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RECEIVED
DEC 22 2023
NMED Hazardous Waste Bureau

*Date*: December 22, 2023
*Refer To*: N3B-2023-0475

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

2023 DEC 22 PM 1:

Ramona Martinez, District Manager
Upper Pecos Basin
Water Resource Allocation Program
Water Rights Division
New Mexico Office of the State Engineer
407 Galisteo Street
Santa Fe, NM 87504-5102

**Subject: Submittal of the Proposed Well Design for Regional Aquifer Monitoring Well R-76**

Dear Mr. Shean and Ms. Martinez:

Please find enclosed the "Proposed Well Design for Regional Aquifer Monitoring Well R-76." If you have questions, please contact Christian Maupin at (505) 695-4281 (christian.maupin@em-la.doe.gov) or Cheryl Rodriguez at (505) 414-0450 (cheryl.rodriguez@em.doe.gov). We look forward to your input.

Sincerely,

Troy Thomson
Program Manager
Environmental Remediation
N3B-Los Alamos

Sincerely,

Digitally signed by Brian G. Harcek
Date: 2023.12.21 11:33:06 -07'00'

Brian Harcek, Acting Director
Office of Quality and Regulatory Compliance
U.S. Department of Energy
Environmental Management
Los Alamos Field Office

Enclosure(s): Five hard copies with electronic files:

1. Proposed Well Design for Regional Aquifer Monitoring Well R-76 (EM2023-0861)

cc (letter and enclosure[s] emailed):
Laurie King, EPA Region 6, Dallas, TX
Steve Yanicak, NMED-DOE-OB
Neelam Dhawan, NMED-HWB
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December 2023
EM2023-0861

# Proposed Well Design for Regional Aquifer Monitoring Well R-76

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## 1.0 WELL OBJECTIVES

R-76 is a recently drilled borehole designated to become a regional groundwater monitoring well located within Mortandad Canyon between regional wells R-28 and CrPZ-2 (Figure 1). The R-76 borehole is located approximately 140 ft northwest of well R-28, and it was drilled to a total depth of 1000 ft below ground surface (bgs).

The primary objective for R-76 is to replace the monitoring historically provided by groundwater monitoring well R-28. In accordance with a July 2017 work plan approved by the New Mexico Environment Department, 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, iron, manganese, and nitrate.

Replacement of R-28 will provide for monitoring in an important area of the chromium plume where hexavalent chromium concentrations in R-28 have historically been in the 350 to 520-µg/L range before chemical injection (analytical data are available on the Intellus New Mexico database [https://intellusnm.com/]). R-76 will also provide long-term performance monitoring for chromium and related constituents as part of future remediation efforts.

R-76 is proposed to be completed with a single screen within the regional aquifer. Conceptually, the monitoring data collected at R-76 will provide an additional monitoring point in the northern portion of Mortandad Canyon and monitor dissolved chromium concentrations near the centroid of the chromium plume. Furthermore, this is an area that has not had a regional well to provide data in over 6 yr since R-28 was impacted by the pilot-scale testing performed in early September 2017.

## 2.0 CONDITIONS ENCOUNTERED DURING DRILLING

Three types of characterization data were obtained during the drilling of well R-76, including drill cuttings examined for mineralogical content and grain-size analyses, geophysical survey data, and groundwater quality samples collected through the construction of temporary wells. All three data types were used to support the screened interval location.

The top of the regional groundwater was predicted to occur at a depth of approximately 895 ft bgs [5835 ft above mean sea level (amsl)] based on recent water levels recorded at R-28. The groundwater level stabilized in the cased borehole at approximately 895 ft (5835 ft amsl) after reaching the total drilling depth of 1000 ft. No perched groundwater zones were encountered during the drilling of the R-76 borehole.

### 2.1 Drill Cuttings

Drill cuttings were collected every 5 ft, washed, and sieved. Whole rock, plus-10, and plus-35 fractions were retained for visual inspection and correlated to identify geologic contacts and to assess the lithologic characteristics of the aquifer. Visual identification of minerals within the cuttings intervals were also used to identify geologic contacts. For example, the Miocene pumiceous unit is made up of tan, pebbly, rhyolitic, tuffaceous sands containing abundant rounded to subrounded, white, vitric pumices, whereas the Puye Formation mainly contains conglomerates, gravels, and sands consisting of subangular to subrounded, intermediate, lava clasts in a sandy matrix.

Preliminary lithological contacts from visual examination of cuttings identified the following geologic contacts in descending stratigraphic order (Figures 2 and 3): Quaternary alluvium (0–60 ft bgs) Bandelier Tuff (undivided Qt–Qbog) (60–315 ft bgs), Cerros del Rio volcanics (Tb4) (315–675 ft bgs), Puye Formation (Tpf) (675–929 ft bgs), and the Miocene pumiceous unit (Tjfp) (929–1000 ft bgs).

Regional groundwater occurs within the Puye Formation (Tpf), the Miocene pumiceous unit (Tjfp), and in deeper hydrologic units at R-76. The R-76 borehole penetrated 71 ft of the Miocene pumiceous unit (Figure 2). Cuttings and the gamma log indicate that the lithologies and particle-size distributions making up the Miocene pumiceous unit are broadly similar. There is no evidence in the cuttings that the Chamita Formation (Tcar) was reached during the drilling.

## 2.2 Grain-Size Analyses

Drill cuttings were also used to carry out a grain-size analysis on the sand fractions. Cuttings were first dried and then sieved in a series of six progressively smaller mesh sizes, with the largest sieve mesh opening (2 mm, #10) retaining gravels and the smallest sieve mesh (0.063 mm, #230) passing silt. The resulting sediment fractions were then weighed to determine the relative fraction of silt, sand, and gravel. Because of the nature of the unconsolidated sediments in the regional aquifer at LANL, the sand fraction was further subdivided into percentages of very fine, fine, medium, coarse, and very coarse sands. The mode of the grain-size distribution for each 5-ft interval was determined by the highest percent fraction.

The mode for each interval is shown in Figure 4. High volumes of cuttings from the air-rotary drilling method blow out of a pipe under high air pressure, whereas a sand separator system is used for the flooded-reverse method because clean water is needed for recirculation downhole. This results in greater retention of fines with the flooded reverse method. Above 915 ft, grain-size modes are gravels. This is due in part to the gravel-rich nature of the Puye Formation and in part to the poor retention of fine-grained sediment by the air-rotary drilling method. Below 915 ft, drilling transitioned to flooded-reverse drilling and more fine-grained material was retained in the cuttings. These grain-size data are considered more representative of conditions in the regional aquifer.

## 2.3 Geophysical Surveys

A gamma log and neutron density survey were executed at R-76. Gamma logs record the amount of natural gamma radiation emitted by the rocks surrounding the borehole, helping to depict any formation changes due to differences in mineralogy. The neutron log is a proxy for porosity. Zones of higher porosity in the coarse unconsolidated sediments at LANL generally correspond to zones of higher permeability.

The gamma log is shown in Figure 5. Also depicted in Figure 5 are the geologic contacts that were determined based on a visual analysis of the cuttings, the location of the water table, and the casing sizes that telescoped with depth. There are two notable features of the gamma log: (1) there is minimal correlation of the gamma log with formation changes and (2) there was a significant response when water was encountered in the casing at a depth of approximately 725 ft, leading to a significant reduction in the number of gamma radiation counts per second. Interferences from the casings (up to five casings at some depths) may limit the contribution of these features to an understanding of the geologic conceptual model.

The neutron probe data shown in Figure 6 (also with geologic contacts, water table, and casing sizes) show limited variability within the targeted location of the R-28 well screen. This result suggests that any interval within the Miocene pumiceous deposits has sufficient permeability for a monitoring well.

## 2.4 Zonal Sampling

Following completion of the borehole, temporary wells were installed at 20-ft increments to collect zonal samples from four different intervals at R-76 (Figure 7). The drilling work plan notes a potential of up to nine zones to be sampled, based on the original planned depth of 1080 ft bgs. With the reduction in planned depth from1080 ft bgs to 1000 ft to avoid contact with the Chamita Formation, the potential zones to be sampled were reduced from nine to five; however, only the lower four zones [zone 5 (deepest) to zone 2 (shallowest)] had sufficient water (submergence) to conduct sampling events. During the purging of these zones, measurements for dissolved chromium and nitrate-nitrite (as nitrogen) were collected with a portable Hach colorimeter model DR 900. Additionally, field parameters were monitored using YSI brand ProDSS multiparameter digital water quality meters during the purges for pH, dissolved oxygen (DO), specific conductance (SC), turbidity, and oxidation reduction potential (ORP).

Appendix A (on CD included with this document) provides analytical chemistry and field data. Table 1 presents results from fixed laboratory analyses. Initial and final values shown in Table 1 refer to when Hach testing was initiated and when a water sample was collected for fixed-laboratory analysis, respectively. The following provides a brief overview of sampling at each zone and corresponding concentration data.

- Zone 5 was the deepest zone sampled with the screened interval placed at 979 to 989 ft bgs (5751.75–5741.75 ft amsl). A total of 8763 gal. of water was purged from this zone partially to account for an estimated 3407 gal. of potable water introduced before the building of the zone. The highest values for dissolved chromium and nitrate-nitrite recorded with the Hach instrument were 90 µg/L and 2.1 mg/L, respectively, with ending values of 70 µg/L for chromium and 0.9 mg/L for nitrate-nitrite. Fixed analytical laboratory results provided by GEL Laboratories, LLC (GELC) for the filtered samples collected at the end of the purge were 77.4 µg/L for chromium, 1.12 mg/L for nitrate-nitrite, and 0.507 mg/L for total organic carbon (TOC). Additionally, ending field parameters were a pH of 7.92, DO of 4.35 mg/L, SC of 207.7 µS/cm, turbidity of 7.71 nephelometric turbidity units (NTU), and ORP of −51.4 mV.
- Zone 4 was screened at 959 to 969 ft bgs (5771.75–5761.75 ft amsl). A total of 1969 gal. of water was purged from this zone. The highest values for dissolved chromium and nitrate-nitrite recorded with the Hach instrument were 75 µg/L and 0.98 mg/L, respectively, with ending values of 17.5 µg/L for chromium and 0.9 mg/L for nitrate-nitrite. Fixed analytical laboratory results provided by GELC for the filtered samples collected at the end of the purge were 12.3 µg/L for chromium, 0.61 mg/L for nitrate-nitrite, and 0.503 mg/L for TOC. Additionally, ending field parameters were a pH of 8.00, DO of 4.37 mg/L, SC of 196.0 µS/cm, turbidity of 23.5 NTU, and ORP of −169.0 mV.
- Zone 3 was screened at 939 to 949 ft bgs (5791.75–5781.75 ft amsl). This screened interval corresponds to the screened interval at R-28. A total of 2500 gal. of water was purged from this zone. The highest values for dissolved chromium and nitrate-nitrite recorded with the Hach instrument were 75 µg/L and 0.98 mg/L, respectively, with ending values of 10 µg/L for chromium and 0.88 mg/L for nitrate-nitrite. Fixed analytical laboratory results provided by GELC for the filtered samples collected at the end of the purge were 4.54 µg/L for chromium, 0.631 mg/L for nitrate-nitrite, and 0.451 mg/L for TOC. Additionally, ending field parameters were a pH of 7.83, DO of 5.26 mg/L, SC of 195.3 µS/cm, turbidity of 39.1 NTU, and ORP of −210.0 mV.

- Zone 2 was screened at 919 to 929 ft bgs (5811.75–5801.75 ft amsl). A total of 1789 gal. of water was purged from this zone. The highest values for dissolved chromium and nitrate-nitrite recorded with the Hach instrument were 30 µg/L and 1.68 mg/L, respectively, with ending values of 20 µg/L for chromium and 0.95 mg/L nitrate-nitrite. Fixed analytical laboratory results provided by GELC for the filtered samples collected at the end of the purge were 25.4 µg/L for chromium, 0.947 mg/L for nitrate-nitrite, and 0.891 mg/L for TOC. Additionally, ending field parameters were a pH of 8.07, DO of 6.51 mg/L, SC of 230.6 µS/cm, turbidity of 319 NTU, and ORP of −173.4 mV.

During the purging of all four zones, DO values varied from 1.42 to 5.18 mg/L for the lower two zones and varied from 0.13 to 6.91 mg/L for the upper two zones. These are generally lower than expected values for the regional aquifer. The ORP stayed consistently negative and dissolved chromium and nitrate-nitrite levels remained low (<20 µg/L for chromium and <2.2 mg/L for nitrate-nitrite) in the higher zones (2 and 3) compared with R-28 historical values (350–520 µg/L before deployment of molasses and other chemical amendments) and other nearby regional wells in the chromium plume centroid, raising a concern that reducing conditions from the molasses injection at R-28 could have reached R-76. However, TOC values collected at the end of each zonal sampling event suggest that the water sampled at each of the four zones was not affected by the R-28 molasses injection. Note that the location of R-76 was selected because it is upgradient of R-28 at a distance intended to minimize the possibility of interference from the previous molasses injection.

Concentration data obtained through zonal sampling may not be representative of pre-drilling conditions. Although thousands of gallons of water were purged, groundwater quality samples likely mixed with drilling water and were not wholly representative of formation water. Finally, the possibility exists that the relatively low chromium concentrations are reflective of the actual concentrations in the aquifer, which may have been impacted by the 6 yr of chromium interim measures operation. Once R-76 is fully developed, more representative groundwater quality samples are anticipated during the well's first year of monitoring.

## 3.0 WELL DESIGN

The R-76 well design proposes a 20-ft-long screen positioned at approximately the same elevation as that of R-28. (Figure 2). However, note that reducing geochemical conditions were encountered during zonal sampling at R-76 at the four depth intervals. This is shown by strongly negative ORP, elevated dissolved concentrations of iron and manganese, and suppressed dissolved chromium concentrations (Table 1). However, the DO concentrations suggest somewhat oxidizing conditions. Concentrations of dissolved chromium measured by fixed laboratory analyses generally increased with depth, ranging from 4.2 to 51 (µg/L), but 3–4 times more water was purged from the lower zone. Moreover, TOC concentrations suggest that the water sampled at each of the four zones was not affected by the R-28 molasses injection. The pre-amendment concentration of dissolved chromium at R-28, measured on August 2, 2017, was 466 µg/L. Hence, there are some concentration data that suggest that the in situ amendments at R-28 may have influenced the groundwater chemistry at R-76, and there are other concentration data that suggest otherwise. Both the Hach instrument and fixed laboratory measurements suggest that all zones sampled were within the plume.

The basis for the proposed well screen is to fulfill the regulatory request for a replacement well for R-28. The screen interval was evaluated using characterization data presented in section 2.0. The grain-size data analysis and the neutron probe provide data that supported a screened interval at any depth within the Miocene pumiceous deposits. By contrast, the gamma logging was inconclusive and did not provide any information to support the selection of the well screen location.

In accordance with the drilling work plan to install a replacement well for R-28 (N3B 2023, 702763), the screened interval would be set at a depth of 935 ft bgs (5795.75 ft amsl) to 955 ft bgs (5775.75 ft amsl) and is shown in Figures 2 and 7. This screened interval will act as a direct replacement for the screened interval at well R-28 (screened from 5794.31 to 5770.51 ft amsl) and is designed to characterize chromium concentrations within the centroid of the chromium plume (Figure 3). This is also a favorable zone, as well as the other zones, with good porosity based on the neutron porosity log (Figure 6) and sieve analysis, which shows that the grain-size distribution for this interval is composed mainly of medium to very coarse sands (Figure 4). A favorable hydraulic condition is also supported by the significant flow rate of 11.2 gallons per minute that was withdrawn from the 10-ft Zone 3 screen. A 20-ft screen at this elevation will almost certainly be at least as productive. The top of the screened interval, if approved by the New Mexico Environment Department, would be set approximately 40 ft below the static water level. This will help to ensure that water levels do not fall within the filter pack and screen during pumping development and to provide longevity for the well in response to the 0.5–1 ft/yr water table decline in the Chromium Project Area.

The proposed screen will be rod-based, wire-wrapped, stainless steel, and 0.050-in. slot. The primary filter pack will consist of 8/16 graded sand extending approximately 5 ft above and 5 ft below the well screen. A 1–3-ft barrier of 20/40 transition sand will be placed above and below the primary filter pack. Neat cement will be placed in the bottom of the borehole from total depth up to approximately 975 ft bgs. Bentonite pellets and/or slurry will be installed from the top of the cement up to approximately 961 ft bgs, which will seal the well annulus below the filter pack. Bentonite pellets will also be placed from the transition sand above the top of the screen interval to above the top of the regional aquifer. Bentonite chips will be placed above the pellets up to 60 ft bgs, and neat cement will compose the surface seal from 60 ft bgs to the surface.

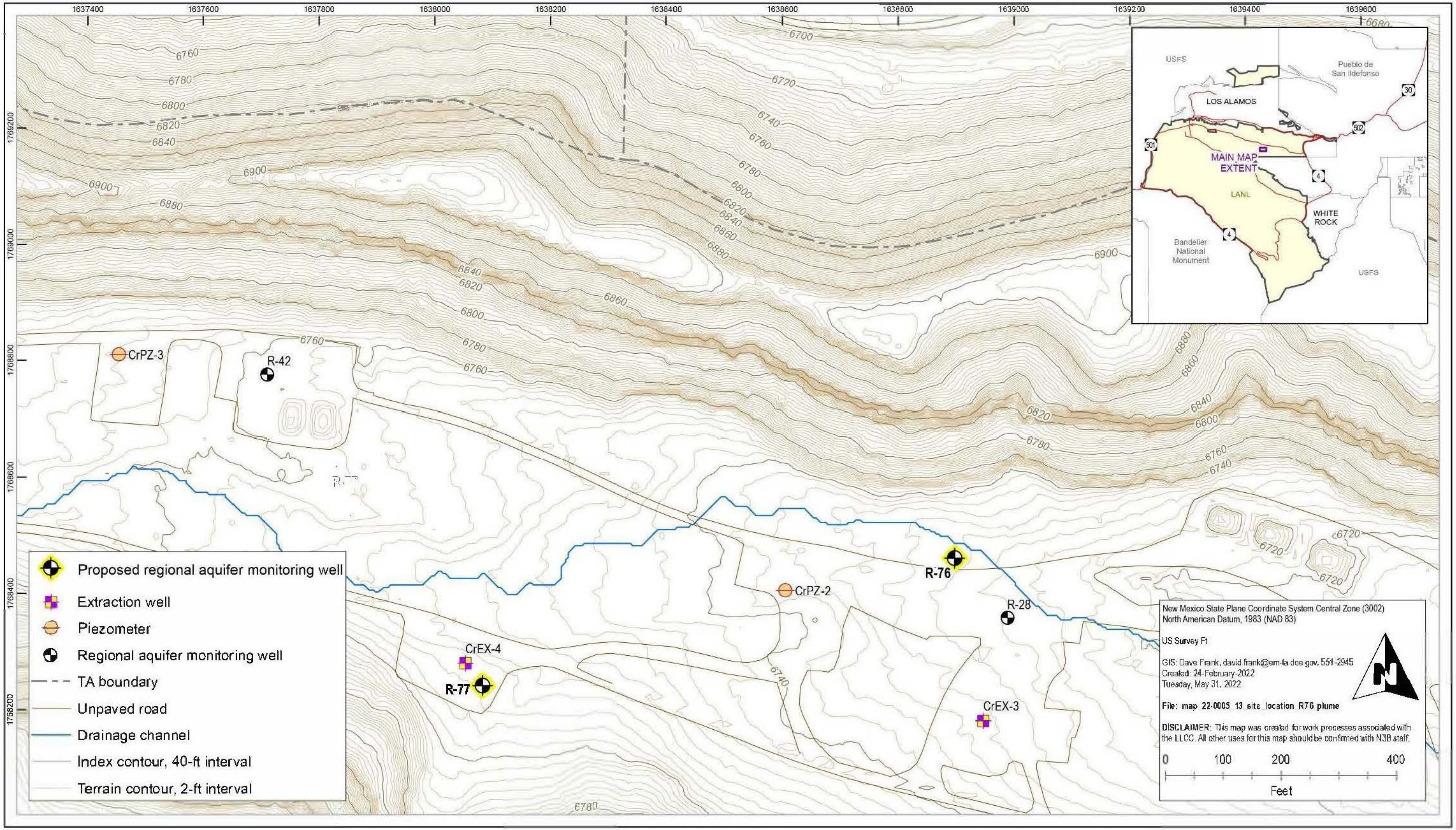
## 4.0 REFERENCES

*The following reference list includes documents cited in this report. 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 Newport News Nuclear BWXT-Los Alamos, LLC (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)

N3B (Newport News Nuclear BWXT-Los Alamos, LLC), May 2023. "Drilling Work Plan for Groundwater Regional Aquifer Monitoring Well R-76 (Replacement of Groundwater Regional Aquifer Monitoring Well R-28), Revision 2," Newport News Nuclear BWXT-Los Alamos, LLC, document EM2023-0312, Los Alamos, New Mexico. (N3B 2023, 702763)

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)




Source: "Drilling Work Plan for Regional Aquifer Monitoring Well R-76, Revision 2" (N3B 2023, 702763).

**Figure 1** **Location map**

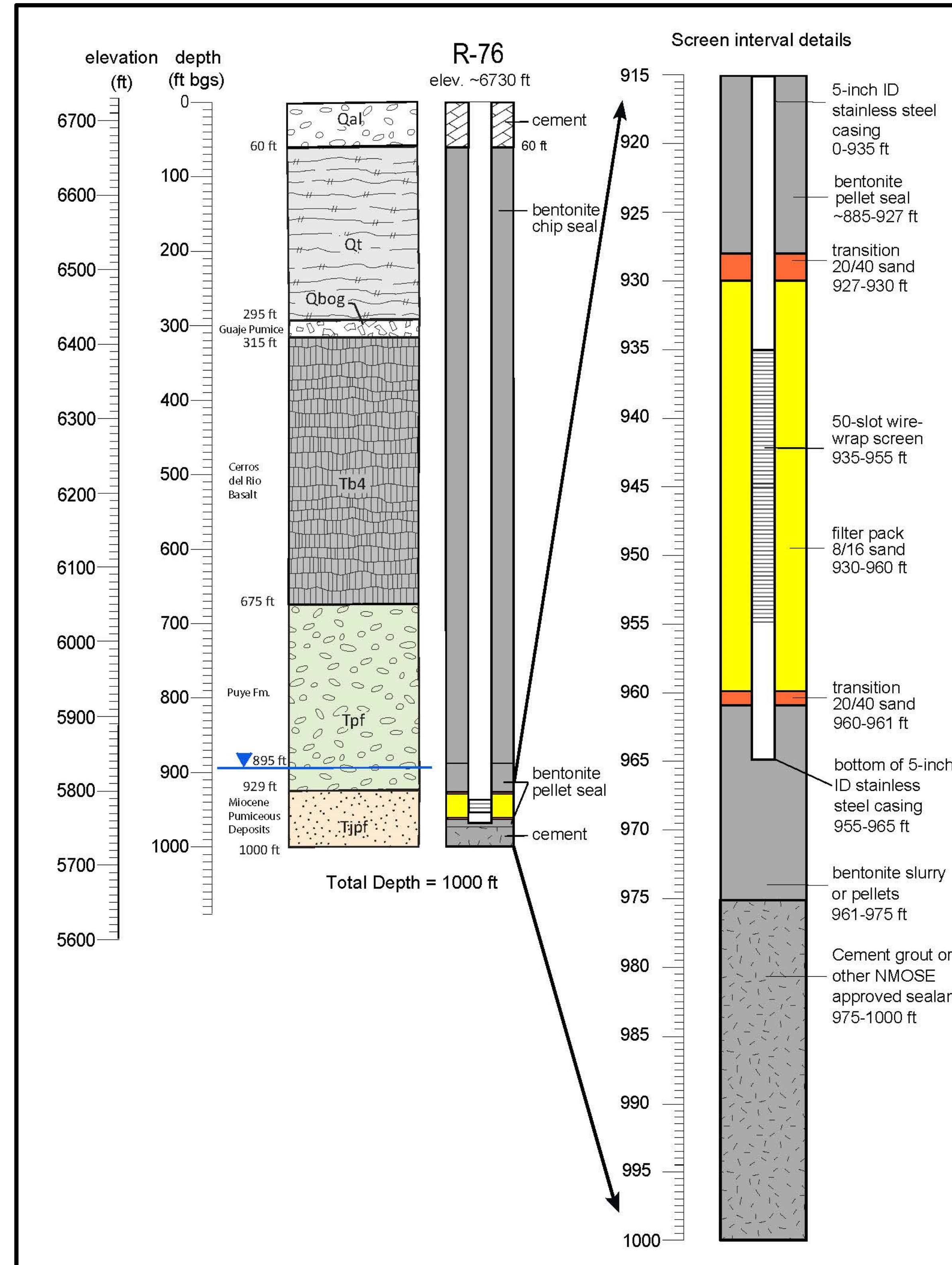
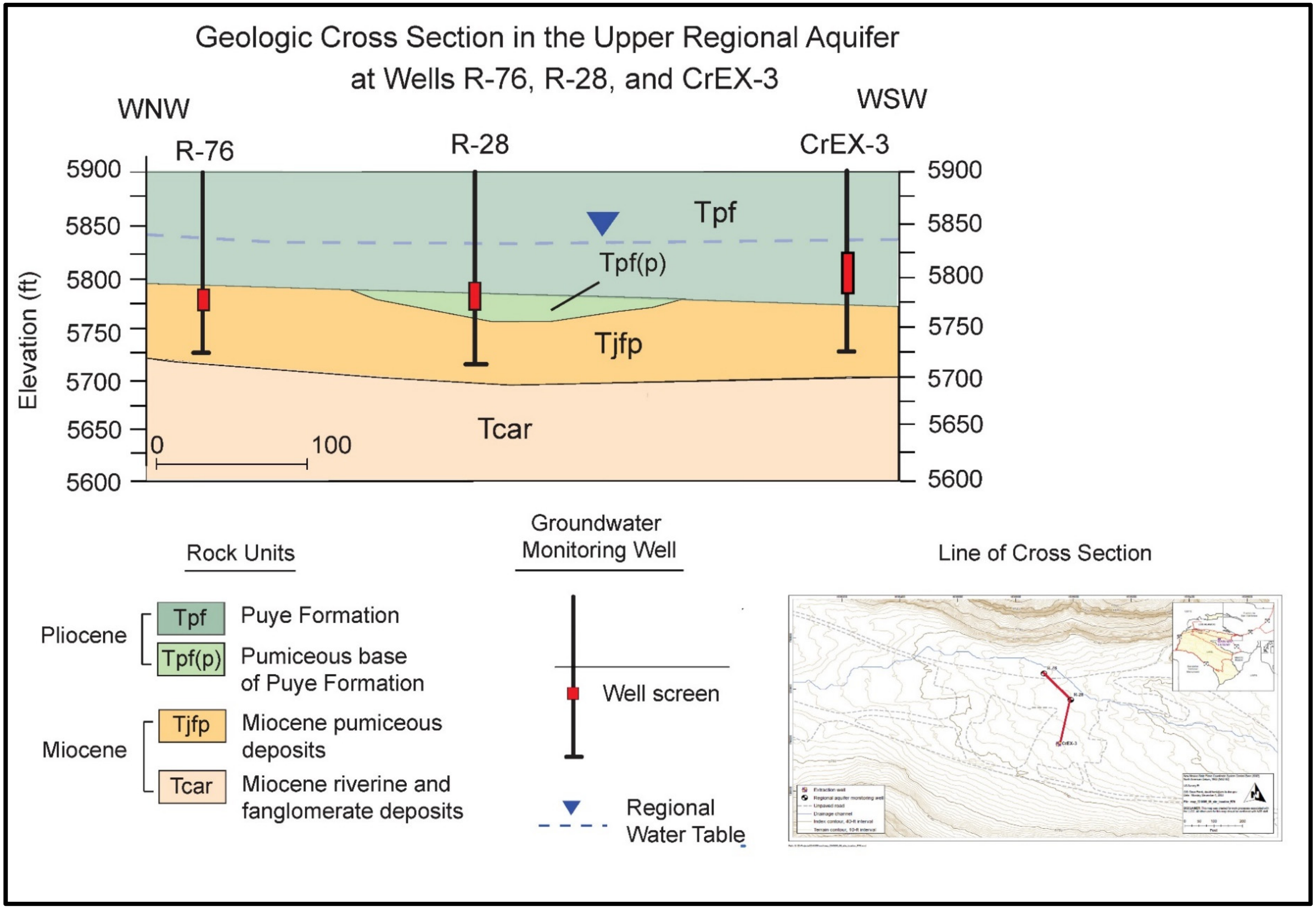



**Figure 2** **Stratigraphy encountered at R-76 and proposed well design**




Note: NMOSE = New Mexico Office of the State Engineer.

**Figure 3** **Geologic cross-section for the upper regional aquifer at wells CrEX-3, R-76, and R-28**

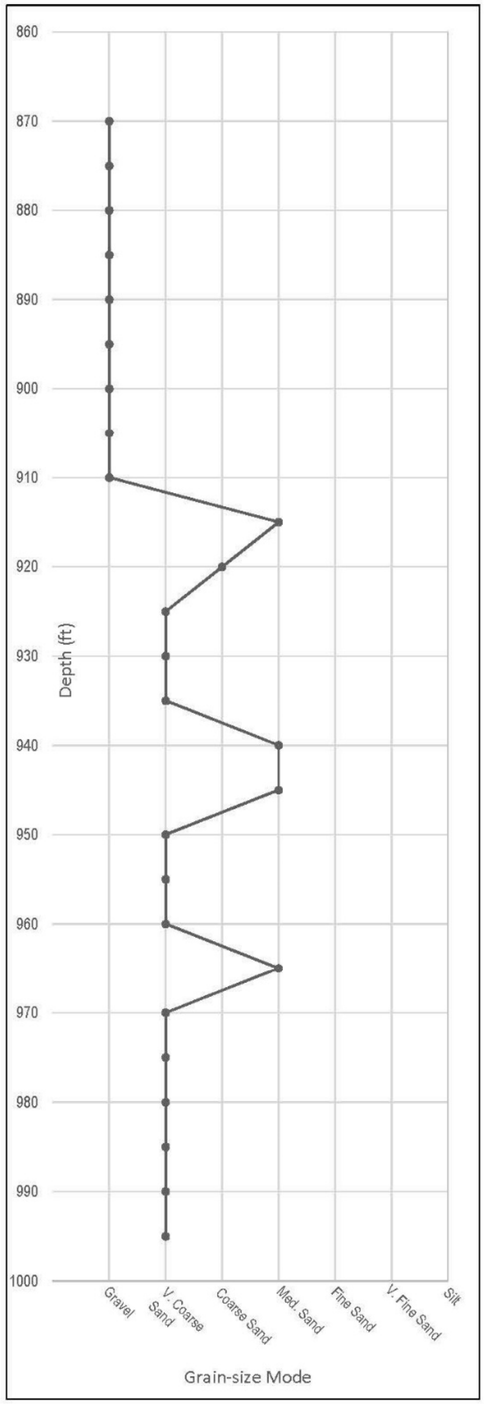



**Figure 4 Grain-size mode at 5-ft depth intervals**

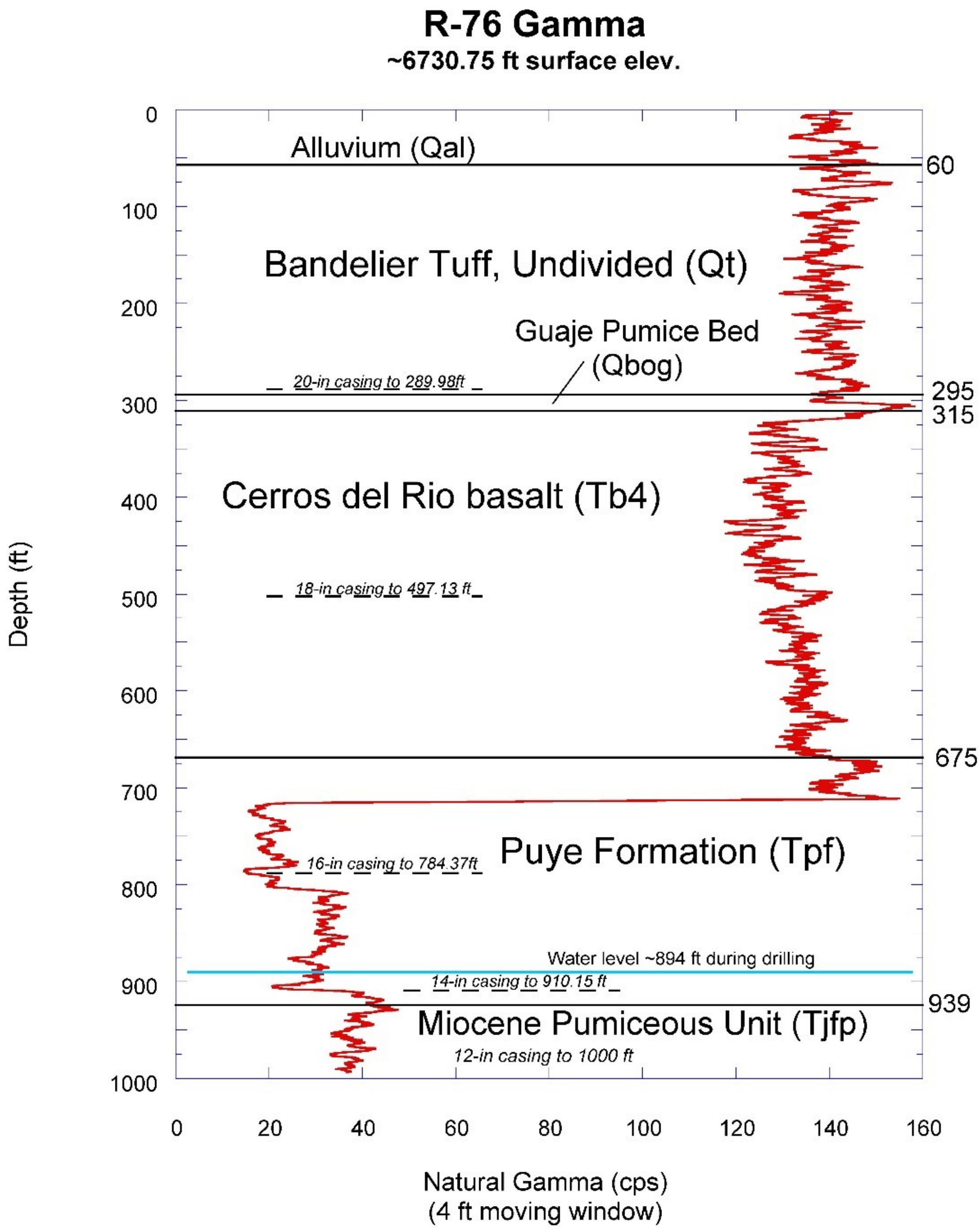



**Figure 5** **Natural gamma log for R-76**

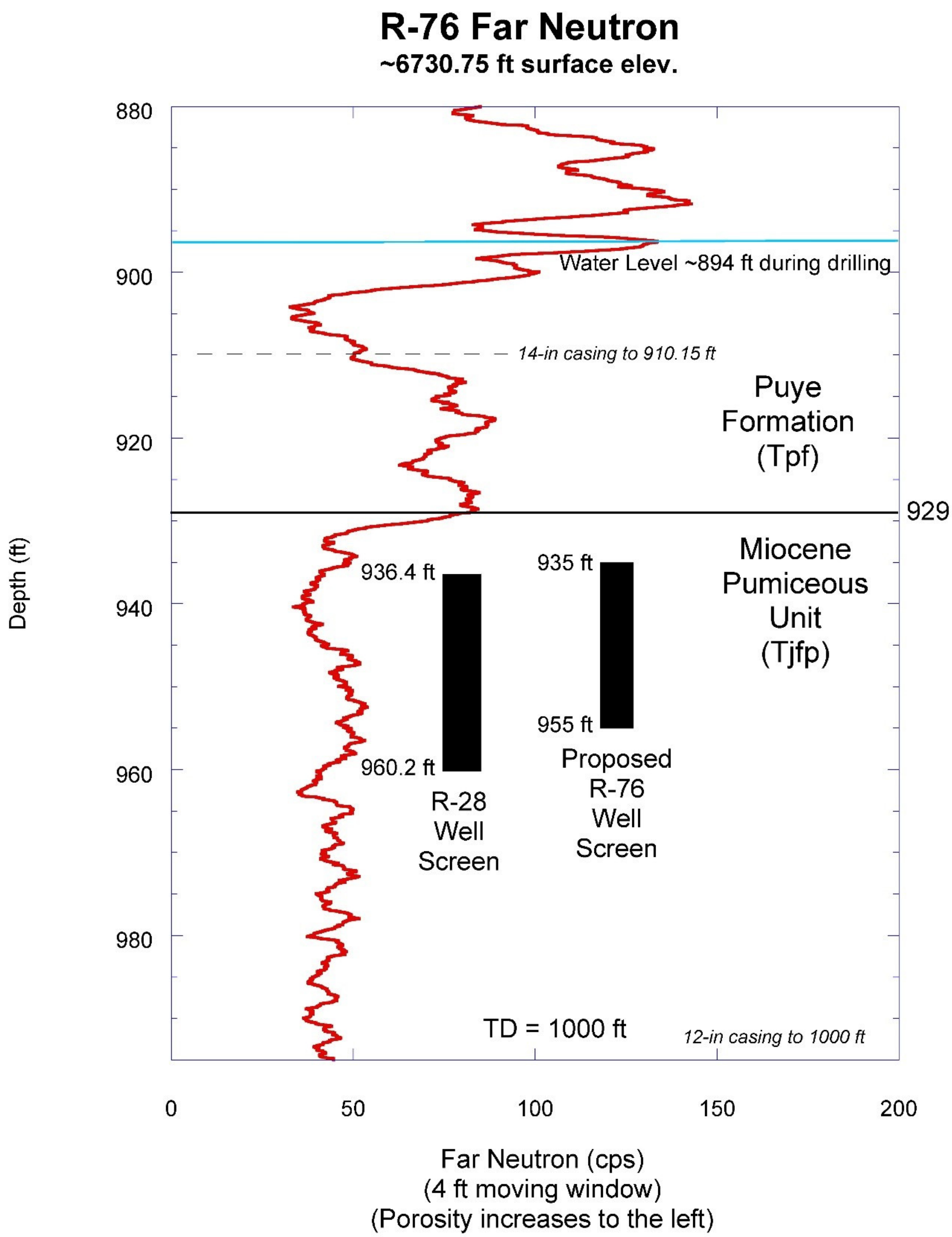



**Figure 6** **Far neutron log for R-76**

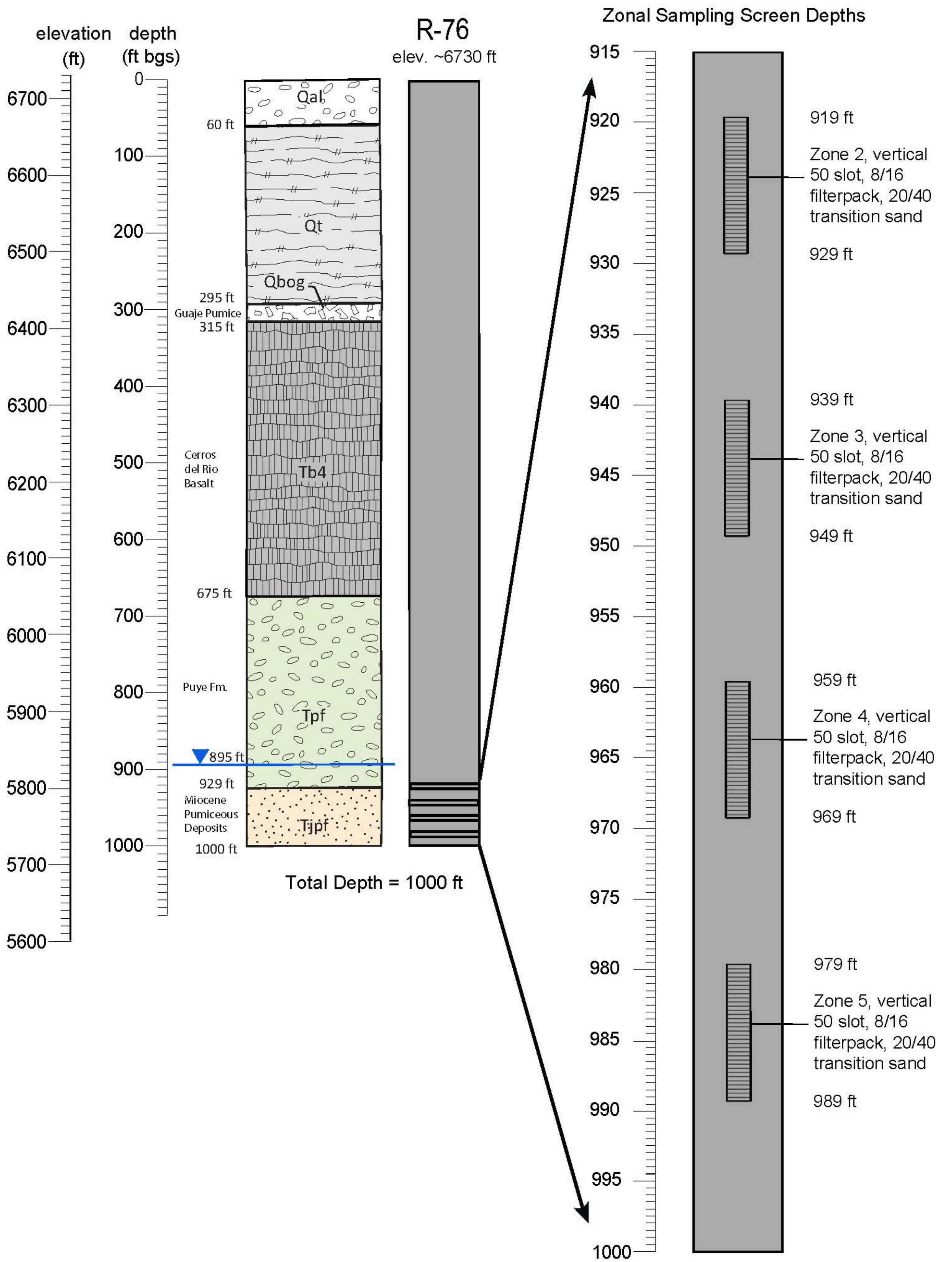



**Figure 7 Zonal sampling screen depths in R-76**

**Table 1**
**Zonal Sampling Results for Field Parameters and Select Analytes**

| Field Parameter or Analyte | Zone 2 919 to 929 ft bgs | | Zone 3 939 to 949 ft bgs | | Zone 4 959 to 969 ft bgs | | Zone 5 979 to 989 ft bgs | |
|---|---|---|---|---|---|---|---|---|
| | Initial Sample | Final Sample | Initial Sample | Final Sample | Initial Sample | Final Sample | Initial Sample | Final Sample |
| Amount Purged (gal.) | 1300.0 | 1789.0 | 1684.0 | 2500.0 | 985.0 | 1969.0 | 4840.0 | 8763.0 |
| Casing Volumes | 8.0 | 11.0 | 6.0 | 8.9 | 3.0 | 6.0 | 3.3 | 9.6 |
| pH | 8.07 | 8.07 | 7.80 | 7.83 | 8.04 | 8.0 | 8.0 | 7.92 |
| Dissolved Oxygen (mg/L) | 4.93 | 6.51 | 5.24 | 5.26 | 3.21 | 4.37 | 3.96 | 4.35 |
| Specific Conductance (µS/cm) | 223.6 | 230.6 | 195.6 | 195.3 | 194.9 | 196.0 | 186.7 | 207.7 |
| Turbidity (NTU) | 303.0 | 319.0 | 23.0 | 39.1 | 40.2 | 23.5 | 4.85 | 7.71 |
| Temperature (°C) | 20.8 | 20.8 | 21.2 | 21.2 | 21.2 | 21.4 | 18.5 | 19.6 |
| Oxidation Reduction Potential (mv) | −184.9 | −173.4 | −225.0 | −210.0 | −194.6 | −169.0 | −107.0 | −51.4 |
| $NO_3$-$NO_2$ as N* (mg/L) | 0.870 | 0.947 | 0.465 | 0.631 | 0.544 | 0.61 | 0.526 | 1.12 |
| Chromium (µg/L) | 13.8 | 25.4 | 3.86 | 4.54 | 5.06 | 12.3 | 24.6 | 77.4 |
| Total Organic Carbon (mg/L) | 1.02 | 0.891 | 0.573 | 0.451 | 0.654 | 0.503 | 2.96 | 0.507 |
| Manganese (µg/L) | 152.0 | 142.0 | 79.1 | 64.1 | 51.5 | 42.5 | 42.3 | 39.4 |
| Iron (µg/L) | 143.0 | 43.7 | 60.5 | 89.1 | 67.7 | 64.4 | 82.9 | 53.6 |

* $NO_3$-$NO_2$ as N = Nitrate-nitrite as nitrogen.

# Appendix A

*Analytical Chemistry and Field Data*
*(on CD included with this document)*

| N3B RECORDS | |
|---|---|
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