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Well R-14 Rehabilitation and Conversion Summary Report

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CONTENTS

Figures

Tables

Appendixes

1.0 INTRODUCTION

This report provides a summary of the work performed and the results of rehabilitating and converting well R-14 from a dual-screen to a single-screen well. Plans for R-14 conversion were presented in the "Work Plan for R-Well Rehabilitation and Replacement, Revision 2" (LANL 2007, 098119) that was approved by the New Mexico Environment Department (NMED) on August 20, 2007 (NMED 2007, 098182). The R-14 borehole was drilled to a total depth (TD) of 1327 ft using fluid-assisted air-rotary and conventional mud-rotary techniques and was completed with two screened intervals in the regional aquifer: screen 1 from 1200.6 to 1233.2 ft and screen 2 from 1286.5 to 1293.1 ft. A dedicated Westbay sampling system was installed in the well after completion.

The results of the well screen analysis for R-14 (LANL 2007, 096330) indicated that the uppermost screen (screen 1) was very good, passing >90% of the assessment tests, and screen 2 passed 71% of the assessment tests. Based on these results, screen 2 was abandoned, screen 1 was subjected to rehabilitation activities, and a single submersible pump will be installed for long-term sampling of screen 1.

2.0 REHABILITATION ACTIVITIES

Well rehabilitation and conversion activities at R-14 included removal of the Westbay multiport sampling system, video logging of the well, initial hydraulic testing of screens 1 and 2, abandonment of screen 2, final hydraulic testing to measure the specific capacity of screen 1, and collection of water samples for laboratory analysis in accordance with the work plan approved by NMED. The permanent sampling pump will be installed after the Threatened and Endangered Species Act exclusion is lifted from the area where R-14 is located.

2.1 Westbay Removal

Retrieval of the Westbay MP55 sampling system was conducted between February 5 and February 10, 2008. A Westbay technical representative was on-site to lead the retrieval operations. All Westbay components were successfully removed from the well. The Westbay retrieval report is presented in Appendix C. The retrieval report describes field operations in detail and documents field measurements recorded in association with the retrieval process.

2.2 Video Logging

After removal of the Westbay system, a downhole video camera was run in the R-14 well on February 11, 2008, to document current screen and casing conditions and verify screen locations, total working depth of the well, and composite static water level (SWL) before testing and backfilling activities began. Los Alamos National Laboratory's (the Laboratory's) geophysical trailer and camera were used to complete video logging from the surface to the TD of the well. Ground surface was used as the datum for all video depth measurements. SWL in the well at the time of logging was recorded at 1181.4 ft below ground surface (bgs). Observed screen depths, SWL, and total well depth are noted in Table 2.2-1. Overall, water clarity was good to very good and provided good visibility of the screened intervals. A well log DVD is included with this report as Appendix D.

2.3 Verification of Hydraulic Parameters—Preabandonment Hydraulic Testing

Specific capacity testing was performed before screen abandonment and after well development. The purpose of performing hydraulic testing at both screens before abandonment of screen 2 was to ensure that screen 1 could provide a sustained rate of pumping during sampling and to determine design parameters for pump selection. Testing consisted of pumping screens 1 and 2 simultaneously and testing each screen individually. After well rehabilitation and conversion efforts, screen 1 was tested again (section 2.6) to evaluate the effectiveness of the development procedures.

Testing was performed by installing a submersible pump. An inflatable packer was located above the pump to eliminate casing storage effects in the drawdown and recovery data. A pressure transducer was installed between the pump and packer to collect water-level data for specific capacity determination. Initial testing was done with a 3 hp submersible pump that was limited in capacity to less than 4 gal./min. Postdevelopment testing was performed with the larger pump used for jet development. One of the postdevelopment tests was conducted by valving back the discharge rate of the large pump to between 3 and 4 gal./min to provide a valid comparison of the pre- and postdevelopment performance.

A corollary benefit of the data collection effort was to obtain a data set that could support hydraulic analysis of the screen 1 and 2 zones. A detailed hydraulic analysis of the data was beyond the scope of services for the well rehabilitation project. The current discussion is limited to presenting the specific capacity results. However, the data will be archived for the future and will be available for examination if the Laboratory chooses to pursue a rigorous analysis of site hydraulics.

Preabandonment specific capacity testing was performed on February 12 and 13. Testing was performed on combined screens 1 and 2 and screen 1 individually on February 12. Screen 2 was tested separately on February 13. Table 2.3-1 summarizes the results of the tests.

The data showed that before development, screen 1 produced 3.36 gal./min with 3.08 ft of drawdown for a specific capacity of 1.09 gal./min/ft of drawdown. Screen 2 produced 3.58 gal./min with 20.7 ft of drawdown for a specific capacity of 0.17 gal./min/ft. The sum of the individual specific capacities was 1.09 + 0.17 = 1.26 gal./min/ft.

The combined zones produced a discharge rate of 3.45 gal./min with a drawdown of 2.62 and a specific capacity of 1.32 gal./min/ft. Curiously, the combined zone specific capacity was greater than the sum of the specific capacities of the individual zones. This was likely caused by greater turbulent flow in the individual tests in which each zone produced more water than during the combined test. For example, testing of screen 2 individually was performed at a rate perhaps fivefold greater than what screen 2 would have contributed during the combined test.

The key statistic from the predevelopment testing was the specific capacity of screen 1 of 1.09 gal./min/ft.

2.4 Screen 2 Abandonment

Abandonment of screen 2 at R-14 was conducted between February 13 and 20, 2008. Details of abandonment materials and placement are presented in Figure 2.4-1. Filter-grade 10/20 silica sand was used as the primary backfill material through the lower screen interval. The 10/20 sand was installed from the TD of the well at 1315.6 to 1283.3 ft bgs. Finer 20/40 filter-grade silica sand was installed above the 10/20 sand from 1283.3 to 1278.8-ft bgs. The finer 20/40 sand serves as a transition interval to keep the cement from flowing into the coarser 10/20 sand. All of the backfill sand was installed with a tremie pipe while running a small volume of potable water to carry the sand into place. A Portland-cement seal was installed above the fine transition sand from 1278.8 to 1270.1 ft bgs. Cement was emplaced using a wireline dump bailer. The dump bailer allowed discrete placement of a calculated volume of cement while minimizing impacts to the well screen by fugitive cement. The cement was allowed to cure overnight before bailing of cement-impacted water proceeded.

Before the final interval of sand was placed above the cement seal, purging with a bailer was conducted to remove any cement-impacted waters produced from seal placement. The bailer was run inside a 3-in.-diameter conductor pipe. The conductor pipe was installed in the well to isolate screen 1 from the bailing process and to prevent any fugitive cement-impacted water from contacting the screen. Approximately 100 gal. was removed with the bailer. A final interval of 10/20 sand was installed above the cement from 1270.1 to 1246.3 ft bgs above the cement seal to help isolate the cement plug. The final sand interval was placed on February 20 and 21, 2008. A stainless steel and viton k-packer was installed above the abandonment materials during final hydraulic testing activities on February 28, 2008. The packer isolates the abandonment materials below from the sampled water column above.

2.5 Redevelopment of Screen 1

Well development of screen 1 consisted of three activities: (1) swabbing, (2), high-velocity jetting with simultaneous pumping, and (3) final purge pumping. All development activities were performed after plugging and abandoning screen 2.

Screen 1 was swabbed using a surge block built by sandwiching a 4-in.-outer diameter nylon disc between two metal plates. The surge block was connected to a heavy weight so that effective swabbing could be accomplished in the downward direction. Swabbing was performed primarily in the downward direction by dropping the tool rapidly through the entire well screen length and then raising it slowly above the screen again to prepare for the next downward swabbing motion. Swabbing was performed continuously in this manner for 40 min. After swabbing, the well was bailed for several hours to remove loosened material from the well.

High-velocity jetting was accomplished by operating a nominal 20 gal./min submersible pump with a jetting tool attached above the pump discharge within the well screen. Because of the deep water level in R-14, it was estimated that the actual production rate of the pump would be approximately 14 gal./min. 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. The jetting tool nozzles were designed to direct a portion of the pump output through the nozzles and the balance to the surface. In this way, the jetting effectiveness was enhanced by ensuring net removal of water from the screen zone throughout the development process, i.e., simultaneous jetting and pumping.

During the jetting procedures, numerous pump problems were encountered. On the first two jetting attempts, operation of the pump did not bring water to the surface. The pump was pulled and tested at the surface and found to underperform. The pump bowls were replaced; the new bowls were also underperforming significantly. A different electrical controller was substituted, resulting in improved pump performance. During subsequent well testing, however, pump operation produced only 11 gal./min compared with the estimated14 gal./min, indicating slight persistent underperformance of the replacement equipment. The cause of the continued substandard pump operation, even with new bowls and controller, was not determined.

Screen 1 was developed using a jetting tool having four nozzles, each 1/16 in. in diameter. Based on the water level in the well, the jetting pressure was estimated to be about 550 psi. At this pressure, the flux rate through the four nozzles was estimated to be about 9 gal./min. A total pumping rate of 14 gal./min would have implied a net discharge to the surface of 14 – 9 = 5 gal./min. During operation, however, flow to the surface averaged between 8 and 9 gal./min. This difference implied a jetting rate of just

5 to 6 gal./min, suggesting that perhaps two of the four jetting nozzles had become plugged or mostly plugged with sediment and that only two were operating. Jetting of the screen surface was performed continuously for more than 3 h. During jetting and simultaneous pumping, the discharge water brought to the surface was discolored and contained sediment, demonstrating effectiveness of the procedures.

After well development, purging was performed to achieve final cleanup of the well. The pump was set and operated at multiple elevations in the well to ensure cleaning the well screen as well as removing the stagnant water above screen 1. Initially, the pump was operated with the intake at 1198 ft (a couple of feet above the well screen). Then the pump was raised to about 1187 ft (within 6 ft of the SWL) and operated briefly to evacuate the stagnant water above the screen. Operating the pump at this elevation ensured "starving" the pump and pulling the pumping water level down to the pump intake so that the entire water column above the screen was pumped out of the well. Finally, the pump intake was returned to 1198 ft for further purging and testing.

The pumping events served multiple purposes. In addition to cleaning the well, each pumping episode was used to quantify the specific capacity of the well for comparison to that measured before well development. Also, the final purging/testing event was extended for several hours to obtain an extensive suite of water samples from the well.

2.6 Hydraulic Testing—Postdevelopment

After development of screen 1, specific capacity tests were performed on February 28 and 29. The pumping results are summarized in Table 2.3-1. On February 28, the discharge rate was adjusted to between 3 and 4 gal./min to obtain data that could be compared with the predevelopment screen 1 test (which was conducted at 3.36 gal./min). The adjusted discharge rate was 3.23 gal./min, resulting in a drawdown of 2.02 ft and a specific capacity of 1.60 gal./min/ft. This represented a 47% increase over the specific capacity measured before well development. This confirmed that the well development procedures were reasonably effective.

On February 29, extensive pumping of screen 1 was performed at a discharge rate of 11.0 gal./min. The resulting drawdown was 7.7 ft, yielding a specific capacity of 1.43 gal./min. The reduction in specific capacity at the greater discharge rate, from 1.60 to 1.43 gal./min/ft, was attributable to increased turbulent flow associated with increased flow velocities at the greater discharge rate.

2.7 Water Quality

Table 2.7-1 shows the sample collection objectives for R-14 screen 1 during the hydraulic testing and the constituents that were measured in the field and laboratory.

2.7.1 Sample Collection, Field Preparation, and Analytical Techniques

A total of 17 primary groundwater samples were collected during the aquifer performance test conducted at R-14 screen 1 on February 29, 2008. Field parameters consisting of pH, turbidity, dissolved oxygen (DO), temperature (T), specific conductance (SC), and oxidation-reduction potential (ORP) were measured using a flow-through cell (Geotech) during pumping and sample collection. Measurements for the different field parameters recorded during the pumping test are provided in Table 2.7-2. Field pH and temperature were measured using a Beckman (Model 255) meter and DO was measured using a WTW (Model OXI-330I) DO meter. SC and ORP were measured using a HACH Sension-5 meter and a Thermoelectron Corp. (Russell RL 060P Model) instrument, respectively. Two equipment rinseate blanks and one field blank were collected during the pumping test. On February 29, 2008, groundwater samples were generally collected every 5 min during the initial 25 min of the pumping test (Table 2.7-1). The frequency of sample collection decreased to every 10 min from 25 to 75 min during the test and every 30 min from 75 to 285 min (4.75 h). Groundwater pumping continued from 315 to 381 min (6.35 h), and no groundwater samples were collected for laboratory analyses during this time period. Field parameters, however, were measured during this interval. Groundwater samples were collected using a submersible pump consisting of a mild-steel discharge pipe equipped with a standard retrofitted submersible pump. The discharge rate varied from 10.40 to 10.97 gal./min during the aquifer performance test.

Twenty-one water samples (including 17 primary groundwater samples, 2 duplicates, and 2 equipment rinseate blanks) were filtered before analyses for metals, trace elements, and major cations and anions. Aliquots of samples collected from R-14 screen 1 were filtered through 0.45-μmeter (μm) Geotech disposable filters. Twenty-two nonfiltered samples (17 primary groundwater samples, 2 duplicates, 1 field blank, and 2 equipment rinseate blanks) were also analyzed for the same suite in addition to sulfide. Thirteen of the 22 nonfiltered samples were analyzed for total organic carbon (TOC) because of a component failure (broken heating element in the reaction chamber) associated with the TOC analytical instrument. Samples were acidified with analytical-grade nitric acid to a pH of 2.0 or less for metal and major cation analyses. Nonfiltered samples were collected for measurement of anions and total sulfide. Samples collected for total sulfide analyses were preserved with a buffer consisting of sodium hydroxide, ethylenediaminetetraacetic acid (EDTA), and ascorbic acid. Samples collected for TOC analysis were not filtered or acidified.

Chemical analyses of screening-groundwater samples were performed at the Laboratory's Earth and Environmental Sciences Group 6 (EES-6) laboratory. Groundwater samples were analyzed by EES-6 using techniques specified in the U.S. Environmental Protection Agency SW-846 Manual. Total carbonate alkalinity was measured using standard titration techniques. Ion chromatography was the analytical method for bromide, chloride, fluoride, nitrate, nitrite, oxalate, chlorate, phosphate, and sulfate. Total sulfide was determined by ion selective electrode, with a detection limit of 0.010 mg/L. Inductively coupled (argon) plasma optical emission spectroscopy (ICPOES) was used for analyses of calcium, magnesium, potassium, silica, and sodium. 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). The precision limits (analytical error) for major ions and trace elements were generally less than ±10% using ICPOES and ICPMS. TOC was measured using a total carbon-organic carbon analyzer.

2.7.2 Field Parameters

Field parameters measured during the February 29, 2008, test and previous values measured from February 9, 2004, to February 29, 2008, are provided in Table 2.7-2 and are shown in Figure 2.7-1. Field pH varied from 7.53 to 7.71; T varied from 23.6°C to 24.3°C during the 2008 aquifer performance test conducted at R-14 screen 1; prior T values are not reliable because of long residence times in Westbay sampling bottles. SC generally decreased from 131 to 127 microSiemens per centimeter (μS/cm) and DO varied from 3.73 to 6.30 mg/L. All turbidity measurements were less than 2 nephelometric turbidity units (NTUs) (Table 2.7-2, Figure 2.7-1). ORP measurements varied from –26 to +118 millivolts during the pumping test. The variability in ORP throughout the pumping test suggests that groundwater is weakly poised with respect to reactive reductants and oxidants, inferring ORP values to be qualitative. A new platinum-reference electrode was used during part of the pumping test, starting with samples collected at 3:06 p.m. on February 29, 2008, in response to instrument drift resulting in anomalous negative readings. Field ORP is used along with analytical results (DO, nitrate, manganese, iron, sulfide, and sulfate) to evaluate the redox state of groundwater. Concentrations of DO ranged between 3.73 and 4.25 mg/L during this part of the test, which are considered to be more reliable than the questionable negative ORP readings recorded between 10:40 a.m. and 2:50 p.m. on February 29, 2008.

2.7.3 Analytical Results

Analytical results for groundwater samples collected during performance testing at R-14 screen 1 are provided in Appendix A, Table A-1. Charge balance errors for dissolved cations and anions were generally less than ±10%. Figure 2.7-2 shows concentration trends of several ions during pumping of the regional aquifer (screen 1) at R-14. Calcium and sodium are the dominant cations present in the regional aquifer at R-14 screen 1 (Table A-1). Dissolved concentrations of calcium and sodium do not exceed maximum background concentrations of 41.70 and 32.90 mg/L, respectively, for regional aquifer groundwater (LANL 2007, 095817). Dissolved concentrations of calcium decreased from 12.0 to 9.88 mg/L or mg/L, and dissolved concentrations of sodium varied from 9.97 to 11.1 mg/L during pumping. Dissolved concentrations of chloride slightly varied from 2.92 to 3.09 mg/L, not exceeding the maximum background of 5.95 mg/L (LANL 2007, 095817). Concentrations of total carbonate alkalinity slightly varied from 75.7 to 76.9 mg $CaCO_3$/L and are less than the maximum background of 152 mg $CaCO_3$/L (LANL 2007, 095817). Dissolved concentrations of sulfate varied from 4.24 to 5.40 mg/L during pumping (Figure 2.7-2, Table A-1). Sulfate concentrations at R-14 screen 1 are less than the maximum background concentration of 8.63 mg/L for this anion (LANL 2007, 095817).

Concentrations of total sulfide were less than detection (0.010 mg/L), suggesting that sulfate reduction was not significant during pumping. ORP and DO measurements and stable sulfate concentrations also indicate that the groundwater is not sufficiently reduced to enhance stability of dissolved sulfide species at R-14 screen 1. Concentrations of TOC generally decreased from 1.13 to 0.42 mgC/L during pumping. Dissolved concentrations of nitrate(N) slightly varied from 0.35 to 0.39 mg/L during pumping (Figure 2.7-2, Table A-1).

Dissolved concentrations of barium ranging from 0.051 to 0.057 mg/L at R-14 screen 1 are within background distributions for regional aquifer groundwater (0.0049 to 0.115 mg/L) (LANL 2007, 095817). Dissolved concentrations of uranium range from 0.0010 to 0.0012 mg/L (Table A-1) and are less than the maximum background of 0.0025 mg/L for this actinide (LANL 2007, 095817). Uranium(VI) for the most part is the stable oxidation state of this actinide at R-14 screen 1, based on similar concentrations of uranium in sample pairs for filtered and nonfiltered aliquots. Uranium(VI) complexes, including $UO_2(CO_3)_2^{2-}$ and $UO_2(CO_3)_3^{4-}$, are mobile in oxidizing groundwater under basic pH conditions (Langmuir 1997, 056037) characteristic of R-14 screen 1.

Figure 2.7-3 shows concentrations of iron and manganese in filtered and nonfiltered samples collected at R-14 screen 1 since February 2004. During the February 2008 test, dissolved concentrations of iron and manganese ranged from 0.17 to 0.22 mg/L and from 0.081 to 0.113 mg/L (Table A-1), respectively. Concentrations of iron and manganese in filtered and nonfiltered samples decreased during characterization sampling conducted from 2004 to 2006. Higher concentrations of iron in both filtered and nonfiltered samples, however, were measured during the 2008 pumping test than during characterization sampling using the Westbay sampling system (Figure 2.7-3). During the 2008 pumping, concentrations of manganese increased; however, they were within the range of previous measurements (Figure 2.7-3). During this test, dissolved concentrations of iron exceeded the maximum background value of 0.147 mg/L, whereas dissolved concentrations of manganese did not exceed the maximum background value of 0.124 mg/L (LANL 2007, 095817).

During the 2008 test, iron concentrations in nonfiltered samples were greater than those in filtered samples (Table A-1) (Figure 2.7-3), suggesting the presence of iron-bearing particulates. Elevated, above-background concentrations of iron at R-14 screen 1 are hypothesized to result mainly from the presence of particulate hydrous ferric oxide (HFO) smaller than 0.45 μm (filter size) derived from the regional aquifer. Secondary effects of elevated iron may result from discharge pipe corrosion (see below) used to collect samples throughout the test. Concentrations of iron in filtered groundwater samples exceed those measured in the two filtered rinseate blanks, providing evidence for colloidal HFO derived from pumping of R-14 screen 1. Concentrations of DO consistently above 2 mg/L, TOC concentrations consistently less than 1 mgC/L, and detectable nitrate (as N) also support the stability of colloidal HFO in oxidizing groundwater at R-14 screen 1. Reductive dissolution of natural manganese dioxide possibly has taken place within the regional aquifer, based on very similar concentrations of manganese in filtered and nonfiltered samples (Figure 2.7-3, Table A-1).

Two equipment rinseate blanks (nonfiltered) collected from the pump (hardened steel) and discharge pipe (mild steel) have concentrations of total manganese and iron of 0.004 and 0.042 mg/L and 0.2 and 11.4 mg/L, respectively (Table A-1). Other metals and trace elements detected in the nonfiltered rinseate blanks include aluminum (0.023 and 0.103 mg/L) and zinc (0.024 and 0.052 mg/L) (Table A-2). Total concentrations of lead in the nonfiltered rinseate samples were 0.0031 and 0.0026 mg/L.

2.7.4 Well Screen Analysis

Previous Results

Analytical results obtained from sampling of well R-14 screen 1 were evaluated for representativeness and reliability of the water quality data obtained from this well, following geochemical protocols established by the Laboratory (2007, 096330) and approved by NMED (2007, 098182). Groundwater samples were collected from this Westbay-equipped well from 2004 to 2007 during 10 sampling events (LANL 2007, 096330). Groundwater samples collected from R-14 screen 1 during that interval have well screen analysis scores that range from 86% to 92%, with an average score of 90% (LANL 2007, 096330). The test scores for the 2004–2007 samples varied over time; two to four analytes or general indicators per sampling event failed the geochemical criteria, consisting of 31 to 36 individual tests. Analytes that did not meet the well screen criteria during one or more of the previous sampling rounds included ORP, manganese, iron, perchlorate, barium, chromium, and/or nitrate (LANL 2007, 096330).

Updated Well Screen Analysis

Table B-1 provides results of the Laboratory's well screen analysis using analytical results obtained during this 2008 pumping test. A total of eight primary groundwater samples were selected for this analysis, including nonfiltered samples GW14-08-10725, GW14-08-10731, GW14-08-10737, and GW14-08-10743 and filtered samples GW14-08-10727, GW14-08-10787, GW14-08-10793, and GW14-08-10799. These four filtered/nonfiltered pairs of samples were collected at evenly spaced intervals throughout the pumping test. These groundwater samples analyzed from well R-14 screen 1 during the 2008 test have scores of 97%, consisting of 33 and 34 criteria (Table B-1). Two negative ORP measurements were not included as part of the geochemical screening criteria for the selected samples due to electrode malfunction. The average well screen test score for the 2008 test is 97%, which is an improvement over the previous average score of 90% for the 2004 to 2007 samples. Elevated above-background concentrations of dissolved iron (17 samples) contributed to samples failing one criterion of the well screen analysis (Table B-1).

Well screen tests for four criteria were not applicable in the updated analysis because groundwater samples were not analyzed for perchlorate, acetone, total Kjeldahl nitrogen, and ammonia.

2.7.5 Geochemical Comparison of Westbay and Pumping Test Samples

A geochemical comparison of selected analytes and pH was performed on the R-14 screen 1 samples to compare groundwaters collected by the 2004 to 2007 passive Westbay sampling system with those collected in 2008 using a submersible pump that allowed active purging. This comparison included analytical results for 10 previous sampling events, conducted from February 9, 2004, to August 14, 2007, using the Westbay system. Concentrations of total carbonate alkalinity, TOC, and dissolved chloride, iron, manganese, nitrate(N), sulfate, strontium, uranium, and zinc were generally lower in samples using Westbay equipment in comparison to those collected using a submersible pump during the 2008 pumping test (Table A-1). Higher total and dissolved concentrations of iron were measured during the 2008 pumping test than concentrations measured during previous characterization sampling. Well rehabilitation involving energetic purging or pumping of screen 1 allowed groundwater outside of the filter pack to be evacuated and sampled, providing more representative groundwater samples.

3.0 SUMMARY AND CONCLUSIONS

There were no deviations from the NMED-approved work plan. All activities were completed successfully with the exception of installation of the permanent sampling pump. R-14 will be outfitted with a single environmentally retrofitted 4-in. submersible pump with a 1-in. stainless-pump column. A dedicated, 1-in.-diameter polyvinyl chloride transducer tube will be installed with and banded to the pump column.

Screen 2 was successfully isolated and abandoned using guidance in the Compliance Order on Consent.

The specific capacity test performed on February 28, 2008, after redevelopment of screen 1 yielded a specific capacity of 1.60 gal./min/ft. This represented a 47% increase over the specific capacity measured before well development of 1.09 gal./min/ft. This confirmed that the well development procedures were reasonably effective, despite poor operation of the submersible jetting pump.

On February 29, 2008, extensive pumping of screen 1 yielded a specific capacity of 1.43 gal./min. The reduction in specific capacity at the greater discharge rate, from 1.60 to 1.43 gal./min/ft, was attributable to increased turbulent flow associated with increased flow velocities at the greater discharge rate.

The water quality of screen 1 was very good even before redevelopment of screen 1 but improved as a result of redevelopment activities. This conclusion is based on the following observations and data.

- Screen 1 turbidity values were less than 2 NTUs throughout the 2008 pumping test.
- Major cations and anions at screen 1, such as Ca, Cl, Na, NO^3(N), and SO_4 and TOC, are within background values established for regional aquifer groundwater.
- The elevated, above-background concentration of iron probably results mainly from the presence of particulate HFO, smaller than 0.45 μm (filter size), within the regional aquifer. Secondary effects of elevated iron may be produced from discharge pipe corrosion during sampling.
- Groundwater samples analyzed from well R-14 screen 1 during the 2008 test have an average well screen analysis score of 97%, with each test having a score of 97%. The average well screen score for the 2004–2007 characterization sampling, during which the nonpurging Westbay sampling system was in use, was 90%. Excessive concentrations of dissolved iron (17 samples) exceeding Laboratory background levels contributed to samples failing only one criterion of the 2008 well screen analysis.

- Concentrations of total carbonate alkalinity, TOC, and dissolved chloride, iron, manganese, nitrate(N), sulfate, strontium, uranium, and zinc were generally lower in samples using Westbay equipment in comparison to those collected during the 2008 test (Table A-1). Well rehabilitation involving energetic purging or pumping of screen 1 allowed groundwater outside of the filter pack to be sampled, providing more representative groundwater samples.

4.0 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 number. This information is also included in text citations. ER ID numbers 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; the U.S. Department of Energy–Los Alamos Site Office; the U.S. Environmental Protection Agency, Region 6; 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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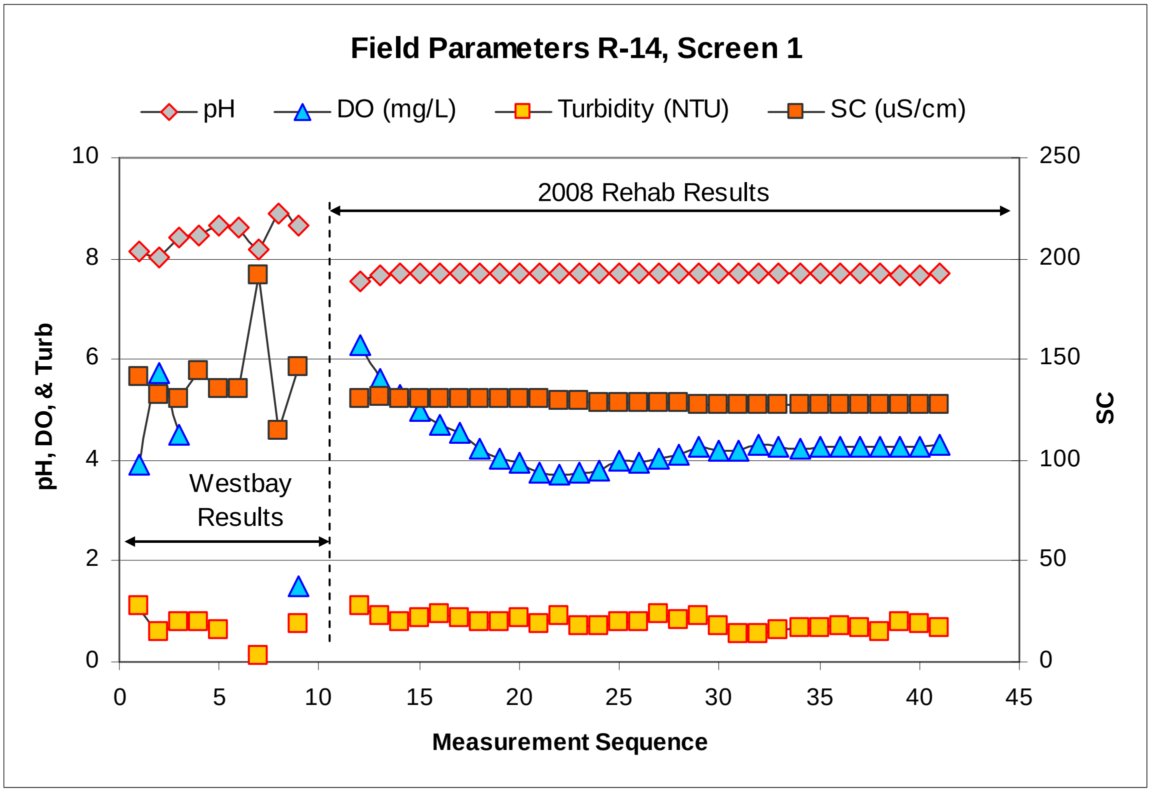

Figure 2.7-1 Field parameters measured at R-14 screen 1 from 2004 to 2007 using the Westbay sampling system and the February 29, 2008, pumping test

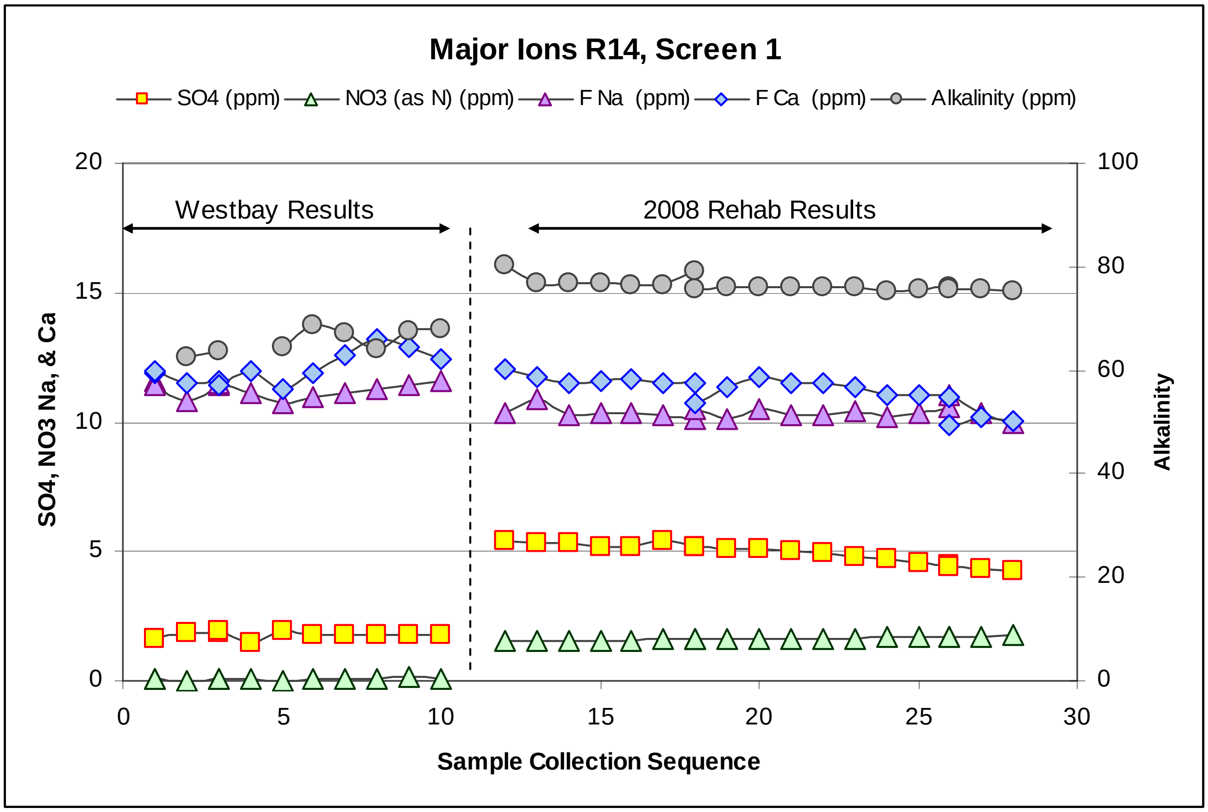

Figure 2.7-2 Sample sequence versus dissolved concentrations of total carbonate alkalinity (mgCaCO^3/L), sodium (Na), calcium (Ca), sulfate (SO_4), and nitrate(N) (NO_3-N) at R-14 screen 1 from 2004 to 2007 using the Westbay sampling system and the February 29, 2008, pumping test

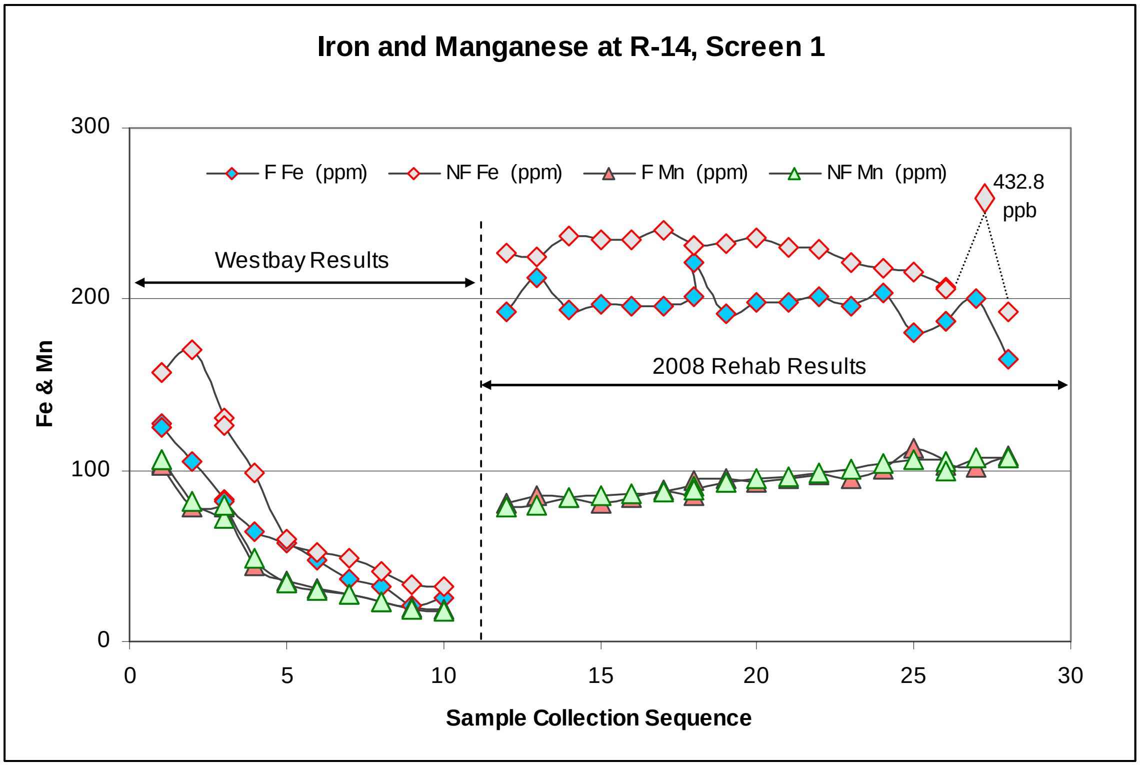

Figure 2.7-3 Sample sequence versus dissolved and total concentrations of iron (Fe) and manganese (Mn) during characterization sampling from 2004 to 2007 using the Westbay sampling system and the February 29, 2008, pumping test

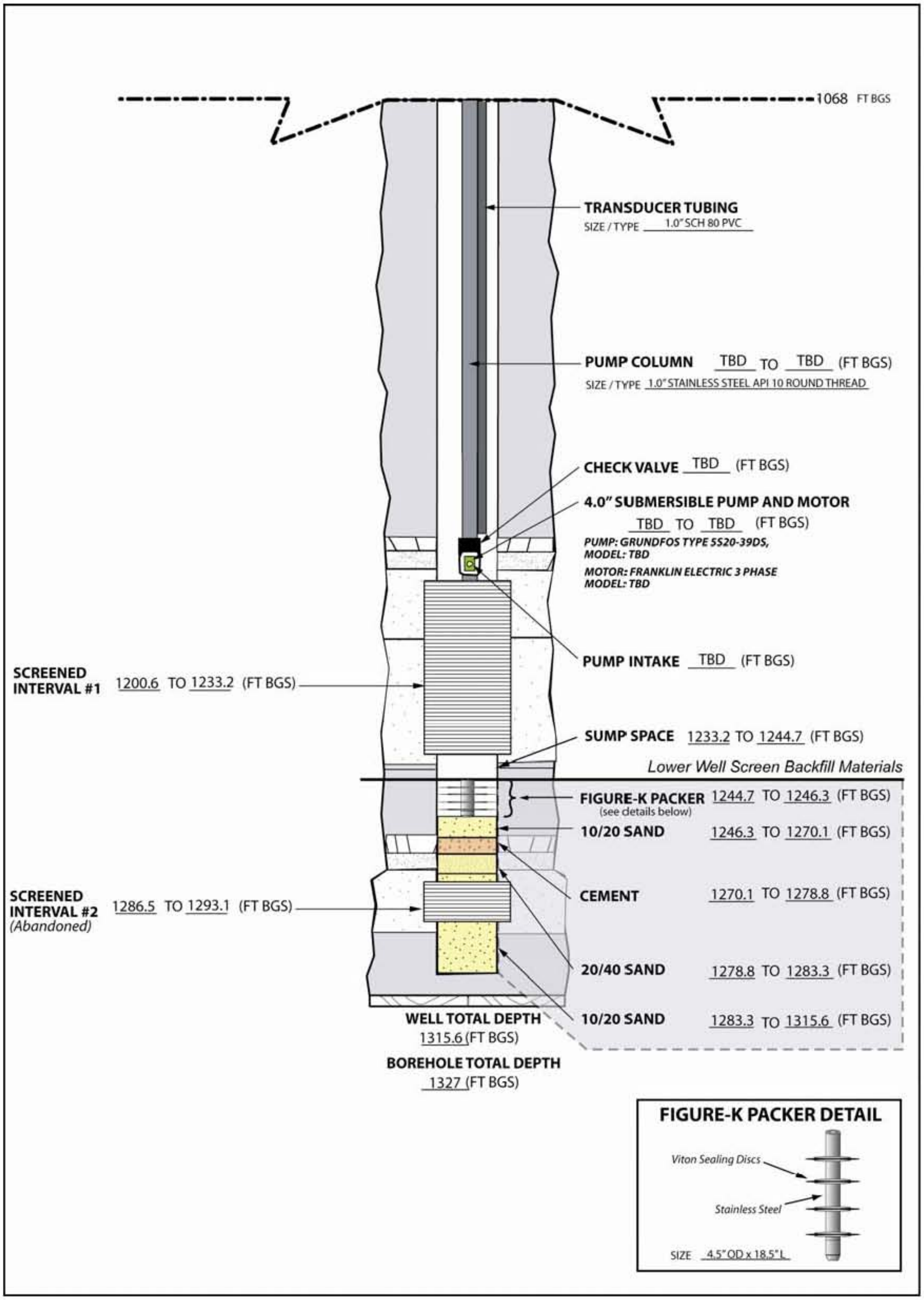

Figure 2.4-1 Well R-14 final rehabilitation and conversion configuration

Table 2.7-1
Sample Collection Objectives and Measured Constituents for the R-14 Well Rehabilitation and Conversion Project

Process/Step	Purpose	Sample Collection	Field Parameters	Frequency/Number of Samples
Remove Westbay System	Prepare well for rehabilitation	None	None	None
Video well	Assess screen condition, determine composite SWL before redevelopment	DVD and VHS recording	None	None
Pump Screen #1 and Screen #2 from Isolated Screens to Evaluate Screen Performance	Measure specific capacity and assess flow rate and drawdown during sustained pumping of each zone.	None	Measure flow rate and drawdown	None
Jet and Simultaneously Pump Screen #1	Redevelop screen #1	None	None	None
Swab Screen #1	Redevelop screen #1	None	None	None
Abandon Screen #2	Isolate screen #2 from screen #1	None	None	None
Pump Screen #1 to Evaluate Groundwater Chemistry and Screen Performance	Measure specific capacity and assess water quality from screen #1 during sustained pumping	Collect performance suite (see notes below)	Flow rate and drawdown, pH, ORP, T, SC, DO, and turbidity	Every 5 min for first 30 min; 10 min for next 30 min; 30 min for a minimum of 3 h; each hour until end of specific capacity test (25 performance suite samples per screen). Paperwork for additional samples will be ordered if rehabilitation activities are extended.
Install K-Packer and Submersible Pump Sample System	Long-term sampling	None	None	None

Table 2.7-1 (continued)

Process/Step	Purpose	Sample Collection	Field Parameters	Frequency/Number of Samples
Performance Measurement, *after* Submersible Pump Installment	Test effects of rehabilitation	Sample 1 mo after installation; full suite analysis, followed by semiannual monitoring, per "2007 Interim Facility-Wide Groundwater Monitoring Plan" requirements and schedule	pH, ORP, T, SC, DO, turbidity	Refer to the "2007 Interim Facility-Wide Groundwater Monitoring Plan" for analytes and sampling schedule

Notes: Performance suite: Sulfide (not filtered), total organic carbon (not filtered), metals and cations (filtered and nonfiltered), alkalinity (nonfiltered), and anions (including perchlorate, filtered), from the Earth and Environmental Sciences-6 laboratory.

Full analytical suite: Refer to the "2007 Interim Groundwater Monitoring Plan" watershed analytical suites (volatile organic compounds, semivolatile organic compounds, general inorganics [including alkalinity], metals, radionuclides, tritium, stable isotopes of hydrogen, oxygen, and nitrogen). Full analytical suite samples to be collected after installation of the dedicated sampling system.

Table 2.7-2
Field Parameters Measured at R-14 Screen 1

Sample Collection System	Sample Collection Date	Sample Collection Time	pH (SU)[a]	Temp (deg C)	SC (uS/cm)	DO (mg/L)	Turbidity (NTU)	ORP[b] (mV)	Cumulative Volume Purged[c] (gal.)	Pumping Rate (gal/min)
Westbay Sampling System	2/9/04	14:00	8.13	18.1	141.4	3.9	1.1	411.5	≈ 5	< 0.1
	5/11/05	8:43	8.03	16.5	132.0	5.7	0.6	na[d]	≈ 5	< 0.1
	1/24/06	9:39	8.40	18.9	130.1	4.5	0.8	na	≈ 5	< 0.1
	6/26/06	11:17	8.44	21.7	144.0	na	0.8	na	≈ 5	< 0.1
	10/23/06	10:30	8.67	20.5	135.0	na	0.6	na	≈ 5	< 0.1
	10/23/06	10:23	8.61	na	135.0	na	na	na	≈ 5	< 0.1
	3/1/07	14:33	8.18	15.3	191.3	na	0.1	na	≈ 5	< 0.1
	6/5/07	8:58	8.9	na	114.8	na	na	na	≈ 5	< 0.1
	8/14/07	11:06	8.66	24.8	146.0	1.5	0.75	na	≈ 5	< 0.1
Packer-Pump Sampling System (well rehabilitation effort)	2/29/2008	9:35	7.53	23.8	130.3	6.3	1.1	83[a]	729.0	10.7
	2/29/2008	9:40	7.66	23.6	131.1	5.6	0.9	28[a]	919.3	10.7
	2/29/2008	9:45	7.69	23.6	130.9	5.3	0.8	20[a]	972.8	10.7
	2/29/2008	9:50	7.70	23.6	130.9	5.0	0.9	12[a]	1031.0	10.8
	2/29/2008	9:55	7.71	23.6	130.7	4.7	0.9	13[a]	1089.8	10.8
	2/29/2008	10:00	7.71	23.6	130.5	4.5	0.9	12a	1149.0	10.9
	2/29/2008	10:10	7.71	23.6	130.4	4.2	0.8	8[a]	1260.9	10.9
	2/29/2008	10:20	7.71	23.6	130.4	4.1	0.8	5[a]	1372.1	10.9
	2/29/2008	10:30	7.71	23.4	130.2	3.9	0.9	3[a]	1482.4	10.9
	2/29/2008	10:40	7.71	23.6	130.1	3.8	0.8	-11[a]	1585.6	10.8
	2/29/2008	10:50	7.71	23.6	129.9	3.7	0.9	-19[a]	1686.4	10.7
	2/29/2008	11:20	7.72	24.0	129.9	3.8	0.7	24[a]	1997.6	10.7
	2/29/2008	11:50	7.70	24.3	128.6	3.8	0.7	-13[a]	2306.9	10.7
	2/29/2008	12:20	7.70	24.1	128.6	4.0	0.8	-11[a]	2632.2	10.9
	2/29/2008	12:50	7.70	23.7	128.5	4.0	0.8	-27[a]	3008.4	10.9

Table 2.7-2 (continued)

Sample Collection System	Sample Collection Date	Sample Collection Time	pH (SU)[a]	Temp (deg C)	SC (uS/cm)	DO (mg/L)	Turbidity (NTU)	ORP[b] (mV)	Cumulative Volume Purged[c] (gal.)	Pumping Rate (gal/min)
Packer-Pump Sampling System (well rehabilitation effort)	2/29/2008	13:20	7.70	23.6	128.5	4.0	1.0	-26[a]	3341.5	10.9
	2/29/2008	13:50	7.69	23.7	128.5	4.1	0.8	-25[a]	3675.8	11.0
	2/29/2008	14:20	7.69	23.7	127.5	4.3	0.9	-19[a]	4015.0	11.0
	2/29/2008	14:50	7.69	23.7	127.5	4.2	0.7	-18[a]	4336.2	10.9
	2/29/2008	15:06	7.69	23.7	127.5	4.2	0.6	109	4503.2	10.9
	2/29/2008	15:11	7.69	23.6	127.3	4.3	0.6	118	4553.6	10.9
	2/29/2008	15:16	7.69	23.7	127.4	4.3	0.6	110	4608.2	10.9
	2/29/2008	15:21	7.69	23.6	127.2	4.2	0.7	96	4662.8	10.8
	2/29/2008	15:26	7.69	23.6	127.3	4.3	0.7	103	4674.2	10.7
	2/29/2008	15:31	7.70	23.7	127.0	4.3	0.7	121	4684.6	10.6
	2/29/2008	15:36	7.70	23.7	127.1	4.3	0.7	116	4694.0	10.5
	2/29/2008	15:41	7.69	23.7	127.1	4.3	0.6	107	4698.0	10.4
	2/29/2008	15:46	7.68	23.6	127.4	4.3	0.8	111	4700.8	10.8
	2/29/2008	15:51	7.66	23.8	127.6	4.3	0.8	109	4935.6	10.8
	2/29/2008	15:56	7.69	23.7	127.0	4.3	0.7	112	4989.6	10.8

[a] SU = Standard unit.
[b] = ORP measurements were not reliable during initial sample collection on 02/29/2008 due to faulty probe.
[c] = Cumulative volume purged during each sampling event; Westbay values are approximate.
[d] na = Not available.

Table 2.2-1
Video Log Observations

	Depth to		Remarks
	Top	Bottom	
SWL	1181 ft 5 in.	n/a*	Composite
Screen #1	1200 ft 1 in.	1231 ft 10 in.	Pipe-based; visibility very good; screen interval clean
Screen #2	1285 ft 4 in.	1291 ft 6 in.	Pipe-based; visibility very good; screen interval clean
TD	1311 ft 11 in.	n/a	Sediment in bottom of sump

*n/a = not applicable.

Table 2.3-1
R-14 Screen 1 and 2 Pumping Results

Date	Zone	Pumping Rate (gal./min)	Drawdown (ft)	Specific Capacity (gal./min/ft)
Predevelopment Data				
2/12/2008	Screens 1 & 2	3.45	2.62	1.32
2/12/2008	Screen 1	3.36	3.08	1.09
2/13/2008	Screen 2	3.58	20.7	0.17
Postdevelopment Data				
2/28/2008	Screen 1	3.23	2.02	1.60
2/29/2008	Screen 1	11.0	7.7	1.43