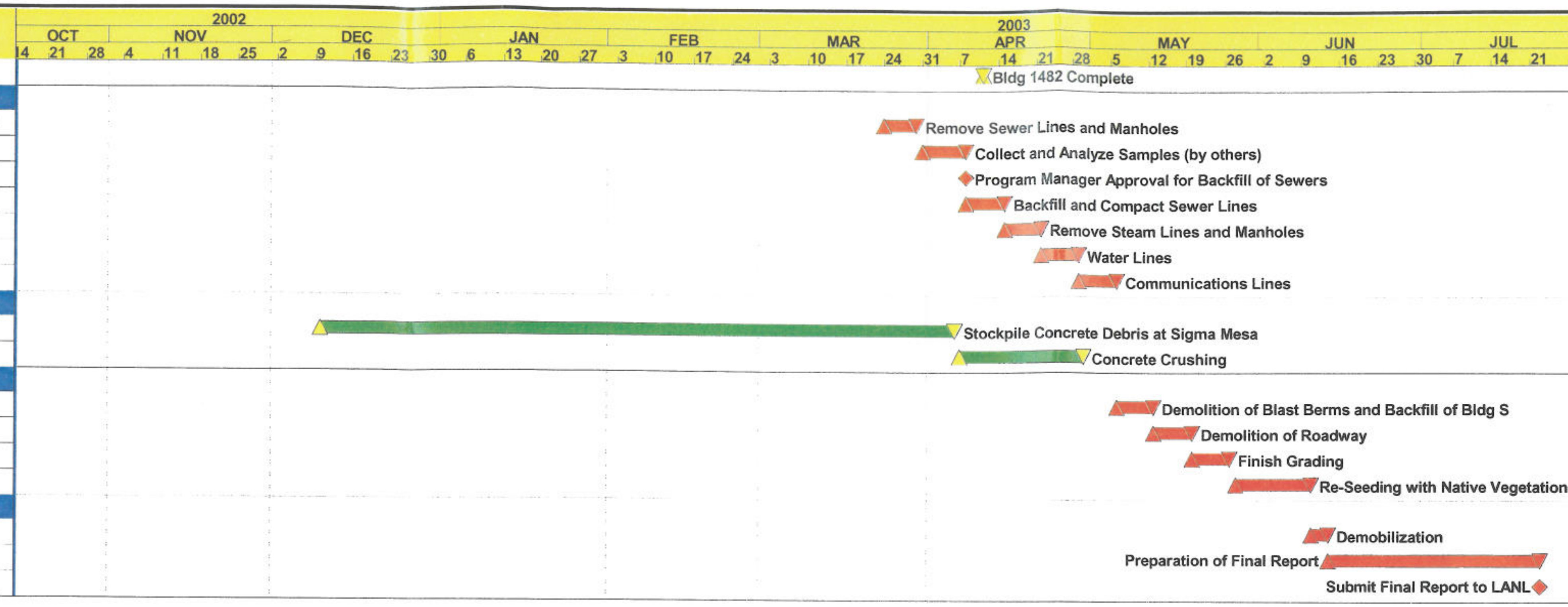
220 COMPLEX D&D
Figure 2 - Planned Schedule

Run Date 07JUL03 16:55

Activity ID	Activity Description	Orig Dur	Early Start	Early Finish
0147	Bldg 1482 Complete	0	11APR03	10APR03
Demolition and Removal of Utilities				
0149	Remove Sewer Lines and Manholes	6	24MAR03	29MAR03
0150	Collect and Analyze Samples (by others)	7	31MAR03	07APR03
0151	Program Manager Approval for Backfill of Sewers	0	08APR03	
0152	Backfill and Compact Sewer Lines	6	08APR03	14APR03
0153	Remove Steam Lines and Manholes	6	15APR03	21APR03
0154	Water Lines	6	22APR03	28APR03
0155	Communications Lines	6	29APR03	05MAY03
Concrete Debris Stockpiling and Crushing				
0156	Stockpile Concrete Debris at Sigma Mesa	87	10DEC02	05APR03
0157	Concrete Crushing	20	07APR03	29APR03
Site Work				
0158	Demolition of Blast Berms and Backfill of Bldg S	6	06MAY03	12MAY03
0159	Demolition of Roadway	6	13MAY03	19MAY03
0160	Finish Grading	6	20MAY03	26MAY03
0161	Re-Seeding with Native Vegetation	12	28MAY03	10JUN03
Project Close-Out				
0162	Demobilization	3	11JUN03	13JUN03
0163	Preparation of Final Report	30	14JUN03	22JUL03
0164	Submit Final Report to LANL	0		22JUL03



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220 COMPLEX D&D
Figure 2 - Planned Schedule

Run Date 07JUL03 16:55

Activity ID	Activity Description	Actual Duration	Actual Start	Actual Finish
Project Start-up Activities				
0001	LANL Issues Contract	0	15OCT02A	
0002	Obtain Performance and Payment Guarantees	10	15OCT02A	28OCT02A
0003	Submit Performance and Payment Guarantees	0		28OCT02A
Preparation and Approval of Plans				
0004	Preparation of Limited Mobilization SSHASP	4	15OCT02A	18OCT02A
0005	LANL Review and Approval of Limited	10	21OCT02A	01NOV02A
0006	Finalize SWPPP	9	22OCT02A	01NOV02A
0007	Submit NOI to EPA	0		21OCT02A
0011	Preparation of SSHASP, SPP, EPCP and	8	29OCT02A	07NOV02A
0020	Submit NESHASP Notification to NMED	0	31OCT02A	
0008	LANL Issues Limited Notice to Proceed	0		31OCT02A
0012	LANL Review and Approval of Plans	6	08NOV02A	15NOV02A
0013	Readiness Review	1	08NOV02A	08NOV02A
0010	NESHAPs Notification Period	13	12NOV02A	26NOV02A
0014	LANL Issues Notice to Proceed	0		18NOV02A
Site Mobilization				
0018	Construct Employee Parking	1	04NOV02A	04NOV02A
0016	Placement and Hookup of Break and Office	1	05NOV02A	05NOV02A
0017	Construct Access Road	1	18NOV02A	18NOV02A
0019	Construct Sediment and Erosion Controls	5	18NOV02A	22NOV02A
Building 221 - Rest House				
0022	Asbestos Abatement	2	26NOV02A	27NOV02A
0023	Demolition	9	04DEC02A	13DEC02A
0024	Load and Transport Debris	5	12DEC02A	17DEC02A
0025	Backfill and Compaction	1	18DEC02A	18DEC02A
0026	Bldg 221 Complete	0		18DEC02A
Building 223 - Rest House				
0028	Asbestos Abatement	2	04DEC02A	05DEC02A
0029	Demolition	5	09DEC02A	13DEC02A
0030	Load and Transport Debris	5	12DEC02A	17DEC02A
0031	Backfill and Compaction	1	18DEC02A	18DEC02A
0032	Bldg 223 Complete	0		18DEC02A
Building 225 - Rest House				
0034	Asbestos Abatement	2	09DEC02A	10DEC02A
0035	Demolition	2	11DEC02A	12DEC02A
0036	Load and Transport Debris	2	12DEC02A	13DEC02A
0037	Backfill and Compaction	1	13DEC02A	13DEC02A
0038	Bldg 225 Complete	0		13DEC02A
Building 234 - Passageway				
0041	HE Decontamination	1	26NOV02A	26NOV02A
0040	Asbestos Abatement	1	04DEC02A	04DEC02A
0042	Demolition	3	04DEC02A	06DEC02A
0043	Load and Transport Debris	10	06DEC02A	17DEC02A
0044	Backfill and Compaction	1	18DEC02A	18DEC02A
0045	Bldg 234 Complete	0		18DEC02A
Building 235 - Passageway				
0048	HE Decontamination	1	26NOV02A	26NOV02A
0047	Asbestos Abatement	4	10DEC02A	13DEC02A
0049	Demolition	1	16DEC02A	16DEC02A

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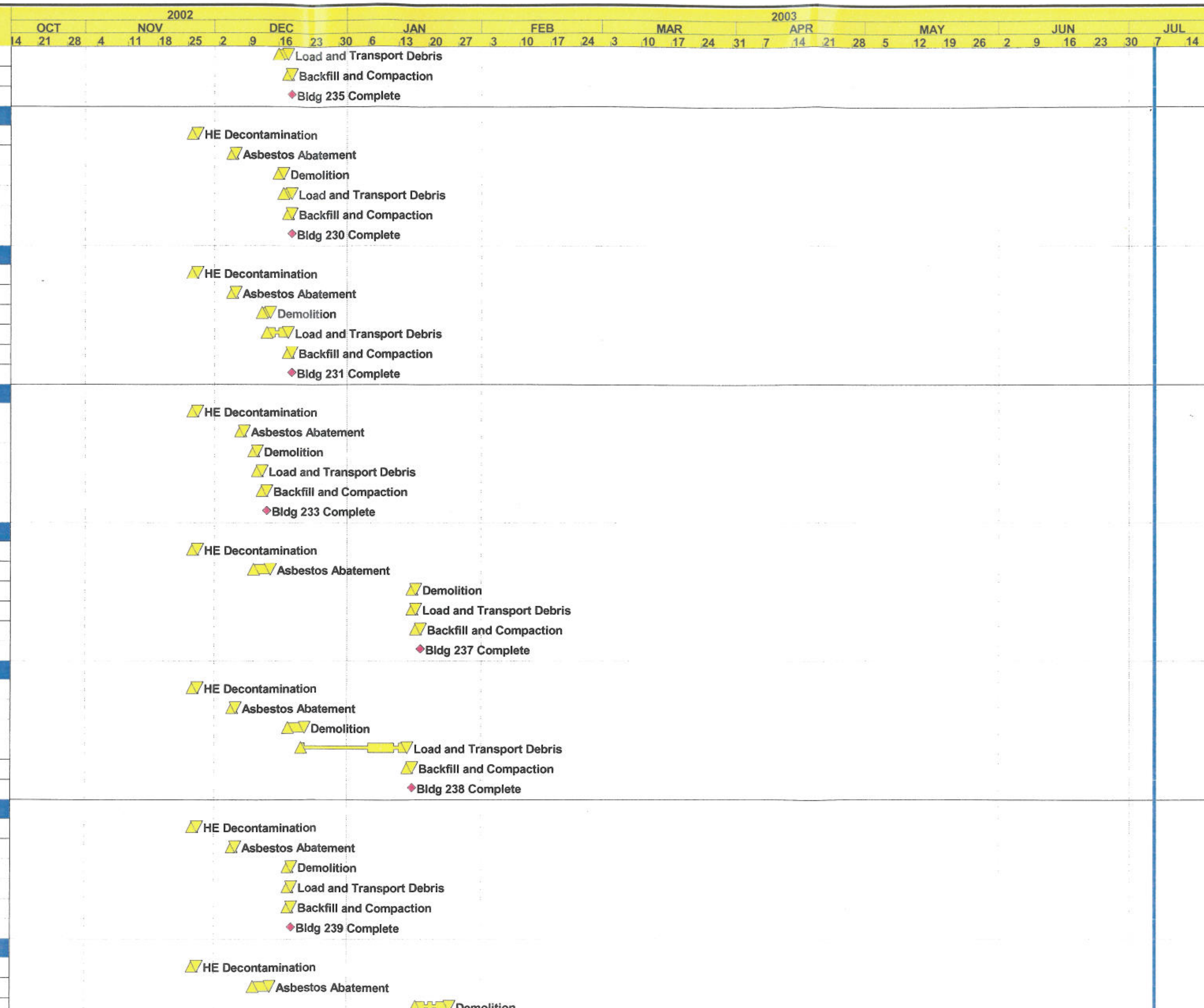
220 COMPLEX D&D
Figure 3 - Actual Schedule

Run Date 07JUL03 16:53

Activity ID	Activity Description	Actual Duration	Actual Start	Actual Finish
0050	Load and Transport Debris	2	16DEC02A	17DEC02A
0051	Backfill and Compaction	1	18DEC02A	18DEC02A
0052	Bldg 235 Complete	0		18DEC02A
Building 230 - Passageway				
0055	HE Decontamination	1	26NOV02A	26NOV02A
0054	Asbestos Abatement	1	05DEC02A	05DEC02A
0056	Demolition	1	16DEC02A	16DEC02A
0057	Load and Transport Debris	2	17DEC02A	18DEC02A
0058	Backfill and Compaction	1	18DEC02A	18DEC02A
0059	Bldg 230 Complete	0		18DEC02A
Building 231 - Passageway				
0062	HE Decontamination	1	26NOV02A	26NOV02A
0061	Asbestos Abatement	1	05DEC02A	05DEC02A
0063	Demolition	2	12DEC02A	13DEC02A
0064	Load and Transport Debris	4	13DEC02A	17DEC02A
0065	Backfill and Compaction	1	18DEC02A	18DEC02A
0066	Bldg 231 Complete	0		18DEC02A
Building 233 - Passageway				
0069	HE Decontamination	1	26NOV02A	26NOV02A
0068	Asbestos Abatement	1	07DEC02A	07DEC02A
0070	Demolition	1	10DEC02A	10DEC02A
0071	Load and Transport Debris	1	11DEC02A	11DEC02A
0072	Backfill and Compaction	1	12DEC02A	12DEC02A
0073	Bldg 233 Complete	0		12DEC02A
Building 237 - Passageway				
0076	HE Decontamination	1	26NOV02A	26NOV02A
0075	Asbestos Abatement	4	10DEC02A	13DEC02A
0077	Demolition	1	16JAN03A	16JAN03A
0078	Load and Transport Debris	1	16JAN03A	16JAN03A
0079	Backfill and Compaction	1	17JAN03A	17JAN03A
0080	Bldg 237 Complete	0		17JAN03A
Building 238 - Passageway				
0083	HE Decontamination	1	26NOV02A	26NOV02A
0082	Asbestos Abatement	1	05DEC02A	05DEC02A
0084	Demolition	4	18DEC02A	21DEC02A
0085	Load and Transport Debris	9	21DEC02A	14JAN03A
0086	Backfill and Compaction	1	15JAN03A	15JAN03A
0087	Bldg 238 Complete	0		15JAN03A
Building 239 - Passageway				
0090	HE Decontamination	1	26NOV02A	26NOV02A
0089	Asbestos Abatement	1	05DEC02A	05DEC02A
0091	Demolition	1	18DEC02A	18DEC02A
0092	Load and Transport Debris	1	18DEC02A	18DEC02A
0093	Backfill and Compaction	1	18DEC02A	18DEC02A
0094	Bldg 239 Complete	0		18DEC02A
Building 232 - Elevated Passageway				
0097	HE Decontamination	1	26NOV02A	26NOV02A
0096	Asbestos Abatement	4	10DEC02A	13DEC02A
0098	Demolition	6	17JAN03A	24JAN03A



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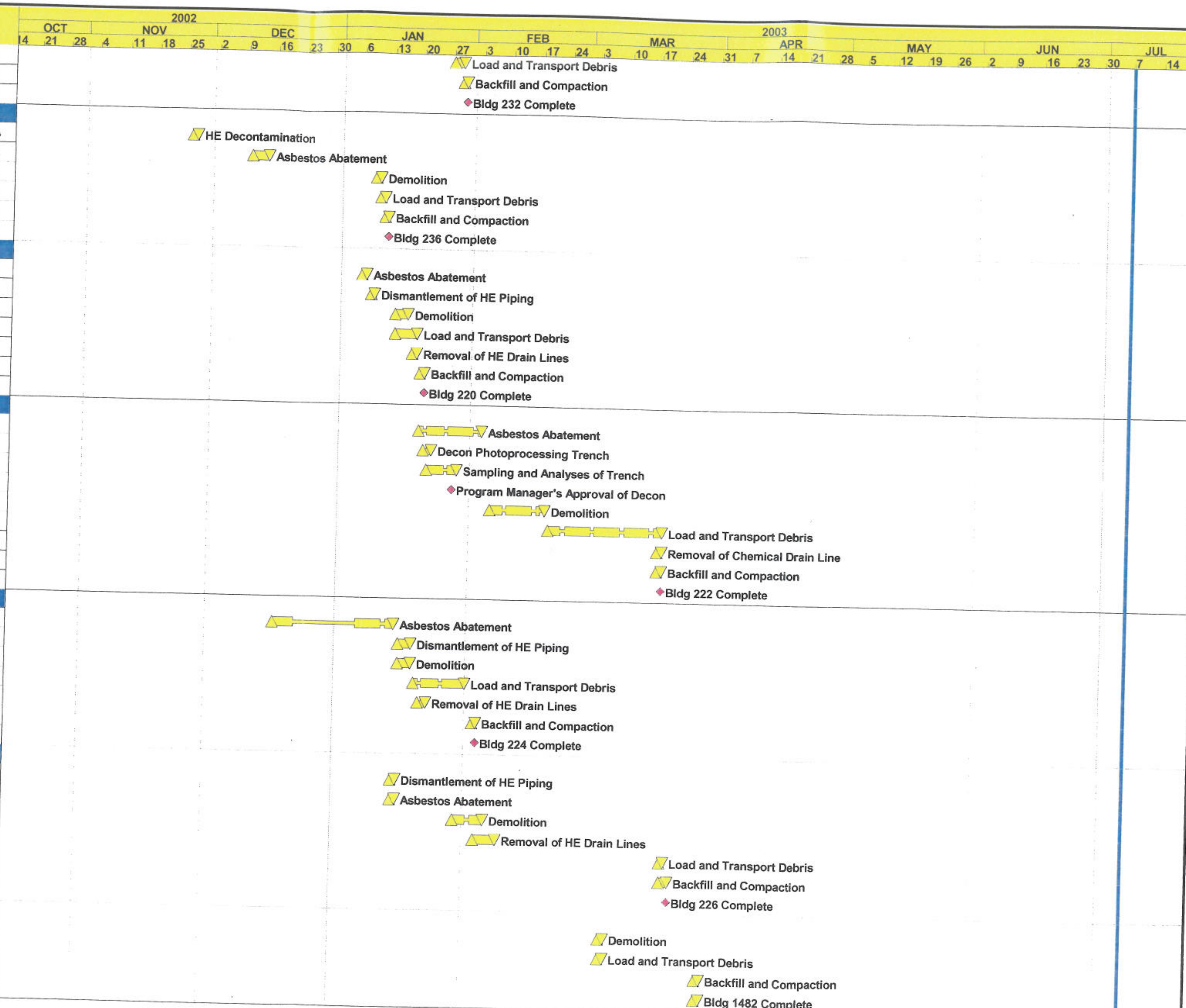
220 COMPLEX D&D
Figure 3 - Actual Schedule

Run Date 07JUL03 16:53

Activity ID	Activity Description	Actual Duration	Actual Start	Actual Finish
0099	Load and Transport Debris	2	27JAN03A	28JAN03A
0100	Backfill and Compaction	1	29JAN03A	29JAN03A
0101	Bldg 232 Complete	0		29JAN03A
Building 236 - Elevated Passageway				
0104	HE Decontamination	1	26NOV02A	26NOV02A
0103	Asbestos Abatement	4	10DEC02A	13DEC02A
0105	Demolition	1	09JAN03A	09JAN03A
0106	Load and Transport Debris	1	10JAN03A	10JAN03A
0107	Backfill and Compaction	1	11JAN03A	11JAN03A
0108	Bldg 236 Complete	0		11JAN03A
Building 220 - X-Ray				
0111	Asbestos Abatement	1	06JAN03A	06JAN03A
0110	Dismantlement of HE Piping	1	08JAN03A	08JAN03A
0112	Demolition	3	14JAN03A	16JAN03A
0113	Load and Transport Debris	5	14JAN03A	18JAN03A
0114	Removal of HE Drain Lines	1	18JAN03A	18JAN03A
0115	Backfill and Compaction	1	20JAN03A	20JAN03A
0116	Bldg 220 Complete	0		20JAN03A
Building 222 - Darkroom				
0121	Asbestos Abatement	12	20JAN03A	03FEB03A
0118	Decon Photoprocessing Trench	1	21JAN03A	22JAN03A
0119	Sampling and Analyses of Trench	6	22JAN03A	28JAN03A
0120	Program Manager's Approval of Decon	0	28JAN03A	
0122	Demolition	10	06FEB03A	18FEB03A
0123	Load and Transport Debris	23	20FEB03A	18MAR03A
0124	Removal of Chemical Drain Line	1	18MAR03A	18MAR03A
0125	Backfill and Compaction	1	18MAR03A	18MAR03A
0126	Bldg 222 Complete	0		18MAR03A
Building 224 - X-Ray				
0129	Asbestos Abatement	13	17DEC02A	14JAN03A
0128	Dismantlement of HE Piping	3	16JAN03A	18JAN03A
0130	Demolition	3	16JAN03A	18JAN03A
0131	Load and Transport Debris	10	20JAN03A	31JAN03A
0132	Removal of HE Drain Lines	1	21JAN03A	22JAN03A
0133	Backfill and Compaction	1	03FEB03A	03FEB03A
0134	Bldg 224 Complete	0		03FEB03A
Building 226 - X-Ray				
0136	Dismantlement of HE Piping	1	15JAN03A	15JAN03A
0137	Asbestos Abatement	1	15JAN03A	15JAN03A
0138	Demolition	6	30JAN03A	05FEB03A
0140	Removal of HE Drain Lines	5	04FEB03A	08FEB03A
0139	Load and Transport Debris	1	20MAR03A	20MAR03A
0141	Backfill and Compaction	2	20MAR03A	21MAR03A
0142	Bldg 226 Complete	0		21MAR03A
Building 1482 - Morgan Building				
0144	Demolition	1	06MAR03A	06MAR03A
0145	Load and Transport Debris	1	06MAR03A	06MAR03A
0146	Backfill and Compaction	1	29MAR03A	29MAR03A
0147	Bldg 1482 Complete	1	29MAR03A	29MAR03A



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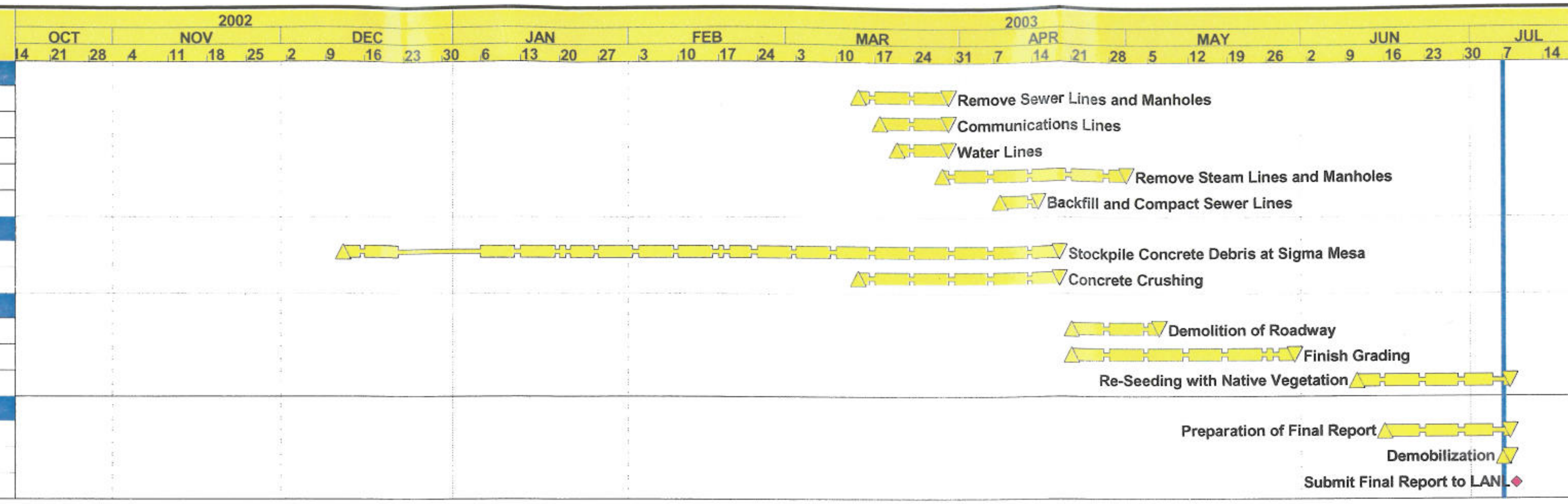
220 COMPLEX D&D
Figure 3 - Actual Schedule

Run Date 07JUL03 16:53

Activity ID	Activity Description	Actual Duration	Actual Start	Actual Finish
Demolition and Removal of Utilities				
0149	Remove Sewer Lines and Manholes	14	14MAR03A	29MAR03A
0155	Communications Lines	11	18MAR03A	29MAR03A
0154	Water Lines	8	21MAR03A	29MAR03A
0153	Remove Steam Lines and Manholes	28	29MAR03A	30APR03A
0152	Backfill and Compact Sewer Lines	6	08APR03A	14APR03A
Concrete Debris Stockpiling and Crushing				
0156	Stockpile Concrete Debris at Sigma Mesa	96	12DEC02A	18APR03A
0157	Concrete Crushing	31	14MAR03A	18APR03A
Site Work				
0159	Demolition of Roadway	14	21APR03A	06MAY03A
0160	Finish Grading	34	21APR03A	30MAY03A
0161	Re-Seeding with Native Vegetation	22	11JUN03A	07JUL03A
Project Close-Out				
0163	Preparation of Final Report	18	16JUN03A	07JUL03A
0162	Demobilization	1	07JUL03A	07JUL03A
0164	Submit Final Report to LANL	0		08JUL03A



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220 COMPLEX D&D
Figure 3 - Actual Schedule

Run Date 07JUL03 16:53

APPENDIX C

Site Photos (pdf files attached)

TA-16-220-SPP2.pdf

16-220-ex-1.pdf

16-220-ex-2.pdf

TA-16-220 Complex — Site Preparation Phase

Characterization

Characterization sampling at the TA-16-220 Complex included 8 buildings, 10 passageways, utility systems, and external soil berms/barricades, etc. The characterization process was used to evaluate the nature and extent of problem areas, to identify and estimate potential or probable waste types and volumes. Historical and analytical data were used to determine the physical, chemical, and radiological condition of the complex.

An environmental scientist uses a hand auger to collect soil samples beside a transformer. The sample was checked for PCBs.

An environmental technician documents samples and packages them for shipment to an off-site DOE-approved laboratory for analysis. The inset photo shows soil samples.

An environmental scientist collects a swipe sample from inside building 22[illegible]. The sample was checked for the presence of high explosives and heavy metals.

Asbestos inspectors and roofers collect roof samples to check for asbestos. The inset photo shows roof samples.

Utility Disconnects

All underground utilities at the TA-16-220 Complex were disconnected at the main utility source. Disconnection and removal involved one branch gas line, three branch water lines, three branch steam lines, one sanitary waste line, and 3,000 linear feet of abandoned underground telecommunications cable. Upon completion of disconnection and removals, all excavations were backfilled and marked accordingly. The site's aboveground power sources were also disconnected.

A water line tee being disconnected and rigged out.

The site's 13.2-kV power source was disconnected at the pole, and the feeders were pulled back to the transformers. Secondary power was also disconnected and pulled back to the transformers. Ultimately, all feeders were removed before demolition.

Utility trench being backfilled.

An underground steam line being disconnected and removed. The inset photo shows 20 linear feet of steam line. The outer protective shell is corrugated metal pipe contaminated with nonfriable asbestos.

Security Fence Installation

A temporary security fence was installed at the TA-16-220 Complex so the escort ratio could be increased from 5:1 to 10:1, allowing the contractor to limit the number of required escorts. A project site security plan allowed the escorts to roam within the TA-16-220 Complex "fenced-in" work area. However, a posted escort remained in place at the work site entrance. The fence also allowed the Laboratory to secure the site of unauthorized personnel.

Contract workers preparing fence posts for caps, drilling holes with a mechanical auger, and placing fence poles in accordance with Laboratory design drawings. The inset photo shows angle cuts made for the post caps.

Fence fabric is attached to the fence posts, a completed fence section crosses Canyon de Valle, and the complete fence is inspected.

NNSA National Nuclear Security Administration

Los Alamos

TA-16-220 Complex — Execution Phase

Demolition

Demolition of 8 buildings and 10 passageways that supported work in the nearby high-explosives (HE) area was completed. Built mostly in the 1950s, the complex included rest houses for unloading HE components and x-ray buildings positioned at the ends of long passageways.

Demolition of building 221.

Demolition and removal of the building foundation and stem wall.

Demolition, removal, and staging of passageway, walkway, and foundation footings.

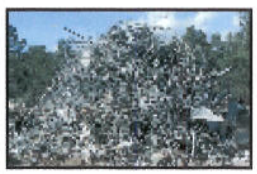
Recycle & Waste Disposal

A concerted effort was made during this project to maximize the amount of material through recycling or reuse. Items included metal frame building, oak planks (10,000 linear ft), concrete (5,047 cu yd), scrap metal, (2,000 cu yd), asphalt, etc. Through waste minimization efforts minimal nonhazardous waste was generated.

Building 1482 (a metal-frame, steel-wall building erected on a reinforced-concrete foundation) was dismantled and processed. The inset photo represents structural support.

Oak planks collected for r-use in repairing lowboy trailers.

Concrete collected, processed and transported for recycling.



Metal scrap was collected for recycling.

Asphalt being used for road bed.

Miscellaneous building debris was loaded, transported, and disposed of at a designated waste-disposal site.

Soil contaminated with oil from heavy-equipment leaks was loaded into 55-gallon drums and disposed of at a designated waste-disposal site.

Crusher Operation

Rock-crushing operations conducted at Sigma Mesa Site. Rubblized concrete debris was transported from the TA-16-220 Complex to Sigma Mesa site for final crushing. Crushed concrete material was reduced to 1/2" aggregate size by use of a mobile rock crusher. The crushed material was used as fill material on various projects throughout the Laboratory and local community.

Concrete crusher set up at Sigma Mesa.

Truck unloading concrete rubble at Sigma Mesa. Inset photo shows concrete rubble stockpile.

Concrete rubble being loaded into a crusher for processing.

A conveyor discharging crushed concrete.

Stockpiles of processed material.

Crushed material being reused as temporary roadway in support of a construction project.

TA-16-220 Complex — Execution Phase

Site Cleanup

Site cleanup activities in preparation for final grading, recontouring, stabilization, and revegetation.

Final site cleanup involved tree and brush minimization, removal of remaining construction debris, and utility trench backfilling.

Samples are collected for analysis in preparation for final site clearance.

Marking coordinates, through use of the global positioning satellite (GPS) system, in support of final as-built drawings.

Site Restoration

Before the site was released, workers completed activities designed to control storm water runoff and erosion. The site was also hydroseeded.

Directing stormwater runoff controls in Canyon de Valle.

Site grading and recontouring activity.

Installation of erosion-control matting.

Hydroseeding.

Because of unseasonably dry weather, the site was watered during hydroseeding.

Hydroseeding completed.

Final Activities

Fence removal, demobilization of the site offices, and a final walkdown brought the project to a close.

The temporary fence being removed.

Site condition following contractor demobilization.

Final site condition, typical throughout the 27 acres.

Final contactor walkdown.