Drilling Work Plan for Regional Aquifer Well R-55

Primary Purpose	Regional aquifer well R-55 is being installed to satisfy a requirement by the New Mexico Environment Department (NMED) to install a regional groundwater monitoring well downgradient of Material Disposal Area (MDA) G at the eastern end of Technical Area 54 (TA-54). The proposed site for well R-55 is located in Cañada del Buey about 2000 ft east of MDA G (Figure 1). The R-55 well will supplement groundwater monitoring for MDA G provided by wells R-22, R-23, R-39, R-41, R-49, and R-57 (Figure 1). The R-55 borehole is expected to penetrate the top of regional saturation at depths of approximately 795 to 835 ft. Given the uncertainties about the depth to water, the initial target for total borehole depth is provisionally set at approximately 1000 ft. However, the target depth may be adjusted once the depth to water is determined during drilling at this location. The well is tentatively designed with two screens within the regional aquifer (Figure 2). Placement of the upper screen is anticipated to be near the top of regional saturation in sedimentary deposits underlying the Cerros del Rio volcanic series; the deeper screen will target a productive zone in sedimentary deposits approximately 100 ft below the water table. Actual well-screen lengths and positions will be based on data acquired during drilling, including information from lithological logs of cuttings, water-level measurements, video logs, geophysical logs, and drillers' observations. Figure 2 shows the predicted geology and proposed well design for well R-55. A final well design will be based on hydrogeologic conditions encountered during drilling, and a revised well-design document will be submitted to NMED for approval.
Conceptual Model	There are some uncertainties in the depth to water at the proposed R-55 well location. Near MDA G, water levels observed in the Cerros del Rio basalt are higher than the water levels observed in the sedimentary deposits beneath the basalts. This phenomenon is observed in multiscreen wells with screens placed both in the basalts and the underlying sediments (e.g., at R-22 [head difference ~60 ft], R-20 [~30 ft], R-32 [~4 ft], and R-49 [~24 ft]). Well R-57 is currently being drilled, and the regional water table occurs in Cerros del Rio lavas at an elevation similar to the uppermost well screen in lavas at R-22. The water-level differences suggest relatively poor hydraulic connection between the basalts and sediments. This stratification of the regional aquifer may be caused by low-permeability zones within the basalts or low-permeability units at the contact between the basalts and the sediments. At R-41, the Cerros del Rio basalts appear to be either very tight (low permeability) or unsaturated (above the regional water table). The R-41 water level measured in the sediments (~5699 ft) is similar to the water level observed in R-22 screen 3 (~5699 ft), R-23 (~5697 ft), and R-16r (~5692 ft); all of these screens are in sediments. Taken together, the observed data suggest steep gradients in the basalts and the sediments to the northwest of MDA G, and relatively flat gradients to the southeast of MDA G. The proposed location of R-55 is intended to monitor regional aquifer groundwater east of MDA G at a location where the regional water table occurs in sedimentary deposits beneath the Cerros del Rio volcanic series.
Drilling Approach	Drilling will be conducted with methods selected to optimize the potential of completing the well without the use of drilling additives in, or immediately above, the target zone of saturation. A combination of open-hole and casing-advance methods will be employed. Each interval of open hole or casing advance will be optimized to meet well objectives. Casing will be used to protect open-hole intervals above, to advance the borehole when open-hole drilling is not possible, and to secure the borehole through unstable zones or through significant perched groundwater intervals.

Potential Drilling Fluids, Composition, and Use	Fluids and additives that may be used to facilitate drilling are consistent with those previously used in the drilling program at Los Alamos National Laboratory (LANL) and have been characterized geochemically. Fluids and additives previously authorized for use by NMED include • potable water, municipal water supply, to aid in delivery of other drilling additives and cool the drill bit; • QUIK-FOAM, a blend of alcohol ethoxy sulfates, used as a foaming agent; and • AQF-2, an anionic surfactant, used as a foaming agent. Complete records will be maintained detailing the type, amount, and volume of drilling fluid used; depth of drilling fluid added to the borehole; amount in storage in borehole; and recovery volume of drilling fluid. No drilling fluids will be used within 100 ft of the regional aquifer, except potable municipal water. If the regional aquifer cannot be reached without adding drilling fluids, the situation will be discussed with NMED. No chemicals, other than those listed above, will be added without approval from NMED.
Hydrogeologic and Geochemical Objectives	The primary objective is to monitor water quality in the regional aquifer downgradient of potential hazardous- or radioactive-chemical releases from TA-54. Additional objectives are as follows: • Establish water levels in the regional aquifer in this area. • Determine if perched-intermediate groundwater occurs in the vicinity of MDA G. This secondary purpose will be addressed to the extent possible, but drilling methods will be optimized to accomplish the primary objective. • Define the hydrostratigraphy of the site, characterizing rock units that can impact contaminant pathways in both the vadose and saturated intervals. • Help resolve the final disposition of well R-22.
Potential Groundwater Occurrence and Detection	**Potential Perched Water**: Within the Cerros del Rio basalt, occurrences of perched groundwater vary from location to location. Drilling will be halted at a depth of 695 ft, approximately 100 ft above the upper estimate for depth of the regional aquifer, to evaluate whether perched groundwater is present in the basalt. **Regional**: The regional groundwater is expected to occur at a depth of 795 ft in sedimentary deposits underlying the Cerros del Rio volcanic series. However, the depth to water is uncertain because water levels may be up to 40 ft lower in sedimentary deposits relative to those observed in lavas near the east boundary of MDA G. It is possible the depth to water could be as deep as 835 ft at R-55. Methods for groundwater detection may include drillers' observations, water-level measurements, borehole video, and borehole geophysics.
Core Sampling	No core collection is planned.
Groundwater-Screening Sampling	Groundwater-screening samples will be collected during drilling at any perched groundwater zones producing sufficient water for sampling. Screening samples of groundwater will be analyzed for cations/metals (dissolved and total) and anions (dissolved) by the Earth and Environmental Sciences Division's Geochemistry and Geomaterials Research Laboratory, and for tritium and volatile organic compounds (VOCs) by off-site laboratories.

Groundwater Characterization Sampling	Groundwater samples will be collected from the completed well between 10 and 60 days after well development, in accordance with the Compliance Order on Consent. These samples will be analyzed for the full suite of constituents including radiochemistry, metals/cations, general inorganic chemicals, high explosives, VOCs, and stable isotopes. If R-55 is completed as a two-screen well, the first characterization samples will be collected at the end of each constant-rate pumping test through a stainless-steel discharge pipe. Subsequent groundwater samples will be collected under the Interim Facility-Wide Groundwater Monitoring Plan (IFGMP).
Geophysical Testing	LANL's borehole video camera, natural gamma, and induction tools will be used in the open borehole if conditions allow. A full suite of geophysical logs will be run, if required, for proper placement of the screens. The logs will be collected by Schlumberger, Inc., and for open-hole conditions will include accelerator porosity sonde (neutron porosity), array induction, combined magnetic resonance, natural and spectral gamma, and formation microimager logs. In cased portions of the borehole, neutron porosity, triple lithodensity, elemental capture, natural gamma, and spectral gamma logs will be collected. These logs will be used to characterize the hydraulic properties of saturated rocks in the regional aquifer. The suite and timing of geophysical logging will depend on borehole conditions.
Well Completion Design	The upper well screen will be placed within volcaniclastic or axial-river sedimentary deposits near the top of the regional aquifer. The deeper screen will be placed in sedimentary deposits approximately 100 ft below the upper screen. Figure 2 shows the proposed well design and predicted geology for well R-55.
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 additives to remove clays, and/or chlorination to kill bacteria introduced during well completion. • After initial swabbing and bailing, a submersible pump will be used to complete the development process. • Water-quality parameters will be measured in a flow-through cell. The parameters to be monitored are pH, specific conductance, dissolved oxygen, temperature, turbidity, oxidation-reduction potential, and total organic carbon (TOC). • If LANL is unable to bring the water-quality parameters to measure within the limits specified below, the use of chemical well development may be discussed with NMED. No chemicals will be added without approval from NMED. • Chemical means that may be used include sodium acid pyrophosphate and AQUA-CLEAR PFD to remove clays, and/or chlorination to kill bacteria introduced during well completion. Well development will be considered complete when target water-quality parameters are met. The target water-quality parameters are turbidity <5 nephelometric turbidity units, TOC <2 ppm, and other parameters stable.
Hydraulic Testing	Hydraulic testing will be considered if significant water-producing horizons are encountered. The most likely tests will be 24-h constant rate with the two screens isolated from one another.

Investigation-Derived Waste Management	Investigation-derived waste (IDW) will be managed in accordance with Standard Operating Procedure (SOP) EP-SOP-5238, Characterization and Management of Environmental Program Waste (http://www.lanl.gov/environment/all/qa/adep.shtml). This SOP incorporates the requirements of applicable U.S. Environmental Protection Agency and NMED regulations, U.S. Department of Energy orders, and LANL requirements. The primary waste streams include drill cuttings, drilling water, development water, purge water, decontamination water, and contact waste. Where Resource Conservation and Recovery Act constituents are detected when duplicate samples are collected during the same sampling event, and one sample is a nondetect and the other a detection, LANL assumes the detection is the result of laboratory or field contamination. The detection will not be used for waste determination and/or land application. Drill cuttings will be managed in accordance with the NMED-approved Notice of Intent (NOI) Decision Tree for Land Application of IDW Solids from Construction of Wells and Boreholes (November 2007). Drilling, purge, and development waters will be managed in accordance with the NMED-approved NOI Decision Tree for Drilling, Development, Rehabilitation, and Sampling Purge Water (March 2010). Initially, drill cuttings and drilling water will be stored in lined pits. The cuttings may or may not contain residue of drilling/well completion additives (e.g., drilling foam and bentonite clay). The contents of the pits will be characterized with direct sampling after completion of drilling activities, and waste determinations will be made from validated data. If validated analytical data show these wastes cannot be land-applied, they will be removed from the pit, containerized, and placed in accumulation areas appropriate to the type of waste. Cuttings, drilling water, development water, and purge water that cannot be land-applied and are designated as hazardous waste will be sent to an authorized treatment, storage, or disposal facility within 90 days of containerization. Development water, purge water, and decontamination water will be containerized separately at their point of generation, placed in an accumulation area appropriate to the type of waste, and directly sampled. Contact waste will be containerized at the point of generation, placed in an appropriate accumulation area, and characterized using acceptable knowledge of the media with which it came in contact.
Schedule	Well R-55 is proposed for completion by September 28, 2010, which is consistent with the date in LANL's proposed integrated well-installation letter of October 14, 2009. Monitoring conducted after installation of R-55 will be implemented under the IFGMP and will support investigations and potential corrective actions at MDA G and other sites in the vicinity as applicable.

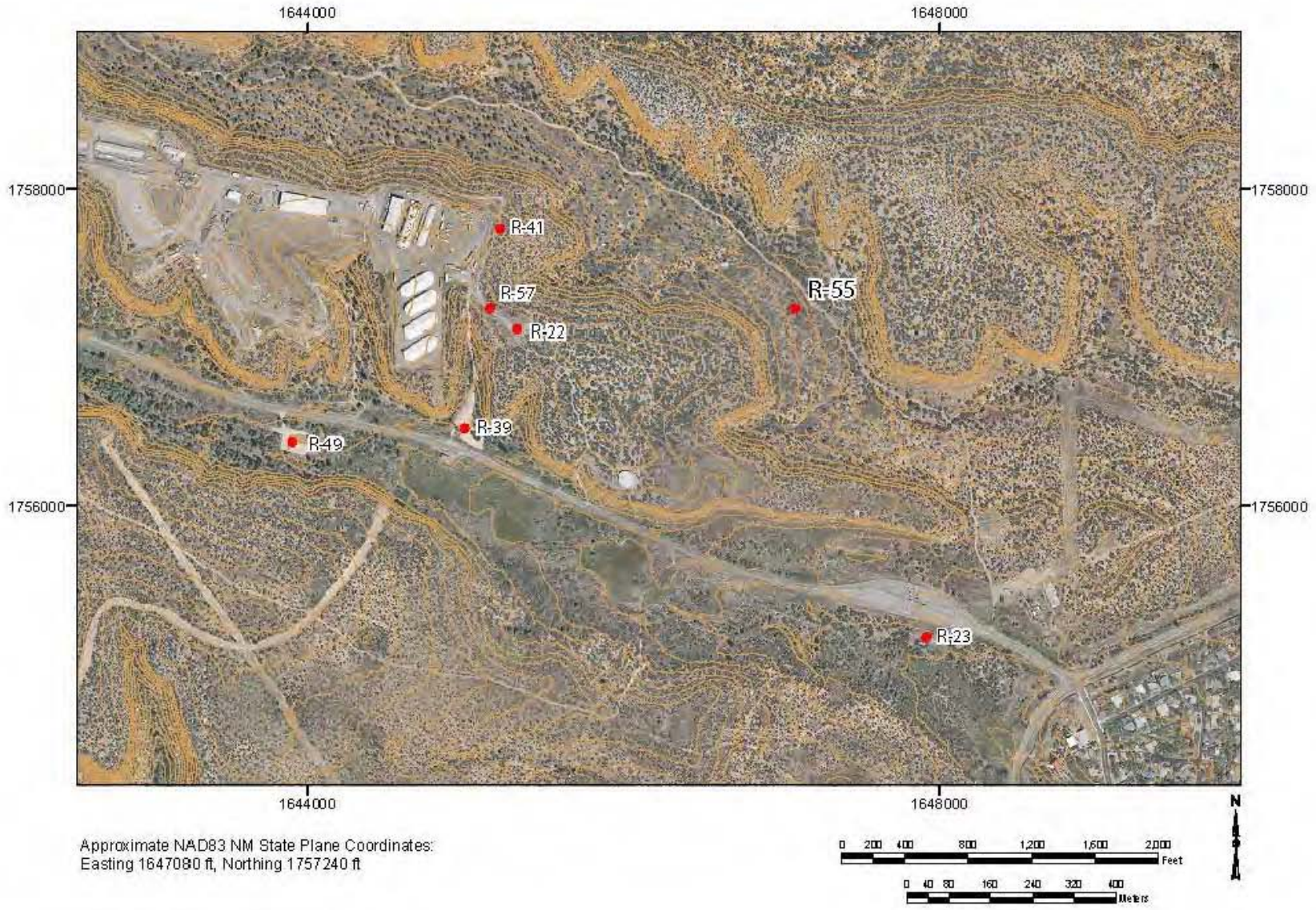

Figure 1 Map of R-55 location

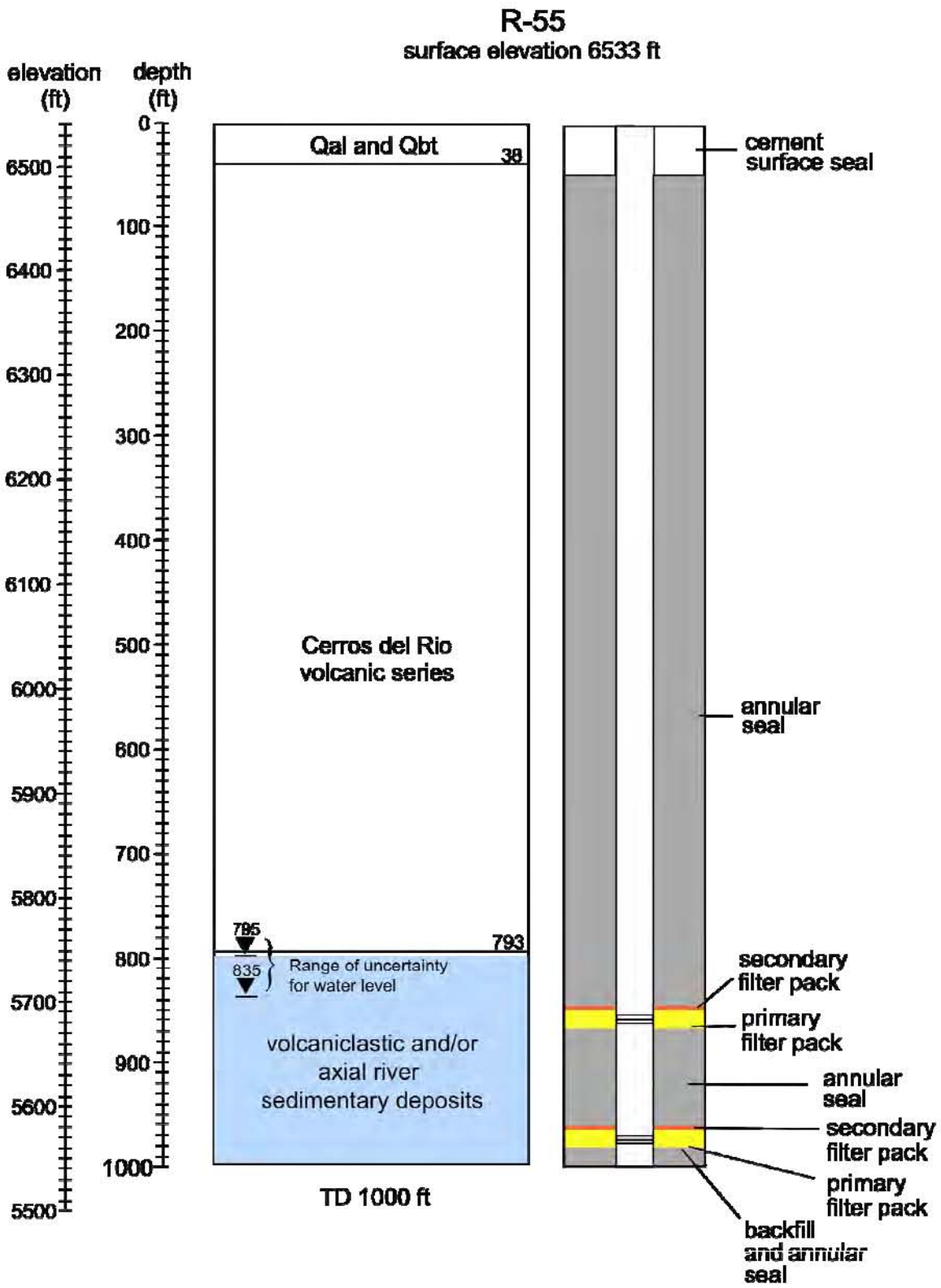

Figure 2 **Predicted geology and proposed well design for well R-55**