LA-UR-11-0189
March 2011
EP2011-0003

Completion Report for Regional Aquifer Well R-60

Prepared by the Environmental Programs Directorate

EP2011-0003

Completion Report for Regional Aquifer Well R-60

March 2011

Responsible project manager:

Printed Name	Signature	Title	Organization	Date
Ted Ball		Project Manager	Environmental Programs	3/8/11

Responsible LANS representative:

Printed Name	Signature	Title	Organization	Date
Bruce Schappell		Associate Director	Environmental Programs	3/8/11

Responsible DOE representative:

Printed Name	Signature	Title	Organization	Date
Everett Trollinger	L. A. Trujillo	Manager	DOE-LASO	3/10/11

for

EXECUTIVE SUMMARY

This well completion report describes borehole drilling, well installation, well development, aquifer testing, and dedicated sampling system installation for regional aquifer well R-60, located on the mesa at the head of Ten Site Canyon, Technical Area 50, at Los Alamos National Laboratory in Los Alamos County, New Mexico. This report was written in accordance with the requirements in Section IV.A.3.e.iv of the March 1, 2005 (revised 2008), Compliance Order on Consent. The well was installed at the direction of the New Mexico Environment Department (NMED) to monitor groundwater quality in the regional aquifer downgradient of Material Disposal Area C at Los Alamos National Laboratory.

The R-60 monitoring well borehole was drilled between September 13 and 29, 2010, using dual-rotary air-drilling methods. Drilling fluid additives included potable water and foam. Foam-assisted drilling was used only in the vadose zone and ceased approximately 100 ft above the regional aquifer. The original R-60 borehole had to be abandoned because of stuck tooling at 887 ft below ground surface (bgs). The second R-60 borehole was successfully completed to a total depth of 1418 ft bgs using casing-advance and open-hole drilling methods.

The following stratigraphy was encountered during drilling of the R-60 borehole: surficial alluvium, Tshirege Member of the Bandelier Tuff, Cerro Toledo interval, Otowi Member of the Bandelier Tuff, Guaje Pumice Bed of the Otowi Member, Tschicoma Formation, Puye Formation, and Miocene pumiceous sediments.

Well R-60 was completed with a single screen well with a 20-ft-long screened interval set from 1330 to 1350 ft bgs; the entire screen plus filter pack is within the lower portion of the Puye Formation encountered at R-60. The depth to water after well installation was 1319.5 ft bgs.

The well was completed in accordance with an NMED-approved final well design. It was thoroughly developed and the regional aquifer groundwater met target water-quality parameters. Hydrogeologic testing indicated the screened interval in monitoring well R-60 is poorly productive but will perform effectively enough to meet the planned objectives. A sampling system and water-level transducer have been placed in the well screen in the R-60 monitoring well, and groundwater sampling will be performed as part of the annual Interim Facility-Wide Groundwater Monitoring Plan.

CONTENTS

Figures

Tables

Appendixes

Acronyms and Abbreviations

amsl	above mean sea level
ASTM	American Society for Testing and Materials
bgs	below ground surface
Consent Order	Compliance Order on Consent
DO	dissolved oxygen
EES-14	Earth and Environmental Sciences Group 14
Eh	oxidation-reduction potential
EP	Environmental Programs
FD	field duplicate
FTB	field trip blank
F	filtered
gpd	gallons per day
gpm	gallons per minute
HE	high explosives
hp	horsepower
I.D.	inside diameter
LANL	Los Alamos National Laboratory
MDA	material disposal area
NAD	North American Datum
NMED	New Mexico Environment Department
NMSW	New Mexico Special Waste
NTU	nephelometric turbidity unit
O.D.	outside diameter
ORP	oxidation-reduction potential
PVC	polyvinyl chloride
Qal	alluvium
Qbo	Otowi Member of the Bandelier Tuff
Qbog	Guaje Pumice Bed of the Otowi Member of the Bandelier Tuff
Qbt	Tshirege Member of the Bandelier Tuff
Qct	Cerro Toledo interval
QP	quality procedure
RPF	Records Processing Facility
SVOC	semivolatile organic compound

TA	technical area
TD	total depth
TOC	total organic carbon
Tjfp	Miocene pumiceous sediments
Tpf	Puye Formation
Tt2	Tschicoma Formation dacitic lavas
U	unfiltered
VOC	volatile organic compound
WCSF	waste characterization strategy form
WES-EDA	Waste and Environmental Services Division–Environmental Data and Analysis
WR	whole rock
wt%	weight percent

1.0 INTRODUCTION

This completion report summarizes borehole drilling, logging, well construction, well development, aquifer testing, and dedicated sampling system installation for regional aquifer groundwater monitoring well R-60. The report is written in accordance with the requirements in Section IV.A.3.e.iv of the March 1, 2005 (revised 2008) Compliance Order on Consent (the Consent Order). The first R-60 borehole was abandoned because of stuck tooling at 887 feet (ft) below ground surface (bgs). The second successful R-60 monitoring well borehole was drilled from September 13 to 29, 2010, and the well was completed from October 6 to 18, 2010, at Los Alamos National Laboratory (LANL or the Laboratory) for the Environmental Programs Directorate.

The R-60 monitoring well is located on the mesa top at the head of Ten Site Canyon within the Laboratory's Technical Area 50 (TA-50) (Figure 1.0-1). R-60 was installed to provide hydrogeologic and groundwater data down gradient of Material Disposal Area (MDA) C (Figure 1.0-1).

The primary objective of the drilling activities at R-60 was to drill and install a single-screen regional aquifer monitoring well. Secondary objectives were to collect drill cuttings samples, conduct borehole geophysical and video logging, and investigate potential perched groundwater zones.

Drilling tools became stuck at approximately 887 ft bgs in the first borehole drilled for the R-60 monitoring well and the borehole was abandoned. The second R-60 borehole was drilled to a total depth (TD) of 1418 ft bgs. During drilling, cuttings samples were collected at 5-ft intervals in both boreholes. A monitoring well was installed with a single 20-ft-long screen set between 1330 and 1350 ft bgs. The depth to water after well installation was 1319.5 ft bgs on October 19, 2010.

Postinstallation activities included well development, aquifer testing, surface completion, geodetic surveying, and dedicated sampling system installation. Future activities will include site restoration and waste management.

The information presented in this report was compiled from field reports, logbooks, and daily activity summaries. Records, including field reports, field logs, and survey information, are on file at the Laboratory's Records Processing Facility (RPF). This report contains brief descriptions of activities with supporting figures, tables, and appendixes associated with the R-60 project. Information on radioactive materials and radionuclides, including the results of sampling and analysis of radioactive constituents, is voluntarily provided to the NMED in accordance with U.S. Department of Energy policy.

2.0 ADMINISTRATIVE PLANNING

The following Laboratory documents were prepared to guide activities associated with the drilling, installation, and sampling of regional aquifer well R-60:

- "Drilling Work Plan for Regional Aquifer Well R-60" Los Alamos National Laboratory document (LANL 2010, 109680)
- "Drilling Plan for Regional Aquifer Well R-60" (TerranearPMC 2010, 109963)
- "IWD [Integrated Work Document] for Drilling and Installation of MTOA Task Order #8 Well R-60 at LANL" (LANL 2010, 111812)
- "Storm Water Pollution Prevention Plan for SWMUs and AOCs (Sites) and Storm Water Monitoring Plan" (LANL 2006, 092600)

- "Waste Characterization Strategy Form, Amendment #2, Regional Well, MDA C, R-60" .(LANL 2011, 111800)

3.0 DRILLING ACTIVITIES

This section describes the drilling strategy and approach and provides a chronological summary of field activities conducted at monitoring well R-60.

3.1 Drilling Approach

The drilling method and selection of equipment and drill-casing sizes for the R-60 monitoring well were designed to retain the ability to investigate and case off potential perched groundwater zones above the regional aquifer, although perched water was not anticipated at this mesa-top site between relatively dry canyons. The approach also ensured that a sufficiently-sized drill casing was used to meet the required 2-in.-minimum annular thickness of the filter pack around a 5.56-in.-outside diameter (O.D.) well.

Dual-rotary air-drilling methods using a Foremost DR-24HD drill rig were employed to drill the R-60 borehole. Dual-rotary drilling has the advantage of simultaneously advancing and casing the borehole. Casing-advance drilling is required where soft and poorly consolidated formation materials underlie the Laboratory. The Foremost DR-24HD drill rig was equipped with conventional drilling rods, tricone bits, downhole hammer bits, a deck-mounted air compressor, and general drilling equipment. Auxiliary equipment included two Ingersol-Rand trailer-mounted air compressors. Three sizes of A53 grade B flush-welded mild carbon-steel casing (18-in.-, 16-in.-, and 12-in.-inside diameter [I.D.]) were used for the R-60 project.

The dual-rotary technique at R-60 used filtered compressed air and fluid-assisted air to evacuate cuttings from the borehole during drilling. Drilling fluids, other than air, used in the borehole included potable water and a mixture of potable water with Baroid AQF-2 foaming agent. The foaming agent was not used below 1235 ft bgs, roughly 100 ft above the predicted top of the regional aquifer. The total amounts of drilling fluids introduced into the borehole are presented in Table 3.1-1.

3.2 Chronological Drilling Activities for the R-60 Well

The drill pad was prepared by Laboratory personnel several weeks before mobilization of the drill rig, air compressors, trailers, and support vehicles to the drill site on July 9 and 10, 2010. Equipment and tooling were decontaminated before mobilization to the site. Alternative drilling tools and construction materials were staged at the Pajarito Road lay-down yard. Potable water used in drilling was obtained from a fire hydrant on Puye Road. Safety barriers and signs were installed around the borehole cuttings containment pit and along the perimeter of the work area.

On July 11, following on-site equipment inspections, the first R-60 monitoring well borehole was initiated at 1045 h using dual-rotary methods with 18-in. drill casing and a 17-in. tricone roller bit.

3.2.1 Drilling Activities at Original Borehole

Drilling and advancing 18-in. casing proceeded rapidly through surface alluvium and the upper portion of the Tshirege Member of the Bandelier Tuff to 200.5 ft bgs, where the casing was landed on July 15. No indications of groundwater were observed while the 18-in. casing was advanced.

On July 16, a string of 16-in. drill casing was started into the borehole. Drilling using dual-rotary methods with the 16-in. casing string and a 14.75-in. tricone bit started on July 18 at 200.5 ft bgs. Drilling progressed through the remaining portion of the Tshirege Member of the Bandelier Tuff and the Otowi Member ash flows to a depth of 478 ft bgs on July 24. No indications of groundwater were observed while the 16-in. casing was advanced.

Open-hole drilling with a 14.75-in. tricone bit commenced late in the day on July 25. Drilling progressed smoothly to the top of Tschicoma Formation dacitic lavas at a depth of 645 ft bgs on July 26. Open-hole drilling continued on July 27 with a 15-in. hammer bit and progressed through fractured dacitic lavas to 787 ft bgs, where cementing was required to stabilize the borehole. Cement was poured on July 30 from 656 to 786 ft bgs. Drilling in dacitic lavas resumed on August 2 after the cement was drilled out. The borehole was cemented again from 779 to 867 ft bgs on August 5. Drilling continued through the cemented interval and back into dacitic lavas on August 7 to a TD of 915 ft bgs. Unstable conditions in the borehole required cementing for a third time, from 789 to 906 ft bgs, on August 9.

On August 10, the 15-in. hammer bit was used to drill into the cement. At 1145 h, the drill rig lost circulation to a void in the cement, and the hammer bit became stuck in the borehole at approximately 887 ft bgs. Efforts to raise the tooling were unsuccessful. Between August 11 and 19, the borehole was cleared of slough above the stuck tooling, multiple video runs were made, but the tooling could not be removed. From August 20 to September 9, with assistance from an oilfield fishing specialist, surface and downhole jars were used during unsuccessful attempts to retrieve the stuck tooling. The decision was made to stop fishing, remove the fishing tools, and prepare to redrill a new borehole on September 9.

3.2.2 Drilling Activities at the Second R-60 Borehole

The second R-60 borehole was located approximately 50 ft west of the first borehole and was initiated at 1930 h on September 13. The drilling approach for the second borehole was to drill and ream out a pilot hole and then advance 16-in. casing into the fractured dacitic lavas to prevent cave in on the tooling. On September 13 and 14, a string of 18-in. casing was advanced to 107 ft bgs. Between September 14 and 18, a 14.75-in. pilot hole was drilled with a tricone bit to 674 ft bgs, 40 ft into the dacitic lavas and reamed with a 20.5-in.-O.D. hole-opening, tricone bit to 630 ft bgs. A string of 16-in. casing was advanced to 647 ft bgs on September 20. The dacitic lavas appeared far less fractured and oxidized than in the first borehole, and the decision was made to drill open-hole if the borehole remained stable.

A 15-in. hammer bit was used for open-hole drilling through the dacitic lavas below 647 ft bgs during the September 20 night shift. On September 21, unstable conditions in the borehole necessitated cementing from 826 to 877 ft bgs. The cement was drilled during the September 21 night shift, and fill was encountered at 867 ft bgs. Drilling continued to 885 ft bgs. On September 22, cement was again poured in the borehole from 814 to 883 ft bgs to further stabilize the borehole. The cement was drilled during the September 22 night shift, and open-hole drilling continued to 905 ft bgs, where unstable borehole conditions were again encountered and the tooling was removed from the borehole.

On September 23, the 16-in. casing shoe was cut at 636 ft bgs, and a 12-in. casing string was started into the borehole. Video, natural gamma, and induction logs were collected on September 24 in the open portion of the borehole between 646 and 901 ft bgs, and the 12-in. casing was advanced below 905 ft bgs with an underreaming hammer bit starting on September 26. Casing advance proceeded smoothly through the Puye Formation sediments, and the use of drilling foam was discontinued at 1235 ft bgs on September 28. The borehole was advanced to a TD of 1418 ft bgs on September 29 in Miocene pumiceous sediments. The 12-in. casing shoe was cut at 1401.4 ft bgs on October 4. No problems were encountered in the second R-60 borehole during 12-in. casing-advance drilling below the dacitic lavas.

During drilling, field crews worked two 12-h shifts each day, 7 d/wk. Drilling operations at R-60 encountered numerous difficulties and delays associated with stuck tooling in the first borehole caused by unstable fractured conditions in the dacite lavas.

3.2.3 Abandonment of original borehole

The Foremost DR-24HD drill rig was mobilized to the site of the original R-60 borehole on October 20 to begin borehole abandonment. The drill rods were removed from the stuck tooling on October 21, leaving approximately 19 ft of tooling and hammer bit in the borehole from approximately 868 to 887 ft bgs. The entire string of 18-in. casing was removed from the borehole on October 22. The 16-in. casing was cut on October 23 at 470 ft bgs, leaving the casing shoe and approximately 8 ft of 16-in. casing in the borehole. On October 24, 455 ft of 16-in. casing was removed from the borehole, leaving 15 ft of casing at the surface for pouring cement. On October 25, the original R-60 borehole was plugged from the top of the stuck tooling to the surface with 43 yd^3 of Portland cement sand grout.

4.0 SAMPLING ACTIVITIES

This section describes the cuttings and groundwater sampling activities for monitoring well R-60. All sampling activities were conducted in accordance with applicable quality procedures.

4.1 Cuttings Sampling

Bulk cuttings samples were collected at 5-ft intervals in the abandoned R-60 borehole from ground surface to 900 ft bgs and in the final R-60 borehole from ground surface to the TD of 1418 ft bgs. At each interval, approximately 500 mL of bulk cuttings was collected by the site geologist from the drilling discharge cyclone, placed in resealable plastic bags, labeled, and archived in core boxes. Sieved fractions (>#10 and >#35 mesh) were also collected from ground surface to TD and placed in chip trays along with unsieved (whole rock) cuttings. Sieved chip tray samples for the 0 to 900 ft bgs interval were collected from the first borehole; sieved chip tray samples for the 900 to 1418 ft bgs interval were collected from the second borehole. Recovery of cuttings samples was close to 100% (10 ft of 1418 ft was unrecovered) from the second R-60 borehole. Radiation control technicians screened cuttings before they were removed from the site. All screening measurements were within the range of background values. The core boxes and chip trays were delivered to the Laboratory's archive at the conclusion of drilling activities.

The stratigraphy of R-60 is summarized in section 5.1 and a detailed lithologic log is presented in Appendix A.

4.2 Water Sampling

One groundwater screening sample was collected on November 1, 2010, at the beginning of the second phase of well development and analyzed for anions and metals. The Laboratory's Earth and Environmental Sciences Group 14 (EES-14) conducted the anion and metals analyses.

Five samples were collected during aquifer testing, and seven samples were collected during the second phase of well development from the pump's discharge line for EES-14 analysis of total organic carbon (TOC) only. Table 4.2-1 presents a summary of screening samples collected from the completed R-60 well. The analytical results are discussed in Appendix B.

Groundwater characterization samples will be collected from the completed well in accordance with the Consent Order. For the first year, the samples will be analyzed for the full suite of constituents, including radioactive elements; anions/cations; general inorganic chemicals; volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs); and stable isotopes of hydrogen, nitrogen, and oxygen. The analytical results will be included in the appropriate periodic monitoring report issued by the Laboratory. After the first year, the analytical suite and sample frequency at R-60 will be evaluated and presented in the annual Interim Facility-Wide Groundwater Monitoring Plan.

5.0 GEOLOGY AND HYDROGEOLOGY

A brief description of the geologic and hydrogeologic features encountered at R-60 is presented below. The Laboratory's geology task leader and project site geologists examined cuttings and geophysical logs to determine geologic contacts and hydrogeologic conditions. Drilling observations, video logging, water-level measurements, and geophysical logs were used to characterize groundwater occurrences encountered at R-60.

5.1 Stratigraphy

Stratigraphic units for the R-60 borehole, drilled to a depth of 1418 ft bgs, are presented below in order of occurrence from youngest to oldest units. The stratigraphic descriptions from 0 to 645 ft bgs are based on samples collected from the first borehole, while the descriptions from 645 to 1418 ft bgs are from samples collected from the second R-60 borehole. Lithologic descriptions are based on binocular microscope analysis of drill cuttings samples collected from the discharge hose. Figure 5.1-1 shows the stratigraphy at R-60. A detailed lithologic log is presented in Appendix A.

Alluvium/Construction Fill, Qal (0–10 ft bgs)

Tuffaceous alluvium and fill consisting of mixed constituents, including abundant quartzite and rounded volcanic pebbles (typical of construction base-course gravel), were encountered from 0 to 10 ft bgs.

Unit 3, Tshirege Member of the Bandelier Tuff, Qbt 3 (10–100 ft bgs)

Unit 3 of the Tshirege Member of the Bandelier Tuff was encountered from 10 to 100 ft bgs, as interpreted from the degree of welding and rate of penetration while drilling. Unit 3 is a poorly welded ash-flow tuff (i.e., ignimbrite) that is crystal-rich, generally slightly pumiceous and lithic-poor and exhibits a matrix of fine vitric ash. The observed degree of welding varies somewhat within the section and locally ranges from moderately to poorly welded. Drill cuttings from Unit 3 typically contain abundant quartz and sanidine phenocryts and minor tuff fragments.

Unit 2, Tshirege Member of the Bandelier Tuff, Qbt 2 (100–180 ft bgs)

Unit 2 of the Tshirege Member of the Bandelier Tuff was intersected from 100 to 180 ft bgs and represents a moderately welded rhyolitic ash-flow tuff that is composed of abundant (up to 30% by volume) quartz and sanidine crystals, moderately compressed devitrified pumice lapilli, and minor volcanic lithic fragments set in a matrix of weathered ash. Cuttings typically contain abundant fragments of indurated tuff and numerous free quartz and sanidine crystals. The level of welding varies through the section from strongly welded, especially in the top 15 ft, to poorly welded.

Unit 1v, Tshirege Member of the Bandelier Tuff, Qbt 1v (180–245 ft bgs)

Unit 1v of the Tshirege Member of the Bandelier Tuff was encountered from 180 to 245 ft bgs. Unit 1v is a poorly to moderately welded rhyolitic ash-flow tuff that is pumiceous, generally lithic-poor and crystal-bearing to locally crystal-rich. Abundant ash matrix is locally preserved in cuttings. Cuttings commonly contain numerous fragments of indurated crystal-rich tuff with compressed, strongly devitrified pumice lapilli. Abundant free quartz and sanidine crystals and minor small (generally less than 10 mm in diameter) volcanic lithic inclusions also occur in cuttings.

Unit 1g, Tshirege Member of the Bandelier Tuff, Qbt 1g (245–345 ft bgs)

Unit 1g of the Tshirege Member of the Bandelier Tuff was intersected in the R-60 borehole from 245 to 345 ft bgs. Unit 1g is a poorly welded rhyolitic ash-flow tuff that is strongly pumiceous, crystal-bearing, and lithic-poor. Unit 1g cuttings locally exhibit fragments of indurated tuff near the top of the section and a lack of tuff fragments below 255 ft, suggesting poor welding below that depth.

Cerro Toledo Interval, Qct (345–450 ft bgs)

The Cerro Toledo interval, a layer of poorly consolidated volcaniclastic sediments that occurs stratigraphically between the Tshirege and Otowi Members of the Bandelier Tuff, is believed to be present from 345 to 450 ft bgs. Locally, these sediments consist of poorly sorted pebble gravels with silty fine to coarse sands comprised of volcanic and tuffaceous debris. Commonly subrounded detrital clasts are composed of various (predominantly hornblende-phyric) dacites, flow-banded rhyolite, andesite, abundant vitric pumices, and quartz and sanidine crystals. At nearby borehole R-46, the Cerro Toledo interval was thought to be considerably thicker (185 ft), but pinpointing the contacts of the unit was based partly on natural gamma log interpretation. Since the gamma log is somewhat ambiguous through this interval and Otowi Member tuffs were observed below 450 ft, the lower contact of the Cerro Toledo interval at R-60 was placed at 450 ft bgs, and the thickness of the Cerro Toledo in the surrounding area may be subject to revision.

Otowi Member of the Bandelier Tuff, Qbo (450–622 ft bgs)

The Otowi Member of the Bandelier Tuff was present in the R-60 section from 450 to 622 ft bgs. The Otowi Member is a poorly welded rhyolitic ash-flow tuff that is pumiceous, crystal-bearing, and locally lithic-rich. Abundant pale orange to white pumice lapilli noted in cuttings are typically glassy, with quartz and sanidine phenocrysts. Locally abundant volcanic lithics occur in cuttings as subangular to subrounded fragments of intermediate composition, including porphyritic dacites and andesite. Cuttings locally exhibit abundant fine volcanic ash and numerous quartz and sanidine crystals.

Guaje Pumice Bed of the Otowi Member of the Bandelier Tuff, Qbog (622–636 ft bgs)

The Guaje Pumice Bed occurred from 622 to 636 ft bgs. This pumice- and ash-fall tephra deposit forms the base of the Otowi Member. The unit contains abundant subrounded, lustrous, vitric, phenocryst-poor pumice lapilli with minor occurrences of small volcanic lithic fragments and quartz and sanidine crystals.

Tschicoma Formation Dacite Lava, Tt2 (636–880 bgs)

A thick section of generally massive, light gray dacite lava was encountered from 636 to 880 ft bgs. The dacites are generally aphanitic with rare phenocrysts of plagioclase and pyroxene. Dacite from the original borehole was highly fractured, strongly oxidized (up to 80% of chips), and posed difficult drilling conditions.

In contrast, the dacitic lava from the second R-60 borehole was more massive, less fractured and more competent with alternating intervals of weak and strong oxidation. It was highly fractured below 840 ft bgs and was strongly oxidized between 860 and 880 ft bgs. Rounded dacite clasts and traces of quartz and microcline were observed from 865 to 870 ft bgs, suggesting the base of the Tschicoma Formation dacitic lava could be at 865 ft bgs. The lithologic log in Appendix A provides more detail regarding possible interpretations of the base of the Tschicoma Formation dacite lava.

Puye Formation, Tpf (880–1393 ft bgs)

The Puye Formation volcaniclastic sediments consisted of poorly sorted to unsorted, moderately indurated, medium to coarse gravels, fine to coarse sand, and varying amounts of silt. Subangular to well-rounded detrital constituents throughout the typical Puye Formation section are predominantly composed of gray biotite- and/or hornblende-phyric dacites and glassy dacites, plus fewer fine-grained siliciclastic sediments, mostly quartzites. A section containing minor pale orange clay was observed from 930 to 955 ft bgs. Sediments are poorly sorted, are generally gravel-rich, and contain varying amounts of medium and fine sand and silt. Volcaniclastic fragments vary in oxidation, and relative proportions of various lithologies indicate changing source areas through the section.

Miocene Pumiceous Sediments, Tjfp (1393–1418 ft bgs)

A pumice-rich volcaniclastic section, referred to as Miocene pumiceous sediments, was intersected from 1393 ft bgs to the bottom of the R-60 borehole at 1418 ft bgs. This unassigned unit is locally interfingered with Puye Formation sediments. These sediments consist of fine to medium gravels with fine to coarse sands and are moderately to poorly sorted, are weakly cemented and contain detrital pumices and perlite clasts making up 40% of samples by volume.

5.2 Groundwater

Drilling proceeded without any groundwater indications until 1325 ft bgs in the Puye Formation, as indicated by the drilling crew. Water production was estimated at 7.5 gallons per minute (gpm) after drilling to 1325 ft bgs. The borehole was advanced to a TD of 1418 ft bgs, where the groundwater production rate was estimated at 30 gpm. Water levels stabilized at 1318.7 ft bgs on October 6, 2010, before well installation.

6.0 BOREHOLE LOGGING

Several video logs and several suites of geophysical logs were collected during the R-60 drilling project. A summary of video and geophysical logging runs is presented in Table 6.0-1. Video logging is included on a DVD in Appendix D of this report; geophysical logs are included on a CD in Appendix E of this report.

6.1 Video Logging

Laboratory video equipment was run from the surface in the original borehole on July 30, 2010, before the borehole was cemented above 787 ft bgs. Laboratory personnel stopped the camera at 660 ft bgs because the borehole walls were very rough. On August 5, an additional video log was made before cementing using the drilling subcontractor's camera.

In the replacement R-60 borehole, a Laboratory video survey was run on September 24 from ground surface to 901 ft bgs to record the open borehole interval (646 to 901 ft bgs) before 12-in. casing was installed. The Laboratory camera was also used on October 5 to confirm the 12-in. casing had been cut at 1401.4 ft bgs.

A Laboratory video log was recorded within the well following aquifer testing on October 28 to show that the well screen was intact. Table 6.0-1 details the video logging runs.

6.2 Geophysical Logging

No geophysical logs were recorded in the original borehole. Natural gamma and induction logs were run in the second R-60 borehole on September 24, 2010, before 12-in. casing was installed. The natural gamma log was run from ground surface to 901 ft bgs, and the induction log was run from 646 to 901 ft bgs. A natural gamma log was run inside the 12-in. casing on September 30 from ground surface to 1405 ft bgs. A natural gamma log was run inside the well casing on October 28 from 1300 to 1350 ft bgs (the bottom of the well screen) to determine if the low water production rate observed in the well was from poor well construction. The gamma log indicated that the filter pack was installed correctly around the well screen and that the low production rate was caused by the low-yield aquifer. The geophysical logging is summarized in Table 6.0-1.

7.0 INSTALLATION OF R-60 MONITORING WELL

The R-60 well was installed between October 6 and 18, 2010.

7.1 Well Design

The R-60 well was designed in accordance with the approved drilling work plan and the final well design that was developed after TD was reached. NMED approved the final well design before well construction began (Appendix F). The well was designed with a single screen to monitor groundwater quality near the top of the regional aquifer within the Puye Formation sediments from 1330 to 1350 ft bgs.

7.2 Well Construction

The R-60 monitoring well was constructed of 5.0-in.-I.D./5.56-in.-O.D., type A304 passivated stainless-steel threaded casing fabricated to American Society for Testing and Materials (ASTM) A312 standards. The screened section utilized two (2) 10-ft lengths of 5.0-in.-I.D. rod-based 0.020-in. wire-wrapped screens to make up the 20-ft-long well screen interval. Compatible external stainless-steel couplings (also type A304 stainless-steel fabricated to ASTM A312 standards) were used to join all individual casing and screen sections. The coupled unions between threaded sections were approximately 0.7 ft long. All casing, couplings, and screens were steam- and pressure-washed on-site before installation. A 2-in.-I.D. threaded steel tremie pipe (decontaminated before use) was utilized to deliver backfill and annular fill materials down-hole during well construction. Short lengths of 12-in. drill casing (15.6-ft casing and shoe from 1401.4 to 1417 ft bgs) and 16-in. drill casing (10.2-ft casing and shoe from 636 to 646.2 ft bgs) remain in the borehole. The 12-in. casing stub was encased in the lowermost bentonite backfill, while the 16-in. casing stub was encased in the upper bentonite seal.

A 10-ft stainless-steel sump was placed below the bottom of the well screen. Stainless-steel centralizers (two sets of four) were welded to the well casing approximately 2.0 ft above and below the screen. The stainless-steel well casing and screen were decontaminated on October 2, along with the mobilization of initial well construction materials to the site. A Pulstar work-over rig was used for well construction activities. Figure 7.2-1 presents an as-built schematic showing construction details for the completed well.

On October 6, 2010, at 1540 h, the 5-in. stainless-steel well casing was started into the borehole. After setting the bottom of the well casing at 1360.9 ft bgs, the drill crew began to emplace annular fill materials on October 8. A lower seal composed of 3/8-in. bentonite chips (42.0 ft^3) was placed from 1404.2 to

1355.6 ft bgs, above slough at the bottom of the borehole. A 10/20 silica sand filter pack (30.5 ft^3) was installed from 1355.6 to 1325.2 ft bgs; the well was then surged to promote filter pack compaction. Approximately 40% more sand was used during construction than had been calculated, indicating the borehole diameter was slightly enlarged across this interval. A 20/40 silica sand transition collar (2.5 ft^3) was placed on top of the screen filter pack from 1322.2 to 1325.2 ft bgs.

Between October 9 and 17, the well's upper bentonite seal was installed from 1322.2 to 198.8 ft bgs using 1638.3 ft^3 of 3/8-in. bentonite chips. The final surface seal of neat Portland cement was placed above the upper bentonite seal from 198.8 to 3 ft bgs. The volume of cement used for the upper seal, 731.3 ft^3, exceeded the calculated volume of 377.7 ft^3 and is likely because cement infiltrated fractures in the Bandelier Tuff. Well construction was completed on October 18. Table 7.2-1 summarizes volumes of all materials used during well construction.

Operationally, well construction proceeded smoothly, 24 h/d, 7 d/wk.

8.0 POSTINSTALLATION ACTIVITIES

Following well installation, the well was developed and aquifer pumping tests were conducted. The wellhead and surface pad were constructed, a geodetic survey was performed and a dedicated sampling system installed. Site restoration activities will be completed following the final disposition of contained drill cuttings and groundwater, per the NMED-approved waste disposal decision trees.

8.1 Well Development

Well development was conducted between October 19 and 22, 2010, and then was paused to allow aquifer testing to be conducted. Well development resumed on October 29 and continued to November 21. Initially, the screened interval was bailed and swabbed to remove formation fines in the filter pack and well sump. Bailing continued until water clarity visibly improved. Final development was then performed with a submersible pump.

The swabbing tool employed was a 4.5-in.-O.D., 1-in.-thick nylon disc attached to a weighted steel rod. The wireline-conveyed tool was repeatedly drawn across the screened interval, causing a surging action across the screen and filter pack. The bailing tool employed was a 4.0-in.-O.D. by 21-ft-long carbon-steel bailer with a total capacity of 12 gal. After bailing, a 5-horsepower (hp), 4-in. submersible pump was used for well development.

The screen was purged from top to bottom in 2-ft increments from 1330 to 1350 ft bgs. Then the pump intake was lowered to 1355 ft bgs for additional pumping. Well development continued on October 29 after aquifer testing was completed. The screen was swabbed again and additional groundwater was removed with the bailing tool. The submersible development pump was then used to complete well development between October 30 and November 21.

Total Volumes of Water Introduced and Purged in the Regional Aquifer

Approximately 8000 gal. of potable water was used during borehole drilling below the regional aquifer water table. Approximately 10,200 gal. of water was used below the water table during well construction, for a total introduced volume of 18,200 gal.

Of this total volume of water used below the water table, approximately 1200 gal. was used during drilling from 1356 to 1325 ft bgs, the eventual filter pack interval in the completed well. During well installation, approximately 5000 gal. was used to install the filter pack across the screened interval. Total potable

water used between 1356 and 1325 ft bgs, the filter pack interval of the completed well, was approximately 6200 gal.

Approximately 17,257 gal. of groundwater was purged at R-60 during well development activities. Another 943 gal. was purged during aquifer testing. Total groundwater purged during postinstallation activities was 18,200 gal.

8.1.1 Well Development Field Parameters

Field parameters were measured at well R-60 by collecting aliquots of groundwater from the discharge pipe with a flow-through cell. Water quality parameters of pH, temperature, specific conductivity, oxidation-reduction potential (ORP), dissolved oxygen (DO), and turbidity were measured during well development and aquifer testing. The final parameters at the end of well development were pH of 7.60, temperature of 24.05°C, specific conductance of 136 µS/cm, and turbidity of 0.8 nephelometric turbidity units.

Appendix B presents a summary of the field parameters measured during well development and aquifer testing. Table B-2.3-1 in Appendix B presents all field parameters and purge volumes from well development and aquifer testing. Figure B-2.3-1 shows a graph with the field parameters measured over the course of well development and aquifer testing.

8.2 Aquifer Testing

Aquifer pumping tests were conducted at R-60 between October 23 and 27, 2010. A 24-h constant rate pump test was performed on October 26. A 5-hp pump was used for the aquifer test. The pump rate was set to approximately 0.57 gpm, and approximately 943.1 gal. of groundwater was purged from the well. A 24-h recovery period followed the 24-h pump test.

Turbidity, temperature, pH, DO, ORP, and specific conductance parameters were measured during the 24-h test. Field parameters are summarized in Appendix B and detailed in Table B-2.3-1 of Appendix B. The results of the R-60 aquifer test are presented in Appendix C.

8.3 Dedicated Sampling System Installation

The dedicated sampling system for R-60 was installed on December 3 and 4, 2010. The pumping system utilizes an environmentally retrofitted 4-in. 5-hp Grundfos submersible pump set near the bottom of the screened interval. Because the top of the water table is within the well screen, the pump was set within the screened interval inside a stainless-steel pump shroud; the bottom of the shroud is set at 1349.6 ft bgs. The pump column is constructed of 1 in. threaded/coupled passivated stainless-steel pipe. A weep valve was installed at the bottom of the uppermost pipe joint to protect the pump column from freezing. To measure water levels in the well, two 1-in.-I.D. schedule 80 polyvinyl chloride (PVC) pipes are installed to sufficient depth to set a dedicated transducer and to provide access for manual water-level measurements. The PVC transducer tubes are equipped with 6-in. sections of 0.010 in. slot screen with a threaded end cap on the bottom of each tube. An In-Situ Level Troll 500 30 pounds per square inch gage transducer is installed in one of the PVC tubes to monitor the water level in the screened interval.

Sampling system details for R-60 are presented in Figure 8.3-1a. Figure 8.3-1b presents technical notes for the well.

8.4 Wellhead Completion

A reinforced concrete surface pad, 10 ft × 10 ft × 6 in. thick, was installed at the R-60 wellhead. The concrete pad was slightly elevated above the ground surface and crowned to promote runoff. The pad will provide long-term structural integrity for the well. A brass survey pin was embedded in the northwest corner of the pad. A 10-in.-I.D. steel protective casing with a locking lid was installed around the stainless-steel well riser. A total of four bollards, painted yellow for visibility, are set at the outside edges of the pad to protect the well from traffic. The bollards are designed for easy removal to allow access to the well. Details of the wellhead completion are presented in Figure 8.3-1a.

8.5 Geodetic Survey

A New Mexico licensed professional land surveyor conducted a geodetic survey on December 16, 2010 (Table 8.5-1). The survey data conform to Laboratory Information Architecture project standards IA-CB02, "GIS Horizontal Spatial Reference System," and IA-D802, "Geospatial Positioning Accuracy Standard for A/E/C and Facility Management." All coordinates are expressed relative to the New Mexico State Plane Coordinate System Central Zone (North American Datum [NAD] 83); elevations are expressed in feet above mean sea level (amsl) using the National Geodetic Vertical Datum of 1929. Survey points include ground surface elevation near the concrete pad, the top of the brass marker in the concrete pad, the top of the stainless-steel well casing, and the top of the protective casing for the R-60 monitoring well.

8.6 Waste Management and Site Restoration

Waste generated from the R-60 project included drilling fluids, drilled-out concrete chips and concrete slurry, drill cuttings, development water, decontamination water, municipal solid waste, petroleum contaminated soils, and contact waste. A summary of the waste characterization samples collected during drilling, construction and development of the R-60 well is presented in Table 8.6-1.

All waste streams produced during drilling and development activities were sampled in accordance with "Waste Characterization Strategy Form, Amendment #2, Regional Well, MDA C, R-60" (LANL 2010, 111800).

Fluids produced during drilling and well development are expected to be land-applied after a review of associated analytical results per the waste characterization strategy form (WCSF) and ENV-RCRA-QP-10.1, Land Application of Groundwater. If it is determined drilling fluids are nonhazardous but cannot meet the criteria for land application, they will be evaluated for treatment and disposal at one of the Laboratory's wastewater treatment facilities. If analytical data indicate the drilling fluids are hazardous/nonradioactive or mixed low-level waste, the drilling fluids will be disposed of at an authorized facility.

Cuttings produced during drilling are anticipated to be land-applied after a review of associated analytical results per the WCSF and ENV-RCRA-QP-11.1, Land Application of Drill Cuttings. If the drill cuttings do not meet the criterion for land application, they will be disposed of at an authorized facility. Decontamination fluid used for cleaning equipment was containerized. The fluid waste was sampled and will be disposed of at an authorized facility. Characterization of contact waste will be based upon acceptable knowledge, pending analyses of the waste samples collected from the drill cuttings, purge water, and decontamination fluid.

Site restoration activities will include removing drilling fluids and cuttings from the pit and managing the fluids and cuttings in accordance with applicable procedures, removing the polyethylene liner, removing the containment area berms, and backfilling and regrading the containment area, as appropriate.

9.0 DEVIATIONS FROM PLANNED ACTIVITIES

Drilling, sampling, and well construction at R-60 were performed as specified in "Drilling Plan for Regional Aquifer Well R-60" (TerranearPMC 2010, 109963). The first R-60 borehole was abandoned after the hammer bit became stuck around 887 ft bgs and could not be removed from the borehole. The second R-60 borehole was drilled successfully to 1418 ft bgs.

10.0 ACKNOWLEDGMENTS

Boart Longyear drilled and installed the R-60 monitoring well.

David C. Schafer designed, implemented and analyzed the aquifer tests.

LANL personnel ran downhole video and geophysical logging equipment.

TerranearPMC provided oversight on all preparatory and field-related activities.

11.0 REFERENCES AND MAP DATA SOURCES

The following list includes all documents cited in this report. Parenthetical information following each reference provides the author(s), publication date, and ER ID. This information is also included in text citations. ER IDs are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the NMED Hazardous Waste Bureau and the Directorate. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.

11.1 References

LANL (Los Alamos National Laboratory), March 2006. "Storm Water Pollution Prevention Plan for SWMUs and AOCs (Sites) and Storm Water Monitoring Plan," Los Alamos National Laboratory document LA-UR-06-1840, Los Alamos, New Mexico. (LANL 2006, 092600)

LANL (Los Alamos National Laboratory), June 2010. "Drilling Work Plan for Regional Aquifer Well R-60," Los Alamos National Laboratory document LA-UR-10-3537, Los Alamos, New Mexico. (LANL 2010, 109680)

LANL (Los Alamos National Laboratory), June 30, 2010. "IWD [Integrated Work Document] for Drilling and Installation of MTOA Task Order #8 Well R-60 at LANL," Los Alamos National Laboratory, Los Alamos, New Mexico. (LANL 2010, 111812)

LANL (Los Alamos National Laboratory), February 28, 2011. "Waste Characterization Strategy Form, Amendment #2, Regional Well, MDA C, R-60," EP2011-0036, Los Alamos, New Mexico. (LANL 2011, 111800)

TerranearPMC, June 2010. "Drilling Plan for Regional Aquifer Well R-60," plan prepared for Los Alamos National Laboratory, Los Alamos, New Mexico. (TerranearPMC 2010, 109963)

11.2 Map Data Sources

Point Feature Locations of the Environmental Restoration Project Database; Los Alamos National Laboratory, Waste and Environmental Services Division, EP2008-0109; December 2010.

Hypsography, 100 and 20 Foot Contour Interval; Los Alamos National Laboratory, ENV Environmental Remediation and Surveillance Program; 1991.

Surface Drainages, 1991; Los Alamos National Laboratory, ENV Environmental Remediation and Surveillance Program, ER2002-0591; 1:24,000 Scale Data; Unknown publication date.

Paved Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 04 January 2008.

Dirt Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 04 January 2008.

Structures; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 04 January 2008.

Technical Area Boundaries; Los Alamos National Laboratory, Site Planning & Project Initiation Group, Infrastructure Planning Division; September 2009.

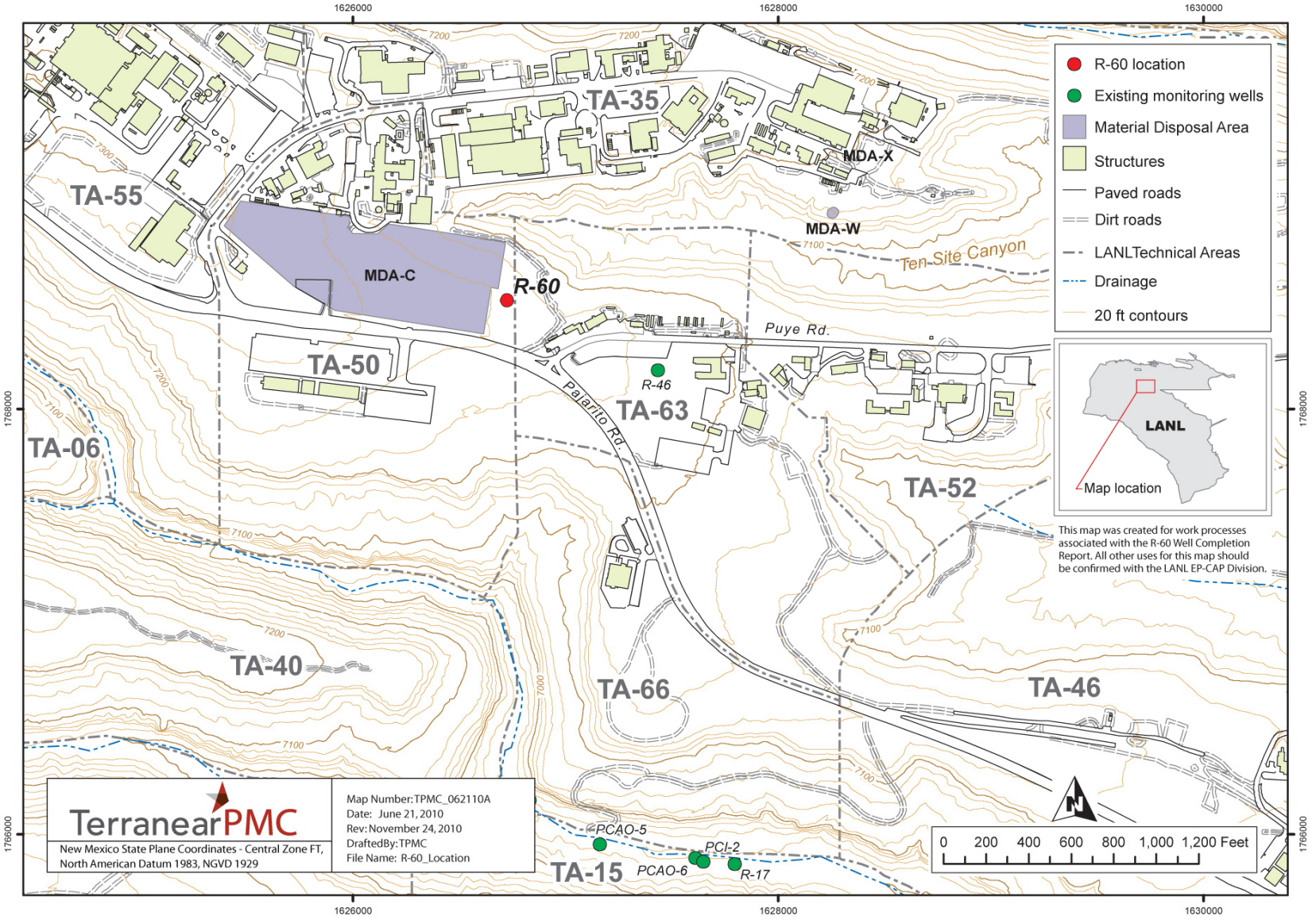

Figure 1.0-1 Location of regional monitoring well R-60

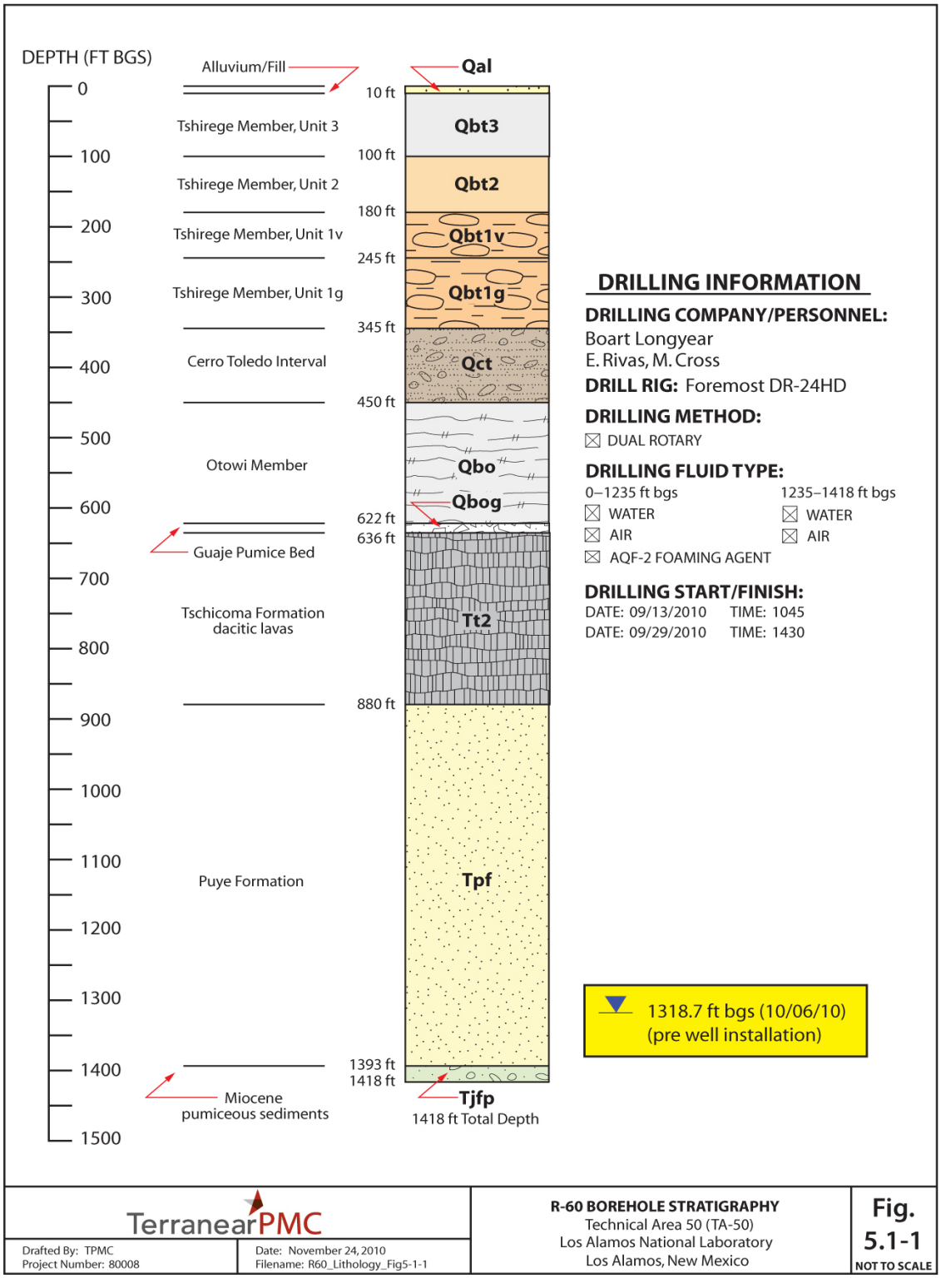

Figure 5.1-1 Regional monitoring well R-60 borehole stratigraphy

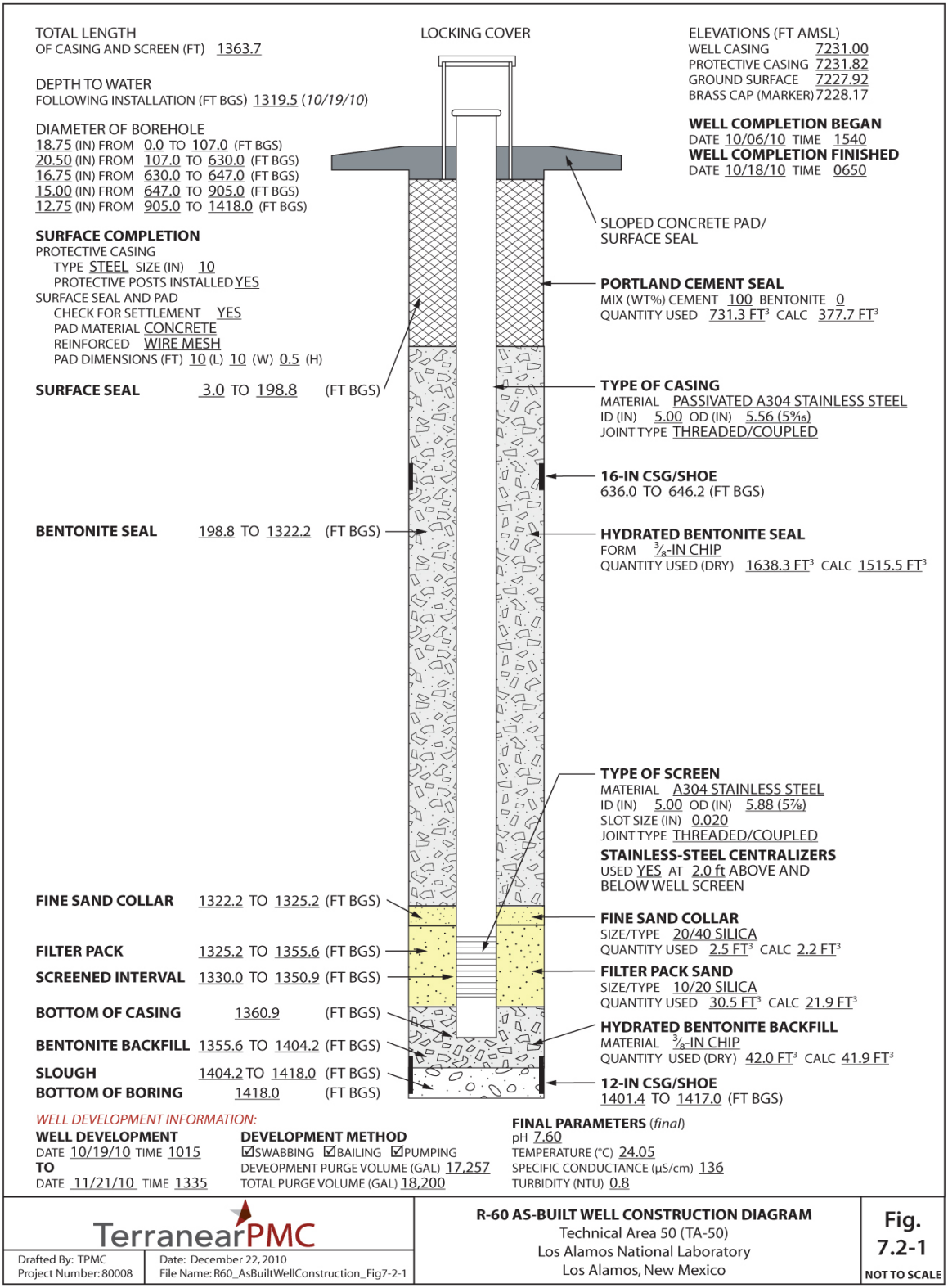

Figure 7.2-1 Regional monitoring well R-60 as-built well construction diagram

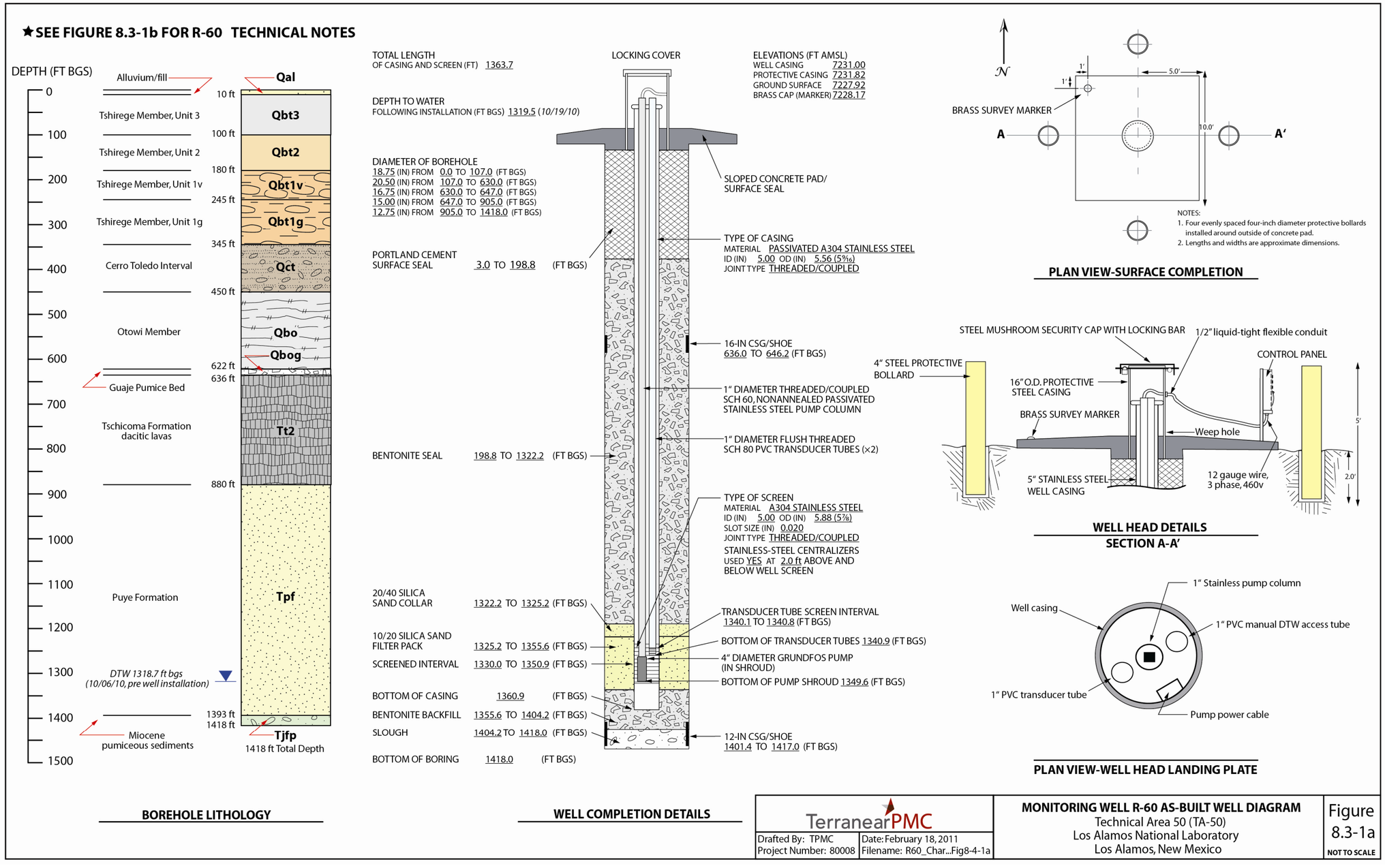

Figure 8.3-1a As-built schematic for regional monitoring well R-60

R-60 TECHNICAL NOTES:

SURVEY INFORMATION*
Brass Marker
Northing: 1768514.75 ft
Easting: 1626734.38 ft
Elevation: 7228.17 ft AMSL

Well Casing (top of stainless steel)
Northing: 1768509.82 ft
Easting: 1626736.74 ft
Elevation: 7231.00 ft AMSL

BOREHOLE GEOPHYSICAL LOGS
LANL: video (×3), natural gamma ray (×2), induction

DRILLING INFORMATION
Drilling Company
Boart Longyear

Drill Rig
Foremost DR-24HD

Drilling Methods
Dual Rotary
Fluid-assisted air rotary

Drilling Fluids
Air, potable water, AQF-2 Foam (to 1235 ft bgs)

MILESTONE DATES
Drilling
Start: 09/13/2010
Finished: 09/29/2010

Well Completion
Start: 10/06/2010
Finished: 10/18/2010

Well Development
Start: 10/19/2010
Finished: 11/21/2010

WELL DEVELOPMENT
Development Methods
Performed swabbing, bailing, and pumping
Total Volume Purged: 17,257 gal

Parameter Measurments (Final)
pH: 7.60
Temperature: 24.05˚C
Specific Conductance: 136 µS/cm
Turbidity: 0.8 NTU

AQUIFER TESTING
Constant Rate Pumping Test
Water Produced: 943 gal.
Average Flow Rate: 0.6 gpm
Performed on: 10/23–27/2010

DEDICATED SAMPLING SYSTEM
Pump (Shrouded)
Make: Grundfos
Model: 10S50-1125CBM
S/N: B96845912-P11041366
10 U.S. gpm
Bottom pump shroud: 1349.6 ft bgs
Environmental retrofit

Motor
Make: Franklin Electric
S/N: 10K14-06-00695C
5 hp, 3-phase

Pump Column
1-in. threaded/coupled schd. 60, ASTM pickled and passivated A312 stainless steel tubing

Transducer Tubes
2 × 1-in. flush threaded schd. 80 PVC tubing
0.01-in. slot screen at 1340.1–1340.8 ft bgs

Transducer
Make: In-Situ, Inc.
Model: Level TROLL 500
30 psig range (vented)
S/N: 177876

NOTES:
* Coordinates based on New Mexico State Plane Grid Coordinates, Central Zone (NAD83); Elevation expressed in feet amsl using the National Geodetic Vertical Datum of 1929.

TerranearPMC	R-60 TECHNICAL NOTES Technical Area 50 (TA-50) Los Alamos National Laboratory Los Alamos, New Mexico	Figure 8.3-1b NOT TO SCALE
Drafted By: TPMC Project Number: 80008	Date: March 4, 2011 Filename: R60_TechnicalNotes_Fig8-3-1b	

Figure 8.3-1b As-built technical notes for regional monitoring well R-60

Table 3.1-1
Fluid Quantities Used during R-60 Drilling and Well Construction

Date	Depth Interval (ft bgs)	Water (gal.)	Cumulative Water (gal.)	AQF-2 Foam (gal.)	Cumulative AQF-2 Foam (gal.)
Drilling					
9/13/10	0–85	1500	1500	0	0
9/14/10	85–537	4850	6350	25	25
9/15/10	537–674	8500	14,850	33	58
9/16/10	Ream 324–644	4000	18,850	50	108
9/17/10	Ream 112–580	5200	24,050	30	138
9/18/10	Ream 580–630	1000	25,050	10	148
9/19/10	Ream 537–595	1200	26,250	8	156
9/20/10	595–860	4500	30,750	30	186
9/21/10	860–885	4500	35,250	30	216
9/22/10	885–905	4200	39,250	20	236
9/26/10	905–1024	2800	42,050	30	266
9/27/10	1024–1218	7000	49,050	95	361
9/28/10	1218–1369[a]	5800	54,850	5	366
9/29/10	1369–1418	0	54,850	0	366
10/5/10	Cut casing	3000	57,850	n/a[b]	n/a
Well Construction					
10/8/10	1404–1344	5200	5200	n/a	n/a
10/9/10	1344–1309	5000	10,200	n/a	n/a
10/10/10	1309–1245	4800	15,000	n/a	n/a
10/11/10	1245–1140	9000	24,000	n/a	n/a
10/12/10	1140–998	10,500	34,500	n/a	n/a
10/13/10	998–800	1600	36,100	n/a	n/a
10/14/10	800–668	750	36,850	n/a	n/a
10/15/10	668–428	2000	38,850	n/a	n/a
10/16/10	428–199	5000	43,850	n/a	n/a
10/17/10	199-3	2600	46,450	n/a	n/a
10/18/10	Top off cement to 3 ft bgs.	36	46,486	n/a	n/a
Total Water Volume (gal.)					
R-60	**104,336**				

[a] Foam use terminated at approximately 1235 ft bgs.
[b] n/a = Not applicable.

Table 4.2-1
Summary of Groundwater Screening Samples Collected during Well Development and Aquifer Testing of Well R-60

Location ID	Sample ID	Date Collected	Collection Depth (ft bgs)	Sample Type	Analysis
Development					
R-60	GW60-10-24563	10/22/2010	1352.00	Groundwater, pumped	TOC
R-60	GW60-10-24557	11/1/2010	1353.72	Groundwater, pumped	Anions, metals
R-60	GW60-10-24569	11/1/2010	1353.72	Groundwater, pumped	TOC
R-60	GW60-10-24570	11/2/2010	1353.72	Groundwater, pumped	TOC
R-60	GW60-10-24571	11/3/2010	1353.72	Groundwater, pumped	TOC
R-60	GW60-10-24572	11/4/2010	1353.72	Groundwater, pumped	TOC
R-60	GW60-10-24573	11/6/2010	1353.72	Groundwater, pumped	TOC
R-60	GW60-10-24574	11/7/2010	1353.72	Groundwater, pumped	TOC
Aquifer Testing					
R-60	GW60-10-24564	10/26/2010	1338.46	Groundwater, pumped	TOC
R-60	GW60-10-24565	10/26/2010	1338.46	Groundwater, pumped	TOC
R-60	GW60-10-24566	10/27/2010	1338.46	Groundwater, pumped	TOC
R-60	GW60-10-24567	10/27/2010	1338.46	Groundwater, pumped	TOC
R-60	GW60-10-24568	10/27/2010	1338.46	Groundwater, pumped	TOC

Table 6.0-1
R-60 Video and Geophysical Logging Runs

Date	Type	Depth (ft bgs)	Description
First R-60 Borehole			
7/30/10	Video	0–660	LANL personnel ran a video log before cementing the borehole above 787ft. The camera was removed at 660 ft bgs due to rough borehole walls. Video shows open hole between 478 and 660 ft bgs.
8/5/10	Video	0–867	Drilling subcontractor ran video log before cementing.
Final R-60 Borehole and Completed Well			
9/24/10	Video, natural gamma, induction	0–901	LANL personnel ran video and induction logs in the open portion of the borehole (646 to 901 ft bgs) before hanging 12-in. casing. Natural gamma log was run from 0 to 901 ft bgs.
9/30/10	Natural gamma	0–1405	LANL personnel ran a natural gamma log inside the 12-in. casing to 1405 ft bgs after TD was reached.
10/5/10	Video	0–1401.4	LANL personnel ran a video to confirm the 12-in. casing had been cut at 1401.4 ft bgs.
10/28/10	Natural gamma, video	1300–1350	Natural gamma and video logs were run in the completed well after aquifer testing to confirm the well screen was installed properly and that the filter pack was still in place.

Table 7.2-1
R-60 Monitoring Well Annular Fill Materials

Material	Volume
Upper surface seal: cement slurry	731.3 ft^3
Upper bentonite seal: bentonite chips	1638.3 ft^3
Fine sand collar: 20/40 silica sand	2.5 ft^3
Filter pack: 10/20 silica sand	30.5 ft^3
Backfill: bentonite chips	42.0 ft^3

Table 8.5-1
R-60 Survey Coordinates

Identification	Northing	Easting	Elevation
R-60 brass cap embedded in pad	1768514.75	1626734.38	7228.17
R-60 ground surface near pad	1768512.61	1626731.65	7227.92
R-60 top of 10-in. protective casing	1768509.80	1626736.72	7231.82
R-60 top of stainless-steel well casing	1768509.82	1626736.74	7231.00

Note: All coordinates are expressed as New Mexico State Plane Coordinate System Central Zone (NAD 83); elevation is expressed in ft amsl using the National Geodetic Vertical Datum of 1929

Table 8.6-1
Summary of Waste Samples Collected during Drilling and Development of R-60

Location ID	Sample ID	Date Collected	Description	Sample Type
R-60	WST60-10-23981(VOCs and SVOCs)	7/12/2010	Drill cuttings	Solid
R-60	WST60-10-23984(FTB)	7/12/2010	Drill cuttings	Solid
R-60	WST60-10-25002	8/23/2010	NMSW	Solid
R-60	WST60-10-25000(FTB)	8/23/2010	NMSW	Solid
R-60	WST60-10-26077(UF)	9/14/2010	Drill rig decon water	Liquid
R-60	WST60-10-26076(F)	9/14/2010	Drill rig decon water	Liquid
R-60	WST60-10-26078(FD)	9/14/2010	Drill rig decon water	Liquid
R-60	WST60-10-26079(FTB)	9/14/2010	Drill rig decon water	Liquid
R-60	WST60-10-23982(VOCs and SVOCs)	9/18/2010	Drill cuttings	Solid
R-60	WST60-10-23985(FTB)	9/18/2010	Drill cuttings	Solid
R-60	WST60-10-23983(VOCs and SVOCs)	9/29/2010	Drill cuttings	Solid
R-60	WST60-10-23986(FTB)	9/29/2010	Drill cuttings	Solid
R-60	WST60-10-26082(UF)	10/8/2010	Well casing decon water	Liquid
R-60	WST60-10-26081(F)	10/8/2010	Well casing decon water	Liquid
R-60	WST60-10-26080(FD)	10/8/2010	Well casing decon water	Liquid
R-60	WST60-10-26083(FTB)	10/8/2010	Well casing decon water	Liquid
R-60	WST60-10-26092	10/8/2010	Drill cuttings	Solid

Table 8.6-1 (continued)

Location ID	Sample ID	Date Collected	Description	Sample Type
R-60	WST60-10-26093(FTB)	10/8/2010	Drill cuttings	Solid
R-60	WST60-10-26086(UF)	10/27/2010	Drill rods decon water (w/ HE)	Liquid
R-60	WST60-10-26085(F)	10/27/2010	Drill rods decon water (w/ HE)	Liquid
R-60	WST60-10-26084(FD)	10/27/2010	Drill rods decon water (w/ HE)	Liquid
R-60	WST60-10-26087(FTB)	10/27/2010	Drill rods decon water (w/ HE)	Liquid
R-60	WST60-10-26090(UF)	10/28/2010	Downhole equip. decon water	Liquid
R-60	WST60-10-26089(F)	10/28/2010	Downhole equip. decon water	Liquid
R-60	WST60-10-26088(FD)	10/28/2010	Downhole equip. decon water	Liquid
R-60	WST60-10-26091(FTB)	10/28/2010	Downhole equip. decon water	Liquid
R-60	WST60-10-26072(UF)	11/1/2010	Development water	Liquid
R-60	WST60-10-260071(F)	11/1/2010	Development water	Liquid
R-60	WST60-10-26073(FD)	11/1/2010	Development water	Liquid
R-60	WST60-10-26074(FTB)	11/1/2010	Development water	Liquid
R-60	WST60-11-1386	11/3/2010	Last use of drill rig at R-60 decon water	Liquid
R-60	WST60-11-1293(UF)	11/4/2010	Drill fluids—south pit	Liquid
R-60	WST60-11-1292(F)	11/4/2010	Drill fluids—south pit	Liquid
R-60	WST60-11-1294(FD)	11/4/2010	Drill fluids—south pit	Liquid
R-60	WST60-11-1295(FTB)	11/4/2010	Drill fluids—south pit	Liquid
R-60	WST60-10-26068(UF)	11/4/2010	Drill fluids—north pit	Liquid
R-60	WST60-10-26067(F)	11/4/2010	Drill fluids—north pit	Liquid
R-60	WST60-10-26069(FD)	11/4/2010	Drill fluids—north pit	Liquid
R-60	WST60-10-26070(FTB)	11/4/2010	Drill fluids—north pit	Liquid
R-60	WST60-10-25003	11/12/2010	NMSW	Solid
R-60	WST60-10-25001(FTB)	11/12/2010	NMSW	Solid

Notes: F = Filtered sample, FD = field duplicate, FTB = field trip blank, HE = high explosives, NMSW = New Mexico Special Waste, UF = unfiltered sample.