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NMED Hazardous Waste Bureau

National Nuclear Security Administration
Los Alamos Site Office, MS A316
Environmental Restoration Program
Los Alamos, New Mexico 87544
(505) 667-4255/FAX (505) 606-2132

Date: March 15, 2008
Refer To: EP2008-0130

James P. Bearzi, Bureau Chief
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505-6303

Subject: Submittal of the Response to Approval with Direction Evaluation of the Suitability of Wells Near Technical Area 16 for Monitoring Contaminant Releases from Consolidated Unit 16-021(c)-99, Revision 1

Dear Mr. Bearzi:

Enclosed are two hard copies with electronic files of the response to the New Mexico Environment Department's (NMED's) Approval with Direction of "Evaluation of the Suitability of Wells Near Technical Area 16 for Monitoring Contaminant Releases from Consolidated Unit 16-021(c)-99, Revision 1" (hereafter, the Report). This response consists of the following: (1) this letter detailing Los Alamos National Laboratory's (LANL's) and the Department of Energy's (DOE's) response to NMED's comments in its Approval with Direction letter; (2) additional calculations and associated discussion of well-network efficiency and the likelihood of detecting contaminants at CdV-R-37-2 (Attachment 1, which is now also an addendum to the Report); (3) a drilling work plan for CdV-16-3(i) (Attachment 2); and (4) a drilling work plan for CdV-R-15-1 (Attachment 3).

Response to Comments

The responses below address each well and activity proposed in section 6 of the Report.

R-25 [*New wells R-25b and R-25c*]—Two new wells into the intermediate zone at R-25 will be drilled to replace screens 1 and 3 of this well. A drilling work plan for well R-25b (LA-UR-07-3952), which is proposed as an 800-ft well targeting screen 1 at R-25, was submitted to NMED on June 30, 2007, and approved by NMED in a letter dated November 2, 2007. A drilling work plan for R-25c (LA-UR-08-0337), which is proposed as a 1200-ft well targeting screen 3 of R-25, was submitted to NMED in February 2008 and was approved by NMED in a letter dated March 11, 2008.

CdV-16-2(i)—Because of its proximity (2000 ft northeast) to CdV-16-3(i), LANL will plug and abandon well CdV-16-2(i) following the deepening and installation of CdV-16-3(i). Note that CdV-16-2(i)r is functional and will continue to be sampled.

CdV-16-3(i)—LANL will extend this borehole to approximately 1700 ft below ground surface (bgs) without using drilling fluids other than potable water and will complete a well in the uppermost water-producing zone. A drilling work plan for this activity is provided as Attachment 2.

CdV-R-15-1—LANL will drill a well to approximately 1350 ft bgs between R-18 and CdV-R-15-3. A drilling work plan for this activity is provided as Attachment 3.

CdV-R-37-2—Based on NMED's approval of the Report and on discussions with NMED staff, it appears the rehabilitation of screen 2 of CdV-R-37-2 is not likely to significantly improve the quality of water samples collected from that screened interval. The two deeper screens of CdV-R-37-2 are effectively developed and reliable monitoring points of the regional aquifer. Screen 2 provides useful water-level data. LANL proposes to wait on any decision concerning Screen 2 until the drilling effort at CdV-16-3(i) and CdV-R-15-1 have been completed and several sampling rounds have been accomplished. Additional information addressing CdV-R-37-2, including additional well network efficiency calculations, is provided in Attachment 1.

If you have any questions, please call Don Hickmott at (505) 667-8753 (dhickmott@lanl.gov) or Lance Woodworth at (505) 665-5820 (lwoodworth@doeal.gov).

Sincerely,

for Susan G. Stiger, Associate Director
Environmental Programs
Los Alamos National Laboratory

Sincerely,

David R. Gregory, Project Director
Environmental Operations
Los Alamos Site Office

SS/DG/JM/DH:sm

Enclosures: Two hard copies with electronic files:
(1) Addendum to the Evaluation of the Suitability of Wells Near Technical Area 16 for Monitoring Contaminant Releases from Consolidated Unit 16, Revision 1 (EP2008-0135)
(2) Drilling work plan for CdV-R-15-1 (EP2008-0113)
(3) Drilling work plan for CdV-16-3(i) (EP2008-0114)

Cy: (w/enc.)
Don Hickmott, EP-CAP, MS M992
RPF, MS M707 (with two CDs)
Public Reading Room, MS M992

Cy: (Letter and CD only)
Laurie King, EPA Region 6, Dallas, TX
Steve Yanicak, NMED-OB, White Rock, NM
Woody Woodworth, DOE-LASO, MS A316
Danny Katzman, LWSP, MS M992
Monty Vesselinov, EES-6, MS T003
Peggy Reneau, WES-DO, MS M992
EP-CAP File, MS M992

Cy: (w/o enc.)
Tom Skibitski, NMED-OB, Santa Fe, NM
Bonita Eichorst, DOE-LASO (date-stamped letter emailed)
Susan G. Stiger, ADEP, MS M991
Carolyn A. Mangeng, ADEP, MS M991
Alison M. Dorries, WES-DO, MS M992
Dave McInroy, EP-CAP, MS M992
Paul Huber, LWSP, MS M992
IRM-RMMSO, MS A150

Addendum to the "Evaluation of the Suitability of Wells Near Technical Area 16 for Monitoring Contaminant Releases from Consolidated Unit 16-021(c)-99, Revision 1"

1.0 CALCULATIONS AND DISCUSSION BEARING ON THE REHABILITATION OF CdV-R-37-2

This addendum to the "Evaluation of the Suitability of Wells Near Technical Area 16 for Monitoring Contaminant Releases from Consolidated Unit 16-021(c)-99, Revision 1" (LANL 2007, 098548) presents additional information bearing on the potential rehabilitation of CdV-R-37-2, including a discussion of the geology and hydrology near this well, an update of well network efficiency calculations relevant to the well, and a discussion of lateral and vertical dispersivity near the well.

1.1 Geologic and Hydrologic Constraints

It appears unlikely a screen near the regional water table at or near CdV-R-37-2 will produce sufficient water for sampling. Screen 2 of CdV-R-37-2 straddles the regional water-table (the water-table elevation is approximately 5 ft below the top of screen 2) (Table 4.2-1); the top of screen 3 is approximately 160 ft below the regional water-table (Table 3.4-2) (LANL 2007, 098548). Although both screens are within the same hydrostratigraphic unit (Tschicoma dacites), screen 2 is located in a relatively massive portion of the dacite flow that is characterized by low permeability. According to the geophysical logs, the interval from 1075 to 1365 ft below ground surface (including screen 2) has a lower porosity than the zone where screen 3 is installed, which appears to be a rubbly section of dacite. These observations suggest monitoring near CdV-R-37-2 may be difficult. The hydrogeology and the location of the screen also pose challenges to successfully rehabilitating this screen, which currently has poor geochemical performance. However, because of advection, the lower permeability of dacites straddling the water table creates the potential for downward diversion of any plume near CdV-R-37-2. In addition, the borehole log data suggest that screen 3 is probably the uppermost producing zone at the CdV-R-37-2 location, and contaminant fluxes are probably most significant in such a producing zone.

The existing data also indicate that the water table at CdV-16-3(i) is within a low-permeability portion of the Tschicoma dacites. This low-permeability zone probably represents the massive interior of an areally extensive lava flow that, at a minimum, extends as far east as CdV-R-37-2. Therefore, it is unlikely a producing zone at the top of the regional aquifer, close to the regional water table, could be found and successfully sampled in the vicinity of CdV-R-37-2 and CdV-16-3(i).

1.2 Update to Network Efficiency Calculations

Updated network efficiency calculations are provided in revised Tables E-5.0-1 through E-5.0-3 of this addendum. Along with calculations originally presented, these tables present calculations of the well network efficiency without well CdV-R-37-2, without well CdV-16-3(i), and without both of these wells.

Key points related to this revised analysis include the following.

- Neither CdV-R-37-2 nor CdV-16-3(i) is important for detecting release from a Cañon de Valle source; the network efficiencies are greater than 95% for all of these scenarios. Cañon de Valle is hypothesized to be the major source of contaminants in the deep perched and regional aquifers at Technical Area 16 (TA-16) (as much as 80% of contaminant mass is expected to be from this source area).

- CdV-R-37-2 is important for detecting releases from S-Site (Martin) Canyon sources; if this well is excluded, the network efficiencies are likely to be less than 95% protective of PM-2 in an S-Site Canyon-sourced release.
- CdV-16-3(i) is important for protecting PM-1 and PM-3 from contamination in an S-Site Canyon release scenario.

There is significant uncertainty in the regional water table map near CdV-16-3(i). Refinement of the water table map, particularly if the head gradients trend to the north, would decrease the importance of CdV-R-37-2 and possibly increase the importance of the new well CdV-R-15-1 for protecting drinking-water wells from releases at S-Site Canyon. The well network efficiency calculations will be updated using the water-level data obtained from the new well at CdV-16-3(i) and at the new well location (CdV-R-15-1).

1.3 Lateral and Vertical Dispersivity

It is possible to estimate the lateral and vertical dispersion of a plume migrating through the regional aquifer. In the analysis, it is assumed that (1) the groundwater fluxes downgradient from the source are similar to the fluxes near the source (i.e., the flow is uniform flow and no large-scale diversion/channeling of the groundwater flow occurs); (2) contaminant source is at a point and instantaneous; and (3) longitudinal and transverse dispersivities are on the order of 1/10 and 1/100 of the traveled distance, respectively. The ratios are considered typical for the scale of simulated contamination transport and type of medium heterogeneity (Freeze and Cherry 1979, 088742, Chapter 9; Neuman 1990, 090184).

To estimate the size of the plume, a scaling parameter σ is calculated:

$$\sigma = \frac{1}{3}\sqrt{2\lambda L}$$

where λ is dispersivity (longitudinal or transverse) and L is the distance of the center of the plume from the source location. The parameter σ defines the standard deviation of the spatial plume dispersion. Typically 68.3%, 95.4%, and 99.7% of contaminant mass are within 1σ, 2σ, and 3σ distances from the center of the plume, respectively (Freeze and Cherry 1979, 088742, Chapter 9). These calculations are based on assumptions for unbounded flow domain and normal spatial distribution of the contaminant plume mass.

The potential plume sizes resulting from longitudinal and transverse dispersion are calculated using the above formula. The computed plume sizes define a portion of the plume that will contain a given fraction of the plume mass. For example, a plume that migrated for 2000 m (the approximate distance between the S-Site area and CdV-R-37-2) is expected to have a longitudinal size (along the flow path) of about 300, 600, and 900 m containing 68.3%, 95.4%, and 99.7%, respectively, of the plume mass. The transverse size (perpendicular to the flow direction) is expected to be about 100, 200, and 300 m containing 68.3%, 95.4%, and 99.7% of plume mass, respectively. Since the flow medium is expected to be vertically anisotropic, the vertical transverse dispersion is expected to be further subdued. For an anisotropic ratio of 0.1, the vertical plume size is calculated to be on the order of 10, 20, and 30 m containing 68.3%, 95.4%, and 99.7% of the plume mass, respectively. The above calculations assume that the flow domain is bounded by the water table (i.e., the regional contaminant flow is confined by the water table). Because the properties of the medium are not known, the vertical dispersion of the plume may range between 30 and 300 m (99.7% of the plume mass). It is important to note that most of the contaminant mass is expected to be in the center of the plume, and the concentrations at the plume fringes could be orders of magnitude lower.

The distance between the top two screens in the regional aquifer at CdV-R-37-2 is 140 ft (~45 m). The distance between the filter packs associated with the two screens is slightly shorter (about 120 ft or 40 m). The vertical dispersion of the plume at CdV-R-37-2 is expected to be between 90 and 900 ft (~30 and 300 m). Because of the low-permeability dacitic unit near the regional water table (discussed above), the vertical dispersion at CdV-R-37-2 is expected to be somewhat higher. Therefore, screen 3 is expected to detect contaminants although it is substantially below the water table. Potential flow paths are not expected to occur through the low-permeable zone above screen 3.

2.0 SUMMARY AND CONCLUSIONS

The water table screen (screen 2) at CdV-R-37-2 and the hydrostratigraphic unit at the water table at CdV-16-3(i) are located within an impermeable dacitic formation. It may be difficult to install a producing well that can be developed properly in such a geologic unit. The impermeable zone between the two wells may be spatially extensive. Targeting the uppermost producing zones below the water table and within the dacites may be a more effective approach.

The borehole logs and water-level data collected during future CdV-16-3(i) and new well (CdV-R-15-1) drilling may provide better information to explain the medium heterogeneity of Tschicoma dacites and will help refine the model of local hydrologic gradients at the regional water table. Network efficiencies will be recalculated following drilling of each of these wells. A final decision on whether to attempt to rehabilitate screen 2 of CdV-R-37-2 or to drill a well downgradient of the dacites (but upgradient of R-27) should be contingent on these new calculations of network efficiency.

3.0 REFERENCES

The following list includes all documents cited in this report. Parenthetical information following each reference provides the author(s), publication date, and ER ID number. This information is also included in text citations. ER ID numbers are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the NMED Hazardous Waste Bureau; the U.S. Department of Energy–Los Alamos Site Office; the U.S. Environmental Protection Agency, Region 6; and the Directorate. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.

Freeze, R.A., and J.A. Cherry, January 1979. *Groundwater*, Prentice-Hall, Inc., Englewood Cliffs, New Jersey. (Freeze and Cherry 1979, 088742)

LANL (Los Alamos National Laboratory), October 2007. "Technical Area 54 Well Evaluation and Network Recommendations, Revision 1," Los Alamos National Laboratory document LA-UR-07-6436, Los Alamos, New Mexico. (LANL 2007, 098548)

Neuman, S.P., August 1990. "Universal Scaling of Hydraulic Conductivities and Dispersivities in Geologic Media," *Water Resources Research,* Vol. 26, No. 8, pp. 1749-1758. (Neuman 1990, 090184)

Table E-5.0-1
Efficiency for the Regional Monitoring Network to Detect Plumes Originating at Cañon de Valle Source Area before Being Observed at the Water-Supply Wells for the Case of Water-Table Model 1

O-1	O-4	PM-1	PM-2	PM-3	PM-4	PM-5	Comment
1	1	1	0.976	1	0.987	1	All wells
0.997	0.943	0.958	0.898	0.93	0.903	0.912	Only CdV wells
0.999	0.991	0.976	0.949	0.974	0.964	0.977	Only CdV wells and R-18
1	1	0.999	0.994	0.999	0.994	0.999	Only CdV wells and R-18, R-17, R-19
1	1	0.999	0.995	0.999	0.994	0.999	Only CdV wells and R-18, R-17, R-19, R-27
1	1	1	1	0.999	1	1	Only CdV wells, R-18 and a new well
1	1	1	0.999	1	1	0.999	Only CdV-R-15-3, R-18, new well
1	1	1	0.999	1	1	0.999	Only CdV-R-15-3, CdV-R-37-2, R-18, new well
1	1	1	0.999	1	1	0.999	Only CdV-R-15-3, CdV-16-3i, R-18, new well

Note: Rows shaded in yellow represent new calculations.

Table E-5.0-2
Efficiency for the Regional Monitoring Network to Detect Plumes Originating at Cañon de Valle Source Area before Being Observed at the Water-Supply Wells for the Case of Water-Table Model 2

O-1	O-4	PM-1	PM-2	PM-3	PM-4	PM-5	Comment
1	1	1	0.951	1	0.969	1	All wells
0.998	0.935	0.921	0.785	0.896	0.817	0.872	Only CdV wells
0.999	0.993	0.973	0.917	0.974	0.949	0.985	Only CdV wells and R-18
1	1	0.993	0.984	0.997	0.989	1	Only CdV wells and R-18, R-17, R-19
1	1	0.998	0.996	0.999	0.996	1	Only CdV wells and R-18, R-17, R-19, R-27
1	1	0.995	0.98	0.998	0.994	0.999	Only CdV wells R-18, and a new well
1	1	1	0.999	1	1	0.999	Only CdV-R-15-3, R-18, new well
1	1	1	0.999	1	1	0.999	Only CdV-R-15-3, CdV-R-37-2, R-18, new well
1	1	1	0.999	1	1	0.999	Only CdV-R-15-3, CdV-16-3i, R-18, new well

Note: Rows shaded in yellow represent new calculations.

Table E-5.0-3
Efficiency for the Regional Monitoring Network to Detect Plumes Originating at S-Site (Martin Spring) Canyon Source Area before Being Observed at the Water-Supply Wells for the Case of Water-Table Model 1

O-1	O-4	PM-1	PM-2	PM-3	PM-4	PM-5	Comment
1	1	1	0.998	1	1	1	All wells
1	1	1	0.996	1	1	1	Only CdV wells
1	1	1	0.996	1	1	1	Only CdV wells and R-18
0.997	0.995	0.924	0.775	0.965	0.938	1	Only CdV-R-15-3, R-18, new well
1	1	1	0.999	1	1	1	Only CdV-R-15-3, CdV-R-37-2, R-18, new well
0.999	0.999	0.962	0.86	0.987	0.974	1	Only CdV-R-15-3, CdV-16-3i, R-18, new well

Note: Rows shaded in yellow represent new calculations.

Drilling Work Plan for Well CdV-R-15-1

Primary Purpose	Well CdV-R-15-1 will be installed at Technical Area (TA) 15, ~1 mi. east of well R-25 (Broxton et al. 2002, 072640), between wells R-18 and CdV-R-15-3. Figure 1 shows the locations of R-25, proposed well CdV-R-15-1, and other wells and boreholes associated with Consolidated Unit 16-021(c)-99 (aka the 260 Outfall) groundwater investigations. The purpose of well CdV-R-15-1 is to enhance the TA-16 monitoring well network by providing a regional aquifer well to the northeast of the 260 Outfall. The TA-16 monitoring well network analysis is presented in "Evaluation of the Suitability of Wells Near Technical Area 16 for Monitoring Contaminant Releases from Consolidated Unit 16-021(c)-99, Revision 1" (LANL 2007, 100113). The planned screened interval for CdV-R-15-1 will be in a producing zone located within 50 ft of the regional water table. Based on the potentiometric surface in the 3-D regional geohydrologic model, the regional water table is expected to be located at a depth of ~1276 ft (Figure 2). The proposed approach is to advance the borehole to a depth of 1380 ft, which is ~100 ft into the regional aquifer. Downhole video and geophysics will be completed below the water table, and a producing zone will be targeted for the screen. Figure 2 shows the stratigraphy for the CdV-R-15-1 area and the proposed well design for the well. Figure 3 is a geologic cross-section that shows the distribution of hydrostratigraphic units in the vicinity of well CdV-R-15-1 and the predicted geology at this location.
Conceptual Model	Modeling results presented in the monitoring well network analysis demonstrated that flow paths from the Cañon de Valle area trend to the northeast, between CdV-R-15-3 and R-18. These calculations also suggest that a well in this area would bring the efficiency of the TA-16 well network to greater than 95% detection efficiency. The final location of this well will be determined following drilling of CdV-16-3(i) and completion of additional network efficiency calculations. Strata at the regional water table are anticipated to be Puye Formation fanglomerates.
Drilling Approach	Drilling will be conducted using methods selected to optimize the potential of completing the well without using any drilling additives in the zone of saturation. Specifically, efforts will be made to meet the target depth of approximately 1380 ft below ground surface (bgs) and to provide a stable borehole environment for constructing the well. The primary method for advancing the borehole will be a combination of open-hole air-rotary and casing-advance with air-rotary. The following is a summary of the proposed methods by depth interval. • A 16-in. surface casing will be set to 20 ft bgs. • A 15-in. open borehole will be advanced with fluid-assisted air-rotary to the base of the Cerro Toledo at ~700 ft bgs. • A 12-in. casing will be lowered into the open borehole and advanced with fluid-assisted air-rotary to 1200 ft. • A 10-in. casing will be advanced to the target depth of 1380 ft without using drilling-fluid additives. If the well cannot be completed without using drilling fluids within the regional aquifer, NMED will be consulted and a modified drilling strategy will be developed. Municipal water may be added to cool the drill bit.
Potential Drilling Fluids, Composition, and Use	The following fluids and additives that may be used are consistent with those previously used in the drilling program at Los Alamos National Laboratory (the Laboratory) and have been characterized geochemically: • potable water from the municipal water supply to aid in delivery of other drilling additives • QUIK-FOAM, a blend of alcohol ethoxy sulfates, to be used as a foaming agent • AQF-2, an anionic surfactant, to be used as a foaming agent
Geochemical Objective	The geochemical objective is to provide a groundwater sampling point free of drilling-fluid effects within the regional aquifer.

Potential Groundwater Occurrence and Detection	The top of the regional groundwater system is expected to occur at a depth of approximately 1276 ft (see Figures 2 and 3) based on the local water table map. Based on drilling at nearby wells (R-18 and CdV-R-15-3), there is no expectation that a perched zone capable of producing water will be detected. Methods for groundwater detection may include driller's observations, water-level measurements, and borehole video.
Core Sampling	Core sampling is not proposed for CdV-R-15-1.
Groundwater Screening Sampling	A screening water sample will be collected from the screened interval following well development. The screening sample will be analyzed by the Earth and Environmental Sciences Group chemistry laboratory for cations/metals (dissolved and total), anions (dissolved), and select high explosives (HE) compounds (total).
Groundwater Characterization Sampling	Groundwater samples will be collected from the completed well between 10 and 60 d after well development in accordance with the Compliance Order on Consent. These samples will be analyzed for the full suite of TA-16-related constituents, including tritium; metals/cations; general inorganic chemicals; volatile organic compounds; semivolatile organic compounds; HE compounds, including RDX (research department explosives [hexahydro-1,3,5-trinitro-1,3,5-triazine]) and related degradation products; and stable isotopes. Subsequent groundwater samples will be collected under the "Interim Facility-Wide Groundwater Monitoring Plan" (LANL 2005, 088789).
Geophysical Testing	The Laboratory's borehole video camera, natural gamma, and induction tools will be used if open-hole conditions allow logging in the CdV-R-15-1 borehole before each casing string is introduced. If borehole conditions are stable and open-hole geophysics can be conducted, the 10-in. casing will be pulled back from total depth to expose the entire saturated interval for borehole logging by Schlumberger tools.
Well Completion Design	The proposed well design is shown in Figure 2, which assumes a producing zone is found at a depth of less than 1380 ft. If such a zone is not found at a depth less than 1380 ft, NMED will be consulted, and a revised drilling strategy will be developed.
Well Development	The well may be developed by both mechanical and chemical means. Mechanical means include swabbing, bailing, and pumping. Chemical means include the use of sodium acid pyrophosphate or AQUA-CLEAR PFD to remove natural and added clays and/or chlorination to kill bacteria introduced during well completion. Chemical means will be used only after additional discussions with, and approval by, NMED. After initial swabbing and bailing, the well will be pumped to complete the development. Water-quality parameters to be monitored are as follows: pH, specific conductance, temperature, turbidity, and total organic carbon (TOC), and acetone or ethylene glycol, as applicable. Target water-quality parameters are as follows: turbidity <5 nephelometric turbidity units, TOC <2 parts per million, other parameters stable.
Hydraulic Testing	A single-step pumping test, injection/straddle packer test, or slug test will be conducted in the well screen.

Investigation-Derived Waste (IDW) Management	All waste water produced during drilling will be managed and disposed of in accordance with the NMED-approved Notice of Intent (NOI) Decision Tree: Drilling, Development, Rehabilitation, and Sampling Purge Water (November 2006). Cuttings produced during drilling will be containerized or stored in lined pits and managed and disposed of in accordance with the NMED-approved NOI Decision Tree: Land Application of IDW Solids from Construction of Wells and Boreholes (November 2006). All wastes, such as contaminated personal protective equipment, disposable sampling equipment, decontamination waste, or other materials contaminated by drilling activities, will be characterized and managed in accordance with the associated waste characterization strategy forms and Standard Operating Procedure 5022, Characterization and Management of Environmental Restoration (ER) Project Waste. It is anticipated that all materials from above the water table will initially be managed as nonhazardous waste because the borehole is located in an area not thought to be contaminated.
Tentative Drilling Schedule	The following are activities and the duration at well CdV-R-15-1: • Drilling and completion of borehole (includes mobilization and site preparation): 45 d • Collection of borehole geophysical data: 2 d • Development of CdV-R-15-1: 5 d • Characterization sampling of CdV-R-15-1: 10 to 60 d (following development) • Site restoration at CdV-R-15-1: 7 d The proposed start date for drilling activities is April 30, 2009.

REFERENCES

The following list includes all documents cited in this plan. Parenthetical information following each reference provides the author(s), publication date, and ER ID number. This information is also included in text citations. ER ID numbers are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

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Broxton, D., R. Warren, P. Longmire, R. Gilkeson, S. Johnson, D. Rogers, W. Stone, B. Newman, M. Everett, D. Vaniman, S. McLin, J. Skalski, and D. Larssen, March 2002. "Characterization Well R-25 Completion Report," Los Alamos National Laboratory report LA-13909-MS, Los Alamos, New Mexico. (Broxton et al. 2002, 072640)

Broxton, D.E., and D.T. Vaniman, August 2005. "Geologic Framework of a Groundwater System on the Margin of a Rift Basin, Pajarito Plateau, North-Central New Mexico," *Vadose Zone Journal,* Vol. 4, No. 3, pp. 522–550. (Broxton and Vaniman 2005, 090038)

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LANL (Los Alamos National Laboratory), November 2007. "Evaluation of the Suitability of Wells Near Technical Area 16 for Monitoring Contaminant Releases from Consolidated Unit 16-021(c)-99, Revision 1," Los Alamos National Laboratory document LA-UR-07-6433, Los Alamos, New Mexico. (LANL 2007, 100113)

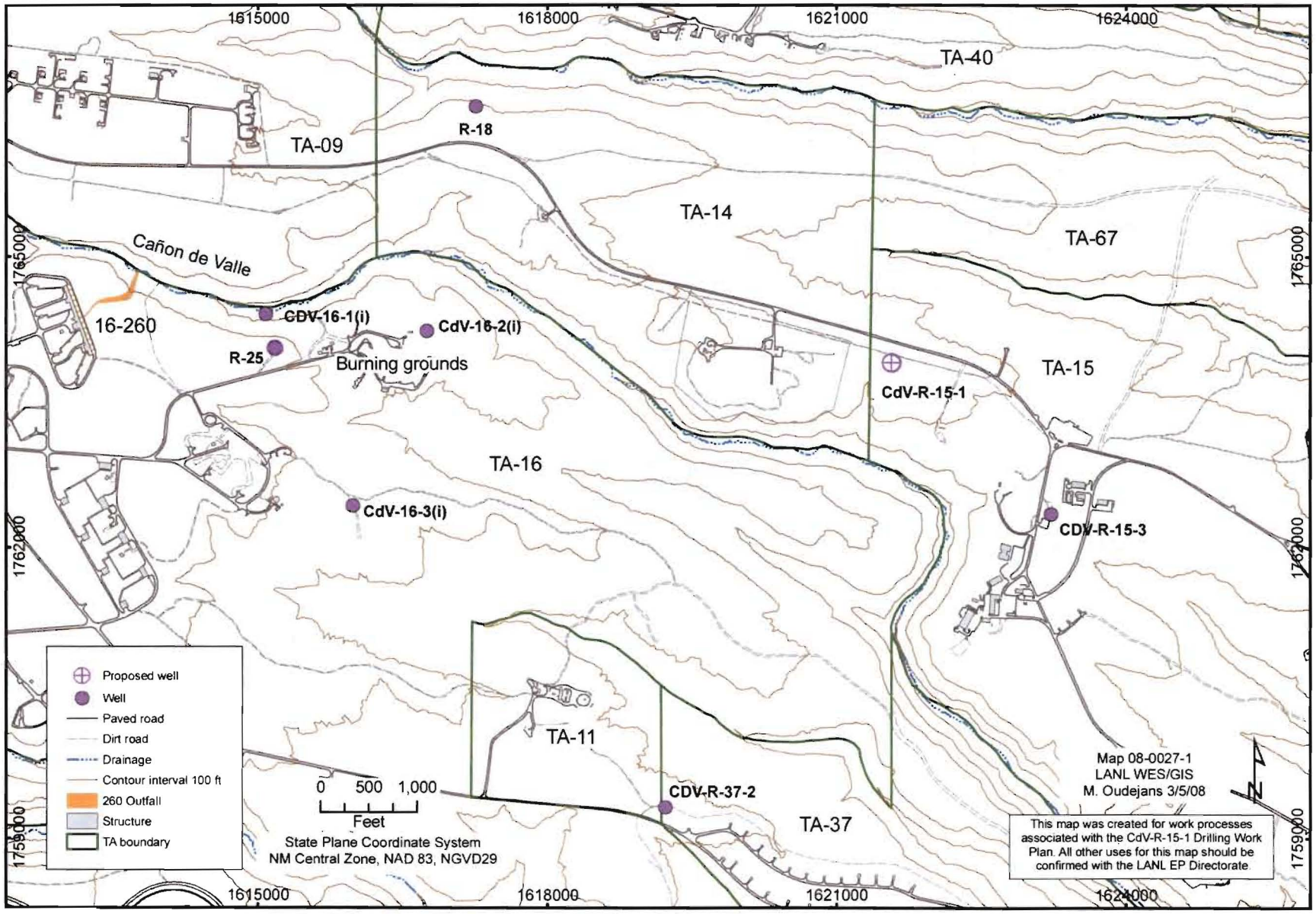
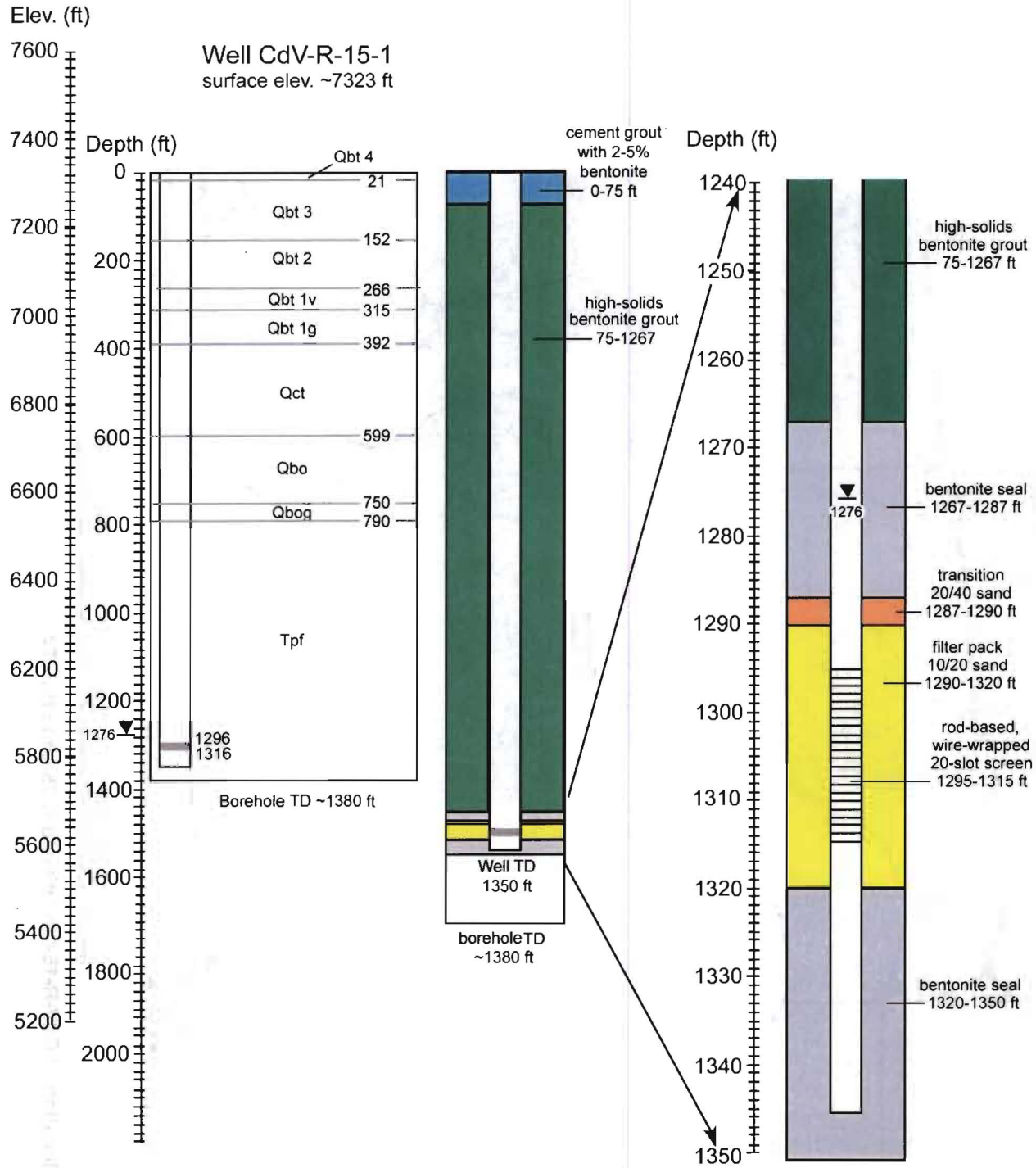
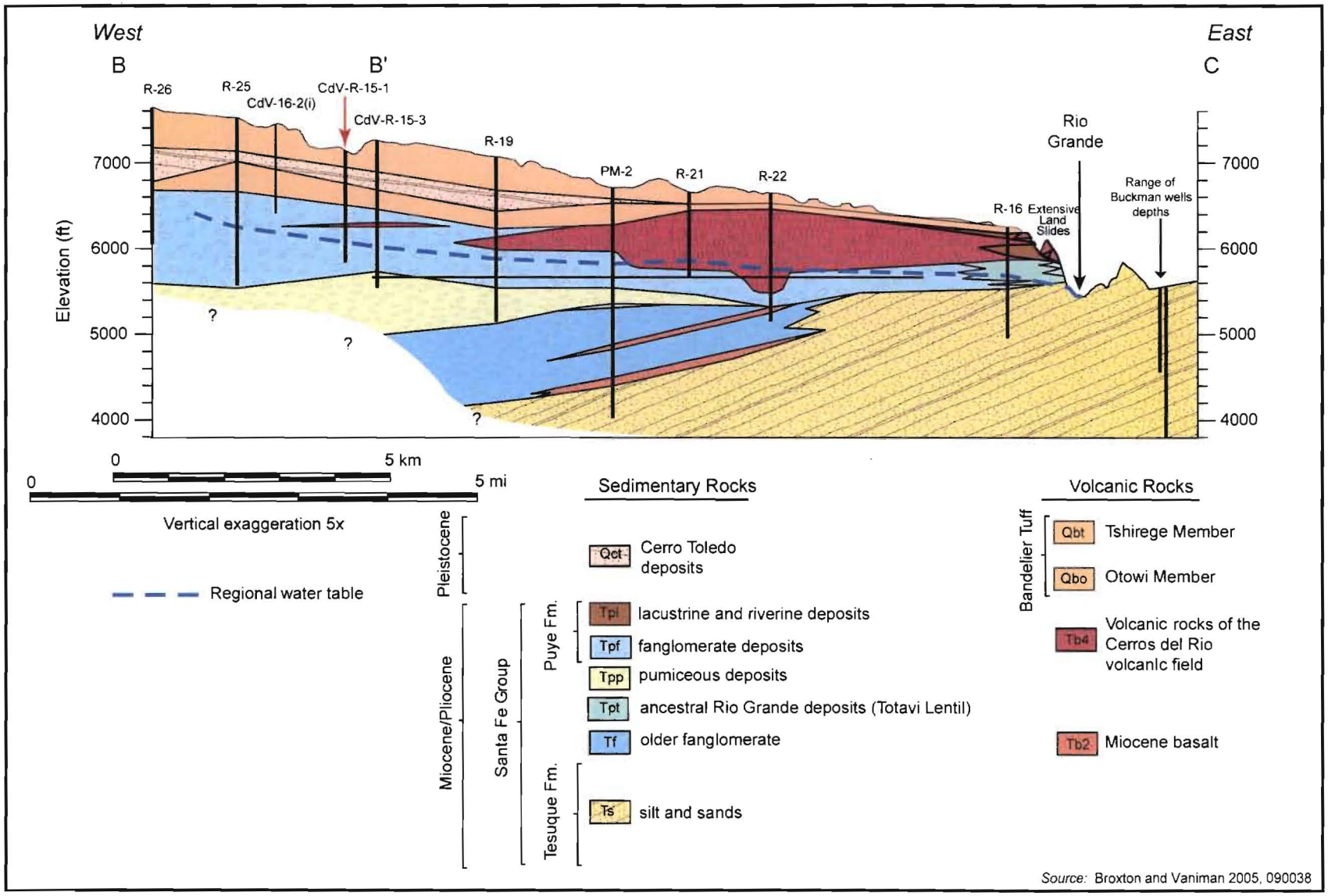


Figure 1 **Proposed location of CdV-R-15-1 relative to R-25 and other TA-16 monitoring wells**



Notes: Qbt = unit 4, 3t, 3, 2, 1v, or 1g of the Tshirege Member of the Bandelier Tuff; Qbtt = Tsankawi Pumice of the Tshirege Member; Qct = Cerro Toledo Interval; Qbo = Otowi Member of the Bandelier Tuff; Qbog = Guaje Pumice of the Otowi Member of the Bandelier Tuff; Tpf = Puye Formation; TD = total depth.

Figure 2 Proposed well design for CdV-R-15-1 in relation to local stratigraphy



Note: Dashed blue line indicates possible top of regional saturation.

Figure 3 Geologic cross-section of the well CdV-R-15-1 area

Drilling Work Plan for Well CdV-16-3(i)

Primary Purpose	Well CdV-16-3(i) will be installed in an existing borehole approximately 1800 ft southeast of well R-25 (Broxton et al. 2002, 072640). Figure 1 shows the locations of R-25, CdV-16-3(i), and other wells and boreholes associated with Consolidated Unit 16-021(c)-99 (aka the 260 Outfall) groundwater investigations. The purpose of well CdV-16-3(i) is to enhance the Technical Area (TA) 16 monitoring well network by providing a regional aquifer well to the southeast of the 260 Outfall and northeast of S-Site Canyon. The planned screened interval for CdV-16-3(i) will be in the uppermost producing zone in the regional aquifer within the Tschicoma dacites at the proposed drilling location. Currently, the CdV-16-3(i) borehole extends to a depth of 1405 ft and is within massive, nonproducing Tschicoma dacites. The existing borehole will be deepened an additional 300 ft to locate more permeable strata within the dacite lavas or in underlying sedimentary deposits. The proposed approach is to advance the borehole from its current depth of 1405 ft to 1700 ft in 100-ft increments. Observations of water production and geophysical measurements will be used to determine if a producing zone is encountered. Once such a zone is located, a single-screen well will be installed in a producing zone. If no producing zones are encountered by 1700 ft, New Mexico Environment Department (NMED) representatives will be contacted to determine a path forward. Figure 2 shows the stratigraphy of CdV-16-3(i) and the proposed well design. Figure 3 is a geologic cross-section showing the distribution of hydrostratigraphic units in the vicinity of well CdV-16-3(i) and the predicted geology at this location.
Conceptual Model	The Tschicoma dacites consist of a heterogeneous mix of low-porosity massive flow interiors and higher-porosity fracture and rubble zones. The former are probably aquitards, and the latter may be more productive parts of the aquifer. It is more likely that significant contaminant fluxes are transmitted through the more permeable zones, so these are the key locations to monitor.
Drilling Approach	Drilling will be conducted using methods selected to optimize the potential of completing the well without using any drilling additives in the zone of saturation. Specifically, efforts will be made to meet the target depth of approximately 1700 ft below ground surface (bgs) and to provide a stable borehole environment for constructing the well. The primary method for advancing the borehole will be a combination of open-hole air-rotary and casing-advance with air-rotary. The following is a summary of the proposed methods by depth interval. • A 12.25-in. open borehole exists to 1405 ft. • A 10-in. casing will be advanced to the target depth of 1700 ft attempting not to use drilling fluid additives. If the well cannot be completed without using drilling fluids within the regional aquifer, NMED will be consulted and a modified drilling strategy will be developed. Municipal water may be added to cool the drill bit.
Potential Drilling Fluids, Composition, and Use	The following fluids and additives that may be used are consistent with those previously used in the drilling program at Los Alamos National Laboratory (the Laboratory) and have been characterized geochemically: • potable water from the municipal water supply to aid in delivery of other drilling additives • QUIK-FOAM, a blend of alcohol ethoxy sulfates, to be used as a foaming agent • AQF-2, an anionic surfactant, to be used as a foaming agent During the initial phase of drilling this borehole, the following fluids were used: • 48 gal. of QUIK FOAM • 14 gal. of EZ-MUD
Geochemical Objective	The geochemical objective is to provide a groundwater sampling point free of drilling-fluid effects within the regional aquifer.

Potential Groundwater Occurrence and Detection	Observations during the drilling of CdV-16-3(i) indicated extremely low influx of water at total depth. The borehole was allowed to recharge and was bailed several times between 2004 and 2006 to determine if water collecting in the borehole represented regional groundwater. Following bailing, the water level always recovered to a depth of approximately 1350 ft (see Figures 2 and 3). Based on the local water table map, it is hypothesized that this is the top of the regional aquifer.
Core Sampling	Core sampling is not proposed for CdV-16-3(i).
Groundwater Screening Sampling	A screening water sample will be collected from the screened interval following well development. The screening sample will be analyzed by the Earth and Environmental Sciences Group chemistry laboratory for cations/metals (dissolved and total), anions (dissolved), and select high explosives (HE) compounds (total).
Groundwater Characterization Sampling	Groundwater samples will be collected from the completed well between 10 and 60 d after well development in accordance with the Compliance Order on Consent. These samples will be analyzed for the full suite of TA-16-related constituents, including tritium; metals/cations; general inorganic chemicals; volatile organic compounds; semivolatile organic compounds; HE compounds, including RDX (research department explosives [hexahydro-1,3,5-trinitro-1,3,5-triazine]) and related degradation products; and stable isotopes. Subsequent groundwater samples will be collected under the "Interim Facility-Wide Groundwater Monitoring Plan" (LANL 2005, 088789).
Geophysical Testing	The Laboratory's borehole video camera, natural gamma, and induction tools will be used if open-hole conditions allow logging in the CdV-16-3(i) borehole before each casing string is introduced. If borehole conditions are stable and allow open hole geophysics, the 10-in. casing will be pulled back from total depth to expose the entire saturated interval for borehole logging by Schlumberger tools.
Well Completion Design	The proposed well design is shown in Figure 2. This figure assumes that a producing zone is found at a depth of 1500 ft.
Well Development	The well may be developed by both mechanical and chemical means. Mechanical means include swabbing, bailing, and pumping. Chemical means include using sodium acid pyrophosphate or AQUA-CLEAR PFD to remove natural and added clays and/or chlorination to kill bacteria introduced during well completion. Chemical means will only be used after additional discussions with, and approval by, NMED. After initial swabbing and bailing, the well will be pumped to complete the development. Water-quality parameters to be monitored are as follows: pH, specific conductance, temperature, turbidity, and total organic carbon (TOC), and acetone or ethylene glycol, as applicable. Target water-quality parameters are as follows: turbidity <5 nephelometric turbidity units, TOC <2 parts per million, other parameters stable.
Hydraulic Testing	A single-step pumping test, injection/straddle-packer test, or slug test will be conducted in the well screen.

Investigation-Derived Waste (IDW) Management	All waste water produced during drilling will be managed and disposed of in accordance with the NMED-approved Notice of Intent (NOI) Decision Tree: Drilling, Development, Rehabilitation, and Sampling Purge Water (November 2006). Cuttings produced during drilling will be containerized or stored in lined pits and managed and disposed of in accordance with the NMED-approved NOI Decision Tree: Land Application of IDW Solids from Construction of Wells and Boreholes (November 2006). All wastes , such as contaminated personal protective equipment, disposable sampling equipment, decontamination waste, or other materials contaminated by drilling activities, will be characterized and managed in accordance with the associated waste characterization strategy forms and Standard Operating Procedure 5022, Characterization and Management of Environmental Restoration (ER) Project Waste.
Tentative Drilling Schedule	The following are activities and durations at well CdV-16-3(i): • Drilling and completion of borehole (including mobilization and site preparation): 45 d • Collection of borehole geophysical data: 2 d • Development of CdV-16-3(i): 5 d • Characterization sampling of CdV-16-3(i): 10 to 60 d (following development) • Site restoration at CdV-16-3(i): 7 d The proposed start date for drilling activities is January 1, 2009, contingent on funding availability.

REFERENCES

The following list includes all documents cited in this plan. Parenthetical information following each reference provides the author(s), publication date, and ER ID number. This information is also included in text citations. ER ID numbers are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the NMED Hazardous Waste Bureau; the U.S. Department of Energy–Los Alamos Site Office; the U.S. Environmental Protection Agency, Region 6; and the Directorate. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.

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Broxton, D.E., and D.T. Vaniman, August 2005. "Geologic Framework of a Groundwater System on the Margin of a Rift Basin, Pajarito Plateau, North-Central New Mexico," *Vadose Zone Journal,* Vol. 4, No. 3, pp. 522–550. (Broxton and Vaniman 2005, 090038)

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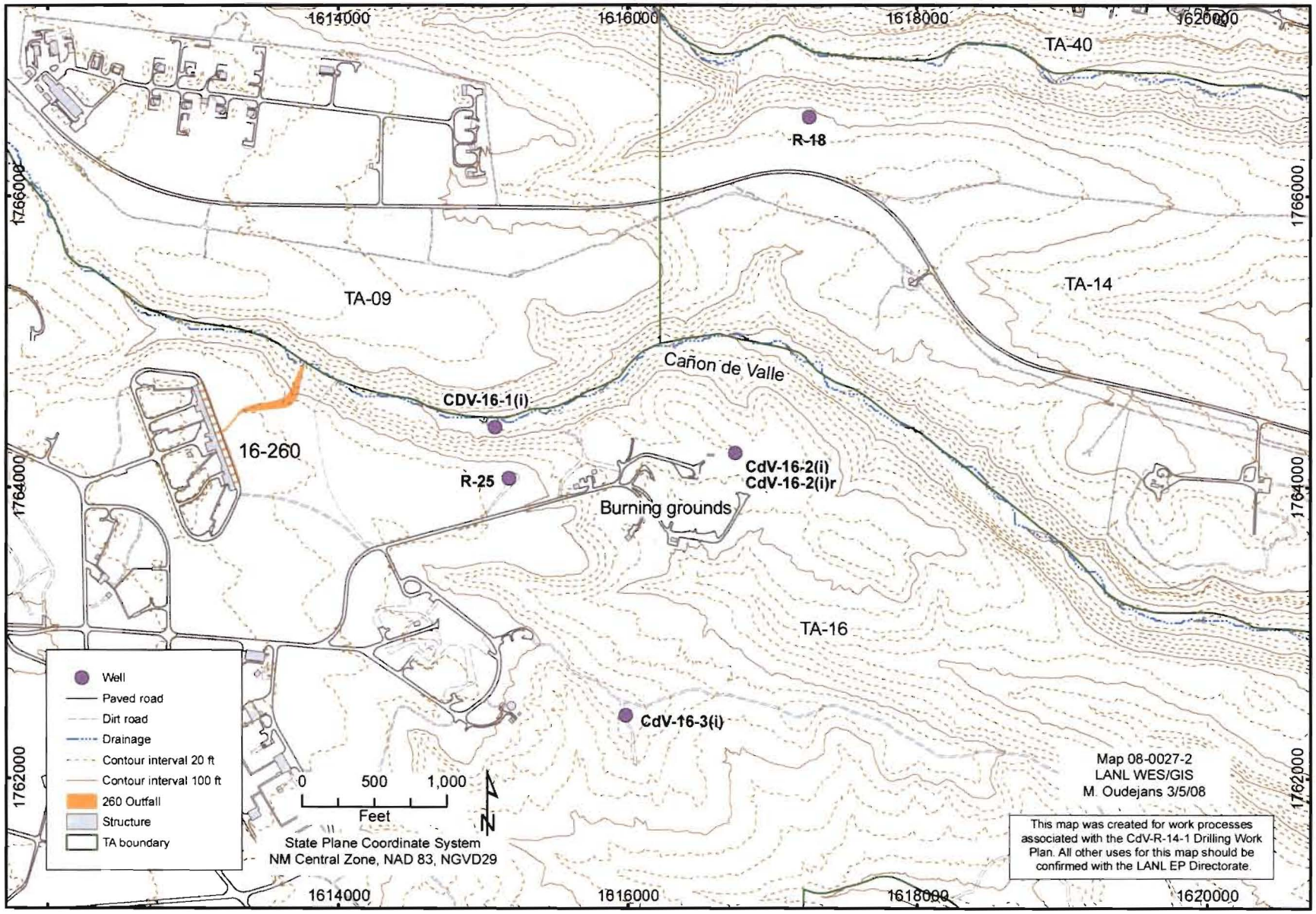

Figure 1 **Proposed location of CdV-16-3(i) relative to R-25 and other TA-16 monitoring wells**

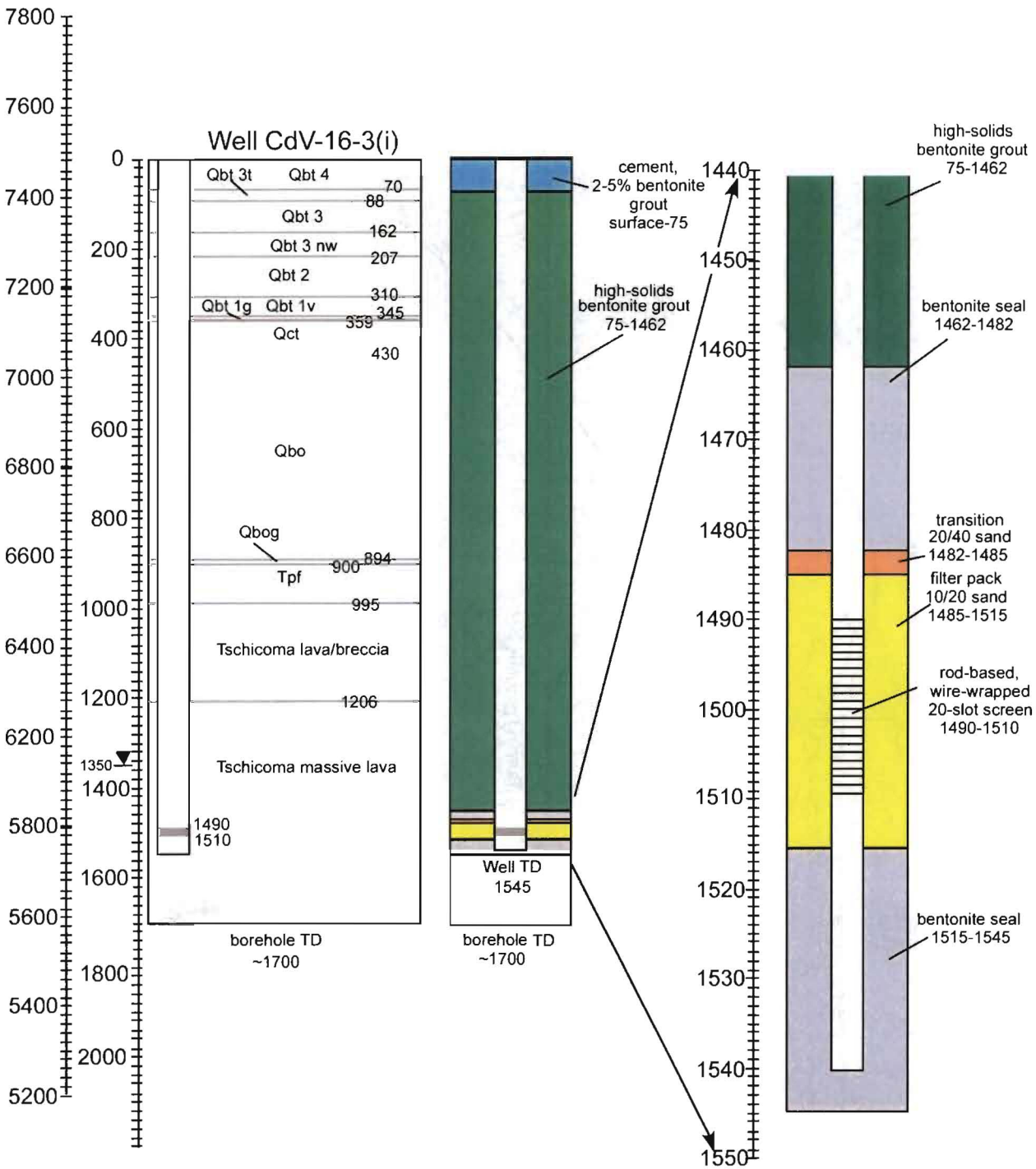

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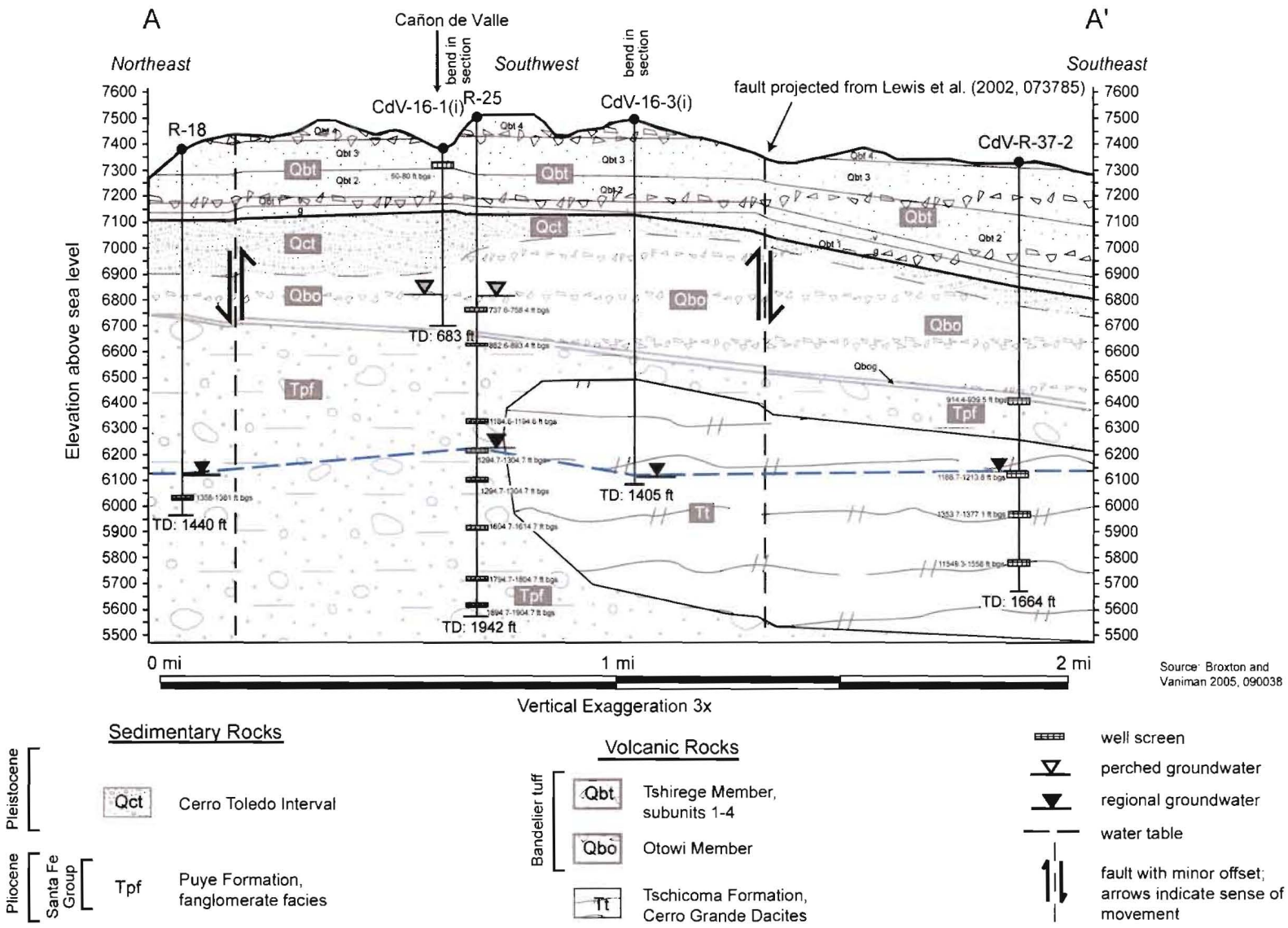
Figure 2 Proposed well design for CdV-16-3(i) in relation to local stratigraphy



Notes: Dashed blue line indicates possible top of regional saturation. Numbers indicate well screens in multiscreen wells. Perched groundwater (?) is shown as a continuous zone of saturation intersecting R-25 and CdV-16-1(i); however, other interpretations about the distribution of groundwater are possible.

Figure 3 Geologic cross-section of the well CdV-16-3(i) area