DEPARTMENT OF ENERGY
Environmental Management Los Alamos Field Office (EM-LA)
Los Alamos, New Mexico 87544

EMLA-23-BF212-2-1

May 31, 2023

Mr. Rick Shean
Designated Agency Manager
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505-6313

Subject: Submittal of the Drilling Work Plan for Groundwater Regional Aquifer Monitoring Well R-76 (Replacement of Groundwater Regional Aquifer Monitoring Well R-28), Revision 2

Dear Mr. Shean:

Enclosed please find two hard copies with electronic files of the "Drilling Work Plan for Groundwater Regional Aquifer Monitoring Well R-76 (Replacement of Groundwater Regional Aquifer Monitoring Well R-28), Revision 2." This submittal replaces Revision 1 of this work plan [Drilling Work Plan for Groundwater Regional Aquifer Monitoring Well R-76 (Replacement of Groundwater Regional Aquifer Monitoring Well R-28), Revision 1, EMID-702131], submitted to NMED on June 10, 2022, and approved with modifications by NMED on June 29, 2022.

The purpose of this submittal is to update the drilling work plan for R-76 as a single-screen well installation, replacing the dual-screen design of the previous submittal. NMOSE (New Mexico Office of the State Engineer) rejected the dual-screen design on the basis that, "any application requesting dual screens in separate hydrogeologic units in areas with known or suspected contamination will not be approved by the [NM]OSE." (EMID- 702624) Although EM-LA does not agree with the NMOSE's assertion that the Puye and Chamita formations are separate hydrogeologic units, EM-LA will implement the single-screen well design at R-76 to meet the 2016 Compliance Order on Consent milestone for replacement of R-28. In the future, EM-LA will continue to pursue a technical basis to advance dual-screen well designs, while also protecting groundwater.

If you have any questions, please contact Clark Short at (505) 551-2942 (Clark.Short@em-la.doe.gov) or Cheryl Rodriguez at (505) 414-0450 (cheryl.rodriguez@em.doe.gov).

Sincerely,

ARTURO DURAN

Digitally signed by ARTURO DURAN
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Arturo Q. Duran
Compliance and Permitting Manager
U.S. Department of Energy
Environmental Management
Los Alamos Field Office

Enclosure(s):

1. Two hard copies with electronic files:
   Drilling Work Plan for Groundwater Regional Aquifer Monitoring Well R-76 (Replacement of Groundwater Regional Aquifer Monitoring Well R-28), Revision 2 (EM2023-0312)

cc (letter and enclosure[s] emailed):
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Drilling Work Plan for Groundwater Regional Aquifer Monitoring Well R-76 (Replacement of Groundwater Regional Aquifer Monitoring Well R-28), Revision 2

Primary Objectives and Purpose	This work plan presents the objectives, drilling approach, and conceptual design for groundwater monitoring well R-76. The primary objective for R-76 is to replace the monitoring capability historically provided by groundwater monitoring well R-28. In accordance with a July 2017 work plan approved by the New Mexico Environment Department (NMED), Los Alamos National Laboratory (LANL or the Laboratory) conducted a study at R-28 of the potential for molasses to be applied in the aquifer as an agent for initiating geochemical reduction that would result in in situ conversion of hexavalent chromium to trivalent chromium (LANL 2017, 602505; NMED 2017, 602546). Data collected from R-28 as part of the study showed that intended chromium reduction was achieved; however, geochemically reducing conditions have persisted in the aquifer around the well, yielding it currently unusable for water-quality monitoring, especially for reduction/oxidation-sensitive constituents such as chromium and nitrate. Replacement of R-28 will provide for monitoring in an important area of the chromium plume where chromium concentrations in R-28 have historically been in the 400 ppb range. R-76 will also provide for long-term performance monitoring for chromium and related constituents as part of future remediation efforts. An additional objective for R-76 is to characterize the vertical extent of contamination in the same area of the plume by drilling the borehole to a depth within the Chamita formation (Tcar). Characterization methods described herein will provide data on the depth of contamination in this portion of the plume. Two considerations drive the proposed location for R-76 (Figure 1). First, the primary objective of R-76 as a replacement for R-28 supports a location close to R-28. Second, the location needs to be off-gradient from aquifer sediments and groundwater potentially influenced by the residual effects of molasses deployed at R-28, and potential effects of tracer deployments into CrPZ-2a. There is some indirect evidence that the naphthalene sulfonate tracer injected into CrPZ-2a (and possibly also the sulfonate tracer injected into CrPZ-2b) may have biodegraded in the aquifer based on its sudden shift to nondetect in monitoring data collected from CrEX-3, whereas the co-deployed perrhenate (rhenium) tracer persisted. If sulfonate degradation has occurred in the aquifer, it could result in the presence of an area with biological activity that could impact data representativeness in the screen interval proposed for R-76. Potential locations are also constrained by nearby existing infrastructure, including buried piping used for the chromium interim measurement system. The proposed location to the northwest of R-28 is shown in Figure 1 as being near an historical drainage based on the current GIS coverage, but current site conditions do not indicate that location would be susceptible to flooding. The proposed location has been vetted through the United States Army Corp of Engineers (USACE) Albuquerque office to ensure that there are no Clean Water Act Section 404 constraints for construction of a drilling pad and drilling activities. Figure 2 presents a cross-section that extends from R-76, to R-28 to CrEX-3 showing the stratigraphic sequence and screen positions of nearby wells and the single screen proposed for R-76, which is at a similar interval as R-28, approximately 938-958 ft below ground surface (bgs). The proposed borehole total depth is 1080 ft bgs. Zonal sampling will be completed every 20 ft through temporary screens to identify the chromium vertical concentration distribution. Once zonal sampling is complete and the final screen interval is selected, the bottom of the borehole will be backfilled with New Mexico Office of the State Engineer (NMOSE)- and NMED-approved sealant to approximately 963 ft bgs or 5 ft below the final designed bottom of the well casing to seal the borehole. A cement grout and/or high-solids bentonite slurry will be used to backfill the bottom of the borehole unless disallowed by NMED Groundwater Quality Bureau (GWQB), NMED Hazardous Waste Bureau (HWB), or NMOSE. Figure 3 shows the conceptual design for R-76, with the understanding that a separate and more detailed design package that reflects actual information obtained during and following drilling will be submitted to NMED for review and approval.

Drilling Approach	The proposed drilling approach for R-76 will use fluid-assisted air-rotary with casing-advance methods. Telescoping casing sizes between 24 in. and 10 in. and dual-rotary methods will be used to advance the borehole to a depth within the upper 185 ft of the regional aquifer. This approach will produce a borehole that can accommodate a minimum 2-in. annular filter pack around the 5-in.-diameter well screen. The pumiceous Puye Formation is estimated at approximately 935 ft bgs, the Miocene pumiceous deposits is estimated at approximately 952 ft bgs, and the Chamita Formation is estimated at approximately 1017 ft bgs. The total depth of the borehole is estimated at 1080 ft bgs, approximately 63 ft into the Chamita Formation. When the depth of the borehole reaches the saturated interval of the Puye Formation, the recommended drilling method is to use flooded-reverse circulation rather than conventional circulation. This will allow hydrostatic pressure(s) and water level(s) across the formations to remain stable (maintain static water level), controlling heave, while allowing the borehole to advance to total depth. Beyond the requirement to use flooded-reverse circulation, the selected drilling subcontractor will be responsible for using drilling and well-completion methods that are best suited for the conditions encountered.All drilling and completion operations will conform to the guidance provided in Appendix F of the 2016 Compliance Order on Consent (Consent Order).Well completion will follow NMOSE regulations concerning well construction including, but not limited to (1) the hanging of the casing throughout well construction and (2) industry standard centralizers allowing for a minimum 2-in. annular space in a vertical well. Drilling subcontractors are required to have a New Mexico Well Driller's License.
Drilling Fluids, Composition, and Use	Fluids and additives will be used to facilitate drilling and may include those previously authorized for use by NMED, including the following: • Potable water, municipal water supply, to aid in delivery of other drilling additives and to cool the drill bit, • QUIK-FOAM, a blend of alcohol ethoxy sulfates, used as a foaming agent to lift cuttings, and • AQF-2, an anionic surfactant, used as a foaming agent to lift cuttings. • Additional drilling muds and polymers (EZ-Mud, Quick-Gel, Aquagel, etc.) may be utilized per NMOSE request, unless prohibited by NMED. Use of additives may be necessary to advance drilling and maintain borehole integrity throughout the regional aquifer. Complete records will be maintained detailing the type, amount, and volume of fluid and additives used and the depth at which fluids or additives were added to the borehole.
Potential Groundwater Occurrence and Detection	Although perched-intermediate groundwater was not observed during drilling of nearby wells R-28 and CrEX-3, perched-intermediate groundwater may be present in the vicinity of the proposed location for R-76. Methods used to identify perched-intermediate groundwater during drilling will include driller's observations and water-level measurements. If perched-intermediate groundwater is encountered, then measures will be taken to seal the zone before advancing the borehole to ensure that the perched water does not follow the drilling downhole. The top of the regional aquifer is projected to occur at approximately 895 ft bgs.
Geophysical Testing	Neutron logging measures the amount of hydrogen in the formation in either a water- or air-filled borehole. The hydrogen content typically provides a good measure of moisture content in the unsaturated zone and porosity in the saturated zone. Gamma surveys employ a scintillation detector to measure the gross gamma radiation activity of the formation. Naturally occurring gamma radiation comes from the decay of potassium-40 plus the uranium and thorium decay series. Typically, these elements occur in varying concentrations within different strata, and the gamma log can be used to estimate porosity and relative content of fine-grained material.

Geophysical Testing (cont.)	Geophysical logging will be conducted through the saturated interval in the regional aquifer when the borehole has been drilled to total depth. Neutron and gamma surveys will be executed to quantify the top of regional saturation, identify geologic contacts, and identify zones of higher permeability for well screen placement. The geophysical data will be used in conjunction with drill cuttings, driller's observations, and screening/zonal water-quality samples to identify intervals within the aquifer that are suitable for screen placement.
Cuttings Characterization	Cuttings will be collected from the length of the borehole. Cuttings collection and characterization methods will attempt to optimize representative retention of the fine-grained fraction, particularly within the regional aquifer. Split samples of all cuttings collected during drilling will be provided to NMED.
Well Development	The well filter pack may be developed by both mechanical and chemical means. Mechanical means may include airlift swabbing, bailing, and pumping. Chemical means include the use of additives to remove clays and/or chlorination to kill bacteria that may be introduced during well completion. Filter pack development during placement will be considered complete when less than 1/10 ml/L of sand is passing through the well screen as determined by an Imhoff cone. A submersible pump will be used in the well development process following construction of the well. Sand production will be measured with a Rossum Sand Tester. The completion of well development will be determined by monitoring groundwater parameters (pH, specific conductance, dissolved oxygen, turbidity, and oxidation-reduction potential [Eh]), and total organic carbon (TOC). During development activities, water samples will be collected in the field and submitted to an analytical laboratory to determine turbidity and TOC. The target water-quality parameters are turbidity at less than 5 nephelometric turbidity units and TOC at less than 2 mg/L. The target sand production quantity is less than 1 mg/L. Chemical development methods that may be used include AQUA-CLEAR PFD (or a similar product to remove clays), and/or chlorination with sodium hypochlorite, unless chlorination is prohibited by NMED. Well development will be considered complete when: (1) groundwater parameters have stabilized (using the U.S. Environmental Protection Agency [EPA] [(Yeskis and Zavala 2002, 204429)] method per the Consent Order), (2) target water-quality parameters and sand production quantities are met, and (3) 200% of the volume of water introduced into the aquifer during drilling and well construction activities (less amount of water removed during these same activities) has been pumped from the well.
Single-Well Aquifer Testing	A standard operating procedure (SOP) for conducting single-well aquifer tests using the NMED Hazardous Waste Bureau's aquifer test guidance as a reference will be developed and submitted for NMED's review and comment before submitting work plans to conduct NMED-approved hydraulic testing.

Water-Quality Sampling	If perched-intermediate groundwater is encountered, attempts will be made to collect screening-level samples using airlifting or bailing methods. Screening samples from perched-intermediate groundwater will be analyzed for dissolved major cations and anions, fluoride, bromide, low-level perchlorate,TOC, low-level tritium, and metals/trace elements. Water-quality samples will be collected via zonal sampling because the reverse circulation drilling method does not allow for screening-level samples to be valid at 20-ft intervals during advancement through the regional aquifer. While advancing the borehole using the flooded-reverse drilling method, there will be minimal migration of formation waters to the borehole because the formation water pressures are stable; thus the water samples will not be representative of formation waters. When the regional aquifer depth has been established at approximately 895 ft bgs, the borehole will be drilled to a total depth of approximately 1080 ft bgs and a series of temporary wells will be constructed in the approximate 11.75-in. borehole to collect zonal samples. Stainless-steel well casing with a 5-ft stainless-steel screen interval will be lowered into the drill casing to total depth of 1080 ft bgs, and the annular space around the well screen will be filled with 10/20 or proximal size filter-grade silica sand (adjacent to screen slots) extending 1 to 2 ft above and below the screened interval and with 20/40 transition sand emplaced 5 ft above and below the primary filter pack interval. The 10-in. drill casing will be retracted just enough to expose the screen interval to the native formation, and this zone will be developed and sampled. The temporary, stainless-steel well casing will be retracted approximately 20 ft above the last sampling zone within the 10-in. drill casing, and another temporary well will be completed with filter pack and transition sand (as noted above). This next zone will be developed and sampled. This process will continue up through the regional aquifer borehole interval of approximately 185 ft. To collect a sample in each zone, a 3- or 4–in. submersible pump will be deployed in the temporary well on stainless-steel drop pipe to purge and sample. The well construction and purging/sampling will be repeated in 20-ft intervals up through the saturated interval of approximately 185 ft. For example, samples will likely be taken starting at 1070 to 1075 ft bgs (lowest screen interval placement with a 5-ft well sump), then 1050 ft to 1055 ft bgs (pulled up 20 ft), then 1030 to 1035 ft bgs, etc., until there is no longer enough submergence to support pumping water up to surface, or up to nine possible sampling zones. After the zonal sampling is completed, the remaining temporary well casing will be removed and the borehole will be drilled back down to a total depth of 1080 ft bgs, removing all the filterpack material. The screen location will be determined using the data collected from drilling, zonal sampling, and geophysical surveys. The bottom of the borehole will be backfilled with NMOSE-, NMED HWB-, and NMED GWQB-approved sealant to approximately 963 ft bgs or 5 ft below the final designed bottom of the well casing to seal the borehole. A cement grout and/or high solids bentonite slurry will be used to backfill the bottom of the borehole unless disallowed by NMED GWQB, NMED HWB, or NMOSE. The purge volumes for each sampling interval will follow this approach: 5 casing volumes for 11.75-in. borehole (5.6 gal./ft) at a (nominal) length of 10 ft plus introduced water volume for the 20-ft drilling interval being sampled plus 10%. For example, 1 casing volume: (5.6 gal./ft) × (10 ft) = 56 gal.; (56 gal.)(5 volumes) = 280 gal.; 280 gal. + introduced volume = X; (X)(1.1) = purge volume. Samples from each of these zones will be analyzed for dissolved major cations and anions, fluoride, bromide, low-level perchlorate, TOC, low-level tritium, and metals/trace elements. These samples also will be provided to NMED, managed under NMED chain-of-custody protocols. These geochemistry data along with the geophysics data, and information from drill cuttings and driller’s observations, will be used for the well-design package submitted to NMED for review and approval.

Water-Quality Sampling (cont.)	After final well development and at the end of the single-well aquifer testing with a temporary pumping system, the first groundwater samples from the completed well will be collected from the installed screen. These samples will be analyzed for metals, general inorganic chemicals (including nitrate, perchlorate, sulfate, etc.), semivolatile organic compounds, volatile organic compounds, and radionuclides (including low-level tritium). Subsequent samples will be collected from the dedicated sampling system installed in the well. All groundwater chemistry results for samples collected during drilling, well development, and hydraulic testing of regional aquifer well R-76 will be shared with NMED as soon as results are received from analytical laboratories.
Sampling System Installation	A Grundfos sampling pump will be installed in the well. The system will use a typical 3- or 4-in. pump and motor to maintain sampling purge rates at or near 5 gal. per minute.
Investigation-Derived Waste Management	Investigation-derived waste will be managed according to Administrative Procedure (AP) N3B-AP-TRU-2150, “Waste Characterization Strategy Form.” This AP incorporates the requirements of applicable EPA and NMED regulations, DOE orders, and Newport News Nuclear BWXT-Los Alamos, LLC (N3B) requirements. The primary waste streams will include drill cuttings, drilling water, drilling fluids and additives, development water, purge water generated during single-well aquifer testing, decontamination water, and contact waste. Drill cuttings will be managed in accordance with the NMED-approved “Decision Tree for the Land Application of Drill Cuttings” (April 2016). Drilling, purge, and development waters will be managed in accordance with the NMED-approved “Decision Tree for Land Application of Drilling, Development, Rehabilitation, and Sampling Purge Water” (November 2016). Initially, drill cuttings and drilling fluids will be stored in a lined pit. Representative samples of the drill cuttings and drilling fluids will be collected and analyzed, 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 prior to shipping offsite. Development and aquifer testing water that meets the requirements to be treated and land-applied will be managed under Discharge Permit 1793. Decontamination water will be containerized separately at the 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 or the media with which it came in contact. Once properly dispositioned, the waste will be shipped offsite or land applied.
Schedule	Documentation of start of drilling of the replacement well for well R-28 (R-76) is a 2023 Milestone due September 21, 2023, and completion and collection of first samples is a proposed fiscal year 2024 Appendix B target.
NMED/NMOSE Communication	NMED and NMOSE will receive daily reports each morning, including weekends and holidays. Weekly meetings with NMED and NMOSE will include updates and planned activities on the drilling status, from initiation of drilling operations to collection of initial groundwater samples from either the vadose zone or the regional aquifer. NMED will receive a 15-day written notice (according to Section XXVII.B of the Consent Order) and invitation to observe collection of initial groundwater samples. The NMOSE-required driller’s well record and log will be included in the well completion report.

REFERENCES

The following reference list includes documents cited in this plan. Parenthetical information following each reference provides the author(s), publication date, and ERID, ESHID, or EMID. ERIDs were assigned by the Laboratory's Associate Directorate for Environmental Management (IDs through 599999); ESHIDs were assigned by the Laboratory's Associate Directorate for Environment, Safety, and Health (IDs 600000 through 699999); and EMIDs are assigned by N3B (IDs 700000 and above).

LANL (Los Alamos National Laboratory), July 2017. "Pilot-Scale Amendments Testing Work Plan for Chromium in Groundwater beneath Mortandad Canyon," Los Alamos National Laboratory document LA-UR-17-25406, Los Alamos, New Mexico. (LANL 2017, 602505)

NMED (New Mexico Environment Department), July 31, 2017. "Approval, Pilot-Scale Amendments Testing Work Plan for Chromium in Groundwater beneath Mortandad Canyon," New Mexico Environment Department letter to D. Hintze (DOE-EM) and B. Robinson (LANL) from J.E. Kieling (NMED-HWB), Santa Fe, New Mexico. (NMED 2017, 602546)

Yeskis, D., and B. Zavala, May 2002. "Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers," a *Ground Water Forum Issue Paper*, EPA 542-S-02-001, Office of Solid Waste and Emergency Response, Washington, D.C. (Yeskis and Zavala 2002, 204429)

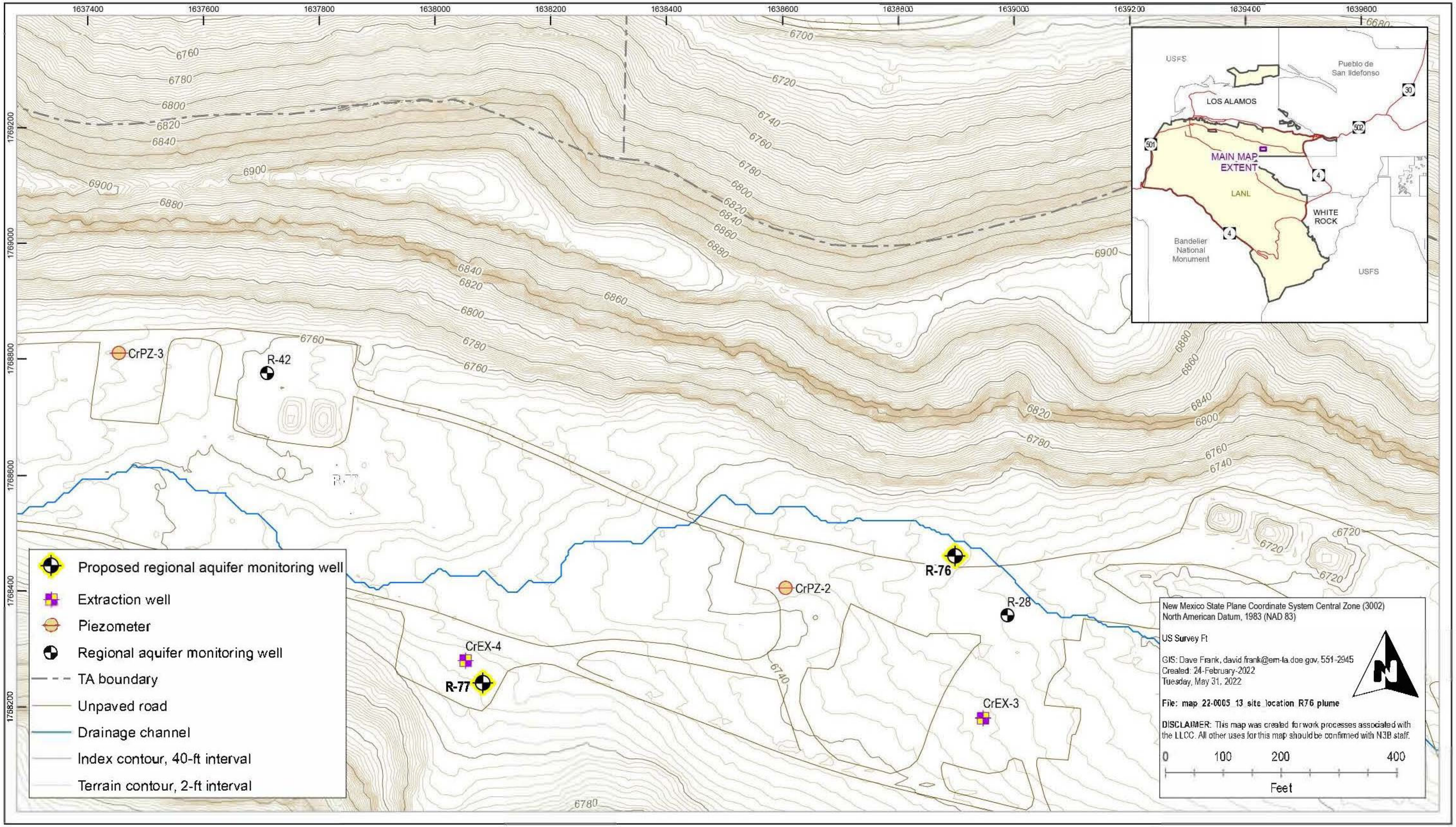

Figure 1 Proposed location for well R-76

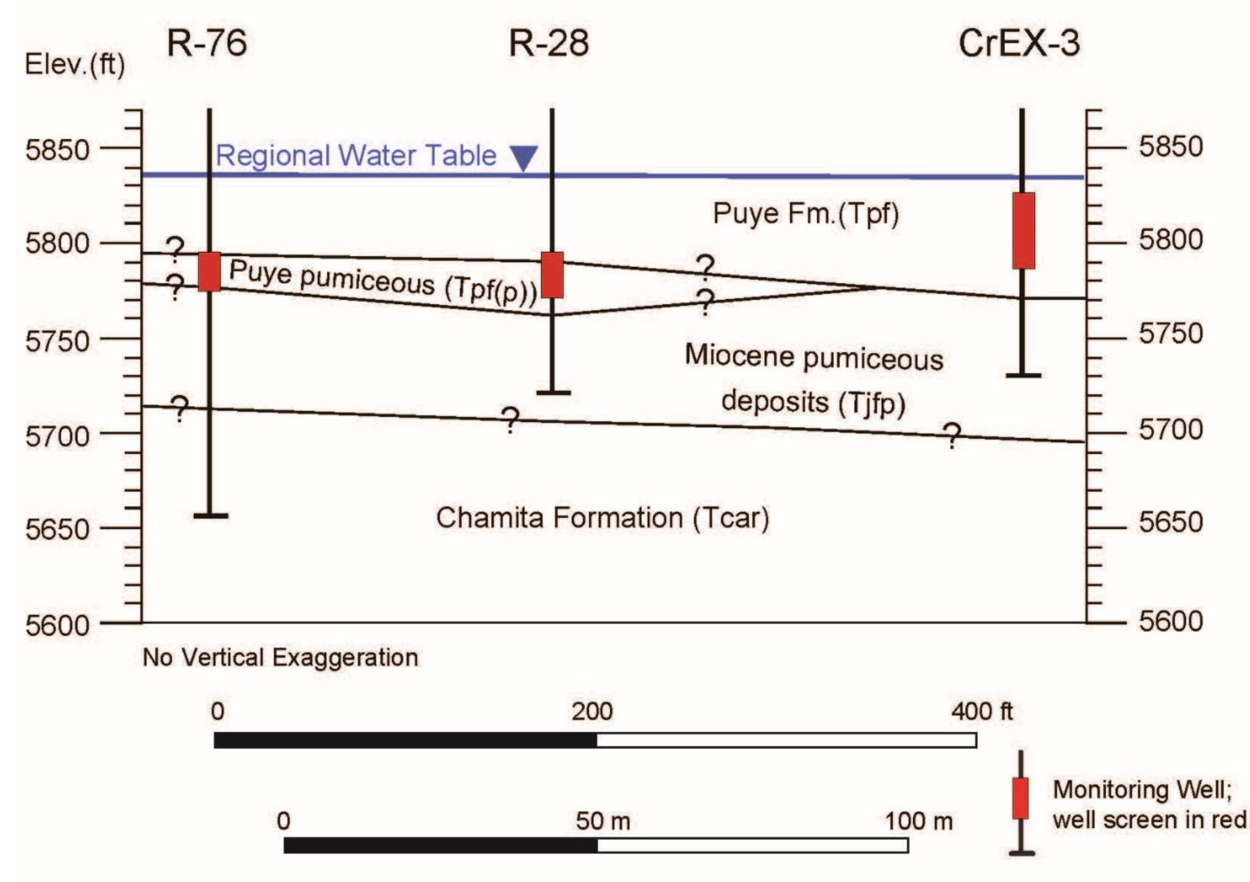

Figure 2 **Stratigraphy in the proposed R-76 area and nearby wells R-28 and CrEX-3, with well-screen locations for existing wells and conceptual position for R-76.**

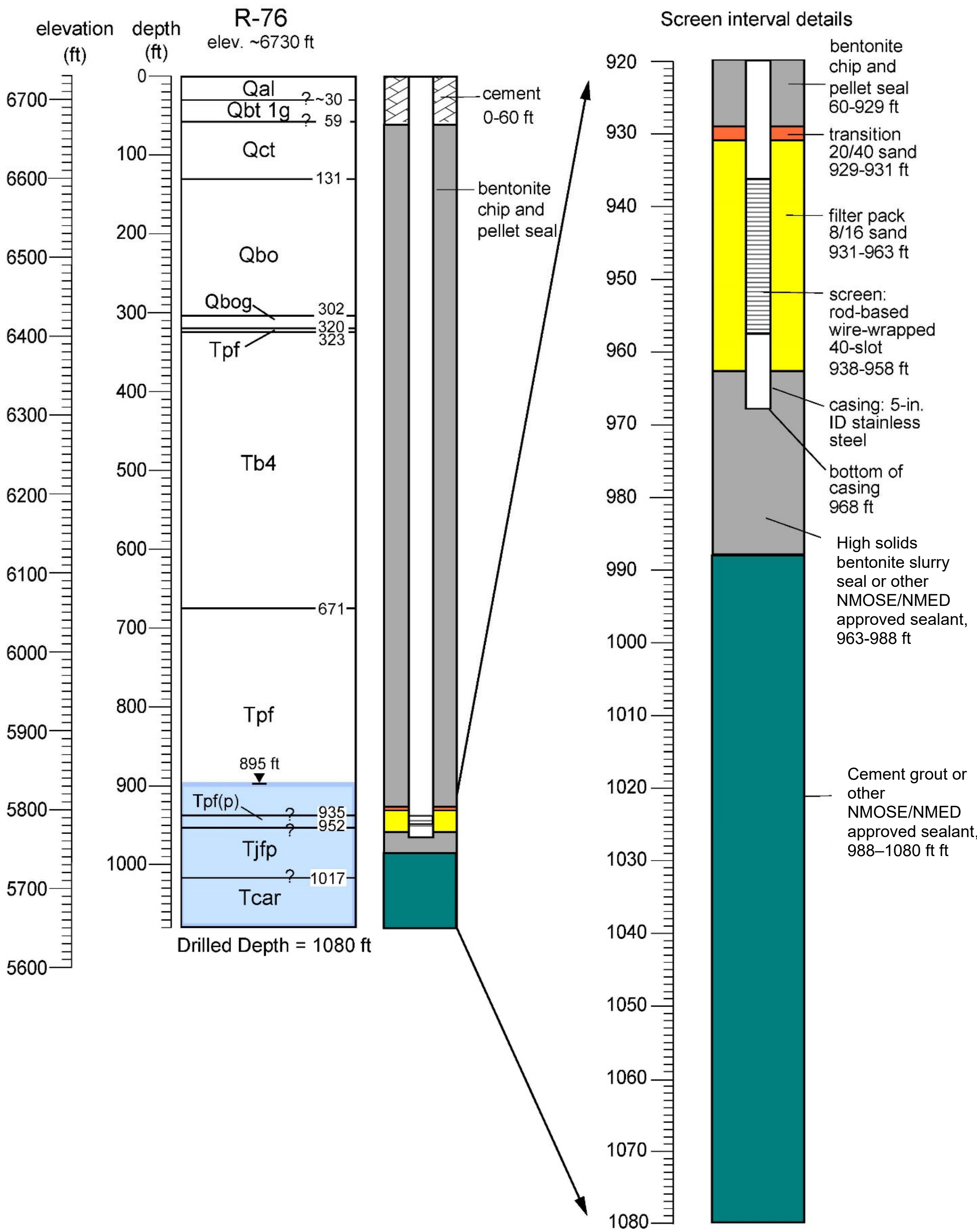

Figure 3 Conceptual well design for R-76