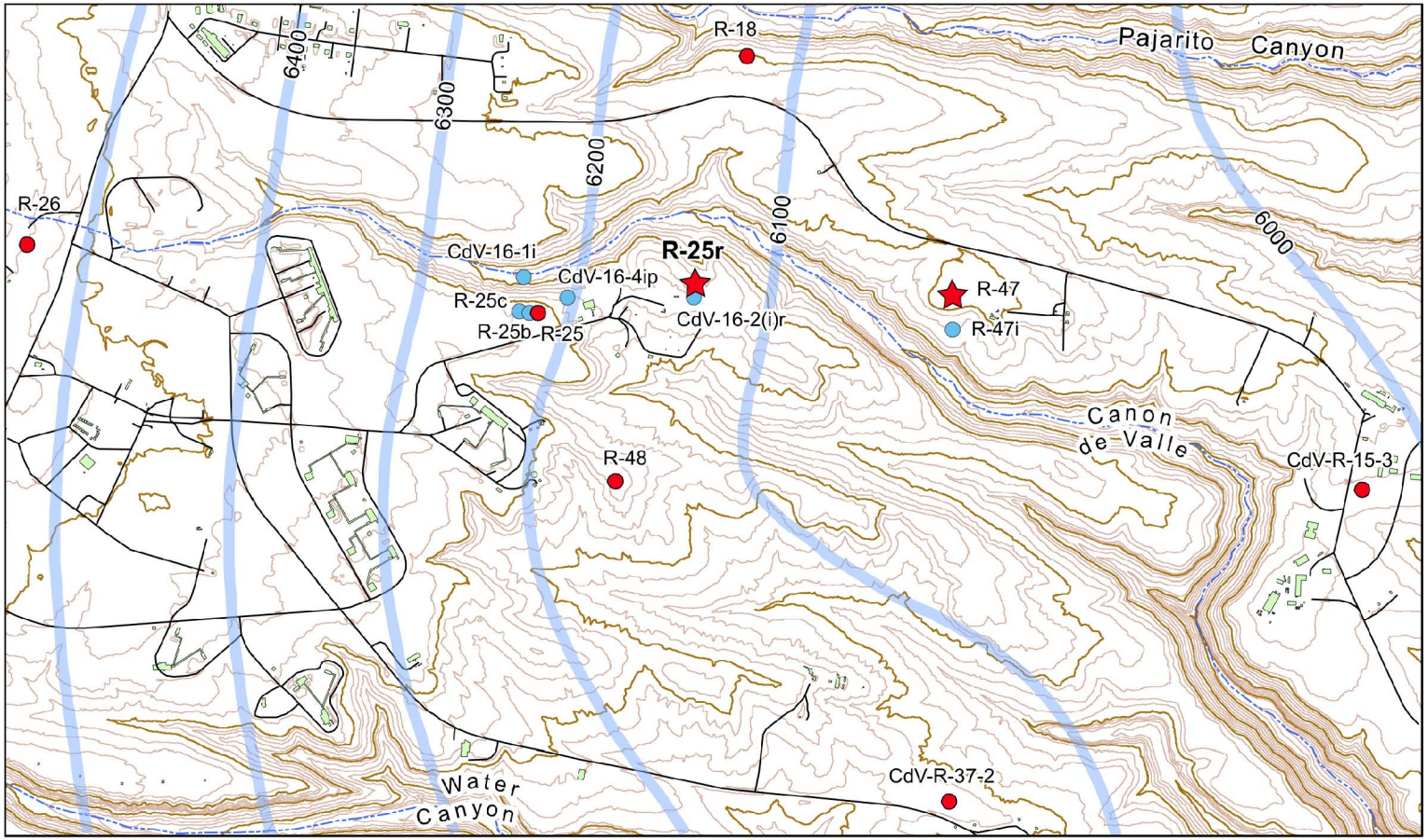
Drilling Work Plan for Regional Aquifer Well R-25r

Primary Purpose	Regional aquifer well R-25r is being installed to satisfy a requirement of the New Mexico Environment Department (NMED) to replace well screen 5 (at the regional water table) for existing well R-25. The primary purpose of R-25r is to provide groundwater monitoring for high explosives (HE) in the regional aquifer downgradient of Consolidated Unit 16-021(c)-99 (the 260 Outfall, located in Technical Area 16 [TA-16]) and beneath infiltration pathways associated with Cañon de Valle and perched groundwater systems in the area. The proposed site for the replacement well is on the CdV-16-2(i)r well pad, about 1600 ft east-northeast of R-25 (Figure 1). Water-level and water-quality data collected at R-25r will also be used to evaluate the need for and location of R-47, a regional aquifer well provisionally sited 2500 ft east of R-25r (Figure 1). The depth to the top of regional saturation at R-25r is expected to be approximately 1322 ft. The target depth for the R-25r borehole is 1422 ft, about 100 ft into the regional aquifer. There are uncertainties about the depth to water, and the target depth may be adjusted once the water depth is determined at this location. The well is tentatively designed with one well screen placed near the water table in Puye Formation deposits (Figure 2). Final selection of well-screen length and position will be based on data acquired during drilling, including information from lithological logs of cuttings, water-level measurements, video logs, geophysical logs, and driller's observations. Figure 2 shows the predicted geology and proposed well design for well R-25r. A final well design will be based on hydrogeological conditions encountered during drilling, and a revised well design document will be submitted to NMED for approval.
Conceptual Model	The primary migration route of contaminants associated with the 260 Outfall likely consisted of discharge of HE compounds as effluent from the outfall, surface flow of effluent to Cañon de Valle through a small tributary drainage, down-canyon transport of contaminants by surface water flow and alluvial groundwater, infiltration into the vadose zone primarily through fractures and surge beds, and subsurface migration of soluble contaminants to deep-perched and regional groundwater. The location of R-25r is optimized to detect contaminants downgradient of the expected infiltration windows. Because of the sparse distribution of regional wells in the area, the depth and flow direction of groundwater at TA-16 is somewhat uncertain. R-25r is located in a transitional area where steep hydraulic gradients flatten eastwards (Figure 1), making estimates of depth to water imprecise. Also, water-table gradients in this area may be influenced by lateral variations in aquifer lithologies. For example, the upper part of the regional aquifer is made up of thick, relatively impermeable dacite lavas to the south of the R-25r site at R-48 and CdV-R-37-2. These lavas pinch out northward where the upper part of the aquifer is made up of fanglomerate deposits of the Puye Formation at R-25 and R-18 (Figure 3). The juxtaposition of these aquifer lithologies may influence the direction of regional groundwater flow in this area. Water-table maps indicate a sharp bend in equipotential lines in the vicinity of TA-16 (Figure 1). The bend suggests that groundwater flow could have a northeasterly component in addition to the primary easterly flow direction. Locating R-25r as proposed is intended to monitor regional aquifer groundwater to the east of infiltration windows postulated for the 260 Outfall.
Drilling Approach	Drilling will be conducted with methods selected to (1) optimize the potential of completing the well without the use of drilling additives in, or immediately above, the target zone of saturation and (2) minimize cross contamination between the deep-perched and regional groundwater. A combination of open-hole and casing-advance methods will be employed, and 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 (the Laboratory), and have been characterized geochemically. Fluids and additives previously authorized for use by NMED include • potable water from the 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 and volume of drilling fluid used, depth at which drilling fluid was 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 HE releases from the 260 Outfall and thereby to provide information that supports the regional groundwater monitoring network for the 260 Outfall corrective measures evaluation (CME) • A secondary objective is to establish water levels and gradients in the regional aquifer in this area for water-table maps and thereby to enable optimization of the monitoring network for the 260 Outfall CME. • Another secondary objective is to determine the vertical extent of perched-intermediate groundwater encountered at CdV-16-2(i)r. This secondary purpose will be addressed to the extent possible, but drilling methods will be optimized to accomplish the primary objective. • A third secondary objective is to define the hydrostratigraphy of the site (Figure 3) to characterize rock units that can impact contaminant pathways in both the vadose and saturated intervals.
Potential Groundwater Occurrence and Detection	*Potential Perched Water:* Perched water is known to occur at CdV-16-2(i)r, but its vertical extent is not well characterized. Drilling will be halted at a depth of 1222 ft, 100 ft above the regional aquifer, to evaluate the number and vertical extent of perched-groundwater zones at this location. *Regional:* At approximately 1322 ft depth, regional groundwater is expected to occur in fanglomerate deposits of the Puye Formation. Methods for groundwater detection may include driller's observations, water-level measurements, borehole video, and borehole geophysics.
Core Sampling	No core collection is planned.
Perched Groundwater Screening Sampling	Groundwater screening samples will be collected during drilling if perched groundwater is found in zones deeper than that sampled at CdV-16-2(i)r and if such zones produce sufficient water for sampling. Screening samples of perched 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 HE, tritium, and volatile organic compounds (VOCs) by off-site laboratories.

Regional 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; VOCs; semivolatile organic compounds; HE compounds, including RDX (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 (IFGMP).
Geophysical Testing	The Laboratory'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 geophysical logs will also be used to select the well-screen depths. The suite and timing of geophysical logging will depend on borehole conditions.
Well Completion Design	Figure 2 shows the proposed well design and predicted geology for well R-25r.
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 the Laboratory is unable to bring the measured water-quality parameters to 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 AQUACLEAR 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 a significant water-producing horizon is encountered. The most likely test will be 24-h constant-rate pumping test.

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 Laboratory 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 and duplicate samples are collected during the same sampling event and one is a nondetect and the other is detected, the Laboratory 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 following 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 d 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-25r is proposed for completion by March 31, 2011. The Laboratory is prioritizing installation of R-25r before R-47 to obtain key water-quality and water-level information that can be used to evaluate the need for the provisional R-47 monitoring well. If the decision is made to install R-47, water-level data collected at R-25r will be used to optimize its location. Monitoring conducted subsequent to installation of R-25r will be implemented under the IFGMP and will support investigations and corrective actions at TA-16.



Notes: The current location for provisional well R-47 is also shown. The need and location for R-47 should be reevaluated after water-quality and water-level data become available from R-25r.

Figure 1 Proposed location of well R-25r

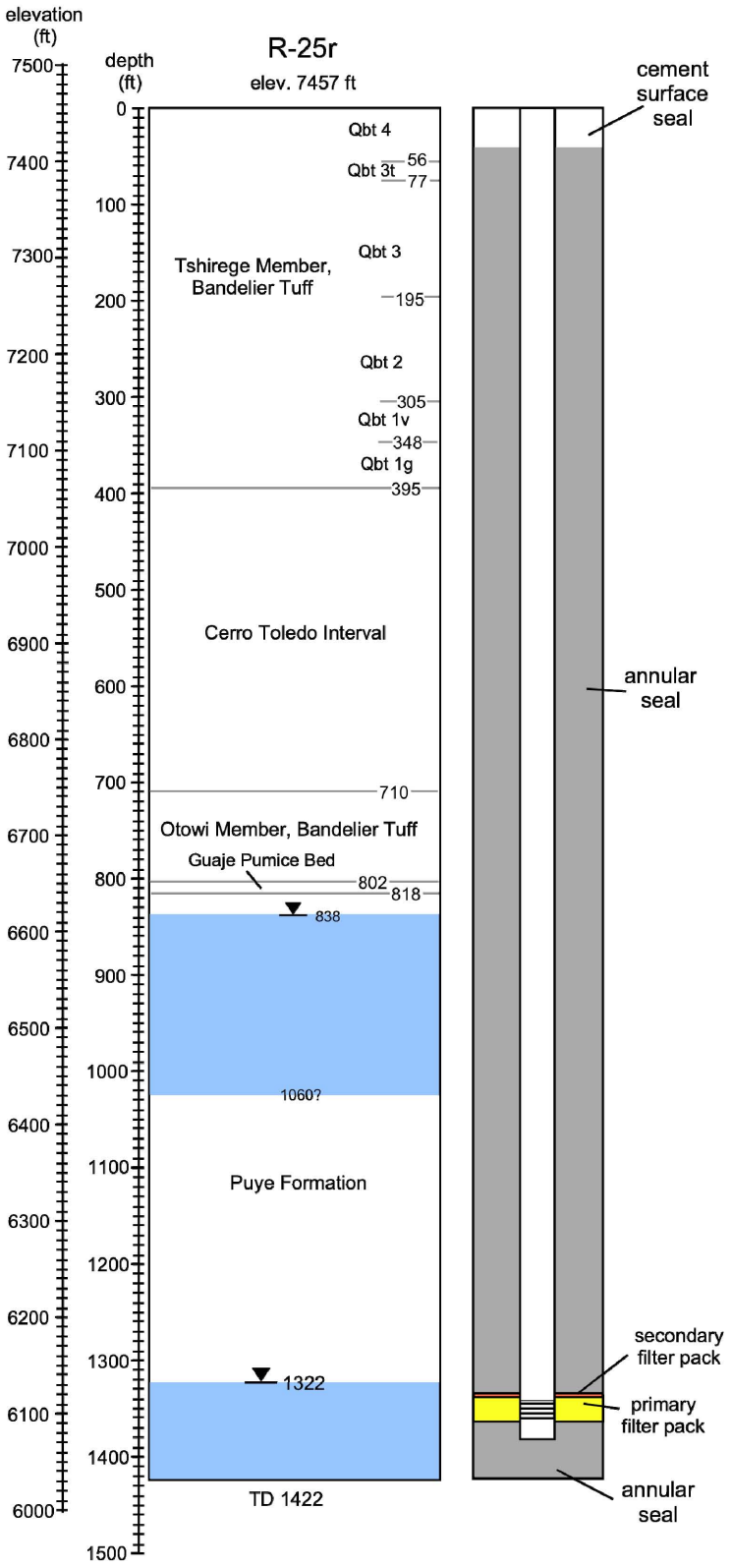


Figure 2 Predicted geology and proposed well design for well R-25r

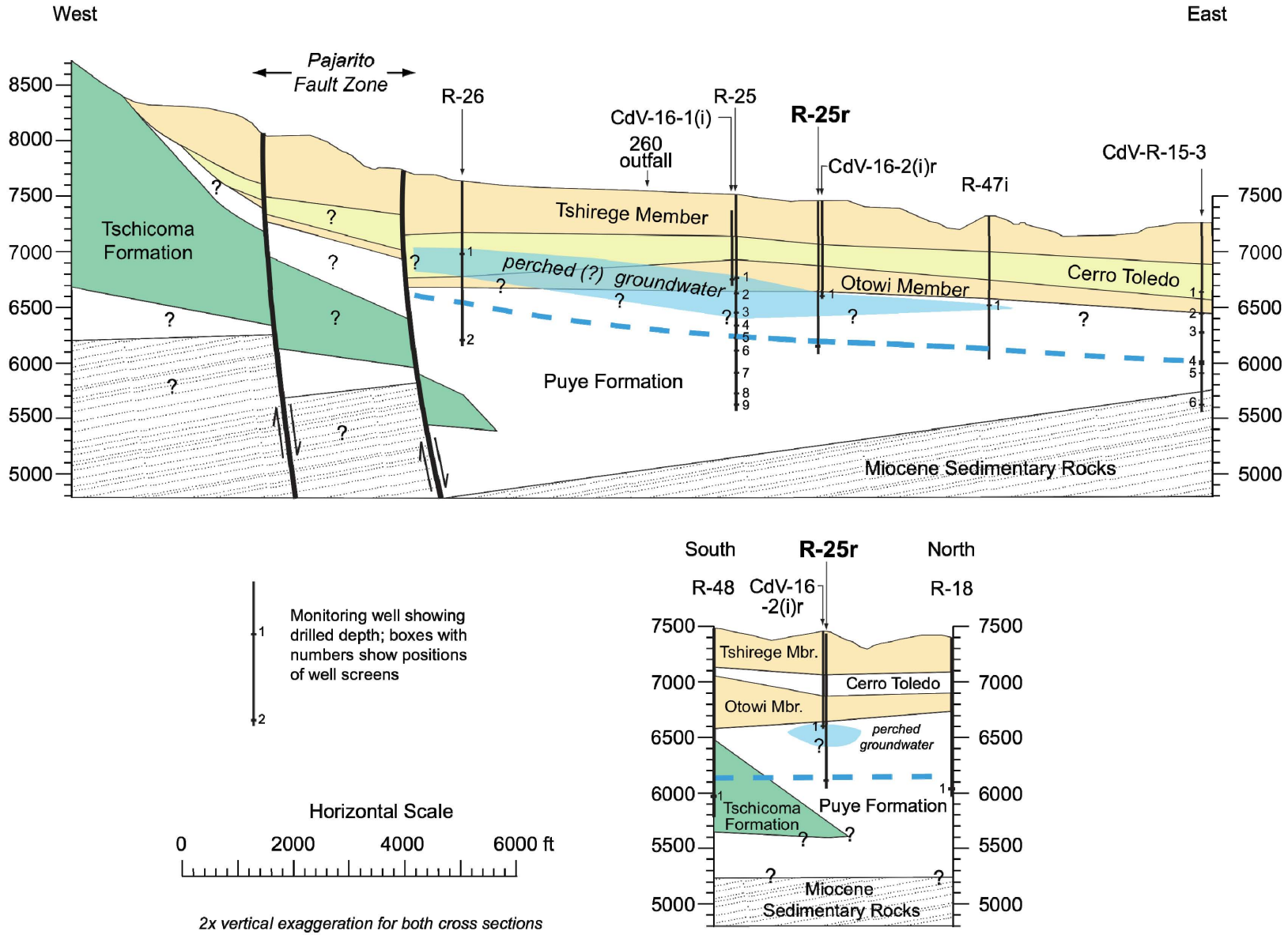


Figure 3 East-west and north-south cross-sections showing the hydrogeology in the vicinity of proposed well R-25r