Drilling Work Plan for Groundwater Extraction Well CrEX-1

Primary Purpose	A pilot pumping well, designated CrEX-1, is being installed to evaluate further the capture zone that began with interim measures pumping at monitoring wells R-42 and R-28 in 2013. This work plan fulfills a schedule commitment of Los Alamos National Laboratory's (the Laboratory's) "Interim Measures Work Plan for Evaluation of Chromium Mass Removal (hereafter, the Interim Measures Plan) (LANL 2013, 241096) to propose additional work by March 31, 2014. It also fulfills a requirement of the New Mexico Environment Department's (NMED's) approval with modification for the Interim Measures Plan dated June 26, 2013 (NMED 2013, 522947) to submit a work plan for a pilot pumping well by March 31, 2014. The primary objective of pumping at CrEX-1 is to evaluate the potential to control chromium migration towards the Laboratory boundary via hydraulic control. Plume control would be accomplished by pumping one or more high-flow capacity wells (including CrEX-1) that would intercept migration of higher chromium concentrations within the regional aquifer and effectively create a low-chromium concentration (<50 ppb) "tail" along the primary flow path that would manifest as increasingly lower concentrations in groundwater at the Laboratory boundary. Aquifer-test data, extended pumping in CrEX-1 (up to 4 consecutive months in 2014), and monitoring of pressure responses in surrounding monitoring wells will provide data to support a capture-zone analysis to evaluate the feasibility of pumping to control chromium migration to the Laboratory boundary via hydraulic control. Although not a primary objective of the well, mass removal of chromium will also be achieved during pumping. Sustained chromium removal rates will also be determined from the pumping period. It is estimated that concentrations between approximately 150 and 250 ppb will be present and sustained during pumping in the upper portion of the regional aquifer at CrEX-1. The well will be located on the south rim of Mortandad Canyon, within the chromium contamination plume in the regional aquifer. The proposed location for the well is shown in Figure 1. The borehole is expected to penetrate the top of regional saturation at a depth of approximately 994 ft within sediments of the Puye Formation. The target borehole depth is approximately 1100 ft. The well is planned to be completed as a single 50- to 100-ft-long screen set near the top of regional saturation. Figure 2 shows the predicted geology and conceptual well design. Final design will be based on data obtained during drilling, including information from lithologic logs of cuttings, water-level measurements, video logs, geophysical logs, and field team observations. Well-design recommendations will be submitted to NMED for approval before construction.
Drilling Approach	Two key factors are considered in developing the drilling approach for CrEX-1. First, recent experience in drilling nearby R-42 and R-45 in Mortandad Canyon indicates flowing sands may be encountered at about the level of regional saturation in this area. Flowing sands can cause the drill casing to lock in place and not retract during well construction. Second, because of the required diameter of the borehole and the target depth for the well of approximately 1100 ft, the casing advance method cannot be used because the weight of 1100 ft of 16-in.-diameter casing cannot be suspended even by a heavy-duty dual-rotary rig of the type used to drill most of the groundwater monitoring wells at the Laboratory. Therefore, to reach the target depth with the required well diameter capable of providing 100 to 150 gallons per minute (gpm) of water to the surface, mud-rotary drilling methods are required for this well. With the proposed well design, it is expected that residual drilling mud can be removed from the screened interval with a combination of mechanical and chemical methods and that the well will produce water representative of the chemistry of the contaminant plume.

Drilling Approach (continued)	The general approach is to drill an 18-in.-diameter borehole to a depth just above the regional aquifer and set 16-in. casing. The drill rig capable of the proposed drilling method can handle the 16-in. casing weight. The upper section of the borehole may be drilled with either air- or mud-rotary methods. The remainder of the borehole will be advanced with either conventional or reverse mud rotary. The final details of the drilling method will be included in the drilling work plan provided by the selected drilling subcontractor.
Drilling Fluids, Composition, and Use	Fluids and additives will be used to facilitate drilling and well development. These fluids and additives may include those previously authorized for use by NMED: • 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 • AQF-2, an anionic surfactant, used as a foaming agent In addition, drilling mud will be used to complete the well. This may include the following products or their equivalents: • Baroid QUIK-GEL bentonite-based drilling mud, or Laboratory-approved equivalent • EZ-MUD polymer, or Laboratory-approved equivalent • QUIK-TROL, PAC-L, or PAC-R filtration control, or Laboratory-approved equivalent • Soda ash pH adjuster Complete records will be maintained detailing the type, amount, and volume of fluid and additives used, depth where fluids or additives are added to the borehole, amount of residual material stored the borehole, and recovery volume of fluids and additives.
Groundwater Occurrence	Based on wells in the area, encountering perched water at this location is not anticipated. A note will be made if perched water is observed during drilling, but drilling will not be stopped to characterize or sample any perched zones. Abundant water-level data from the area indicate regional saturation should be encountered at a depth of 994 ft within sediments of the Puye Formation.
Core Sampling	No core collection or sampling is planned. Drill cuttings will be collected at 10-ft intervals and used for lithologic description.
Geophysical Testing	A full suite of Schlumberger geophysical logs will be collected when the borehole has been drilled to total depth. In open-hole sections of the borehole, this 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 refine estimates of the top of regional saturation and to characterize the hydraulic properties of saturated strata beneath the water table.
Well Completion Design	Figure 2 shows the conceptual well design. Screen placement and length will depend upon the geophysical logs and field crew observations. A proposed well design will be submitted to NMED for approval before construction begins.

Well Development	The well will be developed by both mechanical and chemical means. Mechanical means include swabbing, bailing, jetting/air-lifting, and pumping. Chemical means include using clay dispersants and/or chlorination to kill bacteria introduced during well completion. Chemicals that may be used to aid in the breakdown of drilling muds and additives include the following: • Sodium hypochlorite • AQUA-CLEAR PFD Water-quality parameters will be measured in a flow-through cell during the pumping phase of development. The parameters to be monitored are pH, specific conductance, dissolved oxygen, temperature, turbidity, and oxidation-reduction potential. Samples will be collected daily for total organic carbon (TOC) and analyzed at the Laboratory's Geology and Geochemistry Research Laboratory. Well development will be considered complete when target water-quality parameters are met, sand content averages less than 5 mg/L over a 2-h pumping period, and specific capacity is no longer increasing. The target water-quality parameters are turbidity <5 nephelometric turbidity units, TOC <2 ppm, and other parameters stable.
Hydraulic Testing	A step-drawdown test will be conducted on the well to determine the sustainable yield for the well. During each step (flow rate) a water sample will be collected for chromium concentration screening using a HACH field test kit. Once the optimum pumping rate is identified, the pump will be positioned at 10-ft intervals within the screen for additional HACH chromium testing. Data from these two sets of sampling series will be used to select the final pump position and flow rate to meet pumping objectives.
Pumping System Installation	A pumping system will be designed based on the hydraulic testing results and installed in the well. The well is expected to be capable of delivering 100 to 150 gpm to the surface.
Investigation-Derived Waste Management	Investigation-derived waste (IDW) will be managed in accordance with standard operating procedure (SOP) EP-DIR-SOP-10021, Characterization and Management of Environmental Program Waste (available at http://www.lanl.gov/community-environment/environmental-stewardship/plans-procedures.php). 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 will include drill cuttings, drilling water, drilling fluids and additives, development water, purge water generated during hydraulic testing, decontamination water, and contact waste. Drill cuttings with residual additives 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 (November 2006). 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/or via use of a composite of subsamples collected during drilling, 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 for 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.

Investigation-Derived Waste Management (continued)	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 CrEx-1 will be completed and ready for operation by August 1, 2014.

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. This information is also included in text citations. ER IDs 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 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.

LANL (Los Alamos National Laboratory), April 2013. "Interim Measures Work Plan for the Evaluation of Chromium Mass Removal," Los Alamos National Laboratory document LA-UR-13-22534, Los Alamos, New Mexico. (LANL 2013, 241096)

NMED (New Mexico Environment Department), June 26, 2013. "Approval with Modification, Interim Measures Work Plan for the Evaluation of Chromium Mass Removal," New Mexico Environment Department letter to P. Maggiore (DOE-LASO) and J.D. Mousseau (LANL) from J.E. Kieling (NMED-HWB), Santa Fe, New Mexico. (NMED 2013, 522947)

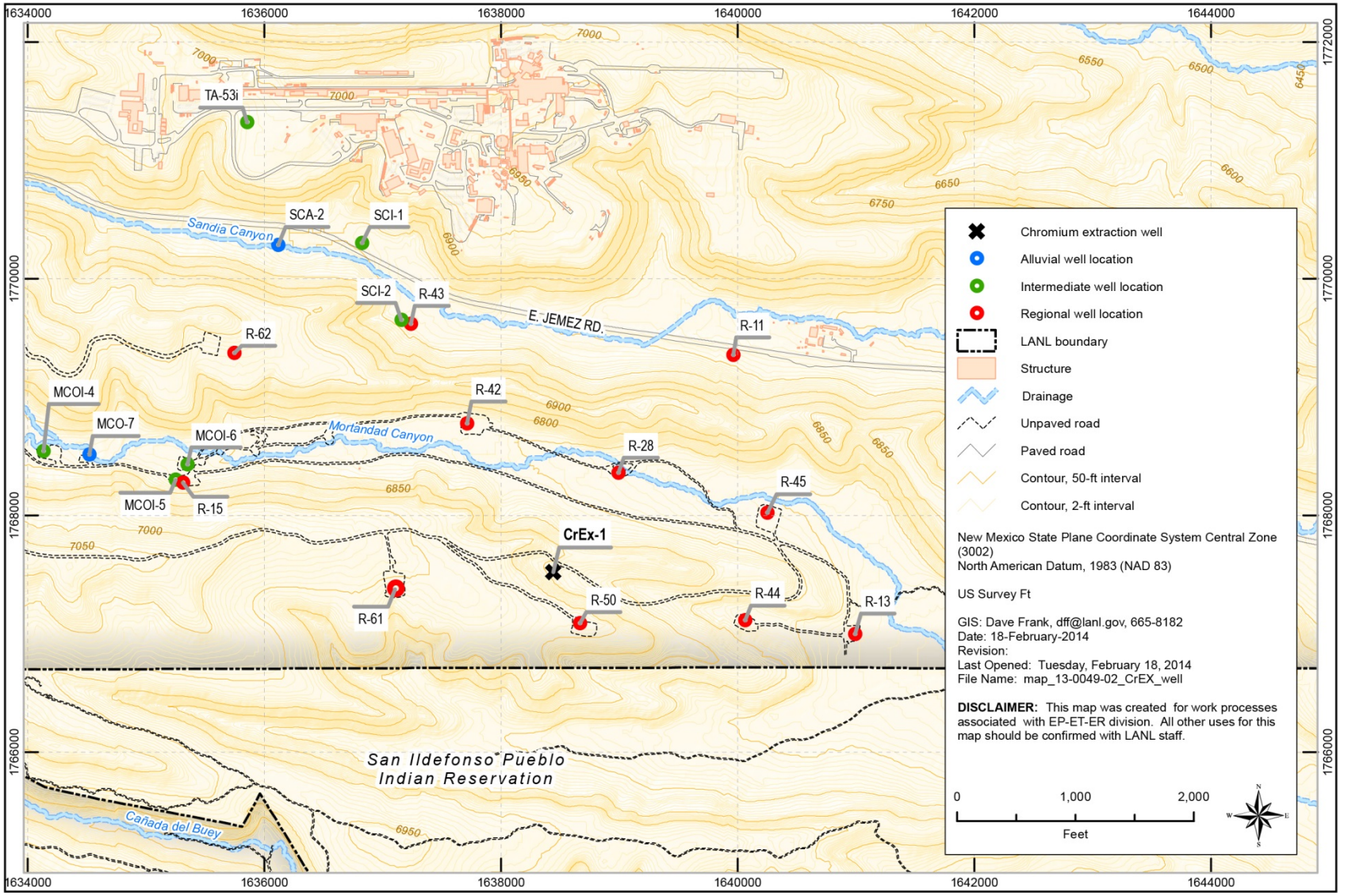

Figure 1 Proposed location for well CrEX-1

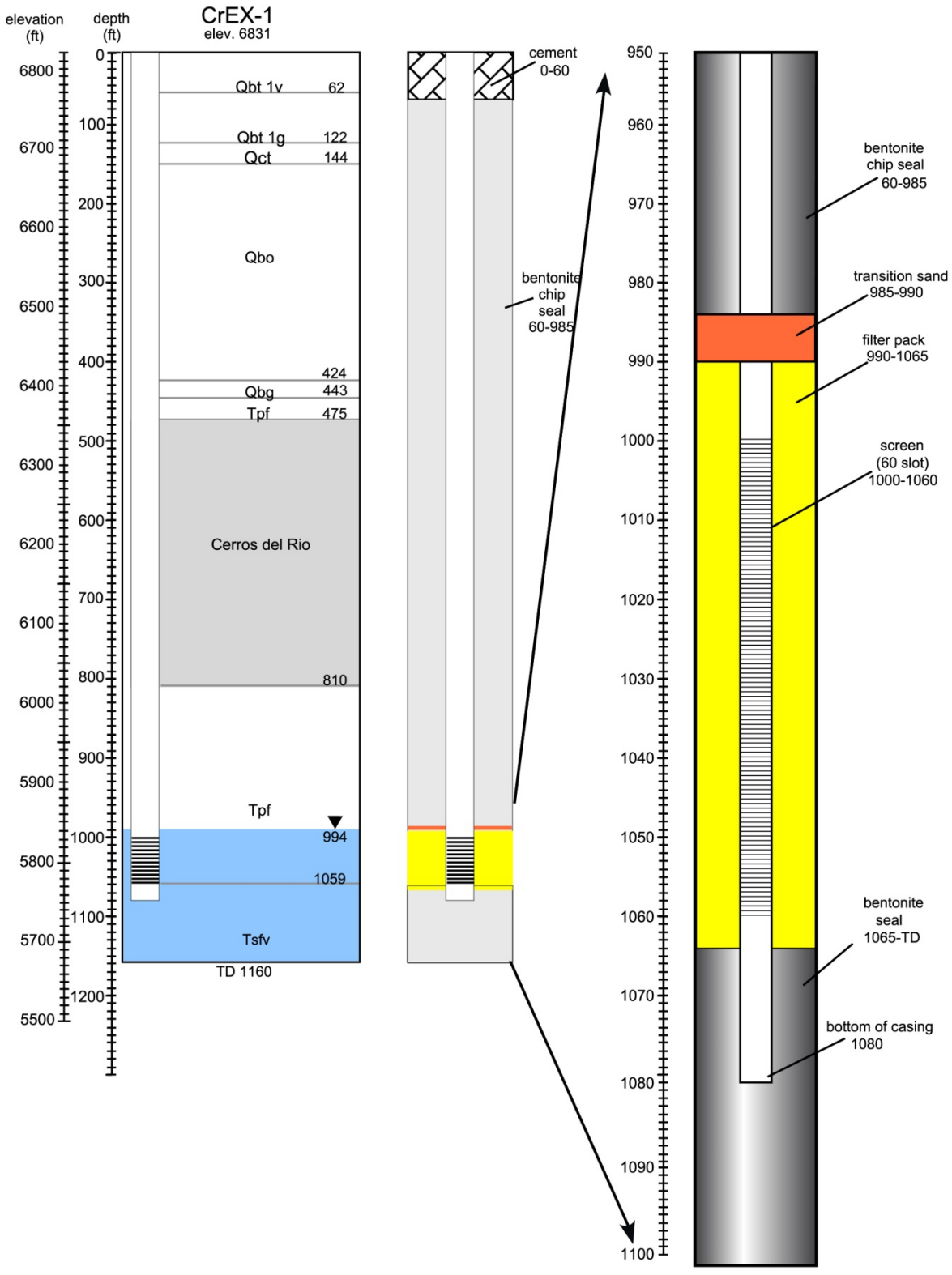

Figure 2 Predicted geology and conceptual well design for well CrEX-1