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Date: May 16, 2002
Refer to: ER2002-0360

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

SUBJECT: SAMPLING AND ANALYSIS PLAN (SAP) FOR THE DRILLING AND TESTING OF LANL REGIONAL AQUIFER CHARACTERIZATION WELL R-14

Dear Mr. Young:

Enclosed are two copies of the SAP for the Drilling and Testing of LANL Regional Aquifer Characterization Well R-14. We anticipate that the drilling portion of this work will begin on Tuesday, May 28, 2002.

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

Sincerely,

David McInroy, Acting Program Manager
Environmental Restoration Project
Los Alamos National Laboratory

Sincerely,

Everett Trollinger, Project Manager
Department of Energy
Office of Los Alamos Site Operations

DM/DB/th

Enclosure: SAP for the Drilling and Testing of LANL Regional Aquifer Characterization Well R-14 (ER2002-0278)

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Los Alamos National Laboratory

SAMPLING AND ANALYSIS PLAN FOR THE DRILLING AND TESTING OF LANL REGIONAL AQUIFER CHARACTERIZATION WELL R-14

Environmental Restoration Project

Groundwater Investigations Focus Area

April 2002

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ACRONYMS AND ABBREVIATIONS

API	American Petroleum Institute
AR	Air Rotary
ASTM	American Society for Testing and Materials
BUS	Business operations
DOE	Department of Energy
EDL	Estimated detection limit
EES	Earth and Environmental Sciences
EM&R	Emergency Management and Response
EPA	Environmental Protection Agency
ER	Environmental Restoration
ESH	Environmental Safety and Health
FAPL	Focus Area Project Leader
FIP	Field Implementation Plan
FPL	Field Project Leader
FSF	Field Support Facility
FTL	Field Team Leader
FTM	Field Team Manager
GIT	Groundwater Integration Team
HSA	Hollow-stem auger
HASP	Health and Safety Plan
ID	Inner diameter
LANL	Los Alamos National Laboratory
MCL	Maximum contaminant level
MSCT	Mechanical sidewall-coring tool

MWIP	Monitoring Well Installation Project
NGR	Natural gamma radiation
NOI	Notice of intent
NMED	New Mexico Environment Department
NTU	Nephelometric turbidity units
PMC	Project Management Company
QA	Quality assurance
OD	Outer diameter
RLWTF	Radioactive Liquid Waste Treatment Facility
RSP	Radiological Screening Personnel
SAP	Sampling and Analysis Plan
SMO	Sample Management Organization
SSO	Site Safety Officer
SSHASP	Site Specific Health and Safety Plan
SOP	Standard Operating Procedure
TA	Technical Area
TD	Total depth
TL	Team Leader
WCSF	Waste Characterization Strategy Form
WGII	Washington Group International, Incorporated
XRD	X-ray diffraction spectroscopy
XRF	X-ray fluorescence analysis

OVERVIEW

Well R-14 is being installed by the Nuclear Weapons Infrastructure, Facilities, and Construction Program as part of the implementation of the Groundwater Protection Management Program's Hydrogeologic Workplan (LANL 1998, 59599). This well is intended to provide hydrogeologic and water-quality data for regional groundwater near contaminant release sites in Mortandad and Ten Site Canyons. This well will also determine contaminant distributions in the upper part of the vadose zone. The data on perched groundwater and contaminant distributions will be used with similar data from wells R-13, R-15, MCOBT-4.4, and MCOBT-8.5 to improve the conceptual model for hydrogeology and hydrochemistry in the vicinity of Mortandad Canyon. These data also provide constraints on numerical models addressing contaminant migration in the vadose zone and the regional aquifer.

R-14 is located in Ten Site Canyon, a major tributary to Mortandad Canyon (Figure 1). R-14 is downgradient of the active radioactive liquid waste treatment facility (RLWTF) at TA-50 and of former radioactive liquid waste and septic treatment facilities at TA-35.

R-14 will be drilled in two phases. Phase I will consist of coring to a depth of about 300 ft to characterize the vertical contaminant profiles in the vadose zone beneath Ten Site Canyon. Phase II will consist of overdrilling the Phase I borehole and extending the borehole to a TD of 1664 ft. A multisceen well with the Westbay sampling system will be installed in the completed borehole to provide geochemical and hydrological characterization of the regional aquifer.

INTRODUCTION

Well R-14 is being installed by the Environmental Restoration (ER) Project for the Nuclear Weapons Infrastructure, Facilities, and Construction Program as part of the Groundwater Protection Management Program's Hydrogeologic Workplan (LANL1998, 59599).

This Sampling and Analysis Plan (SAP) provides guidance to the subcontractor field support team for the testing and development activities for this characterization well. This 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 the SAP is to ensure consistency and quality of characterization data. Unless otherwise noted, all tasks in this SAP shall be performed by the subcontractor.

Summary of Data Quality Objectives

From a groundwater perspective, the potential sources of groundwater contamination of most concern at R-14 are the present-day radioactive liquid waste treatment plant at TA-50 and the former radioactive liquid waste treatment plant at TA-35. R-14 is primarily designed to determine the impact of effluent discharges on groundwater quality in the near-source region cross gradient of the TA-50 liquid waste treatment facility. Liquid discharges from TA-50 enter Mortandad Canyon via the small Effluent Canyon tributary. The Mortandad Canyon stream channel probably serves as a line source of recharge to deeper groundwater systems, and a well located on the canyon floor is the preferred site for determining near-source impacts from TA-50. However, because of the steep topography and narrowness of Mortandad Canyon in this area, R-14 is sited to the south, as close as possible to Mortandad Canyon. The R-14 site in Ten Site Canyon will also provide information about contaminants being drawn towards water supply well PM-5, which is located approximately one mile to the east-southeast. Although focused on

characterizing the impacts of TA-50 releases, this site report also provides information about groundwater impacts due to effluent releases from the former radioactive liquid waste treatment plant and the former septic waste treatment system at TA-35.

The Laboratory's radioactive liquid waste treatment facility (RLWTF) at TA-50 discharges treated wastewater to Mortandad Canyon via Effluent Canyon through an outfall that is currently permitted as NPDES outfall 051. From 1963 to 1995, a total of 342 million gal. (1,294,500 m^3) of treated wastewater was discharged (LANL 1997, 56835). Laboratory surveillance data collected in Mortandad Canyon show elevated concentrations or activities of NO_3, ^{3}H, ^{90}Sr, ^{137}Cs, $^{239,240}Pu$, ^{241}Am, and $^{234,235,238}U$ in ephemeral surface water and in alluvial groundwater.

From 1951 to 1963, the Laboratory operated a radioactive wastewater treatment plant at TA-35. Routine and accidental discharges from the wastewater treatment plant resulted in release of contaminants to Ten Site Canyon. Contaminants of potential concern associated with the TA-35 wastewater plant include ^{140}La, ^{140}Ba, ^{89}Sr and ^{90}Sr, ^{90}Y, ^{137}Cs, ^{106}Ru, ^{238}Pu, $^{239,240}Pu$, caustic, acid, sodium carbonate, strontium nitrate, iron sulfate, and dielectric oil (LANL 1997, 56835). By the early 1960s, the wastewater treatment plant at TA-35 reached its capacity to handle the increasing volume of liquid radioactive wastes associated with expanding Laboratory operations. In 1963, TA-35 wastewater operations were transferred to a new RLWTF at TA-50.

R-14 is designed to collect hydrogeologic and water-quality data for the vadose zone, for the intermediate-depth perched groundwater, and for the regional groundwater system. This information is needed to determine the extent to which contaminants from Laboratory operations in Mortandad and Ten Site Canyons are moving downward through the vadose zone and potentially affecting the water quality of intermediate-depth perched groundwater. Ultimately these data are needed to constrain numerical models addressing contaminant migration through the vadose zone and assessing future impacts to the regional aquifer. These data are also relevant to groundwater investigations of the ER's Mortandad Canyon work plan (LANL1997, 56835) and the pending TA-50 groundwater discharge application.

These goals will be accomplished by collecting geologic and geophysical information about perched groundwater occurrences, installing well screens within the regional aquifer, collecting groundwater to determine water quality, and collecting core samples to determine vertical distributions of contaminants and moisture through the vadose zone. Information for the site-wide 3-D geologic model will be provided by examining and interpreting the cuttings and core.

Location

Characterization well R-14 is located adjacent to the stream channel in the upper part of Ten Site Canyon, just south of a narrow ridge that separates Ten Site and Mortandad Canyons (Figure 1). This location was selected because of the lack of access to Mortandad Canyon downgradient of the TA-50 outfall. The selected location is approximately 850 ft south of the Mortandad Canyon stream channel and 20 ft north of the Ten Site stream channel. It is approximately 3,575 ft east-southeast of the confluence of Effluent and Mortandad Canyons and 5,200 ft west-northwest of well R-15.

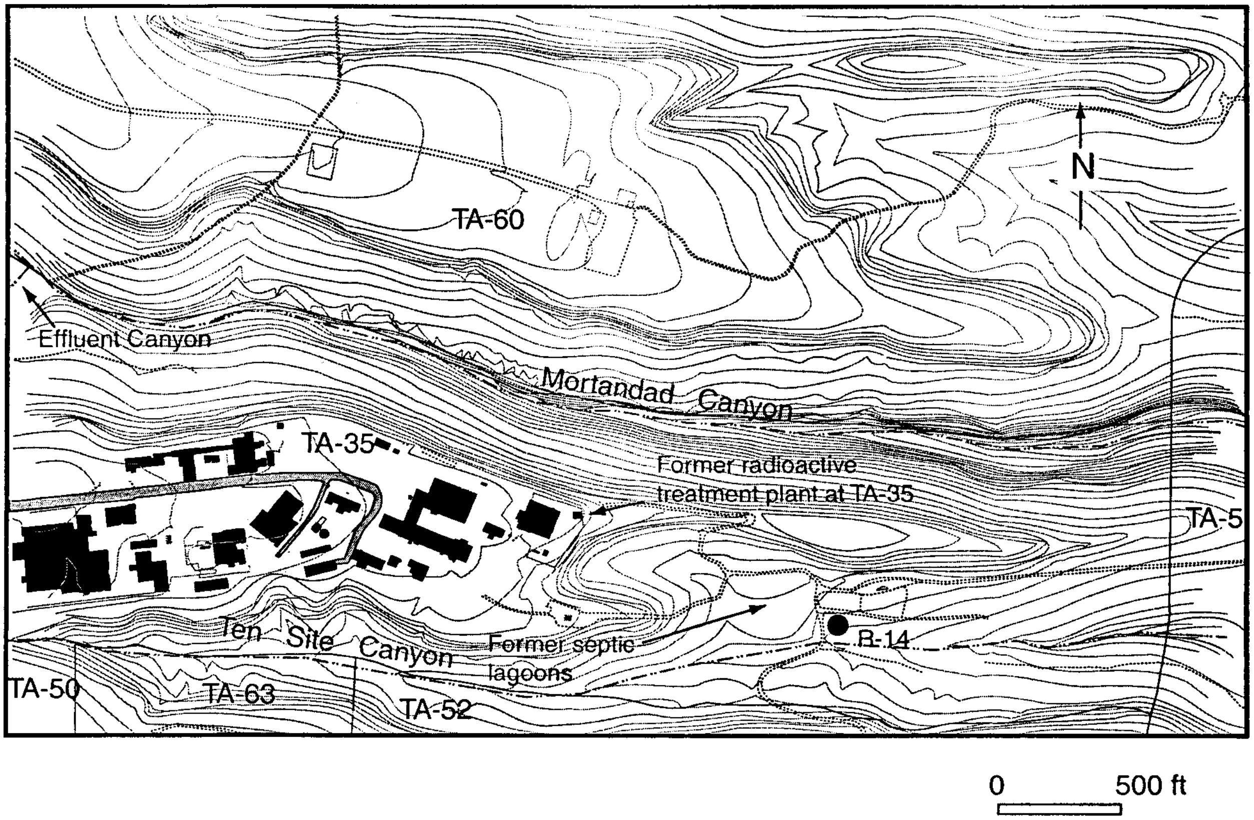

Figure 1. Map showing the location of R-14

Roles and Responsibilities

The functional organization of the R-14 implementation is illustrated in Figure 2. The roles and responsibilities for the investigation team are shown in Table 1.

Health and Safety

All fieldwork shall be conducted in accordance with LANL ER Project Health and Safety Plan (HASP) and the Site Specific Health and Safety Plan (SSHASP) #273 and modifications, and LANL ESH ID Nos. 01-0230.

In the event of an accident or emergency, the following initial contacts will be made:

Contact	*Phone Number (see Table 1 for additional numbers)*
(1) Emergency services, if necessary	911
(2) EM&R	667-6211
(3) FAPL (John McCann)	665-1091/104-8207
(4) FTL Operations (Steve Pearson)	667-3005/699-3684
(5) FTM/FTL (Andy Crowder)	662-1338/780-2975
(6) FMU-80 Facility Manager (Charles Trujillo)	667-0491

Additional notifications per SSHASP #273 will be made by the above listed individuals.

Quality Assurance

The subcontractor is responsible for conducting all procurement, field operations, and drilling in accordance with its own internal Quality Assurance Program. LANL personnel are required to perform work under the ER quality assurance program.

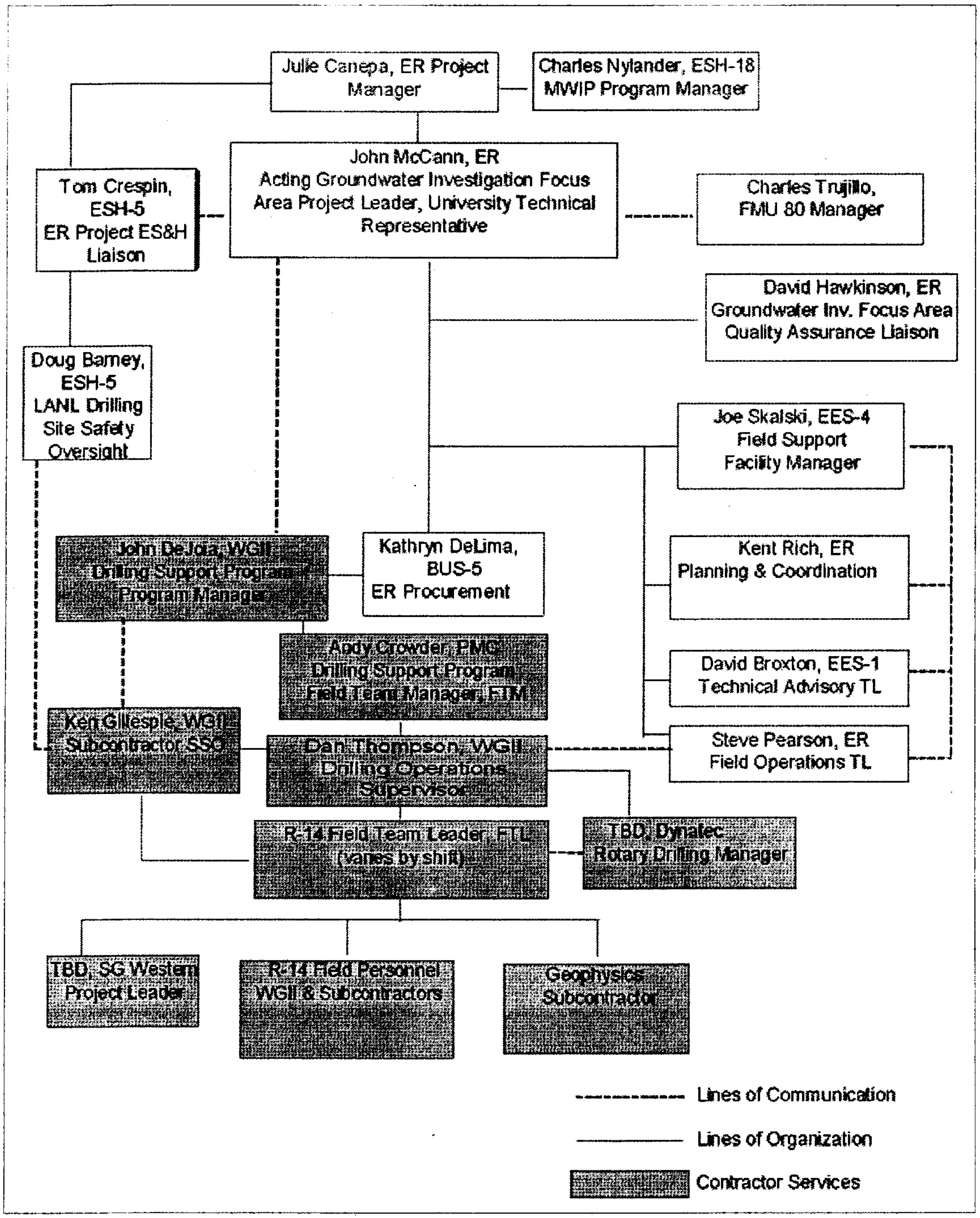

Figure 2. Functional organization of R-14 personnel

Table 1
Roles and Responsibilities

Personnel	Phones/Pager	Org.	Position	Project Responsibilities
Julie Canepa	667-4109 (work)	LANL/ER	ER Project Manager	Responsible for Monitor Well Installation Program construction
Charles Nylander	665-4681 (work) 699-1568 (cell.)	LANL/ ESH-18	Monitor Well Installation Program Manager	Responsible for Monitor Well Installation Program management
John McCann	665-1091 (work)	LANL/ E/ET	Groundwater Focus Area Project Leader (FAPL)	The FAPL is the LANL line manager for well installation and University Technical Representative for the drilling contract
John DeJoia	662-1359 (work)	WGII	WGII Program Manager	Overall WGII/PMC Team program management; responsible for implementation of drilling and field support contract and for the success of the drilling program
TBD		Dynatec	Drilling Manager	Drill team manager and drilling program design and implementation
Kent Rich	665-4272 (work)	LANL/ ER	Groundwater Focus Area Planning and Coordination Team Leader	Responsible for baseline development, project status, and project schedule development
Steve Pearson	667-3005 (work) 104-4525 (page) 699-3684 (cell.) 955-1793 (home)	LANL/ ER	Groundwater Focus Area Field Operations Team Leader	Provides LANL oversight field and drilling activities; coordinates activities of LANL technical team and contractor field support staff
David Broxton	667-2492 (work) 104-3994 (page) 699-0950 (cell.)	LANL/ EES-6	Groundwater Focus Area Technical Advisory Team Leader	Responsible for the design and implementation of the testing program
Mat Johansen	665-5046 (work)	DOE	DOE Oversight	Liaison between DOE and LANL
Patrick Longmire	665-1264 (work) 699-1987 (cell.) 104-3993 (page)	LANL/ EES-6	Groundwater Focus Area Geochemistry Task Leader (TL)	Provides technical leadership for geochemical characterization

Personnel	Phones/Pager	Org.	Position	Project Responsibilities
William Stone	665-8340 (work)	LANL/ EES-5	Groundwater Focus Area Hydrology Task Leader (TL)	Provides technical leadership for hydrologic characterization and well development
David Vaniman	667-1863 (work) 104-7019 (page) 699-1079 (cell.)	LANL/ EES-6	Groundwater Focus Area Geology Task Leader (TL)	Provides technical leadership for geologic characterization
Joe Skalski	667-2876 (work) 996-0891 (page) 672-9060 (home)	LANL/ EES-4	Field Support Facility (FSF) Manager	Provides drilling support and on-site management of the FSF
Andy Crowder	662-1338 (work) 104-3968 (page) 780-2975 (cell.) 983-6643 (home)	PMC	Field Team Manager/ Field Team Leader (FTM/FTL)	Drilling Contract Task Manager
Mark Everett	662-1322 (work) 698-2281 (page) 780-2973 (cell.) 986-8186 (home)	WGII	FTL/Geologist	Oversight of on-site field support activities
Doug Barney	665-5132 (work) 104-5506 (page) 753-9741 (home)	LANL/ ESH-5	LANL Safety Oversight	Responsible for LANL oversight of site safety
Ken Gillespie	662-1306 (work) 780-2905 (cell.)	WGII	SSO	Responsible for contractor site safety
Rene Evans	662-1337 (work)	WGII	Waste Manager	Responsible for on-site waste management
TBD		LANL/ER	Sample Management Task Leader	Responsible for coordinating analytical lab procurements, and sample shipping/receiving
Mark Everett		WGII	Geophysical Support	Responsible for contract issues and deliverables for geophysical logging services

Personnel	Phones/Pager	Org.	Position	Project Responsibilities
Roy Bohn	665-5138 (work) 996-3547 (pgr.)	E/ER	Waste Management Coordinator	Oversight of on-site waste management
Kathryn DeLima	665-3899 (work)	BUS-5	Procurement	Responsible for contract issues
Charles Trujillo	667-0491 (work)	LANL/ FWO-UI	FMU 80 Facility Manager	Landlord for FMU 80
David Hawkinson	667-0207 (work)	LANL/ER-QII	Groundwater Inv. Focus Area QA Liaison	Oversight of LANL and contractor implementation of QA program.
Dan Thompson	662-1332 (work) 780-2898 (cell)	WGII	Drilling Supervisor	Manage day-to-day drilling operations

Waste Management

A site-specific Waste Characterization Strategy Form (WCSF) describes the on-site management of groundwater and cuttings as well as the temporary storage of wastes that are pending waste characterization and/or disposal in accordance with appropriate regulatory requirements. ESH-18 has prepared and submitted a notice of intent (NOI) to discharge drilling water, development water, and purge water on the site to the New Mexico Environment Department (NMED) (ESH-18/WQ&H: 01-234).

GEOLOGIC CHARACTERIZATION

R-14 will provide additional information on the geologic setting in Mortandad Canyon. Predicted depths to geologic contacts are shown in Table 2 and Figure 3.

During drilling, an estimated 500- to 700-ml of bulk drill cuttings shall be collected every 5 ft for the total depth of the boring for geologic characterization (Table 3). 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 the footage range for the box. The core boxes will be transported to the Field Support Facility (FSF) for archiving and storage after the borehole is completed.

Table 2
Projected Depth to Stratigraphic Contacts in R-14

Rock Unit Name	Symbol (Figure 3)	Top (ft)	Bottom (ft)	Thickness (ft)	Comments
Tshirege Member, Bandelier Tuff	Qbt-2 Qbt-1v Qbt-1g Qbtt	0	199	199	Moderately welded to nonwelded ignimbrite with basal pumice fall deposit
Cerro Toledo interval	Qct	199	273	74	Volcaniclastic sediments
Otowi Member, Bandelier Tuff	Qbof	273	575	302	Nonwelded ignimbrite
Guaje Pumice Bed	Qbog	575	608	33	Pumice fall deposit
Puye Formation,	Tpf	608	737	129	Upper fanglomerate
Cerros del Rio lava	Tb	737	881	144	Mafic to intermediate lava
Puye Formation,	Tpf	881	1284	403	Lower fanglomerate
Totavi Lentil	Tpt	1284	1354	70	Ancestral Rio Grande River gravels
Santa Fe Group (?)	Tsf	1354	n/a	n/a	Terrestrial sedimentary deposits

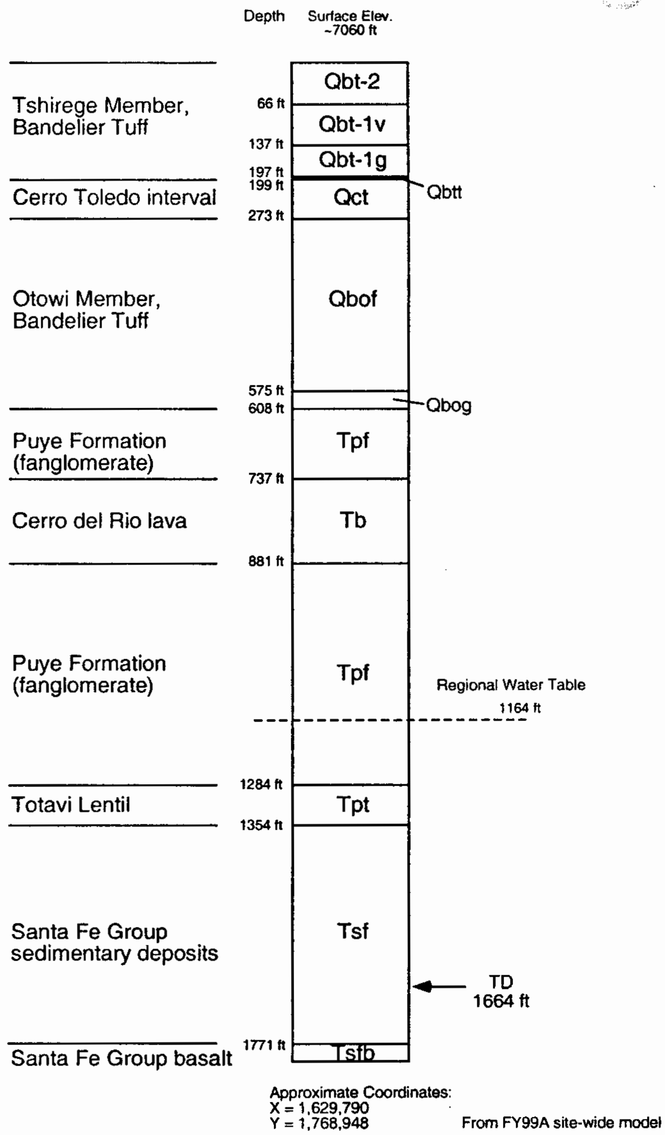

Figure 3. R-14 predicted geology from the site-wide 3-D geologic model

A subset of unsieved and sieved samples (see ER-SOP-9.10, Rev.0, Field Sampling of Core and Cuttings for Geological Analysis) will be collected from each cuttings run and stored in plastic chip trays labeled with the well name and cuttings depth ranges (Table 3). Unsieved and sieved cuttings will be placed in individual tray bins and labeled by footage and sieve size range. Sieve sizes will typically 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 every cuttings run (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 3). Finer sieve sizes or bulk cuttings will be collected when >10 mesh materials are absent. These samples will be transferred to the Geology Task Leader.

Analytical testing of samples may include mineralogy by x-ray diffraction, petrography by modal analysis of thin sections, by electron microprobe, and/or by scanning electron microscope, and geochemistry by x-ray

fluorescence (Table 3). Samples shall be identified, labeled, and handled through logbook sample control maintained by the Geology Task Leader.

Table 3
Sampling of Cuttings and Core [1]

Sample Description	Test	Sample Size	Container	Sample Frequency	Preferred Laboratory
Coring					
Core	Anions and moisture	0.4 ft of 2-in. diam. core	8 oz pre-weighed glass jar	For upper 100 ft: Every 5 ft when drilling dry; otherwise every 10 ft For below 100 ft: Every 50 ft	EES-6
Core	Tritium	0.5 ft of 2-in. diam. core	Sealed plastic bag wrapped with tape and core-protected	For upper 100 ft: Every 5 ft when drilling dry; otherwise every 10 ft For below 100 ft: Every 50 ft	GEL
Core	Radiological screening for gross alpha, beta, and gamma (for off-site transport of samples)	0.2 ft of 2-in. diam. Core	Sealed plastic bag	Every 50 ft	ARL in Los Alamos
Core	Radionuclides	0.5 ft of 2-in. diam. Core	Sealed plastic bag and core-protected	Every 10 ft for first 100 ft, then every 50 ft; also at contacts, weathered zones, fracture fills, high-moisture zones, and oxidized zones	GEL
Core	Metals	0.5 ft of 2-in. diam. core	Sealed plastic bag and core protected	Every 10 ft for first 100 ft, then every 50 ft; also at contacts, weathered zones, fracture fills, high-moisture zones, and oxidized zones	GEL
Core	Stable Isotopes	0.5 ft of 2-in diam. core	Sealed plastic bag and core protected	Every 10 ft for first 100 ft, then every 50 ft; also at contacts, weathered zones, fracture fills, high moisture zones, and oxidized zones	Geochron for δD and $\delta^{18}O$ and Coastal Sciences for $\delta^{15}N$

Drilling					
Cuttings	Bulk cuttings systematically collected for archival purposes and for supplemental sample needs	500–700 ml	Plastic Ziploc bag	One sample every cuttings run (nominally every 5 ft), beginning at the bottom of the core hole	N/A
Cuttings	Sieved cuttings for lithology description, 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, XRF, petrography	200–300 ml sieved, or bulk if necessary	Plastic Ziploc 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 Ziploc bag	Up to 5 samples for the entire borehole within water-bearing zones; sample location to be determined by the geochemistry task leader	GEL
Cuttings	Metals and Anions	1.5 L of cuttings	Plastic Ziploc bag	Up to 5 samples for the entire borehole within water-bearing zones; sample location to be determined by the Geochemistry Task Leader	EES-6

Note: N/A = Not applicable

(1) Priority of sample core collection when recovery is less than 100% should be anions, moisture, and stable isotopes, radionuclides and tritium, radiological screening, and metals.

HYDROLOGIC CHARACTERIZATION

According to the current conceptual hydrogeologic model, groundwater periodically perched in the alluvium drains into subsurface units such as the Cerros del Rio basalt and perhaps ultimately into deeper units. R-14 should provide the data necessary to test this model. Table 4 gives the number and projected positions of potential saturated zones in these wells.

Table 4
Predicted Saturated Zones at R-14

Groundwater Zone	Top (ft)	Bottom (ft)	Comments
Perched Zone 1	575	608	Perched groundwater at base of Guaje Pumice Bed
Perched Zone 2	737	881	Perched groundwater at base of Cerros del Rio lava
Regional Aquifer	1164	n/a	Estimated depth to regional water table within the Puye Formation
Regional Aquifer	1284	1354	Regional groundwater within the Totavi Lentil

Unsaturated Zone(s)

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 the geologic materials lying above perched and regional zones of saturation is important.

In addition, geophysical and video logging will be used prior to setting casing in the vadose zone, and after the borehole reaches total depth (TD) to provide hydrologic information about the vadose zone at R-14. Selection of intervals to log and the types of logs to 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. The borehole logs will also be used to supplement the saturated zone investigations described below.

Saturated Zone(s)

The depth and evidence for the occurrence of all saturated zones shall be noted by the Field Team Leader (FTL) during drilling. This includes both perched zones and the regional water table. When the regional aquifer is first encountered, the FTL shall measure a static water level using an electronic water-level meter and/or a pressure-transducer system.

The water levels shall be measured to the nearest 1/100th of a foot and recorded as depth below ground surface. If the water-level probe used is not graduated, fractions of a foot shall be determined using a measuring tape. To assure *accuracy*, individual measurements shall be repeated until reproducible results are obtained. To assure that water-level values are *static*, measurements shall be repeated every 15 minutes until results are reproduced within 0.2 ft (all readings shall be recorded). Water–level

measurements shall be conducted according to SOP-07.02,R1. The Contractor Field Team Leader/Geologist shall be responsible for transmitting this information to the Groundwater Focus Area Field Operations Team Leader and the Groundwater Focus Area Hydrology Task Leader on the same day the data are collected. The water-level data shall record the following eight observations:

(1) Borehole TD

(2) Casing TD (if applicable)

(3) Amount of open hole (borehole TD – casing TD)

(4) Depth to water (feet below ground surface)

(5) Date

(6) Drilling activity prior to water level measurement

(7) Time elapsed before water level measurement was made

(8) Additional relevant comments

As far as possible, hydraulic properties of materials in the regional water table shall be investigated using in situ methods. The Hydrology Task Leader shall design and conduct slug or pumping tests once the well is completed.

Appropriate Standard Operating Procedures (SOP) for well slug tests and aquifer pumping tests as well as ASTM SOPs (ASTM 1994) shall be followed. Water level shall be allowed to recover to a static level but shall be verified before the test. Only potable water shall be injected for slug tests. Tracers (e.g., potassium bromide) may be used to tag drilling water or water injected during testing. Recovery water-level data will be collected by a transducer. To facilitate making the decision to end the test, a real-time plot of results shall be constructed on site.

GEOCHEMICAL CHARACTERIZATION

The drilling of characterization well R-14 provides the opportunity to evaluate the natural and contaminant chemistry of groundwaters and saturated geologic materials within Ten Site Canyon and Mortandad Canyon. During drilling operations, the Geochemistry Task Leader will determine which core, cuttings, and groundwater samples will be selected for geochemical and contaminant characterization. The locations for samples will depend on the hydrologic and geologic conditions found during drilling. Once the Geochemistry Task Leader identifies samples for collection, the FTL will collect the samples and submit them for analysis through the FSF.

Anion, Stable Isotope, and Tritium Profile Core Samples

During coring, anion, stable isotope, radionuclide, and tritium profiles will be determined from the level of the canyon floor to the upper part of the Otowi Member (approximately 300 ft in depth) according to the schedule provided in Table 3. Table 5 lists the analytical suites, analytical methods, and detection limits for characterization of the core samples.

Contaminant Characterization Core and Cuttings Samples

Up to five core or cuttings samples will be collected for geochemical and contaminant characterization within water-bearing zones encountered during drilling. When water is encountered the Geochemistry Task Leader and Field Operations Team Leader shall be notified to determine if groundwater in the borehole should be collected. Up to 3.5 L of unsieved cuttings will be collected for each sample (Table 3). Sample testing shall include radionuclides, metals, and anions. Samples shall be identified, labeled, and handled through normal chain-of-custody control. Table 5 lists the analytical suites, analytical methods, and detection limits for geochemical and contaminant characterization of cuttings and core samples.

Table 5
Analysis of Cuttings and Core

Analyte	EDL[a]	Analytical Method[b]	Analytical Protocol
Anions[c]/ Stable Isotopes/ ^{3}H Profiles			
Bromide	0.02	IC	SW-846 – EPA Method 300
Chloride	0.02	IC	SW-846 – EPA Method 300
Fluoride	0.02	IC	SW-846 – EPA Method 300
Nitrate plus nitrite	0.02	IC	SW-846 – EPA Method 300
Sulfate	0.02	IC	SW-846 – EPA Method 300
Perchlorate	0.004 (GEL)	IC	SW-846 – EPA Method 300
	0.002 (EES-6)		LCMS (if available through GEL)[d]
TKN	0.1	Titration distillation	SW-846 – EPA Method 351
$^{18}O/^{16}O$	N/A	Isotope Ratio	N/A
D/H	N/A	Isotope Ratio	N/A
$^{15}N/^{14}N$	N/A	Isotope Ratio	N/A
^3H	300 pCi/L	LSC	N/A
Contaminant Characterization Constituents			
^{241}Am	0.01	α-Spectrometry	N/A
^{238}Pu	0.1	α-Spectrometry	N/A
$^{239,240}Pu$	0.1	α-Spectrometry	N/A
^{90}Sr	2	GPC	N/A
^{234}U	0.1	α-Spectrometry	N/A
^{235}U	0.1	α-Spectrometry	N/A
^{238}U	0.1	α-Spectrometry	N/A
Gamma spectroscopy	1.0	γ-Spectroscopy	N/A
Gross alpha	10	α-Spectrometry	N/A
Gross beta	10	GPC or LSC	N/A
Gross gamma	2.0	NaI(Tl) HPGe detection	N/A

a EDL=estimated detection limit; listed as (mg/kg) for metals, mg/L for anions, and pCi/g for radionuclide constitutents except for tritium (pCi/l) extracted water.

b Analytical Methods - IC=ion chromatography, C=colormetric analysis, LSC=liquid scintillation counting, GPC=gas proportional counter, NaI(Tl)=thallium-doped sodium iodide, HPGe=high-purity germanium.

c Anion analyses will be performed on the leachate formed from a deionized water slurry of the homogenized core sample.

d LCMS=liquid chromatography mass spectrometry.

Groundwater Samples

Up to three borehole groundwater screening samples will be collected for geochemical and contaminant characterization during drilling. These samples will target groundwater in the perched zone(s) and in the regional aquifer. These 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. Table 6 lists the analytical suite, sample volumes, and containerization requirements for samples to be collected. Samples shall be collected as directed by the Geochemistry Task Leader, according to these guidelines:

- When water is encountered, the Geochemistry Task Leader shall be notified to determine if groundwater in the borehole should be collected,
- If casing advance is used, the depth to the bottom of casing and depth to groundwater shall be recorded on the sample collection log for each sample.

The FTL will ensure that the sample collection, chain of custody, and routing to analytical laboratories are properly documented via paperwork provided by the ER Central Data Management Group.

For each groundwater-sampling event, field personnel shall perform the following specific activities:

- Record in the sample collection log the *date, time, borehole ID, depth to water prior to sampling, and the depth at which water entered the borehole*;
- Prevent groundwater samples from freezing or overheating;
- Obtain air-lifted groundwater samples to collect approximately 10 gal. of groundwater;
- Record immediately field-measured parameters for groundwater samples (Table 7; see ER SOP-6.02, rev.2 Field Analytical Measurement of Groundwater Samples and the appropriate vendor's manual for instrument calibration for field measurement of pH, temperature, specific conductance, carbonate alkalinity, turbidity, and dissolved oxygen);
- Filter the appropriate volume of each groundwater sample (Table 6);
- Fill appropriate sample containers with filtered and nonfiltered groundwater (Table 6);
- Preserve samples with nitric acid (metals and radionuclides) and sulfuric acid (nitrogen species) to pH 2 for samples sent to GEL (see Table 6);
- Place labels and custody seals on each sample container;
- Preserve samples on ice (4°C) prior to shipment and analyses;
- Transport the samples to the SMO at the FSF; this will require 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 lab for radiological screening required prior to sample shipment from the SMO; and

- Send properly preserved archival samples (Table 6) to be held at the FSF for possible reanalysis needs; the retention period for samples shall be 6 months for radiological constituents, metals, and anions and one year for tritium.

Table 6
Sampling and Analysis of Groundwater (4)

Estimated Number of Water Samples	Analysis	Container	Preservation	Filtered Through Acetate 0.45 Micrometer	Volume of Each Sample (L)	Preferred Laboratory	Collect Archival Sample	Archival Sample Volume (L)
3	Metals (dissolved)	100 ml plastic	HNO_3 to pH 2, 4°C	Yes	0.25	EES-6		
3	Anions (dissolved)	100 ml plastic	No field preservation	Yes	0.25	EES-6 (will filter and preserve)		
3	γ spec, ^{241}Am, ^{137}Cs, ^{238,239,240}Pu, ^{234,235,238}U, ^{90}Sr	1 gal. plastic	HNO_3 to pH 2, 4°C	No	3.78	GEL	X	3.78
3	Stable isotopes (^{18}O/^{16}O, D/H)	30 ml glass w/ poly-seal cap	Ambient temperature	No	0.03	Geochron	X	0.03
3	Stable isotopes (^{15}N/^{14}N)	1 gal. plastic	HCL or H_2SO_4 to pH 2, 4°C	No	3.78	Coastal	X	3.78
3	Tritium(1)	500 ml poly	Ambient temperature	No	0.5	GEL	X	0.5
3	Tritium (low level or direct counting) (1)	500 ml poly	Ambient temperature	No	0.5	University of Miami	X	1
3	Gross α,β ,γ (for off-site shipping)	500 ml poly	Ambient temperature	No	0.5	ARL at Los Alamos	X	0.5
3	TUICPMS(2)	500 ml poly	HNO_3 to pH 2, 4°C	Yes	0.5	EES-6	X	0.5
3	TKN	1L poly	H_2SO_4 to pH 2, 4°C (3)	No	1	GEL	X	1
3	ClO_4^-	250 ml poly	Ambient temperature	Yes	0.25	GEL	X	0.25

Estimated Number of Water Samples	Analysis	Container	Preservation	Filtered Through Acetate 0.45 Micrometer	Volume of Each Sample (L)	Preferred Laboratory	Collect Archival Sample	Archival Sample Volume (L)
				Total volume of each sample event: Filtered and nonfiltered	11.34		Total Volume of each sample event for archival storage–All Nonfiltered	11.34
				Part of Total volume to be filtered	1.25			

(1) Initially analyze tritium using liquid scintillation. If activity is less than 300 pCi/l, analyze archival sample using direct counting or electrolytic enrichment at University of Miami.

(2)TUICPMS = total uranium inductively coupled plasma mass spectrometry.

(3) No preservation for ClO_4^-; Br^{-1}, Cl^{-1}, F^{-1}, SO_4^{-2}; and PO_4^{-3}.

(4) All samples to be analyzed by EES-6 shall be delivered within 1 hour of field collection.

Table 7
Parameters to Be Measured in the Field When Sampling Groundwater

Measurement	Precision[1]
pH	±0.02
Specific conductance	±1 µmho/cm (25 °C)
Dissolved oxygen	0.1 mg/L
Carbonate Alkilinity	1mg $CaCO_3$/L
Temperature	±1 °C
Turbidity (nephelometric)	±1 NTU[2]

(1) Precision with which measurement shall be recorded

(2) NTU = Nephelometric turbidity unit

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. Borehole and well geophysical data will be obtained from two sources: (1) drilling subcontractor personnel may obtain borehole video, caliper, spontaneous potential, single point resistance and induction (conductivity), and natural gamma radiation (NGR) surveys using the Laboratory's geophysical logging

equipment (ER-SOP-5.07, Rev.0 Operation of LANL Owned Borehole Logging Trailer); and (2) a wire-line logging service will be contracted to obtain a suite of borehole geophysical logs (ER-SOP-4.04, Rev.2 Contract Geophysical 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 being addressed by a particular logging run. Table 8 gives typical suites of logs that have been run by wire-line logging services in cased and uncased boreholes during installation of previous hydrogeologic workplan wells.

A wire-line logging service shall be contracted to obtain a borehole geophysical logs twice:

(1) The hole may be logged with a comprehensive suite of tools (Table 8) before setting permanent drill casing and when TD is reached.

(2) An epithermal compensated neutron log and natural gamma log *may* be run in the completed well to document the placement of annular fill materials.

Using the Laboratory's natural gamma radiation tool and the borehole video equipment, the Contractor shall perform geophysical logging for R-14 in open boreholes after each required depth has been reached. A borehole video log shall be collected at the completion of the well installation to document the as-built condition of installed well components. The natural gamma tool shall 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 8
Typical Wire-Line Logging Service Geophysical Logging Tools

Cased Hole	***Cased Hole***	***Open Hole***	***Uncased Hole***
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

(CNL)			saturated conditions
Caliper		X	Measures rugosity of borehole wall
Mechanical Sidewall Coring Tool (MSCT)		X	Designed to retrieve multiple, high quality sidewall cores in hard formations for chemical analysis or hydraulic-property testing
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 frombulk geochemistry; primary use in determination of elemental concentrations of Si, Ca, Fe, Ti and Gd

DOCUMENTATION AND REPORTING

Information generated in conjunction with the well installation of R-14 shall be presented or preserved in various reports and records.

Field Documentation

Table 9 lists all documentation to be completed during the course of fieldwork. The contents and format of most of these documents are well established. However, to ensure consistency in the sample collection logs, team members are reminded to *include well number, sample ID, location ID (if necessary), sample type (D = drill cuttings; C = core), upper and lower depth of interval sampled (ft) and purpose (Geo = geology, Hydro Prop = hydraulic properties and Geochem = geochemical analysis).*

The identified individual or his or her approved designee shall complete all documentation at the frequency given. Documentation will be relinquished to the Field Team Manager (FTM) daily or as needed.

Table 9
Required Field Documentation

Documentation	Responsible Person	Frequency
Daily Activity Log	FTL	Daily
FTL Logbook	FTL	Daily
Driller's Log	Driller	Daily
Geological Field Log	FTL/Geologist/Task Leader	As Needed

Documentation	Responsible Person	Frequency
Drilling Additives Log	FTL/Geologist	Daily
Sample Collection Log	Sampler	As Needed
Chain of Custody, Request For Analysis	Sampler/FTL/Task Leader	As Needed
Miscellaneous Monitoring Forms	SSO/RSP	Daily
Tailgate Meeting Attendance Form	SSO/FTL	Daily
SSO Logbook	SSO	Daily
Visitor's Sign-In Log	SSO/FTL	Ongoing
Well Development Field Parameter Log	FTL	During Development
Waste Mgt. Logbook	Waste Mgr.	As Needed
Miscellaneous Waste Mgt. Forms	Waste Mgr.	As Needed
Weekly Summary Report	FTM	Weekly
Field Photographs	All	As Needed
Water Level Field Log	FTL	As Needed
Water Quality Stabilization Record	FTL	As Needed
Pipe Tally Sheets	FTL	On Going
Borehole Geophysics Forms	Technician	As Needed
Log Header Form	FTL	As Needed
Borehole Geophysical Logs	FTL	As Needed
Well Summary Fact Sheet	FTM/FTL	Within 10 days of geodetic survey

Well Summary Fact Sheet

A well summary fact sheet shall be completed and submitted to the technical advisory team leader within 10 days following geodetic survey of R-14. The fact sheet requires information on the *well owner, location,*

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

Well Completion Report

The Well Completion Report shall be prepared following demobilization and restoration of the drill site. The report, written to document not only well construction but also geologic, hydrologic, and geochemical characterization findings, shall be submitted to DOE and NMED (for information only). LANL shall be responsible for compiling and assembling the well completion report. The subcontractor is responsible for preparing the following sections of the report: drilling, well construction, development, wellhead protection, site restoration, waste management, radiological and geodetic surveys, and lithologic logs.

Submission of Records to the Records Processing Facility (RPF)

At the conclusion of field activities, the subcontractor shall transmit all logs, notebooks, data sheets, and records assembled for the readiness review and for the field and drilling operations to the ER Records Processing Facility (RPF) in accordance with Activity deliverables that are specified in the SOW for Well R-14.

References

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LANL (Los Alamos National Laboratory), September 1997. "Work Plan for Mortandad Canyon," Los Alamos National Laboratory Report LA-UR-97-3291, Los Alamos, New Mexico. (LANL 1997, 56835)

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