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Completion Report for Regional Aquifer Well R-62

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EXECUTIVE SUMMARY

This completion report describes the drilling, installation, well development, aquifer testing, and sampling system installation for regional aquifer well R-62, located in Technical Area 05 (TA-05) at Los Alamos National Laboratory (LANL or the Laboratory). 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.

Regional aquifer well R-62 was installed to monitor water quality in the regional aquifer and to help define the vertical and lateral extent of chromium contamination known to exist in the vicinity of wells R-42 and R-28. Installation of R-62 was approved by the New Mexico Environment Department (NMED) in December 2010.

The R-62 borehole was drilled using fluid-assisted dual-rotary drilling methods. Drilling fluid additives included potable water and a foaming agent. Injection of foam was discontinued at 975 ft below ground surface (bgs), approximately 167 ft above the anticipated top of the regional aquifer. The drilling work plan for R-62 proposed completion of a two-screen monitoring well in the regional aquifer; however, a single-screen well was installed after heaving sands were encountered at the total depth of 1260 ft bgs.

Geologic formations encountered during drilling included, in descending stratigraphic order, Tshirege Member of the Bandelier Tuff, Cerro Toledo interval, Otowi Member of the Bandelier Tuff (including the Guaje Pumice Bed), upper Puye Formation, Cerros del Rio volcanic series, the lower Puye Formation, Miocene pumiceous sediments, and Miocene riverine deposits.

Groundwater encountered during drilling included two perched-intermediate zones and the regional aquifer. The upper perched groundwater zone was encountered in the upper Puye Formation above Cerros del Rio lavas. A lower perched zone was encountered in the lower part of the Cerros del Rio basalt and top of the underlying Puye Formation. The regional water table occurs within Miocene pumiceous sand and gravel at a depth of 1142 ft bgs as measured in the completed well.

Well R-62 was completed per the NMED-approved well design with one screened interval from 1158 ft to 1179 ft bgs.

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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
Eh	oxidation-reduction potential
EP	Environmental Programs
gpd	gallons per day
gpm	gallons per minute
hp	horsepower
I.D.	inside diameter
LANL	Los Alamos National Laboratory, or the Laboratory
NAD	North American Datum
NMAC	New Mexico Administrative Code

NMED	New Mexico Environment Department
NMOSE	New Mexico Office of the State Engineer
NTU	nephelometric turbidity unit
O.D.	outside diameter
ORP	oxidation-reduction potential
PVC	polyvinyl chloride
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
RPF	Records Processing Facility
SC	specific conductance
TA	technical area
Tb4	Cerros del Rio volcanic series
Tcar	Miocene riverine deposits
TD	total depth
TDS	total dissolved solids
Tjfp	Miocene pumiceous sediments
TOC	total organic carbon
Tpf	Puye Formation
WCSF	waste characterization strategy form
wt%	weight percent
WES-EDA	Waste and Environmental Services Division–Environmental Data and Analysis

1.0 INTRODUCTION

This completion report summarizes the drilling, well construction, well development, aquifer testing, and sampling system installation for regional aquifer well R-62. 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). Well R-62 was drilled and installed from July 30 to October 3, 2011, at Los Alamos National Laboratory (LANL or the Laboratory) for the Environmental Programs (EP) Directorate.

Well R-62 is located within Technical Area 05 (TA-05) on a narrow ridge at the east end of Sigma Mesa that separates Sandia and Mortandad Canyons (Figure 1.0-1). The primary purpose of well R-62 is to determine if significant chromium contamination is present in the regional aquifer in the area west and northwest of the contaminant plume that is defined by the existing network of monitoring wells. The location of R-62 was selected to determine if infiltration in upper Sandia Canyon contributes to elevated chromium found in the regional aquifer in the vicinity of wells R-28 and R-42. Water-quality data from well R-62 will also be used along with information from other monitoring wells in the area to assess whether multiple sources of chromium in Sandia and Mortandad Canyons impact the regional aquifer.

Data collected during R-62 drilling was also used to assess the viability of installing a perched-intermediate well (SCI-4) at the same location. Although perched water was detected, borehole videos and water-level data indicated the perched zone of interest in the lower part of the Cerros del Rio basalt was not productive enough to support a perched-intermediate well.

The work plan for installing well R-62 was approved by the New Mexico Environment Department (NMED) letter, “Approval with Modification, Drilling Work Plan for Regional Aquifer Well R-62,” dated December 8, 2010 (NMED 2010, 111496). The approved work plan specified the installation of two well screens in the regional aquifer. However, a deep well screen could not be installed because drilling was halted at 1260 ft total depth (TD) after fine sands and gravels heaved approximately 29 ft up into the 12-in. drill casing, causing concerns about the drilling string becoming stuck downhole. A single-screen monitoring well was installed near the top of regional saturation to maximize the detection of potential contaminants entering the regional aquifer from Sandia Canyon. The well screen was set between 1158 ft and 1179 ft below ground surface (bgs), and the water level was 1142 ft bgs after development of the completed well. NMED approved the single-screen well design.

Characterization during drilling included collection of cuttings samples at 5-ft intervals from ground surface to TD for lithologic evaluation. Borehole logs included video, natural gamma, and induction logs.

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

The information presented in this report was compiled from field reports 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 and supporting figures, tables, and appendixes associated with the R-62 well drilling and installation project.

2.0 ADMINISTRATIVE PREPARATION

The following documents were prepared to guide activities associated with the drilling, installation, and sampling of regional aquifer well R-62:

- “Field Implementation Plan for Regional Aquifer Well R-62 at Los Alamos National Laboratory, Technical Area-05” (Eberline Services 2011, 214982);
- “[Integrated Work Document for] Implementation of the Drilling Work Plan for Regional Aquifer Well R-66 for Task Order 2, subcontract number 89795-002-11, under the Drilling Master Task Order Agreement (MTOA), subcontract number 89795-000-11” (Eberline Services 2011, 211433);
- “Spill Prevention Control and Countermeasures Plan for the ADEP Groundwater Monitoring Well Drilling Operations, Los Alamos National Laboratory, Revision 6” (North Wind Inc. 2011, 213292); and
- “Waste Characterization Strategy Form for R-62 Installation of Regional Aquifer Well” (LANL 2011, 203414).

3.0 DRILLING ACTIVITIES

This section describes the drilling strategy and approach and provides a chronological summary of field activities conducted during the drilling of R-62.

3.1 Drilling Approach

The R-62 borehole was drilled using a Foremost DR-24 HD dual-rotary drilling rig with casing rotator. The dual-rotary system allows the casing to be advanced with a casing rotator while drilling with conventional air/mist/foam methods with the drill string. The Foremost DR-24 HD drill rig was equipped with 5.5-in.–outside diameter (O.D.) dual-wall reverse-circulation drill pipe, tricone bits, downhole hammer bits, and general drilling equipment. Casing sizes used in drilling activities included 20-, 16-, and 12-in. nominal diameters. Casing sizes were selected to ensure the required 2-in. minimum annular thickness of the filter pack would be achieved around a 5.6-in.-O.D. well screen, as required by Section X.C.3 of the Consent Order. The dual-rotary and standard rotary (open hole) techniques used filtered compressed air and fluid-assisted air to evacuate cuttings from the borehole.

Drilling fluids, including compressed air, municipal water, and a mixture of municipal water with Baroid brand Quik-Foam foaming agent were used as needed to advance the borehole to a depth of 975 ft bgs, approximately 167 ft above the top of the regional aquifer. The fluids were used to cool the bit and help lift cuttings from the borehole. Only compressed air and municipal water were used to drill below 975 ft bgs. Table 3.1-1 presents total amounts of drilling fluids introduced into the borehole from the date the top of the regional aquifer was encountered (1138 ft on August 29, 2011) to when the regional was sealed off by bentonite during well construction (September 9).

3.2 Chronology of Drilling Activities

Decontamination of the drill rig and associated tools was performed before the crew arrived at the drill site. Drilling equipment and supplies were mobilized and prepared for drilling between July 28 and July 29, 2011. Drilling of the R-62 borehole began on July 30, when a 20-in.-diameter surface casing was installed with a 17.5-in.-diameter tricone bit and dual-rotary drilling method. The 20-in.-diameter casing was advanced to a depth of 17 ft bgs in unit 2 of the Tshirege Member of the Bandelier Tuff.

On July 31, open borehole drilling commenced using a 14.75-in.-diameter hammer bit and municipal water as the drilling fluid. A breach in the seal between the borehole and the 20-in.-diameter surface casing occurred at a depth of 300 ft bgs. This breach required deepening the surface casing with the lower drive to a depth of 29 ft bgs to create a seal. At a depth of 308 ft, Quik-Foam was added to the air/water mixture to facilitate cuttings returns. Open borehole drilling continued with the 14.75-in.-diameter hammer bit, air, water, and Quik-Foam until the Cerros del Rio basalt was reached at a depth of 655 ft bgs. The borehole advanced very slowly (1 ft in 5.5 h) because of hard drilling and minimal fluid returns. The drilling tools were then removed from the borehole at a depth of 708 ft bgs to prepare for video and geophysical logging to be performed by Laboratory personnel.

Video, natural gamma, and induction logging were performed in the open borehole on August 2 to check for the presence of perched-intermediate groundwater. The survey data indicated the borehole had sloughed to a depth of 664 ft. No conclusive evidence for the presence of formation water was apparent from the surveys.

Between August 3 and 7, the driller began overdrilling the 16-in.-diameter casing in the 14.75-in.-diameter borehole using the lower drive on the DR-24 HD drill rig. The casing became too tight in the borehole and could not be installed to depth using this method. The casing was removed from the borehole, which was then reamed with a 17 5/8-in.-diameter rotary drill bit. On August 8, the 16-in.-diameter casing was reinstalled in the borehole and advanced to a depth of 658 ft bgs. The borehole was blown clear with air to check for perched water. Perched water accumulated in the borehole and the water level stabilized at a depth of 627 ft bgs in the upper Puye Formation.

During August 9 through 10, perched water was sealed off by advancing the casing to a depth of 677 ft bgs and landing it within a bentonite seal. The borehole was advanced open-hole (without casing) with the 14.75-in.-diameter hammer bit to a depth of 688 ft bgs. The casing was retracted to a depth of 674 ft bgs. The bottom of the borehole (at a depth of approximately 688 ft bgs) was filled with 3/8-in. bentonite chips to a depth of approximately 672 ft bgs. The 16-in. casing was reinstalled to a depth of 677 ft bgs and pushed into the bentonite. The 14.75-in.-diameter bit and hammer were lowered into the casing, the bentonite inside the casing was drilled out, and the borehole was advanced to a depth of 702 ft bgs. The bit and the hammer were removed from the borehole because of poor drilling. Inspection of the bit found hydrated bentonite encasing these tools.

On August 11, the bit and hammer were cleaned and successfully tested. The tools were placed back in the borehole and advanced through the basalt to a depth of 923 ft bgs. The tools were removed from the borehole in preparation for geophysics conducted by the Laboratory. On August 13, the Laboratory performed video logging of the open borehole and observed water flowing into the borehole from basalt at depths of approximately 843 ft and 853 ft, and from Puye Formation at depths of approximately 891 ft and 893 ft. The Laboratory also performed natural gamma logging of the open and cased borehole and induction logging of the open hole.

On August 13, the driller began placing 12-in.-diameter casing in the borehole to a depth of 915 ft bgs. After the 12-in.-diameter casing was placed in the borehole, an 11 5/8-in.-diameter tricone bit and drill tools were installed in the casing. After the tools were removed from the casing, the threaded connection between the upper collar and transition sub were observed to have separated, causing the bit, stabilizer, and six collars to fall to the bottom of the borehole. The driller was able to connect back into the dropped portion of the drill string and successfully retrieve the tools. As expected, the bit was damaged from the impact; however, no visual damage to the collars was observed. The 12-in.-diameter casing was photographed with a downhole camera and no damage was observed.

Between August 14 and 17, a new 11 5/8-in.-diameter tricone bit was attached to the drill string and lowered back into the borehole. The drill string separated again, this time between the bottom-most and second-lowest collar. The driller was able to connect back into the dropped portion of the drill string and damaged drill bit. Observation of the damaged bit revealed that all three cones plus part of the skirt were missing and remained downhole. Discussions with the collar manufacturer indicated the correct torque specification had not been provided to the driller.

Fishing for the missing parts of the bit began on August 17 and lasted until August 23. The driller was successful in recovering all three cones along with most of the bearings and skirt. Minor modifications were made to the drill rig to enable torqueing the collars to meet the required torque specification.

Dual-rotary drilling began again on August 25, with an 11 5/8-in.-diameter tricone bit using air, water, and Quik-Foam. The driller was instructed to stop using Quik-Foam at a depth of 950 ft bgs. No presence of foam was observed in the sample collected at a depth of 975 ft bgs.

At a depth of 1010 ft bgs, the 12-in.-diameter casing became very tight and could not be advanced. The drill string was tripped out of the borehole and the 12-in.-diameter casing was retracted to a depth of 970 ft. At that depth, friction was reduced to the point where the casing could move freely. A 13.4-in.-diameter Super Jaws underreaming bit was attached to the hammer, and the drill string was tripped down the borehole. This drilling method was used to TD of the borehole.

Drilling continued to a depth of 1195 ft bgs, and the drill string was tripped out of the borehole on August 29 to check for the presence of groundwater. Regional groundwater was tagged at a depth of 1152 ft bgs and drilling continued. The formation began heaving at a depth of 1240 ft bgs, and the drillers reported caving every time they raised the bit. The drill bit was advanced to a TD of 1260 ft bgs, and the 12-in.-diameter casing was advanced to a depth of 1255 ft bgs. Drilling was terminated at a depth of 1260 ft TD because of the unstable borehole conditions and concerns the drilling string could become stuck downhole. On August 30, the drill string was removed from the borehole.

Well R-62 fieldwork went on standby on August 31 pending the finalized Laboratory well design. The bottom of the formation heave was tagged at a depth of 1225 ft, which corresponded to 29 ft of formation inside the 12-in.-diameter casing. The Laboratory performed natural gamma logging inside the 12-in.-diameter casing. Water was added to the borehole to push heaved sand out of the casing, which was retracted to a depth of 1211 ft bgs. The bottom of the borehole was tagged at a depth of 1223 ft bgs and the depth to water at a depth of 1137 ft bgs on September 1.

4.0 SAMPLING ACTIVITIES

The following sections describe the cuttings and groundwater sampling activities for regional aquifer well R-62. All sampling activities were conducted in general accordance with applicable quality procedures.

4.1 Cuttings Sampling

Cuttings samples were collected at 5-ft intervals from the borehole beginning at ground surface to the TD of 1260 ft bgs. At each interval, the site geologist collected approximately 500 mL of bulk cuttings from the discharge cyclone, placed them in resealable plastic bags, labeled them, and archived in core boxes. Smaller size fractions (>#10 and >#40 mesh) were sieved from the bulk cuttings and placed in chip trays along with unsieved (whole rock) cuttings. Samples were recovered from more than 99% of the borehole; samples were not recovered from 15 ft to 20 ft bgs, 210 ft to 220 ft bgs, and 1075 ft to 1080 ft bgs. Radiation control technicians screened cuttings before they were removed from the site, and 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.

Section 5.1 of this report summarizes the stratigraphy encountered at well R-62. Appendix A provides lithologic descriptions of the drill cuttings.

4.2 Water Sampling

One perched-intermediate groundwater sample was collected on August 9, 2011, at a depth of 628 ft bgs. Water was evacuated from the borehole by airlifting and allowed to recharge the borehole before the sample was collected. The groundwater sample was analyzed for total and dissolved metals, cations and anions, and perchlorate.

A second perched-intermediate groundwater sample was collected on August 26 at a depth of 920 ft bgs. Water was evacuated from the borehole by airlifting and allowed to recharge the borehole before the sample was collected. The groundwater sample was analyzed for total and dissolved metals, cations and anions, and perchlorate.

Table 4.2-1 summarizes screening samples collected at Well R-62. Appendix B provides a discussion of screening, groundwater chemistry, and field water-quality parameters.

5.0 GEOLOGY AND HYDROGEOLOGY

A brief description of the geologic and hydrogeologic features encountered at R-62 is presented below. The Laboratory's geology task leader and site geologists examined the cuttings to determine the geologic contacts and hydrogeologic conditions. Drilling observations, video logging, and water-level measurements were used to characterize groundwater occurrences.

5.1 Stratigraphy

The stratigraphy and contacts presented below are based on lithologic descriptions of cuttings samples collected from the discharge cyclone, borehole geophysical logs, and video logs. Geologic units are described below in order of youngest to oldest geologic units. Figure 5.1-1 illustrates the stratigraphy at R-62, and Appendix A provides a detailed lithologic log based on visual examination and analysis of drill cuttings.

Unit 3, Tshirege Member of the Bandelier Tuff, Qbt 3 (0 to 5 ft bgs)

Unit 3 of the Tshirege Member of the Bandelier Tuff consists of light gray, poorly welded, crystal- and lithic-rich, devitrified ash-flow tuff. The contact between unit 3 and the underlying unit 2 was difficult to determine based on drill cuttings alone; the contact was placed at 5 ft bgs based on borehole gamma-ray response and the position of the contact in nearby outcrops.

Unit 2, Tshirege Member of the Bandelier Tuff, Qbt 2 (5 to 55 ft bgs)

Unit 2 of the Tshirege Member of the Bandelier Tuff consists of light gray to medium gray and brownish-gray, poorly welded to moderately welded, crystal- and lithic-rich, devitrified and vapor phase-altered ash-flow tuff.

Unit 1v, Tshirege Member of the Bandelier Tuff, Qbt 1v (55 to 170 ft bgs)

Unit 1v of the Tshirege Member of the Bandelier Tuff consists of light and brownish gray to dark yellowish-brown, poorly welded, crystal- and lithic rich, devitrified ash-flow tuff. The contact between unit 1v and the underlying unit 1g was placed at 170 ft bgs based on the first appearance of vitric pyroclasts downhole and on the borehole gamma-ray response.

Unit 1g, Tshirege Member of the Bandelier Tuff, Qbt 1g (170 to 300 ft bgs)

Unit 1g of the Tshirege Member of the Bandelier Tuff consists of grayish orange-pink to very pale orange to light brown, nonwelded to poorly welded, vitric ash-flow tuff. The contact between unit 1g and the underlying Cerro Toledo interval was difficult to determine based on drill cuttings alone; the contact was placed at 300 ft bgs based on the abrupt decrease in borehole gamma-ray response downhole.

Cerro Toledo Interval, Qct (300 to 350 ft bgs)

The Cerro Toledo interval consists of light gray to light brownish-gray and pale red to light brown, poorly to well-sorted tuffaceous sedimentary deposits that occur between the Tshirege and Otowi Members of the Bandelier Tuff. The deposits are predominantly reworked tuff with minor silt, sands, granules, and gravels derived from Cerro Toledo rhyolites, Tschicoma dacites, and Otowi tuffs eroded from the Sierra de los Valles highlands west of the Pajarito Plateau. The formation commonly exhibits pervasive light pale orange to grayish-orange oxidation. The contact between Cerro Toledo interval and the underlying Otowi Member was difficult to establish based on drill cuttings alone; the contact was placed at 350 ft bgs based on an increased borehole gamma-ray response associated with the top of the Otowi Member.

Otowi Member of the Bandelier Tuff, Qbo (350 to 588 ft bgs)

The Otowi Member of the Bandelier Tuff consists of white to light gray pumiceous, nonwelded to moderately welded ash-flow tuff with vitric, fibrous pumices, phenocrysts, and lithic clasts that include a variety of pale brown and olive-gray to brownish-gray intermediate-composition volcanic rocks.

Guaje Pumice Bed of the Otowi Member of the Bandelier Tuff, Qbog (588 to 607 ft bgs)

The Guaje Pumice Bed is white to gray and reddish-gray and contains pumice fragments with subordinate amounts of volcanic lithics and quartz and sanidine phenocrysts. The presence of this unit was difficult to determine based on drill cuttings alone. The unit boundaries were determined based on the high borehole gamma-ray response commonly found in this unit in nearby wells.

Puye Formation, Tpf (607 to 655 ft bgs)

The Puye Formation consists of grayish-brown and orange-pink, poorly to moderately sorted volcaniclastic sediments with subangular to subrounded boulders, cobbles, gravels, sands, and silts. Clasts in these sedimentary deposits consist of dacitic detritus shed from the Tschicoma Formation exposed in the Sierra de los Valles highlands west of the Pajarito Plateau.

Cerros del Rio Volcanic Series, Tb4 (655 to 882 ft bgs)

The Cerros del Rio volcanic series consists of light gray to light brownish-gray and olive-black, massive to vesicular basaltic lava flows separated by porous zones of interflow breccias.

Puye Formation, Tpf (882 to 1100 ft bgs)

The Puye Formation consists of moderate brown and grayish-orange to very dusky red, poorly to moderately sorted volcaniclastic sediments with subangular to subrounded boulders, cobbles, gravels, sands, and silts. Clasts in these sedimentary deposits consist of dacitic detritus shed from the Tschicoma Formation exposed in the Sierra de los Valles highlands west of the Pajarito Plateau.

Miocene Pumiceous Sediments, Tjfp (1100 to 1230 ft bgs)

Miocene pumiceous sediments form an unassigned unit that consists of light brown and very light gray to pinkish-gray tuffaceous silty sand with multicolored dacitic and rhyolitic gravel. Cuttings from this unit contain abundant reworked subrounded white vitric pumice and gray vitric and devitrified rhyolite lava clasts. Pumice clasts contain sparse biotite phenocrysts.

Miocene Riverine Deposits, Tcar (1230 to 1260 ft bgs)

Miocene riverine deposits consist of medium brown and grayish orange-pink fine to medium silty sand with fine subrounded to rounded gravel composed of dacite and minor quartzite. The sand and silt fractions are dominated by rounded and frosted quartz with subordinate intermediate volcanic clasts and feldspars. These deposits are probably correlative with the Chamita Formation of the Santa Fe Group.

5.2 Groundwater

An upper perched groundwater zone was detected in the upper part of the Puye Formation, above the Cerros del Rio basalt, at 678 ft bgs. The water stabilized at a depth of 627 ft bgs on August 9, 2011. A groundwater screening sample was collected from the drill rig discharge line on August 9. This groundwater was sealed off from the borehole by landing 16-in.-diameter casing at 672 ft bgs within a bentonite chip seal.

A lower perched groundwater zone video log performed after drilling advanced through the basalt and into the lower Puye Formation on August 13 indicated the presence of groundwater seepage at depths of approximately 843 ft and 853 ft in the basalt and at depths of approximately 881 ft and 893 ft in the underlying Puye Formation. A groundwater screening sample was collected from the drill rig discharge line on August 26.

On August 29, after drilling to a depth of 1195 ft bgs, a water level for the regional aquifer inside the drill casing was measured at 1152 ft bgs. The depth to water in the open borehole at TD before well construction was 1143 ft bgs. On October 17, following well installation, well development, and aquifer testing, depth to water was 1142 ft bgs in the completed well.

5.2.1 Regional Aquifer Groundwater Elevations

Based upon the depth to water of 1143.1 ft bgs measured on October 29 at R-62 after installation, initial development and aquifer testing, the water-level elevation was approximately 5841.8 ft above mean sea level (amsl). This elevation is approximately 1.8 ft higher than the predicted elevation of 5840 ft for R-62 based on the current regional aquifer water-level map (Figure 5.2-1). The water level for R-62 measured after well installation and hydraulic testing is a preliminary value, and the water level may fluctuate as pressures equilibrate in the newly installed well.

Water levels at R-62 will continue to be monitored and data will be incorporated in periodic updates of the water-table elevation map.

6.0 BOREHOLE LOGGING

The following sections describe the borehole logging conducted at R-62. Table 6.0-1 presents a summary of all logging.

6.1 Video Logging

Laboratory personnel ran video logs of the R-62 borehole on two separate occasions. The first video log of the R-62 borehole was recorded on August 2, 2011, from ground surface to 624 ft bgs to observe the open borehole and to check for the presence of perched-intermediate groundwater. A second video log of the R-62 borehole was run on August 13 from ground surface to 910 ft to observe the open borehole below the 16-in. casing (set at 672 ft bgs). Table 6.0-1 provides a description of these logs. The video logs are provided on DVD as Appendix C of this report.

6.2 Geophysical Logging

Laboratory personnel ran natural gamma and induction logs in the R-62 borehole on August 2, 2011, from 664 ft bgs to ground surface. Laboratory personnel also ran natural gamma and conductivity logs on August 13 from 600 to 923 ft bgs and 923 to 668 ft bgs, respectively. Gamma logs were again run by Laboratory personnel on August 31 from 0 ft to 1226 ft through 12-in. well casing and September 19 from 546 ft to 1185 ft bgs through the existing 5-in. well casing. Gamma logs were again run by Laboratory personnel on September 29 to October 4 to evaluate the placement of backfill materials and to determine the location of the well casing. Table 6.0-1 shows the depths of coverage for each type of log. The Laboratory geophysical logs are included as Appendix D of this report (on CD).

7.0 WELL INSTALLATION

The R-62 well was installed between September 1 and October 3, 2011. The following sections summarize the well design and well construction activities.

7.1 Well Design

The R-62 well was designed in accordance with the field implementation plan (Eberline Services 2011, 214982) and a final NMED-approved well design developed after TD was reached (Appendix E). The well was designed with one screened interval to monitor regional groundwater quality and water levels near the regional water table in the Miocene pumiceous sediments.

7.2 Well Construction

The R-62 well was constructed of 5.0-in.–inside diameter (I.D.)/5.6-in.-O.D. passivated type 304 stainless-steel threaded casing fabricated to American Society for Testing and Materials (ASTM) standard A312. Figure 7.2-1 illustrates the final well construction details. The screened interval consists of a 20.7 ft length of 5.0-in.-I.D. rod-based, 0.020-in slot, wire-wrapped well screen. Compatible external stainless-steel couplings (also passivated type 304 stainless steel fabricated to ASTM A312 standards) were used to join all individual casing and screen sections. Casing and screen were provided by the Laboratory and were steam-pressure washed before installation. A 2.5-in.-O.D. steel flush-threaded tremie pipe string, also decontaminated before use, was used to deliver annular fill materials and potable water downhole during well construction.

The final well design was received on September 1, and the well steel and screens were cleaned in preparation for construction. Before the well was constructed, the bottom of the hole was tagged at a depth of 1239 ft bgs. A mixture of 10/20 sand and 3/8-in. bentonite chips was added to the borehole via tremie pipe from depths of 1239 ft to 1202 ft bgs. The 12-in.-diameter casing was retracted to a depth of 1196 ft bgs. The well was installed on September 3, 2011, and the screened interval was placed at depths of 1158 ft to 1179 ft bgs.

On September 4, the 12-in.-diameter casing was retracted to a depth of 1176 ft bgs. After the casing was removed, the formation caved into the boring from depths of approximately 1202 ft to 1189 ft bgs. The lower bentonite seal, consisting of 3/8-in. bentonite chips, was installed via tremie pipe from depths of 1189 ft to 1182 ft. The seal was allowed to hydrate for 4 h.

The primary filter pack (consisting of 10/20 sand) was emplaced via tremie pipe beginning on September 4. The filter pack was installed at depths of 1182 ft to 1154 ft bgs and swabbed. After swabbing, the primary filter pack settled to a depth of 1157 ft bgs on September 8. Additional sand was added on September 8 and 9 to bring the 10/20 sand filter pack up to 1152 ft bgs. The secondary filter pack consisting of 20/40 sand was emplaced via tremie pipe from depths of 1152 ft to 1149 ft bgs. An upper seal consisting of hydrated 3/8-in. bentonite chips was emplaced via tremie pipe at depths of 1149 ft to 1146 ft bgs and allowed to hydrate for a minimum of 4 h. Additional bentonite was emplaced above this seal from 1146 ft to 1129 ft bgs and allowed to hydrate. After this hydration period, a mixture consisting of 66% 3/8-in. bentonite chips and 33% 10/20 sand was emplaced to a depth of 952 ft bgs.

On September 11, the drillers were raising the 12-in.-diameter casing in preparation to cut and remove a 20-ft-long section when the casing slid through the casing grip and fell down the hole. The top of the 12-in.-diameter casing was tagged at a depth of 50 ft bgs, with the bottom of the casing at a depth of 1004 ft bgs. The top of the sand/bentonite backfill was tagged at a depth of 952 ft bgs.

On September 12, the NMED approved leaving the 12-in.-diameter casing in the borehole under the conditions that the annular space between the 5.6-in.-O.D. well casing and the 12-in.-diameter drill casing would be backfilled with an impermeable material. Bentonite pellets were emplaced via tremie pipe in the annular space between the 5.6-in.-O.D. well casing and the 12-in.-diameter drill casing from depths of 952 ft to 916 ft bgs. The tremie pipe was removed from the borehole and a 4-in.-diameter polyvinyl chloride (PVC) tremie pipe was installed into the top of the 12-in.-diameter casing at a depth of 50 ft bgs. Backfill material consisting of hydrated 3/8-in. bentonite chips was emplaced via free fall from depths of 916 ft to 59 ft bgs in the annular space between the 5.6-in.-O.D. well casing and the 12-in.-diameter drill casing from September 12 to September 13.

On September 13, the drillers began to pull the 16-in.-diameter drill casing from the borehole. The casing was very tight in the borehole, and eventually the drillers were able to only retract 11 ft. There was some concern that the 20-in.-diameter casing could not be removed from the borehole. On September 18, the 20-in.-diameter casing was removed from the borehole with little difficulty. Demobilization of the R-62 site equipment (drill rig, compressor, and tools) took place on September 21.

Hydraulic casing jacks were brought to the site and used to pull on the 16-in.-diameter casing. Approximately 1 ft of casing was removed from the ground (the bottom of the casing was calculated to be at a depth of 666 ft bgs) using the casing jacks. Pulling the casing with hydraulic jacks was stopped when it was observed that the casing was beginning to stretch. This presented a concern that the casing stretch could lead to possible separation of the welds in the 16-in.-diameter casing during the pull. Discussions were held between the Laboratory, NMED, and the New Mexico Office of the State Engineer (NMOSE) to determine if the 16-in.-diameter casing could be left in place.

NMED and NMOSE agreed the casing could be left in place as long as a seal was emplaced to minimize the migration of fluids within the annular space. Various borehole sealant materials were researched and BAROTHERM GOLD, a Baroid product, was selected to provide the seal between the borehole wall and casing. A plan to emplace these materials was provided to NMED and NMOSE for their approval. NMED approved the plan on September 28 (Appendix E), along with the Laboratory's notice to proceed.

The BAROTHERM GOLD material was emplaced in three lifts on September 29 and 30. The Laboratory used natural gamma surveys to obtain an estimate of the emplacement depth of the BAROTHERM GOLD. The natural gamma surveys indicated the evidence was sufficient that the seal had been placed correctly. In accordance with the approved plan, a 20-ft-thick lift of neat cement was emplaced above the BAROTHERM GOLD. The remainder of the annular space was filled with a 9.5 sack slurry cement mix (equivalent to 1800 lb of sand, 700 lb of cement, 200 lb of fly ash, 45 gal. of water, and a trace wetting agent). A summary of the annual fill materials is presented in Table 7.2-1.

Based on data from the natural gamma surveys, NMED and NMOSE approved the borehole seal. The Laboratory received the approval to continue with well development October 1.

8.0 POSTINSTALLATION ACTIVITIES

Following well installation at R-62, the well was developed and tested, and the sampling system was installed. The well head and surface pad were completed on January 15, 2012. A geodetic survey was completed on January 19 and February 1. 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 in five different phases. The first phase was performed from October 4 to October 11, 2011. Well development began with swabbing and bailing to remove formation fines in the filter pack and sump. Bailing continued until water clarity visibly improved.

The swabbing tool used was a 4-in.-diameter, 1-in.-thick rubber disc attached to a weighted-steel rod. The swabbing tool was lowered by wireline using a Pulstar 12000 work-over rig to a depth of approximately 1180 ft bgs and drawn repeatedly across the screened interval. The bailing tool was a 4-in.-O.D. by 8-ft-long stainless-steel bailer with a total capacity of 5 gal. The tool was lowered by wireline and used to remove water from the well that was then discharged into the cuttings pit. A total of 300 gal. of groundwater was bailed between October 4 and 6.

After bailing, a 10-horsepower (hp), 4-in.-Grundfos submersible pump was installed in the well and set at multiple depths through the course of well development. The average pump rate was 1.8 gallons per minute (gpm) during the 40 h of pumping development. Approximately 3036 gal. of water was removed during development.

The second phase of development was conducted after the aquifer testing described in section 8.2. This phase consisted of pumping an additional 985 gal. on October 18, jetting and bailing the well on October 25, followed by a short 2-h pumping test to assess the effectiveness of the jetting technique. A total of 6432 gal. of water was removed from the well by the end of this second phase.

The third phase was performed on a 24-h basis from 8 a.m. from January 27 to 8 a.m. on January 31, 2012. This phase of well development was performed using the dedicated sampling system after installation. The average pump rate during this third phase of development was 1.7 gpm during the 96 h of pumping development. Approximately 9774 gal. of water was removed during the third phase of development, bringing the cumulative total removed to about 16,206 gal.

The fourth phase of development was conducted during daylight hours and began on February 6. Pumping continued through February 13, when it was shut down at the Laboratory's request so as not to influence results of an aquifer test being conducted at regional well R-28.

A fifth phase of development resumed on March 7 and continued through March 14. A total of 10,794 and 13,501 gal. of water was removed during the fourth and fifth phases, respectively, resulting in a total of 40,501 gal. removed during well development.

8.1.1 Well Development Field Parameters

The field parameters of turbidity, temperature, pH, dissolved oxygen (DO), oxidation-reduction potential (ORP), and specific conductance were monitored via a flow-through cell at R-62 during each phase of well development. Samples were also collected for laboratory analysis of TOC. The field parameter measurements at the end of development were: pH of 7.98, temperature of 19.86°C, and turbidity of 27.6 nephelometric turbidity units (NTU). Specific conductance was not recorded because of a malfunction of the conductivity probe. The TOC concentration in sample GW62-12-2285, collected on March 14, 2012, was 0.2 mg/L. The field parameters were not measured during the aquifer testing and the second phase of development because of the high turbidity of the groundwater. TOC values less than 2 mg/L indicate the well has been adequately developed. Appendix B discusses field parameters measured during development.

Table B-2.2-1 presents all field parameters and discharge volumes recorded during development.

8.2 Aquifer Testing

Aquifer pumping tests, including preliminary step tests and a 24-h test, were conducted at R-62 between October 12 and 17, 2011, by David Schafer and Associates. Three short-duration pumping intervals with short-duration recovery intervals (step tests) were conducted on October 13. The objective of the short-duration tests was to assess the behavior of the system and properly determine the optimal pumping rate for the 24-h test. A 24-h aquifer test was completed on October 16. A 10-hp, 4-in.-diameter Grundfos submersible pump was used to perform the aquifer tests. Approximately 1722 gal. of groundwater was purged during aquifer testing activities. The test analyses suggested a formation transmissivity on the order of 125 gallons per day (gpd)/ft. The saturated thickness corresponding to the transmissivity value was not known. Assuming this value represented a thickness equal to the screen length (20.7 ft), the estimated average hydraulic conductivity was 6.0 gpd/ft^2, or 0.8 ft/d. Appendix F presents the results and analysis of the R-62 aquifer tests.

8.3 Water Volumes Introduced Versus Volumes Removed

Water introduced below 1142 ft bgs (the approximate static water level of the regional aquifer in R-62) included 6300 gal. used during drilling and 35,000 gal. used during well construction in the regional aquifer for a total of approximately 41,300 gal. It is estimated that 1550 gal. of water was recovered during the drilling and well construction activities in the regional aquifer, which calculates a total of approximately 39,750 gal. introduced into the regional aquifer. Approximately 40,501 gal. of water was removed from the screened interval during well development and aquifer testing.

8.4 Dedicated Sampling System Installation

A dedicated sampling system for R-62 was installed on January 26, 2012. The system uses a single 5.0-hp Franklin Electric motor and 4.0-in.-O.D. environmentally retrofitted Grundfos submersible pump. The pump riser pipe consists of threaded and coupled nonannealed 1.0-in.-I.D. passivated stainless-steel. Two 1-in.-I.D. schedule 80 PVC tubes were installed along with, and banded to, the pump riser. A dedicated In-Situ Level Troll 500 transducer was installed in one of the tubes, and the second tube will be used for manual water-level measurements. Both PVC tubes are equipped with a 0.5-ft section of 0.010-in. slotted screen and a closed bottom. Figure 8.4-1a shows details of the dedicated sampling system. Figure 8.4-1b presents technical notes describing the sampling system components. Figure 8.4-1c shows the Grundfos pump performance curve.

8.5 Wellhead Completion

A reinforced concrete surface pad, 10 ft ×10 ft × 6 in. thick, was installed at the R-62 wellhead on January 15, 2012. The concrete pad was slightly elevated above ground surface and crowned to promote runoff. The pad will provide long-term structural integrity for the well. A brass monument marker was embedded in the northwest corner of the pad. A 16-in.-O.D. steel protective casing with a locking lid was installed around the stainless-steel well riser. A 0.5-in. weep hole was drilled near the base of the protective casing to prevent water accumulation inside the protective casing. Pea gravel was emplaced between the protective casing and well casing to a height of 1 ft above the weep hole. Four steel bollards, covered by high-visibility plastic sleeves, were set at the outside edges of the pad to protect the well from accidental vehicle damage. They are designed for easy removal to allow access to the well. Figure 8.4-1a shows details of the wellhead completion.

8.6 Geodetic Survey

A licensed professional land surveyor conducted a geodetic survey on January 20, 2012 (Table 8.6-1). A resurvey of the top of well casing was conducted on February 2, 2012, as additional casing was added at the time of pump installation. The protective casing was elevated later and resurveyed on March 12. 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 New Mexico State Plane Coordinate System Central Zone 83 (North American Datum [NAD] 83); elevation is expressed in feet amsl using the National Geodetic Vertical Datum of 1929. Survey points included ground-surface elevation near the concrete pad, the top of the monument marker in the concrete pad, the top of the well casing, and the top of the protective casing. The survey data are provided in Table 8.6-1, and the survey location report is provided as Appendix G.

8.7 Waste Management and Site Restoration

Waste generated from the R-62 project includes drilling fluids, purged groundwater, drill cuttings, decontamination water, and contact waste. A summary of the waste characterization samples collected during drilling, construction, and development of the R-62 well is presented in Table 8.7-1. All waste streams produced during drilling and development activities were sampled in accordance with the “Waste Characterization Strategy Form for R-62 Installation of Regional Aquifer Well” (LANL 2011, 203414).

Fluids produced during drilling and containerized in the pit will be evaporated on-site. Evaporation activities began in March 2012.

Analytical results for fluids produced during well development and pump testing will be reviewed with the goal of land application. Data will be reviewed manually and within the automated waste disposition program per the waste characterization strategy form (WCSF) and ENV-RCRA-QP-010.2, Land Application of Groundwater. If it is determined the drilling fluids are nonhazardous but cannot meet the criteria for land application, the drilling fluids will be reevaluated for treatment and disposal at one of the Laboratory's wastewater treatment facilities or other authorized disposal facility. If analytical data indicate the drilling fluids are hazardous/nonradioactive or mixed low-level waste, the drilling fluids will be either treated on-site or disposed of at an authorized facility. Development water was sampled on March 27 and analytical results for disposal analyses are expected at the end of April or beginning of May 2012.

Cuttings produced during drilling will be land-applied after the fluids evaporate from the pit. A review of associated analytical results per the WCSF and ENV-RCRA-QP-011.2, Land Application of Drill Cuttings, indicates the drill cuttings meet all criteria for land application. Materials will be spread across the pad area and the site reseeded as required for site reclamation.

Decontamination fluid used for cleaning the drill rig and equipment was containerized and staged at the Pajarito laydown yard. The fluid waste was sampled and a waste profile form was completed. This decontamination waterwaste was shipped for disposal at the Clean Harbors Waste Disposal Facility in Deer Trail, CO, on March 29, 2012.

Characterization of contact waste was based upon acceptable knowledge, referencing the analyses of the waste samples collected from the drill fluids, drill cuttings, purge water, and decontamination fluid. A waste profile form has been completed, and the contact wastes will be removed from the site following land application of the drill cuttings in the pit. The pit liner will be included in the contact waste disposal materials.

Site restoration activities are conducted by Maintenance and Site Services personnel at the Laboratory. They include evaporating drilling fluids and removing cuttings from the pit and managing the development/pump test fluids in accordance with applicable procedures. The polyethylene liner will be removed following land application of the cuttings, and the containment area berms will be removed and leveled. Activities also include backfilling and regrading the containment area, as appropriate.

9.0 DEVIATIONS FROM PLANNED ACTIVITIES

Drilling and sampling at R-62 were performed in general accordance with "Field Implementation Plan for Regional Aquifer Well R-62 at Los Alamos National Laboratory Technical Area-05" (Eberline Services, Inc., 2011, 214982).

Three major deviations occurred during the installation of R-62. The first occurred on September 11, 2011, when the drillers dropped the 12-in. casing to a depth of 50 ft bgs. NMED approved leaving the 12-in.-diameter casing in the borehole, and bentonite pellets were emplaced via tremie pipe in the annular space between the 5.6-in.-O.D. well casing and the 12-in.-diameter drill casing from depths of 952 ft to 59 ft bgs.

The second deviation occurred on September 13 when the drillers had to use hydraulic casing jacks to remove very tight 16-in.-diameter drill casing from the borehole. After approximately 1 ft of casing was removed, use of the casing jacks was halted when it was observed that the casing was starting to stretch. NMED and NMOSE agreed the casing could be left in place, and BAROTHERM GOLD was emplaced as a seal to mitigate the migration of fluids. Based on data from the natural gamma surveys, NMED and NMOSE approved the borehole seal.

The third deviation occurred during well development. Well development was performed in five phases, not continuously as planned.

10.0 ACKNOWLEDGMENTS

Yellow Jacket Drilling drilled the R-62 borehole, installed the well, and helped conduct well development and aquifer testing.

Kleinfelder West, Inc., provided field geologist and well drilling supervisor services as well as prepare the report.

Laboratory personnel ran downhole video, natural gamma, and induction logging equipment.

David Schafer and Associates performed the aquifer testing and analyzed the data for the aquifer testing report (Appendix F).

11.0 REFERENCES AND MAP DATA SOURCES

11.1 References

The following list includes all documents cited in this report. Parenthetical information following each reference provides the author(s), publication date, and ER ID. The information is also included in text citations. ER IDs are assigned by the EP Directorate's 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.

Eberline Services, July 12, 2011. "Field Implementation Plan for Regional Aquifer Well R-62 at Los Alamos National Laboratory, Technical Area-05," FIP-LANS89795-01, Los Alamos, New Mexico. (Eberline Services 2011, 214982)

Eberline Services, October 11, 2011. "[Integrated Work Document for] Implementation of the Drilling Work Plan for Regional Aquifer Well R-66 for Task Order 2, subcontract number 89795-002-11, under the Drilling Master Task Order Agreement (MTOA), subcontract number 89795-000-11," Albuquerque, New Mexico. (Eberline Services 2011, 211433)

LANL (Los Alamos National Laboratory), May 6, 2011. "Waste Characterization Strategy Form for R-62 Installation of Regional Aquifer Well," Los Alamos National Laboratory, Los Alamos, New Mexico. (LANL 2011, 203414)

NMED (New Mexico Environment Department), December 8, 2010. "Approval with Modification, Drilling Work Plan for Regional Aquifer Well R-62," New Mexico Environment Department letter to G.J. Rael (DOE-LASO) and M.J. Graham (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2010, 111496)

North Wind Inc., July 2011. "Spill Prevention Control and Countermeasures Plan for the ADEP Groundwater Monitoring Well Drilling Operations, Los Alamos National Laboratory, Revision 6," plan prepared for Los Alamos National Laboratory, Los Alamos, New Mexico. (North Wind, Inc., 2011, 213292)

11.2 Map Data Sources

Coarse Scale Drainage Arcs; Los Alamos National Laboratory, Water Quality and Hydrology Group of the Risk Reduction and Environmental Stewardship Program; as published 03 June 2003.

Dirt Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 19 March 2008; as published 04 January 2008.

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

Inactive Outfalls; Los Alamos National Laboratory, Water Quality and Hydrology Group of the Environmental Stewardship Division at Los Alamos National Laboratory Los Alamos New Mexico; 01 September 2003.

Paved Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 19 March 2008; as published 04 January 2008.

Penetrations; Los Alamos National Laboratory, Environment and Remediation Support Services, ER2006-0664; 1:2,500 Scale Data, 01 July 2006.

Structures; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 19 March 2008; as published 04 January 2008.

Technical Area Boundaries; Los Alamos National Laboratory, Site Planning and Project Initiation Group, Infrastructure Planning Division; 19 September 2007.

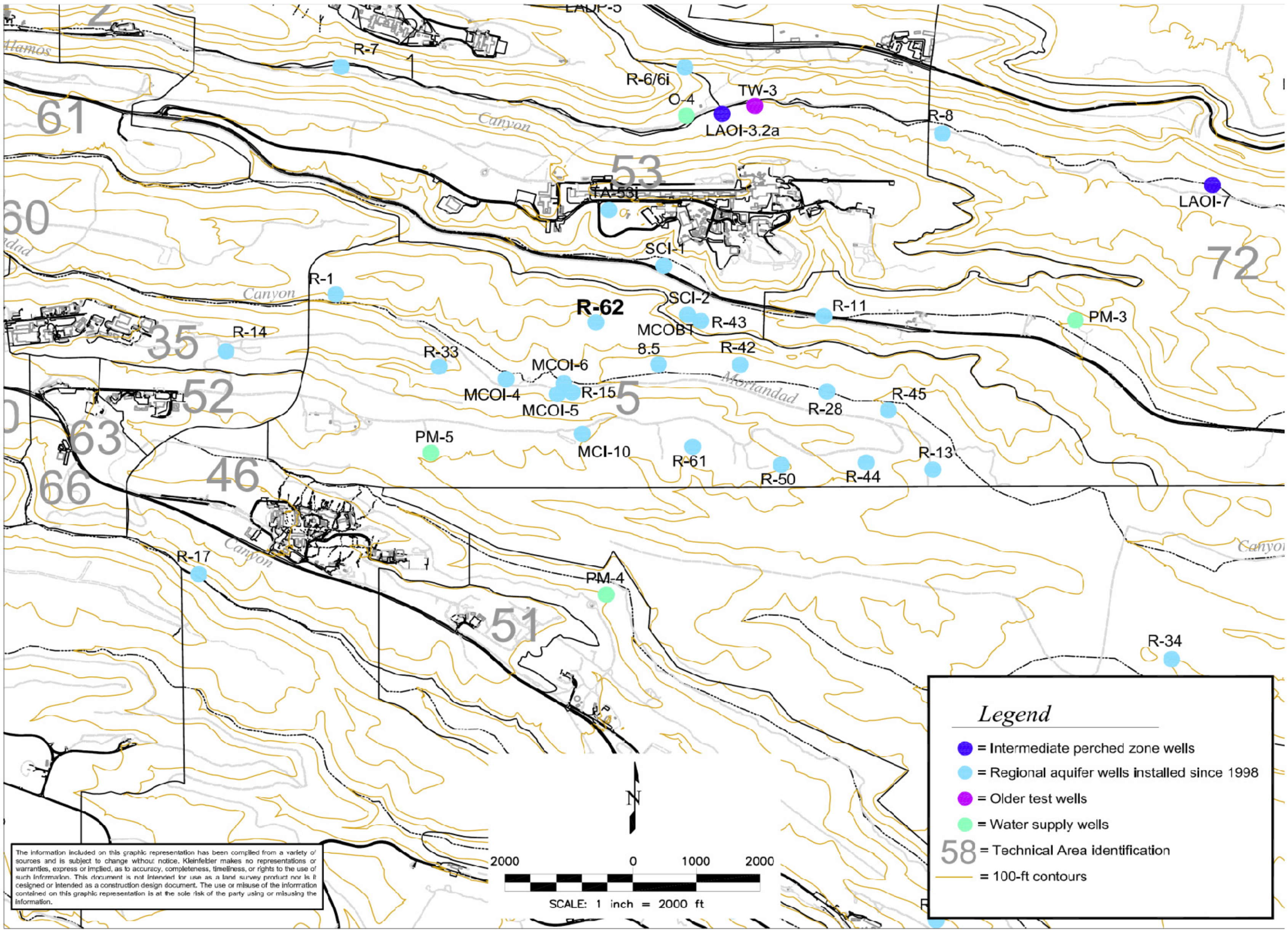


Figure 1.0-1 Well R-62 location

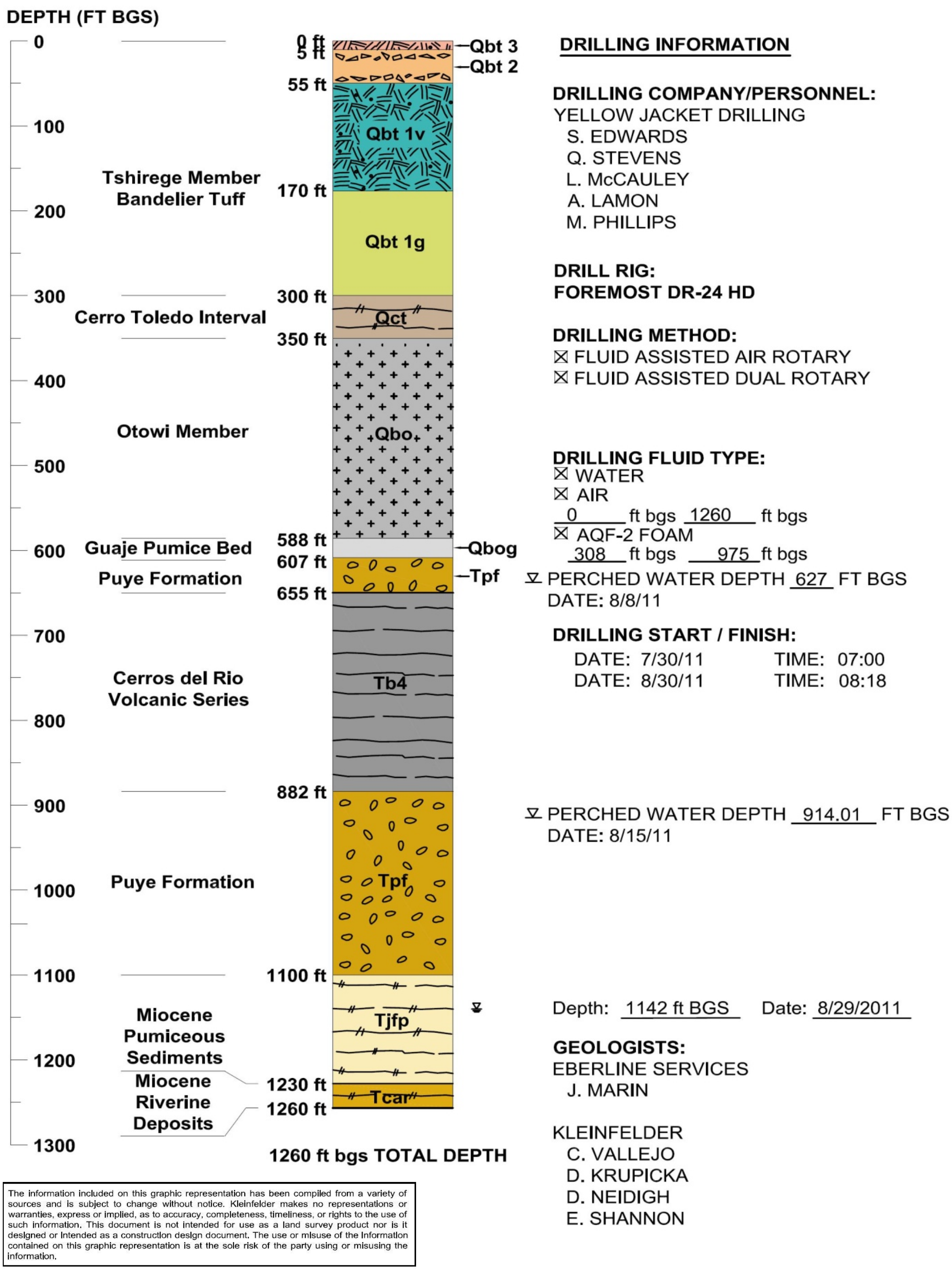
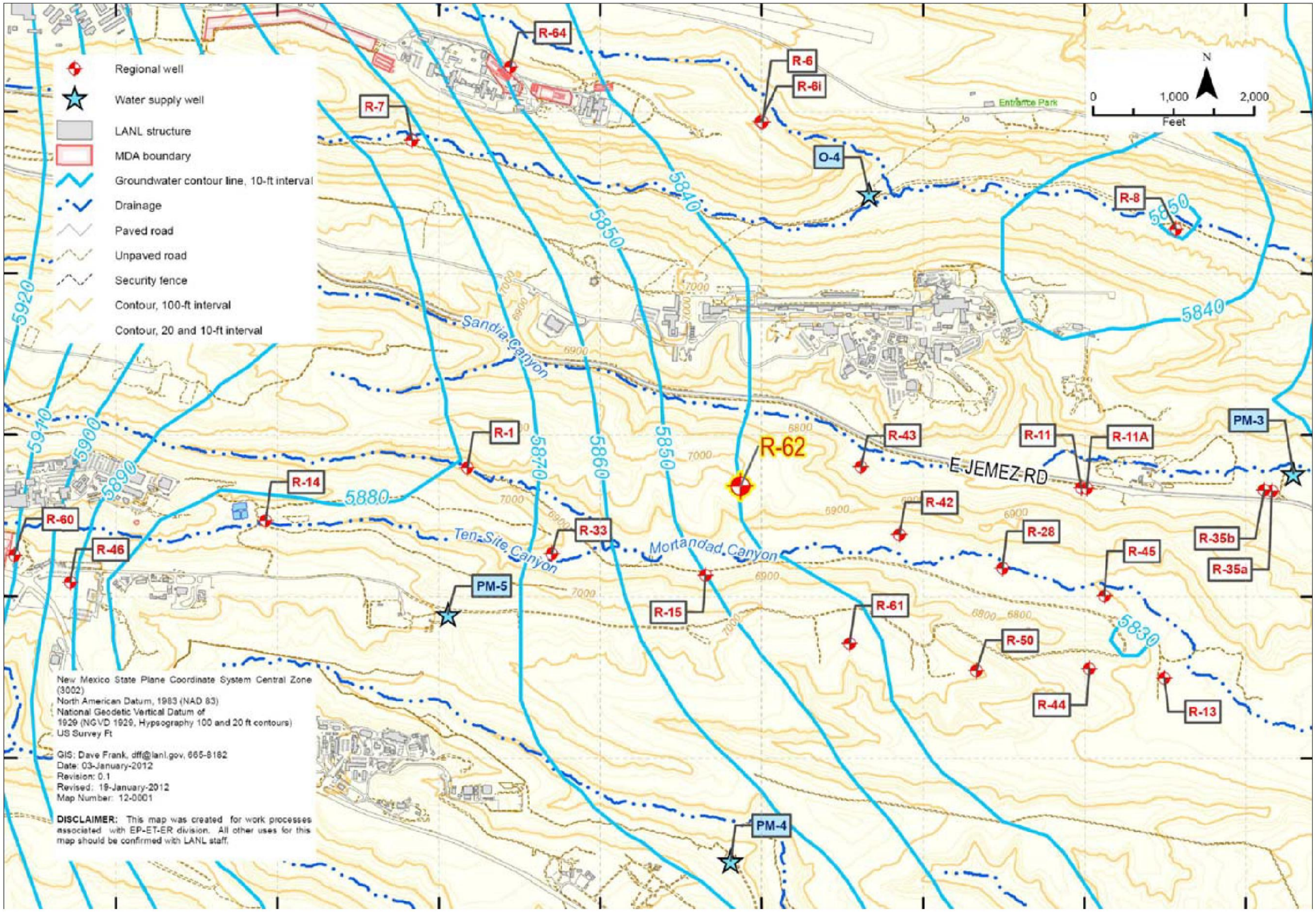


Figure 5.1-1 R-62 borehole stratigraphy



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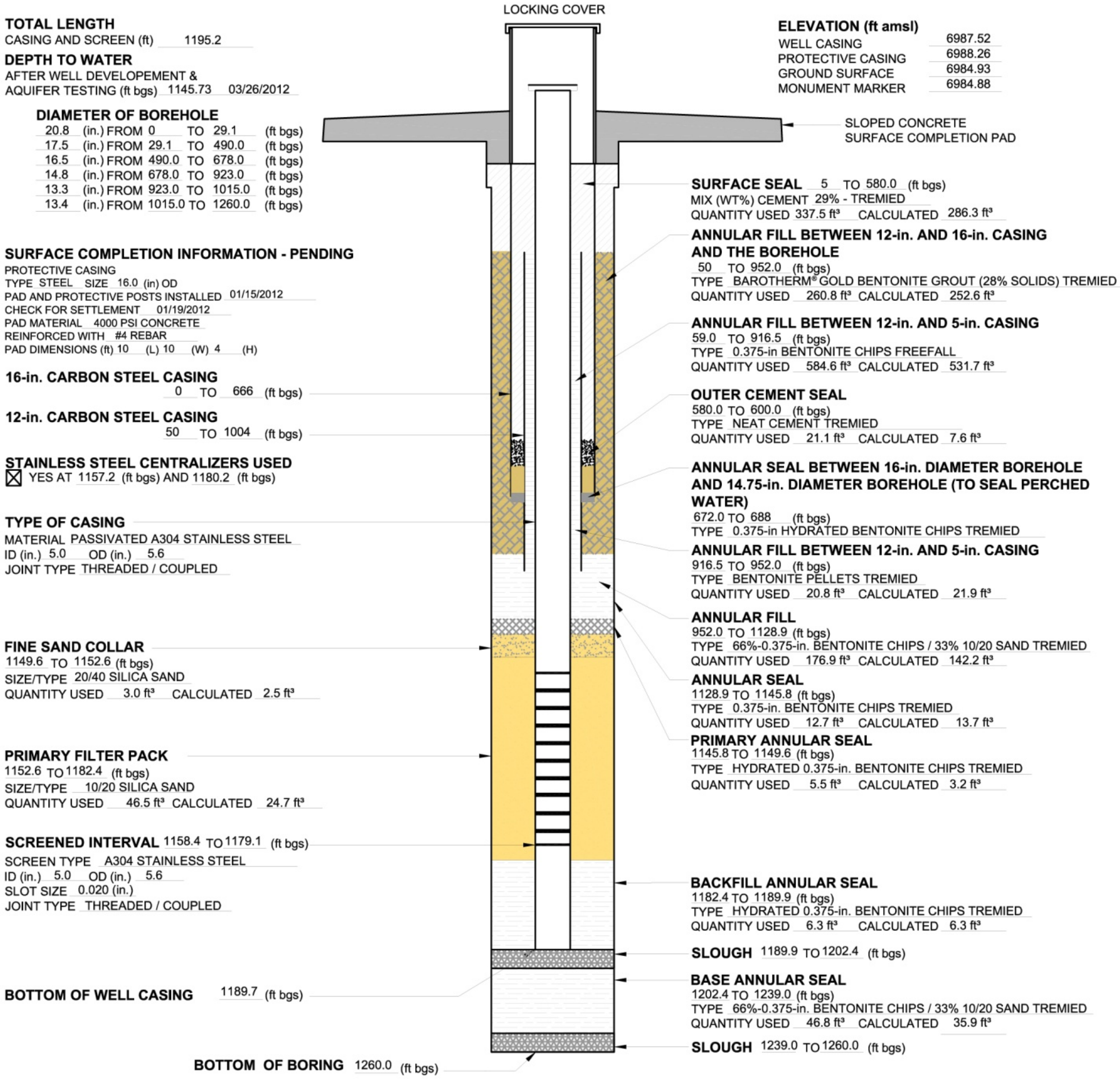
SOURCE:

Figure 5.2-1 Regional aquifer groundwater elevations



WELL DEVELOPMENT BEGAN
DATE 10/4/2011
TIME 13:40

WELL DEVELOPMENT FINISHED
DATE 03/14/2012
TIME 17:50

DEVELOPMENT METHOD
☒ SWABBING ☒ BAILING
☒ PUMPING
TOTAL PURGE VOLUME 40,501 gal.

FINAL PARAMETERS
pH 7.98
TEMPERATURE (°C) 19.86
SPECIFIC CONDUCTANCE (μS/cm) NR
TURBIDITY (NTU) 27.6

WELL COMPLETION BEGAN
DATE 9/1/2011 TIME 21:15

WELL COMPLETION FINISHED
DATE 10/3/2011 TIME 14:20

Figure 7.2-1 As-built construction diagram for well R-62

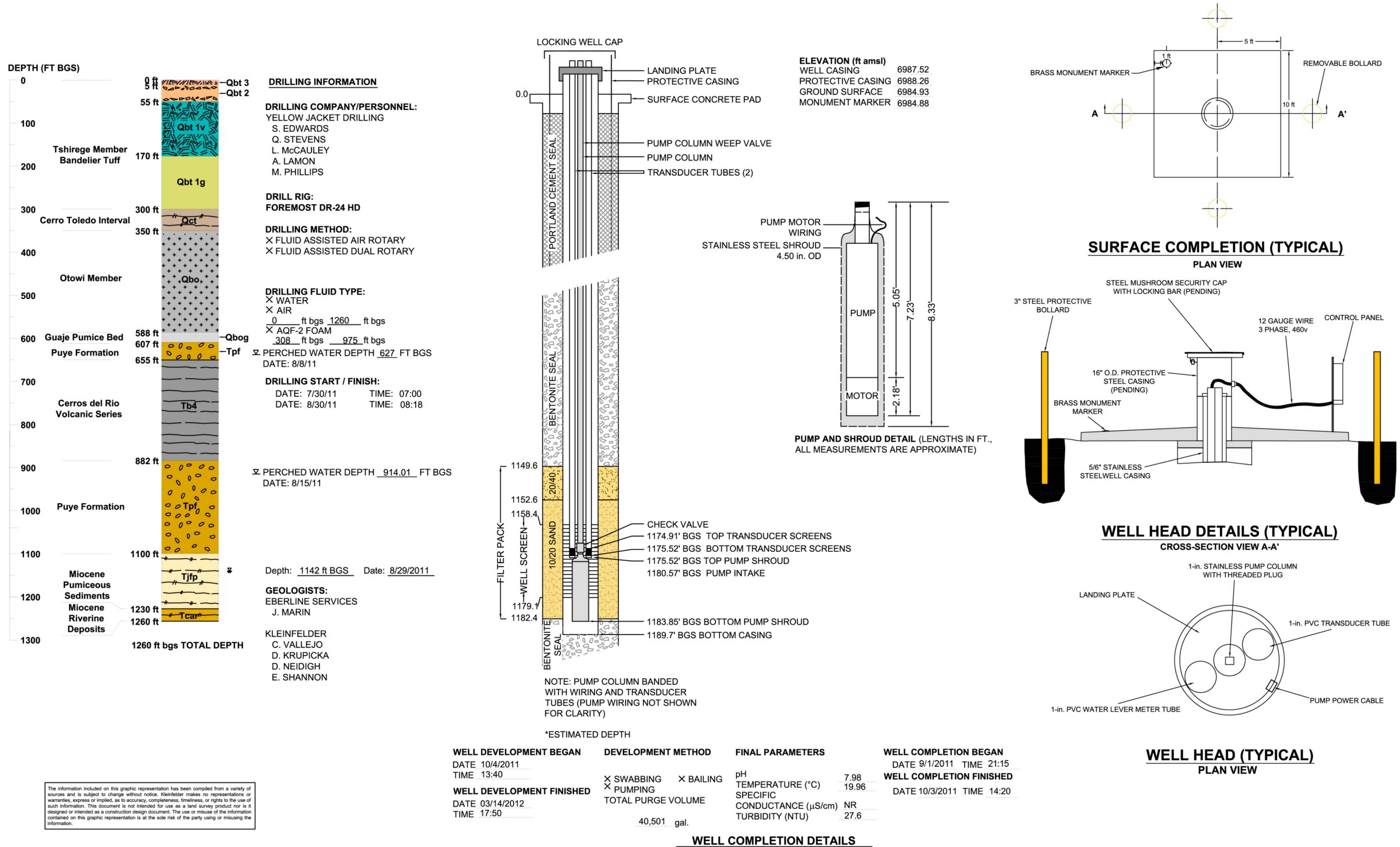


Figure 8.4-1a As-built schematic for well R-62

R-62 TECHNICAL NOTES

SURVEY INFORMATION[1]

BRASS MARKER

NORTHING	1769441.01
EASTING	1635537.94
ELEVATION	6984.88

WELL CASING

NORTHING	1769437.37
EASTING	1635540.50
ELEVATION	6987.52

BOREHOLE GEOPHYSICAL LOGS

LANL NATURAL GAMMA AND ARRAY INDUCTION LOGS
LANL VIDEO LOGS

DRILLING INFORMATION

DRILLING COMPANY
Yellow Jacket Drilling
DRILL RIG
Foremost DR-24 HD
DRILLING METHODS
Fluid-assisted air rotary
Fluid-assisted dual rotary

DRILLING PERSONNEL:
S. Edwards
Q. Stevens S. Edwards
A. Lamon Q. Stevens
GEOLOGISTS:
KLEINFELDER - C. VALLEJO, D. KRUPICKA,
D. NEIDIGH, D. MAZZANTI
E. SHANNON
EBERLINE SERVICES - J. MARIN

DRILLING FLUIDS

AIR: QUICK-FOAM (DISCONTINUED AT 1075 FT BGS)
POTABLE WATER

MILESTONE DATES

DRILLING

START	7/30/2011
FINISH	8/30/2011 8:18

WELL COMPLETION

START	9/1/2011 21:15
FINISH	10/3/2011 14:20

WELL DEVELOPMENT

START	10/4/2011 13:40
FINISH	3/14/2012 17:50

WELL DEVELOPMENT

DEVELOPMENT METHODS

PERFORMED BAILING, SWABBING, AND PUMPING
VOLUME PURGED: 40,501

PARAMETERS MEASUREMENTS (FINAL)

pH	7.98
TEMPERATURE (°C)	19.86
SPECIFIC CONDUCTANCE (µS/cm)	Not Recorded
TURBIDITY (NTU)	27.6

AQUIFER TESTING

WATER PRODUCED	1722
AVERAGE FLOW RATE	1.2 GPM
PERFORMED ON	10/15-16/2011

DEDICATED SAMPLING SYSTEM

PUMP TYPE	SUBMERSIBLE
MAKE	GRUNDFOS
MODEL	10550-930CBM
SN#	B91126364-P11143214

MOTOR	5 HP
MAKE	FRANKLIN
MODEL	2343278902
SN#	11A14-25-00795C

PUMP COLUMN

1-IN THREADED/COUPLED SCHEDULE 60, NONANNEALED,
ASTM PASSIVATED A312 STAINLESS STEEL TUBING

TRANSDUCER AND WATER LEVEL TUBES

2 X 1-IN FLUSH THREADED SCHEDULE 80 PVC TUBING
0.01-IN SLOT SCREENS AT 1177.5-1178.0 FT BELOW
TOP OF CASING

TRANSDUCER

INSTALLED	1/26/2012
MAKE	IN-SITU
MODEL	LEVEL TROLL 500 - 30 PSIG RANGE (VENTED)
SN#	303906

NOTES:

[1] 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

NR Not Recorded

Figure 8.4-1b Technical notes for well R-62

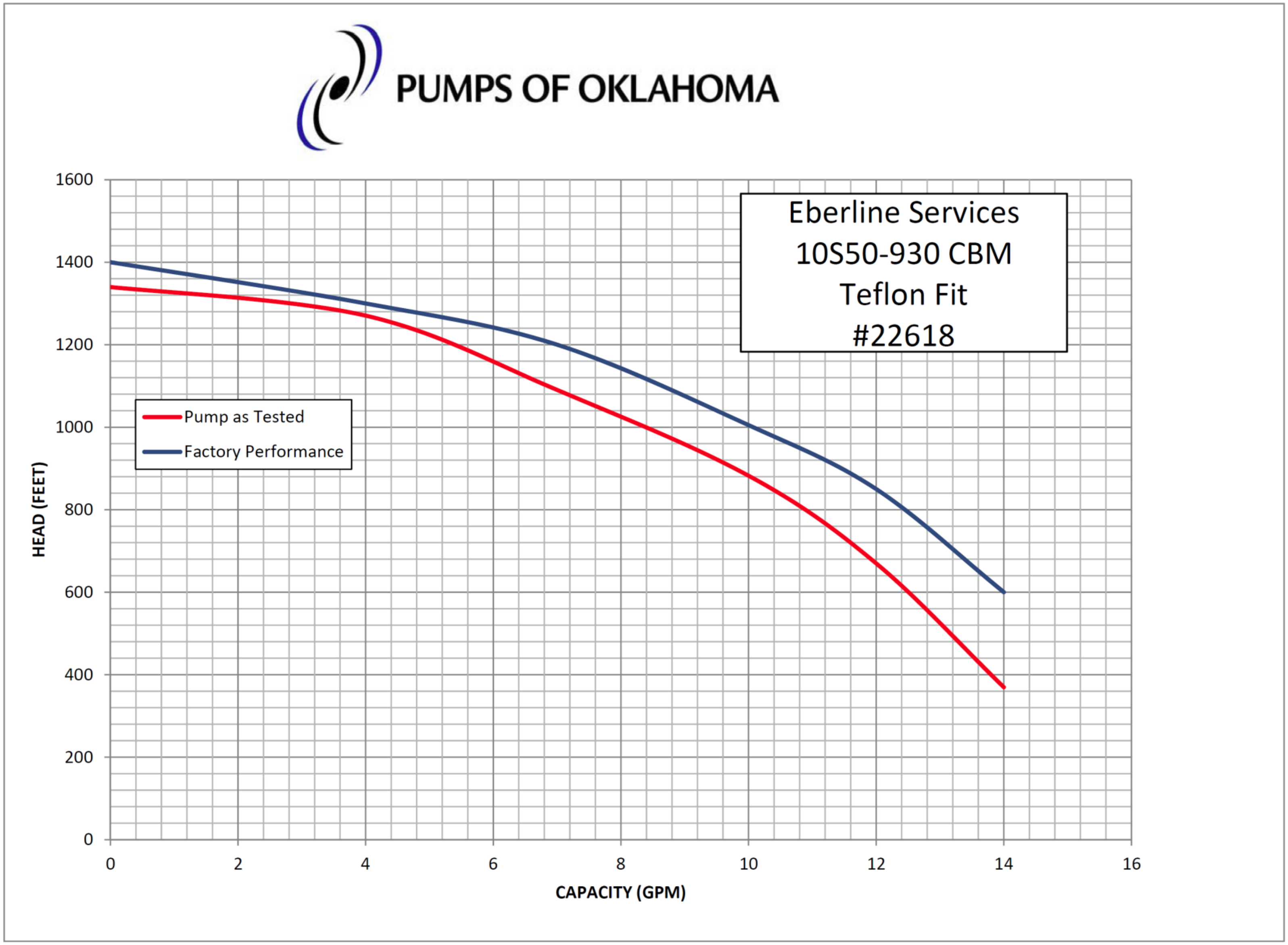


Figure 8.4-1c Pump performance curve

Table 3.1-1
Fluid Quantities Used in the Regional Aquifer during R-62 Drilling and Well Construction

Date and Shift[a]	Drilled Interval (ft bgs)	Daily Tally Water (gal.)	Cumulative Water (gal.)	Estimate of Fluids Recovered (gal.)	Cumulative Estimate of Fluids Recovered (gal.)
8/29/11 AM	1100–1160	4000	4000	1000	1000
8/29/11 PM	1160–1213	300	4300	50	1050
8/30/11 AM	1213–1260	2000	6300	500	1550
8/31/11 AM	—[b]	4000	10,300	0	1550
8/31/11 PM	—	3000	13,300	0	1550
9/2/11 AM	—	3000	16,300	0	1550
9/2/11 PM	—	2900	19,200	0	1550
9/4/11 AM	—	1500	20,700	0	1550
9/4/11 PM	—	600	21,300	0	1550
9/5/11 AM	—	10,900	32,200	0	1550
9/5/11 PM	—	200	32,400	0	1550
9/6/11 AM	—	1800	34,200	0	1550
9/6/11 PM	—	300	34,500	0	1550
9/8/11 PM	—	2100	36,600	0	1550
9/9/11 AM	—	4700	41,300	0	1550

Note: Cumulative water added − cumulative recovered = gallons introduced into regional aquifer: 41,300 − 1550 = 39,750 gal.

[a] AM = Day shift, PM = night shift.

[b] — = Not applicable.

Table 4.2-1
Summary of Groundwater Screening Samples Collected at Well R-62

Location ID	Sample ID	Date Collected	Collection Depth (ft bgs)	Sample Type	Dissolved Metals	Anions	Cations	TOC	pH/ Alkalinity
Drilling									
R-62	GW62-11-25564	8/9/2011	628	R-62 Perched groundwater sample	X[a]	X	X	—[b]	—
R-62	GW62-11-25565	8/9/2011	628	R-62 Perched groundwater sample	X	X	X	—	—
R-62	GW62-11-25566	8/9/2011	628	R-62 Perched groundwater sample	X	X	X	—	—
R-62	GW62-11-25567	8/26/2011	920	R-62 Perched groundwater sample	X	X	X	—	—
Well Development									
R-62	GW62-11-28118	10/5/2011	n/a[c]	Regional groundwater (bailer)	—	—	—	X	—
R-62	GW62-11-28120	10/9/2011	1180	Regional groundwater (pump lift)	—	—	—	X	—
R-62	GW62-11-28121	10/10/2011	1180	Regional groundwater (pump lift)	—	—	—	X	—
R-62	GW62-11-28122	10/18/2011	1180	Regional groundwater (pump lift)	—	—	—	X	—
R-62	GW62-11-28123	10/26/2011	1180	Regional groundwater (pump lift)	—	—	—	X	—
R-62	GW62-12-2219	1/27/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-2205	1/27/2012	1180	Regional groundwater (pump lift)	—	—	—	X	—
R-62	GW62-12-2206	1/27/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-2220	1/27/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-2207	1/28/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-2209	1/28/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-2208	1/28/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-2210	1/28/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-2211	1/29/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-2213	1/29/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-2212	1/29/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-2214	1/29/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—

Table 4.2-1 (continued)

Location ID	Sample ID	Date Collected	Collection Depth (ft bgs)	Sample Type	Dissolved Metals	Anions	Cations	TOC	pH/ Alkalinity
R-62	GW62-12-2215	1/30/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-2217	1/30/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-2216	1/30/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-2218	1/30/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-2225	1/31/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-2224	1/31/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-2272	2/7/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-2275	2/7/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-2270	2/8/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-2268	2/9/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-2269	2/9/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-2266	2/10/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-2267	2/10/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-2262	2/11/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-2264	2/11/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-2273	2/12/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-2274	2/12/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-2261	2/13/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-2265	2/13/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-2277	3/7/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-2278	3/7/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-12281	3/10/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-12280	3/9/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-12279	3/8/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-12291	3/10/2012	1180	Regional groundwater (pump lift)	—	—	—	X	—

Table 4.2-1 (continued)

Location ID	Sample ID	Date Collected	Collection Depth (ft bgs)	Sample Type	Dissolved Metals	Anions	Cations	TOC	pH/ Alkalinity
R-62	GW62-12-12292	3/11/2012	1180	Regional groundwater (pump lift)	—	—	—	X	—
R-62	GW62-12-12282	3/11/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-12283	3/12/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-12293	3/12/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-12284	3/13/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-12294	3/13/2012	1180	Regional groundwater (pump lift)	X	X	X	—	—
R-62	GW62-12-12285	3/14/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-12295	3/14/2012	1180	Regional groundwater (pump lift)	X	X	X	—	—
R-62	GW62-12-2263	2/6/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-12289	3/8/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-12290	3/9/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-2276	2/6/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X

[a] X = Analyzed.

[b] — = Not analyzed.

[c] n/a = Not applicable.

Table 6.0-1
R-62 Logging Runs

Date(s)	Type of Log	Depth (ft bgs)	Description
08/02/11	Video	0–624	LANL video from ground surface to 624 ft bgs. Observed a void in the side of the open borehole at approximately 32 ft bgs.
08/02/11	Natural gamma	0–664	LANL natural gamma log run from ground surface to 664 ft bgs.
08/02/11	Induction	0–664	LANL induction log run from ground surface to 664 ft bgs.
08/13/11	Video	0–908	LANL video from ground surface to 908 ft bgs to observe open borehole below 16-in. casing (set at 677 ft bgs). Groundwater was observed in the well at approximately 907 ft bgs. Water was observed at approximately 843 ft, 853 ft, 881 ft, and 893 ft bgs.
08/13/11	Natural gamma	600–923	LANL natural gamma log run from 600 ft to 923 ft bgs through 16-in. casing and open borehole.
08/13/11	Conductivity	668–923	LANL conductivity log run from 668 ft to 923 ft bgs through 16-in. casing and open borehole.
08/31/11	Natural gamma	0–1226	LANL natural gamma log run from 0 ft to 1226 ft bgs through 12-in. casing
09/19/11	Natural gamma	546–1185	LANL natural gamma log run from 546 ft to 1185 ft bgs through 5-in. well casing.
09/29/11–10/04/11	Natural gamma	Multiple intervals	LANL natural gamma log runs to evaluate placement of backfill materials and to determine location of well casing.
10/01/11	Natural gamma	0–1189	LANL natural gamma log run from ground surface to 1189 ft bgs through 5-in. well casing.

Table 7.2-1
R-62 Annular Fill Materials

Material	Volume (ft^3)
Surface seal: 100 wt% Portland cement	337.5
Upper seal: 0.375-in. bentonite chips	709.8
Transition sand collar: 20/40 silica sand	3.0
Primary filter pack: 10/20 silica sand	46.5
Lower seal: 0.375-in. bentonite chips	53.1

Table 8.6-1
R-62 Survey Coordinates

Identification	Northing	Easting	Elevation
R-62 brass monument marker	1769441.01	1635537.94	6984.88
R-62 top of 16-in. protective casing	1769438.42	1635540.73	6988.26
R-62 top of well casing	1769437.37	1635540.50	6987.52
R-62 ground surface	1769445.73	1635538.85	6984.93

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

Table 8.7-1
Summary of Waste Samples Collected at R-62

Event ID	Sample ID	Date Collected	Description	Sample Matrix
3556	WST05-11-23955	7/30/2011	R-62 drill cuttings	Solid
3556	WST05-22-23958	7/30/2011	R-62 trip blank	Liquid
3556	WST05-11-23957	9/26/2011	R-62 drill cuttings	Solid
3557	WST05-11-23961	9/6/2011	R-62 drill cuttings composite	Solid
3556	WST05-11-23956	8/12/2011	R-62 drill cuttings volatile organic compound sample	Solid
3556	WST05-11-23959	8/12/2011	R-62 trip blank	Liquid
3560	WST05-11-24010	9/25/2011	R-62&SCI-3 decon water	Liquid
3560	WST05-11-24011	9/25/2011	R-62&SCI-3 decon water	Liquid
3558	WST05-11-23962	11/7/2011	Filtered portion of drilling fluids composite	Liquid
3558	WST05-11-23963	11/7/2011	Unfiltered portion of drilling fluids composite	Liquid
3558	WST05-11-23964	11/7/2011	Field duplicate for drilling fluids composite	Liquid
3558	WST05-11-23965	11/7/2011	Field blank for drilling fluids composite	Liquid
3804	GW62-12-12187	3/27/2012	Unfiltered portion of waste samples for development and pump test waters	Liquid
3804	GW62-12-12188	3/27/2012	Filtered Portion of waste samples for development and pump test waters	Liquid
3804	GW62-12-12200	3/27/2012	FTB for waste samples for development and pump test waters	Liquid
3804	GW62-12-12199	3/27/2012	Field duplicate for waste samples for development and pump test waters	Liquid

Appendix A

Well R-62 Borehole Lithologic Log

Borehole Identification (ID): R-62	**Technical Area (TA):** 05	**Page:** 1 of 7
Drilling Company: Yellow Jacket Drilling, Inc.	Start Date/Time: 7/31/11, 1530	**End Date/Time:** 8/31/11, 1215
Drilling Method: Reverse Circulation (RC) Open Borehole; RC Dual Rotary Casing Advance	Machine: DR24HD	**Sampling Method:** Grab
Ground Elevation: 6985 ft amsl		**Total Depth:** 1260 ft bgs
Driller: S. Edwards, L. McCauley, Q. Stevens	**Site Geologists:** J. Marin, D. Mazzanti, D. Neidigh, E. Shannon, C. Vallejo	

Depth (ft bgs)	Lithologic Description	Lithologic Symbol	Notes
0–5	UNIT 3 OF THE TSHIREGE MEMBER OF THE BANDELIER TUFF: WR: Tuff, medium light gray (N6), nonwelded, devitrified. Fine ash matrix with common felsic crystals and lithic grains. +10F: 50–60% lithic grains, angular to subrounded, 50–40% felsic crystals, broken to broken to euhedral. +40F: 100% felsic crystals, broken to euhedral.	Qbt 3	
5–10	UNIT 2 OF THE TSHIREGE MEMBER OF THE BANDELIER TUFF: WR: Tuff, light gray (N7), poorly welded, devitrified. Fine ash matrix with lithic grains and felsic crystals. +10F: 100% fragments of welded tuff. +40F: 100% felsic crystals, broken to euhedral.	Qbt 2	
10–15	WR: Tuff, medium gray (N6), moderately welded, devitrified, fine ash with lithic fragments. +10F: 100% fragments of welded tuff. +40F: 100% felsic crystals.	Qbt 2	
15–20	No recovery.	Qbt 2	
20–25	WR: Tuff, very light gray (N8), poorly welded, devitrified, fine ash matrix. +10F: 100% fragments of welded tuff. +40F: 100% felsic crystals.	Qbt 2	
25–30	WR: Tuff, light gray (N7), nonwelded, devitrified, fine ash matrix. +10F: 100% fragments of welded tuff, subangular to broken pieces. +40F: 100% felsic crystals, angular.	Qbt 2	
30–45	WR: Tuff, light brownish-gray (5YR 6/1), poorly welded, devitrified, fine ash matrix. +10F: 100% fragments of welded tuff. +40F: 100% felsic crystals.	Qbt 2	
45–50	WR: Tuff, light brownish-gray (5YR 6/1), poorly welded, devitrified, fine ash matrix. +10F: 100% fragments of welded tuff, subangular to subrounded gravel, grayish-green (10GY5/2), fragments up to 1.5 cm in size. +40F: 100% felsic crystals.	Qbt 2	Gravel fragments are anomalous to samples above and below.
50–55	WR: Tuff, light gray (N7), nonwelded, devitrified, fine ash matrix with common felsic crystals and lithic grains. +10F: 100% fragments of welded tuff, up to 1 cm in size. Subangular to subrounded. +40F: 100% felsic crystals.	Qbt 2	
55–60	UNIT 1v OF THE TSHIREGE MEMBER OF THE BANDELIER TUFF: WR: Tuff, light gray (N7), nonwelded, devitrified, fine ash matrix with common felsic crystals and lithic grains. +10F: 100% felsic crystal, approximately 4 mm in size. Subangular to subrounded. +40F: 100% felsic crystals.	Qbt 1v	
60–65	WR: Tuff, dark yellowish-brown (10YR 6/6), poorly welded, devitrified, fine ash matrix with common felsic crystals. +10F: 90 to 75% fragments of welded tuff and 10 to 25% felsic crystals. +40F: 100% felsic crystals.	Qbt 1v	
65–70	WR: Tuff, light gray (N7), nonwelded, devitrified, fine ash matrix with common felsic crystals. +10F: 30 to 50% fragments of welded tuff and 50 to 70% felsic crystals, up to 1.5 cm in size, subrounded to subangular. +40F: 100% felsic crystals.	Qbt 1v	

Borehole Identification (ID): R-62	**Technical Area (TA):** 05	**Page:** 2 of 7
Drilling Company: Yellow Jacket Drilling, Inc.	**Start Date/Time:** 7/31/11, 1530	**End Date/Time:** 8/31/11, 1215
Drilling Method: Reverse Circulation (RC) Open Borehole; RC Dual Rotary Casing Advance	**Machine:** DR24HD	**Sampling Method:** Grab
Ground Elevation: 6985 ft amsl		**Total Depth:** 1260 ft bgs
Driller: S. Edwards, L. McCauley, Q. Stevens	**Site Geologists:** J. Marin, D. Mazzanti, D. Neidigh, E. Shannon, C. Vallejo	

Depth (ft bgs)	Lithologic Description	Lithologic Symbol	Notes
70–75	WR: Tuff, very light gray (N8), nonwelded, devitrified, fine ash matrix with common felsic crystals. +10F: 30 to 50% fragments of welded tuff and 50 to 70% felsic crystals, up to 1.5 cm in size, subrounded to subangular. +40F: 100% felsic crystals.	Qbt 1v	
75–90	WR: Tuff, dark yellowish-brown (10YR 6/6), poorly welded, devitrified, fine ash matrix with felsic crystals. +10F: 15 to 30% fragments of welded tuff with 70 to 85% common felsic crystals, up to 8 mm in size, subangular tuff fragments. +40F: 100% felsic crystals.	Qbt 1v	
90–95	WR: Tuff, light gray (N7), nonwelded, devitrified, fine ash matrix with common felsic crystals. +10F: fragments of welded tuff, up to 2 cm in size, subrounded to subangular. +40F: 100% felsic crystals.	Qbt 1v	
95–105	WR: Tuff, dark yellowish-brown (10YR 6/6), poorly welded, devitrified, fine ash matrix with felsic crystals. +10F: fragments of welded tuff, up to 2 cm in size, subrounded to subangular. +40F: 100% felsic crystals.	Qbt 1v	
105–135	WR: Tuff, light gray (N7), nonwelded, devitrified, fine ash matrix with welded tuff fragments and felsic crystals. +10F: fragments of welded tuff, up to 0.5 cm in size, subrounded to subangular. +40F: 100% felsic crystals.	Qbt 1v	
135–140	WR: Tuff, light gray (N7), nonwelded, devitrified, fine ash matrix with welded tuff fragments and felsic crystals. +10F: fragments of welded tuff, up to 1 cm in size, subrounded to subangular. +40F: 100% felsic crystals.	Qbt 1v	
140–145	WR: Tuff, light gray (N7), nonwelded, devitrified, fine ash matrix with welded tuff fragments and felsic crystals. +10F: fragments of welded tuff, up to 2 cm in size, subrounded to sub-angular. +40F: 100% felsic crystals.	Qbt 1v	
145–150	WR: Tuff, light brownish-gray (5YR 6/1), nonwelded, devitrified, fine ash matrix with welded tuff fragments and felsic crystals. +10F: fragments of welded tuff, up to 0.5 cm in size, subrounded to subangular. +40F: 100% felsic crystals.	Qbt 1v	
150–155	WR: Tuff, light brownish-gray (5YR 6/1), nonwelded, devitrified, fine ash matrix with welded tuff fragments and felsic crystals. +10F: fragments of welded tuff, up to 2 cm in size, subrounded to subangular. +40F: 100% felsic crystals	Qbt 1v	
155–158	WR: Tuff, light brownish-gray (5YR 6/1), nonwelded, devitrified, fine ash matrix with welded tuff fragments and felsic crystals. +10F: fragments of welded tuff, up to 1 cm in size, subrounded to subangular. +40F: 100% felsic crystals.	Qbt 1v	
158–170	WR: Tuff, grayish orange-pink (5YR 7/2), nonwelded, vitric, with quartz grains, with pink angular pumice fragments, with dark brown subangular to subrounded dark volcanic lithic fragments. +10F: Same as WR, except trace quartz grains/crystals. +40F: 100% felsic crystals.	Qbt 1v	
170–179	UNIT 1g OF THE TSHIREGE MEMBER OF THE BANDELIER TUFF: WR: Tuff, grayish orange-pink (5YR 7/2), nonwelded, vitric, fine ash matrix with lithic fragments. +10F: 100% lithic grains, subangular. +40F: 100% felsic crystals.	Qbt 1g	

Borehole Identification (ID): R-62	**Technical Area (TA):** 05	**Page:** 3 of 7
Drilling Company: Yellow Jacket Drilling, Inc.	**Start Date/Time:** 7/31/11, 1530	**End Date/Time:** 8/31/11, 1215
Drilling Method: Reverse Circulation (RC) Open Borehole; RC Dual Rotary Casing Advance	**Machine:** DR24HD	**Sampling Method:** Grab
Ground Elevation: 6985 ft amsl		Total Depth: 1260 ft bgs
Driller: S. Edwards, L. McCauley, Q. Stevens	**Site Geologists:** J. Marin, D. Mazzanti, D. Neidigh, E. Shannon, C. Vallejo	

Depth (ft bgs)	Lithologic Description	Lithologic Symbol	Notes
179–190	WR: Tuff, grayish orange-pink (5YR 7/2), nonwelded, fine ash matrix with lithic fragments. +10F: 100% lithic grains, subangular. +40F: 100% felsic crystals.	Qbt 1g	
190–195	WR: Tuff, light brown (5YR 6/4), nonwelded, fine ash matrix with lithic fragments. +10F: 100% lithic grains, subangular. +40F: 100% felsic crystals.	Qbt 1g	
195–200	WR: Tuff, very pale orange (10YR 8/2), nonwelded, fine ash matrix with lithic fragments. +10F: 100% lithic grains, subangular. +40F: 100% felsic crystals.	Qbt 1g	
200–210	WR: Tuff, grayish orange pink (5YR 7/2), poorly welded, fine ash matrix with quartz grains, trace orange and gray pumice fragments, and lithic fragments. +10F: angular pumice and lithic fragments, up to 1 cm in size. +40F: quartz grains.	Qbt 1g	
210–220	No recovery.		
220–225	WR: Tuff, grayish orange-pink (5YR 7/2), poorly welded, fine ash matrix with quartz grains, trace orange and gray pumice fragments, and lithic fragments. +10F: angular pumice and lithic fragments, up to 1 cm in size. +40F: quartz grains.	Qbt 1g	
225–231	WR: Tuff, grayish orange-pink (5YR 7/2), poorly welded, fine ash matrix with quartz grains, trace orange and gray pumice fragments and lithic fragments. +10F: angular pumice and lithic fragments, up to 1.5 cm in size. +40F: quartz grains.	Qbt 1g	
231– 255	WR: Tuff, grayish orange-pink (5YR 7/2), poorly welded, vitric, fine ash matrix with quartz grains, trace orange and gray pumice fragments and lithic fragments. +10F: subrounded to angular pumice fragments, up to 2.5 cm in size. +40F: quartz grains.	Qbt 1g	
255–268	WR: Tuff, very pale orange (10YR 8/2), nonwelded, vitric, fine ash matrix with angular pumice fragments. +10F: subrounded to angular pumice fragments, up to 2 cm in size. +40F: 90% quartz grains, 10% dark lithic fragments.	Qbt 1g	
268–270	WR: Tuff, very pale orange (10YR 8/2), nonwelded, vitric, fine ash matrix with angular pumice fragments. +10F: 70% dark brown lithic fragments, subrounded to angular pumice fragments, up to 2 cm in size. +40F: 90% quartz grains, 10% dark lithic fragments.	Qbt 1g	
270–280	WR: Tuff, grayish orange-pink (5YR 3/4) nonwelded, vitric, fine ash matrix with felsic crystal, lithic and pumice fragments. +10F: gravel-sized pumice fragments. +40F: 20% felsic crystals.	Qbt 1g	
280–285	Tuff, grayish orange-pink (5YR 3/4) nonwelded, vitric, fine ash matrix with felsic crystal, lithic and pumice fragments.	Qbt 1g	
285–290	WR: Tuff, grayish orange-pink (5YR 3/4) nonwelded, vitric, fine ash matrix with felsic crystal, lithic and pumice fragments.	Qbt 1g	
290–300	WR: Tuff, grayish orange pink (5YR 3/4) nonwelded, vitric, fine ash matrix with felsic crystal, lithic and pumice fragments	Qbt 1g	
300–305	CERRO TOLEDO INTERVAL: WR: Clastic sediments, fine sand with trace gravel, light brownish-gray (5YR 6/1). +10F: subrounded.	Qct	
305–310	WR: Tuff, light brown (5YR 6/4) nonwelded, fine ash matrix with angular lithic fragments. +10F: 10% felsic crystals.	Qct	

Borehole Identification (ID): R-62	**Technical Area (TA):** 05	**Page:** 4 of 7
Drilling Company: Yellow Jacket Drilling, Inc.	**Start Date/Time:** 7/31/11, 1530	**End Date/Time:** 8/31/11, 1215
Drilling Method: Reverse Circulation (RC) Open Borehole; RC Dual Rotary Casing Advance	**Machine:** DR24HD	**Sampling Method:** Grab
Ground Elevation: 6985 ft amsl		**Total Depth:** 1260 ft bgs
Driller: S. Edwards, L. McCauley, Q. Stevens	**Site Geologists:** J. Marin, D. Mazzanti, D. Neidigh, E. Shannon, C. Vallejo	

Depth (ft bgs)	Lithologic Description	Lithologic Symbol	Notes
310–335	WR: Tuff, grayish-orange (10YR 7/4) nonwelded, fine ash matrix with angular lithic fragments. +10F: 10% felsic crystals.	Qct	
335–350	WR: Tuff, light brown (5YR 5/6) nonwelded, fine ash matrix with angular lithic fragments. +10F: 10% felsic crystals.	Qct	
350–355	OTOWI ASH FLOW TUFF MEMBER OF THE BANDELIER TUFF: WR: Tuff, pale red (10R 6/2) nonwelded, vitric, fine ash matrix with fine gravel sized pumice. +10F: lithic fragments and pumice. +40F: 20% felsic crystals.	Qbo	
355–360	WR: Tuff, light gray (N7) nonwelded, vitric, fine ash matrix with fine gravel sized pumice. +10F: lithic fragments and pumice. +40F: 20% felsic crystals.	Qbo	
360–365	WR: Tuff, white (N9) nonwelded, vitric, fine ash matrix with fine gravel-sized pumice. +10F: lithic fragments and pumice. +40F: 20% felsic crystals.	Qbo	
365–390	WR: Tuff, light brownish-gray (5YR 6/1) partly welded, vitric, fine ash matrix with lithic fragments. +40F: 20% felsic crystals.	Qbo	
390–395	WR: Tuff, light brownish-gray (5YR 6/1) partly welded, vitric, ash matrix with lithic fragments. +40F: 10% felsic crystals.	Qbo	
395–405	WR: Tuff, dusky brown (5YR 2/2) nonwelded, vitric, fine ash. +10F: lithic fragments +40F: 20% felsic crystals.	Qbo	
405–415	WR: Tuff, light brownish-gray (5YR 6/1) nonwelded, vitric, fine ash. +10F: angular lithic fragments +40F: 50% felsic crystals.	Qbo	
415–420	WR: Tuff, pale brown (5YR 5/2), partly welded, vitric, fine ash. +10F: angular lithic fragments +40F: 80% felsic crystals, 20% dark volcanic lithic fragments.	Qbo	
420–425	WR: Tuff, very light gray (N8), partly welded, vitric, fine ash. +10F: angular lithic fragments +40F: 80% felsic crystals, 20% dark volcanic lithic fragments.	Qbo	
425–430	WR: Tuff, olive gray (5Y 4/1), partly welded, vitric, fine ash. +10F: angular lithic fragments +40F: 80% felsic crystals, 20% dark volcanic lithic fragments.	Qbo	
430–435	WR: Tuff, pale brown (5YR 5/2), partly welded, vitric, fine ash. +10F: angular lithic fragments +40F: 80% felsic crystals, 20% dark volcanic lithic fragments.	Qbo	
435–440	WR: Tuff, very light gray (N5), partly welded, vitric, fine ash. +10F: angular lithic fragments +40F: 80% felsic crystals, 20% dark volcanic lithic fragments.	Qbo	
440–450	WR: Tuff, pale brown (5YR 5/2), partly welded, vitric, fine ash. +10F: angular lithic fragments +40F: 80% felsic crystals, 20% dark volcanic lithic fragments.	Qbo	
450–455	WR: Tuff, light brownish gray (5YR 6/1), partly welded, vitric, fine ash. +10F: sub-angular lithic and pumice fragments +40F: 20% felsic crystals.	Qbo	
455–465	WR: Tuff, light brownish gray (5YR 6/1), partly welded, vitric, fine ash. +10F: sub-angular lithic fragments +40F: 90% lithic fragments, 10% felsic crystals.	Qbo	

Borehole Identification (ID): R-62	**Technical Area (TA):** 05	**Page:** 5 of 7
Drilling Company: Yellow Jacket Drilling, Inc.	**Start Date/Time:** 7/31/11, 1530	**End Date/Time:** 8/31/11,1215
Drilling Method: Reverse Circulation (RC) Open Borehole; RC Dual Rotary Casing Advance	**Machine:** DR24HD	**Sampling Method:** Grab
Ground Elevation: 6985 ft amsl		**Total Depth:** 1260 ft bgs
Driller: S. Edwards, L. McCauley, Q. Stevens	**Site Geologists:** J. Marin, D. Mazzanti, D. Neidigh, E. Shannon, C. Vallejo	

Depth (ft bgs)	Lithologic Description	Lithologic Symbol	Notes
465–470	WR: Tuff, light gray (N7), partly welded, vitric, fine ash. +10F: sub-angular lithic fragments +40F: 90% lithic fragments, 10% felsic crystals.	Qbo	
470–480	WR: Tuff, light brownish gray (5YR 6/1), partly welded, vitric, fine ash. +10F: subangular lithic fragments +40F: 90% lithic fragments, 10% felsic crystals.	Qbo	
480–485	WR: Tuff, light gray (N8), partly welded, vitric, fine ash. +10F: subangular lithic fragments +40F: 90% lithic fragments, 10% felsic crystals.	Qbo	
485–495	WR: Tuff, light brownish gray (5YR 6/1), partly welded, vitric, fine ash. +10F: subangular lithic fragments +40F: 90% lithic fragments, 10% felsic crystals.	Qbo	
495–510	WR: Tuff, light gray (N7), partly welded, vitric, fine ash. +10F: subangular lithic fragments +40F: 90% lithic fragments, 10% felsic crystals.	Qbo	
510–515	WR: Tuff, light brownish-gray (5YR 6/1), partly welded, vitric, fine ash. +10F: subangular lithic fragments +40F: 90% lithic fragments, 10% felsic crystals.	Qbo	
515–525	WR: Tuff, white (N9), partly welded, vitric, fine ash. +10F: subangular lithic fragments +40F: 90% lithic fragments, 10% felsic crystals.	Qbo	
525–530	WR: Tuff, light gray (N7), partly welded, vitric, fine ash. +10F: subangular lithic fragments +40F: 90% lithic fragments, 10% felsic crystals.	Qbo	
530–540	WR: Tuff, light olive-gray (5Y 6/1), partly welded, vitric, fine ash. +10F: angular lithic fragments +40F: 30–40% felsic crystals.	Qbo	
540–545	WR: Tuff, light gray (N7), partly welded, vitric, fine ash. +10F: angular lithic fragments +40F: 30–40% felsic crystals.	Qbo	
545–555	WR: Tuff, light olive-gray (5Y 6/1), partly welded, vitric, fine ash. +10F: angular lithic fragments +40F: 30–40% felsic crystals.	Qbo	
555–560	WR: Tuff, light gray (N7), partly welded, vitric, fine ash. +10F: angular lithic fragments +40F: 30–40% felsic crystals.	Qbo	
560–588	WR: Tuff, light olive-gray (5Y 6/1), partly welded, vitric, fine ash. +10F: angular lithic fragments +40F: 30–40% felsic crystals.	Qbo	
588–590	GUAJE PUMICE BED OF THE OTOWI MEMBER OF THE BANDELIER TUFF: WR: Tuff, light gray (N7), vitric, fine ash. +10F: angular lithic fragments +40F: 30–40% felsic crystals.	Qbog	Contact difficult to recognize in cuttings. Contact at 582 ft based on gamma log.
590–595	WR: Tuff, light olive-gray (5Y 6/1), vitric, fine ash. +10F: angular lithic fragments +40F: 30-40% felsic crystals.	Qbog	595–600 ft bgs: very low returns
595–605	WR: Tuff, light gray (N7), vitric, fine ash. +10F: angular lithic fragments +40F: 30–40% felsic crystals.	Qbog	605 ft bgs: low returns
605–607	WR: Tuff, pale yellowish-brown (10YR 6/2), vitric, fine ash. +10F: angular lithic fragments +40F: 30–40% felsic crystals.	Qbog	

Borehole Identification (ID): R-62	**Technical Area (TA):** 05	**Page:** 6 of 7
Drilling Company: Yellow Jacket Drilling, Inc.	**Start Date/Time:** 7/31/11, 1530	**End Date/Time:** 8/31/11, 1215
Drilling Method: Reverse Circulation (RC) Open Borehole; RC Dual Rotary Casing Advance	**Machine:** DR24HD	**Sampling Method:** Grab
Ground Elevation: 6985 ft amsl		**Total Depth:** 1260 ft bgs
Driller: S. Edwards, L. McCauley, Q. Stevens	**Site Geologists:** J. Marin, D. Mazzanti, D. Neidigh, E. Shannon, C. Vallejo	

Depth (ft bgs)	Lithologic Description	Lithologic Symbol	Notes
607–625	PUYE FORMATION: WR Clastic sediments: sandy gravel, fine sand, fine gravel, moderate orange-pink (5YR 8/4).	Tpf	Contact difficult to recognize in cuttings and is based on gamma log.
625–630	Clastic sediments: sandy gravel, fine sand, fine gravel, moderate orange pink (5YR 8/4).	Tpf	
630–635	Clastic sediments: sandy gravel, fine sand, fine gravel, grayish-brown (5YR 3/2).	Tpf	
635–640	Clastic sediments: sandy gravel, fine sand, fine gravel, - moderate orange pink (5YR 8/4).	Tpf	
640–644	Clastic sediments: sandy gravel, fine sand, fine gravel, grayish-brown (5YR 3/2).	Tpf	
644–655	Clastic sediments: sandy gravel, fine sand, fine gravel, - moderate orange-pink (5YR 8/4).	Tpf	
655–665	CERROS DEL RIO VOLCANIC SERIES: basalt, vesicular, microcrystalline, light gray (N7).	Tb4	655 ft bgs: hard drilling, clay present
665–670	Basalt, trace vesicles, microcrystalline, light brownish gray (5YR 6/1).	Tb4	
670–680	Basalt, trace vesicles, microcrystalline, light gray (N7).	Tb4	672–688 ft bgs: installed 3/8-in. bentonite chips to seal bottom of 16-in. casing
680–685	Basalt, trace vesicles, microcrystalline, light brownish-gray (5YR 6/1).	Tb4	
685–710	Basalt, trace vesicles, microcrystalline, light gray (N7).	Tb4	
710–740	Basalt, massive, microcrystalline, olive-black (5Y 2/1).	Tb4	
740–760	Basalt, trace vesicles, microcrystalline, moderate brown (5YR 4/4), clay in fractures.	Tb4	
760–770	Basalt, massive, microcrystalline, olive black (5Y 2/1).	Tb4	
770–780	Basalt, trace vesicles, microcrystalline, olive black (5Y 2/1).	Tb4	
780–882	Basalt, massive, microcrystalline, olive black (5Y 2/1).	Tb4	
882–923	PUYE FORMATION: clastic sediments: sandy silty conglomerate, grayish-orange (10YR 7/4), poorly sorted, angular to subangular gravel, fine to coarse sand.	Tpf	Lost circulation at 923 ft bgs
925–930	No sample collected.		
930–1005	Clastic sediments: sandy silty conglomerate, very dusky red (10R 2/2), poorly sorted, angular to subangular gravel, fine to medium sand.	Tpf	
1005–1015	Clastic sediments: silty sand with trace fine gravel, very dusky red (10R 2/2), poorly sorted, subangular fine gravel, fine to coarse sand.	Tpf	

Borehole Identification (ID): R-62	**Technical Area (TA):** 05	**Page:** 7 of 7
Drilling Company: Yellow Jacket Drilling, Inc.	**Start Date/Time:** 7/31/11, 1530	**End Date/Time:** 8/31/11,1215
Drilling Method: Reverse Circulation (RC) Open Borehole; RC Dual Rotary Casing Advance	**Machine:** DR24HD	**Sampling Method:** Grab
Ground Elevation: 6985 ft amsl		**Total Depth:** 1260 ft bgs
Driller: S. Edwards, L. McCauley, Q. Stevens	**Site Geologists:** J. Marin, D. Mazzanti, D. Neidigh, E. Shannon, C. Vallejo	

Depth (ft bgs)	Lithologic Description	Lithologic Symbol	Notes
1015–1075	Clastic sediments: silty sand with trace fine gravel, moderate brown (5YR 4/4), poorly sorted, subangular fine gravel, fine to coarse sand.	Tpf	
1075–1080	No recovery		
1080–1100	Clastic sediments: sandy silty conglomerate, moderate brown (5YR 4/4), poorly sorted, angular to subangular gravel, fine to coarse sand.	Tpf	
1100–1115	MIOCENE PUMICEOUS SEDIMENTS: WR: Silty fine to medium sand, with gravel, multicolored; +10F: Multicolored [white (N9), medium brown (5YR 4/4), medium gray (N5), very dusky red (10R 2/2)] fine to medium sand-size pumice and lithic fragments, subangular to subrounded. +40F: same as +10F.	Tjfp	
1115–1120	WR: Silty fine to medium sand, with gravel, light brown (5YR 6/4); +10F: Multicolored [white (N9), medium brown (5YR 4/4), medium gray (N5), very dusky red (10R 2/2)] fine to medium sand-size pumice and lithic fragments, subangular to subrounded. +40F: same as +10F.	Tjfp	
1120–1170	WR: Silty fine to medium sand, with gravel, pinkish gray (5YR 8/1); +10F: Multicolored [white (N9), medium brown (5YR 4/4), medium gray (N5), very dusky red (10R 2/2)] fine to medium sand-size pumice and lithic fragments, subangular to subrounded. +40F: same as +10F.	Tjfp	
1170–1175	WR: Silty fine to medium sand, with gravel, light brown (5YR 6/4); +10F: Multicolored [white (N9), medium brown (5YR 4/4), medium gray (N5), very dusky red (10R 2/2)] fine to medium sand-size pumice and lithic fragments, subangular to subrounded. +40F: same as +10F.	Tjfp	
1175–1180	WR: Silty fine to medium sand, with gravel, pinkish gray (5YR 8/1); +10F: Multicolored [white (N9), medium brown (5YR 4/4), medium gray (N5), very dusky red (10R 2/2)] fine to medium sand-size pumice and lithic fragments, subangular to subrounded. +40F: same as +10F.	Tjfp	
1180–1185	WR: Silty fine to medium sand, with gravel, light brown (5YR 6/4); +10F: Multi-colored [white (N9), medium brown (5YR 4/4), medium gray (N5), very dusky red (10R 2/2)] fine to medium sand-size pumice and lithic fragments, sub-angular to sub-rounded. +40F: same as +10F.	Tjfp	
1185–1205	WR: Silty fine to medium sand, with gravel, very light gray (N8); +10F: Multi-colored [white (N9), medium brown (5YR 4/4), medium gray (N5), very dusky red (10R 2/2)] fine to medium sand-size pumice and lithic fragments, subangular to subrounded. +40F: same as +10F.	Tjfp	
1205–1230	WR: Silty fine to medium sand, with gravel, light brown (5YR 6/4); +10F: Multicolored [white (N9), medium brown (5YR 4/4), medium gray (N5), very dusky red (10R 2/2)] fine to medium sand-size pumice and lithic fragments, subangular to subrounded. +40F: same as +10F.	Tjfp	
1230–1235	MIOCENE RIVERINE DEPOSITS: Silty sand with fine gravel, grayish orange pink (5YR 7/2), fine to medium sand. +10F: subrounded gravel.	Tcar	
1235–1260	Silty sand with fine gravel, medium brown (5YR 4/4), fine to medium sand, increasing gravel content and size with depth. +10F: subrounded gravel.	Tcar	
Bottom of Borehole			

Notations and Abbreviations

7.5YR8/1 = Munsell soil color notation where hue (e.g., 7.5YR), value (e.g., 8), and chroma (e.g., 1) are expressed. Hue indicates soil color's relation to red, yellow, green, blue, and purple. Value indicates soil color's lightness. Chroma indicates soil color's strength.

% material = percentage of material in sieved sample fraction (e.g., 35% crystals, 99% volcanic lithics, etc.)

+10F = plus No. 10 sieve sample fraction

+40F = plus No. 40 sieve sample fraction

bgs = below ground surface

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

Tb4 = Cerros del Rio volcanic series

Tcar = Miocene riverine deposits

Tjfp = Miocene pumiceous sediments

Tpf = Puye Formation

WR = whole rock

Appendix B

Groundwater Screening Analytical Results

B-1.0 SCREENING GROUNDWATER ANALYSIS AT R-62

Well R-62 is a regional aquifer monitoring well with one screened interval from 1158.4 to 1179.1 ft below ground surface (bgs) in the Miocene pumiceous sediments. Regional aquifer well R-62 is located in Technical Area 05 at Los Alamos National Laboratory (LANL or the Laboratory). This appendix presents the screening analytical results for samples collected during drilling, well development and aquifer testing at R-62.

Laboratory Analyses

Two perched water samples were collected during drilling for metals, anions, alkalinity and pH analysis. The samples were collected at 628 ft and 920 ft bgs. Twenty-five groundwater samples were collected during well development for total organic carbon (TOC) analysis. Twenty-four groundwater samples were collected for metals, anions, alkalinity, and pH analysis. The Laboratory's Earth and Environmental Sciences Group 14 conducted the analyses. Table B-1.0-1 lists samples submitted for analysis from R-62.

Field Analyses

Groundwater samples were also collected from a flow-through cell at regular intervals during well development and aquifer testing and measured for pH, specific conductance (SC), temperature, dissolved oxygen (DO), total dissolved solids (TDS), oxidation-reduction potential (ORP), and turbidity.

B-2.0 SCREENING ANALTICAL RESULTS

This section presents the analytical results and field parameters measured during drilling, well development, and aquifer testing. R-62 will be sampled quarterly for 1 yr, after which the data will be assessed and incorporated into the Interim Facility-Wide Groundwater Monitoring Plan. Data from ongoing sampling at R-62 will be analyzed and presented in the appropriate Laboratory periodic monitoring report.

B-2.1 TOC

TOC was detected in 19 of the 27 samples collected during groundwater development in concentrations ranging from 0.2 (U) to 6.6 mg/L (Table B-2.1-1).

B-2.2 Field Parameters

Parameters were collected only during the first, third, fourth and fifth phase of well development. Field parameters were not measured during the aquifer testing and second phase of development because of the high turbidity of the groundwater. Field parameters are presented in Table B-2.2-1.

The field parameter measurements at the end of development were: pH of 7.98, temperature of 19.86°C; SC was not recorded; and turbidity of 27.6 nephelometric turbidity units (NTU). The TOC concentration in sample GW62-12-2282, collected on March 13, 2012, was 0.7 mg/L.

B-2.3 Dissolved Metals, Anions, and Cations

Nitrate was detected at 10.73 mg/L in perched water sample GW62-11-25567, collected on August 26, 2011, from 893 ft bgs. This value is above the Section 20.6.2.3103 New Mexico Administrative Code (NMAC) groundwater human health standard.

No samples collected during well development or aquifer testing detected values above Section 20.6.2.3103 NMAC groundwater human health, domestic water supply, or irrigation standards. Analytical results are listed in Tables B-2.3-1 and B-2.3-2.

Table B-1.0-1
Samples from R-62 Submitted for Analysis

Location ID	Sample ID	Date Collected	Collection Depth (ft bgs)	Sample Type	Dissolved Metals	Anions	Cations	TOC	pH/ Alkalinity
Drilling									
R-62	GW62-11-25564	8/9/2011	628	R-62 Perched groundwater sample	X[a]	X	X	—[b]	—
R-62	GW62-11-25565	8/9/2011	628	R-62 Perched groundwater sample	X	X	X	—	—
R-62	GW62-11-25566	8/9/2011	628	R-62 Perched groundwater sample	X	X	X	—	—
R-62	GW62-11-25567	8/26/2011	920	R-62 Perched groundwater sample	X	X	X	—	—
Well Development									
R-62	GW62-11-28118	10/5/2011	n/a[c]	Regional groundwater (bailer)	—	—	—	X	—
R-62	GW62-11-28120	10/9/2011	1180	Regional groundwater (pump lift)	—	—	—	X	—
R-62	GW62-11-28121	10/10/2011	1180	Regional groundwater (pump lift)	—	—	—	X	—
R-62	GW62-11-28122	10/18/2011	1180	Regional groundwater (pump lift)	—	—	—	X	—
R-62	GW62-11-28123	10/26/2011	1180	Regional groundwater (pump lift)	—	—	—	X	—
R-62	GW62-12-2219	1/27/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-2205	1/27/2012	1180	Regional groundwater (pump lift)	—	—	—	X	—
R-62	GW62-12-2206	1/27/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-2220	1/27/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-2207	1/28/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-2209	1/28/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-2208	1/28/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-2210	1/28/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-2211	1/29/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-2213	1/29/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-2212	1/29/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—

Table B-1.0-1 (continued)

Location ID	Sample ID	Date Collected	Collection Depth (ft bgs)	Sample Type	Dissolved Metals	Anions	Cations	TOC	pH/ Alkalinity
R-62	GW62-12-2214	1/29/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-2215	1/30/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-2217	1/30/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-2216	1/30/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-2218	1/30/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-2225	1/31/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-2224	1/31/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-2272	2/7/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-2275	2/7/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-2270	2/8/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-2268	2/9/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-2269	2/9/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-2266	2/10/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-2267	2/10/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-2262	2/11/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-2264	2/11/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-2273	2/12/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-2274	2/12/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-2261	2/13/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-2265	2/13/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-2277	3/7/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X

Table B-1.0-1 (continued)

Location ID	Sample ID	Date Collected	Collection Depth (ft bgs)	Sample Type	Dissolved Metals	Anions	Cations	TOC	pH/ Alkalinity
R-62	GW62-12-2278	3/7/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-12281	3/10/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-12280	3/9/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-12279	3/8/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-12291	3/10/2012	1180	Regional groundwater (pump lift)	—	—	—	X	—
R-62	GW62-12-12292	3/11/2012	1180	Regional groundwater (pump lift)	—	—	—	X	—
R-62	GW62-12-12282	3/11/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-12283	3/12/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-12293	3/12/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-12284	3/13/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-12294	3/13/2012	1180	Regional groundwater (pump lift)	X	X	X	—	—
R-62	GW62-12-12285	3/14/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X
R-62	GW62-12-12295	3/14/2012	1180	Regional groundwater (pump lift)	X	X	X	—	—
R-62	GW62-12-2263	2/6/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-12289	3/8/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-12290	3/9/2012	1180	Regional groundwater (pump lift)	X	—	—	—	—
R-62	GW62-12-2276	2/6/2012	1180	Regional groundwater (pump lift)	—	—	—	X	X

[a] X = Analyzed.

[b] — = Not analyzed.

[c] n/a = Not applicable.

Table B-2.1-1
Analytical Results (TOC) Collected during R-62 Well Development

Sample ID	Analytical Method	Date	TOC Concentration (mg/L)	Qualifier
GW62-11-28118	SW-846:9060	10/6/2011	5.3	
GW62-11-28120	SW-846:9060	10/12/2011	0.5	
GW62-11-28121	SW-846:9060	10/12/2011	0.4	
GW62-11-28122	SW-846:9060	10/20/2011	0.3	
GW62-11-28123	SW-846:9060	11/8/2011	0.4	
GW62-12-2205	SW-846:9060	1/30/2012	0.4	
GW62-12-2207	SW-846:9060	1/30/2012	0.2	U
GW62-12-2209	SW-846:9060	1/30/2012	0.4	
GW62-12-2211	SW-846:9060	1/30/2012	0.2	U
GW62-12-2213	SW-846:9060	1/30/2012	0.2	U
GW62-12-2215	SW-846:9060	1/30/2012	0.2	U
GW62-12-2217	SW-846:9060	1/31/2012	0.2	
GW62-12-2219	SW-846:9060	1/30/2012	6.6	
GW62-12-2225	SW-846:9060	1/31/2012	0.2	
GW62-12-2264	SW-846:9060	2/15/2012	1.0	
GW62-12-2265	SW-846:9060	2/15/2012	0.2	U
GW62-12-2267	SW-846:9060	2/15/2012	0.2	
GW62-12-2269	SW-846:9060	2/15/2012	0.2	
GW62-12-2271	SW-846:9060	2/9/2012	0.4	
GW62-12-2274	SW-846:9060	2/15/2012	0.2	U
GW62-12-2275	SW-846:9060	2/8/2012	0.7	
GW62-12-2276	SW-846:9060	2/8/2012	0.2	U
GW62-12-2277	SW-846:9060	3/8/2012	2.7	
GW62-12-2279	SW-846:9060	3/13/2012	0.2	
GW62-12-2280	SW-846:9060	3/13/2012	0.2	U
GW62-12-2281	SW-846:9060	3/13/2012	1.8	
GW62-12-2282	SW-846:9060	3/13/2012	0.7	

Notes: U = Undetected. Blank cells indicate the analytical results are not qualified.

Table B-2.2-1
Purge Volumes and Field Parameters during Well Development and Aquifer Testing at R-62

Date	Time	pH	Specific Conductivity (µS/cm)	Turbidity (NTU)	DO (mg/L)	Temp (°C)	TDS (g/L)	ORP (mV)	Pump Intake Depth (ft bgs)	Purge Volume (gal.)	Cumulative Purge Volume (gal.)
Well Development (First Phase)											
10/4/2011	13:40–16:30	—*	—	—	—	—	—	—	Bailer	55	55
10/5/2011	12:03–16:55	—	—	—	—	—	—	—	Bailer	110	165
10/6/2011	07:15–15:00	—	—	—	—	—	—	—	Bailer	135	300
10/8/2011	06:10–12:30	—	—	—	—	—	—	—	1157.5	60	360
10/9/2011	12:30	9.07	999.0	Over range of instrument	5.20	18.18	—	-23	1179.7	217	577
	13:00	8.88	999.0	Over range of instrument	3.97	18.61	—	6	1179.7	80	657
	13:30	8.59	925	Over range of instrument	5.16	18.18	—	29	1179.7	75	732
	14:00	8.50	876	Over range of instrument	5.54	18.57	—	39	1179.7	75	807
	14:30	8.47	849	Over range of instrument	5.69	18.54	—	45	1179.7	75	882
	15:00	8.40	817	Over range of instrument	5.81	18.48	—	50	1179.7	75	957
	15:30	8.38	798	Over range of instrument	6.11	19.12	—	51	1179.7	75	1032
	16:00	8.35	790	Over range of instrument	6.06	18.55	—	54	1179.7	75	1107
	16:30	8.30	774	Over range of instrument	6.26	18.53	—	58	1179.7	75	1182
	17:00	8.30	770	Over range of instrument	6.24	18.49	—	59	1179.7	75	1257
	17:30	8.26	761	Over range of instrument	6.22	18.46	—	63	1179.7	75	1332
10/10/2011	6:30	8.00	766	747	5.62	15.15	—	65	1179.7	71	1403
	7:00	8.28	783	Over range of instrument	4.60	14.85	—	80	1179.7	61	1464
	7:30	8.57	862	633	6.29	17.02	—	64	1179.7	67	1531
	8:00	8.16	783	Over range of instrument	6.44	18.22	—	64	1179.7	70	1601
	8:30	8.34	756	Over range of instrument	6.56	18.52	—	67	1179.7	73	1674
	9:00	8.29	744	696.0	6.75	18.59	—	70	1179.7	74	1748
	9:30	8.25	748	674.0	6.76	18.75	—	73	1179.7	73	1821

Table B-2.2-1 (continued)

Date	Time	pH	Specific Conductivity (µS/cm)	Turbidity (NTU)	DO (mg/L)	Temp (°C)	TDS (g/L)	ORP (mV)	Pump Intake Depth (ft bgs)	Purge Volume (gal.)	Cumulative Purge Volume (gal.)
10/10/2011	10:00	8.21	740	523	6.37	18.49	—	74	1179.7	73	1894
	10:30	8.20	733	480	6.42	19.02	—	74	1179.7	73	1967
	11:00	8.19	725	451	6.73	19.14	—	76	1179.7	73	2040
	11:30	8.17	720	420	6.77	19.09	—	77	1179.7	70	2110
	12:00	8.16	716	354	7.14	19.18	—	79	1179.7	73	2183
	12:30	8.15	647	330	6.74	19.33	—	81	1179.7	71	2254
	13:00	8.15	714	371	7.17	19.32	—	80	1179.7	71	2325
	13:30	8.15	714	337	7.30	19.39	—	81	1179.7	73	2398
	14:00	8.10	707	317	7.16	14.38	—	82	1179.7	70	2468
	14:30	8.13	723	295	7.21	19.20	—	84	1179.7	70	2538
	15:00	8.12	711	269	7.27	19.22	—	85	1179.7	70	2608
	15:30	8.10	706	241	7.37	19.30	—	84	1179.7	70	2678
	16:00	8.12	701	283	7.35	19.30	—	86	1179.7	72	2750
	16:30	8.14	640	242	7.41	19.33	—	85	1179.7	73	2823
	17:00	8.10	702	293	7.50	19.41	—	87	1179.7	70	2893
	17:30	8.04	695	515	7.47	17.09	—	91	1179.7	70	2961
10/11/2011	6:30	7.93	699	239	6.28	15.32	—	84	1179.7	75	3036
Aquifer Pump Test											
10/12/11–10/17/11	—	—	—	—	—	—	—	—	—	300	3336
Well Development (Second Phase)											
10/18/11–10/25/11	—	—	—	—	—	—	—	—	—	3096	6432
Well Development (Third Phase)											
1/27/2012	8:00	9.16	91.9	-5	0	14.28	0.59	262	—	—	—
	8:15	9.13	72.4	-5	1.42	17.4	0.46	220	—	—	—
	8:30	9.17	69.1	-5	1.63	17.96	0.44	207	—	—	—
	9:00	8.78	47.8	223	1.77	18.44	0.32	202	—	—	—
	9:30	8.68	43.5	724	3.54	18.30	0.28	200	—	—	—
	9:34	8.57	40.9	398	4.03	19.14	0.25	204	—	—	—
	10:00	8.45	39.1	302	4.73	19.17	0.25	206	—	—	—
	10:30	8.31	37.0	262	5.11	19.19	0.24	207	—	—	—
	11:00	8.16	37.1	213	5.79	19.08	0.24	213	—	—	—
	11:30	7.95	35.4	123	6.05	19.25	0.23	215	—	—	—
	12:00	8.07	35.2	174	5.97	19.22	0.23	198	—	—	—
	12:30	8.17	34.5	74.6	6.11	19.35	0.22	186	—	—	—

Table B-2.2-1 (continued)

Date	Time	pH	Specific Conductivity (µS/cm)	Turbidity (NTU)	DO (mg/L)	Temp (°C)	TDS (g/L)	ORP (mV)	Pump Intake Depth (ft bgs)	Purge Volume (gal.)	Cumulative Purge Volume (gal.)
1/27/2012	13:00	7.74	32.7	67.8	6.72	19.24	0.22	207	—	—	—
	13:30	8.09	33.2	84.0	6.33	19.23	0.22	183	—	—	—
	14:00	7.91	33.3	40.5	6.32	19.64	0.22	198	—	—	—
	14:30	8.14	33.2	143	6.3	19.02	0.22	188	—	—	—
	15:00	8.08	33.1	80.7	5.88	19.3	0.21	190	—	—	—
	15:30	8.17	33.2	45.9	5.99	19.36	0.22	185	—	—	—
	16:00	8.04	32.7	68.3	6.09	19.07	0.21	194	—	—	—
	16:30	8.13	32.9	92.9	6.24	18.51	0.21	194	—	—	—
	17:00	8.09	31.8	48.2	6.13	18.55	0.21	194	—	—	—
	17:30	8.09	31.7	65.9	6.10	18.34	0.21	202	—	—	—
	18:00	8.07	31.5	121.0	5.95	18.3	0.20	204	—	—	—
	18:30	8.05	31.7	46.8	6.09	17.95	0.20	208	—	—	—
	19:00	8.07	31.4	38.7	6.1	18.1	0.20	209	—	—	—
	19:30	8.07	31.6	57.1	6.06	18.14	0.21	209	—	—	—
	20:00	8.07	3.4	38.8	6.36	18.03	0.21	210	—	1914	8346
	20:30	8.08	31.2	87.1	6.27	18.58	0.20	187	—	—	—
	21:00	8.07	31.3	89.8	6.23	18.63	0.20	190	—	—	—
	21:30	8.09	31.0	104.0	6.20	18.70	0.20	191	—	—	—
	22:00	8.07	31.2	112.1	6.30	18.61	0.20	191	—	—	—
	22:30	8.07	31.2	87.2	6.31	18.52	0.20	191	—	—	—
	23:00	8.06	31.2	56.7	6.33	18.45	0.20	191	—	—	—
	23:30	8.05	31.0	122	6.45	18.24	0.20	192	—	—	—
1/28/2012	0:00	8.05	31.2	105.7	6.45	18.24	0.20	192	—	—	—
	0:30	8.05	31.0	98.3	6.45	18.24	0.20	192	—	—	—
	1:00	8.05	31.0	101.3	6.43	18.25	0.20	192	—	—	—
	1:30	8.03	30.8	79.6	6.42	18.29	0.20	193	—	—	—
	2:00	8.03	30.9	217.0	6.42	18.12	0.20	194	—	—	—
	2:30	8.03	30.5	162.0	6.41	18.34	0.20	193	—	—	—
	3:00	8.02	30.9	129	6.42	18.38	0.20	192	—	—	—
	3:30	8.03	30.6	87	6.40	18.33	0.20	193	—	—	—
	4:00	8.01	30.7	146	6.47	18.31	0.20	193	—	—	—
	4:30	8.01	30.7	112	6.62	18.23	0.20	193	—	—	—
	5:00	8.00	30.6	66	6.49	18.27	0.20	193	—	—	—
	5:30	8.02	30.6	75	6.70	18.19	0.20	192	—	—	—
	6:00	7.97	30.6	55	6.72	18.08	0.20	171	—	—	—

Table B-2.2-1 (continued)

Date	Time	pH	Specific Conductivity (µS/cm)	Turbidity (NTU)	DO (mg/L)	Temp (°C)	TDS (g/L)	ORP (mV)	Pump Intake Depth (ft bgs)	Purge Volume (gal.)	Cumulative Purge Volume (gal.)
1/28/2012	6:30	7.99	27.5	35	6.82	17.15	0.18	185	—	—	—
	7:00	8.00	27.2	30	6.77	17.43	0.18	192	—	—	—
	7:30	7.99	30.1	27	6.97	17.45	0.20	198	—	—	—
	8:00	7.86	30.4	98	6.97	18.92	0.20	198	—	—	—
	8:30	8.03	30.6	72	6.40	10.19	0.20	173	—	—	—
	9:00	8.07	30.8	59.9	6.68	19.28	0.20	170	—	—	—
	9:30	8.07	30.0	30.2	6.45	19.72	0.20	172	—	—	—
	10:00	8.08	30.1	25.5	6.57	18.97	0.20	167	—	—	—
	10:30	8.08	30.2	29.0	6.56	18.83	0.20	165	—	—	—
	11:00	8.05	29.8	31.0	6.60	19.21	0.19	163	—	—	—
	11:30	8.02	29.9	24.3	6.63	19.23	0.20	162	—	—	—
	12:00	7.98	30.0	27.1	6.63	19.17	0.19	160	—	—	—
	12:30	8.04	30.0	18.8	7.16	18.04	0.19	164	—	—	—
	13:00	8.01	30.0	32.4	6.93	17.72	0.20	168	—	—	—
	13:30	7.97	30.3	33.7	7.90	19.28	0.20	176	—	—	—
	14:00	7.89	30.6	27.2	6.89	19.75	0.20	186	—	—	—
	14:30	7.97	29.7	27.1	7.31	18.21	0.19	180	—	—	—
	15:00	7.98	29.3	25.1	6.75	19.49	0.19	172	—	—	—
	15:30	7.99	29.4	21.8	6.85	19.62	0.19	175	—	—	—
	16:00	7.99	30.4	25.6	6.62	19.02	0.20	184	—	—	—
	16:30	7.96	31.2	20.2	6.54	.19.49	0.20	200	—	—	—
	17:00	7.74	30.3	15.3	8.09	20.42	0.20	200	—	—	—
	17:30	7.94	30.0	29.1	6.55	19.68	0.20	182	—	—	—
	18:00	7.91	30.1	24	6.71	19.72	0.20	185	—	—	—
	18:30	7.99	30.0	19	6.83	19.71	0.20	186	—	—	—
	19:00	7.99	29.9	22.2	6.60	19.0	0.19	184	—	—	—
	19:30	7.97	30.0	15.3	6.89	19.8	0.19	178	—	—	—
	20:00	7.94	29.6	20.1	6.63	19.61	0.19	183	—	1391	9737
	20:30	7.98	29.8	15.0	6.57	18.87	0.19	188	—	—	—
	21:00	7.98	29.6	18.0	6.63	19.46	0.19	188	—	—	—
	21:30	7.98	29.5	18.3	6.68	19.41	0.19	189	—	—	—
	22:00	7.96	29.7	18.1	6.49	19.23	0.19	197	—	—	—
	22:30	7.97	29.7	17.0	6.43	19.04	0.19	199	—	—	—
	23:00	7.96	29.7	16.5	6.80	18.93	0.19	181	—	—	—
	23:30	7.97	29.7	15.7	7.12	18.99	0.18	185	—	—	—

Table B-2.2-1 (continued)

Date	Time	pH	Specific Conductivity (µS/cm)	Turbidity (NTU)	DO (mg/L)	Temp (°C)	TDS (g/L)	ORP (mV)	Pump Intake Depth (ft bgs)	Purge Volume (gal.)	Cumulative Purge Volume (gal.)
1/29/2012	0:00	7.97	29.6	13.1	7.09	18.81	0.18	208	—	—	—
	0:30	—	29.6	14.1	7.09	18.75	0.19	209	—	—	—
	1:00	7.97	29.5	13.1	7.20	18.46	0.19	212	—	—	—
	1:30	7.97	29.6	13.5	7.21	1850	0.19	210	—	—	—
	2:00	7.98	29.4	13.0	7.52	18.68	0.19	2.16	—	—	—
	2:30	7.98	29.4	13.0	7.52	18.70	0.19	215	—	—	—
	3:00	7.98	29.2	14.1	7.50	18.70	0.19	220	—	—	—
	3:30	7.97	29.0	15.0	7.31	18.02	0.19	220	—	—	—
	4:00	7.97	29.1	14.3	6.93	18.80	0.19	205	—	—	—
	4:30	7.97	29.3	14.8	6.75	18.86	0.19	210	—	—	—
	5:00	7.99	29.3	14.5	6.51	18.66	0.19	203	—	—	—
	5:30	7.96	29.3	14.5	6.86	19.03	0.19	204	—	—	—
	6:00	7.87	30.1	—	7.14	18.45	0.20	216	—	—	—
	6:30	7.99	29.3	13.4	6.70	19.35	0.19	199	—	—	—
	7:00	7.99	29.4	13.2	6.65	19.43	0.19	193	—	—	—
	7:30	7.95	29.8	15.3	6.89	14.26	0.19	193	—	—	—
	8:00	7.99	29.2	14.1	6.52	19.08	0.19	192	—	1017	10,754
	8:30	7.96	29.6	11.3	7.43	20.25	0.19	189	—	—	—
	9:00	8.07	28.9	13.1	7.66	19.62	0.20	191	—	—	—
	9:30	7.97	29.8	13.0	7.64	20.17	0.19	185	—	—	—
	10:00	8.03	29.5	18.3	7.0	26.5	0.19	186	—	—	—
	10:30	8.03	29.6	30	7.06	20.5	0.19	184	—	—	—
	11:00	7.97	29.8	21.5	6.61	19.72	0.19	167	—	—	—
	11:30	7.98	30.0	18.0	6.94	20.05	0.19	166	—	—	—
	12:00	8.01	29.6	15.3	6.82	20.09	0.19	162	—	—	—
	12:30	8.02	29.5	12.8	6.55	20.21	0.19	161	—	—	—
	13:00	7.98	29.4	14.1	7.52	20.21	0.19	170	—	—	—
	13:30	8.02	29.5	13.2	6.72	19.82	0.19	170	—	—	—
	14:00	7.99	29.3	15.3	6.90	20.6	0.19	167	—	—	—
	14:30	8.02	29.2	13.1	6.73	20.5	0.19	164	—	—	—
	15:00	7.95	29.4	10.8	6.75	20.58	0.19	162	—	—	—
	15:30	7.99	29.2	13.3	6.64	19.99	0.19	157	—	—	—
	16:00	7.97	29.2	11.7	6.91	20.24	0.19	162	—	—	—
	16:30	7.96	29.2	13.2	7.28	19.32	0.19	173	—	—	—
	17:00	7.93	29.3	12.0	6.98	20.25	0.19	175	—	—	—

Table B-2.2-1 (continued)

Date	Time	pH	Specific Conductivity (µS/cm)	Turbidity (NTU)	DO (mg/L)	Temp (°C)	TDS (g/L)	ORP (mV)	Pump Intake Depth (ft bgs)	Purge Volume (gal.)	Cumulative Purge Volume (gal.)
1/29/2012	17:30	7.98	29.2	13.3	6.8	19.67	0.19	177	—	—	—
	18:00	7.91	29.4	17.6	6.78	20.07	0.19	180	—	—	—
	18:30	7.91	29.5	14.4	6.9	19.86	0.19	181	—	—	—
	19:00	7.98	29.4	15.7	6.7	19.27	0.19	179	—	—	—
	19:30	7.98	29.4	13.6	6.72	18.95	0.19	185	—	—	—
	20:00	7.96	29.5	15.7	6.92	19.90	0.19	179	—	987	11,741
	20:30	7.96	29.3	15.7	6.72	19.90	0.19	180	—	—	—
	21:00	7.96	29.2	15.4	6.69	19.80	0.19	181	—	—	—
	21:30	7.97	25.4	13.2	6.84	19.37	0.19	183	—	—	—
	22:00	7.97	29.2	13.5	7.42	18.29	0.19	192	—	—	—
	22:30	7.99	29.4	13.1	7.19	19.27	0.19	188	—	—	—
	23:00	7.97	29.4	12.5	7.03	19.25	0.19	188	—	—	—
	23:30	7.97	29.2	12.4	6.83	19.21	0.19	190	—	—	—
1/30/2012	0:00	7.97	29.2	12.5	6.95	19.30	0.19	190	—	—	—
	0:30	7.95	29.3	12.4	7.05	19.34	0.19	200	—	—	—
	1:00	7.95	29.3	13.0	7.05	19.20	0.19	200	—	—	—
	1:30	7.96	29.2	13.4	7.14	19.00	0.19	205	—	—	—
	2:00	7.97	30.2	13.4	7.08	19.01	0.19	203	—	—	—
	2:30	7.95	29.3	12.9	6.72	19.09	0.19	207	—	—	—
	3:00	7.95	29.2	14.0	6.95	18.92	0.19	205	—	—	—
	3:30	7.96	29.2	13.9	7.45	19.11	0.19	210	—	—	—
	4:00	7.95	29.2	12.7	7.15	19.18	0.19	206	—	—	—
	4:30	7.96	29.1	14.7	7.60	20.08	0.19	214	—	—	—
	5:00	7.96	29.2	14.0	6.85	19.75	0.19	190	—	—	—
	5:30	7.95	29.3	14.2	6.95	19.75	0.19	190	—	—	—
	6:00	7.96	29.4	14.6	6.93	19.64	0.19	193	—	—	—
	6:30	7.95	29.1	14.5	6.35	19.42	0.19	196	—	—	—
	7:00	7.96	29.2	13.5	6.87	19.34	0.19	147	—	—	—
	7:30	7.92	29.5	13.8	7.08	19.15	0.19	195	—	—	—
	8:00	7.89	29.5	16.7	7.01	20.47	0.19	182	—	949	12,690
	8:30	8.03	28.8	11.7	6.58	19.80	0.19	176	—	—	—
	8:45	3.93	0.447	0	13.24	9.17	2.9	334	—	—	—
	9:00	7.53	33.5	3.0	10.68	20.17	0.22	209	—	—	—
	9:30	7.78	33.5	3.4	10.41	20.33	0.22	166	—	—	—
	10:00	7.55	33.1	3.1	11.25	20.08	0.22	171	—	—	—

Table B-2.2-1 (continued)

Date	Time	pH	Specific Conductivity (µS/cm)	Turbidity (NTU)	DO (mg/L)	Temp (°C)	TDS (g/L)	ORP (mV)	Pump Intake Depth (ft bgs)	Purge Volume (gal.)	Cumulative Purge Volume (gal.)
1/30/2012	10:30	7.72	33.1	4.8	9.79	20.19	0.22	183	—	—	—
	11:00	7.78	33.6	2.4	9.52	20.15	0.22	192	—	—	—
	11:30	7.77	33.7	1.7	9.97	20.57	0.22	189	—	—	—
	12:00	7.79	33.4	2.5	9.50	20.49	0.22	191	—	—	—
	12:30	7.8	33.5	1.9	11.95	20.92	0.22	208	—	—	—
	13:00	7.82	34.0	3.8	11.37	20.22	0.22	178	—	—	—
	13:30	7.76	34.0	2.2	12.15	20.14	0.22	169	—	—	—
	14:00	7.75	34.2	2.6	10.44	20.31	0.22	178	—	—	—
	14:30	7.75	33.8	1.5	10.51	20.33	0.22	186	—	—	—
	15:00	7.78	33.5	0	10.32	20.26	0.22	187	—	—	—
	15:30	7.79	33.8	1.3	10.38	20.54	0.22	189	—	—	—
	16:00	7.72	33.2	0.6	11.90	20.55	0.22	175	—	—	—
	16:30	7.76	33.1	0	10.70	20.29	0.22	189	—	—	—
	17:00	7.73	33.3	0	11.24	20.54	0.22	175	—	—	—
	17:30	7.73	33.3	0.1	12.11	19.40	0.22	186	—	—	—
	18:00	7.78	33.2	0	12.27	19.12	0.22	183	—	—	—
	18:30	7.78	33.2	0.2	12.17	19.35	0.22	188	—	—	—
	19:00	7.77	33.3	0	12.08	19.41	0.22	187	—	—	—
	19:30	7.77	33.1	0	12.15	19.13	0.22	191	—	—	—
	20:00	7.75	33.3	0	117.3	20.04	0.22	186	—	880	13,570
	20:30	7.78	33.2	2.1	12.26	19.25	0.21	193	—	—	—
	21:00	7.79	33.3	0	11.92	19.20	0.21	189	—	—	—
	21:30	7.78	33.3	0	11.90	19.20	0.22	193	—	—	—
	22:00	7.79	33.2	0	11.00	19.05	0.22	192	—	—	—
	22:30	7.79	33.2	0	11.51	19.53	0.21	193	—	—	—
	23:00	7.8	33.0	0	12.15	19.69	0.21	197	—	—	—
	23:30	7.78	33.1	0	12.35	19.21	0.22	202	—	—	—
1/31/2012	0:00	7.8	33.1	0	12.37	18.90	0.21	198	—	—	—
	0:30	7.76	33.0	0	12.32	19.52	0.21	201	—	—	—
	1:00	7.77	33.0	0	12.39	19.69	0.21	204	—	—	—
	1:30	7.78	33.0	0	12.40	19.52	0.21	204	—	—	—
	2:00	7.78	33.0	0	12.40	19.40	0.21	207	—	—	—
	2:30	7.76	33.0	0	11.72	19.87	0.21	200	—	—	—
	3:00	7.73	33.2	0	11.56	19.88	0.22	199	—	—	—
	3:30	7.78	33.0	0	11.29	19.90	0.22	197	—	—	—

Table B-2.2-1 (continued)

Date	Time	pH	Specific Conductivity (µS/cm)	Turbidity (NTU)	DO (mg/L)	Temp (°C)	TDS (g/L)	ORP (mV)	Pump Intake Depth (ft bgs)	Purge Volume (gal.)	Cumulative Purge Volume (gal.)
1/31/2012	4:00	7.76	33.2	0	11.26	18.37	0.22	195	—	—	—
	4:30	7.79	33.1	0	12.02	19.12	0.22	195	—	—	—
	5:00	7.79	33.2	0	12.32	19.22	0.21	201	—	—	—
	5:30	7.78	33.1	0	12.32	19.22	0.22	200	—	—	—
	6:00	7.76	33.2	0	12.34	19.19	0.22	208	—	—	—
	6:30	7.71	33.2	0	10.34	15.05	0.22	218	—	—	—
	7:00	7.77	33.1	0	11.60	19.83	0.22	205	—	—	—
	7:30	7.80	33.0	0	12.33	19.07	0.21	209	—	—	—
	8:00	7.81	33.1	0	11.30	20.01	0.21	205	—	842	14,412
2/6/2012	11:25	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—
	—	4	0.5	0.0	9.39	12.24	2.90	342	—	—	—
	—	4.04	0.5	0.0	8.50	12.19	2.90	340	—	—	—
	11:35	—	—	—	—	—	—	—	—	—	—
	12:40	—	—	—	—	13.70	—	—	—	—	—
	12:45	7.04	32.8	89.0	7.39	13.70	0.21	184	—	—	—
	13:00	7.69	36.4	116.0	8.69	14.51	0.22	142	—	—	—
	13:15	8.49	35.2	63.3	4.54	16.13	0.23	129	—	—	—
	13:30	8.46	34.8	44.2	6.90	19.05	0.22	206	—	—	—
	13:45	8.52	33.9	46.4	7.73	18.79	0.22	188	—	—	—
	14:06	8.29	33.0	24.8	7.80	19.22	0.22	185	—	—	—
	14:45	8.02	32.5	33.6	6.69	18.77	0.21	196	—	—	—
	15:15	7.88	31.6	36.6	7.41	19.11	0.21	198	—	—	—
	15:30	7.88	31.5	10.9	7.48	19.17	0.21	201	—	—	—
	16:00	7.86	29.6	3.3	7.62	18.67	0.20	197	—	—	—
	16:05	—	—	—	—	—	—	—	—	519.9	16726.0
2/7/2012	7:15	—	—	—	—	—	—	—	—	—	—
	15:14	7.73	29.0	53.2	7.89	19.67	0.19	226	—	—	—
	15:15	—	—	—	—	—	—	—	—	1200.0	17926.0
2/8/2012	7:30	—	—	—	—	—	—	—	—	—	—
	16:32	7.68	29.0	24.7	7.90	19.79	0.19	209	—	—	—
	16:40	—	—	—	—	—	—	—	—	—	—
	16:45	7.75	29.1	42.0	7.89	19.76	0.19	198	—	—	—
	17:00	—	—	—	—	—	—	—	—	1398.7	19324.7

Table B-2.2-1 (continued)

Date	Time	pH	Specific Conductivity (µS/cm)	Turbidity (NTU)	DO (mg/L)	Temp (°C)	TDS (g/L)	ORP (mV)	Pump Intake Depth (ft bgs)	Purge Volume (gal.)	Cumulative Purge Volume (gal.)
2/9/2012	7:01	—	—	—	—	—	—	—	—	—	—
	16:33	7.78	28.8	59.4	7.52	19.84	0.18	202	—	—	—
	16:45	—	—	—	—	—	—	—	—	—	—
	16:54	7.78	28.2	113.0	7.52	19.26	0.18	191	—	—	—
	16:55	—	—	—	—	—	—	—	—	1484.0	20808.7
2/10/2012	7:15	—	—	—	—	—	—	—	—	—	—
	17:00	7.92	28.9	44.4	7.34	19.54	0.19	200	—	—	—
	17:15	—	—	—	—	—	—	—	—	1530.2	22338.9
2/11/2012	7:15	—	—	—	—	—	—	—	—	—	—
	17:00	7.89	29.8	71.1	7.54	19.42	0.19	181	—	—	—
	17:15	—	—	—	—	—	—	—	—	1566.9	23905.8
2/12/2012	7:00	—	—	—	—	—	—	—	—	—	—
	16:45	7.99	30.0	28.2	7.44	19.13	0.20	211	—	—	—
	17:00	—	—	—	—	—	—	—	—	1561.4	25467.2
2/13/2012	7:15	—	—	—	—	—	—	—	—	—	—
	15:50	—	—	—	—	—	—	—	—	—	—
	16:21	7.9	29.1	94.7	7.51	18.95	0.19	209	—	—	—
	16:30	—	—	—	—	—	—	—	—	1533.0	27000.2
3/7/2012	7:35	—	—	—	—	—	—	—	—	—	—
	18:20	8.01	29.2	233.0	8.96	19.49	0.19	192	—	—	—
	18:35	—	—	—	—	—	—	—	—	1578.0	28578.2
3/8/2012	7:00	—	—	—	—	—	—	—	—	—	—
	8:00	—	—	—	—	—	—	—	—	—	—
	8:30	—	—	—	—	—	—	—	—	—	—
	18:00	7.98	29.4	4.0	9.36	19.14	0.19	184	—	—	—
	18:12	—	—	—	—	—	—	—	—	1697.8	30276.0
3/9/2012	7:00	—	—	—	—	—	—	—	—	—	—
	17:55	7.99	28.9	51.2	8.38	19.18	0.19	232	—	—	—
	18:00	—	—	—	—	—	—	—	—	1947.8	32223.8
3/10/2012	6:45	—	—	—	—	—	—	—	—	—	—
	11:30	—	—	—	—	—	—	—	—	—	—
	12:00	—	—	—	—	—	—	—	—	—	—
	16:45	4.01	—	0.0	8.48	11.99	2.70	341	—	—	—
	17:00	7.99	—	11.7	7.48	17.49	0.19	272	—	—	—
	17:15	—	—	—	—	—	—	—	—	1569.8	33793.6

Table B-2.2-1 (continued)

Date	Time	pH	Specific Conductivity (µS/cm)	Turbidity (NTU)	DO (mg/L)	Temp (°C)	TDS (g/L)	ORP (mV)	Pump Intake Depth (ft bgs)	Purge Volume (gal.)	Cumulative Purge Volume (gal.)
3/11/2012	7:49	—	—	—	—	—	—	—	—	—	—
	18:00	—	—	—	—	—	—	—	—	—	—
	18:18	7.89	—	54.5	8.85	14.83	0.19	223	—	1529.6	35323.2
3/12/2012	7:00	—	—	—	—	—	—	—	—	—	—
	18:00	—	—	—	—	—	—	—	—	—	—
	18:40	7.79	—	12.8	8.89	19.68	0.19	196	—	1697.7	37020.9
3/13/2012	7:00	—	—	—	—	—	—	—	—	—	—
	18:45	—	—	—	—	—	—	—	—	—	—
	19:00	7.96	—	13.1	9.80	19.47	0.19	188	—	1786	38806.9
3/14/2012	7:00	—	—	—	—	—	—	—	—	—	—
	17:40	—	—	—	—	—	—	—	—	—	—
	17:50	7.98	—	27.6	9.38	19.86	0.19	203	—	1693.8	40500.7

*— = Data not collected.

Table B-2.3-1
Analytical Results (pH and Alkalinity) Collected during R-62 Well Development

Sample ID	Date Sampled	pH	Alk-CO_3 (ppm)	Qualifier	Alk-CO_3+HCO_3* (ppm)
GW62-12-12279	3/10/2012	7.54	0.8	U	78
GW62-12-12280	3/9/2012	7.45	0.8	U	77
GW62-12-12281	3/8/2012	7.46	0.8	U	77
GW62-12-12282	3/11/2012	7.48	0.8	U	76
GW62-12-12283	3/12/2012	7.62	0.8	U	76
GW62-12-12284	3/13/2012	7.40	0.8	U	79
GW62-12-12285	3/14/2012	7.48	0.8	U	76
GW62-12-2205	1/27/2012	7.81	0.8	U	85
GW62-12-2207	1/28/2012	7.59	0.8	U	81
GW62-12-2209	1/28/2012	7.61	0.8	U	79
GW62-12-2211	1/29/2012	7.66	0.8	U	78
GW62-12-2213	1/29/2012	7.68	0.8	U	77
GW62-12-2215	1/30/2012	7.72	0.8	U	77
GW62-12-2217	1/30/2012	7.74	0.8	U	78
GW62-12-2219	1/27/2012	8.77	26.7	U	174
GW62-12-2225	1/31/2012	7.51	0.8	U	76
GW62-12-2264	2/11/2012	7.77	0.8	U	79
GW62-12-2265	2/13/2012	7.58	0.8	U	76
GW62-12-2267	2/10/2012	7.55	0.8	U	77
GW62-12-2269	2/9/2012	7.54	0.8	U	77
GW62-12-2271	2/8/2012	7.63	0.8	U	76
GW62-12-2274	2/12/2012	7.62	0.8	U	76
GW62-12-2275	2/7/2012	7.53	0.8	U	76
GW62-12-2276	2/6/2012	7.74	0.8	U	78
GW62-12-2277	3/7/2012	7.68	0.8	U	79

Note: U = Undetected.
*None of the Alk-CO_3+HCO_3 results were qualified.

Table B-2.3-2
Analytical Results (Metals) Collected during R-62 Well Development

Sample ID	Date Sampled	Date Received	Silver	Aluminum	Arsenic	Boron	Barium	Beryllium	Calcium	Cadmium	Cobalt	Chromium	Cesium	Copper	Iron	Mercury	Potassium	Lithium	Magnesium	Manganese
GW62-12-2206	1/27/2012	2/2/2012	<0.001	0.063	0.0010	0.026	0.034	<0.001	16	<0.001	<0.001	0.190	<0.001	0.001	0.04		1	0.024	4.5	0.008
GW62-12-2208	1/28/2012	2/2/2012	<0.001	0.041	0.0008	0.010	0.035	<0.001	16	<0.001	<0.001	0.201	<0.001	<0.001	0.03		1	0.023	4.7	0.007
GW62-12-2210	1/28/2012	2/2/2012	<0.001	0.062	0.0008	0.006	0.034	<0.001	16	<0.001	<0.001	0.188	<0.001	0.001	0.03		1	0.023	4.8	0.007
GW62-12-2212	1/29/2012	2/2/2012	<0.001	0.065	0.0008	<0.002	0.032	<0.001	16	<0.001	<0.001	0.189	<0.001	<0.001	0.03		1	0.024	4.8	0.007
GW62-12-2214	1/29/2012	2/2/2012	<0.001	0.050	0.0008	<0.002	0.033	<0.001	17	<0.001	<0.001	0.194	<0.001	<0.001	0.02		1	0.025	4.9	0.007
GW62-12-2216	1/30/2012	2/2/2012	<0.001	0.045	0.0008	<0.002	0.032	<0.001	17	<0.001	<0.001	0.191	<0.001	<0.001	0.02		1	0.026	4.9	0.005
GW62-12-2218	1/30/2012	2/2/2012	<0.001	0.057	0.0008	<0.002	0.032	<0.001	17	<0.001	0.002	0.195	<0.001	<0.001	0.03		1	0.028	5.0	0.008
GW62-12-2220	1/27/2012	2/2/2012	<0.001	0.144	0.0051	0.131	0.013	<0.001	3	<0.001	<0.001	0.007	<0.001	0.007	0.26		2	0.046	0.7	0.006
GW62-12-2224	1/31/2012	2/2/2012	<0.001	0.038	0.0008	0.002	0.032	<0.001	17	<0.001	<0.001	0.195	<0.001	0.036	0.03		1	0.032	4.9	0.005
GW62-12-2263	2/6/2012	2/8/2012	<0.001	0.069	0.0009	0.022	0.038	<0.001	17	<0.001	0.001	0.196	<0.001	0.002	0.03	0.00005	2	0.025	5.1	0.006
GW62-12-2272	2/7/2012	2/8/2012	<0.001	0.113	0.0008	0.023	0.040	<0.001	18	<0.001	0.001	0.196	<0.001	<0.001	0.05	<0.00005	1	0.026	5.2	0.007
GW62-12-2270	2/8/2012	2/9/2012	<0.001	0.114	0.0008	0.025	0.042	<0.001	17	<0.001	0.002	0.194	<0.001	0.001	0.05	0.00006	2	0.026	5.1	0.009
GW62-12-2261	2/13/2012	2/15/2012	<0.001	0.087	0.0008	0.026	0.042	<0.001	18	<0.001	<0.001	0.199	<0.001	<0.001	0.04	<0.00005	1	0.024	5.4	0.004
GW62-12-2262	2/11/2012	2/15/2012	<0.001	0.073	0.0008	0.021	0.041	<0.001	18	<0.001	0.001	0.198	<0.001	<0.001	0.03	<0.00005	1	0.024	5.4	0.005
GW62-12-2266	2/10/2012	2/15/2012	<0.001	0.067	0.0008	0.017	0.040	<0.001	18	<0.001	0.001	0.197	<0.001	0.001	0.03	<0.00005	2	0.025	5.4	0.007
GW62-12-2268	2/9/2012	2/15/2012	<0.001	0.097	0.0008	0.015	0.040	<0.001	18	<0.001	<0.001	0.196	<0.001	<0.001	0.04	<0.00005	2	0.025	5.3	0.005
GW62-12-2273	2/12/2012	2/15/2012	<0.001	0.080	0.0007	0.013	0.040	<0.001	18	<0.001	<0.001	0.194	<0.001	<0.001	0.03	<0.00005	1	0.025	5.3	0.005
GW62-12-12289	3/8/2012	3/22/2012	<0.001	0.100	0.0006	0.012	0.026	<0.001	18	<0.001	0.001	0.203	<0.001	0.001	0.04		1	0.023	5.0	0.006
GW62-12-12290	3/8/2012	3/22/2012	<0.001	0.065	0.0006	0.009	0.026	<0.001	18	<0.001	0.002	0.204	<0.001	<0.001	0.03		1	0.024	5.1	0.005
GW62-12-12291	3/10/2012	3/22/2012	<0.001	0.063	0.0006	0.008	0.025	<0.001	18	<0.001	0.001	0.200	<0.001	<0.001	0.03		1	0.025	5.0	0.003
GW62-12-12292	3/11/2012	3/22/2012	<0.001	0.049	0.0006	0.007	0.025	<0.001	18	<0.001	0.001	0.201	<0.001	<0.001	0.02		1	0.025	5.1	0.003
GW62-12-12293	3/12/2012	3/22/2012	<0.001	0.052	0.0007	0.007	0.025	<0.001	18	<0.001	0.002	0.203	<0.001	<0.001	0.03		1	0.026	5.0	0.004
GW62-12-12294	3/13/2012	3/22/2012	<0.001	0.037	0.0006	0.003	0.024	<0.001	18	<0.001	0.003	0.202	<0.001	<0.001	0.02		1	0.026	5.0	0.006
GW62-12-12295	3/14/2012	3/22/2012	<0.001	0.048	0.0006	0.003	0.025	<0.001	18	<0.001	0.002	0.200	<0.001	<0.001	0.02		1	0.027	5.1	0.004
GW62-12-2278	3/7/2012	3/22/2012	<0.001	0.097	0.0007		0.027	<0.001	17	<0.001	0.002	0.200	<0.001	0.001	0.04		1	0.024	4.8	0.028

Table B-2.3-2 (continued)

Sample ID	Date Sampled	Date Received	Molybdenum	Sodium	Nickel	Lead	Rubidium	Antimony	Selenium	Silicon	Silicate	Tin	Strontium	Thorium	Titanium	Thallium	Uranium	Vanadium	Zinc
GW62-12-2206	1/27/2012	2/2/2012		21	0.002	0.0002	0.002		0.001	32	68		0.078		<0.002	<0.001	0.0019	0.002	0.010
GW62-12-2208	1/28/2012	2/2/2012		16	0.002	<0.0002	0.002		0.002	31	67		0.078		<0.002	<0.001	0.0015	0.001	0.009
GW62-12-2210	1/28/2012	2/2/2012		15	0.002	<0.0002	0.002		0.001	32	69		0.076		<0.002	<0.001	0.0014	0.002	0.011
GW62-12-2212	1/29/2012	2/2/2012		15	0.002	<0.0002	0.002		0.001	32	69		0.076		<0.002	<0.001	0.0014	0.002	0.009
GW62-12-2214	1/29/2012	2/2/2012		14	0.001	<0.0002	0.002		0.001	32	69		0.076		<0.002	<0.001	0.0013	<0.001	0.008
GW62-12-2216	1/30/2012	2/2/2012		14	0.001	<0.0002	0.002		0.001	32	69		0.075		<0.002	<0.001	0.0012	0.002	0.008
GW62-12-2218	1/30/2012	2/2/2012		14	0.002	0.0002	0.002		0.001	32	70		0.073		<0.002	<0.001	0.0012	<0.001	0.014
GW62-12-2220	1/27/2012	2/2/2012		136	0.032	0.0027	0.003		0.004	18	39		0.029		<0.002	<0.001	0.0104	0.005	0.055
GW62-12-2224	1/31/2012	2/2/2012		13	0.002	0.0007	0.002		0.001	32	68		0.075		<0.002	<0.001	0.0012	<0.001	0.034
GW62-12-2263	2/6/2012	2/8/2012	0.002	17	0.002	<0.0002	0.002	<0.001	0.001	33	71	<0.001	0.074	<0.001	<0.002	<0.001	0.0014	<0.001	0.016
GW62-12-2272	2/7/2012	2/8/2012	0.001	15	0.002	<0.0002	0.002	<0.001	0.001	33	70	<0.001	0.075	<0.001	<0.002	<0.001	0.0013	<0.001	0.013
GW62-12-2270	2/8/2012	2/9/2012	0.001	14	0.002	<0.0002	0.002	<0.001	0.001	32	69	<0.001	0.074	<0.001	<0.002	<0.001	0.0013	<0.001	0.013
GW62-12-2261	2/13/2012	2/15/2012	0.001	13	0.002	<0.0002	0.002	<0.001	0.001	33	71	<0.001	0.076	<0.001	<0.002	<0.001	0.0013	0.001	0.005
GW62-12-2262	2/11/2012	2/15/2012	0.001	14	0.002	<0.0002	0.002	<0.001	0.001	33	71	<0.001	0.077	<0.001	<0.002	<0.001	0.0012	0.001	0.005
GW62-12-2266	2/10/2012	2/15/2012	0.001	14	0.002	<0.0002	0.002	<0.001	0.001	34	72	<0.001	0.077	<0.001	<0.002	<0.001	0.0012	0.001	0.007
GW62-12-2268	2/9/2012	2/15/2012	0.001	14	0.002	0.0002	0.002	<0.001	0.001	34	72	<0.001	0.077	<0.001	<0.002	<0.001	0.0013	0.001	0.006
GW62-12-2273	2/12/2012	2/15/2012	0.001	14	0.002	<0.0002	0.002	<0.001	0.001	33	71	<0.001	0.076	<0.001	<0.002	<0.001	0.0012	0.001	0.005
GW62-12-12289	3/8/2012	3/22/2012		13	0.003	<0.0002	0.002		0.002	33	71		0.079		<0.002	<0.001	0.0009	<0.001	0.008
GW62-12-12290	3/8/2012	3/22/2012		13	0.003	<0.0002	0.002		0.002	33	70		0.081		<0.002	<0.001	0.0009	<0.001	0.007
GW62-12-12291	3/10/2012	3/22/2012		12	0.002	<0.0002	0.002		<0.001	32	69		0.076		<0.002	<0.001	0.0008	0.001	0.006
GW62-12-12292	3/11/2012	3/22/2012		12	0.002	<0.0002	0.002		<0.001	32	69		0.074		<0.002	<0.001	0.0009	<0.001	0.006
GW62-12-12293	3/12/2012	3/22/2012		12	0.002	<0.0002	0.002		<0.001	32	69		0.077		<0.002	<0.001	0.0009	<0.001	0.010
GW62-12-12294	3/13/2012	3/22/2012		12	0.003	<0.0002	0.002		<0.001	32	69		0.073		<0.002	<0.001	0.0008	<0.001	0.008
GW62-12-12295	3/14/2012	3/22/2012		12	0.002	<0.0002	0.002		<0.001	33	70		0.075		<0.002	<0.001	0.0009	0.001	0.005
GW62-12-2278	3/7/2012	3/22/2012		13	0.003	<0.0002	0.002		0.001	32	67		0.080		<0.002	<0.001	0.0009	<0.001	0.014

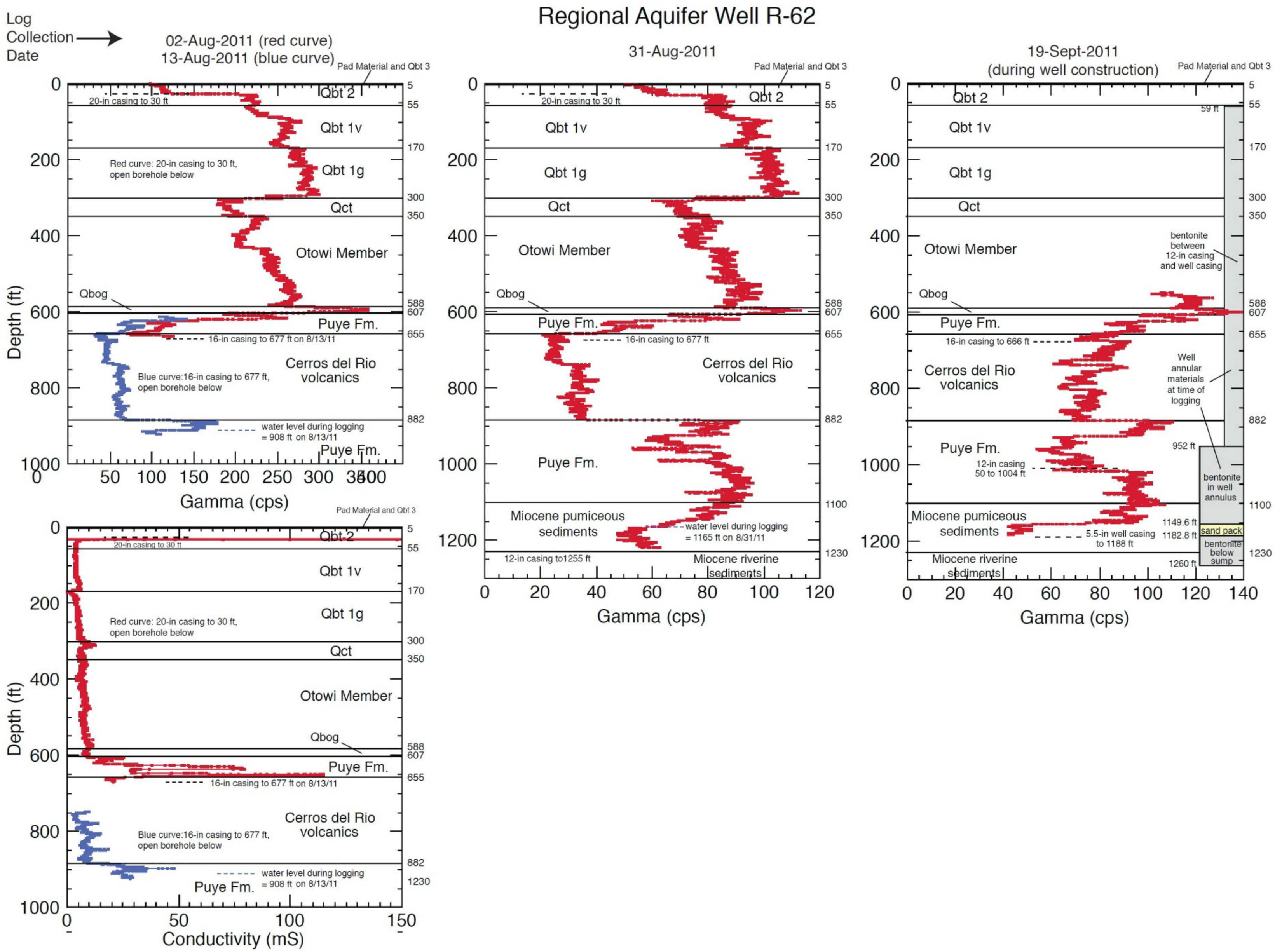
Notes: Units in ppm. Blank cell indicates the sample was not analyzed for that metal.

Appendix C

Borehole Video Logging
(on DVDs included with this document)

Appendix D

Geophysical Logs
(on CD included with this document)


Regional Aquifer Well R-62
Log Collection Date
02-Aug-2011 (red curve)
13-Aug-2011 (blue curve)
31-Aug-2011
19-Sept-2011
(during well construction)
Pad Material and Qbt 3
Qbt 2
Qbt 1v
Qbt 1g
Qct
Otowi Member
Qbog
Puye Fm.
Cerros del Rio volcanics
Miocene pumiceous sediments
Miocene riverine sediments
20-in casing to 30 ft
Red curve: 20-in casing to 30 ft, open borehole below
16-in casing to 677 ft on 8/13/11
Blue curve:16-in casing to 677 ft, open borehole below
water level during logging = 908 ft on 8/13/11
16-in casing to 677 ft
water level during logging = 1165 ft on 8/31/11
12-in casing to1255 ft
16-in casing to 666 ft
59 ft
bentonite between 12-in casing and well casing
Well annular materials at time of logging
952 ft
12-in casing 50 to 1004 ft
bentonite in well annulus
1149.6 ft
1182.8 ft
sand pack
5.5-in well casing to 1188 ft
bentonite below sump
1260 ft
Depth (ft)
Gamma (cps)
Conductivity (mS)

Appendix E

R-62 Final Well Design and
New Mexico Environment Department Approval

Well R-62 Completion Plan

MEMORANDUM

DATE: September 21, 2011

TO: LANS, NMED

FROM: EBERLINE SERVICES, INC.

SUBJECT: COMPLETION STRATEGY FOR R-62

Per the meeting on September 19, 2011 between NMED, Eberline Services, LANL representatives, and Yellow Jacket Drilling, this memorandum provides the proposed completion strategy for regional well R-62.

A gamma log was run in well R-62 after the September 19 meeting and confirmed that the filter pack and bentonite seal above the screened interval are positioned as shown on the attached well schematic. The depth to water inside the 5-inch well casing was measured at 1124 feet below ground surface (bgs).

A pressure test was conducted on September 20 to evaluate the effectiveness of the seal. The top of the 16-inch casing was sealed off and pressurized to 39 pounds per square inch (psi). The pressure was monitored for 60 minutes (min)[1]. The pressure dropped to 25 psi after 7 mins, to 18 psi after 24 mins, and to 15 psi after 84 mins. The ambient temperature dropped approximately 10°F during the course of the test. The pressure loss may indicate that there is communication with the borehole at the base of the 16-in casing.

The following steps will be taken to backfill and seal the casing.

a) Tremie will be lowered as far as possible between the 12-in and 16-in casing
b) High solids bentonite grout (20% bentonite solids) will be pumped from 950 to 900 feet bgs, followed by an optimal cure/hydration period to allow the slurry to thicken so that when pressure is applied as additional material is placed, it does not force the grout downward or out into the formation.
c) A natural gamma log will be run in an attempt to confirm the grout placement interval.
d) High solids bentonite grout (20% bentonite solids) will then be pumped in two additional lifts to bring the grout up to 675 feet bgs with an optimal cure/hydration period of up to 3 hours for each lift.
e) If the natural gamma log run previously was able to identify the grout interval, then it will be run again after each lift.
f) A pressure of 20 psi will then be applied between the 12-inch and 16-inch casing for 60 minutes in order to retest the seal at the base of the 16-inch casing.

Well R-62 Completion Plan

If the pressure test fails,

1. Another lift of high-solids bentonite grout (20% solids) will be added to 600 feet bgs.
2. A pressure of 40 psi will then be applied for 30 min in order to force the grout out the bottom and up behind the 16-inch casing.
3. A 20-ft lift of neat cement will then be pumped into the interval above the high-solids bentonite grout (20% solids). The cement will be allowed to cure 8 hours.
4. A #51 mix[2] cement will be pumped via tremie between the 12-in and 16-in casing from the top of the neat cement to 3 feet bgs.
5. Cement will also be pumped between the 16-in casing and the borehole wall up to 3 feet bgs.
6. The wellhead will be completed per required specifications.

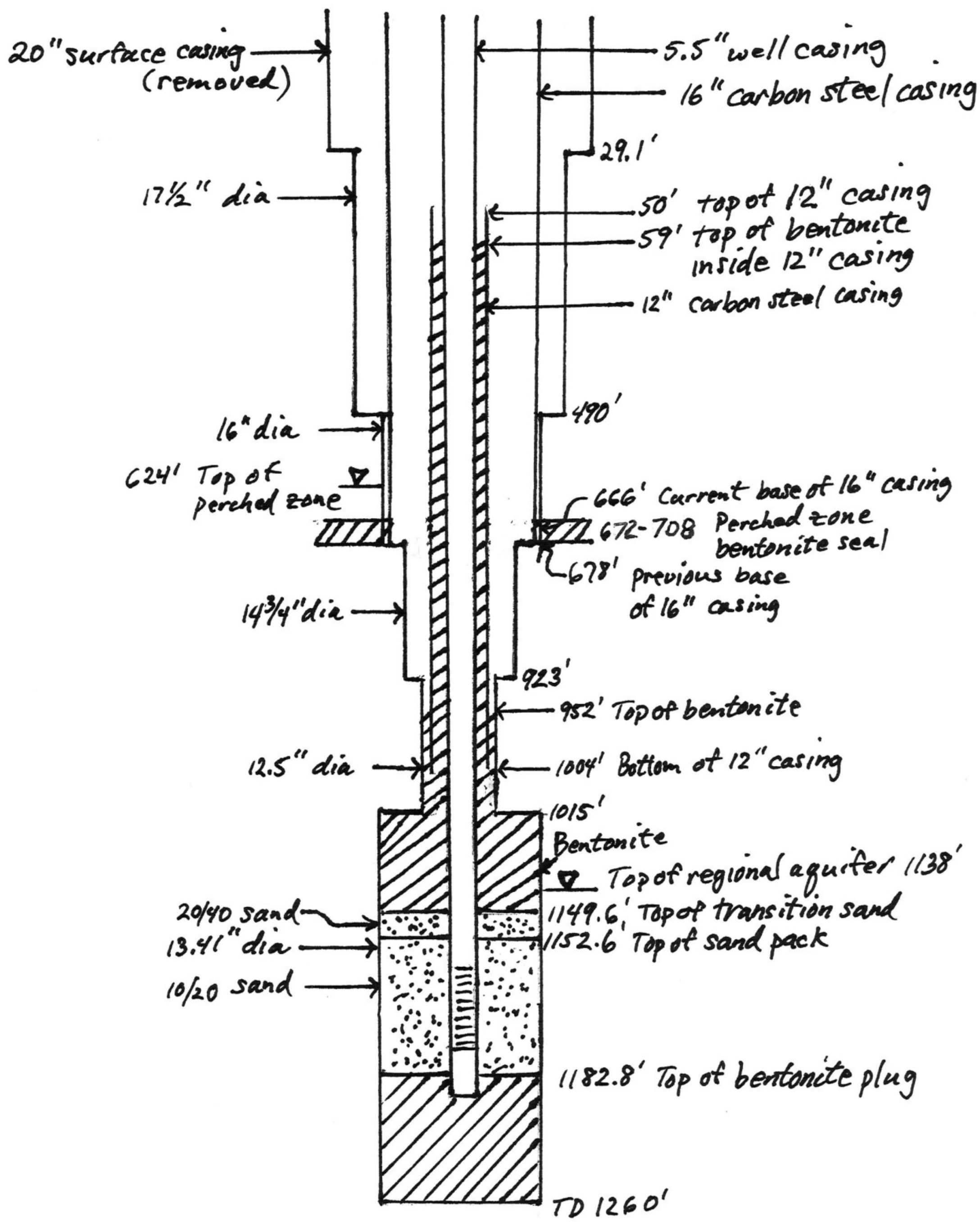
If the pressure test passes,

1. Another lift of high-solids bentonite grout (20% solids) will be added to 600 feet bgs.
2. A 20-ft lift of neat cement will then be pumped into the interval above the high-solids bentonite grout (20% solids). The cement will be allowed to cure 8 hours.
3. A #51 mix[2] cement will be pumped via tremie between the 12-in and 16-in casing from the top of the neat cement to 3 feet bgs.
4. Cement will also be pumped between the 16-in casing and the borehole wall up to 3 feet bgs.
5. The wellhead will be completed per required specifications.

[1]Groundwater and Wells, Edited by Robert J. Sterrett, Third Edition, 2007
[2]Equivalent to 720 lbs cement, 225 lbs fly ash, 2400 lbs sand, 55 gal water, 62 oz wetting agent

9/19/11

Well R-62



Eileen Shannon

From: Rappuhn, Doug H., OSE <doug.rappuhn@state.nm.us>
Sent: Monday, September 26, 2011 6:02 PM
To: Everett, Mark C
Cc: Trujillo, Jerri, OSE; Johnson, Mike S., OSE; Myers, Kevin, OSE; Ball, Theodore T; Shen, Hai; Woodworth, Lance A
Subject: RE: New sand cement slurry mix: Rehab of LANL R-62 monitor well

Hi Mark –

Thanks for the update.
The sand to cement-fly ash ratio is now approvable.

In reviewing my e-mail below, I wrongly called you out on the water increment on the originally proposed "#51 mix". Looking at things today, I find that the water increment was actually OK. Only the sand percent needed to be reined in.

In short, approvable ratios for a sand-cement slurry are:
Sand : cement or dry cement mix (dry weight) ratio of 2 : 1
Cement : fly ash (dry weight) ratio of 75 : 25 (some alternatives exist)
With the cement + fly ash = "dry cement mix", a dry cement mix : water ratio of 89 lbs : 6.0 gallons water (no additional water demand for sand, but it should be moistened before mixing.
Using the proposed 700 lbs cement + 200 lbs fly ash = 900 lbs dry cement mix, 900 lbs / 89 lbs = 10.1 "units" (= standard Halliburton bag mix for this recipe is packaged in 89-lb sacks)
10.1 units at 6. 0 gallons water /unit = 60.6 gallons water per 900 lbs dry cement mix
I assume the wetting agent is proposed in small volumes per mix, similar as stated for the "#51 mix"

Sorry for my error in Friday's e-mail on the water demand. The 45 gallons water proposed today is likely in response to my stated concerns about excess water... using 45 gallons water per 900 lbs dry cement mix + 1800 lbs sand would result in a high compressive strength, but would likely be too stiff to pump down hole easily. Since a shallow tremie set-depth is being forced, both within and outside of the 16" casing, you'll not want to be pumping a mix too stiff to get down to the deeper recesses of the annular spaces. If you think the mix may try to set too quickly, you may look into use of retarders, or mix with very cold water.

Please discuss the matter further with your cementing and drilling team, and give me a shout with any other questions.

Douglas H. Rappuhn

Hydrology Bureau / New Mexico Office of the State Engineer
5550 San Antonio Drive NE
Albuquerque, NM 87109-4127
Phone: 505-383-4000; Fax: 505-383-4030
e-mail: doug.rappuhn@state.nm.us

From: Everett, Mark C [mailto:meverett@lanl.gov]
Sent: Monday, September 26, 2011 3:45 PM
To: Rappuhn, Doug H., OSE
Cc: Trujillo, Jerri, OSE; Johnson, Mike S., OSE; Myers, Kevin, OSE; Ball, Theodore T; Shen, Hai; Woodworth, Lance A

Subject: New sand cement slurry mix: Rehab of LANL R-62 monitor well
Importance: High

Doug,

Our provider says that they can use a "9.5 sack sand slurry". The recipe for this mix is:

1800-lb Sand
700-lb Cement
200-lb Fly Ash
45 Gallons Water
Wetting Agent

Please let me know if this sand-cement mix is acceptable for our application at well R-62.

Thanks,

Mark Everett, PG
ADEP ET-EI
Los Alamos National Laboratory
(505) 667-5931

From: Rappuhn, Doug H., OSE [mailto:doug.rappuhn@state.nm.us]
Sent: Friday, September 23, 2011 3:45 PM
To: Everett, Mark C
Cc: Trujillo, Jerri, OSE; Johnson, Mike S., OSE; Myers, Kevin, OSE
Subject: Rehab of LANL R-62 monitor well

Hi Mark –

Thanks for today's call and the information you provided me last evening to help with the interpretation of the well sketch in the *Well R-62 Completion Plan Memorandum* (9/21/2011 from Eberline Services, Inc., to LANS, NMED) I received from Jerri Trujillo. Knowing you were using casing advance equipment was the key to understanding the unusual borehole sizes (including the lower hole being wider than the upper hole), and the tight borehole diameters surrounding the lower portions of the nominal 12"- and 16'-diameter casing. Please correct any misconceptions I may have in the narrative below. Also, I did not provide an even remotely exhaustive assessment of the site hydrogeology, and have instead considered problems encountered only from a well design perspective.

For this kind of monitor well project, any vacant annular space is undesirable, so the original plan was to have advanced the temporary casing down-hole to total depth (approximately 1260'), then have installed the 5.5" OD casing string within the temporary 12" casing, followed by gradual installation of the annular materials (5.5" X approximate 12 – 13.4" annulus) as the 12" casing was gradually extracted. As I understand, the problem occurred as the 12" casing was being lifted after annular materials were installed to approximately 952' bgl: there was a failure of some component of the hoisting assembly (collar at the top of the then-upper 12" casing joint?). The 12" casing dropped, and apparently lodged 52' into the bentonite chips below, with top of the 12" casing approximately 50' bgl.

Some of the e-mail correspondence I was provided indicates LANL received NMED approval (9/12/2011 e-mail Jerzy Kulis / NMENV to Mark Everett) to leave the remaining 12" casing in place (50' – 1004' bgl). As of 9/12/2011, project

2

correspondence indicated plans were to extract the 16" driven casing as part of the well design. Apparently efforts to remove the nominal 16" casing also failed, and you noted the steel casing was stretched in attempting to extract it. Leaving either or both the 12" and/or 16" casing in the hole is a deviation from the original project plans, so the project team has had to consider whether the proposed rehab design will result in a completed monitor well that will function as designed. At issue is whether the rehab will prevent the entry and leakage of perched groundwater that might spread potential contaminants to a lower zone or affect what is monitored within the water-bearing (apparently unconfined) Tjfp unit (Miocene pumiceous sands and gravel, found at the approx 1100 – 1230 bgl interval).

I understand the presence of perched groundwater intervals were noted at approximately 624' – 655' and 844' – 892' bgl during drilling. The upper perched water was temporarily addressed by pulling back the nominal 16" casing to approximately 672', emplacing bentonite chips in the bottom of the then-708' drill hole (nominal 16" diameter), then advancing the casing downward to 678' (which would have resulted in a very narrow ring of bentonite around the casing bottom from 672 – 678' bgl). According to the as-exists well sketch provided, the 16" casing has been pulled back to a depth of 666' bgl (6' <u>above</u> the noted narrow ring of bentonite), and attempts to further extract the 16" casing have failed. There is not evidence of an existing competent seal at the base of the 16" casing, so a leak there may allow the upper perched water to descend into the 666' – 678' interval of 12" X 16" hole and underlying 678' – 923' interval of 12" X 14.8" hole until the time the annulus is sealed.

Sealing off the deeper (844' – 892') perched water during back-completion of the well will be difficult, given the narrow approximate 12" X 14.8" annular space (678' – 923' interval). The deeper water table (apparently unconfined aquifer) is at approximately 1140' bgl, so above that, the <u>borehole</u> is not saturated. I see no guarantee that the proposed high-solids bentonite grout, if tremied from the current tremie depth of 260' bgl, will ever reach and seal this interval of the borehole, so the existence of an apparently competently sealed annulus from 952 / 1004' down to 1149' bgl will be instrumental in isolating the saturated monitored interval from downward draining discharge from above.

The 923' – 952' interval was drilled as 12.5" diameter, and is occupied by the nominal 12" casing and no annular materials. This interval is likely too tight to receive annular seal materials placed from above. The interval is not in a saturated portion of the well.

We understand that maximum tremie depth thus far attained in the approximate 12" X 16" annulus is 260'. Although the open <u>borehole</u> is reported unsaturated in excess of the open annulus at 952' bgl, the annular spaces become progressively narrower with depth, so discharging bentonite grout from 260', even in a "dry" annular space, is a substantial concern for project success.

<u>NMOSE regulation:</u>

NMAC 19.27.4 regulations regarding general and non-artesian well construction apply, with 19.27.4.30.A.(3) and (4) most directly related to matters at hand. Neither regulation is prescriptive, and the NMOSE may consider their application to preclude loss of hydrologic head between geologic zones and prevent the contamination of potable water as appropriate within the bounds of other regulations for conditions encountered.

On the other hand, NMAC 19.27.4.30.A.(1) is prescriptive, noting required minimum lateral dimension of annular seal (2" on either side of the casing for a non-pressure grout). Project options to potentially rehabilitate the well are limited. Would the well have been completed as designed, it appears a compliant deep, thick annular seal was planned from surface to top of gravel pack. With two strings of advanced casings stuck down hole, there are intervals of casing with minimal (952' – 1004') to essentially no (490' – 666'; 923' – 952') annular seal, leaving problems with sealing the lower annulus with the proposed bentonite grout, and sealing the upper annular spaces with a cement grout.

Bentonite grouted annular space

Having installed the production 5" casing within the stuck 12" casing disallows reasonable attempts to pull the 12" casing. That said, the 12" casing did drop approximately 52' into a pre-existing borehole of bentonite chips, allowing likely competent seal through the 952' – 1004' interval (and below). Although dimensionally not in compliance with NMAC 19.27.4.30.A.(1), the bentonite present through 952' – 1004' may do an adequate job sealing the annular space created through that zone.

It appears the project team may most fully rely on placement of sealant between borehole and outside of the 12" casing through the 666' – 923' interval to isolate upper, perched water from deeper groundwater. Success will be a function of proper placement of an effective sealant.

Due to a lack of options and the potential that an adequately placed, appropriate sealant may meet the intention of NMAC 19.27.4.30.A, the proposed bentonite slurry-grouting process is not deemed a 19.27.4 compliance issue (see cement comment below), since existing and proposed grout placement may adequately address hydrologic separation. It is strongly suggested that the project team explore all other tremie options in the attempt to place a tremie as deep as possible for bentonite slurry placement, given the friction losses that will discourage deep slurry placement by open hole drainage. Options include general use of thin-walled, chemically inert pipe or tubing that may be left down hole if irretrievable. If successful in getting the tremie down deep into the annulus and pumping back-pressure is a problem, the pumping of short batches of the bentonite grout followed by limited raising the tremie and pumping fresh water to clear it might be considered. Tremie pipe as small as ½-inch diameter might be considered, and should be discussed with your driller. Angling the tremie bottom and cutting additional ports in the lower tremie section may be beneficial in snaking the pipe past obstructions and avoiding clogs.

Cement grouted annular space

Perforating the 16" casing to address the lack of a sealed annulus through the 490' – 666' interval, and limited annular space from 490' to 29' bgl is not an option due to the 12" and 5" casings in place (there is not room for perforating devices to be appropriately placed in the 12" X 16" annulus).

I would appreciate hearing additional detail on the depth any form of tremie might be lowered into the limited 17.5" X nominal 16" annulus outside the 16" casing. This is an important safeguard against surface and shallow contaminant sources. It appears a larger annulus exists above 29' bgl, but should the 20" casing not have been grouted appropriately in place, it would be necessary to extract it before top-grouting.

Proposed use of "#51 mix" cement slurry

Well R-62 Completion Plan Memorandum (9/21/2011 from Eberline Services, Inc., to LANS, NMED) references use of a "#51 mix" cement to be placed from approximately 600' to 3' bgl. The slurry is stated to be mixed per the following ratio: 720 lbs cement, 225 lbs fly ash, 2400 lbs sand, 55 gallons water, and 64 oz wetting agent. The NMOSE looks to AWWA Water Well Standards and oilfield cementing tables for prescriptive guidance regarding approvable cement mixes other than 5.2 gallons water per 94-lb of Type I/II Portland cement.

Fly ash develops cementitious properties when finely ground and mixed with cement, and therefore generally has a water demand similar to cement. A 75:25 dry weight ratio of cement to fly ash (as a pozzolan) is an approvable oilfield cement mix (using 6.0 gallons water per 89 lbs. pozzolanic cement mix).

Sand has no water demand, but is expected to be moist before being mixed in cement slurries. AWWA Standards for Water Wells allow the use of sand in cement slurries in ratios of up to 2 parts sand : 1 part cement by dry weight, and mixed with no more than 6.0 gallons water per 94-lb cement.

The proposed "#51 mix" cement slurry is not approvable for well use due to excess sand and water, and an alternate mix must be chosen and reviewed with the NMOSE.

Please contact me for further discussion.

Doug Rappuhn
NMOSE Hydrology Bureau
5550 San Antonio Drive NE
Albuquerque, NM 87109

Eileen Shannon

From:	Kulis, Jerzy, NMENV <jerzy.kulis@state.nm.us>
Sent:	Wednesday, September 28, 2011 2:52 PM
To:	Everett, Mark C; Dale, Michael, NMENV; Cobrain, Dave, NMENV; Rappuhn, Doug H., OSE; Trujillo, Jerri, OSE
Cc:	Ball, Theodore T; Shen, Hai; Douglass, Craig R
Subject:	RE: Revised R-62 completion plan

Mark,

NMED hereby approves the R-62 completion plan (Plan) as proposed in your e-mail below. LANL must keep NMED informed of any deviations from the Plan. No later than seven (7) calendar days after completion of the activities outlined in the Plan, LANL must submit to NMED the results of natural gamma logs, driller's logs and any other information relevant to the execution of the Plan. If NMED's review of the available data indicates that the annulus at R-62 has not been sealed sufficiently to mitigate potential threat to regional aquifer, or if LANL determines the same, LANL will be required to submit a plugging and abandonment plan for R-62 and to install a replacement well for R-62.

Please let me know if you have any questions.

Jerzy Kulis
Environmental Scientist
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Bldg 1
Santa Fe, NM 87505-6303
Phone: 505-476-6039
Fax: 505-476-6030

From: Everett, Mark C [mailto:meverett@lanl.gov]
Sent: Tuesday, September 27, 2011 4:27 PM
To: Dale, Michael, NMENV; Kulis, Jerzy, NMENV; Cobrain, Dave, NMENV; Rappuhn, Doug H., OSE; Trujillo, Jerri, OSE
Cc: Ball, Theodore T; Shen, Hai; Douglass, Craig R
Subject: Revised R-62 completion plan

All,

A revised plan for sealing the annulus at R-62 was discussed during a meeting this morning with NMED, DOE, and LANL staff. At NMED's suggestion, LANL researched various annular sealant materials both with and without added modifier ingredients and now recommends the materials and process in the attached memo. Specifically, we propose to use BAROTHERM, a Baroid product, without adding any sand for the interval below the 16 inch casing and 9.5 sack cement-sand mix above. Please let me know if you wish to discuss this plan further.

Thanks,

Mark Everett, PG
ADEP ET-EI
Los Alamos National Laboratory
(505) 667-5931

Appendix F

Aquifer Testing Report

F-1.0 INTRODUCTION

This appendix describes the hydraulic analysis of pumping tests conducted during October 2011 at R-62, a regional aquifer well located on a narrow ridge between Sandia and Mortandad Canyons at the east end of Sigma Mesa at Los Alamos National Laboratory. The tests on R-62 were conducted to characterize the saturated materials and quantify the hydraulic properties of the screened interval. Testing consisted of brief trial pumping, background water-level data collection, and a 24-h constant-rate pumping test.

As in most of the R-well pumping tests conducted on the Pajarito Plateau, an inflatable packer system was installed in R-62 to try to eliminate casing storage effects on the test data. However, because of the low yield of R-62, previous well development purging pulled the pumping water level into the well screen, dewatering the filter pack around the screen. This would have allowed drainage of the portion of the filter pack above the screen behind the blank casing and possibly would have trapped air in that area during subsequent water level recovery. The hypothesized trapped air would be expected to cause a storage-like effect on the pumping test data by expanding and compressing during pumping and recovery. Indeed, data from the trial tests revealed storage effects.

During recovery, it is theoretically possible to expel most of the trapped air, provided the saturated zone above the well screen is fairly permeable. However, the data presented below showed a significant storage effect, implying the likelihood of tight materials above the screen.

Pumping data from all tests showed erratic response—slightly varying discharge rate and drawdown. This was likely an effect of pumping aerated groundwater. Observation of the pumped water showed it contained a significant fraction of air or gas. The presence of gas in the pumped water causes pump cavitation and temporal changes in bowl efficiency and pumping characteristics, which can affect the discharge rate. The origin of the gas was not known. It could be natural or, more likely, residual air that was pushed into the formation via air drilling during borehole advancement. The presence of gas in the groundwater cannot only affect pump operation but can cause transient and spatial variations in sediment hydraulic conductivity associated with dynamic changes in gas content over time.

Development and test pumping revealed a poor yield from R-62. Therefore, following test pumping, additional well development was performed using high-velocity water jetting and simultaneous pumping. As described below, these procedures resulted in a 47% increase in well yield.

Conceptual Hydrogeology

R-62 lies within Miocene pumiceous deposits. The well screen is 20.7 ft long, extending from 1158.4 to 1179.1 ft below ground surface (bgs). The static water level measured on October 11, 2011, prior to testing was 1,142.27 ft bgs. The ground surface elevation at the well is 6984.93 ft above mean sea level (amsl), making the water level elevation 5842.66 ft amsl.

The proximity of the water table to the top of the well screen typically leads to the assumption of unconfined aquifer conditions. However, as discussed below, evidence suggested rather tight sediments adjacent to the top of the well screen and just above it. This led to assigning semiconfined (leaky-confined) conditions as the most likely description of the producing zone in R-62.

R-62 Testing

R-62 was tested from October 12 to 17, 2011. On October 12, the pump was installed and operated long enough to fill the drop pipe and establish a suitable discharge rate. Testing began with brief trial pumping on October 13.

Trial testing of R-62 began at 8:00 a.m. on October 13, 2011, at a discharge rate of 1.15 gallons per minute (gpm), declining gradually to 1.0 gpm and continued for 30 min. Following 30 min of recovery, a second trial test was performed at 9:00 a.m. for 30 min at an initial discharge rate of 1.13 gpm, declining to 1.0 gpm. Following shutdown, recovery data were recorded for 30 min and a third trial test, a step-drawdown test, was conducted at several discharge rates: 1.00, 1.46, 1.90, and 2.35 gpm. This test was conducted for three h from 10:00 a.m. to 1:00 p.m.

Following 43 h of background data collection, the 24-h pumping test began at 8:00 a.m. on October 15, 2011, at an average discharge rate of 1.2 gpm. Pumping continued until 8:00 a.m. on October 16, 2011. Following shutdown, recovery data were recorded for 24 h until 8:00 a.m. on October 17, 2011, when the pump was pulled from the well.

F-2.0 BACKGROUND DATA

The background water-level data collected in conjunction with running the pumping tests allow the analyst to see what water-level fluctuations occur naturally in the aquifer and help distinguish between water-level changes caused by conducting the pumping test and changes associated with other causes.

Background water-level fluctuations have several causes, among them barometric pressure changes, operation of other wells in the aquifer, Earth tides, and long-term trends related to weather patterns. The background data hydrographs from the monitored wells were compared with barometric pressure data from the area to determine if a correlation existed.

Previous pumping tests on the plateau have demonstrated a barometric efficiency for most wells of between 90% and 100%. Barometric efficiency is defined as the ratio of water-level change divided by barometric pressure change, expressed as a percentage. In the initial pumping tests conducted on the early R-wells, downhole pressure was monitored using a vented pressure transducer. This equipment measures the difference between the total pressure applied to the transducer and the barometric pressure, this difference being the true height of water above the transducer.

Subsequent pumping tests, including R-62, have utilized nonvented transducers. These devices simply record the total pressure on the transducer, that is, the sum of the water height plus the barometric pressure. This results in an attenuated “apparent” hydrograph in a barometrically efficient well. Take as an example a 90% barometrically efficient well. When a vented transducer is used to monitor, an increase in barometric pressure of 1 unit causes a decrease in recorded downhole pressure of 0.9 unit because the water level is forced downward 0.9 unit by the barometric pressure change. However, when a nonvented transducer is used, the total measured pressure increases by 0.1 unit (the combination of the barometric pressure increase and the water-level decrease). Thus, the resulting apparent hydrograph changes by a factor of 100 minus the barometric efficiency and in the same direction as the barometric pressure change rather than in the opposite direction.

Barometric pressure data were obtained from Technical Area 54 (TA-54) tower site from the Waste and Environmental Services Division-Environmental Data and Analysis (WES-EDA). The TA-54 measurement location is at an elevation of 6548 ft amsl, whereas the wellhead elevation is 6984.93 ft amsl. The static water level in R-62 was 1142.27 ft below land surface, making the water-table elevation approximately

5842.66 ft amsl. Therefore, the measured barometric pressure data from TA-54 had to be adjusted to reflect the pressure at the elevation of the water table within R-62.

The following formula was used to adjust the measured barometric pressure data:

$$P_{WT} = P_{TA54} \exp\left[-\frac{g}{3.281R}\left(\frac{E_{R-62} - E_{TA54}}{T_{TA54}} + \frac{E_{WT} - E_{R-62}}{T_{WELL}}\right)\right]$$

Equation F-1

where P_{WT} = barometric pressure at the water table inside R-62

P_{TA54} = barometric pressure measured at TA-54

g = acceleration of gravity, in m/sec^2 (9.80665 m/sec^2)

R = gas constant, in J/kg/degree kelvin (287.04 J/kg/degree Kelvin)

E_{R-62} = land surface elevation at R-62 site, in feet (approximately 6985 ft)

E_{TA54} = elevation of barometric pressure measuring point at TA-54, in feet (6548 ft)

E_{WT} = elevation of the water level in R-62, in feet (approximately 5842.73 ft)

T_{TA54} = air temperature near TA-54, in degrees kelvin (assigned a value of 53.2 degrees Fahrenheit, or 284.9 degrees kelvin)

T_{WELL} = air column temperature inside R-62, in degrees kelvin (assigned a value of 62.7 degrees Fahrenheit, or 290.2 degrees kelvin)

This formula is an adaptation of an equation WES-EDA provided. It can be derived from the ideal gas law and standard physics principles. An inherent assumption in the derivation of the equation is that the air temperature between TA-54 and the well is temporally and spatially constant and that the temperature of the air column in the well is similarly constant.

The corrected barometric pressure data reflecting pressure conditions at the water table were compared with the water-level hydrograph to discern the correlation between the two and to determine whether water level corrections would be needed before data analysis.

F-3.0 IMPORTANCE OF EARLY DATA

When pumping or recovery first begins, the vertical extent of the cone of depression is limited to approximately the well screen length, the filter pack length, or the aquifer thickness in relatively thin permeable strata. For many pumping tests on the plateau, the early pumping period is the only time that the effective height of the cone of depression is known with certainty because, soon after startup, the cone of depression expands vertically through permeable materials above and/or below the screened interval. Thus, the early data often offer the best opportunity to obtain hydraulic conductivity information because conductivity would equal the earliest-time transmissivity divided by the well screen length.

Unfortunately, in many pumping tests, casing-storage effects dominate the early-time data, potentially hindering the effort to determine the transmissivity of the screened interval. The duration of casing-storage effects can be estimated using the following equation (Schafer 1978, 098240).

$$t_c = \frac{0.6\left(D^2 - d^2\right)}{\frac{Q}{s}}$$

Equation F-2

where t_c = duration of casing storage effect, in minutes

D = inside diameter of well casing, in inches

d = outside diameter of column pipe, in inches

Q = discharge rate, in gallons per minute

s = drawdown observed in pumped well at time t_c, in feet

The calculated casing storage time is quite conservative. Often, the data show that significant effects of casing storage have dissipated after about half the computed time.

For wells screened across the water table or wells in which the filter pack can drain during pumping, there can be an additional storage contribution from the filter pack. The following equation provides an estimate of the storage duration accounting for both casing and filter pack storage.

$$t_c = \frac{0.6\left[\left(D^2 - d^2\right) + S_y\left(D_B^2 - D_C^2\right)\right]}{\frac{Q}{s}}$$

Equation F-3

where S_y = short-term specific yield of filter media (typically 0.2)

D_B = diameter of borehole, in inches

D_C = outside diameter of well casing, in inches

This equation was derived from Equation F-2 on a proportional basis by increasing the computed time in direct proportion to the additional volume of water expected to drain from the filter pack. (To prove this, note that the left hand term within the brackets is directly proportional to the annular area [and volume] between the casing and drop pipe while the right hand term is proportional to the area [and volume] between the borehole and the casing, corrected for the drainable porosity of the filter pack. Thus, the summed term within the brackets accounts for all of the volume [casing water and drained filter pack water] appropriately.)

In some instances, it is possible to eliminate casing storage effects by setting an inflatable packer above the tested screen interval before the test is conducted. As described previously, this approach was not successful in the testing performed on R-62 because the data included storage effects associated with trapped air in the filter pack above the screen caused by antecedent dewatering of the screen during well development. Using Equation F-2, the expected storage duration computes to about 2 h when no inflatable packer is used. Using an inflatable packer can be expected to reduce this time by limiting the duration to just that associated with expansion and compression of trapped air. Nevertheless, the data presented below showed a significant storage duration effect.

F-4.0 TIME-DRAWDOWN METHODS

Time-drawdown data can be analyzed using a variety of methods. Among them is the Theis method (1934-1935, 098241). The Theis equation describes drawdown around a well as follows:

$$s = \frac{114.6Q}{T} W(u)$$

Equation F-4

where

$$W(u) = \int_u^{\infty} \frac{e^{-x}}{x} dx$$

Equation F-5

and

$$u = \frac{1.87 r^2 S}{Tt}$$

Equation F-6

and where *s* = drawdown, in feet

Q = discharge rate, in gallons per minute

T = transmissivity, in gallons per day per foot

S = storage coefficient (dimensionless)

t = pumping time, in days

r = distance from center of pumpage, in feet

To use the Theis method of analysis, the time-drawdown data are plotted on log-log graph paper. Then, Theis curve matching is performed using the Theis type curve—a plot of the Theis well function *W*(*u*) versus 1/*u*. Curve matching is accomplished by overlaying the type curve on the data plot and, while keeping the coordinate axes of the two plots parallel, shifting the data plot to align with the type curve, effecting a match position. An arbitrary point, referred to as the match point, is selected from the overlapping parts of the plots. Match-point coordinates are recorded from the two graphs, yielding four values: *W*(*u*), 1/*u*, *s*, and *t*. Using these match-point values, transmissivity and storage coefficient are computed as follows:

$$T = \frac{114.6Q}{s} W(u)$$

Equation F-7

$$S = \frac{Tut}{2693 r^2}$$

Equation F-8

Where *T* = transmissivity, in gallons per day per foot

S = storage coefficient

Q = discharge rate, in gallons per minute

W(*u*) = match-point value

s = match-point value, in feet

u = match-point value

t = match-point value, in minutes

An alternative solution method applicable to time-drawdown data is the Cooper-Jacob method (1946, 098236), a simplification of the Theis equation that is mathematically equivalent to the Theis equation for most pumped well data. The Cooper-Jacob equation describes drawdown around a pumping well as follows:

$$s = \frac{264Q}{T} \log \frac{0.3Tt}{r^2 S}$$

Equation F-9

The Cooper-Jacob equation is a simplified approximation of the Theis equation and is valid whenever the u value is less than about 0.05. For small radius values (e.g., corresponding to borehole radii), u is less than 0.05 at very early pumping times and therefore is less than 0.05 for most or all measured drawdown values. Thus, for the pumped well, the Cooper-Jacob equation usually can be considered a valid approximation of the Theis equation. An exception occurs when the transmissivity of the aquifer is very low. In that case, some of the early pumped well drawdown data may not be well approximated by the Cooper-Jacob equation.

According to the Cooper-Jacob method, the time-drawdown data are plotted on a semilog graph, with time plotted on the logarithmic scale. Then a straight line of best fit is constructed through the data points and transmissivity is calculated using:

$$T = \frac{264Q}{\Delta s}$$

Equation F-10

where *T* = transmissivity, in gallons per day per foot

Q = discharge rate, in gallons per minute

Δs = change in head over one log cycle of the graph, in feet

Because many of the test wells completed on the Plateau are severely partially penetrating, an alternate solution considered for assessing aquifer conditions is the Hantush equation for partially penetrating wells (Hantush 1961, 098237; Hantush 1961, 106003). The Hantush equation is as follows:

Equation F-11

$$s = \frac{Q}{4\pi T}\left[W(u) + \frac{2b^2}{\pi^2 (l-d)(l'-d')} \sum_{n=1}^{\infty} \frac{1}{n^2} \left(\sin\frac{n\pi l}{b} - \sin\frac{n\pi d}{b}\right)\left(\sin\frac{n\pi l'}{b} - \sin\frac{n\pi d'}{b}\right) W\left(u, \sqrt{\frac{K_z}{K_r}}\frac{n\pi r}{b}\right)\right]$$

where, in consistent units, *s*, *Q*, *T*, *t*, *r*, *S*, and *u* are as previously defined and

b = aquifer thickness

d = distance from top of aquifer to top of well screen in pumped well

l = distance from top of aquifer to bottom of well screen in pumped well

d' = distance from top of aquifer to top of well screen in observation well

l' = distance from top of aquifer to bottom of well screen in observation well

K_z = vertical hydraulic conductivity

K_r = horizontal hydraulic conductivity

In this equation, $W(u)$ is the Theis well function and $W(u,\beta)$ is the Hantush well function for leaky aquifers where:

$$\beta = \sqrt{\frac{K_z}{K_r}}\frac{n\pi r}{b}$$

Equation F-12

Note that for single-well tests, $d = d'$ and $l = l'$.

F-5.0 RECOVERY METHODS

Recovery data were analyzed using the Theis recovery method. This is a semilog analysis method similar to the Cooper-Jacob procedure.

In this method, residual drawdown is plotted on a semilog graph versus the ratio t/t', where t is the time since pumping began and t' is the time since pumping stopped. A straight line of best fit is constructed through the data points, and T is calculated from the slope of the line as follows:

$$T = \frac{264Q}{\Delta s}$$

Equation F-13

The recovery data are particularly useful compared with time-drawdown data. Because the pump is not running, spurious data responses associated with dynamic discharge rate fluctuations are eliminated. The result is that the data set is generally “smoother” and easier to analyze.

Recovery data also can be analyzed using the Hantush equation for partial penetration. This approach is generally applied to the early data in a plot of recovery versus recovery time.

F-6.0 SPECIFIC CAPACITY METHOD

The specific capacity of the pumped well can be used to obtain a lower-bound value of hydraulic conductivity. The hydraulic conductivity is computed using formulas based on the assumption that the pumped well is 100% efficient. The resulting hydraulic conductivity is the value required to sustain the observed specific capacity. If the actual well is less than 100% efficient, it follows that the actual hydraulic conductivity would have to be greater than calculated to compensate for well inefficiency. Thus, because the efficiency is unknown, the computed hydraulic conductivity value represents a lower bound. The actual conductivity is known to be greater than or equal to the computed value.

For fully penetrating wells, the Cooper-Jacob equation can be iterated to solve for the lower-bound hydraulic conductivity. However, the Cooper-Jacob equation (assuming full penetration) ignores the contribution to well yield from permeable sediments above and below the screened interval. To account for this contribution, it is necessary to use a computation algorithm that includes the effects of partial penetration. One such approach was introduced by Brons and Marting (1961, 098235) and augmented by Bradbury and Rothschild (1985, 098234).

Brons and Marting introduced a dimensionless drawdown correction factor, s_P, approximated by Bradbury and Rothschild as follows:

$$s_P = \frac{1-\frac{L}{b}}{\frac{L}{b}}\left[\ln\frac{b}{r_w} - 2.948 + 7.363\frac{L}{b} - 11.447\left(\frac{L}{b}\right)^2 + 4.675\left(\frac{L}{b}\right)^3\right]$$

Equation F-14

In this equation, *L* is the well screen length, in ft. Incorporating the dimensionless drawdown parameter, the conductivity is obtained by iterating the following formula:

$$K = \frac{264Q}{sb}\left(\log\frac{0.3Tt}{r_w^2 S} + \frac{2s_P}{\ln 10}\right)$$

Equation F-15

The Brons and Marting procedure can be applied to both partially penetrating and fully penetrating wells.

To apply this procedure, a storage coefficient value must be assigned. Storage coefficient values generally range from 10^{-5} to 10^{-3} for confined aquifers and 0.01 to 0.25 for unconfined aquifers (Driscoll 1986, 104226). Semiconfined conditions generally are associated with intermediate storage coefficient values between these ranges. For R-62, semiconfined conditions were assumed, so calculations were performed for an assigned storage coefficient range of 0.001 to 0.01 for two reasons. First, there appeared to be a significant amount of trapped air in the filter pack, implying tight materials above the well screen that precluded escape of the trapped air. Second, as described below, data from the trial-3 step-drawdown test also implied tight materials in the upper portion of the screened interval. The lower-bound transmissivity calculation result is not particularly sensitive to the choice of storage coefficient value, so a rough estimate is generally adequate to support the calculations.

The analysis also requires assigning a value for the saturated aquifer thickness, *b*. For R-62, calculations were performed assuming fully penetrating conditions. An examination of the data suggested that 3-dimensional flow effects did not reveal themselves until late time and, thus, for the early-time calculations used to support lower-bound transmissivity estimates, 2-dimensional flow was assumed.

F-7.0 BACKGROUND DATA ANALYSIS

Background aquifer pressure data collected during the R-62 tests were plotted along with barometric pressure to determine the barometric effect on water levels.

Figure F-7.0-1 shows aquifer pressure data from R-62 during the test period along with barometric pressure data from TA-54 that have been corrected to equivalent barometric pressure in feet of water at the water table. The R-62 data are referred to in the figure as the “apparent hydrograph” because the measurements reflect the sum of water pressure and barometric pressure, having been recorded using a non-vented pressure transducer. The times of the pumping test periods for the R-62 pumping tests are included on the figure for reference.

On the morning of October 14, 2011, the packer was deflated temporarily to release any air that might have been trapped in the casing beneath it, and reinflated a half-hour later. This operation caused a constant offset in the background data collected after reinflation because of stretching/shrinkage of the drop pipe associated with relieving and reestablishing tensile stress via the packer manipulation.

Therefore, the affected background data shown on Figure F-7.0-1 were adjusted to remove this anomaly from the presentation.

A comparison of the apparent hydrograph and barometric pressure curve showed little correlation between the two, suggesting a high barometric efficiency, likely close to 100%. The primary trend illustrated in the plot was a steady rise in the background aquifer pressure of about 0.1 ft/d. This could be seen in data before the trial testing, background data collected between trial testing and the 24-h test, and in the data collected following the 24-h test. It is possible this reflected general recovery of regional aquifer water levels in response to reduced municipal pumping in the fall compared with antecedent summertime pumping or to recovery of the local groundwater level after screen development and purging.

F-8.0 WELL R-62 DATA ANALYSIS

This section presents the data obtained from the R-62 pumping tests and the results of the analytical interpretations. Data are presented for trial 1, trial 2, trial 3, and the 24-h constant-rate test.

F-8.1 Well R-62 Trial 1 Test

Brief trial testing was performed to obtain “snapshots” of early pumping and recovery response to try to quantify properties of the subsurface materials immediately around the well bore. It was not known a priori whether trapped air in the filter pack had been expelled or if storage effects would be present.

Figures F-8.1-1 and F-8.1-2 show semilog plots of the drawdown and recovery data collected from the trial 1 test on R-62 at an initial discharge rate of 1.15 gpm, declining to 1.0 gpm. As shown on the figures, the data sets were influenced profoundly by storage effects, rendering the data unusable for determining aquifer characteristics.

The substantial storage effect implied that trapped air in the filter pack was not expelled during recovery from previous pumping. This, in turn, suggested tight sediments above the top of the screen and implied the possibility of confined or semiconfined conditions around R-62.

It should be noted that on Figure F-8.1-1 the drawdown data showed erratic response, indicating persistent subtle variations in discharge rate. This was likely attributable to the presence of gas or air in the groundwater affecting temporal and spatial distribution of hydraulic conductivity in the sediments around the well and inducing pump cavitation and temporal bowl efficiency variations.

Recovered water levels on Figure F-8.1-2 data revealed a steady, continuous slope change and premature recovery, i.e., well before a *t/t’* value of 1.0. Normally, in an unconfined setting, this could be attributable to hysteretic effects. In unconfined aquifers, the early rate of recovery can be more rapid than that of drawdown because of a smaller effective storage coefficient during recovery. During pumping the capillary fringe above the water table increases in thickness, while during recovery it gets thinner (Bevan et al. 2005, 105186). If the rate of thinning during recovery exceeds the rate of growth during pumping, the effective storage coefficient during recovery will be less than that during pumping, resulting in a more rapid initial recovery rate than drawdown rate, followed by a corresponding slowing of the recovery rate at late time. Additionally, as the water table rebounds during recovery, it can trap air in the previously dewatered pore spaces, further decreasing the effective recovery storage coefficient.

Because of the likely tightness of the sediments near the top of the well screen and above it, however, it is not certain that true unconfined conditions prevail at R-62. The observed effect also could be explained by a simple reduction in saturated porosity and storage coefficient triggered by excess gas/air accumulation in the aquifer voids during pumping (from pressure reduction associated with aquifer drawdown) and subsequent compression of the accumulated air during water level rebound.

F-8.2 Well R-62 Trial 2 Test

Trial 2 was similar to trial 1 except that the data collection protocol was modified to obtain even more dense data, including very early data.

Figures F-8.2-1 and F-8.2-2 show semi-log plots of the drawdown and recovery data collected from the trial 2 test on R-62 at an initial discharge rate of 1.13 gpm, declining to 1.0 gpm. As with trial 1, the data were significantly influenced by storage and did not support hydraulic analysis.

F-8.3 Well R-62 Trial 3 Test

A third trial test was conducted to evaluate pumping response at several discharge rates—essentially a step-drawdown test. The test included four primary steps of 30 or 40 min duration at successive discharge rates of 1.00, 1.46, 1.90, and 2.35 gpm. Then the valve was adjusted to reduce the rate to about 1.2 gpm in preparation for setting up the equipment for the subsequent 24-h test.

Figure F-8.3-1 shows the drawdown measured at the four primary discharge rates. As with the constant-rate tests, the drawdown patterns were a little erratic rather than completely smooth. This was consistent with hypothesized variations in pump bowl efficiency over time associated with production of gas/air in the water stream. As the discharge rate was increased, the pumping water level was pulled into the well screen, eventually dewatering the upper third of the screen length. (This is the reason the packer was deflated and reinflated on October 14 to expel any air that may have accumulated in the well casing below the packer, as discussed above.)

Normally, when the discharge rate is increased, increases in aquifer dewatering and decreases in saturated well screen length result in reduced specific capacity at the greater flow rates. Further, head losses associated with turbulent flow (second order losses) tend to further reduce the specific capacity at greater discharge rates.

Figure F-8.3-2 shows a plot of the observed specific capacity from R-62 as a function of discharge rate. Remarkably, no decrease in specific capacity was associated with greater discharge rates. (Actually, there was a minor *increase* in specific capacity with increased flow rate, which could have been related to a small gradual reduction in gas content in the sediment pore spaces around the well over time.)

The lack of a distinct reduction in specific capacity with increased drawdown and screen dewatering implied that little of the production obtained from R-62 came from the upper portion of the well screen. This provided additional evidence of the presence of relatively tight sediments near the top of the screened interval and was consistent with the observation of a significant volume of trapped air in the filter pack above the screen. This combination of observations lent credence to the idea that semiconfined conditions may prevail in the vicinity of R-62.

F-8.4 Well R-62 24-Hour Constant-Rate Test

Figure F-8.4-1 shows a semilog plot of the drawdown data collected from the 24-h constant-rate pumping test conducted at an average discharge rate of 1.2 gpm. Early on, the actual discharge rate fell short of the target of 1.2 gpm, even though the discharge valve had been preset before the test. This could have been a result of inconsistent valve performance or a change in the gas content in the pumped water and corresponding reduction in pump bowl efficiency since the previous pumping cycle. To achieve the desired discharge rate of 1.2 gpm, the valve was readjusted about 14 min into the test, resulting in the data offset appearing in the data plot at that time.

As observed during the trial tests, a significant storage effect occurred in the early portion of the data set. The subsequent data showed the same erratic response observed in previous tests because of the presence of gas in the production water.

The transmissivity determined from the line of fit shown on Figure F-8.4-1 was 114 gpd/ft. Assuming a saturated thickness of hydraulically contiguous sediments equal to the well screen length of 20.7 ft, the average hydraulic conductivity computed to 5.5 gpd/ft^2, or 0.74 ft/d. The actual effective saturated thickness of the tested interval is not known, but this calculation provides a rough order of magnitude estimate of the expected hydraulic conductivity. If the thickness of contiguous sediments comprising this transmissivity value were greater than the well screen length, the corresponding hydraulic conductivity would be somewhat less. Similarly, if the thickness of the sediments actually producing water to the screen were less than the screen length, then the hydraulic conductivity of those sediments might be greater.

Over the final 10 h of pumping, little apparent change was evident in the pumping water level. This may have been an indication of partial penetration effects (vertical expansion of the cone of depression into sediments above and/or below the well screen), although the erratic water levels make a sure determination difficult. Late-time delayed drainage from shallow sediments also could account for this apparent response. The late time at which possible curve flattening occurred suggested hydraulic resistance between the pumped zone and overlying and underlying sediments.

Figure F-8.4-2 shows the recovery data collected following shutdown of the 24-h constant-rate pumping test. The early data showed a substantial storage effect, as seen in previous pumping and recovery data sets.

The transmissivity determined from the line of fit shown on Figure F-8.4-2 was 132 gpd/ft. Assuming a saturated thickness of hydraulically contiguous sediments equal to the well screen length of 20.7 ft, the hydraulic conductivity computed to 6.4 gpd/ft^2, or 0.85 ft/d. A somewhat greater actual contiguous thickness of permeable sediments would reduce the hydraulic conductivity value correspondingly.

The substantial slope reduction in the recovery curve at late time is likely related to vertical growth of the cone of impression over time (three-dimensional effects) or, perhaps, delayed yield phenomena in the vicinity of R-62. Again, the late time at which curve flattening occurred suggested hydraulic resistance between the pumped zone and overlying and underlying sediments.

F-8.5 Well R-62 Specific Capacity Data

Specific capacity data were used along with well geometry to estimate a lower-bound hydraulic conductivity value for the permeable zone penetrated by R-62. This was done to provide a frame of reference for evaluating the foregoing analyses.

Following the pumping test effort, additional well development procedures were applied to R-62 in an effort to increase the pumping capacity. Development was performed by high-velocity water jetting the screen using a water pressure of about 540 psi while simultaneously pumping the well. This was accomplished by operating a 5-HP pump within the well screen with a jetting tool located just above the pump. When the pump was operated, a portion of the discharge was directed outward through the jetting tool, with the balance pushed up the drop pipe and out of the well. This approach assured that water and sediment were continuously removed from the well during jetting.

An evaluation of the jetting results was made by comparing the specific capacity recorded prior to jetting with that recorded during a short test that was conducted following development. A valid comparison was achieved by using drawdown data recorded after 1 h of pumping from each test. During the first hour of the 24-h constant-rate test, R-62 produced 1.2 gpm with 12.89 ft of drawdown for a specific capacity of 0.093 gpm/ft. Following jet development, a 1-h test revealed a discharge rate of 2.06 gpm with 15.02 ft of drawdown as shown on Figure F-8.5-1. This resulted in a specific capacity of 0.137 gpm/ft, 47% greater than that obtained before jetting. The post-development specific capacity of 0.137 gpm/ft was used to support the lower-bound transmissivity calculations.

In addition to specific capacity and pumping time, other input values used in the calculations included an assigned storage coefficient range of 0.001 to 0.01, a borehole radius of 0.74 ft (inferred from the volume of filter pack required to backfill the screen zone), and assumed fully penetrating conditions at early pumping times.

Applying the Brons and Marting method to these inputs yielded the lower-bound transmissivity estimates shown on Figure F-8.5-2. Depending on the assumed storage coefficient value, the calculated lower-bound transmissivity values ranged from about 80 to 120 gpd/ft, consistent with the values obtained from test analysis.

F-9.0 SUMMARY

Constant-rate pumping tests were conducted on R-62 to gain an understanding of the hydraulic characteristics of the screened interval.

A comparison of barometric pressure and R-62 water level data showed a highly barometrically efficient screen zone. A background water level rise of about 0.1 ft/d occurred during the test period, perhaps the result of regional aquifer water-level rebound associated with a post-summer reduction in municipal groundwater withdrawal.

Drawdown data obtained from each of the tests showed erratic response from subtle discharge rate variations caused by air (gas bubbles) in the groundwater that affected the operating efficiency of the pump bowl. The source of the gas is not known—it is either naturally occurring or, more likely, air that was pushed into the formation during drilling.

Step-drawdown testing showed no reduction in specific capacity when the upper third of the well screen was dewatered. This suggested minimal yield contribution from that portion of the aquifer and implied the presence of tight sediments at and above the top of the well screen.

Consistent with this, all pumping and recovery tests showed a substantial storage effect even though an inflatable packer was used. This meant that air trapped in the filter pack during development pumping was not expelled during recovery, implying the presence of tight sediments opposite the filter packed zone just above the well screen.

The storage effects were inevitable because of dewatering of the well screen and filter pack that occurred during previous well development pumping. Dewatering the well allowed drainage of the portion of the filter pack above the well screen behind the blank casing, which then trapped air during water level recovery. Expansion and compression of the trapped air during test pumping and recovery causes storage-like effects. Implementation of the inflatable packer could not eliminate storage effects.

Recovery data from trial testing showed hysteretic effects typical of many unconfined aquifers, but the effects can also be explained by accumulation of excess gas/air in the formation voids during pumping.

Three-dimensional effects (vertical growth of the cone of depression) appeared at relatively late time, suggesting resistive sediments between the pumped interval and the underlying greater regional aquifer.

The test analyses suggested a formation transmissivity on the order of 125 gpd/ft. The saturated thickness corresponding to the transmissivity value was not known. However, assuming this value represented a thickness equal to the screen length (20.7 ft), the estimated average hydraulic conductivity was 6.0 gpd/ft^2, or 0.8 ft/d.

Because of the unsatisfactory yield of R-62, additional well development procedures were applied using high-velocity jetting with simultaneous pumping. The results of these efforts increased the specific capacity of the well by 47%.

After jetting, R-62 produced 2.06 gpm for 60 min with 15.02 ft of drawdown for a specific capacity of 0.137 gpm/ft. The lower-bound transmissivity computed from this information ranged from about 80 to 120 gpd/ft, consistent with the estimated pumping test value.

F-10.0 REFERENCES

The following list includes all documents cited in this appendix. 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 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 New Mexico Environment Department 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.

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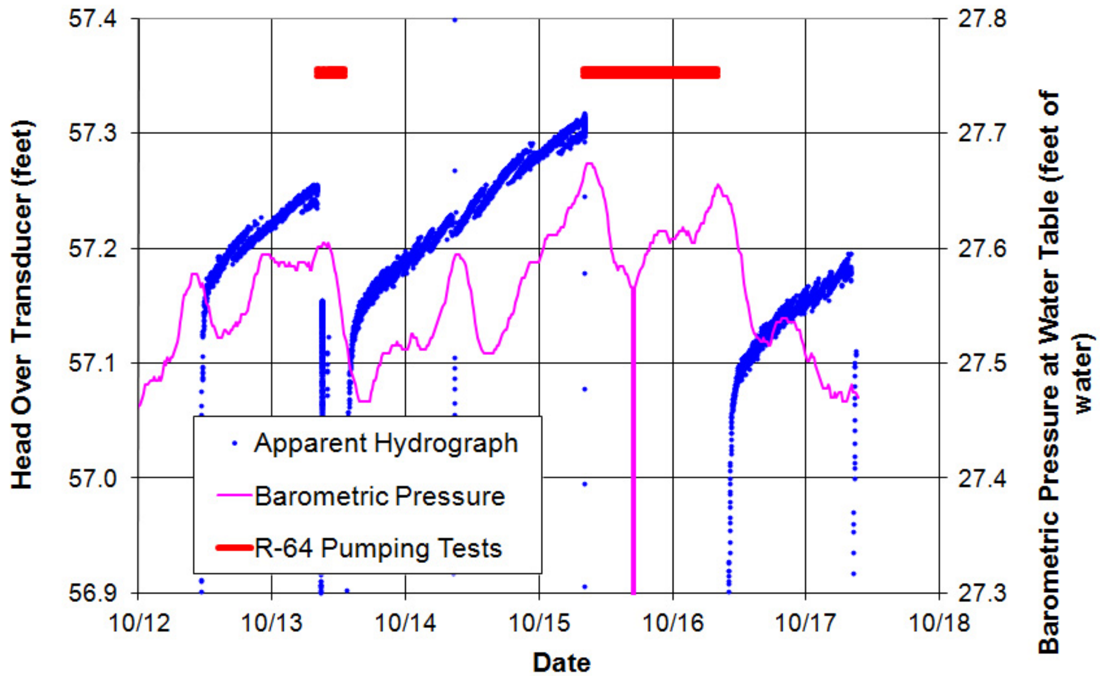

Figure F-7.0-1 Well R-62 apparent hydrograph

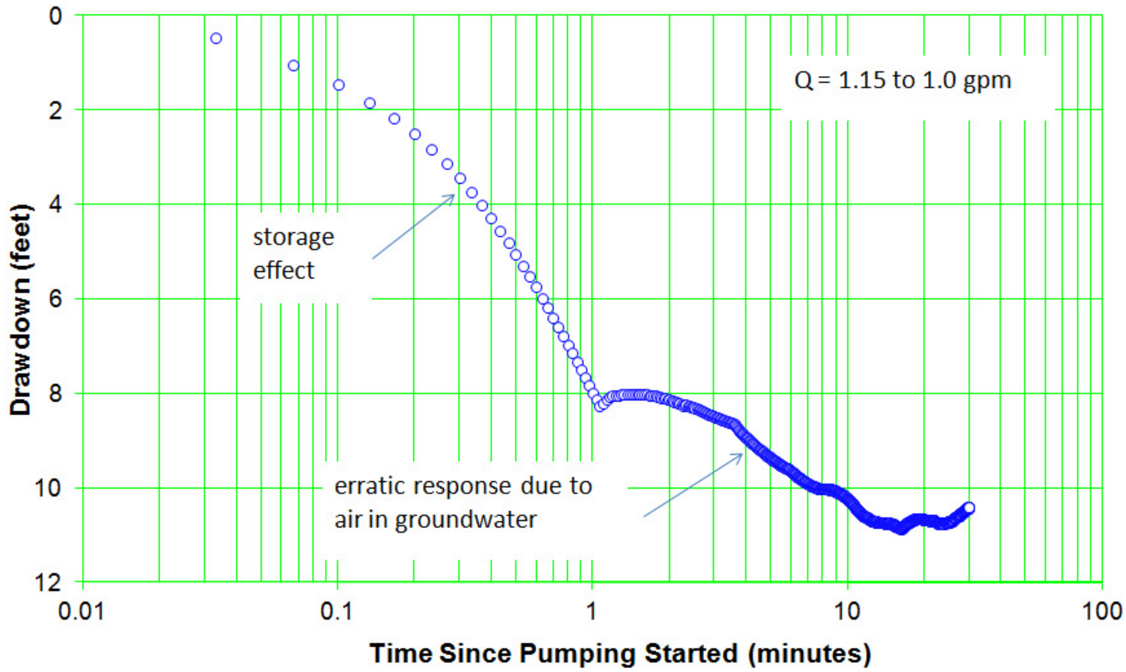

Figure F-8.1-1 Well R-62 trial 1 drawdown

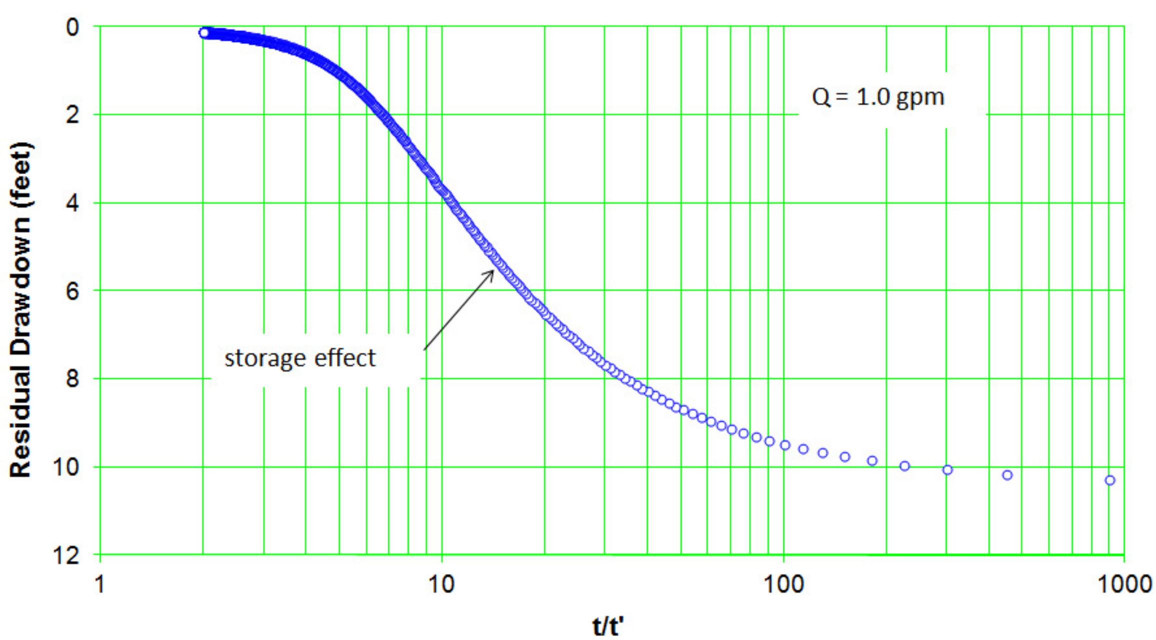

Figure F-8.1-2 Well R-62 trial 1 recovery

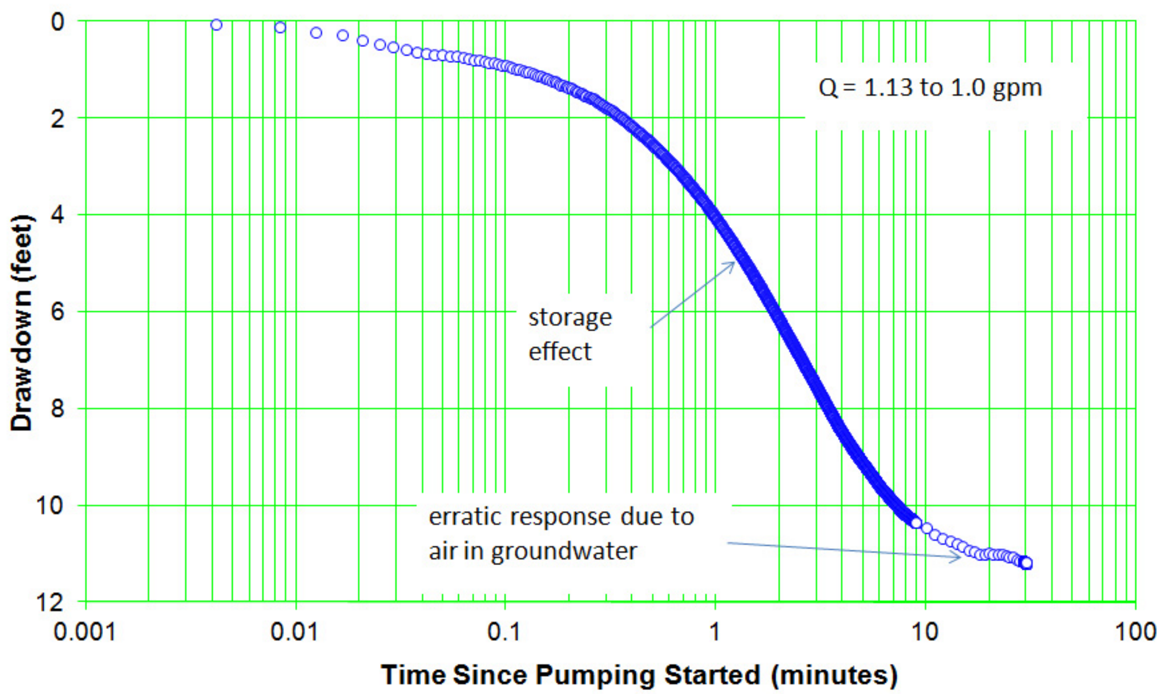

Figure F-8.2-1 Well R-62 trial 2 drawdown

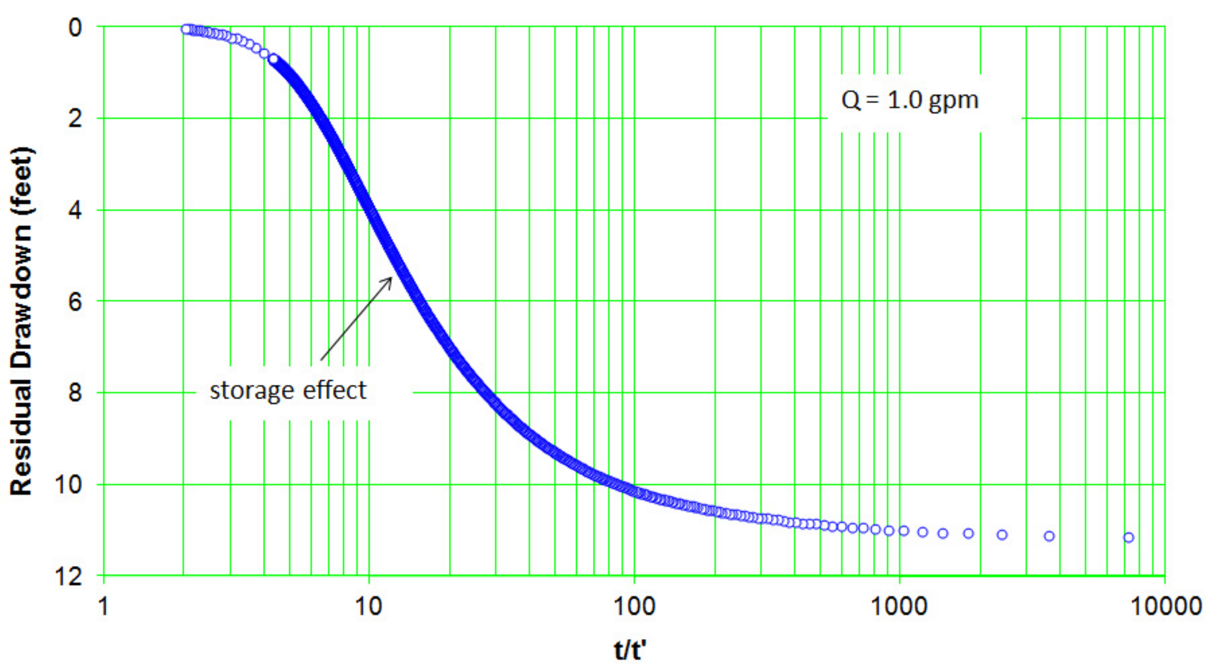

Figure F-8.2-2 Well R-62 trial 2 recovery

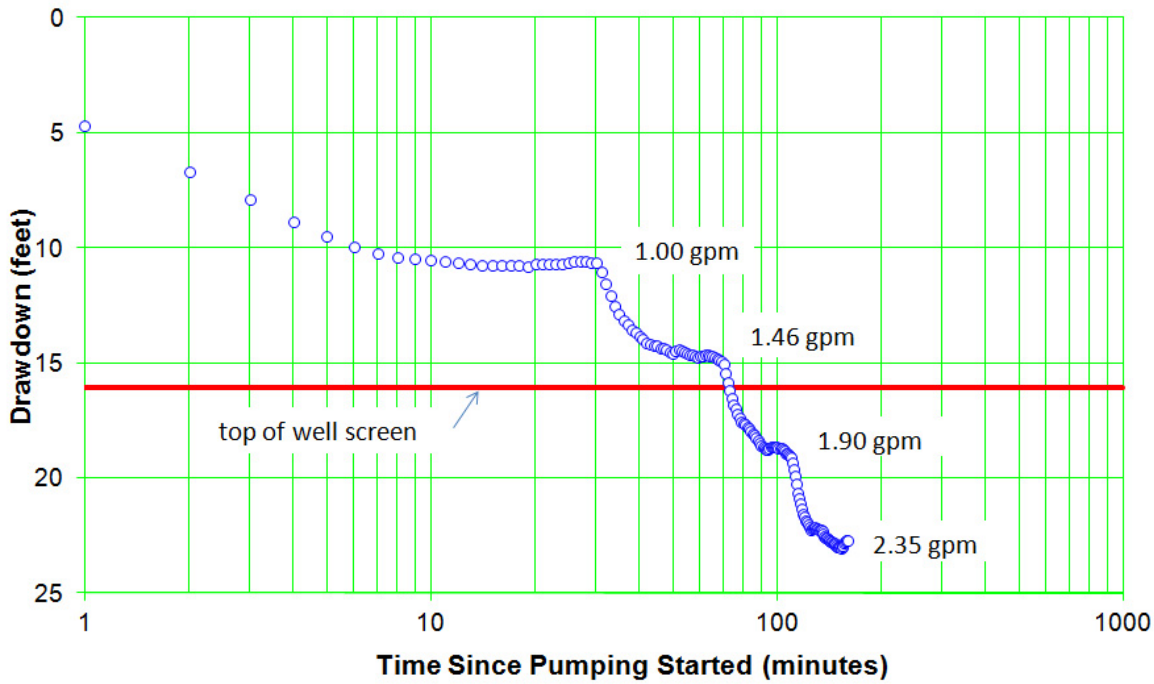

Figure F-8.3-1 Well R-62 trial 3 drawdown

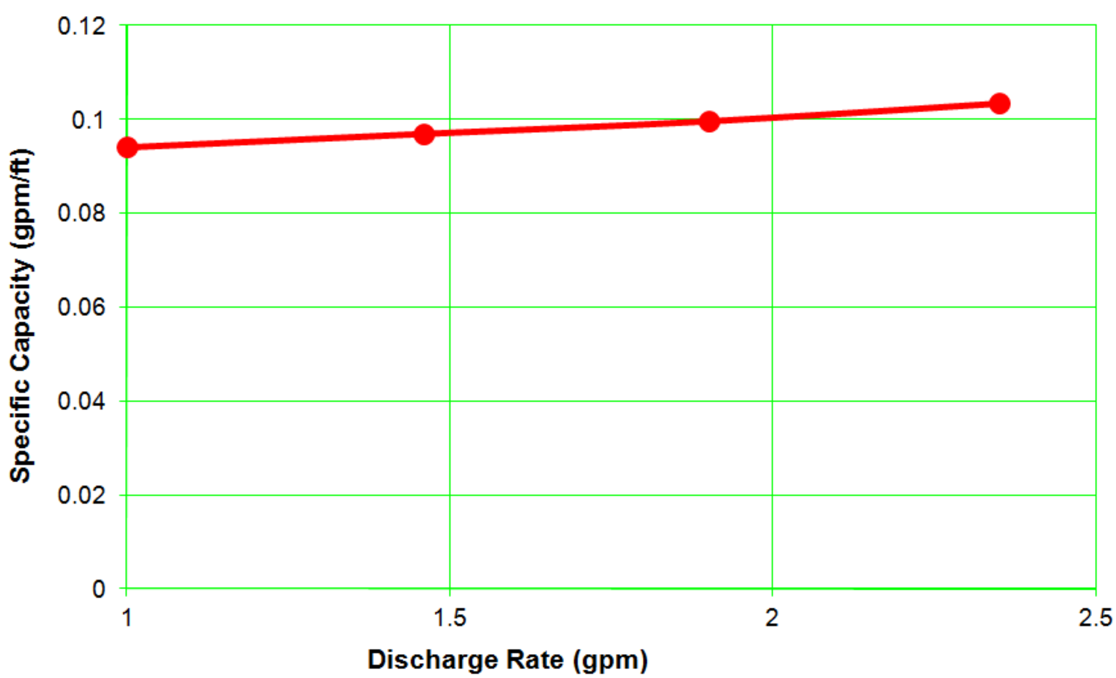

Figure F-8.3-2 Well R-62 specific capacity

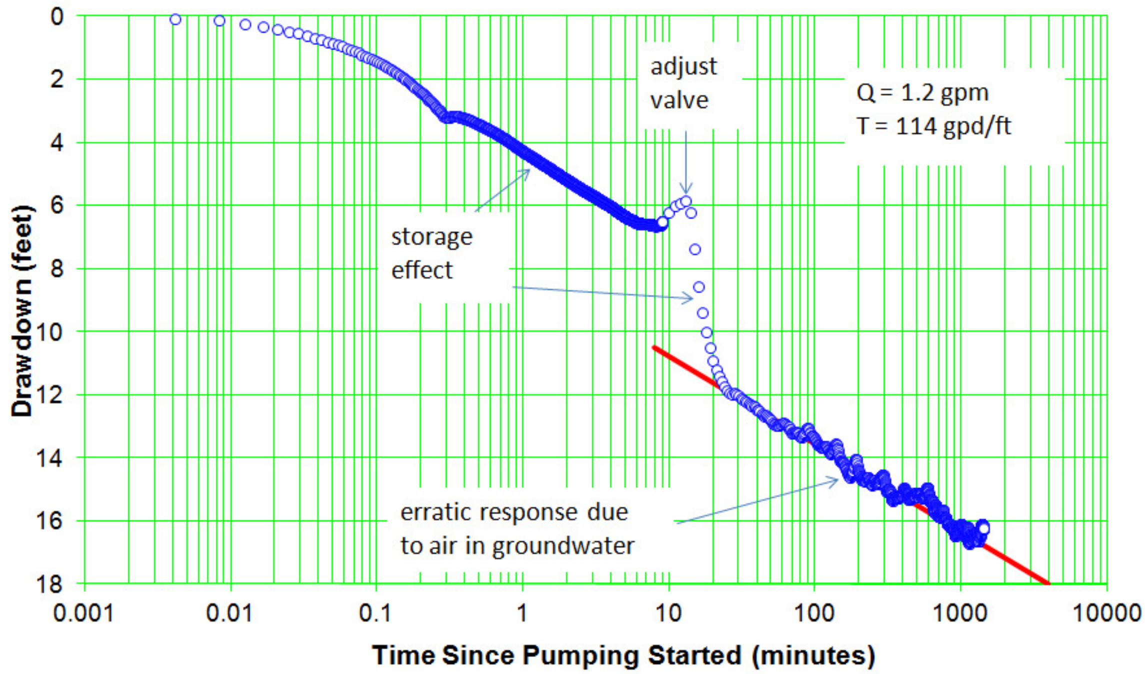

Figure F-8.4-1 Well R-62 drawdown

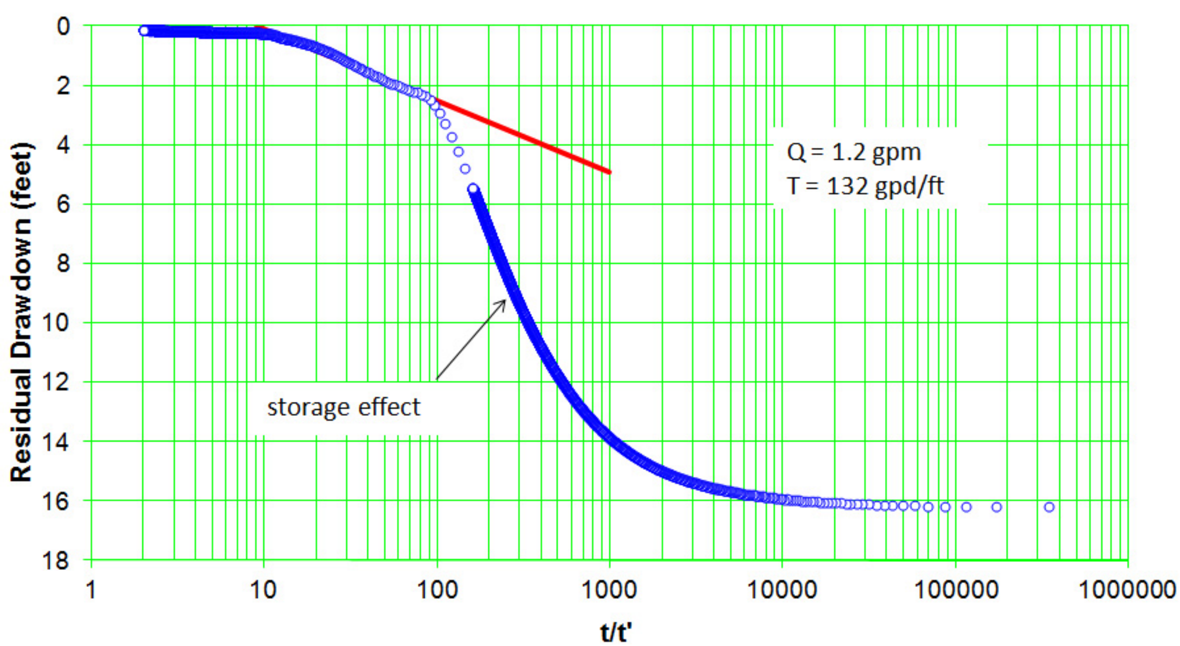

Figure F-8.4-2 Well R-62 recovery

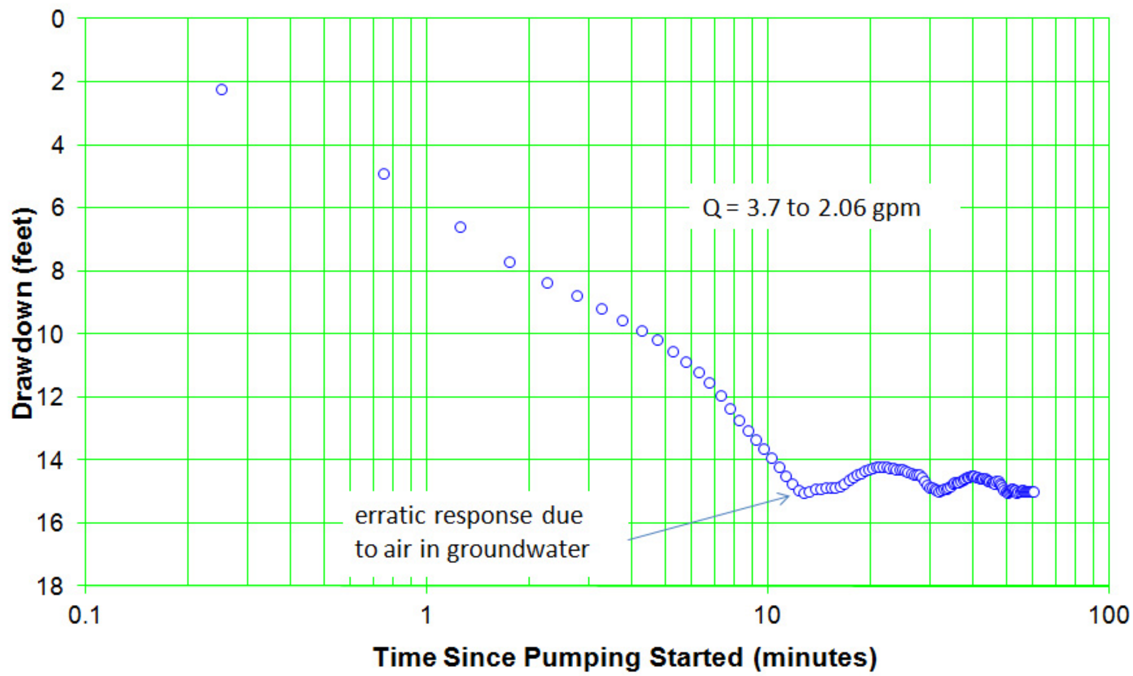

Figure F-8.5-1 Well R-62 drawdown after jetting

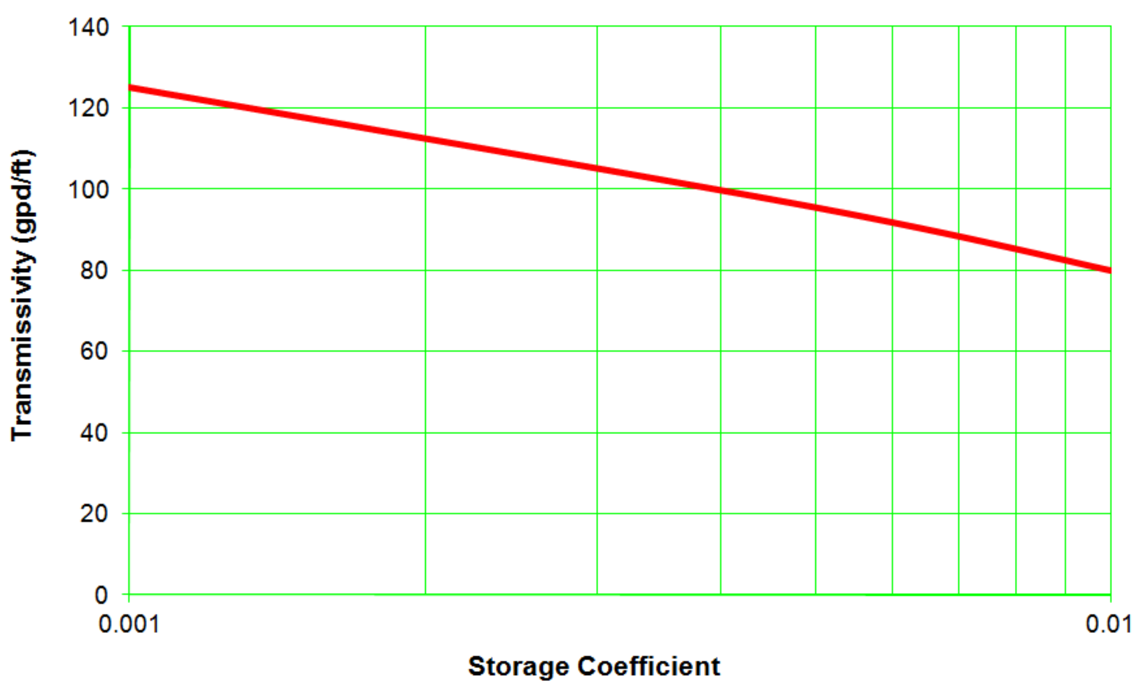

Figure F-8.5-2 Well R-62 lower-bound transmissivity

Appendix G

Geodetic Survey

TO EBERLINE 12012 (REVISED 2-3-12) R-62 and SCI-3

PT#	NORTHING	EASTING	ELEV.	DESCRIPTION
1001	1771610.40	1651994.04	6309.91	B0002
1000	1754880.48	1648970.39	6523.00	B0006
1	1770450.49	1636588.66	6746.93	SCI-3 MONUMENT
2	1770451.23	1636589.46	6746.08	SCI-3 GROUND
3	1769441.01	1635537.94	6984.88	R-62 MONUMENT
4	1769445.73	1635538.85	6984.93	R-62 GROUND
5	1769438.42	1635540.73	6985.68	R-62 PROTECTIVE CASING
6	1769437.78	1635540.54	6987.09	R-62 WELL CASING

Appendix G - Geodetic Survey

2-13-2012

PT#	NORTHING	EASTING	ELEV.	DESCRIPTION
1000	1754880.48	1648970.39	6523.00	B0006
1001	1771610.40	1651994.04	6309.91	B0002
0001	1769437.37	1635540.50	6987.52	R-62 WELL CASING 2
0002	1773065.95	1637496.81	6630.48	R-66 PROTECTIVE CASING
0003	1773065.77	1637496.12	6628.82	R-66 WELL CASING
0004	1773068.55	1637492.97	6626.96	R-66 MONUMENT
0005	1773071.45	1637492.94	6625.86	R-66 GROUND

3-12-2012

PT#	NORTHING	EASTING	ELEV.	DESCRIPTION
1	1769438.42	1635540.73	6988.26	R-62 PROTECTIVE CASING
2	1773065.95	1637496.81	6630.95	R-66 PROTECTIVE CASING
3	1773065.77	1637496.12	6629.61	R-66 WELL CASING