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Rehabilitation and Conversion Summary Report for Well R-16

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EXECUTIVE SUMMARY

This report presents the results of the R-16 well rehabilitation and conversion activities conducted in April and July 2009 at Los Alamos National Laboratory (LANL or the Laboratory). R-16 was sited to monitor regional aquifer groundwater between Technical Area 54 and the Rio Grande. A multiport Westbay sampling system was installed after well completion in 2002. R-16 was originally installed with four well screens; however, it is effectively a three-screen well because the uppermost screen is permanently blocked by stuck drill casing.

Because of concerns regarding the effects of residual drilling fluids on groundwater-monitoring data, R-16, along with two other multiple-screen wells housing Westbay sampling systems, was included in a 2006–2007 pilot well rehabilitation study. At R-16, the pilot rehabilitation consisted of a 12-h specific capacity test accompanied by sample collection.

R-16 was also included in a 2007 well screen analysis study that evaluated groundwater chemistry for potential residual effects from mud drilling fluids. Specific geochemical parameters for each well screen were evaluated for representativeness and reliability by assessment tests, and an overall score was assigned for each screen. The well screen analysis study scored the three R-16 water-bearing zones as follows: screen 2—82%, screen 3—82%, and screen 4—61%.

Based upon the well screen analysis results, in combination with the pilot study rehabilitation efforts, the Laboratory decided to perform more aggressive rehabilitation on screens 2 and 4, convert the well to a two-screen well using screens 2 and 4, and install a dual-port purgeable Baski sampling system at R-16. Screen 2 was selected because it was near the top of the regional aquifer, and screen 4 was chosen because it could monitor potential flow paths deeper in the regional aquifer. Rehabilitation consisted of swabbing/bailing and jetting/pumping followed by a specific capacity test. Samples were collected during the specific capacity tests for screening analysis for anions, cations, metals, alkalinity, total organic carbon (TOC), and sulfide.

The results of the 2009 specific capacity tests indicate that overall yield at screen 2 increased by 6.2% over that measured in 2006; at screen 4, the 2009 yield was 9% lower than that measured in 2006. However, slough around the majority of the well screen at screen 4 likely accounts for the low specific capacity overall.

Analytical results for both screens 2 and 4 showed that concentrations of sulfate, sodium, manganese, and iron concentrations are within the range of background values and that turbidity levels decreased to less than 1 nephelometric turbidity unit. At screen 2, a stable total-to-dissolved manganese ratio, dissolved oxygen levels within background range, and declining TOC concentrations that indicate relatively oxidizing conditions contrast with an inconsistent total-to-dissolved iron ratio and lower overall oxidation-reduction potential (ORP) values than in the pilot study.

At screen 4, ORP, sulfate concentrations, and dissolved oxygen values are all indicative of a relatively oxidizing environment. Declining TOC concentrations indicate that residual drilling fluid is being removed from the well screen. These data indicate that even though the yield is somewhat lower at screen 4, it appears to be functioning as a representative regional aquifer monitoring point.

Screening analytical data from samples collected during the specific capacity tests showed marked improvements in well screen analysis scores: from 82% to 99% for screen 2 and from 61% to 98% for screen 4. Overall, the analytical results and well screen analyses indicate that representative regional aquifer groundwater is beginning to be sampled at screens 2 and 4 at R-16. Analytical data from future sampling campaigns will continue to be evaluated to confirm these preliminary conclusions.

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1.0 INTRODUCTION

1.1 Purpose and Objectives

This report summarizes the R-16 well rehabilitation and conversion activities conducted by Los Alamos National Laboratory (LANL or the Laboratory) at well R-16 from April 16 to 17, 2009, and from July 10 to 18, 2009. The R-16 rehabilitation plans were presented in a letter to the New Mexico Environment Department (NMED) (LANL 2008, 102998). This approach superseded the "no-action" recommendation in the "Work Plan for R-Well Rehabilitation and Replacement, Revision 2" (LANL 2007, 098119) that had been previously approved by NMED (2007, 098182).

The objectives for the 2009 R-16 well rehabilitation were to

- remove the existing Westbay multiport sampling system,
- rehabilitate screens 2 and 4 using swabbing/bailing and jetting techniques,
- conduct postrehabilitation specific capacity tests at both screens,
- collect samples during the specific capacity tests to evaluate any changes in chemistry, and
- install a Baski dual-port sampling system for long-term monitoring of screens 2 and 4, thereby converting R-16 to a two-screen well from a three-screen well.

1.2 Background

R-16 is located east of the Laboratory boundary near the town of White Rock; it is downgradient of Technical Area 54 (TA-54) and west of the Rio Grande (Figure 1.2-1). The well was installed to provide water-quality, geochemical, hydrologic, and geologic information between TA-54 and the Rio Grande. The R-16 borehole was drilled in 2002 to a total depth of 1287 ft using fluid-assisted air-rotary and conventional mud-rotary techniques and was completed with four screened intervals in the regional aquifer (Figure 1.2-2). However, the upper screened interval is blocked by drill casing that could not be retracted following well installation, so R-16 has had three functioning screened intervals since 2002 (LANL 2006, 092737). A dedicated Westbay sampling system was installed in the well in 2002 after well completion.

1.2.1 Well Rehabilitation Pilot Study

A well rehabilitation pilot study was conducted at three regional aquifer wells drilled with mud-rotary techniques, including R-16, during 2006–2007. The original goal of the pilot study was to assess the effectiveness of aggressive redevelopment techniques in removing residual drilling fluids from the screened intervals of the three wells. This goal would be assessed by means of specific capacity test results and analytical data obtained before and after redevelopment. A secondary goal was to evaluate whether the Westbay type of sampling system, i.e., low-volume, no-purge, multiport systems, can provide representative data over time in these types of wells.

According to the "Pilot Well Rehabilitation Study Summary Report" (LANL 2007, 095889), rehabilitation would be considered successful if the following targets were achieved:

- a measured increase in specific capacity of at least 5% from predevelopment to postrehabilitation
- turbidity values less than 5 nephelometric turbidity units (NTUs)

- sulfate, sodium, manganese, and iron concentrations at or below background levels

The initial stage of the pilot study at R-16 consisted of 12-h specific capacity tests that were conducted on screens 2 and 4 on August 11 and 9, 2006, respectively (LANL 2007, 095889). Groundwater samples were collected for analysis of select parameters and particulates. In addition, field water-quality parameters were also measured over the course of the pumping tests. However, after the initial specific capacity tests had been conducted, the U.S. Department of Energy directed that no further redevelopment was necessary at that time because water-quality parameters had stabilized and the turbidity levels were less than 1 (LANL 2007, 095889). Therefore, no aggressive redevelopment or follow-on specific capacity tests were conducted at R-16. The Westbay system was reinstalled and continued to be used for periodic monitoring through November 2008.

1.2.2 2007 Well Screen Analysis

R-16 was also included in a 2007 study that evaluated potential residual effects from mud-rotary fluids on groundwater chemistry. The results of the study were presented in the “Well Screen Analysis Report, Revision 2” (LANL 2007, 096330). Specific geochemical parameters for each well screen were evaluated for representativeness and reliability by assessment tests. Screens were then scored by the percentages of parameters that met or passed their respective test criteria. At R-16, the three water-bearing zones were scored as follows: screen 2—82%, screen 3—82%, and screen 4—61%.

1.2.3 2009 Well Rehabilitation and Conversion

The Laboratory decided to conduct additional rehabilitation of screens 2 and 4 because of the key location of well R-16. Screen 2 monitors the shallow regional aquifer downgradient of TA-54, and screen 4 provides information about deeper flow paths that potentially could affect the Rio Grande or the Buckman well field, located east of the river. Because of the importance of obtaining representative hydrochemical data from these strategic zones in the regional aquifer, the Laboratory decided to rehabilitate screens 2 and 4 using more aggressive methods than the pumping performed during the 2006 pilot study and to convert the well to a dual-screen well with a Baski system. Screen 3 is positioned at a depth that is not critical for monitoring and will no longer be used.

2.0 REHABILITATION ACTIVITIES

The activities performed as part of the R-16 rehabilitation included

- removing the Westbay sampling system,
- redeveloping screens 2 and 4,
- performing specific capacity tests at screens 2 and 4, and
- collecting samples at screens 2 and 4 for laboratory analysis.

Installation of a dedicated Baski dual-screen sampling system for screens 2 and 4 at R-16 is pending final fabrication of the Baski system. After the installation of the Baski system, R-16 will effectively be converted to a two-screen monitoring well. No well screen abandonment (i.e., conversion using grout) took place at R-16, although screen 3 will be isolated with packers and will not be accessed with the permanent sampling system.

Following are brief descriptions of the rehabilitation activities.

2.1 Westbay Sampling System Removal

The Westbay MP55 sampling system installed in R-16 was removed between April 16 and 18, 2009. The task was supported by a Westbay technician and personnel from Boart Longyear, Inc., and was supervised by TerranearPMC. All Westbay components were successfully removed from the well. The packers, sampling ports, and polyvinylchloride (PVC) casing were decontaminated by high-pressure washing, air-dried, and staged for storage at a designated Laboratory location. The decontamination water was containerized and stored on-site for waste characterization. The Westbay retrieval report is included as Appendix A. The retrieval report describes field operations in detail and documents field measurements recorded during the retrieval process.

Because of the overall scheduling of well rehabilitation activities and the Westbay representative’s availability, there was a break in activities after the Westbay retrieval until July 10. The R-16 well was temporarily left with an inflatable packer set between screens 3 and 4 at a depth of 1104.5 ft below ground surface (bgs).

2.2 Video Logging

A downhole video log was planned to be run at R-16 to document well screen and casing conditions before rehabilitation activities; however, this task was not performed because of scheduling conflicts with other well-related activities. Rehabilitation of screens 2 and 4 was conducted as planned, and there was no evidence that either screen or casing was compromised. The Laboratory will make a video log of the well before installing the permanent sampling system to verify that the screens and casing are in good condition.

2.3 Rehabilitation of Screens 2 and 4

Rehabilitation of screens 2 and 4 was conducted between July 10 and July 13, 2009, and consisted of three activities: (1) swabbing and bailing the screened intervals, (2) high-velocity jetting with simultaneous pumping, and (3) final purge pumping during specific capacity testing.

2.3.1 Swabbing

Swabbing was conducted at screens 2 and 4 on July 10, 2009. Screen 4 was swabbed with a 4.5-in. outside diameter nylon surge block on a weighted static rod operated on a wireline. Swabbing consisted of running the tool up and down for 30 min over the entire length of screen 4. Approximately 10 up-and-down cycles per minute were achieved with the surge block. After swabbing, approximately 156 gal. of water was bailed from the well sump to remove accumulated sediment. Initially, the bailed water was highly turbid with silt-sized particles but cleared rapidly.

Screen 2 was swabbed for 40 min on July 11 using the same procedures. After swabbing, approximately 60 gal. of water was bailed from the sump and it was observed to be only slightly turbid.

Screen 4 was then swabbed a second time for an additional 11 min and was bailed briefly to loosen and remove any sediment that might have been carried down from screen 2 by the strong downward gradient in R-16. Bailed water was again noted as highly turbid initially but rapidly cleared within a few trips with the bailer. Approximately 72 gal. of water was bailed after the second swabbing of screen 4.

2.3.2 Simultaneous Jetting and Pumping

High-velocity jetting and pumping were conducted at screens 2 and 4 from July 11 to July 13, 2009. Jetting was accomplished with a nominal 20 gpm 10 hp submersible pump with a jetting tool attached above the pump discharge. The jetting tool directed a portion of water discharged from the pump through the screened interval and annulus. The remainder of the pump output was discharged to the surface to affect net removal of water and sediment from the well during the jetting process. In this way, the jetting effectiveness was enhanced by ensuring net removal of water from the screened zone throughout the redevelopment process, e.g., simultaneous jetting and pumping.

Under the head conditions in R-16, the actual pump discharge rate was estimated to be nearly 30 gpm. The pump and jetting tool were raised and lowered continuously throughout the well screen length while being rotated back and forth periodically to cover the entire screen surface. Jetting pressures achieved during these procedures ranged from about 330 to 350 psi.

During jetting at screen 4, the jetting tool was configured so that the majority of the water was discharged to the surface to overcome the higher yield and strong downward gradient from the screen 2 water-bearing zone. It was necessary to achieve a surface discharge rate greater than the screen 2 contribution; otherwise, only water from screen 2 would have been pumped from the well. The restricted nozzle size limited the discharge through the jetting tool to approximately 8 gpm, and the measured discharge rate at the surface averaged about 22 gpm during the jetting/pumping of screen 4. Screen 4 was pumped and jetted for 30 min on July 11 with a net discharge of 642 gal. Pumping and jetting continued at screen 4 on July 12 for 60 min with a net discharge of 1230 gal.

Screen 2 was developed with the jetting nozzles sized so that the pump output was split approximately evenly between the jetting tool and surface discharge. The number and size of the nozzles were governed by the anticipated pump discharge capacity and jet nozzle exit velocity at the prevailing head conditions in R-16. The discharge through the jetting tool was estimated to be slightly greater than 14 gpm. The measured discharge rate at the surface averaged about 14 gpm during the jetting/pumping of screen 2. Screen 2 was jetted for 89 min with a net discharge of 1246 gal. on July 12. The pumping and jetting assembly was removed from the well on July 13.

After jetting operations, a 4.28-in. gauge slug was run to the bottom of the well sump to confirm the well's inside diameter and, to some degree, alignment. The gauge slug passed to the bottom without incident.

2.3.3 Purging and Specific Capacity Testing

Baseline specific capacity values for the water-bearing zones at R-16 were established during the 2006–2007 pilot well rehabilitation study (LANL 2007, 095889). Therefore, initial specific capacity testing was not performed before the 2009 redevelopment activities.

Specific capacity testing was conducted at screen 4 on July 17 and at screen 2 on July 18. The tests were performed by installing a shrouded 4-in. submersible pump with inflatable packers above and below the pump to isolate the tested zone. A pressure transducer was installed between the pump and bottom packer to collect water-level data for specific-capacity determination. Table 2.3-1 presents the results of the 2009 specific capacity testing along with the 2006 pilot well rehabilitation test results.

Screen 2 Results

Screen 2 was pumped for 210 min on July 18, 2009, at 4.44 gpm with a drawdown of 49.2 ft, for a specific capacity of 0.090 gpm/ft. As indicated in Table 2.3-1, previous testing in 2006 showed a specific capacity of 0.085 gpm/ft, indicating that the 2009 measured specific capacity at screen 2 represents an improved yield of 6.2%. Although the 2009 specific capacity was slightly greater than the value measured in 2006, it is notable that the 2006 specific capacity was based on a substantially greater discharge rate (18 gpm vs. 4.44 gpm) and longer pumping time (720 min vs. 210 min). Increased turbulent flow associated with the greater discharge rate and the greater pumping time in 2006 would tend to bias the specific capacity downward compared with the recent data.

Screen 4 Results

As shown in Table 2.3-1, screen 4 was pumped for 265 min on July 17, 2009, at 2.31 gpm with a drawdown of 117.3 ft, for a specific capacity of 0.020 gpm/ft. The 2006 specific capacity result was 0.022 gpm/ft, indicating a net decrease of 9% in yield in 2009. It should be noted that of the 7.6 ft screened interval at screen 4, the 20/40 filter pack is present only in the top 0.7 ft with borehole slough in direct contact with the lower part of the screen (Figure 1.2-2). It is probable that the slough around the screened interval is preventing an accurate measurement of true formation yield from screen 4 and likely accounts for the overall low yield seen at screen 4 in 2006 and 2009.

In addition, there was a continuous decline in specific capacity over time at screen 4 in both the 2006 and 2009 tests. This effect is likely caused by reduced permeability in the near-well sediments caused by hydraulic compaction from the large drawdown applied to the zone. This effect has been seen in other wells where very large drawdown is imposed. Incremental compaction and permeability reduction during the 2009 testing accounted for a portion of the shortfall in specific capacity compared with the 2006 level.

Static Water Levels

The composite static water level measured in R-16 at the conclusion of testing on July 18 was 641.6 ft bgs. Head data measured in screen 2 showed a water-level rise of 21.9 ft when the isolation packers were inflated, making the screen 2 static water level 619.7 ft bgs. Similar observations for screen 4 showed a head decline of 67.9 ft, making its static water level 709.5 ft bgs.

Purge Cleanup

Purge cleanup was performed following specific capacity testing at both screens 2 and 4. The strong downward gradient from screen 2 in R-16, combined with specific capacity testing procedures, should have effectively cleared turbid water in the blank casing beneath screen 2. Therefore, final purging was conducted to clear sediment-laden water above screen 2 by raising the pump intake to approximately 146 ft above screen 2 (717 ft bgs). The pump was operated long enough to discharge the volume of water between the static water level and the pump intake as well as the volume of water between the pump intake and the top of screen 2.

Temporary Packer Installation

After purge cleanup, an inflatable packer was installed between screens 3 and 4 at R-16 at a depth of 1105.0 ft bgs.

3.0 WATER QUALITY

Table 3.0-1 shows the sample collection objectives for R-16 screens 2 and 4 during well rehabilitation and the constituents to be measured in the field and in laboratory analysis. Samples were submitted to the Laboratory’s Geology and Geochemistry Research Laboratory (GGRL) for the performance suite, or screening analyses, identified in Table 3.0-1.

3.1 Sample Collection and Analytical Techniques

Samples were collected during specific capacity testing from both screens 2 and 4 as shown in Table 3.1 1. Field parameters consisting of pH, dissolved oxygen (DO), temperature, specific conductance (SC), and oxidation-reduction potential (ORP) were measured using a multimeter YSI 650 MDS flow-through cell during sample collection. A 2100P HACH kit was used to take turbidity measurements.

Two equipment rinsate blanks (CAMO-09-9321 and CAMO-09-9322) and two field blanks (CAMO 09 9309, screen 2 and CAMO-09-9320, screen 4) were collected. Two duplicate quality control (QC) samples (CAMO-09-9318 and CAMO-09-9319) were collected for the primary samples CAMO 09 9312 and CAMO-09-9313, respectively, from screen 4. For screen 2, two duplicate QC samples (CAMO-09-9307 and CAMO-09-9308) were collected for the primary samples CAMO-09-9301 and CAMO-09-9302, respectively.

Screening analyses were conducted by GGRL for major anions, major cations, metals, sulfide, alkalinity, and total organic carbon (TOC). Primary samples were filtered through 0.45-μm Geotech disposable filters before analysis for metals, trace elements, and major anions. Nonfiltered primary and duplicate groundwater samples were also analyzed for major cations, trace elements, and metals. All samples were acidified with analytical-grade nitric acid to a pH of 2.0 or less for metal and major cation analyses. The field blanks were analyzed for the above constituents. Nonfiltered samples collected for total sulfide analysis were preserved with a buffer consisting of sodium hydroxide, ethylenediaminetetraacetic acid, and ascorbic acid. Samples collected for TOC analysis were not filtered or acidified.

Screening analyses of water samples used U.S. Environmental Protection Agency (EPA) techniques. Ion chromatography (EPA Method 300, Rev. 2.1) was the analytical method for bromide, chloride, fluoride, nitrate, nitrite, oxalate, phosphate, and sulfate. Total sulfide was determined by ion selective electrode with a detection limit of 0.010 ppm. Inductively coupled (argon) plasma optical emission spectroscopy (ICPOES) (EPA Method 200.7, Rev. 4.4) was used for analyses of dissolved aluminum, barium, boron, calcium, total chromium, iron, lithium, magnesium, manganese, potassium, silica, sodium, strontium, titanium, and zinc. Dissolved aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, cesium, chromium, cobalt, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, rubidium, selenium, silver, thallium, thorium, tin, vanadium, uranium, and zinc were analyzed by inductively coupled (argon) plasma mass spectrometry (ICPMS) (EPA Method 200.8, Rev. 5.4). The precision limits (analytical error) for major ions and trace elements were generally less than ±7% using ICPOES and ICPMS. Total carbonate alkalinity (EPA Method 310.1) was measured using standard titration techniques on nonfiltered samples as specified by the EPA. Analyses of TOC were performed following EPA Method 415.1. Charge balance errors for total cations and anions were generally less than ±2% for complete analyses of the above inorganic chemicals.

3.2 Analytical Results

Screening analytical results for screen 2 and screen 4 samples collected during the specific capacity tests are summarized below.

3.2.1 Screen 2 Analytical Results

Field Parameters

Field parameters measured between 2004 and 2008 as well as during the 2009 rehabilitation are provided in Table 3.2-1 and shown in Figure 3.2-1. Field pH varied slightly from 7.79 to 8.44 standard units (SU); temperature varied from 19.6°C to 24.3°C. Specific conductivity ranged from 473 to 534 microsiemens/centimeter (µS/cm), and DO varied from 5.77 to 6.83 mg/L. ORP measurements fluctuated between 67.6 and 103.0 millivolts (mV). Turbidity ranged from 5.11 NTUs at the beginning of sampling to a low of 0.40 NTU near the end. It should be noted that one turbidity reading was recorded at 5.21 NTUs 1 h into the specific capacity test (Table 3.2-1). However, this reading is highly suspicious because it is bracketed by readings of 1.51 NTUs and, as previously stated, only one other reading was above 5 NTUs, and it was the first measurement at 5.11 NTUs.

As shown in Figure 3.2-1, overall values for specific conductance were higher after rehabilitation at screen 2 in comparison to samples collected previously. ORP values were lower than those measured before rehabilitation. Temperature, pH, and DO concentrations were essentially equivalent before and after rehabilitation. Turbidity values were initially higher at the beginning of pumping, but over the course of the 210-min specific capacity test, they returned to below 1 NTU.

Major Anions

Complete analytical results for the GGRL screening analyses, including major anions, are shown in Table B-1 of Appendix B. Total carbonate alkalinity concentrations ranged from 102 milligrams of carbonate+bicarbonate per liter (mgCO3+HCO3/L) to 106 mgCO3+HCO3/L at screen 2 after rehabilitation (Figure 3.2-2). These values are below the maximum background concentration of total carbonate alkalinity within the regional aquifer of 152 mgCO3+HCO3/L (LANL 2007, 095817). Concentrations of total carbonate alkalinity ranged between 67.5 to 150.4 mgCO3+HCO3/L during the previous sampling before the 2009 rehabilitation.

Dissolved nitrite plus nitrate(N) concentrations varied from 0.49 to 0.51 mg/L at screen 2 during the purging This is below the maximum background concentration for dissolved nitrate plus nitrite (N) of 1.05 mg/L within the regional aquifer (LANL 2007, 095817). In previous samples from screen 2 collected before the 2009 rehabilitation, concentrations of this solute were generally not detected, but when present, concentrations ranged from 0.004 to 0.35 mg/L (LANL 2007, 096330).

Dissolved chloride concentrations varied from 3.0 to 3.1 mg/L at screen 2 and were below the maximum background concentration of dissolved chloride (5.95 mg/L) in the regional aquifer (LANL 2007, 095817).

Dissolved sulfate concentrations were 4.27 to 4.29 mg/L at screen 2 and were below the maximum background concentration for dissolved sulfate (8.63 mg/L) within the regional aquifer (LANL 2007, 095817). These concentrations are within the range of previous sulfate concentrations measured at screen 2 (Figure 3.2-2). Total sulfide concentrations were less than the analytical detection limit (0.01 mg/L) (Table B-1).

TOC concentrations at screen 2 varied from 0.3 to 0.5 milligrams of carbon per liter (mgC/L) (Table B-1). The concentrations were less than the maximum background concentration in the regional aquifer of 1.37 mgC/L (LANL 2007, 095817). Historic TOC concentrations from four samples collected before the 2006 specific capacity testing averaged 1.83 mgC/L; three samples collected after the 2006 sampling averaged 0.68 mgC/L. The 2009 average of 0.4 mgC/L reflects a decreasing trend indicating that total carbon in residual drilling fluid is being removed from screen 2.

Major Cations

Complete analytical results for all cations at screen 2 are shown in Table B-1 of Appendix B. Major cation concentrations for calcium, sodium, magnesium and potassium are plotted in Figure 3.2-3. As the figure shows, calcium concentrations in 2009 were slightly higher than the overall trend shown previously, and sodium concentrations were lower overall in the 2009 sampling than sodium concentrations obtained previously. Potassium and magnesium showed essentially the same concentrations before and after the 2009 rehabilitation.

Dissolved calcium concentrations ranged from 20.2 to 20.8 mg/L in 2009, which is below the maximum background concentration for dissolved calcium (41.70 mg/L) within the regional aquifer (LANL 2007, 095817).

Dissolved sodium concentrations ranged from 12.13 to 12.63 mg/L at screen 2 during the 2009 pumping. These levels are below the maximum background concentration of dissolved sodium (32.90 mg/L) within the regional aquifer (LANL 2007, 095817).

Trace Elements

Complete analytical results for all metals at screen 2 are shown in Table B-1 of Appendix B. Mean, median, and maximum background total dissolved iron concentrations are 19.32, 9.5, and 147 μg/L, respectively, within the regional aquifer (LANL 2007, 095817). Dissolved iron concentrations at screen 2 varied from 18.98 to 41.69 μg/L during 2009 pumping (Figure 3.2-4, Table B-1), below the maximum background concentration for iron of 147 μg/L. The ratio of total iron to dissolved iron in groundwater samples collected from R-16 screen 2 remained fairly constant during the 2009 pumping.

Mean, median, and maximum background total dissolved manganese concentrations are 7.55, 1.0, and 124 μg/L, respectively, within the regional aquifer (LANL 2007, 095817). Total dissolved manganese concentrations varied from 4.07 to 4.55 μg/L during the 2009 pumping at screen 2 (Figure 3.2-4; Table B 1), below the median manganese concentration in the regional aquifer. As with iron, the ratio of total manganese to dissolved manganese in groundwater samples collected from R-16 screen 2 was constant.

Mean, median, and maximum background concentrations of total dissolved nickel are 2.14, 0.50, and 50 μg/L, respectively, within the regional aquifer (LANL 2007, 095817). Dissolved nickel concentrations were consistently slightly above 1 μg/L in 2009, on trend with previous very low concentrations of nickel at screen 2.

Dissolved and total zinc concentrations in the 2009 sampling were between 12 and 20 μg/L and 17 and 29 μg/L, respectively (Figure 3.2-4, Table B-1). These concentrations are below the maximum background concentration for total dissolved zinc of 32 μg/L in the regional aquifer (LANL 2007, 095817).

Summary for Screen 2

As a general guideline, no firm conclusions should be made regarding the efficacy of well rehabilitation until additional data are gathered for a minimum of a 6-mo period following the rehabilitation (LANL 2007, 095889). In addition, given that the 2009 screen 2 analytical results were generated in 3.5 h on a single day, caution should be taken when making any comparisons to previous data.

The following general observations can be made regarding the 2009 analytical results at screen 2 in comparison to the previous analytical data:

- Specific conductance and ORP values showed a response to 2009 rehabilitation (Figure 3.2-1). The specific conductance values had been essentially stable over time, with the exception of one uptick during the 12-h specific capacity test conducted on August 11, 2006; however, after the aggressive rehabilitation over a 3-d period in July 2009, specific conductance more than doubled in response. ORP values, in contrast, declined after rehabilitation. DO concentrations are within the range of background values.

- Anions appear to be more stable postrehabilitation in comparison to 2008 data. If the July 2009 trend continues, it appears that the purging and redevelopment may have affected stabilized anion values. Decreasing TOC concentrations over time indicate that total carbon in residual drilling fluid is being removed from screen 2.
- Cations at screen 2 had been rather stable since the August 2006 pilot study pumping. Calcium concentrations increased slightly and sodium values decreased during the 2009 rehabilitation.
- Trace element concentrations for filtered and nonfiltered iron, manganese, nickel and zinc at screen 2 have shown the most variability over time, particularly during the initial year of Westbay sampling and for approximately a year following the 2006 pilot study pumping. Concentrations of the four constituents stabilized in 2008. Postrehabilitation results indicate an increase in total zinc levels as well as filtered and unfiltered iron. The ratio of total-to-dissolved manganese has remained steady over time. However, the total-to-dissolved iron ratio has not been consistent. The two ratios together, if steady and within background range, can be an indicator of oxidizing conditions. Additional postrehabilitation samples will be required to assess the iron ratio indicator.
- Sulfate, sodium, manganese, and iron are all within their respective ranges of background concentrations, which the “Pilot Well Rehabilitation Summary Report” indicates is a goal for successful rehabilitation (LANL 2007, 095889). These are indicators that regional aquifer groundwater is reaching screen 2. Additional data will need to be taken over time and analyzed to evaluate if representative regional aquifer water continues to be drawn into screen 2.

3.2.2 Screen 4 Analytical Results

Field Parameters

The field parameters measured during 2009 rehabilitation are provided in Table 3.2-1. The 2009 field parameters are shown along with previous results in Figure 3.2-5. Field pH varied slightly from 8.29 to 8.49 SU and temperature varied from 21.41°C to 25.18°C. Specific conductivity varied from 501 to 580 µS/cm and DO varied from 4.40 to 5.50 mg/L. Turbidity varied from 15.7 NTUs near the beginning of the sampling to 0.89 NTU at the end, and ORP measurements varied from 50.5 mV at the beginning to 220.1 mV at the end. Groundwater pumped from screen 4 became increasingly oxidizing, based on DO and increasing ORP measurements.

Specific conductance and ORP values were higher after 2009 rehabilitation relative to previous analytical results from 2003 to 2008. Turbidity values initially increased after rehabilitation activities, declined, and then stabilized at slightly less than 1 NTU. Field pH and temperature values remained essentially the same before and after the 2009 activities. DO after rehabilitation was more stable and slightly higher than the majority of measurements taken since 2006.

Major Anions

Complete analytical results for the GGRL screening analyses of screen 4, including major anions, are shown in Table B-2 of Appendix B. Concentrations of total carbonate alkalinity varied from 106 to 113 $mgCO_3$+HCO_3/L at screen 4, which are below the maximum background concentration for total carbonate alkalinity within the regional aquifer of 152 $mgCO_3$+HCO_3/L (LANL 2007, 095817). Total carbonate alkalinity concentrations were more stable than those measured previously (Figure 3.2-6).

Dissolved concentrations of nitrite plus nitrate (N) varied from 0.52 to 0.57 mg/L at screen 4 during the 2009 pumping (Figure 3.2-6). This is below the background maximum for dissolved nitrate plus nitrite (N) of 1.05 mg/L within the regional aquifer (LANL 2007, 095817). Concentrations of this solute were between nondetected to 0.27 mg/L during the previous sampling at screen 4 (LANL 2007, 096330).

Dissolved sulfate concentrations were between 4.26 and 5.39 mg/L at screen 4 and are below the maximum background concentration for dissolved sulfate (8.63 mg/L) within the regional aquifer (LANL 2007, 095817). Dissolved sulfate concentrations before the 2009 pumping ranged from a high of over 50 mg/L during initial sampling in 2004 down to average readings less than 10 mg/L in 2006 through 2008 (Figure 3.2-6). Total sulfide concentrations were less than analytical detection (0.010 mg/L).

Dissolved chloride concentrations varied from 3.51 to 3.58 mg/L at screen 4, below the maximum background concentration of dissolved chloride (5.95 mg/L) in the regional aquifer (LANL 2007, 095817). These values are within the range of previously measured chloride concentrations at screen 4.

TOC concentrations varied from 0.3 to 0.5 mgC/L at screen 4 during the 2009 pumping (Table B-2). One sample initially reported an anomalously high TOC concentration of 11.4 mgC/L; reanalysis of the sample resulted in a concentration of 0.4 mg/L, in line with the other TOC readings obtained from screen 4 and is therefore the value being reported from the screening analysis. The concentrations are less than the maximum background concentration in the regional aquifer of 1.37 mgC/L (LANL 2007, 095817). Historic TOC concentrations from four samples collected before the 2006 specific capacity testing averaged 2.21 mgC/L; three samples collected after the 2006 sampling averaged 0.96 mgC/L. The 2009 average of 0.4 mgC/L reflects a decreasing trend, indicating that total carbon in residual drilling fluid is being removed from screen 4.

Major Cations

Complete analytical results for all cations at screen 4 are shown in Table B-2 of Appendix B. Major cation concentrations for calcium, sodium, magnesium, and potassium for both Westbay and 2009 rehabilitation sampling are plotted in Figure 3.2-7. Calcium and sodium are the dominant cations present in the regional aquifer at screen 4. During the 2009 pumping, dissolved calcium concentrations ranged from 20.4 to 21.0 mg/L at screen 4 and were slightly lower than previous calcium concentrations (Figure 3.2-7) (LANL 2007, 096330). The 2009 values are below the maximum background dissolved calcium concentration (41.70 mg/L) within the regional aquifer (LANL 2007, 095817).

Dissolved sodium concentrations ranged from 12.61 to 13.03 mg/L at screen 4 during the 2009 pumping and are also below the maximum background dissolved sodium concentration (32.90 mg/L) within the regional aquifer (LANL 2007, 095817). Slightly higher concentrations of dissolved sodium were measured during the previous sampling (LANL 2007, 096330).

Trace Elements

Complete analytical results for all metals at screen 4 are shown in Table B-2 of Appendix B. Mean, median, and maximum background concentrations of total dissolved iron are 19.32, 9.50, and 147 μg/L, respectively, within the regional aquifer (LANL 2007, 095817). Total dissolved concentrations of iron varied from 18.98 to 41.69 μg/L during the May 2009 postrehabilitation pumping at screen 4 (Figure 3.2-8; Table B-2) and are below the maximum background concentration for dissolved iron. The ratio of total iron to dissolved iron in groundwater samples collected from screen 4 remained fairly constant during pumping. Dissolved iron concentrations were higher and varied considerably more during previous sampling at screen 4 (LANL 2007, 096330).

Mean, median, and maximum background concentrations of dissolved manganese are 7.55, 1.0, and 124 µg/L, respectively, within the regional aquifer (LANL 2007, 095817). Dissolved manganese concentrations varied from 4.07 to 4.55 µg/L during the June 2009 pumping at screen 4 (Figure 3.2-8; Table B-2) and are below the median background concentration for dissolved manganese. By comparison, concentrations of dissolved manganese were higher and more variable between mid-2006 and 2008 at screen 4 (LANL 2007, 096330).

Mean, median, and maximum background concentrations of total dissolved nickel are 2.14, 0.50, and 50 µg/L, respectively, within the regional aquifer (LANL 2007, 095817). Total and dissolved concentrations of nickel measured at screen 4 over time are plotted in Figure 3.2-8. As shown in this figure, dissolved concentrations of nickel ranged between 1 and 2 µg/L during the 2009 pumping and were in line with previously detected low nickel concentrations (Table B-2; Figure 3.2-8).

Dissolved concentrations of zinc varied from 35.41 to 57.90 µg/L during the 2009 pumping at screen 4 (Figure 3.2-8; Table B-2) and exceeded the maximum background concentration of dissolved zinc (32 µg/L) in the regional aquifer (LANL 2007, 095817). Dissolved zinc concentrations showed much greater variability previously and fluctuated from a high of approximately 200 µg/L immediately after the 2006 pilot study pumping to between approximately 5 and 11 µg/L since that time (LANL 2007, 096330). It is anticipated that zinc concentrations will once again decrease and stabilize following the 2009 rehabilitation activities.

Summary for Screen 4

As a general guideline, no firm conclusions should be made regarding the efficacy of well rehabilitation until additional data are gathered for a minimum of 6 mo after the rehabilitation (LANL 2007, 095889). In addition, given that the 2009 screen 4 analytical results were generated in 4.3 h on a single day, caution should be taken when making any comparisons to previous data.

The following general observations can be made regarding the 2009 analytical results at screen 4 in comparison to the previous analytical data.

- Both specific conductance and ORP values increased in response to 2009 rehabilitation (Figure 3.2-5). The specific conductance values had shown some variability over time; however, after the rehabilitation over a 3-d period in July 2009, specific conductance almost doubled in response. ORP values increased as well, reaching a maximum of approximately 200 µS/cm at the end of testing. Increasing ORP values indicate that oxidizing water is being drawn into the well screen. DO levels were within the range of background concentrations for the regional aquifer, also indicating oxidizing conditions.
- Alkalinity appears to be more stable post-2009 rehabilitation in comparison to 2008 data. Chloride, nitrate plus nitrite (N), and sulfate concentrations remained steady and similar to prerehabilitation values. Decreasing TOC concentrations over time indicate that total carbon in residual drilling fluid is being removed from screen 4.
- Calcium and sodium concentrations declined after rehabilitation and appear to be more stable.
- Trace element concentrations for filtered and nonfiltered iron, manganese, nickel, and zinc at screen 4 have shown the most variability over time, particularly after the 2006 pilot study pumping and continuing into 2008. Postrehabilitation results indicate an increase in total and dissolved zinc levels as well as filtered iron. The ratio of total to dissolved manganese has remained steady over time. The total-to-dissolved iron ratio postrehabilitation appears to be consistent. The two ratios

together, if steady and within background concentrations, can be an indicator of oxidizing conditions. Additional postrehabilitation samples will be required to assess this indicator.

- Sulfate, sodium, manganese, and iron are all within their respective ranges of background concentrations, which the “Pilot Well Rehabilitation Summary Report” indicates is a goal for successful rehabilitation (LANL 2007, 095889). These are indicators that regional aquifer groundwater is reaching screen 4. Additional data will be taken over time and analyzed to evaluate if representative regional aquifer water continues to be drawn into screen 4.

4.0 UPDATED WELL SCREEN ANALYSIS

4.1 Screen 2

The 2007 “Well Screen Analysis Report, Revision 2” (LANL 2007, 096330) gave screen 2 at R-16 an overall score of 82%. Analytical results for a variety of metals, anions, cations, and ORP did not meet the criteria for various well screen analysis tests. However, the 2009 screening analytical results for four samples indicate that screen 2 now has an updated well screen analysis score of 99% with only one parameter, turbidity, reporting a value out of the target test range (Appendix C, Table C-1). As mentioned in section 3.2.1, that turbidity reading of 5.21 NTUs was recorded 1 h into the specific capacity test and is actually higher than the first recorded turbidity reading of 5.11 NTUs.

4.2 Screen 4

The 2007 “Well Screen Analysis Report, Revision 2” (LANL 2007, 096330) gave screen 4 at R-16 an overall score of 61%. Analytical results for a variety of metals, anions, and ORP did not meet the criteria for various well screen analysis tests. However, the 2009 screening analytical results for four samples indicate that screen 4 now has an updated well screen analysis score of 98% with only one parameter, zinc, exceeding its target threshold value.

5.0 DEDICATED SAMPLE SYSTEM INSTALLATION

At the time of this report, one inflatable packer is set at R-16 between screens 3 and 4 at a depth of 1105.0 ft bgs. R-16 will be outfitted with a Baski-designed sampling system utilizing a single submersible pump for both screens 2 and 4. (Figure 5.0-1).The Baski system will utilize pneumatically actuated access port valves (APVs). The APVs will be actuated using compressed gas from the ground surface. The submersible pump will be an environmentally retrofitted 4-in. Grundfos pump that will be sized on the basis of the specific capacity results. Two inflatable packers will be installed between the two sampling intervals. The 1-in. drop pipe will consist of threaded schedule 40 Type 304 nonannealed pipe meeting the requirements of American Society for Testing and Materials Standard A 554 for welded stainless-steel mechanical tubing. The thread design will be American Petroleum Institute 10 Round Non-Upset Casing Threads. Two dedicated 1-in. PVC transducer tubes will be installed with and banded to the pump column. The transducer tube that will monitor screen 4 will terminate above the pump but will have a flexible tube that will pass through the pump shroud and packers to monitor water levels in screen 4.

6.0 SUMMARY AND CONCLUSIONS

6.1 Summary

The rehabilitation of R-16 screens 2 and 4 was conducted successfully and the following project objectives were achieved.

- The Westbay system was removed successfully.
- Screens 2 and 4 were redeveloped by swabbing/bailing, jetting and simultaneous pumping, and purging.
- Specific capacity tests were performed at screens 2 and 4.
- Samples were collected for field parameters and cations, anions, sulfide, TOC, and metals. An updated well screen analysis was performed to evaluate the analytical data.
- The well will be fitted with Baski-designed dual-port sampling system utilizing a single submersible pump for both screens 2 and 4. Screen 3 will be isolated with inflatable packers above and below the screen.

6.2 Deviations from Plan

The following deviations occurred during the R-16 well rehabilitation activities.

- A video log was not taken before specific capacity testing because of scheduling conflicts with other well-related activities. However, the rehabilitation activities were conducted as planned with no adverse effects. A video log will be taken before installation of the Baski-sampling system.
- As shown in Table 3.0-1, the plan was to measure iron and manganese colloids by sequential filtration to determine their contributions to bulk groundwater chemistry. These data were not collected because of modified sampling equipment. The project team originally planned to use this information to evaluate potential chemical effects on groundwater from a mild steel drop pipe used during sample collection. However, the use of a stainless-steel drop pipe precluded the need to collect the colloid data.
- Ferrous iron was to be measured as a field parameter during sampling, again in relation to evaluating sampling from a mild steel drop pipe. The use of a stainless-steel pipe precluded the need for these data as well.

6.3 Conclusions

The following preliminary conclusions can be made from the R-16 rehabilitation activities.

- Specific capacity tests
    - ❖ The overall yield at screen 2 improved by 6.2% over the specific capacity tests conducted in 2006, thereby slightly exceeding the goal of 5% improvement established for the pilot well rehabilitation project in 2006 (LANL 2007, 095889).
    - ❖ The yield at screen 4 decreased by 9% over the 2006 testing. However, the measured yield at screen 4 is generally low and is likely the result of slough across the screened interval combined with reduced permeability effects caused by hydraulic compaction of near-well sediments.

- Analytical results
    - Sulfate, sodium, manganese and iron concentrations at both screens 2 and 4 were within the range of their respective background concentrations. Turbidity levels declined to less than 1 NTU by the end of the specific capacity testing at both screens. The values of these parameters satisfy the guidelines for successful rehabilitation set forth in the 2006 well rehabilitation pilot study (LANL 2007, 095889).
    - Analytical results from screen 2 are somewhat mixed with respect to increasing oxidizing conditions. A stable total-to-dissolved manganese ratio, DO levels within background range, and declining TOC concentrations contrast with an inconsistent total-to-dissolved iron ratio and lower overall ORP concentrations. These mixed postrehabilitation results indicate that regional aquifer water is likely mixing with water still affected by residual drilling fluids. Additional data collection and analysis will help to evaluate water quality at screen 2.
    - Analytical results from screen 4 are more positive but not conclusive at this point. ORP, sulfate concentrations, and DO values are all indicative of a relatively oxidizing environment. Declining TOC concentrations indicate that residual drilling fluid is being removed from the well screen. These data indicate that even though the yield is somewhat compromised at screen 4, it appears to be functioning as a representative regional aquifer monitoring point. Continued sampling and analysis are needed to confirm these preliminary observations.
- Well screen analysis
    - Screening analytical data from samples collected during the specific capacity tests showed marked improvements in well screen analysis scores: from 82% to 99% for screen 2 and from 61% to 98% for screen 4. An anomalous turbidity value in screen 2 and zinc concentrations in screen 4 were the only constituents that exceeded test criteria at the two screens. Given that zinc concentrations were elevated after the 2006 pilot study and then steadily declined to below background, it is likely that a decline in zinc will occur over time at screen 4.

Overall, the analytical results and well screen analyses indicate that representative regional aquifer groundwater is beginning to be sampled at screens 2 and 4 at R-16. The use of a submersible pump with the Baski dual-port sampling system should allow sufficient water to be purged before sample collection to continue to draw regional groundwater into the well screens during sampling. Analytical data from future sampling campaigns will need to continue to be evaluated to confirm these preliminary conclusions.

7.0 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. This information is also included in text citations. ER IDs are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

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

LANL (Los Alamos National Laboratory), June 2003. "Characterization Well R-16 Completion Report," Los Alamos National Laboratory document LA-UR-03-1841, Los Alamos, New Mexico. (LANL 2003, 076061)

LANL (Los Alamos National Laboratory), June 2006. "Well Rehabilitation Pilot Study Execution Plan," Los Alamos National Laboratory document LA-UR-06-3874, Los Alamos, New Mexico. (LANL 2006, 092737)

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LANL (Los Alamos National Laboratory), March 2007. "Pilot Well Rehabilitation Study Summary Report," Los Alamos National Laboratory document LA-UR-07-1640, Los Alamos National Laboratory. (LANL 2007, 095889)

LANL (Los Alamos National Laboratory), May 2007. "Well Screen Analysis Report, Revision 2," Los Alamos National Laboratory document LA-UR-07-2852, Los Alamos, New Mexico. (LANL 2007, 096330)

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LANL (Los Alamos National Laboratory), September 12, 2008. "Well Rehabilitation Plan for Fiscal Year 2009," Los Alamos National Laboratory letter (EP2008-0497) to J.P. Bearzi (NMED-HWB) from S. Stiger (LANL) and D. Gregory (DOE-LASO), Los Alamos, New Mexico. (LANL 2008, 102998)

NMED (New Mexico Environment Department), August 20, 2007. "Approval of the Workplan for R-Well Rehabilitation and Replacement, Revision 2," New Mexico Environment Department letter to D. Gregory (DOE-LASO) and D. McInroy (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2007, 098182)

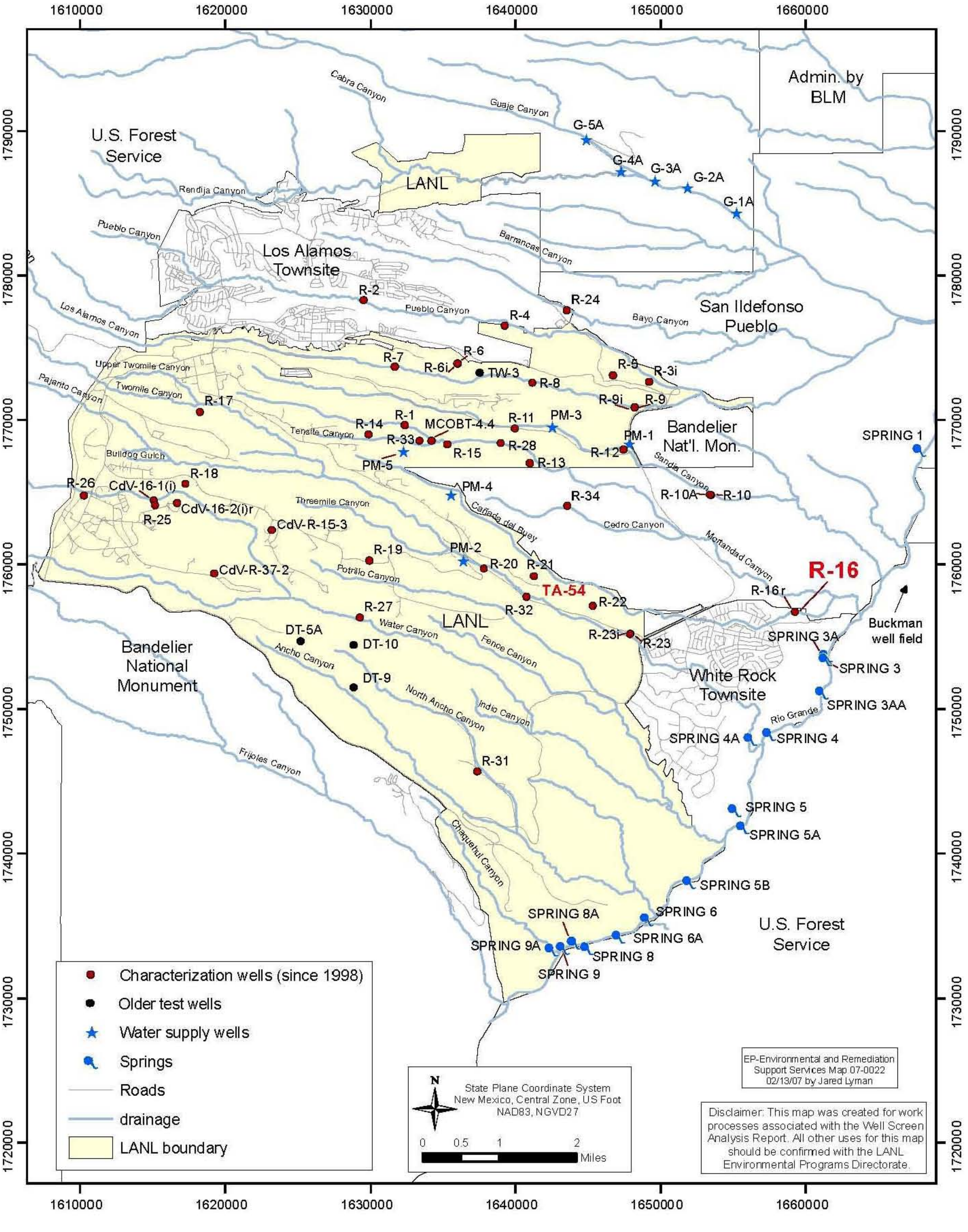
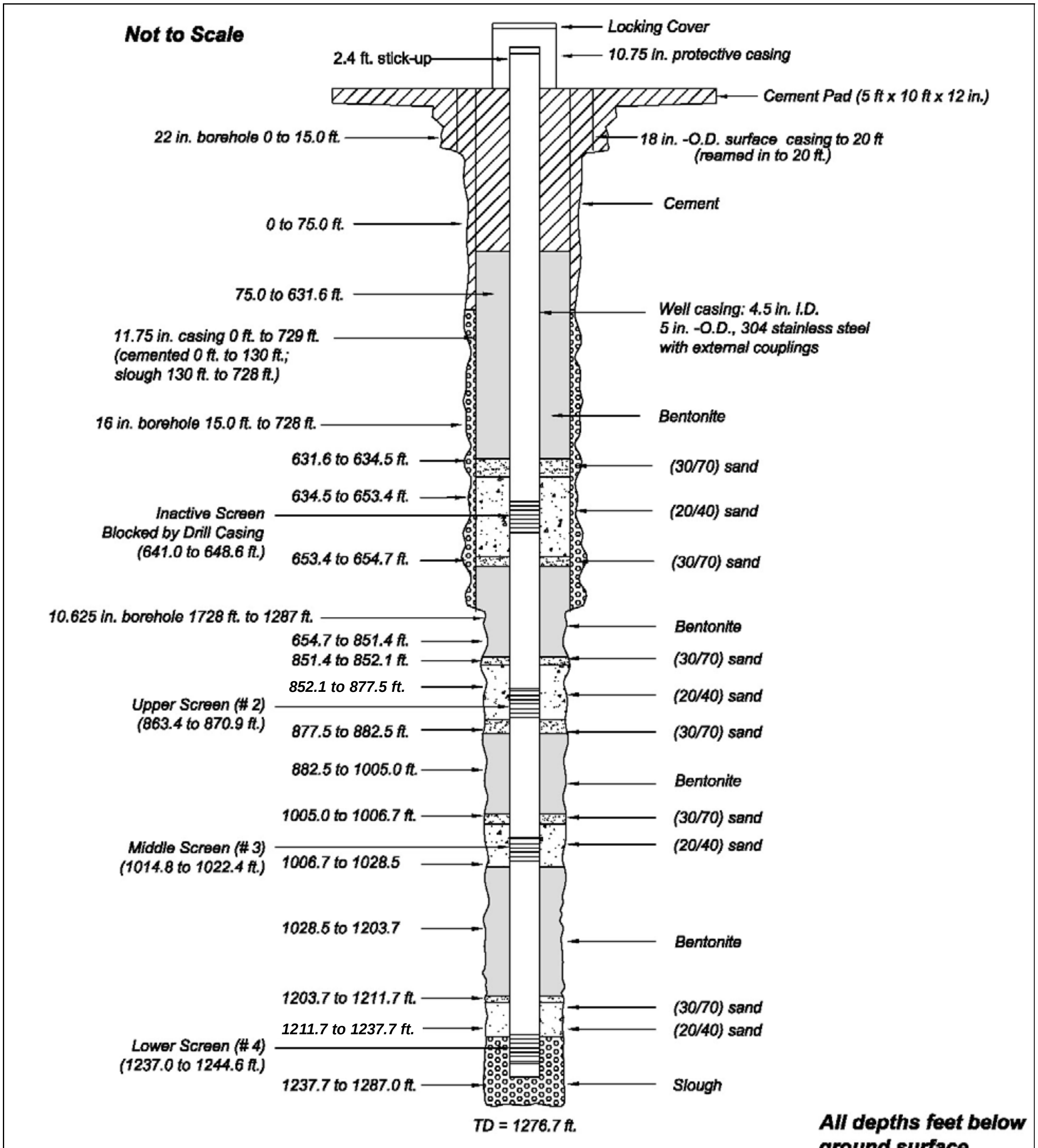


Figure 1.2-1 R-16 site location map



NOTES: 1) This Figure is from "Characterization Well R-16 Completion Report", June 2003, LA-UR-03-1841.
2) Depths for screens are for actual screen intervals, not joints.

Source: LANL (2003, 076061).

Figure 1.2-2 R-16 well construction diagram

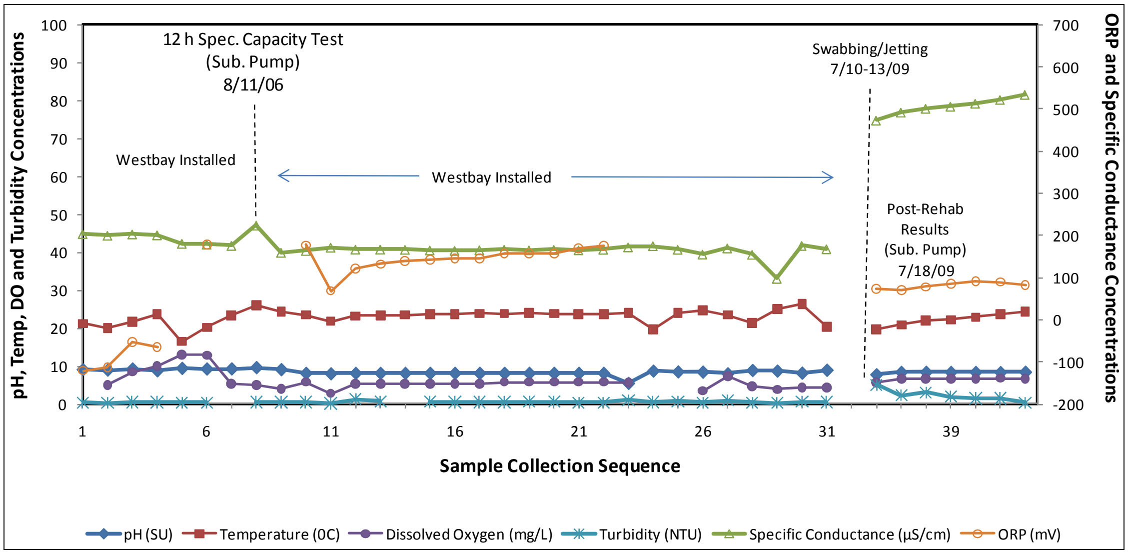


Figure 3.2-1 R-16 screen 2 field parameters

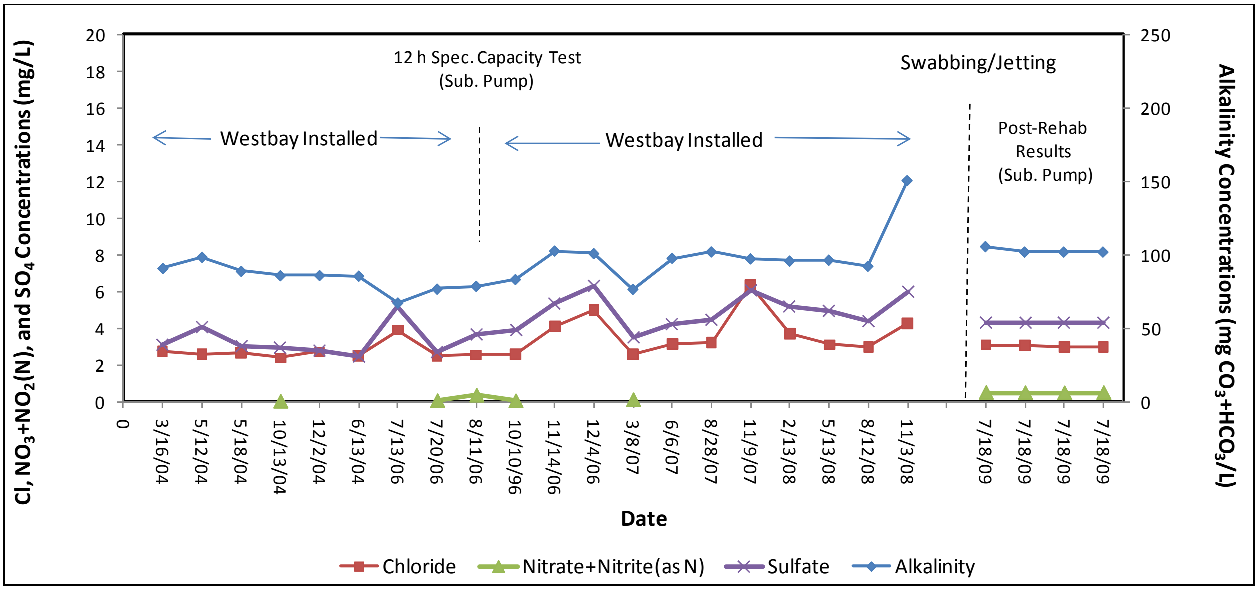


Figure 3.2-2 R-16 screen 2 major anions

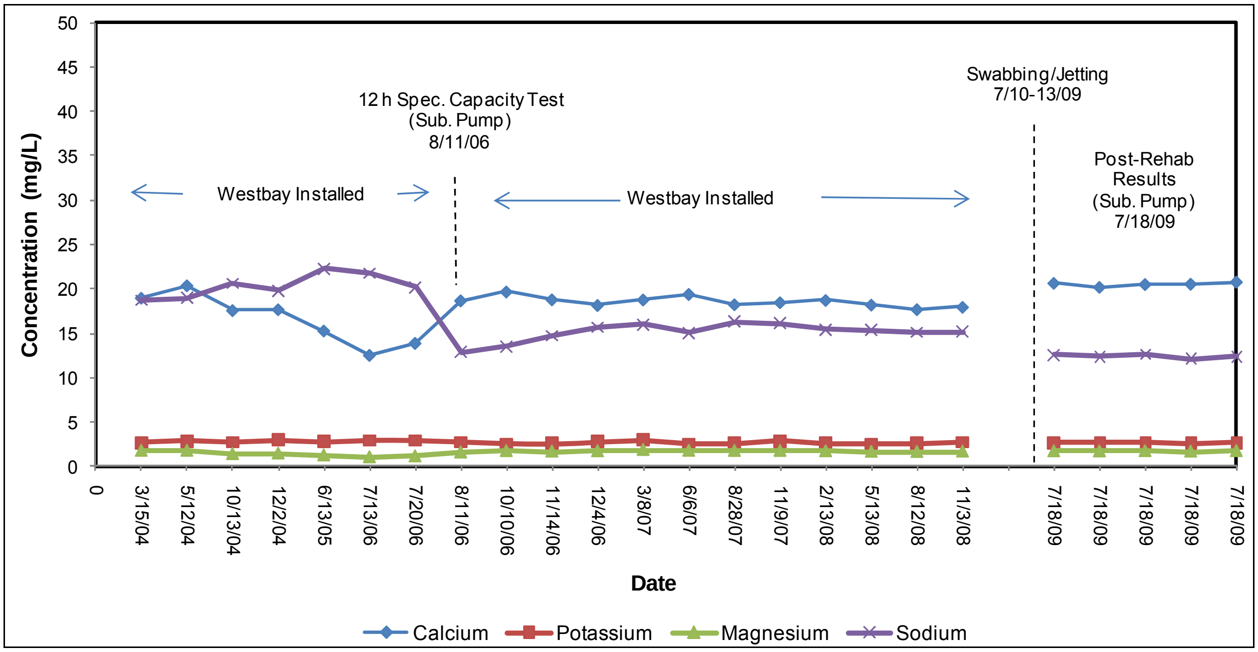


Figure 3.2-3 R-16 screen 2 major cations

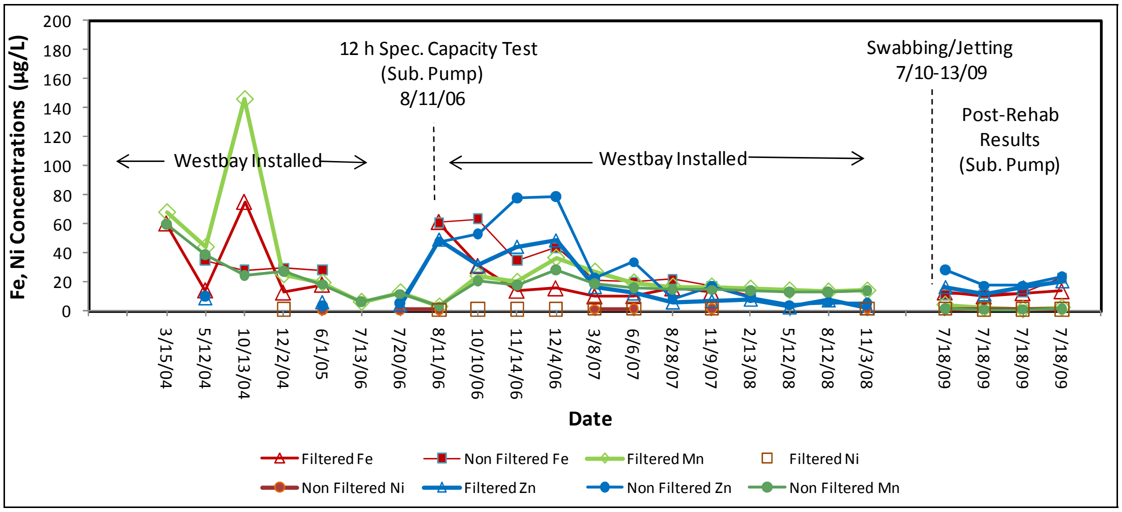


Figure 3.2-4 R-16 screen 2 trace elements

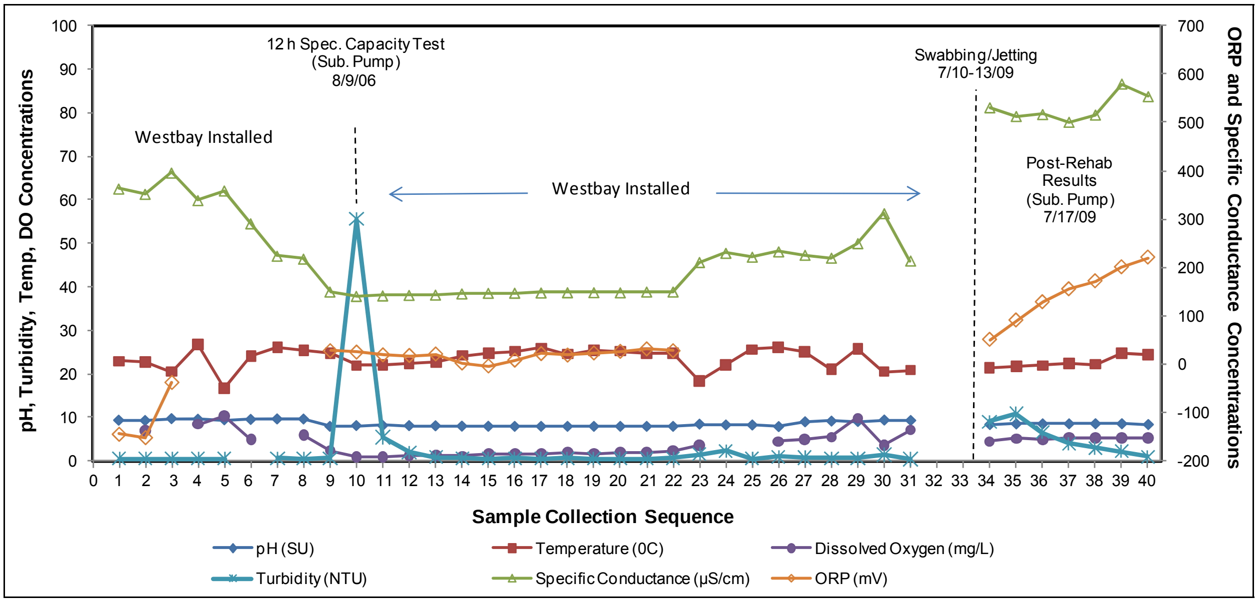


Figure 3.2-5 R-16 screen 4 field parameters

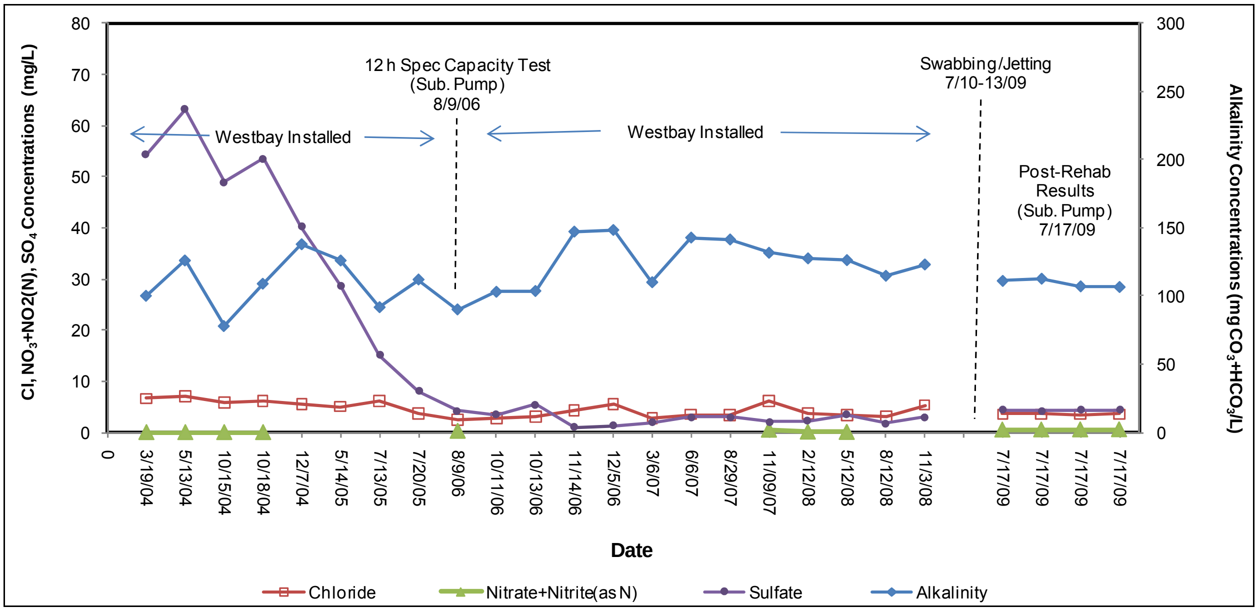


Figure 3.2-6 R-16 screen 4 major anions

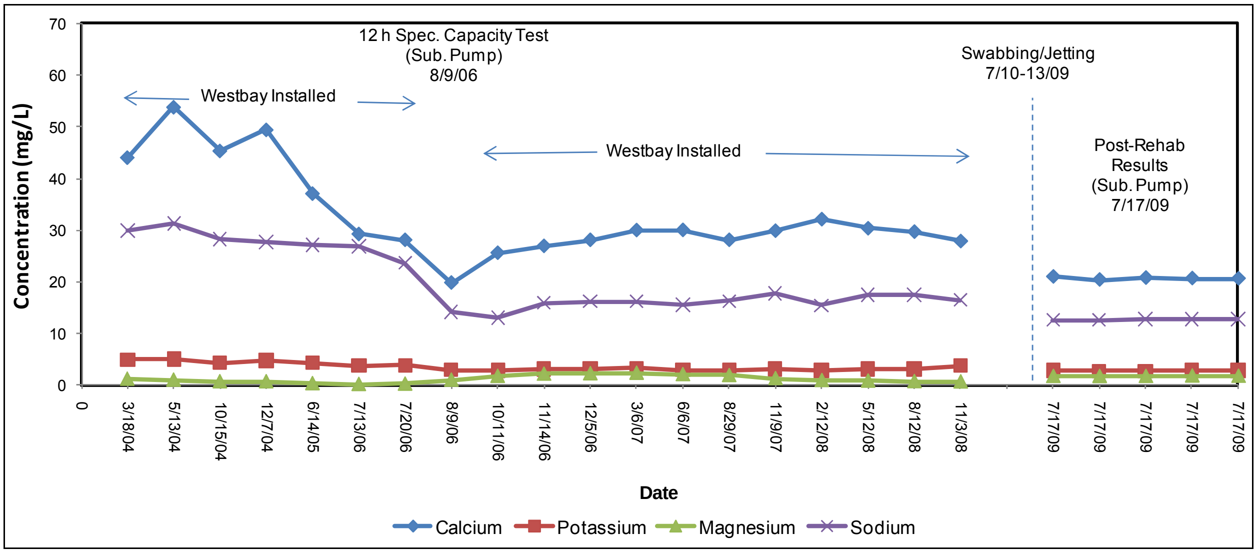


Figure 3.2-7 R-16 screen 4 major cations

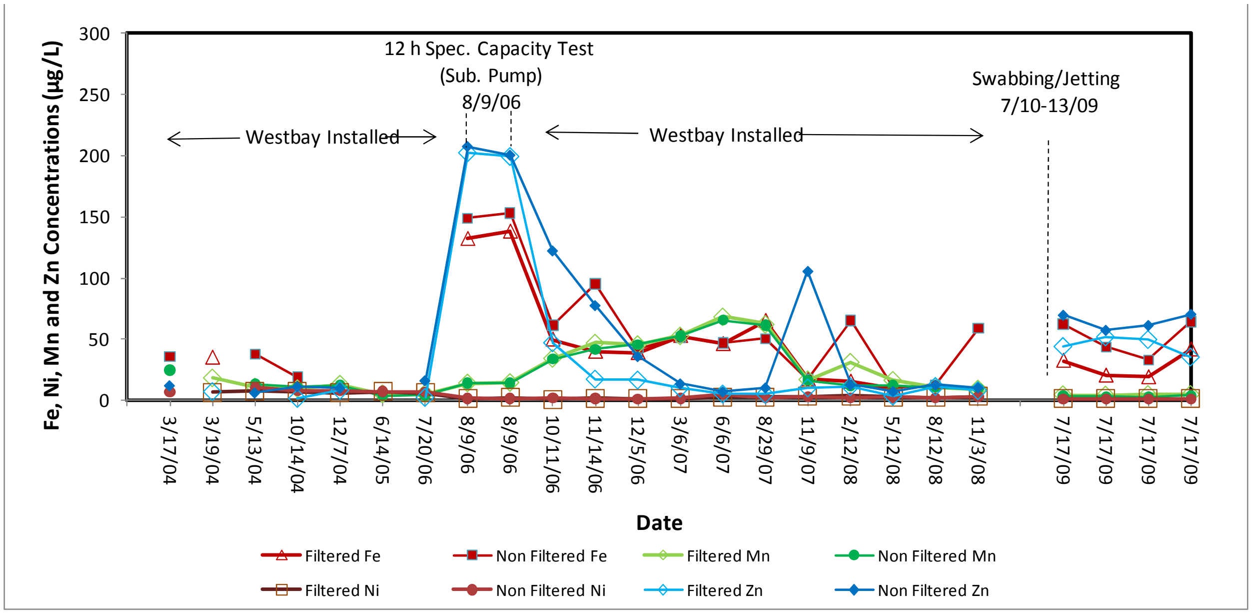


Figure 3.2-8 R-16 screen 4 trace elements

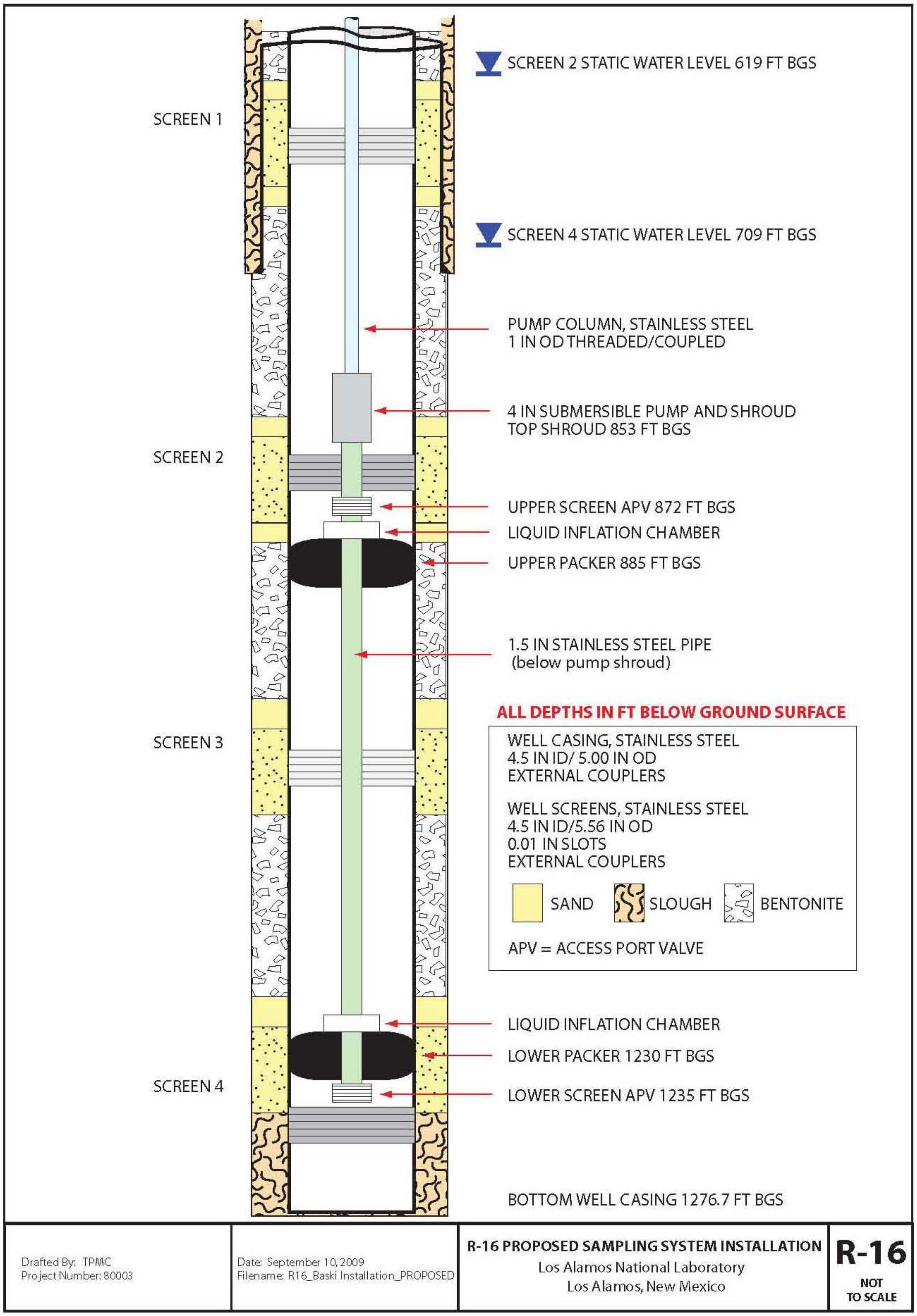


Figure 5.0-1 R-16 well schematic showing proposed Baski installation

Table 2.3-1

R-16 Screen 2 and 4 Specific Capacity Results

Screen Date	Pumping Time (min)	Average Pumping Rate (gpm)	Volume Pumped (gal.)	Drawdown (ft)	Specific Capacity (gpm/ft)	Percentage Change
Screen 2						
8-11-06	720	18.0	12,926	212	0.085	
7-18-09	210	4.44	943	49.2	0.0902	+6.2%
Screen 4						
8-09-06	720	6.0	4368	278	0.022	
7-17-09	265	2.31	612	117.3	0.020	-9.0%

Table 3.0-1

Sample Collection Objectives for R-16 Screens 2 and 4

Process/Step	Purpose	Sample Collection	Field Parameters	Frequency/ No. of Samples
Pump R-16 screens 2 and 4 (postrehab) to evaluate screen performance. In addition, measure iron and manganese colloids by sequential filtration.	Determine the contribution or iron and manganese colloids to bulk groundwater chemistry.	Sequential sampling through time for field parameters (time =0, 10, 15, 20, 25, 30, 40, 50, 60, 90, 120,150, 180 min); collect three primary performance suite samples, one at end of each hour of pumping test (time =60,120,180 min)	pH, ORP, T, SC, DO turbidity, and ferrous iron	As per sample collection, schedule until pumping is terminated.

Note: Performance suite: Sulfide (nonfiltered), TOC (nonfiltered), metals and cations (filtered and nonfiltered), alkalinity (nonfiltered), and anions; all analyses to be performed by the GGRL.

Table 3.1-1
Groundwater Sample Collection Information

Sample ID	Sampler Intake Dept (ft bgs)	Date	Time	Anions/Cations	TOC	Sulfide	Alkalinity	Metals	Notes
CAMO-09-9321	n/a	7/16/09	1030	1 ea.	2	1	1	1	Equipment Blank–pump assembly
CAMO-09-9322	n/a	7/16/09	1030	1 ea.	2	1	1	1	Equipment Blank–drop pipe
Screen 4									
CAMO-09-9318	1233.00	7/17/09	0840	1 ea.				1	QC sample–CAMO-09-9312
CAMO-09-9312	1233.00	7/17/09	0840	1 ea.				1	
CAMO-09-9319	1233.00	7/17/09	0840		2	1	1	1	QC sample–CAMO-09-9313
CAMO-09-9313	1233.00	7/17/09	0840		2	1	1	1	
CAMO-09-9320	n/a*	7/17/09	0940	1 ea.	2	1	1	1	QC sample–CAMO-09-9314
CAMO-09-9314	1233.00	7/17/09	0940		2	1	1	1	
CAMO-09-9315	1233.00	7/17/09	0940	1 ea.				1	
CAMO-09-9316	1233.00	7/17/09	1040		2	1	1	1	
CAMO-09-9317	1233.00	7/17/09	1040	1 ea.				1	
Screen 2									
CAMO-09-9307	861.53	7/18/09	0740		2	1	1	1	QC Sample–CAMO-09-9301
CAMO-09-9301	861.53	7/18/09	0740		2	1	1	1	
CAMO-09-9308	861.53	7/18/09	0740	1 ea.				1	QC Sample–CAMO-09-9302
CAMO-09-9302	861.53	7/18/09	0740	1 ea.				1	
CAMO-09-9309	n/a	7/18/09	0840	1 ea.	2	1	1	1	QC Sample–CAMO-09-9304
CAMO-09-9303	861.53	7/18/09	0840	1 ea.				1	
CAMO-09-9304	861.53	7/18/09	0840		2	1	1	1	
CAMO-09-9305	861.53	7/18/09	0940	1 ea.				1	
CAMO-09-9306	861.53	7/18/09	0940		2	1	1	1	

Note: Blank cells indicate that analyte suites were not planned for collection.

* n/a = Not applicable.

Table 3.2-1
Water-Quality Field Parameters during R-16 Rehabilitation

Date	Time	pH	Temp (°C)	DO (mg/L)	ORP (mV)	Specific Conductivity (µS/cm)	Turbidity (NTU)	Purge Volume between Samples (gal.)	Cumulative Purge Volume (gal.)
Screen 4 Pump Test									
07/17/2009	0740	8.30	21.41	4.40	50.5	531	8.93	0.00	0.00
	0745	8.40	21.49	4.68	67.9	514	15.7	16.15	16.15
	0750	8.45	21.59	5.08	90.4	513	10.8	7.60	23.75
	0755	8.46	22.04	5.14	114.0	507	6.58	12.01	35.76
	0800	8.46	21.90	4.99	128.0	517	6.49	11.76	47.52
	0805	8.48	21.78	5.19	143.0	514	4.87	12.63	60.15
	0810	8.47	22.29	5.38	154.7	501	3.99	11.00	71.15
	0820	8.46	22.59	5.14	175.9	505	2.92	23.67	94.82
	0830	8.49	22.15	5.24	171.2	516	2.90	23.63	118.45
	0840	8.47	22.99	5.50	205.8	557	4.01	23.51	141.96
	0910	8.49	24.7	5.12	200.0	580	2.11	70.25	212.21
	0940	8.29	25.08	5.23	219.0	575	0.99	70.44	282.65
	1010	8.35	25.18	5.14	199.0	568	0.97	69.40	352.05
	1040	8.30	24.27	5.24	220.1	554	0.89	69.56	421.61
Screen 2 Pump Test									
07/18/2009	0640	7.79	19.6	5.77	74.0	473	5.11	0.00	0.00
	0645	8.28	20.4	6.46	67.6	488	3.31	20.10	20.10
	0650	8.40	20.9	6.60	70.3	492	2.31	22.83	42.93
	0655	8.40	21.6	6.66	74.5	498	2.98	22.72	65.65
	0700	8.42	22.0	6.63	78.0	501	3.06	22.67	88.32
	0705	8.39	22.3	6.54	81.5	505	3.08	22.58	110.90
	0710	8.40	22.2	6.61	85.0	506	1.91	22.60	133.50
	0720	8.41	22.6	6.80	78.6	510	1.95	44.80	178.30
	0730	8.39	22.9	6.77	91.2	513	1.51	44.32	222.62
	0740	8.38	23.3	6.83	103.0	515	5.21	44.38	267.00
	0810	8.36	23.7	6.80	89.5	522	1.51	132.52	399.52
	0840	8.37	24.0	6.76	75.6	527	0.62	133.33	532.85
	0910	8.44	24.3	6.76	83.1	534	0.40	132.70	665.55
	0940	8.33	24.3	6.75	89.3	525	0.61	132.38	797.93

Appendix A

Westbay System Retrieval Report

Appendix B

Screening Analytical Results

Table B-1
Analytical Results for R-16 Screen 2 Rehabilitation, July 2009

Sample ID	Date Sample	Sample Prep	ER/RRES-WQH	Screen Number	Sample Depth (ft bgs)	Ag rslt (ppm)	stdev (Ag)	Al rslt (ppm)	Stdev (Al)	As rslt (ppm)	stdev (As)	B rslt (ppm)	stdev (B)	Ba rslt (ppm)	stdev (Ba)	Be rslt (ppm)	stdev (Be)	Br(-) ppm	TOC[a] rslt (ppm)	Ca rslt (ppm)	stdev (Ca)	Cd rslt (ppm)	stdev (Cd)	Cl(-) ppm	Co rslt (ppm)	stdev (Co)
CAMO-09-9301	07/18/09	NF[b]	09-2681	2	863.4–870.9	0	U[c]	0.015	0.001	0.0023	0.0001	0.023	0.000	0.016	0.000	0	U	NA[d]	0.5	20.7	0.0	0	U	NA	0.001	U
CAMO-09-9302	07/18/09	F[e]	09-2681	2	863.4–870.9	0	U	0.030	0.001	0.0023	0.0001	0.022	0.000	0.015	0.000	0	U	0.05	NA	20.6	0.1	0	U	3.10	0.002	0.000
CAMO-09-9303	07/18/09	F	09-2681	2	863.4–870.9	0	U	0.013	0.000	0.0022	0.0001	0.021	0.000	0.015	0.000	0	U	0.06	NA	20.2	0.1	0	U	3.09	0.001	0.000
CAMO-09-9304	07/18/09	NF	09-2681	2	863.4–870.9	0	U	0.029	0.000	0.0021	0.0002	0.021	0.000	0.015	0.000	0	U	NA	0.4	20.5	0.1	0	U	NA	0.001	U
CAMO-09-9305	07/18/09	F	09-2681	2	863.4 –870.9	0	U	0.021	0.000	0.0023	0.0001	0.022	0.000	0.015	0.000	0	U	0.05	NA	20.5	0.1	0	U	3.01	0.001	U
CAMO-09-9306	07/18/09	NF	09-2681	2	863.4 - 870.9	0	U	0.013	0.000	0.0022	0.0000	0.026	0.000	0.015	0.000	0	U	NA	0.3	20.4	0.2	0	U	NA	0.001	U
CAMO-09-9307	07/18/09	NF	09-2681	2 (DUP[f])	863.4–870.9	0	U	0.018	0.000	0.0024	0.0001	0.024	0.000	0.016	0.000	0	U	NA	0.4	20.6	0.1	0	U	NA	0.001	U
CAMO-09-9308	07/18/09	F	09-2681	2 (DUP)	863.4–870.9	0	U	0.016	0.000	0.0026	0.0001	0.020	0.000	0.016	0.000	0	U	0.05	NA	20.8	0.1	0	U	3.00	0.001	U

Table B-1 (continued)

Sample ID	Date Sample	Sample Prep	Alk-CO3 rslt (ppm)	ALK-CO3 (U)	Cr rslt (ppm)	stdev (Cr)	Cs rslt (ppm)	stdev (Cs)	Cu rslt (ppm)	stdev (Cu)	F(-) ppm	Fe rslt (ppm)	stdev (Fe)	Alk-CO3+HCO3 rslt (ppm)	Hg rslt (ppm)	stdev (Hg)	K rslt (ppm)	stdev (K)	Li rslt (ppm)	stdev (Li)	Mg rslt (ppm)	stdev (Mg)	Mn rslt (ppm)	stdev (Mn)	Mo rslt (ppm)	stdev (Mo)
CAMO-09-9301	07/18/09	NF	0.8	U	0.003	0.000	0	U	0.001	U	NA	0.01	0.00	106	0	U	2.69	0.02	0.018	0.001	1.73	0.01	0.001	0.000	0.001	0.000
CAMO-09-9302	07/18/09	F	NA	NA	0.003	0.000	0	U	0.001	U	0.47	0.01	0.00	NA	0	U	2.64	0.02	0.019	0.001	1.69	0.02	0.004	0.000	0.001	0.000
CAMO-09-9303	07/18/09	F	NA	NA	0.002	0.000	0	U	0.002	0.000	0.45	0.01	U	NA	0	U	2.67	0.02	0.013	0.000	1.72	0.02	0.002	0.000	0.001	0.000
CAMO-09-9304	07/18/09	NF	0.8	U	0.002	0.000	0	U	0.001	U	NA	0.01	0.00	102	0	U	2.67	0.02	0.013	0.000	1.72	0.01	0.001	U	0.001	0.000
CAMO-09-9305	07/18/09	F	NA	NA	0.002	0.000	0	U	0.001	U	0.48	0.01	0.00	NA	0	U	2.71	0.02	0.013	0.000	1.74	0.00	0.001	U	0.001	0.000
CAMO-09-9306	07/18/09	NF	0.8	U	0.002	0.000	0	U	0.001	U	NA	0.01	0.00	102	0	U	2.73	0.03	0.013	0.001	1.74	0.02	0.001	U	0.001	U
CAMO-09-9307	07/18/09	NF	0.8	U	0.002	0.001	0	U	0.001	U	NA	0.02	0.00	102	0	U	2.62	0.02	0.016	0.005	1.69	0.01	0.001	0.000	0.001	U
CAMO-09-9308	07/18/09	F	NA	NA	0.004	0.000	0	U	0.002	0.000	0.46	0.01	0.00	NA	0	U	2.69	0.02	0.021	0.000	1.75	0.01	0.002	0.000	0.001	U

Table B-1 (continued)

Sample ID	Date Sample	Sample Prep	Na rslt (ppm)	stdev (Na)	Ni rslt (ppm)	stdev (Ni)	NO2(ppm)	NO2-N rslt	NO3 ppm	NO3-N rslt	C2O4 rslt (ppm)	Pb rslt (ppm)	stdev (Pb)	Lab pH	PO4(-3) rslt (ppm)	Rb rslt (ppm)	stdev (Rb)	S2- rslt (ppm)	Sb rslt (ppm)	stdev (Sb)	Se rslt (ppm)	stdev (Se)	Si rslt (ppm)	stdev (Si)
CAMO-09-9301	07/18/09	NF	12.56	0.10	0.001	0.000	NA	NA	NA	NA	NA	0.0004	0.0000	7.91	NA	0.003	0.000	0.01, U	0	U	0	U	25.7	0.2
CAMO-09-9302	07/18/09	F	12.37	0.12	0.001	0.000	0.01	0.003, U	2.24	0.505	0.01, U	0.0008	0.0000	Not measured	0.01, U	0.003	0.000	NA	0	U	0	U	25.4	0.2
CAMO-09-9303	07/18/09	F	12.41	0.06	0.001	0.000	0.01	0.003, U	2.19	0.495	0.01, U	0.0002	U	Not measured	0.01, U	0.003	0.000	NA	0	U	0	U	25.5	0.1
CAMO-09-9304	07/18/09	NF	12.42	0.06	0.001	0.000	NA	NA	NA	NA	NA	0.0002	U	7.91	NA	0.003	0.000	0.01, U	0	U	0	U	25.5	0.1
CAMO-09-9305	07/18/09	F	12.63	0.08	0.001	U	0.01	0.003, U	2.15	0.485	0.01, U	0.0002	U	Not measured	0.01, U	0.003	0.000	NA	0	U	0	U	25.9	0.2
CAMO-09-9306	07/18/09	NF	12.58	0.19	0.001	U	NA	NA	NA	NA	NA	0.0002	U	7.94	NA	0.003	0.000	0.01, U	0	U	0	U	25.9	0.2
CAMO-09-9307	07/18/09	NF	12.13	0.09	0.001	0.000	NA	NA	NA	NA	NA	0.0002	U	7.99	NA	0.003	0.000	0.01, U	0	U	0	U	25.1	0.1
CAMO-09-9308	07/18/09	F	12.40	0.04	0.001	0.000	0.01	0.003, U	2.22	0.501	0.01, U	0.0002	U	Not measured	0.01, U	0.004	0.000	NA	0	U	0	U	25.9	0.2

Table B-1 (continued)

Sample ID	Date Sample	Sample Prep	SiO2 rslt (ppm)	stdev (SiO2)	Sn rslt (ppm)	stdev (Sn)	SO4(-2) rslt (ppm)	Sr rslt (ppm)	stdev (Sr)	Th rslt (ppm)	stdev (Th)	Ti rslt (ppm)	stdev (Ti)	Tl rslt (ppm)	stdev (Tl)	U rslt (ppm)	stdev (U)	V rslt (ppm)	stdev (V)	Zn rslt (ppm)	stdev (Zn)	TDS[g] (ppm)	Cations	Anions	Balance
CAMO-09-9301	07/18/09	NF	55.0	0.4	0	U	NA	0.162	0.001	0.001	U	0.002	U	0.001	U	0.0007	0.0000	0.013	0.000	0.028	0.001	199	1.80	1.76	0.01
CAMO-09-9302	07/18/09	F	54.3	0.5	0	U	4.28	0.161	0.001	0.001	U	0.002	U	0.001	U	0.0008	0.0000	0.013	0.001	0.016	0.000	102	1.78	NA	NA
CAMO-09-9303	07/18/09	F	54.7	0.3	0	U	4.3	0.162	0.001	0.001	U	0.002	U	0.001	U	0.0007	0.0000	0.009	0.000	0.012	0.000	102	1.77	NA	NA
CAMO-09-9304	07/18/09	NF	54.6	0.2	0	U	NA	0.163	0.002	0.001	U	0.002	U	0.001	U	0.0008	0.0000	0.008	0.000	0.017	0.001	195	1.78	1.70	0.02
CAMO-09-9305	07/18/09	F	55.5	0.5	0	U	4.27	0.164	0.002	0.001	U	0.002	U	0.001	U	0.0008	0.0000	0.009	0.000	0.016	0.002	103	1.79	NA	NA
CAMO-09-9306	07/18/09	NF	55.5	0.5	0	U	NA	0.166	0.001	0.001	U	0.002	U	0.001	U	0.0008	0.0000	0.009	0.000	0.017	0.001	196	1.79	1.70	0.02
CAMO-09-9307	07/18/09	NF	53.8	0.3	0	U	NA	0.161	0.001	0.001	U	0.002	U	0.001	U	0.0007	0.0000	0.011	0.004	0.024	0.000	194	1.77	1.70	0.02
CAMO-09-9308	07/18/09	F	55.4	0.4	0	U	4.29	0.165	0.002	0.001	U	0.002	U	0.001	U	0.0008	0.0000	0.015	0.001	0.020	0.001	103	1.80	NA	NA

[a] TOC = Total organic compound.

[b] NF = Not filtered.

[c] U = Unfiltered.

[d] NA = Not analyzed.

[e] F = Filtered.

[f] DUP = Duplicate.

[g] TDS = Total dissolved solids.

Table B-2
Analytical Results for R-16 Screen 4 Rehabilitation, July 2009

Sample ID	Date Sample	Sample Prep	ER/RRES-WQH	Screen Number	Sample Depth (ft bgs)	Ag rslt (ppm)	stdev (Ag)	Al rslt (ppm)	Stdev (Al)	As rslt (ppm)	stdev (As)	B rslt (ppm)	stdev (B)	Ba rslt (ppm)	stdev (Ba)	Be rslt (ppm)	stdev (Be)	Br(-) ppm	TOC[a] rslt (ppm)	Ca rslt (ppm)	stdev (Ca)	Cd rslt (ppm)	stdev (Cd)	Cl(-) ppm	Co rslt (ppm)	stdev (Co)
CAMO-09-9312	07/17/09	F[b]	09-2681	4	1237.0 - 1244.6	0	U[c]	0.016	0.000	0.0024	0.0000	0.038	0.001	0.021	0.000	0	U	0.04	NA[d]	21.0	0.0	0	U	3.57	0.001	U
CAMO-09-9313	07/17/09	NF[e]	09-2681	4	1237.0 - 1244.6	0	U	0.017	0.000	0.0025	0.0002	0.026	0.000	0.020	0.000	0	U	NA	0.5	20.5	0.1	0	U	NA	0.001	U
CAMO-09-9314	07/17/09	NF	09-2681	4	1237.0 - 1244.6	0	U	0.015	0.000	0.0024	0.0003	0.023	0.000	0.020	0.000	0	U	NA	0.3	20.4	0.1	0	U	NA	0.001	U
CAMO-09-9315	07/17/09	F	09-2681	4	1237.0 - 1244.6	0	U	0.012	0.000	0.0026	0.0001	0.022	0.000	0.020	0.000	0	U	0.04	NA	20.9	0.1	0	U	3.58	0.001	U
CAMO-09-9316	07/17/09	NF	09-2681	4	1237.0 - 1244.6	0	U	0.015	0.000	0.0026	0.0001	0.021	0.000	0.020	0.000	0	U	NA	0.4	20.8	0.0	0	U	NA	0.001	U
CAMO-09-9317	07/17/09	F	09-2681	4	1237.0 - 1244.6	0	U	0.012	0.000	0.0025	0.0001	0.021	0.000	0.020	0.000	0	U	0.04	NA	20.6	0.0	0	U	3.51	0.001	0.000
CAMO-09-9318	07/17/09	F	09-2681	4 (DUP[f])	1237.0 - 1244.6	0	U	0.011	0.000	0.0025	0.0002	0.020	0.000	0.023	0.000	0	U	0.04	NA	20.7	0.2	0	U	3.55	0.001	0.000
CAMO-09-9319	07/17/09	NF	09-2681	4 (DUP)	1237.0 - 1244.6	0	U	0.017	0.000	0.0027	0.0001	0.020	0.000	0.020	0.000	0	U	NA	0.4	20.6	0.1	0	U	NA	0.001	U

Table B-2 (continued)

Sample ID	Date Sample	Sample Prep	Alk-CO3 rslt (ppm)	ALK-CO3 (U)	Cr rslt (ppm)	stdev (Cr)	Cs rslt (ppm)	stdev (Cs)	Cu rslt (ppm)	stdev (Cu)	F(-) ppm	Fe rslt (ppm)	stdev (Fe)	Alk-CO3+HCO3 rslt (ppm)	Hg rslt (ppm)	stdev (Hg)	K rslt (ppm)	stdev (K)	Li rslt (ppm)	stdev (Li)	Mg rslt (ppm)	stdev (Mg)	Mn rslt (ppm)	stdev (Mn)	Mo rslt (ppm)	stdev (Mo)
CAMO-09-9312	07/17/09	F	NA	NA	0.002	0.001	0	U	0.001	U	0.47	0.03	0.00	NA	0	U	2.83	0.02	0.016	0.006	1.77	0.01	0.004	0.001	0.001	0.000
CAMO-09-9313	07/17/09	NF	0.8	U	0.001	0.000	0	U	0.001	U	NA	0.06	0.00	111	0	U	2.82	0.02	0.012	0.001	1.78	0.01	0.004	0.000	0.001	0.000
CAMO-09-9314	07/17/09	NF	0.8	U	0.002	0.001	0	U	0.001	U	NA	0.04	0.00	113	0	U	2.79	0.02	0.016	0.005	1.76	0.01	0.003	0.001	0.001	0.000
CAMO-09-9315	07/17/09	F	NA	NA	0.003	0.000	0	U	0.001	U	0.47	0.02	0.00	NA	0	U	2.88	0.01	0.020	0.001	1.81	0.01	0.004	0.000	0.001	0.000
CAMO-09-9316	07/17/09	NF	0.8	U	0.002	0.001	0	U	0.001	U	NA	0.03	0.00	107	0	U	2.80	0.03	0.016	0.006	1.78	0.01	0.003	0.001	0.001	0.000
CAMO-09-9317	07/17/09	F	NA	NA	0.003	0.000	0	U	0.001	U	0.46	0.02	0.00	NA	0	U	2.83	0.03	0.020	0.001	1.78	0.01	0.005	0.000	0.001	U
CAMO-09-9318	07/17/09	F	NA	NA	0.001	0.000	0	U	0.001	U	0.45	0.04	0.00	NA	0	U	2.83	0.04	0.012	0.000	1.86	0.02	0.005	0.000	0.001	U
CAMO-09-9319	07/17/09	NF	0.8	U	0.002	0.001	0	U	0.001	0.000	NA	0.06	0.00	106	0	U	2.82	0.01	0.015	0.005	1.80	0.00	0.004	0.001	0.001	U

Table B-2 (continued)

Sample ID	Date Sample	Sample Prep	Na rslt (ppm)	stdev (Na)	Ni rslt (ppm)	stdev (Ni)	NO2(ppm)	NO2-N rslt	NO3 ppm	NO3-N rslt	C2O4 rslt (ppm)	Pb rslt (ppm)	stdev (Pb)	Lab pH	PO4(-3) rslt (ppm)	Rb rslt (ppm)	stdev (Rb)	S2- rslt (ppm)	Sb rslt (ppm)	stdev (Sb)	Se rslt (ppm)	stdev (Se)	Si rslt (ppm)	stdev (Si)
CAMO-09-9312	07/17/09	F	12.63	0.06	0.001	0.000	0.01	0.003, U	2.28	0.515	0.01, U	0.0002	U	Not measured	0.03	0.003	0.000	NA	0	U	0	U	24.7	0.0
CAMO-09-9313	07/17/09	NF	12.61	0.13	0.001	0.000	NA	NA	NA	NA	NA	0.0002	U	8.16	NA	0.003	0.000	0.01, U	0	U	0	U	24.8	0.2
CAMO-09-9314	07/17/09	NF	12.62	0.05	0.001	U	NA	NA	NA	NA	NA	0.0002	U	8.10	NA	0.003	0.000	0.01, U	0	U	0	U	24.7	0.0
CAMO-09-9315	07/17/09	F	13.03	0.08	0.001	0.000	0.01	0.003, U	2.38	0.537	0.01, U	0.0002	U	Not measured	0.05	0.004	0.000	NA	0	U	0	U	25.5	0.0
CAMO-09-9316	07/17/09	NF	12.77	0.08	0.001	0.000	NA	NA	NA	NA	NA	0.0002	U	8.12	NA	0.003	0.000	0.01, U	0	U	0	U	25.0	0.0
CAMO-09-9317	07/17/09	F	12.86	0.09	0.001	0.000	0.01	0.003, U	2.43	0.549	0.01, U	0.0002	U	Not measured	0.07	0.004	0.000	NA	0	U	0	U	25.0	0.1
CAMO-09-9318	07/17/09	F	12.78	0.07	0.001	0.000	0.01	0.003, U	2.52	0.569	0.01, U	0.0002	U	Not measured	0.02	0.004	0.000	NA	0	U	0	U	25.1	0.3
CAMO-09-9319	07/17/09	NF	12.77	0.05	0.001	0.000	NA	NA	NA	NA	NA	0.0002	U	8.13	NA	0.004	0.000	0.01, U	0	U	0	U	25.3	0.0

Table B-2 (continued)

Sample ID	Date Sample	Sample Prep	SiO2 rslt (ppm)	stdev (SiO2)	Sn rslt (ppm)	stdev (Sn)	SO4(-2) rslt (ppm)	Sr rslt (ppm)	stdev (Sr)	Th rslt (ppm)	stdev (Th)	Ti rslt (ppm)	stdev (Ti)	Tl rslt (ppm)	stdev (Tl)	U rslt (ppm)	stdev (U)	V rslt (ppm)	stdev (V)	Zn rslt (ppm)	stdev (Zn)	TDS[g] (ppm)	Cations	Anions	Balance
CAMO-09-9312	07/17/09	F	52.8	0.1	0	U	4.45	0.168	0.002	0.001	U	0.002	U	0.001	U	0.0008	0.0000	0.011	0.003	0.044	0.003	102	1.82	NA	NA
CAMO-09-9313	07/17/09	NF	53.1	0.4	0	U	NA	0.170	0.000	0.001	U	0.002	U	0.001	U	0.0008	0.0000	0.008	0.001	0.070	0.003	203	1.80	1.85	-0.01
CAMO-09-9314	07/17/09	NF	52.9	0.0	0	U	NA	0.172	0.002	0.001	U	0.002	U	0.001	U	0.0008	0.0000	0.010	0.003	0.057	0.006	204	1.79	1.87	-0.02
CAMO-09-9315	07/17/09	F	54.5	0.1	0	U	4.26	0.176	0.001	0.001	U	0.002	U	0.001	U	0.0009	0.0000	0.014	0.000	0.052	0.001	104	1.84	NA	NA
CAMO-09-9316	07/17/09	NF	53.4	0.1	0	U	NA	0.175	0.000	0.001	U	0.002	U	0.001	U	0.0008	0.0000	0.011	0.004	0.061	0.005	200	1.82	1.78	0.01
CAMO-09-9317	07/17/09	F	53.4	0.2	0	U	4.39	0.176	0.002	0.001	U	0.002	U	0.001	U	0.0009	0.0000	0.014	0.000	0.050	0.004	103	1.81	NA	NA
CAMO-09-9318	07/17/09	F	53.7	0.6	0	U	4.37	0.170	0.002	0.001	U	0.002	U	0.001	U	0.0007	0.0000	0.008	0.000	0.035	0.004	103	1.82	NA	NA
CAMO-09-9319	07/17/09	NF	54.2	0.1	0	U	NA	0.172	0.001	0.001	U	0.002	U	0.001	U	0.0008	0.0000	0.011	0.004	0.070	0.006	200	1.81	1.77	0.01

[a] TOC = Total organic compound.

[b] F = Filtered.

[c] U = Unfiltered.

[d] NA = Not analyzed.

[e] NF = Not filtered.

[f] DUP = Duplicate.

[g] TDS = Total dissolved solids.

Appendix C

Well Screen Analysis

Table C-1
Well Screen Analysis for R-16, Screen 2, July 2009

Well	Sample Depth (ft)	Screen	Sample Collection Date	Sample Identification Numbers	Field pH	Low pH	High pH	GEN 1	Alkalinity (mg/L $CaCO_3$)	GEN 2	Turbidity (NTU)	GEN 3	Acetone (µg/L)	B1	NH3-N (mg/L)	B2	TKN (mg/L)	B3	TOC (NF) mg/L	B4	Ba ug/L	D3	E1	Ca mg/L	E2a	E2b	E2	Cl (F) mg/L	A2
						SU	**SU**			**mg/L**		**NTU**		**µg/L**		**mg/L**		**mg/L**		**mg/L**		**µg/L**	**µg/L**		**mg/L**	**mg/L**	**Within**		**mg/L**
						>LL	**<UL**			**<UL**		**<UL**		**<UL**		**<UL**		**<UL**		**<UL**		**>LL**	**<UL**		**>LL**	**<UL**	**range**		**<UL**
						6.4	**9.0**			**157**		**5**		**5**		**0.05**		**0.46**		**1.37**		**1.4**	**57**		**4.3**	**42**			**3.6**
R-16	861.5	2	18-Jul-09	GW22-09-9301/9302	8.38 FLD	Y	Y	P	106		5.21	F	NA	NA	NA	NA	NA	NA	0.5	P	0.016	P	P	20.7	Y	Y	P	3.10	P
R-16	861.5	2	18-Jul-09	GW22-09-9303/9304	8.37 FLD	Y	Y	P	102		0.62	P	NA	NA	NA	NA	NA	NA	0.4	P	0.015	P	P	20.4	Y	Y	P	3.09	P
R-16	861.5	2	18-Jul-09	GW22-09-9305/9306	8.33 FLD	Y	Y	P	102		0.61	P	NA	NA	NA	NA	NA	NA	0.3	P	0.015	P	P	20.5	Y	Y	P	3.01	P
R-16	861.5	2	18-Jul-09	GW22-09-9307/9308	8.38 FLD	Y	Y	P	102		5.21	F	NA	NA	NA	NA	NA	NA	0.4	P	0.016	P	P	20.7	Y	Y	P	3.00	P

Notes: NA = not analyzed; n/a = not applicable;
NTU = nephelometric turbidity unit; TKN = Total kjeldahl nitrogen;
TOC = Total organic carbon; Y = yes; UL = upper limit;
LL = lower limit; P = pass; F = fail; U = undetected;
NF = nonfiltered; F = filtered.
(Threshold values revised 8-Nov-07; identical to those used in DQM).

Table C-1
Well Screen Analysis for R-16, Screen 2, July 2009

Well	Sample Depth (ft)	Screen	Sample Collection Date	Sample Identification Numbers	F (F) mg/L	A5	Mg mg/L	E3	NO3-N (F) mg/L	GEN5	C10	ORP	C3	DO	C11	ClO4 (ug/L)	GEN4	C7	PO4 (F) mg/L	Lab Qual Code	A6	Na mg/L	A3	SO4 (F) mg/L	C1	A4	Sulfide (NF) mg/L	Lab Qual Code	C2	B ug/L	A1	Cr (F) ug/L
						mg/L		**mg/L**			**mg/L**		**mV**		**mg/L**			**ug/L**	**Threshold**		**mg/L**		**mg/L**		**mg/L**	**mg/L**			**mg/L**			
						<UL		**<UL**		**<UL**	**>LL**		**>LL**		**>LL**		**<UL**	**>LL**			**<UL**		**<UL**		**>LL**	**<UL**			**<UL**		**<UL**	
						0.57		**4.2**		**0. 89**	**0.01**		**0**		**2**		**0.5**	**0.22**			**0.28**		**25**		**1.7**	**7.2**			**0.01**		**38.8**	
R-16	861.5	2	18-Jul-09	GW22-09-9301/9302	0.47	P	1.71	P	0.505	P	P	103.0	P	6.83	P	NA	NA	NA	0.01	U	P	12.47	P	4.28	P	P	0.01	U	P	23	P	3.0
R-16	861.5	2	18-Jul-09	GW22-09-9303/9304	0.45	P	1.72	P	0.495	P	P	75.6	P	6.76	P	NA	NA	NA	0.01	U	P	12.41	P	4.3	P	P	0.01	U	P	21	P	2.0
R-16	861.5	2	18-Jul-09	GW22-09-9305/9306	0.48	P	1.74	P	0.485	P	P	89.3	P	6.75	P	NA	NA	NA	0.01	U	P	12.61	P	4.27	P	P	0.01	U	P	24	P	2.0
R-16	861.5	2	18-Jul-09	GW22-09-9307/9308	0.46	P	1.75	P	0.501	P	P	103.0	P	6.83	P	NA	NA	NA	0.01	U	P	12.26	P	4.29	P	P	0.01	U	P	22	P	4.0

Notes: NA = not analyzed; n/a = not applicable;
NTU = nephelometric turbidity unit; TKN = Total kjeldahl nitrogen;
TOC = Total organic carbon; Y = yes; UL = upper limit;
LL = lower limit; P = pass; F = fail; U = undetected;
NF = nonfiltered; F = filtered.
(Threshold values revised 8-Nov-07; identical to those used in DQM).

Table C-1
Well Screen Analysis for R-16, Screen 2, July 2009

Well	Sample Depth (ft)	Screen	Sample Collection Date	Sample Identification Numbers	GEN6	C9	Cr (NF) ug/L	F3	Ratio Cr (NF/F)	F4	Fe (F) ug/L	C5	Fe (NF) ug/L	F1	Ratio Fe (NF/F)	F2	Mn (F) ug/L	Lab Qual Code	C6	Ni (F) ug/L	Lab Qual Code	F5	Sr ug/L	D2	E4	U ug/L	C8	D1	E5	V ug/L	C4	Zn ug/L	D4	F6
						ug/L		**ug/**		**Ratio**		**ug/L**		**ug/L**		**Ratio**			**µg/L**			**µg/L**		**µg/L**	**µg/L**		**µg/L**	**µg/L**	**µg/L**				**µg/L**	**µg/L**
					<UL	**>LL**		**<UL**		**<UL**		**<UL**		**<UL**		**<UL**			**<UL**			**<UL**		**>LL**	**<UL**		**>LL**	**>LL**	**<UL**		**>LL**		**>LL**	**<UL**
					5.75	**0.39**		**10**		**5**		**147**		**500**		**10**			**124**			**50**		**44**	**540**		**0.06**	**0.06**	**1.9**		**2.27**		**0.4**	**40**
R-16	861.5	2	18-Jul-09	GW22-09-9301/9302	P	P	3.0	P	1.0	P	12.72	P	11.25	P	0.9	P	4.29	n/a	P	1.34	n/a	P	162	P	P	0.76	P	P	P	13	P	22	P	P
R-16	861.5	2	18-Jul-09	GW22-09-9303/9304	P	P	2.0	P	1.0	P	10.00	P	11.48	P	1.1	P	1.81	n/a	P	1.11	n/a	P	162	P	P	0.74	P	P	P	9	P	15	P	P
R-16	861.5	2	18-Jul-09	GW22-09-9305/9306	P	P	2.0	P	1.0	P	12.15	P	12.60	P	1.0	P	1.00	U	P	1.00	U	P	165	P	P	0.77	P	P	P	9	P	16	P	P
R-16	861.5	2	18-Jul-09	GW22-09-9307/9308	P	P	2.0	P	0.5	P	13.46	P	22.63	P	1.7	P	2.26	n/a	P	2.26	n/a	P	163	P	P	0.74	P	P	P	13	P	22	P	P

Notes: NA = not analyzed; n/a = not applicable;
NTU = nephelometric turbidity unit; TKN = Total kjeldahl nitrogen;
TOC = Total organic carbon; Y = yes; UL = upper limit;
LL = lower limit; P = pass; F = fail; U = undetected;
NF = nonfiltered; F = filtered.
(Threshold values revised 8-Nov-07; identical to those used in DQM).

Table C-1
Well Screen Analysis for R-16, Screen 2, July 2009

Well	Sample Depth (ft)	Screen	Sample Collection Date	Sample Identification Numbers	Total Tests	Tests Passed	Tests Failed	% Pass	General Indicators							Category A Inorganic Indicators						Category B Organic Indicators			
									Mod Water	**Gen-1**	**Gen-2**	**Gen-3**	**Gen-4**	**Gen-5**	**Gen-6**	**A1**	**A2**	**A3**	**A4**	**A5**	**A6**	**B1**	**B2**	**B3**	**B4**
									3H	**pH**	**Alk**	**Turb**	**ClO4**	**NO3-N**	**Cr**	**B**	**Cl**	**Na**	**SO4**	**F**	**PO4**	**Ace**	**NH3**	**TKN**	**TOC**
								99%	**UL=1**	**In range**	**UL=52**	**UL=5**	**UL=0.5**	**UL=0.89**	**UL=5.75**	**UL=39**	**UL=3.6**	**UL=24.5**	**UL=7.2**	**UL=0.57**	**UL=0.28**	**5**	**0.05**	**0.35**	**1.37**
R-16	861.5	2	18-Jul-09	GW22-09-9301/9302	39	38	1	97	NA	P	P	F	NA	P	P	P	P	P	P	P	P	NA	NA	NA	P
R-16	861.5	2	18-Jul-09	GW22-09-9303/9304	39	39	0	100	NA	P	P	P	NA	P	P	P	P	P	P	P	P	NA	NA	NA	P
R-16	861.5	2	18-Jul-09	GW22-09-9305/9306	39	39	0	100	NA	P	P	P	NA	P	P	P	P	P	P	P	P	NA	NA	NA	P
R-16	861.5	2	18-Jul-09	GW22-09-9307/9308	39	38	1	97	NA	P	P	F	NA	P	P	P	P	P	P	P	P	NA	NA	NA	P

Notes: NA = not analyzed; n/a = not applicable;
NTU = nephelometric turbidity unit; TKN = Total kjeldahl nitrogen;
TOC = Total organic carbon; Y = yes; UL = upper limit;
LL = lower limit; P = pass; F = fail; U = undetected;
NF = nonfiltered; F = filtered.
(Threshold values revised 8-Nov-07; identical to those used in DQM).

Table C-1
Well Screen Analysis for R-16, Screen 2, July 2009

Well	Sample Depth (ft)	Screen	Sample Collection Date	Sample Identification Numbers	Category C1 Redox (SO4)			Category C2 Redox (Fe/Mn)						Category C3 Redox (NO3)			Category D Adsorption			
					C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**	**C11**	**D1**	**D2**	**D3**	**D4**	**E1**
					SO4	**S**	**ORP**	**V**	**Fe**	**Mn**	**ClO4**	**U**	**Cr**	**NO3-N**	**DO**	**U**	**Sr**	**Ba**	**Zn**	**Ba**
					LL=1.65	**UL=0.010**	**LL=0**	**LL=2.27**	**UL=147**	**UL=124**	**LL=0.22**	**LL=0.06**	**LL=0.39**	**LL=0.01**	**LL=2**	**LL=0.06**	**LL=44**	**LL=4.9**	**LL=0.4**	**UL=57**
R-16	861.5	2	18-Jul-09	GW22-09-9301/9302	P	P	P	P	P	P	NA	P	P	P	P	P	P	P	P	P
R-16	861.5	2	18-Jul-09	GW22-09-9303/9304	P	P	P	P	P	P	NA	P	P	P	P	P	P	P	P	P
R-16	861.5	2	18-Jul-09	GW22-09-9305/9306	P	P	P	P	P	P	NA	P	P	P	P	P	P	P	P	P
R-16	861.5	2	18-Jul-09	GW22-09-9307/9308	P	P	P	P	P	P	NA	P	P	P	P	P	P	P	P	P

Notes: NA = not analyzed; n/a = not applicable;
NTU = nephelometric turbidity unit; TKN = Total kjeldahl nitrogen;
TOC = Total organic carbon; Y = yes; UL = upper limit;
LL = lower limit; P = pass; F = fail; U = undetected;
NF = nonfiltered; F = filtered.
(Threshold values revised 8-Nov-07; identical to those used in DQM).

Table C-1
Well Screen Analysis for R-16, Screen 2, July 2009

Well	Sample Depth (ft)	Screen	Sample Collection Date	Sample Identification Numbers	Category E Carbonate Mineralogy						Category F Metal Corrosion					
					E2a	**E2b**	**E2**	**E3**	**E4**	**E5**	**F1**	**F2**	**F3**	**F4**	**F5**	**F6**
					Ca	**Ca**	**Ca**	**Mg**	**Sr**	**U**	**FeT**	**FeR**	**CrT**	**CrR**	**Ni**	**Zn**
					LL=4.3	**UL=42**	**In range**	**UL=4.2**	**UL=540**	**UL=1.90**	**UL=500**	**UL=10**	**UL=10**	**UL=5**	**UL=5**	**UL=40**
R-16	861.5	2	18-Jul-09	GW22-09-9301/9302	P	P	P	P	P	P	P	P	P	P	P	P
R-16	861.5	2	18-Jul-09	GW22-09-9303/9304	P	P	P	P	P	P	P	P	P	P	P	P
R-16	861.5	2	18-Jul-09	GW22-09-9305/9306	P	P	P	P	P	P	P	P	P	P	P	P
R-16	861.5	2	18-Jul-09	GW22-09-9307/9308	P	P	P	P	P	P	P	P	P	P	P	P

Notes: NA = not analyzed; n/a = not applicable;
NTU = nephelometric turbidity unit; TKN = Total kjeldahl nitrogen;
TOC = Total organic carbon; Y = yes; UL = upper limit;
LL = lower limit; P = pass; F = fail; U = undetected;
NF = nonfiltered; F = filtered.
(Threshold values revised 8-Nov-07; identical to those used in DQM).

Table C-2
Results of Well Screen Analysis for R-16 (screen 4) July 2009

Well	Sample Depth (ft)	Screen Number	Sample Collection Date	Sample ID	Field pH	Low Ph	High pH	GEN1	Alkalinity (mg/L CaCO3)	GEN2	Turbidity (NTU)	GEN3	Acetone (ug/L)	B1	NH3-N (mg/L)	B2	TKN (mg/L)	B3	TOC (NF) (mg/L)	B4	Ba ug/L	D3	E1	Ca mg/L	E2a	E2b	E2	Cl (F) mg/L
						SU	**SU**			**mg/L**		**NTU**		**ug/L**		**mg/L**		**mg/L**		**mg/L**		**ug/L**	**ug/L**		**mg/L**	**mg/L**	**Within range**	
						>LL	**<UL**			**<UL**		**<UL**		**<UL**		**<UL**		**<UL**		**<UL**		**>LL**	**<UL**		**>LL**	**<UL**		
						6.4	9.0			157		5		5		0.05		0.46		1.37		1.4	57		4.3	42		
R-16	1233	4	17-Jul-09	GW22-09-9312/9313	8.47	Y	Y	P	111		4.01	P	NA	NA	NA	NA	NA	NA	0.5	P	16	P	P	21.0	Y	Y	P	3.57
R-16	1233	4	17-Jul-09	GW22-09-9314/9315	8.29	Y	Y	P	113		0.99	P	NA	NA	NA	NA	NA	NA	0.3	P	15	P	P	20.4	Y	Y	P	3.58
R-16	1233	4	17-Jul-09	GW22-09-9316/9317	8.30	Y	Y	P	107		0.89	P	NA	NA	NA	NA	NA	NA	(11.4) 0.4	P	15	P	P	20.8	Y	Y	P	3.51
R-16	1233	4	17-Jul-09	GW22-09-9318/9319	8.47	Y	Y	P	106		4.01	P	NA	NA	NA	NA	NA	NA	0.4	P	16	P	P	20.7	Y	Y	P	3.55

Table C-2
Results of Well Screen Analysis for R-16 (screen 4) July 2009

Well	Sample Depth (ft)	Screen Number	Sample Collection Date	Sample ID	A2	F (F) mg/L	Test A2	Mg mg/L	E3	NO3-N (F) mg/L	GEN5	C1	ORP	C3	DO	C11	PO4 (F) mg/L	A6	Na mg/L	A3	SO4 (F) mg/L	C1	Test A4	Sulfide (NF)	Lab Qual Code	C2	B ug/L	A1	Cr (F) ug/L	Lab Qual Code
					mg/L		**mg/L**		**mg/L**			**mg/L**		**mV**			**Threshold**	**mg/L P**		**mg/L**		**mg/L**	**mg/L**			**mg/L**				
					<UL		**<UL**		**<UL**		**<UL**	**>LL**		**>LL**		**>LL**		**<UL**		**<UL**		**>LL**	**<UL**			**<UL**		**<UL**		
					3.6		0.57		4.2		0. 89	0.01		0		2		0.28		25		1.7	7.2			0.01		38.8		
R-16	1233	4	17-Jul-09	GW22-09-9312/9313	P	0.47	P	1.77	P	0.515	P	P	205.8	P	5.5	P	0.03	P	12.63	P	4.45	P	P	0.01	U	P	38.32	P	2.01	F
R-16	1233	4	17-Jul-09	GW22-09-9314/9315	P	0.47	P	1.81	P	0.537	P	P	219.0	P	5.23	P	0.05	P	13.03	P	4.26	P	P	0.01	U	P	23.24	P	2.91	F
R-16	1233	4	17-Jul-09	GW22-09-9316/9317	P	0.46	P	1.78	P	0.549	P	P	220.1	P	5.24	P	0.07	P	12.77	P	4.39	P	P	0.01	U	P	21.07	P	3.06	F
R-16	1233	4	17-Jul-09	GW22-09-9318/9319	P	0.45	P	1.86	P	0.569	P	P	205.8	P	5.5	P	0.02	P	12.78	P	4.37	P	P	0.01	U	P	20.44	P	1.43	F

Table C-2
Results of Well Screen Analysis for R-16 (screen 4) July 2009

Well	Sample Depth (ft)	Screen Number	Sample Collection Date	Sample ID	GEN6	C9	Cr (NF) ug/L	Lab Qual Code	F3	Ratio Cr (NF/F)	F4	Fe (F) ug/L	Lab Qual Code	C5	Fe (NF) ug/L	Lab Qual Code	F1	Ratio Fe(NF/F)	F2	Mn (F) ug/L	Lab Qual Code	C6	Ni (F) ug/L	Lab Qual Code	F5	Sr ug/L	D2	E4	U ug/L
						ug/L			**ug/L**		**Ratio**			**ug/L**			**ug/L**		**Ratio**			**ug/L**			**ug/L**		**ug/L**	**ug/L**	
					<UL	**>LL**			**<UL**		**<UL**			**<UL**			**<UL**		**<UL**			**<UL**			**<UL**		**>LL**	**<UL**	
					5.75	0.39			10		5			147			500		10			124			50		44	540	
R-16	1233	4	17-Jul-09	GW22-09-9312/9313	P	P	1.27	NF	P	0.6	P	32	F	P	63	NF	P	1.9	P	4.38	F	P	1.22	F	P	168	P	P	0.78
R-16	1233	4	17-Jul-09	GW22-09-9314/9315	P	P	1.88	NF	P	0.6	P	20	F	P	44	NF	P	2.1	P	4.07	F	P	1.25	F	P	172	P	P	0.81
R-16	1233	4	17-Jul-09	GW22-09-9316/9317	P	P	1.81	NF	P	0.6	P	19	F	P	33	NF	P	1.7	P	4.55	F	P	1.26	F	P	175	P	P	0.80
R-16	1233	4	17-Jul-09	GW22-09-9318/9319	P	P	1.84	NF	P	1.3	P	42	F	P	64	NF	P	1.5	P	4.58	F	P	1.33	F	P	170	P	P	0.75

Table C-2
Results of Well Screen Analysis for R-16 (screen 4) July 2009

Well	Sample Depth (ft)	Screen Number	Sample Collection Date	Sample ID	C8	D1	E5	V ug/L	C4	Zn ug/L	D4	F6	Total Tests	Tests Passed	Tests Failed	% Pass	General Indicators						
					ug/L	**ug/L**	**ug/L**				**ug/L**	**ug/L**					**Mod Water**	**Gen-1**	**Gen-2**	**Gen-3**	**Gen-4**	**Gen-5**	**Gen-6**
					>LL	**>LL**	**<UL**		**>LL**		**>LL**	**<UL**					**3H**	**pH**	**Alk**	**Turb**	**ClO4**	**NO3-N**	**Cr**
					0.06	0.06	1.9		2.27		0.4	40				**98%**	UL=1	In range	UL=52	UL=5	UL=0.5	UL=0.89	UL=5.75
R-16	1233	4	17-Jul-09	GW22-09-9312/9313	P	P	P	11	P	44	P	F	37	36	1	97	NA	P	P	P	NA	P	P
R-16	1233	4	17-Jul-09	GW22-09-9314/9315	P	P	P	10	P	57	P	F	37	36	1	97	NA	P	P	P	NA	P	P
R-16	1233	4	17-Jul-09	GW22-09-9316/9317	P	P	P	11	P	61	P	F	37	36	1	97	NA	P	P	P	NA	P	P
R-16	1233	4	17-Jul-09	GW22-09-9318/9319	P	P	P	8	P	35	P	P	37	37	0	100	NA	P	P	P	NA	P	P

Table C-2
Results of Well Screen Analysis for R-16 (screen 4) July 2009

Well	Sample Depth (ft)	Screen Number	Sample Collection Date	Sample ID	Category A Inorganic Indicators						Category B Organic Indicators				Category C1 Redox (SO4)			Category C2 Redox (Fe/Mn)				Category C3 Redox (NO3)			
					A1	**A2**	**A3**	**A4**	**A5**	**A6**	**B1**	**B2**	**B3**	**B4**	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**	**C11**
					B	**Cl**	**Na**	**SO4**	**F**	**PO4**	**Ace**	**NH3**	**TKN**	**TOC**	**SO4**	**S**	**ORP**	**V**	**Fe**	**Mn**	**ClO4**	**U**	**Cr**	**NO3-N**	**DO**
					UL=39	UL=3.6	UL=24.5	UL=7.2	UL=0.57	UL=0.28	<5	<0.05	<0.35	<1.37	LL=1.65	UL=0.01	LL=0	LL=2.27	UL=147	UL=124	LL=0.22	LL=0.06	LL=0.39	LL=0.01	LL=2
R-16	1233	4	17-Jul-09	GW22-09-9312/9313	P	P	P	P	P	P	NA	NA	NA	P	P	P	P	P	P	P	NA	P	P	P	P
R-16	1233	4	17-Jul-09	GW22-09-9314/9315	P	P	P	P	P	P	NA	NA	NA	P	P	P	P	P	P	P	NA	P	P	P	P
R-16	1233	4	17-Jul-09	GW22-09-9316/9317	P	P	P	P	P	P	NA	NA	NA	P	P	P	P	P	P	P	NA	P	P	P	P
R-16	1233	4	17-Jul-09	GW22-09-9318/9319	P	P	P	P	P	P	NA	NA	NA	P	P	P	P	P	P	P	NA	P	P	P	P

Table C-2
Results of Well Screen Analysis for R-16 (screen 4) July 2009

Well	Sample Depth (ft)	Screen Number	Sample Collection Date	Sample ID		Category D Adsorption				Category E Carbonate Mineralogy						Category F Metal Corrosion					
					D1	**D2**	**D3**	**D4**	**E1**	**E2a**	**E2b**	**E2**	**E3**	**E4**	**E5**	**F1**	**F2**	**F3**	**F4**	**F5**	**F6**
					U	**Sr**	**Ba**	**Zn**	**Ba**	**Ca**	**Ca**	**Ca**	**Mg**	**Sr**	**U**	**FeT**	**FeR**	**CrT**	**CrR**	**Ni**	**Zn**
					LL=0.0	LL=44	LL=4.9	LL=0.4	UL=57	LL=4.3	UL=42	In range	UL=4.2	UL=540	UL=1.90	UL=500	UL=10	UL=10	UL=5	UL=50	UL=40
R-16	1233	4	17-Jul-09	GW22-09-9312/9313	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	F
R-16	1233	4	17-Jul-09	GW22-09-9314/9315	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	F
R-16	1233	4	17-Jul-09	GW22-09-9316/9317	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	F
R-16	1233	4	17-Jul-09	GW22-09-9318/9319	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P