

**Preliminary Interpretations of the Lithostratigraphy,
Hydrostratigraphy, and Borehole Geophysics of Two Well Sites
Drilled in the Albuquerque Basin during late 1999 and early 2000**

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A1

Preliminary Interpretations of the Lithostratigraphy, Hydrostratigraphy, and Borehole Geophysics of the Bernalillo Wastewater Treatment Plant well site, Bernalillo, Sandoval County, New Mexico

Introduction

This report summarizes the preliminary lithostratigraphy and hydrostratigraphy for the Bernalillo Wastewater Treatment Plant monitoring well site (NMOSE-BWTP; Figure 1). This well, completed in cooperation with the NM Office of the State Engineer (NMOSE), U.S. Geological Survey (Water Resources Division), and the New Mexico Bureau of Mines and Mineral Resources (NMBMMR), will be used to monitor groundwater conditions in Bernalillo and to further characterize the Santa Fe Group regional aquifer in the Albuquerque Basin. Historical data for this monitoring well are summarized in Table 1. The well was drilled to a depth of 1250 feet during late July/early August 1999. To minimize caving of unconsolidated sediments near the surface, the well was cased to 48 feet during drilling. Lithologic samples (cuttings) were taken at 5-foot intervals down to 100 feet and at 10-foot intervals below 100 feet. Southwest Geophysical, Inc. of Farmington, NM ran borehole geophysical logs shortly after the target depth was attained. Borehole geophysical logs and cuttings were used to characterize the lithology of sedimentary deposits encountered in this borehole and to provide qualitative estimates of the hydrogeologic character of the regional Santa Fe Group aquifer.

This lithologic log and report are submitted to the NMOSE as partial fulfillment of an intergovernmental service agreement with the NMBMMR, a division of the New Mexico Institute of Mining and Technology. The cuttings and geophysical logs used to prepare this report will be available for inspection at NMBMMR in Socorro, New Mexico. This report has not been reviewed according to NMBMMR standards. ***The contents of this report should not be considered final and complete until it is published by the NMBMMR.***

Table A1. Historical Data

Name:	Bernalillo Wastewater Treatment Plant (NMOSE-BWTP)
Location:	T12N, R4E, Section 31 Bernalillo County, Bernalillo 7.5 Minute Quad Latitude: 35°18'25.197" Longitude: 106°33'18.468" UTM: 0358165mE, 3908000mN (Zone 13, NAD 83)
Elevation:	5046 feet (1538 m) above sea level
Drilling Method:	Mud Rotary
Drillers:	(USGS)
Drill bit size:	16" (0-70 feet), 9.875" (70-1255 feet)
Drilling Start:	July 29, 1999
Drilling Completion:	August 19, 1999
Sample Interval:	5 feet for the upper 100 feet of samples, then 10 feet to the bottom
Screened Intervals:	285-316 feet, 1175-1185 feet
Total Depth:	1250 feet (381 m)
Water Table:	<48 feet below ground level, within the zone of surface casing
Sample Logging:	P.B. Jackson (NMBMMR)
Geophysical Logging:	Southwest Geophysical Services, Inc.
Geophysical Logs:	Gamma Ray (Nat GR), Neutron Porosity (Npor), Density Porosity (Dpor), Caliper, Temperature (T), Differential Temperature (dT), Sonic, Single Point Resistance (Spt Res), 16" Resistivity (16N), 64" Resistivity (64N), Spontaneous Potential (SP), and synthetic (calculated) Electrical Conductivity (C)
Log Synthesis:	P.B. Jackson & S.D. Connell (NMBMMR)

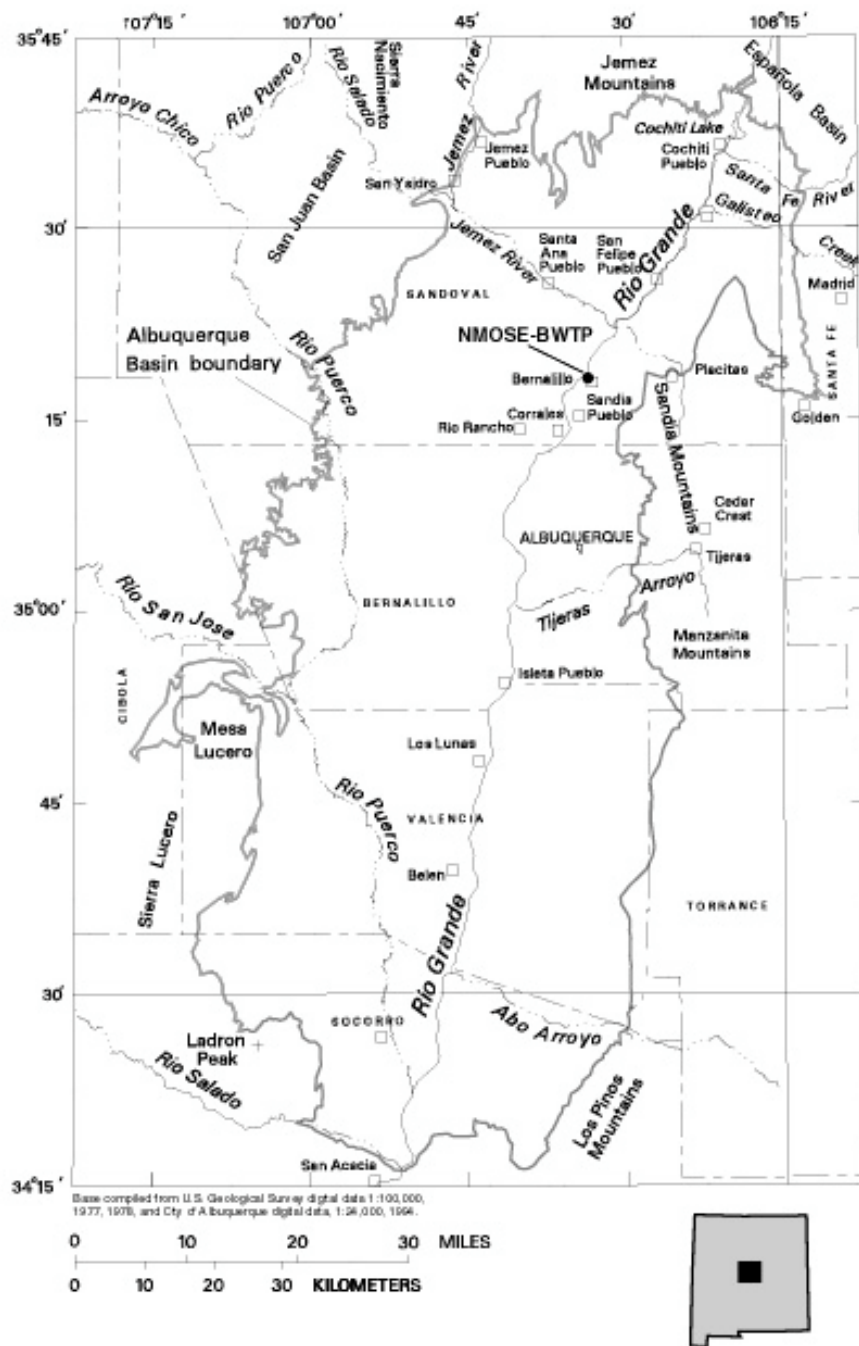


Figure A1. Index map showing the general location of the Bernalillo Wastewater Treatment Plant monitoring well. Base map modified from Bexfield (1998).

Methods

Lithologic descriptions were made by visual examination of mud-rotary cuttings taken from the well head at 5 and 10-foot intervals (Appendix A). Drilling methods prevent a complete evaluation of the finer grained fraction (commonly fine-grained sand and silt) that tends to be held in suspension by the drilling fluids. Lithologic descriptions are based on the following criteria:

1. Major textural class;
2. Estimated grain-size distribution by major textural class:
 - a. silt-clay (<0.05 mm)
 - b. sand (0.05-2.00 mm)
 - c. gravel (>2.00 mm)
3. Grain and clast shape;
4. Sorting and approximate range of grain and clast size;
5. Clast composition and approximate relative abundance, in decreasing order of abundance;
6. Color, using Munsell (1992) notation;
7. Other characteristics and selected driller's comments.

Samples were placed into cuttings trays, photographed (Appendix B), and examined in the lab. Sieve analysis was performed on ten sample intervals to determine grain-size distributions and sorting. Samples were weighed then run through a series of ten sieves. The amount of sand in each of these ten partitions was weighed to calculate the weight percent of each grain-size per sample. These data were tabulated and plotted, producing grain-size distribution curves (Appendix C). The final results of this analysis were incorporated into the sample descriptions and plots of the grain-size distributions have been included in this report.

Hydrostratigraphic subdivisions of the borehole were made using nomenclature developed for alluvial deposits in the Albuquerque Basin by Hawley and Whitworth (1996). In this system deposits are assigned to gravely and sandy fluvial (I-III), eolian (IV), piedmont (V-VIII), and fine-grained basin-floor/playa (IX-X) lithofacies (Table 2). These lithofacies are used to determine hydrostratigraphic units that are subdivided into post-Santa Fe Group and Santa Fe Group deposits. Post-Santa Fe Group units include fluvial-terrace deposits (RA and TA), and piedmont deposits (PA). Santa Fe Group hydrostratigraphic units consist of fluvial and piedmont deposits that are further subdivided into upper (USF), middle (MSF), and lower (LSF) sub-units (Table 3). These are further divided into subunits based on inferred sedimentary provenance: eastern margin piedmont (1), ancestral Rio Grande (2), western margin alluvial (3), and western margin fluvial (4) deposits. The lack of available high-quality lithologic and geophysical log data from neighboring wells precludes definitive hydrostratigraphic classification using this system of nomenclature.

Table A2. Summary of lithofacies assigned to textural units of the regional Santa Fe Group aquifer, and shallow post-Santa Fe Group aquifer (modified from Hawley and Whitworth, 1996).

Lithofacies	Textural Unit	Interpreted Depositional Setting
<i>Shallow</i>	<i>Post-Santa Fe Group aquifer</i>	
A1	Pebble to cobble gravel and sand	River-valley basal channel fluvial deposits
A2	Sand and pebbly sand	River-valley braid-plain fluvial deposits
A3	Silty clay, clay, and sand	Overbank meander belt or oxbow deposits
B	Sand, gravel, silt, and clay (similar to lithofacies V)	Arroyo channel and valley border alluvial fan deposits
<i>Regional</i>	<i>Santa Fe Group aquifer</i>	
I	Coarse-grained sand and pebble gravel with minor silt/clay.	Basin-floor fluvial braid plain
II	Fine to coarse-grained sand with lenses of pebbly sand and silty clay.	Basin-floor fluvial and local eolian
III	Interbedded sand and silty clay with lenses of pebbly/granular fine to coarse-grained sand.	Basin-floor fluvial and local eolian
IV	Sand and sandstone with lenses of silty sand to clay.	Mostly eolian
V	Gravel, sand, silt and clay with sand-silt-clay lenses.	a) Distal to medial piedmont-slope alluvial fan deposits associated with large watersheds b) Distal to medial piedmont-slope alluvial fan deposits associated with steep drainages
VI	Coarse gravelly, loamy sand to sandy loam with lenses of sand and cobble to boulder gravel.	a) see Va b) see Vb
VII	Partly indurated (cemented) equivalent of lithofacies V.	See V
VIII	Partly indurated (cemented) equivalent of lithofacies VI.	See VI
IX	Silty clay interbedded with sand, silty sand, or clay.	Basin-floor playa-lake, alluvial-flat, and distal piedmont-slope
X	Partly indurated equivalent of lithofacies IX.	See IX

Table A3. Summary of hydrostratigraphic units in the Albuquerque Basin (modified from Hawley and Whitworth, 1996).

Hydrostratigraphic Unit (<i>subunit</i>)	Description
<i>Post-Santa Fe Group Aquifer</i>	
RA	Channel, floodplain and lower river terrace alluvial deposits of the modern Rio Grande and Puerco valleys; typically ≤ 120 ft thick; Holocene to late Pleistocene in age. Lithofacies A comprises much of this unit.
VA	Tributary-arroyo channel, fan and terrace alluvial deposits in areas bordering inner valleys of the Rio Grande system; ≤ 100 ft thick; Holocene to early(?) or middle Pleistocene in age. Lithofacies B comprises much of this unit. Subdivided into hydrostratigraphic units VAY and VAO.
	VAY Younger valley border alluvial fans in major arroyo systems.
	VAO Remnants of older arroyo valley fill deposits.
TA	Channel and floodplain deposits of the ancestral Rio Grande fluvial system (including the Rio Jemez/Guadalupe, Rio Puerco, Rio San Jose, Rio Salado, Santa Fe River, and Jemez River) deposited during a series of at least four stages of valley entrenchment and partial backfilling. Commonly forms ≥ 100 -ft thick deposits that unconformably overlie hydrostratigraphic units of USF, MSF, and locally MSF. Basal contacts are erosional and range from 50 ft below, to 250 ft above, the present floor of the Rio Grande and Rio Puerco; Holocene to early(?) or middle Pleistocene in age. Lithofacies A1-A2 comprise much of this unit.
PA	Coalescing alluvial fan and piedmont deposits extending basinward from the fronts of the Sandia, Manzanita, and Manzano Mountains on the eastern and southwestern margins of the Albuquerque Basin. Includes deposits of the ancestral Tijeras arroyo and mountain-front pediments. Deposits are commonly ≤ 150 ft thick; Holocene to middle Pleistocene in age; Lithofacies V and VI commonly comprise this unit. Locally divided into two subunits.
	PAY Younger (late Pleistocene and Holocene) alluvial deposits on upper piedmont slopes flanking the Sandia and Manzano Mountains.
	PAO Older (middle Pleistocene) alluvial deposits flanking the Sandia and Manzano Mountains.

Table A3. *Continued.*

Hydrostratigraphic Unit (<i>subunit</i>)	Description
<i>Regional Santa Fe Group Aquifer</i>	
USF	<p>Ancestral Rio Grande and Rio Puerco deposits that interfinger with piedmont-alluvial facies deposits towards the basin margins with volcanic rocks (commonly a mixture of basalt, andesite, rhyolite) and thin eolian deposits present in local areas. Commonly ≤ 1000 ft thick, but locally exceeds 1500 ft in thickness; early Pleistocene to late Miocene (primarily Pliocene) in age; lithofacies I, II, III, V, VI, VII, VIII, IX, X.</p> <ol style="list-style-type: none"> 1 Alluvial deposits derived from rift flanking uplifts along the eastern margin of the Albuquerque Basin, including the Sandia, Manzanita, and Manzano Mountains. 2 Basin-floor fluvial deposits of the ancestral Rio Grande. Locally interbedded fine to medium-grained alluvial, lacustrine, or eolian deposits. 3 Alluvial deposits derived from rift flanking uplifts along the western margin of the Albuquerque Basin, including the Lucero uplift and the Ladron Mountains. 4 Basin-floor fluvial deposits of the ancestral Rio Jemez/Guadalupe, Rio Puerco, Rio San Jose, and Rio Salado. Underlies much of the Llano de Albuquerque, the topographic divide between the Rio Grande and Rio Puerco valleys. Derived from the Sierra Nacimiento and Colorado Plateau.
MSF	<p>Alluvial, eolian, and playa-lake deposits (MSF-2, 4). Partly indurated piedmont alluvium (MSF-1, 3) interfingers basinward with basin-floor deposits of MSF-2, 4; basaltic and silicic volcanic rocks locally present; in the southwest portion of the basin may be more than 10,000 ft in thickness; in the central portion of the basin deposits may be more than 5,000 ft thick; late to middle Miocene in age; lithofacies III, IV, V, VI, VII, VIII, IX, X.</p> <ol style="list-style-type: none"> 1 Piedmont alluvium derived from emergent rift flanking uplifts along the eastern margin of the Albuquerque Basin, including the Sandia, Manzano, and Manzanita Mountains. 2 Basin-floor sediments of mixed (alluvial, lacustrine, and/or eolian) origin. Contains deposits of possible ancestral Rio Grande origin. 3 Alluvial deposits derived from emergent rift flanking uplifts along the western margin of the Albuquerque Basin, including the Sierra Lucero, and the Ladron Mountains. 4 Basin-floor fluvial deposits of the ancestral Rio Jemez/Guadalupe, Rio Puerco, Rio San Jose, and Rio Salado. Underlies much of the Llano de Albuquerque, the topographic divide between the Rio Grande and Rio Puerco valleys. Derived from the Sierra Nacimiento and Colorado Plateau.
LSF	<p>Eolian, alluvial, and playa-lake basin-floor deposits interbedded with piedmont deposits near basin margins; generally ≤ 3500 ft thick in the central basin; middle Miocene to late Oligocene in age; lithofacies III, IV, VII-X.</p>

Lithostratigraphy and Hydrostratigraphy

Major textural and lithologic units encountered in the well are graphically displayed on Figure 2 and described in Table 4. Figure 2 also illustrates geophysical logs for the well and the various correlations between the geophysical and lithologic logs. Geophysical interpretations shown on the graphic log of Figure 2 are based on the integration of the lithologic and geophysical data. Correlation and nomenclature are generally consistent with the Arroyo Ojito Formation. With the well collared at 4998 ± 5 feet above sea level (asl), the water table is placed between $5046-4998 \pm 5$ feet above sea level. The Rio Grande, approximately 0.4 miles west of the site, is at an elevation of 5050 ± 5 feet above sea level (Bernalillo 7.5 Minute Quadrangle, U.S.G.S., 1954). This would then suggest that the water table is either flat or gently slopes eastward away from the river.

The top 15 feet of this well consists of medium to coarse-grained sand that grades down-hole into 45 feet of coarse-grained pebble gravel. This upper 60 feet of coarse-grained Quaternary Rio Grande alluvial unit is classified as hydrostratigraphic unit RA (Hawley et al, 1995). This unit is a fluvial facies that has been inset into the Santa Fe Group basin-fill.

From 60 feet to 1215 feet there is a stacked succession of alternating beds of silty clay, silty sand, fine to coarse-grained sand with scattered pebbles. Over this interval, nine samples were sieved and analyzed. The results of this analysis are attached as Appendix C. From the sieve analysis it was determined that overall this interval is poorly sorted with some interbeds of cleaner, moderately to poorly sorted, fine to medium-grained sand. The coarser-grained interbeds have gravel clasts that are subangular to subrounded and dominated by granite, quartzite composition. Based on these preliminary data, this interval's lithology most closely resembles that of the Loma Barbon Member of the Arroyo Ojito Formation of Connell et al (1999) with some possible interlayering of Sierra Ladrones Formation or ancestral Rio Grande deposits.

At 1220 feet there is a distinct color change from reddish brown to a mottled pale brown and reddish brown. The samples from 1220 to 1250 feet are poorly sorted, subangular to subrounded, clayey coarse-grained sands to fine pebble gravel. This transition marks the boundary between Upper and Middle Santa Fe hydrostratigraphic units. This lowest unit represents basin-floor alluvial deposition and may correlate to the Navajo Draw Member, the lowest member of the Arroyo Ojito Formation. At the type section measured by Connell et al (1999), the Navajo Draw Member contains 229 m of pale-brown to pale-yellow, poorly to

moderately sorted, fine to coarse-grained sandstone and pebbly sandstone with minor mudstone interbeds. The upper contact of this member is conformable and overlain by reddish-yellow to brown sandstone and granite bearing pebbly sandstone similar to what was observed in the cutting samples from this site. Further petrographic analysis of samples throughout the basin is needed to clearly differentiate between the Sierra Ladrones and Arroyo Ojito Formations in areas near the Rio Grande Valley.

Table A4. Description and interpretation of major textural units. Color represents that of moist sediment.

<u>Depth (ft)</u>	<u>Description</u>
0-60	Pinkish gray (7.5YR 6/2) coarse-grained sand and pebbly gravel with some reddish brown (2.5YR 5/4) silty and clayey zones, moderate to poorly sorted, subrounded grains, with a gravel clast composition of granite, quartzite, and sandstone. <i>Hydrostratigraphic unit RA.</i>
60-1220	Silty clay, silty sand, fine to coarse-grained sand with scattered pebbles, poorly sorted, subrounded to subangular grains, light reddish brown (5YR 6/4). <i>Hydrostratigraphic unit USF 2 or USF 4.</i>
1220-1250	Poorly sorted, subangular to subrounded, clayey coarse-grained sand to fine pebble gravel, mottled pale brown (10YR 6/3) and light reddish brown (5YR 6/4). Gravel clast composition: intermediate volcanics, granite. <i>Hydrostratigraphic unit MSF 4?</i>

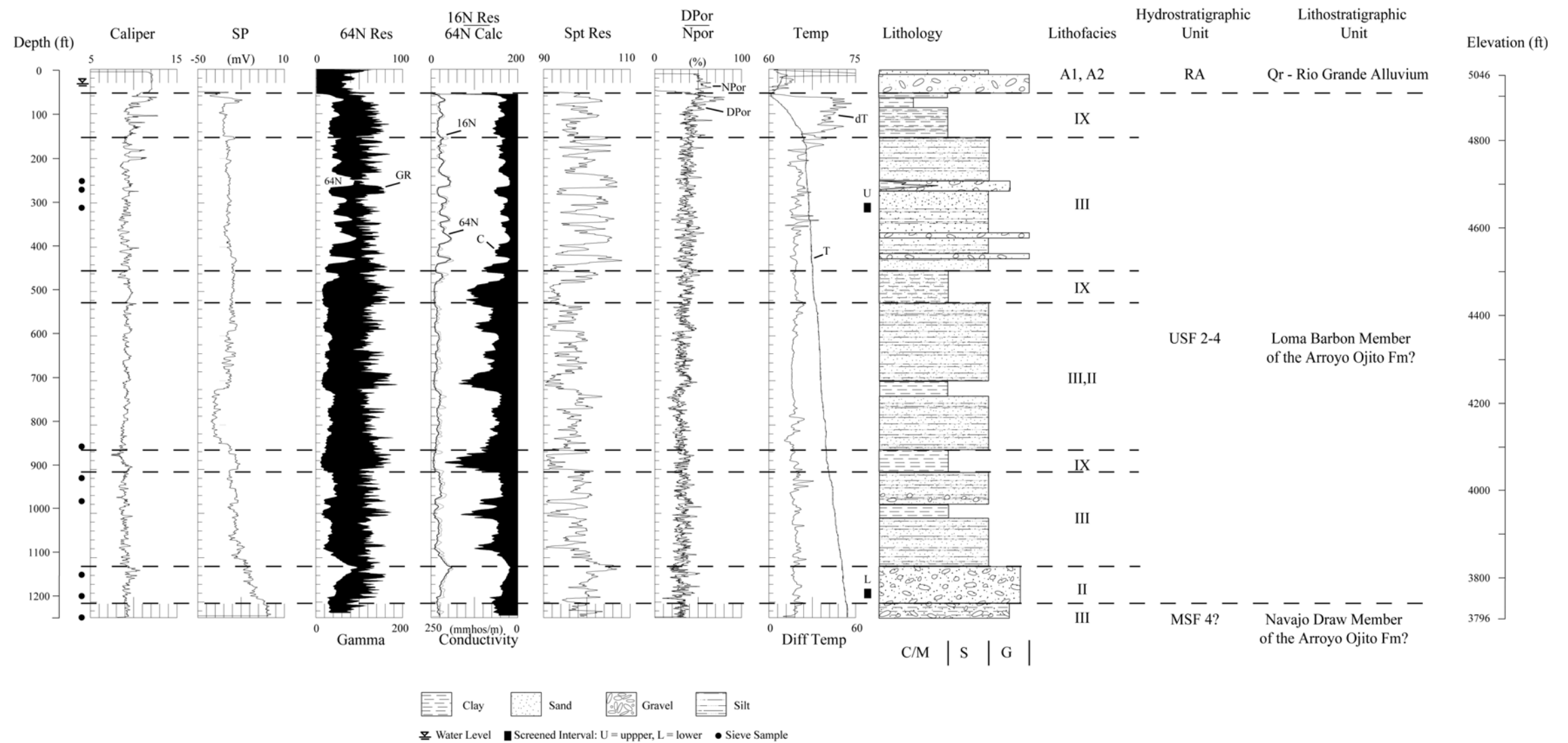


Figure A2. Geophysical data logs, lithologic column, and preliminary hydrostratigraphic & lithostratigraphic interpretations.

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Appendix A1. Field lithologic descriptions of cuttings from the Bernalillo Wastewater Treatment Plant monitoring well.

Sample No.	Depth Interval (ft, bls)	Description
BWTP-1	0-5	Silty medium to coarse-grained sand (75% medium to coarse-grained sand, 20% silt, 5% fine-grained gravel), moderately sorted, subrounded grains, reddish brown silt (5YR 4/3), pinkish gray (7.5YR 6/2) sand. Gravel clast composition: quartzite, granite, sandstone.
BWTP-2	5-10	Medium to coarse-grained sand (95% medium to coarse-grained sand, 5% fine-grained gravel, trace silt), moderately sorted, subrounded grains, pinkish gray (7.5YR 6/2). Gravel clast composition: quartzite, granite, sandstone.
BWTP-3	10-15	Medium-grained sand (100% sand), moderately sorted, subrounded grains, reddish brown silt (5YR 4/3), pinkish gray (7.5YR 6/2) sand.
BWTP-4	15-20	Coarse-pebble gravel (95% gravel, 5% sand, trace silt), moderately sorted, subrounded grains, pinkish gray (7.5YR 6/2). Gravel clast composition: quartzite, granite, sandstone.
BWTP-5	20-25	Coarse-pebble gravel (90% gravel, 10% sand), moderately sorted, subrounded grains, pinkish gray (7.5YR 6/2). Gravel clast composition: quartzite, granite, sandstone.
BWTP-6	25-30	Coarse-pebble gravel (100% gravel, trace sand), moderately sorted, subrounded grains, pinkish gray (7.5YR 6/2). Gravel clast composition: granite, quartzite, sandstone.
BWTP-7	30-35	Coarse-pebble gravel (90% gravel, 10% sand, trace silt), moderately sorted, subrounded grains, pinkish gray (7.5YR 6/2). Gravel clast composition: granite, quartzite, sandstone.
BWTP-8	35-40	Coarse-pebble gravel (100% gravel, trace sand), moderately sorted, subrounded grains, pinkish gray (7.5YR 6/2). Gravel clast composition: granite, quartzite, sandstone.
BWTP-9	40-45	Coarse-grained pebbly sand (60% sand, 35% gravel, 5% silt), moderately sorted, subrounded grains, reddish brown silt (5YR 4/3), pinkish gray (7.5YR 6/2) sand. Gravel clast composition: granite, quartzite, sandstone.
BWTP-10	45-50	Silty coarse-pebble gravel (90% gravel, 10% silt), reddish brown silt (5YR 4/3), moderately sorted, subrounded grains, pinkish gray (7.5YR 6/2) sand. Gravel clast composition: granite, quartzite, sandstone.
BWTP-11	50-55	Clayey/silty pebble gravel (80% gravel, 20% clay/silt), moderate to poorly sorted, subrounded grains, reddish brown silt (2.5YR 5/4), pinkish gray (7.5YR 6/2) sand. Gravel clast composition: granite, quartzite, sandstone.

BWTP-12	55-60	Clayey/silty pebble gravel (80% gravel, 20% clay/silt), moderate to poorly sorted, subrounded grains, reddish brown silt (2.5YR 5/4), pinkish gray (7.5YR 6/2) sand. Gravel clast composition: granite, quartzite, sandstone.
BWTP-13	60-65	Silt (100% silt), light gray to light brownish gray (10YR 7/2-6/2).
BWTP-14	65-70	Clayey silt and scattered pebble gravel (43% silt, 23% clay, 22% gravel, 12% sand), light gray to light brownish gray (10YR 7/2-6/2). Gravel clast composition: granite, quartzite, sandstone.
BWTP-15	70-75	Clay/silt (100% clay/silt), light gray to light brownish gray (10YR 7/2-6/2).
BWTP-16	75-80	Red clay (100% clay), reddish brown (2.5YR 5/4-4/4).
BWTP-17	80-85	Red clay (100% clay), reddish brown (2.5YR 5/4-4/4).
BWTP-18	85-90	Red clay (100% clay), reddish brown (2.5YR 5/4-4/4).
BWTP-19	90-95	Silty clay (100% silt/clay), reddish brown (2.5YR 5/4-4/4).
BWTP-20	95-100	Silty clay (100% silt/clay), reddish brown (2.5YR 5/4-4/4).
BWTP-21	100-110	Silty clay (100% silt/clay), reddish brown (2.5YR 5/4-4/4).
BWTP-22	110-120	Silty clay (100% silt/clay), light reddish brown to reddish brown (2.5YR 6/4-5/4).
BWTP-23	120-130	Silty clay (100% silt/clay), light reddish brown to reddish brown (2.5YR 6/4-5/4).
BWTP-24	130-140	Silty clay (100% silt/clay), light reddish brown to reddish brown (2.5YR 6/4-5/4).
BWTP-25	140-150	Silt and fine-grained sand (95% silt, 5% sand), light gray to light brownish gray (10YR 7/2-6/2).
BWTP-26	150-160	Clayey/silty and fine-grained sand (95% silt, 5% sand), light gray silt and fine sand (10YR 7/2-6/2), reddish brown clay (5YR 5/4).
BWTP-27	160-170	Clayey/silty and fine-grained sand (95% silt, 5% sand), light gray silt and fine sand (10YR 7/2-6/2), reddish brown clay (5YR 5/4).
BWTP-28	170-180	Clayey/silty and fine-grained sand (95% silt, 5% sand), light gray silt and fine sand (10YR 7/2-6/2), reddish brown clay (5YR 5/4).
BWTP-29	180-190	Clayey/silty and fine-grained sand (95% silt, 5% sand), light gray silt and fine sand (10YR 7/2-6/2), reddish brown clay (5YR 5/4).
BWTP-30	190-200	Clayey/silty and fine-grained sand (95% silt, 5% sand), light gray silt and fine sand (10YR 7/2-6/2), reddish brown clay (5YR 5/4).
BWTP-31	200-210	Clayey/silty and fine-grained sand (95% silt, 5% sand), light gray silt and fine sand (10YR 7/2-6/2), reddish brown clay (5YR 5/4).
BWTP-32	210-220	Clayey/silty and fine-grained sand (95% silt, 5% sand), light gray silt and fine sand (10YR 7/2-6/2), reddish brown clay (5YR 5/4).
BWTP-33	220-230	Clayey/silty and fine-grained sand (95% silt, 5% sand), light gray silt and fine sand (10YR 7/2-6/2), reddish brown clay (5YR 5/4).
BWTP-34	230-240	Clayey/silty and fine-grained sand (95% silt, 5% sand), light gray silt and fine sand (10YR 7/2-6/2), reddish brown clay (5YR 5/4).
BWTP-36	250-260	Clayey/silty fine to medium-grained sand with scattered pebbles (65% sand, 20% clayey silt, 15% pebble gravel), light gray silt and fine sand (10YR 7/2-6/2), reddish brown clay (5YR 5/4).

BWTP-37	260-270	Interfingered silt/clay and coarse-grained sand to fine-pebble gravel (45% gravel, 30% silt/clay, 25% sand), moderately sorted, subangular to subrounded grains, light gray sand and gravel (10YR 7/2-6/2), reddish brown clay (5YR 5/4), calcium carbonate cement. Gravel clast composition: granite, quartzite, and intermediate volcanics.
BWTP-38	270-280	Interfingered silt/clay and coarse-grained sand to fine-pebble gravel (45% gravel, 30% silt/clay, 25% sand), moderately sorted, subangular to subrounded grains, light gray sand and gravel (10YR 7/2-6/2), reddish brown clay (5YR 5/4), calcium carbonate cement. Gravel clast composition: granite, quartzite, and intermediate volcanics.
BWTP-39	280-290	Fine to coarse-grained sand (100% sand), moderately sorted, subangular to subrounded grains, light reddish brown (5YR 6/4).
BWTP-40	290-300	Fine to coarse-grained sand (100% sand), moderately sorted, subangular to subrounded grains, light reddish brown (5YR 6/4).
BWTP-41	300-310	Fine to coarse-grained sand (100% sand), moderately sorted, subangular to subrounded grains, light reddish brown (5YR 6/4).
BWTP-42	310-320	Clayey fine to coarse-grained sand (85% sand, 10% clay, <5% gravel), moderately sorted, subangular to subrounded grains, light reddish brown sand and clay (5YR 6/4-2.5YR 6/4). Gravel clast composition: granite, quartzite.
BWTP-43	320-330	Clayey/silty fine to coarse-grained sand (70% sand, 30% clay/silt), moderately sorted, subangular to subrounded grains, light reddish brown sand and clay (5YR 6/4-2.5YR 6/4), calcium carbonate cement.
BWTP-44	330-340	Clayey/silty fine to coarse-grained sand (60% sand, 40% clay/silt), moderately sorted, subangular to subrounded grains, light reddish brown sand and clay (5YR 6/4-2.5YR 6/4), calcium carbonate cement.
BWTP-45	340-350	Clayey/silty fine to coarse-grained sand with scattered pebbles (60% sand, 40% clay/silt, trace gravel), moderately sorted, subangular to subrounded grains, light reddish brown sand and clay (5YR 6/4-2.5YR 6/4), calcium carbonate cement. Gravel clast composition: quartzite, granite.
BWTP-46	350-360	Silty fine-grained sand (90% sand, 10% silt), moderately well sorted, subangular to subrounded grains, light reddish brown (5YR 6/4).
BWTP-47	360-370	Silty fine-grained sand (90% sand, 10% silt), moderately well sorted, subangular to subrounded grains, light reddish brown (5YR 6/4).
BWTP-49	380-390	Silty fine to medium-grained sand with scattered pebbles (90% sand, 10% silt, trace pebble gravel), moderately sorted, subangular to subrounded grains, light reddish brown (5YR 6/4). Gravel clast composition: quartzite, granite.

BWTP-50	390-400	Clayey fine to coarse-grained sand with scattered pebbles (60% sand, 30% clay, 10% gravel), moderately sorted, subangular to subrounded grains, light reddish brown sand and clay (5YR 6/4-2.5YR 6/4), calcium carbonate cement. Gravel clast composition: quartzite, granite.
BWTP-51	400-410	Clayey fine to coarse-grained sand with scattered pebbles (60% sand, 30% clay, 10% gravel), moderately sorted, subangular to subrounded grains, light reddish brown sand and clay (5YR 6/4-2.5YR 6/4), calcium carbonate cement. Gravel clast composition: quartzite, granite.
BWTP-52	410-420	Clayey fine to coarse-grained sand with scattered pebbles (60% sand, 30% clay, 10% gravel), moderately sorted, subangular to subrounded grains, light reddish brown sand and clay (5YR 6/4-2.5YR 6/4), calcium carbonate cement. Gravel clast composition: quartzite, granite.
BWTP-53	420-430	Clay and fine-grained sand with scattered pebbles (70% clay, 20% clay/silt, 10% gravel), poorly sorted, subangular to subrounded grains, light reddish brown sand and clay (5YR 6/4-2.5YR 6/4), calcium carbonate cement. Gravel clast composition: quartzite, granite.
BWTP-54	430-440	Silty fine to medium-grained sand (90% sand, 10% silt), moderately sorted, subangular to subrounded grains, light reddish brown (5YR 6/4).
BWTP-55	440-450	Silty fine to coarse-grained sand with scattered pebbles (85% sand, 10% silt, 5% gravel), moderately sorted, subangular to subrounded grains, light reddish brown (5YR 6/4). Gravel clast composition: quartzite, granite.
BWTP-56	450-460	Clayey fine to coarse-grained sand with scattered pebbles (75% sand, 20% clay, 5% gravel), moderately sorted, subangular to subrounded grains, light reddish brown sand and clay (5YR 6/4-2.5YR 6/4), calcium carbonate cement. Gravel clast composition: quartzite, granite.
BWTP-57	460-470	Clay and fine-grained sand with scattered pebbles (70% clay, 20% sand, 10% gravel), poorly sorted, subangular to subrounded grains, light reddish brown sand and clay (5YR 6/4-2.5YR 6/4), calcium carbonate cement. Gravel clast composition: quartzite, granite.
BWTP-58	470-480	Clay and fine-grained sand with scattered pebbles (70% clay, 20% sand, 10% gravel), poorly sorted, subangular to subrounded grains, light reddish brown sand and clay (5YR 6/4-2.5YR 6/4), calcium carbonate cement. Gravel clast composition: quartzite, granite.
BWTP-60	490-500	Clay and fine-grained sand with scattered pebbles (70% clay, 20% sand, 10% gravel), poorly sorted, subangular to subrounded grains, light reddish brown sand and clay (5YR 6/4-2.5YR 6/4), calcium carbonate cement. Gravel clast composition: quartzite, granite.

BWTP-61	500-510	Clay and fine-grained sand with scattered pebbles (70% clay, 20% sand, 10% gravel), poorly sorted, subangular to subrounded grains, light reddish brown sand and clay (5YR 6/4-2.5YR 6/4), calcium carbonate cement. Gravel clast composition: quartzite, granite.
BWTP-62	510-520	Clay and fine-grained sand with scattered pebbles (70% clay, 20% sand, 10% gravel), poorly sorted, subangular to subrounded grains, light reddish brown sand and clay (5YR 6/4-2.5YR 6/4), calcium carbonate cement. Gravel clast composition: quartzite, granite.
BWTP-64	530-540	Clay and fine-grained sand with scattered pebbles (70% clay, 20% sand, 10% gravel), poorly sorted, subangular to subrounded grains, light reddish brown sand and clay (5YR 6/4-2.5YR 6/4), calcium carbonate cement. Gravel clast composition: quartzite, granite.
BWTP-65	540-550	Clay and fine-grained sand with scattered pebbles (70% clay, 20% sand, 10% gravel), poorly sorted, subangular to subrounded grains, light reddish brown sand and clay (5YR 6/4-2.5YR 6/4), calcium carbonate cement. Gravel clast composition: quartzite, granite.
BWTP-66	550-560	Silty fine-grained sand (80% sand, 20% silt), moderately well sorted, subrounded grains, light reddish brown (5YR 6/4), carbonate cement.
BWTP-67	560-570	Silty fine-grained sand with clay stringers (75% sand, 20% silt, 5% clay), moderately well sorted, subrounded grains, light reddish brown (5YR 6/4).
BWTP-68	570-580	Silty fine-grained sand (80% sand, 20% silt), moderately well sorted, subrounded grains, light reddish brown (5YR 6/4), carbonate cement.
BWTP-69	580-590	Silty fine-grained sand (80% sand, 20% silt), moderately well sorted, subrounded grains, light reddish brown (5YR 6/4), carbonate cement.
BWTP-70	590-600	Silty fine-grained sand with clay stringers (70% sand, 20% silt, 10% clay), moderately well sorted, subrounded grains, light reddish brown (5YR 6/4).
BWTP-71	600-610	No sample.
BWTP-72	610-620	No sample.
BWTP-73	620-630	No sample.
BWTP-74	630-640	No sample.
BWTP-75	640-650	No sample.
BWTP-76	650-660	No sample.
BWTP-77	660-670	No sample.
BWTP-78	670-680	No sample.
BWTP-79	680-690	No sample.
BWTP-80	690-700	No sample.
BWTP-81	700-710	Silty fine-grained sand (80% sand, 20% silt), moderately well sorted, subrounded grains, light reddish brown (5YR 6/4), carbonate cement.
BWTP-82	710-720	Silty clay (100% clay silt), well sorted, reddish brown (5YR 5/4).
BWTP-83	720-730	Silty clay (100% clay silt), well sorted, reddish brown (5YR 5/4).
BWTP-84	730-740	Silty clay (100% clay silt), well sorted, reddish brown (5YR 5/4).
BWTP-85	740-750	Silty/clayey fine-grained sand (80% sand, 15% silt, <5% clay), moderately well sorted, subrounded grains, light reddish brown (5YR 6/4), carbonate cement.
BWTP-86	750-760	Silty/clayey fine-grained sand (80% sand, 15% silt, <5% clay), moderately well sorted, subrounded grains, light reddish brown (5YR 6/4), carbonate cement.
BWTP-87	760-770	Silty/clayey fine-grained sand (80% sand, 15% silt, <5% clay), moderately well sorted, subrounded grains, light reddish brown (5YR 6/4), carbonate cement.
BWTP-88	770-780	Silty/clayey fine-grained sand (80% sand, 15% silt, <5% clay), moderately well sorted, subrounded grains, light reddish brown (5YR 6/4), carbonate cement.
BWTP-89	780-790	Silty/clayey fine-grained sand (80% sand, 15% silt, <5% clay), moderately well sorted, subrounded grains, light reddish brown (5YR 6/4), carbonate cement.
BWTP-90	790-800	Silty/clayey fine-grained sand (80% sand, 15% silt, <5% clay), moderately well sorted, subrounded grains, light reddish brown (5YR 6/4), carbonate cement.
BWTP-91	800-810	Silty/clayey fine-grained sand (80% sand, 15% silt, <5% clay), moderately well sorted, subrounded grains, light reddish brown (5YR 6/4), carbonate cement.

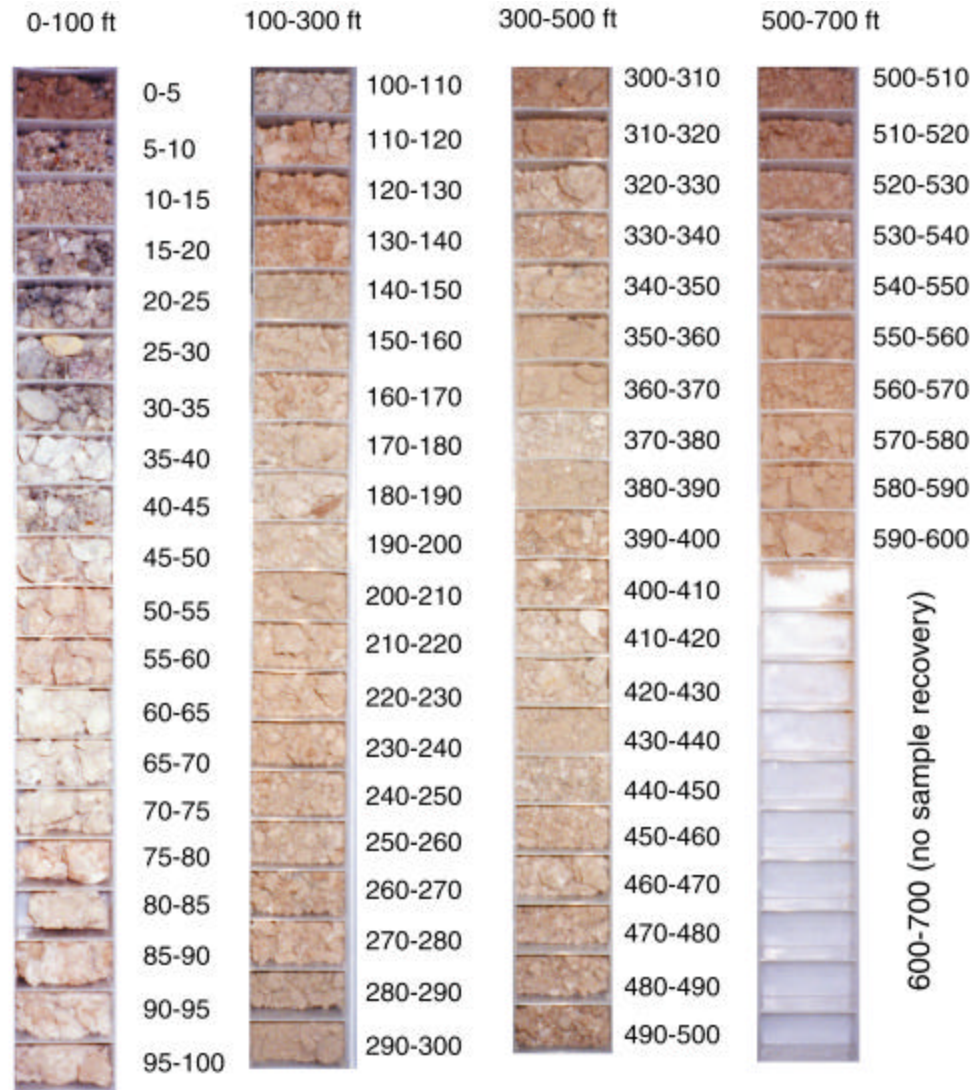
BWTP-93	820-830	Silty/clayey fine-grained sand (80% sand, 15% silt, <5% clay), moderately well sorted, subrounded grains, light reddish brown (5YR 6/4), carbonate cement.
BWTP-94	830-840	Silty/clayey fine-grained sand (80% sand, 15% silt, <5% clay), moderately well sorted, subrounded grains, light reddish brown (5YR 6/4), carbonate cement.
BWTP-95	840-850	Silty/clayey fine-grained sand (80% sand, 15% silt, <5% clay), moderately well sorted, subrounded grains, light reddish brown (5YR 6/4), carbonate cement.
BWTP-96	850-860	Silty/clayey fine-grained sand (80% sand, 15% silt, <5% clay), moderately sorted, subrounded grains, light reddish brown (5YR 6/4), carbonate cement.
BWTP-97	860-870	Silty/clayey fine-grained sand (80% sand, 15% silt, <5% clay), moderately well sorted, subrounded grains, light reddish brown (5YR 6/4), carbonate cement.
BWTP-98	870-880	Silty clay (100% silty clay), well sorted, reddish brown (5YR 5/4).
BWTP-99	880-890	Silty clay (100% silty clay), well sorted, reddish brown (5YR 5/4).
BWTP-100	890-900	Silty clay (100% silty clay), well sorted, reddish brown (5YR 5/4).
BWTP-101	900-910	Silty clay (100% silty clay), well sorted, reddish brown (5YR 5/4).
BWTP-102	910-920	Silty clay (100% silty clay), well sorted, reddish brown (5YR 5/4).
BWTP-103	920-930	Silty/clayey fine to medium-grained sand (85% sand, 10% silt, 5% clay), moderately sorted, subangular to subrounded grains, light reddish brown (5YR 6/3).

BWTP-104	930-940	Silty fine to medium-grained sand (90% sand, 10% silt), moderately sorted, subangular to subrounded grains, light reddish brown (5YR 6/3).
BWTP-105	940-950	Silty fine to coarse-grained sand (90% sand, 10% silt), poor to moderately sorted, subangular to subrounded grains, light reddish brown (5YR 6/3).
BWTP-106	950-960	Silty/clayey fine-grained sand with scattered pebbles (80% sand, 10% silt/clay, 10% gravel), moderately sorted, reddish brown (5YR 5/4). Gravel clast composition: quartzite, granite.
BWTP-107	960-970	Silty/clayey fine-grained sand with scattered pebbles (80% sand, 10% silt/clay, 10% gravel), moderately sorted, reddish brown (5YR 5/4). Gravel clast composition: quartzite, granite.
BWTP-108	970-980	Silty/clayey fine-grained sand with scattered pebbles (80% sand, 10% silt/clay, 10% gravel), moderately sorted, reddish brown (5YR 5/4). Gravel clast composition: quartzite, granite.
BWTP-109	980-990	Silty/clayey fine-grained sand with scattered pebbles (80% sand, 10% silt/clay, 10% gravel), moderately sorted, reddish brown (5YR 5/4). Gravel clast composition: quartzite, granite.
BWTP-110	990-1000	Silty/clayey fine-grained sand with scattered pebbles (80% sand, 10% silt/clay, 10% gravel), moderately sorted, reddish brown (5YR 5/4). Gravel clast composition: quartzite, granite.
BWTP-111	1000-1010	Silty clay (100% clay silt), well sorted, reddish brown (5YR 5/4).
BWTP-112	1010-1020	Silty clay (100% clay silt), well sorted, reddish brown (5YR 5/4).
BWTP-113	1020-1030	Silty clay (100% clay silt), well sorted, reddish brown (5YR 5/4).
BWTP-114	1030-1040	Silty clay (100% clay silt), well sorted, reddish brown (5YR 5/4).
BWTP-115	1040-1050	Silty fine to medium-grained sand (90% sand, 10% silt), moderately sorted, subangular to subrounded grains, light reddish brown (5YR 6/3).
BWTP-116	1050-1060	Silty fine to medium-grained sand (90% sand, 10% silt), moderately sorted, subangular to subrounded grains, light reddish brown (5YR 6/3).
BWTP-117	1060-1070	Silty fine to medium-grained sand (90% sand, 10% silt), moderately sorted, subangular to subrounded grains, light reddish brown (5YR 6/3).
BWTP-118	1070-1080	Silty fine-grained sand (80% sand, 20% silt), moderately well sorted, subrounded grains, light reddish brown (5YR 6/4), carbonate cement.
BWTP-120	1090-1100	Silty fine-grained sand (80% sand, 20% silt), moderately well sorted, subrounded grains, light reddish brown (5YR 6/4), carbonate cement.
BWTP-121	1100-1110	Silty fine-grained sand (80% sand, 20% silt), moderately well sorted, subrounded grains, light reddish brown (5YR 6/4), carbonate cement.

BWTP-122	1110-1120	Silty fine-grained sand (80% sand, 20% silt), moderately well sorted, subrounded grains, light reddish brown (5YR 6/4), carbonate cement.
BWTP-123	1120-1130	Silty fine pebble gravel and coarse-grained sand (65 % sand, 25% gravel, 10% silt/clay), moderately sorted, subangular to subrounded grains/clasts, light reddish brown (5YR 6/4). Gravel clast composition: granite, quartzite, intermediate volcanics.
BWTP-124	1130-1140	Silty fine pebble gravel and coarse-grained sand (65 % sand, 25% gravel, 10% silt/clay), moderately sorted, subangular to subrounded grains/clasts, light reddish brown (5YR 6/4). Gravel clast composition: granite, quartzite, intermediate volcanics.
BWTP-125	1140-1150	Silty fine pebble gravel and coarse-grained sand (65 % sand, 25% gravel, 10% silt/clay), moderately sorted, subangular to subrounded grains/clasts, light reddish brown (5YR 6/4). Gravel clast composition: granite, quartzite, intermediate volcanics.
BWTP-126	1150-1160	Silty fine pebble gravel and coarse-grained sand (65 % sand, 25% gravel, 10% silt/clay), moderately sorted, subangular to subrounded grains/clasts, light reddish brown (5YR 6/4). Gravel clast composition: granite, quartzite, intermediate volcanics.
BWTP-127	1160-1170	Silty fine-grained sand (80% sand, 20% silt), moderately well sorted, subrounded grains, light reddish brown (5YR 6/4), carbonate cement.
BWTP-128	1170-1180	Gravelly/silty coarse-grained sand (75 % sand, 15% gravel, 10% silt/clay), moderately sorted, subangular to subrounded grains/clasts, light reddish brown (5YR 6/4). Gravel clast composition: granite, quartzite, intermediate volcanics.
BWTP-129	1180-1190	Silty/gravelly fine-grained sand (70% sand, 15% gravel, 15% silt/clay), moderately well sorted, subrounded grains, light reddish brown (5YR 6/4), carbonate cement.
BWTP-130	1190-1200	Silty fine pebble gravel and coarse-grained sand (40% gravel, 30% sand, 30% clay), poorly sorted, subangular to subrounded grains/clasts, light reddish brown (5YR 6/4). Gravel clast composition: granite, intermediate volcanics.
BWTP-131	1190-1200	Silty fine pebble gravel and coarse-grained sand (40% gravel, 30% sand, 30% clay), poorly sorted, subangular to subrounded grains/clasts, light reddish brown (5YR 6/4). Gravel clast composition: granite, intermediate volcanics.
BWTP-132	1200-1210	Silty fine-grained sand (80% sand, 20% silt), moderately well sorted, subrounded grains, light reddish brown (5YR 6/4), carbonate cement.
BWTP-133	1210-1220	Silty fine pebble gravel and coarse-grained sand (40% gravel, 30% sand, 30% clay), poorly sorted, subangular to subrounded grains/clasts, light reddish brown (5YR 6/4). Gravel clast composition: granite, intermediate volcanics.

BWTP-134	1220-1230	Clayey coarse-grained sand to fine pebble gravel (40% gravel, 30% sand, 30% clay), moderately to poorly sorted, subangular to subrounded grains/clasts, mottled pale brown (10YR 6/3) and light reddish brown (5YR 6/4). Gravel clast composition: intermediate volcanics, granite.
BWTP-135	1230-1240	Clayey coarse-grained sand to fine pebble gravel (40% gravel, 30% sand, 30% clay), moderately to poorly sorted, subangular to subrounded grains/clasts, mottled pale brown (10YR 6/3) and light reddish brown (5YR 6/4). Gravel clast composition: intermediate volcanics, granite.
BWTP-136	1240-1250	Clayey coarse-grained sand to fine pebble gravel (40% gravel, 30% sand, 30% clay), moderately to poorly sorted, subangular to subrounded grains/clasts, mottled pale brown (10YR 6/3) and light reddish brown (5YR 6/4). Gravel clast composition: intermediate volcanics, granite.

Appendix A2: Photographs of Cuttings for the Bernalillo Waste Water Treatment Plant Piezometer Nest (BWWTP)



Appendix A2: Photographs of Cuttings for the Bernalillo Waste Water Treatment Plant Piezometer Nest (BWWTP)



Appendix A3: Summary of particle-size data for NMOSE-BWWTP. The sand and gravel fraction (10mm-0.053mm) determined by sieving material through a nest of sieves. The silt and clay fractions were measured using a hydrometer.

Mass (g) for each class (sieve).													
US Standard Sieve Nos.	4	10	20	40	60	80	100	140	200	270			
size (mm)	10mm	2mm	0.850m	0.425m	0.246m	0.180m	0.150m	0.106m	0.075m	0.053m	0.002m	0.001m	Total wt. (g)
SAMPLE (g)													
250-260	0.29	5.19	8.54	6.33	4.80	1.34	0.31	0.52	0.29	0.09	3.82	2.46	33.98
260-270	14.37	25.00	11.26	4.37	1.42	0.52	0.19	0.88	1.19	0.78	14.72	11.70	86.40
310-320	0.00	3.03	7.94	18.99	19.63	14.74	10.84	7.82	4.31	1.59	7.98	3.20	100.07
850-860	0.00	0.00	0.07	0.81	6.59	11.38	12.62	18.28	20.94	16.28	15.15	5.47	107.59
920-930	0.00	0.00	0.82	27.14	40.17	14.58	6.55	6.72	5.30	2.65	11.11	7.51	122.55
970-980	0.56	9.47	22.89	10.81	18.38	12.15	7.55	6.43	3.70	1.26	6.47	4.72	104.39
1130-1140	2.44	23.69	61.10	7.84	1.54	0.53	0.17	0.44	0.33	0.15	4.29	3.95	106.47
1170-1180	1.94	16.90	56.41	18.44	16.22	7.46	2.72	2.73	1.63	0.68	5.59	5.26	135.98
1180-1190	3.85	20.92	42.63	18.97	20.91	8.91	3.24	3.27	2.59	2.32	13.10	6.53	147.24
1240-1250	1.91	30.40	27.59	4.93	4.39	2.47	1.16	1.75	1.27	0.53	12.54	1.95	90.89

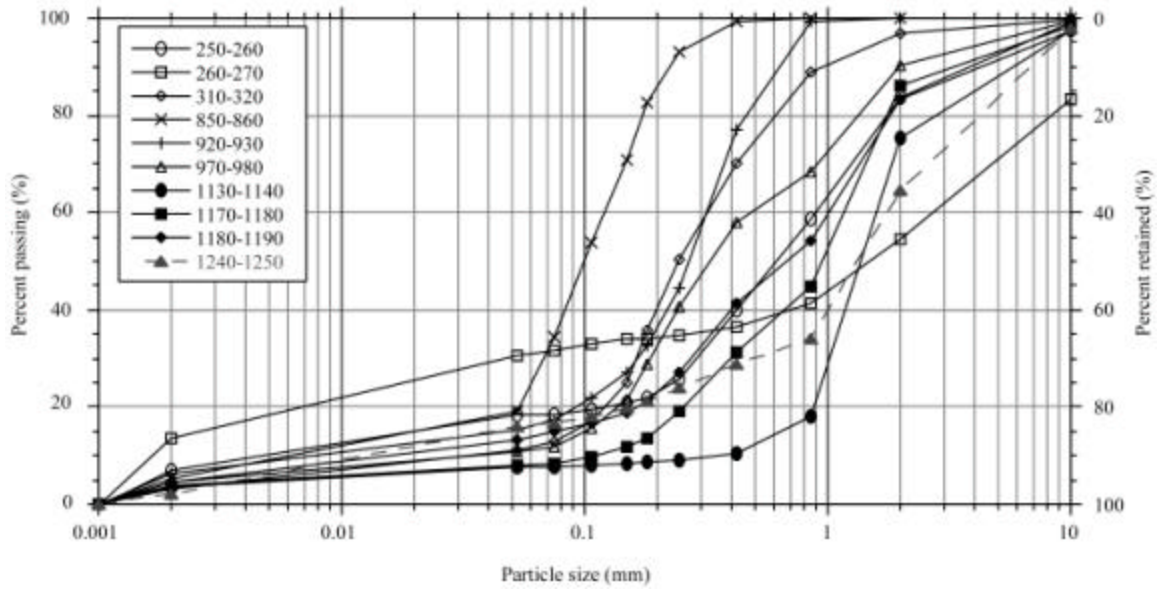
Weight-percent (%) for each class (sieve).

SAMPLE (%)	10mm	2mm	0.850m	0.425m	0.246m	0.180m	0.150m	0.106m	0.075m	0.053m	0.002m	0.001m	
	m	m	m	m	m	m	m	m	m	m	m	m	
250-260	0.9%	15.3%	25.2%	18.7%	14.2%	4.0%	0.9%	1.5%	0.9%	0.3%	11.3%	7.3%	
260-270	16.6%	28.9%	13.0%	5.1%	1.6%	0.6%	0.2%	1.0%	1.4%	0.9%	17.0%	13.5%	
310-320	0.0%	3.0%	7.9%	19.0%	19.6%	14.7%	10.8%	7.8%	4.3%	1.6%	8.0%	3.2%	
850-860	0.0%	0.0%	0.1%	0.8%	6.1%	10.6%	11.7%	17.0%	19.5%	15.1%	14.1%	5.1%	
920-930	0.0%	0.0%	0.7%	22.1%	32.8%	11.9%	5.3%	5.5%	4.3%	2.2%	9.1%	6.1%	
970-980	0.5%	9.1%	21.9%	10.4%	17.6%	11.6%	7.2%	6.2%	3.5%	1.2%	6.2%	4.5%	
1130-1140	2.3%	22.3%	57.5%	7.4%	1.4%	0.5%	0.2%	0.4%	0.3%	0.1%	4.0%	3.7%	
1170-1180	1.4%	12.4%	41.5%	13.6%	11.9%	5.5%	2.0%	2.0%	1.2%	0.5%	4.1%	3.9%	
1180-1190	2.6%	14.2%	29.0%	12.9%	14.2%	6.1%	2.2%	2.2%	1.8%	1.6%	8.9%	4.4%	
1240-1250	2.1%	33.4%	30.4%	5.4%	4.8%	2.7%	1.3%	1.9%	1.4%	0.6%	13.8%	2.1%	

Cumulative weight-percent (c%) for each class (sieve).

SAMPLE (c%)	10mm	2mm	0.850m	0.425m	0.246m	0.180m	0.150m	0.106m	0.075m	0.053m	0.002m	0.001m	
	m	m	m	m	m	m	m	m	m	m	m	m	
250-260	0.9%	16.2%	41.4%	60.1%	74.2%	78.2%	79.1%	80.6%	81.5%	81.8%	93.0%	100.3%	
260-270	16.6%	45.6%	58.6%	63.7%	65.3%	65.9%	66.1%	67.1%	68.5%	69.4%	86.5%	100.0%	
310-320	0.0%	3.0%	11.0%	29.9%	49.6%	64.3%	75.1%	82.9%	87.2%	88.8%	96.8%	100.0%	
850-860	0.0%	0.0%	0.1%	0.8%	6.9%	17.5%	29.2%	46.2%	65.7%	80.8%	94.9%	100.0%	
920-930	0.0%	0.0%	0.7%	22.8%	55.6%	67.5%	72.8%	78.3%	82.6%	84.8%	93.9%	100.0%	
970-980	0.5%	9.6%	31.5%	41.9%	59.5%	71.1%	78.4%	84.5%	88.1%	89.3%	95.5%	100.0%	
1130-1140	2.3%	24.6%	82.1%	89.5%	90.9%	91.4%	91.6%	92.0%	92.3%	92.4%	96.5%	100.2%	
1170-1180	1.4%	13.9%	55.3%	68.9%	80.8%	86.3%	88.3%	90.3%	91.5%	92.0%	96.1%	100.0%	
1180-1190	2.6%	16.8%	45.8%	58.7%	72.9%	78.9%	81.1%	83.3%	85.1%	86.7%	95.6%	100.0%	
1240-1250	2.1%	35.5%	65.9%	71.3%	76.2%	78.9%	80.2%	82.1%	83.5%	84.1%	97.9%	100.0%	

Bernalillo Waste Water Treatment Plant (NMOSE-BWWTP)



B1
**Preliminary Interpretations of the Lithostratigraphy,
Hydrostratigraphy, and Borehole Geophysics
of the Phoenix Road well site,
Rio Rancho, Sandoval County, New Mexico**

Introduction

This report summarizes the preliminary lithostratigraphy and hydrostratigraphy for the Phoenix Road monitoring well site. This well, completed in cooperation with the NM Office of the State Engineer (NMOSE), U.S. Geological Survey (Water Resources Division), and the New Mexico Bureau of Geology and Mineral Resources (NMBGMR), will be used to monitor groundwater conditions in the Rio Rancho area and to further characterize the Santa Fe Group regional aquifer in the Albuquerque Basin. Historical data for this monitoring well are summarized in Table 1. The well was drilled to a depth of 1685 feet in late October 1999. To minimize caving of unconsolidated sediments near the surface, the well was cased to 80 feet during drilling. Lithologic samples (cuttings) were taken at 5-foot intervals down to 80 feet and at 10-foot intervals there after. Borehole geophysical logs were run shortly after the target depth was attained. Borehole geophysical logs and cuttings were used to characterize the lithology of Santa Fe Group deposits encountered in this borehole and to provide qualitative estimates of the hydrogeologic character of the aquifer.

This lithologic log and report are submitted to the NMOSE as partial fulfillment of an intergovernmental service agreement with the NMBGMR, a division of the New Mexico Institute of Mining and Technology. The cuttings and geophysical logs used to prepare this report will be available for inspection at NMBGMR in Socorro, New Mexico. This report has not been reviewed according to NMBGMR standards. ***The contents of this report should not be considered final and complete until it is published by the NMBGMR.***

Table B1. Historical Data

Name:	Phoenix Rd
Location:	T13N, R1E, Section 24 Sandoval County, Sky Village SE 7.5 Minute Quad Latitude: 35°20'19" (35.3386) Longitude: 106°47'48" (106.7967) UTM: N: 3,911,876 m; E: 336,714 m, (Zone 13, NAD 83)
Elevation:	6,150 ft (1,874.52 m) above sea level
Drilling Method:	Mud Rotary
Drillers:	U.S. Geological Survey, Water Resources Division
Drill bit size:	12.25" in diameter (0-80 ft), 7.875" in diameter (80-1685 ft)
Drilling Start:	October 16, 1999
Drilling Completion:	November 3, 1999
Sample Interval:	5 ft for the upper 80 ft, 10 ft below that.
Screened Intervals:	1535-1685 ft below land surface (468-514 m)
Total Depth:	1685 ft (514 m)
Water Table:	1550 ft \pm 10 ft below land surface (472 m): based on borehole geophysical log data
Sample Logging:	P.B. Jackson (NMBGMR)
Geophysical Logging:	Gamma Ray, Neutron Porosity, Density Porosity, Caliper, Electric Log, Temperature, Sonic, Single Point Resistance (Spt Res), 16" Resistivity, 64" Resistivity, Spontaneous Potential (SP)
Geophysical Logs:	Southwest Geophysical Services, Inc.
Log Synthesis:	P.J. Paul & S.D. Connell (NMBGMR)

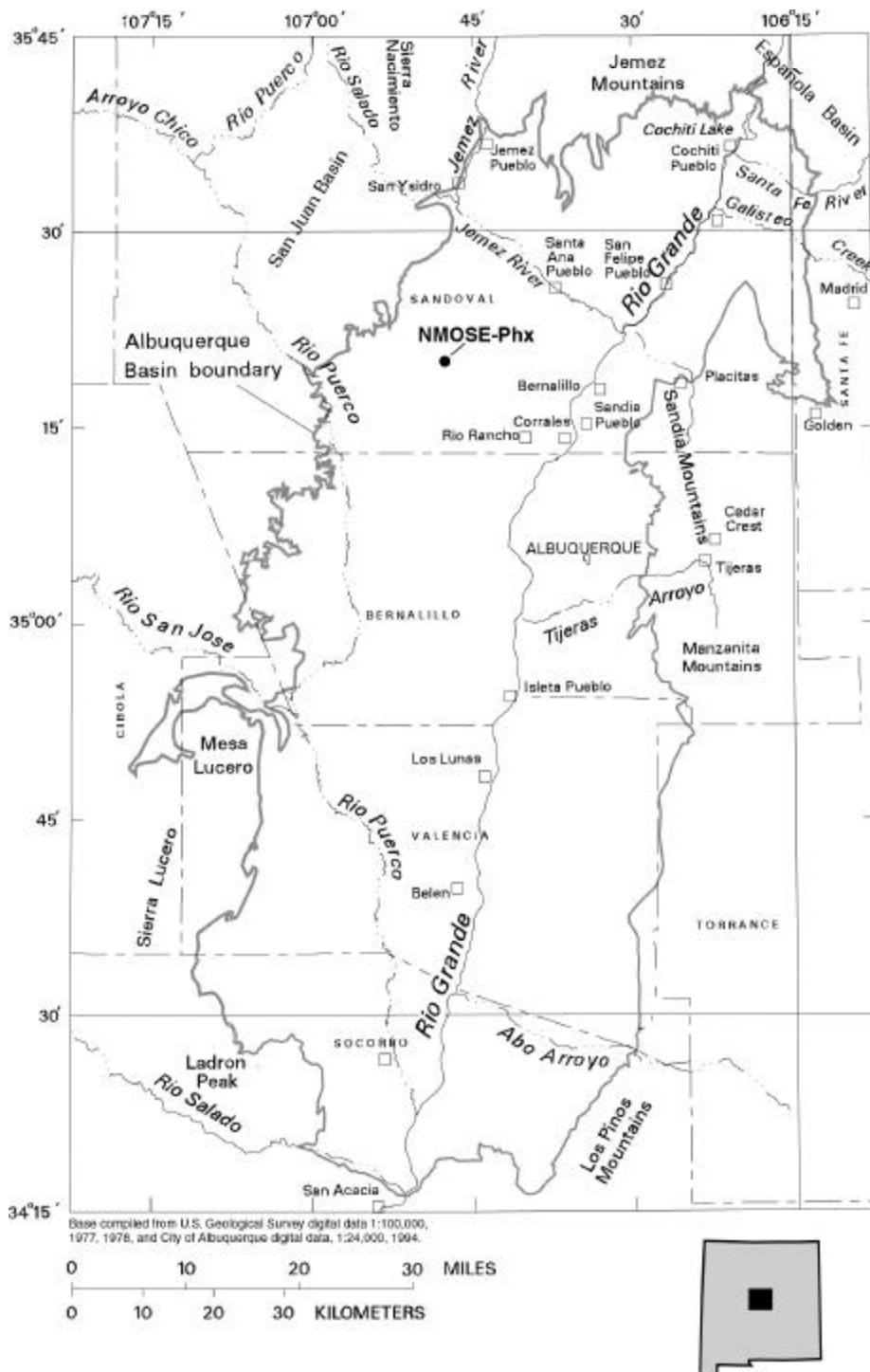


Figure B1. Index map showing the general location of the Phoenix Rd (NMOSE-Phx) monitoring well. Base map modified from Bexfield (1998).

Methods

Lithologic descriptions were made by visual examination of mud-rotary cuttings taken from the well head at 5 and 10-foot intervals (Appendix A). Drilling methods prevent a complete evaluation of the finer grained fraction (commonly fine-grained sand and silt) that tends to be held in suspension by the drilling fluids. Sieve testing was not conducted. Lithologic descriptions are based on the following criteria:

1. Major textural class;
2. Estimated grain-size distribution by major textural class:
 - a. silt-clay (<0.05 mm)
 - b. sand (0.05-2.00 mm)
 - c. gravel (>2.00 mm)
3. Grain and clast shape;
4. Sorting and approximate range of grain and clast size;
5. Clast composition and approximate relative abundance, in decreasing order of abundance;
6. Color, using Munsell (1992) notation;
7. Other characteristics and selected driller's comments.

Samples were placed into cuttings trays, photographed (Appendix B), and visually examined. Hydrostratigraphic subdivisions of the borehole were made using nomenclature developed for alluvial deposits in the Albuquerque Basin by Hawley and Whitworth (1996). In this system deposits are assigned to gravely and sandy fluvial (I-III), eolian (IV), piedmont (V-VIII), and fine-grained basin-floor/playa (IX-X) lithofacies (Table 2). These lithofacies are used to determine hydrostratigraphic units that are subdivided into post-Santa Fe Group and Santa Fe Group deposits. Post-Santa Fe Group units include fluvial-terrace deposits (RA and TA), and piedmont deposits (PA). Santa Fe Group hydrostratigraphic units consist of fluvial and piedmont deposits that are further subdivided into upper (USF), middle (MSF), and lower (LSF) sub-units (Table 3). These are further divided into subunits based on inferred sedimentary provenance: eastern margin piedmont (1), ancestral Rio Grande (2), western margin alluvial (3), and western margin fluvial (4) deposits.

Table B2. Summary of lithofacies assigned to textural units of the regional Santa Fe Group aquifer, and shallow post-Santa Fe Group aquifer (modified from Hawley and Whitworth, 1996).

Lithofacies	Textural Unit	Interpreted Depositional Setting
<i>Shallow</i>	<i>Post-Santa Fe Group aquifer</i>	
A1	Pebble to cobble gravel and sand	River-valley basal channel fluvial deposits
A2	Sand and pebbly sand	River-valley braid-plain fluvial deposits
A3	Silty clay, clay, and sand	Overbank meander belt or oxbow deposits
B	Sand, gravel, silt, and clay (similar to lithofacies V)	Arroyo channel and valley border alluvial fan deposits
<i>Regional</i>	<i>Santa Fe Group aquifer</i>	
I	Coarse-grained sand and pebble gravel with minor silt/clay.	Basin-floor fluvial braid plain
II	Fine to coarse-grained sand with lenses of pebbly sand and silty clay.	Basin-floor fluvial and local eolian
III	Interbedded sand and silty clay with lenses of pebbly/granular fine to coarse-grained sand.	Basin-floor fluvial and local eolian
IV	Sand and sandstone with lenses of silty sand to clay.	Mostly eolian
V	Gravel, sand, silt and clay with sand-silt-clay lenses.	a) Distal to medial piedmont-slope alluvial fan deposits associated with large watersheds b) Distal to medial piedmont-slope alluvial fan deposits associated with steep drainages
VI	Coarse gravelly, loamy sand to sandy loam with lenses of sand and cobble to boulder gravel.	a) see Va b) see Vb
VII	Partly indurated (cemented) equivalent of lithofacies V.	See V
VIII	Partly indurated (cemented) equivalent of lithofacies VI.	See VI
IX	Silty clay interbedded with sand, silty sand, or clay.	Basin-floor playa-lake, alluvial-flat, and distal piedmont-slope
X	Partly indurated equivalent of lithofacies IX.	See IX

Table B3. Summary of hydrostratigraphic units in the Albuquerque Basin (modified from Hawley and Whitworth, 1996).

Hydrostratigraphic Unit (<i>subunit</i>)	Description
<i>Post-Santa Fe Group Aquifer</i>	
RA	Channel, floodplain and lower river terrace alluvial deposits of the modern Rio Grande and Puerco valleys; typically =120 ft thick; Holocene to late Pleistocene in age. Lithofacies A comprises much of this unit.
VA	Tributary-arroyo channel, fan and terrace alluvial deposits in areas bordering inner valleys of the Rio Grande system; = 100 ft thick; Holocene to early(?) or middle Pleistocene in age. Lithofacies B comprises much of this unit. Subdivided into hydrostratigraphic units VAY and VAO.
	VAY Younger valley border alluvial fans in major arroyo systems.
	VAO Remnants of older arroyo valley fill deposits.
TA	Channel and floodplain deposits of the ancestral Rio Grande fluvial system (including the Rio Jemez/Guadalupe, Rio Puerco, Rio San Jose, Rio Salado, Santa Fe River, and Jemez River) deposited during a series of at least four stages of valley entrenchment and partial backfilling. Commonly forms =100-ft thick deposits that unconformably overlie hydrostratigraphic units of USF, MSF, and locally MSF. Basal contacts are erosional and range from 50 ft below, to 250 ft above, the present floor of the Rio Grande and Rio Puerco; Holocene to early(?) or middle Pleistocene in age. Lithofacies A1-A2 comprise much of this unit.
PA	Coalescing alluvial fan and piedmont deposits extending basinward from the fronts of the Sandia, Manzanita, and Manzano Mountains on the eastern and southwestern margins of the Albuquerque Basin. Includes deposits of the ancestral Tijeras arroyo and mountain-front pediments. Deposits are commonly = 150 ft thick; Holocene to middle Pleistocene in age; Lithofacies V and VI commonly comprise this unit. Locally divided into two subunits.
	PAY Younger (late Pleistocene and Holocene) alluvial deposits on upper piedmont slopes flanking the Sandia and Manzano Mountains.
	PAO Older (middle Pleistocene) alluvial deposits flanking the Sandia and Manzano Mountains.

Table B3. Continued.

Hydrostratigraphic Unit (<i>subunit</i>)	Description
<i>Regional Santa Fe Group Aquifer</i>	
USF	<p>Ancestral Rio Grande and Rio Puerco deposits that interfinger with piedmont-alluvial facies deposits towards the basin margins with volcanic rocks (commonly a mixture of basalt, andesite, rhyolite) and thin eolian deposits present in local areas. Commonly = 1000 ft thick, but locally exceeds 1500 ft in thickness; early Pleistocene to late Miocene (primarily Pliocene) in age; lithofacies I, II, III, V, VI, VII, VIII, IX, X.</p>
	<ol style="list-style-type: none"> 1 Alluvial deposits derived from rift flanking uplifts along the eastern margin of the Albuquerque Basin, including the Sandia, Manzanita, and Manzano Mountains. 2 Basin-floor fluvial deposits of the ancestral Rio Grande. Locally interbedded fine to medium-grained alluvial, lacustrine, or eolian deposits. 3 Alluvial deposits derived from rift flanking uplifts along the western margin of the Albuquerque Basin, including the Lucero uplift and the Ladron Mountains. 4 Basin-floor fluvial deposits of the ancestral Rio Jemez/Guadalupe, Rio Puerco, Rio San Jose, and Rio Salado. Underlies much of the Llano de Albuquerque, the topographic divide between the Rio Grande and Rio Puerco valleys. Derived from the Sierra Nacimiento and Colorado Plateau.
MSF	<p>Alluvial, eolian, and playa-lake deposits (MSF-2, 4). Partly indurated piedmont alluvium (MSF-1, 3) interfingers basinward with basin-floor deposits of MSF-2, 4; basaltic and silicic volcanic rocks locally present; in the southwest portion of the basin may be more than 10,000 ft in thickness; in the central portion of the basin deposits may be more than 5,000 ft thick; late to middle Miocene in age; lithofacies III, IV, V, VI, VII, VIII, IX, X.</p>
	<ol style="list-style-type: none"> 1 Piedmont alluvium derived from emergent rift flanking uplifts along the eastern margin of the Albuquerque Basin, including the Sandia, Manzano, and Manzanita Mountains. 2 Basin-floor sediments of mixed (alluvial, lacustrine, and/or eolian) origin. Contains deposits of possible ancestral Rio Grande origin. 3 Alluvial deposits derived from emergent rift flanking uplifts along the western margin of the Albuquerque Basin, including the Sierra Lucero, and the Ladron Mountains. 4 Basin-floor fluvial deposits of the ancestral Rio Jemez/Guadalupe, Rio Puerco, Rio San Jose, and Rio Salado. Underlies much of the Llano de Albuquerque, the topographic divide between the Rio Grande and Rio Puerco valleys. Derived from the Sierra Nacimiento and Colorado Plateau.
LSF	<p>Eolian, alluvial, and playa-lake basin-floor deposits interbedded with piedmont deposits near basin margins; generally =3500 ft thick in the central basin; middle Miocene to late Oligocene in age; lithofacies III, IV, VII-X.</p>

Lithostratigraphy and Hydrostratigraphy

Major textural and lithologic units encountered in the well are graphically displayed on Figure 2 and described in Table 4. Figure 2 also illustrates geophysical logs for the well and the various correlations between the geophysical and lithologic logs. Geophysical interpretations shown on the graphic log of Figure 2 are based on the integration of the lithologic and geophysical data. Correlation and nomenclature are generally consistent with the Arroyo Ojito Formation. Based on the geophysical data the water table is placed between 4995 ± 5 feet above sea level. The Rio Grande, approximately 11 miles northwest of the site, is at an elevation of 5050 ± 5 feet above sea level (Bernalillo 7.5 Minute Quadrangle, U.S.G.S., 1954). This would then suggest that the water table gently slopes west away from the river.

The upper 720 feet of this well primarily consists of silty fine to medium-grained sand. The dominant lithofacies (II) is composed of basin-floor fluvial deposits of sand with lenses of pebbly sand and silty clay. Lithofacies units III and I have been included to indicate zones where there are more gravelly (I) or silty/clayey (II) lenses present. At 180 feet below the ground surface, there is a 50-foot gravel layer. This is only significant gravelly facies in the well cuttings. Another minor 10-15 foot gravel lens occurs 30 feet below the surface. At 290 feet, there is a distinct reddish brown silty clay lens, approximately 20 feet thick. Overall this package of sediment is poorly to moderately sorted, with grain shape ranging from subangular to subrounded. Where gravel clasts are present, their composition listed in order of abundance is red granite, quartzite, rhyolitic volcanics, mudstone and scarce pieces of pumice. Based on these preliminary observations, this interval's lithology most closely resembles that of the Loma Barbon Member of the Arroyo Ojito Formation of Connell et al (1999).

At 720 feet there is a distinct change from a sandy to a more silty, finer-grained lithology. This transition marks the boundary between Upper and Middle Santa Fe hydrostratigraphic units. The samples from 720 to 1470 feet are cemented, moderately sorted, subrounded, fine-grained sand and silt. At 1490 there is a color change from pinkish white to very pale brown. This lowest unit represents basin-floor alluvial deposition and may correlate to the Navajo Draw Member, the lowest member of the Arroyo Ojito Formation. At the type section measured by Connell et al (1999), the

Navajo Draw Member contains 229 m of pale-brown to pale-yellow, poorly to moderately sorted, fine to coarse-grained sandstone and pebbly sandstone with minor mudstone interbeds. The upper contact of this member is conformable and overlain by reddish-yellow to brown sandstone and granite bearing pebbly sandstone similar to what was observed in the cutting samples from this site.

From 1600 feet to the bottom of the well (1680 feet), the lithology is that of well-cemented, fine-grained, sandy silt similar to that between 720 and 1470 feet. However, the color becomes paler, going from pale brown to pinkish white. This is due to a much higher carbonate cement content. The pinkish tinge is from the minor presence of clay lenses and films. The grains are subrounded and the grain sorting is moderate. This unit may correlate to the Cerro Conejo Member of the upper Zia Formation. The Cerro Conejo Member is currently thought to be a transitional unit between the more eolian deposits of the lower Zia Formation and the overlying fluvial deposits of the Arroyo Ojito Formation. The cuttings examined for this location do not appear to be eolian but rather fluvial. This is based on grain shape and sorting. Eolian deposits tend to exhibit more rounding of grains and better sorting. Grains are often frosted in eolian deposits as well. Little to no frosting was observed in these samples.

Table B4. Summary and Interpretation of major textural units in the Phoenix Road well. Depth is in feet below land surface (bls). Details of lithologic descriptions are in Appendix A. Gravel and sand composition are based on visual estimates of cuttings and are listed in decreasing order of abundance.

<u>Depth (ft)</u>	<u>Summary</u>
0-720	Fluvial deposits of the Loma Barbon Member of the Arroyo Ojito Formation (USF 2-4): of silty fine- to medium-grained sand with some gravelly interbeds, poorly to moderately sorted, subangular to subrounded grains and gravel clasts. Gravel clast composition: red granite, quartzite, rhyolitic volcanics, mudstone and scarce pieces of pumice. Color is pinkish gray to brown (7.5YR 7/2-5/4). Lithofacies I, II, and III.
720-1600	Alluvial deposits of the Navajo Draw Member of the Arroyo Ojito Formation (MSF 2-4): cemented, moderately sorted, subrounded, fine-grained sand and silt, very pale brown (10YR 7/3) to pinkish white (7.5YR 8/2). Lithofacies II and III.
1600-1680	Eolian deposits of the Cerro Conejo Member (?) of the Zia Formation (Hydrostratigraphic unit LSF): moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2) to pale brown (10 YR 6/3). Lithofacies IV.

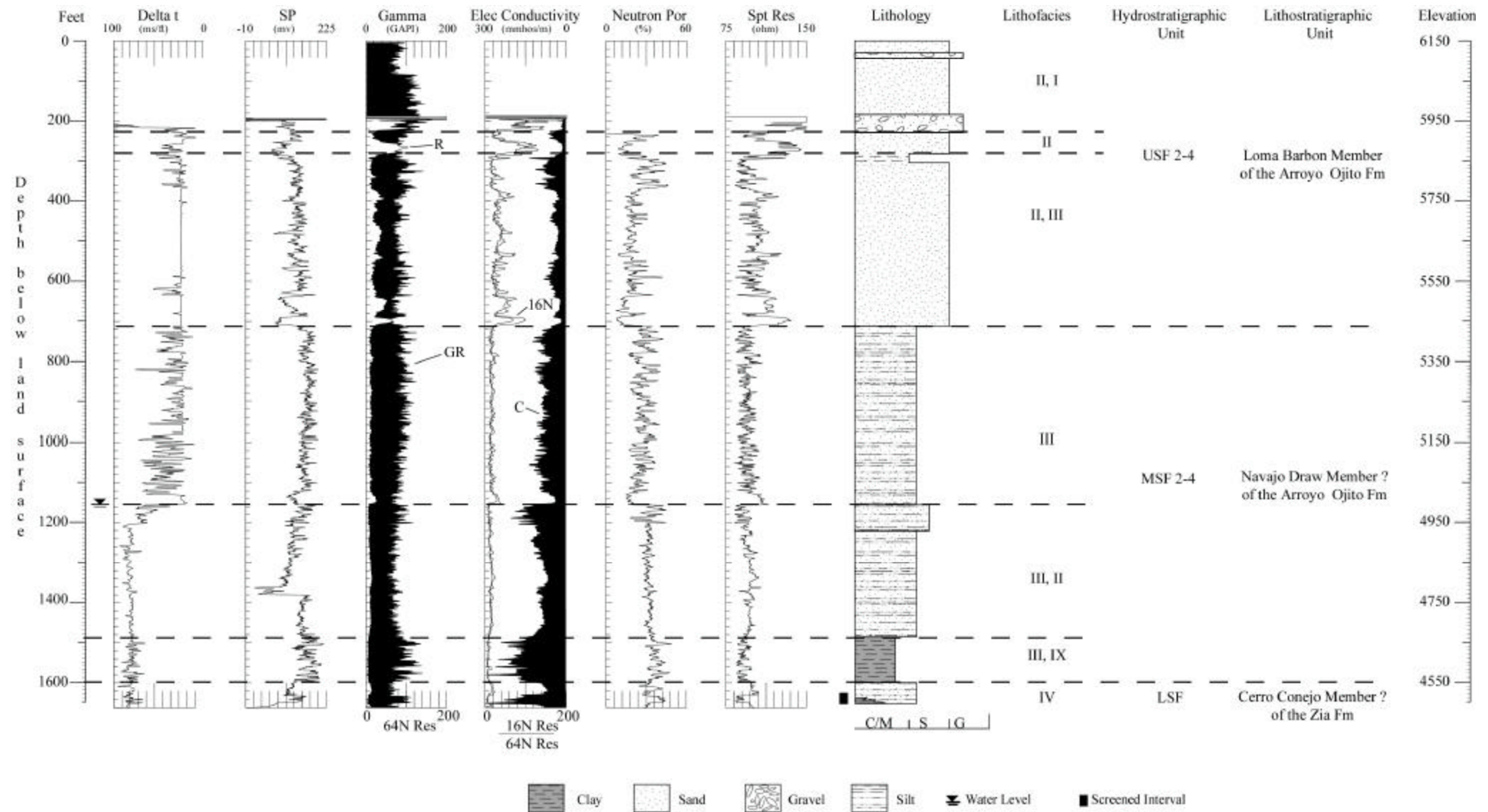


Figure B2. Geophysical data logs, lithologic column, and preliminary hydrostratigraphic and lithostratigraphic interpretations.

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Appendix B1. Lithologic descriptions of cuttings from the Phoenix Road (PR) monitoring well site. Depth intervals are measured in feet below land surface (bls).

Sample No.	Depth Interval (ft, bls)	Description
RR-PHX-1	0-5	Cemented fine to medium-grained sand (100% sand), well sorted, subrounded to rounded grains, brown (7.5YR 5/4).
RR-PHX-2	5-10	Cemented fine to medium-grained sand (100% sand), well sorted, subrounded to rounded grains, brown (7.5YR 5/4).
RR-PHX-3	10-15	Cemented fine to medium-grained sand (100% sand), well sorted, subrounded to rounded grains, brown (7.5YR 5/4).
RR-PHX-4	15-20	Cemented fine to medium-grained sand (100% sand), well sorted, subrounded to rounded grains, brown (7.5YR 5/4).
RR-PHX-5	20-25	Cemented fine to medium-grained sand with minor clay (95% sand, 5% clay), well sorted, subrounded to rounded grains, brown (7.5YR 5/4).
RR-PHX-6	25-30	Cemented fine to medium-grained sand with minor clay (95% sand, 5% clay), well sorted, subrounded to rounded grains, brown (7.5YR 5/4).
RR-PHX-7	30-35	Very coarse-grained sand and pebble gravel (70% sand, 30% gravel), moderately sorted, angular to subangular, pinkish gray (7.5YR 7/2). Gravel clast composition: granite, quartzite, rhyolitic volcanics, mudstone, trace pumice.
RR-PHX-8	35-40	Very coarse-grained sand and pebble gravel (70% sand, 30% gravel), moderately sorted, angular to subangular, pinkish gray (7.5YR 7/2). Gravel clast composition: granite, quartzite, rhyolitic volcanics, mudstone, trace pumice.
RR-PHX-9	40-45	Silty fine to very coarse-grained sand with scattered pebbles (70% sand, 15% silt, 15% gravel), poorly sorted, subangular grains, pinkish gray to brown (7.5YR 7/2-5/4). Gravel clast composition: granite, quartzite, rhyolitic volcanics, mudstone, trace pumice.
RR-PHX-10	45-50	Silty fine-grained sand (80% sand, 20% silt), well sorted, subrounded grains, brown (7.5YR 5/4).
RR-PHX-11	50-55	Silty fine-grained sand (80% sand, 20% silt), well sorted, subrounded grains, brown (7.5YR 5/4).
RR-PHX-12	55-60	Silty fine-grained sand (80% sand, 20% silt), well sorted, subrounded grains, brown (7.5YR 5/4).
RR-PHX-13	60-65	Silty fine-grained sand (80% sand, 20% silt), well sorted, subrounded grains, brown (7.5YR 5/4).
RR-PHX-14	65-70	Silty fine-grained sand (80% sand, 20% silt), well sorted, subrounded grains, brown (7.5YR 5/4).
RR-PHX-15	70-75	Silty fine-grained sand (80% sand, 20% silt), well sorted, subrounded grains, brown (7.5YR 5/4).
RR-PHX-16	75-80	Silty fine-grained sand (80% sand, 20% silt), well sorted, subrounded grains, brown (7.5YR 5/4).
RR-PHX-17	80-90	Silty fine-grained sand (80% sand, 20% silt), well sorted, subrounded grains, brown (7.5YR 5/4).

RR-PHX-18	90-100	Silty fine-grained sand (80% sand, 20% silt), well sorted, subrounded grains, brown (7.5YR 5/4).
RR-PHX-19	100-110	Silty fine-grained sand (80% sand, 20% silt), well sorted, subrounded grains, brown (7.5YR 5/4).
RR-PHX-20	110-120	Silty fine-grained sand (80% sand, 20% silt), well sorted, subrounded grains, brown (7.5YR 5/4).
RR-PHX-21	120-130	Silty fine-grained sand (80% sand, 20% silt), well sorted, subrounded grains, brown (7.5YR 5/4).
RR-PHX-22	130-140	Silty fine-grained sand (80% sand, 20% silt), well sorted, subrounded grains, brown (7.5YR 5/4).
RR-PHX-23	140-150	Silty fine-grained sand (80% sand, 20% silt), well sorted, subrounded grains, brown (7.5YR 5/4).
RR-PHX-24	150-160	Silty fine to very coarse-grained sand with scattered pebbles (70% sand, 15% silt, 15% gravel), poorly sorted, subangular grains, pinkish gray to brown (7.5YR 7/2-5/4). Gravel clast composition: granite, quartzite, rhyolitic volcanics, mudstone, trace pumice.
RR-PHX-25	160-170	Cemented silty fine-grained sand (80% sand, 20% silt), well sorted, subrounded grains, brown (7.5YR 5/4).
RR-PHX-26	170-180	Silty fine-grained sand (80% sand, 20% silt), well sorted, subrounded grains, brown (7.5YR 5/4).
RR-PHX-27	180-190	Very coarse-grained sand and pebble gravel (70% sand, 30% gravel), moderately sorted, angular to subangular, pinkish gray (7.5YR 7/2). Gravel clast composition: granite, quartzite, rhyolitic volcanics, mudstone, trace pumice.
RR-PHX-28	190-200	Very coarse-grained sand and pebble gravel (70% sand, 30% gravel), moderately sorted, angular to subangular, pinkish gray (7.5YR 7/2). Gravel clast composition: granite, quartzite, rhyolitic volcanics, mudstone, trace pumice.
RR-PHX-29	200-210	Very coarse-grained sand and pebble gravel (70% sand, 30% gravel), moderately sorted, angular to subangular, pinkish gray (7.5YR 7/2). Gravel clast composition: granite, quartzite, rhyolitic volcanics, mudstone, trace pumice.
RR-PHX-30	210-220	Silty very coarse-grained sand and pebble gravel (50% sand, 40% gravel, 10% silt), moderately sorted, angular to subangular, pinkish gray (7.5YR 7/2). Gravel clast composition: granite, quartzite, rhyolitic volcanics, mudstone, trace pumice.
RR-PHX-31	220-230	Silty very coarse-grained sand and pebble gravel (50% sand, 40% gravel, 10% silt), moderately sorted, angular to subangular, pinkish gray (7.5YR 7/2). Gravel clast composition: granite, quartzite, rhyolitic volcanics, mudstone, trace pumice.
RR-PHX-32	230-240	Silty/clayey fine-grained sand (80% sand, 20% silt/ clay), moderately sorted, subrounded grains, brown (7.5YR 5/4).
RR-PHX-33	240-250	Silty/clayey fine-grained sand (80% sand, 20% silt/ clay), moderately sorted, subrounded grains, brown (7.5YR 5/4).
RR-PHX-34	250-260	Silty/clayey fine-grained sand (80% sand, 20% silt/ clay), moderately sorted, subrounded grains, brown (7.5YR 5/4).
RR-PHX-35	260-270	Silty/clayey fine-grained sand (80% sand, 20% silt/ clay), moderately sorted, subrounded grains, brown (7.5YR 5/4).

RR-PHX-36	270-280	Silty/clayey fine-grained sand (80% sand, 20% silt/ clay), moderately sorted, subrounded grains, brown (7.5YR 5/4).
RR-PHX-37	280-290	Silty/clayey fine-grained sand(80% sand, 20% silt/ clay), moderately sorted, subrounded grains, brown (7.5YR 5/4).
RR-PHX-38	290-300	Silty clay (95% silt/clay, 5% fine-grained sand), moderately to well sorted, reddish brown (2.5YR 4/4).
RR-PHX-39	300-310	Silty clay (95% silt/clay, 5% fine-grained sand), moderately to well sorted, reddish brown (2.5YR 4/4).
RR-PHX-40	310-320	Silt and fine-grained sand with minor clay (50% silt, 45% sand, 5% clay), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-41	320-330	Silt and fine-grained sand with minor clay (50% silt, 45% sand, 5% clay), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-42	330-340	Silt and fine-grained sand with minor clay (50% silt, 45% sand, 5% clay), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-43	340-350	Silt and fine-grained sand with minor clay (50% silt, 45% sand, 5% clay), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-44	350-360	Silt and fine-grained sand with minor clay (50% silt, 45% sand, 5% clay), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-45	360-370	Silt and fine-grained sand with minor clay (50% silt, 45% sand, 5% clay), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-46	370-380	Silt and fine-grained sand with minor clay (50% silt, 45% sand, 5% clay), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-47	380-390	Silt and fine-grained sand with minor clay (50% silt, 45% sand, 5% clay), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-48	390-400	Silt and fine-grained sand with minor clay (50% silt, 45% sand, 5% clay), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-49	400-410	Silt and fine-grained sand with minor clay (50% silt, 45% sand, 5% clay), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-50	410-420	Silt and fine-grained sand with minor clay (50% silt, 45% sand, 5% clay), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-51	420-430	Silt and fine-grained sand with minor clay (50% silt, 45% sand, 5% clay), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-52	430-440	Silt and fine-grained sand with minor clay (50% silt, 45% sand, 5% clay), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-53	440-450	Silt, fine-grained sand, clay (40% silt, 40% sand, 20% clay), moderately sorted, subrounded grains, pink (7.5YR 7/4).

RR-PHX-54	450-460	Silt, fine-grained sand, clay (40% silt, 40% sand, 20% clay), moderately sorted, subrounded grains, pink (7.5YR 7/4).
RR-PHX-55	460-470	Silt, fine-grained sand, clay (40% silt, 40% sand, 20% clay), moderately sorted, subrounded grains, pink (7.5YR 7/4).
RR-PHX-56	470-480	Silt, fine-grained sand, clay (50% silt, 45% sand, 5% clay), moderately sorted, subrounded grains, pinkish gray (7.5YR 7/2).
RR-PHX-57	480-490	Silt, fine-grained sand, clay (50% silt, 45% sand, 5% clay), moderately sorted, subrounded grains, pinkish gray (7.5YR 7/2).
RR-PHX-58	490-500	Silt, fine-grained sand, clay (50% silt, 45% sand, 5% clay), moderately sorted, subrounded grains, pinkish gray (7.5YR 7/2).
RR-PHX-59	500-510	Silt, fine-grained sand, clay (50% silt, 45% sand, 5% clay), moderately sorted, subrounded grains, pinkish gray (7.5YR 7/2).
RR-PHX-60	510-520	Silt, fine-grained sand, clay (50% silt, 45% sand, 5% clay), moderately sorted, subrounded grains, pinkish gray (7.5YR 7/2).
RR-PHX-61	520-530	Silt, fine-grained sand (50% silt, 50% sand), moderately sorted, subrounded grains, pink (7.5YR 7/4).
RR-PHX-62	530-540	Silt, fine-grained sand (50% silt, 50% sand), moderately sorted, subrounded grains, pink (7.5YR 7/4).
RR-PHX-63	540-550	Silt, fine-grained sand (50% silt, 50% sand), moderately sorted, subrounded grains, pink (7.5YR 7/4).
RR-PHX-64	550-560	Silt, fine-grained sand (50% silt, 50% sand), moderately sorted, subrounded grains, pink (7.5YR 7/4).
RR-PHX-65	560-570	Silt, fine-grained sand (50% silt, 50% sand), moderately sorted, subrounded grains, pink (7.5YR 7/4).
RR-PHX-66	570-580	Silt, fine-grained sand (50% silt, 50% sand), moderately sorted, subrounded grains, pink (7.5YR 7/4).
RR-PHX-67	580-590	Silt, fine-grained sand (50% silt, 50% sand), moderately sorted, subrounded grains, pink (7.5YR 7/4).
RR-PHX-68	590-600	Silt, fine-grained sand (50% silt, 50% sand), moderately sorted, subrounded grains, pink (7.5YR 7/4).
RR-PHX-69	600-610	Silt, fine-grained sand (50% silt, 50% sand), moderately sorted, subrounded grains, pink (7.5YR 7/4).
RR-PHX-70	610-620	Silt, fine-grained sand (50% silt, 50% sand), moderately sorted, subrounded grains, pink (7.5YR 7/4).
RR-PHX-71	620-630	Silt, fine-grained sand (50% silt, 50% sand), moderately sorted, subrounded grains, pink (7.5YR 7/4).
RR-PHX-72	630-640	Silt, fine-grained sand (50% silt, 50% sand), moderately sorted, subrounded grains, pink (7.5YR 7/4).
RR-PHX-73	640-650	Silt, fine-grained sand (50% silt, 50% sand), moderately sorted, subrounded grains, pink (7.5YR 7/4).
RR-PHX-74	650-660	Silt, fine-grained sand (50% silt, 50% sand), moderately sorted, subrounded grains, pink (7.5YR 7/4).
RR-PHX-75	660-670	Silt, fine-grained sand (50% silt, 50% sand), moderately sorted, subrounded grains, pink (7.5YR 7/4).
RR-PHX-76	670-680	Silt, fine-grained sand (50% silt, 50% sand), moderately sorted, subrounded grains, pink (7.5YR 7/4).
RR-PHX-77	680-690	Silt, fine-grained sand (50% silt, 50% sand), moderately sorted, subrounded grains, pink (7.5YR 7/4).
RR-PHX-78	690-700	Silt, fine-grained sand (50% silt, 50% sand), moderately sorted, subrounded grains, pink (7.5YR 7/4).

RR-PHX-79	700-710	No sample.
RR-PHX-80	710-720	Silt, fine-grained sand (50% silt, 50% sand), moderately sorted, subrounded grains, pink (7.5YR 7/4).
RR-PHX-81	720-730	Sandy silt (80% silt, 20% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-82	730-740	Sandy silt (80% silt, 20% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-83	740-750	Sandy silt (80% silt, 20% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-84	750-760	Sandy silt (80% silt, 20% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-85	760-770	Sandy silt (80% silt, 20% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-86	770-780	Sandy silt (80% silt, 20% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-87	780-790	Sandy silt (80% silt, 20% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-88	790-800	Silty sand (60% fine-grained sand, 40% silt), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-89	800-810	Silty sand (60% fine-grained sand, 40% silt), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-90	810-820	Silty sand (60% fine-grained sand, 40% silt), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-91	820-830	Silty sand (60% fine-grained sand, 40% silt), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-92	830-840	Sandy silt (75% silt, 25% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-93	840-850	Sandy silt (75% silt, 25% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-94	850-860	Sandy silt (75% silt, 25% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-95	860-870	Sandy silt (75% silt, 25% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-96	870-880	Sandy silt (80% silt, 20% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-97	880-890	Sandy silt (80% silt, 20% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-98	890-900	Sandy silt (80% silt, 20% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-99	900-910	Sandy silt (80% silt, 20% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-100	910-920	Sandy silt (80% silt, 20% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-101	920-930	Sandy silt (80% silt, 20% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-102	930-940	Sandy silt (60% silt, 40% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-103	940-950	Sandy silt (60% silt, 40% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-104	950-960	Sandy silt (60% silt, 40% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).

RR-PHX-105	960-970	Sandy silt (80% silt, 20% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-106	970-980	Sandy silt (80% silt, 20% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-107	980-990	Sandy silt (80% silt, 20% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-108	990-1000	Sandy silt (80% silt, 20% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-109	1000-1010	Sandy silt (80% silt, 20% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-110	1010-1020	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-111	1020-1030	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-112	1030-1040	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-113	1040-1050	No sample.
RR-PHX-114	1050-1060	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-115	1060-1070	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-116	1070-1080	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-117	1080-1090	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-119	1100-1110	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-120	1110-1120	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-121	1120-1130	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-122	1130-1140	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-123	1140-1150	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-124	1150-1160	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).

RR-PHX-125	1160-1170	Silt, fine-grained sand, clay (50% silt, 45% sand, 5% clay), moderately sorted, subrounded grains, pinkish gray (7.5YR 7/2).
RR-PHX-126	1180-1190	Silt, fine-grained sand, clay (50% silt, 45% sand, 5% clay), moderately sorted, subrounded grains, pinkish gray (7.5YR 7/2).
RR-PHX-127	1190-1200	Silt, fine-grained sand, clay (50% silt, 45% sand, 5% clay), moderately sorted, subrounded grains, pinkish gray (7.5YR 7/2).
RR-PHX-128	1190-1200	No sample.
RR-PHX-129	1200-1210	Silt, fine-grained sand, clay (50% silt, 45% sand, 5% clay), moderately sorted, subrounded grains, pinkish gray (7.5YR 7/2).
RR-PHX-130	1210-1220	Silt, fine-grained sand, clay (50% silt, 45% sand, 5% clay), moderately sorted, subrounded grains, pinkish gray (7.5YR 7/2).
RR-PHX-131	1220-1230	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-132	1230-1240	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-133	1240-1250	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-134	1250-1260	Sandy silt (75% silt, 25% fine-grained sand), moderately sorted, subrounded grains, well cemented, pinkish white (7.5YR 8/2).
RR-PHX-135	1260-1270	Sandy silt (75% silt, 25% fine-grained sand), moderately sorted, subrounded grains, well cemented, pinkish white (7.5YR 8/2).
RR-PHX-136	1270-1280	Sandy silt (75% silt, 25% fine-grained sand), moderately sorted, subrounded grains, well cemented, pinkish white (7.5YR 8/2).
RR-PHX-137	1280-1290	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-138	1290-1300	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-139	1300-1310	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-140	1310-1320	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-141	1320-1330	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-142	1330-1340	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-143	1340-1350	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-144	1350-1360	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).

RR-PHX-145	1360-1370	Sandy silt (75% silt, 25% fine-grained sand), moderately sorted, subrounded grains, well cemented, pinkish white (7.5YR 8/2).
RR-PHX-146	1370-1380	Sandy silt (75% silt, 25% fine-grained sand), moderately sorted, subrounded grains, well cemented, pinkish white (7.5YR 8/2).
RR-PHX-147	1380-1390	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-148	1390-1400	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-149	1400-1410	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-150	1410-1420	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-151	1420-1430	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-152	1430-1440	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-153	1440-1450	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-154	1450-1460	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-155	1460-1470	Sandy silt (75% silt, 25% fine-grained sand), moderately sorted, subrounded grains, well cemented, pinkish white (7.5YR 8/2).
RR-PHX-155	1460-1470	Sandy silt (75% silt, 25% fine-grained sand), moderately sorted, subrounded grains, well cemented, pinkish white (7.5YR 8/2).
RR-PHX-156	1470-1480	Sandy silt (80% silt, 20% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-157	1480-1490	Sandy silt (80% silt, 20% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-158	1490-1500	Sandy silt (80% silt, 20% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-159	1500-1510	Sandy silt (80% silt, 20% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-160	1510-1520	Sandy silt (80% silt, 20% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-161	1520-1530	Sandy silt (80% silt, 20% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-162	1530-1540	Sandy silt (80% silt, 20% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-163	1540-1550	Sandy silt (80% silt, 20% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-164	1550-1560	Sandy silt (80% silt, 20% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).

RR-PHX-165	1560-1570	Sandy silt (80% silt, 20% fine-grained sand), moderately sorted, subrounded grains, very pale brown (10YR 7/3).
RR-PHX-167	1570-1580	Silt/clay and fine-grained sand (50% silt/clay, 50% sand) moderately to poorly sorted, subrounded grains, pale brown (10 YR 6/3).
RR-PHX-168	1580-1590	Silt/clay and fine-grained sand (50% silt/clay, 50% sand) moderately to poorly sorted, subrounded grains, pale brown (10 YR 6/3).
RR-PHX-169	1590-1600	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-170	1600-1610	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-171	1610-1620	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-172	1620-1630	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-173	1630-1640	Silt/clay and fine-grained sand (50% silt/clay, 50% sand) moderately sorted, subrounded grains, pale brown (10 YR 6/3).
RR-PHX-174	1640-1650	Silt/clay and fine-grained sand (50% silt/clay, 50% sand) moderately sorted, subrounded grains, pale brown (10 YR 6/3).
RR-PHX-175	1650-1660	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-176	1660-1670	Silt, fine-grained sand, trace clay (70% silt, 25% sand, =5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white (7.5YR 8/2).
RR-PHX-177	1670-1680	Silty fine-grained sand and red clay (70% sand, 25% silt, 5% clay), moderately sorted, subrounded grains, moderately to well cemented, pinkish white sand and silt (7.5YR 8/2), red clay (2.5YR 4/6).

Appendix B2: Photographs of cuttings of the Phoenix Road monitoring well.



