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Date: August 1, 2003
Refer to: RRES-GPP-03-082

Mr. John Young, Corrective Action Project Leader
Permits Management Program
NMED – Hazardous Waste Bureau
2905 Rodeo Park Drive East
Building 1
Santa Fe, NM 87505-6303

RECEIVED
AUG 2003
NMED Hazardous Waste Bureau

SUBJECT: SAMPLING AND ANALYSIS PLAN (SAP) FOR THE DRILLING AND TESTING OF CHARACTERIZATION WELLS R-2, R-4, R-11, AND R-26

Dear Mr. Young:

Enclosed are two copies of the SAP for the Drilling and Testing of LANL Regional Aquifer Characterization Wells R-2, R-4, R-11, and R-26. We anticipate that the drilling portion of this work will begin on August 18, 2003.

Please provide any comments to John McCann at (505) 665-1091or Dave Broxton at (505) 667-2492 at your earliest possible convenience.

Sincerely,

for

Charles Nylander, Program Manager
Groundwater Protection Program
Los Alamos National Laboratory

Sincerely,

for

Mat Johansen, Project Manager
Program Compliance Manager
National Nuclear Security Admin.
Office of Los Alamos Site Operations

CN/MJ/th

Enclosure: SAP for Drilling and Testing Characterization Wells R-2, R-4, R-11, and R-26 (GPP-03-078/ ER2003-0470)

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July 2003
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GPP-03-078

SAP for Drilling and Testing Characterization Wells R-2, R-4, R-11, and R-26

Los Alamos
NATIONAL LABORATORY
Los Alamos NM 87545

Prepared by the Risk Reduction and Environmental Stewardship Division
Groundwater Protection Program

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List of Acronyms and Abbreviations

3-D	three-dimensional
ARS	American Radiation Services of New Mexico
ASTM	American Society for Testing and Materials
bgs	below ground surface
DOE	US Department of Energy
DQO	data quality objective
EDL	estimated detection limit
EES	Earth and Environmental Sciences
EPA	US Environmental Protection Agency
FSF	Field Support Facility
FTL	field team leader
FTM	field team manager
GEL	General Engineering Laboratory
IC	ion chromatography
LANL	Los Alamos National Laboratory
NAD83	North American Datum of 1983
NGR	natural gamma radiation
NMED	New Mexico Environment Department

NTU	nephelometric turbidity unit
QA	quality assurance
QP	quality procedure
RPF	Records Processing Facility
RRES-RS	Risk Reduction and Environmental Stewardship-Remediation Services
SAP	sampling and analysis plan
SMO	Sample Management Office
SOP	standard operating procedure
TA	technical area
TD	total depth
TL	team leader
WCSF	waste characterization strategy form
WWTP	wastewater treatment plant
XRD	x-ray diffraction spectroscopy
XRF	x-ray fluorescence analysis

Metric to US Customary Unit Conversions

Multiply SI (Metric) Unit	by	To Obtain US Customary Unit
kilometers (km)	0.622	miles (mi)
kilometers (km)	3281	feet (ft)
meters (m)	3.281	feet (ft)
meters (m)	39.37	inches (in.)
centimeters (cm)	0.03281	feet (ft)
centimeters (cm)	0.394	inches (in.)
millimeters (mm)	0.0394	inches (in.)
micrometers or microns (μm)	0.0000394	inches (in.)
square kilometers (km^2)	0.3861	square miles (mi^2)
hectares (ha)	2.5	acres
square meters (m^2)	10.764	square feet (ft^2)
cubic meters (m^3)	35.31	cubic feet (ft^3)
kilograms (kg)	2.2046	pounds (lb)
grams (g)	0.0353	ounces (oz)
grams per cubic centimeter (g/cm^3)	62.422	pounds per cubic foot (lb/ft^3)
milligrams per kilogram (mg/kg)	1	parts per million (ppm)
micrograms per gram (μg/g)	1	parts per million (ppm)
liters (L)	0.26	gallons (gal.)
milligrams per liter (mg/L)	1	parts per million (ppm)
degrees Celsius (°C)	9/5 + 32	degrees Fahrenheit (°F)

OVERVIEW

Characterization wells R-2, R-4, R-11, and R-26 are being installed at Los Alamos National Laboratory by the Laboratory's Groundwater Protection Program as part of the "Hydrogeologic Workplan" (LANL 1998, 59599). The Nuclear Weapons Infrastructure, Facilities, and Construction Program is sponsoring the installation of well R-26 and the Risk Reduction and Environmental Stewardship-Remediation Services Program is sponsoring the installation of wells R-2, R-4, and R-11. These wells are intended to provide hydrogeologic and water-quality data for regional groundwater in the vicinity of potential contaminant sources in Pueblo and Sandia Canyons and in Cañon de Valle. These data will be used with similar data from other wells in the area to improve the conceptual model for geology, hydrology, and chemistry in these wet canyons and will provide constraints on numerical models that address contaminant migration in the vadose zone and the regional aquifer.

Wells R-2 and R-4 are located in Pueblo Canyon, well R-11 is located in Sandia Canyon, and well R-26 is located adjacent to Cañon de Valle. These wells are being installed to provide hydrologic, geologic, and geochemical information about groundwater occurrences in some wet canyons of the Laboratory. In addition to wet conditions, these canyons contain active and inactive Laboratory potential contaminant sources. All four wells will be installed by drilling boreholes through the regional water table and installing a well. The wells will undergo hydrologic testing and will be sampled to determine water quality. The wells will be drilled in two phases. Phase I consists of collecting continuous core from the surface to specific target depths for each borehole or to auger refusal. Core from these holes will be used to characterize vertical contaminant profiles in the vadose zone beneath the canyon floors. In Phase II, drilling will be to approximately 100 ft into the regional aquifer.

1.0 INTRODUCTION

Characterization wells R-2, R-4, R-11, and R-26 are being installed at Los Alamos National Laboratory (the Laboratory) by the Laboratory's Groundwater Protection Program as part of the "Hydrogeologic Workplan" (LANL 1998, 59599). Wells R-2 and R-4 will supplement other wells being installed under the Los Alamos/Pueblo Canyon work plan (LANL 1995, 50290) to characterize groundwater in this area. Wells R-2 and R-4 are located in Pueblo Canyon, well R-11 is located in Sandia Canyon, and well R-26 is located adjacent to Cañon de Valle (Figure 1).

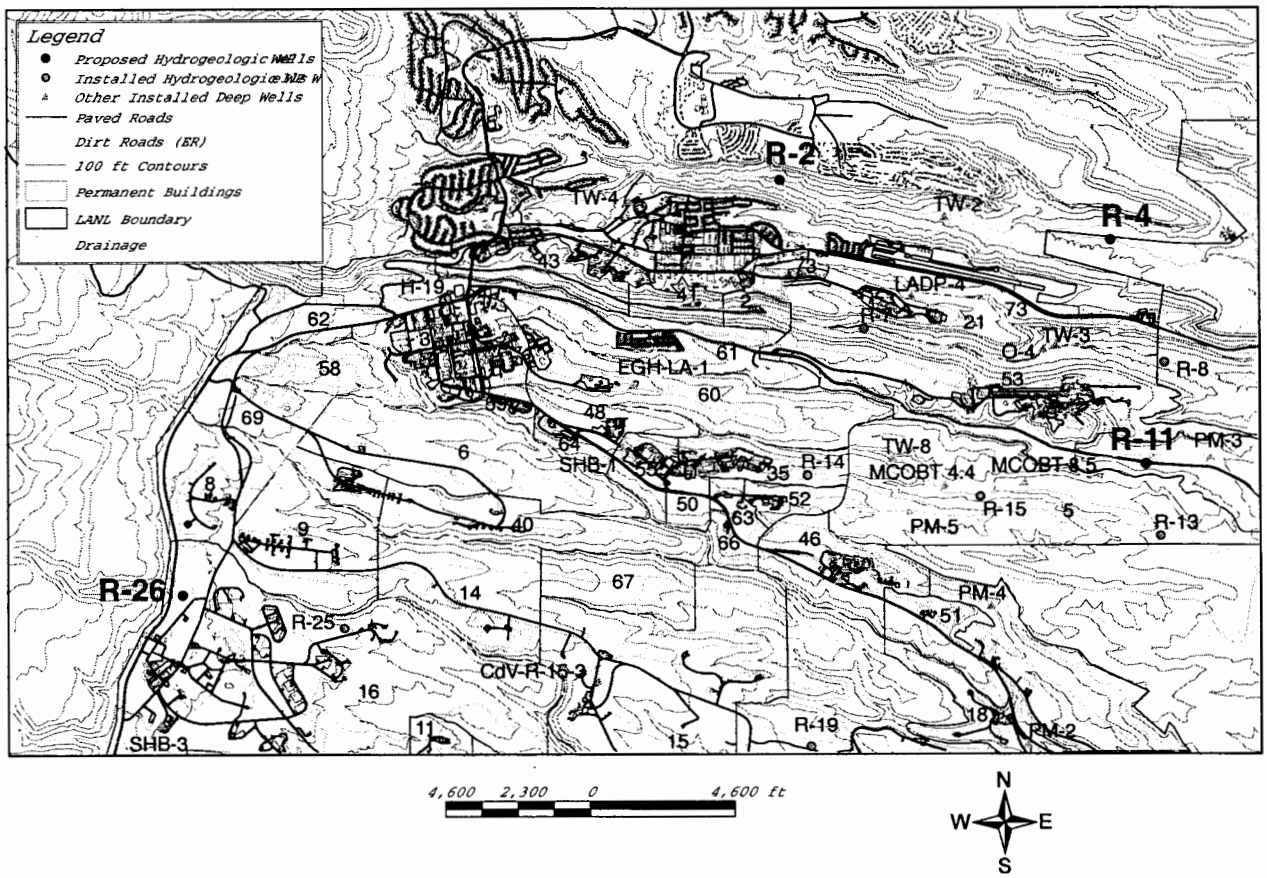

Figure 1. Location map of proposed wells R-2, R-4, R-11, and R-26

The Nuclear Weapons Infrastructure, Facilities, and Construction Program is sponsoring the installation of R-26 and the Risk Reduction and Environmental Stewardship-Remediation Services (RRES-RS) Project is sponsoring the installation of wells R-2, R-4, and R-11. Wells R-2, R-4, and R-11 will provide hydrogeologic and water-quality data for regional groundwater downgradient of potential contaminant sources in wet canyons. Well R-26 is upgradient of potential contaminant sources in Cañon de Valle and will provide background water-quality data for Technical Area (TA)-16. Together with data from other hydrogeologic work plan wells, data from these new wells will provide a basis for evaluating the need for groundwater monitoring and form the technical basis for the design of a groundwater monitoring system, if needed.

This sampling and analysis (SAP) includes a brief description of the overall objectives of these wells, the roles and responsibilities of various Laboratory and contractor participants, the type and frequency of data to be collected, and information about the types, frequency, volumes, and containerization of samples that will be collected. The objective of this SAP is to ensure consistency and quality of characterization data. Unless otherwise noted, all tasks in this SAP will be performed by the contractor.

1.1 Summary of Data Quality Objectives

R-2, R-4, and R-11 are located in canyons that contain current and past Laboratory wastewater treatment plants (WWTPs). R-26 is located upgradient of Laboratory operations and is intended to provide background water-quality information.

Pueblo Canyon, the location of wells R-2 and R-4, was the site of TA-45, now decommissioned. TA-45 was the site of liquid radioactive WWTP discharges. Known contaminants from former TA-45 include tritium, isotopes of uranium and plutonium, strontium-90, cesium-137, and gross-alpha radiation. In addition, Los Alamos County operated a sewage treatment plant in upper Pueblo Canyon (known as the Pueblo Sewage Treatment Plant) until the current Los Alamos County Sewage Treatment Plant came on-line in 1963. Effluent from these past sources likely supported sustained saturated conditions throughout the mid-reach of Pueblo Canyon. This alluvial groundwater may have provided a source for infiltration to intermediate perched groundwater zones and the regional aquifer. R-2 and R-4 are single-screen wells that are designed to characterize groundwater quality at the top of the regional zone of saturation.

Sandia Canyon, the location of well R-11, receives effluent from the Laboratory sanitary WWTP. In addition, R-11 is downgradient from source terms with a long history of liquid releases at TA-53 (Sandia Canyon watershed), TA-35 and TA-50 (Mortandad Canyon watershed), and TA-21 (Los Alamos Canyon watershed). Two water supply wells (PM-1 and PM-3) are located in Sandia Canyon; R-11 is intended to act as a sentinel well for water-supply well PM-3. R-11 is designed with a single screen at the top of the regional zone of saturation, and as such it will detect contaminants from upgradient (western) sources if they occur near the water table.

R-26 is located in Cañon de Valle, just east of State Highway 4. Well R-26 has two main objectives: (1) to characterize intermediate-depth perched groundwater penetrated by existing wells R-25 and SHB-3, and (2) provide background water chemistry for perched and regional groundwater upgradient of Laboratory activities in the TA-16 area. This well is designed with two screens: one will be placed in intermediate-depth perched groundwater and the other at the top of the regional zone of saturation. R-26 is located on the downthrown block of the Pajarito fault system; data from this well will be used to evaluate the influence of the Pajarito fault system on the regional aquifer piezometric surface and provide information on the role of faults in recharge.

The data quality objectives (DQOs) identified in Table 1 will be accomplished by collecting geologic and geophysical information about perched groundwater occurrences, installing wells with single and multiple screens in the regional aquifer, collecting groundwater to determine water quality, and, in some wells, collecting core samples to determine the vertical distributions of contaminants and moisture content through the vadose zone. Information for the sitewide, three-dimensional (3-D) geologic model will be provided by examining and interpreting the cuttings, core, and geophysical logs.

Table 1
Data Quality Objectives for Wells R-2, R-4, R-11, and R-26

Well	R-2	R-4	R-11	R-26
Primary Purposes	Determine subsurface distribution of contaminants in an area expected to contain maximum groundwater contamination from recharge emanating from Acid Canyon. These data are needed to bound maximum risk levels associated with deep groundwater contamination in the near-source area. Evaluate groundwater pathways and interconnections between the surface and deep groundwater in upper Pueblo Canyon. These data are needed to properly constrain the vadose-zone numerical flow-and-transport model for Pueblo Canyon. Identify geologic and hydrologic controls on groundwater pathways. These data are part of the general characterization of groundwater conditions beneath the Laboratory and support ongoing efforts to improve the hydrogeologic conceptual model. Provide water-level, aquifer-characteristic, and chemistry data for improving the regional flow-and-transport model.	Determine subsurface contaminant distribution in an area downgradient of releases in Pueblo Canyon and characterize groundwater quality upgradient of the treatment plant effluent. These data are needed to understand the contributions to groundwater from treatment plant discharges. Evaluate groundwater pathways and interconnections between the surface and deep groundwater in Pueblo Canyon. These data are needed to properly constrain the vadose-zone numerical flow-and-transport model for Pueblo Canyon. Identify geologic and hydrologic controls on groundwater pathways. These data are part of the general characterization of groundwater conditions beneath the Laboratory and support ongoing efforts to improve the hydrogeologic conceptual model. Provide water-level, aquifer-characteristic, and chemistry data for improving the regional flow-and-transport model.	Determine subsurface contaminant distribution in an area downgradient of releases in Sandia Canyon, and potentially from Mortandad and Los Alamos Canyons. These data are needed to understand the contributions to groundwater from different source terms. Provide early detection of potential contaminants moving along the top of the regional aquifer toward supply well PM-3. Evaluate groundwater pathways and interconnections between the surface and deep groundwater in Sandia Canyon. Identify geologic and hydrologic controls on groundwater pathways. These data are part of the general characterization of groundwater conditions beneath the Laboratory and support ongoing efforts to improve the hydrogeologic conceptual model. Provide water-level, aquifer-characteristic, and chemistry data for improving the regional flow-and-transport model.	Determine water quality in an area upgradient of releases from Laboratory operations in the vicinity of TA-16. These data are needed to understand the contribution to groundwater quality from Laboratory operations. Identify geologic and hydrologic controls on groundwater pathways, particularly the effect of the Pajarito fault on groundwater flow and the presence or absence of a perching horizon similar to that of R-25. These data are part of the general characterization of the groundwater conditions beneath the Laboratory and will support ongoing efforts to improve the hydrogeologic conceptual model. Provide water-level, aquifer-characteristic, and chemistry data in a likely recharge area for improving the regional flow-and-transport model.
Projected Depth	910 ft TD[a] of approximately 100 ft through regional water table. Regional water table expected at ~810 ft.	820 ft TD of approximately 100 ft through regional water table. Regional water table expected at ~720 ft.	945 ft TD of approximately 100 ft through regional water table. Regional water table expected at ~845 ft.	1414 ft TD of approximately 100 ft through regional water table. Regional water table expected at ~1314 ft.

Table 1 (continued)

Well	R-2	R-4	R-11	R-26
Geology Issues/ Activities	Determine Otowi Member thickness in vicinity of onlap onto structurally high Tschicoma lava flows to the west. Determine pre-Bandelier stratigraphy in area where large uncertainties exist. Evaluate recharge and groundwater flow in vicinity of the Guaje Mountain fault, which projects into this area from the north.	Determine western extent of the Cerros del Rio basalt in Pueblo Canyon. Constrain western extent of structurally high pre-Bandelier rocks found in lower Pueblo Canyon at R-5 and Otowi 1. Determine the western extent of extensive alteration zone that may decrease the permeability of rocks at the base of the Cerros del Rio basalt and in older units at R-5 and Otowi 1. Determine lithologic and hydrological characteristics of the regional aquifer in this area.	The geology of this area is well constrained by nearby wells PM-3, Otowi 4, TW-8, R-7, R-8, R-13, and R-15. Geologic data collected at this location will be used to test uncertainties in the site-wide 3-D geologic model.	Determine lithology and hydrologic characteristics of the regional aquifer in this area. Specifically, determine if Tschicoma lava flows extend into this area from the west and determine the lithology of pre-Bandelier sedimentary rocks. Identify nature of perching horizon if perched groundwater is found. Provide ground truth for aerial electromagnetic survey, which showed high conductivity close to the surface in this area. A moisture profile will be collected from this borehole to determine if high conductivity correlates with degree of saturation. Document fracture characteristics in the hanging wall block in proximity (260 m) to the Pajarito fault zone.
Hydrology Issues/ Activities	Examine extent of two perched zones encountered in other wells in Pueblo Canyon. Characterize nature and extent of contamination in perched zones. Collect sufficient information to develop contaminant mass balance. Determine primary mode of contaminant distribution; i.e., does effluent released spread out laterally or migrate vertically downward. Bound northern extent of thick, perched zone and downward gradients seen in R-25.	Examine extent of two perched zones encountered in other wells in Pueblo Canyon. Characterize nature and extent of contamination in perched zones. Evaluate flow and chemical gradients in the regional aquifer. Conduct hydrologic testing to estimate permeability in the upper part of the regional zone of saturation.	Determine if infiltration from Sandia Canyon and its associated wetlands leads to the development of intermediate-depth perched groundwater. Identify perched groundwater zones. Measure water quality downgradient of potential contaminant sources.	Investigate extent of the thick, perched zone encountered in R-25. Collect data needed for regional aquifer model, including piezometric surface and vertical gradient.

Table 1 (continued)

Well	R-2	R-4	R-11	R-26
Geochemistry Issues/ Activities	Extent of nonsorbing (tritium, perchlorate, nitrate) and sorbing contaminants that have been detected in the perched zones and the regional aquifer. Water samples from the completed borehole will be analyzed for a full suite of analytes, after the formation has re-equilibrated and the water is representative of the formation.	Extent of nonsorbing (tritium, perchlorate, nitrate) and sorbing contaminants that have been detected in the perched zones and the regional aquifer. Water samples from the completed borehole will be analyzed for a full suite of analytes, after the formation has re-equilibrated and the water is representative of the formation.	Extent of nonsorbing (tritium, perchlorate, nitrate) and sorbing contaminants that have been released and/or detected in the surface water, perched zones, and regional aquifer. Water samples from the completed borehole will be analyzed for a full suite of analytes, after the formation has re-equilibrated and the water is representative of the formation. Sampling for colloids will be conducted to evaluate colloidal transport as a possible mechanism for sporadic plutonium detections in PM-3.	Determine recharge chemistry and background regional aquifer water chemistry. Water samples from the completed borehole will be analyzed for a full suite of analytes, after the formation has re-equilibrated and the water is representative of the formation. Establish background values for anions and cations for comparison to cores collected from areas containing contaminants.
Vadose Zone Sampling	Upper portion of the boring will be cored to determine contaminant distribution, moisture content, and anion/tritium/isotope profiles in the vadose zone. Below TD of the Phase I core hole, drill cuttings will be collected every 5 ft to identify geologic contacts, describe rock characteristics, and provide samples for additional geologic characterization. Water samples will be collected if perched water is encountered during drilling.	Upper portion of the boring will be cored to determine contaminant distribution, moisture content, and anion/tritium /isotope profiles in the vadose zone. Below TD of the Phase I core hole, drill cuttings will be collected every 5 ft to identify geologic contacts, describe rock characteristics, and provide samples for additional geologic characterization. Water samples will be collected if perched water is encountered during drilling.	Upper portion of the boring (until auger refusal or a maximum of 250 ft) will be cored to determine contaminant distribution, moisture content, and anion/tritium /isotope profiles in the vadose zone. Below TD of the Phase I core hole, drill cuttings will be collected every 5 ft to identify geologic contacts, describe rock characteristics, and provide samples for additional geologic characterization. Water samples will be collected if perched water is encountered during drilling.	Core will be collected in the upper 250-ft portion of the borehole to measure moisture content and anion profiles. Below TD of the Phase I core hole, drill cuttings will be collected every 5 ft to identify geologic contacts, describe rock characteristics, and provide samples for additional geologic characterization. Water samples will be collected if perched water is encountered during drilling.
Regional Aquifer Sampling Activities	Collect screening water samples during drilling at the top of the regional aquifer, if feasible. Install well screen to collect water-quality data for the regional aquifer. Measure water levels in the completed well.	Collect screening water samples during drilling at the top of the regional aquifer, if feasible. Install well screen to collect water-quality data for the regional aquifer. Measure water levels in the completed well.	Collect screening water samples during drilling at the top of the regional aquifer, if feasible. Install well screen to collect water-quality data for the regional aquifer Measure water levels in the completed well.	Collect screening water samples during drilling at the top of the regional aquifer, if feasible. Install well screen to collect water-quality data for the regional aquifer. Measure water levels in the completed well.

Table 1 (continued)

Well	R-2	R-4	R-11	R-26
Core Needs/ Collection	Core target depth is 200 ft, with the goal of completely penetrating the uppermost intermediate perched groundwater zone. However, coring will continue if perched zone is not yet encountered or, if present, not fully penetrated. In this case, coring will not exceed 300 ft.	Core target depth is 200 ft, with the goal of completely penetrating the uppermost intermediate perched groundwater zone. However, coring will continue if perched zone is not yet encountered or, if present, not fully penetrated. In this case, coring will not exceed 300 ft.	Coring will take place from the surface to a target depth that is 50 ft beneath the top of the Cerros del Rio basalt (approximately 347 ft); however, coring will not exceed 350 ft.	Core target depth is 250 ft.
Hydrologic Testing	Testing will consist of injection, pumping, or slug tests if the screen is completed below the regional water table.	Testing will consist of injection, pumping, or slug tests if the screen is completed below the regional water table.	Testing will consist of injection, pumping, or slug tests if the screen is completed below the regional water table.	Testing will consist of injection, pumping, or slug tests in the lower screen if it is completed below the regional water table.
Geophysical Testing	Suite and timing of geophysical logging will depend on borehole conditions. The suite of possible logs is listed in Table 10. Laboratory borehole video camera will be used when open-hole conditions in the vadose zone are favorable for logging.	Suite and timing of geophysical logging will depend on borehole conditions. The suite of possible logs is listed in Table 10. Laboratory borehole video camera will be used when open-hole conditions in the vadose zone are favorable for logging.	Suite and timing of geophysical logging will depend on borehole conditions. The suite of possible logs is listed in Table 10. Laboratory borehole video camera will be used when open-hole conditions in the vadose zone are favorable for logging.	Suite and timing of geophysical logging will depend on borehole conditions. The suite of possible logs is listed in Table 10. Laboratory borehole video camera will be used when open-hole conditions in the vadose zone are favorable for logging.
Number of Well Screens in Regional Aquifer	A single screen will be placed just below the regional aquifer water table. Screen length and placement will be determined after evaluation of water-table depth, locations of hydrogeologic units, locations of productive water zones, and water-level declines in the area. The screen will provide access to groundwater so that contaminant concentration in the upper part of the regional aquifer can be determined.	A single screen will be placed just below the regional aquifer water table. Screen length and placement will be determined after evaluation of water-table depth, locations of hydrogeologic units, locations of productive water zones, and water-level declines in the area. The screen will provide access to groundwater so that contaminant concentration in the upper part of the regional aquifer can be determined.	A single screen will be placed just below the regional aquifer water table. Screen length and placement will be determined after evaluation of water table depth, location of hydrogeologic units, location of productive water zones, and water-level declines in the area. The screen will provide access to groundwater so that contaminant concentration in the upper part of the regional aquifer can be determined.	Two screened intervals: one in the perched zone (if present) and one in the regional aquifer. Screen length and placement will be determined after evaluation of water-table depths, locations of hydrogeologic units, and locations of productive water zones. The screens will be designed to provide access to groundwater so that background water quality can be measured in both perched and regional water zones.

[a] TD = Total depth.

1.2 Locations of Wells

Figure 1 shows the locations of the four wells. Table 2 shows horizontal well coordinates as New Mexico State Plane Grid Coordinates, Central Zone (North American Datum of 1983). Elevations are expressed in feet above sea level relative to the National Geodetic Vertical Datum of 1929 (NAD83).

Table 2
Approximate NAD83 State Plane Coordinates for Proposed Wells

Well	Easting (ft)	Northing (ft)	Elevation (ft)
R-2	1,629,334	1,778,298	6770
R-4	1,639,441	1,776,618	6569
R-11	1,640,565	1,769,290	6670
R-26	1,6102,20	1,764,690	7639

1.3 Roles and Responsibilities

The US Department of Energy (DOE) is responsible for drilling and installing the regional wells described in this SAP, as administered through a federal contract to conduct drilling services with Kleinfelder, Inc. DOE/Kleinfielder are responsible for

- planning and drilling cores and boreholes,
- geophysical investigations,
- well construction
- site restoration,
- waste management,
- health and safety, and
- preparing well completion reports.

The Laboratory's role is to provide technical and logistical support to the drilling effort. The functional organization of the implementation of this well installation effort is illustrated in Figure 2. Roles and responsibilities for the investigation team are shown in Table 3.

1.4 Communicating with NMED

The Laboratory/DOE will provide the New Mexico Environment Department (NMED) with weekly reports about the status of drilling, characterization, well construction, and well development activities. In addition, NMED will be contacted by phone, with follow-up by e-mail or letter, when changes in borehole conditions, well installation and development activities, or data collection activities result in significant deviations from this SAP. When possible, input from NMED will be sought before changes in planned activities take place. However, some decisions may be made prior to NMED consultation because of the rapid pace of drilling activities. In this case, NMED will be contacted as soon as possible with information about changes to ongoing activities and an assessment of how these changes affect the goals of this SAP. Deviations from this SAP will be identified in the well completion reports.

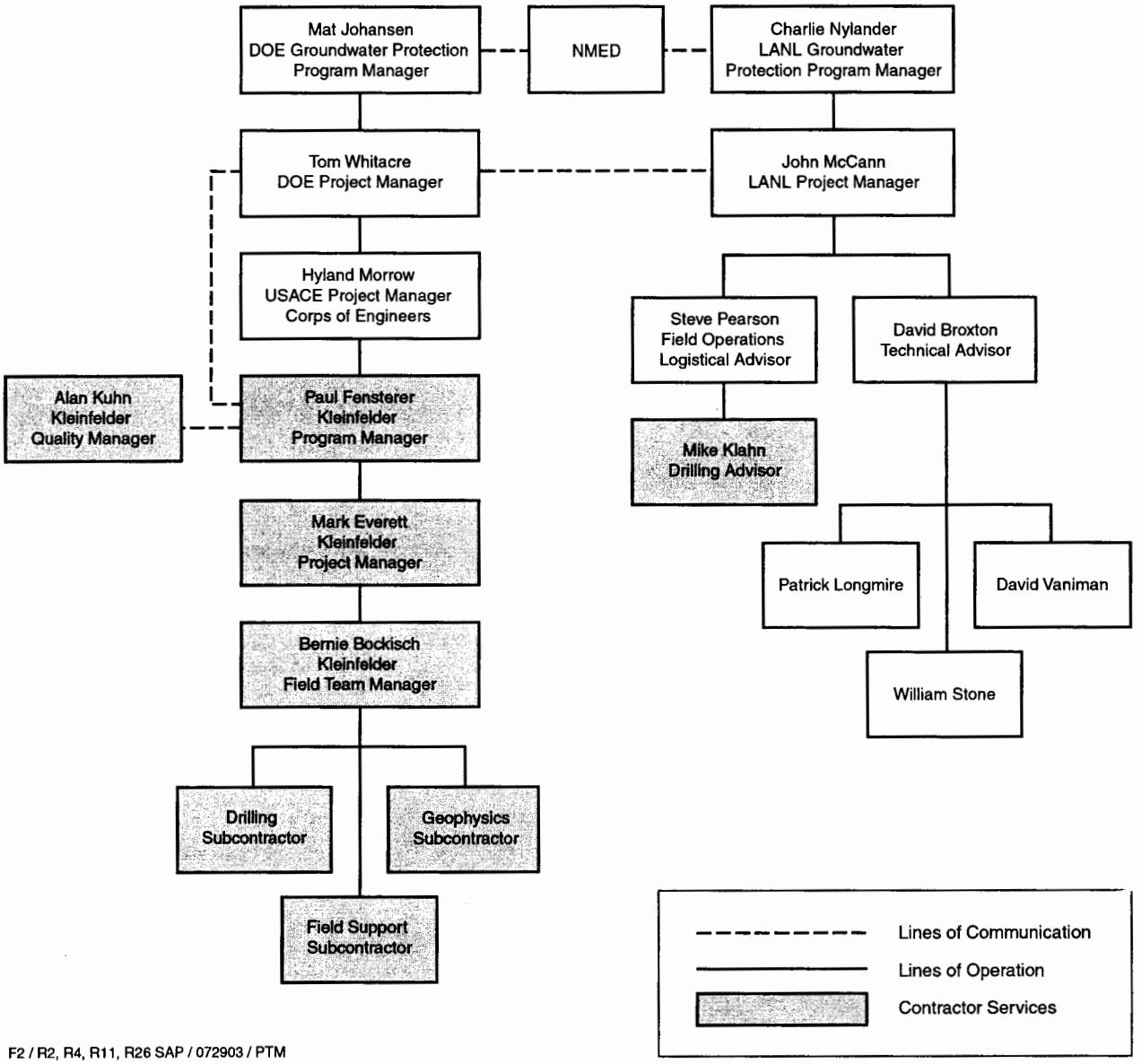

Figure 2. Functional organization of well installation personnel

Table 3
Roles and Responsibilities

Personnel	Phone/Pager	Organization	Position	Project Roles/Responsibilities
Charles Nylander	665-4681 (work) 699-1568 (cell)	LANL[a]/ RRES-RS	Groundwater Protection Program Program Manager	Responsible for LANL Groundwater Protection Program
Mat Johansen	665-5046 (work)	DOE	Program Manager	Management of groundwater programs
Tom Whitacre	665-5042 (work)	DOE	Project Manager	Drilling subcontract technical representative; responsible for successful completion of the drilling program
Hyland Morrow	916-557-7865 (work)	US Army Corps of Engineers	Project Manager	Contract manager for drilling contract
Paul Fensterer	505-344-7373 (work) 505-249-6486 (cell)	Kleinfelder	Program Manager	Responsible for completing drilling program, health and safety, QA, and waste management
Alan Kuhn	505-344-7373	Kleinfelder	Quality Manager	Responsible for project QA
Mark Everett	505-7373 (work) 505-681-5333 (cell)	Kleinfelder	Project Manager	Responsible for oversight of contractor field and drilling activities
Bernie Bockisch	505-401-1955 (cell)	Kleinfelder	Field manager	Responsible for contractor field and drilling activities
John McCann	665-1091 (work) 699-2204 (cell)	LANL/ RRES-RS	Groundwater Protection Program Project Leader	LANL manager responsible for LANL personnel and activities
Steve Pearson	667-3005 (work) 699-3684 (cell)	LANL/ RRES-RS	Groundwater Protection Program field operations team leader	Provide LANL oversight for field and drilling activities; coordinate field activities of LANL technical team
David Broxton	667-2492 (work) 699-0950 (cell)	LANL/ EES-6[b]	Groundwater Protection Program technical advisory team leader	Provide technical leadership for design of testing program
Patrick Longmire	665-1264 (work) 699-1987 (cell) 104-3993 (page)	LANL/ EES-6	Groundwater Protection Program geochemistry lead	Provide technical leadership for geochemical characterization and sampling
William Stone	665-8340 (work)	LANL/ EES-5	Groundwater Protection Program hydrology lead	Provide technical leadership for hydrologic characterization and well development.
David Vaniman	667-1863 (work) 104-7019 (page) 699-1079 (cell)	LANL/ EES-6	Groundwater Protection Program geology lead	Provide technical leadership for geologic characterization
Mike Klahn	667-7977 (work) (979) 229-8332 (cell)	LANL/ RRES-RS	Drilling advisor	Provide drilling expertise and advice to LANL Program Manager
Ann Lee	667-0753 (work)	LANL/ RRES-RS	Data steward	Responsible for incorporating data generated during investigations into LANL data bases

[a] LANL = Los Alamos National Laboratory.

[b] EES-6 = Earth and Environmental Sciences Hydrology, Geochemistry, and Geology Group.

1.5 Health and Safety

All fieldwork will be conducted in accordance with the Kleinfelder health and safety plan as approved by DOE. DOE is responsible for completing the Laboratory ESH-ID profile for each of the four wells.

1.6 Quality Assurance

Kleinfelder is responsible for conducting all procurement, field operations, and drilling in accordance with its contractor quality assurance (QA) program. The contractor's quality management plan will be consistent with DOE Order 414.1A, Quality Assurance, and reflect the technical intent of the standard operating procedures (SOPs) and quality procedures (QPs) provided by the University of California and adopted by DOE as pertinent to these investigations. Pertinent SOPs and QPs are listed in Appendix A, Pertinent Procedures.

Laboratory personnel are required to perform work under the RRES-RS QA program.

1.7 Waste Management

Kleinfelder, DOE's contractor for drilling services, is responsible for all waste-management activities. A waste characterization strategy form (WCSF) for wells R-2, R-4, R-11, and R-26 will be prepared that describes the on-site management of groundwater, cuttings, and drilling media as well as the temporary storage of wastes pending waste characterization and/or disposal in accordance with appropriate regulatory requirements. The Laboratory will prepare and submit a notice of intent to NMED to discharge drilling fluids, development water, and groundwater on the site. Drill cuttings will be characterized for potential contaminants and disposed of as nonhazardous, nonradioactive solid waste or reused on the site for restoration activities. After solids are removed and wastes are characterized, re-use, land application, or disposal of drilling fluids will be evaluated.

2.0 GEOLOGIC CHARACTERIZATION

Drill holes R-2, R-4, R-11, and R-26 will provide information on the geologic setting in Pueblo and Sandia Canyons and Cañon de Valle. Figures 3 through 6 show predicted depths to geologic contacts for all four drill holes. These drill holes will be drilled in two phases, with core collected in Phase I. Cuttings will be collected in Phase II. The core is necessary to determine contaminant distribution in the vadose zone for R-2, R-4, and R-11 and to estimate the recharge rate in R-26. The cuttings will provide lithologic information for intervals that are not cored.

During Phase I drilling, all recovered core will be preserved for geologic examination and for selection of vadose-zone samples. During Phase II drilling, an estimated 500 to 700 mL of bulk drill cuttings will be collected every 5 ft, as conditions permit, for the total depth (TD) of the boring. Table 4 lists sample collection activities for cuttings and core. Cuttings will be stored in plastic bags labeled with the well name and footage range representing the depth interval at which the cuttings were derived. The core samples and cuttings bags will be stored in core boxes labeled with the well name, box number, and footage range for the box. The core boxes will be transported to a Laboratory-designated facility for archiving and storage after the borehole is completed.

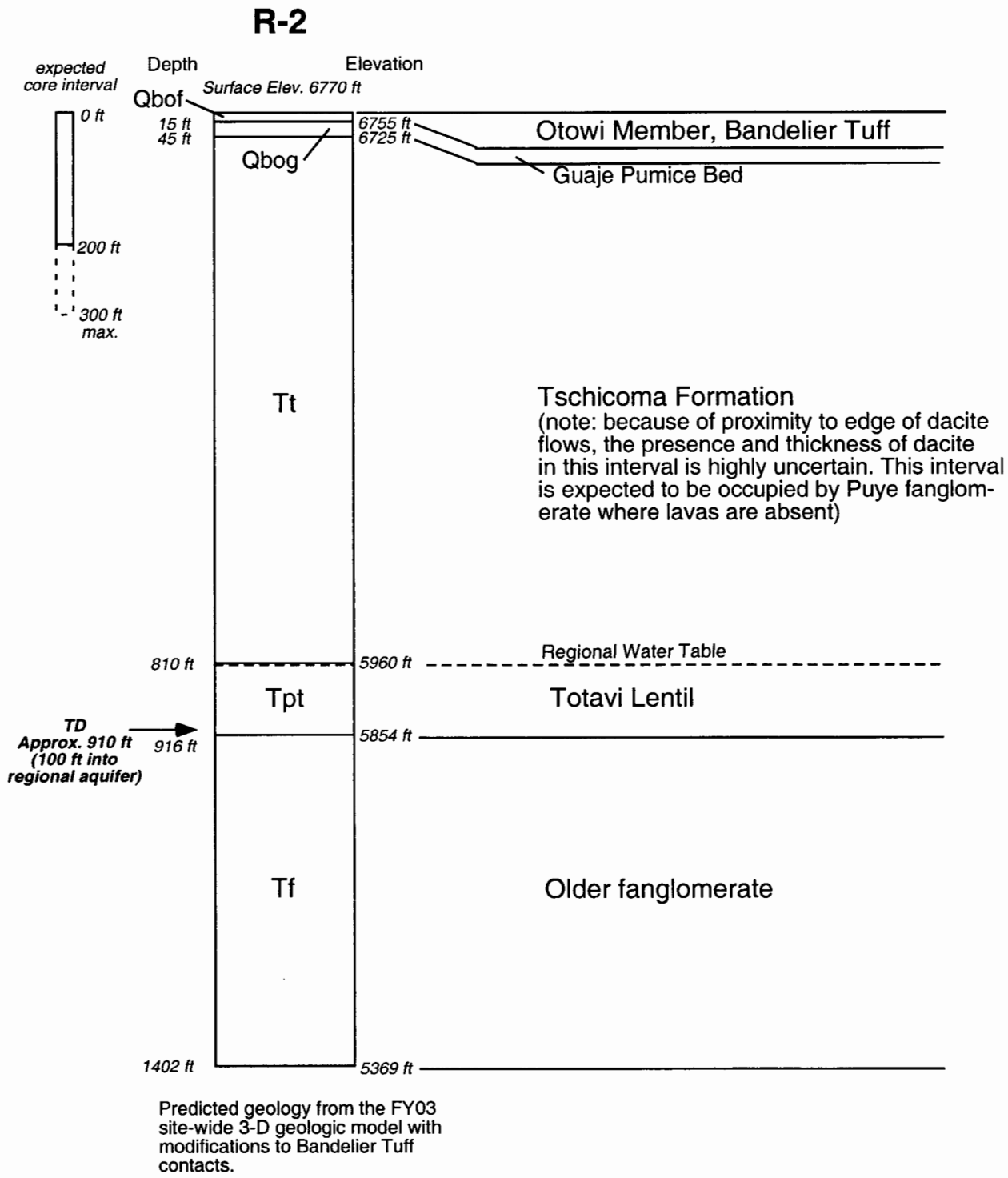

Figure 3. Predicted geology for proposed well R-2

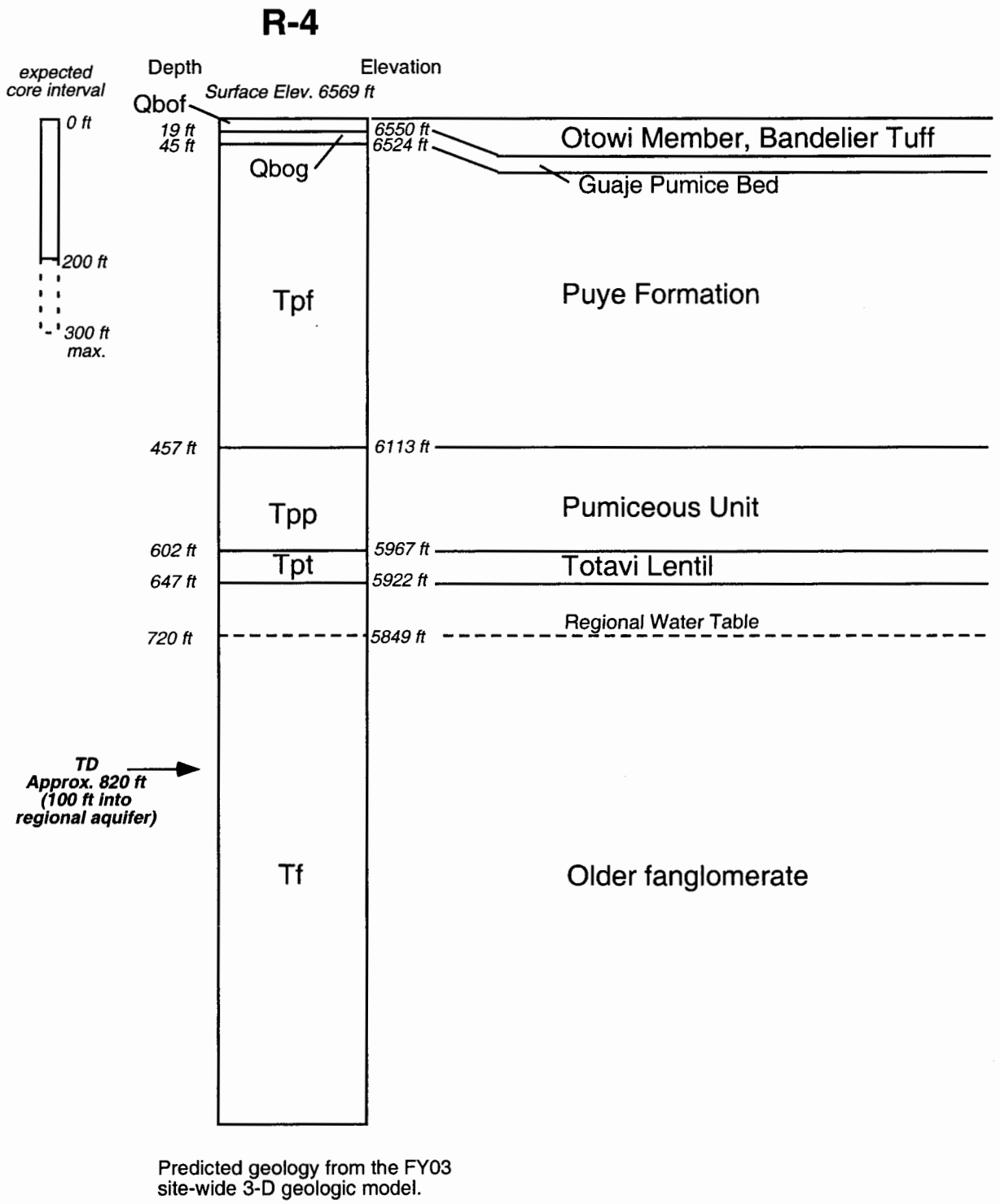

Figure 4. Predicted geology for proposed well R-4

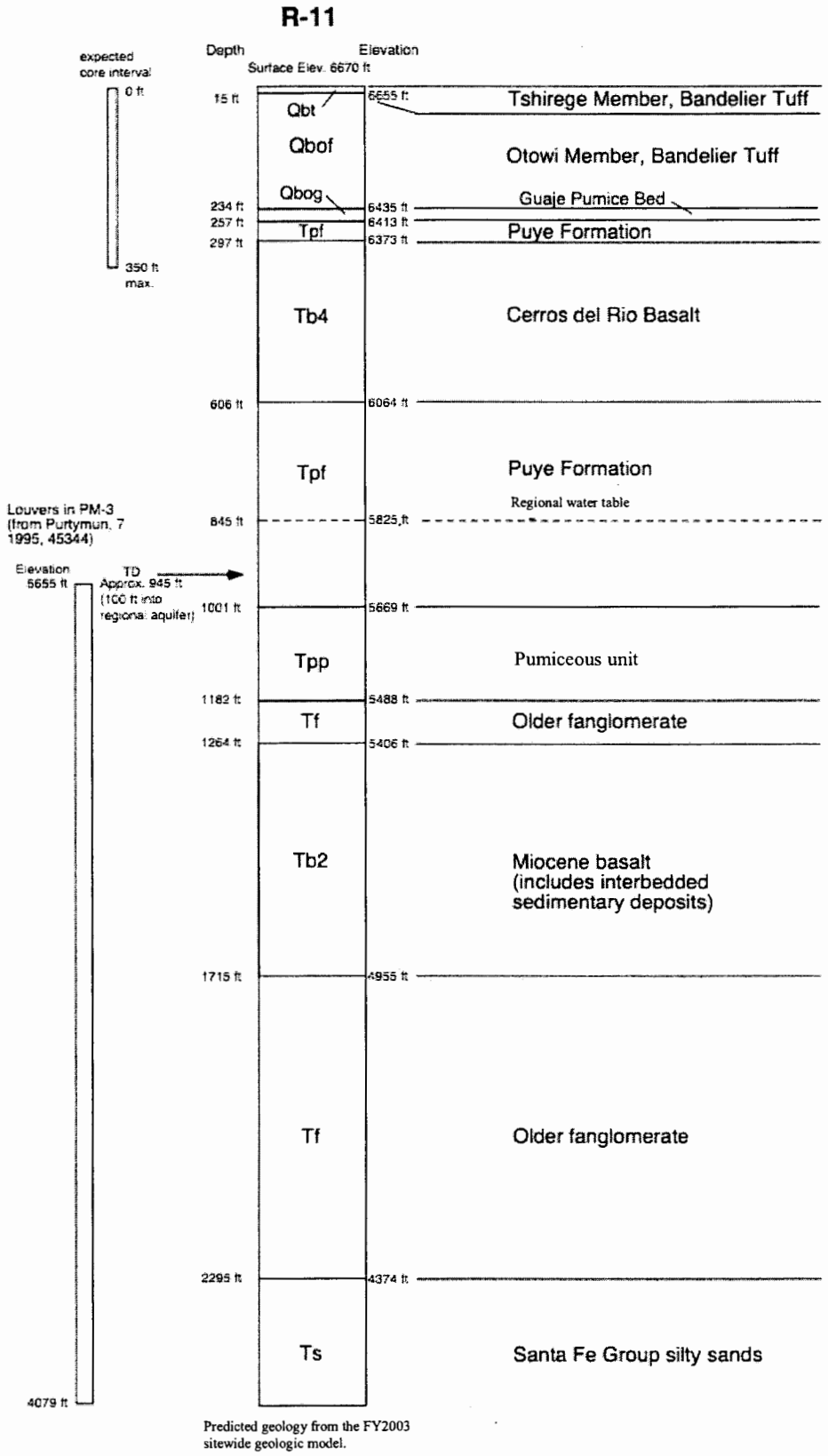

Figure 5. Predicted geology for proposed well R-11

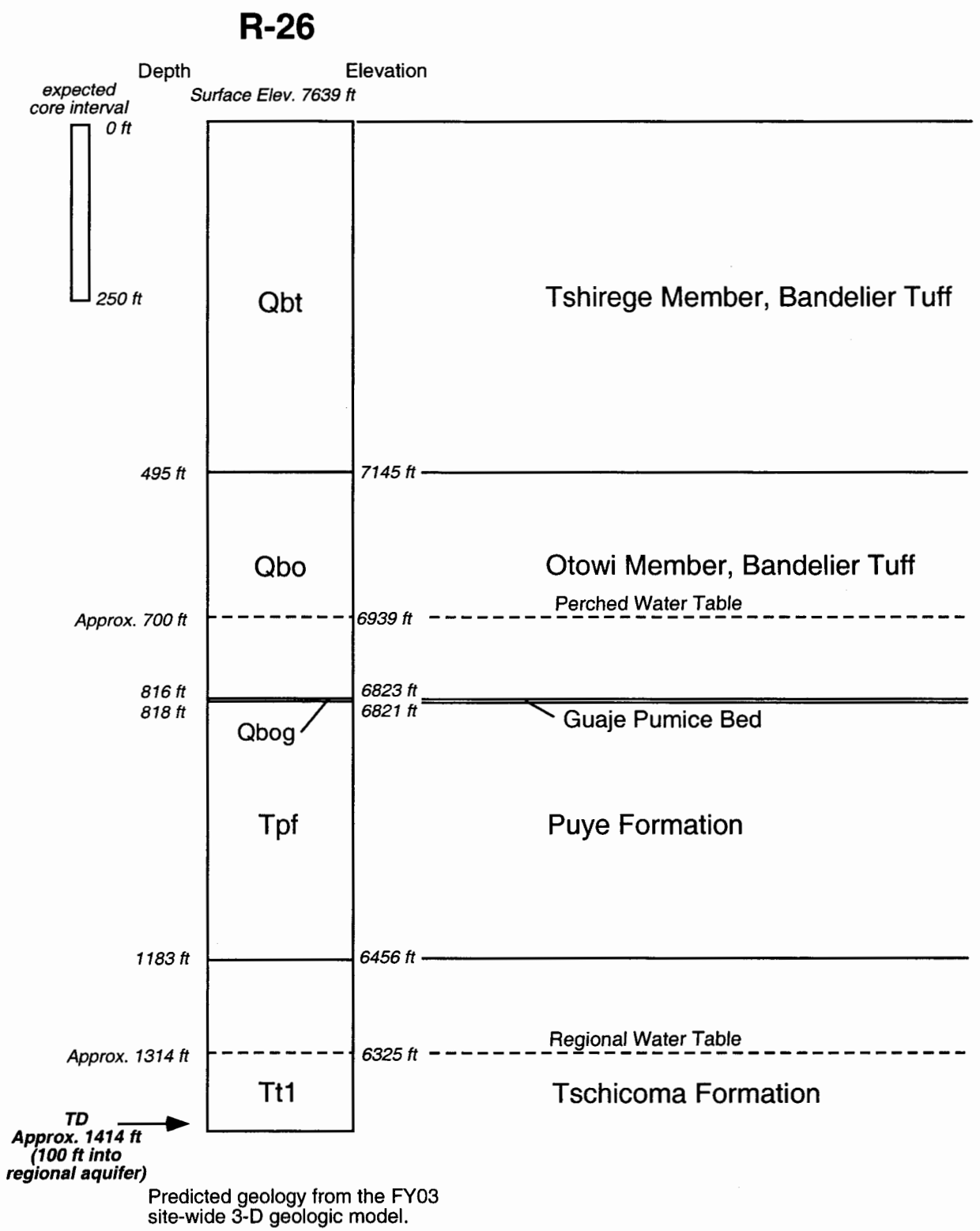

Figure 6. Predicted geology for proposed well R-26

Table 4
Sample Collection Activities for Cuttings and Core

Sample Description	Analyte	Sample Size	Container	Sample Frequency	Preferred Laboratory
Phase 1 Coring					
Core	Anions, cations, and moisture content	0.4 ft of 2-in.-diameter core	8-oz preweighed glass jar	Target depths: 10, 20, 30, 40, 50, 75, 100, 125, 150, 175, 200, 225, 250, 275, 300, 325, and 350 ft. In R-2 and R-4, the core target depth is 200 ft with the goal of completely penetrating the uppermost intermediate perched groundwater zone; however, coring will not exceed 300 ft. In R-11, coring to terminate after penetrating the top 50 ft of Cerros del Rio basalt, but will not exceed 350 ft. In R-26, core target depth is 250 ft.	EES-6[a]
Core	Tritium	0.5 ft of 2-in.-diameter core	Sealed plastic bag wrapped with tape and core protected	Target depths: 10, 20, 30, 40, 50, 75, 100, 125, 150, 175, 200, 225, 250, 275, 300, 325, 350 ft. In R-2 and R-4, the core target depth is 200 ft with the goal of completely penetrating the uppermost intermediate perched groundwater zone; however, coring will not exceed 300 ft. In R-11, coring to terminate after penetrating the top 50 ft of Cerros del Rio basalt, but not to exceed 350 ft. In R-26, no tritium samples will be collected.	GEL[b]
Core	Radiological screening for gross alpha, beta, and gamma (for off-site transport of samples)	0.2 ft of 2-in.-diameter core	Sealed plastic bag	Every 50 ft	ARS[c] in Los Alamos
Core	Radionuclides	0.5 ft of 2-in.-diameter core	Sealed plastic bag and core protected	Target depths: 10, 20, 30, 40, 50, 75, 100, 125, 150, 175, 200, 225, 250, 275, 300, 325, and 350 ft. In R-2 and R-4, the core target depth is 200 ft with the goal of completely penetrating the uppermost intermediate perched groundwater zone; however, coring will not exceed 300 ft. In R-11, coring to terminate after penetrating top 50 ft of Cerros del Rio basalt, but not to exceed 350 ft. In R-26, no radionuclide samples will be collected.	GEL
Core	Stable isotopes	0.5 ft of 2-in.-diameter core	Place samples into two sealed plastic bags and with core protected	Target depths: 10, 20, 30, 40, 50, 75, 100, 125, 150, 175, 200, 225, 250, 275, 300, 325, and 350 ft. In R-2 and R-4, the core target depth is 200 ft with the goal of completely penetrating the uppermost intermediate perched groundwater zone; however, coring will not exceed 300 ft. In R-11, coring to terminate after penetrating the top 50 ft of Cerros del Rio basalt, but not to exceed 350 ft. In R-26, the core target depth is 250 ft.	Socorro[d] for δD and $\delta^{18}O$ and Coastal Sciences for $\delta^{15}N$

Table 4 (continued)

Sample Description	Analyte	Sample Size	Container	Sample Frequency	Preferred Laboratory
Phase 1 Coring (continued)					
Core	Laboratory hydrologic tests	1 ft of 2-in.-diameter core	None	For R-26 only; up to 8 samples to be selected for testing.	To be determined
Phase 2 Drilling					
Cuttings	Bulk cuttings systematically collected for archival purposes and for supplemental sample needs	500–700 mL	Plastic ziplock bag	One sample every cuttings run (nominally every 5 ft), beginning at bottom of core hole. If main borehole is drilled before coring takes place for operational reasons, cuttings will be collected from the surface to TD.	n/a[e]
Cuttings	Sieved cuttings for lithology description and binocular microscope examination	Enough to partly fill trays	Plastic chip trays	One sample every cuttings run (nominally every 5 ft), including over-drilling the core hole. Normally, an unsieved sample, a >10 mesh sample, and a >35 mesh sample every cuttings run.	n/a
Cuttings	Sieved cuttings for XRD[f], XRF[g], petrography	200–300 mL sieved, or bulk if necessary	Plastic ziplock bag	One >10-mesh sample every cuttings run (nominally every 5 ft); finer sizes or bulk split will be substituted where >10-mesh size cannot be obtained.	EES-6
Cuttings	Radiological	2 L of cuttings	Plastic ziplock bag	Up to 5 samples for the entire borehole within water-bearing zones; sample location to be determined by the geochemistry lead	GEL

Note: Priority of sample core collection when recovery is less than 100% should be anions, moisture content, and stable isotopes, radionuclides and tritium, and radiological screening.

[a] EES-6 = Earth and Environmental Sciences Hydrology, Geochemistry, and Geology Group.

[b] GEL = General Engineering Laboratory.

[c] ARS = American Radiation Services of New Mexico.

[d] New Mexico Institute of Mining and Technology.

[e] n/a = Not applicable.

[f] XRD = x-ray diffraction spectroscopy.

[g] XRF = x-ray fluorescence.

A subset of unsieved and sieved samples will be collected from each cuttings interval and stored in plastic chip trays labeled with the well name and cuttings depth ranges (Table 4). Unsieved and sieved cuttings will be placed in individual tray bins and labeled by footage and sieve size-range. Sieve sizes typically will be >10 and >35 mesh, but will be >35 and >60 mesh for finer-grained materials. Lost-circulation zones (no cuttings returns) will be indicated by empty trays.

Additionally, about 200 to 300 mL of >10-mesh cuttings will be collected at every cuttings interval (nominally every 5 ft) and stored in sealed plastic bags labeled with the well name and footage range representing the depth interval at which the cuttings were derived (Table 4). Finer sieve sizes or bulk cuttings will be collected when >1-mesh materials are absent. The Laboratory will obtain these samples from the contractor after drilling activities are completed for each well.

Analytical testing of samples by the Laboratory may include mineralogy by x-ray diffraction (XRD); petrography by modal analysis of thin sections, by electron microprobe, and/or by scanning electron microscope; and geochemistry by x-ray fluorescence (XRF) (Table 4). Samples will be identified, labeled, and handled through logbook sample control maintained by the geology lead.

3.0 HYDROLOGIC CHARACTERIZATION

The number, location, and extent of saturated zones near the planned well locations in Pueblo and Sandia Canyons and Cañon de Valle are not yet fully characterized. Wells installed as part of this drilling effort will provide additional data to evaluate groundwater occurrences in this area. Table 5 identifies geologic settings where potential saturated zones may occur. These potential occurrences are based on settings where groundwater is known to occur in other parts of the Laboratory, but their inclusion in Table 5 is not based on site-specific data. Figures 3 through 6 show predicted depths to the regional water table for each well.

Table 5
Potential Saturated Zones in Wells R-2, R-4, R-11, and R-26

Well	Groundwater Zone	Approximate Depth (ft)	Comments
R-2	Perched zone 1	0–10	Perched groundwater in alluvium.
	Perched zone 2	35–45	Perched groundwater at base of Guaje Pumice Bed.
	Perched zone 3	100–200	Perched groundwater within upper Puye Formation; setting similar to perched water at TW-2.
	Regional water table	810	Regional groundwater within Tschicoma Formation, Puye Formation, or Totavi Lentil.
R-4	Perched zone 1	0–10	Perched groundwater in alluvium.
	Perched zone 2	35–45	Perched groundwater at base of Guaje Pumice Bed.
	Perched zone 3	100–200	Perched groundwater within upper Puye Formation; setting similar to perched water at TW-2.
	Regional water table	720	Regional groundwater within the older fanglomerates beneath Totavi Lentil.
R-11	Perched zone 1	257	Perched groundwater at base of Guaje Pumice Bed.
	Perched zone 2	500–606	Perched groundwater within lower part of Cerros del Rio basalt; setting similar to perched water at R-12.
	Regional water table	845	Regional groundwater within Puye Formation.
R-26	Perched zone 1	700–900	Perched groundwater in lower Otowi Member and upper Puye Formation.
	Regional water table	1314	Regional groundwater within Tschicoma Formation or Puye Formation.

3.1 Unsaturated Zones

Water (and thus potential contaminants) can move downward from the surface to saturated zones, especially in recharge areas. Thus, the characterization of hydrologic properties of geologic materials lying above perched and regional zones of saturation is important.

Geophysical and video logging will be conducted before casing is set in the vadose zone and after the borehole reaches TD to provide hydrologic information about the vadose zone in each well, if open-borehole conditions are favorable for logging. Selection of intervals to log and the types of logs that will be run will depend on factors such as availability of open-borehole, characterization questions that arise during drilling, and synchronization with other drilling and well-construction activities.

At R-26, up to eight core samples in units Qbt 3 and Qbt 4 of the Bandelier Tuff will be selected for laboratory testing of hydrologic properties. The Laboratory will identify cores up to 1 ft in length for hydrologic testing. In addition, R-26 cores at depths of 10, 20, 30, 40, 50, 75, 100, 125, 150, 175, 200, 225, and 250 ft will be sampled for anions, moisture content, and stable isotopes (hydrogen and oxygen) to estimate recharge rates. Moisture-content samples will be collected in the same 8-oz preweighed glass jar as the anion profile samples (Table 4).

At R-2, R-4, and R-11, moisture profiles in the vadose zone will be determined by collecting core samples between ground surface and specified target depths for each borehole. General target depths applied to collecting moisture content samples are 10, 20, 30, 40, 50, 75, 100, 125, 150, 175, 200, 225, 250, 275, 300, 325, and 350 ft (Table 4). In R-2 and R-4, coring will terminate after the upper perched zone in the Puye Formation is fully penetrated, but coring will not exceed 300 ft. In R-11, coring will terminate after the top 50 ft of Cerros del Rio basalt is penetrated, but coring will not exceed 350-ft depth. Moisture content samples will be collected in the same 8-oz preweighed glass jar (Table 4) as the anion/cation profile samples described in Section 4.0, Geochemical Characterization, of this SAP.

3.2 Saturated Zones

The depth and evidence for the occurrence of all saturated zones will be noted during drilling by the contractor. Boreholes will be drilled as open borehole, if feasible, using air with minimal fluids. The open hole will facilitate the use of borehole geophysics, which can be used to characterize moisture distribution and identify perched groundwater in the vadose zone and the regional water table. Evidence of saturation during drilling may include driller's observations of water production in the borehole, wet cuttings or core when drilling dry, open-borehole videos showing zones of flowing groundwater, and geophysical logs.

When the regional water table is first encountered, the contractor will measure a static water level using an electric water-level meter and/or a pressure-transducer system. Water levels will be recorded to the nearest 0.01 of a foot and recorded as depth below ground surface (bgs). If a graduated water-level probe is not used, fractions of a foot will be determined using a measuring tape. To ensure accuracy, individual measurements will be repeated until three reproducible results are obtained. To ensure that water-level values are static, measurements will be repeated every 15 min until results are reproduced within .5 ft (all readings will be recorded). Water-level measurements will be provided to the Laboratory/DOE within 12 hr of collection. Water-level data will include the following eight observations, which must be included in the data sheet provided in Appendix B, Water-Level Measurement Data Sheet:

1. borehole TD,
2. casing TD (if applicable),
3. amount of open hole (borehole TD – casing TD),
4. depth to water (ft bgs),
5. date,
6. drilling activity prior to water-level measurement,

7. time elapsed before water-level measurement was made, and
8. additional relevant comments.

As far as possible, the hydraulic properties of regional aquifer materials will be investigated using straddle-packer/injection, pumping, or slug tests. Hydrologic test design will be based on the final well configuration and the productivity of the screen during well development.

Appropriate SOPs for hydrologic tests as well as American Society for Testing and Materials (ASTM) SOPs (ASTM 1994) will be followed. Only potable water will be used for injection tests, and a volume equal to three times that introduced will be pumped from the well after testing to minimize dilution of the native groundwater. Tracers (e.g., potassium bromide) may be used to tag drilling water or water injected during testing. To facilitate making a decision to end the test, a real-time plot of results will be constructed on the site.

4.0 GEOCHEMICAL CHARACTERIZATION

Drilling characterization wells R-2, R-4, R-11, and R-26 will provide an opportunity to evaluate the natural and contaminant chemistry of both the unsaturated and saturated hydrogeologic materials in three wet canyons. Groundwater encountered at these well sites will be sampled for selected inorganic and organic chemicals and radionuclides.

4.1 Anion, Cation, Metal, Stable Isotope, and Tritium Profiles and Contaminant Characterization of Core Samples Within the Unsaturated Zone

Core for geochemical characterization will be collected at wells R-2, R-4, R-11, and R-26. Core samples will be collected between ground surface and specified target depths for each borehole (see Tables 1 and 4). General target depths applied to geochemical sampling in all four boreholes are 10, 20, 30, 40, 50, 75, 100, 125, 150, 175, 200, 225, 250, 275, 300, 325, and 350 ft. In R-2 and R-4, coring will terminate after the upper perched zone in the Puye Formation is fully penetrated, but coring will not exceed 300 ft. In well R-11, coring will terminate after the top 50 ft of Cerros del Rio basalt is penetrated, but coring will not exceed 350-ft depth. In R-26, the core target depth is 250 ft.

Core and cutting samples will be analyzed for selected radionuclides and stable isotopes. Analyses of anions, including perchlorate and nitrogen isotopes, and metals and cations will be performed on leachate formed from a deionized water slurry of the homogenized core samples. If core cannot be collected from the target depths listed in Table 4, the cation and radionuclide analyses will be performed on unsieved cuttings collected from the same target depths in the Phase II borehole; samples for anion and metal analyses will not be collected from drill cuttings, because they are strongly affected by drilling fluids. Solid samples will be identified, labeled, and handled through normal chain-of-custody control. Table 4 identifies the container and preservation requirements for core and cutting samples. Table 6 lists the analytical suites, analytical methods, and estimated detection limits (EDLs) for geochemical and contaminant characterization of cutting and core samples.

Table 6
Analyses of Core and Cuttings Samples

Analyte	EDL[a]	Analytical Technique	Analytical Method
Anions and Cations[b]/Stable Isotopes			
Bromine, chlorine, fluorine, iodine, nitrate, nitrite, oxalate, phosphate, sulfate	0.02 mg/L	IC	SW-846-EPA Method 300
Perchlorate	0.004 mg/L (GEL[c]) 0.002 mg/L (EES-6[d])	IC	SW-846-EPA Method 300 LCMS/MS (if available through GEL)[e]
Arsenic, strontium, uranium	0.001 mg/L	Inductively coupled mass spectrometry (ICPMS)	SW-846-EPA Method 6020
Aluminum, calcium, iron, magnesium, manganese, sodium, potassium	0.01 mg/L	Inductively coupled optical emission spectroscopy (ICPOES)	SW-846-EPA Method 6010B
$^{18}O/^{16}O$	n/a[f] (permil)	Isotope ratio mass spectrometry	Generic – oxygen isotope ratio
$^{2}H/^{1}H$	n/a (permil)	Isotope ratio mass spectrometry	Generic – deuterium ratio
Nitrogen Isotopes	n/a (permil)	Isotope ratio mass spectrometry	Generic – nitrogen isotope ratio
Contaminant Characterization Constituents			
Tritium	700 pCi/L	Liquid scintillation counting	EPA Method 906.0
Tritium	0.5 pCi/L	Direct counting or electrolytic enrichment	Generic low-level tritium
Americium-241	0.05 pCi/g	α-spectrometry	HASL-300: americium-241
Plutonium-238	0.05 pCi/g	α-spectrometry	HASL-300: isotopic plutonium
Plutonium-239,240	0.05 pCi/g	α-spectrometry	HASL-300: isotopic plutonium
Strontium-90	0.5 pCi/g	Gas proportional counting	EPA Method 905.0
Technetium-99	5 pCig	Gas proportional counting	HASL-300: Technetium-99
Uranium-234	0.1 pCi/g	α-spectrometry	HASL-300: isotopic uranium
Uranium-235	0.1 pCi/g	α-spectrometry	HASL-300: isotopic uranium
Uranium-238	0.1 pCi/g	α-spectrometry	HASL-300: isotopic uranium
Gamma spectroscopy	1.0 pCi/g	γ-spectroscopy	EPA Method 901.1

[a] EDL= listed as milligrams per liter for anions and picocuries per gram for radionuclide constituents except tritium (which is listed in picocuries per liter) in extracted or leached water.

[b] Anion and cation analyses will be performed on the leachate formed from a deionized water slurry of the homogenized core sample at EES-6.

[c] GEL = General Engineering Laboratory.

[d] EES-6 = Earth and Environmental Sciences Hydrology, Geochemistry, and Geology Group.

[e] LCMS = liquid chromatography mass spectrometry; used for low-level perchlorate analysis (0.25 µg/L).

[f] n/a = Not applicable.

Solid samples will be submitted to the Laboratory's Earth and Environmental Sciences (EES) Division's Hydrology, Geochemistry, and Geology (EES-6) Group, and to appropriate off-site laboratories for various

analyses. Core samples will be analyzed for moisture content at EES-6 and General Engineering Laboratory (GEL) (tritium analyses). These samples will be placed in preweighed jars provided by the Laboratory. After moisture content has been determined, these samples will be analyzed for anions (bromide, chloride, fluoride, iodide, nitrate, nitrite, oxalate, perchlorate, phosphate, and sulfate) at EES-6 using ion chromatography (IC). Other analytes and parameters include percent or fraction of solid organic carbon, tritium, technetium-99, uranium-234, uranium-235, uranium-236, uranium-238, and stable isotopes of hydrogen and oxygen.

4.2 Hydrochemistry and Contaminant Characterization Within Perched Zones and Regional Aquifer

4.2.1 Cuttings or Core Samples

Core or cutting samples may be collected within perched zones and the regional aquifer provided drilling methods are conducive to such sampling. The Laboratory will identify the depth intervals of core or cuttings samples that will be collected for geochemical and contaminant characterization within water-bearing zones encountered during drilling at each well site. A minimum of two samples will be collected from each saturated zone encountered during drilling, if possible. Up to 3.5 L of unsieved cuttings will be collected for each sample. Sample testing will include selected radionuclides, stable isotopes, cations, metals, and anions. Samples will be identified, labeled, and handled through normal chain-of-custody control. Table 4 identifies the container and preservation requirements for core and cutting samples. Table 6 lists the analytical suites, analytical methods, and detection limits for geochemical and contaminant characterization of cuttings and core samples collected within perched zones and the regional aquifer.

4.2.2 Groundwater Samples

Saturated conditions are anticipated within the Cerros del Rio basalt and Puye Formation at the proposed well sites. Groundwater screening samples provide an early indication about whether contaminants could be present in perched and regional groundwater before routine characterization samples are collected from the completed well. Depending on the number of perched-water zones encountered, up to five groundwater samples may be collected for analysis of various constituents at each well site. Table 7 provides information about containers, preservation, and volumes of groundwater samples. If perched water is encountered within the unsaturated zone, one groundwater sample will be collected within up to three perched zones. Groundwater samples will be collected within the regional aquifer at the regional water table and at the borehole TD, if feasible.

Water samples will be filtered and acidified at EES-6 prior to delivery to the Sample Management Office (SMO) for processing. Samples should be delivered to EES-6 within 2 hr of collection during normal working hours. Samples that cannot be delivered during normal working hours must be delivered to EES-6 the following morning, after being stored overnight at 4°C in coolers.

When groundwater is encountered, the Laboratory will be notified to determine if groundwater in the borehole should be collected. Groundwater will be analyzed for perchlorate, low-detection tritium, gamma spectroscopy, americium-241; plutonium-238; plutonium-239,-240; strontium-90; technetium-99; uranium-234; uranium-235; uranium-238; bromide, chloride, fluoride, nitrate, nitrite, oxalate, phosphate, sulfate, uranium, target analyte list metals, and stable isotopes of hydrogen, oxygen, and nitrogen.

Table 7
Containers, Preservation, and Volumes of Groundwater Samples

Number of Water Samples	Analyte	Container	Preservation	Filtered through Acetate 0.45 micrometer?	Volume (L)	Laboratory	Archive Sample	Archival Sample Volume (L)
Up to 3 perched and 2 regional	Metals/cations (dissolved)	250-mL plastic	Nitric acid to pH 2, 4°C	Yes	0.25	EES-6	No	No
Up to 3 perched and 2 regional	Anions (dissolved)	250-mL plastic	None	Yes	0.25	EES-6	No	No
Up to 3 perched and 2 regional	Perchlorate, IC and/or LCMS/mass spectrometry	1-L	None	No	1.0	GEL	No	No
Up to 3 perched and 2 regional	Technetium-99 (total)[a]	1-gal. plastic	Hydrochloric acid to pH 2, 4°C	No	4.55	GEL	Yes	4.55
Up to 3 perched and 2 regional	Gamma spectroscopy, americium-241; cesium-137; plutonium-238, plutonium-239,240; uranium-234, uranium-235, uranium-238; strontium-90 (total)	1-gal. plastic	Nitric acid to pH 2, 4°C	No	4.55	GEL	Yes	4.55
Up to 3 perched and 2 regional	Stable isotopes ($^{18}O/^{16}O$, D/H)	30-mL glass w/poly-seal cap	Ambient temperature	No	0.03	Geochron[b]	Yes	0.03
Up to 3 perched and 2 regional	Nitrogen isotopes	1-gal. plastic	Hydrochloric acid to pH 2, ambient temperature	No	3.8	Coastal[c]	Yes	3.8
Up to 3 perched and 2 regional	Tritium (low-level screening)	500-mL poly	Ambient temperature	No	0.5	University of Miami	Yes	0.5
Up to 3 perched and 2 regional	ARS[d] gross alpha, gross gamma plus ARS gross gamma (R-2, R-4, and R-11 only)	500-mL poly	Ambient temperature	No	0.5	TA-21 count laboratory	Yes	0.5
							Sample volume (L) for archived samples	14

[a] For analysis of technetium-99, sample will settle to separate solids from aqueous phase prior to acidification with nitric acid. Water can be pumped from the container using a parastatic pump.

[b] Geochron = Geochron Laboratory.

[c] Coastal = Coastal Science Laboratory.

[d] ARS = American Radiation Services of New Mexico.

Groundwater samples will be collected according to the following guidelines.

- If casing-advance is used, the depth to the bottom of casing and depth to groundwater will be recorded on the sample collection log for each sample.
- The contractor will ensure that the sample collection, chain-of-custody, and routing to analytical laboratories are properly documented through paperwork provided by the RRES-RS central data management group.
- To minimize drill-rig down-time, water samples will be collected from the cyclone or other appropriate means.

Additional guidelines to be followed for groundwater sampling, field-parameter measurement, and sample preservation include the following.

- Record in the sample collection log the date, time, borehole inner diameter, depth to water prior to sampling, and the depth at which water entered the borehole.
- Record drilling fluids and additives in the borehole at the time of water collection.
- Prevent groundwater samples from freezing or overheating.
- Obtain air-lifted groundwater samples to collect approximately 7 gal. of groundwater, if practical.
- Immediately record field-measured parameters for groundwater samples (Table 8); see pertinent procedures in Appendix A and the appropriate vendor manual for instrument calibration for field measurement of pH, temperature, specific conductance, and turbidity.
- Filter and preserve selected groundwater samples at EES-6 analytical laboratory for anions and metals (Table 4). Collect appropriate volume (0.5 to 1 L, depending on turbidity or amount of suspended solids) of groundwater for filtering.
- Fill appropriate sample containers with nonfiltered groundwater (Table 7).
- Preserve nonfiltered samples with nitric acid (radionuclides) to pH 2 for samples sent to GEL (see Table 7).
- Place labels and custody seals on each sample container.
- Preserve samples on ice (4°C) prior to shipment and analysis.
- Transport samples to EES-6 and the SMO in coordination with the central data management group to provide the electronic and paper chain-of-custody for transfer of samples to the SMO.
- Transport the indicated sample portion to the count laboratory, American Radiation Services of New Mexico (ARS) for radiological screening required prior to sample shipment from the SMO.
- Send properly preserved archival samples to be held at the Laboratory-designate facility for possible reanalysis needs (Table 7); retention period for samples will be 6 months for radiological constituents, metals, and anions and 1 yr for tritium.

Samples of groundwater encountered at each R-well will be submitted to GEL and other laboratories for the analyses shown in Table 7. Table 9 shows the total volumes of water required for a complete suite of analyses and for archival purposes. Table 8 specifies chemical parameters to be measured in the field.

Table 8
Parameters to be Measured in the Field During Groundwater Sampling

Measurement	Sensitivity[a]
pH	±0.02
Carbonate alkalinity	1 mg $CaCO_3$/L
Specific conductance	±1 µmho/cm (25°C)
Temperature	±1 °C
Turbidity (nephelometric)	±1 NTU[b]

[a] Precision with which measurement will be recorded.
[b] NTU = nephelometric turbidity unit.

Table 9
Total Volumes of Water Required for Complete Suite of Analyses

Groundwater Sample	Volume (L)	Archived Sample	Volume (L)	Total Volume (L)	Plus NMED split (25%) (L)
Nonfiltered	11.13	Nonfiltered	14	25.13	6.3
Filtered	0.50	Filtered	0	0.50	0.13
Total	11.63	Total	14	25.63	6.4

5.0 GEOPHYSICAL CHARACTERIZATION

Geophysical logs will be collected as specified by the technical advisory team leader to determine the geologic and hydrologic characteristics of the vadose zone, perched saturated zones, and regional aquifer, if required. Calibration licensing of radioactive source tools and logging will be performed in accordance with ASTM D5753-95e1, "Standard Guide for Planning and Conducting Borehole Geophysical Logging." Borehole and well geophysical data will be obtained from the following two sources.

- Using the Laboratory's geophysical logging equipment, Laboratory/contractor personnel may collect video, caliper, spontaneous potential, single-point resistance and induction (conductivity), and natural gamma radiation (NGR) surveys when conditions permit the collection of open-borehole data.
- A wire-line logging service will be contracted to obtain a suite of borehole geophysical logs once the borehole reaches TD; drilling conditions will determine whether the borehole is open or cased at the time of logging.

The number and types of logs will vary as a function of borehole condition, the presence or absence of drill or well casing, and technical issues addressed by a particular logging run. Table 10 gives typical suites of logs that have been run by wire-line logging services in cased and open boreholes during installation of previous hydrogeologic work plan wells (LANL 1998, 59599). General logging information and borehole conditions at the time of logging will be documented in the log header form and the borehole status form (Appendix C, Geophysics Data Sheets).

Kleinfelder may perform geophysical logging in open boreholes using the Laboratory's geophysical logging equipment, at the request of DOE. Such requests will be limited in number and generally correspond to changes in drilling conditions that require advancement of casing through open-borehole segments. Kleinfelder will follow the SOP governing the operation of a Laboratory-owned borehole logging trailer (Appendix A).

A borehole video log will be collected at the completion of well installation to document the as-built condition of installed well components. The natural gamma tool will be used to check tagged depths of annular fill materials. Additional borehole videos may be run during and after well development to assess the effectiveness of development techniques.

Table 10
Typical Wire-Line Logging Service Geophysical Logging Tools

Tool/Log Type	Cased Borehole	Open Borehole	Purpose
Array Induction Tool (AIT)		X	Measures open-hole formation conductivity with multiple depths of investigation at varied vertical resolution.
Triple LithoDensity tool (TLD)	X	X	Evaluates formation porosity where grain density can be estimated.
Combinable Magnetic Resonance tool (CMR)		X	Provides information on water content and relative abundance of hydrous minerals and capillary-bound versus mobile water.
Natural Gamma Tool	X	X	Used to distinguish lithologies by their gross gamma signature; also used to calibrate depth of other geophysical tool readings.
Natural Gamma Ray Spectrometry tool (NGS; also called the spectral gamma tool)	X	X	Used to distinguish lithologies where formations vary in relative and overall concentrations of potassium, thorium, and/or uranium.
Epithermal Compensated Neutron Log (CNL)	X	X	Measures moisture content in unsaturated conditions and porosity in saturated conditions.
Caliper		X	Measures rugosity of borehole wall.
Fullbore Formation Microimager (FMI)		X	Provides high-quality image of borehole; used to determine lithologies, bedding attitudes, fracture characteristics, and borehole deviation.
Elemental Capture Spectrometer (ECS)	X	X	Determines formation lithology from bulk geochemistry; primary use in determination of elemental concentrations of silicon, calcium, iron, thallium, and gadolinium.
Dipole Sonic Imager (DSI)	X		Measures depth-dependent travel time and attention of an acoustic signal in the borehole; primary use is to calibrate surface seismic surveys; also can be used to characterize mechanical properties of rock and fractures.
Borehole Compensated Sonic (BHC)		X	Measures depth-dependent travel time and attention of an acoustic signal in the borehole; primary use is to calibrate surface seismic surveys; also can be used to characterize mechanical properties of rock and fractures.

Note: Blank cells indicate logging services that are not appropriate for the borehole conditions.

6.0 DOCUMENTATION AND REPORTING

Information generated in conjunction with the installation of these wells will be presented or preserved in various reports and records described below.

6.1 Field Documentation

Table 11 lists documentation that will be completed during the course of fieldwork. The content and format of most of these documents are well established. However, to ensure consistency in the sample collection logs, team members must include

- well number,
- sample identification (ID),
- location ID number (if necessary),
- sample type (D = drill cuttings; C = core),
- upper and lower depth of interval sampled (in feet), and
- purpose (Geo = geology, Hydro Prop = hydraulic properties, and Geochem = geochemical analysis).

The identified individual or his or her approved designee will complete all documentation at the frequency given. Documentation will be relinquished to the field team manager (FTM) daily or as needed.

Table 11
Required Field Documentation

Documentation	Responsible Kleinfielder Person	Frequency
Daily activity report (see Appendix D)	FTL	Daily
FTM logbook	FTM	Daily
Driller's log	Driller	Daily
Geological field log	FTM/geologist/task leader	As needed
Sample collection log	Sampler	As needed
Chain-of-custody, request for analysis	Sampler/FTM/task leader	As needed
Tailgate meeting attendance form	SSO/FTM	Daily
Visitor's sign-in log	SSO/FTM	Ongoing
Miscellaneous waste management forms	Waste manager	As needed
Weekly summary report	FTM	Weekly
Field photographs	All	As needed
Water level measurement data sheet (see Appendix B)	FTM	As needed
Pipe tally sheets	FTM	Ongoing
Borehole status form (geophysics) (see Appendix C)	Geologist/technician	As Needed
Borehole geophysical logs	Technician performing logging	Within 5 days of logging
Well summary fact sheet	FTM/FTM	Within 5 days of completing well installation
As-built well design drawing	FTM	As needed

6.2 Submittal of Information Management Data Sheets

In addition to the records cited above in the Section 6.1, Field Documentation, the contractor will complete information management data sheets (Table 12) and submit them to the Laboratory data steward. These data sheets summarize drilling information for each well in a form that can be captured by the Laboratory's information management system. Examples of the data sheets are provided in Appendix D.

Table 12
Information Management Forms

Name of Form	Description
Drilling Associated Activities	Captures all drilling, drill casing, and surface casing related information.
Borehole Status (see Appendix C)	Captures status of the borehole at the time of geophysical/video logging runs.
Log Header (see Appendix C)	Captures logging detail. A new form should be filled out for each logging run.
Well Construction	Captures all production casing, centralizer, steel tab, screen, and annular information associated with well construction.
Well Development	Captures all well-development activities, including methods and field-parameter measurements.
Pump Installation	Captures all non-Westbay pump installation information.
Surface Completion	Captures all surface completion information.

Note: The forms will be part of a controlled logbook.

The field geologist is responsible for completing the forms as work progresses. The contractor FTM is responsible for checking the accuracy and completeness of the completed forms. The FTM then submits the completed forms to the Laboratory data steward. The drilling-associated activities, borehole-status, log-header, well-construction, pump-installation, and surface-completion forms can be submitted electronically and by hardcopy (Appendix D). The FTM also will submit paper borehole geophysical logs to the Laboratory data steward and notify the Laboratory data steward when the logs become available electronically.

6.3 Well Summary Fact Sheets

A well summary fact sheet for each well will be submitted to the technical advisory team leader. The fact sheet requires information on

- well owner,
- location,
- drilling contractor,
- well construction and geology,
- water-bearing strata,
- contaminants detected in screening samples, and
- other general information (drilling method, depth to water, etc.).

6.4 Well Completion Reports

A well completion report for each of the four wells will be prepared after completion of well installation activities. Kleinfelder is responsible for compiling and assembling the well completion reports. The reports will include summaries of drilling, well construction, development, wellhead protection, site restoration, waste management, radiological and geodetic surveys, and lithologic logs.

6.5 Submission of Records to Records Processing Facility

At the conclusion of field activities for each well, the contractor will transmit all logs, notebooks, data sheets, and records assembled for the readiness review and for the field and drilling operations to the RRES-RS Records Processing Facility. Records submitted to the RPF must be hard copy originals or copies that meet the RPF clarity requirements for lifetime retention and dual storage of records.

7.0 REFERENCES

ASTM (American Society for Testing and Materials), 1994. "ASTM Standards on Groundwater and Vadose Zone Investigations," sponsored by ASTM Committee on Rock and Soil (D-18), Philadelphia, Pennsylvania. (ASTM 1994)

ASTM (American Society for Testing and Materials), 1995. "ASTM D5753-95e1 Standard Guide for Planning and Conducting Borehole Geophysical Logging", sponsored by ASTM Committee on Rock and Soil (D-18), Philadelphia, Pennsylvania. (ASTM 1995)

ASTM (American Society for Testing and Materials), 2000. "ASTM Standard Specification for Portland Cement," developed by ASTM Subcommittee: C01.01, West Conshohocken, Pennsylvania. (ASTM 2000)

LANL (Los Alamos National Laboratory), November 1995. "Task/Site Work Plan for Operable Unit 1049: Los Alamos Canyon and Pueblo Canyon," Los Alamos National Laboratory Report LA-UR-95-2053, Los Alamos, New Mexico. (LANL 1995, 50290)

LANL (Los Alamos National Laboratory), May 22, 1998. "Hydrogeologic Workplan," Los Alamos, New Mexico. (LANL 1998, 59599)

Purtymun, W. D., January 1995. "Geologic and Hydrologic Records of Observation Wells, Test Holes, Test Wells, Supply Wells, Springs, and Surface Water Stations in the Los Alamos Area," Los Alamos National Laboratory report LA-12883-MS, Los Alamos, New Mexico. (Purtymun 1995, 45344)

Appendix A

Pertinent Procedures

Procedure	Title
SOP-01.02, Rev.1, ICN1	Sample Containers and Preservation
SOP-01.03, Rev.2, ICN2	Handling, Packaging, and Shipping of Samples
SOP-01.04, Rev.5, ICN1	Sample Control and Field Documentation
SOP-01.06, Rev.2;	Management of Environmental Restoration Project Waste
SOP-01.08, Rev.1	Field Decontamination of Drilling and Sampling Equipment
SOP-01.10, Rev.1	Waste Characterization
SOP-04.01, Rev.2	Drilling Methods and Drill Site Management
SOP-04.04, Rev.2	Contract Geophysical Logging
SOP-05.01, Rev.3	Well Construction
SOP-05.07, Rev.0	Operation of LANL Owned Borehole Logging Trailer
SOP-06.02, Rev.2	Field Analytical Measurements of Groundwater Samples
SOP-07.02, Rev.1	Water Level Measurements
SOP-07.03, Rev.1	Slug Tests
SOP-07.04, Rev.2	Pumping Tests
SOP-09.10, Rev.0	Field Sampling of Core and Cuttings for Geological Analysis
SOP-12.01, Rev.4	Field Logging, Handling, and Documentation of Borehole Materials
SOP-12.02, Rev.4	Transportation, Receipt, and Admittance of Borehole Samples to the Field Support Facility
SOP-12-.04, Rev.2	Physical Processing, Storage, and Examination of Borehole Material at the FSF
QP-5.3, Rev.3, ICN 2	Readiness Planning and Review

Appendix B

Water-Level Measurement Data Sheet

APPENDIX A
Water-Level Measurement Data Sheet

Borehole TD (ft)	Drill Casing TD (ft)	Open Hole (ft)	Depth to Water (ft bgs)	Date/time	pre-DTW Activity	Time Since Activity (hr)	Comments

Appendix C

Geophysics Data Sheets

BOREHOLE STATUS FORM

To be filled out by drilling engineer or site geologist

Logging Date: ___/___/___ Borehole / Well Name: _____

Contractor: _____

Well Status: ☐ Open Hole ☐ Completed ☐ Other _____

Number of Concentric Casing(s): _____ Current Borehole Depth_____ft

Casing Top Depth						
Casing Bottom Depth						
Casing Inside Diameter						
Casing Wall Thickness						
Casing Type/Material						
Bit Size						
From						
To						
Cement Plugs						
From						
To						

Type of Fluid in Hole: _____ Fluid Level: _____ft.

Casing Collars: ☐ Yes

Average Spacing: _____ft.

Shoes: ☐ Yes

Other Materials in Hole:

_____From_____To_____ft.

_____From_____To_____ft.

_____From_____To_____ft.

Reason for running log:

Comment:

Form Completed By: _____ LANL Observer: _____

QA Reviewer: _____

LOG HEADER FORM

Fill out one form for each logging run

Logging Date: __/__/__ Borehole / Well Name: _____

Contractor: _____ Operator: _____

Run Number: _____ Logging Vehicle Number: _____

LANL Logging Trailer ☐

Logging Tool(s) ☐Gamma Ray ☐Induction/Resistivity ☐ Caliper ☐ Borehole Video Camera _____

☐Neutron ☐Hole Deviation ☐Other

Electronic File Name: _____ Format
(LAS, txt, etc.):

Null Value (*If Applicable*): _____

Start Time: _____ End Time: _____

Measuring Point Description: ☐GL (Ground Level) *Measure from Ground Level when possible*

☐Other _____

Measuring Point Relative to Ground Level: _____ft

Log Run Through: ☐ Casing ☐ Annular Space ☐ Tremie ☐ Open Hole

Bottom Log Depth: _____ft Top Log Depth: _____ ft

Quality of Log: ☐Good ☐Fair ☐Poor

Quality Comment (*Required for Fair or Poor*):

Calibration Note:

Logger Remarks:

Form Completed by: _____LANL Observer: _____

QA Reviewer: _____

Appendix D

Information Management Data Sheets

DRILLING ASSOCIATED ACTIVITIES

Provide all depth measurements with respect to ground surface

WELL NAME: _____ Submittal Date _____
Drilling Company _____ Field Geologist/Info Source _____
Field Support Company _____ QAed By _____

DRILLING

Each column represents a new drilling phase. A new drilling phase is defined by change in drilling method, rig type, bit diameter, and/or fluid type. Please refer to the attached list for drilling method, rig type and fluid type options.

Begin Date/Time						
End Date/Time						
Top Depth(ft)						
Bottom Depth(ft)						
Drilling Method[1]						
Rig Type[2]						
Bit Diameter(in)						
Fluid Type[3]						

CASING (Drill Casing and Surface Casing)

Each column represents different casing. Please refer to the attached list for casing type and joint type options.

Begin Install Date						
End Install Date						
Begin Removal Date						
End Removal Date						
Casing Type[4]						
Top Depth(ft)						
Bottom Depth(ft)						
Joint Type[5]						

For Surface Casing: Material used to case it in _____
Top Depth _____ ft Bottom Depth _____ ft
Hole Diameter _____ in
Material installation Begin Date _____ End Date _____

Comments:

WELL CONSTRUCTION

Provide all depth measurements with respect to ground surface

All information required except where italicized

WELL NAME: _____ Submittal Date _____

Drilling Company _____ Field Geologist/Info Source _____

Field Support Company _____ QAed By _____

PRODUCTION CASING

Each column represents different casing. *Provide removal dates only if applicable.*

Please refer to the attached list for casing type and joint type options.

Begin Install Date						
End Install Date						
Begin Removal Date						
End Removal Date						
Casing Type[4]						
Top Depth(ft)						
Bottom Depth(ft)						
Inner Diameter(in)						
Outer Diameter(in)						
Casing Material[5]						
Joint Type[5]						

CENTRALIZER or STEEL TAB

Each column represents centralizer or tab information.

	Centralizer					
Provide all depths (ft)						
Material (S or SS)						

	Steel Tab					
Provide all depths (ft)						
Material (S or SS)						

SCREEN

Each column represents different screen. Please refer to the attached list for screen type, screen material, and joint type options.

Screen Common Name						
Install Date						
Screen Type[6]						
Screen Material[7]						
Open Top Depth(ft)						
Open Bottom Depth(ft)						
Inner Diameter(in)						
Outer Diameter(in)						
Slot Size(in)						
% Open Area Per Ft						
Joint Type[5]						

ANNULAR FILL

Each column represents different annular fill. Provide geophysics depths only if applicable.

Please refer to the attached list for annular material and annular material function options.

Tagged Top Depth(ft)						
Tagged Bottom Depth(ft)						
Geophysics Top Depth(ft)						
Geophysics Bottom Depth(ft)						
Annular Material[8]						
Annular Material Function[9]						
Hole Diameter(in)						
Begin Date						
End Date						
Calculated Volume (ft^3)						
Actual Volume (ft^3)						

Comments:

WELL DEVELOPMENT (Cover Page)

Well Name: _____ Submittal Date: _____
Drilling Company: _____ Field Geologist/Info Source: _____
Field Support Company: _____ QAed By: _____
Predevelopment Water Level (ft): _____

DEVELOPMENT METHODS

WB (Wirebrushing - Enter begin and end times only)
Bail (Bailing - Measure/record parameters only for the first and last bail; bail after non-pumping methods)
Jet (Jetting - Enter date, time and water injected)
Surg (Surging - Enter begin and end times only)
Swab (Swabbing - Enter date, time and water injected)
Pump (Pumping - Measure/record parameters at regular intervals)

DEVELOPMENT TOOLS

PerfP (Perforated Pipe usded for jetting)
Nozzle (Nozzles used for jetting)
SingleWL (Single block on wireline used for surging)
SingleR (Single block on drill rod used for surging)
SingleBP (Single block with bypass used for swabbing)
Single (Single block without bypass used for swabbing)
DoubleBP (Double block with bypass used for swabbing
Double (Double block without bypass used for swabbing

Screen #	Date	Time	Development Method	Development Tool	Total volume withdrawn / Injected (gal)	pH	Temp (°C)	SC (mS/cm)	Turbidity (NTU)	Comments (water/ sediment observations: color, smell, particulates, etc.)

PUMP INSTALLATION

Provide all depth measurements with respect to ground surface

WELL NAME: _____ Submittal Date _____

Field Support Company _____ Field Geologist/Info Source _____

QAed By _____

_____

Installation Company _____

Installation Start Date/Time _____

Installation End Date/Time _____

Intake Depth (Ft) _____

Manufacturer _____

Model _____

Horsepower _____

Pump Capacity (gal/min) _____

Power Source _____

Riser Diameter (in) _____

Comments:

SURFACE COMPLETION

Provide all depth measurements with respect to ground surface

WELL NAME:	_____	Submittal Date	_____
Drilling Company	_____	Field Geologist/Info Source	_____
Field Support Company	_____	QAed By	_____
Surface Pad Install Date	_____	Completion Depth(ft)	_____
Surface Pad Thickness(in)	_____	Site Restoration Start Date	_____
Surface Pad Length(ft)	_____	Site Restoration End Date	_____
Surface Pad Width(ft)	_____		

Comments:

Definitions

Drilling Method[1]	Rig Type[2]	Fluid Type[3]	Casing Type[4]	Joint Type[5]	Screen Type[6]	Screen Material[7]	Annular Material[8]	Annular Material Function[9]
A (Auger)	**T-4** (T-4 Ingersol Rand)	**A** (Air)	**S16** (Surface Casing: 16"OD, 15½"ID, low-carbon steel)	**20W** (20FT Welded)	**PB** (Pipe based)	**SS304** (304 Stainless steel)	**B** (Bentonite)	**B** (Backfill)
CA (Casing Advance)	**T685** (Schramm T685)	**AW** (Air with Water)	**S18** (Surface Casing: 18"OD, 17½"ID, low-carbon steel)	**API L/T** (API Long Thread, external collar)	**MSPVC** (Machine Slotted PVC)	**PVC** (Polyvinyl-chloride)	**C** (Cement)	**FP** (Filter Pack)
C (Coring)	**UDR1000** (Universal Drill Rig 1000)	**AWB** (Air with Water and Bentonite)	**11-3/4DC** (Drill Casing: 11¾"OD, 10¾"ID, low-carbon steel)	**FC** (Flush Coupled)	**WR** (wire wrapped, 304 stainless steel)		**CB** (Cement with Bentonite)	**S** (Seal)
OH (Open-Hole)	**DR24D** (Dual Rotary 24D Foremost)	**AWBLA** (Air with Water, Bentonite, Liqui-Trol, & Attack Foam)	**13-3/8DC** (Drill Casing: 13$^{3}/_{8}$"OD, 12$^{3}/_{8}$"ID, low-carbon steel)	**FJT** (Flush Joint Threaded)			**W/G** (Ungraded washed gravel upto 3/8)	
CS (Continuous Sampler)	**CME750** (Central Mining Equipment 750: CME75 drill system mounted on an all terrain vehicle)	**AWBSL** (Air with Water, Bentonite, Soda Ash, & Lost Circulation Material)	**13-5/8DC** (Drill Casing: 13$^{5}/_{8}$"OD, 12$^{5}/_{8}$"ID, High grade tempered carbon steel-N80 grade)	**M3** (Matrix 3 lead)			**6/9** (Sand (6/9))	
	SS-15 (StrataStar brand, can core and auger shallow depth)	**AWBTF** (Air with Water, Bentonite, Tork Ease, and Fiberous material)	**9-5/8DC** (Drill Casing: 9$^{7}/_{8}$"OD, 8$^{3}/_{8}$"ID, High grade tempered carbon steel-N80 grade)	**PE** (Plain End)			**8/12** (Sand (8/12))	
	T70-W (Dresser brand rotary rig capable of air, mud, and Stratex casing advance drilling)	**AWBTQ** (Air with Water, Bentonite, Tork Ease, Quick Foam, E-Z- Mud, & Fiberous material)	**6-5/8UR** (Under Reaming ODEX Pipe: 6$^{5}/_{8}$"OD, 5$^{5}/_{8}$"ID, High grade tempered carbon steel-P110 grade)	**RC** (Regular Coupling)			**6/9+8/12** (Sand Combination (6/9+8/12))	
	CME75 (Central Mining Equipment 75)	**AWE** (Air with Water and E-Z Mud)	**8-5/8UR** (Under Reaming ODEX Pipe: 8$^{5}/_{8}$"OD, 7$^{5}/_{8}$"ID, High grade tempered carbon steel-P110 grade)				**20/40** (Coarse Sand (20/40))	
	F-10 [Failing - 10 (Core/Auger Rig)]	**AWQ** (Air with Water and Quick Foam)	**9-5/8UR** (Under Reaming ODEX Pipe: 9$^{7}/_{8}$"OD, 8$^{3}/_{8}$"ID, High grade tempered carbon steel-N80 grade)				**30/70** (Fine Sand (30/70))	
	F-2500 [Failing-2500 (Rotary air/mud Rig)]	**AWQE** (Air with Water, Quick Foam and E-Z Mud)	**10-3/4UR** (Under Reaming ODEX Pipe: 10¾"OD, 9¾"ID, High grade tempered carbon steel-N80 grade)				**S** (Mixed fine (30/70) and coarse sand (20/40))	
		AWQET (Air with Water, Quick Foam, E-Z Mud and Tork Ease)	**11-3/4UR** (Under Reaming ODEX Pipe: 12"OD, 10½"ID, High grade tempered carbon steel, N80 grade)				**SL** (Slough)	
		AWT (Air with Water and Tork Ease)	**12-3/4UR** (Under Reaming ODEX Pipe: 12¾"OD, 12"ID, High grade tempered carbon steel-N80 grade)					
		AWTE (Air with Water, TORKease ploymer, and EZ-MUD)	**14UR** (Under Reaming ODEX Pipe: 14"OD, 13$^{1}/_{3.7}$"ID, High grade tempered carbon steel-N80 grade)					
		NONE	**API L/T 8** (API 8 round long thread: 5"OD, 4½"ID, stainless steel)					
		W (Water)	**MS5** (Mild Steel 5"OD, 4$^{1}/_{3}$"ID, 40 low-carbon steel)					
			MS5.56 (Production Casing: 5.56"OD, 5"ID, Schedule 40 low-carbon steel casing)					

DAILY ACTIVITY / QUALITY CONTROL REPORT (12HR)

WELL NAME & LOCATION:	FOOTAGE LAST 24 HOURS:	REPORT DATE:
TA-	TOTAL DEPTH AT END OF REPORT TIME:	REPORT NUMBER:

CONTRACTOR:	DRILLING SUBCONTRACTOR, RIG TYPE, & DRILLER:

AM WEATHER:	PM WEATHER:	PRECIPITATION:	MAX TEMP: °F	MIN. TEMP: °F

DRILL RIG(S) USED

EQUIPMENT DESCRIPTION	Last 12 Hr Shift			Total Since Project Start		
	Operational	Non-operational	Downtime/ Maintenance	Operational	Non-operational	Downtime/ Maintenance

DESCRIPTION OF DAILY ACTIVITIES (include fluid level meas. data:

CASING/BIT SIZE INFORMATION

Casing Type	Casing Size	Bit Type	Bit Size	Depth From	Depth To

JOB SAFETY	YES	NO
SAFETY MEETING HELD TODAY? if YES, attach a copy of meeting minutes		
ANY LOST TIME ACCIDENTS? if YES, attach copy of completed report(s), OSHA 200 log, et al		
TRENCHING/CAFFOLDING/HIGH VOLTAGE ELECTRICAL/ELEVATED WORK/WELDING PERFORMED? if YES, include copy of report(s) of inspection(s) performed by competent or qualified person(s)		
ANY SPILLS OR HAZARDOUS WASTE RELEASED TO THE ENVIRONMENT? if YES, include copy of completed reports indicating response action(s) and notification(s)		
ANY VIOLATIONS OF JOB SAFETY RULES OBSERVED? if YES, include copy of completed reports indicating response action(s)		
DISCUSSION OF SAFETY ACTIONS/INSPECTIONS CONDUCTED: See attached Tailgate Safety Meeting, Daily Safety Inspection, Drill Rig Inspection and Heavy Equipment Checklists		

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DRILL FLUID/ADDITIVE(S) SUMMARY (include potable water)

MATERIAL DESCRIPTION	QUANTITY	QUANTITY USED LAST 12 HR SHIFT	CUMULATIVE QUANTITY USED

FIELD SCREENING

EQUIPMENT CALIBRATION(S)

SAMPLES COLLECTED (inc. duplicates, splits, etc.)

WASTE/DRILLING MEDIA GENERATION

TYPE/DESCRIPTION	QUANTITY LAST 12 HR SHIFT	CUMULATIVE QUANTITY ON SITE

GEOPHYSICAL/BOREHOLE VIDEO SURVEYS CONDUCTED (list also depth interval logged, TD of borehole, fluid levels, etc)

SIGNATURE OF SITE SUPERVISOR	DATE

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