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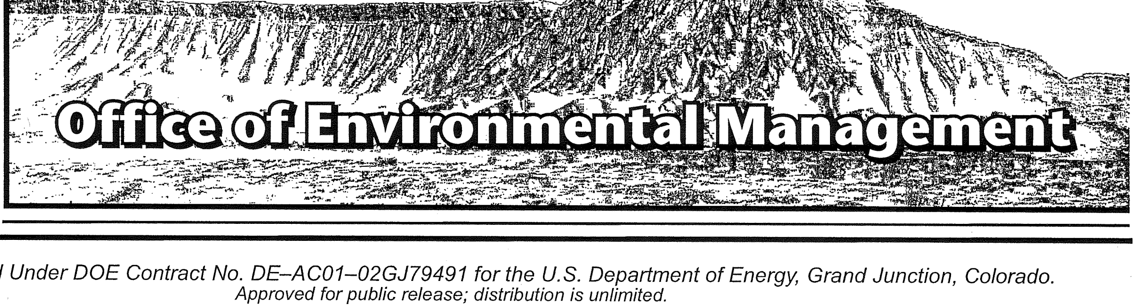
Moab Project

Fall 2004 Performance Assessment of the Ground Water Interim Action Well Fields at the Moab, Utah, Project Site

January 2005



U.S. Department
of Energy

Work Performed Under DOE Contract No. DE–AC01–02GJ79491 for the U.S. Department of Energy, Grand Junction, Colorado.

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Work Performed by S.M. Stoller Corporation under DOE Contract No. DE–AC01–02GJ79491 for
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1.0 Introduction

This document presents an evaluation of the mass extraction portion of the Ground Water Interim Action (Ground Water IA) at the Moab Project site in 2004. The IA remediation system is intended to mitigate potential environmental effects of contaminated ground water in the alluvial aquifer underlying the site as it discharges naturally to the nearby Colorado River. The system currently consists of two components, or configurations. Configuration 1, comprising ten wells close to the west bank of the Colorado River that are used solely for the extraction of contaminated ground water, began operation in July 2003. Configuration 2, comprising ten wells located immediately north-northeast of Configuration 1, was constructed during 2004 to provide extraction of contaminated ground water during a portion of each year and injection of relatively clean Colorado River water during the remainder.

Performance assessment of the Ground Water IA is important for optimal management of the Moab site in coming years. The discharge of locally contaminated ground water tends to be concentrated in sections of the river near its west bank (DOE 2003e) that are referred to as backwater areas. The IA focuses on minimizing exposure of an endangered fish population in the backwater areas to contamination in the form of dissolved ammonia.

Between December 2003 and May 2004, Configuration 1 was shut down in anticipation of renewed pumping in summer 2004. Thus, the evaluation contained herein focuses on Configuration 1 pumping from June 2004 through October of the year. Configuration 2 pumping wells were installed in late July of 2004, and test pumping of this part of the system began in early September 2004. Consequently, the Configuration 2 evaluation is limited to the months of September and October.

Various data were collected in 2004 regarding operation of the two extraction systems and aquifer responses to the pumping. In addition, discharge of the extracted ground water to an evaporation pond for treatment, contaminant concentrations in the discharge, and water surface fluctuations in the pond, were monitored.

The evaluation presented herein requires descriptions of baseline conditions in the aquifer that can be compared to those observed during pumping. Baseline data from 2003 regarding the area affected by Configuration 1 were first reported in the *Operations, Maintenance, and Performance Monitoring Plan for the Interim Action Ground Water Treatment System, Moab Utah* (DOE 2004a). The subsequent calculation entitled *Evaluation of September 2003 Preliminary Performance Data for the Interim Action* (DOE 2004b) contained additional background information. Data collected later, particularly during April and May of 2004, provided even more baseline information that could be compared to hydraulic and water quality data gathered during the Configuration 1 pumping months of June through October.

Baseline information for the area affected by Configuration 2 pumping is less plentiful than that available for Configuration 1. Nonetheless, some data gathered between July 2004, when Configuration 2 construction started, and early September 2004, when test pumping of the system began, can be used for comparison with pumping-affected information collected in September and October.

Baseline information that is useful for evaluation of both Configurations 1 and 2 is drawn from a separate area adjacent to the Colorado River but north of the extraction well fields. Located just to the south of where Moab Wash enters the Colorado River, the Baseline Monitoring Area consists of observation wells and piezometers oriented along a line orthogonal to the river channel. Monitoring of the area is designed to determine how much natural variability in chemical and hydrologic properties exists in a portion of the aquifer that is not stressed by active remediation. Some of the observation wells and piezometers in the Baseline Monitoring Area were installed during 2004 explicitly for the purpose of assisting the evaluation of Ground Water IA performance. However many of the wells were installed in previous years as part of a well cluster referred to as SMI−PW01.

2.0 Purpose and Scope

The overarching purpose of this study was to develop a comprehensive understanding of the capacity of the Ground Water IA system to extract and treat contaminated water in the alluvial ground water system lying between the Moab tailings pile and the Colorado River. This understanding was in turn used to ground truth the conceptual model of ground water flow previously developed for the site, and to assess the degree to which quantitative models of local ground water flow have been able to capture operative ground water flow and transport processes. Because of the close proximity of the Colorado River to the components of Configurations 1 and 2, it was imperative that the assessment provided in this report include some analysis of ground water/surface water interaction in response to pumping at extraction wells.

Where possible, the evaluations conducted under this study attempted to answer several questions that were identified in the *Interim Action Expansion Work Plan for the Moab, Utah, Site* (DOE 2004c). These questions, stated in general terms, included:

- Are existing extraction well locations optimal for achieving the greatest amount of contaminant mass removal and decreasing ammonia loading to backwater areas?
- What is the spatial relationship between dissolved ammonia concentrations and salinity levels in ground water?
- If ammonia concentrations are linked to salinity levels under baseline conditions, how is this linkage affected by ground water pumping?
- Does discharge of contaminated ground water to backwater areas change during pumping in comparison to baseline conditions, and in what ways?
- After pumping starts (or stops), how much time is required for the alluvial system to equilibrate?
- Will mass reduction achieved through ground water pumping impact the site’s ability to achieve long-term cleanup goals?
- Are extraction rates limited by the potential for degradation of surface water?

An additional purpose of this investigation was to identify those parts of the remedial system that contribute most to contaminant mass removal from ground water, as well as those that are not performing as originally expected. When system components are noted as performing at less-than-expected levels, such as pumping wells that appear less efficient than anticipated, it does not necessarily mean that system corrections are required. As long as the Ground Water IA system reduces contaminant discharge to acceptable levels, thereby minimizing potential environmental effects in the Colorado River, the remedial process can be considered generally effective. Mention of the performance of individual system components is made mostly for the purpose of optimizing any future remedial activities that might be called for at the Moab site.

Though the scope of work performed under this investigation focuses primarily on ground water extraction activities that occurred in 2004, reference is occasionally made to data and observations from earlier years where they enhance the evaluation of Ground Water IA performance. Activities that took place in 2003 and 2004 in the Configuration 1 area are summarized in Chapter 3 as are the activities that occurred in 2004 in the Configuration 2 area.

Because the work presented herein builds upon previous studies of the site, those studies are mentioned periodically in this report. In addition to the previously mentioned *Operations, Maintenance, and Performance Monitoring Plan for the Interim Action Ground Water Treatment System, Moab Utah* (DOE 2004a), the *Evaluation of September 2003 Preliminary Performance Data for the Interim Action* (DOE 2004b), and the *Interim Action Expansion Work Plan for the Moab, Utah, Site* (DOE 2004c), they include:

- *Site Observational Work Plan for the Moab, Utah, Site* (DOE 2003e), and
- *Site Hydrogeologic and Geochemical Characterization and Alternatives Assessment for the Moab Mill Tailings Site, Moab, Utah* (SMI 2001).

It is anticipated that some of the findings in this report will be helpful in answering questions and comments regarding the Draft Environmental Impact Statement (Draft EIS) that has been prepared for the Moab site.

3.0 Ground Water Interim Action Components and Operation

A map view of all components of the Ground Water IA is presented in Figure 1. Shown are the extraction wells, manifold systems connecting the wells, a pipeline that conveys contaminated water to the top of the Moab tailings pile, and the evaporation pond used for treating the water. A sprinkler system is used on the tailings pile to enhance evaporation of the contaminated water. Flow meters are used at each of the extraction wells to monitor pumping rates, and totalizing meters record cumulative flows originating in the respective and combined IA configurations. A staff gage in the evaporation pond tracks pond levels that change in response to incoming flows and evaporation.

Configuration 1 pumping wells were installed about 100 feet (ft) from a steep bank that forms the west bank of the Colorado River (Figure 1) during relatively high runoff periods. These wells intercept ground water that was contaminated by seepage from fluids in the Moab tailings pile.

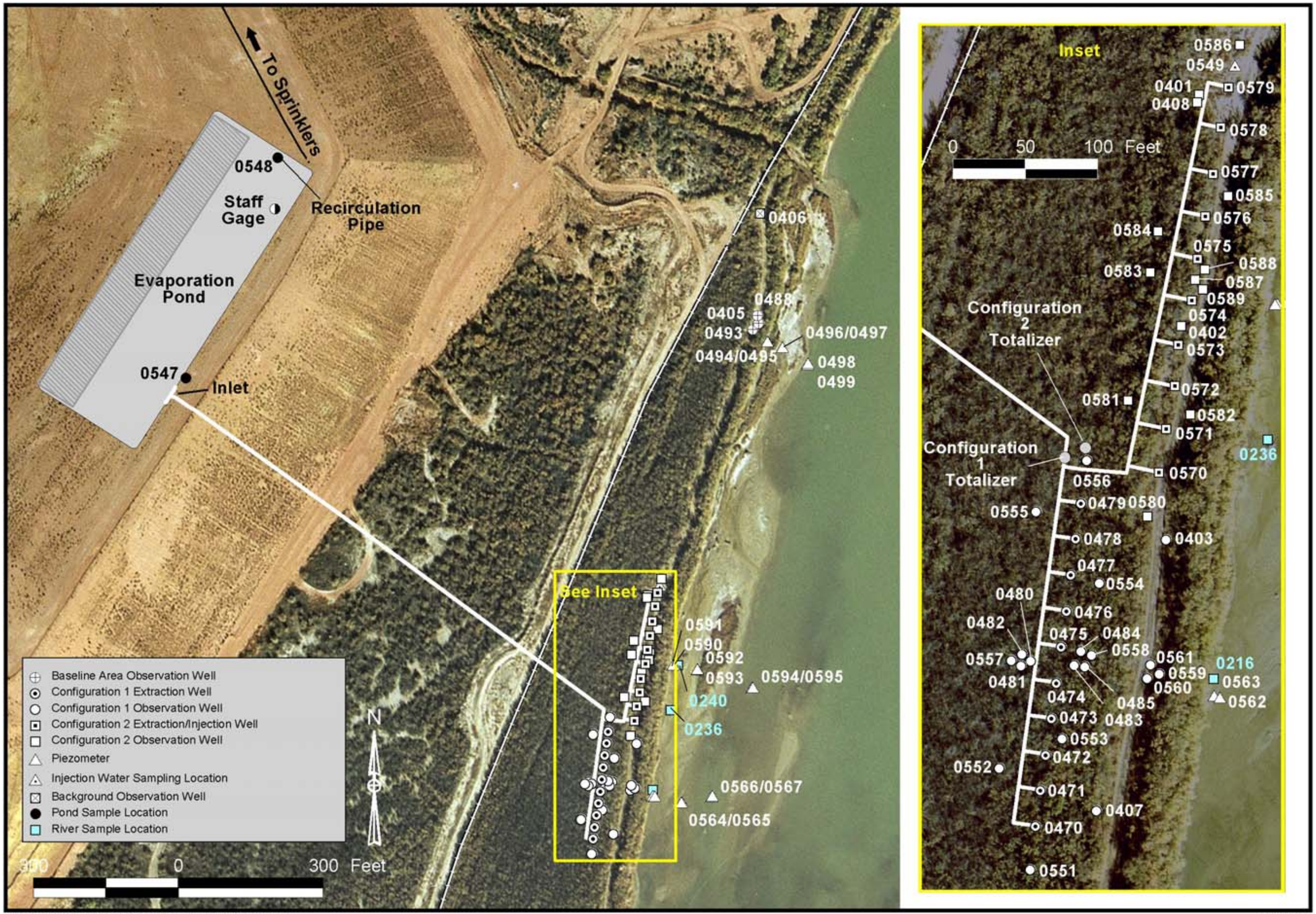

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Figure 1. Map View of Interim Action Components and Well Locations

Spacing between the extraction wells is about 25 ft. Configuration 2 wells, used for both pumping and injection (Figure 1), were placed closer to the river (about 50 ft from the steep bank) with the intent of minimizing the time for injected uncontaminated water to reach backwater areas of the Colorado River near its west bank. Spacing between Configuration 2 extraction wells is 30 ft.

3.1 Configuration 1

Configuration 1 currently consists of the ten previously mentioned extraction wells and 25 observation wells and piezometers for monitoring aquifer responses to pumping and other hydraulic stresses. Table 1 summarizes the construction of all the wells comprising Configuration 1. As this table indicates, the ten extraction wells are installed to depths of about 21 to 25 ft below ground surface (bgs). Eight of the ten are screened over identical intervals of 10.3 to 19.7 ft bgs, and the remaining two are screened over depths of about 9 to 24 ft bgs. In contrast to the extraction wells, the depths and screened intervals of Configuration 1 observation wells vary so that information collected from them can be used to portray three-dimensional (3-D) responses of the alluvial aquifer and the Colorado River to ground water pumping.

3.1.1 Alluvial Aquifer Hydrology

The uppermost 10 ft of subsurface in the vicinity of the Configuration 1 well field consists of sandy silt and silty sand deposits and is underlain by 6 ft of fine- to coarse-grained sand. Between depths of approximately 16 ft and 29 ft bgs, gravelly sands predominate, but thin clayey gravelly sand units are also occasionally encountered. From 29 ft bgs to depths approaching hundreds of feet, the alluvium appears to consist primarily of gravelly sands and sandy gravels. The top of the saturated zone in this area is located about 10 to 12 ft bgs; consequently, ground water flow in the alluvial aquifer occurs mostly within gravelly sand and sandy gravel materials.

As with other sedimentary systems, the alluvium comprising the aquifer at the Moab site is stratified. As a result, hydraulic conductivities vary with depth. The stratification also means that, at each point in the ground water system, the aquifer exhibits anisotropy, with the effective hydraulic conductivity in the vertical direction being perhaps 10 to 100 times smaller than the horizontal hydraulic conductivity.

Lithologic logs and well completion information for most of the wells in Configuration 1 were presented in Appendix A of the *Operations, Maintenance, and Performance Monitoring Plan for the Interim Action Ground Water Treatment System, Moab Utah* (DOE 2004). Those logs and others for observation wells that have been added to the Configuration 1 system since the above-mentioned report are provided in Appendix A of this report.

Table 1. Summary of Well and Piezometer Construction in the Configuration 1 Area

Well	Well Type/Relative Depth	Diameter (inches)	Ground Surface Elevation (ft above msl)	Screen Interval (ft bgs)	Total Depth (ft bgs)
MOA-403	Observation / Shallow	1	3966.90	13.3 - 18.2	18.4
MOA-407	Observation / Shallow	1	3967.20	13.3 - 18.3	18.5
MOA-470	Extraction	4	3966.56	10.3 - 19.7	21.3
MOA-471	Extraction	4	3966.59	10.3 - 19.7	21.3
MOA-472	Extraction	4	3966.62	10.3 - 19.7	21.3
MOA-473	Extraction	4	3966.67	10.3 - 19.7	21.3
MOA-474	Extraction	4	3967.02	10.3 - 19.7	21.3
MOA-475	Extraction	4	3967.13	10.3 - 19.7	21.3
MOA-476	Extraction	4	3967.38	10.3 - 19.7	21.3
MOA-477	Extraction	4	3967.30	10.3 - 19.7	21.3
MOA-478	Extraction	4	3966.82	9.6 - 23.9	25.5
MOA-479	Extraction	4	3966.60	9.3 - 23.6	25.2
MOA-480	Observation / Shallow	4	3966.94	15.5 - 19.8	20.3
MOA-481	Observation / Intermediate	4	3967.01	25.4 - 29.7	31.3
MOA-482	Observation / Deep	4	3967.03	55.4 - 59.7	61.3
MOA-483	Observation / Shallow	4	3967.00	15.5 - 19.8	20.3
MOA-484	Observation / Intermediate	4	3967.19	25.5 - 29.8	30.3
MOA-485	Observation / Deep	4	3966.99	55.6 - 59.9	60.4
MOA-551	Observation / Shallow	1	3966.65	10.3 - 20.3	20.6
MOA-552	Observation / Shallow	1	3966.33	10.2 - 20.2	20.4
MOA-553	Observation / Shallow	1	3966.87	10.6 - 20.5	20.8
MOA-554	Observation / Shallow	1	3967.63	10.4 - 20.4	20.6
MOA-555	Observation / Shallow	1	3967.32	10.2 - 20.1	20.4
MOA-556	Observation / Shallow	1	3966.69	10.2 - 20.1	20.4
MOA-557	Observation / Intermediate	6	3967.01	35.0 - 45.0	45.9
MOA-558	Observation / Intermediate	6	3966.85	35.0 - 45.0	45.1
MOA-559	Observation / Shallow	1	3967.84	10.5 - 20.5	20.7
MOA-560	Observation / Intermediate	6	3966.95	30.0 - 40.0	40.4
MOA-561	Observation / Deep	6	3966.46	45.2 - 55.2	55.3
MOA-562	Floodplain Piezometer	1	3952.82	na	1.5
MOA-563	Floodplain Piezometer	1	3953.50	na	4.0
MOA-564	Floodplain Piezometer	1	3952.71	na	1.3
MOA-565	Floodplain Piezometer	1	3952.87	na	4.3
MOA-566	Floodplain Piezometer	1	3951.73	na	1.4
MOA-567	Floodplain Piezometer	1	3951.72	na	3.8

na = not applicable

3.1.1.1 Density-Dependent Ground Water Flow

Ground water flow in the vicinity of Configuration 1 is strongly affected by water density, which varies spatially with changes in total dissolved solids (TDS) concentration (DOE 2003e). Local TDS concentrations vary from those categorized as moderately saline (TDS = 3,000 to

10,000 milligrams per liter [mg/L]) to very saline (TDS = 10,000 to 35,000 mg/L), and briny (TDS > 35,000 mg/L) (McCutcheon et al. 1993). Brine waters dominate the deepest parts of the alluvium and are attributed to chemical dissolution of the underlying Paradox Formation, a large and relatively deep evaporite unit that has been deformed to create a salt-cored anticline aligned with and underlying the Moab Valley (Doelling et al. 2002). The moderately saline and very saline waters result mostly from the mixing of eastward-moving shallow ground water at the site with the deeper brine. However, some of the highly saline ground water is also attributed to downward seepage of high-TDS fluids from the base of the Moab tailings pile, a process that occurred during and immediately after the years of facility operation. Density-dependent ground water flow processes cause TDS concentrations to increase with depth near Configuration 1.

Depth to the top of the brine (brine surface) is greatest in the western and northern portions of the site and shallowest at the Colorado River. Depth to the brine surface also decreases gradually with distance south of Configuration 1, and brine is found in shallow ground water west of and adjacent to the river in a sizeable area located about 1,000 ft south of Configuration 1. In the Ground Water IA areas, hydrologic data indicate that the river and much of the alluvium immediately adjacent to it collectively act as a site of ground water discharge, with moderately saline and very saline water entering the river right at its west bank, and brine discharging somewhat farther away from the bank. Figure 2 provides a cross-sectional view of conceptualized ground water flow near Configuration 1 under background, non-pumping conditions. The brine surface (referred to in other reports as the “saltwater interface”) in the vicinity of Configuration 1 is about 35 to 40 ft bgs. And, as suggested in Figure 2, this surface appears to intersect the river close to its west bank (DOE 2003e).

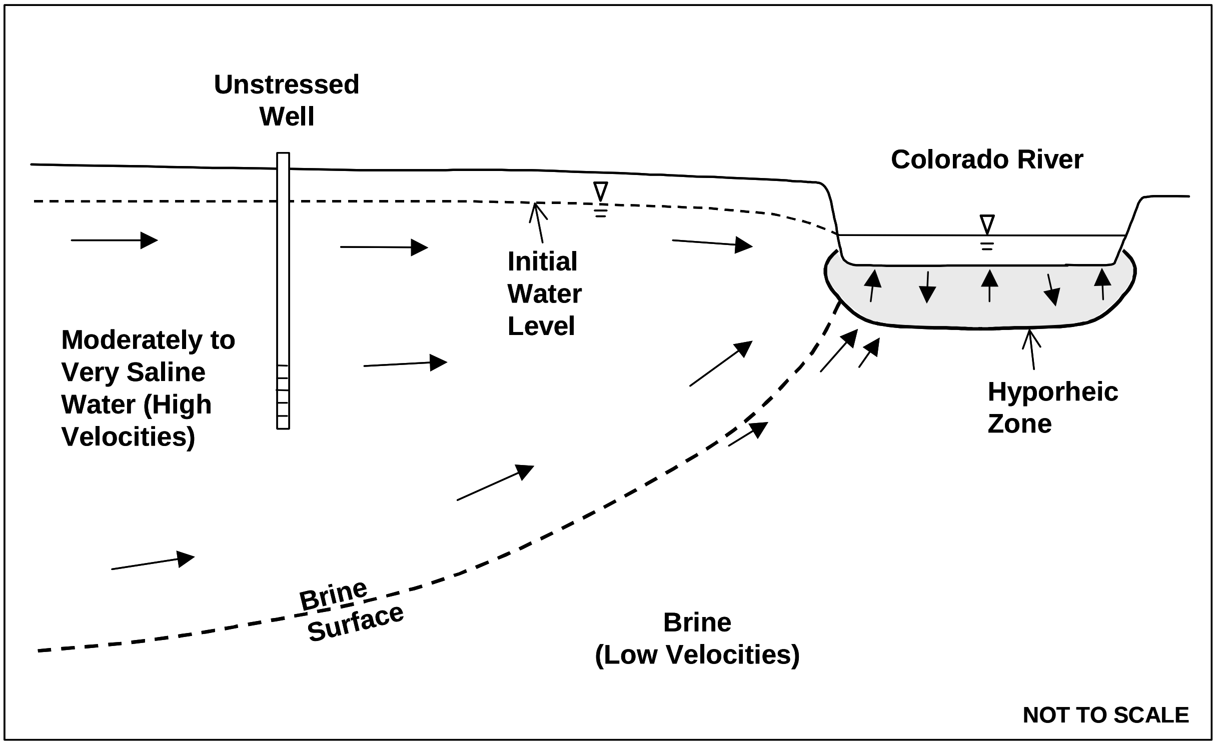

Figure 2. Conceptualization of Ground Water Flow Under Background Conditions

3.1.1.2 River-Aquifer Relationships

Previous data analyses and density-dependent ground water modeling (DOE 2003e) indicate that ground water flow in the vicinity of Configuration 1 has both an eastward and upward component, with the latter of these being caused by upward migration of saline and briny water toward the Colorado River. Though there is a preponderance of ground water discharge to the river, the potential presence of a hyporheic zone at the base of the river is also indicated (Figure 2). Mixing of river water with ground water is possible within this zone where it does exist, making it possible for shallow ground water to sometimes exhibit TDS concentrations that are less than those in deeper sediments. Accordingly, mixing of waters in the hyporheic zone could also dilute contaminated ground water before it ultimately discharges to the river.

Previous investigations (DOE 2003; DOE 2004b) have shown that surface water flow in the Colorado River can strongly affect ground water elevations in, and, therefore, the flow hydraulics of, the alluvial aquifer at the Moab site. In particular, as river flow increases, causing the river's water surface to rise, ground water levels in the aquifer also increase. When this happens, the amount of available drawdown in shallow Configuration 1 extraction wells increases, making it possible for the wells to be more productive than when water levels are lower.

Changes in river surface elevation tend to also affect ground water salinity, in that an increase in river stage causes a proportional increase in the elevation of the brine surface, and vice versa. This phenomenon is analogous to the movement of the transition zone between seawater and freshwater within coastal aquifers in response to ocean tides. The net effect of increasing river flows under non-pumping conditions is an increase in the average TDS concentration within the screened interval of a well. Concomitant changes in the concentrations of individual ground water constituents, if they do occur, are not readily identified.

Because an increase in river flow tends to raise background salinity levels near a well, a related increase in the TDS concentrations of water pumped from that well might also be expected. However, an opposite result is frequently seen, wherein TDS levels in the pumped ground water appear to decrease with increasing river stage (Section 8.4.1). Such cases suggest that a greater portion of the water drawn into a well during a high river stage comes from the shallow part of the aquifer, where TDS concentrations are relatively low, than occurs when river stage is low. The increased availability of shallow ground water might be caused by migration of the river surface closer to the pumping wells as the river rises. The net result is that less of the total volume of pumped water comes from deeper horizons where TDS levels are higher.

3.1.2 Hydrogeologic Characterization in 2003

The Configuration 1 extraction wells were installed in June of 2003. The wells were developed using surge and bail techniques, as described in Appendix B of the *Operations, Maintenance, and Performance Monitoring Plan for the Interim Action Ground Water Treatment System, Moab Utah* (DOE 2004). Step-drawdown aquifer tests were conducted at each of the pumping wells after they were developed to estimate hydraulic properties of the aquifer prior to operating the well field and to provide some information regarding well efficiency. The pump intake was set at 18 ft bgs during each of the tests. Pumping rates and drawdowns were monitored during each of three steps (Table 2). Extraction rates during the first and second steps were maintained at 3 and 10 gallons per minute (gpm), respectively. Rates varying from 11 to 20 gpm were applied during the third step (Table 2).

Aquifer hydraulic conductivities cannot be determined using pumping rate information alone as measured drawdowns are also required. Specific capacity, defined as pumping rate divided by drawdown in a pumping well, is a variable that is often used to estimate hydraulic conductivity and to assess well efficiency. Decreasing well efficiency is often correlated with decreasing specific capacity.

Table 2. Pumping Rates, Drawdowns, and Calculated Specific Capacities During Baseline Testing of Configuration 1 Extraction Wells in July 2003

Well	**1st Step**			**2nd Step**			**3rd Step**		
	Q (gpm)	**s (ft)**	**Specific Capacity (gpm/ft)**	**Q (gpm)**	**s (ft)**	**Specific Capacity (gpm/ft)**	**Q (gpm)**	**s (ft)**	**Specific Capacity (gpm/ft)**
470	3	0.6	5.00	10	1.6	6.25	20	4.8	4.17
471	3	0.7	4.29	10	2.1	4.76	15.5	4.7	3.30
472	3	0.7	4.29	10	2.1	4.76	15.5	4.1	3.78
473	3	0.6	5.00	10	2.3	4.35	14	5.8	2.41
474	3	0.6	5.00	10	1.5	6.67	15	2.7	5.56
475	3	0.7	4.29	10	2.6	3.85	12.5	4.8	2.60
476	3	0.8	3.75	10	3.3	3.03	11	4.8	2.29
477	3	0.7	4.29	10	2.5	4.00	12	4.5	2.67
478	3	0.8	3.75	10	3.4	2.94	12.5	6.4	1.95
479	3	0.8	3.75	10	2.9	3.45	12	5.8	2.07
Average =			**4.34**	**Average =**		**4.41**	**Average =**		**3.08**

Q = Flow Rate; s = Drawdown; Spec. Cap. = Specific Capacity; gpm = gallons per minute; ft = feet; gpm/ft = gallons per minute per foot.

The specific capacities listed in Table 2 for each Configuration 1 well during the 2003 step-drawdown tests can be translated into hydraulic conductivities by first estimating the transmissivity of the tested portion of an aquifer (Heath 1989).

$$T \approx 300\frac{Q}{s} \qquad (1)$$

where T = transmissivity (ft^2/day),
Q/s = specific capacity (gpm/ft),
Q = pumping rate (gpm), and
s = drawdown (ft).

Hydraulic conductivity is in turn estimated with

$$K = \frac{T}{b} \qquad (2)$$

where K = aquifer hydraulic conductivity (ft/day), and
b = the thickness of the tested portion of the aquifer (ft).

Typically, the thickness of the tested portion of the aquifer is assumed equal to the pumping well's screen length. When applying this assumption with equations (1) and (2), the average specific capacities reported in Table 2 for steps 1 through 3 translate into hydraulic conductivities of about 130, 132, and 92 ft/day. These values are relatively similar to past derivations of the alluvial aquifer's hydraulic conductivity (SMI 2001; DOE 2002; DOE 2003e) based on aquifer pumping tests. Previous estimates of K for the gravelly sand and sandy gravel materials comprising most of the alluvial aquifer tend to range from 100 to 180 ft/day.

The data in Table 2 and hydraulic conductivity estimates discussed herein provide some measure of the initial productivity of Configuration 1 extraction wells. On the basis of step-drawdown testing, well 474 was originally identified as the most productive of the Configuration 1 extraction wells, and well 470 was the second most productive. Well 478 consistently exhibited the lowest specific capacities. In general, the wells located in the southern portion of the well field appeared to be more productive than the wells in the northern portion.

3.1.3 Water Quality in 2003

Baseline (pre-pumping) water chemistry data collected in Configuration 1 extraction and observation wells during the summer of 2003 included pH, specific conductance, and concentrations of TDS, dissolved ammonia as nitrogen (NH_3-N), nitrate (NO_3), chloride (Cl), sulfate (SO_4), and dissolved uranium (U) (DOE 2004a). Subsequent measurement of these and additional water quality parameters in September 2003 (DOE 2004b) facilitated an initial assessment of the potential effects of Configuration 1 pumping on aquifer water chemistry (DOE 2004b). The observed influences of pumping included increases of 10 to 24 percent in specific conductance within the screened portions of wells. These increases inferred proportional rises in TDS levels.

Baseline water quality characterization of Configuration 1 wells included attempts to quantify changes in water chemistry with depth in individual wells. These analyses confirmed previous observations of generally increasing specific conductances, and, therefore, TDS concentrations, with depth in the alluvial aquifer. Background concentration data on individual constituents, however, were less insightful regarding vertically varying patterns of their concentrations.

Chemical data collection subsequent to extraction well pumping in September 2003 did show signs of distinct vertical profiles of dissolved ammonia (DOE 2004b) within pumping wells. Concentrations of dissolved uranium, however, did not appear to change much with depth in the extraction wells. Observed ammonia (NH_3-N) concentrations in the extraction wells in September 2003 varied from 570 to 1,200 mg/L. Measured uranium concentrations in the extraction wells tended to fall in a range of 2.5 to 3 mg/L.

A measure of dissolved constituent chemistry that did exhibit changes with depth in the aquifer in September 2003 was the dimensionless ratio of sulfate to chloride concentrations (DOE 2004b). Shallower ground water tended to yield sulfate/chloride ratios of between 2 and 4, which were considered somewhat representative of contamination originating in the Moab tailings pile. Deeper ground water exhibited sulfate/chloride ratios of about 1 to 2, which were considered more representative of the brine that originates from dissolution of the Paradox Formation.

3.1.4 Water Quality in April 2004

Ground water concentrations measured at Configuration 1 wells on April 6th and 7th of 2004 provided additional information for characterizing local water quality under non-pumping conditions. TDS concentrations were measured at three different depths in each of the ten extraction wells during these two days. These data showed no distinct trend in salinity from one end of the well field to another. TDS levels in the deepest portions of each well suggested that the brine surface might be as shallow as 25 ft bgs. However, TDS concentrations measured in observation well clusters indicated that the brine surface was somewhat deeper, probably occurring between depths of 30 to 35 ft bgs. The observation well data were considered more reliable in this case because of the shorter screen intervals for the observation wells (~ 4 ft) than those for the extraction wells (~ 10 to 14 ft); shorter screen lengths implied less mixing of water between horizons. Further discussion of the TDS concentrations measured in Configuration 1 observation well clusters is presented in Section 5.2.

Uranium concentration data collected in April 2004 indicated that levels of this constituent typically decreased with depth during non-pumping periods, ranging from greater than 3 mg/L in shallow ground water to less than 1 mg/L at depths approaching 60 ft bgs. Background ammonia (NH_3-N) concentrations in the Configuration 1 area were usually less than 100 mg/L in shallow ground water, increased to maximum levels of 1000 mg/L or greater in horizons encompassing the brine surface, and decreased to 600 mg/L at a depth of about 60 ft bgs (see Section 5.2).

3.1.5 Anticipated Aquifer Response to Pumping

Upconing of very saline and briny ground water has traditionally been observed at the Moab site in response to ground water pumping (e.g., DOE 2002). The total depths of Configuration 1 wells were purposefully kept above the depth of the brine surface with the intent of minimizing the amount of upconing resulting from their pumping. Total depth of all Configuration 1 extraction wells is about 21 ft bgs, and the brine surface occurs about 30 to 35 ft bgs.

The responses of aquifer water levels and the brine surface to extraction well pumping are transient phenomena. Figure 3 illustrates the anticipated effects of the ground water system during early stages of a pumping event in the Configuration 1 area. In this case, the zone of influence created by the pumping has not yet reached the river, and all water collected in the extraction well is derived from aquifer storage and incoming flows from upgradient areas. Figure 3 depicts upconing in this instance as being relatively limited, in both vertical and horizontal directions.

As pumping continues at the extraction wells, the zone of influence is expected to eventually extend to the river. And after sufficient pumping time, inflow induced from the river to the aquifer by the drawdowns occurring at the river are expected to create relatively steady flow conditions, wherein the total rate at which water is drawn into the extraction wells is matched by the combination of inflowing upgradient water and water losses from the river (Figure 4). This condition does not represent a true steady state because, until such time that TDS levels between the extraction wells and the river have fully stabilized as a result of inflowing river water, hydraulic heads in the ground water system can still theoretically change. It can, however, be classified as a quasi-steady state since heads are expected to change only minimally after the start of river inflow. Under the quasi-steady state scenario, the breadth and height of the brine upconing would be close to their maximum values.

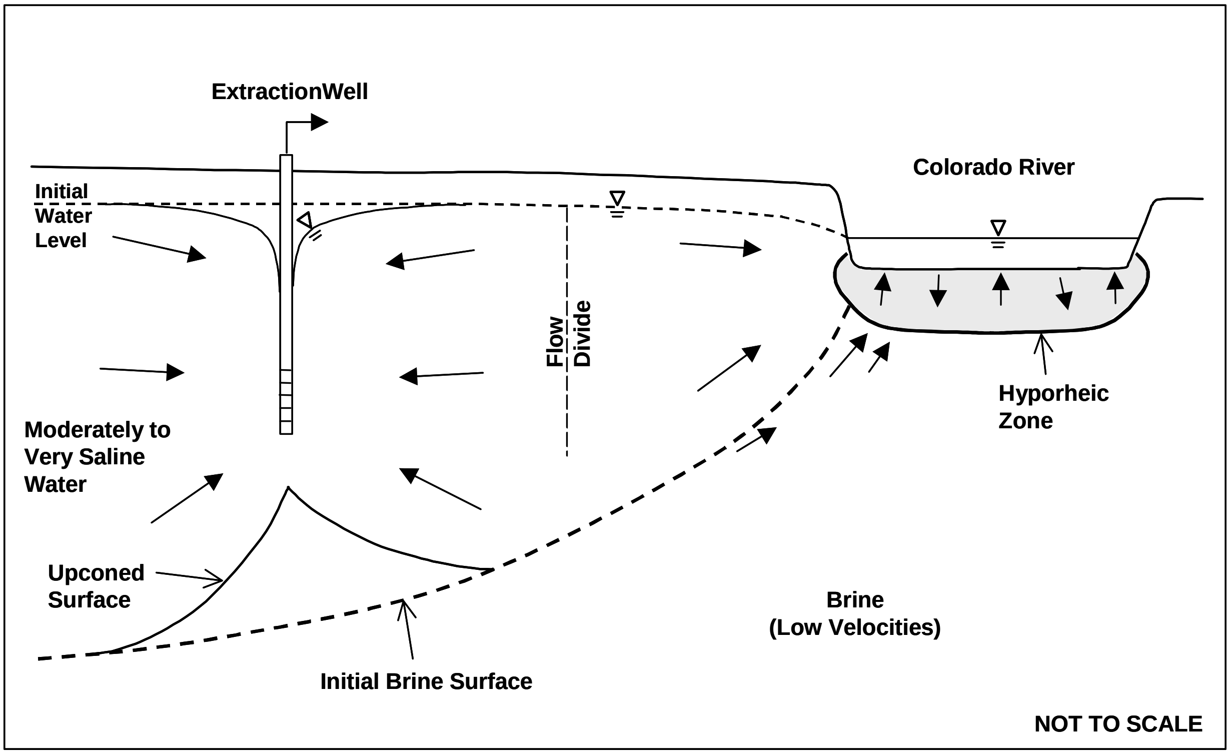

Figure 3. Conceptualization of Early-Time Response to Pumping from Extraction Wells

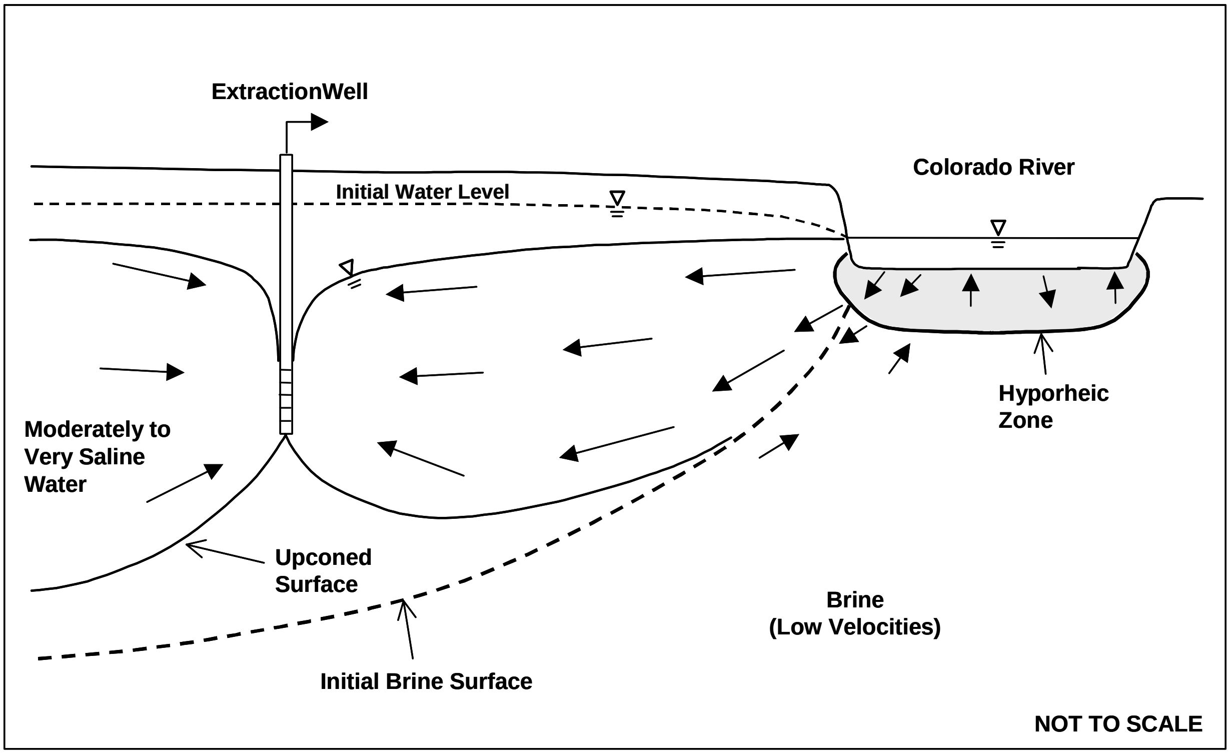

Figure 4. Conceptualization of the Quasi-Steady-State Response to Pumping from Extraction Wells

The flow phenomena depicted in Figure 3 and Figure 4 are easy to foresee. What has not been previously determined is the time that it takes for the Configuration 1 well system to create quasi-steady-state flow conditions. Such a response time can be estimated in aquifers containing only fresh water (e.g., TDS < 1,000 mg/L) to slightly saline water (1,000 < TDS < 3,0000 mg/L) using the concept of time constants (e.g., Domenico and Schwartz 1998). If ground water at the Moab site did not contain high TDS concentrations, the local time constant would likely be very small, perhaps on the order of just several minutes. This would occur because hydraulic conductivity in the alluvial aquifer is quite large and, despite the shallow depth to local ground water, the aquifer tends to yield water under both confined (elastic storage) and unconfined (gravity drainage) conditions. But because the alluvial aquifer near the Colorado River exhibits large variations in TDS concentration and, therefore, water density, over small distances, it is possible that the response time of the aquifer to hydraulic stresses is longer than observed in a system with only low TDS concentrations. Flow time constants, as affected by variable water density, are of interest because they affect optimization of the IA systems.

3.2 Configuration 2

In addition to being closer to the Colorado River, Configuration 2 extraction wells differ from those in Configuration 1 with regard to their construction and possible operation. Half of the ten Configuration 2 pumping wells are considered to be shallow, whereas the remaining five are classified as deep. All shallow extraction wells are screened between depths of 15 and 30 ft bgs, which places them noticeably deeper than Configuration 1 extraction wells (mostly screened between 10 and 20 ft bgs). The deep well screens span depths of 25 to 40 ft bgs. The shallow and deep wells alternate with one another along the well field; even numbered wells are shallow, and odd-numbered wells are deep. A total of 19 observation wells and floodplain piezometers are used to monitor alluvial aquifer and Colorado River responses to pumping in Configuration 2. All but two of the observation wells are classified as shallow; the screened intervals of most shallow monitoring wells are located between 10 and 20 ft bgs. Table 3 summarizes construction information for Configuration 2 wells.

The deep wells were added to this Ground Water IA configuration for the purpose of assuring that river water injected into extraction wells would spread laterally toward the river over a wide vertical interval. It was believed that injection of uncontaminated water in both shallow and deep wells would cause a larger portion of backwaters in the river to experience more dilution of ammonia than would occur using shallow wells only (DOE 2004c). Greater mass removal of ammonia contamination during pumping was also surmised as being a possible benefit of using deep wells.

Borehole and well logs for Configuration 2 wells, provided in Appendix A, indicate the composition of the alluvial aquifer is very similar to that observed in the vicinity of Configuration 1. Gravelly sands and sandy gravels dominate the alluvium below a depth of 15 ft bgs. Consequently, all of the pumping wells are drawing virtually all of their ground water from very permeable horizons.

Table 3. Summary of Well and Piezometer Construction in the Configuration 2 Area

Well	Well Type/Relative Depth	Diameter (inches)	Ground Surface Elevation (ft above msl)	Screen Interval (ft bgs)	Total Depth (ft bgs)
MOA-401	Observation / Shallow	1	3967.70	13.0 - 17.9	18.9
MOA-402	Observation / Shallow	1	3967.70	13.4 - 18.3	18.5
MOA-408	Observation / Shallow	1	3967.80	23.0 - 27.9	28.0
MOA-570	Extraction / Shallow	6	3967.52	15.0 - 30.0	31.3
MOA-571	Extraction / Deep	6	3967.01	25.0 - 40.0	41.3
MOA-572	Extraction / Shallow	6	3967.01	15.0 - 30.0	31.3
MOA-573	Extraction / Deep	6	3967.70	25.0 - 40.0	41.3
MOA-574	Extraction / Shallow	6	3967.30	15.0 - 30.0	31.3
MOA-575	Extraction / Deep	6	3967.30	25.0 - 40.0	41.3
MOA-576	Extraction / Shallow	6	3967.17	15.0 - 30.0	31.3
MOA-577	Extraction / Deep	6	3967.59	25.0 - 40.0	41.3
MOA-578	Extraction / Shallow	6	3967.80	15.0 - 30.0	31.3
MOA-579	Extraction / Deep	6	3967.21	25.0 - 40.0	41.3
MOA-580	Observation / Shallow	1	3967.52	10.2 - 20.2	20.4
MOA-581	Observation / Shallow	1	3967.01	10.3 - 20.3	20.5
MOA-582	Observation / Shallow	1	3967.67	9.8 - 19.7	20.0
MOA-583	Observation / Shallow	1	3967.53	8.9 - 18.8	19.1
MOA-584	Observation / Shallow	1	3967.17	10.3 - 20.2	20.5
MOA-585	Observation / Shallow	1	3967.59	10.4 - 20.3	20.6
MOA-586	Observation / Shallow	1	3967.21	10.0 - 19.9	20.2
MOA-587	Observation / Shallow	1	3967.30	10.0 - 19.6	20.2
MOA-588	Observation / Intermediate	6	3967.22	24.8 - 34.8	35.0
MOA-589	Observation / Deep	6	3966.98	42.7 - 52.7	53.0
MOA-590	Floodplain Piezometer	1	3952.78	na	1.1
MOA-591	Floodplain Piezometer	1	3952.71	na	4.2
MOA-592	Floodplain Piezometer	1	3953.46	na	2.1
MOA-593	Floodplain Piezometer	1	3953.53	na	4.1
MOA-594	Floodplain Piezometer	1	3952.45	na	2.0
MOA-595	Floodplain Piezometer	1	3952.42	na	3.8

na = not applicable

3.2.1 Planned Extraction

Configuration 2 was selected to be an extension of the Ground Water IA because it was thought that its dual purpose (extraction and injection) wells could be used in an optimal manner as governed by seasonal hydrologic conditions at the Moab site. Ground water extraction was expected to occur mostly in late spring, summer and early fall months, during which flows in the Colorado River are typically large and are thus capable of diluting ground water discharge from the site. The period encompassing late spring to early fall is also the warmest of the year, during which extracted ground water can be safely pumped to the treatment system on the Moab tailings pile and successfully evaporated. During other months, in which flows in the river are typically smaller than they are in spring and summer, injection of river water was planned with the objective of delivering mostly uncontaminated water to portions of the aquifer that discharge to the western portion of the river.

Hydraulic design of Configuration 2 dual-purpose wells (DOE 2004c) was based on the results of a 3-D flow model that accounted only for the non-brine portion of the aquifer at the Moab site. Ten extraction wells, with locations similar to those for the final constructed wells, were simulated. Because the model only simulated flow in the non-brine portion of the aquifer, the effects of the deep wells that were ultimately used could only be approximated using hypothetical wells with screened intervals located above the brine surface. Each well was assumed to extract 7.5 gpm continuously, resulting in a total pumping rate of 75 gpm. This modeling scenario suggested that ground water extraction in the Configuration 2 area would be successful in intercepting ground water contaminants from the tailings pile areas as well as drawing a significant quantity of water from the Colorado River. As discussed in subsequent parts of this report, the assumed average per-well pumping rate of 7.5 gpm may not be achievable under current well field conditions.

3.2.2 Planned Injection

The model of non-brine ground water flow used to evaluate pumping of Configuration 2 wells was also applied for the purpose of preliminarily assessing the effects of surface water injection on the alluvia aquifer (DOE 2004c). Again, it was assumed that all ten dual purpose wells would be capable of handling flows of 7.5 gpm each. Though it is not the purpose of this report to evaluate the efficacy of water injection at the site, it should be mentioned that injection in the Configuration 2 well field began in early October 2004. It is anticipated that results of the injection testing will provide insight into some of the observed influences of IA ground water extraction this year, and vice versa. Results of the injection testing and any ancillary information that has bearing on ground water pumping will be included in a future report.

3.2.3 Pre-Extraction Characterization

Water level data were collected in a few Configuration 2 observation wells and the extraction wells during August 2004, prior to initial test pumping in early September. The background water levels in shallow observation wells were, on the whole, slightly higher (3,952 to 3,954 ft above msl) than those at comparable Configuration 1 locations at this time (3,951 to 3,952 ft above msl). Hydraulic heads in shallow observation wells for Configuration 1 in August did not appear to be strongly affected by Configuration 1 pumping. The apparently slight disparity in water elevations between the two configurations was expected given that the generally east-southeast ground water flow direction observed at the Moab site infers higher shallow water levels with increasing distance north along the river.

Background water chemistry data for the Configuration 2 area similar to those collected during baseline characterization of Configuration 1 (DOE 2004a) were derived from ground water samples collected in mid-August of 2004. These included measures of pH, specific conductance and concentrations of TDS, NH_3-N, NO_3, sulfate, chloride, and uranium. As expected, TDS and specific conductance levels typically increased with depth in the aquifer. However, ground water salinity levels in the Configuration 2 area showed considerably different patterns than those observed in the vicinity of Configuration 1. To begin with, TDS concentrations in extraction wells in the southern portion of the well field (wells 570 through 575) and two nearby observation wells (wells 588 and 589) indicated that the brine surface was near a depth of 20 to 25 ft bgs, which was much shallower than the apparent brine surface depth in the Configuration 1 area (~30 to 35 ft bgs). This result was not surprising given that previous observations had indicated increasing brine surface elevations with proximity to the Colorado River (DOE 2003e) and a tendency for the brine surface to intersect the river somewhere near its west bank. What was unexpected, however, were relatively low salinity levels measured in well 579, located on the north end of the well field. The TDS concentrations in this latter well indicated a brine surface located deeper than 40 ft bgs. Moreover, TDS levels measured in extraction wells located between wells 575 and 579 (i.e., well 576, 577, and 578) suggested that the elevation of the brine surface in this part of the well field occurred at elevations intermediate to those observed at either end.

The shallower depths to the brine surface observed in the southern portion of the Configuration 2 well field (~20 to 25 ft bgs) in comparison to the apparent brine surface depth near Configuration 1 (~30 to 35 ft bgs) supports the conceptual model of ground water flow at the Moab site, as well as a numerical model of density-dependent flow presented in Appendix K of the *Site Observational Work Plan for the Moab, Utah, Site* (DOE 2003e). In addition to predicting decreased brine depth with proximity to the river, these models also indicate increasing vertically upward flow as the river is approached. Under the assumption that the per-unit-area discharge to the river stays relatively uniform along all portions of the river, these models suggest that the pre-pumping brine surface would occur at a relatively uniform elevation along the full length of Configuration 2. However, because the brine surface appeared in August 2004 to decrease in elevation from the middle of the well field to the northernmost extraction well, it appears possible that ground water in the northern portion of the well field was discharging to the river at a greater rate than was occurring in the southern portion. Such an observation infers that ground water flow varies considerably with location at the Moab site.

The lowest background uranium levels in Configuration 2 wells were observed in extraction wells 570 and 571, on the southern end of the well field, where most U concentrations were in the range of 1.7 to 2.1 mg/L. North of these wells, however, the Configuration 2 extraction wells exhibited U concentrations that mostly fell within the range of 2.5 to 3.0 mg/L. Unlike uranium concentration measurements made at Configuration 1 wells in April 2004, no distinct trends in uranium concentration with depth were observed in the Configuration 2 wells

Ammonia concentrations did vary with depth in the Configuration 2 area. Background NH_3-N concentrations at depths above 20 ft bgs tended to fall in the range of 500 to 800 mg/L, whereas, below the 20-ft depth, concentrations ranging from 1000 to 1,700 mg/L were common. Ammonia levels in this latter range were observed at depths as great as 56 ft bgs (in observation well 589). This observation tended to contrast with pre-pumping measurements made near Configuration 1 in April 2004, which suggested that ammonia concentrations decrease to below 600 mg/L and less at similar depths.

3.3 Baseline Monitoring Area

The baseline monitoring area is used to portray background hydraulic and water chemistry conditions in the alluvial aquifer that are unaffected by ground water pumping or injection.

Though the alluvial makeup of the aquifer in the baseline area is not identical to that occurring in either the Configuration 1 or Configuration 2 areas, the types of aquifer materials encountered are generally the same. No hydraulic testing occurred at the baseline area for the purposes of this study. However, ground water levels and local aquifer chemistry were monitored in 2004 for comparison to data equivalents in the Configuration 1 and 2 areas. It was anticipated that background phenomena such as ground water level variations in response to changes in river flow, concomitant changes in brine surface elevation, and hyporheic zone processes might be discerned by monitoring baseline area wells and piezometers.

As previously mentioned, the baseline monitoring area is located upstream of Configurations 1 and 2, just south of where the Moab Wash channel joins the Colorado River (Figure 1). A summary of the construction of observation wells and piezometers installed in the baseline area is presented in Table 4.

Table 4. Summary of Well and Piezometer Construction in the Baseline Area

Well	Well Type/Relative Depth	Diameter (inches)	Ground Surface Elevation (ft above msl)	Screen Interval (ft bgs)	Total Depth (ft bgs)
MOA-405	Observation / Shallow	1	3966.40	15.1 - 20.0	20.3
MOA-488	Observation / Intermediate	6	3966.82	25.0 - 40.0	40.3
MOA-493	Observation / Deep	6	3966.08	45.0 - 55.0	55.3
MOA-494	Floodplain Piezometer	1	3956.36	na	2.1
MOA-495	Floodplain Piezometer	1	3956.50	na	4.2
MOA-496	Floodplain Piezometer	1	3954.16	na	1.7
MOA-497	Floodplain Piezometer	1	3954.28	na	4.1
MOA-498	Floodplain Piezometer	1	3952.23	na	1.4
MOA-499	Floodplain Piezometer	1	3952.23	na	4.3

na = not applicable

3.4 Operation and Testing Activities in 2004

The scope of work associated performance assessment of the two Ground Water IA configurations was based on activities that occurred with the remediation system in 2004. Chronologies of those activities at Configurations 1 and 2 are presented in Table 5 and Table 6, respectively.

4.0 Extraction System Hydraulic Performance

4.1 Configuration 1 Performance

4.1.1 Water Extraction Volumes

Monthly extraction volumes between June and October for each of the ten wells comprising Configuration 1 are listed in Table 7. The largest quantity of pumped ground water during this period was observed in well 470, which is the southernmost location in the well field. Well 471, located closest to well 470, yielded the second largest extraction volume. The lowest pumped volume between June and October 2004 was observed in well 476 (Table 7), located toward the middle of the well field.

Table 5. Chronology of Configuration 1 Activities in 2004

Date	Activity	Samples Collected
December 27, 2003	System shut down for winter	NA
April 5−8, 2004	Completed profile baseline sampling	All extraction wells sampled at three depths, observation wells at a single depth
May 3−7, 2004	Developed extraction wells 470−479, completed small scale injection test	NA
Week of May 24, 2004	Started pumping from well field, flow rates set at ~ 1 gpm for each well	NA
June 3, 2004	Completed monthly sampling	Extraction wells 470 thru 479, observation wells 480 thru 485, pond inlet sample 547, pond recirculation pump 548, and surface water location 216)
Week of June 7, 2004	Flows increased to maximum rates (varies for each well)	NA
July 6−7, 2004	Completed monthly sampling	Same as June 3, 2004, sampling effort
Late July 2004	Installed and developed four deep observation wells (557, 558, 560, and 561), seven shallow observation wells (551−556, and 559), and six floodplain piezometers	NA
August 3−4, 2004	Completed monthly sampling	Same as June 3, 2004, sampling effort
September 1−2, 2004	Completed monthly sampling	Same as June 3, 2004 sampling effort plus added observation wells 557 thru 561 (installed in August 2004).
October 13−14, 2004	Completed monthly sampling	Same as Sept 1−2, 2004, sampling effort

Some of the monthly quantities presented in Table 7 are based on estimates. Flow meters at individual wells occasionally malfunctioned, which meant that some pumping rates had to be assumed using rates that were accurately captured prior to and after periods of malfunction. In addition, even when flow meter readings appeared to be accurate, they did not always fall on the last day of a month. Finally, the pumps in some wells were at times not operating; consequently the periods over which pumping occurred sometimes had to be assumed. Despite these difficulties, the listed extraction volumes are considered sufficiently accurate to estimate contaminant mass withdrawals on a per-well basis.

4.1.2 Individual Well Pumping Rates

The average monthly pumping rates at Configuration 1 wells were analyzed with the intent of characterizing individual well contributions to contaminant mass removal. Care was taken to avoid using recorded pumping rates that appeared to be affected by malfunctioning flow meters. Because, as previously mentioned, pumps were sometimes shut off during the June-through-October 2004 period, the pumping rate analysis was based solely on measured rates when the meters were operating properly in lieu of cumulative pumping volumes.

Table 6. Chronology of Configuration 2 Testing Activities in 2004

Date	Activity	Samples Collected
Late July 2004	Ten extraction wells, seven shallow observation wells, two deep observation wells, and six floodplain piezometers installed and developed in late July 2004	NA
August 5−6, 17−20, 2004	Completed profile baseline sampling	Collected profile baseline data from extraction wells 570−579 (sampled from three depths), deep observation wells 588 and 589 (sampled from two depths), and piezometers 590 thru 595.
September 2, 2004	Started pumping from extraction wells	NA
September 3, 2004	Collected discharge baseline samples	Extraction wells 570−579, shallow observation well 580. System shut down for weekend.
September 8, 2004	Started extraction deep well test	NA
September 13, 2004	Shut down extraction deep well test	Extraction wells 571, 573, 575, and 579 (577 pump not working), observation well 580 at end of deep test
September 14, 2004	Started extraction shallow well test	Extraction wells 570, 572, 574, 576, and 578 at the beginning of shallow test. Collected surface water sample from location 236 for ESL NH_3 analysis
September 22, 2004	Shut down extraction shallow well test	Extraction wells 570, 572, 574, 576, and 578 at the end shallow test. Collected surface water sample off PZ 592 for ESL NH_3 analysis
September 23, 2004	Started extraction full scale test	Observation wells 581−587, piezometers 590−593 were sampled prior to full scale test for injection test background
October 5, 2004	Shut down extraction full scale test	Extraction wells 570−579 and shallow observation well 580 at end of test
October 6, 2004	Started injection test	Measured field parameters of all shallow observation wells prior to test startup, injection water sample collected at beginning of test
October 14−15, 2004	Injection test midpoint sampling	Shallow observation wells 401, 402, 580, 582, 583, and 585−587, submitted for analysis, measured field parameters in all other shallow observation wells, injection water sample collected. Also sampled surface water location 236 (split analyzed by ESL).
October 19, 2004	Injection test midpoint sampling, cont.	Piezometers 590, 591, and 593 (592 was dry). Also sampled surface water location 236.

Table 7. Monthly Extraction Volumes from Configuration 1 Pumping Wells

Month	Extraction Volumes (gallons)										
	Well 470	Well 471	Well 472	Well 473	Well 474	Well 475	Well 476	Well 477	Well 478	Well 479	Total
Jun-04	123,058	117,072	118,923	111,826	120,713	112,875	109,851	113,184	96,645	125,342	1,149,489
Jul-04	199,888	141,162	138,086	96,670	80,302	129,109	64,034	106,144	75,590	119,685	1,150,670
Aug-04	192,901	148,819	140,002	67,964	72,038	108,866	48,658	81,189	65,732	79,794	1,005,963
Sep-04	178,752	154,944	126,864	58,224	68,304	93,216	42,000	47,568	82,512	80,352	932,736
Oct-04	189,218	153,059	130,851	56,135	73,768	97,594	59,929	57,474	93,800	95,418	1,007,246
5-Month Total	883,817	715,056	654,727	390,820	415,125	541,660	324,472	405,559	414,279	500,591	5,246,106

Average monthly pumping rates at each well (Table 8) and the average pumping rates for the June through October period (Figure 5) indicated that the most productive wells (wells 470−472) are located on the southern end of the well field. Of some significance is the fact that the four wells with the largest 5-month average pumping rates (well 470 [4.2 gpm], well 471 [3.3 gpm], well 472 [3.03 gpm], well 475 [2.46 gpm]) show an increase in pumping rate between the first month of pumping (June) and the second month (July), whereas all remaining six wells show a reduction in pumping rate from the first month of pumping (June) through the following two months (July and August). Furthermore, the four most productive wells also exhibit a tendency to maintain relatively constant pumping rates throughout the 5-month period. Such observations likely indicate a propensity for these four wells to be more efficient than the other extraction wells.

Table 8. Average Monthly and Five-Month Pumping Rates in Configuration 1 Extraction Wells

Month	Pumping Rate (gpm)	Average Drawdown (ft)	Average Specific Capacity (gpm/ft)	Average Ground Water Elevation (ft)	Colorado River Flow (cfs)
Well 470					
June 2004	3.79	1.21	3.14	3,952.4	5,706
July 2004	4.48	4.05	1.11	3,949.56	3,126
August 2004	4.32	5.51	0.78	3,948.11	2,488
September 2004	4.14	4.63	0.89	3,948.98	3,199
October 04	4.29	4.06	1.05	3,949.55	3,880
Average	4.2	3.89	1.39	3,949.72	3,680
Well 471					
June 2004	3	2	1.5	3,951.78	5,706
July 2004	3.16	3.79	0.84	3,949.98	3,126
August 2004	3.33	5.31	0.63	3,948.46	2,488
September 2004	3.59	4.93	0.73	3,948.84	3,199
October 04	3.43	4.35	0.79	3,949.42	3,880
Average	3.3	4.08	0.9	3,949.70	3,680
Well 472					
June 2004	3.04	2.14	1.42	3,951.47	5,706
July 2004	3.09	4.16	0.74	3,949.45	3,126
August 2004	3.14	5.6	0.56	3,948.01	2,488
September 2004	2.94	4.85	0.61	3,948.76	3,199
October 04	2.93	4.24	0.69	3,949.38	3,880
Average	3.03	4.20	0.8	3,949.41	3,680
Well 473					
June 2004	2.86	1.96	1.46	3,951.99	5,706
July 2004	2.17	4.4	0.49	3,949.55	3,126
August 2004	1.55	5	0.31	3,948.95	2,488
September 2004	1.45	4.27	0.34	3,949.68	3,199
October 04	1.04	3.27	0.32	3,950.9	3,880
Average	1.81	3.78	0.58	3,950.21	3,680
Well 474					
June 2004	3.07	2.06	1.49	3,951.02	5,706
July 2004	2.7	3.4	0.79	3,949.68	3,126
August 2004	1.84	3.71	0.5	3,949.37	2,488
September 2004	1.47	3.28	0.45	3,949.8	3,199
October 04	1.65	2.95	0.56	3,950.13	3,880
Average	2.15	3.08	0.76	3,950.00	3,680

Table 8 (continued). Average Monthly and Five-Month Pumping Rates in Configuration 1 Extraction Wells

Month	Pumping Rate (gpm)	Average Drawdown (ft)	Average Specific Capacity (gpm/ft)	Average Ground Water Elevation (ft)	Colorado River Flow (cfs)
Well 475					
June 2004	2.61	2.12	1.23	3,951.82	5,706
July 2004	2.89	4.44	0.65	3,949.5	3,126
August 2004	2.44	5.13	0.48	3,948.81	2,488
September 2004	2.16	4.73	0.46	3,949.21	3,199
October 04	2.19	3.91	0.56	3,950.03	3,880
Average	2.46	4.07	0.68	3,949.87	3,680
Well 476					
June 2004	2.8	2.55	1.1	3,951.31	5,706
July 2004	1.43	4.34	0.33	3,949.52	3,126
August 2004	1.09	5.03	0.22	3,948.83	2,488
September 2004	1.11	4.63	0.24	3,949.23	3,199
October 04	1.34	3.81	0.35	3,950.05	3,880
Average	1.55	4.07	0.45	3,949.79	3,680
Well 477					
June 2004	2.51	2.48	1.01	3,951.48	5,706
July 2004	2.38	4.08	0.58	3,949.88	3,126
August 2004	1.82	3.77	0.48	3,950.19	2,488
September 2004	1.05	3.44	0.3	3,950.52	3,199
October 04	1.23	3.12	0.39	3,950.85	3,880
Average	1.8	3.38	0.56	3,950.58	3,680
Well 478					
June 2004	2.93	2.41	1.21	3,951.53	5,706
July 2004	2.54	4.68	0.54	3,949.26	3,126
August 2004	1.96	5.31	0.37	3,948.63	2,488
September 2004	1.91	4.7	0.41	3,949.24	3,199
October 04	2.1	3.88	0.54	3,950.06	3,880
Average	2.29	4.20	0.62	3,949.74	3,680
Well 479					
June 2004	2.9	2.87	1.01	3,951.23	5,706
July 2004	2.68	5.38	0.5	3,948.72	3,126
August 2004	1.79	5.27	0.34	3,948.84	2,488
September 2004	1.86	5.04	0.37	3,949.06	3,199
October 04	2.14	4.4	0.49	3,949.7	3,880
Average	2.27	4.59	0.54	3,949.51	3,680

As discussed in Section 5.1.2, the relative efficiency of a pumping well can be discerned through analysis of computed specific capacities. Under this premise, the specific capacities listed in Table 8 suggest that wells 470, 471, and 472 are the most efficient of the ten Configuration 1 pumping wells. However, it is possible that other variables, such as the elevation of the Colorado River water surface, can affect available drawdown and, therefore, the pumping capacity at nearby pumping wells. For this reason, average monthly flow of the river at the Cisco gaging station, located upstream of the Moab site, are also listed in Table 8. Further discussion of well efficiency issues and the effect of the Colorado River on extraction well productivity are discussed in subsequent sections.

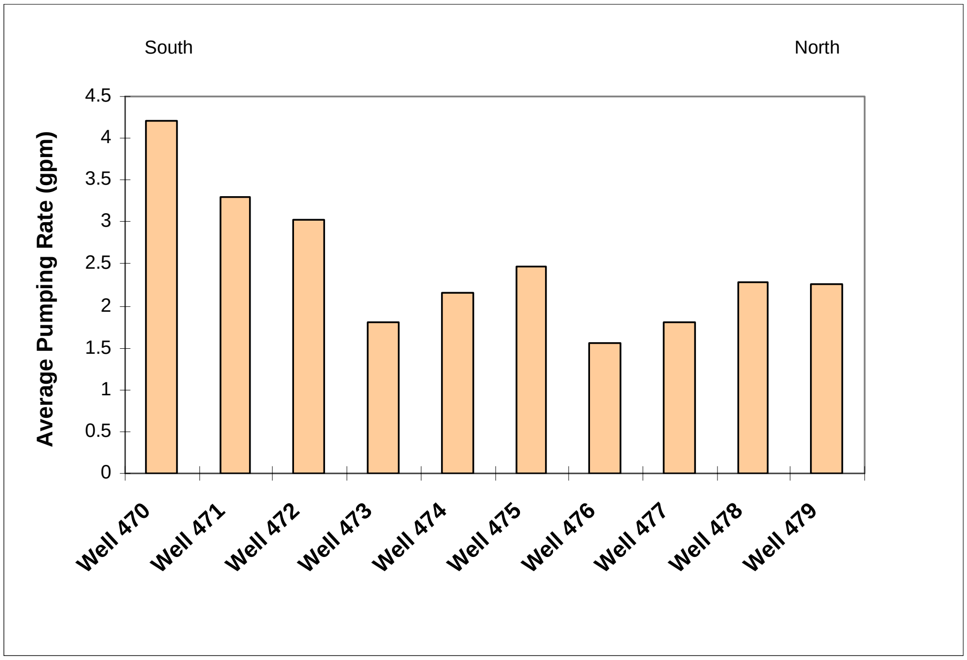

Figure 5. Average Pumping Rates from Configuration 1 Wells Between June and October 2004

4.2 Configuration 2 Performance

4.2.1 Water Extraction Volumes

Like the pumping information collected at Configuration 1 wells, the measured volumes of extracted ground water in Configuration 2 pumping wells provide insight to performance of this system. Less data are available from Configuration 2 because the system was installed during late July 2004 and did not undergo preliminary testing for pumping capacity until early September, well into the assessment period covered by this study. As discussed in previous sections of this report, pumping of the deep extraction wells only in this configuration occurred over a 6-day period in the middle of September, and a similar test of the shallow wells only was limited to a period of seven days in the last half of September. Continuous pumping of all ten Configuration 2 wells (full-scale extraction) occurred between September 23rd and October 5th; data collected during this last test provides the most comprehensive information regarding the productivity of this configuration's wells.

The pumped volumes of ground water from the ten Configuration 2 extraction wells during the September−October 2004 timeframe are listed in Table 9. These data indicate that the deep wells produced considerably more water than the shallow wells because of the additional drawdown that was available to them. The most productive deep well was well 579, located on the north end of the extraction field.

4.2.2 Individual Well Pumping Rates

The pumping rates reported for Configuration 2 wells during September and early October 2004 varied significantly depending on the testing event (Table 10). During initial test pumping on September 2nd and 3rd, pumping rates in the shallow wells ranged from 1.84 to 3.65 gpm, and deep well rates ranged from 4.86 to 9.8 gpm. In contrast to these values, the maximum extraction rate observed during the shallow well test of September 14th through 22nd was limited to 2.23 gpm, and most extraction rates during the deep well test of September 8th through 13th were less than 4 gpm. Extraction rates decreased further when both shallow and deep wells were pumped (full-scale extraction) for about 12 days in late September and early October; shallow well rates ranged from 0.43 to 1.05 gpm, and 3 of the 5 deep well rates were less than 4 gpm (Table 10). The most consistent well in terms of production was deep well 579, with pumping rates that ranged from 8.84 to 9.89 gpm. Deep well 577, with pumping rates that ranged from 4.97 to 9.80 gpm, was the second most productive well.

Table 9. Configuration 2 Extraction Volumes During 2004

Pumping Event	Dates	Pumped Volume (gallons) by Well[a]										
		570	**571**	**572**	**573**	**574**	**575**	**576**	**577**	**578**	**579**	**Total**
Initial Testing	9/2−9/3	3,896	7,694	4,541	2,518	121	6,047	2,168	11,817	2,315	11,719	52,836
Deep Well Test	9/8−9/13	na	26,079	na	27,907	na	12,055	na	4,680	na	71,460	142,181
Shallow Well Test	9/14−9/22	22,011	na	29,232	na	17,798	na	15,934	na	15,173	na	100,148
Combined Deep and Shallow Wells	9/23−10/5	18,445	40,456	14,735	60,204	11,149	41,252	14,598	91,745	7,558	226,276	526,418
Total	9/2−10/5	44,352	74,229	48,508	90,629	29,068	59,354	32,700	108,242	25,046	309,455	821,583

[a] na = not applicable

Table 10. Measured Pumping Rates in Configuration 2 Extraction Wells

Pumping Event	Dates	Average Pumping Rate (gpm)	Average Drawdown (ft)	Average Specific Capacity (gpm/ft)	Average Ground Water Elevation (ft above msl)	Colorado River Flow (cfs)[a]
Well 570 (Shallow)						
Initial Test Pumping	9/2 to 9/3/04	3.08	12.28	0.25	3,939.59	2,160
Shallow Well Extraction	9/14 to 9/22/04	1.85	12.81	0.14	3,938.95	3,442
Full Scale Extraction	9/23 to 10/5/04	1.05	13.25	0.08	3,938.89	4,413
Well 571 (Deep)						
Initial Test Pumping	9/2 to 9/3/04	6.10	14.20	0.43	3,937.74	2,160
Deep Well Extraction	9/8 to 9/13/04	3.42	20.79	0.16	3,930.64	3,260
Full Scale Extraction	9/23 to 10/5/04	2.13	22.56	0.09	3,929.64	4,413

Table 10 (continued). Measured Pumping Rates in Configuration 2 Extraction Wells

Pumping Event	Dates	Average Pumping Rate (gpm)	Average Drawdown (ft)	Average Specific Capacity (gpm/ft)	Average Ground Water Elevation (ft above msl)	Colorado River Flow (cfs)[a]
Well 572 (Shallow)						
Initial Test Pumping	9/2 to 9/3/04	3.65	13.87	0.26	3,938.37	2,160
Shallow Well Extraction	9/14 to 9/22/04	2.23	13.12	0.17	3,939.04	3,442
Full Scale Extraction	9/23 to 10/5/04	0.84	12.90	0.07	3,939.43	4,413
Well 573 (Deep)						
Initial Test Pumping	9/2 to 9/3/04	na	na	na	na	2,160
Deep Well Extraction	9/8 to 9/13/04	3.66	15.26	0.24	3,937.25	3,260
Full Scale Extraction	9/23 to 10/5/04	1.84	23.20	0.08	3,929.27	4,413
Well 574 (Shallow)						
Initial Test Pumping	9/2 to 9/3/04	na	na	na	na	2,160
Shallow Well Extraction	9/14 to 9/22/04	1.50	13.80	0.11	3,938.57	3,442
Full Scale Extraction	9/23 to 10/5	0.64	14.06	0.05	3,938.44	4,413
Well 575 (Deep)						
Initial Test Pumping	9/2 to 9/3/04	4.86	18.15	0.27	3,934.11	2,160
Deep Well Extraction	9/8 to 9/13/04	3.77	15.43	0.24	3,937.06	3,260
Full Scale Extraction	9/23 to 10/5/04	1.40	20.31	0.07	3,932.19	4,413
Well 576 (Shallow)						
Initial Test Pumping	9/2 to 9/3/04	1.84	9.81	0.19	3,942.84	2,160
Shallow Well Extraction	9/14 to 9/22/04	1.34	11.42	0.12	3,941.18	3,442
Full Scale Extraction	9/23 to 10/5/04	0.83	13.54	0.06	3,939.18	4,413
Well 577 (Deep)						
Initial Test Pumping	9/2 to 9/3/04	9.80	19.27	0.51	3,933.51	2,160
Deep Well Extraction	9/8 to 9/13/04	na	na	na	na	3,260
Full Scale Extraction	9/23 to 10/5/04	4.97	21.87	0.23	3,931.02	4,413
Well 578 (Shallow)						
Initial Test Pumping	9/2 to 9/3/04	1.98	12.87	0.15	3,939.98	2,160
Shallow Well Extraction	9/14 to 9/22/04	1.27	14.35	0.09	3,938.30	3,442
Full Scale Extraction	9/23 to 10/5/04	0.43	14.77	0.03	3,938.05	4,413
Well 579 (Deep)						
Initial Test Pumping	9/2 to 9/3/04	9.69	9.95	0.97	3,943.11	2,160
Deep Well Extraction	9/8 to 9/13/04	9.38	11.26	0.83	3,941.88	3,260
Full Scale Extraction	9/23 to 10/5/04	8.84	19.74	0.45	3,933.38	4,413

[a] Value represents average daily mean flow over the test period.

Notes: Wells 573 and 574 were not pumped overnight during the initial test because of equipment problems.
The pump in well 577 stopped operating shortly after the deep well test started.

The data presented in Table 10 indicate not only a considerable drop in pumping rates between the initial test in early September and subsequent tests through early October, but also a noticeable decline in individual well specific capacities. This uniform reduction in specific capacity with continued pumping occurred even though Colorado River flows, and thus river stages, increased with each successive test. Thus it is likely that the efficiencies of the Configuration 2 extraction wells decreased during the successive pumping tests.

Estimated average pumping rates from the Configuration 2 extraction wells are shown in Figure 6. These values were calculated by weighting the average pumping rates during each pumping test (Table 10) by the approximate duration of each test. The graph in Figure 6 clearly illustrates the larger extraction rates achieved in the deep wells versus those in the shallow wells, and the greatest productivity observed at deep wells 579 and 577, on the northern end of the well field. The apparent increase in deep well productivity from south to north might be related to the deeper brine surface observed in the northern part of the well field (Section 3.2.3). However, as discussed later in Section 4.4.2, it is not clear whether this greater productivity is the result of increased ground water flow to the northern part of the well field or a reflection of the possibility that well efficiencies are less adversely affected in areas of relatively low salinity.

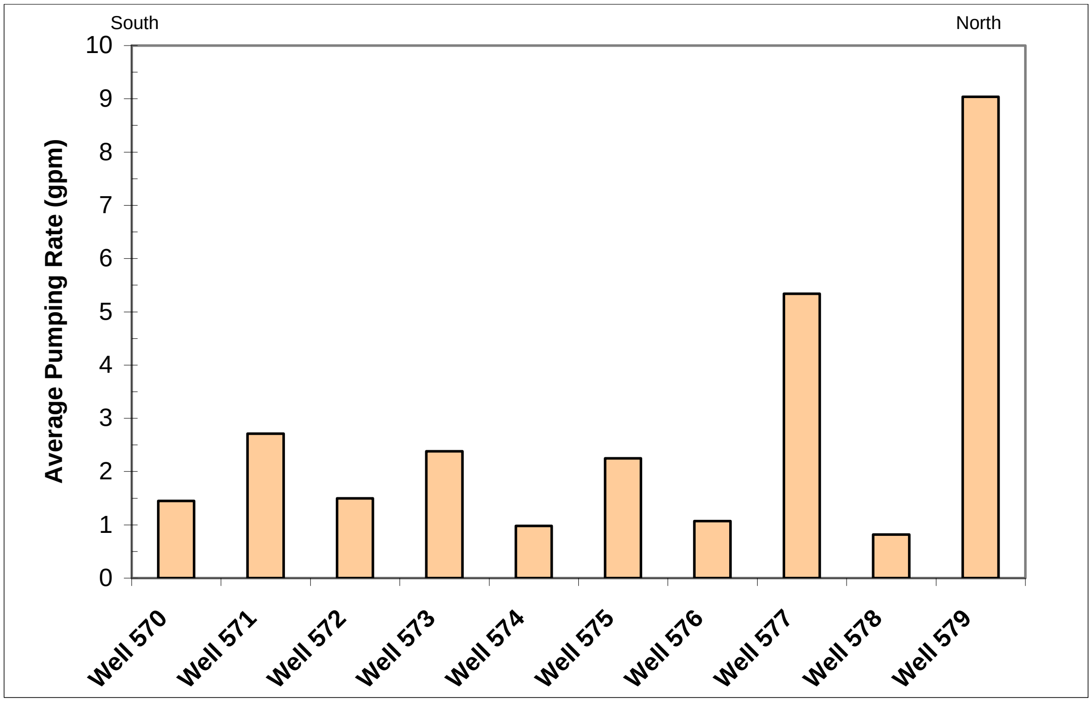

Figure 6. Average Pumping Rate from Configuration 2 Wells Between September and October 2004

4.3 Observed Hydraulic Heads

4.3.1 Configuration 1

4.3.1.1 Horizontal Capture

The ability of extraction wells to capture shallow ground water migrating toward the Colorado River can be assessed by examining hydraulic heads in wells screened over the shallowest parts of the alluvial aquifer. In the case of Configuration 1, this exercise was accomplished using computed equivalent freshwater heads in shallow wells. As long as the computed freshwater heads were determined at a relatively uniform elevation, they could be used to determine general flow directions in a horizontal plane (Lusczynski 1961).

Equivalent freshwater heads were calculated with the formula (Guo and Langevin 2002)

$$h_f = \frac{\rho}{\rho_f} h - \frac{\rho - \rho_f}{\rho_f} Z \tag{3}$$

where h_f = equivalent freshwater head (ft above mean sea level [msl]),
h = measured water elevation in the well (ft above msl),
ρ = density of water in the well (mass/volume),
ρ_f = density of freshwater (mass/volume), and
Z = elevation of the midpoint of the screened portion of the well (ft above msl).

Use of this equation required measured water levels in each shallow well and estimation of water density at the midpoint of the well's screened interval. The latter of these variables was calculated with (Guo and Langevin 2002)

$$\rho = \rho_f + EC_{TDS} \tag{4}$$

where: C_{TDS} = total dissolved solids concentration (mass/volume) and
E = 0.7143, a dimensionless constant.

The determination of equivalent freshwater heads was considered necessary if the effects of water density on flow were to be assessed. Measured TDS concentrations in Configuration 1 shallow wells ranged from near 1,000 mg/L in shallow piezometers in the riverbed to as large as 34,000 mg/L in the pumping wells. Ultimately, however, freshwater heads were found to only slightly diverge from measured water levels in wells. This meant that water levels by themselves could, in many cases, be used to discern flow directions in the event that TDS concentrations could not be measured or estimated.

Map views of posted equivalent freshwater heads at the shallow wells comprising Configuration 1 illustrate the horizontal spatial effects of extraction well pumping. Figure 7 shows that all heads in local shallow wells during April 2004 were of the same general magnitude, approximately 3,953 ft above msl. This set of observations indicated that, prior to pumping of contaminated water, ambient shallow ground water was flowing toward the river at background rates. In contrast, posted heads during September (Figure 8) indicated that

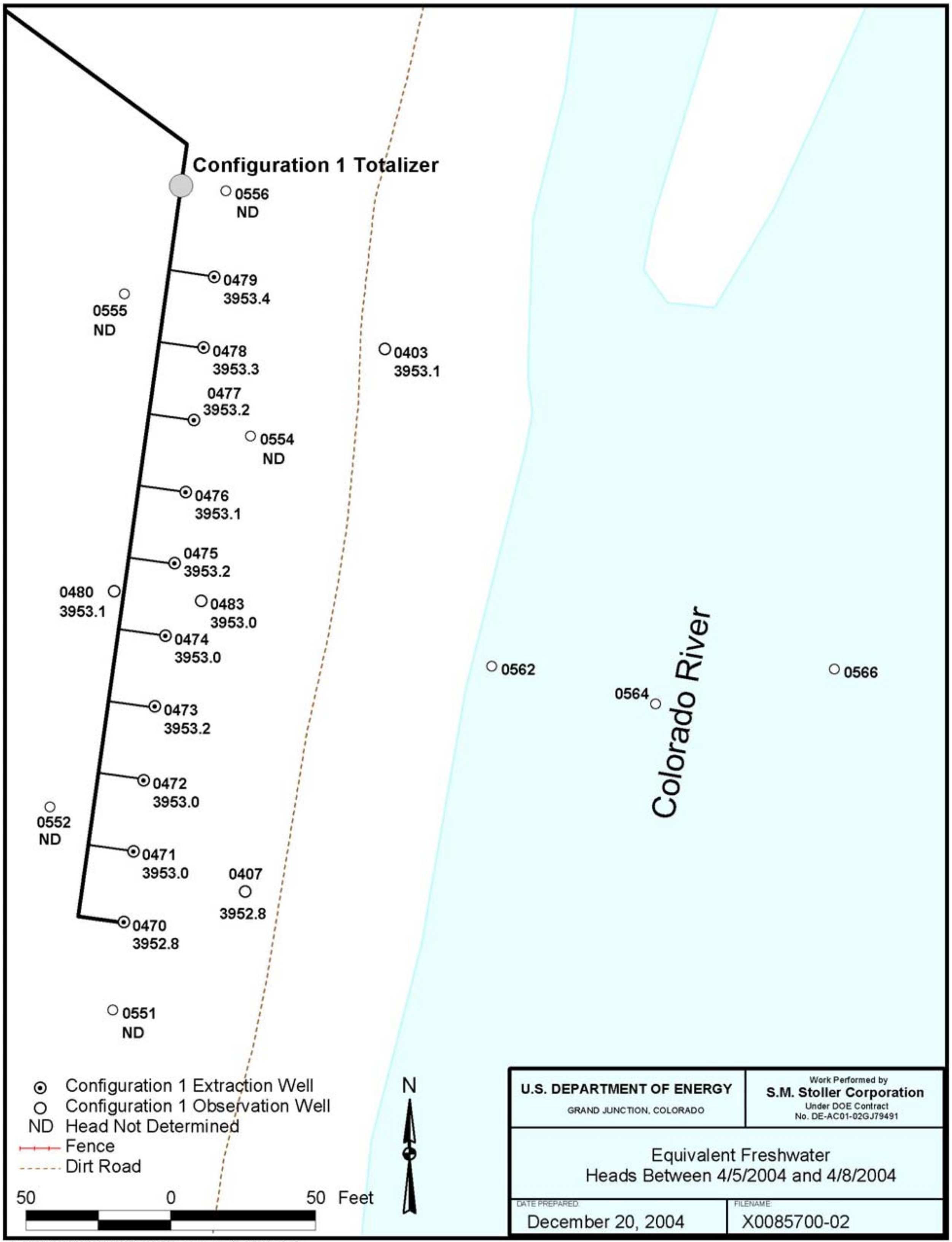

Figure 7. Calculated Equivalent Freshwater Heads in Shallow Configuration 1 Wells During April 2004.

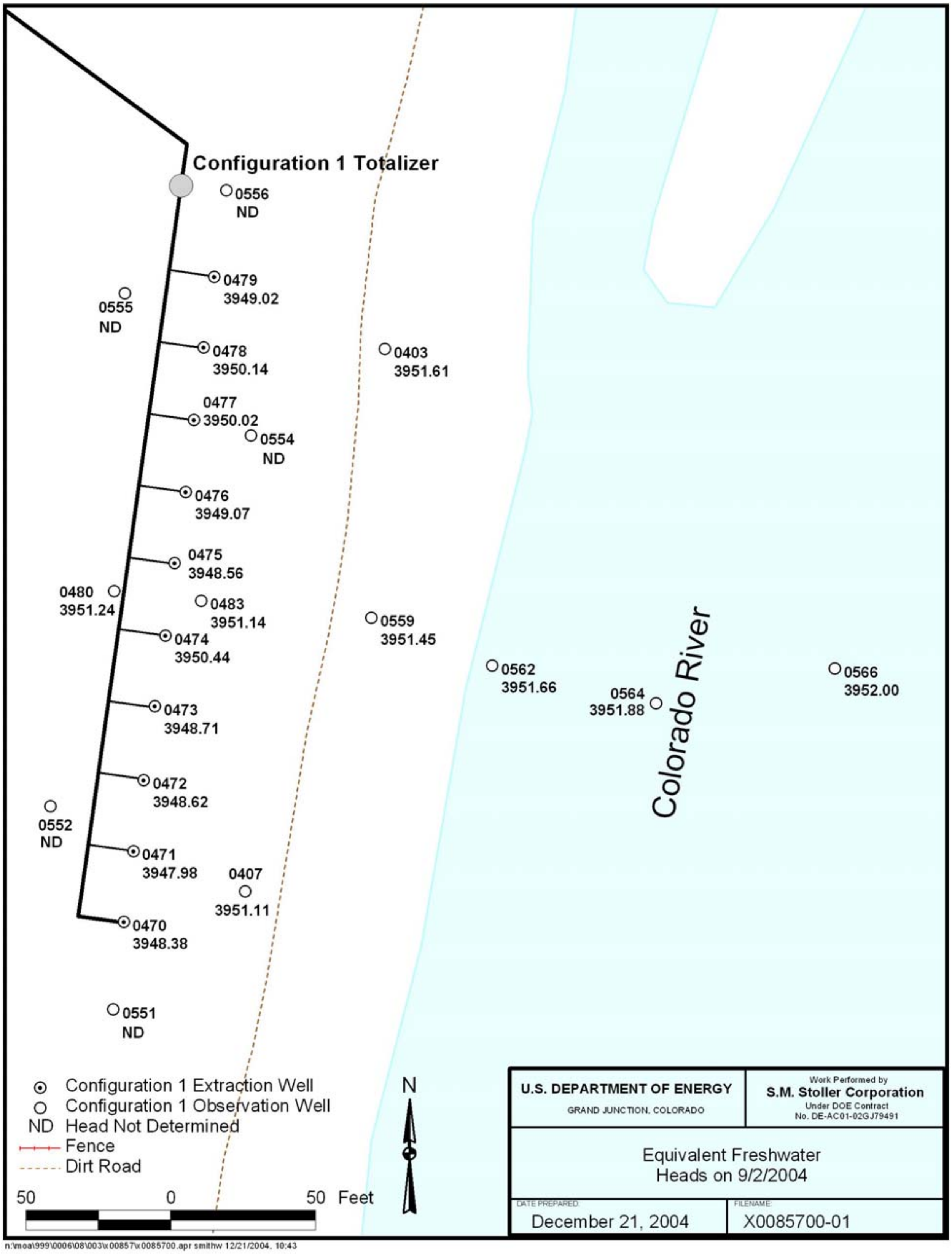

Figure 8. Calculated Equivalent Freshwater Heads in Shallow Configuration 1 Wells During September 2004

shallow ground water was flowing toward the extraction wells from all directions. This included ground water flow from the area of the Colorado River, which suggested that some water was seeping from the river to feed ground water. Additional maps of posted freshwater heads for the months of June, July, and August are presented in Appendix B of this report.

The heads plotted in Figure 8 suggest that Configuration 1 extraction wells are capturing all of the shallow contaminated ground water flowing toward them from the tailings pile. That is, shallow contamination is not passing between wells and discharging to the river. This conclusion is made based on the extent to which the area of influence from pumping is observed: if this area extends as far away as shallow observation well 559, it must also extend at least over the 25 ft of distance that separates each extraction well. Such well interference was intended as part of the Configuration 1 design.

The total capture length of the Configuration 1 well field can be estimated using the freshwater heads shown in Figure 8. Because effects on measured heads are indicated at shallow well 559, which is located about 65 ft east-southeast of the line of extraction wells, it is reasonable to assume that horizontal capture of ground water also extends at least 65 ft both south of well 470 and 65 ft north of well 479. Under this assumption and given the 25 ft that separates each of the extraction wells, the estimated total capture width of the Configuration 1 pumping wells is at least 355 ft.

4.3.1.2 Vertical Capture

The capacity of the Configuration 1 pumping wells to capture any contamination occurring below the brine surface was also assessed. This was accomplished using a technique referred to as the Darcy Method by Jorgensen et al. (1982). This method uses measured water levels and water densities at two distinct locations within a ground water system to compute the change in flow potential between the two locations. In this study, the resulting gradients of flow potential were computed in units of Pascals per foot (Pa/ft).

Two types of Darcy Method calculations were made to assess vertical capture of contaminated ground water in the Configuration 1 area. The first type provided estimates of vertical gradients at two observations well clusters: (1) the cluster formed by wells 483, 484, and 485, and (2) the cluster formed by wells 480, 481, and 482. The assumption was made that the wells in each cluster were essentially in the same areal location, and that measure of the difference in flow potential between each pair of wells provided an estimate of the vertical gradient in flow potential. The second type of calculation examined the flow gradient between a deep observation well offset from the extraction well field and a pumping well located near the middle of the well field. The well pairs used for these calculations are identified in a cross-sectional view of the Configuration 1 system (Figure 9).

The results of the Darcy Method calculations for the 483/484/485 cluster, shown in Table 11 indicate that upward flow gradients existed at this location at all depths, both prior to and after the start of Configuration 1 pumping. However, computed gradients become much larger after the start of pumping in early June 2004. This observation, particularly with regard to an in increase in flow gradient between the deepest well in the cluster (well 485) and the intermediate well 484, indicated that that capture of ground water extended fairly deep into the alluvial aquifer. The implication was that Configuration 1 extraction wells, most of which are screened between depths of 10.3 and 19.5 ft bgs, were capable of drawing water from as deep as 60 ft bgs.

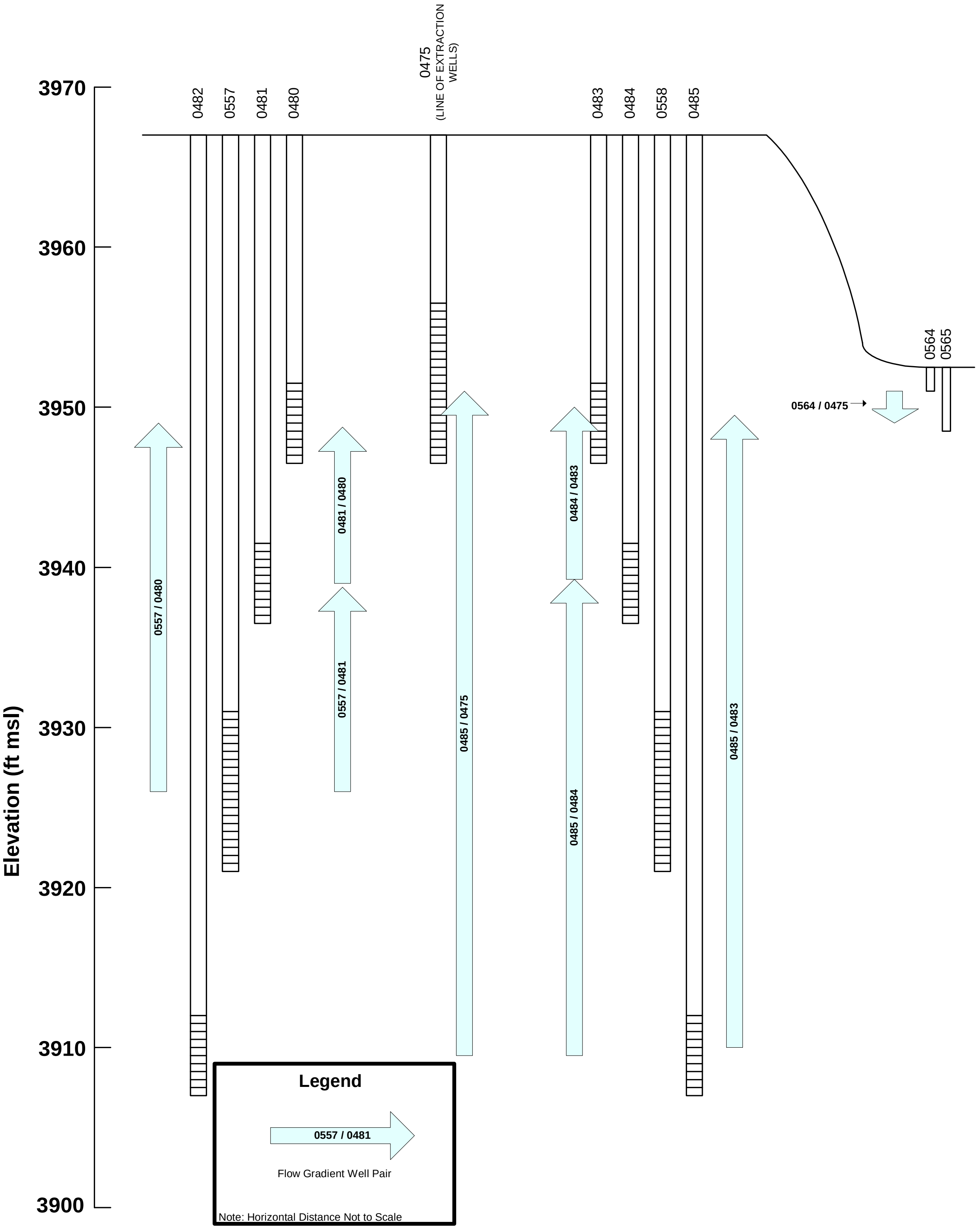

Figure 9. Configuration 1 Well Pairs Used to Calculate Interwell Flow Potential Gradients.

Table 11. Calculated Flow Potential Gradients Between Configuration 1 Wells

Date	Well Pair Information						Flow Potential Gradient[b] (Pascals/foot)
	First Well	Screen Depth[a] (ft bgs)	TDS Concentration (mg/L)	Second Well	Screen Depth[a] (ft bgs)	TDS Concentration (mg/L)	
483/484/485 Well Cluster							
4/5/2004	484	27.7	27,000	483	17.7	19,000	-100
	485	57.8	83,000	484	27.7	27,000	-87
	485	57.8	83,000	483	17.7	19,000	-82
6/3/2004	484	27.7	24,000	483	17.7	23,000	-108
	485	57.8	84,000	484	27.7	24,000	-84
	485	57.8	84,000	483	17.7	23,000	-75
7/6/2004	484	27.7	28,000	483	17.7	24,000	-297
	485	57.8	84,000	484	27.7	28,000	-132
	485	57.8	84,000	483	17.7	24,000	-161
8/4/2004	484	27.7	28,000	483	17.7	27,000	-268
	485	57.8	81,000	484	27.7	28,000	-123
	485	57.8	81,000	483	17.7	27,000	-146
9/1/2004	484	27.7	33,000	483	17.7	34,000	-229
	485	57.8	86,000	484	27.7	33,000	-100
	485	57.8	86,000	483	17.7	34,000	-117
480/481/557 Well Cluster							
4/5/2004	481	27.6	25,000	480	17.7	25,000	-121
6/3/2004	481	27.6	25,000	480	17.7	20,000	-133
7/6/2004	481	27.6	26,000	480	17.7	25,000	-104
8/4/2004	481	27.6	26,000	480	17.7	25,000	-414
9/1/2004	557	40	31,000	481	27.6	27,000	-101
	557	40	31,000	480	17.7	28,000	-177
Well 485 (Observation) and Well 475 (Pumping)							
4/5/2004	475	19.7	15,000	485	57.8	83,000	-345
6/3/2004	475	19.7	17,000	485	57.8	84,000	-360
7/6/2004	475	19.7	18,000	485	57.8	84,000	-593
8/4/2004	475	19.7	20,000	485	57.8	81,000	-579
9/1/2004	475	19.7	21,000	485	57.8	86,000	-596
Well 564 (River Piezometer) and Well 475 (Pumping)[c]							
8/20/2004	564	1.3	1,547	475	19.7	~21,000	-1.3 (-0.01954 ft/ft)

[a] Depth of well screen mid-point except bottom of screen given for pumping well 475.

[b] Negative gradient signifies flow from the first well to the second well.

[c] Intakes for Well 475 and Piezometer 564 are at about the same elevation. Calculated horizontal flow gradient based on equivalent fresh water heads.

Attempts to compute similar vertical flow gradients at the 480/481/482 cluster were complicated by the fact that water levels in well 482 were anomalously low. When data from this well were used, the gradient computations indicated downward migration of water as well as westward movement of briny ground water from well 485 toward well 482. Since both of these observations were considered unlikely, data from well 482 were not included in the final calculations. In September 2004, data from an additional deep well in the cluster (well 557) became available. Consequently, the results from one sampling event in this well were used to calculate vertical gradients in addition to gradients between the shallower wells 480 and 481 throughout the April- to-October period (Table 11). These results also indicated upward flow that increases in response to pumping of the Configuration 1 extraction wells.

A single well pair was used to compute flow gradients between a deep observation well (well 485) and an extraction well (well 475). The results of this calculation, included in Table 11, provide additional evidence that the extraction wells are capable of drawing on ground water from as deep as 60 ft bgs.

4.3.1.3 Capture of River Water

An additional calculation was made to estimate the flow potential gradient occurring between the river and the pumping wells in September 2004. Using data from extraction well 475 and floodplain piezometer 564, the gradient in this case is reported both in units of Pa/ft and a dimensionless ratio (Table 11). The latter reflects the gradient of equivalent freshwater heads between the river and the pumping well, which is very similar to the gradient that would be measured using water levels alone between the pumping well and an observation well located tens of feet away. Though the computed gradient in units of Pa/ft is very small compared to the other gradients listed in Table 11, it does indicate a potential for flow from the river to the extraction wells.

4.3.2 Configuration 2

4.3.2.1 Horizontal Capture

Analyses similar to the freshwater head calculations that were applied to shallow aquifer locations in Configuration 1 provided only approximate measures of flow direction in the Configuration 2 area. Sparse TDS data collected during the various pumping tests at Configuration 2 limited the quantity of simultaneous freshwater heads that could be compared to each other. In addition, because even the shallow extraction wells in the Configuration 2 area were deeper than nearby observation wells, freshwater heads calculated for extraction wells often applied to elevations that were deeper than those for the observation wells; comparison of freshwater heads in such instances could lead to an inaccurate depiction of ground water flow directions (Lusczynski 1961).

Despite these obstacles, a set of calculated freshwater heads was developed for Configuration 2 extraction wells and shallow- and intermediate-depth observation wells for October 5, 2004 (Figure 10), near the end of full-scale extraction test. To calculate these values, some TDS concentrations, and, therefore, water densities, had to be estimated using electrical conductance data measured on days other than October 5th. The heads in this case were considered only partially representative of flow conditions just prior to the end of the combined testing of both deep and shallow extraction wells.

Assuming that the freshwater heads posted in Figure 10 are at least partially indicative of flow capture during pumping, two general conclusions can be reached. First, the extraction wells are drawing water toward them from all directions. Second, computed freshwater heads in the deep extraction wells (odd-numbered wells) are uniformly lower than those associated with the

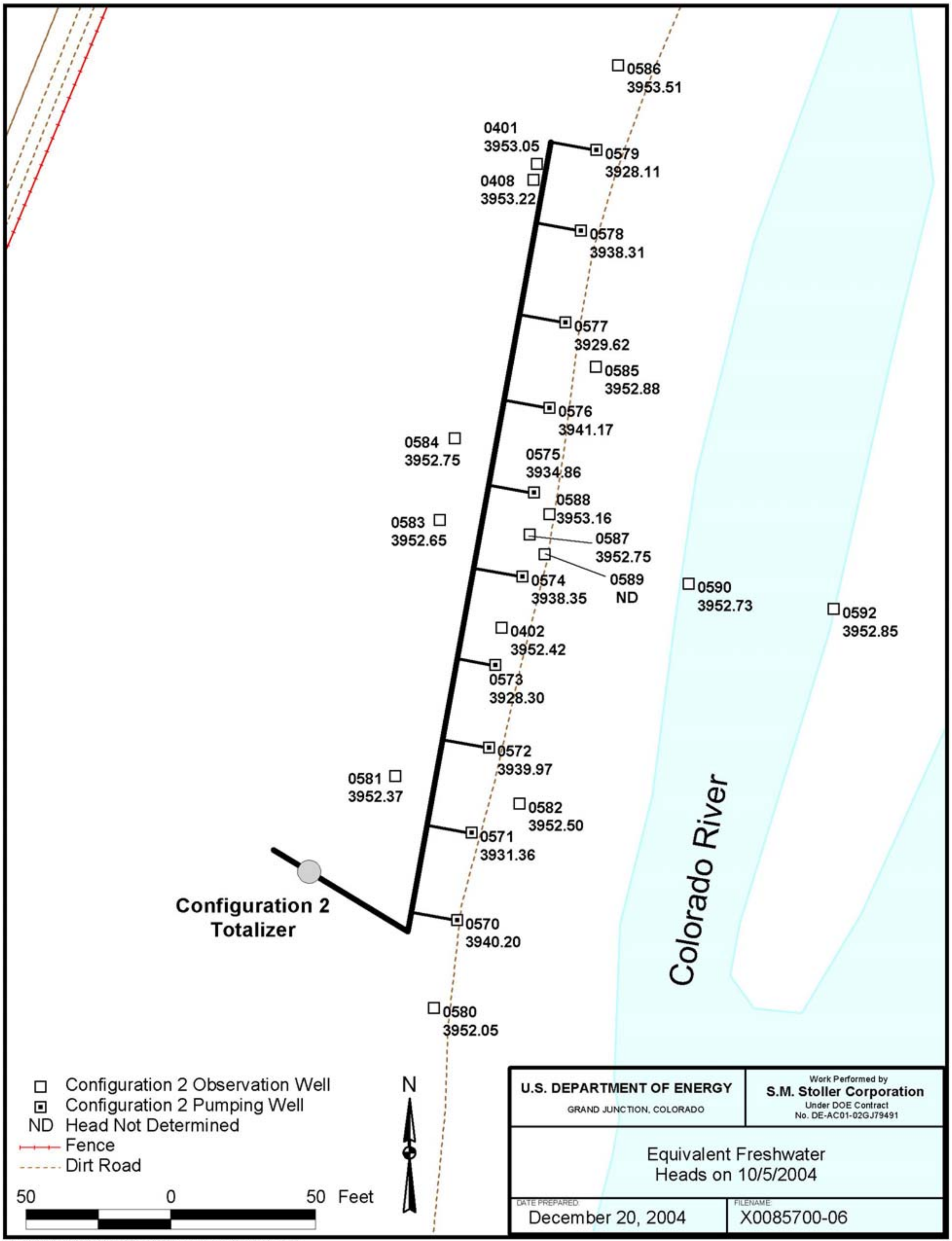

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Figure 10. Calculated Equivalent Freshwater Heads in Configuration 2 Wells During October 2004

shallow wells, a clear result of the additional drawdown available to deep wells in comparison to shallow wells. This last observation suggests that deep extraction wells have the potential of drawing water from shallow portions of the aquifer.

Though not necessarily demonstrated by the equivalent freshwater heads shown in Figure 10, additional conclusions regarding flow capture can be drawn from the water level and TDS data collected in Configuration 2 wells near the end of the full-scale extraction test. The first is that sufficient time had elapsed during the test for the pumping wells to have induced flow of surface water from the river; this conclusion is supported through analysis of system response times, as discussed later in Section 7.2. Consequently, the equivalent freshwater heads in Figure 10 provide some measure of the flow potential gradients that exist between the river and the shallow extraction wells after steady-state pumping conditions (Figure 4) are reached. A second conclusion is that the freshwater heads calculated for shallow observation wells 402 and 587 (Figure 10) do reflect capture of shallow ground water between the pumping wells, despite the fact that these heads are noticeably greater than those calculated for the shallow (even-numbered) extraction wells. This conclusion stems partly from the foregoing one regarding capture of river water; i.e., if the pumping wells are capable of inducing flow from areas occupied by river piezometers, located at least 60 ft away from the well field, then full capture of shallow ground water between adjacent shallow extraction wells (separated by a 60-ft distance) is also likely. Additional support for this conclusion is found in the response of transducers monitored in shallow observation wells during the full-scale pumping test (see Section 4.3.2.3). The presumed cause of considerable differences between computed freshwater heads in shallow extraction wells and comparable heads in observation wells 402 and 587 near the end of the full-scale test (Figure 10) is the different screened intervals used for each (15 to 30 ft bgs in extraction wells, and about 10 to 20 ft bgs in the observation wells).

4.3.2.2 Vertical Capture

Two Darcy Method calculations were performed to assess vertical capture of ground water in the Configuration 2 area (Table 12). The first, between deep observation well 589 and intermediate depth well 588 in August, indicated that an upward flow component existed in the area of the 587/588/589 well cluster prior to well extraction. The second, between shallow observation well 586 and deep pumping well 579 near the end of the full-scale extraction tests, suggested that pumping of a deep extraction well can induce downward flow of shallow ground water located at least 35 ft away horizontally.

Table 12. Calculated Flow Potential Gradients Between Selected Configuration 2 Wells

Date	**Well Pair Information**						**Flow Potential Gradient[b] (Pascals/ft)**
	First Well	**Screen Depth[a] (ft bgs)**	**TDS Concentration (mg/L)**	**Second Well**	**Screen Depth[a] (ft bgs)**	**TDS Concentration (mg/L)**	
587/588/589 Well Cluster							
8/18/2004	588	30	41,500	589	48	65,000	-10
Well 586 (Observation) and Deep Well 579 (Pumping)							
10/5/2004	586	18	14,000	579	32.5	39,000	-1915

[a] Depth of well screen mid-point except bottom of screen used for pumping well 579
[b] Negative gradient signifies flow from the first well to the second well.

4.3.2.3 Configuration 2 Transducer Data

Pressure transducers were installed in a number of observation wells to monitor water levels during the deep-well, shallow-well, and full-scale pumping tests. The data from each test were converted to water elevations and plotted over time along with water levels in a shallow background monitoring well (well 406) located north of the Baseline Monitoring Area (Figure 1). The results from one observation well during the deep-well test are presented in Figure 11. The remaining graphs are included in Appendix C.

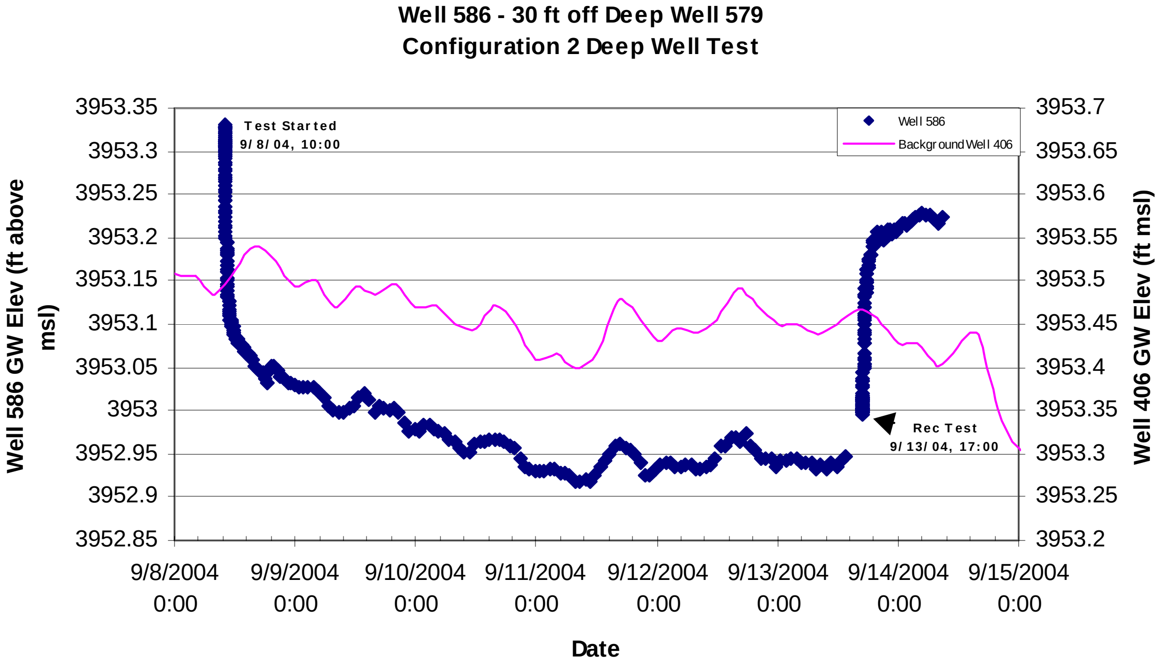

Figure 11. Measured Water Levels in Shallow Well 586 During the Configuration 2 Deep Well Pumping Test

The transducer data from all wells tended to reflect consistent aquifer behavior. As long as background water levels (in well 406) tended to remain constant, steady-state drawdowns were typically achieved in response to pumping over a period of 1 to 2 days. However, if background water levels were steadily dropping or rising in response to changing river flows, the measured water levels in Configuration 2 observation wells dropped or increased accordingly. Specific observations made during each of the pumping tests are summarized below.

Deep-Well Test (9/8/04 through 9/13/04)

Wells 571, 573, 575, 577, and 579 were pumped during the deep-well test, and transducer data were collected in pumping wells 570, 576, and 578; observation wells 580 and 586 (at the southern and northern ends of Configuration 2, respectively); wells 582 and 585 (downgradient of the well field); well 583 (upgradient of the well field); and well 587 (inline with the extraction wells). Each monitoring well was located within 60 ft of a deep extraction well. The pump in well 577 failed shortly after the test start and was not replaced until test completion.

Each observation well responded quickly to the start of ground water withdrawal, with initial drops in water level from 0.2 to 0.5 ft being common. After responding to initial pumping, the water elevations measured in wells 576, 578, and 586 tended to just mimic the fluctuations measured in background well 406, suggesting that changes in river stage were exerting more influence on water elevations than nearby pumping. Water elevations in well 570 also mimicked those in well 406 for the first few days after the start of pumping, but eventually began dropping apparently in response to continued deep well pumping. The water elevations in wells 580, 582, 583, 585, and 587 exhibited constant ground water elevation decreases over the course of the test, indicating strong influence by the deep well pumping and little to no influence by the river. In addition, shallow observation well 580 and shallow extraction well 570, at the southern end of Configuration 2, appeared to be influenced by Configuration 1 pumping.

Shallow-Well Test (9/14/04 through 9/22/04)

Wells 570, 572, 574, 576, and 578 were pumped during the shallow-well test. Pressure transducers were installed in deep extraction wells 571, 575, and 579; observation wells 580 and 586 (at the southern and northern ends of Configuration 2, respectively); wells 582 and 585 (downgradient of the well field); well 583 (upgradient of the well field), and well 587 (inline with the extraction wells).

As with the deep-well test, each monitoring well responded quickly to the start of the pumping, with initial water level drops from 0.2 to 0.4 ft being typical. The water elevations measured in wells 571, 575, 579, and 586 mimicked the fluctuations in the background well almost immediately, again indicating the strong influence of river levels. Water elevations in wells 580, 582, 583, 585, and 587 declined steadily through September 19, 2004, at which time water levels in these wells began to rise in response to increases in Colorado River flow.

Full-Scale Test (9/23/04 through 10/5/04)

All extraction wells were pumped during the full-scale test. Pressure transducers were installed in wells 580 and 586 (at the southern and northern ends of Configuration 2, respectively); wells 582 and 585 (downgradient of the well field); well 583 (upgradient of the well field); and well 587 (inline with the extraction wells). Each monitoring well was located within 30 ft of a shallow extraction well.

Initial drops in monitored water elevation during this test varied from 0.1 to 0.2 ft. However, unlike the previous tests, water levels in each instrumented well began steadily increasing thereafter until October 2nd, at which time water elevations appeared to be controlled by the river. Data collected in well 586 fluctuated quickly in response to daily variations in river flow, whereas water levels in the remaining monitoring wells were less erratic.

4.4 Observed Drawdowns and Implications

Measured drawdowns over time in pumping wells at the two Ground Water IA configurations provide indications of evolving well productivity. If drawdowns tend to increase with time while pumping rates remain relatively constant, it is likely that the affected pumping wells have gradually become less efficient. The less efficient a well is, the greater the disparity between water levels occurring outside the well casing and those within it. Occasional development of wells by physical or chemical means may be helpful for the purpose of increasing contaminant mass removal and increasing the widths of well field capture zones.

4.4.1 Configuration 1

4.4.1.1 Comparisons with Expected Drawdowns

Average drawdowns observed in Configuration 1 extraction wells during the June−October 2004 period (Table 8) were on the order of 3 to 4.5 ft for mean pumping rates that ranged from about 1.5 to 4 gpm. In comparison, an analytical model used in the hydraulic design of Configuration 1 wells (DOE 2003c) suggested drawdowns in the wells would be about 0.7 ft assuming each well was pumped at a rate of 3 gpm. At first glance, the obviously larger drawdowns measured during 2004 suggest that the extraction wells are not 100 percent efficient. However, this conclusion cannot be reached solely on the basis of a comparison between computed and measured drawdowns. The analytical solution applied in the DOE (2003a) calculation assumed that hydraulic heads are affected by leaky aquifer conditions, which allowed significant quantities of water to feed the pumping wells by means of vertical flow across an aquitard layer. At the time, this approach to the hydraulic design was felt to be appropriate based on a recently conducted aquifer test in shallow alluvium at the site (DOE 2003a). It is possible, therefore, that significantly greater drawdowns could have been predicted if the leaky aquifer assumptions had not been applied. To further assess the efficiency of the Configuration 1 wells, calculated specific capacities are analyzed in the next section.

4.4.1.2 Well Efficiency Changes

The well efficiencies observed in Configuration 1 wells when they were first tested in 2003 (Table 2) at pumping rates equal to or less than 10 gpm ranged from 2.94 gpm/ft to 5 gpm/ft. In contrast, monthly average specific capacities in these wells during 2004 varied from 0.22 to 3.14 gpm/ft. Given this comparison, and the observation that Colorado River flows during the summer of 2003 were not radically different from summer 2004 flows, it can be concluded that Configuration 1 well efficiencies decreased during 2004. The exact reason for this decline in well productivity is unknown. However, short of having evidence to the contrary, one suggested cause is the gradual clogging of filter pack and aquifer pores close to the well screens in response to convergent flow to the well casing during pumping. Such clogging is possible even at wells with properly designed filter packs in an aquifer containing a wide range of grain sizes, particularly the gravelly sands and sandy gravels that comprise pumped horizons in the alluvial aquifer. It is also possible that the apparent decrease in well efficiency is related to chemical scale buildup, which might in turn be affected by the elevated salinity of local ground water. Further work is needed to determine how the various dissolved constituents in high salinity waters at the site react with one another in well filter packs and within the relatively thin openings of extraction well screens.

4.4.2 Configuration 2

An assessment of the 3-D model used for the design of Configuration 2 wells (DOE 2004c) was not made because drawdowns predicted by the model were based on a per-unit well pumping rate of 7.5 gpm, which was larger than the pumping rate observed in most Configuration 2 wells.

Nonetheless, it was possible to identify efficiency issues at the Configuration 2 well field during September and October 2004 through analysis of specific capacity data (Table 10). As this table indicates, Configuration 2 specific capacities ranged from as low as 0.05 to a maximum of 0.97 gpm/ft. These values were, on average, about 3 to 5 times smaller than comparable specific capacities at the Configuration 1 field. Moreover, a progressive decline in specific capacities was observed in the Configuration 2 area with each successive pumping test during September and October (Table 10). Such observations suggest that efficiencies in the Configuration 2 well field were affected by conditions that were somewhat unique to this part of the Ground Water IA.

For example, the larger TDS concentrations measured in Configuration 2 wells, because of their deeper screened intervals, and possibly because of their closer proximity to the Colorado River, could be indicative of chemical scaling processes that have not yet been identified. This seems to be possible given that the most productive Configuration 2 wells (deep wells 579 and 577) are located on the northern end of the well field where salinity levels are apparently lower than observed in the southern half of the field. Further investigation of the efficiency issues in the Configuration 2 area would be helpful in assessing whether water chemistry plays a distinct role in controlling well productivity, or whether well efficiency is more strongly affected by physical, pore-clogging phenomena in aquifer media.

5.0 Contaminant Mass Removal

5.1 Well Quantities

5.1.1 Configuration 1

The amounts of ammonia and uranium mass removed from ground water by Configuration 1 extraction wells between June and October of 2004 were estimated by multiplying extraction volumes listed in Table 7 by the measured concentration of each constituent in these wells during each month. The concentration data used in these calculations are listed in Table 13.

Table 13. Constituent Concentrations Used to Calculate Mass Withdrawals at Configuration 1 Extraction Wells

Constituent and Month	**Measured Concentration (mg/L)**									
Well Number	**470**	**471**	**472**	**473**	**474**	**475**	**476**	**477**	**478**	**479**
Ammonia—June 2004	960	890	780	770	710	640	650	650	760	780
Ammonia—July 2004	1000	1100	940	810	860	810	840	750	1400	760
Ammonia—August 2004	990	1100	990	920	960	890	860	810	920	840
Ammonia—September 2004	840	910	880	900	930	890	850	710	840	840
Ammonia—October 2004	650	740	700	660	770	700	760	680	710	720
Uranium—June 2004	3.4	3.3	3.2	3.1	2.9	3	3.1	3	2.9	3
Uranium—July 2004	3	2.7	2.6	2.5	2.8	2.9	3.2	2.9	2.7	2.7
Uranium—August 2004	2.7	2.5	2.8	3	3.1	3.1	3.2	3	2.8	2.6
Uranium—September 2004	2.7	2.5	2.8	3.1	3.5	3.2	3.1	2.9	2.8	2.7
Uranium—October 2004	2.1	2	1.9	2.3	2.3	2.3	2.2	2.3	2.2	2.3

The resulting estimated total amounts of ammonia as nitrogen (NH_3-N) removed by Configuration 1 extraction wells between June and October 2004 are shown in Figure 12. The ammonia mass removals tended to parallel the average pumping rates shown in Figure 5 because NH_3-N concentrations in the extraction wells were relatively uniform. The largest amount of ammonia mass reduction was attributed to well 470 with an average pumping rate of 4.2 gpm, and the smallest mass removal occurred in at well 476, where the average pumping rate between June and October 2004 was less than half that at well 470.

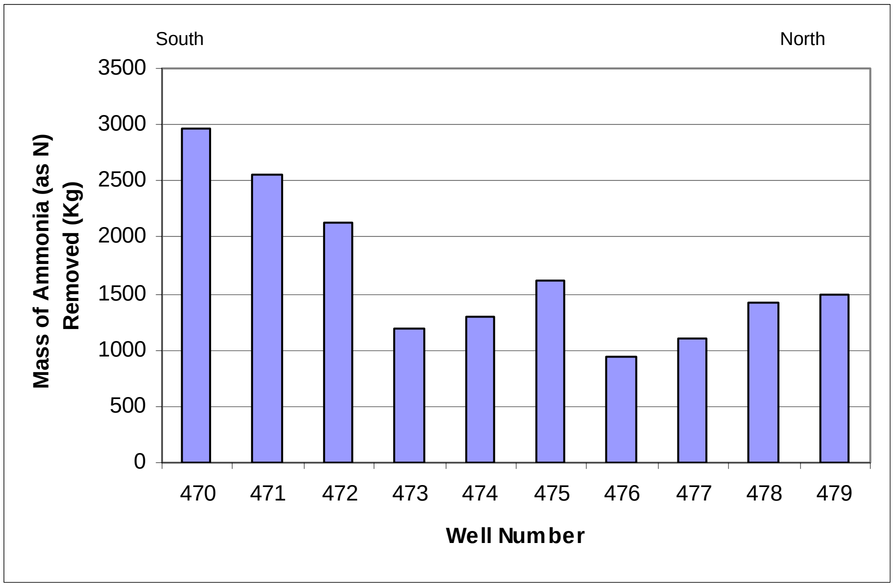

Figure 12. Mass of Ammonia Removed by Configuration 1 Wells Between June and October of 2004

Removal of uranium mass from Configuration 1 extraction wells during 2004 (Figure 13) exhibits a similar pattern to that for ammonia. Again, with little variation in uranium concentrations between wells, the largest mass removal rates are observed in the most productive wells.

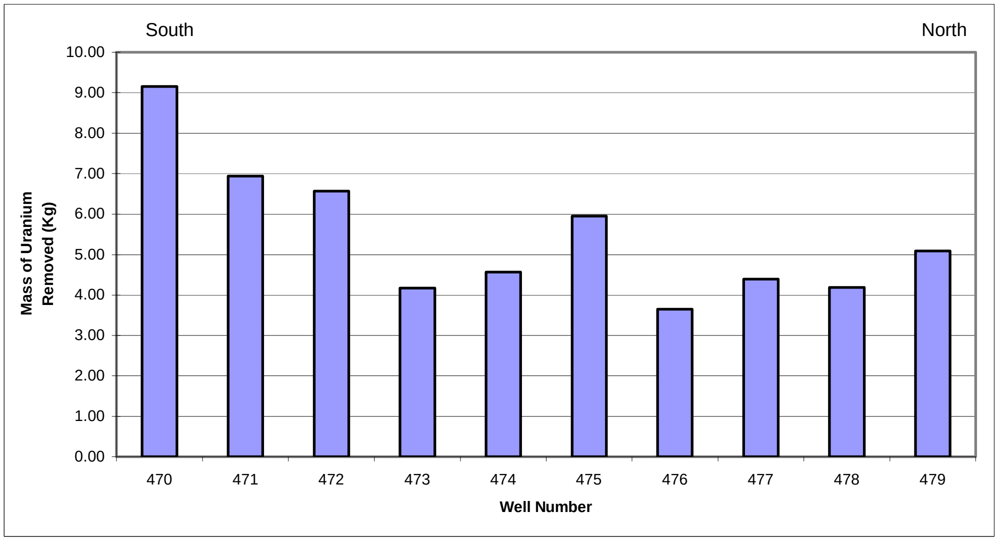

Figure 13. Mass of Uranium Removed by Configuration 1 Wells Between June and October 2004

5.1.2 Configuration 2

Estimates of quantities of ammonia and uranium mass contributed to the treatment system by the Configuration 2 extraction system during 2004 were based on concentration data collected at three different times. The resulting average concentrations of ammonia and uranium adopted for each of the Configuration 2 extraction wells are listed in Table 14. These values show a tendency for ammonia concentrations during pumping to be larger in the southern portion of the well field than in the northern half. Also, the listed concentrations for uranium reflect the observation presented in Section 3.2.3 that background levels of this constituent in August 2004 tended to be lower in wells 570 and 571 than in the other wells located to the north.

Table 14. Average Constituent Concentrations Used to Calculate Mass Withdrawals at Configuration 2 Extraction Wells

Average Concentration (mg/L)	**Measured Concentration (mg/L)**									
Well Number	**570**	**571**	**572**	**573**	**574**	**575**	**576**	**577**	**578**	**579**
Ammonia as N	1600	1500	1050	1200	870	1125	980	995	740	760
Uranium	2.05	1.75	2.2	2.1	2.45	2.4	2.7	2.4	2.5	2.3

The Configuration 2 extraction volumes shown in Table 9 were combined with appropriate concentrations in Table 14 to produce individual well mass removals for ammonia and uranium (Figure 14 and Figure 15). For the most part, the ammonia mass extractions parallel average pumping rates. However, higher ammonia concentrations in the southern part of the well field cause the ammonia masses removed from deep wells 571 and 573 to be about the same magnitude as that removed from deep well 577, even though the average pumping rate at this last well was more than twice that at either of the former wells. Uranium mass removals at individual wells (Figure 15) are clearly proportional to average pumping rates.

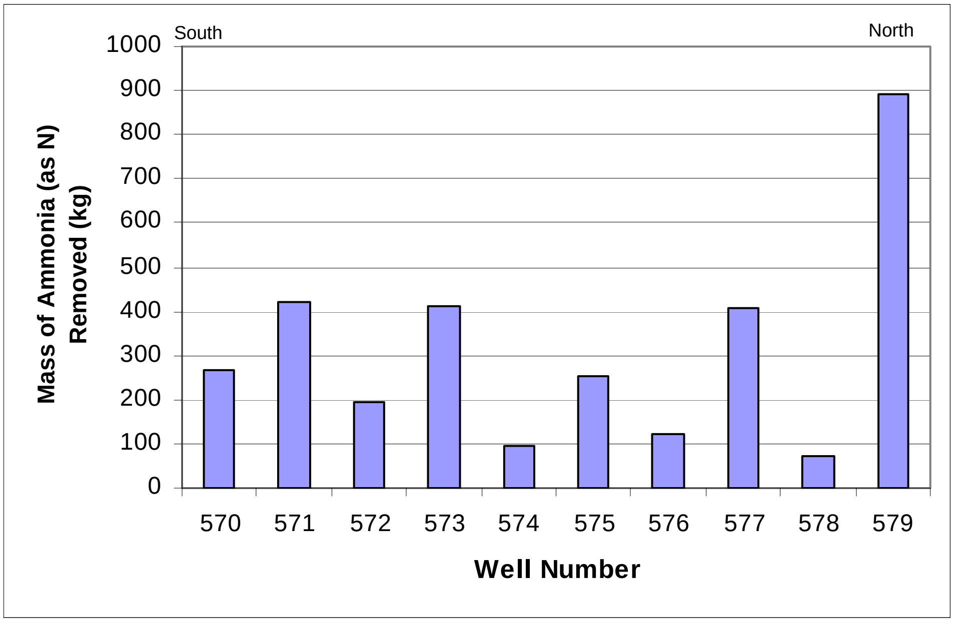

Figure 14. Mass of Ammonia Removed by Configuration 2 Wells Between June and October 2004

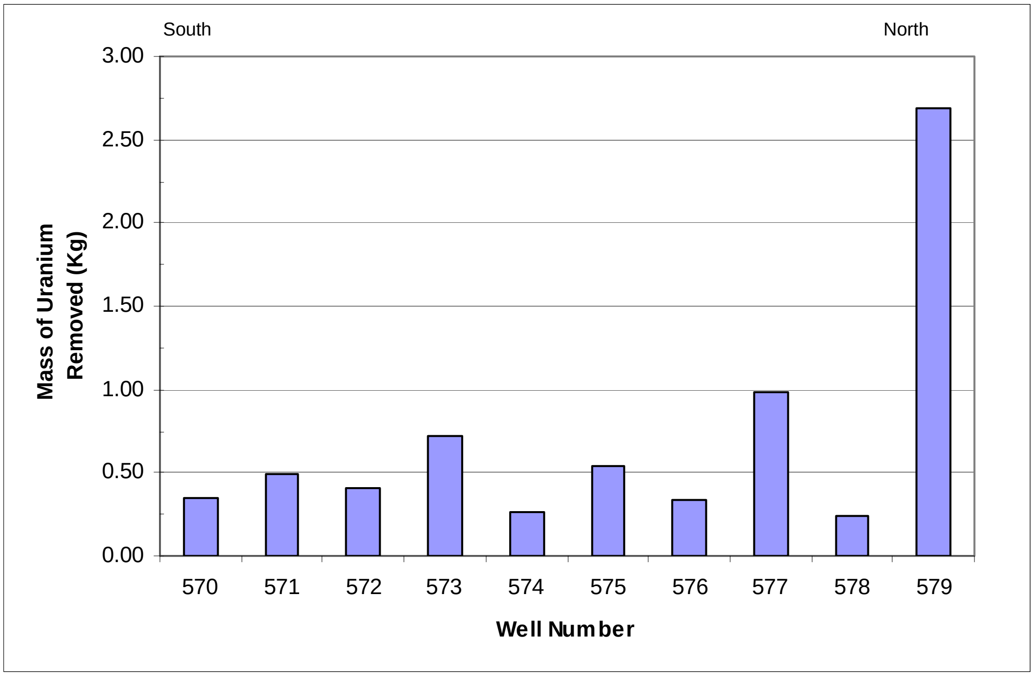

Figure 15. Mass of Uranium Removed by Configuration 2 Wells Between June and October 2004

5.2 Mass Withdrawal by Horizon

The measurement of vertically varying concentrations of ammonia in Configuration 1 wells under baseline conditions in 2003 and prior to full-scale pumping in June 2004 makes it possible to identify horizons from which large amounts of ammonia might have been removed. In April 2004, vertical profiles of ammonia concentration in well clusters 480/481/482 and 483/484/485 indicated that the largest ammonia concentrations were observed at a depth of somewhere between 30 and 45 ft bgs (Figure 16 and Figure 17). This suggested that the highest ammonia levels occurred near the brine surface in the Configuration 1 area. Similar vertical distributions of ammonia have been observed in other parts of the Moab site, but not in all areas (DOE 2003e). Where such a distribution does occur, it appears to be a legacy of past releases of ammonia from the tailings pile, during which contamination was able to penetrate the brine surface, but was eventually limited from migrating to very large depths because of the large density of underlying brines. Because the screened intervals of Configuration 1 wells (10.3 to 19.7 ft bgs, or 9 to 24 ft bgs) lie above the local brine surface during non-pumping periods (35−40 ft bgs), it appears probable that a large portion, if not most, of the ammonia withdrawn from the area comes from upconing of briny ground water directly beneath the wells.

Prior to pumping, uranium concentrations in Configuration 1 observation wells appeared to decrease consistently with depth (Figure 18 and Figure 19). Thus, it is likely that the greatest rate of uranium removal by Configuration 1 wells occurred during periods in which shallow water comprised a large fraction of the total quantity of pumped ground water.

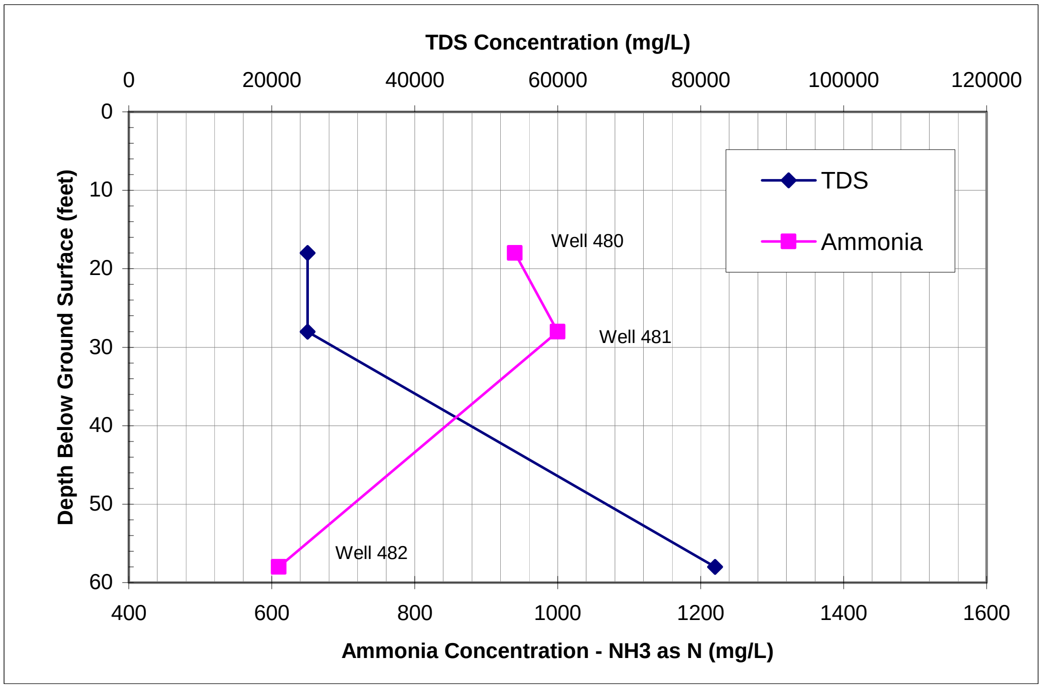

Figure 16. Measured Background Concentrations of TDS and Ammonia in Observation Wells 480, 481, and 482 on April 7, 2004

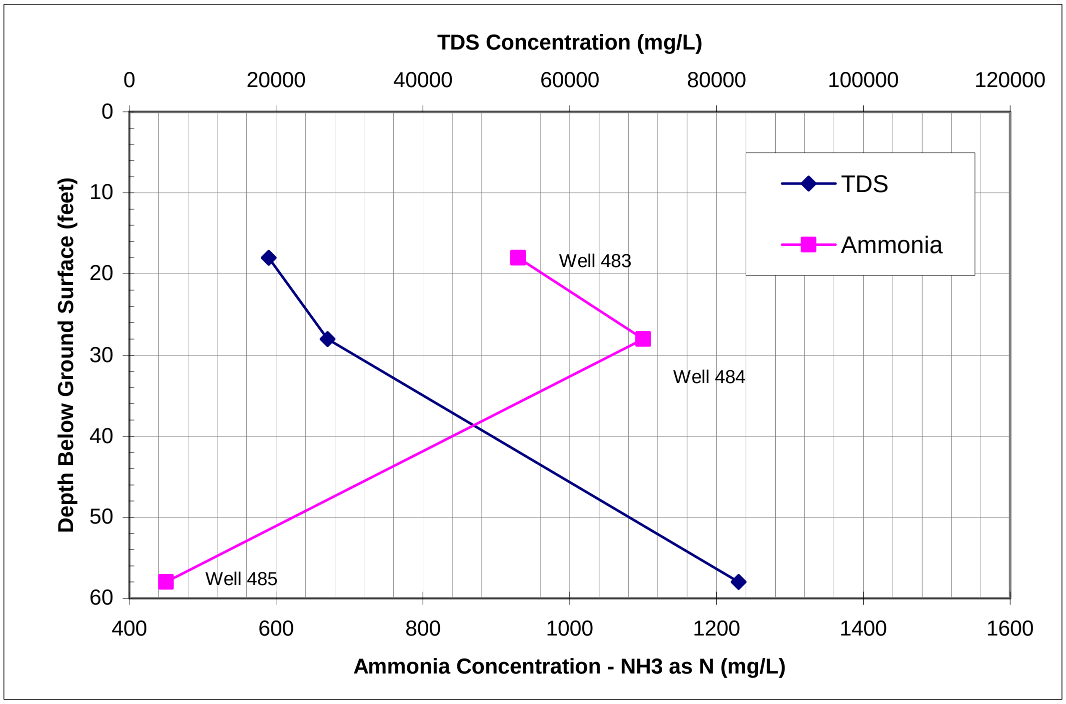

Figure 17. Measured Background Concentrations of TDS and Ammonia in Observation Wells 483 484, and 485 on April 7, 2004

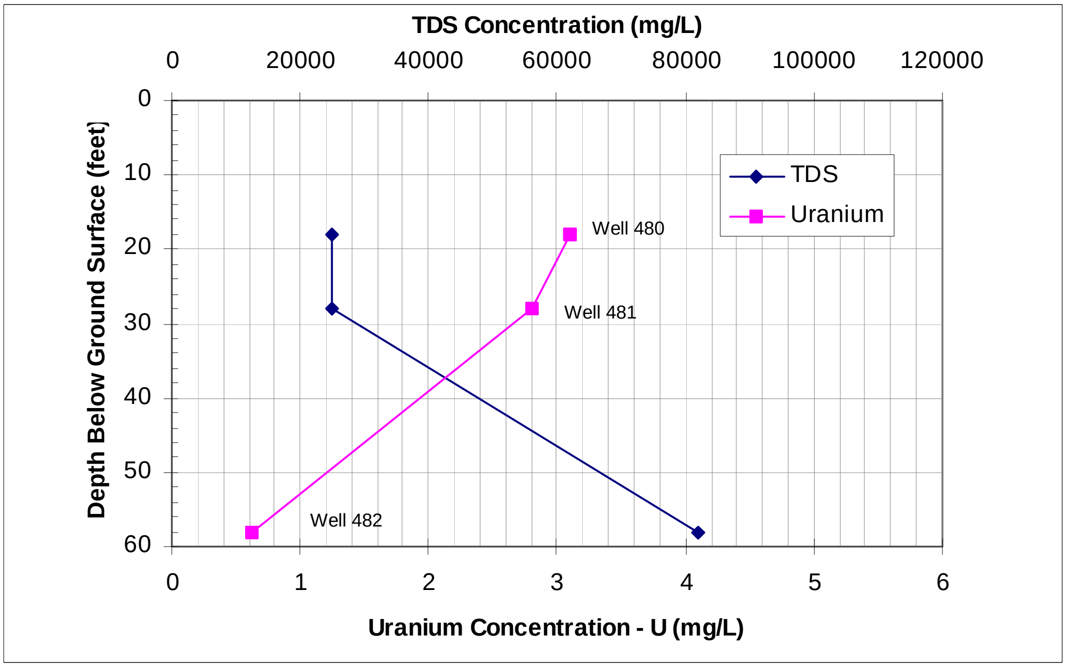

Figure 18. Measured Background Concentrations of TDS and Uranium in Observation Wells 480, 481, and 482 on April 7, 2004

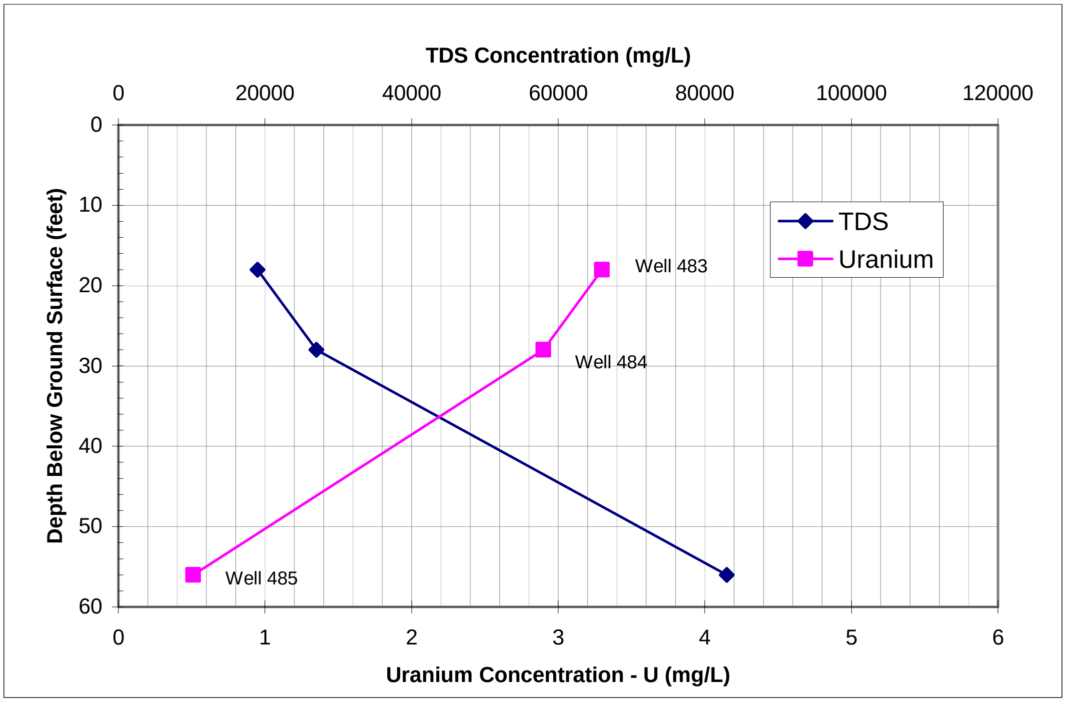

Figure 19. Measured Background Concentrations of TDS and Uranium in Observation Wells 483, 484, and 485 on April 7, 2004

The background vertical distributions of ammonia and uranium in the Configuration 2 area were estimated using concentration data from August 18, 2004. The data in this case suggested vertical profiles of ammonia that were different from those observed at well clusters in the Configuration 1 area. Instead of the largest concentrations occurring near the depth of the brine surface, ammonia levels in wells located in the southern half of the well field appeared to increase from about 500 mg/L in the shallowest part of the saturated zone to 1,000 mg/L near a depth of 30 ft bgs (i.e., near the brine surface), below which the concentrations remained in the range of 1,000 to 1,700 mg/L to depths as great as 52 ft bgs. This trend suggested that the local base of ammonia contamination was not identifiable using existing wells. The observed vertical distribution might be explained by natural variability of ammonia levels, as similar vertical distributions have been observed at the PW−02 well cluster located about 250 ft upgradient of Configuration 1, and at the PW−01 cluster in the baseline monitoring area. Alternatively, it is possible that the local vertical distribution of NH_3-N is influenced by the configuration's closer proximity to the Colorado River. Convergent flow of ground water near the west bank of the river may tend to focus ammonia discharge in this area from multiple depths (see Figure 2). Regardless of the cause, the observed ammonia distribution indicated that both deep and shallow pumping wells in the southern half of the Configuration 2 field are likely to be screened in horizons containing ammonia contamination at relatively high levels.

The background vertical distribution of ammonia in the northern portion of the Configuration 2 well field was more difficult to characterize. NH_3-N concentrations in shallow extraction well 578, which is screened between depths of 15 and 30 ft bgs, were on the order of 1,000 mg/L. Yet comparable shallow concentrations in nearby deep well 579 (screened between depths of 25 and 40 ft bgs) were on the order of 600 to 700 mg/L. Near the base of well 579, the background ammonia concentration was 1,100 mg/L. The lack of any distinct vertical trends for ammonia levels in these two wells made it difficult to project which horizons in the northern part of the Configuration 2 well field would produce the greatest ammonia mass.

As discussed in Section 3.2.3, no distinct vertical trends in uranium concentration were observed in Configuration 2 wells. Consequently, it is unlikely that more uranium was drawn from one horizon in comparison to another.

6.0 Treatment System Performance

Construction of the sprinkler system was completed April 22, 2004 and routine operations and monitoring of the sprinkler system began on May 5, 2004. The sprinkler system was operated during the week on a 4-day work schedule. An increasing rate of decline in the pond level was seen immediately after the sprinkler system was started (Figure 20). Although most of the decrease in pond depth reflected discharge to the sprinkler system, some of the decrease could also be related to the gradual rise in ambient air temperatures that increased evaporation from the pond surface.

The interim action extraction well pumps were started on June 3, 2004, after the pond level reached an optimum depth of 4 ft. After the first week of pumping, the inflow to the pond from the extraction wells remained relatively constant at approximately 35 gpm (Figure 20). The sprinkler system was operated on a 4-day schedule for several successive weeks at a rate that maintained the pond depth at approximately 4 ft. Therefore, the sum of the outflow to the sprinkler system and evaporation from the pond surface was approximately equal to the inflow from the well field during this period.

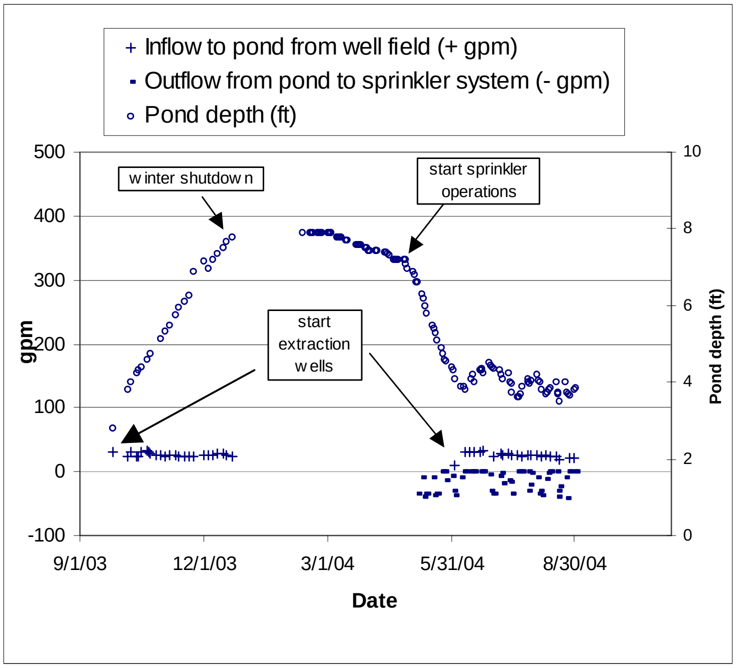

Figure 20. Inflow from the Well Field, Outflow to the Sprinkler System, and Water Levels for the Evaporation Pond in 2003 and 2004

The percent of total evaporation resulting from only the sprinkler system can be estimated during the period of relatively steady conditions when the pond depth remained constant. A summary of all the weekly monitoring data collected during this period, when both inflow volumes from the well field and outflow volumes to the sprinkler system were available, is presented in Table 15.

Table 15. Summary of Weekly Treatment Rates

Week (2004)	Volume pumped to pond (gals)	Volume pumped to sprinkler system (gals)	Actual % of total volume treated by sprinkler system (minimum)	Potential percent increase in the total treatment volume by the sprinkler system (adjusted for 7 days)
6/3−6/10	231,966	54,683	24	42
6/24–7/1	364,586	173,146	47	82
7/1–7/8	365,089	192,463	53	93
7/8–7/15	363,608	203,023	56	98
7/29–8/5	362,157	193,222	53	93
8/5–8/12	368,483	78,100	21	37
8/12–8/19	368,706	137,949	37	65
Total	2,424,595	1,032,586	43	75

On average, the sprinkler system evaporated approximately 43 percent of the inflow from the well field (Table 15). This estimate is based on an operating schedule limited to 4 days per week to avoid drawing the pond level below the 4-ft depth. Had the well field delivered more water to the pond, the sprinkler system could have operated on a 7-day-per-week schedule, which would have provided a 75 percent increase in total treatment capacity. Further increases in treatment capacity by the sprinkler system may be possible by either increasing the application time using existing sprinklers or installing more sprinklers.

7.0 Hydrogeologic Analysis

Ground water extraction in the Configuration 1 and 2 well fields during 2004 and the data collected in association with the pumping has helped minimally in characterizing the alluvial aquifer at the Moab site. As discussed in a following section, little can be learned regarding aquifer hydraulic conductivities because of the efficiency issues with both Configuration 1 and 2 extraction wells. However, some information regarding the effect that the Colorado River on ground water flow and well productivity can be gleaned from analysis of the Ground Water IA database. In addition, new information concerning the response time of the alluvial aquifer to hydrologic stresses is useful for future operation of the Ground Water IA system.

7.1 Influence of the Colorado River

Previous comparisons of ground water levels at the Moab site with Colorado River flows (DOE 2003b, 2003e) demonstrated clearly that hydraulic heads in the alluvial aquifer rise with increasing river flow and decrease as flows decline. A lag time on the order of as much as a day is typically observed between river rise and increases in ground water levels in wells located several hundreds of feet from the river. However, the response time of ground water close to the river is relatively short, making it likely that river effects on water levels in Configuration 1 and 2 wells would be observed within periods of just tens of minutes.

Water level data collected in 2004 from extraction wells while they were pumped illustrate the influence the Colorado River has on well yields. As shown in Figure 21, the monthly average specific capacity of each of the Configuration 1 extraction wells increased between August and September due to an increase in river flow during this period. This increase in well yield with rising river flows becomes even more apparent in a scatter plot of specific capacity and river flow for each of the Configuration 1 pumping wells (Figure 22). However, it is difficult to develop a specific relationship between well yield and river flow from this latter plot because the data used to develop it are also affected by well efficiency problems.

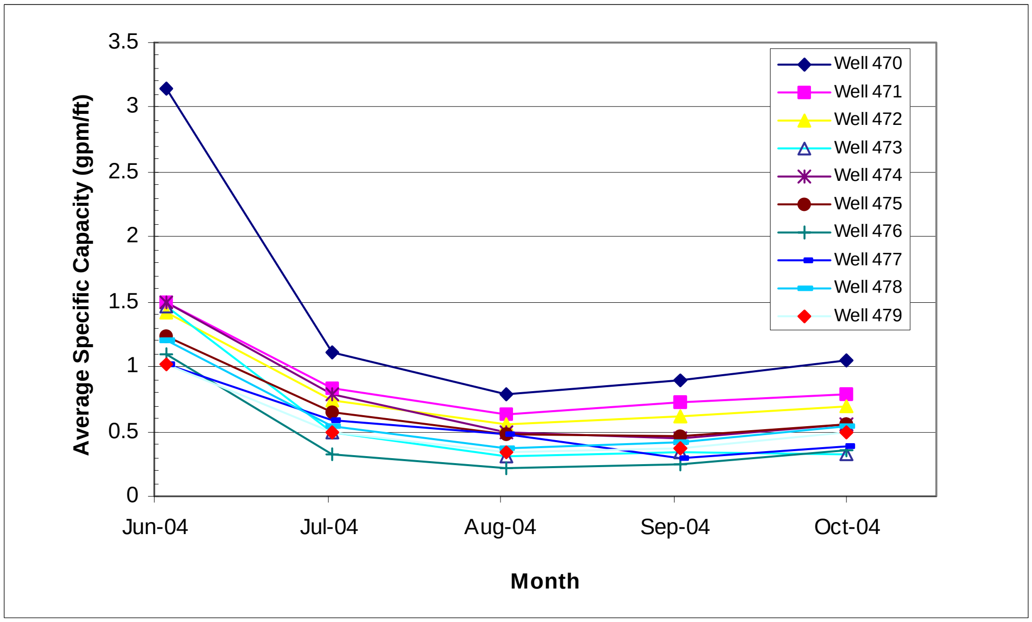

Figure 21. Average Specific Capacities at Configuration 1 Wells Between June and October 2004

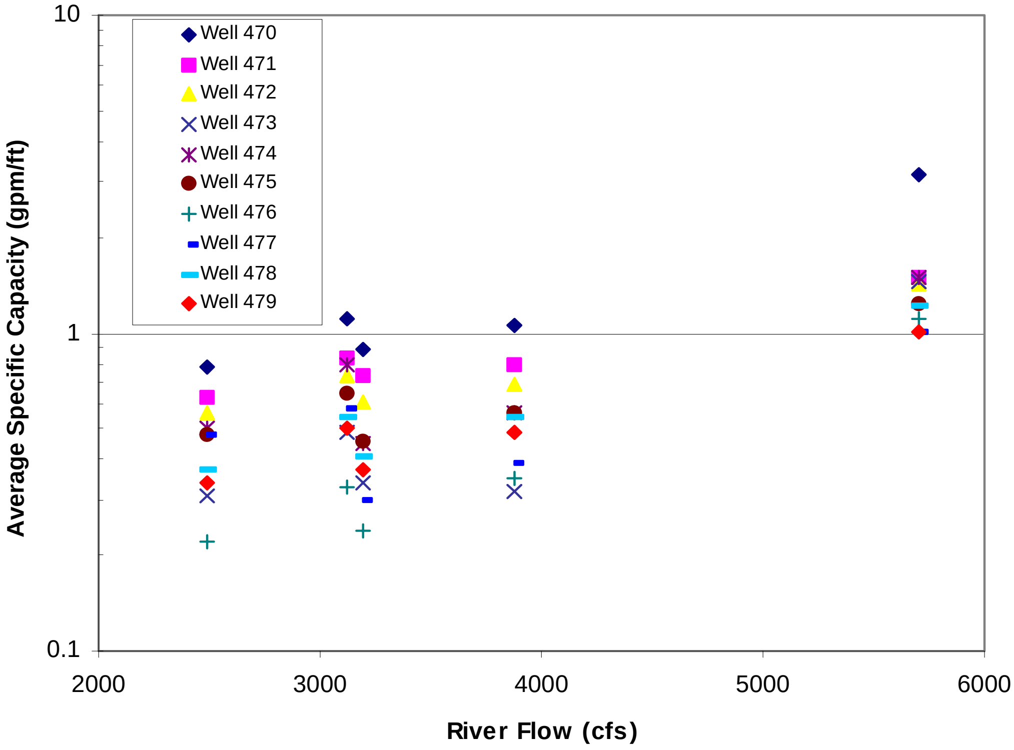

Figure 22. Average Specific Capacity in Configuration 1 Wells and Colorado River Flows

7.2 Time Constants

The expression "hydraulic time constant" is used in this study to represent the approximate time that is needed for the effect of a hydraulic stress on a ground water system to be observed at some characteristic length L from where the stress occurs. With regard to Configurations 1 and 2, it is desirable to develop a constant that describes the time necessary for the effects of pumping from extraction wells to be observed in the form of measurable drawdown at the river such that flow from surface water to ground water is induced. The previously discussed lag time between a peak river flow and an associated increase in a well's water level (Section 7.1) provides a preliminary estimate of such a time constant. In Section 3.1.5, it was suggested that the response time between a river rise and ground water levels in the Configuration 1 and 2 areas was less than 24 hours. Calculations are performed in this section to provide a more precise estimate of the time constant associated with ground water pumping in the Ground Water IA remediation areas.

If only a single well were used to extract ground water near the Colorado River, equations describing radial flow toward that well would be appropriate for estimating the time constant. However, because ten collinear wells are pumped in both Configurations 1 and 2, the extraction wells in each case tend to act cumulatively like a line sink. Because of this, ground water flow occurring in the areas between the extraction wells and the river tends to be more one-dimensional than radial. Assuming linear flow under confined aquifer conditions, a conservatively small time constant can be estimated using (Domenico and Schwartz 1998)

$$t^* = \frac{S_S L^2}{K} \tag{5}$$

where t^* = the time constant (days),
S_s = aquifer specific storage (ft^{-1}),
L = distance between the pumping wells and the river (ft), and
K = aquifer hydraulic conductivity (ft/day).

For both the Configuration 1 and 2 systems, K can be assumed to equal 140 ft/day, and a reasonable specific storage for an aquifer dominated by the sandy gravels and gravelly sands in the alluvial aquifer is 1×10^{-5} ft^{-1}. Assuming L = 100 ft in the case of Configuration 1 (i.e., the distance between the river's west bank and the extraction wells) and applying the above-mentioned constants, a time constant of 7×10^{-4} days is computed. This value translates into approximately 1 minute.

Such a small time constant implies that pumping from Configuration 1 extraction wells produces drawdowns at the west bank of the river virtually instantaneously. However, the assumption of confined aquifer conditions applied in this calculation is probably not fully applicable to the alluvial aquifer in the shallow horizons from which water is pumped. Rather, it is likely that gravity drainage, as observed in an unconfined aquifer, yields some of the extracted ground water. An alternative time constant can be estimated by assuming completely unconfined conditions using the following formula (Reilly and Harbaugh 2004).

$$t^* = \frac{S_y L^2}{bK} \tag{6}$$

where: S_y = aquifer specific yield (dimensionless), and
b = aquifer thickness (ft).

Assuming that (1) aquifer specific yield S_y is equal to 0.3, (2) the extraction well screen depth (~ 10 ft) can be used to approximate the aquifer thickness, and (3) all remaining parameters are as assumed above, the time constant resulting from applying Equation (6) is 2.14 days. This latter result suggests more than one day of pumping would pass before inflow to the aquifer from the river would be induced.

In all likelihood, the time that it takes for the effects of pumping at Configuration 1 to be observed along the west bank of the Colorado River such that recharge of surface water is induced is somewhere between a few minutes and a few days. This is because monitoring of shallow ground water at the site shows signs of ground water flow being affected by both confined and unconfined aquifer conditions.

The above reasoning indicates that the corresponding time constant for Configuration 2 is very small, and is perhaps on the order of less than an hour. The influence of pumping at the river is felt within such a short time both because the extraction wells in this configuration lie closer to the river (~ 50 ft) than the Configuration 1 extraction locations (~ 100 ft) and the screened intervals for the Configuration 2 wells lie deeper than those for Configuration 1. The portion of the aquifer tapped by deep pumping wells in this area (screened between 25 and 40 ft bgs) is likely to yield its water under mostly elastic storage conditions. The quick responses to pumping seen in observation wells in the Configuration 2 area (Figure 11 and Appendix C) support this notion.

Though useful for preliminary estimates of aquifer temporal response, Equations (5) and (6) have somewhat limited application because they do not account for the effects of water density on ground water flow. The existence of both very saline and briny ground water in the Configuration 1 and 2 areas signifies that time constants will be somewhat larger than estimated above. Density-dependent ground water modeling for the conditions observed in these locales would help to determine the degree to which water salinity affects aquifer response time.

7.3 Assessment of Aquifer Properties

Pumping well and observation well data collected in 2004 in the Ground Water IA remediation areas were analyzed for their potential to yield estimates of alluvial aquifer hydraulic properties. Unfortunately, the issues with efficiency of Configuration 1 and 2 extraction wells meant that the specific capacities reported for these wells could not be used with Equations (1) and (2) to estimate aquifer hydraulic conductivity. With the exception of data collected in June for extraction well 470 under Configuration 1, the specific capacities listed in Table 8 are all indicative of hydraulic conductivities that are far less than the 100 to 180 ft/day that have previously been attributed to gravel and sand deposits in the local alluvial aquifer (SMI 2001, DOE 2002, DOE 2003e). Hydraulic conductivities estimated from the specific capacity values associated with Configuration 2 wells (Table 10) are typically even smaller than those based on Configuration 1 data collected during 2004.

It is possible that reasonable estimates of hydraulic conductivity and the storage properties of the alluvial aquifer could be derived through modeling of density-dependent ground water flow in the Ground Water IA remediation areas. For example, this type of modeling might be applied to match transducer-derived water levels in Configuration 2 observation wells (Figure 11 and Appendix C) during the separate pumping tests conducted in this area during 2004. Such a modeling exercise would require the estimation of Colorado River water levels adjacent to the area during each test. Similar modeling might be applied to the Configuration 1 area using transducer data collected during 2003 (DOE 2004a).

7.4 Hydraulic Analysis of Floodplain Piezometers

Measured 2004 water levels and TDS concentration data in all floodplain piezometers were analyzed for potential flow trends in the zone located immediately below the Colorado River channel. The objective of this analysis was to discern whether locally upward flow toward the Colorado riverbed was evident during non-pumping periods and possibly reversed during months of ground water extraction. Using the previously described Darcy Method for determining flow direction in variably dense ground water (Section 5.2.1.1), no apparent local trends were identified (Appendix D). These results did not necessarily conflict with previous analyses that suggested flow was induced from the river toward extraction wells during pumping. Rather, they inferred that hyporheic zone processes in the vicinity of the floodplain piezometers tend to cause complicated three-dimensional flow patterns. As shown in Appendix D, both upward and downward flows were calculated for the three areas where floodplain piezometers were installed (Configurations 1 and 2, Baseline Monitoring Area), and the direction of flow appeared to vary with time.

The apparent occurrence of hyporheic zone processes in the area of the river channel suggests that the river loses water to the subsurface in some locations only to regain that water in others, with mixing of waters occurring in between. This likely leads not only to some dilution of contaminated ground water, but also highly variable spatial and temporal patterns of surface water/ground water exchange. As a consequence, identification of net ground water discharge to the Colorado River under background conditions will probably require installation of floodplain piezometers to depths greater than those affected by the hyporheic zone; the deepest piezometers currently used (~3 to 4 ft bgs) are apparently too shallow for this purpose. In addition to deeper piezometers or wells, a more intense spatial network of monitoring locations in floodplain areas would help to identify where and to what extent hyporheic exchange with surface water occurs. Observations made with such a network might also better define where and when river water flows toward extraction wells during pumping.

8.0 Mass Transport Assessment

8.1 Effects of Pumping on Water Salinity

8.1.1 Configuration 1

Changes in TDS concentration in the Configuration 1 area during pumping, if they did occur, were subdued. The drawdowns created in this area's extraction wells were expected to cause some upconing of brine, particularly in the areas closest to the pumping wells (Figure 3 and Figure 4). However, little change in TDS concentration was observed in the pumping wells between early April and October of 2004. And signs of upconing in observation wells were mostly limited to two observation wells in the 483/484/485 cluster.

Figure 23 illustrates the behavior of TDS concentration in four extraction wells during the period of April through October 2004. The four sets of data tend to span the types of salinity responses observed in all Configuration 1 wells during 2004. All four wells show a decrease in TDS concentration between background sampling in April 2004 and a sampling event on June 3, 2004, after pumping had occurred for several hours. The drop in TDS levels in well 479 (on the north end of the well field) is the most dramatic over this time period (31,000 to 17,000 mg/L). This large drop might be attributed to increased river flow between April and early June rather than chemical changes brought on by incipient pumping of the well field. In contrast to well 479, relatively mild declines in TDS concentration were observed between April and early June in extraction wells 474 (20,000 to 19,000 mg/L) and 470 (26,000 to 22,000 mg/L). These disparate results are considered indicative of large spatial variability in aquifer response to local hydraulic stresses.

Mild increases in TDS level of 3,000 to 5,000 mg/L are observed between June 3rd and September 2nd at three of the four extraction wells considered in Figure 23. Though these mild trends might be the result of brine upconing during three months of pumping, the temporal behavior of TDS concentration in well 470 indicates virtually no change in salinity. Such mixed results do not provide conclusive evidence that brine upconing occurs in Configuration 1 extraction wells when pumped.

Effects of possible upconing at the observation well cluster containing wells 483, 484, and 485 are shown in Figure 24. In the shallow and intermediate-depth wells (wells 483 and 484) at this location, TDS levels increased from about 23,000 mg/L to near 33,000 mg/L between early June and early September of 2004. Because this result conflicted with the previously described lack of evidence for upconing in the extraction wells themselves it suggested that upconing effects in the Configuration 1 area might be translated downgradient by ground water flow from the tailings pile area. The 483/484/485 cluster is located about 11 to 16 ft downgradient (east) of the well field line (Figure 1).

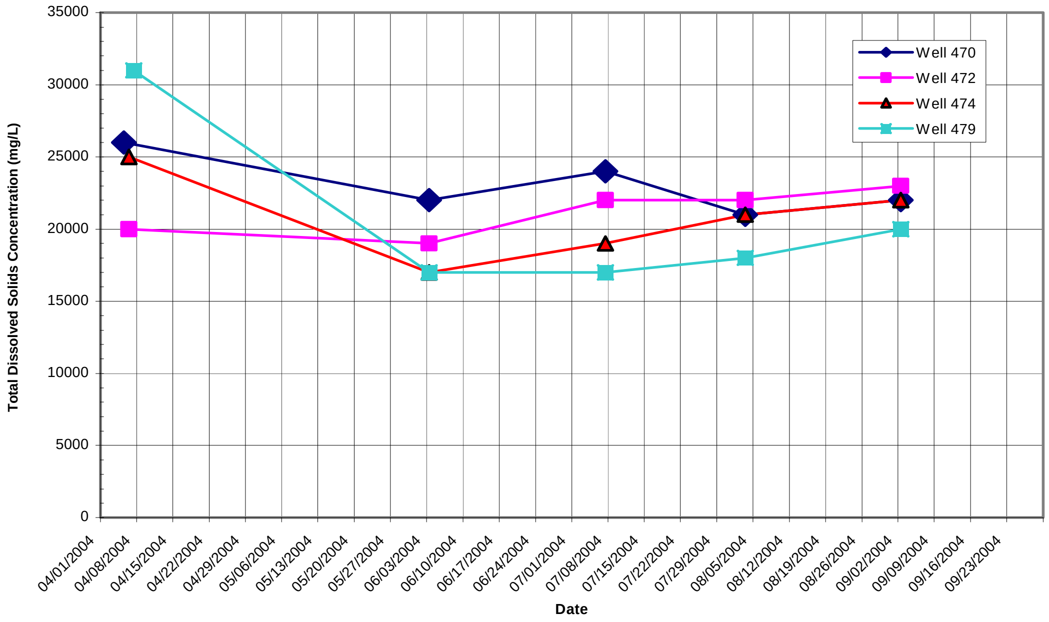

Figure 23. TDS Concentrations in Four Configuration 1 Extraction Wells During 2004

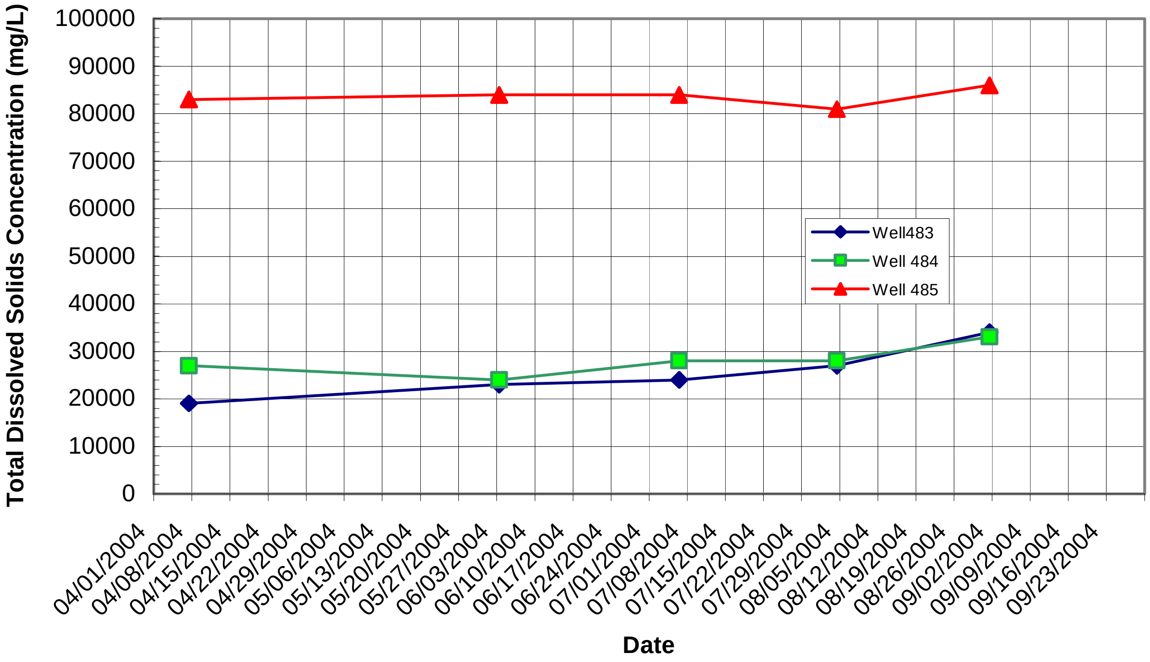

Figure 24. TDS Concentrations in Observation Wells 483, 484, and 485 During 2004

8.1.2 Configuration 2

Temporal trends in salinity as a result of pumping in the Configuration 2 area were not discernible. However, it was probable that, during 2004, salinity levels in Configuration 2 wells in the southern portion of the well field (wells 570 through 575) were larger than comparable salinity levels in Configuration 1 extraction wells. This likely occurred both because of the apparently shallower brine surface in the southern half of the Configuration 2 well field (~ 20 to 25 ft bgs) (see Section 3.2.3) and the observation that most deep extraction well in the Configuration 2 area were screened below the ambient brine surface. TDS and electrical conductance data collected in extraction wells 576 through 579 during the test pumping between early September and early October were inconclusive as to the salinity contributions from the northern portion of the well field.

8.2 Effects of Induced Recharge from the Colorado River

The water chemistry at shallow observation wells located between the well fields and the Colorado River was examined to identify any concentration trends that could be attributed to pumping during 2004. The locations included in this exercise were wells 403, 407, and 483 at Configuration 1, and wells 582 and 585 at Configuration 2. All three Configuration 1 wells showed distinct signs of being affected by pumping. Concentrations of multiple constituents in well 407 began decreasing within a month after the start of pumping on June 3rd, and remained at relatively low levels during subsequent sampling events in August, September, and October. These decreases were apparently due to induced flow from the river, which led to significant dilution of ambient ground water. Though dilution by river water also apparently occurred in wells 403 and 483, the resulting decreases in concentration were less substantial than those observed in well 407 and were not discernible until October.

Temporal plots of TDS, sulfate, ammonia, and uranium concentrations, in Figure 25 through Figure 28, illustrate the degree to which these constituents were affected in Configuration 1 observation wells during 2004 pumping at Configuration 1. As indicated in Figure 25, the decrease in TDS concentration at well 407 between early June and the first week of July was about six-fold, and even greater between April and the following months of August through October. Similar reductions in sulfate concentration were observed at this well between pre-pumping conditions in spring 2004 and later months. Though ammonia levels in well 407 dropped to below 100 mg/L in August through October, these concentrations still indicated the presence of tailings-derived contamination. Thus it was likely that a mixture of river water and ambient ground water were sampled in this well during July through October.

The temporal plot of ammonia concentration at well 403 (Figure 27) is of interest because it suggests levels of this constituent decreased both prior to the start of pumping in early June and between June and July. Though the cause of these “early” decreases was not apparent, it is unlikely that they were the result of dilution by induced river losses. If this type of dilution were the cause, concentrations of TDS, sulfate, and uranium would have also likely declined during the April-through-July period rather than maintaining relatively constant values (Figure 25, Figure 26, and Figure 27). On the other hand, the concentration decreases that were observed for all constituents between September and October at well 403 signify that dilution by river water was indeed occurring at this location some three to four months after the start of Configuration 1

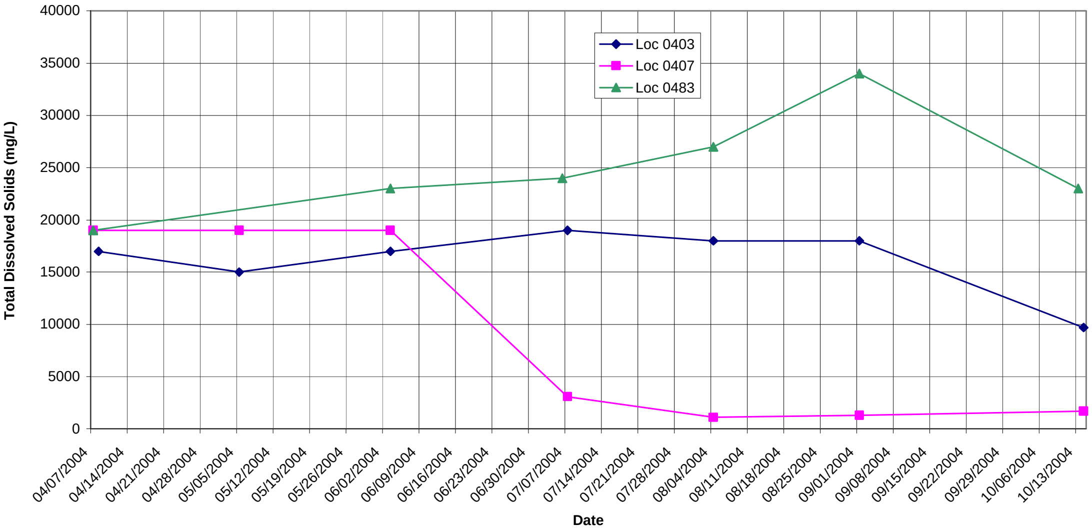

Figure 25. Measured TDS Concentrations at Three Shallow Observation Wells Downgradient of the Configuration 1 Extraction Well Field

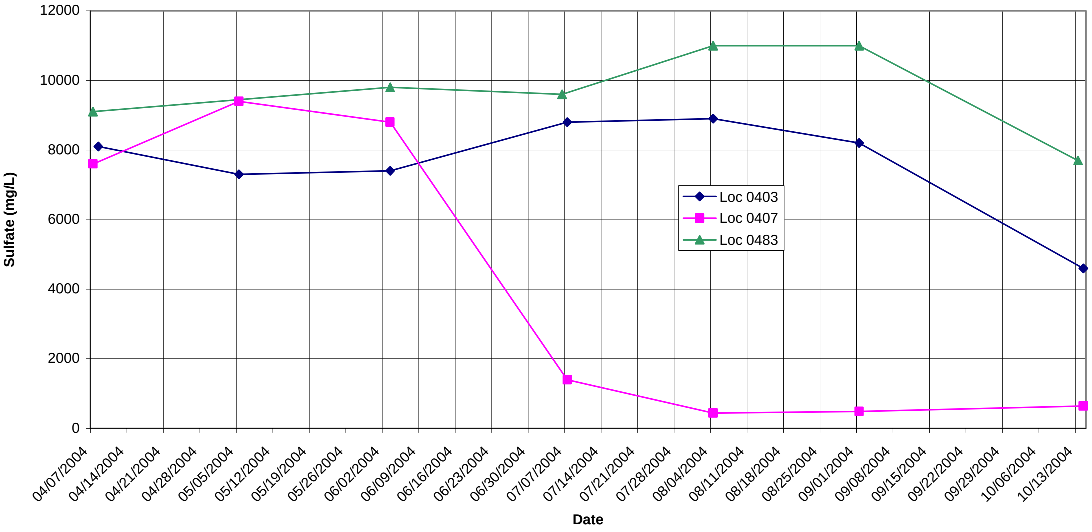

Figure 26. Measured Sulfate Concentrations at Three Shallow Observation Wells Downgradient of the Configuration 1 Extraction Well Field

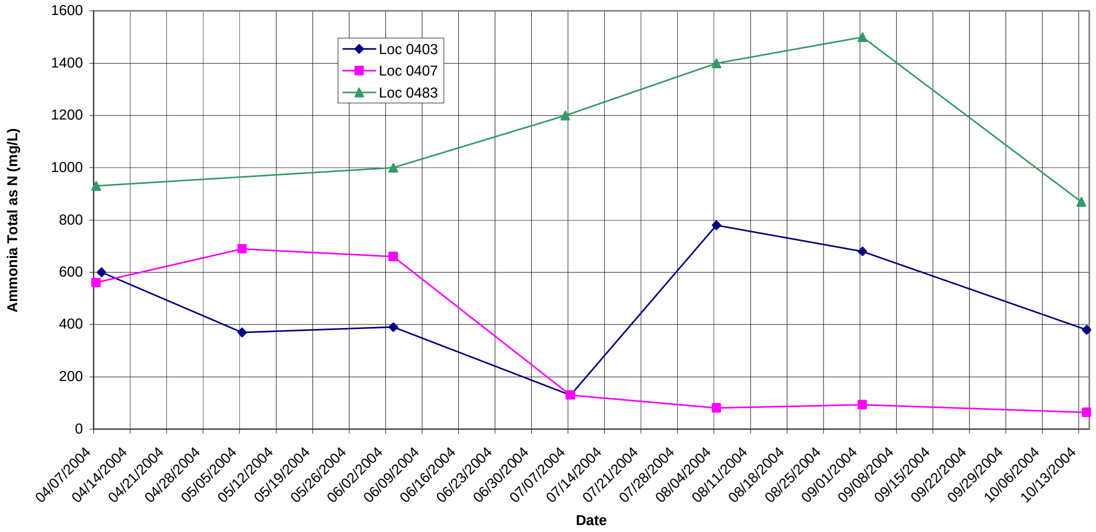

Figure 27. Measured Ammonia (NH_3-N) Concentrations at Three Shallow Observation Wells Downgradient of the Configuration 1 Extraction Well Field

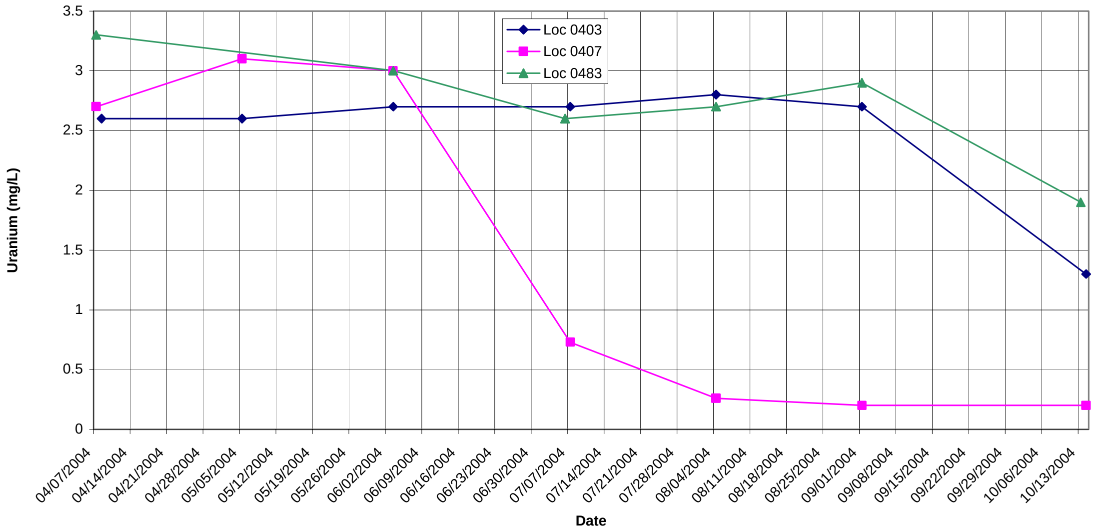

Figure 28. Measured Uranium Concentrations at Three Shallow Observation Wells Downgradient of the Configuration 1 Extraction Well Field

pumping. This latter observation applies equally to well 483, which also exhibited noticeable decreases in constituent concentrations between September and October after three months of gradual increases in TDS, sulfate, and ammonia levels. It is likely that well 483, which is located approximately 11 ft downgradient from the line of Configuration 1 extraction wells, was experiencing the effects of upconing and associated dispersion (Section 8.1.1) prior to the influx of river water between September and October.

The apparent lag time of about 3 months between incipient dilution effects in well 407 and comparable effects in wells 403 and 483 was apparently caused by spatial variations in hydraulic parameters that affect river-aquifer water exchange. Whether these variations occur within the alluvial aquifer, more locally at the riverbed, or both, is unclear at this time. Regardless of the cause, the differing temporal responses between locations indicates that travel times for water leaving the river and migrating to the pumping wells will vary considerably.

Additional evidence for induced inflow of river water to the Configuration 1 area was observed in measures of oxidation-reduction potential (ORP) at well 407 in early September and late October 2004. Specifically, the ORP at these respective times had values of about –70 and −75 millivolts (mV), which indicated the presence of chemically reducing conditions. These observations were considered anomalous given that all previous ORP values for this well were positive, indicating relatively oxidizing conditions. In addition, ORP measures at most other observation wells in the Configuration 1 area were consistently positive. The most logical explanation for the negative values at well 407 was the presence of bacteria that had been drawn from the area of the river. Such biological activity occurs when a source of organic carbon and electron acceptors (e.g., nitrate, ferric iron, sulfate) are available to drive bacterial metabolism. If the locally negative ORP values in September were the result of biologically mediated reduction, it could signify that the affected bacteria were transported from the river to well 407 within three months after the start of pumping. Alternatively, it is possible that bacteria were present in the aquifer prior to the start of pumping, but were not noticeably active until a source of organic carbon was delivered to this locale. Evidence for bacterial activity at the river is presented in Section 9.5.

8.3 Potential Influence of Pumping on River Water Quality

As discussed in Section 7.4, water level and TDS concentration data collected from flood plain piezometers were apparently affected by hyporheic zone processes and were, therefore, inconclusive as to whether briny ground water discharges to the base of the Colorado River in accordance with the conceptual model of the Moab site. Nonetheless, because other data analyses indicate that that pumping in the Configuration 1 and 2 areas was inducing flow from the western portion of the river (Sections 7.2 and 8.2) during the year, it is possible that an associated effect on river water quality was occurring. Short of having voluminous data to demonstrate how and when such an effect occurred, if at all, a preliminary assessment of this possibility is conducted herein simply by evaluating river water quality data collected both prior to and during IA ground water pumping in 2004.

Routine sampling of river water was performed in May 2004 (Calculation No. 11-2004-03-03-00, in progress), before pumping of either Configuration 1 or 2 wells began. At that time, elevated ammonia concentrations exceeding ambient water quality criteria (AWQC) were confined to a short length of the riverbank immediately adjacent to the IA well fields. Several of these locations exceeded acute AWQC and the highest observed ammonia concentration was 320 mg/L.

During subsequent sampling in August, despite the fact that the river stage was approximately half of that in May, no locations exceeded acute AWQC. However, many locations did exceed chronic AWQC from just below Moab Wash to as far as 2,000 ft downstream of the

Configuration 1 area. Only a single location in the vicinity of the Ground Water IA exceeded applicable chronic AWQC. The August samples were collected after Configuration 1 wells had been pumping for nearly 3 months.

It is possible that the higher number and wider distribution of ammonia exceedances in August could be attributed to reduced river flows, resulting in less dilution of discharged ground water. However, the lack of acutely high concentrations of ammonia in the vicinity of the Ground Water IA despite the lower river flows may be an indication that the Configuration 1 pumping was reducing ammonia discharge to the river in the areas sampled. It must be noted that, spatially, the August samples were obtained farther off the west bank of the river than were the May samples (of necessity because of the lower river levels). This could account for some of the difference between results of the two sampling events since it was possible that a different portion of the aquifer (with different concentrations of ammonia) was discharging to the river in these areas during the respective events. However, assuming that the brine surface shifts in response to river stage and tracks with the river's edge (as the current conceptual site model indicates, Section 3.1.1.2), it is likely that nearshore sampling events tend to sample similar aquifer discharges regardless of river stage. While data collected in 2004 were insufficient to conclusively state that decreased concentrations of ammonia observed in the river during the August sampling event compared to the May event were a direct result of IA pumping, the data did indicate this was a possibility.

8.4 Temporal Patterns

8.4.1 Configuration 1

Some water chemistry data for Configuration 1 extraction wells during 2004 show a distinct and repeatable pattern over time. In particular, dissolved concentrations of certain constituents tend to (1) be relatively low during June, the first month of pumping; (2) increase noticeably during the three following months (July, August, and September); and (3) subsequently decrease in October below peak concentrations that occurred in either August or September. Graphs illustrating this apparent pattern are provided in Figure 29, which show the variability of TDS concentration in each Configuration 1 extraction well between April and October 2004. An equivalent set of graphs for ammonia is presented in Figure 30. Though the plotted concentrations do not necessarily comply with the described pattern in all instances, it is repeated in a sufficient number of wells for both measures of water chemistry to conclude that it is real.

This temporal pattern Configuration 1 wells is apparently a consequence of flows in the Colorado River, with concentrations being inversely related to river discharge. The inverse relationship can be observed in a cursory fashion by comparing the average weekly river discharges during the months of June through October (Figure 31) with the plotted concentrations in Figure 29 and Figure 30. Between the week ending on June 6th and the week ending on July 11th, flow in the river shows a decreasing trend, but TDS and ammonia concentrations measured on days during each of these respective weeks (June 3rd and July 6th and 7th) tend to show increases. Subsequently, with river flows remaining low through the week

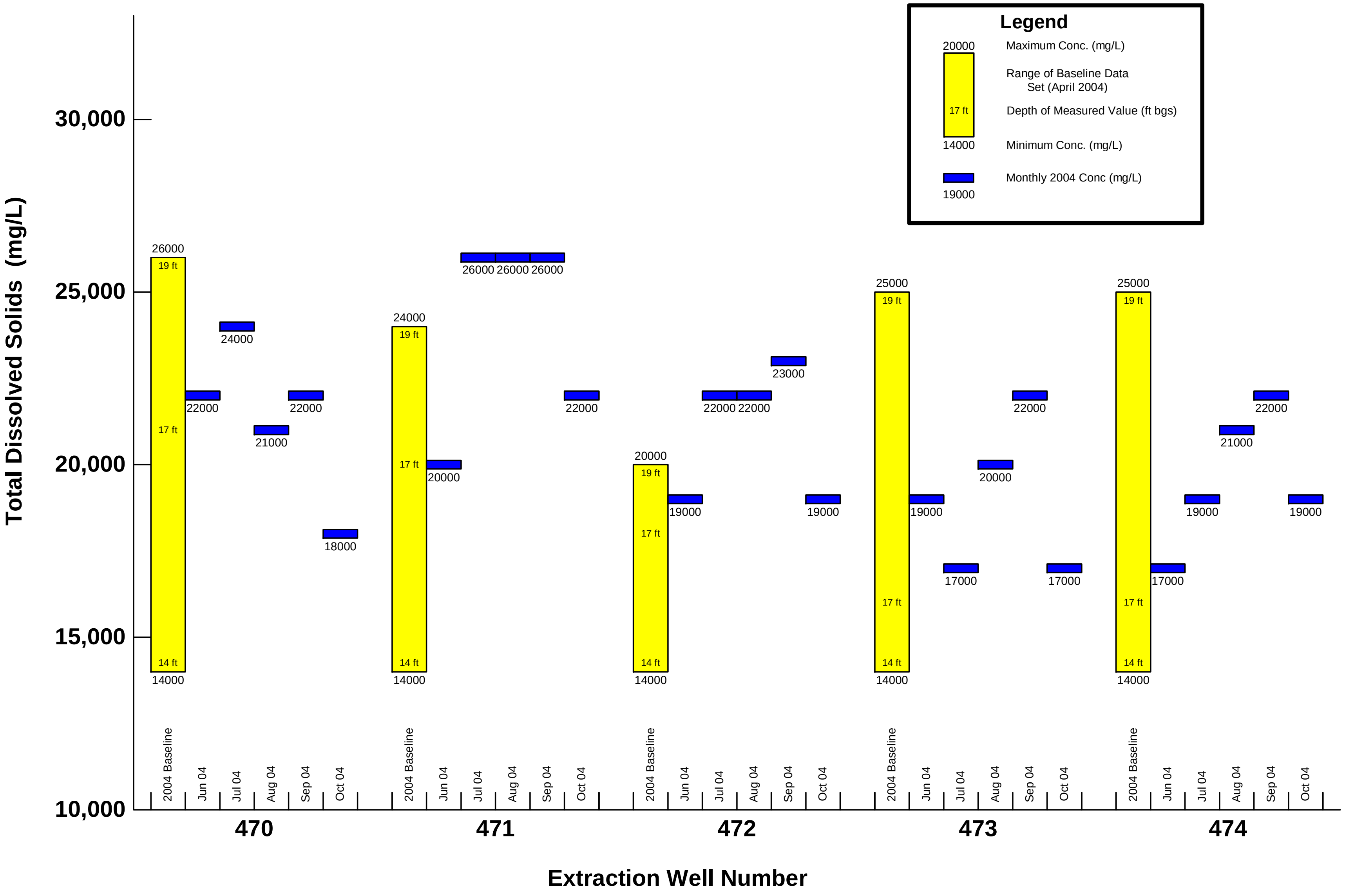

Figure 29. Measured TDS Concentrations in Configuration 1 Extraction Wells

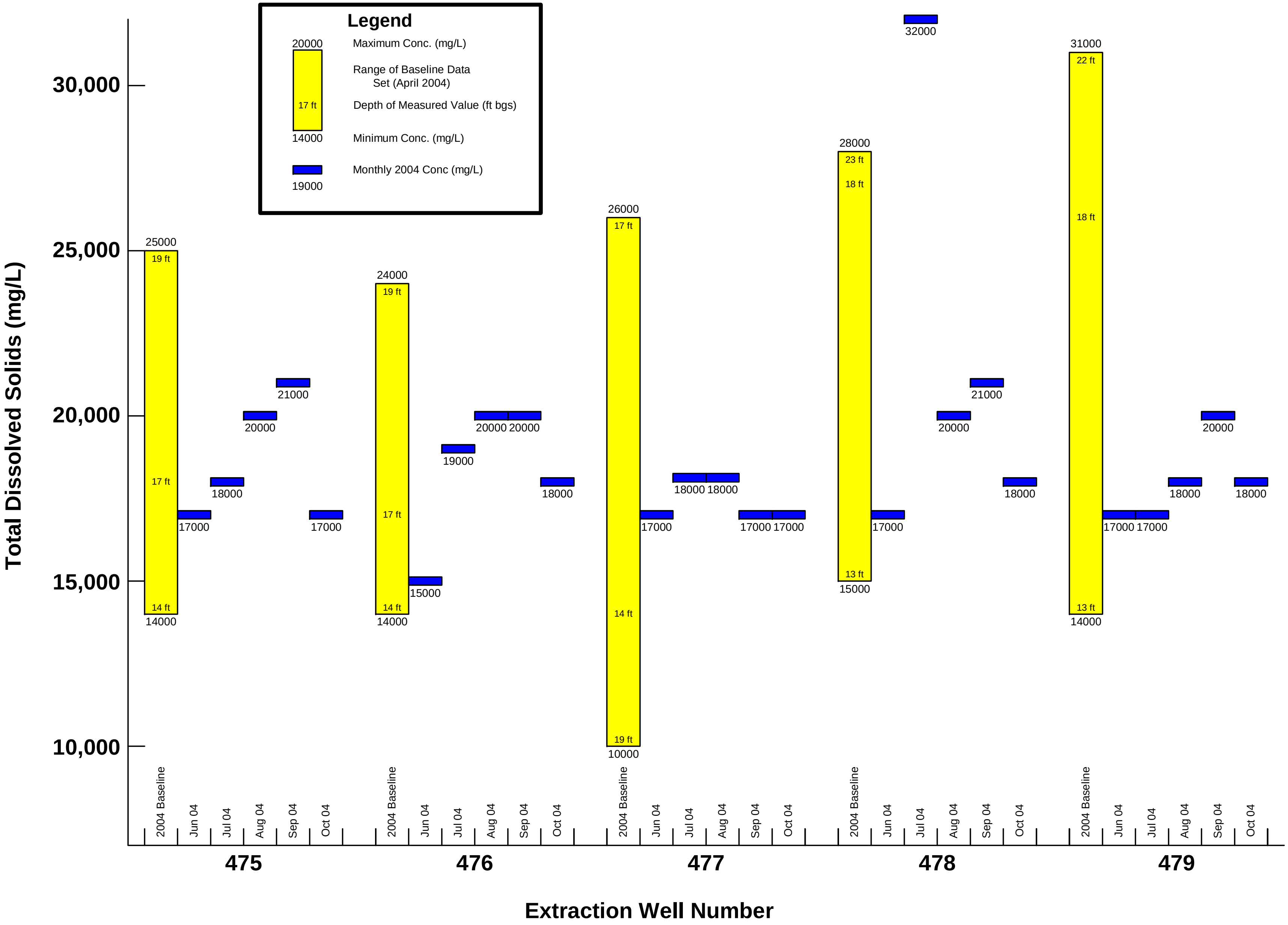

Figure 29 (continued). Measured TDS Concentrations in Configuration 1 Extraction Wells

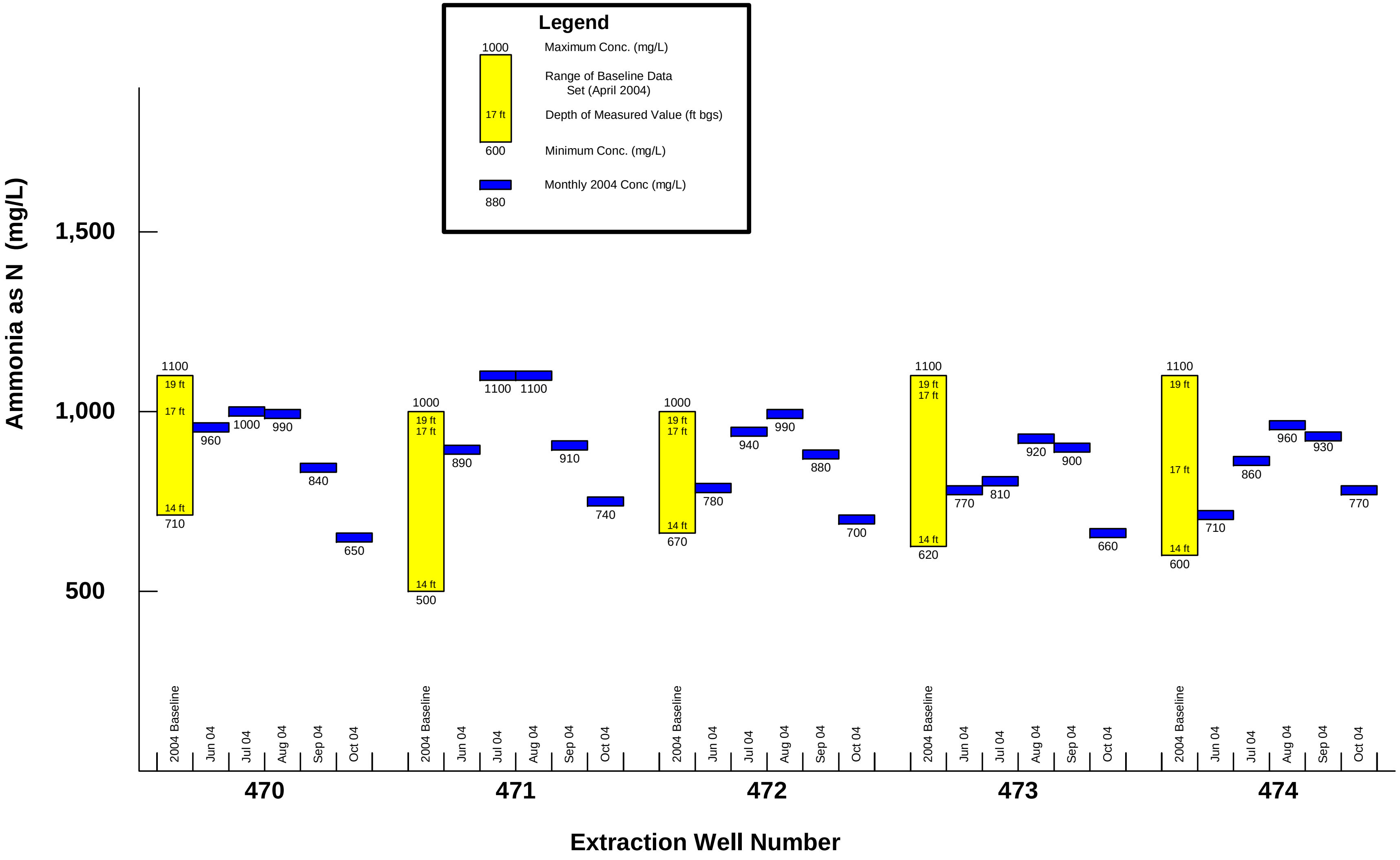

Figure 30. Measured Ammonia Concentrations in Configuration 1 Extraction Wells

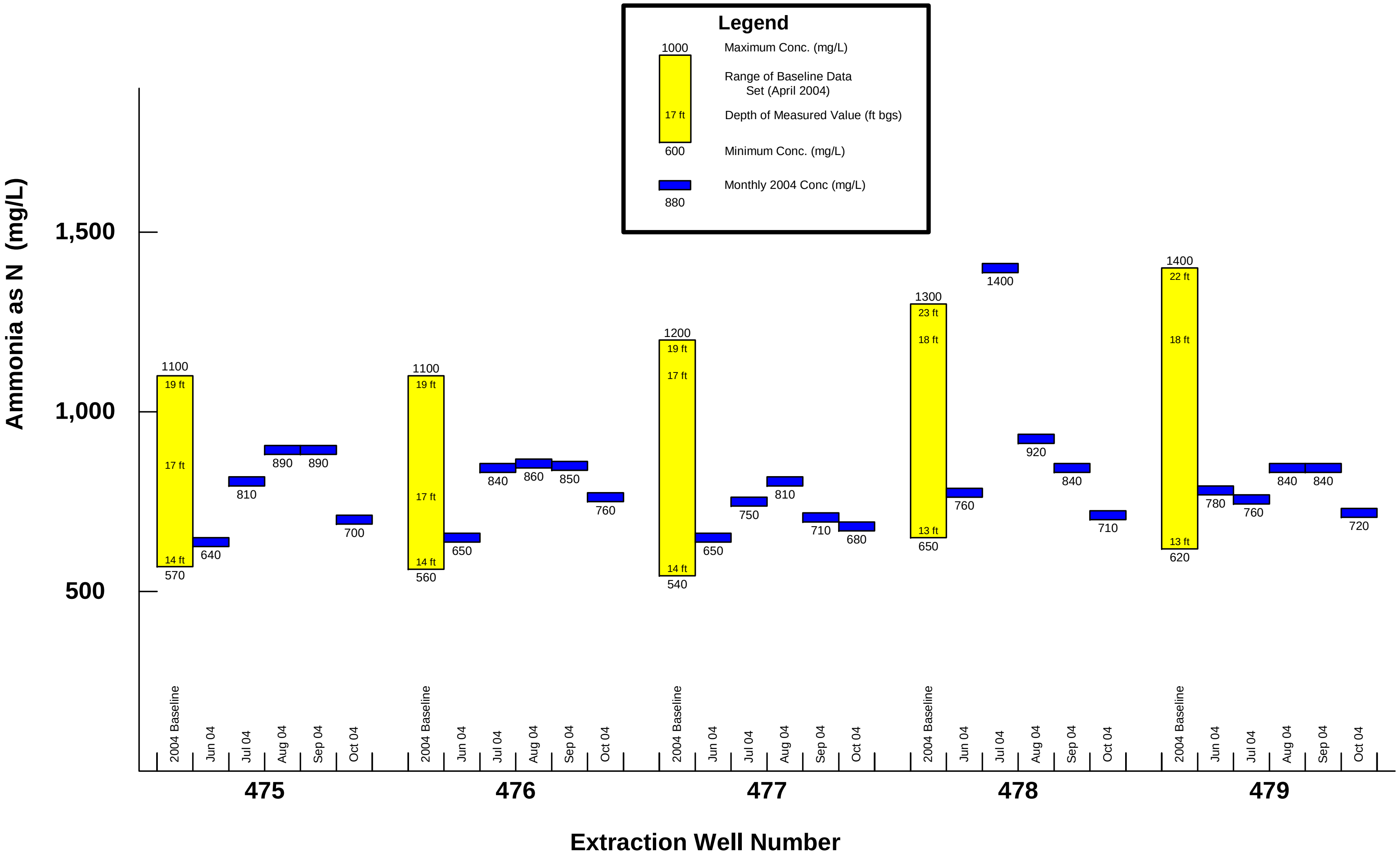

Figure 30 (continued). Measured Ammonia Concentrations in Configuration 1 Extraction Wells

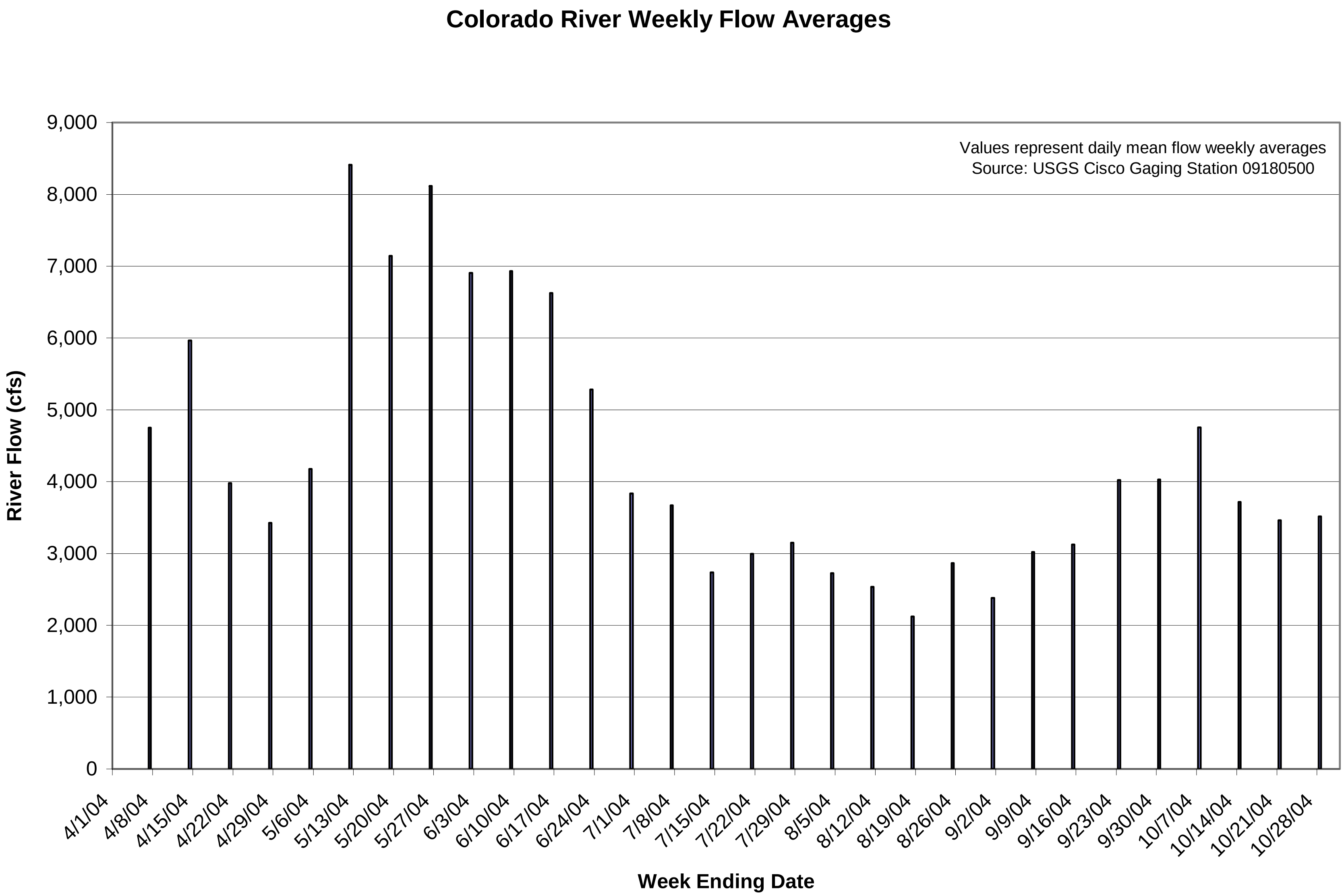

Figure 31. Average Weekly Flows in the Colorado River at Cisco

ending on September 5th, both TDS and ammonia levels measured on August 3rd and 4th and September 1st and 2nd remain relatively high. It is only during remaining weeks in September and the first three weeks in October, over which river flows show a gradual increase (Figure 31), that TDS and ammonia concentrations, as measured on October 13th and 14th, show a very distinct decrease (Figure 29 and Figure 30).

At some of the Configuration 1 extraction wells, the ammonia concentration measured during October is less than the comparable concentration measured during the week ending on June 6th despite the fact that the river flow during October was always less than that occurring in early June. Such observations might be caused by river water reaching some of the extraction wells in October, thus resulting in mixtures of contaminated and uncontaminated water. As discussed in Section 8.2, apparent inflow of river water caused concentrations of key dissolved constituents to decrease in October at shallow observation well 483, which is located about 11 ft downgradient of the pumping well field.

The relationship between river flow and well concentration suggests that a large portion of the ground water withdrawn during periods of relatively high flow comes from depths of about 10 to 20 ft bgs, in which both ammonia and TDS concentrations are low in comparison to those at greater depths near the brine surface (Figure 16 and Figure 17). Conversely, with decreasing river flows, more water is pumped from depths of 25 to 50 ft bgs (i.e., from intervals spanning the brine surface), where TDS and ammonia levels tend to be larger. This phenomenon appears to hold true despite the tendency for the brine surface to rise as river levels increase. The occurrence of river water closer to the pumping wells during periods of higher river flow provides a possible explanation for simultaneous increased withdrawals of shallow ground water.

Uranium concentrations measured in Configuration 1 extraction wells (Figure 32) showed mixed temporal patterns. Only a few wells exhibited trends similar to those previously described for TDS and ammonia, with uranium concentrations increasing during the low river flow period of July through early September, followed by a distinct decrease in concentration in October. In contrast, five of the extraction wells exhibited relatively continuous decreases between early June and the sampling date in October, whereas three others show little to no change between these times. The reason for this mixed behavior is not evident. However, it is possible that the consistent decline in U concentration observed in some wells between June and early September is indicative of increasing withdrawal of ground water at greater depths in the aquifer, where uranium concentrations tend to decrease (Figure 18 and Figure 19).

Regardless of the cause of mixed uranium responses in the Configuration 1 extraction wells, it is apparent in Figure 32 that the uranium concentration measured in October was the lowest observed at each well during the 2004 evaluation period. This observation provides additional evidence that the wells were possibly withdrawing a mixture of relatively clean river water and contaminated ground water in October.

8.4.2 Configuration 2

The temporal distributions of TDS, ammonia, and uranium concentrations measured in Configuration 2 extraction wells between early September and early October of 2004 are presented in Figure 33, Figure 34, and Figure 35, respectively. As was the case with uranium in Configuration 1 wells, no apparent patterns or trends can be discerned from these plots. Though

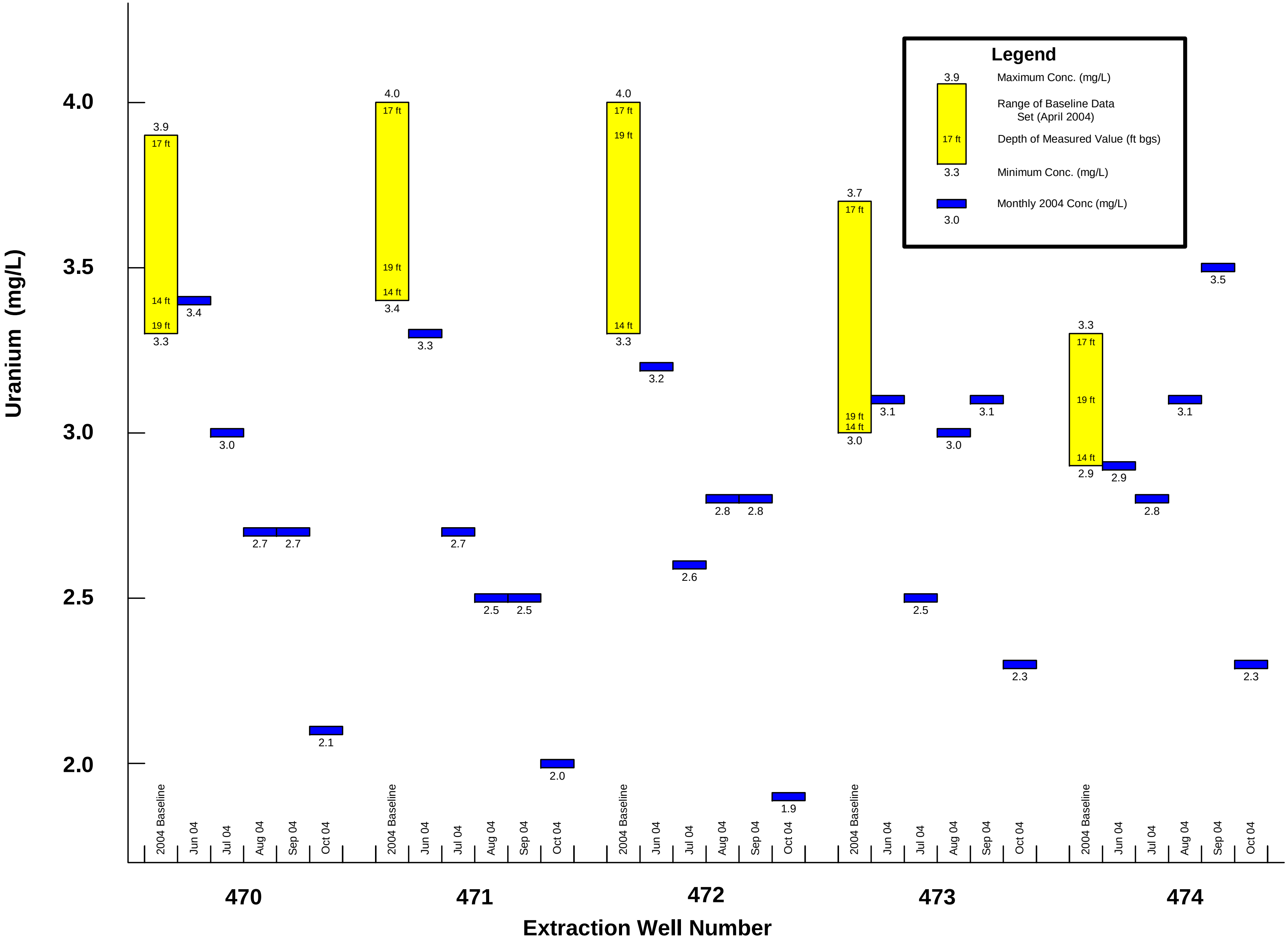

Figure 32. Measured Uranium Concentrations in Configuration 1 Extraction Wells

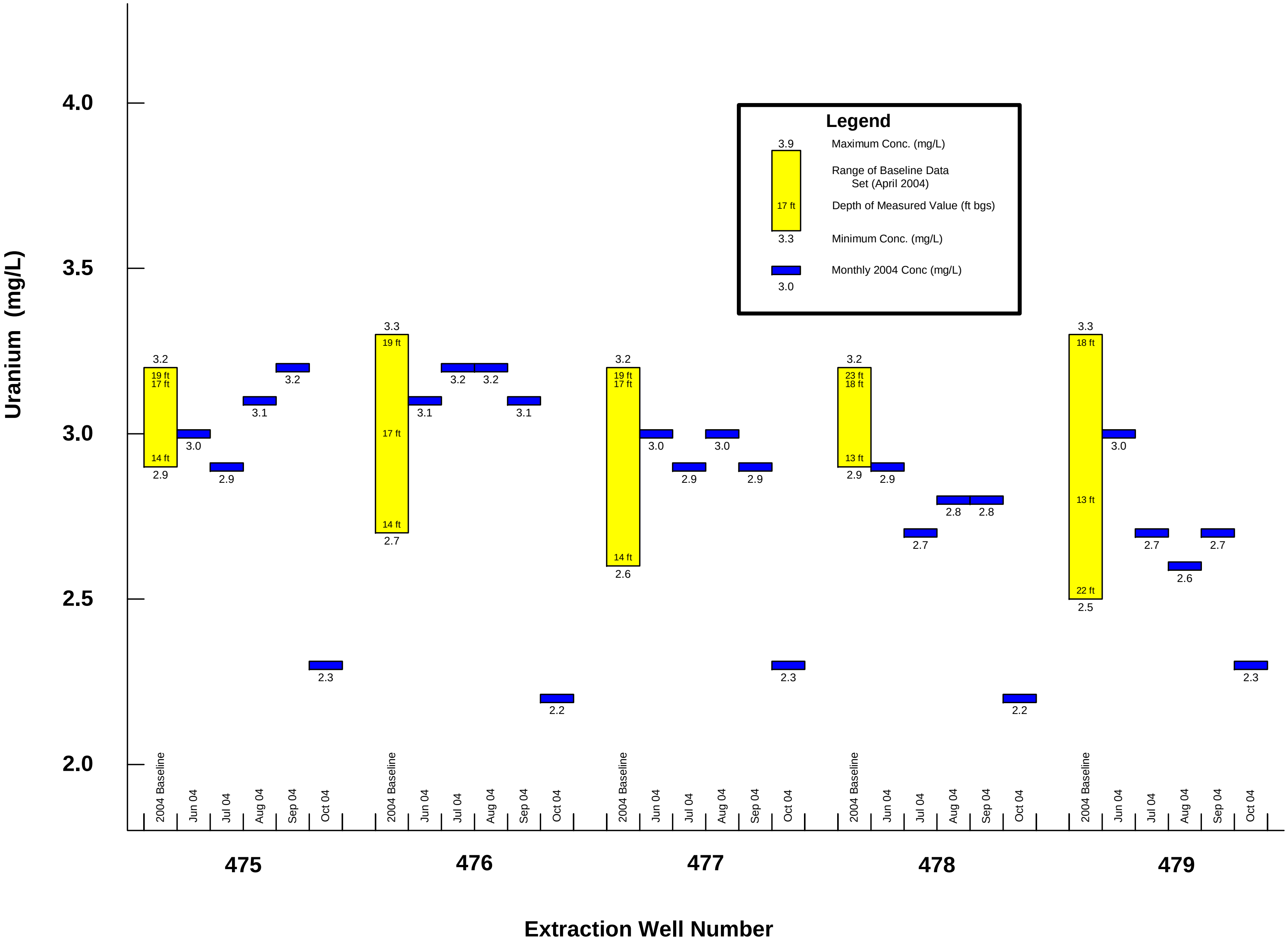

Figure 32 (continued). Measured Uranium Concentrations in Configuration 1 Extraction Wells

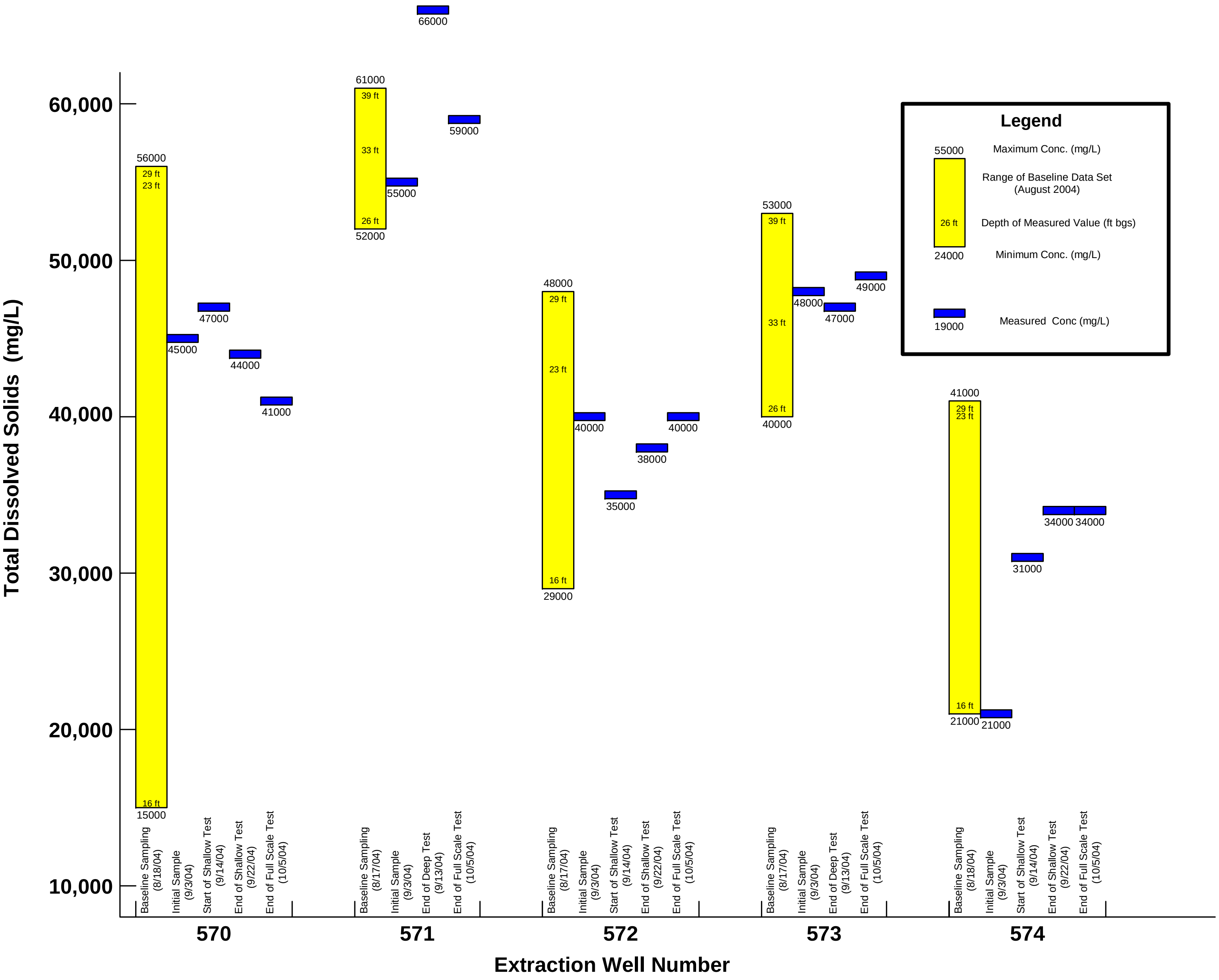

Figure 33. Measured TDS Concentrations in Configuration 2 Extraction Wells

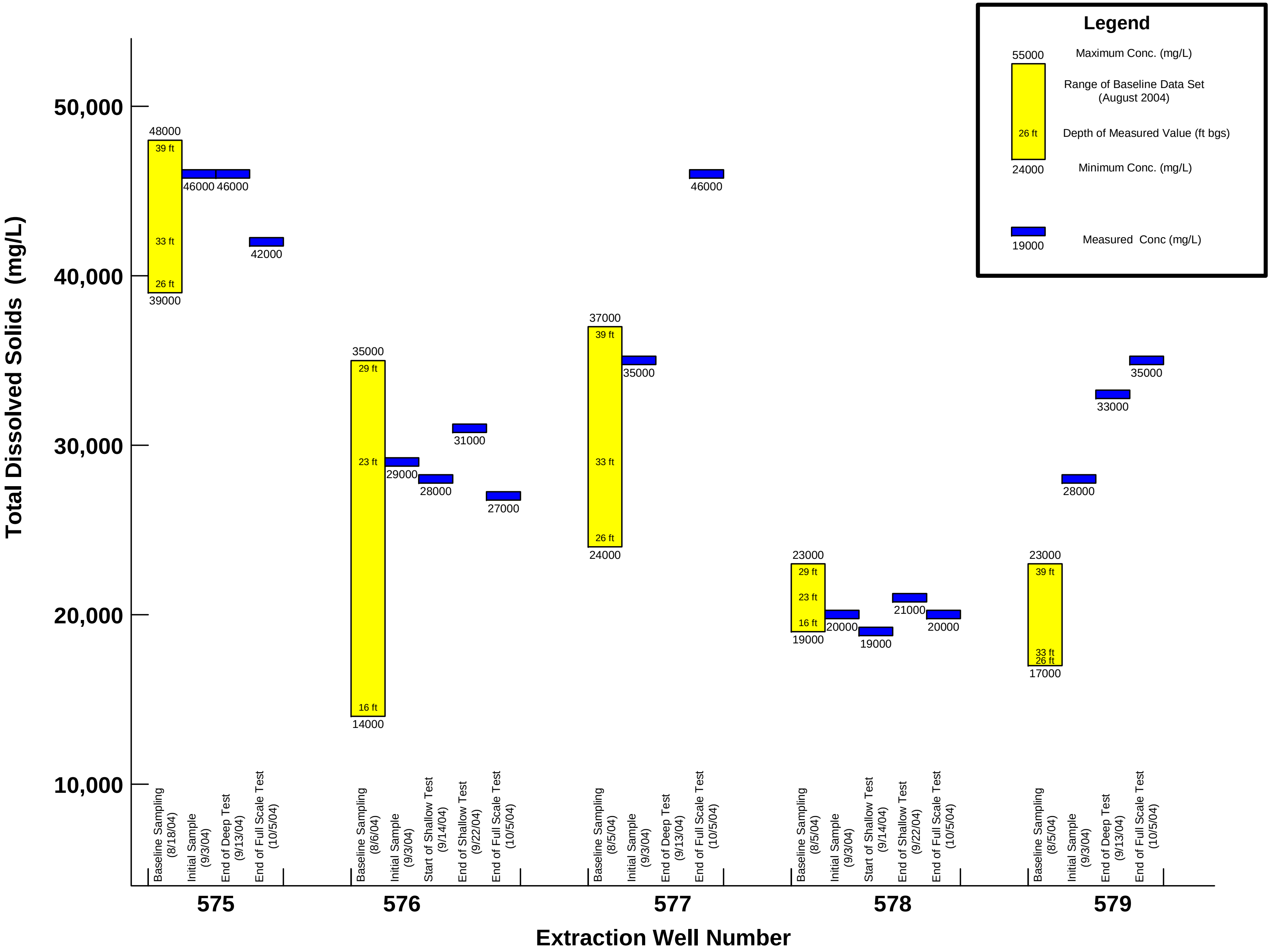

Figure 33 (continued). Measured TDS Concentrations in Configuration 2 Extraction Wells

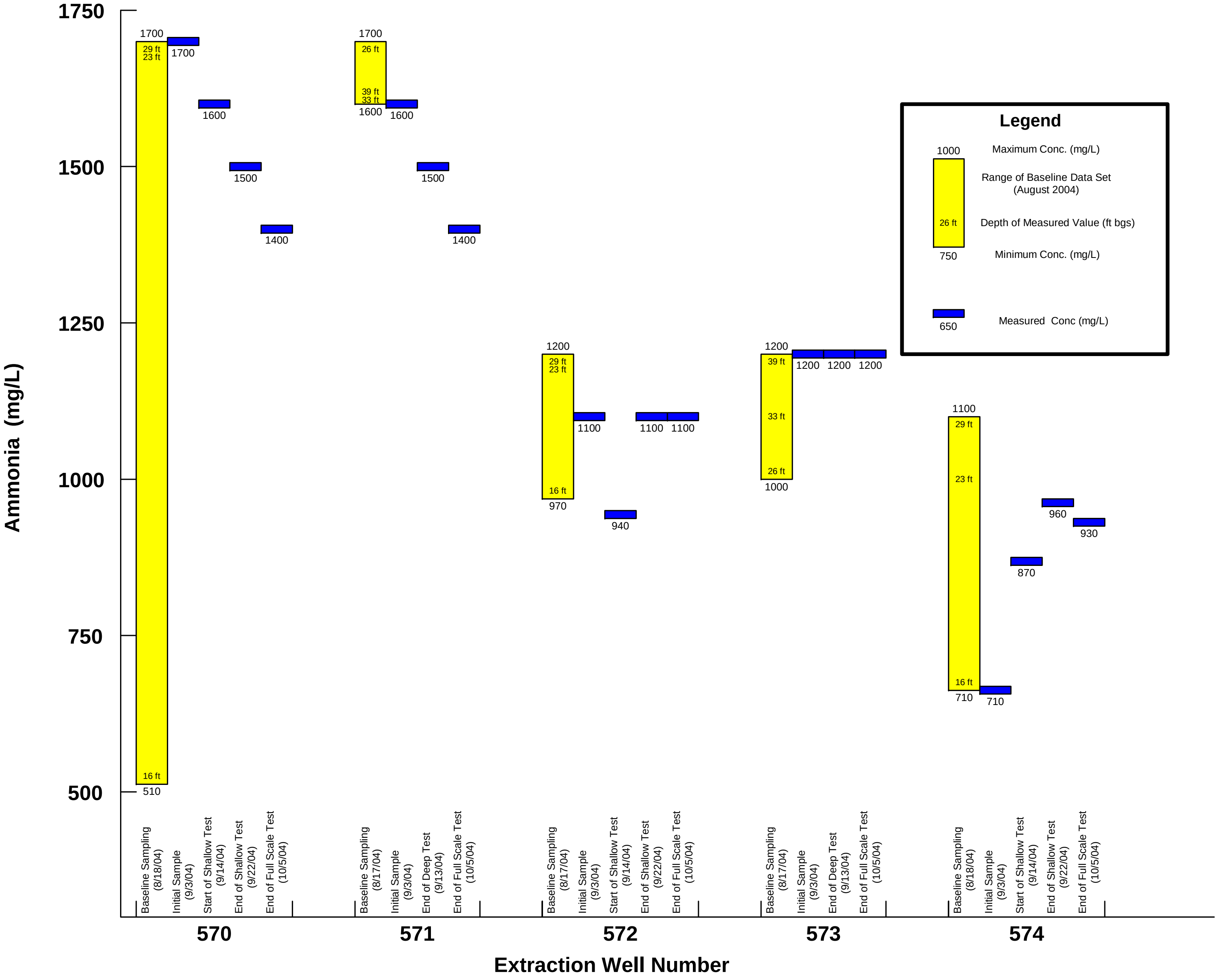

Figure 34. Measured Ammonia Concentrations in Configuration 2 Monitoring Wells

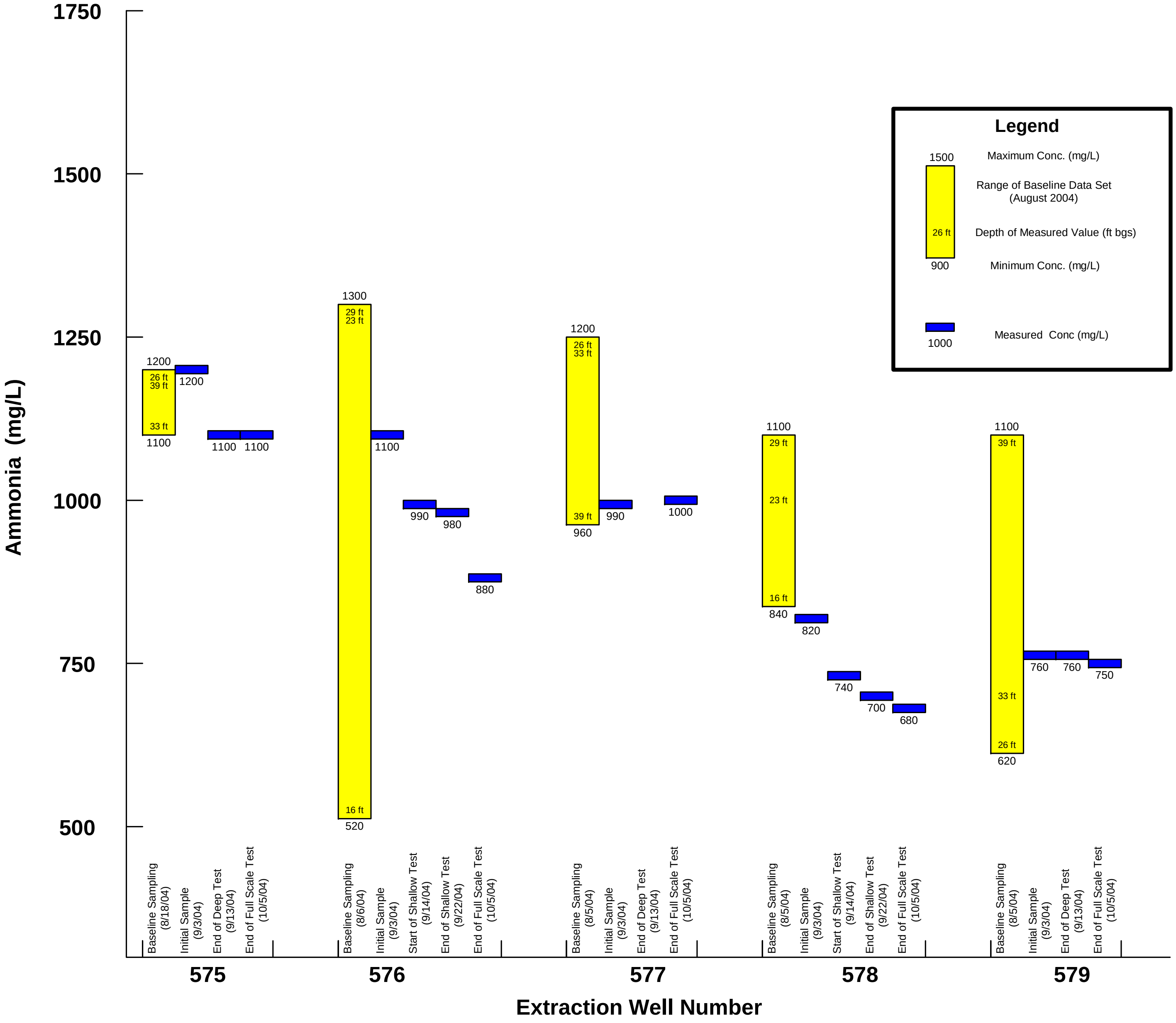

Figure 34 (continued). Measured Ammonia Concentrations in Configuration 2 Monitoring Wells

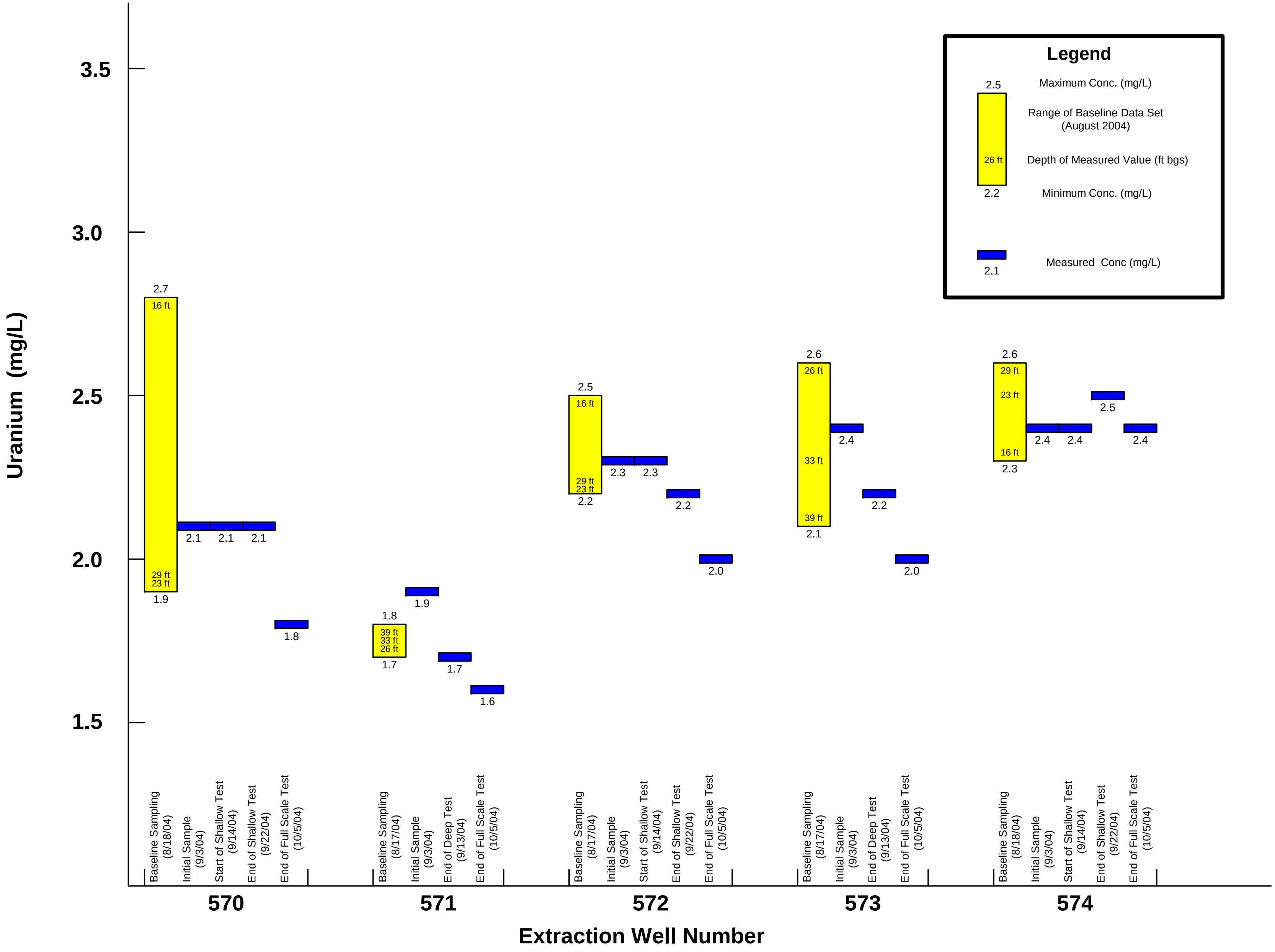

Figure 35. Measured Uranium Concentrations in Configuration 2 Extraction Wells

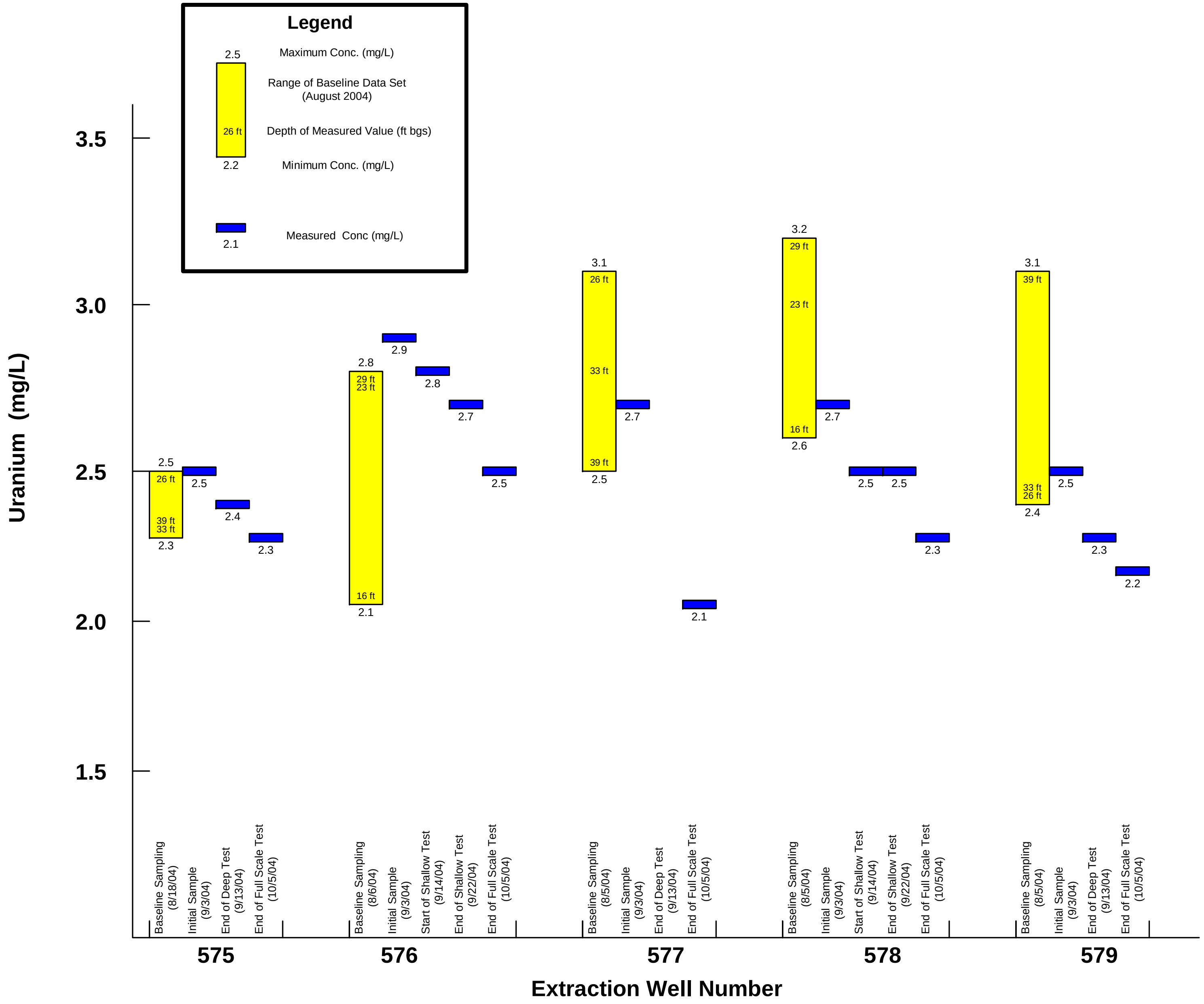

Figure 35 (continued). Measured Uranium Concentrations in Configuration 2 Extraction Wells it was logical to expect distinctly different concentrations in the deep extraction wells from those observed in the shallow wells, no such difference was observed. It is likely that the apparent lack of concentration trends and/or patterns was partially attributable to a lack of major changes in river flow (Figure 31) over the September- to-October period during which the Configuration 2 wells were tested. Further testing over a longer period of time would likely expose patterns that are somewhat similar to those observed at the Configuration 1 well field.

8.5 Transport Time Constants

In Section 8.2, it was estimated that the time it takes for pumping from Configuration 1 wells to effect losses of surface water from the Colorado River ranges between a minute or so to as much as a few days. These relatively short response times can be compared to the estimated, longer times it takes for river water to reach the extraction wells in response to their being pumped.

The earliest observation of river water passing through the aquifer was observed in observation well 407 within about 35 days after the start of Configuration 1 pumping in early June. Given that the distance between well 407 and the west bank of the river is approximately 60 ft, this response time translated into an average linear ground water velocity of about 1.7 ft/day. This same reasoning can be applied to wells 403 and 483, each of which did not exhibit influences from river inflow until mid-October, some 130 days after the start of pumping. For well 403, located about 40 ft from the riverbank, this delayed response translated into an average linear velocity of about 0.3 ft/day. For well 483, located approximately 90 ft from the river, the computed velocity was about 0.7 ft/day.

These calculations suggest that the average ground water velocities occurring between the river and the pumping wells in Configuration 1 can vary substantially. As a consequence, travel times between the river and the extraction wells will also vary. However, it appears likely that such travel times are considerably larger than the hydraulic time constants associated with the area lying between the pumping wells and the river. In other words, the time it takes for pumping to begin causing river losses is relatively short (minutes to hours), whereas the time needed for river water to reach pumping wells is on the order of several days to months.

8.6 Assessment of Transport Processes

The monitoring performed in the Configuration 1 and 2 areas during 2004 was not explicitly designed to provide estimates of transport properties. However, some evidence of mixing, or dispersion, was observed in the horizons monitored by observation wells 483 and 484 in the Configuration 1 area during the 5 months of pumping analyzed in this study. This can be seen by comparing the vertical distribution of ammonia at the well 483/484/485 cluster on the first day of pumping, June 3rd (Figure 36), with the equivalent distribution observed during the next three sampling events (Figure 37 through Figure 39). These plots show NH_3-N concentrations in well 483 and 484 increasing steadily from about 1,000 to 1,100 mg/L in early June to 1,300 to 1,500 mg/L in early September. The changes in ammonia concentration are accompanied by TDS level increases, ranging from 23,000 to 24,000 mg/L in June (Figure 36) to as large as 33,000 to 34,000 mg/L in September (Figure 39). This latter increase in salinity in the relatively shallow horizons at the 483/484/485 cluster was discussed earlier in Section 8.1.1.

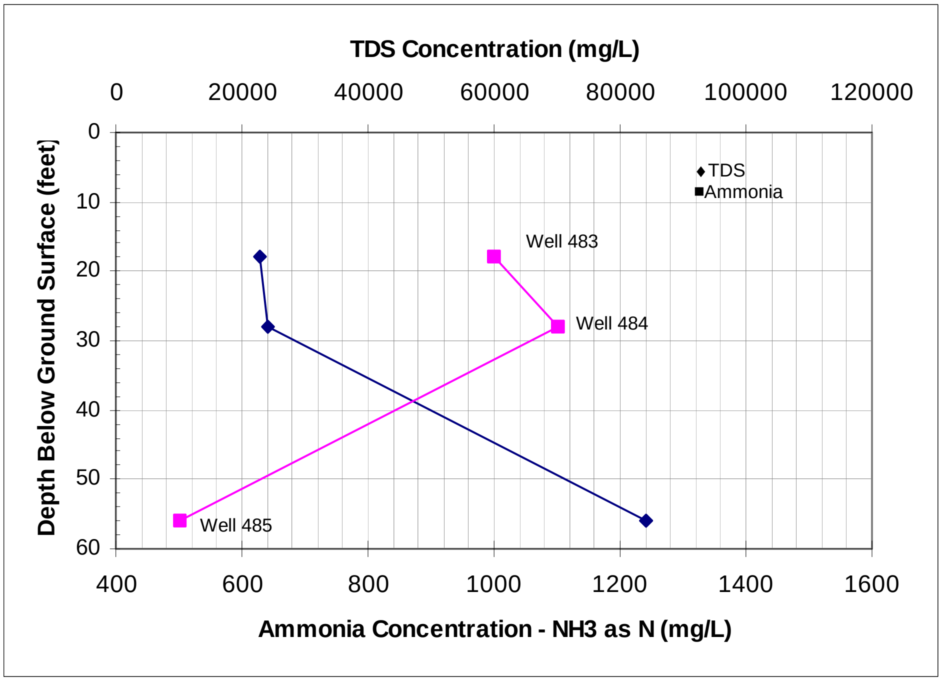

Figure 36. Measured Concentrations of TDS and Ammonia in Observation Wells 483, 484, and 485 on June 3, 2004

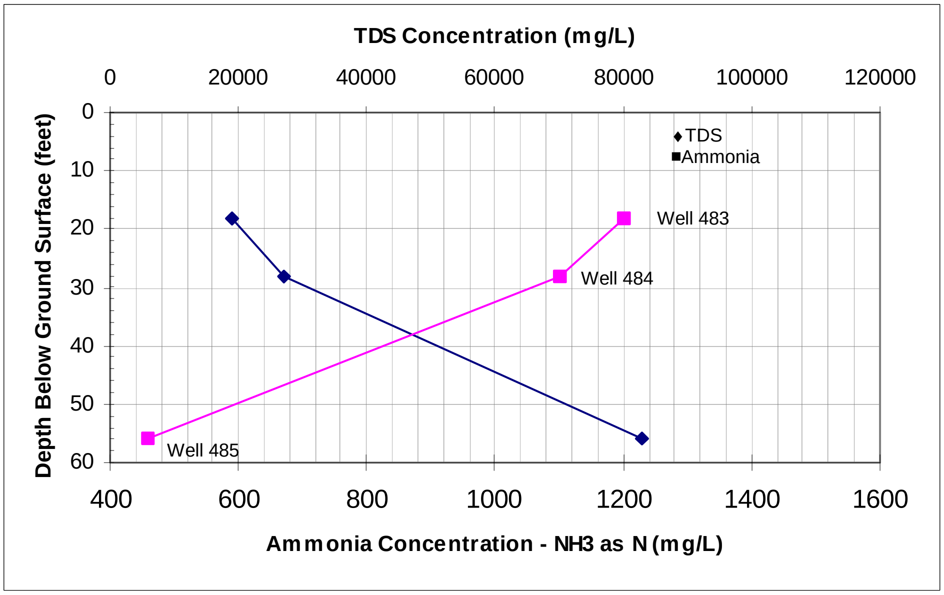

Figure 37. Measured Concentrations of TDS and Ammonia in Observation Wells 483, 484, and 485 on July 6 and 7, 2004

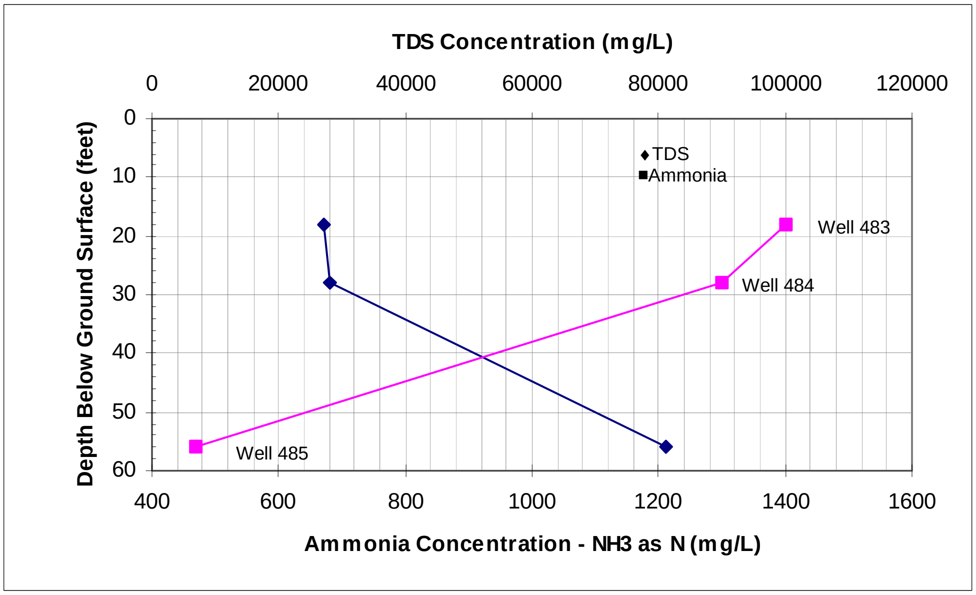

Figure 38. Measured Concentrations of TDS and Ammonia in Observation Wells 483, 484, and 485 on August 3 and 4, 2004

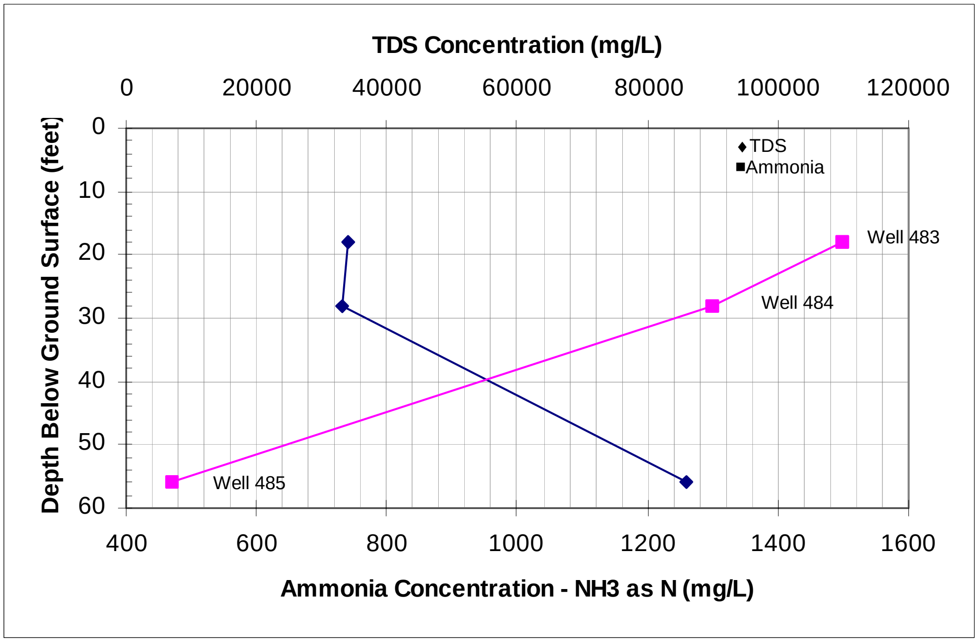

Figure 39. Measured Concentrations of TDS and Ammonia in Observation Wells 483, 484, and 485 on September 1 and 2, 2004

The presumed cause of increased NH_3-N concentrations in wells 483 and 484 is upward migration of ammonia from zones near the brine surface, which appeared to occur around a depth of about 30 to 35 ft bgs prior to the start of pumping. As discussed in Section 5.2, the largest concentrations of ammonia near the 483/484/485 cluster appear to occur deeper than the screened interval for well 484 (~25-30 ft bgs); consequently, when vertical gradients toward the extraction wells increase in response to pumping, it is likely that the ammonia will increase in shallower intervals. This upward migration is probably effected by both advection and dispersion.

The gradual change in vertical distribution of constituent concentrations near Configuration 1 was discernible because of the multiple monthly sampling events that occurred in this area during the summer of 2004. The lack of similar sequential sampling in Configuration 2 observation wells prevented a comparable analysis of this area for this report. Future assessments will likely provide indication of dispersive (mixing) transport processes.

8.7 Water Chemistry in Floodplain Piezometers

Water chemistry data collected in floodplain piezometers during 2004 were examined for potential trends. This analysis included piezometers in both the Configuration 1 and 2 areas, as well as the Baseline Monitoring area.

Water chemistry data from the floodplain piezometers associated with Configurations 1 were not collected until after pumping had commenced in early June 2004. As a result, changes in the concentrations of key parameters in response to pumping were not identified. Nonetheless, a few general findings were made using the data that were available. For example, TDS concentrations in the shallow floodplain piezometers were, with one exception, consistently less than those observed in shallow observation water wells onshore. The single exception to this rule occurred at observation well 407, where pumping had clearly caused concentrations to decrease in response to pumping (Section 9.2). Otherwise, the tendency of shallow TDS concentrations below the riverbed to be low suggested that river water was locally recharging the aquifer and mixing with ambient ground water. It was not possible to determine, however, whether the influent surface water occurred in response to pumping or was simply the result of background hyporheic water exchange.

Where paired data were available from both Configuration 1 floodplain piezometers in a cluster, TDS levels in the deeper piezometer were typically larger than those observed in the shallower piezometer. Though this was expected, none of the deeper piezometers showed TDS concentrations approaching those for brine. And because even the deeper piezometers appeared to be affected by inflowing river water, data indicating a net discharge of very saline to briny ground water to the river were unavailable. This finding also applied to the data collected from piezometer pairs in the Configuration 2 and Baseline Monitoring areas.

Measures of ORP provided additional evidence for river water recharging the shallow aquifer beneath the riverbed. ORP levels in many of the floodplain piezometers were negative, indicating the presence of chemically reducing conditions. In some cases, ORP values in floodplain piezometers were observed to be as low as –200 mV. In contrast, with the exception of two negative ORP values observed in well 407 during September and October 2004, comparable ORP measures in onshore observation wells were nearly always positive. As mentioned in Section 9.2, the locally reducing conditions were likely caused by metabolic bacterial activity, with dissolved organic materials in river water being the carbon source for this activity.

9.0 Summary of System Performance

9.1 On-Line Efficiencies

As previously discussed, pumping of the Configuration 1 wells during 2004 began on June 3rd. After ground water extraction began for the year, pumps in some of the wells were occasionally inoperative due to mechanical problems. In addition, the entire well field was shut down on August 26, 2004 for system maintenance. Periods during which pumping was either limited or shut off are summarized in Table 16. Also listed are the estimated percentages of total monthly time that pumping occurred. These percentages are referred to as on-line efficiencies.

Table 16. Summary of Pumping Efficiencies in Configuration 1 Extraction Wells

Well	Well Field Pumping Issue	Estimated On-line Efficiency (%)
470	Pump not working on 6/28/04, replaced on 7/1/04	97
471	None	100
472	None	100
473	Leaking bypass valve noted on 9/30/04, again noted on 10/4/04. Valves replaced	96
474	Pump not working 7/15/04 through 7/22/04	95
475	None	100
476	Pump not working 9/9/04 through 9/13/04	97
477	Problem with pump electrical system on 8/16/04, again on 9/7/04	99
478	Pump not working 6/28/04 through 7/7/04 and on 8/26/04 through 9/2/04	90
479	None	100
Well Field	Shut down for repair on 8/26/04	97

Like Configuration 1, pumping in some Configuration 2 extraction wells was occasionally interrupted due to mechanical difficulties. Table 17 summarizes issues that arose during pumping of the Configuration 2 wells and the estimated on-line efficiencies for these wells during testing in 2004.

Table 17. Summary of Pumping Efficiencies in Configuration 2 Extraction Wells

Well	Configuration 2 Well Field Pumping Issue	Estimated On-line Efficiency (%)
570	None	100
571	None	100
572	None	100
573	Necessary to replace pump after initial sampling event on 9/2/04	95
574	Valve leak inside vault during initial sampling event on 9/2/04	95
575	None	100
576	None	100
577	Pump not working after ~8 hrs into deep well test, replaced prior to full scale test	70
578	None	100
579	None	100
Well Field	None	94

9.2 Cumulative Mass Withdrawals

Data collected at extraction and observation wells in the Configuration 1 and 2 areas indicate that the Ground Water IA is effectively designed for removing dissolved contaminant mass, thus preventing the discharge of a portion of the contamination to the Colorado River. The screened intervals of extraction wells have been appropriately selected to intercept a significant amount of the contaminated ground water that would normally enter the river near its west bank.

As shown in Table 7, the Configuration 1 well field removed an estimated total volume of 5,246,106 gallons of ground water between June and October of 2004. The estimated total masses of ammonia and uranium removed by Configuration 1 wells during this period were 16,700 and 55 kg, respectively.

During September and the first week in October of 2004, Configuration 2 extraction wells removed an estimated total ground water volume of 821,583 gallons (Table 9). The mass withdrawals of ammonia and uranium associated with this extraction volume were 3,130 and 7 kg, respectively.

10.0 Summary and Conclusions

This performance assessment study was conducted to (1) update the understanding of the capacity of the Moab Ground Water Interim Action (Ground Water IA) system to extract and treat contaminated water in the alluvial ground water system lying between the Moab tailings pile and the Colorado River, and (2) interpret hydraulic and water quality changes observed in ground water as a result of pumping the IA extraction wells. As part of this investigation, data collected during 2004 and previous years were used to qualitatively evaluate the conceptual model of ground water flow that had been developed for the site. In addition, responses of the aquifer to ground water pumping under the Ground Water IA were compared to results from previous quantitative analyses of local ground water to ascertain the degree to which the alluvial aquifer and well productivity behaved as expected. The effects of hydraulic stresses other than pumping from Ground Water IA extraction wells, such as changes in flow on the nearby Colorado River, were also taken into account.

In the interest of simplifying the numerous analyses carried out of the Ground Water IA, the findings from this study are presented within three general categories: (1) the Moab site conceptual model, (2) performance of individual components of the Ground Water IA, and (3) site hydrogeology and water chemistry. Though some overlap between these categories is apparent, the manner with which study conclusions are provided should help to plan both future ground water investigations and activities for improving IA operations.

10.1 Conclusions Regarding the Site Conceptual Model

1. Depth to the brine surface is about 35 to 40 ft below ground surface near the Configuration 1 extraction wells (~100 ft from the Colorado River) and about 25 to 30 ft in the southern half of the Configuration 2 well field (~ 50 ft from the river). This apparent rise of briny water

between well fields conforms with the site conceptual model that assumes a rise in brine surface with proximity to the river.

2. Depth to the brine surface in the northernmost portion of the Configuration 2 well field is larger than 40 ft below ground surface, which is greater than brine surface depths near Configuration 1 and the southern half of the Configuration 2 well field. The greater depth is probably caused by a larger ground water flow toward the river in this area under background conditions.
3. The hydraulic gradients that drive ground water flow have an upward component that increases with proximity to the river. Upward hydraulic gradients are identified in several parts of the Configuration 1 area under background, pre-pumping conditions. Data from wells near the Configuration 2 system provide limited evidence of upward gradients under background conditions.
4. Evidence for mild upconing of very saline ground water and brine is observed in Configuration 1 extraction wells while they are pumped. Indications of stronger upconing are observed in a shallow well and an intermediate-depth well that are part of a well cluster located about 11 to 14 ft downgradient of the extraction wells.
5. Drawdowns created by pumping of the Configuration 1 and 2 extraction wells extend as far as the west bank of the Colorado River, thereby inducing flow from the river to the aquifer. Relatively steady flow conditions are reached within time periods of as little as a day or less.
6. Strong correlation exists between flow in the Colorado River and the ground water levels measured in wells comprising the Configuration 1 and 2 remediation systems.

10.2 Conclusions Regarding Performance of the Ground Water Interim Action

1. The efficiencies of extraction wells in the Configuration 1 and 2 systems appear to have decreased over time.
2. Causes of the well efficiency problems cannot be discerned at this time. Possible mechanisms include the clogging of pores in aquifer materials and well filter packs by finer-grained portions of materials comprising the alluvial aquifer and chemical scaling in well screens.
3. Extraction wells 470 and 471, located on the south end of the Configuration 1 well field, are the most productive and efficient wells in this area. Average pumping rates from these wells between June and October of 2004 were 4.2 and 3.3 gallons per minute, respectively. The average pumping rate at the remaining 8 extraction wells was about 2.2 gallons per minute.
4. As expected, deep extraction wells in the Configuration 2 area produce more water than the area’s shallow wells. The average pumping rate at Configuration 2 shallow wells during pumping tests in 2004 was less than 2 gallons per minute, and the average pumping rate at deep wells was about 4.5 gallons per minute.
5. The most productive wells in the Configuration 2 well field are deep wells 579 and 577, located on the north end of the field. The relatively large productivities and efficiencies of these wells might be related to smaller salinity levels observed in this part of the well field in comparison to the southern part.

6. Lines of evidence indicating pumping-induced river losses to ground water in the vicinity of Configuration 1 include calculated flow potential gradients and decreases in concentrations of dissolved constituents in three observation wells (wells 407, 403, and 483) in the area.
7. Vertical capture of ground water by Configuration 1 extraction wells occurs at depths as large as 60 ft below ground surface. Calculated flow potential gradients between deep observation wells and the pumping wells increase after pumping starts.
8. The width of the capture zone caused by pumping of Configuration 1 wells is estimated to be at least 355 ft.
9. The greatest amounts of ammonia and uranium mass removal in the Configuration 1 area were observed at wells 470 and 471 because of the large productivity of these wells and relatively uniform concentrations for ammonia and uranium between extraction wells.
10. The greatest amount of ammonia mass removal in the Configuration 2 area was observed at deep well 579 because of the comparatively large pumping rates achieved at this well. Relatively large ammonia concentrations in deep wells 571 and 573 caused these wells to produce ammonia masses that were close in value to the ammonia mass extracted from deep well 577, the well with the second largest pumping rate in the Configuration 2 area.
11. Uranium mass removal in the Configuration 2 area was generally proportional to pumping rate because uranium concentrations did not vary considerably between extraction wells.
12. The largest background concentrations of ammonia in the Configuration 1 area were observed near the brine surface and below the base of the extraction wells, signifying that the greatest amounts of ammonia mass are potentially withdrawn from near this depth. Background uranium concentrations in the area were largest in shallow ground water, in horizons that are equivalent to the screened intervals of extraction wells.
13. Background distributions of ammonia in the Configuration 2 area indicate that the deep extraction wells in this area remove greater quantities of ammonia per unit volume of ground water pumped than do the shallow extraction wells. Vertical profiles of uranium in the Configuration 2 area suggest that mass removal of this constituent per unit volume of pumped ground water is equally good for shallow and deep extraction wells.
14. Assessment of pumping records for individual extraction wells indicates that all Configuration 1 well wells had on-line efficiencies of greater than or equal to 95%, and all but one of the Configuration 2 wells had online efficiencies of greater than or equal to 94%

10.3 Conclusions Regarding Site Hydrogeology and Water Chemistry

1. Increases in flow of the Colorado River and the associated river stage increase the hydraulic productivity of Configuration 1 extraction wells.
2. The time it takes for Configuration 1 pumping to induce inflow of Colorado River water to the alluvial aquifer appears to be on the order of a day or less; the alluvium in this area appears to yield ground water under both confined and unconfined aquifer conditions. Quicker response times of the river to pumping are expected at the Configuration 2 well field because of its closer proximity to the river and because the area's deep extraction wells produce water under predominantly confined aquifer conditions.

3. Aquifer properties in the Configuration 1 and 2 areas can probably be estimated using density-dependent ground water flow models in conjunction with monitored hydraulic parameters and dissolved constituent concentrations at each area.
4. Measured water levels in floodplain piezometers adjacent to the Configuration 1 and 2 areas and the Baseline Monitoring Area indicate the presence of an active hyporheic zone below the riverbed. The piezometers are not deep enough to define the base of the hyporheic zone and to identify potential discharge of brine to parts of the river.
5. Total dissolved solids concentrations measured at observation wells 483 and 484 in the Configuration 1 area during extraction well pumping showed evidence of brine upconing and possible vertical spreading (dispersion) of dissolved ammonia. These wells are located less than 15 ft downgradient of the well field.
6. Pumping-induced river losses caused mixing of relatively fresh water and contaminated water in three observation wells (wells 407, 403, and 483) located between the Colorado River and the Configuration 1 well field.
7. Evidence of diluted constituent concentrations in the Configuration 1 observation wells due to induced river losses was observed in one well about 1 month after the start of pumping and in the two additional wells about 3 to 4 months after the start of pumping; the varied response times indicated that average linear velocities of ground water between the river and well field ranged between 0.3 and 1.7 ft per day.
8. Measured ammonia concentrations in surface water near the west bank of the Colorado River in May and August 2004 suggest that the latter set of concentrations might have been reduced due to as yet undetermined effects of Configuration 1 pumping on river-aquifer exchange.
9. Repeated temporal patterns of total dissolved solids and ammonia concentrations in Configuration 1 extraction wells during 2004 suggest an inverse relationship between these concentrations and river stage. This appears to be caused by a greater proportion of shallow ground water being pumped as the river level rises, which could be the result of decreasing distance between surface water and the Configuration 1 well field with increasing river levels.
10. Negative oxidation-reduction potentials measured in several floodplain piezometers are indicative of bacterial metabolism in the hyporheic zone underlying the Colorado River. Additional signs of chemically reducing conditions in an observation well located between the river and the well field some 3 to 4 months after the start of pumping suggested that bacteria were migrating in ground water from the river to the pumping wells.

11.0 References

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Appendix A

Well Logs

Configuration I

Well Logs

MONITORING WELL COMPLETION LOG MOA01-0403

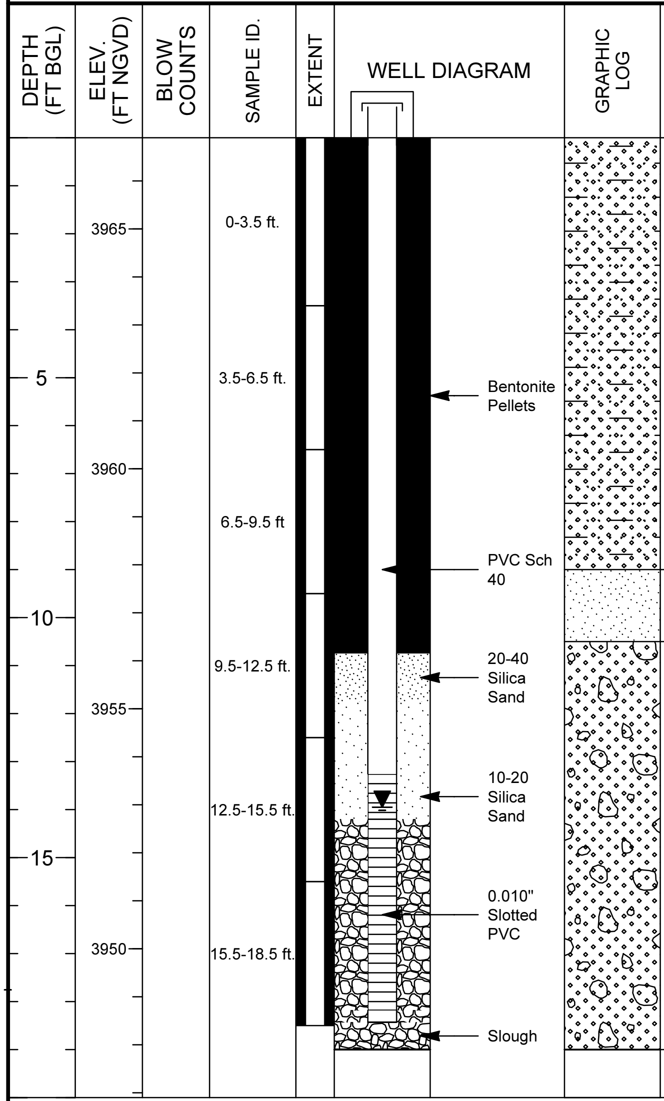
PROJECT MOAB
LOCATION ,
SITE MOAB
WELL NUMBER 0403

NORTH COORD. (FT) 6663534.54
EAST COORD. (FT) 2186078.28
HOLE DEPTH (FT) 19.00
WELL DEPTH (FT) 18.50

DATE DRILLED 12/04/2001
SURFACE ELEV. (FT NGVD) 3966.90
TOP OF CASING (FT) 3968.95
MEAS. PT. ELEV. (FT) 3968.95
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 2.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	1 in. PVC Sch 40	-2.05	to	13.26
WELL SCREEN:	1 in. Slotted PVC	13.26	to	18.18
SUMP/END CAP:	1 in. PVC Sch 40	18.18	to	18.43
SURFACE SEAL:				
GROUT:				
SEAL:	Bentonite Pellets	0.0	to	10.75
UPPER PACK:	20-40 Silica Sand	10.75	to	11.75
LOWER PACK:	10-20 Silica Sand	11.75	to	14.2

DRILLING METHOD GEOPROBE
SAMPLING METHOD CORE BARREL
DATE DEVELOPED 12/04/2001
WATER LEVEL (FT BTOC) 16.0 on 12/04/2001
LOGGED BY Hopping, B.
REMARKS



LITHOLOGIC DESCRIPTION

0-9.0 ft. SILTY SAND (SM); light brown, brown fine sand and silt, moist but become drier at depth, well sorted organics at 3.5 ft. Some iron staining.

9.0-10.5 ft. SAND (SP); reddish brown to brick red with some silt, light brown medium grained sand, moist.

10.5-19.0 ft. GRAVELLY SAND (SW-GW); fine to medium sand, poorly sorted, some coarse, small pebbles grading to coarse sand and gravels at depth. Becomes wet at depth and color of sand is brick red.

Total Depth 19.0 ft.

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MONITORING WELL COMPLETION LOG MOA01-0407

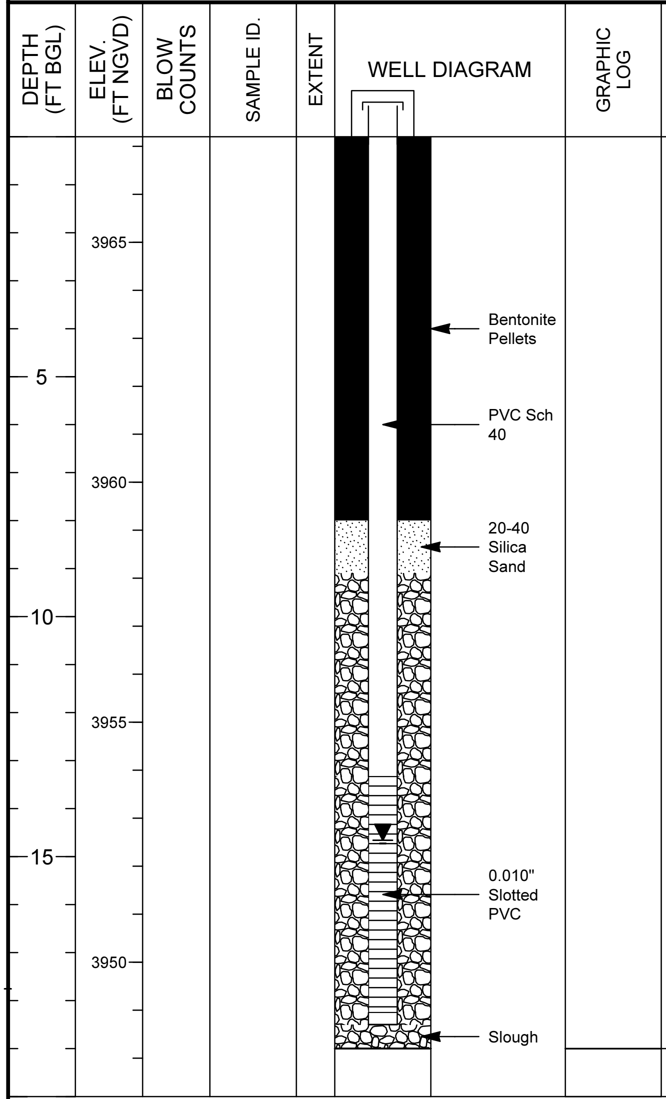
PROJECT MOAB
LOCATION ,
SITE MOAB
WELL NUMBER 0407

NORTH COORD. (FT) 6663347.51
EAST COORD. (FT) 2186030.11
HOLE DEPTH (FT) 19.00
WELL DEPTH (FT) 18.50

DATE DRILLED 12/06/2001
SURFACE ELEV. (FT NGVD) 3967.20
TOP OF CASING (FT) 3969.09
MEAS. PT. ELEV. (FT) 3969.09
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 2.13

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	1 in. PVC Sch 40	-1.89	to	13.33
WELL SCREEN:	1 in. Slotted PVC	13.33	to	18.25
SUMP/END CAP:	1 in. PVC Sch 40	18.25	to	18.5
SURFACE SEAL:				
GROUT:				
SEAL:	Bentonite Pellets	0.0	to	8.0
UPPER PACK:				
LOWER PACK:	20-40 Silica Sand	8.0	to	9.1

DRILLING METHOD GEOPROBE
SAMPLING METHOD
DATE DEVELOPED 12/06/2001
WATER LEVEL (FT BTOC) 16.55 on 12/06/2001
LOGGED BY Hopping, B.
REMARKS



LITHOLOGIC DESCRIPTION

No Samples taken.

Total Depth 19.0 ft.

MONITORING WELL COMPLETION LOG MOA01-0473

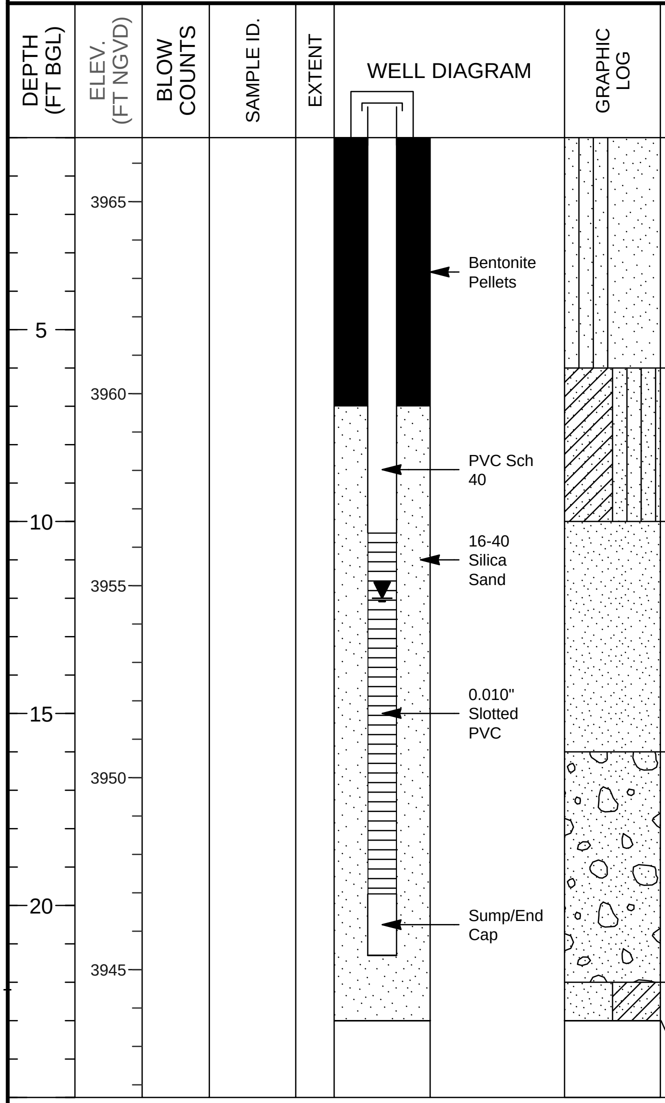
PROJECT MOAB
LOCATION Moab, UT
SITE MOAB
WELL NUMBER 0473

NORTH COORD. (FT) 6663411.34
EAST COORD. (FT) 2185999.02
HOLE DEPTH (FT) 23.00
WELL DEPTH (FT) 21.30

DATE DRILLED 06/24/2003
SURFACE ELEV. (FT NGVD) 3966.67
TOP OF CASING (FT) 3966.74
MEAS. PT. ELEV. (FT) 3966.74
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 9.0 / / 6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-0.07	to	10.3
WELL SCREEN:	4 in. 0.01 Slotted PVC	10.3	to	19.7
SUMP/END CAP:	4 in. PVC Sch 40	19.7	to	21.3
SURFACE SEAL:				
GROUT:				
SEAL:	Bentonite Pellets	0.0	to	7.0
UPPER PACK:				
LOWER PACK:	16-40 Silica Sand	7.0	to	23.0

DRILLING METHOD AIR HAMMER PERCUSSION
SAMPLING METHOD CYCLONE
DATE DEVELOPED 06/26/2003
WATER LEVEL (FT BGS) 12.0 on 06/24/2003
LOGGED BY Pill, K.
REMARKS



LITHOLOGIC DESCRIPTION

0-6.0 ft. SANDY SILT (ML-SP); dark yellowish brown (10YR 4/4), 30% fine sand, 70% silt/clay, moist.

6.0-10.0 ft. CLAYEY SILT (SC-SM); brown (7.5YR 4/4), 20% clay (stiff), 10% fine sand, 70% silt, moist.

10.0-16.0 ft. SAND (SP); reddish brown (5YR 5/4), fine to coarse grained, clean, wet.

16.0-22.0 ft. GRAVELLY SAND (SP-GP); brown (7.5YR 4/4), 20% gravel, 80% fine to medium grained sand, trace of subangular cobbles, fine to coarse gravel, wet.

22.0-23.0 ft. CLAYEY GRAVELLY SAND (SP-SC); brown (7.5YR 4/4), 60% fine to medium sand, 20% silt/clay, 20% gravel subangular to subrounded, wet.

Total Depth 23.0 ft.

MONITORING WELL COMPLETION LOG MOA01-0470

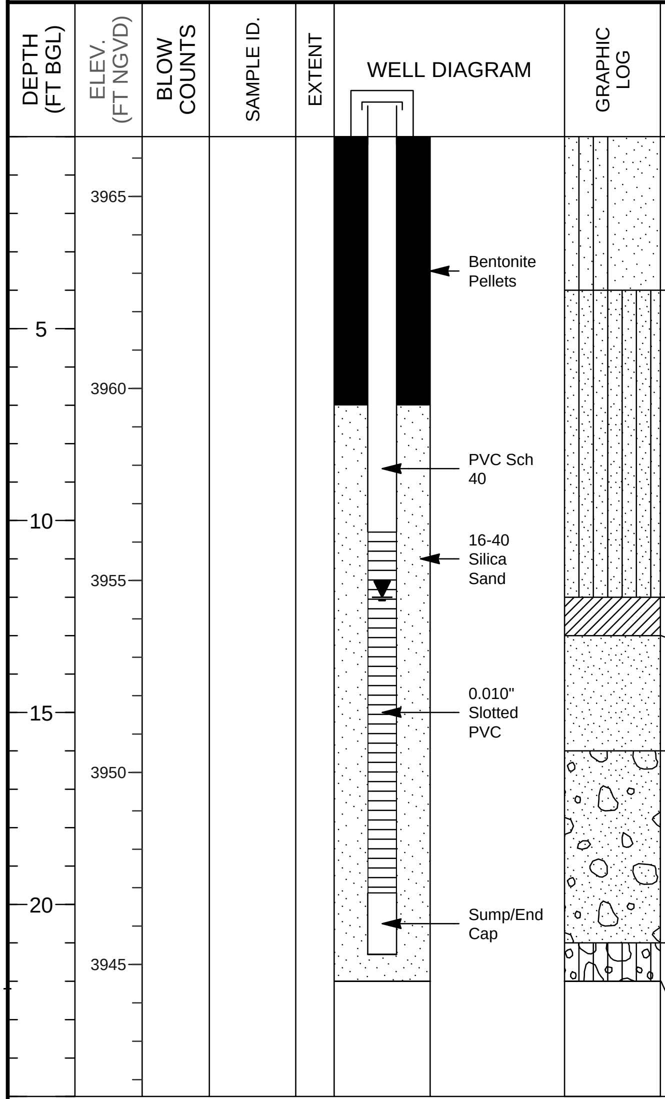
PROJECT MOAB
LOCATION Moab, UT
SITE MOAB
WELL NUMBER 0470

NORTH COORD. (FT) 6663337.05
EAST COORD. (FT) 2185988.21
HOLE DEPTH (FT) 22.00
WELL DEPTH (FT) 21.30

DATE DRILLED 06/25/2003
SURFACE ELEV. (FT NGVD) 3966.56
TOP OF CASING (FT) 3966.41
MEAS. PT. ELEV. (FT) 3966.41
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 9.0 / / 6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	0.15	to	10.3
WELL SCREEN:	4 in. 0.01 Slotted PVC	10.3	to	19.7
SUMP/END CAP:	4 in. PVC Sch 40	19.7	to	21.3
SURFACE SEAL:				
GROUT:				
SEAL:	Bentonite Pellets	0.0	to	7.0
UPPER PACK:				
LOWER PACK:	16-40 Silica Sand	7.0	to	22.0

DRILLING METHOD AIR HAMMER PERCUSSION
SAMPLING METHOD CYCLONE
DATE DEVELOPED 06/26/2003
WATER LEVEL (FT BGS) 12.0 on 06/25/2003
LOGGED BY Pill, K.
REMARKS



LITHOLOGIC DESCRIPTION

0-4.0 ft. SANDY SILT (ML-SP); strong brown (7.5YR 4/6). 40% sand, fine grained, 60% silt/clay, moist.

4.0-12.0 ft. SILTY SAND (SM); reddish brown (5YR 4/4), 25% silt, ~10% clay, 65% fine sand, moist.

12.0-13.0 ft. CLAY (CL); reddish gray (5YR 5/2), medium stiff, slightly mottled, moist.

13.0-16.0 ft. SAND (SP); reddish brown (5YR 5/2), fine to coarse grained with ~10% fine gravel, rounded, wet.

16.0-21.0 ft. GRAVELLY SAND (SP-GP); brown (7.5YR 4/4), 10% silt/clay, 20% gravel/cobbles fine to coarse, subrounded to well rounded - cobbles are well rounded, 70% fine to coarse sand, wet.

21.0-22.0 ft. CLAYEY SILTY GRAVEL (GM); brown (7.5YR 4/3), 30% silt/clay, 20% fine to medium grained sand, 50% fine to coarse gravel, rounded to well rounded, trace of well rounded cobbles, wet.

Total Depth 22.0 ft.

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MONITORING WELL COMPLETION LOG MOA01-0471

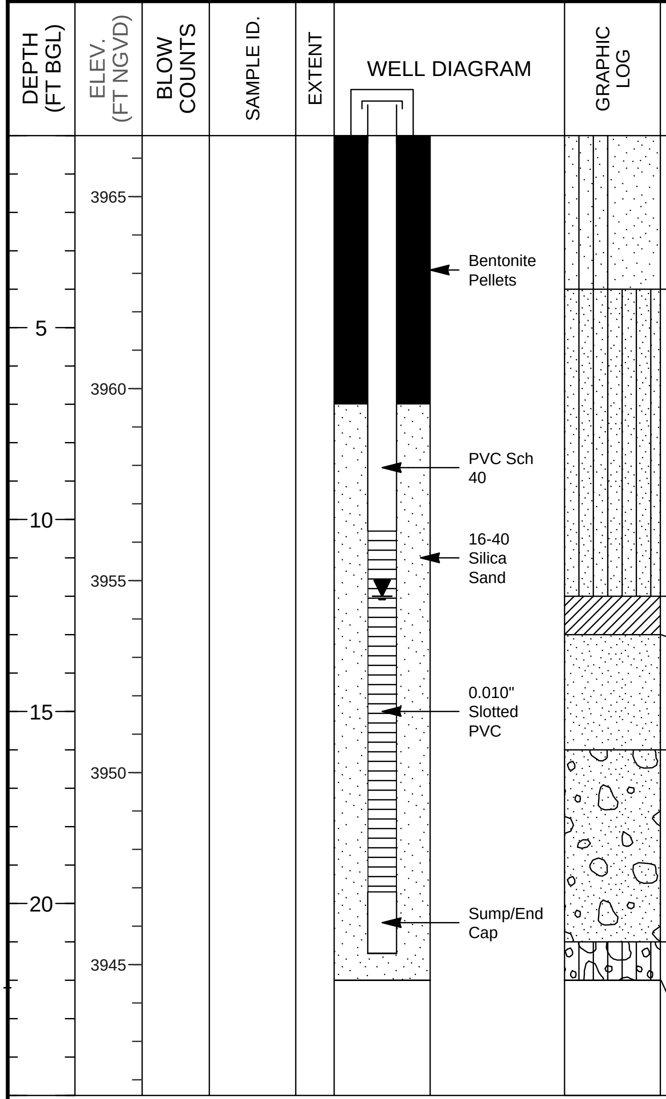
PROJECT MOAB
LOCATION Moab, UT
SITE MOAB
WELL NUMBER 0471

NORTH COORD. (FT) 6663361.48
EAST COORD. (FT) 2185991.55
HOLE DEPTH (FT) 22.00
WELL DEPTH (FT) 21.30

DATE DRILLED 06/25/2003
SURFACE ELEV. (FT NGVD) 3966.59
TOP OF CASING (FT) 3966.62
MEAS. PT. ELEV. (FT) 3966.62
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 9.0 / / 6.0

	WELL INSTALLATION	**INTERVAL (FT)**		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-0.03	to	10.3
WELL SCREEN:	4 in. 0.01 Slotted PVC	10.3	to	19.7
SUMP/END CAP:	4 in. PVC Sch 40	19.7	to	21.3
SURFACE SEAL:				
GROUT:				
SEAL:	Bentonite Pellets	0.0	to	7.0
UPPER PACK:				
LOWER PACK:	16-40 Silica Sand	7.0	to	22.0

DRILLING METHOD AIR HAMMER PERCUSSION
SAMPLING METHOD CYCLONE
DATE DEVELOPED 06/26/2003
WATER LEVEL (FT BGS) 12.0 on 06/25/2003
LOGGED BY Pill, K.
REMARKS



LITHOLOGIC DESCRIPTION

0-4.0 ft. SANDY SILT (ML-SP); strong brown (7.5YR 4/6). 40% sand, fine grained, 60% silt/clay, moist.

4.0-12.0 ft. SILTY SAND (SM); reddish brown (5YR 4/4), 25% silt, ~10% clay, 65% fine sand, moist.

12.0-13.0 ft. CLAY (CL); reddish gray (5YR 5/2), medium stiff, slightly mottled, moist.

13.0-16.0 ft. SAND (SP); reddish brown (5YR 5/2), fine to coarse grained with ~10% fine gravel, rounded, wet.

16.0-21.0 ft. GRAVELLY SAND (SP-GP); brown (7.5YR 4/4), 10% silt/clay, 20% gravel/cobbles fine to coarse, subrounded to well rounded - cobbles are well rounded, 70% fine to coarse sand, wet.

21.0-22.0 ft. CLAYEY SILTY GRAVEL (GM); brown (7.5YR 4/3), 30% silt/clay, 20% fine to medium grained sand, 50% fine to coarse gravel, rounded to well rounded, trace of well rounded cobbles, wet.

Total Depth 22.0 ft.

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MONITORING WELL COMPLETION LOG MOA01-0472

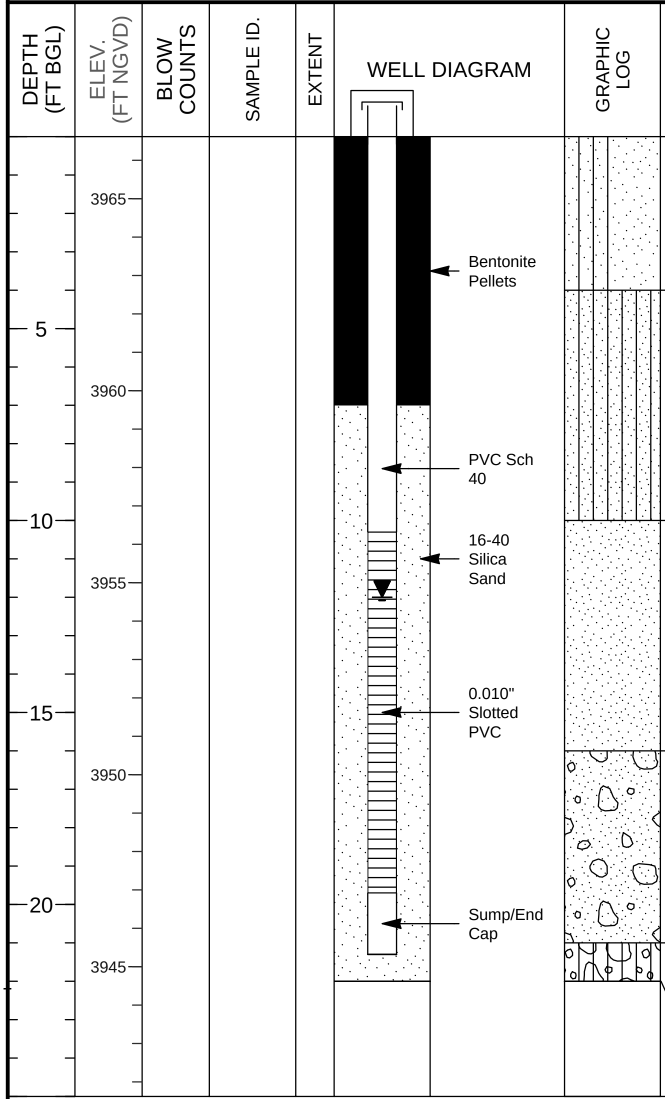
PROJECT MOAB
LOCATION Moab, UT
SITE MOAB
WELL NUMBER 0472

NORTH COORD. (FT) 6663386.00
EAST COORD. (FT) 2185995.11
HOLE DEPTH (FT) 22.00
WELL DEPTH (FT) 21.30

DATE DRILLED 06/24/2003
SURFACE ELEV. (FT NGVD) 3966.62
TOP OF CASING (FT) 3966.68
MEAS. PT. ELEV. (FT) 3966.68
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 9.0 / / 6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-0.06	to	10.3
WELL SCREEN:	4 in. 0.01 Slotted PVC	10.3	to	19.7
SUMP/END CAP:	4 in. PVC Sch 40	19.7	to	21.3
SURFACE SEAL:				
GROUT:				
SEAL:	Bentonite Pellets	0.0	to	7.0
UPPER PACK:				
LOWER PACK:	16-40 Silica Sand	7.0	to	22.0

DRILLING METHOD AIR HAMMER PERCUSSION
SAMPLING METHOD CYCLONE
DATE DEVELOPED 06/26/2003
WATER LEVEL (FT BGS) 12.0 on 06/24/2003
LOGGED BY Pill, K.
REMARKS



LITHOLOGIC DESCRIPTION

0-4.0 ft. SANDY SILT (ML-SP); reddish brown (5YR 4/4), 40% sand, fine grained, 60% silt/clay, moist.

4.0-10.0 ft. SILTY SAND (SM); dark reddish brown (5YR 3/4), 40% silt, ~50% fine sand, ~10 % clay (stiff), slightly mottled, moist.

10.0-16.0 ft. SAND (SP); reddish brown (5YR 4/4), fine to coarse grained with sand, ~10% fine gravel, subrounded to rounded, wet.

16.0-21.0 ft. GRAVELLY SAND (SP-GP); brown (7.5YR 4/4), 10% silt/clay, 20% fine to coarse gravel/cobbles, subrounded to well rounded - cobbles are well rounded, 70% fine to coarse sand, wet.

21.0-22.0 ft. CLAYEY SILTY GRAVEL (GM); brown (7.5YR 4/3), 30% silt/clay, 20% fine to medium grained sand, 50% fine to coarse gravel, rounded to well rounded, trace of well rounded cobbles, wet.

Total Depth 22.0 ft.

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MONITORING WELL COMPLETION LOG MOA01-0474

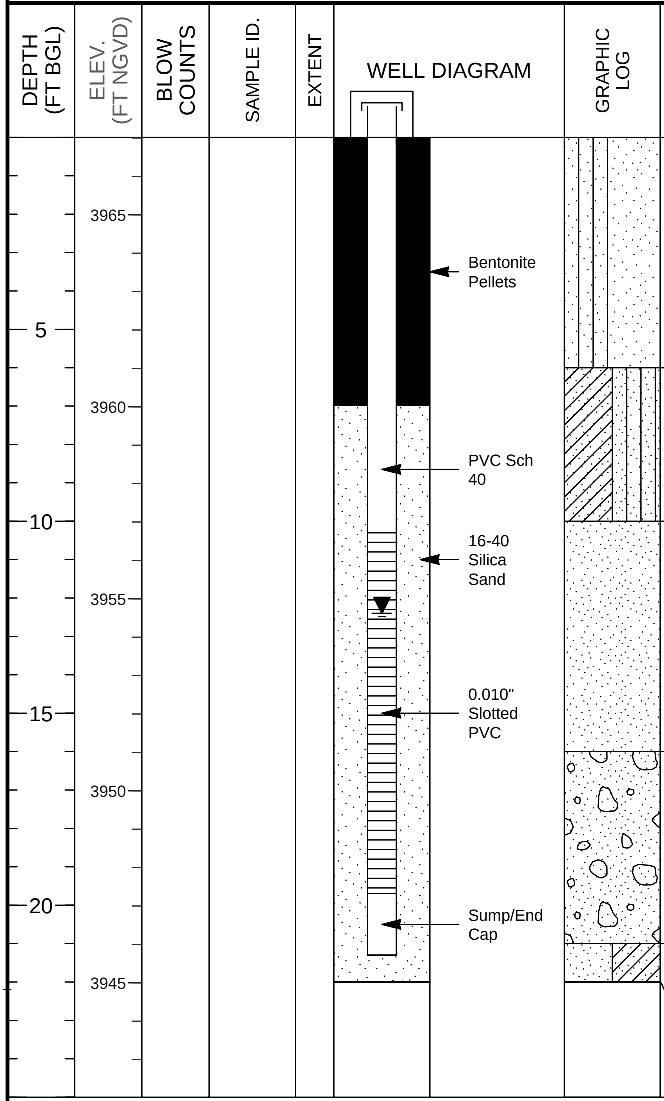
PROJECT MOAB
LOCATION Moab, UT
SITE MOAB
WELL NUMBER 0474

NORTH COORD. (FT) 6663435.71
EAST COORD. (FT) 2186002.61
HOLE DEPTH (FT) 22.00
WELL DEPTH (FT) 21.30

DATE DRILLED 06/24/2003
SURFACE ELEV. (FT NGVD) 3967.02
TOP OF CASING (FT) 3967.10
MEAS. PT. ELEV. (FT) 3967.10
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 9.0 / / 6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-0.08	to	10.3
WELL SCREEN:	4 in. 0.01 Slotted PVC	10.3	to	19.7
SUMP/END CAP:	4 in. PVC Sch 40	19.7	to	21.3
SURFACE SEAL:				
GROUT:				
SEAL:	Bentonite Pellets	0.0	to	7.0
UPPER PACK:				
LOWER PACK:	16-40 Silica Sand	7.0	to	22.0

DRILLING METHOD AIR HAMMER PERCUSSION
SAMPLING METHOD CYCLONE
DATE DEVELOPED 06/24/2003
WATER LEVEL (FT BGS) 12.4 on 06/24/2003
LOGGED BY Pill, K.
REMARKS



LITHOLOGIC DESCRIPTION

0-6.0 ft. SANDY SILT (ML-SP); dark yellowish brown (10YR 4/4), 30% fine sand, 70% silt/clay, moist.

6.0-10.0 ft. CLAYEY SILT (SC-SM); brown (7.5YR 4/4), 20% clay (stiff), 10% fine sand, 70% silt, moist.

10.0-16.0 ft. SAND (SP); reddish brown (5YR 5/4), fine to coarse grained, clean, wet.

16.0-21.0 ft. GRAVELLY SAND (SP-GP); brown (7.5YR 4/4), 20% gravel, 80% fine to medium grained sand, trace of subangular cobbles, fine to coarse gravel, wet.

21.0-22.0 ft. CLAYEY GRAVELLY SAND (SP-SC); brown (7.5YR 4/4), 60% fine to medium sand, 20% silt/clay, 20% gravel subangular to subrounded, wet.

Total Depth 22.0 ft.

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GRAND JUNCTION OFFICE, COLORADO

MONITORING WELL COMPLETION LOG MOA01-0475

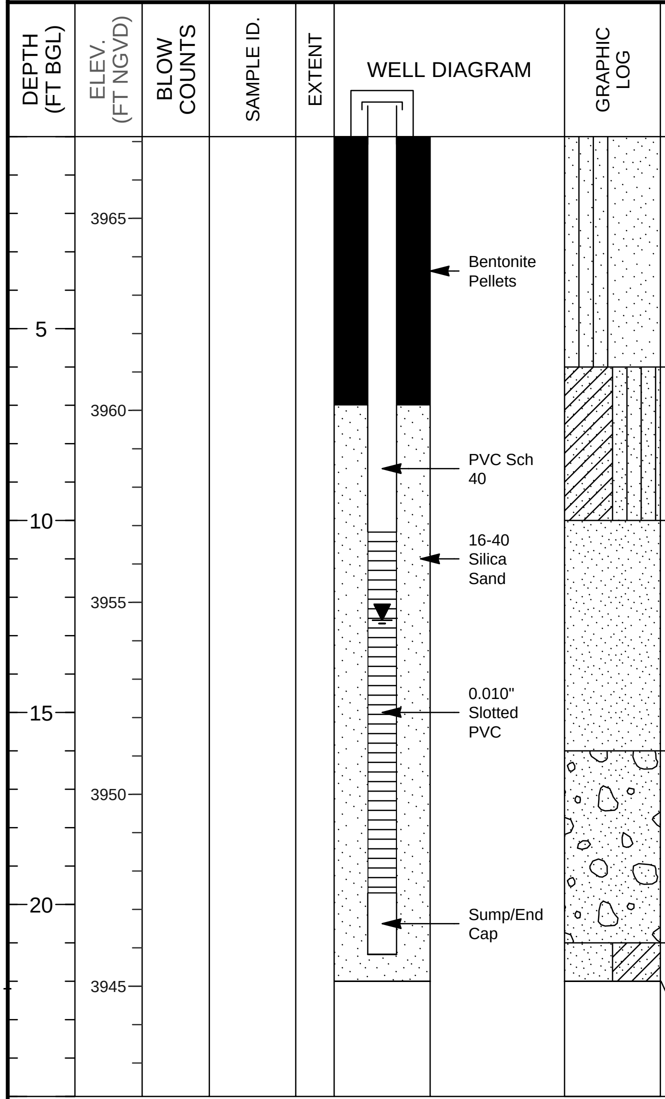
PROJECT MOAB
LOCATION Moab, UT
SITE MOAB
WELL NUMBER 0475

NORTH COORD. (FT) 6663460.70
EAST COORD. (FT) 2186005.78
HOLE DEPTH (FT) 22.00
WELL DEPTH (FT) 21.30

DATE DRILLED 06/24/2003
SURFACE ELEV. (FT NGVD) 3967.13
TOP OF CASING (FT) 3967.32
MEAS. PT. ELEV. (FT) 3967.32
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 9.0 / / 6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-0.19	to	10.3
WELL SCREEN:	4 in. 0.01 Slotted PVC	10.3	to	19.7
SUMP/END CAP:	4 in. PVC Sch 40	19.7	to	21.3
SURFACE SEAL:				
GROUT:				
SEAL:	Bentonite Pellets	0.0	to	7.0
UPPER PACK:				
LOWER PACK:	16-40 Silica Sand	7.0	to	22.0

DRILLING METHOD AIR HAMMER PERCUSSION
SAMPLING METHOD CYCLONE
DATE DEVELOPED 06/24/2003
WATER LEVEL (FT BGS) 12.6 on 06/24/2003
LOGGED BY Pill, K.
REMARKS



LITHOLOGIC DESCRIPTION

0-6.0 ft. SANDY SILT (ML-SP); dark yellowish brown (10YR 4/4), 30% fine sand, 70% silt/clay, moist.

6.0-10.0 ft. CLAYEY SILT (SC-SM); brown (7.5YR 4/4), 20% clay (stiff), 10% fine sand, 70% silt, moist.

10.0-16.0 ft. SAND (SP); reddish brown (5YR 5/4), fine to coarse grained, clean, wet.

16.0-21.0 ft. GRAVELLY SAND (SP-GP); brown (7.5YR 4/4), 20% gravel, 80% fine to medium grained sand, trace of subangular cobbles, fine to coarse gravel, wet.

21.0-22.0 ft. CLAYEY GRAVELLY SAND (SP-SC); brown (7.5YR 4/4), 60% fine to medium sand, 20% silt/clay, 20% gravel subangular to subrounded, wet.

Total Depth 22.0 ft.

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GRAND JUNCTION OFFICE, COLORADO

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MONITORING WELL COMPLETION LOG MOA01-0476

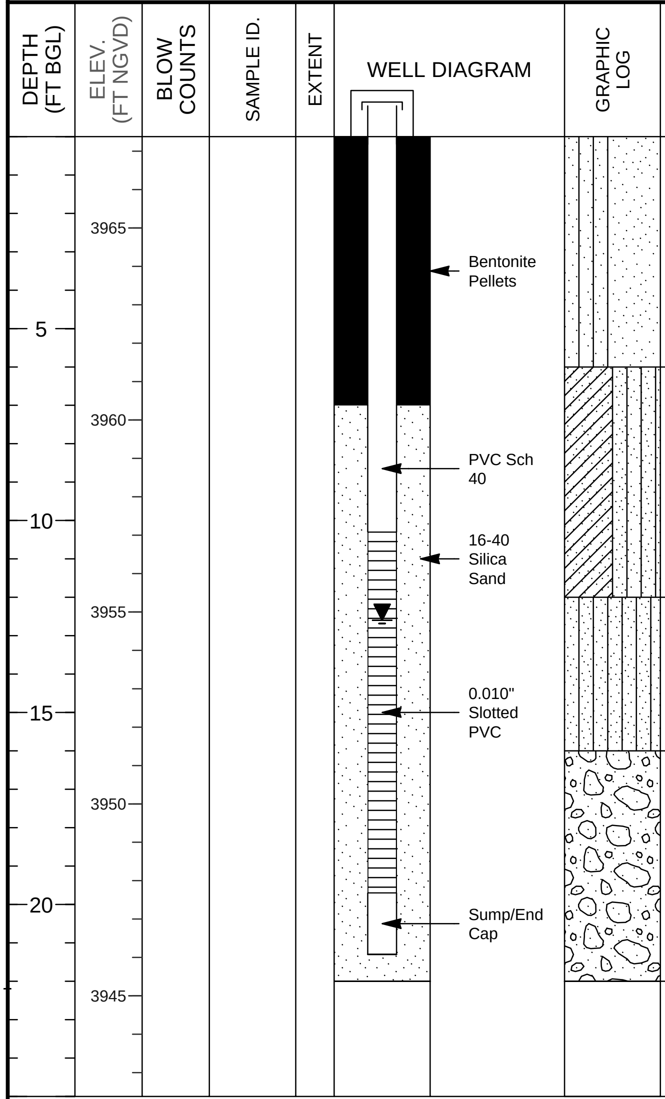
PROJECT MOAB
LOCATION Moab, UT
SITE MOAB
WELL NUMBER 0476

NORTH COORD. (FT) 6663485.25
EAST COORD. (FT) 2186009.58
HOLE DEPTH (FT) 22.00
WELL DEPTH (FT) 21.30

DATE DRILLED 06/23/2003
SURFACE ELEV. (FT NGVD) 3967.38
TOP OF CASING (FT) 3967.46
MEAS. PT. ELEV. (FT) 3967.46
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 9.0 / / 6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-0.08	to	10.3
WELL SCREEN:	4 in. 0.01 Slotted PVC	10.3	to	19.7
SUMP/END CAP:	4 in. PVC Sch 40	19.7	to	21.3
SURFACE SEAL:				
GROUT:				
SEAL:	Bentonite Pellets	0.0	to	7.0
UPPER PACK:				
LOWER PACK:	16-40 Silica Sand	7.0	to	22.0

DRILLING METHOD AIR HAMMER PERCUSSION
SAMPLING METHOD CYCLONE
DATE DEVELOPED 06/24/2003
WATER LEVEL (FT BGS) 12.6 on 06/23/2003
LOGGED BY Pill, K.
REMARKS



LITHOLOGIC DESCRIPTION

0-6.0 ft. SANDY SILT (ML-SP); brown (7.5YR 4/4), 40% sand, fine grained, 60% silt/clay, moist.

6.0-12.0 ft. CLAYEY SILT (SC-SM); brown (7.5YR 4/4), 20% fine sand, 60% silt, 20% clay,stiff, moist.

12.0-16.0 ft. SILTY SAND (SM); dark brown (7.5YR 3/4), fine to coarse grained sand, 10% fine gravel, 15% silt, wet.

16.0-22.0 ft. SANDY GRAVEL (GP-SP); gravel, brown (7.5YR 4/4), 15% silt, 25% sand, fine to coarse grained, 10% cobbles, subrounded to rounded, wet.

Total Depth 22.0 ft.

MONITORING WELL COMPLETION LOG MOA01-0477

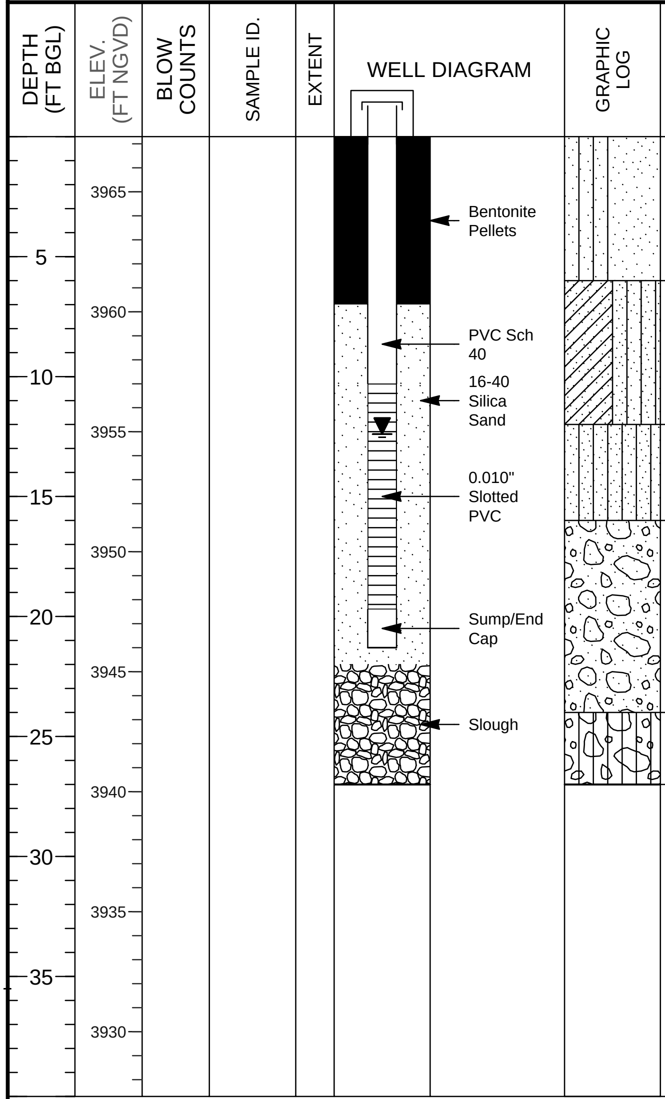
PROJECT MOAB
LOCATION Moab, UT
SITE MOAB
WELL NUMBER 0477

NORTH COORD. (FT) 6663510.11
EAST COORD. (FT) 2186012.49
HOLE DEPTH (FT) 27.00
WELL DEPTH (FT) 21.30

DATE DRILLED 06/23/2003
SURFACE ELEV. (FT NGVD) 3967.30
TOP OF CASING (FT) 3967.30
MEAS. PT. ELEV. (FT) 3967.30
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 9.0 / / 6.0

	WELL INSTALLATION	**INTERVAL (FT)**		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	0.0	to	10.3
WELL SCREEN:	4 in. 0.01 Slotted PVC	10.3	to	19.7
SUMP/END CAP:	4 in. PVC Sch 40	19.7	to	21.3
SURFACE SEAL:				
GROUT:				
SEAL:	Bentonite Pellets	0.0	to	7.0
UPPER PACK:				
LOWER PACK:	16-40 Silica Sand	7.0	to	22.0

DRILLING METHOD AIR HAMMER PERCUSSION
SAMPLING METHOD CYCLONE
DATE DEVELOPED 06/23/2003
WATER LEVEL (FT BGS) 12.4 on 06/23/2003
LOGGED BY Pill, K.
REMARKS



LITHOLOGIC DESCRIPTION

0-6.0 ft. SANDY SILT (ML-SP); brown (7.5YR 4/4), 40% sand, fine grained, 60% silt/clay, moist.

6.0-12.0 ft. CLAYEY SILT (SC-SM); brown (7.5YR 4/4), 20% fine sand, 60% silt, 20% clay,stiff, moist.

12.0-16.0 ft. SILTY SAND (SM); dark brown (7.5YR 3/4), fine to coarse grained sand, 10% fine gravel, 15% silt, wet.

16.0-24.0 ft. SANDY GRAVEL (GP-SP); gravel, brown (7.5YR 4/4), 15% silt, 25% sand, fine to coarse grained, 10% cobbles, subrounded to rounded, wet.

24.0-27.0 ft. SILTY GRAVEL (GM); dark reddish brown (5YR 3/4), 20% fine grained sand, 30% silt/clay, 50% gravel/cobbles, gravel rounded to subrounded.

Total Depth 27.0 ft.

MONITORING WELL COMPLETION LOG MOA01-0478

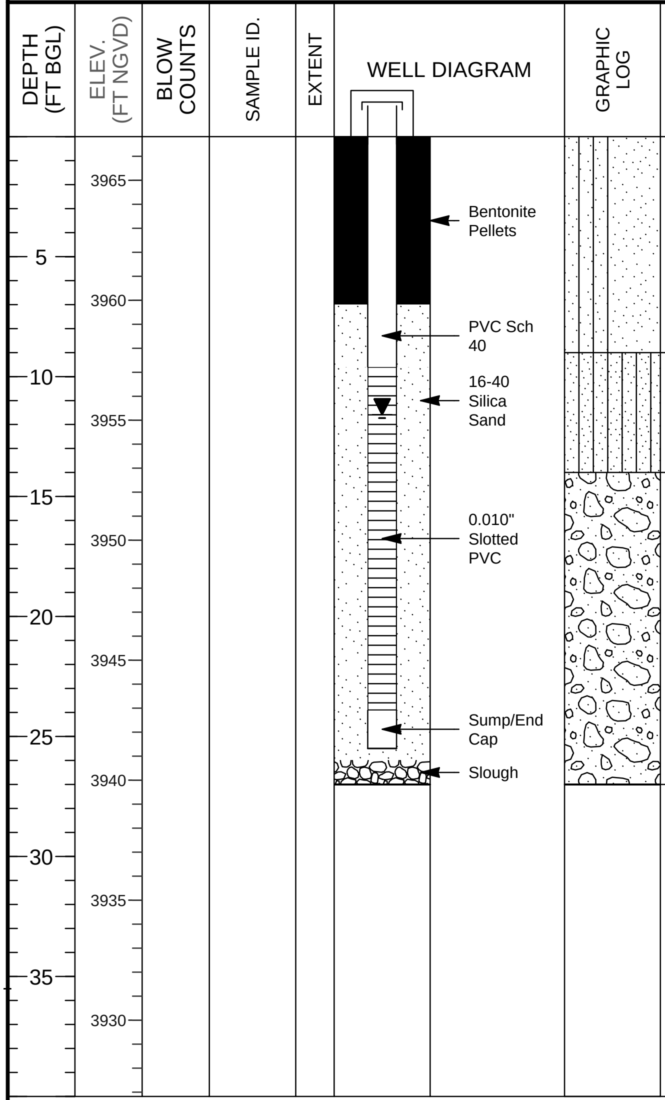
PROJECT MOAB
LOCATION Moab, UT
SITE MOAB
WELL NUMBER 0478

NORTH COORD. (FT) 6663535.08
EAST COORD. (FT) 2186015.76
HOLE DEPTH (FT) 27.00
WELL DEPTH (FT) 25.50

DATE DRILLED 06/21/2003 to 06/23/2003
SURFACE ELEV. (FT NGVD) 3966.82
TOP OF CASING (FT) 3967.43
MEAS. PT. ELEV. (FT) 3967.43
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 9.0 / / 6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-0.61	to	9.6
WELL SCREEN:	4 in. 0.01 Slotted PVC	9.6	to	23.9
SUMP/END CAP:	4 in. PVC Sch 40	23.9	to	25.5
SURFACE SEAL:				
GROUT:				
SEAL:	Bentonite Pellets	0.0	to	7.0
UPPER PACK:				
LOWER PACK:	16-40 Silica Sand	7.0	to	26.0

DRILLING METHOD AIR HAMMER PERCUSSION
SAMPLING METHOD CYCLONE
DATE DEVELOPED 06/23/2003
WATER LEVEL (FT BGS) 11.6 on 06/21/2003
LOGGED BY Pill, K.
REMARKS



LITHOLOGIC DESCRIPTION

0-9.0 ft. SANDY SILT (ML-SP);. brown (7.5YR 4/4), 40% fine grained sand, 60% silt/clay, moist.

9.0-14.0 ft. SILTY SAND (SM); brown (7.5YR 4/4), 70% fine to medium grained sand, 30% silt/clay.

14.0-27.0 ft. SANDY GRAVEL (GP-SP); dark red brown (5YR 3/4), medium to coarse grained sand, rounded to subrounded gravel, trace of cobbles, wet.

Total Depth 27.0 ft.

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GRAND JUNCTION OFFICE, COLORADO

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MONITORING WELL COMPLETION LOG MOA01-0479

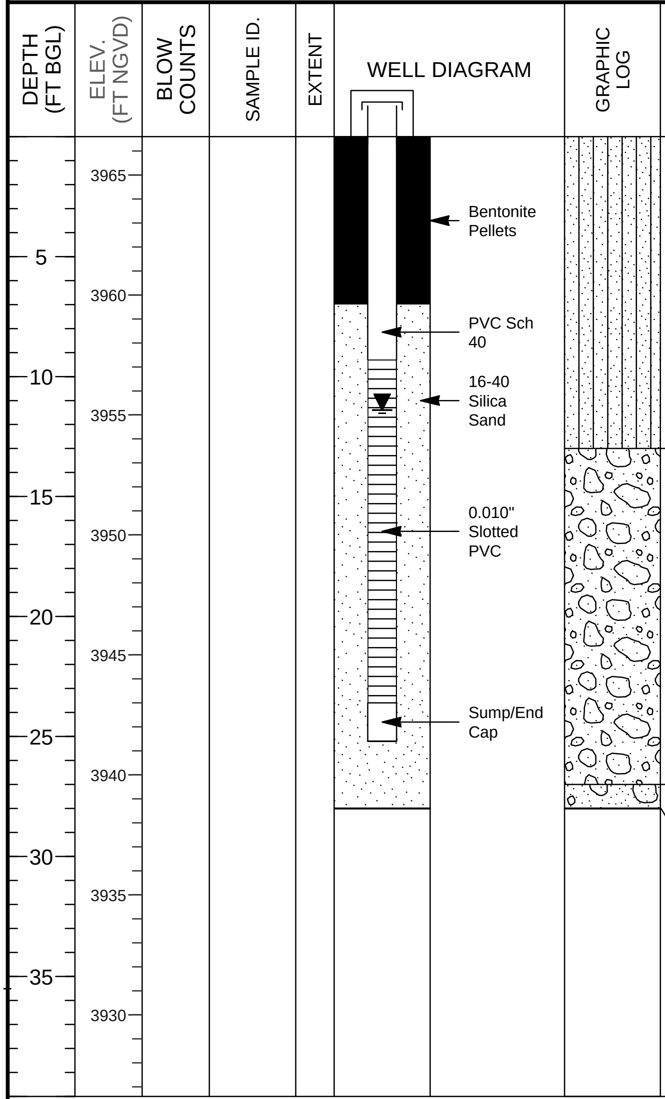
PROJECT MOAB
LOCATION Moab, UT
SITE MOAB
WELL NUMBER 0479

NORTH COORD. (FT) 6663559.47
EAST COORD. (FT) 2186019.45
HOLE DEPTH (FT) 28.00
WELL DEPTH (FT) 25.20

DATE DRILLED 06/21/2003
SURFACE ELEV. (FT NGVD) 3966.60
TOP OF CASING (FT) 3967.13
MEAS. PT. ELEV. (FT) 3967.13
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 9.0 / / 6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-0.53	to	9.3
WELL SCREEN:	4 in. 0.01 Slotted PVC	9.3	to	23.6
SUMP/END CAP:	4 in. PVC Sch 40	23.6	to	25.2
SURFACE SEAL:				
GROUT:				
SEAL:	Bentonite Pellets	0.0	to	7.0
UPPER PACK:				
LOWER PACK:	16-40 Silica Sand	7.0	to	26.0

DRILLING METHOD AIR HAMMER PERCUSSION
SAMPLING METHOD CYCLONE
DATE DEVELOPED 06/23/2003
WATER LEVEL (FT BGS) 11.4 on 06/21/2003
LOGGED BY Pill, K.
REMARKS



LITHOLOGIC DESCRIPTION

0-13.0 ft. SILTY SAND (SM); brown (7.5YR 4/4), 80% fine to medium grained sand, 20% silt/clay, moist.

9.0-13.0 ft. color changes to reddish brown (5YR 4/4), sand is more coarse, and less silt/clay (10%).

13.0-27.0 ft. SANDY GRAVEL (GP-SP); dark reddish brown (5YR 3/4), medium to coarse grained sand, subrounded to rounded gravel, trace of silt and cobbles, wet.

27.0-28.0 ft. GRAVELLY SAND (SP-GP); dark red brown (5YR 3/4), slightly finer grained sand. No clay.

Total Depth 28.0 ft.

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GRAND JUNCTION OFFICE, COLORADO

MONITORING WELL COMPLETION LOG MOA01-0480

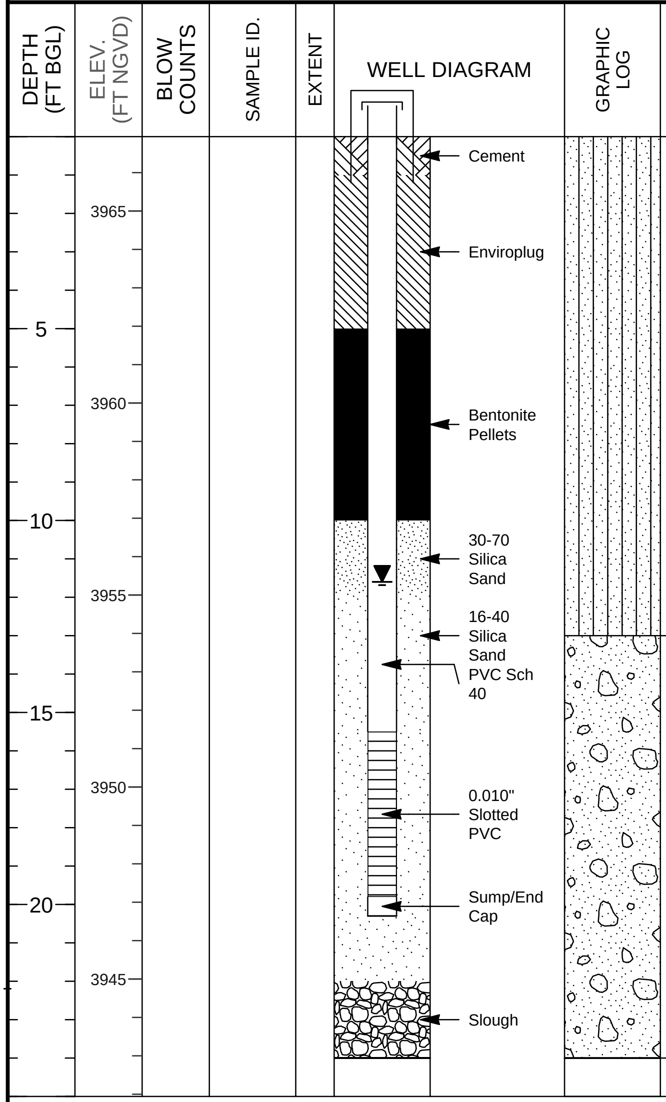
PROJECT MOAB
LOCATION Moab, UT
SITE MOAB
WELL NUMBER 0480

NORTH COORD. (FT) 6663451.03
EAST COORD. (FT) 2185984.93
HOLE DEPTH (FT) 24.00
WELL DEPTH (FT) 20.30

DATE DRILLED 06/21/2003
SURFACE ELEV. (FT NGVD) 3966.94
TOP OF CASING (FT) 3968.65
MEAS. PT. ELEV. (FT) 3968.65
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 9.0 / / 6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-1.71	to	15.5
WELL SCREEN:	4 in. 0.01 Slotted PVC	15.5	to	19.8
SUMP/END CAP:	4 in. PVC Sch 40	19.8	to	20.3
SURFACE SEAL:	Cement	0.0	to	1.0
GROUT:	Enviroplug	1.0	to	5.0
SEAL:	Bentonite Pellets	5.0	to	10.0
UPPER PACK:	30-70 Silica Sand	10.0	to	12.0
LOWER PACK:	16-40 Silica Sand	12.0	to	22.0

DRILLING METHOD AIR HAMMER PERCUSSION
SAMPLING METHOD CYCLONE
DATE DEVELOPED 06/25/2003
WATER LEVEL (FT BGS) 11.6 on 06/21/2003
LOGGED BY Pill, K.
REMARKS



LITHOLOGIC DESCRIPTION

0-13.0 ft. SILTY SAND (SM); reddish brown (5YR 4/4), 50% fine to very fine sand, 50% silt/clay, moist.

13.0-24 ft. GRAVELLY SAND (SP-GP); reddish brown (5YR 4/4), 75% fine to medium grained sand (rounded), 20% rounded to subrounded gravel (1/2" to 1.0" in diameter), trace of silt/clay, wet

@16.0 ft. sand becomes coarse.

Total Depth 24.0 ft.

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GRAND JUNCTION OFFICE, COLORADO

MONITORING WELL COMPLETION LOG MOA01-0481

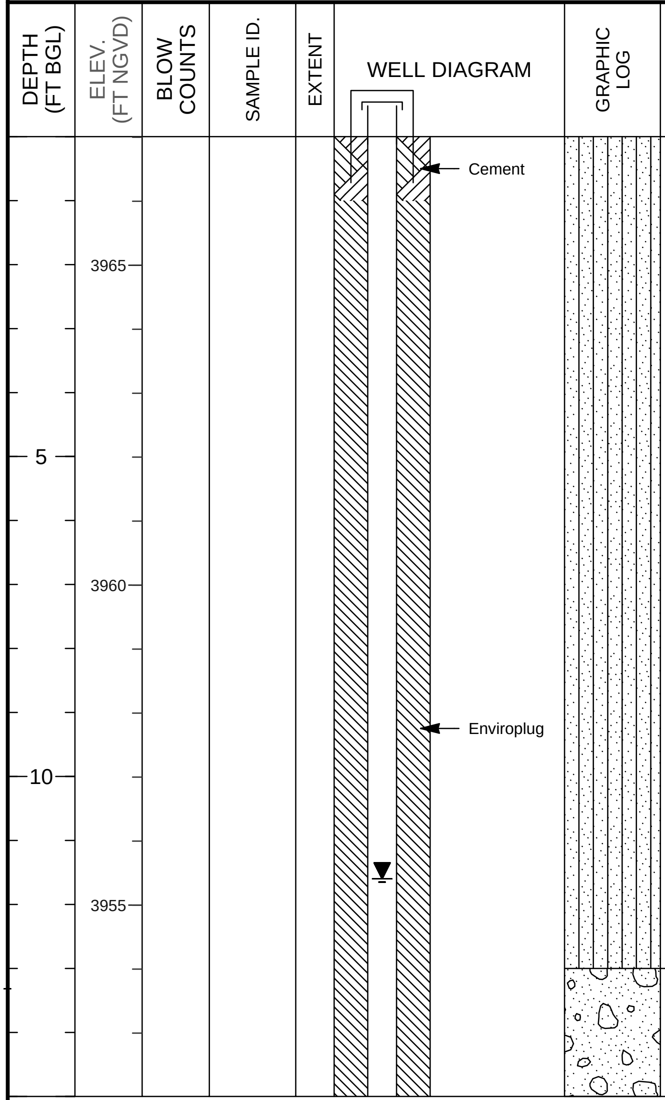
PROJECT MOAB
LOCATION Moab, UT
SITE MOAB
WELL NUMBER 0481

NORTH COORD. (FT) 6663447.46
EAST COORD. (FT) 2185978.30
HOLE DEPTH (FT) 33.40
WELL DEPTH (FT) 31.30

DATE DRILLED 06/20/2003
SURFACE ELEV. (FT NGVD) 3967.01
TOP OF CASING (FT) 3968.83
MEAS. PT. ELEV. (FT) 3968.83
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 9.0 / / 6.0

	WELL INSTALLATION	**INTERVAL (FT)**		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-1.82	to	25.4
WELL SCREEN:	4 in. 0.01 Slotted PVC	25.4	to	29.7
SUMP/END CAP:	4 in. PVC Sch 40	29.7	to	31.3
SURFACE SEAL:	Cement	0.0	to	1.0
GROUT:	Enviroplug	1.0	to	17.5
SEAL:	Bentonite Pellets	17.5	to	18.0
UPPER PACK:	30-70 Silica Sand	18.0	to	22.0
LOWER PACK:	16-40 Silica Sand	22.0	to	31.3

DRILLING METHOD AIR HAMMER PERCUSSION
SAMPLING METHOD CYCLONE
DATE DEVELOPED 06/25/2003
WATER LEVEL (FT BGS) 11.6 on 06/20/2003
LOGGED BY Pill, K.
REMARKS



LITHOLOGIC DESCRIPTION

0-13.0 ft. SILTY SAND (SM); reddish brown (5YR 4/4), 50% fine to very fine sand, 50% silt/clay, moist.

13.0-25 ft. GRAVELLY SAND (SP-GP); reddish brown (5YR 4/4), 75% fine to medium grained sand (rounded), 20% rounded to subrounded gravel (1/2" to 1.0" in diameter), trace of silt/clay, wet

MONITORING WELL COMPLETION LOG MOA01-0481

PROJECT MOAB

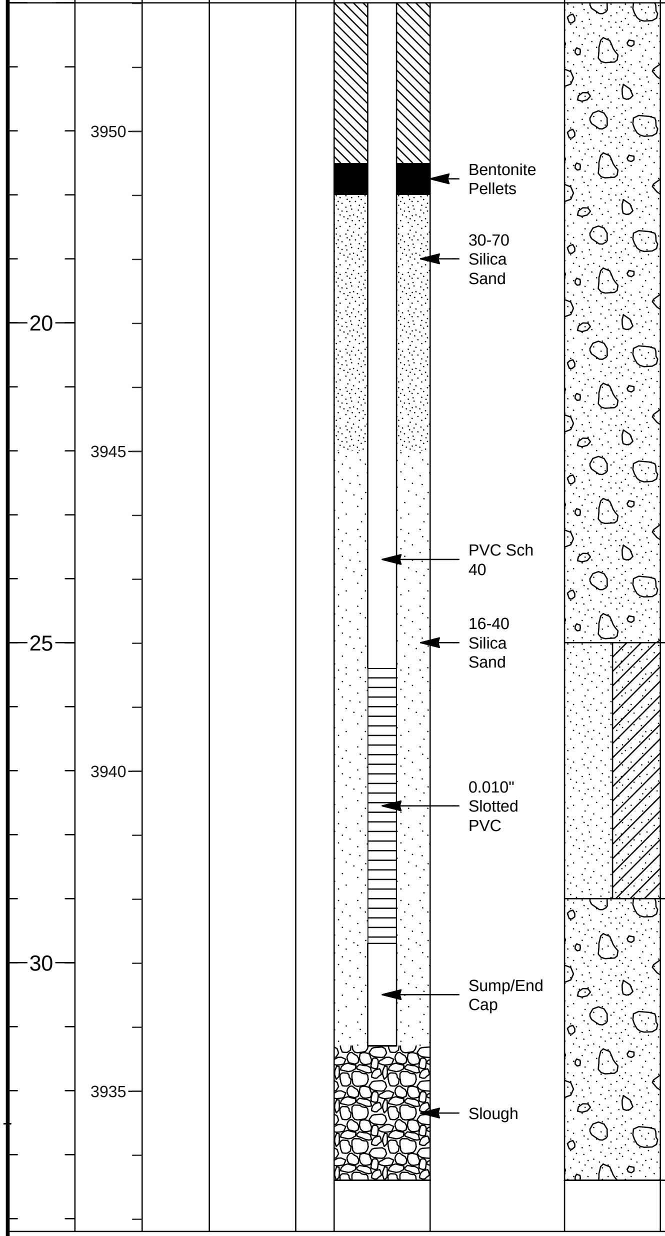
SITE MOAB

WELL NUMBER 0481

DATES DRILLED 06/20/2003

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							@16.0 ft. sand becomes coarse.
							25.0-29.0 ft. CLAYEY GRAVELLY SAND (SP-SC); gray brown (10YR 5/2), 50% medium to coarse grained sand (rounded), 25% clay, 15% rounded to subrounded gravel, wet.
							29.0-33.4 ft. GRAVELLY SAND (SP-GP); grayish brown (10YR 5/2), 70% medium to coarse grained sand, 20% fine rounded to well rounded gravel, 10% rounded cobbles, wet.
							Total Depth 33.4 ft.



MONITORING WELL COMPLETION LOG MOA01-0482

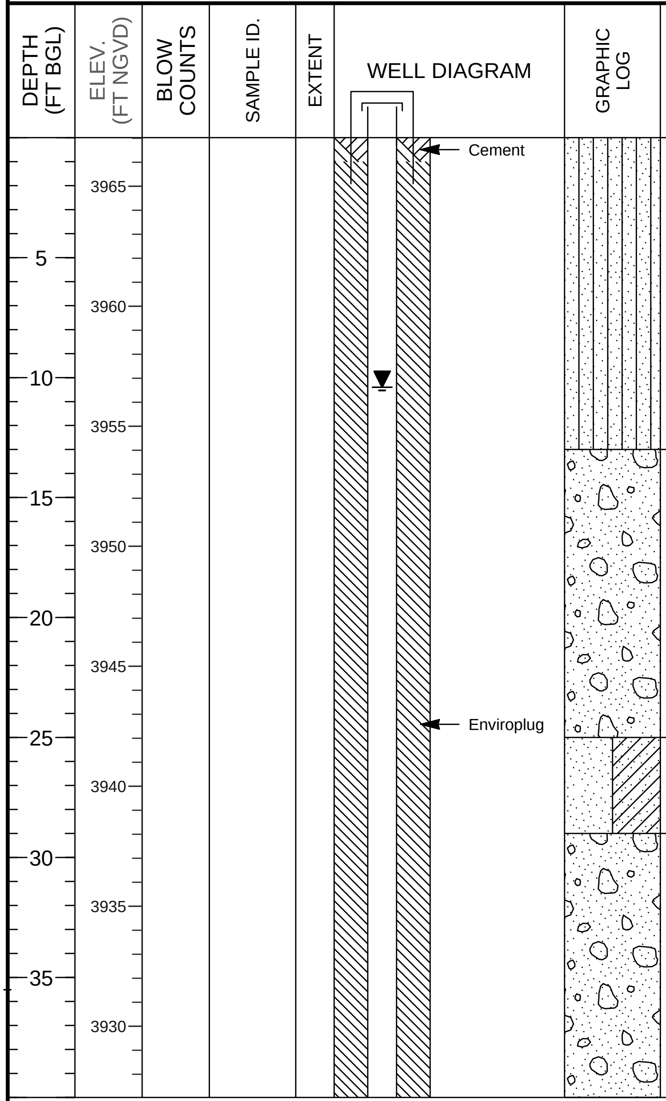
PROJECT MOAB
LOCATION Moab, UT
SITE MOAB
WELL NUMBER 0482

NORTH COORD. (FT) 6663455.70
EAST COORD. (FT) 2185978.84
HOLE DEPTH (FT) 64.00
WELL DEPTH (FT) 61.30

DATE DRILLED 06/19/2003
SURFACE ELEV. (FT NGVD) 3967.03
TOP OF CASING (FT) 3968.70
MEAS. PT. ELEV. (FT) 3968.70
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 9.0 / / 6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-1.67	to	55.4
WELL SCREEN:	4 in. 0.01 Slotted PVC	55.4	to	59.7
SUMP/END CAP:	4 in. PVC Sch 40	59.7	to	61.3
SURFACE SEAL:	Cement	0.0	to	1.0
GROUT:	Enviroplug	1.0	to	47.9
SEAL:	Bentonite Pellets	47.9	to	48.0
UPPER PACK:	30-70 Silica Sand	48.0	to	52.0
LOWER PACK:	16-40 Silica Sand	52.0	to	64.0

DRILLING METHOD AIR HAMMER PERCUSSION
SAMPLING METHOD CYCLONE
DATE DEVELOPED 06/25/2003
WATER LEVEL (FT BGS) 10.4 on 06/20/2003
LOGGED BY Pill, K.
REMARKS



LITHOLOGIC DESCRIPTION

0-13.0 ft. SILTY SAND (SM); reddish brown (5YR 4/4), 50% fine to very fine sand, 50% silt/clay, moist.

13.0-25 ft. GRAVELLY SAND (SP-GP); reddish brown (5YR 4/4), 75% fine to medium grained sand (rounded), 20% rounded to subrounded gravel (1/2" to 1.0" in diameter), trace of silt/clay, wet

@16.0 ft. sand becomes coarse.

25.0-29.0 ft. CLAYEY GRAVELLY SAND (SP-SC); gray brown (10YR 5/2), 50% medium to coarse grained sand (rounded), 25% clay, 15% rounded to subrounded gravel, wet.

29.0-64.0 ft. GRAVELLY SAND (SP-GP); grayish brown (10YR 5/2), 70% medium to coarse grained sand, 20% fine rounded to well rounded gravel, 10% rounded cobbles, wet.

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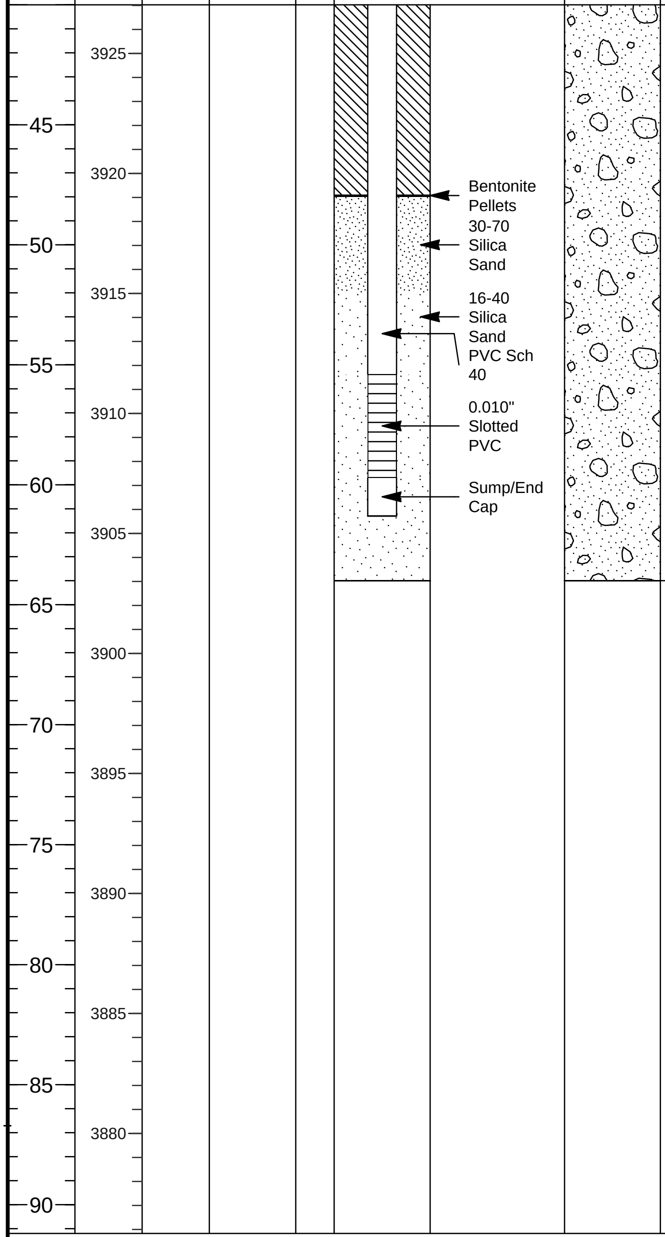
MONITORING WELL COMPLETION LOG MOA01-0482

PROJECT MOAB
WELL NUMBER 0482
SITE MOAB
DATES DRILLED 06/19/2003

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							@ 40.0 ft. slightly coarser grains, fine crystalline lithic types (up to 6.0" to 8.0" in diameter).
							Total Depth 64.0 ft.



Stoller–GJO **U.S. DEPARTMENT OF ENERGY**
GRAND JUNCTION OFFICE, COLORADO

MONITORING WELL COMPLETION LOG MOA01-0483

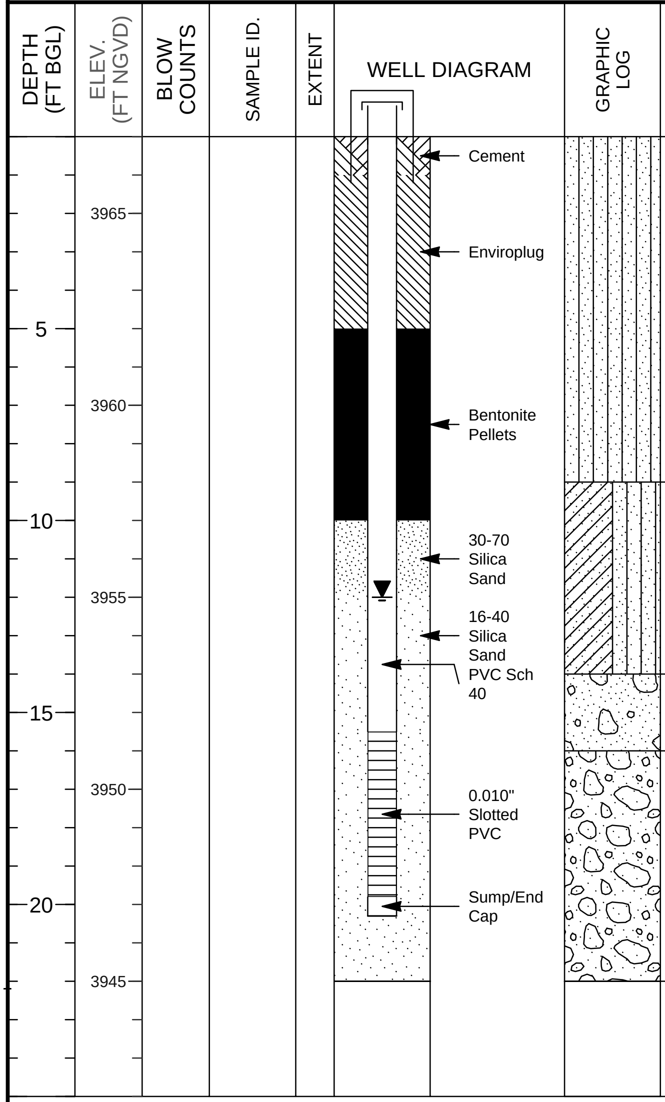
PROJECT MOAB
LOCATION Moab, UT
SITE MOAB
WELL NUMBER 0483

NORTH COORD. (FT) 6663447.82
EAST COORD. (FT) 2186014.93
HOLE DEPTH (FT) 22.00
WELL DEPTH (FT) 20.30

DATE DRILLED 06/23/2003
SURFACE ELEV. (FT NGVD) 3967.00
TOP OF CASING (FT) 3968.90
MEAS. PT. ELEV. (FT) 3968.90
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 9.0 / / 6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-1.9	to	15.5
WELL SCREEN:	4 in. 0.01 Slotted PVC	15.5	to	19.8
SUMP/END CAP:	4 in. PVC Sch 40	19.8	to	20.3
SURFACE SEAL:	Cement	0.0	to	1.0
GROUT:	Enviroplug	1.0	to	5.0
SEAL:	Bentonite Pellets	5.0	to	10.0
UPPER PACK:	30-70 Silica Sand	10.0	to	12.0
LOWER PACK:	16-40 Silica Sand	12.0	to	22.0

DRILLING METHOD AIR HAMMER PERCUSSION
SAMPLING METHOD CYCLONE
DATE DEVELOPED 06/26/2003
WATER LEVEL (FT BGS) 12.0 on 06/23/2003
LOGGED BY Pill, K.
REMARKS



LITHOLOGIC DESCRIPTION

0-9.0 ft. SILTY SAND (SM); brown (7.5YR 4/4), fine grained sand, 40% silt/clay, moist.

9.0-14.0 ft. CLAYEY SILT (SC-SM); brown (7.5YR 4/4); 20% fine grained sand, 60% silt, 20% clay, stiff, slightly mottled, moist.

14.0-16.0 ft. GRAVELLY SAND (SP-GP); brown (7.5YR 4/4); fine to coarse grained sand, fine gravel, subrounded to rounded, 10% silt, moist.

16.0-22.0 ft. SANDY GRAVEL (GP-SP); brown (7.5YR 4/4), medium to coarse grained sand, subangular to subrounded gravel, cobbles, wet.

Total Depth 22.0 ft.

Stoller–GJO **U.S. DEPARTMENT OF ENERGY**
GRAND JUNCTION OFFICE, COLORADO

PAGE 1 OF 1 07/25/2003

MONITORING WELL COMPLETION LOG MOA01-0484

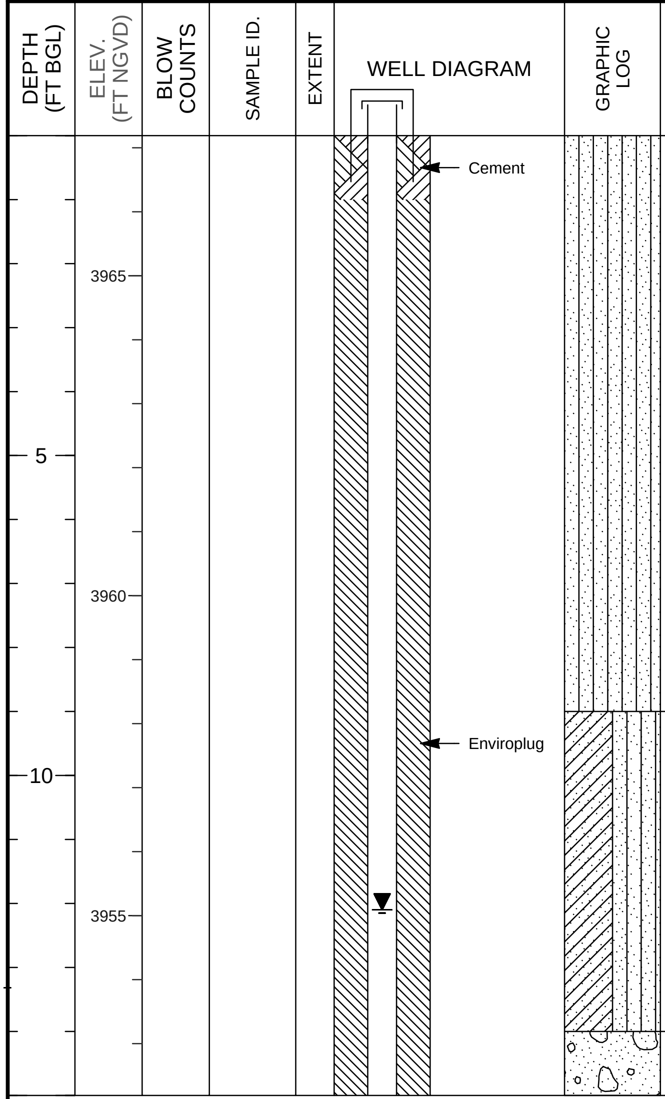
PROJECT MOAB
LOCATION Moab, UT
SITE MOAB
WELL NUMBER 0484

NORTH COORD. (FT) 6663457.71
EAST COORD. (FT) 2186019.38
HOLE DEPTH (FT) 32.00
WELL DEPTH (FT) 30.30

DATE DRILLED 06/22/2003
SURFACE ELEV. (FT NGVD) 3967.19
TOP OF CASING (FT) 3969.19
MEAS. PT. ELEV. (FT) 3969.19
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 9.0 / / 6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-2.0	to	25.5
WELL SCREEN:	4 in. 0.01 Slotted PVC	25.5	to	29.8
SUMP/END CAP:	4 in. PVC Sch 40	29.8	to	30.3
SURFACE SEAL:	Cement	0.0	to	1.0
GROUT:	Enviroplug	1.0	to	18.0
SEAL:	Bentonite Pellets	18.0	to	18.5
UPPER PACK:	30-70 Silica Sand	18.5	to	22.0
LOWER PACK:	16-40 Silica Sand	22.0	to	32.0

DRILLING METHOD AIR HAMMER PERCUSSION
SAMPLING METHOD CYCLONE
DATE DEVELOPED 06/26/2003
WATER LEVEL (FT BGS) 12.1 on 06/23/2003
LOGGED BY Pill, K.
REMARKS



LITHOLOGIC DESCRIPTION

0-9.0 ft. SILTY SAND (SM); brown (7.5YR 4/4), fine grained sand, 40% silt/clay, moist.

9.0-14.0 ft. CLAYEY SILT (SC-SM); brown (7.5YR 4/4); 20% fine grained sand, 60% silt, 20% clay, stiff, slightly mottled, moist.

14.0-16.0 ft. GRAVELLY SAND (SP-GP); brown (7.5YR 4/4); fine to coarse grained sand, fine gravel, subrounded to rounded, 10%

MONITORING WELL COMPLETION LOG MOA01-0484

PROJECT MOAB

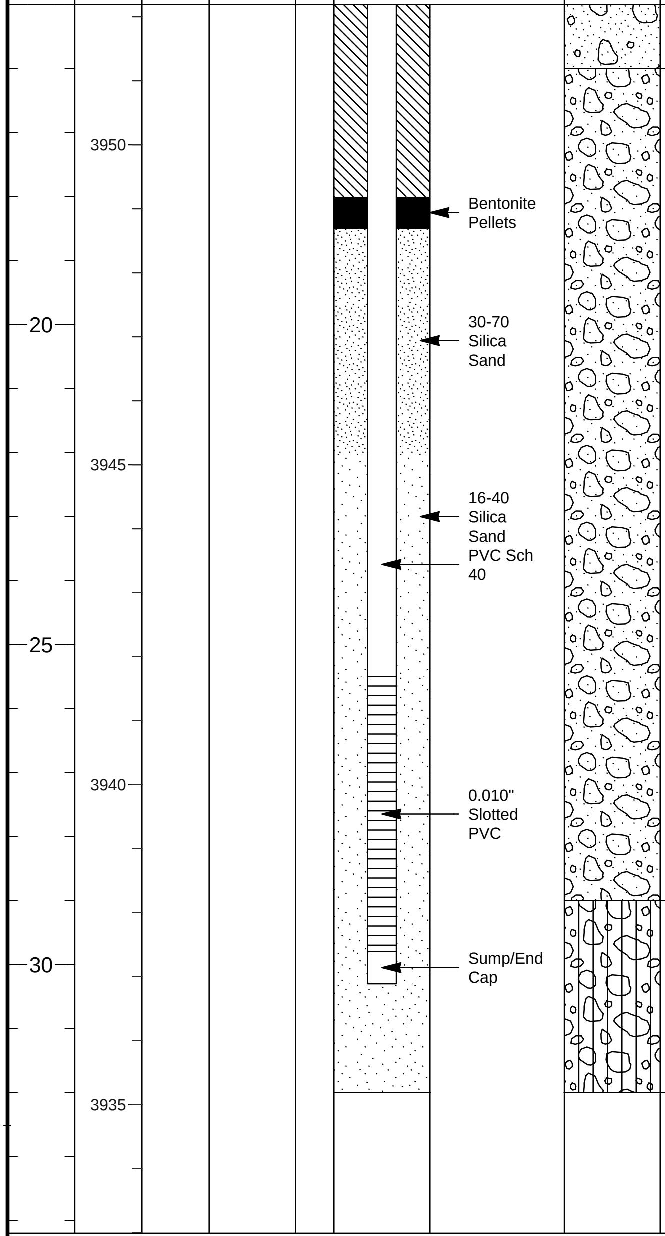
WELL NUMBER 0484

SITE MOAB

DATES DRILLED 06/22/2003

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION



silt, moist.

16.0-29.0 ft. SANDY GRAVEL (GP-SP); brown (7.5YR 4/4), medium to coarse grained sand, subangular to subrounded gravel, cobbles, wet.

29.0-32.0 ft. SILTY GRAVEL (GM); dark reddish brown (5YR 3/4), 20% fine sand, subangular to subrounded gravel, minor clastic cobbles, rounded wet.

Total Depth 32.0 ft.

MONITORING WELL COMPLETION LOG MOA01-0485

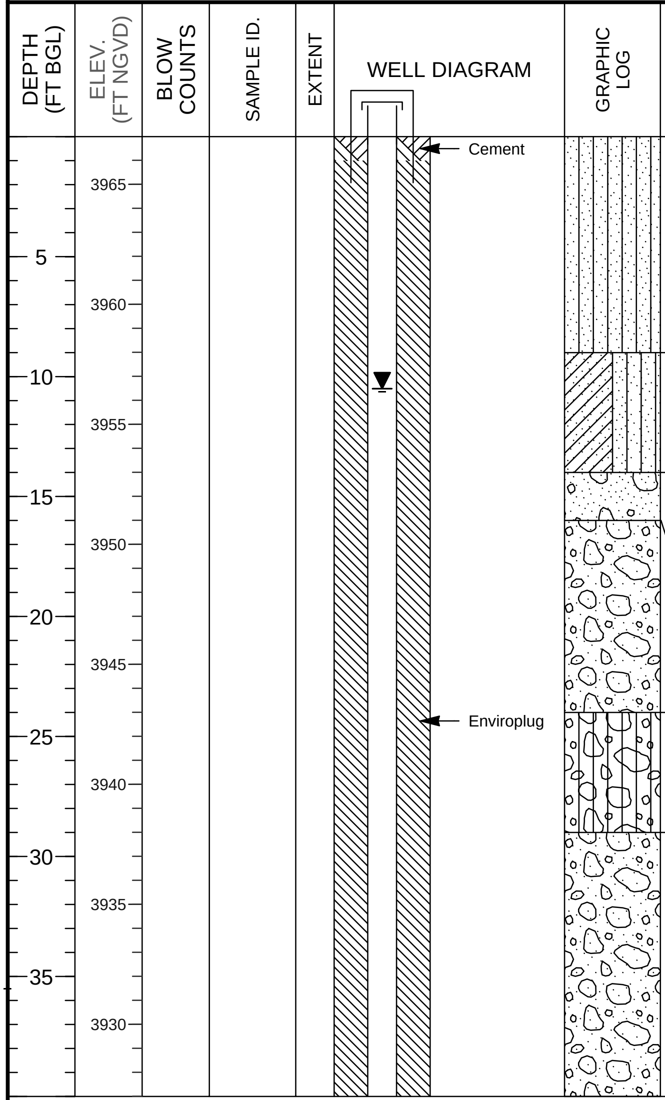
PROJECT MOAB
LOCATION Moab, UT
SITE MOAB
WELL NUMBER 0485

NORTH COORD. (FT) 6663446.91
EAST COORD. (FT) 2186022.10
HOLE DEPTH (FT) 63.00
WELL DEPTH (FT) 60.40

DATE DRILLED 06/22/2003
SURFACE ELEV. (FT NGVD) 3966.99
TOP OF CASING (FT) 3968.81
MEAS. PT. ELEV. (FT) 3968.81
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 9.0 / / 6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-1.82	to	55.6
WELL SCREEN:	4 in. 0.01 Slotted PVC	55.6	to	59.9
SUMP/END CAP:	4 in. PVC Sch 40	59.9	to	60.4
SURFACE SEAL:	Cement	0.0	to	1.0
GROUT:	Enviroplug	0.0	to	47.7
SEAL:				
UPPER PACK:	30-70 Silica Sand	47.7	to	52.0
LOWER PACK:	16-40 Silica Sand	52.0	to	63.0

DRILLING METHOD AIR HAMMER PERCUSSION
SAMPLING METHOD CYCLONE
DATE DEVELOPED 06/26/2003
WATER LEVEL (FT BGS) 10.5 on 06/22/2003
LOGGED BY Pill, K.
REMARKS



LITHOLOGIC DESCRIPTION

0-9.0 ft. SILTY SAND (SM); brown (7.5YR 4/4), fine grained sand, 40% silt/clay, moist.

9.0-14.0 ft. CLAYEY SILT (SC-SM); brown (7.5YR 4/4); 20% fine grained sand, 60% silt, 20% clay, stiff, slightly mottled, moist.

14.0-16.0 ft. GRAVELLY SAND (SP-GP); brown (7.5YR 4/4); fine to coarse grained sand, fine gravel, subrounded to rounded, 10% silt, moist.
@15.0 ft. pine cone wood fragments at 15.0 ft.

16.0-24.0 ft. SANDY GRAVEL (GP-SP); brown (7.5YR 4/4), medium to coarse grained sand, subangular to subrounded gravel, cobbles, wet.

24.0-29.0 ft. SILTY GRAVEL (GM); yellowish red (5YR 4/6), 25% fine to medium grained sand, 30% silt/clay, subrounded to rounded gravel and cobbles, clastic, wet.

29.0-63.0 ft. SANDY GRAVEL (GP-SP); reddish brown (5YR 4/4), medium to coarse grained sand, fine to coarse gravel, 20% subrounded to rounded cobbles, clastic, wet.

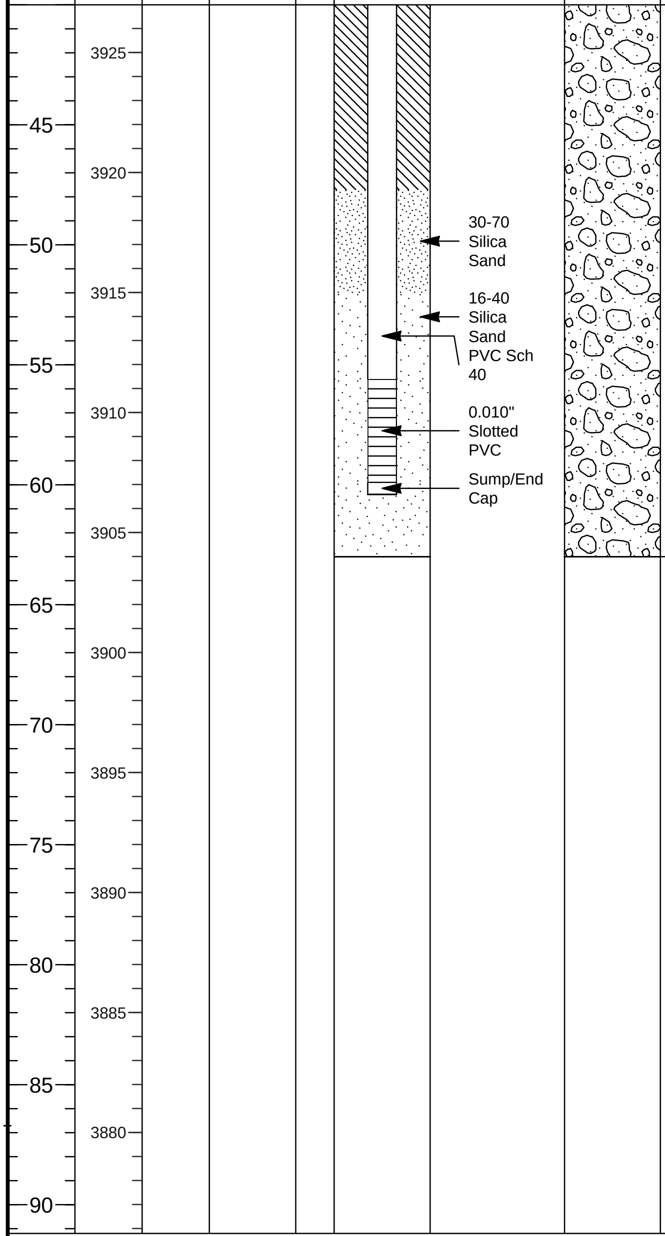
36.0-63.0 ft. color changes to dark gray (10YR 4/1), 30% medium to coarse grained sand, fine to coarse and subangular to rounded gravel 10% clastic cobbles (up to 8.0" in diameter), well rounded, wet.

MONITORING WELL COMPLETION LOG MOA01-0485

PROJECT MOAB
WELL NUMBER 0485
SITE MOAB
DATES DRILLED 06/22/2003

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION



@53.0 ft. no cobbles, slightly finer grained.

Total Depth 63.0 ft.

MONITORING WELL COMPLETION LOG MOA01-0551

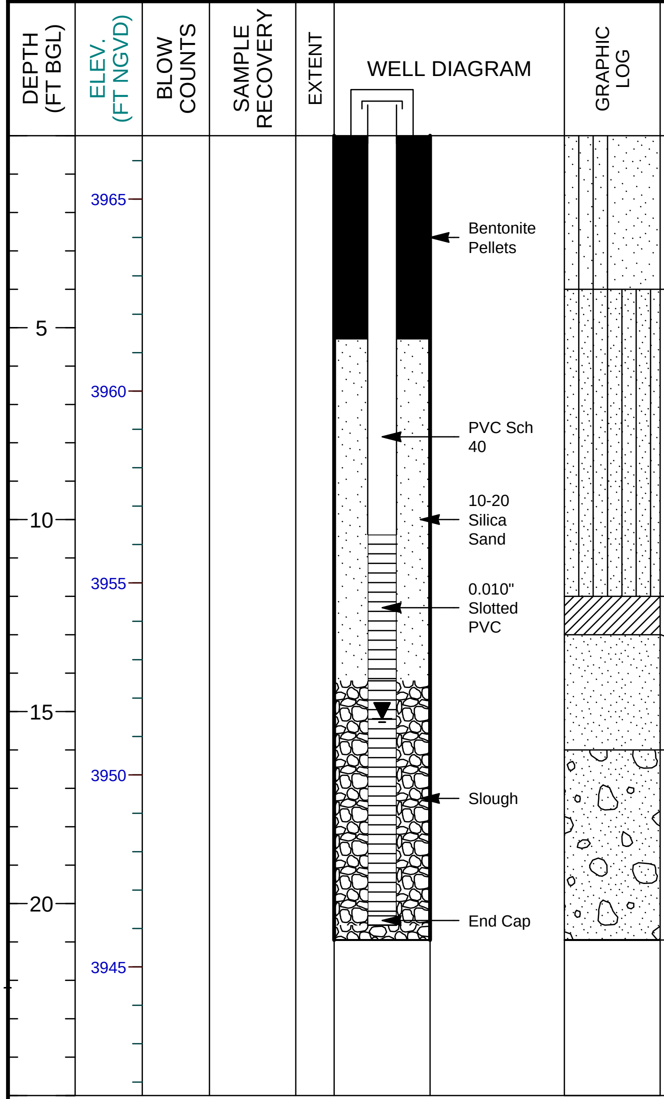
PROJECT MOAB
LOCATION Moab, UT
SITE Moab Disposal Site
DRILLING METHOD GEOPROBE
DRILL COMPANY S.M. Stoller
RIG TYPE GEOPROBE

WELL NUMBER 0551
NORTH COORD. (FT) 6663306.89
EAST COORD. (FT) 2185984.62
HOLE DEPTH (FT) 20.95
WELL DEPTH (FT) 20.56
WATER LEVEL (FT BTOC) 17.21

DATE DRILLED 07/28/2004
SURFACE ELEV. (FT NGVD) 3966.65
TOP OF CASING (FT) 3968.67
MEAS. PT. ELEV. (FT) 3968.67
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 2.13

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:	4 in. PVC Sch 40	-2.05	to	0.0
BLANK CASING:	1 in. PVC Sch 40	-2.02	to	10.39
WELL SCREEN:	1 in. 0.01 Slotted PVC	10.39	to	20.32
SUMP/END CAP:	1 in. PVC Sch 40	20.32	to	20.56
SEAL:	Bentonite Pellets	0.0	to	5.3
UPPER PACK:				
LOWER PACK:	10-20 Silica Sand	5.3	to	14.2

DRILLER Trevino, Joe
LOGGED BY Hopping, B.
SAMPLING METHOD CORE BARREL
DATE DEVELOPED 08/13/2004
REMARKS Lithology from well 0470 was used for the lithology description for this well.



LITHOLOGIC DESCRIPTION

0-4.0 ft. SANDY SILT (ML-SP); strong brown (7.5YR 4/6). 40% sand, fine grained, 60% silt/clay, moist.

4.0-12.0 ft. SILTY SAND (SM); reddish brown (5YR 4/4), 25% silt, ~10% clay, 65% fine sand, moist.

12.0-13.0 ft. CLAY (CL); reddish gray (5YR 5/2), medium stiff, slightly mottled, moist.

13.0-16.0 ft. SAND (SP); reddish brown (5YR 5/2), fine to coarse grained with ~10% fine gravel, rounded, wet.

16.0-20.95 ft. GRAVELLY SAND (SP-GP); brown (7.5YR 4/4), 10% silt/clay, 20% gravel/cobbles fine to coarse, subrounded to well rounded - cobbles are well rounded, 70% fine to coarse sand, wet.

Total Depth 20.95 ft.

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MONITORING WELL COMPLETION LOG MOA01-0552

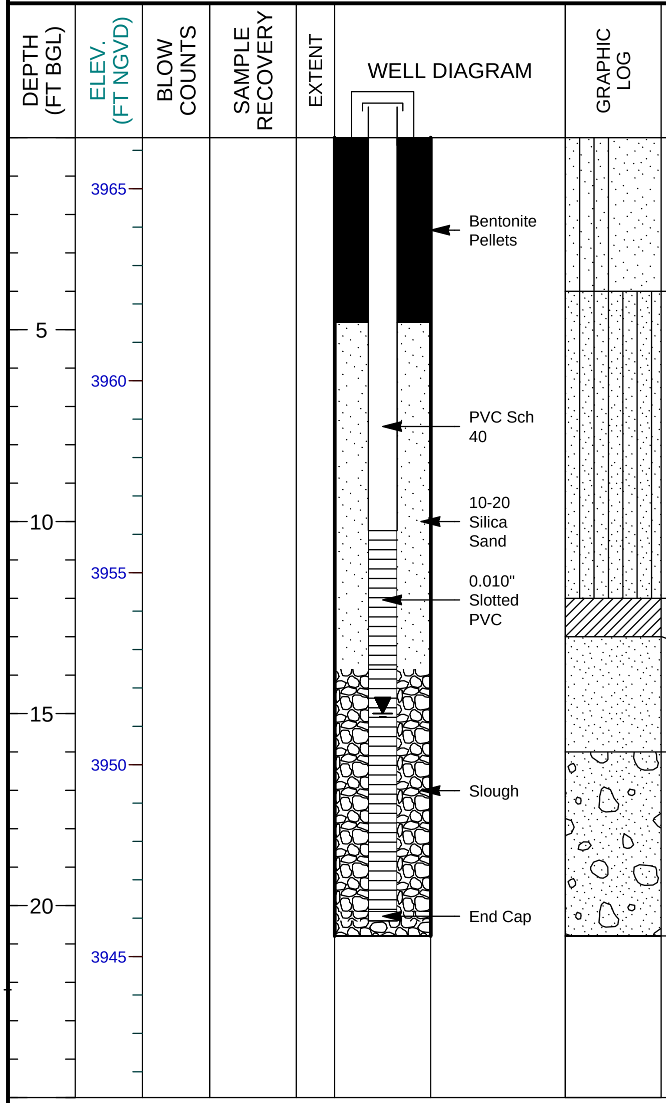
PROJECT MOAB
LOCATION Moab, UT
SITE Moab Disposal Site
DRILLING METHOD GEOPROBE
DRILL COMPANY S.M. Stoller
RIG TYPE GEOPROBE

WELL NUMBER 0552
NORTH COORD. (FT) 6663376.94
EAST COORD. (FT) 2185963.03
HOLE DEPTH (FT) 20.79
WELL DEPTH (FT) 20.40
WATER LEVEL (FT BTOC) 17.07

DATE DRILLED 07/28/2004
SURFACE ELEV. (FT NGVD) 3966.33
TOP OF CASING (FT) 3968.40
MEAS. PT. ELEV. (FT) 3968.40
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 2.13

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:	4 in. PVC Sch 40	-1.93	to	0.0
BLANK CASING:	1 in. PVC Sch 40	-2.07	to	10.23
WELL SCREEN:	1 in. 0.01 Slotted PVC	10.23	to	20.16
SUMP/END CAP:	1 in. PVC Sch 40	20.16	to	20.4
SEAL:	Bentonite Pellets	0.0	to	4.82
UPPER PACK:				
LOWER PACK:	10-20 Silica Sand	4.82	to	13.85

DRILLER Trevino, Joe
LOGGED BY Hopping, B.
SAMPLING METHOD CORE BARREL
DATE DEVELOPED 08/13/2004
REMARKS Lithology from well 0471 was used for the lithology description for this well.



LITHOLOGIC DESCRIPTION

0-4.0 ft. SANDY SILT (ML-SP); strong brown (7.5YR 4/6). 40% sand, fine grained, 60% silt/clay, moist.

4.0-12.0 ft. SILTY SAND (SM); reddish brown (5YR 4/4), 25% silt, ~10% clay, 65% fine sand, moist.

12.0-13.0 ft. CLAY (CL); reddish gray (5YR 5/2), medium stiff, slightly mottled, moist.

13.0-16.0 ft. SAND (SP); reddish brown (5YR 5/2), fine to coarse grained with ~10% fine gravel, rounded, wet.

16.0-20.79 ft. GRAVELLY SAND (SP-GP); brown (7.5YR 4/4), 10% silt/clay, 20% gravel/cobbles fine to coarse, subrounded to well rounded - cobbles are well rounded, 70% fine to coarse sand, wet.

Total Depth 20.79 ft.

MONITORING WELL COMPLETION LOG MOA01-0553

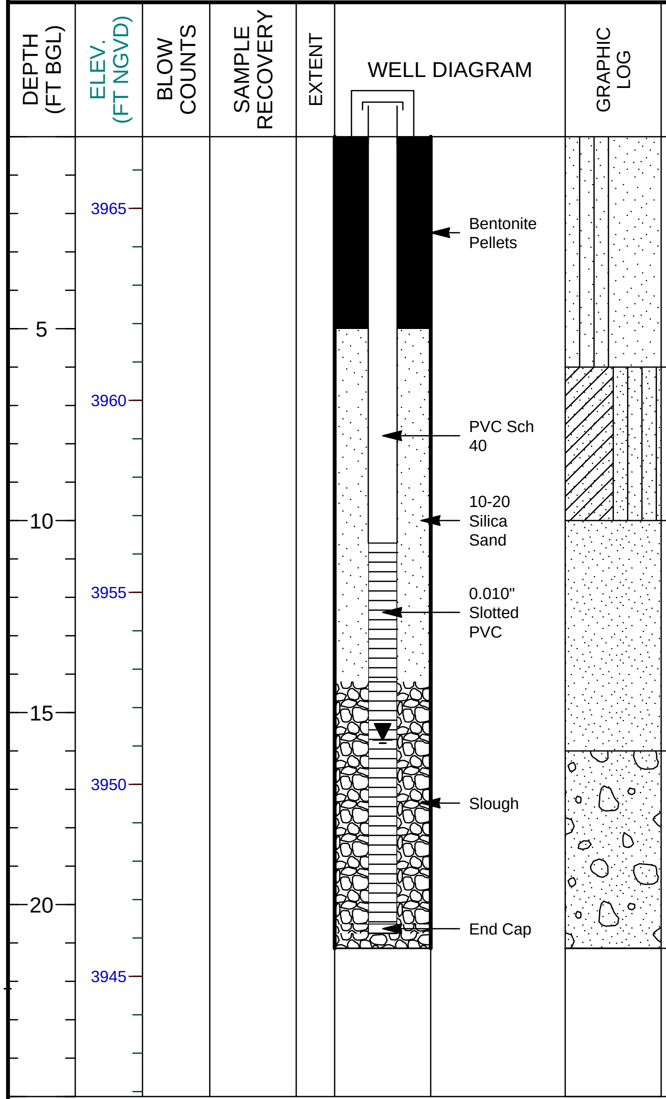
PROJECT MOAB
LOCATION Moab, UT
SITE Moab Disposal Site
DRILLING METHOD GEOPROBE
DRILL COMPANY S.M. Stoller
RIG TYPE GEOPROBE

WELL NUMBER 0553
NORTH COORD. (FT) 6663397.34
EAST COORD. (FT) 2186006.67
HOLE DEPTH (FT) 21.14
WELL DEPTH (FT) 20.75
WATER LEVEL (FT BTOC) 17.72

DATE DRILLED 07/29/2004
SURFACE ELEV. (FT NGVD) 3966.87
TOP OF CASING (FT) 3968.88
MEAS. PT. ELEV. (FT) 3968.88
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 2.13

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:	4 in. PVC Sch 40	-1.89	to	0.0
BLANK CASING:	1 in. PVC Sch 40	-2.01	to	10.58
WELL SCREEN:	1 in. 0.01 Slotted PVC	10.58	to	20.51
SUMP/END CAP:	1 in. PVC Sch 40	20.51	to	20.75
SEAL:	Bentonite Pellets	0.0	to	5.0
UPPER PACK:				
LOWER PACK:	10-20 Silica Sand	5.0	to	14.2

DRILLER Trevino, Joe
LOGGED BY Hopping, B.
SAMPLING METHOD CORE BARREL
DATE DEVELOPED 08/13/2004
REMARKS Lithology from well 0473 was used for the lithology description for this well.



LITHOLOGIC DESCRIPTION

0-6.0 ft. SANDY SILT (ML-SP); dark yellowish brown (10YR 4/4), 30% fine sand, 70% silt/clay, moist.

6.0-10.0 ft. CLAYEY SILT (SC-SM); brown (7.5YR 4/4), 20% clay (stiff), 10% fine sand, 70% silt, moist.

10.0-16.0 ft. SAND (SP); reddish brown (5YR 5/4), fine to coarse grained, clean, wet.

16.0-21.14 ft. GRAVELLY SAND (SP-GP); brown (7.5YR 4/4), 20% gravel, 80% fine to medium grained sand, trace of subangular cobbles, fine to coarse gravel, wet.

Total Depth 21.14 ft.

MONITORING WELL COMPLETION LOG MOA01-0554

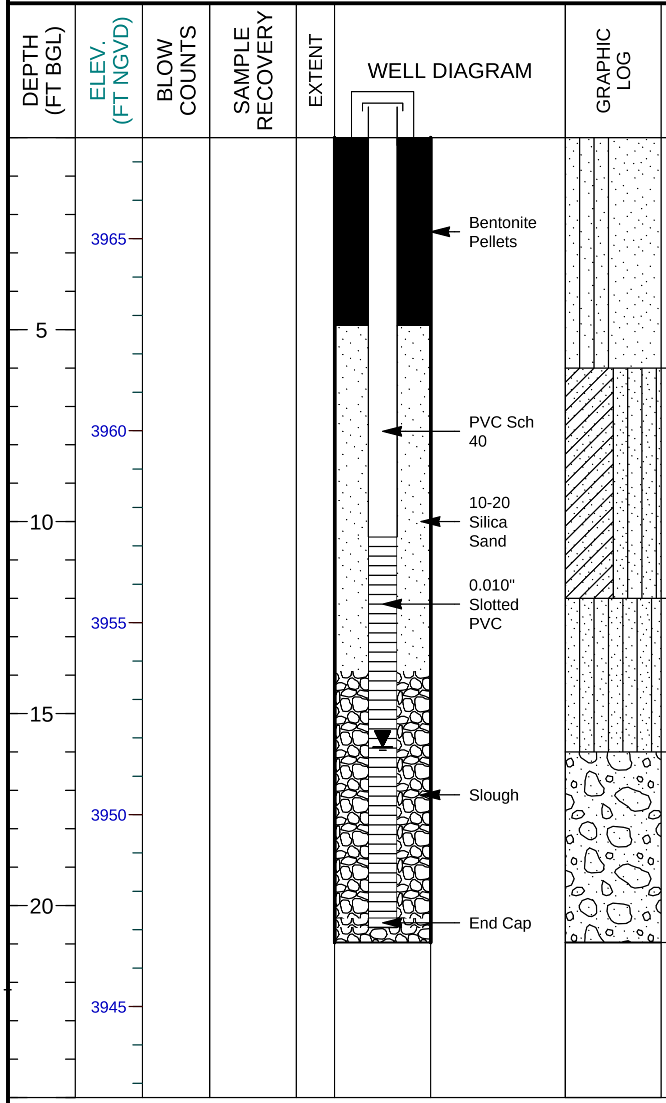
PROJECT MOAB
LOCATION Moab, UT
SITE Moab Disposal Site
DRILLING METHOD GEOPROBE
DRILL COMPANY S.M. Stoller
RIG TYPE GEOPROBE

WELL NUMBER 0554
NORTH COORD. (FT) 6663504.70
EAST COORD. (FT) 2186032.15
HOLE DEPTH (FT) 20.96
WELL DEPTH (FT) 20.57
WATER LEVEL (FT BTOC) 17.58

DATE DRILLED 07/28/2004
SURFACE ELEV. (FT NGVD) 3967.63
TOP OF CASING (FT) 3969.34
MEAS. PT. ELEV. (FT) 3969.34
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 2.13

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:	4 in. PVC Sch 40	-1.87	to	0.0
BLANK CASING:	1 in. PVC Sch 40	-1.71	to	10.4
WELL SCREEN:	1 in. 0.01 Slotted PVC	10.4	to	20.33
SUMP/END CAP:	1 in. PVC Sch 40	20.33	to	20.57
SEAL:	Bentonite Pellets	0.0	to	4.9
UPPER PACK:				
LOWER PACK:	10-20 Silica Sand	4.9	to	13.9

DRILLER Trevino, Joe
LOGGED BY Hopping, B.
SAMPLING METHOD CORE BARREL
DATE DEVELOPED 08/13/2004
REMARKS Lithology from well 0477 was used for the lithology description for this well.



LITHOLOGIC DESCRIPTION

0-6.0 ft. SANDY SILT (ML-SP); brown (7.5YR 4/4), 40% sand, fine grained, 60% silt/clay, moist.

6.0-12.0 ft. CLAYEY SILT (SC-SM); brown (7.5YR 4/4), 20% fine sand, 60% silt, 20% clay,stiff, moist.

12.0-16.0 ft. SILTY SAND (SM); dark brown (7.5YR 3/4), fine to coarse grained sand, 10% fine gravel, 15% silt, wet.

16.0-20.96 ft. SANDY GRAVEL (GP-SP); gravel, brown (7.5YR 4/4), 15% silt, 25% sand, fine to coarse grained, 10% cobbles, subrounded to rounded, wet.

Total Depth 20.96 ft.

MONITORING WELL COMPLETION LOG MOA01-0555

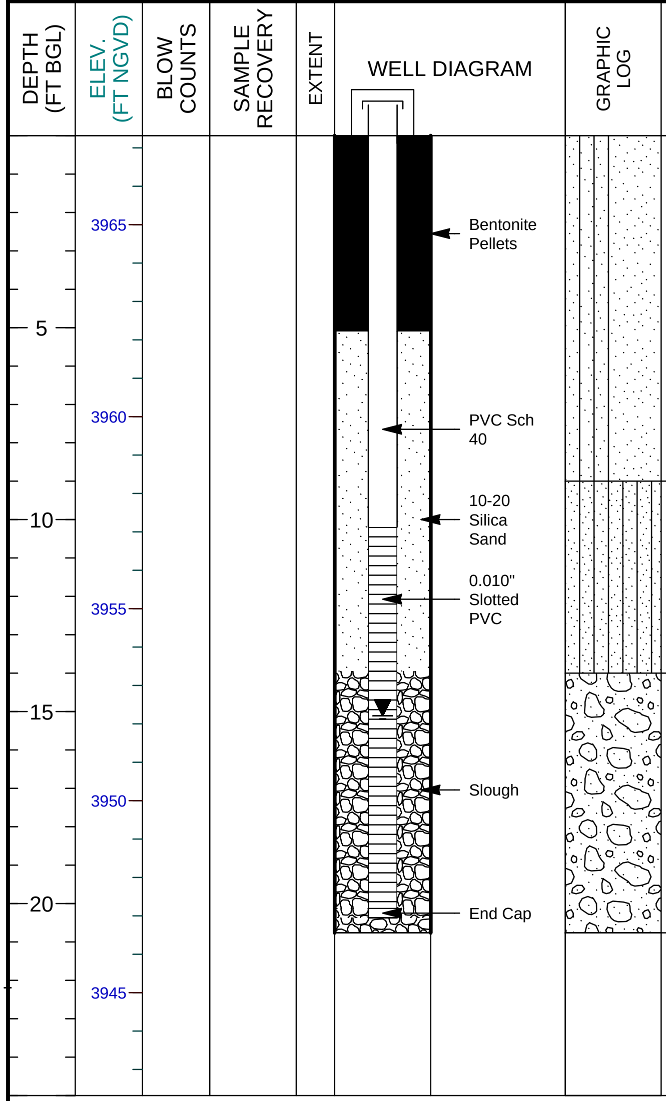
PROJECT MOAB
LOCATION Moab, UT
SITE Moab Disposal Site
DRILLING METHOD GEOPROBE
DRILL COMPANY S.M. Stoller
RIG TYPE GEOPROBE

WELL NUMBER 0555
NORTH COORD. (FT) 6663553.79
EAST COORD. (FT) 2185988.55
HOLE DEPTH (FT) 20.76
WELL DEPTH (FT) 20.37
WATER LEVEL (FT BTOC) 17.1

DATE DRILLED 07/28/2004
SURFACE ELEV. (FT NGVD) 3967.32
TOP OF CASING (FT) 3969.31
MEAS. PT. ELEV. (FT) 3969.31
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 2.13

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:	4 in. PVC Sch 40	-2.07	to	0.0
BLANK CASING:	1 in. PVC Sch 40	-1.99	to	10.2
WELL SCREEN:	1 in. 0.01 Slotted PVC	10.2	to	20.13
SUMP/END CAP:	1 in. PVC Sch 40	20.13	to	20.37
SEAL:	Bentonite Pellets	0.0	to	5.1
UPPER PACK:				
LOWER PACK:	10-20 Silica Sand	5.1	to	13.95

DRILLER Trevino, Joe
LOGGED BY Hopping, B.
SAMPLING METHOD CORE BARREL
DATE DEVELOPED 08/13/2004
REMARKS Lithology from well 0478 was used for the lithology description for this well.



LITHOLOGIC DESCRIPTION

0-9.0 ft. SANDY SILT (ML-SP);. brown (7.5YR 4/4), 40% fine grained sand, 60% silt/clay, moist.

9.0-14.0 ft. SILTY SAND (SM); brown (7.5YR 4/4), 70% fine to medium grained sand, 30% silt/clay.

14.0-20.76 ft. SANDY GRAVEL (GP-SP); dark red brown (5YR 3/4), medium to coarse grained sand, rounded to subrounded gravel, trace of cobbles, wet.

Total Depth 20.76 ft.

Stoller

U.S. DEPARTMENT OF ENERGY
GRAND JUNCTION OFFICE, COLORADO

11/16/2004

MONITORING WELL COMPLETION LOG MOA01-0556

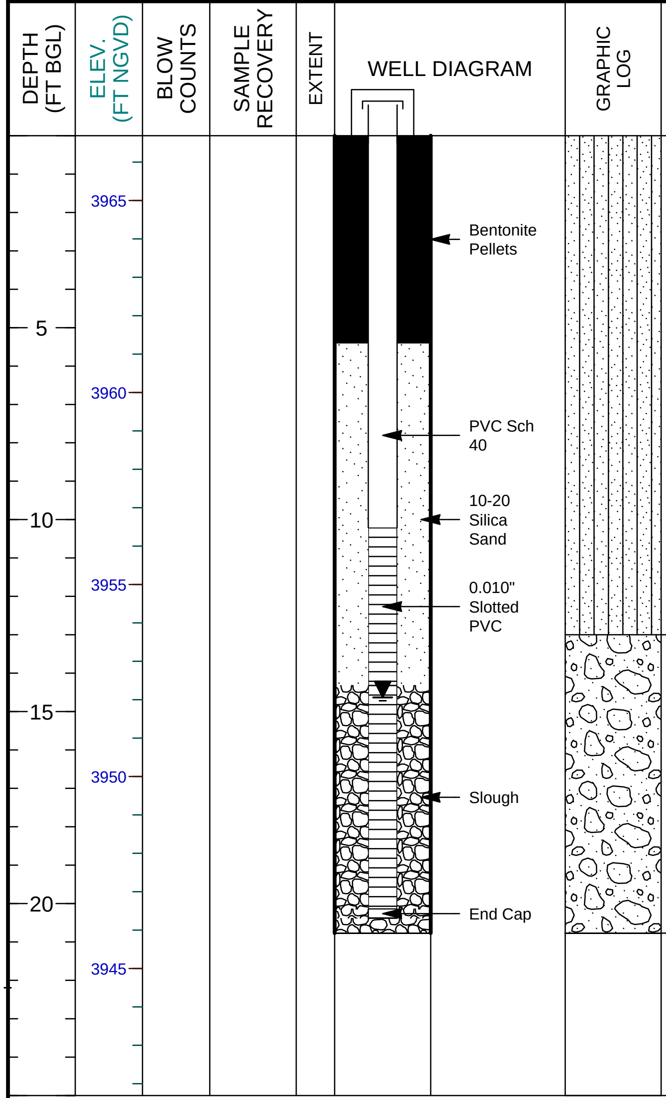
PROJECT MOAB
LOCATION Moab, UT
SITE Moab Disposal Site
DRILLING METHOD GEOPROBE
DRILL COMPANY S.M. Stoller
RIG TYPE GEOPROBE

WELL NUMBER 0556
NORTH COORD. (FT) 6663589.24
EAST COORD. (FT) 2186023.54
HOLE DEPTH (FT) 20.77
WELL DEPTH (FT) 20.38
WATER LEVEL (FT BTOC) 16.55

DATE DRILLED 07/27/2004
SURFACE ELEV. (FT NGVD) 3966.69
TOP OF CASING (FT) 3968.61
MEAS. PT. ELEV. (FT) 3968.61
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 2.13

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:	4 in. PVC Sch 40	-2.21	to	0.0
BLANK CASING:	1 in. PVC Sch 40	-1.92	to	10.21
WELL SCREEN:	1 in. 0.01 Slotted PVC	10.21	to	20.14
SUMP/END CAP:	1 in. PVC Sch 40	20.14	to	20.38
SEAL:	Bentonite Pellets	0.0	to	5.41
UPPER PACK:				
LOWER PACK:	10-20 Silica Sand	5.41	to	14.32

DRILLER Trevino, Joe
LOGGED BY Hopping, B.
SAMPLING METHOD CORE BARREL
DATE DEVELOPED 08/13/2004
REMARKS Lithology from well 0479 was used for the lithology description for this well.



LITHOLOGIC DESCRIPTION

0-13.0 ft. SILTY SAND (SM); brown (7.5YR 4/4), 80% fine to medium grained sand, 20% silt/clay, moist.

9.0-13.0 ft. color changes to reddish brown (5YR 4/4), sand is more coarse, and less silt/clay (10%).

13.0-20.77 ft. SANDY GRAVEL (GP-SP); dark reddish brown (5YR 3/4), medium to coarse grained sand, subrounded to rounded gravel, trace of silt and cobbles, wet.

Total Depth 20.77 ft.

Stoller

U.S. DEPARTMENT OF ENERGY
GRAND JUNCTION OFFICE, COLORADO

MONITORING WELL COMPLETION LOG MOA01-0557

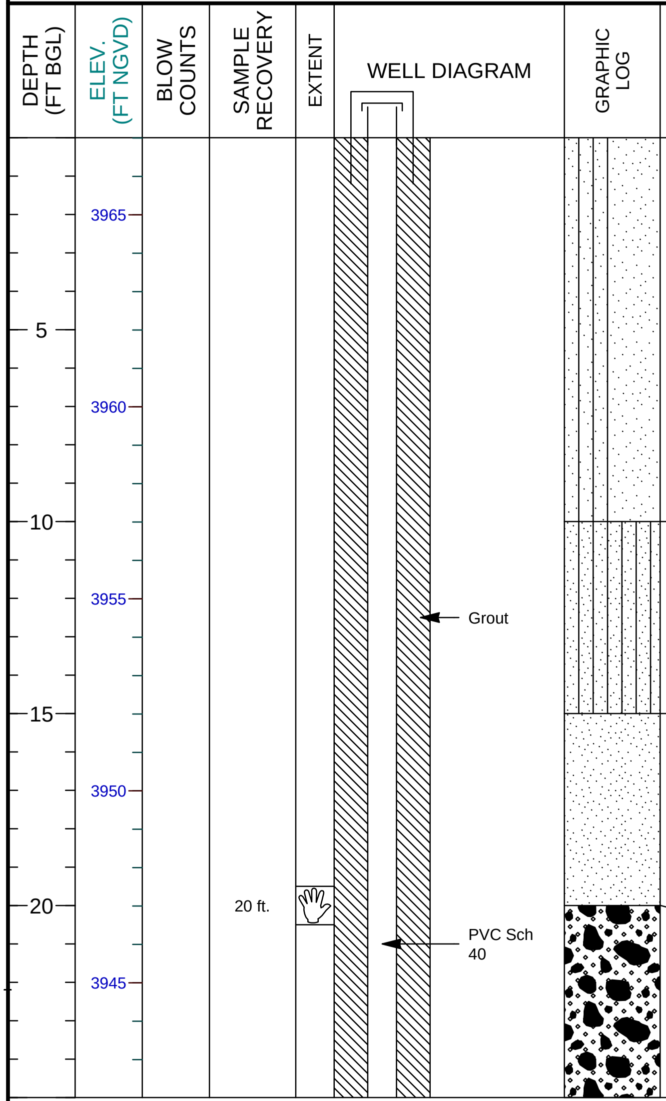
PROJECT MOAB
LOCATION Moab, UT
SITE Moab Disposal Site
DRILLING METHOD AIR PERCUSSION
DRILL COMPANY Layne Christensen Co
RIG TYPE AP 1000

WELL NUMBER 0557
NORTH COORD. (FT) 6663451.18
EAST COORD. (FT) 2185971.51
HOLE DEPTH (FT) 50.00
WELL DEPTH (FT) 45.30
WATER LEVEL (FT BGS)

DATE DRILLED 07/17/2004 to 07/18/2004
SURFACE ELEV. (FT NGVD) 3967.01
TOP OF CASING (FT) 3968.85
MEAS. PT. ELEV. (FT) 3968.85
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 12.5

	WELL INSTALLATION	INTERVAL (FT)		
BLANK CASING:	6 in. PVC Sch 40	-1.84	to	35.0
WELL SCREEN:	6 in. Machine Slotted PVC	35.0	to	45.0
SUMP/END CAP:	6 in. PVC Sch 40	45.0	to	45.3
GROUT:	Grout	0.0	to	25.0
SEAL:	Bentonite Chips	25.0	to	29.5
UPPER PACK:	30-70 Silica Sand	29.5	to	32.5
LOWER PACK:	16-40 Silica Sand	32.5	to	50.0

DRILLER Kern, T
LOGGED BY Karp, K.
SAMPLING METHOD CYCLONE- 5.0 ft. intervals
DATE DEVELOPED
REMARKS



LITHOLOGIC DESCRIPTION

0-10.0 ft. SANDY SILT (ML-SP); very fine sand (ML), dark yellowish brown (10YR 4/4), dry, calcareous.

10.0-15.0 ft. SILTY SAND (SM); subrounded to angular, 50% silt, 50% fine sand, poorly sorted, light brown (7.5YR 6/4), moist.

15.0-20.0 ft. SAND (SP); fine to medium grained, subrounded to angular, wet, trace clay, trace of subrounded pebbles up to 1.0" in diameter, brown (7.5YR 4/4).

@20.0 ft. large root fragment.

20.0-50.0 ft. SANDY GRAVEL (GW-SW); subrounded pebbles and cobbles (80%) up to 3.0" in diameter. Fine to medium grained sand matrix (20%).

MONITORING WELL COMPLETION LOG MOA01-0557

PROJECT MOAB
WELL NUMBER 0557
SITE Moab Disposal Site
DATES DRILLED 07/17/2004 to 07/18/2004

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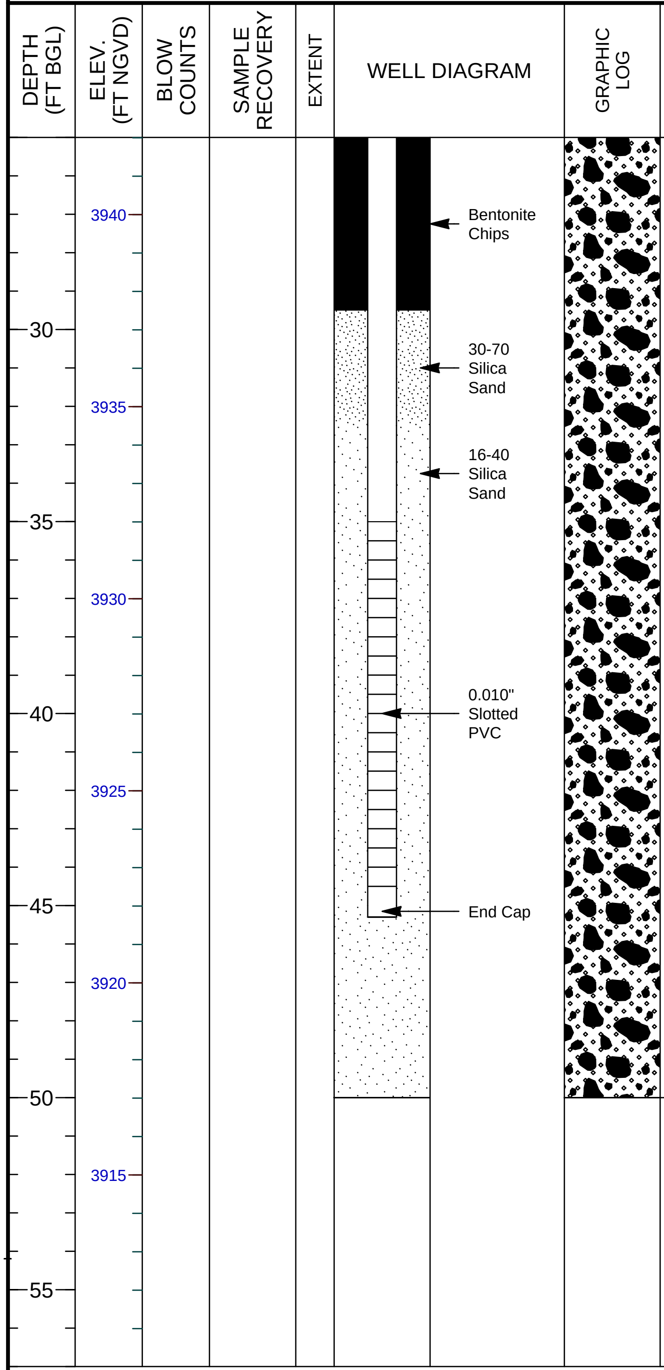


LITHOLOGIC DESCRIPTION

25.0-30.0 ft. larger cobbles up to 6.0" in diameter.

30.0-35.0 ft. poorly sorted gravel, mostly pebbles and cobbles up to 6.0" in diameter.

35.0-40.0 ft. less pebbles and cobbles (70%) and more medium sand (30%).

40.0-45.0 ft. poorly sorted gravel, mostly pebbles and cobbles up to 6.0" in diameter.

45.0-50.0 ft. less pebbles and cobbles (70%) and more medium sand (30%).

Total Depth 50.0 ft.

MONITORING WELL COMPLETION LOG MOA01-0558

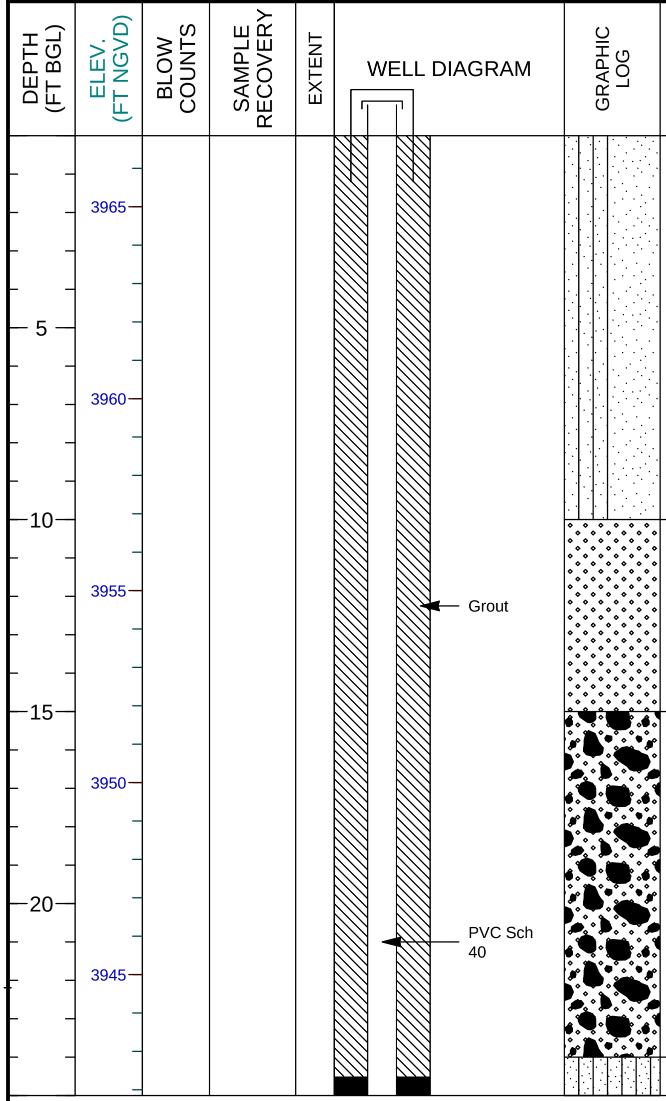
PROJECT MOAB
LOCATION Moab, UT
SITE Moab Disposal Site
DRILLING METHOD AIR PERCUSSION
DRILL COMPANY Layne Christensen Co
RIG TYPE AP 1000

WELL NUMBER 0558
NORTH COORD. (FT) 6663455.01
EAST COORD. (FT) 2186026.70
HOLE DEPTH (FT) 50.00
WELL DEPTH (FT) 45.00
WATER LEVEL (FT BGS)

DATE DRILLED 07/17/2004
SURFACE ELEV. (FT NGVD) 3966.85
TOP OF CASING (FT) 3968.79
MEAS. PT. ELEV. (FT) 3968.79
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 12.5

	WELL INSTALLATION	**INTERVAL (FT)**		
BLANK CASING:	6 in. PVC Sch 40	-1.94	to	35.0
WELL SCREEN:	6 in. Machine Slotted PVC	35.0	to	45.0
SUMP/END CAP:	6 in. PVC Sch 40	45.0	to	45.3
GROUT:	Grout	0.0	to	24.5
SEAL:	Bentonite Chips	24.5	to	29.5
UPPER PACK:	30-70 Silica Sand	29.5	to	32.5
LOWER PACK:	16-40 Silica Sand	32.5	to	50.0

DRILLER Kern, T
LOGGED BY Karp, K.
SAMPLING METHOD CYCLONE- 5.0 ft. intervals
DATE DEVELOPED
REMARKS



LITHOLOGIC DESCRIPTION

0-10.0 ft. SANDY SILT (ML-SP); very fine sand, brown (7.5YR 5/4), dry, calcareous.

5.0-10.0 ft. slightly damp, calcareous, trace of clay.

10.0-15.0 ft. SAND (SW); moslty medium grained, subrounded to angular, and trace of pebbles up to 1/2" in diameter, poorly sorted, light reddish brown (2.5YR 6/4), damp.

15.0-24.0 ft. SANDY GRAVEL (GW-SW); cobbles up to 6.0" in diameter, mostly gravel, damp, brown (7.5YR 5/4).

24.0-25.0 ft. SILT (ML), reddish brown (7.5YR 4/4), well sorted,

MONITORING WELL COMPLETION LOG MOA01-0558

PROJECT MOAB

SITE Moab Disposal Site

WELL NUMBER 0558

DATES DRILLED 07/17/2004

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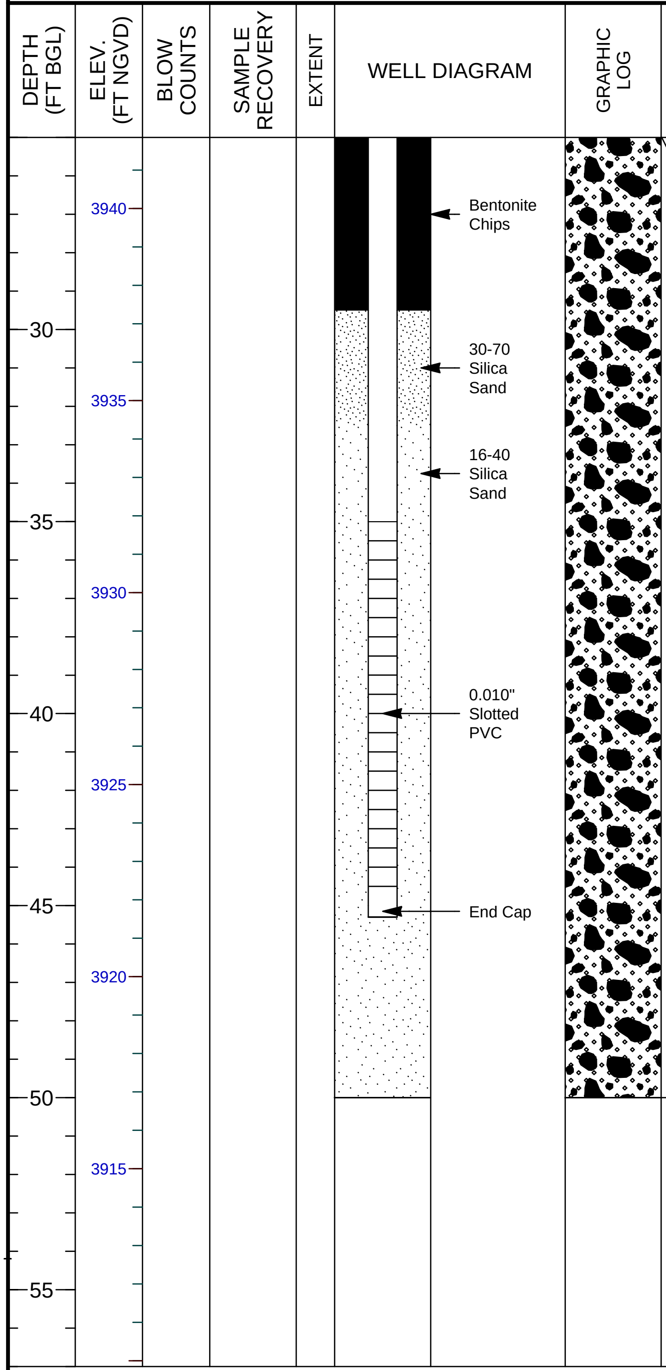


LITHOLOGIC DESCRIPTION

calcareous, subrounded, wet.

25.0-50.0 ft. SANDY GRAVEL (GW-SW); cobbles up to 3.0" long axis, brown (7.3YR 5/4).

30.0-40.0 ft. 80% gravel, slightly more sand, mostly medium grained.

Total Depth 50.0 ft.

MONITORING WELL COMPLETION LOG MOA01-0559

PROJECT	MOAB	**WELL NUMBER**	0559	**DATE DRILLED**	07/28/2004
LOCATION	Moab, UT	**NORTH COORD. (FT)**	6663441.98	**SURFACE ELEV. (FT NGVD)**	3967.84
SITE	Moab Disposal Site	**EAST COORD. (FT)**	2186073.67	**TOP OF CASING (FT)**	3969.92
DRILLING METHOD	GEOPROBE	**HOLE DEPTH (FT)**	21.08	**MEAS. PT. ELEV. (FT)**	3969.92
DRILL COMPANY	S.M. Stoller	**WELL DEPTH (FT)**	20.69	**SLOT SIZE (IN)**	0.010
RIG TYPE	GEOPROBE	**WATER LEVEL (FT BTOC)**	18.2	**BIT SIZE(S) (IN)**	2.13

	WELL INSTALLATION	**INTERVAL (FT)**		
SURFACE CASING:	4 in. PVC Sch 40	-1.91	to	0.0
BLANK CASING:	1 in. PVC Sch 40	-2.08	to	10.52
WELL SCREEN:	1 in. 0.01 Slotted PVC	10.52	to	20.45
SUMP/END CAP:	1 in. PVC Sch 40	20.45	to	20.69
SEAL:	Bentonite Pellets	0.0	to	5.0
UPPER PACK:				
LOWER PACK:	10-20 Silica Sand	5.0	to	14.2

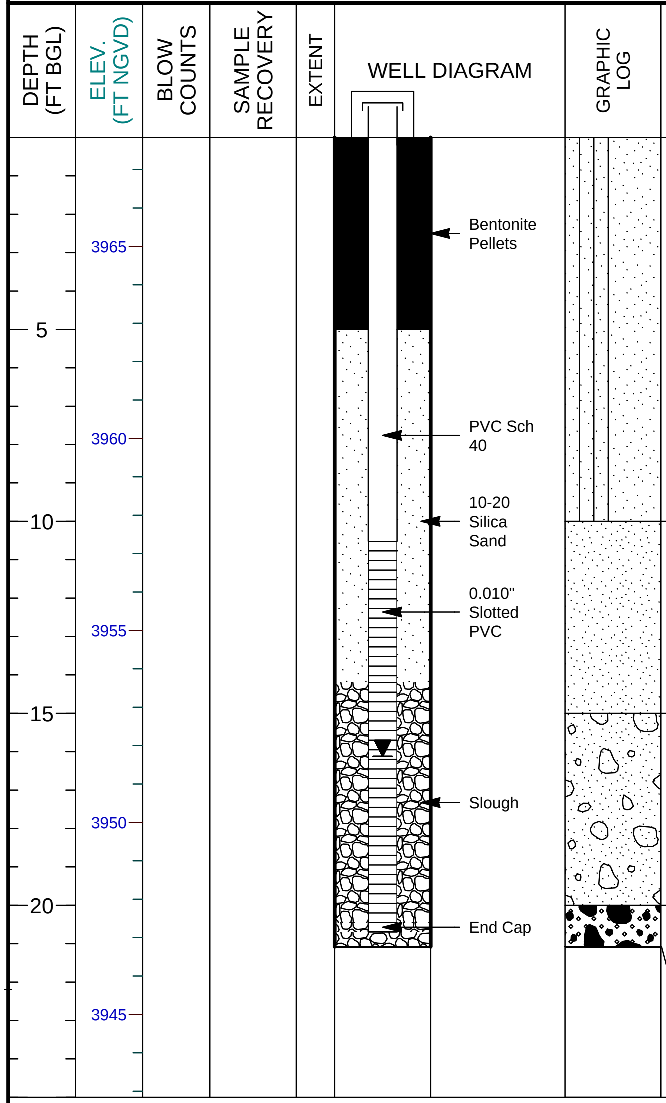
DRILLER Trevino, Joe

LOGGED BY Hopping, B.

SAMPLING METHOD CORE BARREL

DATE DEVELOPED 08/13/2004

REMARKS Lithology from well 0560 was used for the lithology description for this well.



LITHOLOGIC DESCRIPTION

0-10.0 ft. SANDY SILT (ML-SP); brown (7.5YR 5/3), dry, mostly silt (80%), some very fine grained sand, calcareous, well rounded, trace mica.

5.0-10.0 ft. slightly damp, with trace clay, some mottling. Very fine grained sand increasing, calcareous.

10.0-15.0 ft. SAND (SP); fine to medium grained, damp, reddish brown (5YR 5/4), pebbles up to 3.0" in diameter, calcareous.

15.0-20.0 ft. GRAVELLY SAND (SP-GP); sand (80%) is medium to fine grained, well to subrounded, cobbles (20%) up to 3.0" in diameter axis, calcareous, moist, brown (7.5YR 4/4).

20.0-21.08 ft. SANDY GRAVEL (GW-SW); mostly subrounded to well rounded gravel and cobbles (up to 6.0" in diameter), fine to medium grained sand matrix (~25%), wet, calcareous, brown (7.5YR 4/3).

Total Depth 21.08 ft.

Stoller

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GRAND JUNCTION OFFICE, COLORADO

MONITORING WELL COMPLETION LOG MOA01-0560

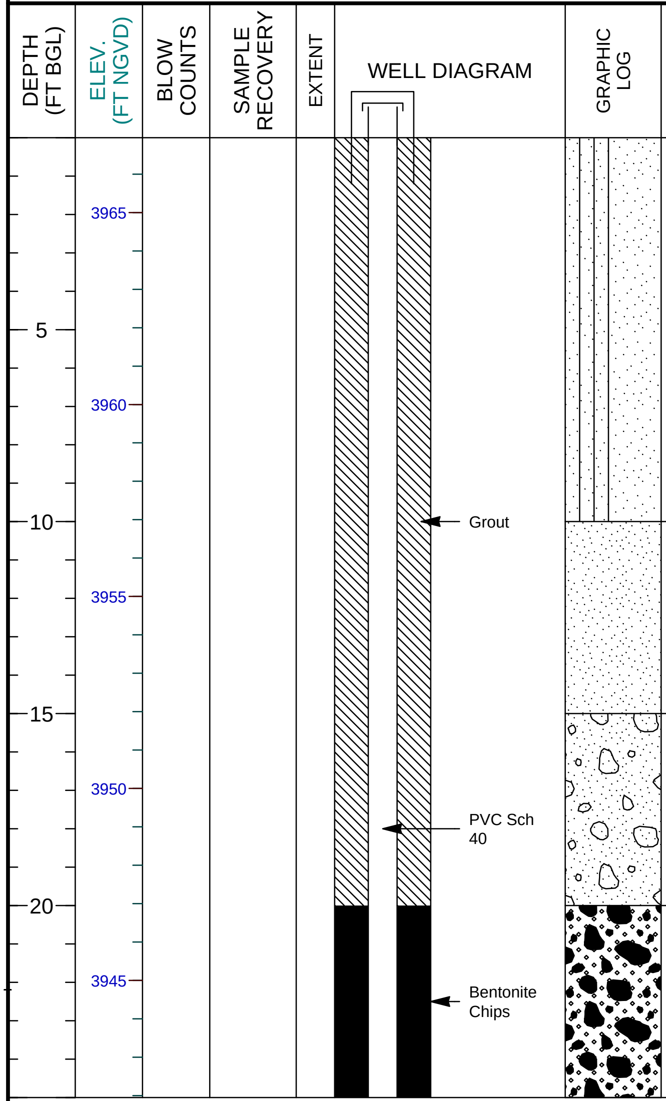
PROJECT MOAB
LOCATION Moab, UT
SITE Moab Disposal Site
DRILLING METHOD AIR PERCUSSION
DRILL COMPANY Layne Christensen Co
RIG TYPE AP 1000

WELL NUMBER 0560
NORTH COORD. (FT) 6663438.74
EAST COORD. (FT) 2186065.27
HOLE DEPTH (FT) 45.00
WELL DEPTH (FT) 40.30
WATER LEVEL (FT BGS)

DATE DRILLED 07/16/2004
SURFACE ELEV. (FT NGVD) 3966.95
TOP OF CASING (FT) 3968.77
MEAS. PT. ELEV. (FT) 3968.77
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 12.5

	WELL INSTALLATION	INTERVAL (FT)		
BLANK CASING:	6 in. PVC Sch 40	-1.82	to	30.0
WELL SCREEN:	6 in. Machine Slotted PVC	30.0	to	40.0
SUMP/END CAP:	6 in. PVC Sch 40	40.0	to	40.3
GROUT:	Grout	0.0	to	20.0
SEAL:	Bentonite Chips	20.0	to	25.0
UPPER PACK:	30-70 Silica Sand	25.0	to	28.0
LOWER PACK:	16-40 Silica Sand	28.0	to	45.0

DRILLER Kern, T
LOGGED BY Karp, K.
SAMPLING METHOD CYCLONE- 5.0 ft. intervals
DATE DEVELOPED
REMARKS



LITHOLOGIC DESCRIPTION

0-10.0 ft. SANDY SILT (ML-SP); brown (7.5YR 5/3), dry, mostly silt (80%), some very fine grained sand, calcareous, well rounded, trace mica.

5.0-10.0 ft. slightly damp, with trace clay, some mottling. Very fine grained sand increasing, calcareous.

10.0-15.0 ft. SAND (SP); fine to medium grained, damp, reddish brown (5YR 5/4), pebbles up to 3.0" in diameter, calcareous.

15.0-20.0 ft. GRAVELLY SAND (SP-GP); sand (80%) is medium to fine grained, well to subrounded, cobbles (20%) up to 3.0" in diameter axis, calcareous, moist, brown (7.5YR 4/4).

20.0-35.0 ft. SANDY GRAVEL (GW-SW); mostly subrounded to well rounded gravel and cobbles (up to 6.0" in diameter), fine to medium grained sand matrix (~25%), wet, calcareous, brown (7.5YR 4/3).

MONITORING WELL COMPLETION LOG MOA01-0560

PROJECT MOAB
WELL NUMBER 0560
SITE Moab Disposal Site
DATES DRILLED 07/16/2004

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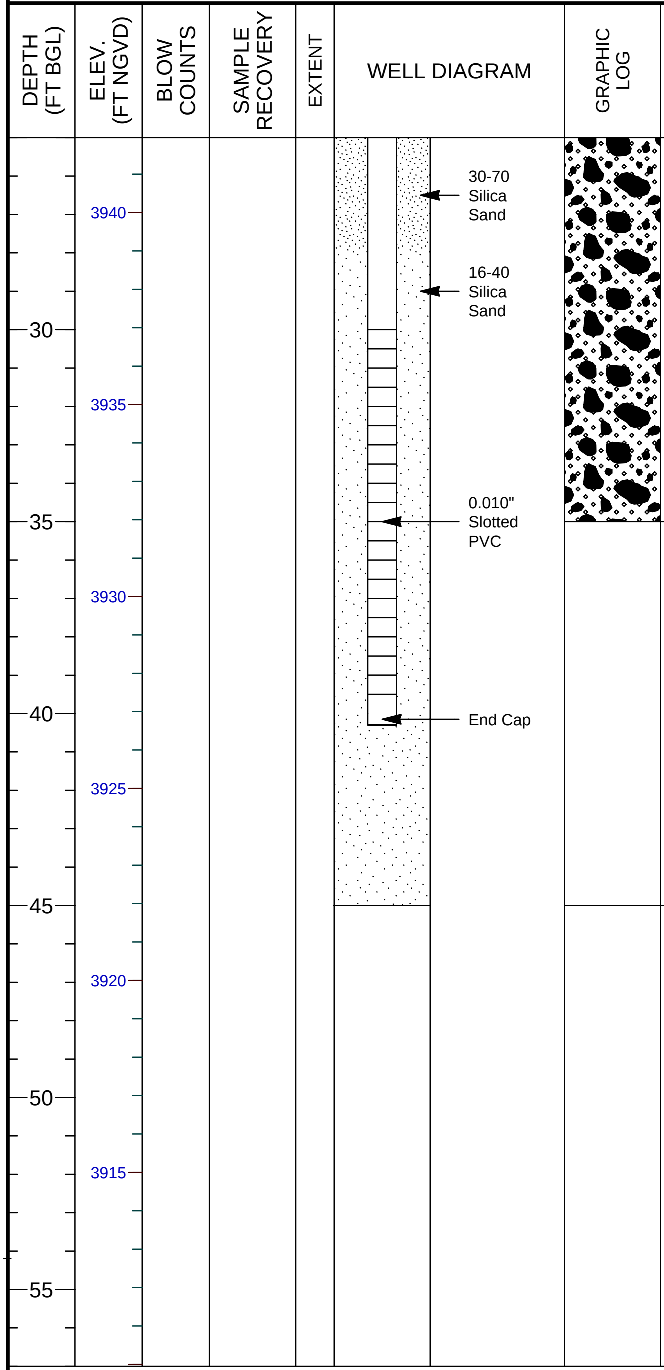


LITHOLOGIC DESCRIPTION

25.0-30.0 ft. more sand, medium grained (30-40%).

30.0-35.0 ft. less sandy matrix (20%), gravel and cobbles (80%), calcareous, color change to dark grayish brown (2.5Y 4/2), wet, light gray when dry (10YR 7/1).

35.0-45.0 ft. No recovery.

Total Depth 45.0 ft.

MONITORING WELL COMPLETION LOG MOA01-0561

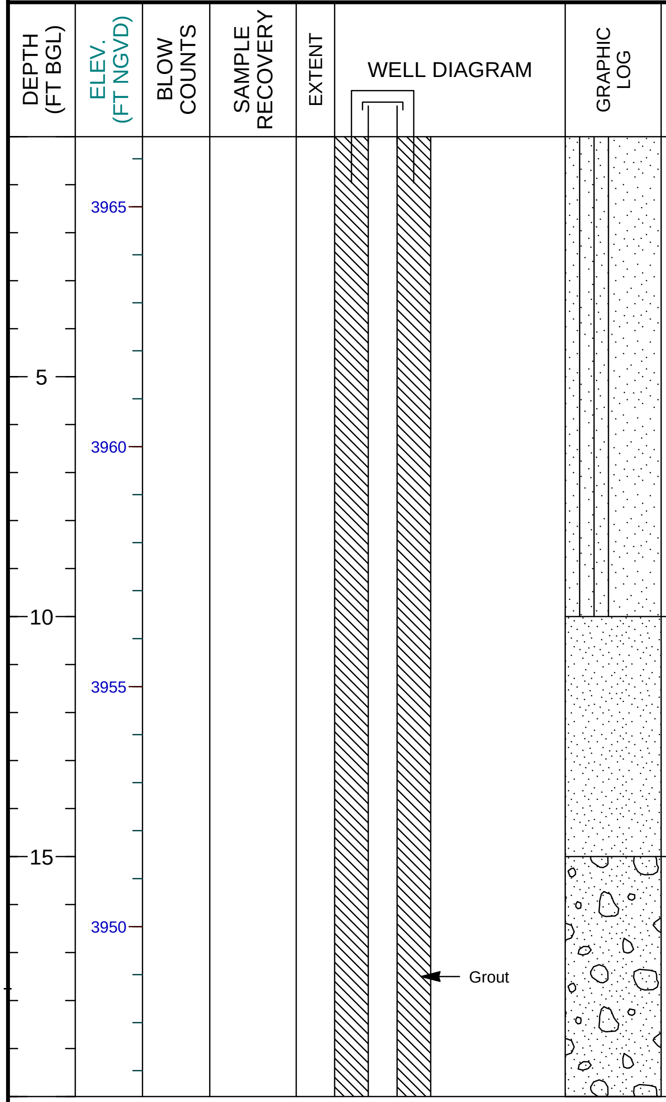
PROJECT MOAB
LOCATION Moab, UT
SITE Moab Disposal Site
DRILLING METHOD AIR PERCUSSION
DRILL COMPANY Layne Christensen Co
RIG TYPE AP 1000

WELL NUMBER 0561
NORTH COORD. (FT) 6663448.20
EAST COORD. (FT) 2186067.44
HOLE DEPTH (FT) 60.00
WELL DEPTH (FT) 55.50
WATER LEVEL (FT BGS)

DATE DRILLED 07/15/2004 to 07/16/2004
SURFACE ELEV. (FT NGVD) 3966.46
TOP OF CASING (FT) 3968.56
MEAS. PT. ELEV. (FT) 3968.56
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 12.5

	WELL INSTALLATION	INTERVAL (FT)		
BLANK CASING:	6 in. PVC Sch 40	-2.1	to	45.2
WELL SCREEN:	6 in. Machine Slotted PVC	45.2	to	55.2
SUMP/END CAP:	6 in. PVC Sch 40	55.2	to	55.5
GROUT:	Grout	0.0	to	35.0
SEAL:	Bentonite Chips	35.0	to	40.0
UPPER PACK:	30-70 Silica Sand	40.0	to	43.0
LOWER PACK:	16-40 Silica Sand	43.0	to	60.0

DRILLER Kern, T
LOGGED BY Goodknight, C.
SAMPLING METHOD CYCLONE- 5.0 ft. intervals
DATE DEVELOPED
REMARKS



LITHOLOGIC DESCRIPTION

0-10.0 ft. SANDY SILT (ML-SP); brown (7.5YR 5/3), dry, mostly silt with some very fine grained sand, calcareous.

5.0-10.0 ft. slightly damp, with trace clay, some mottling, very fine grained sand increasing, calcareous.

10.0-15.0 ft. SAND (SP); fine to medium grained sand, damp, reddish brown (5YR 5/4), trace pebbles up to 1/2" in diameter, calcareous.

15.0-20.0 ft. GRAVELLY SAND (SP-GP); sand is medium to fine grained (80%), well to subrounded pebbles and cobbles up to 3.0" in diameter (~20%), calcareous, moist, brown (7.5YR 4/4).

Stoller

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MONITORING WELL COMPLETION LOG MOA01-0561

PROJECT MOAB
WELL NUMBER 0561
SITE Moab Disposal Site
DATES DRILLED 07/15/2004 to 07/16/2004

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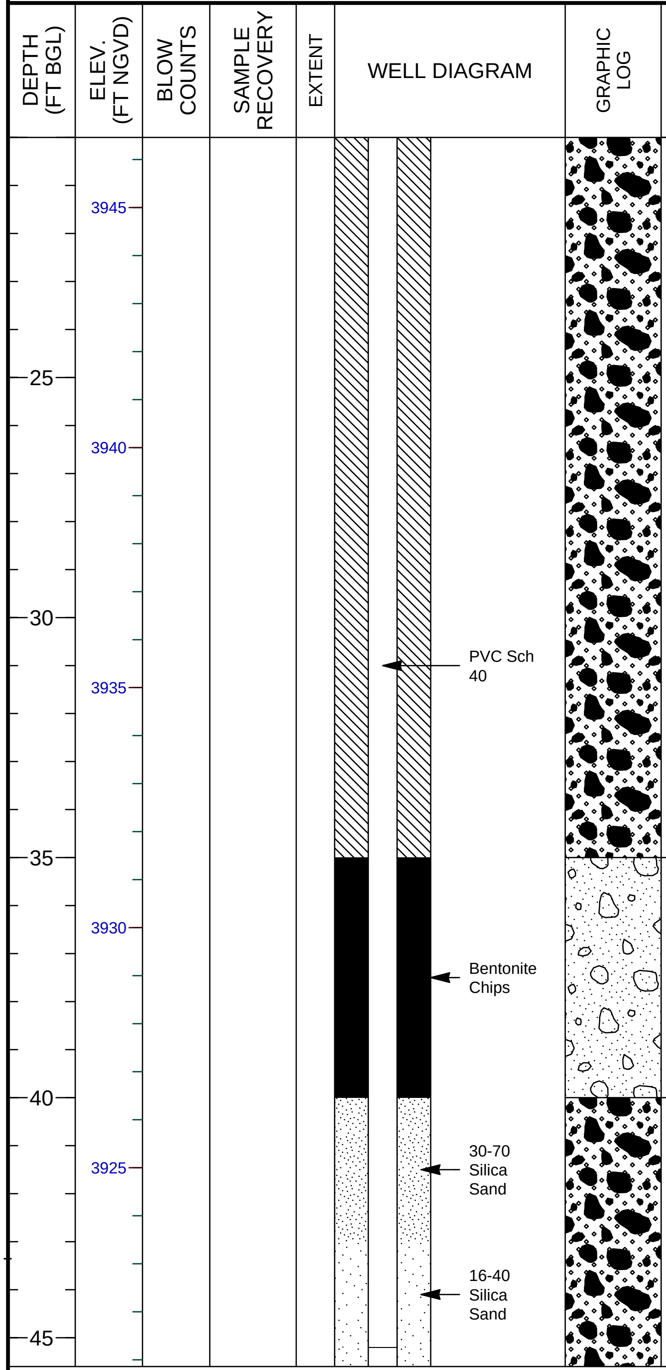

LITHOLOGIC DESCRIPTION

20.0-35.0 ft. SANDY GRAVEL (GW-SW); mostly subrounded to well rounded gravel and cobbles (up to 6.0" in diameter), and fine to medium grained sand matrix (~25%), wet, calcareous, brown (7.5YR 4/3).

25.0-30.0 ft. more sand, mainly medium grained (30-40%).

30.0-35.0 ft. less sandy matrix, ~80% gravel and cobbles, calcareous.

35.0-40.0 ft. GRAVELLY SAND (SP-GP); mostly fine grained sand, brown (7.5YR 4/2), sand (~ 60%), pebbles and cobbles (~40%) up to 3.0" in diameter. Water in this interval.

40.0-50.0 ft. SANDY GRAVEL (GW-SW); mostly subrounded to well rounded pebbles and cobbles (up to 5.0" in diameter) and fine to medium grained sand matrix (~30%), wet, calcareous, brown (7.5YR 5/2).

MONITORING WELL COMPLETION LOG MOA01-0561

PROJECT MOAB

SITE Moab Disposal Site

WELL NUMBER 0561

DATES DRILLED 07/15/2004 to 07/16/2004

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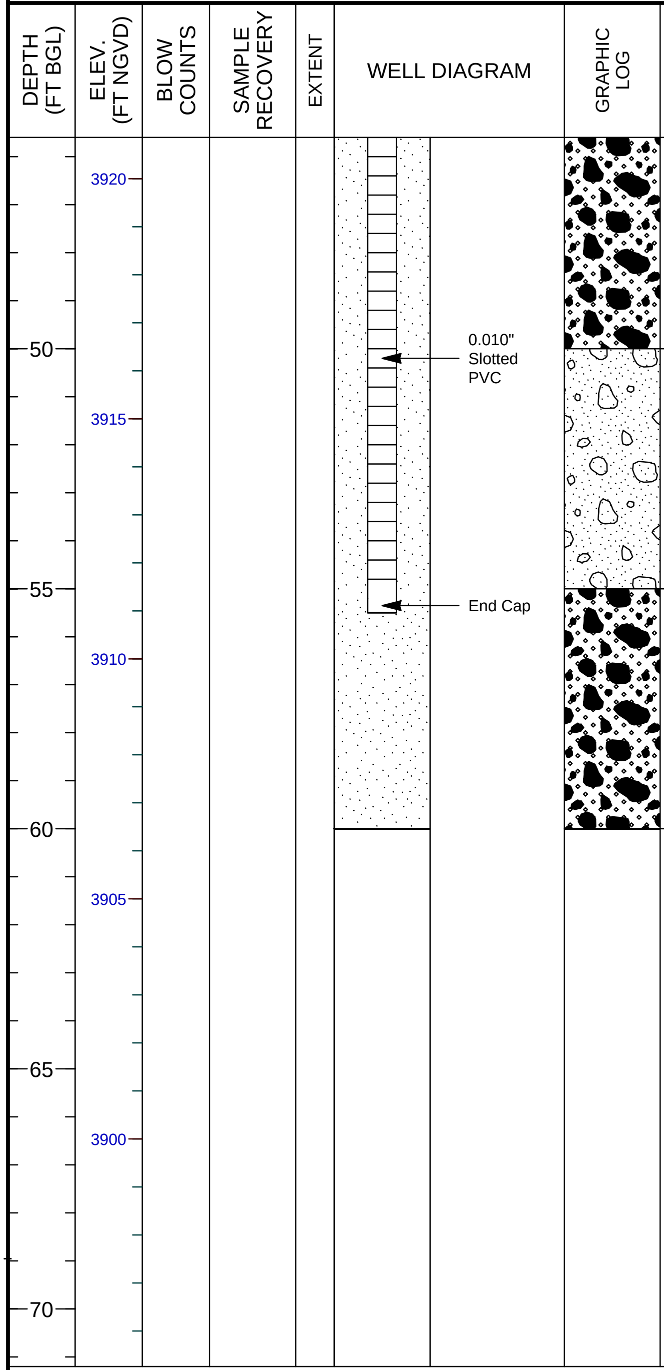


LITHOLOGIC DESCRIPTION

50.0-55.0 ft. GRAVELLY SAND (SP-GP); mostly fine to medium grained sand (~80%), calcareous, dark gray (7.5YR 4/1) to gray (7.5YR 5/1). "Salt and Pepper" sand. About 20% pebbles up to 2.0" in diameter.

55.0-60.0 ft. SANDY GRAVEL (GW-SW); about 60% subrounded to well rounded pebbles and cobbles to 3.0" in diameter. Sand matrix (~40%), is mostly fine to medium grained sand (salt and pepper), brown (7.5YR 4/2 to 7.5YR 5/2).

Total Depth 60.0 ft.

Configuration II

Well Logs

MONITORING WELL COMPLETION LOG MOA01-0401

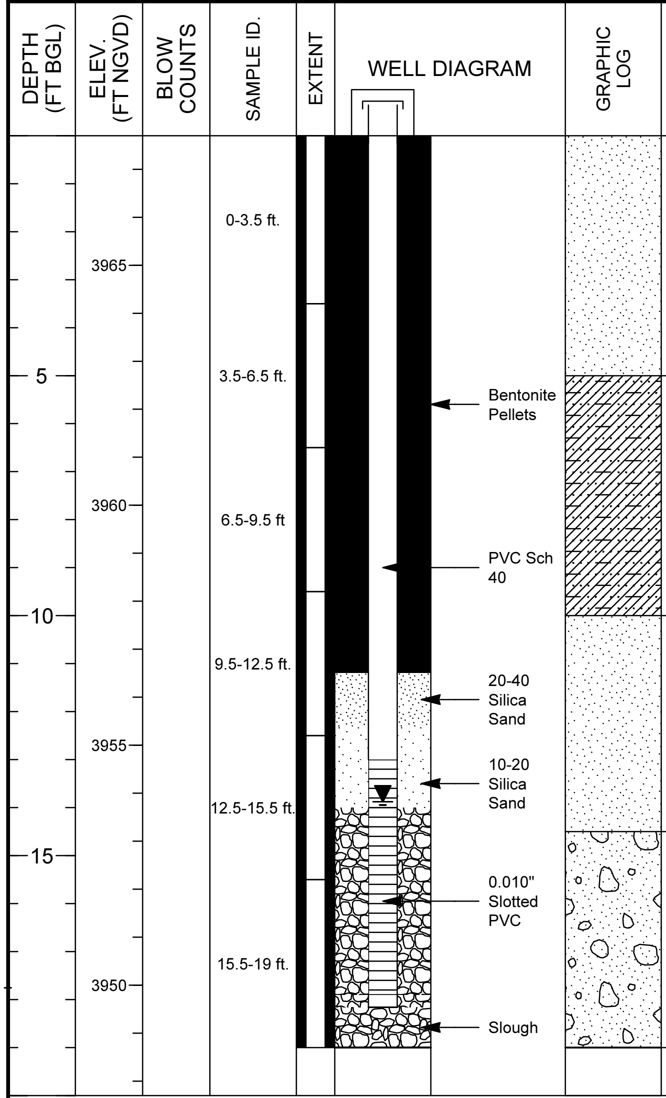
PROJECT MOAB
LOCATION ,
SITE MOAB
WELL NUMBER 0401

NORTH COORD. (FT) 6663841.69
EAST COORD. (FT) 2186100.72
HOLE DEPTH (FT) 19.00
WELL DEPTH (FT) 18.16

DATE DRILLED 12/03/2001
SURFACE ELEV. (FT NGVD) 3967.70
TOP OF CASING (FT) 3969.60
MEAS. PT. ELEV. (FT) 3969.60
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 2.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	1 in. PVC Sch 40	-1.9	to	13.0
WELL SCREEN:	1 in. Slotted PVC	13.0	to	17.9
SUMP/END CAP:	1 in. PVC Sch 40	17.9	to	18.16
SURFACE SEAL:				
GROUT:				
SEAL:	Bentonite Pellets	0.0	to	11.2
UPPER PACK:	20-40 Silica Sand	11.2	to	12.3
LOWER PACK:	10-20 Silica Sand	12.3	to	14.0

DRILLING METHOD GEOPROBE
SAMPLING METHOD CORE BARREL
DATE DEVELOPED 12/04/2001
WATER LEVEL (FT BTOC) 15.78 on 12/03/2001
LOGGED BY Hopping, B.
REMARKS



LITHOLOGIC DESCRIPTION

0-5.0 ft. SAND (SP); brown to tan, fine sand to silt. Trace of black organics at 3.5 ft. Dry to moist.

5.0-10.0 ft. SILTY CLAY (CL-ML); low plasticity, organics (roots), color change to pinkish brown, some fine sand, moist to dry.

10.0-14.5 ft. SAND (SP); well sorted, light brown to tan, fine to medium sand, organics on last foot (wood fragments), dry to damp.

14.5-19.0 ft. GRAVELLY SAND (SP-GP); sand becomes medium to coarse grained, mixture of pebbles, cobbles and gravel, moist to wet. Sandy material changes color to dark brick red at 16.0 to 17.0 ft.

Total Depth 19.0 ft.

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GRAND JUNCTION OFFICE, COLORADO

MONITORING WELL COMPLETION LOG MOA01-0402

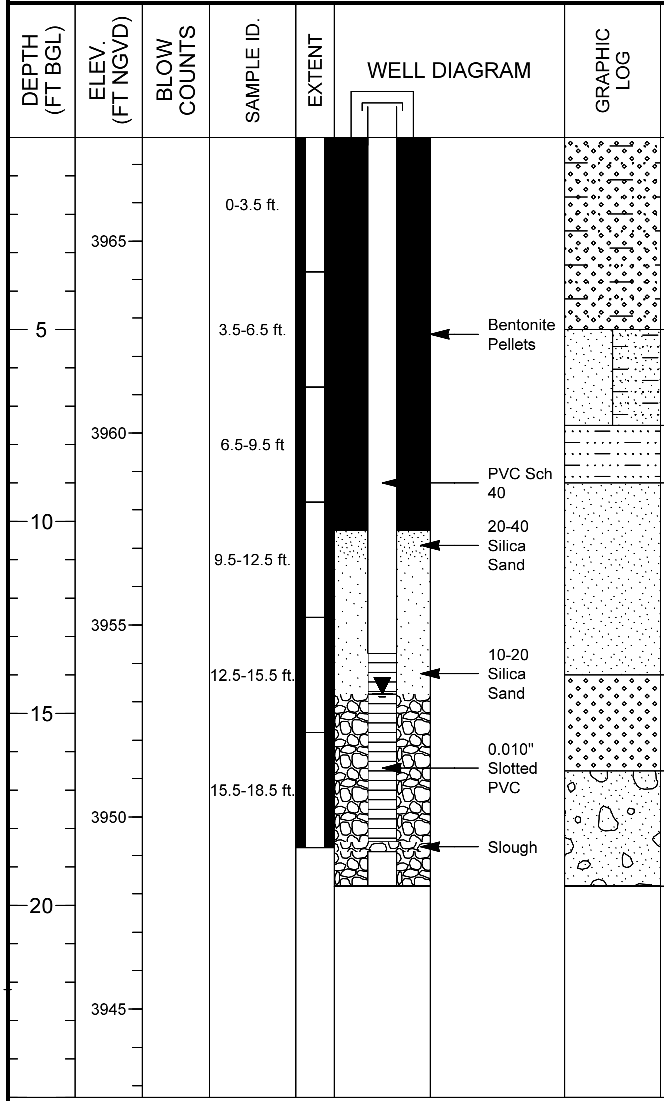
PROJECT MOAB
LOCATION ,
SITE MOAB
WELL NUMBER 0402

NORTH COORD. (FT) 6663681.81
EAST COORD. (FT) 2186088.56
HOLE DEPTH (FT) 19.50
WELL DEPTH (FT) 18.60

DATE DRILLED 12/03/2001 to 12/04/2001
SURFACE ELEV. (FT NGVD) 3967.70
TOP OF CASING (FT) 3968.63
MEAS. PT. ELEV. (FT) 3968.63
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 2.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	1 in. PVC Sch 40	-0.93	to	13.43
WELL SCREEN:	1 in. Slotted PVC	13.43	to	18.35
SUMP/END CAP:	1 in. PVC Sch 40	18.35	to	18.6
SURFACE SEAL:				
GROUT:				
SEAL:	Bentonite Pellets	0.0	to	10.25
UPPER PACK:	20-40 Silica Sand	10.25	to	11.0
LOWER PACK:	10-20 Silica Sand	11.0	to	14.5

DRILLING METHOD GEOPROBE
SAMPLING METHOD CORE BARREL
DATE DEVELOPED 12/04/2001
WATER LEVEL (FT BTOC) 15.41 on 12/04/2001
LOGGED BY Hopping, B.
REMARKS



LITHOLOGIC DESCRIPTION

0-5.0 ft. SILTY SAND (SM); light brown to brown, fine sand to silt. Abundant organics (roots) at 3.0 ft. Dry to moist.

5.0-7.5 ft. SAND WITH SILT (SP-SM); light brown to brown, fine grained sand with some silt, dry. Caliche layering at 5 ft.

7.5-9.0 ft. SILT (ML); silt mixed with organics of some calcite.

9.0-14 ft. SAND (SP); light brown fine to medium sand, dry.

14-16.5 ft. SAND (SW); medium brown sand mixed with few pebbles, wet @15.0 ft.

16.5-19.5 ft. GRAVELLY SAND (SP); reddish brown sand mixed with well rounded pebbles gravel, wet.

Total Depth 19.5 ft.

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GRAND JUNCTION OFFICE, COLORADO

PAGE 1 OF 1 02/27/2002

MONITORING WELL COMPLETION LOG MOA01-0408

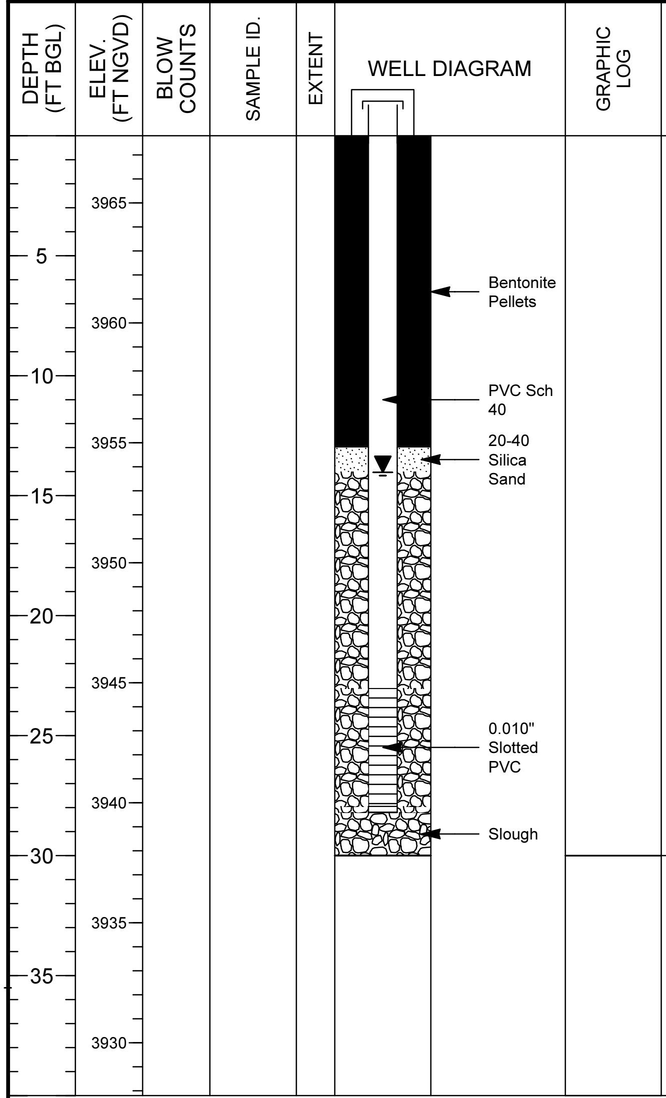
PROJECT MOAB
LOCATION ,
SITE MOAB
WELL NUMBER 0408

NORTH COORD. (FT) 6663836.19
EAST COORD. (FT) 2186099.60
HOLE DEPTH (FT) 30.00
WELL DEPTH (FT) 28.20

DATE DRILLED 12/05/2001
SURFACE ELEV. (FT NGVD) 3967.80
TOP OF CASING (FT) 3969.17
MEAS. PT. ELEV. (FT) 3969.17
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 2.13

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	1 in. PVC Sch 40	-1.37	to	23.03
WELL SCREEN:	1 in. Slotted PVC	23.03	to	27.95
SUMP/END CAP:	1 in. PVC Sch 40	27.95	to	28.2
SURFACE SEAL:				
GROUT:				
SEAL:	Bentonite Pellets	0.0	to	13.0
UPPER PACK:				
LOWER PACK:	20-40 Silica Sand	13.0	to	14.0

DRILLING METHOD GEOPROBE
SAMPLING METHOD
DATE DEVELOPED 12/05/2001
WATER LEVEL (FT BTOC) 15.4 on 12/05/2001
LOGGED BY Hopping, B.
REMARKS Bottom 1.05 ft. filled with fines (material installed). Actual TD will change after well development.



LITHOLOGIC DESCRIPTION

No Samples taken.

Total Depth 30.0 ft.

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GRAND JUNCTION OFFICE, COLORADO

MONITORING WELL COMPLETION LOG MOA01-0570

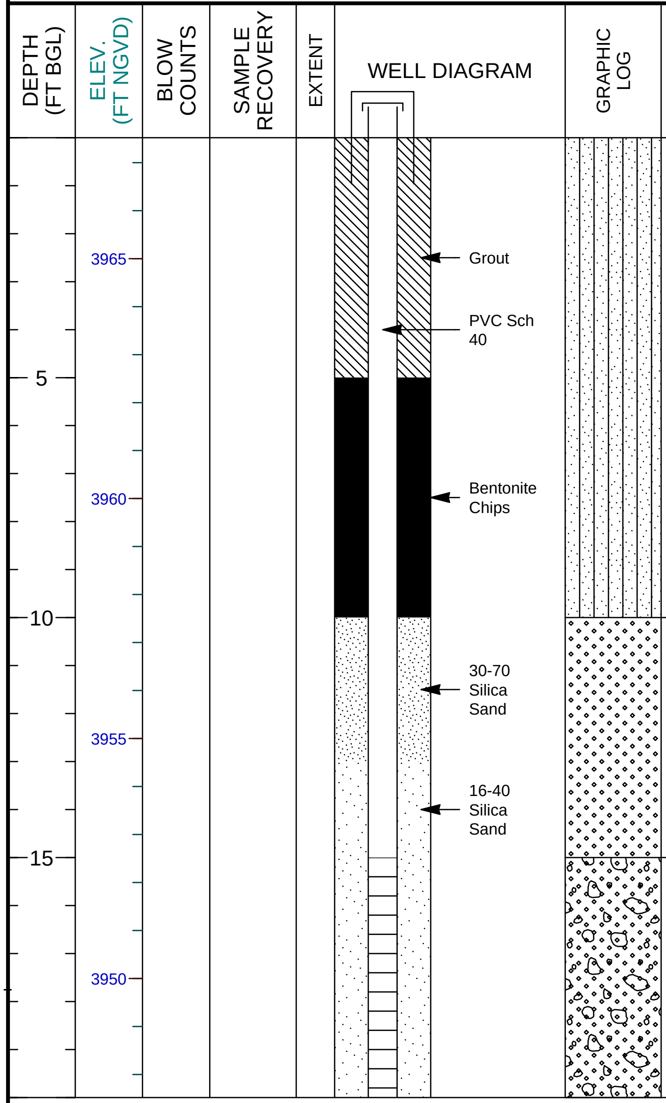
PROJECT MOAB
LOCATION Moab, UT
SITE Moab Disposal Site
DRILLING METHOD AIR PERCUSSION
DRILL COMPANY Layne Christensen Co
RIG TYPE AP 1000

WELL NUMBER 0570
NORTH COORD. (FT) 6663580.95
EAST COORD. (FT) 2186073.15
HOLE DEPTH (FT) 35.00
WELL DEPTH (FT) 31.30
WATER LEVEL (FT BGS)

DATE DRILLED 07/28/2004 to 07/29/2004
SURFACE ELEV. (FT NGVD) 3967.52
TOP OF CASING (FT) 3965.22
MEAS. PT. ELEV. (FT) 3965.22
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 12.5

	WELL INSTALLATION	INTERVAL (FT)		
BLANK CASING:	6 in. PVC Sch 40	2.3	to	15.0
WELL SCREEN:	6 in. PVC Vee Wire Wrapped	15.0	to	30.0
SUMP/END CAP:	6 in. PVC Sch 40	30.0	to	31.3
GROUT:	Grout	0.0	to	5.0
SEAL:	Bentonite Chips	5.0	to	10.0
UPPER PACK:	30-70 Silica Sand	10.0	to	13.0
LOWER PACK:	16-40 Silica Sand	13.0	to	35.0

DRILLER Kern, T
LOGGED BY Goodknight, C.
SAMPLING METHOD CYCLONE- 5.0 ft. intervals
DATE DEVELOPED
REMARKS Extraction well.



LITHOLOGIC DESCRIPTION

0-10.0 ft. SILTY SAND (SM); dry, mostly very fine grained sand (80%), and ~20% silt, brown (7.5YR 5/4).

5.0-10.0 ft. sightly damp, brown (7.5YR 5/3).

10.0-15.0 ft. SAND (SW); mostly fine to medium grained, damp, brown (7.5YR 5/4), trace small pebbles up to 1/4" in diameter.

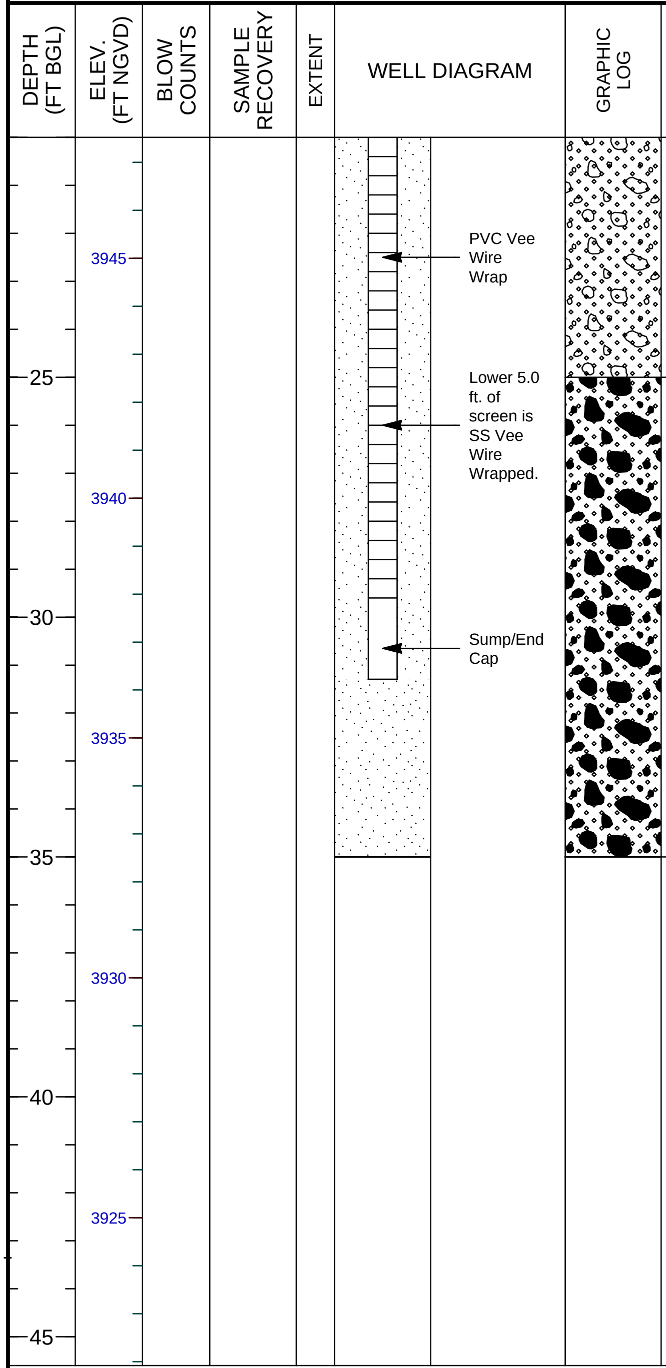
15.0-25.0 ft. GRAVELLY SAND (SW-GW); moist to wet, ~80% sand, very fine grained to medium grained, ~20% pebbles up to 2.0" in diameter, matrix sand is brown (7.5YR 4/4).

MONITORING WELL COMPLETION LOG MOA01-0570

PROJECT MOAB **WELL NUMBER** 0570

SITE Moab Disposal Site **DATES DRILLED** 07/28/2004 to 07/29/2004

Continued from Previous Page



LITHOLOGIC DESCRIPTION

20.0-25.0 ft. approximately equal amounts of sand (fine to medium grained) and gravel (pebbles and cobbles up to 3.0" in diameter), matrix sandy material is brown (7.5YR 4/3), wet.

25.0-35.0 ft. SANDY GRAVEL (GW-SW); approximately 70% gravel and cobbles up to 3.0" in diameter, matrix sandy material is fine to medium grained and brown (7.5YR 4/2), wet.

30.0-35.0 ft. slightly more sand, fine to very fine grained (~35-40%). Runny sand begins at approximately 34.0 ft. Sand is dark grayish brown (10YR 4/2). Calcareous throughout hole.

Total Depth 35.0 ft.

MONITORING WELL COMPLETION LOG MOA01-0571

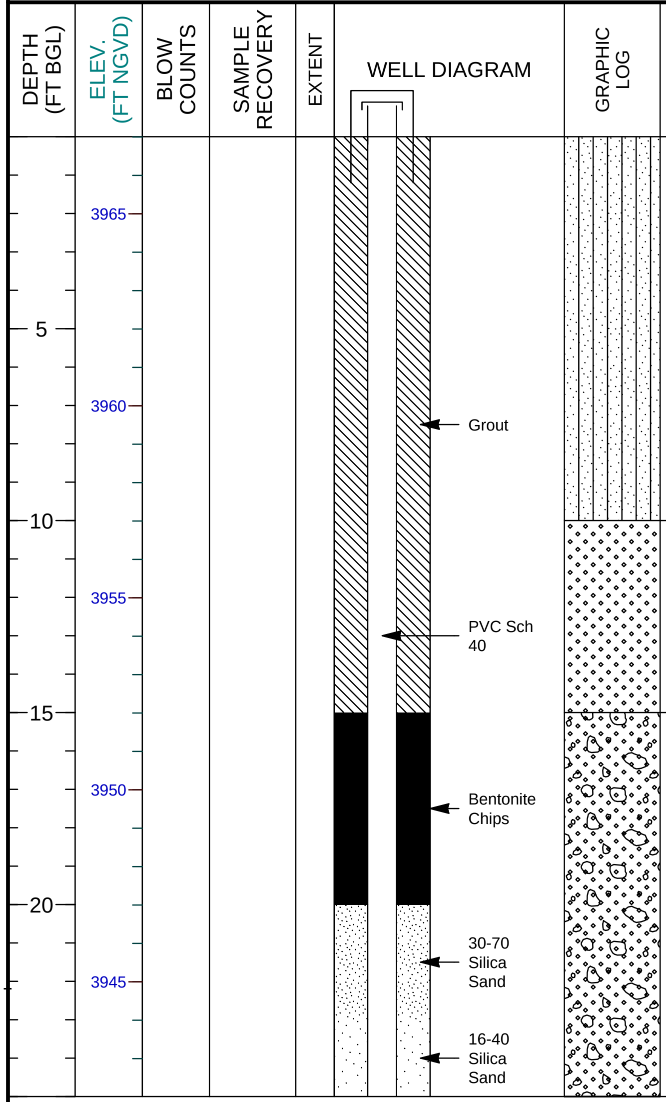
PROJECT MOAB
LOCATION Moab, UT
SITE Moab Disposal Site
DRILLING METHOD AIR PERCUSSION
DRILL COMPANY Layne Christensen Co
RIG TYPE AP 1000

WELL NUMBER 0571
NORTH COORD. (FT) 6663611.00
EAST COORD. (FT) 2186078.14
HOLE DEPTH (FT) 45.00
WELL DEPTH (FT) 41.30
WATER LEVEL (FT BGS)

DATE DRILLED 07/27/2004 to 07/28/2004
SURFACE ELEV. (FT NGVD) 3967.01
TOP OF CASING (FT) 3964.89
MEAS. PT. ELEV. (FT) 3964.89
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 12.5

	WELL INSTALLATION	INTERVAL (FT)		
BLANK CASING:	6 in. PVC Sch 40	2.12	to	25.0
WELL SCREEN:	6 in. PVC Vee Wire Wrapped	25.0	to	40.0
SUMP/END CAP:	6 in. PVC Sch 40	40.0	to	41.3
GROUT:	Grout	0.0	to	15.0
SEAL:	Bentonite Chips	15.0	to	20.0
UPPER PACK:	30-70 Silica Sand	20.0	to	23.0
LOWER PACK:	16-40 Silica Sand	23.0	to	45.0

DRILLER Kern, T
LOGGED BY Goodknight, C.
SAMPLING METHOD CYCLONE- 5.0 ft. intervals
DATE DEVELOPED
REMARKS Extraction Well.



LITHOLOGIC DESCRIPTION

0-10.0 ft. SILTY SAND (SM); dry, mostly very fine grained sand (~80%) and ~20% silt, brown (7.5YR 5/4).

5.0-10.0 ft. trace clay that has white (caliche) mottles, brown (7.5YR 5/3), slightly damp.

10.0-15.0 ft. SAND (SW); mostly fine to medium grained, damp, brown (7.5YR 5/4), trace pebbles up to 1/2" in diameter, trace burned woody material.

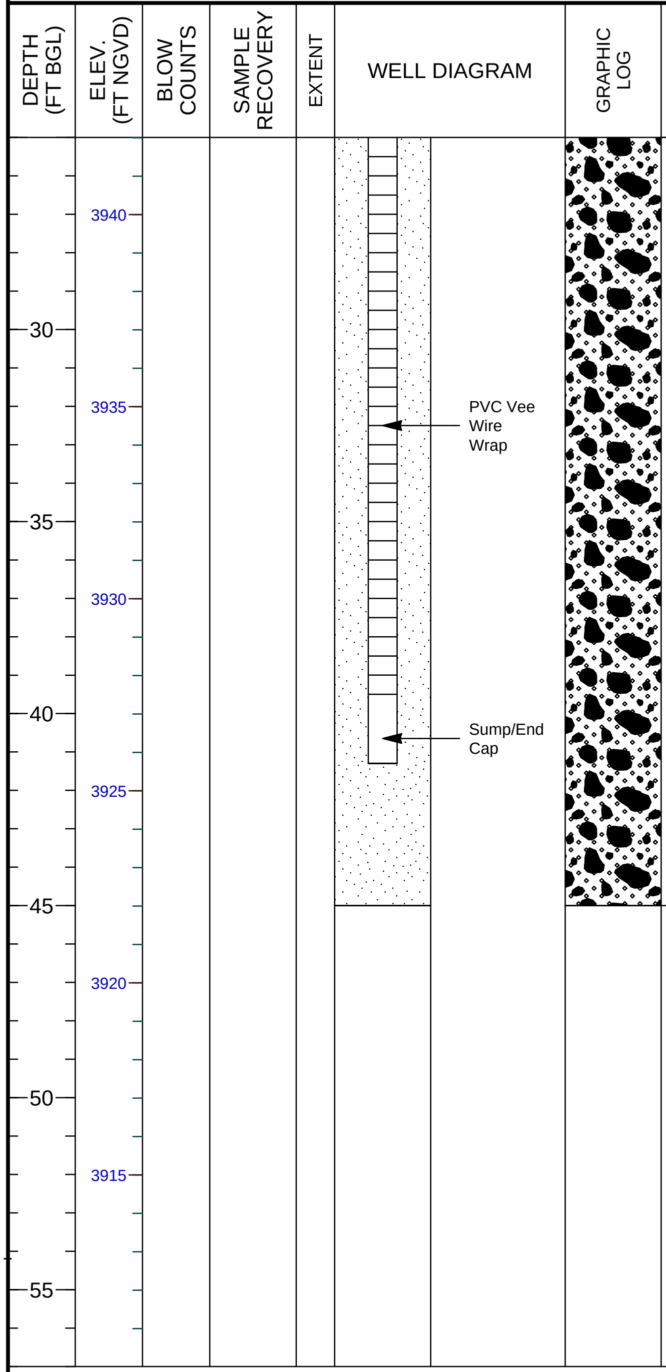
15.0-20.0 ft. GRAVELLY SAND (SW-GW); moist to wet, ~80% sand, very fine to medium grained, ~20% pebbles and cobbles up to 4.0" in diameter, matrix sand is brown (7.5YR 4/4).

20.0-25.0 ft. approximately equal amounts of sand (fine to medium grained) and gravel (pebbles and cobbles up to 3.0" in diameter), matrix sandy material is brown (7.5YR 4/3), wet.

MONITORING WELL COMPLETION LOG MOA01-0571

PROJECT MOAB
SITE Moab Disposal Site
WELL NUMBER 0571
DATES DRILLED 07/27/2004 to 07/28/2004

Continued from Previous Page



LITHOLOGIC DESCRIPTION

25.0-45.0 ft. SANDY GRAVEL (GW-SW); 70% gravel and cobbles up to 3.0" in diameter, matrix sandy material is fine to medium grained and brown (7.5YR 4/2), wet.

30.0-35.0 ft. more sand (35-40%), mostly fine to medium grained, dark grayish brown (10YR 4/2), wet.

35.0-40.0 ft. sand becoming mostly fine grained and runny-water saturated.

40.0-45.0 ft. more runny-sand (very fine to fine grained) and cobbles up to 6.0" in diameter, matrix is dark grayish brown (10YR 4/2). Calcareous throughout hole.

Total Depth 45.0 ft.

MONITORING WELL COMPLETION LOG MOA01-0572

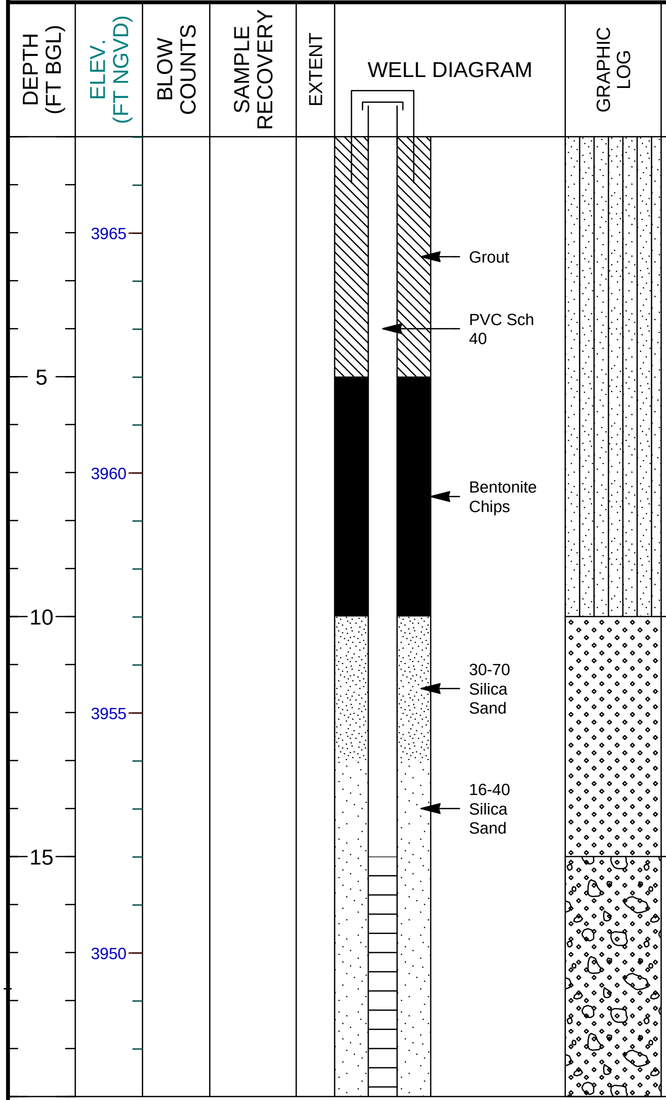
PROJECT MOAB
LOCATION Moab, UT
SITE Moab Disposal Site
DRILLING METHOD AIR PERCUSSION
DRILL COMPANY Layne Christensen Co
RIG TYPE AP 1000

WELL NUMBER 0572
NORTH COORD. (FT) 6663640.46
EAST COORD. (FT) 2186084.14
HOLE DEPTH (FT) 35.00
WELL DEPTH (FT) 31.30
WATER LEVEL (FT BGS)

DATE DRILLED 07/27/2004
SURFACE ELEV. (FT NGVD) 3967.01
TOP OF CASING (FT) 3965.14
MEAS. PT. ELEV. (FT) 3965.14
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 12.5

	WELL INSTALLATION	INTERVAL (FT)		
BLANK CASING:	6 in. PVC Sch 40	1.87	to	15.0
WELL SCREEN:	6 in. PVC Vee Wire Wrapped	15.0	to	30.0
SUMP/END CAP:	6 in. PVC Sch 40	30.0	to	31.3
GROUT:	Grout	0.0	to	5.0
SEAL:	Bentonite Chips	5.0	to	10.0
UPPER PACK:	30-70 Silica Sand	10.0	to	13.0
LOWER PACK:	16-40 Silica Sand	13.0	to	35.0

DRILLER Kern, T
LOGGED BY Goodknight, C.
SAMPLING METHOD CYCLONE- 5.0 ft. intervals
DATE DEVELOPED
REMARKS Extraction Well.



LITHOLOGIC DESCRIPTION

0-10.0 ft. SILTY SAND (SM); dry, mostly very fine grained sand (80%) and ~20% silt, brown (7.5YR 5/4).

5.0-10.0 ft. trace clay that has white (caliche) mottles, brown (7.5YR 5/3), slightly damp.

10.0-15.0 ft. SAND (SW); mostly fine to medium grained sand, damp, brown (7.5YR 5/4), trace pebbles up to 1/2" in diameter, trace burned woody material.

15.0-25.0 ft. GRAVELLY SAND (SW-GW); moist to wet, 80-85% sand, very fine to medium grained. Pebbles (~15%) up to 2.0" in diameter, matrix sand is brown (7.5YR 4/4), some clay/silt (~5%).

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U.S. DEPARTMENT OF ENERGY
GRAND JUNCTION OFFICE, COLORADO

MONITORING WELL COMPLETION LOG MOA01-0572

PROJECT MOAB
SITE Moab Disposal Site
WELL NUMBER 0572
DATES DRILLED 07/27/2004

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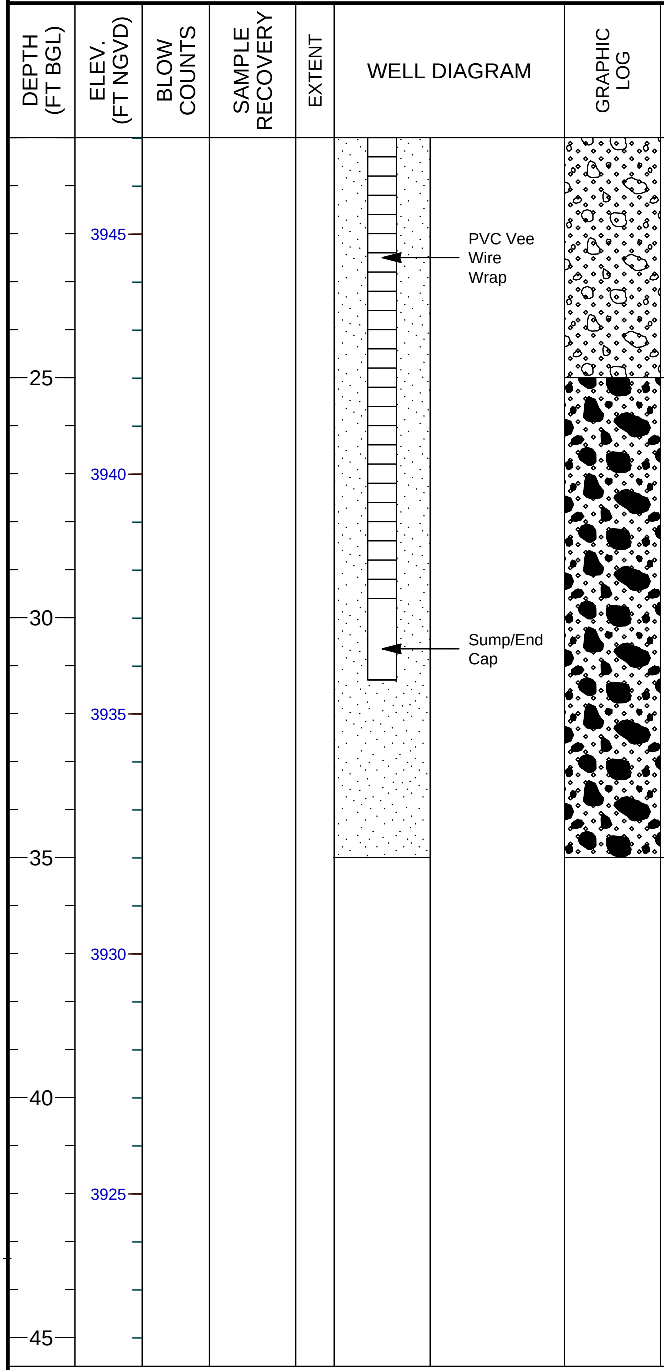


LITHOLOGIC DESCRIPTION

20.0-25.0 ft. gravelly sand to sandy gravel. Equal amounts of sand (fine to medium grained) and gravel (pebbles and cobbles up to 3.0" in diameter), matrix sandy material is brown (7.5YR 4/3), wet

25.0-35.0 ft. SANDY GRAVEL (GW-SW); ~70% gravel and cobbles up to 4.0" in diameter, matrix sandy material is fine grained to medium grained sand and brown (7.5YR 4/3), wet.

30.0-35.0 ft. more sand, very fine to fine grained, which becomes runny-water saturated near 35.0 ft, dark grayish brown (10YR 4/2). Calcareous throughout hole depth.

Total Depth 35.0 ft.

MONITORING WELL COMPLETION LOG MOA01-0573

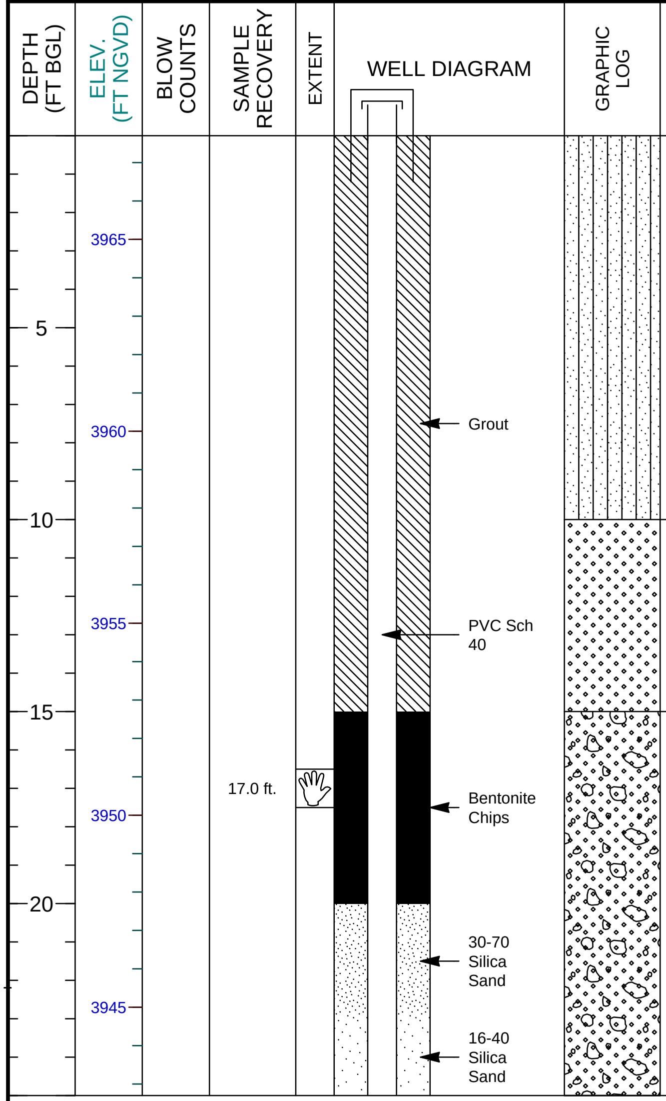
PROJECT MOAB
LOCATION Moab, UT
SITE Moab Disposal Site
DRILLING METHOD AIR PERCUSSION
DRILL COMPANY Layne Christensen Co
RIG TYPE AP 1000

WELL NUMBER 0573
NORTH COORD. (FT) 6663668.84
EAST COORD. (FT) 2186086.40
HOLE DEPTH (FT) 45.00
WELL DEPTH (FT) 41.30
WATER LEVEL (FT BGS)

DATE DRILLED 07/27/2004
SURFACE ELEV. (FT NGVD) 3967.70
TOP OF CASING (FT) 3965.15
MEAS. PT. ELEV. (FT) 3965.15
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 12.5

	WELL INSTALLATION	INTERVAL (FT)		
BLANK CASING:	6 in. PVC Sch 40	2.55	to	25.0
WELL SCREEN:	6 in. PVC Vee Wire Wrapped	25.0	to	40.0
SUMP/END CAP:	6 in. PVC Sch 40	40.0	to	41.3
GROUT:	Grout	0.0	to	15.0
SEAL:	Bentonite Chips	15.0	to	20.0
UPPER PACK:	30-70 Silica Sand	20.0	to	23.0
LOWER PACK:	16-40 Silica Sand	23.0	to	45.0

DRILLER Kern, T
LOGGED BY Goodknight, C.
SAMPLING METHOD CYCLONE- 5.0 ft. intervals
DATE DEVELOPED
REMARKS Extraction Well.



LITHOLOGIC DESCRIPTION

0-10.0 ft. SILTY SAND (SM); dry, mostly very fine grained sand (80%) and 20% silt, brown (7.5YR 5/4), dry.

5.0-10.0 ft. trace of clay with mottles (white), brown (7.5YR 5/3), slightly damp.

10.0-15.0 ft. SAND (SW); mostly fine to medium grained sand, damp, brown (7.5YR 5/3), trace pebbles up to 1/2" in diameter.

15.0-25.0 ft. GRAVELLY SAND (SW-GW): moist, 80-85% sand, very fine to medium grained, ~15-20% pebbles up to 2.0" in diameter, matrix sand is brown (7.5YR 4/4).

@~17.0 ft. woody material, slightly carbonized.

20.0-25.0 ft. increase in amount of pebbles up to 2.0" in diameter (~25-30%), wet, brown (7.5YR 4/3).

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U.S. DEPARTMENT OF ENERGY
GRAND JUNCTION OFFICE, COLORADO

MONITORING WELL COMPLETION LOG MOA01-0573

PROJECT MOAB
WELL NUMBER 0573
SITE Moab Disposal Site
DATES DRILLED 07/27/2004

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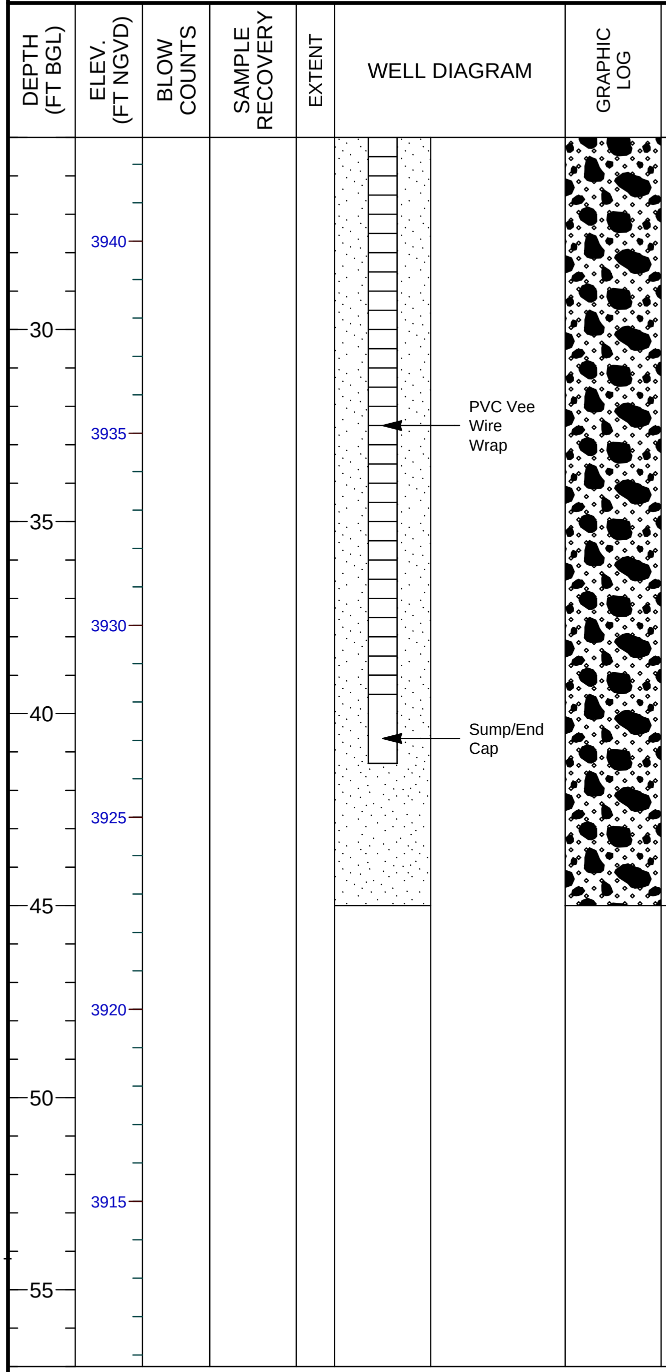


LITHOLOGIC DESCRIPTION

25.0-45.0 ft. SANDY GRAVEL (GW-SW); approximately 65% gravel and cobbles up to 3.0" in diameter, matrix sandy material is fine to medium grained and brown (7.5YR 4/3), wet.

30.0-35.0 ft. more sand, very fine to fine grained, becomes runny-water saturated at 35.0 ft, dark grayish brown sandy matrix (10YR 4/2).

35.0-40.0 ft. less runny sand and more (~70%) large cobbles (up to 6.0" in diameter). Sandy matrix is dark grayish brown (10YR 4/2). Calcareous throughout hole depth.

40.0-45.0 ft. large cobbles (up to 6.0" in diameter).

Total Depth 45.0 ft.

MONITORING WELL COMPLETION LOG MOA01-0574

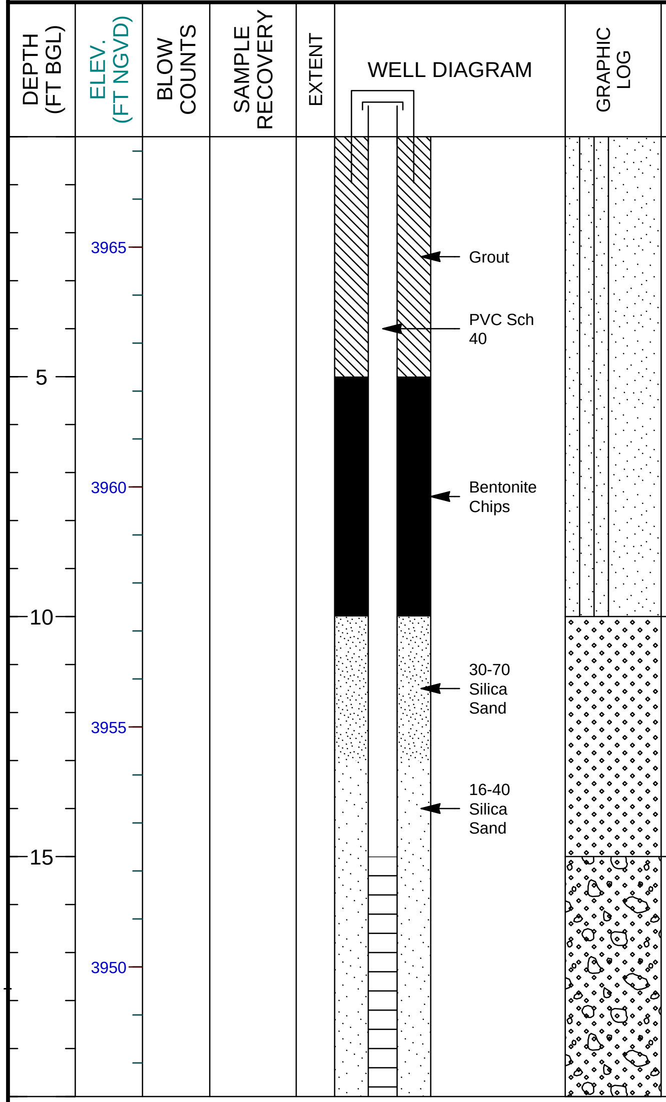
PROJECT MOAB
LOCATION Moab, UT
SITE Moab Disposal Site
DRILLING METHOD AIR PERCUSSION
DRILL COMPANY Layne Christensen Co
RIG TYPE AP 1000

WELL NUMBER 0574
NORTH COORD. (FT) 6663699.41
EAST COORD. (FT) 2186095.79
HOLE DEPTH (FT) 35.00
WELL DEPTH (FT) 31.30
WATER LEVEL (FT BGS)

DATE DRILLED 07/26/2004 to 07/27/2004
SURFACE ELEV. (FT NGVD) 3967.30
TOP OF CASING (FT) 3965.12
MEAS. PT. ELEV. (FT) 3965.12
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 12.5

	WELL INSTALLATION	INTERVAL (FT)		
BLANK CASING:	6 in. PVC Sch 40	2.18	to	15.0
WELL SCREEN:	6 in. PVC Vee Wire Wrapped	15.0	to	30.0
SUMP/END CAP:	6 in. PVC Sch 40	30.0	to	31.3
GROUT:	Grout	0.0	to	5.0
SEAL:	Bentonite Chips	5.0	to	10.0
UPPER PACK:	30-70 Silica Sand	10.0	to	13.0
LOWER PACK:	16-40 Silica Sand	13.0	to	35.0

DRILLER Kern, T
LOGGED BY Goodknight, C.
SAMPLING METHOD CYCLONE- 5.0 ft. intervals
DATE DEVELOPED
REMARKS Extraction Well.



LITHOLOGIC DESCRIPTION

0-10.0 ft. SANDY SILT (ML-SP); dry, mostly silt (80%) and ~20% very fine grained sand, pale brown (10YR 6/3).

5.0-10.0 ft. trace clay with mottles (white), brown (7.5YR 5/3), slightly damp.

10.0-15.0 ft. SAND (SW); mostly fine to medium grained, damp, brown (7.5YR 5/3), trace pebbles up to 1/2" in diameter.

15.0-25.0 ft. GRAVELLY SAND (SW-GW); moist, 80% sand, very fine to medium grained, 20% pebbles up to 2.0" in diameter, matrix sand is brown (7.5YR 4/3).

MONITORING WELL COMPLETION LOG MOA01-0574

PROJECT MOAB
SITE Moab Disposal Site
WELL NUMBER 0574
DATES DRILLED 07/26/2004 to 07/27/2004

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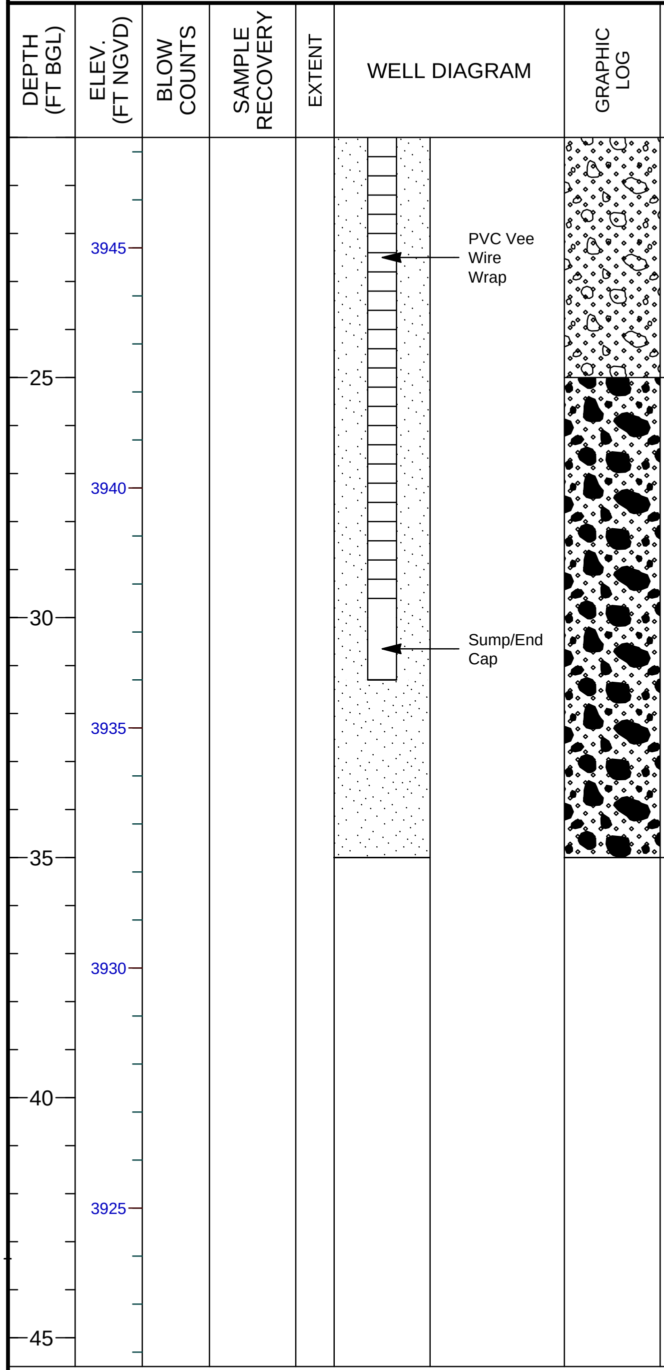


LITHOLOGIC DESCRIPTION

20.0-25.0 ft. increasing amount of pebbles (25-30%), wet.

25.0-35.0 ft. SANDY GRAVEL (GW-SW), approximately 60-65% gravel and cobbles up to 3.0" in diameter, matrix sandy material is fine to medium grained and brown (7.5YR 4/2), wet.

30.0-35.0 ft. slightly more sand (40%), wet.

Total Depth 35.0 ft.

MONITORING WELL COMPLETION LOG MOA01-0575

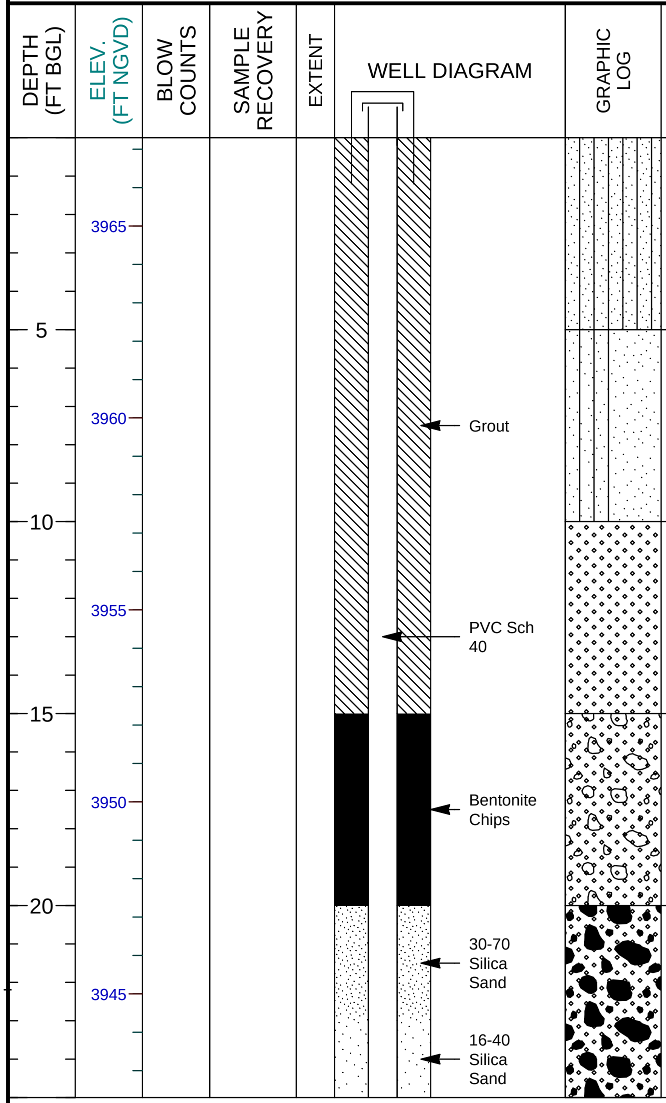
PROJECT MOAB
LOCATION Moab, UT
SITE Moab Disposal Site
DRILLING METHOD AIR PERCUSSION
DRILL COMPANY Layne Christensen Co
RIG TYPE AP 1000

WELL NUMBER 0575
NORTH COORD. (FT) 6663728.34
EAST COORD. (FT) 2186099.71
HOLE DEPTH (FT) 45.00
WELL DEPTH (FT) 41.30
WATER LEVEL (FT BGS)

DATE DRILLED 07/26/2004
SURFACE ELEV. (FT NGVD) 3967.30
TOP OF CASING (FT) 3965.01
MEAS. PT. ELEV. (FT) 3965.01
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 12.5

	WELL INSTALLATION	**INTERVAL (FT)**		
BLANK CASING:	6 in. PVC Sch 40	2.29	to	25.0
WELL SCREEN:	6 in. PVC Vee Wire Wrapped	25.0	to	40.0
SUMP/END CAP:	6 in. PVC Sch 40	40.0	to	41.3
GROUT:	Grout	0.0	to	15.0
SEAL:	Bentonite Chips	15.0	to	20.0
UPPER PACK:	30-70 Silica Sand	20.0	to	23.0
LOWER PACK:	16-40 Silica Sand	23.0	to	45.0

DRILLER Kern, T
LOGGED BY Goodknight, C.
SAMPLING METHOD CYCLONE- 5.0 ft. intervals
DATE DEVELOPED
REMARKS Extraction Well.



LITHOLOGIC DESCRIPTION

0-5.0 ft. SILTY SAND (SM); approximately 80% very fine grained sand with 20% silt, pale brown (10YR 6/3), dry.

5.0-10.0 ft. SANDY SILT (ML-SP); slightly damp, mostly silt (80%) and ~20% very fine grained sand, brown (7.5YR 5/3), trace clay with mottles (white).

10.0-15.0 ft. SAND (SW); fine to medium grained, damp, brown (7.5YR 5/3).

15.0-20.0 ft. GRAVELLY SAND (SW-GW); moist, ~80% sand, very fine to medium grained, ~20% pebbles up to 2.0" in diameter, matrix sand is brown (7.5YR 4/3).

20.0-45.0 ft. SANDY GRAVEL (GW-SW); ~60% gravel and cobbles up to 3.0" in diameter, matrix sandy material is fine to medium grained and brown (7.5YR 4/3), wet.

MONITORING WELL COMPLETION LOG MOA01-0575

PROJECT MOAB
SITE Moab Disposal Site
WELL NUMBER 0575
DATES DRILLED 07/26/2004

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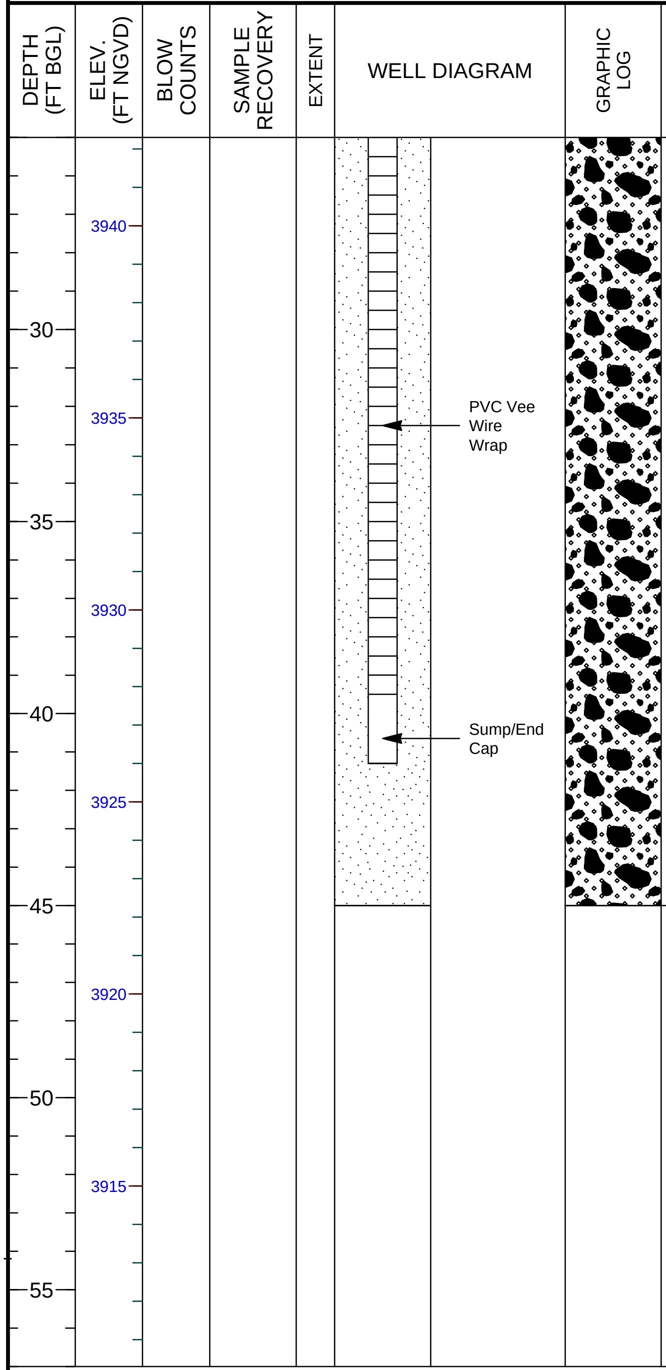


LITHOLOGIC DESCRIPTION

25.0-30.0 ft. gravel increases to ~75%, matrix sand is brown (7.5YR 4/2).

30.0-35.0 ft. gravel increases to 80%, well rounded gravel and cobbles (up to 6.0" in diameter), ~20% fine grained sand matrix, brown (7.5YR 4/2), wet.

35.0-40.0 ft. more sand (~25%), which is runny-water saturated.

40.0-45.0 ft. less sand (15-20%) and less runny.

Total Depth 45.0 ft.

MONITORING WELL COMPLETION LOG MOA01-0576

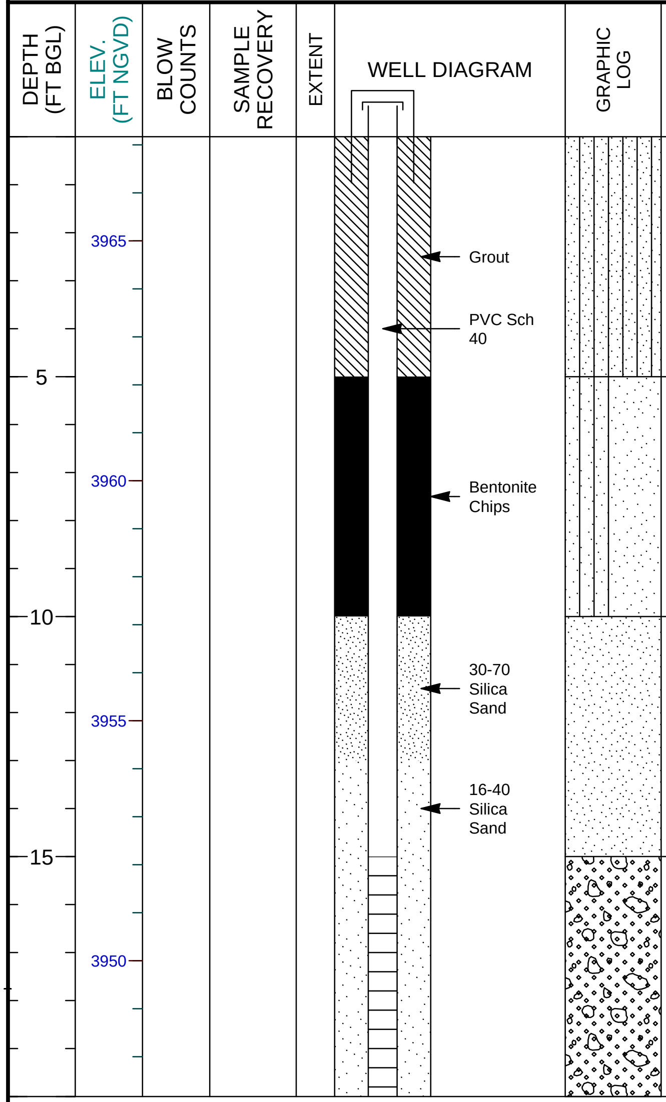
PROJECT MOAB
LOCATION Moab, UT
SITE Moab Disposal Site
DRILLING METHOD AIR PERCUSSION
DRILL COMPANY Layne Christensen Co
RIG TYPE AP 1000

WELL NUMBER 0576
NORTH COORD. (FT) 6663757.65
EAST COORD. (FT) 2186105.08
HOLE DEPTH (FT) 35.00
WELL DEPTH (FT) 31.30
WATER LEVEL (FT BGS)

DATE DRILLED 07/26/2004
SURFACE ELEV. (FT NGVD) 3967.17
TOP OF CASING (FT) 3965.15
MEAS. PT. ELEV. (FT) 3965.15
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 12.5

	WELL INSTALLATION	INTERVAL (FT)		
BLANK CASING:	6 in. PVC Sch 40	2.02	to	15.0
WELL SCREEN:	6 in. PVC Vee Wire Wrapped	15.0	to	30.0
SUMP/END CAP:	6 in. PVC Sch 40	30.0	to	31.3
GROUT:	Grout	0.0	to	5.0
SEAL:	Bentonite Chips	5.0	to	10.0
UPPER PACK:	30-70 Silica Sand	10.0	to	13.0
LOWER PACK:	16-40 Silica Sand	13.0	to	35.0

DRILLER Kern, T
LOGGED BY Goodknight, C.
SAMPLING METHOD CYCLONE- 5.0 ft. intervals
DATE DEVELOPED
REMARKS Extraction Well.



LITHOLOGIC DESCRIPTION

0-5.0 ft. SILTY SAND (SM); dry, ~80% very fine grained sand with ~20% silt, brown (7.5YR 4/2).

5.0-10.0 ft. SANDY SILT (ML-SP); dry, ~80% silt, and ~20% very fine grained sand, brown (7.5YR 5/4), trace clay.

10.0-15.0 ft. SAND (SP); mostly very fine grained sand, damp, trace of pebbles and cobbles up to 2.0" in diameter, brown (7.5YR 4/4).

15.0-35.0 ft. GRAVELLY SAND (SW-GW); damp to moist, ~60% sand, very fine to medium grained, ~40% pebbles and cobbles up to 3.0" in diameter, matrix sand is brown (7.5YR 4/4).

MONITORING WELL COMPLETION LOG MOA01-0576

PROJECT MOAB

SITE Moab Disposal Site

WELL NUMBER 0576

DATES DRILLED 07/26/2004

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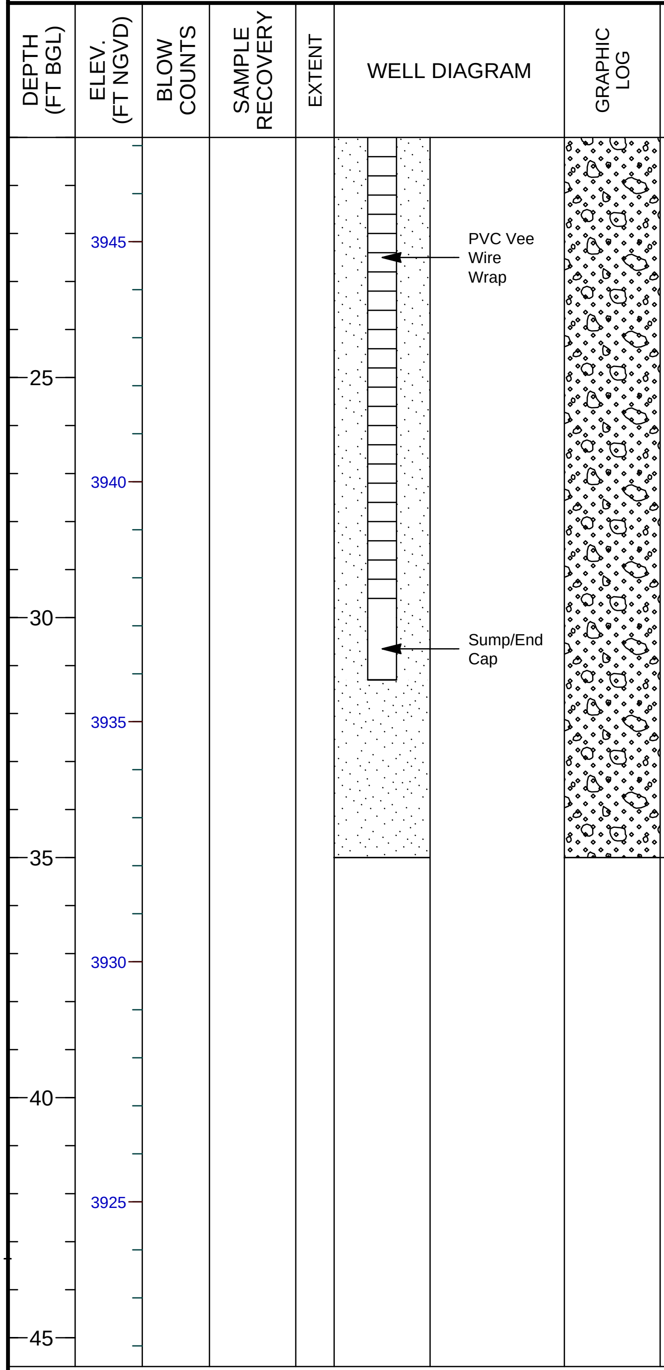


LITHOLOGIC DESCRIPTION

20.0-30.0 ft. approximately equal amounts of sand (fine to medium grained) and gravel (pebbles and cobbles up to 3.0" in diameter), matrix sandy material is brown (7.5YR 4/3), wet, calcareous throughout hole depth.

30.0-35.0 ft. more sand and more water in sample.

Total Depth 35.0 ft.

Stoller

U.S. DEPARTMENT OF ENERGY

GRAND JUNCTION OFFICE, COLORADO

MONITORING WELL COMPLETION LOG MOA01-0577

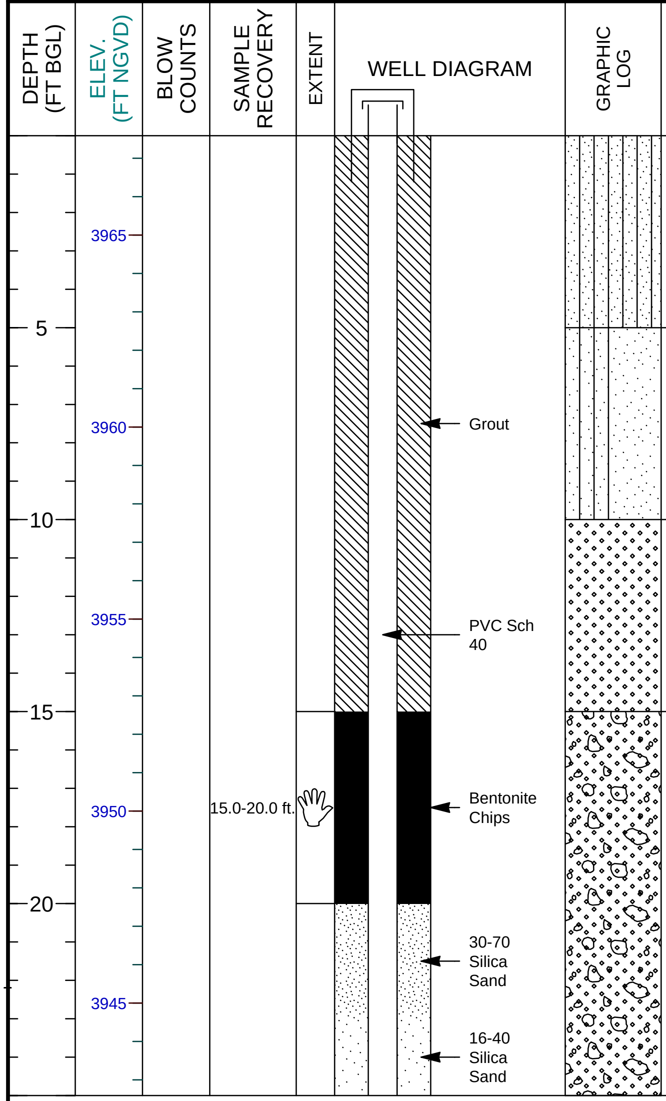
PROJECT MOAB
LOCATION Moab, UT
SITE Moab Disposal Site
DRILLING METHOD AIR PERCUSSION
DRILL COMPANY Layne Christensen Co
RIG TYPE AP 1000

WELL NUMBER 0577
NORTH COORD. (FT) 6663787.03
EAST COORD. (FT) 2186110.53
HOLE DEPTH (FT) 45.00
WELL DEPTH (FT) 41.30
WATER LEVEL (FT BGS)

DATE DRILLED 07/19/2004 to 07/20/2004
SURFACE ELEV. (FT NGVD) 3967.59
TOP OF CASING (FT) 3965.10
MEAS. PT. ELEV. (FT) 3965.10
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 12.5

	WELL INSTALLATION	INTERVAL (FT)		
BLANK CASING:	6 in. PVC Sch 40	2.49	to	25.0
WELL SCREEN:	6 in. PVC Vee Wire Wrapped	25.0	to	40.0
SUMP/END CAP:	6 in. PVC Sch 40	40.0	to	41.3
GROUT:	Grout	0.0	to	15.0
SEAL:	Bentonite Chips	15.0	to	20.0
UPPER PACK:	30-70 Silica Sand	20.0	to	23.0
LOWER PACK:	16-40 Silica Sand	23.0	to	45.0

DRILLER Kern, T
LOGGED BY Goodknight, C.
SAMPLING METHOD CYCLONE- 5.0 ft. intervals
DATE DEVELOPED
REMARKS Extraction Well.



LITHOLOGIC DESCRIPTION

0-5.0 ft. SILTY SAND (SM); damp, mostly very fine grained sand (80%), 20% silt, brown (7.5YR 4/2).

5.0-10.0 ft. SANDY SILT (ML-SP); dry, 80% silt, and 20% very fine grained sand, brown (7.5YR 5/3), trace clay with mottles (white).

10.0-15.0 ft. SAND (SW); mostly fine to medium grained, damp, brown (7.5YR 5/3), trace pebbles (1/2" in diameter).

15.0-30.0 ft. GRAVELLY SAND (SW-GW); damp to moist, 75-80% very fine to medium grained sand, 20% pebbles up to 2.0" in diameter, matrix sand is brown (7.5YR 5/3).

@15.0-20.0 ft. sample of small seed pod (1/2" in diameter), partially carbonized (?), possibly a Russian Olive.

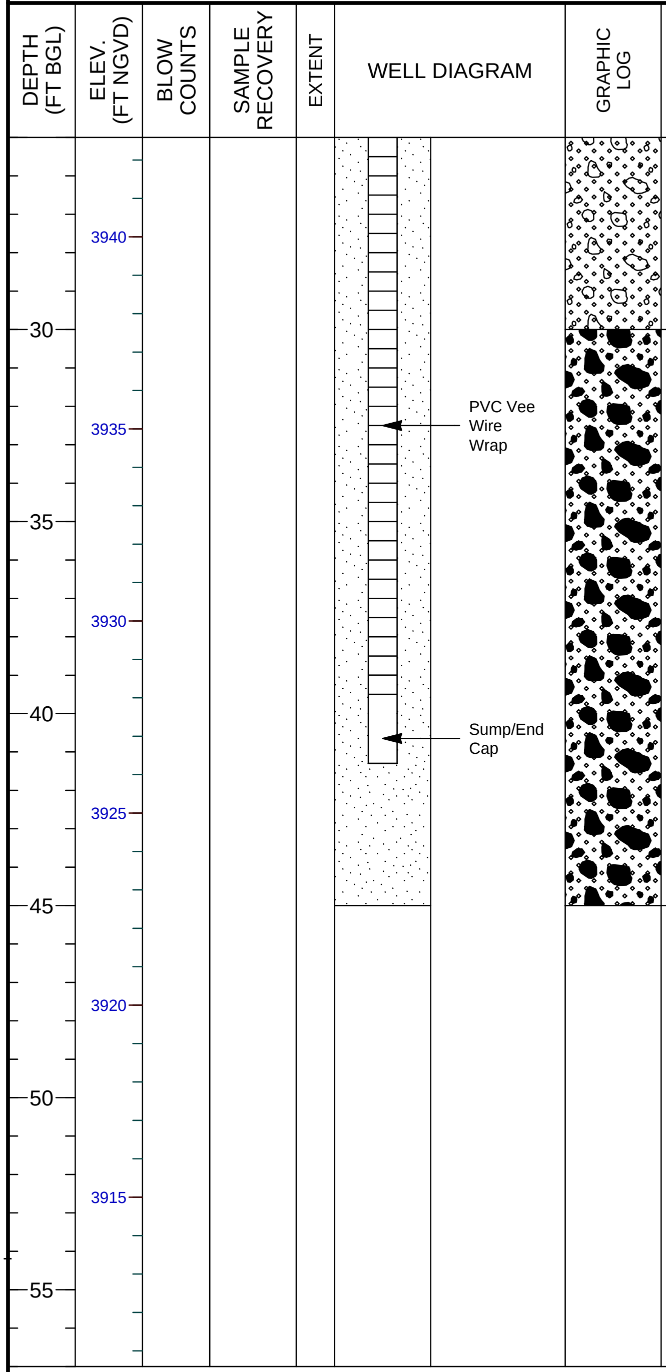
20.0-30.0 ft. equal amounts of sand (fine to medium grained) and gravel (pebbles and cobbles up to 3.0" in diameter), matrix sandy material is brown (7.5YR 4/3), wet, calcareous throughout hole depth.

MONITORING WELL COMPLETION LOG MOA01-0577

PROJECT MOAB | **WELL NUMBER** 0577

SITE Moab Disposal Site | **DATES DRILLED** 07/19/2004 to 07/20/2004

Continued from Previous Page



LITHOLOGIC DESCRIPTION

30.0-45.0 ft. SANDY GRAVEL (GW-SW), mostly (80%) well rounded gravel and cobbles (up to 6.0" in diameter), approximately 20% fine to medium grained sand matrix, brown (7.5YR 4/2), wet.

40.0-45.0 ft. greater amount of very fine grained sand (30%), wet and runny, sand matrix is dark grayish brown (10YR 4/2).

Total Depth 45.0 ft.

Stoller

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MONITORING WELL COMPLETION LOG MOA01-0578

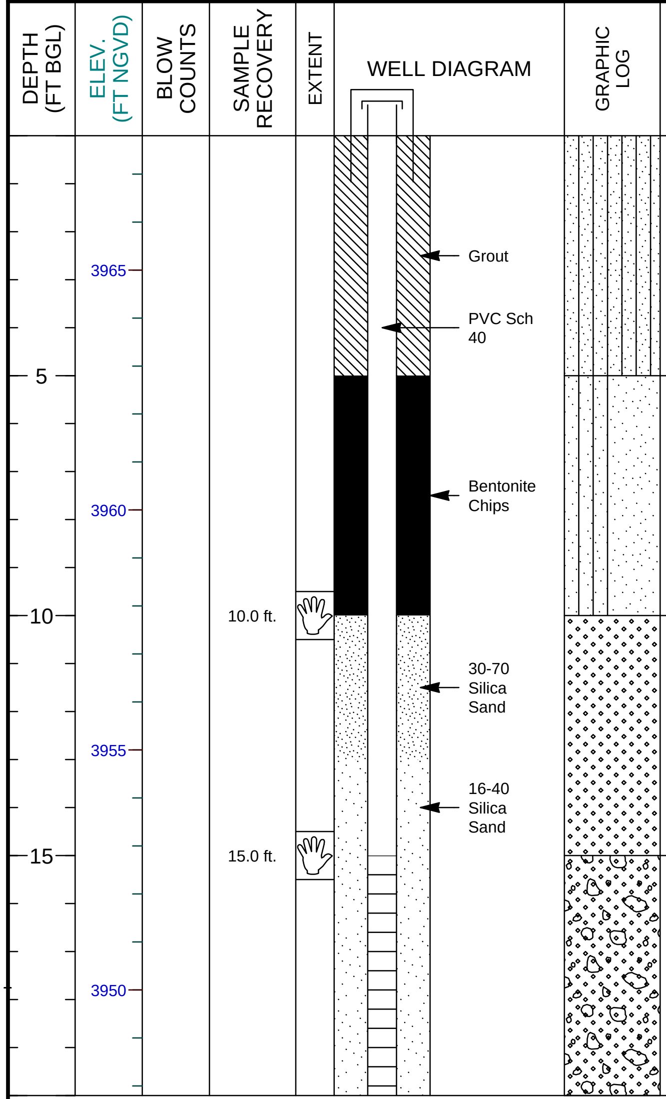
PROJECT MOAB
LOCATION Moab, UT
SITE Moab Disposal Site
DRILLING METHOD AIR PERCUSSION
DRILL COMPANY Layne Christensen Co
RIG TYPE AP 1000

WELL NUMBER 0578
NORTH COORD. (FT) 6663818.80
EAST COORD. (FT) 2186115.88
HOLE DEPTH (FT) 35.00
WELL DEPTH (FT) 31.30
WATER LEVEL (FT BGS)

DATE DRILLED 07/18/2004 to 07/19/2004
SURFACE ELEV. (FT NGVD) 3967.80
TOP OF CASING (FT) 3965.08
MEAS. PT. ELEV. (FT) 3965.08
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 12.5

	WELL INSTALLATION	INTERVAL (FT)		
BLANK CASING:	6 in. PVC Sch 40	2.72	to	15.0
WELL SCREEN:	6 in. PVC Vee Wire Wrapped	15.0	to	30.0
SUMP/END CAP:	6 in. PVC Sch 40	30.0	to	31.3
GROUT:	Grout	0.0	to	5.0
SEAL:	Bentonite Chips	5.0	to	10.0
UPPER PACK:	30-70 Silica Sand	10.0	to	13.0
LOWER PACK:	16-40 Silica Sand	13.0	to	35.0

DRILLER Kern, T
LOGGED BY Goodknight, C.
SAMPLING METHOD CYCLONE- 5.0 ft. intervals
DATE DEVELOPED
REMARKS Extraction Well.



LITHOLOGIC DESCRIPTION

0-5.0 ft. SILTY SAND (SM); brown (10YR 5/3), 80% very fine sand, 20% silt, dry.

5.0-10.0 ft. SANDY SILT (ML-SP); brown (10YR 4/3), 80% silt, 20% very fine sand, slightly moist.

@10.0 ft. small piece of wood about 3.0" x 1/4".

10.0-15.0 ft. SAND (SW); brown (7.5YR 5/4), 80% fine sand, 10% silt, 10% medium sand including trace amount of 1/4" to 1/2" pebbles, slightly moist. Piece of wood fragment about 9.0" x 1.5".

@15.0 ft. wood fragment about 9.0" x 1.5".

15.0-35.0 ft. GRAVELLY SAND (SW-GW); brown (7.5YR 4/3), 20% gravel up to 2.0" in diameter, 80% matrix of mostly very fine to medium grained sand.

MONITORING WELL COMPLETION LOG MOA01-0578

PROJECT MOAB

SITE Moab Disposal Site

WELL NUMBER 0578

DATES DRILLED 07/18/2004 to 07/19/2004

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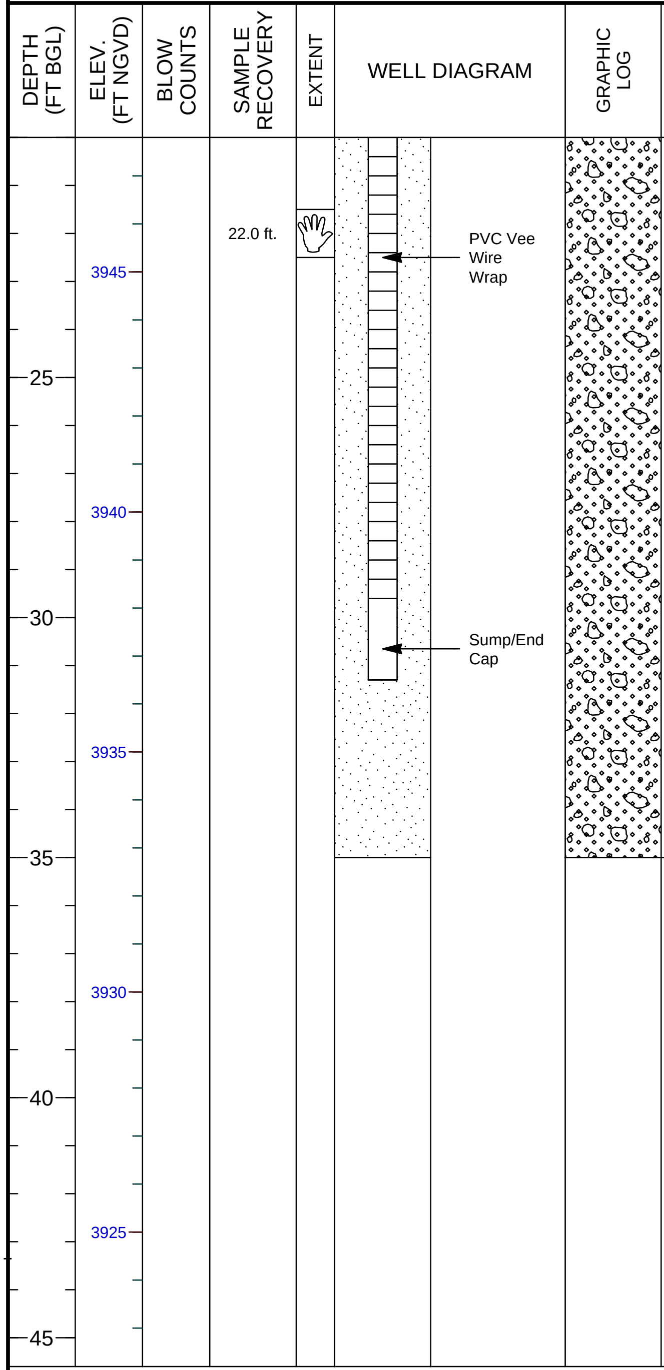


LITHOLOGIC DESCRIPTION

20.0-35.0 ft. wet, approximately equal amounts of sand (medium to fine grained) and gravel (pebbles and cobbles up to 3.0" in diameter), matrix sandy material is brown (7.5YR 4/3). Calcareous throughout hole depth.

@22.0 ft. soft unburned wood fragments.

Total Depth 35.0 ft.

MONITORING WELL COMPLETION LOG MOA01-0579

PROJECT	MOAB	**WELL NUMBER**	0579	**DATE DRILLED**	07/12/2004 to 07/18/2004
LOCATION	Moab, UT	**NORTH COORD. (FT)**	6663846.60	**SURFACE ELEV. (FT NGVD)**	3967.21
SITE	Moab Disposal Site	**EAST COORD. (FT)**	2186121.18	**TOP OF CASING (FT)**	3965.11
DRILLING METHOD	AIR PERCUSSION	**HOLE DEPTH (FT)**	45.00	**MEAS. PT. ELEV. (FT)**	3965.11
DRILL COMPANY	Layne Christensen Co	**WELL DEPTH (FT)**	41.30	**SLOT SIZE (IN)**	0.010
RIG TYPE	AP 1000	**WATER LEVEL (FT BGS)**		**BIT SIZE(S) (IN)**	12.5

	WELL INSTALLATION	**INTERVAL (FT)**		
BLANK CASING:	6 in. PVC Sch 40	2.1	to	25.0
WELL SCREEN:	6 in. PVC Vee Wire Wrapped	25.0	to	40.0
SUMP/END CAP:	6 in. PVC Sch 40	40.0	to	41.3
GROUT:	Grout	0.0	to	14.5
SEAL:	Bentonite Chips	14.5	to	19.5
UPPER PACK:	30-70 Silica Sand	19.5	to	22.5
LOWER PACK:	16-40 Silica Sand	22.5	to	45.0

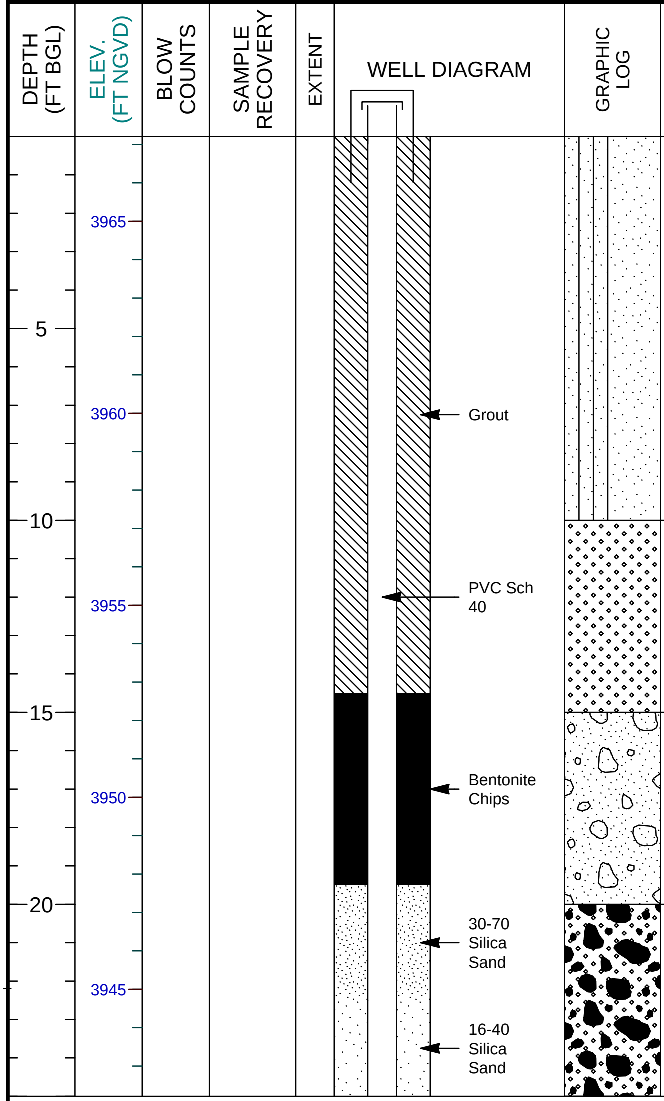
DRILLER Kern, T

LOGGED BY Goodknight, C.

SAMPLING METHOD CYCLONE- 5.0 ft. intervals

DATE DEVELOPED

REMARKS Extraction Well.



LITHOLOGIC DESCRIPTION

0-10.0 ft. SANDY SILT (ML-SP); reddish brown (5YR 4/4), slightly damp, mostly silt and very fine grained sand, trace clay.

10.0-15.0 ft. SAND (SW); mostly fine to medium grained, damp, brown (7.5YR 4/4).

15.0-20.0 ft. GRAVELLY SAND (SP-GP); damp to moist, brown (7.5YR 4/4), sand (75%) and gravel (25%) up to 3.0" in diameter.

20.0-25.0 ft. SANDY GRAVEL (GW-SW); mostly well rounded gravel of 1.0" to 4.0" in diameter (70%), and fine to medium grained sand (30%), wet, brown.

MONITORING WELL COMPLETION LOG MOA01-0579

PROJECT MOAB
SITE Moab Disposal Site
WELL NUMBER 0579
DATES DRILLED 07/12/2004 to 07/18/2004

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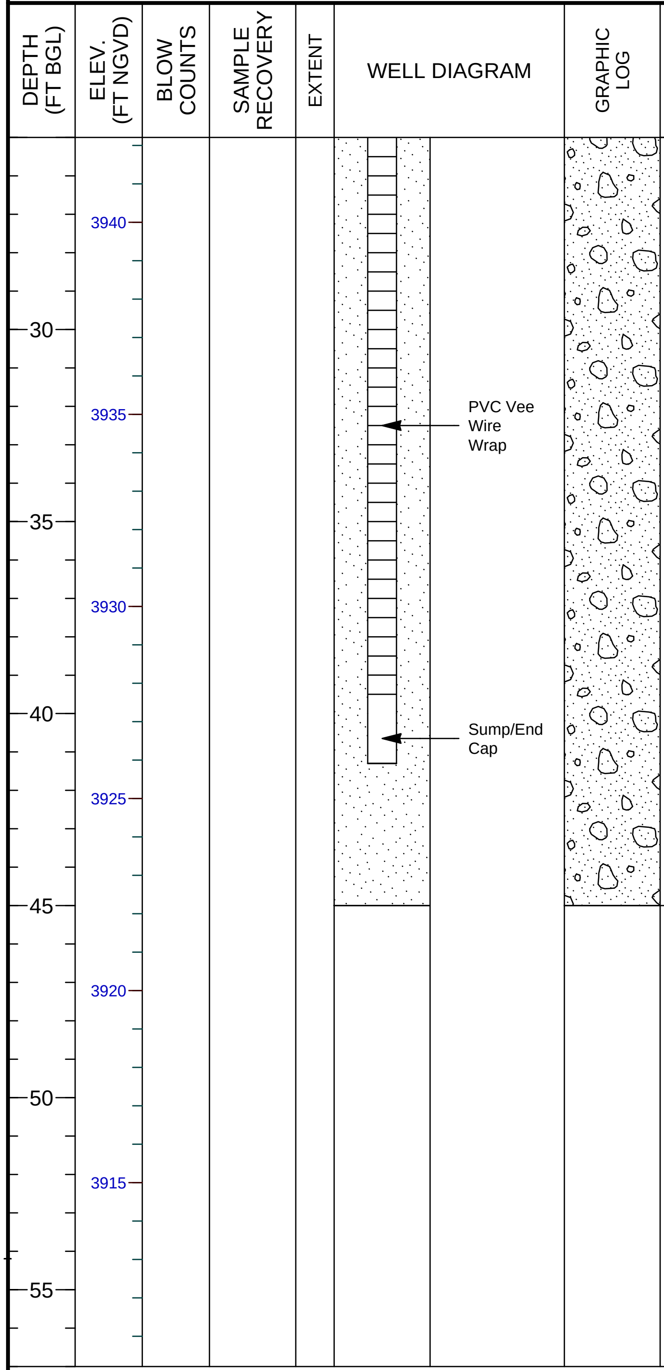

LITHOLOGIC DESCRIPTION

25.0-45.0 ft. GRAVELLY SAND (SP-GP); mostly fine to medium grained sand (60%), and well-rounded cobbles 1.0" to 3.0" in diameter (40%), brown (7.5YR 4/2).

@33.0 ft. becomes more sandy and fewer cobbles.

@38.0 ft. More sand (80%) and cobbles (20%) up to 2.0" in diameter, brown (7.5YR 4/2).

Total Depth 45.0 ft.

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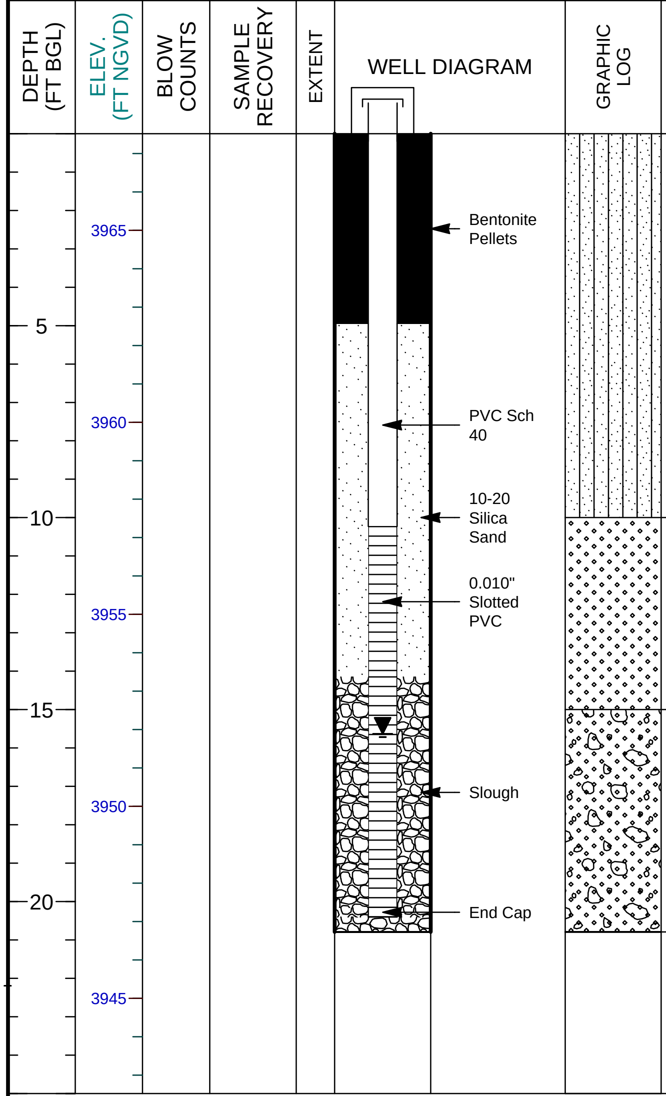
GRAND JUNCTION OFFICE, COLORADO

MONITORING WELL COMPLETION LOG MOA01-0580

PROJECT MOAB	**WELL NUMBER** 0580	**DATE DRILLED** 07/28/2004
LOCATION Moab, UT	**NORTH COORD. (FT)** 6663550.52	**SURFACE ELEV. (FT NGVD)** 3967.52
SITE Moab Disposal Site	**EAST COORD. (FT)** 2186065.17	**TOP OF CASING (FT)** 3969.32
DRILLING METHOD GEOPROBE	**HOLE DEPTH (FT)** 20.79	**MEAS. PT. ELEV. (FT)** 3969.32
DRILL COMPANY S.M. Stoller	**WELL DEPTH (FT)** 20.40	**SLOT SIZE (IN)** 0.010
RIG TYPE GEOPROBE	**WATER LEVEL (FT BTOC)** 17.43	**BIT SIZE(S) (IN)** 2.13

	WELL INSTALLATION	**INTERVAL (FT)**		
SURFACE CASING:	4 in. PVC Sch 40	-2.14	to	0.0
BLANK CASING:	1 in. PVC Sch 40	-1.8	to	10.23
WELL SCREEN:	1 in. 0.01 Slotted PVC	10.23	to	20.16
SUMP/END CAP:	1 in. PVC Sch 40	20.16	to	20.4
SEAL:	Bentonite Pellets	0.0	to	4.95
UPPER PACK:				
LOWER PACK:	10-20 Silica Sand	4.95	to	14.15

DRILLER Trevino, Joe
LOGGED BY Hopping, B.
SAMPLING METHOD CORE BARREL
DATE DEVELOPED 08/13/2004
REMARKS Lithology from well 0570 was used for the lithology description for this well.



LITHOLOGIC DESCRIPTION

0-10.0 ft. SILTY SAND (SM); dry, mostly very fine grained sand (80%), and ~20% silt, brown (7.5YR 5/4).

5.0-10.0 ft. sightly damp, brown (7.5YR 5/3).

10.0-15.0 ft. SAND (SW); mostly fine to medium grained, damp, brown (7.5YR 5/4), trace small pebbles up to 1/4" in diameter.

15.0-20.79 ft. GRAVELLY SAND (SW-GW); moist to wet, ~80% sand, very fine grained to medium grained, ~20% pebbles up to 2.0" in diameter, matrix sand is brown (7.5YR 4/4).

Total Depth 20.79 ft.

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MONITORING WELL COMPLETION LOG MOA01-0581

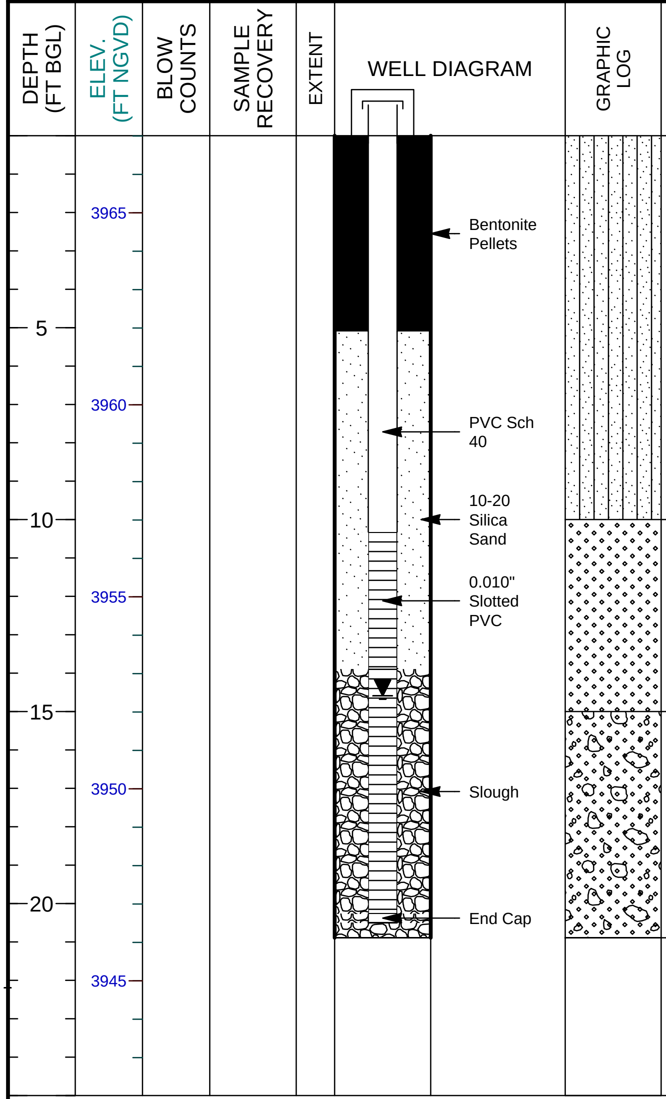
PROJECT MOAB
LOCATION Moab, UT
SITE Moab Disposal Site
DRILLING METHOD GEOPROBE
DRILL COMPANY S.M. Stoller
RIG TYPE GEOPROBE

WELL NUMBER 0581
NORTH COORD. (FT) 6663630.59
EAST COORD. (FT) 2186051.86
HOLE DEPTH (FT) 20.89
WELL DEPTH (FT) 20.50
WATER LEVEL (FT BTOC) 16.6

DATE DRILLED 07/28/2004
SURFACE ELEV. (FT NGVD) 3967.01
TOP OF CASING (FT) 3969.02
MEAS. PT. ELEV. (FT) 3969.02
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 2.13

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:	4 in. PVC Sch 40	-2.09	to	0.0
BLANK CASING:	1 in. PVC Sch 40	-2.01	to	10.33
WELL SCREEN:	1 in. 0.01 Slotted PVC	10.33	to	20.26
SUMP/END CAP:	1 in. PVC Sch 40	20.26	to	20.5
SEAL:	Bentonite Pellets	0.0	to	5.1
UPPER PACK:				
LOWER PACK:	10-20 Silica Sand	5.1	to	13.9

DRILLER Trevino, Joe
LOGGED BY Hopping, B.
SAMPLING METHOD CORE BARREL
DATE DEVELOPED 08/13/2004
REMARKS Lithology from well 0571 was used for the lithology description for this well.



LITHOLOGIC DESCRIPTION

0-10.0 ft. SILTY SAND (SM); dry, mostly very fine grained sand (~80%) and ~20% silt, brown (7.5YR 5/4).

5.0-10.0 ft. trace clay that has white (caliche) mottles, brown (7.5YR 5/3), slightly damp.

10.0-15.0 ft. SAND (SW); mostly fine to medium grained, damp, brown (7.5YR 5/4), trace pebbles up to 1/2" in diameter, trace burned woody material.

15.0-20.89 ft. GRAVELLY SAND (SW-GW); moist to wet, ~80% sand, very fine to medium grained, ~20% pebbles and cobbles up to 4.0" in diameter, matrix sand is brown (7.5YR 4/4).

Total Depth 20.89 ft.

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MONITORING WELL COMPLETION LOG MOA01-0582

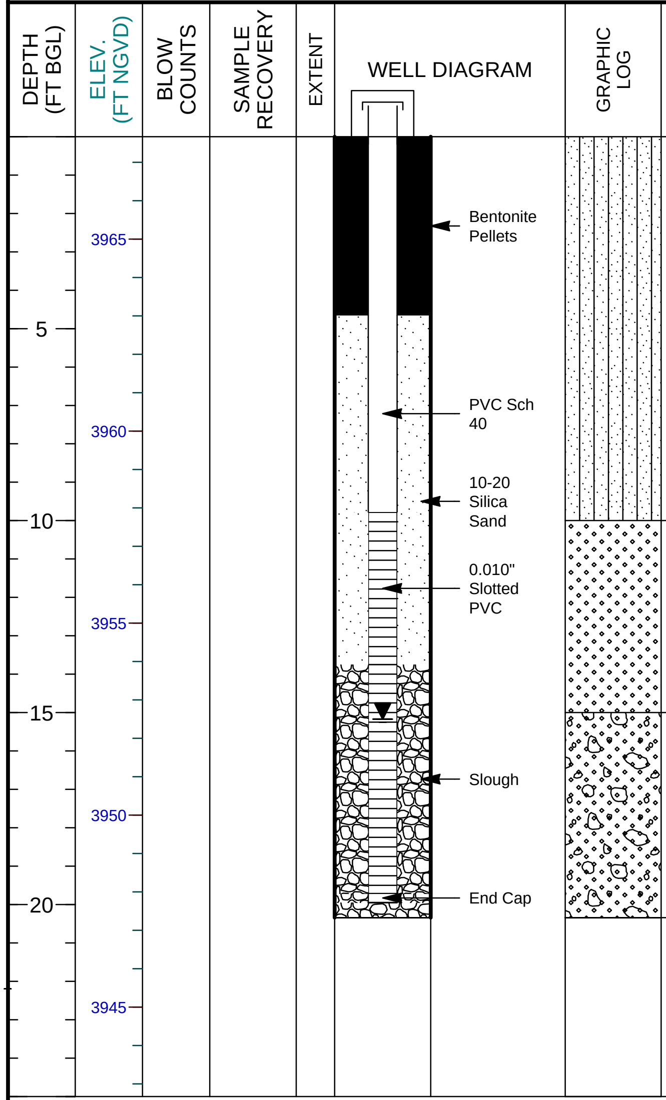
PROJECT MOAB
LOCATION Moab, UT
SITE Moab Disposal Site
DRILLING METHOD GEOPROBE
DRILL COMPANY S.M. Stoller
RIG TYPE GEOPROBE

WELL NUMBER 0582
NORTH COORD. (FT) 6663621.04
EAST COORD. (FT) 2186094.78
HOLE DEPTH (FT) 20.34
WELL DEPTH (FT) 19.95
WATER LEVEL (FT BTOC) 17.15

DATE DRILLED 07/28/2004
SURFACE ELEV. (FT NGVD) 3967.67
TOP OF CASING (FT) 3969.65
MEAS. PT. ELEV. (FT) 3969.65
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 2.13

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:	4 in. PVC Sch 40	-2.06	to	0.0
BLANK CASING:	1 in. PVC Sch 40	-1.98	to	9.78
WELL SCREEN:	1 in. 0.01 Slotted PVC	9.78	to	19.71
SUMP/END CAP:	1 in. PVC Sch 40	19.71	to	19.95
SEAL:	Bentonite Pellets	0.0	to	4.65
UPPER PACK:				
LOWER PACK:	10-20 Silica Sand	4.65	to	13.75

DRILLER Trevino, Joe
LOGGED BY Hopping, B.
SAMPLING METHOD CORE BARREL
DATE DEVELOPED 08/13/2004
REMARKS Lithology from well 0572 was used for the lithology description for this well.



LITHOLOGIC DESCRIPTION

0-10.0 ft. SILTY SAND (SM); dry, mostly very fine grained sand (80%) and ~20% silt, brown (7.5YR 5/4).

5.0-10.0 ft. trace clay that has white (caliche) mottles, brown (7.5YR 5/3), slightly damp.

10.0-15.0 ft. SAND (SW); mostly fine to medium grained sand, damp, brown (7.5YR 5/4), trace pebbles up to 1/2" in diameter, trace burned woody material.

15.0-20.34 ft. GRAVELLY SAND (SW-GW); moist to wet, 80-85% sand, very fine to medium grained. Pebbles (~15%) up to 2.0" in diameter, matrix sand is brown (7.5YR 4/4), some clay/silt (~5%).

Total Depth 20.34 ft.

MONITORING WELL COMPLETION LOG MOA01-0583

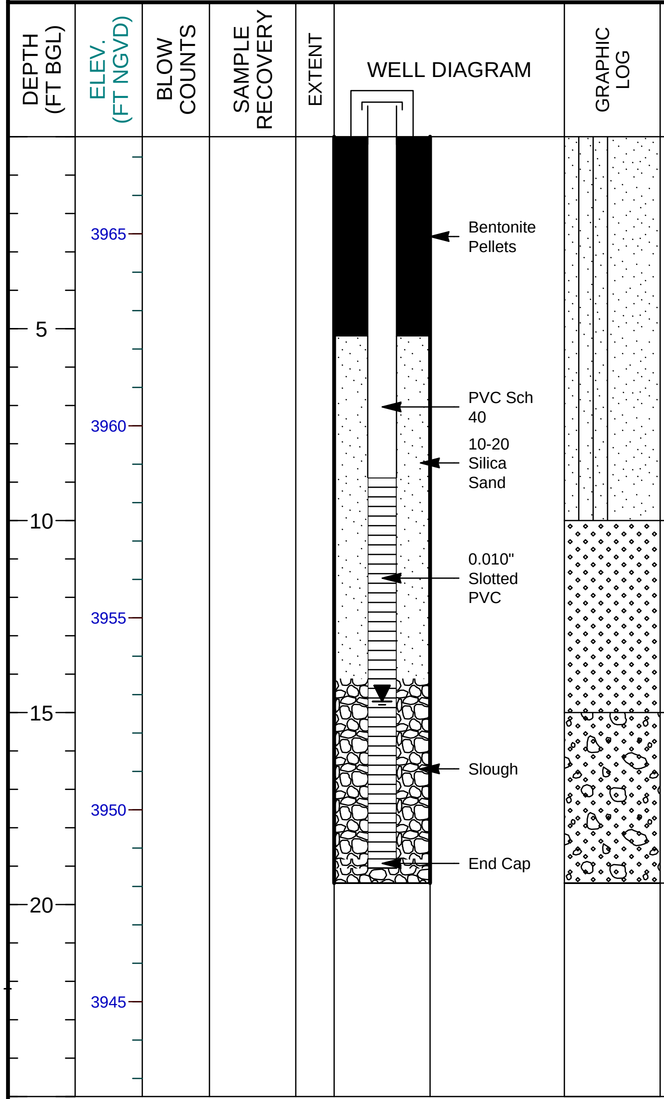
PROJECT MOAB
LOCATION Moab, UT
SITE Moab Disposal Site
DRILLING METHOD GEOPROBE
DRILL COMPANY S.M. Stoller
RIG TYPE GEOPROBE

WELL NUMBER 0583
NORTH COORD. (FT) 6663718.85
EAST COORD. (FT) 2186067.22
HOLE DEPTH (FT) 19.44
WELL DEPTH (FT) 19.05
WATER LEVEL (FT BTOC) 16.82

DATE DRILLED 07/27/2004
SURFACE ELEV. (FT NGVD) 3967.53
TOP OF CASING (FT) 3969.64
MEAS. PT. ELEV. (FT) 3969.64
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 2.13

	WELL INSTALLATION	**INTERVAL (FT)**		
SURFACE CASING:	4 in. PVC Sch 40	-2.39	to	0.0
BLANK CASING:	1 in. PVC Sch 40	-2.11	to	8.88
WELL SCREEN:	1 in. 0.01 Slotted PVC	8.88	to	18.81
SUMP/END CAP:	1 in. PVC Sch 40	18.81	to	19.05
SEAL:	Bentonite Pellets	0.0	to	5.2
UPPER PACK:				
LOWER PACK:	10-20 Silica Sand	5.2	to	14.12

DRILLER Trevino, Joe
LOGGED BY Hopping, B.
SAMPLING METHOD CORE BARREL
DATE DEVELOPED 08/13/2004
REMARKS Lithology from well 0574 was used for the lithology description for this well.



LITHOLOGIC DESCRIPTION

0-10.0 ft. SANDY SILT (ML-SP); dry, mostly silt (80%) and ~20% very fine grained sand, pale brown (10YR 6/3).

5.0-10.0 ft. trace clay with mottles (white), brown (7.5YR 5/3), slightly damp.

10.0-15.0 ft. SAND (SW); mostly fine to medium grained, damp, brown (7.5YR 5/3), trace pebbles up to 1/2" in diameter.

15.0-19.44 ft. GRAVELLY SAND (SW-GW); moist, 80% sand, very fine to medium grained, 20% pebbles up to 2.0" in diameter, matrix sand is brown (7.5YR 4/3).

Total Depth 19.44 ft.

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GRAND JUNCTION OFFICE, COLORADO

11/16/2004

MONITORING WELL COMPLETION LOG MOA01-0584

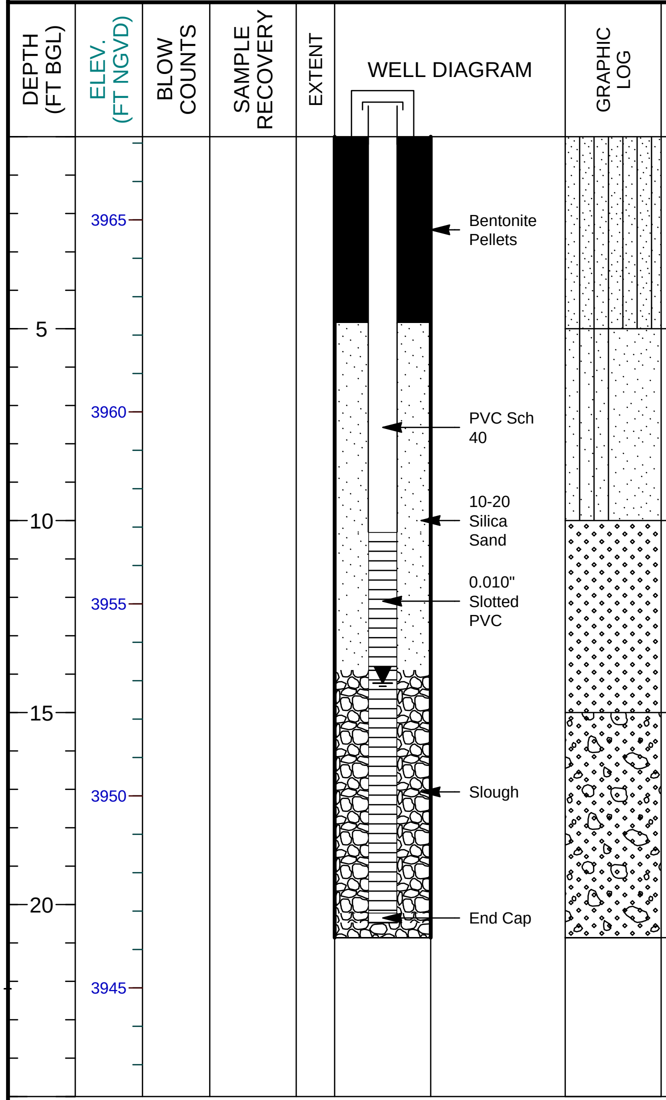
PROJECT MOAB
LOCATION Moab, UT
SITE Moab Disposal Site
DRILLING METHOD GEOPROBE
DRILL COMPANY S.M. Stoller
RIG TYPE GEOPROBE

WELL NUMBER 0584
NORTH COORD. (FT) 6663747.08
EAST COORD. (FT) 2186072.43
HOLE DEPTH (FT) 20.86
WELL DEPTH (FT) 20.47
WATER LEVEL (FT BTOC) 16.19

DATE DRILLED 07/27/2004
SURFACE ELEV. (FT NGVD) 3967.17
TOP OF CASING (FT) 3969.13
MEAS. PT. ELEV. (FT) 3969.13
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 2.13

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:	4 in. PVC Sch 40	-2.41	to	0.0
BLANK CASING:	1 in. PVC Sch 40	-1.96	to	10.3
WELL SCREEN:	1 in. 0.01 Slotted PVC	10.3	to	20.23
SUMP/END CAP:	1 in. PVC Sch 40	20.23	to	20.47
SEAL:	Bentonite Pellets	0.0	to	4.85
UPPER PACK:				
LOWER PACK:	10-20 Silica Sand	4.85	to	13.9

DRILLER Trevino, Joe
LOGGED BY Hopping, B.
SAMPLING METHOD CORE BARREL
DATE DEVELOPED 08/13/2004
REMARKS Lithology from well 0575 was used for the lithology description for this well.



LITHOLOGIC DESCRIPTION

0-5.0 ft. SILTY SAND (SM); approximately 80% very fine grained sand with 20% silt, pale brown (10YR 6/3), dry.

5.0-10.0 ft. SANDY SILT (ML-SP); slightly damp, mostly silt (80%) and ~20% very fine grained sand, brown (7.5YR 5/3), trace clay with mottles (white).

10.0-15.0 ft. SAND (SW); fine to medium grained, damp, brown (7.5YR 5/3).

15.0-20.86 ft. GRAVELLY SAND (SW-GW); moist, ~80% sand, very fine to medium grained, ~20% pebbles up to 2.0" in diameter, matrix sand is brown (7.5YR 4/3).

Total Depth 20.86 ft.

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MONITORING WELL COMPLETION LOG MOA01-0585

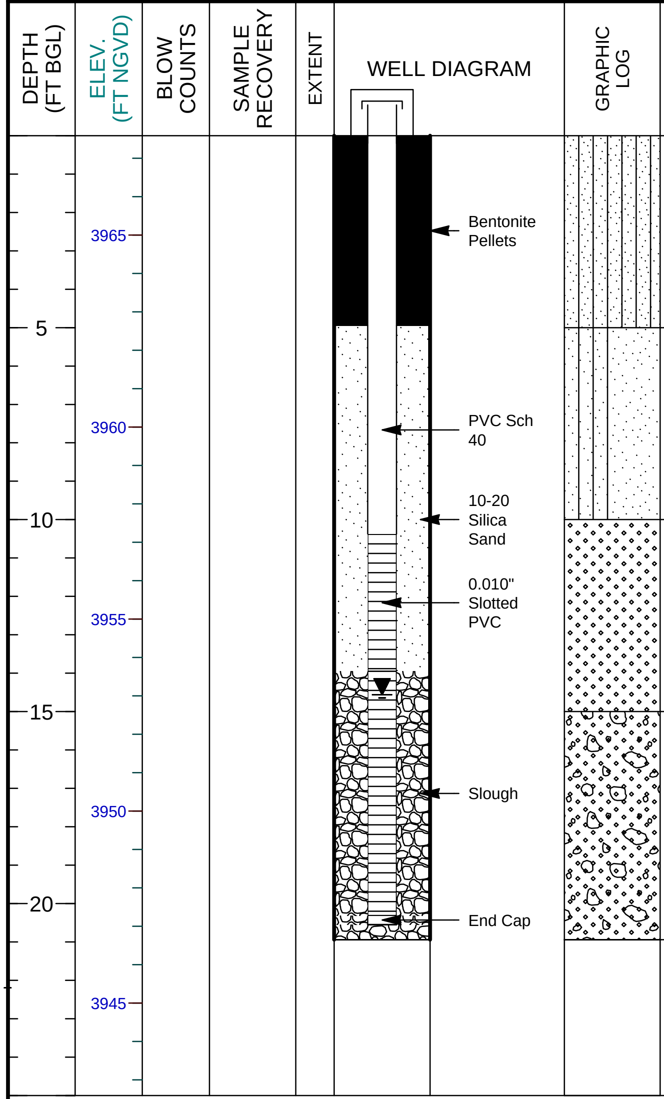
PROJECT MOAB
LOCATION Moab, UT
SITE Moab Disposal Site
DRILLING METHOD GEOPROBE
DRILL COMPANY S.M. Stoller
RIG TYPE GEOPROBE

WELL NUMBER 0585
NORTH COORD. (FT) 6663771.73
EAST COORD. (FT) 2186121.01
HOLE DEPTH (FT) 20.94
WELL DEPTH (FT) 20.55
WATER LEVEL (FT BTOC) 16.33

DATE DRILLED 07/29/2004
SURFACE ELEV. (FT NGVD) 3967.59
TOP OF CASING (FT) 3969.36
MEAS. PT. ELEV. (FT) 3969.36
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 2.13

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:	4 in. PVC Sch 40	-1.86	to	0.0
BLANK CASING:	1 in. PVC Sch 40	-1.77	to	10.38
WELL SCREEN:	1 in. 0.01 Slotted PVC	10.38	to	20.31
SUMP/END CAP:	1 in. PVC Sch 40	20.31	to	20.55
SEAL:	Bentonite Pellets	0.0	to	4.95
UPPER PACK:				
LOWER PACK:	10-20 Silica Sand	4.95	to	13.95

DRILLER Trevino, Joe
LOGGED BY Hopping, B.
SAMPLING METHOD CORE BARREL
DATE DEVELOPED 08/13/2004
REMARKS Lithology from well 0577 was used for the lithology description for this well.



LITHOLOGIC DESCRIPTION

0-5.0 ft. SILTY SAND (SM); damp, mostly very fine grained sand (80%), 20% silt, brown (7.5YR 4/2).

5.0-10.0 ft. SANDY SILT (ML-SP); dry, 80% silt, and 20% very fine grained sand, brown (7.5YR 5/3), trace clay with mottles (white).

10.0-15.0 ft. SAND (SW); mostly fine to medium grained, damp, brown (7.5YR 5/3), trace pebbles (1/2" in diameter).

15.0-20.94 ft. GRAVELLY SAND (SW-GW); damp to moist, 75-80% very fine to medium grained sand, 20% pebbles up to 2.0" in diameter, matrix sand is brown (7.5YR 5/3).

Total Depth 20.94 ft.

MONITORING WELL COMPLETION LOG MOA01-0586

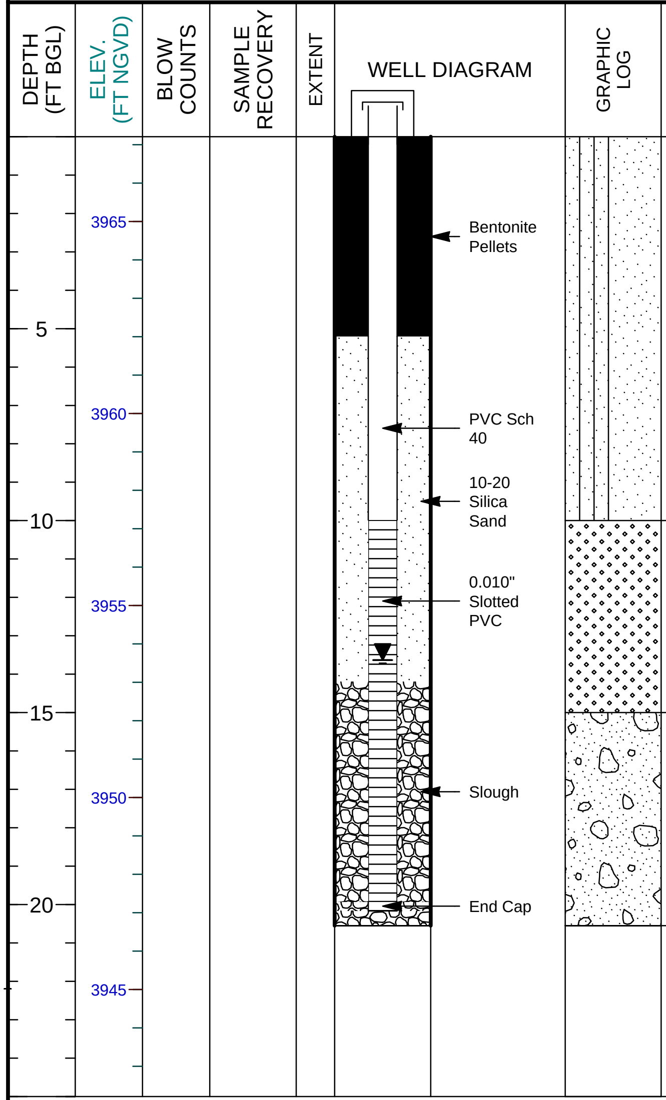
PROJECT MOAB
LOCATION Moab, UT
SITE Moab Disposal Site
DRILLING METHOD GEOPROBE
DRILL COMPANY S.M. Stoller
RIG TYPE GEOPROBE

WELL NUMBER 0586
NORTH COORD. (FT) 6663875.81
EAST COORD. (FT) 2186128.79
HOLE DEPTH (FT) 20.55
WELL DEPTH (FT) 20.16
WATER LEVEL (FT BTOC) 15.62

DATE DRILLED 07/27/2004
SURFACE ELEV. (FT NGVD) 3967.21
TOP OF CASING (FT) 3969.20
MEAS. PT. ELEV. (FT) 3969.20
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 2.13

	WELL INSTALLATION	**INTERVAL (FT)**		
SURFACE CASING:	4 in. PVC Sch 40	-2.25	to	0.0
BLANK CASING:	1 in. PVC Sch 40	-1.99	to	9.99
WELL SCREEN:	1 in. 0.01 Slotted PVC	9.99	to	19.92
SUMP/END CAP:	1 in. PVC Sch 40	19.92	to	20.16
SEAL:	Bentonite Pellets	0.0	to	5.2
UPPER PACK:				
LOWER PACK:	10-20 Silica Sand	5.2	to	14.2

DRILLER Trevino, Joe
LOGGED BY Hopping, B.
SAMPLING METHOD CORE BARREL
DATE DEVELOPED 08/13/2004
REMARKS Lithology from well 0579 was used for the lithology description for this well.



LITHOLOGIC DESCRIPTION

0-10.0 ft. SANDY SILT (ML-SP); reddish brown (5YR 4/4), slightly damp, mostly silt and very fine grained sand, trace clay.

10.0-15.0 ft. SAND (SW); mostly fine to medium grained, damp, brown (7.5YR 4/4).

15.0-20.55 ft. GRAVELLY SAND (SP-GP); damp to moist, brown (7.5YR 4/4), sand (75%) and gravel (25%) up to 3.0" in diameter.

Total Depth 20.55 ft.

Stoller

U.S. DEPARTMENT OF ENERGY
GRAND JUNCTION OFFICE, COLORADO

11/16/2004

MONITORING WELL COMPLETION LOG MOA01-0587

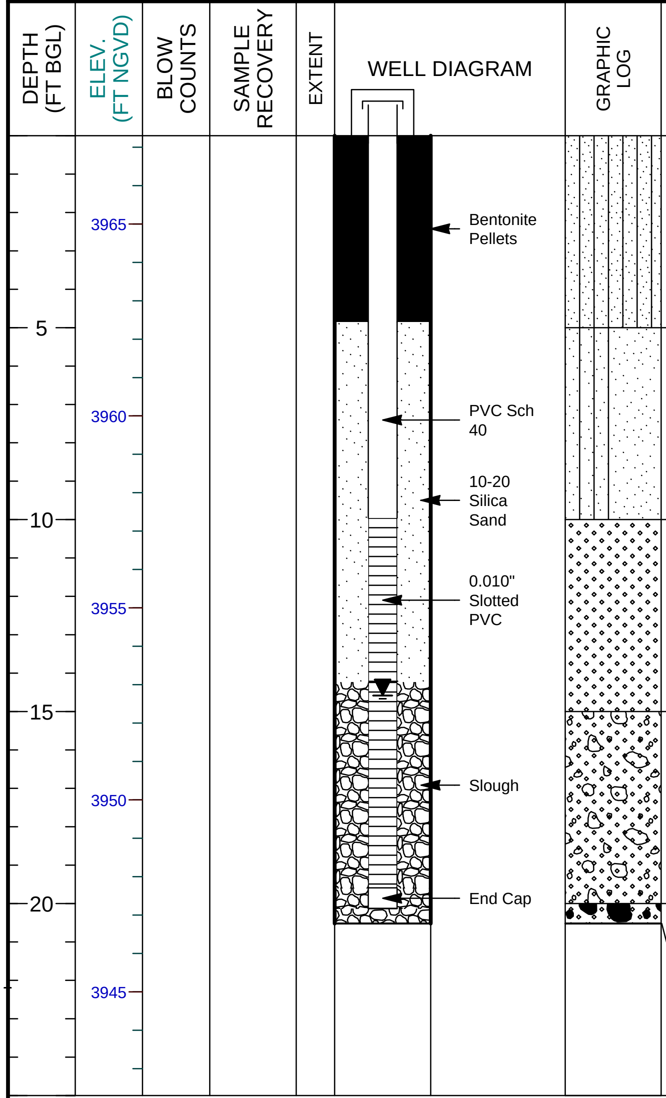
PROJECT MOAB
LOCATION Moab, UT
SITE Moab Disposal Site
DRILLING METHOD GEOPROBE
DRILL COMPANY S.M. Stoller
RIG TYPE GEOPROBE

WELL NUMBER 0587
NORTH COORD. (FT) 6663713.83
EAST COORD. (FT) 2186098.18
HOLE DEPTH (FT) 20.52
WELL DEPTH (FT) 20.13
WATER LEVEL (FT BTOC) 16.17

DATE DRILLED 07/28/2004
SURFACE ELEV. (FT NGVD) 3967.30
TOP OF CASING (FT) 3968.89
MEAS. PT. ELEV. (FT) 3968.89
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 2.13

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:	4 in. PVC Sch 40	-2.15	to	0.0
BLANK CASING:	1 in. PVC Sch 40	-1.59	to	9.96
WELL SCREEN:	1 in. 0.01 Slotted PVC	9.96	to	19.59
SUMP/END CAP:	1 in. PVC Sch 40	19.59	to	20.13
SEAL:	Bentonite Pellets	0.0	to	4.85
UPPER PACK:				
LOWER PACK:	10-20 Silica Sand	4.85	to	14.24

DRILLER Trevino, Joe
LOGGED BY Hopping, B.
SAMPLING METHOD CORE BARREL
DATE DEVELOPED 08/13/2004
REMARKS Lithology from well 0575 was used for the lithology description for this well.



LITHOLOGIC DESCRIPTION

0-5.0 ft. SILTY SAND (SM); approximately 80% very fine grained sand with 20% silt, pale brown (10YR 6/3), dry.

5.0-10.0 ft. SANDY SILT (ML-SP); slightly damp, mostly silt (80%) and ~20% very fine grained sand, brown (7.5YR 5/3), trace clay with mottles (white).

10.0-15.0 ft. SAND (SW); fine to medium grained, damp, brown (7.5YR 5/3).

15.0-20.0 ft. GRAVELLY SAND (SW-GW); moist, ~80% sand, very fine to medium grained, ~20% pebbles up to 2.0" in diameter, matrix sand is brown (7.5YR 4/3).

20.0-20.52 ft. SANDY GRAVEL (GW-SW); ~60% gravel and cobbles up to 3.0" in diameter, matrix sandy material is fine to medium grained and brown (7.5YR 4/3), wet.

Total Depth 20.52 ft.

MONITORING WELL COMPLETION LOG MOA01-0588

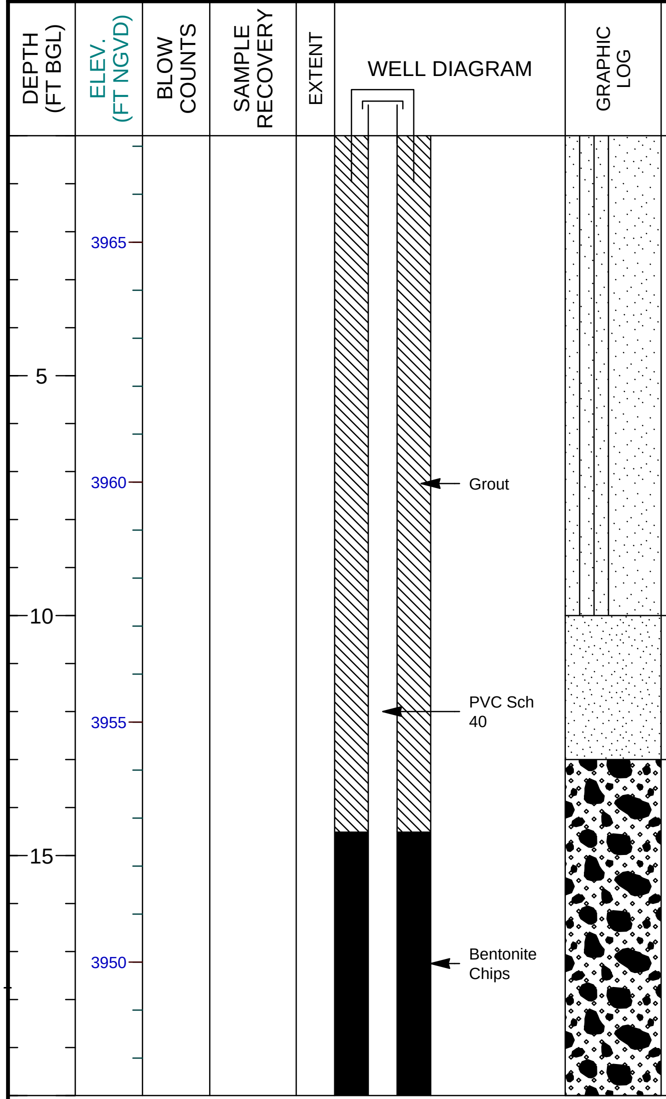
PROJECT MOAB
LOCATION Moab, UT
SITE Moab Disposal Site
DRILLING METHOD AIR PERCUSSION
DRILL COMPANY Layne Christensen Co
RIG TYPE AP 1000

WELL NUMBER 0588
NORTH COORD. (FT) 6663720.93
EAST COORD. (FT) 2186105.00
HOLE DEPTH (FT) 40.00
WELL DEPTH (FT) 35.10
WATER LEVEL (FT BGS)

DATE DRILLED 07/13/2004
SURFACE ELEV. (FT NGVD) 3967.22
TOP OF CASING (FT) 3969.04
MEAS. PT. ELEV. (FT) 3969.04
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 12.5

	WELL INSTALLATION	**INTERVAL (FT)**		
BLANK CASING:	6 in. PVC Sch 40	-1.82	to	24.8
WELL SCREEN:	6 in. PVC Vee Wire Wrapped	24.8	to	34.8
SUMP/END CAP:	6 in. PVC Sch 40	34.8	to	35.1
GROUT:	Grout	0.0	to	14.5
SEAL:	Bentonite Chips	14.5	to	20.0
UPPER PACK:	30-70 Silica Sand	20.0	to	23.0
LOWER PACK:	16-40 Silica Sand	23.0	to	40.0

DRILLER Kern, T
LOGGED BY Goodknight, C.
SAMPLING METHOD CYCLONE- 5.0 ft. intervals
DATE DEVELOPED
REMARKS



LITHOLOGIC DESCRIPTION

0-10.0 ft. SANDY SILT (ML-SP); reddish brown (5YR 4/4), dry, mostly silt and very fine grained sand.

6.0-10.0 ft. sand increases, very fine grained, mottling with white caliche, trace clay, trace small pebbles.

10.0-13.0 ft. SAND (SP); mostly medium grained sand, with <5% clay, brown (7.5YR 4/4), trace pebbles.

13.0-40.0 ft. SANDY GRAVEL (GW-SW); damp, mostly (65%) well-rounded gravel up to 3.0" in diameter and fine to medium grained sand (30%), trace of clay or very fine grained sand, brown (7.5YR 4/4).

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GRAND JUNCTION OFFICE, COLORADO

MONITORING WELL COMPLETION LOG MOA01-0588

PROJECT MOAB

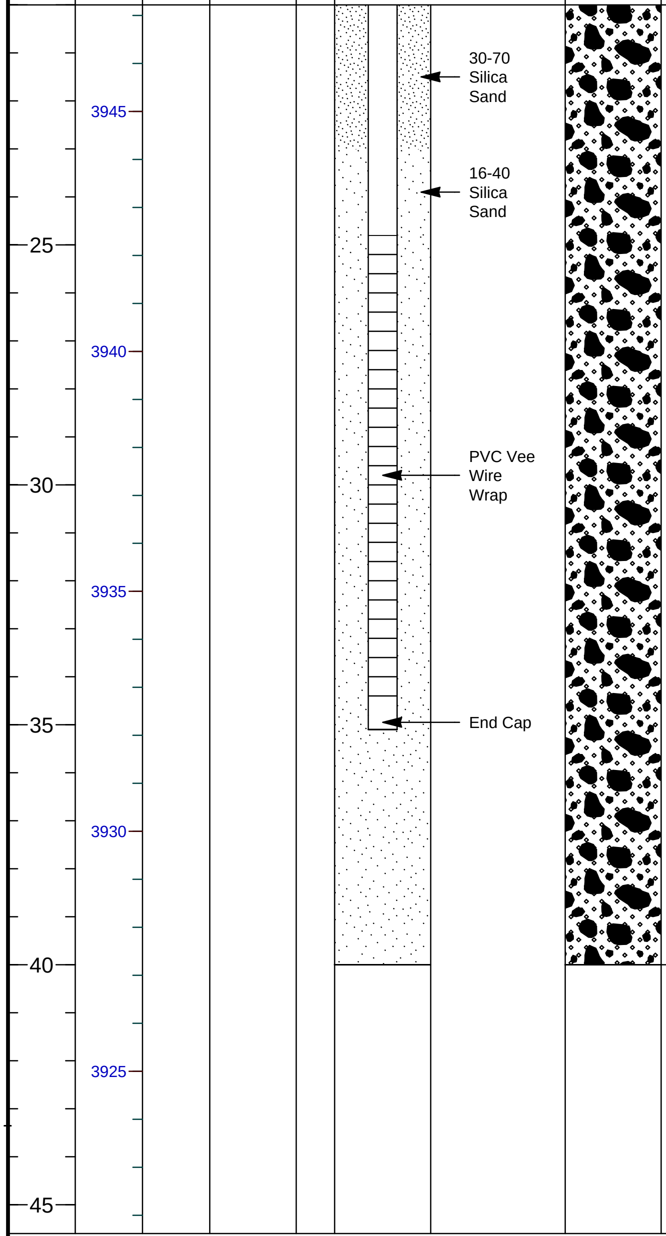
SITE Moab Disposal Site

WELL NUMBER 0588

DATES DRILLED 07/13/2004

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE RECOVERY	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION



20.0-25.0 ft. fine to medium grained sand increases to 40%, wet.

25.0-40.0 ft. sand decreases to 25% and cobble size increases to up to 5.0" in diameter.

Total Depth 40.0 ft.

MONITORING WELL COMPLETION LOG MOA01-0589

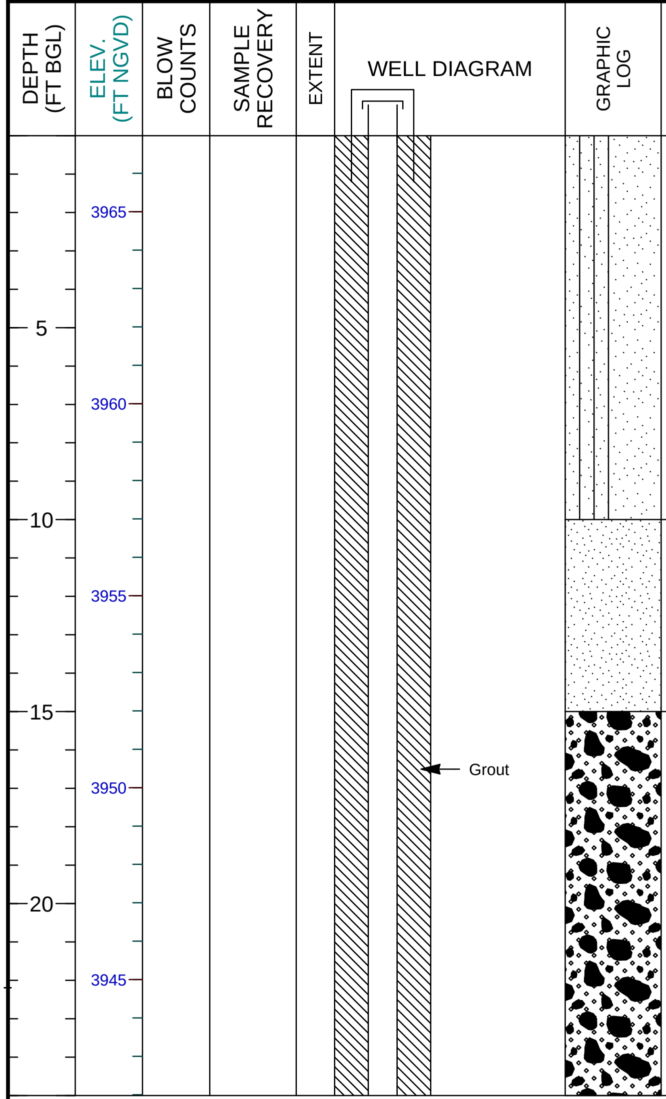
PROJECT MOAB
LOCATION Moab, UT
SITE Moab Disposal Site
DRILLING METHOD AIR PERCUSSION
DRILL COMPANY Layne Christensen Co
RIG TYPE AP 1000

WELL NUMBER 0589
NORTH COORD. (FT) 6663707.15
EAST COORD. (FT) 2186103.42
HOLE DEPTH (FT) 55.00
WELL DEPTH (FT) 53.00
WATER LEVEL (FT BGS)

DATE DRILLED 07/14/2004
SURFACE ELEV. (FT NGVD) 3966.98
TOP OF CASING (FT) 3968.87
MEAS. PT. ELEV. (FT) 3968.87
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 12.5

	WELL INSTALLATION	INTERVAL (FT)		
BLANK CASING:	6 in. PVC Sch 40	-1.89	to	42.7
WELL SCREEN:	6 in. PVC Vee Wire Wrapped	42.7	to	52.7
SUMP/END CAP:	6 in. PVC Sch 40	52.7	to	53.0
GROUT:	Grout	0.0	to	33.0
SEAL:	Bentonite Chips	33.0	to	37.5
UPPER PACK:	30-70 Silica Sand	37.5	to	41.0
LOWER PACK:	16-40 Silica Sand	41.0	to	55.0

DRILLER Kern, T
LOGGED BY Goodknight, C.
SAMPLING METHOD CYCLONE- 5.0 ft. intervals
DATE DEVELOPED
REMARKS



LITHOLOGIC DESCRIPTION

0-10.0 ft. SANDY SILT (ML-SP); brown (7.5YR 5/4), dry, mostly silt with some very fine grained sand, calcareous.

5.0-10.0 ft. slightly damp, trace clay, some mottling, increase of very fine grained sand, calcareous.

10.0-15.0 ft. SAND (SP); fine to medium grained sand, damp to moist, reddish brown (5YR 5/4), trace pebbles up to 1/2" in diameter, calcareous.

15.0-55.0 ft. SANDY GRAVEL (GW-SW); mostly well to subrounded gravel and cobbles up to 6.0" in diameter and fine to medium grained sand matrix (20-30%), reddish brown (7.5YR 4/4), wet, calcareous.

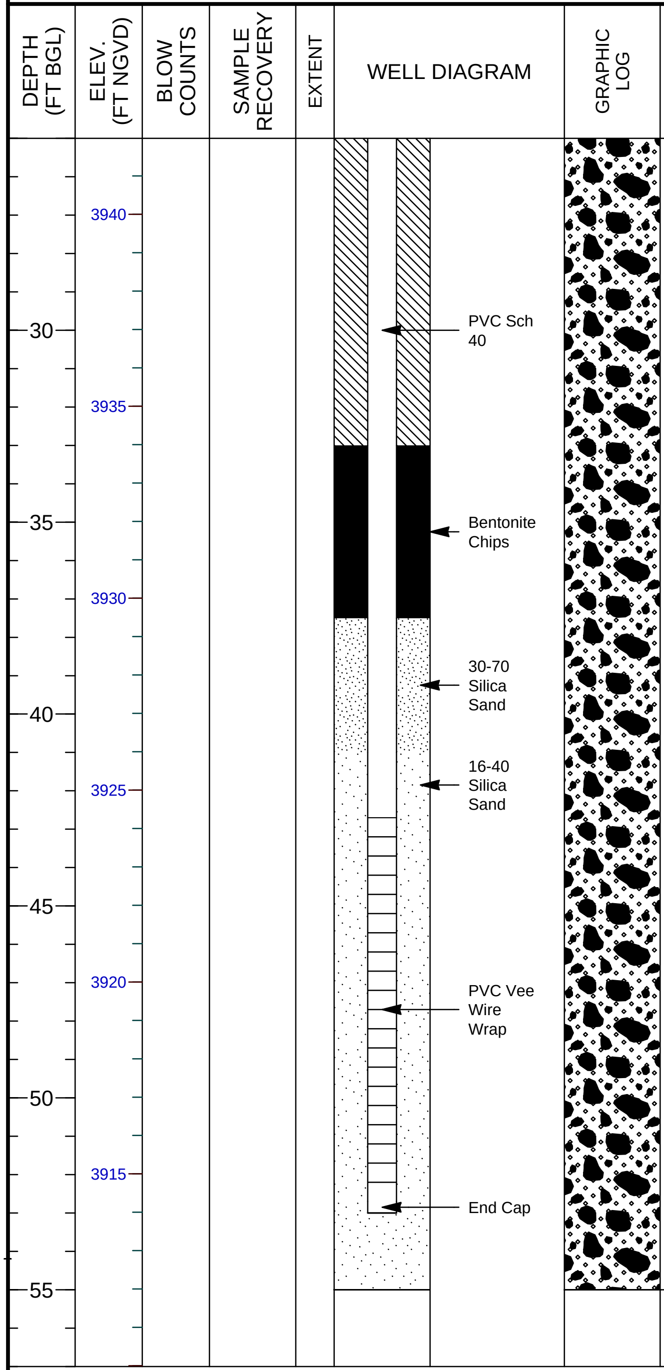
20.0-30.0 ft. assumed to be sandy gravel, as above. Large igneous cobble (6.0" in diameter) plugged bit during advance through this interval. Saved pieces of this cobble.

MONITORING WELL COMPLETION LOG MOA01-0589

PROJECT MOAB **WELL NUMBER** 0589

SITE Moab Disposal Site **DATES DRILLED** 07/14/2004

Continued from Previous Page



LITHOLOGIC DESCRIPTION

30.0-35.0 ft. mostly well rounded pebbles and cobbles (1.0-2.0" in diameter) and fine to medium grained sand (20-30%), color of sandy matrix is brown (7.5YR 4/2).

35.0-40.0 ft. slightly more fine grained sand (30-40%) and cobbles up to 4.0" in diameter, calcareous.

40.0-45.0 ft. less sand (25%), and more pebbles/cobbles. Color of matrix is dark reddish gray (5YR 4/2), calcareous.

45.0-50.0 ft. cobbles up to 6.0" in diameter.

50.0-55.0 ft. more sand (35%), medium to fine grained sand, matrix is brown (7.5YR 4/2). Cobbles up to 4.0" in diameter, calcareous.

Total Depth 55.0 ft.

Baseline Area

Well Logs

MONITORING WELL COMPLETION LOG MOA01-0405

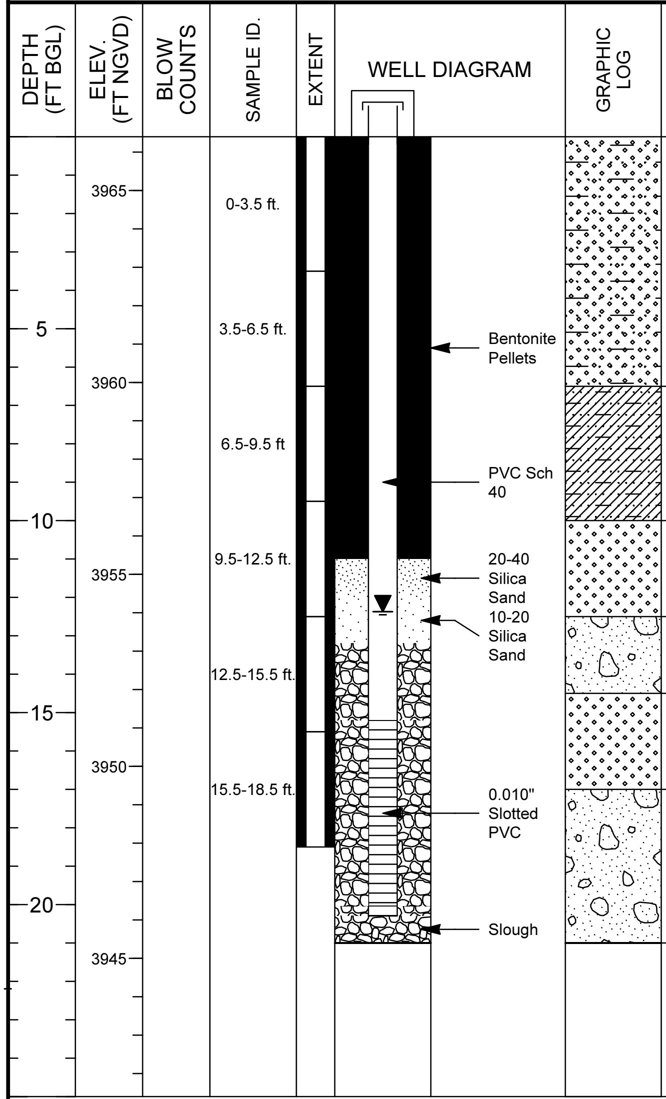
PROJECT MOAB
LOCATION ,
SITE MOAB
WELL NUMBER 0405

NORTH COORD. (FT) 6664404.03
EAST COORD. (FT) 2186330.59
HOLE DEPTH (FT) 21.00
WELL DEPTH (FT) 20.29

DATE DRILLED 12/04/2001
SURFACE ELEV. (FT NGVD) 3966.40
TOP OF CASING (FT) 3968.47
MEAS. PT. ELEV. (FT) 3968.47
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 2.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	1 in. PVC Sch 40	-2.07	to	15.12
WELL SCREEN:	1 in. Slotted PVC	15.12	to	20.04
SUMP/END CAP:	1 in. PVC Sch 40	20.04	to	20.29
SURFACE SEAL:				
GROUT:				
SEAL:	Bentonite Pellets	0.0	to	11.0
UPPER PACK:	20-40 Silica Sand	11.0	to	12.0
LOWER PACK:	10-20 Silica Sand	12.0	to	13.2

DRILLING METHOD GEOPROBE
SAMPLING METHOD CORE BARREL
DATE DEVELOPED 12/04/2001
WATER LEVEL (FT BTOC) 14.44 on 12/04/2001
LOGGED BY Hopping, B.
REMARKS



LITHOLOGIC DESCRIPTION

0-6.5 ft. SILTY SAND (SM); light brown to brown, fine to very fine silty sand, some calcite and organics present (roots), dry.

6.5-10.0 ft. CLAYEY SILT (CL-ML); brown to light brown, mixed with fine sand, slightly plastic. Color change at 9.0 ft (Red sand).

10.0-12.5 ft. SAND (SW); Brick red to brown fine grained sand, well sorted (sand grading).

12.5-14.5 ft. GRAVELLY SAND (SP-GP); brown to reddish brown, fine to coarse grained sand mixed with pebbles-gravel mix, wet.

14.5-17.0 ft. SAND (SW); fine to medium grained sand, occasional pebbles.

17-21.0 ft GRAVELLY SAND (SP-GP); abundant pebble/gravel mix, rounded. Medium to fine sand, wet.

Total Depth 21.0 ft.

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GRAND JUNCTION OFFICE, COLORADO

MONITORING WELL COMPLETION LOG MOA01-0488

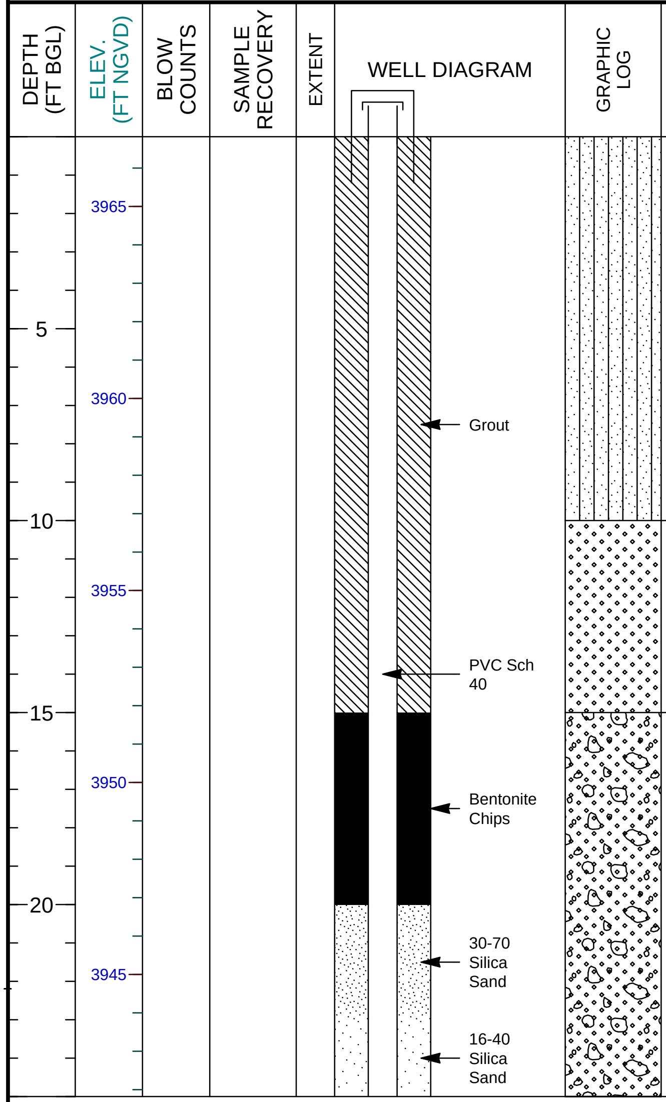
PROJECT MOAB
LOCATION Moab, UT
SITE Moab Disposal Site
DRILLING METHOD AIR PERCUSSION
DRILL COMPANY Layne Christensen Co
RIG TYPE AP 1000

WELL NUMBER 0488
NORTH COORD. (FT) 6664420.38
EAST COORD. (FT) 2186328.02
HOLE DEPTH (FT) 50.00
WELL DEPTH (FT) 40.30
WATER LEVEL (FT BGS)

DATE DRILLED 07/29/2004
SURFACE ELEV. (FT NGVD) 3966.82
TOP OF CASING (FT) 3968.48
MEAS. PT. ELEV. (FT) 3968.48
SLOT SIZE (IN) 0.010
BIT SIZE(S) (IN) 12.5

	WELL INSTALLATION	INTERVAL (FT)		
BLANK CASING:	6 in. PVC Sch 40	-1.66	to	25.0
WELL SCREEN:	6 in. Machine Slotted PVC	25.0	to	40.0
SUMP/END CAP:	6 in. PVC Sch 40	40.0	to	40.3
GROUT:	Grout	0.0	to	15.0
SEAL:	Bentonite Chips	15.0	to	20.0
UPPER PACK:	30-70 Silica Sand	20.0	to	23.0
LOWER PACK:	16-40 Silica Sand	23.0	to	50.0

DRILLER Kern, T
LOGGED BY Goodknight, C.
SAMPLING METHOD CYCLONE- 5.0 ft. intervals
DATE DEVELOPED
REMARKS



LITHOLOGIC DESCRIPTION

0-10.0 ft. SILTY SAND (SM); mostly very fine grained sand (80%) and silt (~20%), brown (7.5YR 5/4), dry, slightly damp below 5.0 ft.

10.0-15.0 ft. SAND (SW): well sorted, mostly fine to medium grained sand, damp, ~10% pebbles and cobbles up to 4.0" in diameter, brown (7.5YR 5/4).

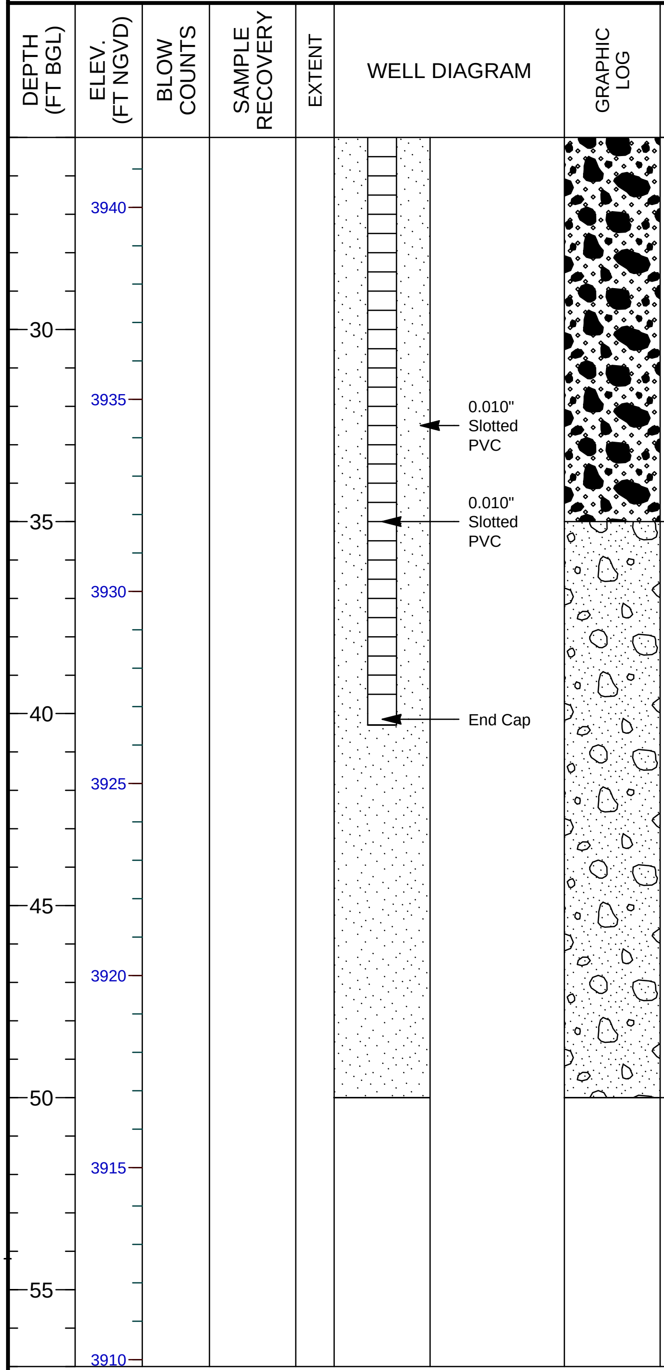
15.0-25.0 ft. GRAVELLY SAND (SW-GW); moist to wet, ~60% sand, very fine to medium grained, ~40% pebbles and cobbles up to 4.0 " in diameter, matrix sand is brown (7.5YR 4/3).

20.0-25.0 ft. more sand (~70%).

MONITORING WELL COMPLETION LOG MOA01-0488

PROJECT MOAB
WELL NUMBER 0488
SITE Moab Disposal Site
DATES DRILLED 07/29/2004

Continued from Previous Page



LITHOLOGIC DESCRIPTION

25.0-35.0 ft. SANDY GRAVEL (GW-SW); ~60% subrounded to well rounded gravel and cobbles (up to 5.0" in diameter), and fine to medium grained sand (~40%) matrix, wet, brown (7.5YR 4/3).

30.0-35.0 ft. sightly less sand (30-35%).

35.0-50.0 ft. GRAVELLY SAND (SP-GP); mostly fine grained sand (60%), dark grayish brown (10YR 4/2), pebbles and cobbles (~40%) up to 3.0" in diameter. Sand is runny-water saturated.

40.0-45.0 ft. larger amount of sand (70%), very runny-water saturated.

Total Depth 50.0 ft.

MONITORING WELL COMPLETION LOG MOA01-0493

PROJECT	MOAB	**WELL NUMBER**	0493	**DATE DRILLED**	07/28/2004
LOCATION	Moab, UT	**NORTH COORD. (FT)**	6664391.83	**SURFACE ELEV. (FT NGVD)**	3966.08
SITE	Moab Disposal Site	**EAST COORD. (FT)**	2186318.49	**TOP OF CASING (FT)**	3967.94
DRILLING METHOD	AIR PERCUSSION	**HOLE DEPTH (FT)**	60.00	**MEAS. PT. ELEV. (FT)**	3967.94
DRILL COMPANY	Layne Christensen Co	**WELL DEPTH (FT)**	55.30	**SLOT SIZE (IN)**	0.010
RIG TYPE	AP 1000	**WATER LEVEL (FT BGS)**		**BIT SIZE(S) (IN)**	12.5

	WELL INSTALLATION	**INTERVAL (FT)**		
BLANK CASING:	6 in. PVC Sch 40	-1.86	to	45.0
WELL SCREEN:	6 in. Machine Slotted PVC	45.0	to	55.0
SUMP/END CAP:	6 in. PVC Sch 40	55.0	to	55.3
GROUT:	Grout	0.0	to	35.0
SEAL:	Bentonite Chips	35.0	to	40.0
UPPER PACK:	30-70 Silica Sand	40.0	to	43.0
LOWER PACK:	16-40 Silica Sand	43.0	to	60.0

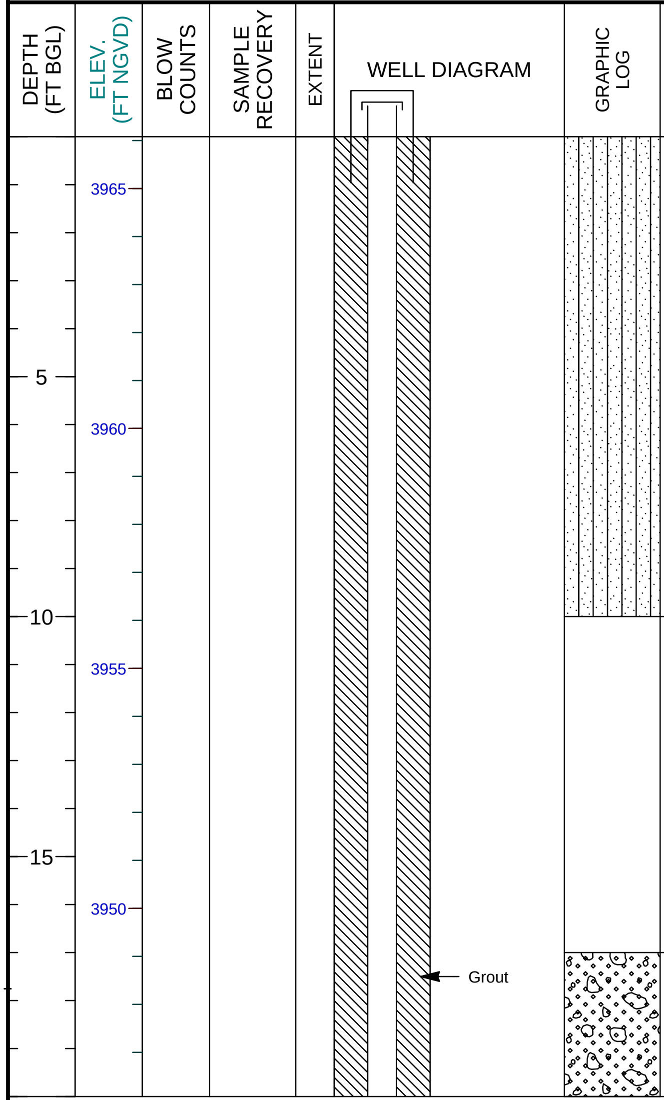
DRILLER Kern, T

LOGGED BY Goodknight, C.

SAMPLING METHOD CYCLONE- 5.0 ft. intervals

DATE DEVELOPED

REMARKS



LITHOLOGIC DESCRIPTION

0-10.0 ft. SILTY SAND (SM); mostly very fine grained sand (~80%) and ~20% silt, light brown (7.5YR 6/3), dry.

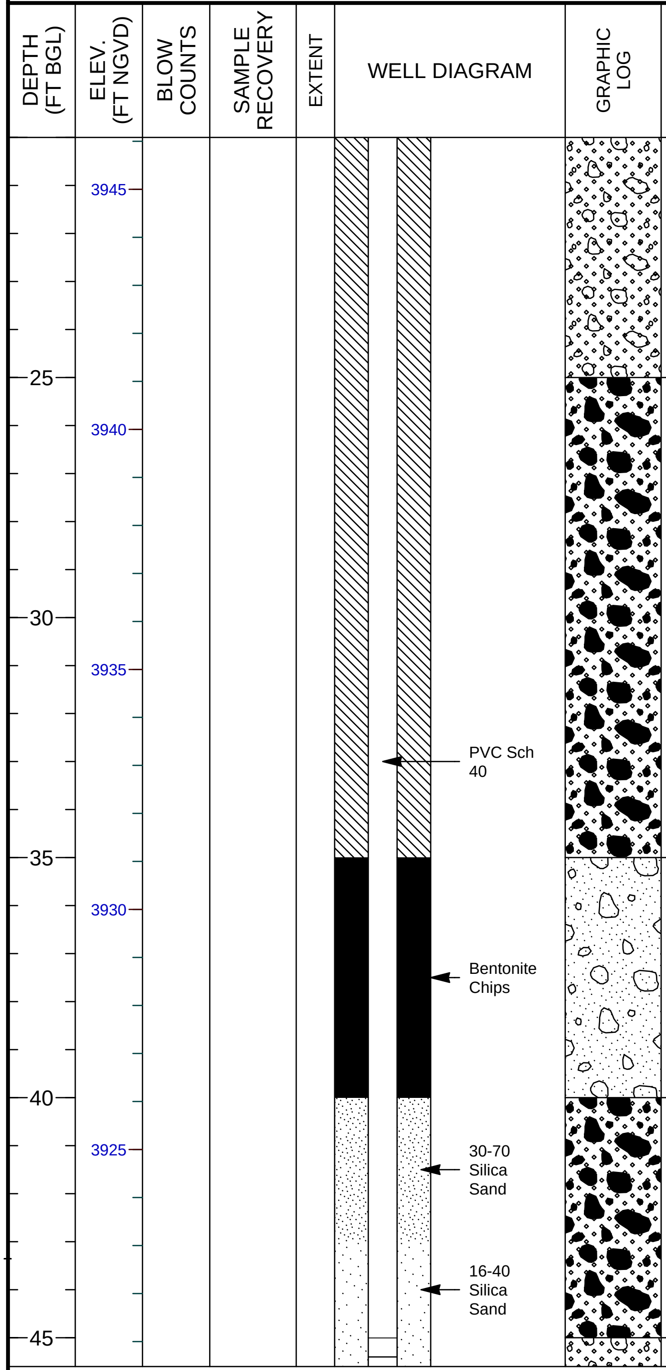
10.0-17.0 ft. No Recovery.

17.0-25.0 ft. GRAVELLY SAND (SW-GW); sand(~60%), very fine to medium grained, ~40% pebbles and cobbles up to 3.0" in diameter, matix sand is brown (7.5YR 4/3), moist to wet.

MONITORING WELL COMPLETION LOG MOA01-0493

PROJECT MOAB
WELL NUMBER 0493
SITE Moab Disposal Site
DATES DRILLED 07/28/2004

Continued from Previous Page



LITHOLOGIC DESCRIPTION

20.0-25.0 ft. more sand (70%).

25.0-35.0 ft. SANDY GRAVEL (GW-SW); mostly subrounded to well rounded gravel and cobbles (up to 6.0" in diameter) and fine to medium grained sand (~40%) matrix, wet, brown (7.5YR 4/3).

30.0-35.0 ft. slightly less sand (~35%), brown (7.5YR 4/2), wet.

35.0-40.0 ft. GRAVELLY SAND (SP-GP); mostly fine grained sand (~60%), dark grayish brown (10YR 4/2), pebbles and cobbles (40%) up to 3.0" in diameter. Sand is runny-water saturated.

40.0-45.0 ft. SANDY GRAVEL (GW-SW); mostly subrounded to well rounded pebbles and cobbles (up to 4.0" in diameter) and fine to medium grained sand (~25%), wet, brown (7.5YR 4/2).

45.0-50.0 ft. GRAVELLY SAND (SW-GW); approximately equal

MONITORING WELL COMPLETION LOG MOA01-0493

PROJECT MOAB
SITE Moab Disposal Site
WELL NUMBER 0493
DATES DRILLED 07/28/2004

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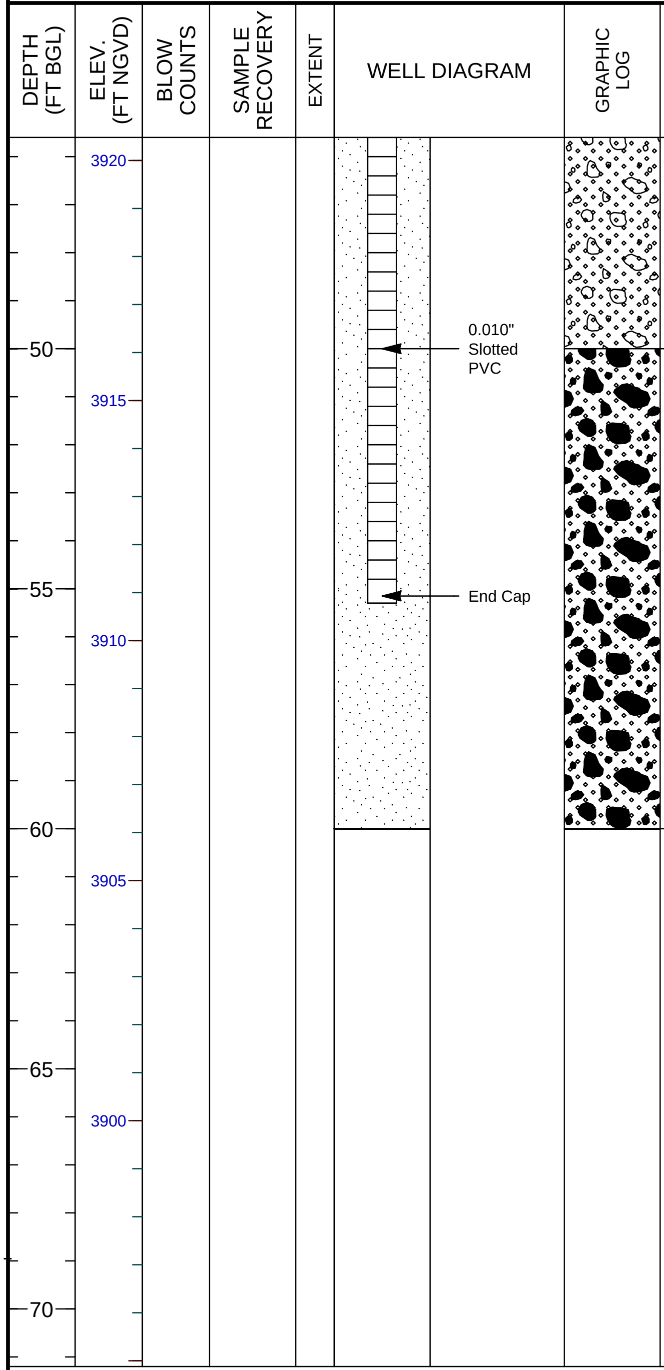

LITHOLOGIC DESCRIPTION

amounts of sand (fine to medium grained) and gravel (pebbles and cobbles up to 4.0" in diameter). Matrix sandy material is dark grayish brown (10YR 4/2), wet.

50.0-60.0 ft. SANDY GRAVEL (GW-SW); mostly (80%) pebbles and cobbles up to 3.0" in diameter. Little sand (20% or less), wet.

Total Depth 60.0 ft.

Appendix B

Equivalent Freshwater Heads in the Configuration 1 Area

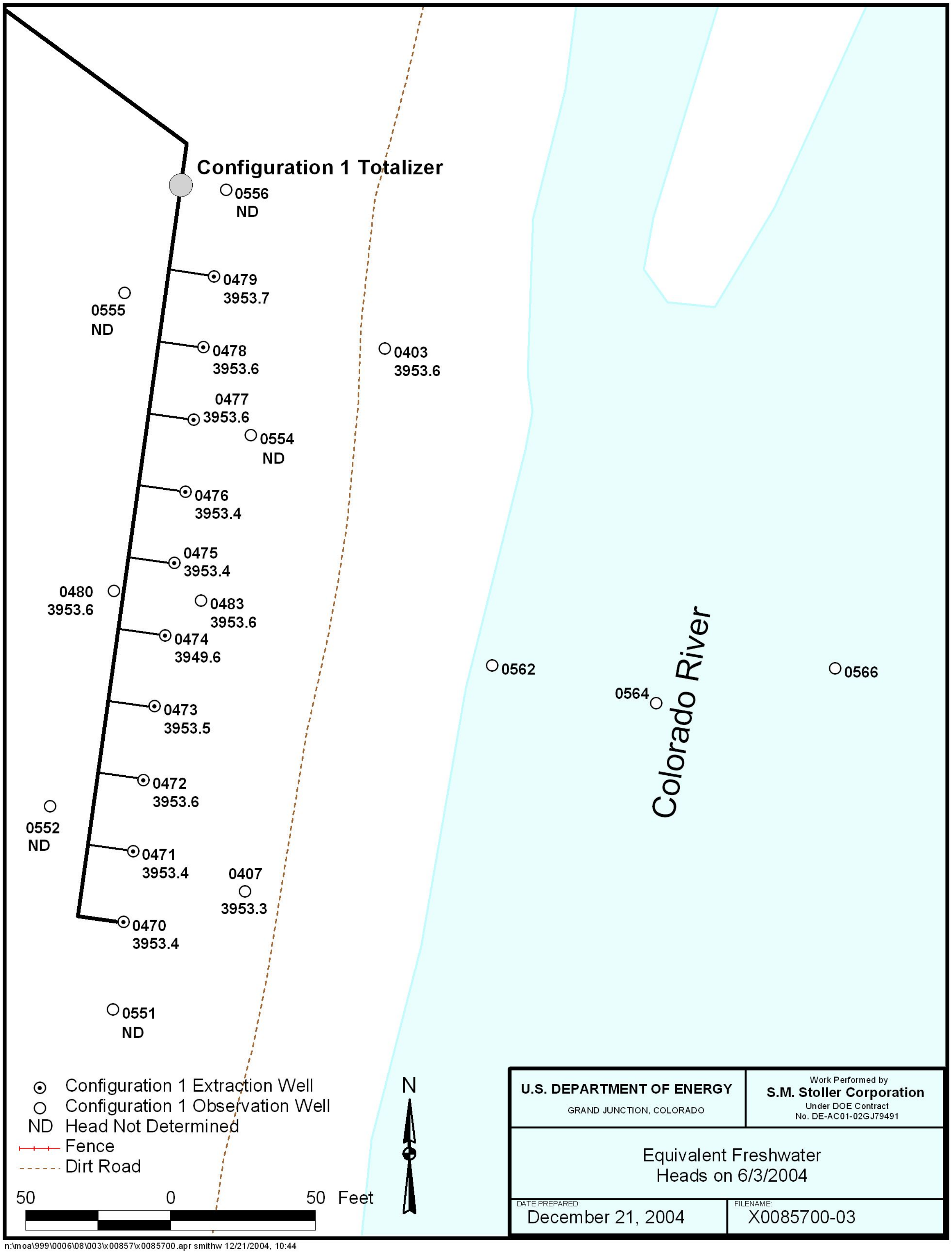

Figure B−1. Calculated Equivalent Freshwater Heads in Shallow Configuration 1 Wells During June 2004

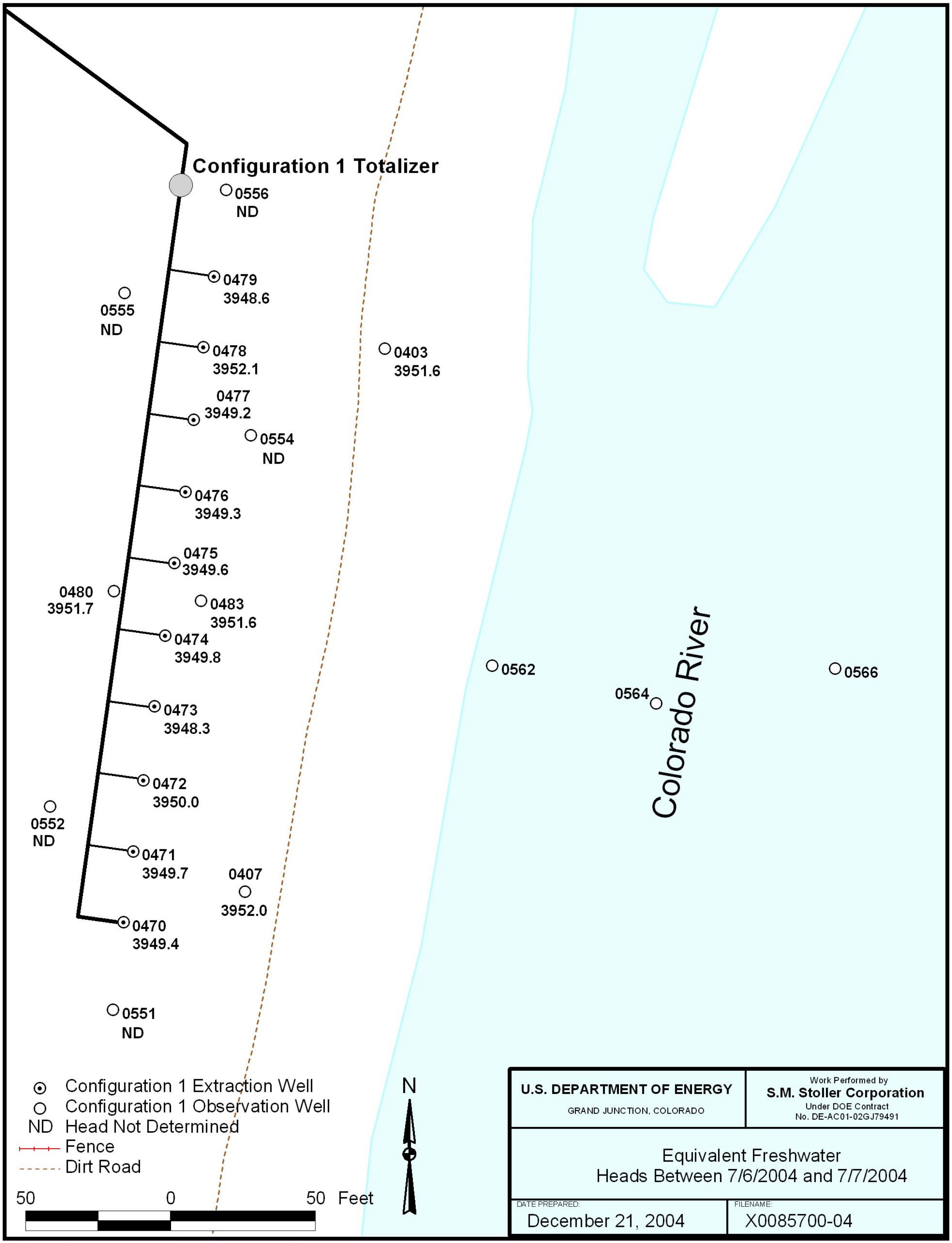

Figure B−2. Calculated Equivalent Freshwater Heads in Shallow Configuration 1 Wells During July 2004

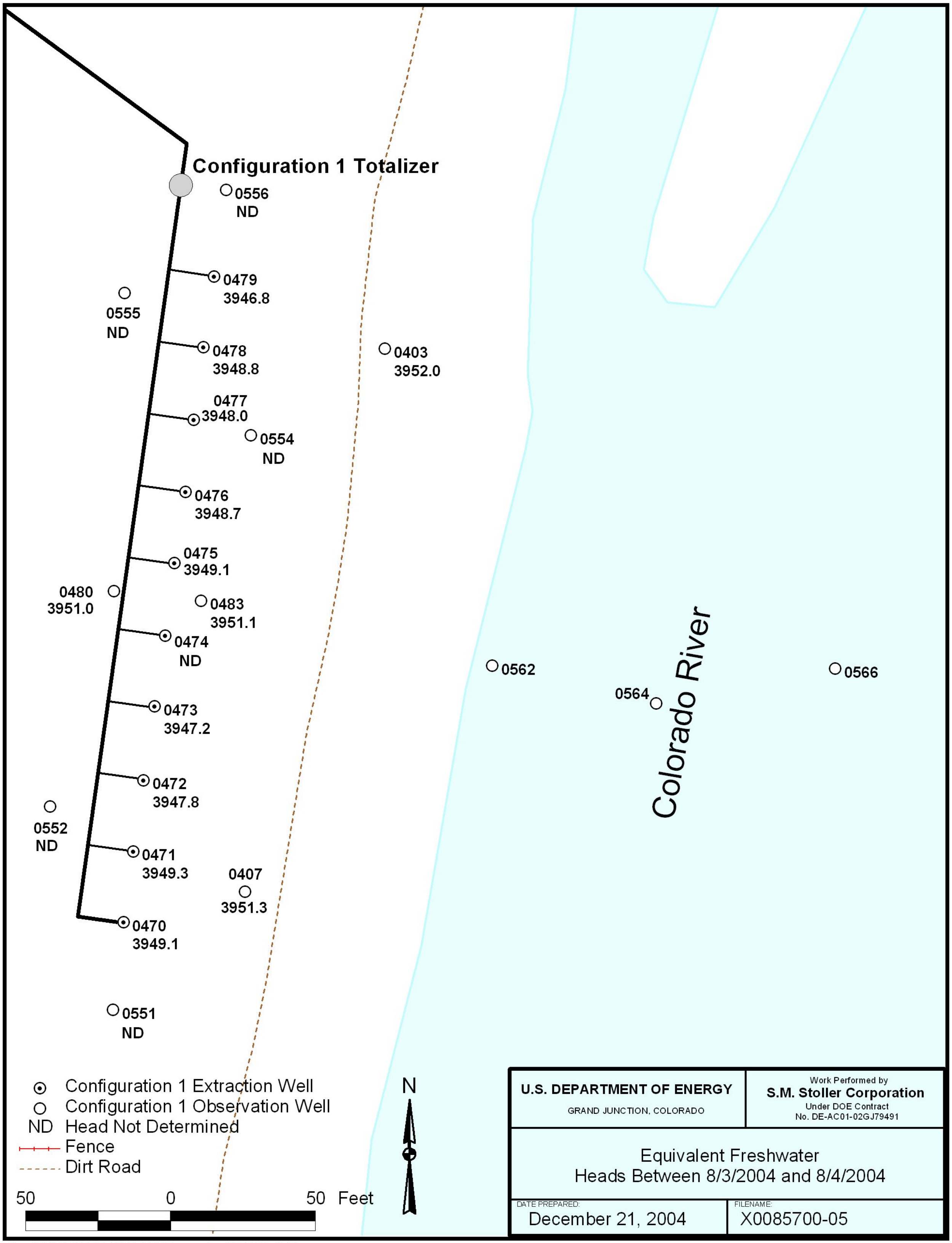

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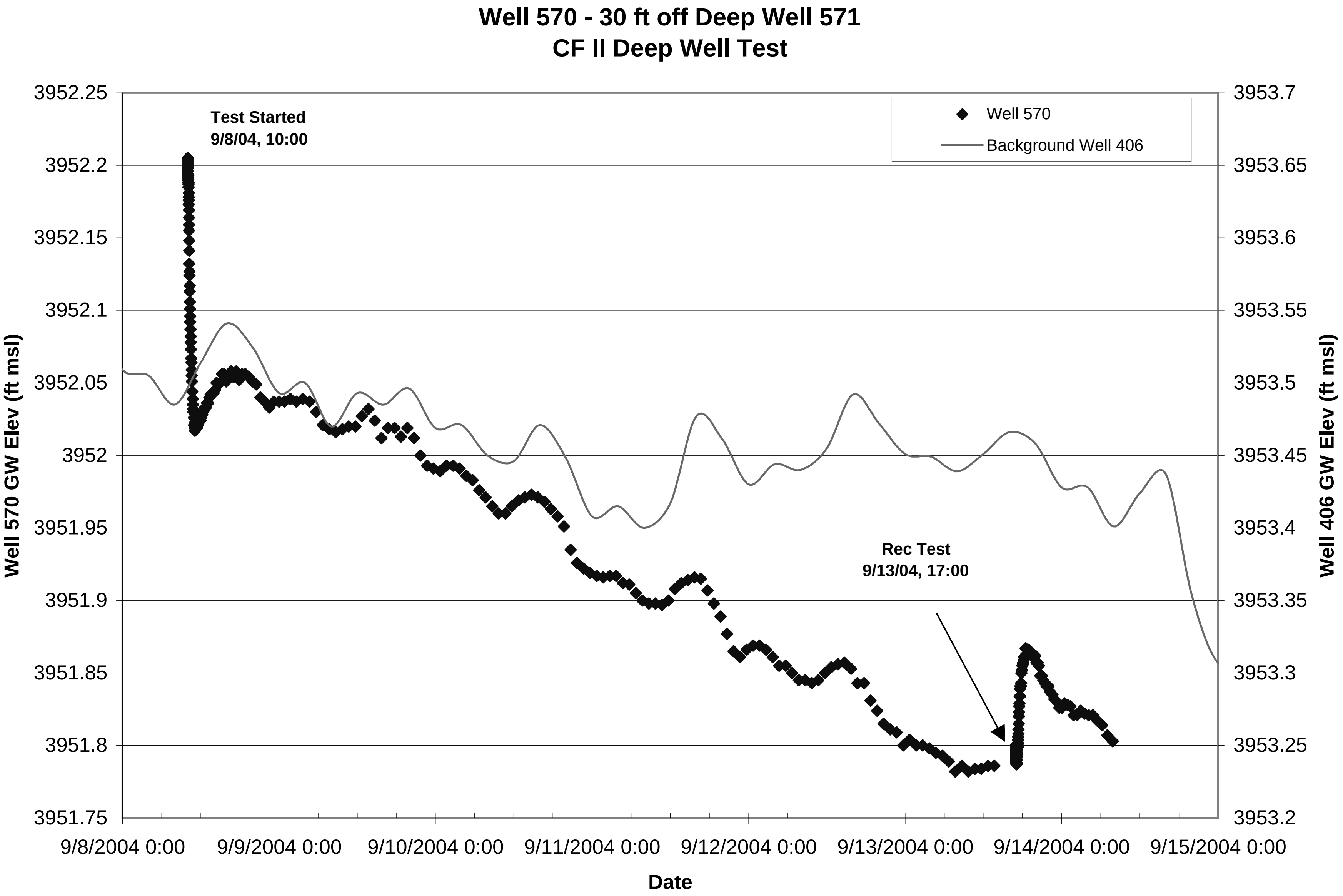
Figure B−3. Calculated Equivalent Freshwater Heads in Shallow Configuration 1 Wells During August 2004

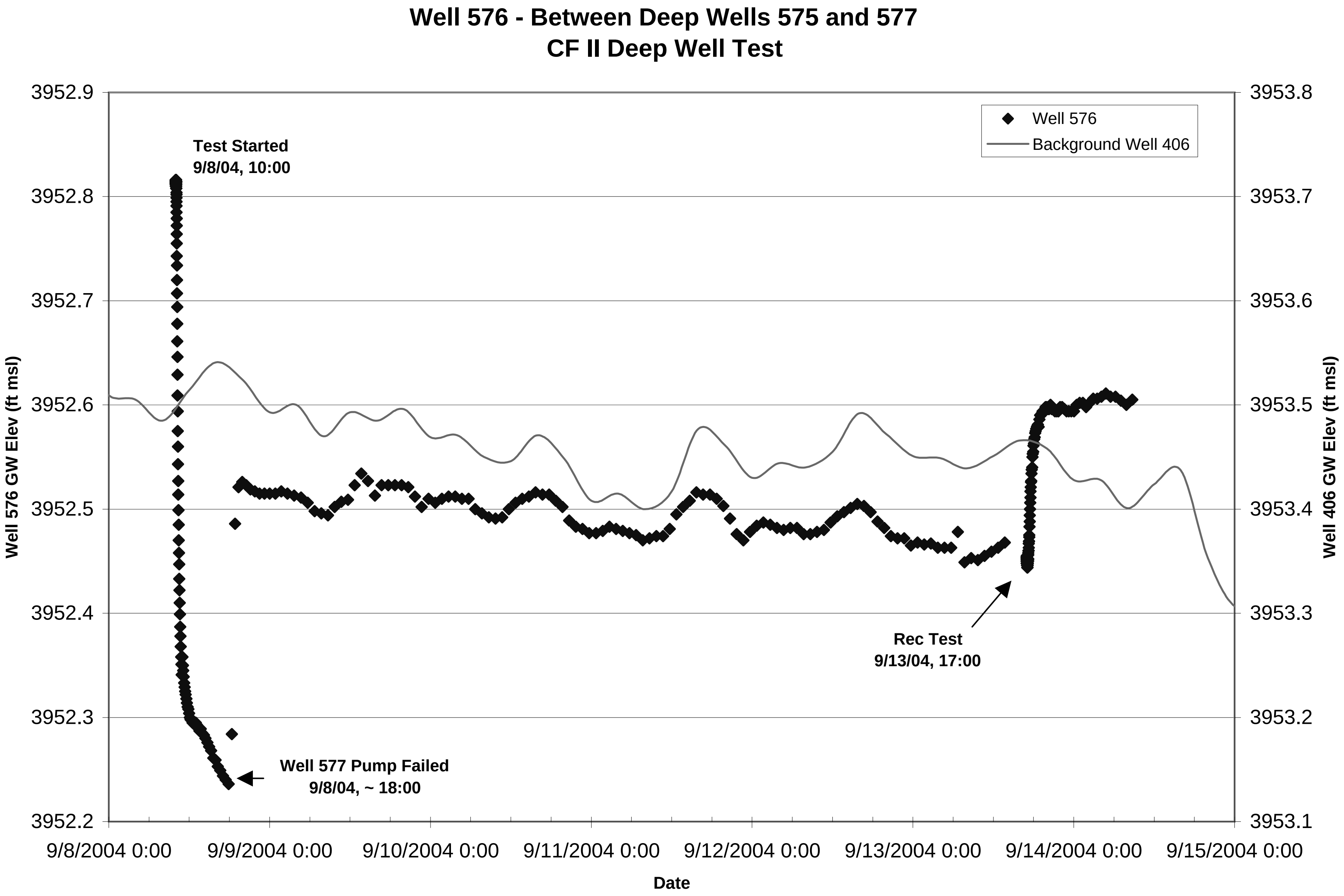
Appendix C

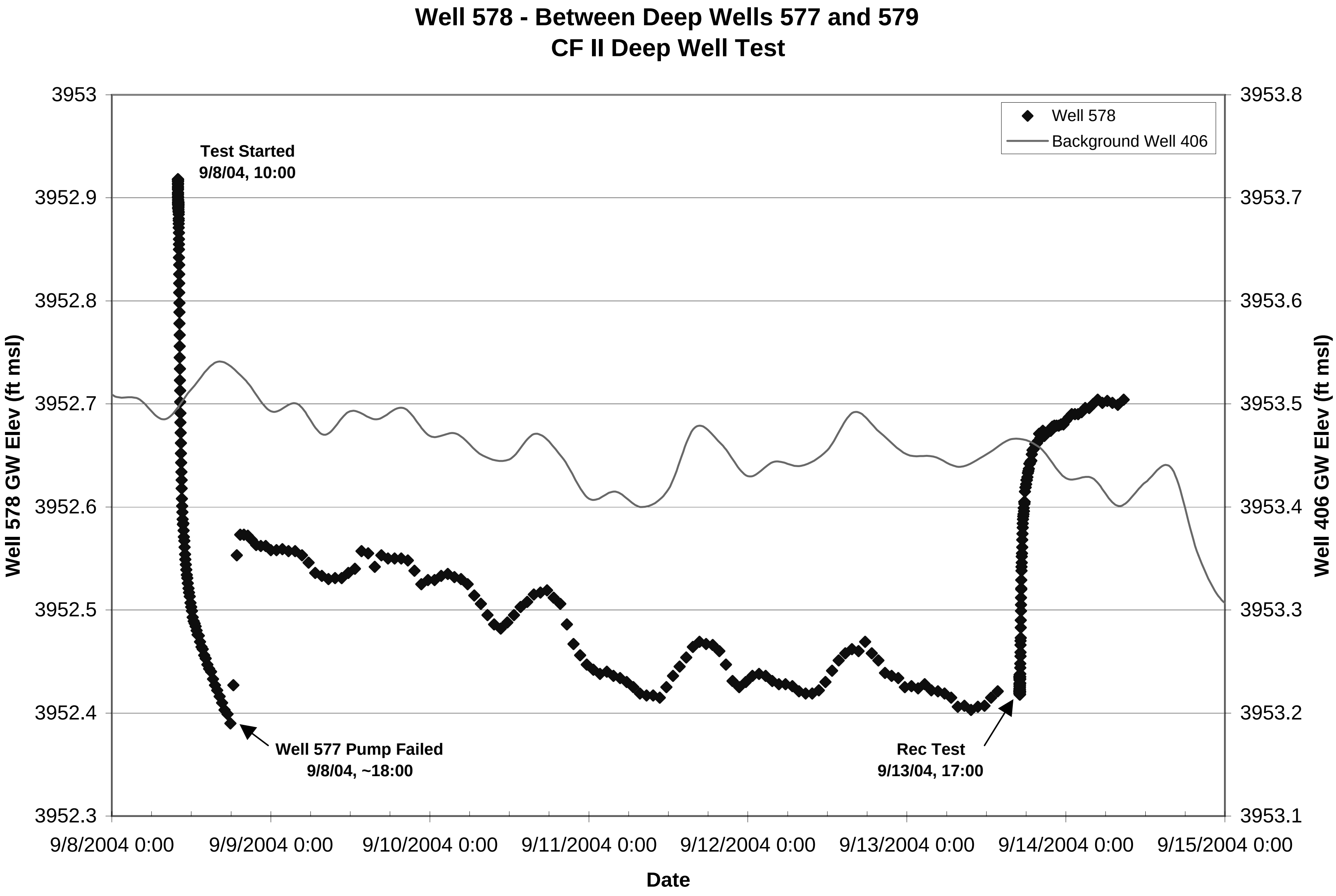
Transducer Data

Appendix C−1

Configuration 2 Deep Well Extraction Test Pressure Transducer Data


Well 570 - 30 ft off Deep Well 571
CF II Deep Well Test
Test Started
9/8/04, 10:00
Rec Test
9/13/04, 17:00
◆ Well 570
Background Well 406
Well 570 GW Elev (ft msl)
3952.25
3952.2
3952.15
3952.1
3952.05
3952
3951.95
3951.9
3951.85
3951.8
3951.75
Well 406 GW Elev (ft msl)
3953.7
3953.65
3953.6
3953.55
3953.5
3953.45
3953.4
3953.35
3953.3
3953.25
3953.2
9/8/2004 0:00
9/9/2004 0:00
9/10/2004 0:00
9/11/2004 0:00
9/12/2004 0:00
9/13/2004 0:00
9/14/2004 0:00
9/15/2004 0:00
Date


Well 576 - Between Deep Wells 575 and 577
CF II Deep Well Test
Well 576
Background Well 406
Test Started
9/8/04, 10:00
Well 577 Pump Failed
9/8/04, ~ 18:00
Rec Test
9/13/04, 17:00
Well 576 GW Elev (ft msl)
Well 406 GW Elev (ft msl)
3952.9
3952.8
3952.7
3952.6
3952.5
3952.4
3952.3
3952.2
3953.8
3953.7
3953.6
3953.5
3953.4
3953.3
3953.2
3953.1
9/8/2004 0:00
9/9/2004 0:00
9/10/2004 0:00
9/11/2004 0:00
9/12/2004 0:00
9/13/2004 0:00
9/14/2004 0:00
9/15/2004 0:00
Date

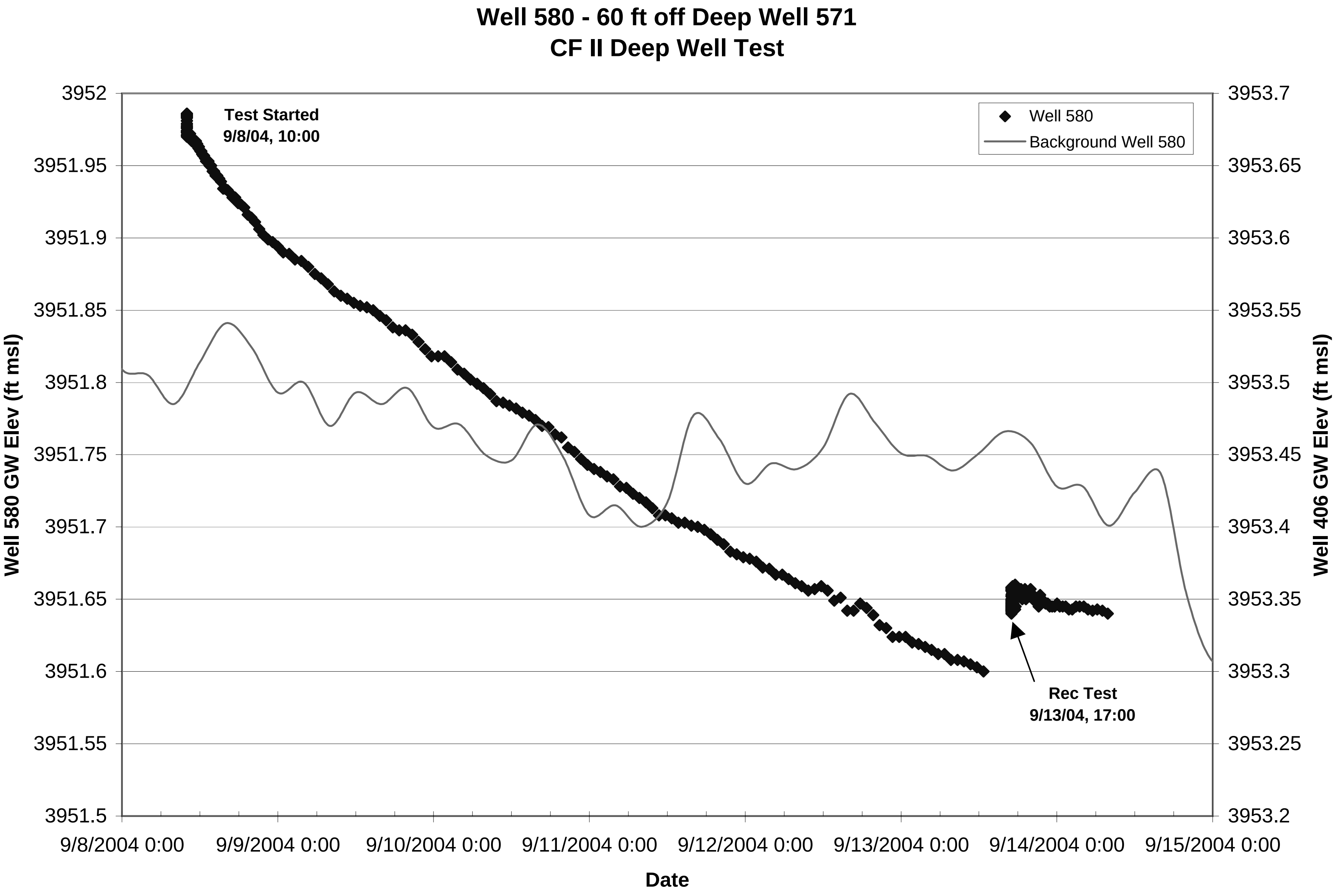


Well 578 - Between Deep Wells 577 and 579
CF II Deep Well Test

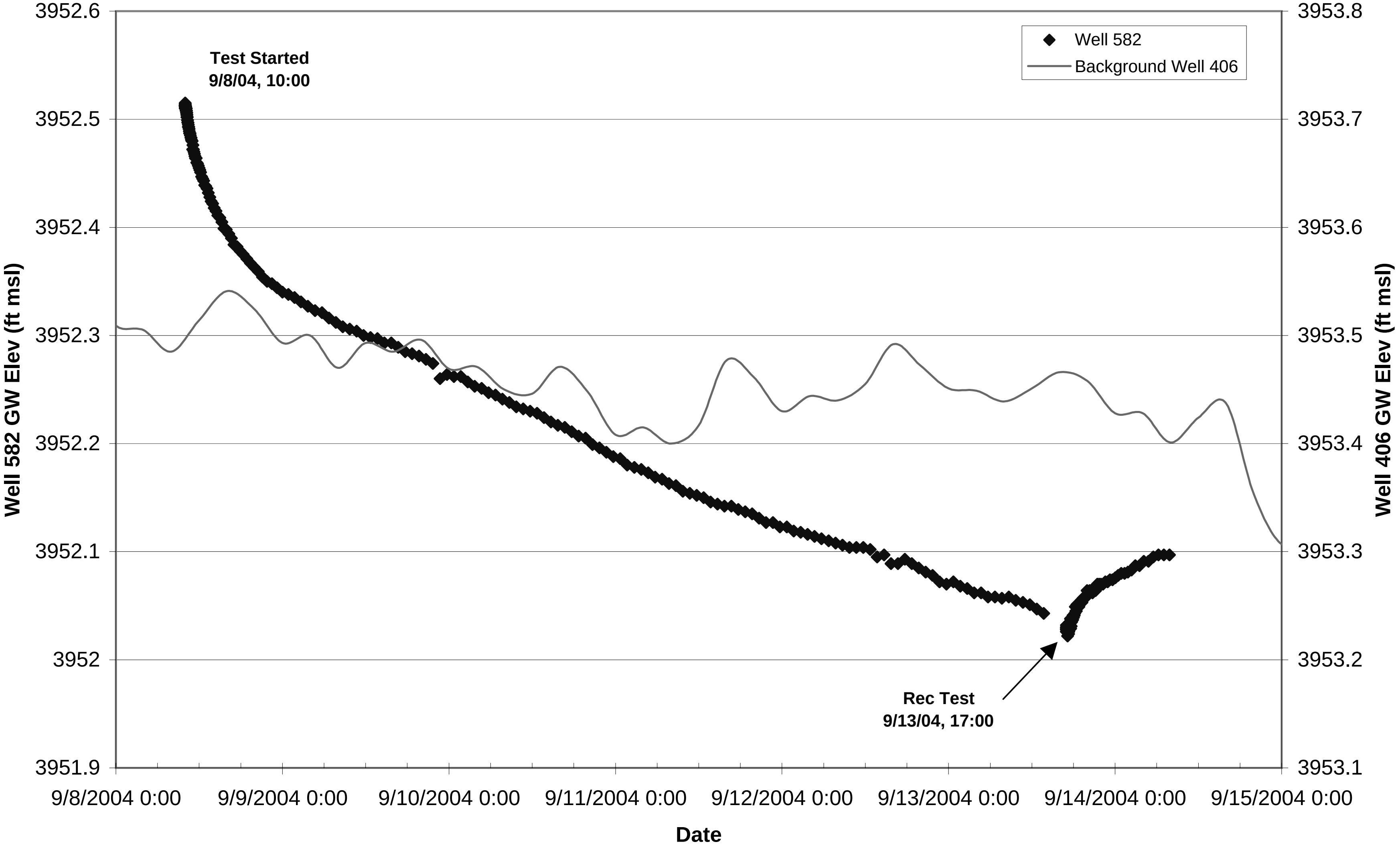
Test Started
9/8/04, 10:00

Well 577 Pump Failed
9/8/04, ~18:00

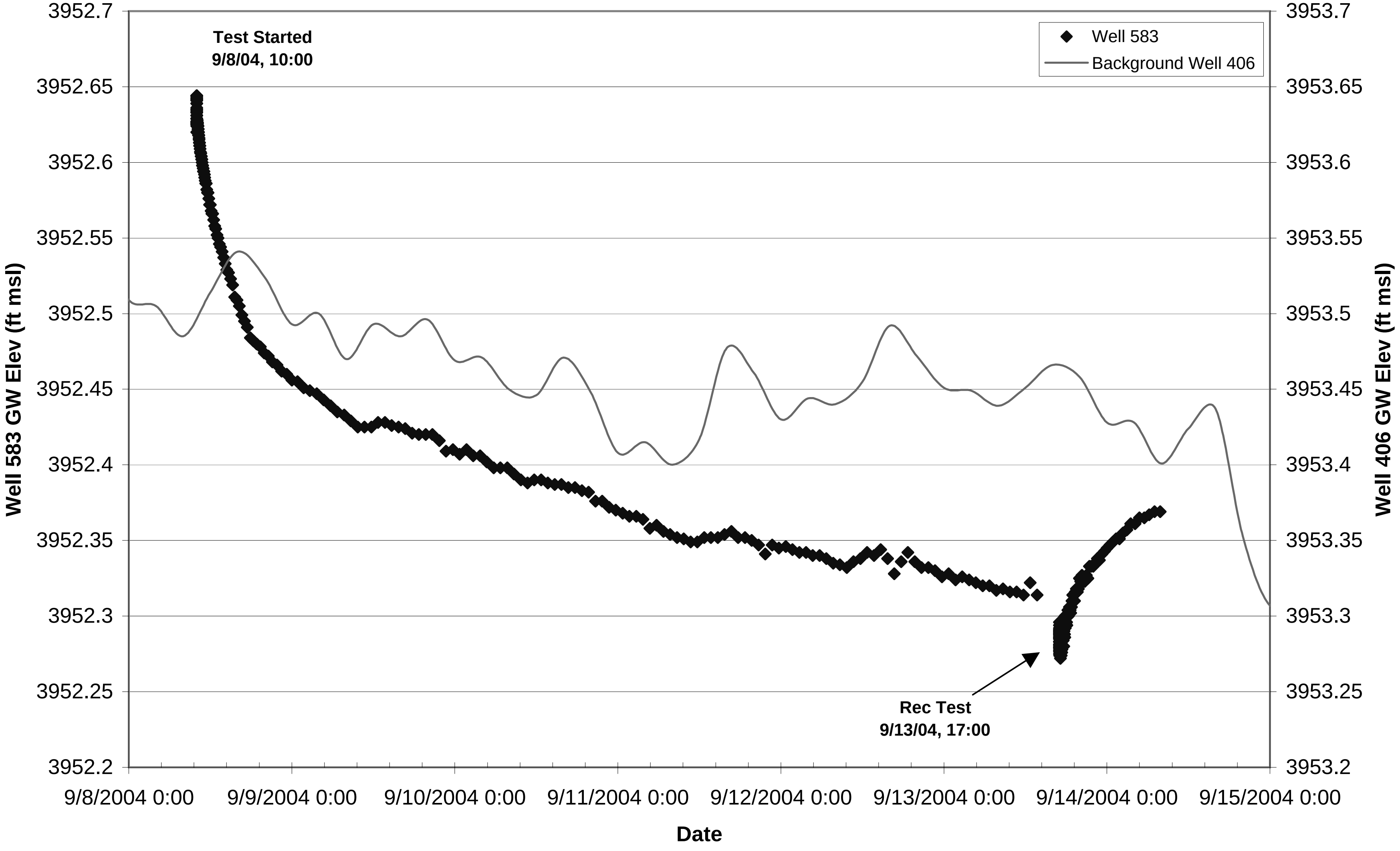
Rec Test
9/13/04, 17:00

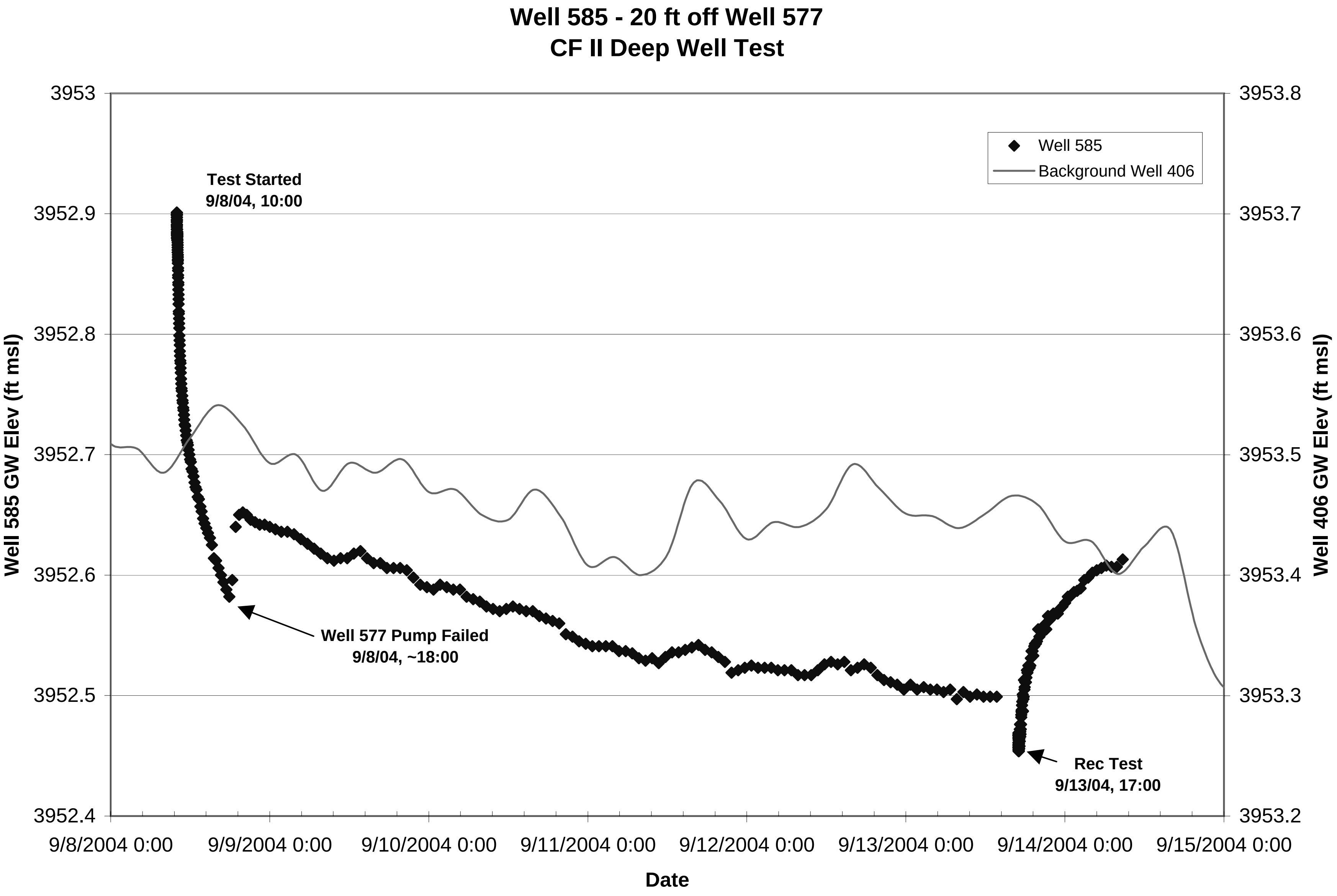

Well 580 - 60 ft off Deep Well 571
CF II Deep Well Test
Well 580 GW Elev (ft msl)
Well 406 GW Elev (ft msl)
Date
3952
3951.95
3951.9
3951.85
3951.8
3951.75
3951.7
3951.65
3951.6
3951.55
3951.5
3953.7
3953.65
3953.6
3953.55
3953.5
3953.45
3953.4
3953.35
3953.3
3953.25
3953.2
9/8/2004 0:00
9/9/2004 0:00
9/10/2004 0:00
9/11/2004 0:00
9/12/2004 0:00
9/13/2004 0:00
9/14/2004 0:00
9/15/2004 0:00
Well 580
Background Well 580
Test Started
9/8/04, 10:00
Rec Test
9/13/04, 17:00

Well 582 - 20 ft off Deep Well 571
CF II Deep Well Test



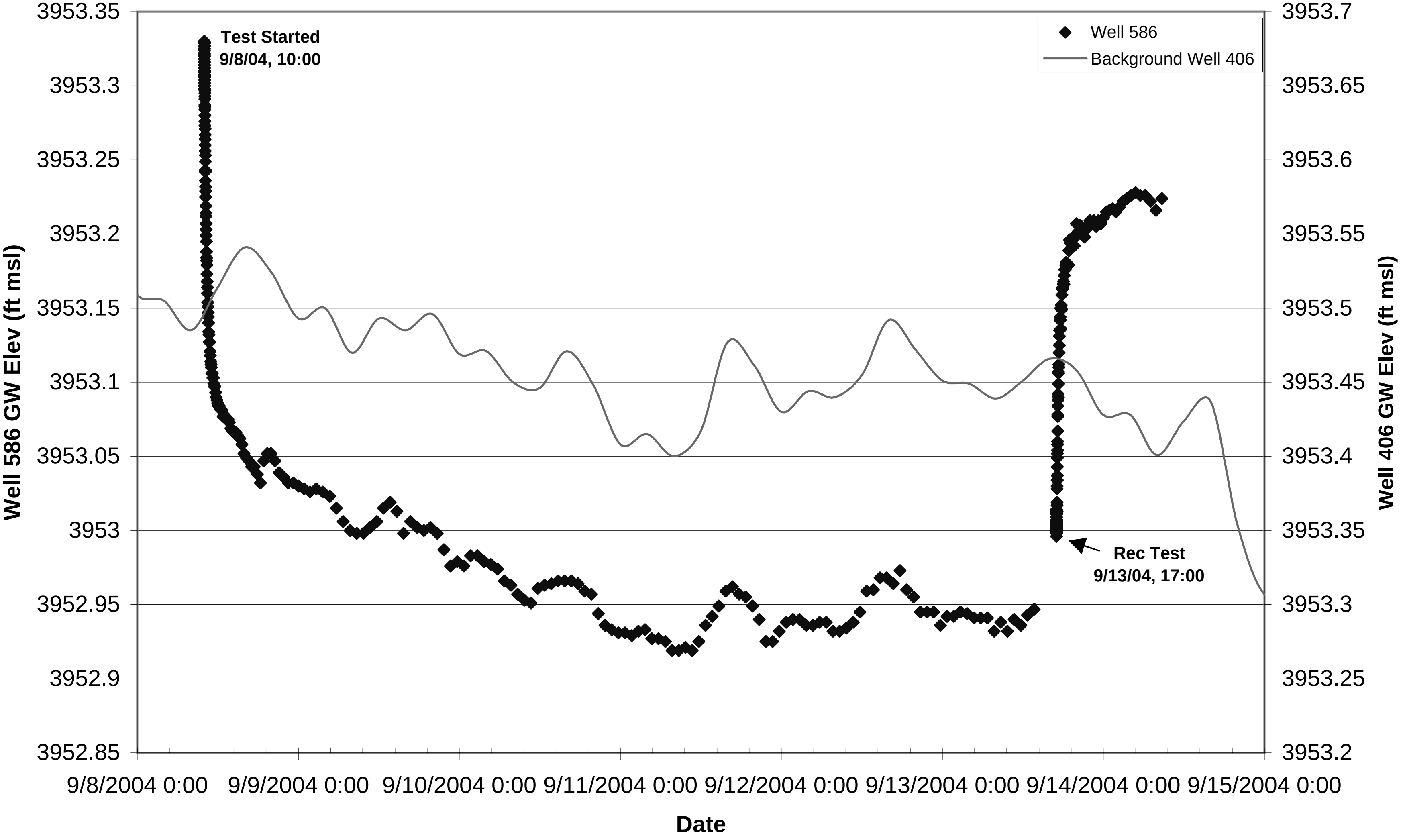
Well 583 - 35 ft off Deep Well 575
CF II Deep Well Test



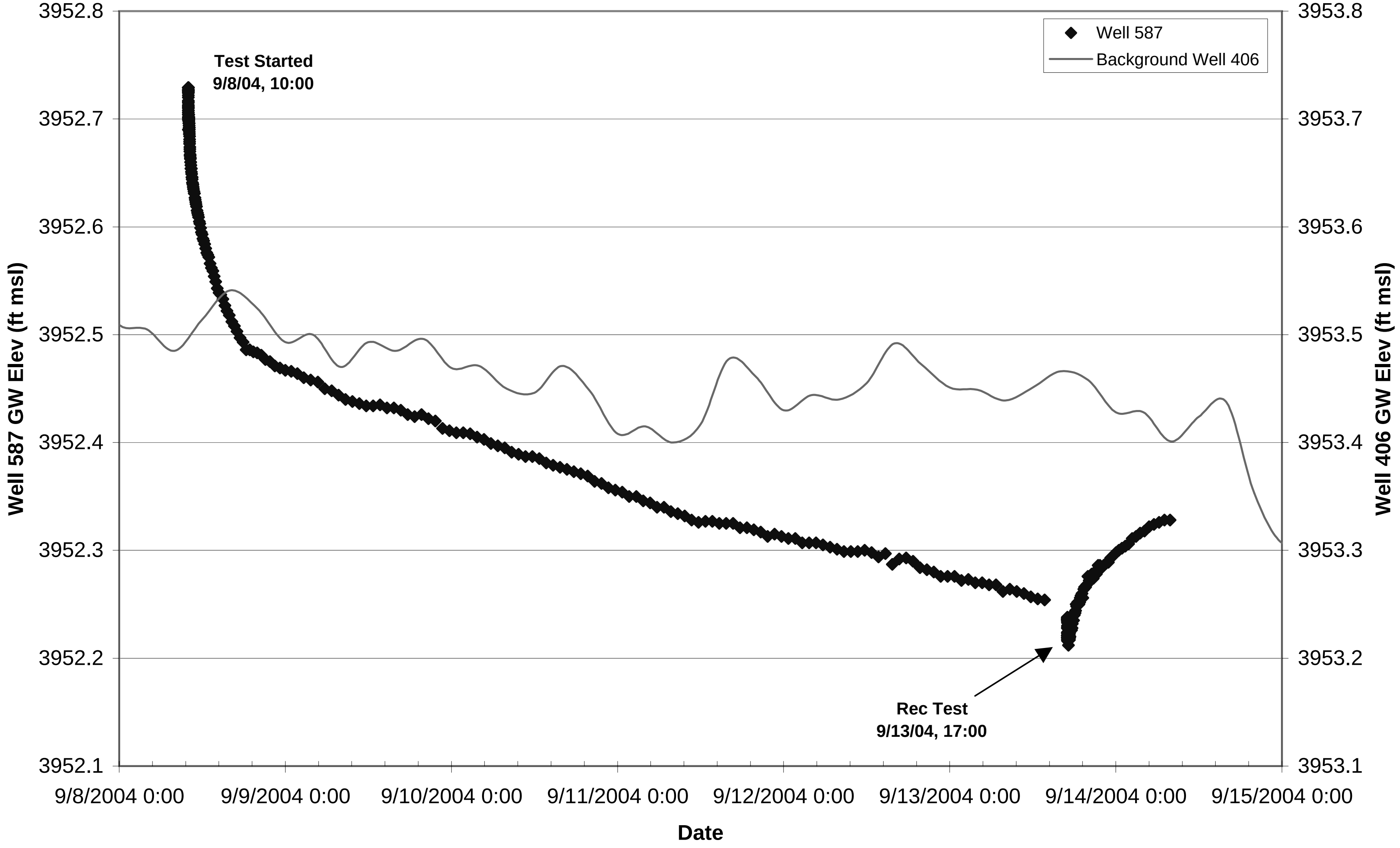


Well 585 - 20 ft off Well 577
CF II Deep Well Test

Well 586 - 30 ft off Deep Well 579
CF II Deep Well Test

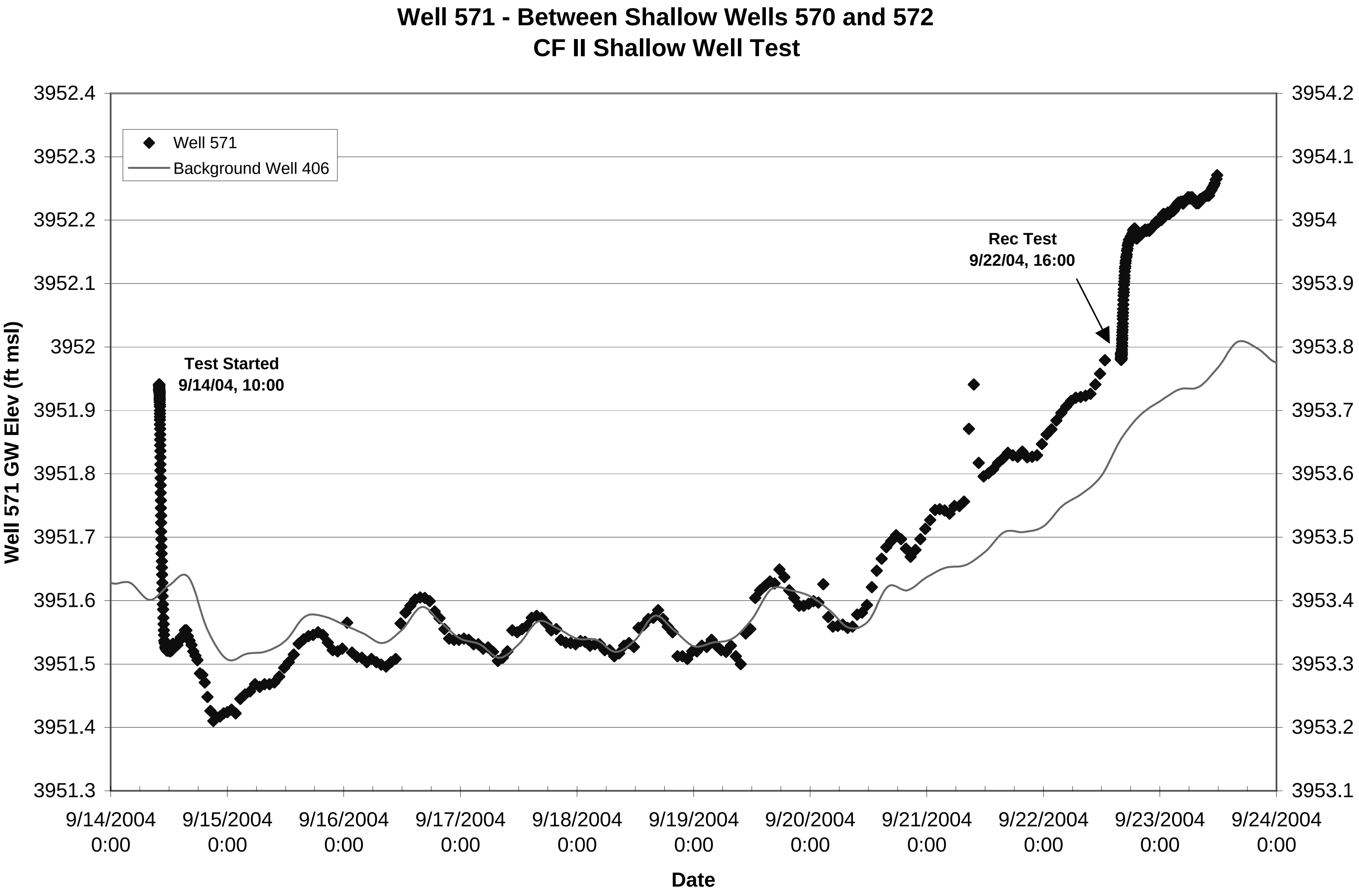


Well 587 - 15 ft off Deep Well 575
CF II Deep Well Test

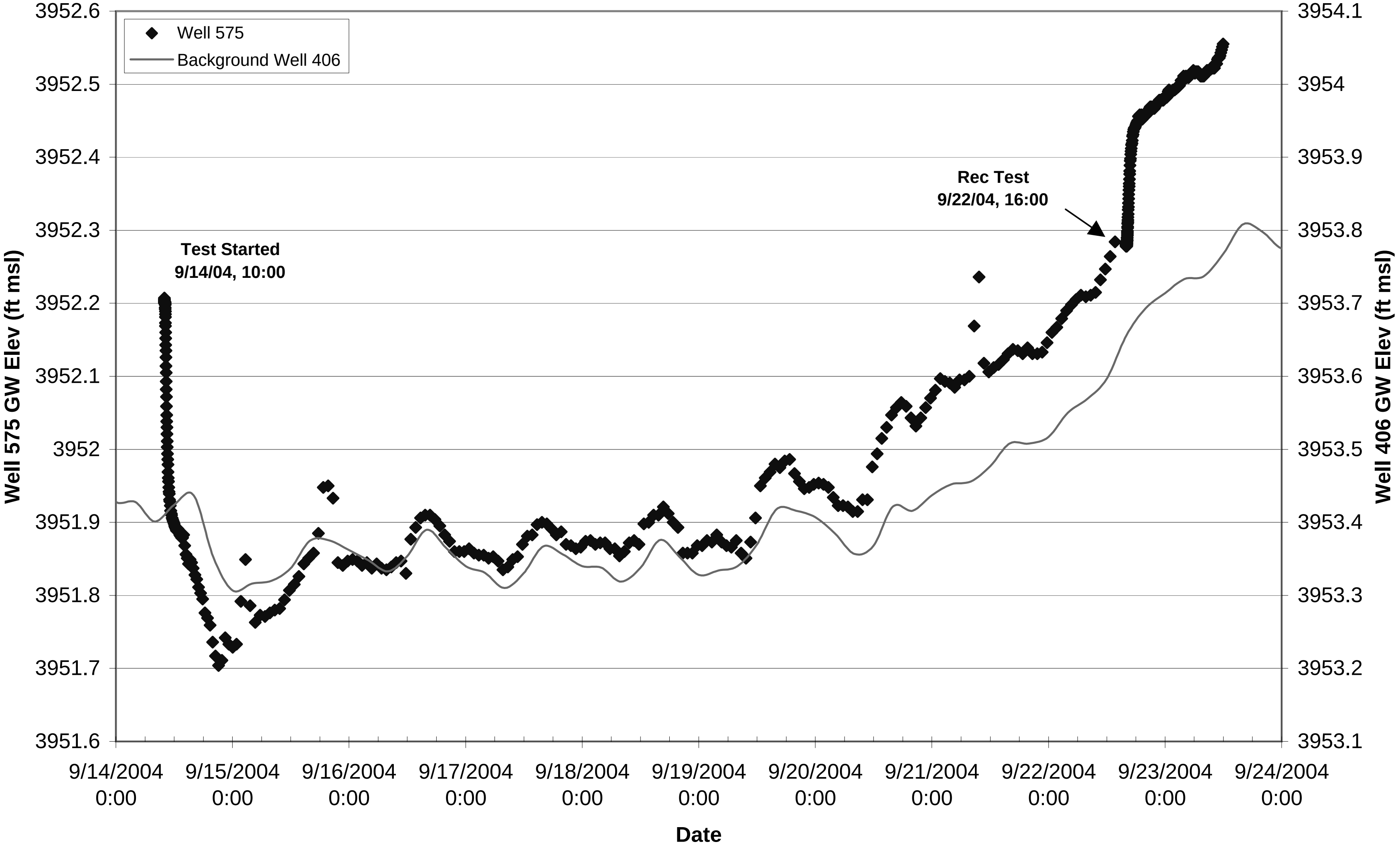


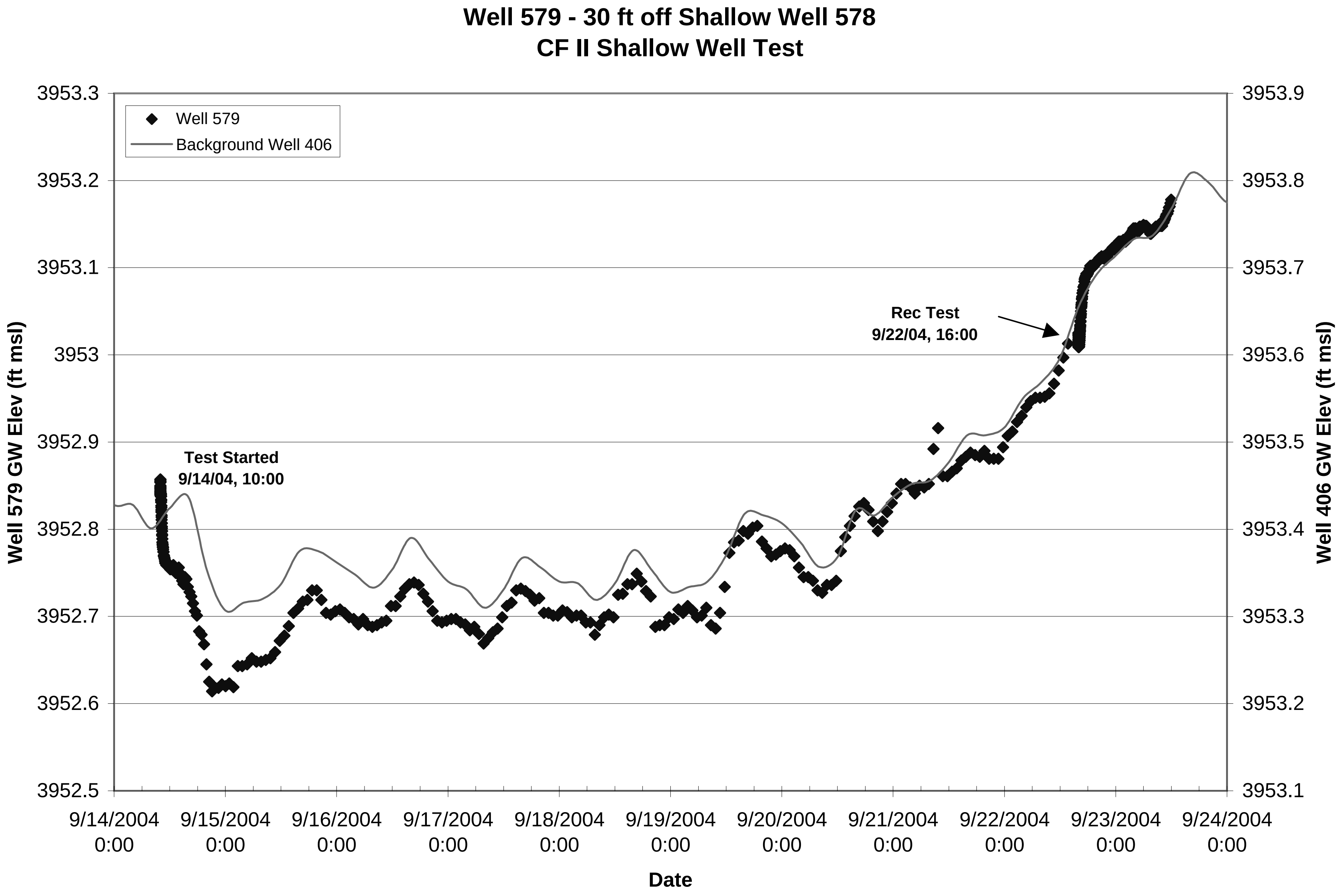
Appendix C−2

Configuration 2 Shallow Well Extraction Test Pressure Transducer Data


Well 571 - Between Shallow Wells 570 and 572
CF II Shallow Well Test
◆ Well 571
Background Well 406
Test Started
9/14/04, 10:00
Rec Test
9/22/04, 16:00
Well 571 GW Elev (ft msl)
3952.4
3952.3
3952.2
3952.1
3952
3951.9
3951.8
3951.7
3951.6
3951.5
3951.4
3951.3
3954.2
3954.1
3954
3953.9
3953.8
3953.7
3953.6
3953.5
3953.4
3953.3
3953.2
3953.1
9/14/2004 0:00
9/15/2004 0:00
9/16/2004 0:00
9/17/2004 0:00
9/18/2004 0:00
9/19/2004 0:00
9/20/2004 0:00
9/21/2004 0:00
9/22/2004 0:00
9/23/2004 0:00
9/24/2004 0:00
Date

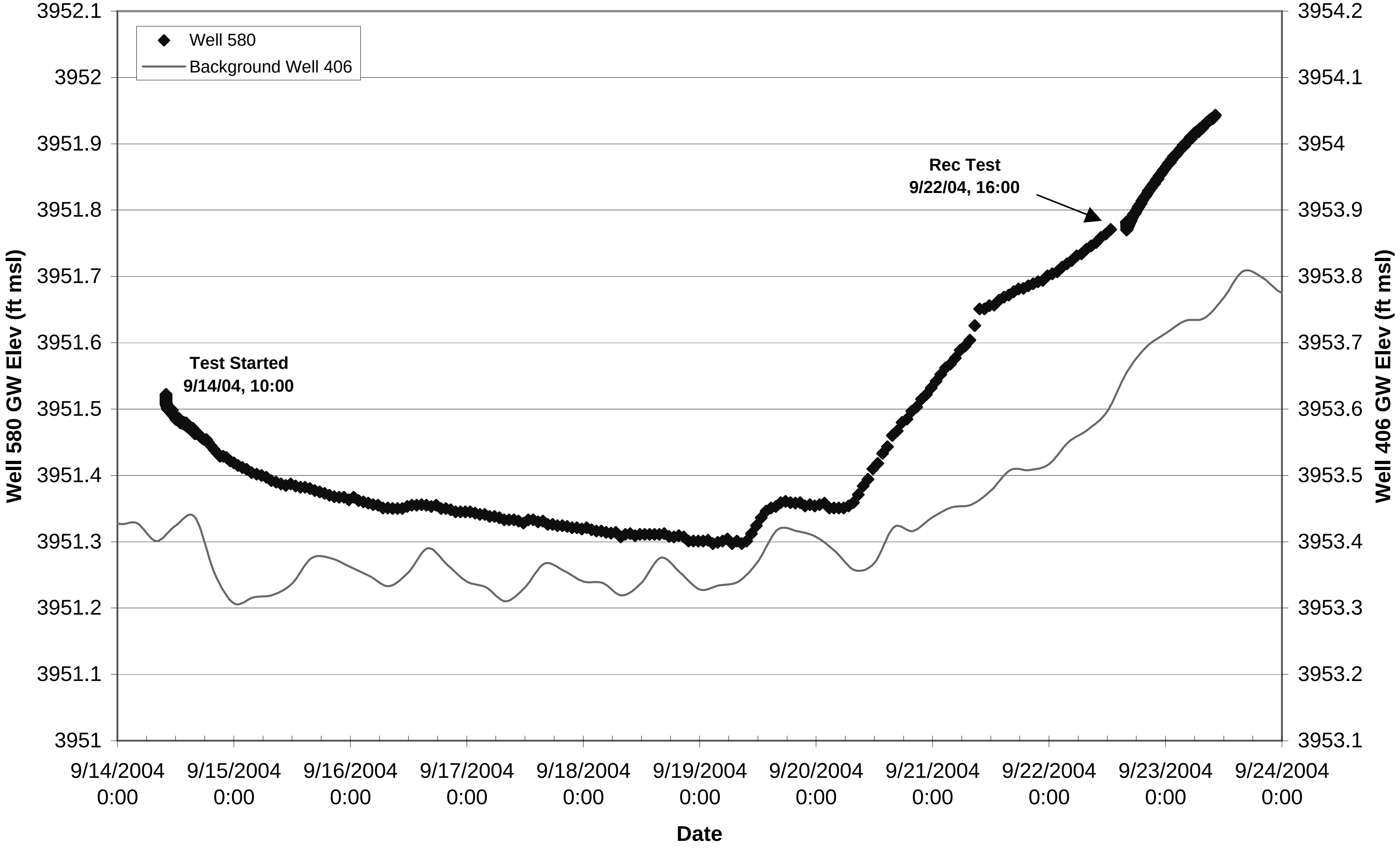
Well 575 - Between Shallow Wells 574 and 576
CF II Shallow Well Test



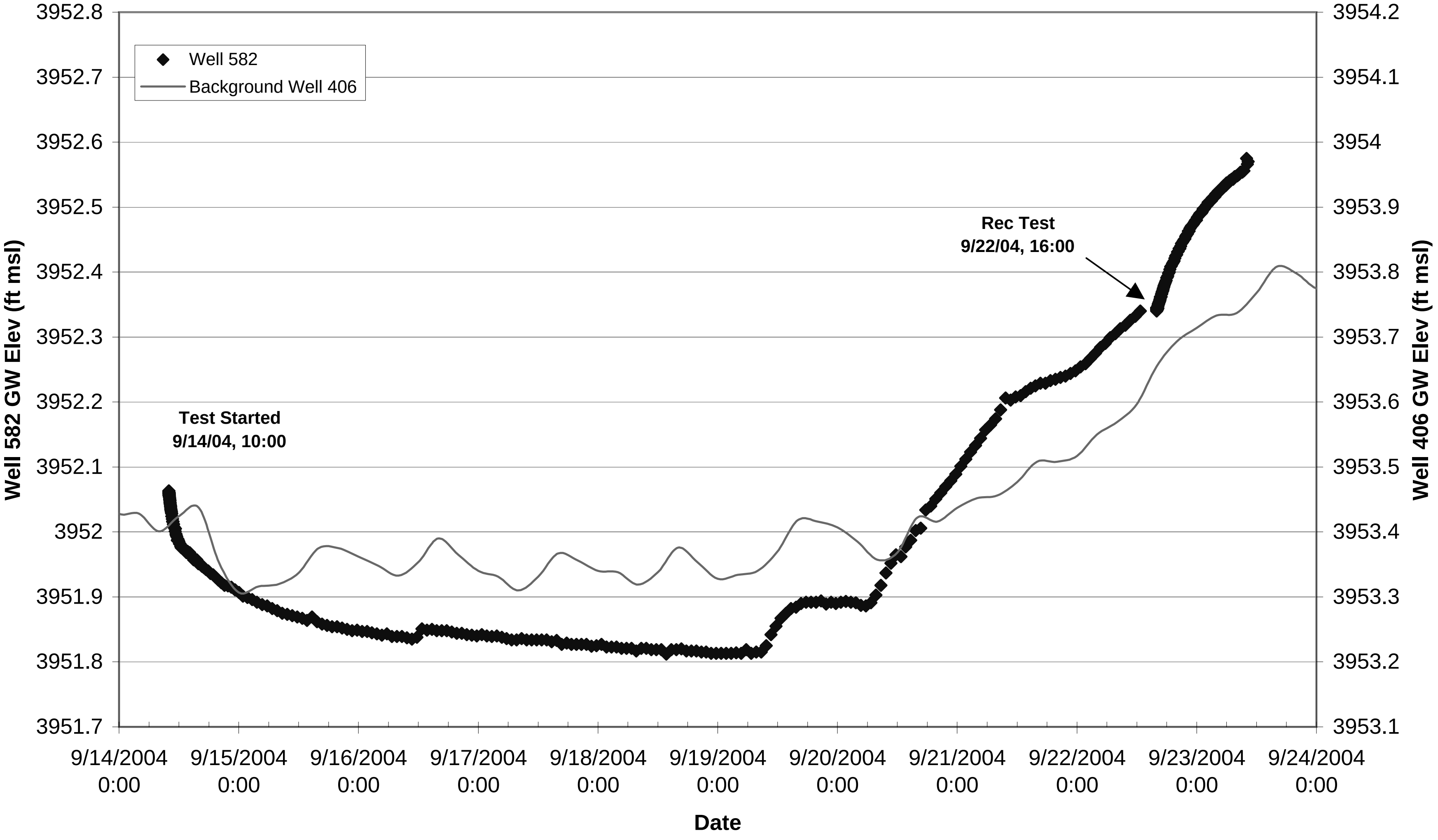


Well 579 - 30 ft off Shallow Well 578
CF II Shallow Well Test
Well 579
Background Well 406
Test Started
9/14/04, 10:00
Rec Test
9/22/04, 16:00
Well 579 GW Elev (ft msl)
Well 406 GW Elev (ft msl)
3953.3
3953.2
3953.1
3953
3952.9
3952.8
3952.7
3952.6
3952.5
3953.9
3953.8
3953.7
3953.6
3953.5
3953.4
3953.3
3953.2
3953.1
9/14/2004 0:00
9/15/2004 0:00
9/16/2004 0:00
9/17/2004 0:00
9/18/2004 0:00
9/19/2004 0:00
9/20/2004 0:00
9/21/2004 0:00
9/22/2004 0:00
9/23/2004 0:00
9/24/2004 0:00
Date

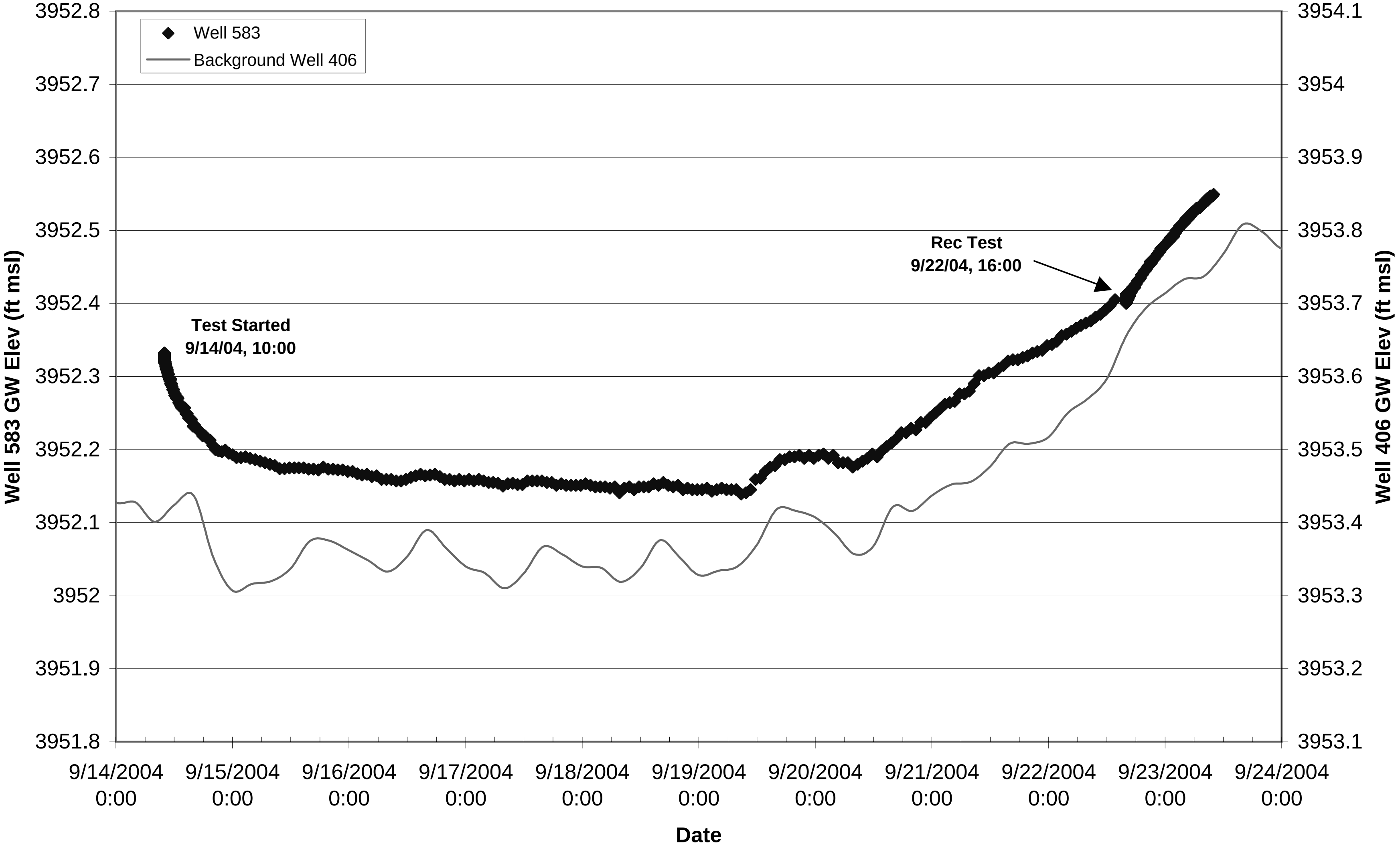
Well 580 - 30 ft off Shallow Well 570
CF II Shallow Well Test

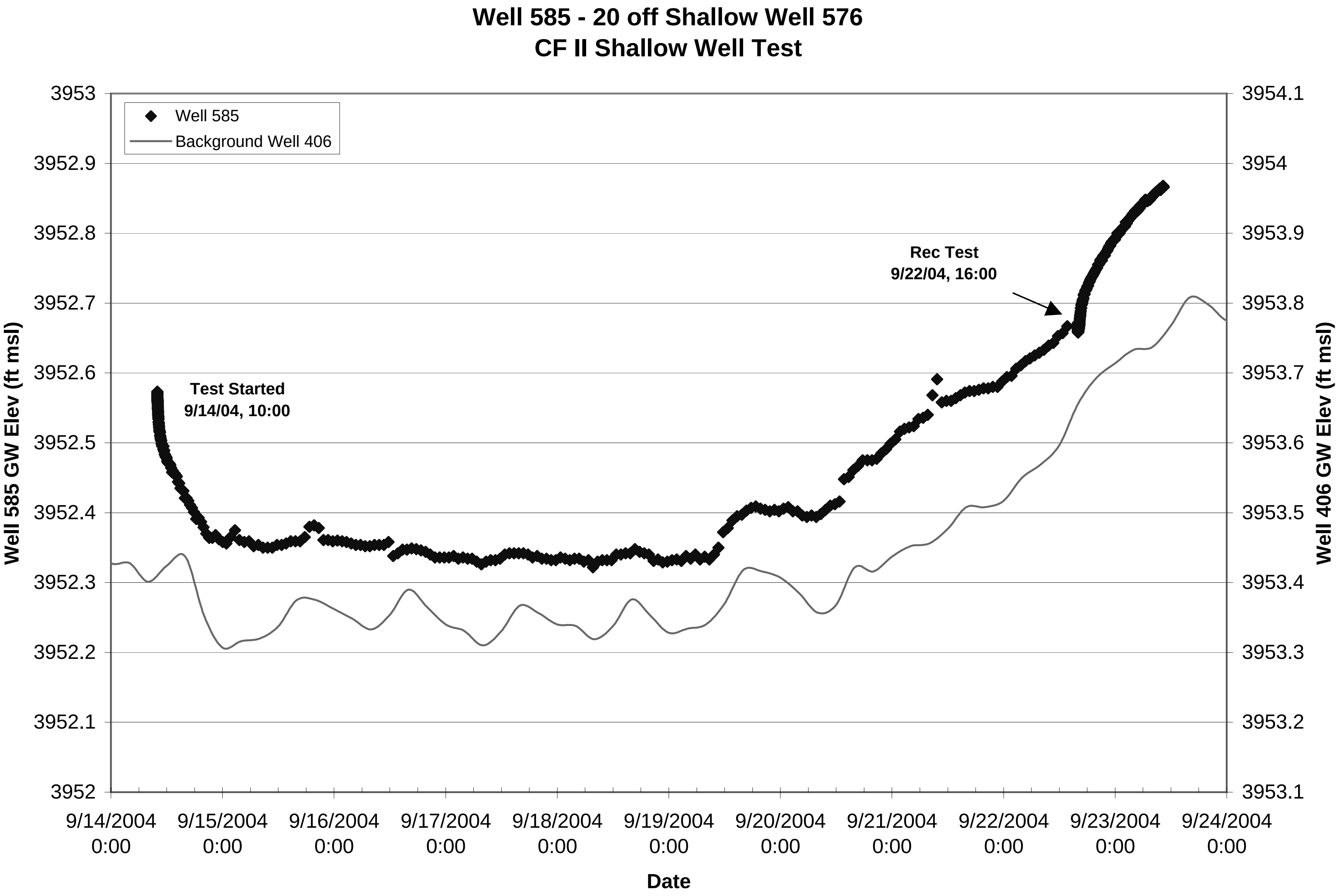


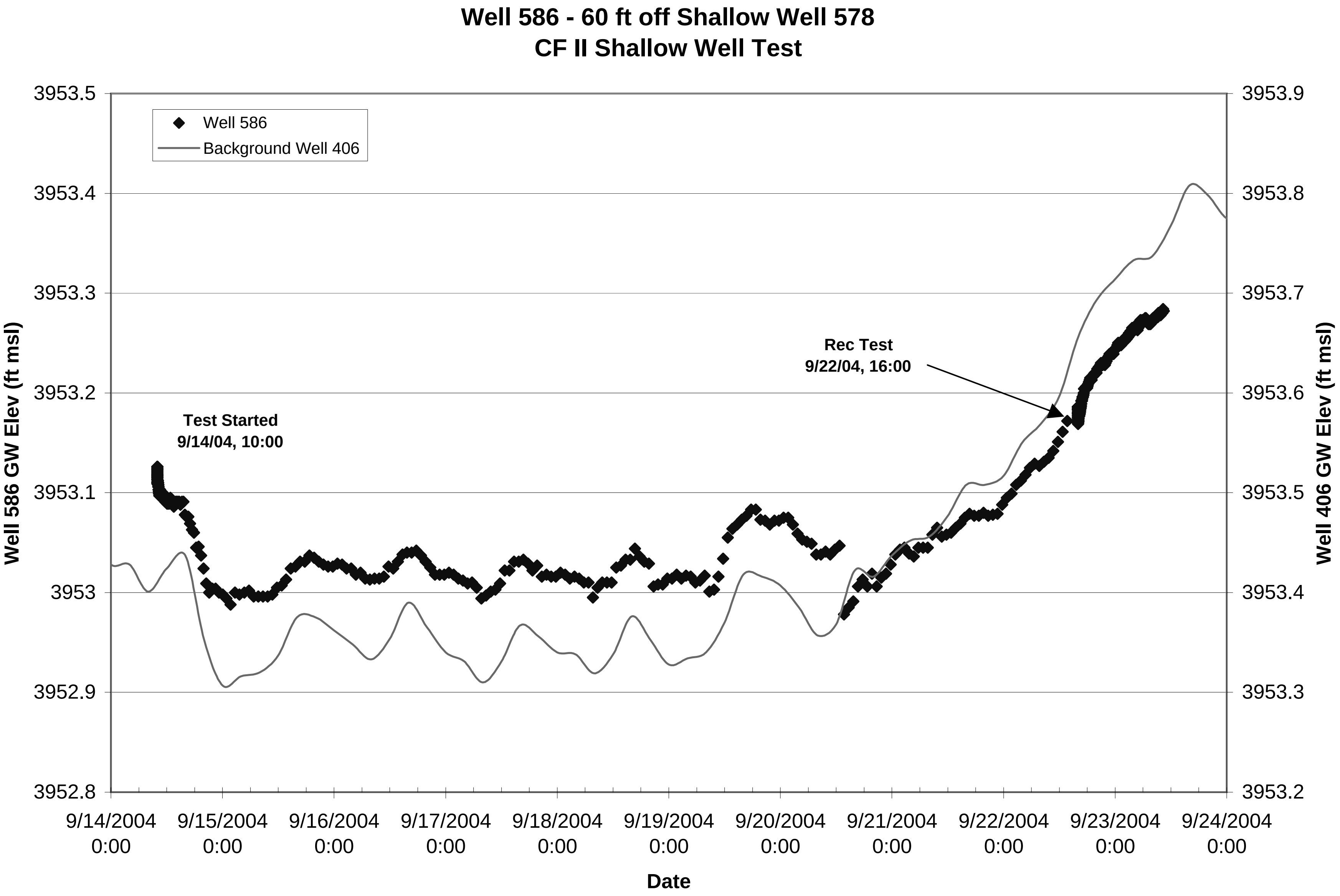
Well 582 - 20 ft off Shallow Well 572
CF II Shallow Well Test

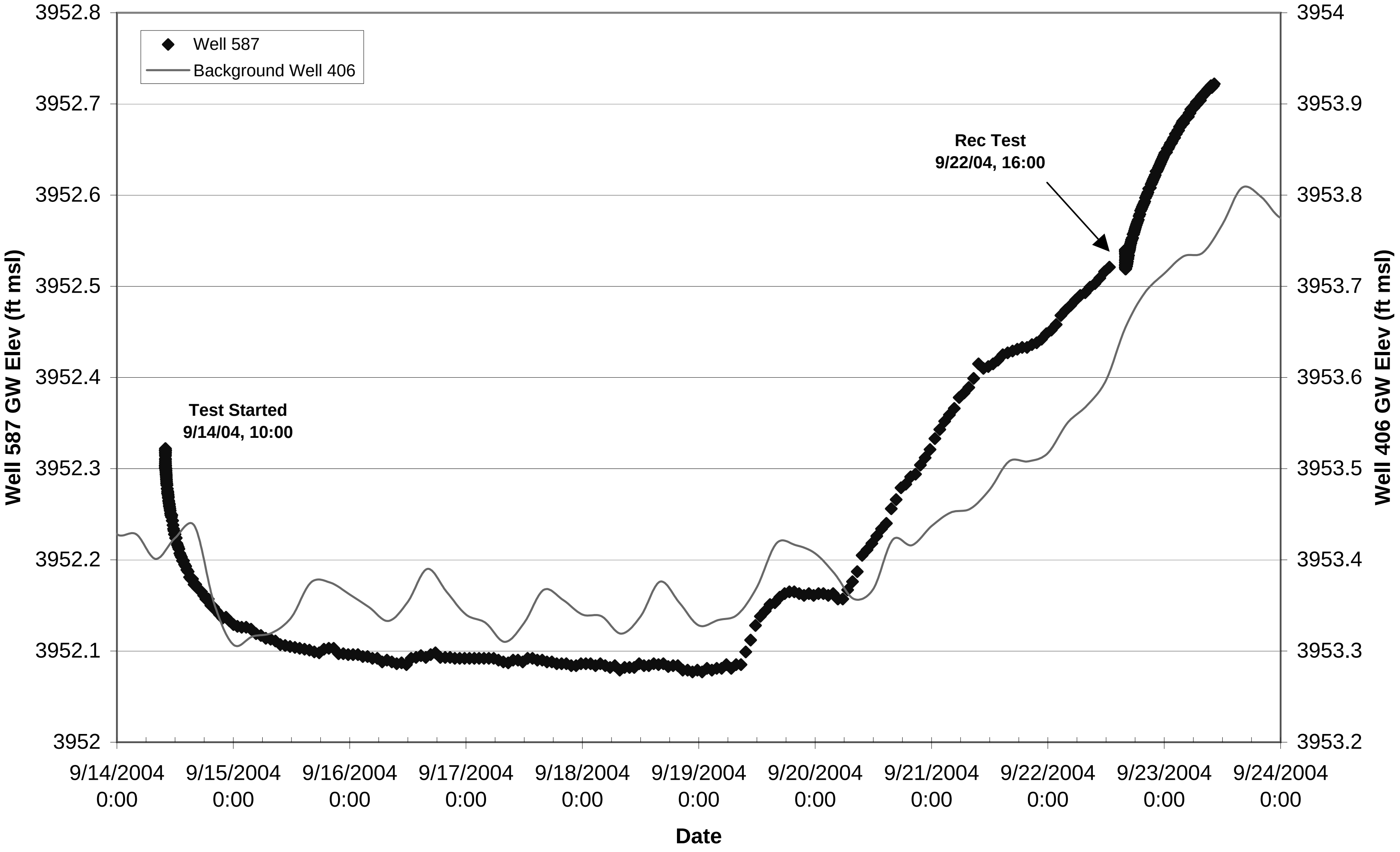


Well 583 - 35 ft off Shallow Well 574
CF II Shallow Well Test




Well 585 - 20 off Shallow Well 576
CF II Shallow Well Test
◆ Well 585
Background Well 406
Test Started
9/14/04, 10:00
Rec Test
9/22/04, 16:00
Well 585 GW Elev (ft msl)
Well 406 GW Elev (ft msl)
3953
3952.9
3952.8
3952.7
3952.6
3952.5
3952.4
3952.3
3952.2
3952.1
3952
3954.1
3954
3953.9
3953.8
3953.7
3953.6
3953.5
3953.4
3953.3
3953.2
3953.1
9/14/2004 0:00
9/15/2004 0:00
9/16/2004 0:00
9/17/2004 0:00
9/18/2004 0:00
9/19/2004 0:00
9/20/2004 0:00
9/21/2004 0:00
9/22/2004 0:00
9/23/2004 0:00
9/24/2004 0:00
Date

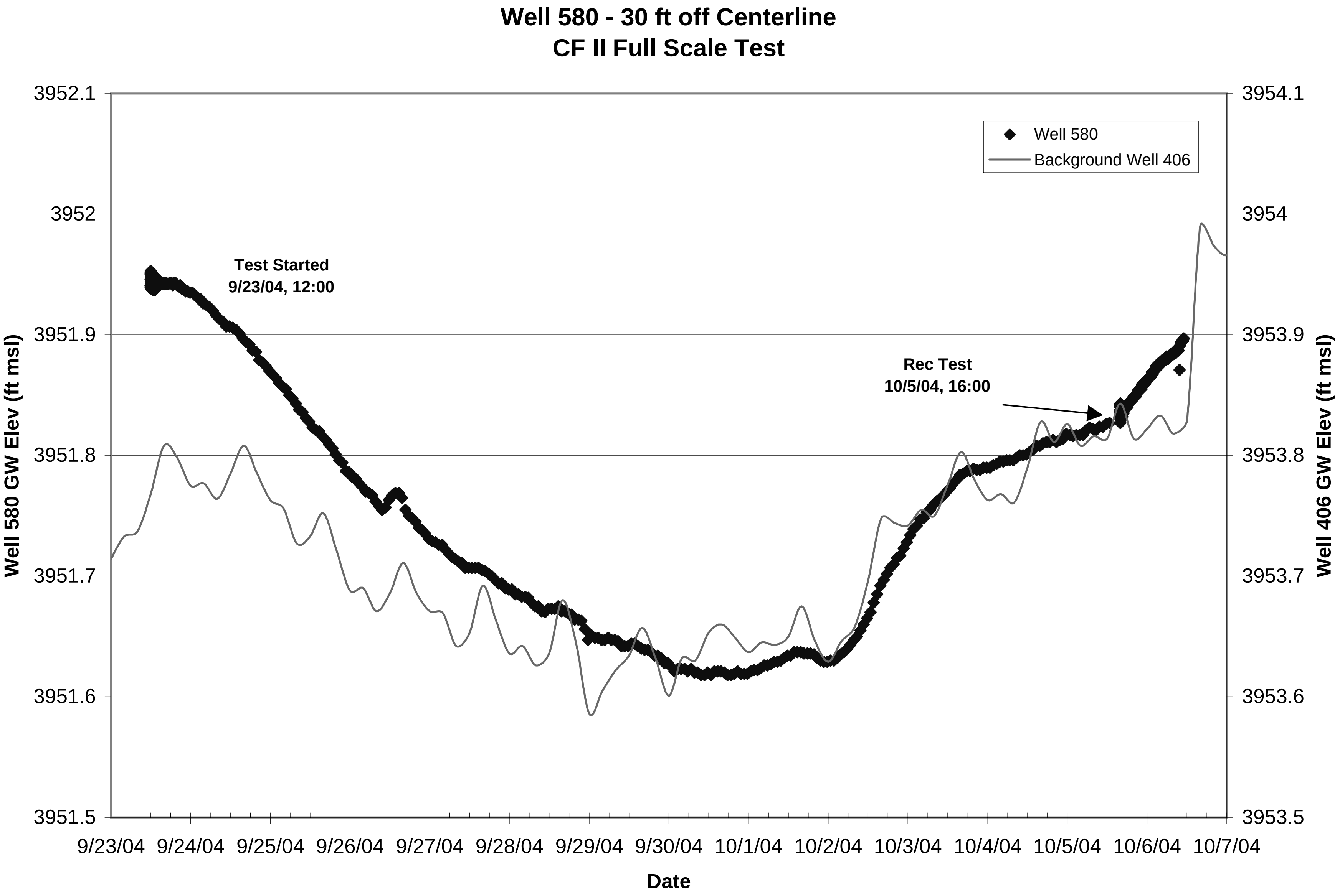

Well 586 - 60 ft off Shallow Well 578
CF II Shallow Well Test
Well 586
Background Well 406
Test Started
9/14/04, 10:00
Rec Test
9/22/04, 16:00
Well 586 GW Elev (ft msl)
Well 406 GW Elev (ft msl)
Date
3953.5
3953.4
3953.3
3953.2
3953.1
3953
3952.9
3952.8
3953.9
3953.8
3953.7
3953.6
3953.5
3953.4
3953.3
3953.2
9/14/2004 0:00
9/15/2004 0:00
9/16/2004 0:00
9/17/2004 0:00
9/18/2004 0:00
9/19/2004 0:00
9/20/2004 0:00
9/21/2004 0:00
9/22/2004 0:00
9/23/2004 0:00
9/24/2004 0:00



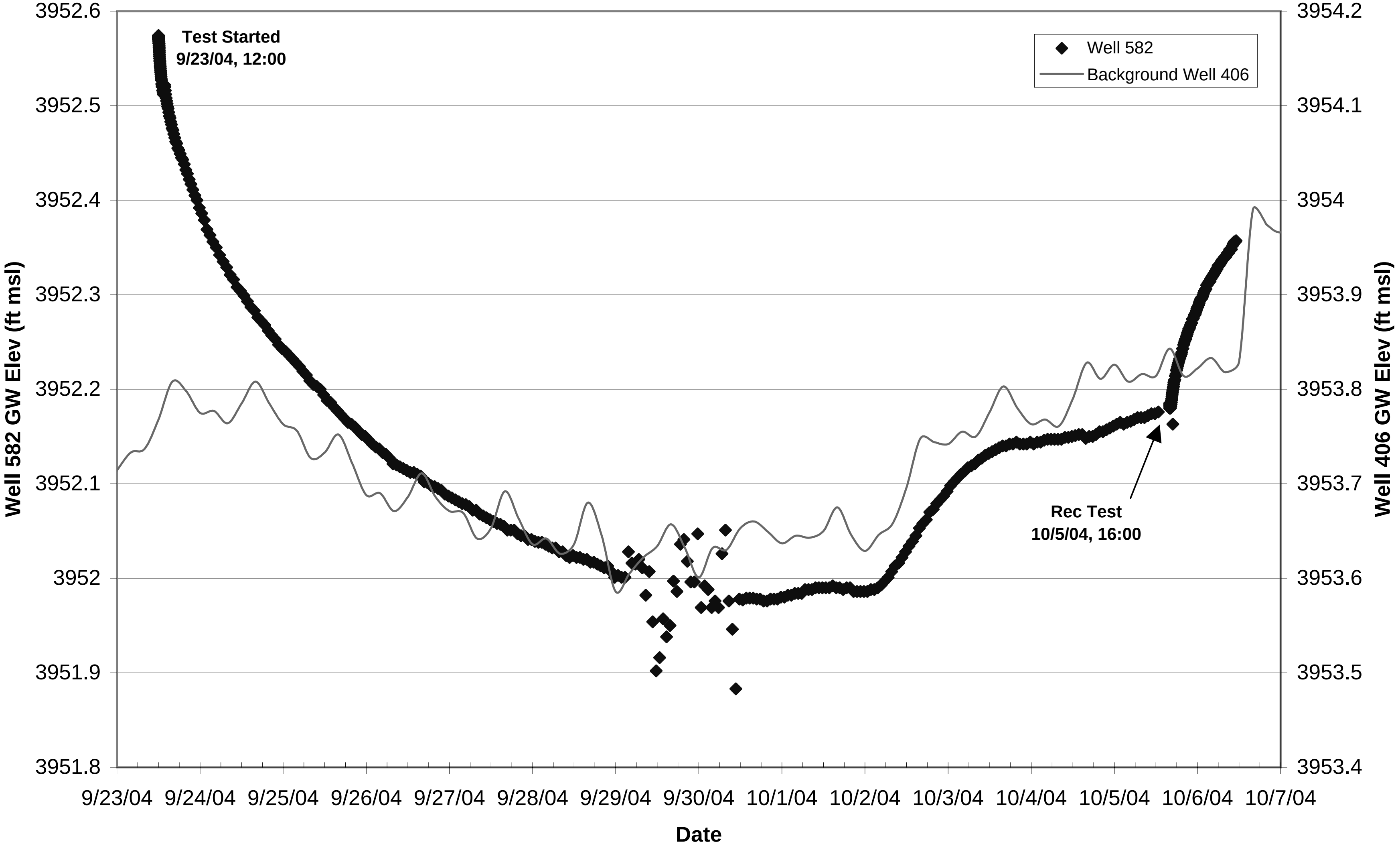
Well 587 - 15 ft off Shallow Well 574
CF II Shallow Well Test

Appendix C−3

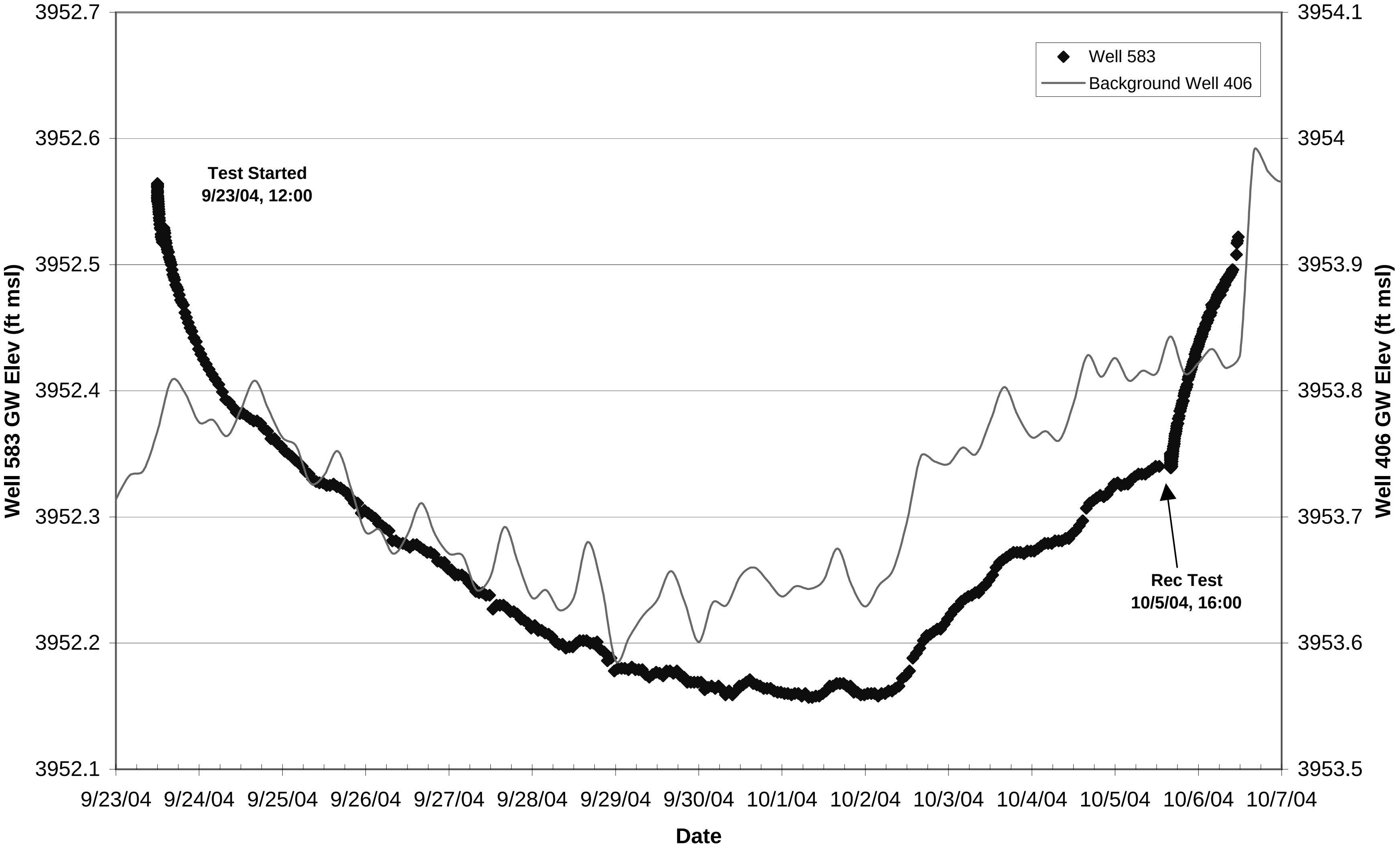
Configuration 2 Full Scale Extraction Test Pressure Transducer Data


Well 580 - 30 ft off Centerline
CF II Full Scale Test
Well 580
Background Well 406
Test Started
9/23/04, 12:00
Rec Test
10/5/04, 16:00
Well 580 GW Elev (ft msl)
Well 406 GW Elev (ft msl)
Date
3952.1
3952
3951.9
3951.8
3951.7
3951.6
3951.5
3954.1
3954
3953.9
3953.8
3953.7
3953.6
3953.5
9/23/04
9/24/04
9/25/04
9/26/04
9/27/04
9/28/04
9/29/04
9/30/04
10/1/04
10/2/04
10/3/04
10/4/04
10/5/04
10/6/04
10/7/04

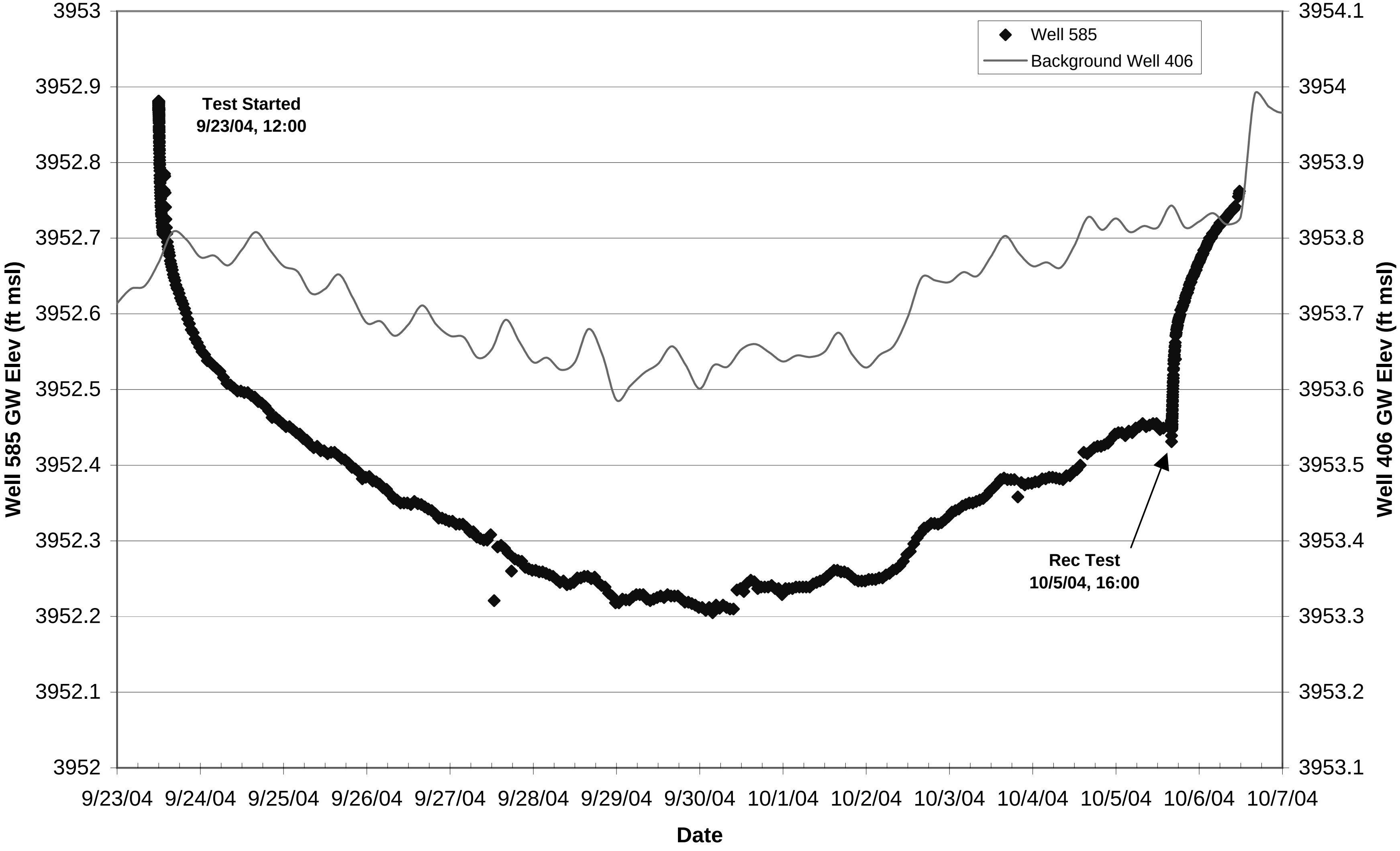
Well 582 - 15 ft off Centerline
CF II Full Scale Test



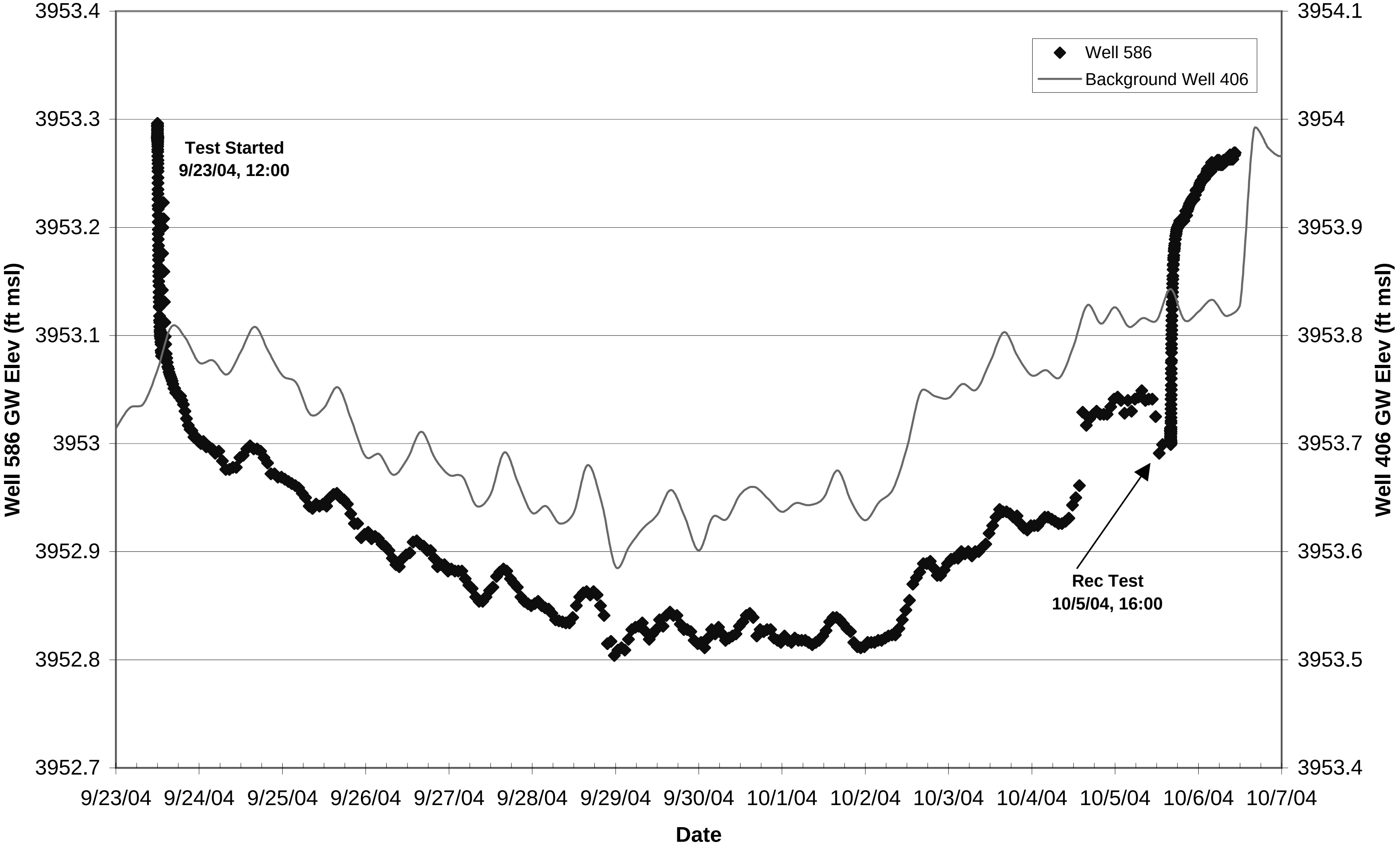
Well 583 - 30 ft off Centerline
CF II Full Scale Test



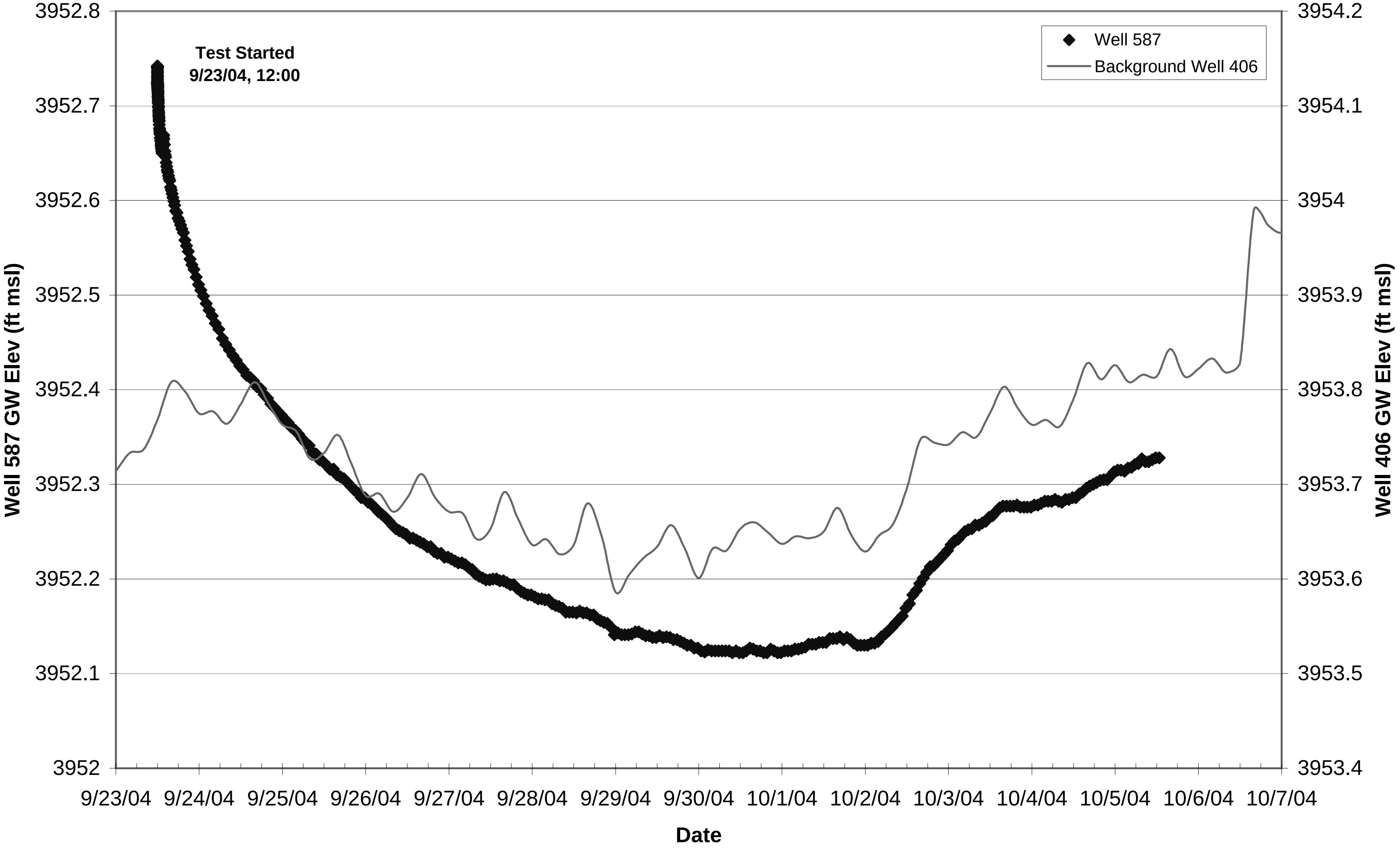
Well 585 - 15 ft off Centerline
CF II Full Scale Test



Well 586 - 30 off Centerline
CF II Full Scale Test



Well 587 - In Centerline Between Wells 574 and 575
CF II Full Scale Test



Appendix D

Piezometer Ground Water Elevation Data

Baseline Area Piezometers

Date	PZ no.	PZ Type	Ground Elevation (ft msl)	PZ Depth (ft bgs)	PZ Depth Elev (ft msl)	TOC Elev (ft msl)	DTW (ft btoc)	GW Elev (ft msl)	Spec Cond (uS/cm)	Measured TDS (mg/L)	Approx. TDS (mg/L)	Density	Equivalent Freshwater Head (ft msl)	Δh / Δz	$(\rho-\rho_f)/\rho_f$	Total Gradient	Flow Direction
8/20/2004 2670 cfs	0494	shallow	3956.36	2.09	3954.27	3959.27	dry	na	no data	no data	no data						
	0495	deep	3956.5	4.19	3952.31	3957.81	4.51	3953.3	17191	13000	na	1.0093					
	0496	shallow	3954.16	1.68	3952.48	3957.48	dry	na	no data	no data	no data						
	0497	deep	3954.28	4.12	3950.16	3955.66	2.44	3953.22	16333	13000	na	1.0093					
	0498	shallow	3952.23	1.37	3950.86	3955.86	2.93	3952.93	13148	12000	na	1.0086	3952.95	0.0167	0.0093	0.0259	downward
	0499	deep	3952.23	4.29	3947.94	3953.44	0.59	3952.85	18744	14000	na	1.0100	3952.90				
10/19/2004 3590 cfs	0494	shallow	3956.36	2.09	3954.27	3959.27	dry	na	no data	no data	no data						
	0495	deep	3956.5	4.19	3952.31	3957.81	3.99	3953.82	15244	13000	na	1.0093					
	0496	shallow	3954.16	1.68	3952.48	3957.48	3.96	3953.52	13262	no data	9836	1.0070	3953.53	0.0001	0.0082	0.0082	downward
	0497	deep	3954.28	4.12	3950.16	3955.66	1.84	3953.82	14510	13000	na	1.0093	3953.85				

Notes:
PZ = Piezometer
TOC = Top Of Casing
DTW = Depth To Water
ft msl = feet above mean sea level
ft bgs = feet below ground surface
ft btoc = feet below top of casing
GW = Groundwater
Spec Cond = Specific Conductance (field measurement)
TDS = Total Dissolved Solids
Approx. TDS = Approximate TDS Concentration (based on Specific Conductance measurements from other piezometers)

CF I Piezometers

Date	PZ no.	PZ Type	Ground Elevation (ft msl)	PZ Depth (ft bgs)	PZ Depth Elev (ft msl)	TOC Elev (ft msl)	DTW (ft btoc)	GW Elev (ft msl)	Spec Cond (uS/cm)	Measured TDS (mg/L)	Approx. TDS (mg/L)	Density	Equivalent Freshwater Head (ft msl)	$\Delta h / \Delta z$	$(\rho-\rho_f)/\rho_f$	Total Gradient	Flow Direction
8/20/2004 2670 cfs	0562	shallow	3952.82	1.53	3951.29	3956.29	4.63	3951.66	1368	no data	1148	1.0008	3951.66	-0.0430	0.0016	-0.0414	upward
	0563	deep	3953.5	3.95	3949.55	3955.05	3.32	3951.73	3927	no data	3294	1.0024	3951.74				
	0564	shallow	3952.71	1.32	3951.39	3956.39	4.51	3951.88	1958	no data	1643	1.0012	3951.88	0.0257	0.0018	0.0274	downward
	0565	deep	3952.87	4.32	3948.55	3954.05	2.25	3951.8	3930	no data	3297	1.0024	3951.81				
	0566	shallow	3951.73	1.43	3950.3	3955.3	3.3	3952	1766	no data	1481	1.0011	3952.00	0.6651	0.0084	0.6735	downward
	0567	deep	3951.72	3.83	3947.89	3953.39	3.03	3950.36	26230	no data	22004	1.0157	3950.40				

10/14/2004 3340 cfs	0562	shallow	3952.82	1.53	3951.29	3956.29	3.84	3952.45	no data	no data	no data						
	0563	deep	3953.5	3.95	3949.55	3955.05	2.81	3952.24	no data	no data	no data						
	0564	shallow	3952.71	1.32	3951.39	3956.39	3.86	3952.53	no data	no data	no data						
	0565	deep	3952.87	4.32	3948.55	3954.05	1.49	3952.56	no data	no data	no data						

Notes: PZ = Piezometer
TOC = Top Of Casing
DTW = Depth To Water
ft msl = feet above mean sea level
ft bgs = feet below ground surface
ft btoc = feet below top of casing
GW = Groundwater
Spec Cond = Specific Conductance (field measurement)
TDS = Total Dissolved Solids
Approx. TDS = Approximate TDS Concentration (based on Specific Conductance measurements from other piezometers)

CF II Piezometers

Date	PZ no.	PZ Type	Ground Elevation (ft msl)	PZ Depth (ft bgs)	PZ Depth Elev (ft msl)	TOC Elev (ft msl)	DTW (ft btoc)	GW Elev (ft msl)	Spec Cond (uS/cm)	Measured TDS (mg/L)	Approx. TDS (mg/L)	Density	Equivalent Freshwater Head (ft msl)	$\Delta h / \Delta z$	$(\rho-\rho_f)/\rho_f$	Total Gradient	Flow Direction
8/20/2004 2670 cfs	590	shallow	3952.78	1.08	3951.7	3956.7	4.22	3952.48	22825	no data	18683	1.0133	3952.49	0.0105	0.0152	0.0257	downward
	591	deep	3952.71	4.22	3948.49	3953.99	1.6	3952.39	28650	24000	na	1.0171	3952.46				
	592	shallow	3953.46	2.1	3951.36	3956.36	4.11	3952.25	22625	no data	18497	1.0132	3952.26	-0.1038	0.0141	-0.0897	upward
	593	deep	3953.53	4.13	3949.4	3954.9	2.48	3952.42	25527	21000	na	1.0150	3952.47				
	594	shallow	3952.45	2.02	3950.43	3955.43	2.69	3952.74	2875	850	na	1.0006	3952.74	1.1135	0.0006	1.1142	downward
	595	deep	3952.42	3.84	3948.58	3954.08	3.4	3950.68	3630	no data	925	1.0007	3950.68				
9/22/2004 5760 cfs	590	shallow	3952.78	1.08	3951.7	3956.7	3.82	3952.88	15063	11000	na	1.0079	3952.89	0.0478	0.0118	0.0596	downward
	591	deep	3952.71	4.22	3948.49	3953.99	1.32	3952.67	22372	22000	na	1.0157	3952.74				
	592	shallow	3953.46	2.1	3951.36	3956.36	3.1	3953.26	18379	6300	na	1.0045	3953.27	-0.0186	0.0094	-0.0092	upward
	593	deep	3953.53	4.13	3949.4	3954.9	1.65	3953.25	20530	20000	na	1.0143	3953.31				
10/14/2004 3340 cfs	590	shallow	3952.78	1.08	3951.7	3956.7	3.7	3953	no data	no data	no data						
	591	deep	3952.71	4.22	3948.49	3953.99	0.95	3953.04	no data	no data	no data						
	592	shallow	3953.46	2.1	3951.36	3956.36	3.68	3952.68	no data	no data	no data						
	593	deep	3953.53	4.13	3949.4	3954.9	1.88	3953.02	no data	no data	no data						
10/19/2004 3590 cfs	590	shallow	3952.78	1.08	3951.7	3956.7	3.61	3953.09	22420	18000	18308	1.0129	3953.11	-0.0496	0.0146	-0.0350	upward
	591	deep	3952.71	4.22	3948.49	3953.99	0.8	3953.19	28195	23000	23650	1.0164	3953.27				
	592	shallow	3953.46	2.1	3951.36	3956.36	3.63	3952.73	9285	no data	6157	1.0044	3952.74	-0.2178	0.0093	-0.2085	upward
	593	deep	3953.53	4.13	3949.4	3954.9	1.79	3953.11	24414	20000	20152	1.0143	3953.16				

Notes:
PZ = Piezometer
TOC = Top Of Casing
DTW = Depth To Water
ft msl = feet above mean sea level
ft bgs = feet below ground surface
ft btoc = feet below top of casing
GW = Groundwater
Spec Cond = Specific Conductance (field measurement)
TDS = Total Dissolved Solids
Approx. TDS = Approximate TDS Concentration (based on Specific Conductance measurements from other piezometers)

Appendix E

Appendix E−1

Configuration 1 Extraction Well Data

		Well 470										
		Depth to	flow rate	total vol		pressure	temp	spec cond	pH	comments		GW Elev
Date	Time	water (ft)	gpm	raw gls	corrected	psi	°C	µS/cm x1K				(ft msl)
3/11/2004	9:18	16.45								First spring measurement		3952.04
3/18/2004	11:04	16.38										3952.11
3/25/2004	8:04	16.17										3952.32
4/1/2004	8:52	15.75										3952.74
4/15/2004	7:20	15.30										3953.19
4/26/2004	8:38	15.85										3952.64
5/3/2004	8:59	15.66										3952.83
5/13/2004	2:54	14.10										3954.39
5/20/2004	9:00	14.88										3953.61
6/3/2004	10:11	15.09	0	642593			19.1	27.4	6.62	Pump working, but flow meter is not		3953.40
6/10/2004	8:59	15.36	2.99	651138		115	17.02	29.96	6.78			3953.13
6/14/2004	9:11	15.97	2.99	668537		148	17.32	30.5	6.77			3952.52
6/17/2004	9:00	16.40	3.05	681398		147	17.32	30.1	6.74			3952.09
6/21/2004	10.08	16.62	2.99	698677		144	17.71	30.39	6.75			3951.87
6/24/2004	8:55	19.29	6.92	722884		119	15.97	31.46	6.82			3949.20
6/28/2004										Pump not working		
7/1/2004	14:15	16.42	4.52	745383						Replace pump and started back up		3952.07
7/6/2004	11:05	18.60	4.39	776393		126	17.82	31.82	6.91			3949.89
7/7/2004	11:23	19.05	4.33	782879			16.8	34.32	6.62			3949.44
7/12/2004	11:41	19.57	4.46	814704		127	19.28	33.13	6.82			3948.92
7/15/2004	8:38	19.79	4.52	833071		128	16.83	32.66	6.75			3948.70
7/19/2004	10:55	18.49	4.52	835645		64	19.6	29.4	6.87			3950.00
7/22/2004	9:45	19.43	4.52	854717		75	19.45	32.84	6.87			3949.06
7/26/2004	10:12	20.10	4.52	880741		92	19.87	33.56	6.87			3948.39
7/29/2004	10:41	20.05	4.52	900019		102	19	33.13	6.86			3948.44
8/2/2004	10:47	20.40	4.52	925928		107	20.07	31.17	6.92			3948.09
8/9/2004	3.38	20.70	4.52	922359		120	19.77	30.85	6.72			3947.79
8/12/2004	9:22	21.10	4.46	990047		113	18.41	30.75	6.81			3947.39
8/16/2004	10:28	21.01	4.33	1015436		117	18.54	30.26	6.89			3947.48
8/19/2004	11:22	20.07	4.14	1033335		78	17.38	31.01	6.79			3948.42
8/23/2004	12:55	20.02	4.2	1056772		56	18.38	30.64	6.86			3948.47
8/26/2004	10:05	19.73	4.2	1067117		42	18.87	30.45	6.85	Well field shut down at 11:45 for repair		3948.76
8/30/2004	12:03	20.45	4.2	1090673		40	18.63	30.95	6.75			3948.04
9/2/2004	11:12	20.12	4.2	1102733			16.76	27.87	6.83			3948.37
9/7/2004	11:46	19.53	4.2	1132787		39	17.49	29.21	7.02			3948.96
9/9/2004	9:06	19.37	4.14	1144075		39	17.22	28.68	6.65			3949.12
9/13/2004	12:38	19.91	4.01	1168640		40	18.67	28.61	6.73			3948.58
9/16/2004	9:30	20.20	4.14	1185577		40	17.31	28.45	6.69			3948.29
9/20/2004	10:00	20.18	4.14	1209450		40	17.33	28.3	6.81			3948.31
9/23/2004	10:25	18.58	4.2	1227103		40	16.66	24.78	6.75			3949.91
9/27/2004	10:01	18.68	4.14	1250600		40	17.18	24.84	6.81			3949.81
9/30/2004	10:31	19.06	4.07	1268460		42	17.06	25.77	6.84			3949.43
10/4/2004	11:19	18.40	4.14	1292429		42	17.51	24.72	6.88			3950.09
10/7/2004	10:57	18.35	4.26	1310431		43	17.22	24.13	6.88			3950.14
10/11/2004	10:53	18.87	4.71	1334555		42	17.32	25.3	6.77			3949.62
10/14/2004	13:34	19.16	4.26	1353339		42	16.56	25.3	6.86	Field parameters taken on 10/13/04		3949.33
10/18/2004	14:10	19.29	4.14	1369773		43	18.04	25.47	6.76			3949.20
10/21/2004	10:21	19.20	0.25	1373424		43	16.7	27.15	6.74			3949.29
10/25/2004	13:54	19.21	0.12	1373508		43	17.5	27.37	6.92			3949.28
10/28/2004	10:12	19.25	4.2	1373509		43	16.21	30.08	6.92	Showing no flow, changed batteries, showed flow of 4.2		3949.24

Date	Time	Well 471							comments		
		Depth to water (ft)	flow rate gpm	total vol gls	pressure psi	temp ^{o}C	spec cond µS/cm x1K	pH			GW Elev (ft msl)
3/11/2004	9:20	16.58							First spring measurement		3952.25
3/18/2004	11:06	16.53									3952.30
3/25/2004	8:06	16.32									3952.51
4/1/2004	8:54	15.93									3952.90
4/15/2004	7:23	15.52									3953.31
4/26/2004	8:41	16.00									3952.83
5/3/2004	9:01	15.82									3953.01
5/13/2004	2:56	14.31									3954.52
5/20/2004	8:59	15.06									3953.77
6/3/2004	10:20	15.45	0	394128		17.7	26.25	6.63	Pump working, but flow meter is not		3953.38
6/10/2004	9:03	15.92	2.88	403145	120	17.38	31.74	6.81			3952.91
6/14/2004	9:17	16.54	3.07	420281	120	16.55	32.59	6.8			3952.29
6/17/2004	9:04	17.00	2.88	433377	128	17.05	31.43	6.77			3951.83
6/21/2004	10:13	17.28	3.07	450919	120	16.58	31.92	6.76			3951.55
6/24/2004	9:00	17.71	3	463806	120	16.06	32.24	6.83			3951.12
6/28/2004	10:28	17.88	3.07	481578	120	16.86	31.66	6.93			3950.95
7/1/2004	8:55	17.95	3.13	494498	120	17.58	32.18	6.76			3950.88
7/6/2004	11:00	18.24	3.07	516983	120	17.53	34.12	6.86			3950.59
7/7/2004	11:40	19.10	3.07	521580		17	37.05	6.59			3949.73
7/12/2004	11:36	19.20	3.13	543786	118	19.1	35.29	6.76			3949.63
7/15/2004	8:44	18.65	3.07	556745	119	17.03	34.59	6.77			3950.18
7/19/2004	11:02	18.28	3.17	558579	67	22.4	31.69	6.9			3950.55
7/22/2004	9:40	18.98	3.13	572059	84	20.19	33.45	6.85			3949.85
7/26/2004	10:17	19.55	3.43	590277	100	19.88	36.04	6.85			3949.28
7/29/2004	10:35	19.67	3.26	603705	107	18.81	37.18	6.81			3949.16
8/2/2004	10:41	19.90	3.13	622131	113	19.01	36.15	6.82			3948.93
8/9/2004	7:55	20.18	3.2	655186	117	19.61	36.27	6.65			3948.65
8/12/2004	9:27	20.43	3.33	668135	117	19.25	35.7	6.83			3948.40
8/16/2004	10:23	20.65	3.33	681459	118	18.76	34.88	6.86			3948.18
8/19/2004	11:29	20.06	3.13	701546	112	17.83	35.94	6.81			3948.77
8/23/2004	12:50	20.53	3.45	718123	48	17.21	37.67	6.83			3948.30
8/26/2004	10:10	20.26	3.58	726969	34	17.48	35.56	6.79	Well field shut down at 11:45 for repair		3948.57
8/30/2004	11:58	20.95	3.52	746972	40	17.61	36.43	6.7			3947.88
9/2/2004	11:35	20.86	3.58	751423		16.48	32.56	6.76			3947.97
9/7/2004	11:41	20.28	3.64	782895	43	17.19	37.67	6.97			3948.55
9/9/2004	9:12	19.37	4.14	793665	44	16.67	35.04	6.59			3949.46
9/13/2004	12:32	20.51	3.52	813372	45	18.84	33.96	6.75			3948.32
9/16/2004	9:35	20.85	3.52	827863	44	16.32	33.48	6.68			3947.98
9/20/2004	10:05	19.90	3.52	848014	45	16.8	34.83	6.76			3948.93
9/23/2004	10:19	19.32	3.52	862745	44	16.46	35.39	6.7			3949.51
9/27/2004	10:06	19.23	3.45	882249	46	16.91	30.69	6.74			3949.60
9/30/2004	10:25	19.61	3.39	897032	46	16.97	30.88	6.81			3949.22
10/4/2004	11:27	19.03	3.45	917002	45	17.09	31.57	6.82			3949.80
10/7/2004	10:52	19.02	3.58	931993	45	17.16	31.32	6.82			3949.81
10/11/2004	11:02	19.39	3.45	952087	45	17.19	30.93	6.78			3949.44
10/14/2004	13:35	19.55	3.39	967315	46	16.72	30.86	6.89	Field parameters taken on 10/13/04		3949.28
10/18/2004	14:07	19.73	3.39	987018	46	17.45	29.91	6.7			3949.10
10/21/2004	10:26	19.59	3.45	1001009	44	16.91	33.37	6.73			3949.24
10/25/2004	13:49	19.53	3.39	1021148	45	17.2	33.11	6.88			3949.30
10/28/2004	10:27	19.46	3.33	1034603	45	16.33	33.68	6.93			3949.37

		Well 472									
Date	Time	Depth to water (ft)	flow rate gpm	total vol gls	pressure psi	temp °C	spec cond µS/cm x1K	pH	comments		GW Elev (ft msl)
3/11/2004	9:22	16.57							First spring measurement		3952.24
3/18/2004	11:08	16.53									3952.28
3/25/2004	8:08	16.33									3952.48
4/1/2004	8:58	15.92									3952.89
4/15/2004	7:25	15.52									3953.29
4/26/2004	8:43	16.00									3952.81
5/3/2004	9:04	15.82									3952.99
5/13/2004	2:58	14.40									3954.41
5/20/2004	8:58	15.07									3953.74
6/3/2004	10:35	15.23	0	353353		18.8	23.75	6.64	Pump working, but flow meter is not		3953.58
6/10/2004	9:07	16.08	3.03	761463	134	16.52	29.79	6.82			3952.73
6/14/2004	9:22	16.65	3.03	377748	133	16.84	30.13	6.79			3952.16
6/17/2004	9:09	17.13	2.99	390445	130	16.71	29.13	6.79			3951.68
6/21/2004	10:19	17.42	3.1	408211	134	17.38	29.99	6.84			3951.39
6/24/2004	9:03	17.83	3.06	421161	126	15.96	28.57	6.85			3950.98
6/28/2004	10:17	18.10	3.06	438917	130	17.36	29.08	6.98			3950.71
7/1/2004	9:02	18.24	3.06	451839	132	18.03	30.24	6.95			3950.57
7/6/2004	10:53	18.70	3.06	474108	131	18.14	29.69	6.93			3950.11
7/7/2004	11:52	18.75	3.06	478708		18	31.5	6.61			3950.06
7/14/2004	10:32	19.38	3.12	500555	131	19.94	30.03	6.85			3949.43
7/15/2004	8:50	19.45	3.12	513214	130	17.33	29.73	6.8			3949.36
7/19/2004	11:10	18.34	3.12	514984	131	20.82	26.88	6.95			3950.47
7/22/2004	9:34	19.12	3.1	527569	131	19.33	29.32	6.86			3949.69
7/26/2004	10:22	19.71	3.1	543913	130	18.5	30.7	6.87			3949.10
7/29/2004	10:30	19.71	3.1	555900	130	19.04	31.51	6.89			3949.10
8/2/2004	10:36	20.05	3.08	572114	130	18.69	30.98	6.85			3948.76
8/9/2004	3.27	20.52	3.1	601297	128	18.25	31.68	6.61			3948.29
8/12/2004	9:32	20.86	3.12	612450	129	19.03	31.6	6.85			3947.95
8/16/2004	10:14	21.07	3.14	628669	130	19.83	31.06	6.95			3947.74
8/19/2004									Jeff Price working on well		
8/23/2004	12:43	20.85	3.16	656434	112	18.52	29.07	6.87			3947.96
8/26/2004	10:14	20.13	3.23	664470	113	18.63	32.32	6.82	Well field shut down at 11:45 for repair		3948.68
8/30/2004	11:53	19.90	3.16	680281	109	19.07	31.6	6.76			3948.91
9/2/2004	11:42	20.20	3.23	688560		17.32	28.32	6.75			3948.61
9/7/2004	11:36	20.28	3.25	708788	109	17.87	31.38	6.99			3948.53
9/9/2004	9:17	19.45	2.84	715926	45	17.17	31.19	6.64			3949.36
9/13/2004	12:26	19.87	2.82	731713	44	18.45	30.63	6.73			3948.94
9/16/2004	9:41	20.21	2.86	743338	44	16.82	30.6	6.71			3948.60
9/20/2004	10:10	20.28	2.86	759617	44	16.98	30.16	6.8			3948.53
9/23/2004	10:13	19.10	2.93	771501	44	16.65	28.3	6.76			3949.71
9/27/2004	10:12	18.94	2.82	786935	45	17.24	27.33	6.85			3949.87
9/30/2004	10:20	19.20	2.82	797430	44	17.17	27.35	6.87			3949.61
10/4/2004	11:30	18.77	2.86	813772	44	17.33	26.67	6.9			3950.04
10/7/2004	10:47	18.78	2.97	825793	44	17.28	26	6.9			3950.03
10/11/2004	11:07	19.04	2.97	842050	43	17.18	26.51	6.8			3949.77
10/14/2004	13:36	19.22	2.93	854621	43	16.69	26.43	6.89	Field parameters taken on 10/13/04		3949.59
10/18/2004	14:04	19.31	2.93	870889	44	17.28	27.82	6.72			3949.50
10/21/2004	10:28	19.22	2.95	882429	44	16.5	28.14	6.85			3949.59
10/25/2004	13:44	19.21	2.93	899173	43	17.15	28.4	6.91			3949.60
10/28/2004	10:34	19.37	2.91	910786	43	15.79	27.68	6.96			3949.44

			Well 473									
	Time	Depth to	flow rate	total vol (gls)		pressure	temp	spec cond		comments		GW Elev
Date		water (ft)	gpm	raw data	corrected	psi	°C	µS/cm x1K	pH			(ft msl)
3/11/2004	9:24	16.57								First spring measurement		3952.48
3/18/2004	11:10	16.50										3952.55
3/25/2004	8:10	16.35										3952.70
4/1/2004	9:00	15.93										3953.12
4/15/2004	7:27	15.53										3953.52
4/26/2004	8:44	16.02										3953.03
5/3/2004	9:06	15.84										3953.21
5/13/2004	3:01	14.48										3954.57
5/20/2004	8:56	15.10										3953.95
6/3/2004	10:50	15.52	0		307876		20.6	24.29	6.64	Pump working, but flow meter is not		3953.53
6/10/2004	9:14	15.27	2.94		316088	22	17.2	24.36	6.79	O ring is bad		3953.78
6/14/2004	9:28	17.13	2.88		332656	50	16.97	25.43	6.76			3951.92
6/17/2004	9:16	17.75	2.81		344902	93	16.92	25.11	6.79			3951.30
6/21/2004	10:25	18.08	2.81		361311	114	17.08	24.87	6.77			3950.97
6/24/2004	9:15	16.82	0		373204	112	16.83	24.02	6.89			3952.23
6/28/2004	10:10	19.10	2.88		389601	115	18.72	24.35	6.92			3949.95
7/1/2004	9:08	19.40	2.88		401638	114	18.26	24.03	6.89			3949.65
7/6/2004	10:45	20.32	2.88		422433	114	18.7	23.83	6.89			3948.73
7/7/2004	12:01	20.65	2.75		426798		18.1	24.58	6.64			3948.40
7/12/2004	11:27	19.74	1.85		441117	120	20.12	25.17	6.8			3949.31
7/15/2004	8:55	19.70	1.85		448908	120	18.35	25.85	6.8			3949.35
7/19/2004	11:16	18.10	1.92		450015	8	21.32	24.78	6.83	Bad gauge?		3950.95
7/22/2004	9:26	18.60	1.92		457630	20	21.63	26.48	6.84	Bypass valve is leaking		3950.45
7/26/2004	10:31	19.88	1.72		467979	60	21.27	26.82	6.91			3949.17
7/29/2004	10:25	19.90	1.72		475366	120	20.35	26.81	6.84			3949.15
8/3/2004	10:31	20.27	1.72		485360	120	21.63	26.8	6.84			3948.78
8/9/2004	3:22	21.05	1.79		503416	120	19.14	27.25	6.67			3948.00
8/12/2004	9:38	21.05	1.72		510250	12	18.83	27.91	6.79			3948.00
8/16/2004	10:00	17.90	1.02		518027	100	19.99	27.27	6.77	Not pumping, check breaker		3951.15
8/19/2004	11:34	21.07	1.4		522399	116	20.09	29.64	6.8			3947.98
8/23/2004	12:38	20.10	1.53		531070	95	19.02	28.85	6.81			3948.95
8/26/2004	10:19	19.45	1.47		585438	96	18.86	29.06	6.75	Well field shut down at 11:45 for repair		3949.60
8/30/2004	11:44	20.00	1.53		544031	96	19.7	29.66	6.69			3949.05
9/2/2004	11:59	20.35	1.53		548528		18.38	27.74	6.73			3948.70
9/7/2004	11:30	19.58	1.53		559297	95	18.94	29.04	6.98			3949.47
9/9/2004	9:22	19.10	1.6		563506	44	17.3	28.43	6.52			3949.95
9/13/2004	12:20	19.39	1.53		572479	45	19.52	28.51	6.73			3949.66
9/16/2004	9:48	19.61	1.4		578508	44	17.71	28.35	6.64			3949.44
9/20/2004	10:16	19.45	1.27		586246	44	17.08	28.04	6.72			3949.60
9/23/2004	10:07	18.50	1.27		591383	44	17.09	25.7	6.7			3950.55
9/27/2004	10:20	18.32	0.12		592993	46	17.69	25.12	6.74			3950.73
9/30/2004	10:13	18.44	0		592998	46	17.67	25.42	6.81	Leaking bypass valve, changed batteries		3950.61
10/4/2004	11:33	18.05	0			45	18.17	23.13	6.83	No flow, leaking bypass valve		3951.00
10/7/2004	10:41	18.08	1.15	3159	596157	44	17.65	23	6.84	Batteries changed and meter was reset to zero		3950.97
10/11/2004	11:13	18.14	0.83	9123	602121	44	17.63	23.66	6.84			3950.91
10/14/2004	13:38	18.20	0.12	10101	603099	44	17.65	23.95	6.84			3950.85
10/18/2004	14:01	18.21	0.12	10189	603187	44	18.61	23.66	6.79			3950.84
10/21/2004	3:20	18.09	1.04	0	603187	45	16.55	25.32	6.83	Valves replaced and totals restarted at zero		3950.96
10/25/2004	13:40	17.99	0.98	5528	608715	44	18.1	25.79	6.85			3951.06
10/28/2004	10:40	19.68	3.06	11996	615183	48	16.53	26.62	6.97			3949.37

			Well 474								
Date	Time	Depth to water (ft)	flow rate gpm	total vol gls	pressure psi	temp °C	spec cond µS/cm x1K	pH	comments		GW Elev (ft msl)
3/11/2004	9:26	16.83							First spring measurement		3952.39
3/18/2004	11:12	16.78									3952.44
3/25/2004	8:12	16.63									3952.59
4/1/2004	9:02	16.75									3952.47
4/15/2004	7:28	15.90									3953.32
4/26/2004	8:45	16.30									3952.92
5/3/2004	9:08	16.15									3953.07
5/13/2004	3:02	14.50									3954.72
5/20/2004	8:55	15.41									3953.81
6/3/2004	11:00	16.08	0	367554		18	22.56	6.65	Pump working, but flow meter is not		3953.14
6/10/2004	9:21	16.65	3	376279	108	17.87	24.23	6.83			3952.57
6/14/2004	9:33	17.13	3.06	393830	115	18.95	24.74	6.83			3952.09
6/17/2004	9:21	17.60	3	407092	108	17.44	24.65	6.83			3951.62
6/21/2004	10:32	17.85	3.12	425114	113	18.25	25.02	6.8			3951.37
6/24/2004	9:19	18.13	3.19	438495	118	16.71	24.55	6.87			3951.09
6/28/2004	10:05	18.52	3.19	456789	116	18.99	24.48	6.95			3950.70
7/1/2004	9:13	18.65	3.19	470284	136	18.33	24.64	6.88			3950.57
7/6/2004	10:38	19.02	3.19		118	19.08	24.69	6.92	Total gallons on flow reading not reading		3950.20
7/7/2004	12:12	19.60	3.19	498492		17.2	26.75	6.61			3949.62
7/14/2004	11:22	19.10	2.68	518357	94	23.35	26.01	6.9			3950.12
7/15/2004									Pump not working		
7/19/2004									Pump not working		
7/22/2004	9:13	17.64							Pump not working		3951.58
7/26/2004	10:38	18.83	1.97	532722	122	20.92	27.21	6.97			3950.39
7/29/2004	10:21	18.85	1.97	541034	123	20.68	27.61	6.85			3950.37
8/3/2004	10:25	19.02	1.97	552365	123	21.45	28.36	6.95			3950.20
8/9/2004	3:17	19.20	1.97	572764	124	21.56	29.19	6.74			3950.02
8/12/2004	9:41	19.30	1.97	580605	125	20.06	29.25	6.8			3949.92
8/16/2004	9:54	19.26	1.97	591932	124	21.03	28.91	6.65			3949.96
8/19/2004	11:40	20.60	1.97	600529	124	20.69	30.15	6.76			3948.62
8/23/2004	12:31	19.35	1.91	611248	122	20.87	30.5	6.82			3949.87
8/26/2004	10:21	18.00			122				Keeps kicking breaker		3951.22
8/30/2004	12:10	18.20	1.15	613652	127	21.56	33.71	6.75	Adjusted to 1.15, 127 lbs (was kicked off)		3951.02
9/2/2004	14:32	18.19	0	613786							3951.03
9/7/2004	11:25	18.50	1.08	621036	125	20.93	31.32	7.02			3950.72
9/9/2004	9:28	18.70	1.72	624896	48	18.46	32.04	6.52			3950.52
9/13/2004	12:13	18.95	1.72	635248	48	20.78	31.89	6.72			3950.27
9/16/2004	9:55	19.15	1.78	642693	45	18.26	31.21	6.68			3950.07
9/20/2004	10:22	19.19	1.72	658292	46	17.82	31.19	6.78			3950.03
9/23/2004	10:02	18.60	1.91	660418	46	16.87	30.9	6.69			3950.62
9/27/2004	10:27	18.40	1.65	669921	44	17.84	29.03	6.72			3950.82
9/30/2004	10:06	18.52	1.65	676841	48	17.58	28.17	6.79			3950.70
10/4/2004	11:41	18.31	1.59	686285	48	17.69	27.34	6.82			3950.91
10/7/2004	10:32	18.28	1.78	693423	48	17.67	26.71	6.82			3950.94
10/11/2004	11:22	18.33	1.65	703427	48	17.41	26.46	6.75			3950.89
10/14/2004	13:39	18.39	1.72	710930	45	16.73	26.55	6.85			3950.83
10/18/2004	13:57	18.43	1.65	720513	46	18.03	27.04	6.71			3950.79
10/21/2004	10:35	18.35	1.65	727253	46	16.67	27.45	6.8			3950.87
10/25/2004	13:35	18.32	1.59	736869	46	17.53	28.68	6.89			3950.90
10/28/2004	10:44	18.45	1.59	743406	46	15.09	23.59	6.94			3950.77

Date	Time		Well 475						comments		
		Depth to water (ft)	flow rate gpm	total vol gls	pressure psi	temp ^{o}C	spec cond µS/cm x1K	pH			GW Elev (ft msl)
3/11/2004	9:28	16.92							First spring measurement		3952.54
3/18/2004	11:14	16.85									3952.61
3/25/2004	8:14	16.71									3952.75
4/1/2004	9:04	16.30									3953.16
4/15/2004	7:29	15.97									3953.49
4/26/2004	8:47	16.38									3953.08
5/3/2004	9:09	16.23									3953.23
5/13/2004	3:04	15.00									3954.46
5/20/2004	8:54	15.52									3953.94
6/3/2004	11:10	16.01	0.95	343994		17.8	23.7	6.64			3953.45
6/10/2004	9:24	17.11	2.91	359428	132	17.08	23.11	6.85			3952.35
6/14/2004	9:42	17.60	2.91	376271	130	17.55	23.58	6.85			3951.86
6/17/2004	9:26	18.16	2.85	388771	132	17.66	23.51	6.84			3951.30
6/21/2004	10:38	18.46	2.91	405673	132	17.48	24.44	6.81			3951.00
6/24/2004	9:23	18.49	2.91	417880	132	16.27	24.18	6.83			3950.97
6/28/2004	9:58	19.20	2.85	434476	136	18.96	23.94	6.93			3950.26
7/1/2004	9:19	19.30	2.85	446751	134	18.18	23.68	6.89			3950.16
7/6/2004	10:32	19.12	2.91	467859	132	18.4	23.4	6.92			3950.34
7/7/2004	12:24	19.80	2.79	472325		17.7	24.71	6.59			3949.66
7/14/2004	11:18	20.76	2.85	492738	130	22	24.25	6.82			3948.70
7/15/2004	8:59	19.51	2.91	504910	131	20.07	25.18	6.81			3949.95
7/19/2004	11:26	18.85	3.04	506624	14	19.77	24.81	6.77	Bad gauge?		3950.61
7/22/2004	9:12	20.08	2.98	519101	74	19.33	25.75	6.82			3949.38
7/26/2004	10:44	21.10	2.85	535404	112	20.52	25.85	6.88			3948.36
7/29/2004	10:16	21.10	2.85	545228	120	20.38	25.62	6.85			3948.36
8/3/2004	10:20	21.10	2.66	561113	113	20.11	25.68	6.83			3948.36
8/9/2004	3:11	20.99	2.47	587811	100	20.75	25.96	6.68			3948.48
8/12/2004	9:54	21.05	2.41	597603	96	20.62	26.7	6.9			3948.41
8/16/2004	9:47	21.05	2.34	611130	92	20.12	26.31	6.87			3948.41
8/19/2004	11:45	21.05	2.28	621252	92	20.74	27.46	6.8			3948.41
8/23/2004	12:15	19.91	2.15	633526	90	18.85	28.16	6.79			3949.55
8/26/2004	10:33	19.91	2.79	640695	82	20.49	28.15	6.8	Probe stuck/well field shut down at 11:45 for repair		3949.55
8/30/2004	11:32	20.15	2.41	654745	96	18.38	28.89	6.64			3949.31
9/2/2004	12:15	20.91	2.41	662567		17.6	25.942	6.69			3948.55
9/7/2004	11:07	20.90	2.66	679097	100	18.66	29.42	6.94			3948.56
9/9/2004	9:33	19.73	1.96	685630	46	17.5	28.97	6.51			3949.73
9/13/2004	12:07	20.20	2.09	697866	46	19.92	28.44	6.73			3949.26
9/16/2004	10:03	20.68	2.02	706629	45	17.79	28.49	6.7			3948.78
9/20/2004	10:28	20.82	2.02	719396	46	17.56	28.41	6.76			3948.64
9/23/2004	9:57	19.85	2.15	727126	45	16.68	28.72	6.63			3949.61
9/27/2004	10:33	19.47	2.02	739199	46	17.52	27.74	6.73			3949.99
9/30/2004	10:00	19.67	2.09	748145	46	17.23	26.69	6.75			3949.79
10/4/2004	11:45	19.34	2.09	760635	46	17.62	26.03	6.81			3950.12
10/7/2004	10:25	19.40	2.22	770019	45	17.47	25.49	6.81			3950.06
10/11/2004	11:30	19.41	2.22	783115	44	17.17	24.92	6.78			3950.05
10/14/2004	13:40	19.48	2.15	792858	45	16.79	24.17	6.84			3949.98
10/18/2004	13:54	19.52	2.22	805421	45	17.51	24.36	6.7			3949.94
10/21/2004	10:38	19.40	2.22	814417	44	16.8	24.57	6.76			3950.06
10/25/2004	13:30	19.36	2.22	827419	45	17.23	24.66	6.9			3950.10
10/28/2004	10:49	19.51	2.15	836246	45	15.64	24.76	6.91			3949.95

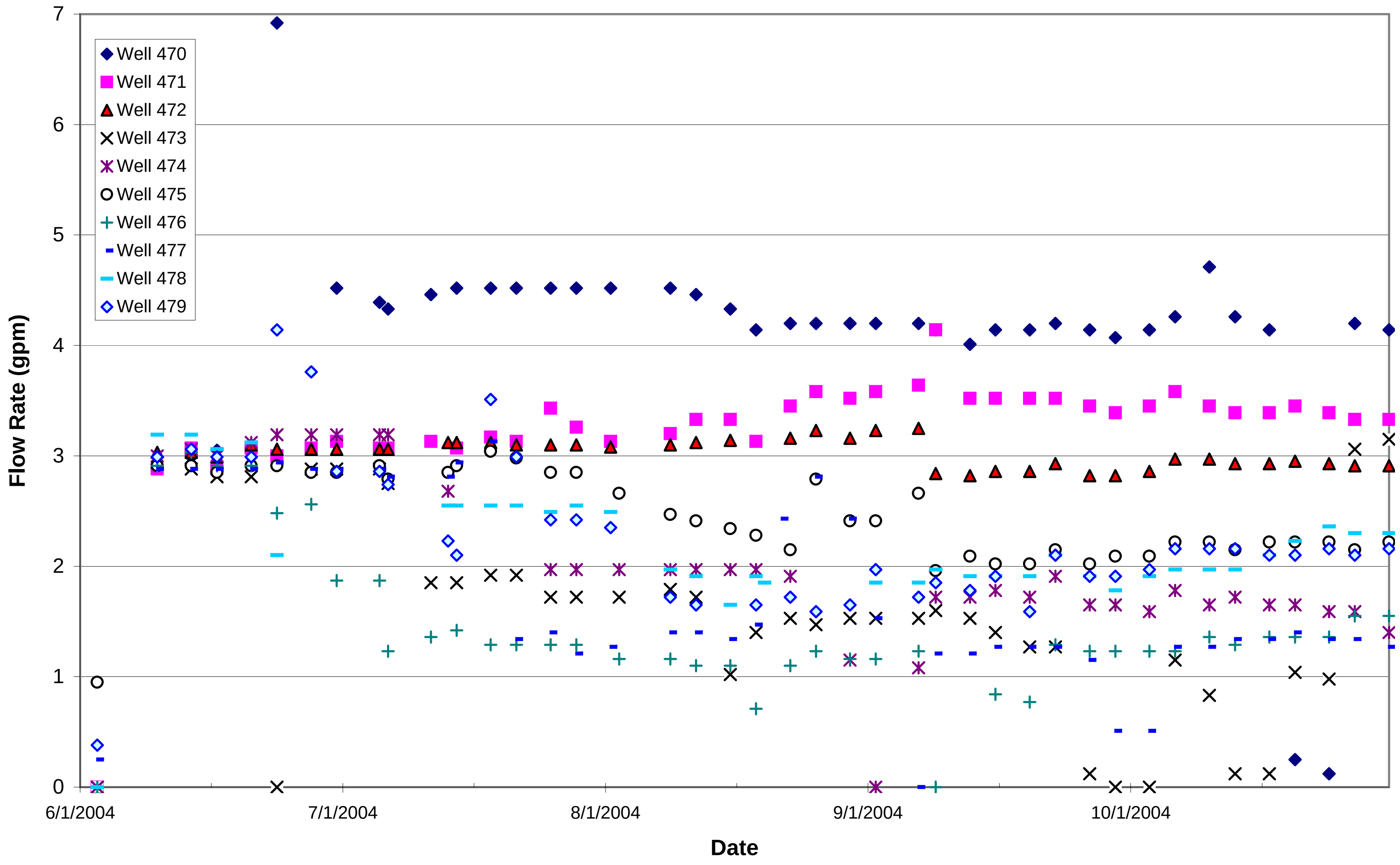
Date	Time		Well 476						comments		
		Depth to water (ft)	flow rate gpm	total vol gls	pressure psi	temp ^{o}C	spec cond µS/cm x1K	pH			GW Elev (ft msl)
3/11/2004	9:30	16.96							First spring measurement		3952.52
3/18/2004	11:16	16.90									3952.58
3/25/2004	8:16	16.79									3952.69
4/1/2004	9:05	16.41									3953.07
4/15/2004	7:31	16.40									3953.08
4/26/2004	8:49	16.44									3953.04
5/3/2004	9:11	16.32									3953.16
5/13/2004	3:05	15.15									3954.33
5/20/2004	8:53	15.62									3953.86
6/3/2004	11:20	16.05	0	201959		18	21.05	6.64	Pump working, but flow meter is not		3953.43
6/10/2004	9:28	17.95	2.91	210523	132	17	22.35	6.83			3951.53
6/14/2004	9:48	18.10	3.03	227618	134	17.08	27.78	6.8			3951.38
6/17/2004	9:31	20.10	2.91	240391	130	16.83	23.52	6.8			3949.38
6/21/2004	10:46	21.06	2.91	257900	120	18.58	23.62	6.87	Starting to surge		3948.42
6/24/2004	9:27	21.06	2.48	269259	122	16.29	22.24	6.84			3948.42
6/28/2004	9:49	21.03	2.56	283091	100	18.82	23.78	7	Adjusted to 1.94 gpm, 136 lbs		3948.45
7/1/2004	9:25	20.05	1.87	291043	136	18.01	24.14	6.91			3949.43
7/6/2004	10:27	19.30	1.87	304471	136	18.41	24.88	6.86			3950.18
7/7/2004	12:38	20.10	1.23	307376		17.6	24.8	6.54			3949.38
7/12/2004	11:11	20.87	1.36	317432	138	22.89	25.67	6.96			3948.61
7/15/2004	9:08	19.71	1.42	322956	132	20.7	25.49	6.9			3949.77
7/19/2004	11:31	18.65	1.29	323704	138	21.53	24.6	6.85			3950.83
7/22/2004	9:06	19.72	1.29	329100	138	19.94	25.74	6.82			3949.76
7/26/2004	10:49	19.68	1.29	336579	138	20.04	26.04	6.82			3949.80
7/29/2004	10:11	20.80	1.29	341910	137	20.75	25.83	6.87			3948.68
8/3/2004	10:14	21.04	1.16	348947	124	22.78	26.2	6.96			3948.44
8/9/2004	3:05	19.90	1.16	359786	95	21.43	25.7	6.77	Adjusted to 1.16 gpm, 138 lbs		3949.58
8/12/2004	10:02	20.53	1.1	361324	138	20.43	25.38	6.8			3948.95
8/16/2004	9:41	21.04	1.1	367476	130	21.55	25.56	6.9			3948.44
8/19/2004	11:52	21.00	0.71	371045	117	20.89	25.68	6.79			3948.48
8/23/2004	12:10	20.88	1.1	376664	113	19.86	26.28	6.78			3948.60
8/26/2004	10:49	20.58	1.23	379534	128	20.05	27.09	6.79	Well field shut down at 11:45 for repair		3948.90
8/30/2004	11:23	20.88	1.16	386168	120	20.02	27.08	6.66			3948.60
9/2/2004	12:34	20.42	1.16	389844		18.29	24.558	6.72			3949.06
9/7/2004	11:00	20.85	1.23	396649	125	19.78	27.09	6.94			3948.63
9/9/2004	9:36	19.42	0	398322	48				Not pumping		3950.06
9/13/2004	12:01	19.85		398322	48				Not pumping		3949.63
9/16/2004	10:10	20.88	0.84	399776		18.84	26.03	6.7			3948.60
9/20/2004	10:34	20.88	0.77	403101	105	18.6	25.42	6.76			3948.60
9/23/2004	9:51	20.64	1.29	407645	120	17.44	25.25	6.65			3948.84
9/27/2004	10:39	20.50	1.23	414696	120	18.33	25.08	6.73			3948.98
9/30/2004	9:55	20.80	1.23	419801	122	17.88	23.97	6.79			3948.68
10/4/2004	11:49	20.38	1.23	426820	121	18.13	23.71	6.82			3949.10
10/7/2004	10:20	20.21	1.23	432039	122	18	22.6	6.79			3949.27
10/11/2004	11:35	20.11	1.36	439681	122	17.19	23.64	6.7			3949.37
10/14/2004	13:41	20.17	1.29	445538	122	17.32	23.52	6.81			3949.31
10/18/2004	13:51	19.86	1.36	453121	120	17.9	23.84	6.68			3949.62
10/21/2004	10:40	20.11	1.36	458585	121	17.54	23.73	6.74			3949.37
10/25/2004	13:25	20.14	1.36	466630	120	17.79	23.46	6.85			3949.34
10/28/2004	10:54	20.41	1.55	472701	120	16.23	17.54	6.92			3949.07
11/1/2004	10:04	20.32	1.55	481601	118	15.79	22.32	6.64			3949.16
11/4/2004	11:15	20.97	1.87	488655	20	16.28	22.11	6.74	Leak outside of flow meter, shut down at 11:10 to repair		3948.51
11/8/2004	10:32	18.91	0.38	489835	127	16.49	21.64	6.68	Raised flow to 1.81		3950.57

		Well 477								comments		
		Depth to water (ft)	flow rate	total vol (gls)		pressure	temp	spec cond	pH			GW Elev
Date	Time		gpm	raw data	corrected	psi	^{o}C	µS/cm x1K				(ft msl)
3/11/2004	9:32	16.78								First spring measurement		3952.62
3/18/2004	11:18	16.70										3952.70
3/25/2004	8:18	16.58										3952.82
4/1/2004	9:06	16.22										3953.18
4/15/2004	7:32	15.88										3953.52
4/26/2004	8:51	16.24										3953.16
5/3/2004	9:12	16.12										3953.28
5/13/2004	3:06	15.04										3954.36
5/20/2004	8:52	15.44										3953.96
6/3/2004	11:30	15.73	0.25		360638		17.2	20.54	6.64			3953.67
6/10/2004	9:31	17.24	2.88		370763	117	16.89	21.97	6.86			3952.16
6/14/2004	9:55	17.60	2.88		387561	118	17.27	22.51	6.83			3951.80
6/17/2004	9:36	18.28	2.88		399922	118	16.54	22.12	6.78			3951.12
6/21/2004	10:51	18.56	2.88		416784	120	16.97	22.83	6.81			3950.84
6/24/2004	9:31	18.96	2.94		429036	120	15.88	22.72	6.82			3950.44
6/28/2004	9:37	19.08	2.88		445615	120	17.3	22.78	6.92			3950.32
7/1/2004	9:31	19.18	2.88		458816	120	17.6	26.84	6.9			3950.22
7/6/2004	10:20	19.50	2.88		478866	120	18.07	22.38	6.88			3949.90
7/7/2004	12:43	20.18	2.81		483455		17.2	24.9	6.52			3949.22
7/14/2004	11:05	20.90	2.81		503828	118	20.53	33.36	6.85			3948.50
7/15/2004	9:14	20.90	2.94		515347	115	17.92	23.23	6.76			3948.50
7/19/2004	11:37	19.27	3.13		516193	72	19.65	22.78	6.83			3950.13
7/22/2004	9:00	18.56	1.34		526801	70	19.5	23.65	6.79			3950.84
7/26/2004	10:54	18.82	1.4		534782	60	20.33	24.38	6.82			3950.58
7/29/2004	10:06	18.40	1.21		538860	55	20.02	23.89	6.82			3951.00
8/2/2004	10:08	17.95	1.27		544842	45	16.13	25.68	6.73	was kicked off, sampled when kicked on		3951.45
8/9/2004	2:58	18.72	1.4		549492	52	20.46	23.63	6.78			3950.68
8/12/2004	10:07	18.06	1.4		551785	72	19.2	23.06	6.78			3951.34
8/16/2004	10:58	18.13	1.34		555045	54	19.64	22.69	6.84	Not pumping (check breaker)		3951.27
8/19/2004	12:00	18.14	1.47		557489	54	21.08	23.71	6.8			3951.26
8/22/2004	12:06	20.89	2.43		570804	124	19.72	24.98	6.82			3948.51
8/26/2004	10:54	20.90	2.81		578483	64	19.1	24.98	6.73	Well field shut down at 11:45 for repair		3948.50
8/30/2004	11:18	20.90	2.43		592943	68	19.15	24.16	6.65			3948.50
9/2/2004	14:26	19.39	1.53	2978	595921		18.26	20.878	6.69	Reset with new batteries		3950.01
9/7/2004	10:53	17.85	0	3519	596462	66				Not pumping (592943+3519=596462)		3951.55
9/9/2004	9:42	18.80	1.21	5199	598142	65	18.03	24.33	6.59			3950.60
9/13/2004	11:57	19.04	1.21	12297	605240	61	18.67	24.3	6.67			3950.36
9/16/2004	10:16	19.25	1.27	17560	610503	59	18	23.6	6.66			3950.15
9/20/2004	10:04	19.28	1.27	24449	617392	58	17.51	23.26	6.7			3950.12
9/23/2004	9:46	18.85	1.27	29585	622528	56	16.84	24.06	6.63			3950.55
9/27/2004	10:45	18.72	1.15	36481	629424	55	16.68	23.46	6.73			3950.68
9/30/2004	9:49	18.73	0.51	39790	632733	54	17.26	22.88	6.73			3950.67
10/4/2004	11:52	18.59	0.51	43068	636011	52	17.64	22.7	6.77			3950.81
10/7/2004	10:13	18.60	1.27	47393	640336	52	17.33	22.91	6.79			3950.80
10/11/2004	11:39	18.53	1.27	54899	647842	51	17.2	22.65	6.7			3950.87
10/14/2004	13:42	18.56	1.34	60919	653862	50	16.9	21.86	6.82			3950.84
10/18/2004	13:48	18.58	1.34	68716	661659	49	17.24	22.19	6.68			3950.82
10/21/2004	10:42	18.54	1.4	74415	667358	48	16.92	22.53	6.74			3950.86
10/25/2004	13:22	18.51	1.34	82727	675670	48	17.01	22.19	6.85			3950.89
10/28/2004	11:05	18.53	1.34	88414	681357	47	15.61	18.27	6.89			3950.87

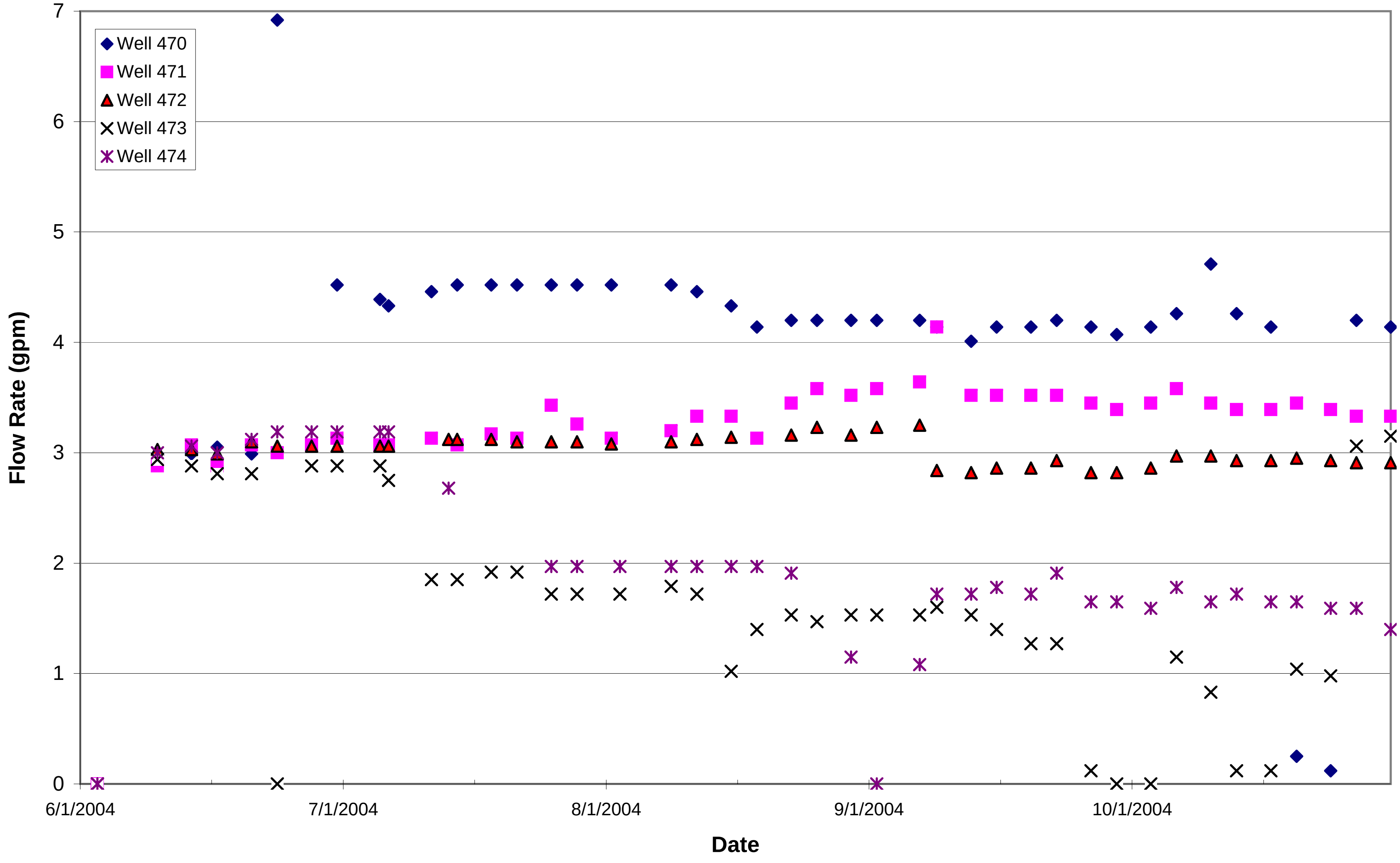
		Well 478										
		Depth to	flow rate	total vol (gls)		pressure	temp	spec cond	pH	comments		GW Elev
Date	Time	water (ft)	gpm	raw data	corrected	psi	^{o}C	µS/cm x1K				(ft msl)
3/11/2004	9:34	16.80								First spring measurement		3952.69
3/18/2004	11:20	16.73										3952.76
3/25/2004	8:20	16.65										3952.84
4/1/2004	9:07	16.31										3953.18
4/15/2004	7:33	15.98										3953.51
4/26/2004	8:52	16.31										3953.18
5/3/2004	9:13	16.20										3953.29
5/13/2004	3:08	15.20										3954.29
5/20/2004	8:51	15.55										3953.94
6/3/2004	11:40	15.92	0		283794		19.2	21.64	6.11	Pump working, but flow meter is not		3953.57
6/10/2004	9:35	17.55	3.19		292904	125	17.48	22.75	6.8			3951.94
6/14/2004	10:01	17.82	3.19		311355	125	18.91	22.66	6.88			3951.67
6/17/2004	9:41	18.63	3.06		324681	122	17.09	22.74	6.81			3950.86
6/21/2004	10:57	19.04	3.12		342820	124	18.02	23.14	6.84			3950.45
6/24/2004	9:39	17.12	2.1		355833	45	16.66	23.63	6.82			3952.37
6/28/2004										Pump not working		3969.49
7/1/2004	9:33	17.25								Pump not working		3952.24
7/6/2004	10:14	17.36								Pump not working		3952.13
7/7/2004	15:47	17.40								Pump not working		3952.09
7/14/2004	10:50	20.07	2.55		372845	132	21.22	24.82	6.88			3949.42
7/15/2004	9:17	20.33	2.55		383584	132	18.97	26.13	6.76			3949.16
7/19/2004	11:43	19.10	2.55		385075	132	21.44	24.85	6.83			3950.39
7/22/2004	8:53	20.00	2.55		395600	133	20.23	25.53	6.9			3949.49
7/26/2004	11:01	20.53	2.49		410430	132	20.25	26.51	6.81			3948.96
7/29/2004	10:01	20.61	2.55		420954	132	19.15	26.9	6.77			3948.88
8/2/2004	10:04	20.90	2.49		435246	132	20.7	27.82	6.82			3948.59
8/9/2004	2:51	22.08	1.97		462458	108	20.52	28.3	6.78	Adjusted to 1.97 gpm, 124 lbs		3947.41
8/12/2004	10:12	20.13	1.91		470220	137	20.46	26.27	6.79			3949.36
8/16/2004	9:28	20.20	1.65		593288	125	19.17	24.06	6.74			3949.29
8/19/2004	12:05	20.35	1.91		489566	134	19.94	26.69	6.75			3949.14
8/20/2004	12:01	20.45	1.85		499906	136	19.67	27.3	6.76			3949.04
8/26/2004	11:05	17.93								No pump		3951.56
8/30/2004	11:13	18.05								No pump		3951.44
9/2/2004	14:28	19.40	1.85	23	5023010		18.41	26.37	6.5	Reset with new batteries		3950.09
9/7/2004	10:48	19.45	1.85	12789	5035776	122	19.09	27.36	6.95	(5022987+12789=5035776)		3950.04
9/9/2004	9:47	19.76	1.97	17938	5040925	46	17.55	27.56	6.5			3949.73
9/13/2004	11:52	19.78	1.91	29576	5052563	46	19.06	27.65	6.67			3949.71
9/16/2004	10:21	20.36	1.91	37757	5060744	46	17.4	27.51	6.58			3949.13
9/20/2004	10:45	20.42	1.91	48745	5071732	46	17.6	27.47	6.7			3949.07
9/23/2004	9:40	19.96	2.1	57059	5080046	45	16.58	27.58	6.59			3949.53
9/27/2004	10:42	19.72	1.91	68477	5091464	46	17.21	26.56	6.68			3949.77
9/30/2004	9:44	19.81	1.78	76642	5099629	44	16.96	26.11	6.69			3949.68
10/4/2004	11:55	19.59	1.91	87878	5110865	46	17.26	25.93	6.72			3949.90
10/7/2004	10:06	19.63	1.97	96325	5119312	45	16.95	26.03	6.71			3949.86
10/11/2004	11:44	19.48	1.97	108177	5131164	45	17.03	25.35	6.66			3950.01
10/14/2004	13:43	19.47	1.97	117016	5140003	45	16.91	24.71	6.81			3950.02
10/18/2004	13:45	19.56	2.1	128634	5151621	46	17.04	25.22	6.66			3949.93
10/21/2004	10:44	19.78	2.23	137600	5160587	45	16.65	25.79	6.69			3949.71
10/25/2004	13:18	19.85	2.36	151380	5174367	44	16.8	25.31	6.81			3949.64
10/28/2004	11:13	19.27	2.3	161116	5184103	44	14.04	25.38	6.87			3950.22

Date	Time	Well 479							comments		GW Elev
		Depth to Water	flow rate gpm	total vol gls	pressure psi	temp °C	spec cond μS/cm x1K	pH			(ft msl)
3/11/2004	9:36	16.44							First spring measurement		3952.83
3/18/2004	11:22	16.38									3952.89
3/25/2004	8:22	16.28									3952.99
4/1/2004	9:09	15.95									3953.32
4/15/2004	7:35	15.60									3953.67
4/26/2004	8:54	15.94									3953.33
5/3/2004	9:15	15.83									3953.44
5/13/2004	3:09	14.90									3954.37
5/20/2004	8:50	15.17									3954.10
6/3/2004	11:50	15.57	0.38	337626		18.1	21.62	6.67			3953.70
6/10/2004	9:38	16.71	2.99	347122	124	16.14	22.22	6.83			3952.56
6/14/2004	10:09	17.16	3.06	364724	124	16.52	21.78	6.78			3952.11
6/17/2004	9:46	17.68	2.99	377702	120	16.5	21.73	6.78			3951.59
6/21/2004	11:02	18.06	2.99	395547	124	16.89	22.1	6.79			3951.21
6/24/2004	9:44	19.67	4.14	412652	78	16.02	23.26	6.9			3949.60
6/28/2004	9:30	21.4	3.76	435479	75	17.69	21.46	6.87	Adjusted to 2.93 gpm, 122 lbs		3947.87
7/1/2004	9:50	19.31	2.86	447841	122	17.76	21.09	6.82			3949.96
7/6/2004	10:11	19.9	2.86	468484	124	17.84	22.14	6.77			3949.37
7/7/2004	12:49	20.57	2.74	473041		18.1	24.06	6.51			3948.70
7/14/2004	10:54	22.1	2.23	493048	116	19.99	23.89	6.76			3947.17
7/15/2004	9:20	20.12	2.1	501911	122	19.1	23.02	6.77			3949.15
7/19/2004	11:50	18.3	3.51	503148	125	19.05	23.54	6.79			3950.97
7/22/2004	8:48	22	2.99	516190	100	18.73	21.9	6.73	Adjusted to 2.48 gpm, 122 lbs		3947.27
7/26/2004	11:07	21.55	2.42	530289	123	18.08	24.78	6.74			3947.72
7/29/2004	9:55	21.13	2.42	540257	122	18.39	24.66	6.73			3948.14
8/2/2004	9:58	22.08	2.35	553835	118	18.89	25.86	6.74			3947.19
8/9/2004	2:43	22.07	1.72	577330	115	28.78	25.2	6.74	Adjusted to 1.72 gpm, 126 lbs		3947.20
8/12/2004	10:20	19.82	1.65	583982	125	18.8	23.98	6.72			3949.45
8/19/2004	12:10	20.37	1.65	600595	125	19.38	25.13	6.72			3948.90
8/23/2004	11:56	20.2	1.72	609840	125	19.6	25.82	6.76			3949.07
8/26/2004	11:01	19.12	1.59	614583	126	19.16	24.06	6.67	Well field shut down at 11:45 for repair		3950.15
8/30/2004	11:12	19.53	1.65	623666	126	19.22	26.1	6.63	Adjusted to 2.04, 124 lbs		3949.74
9/2/2004	14:29	20.29	1.97	629892		18.95	25.4	6.7			3948.98
9/7/2004	10:42	19.43	1.72	642026	114	18.86	25.48	6.9			3949.84
9/9/2004	9:52	19.38	1.85	646985	47	17.16	25.33	6.5			3949.89
9/13/2004	11:46	20.11	1.78	657865	47	18.6	26.48	6.69			3949.16
9/16/2004	10:27	20.74	1.91	665800	46	17.47	27.05	6.61			3948.53
9/20/2004	10:50	21.32	1.59	675896	46	17.31	26.83	6.68			3947.95
9/23/2004	9:35	20.2	2.1	683891	46	16.68	25.87	6.58			3949.07
9/27/2004	10:57	20.03	1.91	695189	46	17.22	25.11	6.65			3949.24
9/30/2004	9:38	20.41	1.91	703346	46	17.01	25.27	6.68			3948.86
10/4/2004	11:58	20.23	1.97	714837	46	17.27	24.69	6.68			3949.04
10/7/2004	10:01	20.16	2.16	723489	46	17.31	24.95	6.7			3949.11
10/11/2004	11:49	19.8	2.16	736142	44	17.16	23.93	6.65			3949.47
10/14/2004	13:44	19.81	2.16	745712	44	16.74	24.02	6.78			3949.46
10/18/2004	13:40	18.84	2.1	758080	45	17.14	24.7	6.62			3950.43
10/21/2004	10:46	19.62	2.1	766927	44	17.04	25.15	6.67			3949.65
10/25/2004	13:10	19.52	2.16	779636	44	17.14	24.98	6.78			3949.75
10/28/2004	11:20	19.52	2.1	788695	45	16.26	24.67	6.82			3949.75

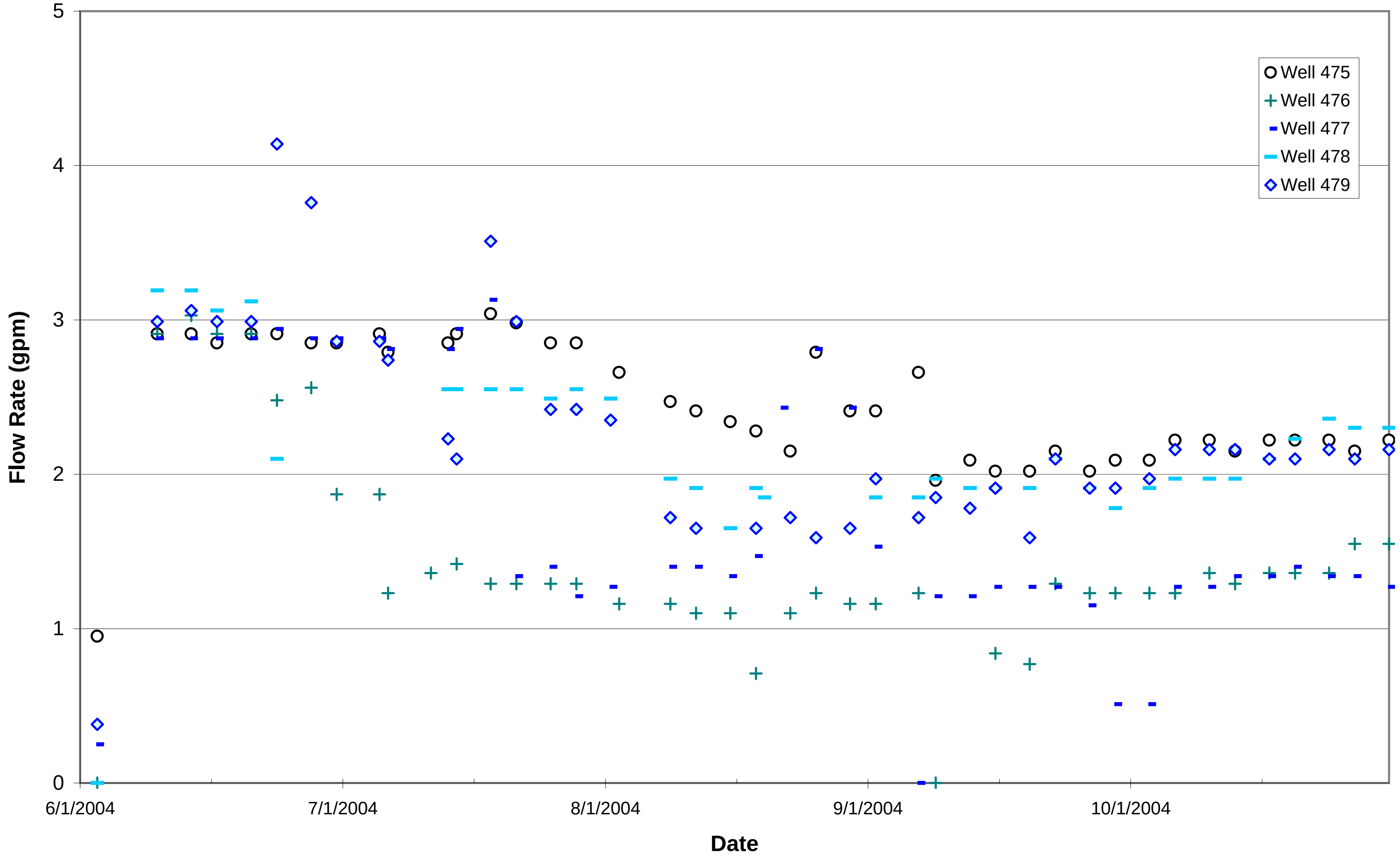
CF 1 Extraction Well Flow Rates

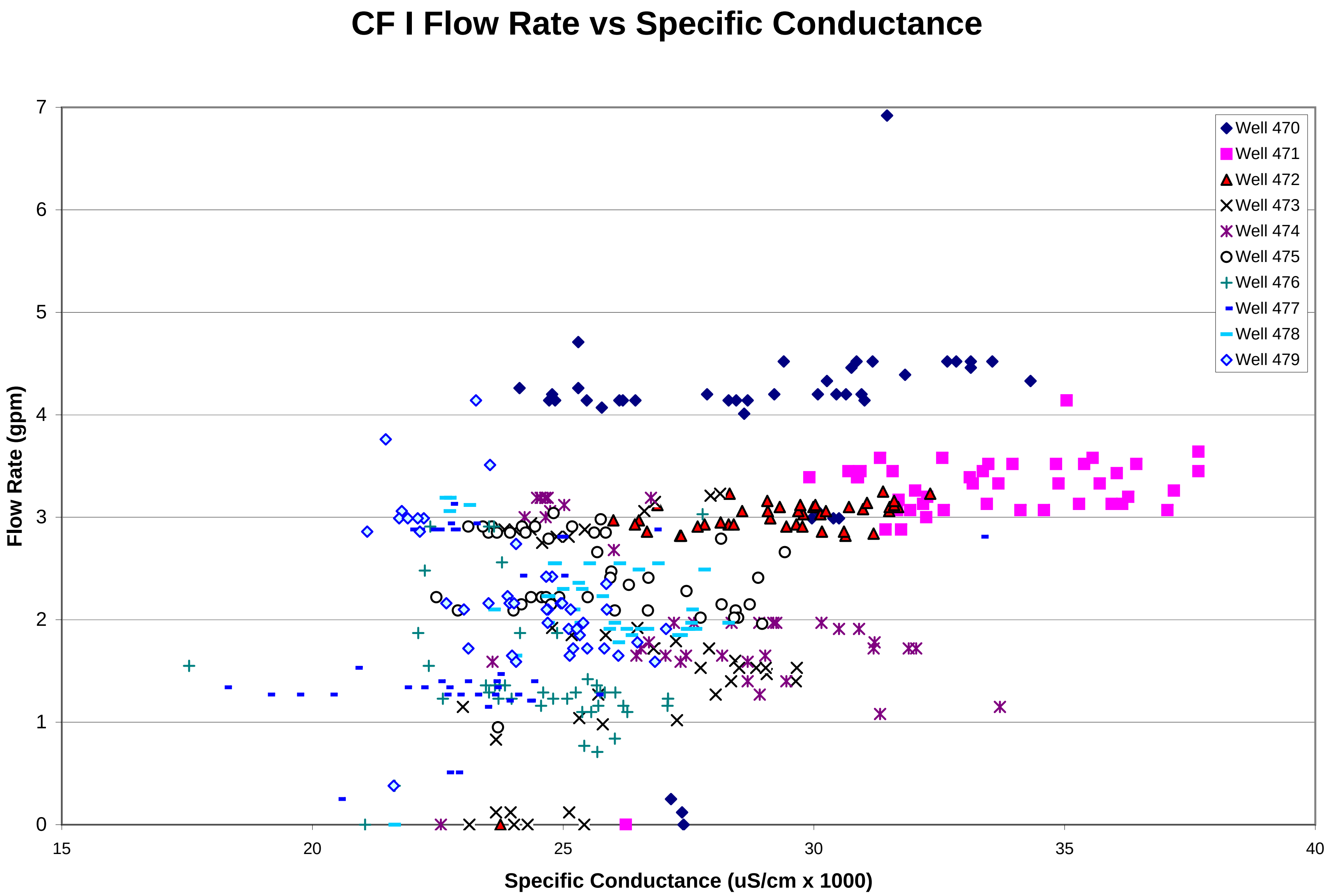


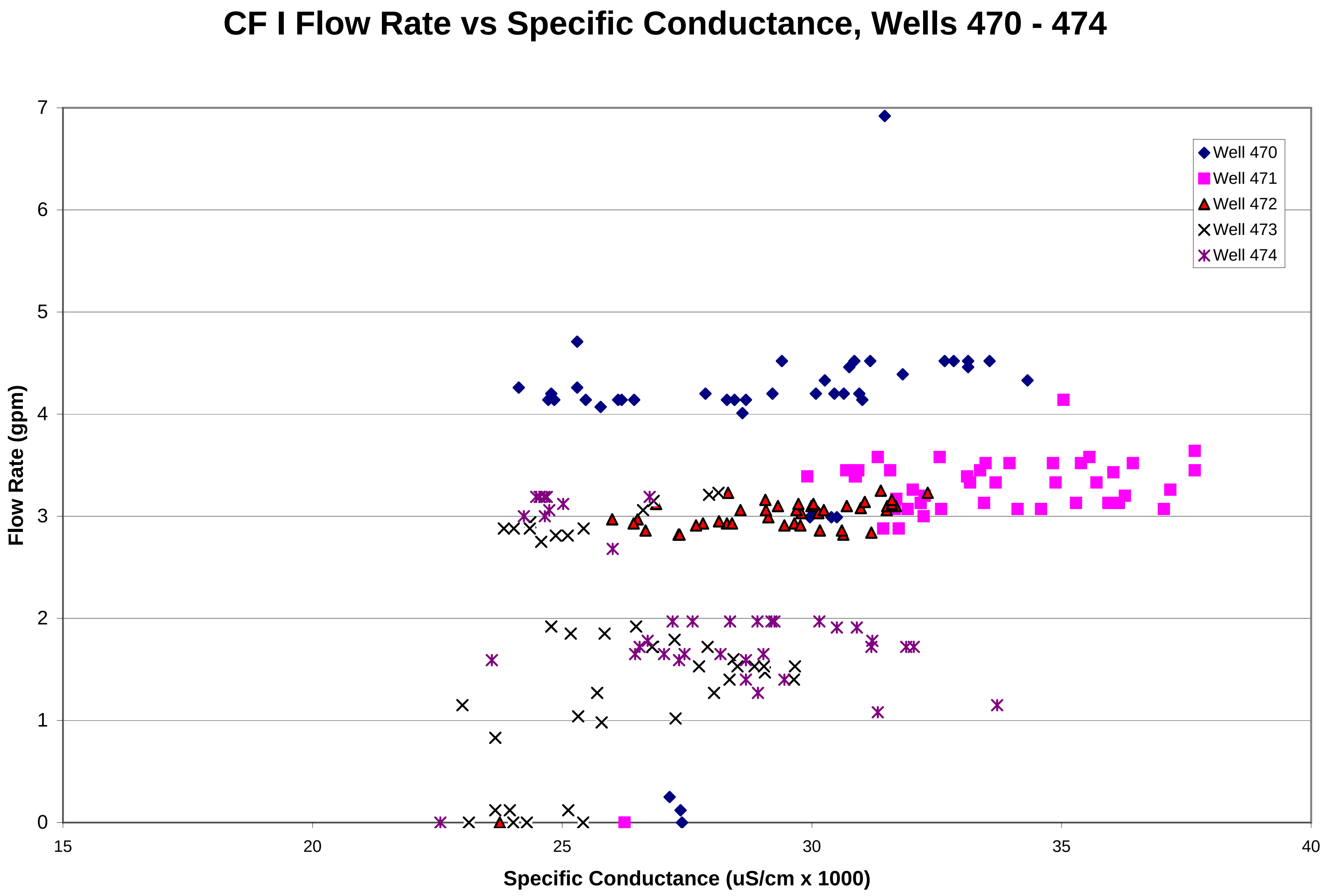
CF 1 Extraction Wells 470-474 Flow Rates



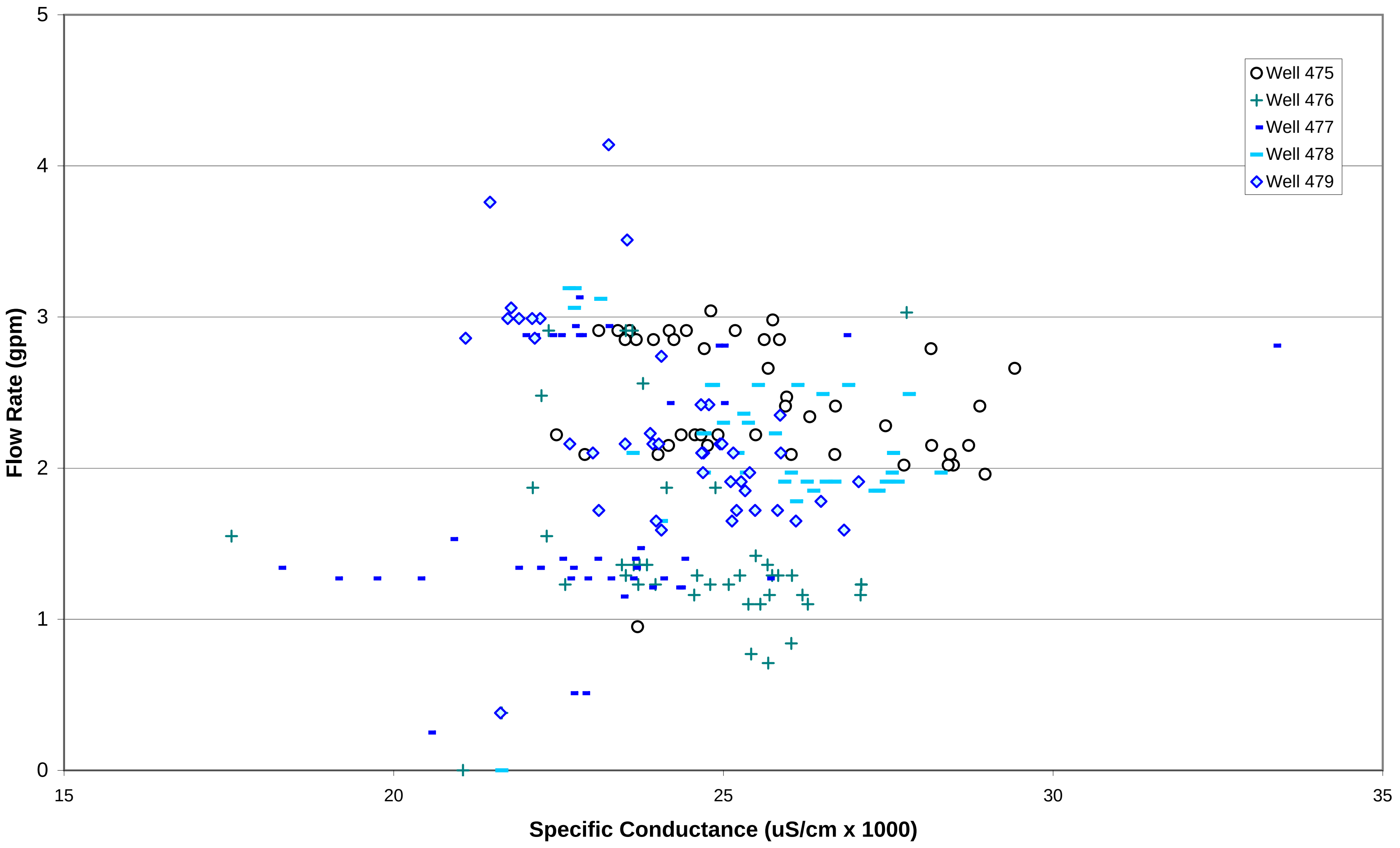
CF 1 Extraction Wells 475 - 479 Flow Rates



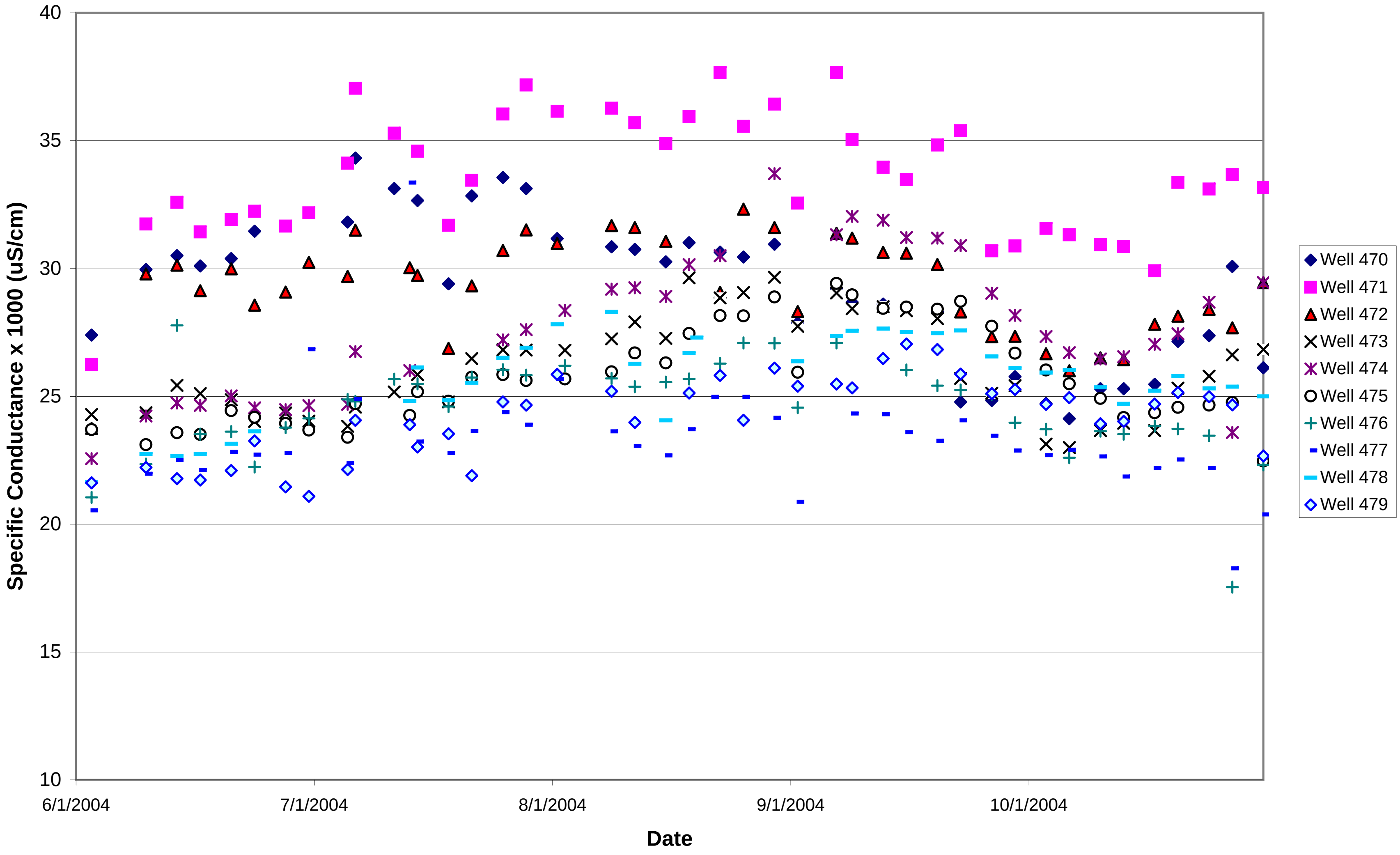
CF I Flow Rate vs Specific Conductance
Flow Rate (gpm)
Specific Conductance (uS/cm x 1000)
0
1
2
3
4
5
6
7
15
20
25
30
35
40
Well 470
Well 471
Well 472
Well 473
Well 474
Well 475
Well 476
Well 477
Well 478
Well 479


CF I Flow Rate vs Specific Conductance, Wells 470 - 474
Flow Rate (gpm)
0
1
2
3
4
5
6
7
Specific Conductance (uS/cm x 1000)
15
20
25
30
35
40
◆ Well 470
■ Well 471
▲ Well 472
✕ Well 473
✳ Well 474

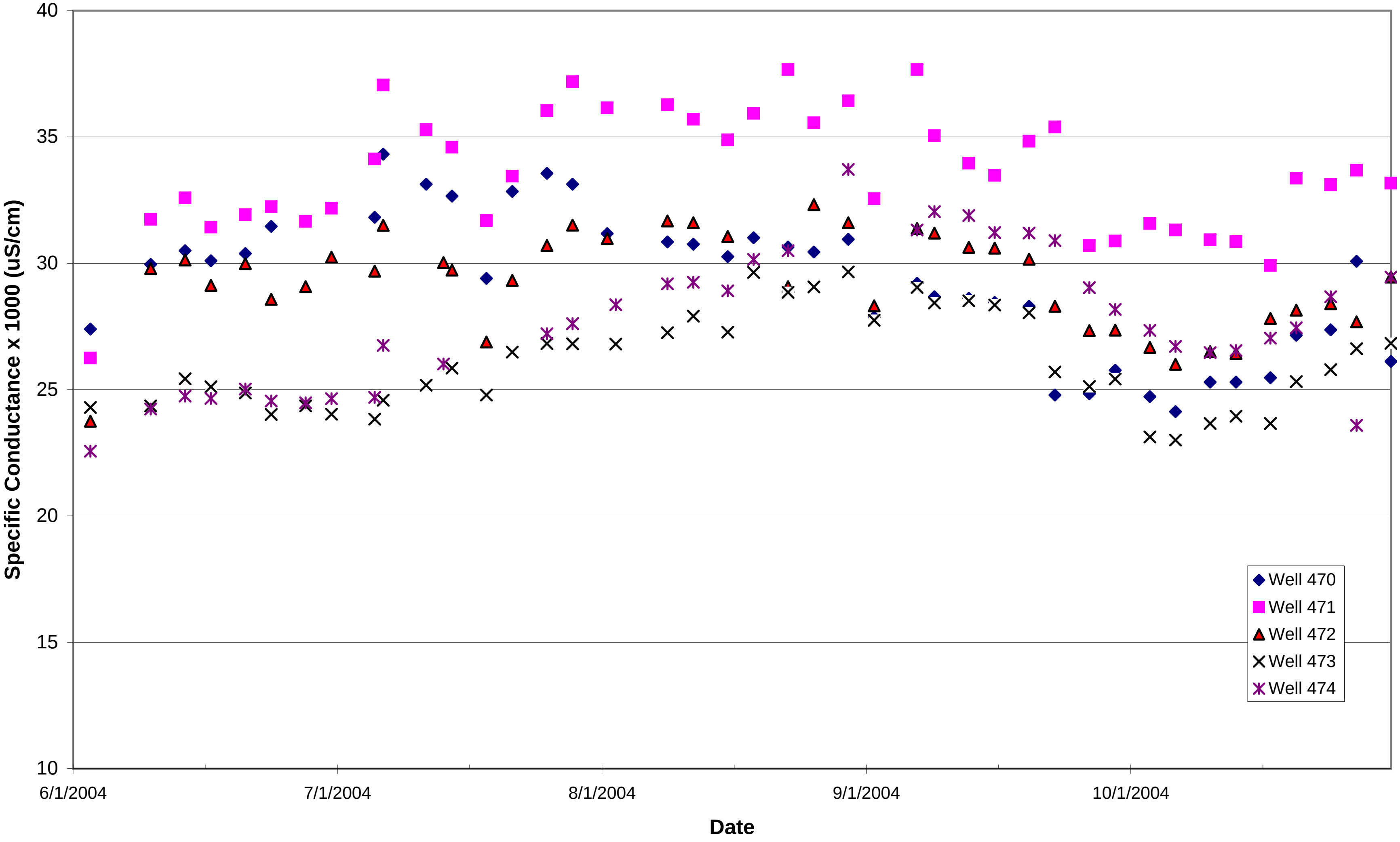
CF I Flow Rate vs Specific Conductance, Wells 475 - 479



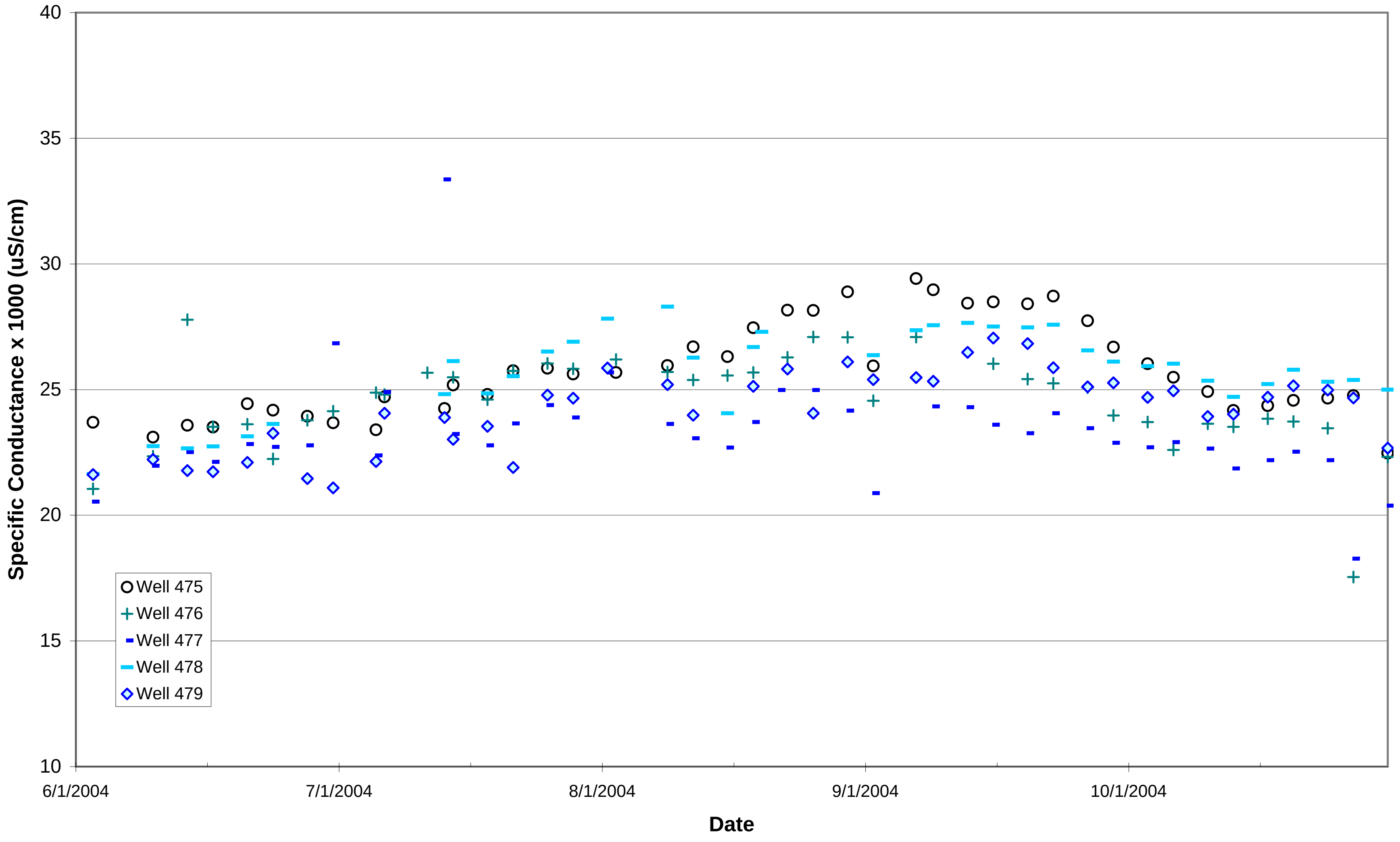
Extraction Well Specific Conductance

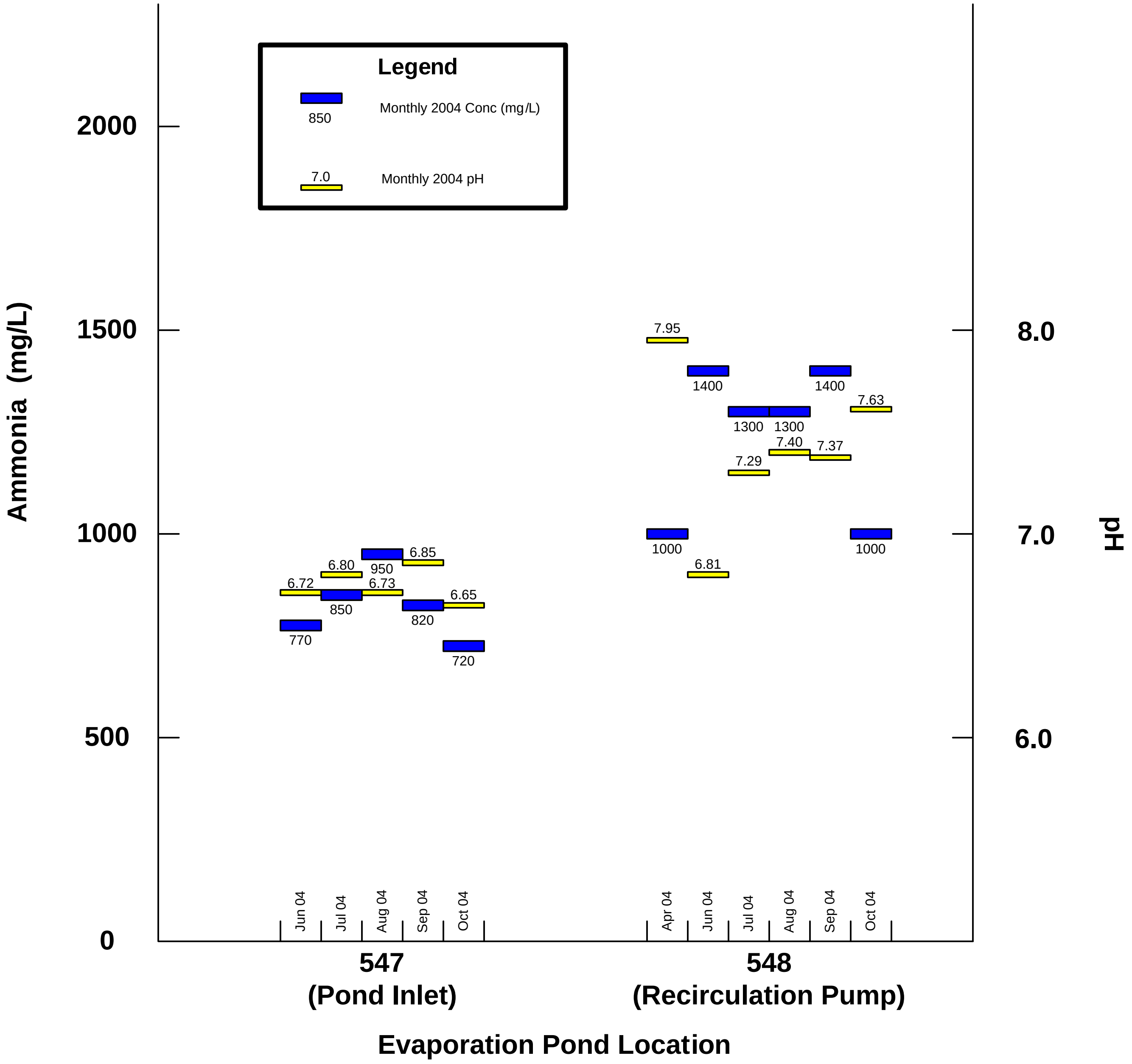


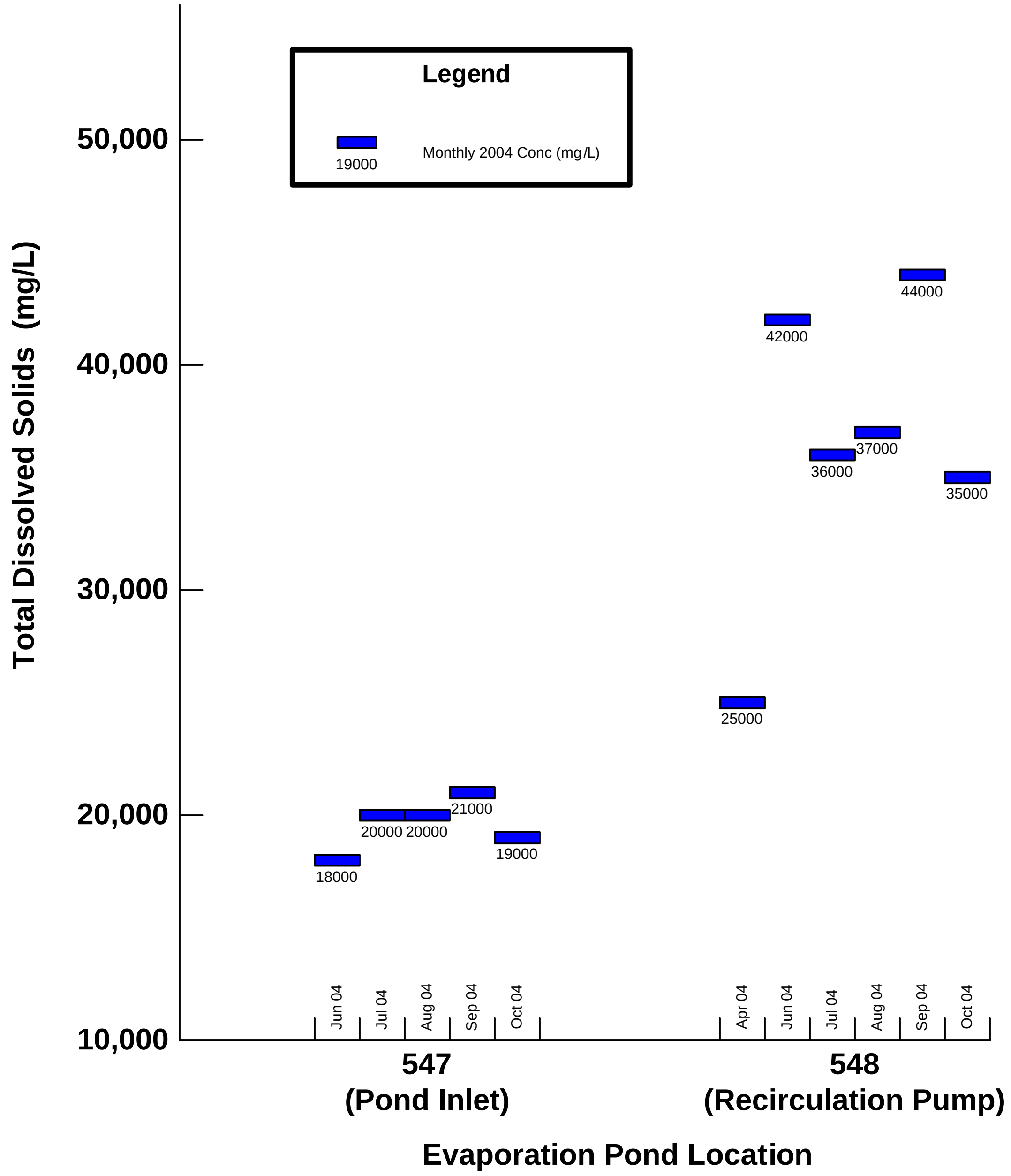
CF 1 Extraction Well 470 - 474 Specific Conductance



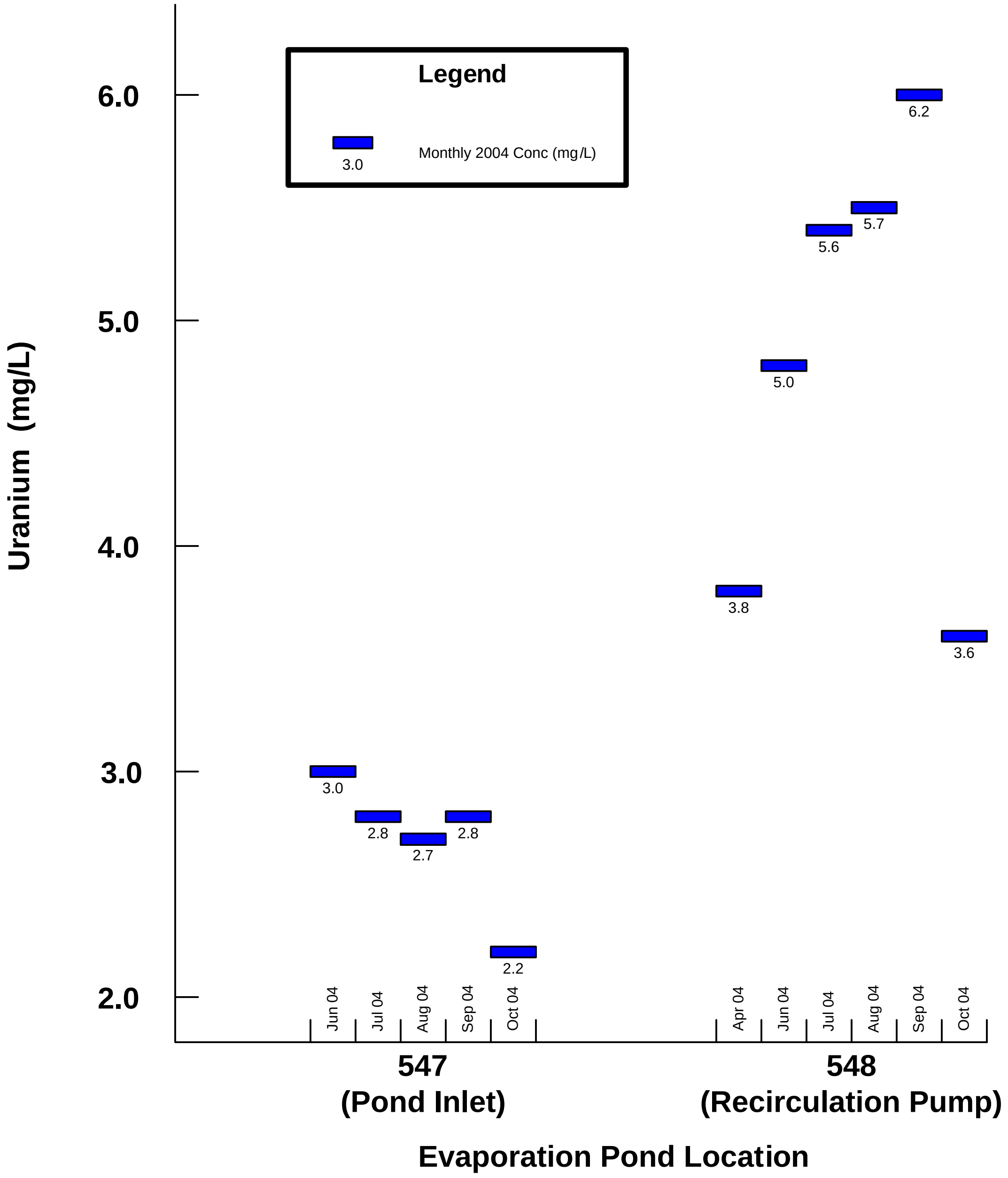
CF 1 Extraction Well 475 - 479 Specific Conductance



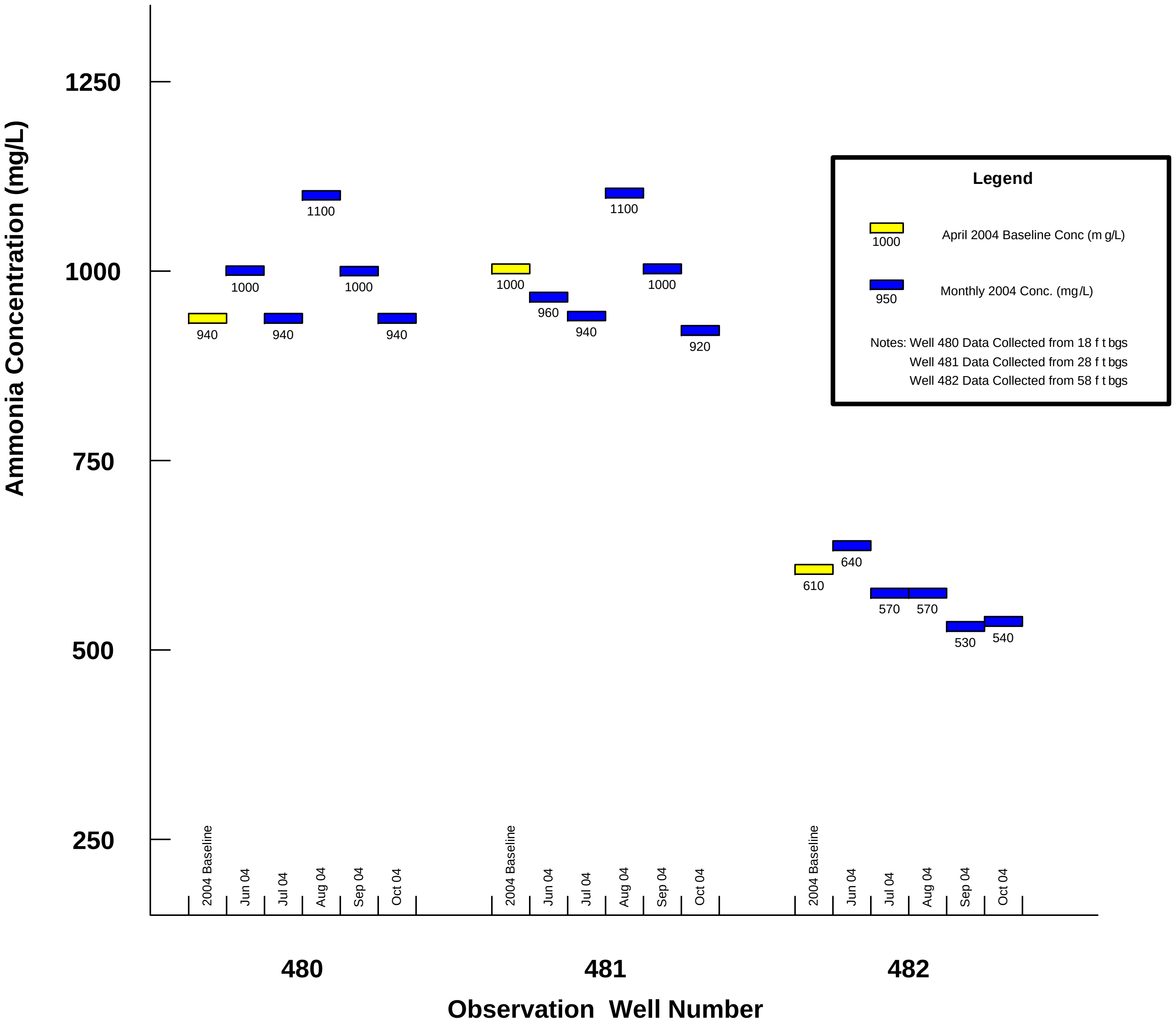

Legend
850
Monthly 2004 Conc (mg/L)
7.0
Monthly 2004 pH
Ammonia (mg/L)
2000
1500
1000
500
0
8.0
7.0
6.0
pH
6.72
770
6.80
850
950
6.73
6.85
820
6.65
720
7.95
1000
1400
6.81
1300
7.29
1300
7.40
1400
7.37
7.63
1000
Jun 04
Jul 04
Aug 04
Sep 04
Oct 04
Apr 04
Jun 04
Jul 04
Aug 04
Sep 04
Oct 04
547
(Pond Inlet)
548
(Recirculation Pump)
Evaporation Pond Location

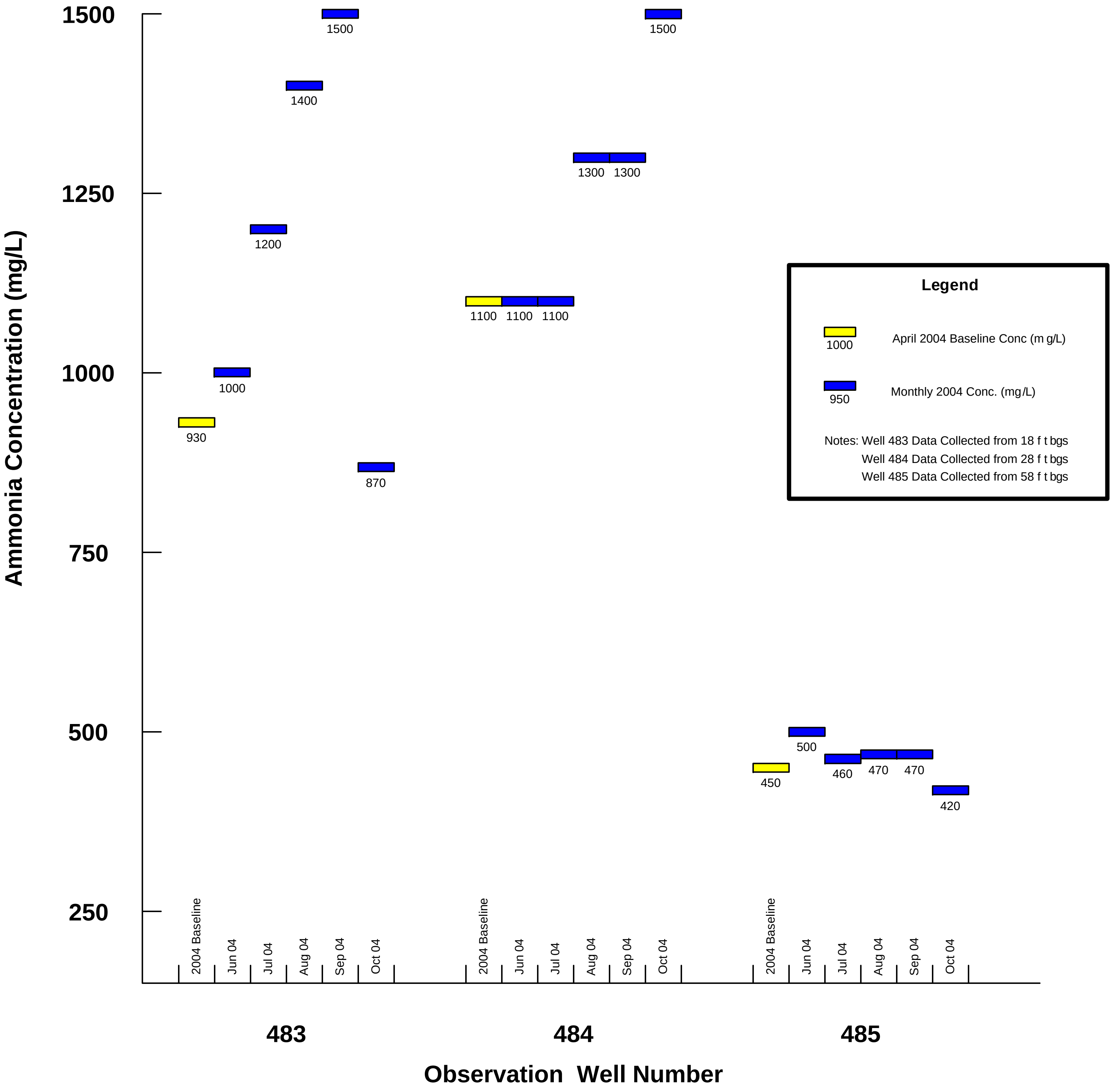


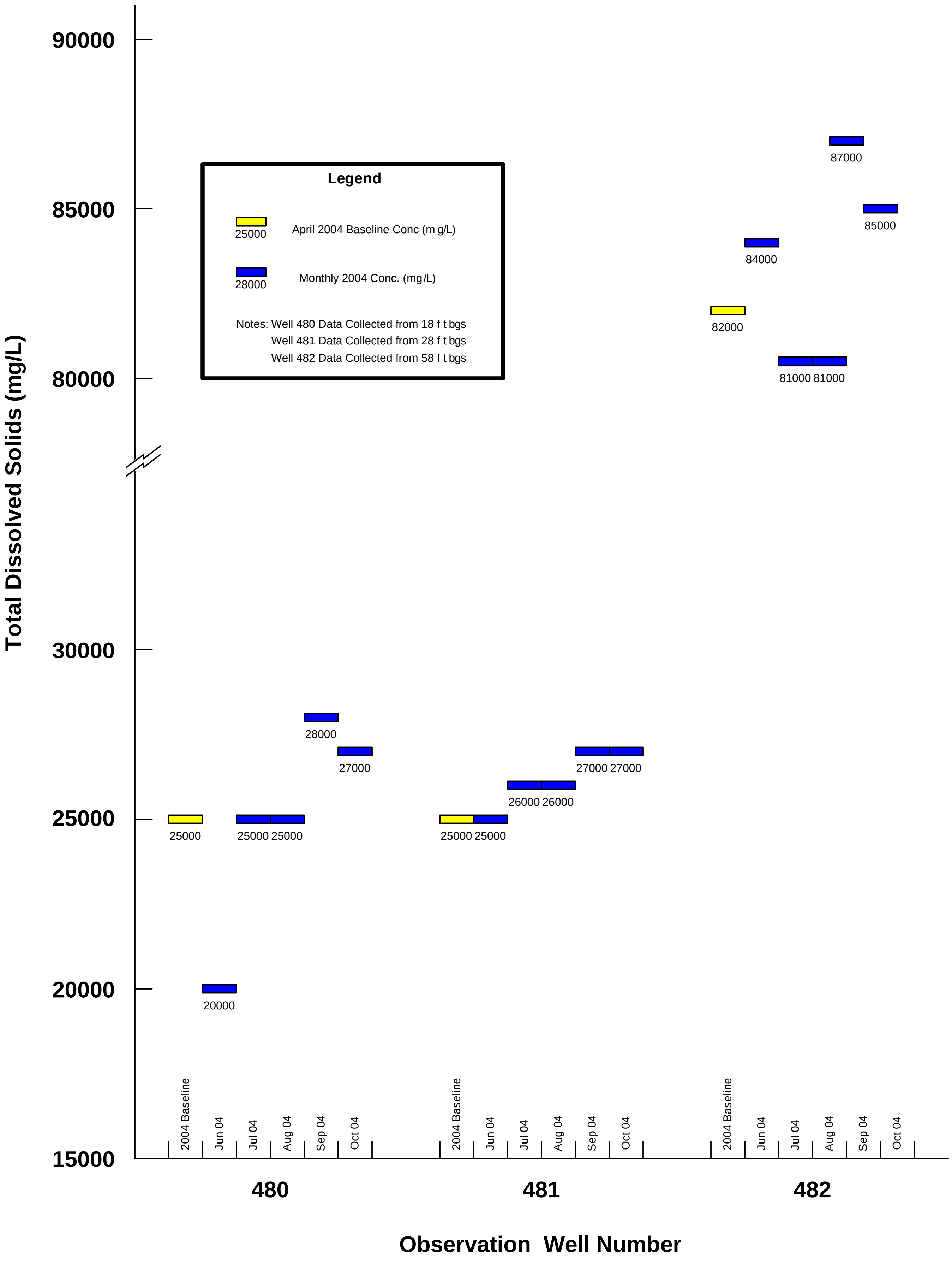
Legend
19000
Monthly 2004 Conc (mg/L)
Total Dissolved Solids (mg/L)
50,000
40,000
30,000
20,000
10,000
18000
20000
20000
21000
19000
25000
42000
36000
37000
44000
35000
Jun 04
Jul 04
Aug 04
Sep 04
Oct 04
Apr 04
Jun 04
Jul 04
Aug 04
Sep 04
Oct 04
547
(Pond Inlet)
548
(Recirculation Pump)
Evaporation Pond Location



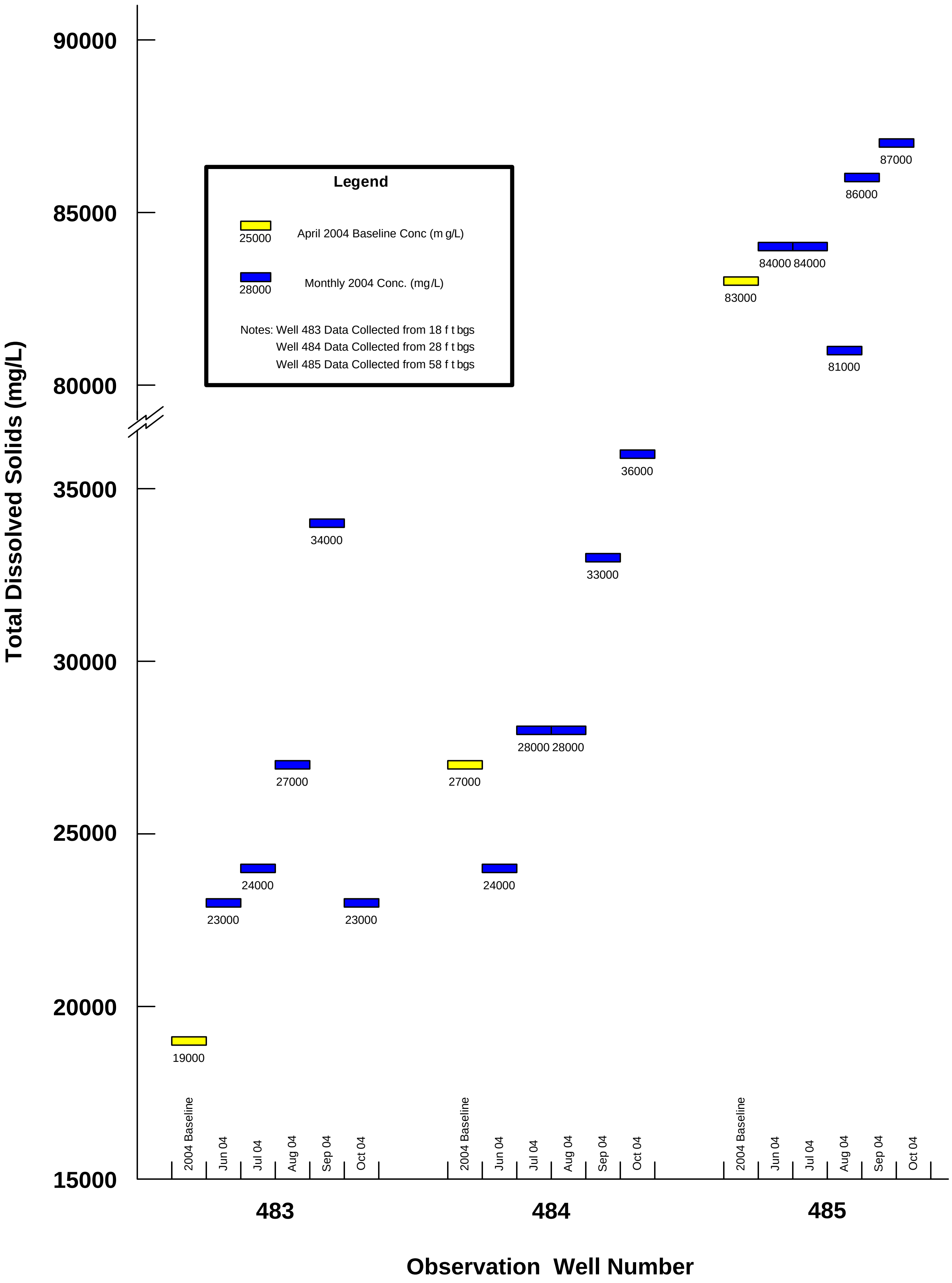
Legend
3.0
Monthly 2004 Conc (mg/L)
Uranium (mg/L)
6.0
5.0
4.0
3.0
2.0
3.0
2.8
2.7
2.8
2.2
3.8
5.0
5.6
5.7
6.2
3.6
Jun 04
Jul 04
Aug 04
Sep 04
Oct 04
Apr 04
Jun 04
Jul 04
Aug 04
Sep 04
Oct 04
547
(Pond Inlet)
548
(Recirculation Pump)
Evaporation Pond Location


Ammonia Concentration (mg/L)
1250
1000
750
500
250
940
1000
940
1100
1000
940
1000
960
940
1100
1000
920
610
640
570
570
530
540
2004 Baseline
Jun 04
Jul 04
Aug 04
Sep 04
Oct 04
2004 Baseline
Jun 04
Jul 04
Aug 04
Sep 04
Oct 04
2004 Baseline
Jun 04
Jul 04
Aug 04
Sep 04
Oct 04
480
481
482
Observation Well Number
Legend
1000
April 2004 Baseline Conc (mg/L)
950
Monthly 2004 Conc. (mg/L)
Notes: Well 480 Data Collected from 18 ft bgs
Well 481 Data Collected from 28 ft bgs
Well 482 Data Collected from 58 ft bgs

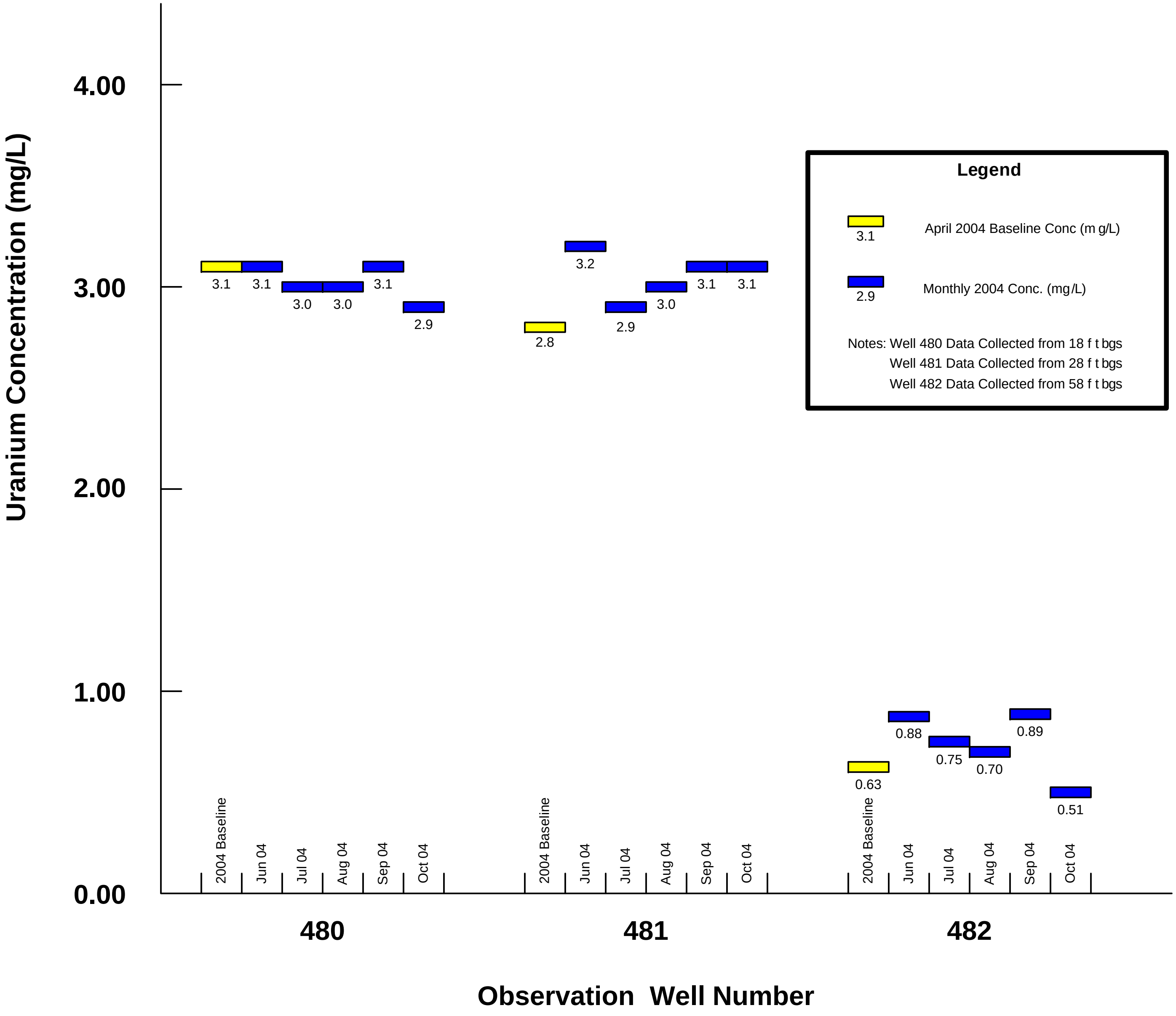

Ammonia Concentration (mg/L)
1500
1250
1000
750
500
250
930
1000
1200
1400
1500
870
1100
1100
1100
1300
1300
1500
450
500
460
470
470
420
2004 Baseline
Jun 04
Jul 04
Aug 04
Sep 04
Oct 04
483
484
485
Observation Well Number
Legend
1000
April 2004 Baseline Conc (m g/L)
950
Monthly 2004 Conc. (mg/L)
Notes: Well 483 Data Collected from 18 f t bgs
Well 484 Data Collected from 28 f t bgs
Well 485 Data Collected from 58 f t bgs

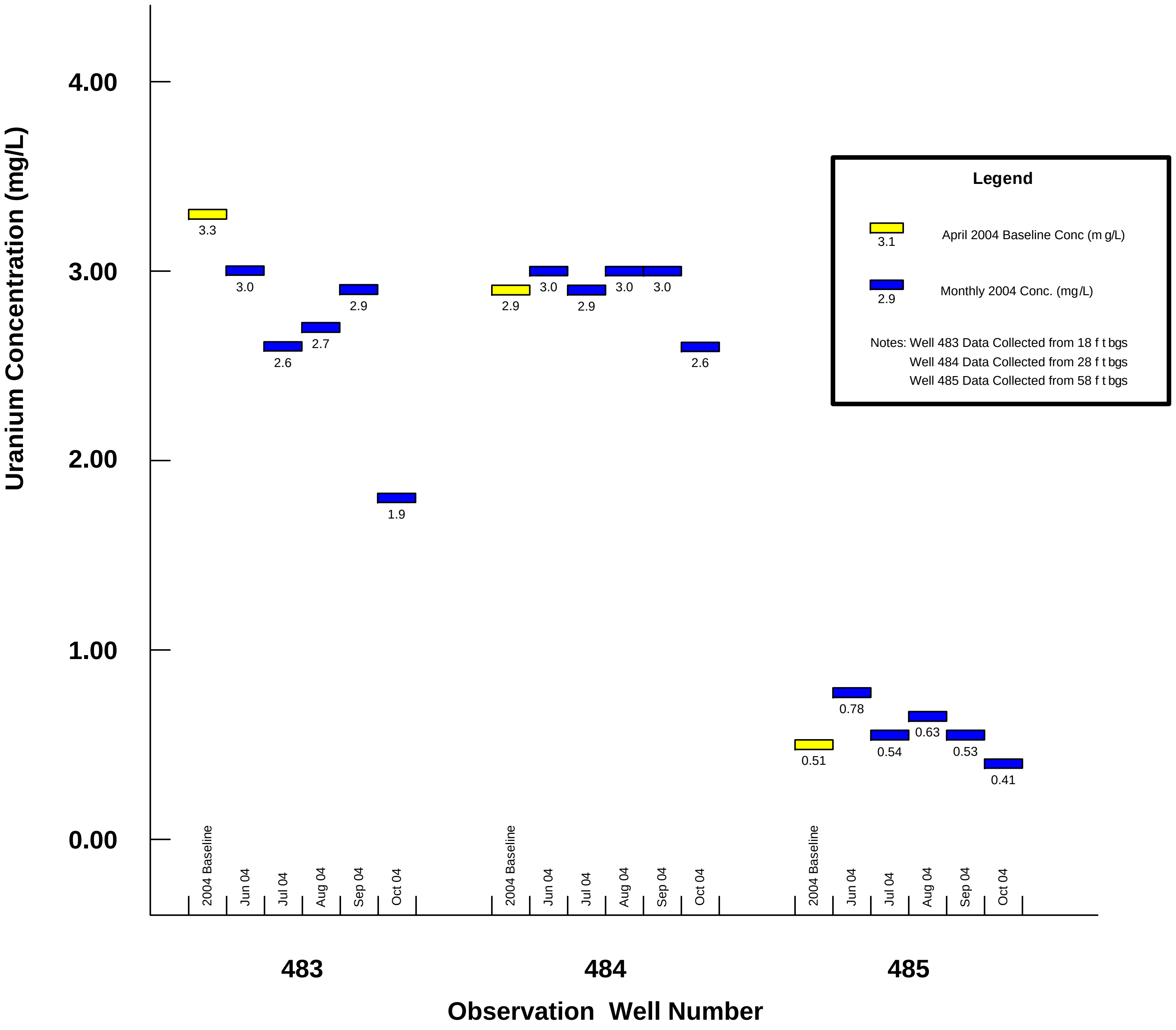


Total Dissolved Solids (mg/L)
90000
85000
80000
30000
25000
20000
15000
Legend
25000 April 2004 Baseline Conc (m g/L)
28000 Monthly 2004 Conc. (mg/L)
Notes: Well 480 Data Collected from 18 f t bgs
Well 481 Data Collected from 28 f t bgs
Well 482 Data Collected from 58 f t bgs
25000
20000
25000
25000
28000
27000
25000
25000
26000
26000
27000
27000
82000
84000
81000
87000
81000
85000
2004 Baseline
Jun 04
Jul 04
Aug 04
Sep 04
Oct 04
480
481
482
Observation Well Number



Total Dissolved Solids (mg/L)
90000
85000
80000
35000
30000
25000
20000
15000
Legend
25000
April 2004 Baseline Conc (m g/L)
28000
Monthly 2004 Conc. (mg/L)
Notes: Well 483 Data Collected from 18 f t bgs
Well 484 Data Collected from 28 f t bgs
Well 485 Data Collected from 58 f t bgs
19000
23000
24000
27000
34000
23000
27000
24000
28000 28000
33000
36000
83000
84000 84000
81000
86000
87000
2004 Baseline
Jun 04
Jul 04
Aug 04
Sep 04
Oct 04
483
484
485
Observation Well Number


Uranium Concentration (mg/L)
4.00
3.00
2.00
1.00
0.00
3.1
3.1
3.0
3.0
3.1
2.9
2.8
3.2
2.9
3.0
3.1
3.1
0.63
0.88
0.75
0.70
0.89
0.51
2004 Baseline
Jun 04
Jul 04
Aug 04
Sep 04
Oct 04
2004 Baseline
Jun 04
Jul 04
Aug 04
Sep 04
Oct 04
2004 Baseline
Jun 04
Jul 04
Aug 04
Sep 04
Oct 04
480
481
482
Observation Well Number
Legend
3.1
April 2004 Baseline Conc (m g/L)
2.9
Monthly 2004 Conc. (mg/L)
Notes: Well 480 Data Collected from 18 f t bgs
Well 481 Data Collected from 28 f t bgs
Well 482 Data Collected from 58 f t bgs


Uranium Concentration (mg/L)
4.00
3.00
2.00
1.00
0.00
3.3
3.0
2.6
2.7
2.9
1.9
2.9
3.0
2.9
3.0
3.0
2.6
0.51
0.78
0.54
0.63
0.53
0.41
2004 Baseline
Jun 04
Jul 04
Aug 04
Sep 04
Oct 04
2004 Baseline
Jun 04
Jul 04
Aug 04
Sep 04
Oct 04
2004 Baseline
Jun 04
Jul 04
Aug 04
Sep 04
Oct 04
483
484
485
Observation Well Number
Legend
3.1
April 2004 Baseline Conc (m g/L)
2.9
Monthly 2004 Conc. (mg/L)
Notes: Well 483 Data Collected from 18 f t bgs
Well 484 Data Collected from 28 f t bgs
Well 485 Data Collected from 58 f t bgs

Appendix E−2

Configuration 2 Extraction Well Data

Date	Time	Well 570										comments		GW Elev
		Depth to water (ft)	flow rate	total vol (gls) *EXTRACTED*		total vol (gls) *INJECTED*		pressure	temp	spec cond	pH			
			gpm	raw data	corrected	raw data	corrected	psi	°C	µS/cm x1K				(ft msl)
9/2/04	17:00	13.35										initial wl, pump off		3951.87
9/3/2004	13:30	25.63	3.12		3,773							initial sampling		3939.59
9/7/2004	14:30	13.04	0		3,896							pump off		3952.18
9/8/2004	10:00				3,896							started deep well extraction test		
9/9/2004	10:27	13.20			3,896							pump off (shallow well)		3952.02
9/13/2004	17:00				3,896							shut down deep well extraction test		
9/14/2004	10:00	13.46			3,896							started shallow well extraction test		
9/16/2004	10:54	26.90	2.37					100	18.93	7.91	6.68	Adjusted to 1.87 gpm, 1.40 lbs		3938.32
9/20/2004	11:06	26.36	1.88		21,231			140	18.71	67.28	6.70			3938.86
9/22/2004	14:23	25.55	1.85		25,757			100+	18.55	49.03	6.74	sample collected near end of test		3939.67
9/22/2004	16:00				25,907							shut down shallow well extraction test		
9/22/2004	18:55	13.08	0.00		25,907			46				Pump off		3952.14
9/23/2004	12:00				25,907							started full scale extraction test		
9/27/2004	11:09	26.88	1.80		33,383			140	19.50	64.17	6.69			3938.34
9/30/2004	10:55	26.45	1.47		37,413			120	19.01	63.48	6.71			3938.77
10/4/2004	14:18	25.06	1.57		42,989			110	19.15	56.01	6.75			3940.16
10/5/2004	14:20	26.92	1.44		44,274			98	16.57	44.31	6.68	sample collected near end of test		3938.30
10/5/2004	16:00		0.00		44,352			46				full scale extraction test stopped		
10/6/2004	7:30	13.00	0.00		44,352									3952.22
10/6/2004	13:00		0.00		44,352							injection test started		
10/6/2004	13:57	11.55	1.03									injecting water		3953.67
10/6/2004	15:37	11.40	1.01									injecting water		3953.82
10/7/2004	11:14	11.61	2.00			45,346	994	8				injecting water		3953.61
10/11/2004	14:03	10.95	1.01			49,031	4,679	8						3954.27
10/14/2004	10:41	10.89	1.00			51,918	7,566	9				Shut down 1 min to clean filter		3954.33
10/14/2004	16:53		1.44									Increased injection flow rate		
10/15/2004	7:56	10.16	1.42											3955.06
10/15/2004	14:18	10.08	1.42											3955.14
10/18/2004	14:18	9.95	1.41			57,197	12,845	9				Increased to 2.06 gpm		3955.27
10/21/2004	10:54	8.65	2.01			64,914	20,562	9						3956.57
10/25/2004	10:49	7.43	1.99			75,703	31,351	9						3957.79
10/28/2004	11:56	7.22	1.97			80,890	36,538							3958.00

Date	Time	Well 571										comments		GW Elev
		Depth to water (ft)	flow rate	total vol (gls) *EXTRACTED*		total vol (gls) *INJECTED*		pressure	temp	spec cond	pH			(ft msl)
			gpm	raw data	corrected	raw data	corrected	psi	°C	µS/cm x1K				
9/2/04	17:00	12.95										initial wl, pump off		3951.94
9/3/2004	13:30	27.15	10		7,554							initial sampling		3937.74
9/7/2004	14:35	12.7	0		7,694							pump off		3952.19
9/8/2004	10:00				7,694							started deep well extraction test		
9/9/2004	10:51	34.25	4.38		14,250			80	17.36	81.52	6.62			3930.64
9/13/2004	17:00				33,773							shut down deep well extraction test		
9/14/2004	10:00	12.96			33,773							started shallow well extraction test		
9/16/2004	10:57	13.38			33,773									3951.51
9/20/2004	11:09	13.32			33,773									3951.57
9/22/2004	16:00				33,773							shut down shallow well extraction test		
9/22/2004	18:57	12.69	0.00		33,773			42				Pump off		3952.20
9/23/2004	12:00				33,773							started full scale extraction test		
9/27/2004	11:20	36.60	2.66		48,132			65	17.42	82.69	6.70	Adjusted 3.81 gpm, 1.3 psi		3928.29
9/30/2004	11:04	36.60	2.48		56,996			75	17.53	83.11	6.73	Adjusted 2.03 gpm, 1.3 psi		3928.29
10/4/2004	14:15	33.63	2.02		68,154			120	17.62	82.75	6.66			3931.26
10/5/2004	14:30	34.18	2.01		70,884			100+	16.61	79.71	6.68	sample collected near end of test		3930.71
10/5/2004	16:00		0.00		71,056			44				full scale extraction test stopped		
10/6/2004	7:30	12.55	0.00		71,056									3952.34
10/6/2004	13:00		0.00		71,056							injection test started		
10/6/2004	13:58	10.32	1.24									injecting water		3954.57
10/6/2004	15:39	10.38	1.20									injecting water		3954.51
10/7/2004	11:19	10.64	1.08			71,085	29	23				injecting water		3954.25
10/11/2004	14:04	10.40	0.85			71,085	29	21						3954.49
10/14/2004	10:41	10.41	0.98			71,086	30	18				Shut down 1 min to clean filter, flow increased t		3954.48
10/14/2004	16:55		1.59									Increased injection flow rate		
10/15/2004	7:58	9.68	1.57											3955.21
10/15/2004	14:20	9.60	1.56											3955.29
10/18/2004	14:23	9.70	1.52			71,085	29	16				Increased to 2.17 gpm		3955.19
10/21/2004	10:57	8.73	2.00			78,798	7,742	16						3956.16
10/25/2004	10:51	7.92	1.98			89,586	18,530	14						3956.97
10/28/2004	11:59	7.67	2.07			94,798	23,742							3957.22

		Well 572												
Date	Time	Depth to water (ft)	flow rate gpm	total vol (gls) *EXTRACTED* raw data	corrected	total vol (gls) *INJECTED* raw data	corrected	pressure psi	temp °C	spec cond µS/cm x1K	pH	comments		GW Elev (ft msl)
9/2/04	17:00	12.9										initial wl, pump off		3952.24
9/3/2004	13:30	26.77	3.15		4,420							initial sampling		3938.37
9/7/2004	14:40	12.7	0		4,541							pump off		3952.44
9/8/2004	10:00				4,541							started deep well extraction test		
9/9/2004	11:01	13.04			4,541							pump off (shallow well)		3952.10
9/13/2004	17:00				4,541							shut down deep well extraction test		
9/14/2004	10:00	12.98			4,541							started shallow well extraction test		
9/16/2004	11:08	26.74	2.60					55	18.06	67.14	6.67	Adjusted to 1.96 gpm, 140 lbs		3938.40
9/20/2004	11:16	27.65	1.89		25,631			140	18.15	59.19	6.70	Was 2.02, 95-120 lbs		3937.49
9/22/2004	14:37	23.92	1.85		30,332			100+	17.99	40.84	6.81	sample collected near end of test		
9/22/2004	16:00											shut down shallow well extraction test		
9/22/2004	19:01	12.82	0.00		33,773			45				Pump off		3952.32
9/23/2004	12:00				33,773							started full scale extraction test		
9/27/2004	11:25	25.44	2.85		37,249			140	18.64	58.15	6.64			3939.70
9/30/2004	11:11	26.73	1.70		41,484			125	18.43	59.77	6.69	Adjusted to 1.56 gpm, 140 lbs		3938.41
10/4/2004	14:11	25.22	1.53		47,053			130	18.90	55.47	6.65			3939.92
10/5/2004	14:43	25.47	1.53		48,431			100+	17.67	50.17	6.68	sample collected near end of test		3939.67
10/5/2004	16:00		0.00		48,508			0				full scale extraction test stopped		
10/6/2004	7:30	12.69	0.00		48,508									3952.45
10/6/2004	13:00		0.00		48,508							injection test started		
10/6/2004	13:59	11.35	1.46									injecting water		3953.79
10/6/2004	15:40	11.09	1.46									injecting water		3954.05
10/7/2004	11:21	10.49	1.44			49,780	1,272	0				injecting water		3954.65
10/11/2004	14:05	9.34	1.29			55,332	6,824	0						3955.80
10/14/2004	10:56	8.98	1.29			59,203	10,695	2				Shut down 1 min to clean filter, flow increased t		3956.16
10/14/2004	16:57		1.98									Increased injection flow rate		
10/15/2004	8:00	8.11	1.95											3957.03
10/15/2004	14:22	7.93	1.96											3957.21
10/18/2004	14:25	7.92	1.85			66,903	18,395	0				Increased to 1.98 gpm		3957.22
10/21/2004	11:00	6.62	2.22			74,618	26,110	1						3958.52
10/25/2004	10:52	7.23				85,402	36,894	2						3957.91
10/28/2004	12:03	7.58	2.20			90,613	42,105							3957.56

		Well 573												
		Depth to water (ft)	flow rate	total vol (gls) *EXTRACTED*		total vol (gls) *INJECTED*		pressure	temp	spec cond	pH	comments		GW Elev
Date	Time		gpm	raw data	corrected	raw data	corrected	psi	^{o}C	µS/cm x1K				(ft msl)
9/2/04	17:00	12.94										initial wl, pump off		3952.21
9/3/2004	13:30	33.9	7.9		2,485							initial sampling		3931.25
9/7/2004	14:45	12.64	0		2,518							pump off		3952.51
9/8/2004	10:00				2,518							started deep well extraction test		
9/9/2004	11:15	27.90	4.54		10,900			60	16.74	65.77	6.69			3937.25
9/13/2004	17:00				30,425							shut down deep well extraction test		
9/14/2004	10:00	12.88			30,425							started shallow well extraction test		
9/16/2004	11:12	13.29			30,425									3951.86
9/20/2004	11:20	13.18			30,425									3951.97
9/22/2004	16:00				30,425							shut down shallow well extraction test		
9/22/2004	19:04	12.69	0.00		30,425			0				Pump off		3952.46
9/23/2004	12:00				30,425							started full scale extraction test		
9/27/2004	11:36	33.15	2.34		43,746			75	18.27	69.12	6.97			3932.00
9/30/2004	11:45	36.78	3.58		51,586			90	17.31	51.48	6.75	Adjusted to 2.16 gpm, 130 psi		3928.37
10/4/2004	14:08	36.86	1.88		60,657			56	17.60	70.15	6.81			3928.29
10/5/2004	14:58	36.75	1.82		62,633			70	16.86	69.40	6.76	sample collected near end of test		3928.40
10/5/2004	16:00		0.00		62,722			0				full scale extraction test stopped		
10/6/2004	7:30	12.58	0.00		62,722									3952.57
10/6/2004	13:00		0.00		62,722							injection test started		
10/6/2004	14:00	9.91	1.36									injecting water		3955.24
10/6/2004	15:41	9.91	1.35									injecting water		3955.24
10/7/2004	11:23	10.42	1.36			63,977	1,255	0				injecting water		3954.73
10/11/2004	14:07	8.75	1.27			65,536	2,814	0						3956.40
10/14/2004	10:58	8.94	1.28			65,536	2,814	0				Shut down 1 min to clean filter, flow increased to		3956.21
10/14/2004	17:00		1.84									Increased injection flow rate		
10/15/2004	8:02	8.24	1.82											3956.91
10/15/2004	14:23	8.16	1.83											3956.99
10/18/2004	14:27	8.84	1.72			66,309	3,587	0				Increased to 2.2 gpm		3956.31
10/21/2004	11:03	7.85	2.21			74,024	11,302	0						3957.30
10/25/2004	10:53	6.43	2.22			84,804	22,082	0						3958.72
10/28/2004	12:05	6.21	2.24			90,019	27,297							3958.94

Date	Time	Well 574										comments		GW Elev
		Depth to water (ft)	flow rate	total vol (gls) *EXTRACTED*		total vol (gls) *INJECTED*		pressure	temp	spec cond	pH			(ft msl)
			gpm	raw data	corrected	raw data	corrected	psi	°C	µS/cm x1K				
9/2/04	17:00	12.73										initial wl, pump off		3952.39
9/3/2004	13:32	26.9	1.46		61							initial sampling		3938.22
9/7/2004	14:45	12.54	0		121							pump off		3952.58
9/8/2004	10:00				121							started deep well extraction test		
9/9/2004	11:20	13.05			121							pump off (shallow well)		3952.07
9/13/2004	17:00				121							shut down deep well extraction test		
9/14/2004	10:00	12.75			121							started shallow well extraction test		
9/16/2004	11:20	26.55	1.73					60	17.67	49.68	6.76			3938.57
9/20/2004	11:30	26.57	1.17		14,532			52	18.16	48.42	6.83			3938.55
9/22/2004	14:49	26.52	1.30		17,853			52	17.34	38.37	7.31	sample collected near end of test		
9/22/2004	16:00				17,919							shut down shallow well extraction test		
9/22/2004	19:06	12.63	0.00		17,919			44				Pump off		3952.49
9/23/2004	12:00											started full scale extraction test		
9/27/2004	11:43	26.60	0.94		23,353			50	19.10	46.29	6.79			3938.52
9/30/2004	11:22	26.61	0.85		25,556			50	18.69	47.20	6.75			3938.51
10/4/2004	14:02	26.78	0.82		28,337			49	18.83	44.79	6.75			3938.34
10/5/2004	15:13	26.75	0.82		29,046			50	18.21	47.52	7.11	sample collected near end of test		3938.37
10/5/2004	16:00		0.00		29,068			43				full scale extraction test stopped		
10/6/2004	7:30	12.58	0.00		29,068									3952.54
10/6/2004	13:00		0.00		29,068							injection test started		
10/6/2004	14:01	11.68	0.53									injecting water		3953.44
10/6/2004	15:42	11.52	0.51									injecting water		3953.60
10/7/2004	11:24	11.30	0.51			29,385	317	40				injecting water		3953.82
10/11/2004	14:08	11.15	0.51			30,660	1,592	36						3953.97
10/14/2004	11:08	11.05	0.48			31,338	2,270	32				Shut down 1 min to clean filter, flow increased t		3954.07
10/14/2004	17:02		1.07									Increased injection flow rate		
10/15/2004	8:03	10.11	1.04											3955.01
10/15/2004	14:24	10.00	1.04											3955.12
10/18/2004	14:29	9.78	1.00			36,476	7,408	30				Increased to 2.05 gpm		3955.34
10/21/2004	11:06	7.51	2.02			44,194	15,126	29						3957.61
10/25/2004	10:54	5.60	1.99			54,971	25,903	27						3959.52
10/28/2004	12:11	5.40	1.99			60,196	31,128							3959.72

Date	Time	Well 575										comments		
		Depth to water (ft)	flow rate	total vol (gls) *EXTRACTED*		total vol (gls) *INJECTED*		pressure	temp	spec cond	pH			GW Elev
			gpm	raw data	corrected	raw data	corrected	psi	°C	µS/cm x1K				(ft msl)
9/2/04	17:00	12.75										initial wl, pump off		3952.26
9/3/2004	12:58	30.9	7.7		5,760							initial sampling		3934.11
9/7/2004	14:45	12.52	0		6,047							pump off		3952.49
9/8/2004	10:00				6,047							started deep well extraction test		
9/9/2004	11:34	27.95	5.11		15,354			92	17.12	62.97	6.59			3937.06
9/13/2004	17:00				34,750							shut down deep well extraction test		
9/14/2004	10:00	12.81			34,750							started shallow well extraction test		
9/16/2004	11:24	13.11			34,750									3951.90
9/20/2004	11:34	13.00			34,750									3952.01
9/22/2004	16:00				34,750							shut down shallow well extraction test		
9/22/2004	19:07	12.51	0.00		34,750			46				Pump off		3952.50
9/23/2004	12:00				34,750							started full scale extraction test		
9/27/2004	11:51	36.78	2.31		48,315			95	18.02	65.65	6.83	Adjusted to 1.53 gpm, 1.4 psi		3928.23
9/30/2004														
10/4/2004	13:58	30.28	1.66		57,888			130	18.62	64.14	6.70			3934.73
10/5/2004	15:19	31.39	1.67		59,315			100+	17.33	59.65	6.75	sample collected near end of test		
10/5/2004	16:00		0.00		59,354			8				full scale extraction test stopped		
10/6/2004	7:30	12.47	0.00		59,354									3952.54
10/6/2004	13:00		0.00		59,354							injection test started		
10/6/2004	14:01	9.38	1.43									injecting water		3955.63
10/6/2004	15:43	9.57	1.54									injecting water		3955.44
10/7/2004	11:26	10.03	1.61			60,618	1,264	4				injecting water		3954.98
10/11/2004	14:09	8.00	1.50			65,536	6,182	4						3957.01
10/14/2004	11:12	7.57	1.56			65,536	6,182	3				shut down 1 min to clean filter, flow increaed to		3957.44
10/14/2004	17:03		1.88									Increased injection flow rate		
10/15/2004	8:04	6.86	1.88											3958.15
10/15/2004	14:25	6.78	1.83											3958.23
10/18/2004	14:30	6.76	1.72			66,552	7,198	4						3958.25
10/21/2004	11:08	5.95	1.66			66,552	7,198	3						3959.06
10/25/2004	10:56	4.25	1.79			66,552	7,198	3						3960.76
10/28/2004	12:14	4.17	1.76			66,552	7,198							3960.84

Date	Time	Well 576										comments		GW Elev
		Depth to water (ft)	flow rate	total vol (gls) *EXTRACTED*		total vol (gls) *INJECTED*		pressure	temp	spec cond	pH			(ft msl)
			gpm	raw data	corrected	raw data	corrected	psi	°C	µS/cm x1K				
9/2/04	17:00	12.5										initial wl, pump off		3952.65
9/3/2004	12:48	22.31	1.81		2,108							initial sampling		3942.84
9/7/2004	14:50	12.37	0		2,168							pump off		3952.78
9/8/2004	10:00				2,168							started deep well extraction test		
9/9/2004	11:37	12.70			2,168							pump off (shallow well)		3952.45
9/13/2004	17:00				2,168							shut down deep well extraction test		
9/14/2004	10:00	12.55			2,168							started shallow well extraction test		
9/16/2004	11:33	26.78	1.97					85	18.83	42.52	6.75	Adjusted to 1.27 gpm, 130 lbs		3938.37
9/20/2004	11:39	22.58	1.27		14,962			130	19.24	42.85	6.73			3942.57
9/22/2004	15:10	22.56	1.26		18,053			100+	18.76	30.33	6.87	sample collected near end of test		
9/22/2004	16:00				18,102							shut down shallow well extraction test		
9/22/2004	19:08	12.43	0.00		18,102			46				Pump off		3952.72
9/23/2004	12:00				18,102							started full scale extraction test		
9/27/2004	3:55	16.05	1.59		23,548			140	20.63	51.32	6.72	Readjusted		3949.10
9/30/2004	11:27	28.92	1.61		52,346			140	18.38	60.94	6.72			3936.23
10/4/2004	13:53	24.02	0.95		31,744			130	20.56	46.26	6.72			3941.13
10/5/2004	15:26	24.97	0.95		32,680			100+	18.74	36.25	6.77	sample collected near end of test		3940.18
10/5/2004	16:00		0.00		32,700			46				full scale extraction test stopped		
10/6/2004	7:30	12.40	0.00		32,700									3952.75
10/6/2004	13:00		0.00		32,700							injection test started		
10/6/2004	14:02	10.81	0.81									injecting water		3954.34
10/6/2004	15:45	10.56	0.79									injecting water		3954.59
10/7/2004	11:29	10.34	0.79			32,768	68	0				injecting water		3954.81
10/11/2004	14:10	9.73	0.74			32,768	68	0						3955.42
10/14/2004	11:15	9.54	0.77			32,768	68	0				Shut down 1 min to clean filter, flow increaed to		3955.61
10/14/2004	17:05		1.19									Increased injection flow rate		
10/15/2004	8:07	8.55	1.17											3956.60
10/15/2004	14:26	8.42	1.19											3956.73
10/18/2004	14:33	8.30	1.26			34,292	1,592	0				Increased to 2.14 gpm		3956.85
10/21/2004	11:12	6.12	1.87			39,870	7,170	0						3959.03
10/25/2004	10:57	4.68	1.88			49,394	16,694	0						3960.47
10/28/2004	12:17	4.94	1.70			52,015	19,315							3960.21

Date	Time	Well 577										comments		
		Depth to water (ft)	flow rate	total vol (gls) *EXTRACTED*		total vol (gls) *INJECTED*		pressure	temp	spec cond	pH			GW Elev
			gpm	raw data	corrected	raw data	corrected	psi	°C	µS/cm x1K				(ft msl)
9/2/04	17:00	12.32										initial wl, pump off		3952.78
9/3/2004	12:54	31.59	9.62		11,430							initial sampling		3933.51
9/7/2004	14:50	12.16	0		11,817							pump off		3952.94
9/8/2004	10:00				11,817							started deep well extraction test		
9/9/2004	11:42	12.63										deep well, pump not working		3952.47
9/13/2004	17:00				16,494							shut down deep well extraction test		
9/14/2004	10:00	12.45			16,494							started shallow well extraction test		
9/16/2004	11:37	12.75			16,494									3952.35
9/20/2004	11:42	12.66			16,494									3952.44
9/22/2004	16:00				16,494							shut down shallow well extraction test		
9/22/2004	19:01	12.21	0.00		16,497			3.5				Pump off		3952.89
9/23/2004	12:00				16,497							started full scale extraction test		
9/27/2004	12:05	29.78	6.37		49,175			56.0	17.00	59.85	6.73			3935.32
9/30/2004	11:58	34.38	6.24		73,438			56.0	16.40	63.59	6.68			3930.72
10/4/2004	13:42	35.52	5.31		97,667			51.0	16.52	65.73	6.67			3929.58
10/5/2004	15:35	36.65	5.22		103,466			50.0	15.52	63.83	6.72	sample collected near end of test		3928.45
10/5/2004	16:00		0.00		103,562			8				full scale extraction test stopped		
10/6/2004	7:30	12.24	0.00		103,562									3952.86
10/6/2004	13:00		0.00		103,562							injection test started		
10/6/2004	14:03	8.25	3.19									injecting water		3956.85
10/6/2004	15:46	8.70	3.19									injecting water		3956.40
10/7/2004	11:32	8.72	3.11			106,076	2,514	0.0				Shut off for 1 min to clean filter, injecting water		3956.38
10/11/2004	14:11	6.25	2.15			117,169	13,607	0.0						3958.85
10/14/2004	11:20	5.54	2.33			124,946	21,384	0.0				Shut down for 1 min to clean filter, flow increase		3959.56
10/14/2004	17:06		2.74											
10/15/2004	8:07	4.46	2.67											3960.64
10/15/2004	14:28	4.29	2.68											3960.81
10/18/2004	14:35	3.41	2.40			137,547	33,985	0.0						3961.69
10/21/2004	11:14	2.95	2.28			146,624	43,062	0.0						3962.15
10/25/2004	10:58	0.00	2.40			159,807	56,245	0.0				Water at top of well, adjusted flow to 1.73		3965.10
10/28/2004	12:21	1.88	1.70			164,333	60,771							3963.22

Date	Time	Well 578										comments		GW Elev (ft msl)
		Depth to water (ft)	flow rate gpm	total vol (gls) *EXTRACTED* raw data	corrected	total vol (gls) *INJECTED* raw data	corrected	pressure psi	temp °C	spec cond µS/cm x1K	pH			
9/2/04	17:00	12.23										initial wl, pump off		3952.85
9/3/2004	13:00	25.1	2.1		2,266							initial sampling		3939.98
9/7/2004	14:55	12.19	0		2,315							pump off		3952.89
9/8/2004	10:00				2,315							started deep well extraction test		
9/9/2004	11:46	12.54			2,315							pump off (shallow well)		3952.54
9/13/2004	17:00				2,315							shut down deep well extraction test		
9/14/2004	10:00	12.43			2,315							started shallow well extraction test		
9/16/2004	11:40	26.75	0.00					85	18.32	27.19	6.84	Adjusted to 1.75 gpm, 55 lbs		3938.33
9/20/2004	11:47	26.77	1.58		13,680			50	17.97	27.61	6.91			3938.31
9/22/2004	15:30	26.81	1.49		17,448			50	17.73	21.02	6.90	sample collected near end of test		
9/22/2004	16:00				17,488							shut down shallow well extraction test		
9/22/2004	19:12	12.26	0.00		17,488			44				Pump off		3952.82
9/23/2004	12:00				17,488							started full scale extraction test		
9/27/2004	12:11	26.75	1.03		22,247			60	18.78	26.12	6.79			3938.33
9/30/2004	12:05	26.75	1.04		23,090			56	18.77	26.52	6.76			3938.33
10/4/2004	13:35	26.77	0.00		23,683			56	18.67	26.90		Adjusted flow to 1.94 gpm, 120 lbs		3938.31
10/5/2004	15:43	27.85	1.12		25,044			100+	18.82	26.05	6.78	sample collected near end of test		3937.23
10/5/2004	16:00		0.00		25,046			44				full scale extraction test stopped		
10/6/2004	7:30	12.16	0.00		25,046									3952.92
10/6/2004	13:00		0.00		25,046							injection test started		
10/6/2004	14:04	10.99	0.70									injecting water		3954.09
10/6/2004	15:47	10.78	0.79									injecting water		3954.30
10/7/2004	11:42	10.25	0.60			25,114	68	31				injecting water, filter cleaned, adjusted flow to 0.		3954.83
10/11/2004	14:13	10.30	0.26			25,124	78	16				GPM up and down		3954.78
10/14/2004	11:26	10.18	0.58			25,240	194	8				Shut down 1 min to clean filter, increased flow to		3954.90
10/14/2004	17:09		1.16									Increased injection flow rate		
10/15/2004	8:08	9.41	1.10											3955.67
10/15/2004	14:29	9.32	1.10											3955.76
10/18/2004	14:37	9.22	1.07			30,659	5,613	3				Increased to 1.99 gpm		3955.86
10/21/2004	11:17	7.24	1.83			38,380	13,334	2						3957.84
10/25/2004	11:00	5.54	1.89			49,072	24,026	2						3959.54
10/28/2004	12:24	5.36	1.80			51,727	26,681							3959.72

Date	Time	Well 579										comments		
		Depth to water (ft)	flow rate	total vol (gls) *EXTRACTED*		total vol (gls) *INJECTED*		pressure	temp	spec cond	pH			GW Elev
			gpm	raw data	corrected	raw data	corrected	psi	°C	µS/cm x1K				(ft msl)
9/2/04	17:00	12.05										initial wl, pump off		3953.06
9/3/2004	13:11	22	9.6		11,455							initial sampling		3943.11
9/7/2004	15:00	11.97	0		11,719							pump off		3953.14
9/8/2004	10:00				11,719							started deep well extraction test		
9/9/2004	11:56	23.23	9.73		26,326			82	16.52	37.69	6.51			3941.88
9/13/2004	17:00				83,179							shut down deep well extraction test		
9/14/2004	10:00	12.27			83,179							started shallow well extraction test		
9/16/2004	11:48	12.35			83,179									3952.76
9/20/2004	11:50	12.30			83,179									3952.81
9/22/2004	16:00				83,179							shut down shallow well extraction test		
9/22/2004	19:13	11.99	0.00		83,179			44				Pump off		3953.12
9/23/2004	12:00				83,179							started full scale extraction test		
9/27/2004	12:19	28.40	9.55		134,518			80	16.46	46.65	6.65			3936.71
9/30/2004	12:12	29.78	9.35		174,637			80	16.71	47.94	6.64			3935.33
10/4/2004	13:28	37.01	9.34		228,676			77	16.41	49.83	6.75	Adjusted flow to 5.13, 120 lbs		3928.10
10/5/2004												Adjusted flow to 8.9 gpm, 88 lbs		
10/5/2004	15:53	24.55	8.79		237,895			86	15.61	47.98	6.73	sample collected near end of test		3940.56
10/5/2004	16:00		0.00		237,995							full scale extraction test stopped		
10/6/2004	7:30	11.96	0.00		237,995									3953.15
10/6/2004	13:00		0.00		237,995							injection test started		
10/6/2004	14:06	9.38	3.02									injecting water		3955.73
10/6/2004	15:48	10.27	1.69									injecting water		3954.84
10/7/2004	11:47	10.41	1.69			239,947	1,952	0				injecting water, cleaned filter, adjusted flow to 5.3		3954.70
10/11/2004	14:15	9.65	3.06			265,018	27,023	0						3955.46
10/14/2004	11:32	8.46	4.00			280,075	42,080	0				shut down 1 min to clean filter, flow increased to 5.17		3956.65
10/14/2004	17:11		5.86									Increased injection flow rate		
10/15/2004	8:09	8.74	5.30											3956.37
10/15/2004	14:30	8.84	5.35											3956.27
10/18/2004	14:40	8.91	4.28			308,824	70,829	0				Increased to 5.16 gpm		3956.20
10/21/2004	11:21	9.21	4.31			325,195	87,200							3955.90
10/25/2004	11:02	7.95	4.55			349,466	111,471	0						3957.16
10/28/2004	12:28	7.75	3.98			358,648	120,653							3957.36