Energy Fuels Resources (USA) Inc.

November 7, 2012

VIA E-MAIL AND OVERNIGHT DELIVERY

Mr. Rusty Lundberg
Director, Division of Radiation Control
Utah Department of Environmental Quality
195 North 1950 West
P.O. Box 144850
Salt Lake City, UT 84114-4820

Re: Transmittal of Revised Southwest Hydrogeology Investigation Report Utah Groundwater Discharge Permit UGW370004 White Mesa Uranium Mill

Dear Mr. Lundberg:

This letter transmits the revised Report entitled "Second Revision: Hydrogeology of the Perched Groundwater Zone in the Area Southwest of the Tailings Cells, White Mesa Uranium Mill Site" (the "Report") prepared in response to Part I.H.6. of Energy Fuels Resources (USA) Inc.'s ("EFRI's") Utah Ground Water Discharge Permit No. UGW370004 (the "Permit"). Reference is also made to the Utah Division of Radiation Control's ("DRC's") May 30, 2012 Notice of Enforcement Discretion/Request for Information ("NOED/RFI"), Denison's response letter dated July 13, 2012, and DRC's Review Summary, Request for Information and Conclusions dated September 20, 2012.

Pursuant to Part I.H.6 of the Permit, EFRI submitted the initial version of the Report on January 12, 2012. DRC provided comments on the Report in the NOED/RFI letter of May 30, 2012. In response to the NOED/RFI, EFRI submitted a revised version of the Report on August 3, 2012 and agreed to repeat slug testing of piezometer DR-08. DRC's September 20, 2012 review Summary and RFI, specifically requested that EFRI:

- repeat slug testing of piezometer DR-08,
- recalculate hydraulic properties, and
- recalculate travel times if necessary based on new data.

Enclosed are two copies of the November 2012 Second Revision to the Report, addressing the data and re-calculations resulting from retesting of piezometer DR-08. This transmittal includes two hard copies of the report, along with two CDs, each containing a word searchable electronic copy of the Report in pdf format.

Please contact me if you have any questions or require any further information.

Yours very truly,

ENERGY FUELS RESOURCES (USA) INC.

Jo Ann Tischler
Director, Compliance

cc: David C. Frydenlund
Daniel C. Hillsten
Harold R. Roberts
David E. Turk
Kathy A. Weinel

Attachments

SECOND REVISION
HYDROGEOLOGY OF THE PERCHED GROUNDWATER ZONE IN THE AREA SOUTHWEST OF THE TAILINGS CELLS WHITE MESA URANIUM MILL SITE

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BLANDING, UTAH

January 12, 2012 | Revised August 3, 2012;
Second Revision November 7, 2012

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Environmental Science & Technology

SECOND REVISION
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PERCHED GROUNDWATER ZONE
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January 12, 2012 | Revised August 3, 2012
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TABLE OF CONTENTS

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TABLE OF CONTENTS (Continued)

TABLES

FIGURES

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APPENDICES

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1. INTRODUCTION

In response to Part 1.H.6 of the amended Utah Department of Environmental Quality (UDEQ) Ground Water Quality Discharge Permit UGW370004 (the Permit), this report discusses the investigation of the hydrogeology of the perched groundwater zone southwest of the tailings cells at the White Mesa Uranium Mill, (the Mill or the site) located south of Blanding, Utah. The investigation of the area southwest of the tailings cells was first presented in Hydro Geo Chem [HGC] (2012a). A revised version of HGC (2012a) was prepared based on UDEQ comments [HGC (2012b)]. This report is a revised version of HGC (2012b) and incorporates data collected during hydraulic retesting of piezometer DR-8 during October, 2012. Installation and testing of DR-series piezometers will be discussed in Section 2. Figure 1 shows the locations of the investigation area, perched monitoring wells at the site, and seeps and springs along the margins of White Mesa.

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Specifically, UDEQ requests the following in Part I.H.6 of the Permit:

Detailed Southwest Hydrogeologic Investigation and Report - the purpose of this investigation is to define, demonstrate, and characterize: 1) hydraulic connection and local groundwater flow directions between the area near Tailings Ce114B, and the western margin of White Mesa, including Westwater and Cottonwood Seeps, and Ruin Spring, and 2) the full physical extent of unsaturated area between former well MW-16, MW-33 and the western margin of White Mesa, as defined above. In preparation of this report, the Permittee shall:

a) *Install multiple borings and/or monitoring wells to completely enclose and define both: 1) the subsurface structural high area of the upper Brushy Basin Shale Member geologic contact and 2) the horizontal limits of saturation in the Burro Canyon Formation. Said study shall include, but is not limited to a subsurface area between Tailings Cell 4B, and the Westwater and Cottonwood Seeps, and Ruin Spring. At a minimum the characterization/definition of said subsurface area shall be based on:*

    1) *Dry wells or piezometers, completed down to a depth equal to or below the upper geologic contact of the Brushy Basin Shale Member,*

    2) *Piezometers or wells that intercept the shallow aquifer and encounter a saturation thickness of 5-feet or more. Said wells and piezometers shall have a minimum inside diameter of 3 inches. The Permittee shall complete hydraulic testing of all such wells and piezometers in accordance with Part I.F.6(c) of this Permit.*

b) *Demonstrate the full geologic and physical extent of the apparent unsaturated structural high between Tailings Cell 4B and the western margin of White Mesa, including Westwater and Cottonwood Seeps and Ruin Spring.*

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c) *Demonstrate the location and direction of all groundwater flow paths between Tailings Cell 4B and nearby Westwater and Cottonwood Seeps and Ruin Spring. Determine average linear groundwater velocity to said groundwater discharge locations.*

d) *Perform geologic logging of all borings/wells, and submit geologic logs performed and certified by a Utah licensed Professional Geologist.*

e) *Submit the investigation report for Executive Secretary review and approval on or before January l3, 2012. This report shall be certified by a Utah Licensed Professional Engineer or Geologist and will include but is not limited to:*

   1) *Geologic logs and well As-built diagrams that comply with the requirements of Part I.F.6.*

   2) *A revised equipotential map to describe both the physical extent of the dry zone and all groundwater flow directions near Tailings Cell 4B and Westwater and Cottonwood Seeps, and Ruin Spring. Said map shal1 demonstrate flowpaths (streamtubes) to all respective groundwater discharge locations at the western margin of White Mesa.*

   3) *A revised structural contour map for the upper Brushy Basin Shale for the facility and physical extent of White Mesa.*

   4) *A revised saturation thickness map based on contemporaneous groundwater head data for the Burro Canyon aquifer for the facility and physical extent of White Mesa.*

   5) *Appropriate geologic and hydrogeologic maps and cross-sections (to scale).*

   6) *Results and interpretation of aquifer permeability testing as per Part I.F.6(c) of this Permit*.

Section 2 discusses the southwest area investigation as per Part 1.H.6 items (a) and (d). Section 3 provides an overview of site hydrogeology, an update of site hydrogeology based on the results of the southwest area investigation, and seep and spring hydrogeology in relation to the perched water system in the southwest area of the site. Section 4 discusses the implications of the results with regard to seeps and springs in the southwest portion of the site. Sections 3 and 4 satisfy the elements of Part 1.H.6 items (b) and (c) and item (e).

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2. SOUTHWEST AREA INVESTIGATION

The southwest area investigation included the drilling and logging of 22 borings (referred to as the DR-series borings) in the southwest portion of the site, completion of 18 of the borings as piezometers, hydraulic testing of the piezometers having at least 5 feet of water in the casings, water level monitoring, and additional examination of the area near Cottonwood Seep. Details of the investigation are provided in Sections 2.1 through 2.4. The results of the investigation show that permeabilities in the southwest portion of the site are on average lower than previously estimated, and provide no evidence for a direct hydraulic connection between the perched water zone and Cottonwood Seep. As discussed in Section 3, the hydraulic test and water level data also demonstrate that the perched zone southwest of Cell 4B is inadequate as a primary supply to Cottonwood Seep by several orders of magnitude. As will also be discussed in Section 3, a hypothetical connection between the perched zone near piezometer DR-8 and Cottonwood Seep is postulated for the purposes of calculating perched water travel times and to allow for the possibility that an as yet unidentified connection may exist.

2.1 Rationale for Locating Piezometers

Piezometers were located to satisfy the following goals specified in Part 1.H.6 of the Permit:

a) Investigate the extent of the unsaturated Brushy Basin Member paleoridge between tailings Cell 4B and the western margin of White Mesa and associated seeps and springs, and

b) Investigate perched groundwater flow paths and saturated thicknesses between Cell 4B and the western margin of White Mesa and associated seeps and springs

Twenty two boring locations were sited in the southwest area including five optional borings as shown in Figure 1. The five optional borings were installed based on data collected during drilling and subsequent water level monitoring of the remainder of the borings.

2.2 DR-Series Piezometer Installation and Testing

DR-series piezometers were installed, monitored, and tested as described in Sections 2.2.1 through 2.2.4 and Section 2.3. The installation, logging, and testing were conducted in accordance with Part 1.H.6 items (a) and (d) of the Permit.

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2.2.1 Installation

Installation procedures were similar to those used previously at the site for the construction of perched zone monitoring wells (Hydro Geo Chem, Inc. [HGC], 2005) except that smaller diameter borings were drilled to accommodate smaller (3-inch rather than 4-inch) diameter casings. Drilling and construction were performed by Bayles Exploration, Inc., and borings logged by Mr. Lawrence Casebolt under contract to Denison Mines (USA) Corporation (Denison). Mr. Stewart Smith of HGC was onsite during a portion of the drilling and well construction activities. As-built diagrams for the well constructions, based primarily on information provided by Bayles Exploration, are shown in Appendix A as per Part 1.H.6 (e) item 1 of the Permit. The depths to water shown in the as-built diagrams are based on water level measurements taken during the third quarter, 2011. Surveyed land surface and top-of-casing elevations are provided on the diagrams. Table 1 provides surveyed position coordinates and elevations for piezometers.

2.2.2 Drilling and Logging Procedures

A 6 ¾ inch diameter tricone bit was used to drill a boring of sufficient diameter to install 6-inch-diameter, Schedule 40 polyvinyl chloride (PVC) surface (or conductor) casing. The surface casing extended to a depth of approximately five feet below land surface. Once each surface casing was in place, the boreholes were drilled by air rotary adding water and/or foam only when needed to maintain circulation. Boreholes were drilled using 5 $^{5}/_{8}$ to 6 $^{1}/_{8}$ inch diameter tricone bits. Each borehole penetrated the Dakota Sandstone and the Burro Canyon Formation and terminated in the Brushy Basin Member of the Morrison Formation.

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Drill cutting samples used for lithologic logging were collected at 2½-foot depth intervals and placed in labeled, zip-sealed plastic bags and labeled plastic cuttings storage boxes. Copies of the lithologic logs submitted by Mr. Casebolt are provided in Appendix B (as per Part 1.H.6 (e) item (1) of the Permit).

2.2.3 Water Level Monitoring

Prior to completion as piezometers, open borings were protected by capping the surface casings with 6-inch diameter PVC caps, and water levels periodically taken over approximately 1 month. Based on the data collected, decisions were made whether to complete each boring as a piezometer or to abandon the boring, as discussed in Section 2.2.4.

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2.2.4 Piezometer Completion and Abandonment of Non-Completed Borings

Completed piezometers were constructed using 3-inch diameter, Schedule 40, flush-threaded PVC casing and 0.02-slot, factory-slotted PVC screen. Colorado Silica Sand was used as a filter pack and installed to a depth approximately three to six feet above the screened interval of each piezometer. The annular space above the filter pack was then sealed with approximately three to eight feet of hydrated bentonite chips and grouted to the surface using Portland cement.

DR-2 was abandoned as it was deemed unnecessary to meet the water level monitoring objectives of this investigation (other than the water level monitoring conducted prior to abandonment) and DR-5 provided similar information. Water level monitoring established that the saturated thicknesses at DR-2 and DR-5 were similar, that the area appears to be a groundwater divide for perched water, and that flow appears to be primarily either north-northeast to known discharge point Westwater Seep or south toward known discharge point Ruin Spring.

DR-16 was abandoned as unnecessary due to the proximity of MW-3, MW-20, and DR-15. Only DR-15 was considered necessary to establish the boundary of the dry zone to the west. Water level monitoring of DR-16 confirmed that a continuous saturated zone exists between MW-3 and MW-20 but the boring did not add significant information regarding hydraulic conditions in the area.

DR-18 was abandoned because it remained dry. DR-18 helped define the southern extension of the Brushy basin Member paleoridge and dry area intercepted by MW-21.

DR-25 was abandoned as unnecessary because the boring established that significant saturated thickness exists immediately upgradient of Ruin Spring, but did not add significant information regarding hydraulic conditions in the area.

2.3 Hydraulic Testing and Results

Hydraulic testing (as per Part 1.H.6 (a) item (2) of the Permit) consisted of slug tests conducted by HGC personnel using a methodology similar to that described in HGC (2005). This is substantially the same methodology used for hydraulic testing of all monitoring wells installed since 2005. All DR-series piezometers with at least 5 feet of water in the casings were tested. The saturated thickness is defined as the difference between the water level elevation and the Brushy Basin Member contact elevation which is not necessarily the same as the water column in the piezometers, because the casings generally extend below the contact. The saturated

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thickness at DR-12 was greater than 5 feet but the water column in the well was not sufficient for testing because of about 3 feet of sediment in the bottom of the casing.

Testing of all DR-series piezometers was performed during October 2011. The original test at DR-8 was strongly influenced by barometric pressure changes. UDEQ expressed concern over the factor of three difference between the hydraulic conductivity estimated from the hand-collected data (1 x 10^{-7} cm/s) and the hydraulic conductivity estimated from the automatically logged data (3.4 x 10^{-8} cm/s) using the KGS slug test solution (Hyder et al., 1994). UDEQ considered there to be sufficient uncertainty in the results to warrant a retest. Retesting of piezometer DR-8 was performed during October 2012. The hydraulic test results reported for DR-8 in this revision are based on retesting of the well in October 2012.

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The results of the testing (Section 2.3.2) indicate that hydraulic conductivities in the southwest portion of the site are lower than previously estimated indicating perched water moves more slowly than previous calculations would indicate. The hydraulic conductivity estimates calculated for piezometer DR-8 (located at the western edge of the mesa east of Cottonwood Seep as shown in Figure 1) are among the lowest measured on site.

2.3.1 October 2011 Testing Procedures

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The slugs used for the October 2011 tests consisted of a sealed, pea-gravel-filled, schedule 80 PVC pipe approximately 4 feet long as described in HGC (2002), and a slug of the same diameter having a length of 3 feet. The 4-foot slug displaced approximately 0.47 gallons of water and the 3-foot slug approximately 0.35 gallons.

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Three 0-30 pounds per square inch absolute (psia) Level Troll™ data loggers were used for the tests. One Level Troll was used to measure barometric pressure and was placed in a protected environment for the duration of the testing. The other Level Trolls were deployed below the static water columns in the tested wells and used to measure the changes in water levels during the tests. Automatically logged water level data were collected at 3-second intervals and barometric data at 5-minute intervals.

Prior to each test, the static water level was measured by hand using an electric water level meter. The data logger was then lowered to a depth of approximately one foot above the base of the well casing, and background pressure readings were collected for approximately 30 minutes prior to beginning each test. The purpose of collecting the background data was to allow correction for any detected water level trends.

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Once background data were collected, the slug and electric water level meter sensor were suspended in the tested well just above the static water level. Each test commenced by lowering the slug to a depth of approximately 1 to 2 feet below the static water level over a period of a few seconds and taking water level readings by hand as soon as possible afterwards. Hand-collected data were obtained more frequently in the first few minutes when water levels were changing rapidly, then less frequently as the rate of water level change diminished. Upon completion of each test, automatically logged data were checked and backed up on the hard drive of a laptop computer.

2.3.2 October 2012 Testing Procedures (DR-8 Retest)

The DR-8 retesting procedure included collection and analysis of both automatically logged data and data collected by hand using an electric water level meter, in substantially the same fashion as for the October 2011 tests. A 0-30 psia Level Troll™ pressure transducer was used to collect the automatically logged data and a 0-30 psia BaroTroll™ was used to collect atmospheric pressure data

The primary differences between the original test and the retest are that 1) a smaller slug was used (approximately 0.23 gallons rather than approximately 0.47 gallons) to eliminate any possibility that the slug could interfere with the data logger suspended near the base of the water column in the well, 2) a 6-second (rather than 3-second) data collection interval was used for automatically logged water level data, and 3) a 1-minute (rather than 5-minute) interval was used to collect barometric data. The automatically logged data were corrected for changes in atmospheric pressure prior to analysis and processed in substantially the same fashion as for the October 2011 tests.

2.3.3 Hydraulic Test Data Analysis

Data from the tests were analyzed using AQTESOLVE™ (HydroSOLVE, 2000), a computer program developed and marketed by HydroSOLVE, Inc. In each test, the maximum measured rise in water level was reasonable considering the slug volume, the volume in the 3-inch-diameter casing, and the volume in the annular space between the casing and the bore.

In preparing the October 2011 automatically logged data for analysis, the total number of records was reduced. In general, all data collected in the first 30 seconds were retained, then every 2nd, then 3rd, then 4th, etc. record was retained for analysis. For example, if the first 10 records were retained (30 seconds of data at 3-second intervals), the next records to be retained would be the 12th, the 15th, the 19th, the 24th, etc. A similar process was used for the October 2012 data collected during retesting of DR-8. The primary difference was that all automatically logged data

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collected during the first 60 seconds (rather than 30 seconds) were retained before reducing the number of data points as described above.

Data were analyzed using two solution methods: the KGS unconfined method (Hyder et al., 1994) and the Bouwer-Rice unconfined method (Bouwer and Rice, 1976). When filter pack porosities were required by the analytical method, a value of 30 percent was used. The saturated thickness was taken to be the difference between the depth of the static water level measured just prior to the test and the depth to the Brushy Basin Member contact as defined in the drilling logs (Appendix B). The static water levels were below the tops of the screened intervals and the saturated thicknesses were taken to be the effective screen lengths. Short-duration tests generally did not require correction for changes in barometric pressure. Some of the longer-duration tests, specifically tests at DR-8, DR-10, DR-13, and DR-14, did require corrections to be applied as shown in Appendix C. Appendix C also provides displacement data for each test.

The KGS solution allows estimation of both specific storage and hydraulic conductivity, while the Bouwer-Rice solution allows estimation of only the hydraulic conductivity. The Bouwer-Rice solution is valid only for any straight-line portions of the data that result when the log of displacement is plotted against time and is insensitive to both storage and the specified initial water level rise. Typically, only the later-time data are interpretable using Bouwer-Rice.

The KGS solution generally allows a fit to both early and late time data and is sensitive to storage and the specified initial water level rise. Both solutions were used for comparison. Automatically logged and hand-collected data were analyzed separately using both solution methods. The hand-collected data, therefore, served as an independent data set and a check on the accuracy of the automatically logged data.

Table 2 summarizes parameters for each test. The results of the analyses are provided in Table 3 and Appendix D (as per Part 1.H.6 (e) item (6) of the Permit). Appendix D contains plots generated by AQTESOLVE™ that show the quality of fit between measured and simulated displacements, and reproduce the parameters used in each solution. Estimates of hydraulic conductivity range from 2.5 x 10^{-8} centimeters per second (cm/s) to 4.5 x 10^{-4} cm/s using automatically logged data, and from 4.5 x 10^{-8} cm/s to 4.7 x 10^{-4} cm/s using hand-collected data.

Agreement between analyses using the KGS and Bouwer-Rice solutions, and between automatically-logged and hand-collected data, was generally good. Except for DR-8 all KGS and Bouwer-Rice estimates using automatically logged data were within a factor of two, and the majority were within 30%. KGS and Bouwer-Rice estimates using hand-collected data were within a factor of three (except at DR-8), and the majority were also within 30%. Agreement

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between KGS solution estimates using automatically logged and hand-collected data were within a factor of two except at DR-10 where the estimates were within a factor of three.

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At DR-8, the KGS solution estimates obtained from automatically logged and hand collected data are within a factor of two, a substantial improvement over the original test. The primary reason for the improvement is that the influence of barometric pressure change was smaller during the retest than during the original test. However, the KGS and Bouwer-Rice estimates for the DR-8 retest data differ by approximately an order of magnitude.

Differences between hydraulic conductivity estimates obtained using the KGS and Bouwer-Rice solutions are common and expected because of the differences between the two solution methods. The KGS solution accounts for non-steady flow and aquifer storage while the Bouwer-Rice solution does not. Accounting for non-steady flow and storage allows a fit to the entire data set using KGS rather than typically only the later-time portion of the data using Bouwer-Rice.

Because the KGS solution accounts for non-steady flow and aquifer storage it is considered a more accurate solution than Bouwer-Rice. For this reason, hydraulic conductivity estimates obtained from the KGS solution are used in the groundwater flow and pore velocity calculations presented in Sections 3.3 and 3.4.

2.4 Examination of the Area Near Cottonwood Seep

HGC investigated the area near Cottonwood Seep in July 2010 as discussed in HGC (2010b). Additional investigation of the area between Cottonwood Seep and the mesa rim to the east and northeast (where the perched zone hosted by the Burro Canyon Formation terminates) was conducted by HGC personnel at the time of the hydraulic testing (in support of Part 1.H.6 item (c) of the Permit). The purpose of the examination was to determine if any previously unidentified hydraulic connection between Cottonwood Seep and the Burro Canyon Formation may exist. In particular, the ground was examined for any previously unidentified seeps originating from the Burro Canyon Formation near the mesa rim, or any areas of enhanced vegetation that would indicate surface or near-surface waters (such as cottonwood trees associated with all other seeps and springs) that may potentially establish a connection between the perched zone and Cottonwood Seep.

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Examination of the area provided no evidence to establish a hydraulic connection. The absence of any visible seeps or anomalous vegetation in the Brushy Basin Member northeast and east of Cottonwood Seep is consistent with dry conditions within the upper portion of the Brushy Basin above Cottonwood Seep. As will be discussed in Section 3, a hypothetical connection between the perched zone near DR-8 and Cottonwood Seep is postulated for the purposes of calculating

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perched water travel times and to allow for the possibility that an as yet unidentified connection may exist.

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3. HYDROGEOLOGY OF THE AREA SOUTHWEST OF THE TAILINGS CELLS

The site hydrogeology has been described previously in HGC (2010b), HGC (2009b), HGC (2007) and TITAN (1994).The results of these previous investigations are summarized in Section 3.1. Section 3.2 updates the site hydrogeology with the results of the present investigation, Section 3.3 provides calculations of perched water travel times from tailings cells to Westwater Seep, piezometer DR-8 (located near the mesa rim above Cottonwood Seep), and Ruin Spring, and Section 3.4 discusses water balance calculations in the southwest portion of the site. The data show that saturated thicknesses and rates of perched water movement are low in the southwest portion of the site, and local recharge likely contributes to flow at Westwater Seep and Ruin Spring.

Perched water travel times from Cell 4B to DR-8 are calculated rather than travel times to Cottonwood Seep because there is no evidence to establish a hydraulic connection between Cottonwood Seep and the perched water system. Furthermore, the hydraulic test and water level data demonstrate that the perched zone southwest of Cell 4B is inadequate as a primary supply to Cottonwood Seep by several orders of magnitude and that the primary source(s) for Cottonwood Seep lie(s) elsewhere. However, a hypothetical connection between the perched zone near piezometer DR-8 and Cottonwood Seep is postulated in Section 3.3 for the purposes of calculating perched water travel times and to allow for the possibility that an as yet unidentified connection may exist.

3.1 Background and Overview

Section 3.1.1 provides a brief summary of site hydrogeology taken primarily from HGC (2010b) and updated with third quarter, 2011 water level data. Section 3.1.2 discusses key findings of HGC (2010b) regarding the relationship between the perched water zone and seeps and springs that occur at the margins of White Mesa. Figure 1 shows site features, the locations of perched monitoring wells, and the locations of seeps and springs.

3.1.1 Summary

Perched groundwater at the site is hosted primarily by the Burro Canyon Formation, which consists of a relatively hard to hard, fine- to medium-grained sandstone containing siltstone, shale and conglomeratic materials. The Burro Canyon Formation is separated from the underlying regional Navajo/Entrada aquifer by approximately 1,000 to 1,100 feet of Morrison Formation and Summerville Formation materials having a low average vertical permeability. The Brushy Basin Member of the Morrison Formation is a bentonitic shale that lies immediately

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beneath the Burro Canyon Formation and forms the base of the perched water zone at the site. Figure 2 is a photograph of the contact between the Burro Canyon Formation and the underlying Brushy Basin Member taken from a location along highway 95 north of the Mill. This photograph illustrates the transition from the cliff-forming sandstone of the Burro Canyon Formation to the slope-forming Brushy Basin Member. Based on hydraulic tests at perched zone monitoring wells (prior to the present investigation), the hydraulic conductivity of the perched zone ranges from approximately 2 x 10^{-7} to 0.01 cm/s (HGC, 2009b).

Perched water flow is generally from northeast to southwest across the site. Beneath and south of the tailings cells, in the west central portion of the site, perched water flow is south-southwest to southwest. As the results of the present investigation will show, flow on the western margin of the mesa is also south, approximately parallel to the rim (where the Burro Canyon Formation is terminated by erosion). On the eastern side of the site perched water flow is also generally southerly. Because of mounding near wildlife ponds, flow direction ranges locally from westerly (west of the ponds) to easterly (east of the ponds). Perched water generally has a low quality, with total dissolved solids ranging from approximately 1,100 to 7,900 mg/L, and is used primarily for stock watering and irrigation north (upgradient) of the site.

As of the third quarter of 2011, depths to perched water range from approximately 17 to 18 feet near the wildlife ponds in the northeastern portion of the site to approximately 114 feet at the southwestern margin of tailings Cell #3. Saturated thicknesses range from approximately 92 feet near the wildlife ponds to less than 5 feet in the southwest portion of the site, downgradient of the tailings cells. A saturated thickness of approximately 2 feet occurs in well MW-34 along the south dike of new tailings Cell 4B, and the perched zone is apparently dry at MW-33 located at the southwest corner of Cell 4B. Although sustainable yields of as much as 4 gallons per minute (gpm) have been achieved in wells penetrating higher transmissivity zones, well yields are typically low (<$^1/_2$ gpm) due to the generally low permeability of the perched zone.

Hydraulic testing of perched zone wells prior to the present investigation yielded a hydraulic conductivity range of approximately 2 x 10^{-7} to 0.01 cm/s. In general, the highest permeabilities and well yields are in the area of the site immediately northeast and east (upgradient to cross gradient) of the tailings cells. A relatively continuous, higher permeability zone associated with a chloroform plume has been inferred to exist in this portion of the site (HGC, 2007). Analysis of drawdown data collected from this zone during long-term pumping of MW-4, TW4-19, and MW-26 (TW4-15) yielded estimates of hydraulic conductivity ranging from 4 x 10^{-5} to 1 x 10^{-3} cm/s.

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Permeabilities downgradient of the tailings cells are generally low. Hydraulic tests conducted prior to the present investigation at wells located at the downgradient edge of the cells, and south and southwest of the cells, yielded geometric average hydraulic conductivities of 2.3 x 10^{-5} and 4.3 x 10^{-5} cm/s depending on the testing and analytical method. The low permeabilities and shallow hydraulic gradients downgradient of the tailings cells result in average perched groundwater pore velocity estimates that are among the lowest on site.

3.1.2 Seeps and Springs in Relation to Perched Zone Hydrogeology

Hydro Geo Chem (2010b) discusses the relationships between the perched water zone and seeps and springs at the margins of White Mesa (shown in Figure 1). Key findings of that report include the following:

a) Cottonwood Seep is located more than 1,500 feet west of the mesa rim in an area where the Dakota Sandstone and Burro Canyon Formation (which hosts the perched water system) are absent due to erosion. Cottonwood Seep occurs near a transition from slope-forming to bench-forming morphology (indicating a change in lithology). Cottonwood Seep (and 2nd Seep located immediately to the north) are interpreted to originate from coarser-grained materials within the lower portion of the Brushy Basin Member and are therefore not (directly) connected to the perched water system at the site.

b) Ruin Spring and Westwater Seep are interpreted to occur at the contact between the Burro Canyon Formation and the Brushy Basin Member. Corral Canyon Seep, Entrance Spring, and Corral Springs are interpreted to occur at elevations within the Burro Canyon Formation at their respective locations but above the contact with the Brushy Basin Member. All seeps and springs (except Cottonwood Seep which is located near the Brushy Basin Member/Westwater Canyon Member contact) are associated with conglomeratic portions of the Burro Canyon Formation. The more conglomeratic portions of the Burro Canyon Formation are likely to have higher permeabilities and the ability to transmit water more readily than finer-grained portions. This behavior is consistent with on-site drilling and hydraulic test data that associates higher permeability with the conglomeratic horizons detected east and northeast of the tailing cells

c) Only Ruin Spring appears to receive a predominant and relatively consistent proportion of its flow from perched water. Ruin Spring originates from conglomeratic Burro Canyon Formation sandstone where it contacts the underlying Brushy Basin Member, at an elevation above the alluvium in the associated drainage. Westwater Seep, which also originates at the contact between the Burro Canyon Formation and the Brushy Basin Member, likely receives a significant contribution from perched water. All seeps and springs other than Ruin Spring (and 2nd Seep just north of Cottonwood Seep) are located within alluvium occupying the basal portions of small drainages and canyons. The relative contribution of flow to these features from bedrock and from alluvium is indeterminate.

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d) All seeps and springs are reported to have enhanced flow during wet periods. For seeps and springs associated with alluvium, this behavior is consistent with an alluvial contribution to flow. Enhanced flow during wet periods at Ruin Spring, which originates from bedrock above the level of the alluvium, likely results from direct recharge of Burro Canyon Formation and Dakota Sandstone outcropping near the mesa margin in the vicinity of Ruin Spring. This recharge would be expected to temporarily increase the flow at Ruin Spring (as well as other seeps and springs where associated bedrock is directly recharged) after precipitation events.

As discussed in item a), Cottonwood Seep was interpreted in HGC (2010b) to be associated with coarser-grained materials within the lower portion of the Brushy Basin Member. The justification for this interpretation is based primarily on 1) the rate of flow at Cottonwood Seep, which is estimated to be between 1 and 10 gpm (consistent with Dames and Moore, 1978), 2) the need for relatively permeable materials to transmit this rate of flow, and 3) the change in morphology near Cottonwood Seep indicating a change in lithology. The change in morphology from slope-former to bench-former just east of Cottonwood Seep can be seen in the topographic map included in Appendix E (Figure E.1) and the annotated photograph provided in Figure 3.

The upper portion of the Brushy Basin Member, which hydraulically isolates the perched zone from underlying materials, is composed primarily of bentonitic mudstone, claystone, and shale. The rate of flow at Cottonwood Seep is inconsistent with the materials found within the upper portion of the Brushy Basin but is consistent with coarser-grained materials expected either within the lower portion of the Brushy Basin Member or within the upper portion of the underlying Westwater Canyon (sandstone) Member. The relationship between Cottonwood Seep and lithology is shown on the geologic map provided in Appendix E (Figure E.2) and Figure 3.

As shown in Figure 3, Cottonwood Seep is located approximately 230 feet below the base of the perched zone defined by the contact between the cliff-forming Burro Canyon Formation and the underlying slope-forming Brushy Basin Member. The change in morphology from slope-former to bench-former occurs within the lower portion of the Brushy Basin Member (or the upper portion of the Westwater Canyon Member), between the termination of the perched zone at the mesa rim and Cottonwood Seep. The bench-like area hosting Cottonwood Seep begins at the change in morphology east of Cottonwood Seep and terminates west of Cottonwood Seep where a cliff-forming sandstone, interpreted to be within the Westwater Canyon Member, is exposed. The contact between the Westwater Canyon Member and the Brushy Basin Member is interpreted to be located between this sandstone outcrop and the change in morphology from slope-former to bench-former. This places Cottonwood Seep at the transition between the Brushy Basin Member and the underlying Westwater Canyon Member. This placement is consistent

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with lithologic cross-sections provided in TITAN (1994) which place the contact between the Brushy Basin Member and the Westwater Canyon Member at elevations between approximately 5,220 and 5,230 feet above mean sea level (ft amsl), within 5 to 15 feet of the elevation of Cottonwood Seep (5234 ft amsl).

The occurrence of coarser-grained materials within the lower portion of the Brushy Basin Member is discussed in Shawe (2005). The lower unit of the Brushy Basin Member is described as "mudstone layers which contain, near their base, lenses lithologically similar to sandstone of the Salt Wash Member, and near their top, conglomeratic sandstone lenses". By contrast, the upper portion of the Brushy Basin Member is described by Shawe (2005) as "principally mudstone; it contains only minor amounts of sandstone, conglomeratic sandstone, and conglomerate as discontinuous lenses".

The expectation of coarser-grained materials at Cottonwood Seep is also consistent with the transition from the Brushy Basin Member into the underlying Westwater Canyon Member. As discussed in Craig (1955), and Flesch (1974), The Westwater Canyon Member intertongues with the Brushy Basin Member. Craig (1955) states "The Westwater Canyon Member forms the lower portion of the upper part of the Morrison in northeastern Arizona, northwestern New Mexico, and places in southeastern Utah and southwestern Colorado near the Four Corners, and it intertongues and intergrades northward into the Brushy Basin Member".

3.2 Incorporation of DR-series Data

DR-series water level, hydraulic test, and lithologic data were used in conjunction with existing data to provide a more comprehensive description of the perched zone hydrogeology as described in Sections 3.2.1 through 3.2.4.

3.2.1 Brushy Basin Member Contact Elevations

Figure 4 (as per Part 1.H.6 (e) item (3) of the Permit) is a contour map of the Burro Canyon Formation/Brushy Basin Member contact generated from perched well, piezometer, DR-series boring data and the locations and elevations of Westwater Seep and Ruin Spring. Figure 4 was generated based on data indicating that only Westwater Seep and Ruin Spring are located at the contact between the Burro Canyon Formation and the Brushy Basin Member (HGC, 2010b).

As discussed in Section 2, examination of the area near Cottonwood Seep in July 2010 and re-examination in October 2011 revealed no evidence for a hydraulic connection with the perched zone. The absence of any visible seeps or anomalous vegetation in the Brushy Basin Member

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east and northeast of Cottonwood Seep is consistent with dry conditions in the upper portion of the Brushy Basin Member.

3.2.2 Perched Water Elevations, Saturated Thicknesses and Depths to Water

In support of Part 1.H.6 (e) item (2) of the Permit, Figures 5, 6, and 7 are contour maps of perched water elevations generated from second and third quarters, 2011, and first quarter, 2012 water level data. Each contains perched well and piezometer water level data, and the elevations of all seeps and springs except Cottonwood Seep (for which there is no evidence to establish a connection to the perched water system and which is located near the Brushy Basin Member/Westwater Canyon Member contact, indicating that its elevation is not representative of the perched potentiometric surface). Fill-in contours between the 10-foot elevation contours are provided in the area immediately west-southwest of the tailings cells to allow detail in an area having relatively flat hydraulic gradients.

Figure 5 (second quarter, 2011 data) also contains data from DR-2, DR-16, DR-18, and DR-25 that were abandoned after the second quarter, 2011. Figures 5, 6, and 7 were generated assuming that each seep or spring (except Cottonwood Seep) is a known discharge point for perched water and that the elevation of the seep or spring is representative of the elevation of perched water at that location (HGC, 2010b). As per Part 1.H.6 (e) item (4) of the Permit, Figures 8, 9, and 10 show the saturated thicknesses of the perched zone based on second and third quarter, 2011, and first quarter, 2012 water level data. Differences between the second and third quarters are due primarily to the slow recovery of water levels in many DR-series borings (in particular DR-6, DR-8, and DR-12).

The dry areas shown in Figures 5 through 10 occur where the kriged contact between the Burro Canyon Formation and the Brushy Basin Member is higher in elevation than the kriged perched water elevation. The dry areas shown in these Figures encompass abandoned dry well MW-16, dry well MW-21, dry well MW-33, and abandoned dry boring DR-18. Dry areas in Figure 5 also encompass DR-6 and DR-12 which recovered slowly after drilling, but contained measurable water by the third quarter of 2011. The areas defined by the heavy yellow dashed contour lines have saturated thicknesses less than 5 feet. As shown in Figures 6, 7, 9 and 10, a large portion of the perched zone west and southwest (downgradient) of the tailings cells has a saturated thickness less than 5 feet as of (and subsequent to) the third quarter, 2011. An apparent perched water divide exists in the vicinity of DR-2 and DR-5 (Figures 5, 6 and 7). Perched water north of this apparent divide is expected to flow primarily northeast toward Westwater Seep and perched water south of this apparent divide is expected to flow primarily south toward Ruin Spring.

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As per Part 1.H.6 (b) and (e) items (2), (3), and (4) of the Permit, Figure 11 shows the axes of paleoridges and paleovalleys in the Brushy Basin Member erosional paleosurface and posted third quarter, 2011 saturated thicknesses. Also shown is the region estimated to have saturated thicknesses greater than 10 feet. As indicated, paleoridges in the southwest area of the site are associated with dry areas and with areas with low saturated thicknesses; paleovalleys are associated with areas of higher saturated thicknesses. Westwater Seep and Ruin Spring are located in paleovalleys.

3.2.3 Interpretation of Cross-Sections

As per Part 1.H.6 (e) item (5) of the Permit, Figures 12 and 13 are cross-sections showing the hydrogeology of the perched zone in the area southwest of the tailings cells. The locations of the cross-sections are provided on Figure 1. Figure 12 provides east-west cross-sections (E-W and E2-W2) across the area immediately west and southwest of Cell 4B. Figure 13 is a north-south cross-section (N-S) from the south dike of Cell 4B to Ruin Spring. Cross-sections E-W and N-S are oriented approximately parallel to perched water flow and E2-W2 is oriented roughly perpendicular to perched water flow. Except for abandoned DR-series borings, water levels in the cross sections are based on third quarter, 2011 data. Water levels for abandoned borings are from the second quarter, 2011. Water levels did not change significantly between the third quarter of 2011 and the first quarter of 2012.

As shown in cross-section E-W of Figure 12 (and in Figures 8, 9 and 10) the saturated thickness of the perched zone in the southwest area of the site varies from negligible to more than 20 feet. The variable saturated thickness has implications regarding the flow of perched water to known discharge points Westwater Seep and Ruin Spring. Perched water moving downgradient from the area of the tailings cells westward toward abandoned boring DR-2 must pass through a region of low saturated thickness occupied by DR-6 and DR-7 (Figure 12). As will be discussed in more detail in Section 3.4, this implies (by Darcy's Law) that some downgradient areas having larger saturated thicknesses must receive local recharge from precipitation because the water supplied by lateral perched flow is inadequate to maintain the large saturated thicknesses in areas near sinks such as Westwater Seep and Ruin Spring.

Two areas of relatively large saturated thickness that are downgradient of areas of small saturated thickness are of particular interest: the area near DR-2 and DR-5 located west of the area near DR-6 and DR-7 as shown in Figure 12 (cross-section E-W), and the area near DR-25 located south of the area near MW-20 as shown in Figure 13 (cross-section N-S). Each of the above areas of larger saturated thickness is downgradient of the corresponding area of small saturated thickness, and each downgradient area of larger saturated thickness is near a perched

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water sink. The primary known sinks downgradient of DR-2 and DR-5 are Westwater Seep to the northeast and the paleovalley leading south to Ruin Spring (Figure 11). The primary sink near DR-25 is Ruin Spring. Lateral flow from areas of larger saturated thickness that may exist to the east of cross-section N-S may supply the water needed to maintain the relatively large saturated thickness near DR-25. However, the reported temporary increases in flow from Ruin Spring (and Westwater Seep) after precipitation events (HGC, 2010b) are difficult to explain unless flow is temporarily enhanced by local recharge.

As discussed in HGC (2010b), enhanced local recharge is likely near the mesa margins where weathered Dakota Sandstone and Burro Canyon Formation are exposed by erosion (Figure E.2, Appendix E). Logs at DR-2 and DR-5 show only a few feet of unconsolidated material above the Dakota Sandstone and visual inspection of the area of the mesa near DR-2 and DR-5 shows that weathered Dakota is often exposed (consistent with the geology presented in Dames and Moore (1978). Due to the thin veneer of alluvium overlying the Dakota Sandstone, and thin or absent Mancos Shale, recharge near DR-2 and DR-5 (cross-section E-W, Figure 12) will be facilitated. Similarly, in the area near abandoned boring DR-25 and Ruin Spring, recharge will be facilitated by the thinness or absence of the Mancos Shale and the surface exposure of the Dakota Sandstone and Burro Canyon Formation between DR-25 and Ruin Spring (Figure 13).

3.2.4 Perched Water Flow Directions

As per Part 1.H.6 (e) item (2) of the permit, Figure 14 is a water level contour map showing estimated pathlines from various locations on the west or south (downgradient) dikes of the tailings cells toward known discharge points Westwater Seep and Ruin Spring. These pathlines show the primary expected directions of perched water flow. As indicated, perched water passing beneath the west dike of Cell 4B has the potential to travel to either of known discharge points Westwater Seep or to Ruin Spring because of an apparent groundwater divide in the vicinity of DR-2 and DR-5. Perched water north of this apparent divide is expected to flow primarily northeast to Westwater Seep and perched water south of this apparent divide is expected to flow primarily south toward Ruin Spring. The presence of this apparent divide is consistent with enhanced local recharge.

The path to Ruin Spring from the area south of the apparent divide is sub-parallel to the western rim of the mesa. The path is generally along a paleovalley between the mesa rim and the dry portion of the Brushy Basin Member paleoridge defined by MW-21 and abandoned boring DR-18. Perched water passing beneath the south dike of Cell 4B is expected to travel south-southwest to Ruin Spring, to the east of the dry paleoridge defined by MW-21 and abandoned boring DR-18.

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Overall, the data suggest that flow in the southwest portion of the site is influenced by paleotopography to a greater extent than in other areas of the site due to the prevalence of small saturated thicknesses.

As discussed in Section 3.1.2, there is no evidence to hydraulically connect Cottonwood Seep to the perched water system, therefore no primary flow pathway depicted in Figure 14 leads to Cottonwood Seep. Section 3.3 posits a potential pathway that may hypothetically exist between the perched zone near DR-8 and Cottonwood Seep for purposes of travel time calculations, and to allow for the possibility that an as yet unidentified pathway may exist.

3.3 Perched Water Travel Times

As per Part 1.H.6 item (c) of the Permit, perched water pore velocities and travel times along selected paths between the tailings cells and perched water discharge points were calculated for the pathlines shown in Figure 15 using Darcy's Law. The calculated pore velocities and travel times are representative of the movement of a conservative solute assuming no hydrodynamic dispersion. Calculated perched water travel times in the area southwest (downgradient) of the tailings cells are generally longer than previously estimated and pore velocities generally lower than previously estimated.

The Figure 15 pathlines were selected as the shortest Figure 14 paths from the tailings cells to a) Westwater Seep (Path 1), b) Ruin Spring via the west side of the Brushy Basin paleoridge (Path 3), and c) Ruin Spring via the east side of the Brushy Basin paleoridge (Path 4). A pathline from the tailngs cells to the vicinity of DR-8 (Path 2) is also shown in Figure 15. From the vicinity of DR-8 perched water is expected to flow primarily south (within a paleovalley) toward Ruin Spring. However, a potential pathline from the vicinity of DR-8 is also shown in Figure 15 that posits a hypothetical connection between the perched zone and Cottonwood Seep. Path 2 provides the shortest pathline between the tailings cells and the western edge of the perched zone near DR-8, and the potential path provides the shortest hypothetical connection between the western edge of Path 2 and Cottonwood Seep.

Hydraulic conductivities used in the calculations are from TITAN (1994), HGC (2002), HGC (2005), HGC (2009a), HGC (2010a), HGC (2011), and Table 3. Data are summarized in Table 4. Hydraulic conductivity estimates are based on automatically logged slug test data analyzed using the KGS solution method, except for MW-12, MW-14, and MW-15. Hydraulic conductivity estimates at MW-12, MW-14, and MW-15 are based on pumping test analyses reported in TITAN (1994). Pore velocity calculations for each pathline are summarized in Table 5.

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Path 1 is approximately 2,200 feet long with an average hydraulic gradient of 0.0132 feet per foot (ft/ft) based on the first quarter, 2012 water level at MW-23 (5,497 ft amsl) and the elevation of Westwater Seep (5,468 ft amsl). The geometric average hydraulic conductivity of the perched zone in the vicinity of Path 1 (based on data from DR-5, DR-8, DR-9, DR-10, DR-11, MW-12, MW-23, MW-24, and MW-36) is 9.8 x 10^{-6} cm/s (0.027 feet per day [ft/day]). Assuming an effective porosity of 0.18, the average perched water pore velocity along Path 1 is 0.73 feet per year (ft/yr), yielding a total travel time of approximately 3,010 years.

Path 2 is approximately 4,125 feet long with an average hydraulic gradient of 0.0046 ft/ft based on the first quarter, 2012 water level at MW-36 (5,493 ft amsl) and the water level at DR-8 (5,474 ft amsl). The geometric average hydraulic conductivity of the perched zone in the vicinity of Path 2 (based on data from DR-5, DR-8, DR-9, DR-10, DR-11, MW-12, MW-23, MW-24, and MW-36) is 9.8 x 10^{-6} cm/s (0.027 ft/day). Assuming an effective porosity of 0.18, the average perched water pore velocity along Path 2 is 0.26 feet per year (ft/yr), yielding a total travel time of approximately 15,850 years. The additional time to travel along the hypothetical pathway to Cottonwood Seep is not calculated because of the hypothetical nature of the pathway. If such a pathway exists, the combined travel time along Path 2 and the hypothetical pathway (which adds approximately 2,150 horizontal feet to the total path length), is expected to be significantly greater than 15,850 years.

Path 3 is approximately 11,800 feet long with an average hydraulic gradient of 0.0096 ft/ft based on the first quarter, 2012 water level at MW-36 (5,493 ft amsl) and the elevation of Ruin Spring (5,380 ft amsl). The geometric average hydraulic conductivity of the perched zone in the vicinity of Path 2 (based on test data from DR-5, DR-8, DR-9, DR-10, DR-11, DR-14, DR-17, DR-19, DR-20, DR-21, DR-23, DR-24, MW-23, MW-24, and MW-36) is 1.1 x 10^{-5} cm/s (0.031 ft/day). Assuming an effective porosity of 0.18, the average perched water pore velocity along Path 3 is 0.60 ft/yr, yielding a total travel time of approximately 19,650 years.

Path 4 is approximately 9,685 feet long with an average hydraulic gradient of 0.0116 ft/ft based on the first quarter, 2011 water levels at MW-15, MW-34, and MW-37 (5,492 ft amsl) and the elevation of Ruin Spring (5,380 ft amsl). The geometric average hydraulic conductivity of the perched zone in the vicinity of Path 4 (based on KGS analysis of automatically test data from DR-11, DR-13, DR-21, DR-23, DR-24, MW-3, MW-14, MW-15, MW-20 and MW-37) is 1.38 x 10^{-5} cm/s (0.039 ft/day). Assuming an effective porosity of 0.18, the average perched water pore velocity along Path 4 is 0.91 ft/yr, yielding a total travel time of approximately 10,650 years.

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3.4 Water Balance Near DR-2 and DR-5

Enhanced recharge south/southwest of Westwater Seep near DR-2 and DR-5 is likely needed to maintain the relatively large saturated thicknesses there, considering the slow rate of perched water flow into that area via the zone of low saturated thickness and the presence of known sinks to the northeast (Westwater Seep) and to the south (paleovalley leading to Ruin Spring).

Because the water columns in most piezometers penetrating the area of low saturated thicknesses were inadequate for hydraulic testing, only one estimate of hydraulic conductivity was obtained, at DR-10. As shown in Table 3, the KGS method hydraulic conductivity estimates at DR-10 (located within the area of low saturated thickness) were one to two orders of magnitude lower than at DR-5 and DR-9, located west of the area of low saturated thickness. Assuming the estimate at DR-10 is representative of the area of low saturated thickness, the transmissivity (the product of hydraulic conductivity and saturated thickness) of the area of low saturated thickness is two to three orders of magnitude lower than for the area of larger saturated thickness to the west (near DR-2, DR-5, and DR-9). Figures 6 and 7 show that the hydraulic gradient in this area is relatively flat, and the gradient does not change significantly across the area of low saturated thickness.

Water flows westward from the area of the tailings cells through the area of low saturated thickness between DR-6 and DR-10 (Figure 7). Using Darcy's Law, and assuming a hydraulic conductivity of 3 x 10^{-6} cm/s (0.0084 ft/day, based on the KGS estimate provided for DR-10 in Table 3), an average hydraulic gradient of 0.0065 ft/ft, an average saturated thickness of 2 $^{1}/_{3}$ ft, and a width of approximately 1,600 feet (the approximate distance between DR-6 and DR-10), the rate of perched water flow westward through the area of low saturated thickness is approximately 0.2 cubic feet per day (ft^3/day) or 0.0011 gpm.

Water flows out of the area of larger saturated thickness (near DR-2 and DR-5) to the northeast toward known discharge point Westwater Seep and to the south through the paleovalley leading towards known discharge point Ruin Spring. The rate of flow out of this area northeast to Westwater Seep is expected to be smaller than the discharge rate at Westwater Seep which also receives water from the east and northeast. The discharge rate at Westwater Seep is too small for a reliable estimate. However, the rate of flow south through the paleovalley leading towards Ruin Spring can be calculated using the geometric average hydraulic conductivity of 0.0089 ft/day (based on KGS estimates for DR-8, DR-9, and DR-10 in Table 3), an approximate hydraulic gradient of 0.0088 ft/ft, an average saturated thickness of 12 ft, and a width of approximately 2,250 ft (between DR-8 and DR-10), as 2.1 ft^3/day, or 0.011 gpm, an order of magnitude larger

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than the calculated flow into the area. The difference between calculated inflow and outflow is approximately 0.01 gpm.

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These calculations indicate that an additional water source is needed to maintain the relatively large saturated thicknesses west of the area of low saturated thickness between DR-6 and DR-10; otherwise Westwater Seep and the paleovalley to the south would drain the area of larger saturated thickness more quickly than water was supplied. The most likely source of additional water is infiltration of precipitation enhanced by the direct exposure of weathered Dakota Sandstone and Burro Canyon Formation, and the thinness or absence of any overlying low permeability materials such as the Mancos Shale. Assuming uniform recharge over an area of approximately 175 acres (the portion of the mesa west of Westwater Seep and north of DR-8 and DR-9), the calculated difference of 0.01 gpm implies a conservatively low recharge rate of 0.0011 inches per year (in/yr). Most of the recharge likely occurs near the mesa rim where the Dakota and Burro Canyon are exposed (Figure 12 and Figure E.2, Appendix E). Such recharge is expected to be enhanced within drainages where they cross weathered Dakota Sandstone and Burro Canyon Formation.

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Furthermore, these calculations indicate that perched water flow in the portion of the site south of Westwater Seep is inadequate as a primary supply to Cottonwood Seep. Perched water flow from the area of the tailings cells through the area of low saturated thickness towards Cottonwood Seep would have to be more than three orders of magnitude higher than calculated above to provide a supply of between 1 and 10 gpm. The required flow would have to be even larger considering that some of the incoming flow is diverted to known discharge point Westwater Seep and to the paleovalley that leads south to known discharge point Ruin Spring. Even if this calculation were performed using the geometric average of the KGS hydraulic conductivity estimates for all tested DR-series piezometers (approximately 1 x 10^{-5} cm/s or 0.028 ft/day) rather than the estimate for DR-10 (3 x 10^{-6} cm/s or 0.0084 ft/day), the calculated rate of flow through the area of low saturated thickness would be 0.0035 gpm, which is still approximately three orders of magnitude lower than the estimated discharge rate of Cottonwood Seep. The inadequacy of the perched zone as the primary supply to Cottonwood Seep indicates that the primary source or sources of Cottonwood Seep lie elsewhere.

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4. IMPLICATIONS FOR SEEPS AND SPRINGS

The lithologic and hydraulic data collected from the southwest area investigation allow a more comprehensive assessment of the hydrogeology of the site and have implications with regard to seeps and springs southwest of the site. The data indicate that dilution of perched water by local recharge is expected to occur in the vicinities of Westwater Seep and Ruin Spring, and that perched zone permeabilities and flow rates in the southwestern portion of the site are too low (by several orders of magnitude) for the perched zone to serve as the primary source of water for Cottonwood Seep

4.1 Westwater Seep and Ruin Spring

As discussed in HGC (2010b) the water source for both Westwater Seep and Ruin Spring is lateral flow from upgradient portions of the perched zone enhanced by local recharge near the edge of the mesa. Most of this recharge likely occurs near the mesa rim where weathered Dakota Sandstone and Burro Canyon Formation are exposed. Such recharge is likely to be enhanced within drainages where they cross weathered Dakota Sandstone and Burro Canyon Formation. The results of the present study indicate that the permeability of the perched zone in the southwest area of the site is on average lower than previously estimated and that the contribution to flow at Westwater Seep and Ruin Spring by local recharge is more significant than previously thought.

4.2 Cottonwood Seep

The low perched zone permeabilities and small saturated thicknesses in the southwest area of the site are consistent with low rates of perched water flow, as shown by the calculated flow through the area of small saturated thickness southwest of the tailings cells (between DR-6 and DR-10) provided in Section 3.4. This low rate of perched water flow (approximately 0.001 gpm) is inadequate (by more than three orders of magnitude) to function as the primary supply to Cottonwood Seep which has flows estimated to be between 1 and 10 gpm. As discussed in Section 3.1.2, the estimated flow at Cottonwood Seep is consistent with Dames and Moore (1978).

In summary, the perched zone cannot be the primary source of water to Cottonwood Seep for the following reasons:

a) Cottonwood Seep occurs in the lower third of Brushy Basin Member, approximately 230 feet below the contact between the Burro Canyon Formation and the Brushy Basin Member, more than 1,500 ft west of the termination of the perched zone, and just west of

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a change in morphology from slope-former to bench-former. The change in morphology is indicative of a change in lithology. As discussed in HGC (2010b) Cottonwood Seep likely originates from coarser-grained materials within the lower portion of the Brushy Basin Member. Alternatively, Cottonwood Seep may originate from coarser-grained materials of the Westwater Canyon (sandstone) Member intertongueing with the overlying Brushy Basin Member at the transition between the two Members. The presence of coarser-grained materials similar to the Salt Wash (sandstone) Member within the lower portion of the Brushy Basin member is discussed in Shawe (2005). The intertongueing of the Westwater Canyon and Brushy Basin Members is discussed in Craig (1955) and Flesch (1974). Based on lithologic cross sections provided in TITAN (1994), the elevation of Cottonwood Seep (5234 ft amsl) is within 5 to 15 feet of the elevation of the contact between the Brushy Basin Member and the underlying Westwater Canyon Member (5220 to 5230 ft amsl).

b) The flow at Cottonwood Seep exceeds the flow in the perched zone in the area southwest of the tailings cells by several orders of magnitude. Flows at Cottonwood Seep are also relatively large compared to seeps and springs known to originate from the perched zone, consistent with a primary source other than perched water.

c) There is no evidence to establish a direct hydraulic connection between the perched zone and Cottonwood Seep. Cottonwood Seep is located more than 1,500 ft west of the termination of the Burro Canyon Formation which hosts the perched water zone. Examination of the area between Cottonwood Seep and mesa rim (the edge of the perched zone) reveals that the upper portion of the Brushy Basin Member appears dry and no previously undiscovered seeps originating from the Burro Canyon Formation near Cottonwood Seep were identified.

Because the results of the southwest area investigation do not provide evidence that Cottonwood Seep is hydraulically connected to the perched water system at the site, and because the perched zone near Cottonwood Seep is inadequate as a primary supply, the primary source (or sources) of water to Cottonwood Seep must lie elsewhere. The primary source(s) must be significant to supply consistent flows at rates between 1 and 10 gpm. By contrast, flows at Ruin Spring (estimated at less than about $^1/_2$ gpm, consistent with Dames and Moore, 1978) are lower than at Cottonwood Seep (between 1 and 10 gpm), and flows at Westwater Seep are too small to measure. Westwater Seep generally consists of a damp spot that can be sampled only by digging a hole and waiting for enough water to seep in for sample collection (see Figures 16 and 17 taken from HGC, 2010b).

Although no evidence of a direct hydraulic connection between the perched zone and Cottonwood Seep was provided by the investigation, the possibility of a hypothetical, as yet unknown, connection was postulated for the purpose of calculating a travel time from the tailngs cells to the western edge of the perched zone (near DR-8), and thence along a potential pathway

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to Cottonwood Seep. The travel time from the tailings cells to DR-8 was calculated as approximately 15,850 years. Should a potential pathline such as that shown in Figure 15 exist, the total time needed to travel from the tailings cells to Cottonwood Seep is expected to be significantly larger than 15,850 years.

4.3 Potential Dilution of Perched Water Resulting From Local Recharge of the Dakota and Burro Canyon Near Seeps and Springs

As discussed in Section 3, the rate of flow in the perched water zone in the southwest area of the site is small and a contribution from local recharge is needed to explain many areas of higher saturated thickness near sinks such as Westwater Seep and Ruin Spring that are downgradient of areas of low saturated thickness. The presence of local recharge is expected to affect the water quality of seeps and springs and has the potential to dilute any dissolved constituents that may migrate from upgradient areas.

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5. CONCLUSIONS

As per Part 1.H.6 (a) through (d) of the Permit, the southwest area investigation included the drilling and logging of 22 borings in the southwest portion of the site, completion of 18 of the borings as piezometers, hydraulic testing of the piezometers having at least 5 feet of water in the casings, water level monitoring, and additional examination of the area near Cottonwood Seep. Water level data obtained from the borings and piezometers (including dry borings) yielded data that satisfy Part 1.H.6 (b) and (c) of the Permit.

Interpretation of well survey, lithologic, water level, and hydraulic test data provided in Tables 1 through 4, Figures 2 through 14, and Appendices A through D satisfy Part 1.H.6 (e) items 1 through 6 of the Permit. Specifically, Appendices A and B satisfy item 1; Figures 5, 6, 7, 14, and 15 satisfy item 2; Figures 4 and 11 satisfy item 3; Figures 7 through 11 satisfy item 4; Figures 12 and 13 satisfy item 5; and Tables 2, 3, and 4 satisfy item 6. Figure 15 and Table 5 support perched water travel time calculations satisfying Part 1.H.6 © of the Permit.

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The results of the investigation are substantially consistent with and build upon the results and conclusions presented in HGC (2010b). The results of the investigation show that permeabilities in the southwest portion of the site are on average lower than previously estimated, and provide no evidence for a direct hydraulic connection between the perched water zone and Cottonwood Seep. The hydraulic test and water level data also demonstrate that the perched zone southwest of Cell 4B is inadequate as a primary supply to Cottonwood Seep by several orders of magnitude and that that the primary source of Cottonwood Seep lies elsewhere. However, a hypothetical connection between the perched zone near piezometer DR-8 and Cottonwood Seep is postulated for the purposes of calculating perched water travel times and to allow for the possibility that an as yet unidentified connection may exist

Important results of the southwest area investigation are:

a) The Brushy Basin Member erosional paleosurface in the southwest area of the Mill site is dominated by a paleoridge extending from beneath Cell 4B to abandoned boring DR-18 (Figures 4 and 11). The paleoridge is flanked to the west by a north-south trending paleovalley oriented roughly parallel to the western mesa rim (Figure 11).

b) The southwest area of the Mill site is characterized by generally low saturated thicknesses, low permeabilities, and relatively shallow hydraulic gradients. This is illustrated in Table 3 and Figures 5 through 13.

c) The paleotopography of the Brushy Basin Member erosional surface has a greater influence on perched water flow in the southwest portion of the site than other areas

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because of the low saturated thicknesses and dry areas associated with the paleoridge (Figure 14).

d) The low transmissivities implied by the low permeabilities and low saturated thicknesses combined with the shallow hydraulic gradients imply low rates of perched water flow in the southwest portion of the site. Calculated average pore velocities along Pathlines 1, 3, and 4 (Figure 15) from tailings cells to known discharge points Westwater Seep and Ruin Spring range from 0.60 ft/yr to 0.91 ft/yr, and travel times from 3,010 to 19,650 years based on first quarter, 2012 water level data.

e) The estimated travel time from the tailings cells to the vicinity of DR-8 (Path 2) is approximately 15,850 years based on first quarter, 2012 water level data and a calculated pore velocity of 0.26 ft/yr. Assuming a hypothetical pathway to Cottonwood Seep, the time to travel along Path 2 and thence along the potential pathway from the edge of Path 2 to Cottonwood Seep (which adds approximately 2,150 horizontal feet) is expected to be significantly greater than 15,850 years.

f) Brushy Basin Member paleotopography influences the locations of Westwater Seep and Ruin Spring; both are located in paleovalleys within the Brushy Basin Member paleosurface (Figure 11).

g) Local recharge is needed to explain areas of relatively large saturated thickness that supply Westwater Seep and Ruin Spring, because lateral flow into these areas from upgradient low saturated thickness portions of the perched zone is inadequate. The calculated perched zone recharge rate in the approximate 175 acre area southwest of Westwater Seep (near DR-2 and DR-5) is 0.0011 in/yr.

h) The perched water system in the southwestern portion of the site is inadequate as the primary supply to Cottonwood Seep by several orders of magnitude. Therefore the primary source(s) of Cottonwood Seep must lie elsewhere.

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7. LIMITATIONS STATEMENT

The opinions and recommendations presented in this report are based upon the scope of services and information obtained through the performance of the services, as agreed upon by HGC and the party for whom this report was originally prepared. Results of any investigations, tests, or findings presented in this report apply solely to conditions existing at the time HGC's investigative work was performed and are inherently based on and limited to the available data and the extent of the investigation activities. No representation, warranty, or guarantee, express or implied, is intended or given. HGC makes no representation as to the accuracy or completeness of any information provided by other parties not under contract to HGC to the extent that HGC relied upon that information. This report is expressly for the sole and exclusive use of the party for whom this report was originally prepared and for the particular purpose that it was intended. Reuse of this report, or any portion thereof, for other than its intended purpose, or if modified, or if used by third parties, shall be at the sole risk of the user.

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TABLES

FIGURES

APPENDIX A

AS-BUILT PIEZOMETER CONSTRUCTION DIAGRAMS

APPENDIX B

LITHOLOGIC LOGS FOR DR-SERIES PIEZOMETERS

APPENDIX C

PLOTS OF RAW AND CORRECTED DISPLACEMENTS FOR SELECTED PIEZOMETERS AND DISPLACEMENT DATA USED IN THE AQTESOLVE ANALYSIS

APPENDIX D

SLUG TEST ANALYSIS PLOTS

APPENDIX E

TOPOGRAPHIC AND GEOLOGIC MAPS

SECOND REVISION
HYDROGEOLOGY OF THE PERCHED GROUNDWATER ZONE IN THE AREA SOUTHWEST OF THE TAILINGS CELLS WHITE MESA URANIUM MILL SITE

BLANDING, UTAH

January 12, 2012 | Revised August 3, 2012;
Second Revision November 7, 2012

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Environmental Science & Technology

SECOND REVISION
HYDROGEOLOGY OF THE
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Second Revision November 7, 2012

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLES

FIGURES

TABLE OF CONTENTS (Continued)

APPENDICES

1. INTRODUCTION

In response to Part 1.H.6 of the amended Utah Department of Environmental Quality (UDEQ) Ground Water Quality Discharge Permit UGW370004 (the Permit), this report discusses the investigation of the hydrogeology of the perched groundwater zone southwest of the tailings cells at the White Mesa Uranium Mill, (the Mill or the site) located south of Blanding, Utah. The investigation of the area southwest of the tailings cells was first presented in Hydro Geo Chem [HGC] (2012a). A revised version of HGC (2012a) was prepared based on UDEQ comments [HGC (2012b)]. This report is a revised version of HGC (2012b) and incorporates data collected during hydraulic retesting of piezometer DR-8 during October, 2012. Installation and testing of DR-series piezometers will be discussed in Section 2. Figure 1 shows the locations of the investigation area, perched monitoring wells at the site, and seeps and springs along the margins of White Mesa.

Specifically, UDEQ requests the following in Part I.H.6 of the Permit:

Detailed Southwest Hydrogeologic Investigation and Report - the purpose of this investigation is to define, demonstrate, and characterize: 1) hydraulic connection and local groundwater flow directions between the area near Tailings Ce114B, and the western margin of White Mesa, including Westwater and Cottonwood Seeps, and Ruin Spring, and 2) the full physical extent of unsaturated area between former well MW-16, MW-33 and the western margin of White Mesa, as defined above. In preparation of this report, the Permittee shall:

a) *Install multiple borings and/or monitoring wells to completely enclose and define both: 1) the subsurface structural high area of the upper Brushy Basin Shale Member geologic contact and 2) the horizontal limits of saturation in the Burro Canyon Formation. Said study shall include, but is not limited to a subsurface area between Tailings Cell 4B, and the Westwater and Cottonwood Seeps, and Ruin Spring. At a minimum the characterization/definition of said subsurface area shall be based on:*

    1) *Dry wells or piezometers, completed down to a depth equal to or below the upper geologic contact of the Brushy Basin Shale Member,*

    2) *Piezometers or wells that intercept the shallow aquifer and encounter a saturation thickness of 5-feet or more. Said wells and piezometers shall have a minimum inside diameter of 3 inches. The Permittee shall complete hydraulic testing of all such wells and piezometers in accordance with Part I.F.6(c) of this Permit.*

b) *Demonstrate the full geologic and physical extent of the apparent unsaturated structural high between Tailings Cell 4B and the western margin of White Mesa, including Westwater and Cottonwood Seeps and Ruin Spring.*

c) *Demonstrate the location and direction of all groundwater flow paths between Tailings Cell 4B and nearby Westwater and Cottonwood Seeps and Ruin Spring. Determine average linear groundwater velocity to said groundwater discharge locations.*

d) *Perform geologic logging of all borings/wells, and submit geologic logs performed and certified by a Utah licensed Professional Geologist.*

e) *Submit the investigation report for Executive Secretary review and approval on or before January l3, 2012. This report shall be certified by a Utah Licensed Professional Engineer or Geologist and will include but is not limited to:*

   1) *Geologic logs and well As-built diagrams that comply with the requirements of Part I.F.6.*

   2) *A revised equipotential map to describe both the physical extent of the dry zone and all groundwater flow directions near Tailings Cell 4B and Westwater and Cottonwood Seeps, and Ruin Spring. Said map shal1 demonstrate flowpaths (streamtubes) to all respective groundwater discharge locations at the western margin of White Mesa.*

   3) *A revised structural contour map for the upper Brushy Basin Shale for the facility and physical extent of White Mesa.*

   4) *A revised saturation thickness map based on contemporaneous groundwater head data for the Burro Canyon aquifer for the facility and physical extent of White Mesa.*

   5) *Appropriate geologic and hydrogeologic maps and cross-sections (to scale).*

   6) *Results and interpretation of aquifer permeability testing as per Part I.F.6(c) of this Permit.*

Section 2 discusses the southwest area investigation as per Part 1.H.6 items (a) and (d). Section 3 provides an overview of site hydrogeology, an update of site hydrogeology based on the results of the southwest area investigation, and seep and spring hydrogeology in relation to the perched water system in the southwest area of the site. Section 4 discusses the implications of the results with regard to seeps and springs in the southwest portion of the site. Sections 3 and 4 satisfy the elements of Part 1.H.6 items (b) and (c) and item (e).

2. SOUTHWEST AREA INVESTIGATION

The southwest area investigation included the drilling and logging of 22 borings (referred to as the DR-series borings) in the southwest portion of the site, completion of 18 of the borings as piezometers, hydraulic testing of the piezometers having at least 5 feet of water in the casings, water level monitoring, and additional examination of the area near Cottonwood Seep. Details of the investigation are provided in Sections 2.1 through 2.4. The results of the investigation show that permeabilities in the southwest portion of the site are on average lower than previously estimated, and provide no evidence for a direct hydraulic connection between the perched water zone and Cottonwood Seep. As discussed in Section 3, the hydraulic test and water level data also demonstrate that the perched zone southwest of Cell 4B is inadequate as a primary supply to Cottonwood Seep by several orders of magnitude. As will also be discussed in Section 3, a hypothetical connection between the perched zone near piezometer DR-8 and Cottonwood Seep is postulated for the purposes of calculating perched water travel times and to allow for the possibility that an as yet unidentified connection may exist.

2.1 Rationale for Locating Piezometers

Piezometers were located to satisfy the following goals specified in Part 1.H.6 of the Permit:

a) Investigate the extent of the unsaturated Brushy Basin Member paleoridge between tailings Cell 4B and the western margin of White Mesa and associated seeps and springs, and

b) Investigate perched groundwater flow paths and saturated thicknesses between Cell 4B and the western margin of White Mesa and associated seeps and springs

Twenty two boring locations were sited in the southwest area including five optional borings as shown in Figure 1. The five optional borings were installed based on data collected during drilling and subsequent water level monitoring of the remainder of the borings.

2.2 DR-Series Piezometer Installation and Testing

DR-series piezometers were installed, monitored, and tested as described in Sections 2.2.1 through 2.2.4 and Section 2.3. The installation, logging, and testing were conducted in accordance with Part 1.H.6 items (a) and (d) of the Permit.

2.2.1 Installation

Installation procedures were similar to those used previously at the site for the construction of perched zone monitoring wells (Hydro Geo Chem, Inc. [HGC], 2005) except that smaller diameter borings were drilled to accommodate smaller (3-inch rather than 4-inch) diameter casings. Drilling and construction were performed by Bayles Exploration, Inc., and borings logged by Mr. Lawrence Casebolt under contract to Denison Mines (USA) Corporation (Denison). Mr. Stewart Smith of HGC was onsite during a portion of the drilling and well construction activities. As-built diagrams for the well constructions, based primarily on information provided by Bayles Exploration, are shown in Appendix A as per Part 1.H.6 (e) item 1 of the Permit. The depths to water shown in the as-built diagrams are based on water level measurements taken during the third quarter, 2011. Surveyed land surface and top-of-casing elevations are provided on the diagrams. Table 1 provides surveyed position coordinates and elevations for piezometers.

2.2.2 Drilling and Logging Procedures

A 6 ¾ inch diameter tricone bit was used to drill a boring of sufficient diameter to install 6-inch-diameter, Schedule 40 polyvinyl chloride (PVC) surface (or conductor) casing. The surface casing extended to a depth of approximately five feet below land surface. Once each surface casing was in place, the boreholes were drilled by air rotary adding water and/or foam only when needed to maintain circulation. Boreholes were drilled using 5 $^{5}/_{8}$ to 6 $^{1}/_{8}$ inch diameter tricone bits. Each borehole penetrated the Dakota Sandstone and the Burro Canyon Formation and terminated in the Brushy Basin Member of the Morrison Formation.

Drill cutting samples used for lithologic logging were collected at 2½-foot depth intervals and placed in labeled, zip-sealed plastic bags and labeled plastic cuttings storage boxes. Copies of the lithologic logs submitted by Mr. Casebolt are provided in Appendix B (as per Part 1.H.6 (e) item (1) of the Permit).

2.2.3 Water Level Monitoring

Prior to completion as piezometers, open borings were protected by capping the surface casings with 6-inch diameter PVC caps, and water levels periodically taken over approximately 1 month. Based on the data collected, decisions were made whether to complete each boring as a piezometer or to abandon the boring, as discussed in Section 2.2.4.

2.2.4 Piezometer Completion and Abandonment of Non-Completed Borings

Completed piezometers were constructed using 3-inch diameter, Schedule 40, flush-threaded PVC casing and 0.02-slot, factory-slotted PVC screen. Colorado Silica Sand was used as a filter pack and installed to a depth approximately three to six feet above the screened interval of each piezometer. The annular space above the filter pack was then sealed with approximately three to eight feet of hydrated bentonite chips and grouted to the surface using Portland cement.

DR-2 was abandoned as it was deemed unnecessary to meet the water level monitoring objectives of this investigation (other than the water level monitoring conducted prior to abandonment) and DR-5 provided similar information. Water level monitoring established that the saturated thicknesses at DR-2 and DR-5 were similar, that the area appears to be a groundwater divide for perched water, and that flow appears to be primarily either north-northeast to known discharge point Westwater Seep or south toward known discharge point Ruin Spring.

DR-16 was abandoned as unnecessary due to the proximity of MW-3, MW-20, and DR-15. Only DR-15 was considered necessary to establish the boundary of the dry zone to the west. Water level monitoring of DR-16 confirmed that a continuous saturated zone exists between MW-3 and MW-20 but the boring did not add significant information regarding hydraulic conditions in the area.

DR-18 was abandoned because it remained dry. DR-18 helped define the southern extension of the Brushy basin Member paleoridge and dry area intercepted by MW-21.

DR-25 was abandoned as unnecessary because the boring established that significant saturated thickness exists immediately upgradient of Ruin Spring, but did not add significant information regarding hydraulic conditions in the area.

2.3 Hydraulic Testing and Results

Hydraulic testing (as per Part 1.H.6 (a) item (2) of the Permit) consisted of slug tests conducted by HGC personnel using a methodology similar to that described in HGC (2005). This is substantially the same methodology used for hydraulic testing of all monitoring wells installed since 2005. All DR-series piezometers with at least 5 feet of water in the casings were tested. The saturated thickness is defined as the difference between the water level elevation and the Brushy Basin Member contact elevation which is not necessarily the same as the water column in the piezometers, because the casings generally extend below the contact. The saturated thickness at DR-12 was greater than 5 feet but the water column in the well was not sufficient for testing because of about 3 feet of sediment in the bottom of the casing.

Testing of all DR-series piezometers was performed during October 2011. The original test at DR-8 was strongly influenced by barometric pressure changes. UDEQ expressed concern over the factor of three difference between the hydraulic conductivity estimated from the hand-collected data (1×10^{-7} cm/s) and the hydraulic conductivity estimated from the automatically logged data (3.4×10^{-8} cm/s) using the KGS slug test solution (Hyder et al., 1994). UDEQ considered there to be sufficient uncertainty in the results to warrant a retest. Retesting of piezometer DR-8 was performed during October 2012. The hydraulic test results reported for DR-8 in this revision are based on retesting of the well in October 2012.

The results of the testing (Section 2.3.2) indicate that hydraulic conductivities in the southwest portion of the site are lower than previously estimated indicating perched water moves more slowly than previous calculations would indicate. The hydraulic conductivity estimates calculated for piezometer DR-8 (located at the western edge of the mesa east of Cottonwood Seep as shown in Figure 1) are among the lowest measured on site.

2.3.1 October 2011 Testing Procedures

The slugs used for the October 2011 tests consisted of a sealed, pea-gravel-filled, schedule 80 PVC pipe approximately 4 feet long as described in HGC (2002), and a slug of the same diameter having a length of 3 feet. The 4-foot slug displaced approximately 0.47 gallons of water and the 3-foot slug approximately 0.35 gallons.

Three 0-30 pounds per square inch absolute (psia) Level Troll™ data loggers were used for the tests. One Level Troll was used to measure barometric pressure and was placed in a protected environment for the duration of the testing. The other Level Trolls were deployed below the static water columns in the tested wells and used to measure the changes in water levels during the tests. Automatically logged water level data were collected at 3-second intervals and barometric data at 5-minute intervals.

Prior to each test, the static water level was measured by hand using an electric water level meter. The data logger was then lowered to a depth of approximately one foot above the base of the well casing, and background pressure readings were collected for approximately 30 minutes prior to beginning each test. The purpose of collecting the background data was to allow correction for any detected water level trends.

Once background data were collected, the slug and electric water level meter sensor were suspended in the tested well just above the static water level. Each test commenced by lowering the slug to a depth of approximately 1 to 2 feet below the static water level over a period of a few seconds and taking water level readings by hand as soon as possible afterwards. Hand-collected data were obtained more frequently in the first few minutes when water levels were changing rapidly, then less frequently as the rate of water level change diminished. Upon completion of each test, automatically logged data were checked and backed up on the hard drive of a laptop computer.

2.3.2 October 2012 Testing Procedures (DR-8 Retest)

The DR-8 retesting procedure included collection and analysis of both automatically logged data and data collected by hand using an electric water level meter, in substantially the same fashion as for the October 2011 tests. A 0-30 psia Level Troll™ pressure transducer was used to collect the automatically logged data and a 0-30 psia BaroTroll™ was used to collect atmospheric pressure data

The primary differences between the original test and the retest are that 1) a smaller slug was used (approximately 0.23 gallons rather than approximately 0.47 gallons) to eliminate any possibility that the slug could interfere with the data logger suspended near the base of the water column in the well, 2) a 6-second (rather than 3-second) data collection interval was used for automatically logged water level data, and 3) a 1-minute (rather than 5-minute) interval was used to collect barometric data. The automatically logged data were corrected for changes in atmospheric pressure prior to analysis and processed in substantially the same fashion as for the October 2011 tests.

2.3.3 Hydraulic Test Data Analysis

Data from the tests were analyzed using AQTESOLVE™ (HydroSOLVE, 2000), a computer program developed and marketed by HydroSOLVE, Inc. In each test, the maximum measured rise in water level was reasonable considering the slug volume, the volume in the 3-inch-diameter casing, and the volume in the annular space between the casing and the bore.

In preparing the October 2011 automatically logged data for analysis, the total number of records was reduced. In general, all data collected in the first 30 seconds were retained, then every 2nd, then 3rd, then 4th, etc. record was retained for analysis. For example, if the first 10 records were retained (30 seconds of data at 3-second intervals), the next records to be retained would be the 12th, the 15th, the 19th, the 24th, etc. A similar process was used for the October 2012 data collected during retesting of DR-8. The primary difference was that all automatically logged data collected during the first 60 seconds (rather than 30 seconds) were retained before reducing the number of data points as described above.

Data were analyzed using two solution methods: the KGS unconfined method (Hyder et al., 1994) and the Bouwer-Rice unconfined method (Bouwer and Rice, 1976). When filter pack porosities were required by the analytical method, a value of 30 percent was used. The saturated thickness was taken to be the difference between the depth of the static water level measured just prior to the test and the depth to the Brushy Basin Member contact as defined in the drilling logs (Appendix B). The static water levels were below the tops of the screened intervals and the saturated thicknesses were taken to be the effective screen lengths. Short-duration tests generally did not require correction for changes in barometric pressure. Some of the longer-duration tests, specifically tests at DR-8, DR-10, DR-13, and DR-14, did require corrections to be applied as shown in Appendix C. Appendix C also provides displacement data for each test.

The KGS solution allows estimation of both specific storage and hydraulic conductivity, while the Bouwer-Rice solution allows estimation of only the hydraulic conductivity. The Bouwer-Rice solution is valid only for any straight-line portions of the data that result when the log of displacement is plotted against time and is insensitive to both storage and the specified initial water level rise. Typically, only the later-time data are interpretable using Bouwer-Rice.

The KGS solution generally allows a fit to both early and late time data and is sensitive to storage and the specified initial water level rise. Both solutions were used for comparison. Automatically logged and hand-collected data were analyzed separately using both solution methods. The hand-collected data, therefore, served as an independent data set and a check on the accuracy of the automatically logged data.

Table 2 summarizes parameters for each test. The results of the analyses are provided in Table 3 and Appendix D (as per Part 1.H.6 (e) item (6) of the Permit). Appendix D contains plots generated by AQTESOLVE™ that show the quality of fit between measured and simulated displacements, and reproduce the parameters used in each solution. Estimates of hydraulic conductivity range from 2.5×10^{-8} centimeters per second (cm/s) to 4.5×10^{-4} cm/s using automatically logged data, and from 4.5×10^{-8} cm/s to 4.7×10^{-4} cm/s using hand-collected data.

Agreement between analyses using the KGS and Bouwer-Rice solutions, and between automatically-logged and hand-collected data, was generally good. Except for DR-8 all KGS and Bouwer-Rice estimates using automatically logged data were within a factor of two, and the majority were within 30%. KGS and Bouwer-Rice estimates using hand-collected data were within a factor of three (except at DR-8), and the majority were also within 30%. Agreement between KGS solution estimates using automatically logged and hand-collected data were within a factor of two except at DR-10 where the estimates were within a factor of three.

At DR-8, the KGS solution estimates obtained from automatically logged and hand collected data are within a factor of two, a substantial improvement over the original test. The primary reason for the improvement is that the influence of barometric pressure change was smaller during the retest than during the original test. However, the KGS and Bouwer-Rice estimates for the DR-8 retest data differ by approximately an order of magnitude.

Differences between hydraulic conductivity estimates obtained using the KGS and Bouwer-Rice solutions are common and expected because of the differences between the two solution methods. The KGS solution accounts for non-steady flow and aquifer storage while the Bouwer-Rice solution does not. Accounting for non-steady flow and storage allows a fit to the entire data set using KGS rather than typically only the later-time portion of the data using Bouwer-Rice.

Because the KGS solution accounts for non-steady flow and aquifer storage it is considered a more accurate solution than Bouwer-Rice. For this reason, hydraulic conductivity estimates obtained from the KGS solution are used in the groundwater flow and pore velocity calculations presented in Sections 3.3 and 3.4.

2.4 Examination of the Area Near Cottonwood Seep

HGC investigated the area near Cottonwood Seep in July 2010 as discussed in HGC (2010b). Additional investigation of the area between Cottonwood Seep and the mesa rim to the east and northeast (where the perched zone hosted by the Burro Canyon Formation terminates) was conducted by HGC personnel at the time of the hydraulic testing (in support of Part 1.H.6 item (c) of the Permit). The purpose of the examination was to determine if any previously unidentified hydraulic connection between Cottonwood Seep and the Burro Canyon Formation may exist. In particular, the ground was examined for any previously unidentified seeps originating from the Burro Canyon Formation near the mesa rim, or any areas of enhanced vegetation that would indicate surface or near-surface waters (such as cottonwood trees associated with all other seeps and springs) that may potentially establish a connection between the perched zone and Cottonwood Seep.

Examination of the area provided no evidence to establish a hydraulic connection. The absence of any visible seeps or anomalous vegetation in the Brushy Basin Member northeast and east of Cottonwood Seep is consistent with dry conditions within the upper portion of the Brushy Basin above Cottonwood Seep. As will be discussed in Section 3, a hypothetical connection between the perched zone near DR-8 and Cottonwood Seep is postulated for the purposes of calculating perched water travel times and to allow for the possibility that an as yet unidentified connection may exist.

3. HYDROGEOLOGY OF THE AREA SOUTHWEST OF THE TAILINGS CELLS

The site hydrogeology has been described previously in HGC (2010b), HGC (2009b), HGC (2007) and TITAN (1994).The results of these previous investigations are summarized in Section 3.1. Section 3.2 updates the site hydrogeology with the results of the present investigation, Section 3.3 provides calculations of perched water travel times from tailings cells to Westwater Seep, piezometer DR-8 (located near the mesa rim above Cottonwood Seep), and Ruin Spring, and Section 3.4 discusses water balance calculations in the southwest portion of the site. The data show that saturated thicknesses and rates of perched water movement are low in the southwest portion of the site, and local recharge likely contributes to flow at Westwater Seep and Ruin Spring.

Perched water travel times from Cell 4B to DR-8 are calculated rather than travel times to Cottonwood Seep because there is no evidence to establish a hydraulic connection between Cottonwood Seep and the perched water system. Furthermore, the hydraulic test and water level data demonstrate that the perched zone southwest of Cell 4B is inadequate as a primary supply to Cottonwood Seep by several orders of magnitude and that the primary source(s) for Cottonwood Seep lie(s) elsewhere. However, a hypothetical connection between the perched zone near piezometer DR-8 and Cottonwood Seep is postulated in Section 3.3 for the purposes of calculating perched water travel times and to allow for the possibility that an as yet unidentified connection may exist.

3.1 Background and Overview

Section 3.1.1 provides a brief summary of site hydrogeology taken primarily from HGC (2010b) and updated with third quarter, 2011 water level data. Section 3.1.2 discusses key findings of HGC (2010b) regarding the relationship between the perched water zone and seeps and springs that occur at the margins of White Mesa. Figure 1 shows site features, the locations of perched monitoring wells, and the locations of seeps and springs.

3.1.1 Summary

Perched groundwater at the site is hosted primarily by the Burro Canyon Formation, which consists of a relatively hard to hard, fine- to medium-grained sandstone containing siltstone, shale and conglomeratic materials. The Burro Canyon Formation is separated from the underlying regional Navajo/Entrada aquifer by approximately 1,000 to 1,100 feet of Morrison Formation and Summerville Formation materials having a low average vertical permeability. The Brushy Basin Member of the Morrison Formation is a bentonitic shale that lies immediately beneath the Burro Canyon Formation and forms the base of the perched water zone at the site. Figure 2 is a photograph of the contact between the Burro Canyon Formation and the underlying Brushy Basin Member taken from a location along highway 95 north of the Mill. This photograph illustrates the transition from the cliff-forming sandstone of the Burro Canyon Formation to the slope-forming Brushy Basin Member. Based on hydraulic tests at perched zone monitoring wells (prior to the present investigation), the hydraulic conductivity of the perched zone ranges from approximately 2×10^{-7} to 0.01 cm/s (HGC, 2009b).

Perched water flow is generally from northeast to southwest across the site. Beneath and south of the tailings cells, in the west central portion of the site, perched water flow is south-southwest to southwest. As the results of the present investigation will show, flow on the western margin of the mesa is also south, approximately parallel to the rim (where the Burro Canyon Formation is terminated by erosion). On the eastern side of the site perched water flow is also generally southerly. Because of mounding near wildlife ponds, flow direction ranges locally from westerly (west of the ponds) to easterly (east of the ponds). Perched water generally has a low quality, with total dissolved solids ranging from approximately 1,100 to 7,900 mg/L, and is used primarily for stock watering and irrigation north (upgradient) of the site.

As of the third quarter of 2011, depths to perched water range from approximately 17 to 18 feet near the wildlife ponds in the northeastern portion of the site to approximately 114 feet at the southwestern margin of tailings Cell #3. Saturated thicknesses range from approximately 92 feet near the wildlife ponds to less than 5 feet in the southwest portion of the site, downgradient of the tailings cells. A saturated thickness of approximately 2 feet occurs in well MW-34 along the south dike of new tailings Cell 4B, and the perched zone is apparently dry at MW-33 located at the southwest corner of Cell 4B. Although sustainable yields of as much as 4 gallons per minute (gpm) have been achieved in wells penetrating higher transmissivity zones, well yields are typically low ($<^1/_2$ gpm) due to the generally low permeability of the perched zone.

Hydraulic testing of perched zone wells prior to the present investigation yielded a hydraulic conductivity range of approximately 2×10^{-7} to 0.01 cm/s. In general, the highest permeabilities and well yields are in the area of the site immediately northeast and east (upgradient to cross gradient) of the tailings cells. A relatively continuous, higher permeability zone associated with a chloroform plume has been inferred to exist in this portion of the site (HGC, 2007). Analysis of drawdown data collected from this zone during long-term pumping of MW-4, TW4-19, and MW-26 (TW4-15) yielded estimates of hydraulic conductivity ranging from 4×10^{-5} to 1×10^{-3} cm/s.

Permeabilities downgradient of the tailings cells are generally low. Hydraulic tests conducted prior to the present investigation at wells located at the downgradient edge of the cells, and south and southwest of the cells, yielded geometric average hydraulic conductivities of 2.3×10^{-5} and 4.3×10^{-5} cm/s depending on the testing and analytical method. The low permeabilities and shallow hydraulic gradients downgradient of the tailings cells result in average perched groundwater pore velocity estimates that are among the lowest on site.

3.1.2 Seeps and Springs in Relation to Perched Zone Hydrogeology

Hydro Geo Chem (2010b) discusses the relationships between the perched water zone and seeps and springs at the margins of White Mesa (shown in Figure 1). Key findings of that report include the following:

a) Cottonwood Seep is located more than 1,500 feet west of the mesa rim in an area where the Dakota Sandstone and Burro Canyon Formation (which hosts the perched water system) are absent due to erosion. Cottonwood Seep occurs near a transition from slope-forming to bench-forming morphology (indicating a change in lithology). Cottonwood Seep (and 2nd Seep located immediately to the north) are interpreted to originate from coarser-grained materials within the lower portion of the Brushy Basin Member and are therefore not (directly) connected to the perched water system at the site.

b) Ruin Spring and Westwater Seep are interpreted to occur at the contact between the Burro Canyon Formation and the Brushy Basin Member. Corral Canyon Seep, Entrance Spring, and Corral Springs are interpreted to occur at elevations within the Burro Canyon Formation at their respective locations but above the contact with the Brushy Basin Member. All seeps and springs (except Cottonwood Seep which is located near the Brushy Basin Member/Westwater Canyon Member contact) are associated with conglomeratic portions of the Burro Canyon Formation. The more conglomeratic portions of the Burro Canyon Formation are likely to have higher permeabilities and the ability to transmit water more readily than finer-grained portions. This behavior is consistent with on-site drilling and hydraulic test data that associates higher permeability with the conglomeratic horizons detected east and northeast of the tailing cells

c) Only Ruin Spring appears to receive a predominant and relatively consistent proportion of its flow from perched water. Ruin Spring originates from conglomeratic Burro Canyon Formation sandstone where it contacts the underlying Brushy Basin Member, at an elevation above the alluvium in the associated drainage. Westwater Seep, which also originates at the contact between the Burro Canyon Formation and the Brushy Basin Member, likely receives a significant contribution from perched water. All seeps and springs other than Ruin Spring (and 2nd Seep just north of Cottonwood Seep) are located within alluvium occupying the basal portions of small drainages and canyons. The relative contribution of flow to these features from bedrock and from alluvium is indeterminate.

d) All seeps and springs are reported to have enhanced flow during wet periods. For seeps and springs associated with alluvium, this behavior is consistent with an alluvial contribution to flow. Enhanced flow during wet periods at Ruin Spring, which originates from bedrock above the level of the alluvium, likely results from direct recharge of Burro Canyon Formation and Dakota Sandstone outcropping near the mesa margin in the vicinity of Ruin Spring. This recharge would be expected to temporarily increase the flow at Ruin Spring (as well as other seeps and springs where associated bedrock is directly recharged) after precipitation events.

As discussed in item a), Cottonwood Seep was interpreted in HGC (2010b) to be associated with coarser-grained materials within the lower portion of the Brushy Basin Member. The justification for this interpretation is based primarily on 1) the rate of flow at Cottonwood Seep, which is estimated to be between 1 and 10 gpm (consistent with Dames and Moore, 1978), 2) the need for relatively permeable materials to transmit this rate of flow, and 3) the change in morphology near Cottonwood Seep indicating a change in lithology. The change in morphology from slope-former to bench-former just east of Cottonwood Seep can be seen in the topographic map included in Appendix E (Figure E.1) and the annotated photograph provided in Figure 3.

The upper portion of the Brushy Basin Member, which hydraulically isolates the perched zone from underlying materials, is composed primarily of bentonitic mudstone, claystone, and shale. The rate of flow at Cottonwood Seep is inconsistent with the materials found within the upper portion of the Brushy Basin but is consistent with coarser-grained materials expected either within the lower portion of the Brushy Basin Member or within the upper portion of the underlying Westwater Canyon (sandstone) Member. The relationship between Cottonwood Seep and lithology is shown on the geologic map provided in Appendix E (Figure E.2) and Figure 3.

As shown in Figure 3, Cottonwood Seep is located approximately 230 feet below the base of the perched zone defined by the contact between the cliff-forming Burro Canyon Formation and the underlying slope-forming Brushy Basin Member. The change in morphology from slope-former to bench-former occurs within the lower portion of the Brushy Basin Member (or the upper portion of the Westwater Canyon Member), between the termination of the perched zone at the mesa rim and Cottonwood Seep. The bench-like area hosting Cottonwood Seep begins at the change in morphology east of Cottonwood Seep and terminates west of Cottonwood Seep where a cliff-forming sandstone, interpreted to be within the Westwater Canyon Member, is exposed. The contact between the Westwater Canyon Member and the Brushy Basin Member is interpreted to be located between this sandstone outcrop and the change in morphology from slope-former to bench-former. This places Cottonwood Seep at the transition between the Brushy Basin Member and the underlying Westwater Canyon Member. This placement is consistent with lithologic cross-sections provided in TITAN (1994) which place the contact between the Brushy Basin Member and the Westwater Canyon Member at elevations between approximately 5,220 and 5,230 feet above mean sea level (ft amsl), within 5 to 15 feet of the elevation of Cottonwood Seep (5234 ft amsl).

The occurrence of coarser-grained materials within the lower portion of the Brushy Basin Member is discussed in Shawe (2005). The lower unit of the Brushy Basin Member is described as “mudstone layers which contain, near their base, lenses lithologically similar to sandstone of the Salt Wash Member, and near their top, conglomeratic sandstone lenses”. By contrast, the upper portion of the Brushy Basin Member is described by Shawe (2005) as “principally mudstone; it contains only minor amounts of sandstone, conglomeratic sandstone, and conglomerate as discontinuous lenses”.

The expectation of coarser-grained materials at Cottonwood Seep is also consistent with the transition from the Brushy Basin Member into the underlying Westwater Canyon Member. As discussed in Craig (1955), and Flesch (1974), The Westwater Canyon Member intertongues with the Brushy Basin Member. Craig (1955) states “The Westwater Canyon Member forms the lower portion of the upper part of the Morrison in northeastern Arizona, northwestern New Mexico, and places in southeastern Utah and southwestern Colorado near the Four Corners, and it intertongues and intergrades northward into the Brushy Basin Member”.

3.2 Incorporation of DR-series Data

DR-series water level, hydraulic test, and lithologic data were used in conjunction with existing data to provide a more comprehensive description of the perched zone hydrogeology as described in Sections 3.2.1 through 3.2.4.

3.2.1 Brushy Basin Member Contact Elevations

Figure 4 (as per Part 1.H.6 (e) item (3) of the Permit) is a contour map of the Burro Canyon Formation/Brushy Basin Member contact generated from perched well, piezometer, DR-series boring data and the locations and elevations of Westwater Seep and Ruin Spring. Figure 4 was generated based on data indicating that only Westwater Seep and Ruin Spring are located at the contact between the Burro Canyon Formation and the Brushy Basin Member (HGC, 2010b).

As discussed in Section 2, examination of the area near Cottonwood Seep in July 2010 and re-examination in October 2011 revealed no evidence for a hydraulic connection with the perched zone. The absence of any visible seeps or anomalous vegetation in the Brushy Basin Member east and northeast of Cottonwood Seep is consistent with dry conditions in the upper portion of the Brushy Basin Member.

3.2.2 Perched Water Elevations, Saturated Thicknesses and Depths to Water

In support of Part 1.H.6 (e) item (2) of the Permit, Figures 5, 6, and 7 are contour maps of perched water elevations generated from second and third quarters, 2011, and first quarter, 2012 water level data. Each contains perched well and piezometer water level data, and the elevations of all seeps and springs except Cottonwood Seep (for which there is no evidence to establish a connection to the perched water system and which is located near the Brushy Basin Member/Westwater Canyon Member contact, indicating that its elevation is not representative of the perched potentiometric surface). Fill-in contours between the 10-foot elevation contours are provided in the area immediately west-southwest of the tailings cells to allow detail in an area having relatively flat hydraulic gradients.

Figure 5 (second quarter, 2011 data) also contains data from DR-2, DR-16, DR-18, and DR-25 that were abandoned after the second quarter, 2011. Figures 5, 6, and 7 were generated assuming that each seep or spring (except Cottonwood Seep) is a known discharge point for perched water and that the elevation of the seep or spring is representative of the elevation of perched water at that location (HGC, 2010b). As per Part 1.H.6 (e) item (4) of the Permit, Figures 8, 9, and 10 show the saturated thicknesses of the perched zone based on second and third quarter, 2011, and first quarter, 2012 water level data. Differences between the second and third quarters are due primarily to the slow recovery of water levels in many DR-series borings (in particular DR-6, DR-8, and DR-12).

The dry areas shown in Figures 5 through 10 occur where the kriged contact between the Burro Canyon Formation and the Brushy Basin Member is higher in elevation than the kriged perched water elevation. The dry areas shown in these Figures encompass abandoned dry well MW-16, dry well MW-21, dry well MW-33, and abandoned dry boring DR-18. Dry areas in Figure 5 also encompass DR-6 and DR-12 which recovered slowly after drilling, but contained measurable water by the third quarter of 2011. The areas defined by the heavy yellow dashed contour lines have saturated thicknesses less than 5 feet. As shown in Figures 6, 7, 9 and 10, a large portion of the perched zone west and southwest (downgradient) of the tailings cells has a saturated thickness less than 5 feet as of (and subsequent to) the third quarter, 2011. An apparent perched water divide exists in the vicinity of DR-2 and DR-5 (Figures 5, 6 and 7). Perched water north of this apparent divide is expected to flow primarily northeast toward Westwater Seep and perched water south of this apparent divide is expected to flow primarily south toward Ruin Spring.

As per Part 1.H.6 (b) and (e) items (2), (3), and (4) of the Permit, Figure 11 shows the axes of paleoridges and paleovalleys in the Brushy Basin Member erosional paleosurface and posted third quarter, 2011 saturated thicknesses. Also shown is the region estimated to have saturated thicknesses greater than 10 feet. As indicated, paleoridges in the southwest area of the site are associated with dry areas and with areas with low saturated thicknesses; paleovalleys are associated with areas of higher saturated thicknesses. Westwater Seep and Ruin Spring are located in paleovalleys.

3.2.3 Interpretation of Cross-Sections

As per Part 1.H.6 (e) item (5) of the Permit, Figures 12 and 13 are cross-sections showing the hydrogeology of the perched zone in the area southwest of the tailings cells. The locations of the cross-sections are provided on Figure 1. Figure 12 provides east-west cross-sections (E-W and E2-W2) across the area immediately west and southwest of Cell 4B. Figure 13 is a north-south cross-section (N-S) from the south dike of Cell 4B to Ruin Spring. Cross-sections E-W and N-S are oriented approximately parallel to perched water flow and E2-W2 is oriented roughly perpendicular to perched water flow. Except for abandoned DR-series borings, water levels in the cross sections are based on third quarter, 2011 data. Water levels for abandoned borings are from the second quarter, 2011. Water levels did not change significantly between the third quarter of 2011 and the first quarter of 2012.

As shown in cross-section E-W of Figure 12 (and in Figures 8, 9 and 10) the saturated thickness of the perched zone in the southwest area of the site varies from negligible to more than 20 feet. The variable saturated thickness has implications regarding the flow of perched water to known discharge points Westwater Seep and Ruin Spring. Perched water moving downgradient from the area of the tailings cells westward toward abandoned boring DR-2 must pass through a region of low saturated thickness occupied by DR-6 and DR-7 (Figure 12). As will be discussed in more detail in Section 3.4, this implies (by Darcy's Law) that some downgradient areas having larger saturated thicknesses must receive local recharge from precipitation because the water supplied by lateral perched flow is inadequate to maintain the large saturated thicknesses in areas near sinks such as Westwater Seep and Ruin Spring.

Two areas of relatively large saturated thickness that are downgradient of areas of small saturated thickness are of particular interest: the area near DR-2 and DR-5 located west of the area near DR-6 and DR-7 as shown in Figure 12 (cross-section E-W), and the area near DR-25 located south of the area near MW-20 as shown in Figure 13 (cross-section N-S). Each of the above areas of larger saturated thickness is downgradient of the corresponding area of small saturated thickness, and each downgradient area of larger saturated thickness is near a perched water sink. The primary known sinks downgradient of DR-2 and DR-5 are Westwater Seep to the northeast and the paleovalley leading south to Ruin Spring (Figure 11). The primary sink near DR-25 is Ruin Spring. Lateral flow from areas of larger saturated thickness that may exist to the east of cross-section N-S may supply the water needed to maintain the relatively large saturated thickness near DR-25. However, the reported temporary increases in flow from Ruin Spring (and Westwater Seep) after precipitation events (HGC, 2010b) are difficult to explain unless flow is temporarily enhanced by local recharge.

As discussed in HGC (2010b), enhanced local recharge is likely near the mesa margins where weathered Dakota Sandstone and Burro Canyon Formation are exposed by erosion (Figure E.2, Appendix E). Logs at DR-2 and DR-5 show only a few feet of unconsolidated material above the Dakota Sandstone and visual inspection of the area of the mesa near DR-2 and DR-5 shows that weathered Dakota is often exposed (consistent with the geology presented in Dames and Moore (1978). Due to the thin veneer of alluvium overlying the Dakota Sandstone, and thin or absent Mancos Shale, recharge near DR-2 and DR-5 (cross-section E-W, Figure 12) will be facilitated. Similarly, in the area near abandoned boring DR-25 and Ruin Spring, recharge will be facilitated by the thinness or absence of the Mancos Shale and the surface exposure of the Dakota Sandstone and Burro Canyon Formation between DR-25 and Ruin Spring (Figure 13).

3.2.4 Perched Water Flow Directions

As per Part 1.H.6 (e) item (2) of the permit, Figure 14 is a water level contour map showing estimated pathlines from various locations on the west or south (downgradient) dikes of the tailings cells toward known discharge points Westwater Seep and Ruin Spring. These pathlines show the primary expected directions of perched water flow. As indicated, perched water passing beneath the west dike of Cell 4B has the potential to travel to either of known discharge points Westwater Seep or to Ruin Spring because of an apparent groundwater divide in the vicinity of DR-2 and DR-5. Perched water north of this apparent divide is expected to flow primarily northeast to Westwater Seep and perched water south of this apparent divide is expected to flow primarily south toward Ruin Spring. The presence of this apparent divide is consistent with enhanced local recharge.

The path to Ruin Spring from the area south of the apparent divide is sub-parallel to the western rim of the mesa. The path is generally along a paleovalley between the mesa rim and the dry portion of the Brushy Basin Member paleoridge defined by MW-21 and abandoned boring DR-18. Perched water passing beneath the south dike of Cell 4B is expected to travel south-southwest to Ruin Spring, to the east of the dry paleoridge defined by MW-21 and abandoned boring DR-18.

Overall, the data suggest that flow in the southwest portion of the site is influenced by paleotopography to a greater extent than in other areas of the site due to the prevalence of small saturated thicknesses.

As discussed in Section 3.1.2, there is no evidence to hydraulically connect Cottonwood Seep to the perched water system, therefore no primary flow pathway depicted in Figure 14 leads to Cottonwood Seep. Section 3.3 posits a potential pathway that may hypothetically exist between the perched zone near DR-8 and Cottonwood Seep for purposes of travel time calculations, and to allow for the possibility that an as yet unidentified pathway may exist.

3.3 Perched Water Travel Times

As per Part 1.H.6 item (c) of the Permit, perched water pore velocities and travel times along selected paths between the tailings cells and perched water discharge points were calculated for the pathlines shown in Figure 15 using Darcy's Law. The calculated pore velocities and travel times are representative of the movement of a conservative solute assuming no hydrodynamic dispersion. Calculated perched water travel times in the area southwest (downgradient) of the tailings cells are generally longer than previously estimated and pore velocities generally lower than previously estimated.

The Figure 15 pathlines were selected as the shortest Figure 14 paths from the tailings cells to a) Westwater Seep (Path 1), b) Ruin Spring via the west side of the Brushy Basin paleoridge (Path 3), and c) Ruin Spring via the east side of the Brushy Basin paleoridge (Path 4). A pathline from the tailngs cells to the vicinity of DR-8 (Path 2) is also shown in Figure 15. From the vicinity of DR-8 perched water is expected to flow primarily south (within a paleovalley) toward Ruin Spring. However, a potential pathline from the vicinity of DR-8 is also shown in Figure 15 that posits a hypothetical connection between the perched zone and Cottonwood Seep. Path 2 provides the shortest pathline between the tailings cells and the western edge of the perched zone near DR-8, and the potential path provides the shortest hypothetical connection between the western edge of Path 2 and Cottonwood Seep.

Hydraulic conductivities used in the calculations are from TITAN (1994), HGC (2002), HGC (2005), HGC (2009a), HGC (2010a), HGC (2011), and Table 3. Data are summarized in Table 4. Hydraulic conductivity estimates are based on automatically logged slug test data analyzed using the KGS solution method, except for MW-12, MW-14, and MW-15. Hydraulic conductivity estimates at MW-12, MW-14, and MW-15 are based on pumping test analyses reported in TITAN (1994). Pore velocity calculations for each pathline are summarized in Table 5.

Path 1 is approximately 2,200 feet long with an average hydraulic gradient of 0.0132 feet per foot (ft/ft) based on the first quarter, 2012 water level at MW-23 (5,497 ft amsl) and the elevation of Westwater Seep (5,468 ft amsl). The geometric average hydraulic conductivity of the perched zone in the vicinity of Path 1 (based on data from DR-5, DR-8, DR-9, DR-10, DR-11, MW-12, MW-23, MW-24, and MW-36) is 9.8 x 10^{-6} cm/s (0.027 feet per day [ft/day]). Assuming an effective porosity of 0.18, the average perched water pore velocity along Path 1 is 0.73 feet per year (ft/yr), yielding a total travel time of approximately 3,010 years.

Path 2 is approximately 4,125 feet long with an average hydraulic gradient of 0.0046 ft/ft based on the first quarter, 2012 water level at MW-36 (5,493 ft amsl) and the water level at DR-8 (5,474 ft amsl). The geometric average hydraulic conductivity of the perched zone in the vicinity of Path 2 (based on data from DR-5, DR-8, DR-9, DR-10, DR-11, MW-12, MW-23, MW-24, and MW-36) is 9.8 x 10^{-6} cm/s (0.027 ft/day). Assuming an effective porosity of 0.18, the average perched water pore velocity along Path 2 is 0.26 feet per year (ft/yr), yielding a total travel time of approximately 15,850 years. The additional time to travel along the hypothetical pathway to Cottonwood Seep is not calculated because of the hypothetical nature of the pathway. If such a pathway exists, the combined travel time along Path 2 and the hypothetical pathway (which adds approximately 2,150 horizontal feet to the total path length), is expected to be significantly greater than 15,850 years.

Path 3 is approximately 11,800 feet long with an average hydraulic gradient of 0.0096 ft/ft based on the first quarter, 2012 water level at MW-36 (5,493 ft amsl) and the elevation of Ruin Spring (5,380 ft amsl). The geometric average hydraulic conductivity of the perched zone in the vicinity of Path 2 (based on test data from DR-5, DR-8, DR-9, DR-10, DR-11, DR-14, DR-17, DR-19, DR-20, DR-21, DR-23, DR-24, MW-23, MW-24, and MW-36) is 1.1 x 10^{-5} cm/s (0.031 ft/day). Assuming an effective porosity of 0.18, the average perched water pore velocity along Path 3 is 0.60 ft/yr, yielding a total travel time of approximately 19,650 years.

Path 4 is approximately 9,685 feet long with an average hydraulic gradient of 0.0116 ft/ft based on the first quarter, 2011 water levels at MW-15, MW-34, and MW-37 (5,492 ft amsl) and the elevation of Ruin Spring (5,380 ft amsl). The geometric average hydraulic conductivity of the perched zone in the vicinity of Path 4 (based on KGS analysis of automatically test data from DR-11, DR-13, DR-21, DR-23, DR-24, MW-3, MW-14, MW-15, MW-20 and MW-37) is 1.38 x 10^{-5} cm/s (0.039 ft/day). Assuming an effective porosity of 0.18, the average perched water pore velocity along Path 4 is 0.91 ft/yr, yielding a total travel time of approximately 10,650 years.

3.4 Water Balance Near DR-2 and DR-5

Enhanced recharge south/southwest of Westwater Seep near DR-2 and DR-5 is likely needed to maintain the relatively large saturated thicknesses there, considering the slow rate of perched water flow into that area via the zone of low saturated thickness and the presence of known sinks to the northeast (Westwater Seep) and to the south (paleovalley leading to Ruin Spring).

Because the water columns in most piezometers penetrating the area of low saturated thicknesses were inadequate for hydraulic testing, only one estimate of hydraulic conductivity was obtained, at DR-10. As shown in Table 3, the KGS method hydraulic conductivity estimates at DR-10 (located within the area of low saturated thickness) were one to two orders of magnitude lower than at DR-5 and DR-9, located west of the area of low saturated thickness. Assuming the estimate at DR-10 is representative of the area of low saturated thickness, the transmissivity (the product of hydraulic conductivity and saturated thickness) of the area of low saturated thickness is two to three orders of magnitude lower than for the area of larger saturated thickness to the west (near DR-2, DR-5, and DR-9). Figures 6 and 7 show that the hydraulic gradient in this area is relatively flat, and the gradient does not change significantly across the area of low saturated thickness.

Water flows westward from the area of the tailings cells through the area of low saturated thickness between DR-6 and DR-10 (Figure 7). Using Darcy's Law, and assuming a hydraulic conductivity of 3×10^{-6} cm/s (0.0084 ft/day, based on the KGS estimate provided for DR-10 in Table 3), an average hydraulic gradient of 0.0065 ft/ft, an average saturated thickness of $2\ ^{1}/_{3}$ ft, and a width of approximately 1,600 feet (the approximate distance between DR-6 and DR-10), the rate of perched water flow westward through the area of low saturated thickness is approximately 0.2 cubic feet per day (ft^3/day) or 0.0011 gpm.

Water flows out of the area of larger saturated thickness (near DR-2 and DR-5) to the northeast toward known discharge point Westwater Seep and to the south through the paleovalley leading towards known discharge point Ruin Spring. The rate of flow out of this area northeast to Westwater Seep is expected to be smaller than the discharge rate at Westwater Seep which also receives water from the east and northeast. The discharge rate at Westwater Seep is too small for a reliable estimate. However, the rate of flow south through the paleovalley leading towards Ruin Spring can be calculated using the geometric average hydraulic conductivity of 0.0089 ft/day (based on KGS estimates for DR-8, DR-9, and DR-10 in Table 3), an approximate hydraulic gradient of 0.0088 ft/ft, an average saturated thickness of 12 ft, and a width of approximately 2,250 ft (between DR-8 and DR-10), as 2.1 ft^3/day, or 0.011 gpm, an order of magnitude larger than the calculated flow into the area. The difference between calculated inflow and outflow is approximately 0.01 gpm.

These calculations indicate that an additional water source is needed to maintain the relatively large saturated thicknesses west of the area of low saturated thickness between DR-6 and DR-10; otherwise Westwater Seep and the paleovalley to the south would drain the area of larger saturated thickness more quickly than water was supplied. The most likely source of additional water is infiltration of precipitation enhanced by the direct exposure of weathered Dakota Sandstone and Burro Canyon Formation, and the thinness or absence of any overlying low permeability materials such as the Mancos Shale. Assuming uniform recharge over an area of approximately 175 acres (the portion of the mesa west of Westwater Seep and north of DR-8 and DR-9), the calculated difference of 0.01 gpm implies a conservatively low recharge rate of 0.0011 inches per year (in/yr). Most of the recharge likely occurs near the mesa rim where the Dakota and Burro Canyon are exposed (Figure 12 and Figure E.2, Appendix E). Such recharge is expected to be enhanced within drainages where they cross weathered Dakota Sandstone and Burro Canyon Formation.

Furthermore, these calculations indicate that perched water flow in the portion of the site south of Westwater Seep is inadequate as a primary supply to Cottonwood Seep. Perched water flow from the area of the tailings cells through the area of low saturated thickness towards Cottonwood Seep would have to be more than three orders of magnitude higher than calculated above to provide a supply of between 1 and 10 gpm. The required flow would have to be even larger considering that some of the incoming flow is diverted to known discharge point Westwater Seep and to the paleovalley that leads south to known discharge point Ruin Spring. Even if this calculation were performed using the geometric average of the KGS hydraulic conductivity estimates for all tested DR-series piezometers (approximately 1×10^{-5} cm/s or 0.028 ft/day) rather than the estimate for DR-10 (3×10^{-6} cm/s or 0.0084 ft/day), the calculated rate of flow through the area of low saturated thickness would be 0.0035 gpm, which is still approximately three orders of magnitude lower than the estimated discharge rate of Cottonwood Seep. The inadequacy of the perched zone as the primary supply to Cottonwood Seep indicates that the primary source or sources of Cottonwood Seep lie elsewhere.

4. IMPLICATIONS FOR SEEPS AND SPRINGS

The lithologic and hydraulic data collected from the southwest area investigation allow a more comprehensive assessment of the hydrogeology of the site and have implications with regard to seeps and springs southwest of the site. The data indicate that dilution of perched water by local recharge is expected to occur in the vicinities of Westwater Seep and Ruin Spring, and that perched zone permeabilities and flow rates in the southwestern portion of the site are too low (by several orders of magnitude) for the perched zone to serve as the primary source of water for Cottonwood Seep

4.1 Westwater Seep and Ruin Spring

As discussed in HGC (2010b) the water source for both Westwater Seep and Ruin Spring is lateral flow from upgradient portions of the perched zone enhanced by local recharge near the edge of the mesa. Most of this recharge likely occurs near the mesa rim where weathered Dakota Sandstone and Burro Canyon Formation are exposed. Such recharge is likely to be enhanced within drainages where they cross weathered Dakota Sandstone and Burro Canyon Formation. The results of the present study indicate that the permeability of the perched zone in the southwest area of the site is on average lower than previously estimated and that the contribution to flow at Westwater Seep and Ruin Spring by local recharge is more significant than previously thought.

4.2 Cottonwood Seep

The low perched zone permeabilities and small saturated thicknesses in the southwest area of the site are consistent with low rates of perched water flow, as shown by the calculated flow through the area of small saturated thickness southwest of the tailings cells (between DR-6 and DR-10) provided in Section 3.4. This low rate of perched water flow (approximately 0.001 gpm) is inadequate (by more than three orders of magnitude) to function as the primary supply to Cottonwood Seep which has flows estimated to be between 1 and 10 gpm. As discussed in Section 3.1.2, the estimated flow at Cottonwood Seep is consistent with Dames and Moore (1978).

In summary, the perched zone cannot be the primary source of water to Cottonwood Seep for the following reasons:

a) Cottonwood Seep occurs in the lower third of Brushy Basin Member, approximately 230 feet below the contact between the Burro Canyon Formation and the Brushy Basin Member, more than 1,500 ft west of the termination of the perched zone, and just west of a change in morphology from slope-former to bench-former. The change in morphology is indicative of a change in lithology. As discussed in HGC (2010b) Cottonwood Seep likely originates from coarser-grained materials within the lower portion of the Brushy Basin Member. Alternatively, Cottonwood Seep may originate from coarser-grained materials of the Westwater Canyon (sandstone) Member intertongueing with the overlying Brushy Basin Member at the transition between the two Members. The presence of coarser-grained materials similar to the Salt Wash (sandstone) Member within the lower portion of the Brushy Basin member is discussed in Shawe (2005). The intertongueing of the Westwater Canyon and Brushy Basin Members is discussed in Craig (1955) and Flesch (1974). Based on lithologic cross sections provided in TITAN (1994), the elevation of Cottonwood Seep (5234 ft amsl) is within 5 to 15 feet of the elevation of the contact between the Brushy Basin Member and the underlying Westwater Canyon Member (5220 to 5230 ft amsl).

b) The flow at Cottonwood Seep exceeds the flow in the perched zone in the area southwest of the tailings cells by several orders of magnitude. Flows at Cottonwood Seep are also relatively large compared to seeps and springs known to originate from the perched zone, consistent with a primary source other than perched water.

c) There is no evidence to establish a direct hydraulic connection between the perched zone and Cottonwood Seep. Cottonwood Seep is located more than 1,500 ft west of the termination of the Burro Canyon Formation which hosts the perched water zone. Examination of the area between Cottonwood Seep and mesa rim (the edge of the perched zone) reveals that the upper portion of the Brushy Basin Member appears dry and no previously undiscovered seeps originating from the Burro Canyon Formation near Cottonwood Seep were identified.

Because the results of the southwest area investigation do not provide evidence that Cottonwood Seep is hydraulically connected to the perched water system at the site, and because the perched zone near Cottonwood Seep is inadequate as a primary supply, the primary source (or sources) of water to Cottonwood Seep must lie elsewhere. The primary source(s) must be significant to supply consistent flows at rates between 1 and 10 gpm. By contrast, flows at Ruin Spring (estimated at less than about $^1/_2$ gpm, consistent with Dames and Moore, 1978) are lower than at Cottonwood Seep (between 1 and 10 gpm), and flows at Westwater Seep are too small to measure. Westwater Seep generally consists of a damp spot that can be sampled only by digging a hole and waiting for enough water to seep in for sample collection (see Figures 16 and 17 taken from HGC, 2010b).

Although no evidence of a direct hydraulic connection between the perched zone and Cottonwood Seep was provided by the investigation, the possibility of a hypothetical, as yet unknown, connection was postulated for the purpose of calculating a travel time from the tailngs cells to the western edge of the perched zone (near DR-8), and thence along a potential pathway to Cottonwood Seep. The travel time from the tailings cells to DR-8 was calculated as approximately 15,850 years. Should a potential pathline such as that shown in Figure 15 exist, the total time needed to travel from the tailings cells to Cottonwood Seep is expected to be significantly larger than 15,850 years.

4.3 Potential Dilution of Perched Water Resulting From Local Recharge of the Dakota and Burro Canyon Near Seeps and Springs

As discussed in Section 3, the rate of flow in the perched water zone in the southwest area of the site is small and a contribution from local recharge is needed to explain many areas of higher saturated thickness near sinks such as Westwater Seep and Ruin Spring that are downgradient of areas of low saturated thickness. The presence of local recharge is expected to affect the water quality of seeps and springs and has the potential to dilute any dissolved constituents that may migrate from upgradient areas.

5. CONCLUSIONS

As per Part 1.H.6 (a) through (d) of the Permit, the southwest area investigation included the drilling and logging of 22 borings in the southwest portion of the site, completion of 18 of the borings as piezometers, hydraulic testing of the piezometers having at least 5 feet of water in the casings, water level monitoring, and additional examination of the area near Cottonwood Seep. Water level data obtained from the borings and piezometers (including dry borings) yielded data that satisfy Part 1.H.6 (b) and (c) of the Permit.

Interpretation of well survey, lithologic, water level, and hydraulic test data provided in Tables 1 through 4, Figures 2 through 14, and Appendices A through D satisfy Part 1.H.6 (e) items 1 through 6 of the Permit. Specifically, Appendices A and B satisfy item 1; Figures 5, 6, 7, 14, and 15 satisfy item 2; Figures 4 and 11 satisfy item 3; Figures 7 through 11 satisfy item 4; Figures 12 and 13 satisfy item 5; and Tables 2, 3, and 4 satisfy item 6. Figure 15 and Table 5 support perched water travel time calculations satisfying Part 1.H.6 © of the Permit.

The results of the investigation are substantially consistent with and build upon the results and conclusions presented in HGC (2010b). The results of the investigation show that permeabilities in the southwest portion of the site are on average lower than previously estimated, and provide no evidence for a direct hydraulic connection between the perched water zone and Cottonwood Seep. The hydraulic test and water level data also demonstrate that the perched zone southwest of Cell 4B is inadequate as a primary supply to Cottonwood Seep by several orders of magnitude and that that the primary source of Cottonwood Seep lies elsewhere. However, a hypothetical connection between the perched zone near piezometer DR-8 and Cottonwood Seep is postulated for the purposes of calculating perched water travel times and to allow for the possibility that an as yet unidentified connection may exist

Important results of the southwest area investigation are:

a) The Brushy Basin Member erosional paleosurface in the southwest area of the Mill site is dominated by a paleoridge extending from beneath Cell 4B to abandoned boring DR-18 (Figures 4 and 11). The paleoridge is flanked to the west by a north-south trending paleovalley oriented roughly parallel to the western mesa rim (Figure 11).

b) The southwest area of the Mill site is characterized by generally low saturated thicknesses, low permeabilities, and relatively shallow hydraulic gradients. This is illustrated in Table 3 and Figures 5 through 13.

c) The paleotopography of the Brushy Basin Member erosional surface has a greater influence on perched water flow in the southwest portion of the site than other areas because of the low saturated thicknesses and dry areas associated with the paleoridge (Figure 14).

d) The low transmissivities implied by the low permeabilities and low saturated thicknesses combined with the shallow hydraulic gradients imply low rates of perched water flow in the southwest portion of the site. Calculated average pore velocities along Pathlines 1, 3, and 4 (Figure 15) from tailings cells to known discharge points Westwater Seep and Ruin Spring range from 0.60 ft/yr to 0.91 ft/yr, and travel times from 3,010 to 19,650 years based on first quarter, 2012 water level data.

e) The estimated travel time from the tailings cells to the vicinity of DR-8 (Path 2) is approximately 15,850 years based on first quarter, 2012 water level data and a calculated pore velocity of 0.26 ft/yr. Assuming a hypothetical pathway to Cottonwood Seep, the time to travel along Path 2 and thence along the potential pathway from the edge of Path 2 to Cottonwood Seep (which adds approximately 2,150 horizontal feet) is expected to be significantly greater than 15,850 years.

f) Brushy Basin Member paleotopography influences the locations of Westwater Seep and Ruin Spring; both are located in paleovalleys within the Brushy Basin Member paleosurface (Figure 11).

g) Local recharge is needed to explain areas of relatively large saturated thickness that supply Westwater Seep and Ruin Spring, because lateral flow into these areas from upgradient low saturated thickness portions of the perched zone is inadequate. The calculated perched zone recharge rate in the approximate 175 acre area southwest of Westwater Seep (near DR-2 and DR-5) is 0.0011 in/yr.

h) The perched water system in the southwestern portion of the site is inadequate as the primary supply to Cottonwood Seep by several orders of magnitude. Therefore the primary source(s) of Cottonwood Seep must lie elsewhere.

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7. LIMITATIONS STATEMENT

The opinions and recommendations presented in this report are based upon the scope of services and information obtained through the performance of the services, as agreed upon by HGC and the party for whom this report was originally prepared. Results of any investigations, tests, or findings presented in this report apply solely to conditions existing at the time HGC's investigative work was performed and are inherently based on and limited to the available data and the extent of the investigation activities. No representation, warranty, or guarantee, express or implied, is intended or given. HGC makes no representation as to the accuracy or completeness of any information provided by other parties not under contract to HGC to the extent that HGC relied upon that information. This report is expressly for the sole and exclusive use of the party for whom this report was originally prepared and for the particular purpose that it was intended. Reuse of this report, or any portion thereof, for other than its intended purpose, or if modified, or if used by third parties, shall be at the sole risk of the user.

TABLES

TABLE 1
Surveyed Position Coordinates for DR-series Piezometers

Location	Latitude N	Longitude W	Top of Casing Elevation (ft amsl)	Ground Elevation (ft amsl)
DR-2	37°31'43.2384"	109°31'48.9843"	abandoned	5551.34
DR-5	37°31'42.8093"	109°31'36.6427"	5565.56	5564.05
DR-6	37°31'42.7892"	109°31'20.4809"	5578.87	5577.91
DR-7	37°31'42.7607"	109°31'09.9342"	5583.86	5582.39
DR-8	37°31'27.1416"	109°31'48.7868"	5525.01	5523.69
DR-9	37.31'24.9239"	109°31'37.8796"	5566.25	5565.09
DR-10	37°31'26.9443"	109°31'20.6076"	5560.49	5559.49
DR-11	37°31'26.7357"	109°31'09.9599"	5585.64	5584.42
DR-12	37°31'26.6924"	109°30'58.2466"	5579.94	5578.70
DR-13	37°31'26.4497"	109°30'48.8041"	5556.44	5555.11
DR-14	37°31'08.3875"	109°31'37.0783"	5542.58	5541.31
DR-15	37°31'07.6211"	109°31'08.2651"	5558.24	5557.16
DR-16	37°31'08.1536"	109°30'58.3915"	abandoned	5550.76
DR-17	37°30'55.3156"	109°31'37.0518"	5518.55	5517.16
DR-18	37°30'55.1352"	109°31'20.5340"	abandoned	5524.48
DR-19	37°30'43.3468"	109°31'49.5061"	5517.94	5517.16
DR-20	37°30'43.4778"	109°31'38.4324"	5498.67	5497.88
DR-21	37°30'42.6634"	109°31'14.0727"	5521.75	5520.58
DR-22	37°30'30.0936"	109°31'50.0818"	5484.42	5482.97
DR-23	37°30'37.0276"	109°31'25.8592"	5495.94	5494.65
DR-24	37°30'23.5938"	109°31'41.7780"	5461.44	5460.19
DR-25	37°30'19.3288"	109°31'16.5987"	abandoned	5461.78

Note:
ft amsl = feet above mean sea level

TABLE 2
Slug Test Parameters

Well	Depth to Brushy Basin (feet)	Depth to Water (feet)	Depth to Top of Screen (feet)	Depth to Base of Screen (feet)	Saturated Thickness Above Brushy Basin (feet)
DR-5	94	81.7	76.1	96.1	12.3
DR-8	58	49.7	40.0	60.0	7.8
DR-9	110	85.5	82.1	112.1	24.5
DR-10	80	77.0	63.0	83.0	3.0
DR-11	106	97.1	89.0	109.0	8.9
DR-13	80	68.8	65.0	85.0	11.2
DR-14	94	75.2	67.2	97.2	18.8
DR-17	70	63.5	53.1	73.1	6.5
DR-19	66	62.5	49.0	69.0	3.5
DR-20	73	55.1	56.0	76.0	17.9
DR-21	114	100.5	96.9	116.9	13.5
DR-23	77	69.5	59.1	79.1	7.5
DR-24	60	42.6	43.0	63.0	17.4

TABLE 3
Slug Test Results

Test	Saturated Thickness	Automatically Logged Data: KGS K (cm/s)	Automatically Logged Data: KGS Ss (1/ft)	Automatically Logged Data: Bouwer-Rice K (cm/s)	Hand Collected Data: KGS K (cm/s)	Hand Collected Data: KGS Ss (1/ft)	Hand Collected Data: Bouwer-Rice K (cm/s)
DR-5	12.3	2.95E-05	4.21E-05	3.80E-05	2.86E-05	2.65E-03	3.76E-05
[1]DR-8	7.8	2.46E-08	1.00E-02	3.56E-07	4.46E-08	1.00E-02	4.45E-07
DR-9	24.5	4.49E-04	4.30E-06	3.41E-04	4.73E-04	1.21E-05	4.73E-04
DR-10	3	2.92E-06	6.54E-03	5.56E-06	9.71E-06	8.41E-04	9.71E-06
DR-11	8.9	8.88E-06	8.88E-04	1.54E-05	5.83E-06	2.22E-03	1.11E-05
DR-13	11.2	5.90E-06	7.33E-05	5.38E-06	4.93E-06	1.57E-04	1.49E-06
DR-13(et)	11.2	NA	NA	NA	NA	NA	6.81E-06
DR-14	18.8	1.26E-05	7.34E-05	1.66E-05	7.78E-06	4.84E-04	6.18E-06
DR-14(et)	18.8	NA	NA	NA	NA	NA	1.23E-05
DR-17	6.5	1.24E-05	1.53E-04	1.43E-05	3.17E-06	5.00E-03	2.19E-06
DR-17(et)	6.5	NA	NA	NA	NA	NA	8.35E-06
DR-19	3.5	3.29E-05	2.54E-03	3.78E-05	3.39E-05	1.86E-03	4.08E-05
DR-20	17.9	2.14E-06	1.91E-05	2.69E-06	1.43E-06	1.90E-05	1.89E-06
DR-21	13.5	3.29E-05	7.17E-06	3.60E-05	2.21E-05	1.87E-04	3.49E-05
DR-23	7.5	1.96E-05	3.85E-04	2.35E-05	7.49E-06	5.00E-03	4.51E-06
DR-23(et)	7.5	NA	NA	NA	NA	NA	2.16E-05
DR-24	17.4	1.64E-05	7.49E-05	1.43E-05	1.64E-05	7.49E-05	8.23E-06
DR-24(et)	17.4	NA	NA	NA	NA	NA	1.97E-05

Notes:
[1] DR-8 results from retesting during October, 2012
Bouwer-Rice = Unconfined Bouwer-Rice solution method in Aqtesolve™
cm/s = centimeters per second
et = early time data
ft = feet
K = hydraulic conductivity
KGS = Unconfined KGS solution method in Aqtesolve™
Ss= specific storage

TABLE 4
Hydraulic Conductivity Estimates for Travel Time Calculations

PATHS 1 and 2		PATH 3		PATH 4	
location	**k (cm/s)**	**location**	**k (cm/s)**	**location**	**k (cm/s)**
DR-5	2.95E-05	DR-5	2.95E-05	DR-11	8.88E-06
DR-8	2.46E-08	DR-8	2.46E-08	DR-13	5.89E-06
DR-9	4.49E-04	DR-9	4.49E-04	DR-21	3.29E-05
DR-10	2.92E-06	DR-10	2.92E-06	DR-23	1.54E-05
DR-11	8.88E-06	DR-11	8.88E-06	MW-3	4.00E-07
MW-12	2.20E-05	DR-14	1.26E-05	MW-14	7.50E-04
MW-23	2.30E-07	DR-17	1.24E-05	MW-15	1.90E-05
MW-24	4.16E-05	DR19	3.29E-05	MW-20	9.30E-06
MW-36	4.51E-04	DR-20	2.14E-06	MW-37	1.28E-05
		DR-21	3.29E-05		
		DR-23	1.96E-05		
		DR-24	1.64E-05		
		MW-23	2.30E-07		
		MW-24	4.16E-05		
		MW-36	4.51E-04		
geomean:	9.76E-06	**geomean:**	1.10E-05	**geomean:**	1.38E-05

Notes:
k = hydraulic conductivity
cm/s = centimeters per second

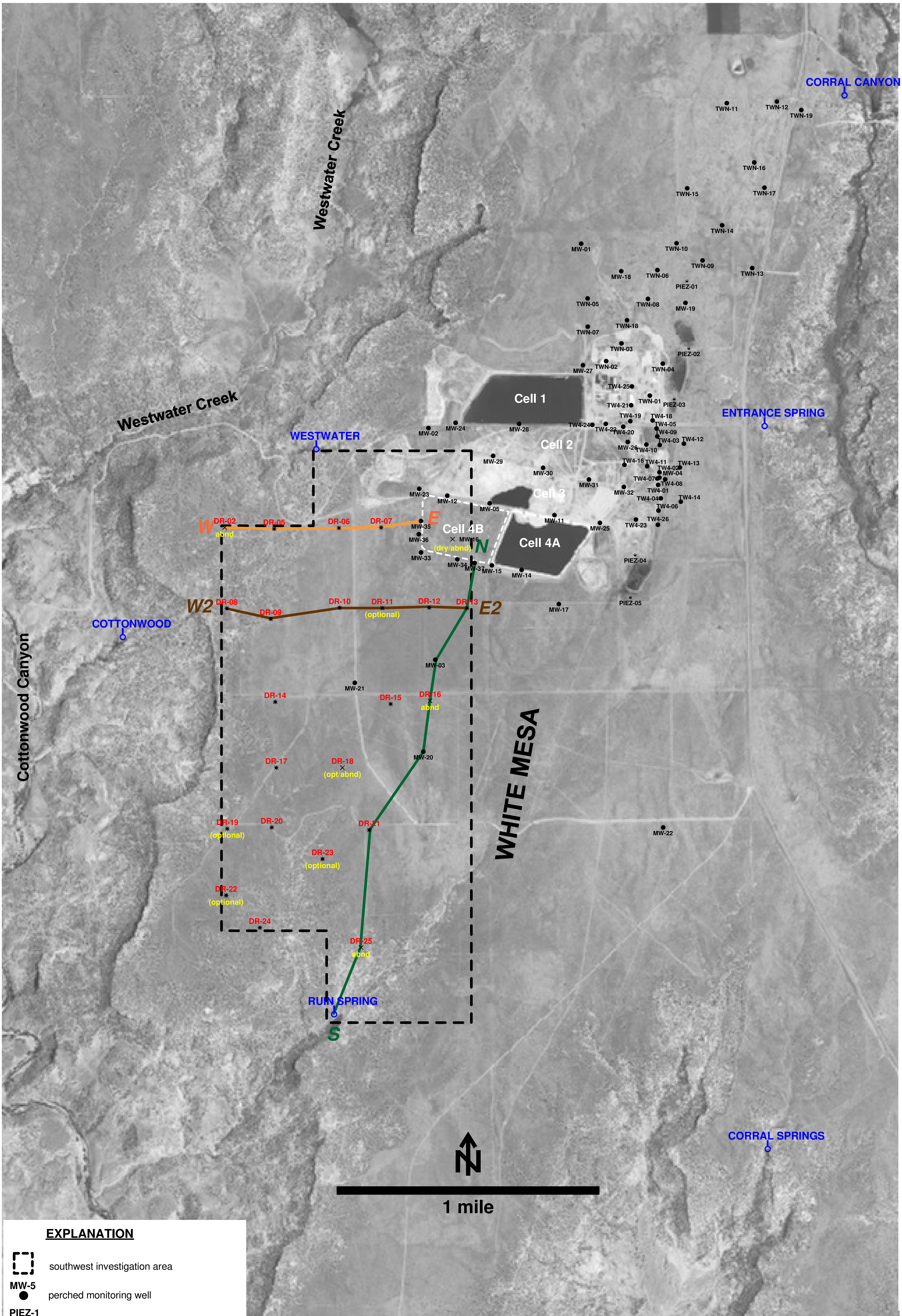
TABLE 5
Estimated Perched Zone Pore Velocities Along Path Lines

Path	Hydraulic Conductivity[a]		Path Length	Head Change	Hydraulic Gradient	Pore Velocity
	(cm/s)	(ft/yr)	(ft)	(ft)	ft/ft	ft/yr
1	9.76E-06	10.0	2,200	29	0.0132	0.73
2	9.76E-06	10.0	4,125	19	0.0046	0.26
3	1.10E-05	11.3	11,800	113	0.0096	0.60
4	1.38E-05	14.1	9,685	112	0.0116	0.91

Notes:

[a] Geometric average (from Table 4)
Assumes effective porosity of 0.18
cm/s = centimeters per second
ft/ft = feet per foot
ft/yr = feet per year

FIGURES



EXPLANATION

- southwest investigation area
- MW-5 — perched monitoring well
- PIEZ-1 — perched piezometer
- DR-5 — perched piezometer installed May/June, 2011
- abandoned perched well or boring
- RUIN SPRING — seep or spring

HYDRO GEO CHEM, INC.

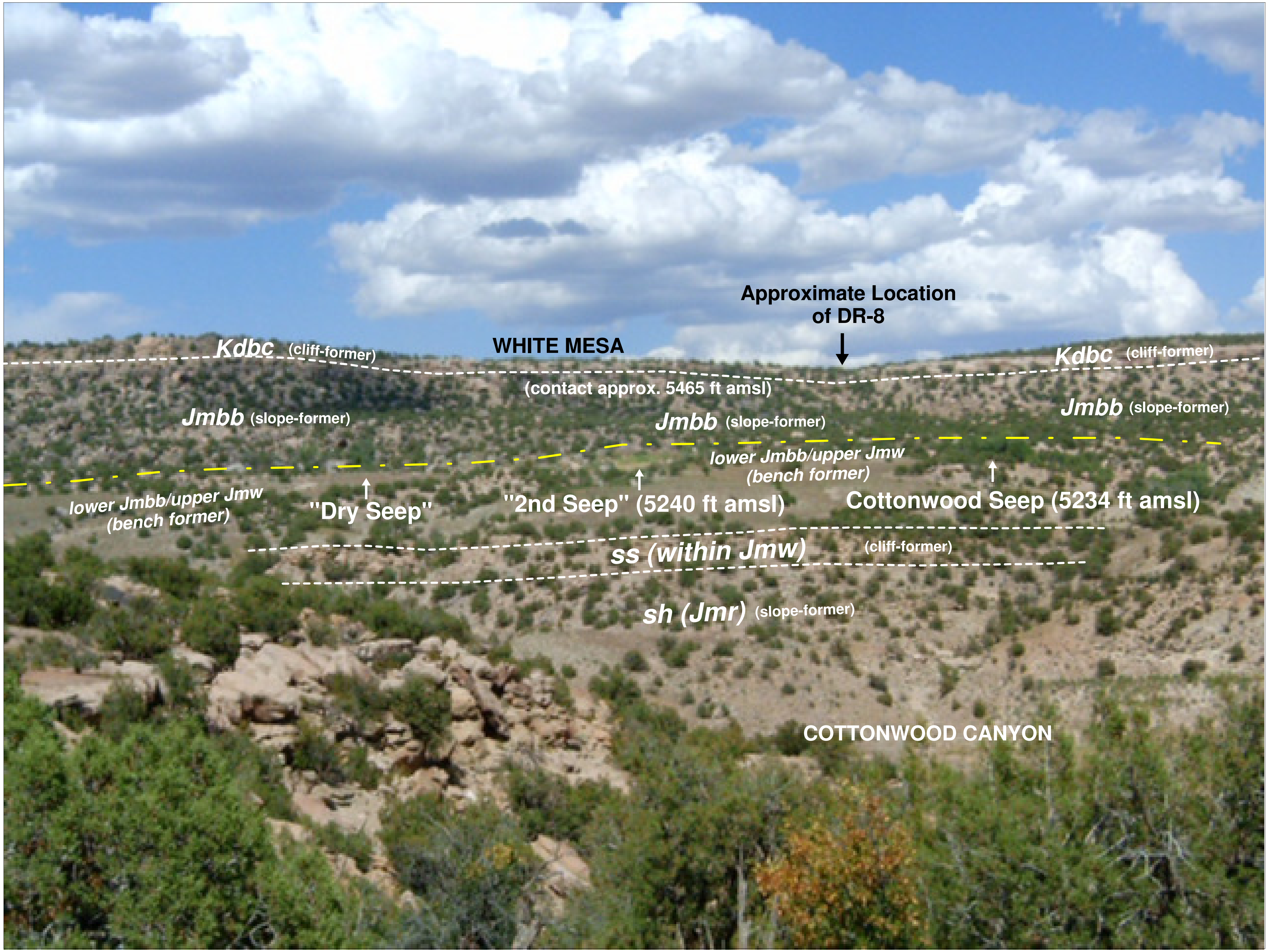
WHITE MESA SITE PLAN SHOWING SOUTHWEST INVESTIGATION AREA AND LOCATIONS OF PERCHED WELLS, PIEZOMETERS, BORINGS AND CROSS SECTIONS

APPROVED	DATE	REFERENCE	FIGURE
SJS	7/20/12	H:/718000/cell4bdryarea/ UTMbase/UTMwelloc11e.srf	1

HYDRO GEO CHEM, INC.

PHOTOGRAPH OF THE CONTACT BETWEEN THE BURRO CANYON FORMATION AND THE BRUSHY BASIN MEMBER

APPROVED	DATE	REFERENCE	FIGURE
SJS	7/20/12	H:/718000/ cell4bjuly2010/springsQ2/contact.srf	2



EXPLANATION

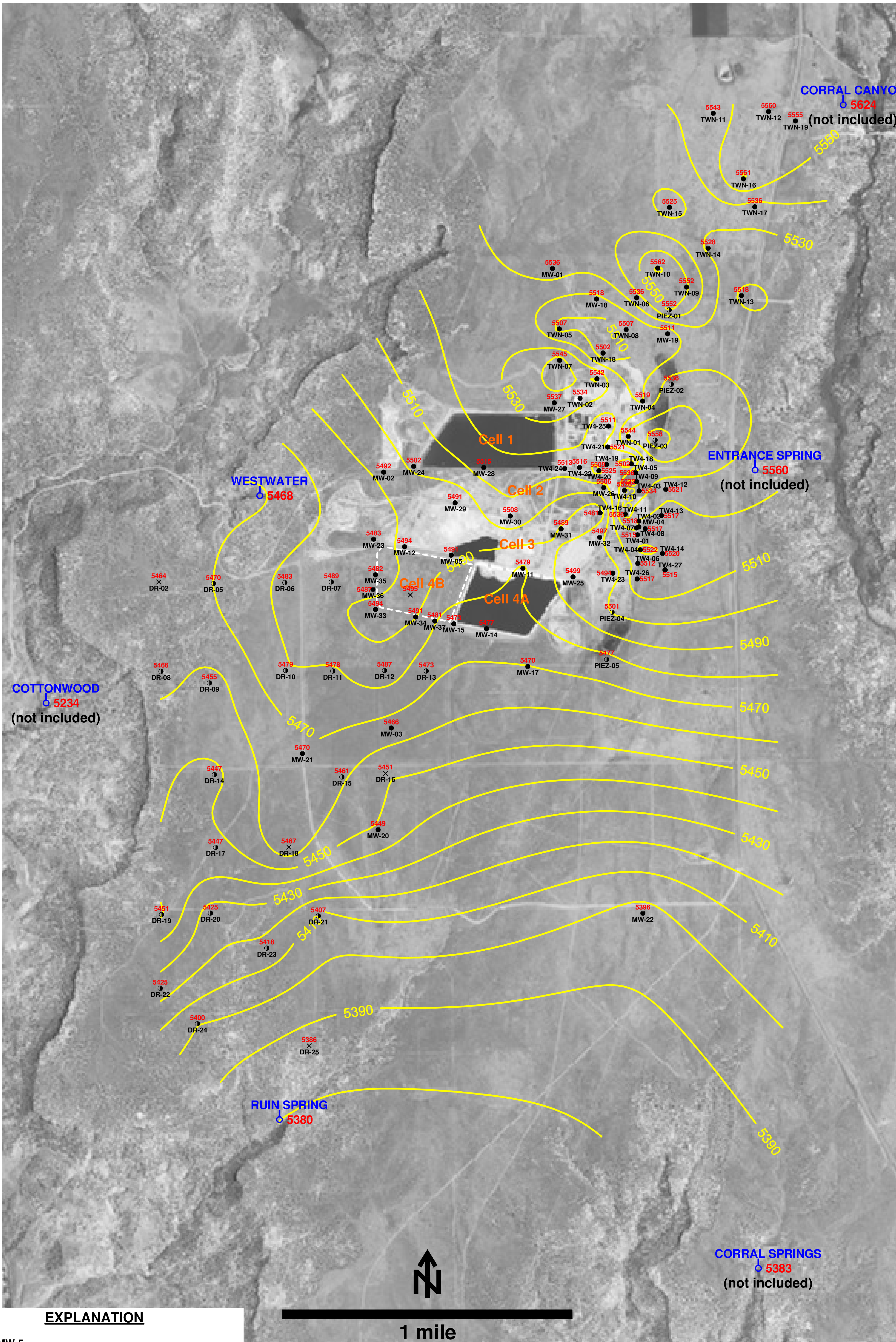
Symbol	Description
(white dashed line)	Approximate Location of Geologic Contact
(yellow dashed line)	Approximate Change From Slope-Former to Bench-Former
Kdbc	Dakota Sandstone/ Burro Canyon Formation
Jmbb	Brushy Basin (Shale) Member
ss (within Jmw)	sandstone (within Westwater Canyon Member)
sh (Jmr)	shale (Recapture Member)

NOTES: adapted from HGC (2010b); "2nd Seep" and "Dry Seep" are described in HGC (2010b)

HYDRO GEO CHEM, INC.

ANNOTATED PHOTOGRAPH SHOWING EAST SIDE OF COTTONWOOD CANYON (looking east toward White Mesa from west side of Cottonwood Canyon)

APPROVED	DATE	REFERENCE	FIGURE
SJS	7/20/12	H:/718000/cell4bdryarea/cottonwood.srf	3



EXPLANATION

MW-5 ● 5491 perched monitoring well showing elevation in feet amsl

DR-5 ◑ 5470 perched piezometer showing elevation in feet amsl

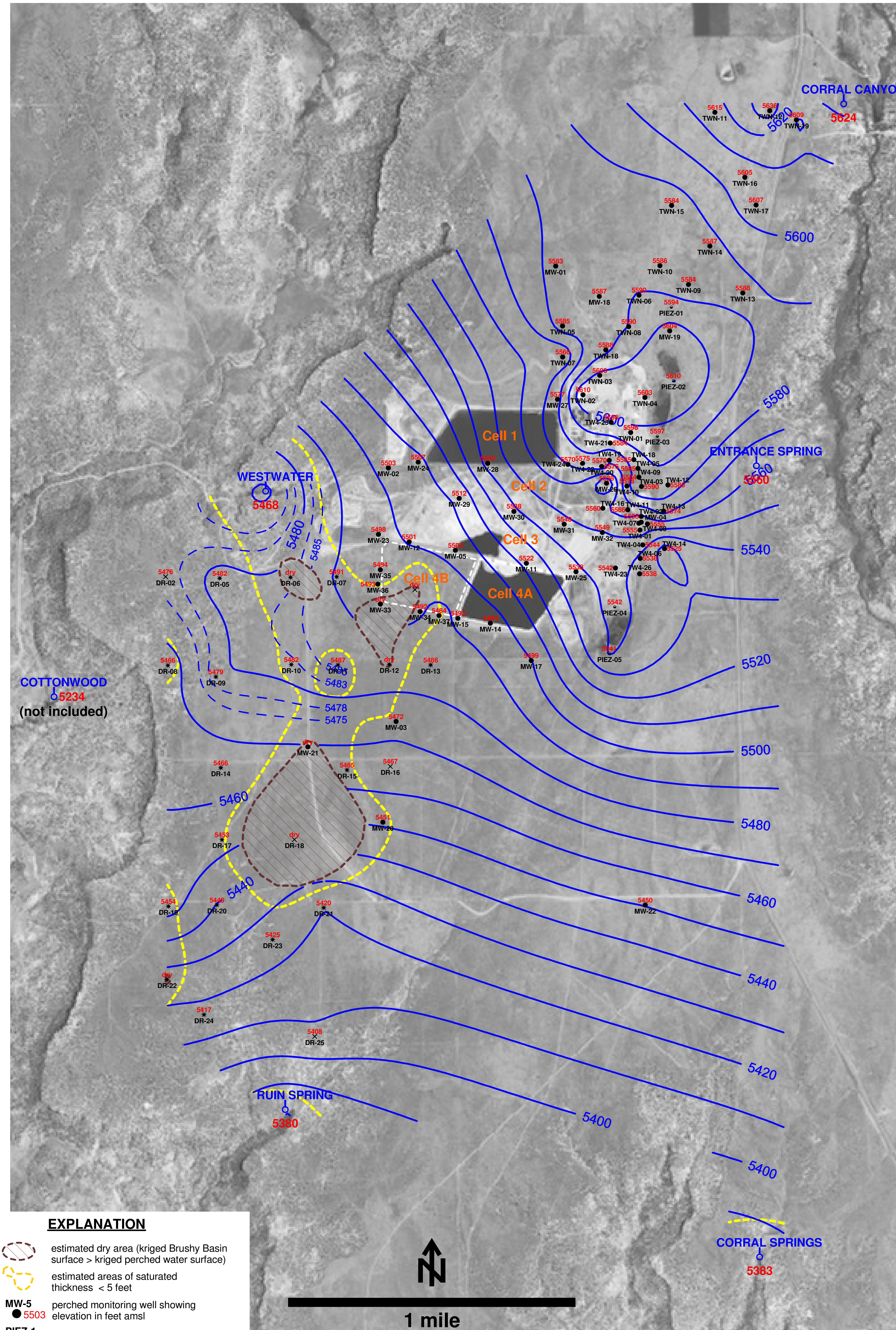
DR-16 ✕ 5451 abandoned perched well or boring showing elevation in feet amsl

RUIN SPRING 5380 seep or spring showing elevation in feet amsl

HYDRO GEO CHEM, INC.

APPROXIMATE ELEVATION OF TOP OF BRUSHY BASIN (Ruin Spring and Westwater Seep included in the contouring)

APPROVED	DATE	REFERENCE	FIGURE
SJS	7/20/12	H:/718000/cell4bdryarea/ UTMbase_revisedmaps/Ubb0312_v2.srf	4



EXPLANATION

estimated dry area (kriged Brushy Basin surface > kriged perched water surface)

estimated areas of saturated thickness < 5 feet

MW-5 ● 5503 — perched monitoring well showing elevation in feet amsl

PIEZ-1 5594 — perched piezometer showing elevation in feet amsl

DR-5 ✷ 5482 — perched piezometer installed May, 2011 showing elevation in feet amsl

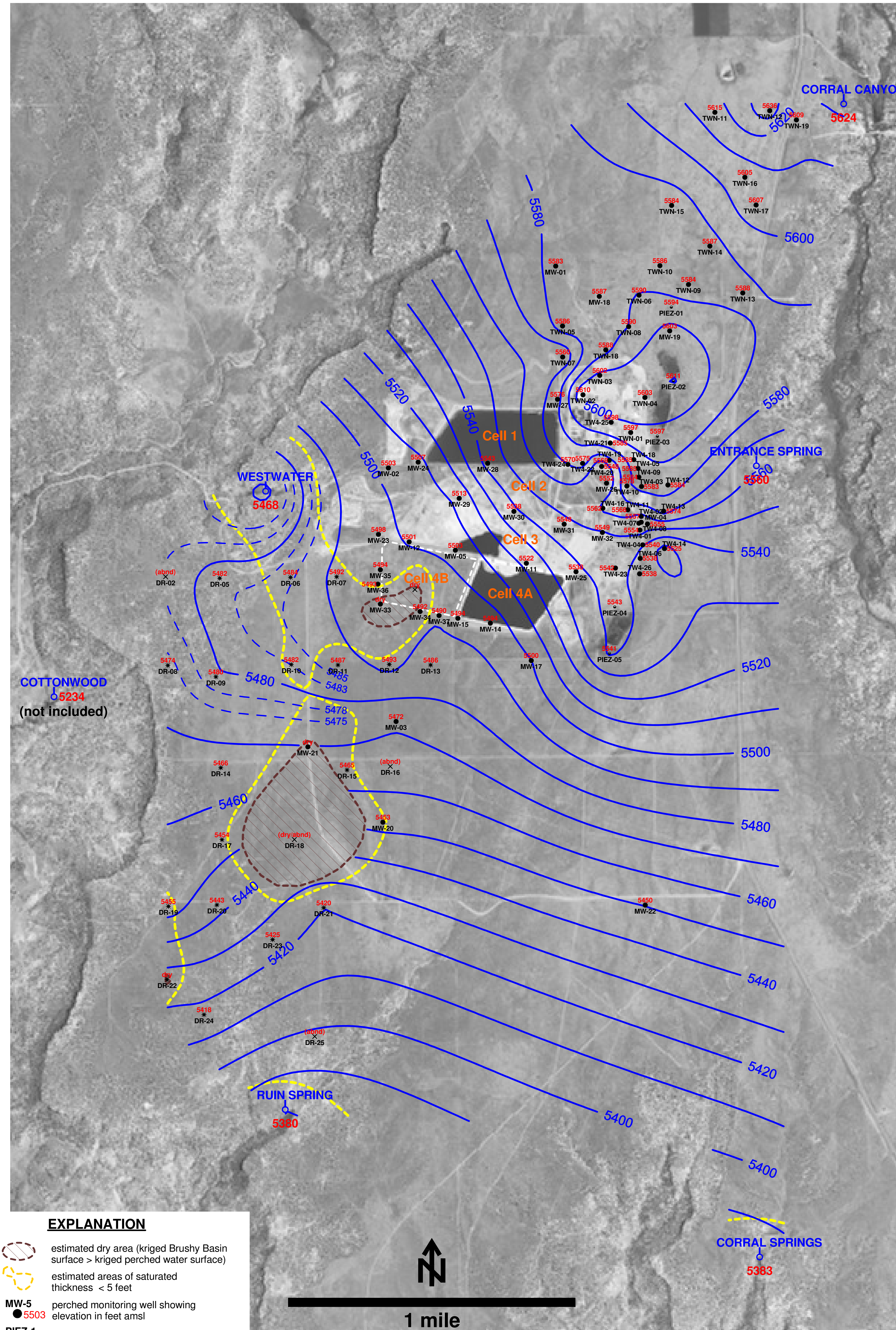
DR-16 ✕ — abandoned perched well; or DR-boring abandoned after May 25 measurement

RUIN SPRING 5380 — seep or spring showing elevation in feet amsl

HYDRO GEO CHEM, INC.

KRIGED 2nd QUARTER, 2011 WATER LEVELS (DR-series water levels from open boreholes on May 25) (All seeps except Cottonwood included in contouring)

APPROVED	DATE	REFERENCE	FIGURE
SJS	7/20/12	H:/718000/cell4bdryarea/ UTMbase_revisedmaps/UTMwlq211_rev0712.srf	5



EXPLANATION

estimated dry area (kriged Brushy Basin surface > kriged perched water surface)

estimated areas of saturated thickness < 5 feet

MW-5 5503 perched monitoring well showing elevation in feet amsl

PIEZ-1 5594 perched piezometer showing elevation in feet amsl

DR-5 5482 perched piezometer installed May, 2011 showing elevation in feet amsl

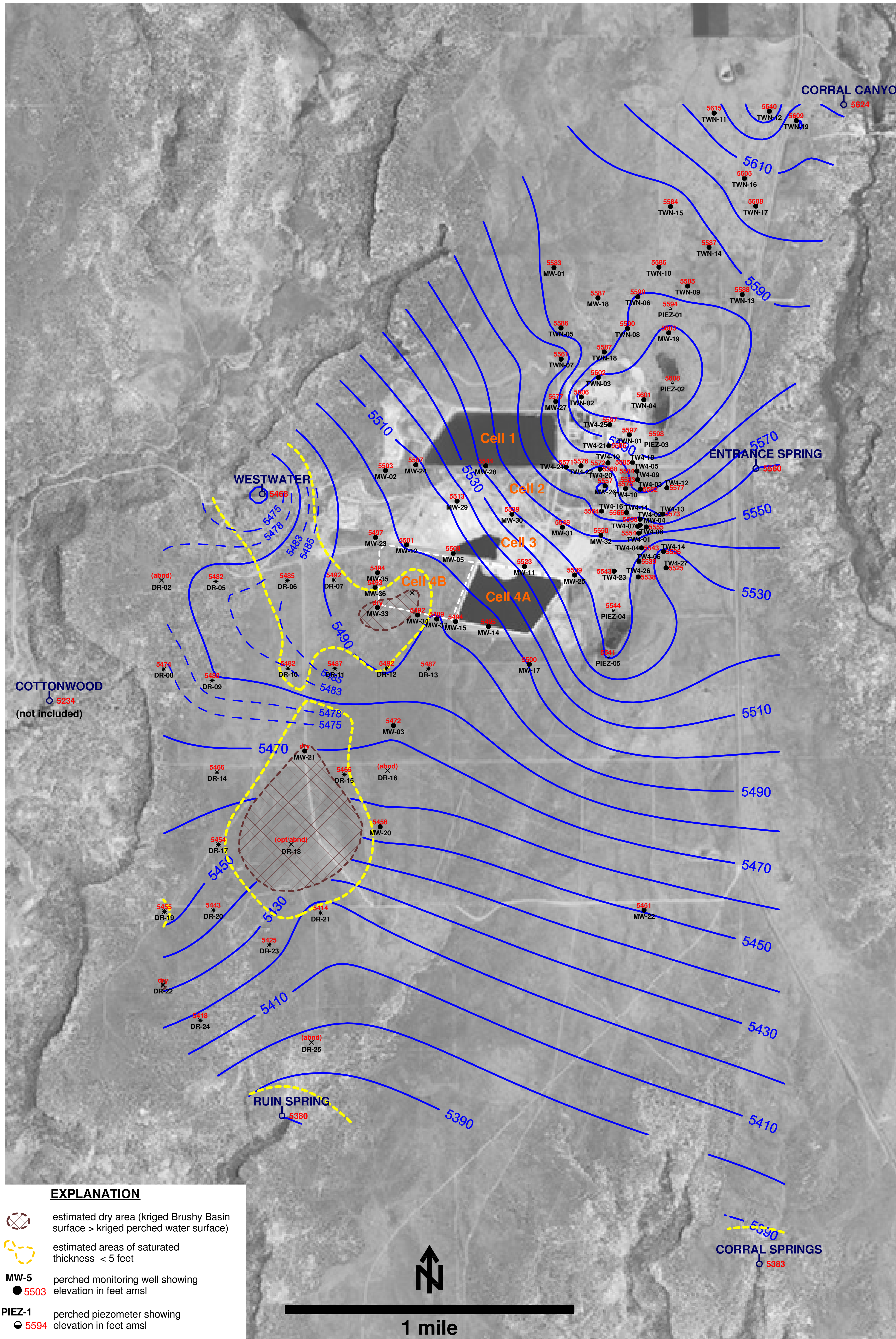
DR-16 abandoned perched well or boring

RUIN SPRING 5380 seep or spring showing elevation in feet amsl

HYDRO GEO CHEM, INC.

KRIGED 3rd QUARTER, 2011 WATER LEVELS (All seeps/springs except Cottonwood Seep included in the contouring)

APPROVED	DATE	REFERENCE	FIGURE
SJS	7/20/12	H:/718000/cell4bdryarea/ UTMbase_revisedmaps/UTMwlq311_rev0712.srf	6



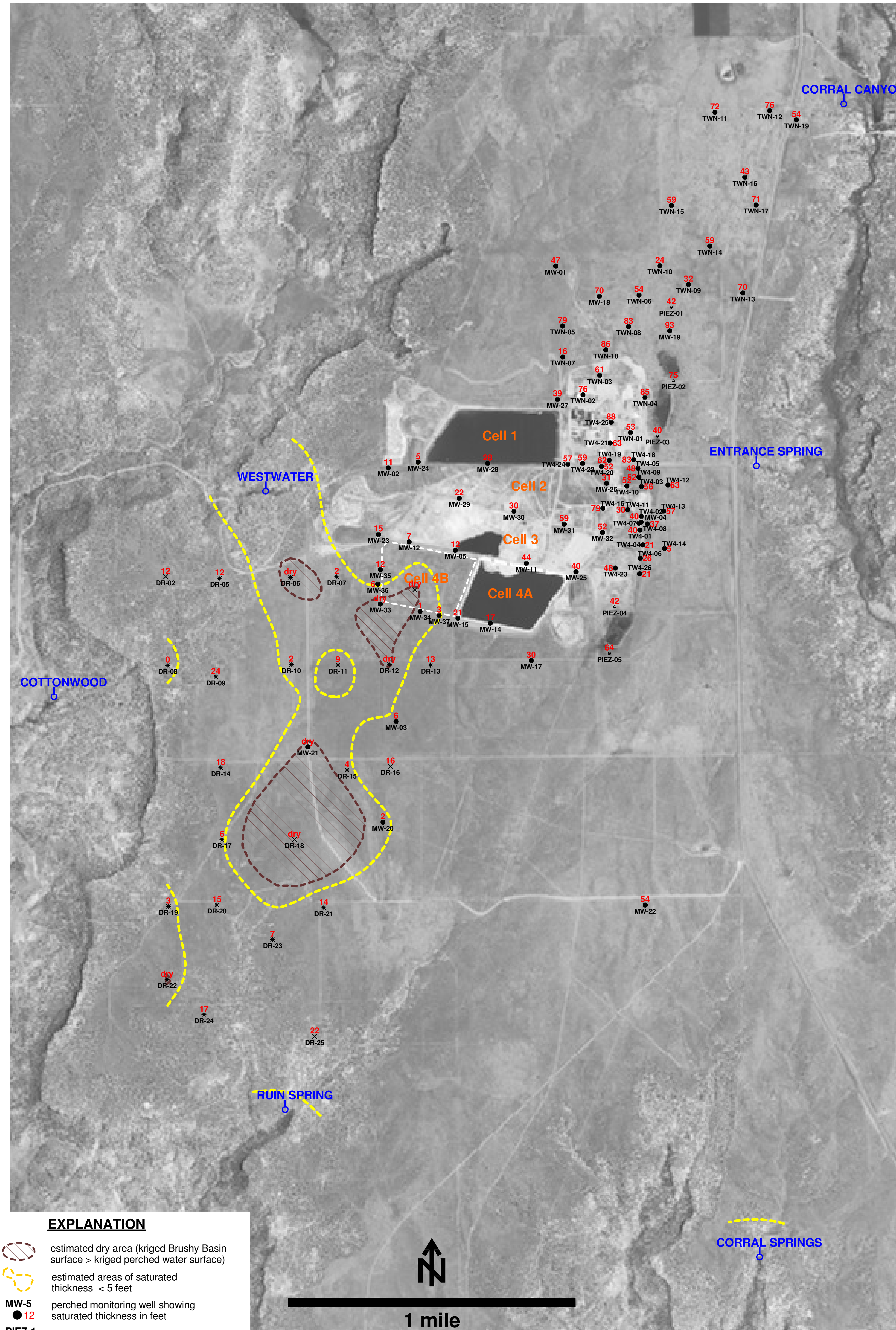
EXPLANATION

(dashed brown outline)	estimated dry area (kriged Brushy Basin surface > kriged perched water surface)
(dashed yellow outline)	estimated areas of saturated thickness < 5 feet
MW-5 ● 5503	perched monitoring well showing elevation in feet amsl
PIEZ-1 ◒ 5594	perched piezometer showing elevation in feet amsl
DR-5 ✷ 5482	perched piezometer installed May, 2011 showing elevation in feet amsl
DR-16 ✕ abnd	abandoned perched well or boring
RUIN SPRING ♁ 5380	seep or spring showing elevation in feet amsl

HYDRO
GEO
CHEM, INC.

KRIGED 1st QUARTER, 2012 WATER LEVELS
WHITE MESA SITE

APPROVED	DATE	REFERENCE	FIGURE
SJS	7/20/12	H:/718000/cell4bdryarea/UTbase_revisedmaps/Uwl0312v2.srf	7



EXPLANATION

estimated dry area (kriged Brushy Basin surface > kriged perched water surface)

estimated areas of saturated thickness < 5 feet

MW-5 12 — perched monitoring well showing saturated thickness in feet

PIEZ-1 42 — perched piezometer showing saturated thickness in feet

DR-5 12 — perched piezometer installed May/June, 2011 showing saturated thickness in feet

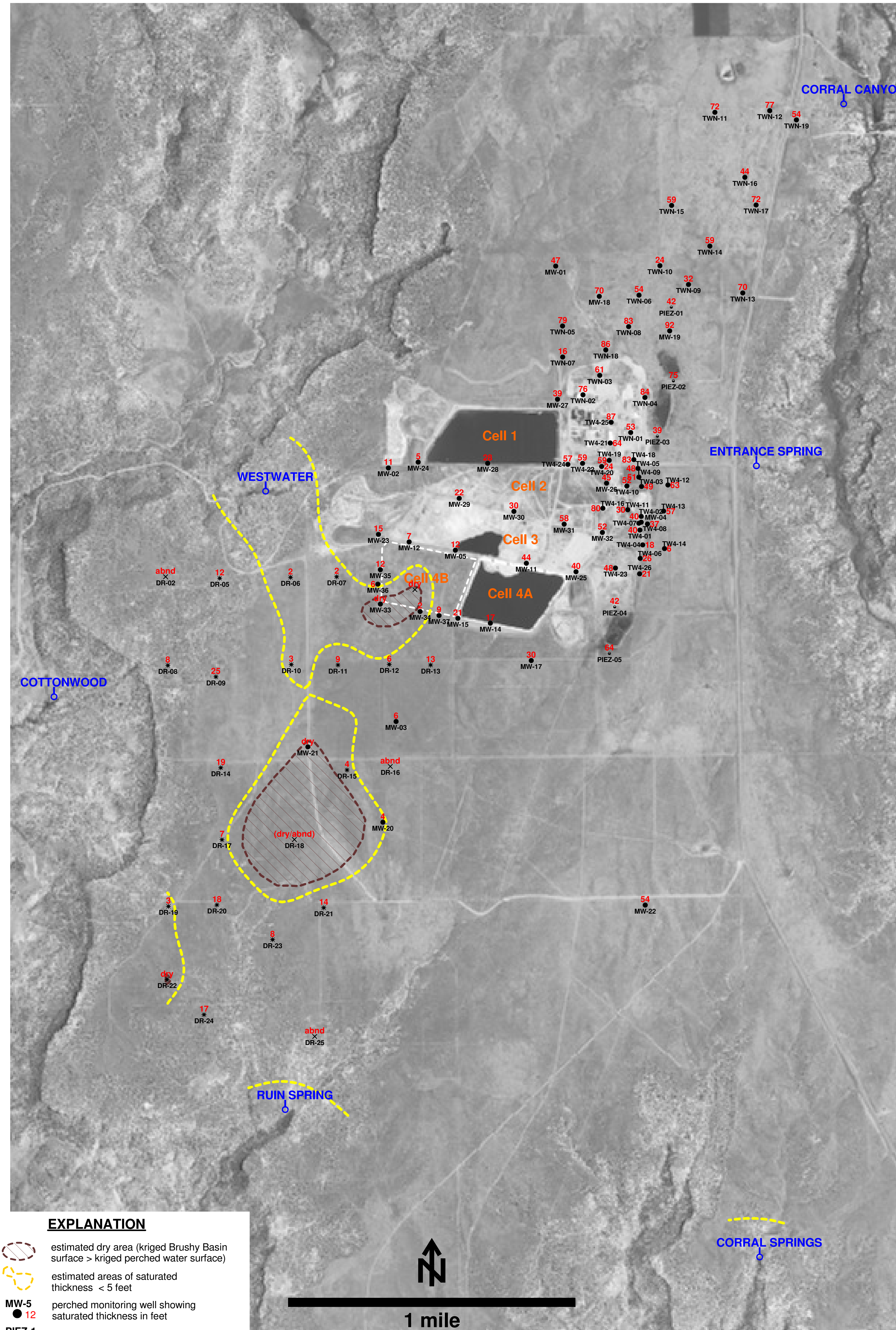
DR-16 — abandoned perched well; or DR-boring abandoned after May 25 measurement

RUIN SPRING — seep or spring

HYDRO GEO CHEM, INC.

2nd QUARTER, 2011 SATURATED THICKNESSES (DR-series water levels measured in open boreholes on May 25)

APPROVED	DATE	REFERENCE	FIGURE
SJS	7/20/12	H:/718000/cell4bdryarea/ UTMbase_revisedmaps/UTMstq211_rev0712.srf	8



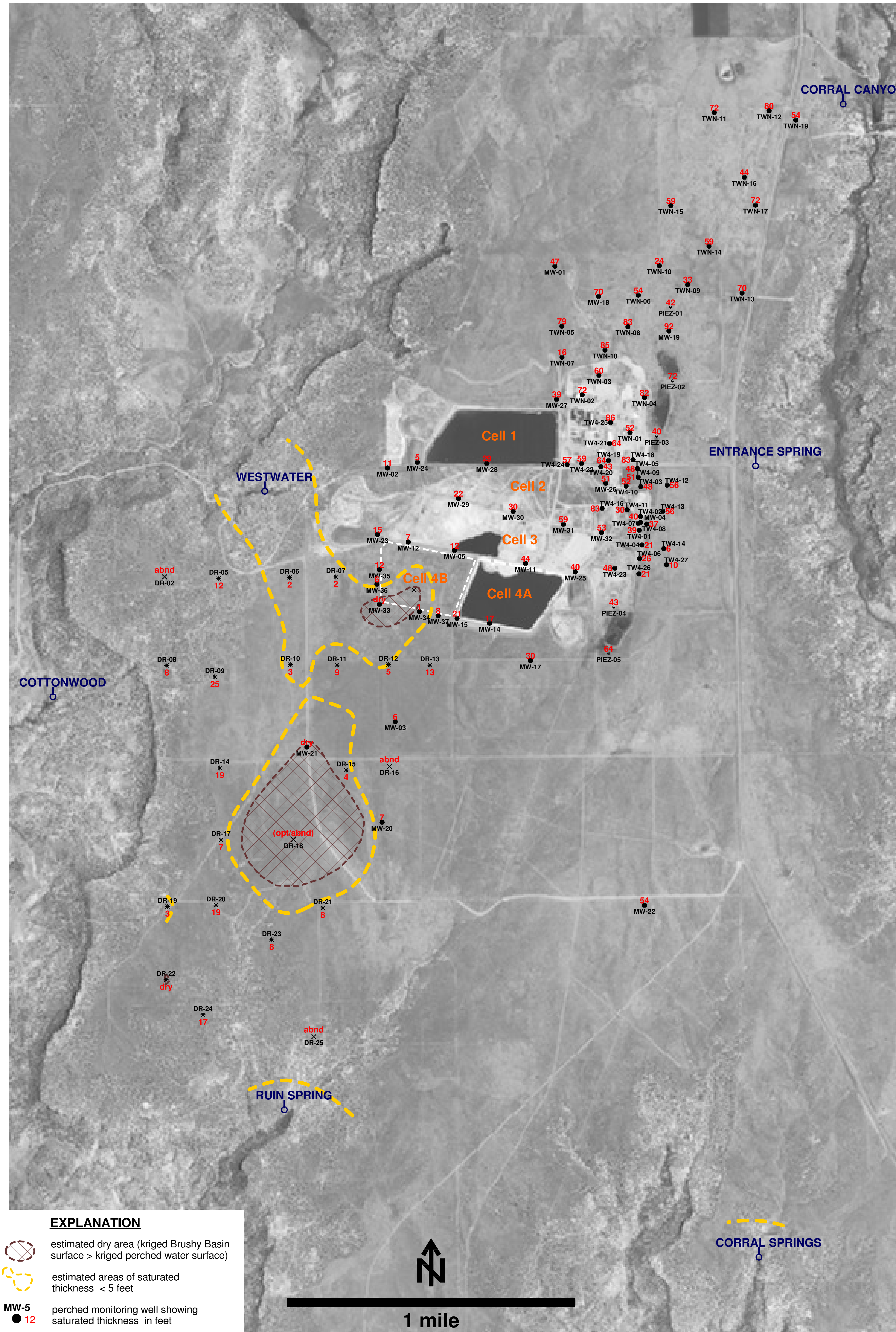
EXPLANATION

- estimated dry area (kriged Brushy Basin surface > kriged perched water surface)
- estimated areas of saturated thickness < 5 feet
- MW-5 ● 12 — perched monitoring well showing saturated thickness in feet
- PIEZ-1 ◒ 42 — perched piezometer showing saturated thickness in feet
- DR-5 ✷ 12 — perched piezometer installed May/June, 2011showing saturated thickness in feet
- DR-16 ✕ abnd — abandoned perched well or boring
- RUIN SPRING — seep or spring

HYDRO GEO CHEM, INC.

3rd QUARTER, 2011 SATURATED THICKNESSES (DR-series water levels measured in completed piezometers)

APPROVED	DATE	REFERENCE	FIGURE
SJS	7/20/12	H:/718000/cell4bdryarea/ UTMbase_revisedmaps/UTMstq311_rev0712.srf	9



EXPLANATION

estimated dry area (kriged Brushy Basin surface > kriged perched water surface)

estimated areas of saturated thickness < 5 feet

MW-5 12 perched monitoring well showing saturated thickness in feet

PIEZ-1 42 perched piezometer showing saturated thickness in feet

DR-5 12 perched piezometer installed May/June, 2011showing saturated thickness in feet

DR-2 abnd abandoned perched well or boring

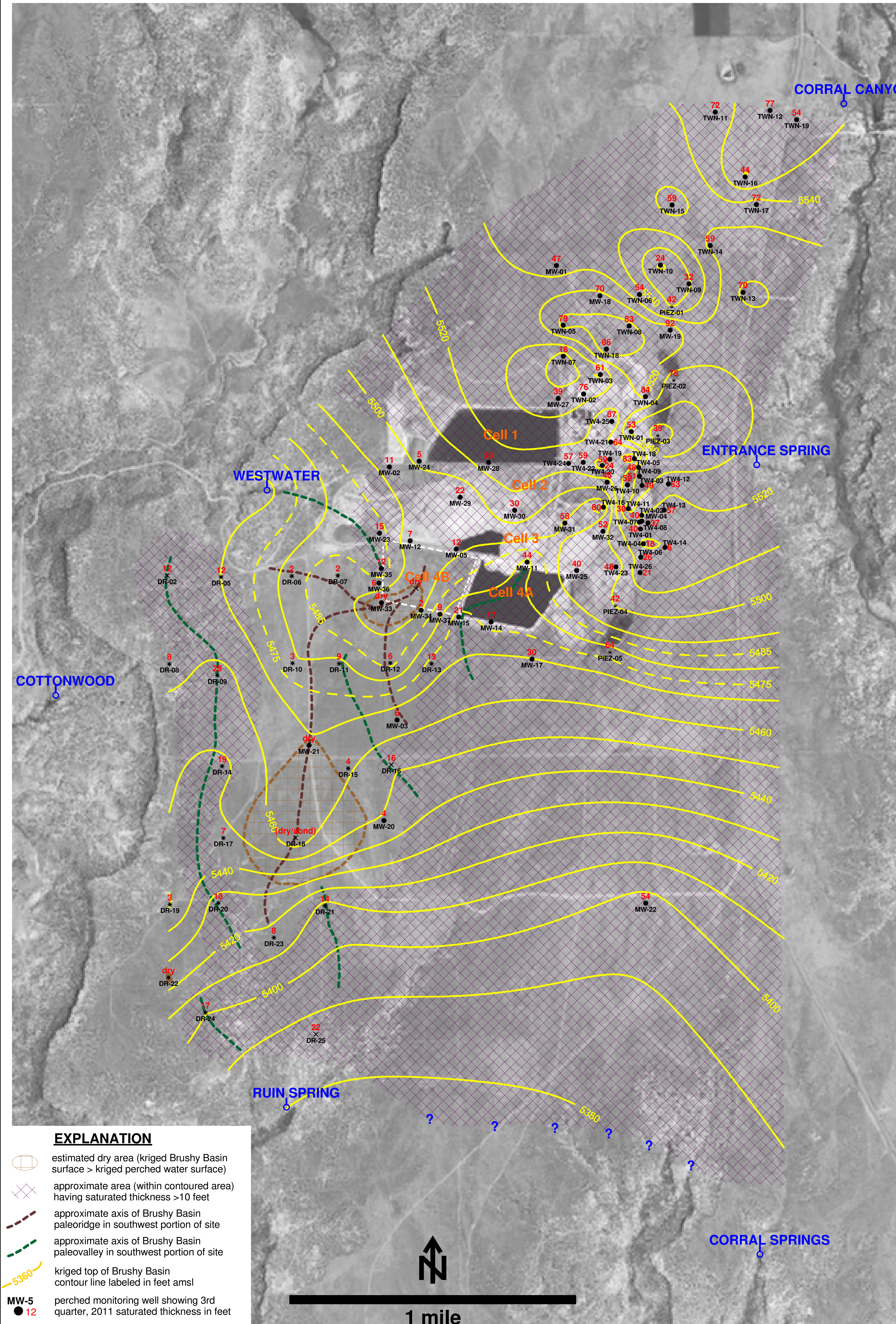
RUIN SPRING seep or spring (saturated thickness not defined)

NOTE: MW-4, MW-26, TW4-4, TW4-19, and TW4-20 are pumping wells

HYDRO GEO CHEM, INC.

1st QUARTER, 2012
PERCHED WATER SATURATED THICKNESSES
WHITE MESA SITE

APPROVED	DATE	REFERENCE	FIGURE
SJS	7/20/12	H:/718000/cell4bdryarea/ UTbase_revisedmaps/Usat0312v2.srf	10



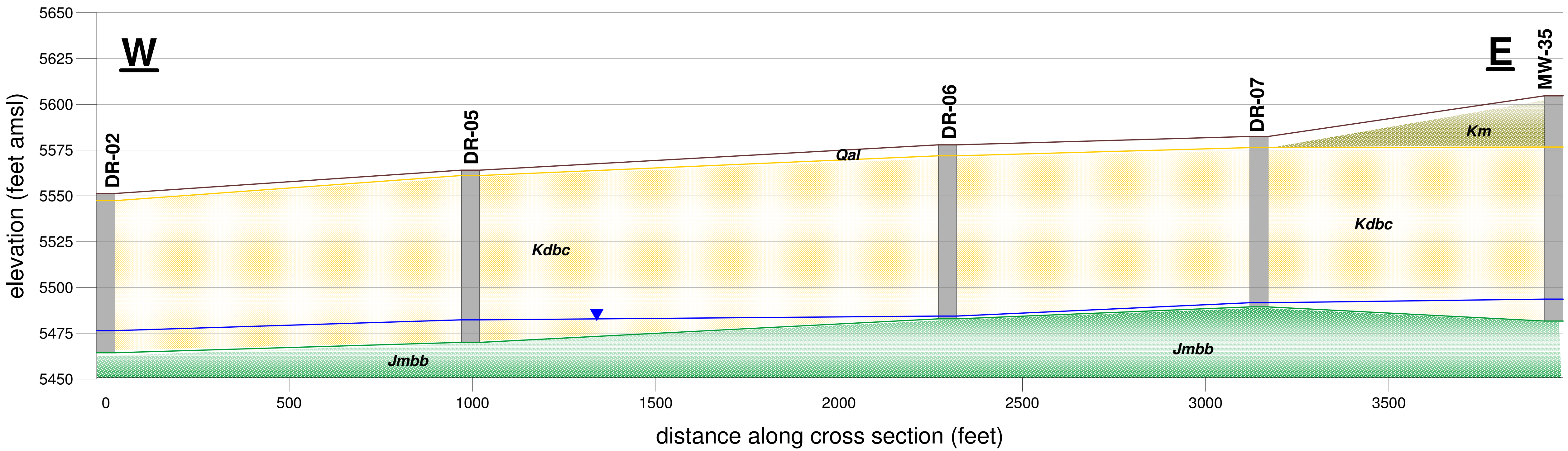
EXPLANATION

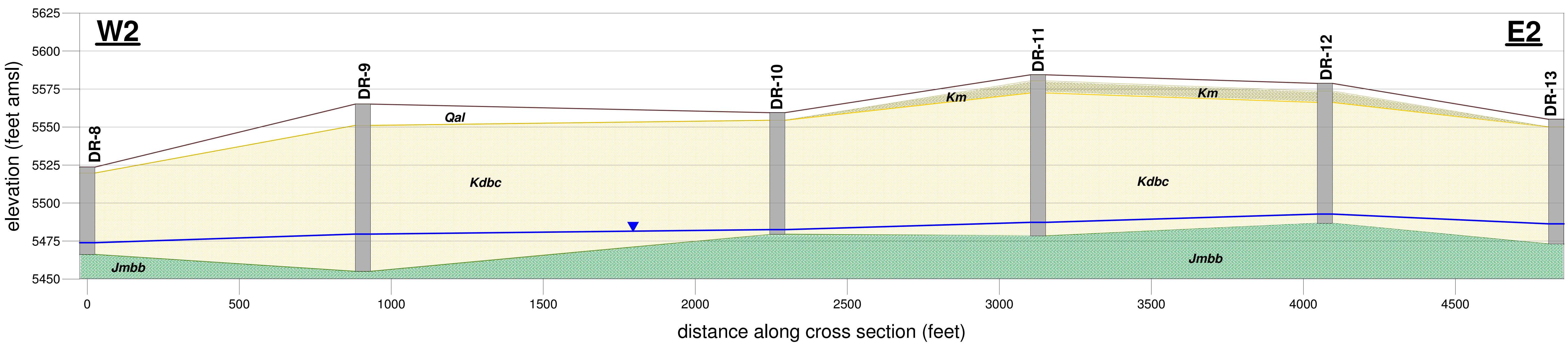
- estimated dry area (kriged Brushy Basin surface > kriged perched water surface)
- approximate area (within contoured area) having saturated thickness >10 feet
- approximate axis of Brushy Basin paleoridge in southwest portion of site
- approximate axis of Brushy Basin paleovalley in southwest portion of site
- 5360 kriged top of Brushy Basin contour line labeled in feet amsl
- MW-5 12 perched monitoring well showing 3rd quarter, 2011 saturated thickness in feet
- PIEZ-1 42 perched piezometer showing 3rd quarter, 2011 saturated thickness in feet
- DR-5 12 perched piezometer installed May/June, 2011 showing 3rd quarter, 2011 saturated thickness in feet
- DR-2 12 abandoned perched well or boring showing 2nd quarter, 2011 saturated thickness in feet
- RUIN SPRING seep or spring

HYDRO GEO CHEM, INC.

APPROXIMATE AXES OF BRUSHY BASIN PALEORIDGES AND PALEOVALLEYS IN SOUTHWEST AREA (with top of Brushy Basin elevation contours and posted 3rd quarter, 2011 saturated thicknesses)

APPROVED	DATE	REFERENCE	FIGURE
SJS	7/20/12	H:/718000/cell4bdryarea/ UTbase_revisedmaps/UTMbbst11v2_rev0712.srf	11





vertical exaggeration = 5:1

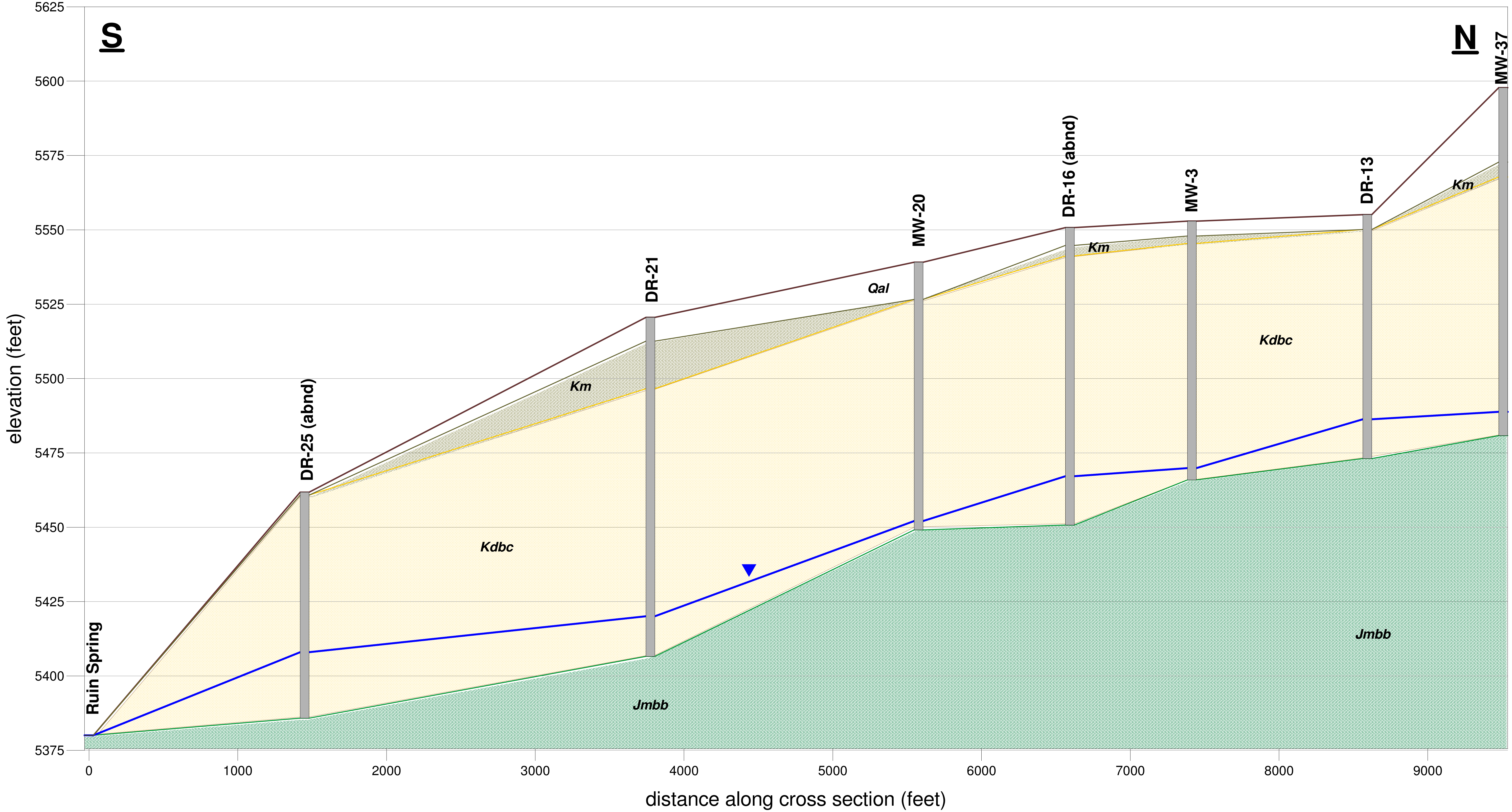
EXPLANATION

- *Qal* — Alluvium/Fill
- *Km* — Mancos Shale
- *Kdbc* — Dakota Sandstone/ Burro Canyon Formation
- Piezometric surface (NOTE: abandoned DR-2 water level from 2nd quarter, 2011)
- *Jmbb* — Brushy Basin Member of Morrison Formation

HYDRO GEO CHEM, INC.

INTERPRETIVE EAST-WEST CROSS SECTIONS (W-E and W2-E2) SOUTHWEST INVESTIGATION AREA

APPROVED	DATE	REFERENCE	FIGURE
SJS	7/20/12	H:/718000/cell4bdryarea/ UTMbase_revisedmaps/ewxsectb_rev0712.srf	12



EXPLANATION

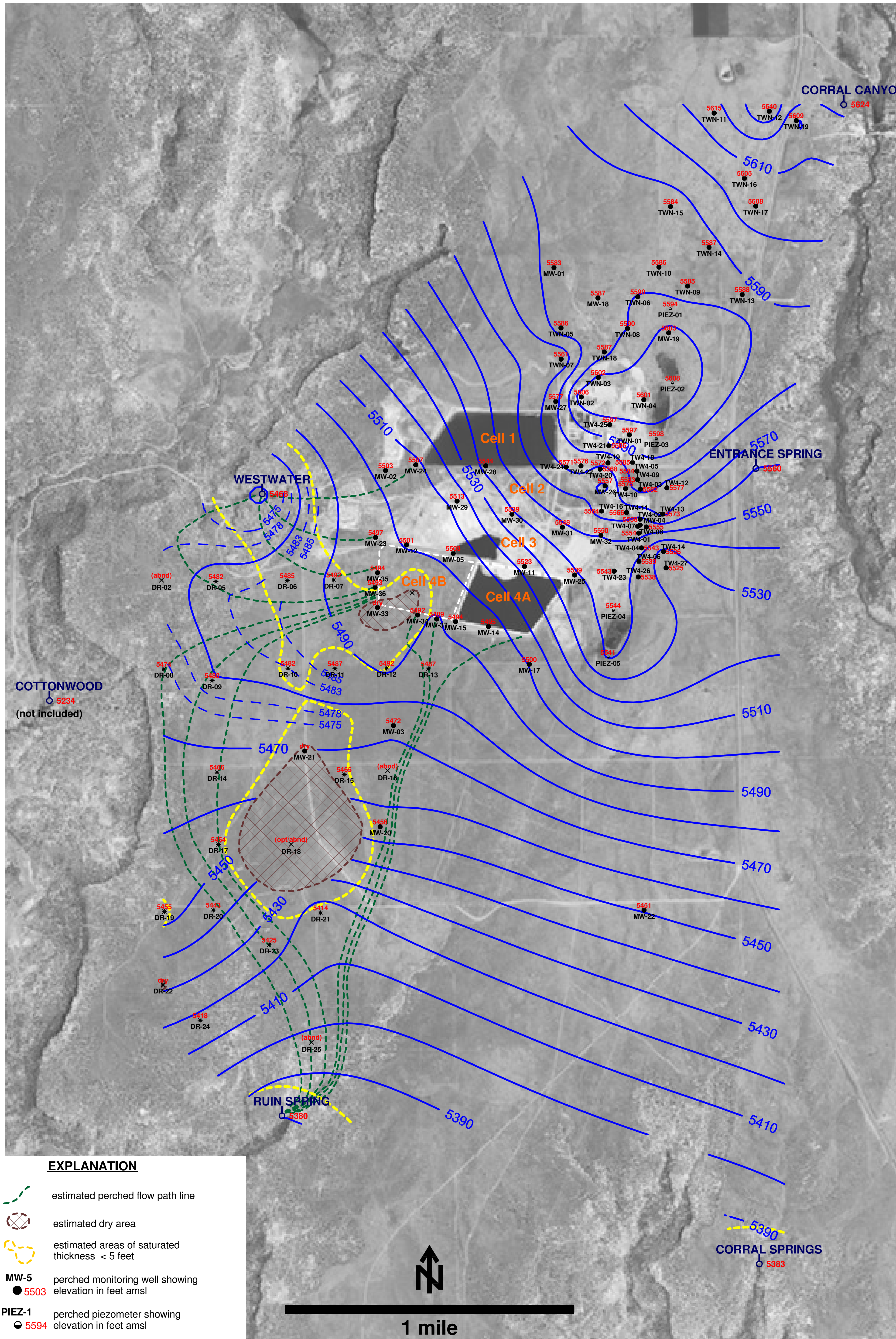
vertical exaggeration = 20:1

Qal	Alluvium/Fill
Km	Mancos Shale
Kdbc	Dakota Sandstone/ Burro Canyon Formation
Jmbb	Brushy Basin Member of Morrison Formation
(blue line with triangle)	Piezometric surface (NOTES: abandoned DR-16 and DR-25 water levels are from the 2nd quarter, 2011)

HYDRO GEO CHEM, INC.

INTERPRETIVE NORTH-SOUTH CROSS SECTION (S-N) SOUTHWEST INVESTIGATION AREA

APPROVED	DATE	REFERENCE	FIGURE
SJS	7/20/12	H:/718000/cell4bdryarea/ UTMbase_revisedmaps/nsxsectb_rev0712.srf	13



EXPLANATION

estimated perched flow path line

estimated dry area

estimated areas of saturated thickness < 5 feet

MW-5 ● 5503 perched monitoring well showing elevation in feet amsl

PIEZ-1 5594 perched piezometer showing elevation in feet amsl

DR-5 5482 perched piezometer installed May, 2011 showing elevation in feet amsl

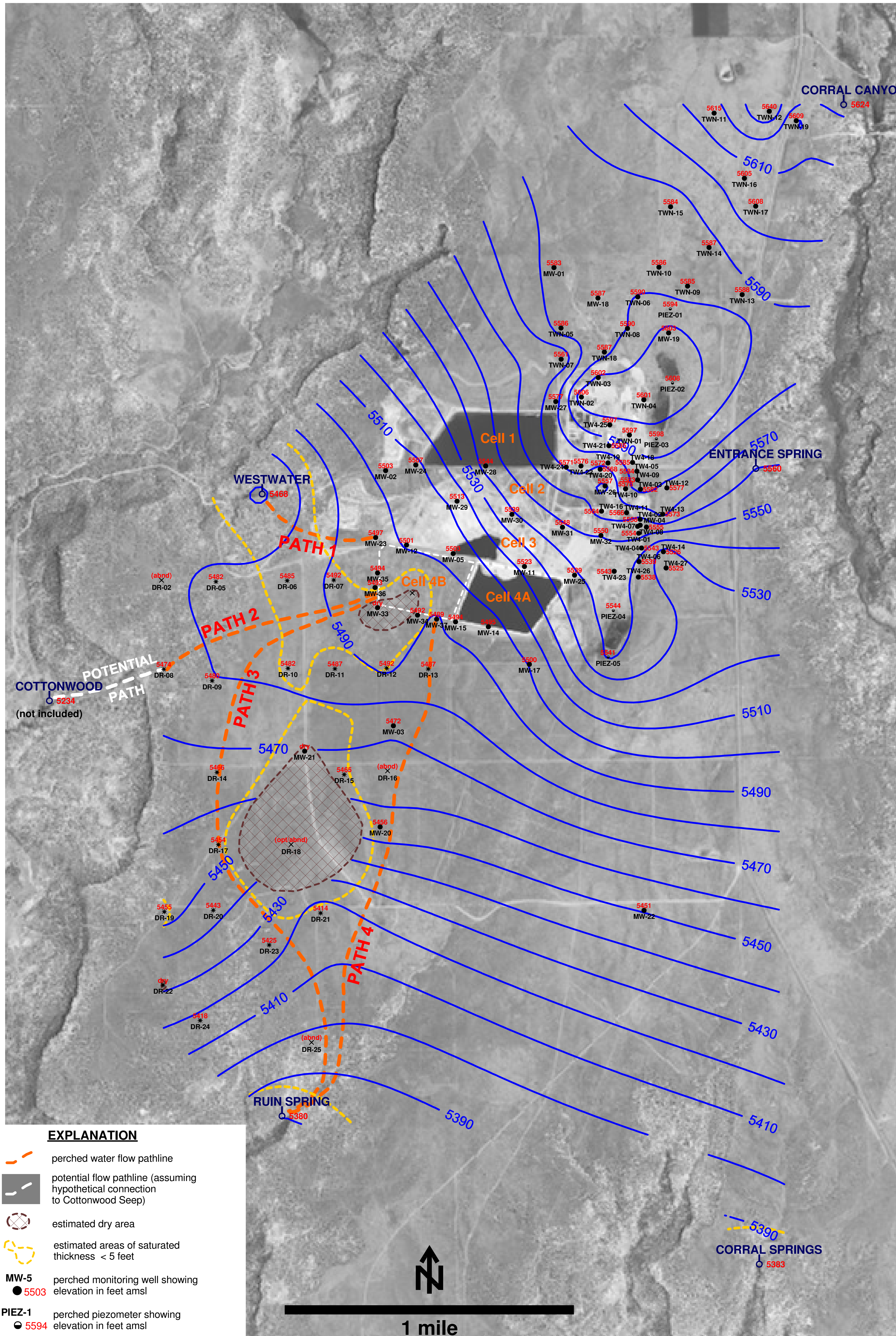
DR-16 ✕ abandoned perched well or boring

RUIN SPRING 5380 seep or spring showing elevation in feet amsl

HYDRO GEO CHEM, INC.

KRIGED 1st QUARTER, 2012 WATER LEVELS SHOWING INFERRED PERCHED WATER FLOW PATHLINES SOUTHWEST (DOWNGRADIENT) OF CELLS

APPROVED	DATE	REFERENCE	FIGURE
SJS	7/20/12	H:/718000/cell4bdryarea/ UTbase_revisedmaps/Uflow0312v2.srf	14



EXPLANATION

perched water flow pathline

potential flow pathline (assuming hypothetical connection to Cottonwood Seep)

estimated dry area

estimated areas of saturated thickness < 5 feet

MW-5 5503 perched monitoring well showing elevation in feet amsl

PIEZ-1 5594 perched piezometer showing elevation in feet amsl

DR-5 5482 perched piezometer installed May, 2011 showing elevation in feet amsl

DR-16 abandoned perched well or boring

RUIN SPRING 5380 seep or spring showing elevation in feet amsl

HYDRO GEO CHEM, INC.

PERCHED WATER ELEVATIONS AND PATHLINES USED FOR PERCHED WATER TRAVEL TIME ESTIMATES

APPROVED	DATE	REFERENCE	FIGURE
SJS	7/20/12	H:/718000/cell4bdryarea/ UTbase_revisedmaps/Upath0312v2.srf	15

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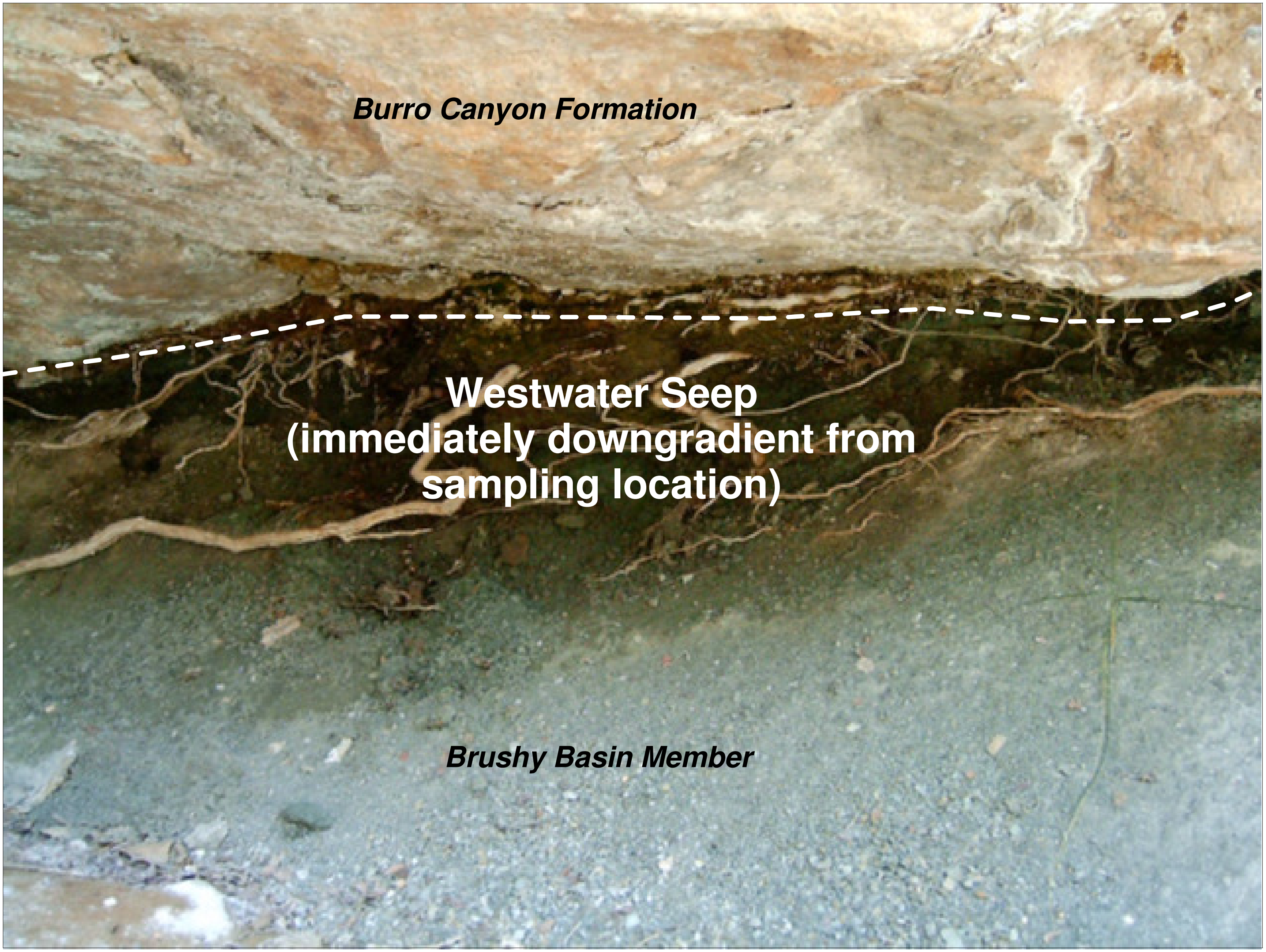
PHOTOGRAPH OF THE WESTWATER SEEP SAMPLING LOCATION JULY 2010

APPROVED	DATE	REFERENCE	FIGURE
SJS	7/20/12	H:/718000/cell4bdryarea/ UTbase_revisedmaps/westsampl_v2.srf	16



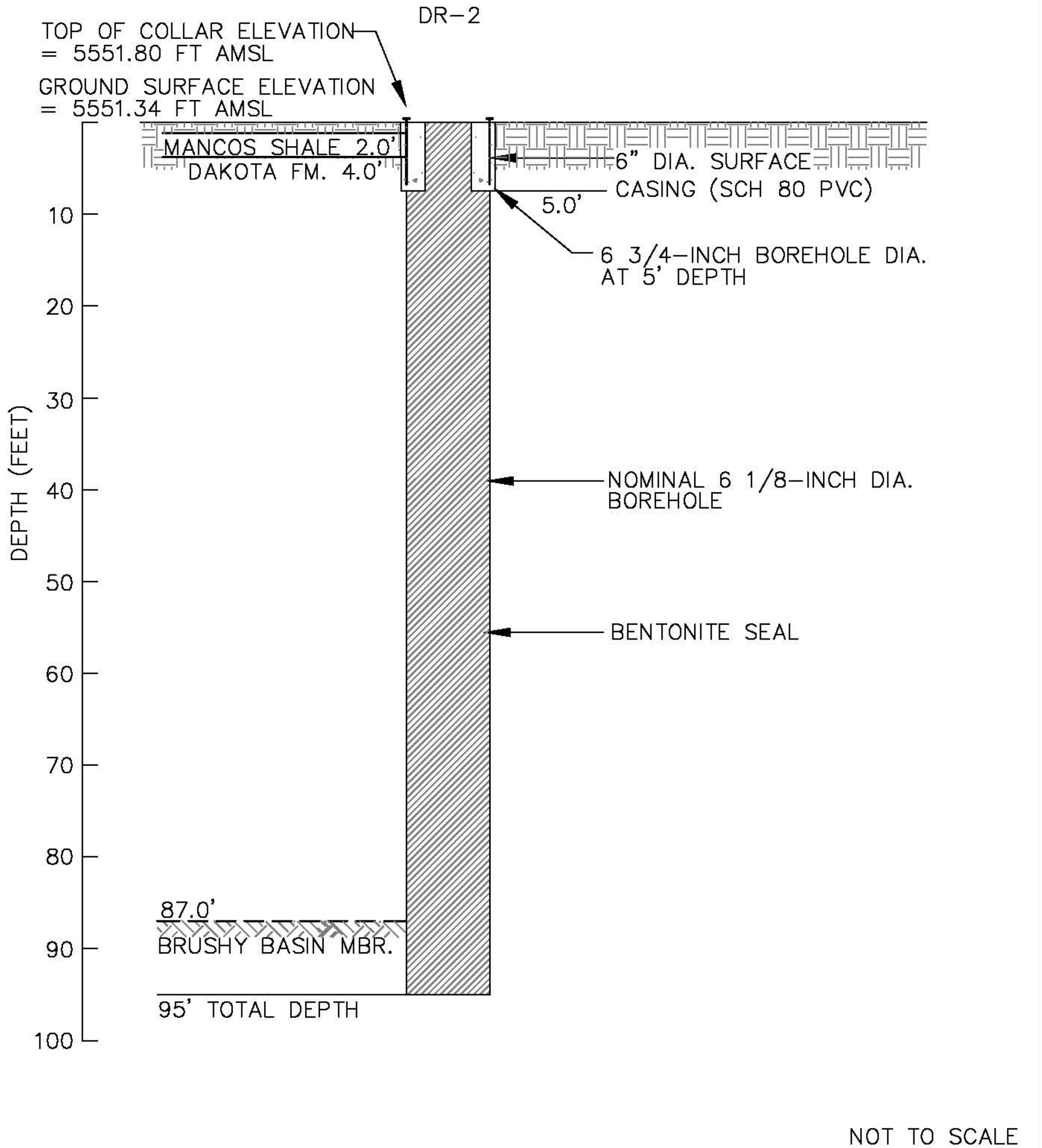
HYDRO
GEO
CHEM, INC.

PHOTOGRAPH OF THE CONTACT BETWEEN THE BURRO CANYON FORMATION AND THE BRUSHY BASIN MEMBER AT WESTWATER SEEP

APPROVED	DATE	REFERENCE	FIGURE
SJS	7/20/12	H:/718000/cell4bdryarea/ UTbase_revisedmaps/westcontact_v2.srf	17

APPENDIX A

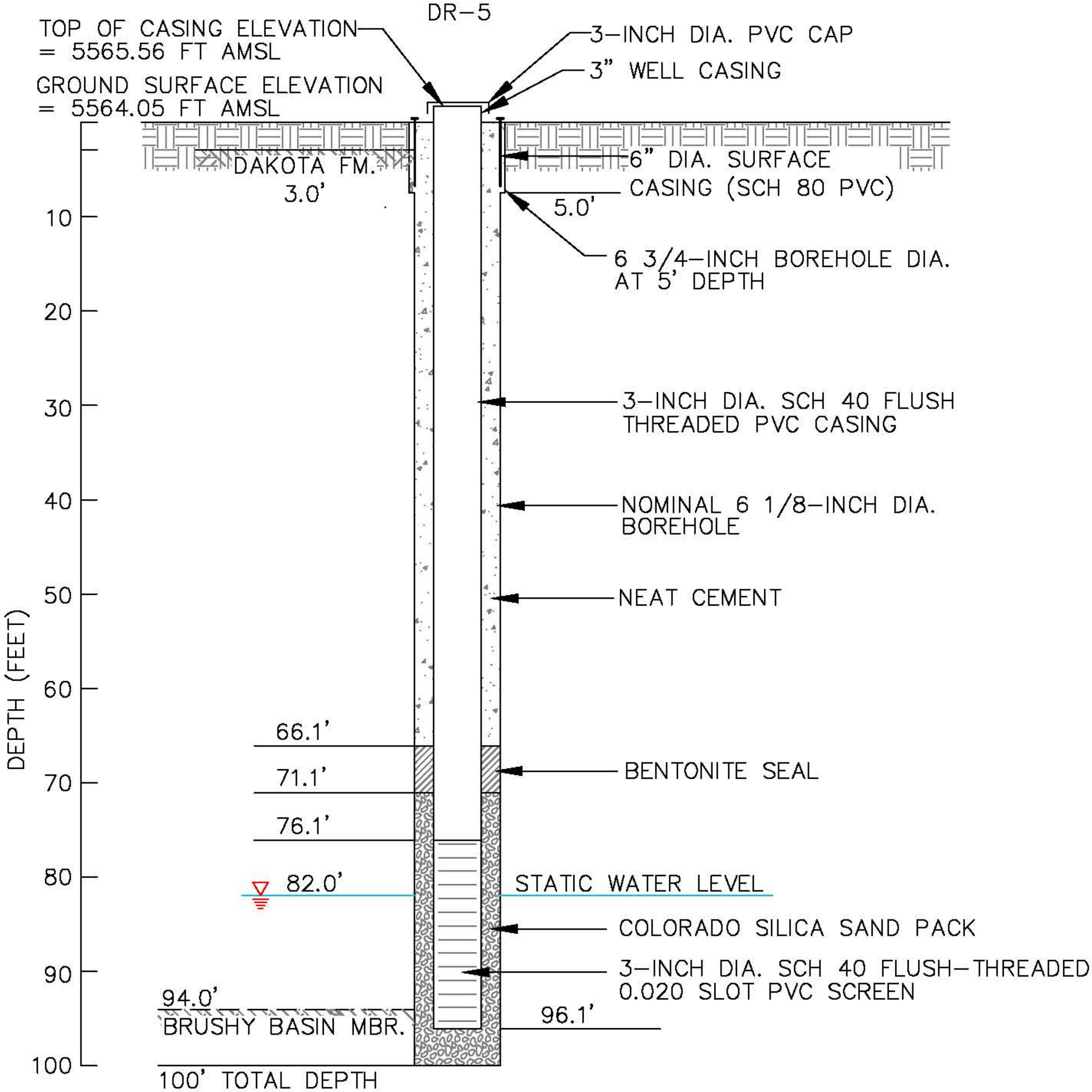
AS-BUILT PIEZOMETER CONSTRUCTION DIAGRAMS



HYDRO GEO CHEM, INC.

DR-2
WELL ABANDONMENT SCHEMATIC

Approved	Date	Reference	Figure
SJS	1/9/12	K:\7180271A Well Construction Diagram	

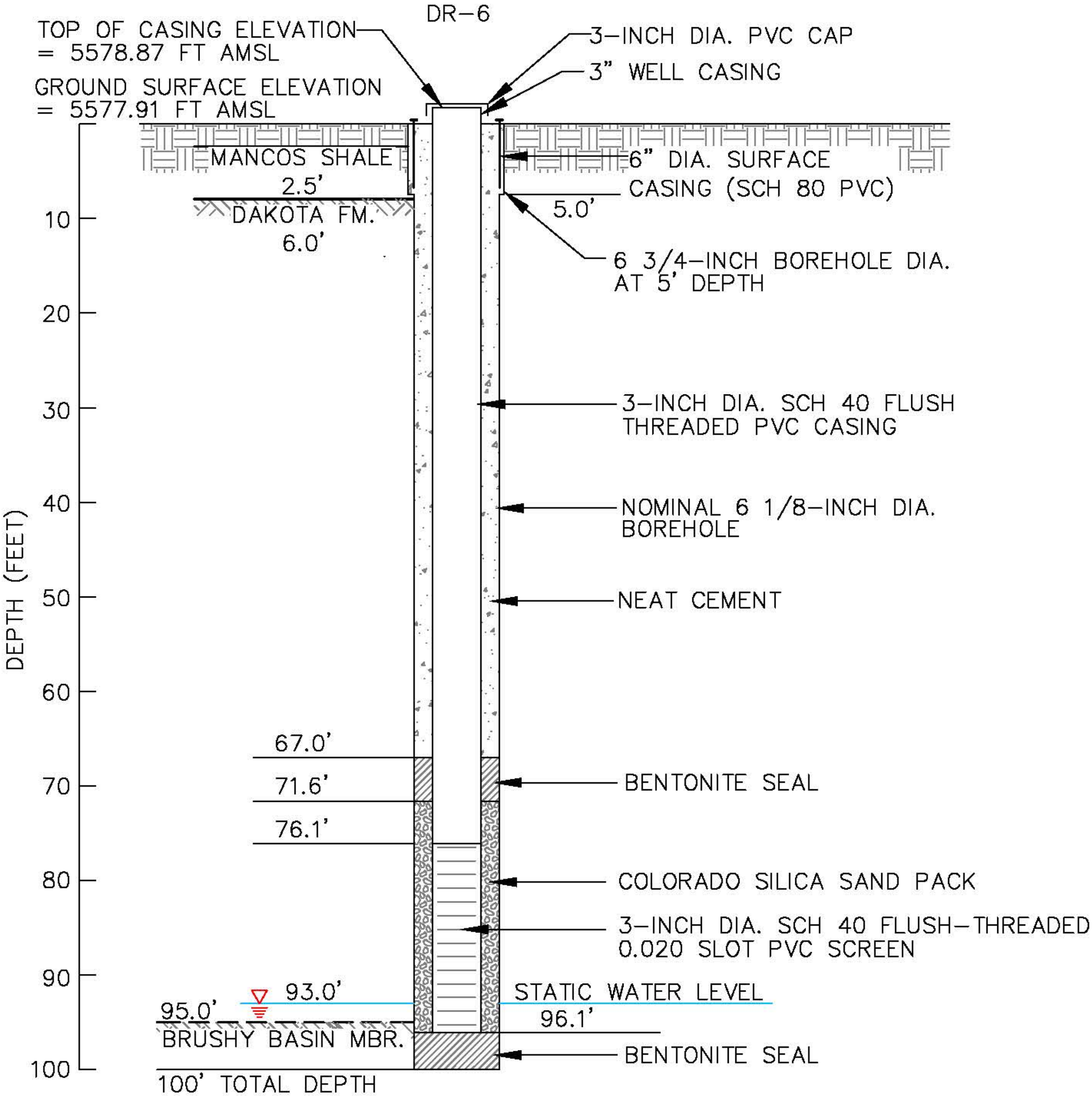


NOT TO SCALE

HYDRO GEO CHEM, INC.

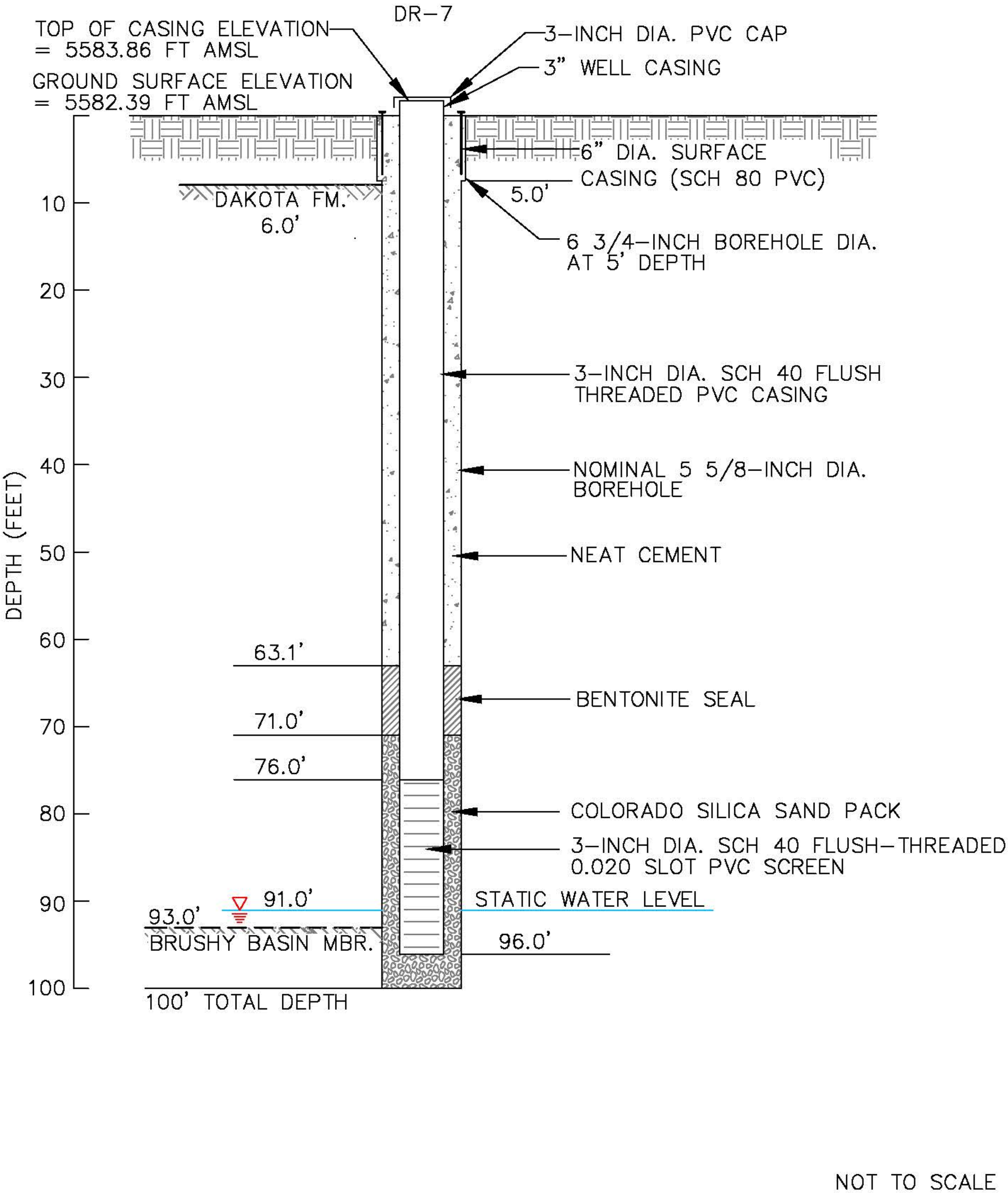
DR-5
AS-BUILT WELL CONSTRUCTION SCHEMATIC

Approved	Date	Reference	Figure
SJS	1/9/12	K:\7180250A Well Construction Diagram	



NOT TO SCALE

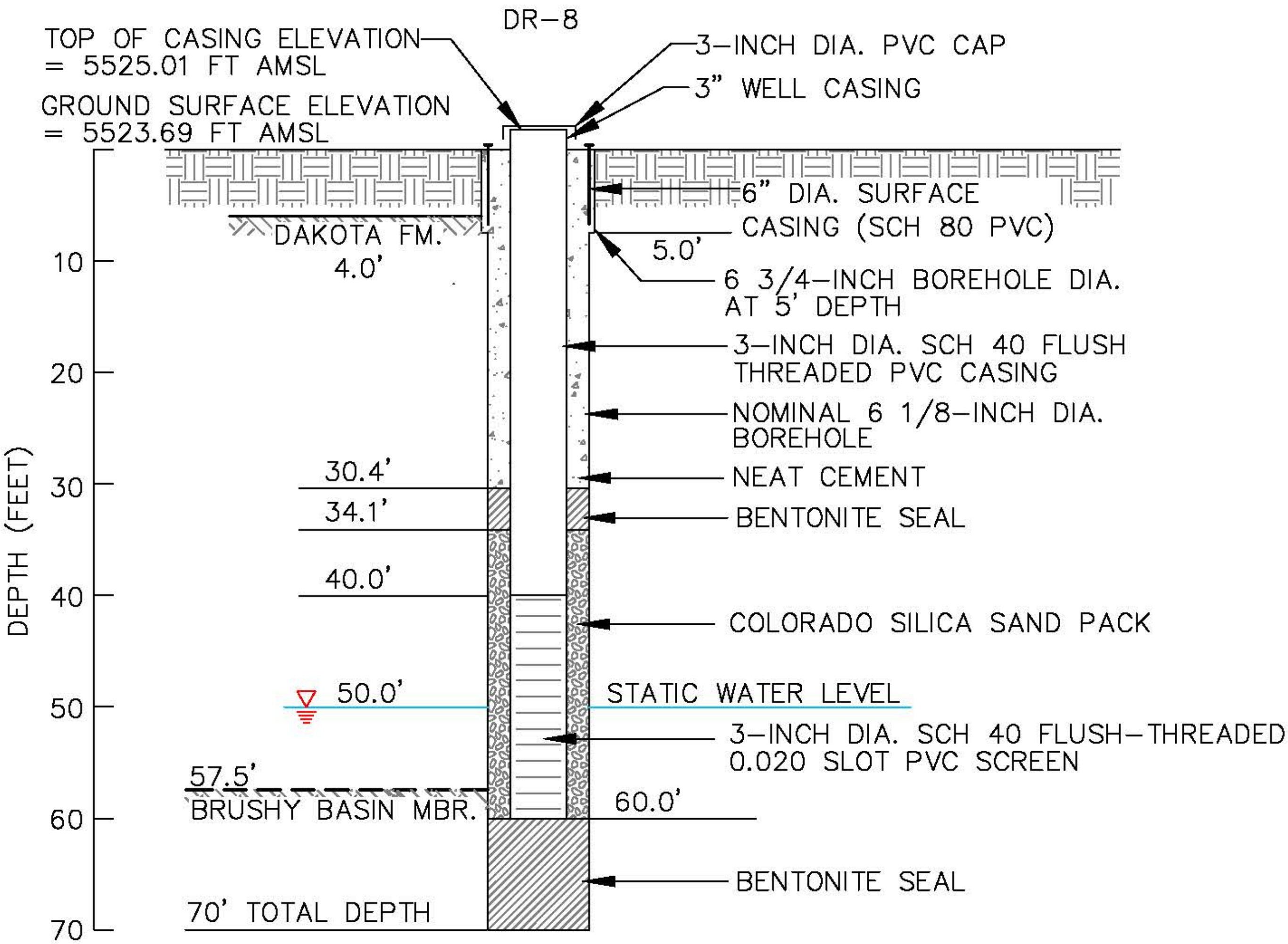
HYDRO GEO CHEM, INC.	DR-6 AS-BUILT WELL CONSTRUCTION SCHEMATIC		
Approved SJS	Date 1/9/12	Reference K:\7180251A Well Construction Diagram	Figure



HYDRO GEO CHEM, INC.

DR-7
AS-BUILT WELL CONSTRUCTION SCHEMATIC

Approved	Date	Reference	Figure
SJS	1/9/12	K:\7180252A Well Construction Diagram	

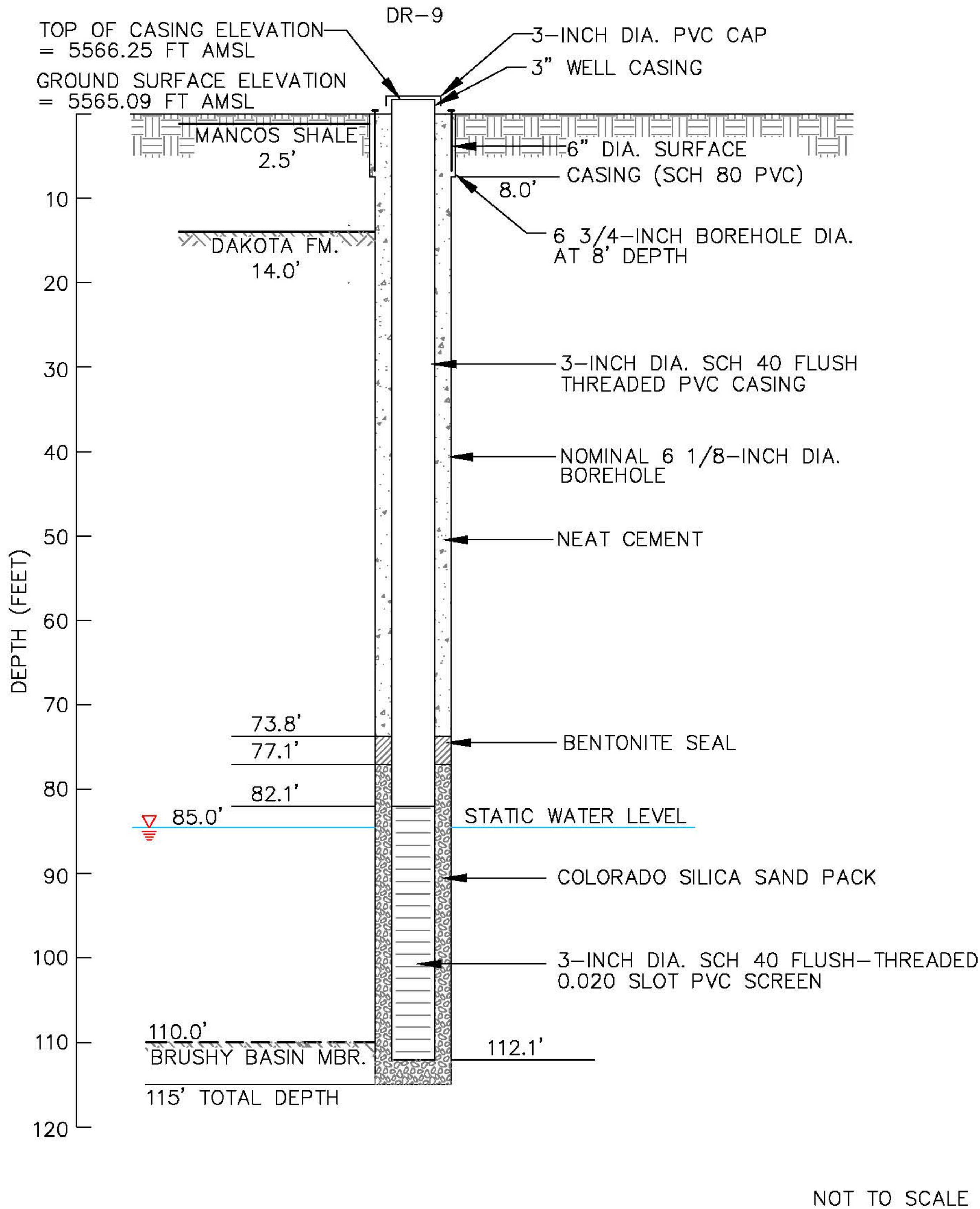


NOT TO SCALE

HYDRO GEO CHEM, INC.

DR-8
AS-BUILT WELL CONSTRUCTION SCHEMATIC

Approved	Date	Reference	Figure
SJS	1/9/12	K:\7180253A Well Construction Diagram	

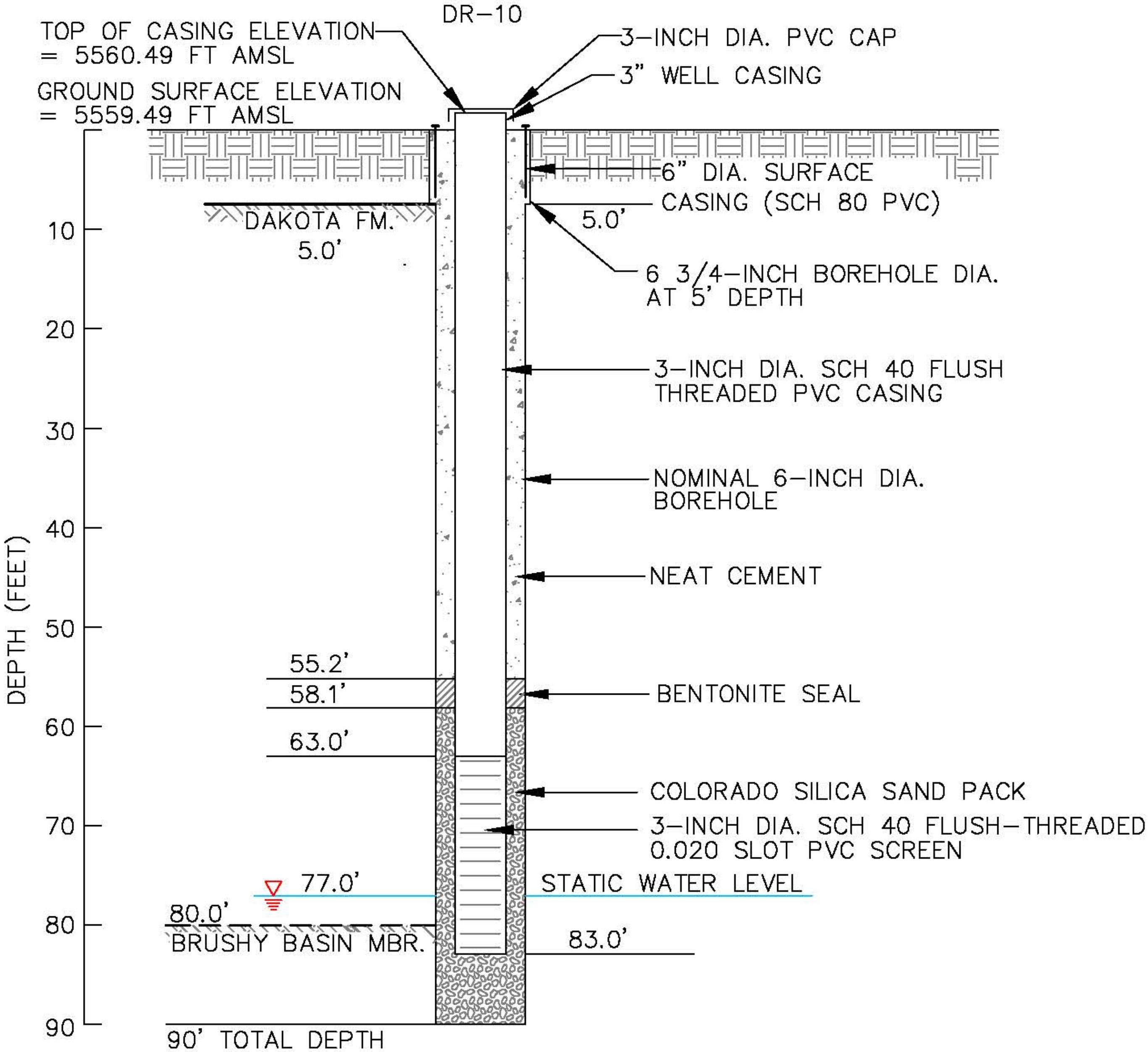


NOT TO SCALE

HYDRO GEO CHEM, INC.

DR-9
AS-BUILT WELL CONSTRUCTION SCHEMATIC

Approved	Date	Reference	Figure
SJS	1/9/12	K:\7180254A Well Construction Diagram	

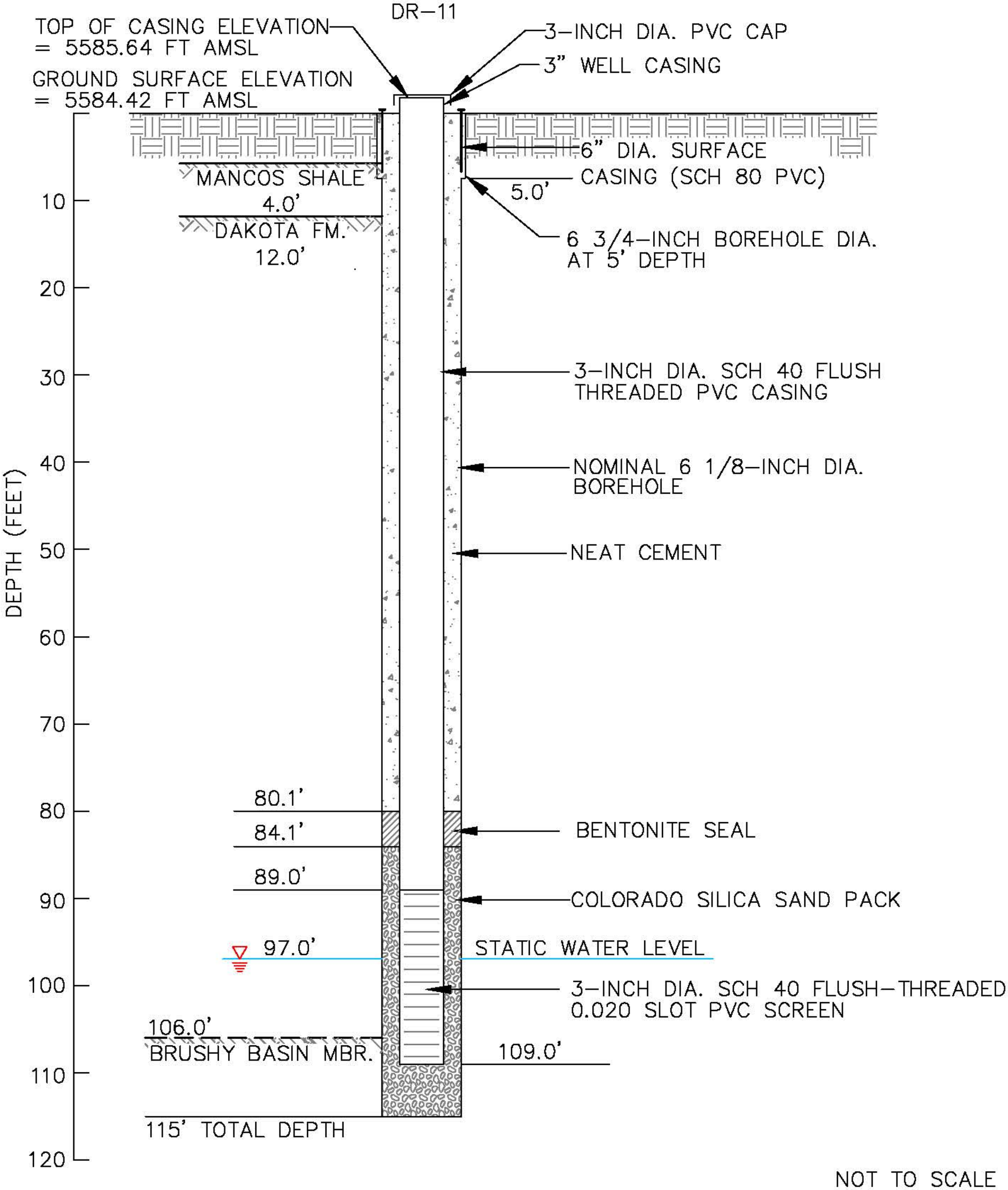


NOT TO SCALE

HYDRO GEO CHEM, INC.

DR-10
AS-BUILT WELL CONSTRUCTION SCHEMATIC

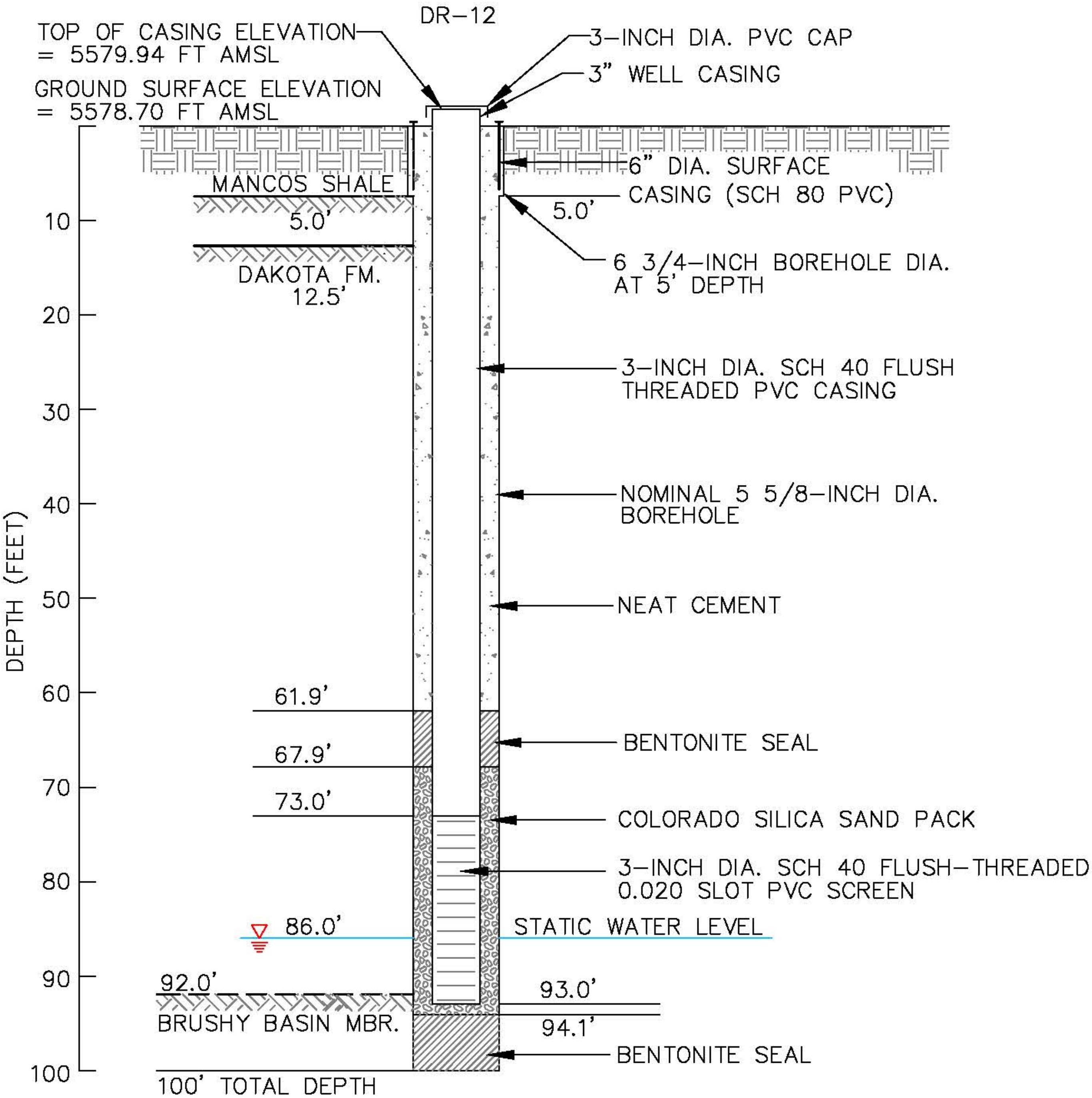
Approved	Date	Reference	Figure
SJS	1/9/12	K:\7180255A Well Construction Diagram	



HYDRO GEO CHEM, INC.

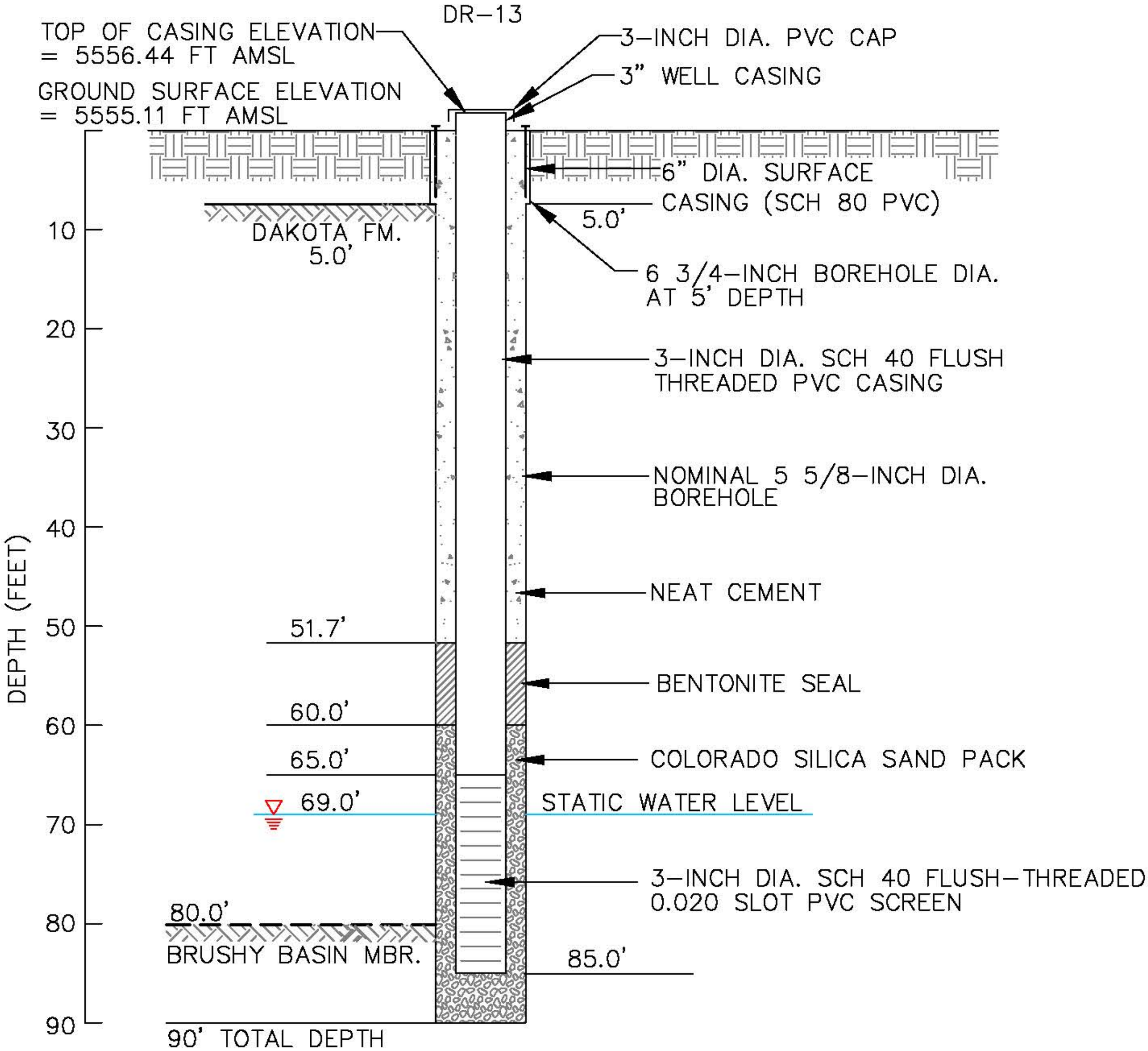
DR-11
AS-BUILT WELL CONSTRUCTION SCHEMATIC

Approved	Date	Reference	Figure
SJS	1/9/12	K:\7180256A Well Construction Diagram	



NOT TO SCALE

HYDRO GEO CHEM, INC.	DR-12 AS-BUILT WELL CONSTRUCTION SCHEMATIC		
Approved: SJS	Date: 1/9/12	Reference: K:\7180257A Well Construction Diagram	Figure

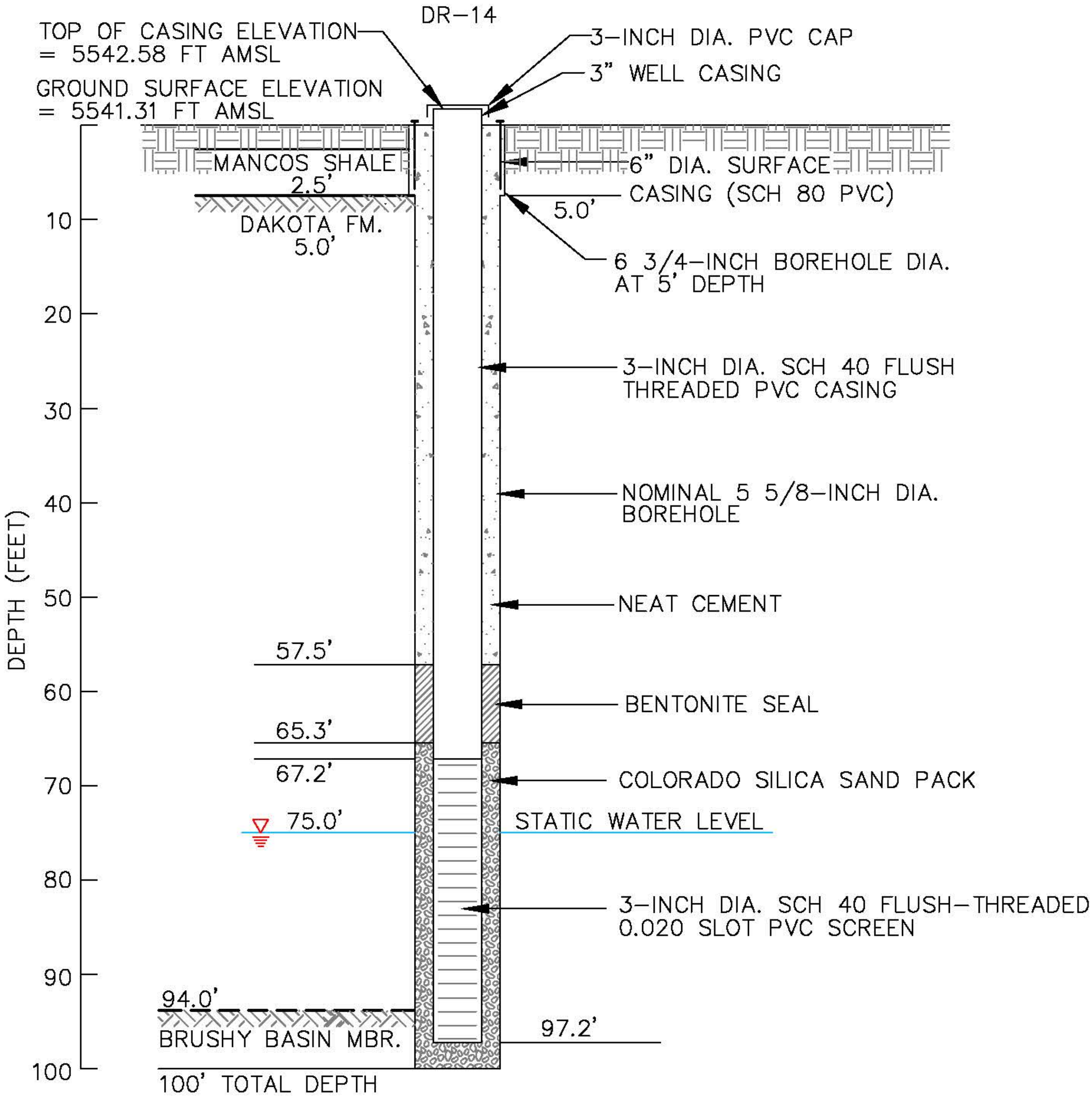


NOT TO SCALE

HYDRO GEO CHEM, INC.

DR-13
AS-BUILT WELL CONSTRUCTION SCHEMATIC

Approved	Date	Reference	Figure
SJS	1/9/12	K:\7180258A Well Construction Diagram	

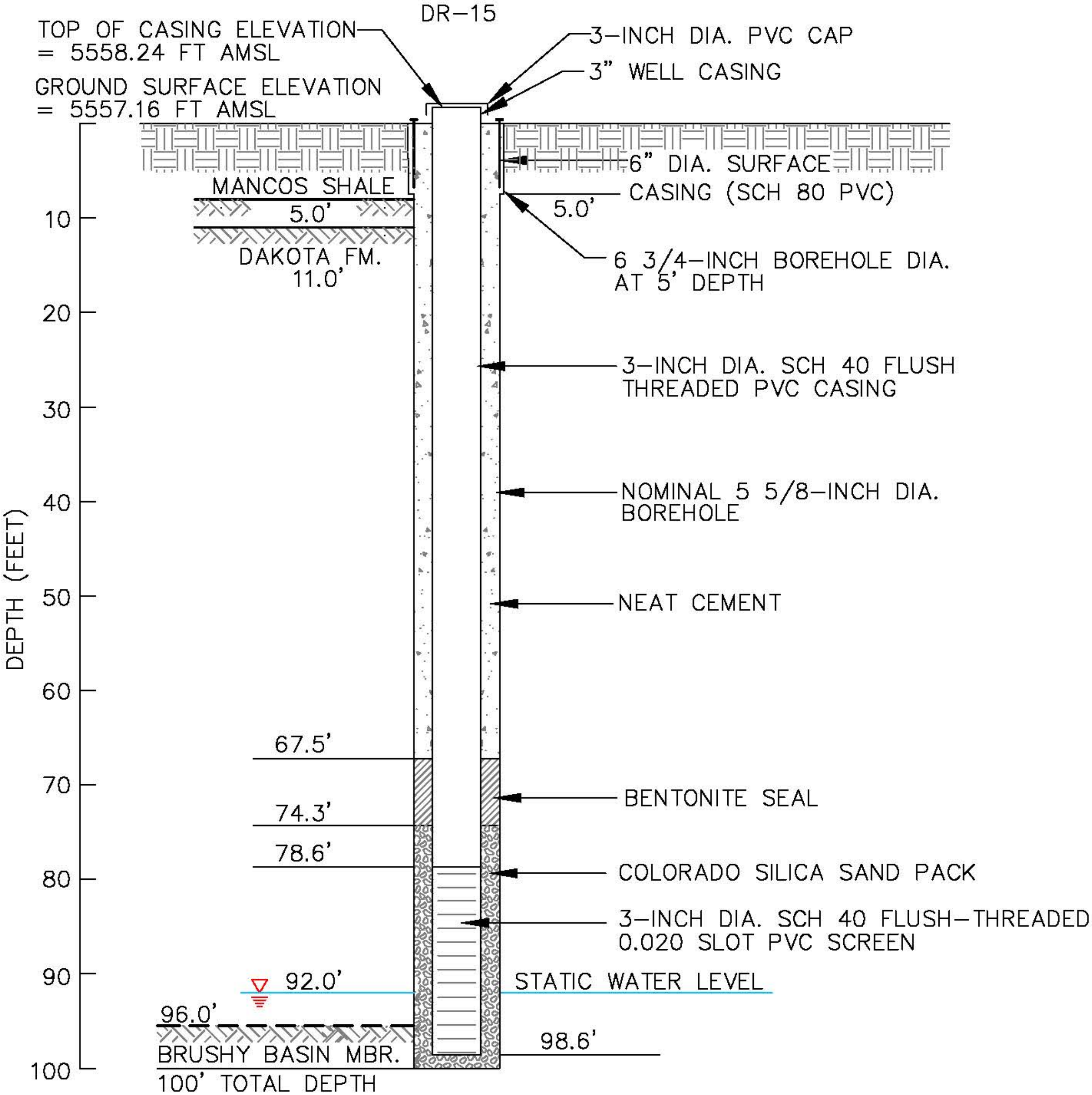


NOT TO SCALE

HYDRO GEO CHEM, INC.

DR-14
AS-BUILT WELL CONSTRUCTION SCHEMATIC

Approved	Date	Reference	Figure
SJS	1/9/12	K:\7180259A Well Construction Diagram	

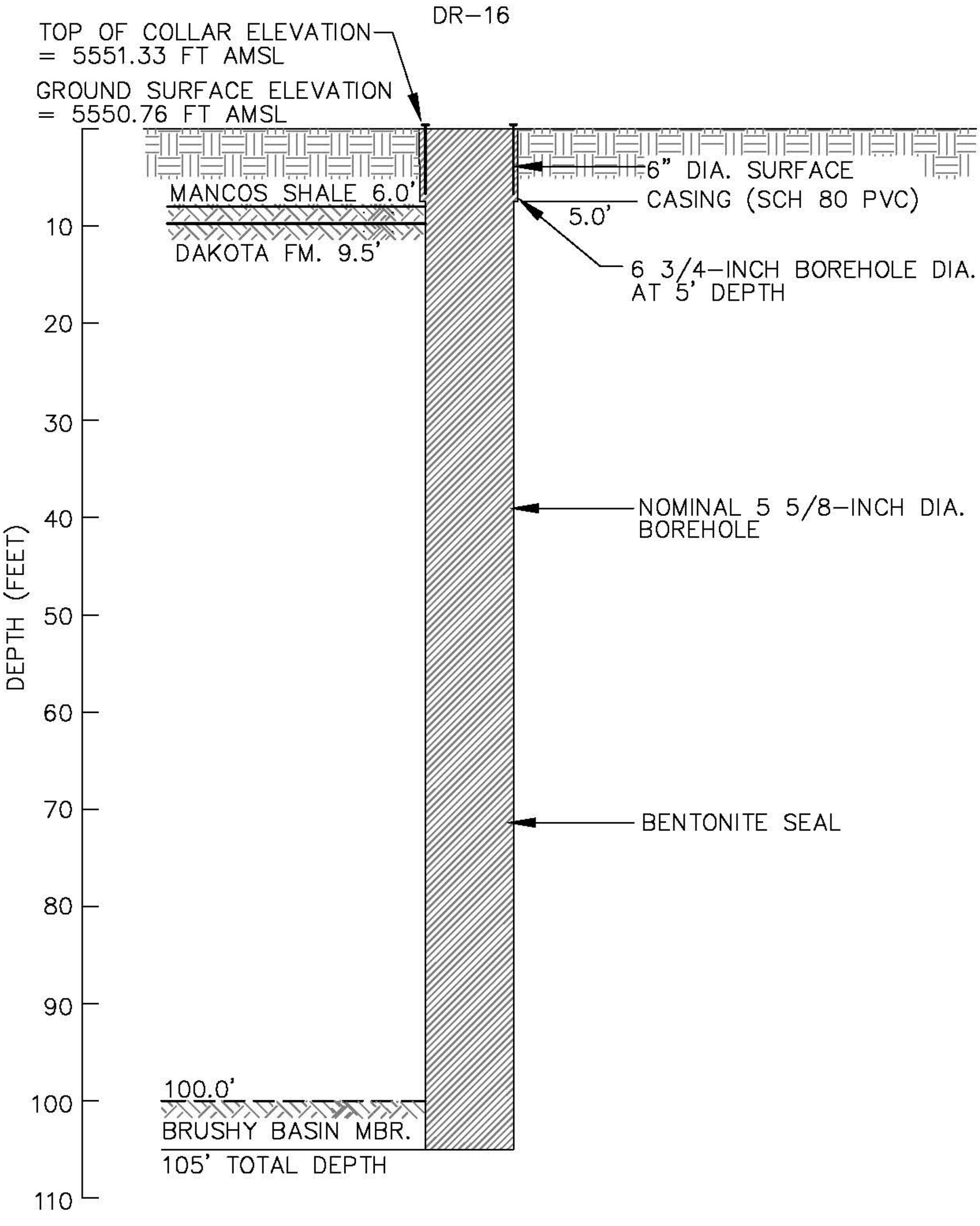


NOT TO SCALE

HYDRO GEO CHEM, INC.

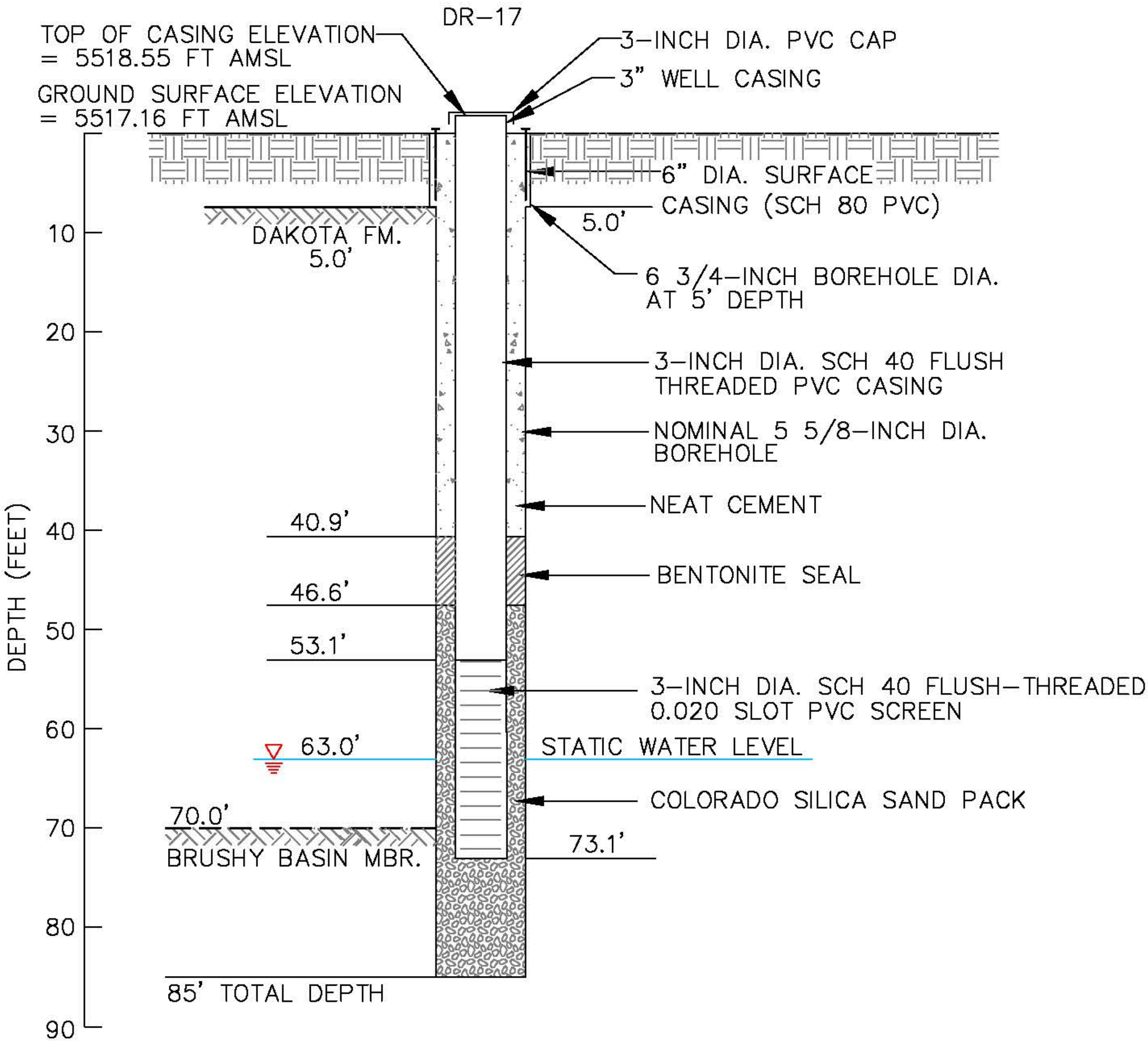
DR-15
AS-BUILT WELL CONSTRUCTION SCHEMATIC

Approved	Date	Reference	Figure
SJS	1/9/12	K:\7180260A Well Construction Diagram	



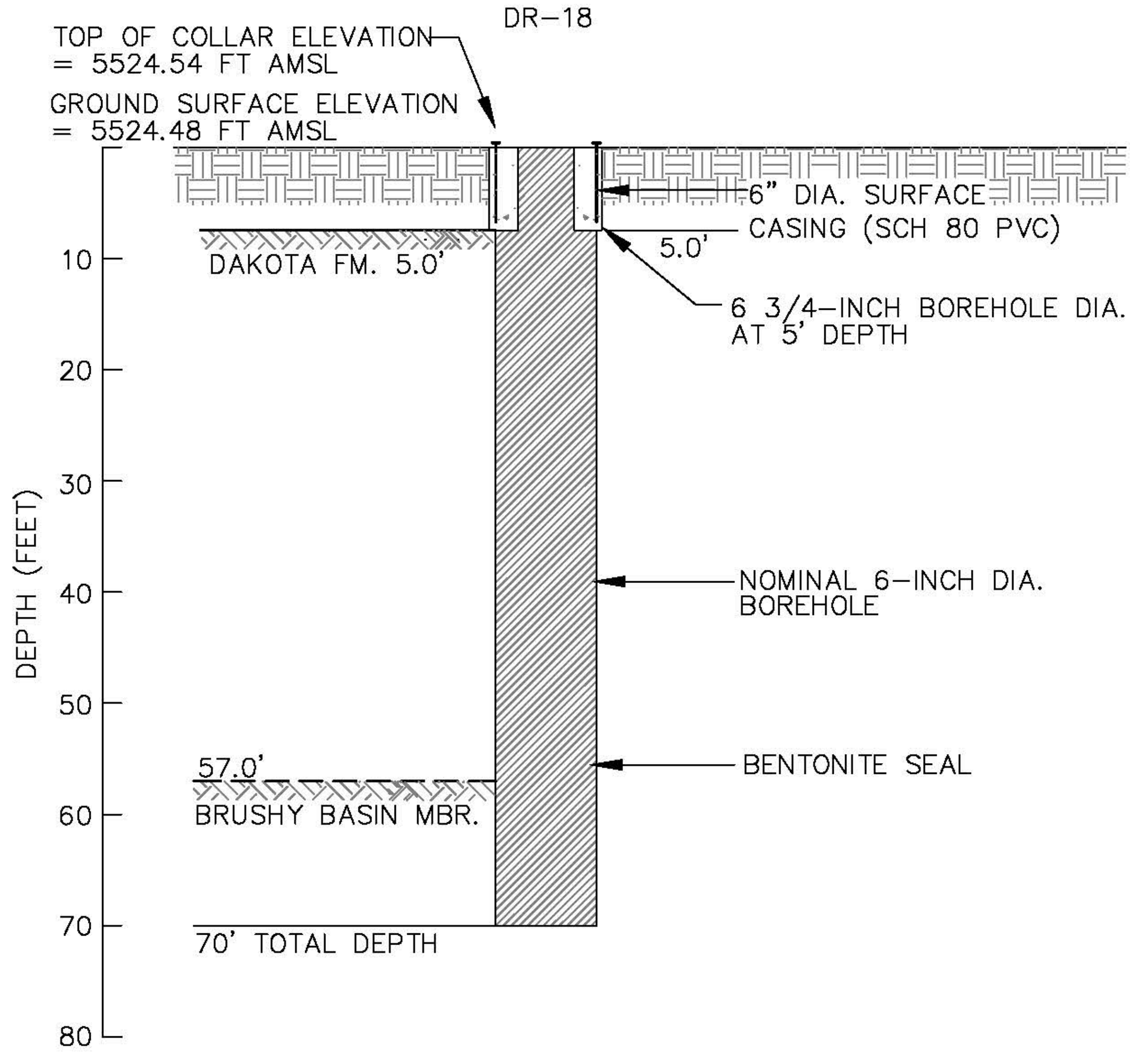
NOT TO SCALE

HYDRO GEO CHEM, INC.	DR-16 WELL ABANDONMENT SCHEMATIC		
Approved: SJS	Date: 1/9/12	Reference: K:\7180261A Well Construction Diagram	Figure



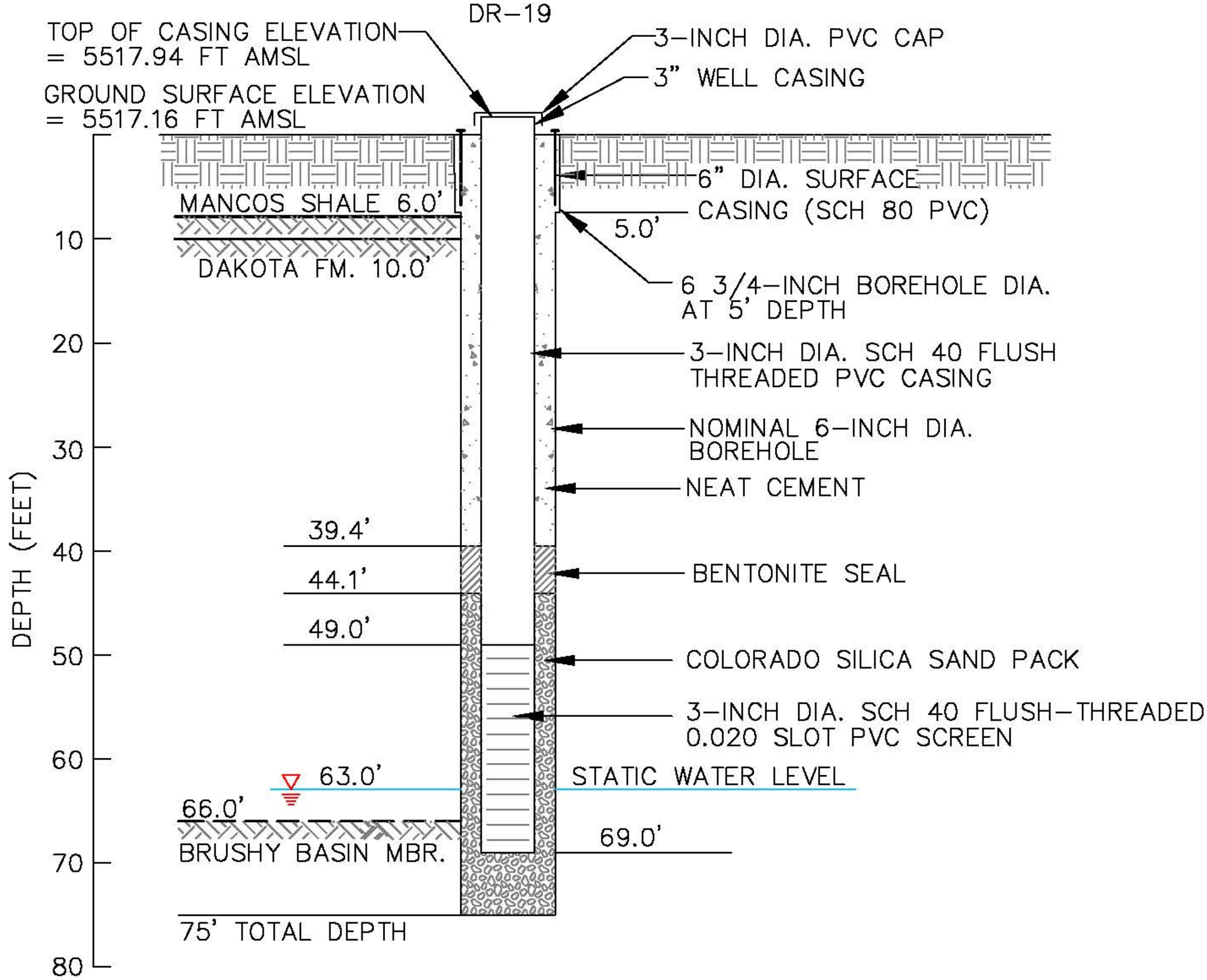
NOT TO SCALE

HYDRO GEO CHEM, INC.	DR-17 AS-BUILT WELL CONSTRUCTION SCHEMATIC			
	Approved SJS	Date 1/9/12	Reference K:\7180262A Well Construction Diagram	Figure



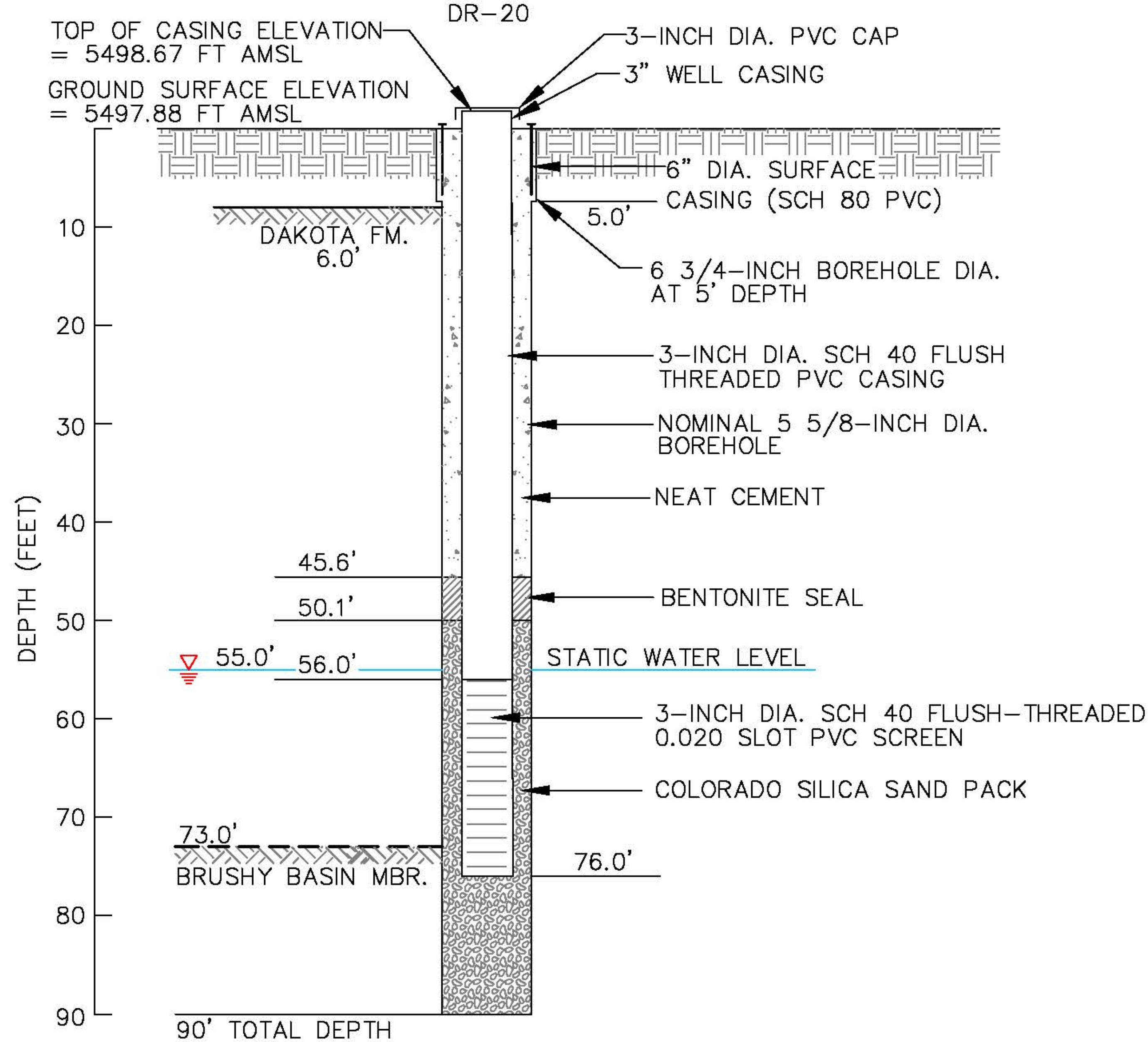
NOT TO SCALE

HYDRO GEO CHEM, INC.	DR-18 WELL ABANDONMENT SCHEMATIC		
Approved: SJS	Date: 1/9/12	Reference: K:\7180263A Well Construction Diagram	Figure



NOT TO SCALE

HYDRO GEO CHEM, INC.	DR-19 AS-BUILT WELL CONSTRUCTION SCHEMATIC		
Approved: SJS	Date: 1/9/12	Reference: K:\7180264A Well Construction Diagram	Figure

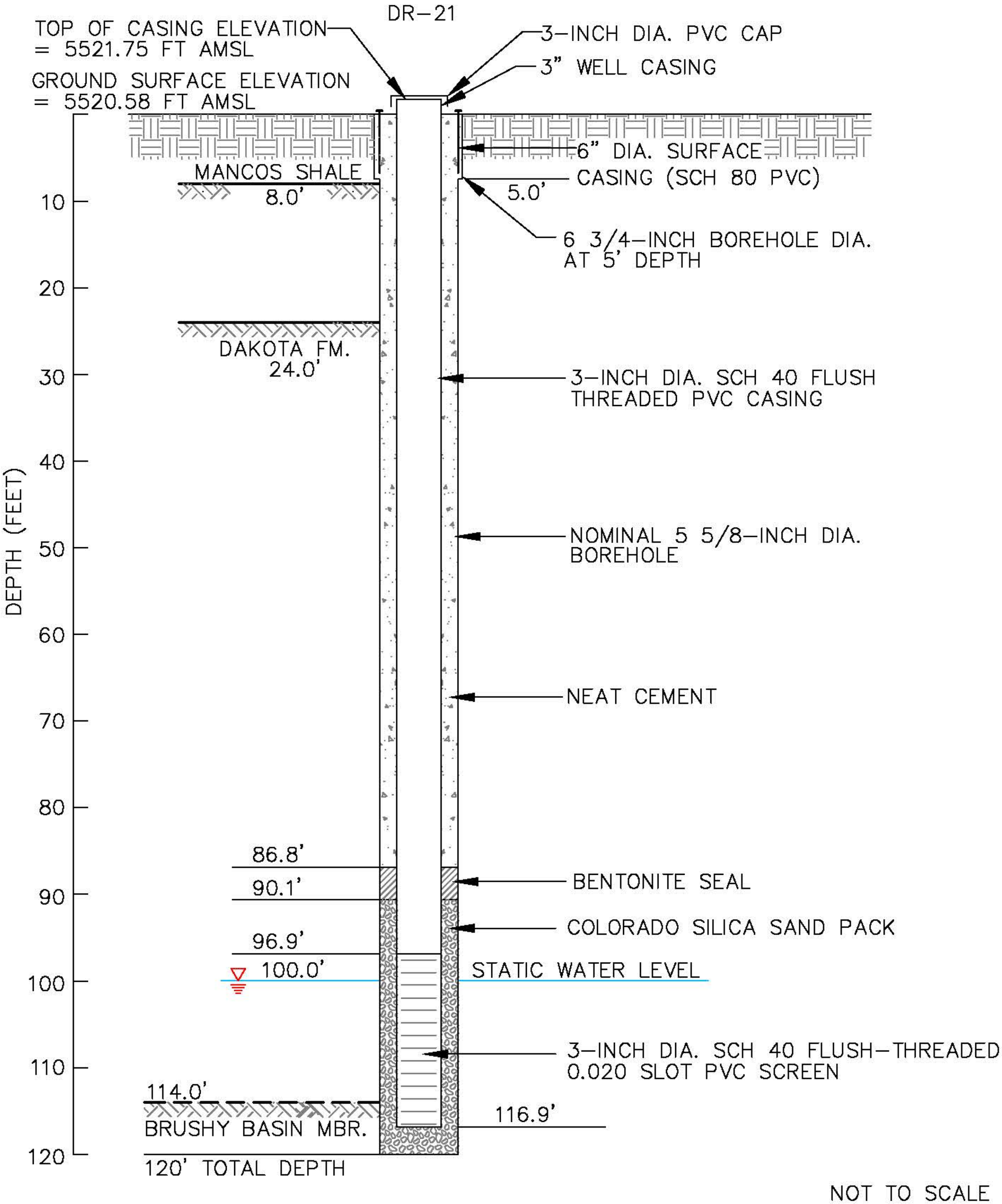


NOT TO SCALE

HYDRO GEO CHEM, INC.

DR-20
AS-BUILT WELL CONSTRUCTION SCHEMATIC

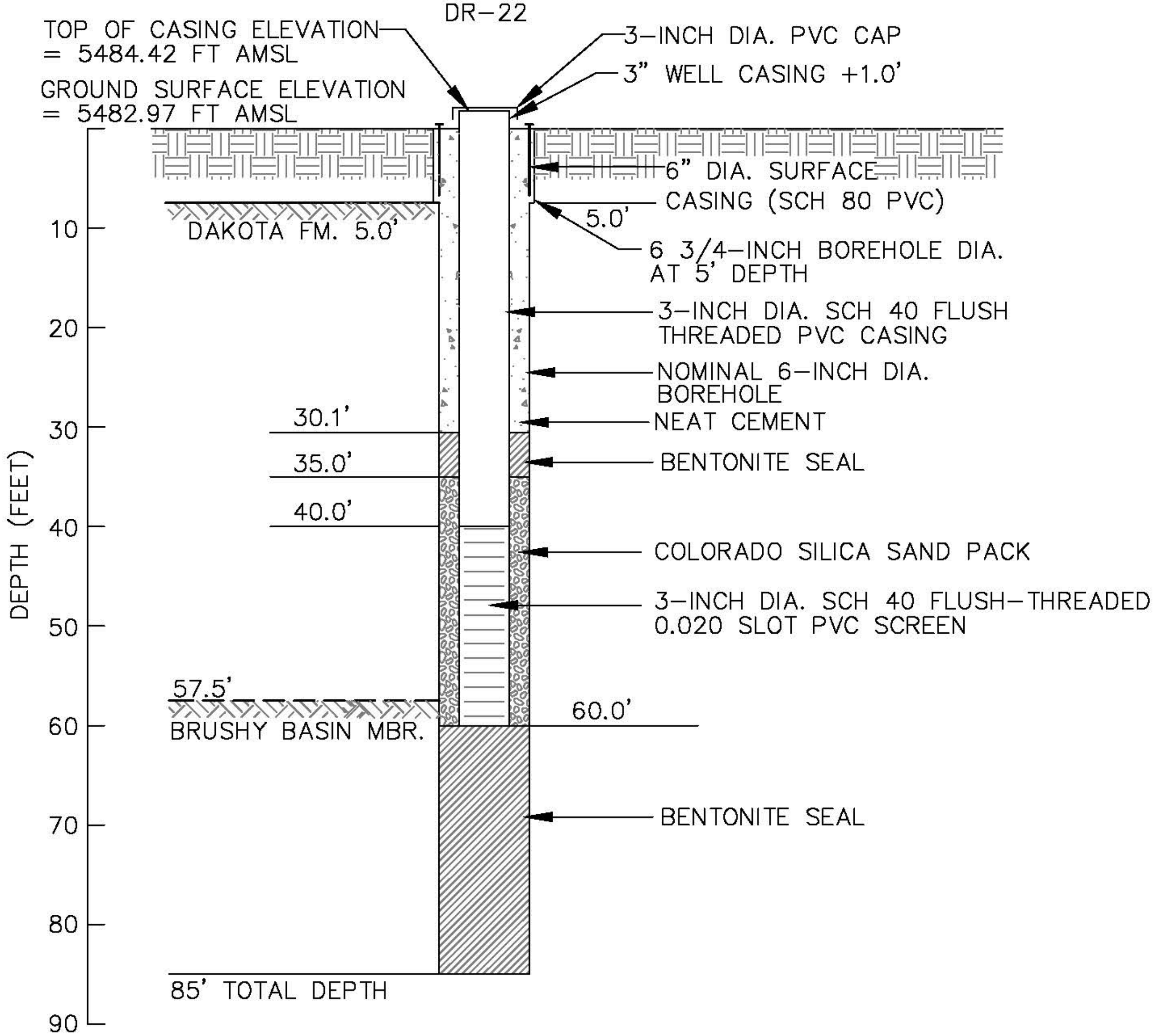
Approved	Date	Reference	Figure
SJS	1/9/12	K:\7180265A Well Construction Diagram	



HYDRO GEO CHEM, INC.

DR-21
AS-BUILT WELL CONSTRUCTION SCHEMATIC

Approved	Date	Reference	Figure
SJS	1/9/12	K:\7180266A Well Construction Diagram	

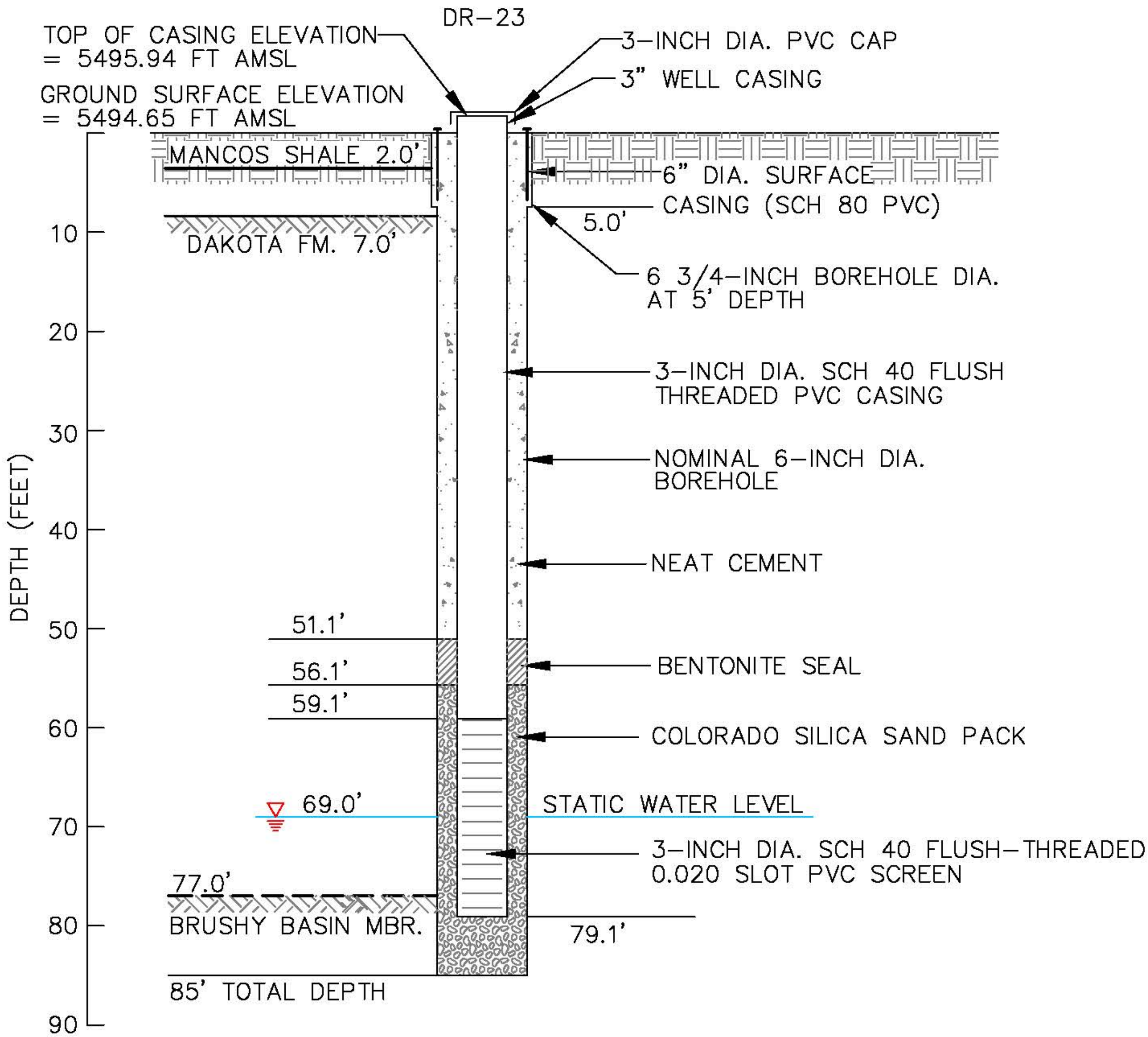


NOT TO SCALE

HYDRO GEO CHEM, INC.

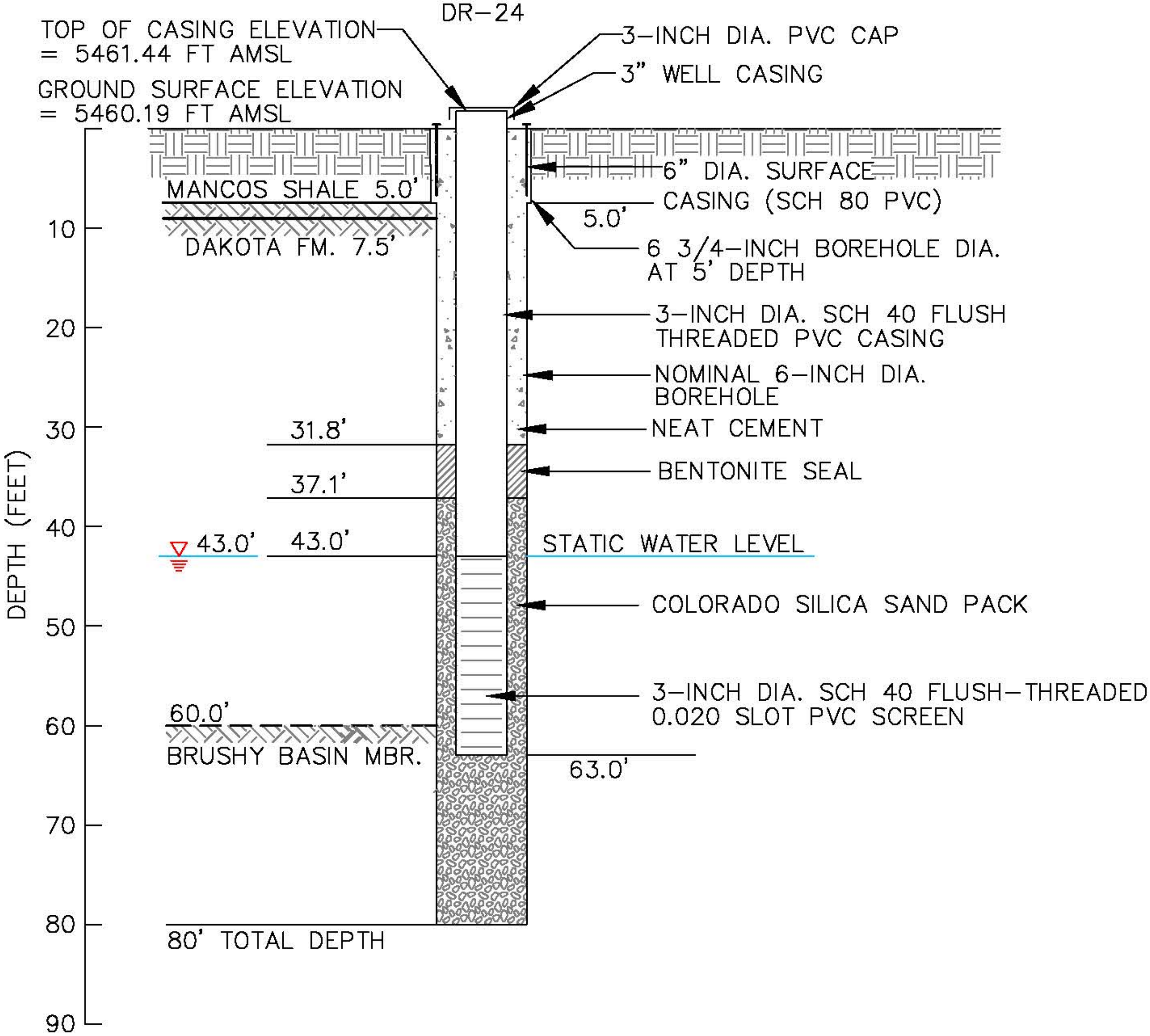
DR-22
AS-BUILT WELL CONSTRUCTION SCHEMATIC

Approved	Date	Reference	Figure
SJS	1/9/12	K:\7180267A Well Construction Diagram	



NOT TO SCALE

HYDRO GEO CHEM, INC.	DR-23 AS-BUILT WELL CONSTRUCTION SCHEMATIC		
Approved: SJS	Date: 1/9/12	Reference: K:\7180268A Well Construction Diagram	Figure:

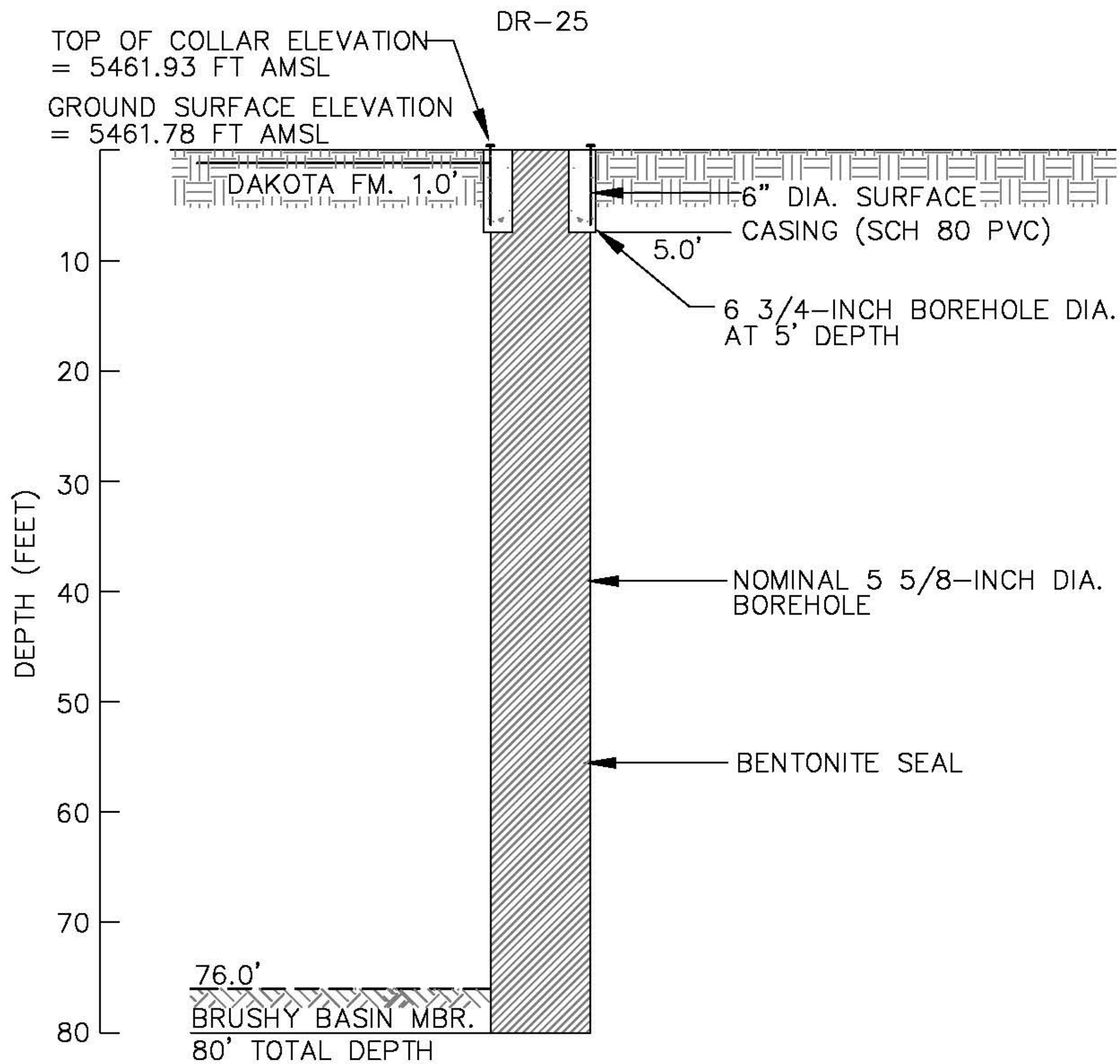


NOT TO SCALE

HYDRO GEO CHEM, INC.

DR-24
AS-BUILT WELL CONSTRUCTION SCHEMATIC

Approved	Date	Reference	Figure
SJS	1/9/12	K:\7180269A Well Construction Diagram	



NOT TO SCALE

HYDRO GEO CHEM, INC.	DR-25 WELL ABANDONMENT SCHEMATIC		
Approved SJS	Date 1/9/12	Reference K:\7180270A Well Construction Diagram	Figure

APPENDIX B

LITHOLOGIC LOGS FOR DR-SERIES PIEZOMETERS

Date 5 May 2011 Geologist L. Casebolt Drilling Co. Boyles Exploration Inc. Hole No. DR2

Property White Mesa Mill Project Cell 4B Unit No. ______ Sec. ______ Twp. ______ Rge. ______

County San Juan State Utah Location ______ Elev. ≈5576

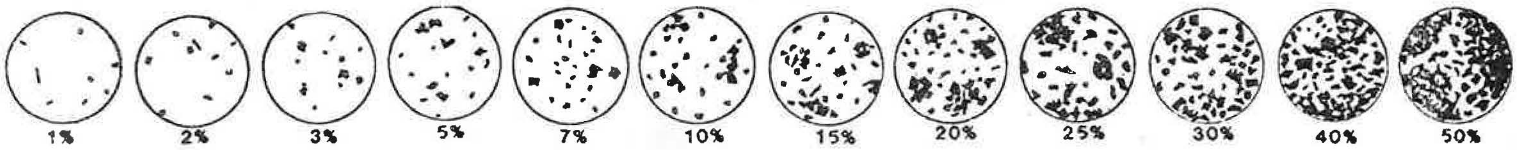
T.D. PROBE ______

T.D. DRILL 95.0

FLUID LEVEL ______

Depth	Sample Taken	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	Pyrite Habit	Pyrite Alter.	Metallic	Non-Metallic	React.-10% HCL	Carbon Amount	Carbon Type	Remarks
0																				
2.5					sndy mdst	rdbn-lt pk tn	f-c	p	a								S			Surface Soil to 2.0' Mancos Shale (unconsolidated)
5.0					sh-qtz ss	lt pk tn-	m-c	f	a								VS			Upper Dakota Ct. @ 4.0' (unconsol. to 4.0')
7.5					qtz ss	lt br	m-c	f	a		H						N			wh chert grains
10.0					sh	yw gy											S			
12.5					sh-qtz ss	dk gy	m-c	f	a								M			
15.0					qtz ss	yw tn	m	w	R								N			
17.5					qtz ss	yw tn	m	w	R		L						N			sparce limonite grain coating
20.0					qtz ss	lt gy tn	m	w	R								N			gy qtz grains
22.5					qtz ss	yw tn	m-peb	p	a								N			Moist cuttings this morning, dk chert grains + peb.
25.0					qtz ss	yw tn	m-peb	p	a								N			lt-dk chert grains
27.5					qtz ss	lt tn	f-m	w	R								N			
30.0					sh	yw gy bl											N			
32.5					sh	yw gy bl											N			
35.0					sh	yw gy bl											N			
37.5					sh	yw gy bl											N			
40.0					qtz ss sltst	lt yw tn	slt-vf	m	r								N			
42.5					qtz ss sltst	lt tn	slt-vf	m	r								N			
45.0					qtz ss sltst	lt tn	slt-vf	m	r								N			
47.5					sltst-sh	lt yw gn											N			
50.0					sh	lt gn-lt pp rd											N			
52.5					sltst-qtz ss	lt bl gy	slt-m	p	a								N			
55.0					sltst-qtz ss	lt tn	slt-vf	m	r								N			
57.5					qtz ss	lt tn	f	w	r								M			
60.0					qtz ss	lt tn	f	w	r								N			
62.5					sltst-sh	yw gy tn											N			
65.0					sh	lt gn-pp bn											N			
67.5					qtz ss	lt gy tn	vf-m	m	r			tr	a				N			
70.0					qtz ss	lt tn	m	w	R								N			
72.5					qtz ss	lt tn	m	w	R								N			
75.0					qtz/chert ss	gy tn	m-peb	p	a								N			abund dk-lt chert grains & pebbles.
77.5					qtz ss cgl	or gy	vc-peb	p	A								N			abund multi colored chert grains
80.0					qtz ss, cgl	or gy	vc-peb	p	A								N			Well began producing approx 3gpm @ 78.0'
82.5					cgl, qtz ss	wh-lt gy	m-peb	p	A	si							N			
85.0					qtz ss	wh-lt gy	m-peb	f	A	si							N			
87.5					qtz ss, sh	wh-gn	m-vc	p	a	si	L						N			Brushy Basin Ct. @ 87.0' good ct. poss. oil as cement?
90.0					sh	gn-pp bn											N			flow increased to 20 gpm @ 87.0'
92.5					sh	gn-pp bn											N			
95.0					sh	gn-pp bn											N			T.D. some tell tale rd chert grains · 1-2 mm
97.5																				
100.0																				(noteable dk bn material (dead oil?) in
102.5																				interstacese of sand grains @ 87.5)
105.0																				
107.5																				
110.0																				
112.5																				
115.0																				
117.5																				
120.0																				
122.5																				
125.0																				Note: this well completed on 6 May 2011

PERCENTAGE COMPOSITION IMAGE



Date 5 May 2011 Geologist L. Casebolt Drilling Co. Boyles Exploration Inc. Hole No. DR5

Property White Mesa Mill Project cell 4B Unit No. ____ Sec. ____ Twp. ____ Rge. ____

County San Juan State Utah Location ____ Elev. ≈5560

PAGE 1 OF 1

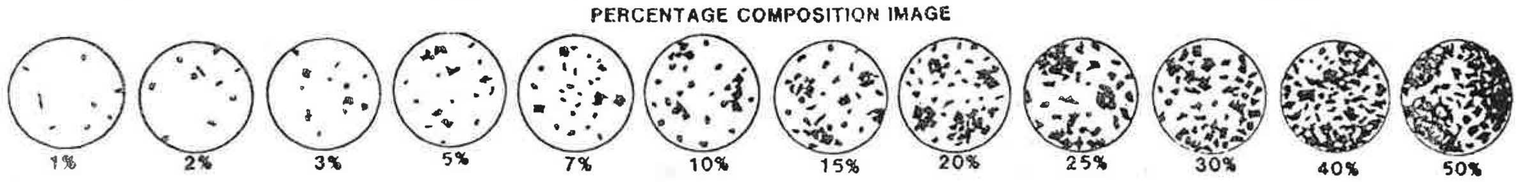
T.D. PROBE ____

T.D. DRILL 100.0

FLUID LEVEL ____

Depth	Sample Taken	Graphic Log	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	Pyrite Habit	Pyrite Alter.	Metallic	Non-Metallic	React.-10% HCL	Carbon Amount	Carbon Type	Remarks
0–2.5						mdst	rdbn											S			Surface Soil - unconsolidated CL
2.5–5.0						qtz ss, mdst	ywrdbn	m-c	m	a								N			Upper Dakota Ct. @ 3.0'
5.0–7.5						qtz ss	ltorbn	m-c	m	a		L						N			
7.5–10.0						qtz ss	tn	m	w	r								N			
10.0–12.5						qtz ss	tn	m	w	r								N			
12.5–15.0						qtz ss, sh	ltbn - ltgy	f	w	a		L						N			
15.0–17.5						qtz ss	vltbn	f	w	a		L						N			
17.5–20.0						qtz ss	ywgy	vf-c	p	r								N			some chert grains
20.0–22.5						qtz ss	ltgy	m-c	m	R								N			" " "
22.5–25.0						qtz ss	tn	m	w	R								N			
25.0–27.5						qtz ss	ltgy	m-c	m	r								N			
27.5–30.0						sndy sh	vltywgy	f-m	m	r								N			CH
30.0–32.5						sh	ltywgy											N			CH
32.5–35.0						sh	ywgy											N			
35.0–37.5						qtz ss, sh	tn - orgy	f-m	m	r		L						N			
37.5–40.0						qtz ss	tn	m	w	r								N			
40.0–42.5						qtz ss	ltbn	m-c	m	r		L						N			Some chert frags. and grains
42.5–45.0						qtz ss	tn	m	w	r								N			
45.0–47.5						qtz ss	vltbn	m	w	r								N			
47.5–50.0						qtz ss	ltbn	m	w	r								N			
50.0–52.5						qtz ss	lttn	m	w	r								N			
52.5–55.0						qtz ss	ltgytn	m	w	r								N			
55.0–57.5						qtz ss	ltgytn	m	w	a								N			
57.5–60.0						qtz ss	ltgytn	f-m	m	a								N			
60.0–62.5						qtz ss	wh-vdkbn	f-peb	p	a								W			moisture 1st noticed chert pebble frags.
62.5–65.0						qtz ss, sh	wh-vltgn	vf-c	p	a								N			
65.0–67.5						qtz ss	vltgytn	m-peb	p	r								N			abund. chert grains
67.5–70.0						qtz ss	vltgytn	m-c	m	r								N			
70.0–72.5						qtz ss, sh	vltgytn	m-peb	f	r								N			some chert frags & grains
72.5–75.0						qtz ss	vltgytn	m	w	r		L						N			
75.0–77.5						qtz ss	vltgytn	m	w	r								N			
77.5–80.0						qtz ss	ltortn	m	w	r		L						N			very hard drilling
80.0–82.5						qtz ss	lttn	m	w	r		L						N			"
82.5–85.0						qtz ss	lttn	m	w	R								N			"
85.0–87.5						qtz ss	vlttn	m-c	m	a								N			"
87.5–90.0						qtz ss	vlttn	f-m	f	r								N			"
90.0–92.5						qtz ss	vlttn	f-m	f	r								N			"
92.5–95.0						qtz ss, sh	wh-gn	f-m	f	r			Tr	A				M			Brushy Basin Ct @ 94.0' good contact
95.0–97.5						sh	gn											N			
97.5–100.0						sh	gn											N			T.D. telltale small red chert grains
102.5																					
105.0																					
107.5																					
110.0																					
112.5																					
115.0																					
117.5																					
120.0																					
122.5																					
125.0																					

PERCENTAGE COMPOSITION IMAGE



Date 5 May 2011 Geologist L. Casebolt Drilling Co. Bayles Exploration Inc. Hole No. DR6

Property White Mesa Mill Project cell 4B Unit No. ______ Sec. ______ Twp. ______ Rge. ______

County San Juan State Utah Location ______ Elev. ≈5579

PAGE 1 OF 1

T.D. PROBE ______

T.D. DRILL 100.0

FLUID LEVEL ______

Depth	Sample Taken	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	Pyrite Habit	Pyrite Alter.	Metallic	Non-Metallic	React.-10% HCL	Carbon Amount	Carbon Type	Remarks
0					mdst	rdbn											W			Surface Soil - unconsolidated - CH
2.5					mdst, sh	rdbn, ltpk											VS			Mancos Shale " CH
5.0					qtz ss, sh	ltpktn	f-m	m	r		L						VS			Upper Dakota Fm Ct. @ 6.0'
7.5					qtz ss	tn	m	w	r								N			
10.0					qtz ss	tn	m-c	m	a		L						N			
12.5					qtz ss	tn	m	w	a								N			
15.0					qtz ss	tn	m	w	a								N			
17.5					qtz ss	tn	m	w	a								N			
20.0					qtz ss	tn	m-c	m	a		L						N			
22.5					qtz ss, sh	orbn	m	w	r		L						N			
25.0					qtz ss	tn	m	w	r								N			
27.5					qtz ss	tn	m	w	a								N			
30.0					qtz ss	tn	m	w	a								N			
32.5					qtz ss	tn	m	w	R								N			
35.0					qtz ss	tn	m	w	r								N			
37.5					qtz ss.	tn	m	w	r								N			sparse chert grains
40.0					qtz ss, sh	tn-vltgn	m-vc	p	a								N			
42.5					sh, qtz ss	ltywgy	m	w	r								N			CL
45.0					qtz ss	vlt tn	m	w	r								N			
47.5					qtz ss	vlt tn	f	w	r								N			
50.0					qtz ss	vlttn	m-c	m	r								N			
52.5					qtz ss	lttn	m-vc	f	r		L						N			
55.0					qtz ss	lttn	m	w	r								N			
57.5					qtz ss	lt tn	f-c	f	r								N			
60.0					qtz ss	ltpktn	m	w	R								N			
62.5					qtz ss	vltgy	f-m	f	r								N			
65.0					qtz ss	vltgy	m	w	R								N			
67.5					qtz ss	vltgy	m	w	r								N			
70.0					qtz ss	vltgy	f	w	r								N			
72.5					qtz ss	vltgy	f	w	r								N			
75.0					qtz ss	tn	m-vc	m	r								N			chert frag + grains
77.5					qtz ss	ltgytn	m	w	R								N			
80.0					qtz ss	ltgytn	m-c	m	r								N			mositure 1st noticed @ 80.0'
82.5					qtz ss	ltgy tn	m-c	m	r								N			
85.0					qtz ss	ltgytn	m-peb	p	a								N			chert pebbles + frags.
87.5					qtz ss	tn	m-peb	p	a								N			" " "
90.0					qtz ss	tn	c-peb	p	a								N			" " "
92.5					qtz ss	ltgytn	c-peb	p	a			tr	C				VS			
95.0					sh	ppbn-gn											N			Brushy Basin Ct @ 95.0' good contact
97.5					sh	ppbn-gn											N			T.D.
100.0																				
102.5																				
105.0																				
107.5																				
110.0																				
112.5																				
115.0																				
117.5																				
120.0																				
122.5																				
125.0																				

PERCENTAGE COMPOSITION IMAGE

1% 2% 3% 5% 7% 10% 15% 20% 25% 30% 40% 50%

Date 27 APR 2011 Geologist L. CASEROLT Drilling Co. BAYLES EXPLORATION CO. Hole No. DR7

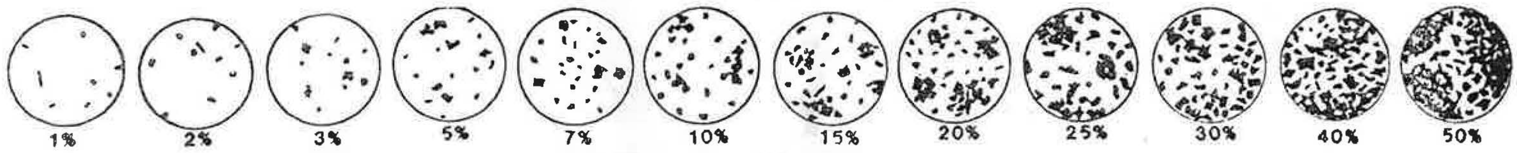
Property WHITE MESA MILL Project CELL 4B Unit No. ______ Sec. ______ Twp. ______ Rge. ______

County SAN JUAN State UTAH Location ______ Elev. 5594

PAGE 1 OF 1
T.D. PROBE ______
T.D. DRILL 100.0
FLUID LEVEL ______

Depth	Sample Taken	Graphic Log	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite: Amount	Pyrite: Habit	Pyrite: Alter.	Metallic	Non-Metallic	React.-10% HCL	Carbon: Amount	Carbon: Type	Remarks	
2.5						mdst	rdbn											N			Surface soil-unconsolidated	CH
5.0						mdst	rdbn											W			surface soil - unconsolidated	CH
7.5						qtz ss	orbn	m-c	m	a		L						VS			Upper Dakota Ct @ 6.0'	
10.0						qtz ss	ortn	m-c	m	A								N				
12.5						qtz ss	ltbn	m	w	a								N				
15.0						qtz ss	ltbn	m	w	a								N				
17.5						qtz ss	ortn	m-c	m	a								N				
20.0						qtz ss	tn	m	w	a								N				
22.5						qtz ss	tn	m	w	r								N				
25.0						qtz ss	ltbn	m-c	m	r								N			Some chert frags.	
27.5						qtz ss	tn	m	w	r								N				
30.0						qtz ss	ltgytn	f-m	m	r								N				
32.5						qtz ss, sh	ltgytn	m	w	r								N				
35.0						qtz ss	ltgybn	m-c	m	r								N				
37.5						qtz ss	vltgytn	f	w	R								N				
40.0						qtz ss, cgl	ltgytn	m-peb	f	r								N				
42.5						sh, qtz ss	ltywgy	vf-f	m	r		L						N				CH
45.0						qtz ss	lttn	f-m	m	r		L						N				
47.5						qtz ss	ltpktn	m-c	f	R								N				
50.0						qtz ss	ltpktn	m-c	f	R								N				
52.5						qtz ss	ltpktn	m-peb	f	a								N			some multi colored chert grains	
55.0						qtz ss	vltpktn	m	w	R								N				
57.5						qtz ss	vltpktn	f-m	m	r								N				
60.0						qtz ss	ltpktn	m-peb	f	a								N				
62.5						qtz ss	ltgytn	m	w	a								N				
65.0						qtz ss	ltgytn	m-c	m	a								N				
67.5						qtz ss	bn	c-vc	m	a								N			abund. chert frags	
70.0						qtz ss	ltgybn	m-vc	m	a								N				
72.5						qtz ss, cgl	bn	c-peb	m	a								N				
75.0						qtz ss	gytn	m-c	m	r								N				
77.5						qtz ss	ltgytn	m	w	r								N			moisture first noted, some chert grains	
80.0						qtz ss	ortn	m-c	m	r								N				
82.5						qtz ss	orpktn	m	w	R								N				
85.0						qtz ss	tn	m	w	R								N				
87.5						qtz ss	lttn	m	w	R								N				
90.0						qtz ss	gytn	m	w	R								N				
92.5						qtz ss	gytn	m-c	m	r								VW				
95.0						qtz ss, sh, cgl	wh, ltblgn	m-peb	m	r								W			Brushy Basin Fm Ct @ 93.0' chert pebbles.	
97.5						sh,	pprdbn-gn											N			mottled frags.	
100.0						sh, qtz ss	gn-vltgy	vf-c	P	r		Tr	A					N			T.D.	
102.5																						
105.0																						
107.5																						
110.0																						
112.5																						
115.0																						
117.5																						
120.0																						
122.5																						
125.0																						

PERCENTAGE COMPOSITION IMAGE

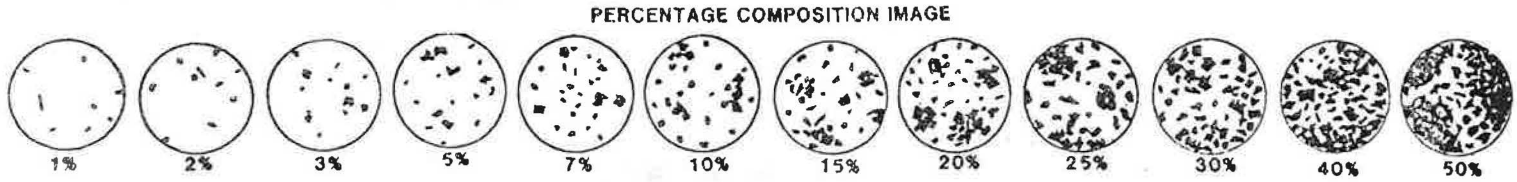


Date 5 May 2011 Geologist L. Casebolt Drilling Co. Boyles Exploration Inc. Hole No. DR8
Property White Mesa Mill Project Cell 4B Unit No. ______ Sec. ______ Twp. ______ Rge. ______
County San Juan State Utah Location ______ Elev. ≈5537

PAGE 1 OF 1
T.D. PROBE ______
T.D. DRILL 70.0
FLUID LEVEL ______

Depth	Sample Taken	Graphic Log	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	Pyrite Habit	Pyrite Alter.	Metallic	Non-Metallic	React.-10% HCL	Carbon Amount	Carbon Type	Remarks
0–2.5						sh, qtz ss	ltywgy	vf	w	r								VS			Mancos Shale - soil was removed during site prep CL
2.5–5.0						sh - qtz ss	ltywgy	vf	w	r								S			upper Dakota Fm Ct @ 4.0' ML
5.0–7.5						qtz ss	tn	f-m	M	a		L						N			
7.5–10.0						qtzss	tn	f-m	m	a								N			
10.0–12.5						qtz ss	tn	m	w	a								N			
12.5–15.0						qtz ss	tn	m-c	m	a								N			
15.0–17.5						qtzss	pktn	m-c	f	r								N			
17.5–20.0						qtz ss	tn	f-m	f	r								N			
20.0–22.5						sh, qtzss	ltywgn	f-m	f	r								N			CL
22.5–25.0						qtzss, sh	ltywgy	f-m	f	r								N			ML
25.0–27.5						qtzss, sltst	lttn	vf-m	f	r		L						N			
27.5–30.0						qtzss, sh	lttn	vf-m	f	r		L						N			
30.0–32.5						qtz ss, sh	lttn - ltywgn	m	w	r								N			very hard drilling
32.5–35.0						qtz ss	ltgytn	m-c	M	R		L						N			some dkgy chert grains
35.0–37.5						qtzss, qtzite	ltgytn	m-vc	f	a								N			abund " " "
37.5–40.0						qtz ss, qtzite	wh	m-vc	f	a								N			very hard drilling
40.0–42.5						qtzss, qtzite	wh	m-vc	f	a								N			extremely hard drilling
42.5–45.0						qtz ss, qtzite	wh	m-vc	f	a								N			" " "
45.0–47.5						qtz ss, qtzite	wh	m-peb	P	a								N			" " "
47.5–50.0						qtz ss, qtzite	wh-vlttn	m-vc	P	a								N			" " "
50.0–52.5						qtz ss, qtzite	wh-or-dkgy	m peb	P	A								N			" " "
52.5–55.0						sh	ltgybl											N			
55.0–57.5						qtz ss, qtzite	ltgytn	f-m	M	r								W			
57.5–60.0						sh	gygn-pprdbn											N			Brushy Basin Ct @ 57.5' cutting are mottled.
60.0–62.5						sh	gn-pprdbn											N			tale tell rd chert grains
62.5–65.0						sh	gn											N			
65.0–67.5						sh	gn						Tr	A				N			
67.5–70.0						sh	gn											N			TD.
72.5																					
75.0																					
77.5																					
80.0																					
82.5																					
85.0																					
87.5																					
90.0																					
92.5																					
95.0																					
97.5																					
100.0																					
102.5																					
105.0																					
107.5																					
110.0																					
112.5																					
115.0																					
117.5																					
120.0																					
122.5																					
125.0																					

PERCENTAGE COMPOSITION IMAGE



Date 4 May 2011 Geologist L. Casebolt Drilling Co. Boyles Exploration Inc. Hole No. DR9

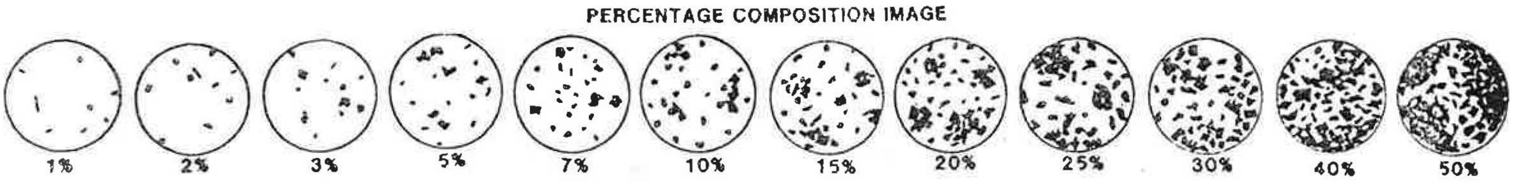
Property White Mesa Mill Project Cell 4B Unit No. ______ Sec. ______ Twp. ______ Rge. ______

County San Juan State Utah Location ______ Elev. ≈ 5562

PAGE 1 OF 1
T.D. PROBE ______
T.D. DRILL 115.0
FLUID LEVEL ______

Depth	Sample Taken	Graphic Log	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	Pyrite Habit	Pyrite Alter.	Metallic	Non-Metallic	React.-10% HCL	Carbon Amount	Carbon Type	Remarks
0–2.5						mdst	rdbn-ltpk											W			Surface soil to 2.0', Mancos Shale to 2.5 CL
5.0						qtz ss, sh	rdbn	f-m	m	r								S			unconsolidated ML
7.5						qtz ss, sh	rdbn	f	w	r								N			" ML
10.0						qtz ss, sh	rdbn	vf f	m	r								W			
12.5						qtz ss	rdbn	m	w	r								VS			
15.0						sh, qtz ss	dkgybn	f m	m	a		L						VS			Upper Dakota Fm Ct @ 14.0'
17.5						qtz ss	tn	m	w	a		L						N			
20.0						qtz ss	tn	m	w	a								N			
22.5						qtz ss	tn	f m	m	a								N			
25.0						qtz ss	tn	m	w	a								N			
27.5						qtz ss	tn	f	w	r								N			
30.0						qtz ss	tn	m	w	r								N			
32.5						qtz ss	tn	m	w	a								N			
35.0						qtz ss	tn	m	w	a								N			
37.5						qtz ss	tn	m	w	a								N			
40.0						qtz ss	tn	m-c	m	a								N			
42.5						qtz ss	tn	m	w	r								N			
45.0						qtz ss	tn	f	w	r								W			
47.5						qtz ss	orgy	c-vc	p	a								N			abund chert frags
50.0						qtz ss	orgy	c-vc	p	a		L						W			" " "
52.5						qtz ss	tn	m-c	m	a								N			
55.0						qtz ss	tn	m-c	m	a								N			
57.5						sh	ywgy											N			
60.0						qtz ss, sh	ywgy	f	w	r								N			
62.5						qtz ss, sh	gy	f m	m	r								N			
65.0						qtz ss, sh	gy	f	w	r								N			
67.5						qtz ss, sh	gy	f	w	r								N			
70.0						qtz ss, sh	gy	vf f	m	r			tr	A				N			
72.5						qtz ss	gy	vf-f	m	r			tr	A				N			
75.0						qtz ss	wh	vf f	m	r								N			
77.5						qtz ss	lttn	m	w	r								N			
80.0						qtz ss	lttn	m	w	a								N			
82.5						qtz ss	lttn	m	w	a								N			
85.0						qtz ss	ltgytn	m	w	R								N			moisture first noted @ 85.0'
87.5						qtz ss, sh	ltgytn	m	w	R								N			
90.0						qtz ss	lttn	m-c	m	r								N			
92.5						qtz ss	lttn	m	w	r								S			
95.0						qtz ss	lttn	m	w	r								N			
97.5						qtz ss	lttn	m	w	R								N			
100.0						qtz ss, sh	ltywgy	m	w	R								N			
102.5						qtz ss	wh	m	w	r								N			
105.0						qtz ss, cgl	wh-dkgy	c-peb	p	a			1%	C				N			
107.5						qtz ss, cgl	wh-dkgy	c-peb	p	a			1%	C				VW			
110.0						qtz ss, cgl	dkgy-gn	c-peb	p	a								N			
112.5						sh	gn											N			Brushy Basin Ct @ 110.0
115.0						sh	gn											N			T.D.
117.5																					
120.0																					
122.5																					
125.0																					

PERCENTAGE COMPOSITION IMAGE

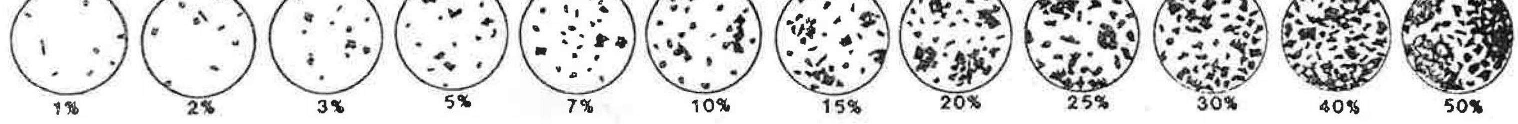


Date 4 May 2011 Geologist L. Casebolt Drilling Co. Bayles Exploration Inc. Hole No. DR 10
Property White Mesa Mill Project cell 4B Unit No. ____ Sec. ____ Twp. ____ Rge. ____
County San Juan State Utah Location ____ Elev. ≈5559

PAGE 1 OF 1
T.D. PROBE ____
T.D. DRILL 90.0
FLUID LEVEL ____

DEPTH	SAMPLE TAKEN	GRAPHIC LOG	ALTERATION	GAMMA ANOMALY	BRECCIA PIPE	LITHOLOGY	COLOR OF WET SAMPLE	GRAIN SIZE	SORTING	ANGULARITY	CEMENT MATRIX	IRON OXIDE	PYRITE AMOUNT	PYRITE HABIT	PYRITE ALTER.	METALLIC	NON-METALLIC	REACT.-10% HCL	CARBON AMOUNT	CARBON TYPE	REMARKS
0–2.5						mdst	rdbn										W				Surface Soil. Unconsolidated CH
5.0						mdst	rdbn										W				Surface Soil " CH
7.5						qtz ss	tn	m	w	a		L					N				Upper Dakota Fm Ct @ 5.0'
10.0						qtz ss	tn	m	w	a		L					N				
12.5						qtz ss	tn	f	w	a							N				
15.0						qtz ss	tn	m	w	a							N				
17.5						qtz ss	tn	m-c	m	a							N				some chert frags and grains
20.0						qtz ss	tn	f-m	m	r							N				
22.5						qtz ss	tn	f-m	m	r							N				
25.0						qtz ss, sh	ltywgy	f-m	m	r							N				sandy lean clay CL
27.5						qtz ss, sh	ltgy	f-m	m	r		L					N				" " , CL some chert pebbles.
30.0						qtz ss, cgl sh	dkywgy	f-peb	m	r							N				sandy lean clay CL " " "
32.5						qtz ss, cgl	ywgy	vf-peb	m	r							N				
35.0						qtz ss, sh	ywgy	vf-c	m	r							N				Lean clay CL, some chert grains
37.5						qtz ss	ywtn	f	w	r							N				
40.0						qtz ss	ywtn	f	w	r							N				
42.5						qtz ss	pktn	f	w	r							N				
45.0						qtz ss	ywgy-tn	f-m	m	r		L					N				
47.5						qtz ss	tn	f	w	r		L					N				
50.0						qtz ss	tn	m	w	r							N				
52.5						qtz ss	tn	m	w	r							N				
55.0						qtz ss	ltbn	m-peb	m	r		H					N				abund chert grains
57.5						qtz ss	tn	m	w	R							N				
60.0						qtz ss	tn	m	w	R							N				
62.5						qtz ss	tn	m-c	m	a							N				
65.0						qtz ss	ltortn	m-c	m	a		L					N				
67.5						qtz ss	ltgy	m-c	m	r							N				very hard drilling!
70.0						qtz ss, cgl	ltgybn	m-peb	p	a							N				very abund chert frags & grains
72.5						qtzite, cgl	gytn	m-peb	p	a							N				" " "
75.0						qtzite, cgl	gytn	m-vc	p	a							N				
77.5						qtzite	gytn-wh	m-vc	p	a							N				very abund chert frags & grains
80.0						qtzite	gytn-wh	m-vc	p	a							N				
82.5						sltst, sh	gn										N				Brushy Basin Ct @ 80.0'
85.0						sltst, sh	gn										N				
87.5						sh	gn										N				
90.0						sh	gn										N				T.D.
92.5																					
95.0																					
97.5																					
100.0																					
102.5																					
105.0																					
107.5																					
110.0																					
112.5																					
115.0																					
117.5																					
120.0																					
122.5																					
125.0																					

PERCENTAGE COMPOSITION IMAGE



Date 6 May 2011 Geologist L. Casebolt Drilling Co. Boyles Exploration Inc. Hole No. DR 11

Property White Mesa Mill Project cell 4B Unit No. ____ Sec. ____ Twp. ____ Rge. ____

County San Juan State Utah Location ____ Elev. ≈5582

PAGE 1 OF 1

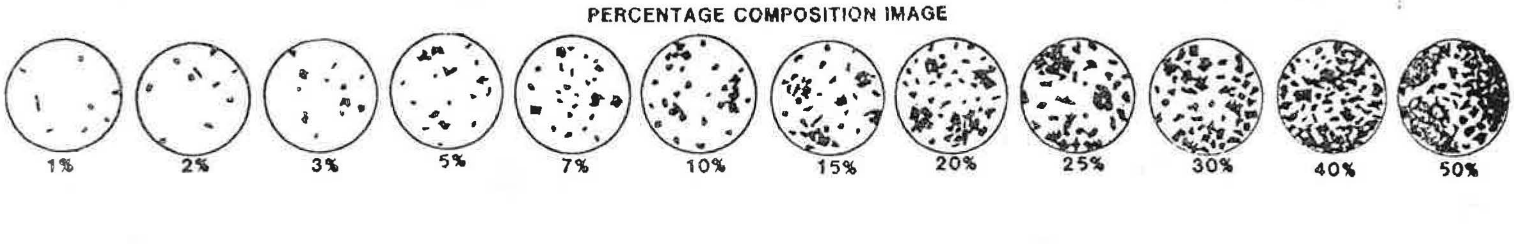
T.D. PROBE ____

T.D. DRILL 115.0

FLUID LEVEL ____

Depth	Sample Taken	Graphic Log	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	Pyrite Habit	Pyrite Alter.	Metallic	Non-Metallic	React.-10% HCL	Carbon Amount	Carbon Type	Remarks
2.5						mdst	rdbn											W			Surface Soil (unconsolidated)
5.0						mdst, sh	rdbn, ltpk											VS			Surface soil (unconsolidated, Mancos Shale @ 4.0'
7.5						sndy sh	rdbn	m	f	r								VS			
10.0						sh, qtz ss	rdbn - ltpk	m	m	r								VS			
12.5						sh, qtz ss	ltpk - vlttn	m	m	r								VS			Upper Dakota Fm Ct. @ 12.0'
15.0						qtz ss	ltgybn	m-c	m	r								S			
17.5						qtz ss	lt yw	m-vc	f	a		L						N			abund. lt colored chert frags.
20.0						qtz ss	ltgytn	m-c	f	r								N			
22.5						qtz ss	ltgytn	m	w	r								N			
25.0						qtz ss	ltgytn	f-m	w	r								N			
27.5						qtz ss	ltgytn	M	W	R								N			
30.0						qtz ss	ltgytn	c	w	r								N			
32.5						qtz ss	lttn	f	w	r								N			
35.0						qtz ss	lt tn	f-c	P	a								N			some dk chert grains.
37.5						qtz ss	gytn	m-c	M	r								N			abund. dk chert grains
40.0						qtz ss	lt tn	M	W	R								N			
42.5						qtz ss	lt tn	m-c	m	a								N			
45.0						qtz ss	lt tn	m	W	R								N			
47.5						qtz ss	ltgytn	c	W	R								N			
50.0						qtz ss, sh	tn-ltgn	c-peb	P	A								N			multi colored chert frags & grit
52.5						qtz ss	tn	m-vc	M	r								N			" " " " "
55.0						qtz ss	tn	m-c	M	r								N			
57.5						qtz ss, sltst	lt blgy	m-peb	f	a								N			chert pebble frags.
60.0						sltst, qtz ss	lt blgy	f-vc	P	a								N			
62.5						sltst, qtz ss	lt blgy	f-vc	P	a								N			
65.0						qtz ss, sltst	lt blgy - lt tn	m-c	m	a								N			
67.5						qtz ss	tn	m-c	m	a								S			
70.0						qtz ss, cgl	tn bn	m-peb	P	a								M			multi colored chert frags.
72.5						qtz ss, cgl	tn bn	c-peb	P	a								N			
75.0						qtz ss	ltgytn	m-c	m	a								N			
77.5						qtz ss	ltgy tn	m-vc	f	a								N			
80.0						qtz ss	ltgytn	f-m	W	r								N			Moisture first noted @ 80.0
82.5						qtz ss	ltgy tn	m-c	w	r								N			
85.0						qtz ss	ltgy tn	m	w	R								N			
87.5						qtz ss	ltgytn	f-m	m	r								N			
90.0						qtz ss	ltgytn	f-m	m	r								N			
92.5						qtz ss	gytn	m-peb	f	r								N			
95.0						qtz ss	gytn	c-peb	m	r								N			
97.5						qtz ss, cgl	gytn	c-peb	m	r								N			
100.0						qtz ss, cgl	gytn	m-c	M	r								N			very hard drilling
102.5						qtz ss, cgl	tn bn	m-peb	P	a								N			" " " abund. dkgy chert frags.
105.0						qtz ss, cgl	tn bn	m-peb	P	a			tr					N			" " " gy chert frags.
107.5						qtz ss, sh	wh-gygn	f-peb	P	a								N			Brushy Basin Ct. @ 106.0' good contact chert frags.
110.0						sh	gygn						<1%/c					N			some masses of sulfide (pyrite?)
112.5						sh	gygn											N			
115.0						sh	gygn-bpbn											N			T.D. mottled cuttings
117.5																					
120.0																					
122.5																					
125.0																					

PERCENTAGE COMPOSITION IMAGE

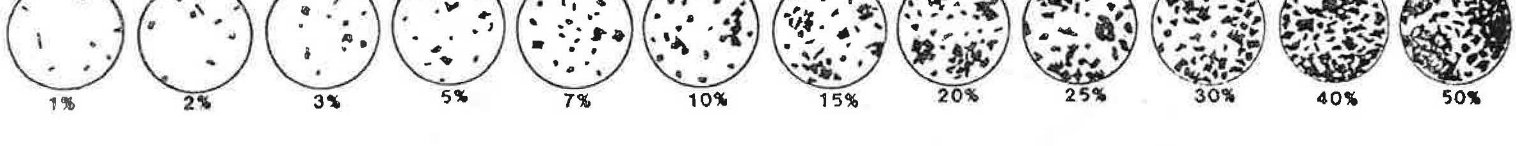


Date 28 APR 2011 Geologist L. Casebolt Drilling Co. Bayles Exploration Co. Hole No. DR12
Property White Mesa Mill Project Cell 4B Unit No. ______ Sec. ______ Twp. ______ Rge. ______
County San Juan State Utah Location ______ Elev. ≈5584

PAGE 1 OF 1
T.D. PROBE ______
T.D. DRILL 100.0
FLUID LEVEL ______

Depth	Sample Taken	Graphic Log	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	Pyrite Habit	Pyrite Alter.	Metallic	Non-Metallic	React.-10% HCL	Carbon Amount	Carbon Type	Remarks
0–2.5						mdst	rdbn											W			Surface Soil unconsolidated fat clay w/ sand CH
5.0						mdst	rdbn											VW			Surface Soil " " " " CH
7.5						sh	ltpktn											VS			Mancos Shale Fm. consolidated. Lean clay w/ sand CL
10.0						sh	ltpktn											VS			" "
12.5						sh	ltpktn											S			" "
15.0						qtz ss, sh	lt bn	m	w	r		L						N			Upper Dakota Ct @ 12.5'
17.5						qtz ss	tn	m	w	r		L						N			
20.0						qtz ss	ltortn	m	w	r		L						N			
22.5						qtz ss	tn	m	w	a								N			
25.0						qtz ss	tn	m	w	a								N			
27.5						qtz ss	ltgytn	m	w	r								N			some chert grains
30.0						qtz ss	tn	m-c	m	r								N			" " "
32.5						qtz ss	tn	m-c	m	r								N			
35.0						qtz ss	tn	m-c	m	r								N			
37.5						qtz ss	ltortn	m	w	R		L						N			
40.0						qtz ss	tn	m	w	R								N			
42.5						qtz ss	tn	m-peb	f	a								N			some chert grains
45.0						qtz ss	lt bn	f-peb	p	a								N			" " "
47.5						qtz ss, sh, cgl	tn-gn	f-peb	p	a								N			" " "
50.0						qtz ss, sh, cgl	gn-tn	m-peb	p	A								N			" " "
52.5						qtz ss, sh	gn-tn	m-peb	p	a								N			abund. chert frags. grains
55.0						qtz ss	tn	m-peb	p	a		L						N			" " " "
57.5						qtz ss	tn	f-c	p	a		L						N			
60.0						qtz ss	tn	f-c	p	a								N			
62.5						qtz ss	ltgytn	m	w	r								N			
65.0						qtz ss	ltgytn	m	w	r								N			
67.5						qtz ss	ltgytn	m	w	r								N			
70.0						qtz ss	tn	m	w	r								N			
72.5						qtz ss	ltgytn	m	w	r								N			
75.0						qtz ss	lt bn	m	w	a								N			
77.5						qtz ss	ltgytn	m	w	a								N			
80.0						qtz ss	tn	f-m	m	r								N			
82.5						qtz ss	tn	m	w	a								N			
85.0						qtz ss	tn	m-c	m	a			tr	C				N			
87.5						qtz ss, sh	gn-tn	f-c	m	a			tr	C				N			
90.0						qtz ss, sh	wh-ltgn	f-m	m	r			tr	C				N			
92.5						qtz ss, sh	wh-ltgn	f-m	m	r								N			Brushy Basin Ct @ 92.0 ft.
95.0						sh	gn, rdbn											N			
97.5						qtz ss, sh	wh-gn	f-m	m	R								N			
100.0						sh	gn-rdbn											N			T.D. Mottled Frags.
102.5																					
105.0																					
107.5																					
110.0																					
112.5																					
115.0																					
117.5																					
120.0																					
122.5																					
125.0																					

PERCENTAGE COMPOSITION IMAGE



1% 2% 3% 5% 7% 10% 15% 20% 25% 30% 40% 50%

Changed PB Ct. from 82

Date 27 APR 2011 Geologist L. Casebolt Drilling Co. Bayles Exploration Co. Hole No. DR13

Property White Mesa Mill Project Cell 4B Unit No. ______ Sec. ______ Twp. ______ Rge. ______

County San Juan State Utah Location ______ Elev. 5575

PAGE 1 OF 1

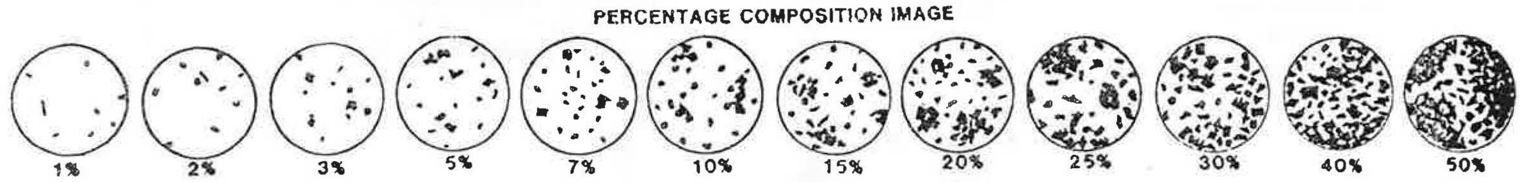
T.D. PROBE ______

T.D. DRILL 90.0

FLUID LEVEL ______

DEPTH	LITHOLOGY	COLOR OF WET SAMPLE	GRAIN SIZE	SORTING	ANGULARITY	IRON OXIDE	REACT.-10% HCL	REMARKS
2.5	mdst	rdbn					W	Surface Soil - unconsolidated - lean clay w/ sand CL
5.0	mdst	rdbn					S	surface Soil - unconsolidated - lean clay w/ sand CL
7.5	qtz ss	ortn	m-peb	p	A		N	upper Dakota Ct @ 5.0' abund. chert frags, pebbles,
10.0	qtz ss, cgl	gy ortn	m-peb	p	A		N	abundant chert frags & pebbles.
12.5	qtz ss	ortn	m-peb	p	r	L	N	" " " "
15.0	qtz ss, sh	ltgy tn	m-peb	p	a		N	Some chert frag & pebbles sandy fat clay CH
17.5	qtz ss, sh	ltgygntn	m-peb	p	a		N	" " " "
20.0	qtz ss, cgl	ltgytn-rd	m-peb	p	a		N	" " " "
22.5	qtz ss	lt tn	m-c	m	a		N	
25.0	qtz ss, sh	lt tn-ltgn	m-vc	f	a		N	
27.5	qtz ss, sh	lttn-ltgygn	m-peb	P	a		N	
30.0	qtz ss	tn	m	w	r		N	
32.5	qtz ss	tn	m	w	a		N	
35.0	qtz ss	lt bn	m-peb	p	a		N	
37.5	qtz ss, cgl	dk bn	m-peb	p	a		W	
40.0	qtz ss	tn	m	w	R		N	
42.5	qtzs	tn	m-peb	p	r		N	
45.0	qtz ss	tn	f-peb	p	a		N	
47.5	qtz ss	tn	m	w	r		N	
50.0	qtz ss	tn	m	w	r		N	
52.5	qtz ss	vlttn	m	w	r		N	
55.0	qtz ss	vlttn	m	w	r		N	
57.5	qtz ss	lttn	m	w	r		N	
60.0	qtz ss, cgl	gytn	m-peb	p	a	L	N	abund multi colored chert frags & grains
62.5	qtz ss, cgl	ltgytn	m-peb	p	a	L	N	" " " " " "
65.0	qtz ss	lt tn	m	w	r		VS	
67.5	sh, qtz ss	lt blgy	m-peb	p	a		VW	
70.0	qtz ss, sh	wh-blgy	vf-m	f	r		N	
72.5	qtz ss	wh-ltgy	f	w	r		N	
75.0	qtz ss	wh-ltgy	f	w	r		N	
77.5	qtz ss	wh-ltblgn	f	w	r		N	
80.0	qtz ss	wh-ltblgn	f	w	r		N	sparse chert pebble frags.
82.5	sh	gy-rdbn					N	Brushy Basin Fm Ct @ 80.0'
85.0	sh	blgy-rdbn					N	
87.5	sh	blgy-rdbn					N	
90.0	sh	pprdbn-gn					N	TD
92.5								
95.0								
97.5								
100.0								
102.5								
105.0								
107.5								
110.0								
112.5								
115.0								
117.5								
120.0								
122.5								
125.0								

PERCENTAGE COMPOSITION IMAGE



Date 29 APR 2011 Geologist L. Casebolt Drilling Co. Bayles Exploration Co. Hole No. DR14

Property White Mesa Mill Project CELL 4B Unit No. ____ Sec. ____ Twp. ____ Rge. ____

County San Juan State Utah Location ____ Elev. ≈ 5546

PAGE 1 OF 1
T.D. PROBE ____
T.D. DRILL 100.0
FLUID LEVEL ____

Depth	Sample Taken	Graphic Log	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	Pyrite Habit	Pyrite Alter.	Metallic	Non-Metallic	React.-10% HCL	Carbon Amount	Carbon Type	Remarks
0–2.5						mdst	rdbn											N			Surface Soil.
2.5–5.0						mdst	rdbn											VS			Mancos Shale
5.0–7.5						qtz ss	tn	m	w	a								w			Upper Dakota Fm Ct. @ 5.0'
7.5–10.0						qtz ss	tn	m	w	a								N			
10.0–12.5						qtz ss	lttn	m	w	a								N			
12.5–15.0						qtz ss	wh-lttn	m	w	a		L						N			
15.0–17.5						qtz ss	wh-lttn	m-c	m	a								N			some chert grains
17.5–20.0						qtz ss	tn	f-c	f	a								N			
20.0–22.5						qtz ss, cgl, sh	ltgy	m-peb	f	a								N			abund. dkgy chert frags.
22.5–25.0						qtz ss	tn	m	w	r								N			
25.0–27.5						qtz ss	tn	m-c	m	r								N			
27.5–30.0						qtz ss	tn	m-c	m	r								N			
30.0–32.5						qtz ss	tn	m	w	r								N			
32.5–35.0						qtz ss	tn	f-m	m	r		H						N			
35.0–37.5						qtz ss	tn	m	w	a								N			
37.5–40.0						qtz ss	ltortn	m	w	r								N			
40.0–42.5						qtz ss	gytn	m-peb	m	r								N			
42.5–45.0						qtz ss, sh	ltgytn	f-m	m	r								N			
45.0–47.5						qtz ss	ltgytn	f-m	m	r			1%	A				N			
47.5–50.0						qtz ss	ltortn	f	w	r								N			
50.0–52.5						qtz ss sltst	ltgytn	f-m	m	a								N			
52.5–55.0						qtz ss	ltpktn	m	w	r		H						N			
55.0–57.5						qtz ss	tn	m	w	r								N			
57.5–60.0						qtz ss	tn	m-c	m	r								N			
60.0–62.5						qtz ss	dkgytn	c-vc	m	a								N			
62.5–65.0						qtz ss	ltgytn	m	w	a								N			
65.0–67.5						qtz ss	ltgytn	m	w	r								N			
67.5–70.0						qtz ss	lttn	m-c	m	r								N			
70.0–72.5						qtz ss	lttn	m-c	m	r								N			
72.5–75.0						qtz ss	lttn	m	w	r								N			
75.0–77.5						qtz ss	lttn	m	w	r								N			
77.5–80.0						qtz ss	ltgytn	m-c	m	r								N			
80.0–82.5						qtz ss	ltgybn	m-peb	m	r								N			
82.5–85.0						qtz ss	gytn	f-m	m	r		L						N			
85.0–87.5						qtz ss	tn	f-m	m	r		L						N			
87.5–90.0						qtz ss	tn	f-m	m	a								N			
90.0–92.5						qtz ss	tn	m	w	r								N			
92.5–95.0						qtz ss, sh	wh-tn, gn	m	w	r		L	tr	c				N			Brushy Basin Fm Ct @ 94.0' good ct.
95.0–97.5						sh	ppbn											N			
97.5–100.0						sh	ppbn-gn											N			T.D.
102.5																					
105.0																					
107.5																					
110.0																					
112.5																					
115.0																					
117.5																					
120.0																					
122.5																					
125.0																					

PERCENTAGE COMPOSITION IMAGE

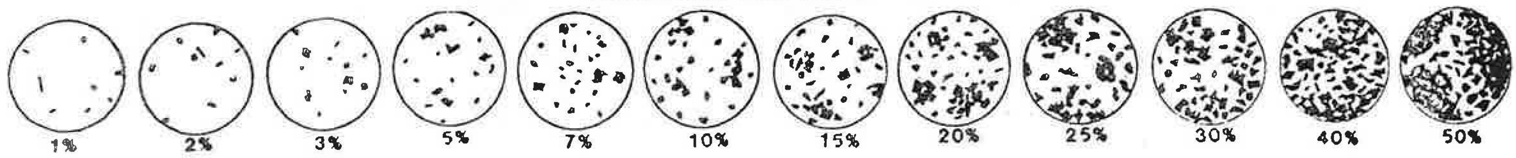
1% 2% 3% 5% 7% 10% 15% 20% 25% 30% 40% 50%

Date 28 APR 2011 Geologist L. Casebolt Drilling Co. Bayles Exploration Co. Hole No. DR15
Property White Mesa Mill Project Cell 4B Unit No. ______ Sec. ____ Twp. ____ Rge. ____
County San Juan State Utah Location ______________ Elev. ≈5571

PAGE 1 OF 1
T.D. PROBE ______
T.D. DRILL 100.0 T.D
FLUID LEVEL ______

DEPTH	SAMPLE TAKEN	GRAPHIC LOG	ALTERATION	GAMMA ANOMALY	BRECCIA PIPE	LITHOLOGY	COLOR OF WET SAMPLE	GRAIN SIZE	SORTING	ANGULARITY	CEMENT MATRIX	IRON OXIDE	PYRITE AMOUNT	PYRITE HABIT	PYRITE ALTER.	METALLIC	NON-METALLIC	REACT.-10% HCL	CARBON AMOUNT	CARBON TYPE	REMARKS
0																					
2.5						mdst	rdbn											S			Surface Soil - unconsolidated - sandy lean clay CL
5.0						mdst	rdbn											S			Surface Soil - unconsolidated " " " CL
7.5						sh	ltpktn											VS			Mancos sh sandy fat clay CH
10.0						sndy sh	ywgy	f-m	f	a								S			mancos sh
12.5						qtzss, sh	vltbn	f	w	r								W			Upper Dakota Ct. @ 11.0'
15.0						qtz ss	ltywbn	vf-f	m	r								N			
17.5						qtzss	ltywbn	f-m	m	r		L						N			
20.0						qtzss	gytn	f	w	r								N			
22.5						qtzss	ltywbn	f	w	r		L						N			
25.0						qtzss	lttn	m	w	r								N			
27.5						qtzss	tn	m	w	r								N			
30.0						qtz ss	tn	m-c	m	r								N			some chert frags. and grains
32.5						qtzss	ltortn	f-m	m	r		L						N			
35.0						qtz ss	tn	f	w	r								N			
37.5						qtzss	tn	m	w	a								N			
40.0						qtz ss	tn	m-c	m	a								N			
42.5						qtz ss	tn	m-c	m	r								N			
45.0						qtz ss	tn	m-c	m	r								N			
47.5						qtz ss	tn	m-c	m	r								N			some chert frags and grains
50.0						qtz ss, sh	ltbn, gn	m-peb	m	r								W			some gn shale frags.
52.5						sh	ywgygn											N			
55.0						sh, qtz ss, cgl	ltgygn	m-peb	p	a								N			abund chert frags and grains.
57.5						qtz ss	tn	m-vc	p	a								N			" " " " "
60.0						qtz ss	tn	m	w	r								N			
62.5						qtzss	tn	m	w	R		L						N			
65.0						qtz ss	ltortn	m	w	R		L						N			
67.5						qtzss	ltortn	m-vc	m	r		L						N			abund chert frags and grains
70.0						qtz ss, cgl	dkgyortn	m-peb	f	r								N			50% chert frags, grains, and pebbles.
72.5						qtz ss	lttn	m-vc	f	a								N			some " " "
75.0						qtz ss	vlttn	m	w	r								N			
77.5						qtz ss	ltgytn	m-peb	m	a								N			10% chert frags, grains.
80.0						qtz ss, cgl	gy-dkgy	m-peb	m	a								N			50% chert frags, grains and pebbles.
82.5						qtz ss	tn	m	w	R								N			
85.0						qtz ss	tn-gy	m-peb	f	a								N			some chert
87.5						qtzss, cgl	gy	m-peb	f	a								N			60% chert frags, grains and pebbles.
90.0						qtzss, cgl	gy	m-peb	f	a								N			note: some material is a qtzite - hard drilling!
92.5						qtz ss	ltpktn	m	w	r								N			qtzite - hard drilling.
95.0						qtz ss	lttn-wh	m	w	r								N			
97.5						qtz ss, sh, cgl	gn-wh	m-peb	p	a			tr.	C				N			Brushy Basin Ct @ 96.0 pyrite assoc. w/qtz.
100.0						sh,	gn											N			T.D
102.5																					
105.0																					
107.5																					
110.0																					
112.5																					
115.0																					
117.5																					
120.0																					
122.5																					
125.0																					

PERCENTAGE COMPOSITION IMAGE



Dakota Ct. to 9.5 ft [illegible]

Date 28 APR 2011 Geologist L. Casebolt Drilling Co. Bayles Exploration Co. Hole No. DR16

Property White Mesa Mill Project Cell 4B Unit No. ______ Sec. ______ Twp. ______ Rge. ______

County San Juan State Utah Location ______ Elev. ≈5555

PAGE 1 OF 1

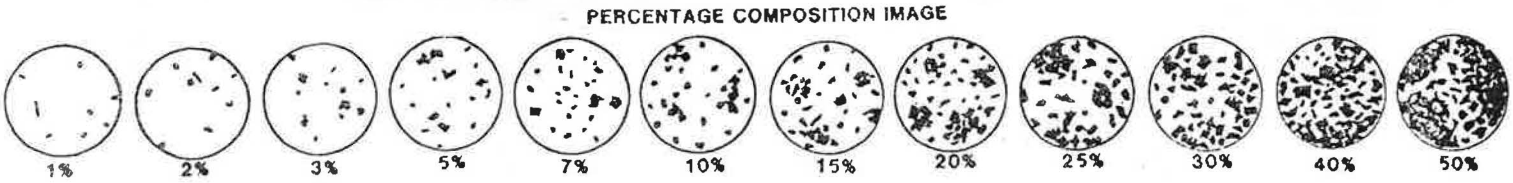
T.D. PROBE ______

T.D. DRILL 105.0

FLUID LEVEL ______

Depth	Sample Taken	Graphic Log	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	Pyrite Habit	Pyrite Alter.	Metallic	Non-Metallic	React.-10% HCL	Carbon Amount	Carbon Type	Remarks
0																					
2.5						mdst	rd bn											W			Surface Soil-unconsolidated - sandy lean clay CL
5.0						mdst	rd bn											W			Surface Soil-unconsolidated-sandy lean clay CL
7.5						mdst, lmysh	rd bn-pk tn											VS			Mancos Shale @ 6.0 ft.
10.0						lmysh-qtz ss	pk tn-wh	m	w	r								VS			Mancos Shale ss is qtzitic
12.5						qtz ss	or tn	m	w	r		v						S			Upper Dakota Fm Ct @ 9.5'
15.0						qtz ss	tn	m	w	R								N			
17.5						qtz ss	tn	f-m	m	r								N			
20.0						qtz ss	tn	f-m	m	r								N			
22.5						qtz ss	tn	f	w	r								N			
25.0						qtz ss	tn	m	w	R								N			
27.5						qtz ss	tn	vf-f	m	R								N			
30.0						qtz ss	tn	m	w	R								N			
32.5						qtz ss	tn	m	w	R								N			
35.0						qtz ss	tn	vf	w	R								N			
37.5						qtz ss	ltgytn	m-c	m	a								N			
40.0						qtz ss	tn	m	w	a								N			
42.5						qtz ss	tn	m	w	a								N			
45.0						qtz ss	tn	m-peb	p	a								N			
47.5						sh-qtz ss	ywgygn	m-vc	p	a								N			
50.0						qtz ss, sh	ywgy-tn	m-peb	p	a								N			abund. multi colored chert frags, grains & pebbles
52.5						qtz ss	gy tn	m-peb	p	a								N			" " " " " " "
55.0						qtz ss	lt or tn	m-c	m	a		L						N			
57.5						qtz ss	lt or tn	m-c	m	a		L						N			
60.0						qtz ss	tn	m	w	r								N			
62.5						qtz ss	tn	m	w	r								N			
65.0						qtz ss, sh	ltgytn	m c	m	a								N			
67.5						qtz ss	ltgytn	m c	m	r								N			
70.0						qtz ss	tn	f-m	m	r								N			
72.5						qtz ss	tn	m-vc	p	a								N			chert grains
75.0						qtz ss	lt or tn	m-c	m	r								N			
77.5						qtz ss, cgl	lt bn	m-peb	p	a								N			50% chert grains & frags.
80.0						qtz ss	ltgytn	m-vc	p	a								N			
82.5						qtz ss	ltgytn	m-vc	p	a								N			
85.0						qtz ss	ltgytn	m-vc	p	a								N			
87.5						qtz ss, cgl	gy bn	m-peb	p	a								N			50%+ chert grains, fragments & grains
90.0						qtz ss	tn	m	w	r								N			
92.5						qtz ss, cgl	gy bn	m-peb	p	a								N			50%+ chert grains, frags & grains
95.0						qtz ss, cgl	gy bn	m-peb	p	a								N			75% chert grains, frags & grains
97.5						qtz ss	tn	m	w	r								N			
100.0						qtz ss	tn-gn	m-c	m	a			tr	C				W			Brushy Basin Ct @ 100.0, pyrite assoc. w/qtz
102.5						sh	gn-vltgn											N			
105.0						sh	gn-pp bn											N			telltale small red chert grains T.D.
107.5																					
110.0																					
112.5																					
115.0																					
117.5																					
120.0																					
122.5																					
125.0																					

PERCENTAGE COMPOSITION IMAGE



Date 29 APR 2011 Geologist L. Casebolt Drilling Co. Bayles Exploration Co. Hole No. DR17

Property White Mesa Mill Project CELL 4B Unit No. ______ Sec. ______ Twp. ______ Rge. ______

County San Juan State Utah Location ______ Elev. ______

PAGE 1 OF 1

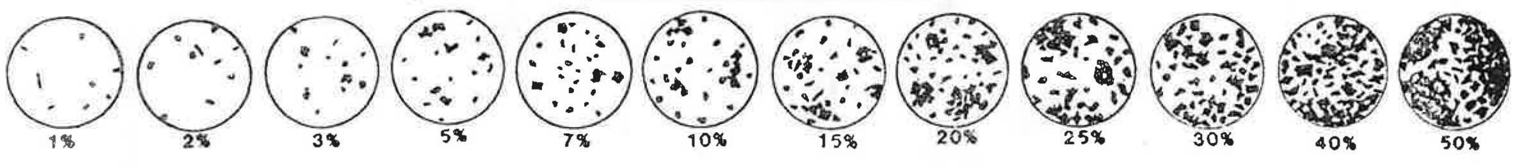
T.D. PROBE ______

T.D. DRILL 85.0

FLUID LEVEL ______

DEPTH	SAMPLE TAKEN	GRAPHIC LOG	ALTERATION	GAMMA ANOMALY	BRECCIA PIPE	LITHOLOGY	COLOR OF WET SAMPLE	GRAIN SIZE	SORTING	ANGULARITY	CEMENT MATRIX	IRON OXIDE	PYRITE AMOUNT	PYRITE HABIT	PYRITE ALTER.	METALLIC	NON-METALLIC	REACT.-10% HCL	CARBON AMOUNT	CARBON TYPE	REMARKS
0–2.5						mdst	rdbn											N			Surface Soil-unconsolidated - lean sandy clay CL
2.5–5.0						mdst	rdbn											W			Surface Soil-unconsolidated - lean sandy clay CL
5.0–7.5						qtz ss	ortn	m	w	r		L						N			Upper Dakota Fm Ct @ 5.0'
7.5–10.0						qtz ss	tn	m-c	m	r								N			
10.0–12.5						qtz ss	tn	m	w	r								N			
12.5–15.0						qtz ss	lt gy tn	m	w	R								N			
15.0–17.5						qtz ss	lt gy tn	m-c	m	r								N			Some dk chert frags.
17.5–20.0						qtz ss	lt gy tn	f-c	f	a								N			
20.0–22.5						qtz ss	tn	m	w	a								N			
22.5–25.0						qtz ss	tn	m-c	m	a								N			
25.0–27.5						qtz ss, sh	vlt tn	f-vc	p	a								N			
27.5–30.0						cgl, qtz ss	tn - dk gy tn	m-peb	p	a								N			dk gy chert pebbles & frags, 75%
30.0–32.5						sh, qtz ss	lt gy gn tn	m-vc	f	a								N			
32.5–35.0						sndy sltst	lt or tn	vf-m	f	a								N			
35.0–37.5						sndy sh	lt gy tn	vf-m	p	a								N			
37.5–40.0						sndy sh	lt gy tn	vf-f	f	a								N			
40.0–42.5						sndy sh, ss	lt gy - lt or tn	vf-f	f	a								N			
42.5–45.0						qtz ss	tn	m-c	m	r								N			
45.0–47.5						qtz ss	v lt gy	vf-f	m	r								N			
47.5–50.0						qtz ss, sltst	v lt gy	vf-m	f	r								N			
50.0–52.5						qtz ss	tn	f-c	f	a								N			
52.5–55.0						qtz ss	tn	f-m	m	a								N			
55.0–57.5						qtz ss	lt tn	m-peb	p	a								N			Some light colored chert frags, and pebbles
57.5–60.0						qtz ss, cgl	lt gy tn	m-peb	p	a								N			" " " " " " "
60.0–62.5						qtz ss	lt gy tn	m-vc	p	a								N			
62.5–65.0						qtz ss	lt gy tn	f-m	m	a								N			
65.0–67.5						qtz ss	tn	f-m	w	r								N			
67.5–70.0						qtz ss	tn	f-m	w	r								W			Brushy Basin Ct @ 70.0'
70.0–72.5						sh cgl	gn	peb										N			some dk chert pebbles.
72.5–75.0						sh cgl	gn	peb										N			" " " " tell tale red chert frags.
75.0–77.5						sh	gn											N			
77.5–80.0						sh	gn											N			red chert frags.
80.0–82.5						Sh	gn - lt gy											N			
82.5–85.0						sh	gn						tr	A				N			T.D. red chert frags, pyrite as small aggre.
87.5																					
90.0																					
92.5																					
95.0																					
97.5																					
100.0																					
102.5																					
105.0																					
107.5																					
110.0																					
112.5																					
115.0																					
117.5																					
120.0																					
122.5																					
125.0																					

PERCENTAGE COMPOSITION IMAGE

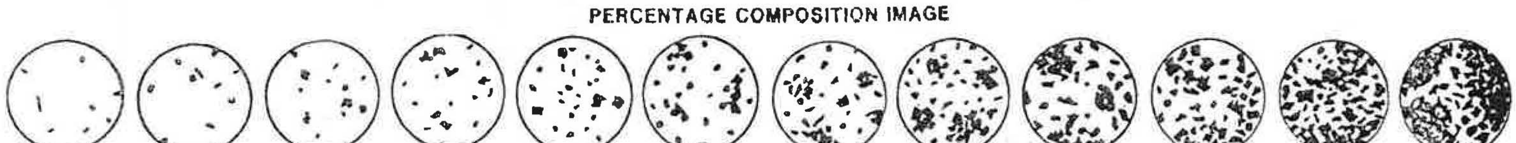


Date 4 May 2011 Geologist L. Casebolt Drilling Co. Bayles Exploration Inc. Hole No. DR 18
Property White Mesa Mill Project Cell 4B Unit No. ______ Sec. ____ Twp. ____ Rge. ____
County San Juan State Utah Location ______ Elev. ≈ 5536

PAGE 1 OF 1
T.D. PROBE ______
T.D. DRILL 70.0
FLUID LEVEL ______

DEPTH	LITHOLOGY	COLOR OF WET SAMPLE	GRAIN SIZE	SORTING	ANGULARITY	CEMENT MATRIX	IRON OXIDE	PYRITE AMOUNT	PYRITE HABIT	PYRITE ALTER.	METALLIC	NON-METALLIC	REACT.-10% HCL	CARBON AMOUNT	CARBON TYPE	REMARKS
0–2.5	mdst	rdbn											W			Surface Soil- unconsolidated - sndy slt ML
2.5–5.0	mdst	rdbn											m			Surface soil- unconsolidated - sndy slt ML
5.0–7.5	qtz ss	bn	m-vc	p	A								N			Upper Dakota Fm Ct. @ 5.0' wh-gy chert frags.
7.5–10.0	qtz ss	wh-gybn	m-vc	p	A								N			abund chert frags.
10.0–12.5	cgl, qtz ss	gybn	m-peb	p	a								N			75% multi colored chert frags. & grains
12.5–15.0	qtz ss	dkgy	m	w	a								N			
15.0–17.5	qtzss	tn	f	w	r								N			
17.5–20.0	qtz ss	lt ortn	m	w	r								N			
20.0–22.5	qtz ss	tn	m-c	m	r								N			
22.5–25.0	qtz ss	tn	m-vc	f	r								N			
25.0–27.5	cgl, qtz ss	gytnbn	m-peb	p	a								N			
27.5–30.0	qtz ss	tn	m	w	R								N			moisture first noticed @ 30.0'
30.0–32.5	qtzss	tn	m	w	R								N			
32.5–35.0	qtz ss	tn	m c	m	R								N			
35.0–37.5	qtz ss	tn	m c	m	R								N			
37.5–40.0	qtz ss	lt orbn	m-vc	f	r								N			abund chert frags. & grains
40.0–42.5	qtz ss	vltgytn	m	w	a								N			
42.5–45.0	qtz ss	vltgytn	m-c	m	a								N			
45.0–47.5	qtz ss, qtzite	wh	m-c	m	a		L						N			very hard drilling some small chert grains
47.5–50.0	qtz ss, qtzite	wh	m-c	m	a		L						N			" " "
50.0–52.5	qtzite	wh-vlttn	m-vc	p	a								N			" " "
52.5–55.0	qtzite	wh-vlttn	m-vc	p	a								N			" " "
55.0–57.5	qtzite, sh	rdgybn-ltgn	m-peb	p	A			tr					N			Brushy Basin Ct. @ 57.0' chert breccia.
57.5–60.0	sh	ywgygn					H						N			
60.0–62.5	sh	blgy					L						N			some chert grains
62.5–65.0	sh	blgy											N			telltale red chert grains
65.0–67.5	sh	blgy											N			
67.5–70.0	sh	blgy											N			T.D.
72.5																
75.0																
77.5																
80.0																
82.5																
85.0																
87.5																
90.0																
92.5																
95.0																
97.5																
100.0																
102.5																
105.0																
107.5																
110.0																
112.5																
115.0																
117.5																
120.0																
122.5																
125.0																

PERCENTAGE COMPOSITION IMAGE



1% 2% 3% 5% 7% 10% 15% 20% 25% 30% 40% 50%

Date 3 May 2011 Geologist L. Casebolt Drilling Co. Boyles Exploration Inc. Hole No. DR19

Property White Mesa Mill Project Cell 4B Unit No. ______ Sec. ______ Twp. ______ Rge. ______

County San Juan State Utah Location ______ Elev. ≈ 5513

PAGE 1 OF 1

T.D. PROBE ______

T.D. DRILL 75.0

FLUID LEVEL ______

DEPTH	SAMPLE TAKEN	GRAPHIC LOG	ALTERATION	GAMMA ANOMALY	BRECCIA PIPE	LITHOLOGY	COLOR OF WET SAMPLE	GRAIN SIZE	SORTING	ANGULARITY	CEMENT MATRIX	IRON OXIDE	PYRITE AMOUNT	PYRITE HABIT	PYRITE ALTER.	METALLIC	NON-METALLIC	REACT.-10% HCL	CARBON AMOUNT	CARBON TYPE	REMARKS
0–2.5						mdst	rdbn											N			Surface soil - unconsolidated
5.0						mdst	rdbn											S			Surface soil - unconsolidated
7.5						sndy sltst	rdbn-pk	vf-f	m	r								VS			mancos Sh @ 6.0'
10.0						sndy sltst	rdbn-pk	vf-m	f	r								VS			" "
12.5						qtz ss	ywtn	f-m	m	r								N			Upper Dakota Fm Ct. @ 10.0'
15.0						qtz ss	lt or bn	m	w	a		L						N			
17.5						qtz ss, sh	gytn-vdkgy	m-c	m	a								N			
20.0						qtz ss	ltgytn	m	w	a								N			sparse gy chert grains
22.5						qtz ss	tn	m	w	r		L						N			" " " "
25.0						qtz ss, cgl, qtzite	gy-wh	m-peb	f	r								N			25% lt-dk gy chert pebbles & frags.
27.5						qtz ss	wh-gybn	m-peb	f	a								N			abund chert frags. & pebbles.
30.0						qtz ss	ltgytn	m	w	r								N			
32.5						qtz ss, sh	wh-ltgytn	m-peb	m	a								N			
35.0						qtz ss	ltgytn	m-vc	f	a								N			
37.5						qtz ss	ltgytn	m-c	m	a								N			
40.0						qtz ss	vltgytn	m	w	r								N			
42.5						qtz ss	vltgytn	f-m	m	r								N			
45.0						qtz ss	vltgytn	f	w	r								N			
47.5						qtz ss	vltgytn	m	w	r								N			
50.0						qtz ss	lt pk tn	m-vc	m	r		H						N			abund chert frags.
52.5						qtz ss	ltgytn	m-c	f	a								N			
55.0						qtz ss	ltgytn	m-c	f	a								N			
57.5						qtz ss	wh-ltgytn	m-vc	f	a								N			
60.0						qtz ss, cgl	dkgytn	c-peb	p	a								N			50% lt & dk gy chert pebbles & frags.
62.5						qtz ss	tn-dkgy	m-peb	p	a								N			
65.0						cgl, qtz ss	tn bn	c-peb	p	a								N			75% multicolored chert pebbles & frags.
67.5						sh, qtz ss	bn-gy	m-c	m	r								N			Brushy Basin Ct @ 66.0'
70.0						sh	ltgygn											N			
72.5						sndy sh	blgn											N			
75.0						sh	blgn											N			T.D. some red chert grains
77.5																					
80.0																					
82.5																					
85.0																					
87.5																					
90.0																					
92.5																					
95.0																					
97.5																					
100.0																					
102.5																					
105.0																					
107.5																					
110.0																					
112.5																					
115.0																					
117.5																					
120.0																					
122.5																					
125.0																					

PERCENTAGE COMPOSITION IMAGE

1% 2% 3% 5% 7% 10% 15% 20% 25% 30% 40% 50%

Date 2 MAY 2011 Geologist L. Casebolt Drilling Co. Bayles Exploration Inc. Hole No. DR 20

Property White Mesa Mill Project Cell 4B Unit No. ______ Sec. ______ Twp. ______ Rge. ______

County San Juan State Utah Location ______ Elev. ≈5499

PAGE 1 OF 1

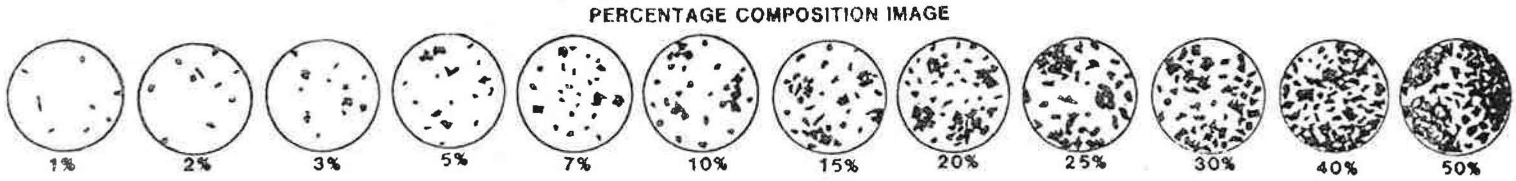
T.D. PROBE ______

T.D. DRILL ______

FLUID LEVEL ______

Depth	Sample Taken	Graphic Log	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	Pyrite Habit	Pyrite Alter.	Metallic	Non-Metallic	React.-10% HCL	Carbon Amount	Carbon Type	Remarks
0																					
2.5						mdst	rd bn											N			Surface Soil-unconsolidated sndy lean clay CL
5.0						mdst	rd bn											N			Surface soil-unconsolidated-sndy lean clay CL
7.5						qtzss, sh	pk tn	m-peb				L						VS			upper Dakota Fm Ct. @ 6.0' some chert frags.
10.0						qtzss	lt rd bn	m-c	m	r		H						N			
12.5						qtzss	vlt gy tn	m-c	m	a								N			
15.0						qtz ss	vlt gy tn	m	w	a								N			
17.5						qtz ss	lt gy tn	m	w	a								N			
20.0						qtz ss	tn	m	w	a								N			
22.5						qtz ss	tn	m-c	m	a								N			
25.0						qtz ss	lt tn	f	w	a								N			
27.5						qtz ss	tn	m-c	m	a								N			some chert frags
30.0						qtz ss	lt gy	m-c	m	a		H						N			" " "
32.5						qtz ss	lt gy tn	m-c	m	a								N			
35.0						qtzss-sh	yw gn bn	f-M	m	r		L						N			
37.5						sndy sh	lt bl gy	M	w	r								N			sparse chert grains
40.0						sndy sh	lt bl gy	f-m	m	r								N			
42.5						sh	lt bl gy											N			
45.0						sh	bl gy-bn											N			sparse chert frags.
47.5						qtz ss, sh	gy bn	vf-m	f	a								N			
50.0						sh, qtzite	gy bn	vf-m	f	a								N			
52.5						sndy sh	gy gn	m-peb	f	a								N			sparse chert pebbles + grains
55.0						sh, qtzss	lt gn gy	m	w	a		L						N			
57.5						sndy sh	lt gy tn	f m	m	r			tr					N			
60.0						qtz ss, sh	yw gy bn	f-m	m	r								N			
62.5						sndy sh	lt bl gy	f-M	m	r								N			
65.0						sh	gy gn											N			sparse red-bn chert frags.
67.5						sh	gy gn											N			
70.0						qtzite, sh	wh-gy	f-m	m	r								N			some red-bn chert grains + frags.
72.5						qtz ss, sh	wh-gy	f-c	p	a								N			
75.0						qtzss, sh	wh-gy gn	f m	m	a								N			Brushy Basin Ct @ 73.0' abund. rd-gy chert pebbles
77.5						sh	gy gn											N			
80.0						sh	gy gn-pp bn											N			mottled shale frags.
82.5						sh	gy gn											N			
85.0						qtzss, sh	wh-gy gn	m-c	m	a								N			micaceous ss. (muscovite?)
87.5						sndy sh	gy-gy gn	f-m	m	r								N			
90.0						sh	lt gy						tr					N			T.D.
92.5																					
95.0																					
97.5																					
100.0																					
102.5																					
105.0																					
107.5																					
110.0																					
112.5																					
115.0																					
117.5																					
120.0																					
122.5																					
125.0																					

PERCENTAGE COMPOSITION IMAGE



Date 2 May 2011 Geologist L. Casebolt Drilling Co. Bayles Exploration Inc Hole No. DR21

Property White Mesa Mill Project Cell 4B Unit No. ____ Sec. ____ Twp. ____ Rge. ____

County San Juan State Utah Location ____ Elev. ≈ 5530

PAGE 1 OF 1

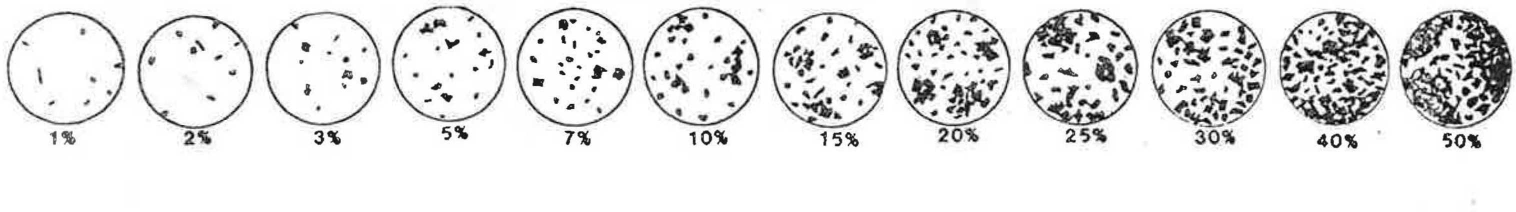
T.D. PROBE ____

T.D. DRILL ____

FLUID LEVEL ____

Depth	Sample Taken	Graphic Log	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite: Amount	Pyrite: Habit	Pyrite: Alter.	Metallic	Non-Metallic	React.-10% HCL	Carbon: Amount	Carbon: Type	Remarks
0–2.5						mdst	rdbn											W			Surface soil-unconsolidated-sndy lean clay CL
2.5–5.0						mdst	rdbn											S			Surface soil-unconsolidated-sndy lean clay CL
5.0–7.5						sndysh	rdbn-ltpk	m	w	a								VS			Mancos Shale @ 8.0'
7.5–10.0						sh	pktn											VS			
10.0–12.5						sh	ywgy											VS			
12.5–15.0						sh	ywgy											m			
15.0–17.5						sh	ywgy											m			
17.5–20.0						sndysh	ywgy	f	w	a								M			
20.0–22.5						sndy sh	ywgy	m	w	a		L						VW			
22.5–25.0						sndy sh, ss	tn	f-m	m	a								VW			Upper Dakota Fm Ct @ 24.0'
25.0–27.5						qtz ss	tn	m	w	a								N			
27.5–30.0						qtz ss	tn	m	w	a								N			
30.0–32.5						qtz ss	tn	m	w	a								N			
32.5–35.0						qtz ss	tn	f-m	m	a								N			
35.0–37.5						qtz ss	tn	m	w	a								N			
37.5–40.0						qtz ss	tn	f	w	a								N			
40.0–42.5						qtz ss	tn	m	w	a								N			
42.5–45.0						qtz ss, sh	dkbn	m	w	a		L						N			
45.0–47.5						qtz ss	tn	m-c	m	a								N			
47.5–50.0						qtz ss	gytn	m-vc	p	a								N			abund multicolored chert frags.
50.0–52.5						qtz ss	tn	m-vc	p	a								N			" " " " "
52.5–55.0						qtz ss	tn	m-c	f	a								N			" " " " "
55.0–57.5						sh	ltgy-gybn											N			chert pebbles & frags
57.5–60.0						sh	ltgy											N			
60.0–62.5						sndy sh	vltgytn	vf-m	f	a								N			
62.5–65.0						qtz ss	tn	m	w	a								N			
65.0–67.5						qtz ss	tn	m-c	m	a								N			
67.5–70.0						qtz ss	tn	c	w	r								N			
70.0–72.5						qtz ss, cgl	ltgytn	m-peb	f	r								N			
72.5–75.0						qtz ss	ltgytn	c	w	r								N			some gy chert grains
75.0–77.5						qtz ss	tn	c	w	r								N			
77.5–80.0						qtz ss	tn	m-c	m	a								N			
80.0–82.5						qtz ss	tn	m	w	r								N			
82.5–85.0						qtz ss	tn	f-m	m	r								N			
85.0–87.5						qtz ss	ltpktn	vf	w	r								N			
87.5–90.0						qtz ss	tn	f-m	m	r								N			
90.0–92.5						qtz ss	tn	m	w	r								N			
92.5–95.0						qtz ss, cgl	tn	m-peb	f	a								N			some gy chert frags.
95.0–97.5						qtz ss	wh-vlttn	m-vc	m	a								N			abund. wh-lt colored qtzite & chert frags.
97.5–100.0						qtz ss	wh-vlttn	m-vc	m	a								N			" " " " " "
100.0–102.5						qtz ss	wh-tn	m-peb	f	a								N			" " " " " "
102.5–105.0						qtz ss	wh-tn	m-peb	f	a								N			hard drilling, abund rusting steel frags.
105.0–107.5						qtz ss, qtzite	wh-tn	m-peb	f	a								N			" " " " " "
107.5–110.0						qtz ss, qtzite	wh-tn	m-peb	f	a								N			50% of grains are chert
110.0–112.5						qtz ss, cgl	gytn	m-peb	f	a								N			
112.5–115.0						qtz ss, cgl - sltysh	ywtn-gygn	m-peb	f	a		L						N			Brushy Basin Ct. @ 114.0
115.0–117.5						slty sh	gn-ppbn											N			
117.5–120.0						sltysh	gn-ppbn											N			T.D.
120.0–122.5																					
122.5–125.0																					

PERCENTAGE COMPOSITION IMAGE

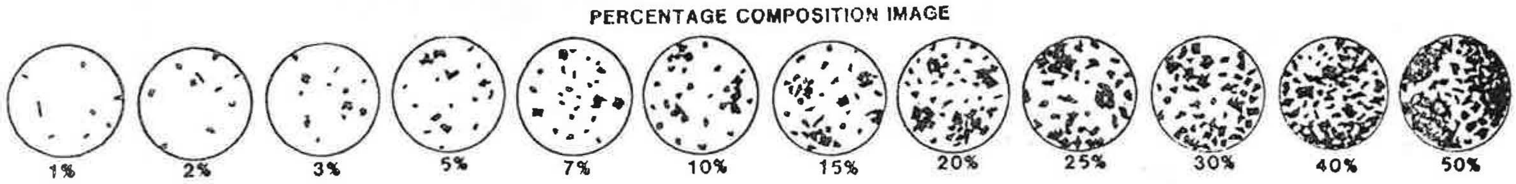


Date 3 May 2011 Geologist L. Casebolt Drilling Co. Boyles Exploration Inc. Hole No. DR 22
Property White mesa mill Project Cell 4B Unit No. ______ Sec. ____ Twp. ____ Rge. ____
County San Juan State Utah Location ______________ Elev. 5488

PAGE 1 OF 1
T.D. PROBE ______
T.D. DRILL 85.0
FLUID LEVEL ______

DEPTH	SAMPLE TAKEN	GRAPHIC LOG	ALTERATION	GAMMA ANOMALY	BRECCIA PIPE	LITHOLOGY	COLOR OF WET SAMPLE	GRAIN SIZE	SORTING	ANGULARITY	CEMENT MATRIX	IRON OXIDE	PYRITE AMOUNT	PYRITE HABIT	PYRITE ALTER.	METALLIC	NON-METALLIC	REACT.-10% HCL	CARBON AMOUNT	CARBON TYPE	REMARKS
0																					
2.5						mdst	rdbn											W			Surface Soil - unconsolidated - sndy lean clay CL
5.0						mdst	rdbn											W			Surface Soil - unconsolidated - sndy lean clay CL
7.5						qtz ss	ltgytn											N			Upper Dakota Ct @ 5.0'
10.0						qtz ss cgl	ltgytn	m-peb	f	r								N			abund gray chert frags.
12.5						qtz ss,	ltgytn	m	w	r								N			
15.0						qtz ss, sh	wh-ltgytn	m-c	m	r								N			
17.5						qtz ss	wh-ltgytn	m-vc	m	r								N			some chert frags.
20.0						qtz ss	ltgytn	m-c	m	r								N			
22.5						qtz ss, cgl	gytn	m-peb	f	a								N			50% chert grains & frags.
25.0						qtz ss, cgl	gytn	m-peb	f	a								N			" " " "
27.5						qtz ss,	tn	m	w	a								N			
30.0						qtz ss cgl	gytn	m peb	f	a								N			abund light colored chert grains.
32.5						qtz ss	ltgytn	m-c	m	R								N			
35.0						qtz ss	ltgytn	m	w	R								N			
37.5						qtz ss	ltgytn	m	w	r								N			
40.0						qtz ss	ltgytn	m-c	m	a								N			
42.5						qtz ss	ltgytn	m	w	r								N			
45.0						qtz ss	ltgytn	m-c	m	r								N			
47.5						qtz ss	ltgytn	m	w	r								N			
50.0						qtz ss	ltgytn	m-c	m	r								N			
52.5						qtz ss	ltgytn	m-c	m	a								N			
55.0						qtz ss	ltgy	m-c	m	a								N			
57.5						qtz ss	ltgy	m-c	m	a								M			
60.0						sh	ltgy-ltgn											N			Brushy Basin Ct @ 57.5' some chert Grains
62.5						sh	wh-ltgygn											N			
65.0						sh	gybn											N			some red chert grains
67.5						sh	gn-ppbn											N			Extremely hard drilling (chert) from 67.5
70.0						sh, qtz	ortn-gn											N			to 72.5' chert pebbles & frags.
72.5						sh, qtzite	wh-ltgn	m-peb										N			
75.0						sh	blgy											N			red chert frags.
77.5						sh	blgy	peb										N			" " " & pebbles
80.0						sh	blgy											N			
82.5						sh, qtz ss	blgy	f-m	m	a			tr	C				N			
85.0						qtz ss, sh	ltgy	vf-m	f	a								N			TD
87.5																					
90.0																					
92.5																					
95.0																					
97.5																					
100.0																					
102.5																					
105.0																					
107.5																					
110.0																					
112.5																					
115.0																					
117.5																					
120.0																					
122.5																					
125.0																					

PERCENTAGE COMPOSITION IMAGE



Date 4 May 2011 Geologist L. Casebolt Drilling Co. Bayles Exploration, Inc. Hole No. DR 23

Property White Mesa Mill Project Cell 4B Unit No. ______ Sec. ______ Twp. ______ Rge. ______

County San Juan State Utah Location ______ Elev. ≈5491

PAGE 1 OF 1

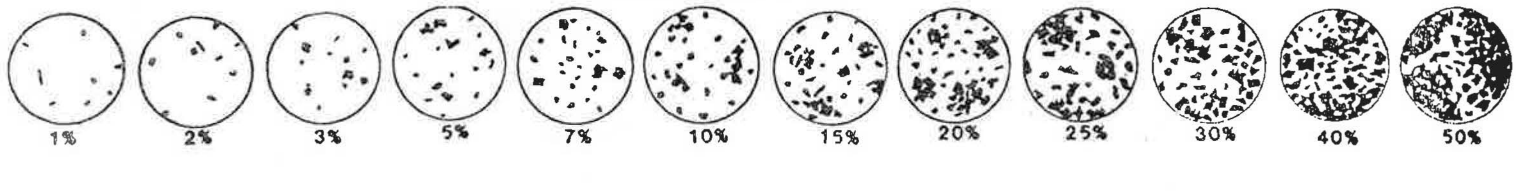
T.D. PROBE ______

T.D. DRILL 85.0

FLUID LEVEL ______

Depth	Sample Taken	Graphic Log	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	Pyrite Habit	Pyrite Alter.	Metallic	Non-Metallic	React.-10% HCL	Carbon Amount	Carbon Type	Remarks
0																					
2.5						mdst	rdbn											S			Surface soil. Mancos Shale @ 2.0'-unconsolidated
5.0						sndysh	rdbn-ltpktn	vf-f	w	r								VS			Mancos Sh
7.5						sndysh, qtzss	pktn-ywbn	f-m	m	r								VS			Upper Dakota Ct @ 7.0'
10.0						qtz ss	wh-ywtn	m-c	m	r		L						N			
12.5						qtz ss	tn	m-c	m	r		L						N			
15.0						qtz ss	tn	m-c	m	a								N			
17.5						qtz ss	tn	f-m	m	a								N			
20.0						qtz ss	tn	m	w	a		L						N			
22.5						qtz ss	tn	m	w	r								N			
25.0						qtz ss	tn	m c	m	a								N			
27.5						qtz ss	lt	m c	m	r								N			
30.0						qtz ss	ltgytn	m	w	R								N			
32.5						qtz ss	ltgytn	m	w	r								N			
35.0						qtz ss	ltgytn	m	w	r								N			
37.5						qtz ss	ltgytn	m-c	m	r								N			
40.0						qtz ss	ltgytn	m-c	m	a								N			
42.5						qtz ss, cgl	gytn-dkgy	m-peb	f	a								N			30% chert pebbles & grains
45.0						qtz ss	gytn	m-c	m	r								N			
47.5						qtz ss	gytn	m-c	m	r								N			Some chert frags.
50.0						qtz ss	gytn	m-c	m	r								N			
52.5						qtz ss	vltgy	vf-m	f	r								N			
55.0						qtz ss	wh-ortn	f-m	m	r		L						N			
57.5						qtz ss	wh	f	w	a								N			
60.0						qtz ss	wh	m	w	r								N			
62.5						qtz ss	vltgy	m	w	r								N			
65.0						qtz ss	vltgy	m	w	r								N			
67.5						qtz ss	vltgy	m	w	r								N			quite moist @ 67.5
70.0						qtz ss	vltgy	m	w	r								N			
72.5						qtz ss	vltgy	m-c	m	r								N			Some gy chert grains & frags.
75.0						qtz ss, sh	ywbn-tnbn	m-c	m	r		L						N			
77.5						qtzss, sh	wh-tn-gn	m-peb	p	a			tr	C				N			Brushy Basin Ct @ 77.0' good contact
80.0						sh	gygn											N			some red chert grains
82.5						sh	gygn											N			
85.0						sh	gn											N			T.D.
87.5																					
90.0																					
92.5																					
95.0																					
97.5																					
100.0																					
102.5																					
105.0																					
107.5																					
110.0																					
112.5																					
115.0																					
117.5																					
120.0																					
122.5																					
125.0																					

PERCENTAGE COMPOSITION IMAGE

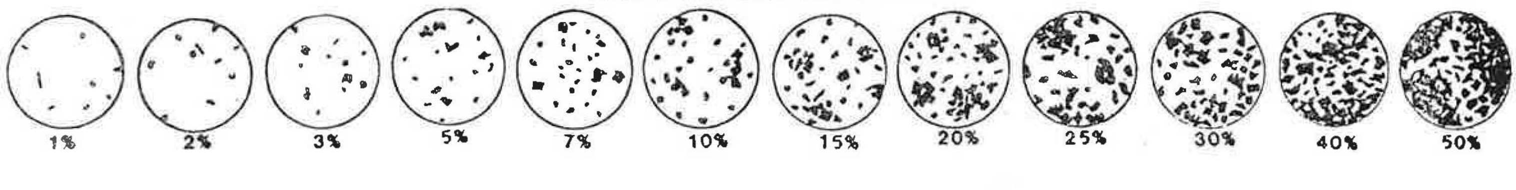


Date 3 MAY 2011 Geologist L. Casebolt Drilling Co. Byles Exploration Inc. Hole No. DR 24
Property White Mesa Mill Project Cell 4B Unit No. ____ Sec. ____ Twp. ____ Rge. ____
County San Juan State Utah Location ____ Elev. ≈5469

PAGE 1 OF 1
T.D. PROBE ____
T.D. DRILL 80.0′
FLUID LEVEL ____

Depth	Sample Taken	Graphic Log	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	Pyrite Habit	Pyrite Alter.	Metallic	Non-Metallic	React.-10% HCL	Carbon Amount	Carbon Type	Remarks
0–2.5						mdst	rdbn											W			Surface Soil-unconsolidated - sndy lean clay - CL
2.5–5.0						mdst	rdbn											W			Surface soil - unconsolidated - sndy lean clay - CL
5.0–7.5						sndy sh	pktn	c-vc	p	r								VS			Mancos Sh
7.5–10.0						qtz ss	gytn	m-peb	f	r								N			Upper Dakota Fm Ct @ 7.5′ chert pebbles & grains
10.0–12.5						qtz ss	gytn	m-vc	f	a								N			light colored chert frags. & grains
12.5–15.0						qtz ss	gytn	m-peb	f	a								N			" " " " "
15.0–17.5						qtz ss	ltgytn	f-m	m	r								N			
17.5–20.0						qtz ss	ltgytn	m-c	m	a								N			
20.0–22.5						qtz ss	ltgytn	m	w	r								N			
22.5–25.0						qtz ss	ltgytn	m	w	r								N			
25.0–27.5						qtz ss	gytn	m-c	m	R								N			
27.5–30.0						qtz ss	ywgytn	m-vc	f	a								N			abund white chert frags.
30.0–32.5						qtz ss	ltgytn	m-c	m	r								N			
32.5–35.0						qtz ss	ltgytn	m	w	r								N			moisture 1st noticed 35.0′
35.0–37.5						qtz ss	ltgytn	m	w	r								N			
37.5–40.0						qtz ss	ltgytn	m	w	r								N			
40.0–42.5						qtz ss	ltgytn	f	w	r								N			
42.5–45.0						qtz ss	ltgytn	f-m	m	r								N			
45.0–47.5						qtz ss	gytn	f-c	f	a								N			
47.5–50.0						qtz ss	ltywtn	m-vc	f	a		L						N			
50.0–52.5						qtz ss	ywgytn	m-peb	f	a		L						N			abund light colored chert pebbles & grains
52.5–55.0						qtz ss, cgl	orgytn	m-peb	p	a		L						N			30% " " " " "
55.0–57.5						qtz ss	ywgytn	m-vc	f	a								VS			
57.5–60.0						qtz ss	gy	f-c	f	a			tr					VS			
60.0–62.5						sh	gn											N			Brushy Basin Ct @ 60.0′ some ppbn chert pebbles.
62.5–65.0						sh	gn						tr					N			some ppbn-red chert frags.
65.0–67.5						sh	gygn											N			
67.5–70.0						sh	gygn-ppbn											N			some mottled cuttings
70.0–72.5						sh	gn											N			
72.5–75.0						sh	gn											N			some red chert grains
75.0–77.5						sh	gn											N			
77.5–80.0						sh	gygn											N			T.D.
82.5																					
85.0																					
87.5																					
90.0																					
92.5																					
95.0																					
97.5																					
100.0																					
102.5																					
105.0																					
107.5																					
110.0																					
112.5																					
115.0																					
117.5																					
120.0																					
122.5																					
125.0																					

PERCENTAGE COMPOSITION IMAGE



Date 2 May 2011 Geologist L. Casebolt Drilling Co. Bayles Exploration, Inc. Hole No. DR 25

Property White Mesa Mill Project Cell 4B Unit No. ____ Sec. ____ Twp. ____ Rge. ____

County San Juan State Utah Location ____ Elev. ≈ 5462

PAGE 1 OF 1

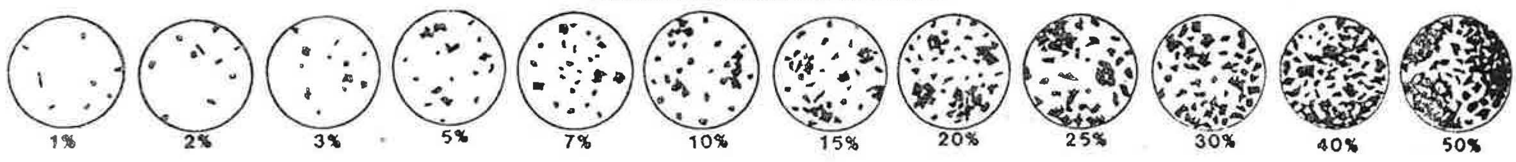
T.D. PROBE ____

T.D. DRILL 80.0

FLUID LEVEL ____

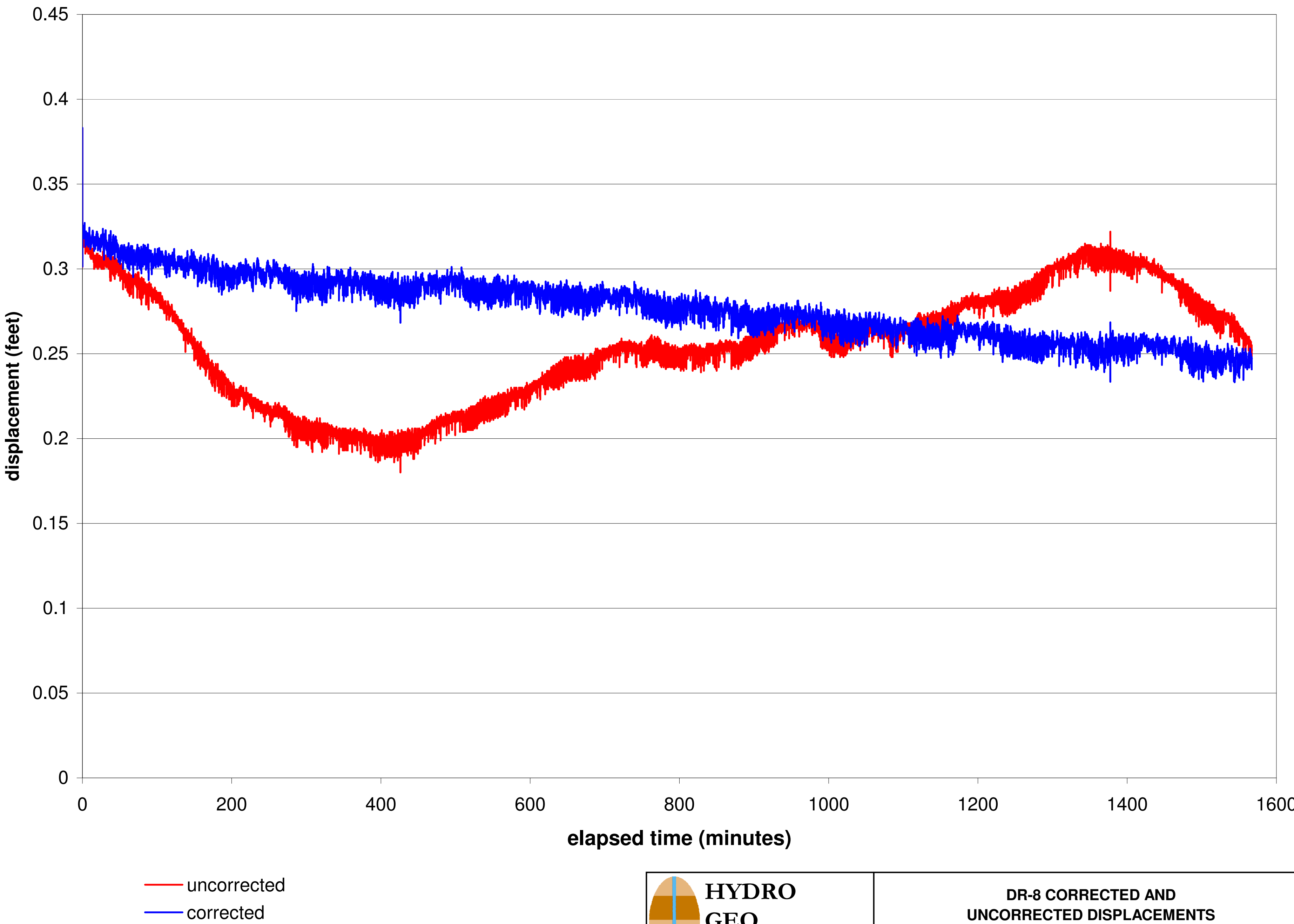
Depth	Sample Taken	Graphic Log	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	Pyrite Habit	Pyrite Alter.	Metallic	Non-Metallic	React.-10% HCL	Carbon Amount	Carbon Type	Remarks
0–2.5						qtz ss, mdst	lt or bn	m-c	m	a		L						VW			Surface soil to 1 foot. Upper Dakota Fm Ct @ 1.0'
2.5–5.0						qtz ss	orgybn	c-vc	m	a		L						N			30% chert frags.
5.0–7.5						qtz ss	tn	m-c	m	a								N			20% " "
7.5–10.0						qtz ss	ortn	m-c	m	a								N			Moisture First noted @ 7.5' 30% chert.
10.0–12.5						qtz ss, sh, cgl	ywtn	m-peb	p	a								N			
12.5–15.0						qtz ss	tn	m-c	m	r								N			30% chert grains
15.0–17.5						qtz ss, cgl	orbn	c-peb	p	a								N			80%+ " " & pebbles
17.5–20.0						qtz ss, cgl	orbn	c-peb	p	a		L						N			90%+ " " "
20.0–22.5						qtz ss, cgl	orgybn	c-peb	p	a		L						N			90%+ " " "
22.5–25.0						qtz ss, cgl	orgybn	c-peb	p	a		L						N			90%+ " " "
25.0–27.5						qtz ss, cgl	gybn	c-peb	p	a		L						N			90%+ " " "
27.5–30.0						qtz ss, cgl	orgybn	c-peb	p	a								N			90%+ " " "
30.0–32.5						qtz ss, cgl	orbn	c-peb	p	a								N			70%+ " " "
32.5–35.0						qtz ss, cgl	gybn	c-peb	p	a								N			90%+ " " "
35.0–37.5						qtz ss	tn	m	w	R								N			
37.5–40.0						qtz ss	lt ortn	f-m	m	r		L						N			
40.0–42.5						qtz ss	tn	f-m	m	r								N			
42.5–45.0						qtz ss	tn	m	w	r								N			
45.0–47.5						qtz ss	tn	f-m	m	r								N			Some chert frags.
47.5–50.0						qtz ss	tn	m	w	R								N			
50.0–52.5						qtz ss	tn	m-c	f	a								VW			some gy chert frags & grains
52.5–55.0						qtz ss	lt gytn	m-vc	f	a								N			abund. " " " "
55.0–57.5						qtz ss, cgl	lt gytn	m-peb	p	a								N			30% wh-gy chert pebbles & frags.
57.5–60.0						qtz ss	lt tn	m-peb	p	a			tr.	A				N			Some " " " " "
60.0–62.5						qtz ss	lt tn	m	w	R								N			
62.5–65.0						qtz ss, cgl	ortn	m-peb	p	a								N			40% multi colored chert pebbles, frags, & grains
65.0–67.5						qtz ss, cgl	gytn	m-peb	p	a								N			80% " " " " " "
67.5–70.0						qtz ss	vltgy	m-c	f	a								N			
70.0–72.5						qtz ss	vltgy	m	w	r								N			
72.5–75.0						qtz ss	vltgy	f-m	m	r								N			Well began producing water @ 72.5'
75.0–77.5						qtz ss, cgl, sh	ywtn-blgn	m-peb	p	a			1%	C				N			Brushy Basin Ct. @ 76.0' (good contact)
77.5–80.0						sh	blgn						tr.	A				N			T.D. some ppbn chert pebbles
80.0–82.5																					
82.5–85.0																					
85.0–87.5																					
87.5–90.0																					
90.0–92.5																					
92.5–95.0																					
95.0–97.5																					
97.5–100.0																					
100.0–102.5																					
102.5–105.0																					
105.0–107.5																					
107.5–110.0																					
110.0–112.5																					
112.5–115.0																					
115.0–117.5																					
117.5–120.0																					
120.0–122.5																					
122.5–125.0																					

PERCENTAGE COMPOSITION IMAGE



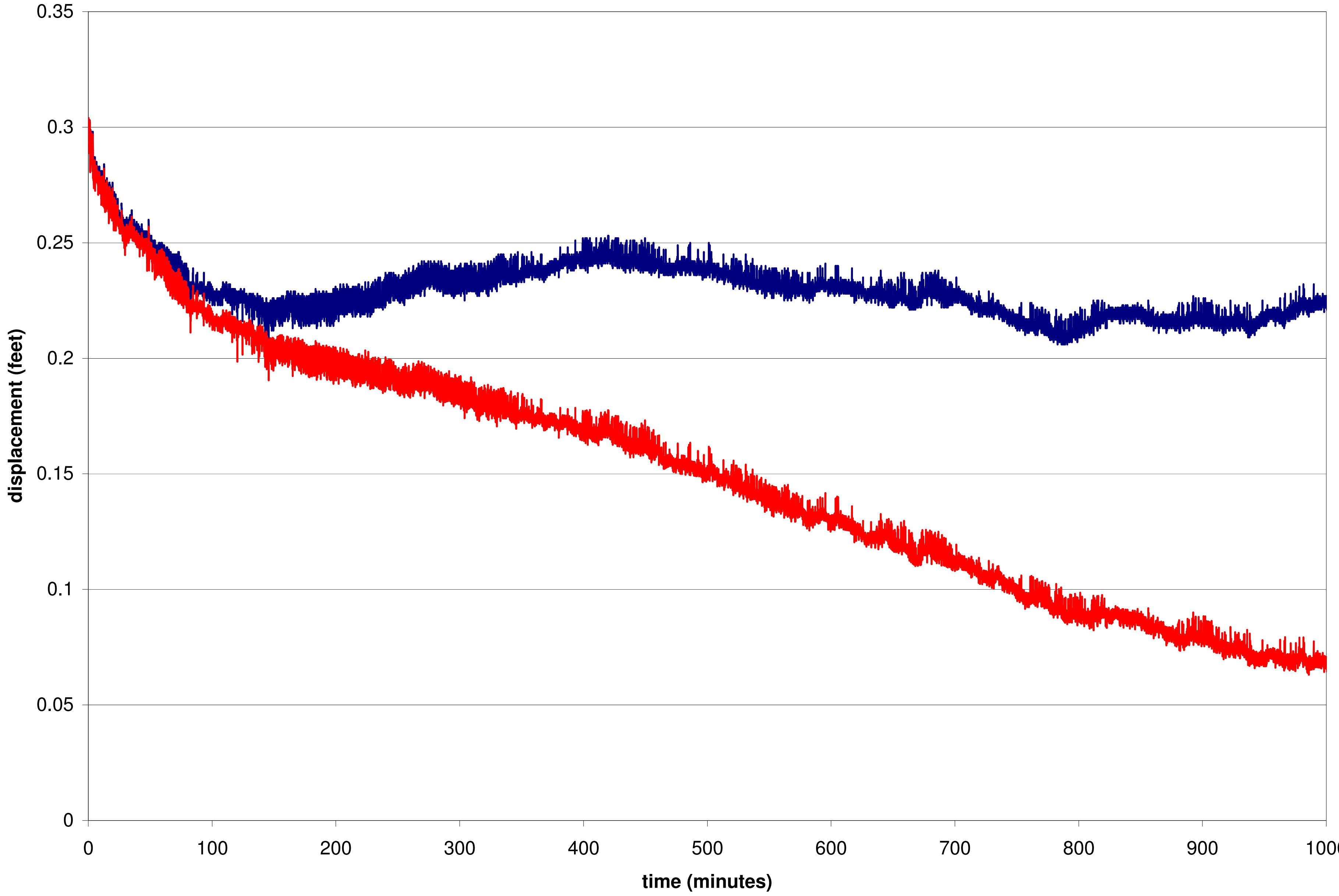
APPENDIX C

PLOTS OF RAW AND CORRECTED DISPLACEMENTS FOR SELECTED PIEZOMETERS AND DISPLACEMENT DATA USED IN THE AQTESOLVE ANALYSIS



HYDRO GEO CHEM, INC.	DR-8 CORRECTED AND UNCORRECTED DISPLACEMENTS				
Approved SJS	Date 10/30/12	Author SJS	Date 10/30/12	File Name F2 DR-8 Plot	Figure C.1

H:\718000\cell4bdryarea\revisedreport_nov2012\DR-8 retest C.1.xls: F2 DR-8 plot

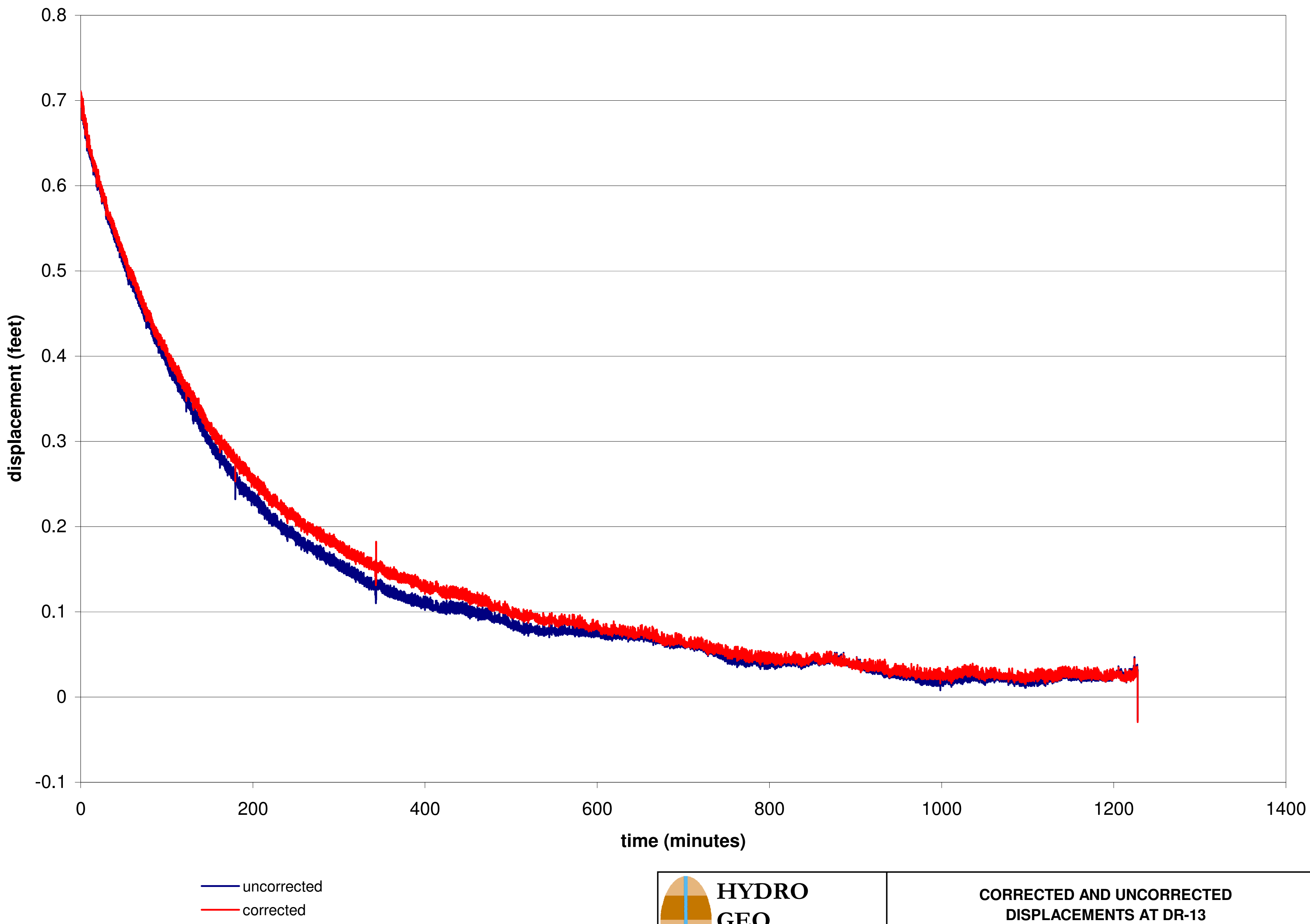


HYDRO GEO CHEM, INC.

CORRECTED AND UNCORRECTED DISPLACEMENTS AT DR-10

Approved	Date	Author	Date	File Name	Figure
SJS	12/5/11	SJS	12/5/11	FC.2 DR10 PLOT	C.2

H:\718000\hydtst11b\data\WhiteMesa_DRtestdata_2.xls: FC.2 DR10 plot

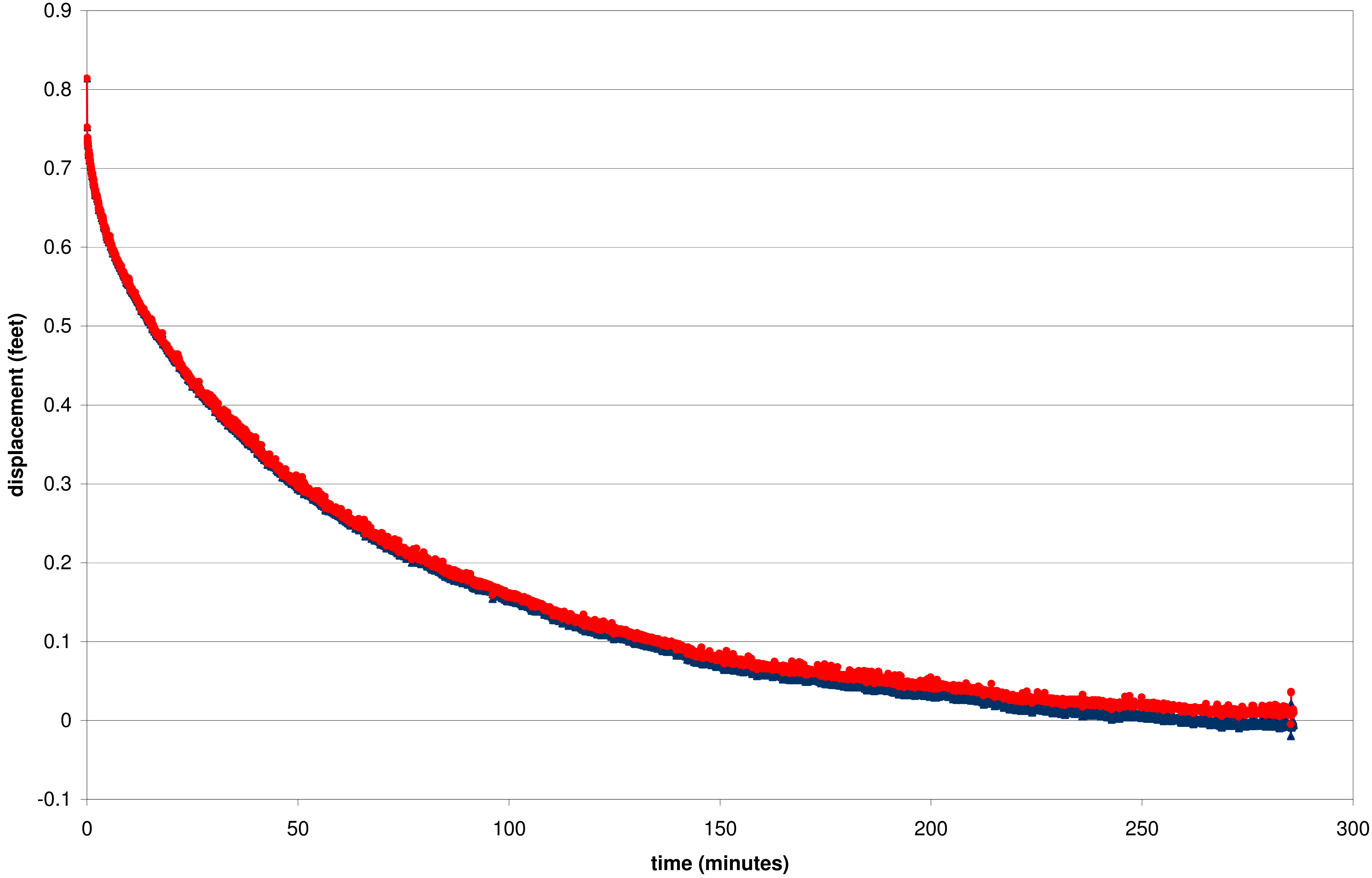


HYDRO GEO CHEM, INC.

CORRECTED AND UNCORRECTED DISPLACEMENTS AT DR-13

Approved	Date	Author	Date	File Name	Figure
SJS	12/5/11	SJS	12/5/11	FC.3 DR13 PLOT	C.3

H:\718000\hydtst11b\data\WhiteMesa_DRtestdata_3.xls: FC.3 DR13 plot



HYDRO GEO CHEM, INC.

CORRECTED AND UNCORRECTED DISPLACEMENTS AT DR-14					
Approved	Date	Author	Date	File Name	Figure
SJS	12/5/11	SJS	12/5/11	FC.4 DR14 PLOT	C.4

time (minutes)	automatically logged DR-5 displacement (ft)
0.05	0.668
0.1	0.662
0.15	0.654
0.2	0.662
0.25	0.65
0.3	0.655
0.35	0.656
0.4	0.652
0.45	0.65
0.5	0.651
0.6	0.644
0.75	0.65
0.95	0.643
1.2	0.636
1.5	0.634
1.85	0.621
2.25	0.613
2.7	0.599
3.2	0.59
3.75	0.577
4.35	0.559
5	0.546
5.7	0.531
6.45	0.518
7.25	0.506
8.1	0.497
9	0.48
9.95	0.472
10.95	0.455
12	0.443
13.1	0.43
14.25	0.431
15.45	0.412
16.7	0.399
18	0.389
19.35	0.374
20.75	0.362
22.2	0.353
23.7	0.341
25.25	0.327
26.85	0.32
28.5	0.309
30.2	0.29
31.95	0.283
33.75	0.277
35.6	0.268
37.5	0.258
39.45	0.248
41.45	0.235
43.5	0.229
45.6	0.217
47.75	0.209
49.95	0.192
52.2	0.179
54.5	0.173
56.85	0.167
59.25	0.16
61.7	0.151
64.2	0.145
66.75	0.137
69.35	0.132

72	0.126
74.7	0.124
77.45	0.111
80.25	0.103
83.1	0.096
86	0.099

time (minutes)	hand collected DR-5 displacement (ft)
0.10	0.67
0.27	0.67
0.50	0.66
1.00	0.65
1.50	0.64
2.00	0.62
2.50	0.61
3.00	0.60
3.50	0.59
4.00	0.58
4.50	0.57
5.00	0.56
6.00	0.54
7.00	0.52
8.00	0.51
9.00	0.50
10.00	0.48
15.00	0.44
20.00	0.39
25.00	0.35
30.00	0.31
35.00	0.28
45.00	0.24
55.00	0.20
65.00	0.16
75.00	0.13
85.00	0.10

time (min)	displacement (ft)
0	0.38316
0.1	0.30135
0.2	0.32554
0.3	0.321825
0.4	0.320015
0.5	0.319205
0.6	0.323395
0.7	0.32468
0.8	0.31887
0.9	0.32306
1.1	0.323535
1.4	0.3242
1.8	0.31915
2.3	0.32429
2.9	0.327145
3.6	0.320625
4.4	0.31615
5.3	0.31815
6.3	0.32015
7.4	0.31615
8.6	0.31686
9.9	0.316145
11.3	0.315335
12.8	0.31752
14.4	0.31847
16.1	0.3188
17.9	0.31699
19.8	0.316985
21.8	0.3168
23.9	0.310995
26.1	0.31965
28.4	0.311665
30.8	0.32045
33.3	0.308475
35.9	0.316795
38.6	0.31414
41.4	0.317985
44.3	0.319125
47.3	0.31066
50.4	0.30285
53.6	0.311985
56.9	0.305175
60.3	0.301125
63.8	0.31117
67.4	0.30646
71.1	0.306515
74.9	0.306465
78.8	0.309635
82.8	0.30417
86.9	0.304115
91.1	0.309155
95.4	0.304305
99.8	0.30282
104.3	0.30824
108.9	0.304475
113.6	0.30442
118.4	0.30375
123.3	0.307215
128.3	0.30626
133.4	0.3024
138.6	0.304245
143.9	0.30224

149.3	0.30756
154.8	0.294235
160.4	0.30142
166.1	0.301215
171.9	0.29736
177.8	0.29272
183.8	0.292535
189.9	0.29681
196.1	0.297375
202.4	0.29332
208.8	0.29365
215.3	0.29765
221.9	0.297495
228.6	0.295545
235.4	0.30462
242.3	0.297485
249.3	0.30081
256.4	0.301465
263.6	0.295485
270.9	0.29786
278.3	0.29381
285.8	0.287135
293.4	0.295135
301.1	0.290615
308.9	0.299495
316.8	0.295135
324.8	0.284135
332.9	0.286335
341.1	0.29412
349.4	0.293795
357.8	0.295785
366.3	0.293785
374.9	0.29426
383.6	0.296115
392.4	0.2866
401.3	0.28246
410.3	0.282415
419.4	0.28593
428.6	0.28593
437.9	0.287945
447.3	0.28674
456.8	0.29132
466.4	0.29466
476.1	0.28962
485.9	0.293475
495.8	0.2883
505.8	0.294485
515.9	0.29301
526.1	0.292355
536.4	0.28498
546.8	0.29037
557.3	0.282465
567.9	0.288
578.6	0.296185
589.4	0.28868
600.3	0.27921
611.3	0.28921
622.4	0.2887
633.6	0.287235
644.9	0.27796
656.3	0.27791
667.8	0.27777
679.4	0.28573

691.1	0.28607
702.9	0.28512
714.8	0.28275
726.8	0.284935
738.9	0.284415
751.1	0.282135
763.4	0.2831
775.8	0.280285
788.3	0.270565
800.9	0.2771
813.6	0.275575
826.4	0.276955
839.3	0.279285
852.3	0.27382
865.4	0.276625
878.6	0.27178
891.9	0.272645
905.3	0.26694
918.8	0.267985
932.4	0.27319
946.1	0.27548
959.9	0.27733
973.8	0.279335
987.8	0.26952
1001.9	0.26361
1016.1	0.268805
1030.4	0.2652
1044.8	0.26587
1059.3	0.26201
1073.9	0.265145
1088.6	0.2678
1103.4	0.26687
1118.3	0.255035
1133.3	0.25836
1148.4	0.26052
1163.6	0.252385
1178.9	0.262675
1194.3	0.26306
1209.8	0.2642
1225.4	0.262405
1241.1	0.251885
1256.9	0.25881
1272.8	0.25262
1288.8	0.25225
1304.9	0.25561
1321.1	0.257285
1337.4	0.253485
1353.8	0.2463
1370.3	0.243115
1386.9	0.253485
1403.6	0.250425
1420.4	0.25961
1437.3	0.25195
1454.3	0.254785
1471.4	0.255775
1488.6	0.2363
1505.9	0.25436
1523.3	0.24827
1540.8	0.25092
1558.4	0.25185

time (min)	displacement (ft, hand collected)
0.42	0.33
0.75	0.32
1.00	0.32
1.50	0.32
2	0.32
3	0.32
4	0.32
5	0.32
6	0.32
7	0.32
8	0.31
9	0.32
10	0.31
12	0.32
14	0.31
16	0.31
18	0.31
20	0.31
23	0.31
26	0.31
29	0.31
33	0.31
37	0.31
41	0.31
45	0.31
50	0.30
55	0.30
60	0.30
75	0.30
90	0.30
150	0.30
180	0.29
210	0.29
240	0.29
300	0.29
360	0.29
420	0.28
1260	0.24
1320	0.24
1380	0.24
1440	0.23
1500	0.23
1560	0.23

time (minutes)	automatically logged DR-9 displacement (ft)
0.05	0.5
0.1	0.511
0.15	0.478
0.2	0.449
0.25	0.432
0.3	0.41
0.35	0.401
0.4	0.384
0.45	0.368
0.5	0.356
0.6	0.328
0.75	0.301
0.95	0.262
1.2	0.223
1.5	0.186
1.85	0.157
2.25	0.126
2.7	0.105
3.2	0.076
3.75	0.066
4.35	0.051
5	0.043
5.7	0.035
6.45	0.027
7.25	0.022
8.1	0.022
9	0.017
9.95	0.017
10.95	0.015
12	0.015
13.1	0.011
14.25	0.01
15.45	0.009
16.7	0.006
18	0.012
19.35	0.006
20.75	0.01
22.2	0.012
23.7	0.007
25.25	0.007
26.85	0.005
28.5	0.006
30.2	0.01
31.95	0.007
33.75	0.006
35.6	0.005
37.5	0.005
39.45	0.006
41.45	0.006
43.5	-0.001
45.6	0.007

time (minutes)	hand collected DR-9 displacement (ft)
0.22	0.41
0.50	0.35
0.67	0.28
0.83	0.25
1.00	0.23
1.25	0.20
1.50	0.18
2.00	0.13
2.50	0.10
3.00	0.08
3.50	0.06
4.00	0.05
4.50	0.05
5.00	0.03
5.50	0.03
6.00	0.02
6.50	0.02
7.00	0.02
8.00	0.01
9.00	0.01
15.00	0.00
20.00	0.00

time (minutes)	automatically logged DR-10 displacement (ft)
0.05	0.303
0.1	0.297
0.15	0.303
0.2	0.299
0.25	0.296
0.3	0.292
0.35	0.296
0.4	0.292
0.45	0.294
0.5	0.294
0.6	0.299
0.75	0.291
0.95	0.294
1.2	0.299
1.5	0.293
1.85	0.297
2.25	0.290
2.7	0.290
3.2	0.289
3.75	0.28
4.35	0.284
5	0.283
5.7	0.28
6.45	0.282
7.25	0.27
8.1	0.277
9	0.278
9.95	0.274
10.95	0.276
12	0.271
13.1	0.275
14.25	0.265
15.45	0.270
16.7	0.26
18	0.26
19.35	0.264
20.75	0.260
22.2	0.259
23.7	0.26
25.25	0.25
26.85	0.262
28.5	0.253
30.2	0.256
31.95	0.253
33.75	0.255
35.6	0.255
37.5	0.254
39.45	0.251
41.45	0.244
43.5	0.24
45.6	0.249
47.75	0.246
49.95	0.247
52.2	0.245
54.5	0.242
56.85	0.242
59.25	0.239
61.7	0.243
64.2	0.232
66.75	0.237
69.35	0.230

72	0.227
74.7	0.226
77.45	0.226
80.25	0.222
83.1	0.223
86	0.223
88.95	0.22
91.95	0.221
95	0.219
98.1	0.214
101.25	0.21
104.45	0.214
107.7	0.214
111	0.218
114.35	0.216
117.75	0.210
121.2	0.20
124.7	0.211
128.25	0.212
131.85	0.213
135.5	0.210
139.2	0.21
142.95	0.19
146.75	0.206
150.6	0.205
154.5	0.208
158.45	0.206
162.45	0.204
166.5	0.200
170.6	0.206
174.75	0.202
178.95	0.2
183.2	0.202
187.5	0.203
191.85	0.202
196.25	0.203
200.7	0.19
205.2	0.201
209.75	0.192
214.35	0.198
219	0.197
223.7	0.190
228.45	0.189
233.25	0.190
238.1	0.189
243	0.191
247.95	0.188
252.95	0.194
258	0.187
263.1	0.184
268.25	0.187
273.45	0.191
278.7	0.184
284	0.182
289.35	0.181
294.75	0.183
300.2	0.188
305.7	0.181
311.25	0.179
316.85	0.17
322.5	0.180
328.2	0.177
333.95	0.178

339.75	0.175
345.6	0.169
351.5	0.179
357.45	0.174
363.45	0.175
369.5	0.174
375.6	0.173
381.75	0.174
387.95	0.172
394.2	0.172
400.5	0.167
406.85	0.165
413.25	0.167
419.7	0.167
426.2	0.168
432.75	0.165
439.35	0.160
446	0.159
452.7	0.159
459.45	0.159
466.25	0.153
473.1	0.154
480	0.15
486.95	0.155
493.95	0.151
501	0.151
508.1	0.148
515.25	0.148
522.45	0.147
529.7	0.143
537	0.143
544.35	0.14
551.75	0.139
559.2	0.135
566.7	0.132
574.25	0.136
581.85	0.129
589.5	0.129
597.2	0.132
604.95	0.13
612.75	0.127
620.6	0.126
628.5	0.122
636.45	0.121
644.45	0.121
652.5	0.118
660.6	0.118
668.75	0.111
676.95	0.117
685.2	0.116
693.5	0.115
701.85	0.113
710.25	0.109
718.7	0.109
727.2	0.103
735.75	0.105
744.35	0.101
753	0.098
761.7	0.096
770.45	0.096
779.25	0.090
788.1	0.091
797	0.098

805.95	0.088
814.95	0.091
824	0.090
833.1	0.09
842.25	0.085
851.45	0.083
860.7	0.084
870	0.08
879.35	0.079
888.75	0.081
898.2	0.079
907.7	0.076
917.25	0.072
926.85	0.074
936.5	0.072
946.2	0.068
955.95	0.070
965.75	0.070
975.6	0.068
985.5	0.06
995.45	0.071
1005.45	0.068

time (minutes)	hand collected DR-10 displacement (ft)
0.05	0.31
0.25	0.30
0.50	0.30
0.83	0.30
1.00	0.30
3.00	0.29
4.00	0.29
5.00	0.29
10.00	0.28
22.00	0.27
30.00	0.26
44.00	0.25
1012.00	0.03

time (minutes)	automatically logged DR-11 displacement (ft)
0.05	0.653
0.1	0.656
0.15	0.644
0.2	0.654
0.25	0.648
0.3	0.642
0.35	0.649
0.4	0.638
0.45	0.647
0.5	0.643
0.6	0.639
0.75	0.64
0.95	0.638
1.2	0.636
1.5	0.625
1.85	0.618
2.25	0.617
2.7	0.607
3.2	0.601
3.75	0.59
4.35	0.586
5	0.576
5.7	0.564
6.45	0.536
7.25	0.553
8.1	0.55
9	0.542
9.95	0.533
10.95	0.522
12	0.515
13.1	0.51
14.25	0.5
15.45	0.501
16.7	0.485
18	0.48
19.35	0.472
20.75	0.469
22.2	0.463
23.7	0.458
25.25	0.447
26.85	0.444
28.5	0.438
30.2	0.432
31.95	0.425
33.75	0.418
35.6	0.414
37.5	0.402
39.45	0.402
41.45	0.384
43.5	0.381
45.6	0.372
47.75	0.369
49.95	0.361
52.2	0.358
54.5	0.353
56.85	0.344
59.25	0.339
61.7	0.336
64.2	0.33
66.75	0.321
69.35	0.316

72	0.311
74.7	0.303
77.45	0.297
80.25	0.291
83.1	0.284
86	0.282
88.95	0.275
91.95	0.272
95	0.264
98.1	0.264
101.25	0.257
104.45	0.255
107.7	0.248
111	0.24
114.35	0.227
117.75	0.23
121.2	0.228
124.7	0.219
128.25	0.215
131.85	0.21
135.5	0.208
139.2	0.199
142.95	0.196
146.75	0.192
150.6	0.187
154.5	0.178
158.45	0.18
162.45	0.175
166.5	0.168
170.6	0.165
174.75	0.151
178.95	0.148
183.2	0.143
187.5	0.139
191.85	0.138
196.25	0.137
200.7	0.13
205.2	0.129
209.75	0.121

time (minutes)	hand collected DR-11 displacement (ft)
0.10	0.65
0.33	0.64
0.50	0.64
0.67	0.64
0.83	0.63
1.00	0.63
1.50	0.62
2.00	0.62
2.50	0.61
3.00	0.60
3.50	0.59
4.00	0.59
4.50	0.58
5.00	0.57
6.00	0.56
7.00	0.55
8.00	0.54
9.00	0.53
10.00	0.53
15.00	0.50
20.00	0.47
25.00	0.45
30.00	0.43
75.00	0.32
150.00	0.22
190.00	0.18
210.00	0.17

time (minutes)	automatically logged DR-13c displacement (ft)
0.05	7.08E-01
0.1	7.03E-01
0.15	6.99E-01
0.2	7.04E-01
0.25	7.01E-01
0.3	7.00E-01
0.35	6.98E-01
0.4	7.09E-01
0.45	6.94E-01
0.55	6.98E-01
0.7	7.00E-01
0.9	6.96E-01
1.15	6.93E-01
1.45	6.93E-01
1.8	6.91E-01
2.2	6.92E-01
2.65	6.91E-01
3.15	6.87E-01
3.7	6.88E-01
4.3	6.81E-01
4.95	6.67E-01
5.65	6.66E-01
6.4	6.61E-01
7.2	6.58E-01
8.05	6.59E-01
8.95	6.47E-01
9.9	6.52E-01
10.9	6.47E-01
11.95	6.36E-01
13.05	6.35E-01
14.2	6.25E-01
15.4	6.27E-01
16.65	6.19E-01
17.95	6.13E-01
19.3	6.11E-01
20.7	6.11E-01
22.15	6.00E-01
23.65	5.93E-01
25.2	5.92E-01
26.8	5.85E-01
28.45	5.78E-01
30.15	5.71E-01
31.9	5.62E-01
33.7	5.61E-01
35.55	5.58E-01
37.45	5.49E-01
39.4	5.45E-01
41.4	5.38E-01
43.45	5.31E-01
45.55	5.33E-01
47.7	5.27E-01
49.9	5.12E-01
52.15	5.15E-01
54.45	5.03E-01
56.8	5.02E-01
59.2	4.93E-01
61.65	4.92E-01
64.15	4.77E-01
66.7	4.73E-01
69.3	4.63E-01
71.95	4.65E-01

74.65	4.56E-01
77.4	4.44E-01
80.2	4.51E-01
83.05	4.38E-01
85.95	4.33E-01
88.9	4.23E-01
91.9	4.18E-01
94.95	4.18E-01
98.05	4.13E-01
101.2	3.96E-01
104.4	3.88E-01
107.65	3.94E-01
110.95	3.79E-01
114.3	3.76E-01
117.7	3.69E-01
121.15	3.71E-01
124.65	3.57E-01
128.2	3.51E-01
131.8	3.46E-01
135.45	3.47E-01
139.15	3.35E-01
142.9	3.27E-01
146.7	3.21E-01
150.55	3.21E-01
154.45	3.11E-01
158.4	3.02E-01
162.4	2.94E-01
166.45	2.95E-01
170.55	2.85E-01
174.7	2.80E-01
178.9	2.74E-01
183.15	2.78E-01
187.45	2.67E-01
191.8	2.63E-01
196.2	2.55E-01
200.65	2.49E-01
205.15	2.47E-01
209.7	2.42E-01
214.3	2.40E-01
218.95	2.31E-01
223.65	2.28E-01
228.4	2.32E-01
233.2	2.21E-01
238.05	2.14E-01
242.95	2.15E-01
247.9	2.14E-01
252.9	2.12E-01
257.95	2.00E-01
263.05	1.96E-01
268.2	1.95E-01
273.4	1.94E-01
278.65	1.88E-01
283.95	1.82E-01
289.3	1.79E-01
294.7	1.77E-01
300.15	1.70E-01
305.65	1.68E-01
311.2	1.68E-01
316.8	1.62E-01
322.45	1.67E-01
328.15	1.62E-01
333.9	1.57E-01
339.7	1.52E-01

345.55	1.46E-01
351.45	1.54E-01
357.4	1.43E-01
363.4	1.44E-01
369.45	1.39E-01
375.55	1.46E-01
381.7	1.36E-01
387.9	1.35E-01
394.15	1.30E-01
400.45	1.27E-01
406.8	1.26E-01
413.2	1.30E-01
419.65	1.20E-01
426.15	1.20E-01
432.7	1.20E-01
439.3	1.15E-01
445.95	1.20E-01
452.65	1.12E-01
459.4	1.15E-01
466.2	1.11E-01
473.05	1.08E-01
479.95	1.05E-01
486.9	1.00E-01
493.9	1.01E-01
500.95	9.73E-02
508.05	9.63E-02
515.2	1.01E-01
522.4	9.14E-02
529.65	9.31E-02
536.95	8.66E-02
544.3	9.08E-02
551.7	8.73E-02
559.15	8.56E-02
566.65	8.60E-02
574.2	8.71E-02
581.8	8.46E-02
589.45	8.13E-02
597.15	7.94E-02
604.9	7.71E-02
612.7	7.79E-02
620.55	7.88E-02
628.45	7.73E-02
636.4	7.67E-02
644.4	7.11E-02
652.45	7.35E-02
660.55	7.12E-02
668.7	6.77E-02
676.9	6.57E-02
685.15	6.60E-02
693.45	6.90E-02
701.8	6.12E-02
710.2	6.10E-02
718.65	6.00E-02
727.15	5.95E-02
735.7	5.44E-02
744.3	5.28E-02
752.95	5.10E-02
761.65	4.80E-02
770.4	5.07E-02
779.2	4.61E-02
788.05	4.40E-02
796.95	4.40E-02
805.9	4.48E-02

814.9	4.00E-02
823.95	4.32E-02
833.05	4.10E-02
842.2	4.05E-02
851.4	5.01E-02
860.65	3.91E-02
869.95	4.39E-02
879.3	3.91E-02
888.7	4.32E-02
898.15	4.00E-02
907.65	3.71E-02
917.2	3.43E-02
926.8	3.43E-02
936.45	3.01E-02
946.15	2.70E-02
955.9	3.26E-02
965.7	2.98E-02
975.55	2.47E-02
985.45	2.80E-02
995.4	2.70E-02
1005.4	2.49E-02
1015.45	3.10E-02
1025.55	2.68E-02
1035.7	2.75E-02
1045.9	2.51E-02
1056.15	2.77E-02
1066.45	2.32E-02
1076.8	2.47E-02
1087.2	2.14E-02
1097.65	2.05E-02
1108.15	2.33E-02
1118.7	3.10E-02
1129.3	2.42E-02
1139.95	2.89E-02
1150.65	2.28E-02
1161.4	2.30E-02
1172.2	2.95E-02
1183.05	2.23E-02
1193.95	2.55E-02
1204.9	2.70E-02
1215.9	2.32E-02
1226.95	2.56E-02

time (minutes)	hand collected DR-13 displacement (ft)
0.17	0.71
0.42	0.70
0.67	0.70
1.00	0.70
1.50	0.70
2.00	0.69
3.00	0.69
4.00	0.68
5.00	0.67
6.00	0.67
7.00	0.66
8.00	0.65
9.00	0.65
10.00	0.64
15.00	0.62
20.00	0.61
25.00	0.59
30.00	0.57
115.00	0.38
130.00	0.35
140.00	0.34
345.00	0.16
1226.00	0.08

time (minutes)	automatically logged DR-14 displacement (ft)
0.05	0.752
0.1	0.736
0.15	0.739
0.2	0.733
0.25	0.730
0.3	0.732
0.35	0.728
0.4	0.717
0.45	0.719
0.5	0.722
0.6	0.710
0.75	0.70
0.95	0.702
1.2	0.694
1.5	0.68
1.85	0.674
2.25	0.66
2.7	0.658
3.2	0.644
3.75	0.6
4.35	0.625
5	0.611
5.7	0.601
6.45	0.592
7.25	0.584
8.1	0.573
9	0.56
9.95	0.56
10.95	0.542
12	0.53
13.1	0.519
14.25	0.51
15.45	0.503
16.7	0.49
18	0.477
19.35	0.471
20.75	0.457
22.2	0.450
23.7	0.438
25.25	0.429
26.85	0.415
28.5	0.414
30.2	0.40
31.95	0.386
33.75	0.378
35.6	0.377
37.5	0.368
39.45	0.349
41.45	0.335
43.5	0.327
45.6	0.31
47.75	0.309
49.95	0.295
52.2	0.293
54.5	0.283
56.85	0.27
59.25	0.265
61.7	0.258
64.2	0.249
66.75	0.239
69.35	0.232

72	0.222
74.7	0.216
77.45	0.210
80.25	0.203
83.1	0.194
86	0.191
88.95	0.178
91.95	0.171
95	0.170
98.1	0.164
101.25	0.156
104.45	0.154
107.7	0.14
111	0.139
114.35	0.131
117.75	0.124
121.2	0.12
124.7	0.114
128.25	0.110
131.85	0.104
135.5	0.102
139.2	0.094
142.95	0.086
146.75	0.084
150.6	0.077
154.5	0.075
158.45	0.068
162.45	0.066
166.5	0.059
170.6	0.064
174.75	0.059
178.95	0.056
183.2	0.051
187.5	0.056
191.85	0.050
196.25	0.04
200.7	0.043
205.2	0.041
209.75	0.04
214.35	0.034
219	0.025
223.7	0.027
228.45	0.025
233.25	0.026
238.1	0.023
243	0.018
247.95	0.020
252.95	0.016
258	0.015
263.1	0.015
268.25	0.012
273.45	0.010
278.7	0.009
284	0.009

time (minutes)	hand collected DR-14 displacement (ft)
0.05	0.73
0.32	0.67
0.60	0.71
1.03	0.69
1.50	0.69
2.00	0.67
3.00	0.65
4.00	0.63
5.00	0.62
10.00	0.56
15.00	0.51
20.00	0.47
30.00	0.41
40.00	0.35
50.00	0.30
70.00	0.24
90.00	0.18
188.00	0.08
285.00	0.07

time (minutes)	automatically logged DR-17 displacement (ft)
0.001	0.814
0.05	0.736
0.1	0.723
0.15	0.721
0.2	0.714
0.25	0.71
0.3	0.706
0.35	0.711
0.4	0.707
0.5	0.711
0.65	0.702
0.85	0.7
1.1	0.701
1.4	0.695
1.75	0.693
2.15	0.69
2.6	0.68
3.1	0.677
3.65	0.673
4.25	0.665
4.9	0.665
5.6	0.659
6.35	0.651
7.15	0.647
8	0.641
8.9	0.636
9.85	0.635
10.85	0.622
11.9	0.615
13	0.608
14.15	0.607
15.35	0.595
16.6	0.592
17.9	0.593
19.25	0.58
20.65	0.573
22.1	0.566
23.6	0.561
25.15	0.557
26.75	0.555
28.4	0.548
30.1	0.541
31.85	0.536
33.65	0.528
35.5	0.526
37.4	0.515
39.35	0.511
41.35	0.505
43.4	0.499
45.5	0.496
47.65	0.49
49.85	0.479
52.1	0.478
54.4	0.474
56.75	0.467
59.15	0.459
61.6	0.456
64.1	0.446
66.65	0.439
69.25	0.43
71.9	0.425

74.6	0.417
77.35	0.41
80.15	0.402
83	0.396
85.9	0.391
88.85	0.386
91.85	0.379
94.9	0.374
98	0.368
101.15	0.362
104.35	0.358
107.6	0.352
110.9	0.343
114.25	0.333
117.65	0.332
121.1	0.322
124.6	0.319
128.15	0.316
131.75	0.305
135.4	0.299
139.1	0.294
142.85	0.289
146.65	0.287
150.5	0.283
154.4	0.27
158.35	0.265
162.35	0.261
166.4	0.254
170.5	0.25
174.65	0.242
178.85	0.238
183.1	0.232
187.4	0.227
191.75	0.221
196.15	0.222
200.6	0.211
205.1	0.21
209.65	0.206
214.25	0.198
218.9	0.195
223.6	0.187
228.35	0.187
233.15	0.18
238	0.176
242.9	0.172
247.85	0.167
252.85	0.165
257.9	0.163
263	0.155
268.15	0.15
273.35	0.145
278.6	0.137
283.9	0.135
289.25	0.131
294.65	0.127
300.1	0.127
305.6	0.119
311.15	0.114
316.75	0.111
322.4	0.106
328.1	0.113
333.85	0.102
339.65	0.1

345.5	0.098
351.4	0.095
357.35	0.094
363.35	0.091
369.4	0.089
375.5	0.087
381.65	0.089
387.85	0.088
394.1	0.086
400.4	0.087
406.75	0.085
413.15	0.078
419.6	0.076
426.1	0.071
432.65	0.071
439.25	0.074
445.9	0.073
452.6	0.076
459.35	0.071
466.15	0.071
473	0.073
479.9	0.069
486.85	0.067
493.85	0.067
500.9	0.068
508	0.065
515.15	0.062
522.35	0.058
529.6	0.06
536.9	0.058
544.25	0.06
551.65	0.062
559.1	0.064
566.6	0.063
574.15	0.058
581.75	0.056
589.4	0.055
597.1	0.05
604.85	0.05
612.65	0.05
620.5	0.046
628.4	0.046
636.35	0.042
644.35	0.041
652.4	0.039
660.5	0.036
668.65	0.035
676.85	0.037
685.1	0.039
693.4	0.039
701.75	0.04
710.15	0.035
718.6	0.026
727.1	0.031
735.65	0.025
744.25	0.033
752.9	0.035
761.6	0.028
770.35	0.022
779.15	0.019
788	0.024
796.9	0.019
805.85	0.017

814.85	0.015
823.9	0.015
833	0.015
842.15	0.01
851.35	0.011
860.6	0.013
869.9	0.017
879.25	0.015
888.65	0.011
898.1	0.013
907.6	0.012
917.15	0.013
926.75	0.012
936.4	0.01
946.1	0.013
955.85	0.012
965.65	0.01
975.5	0.01
985.4	0.006
995.35	0.008
1005.35	0.007
1015.4	0.008
1025.5	0.008
1035.65	0.005
1045.85	0.015
1056.1	0.008
1066.4	0.012
1076.75	0.009
1087.15	0.011
1097.6	0.011
1108.1	0.01
1118.65	0.007
1129.25	0.004
1139.9	0.001
1150.6	0.004
1161.35	0.001
1172.15	0.009

time (minutes)	hand collected DR-17 displacement (ft)
0.08	0.75
0.33	0.74
0.67	0.74
1.00	0.73
1.50	0.73
2.00	0.72
3.00	0.71
4.00	0.70
5.00	0.69
10.00	0.66
15.00	0.63
25.00	0.60
35.00	0.57
125.00	0.39
250.00	0.28
278.00	0.28
1203.00	0.13

time (minutes)	automatically logged DR-19 displacement (ft)
0.001	0.842
0.05	0.652
0.1	0.631
0.15	0.635
0.2	0.626
0.25	0.624
0.3	0.627
0.35	0.624
0.4	0.621
0.5	0.616
0.65	0.617
0.85	0.607
1.1	0.602
1.4	0.594
1.75	0.591
2.15	0.585
2.6	0.572
3.1	0.563
3.65	0.555
4.25	0.543
4.9	0.541
5.6	0.532
6.35	0.52
7.15	0.513
8	0.504
8.9	0.498
9.85	0.496
10.85	0.482
11.9	0.477
13	0.473
14.15	0.464
15.35	0.454
16.6	0.439
17.9	0.44
19.25	0.431
20.65	0.427
22.1	0.413
23.6	0.412
25.15	0.404
26.75	0.397
28.4	0.383
30.1	0.372
31.85	0.366
33.65	0.366
35.5	0.351
37.4	0.345
39.35	0.338
41.35	0.331
43.4	0.329
45.5	0.324
47.65	0.312
49.85	0.309
52.1	0.303
54.4	0.295
56.75	0.287
59.15	0.281
61.6	0.273
64.1	0.259
66.65	0.259
69.25	0.251
71.9	0.243

74.6	0.238
77.35	0.235
80.15	0.226
83	0.219
85.9	0.214
88.85	0.209
91.85	0.197
94.9	0.197
98	0.193
101.15	0.184
104.35	0.186
107.6	0.178
110.9	0.17
114.25	0.165
117.65	0.161
121.1	0.154
124.6	0.151
128.15	0.146
131.75	0.138
135.4	0.136
139.1	0.131
142.85	0.125
146.65	0.119
150.5	0.116
154.4	0.111
158.35	0.11
162.35	0.1
166.4	0.102
170.5	0.099
174.65	0.091
178.85	0.089
183.1	0.088
187.4	0.083
191.75	0.083
196.15	0.074
200.6	0.072
205.1	0.066
209.65	0.063
214.25	0.059
218.9	0.057
223.6	0.1

time (minutes)	hand collected DR-19 displacement (ft)
0.33	0.63
0.55	0.62
0.93	0.60
1.18	0.60
1.50	0.59
2.00	0.59
3.00	0.58
4.00	0.56
5.00	0.55
10.00	0.50
15.00	0.47
20.00	0.45
25.00	0.42
30.00	0.39
35.00	0.36
40.00	0.34
45.00	0.33
50.00	0.30
55.00	0.29
60.00	0.28
139.00	0.13
221.00	0.05

time (minutes)	automatically logged DR-20 displacement (ft)
0.001	1.305
0.05	1.135
0.1	1.213
0.15	1.214
0.2	1.22
0.25	1.202
0.3	1.206
0.35	1.215
0.4	1.21
0.5	1.194
0.65	1.195
0.85	1.199
1.1	1.189
1.4	1.195
1.75	1.175
2.15	1.19
2.6	1.182
3.1	1.181
3.65	1.176
4.25	1.175
4.9	1.18
5.6	1.164
6.35	1.166
7.15	1.163
8	1.161
8.9	1.15
9.85	1.153
10.85	1.139
11.9	1.145
13	1.148
14.15	1.141
15.35	1.125
16.6	1.12
17.9	1.115
19.25	1.118
20.65	1.117
22.1	1.105
23.6	1.095
25.15	1.09
26.75	1.089
28.4	1.083
30.1	1.084
31.85	1.07
33.65	1.072
35.5	1.068
37.4	1.064
39.35	1.058
41.35	1.053
43.4	1.036
45.5	1.025
47.65	1.024
49.85	1.019
52.1	1.008
54.4	1.012
56.75	1.005
59.15	0.99
61.6	0.991
64.1	0.974
66.65	0.97
69.25	0.968
71.9	0.956

74.6	0.949
77.35	0.947
80.15	0.93
83	0.923
85.9	0.916
88.85	0.913
91.85	0.912
94.9	0.895
98	0.9
101.15	0.876
104.35	0.872
107.6	0.874
110.9	0.857
114.25	0.859
117.65	0.842
121.1	0.83
124.6	0.827
128.15	0.82
131.75	0.816
135.4	0.806
139.1	0.798
142.85	0.786
146.65	0.778
150.5	0.773
154.4	0.772
158.35	0.755
162.35	0.747
166.4	0.739
170.5	0.729
174.65	0.736
178.85	0.722
183.1	0.715
187.4	0.709
191.75	0.701
196.15	0.697
200.6	0.691
205.1	0.686
209.65	0.674
214.25	0.664
218.9	0.657
223.6	0.653
228.35	0.651
233.15	0.635
238	0.629
242.9	0.626
247.85	0.621
252.85	0.624
257.9	0.608
263	0.609
268.15	0.593
273.35	0.589
278.6	0.575
283.9	0.571
289.25	0.57
294.65	0.563
300.1	0.557
305.6	0.548
311.15	0.543
316.75	0.536
322.4	0.53
328.1	0.523
333.85	0.514
339.65	0.512

345.5	0.513
351.4	0.503
357.35	0.497
363.35	0.493
369.4	0.488
375.5	0.482
381.65	0.471
387.85	0.467
394.1	0.466
400.4	0.452
406.75	0.445
413.15	0.44
419.6	0.432
426.1	0.425
432.65	0.418
439.25	0.411
445.9	0.407
452.6	0.4
459.35	0.389
466.15	0.393
473	0.382
479.9	0.378
486.85	0.377
493.85	0.37
500.9	0.368
508	0.361
515.15	0.345
522.35	0.342
529.6	0.342
536.9	0.336
544.25	0.337
551.65	0.331
559.1	0.325
566.6	0.316
574.15	0.309
581.75	0.302
589.4	0.298
597.1	0.292
604.85	0.289
612.65	0.281
620.5	0.283
628.4	0.275
636.35	0.271
644.35	0.261
652.4	0.26
660.5	0.263
668.65	0.257
676.85	0.259
685.1	0.253
693.4	0.25
701.75	0.241
710.15	0.237
718.6	0.238
727.1	0.233
735.65	0.229
744.25	0.228
752.9	0.224
761.6	0.22
770.35	0.22
779.15	0.21
788	0.213
796.9	0.205
805.85	0.208

814.85	0.205
823.9	0.199
833	0.199
842.15	0.199
851.35	0.197
860.6	0.194
869.9	0.192
879.25	0.188
888.65	0.187
898.1	0.182
907.6	0.18
917.15	0.176
926.75	0.173
936.4	0.167
946.1	0.168
955.85	0.172
965.65	0.165
975.5	0.166
985.4	0.169
995.35	0.166
1005.35	0.167

time (minutes)	hand collected DR-20 displacement (ft)
0.08	1.26
0.42	1.26
1.00	1.25
2.00	1.24
3.00	1.24
4.00	1.23
5.00	1.23
15.00	1.20
20.00	1.18
26.00	1.16
35.00	1.15
85.00	1.03
1042.00	0.26

time (minutes)	automatically logged DR-21 displacement (ft)
0.05	0.747
0.1	0.821
0.15	0.811
0.2	0.81
0.25	0.806
0.3	0.807
0.35	0.804
0.4	0.801
0.45	0.806
0.5	0.806
0.6	0.792
0.75	0.781
0.95	0.783
1.2	0.759
1.5	0.757
1.85	0.742
2.25	0.733
2.7	0.727
3.2	0.71
3.75	0.698
4.35	0.681
5	0.661
5.7	0.658
6.45	0.645
7.25	0.623
8.1	0.614
9	0.599
9.95	0.588
10.95	0.575
12	0.561
13.1	0.547
14.25	0.536
15.45	0.517
16.7	0.507
18	0.491
19.35	0.471
20.75	0.467
22.2	0.448
23.7	0.434
25.25	0.41
26.85	0.395
28.5	0.384
30.2	0.363
31.95	0.353
33.75	0.346
35.6	0.333
37.5	0.315
39.45	0.294
41.45	0.283
43.5	0.273
45.6	0.258
47.75	0.246
49.95	0.232
52.2	0.225
54.5	0.21
56.85	0.199
59.25	0.19
61.7	0.184
64.2	0.168
66.75	0.16
69.35	0.147

72	0.14
74.7	0.142
77.45	0.123
80.25	0.115
83.1	0.112
86	0.106
88.95	0.094
91.95	0.093
95	0.083
98.1	0.075
101.25	0.074
104.45	0.068
107.7	0.064
111	0.064
114.35	0.051
117.75	0.048
121.2	0.045
124.7	0.042
128.25	0.042
131.85	0.041
135.5	0.03
139.2	0.036
142.95	0.035
146.75	0.026
150.6	0.023
154.5	0.031
158.45	0.031
162.45	0.031
166.5	0.016
170.6	0.017
174.75	0.028
178.95	0.013
183.2	0.012
187.5	0.013
191.85	0.018
196.25	0.012
200.7	0.009
205.2	0.007
209.75	0.004
214.35	0.003
219	0.005
223.7	0.003
228.45	0
233.25	0.01
238.1	0.001
243	0.001
247.95	-0.002
252.95	0.001
258	-0.002
263.1	-0.004
268.25	-0.003
273.45	-0.005
278.7	-0.003
284	-0.007
289.35	-0.005
294.75	-0.002
300.2	-0.01
305.7	-0.011
311.25	-0.007
316.85	-0.005
322.5	-0.004
328.2	-0.006
333.95	-0.004

339.75	-0.003
345.6	0
351.5	0.007
357.45	-0.006
363.45	0

time (minutes)	hand collected DR-21 displacement (ft)
0.05	0.81
0.33	0.79
0.48	0.78
0.75	0.77
0.83	0.76
1.25	0.75
1.50	0.74
2.00	0.72
2.50	0.71
3.00	0.70
3.50	0.68
4.00	0.67
4.50	0.66
5.00	0.65
7.00	0.62
8.00	0.60
9.00	0.59
10.00	0.57
15.00	0.52
20.00	0.46
25.00	0.41
30.00	0.37
35.00	0.33
40.00	0.29
45.00	0.25
50.00	0.23
55.00	0.21
60.00	0.18
65.00	0.16
115.00	0.05
195.00	0.03
300.00	0.07
365.00	0.11

time (minutes)	automatically logged DR-23 displacement (ft)
0.05	0.649
0.1	0.649
0.15	0.65
0.2	0.644
0.25	0.638
0.3	0.635
0.35	0.635
0.4	0.635
0.45	0.631
0.5	0.631
0.6	0.625
0.75	0.619
0.95	0.617
1.2	0.611
1.5	0.61
1.85	0.596
2.25	0.594
2.7	0.581
3.2	0.573
3.75	0.576
4.35	0.559
5	0.543
5.7	0.546
6.45	0.54
7.25	0.52
8.1	0.509
9	0.507
9.95	0.505
10.95	0.498
12	0.486
13.1	0.482
14.25	0.472
15.45	0.463
16.7	0.449
18	0.441
19.35	0.443
20.75	0.434
22.2	0.424
23.7	0.417
25.25	0.409
26.85	0.391
28.5	0.389
30.2	0.377
31.95	0.37
33.75	0.365
35.6	0.354
37.5	0.347
39.45	0.339
41.45	0.332
43.5	0.323
45.6	0.317
47.75	0.312
49.95	0.303
52.2	0.297
54.5	0.29
56.85	0.284
59.25	0.278
61.7	0.272
64.2	0.263
66.75	0.257
69.35	0.254

72	0.243
74.7	0.238
77.45	0.23
80.25	0.228
83.1	0.224
86	0.214
88.95	0.21
91.95	0.205
95	0.196
98.1	0.195
101.25	0.189
104.45	0.184
107.7	0.178
111	0.175
114.35	0.168
117.75	0.161
121.2	0.158
124.7	0.154
128.25	0.153
131.85	0.141
135.5	0.14
139.2	0.132
142.95	0.128
146.75	0.125
150.6	0.119
154.5	0.116
158.45	0.109
162.45	0.108
166.5	0.102
170.6	0.1
174.75	0.095
178.95	0.09
183.2	0.085
187.5	0.083
191.85	0.077
196.25	0.08
200.7	0.072
205.2	0.07
209.75	0.065
214.35	0.063
219	0.06
223.7	0.056
228.45	0.056
233.25	0.051
238.1	0.051
243	0.051
247.95	0.045
252.95	0.045
258	0.045
263.1	0.044
268.25	0.039
273.45	0.039
278.7	0.039
284	0.036
289.35	0.035
294.75	0.034
300.2	0.037
305.7	0.033
311.25	0.031
316.85	0.028
322.5	0.026

time (minutes)	hand collected DR-23 displacement (ft)
0.05	0.63
0.25	0.62
0.58	0.61
0.83	0.60
1.08	0.60
1.50	0.59
2.00	0.58
2.50	0.57
3.00	0.56
3.50	0.55
4.00	0.55
4.50	0.54
5.00	0.54
6.00	0.53
7.00	0.52
8.00	0.51
9.00	0.50
10.00	0.48
15.00	0.46
20.00	0.43
25.00	0.40
32.00	0.37
35.00	0.36
125.00	0.17
255.00	0.13
320.00	0.13

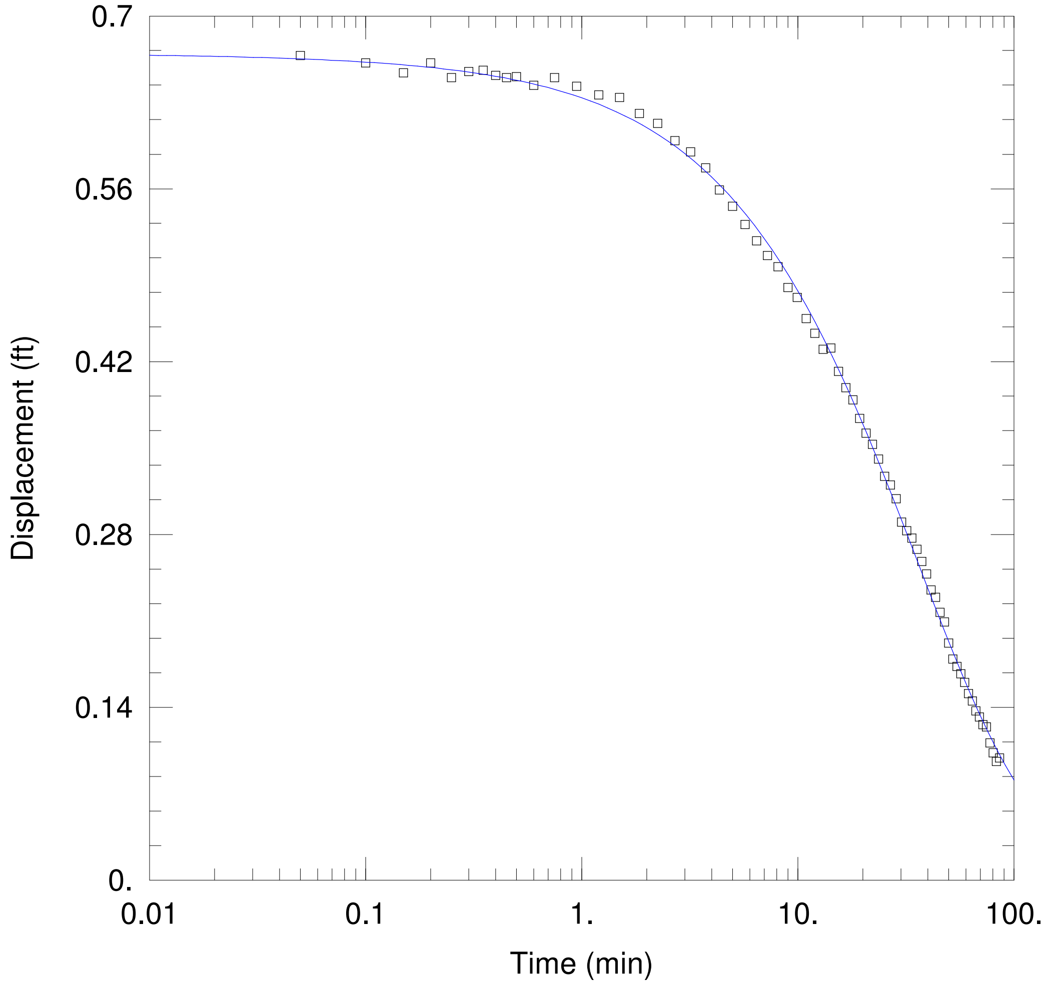
-0.001	0
0.001	1.211
0.05	1.159
0.1	1.094
0.15	1.084
0.2	1.069
0.25	1.073
0.3	1.071
0.35	1.067
0.4	1.065
0.45	1.062
0.55	1.057
0.7	1.053
0.9	1.045
1.15	1.027
1.45	1.02
1.8	1.007
2.2	0.996
2.65	0.976
3.15	0.958
3.7	0.945
4.3	0.931
4.95	0.916
5.65	0.9
6.4	0.882
7.2	0.863
8.05	0.844
8.95	0.817
9.9	0.798
10.9	0.778
11.95	0.766
13.05	0.736
14.2	0.717
15.4	0.702
16.65	0.682
17.95	0.653
19.3	0.644
20.7	0.62
22.15	0.603
23.65	0.577
25.2	0.567
26.8	0.549
28.45	0.526
30.15	0.507
31.9	0.495
33.7	0.482
35.55	0.458
37.45	0.443
39.4	0.427
41.4	0.417
43.45	0.396
45.55	0.382
47.7	0.37
49.9	0.357
52.15	0.346
54.45	0.333
56.8	0.319
59.2	0.306
61.65	0.296
64.15	0.284
66.7	0.273
69.3	0.264
71.95	0.252

74.65	0.243
77.4	0.234
80.2	0.226
83.05	0.217
85.95	0.206
88.9	0.2
91.9	0.195
94.95	0.188
98.05	0.185
101.2	0.174
104.4	0.158
107.65	0.159
110.95	0.158
114.3	0.15
117.7	0.137
121.15	0.142
124.65	0.126
128.2	0.131
131.8	0.12
135.45	0.119
139.15	0.118
142.9	0.115
146.7	0.104
150.55	0.099
154.45	0.106
158.4	0.091
162.4	0.089
166.45	0.085
170.55	0.093
174.7	0.078
178.9	0.072
183.15	0.081
187.45	0.069
191.8	0.068
196.2	0.066
200.65	0.061
205.15	0.061
209.7	0.058
214.3	0.056
218.95	0.055
223.65	0.051

0.05	1.08
0.30	1.05
0.58	1.04
0.83	1.03
1.00	1.02
1.50	1.01
2.00	1.00
3.00	0.96
4.00	0.93
5.00	0.91
6.00	0.88
7.00	0.86
8.00	0.83
9.00	0.81
10.00	0.79
15.00	0.71
20.00	0.63
25.00	0.56
30.00	0.51
35.00	0.45
40.00	0.41
45.00	0.38
50.00	0.35
55.00	0.32
60.00	0.29
121.00	0.13
226.00	0.07

APPENDIX D

SLUG TEST ANALYSIS PLOTS



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr5.aqt
Date: 12/14/11 Time: 10:54:31

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 12.3 ft

WELL DATA (DR-5)

Initial Displacement: 0.67 ft
Total Well Penetration Depth: 12.3 ft
Casing Radius: 0.125 ft

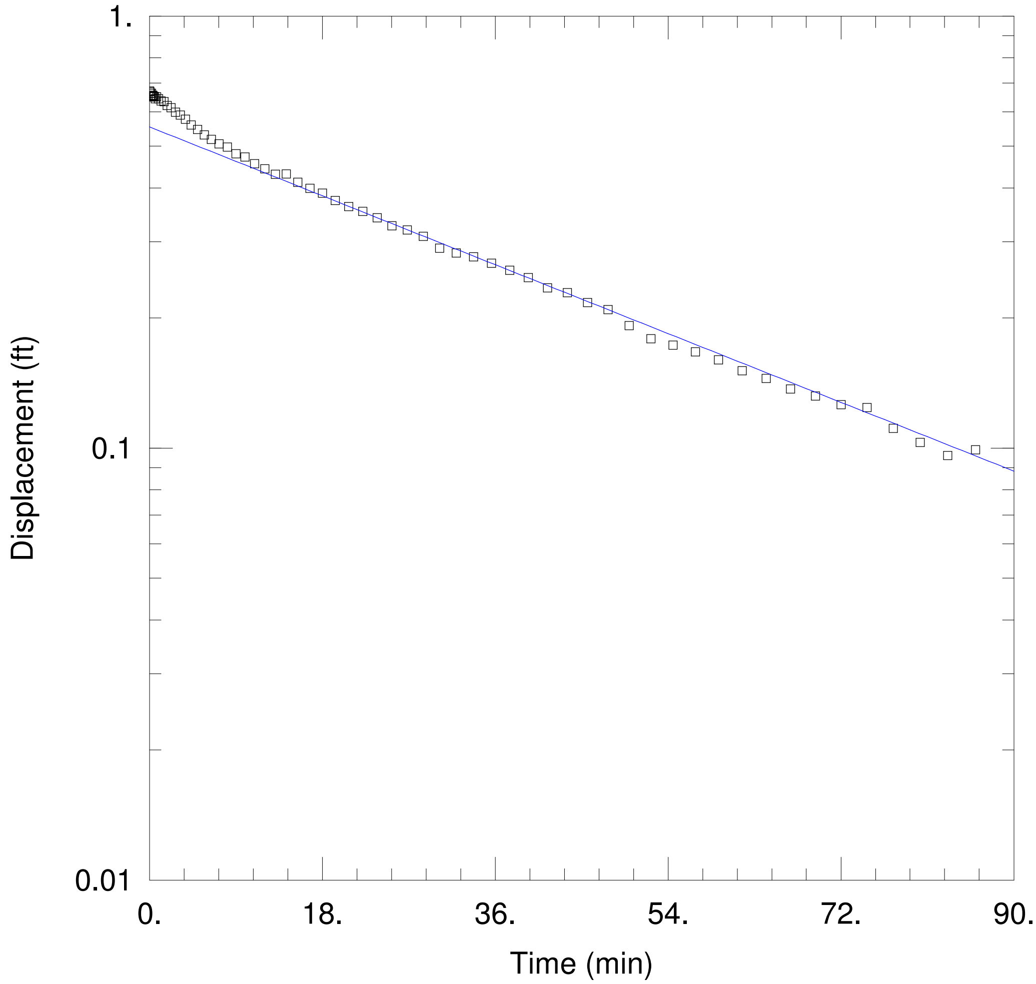
Static Water Column Height: 12.3 ft
Screen Length: 12.3 ft
Well Radius: 0.255 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 2.949E-5 cm/sec
Kz/Kr = 0.1

Ss = 4.212E-5 ft^{-1}



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr5br.aqt
Date: 12/14/11 Time: 10:57:29

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

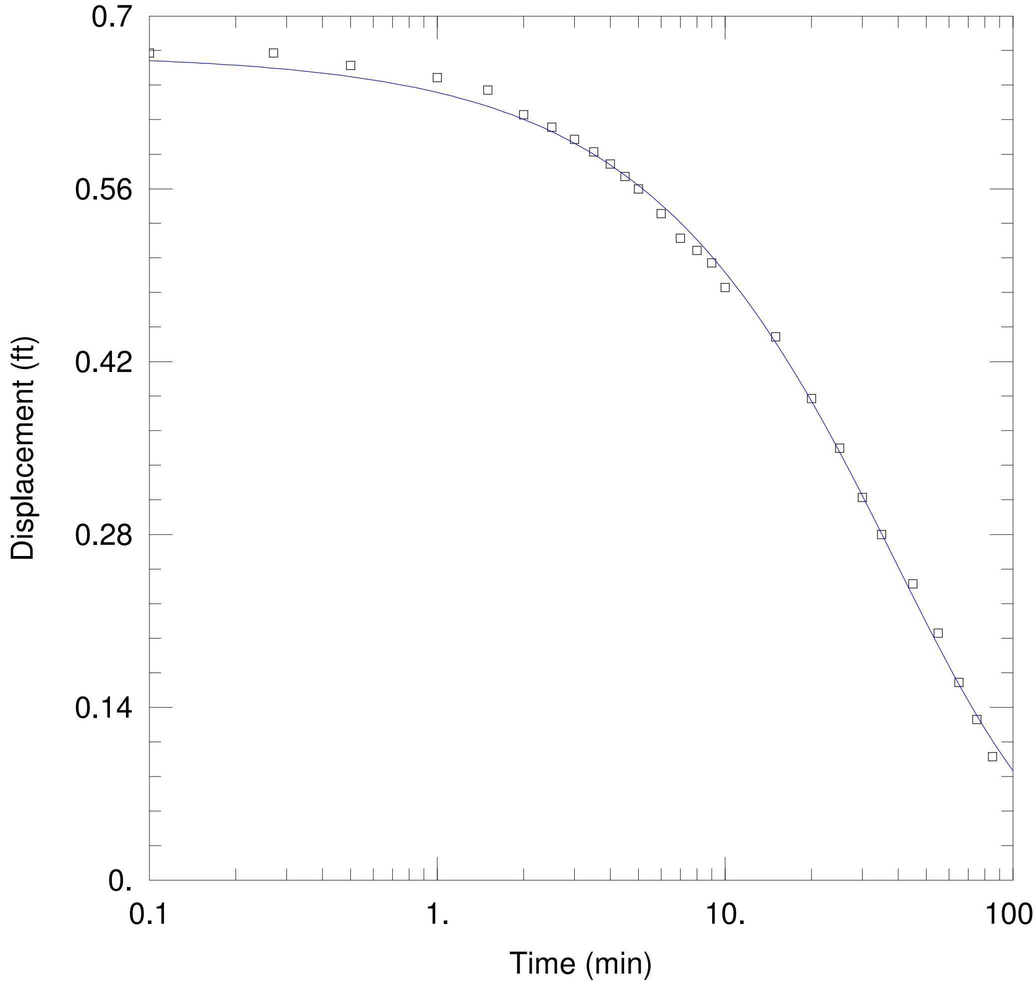
Saturated Thickness: 12.3 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (DR-5)

Initial Displacement: 0.67 ft
Total Well Penetration Depth: 12.3 ft
Casing Radius: 0.125 ft
Static Water Column Height: 12.3 ft
Screen Length: 12.3 ft
Well Radius: 0.255 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 3.8E-5 cm/sec
y0 = 0.5537 ft



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr5h.aqt
Date: 12/14/11 Time: 10:57:59

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 12.3 ft

WELL DATA (DR-5)

Initial Displacement: 0.67 ft
Total Well Penetration Depth: 12.3 ft
Casing Radius: 0.125 ft

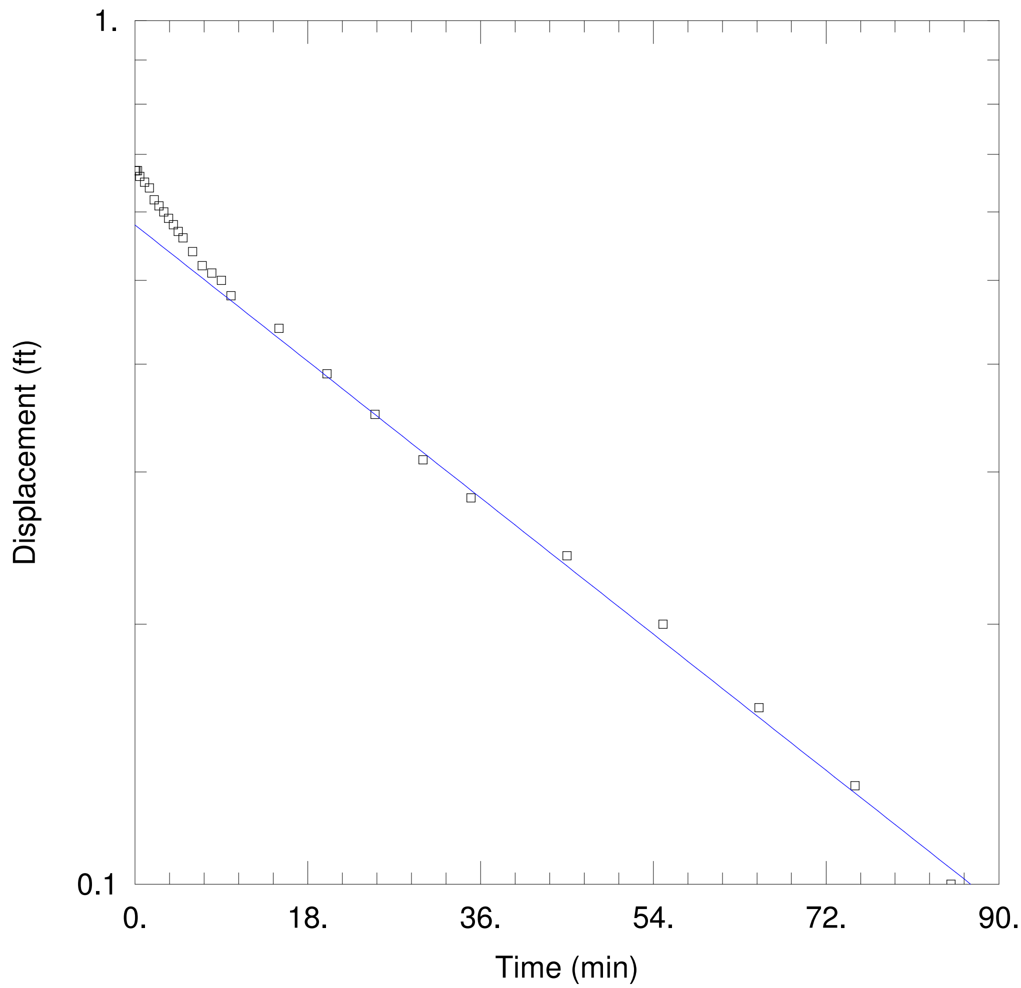
Static Water Column Height: 12.3 ft
Screen Length: 12.3 ft
Well Radius: 0.255 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 2.855E-5 cm/sec
Kz/Kr = 0.1

Ss = 2.651E-5 ft^{-1}



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr5hbr.aqt
Date: 12/14/11 Time: 10:55:07

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 12.3 ft Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (DR-5)

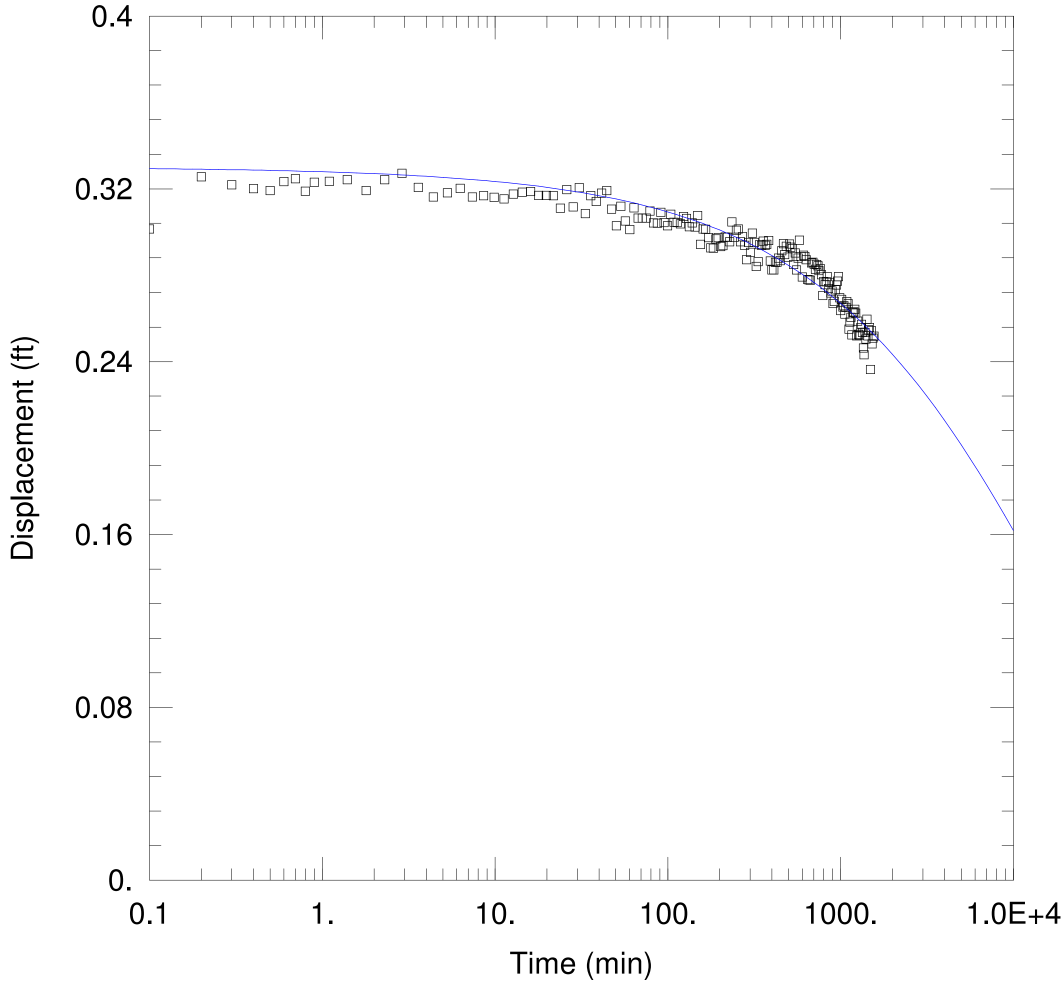
Initial Displacement: 0.67 ft
Total Well Penetration Depth: 12.3 ft
Casing Radius: 0.125 ft

Static Water Column Height: 12.3 ft
Screen Length: 12.3 ft
Well Radius: 0.255 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 3.764E-5 cm/sec y0 = 0.5798 ft



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst12\aqtesolve\dr8r2.aqt
Date: 10/31/12 Time: 10:13:27

PROJECT INFORMATION

Company: HGC
Client: Energy Fuels
Location: White Mesa
Test Well: DR-8
Test Date: 10-9-12

AQUIFER DATA

Saturated Thickness: 7.8 ft

WELL DATA (DR-8)

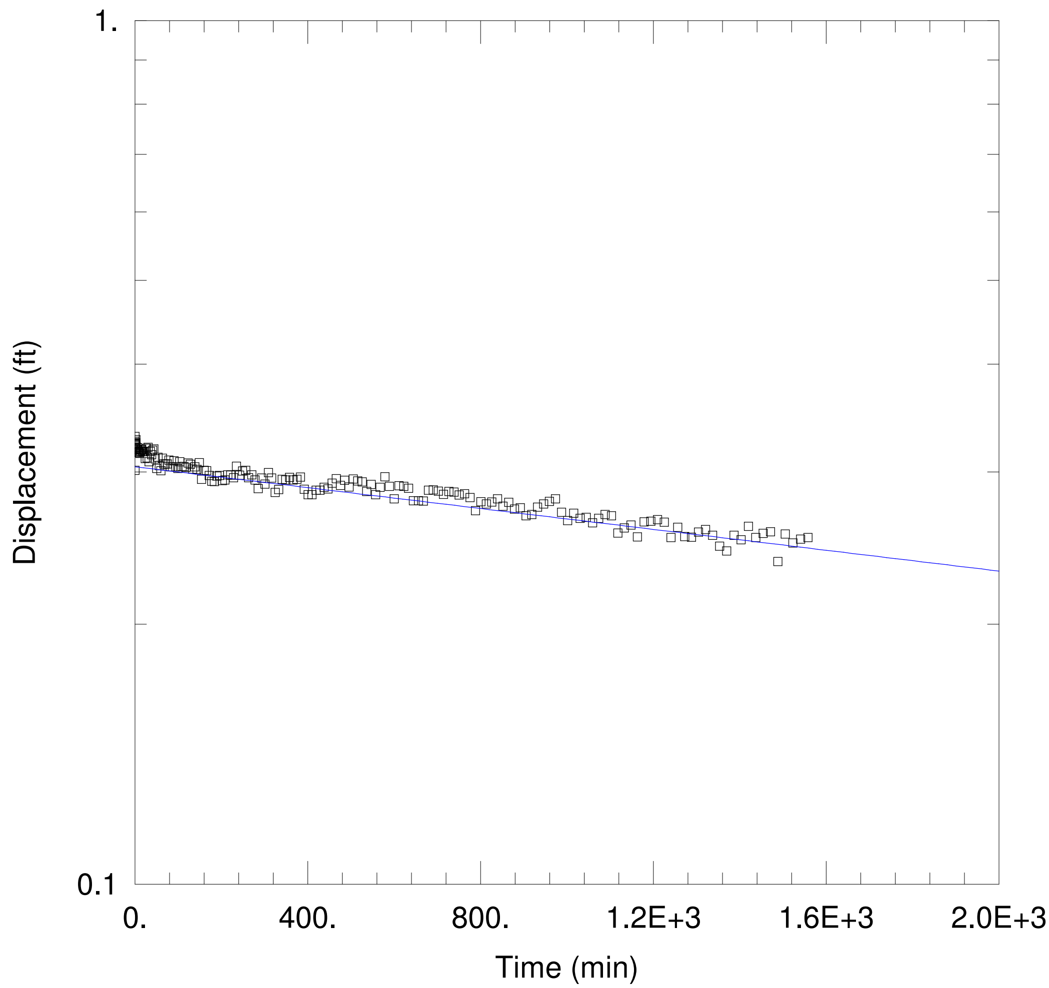
Initial Displacement: 0.33 ft
Total Well Penetration Depth: 7.8 ft
Casing Radius: 0.125 ft

Static Water Column Height: 7.8 ft
Screen Length: 7.8 ft
Well Radius: 0.255 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 2.463E-8 cm/sec
Kz/Kr = 0.1
Ss = 0.01 ft^{-1}



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst12\aqtesolve\dr8rbr.aqt
Date: 10/31/12 Time: 10:14:24

PROJECT INFORMATION

Company: HGC
Client: Energy Fuels
Location: White Mesa
Test Well: DR-8
Test Date: 10-9-12

AQUIFER DATA

Saturated Thickness: 7.8 ft
Anisotropy Ratio (Kz/Kr): 0.1

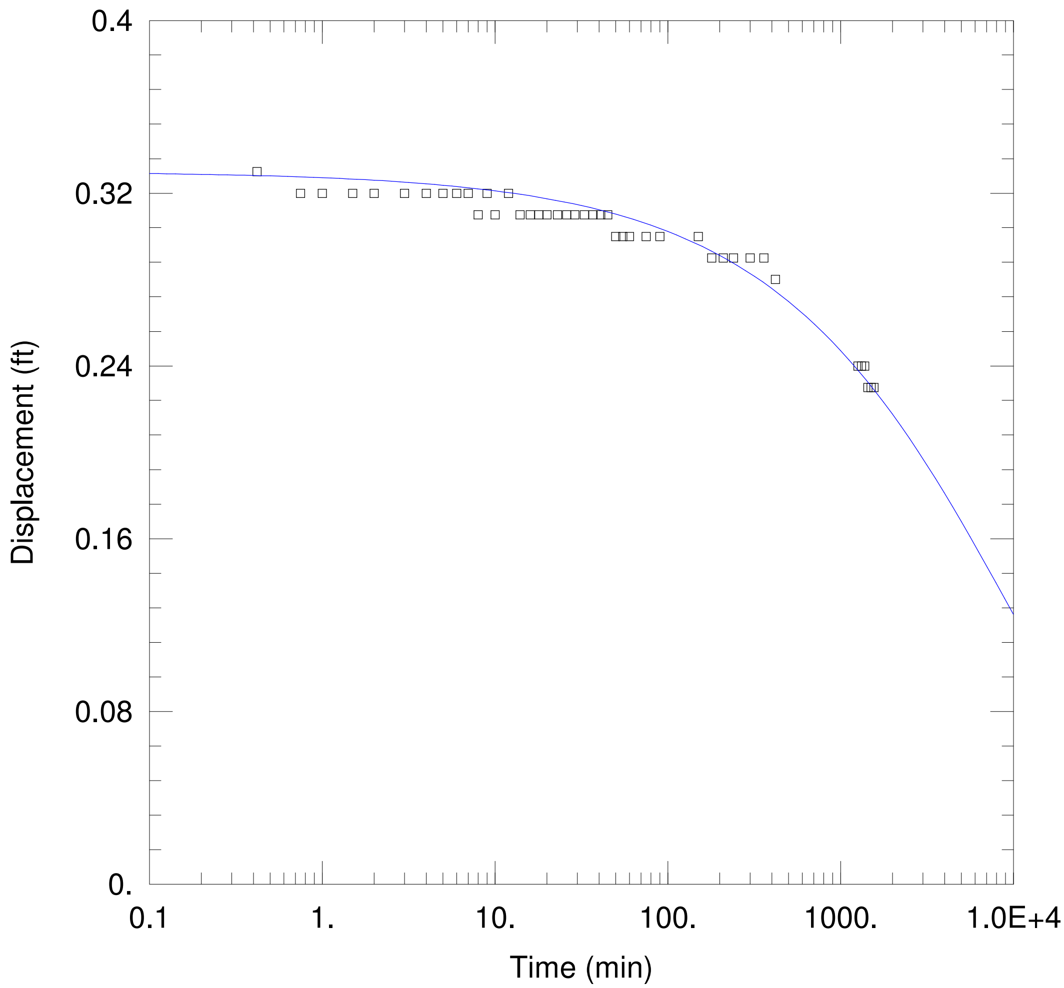
WELL DATA (DR-8)

Initial Displacement: 0.33 ft
Total Well Penetration Depth: 7.8 ft
Casing Radius: 0.125 ft
Static Water Column Height: 7.8 ft
Screen Length: 7.8 ft
Well Radius: 0.255 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 3.568E-7 cm/sec
y0 = 0.3043 ft



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst12\aqtesolve\dr8rh.aqt
Date: 10/31/12 Time: 10:14:00

PROJECT INFORMATION

Company: HGC
Client: Energy Fuels
Location: White Mesa
Test Well: DR-8
Test Date: 10-9-12

AQUIFER DATA

Saturated Thickness: 7.8 ft

WELL DATA (DR-8)

Initial Displacement: 0.33 ft
Total Well Penetration Depth: 7.8 ft
Casing Radius: 0.125 ft

Static Water Column Height: 7.8 ft
Screen Length: 7.8 ft
Well Radius: 0.255 ft
Gravel Pack Porosity: 0.3

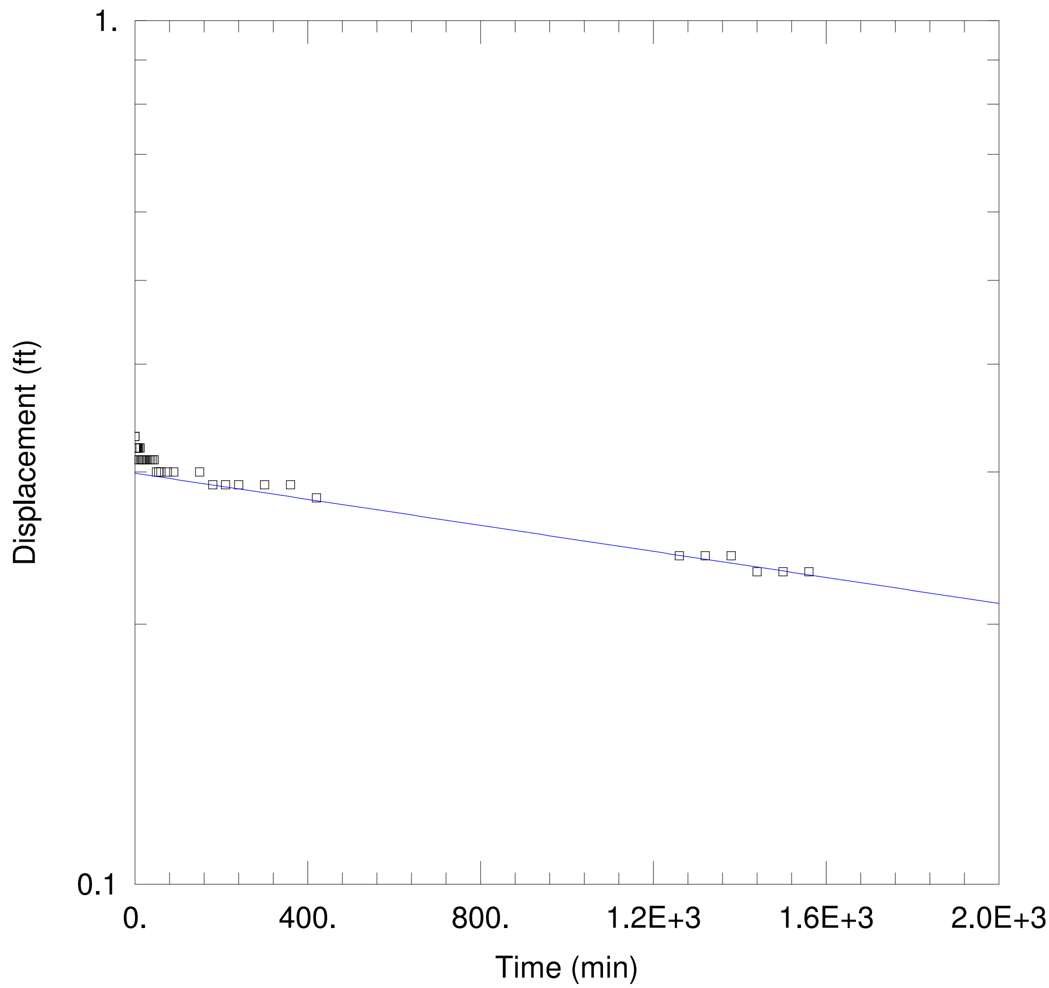
SOLUTION

Aquifer Model: Unconfined

Solution Method: KGS Model

Kr = 4.462E-8 cm/sec
Kz/Kr = 0.1

Ss = 0.01 ft^{-1}



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst12\aqtesolve\dr8rhbr.aqt
Date: 10/31/12
Time: 10:14:44

PROJECT INFORMATION

Company: HGC
Client: Energy Fuels
Location: White Mesa
Test Well: DR-8
Test Date: 10-9-12

AQUIFER DATA

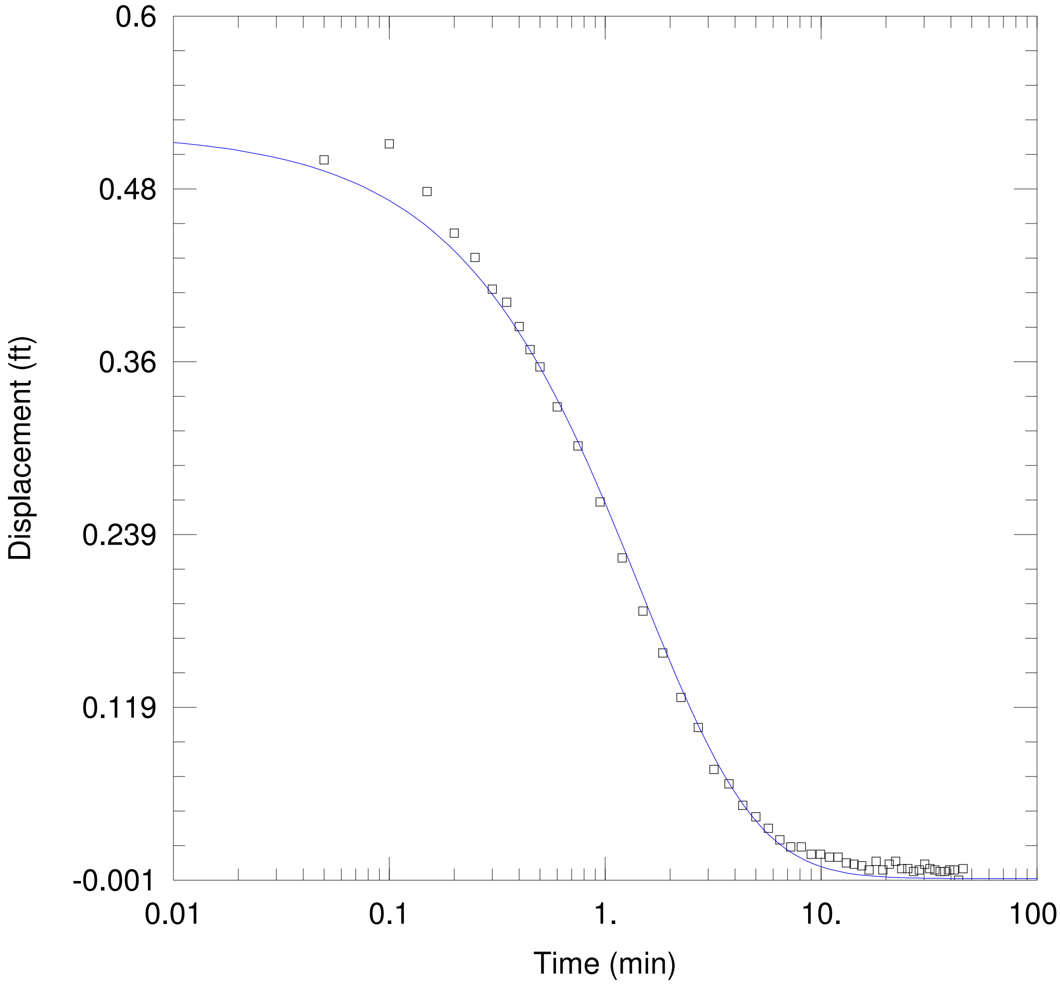
Saturated Thickness: 7.8 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (DR-8)

Initial Displacement: 0.33 ft
Total Well Penetration Depth: 7.8 ft
Casing Radius: 0.125 ft
Static Water Column Height: 7.8 ft
Screen Length: 7.8 ft
Well Radius: 0.255 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 4.451E-7 cm/sec
y0 = 0.299 ft



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr9.aqt
Date: 12/14/11 Time: 11:00:51

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 24.5 ft

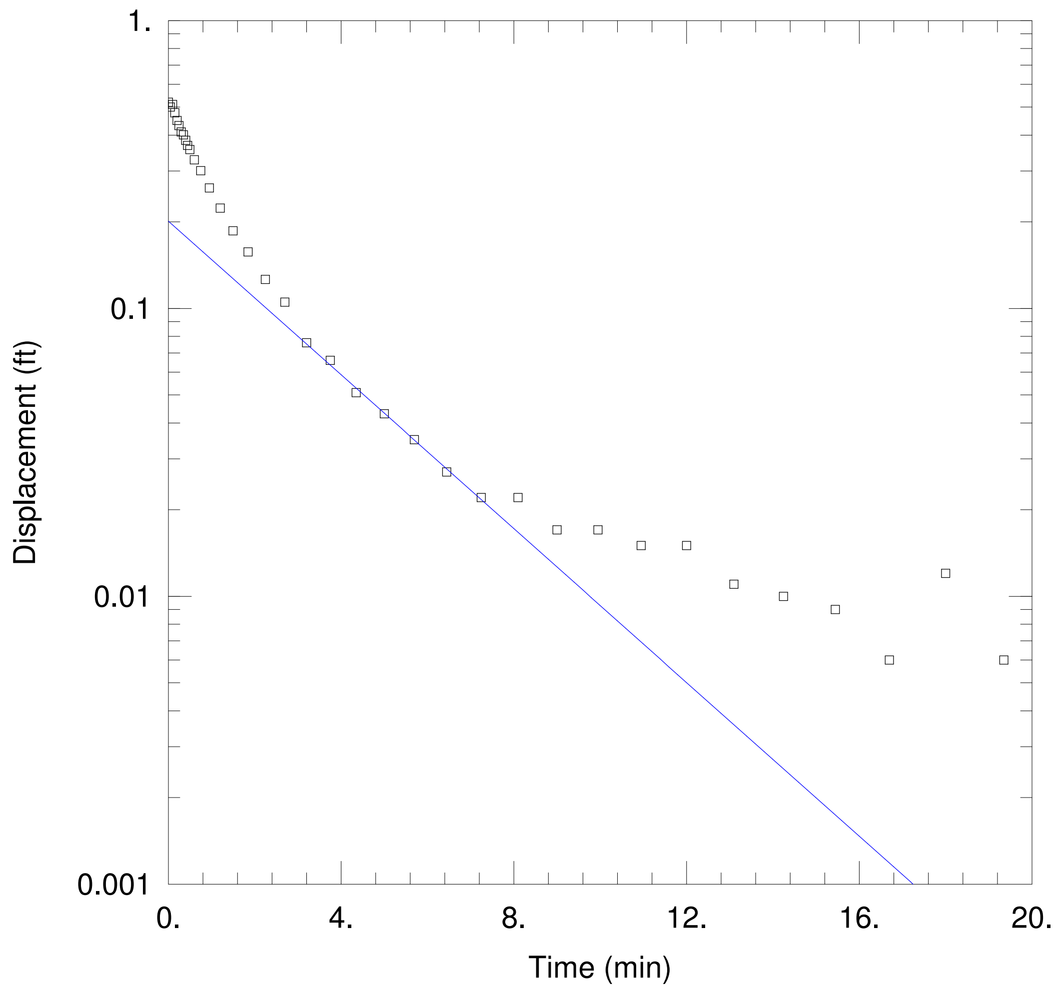
WELL DATA (DR-9)

Initial Displacement: 0.52 ft
Total Well Penetration Depth: 24.5 ft
Casing Radius: 0.125 ft
Static Water Column Height: 24.4 ft
Screen Length: 24.5 ft
Well Radius: 0.255 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 0.0004493 cm/sec
Kz/Kr = 0.1
Ss = 4.292E-6 ft^{-1}



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr9br.aqt
Date: 12/14/11 Time: 11:01:19

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 24.5 ft
Anisotropy Ratio (Kz/Kr): 0.1

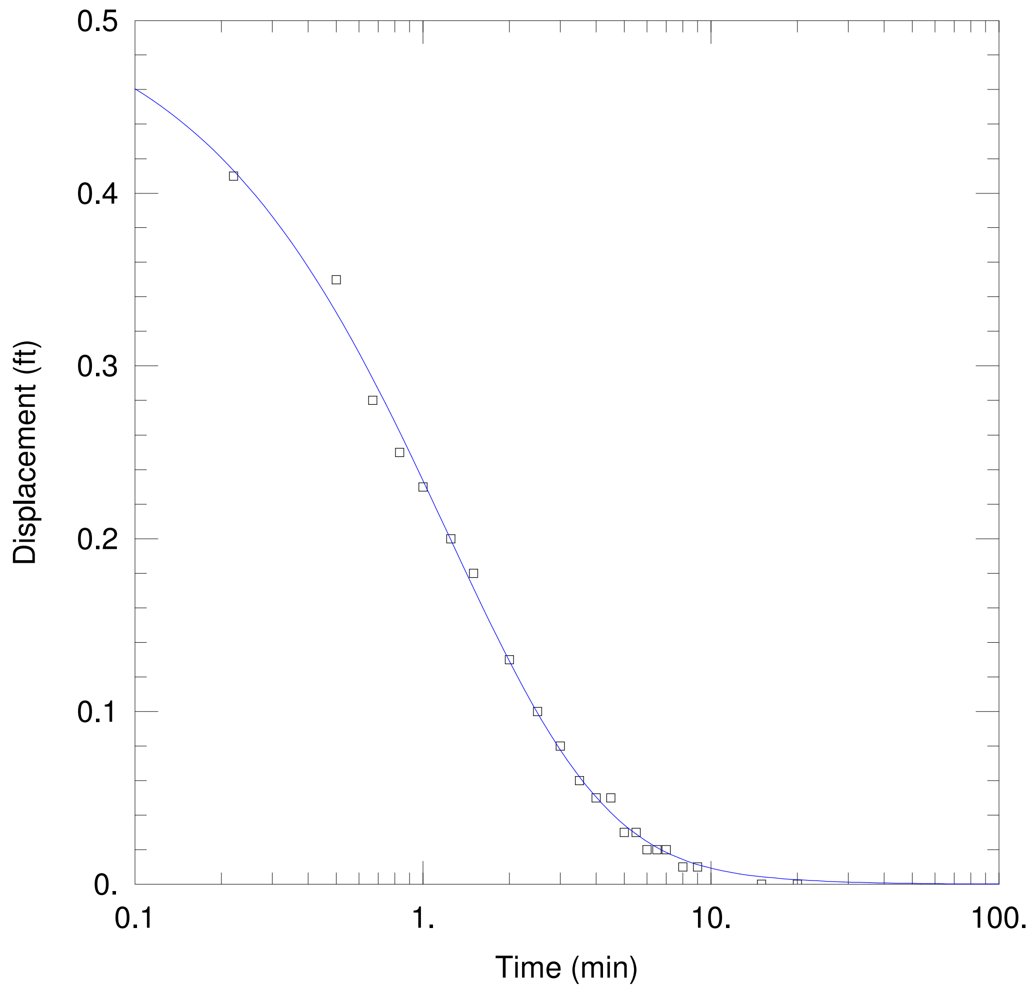
WELL DATA (DR-9)

Initial Displacement: 0.52 ft
Total Well Penetration Depth: 24.5 ft
Casing Radius: 0.125 ft
Static Water Column Height: 24.4 ft
Screen Length: 24.5 ft
Well Radius: 0.255 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.0003408 cm/sec
y0 = 0.201 ft



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr9h.aqt
Date: 12/14/11 Time: 11:01:47

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 24.5 ft

WELL DATA (DR-9)

Initial Displacement: 0.52 ft
Total Well Penetration Depth: 24.5 ft
Casing Radius: 0.125 ft

Static Water Column Height: 24.4 ft
Screen Length: 24.5 ft
Well Radius: 0.255 ft
Gravel Pack Porosity: 0.3

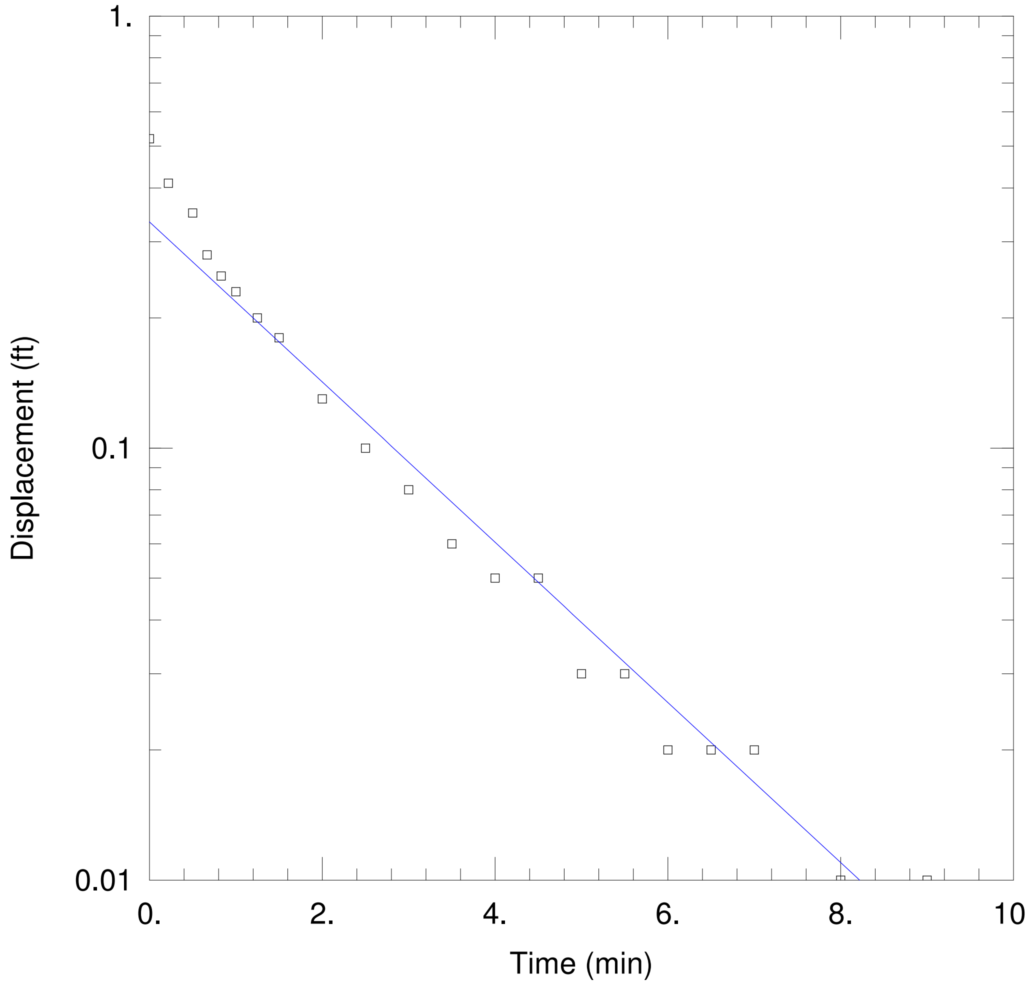
SOLUTION

Aquifer Model: Unconfined

Solution Method: KGS Model

Kr = 0.000473 cm/sec
Kz/Kr = 0.1

Ss = 1.21E-5 ft^{-1}



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr9hbr.aqt
Date: 12/14/11 Time: 11:02:17

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 24.5 ft
Anisotropy Ratio (Kz/Kr): 0.1

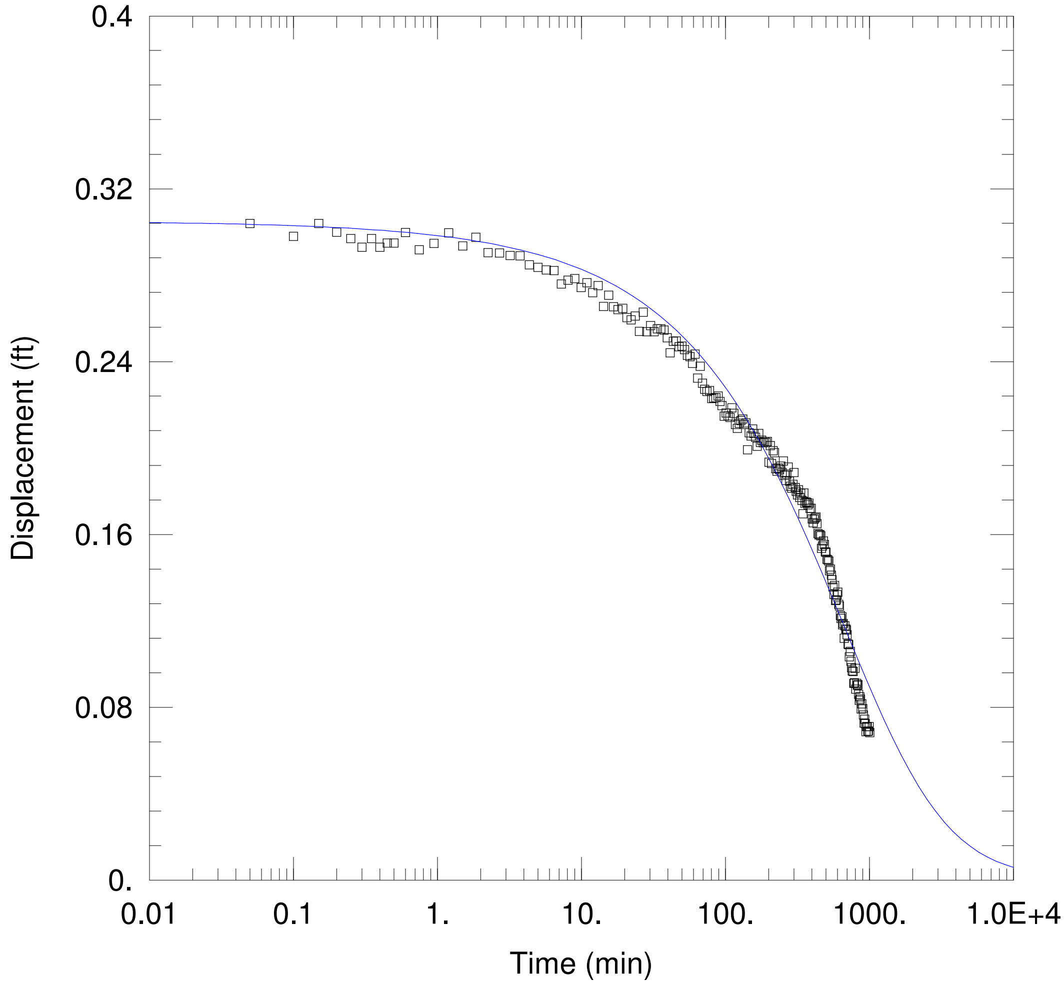
WELL DATA (DR-9)

Initial Displacement: 0.52 ft
Total Well Penetration Depth: 24.5 ft
Casing Radius: 0.125 ft
Static Water Column Height: 24.4 ft
Screen Length: 24.5 ft
Well Radius: 0.255 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.000473 cm/sec
y0 = 0.3336 ft



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr10c2.aqt
Date: 12/14/11 Time: 09:58:35

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 3. ft

WELL DATA (DR-10)

Initial Displacement: 0.305 ft
Total Well Penetration Depth: 3. ft
Casing Radius: 0.125 ft

Static Water Column Height: 3. ft
Screen Length: 3. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

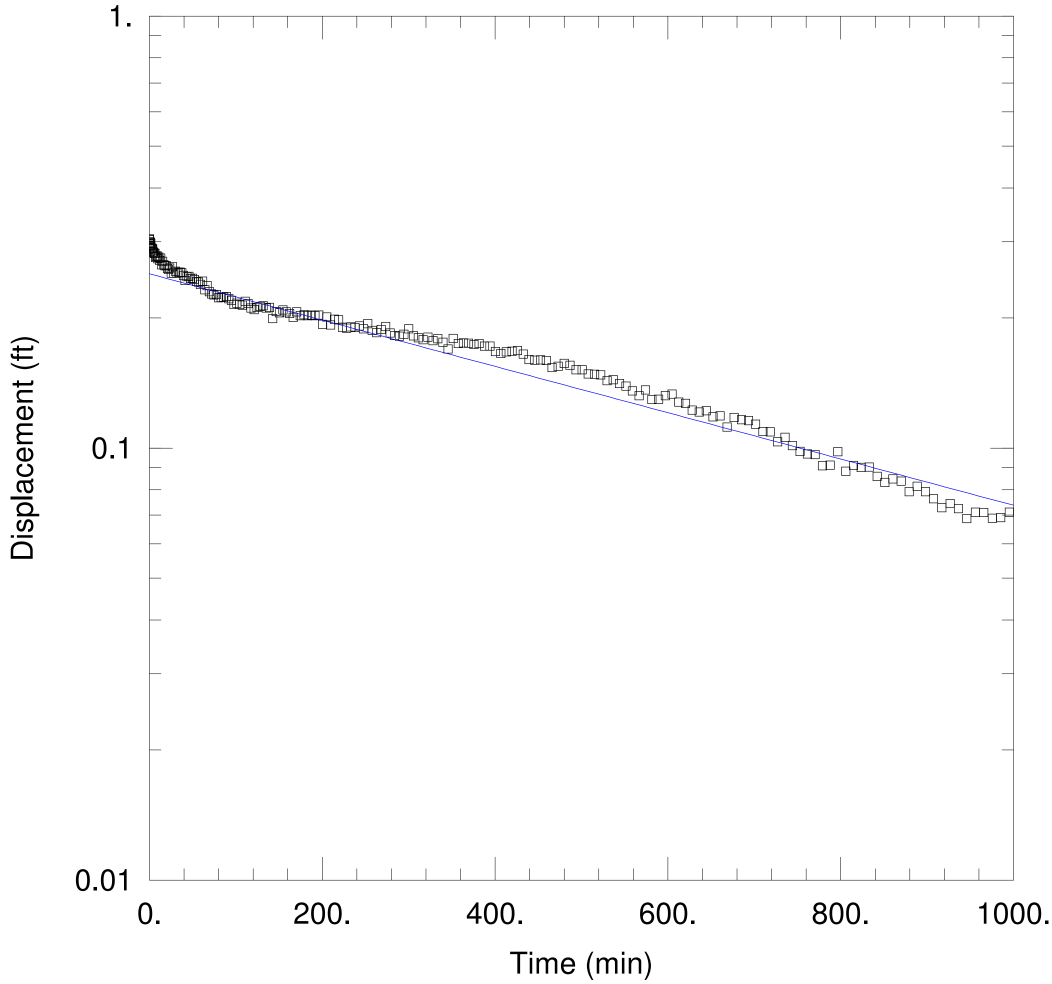
SOLUTION

Aquifer Model: Unconfined

Solution Method: KGS Model

Kr = 2.918E-6 cm/sec
Kz/Kr = 0.1

Ss = 0.006538 ft^{-1}



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr10c2br.aqt
Date: 12/14/11 Time: 09:59:24

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 3. ft Anisotropy Ratio (Kz/Kr): 0.1

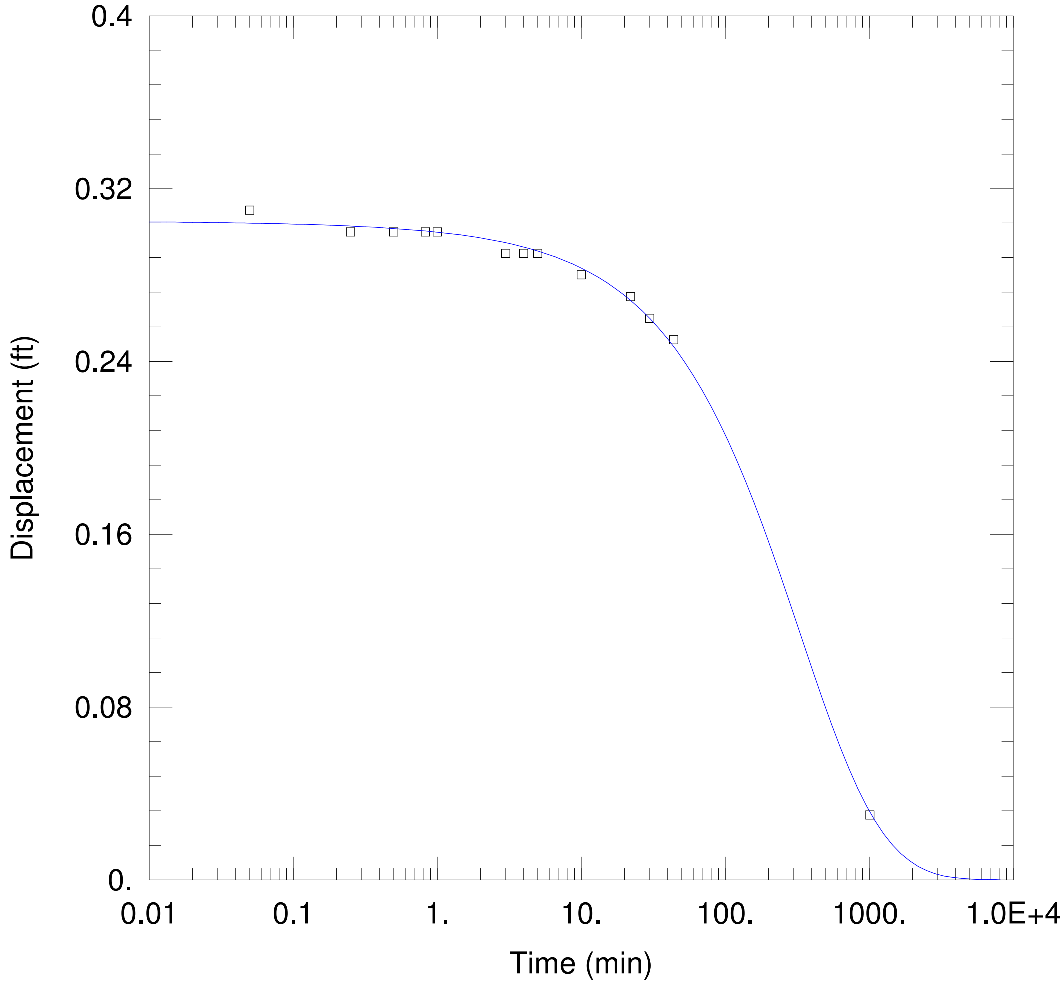
WELL DATA (DR-10)

Initial Displacement: 0.305 ft
Total Well Penetration Depth: 3. ft
Casing Radius: 0.125 ft
Static Water Column Height: 3. ft
Screen Length: 3. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 5.56E-6 cm/sec y0 = 0.2531 ft



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr10h.aqt
Date: 12/14/11 Time: 09:59:55

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 3. ft

WELL DATA (DR-10)

Initial Displacement: 0.305 ft
Total Well Penetration Depth: 3. ft
Casing Radius: 0.125 ft

Static Water Column Height: 3. ft
Screen Length: 3. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

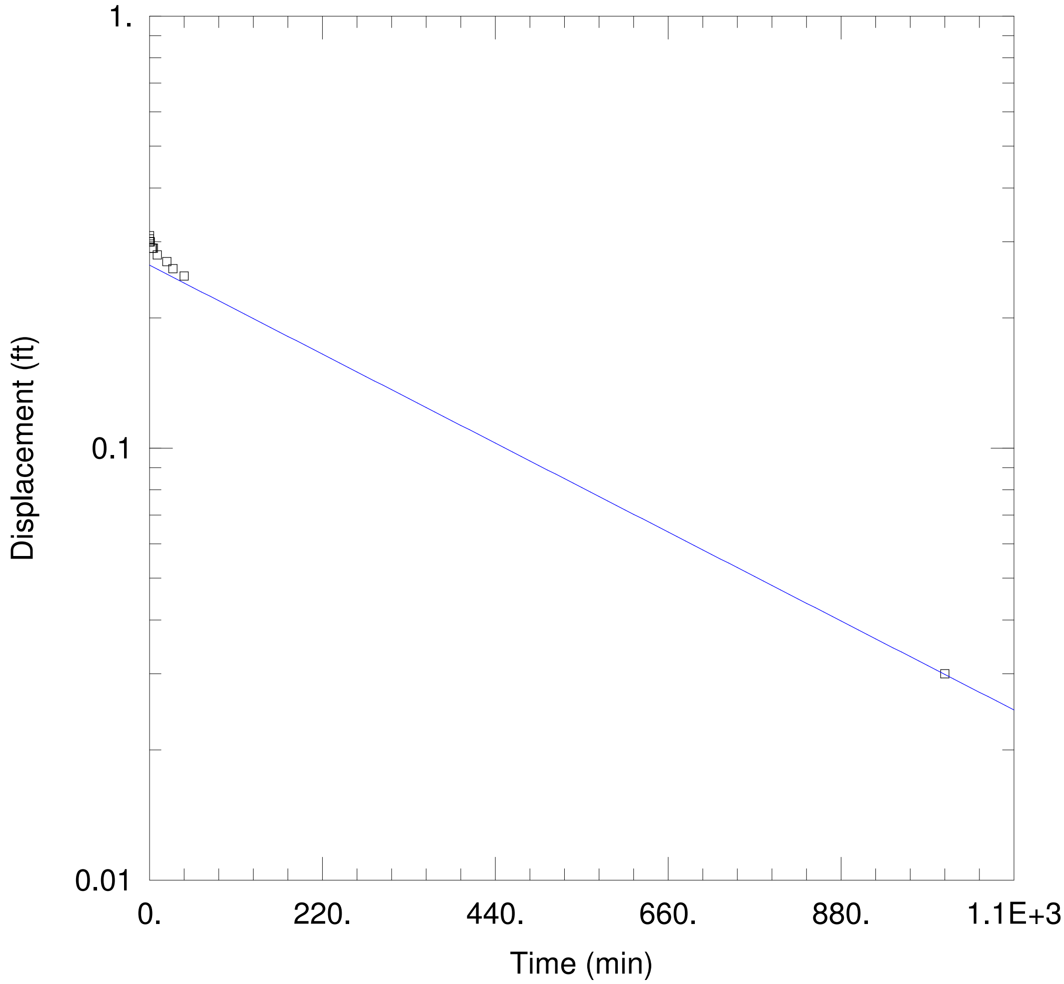
SOLUTION

Aquifer Model: Unconfined

Kr = 9.713E-6 cm/sec
Kz/Kr = 0.1

Solution Method: KGS Model

Ss = 0.0008413 ft^{-1}



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr10hbr.aqt
Date: 12/14/11 Time: 10:00:34

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 3. ft
Anisotropy Ratio (Kz/Kr): 0.1

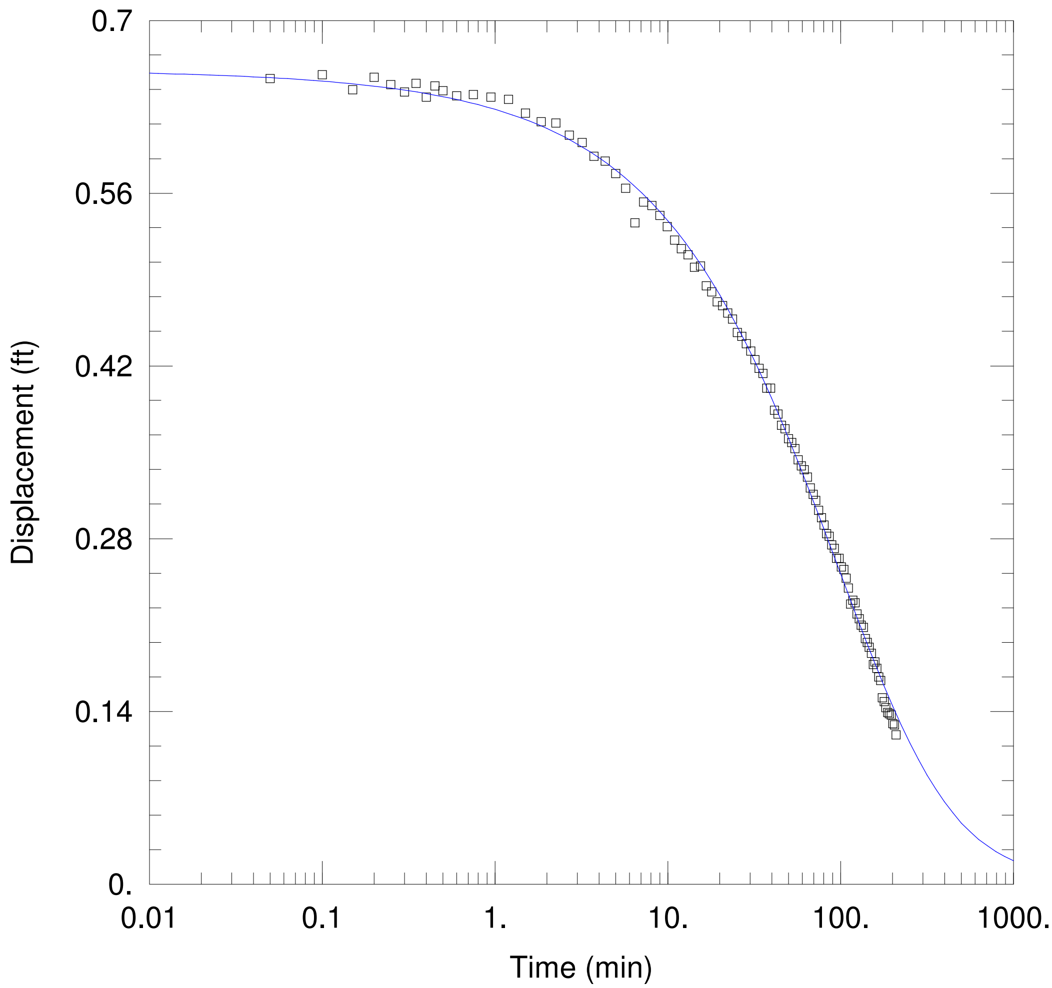
WELL DATA (DR-10)

Initial Displacement: 0.305 ft
Total Well Penetration Depth: 3. ft
Casing Radius: 0.125 ft
Static Water Column Height: 3. ft
Screen Length: 3. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 9.713E-6 cm/sec
y0 = 0.265 ft



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr11.aqt
Date: 12/14/11 Time: 10:01:02

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 8.9 ft

WELL DATA (DR-11)

Initial Displacement: 0.66 ft
Total Well Penetration Depth: 8.9 ft
Casing Radius: 0.125 ft

Static Water Column Height: 8.9 ft
Screen Length: 8.9 ft
Well Radius: 0.255 ft
Gravel Pack Porosity: 0.3

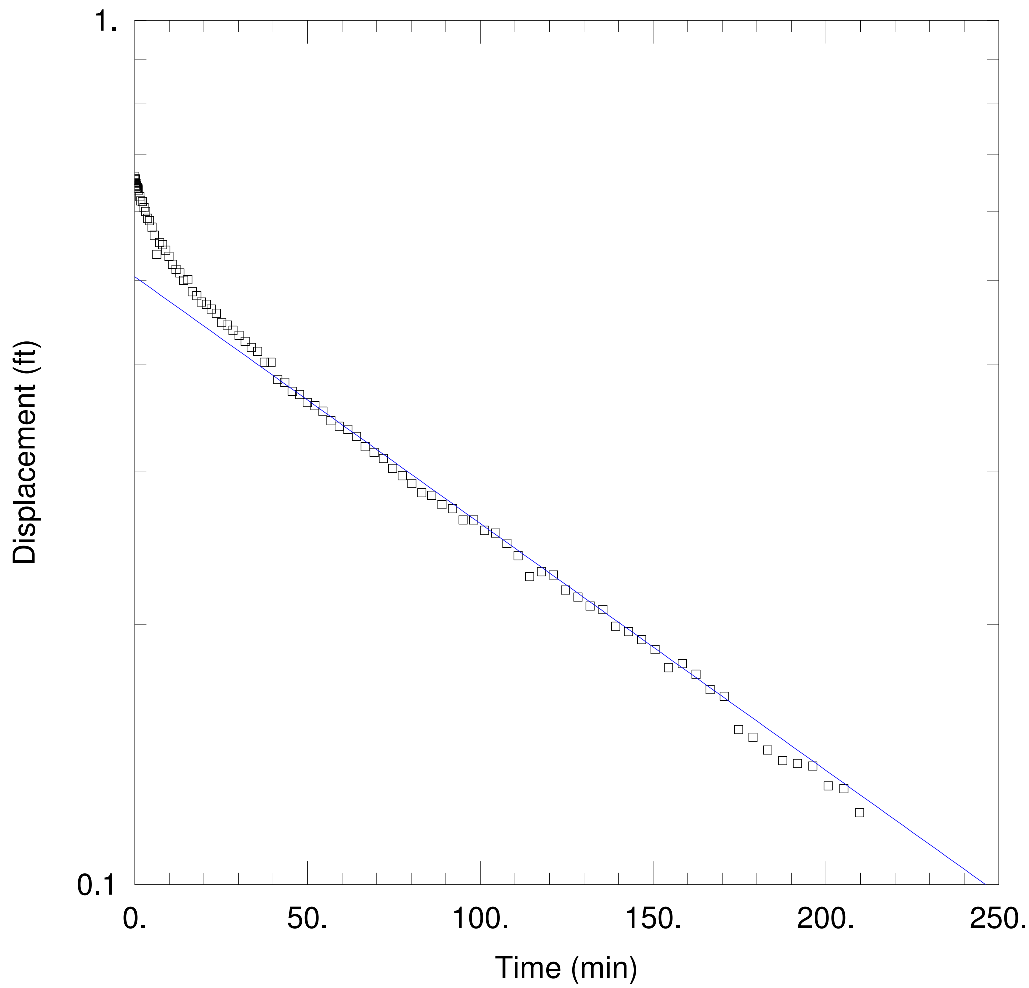
SOLUTION

Aquifer Model: Unconfined

Solution Method: KGS Model

Kr = 8.877E-6 cm/sec
Kz/Kr = 0.1

Ss = 0.0008882 ft^{-1}



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr11br.aqt
Date: 12/14/11 Time: 10:01:26

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 8.9 ft Anisotropy Ratio (Kz/Kr): 0.1

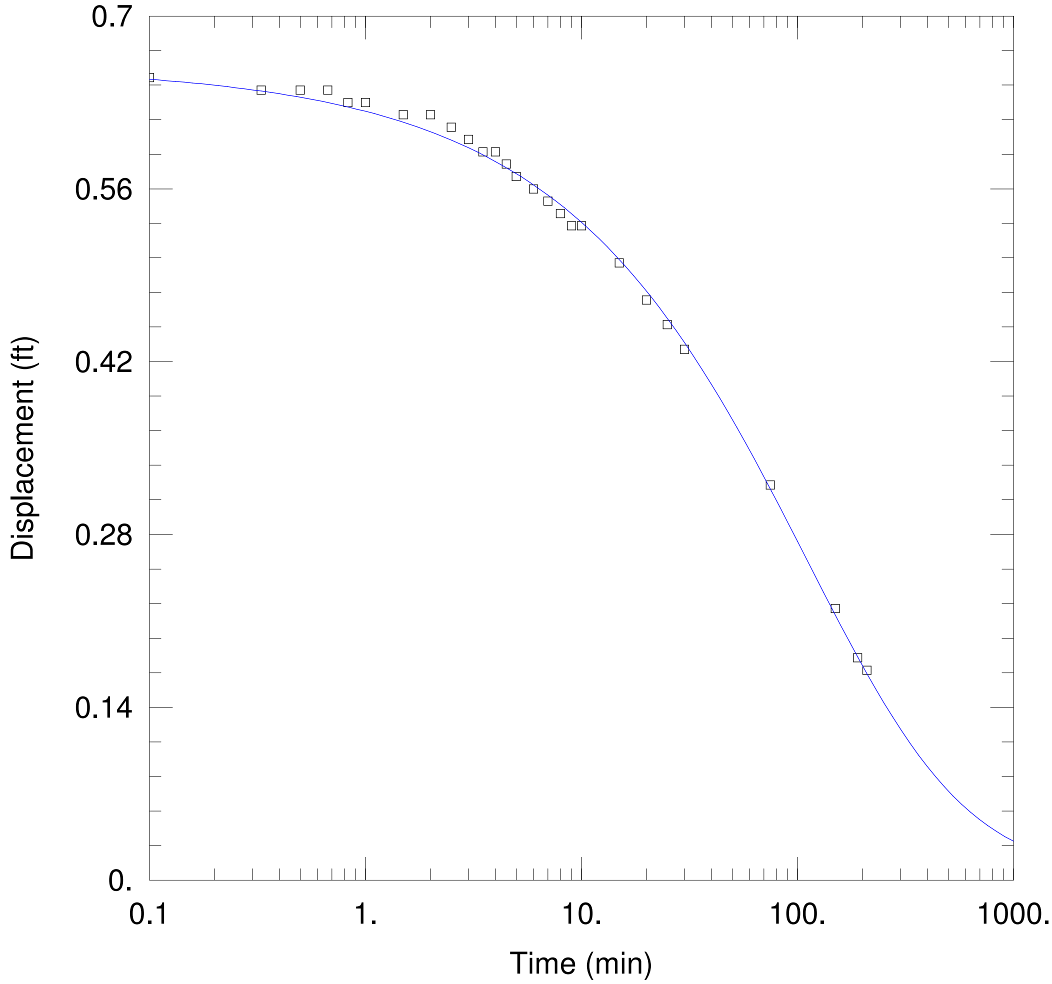
WELL DATA (DR-11)

Initial Displacement: 0.66 ft
Total Well Penetration Depth: 8.9 ft
Casing Radius: 0.125 ft
Static Water Column Height: 8.9 ft
Screen Length: 8.9 ft
Well Radius: 0.255 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 1.543E-5 cm/sec y0 = 0.5049 ft



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr11h.aqt
Date: 12/14/11 Time: 10:01:58

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 8.9 ft

WELL DATA (DR-11)

Initial Displacement: 0.66 ft
Total Well Penetration Depth: 8.9 ft
Casing Radius: 0.125 ft

Static Water Column Height: 8.9 ft
Screen Length: 8.9 ft
Well Radius: 0.255 ft
Gravel Pack Porosity: 0.3

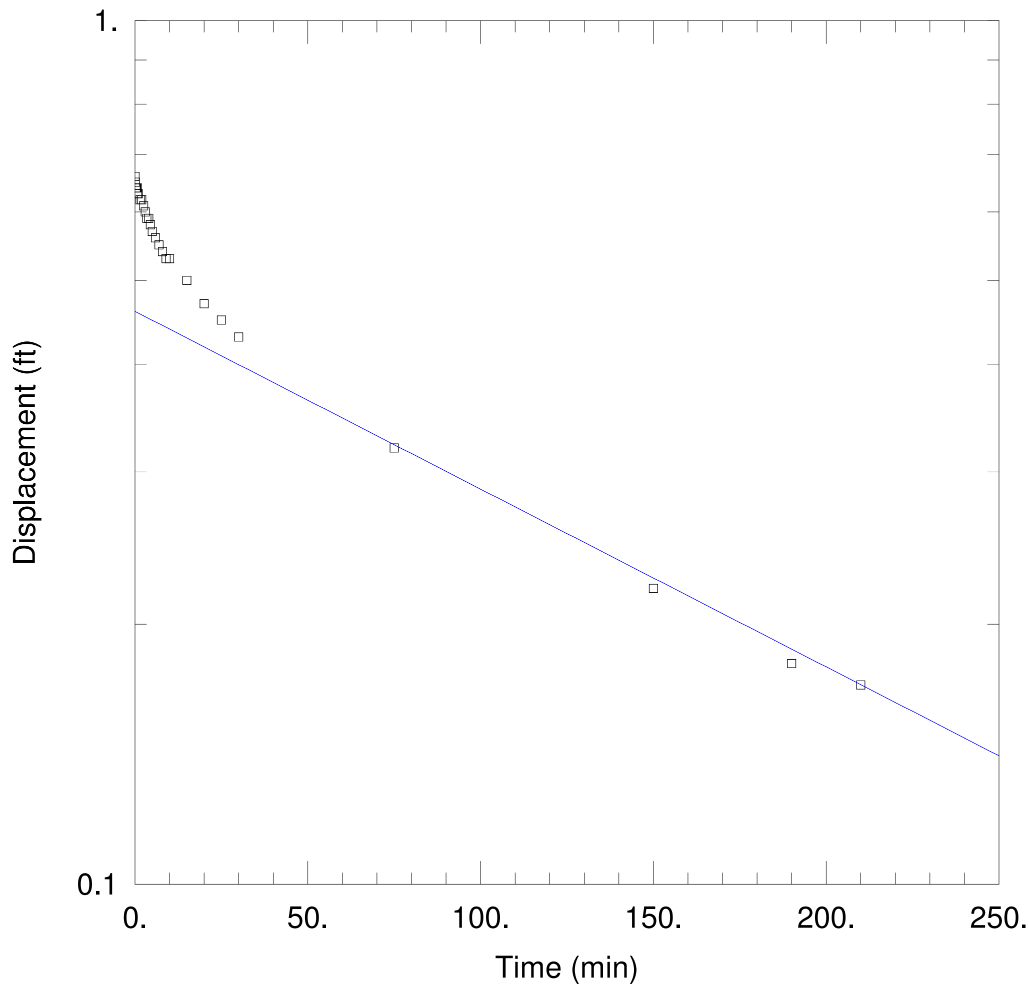
SOLUTION

Aquifer Model: Unconfined

Solution Method: KGS Model

Kr = 5.833E-6 cm/sec
Kz/Kr = 0.1

Ss = 0.002217 ft^{-1}



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr11hbr.aqt
Date: 12/14/11 Time: 10:02:36

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 8.9 ft Anisotropy Ratio (Kz/Kr): 0.1

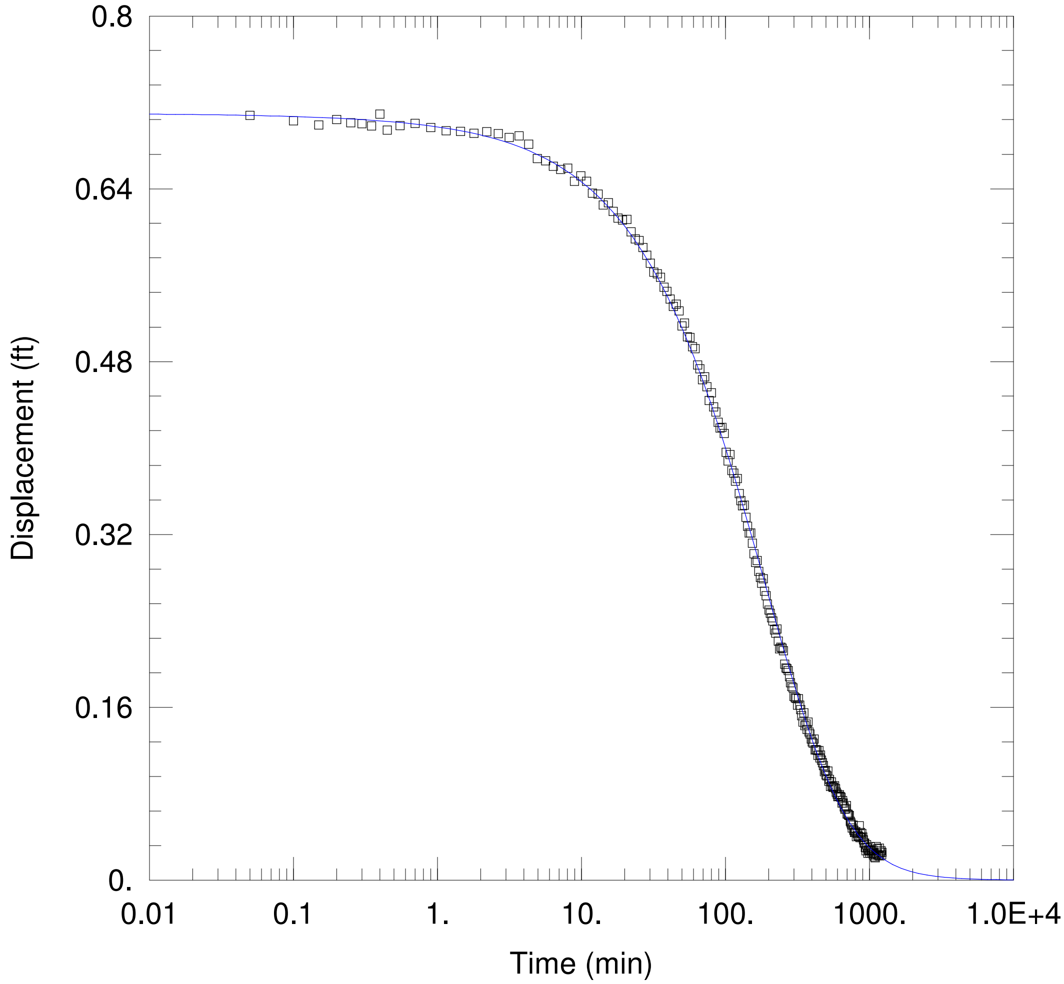
WELL DATA (DR-11)

Initial Displacement: 0.66 ft
Total Well Penetration Depth: 8.9 ft
Casing Radius: 0.125 ft
Static Water Column Height: 8.9 ft
Screen Length: 8.9 ft
Well Radius: 0.255 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 1.111E-5 cm/sec y0 = 0.4605 ft



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr13.aqt
Date: 12/14/11 Time: 10:03:10

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 11.2 ft

WELL DATA (DR-13)

Initial Displacement: 0.71 ft
Total Well Penetration Depth: 11.2 ft
Casing Radius: 0.125 ft

Static Water Column Height: 11.2 ft
Screen Length: 11.2 ft
Well Radius: 0.234 ft
Gravel Pack Porosity: 0.3

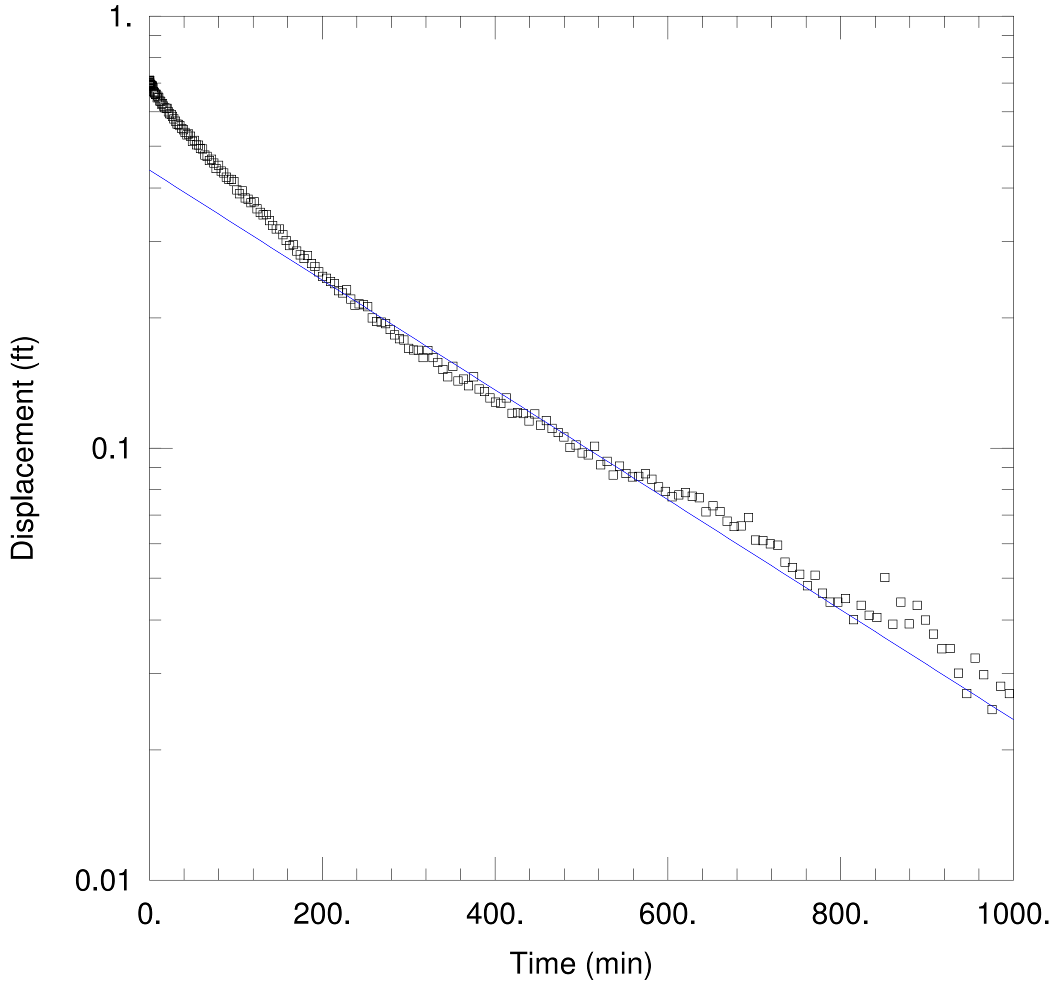
SOLUTION

Aquifer Model: Unconfined

Solution Method: KGS Model

Kr = 5.896E-6 cm/sec
Kz/Kr = 0.1

Ss = 7.327E-5 ft^{-1}



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr13br.aqt
Date: 12/14/11 Time: 10:03:39

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 11.2 ft
Anisotropy Ratio (Kz/Kr): 0.1

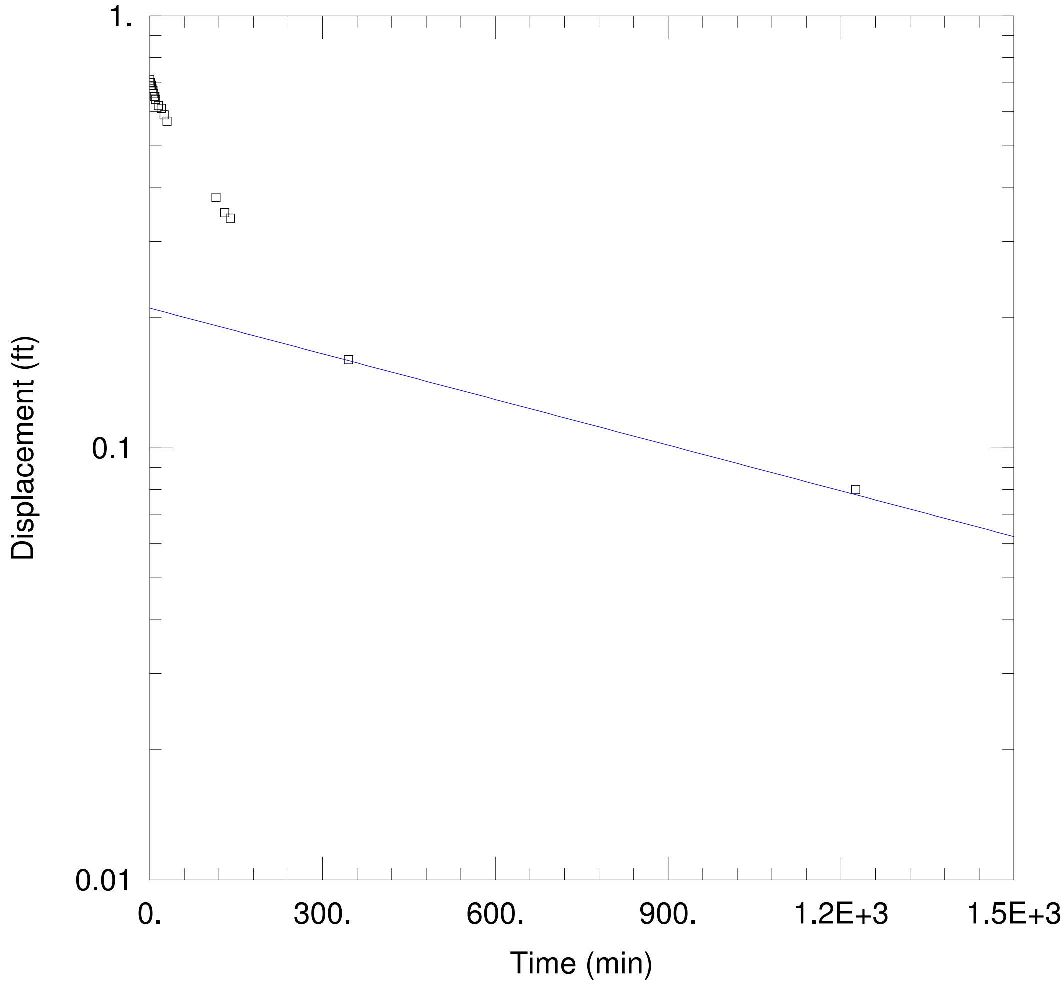
WELL DATA (DR-13)

Initial Displacement: 0.71 ft
Total Well Penetration Depth: 11.2 ft
Casing Radius: 0.125 ft
Static Water Column Height: 11.2 ft
Screen Length: 11.2 ft
Well Radius: 0.234 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 5.377E-6 cm/sec
y0 = 0.4398 ft



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr13hbr.aqt
Date: 12/14/11 Time: 10:13:59

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 11.2 ft
Anisotropy Ratio (Kz/Kr): 0.1

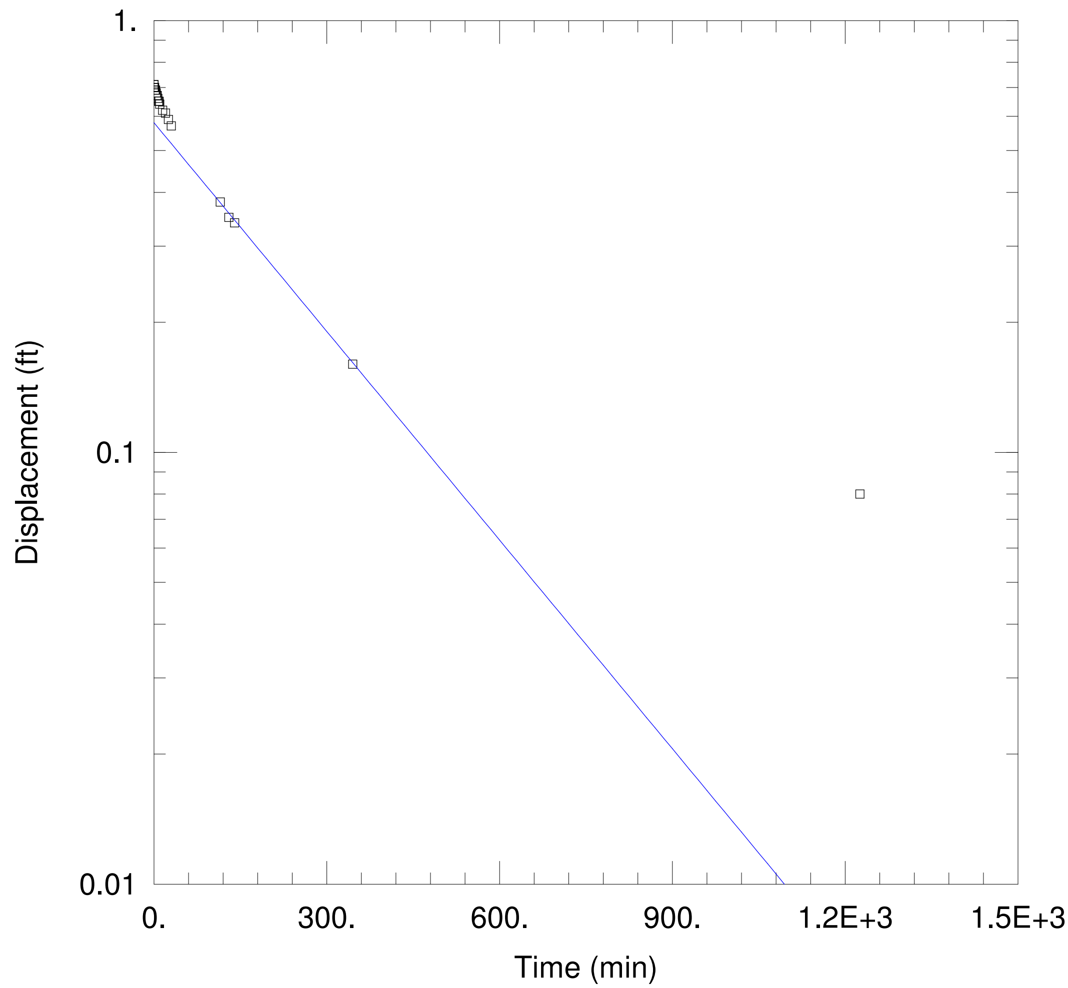
WELL DATA (DR-13)

Initial Displacement: 0.71 ft
Total Well Penetration Depth: 11.2 ft
Casing Radius: 0.125 ft
Static Water Column Height: 11.2 ft
Screen Length: 11.2 ft
Well Radius: 0.234 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.49E-6 cm/sec
y0 = 0.2105 ft



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr13hbret.aqt
Date: 12/14/11 Time: 10:14:35

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 11.2 ft
Anisotropy Ratio (Kz/Kr): 0.1

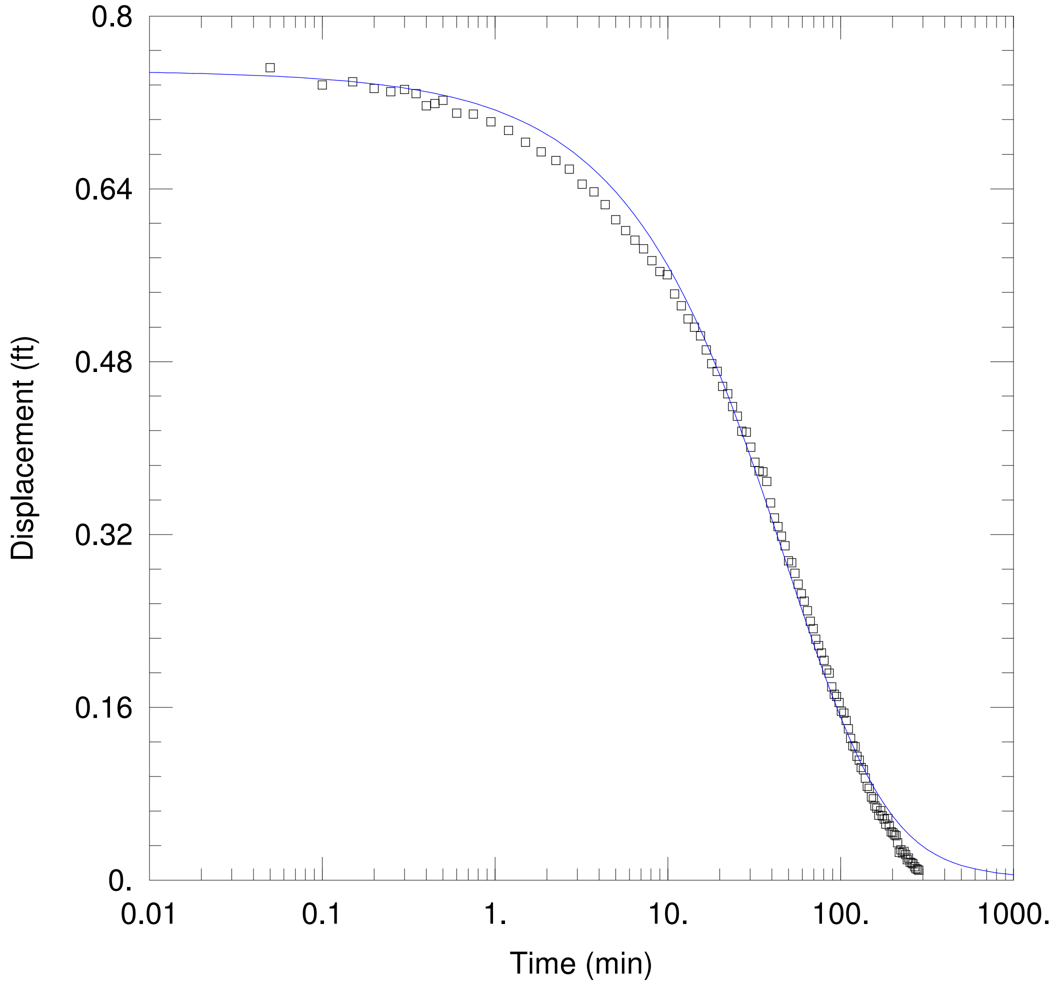
WELL DATA (DR-13)

Initial Displacement: 0.71 ft
Total Well Penetration Depth: 11.2 ft
Casing Radius: 0.125 ft
Static Water Column Height: 11.2 ft
Screen Length: 11.2 ft
Well Radius: 0.234 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 6.811E-6 cm/sec
y0 = 0.5798 ft



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr14c.aqt
Date: 12/14/11 Time: 10:35:48

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 18.8 ft

WELL DATA (DR-14)

Initial Displacement: 0.75 ft
Total Well Penetration Depth: 18.8 ft
Casing Radius: 0.125 ft

Static Water Column Height: 18.8 ft
Screen Length: 18.8 ft
Well Radius: 0.234 ft
Gravel Pack Porosity: 0.3

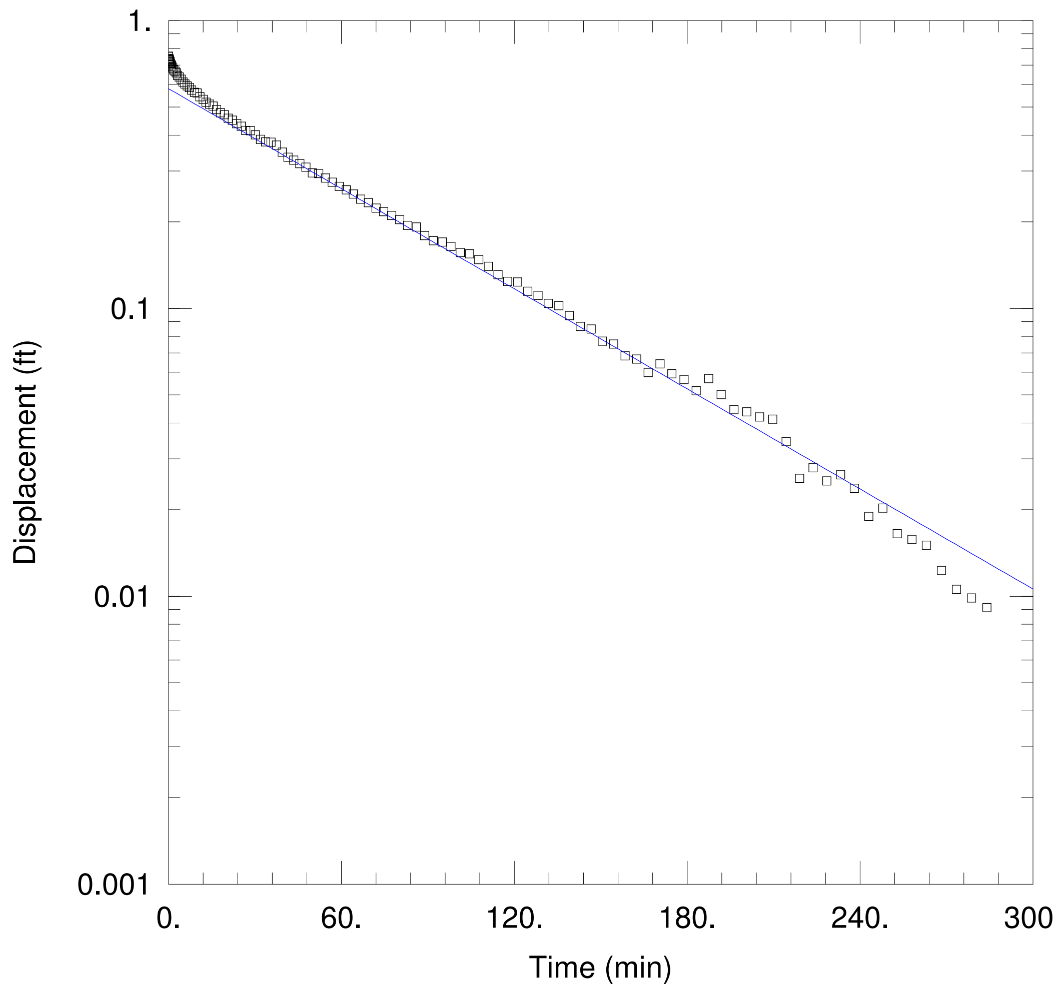
SOLUTION

Aquifer Model: Unconfined

Solution Method: KGS Model

Kr = 1.261E-5 cm/sec
Kz/Kr = 0.1

Ss = 7.337E-5 ft^{-1}



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr14cbr.aqt
Date: 12/14/11 Time: 10:36:15

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 18.8 ft
Anisotropy Ratio (Kz/Kr): 0.1

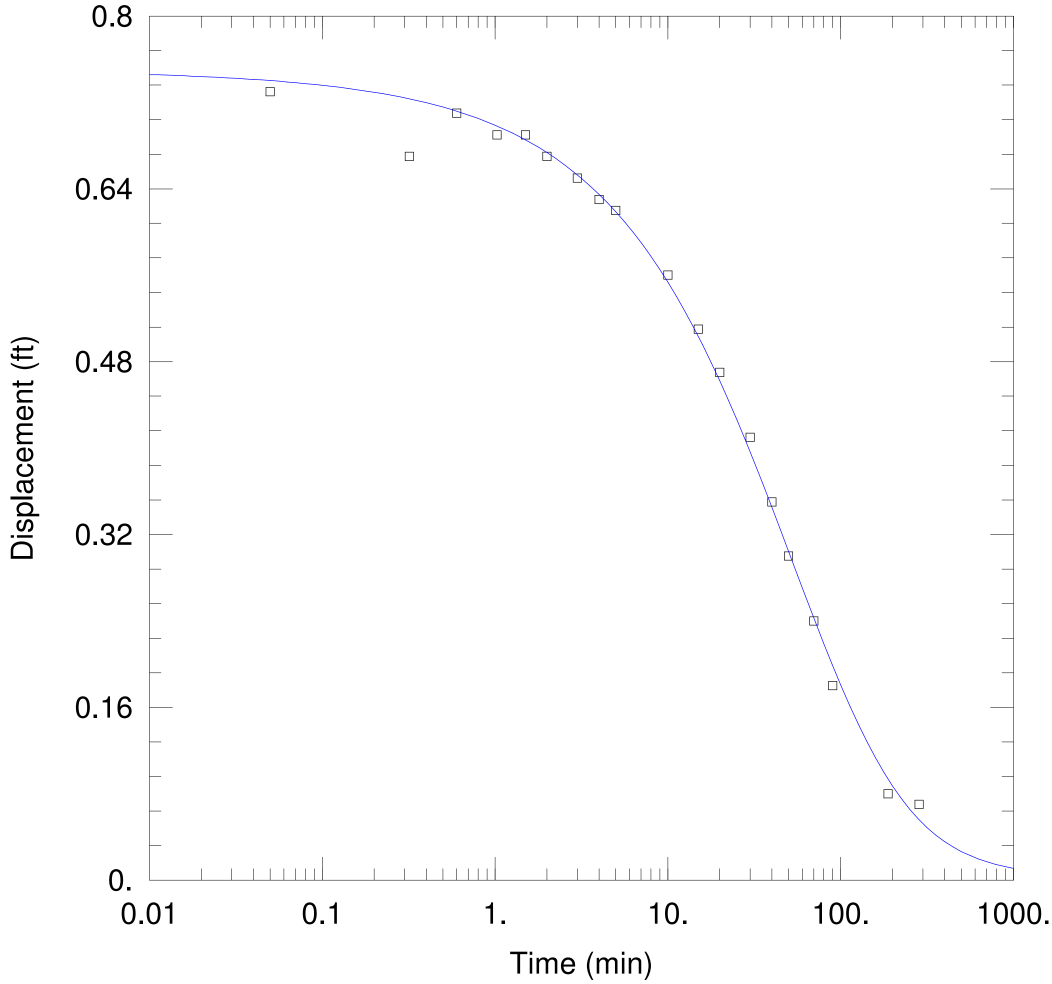
WELL DATA (DR-14)

Initial Displacement: 0.75 ft
Total Well Penetration Depth: 18.8 ft
Casing Radius: 0.125 ft
Static Water Column Height: 18.8 ft
Screen Length: 18.8 ft
Well Radius: 0.234 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.663E-5 cm/sec
y0 = 0.5798 ft



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr14h.aqt
Date: 12/14/11 Time: 10:36:42

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 18.8 ft

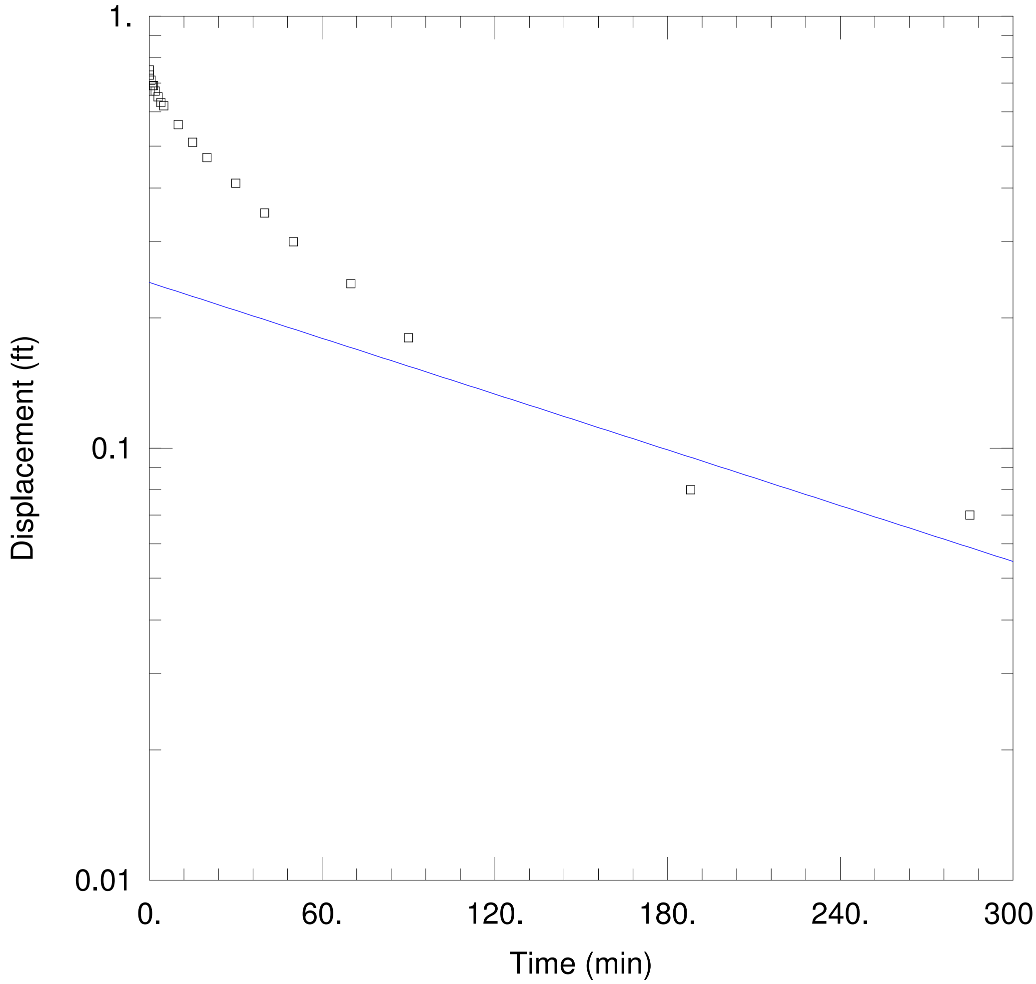
WELL DATA (DR-14)

Initial Displacement: 0.75 ft
Total Well Penetration Depth: 18.8 ft
Casing Radius: 0.125 ft
Static Water Column Height: 18.8 ft
Screen Length: 18.8 ft
Well Radius: 0.234 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 7.776E-6 cm/sec
Kz/Kr = 0.1
Ss = 0.0004841 ft^{-1}



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr14hbr.aqt
Date: 12/14/11 Time: 10:37:06

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 18.8 ft Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (DR-14)

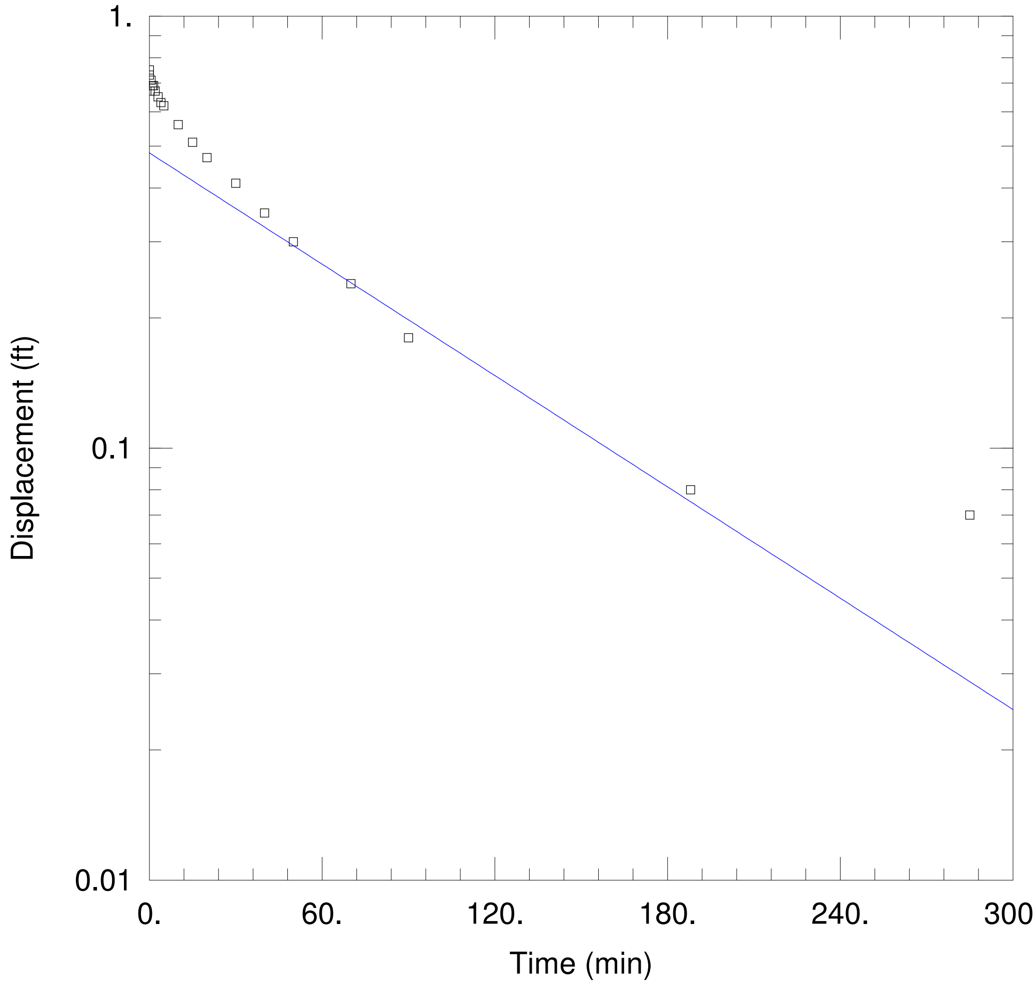
Initial Displacement: 0.75 ft
Total Well Penetration Depth: 18.8 ft
Casing Radius: 0.125 ft

Static Water Column Height: 18.8 ft
Screen Length: 18.8 ft
Well Radius: 0.234 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 6.177E-6 cm/sec y0 = 0.2417 ft



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr14hbret.aqt
Date: 12/14/11 Time: 10:37:34

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 18.8 ft
Anisotropy Ratio (Kz/Kr): 0.1

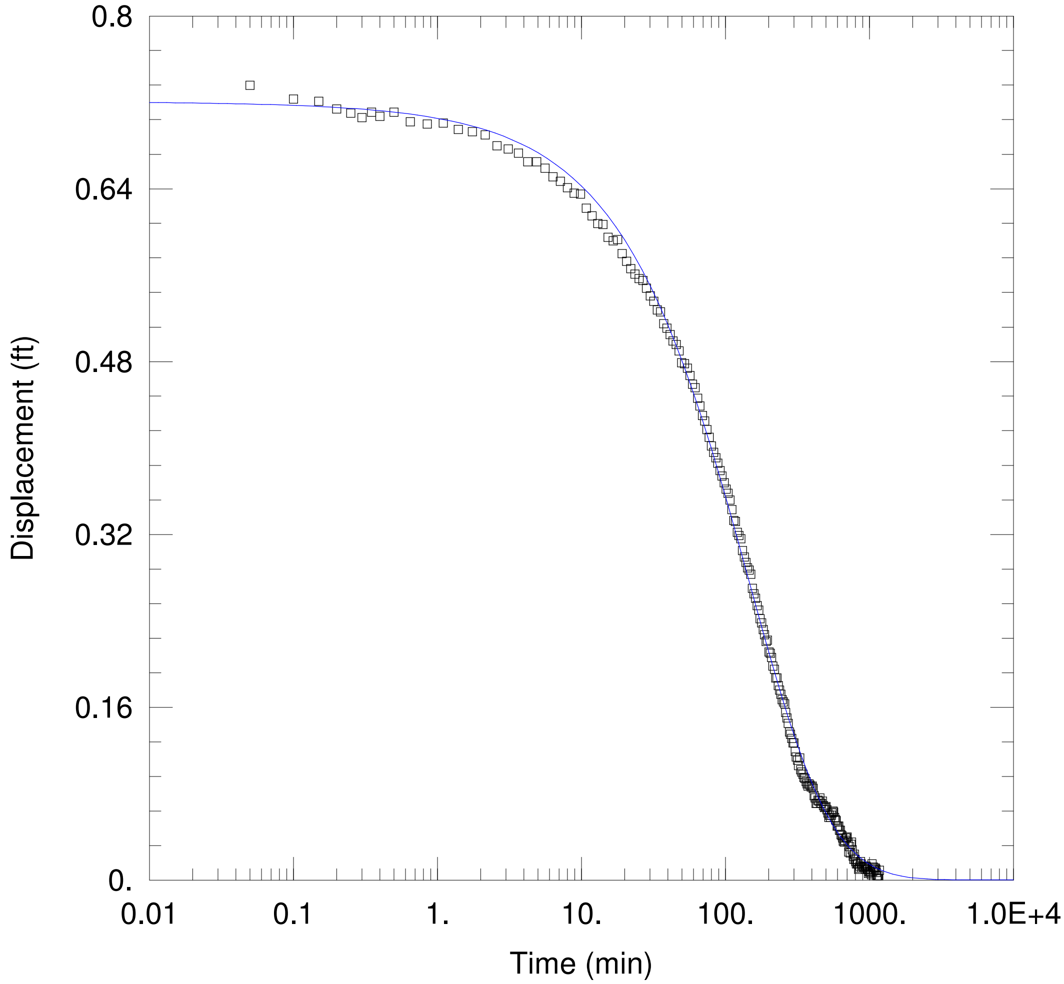
WELL DATA (DR-14)

Initial Displacement: 0.75 ft
Total Well Penetration Depth: 18.8 ft
Casing Radius: 0.125 ft
Static Water Column Height: 18.8 ft
Screen Length: 18.8 ft
Well Radius: 0.234 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.232E-5 cm/sec
y0 = 0.4822 ft



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr17.aqt
Date: 12/14/11 Time: 10:38:17

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 6.5 ft

WELL DATA (DR-17)

Initial Displacement: 0.721 ft
Total Well Penetration Depth: 6.5 ft
Casing Radius: 0.125 ft

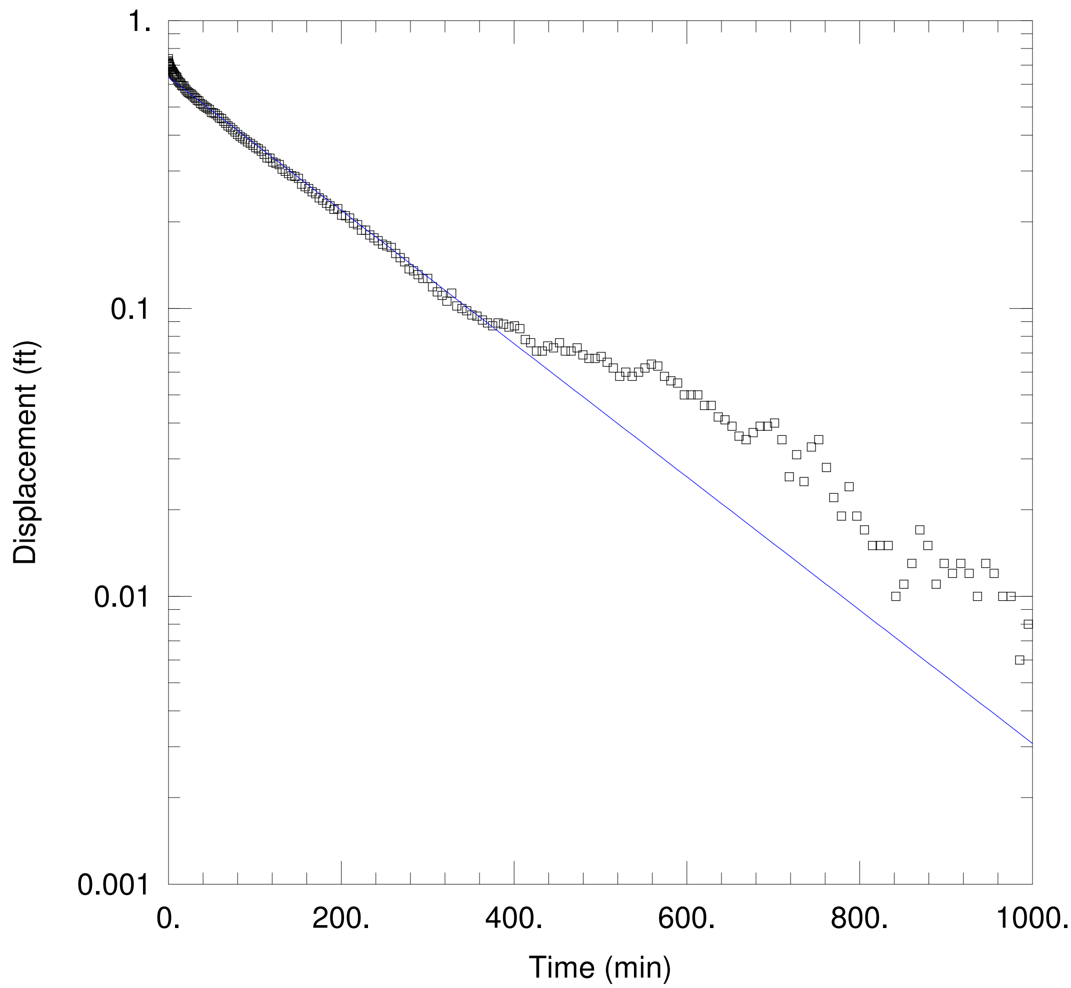
Static Water Column Height: 6.5 ft
Screen Length: 6.5 ft
Well Radius: 0.234 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 1.243E-5 cm/sec
Kz/Kr = 0.1

Ss = 0.0001533 ft^{-1}



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr17br.aqt
Date: 12/14/11 Time: 10:38:43

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 6.5 ft Anisotropy Ratio (Kz/Kr): 0.1

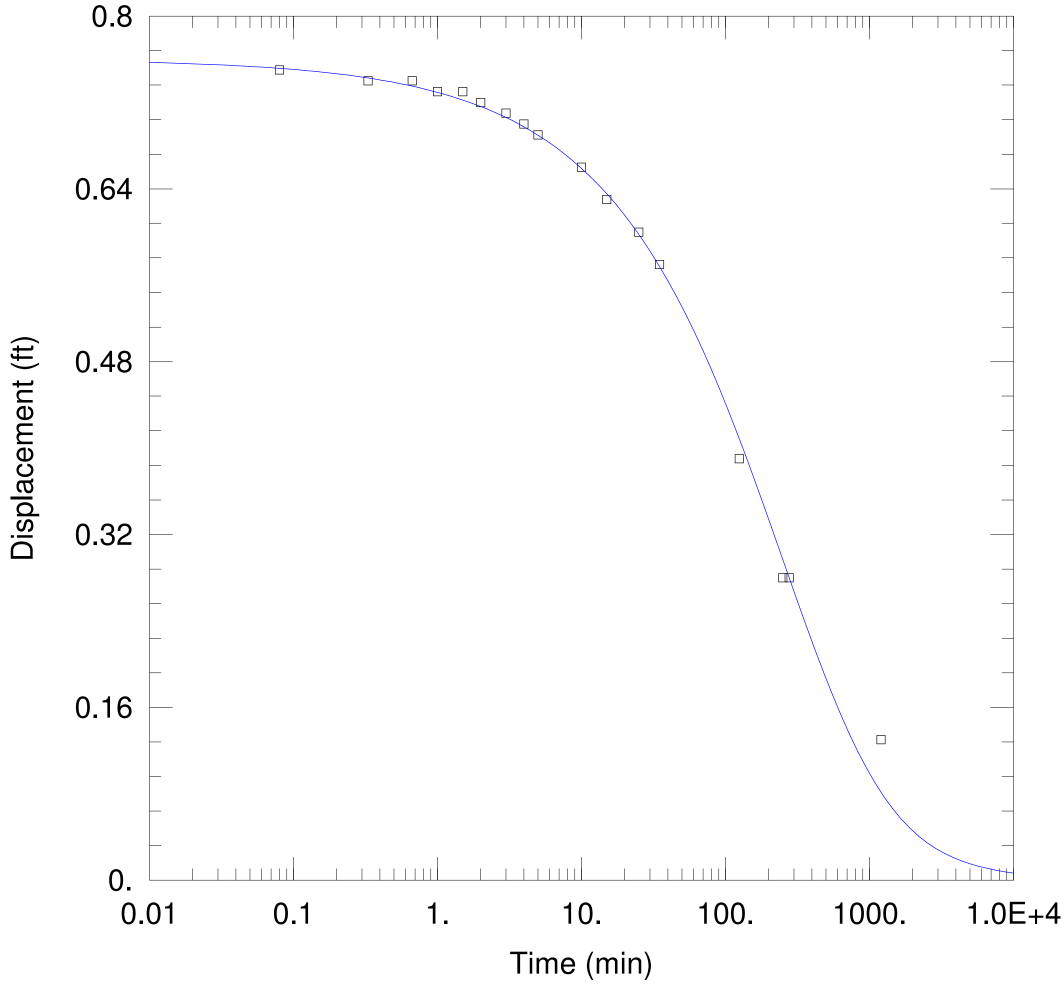
WELL DATA (DR-17)

Initial Displacement: 0.721 ft
Total Well Penetration Depth: 6.5 ft
Casing Radius: 0.125 ft
Static Water Column Height: 6.5 ft
Screen Length: 6.5 ft
Well Radius: 0.234 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 1.427E-5 cm/sec y0 = 0.6357 ft



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr17h.aqt
Date: 12/14/11 Time: 10:39:10

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 6.5 ft

WELL DATA (DR-17)

Initial Displacement: 0.76 ft
Total Well Penetration Depth: 6.5 ft
Casing Radius: 0.125 ft

Static Water Column Height: 6.5 ft
Screen Length: 6.5 ft
Well Radius: 0.234 ft
Gravel Pack Porosity: 0.3

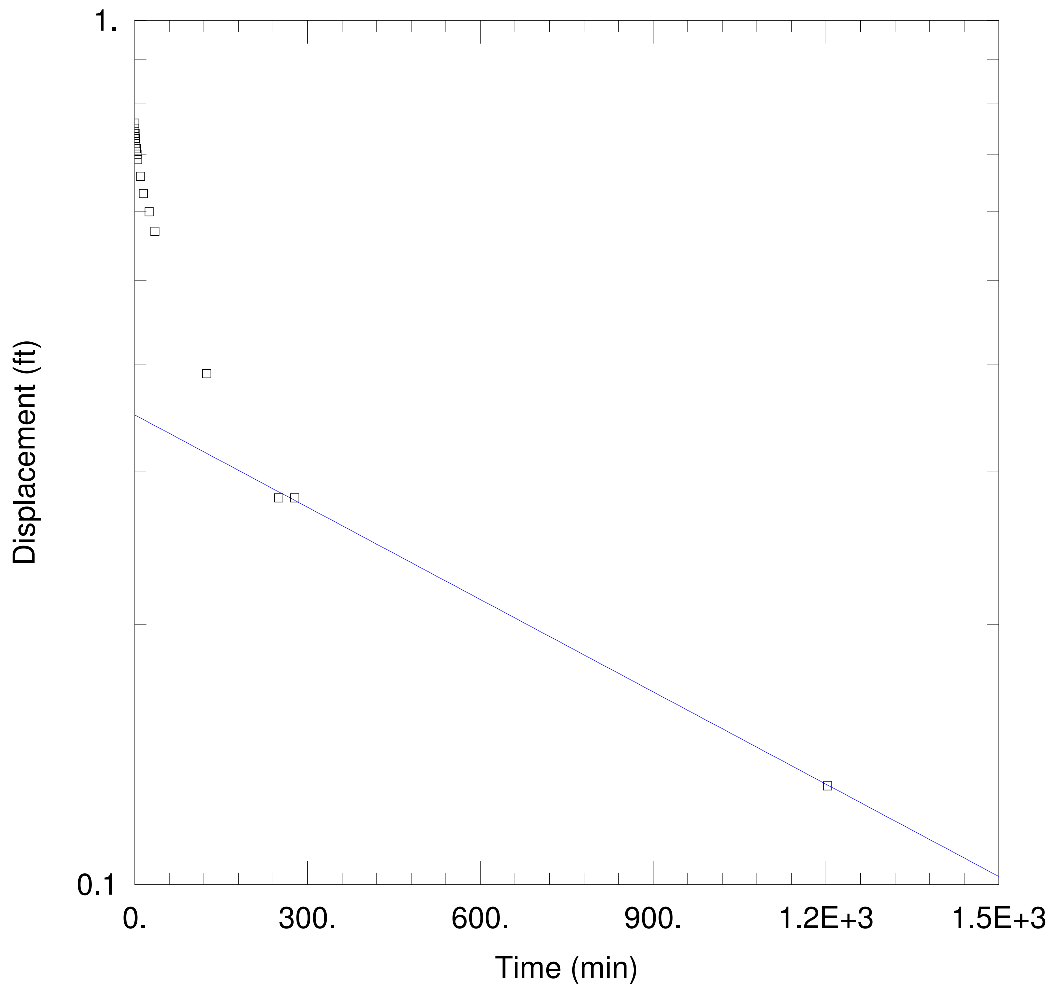
SOLUTION

Aquifer Model: Unconfined

Kr = 3.174E-6 cm/sec
Kz/Kr = 0.1

Solution Method: KGS Model

Ss = 0.005 ft^{-1}



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr17hbr.aqt
Date: 12/14/11 Time: 10:39:35

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 6.5 ft
Anisotropy Ratio (Kz/Kr): 0.1

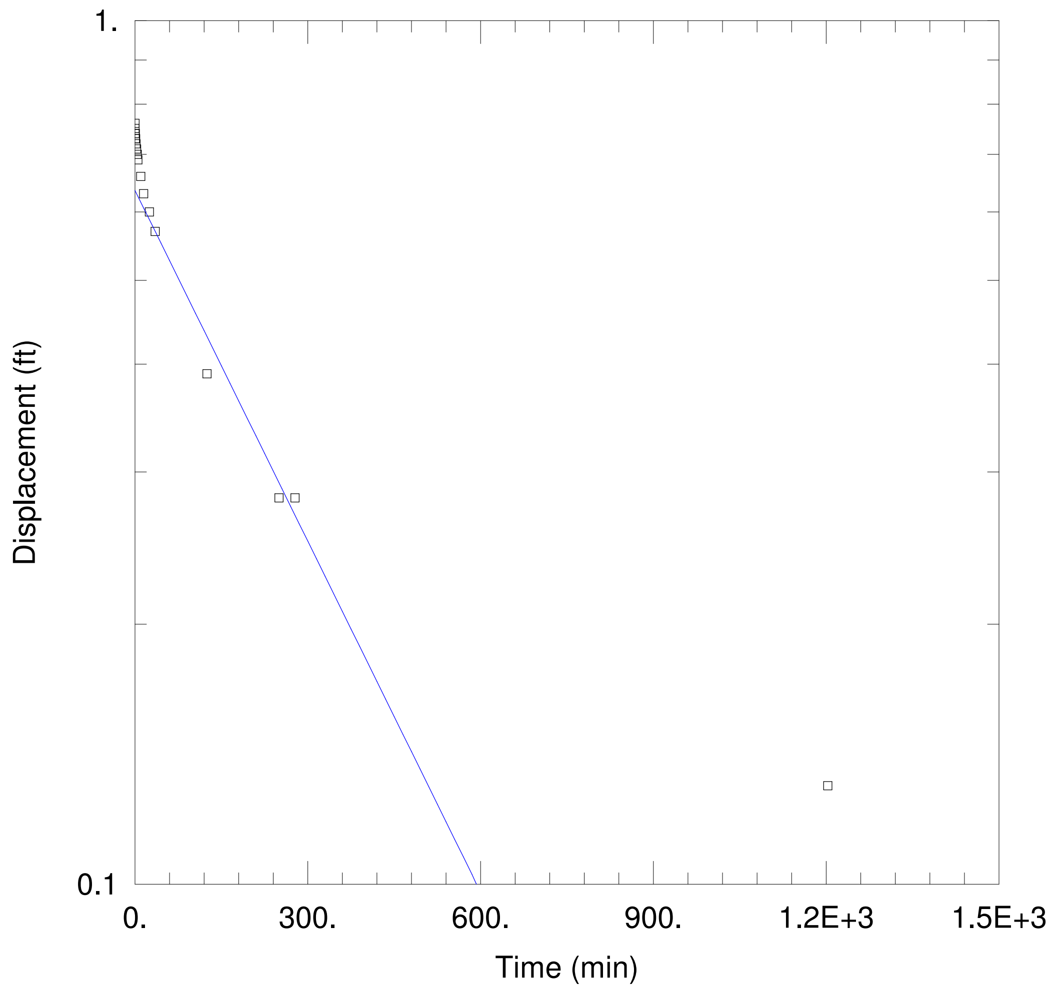
WELL DATA (DR-17)

Initial Displacement: 0.76 ft
Total Well Penetration Depth: 6.5 ft
Casing Radius: 0.125 ft
Static Water Column Height: 6.5 ft
Screen Length: 6.5 ft
Well Radius: 0.234 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 2.196E-6 cm/sec
y0 = 0.3493 ft



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr17hbret.aqt
Date: 12/14/11 Time: 10:40:01

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 6.5 ft
Anisotropy Ratio (Kz/Kr): 0.1

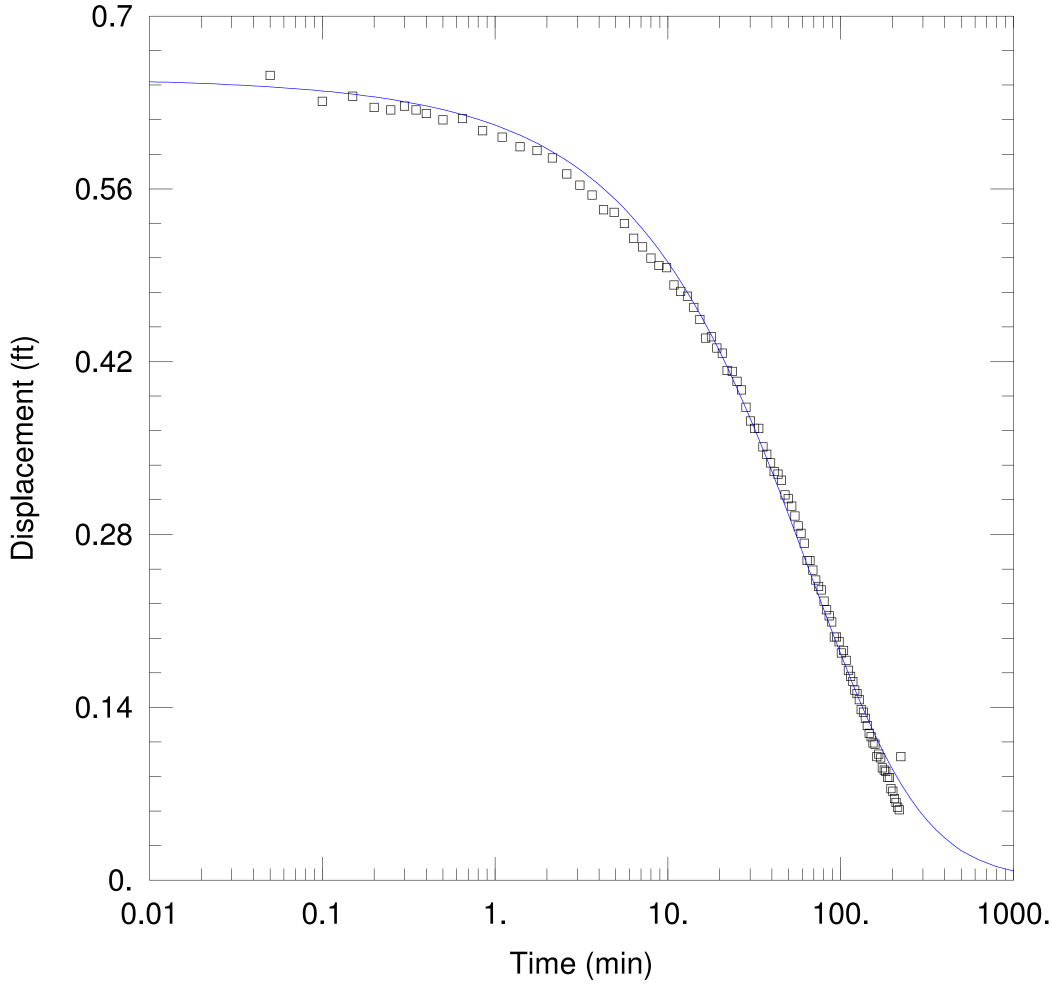
WELL DATA (DR-17)

Initial Displacement: 0.76 ft
Total Well Penetration Depth: 6.5 ft
Casing Radius: 0.125 ft
Static Water Column Height: 6.5 ft
Screen Length: 6.5 ft
Well Radius: 0.234 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 8.349E-6 cm/sec
y0 = 0.6357 ft



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr19.aqt
Date: 12/14/11 Time: 10:40:33

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 3.5 ft

WELL DATA (DR-19)

Initial Displacement: 0.65 ft
Total Well Penetration Depth: 3.5 ft
Casing Radius: 0.125 ft

Static Water Column Height: 3.5 ft
Screen Length: 3.5 ft
Well Radius: 0.234 ft
Gravel Pack Porosity: 0.3

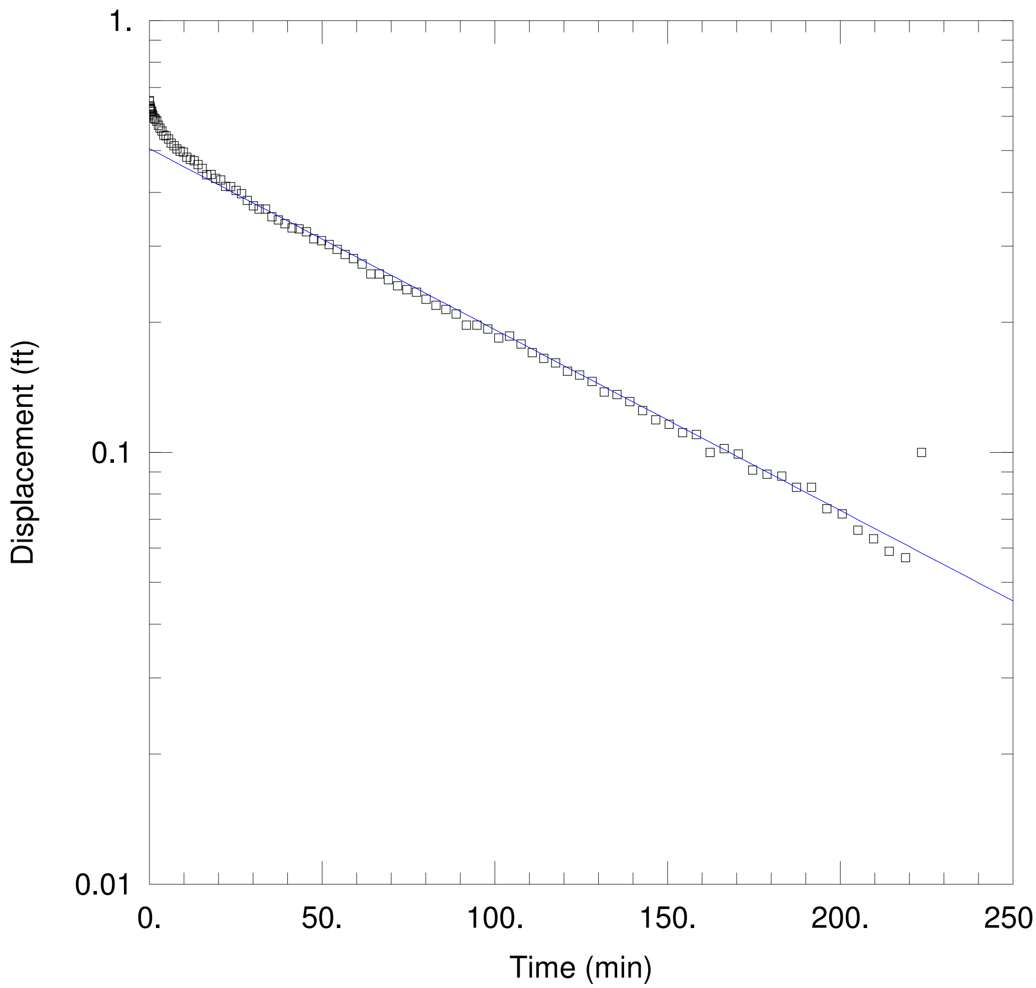
SOLUTION

Aquifer Model: Unconfined

Solution Method: KGS Model

Kr = 3.293E-5 cm/sec
Kz/Kr = 0.1

Ss = 0.002542 ft^{-1}



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr19br.aqt
Date: 12/14/11 Time: 10:41:14

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 3.5 ft Anisotropy Ratio (Kz/Kr): 0.1

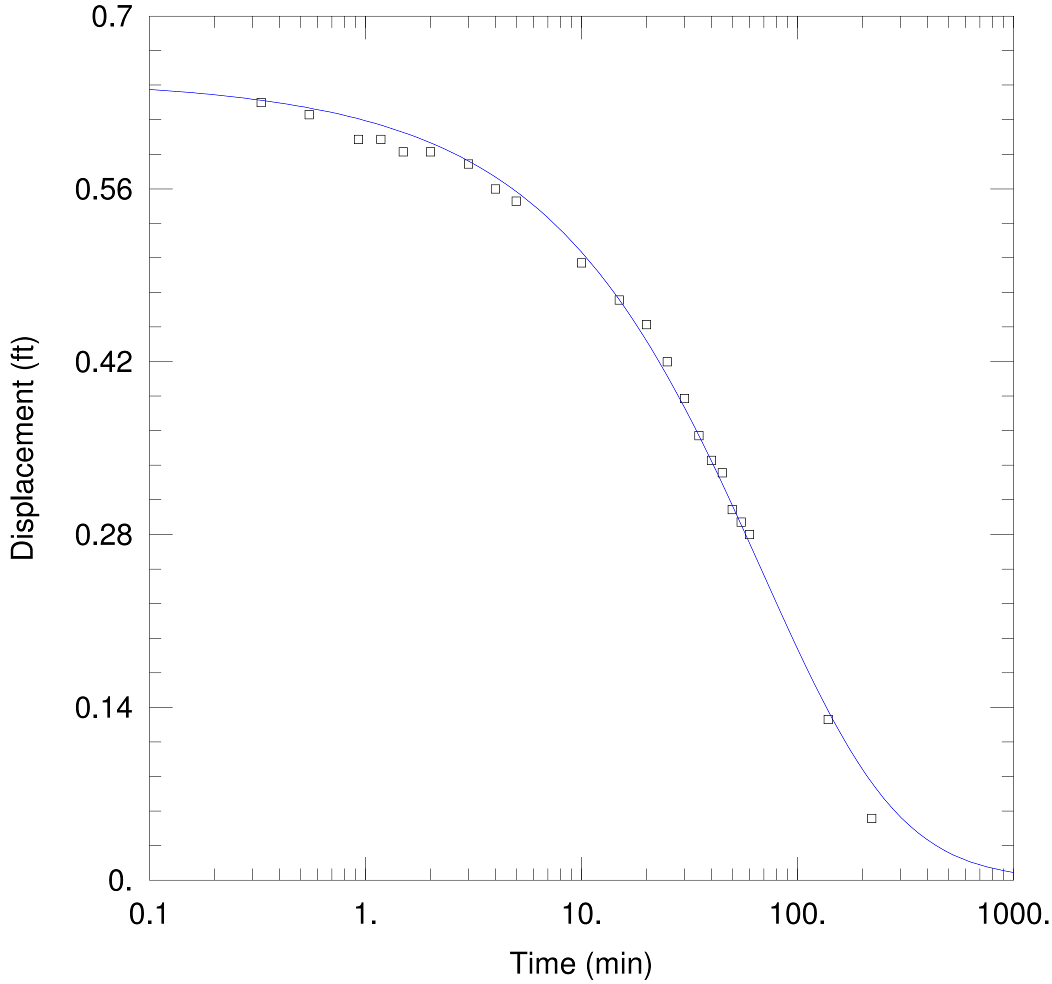
WELL DATA (DR-19)

Initial Displacement: 0.65 ft
Total Well Penetration Depth: 3.5 ft
Casing Radius: 0.125 ft
Static Water Column Height: 3.5 ft
Screen Length: 3.5 ft
Well Radius: 0.234 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 3.781E-5 cm/sec y0 = 0.5049 ft



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr19h.aqt
Date: 12/14/11 Time: 10:41:46

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 3.5 ft

WELL DATA (DR-19)

Initial Displacement: 0.65 ft
Total Well Penetration Depth: 3.5 ft
Casing Radius: 0.125 ft

Static Water Column Height: 3.5 ft
Screen Length: 3.5 ft
Well Radius: 0.234 ft
Gravel Pack Porosity: 0.3

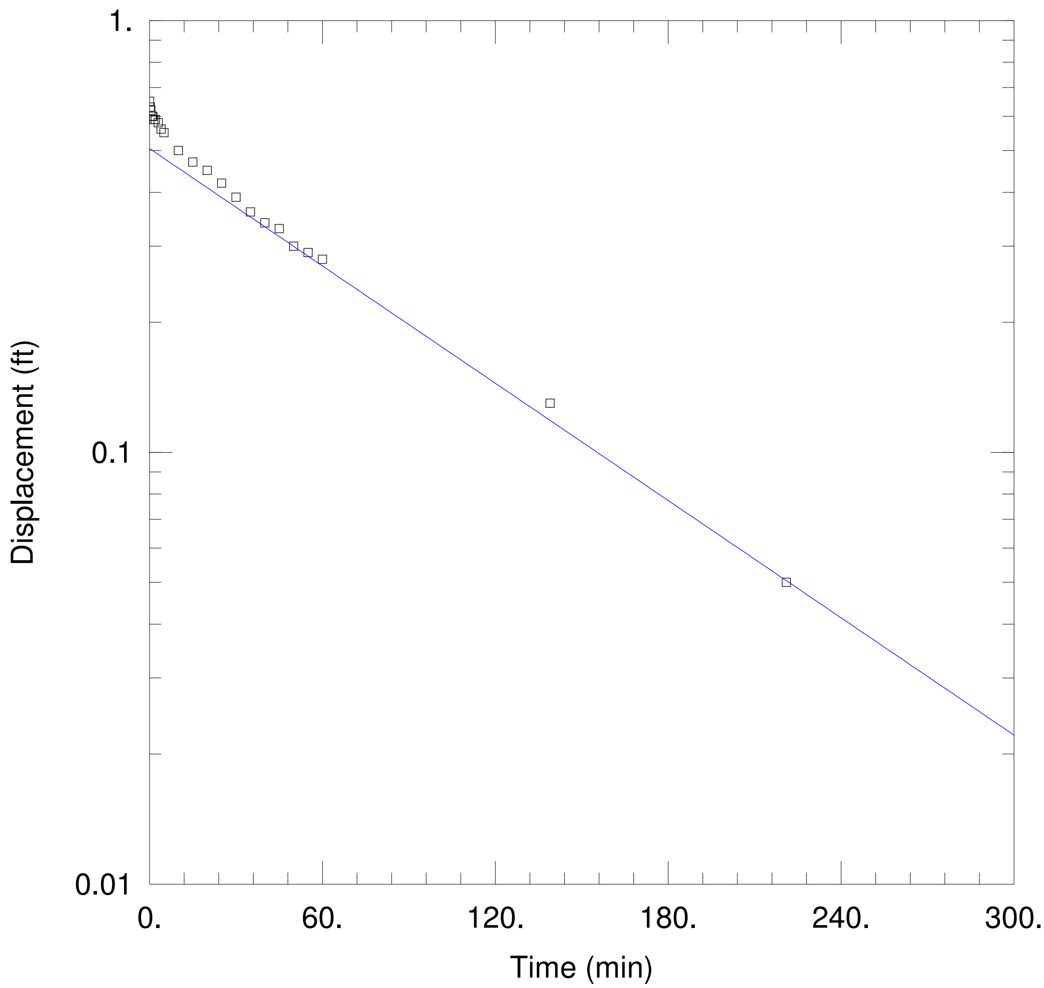
SOLUTION

Aquifer Model: Unconfined

Solution Method: KGS Model

Kr = 3.398E-5 cm/sec
Kz/Kr = 0.1

Ss = 0.00186 ft^{-1}



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr19hbr.aqt
Date: 12/14/11 Time: 10:42:16

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 3.5 ft Anisotropy Ratio (Kz/Kr): 0.1

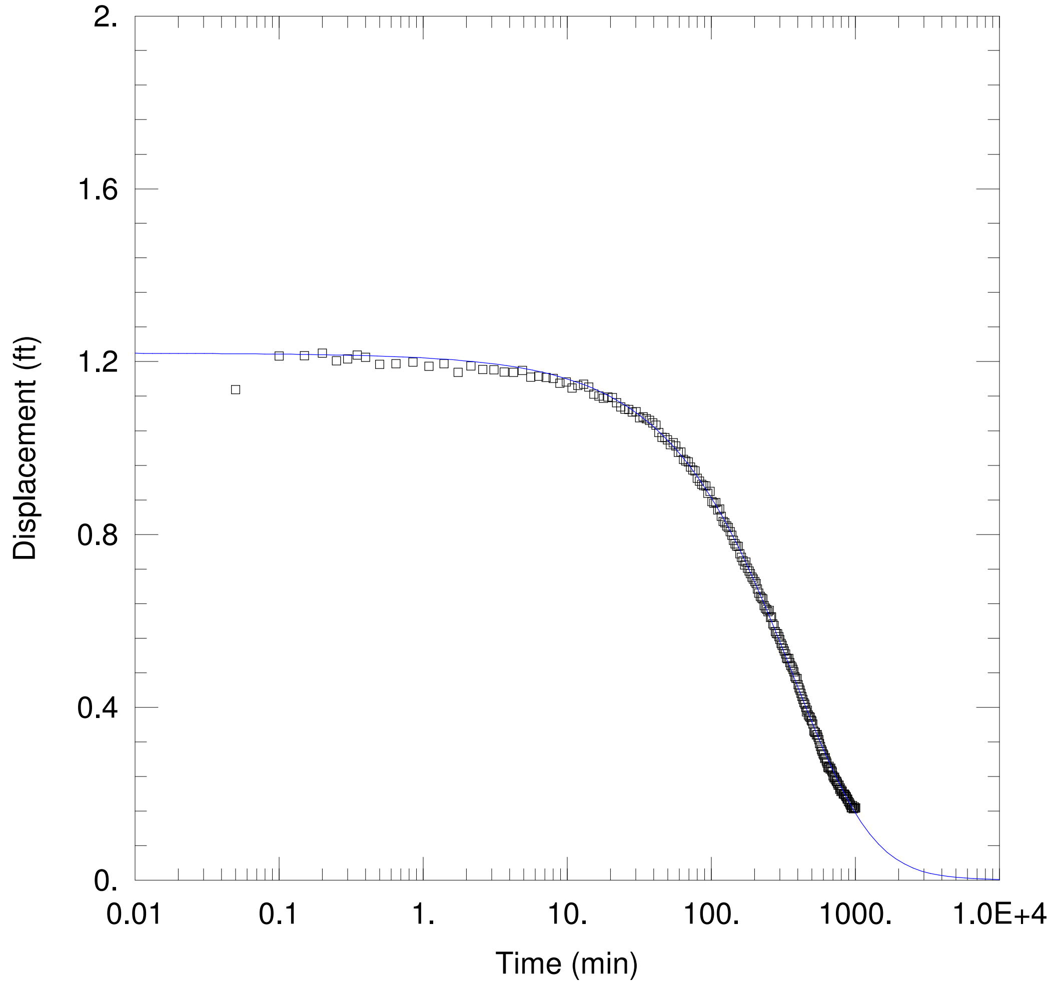
WELL DATA (DR-19)

Initial Displacement: 0.65 ft
Total Well Penetration Depth: 3.5 ft
Casing Radius: 0.125 ft
Static Water Column Height: 3.5 ft
Screen Length: 3.5 ft
Well Radius: 0.234 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 4.086E-5 cm/sec y0 = 0.5049 ft



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr20.aqt
Date: 12/14/11 Time: 10:42:49

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 17.9 ft

WELL DATA (DR-20)

Initial Displacement: 1.22 ft
Total Well Penetration Depth: 17.9 ft
Casing Radius: 0.125 ft

Static Water Column Height: 17.9 ft
Screen Length: 17.9 ft
Well Radius: 0.234 ft
Gravel Pack Porosity: 0.3

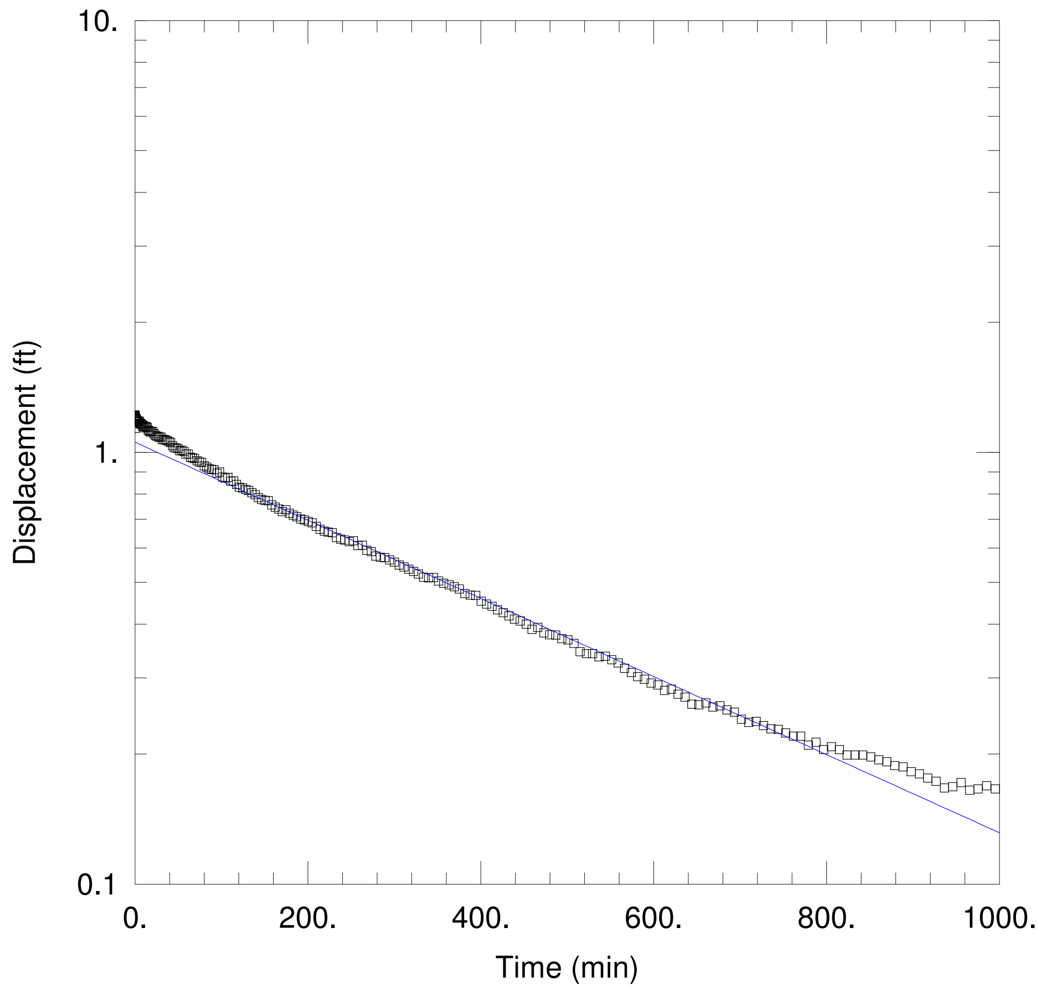
SOLUTION

Aquifer Model: Unconfined

Solution Method: KGS Model

Kr = 2.14E-6 cm/sec
Kz/Kr = 0.1

Ss = 1.905E-5 ft^{-1}



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr20br.aqt
Date: 12/14/11 Time: 10:43:21

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 17.9 ft
Anisotropy Ratio (Kz/Kr): 0.1

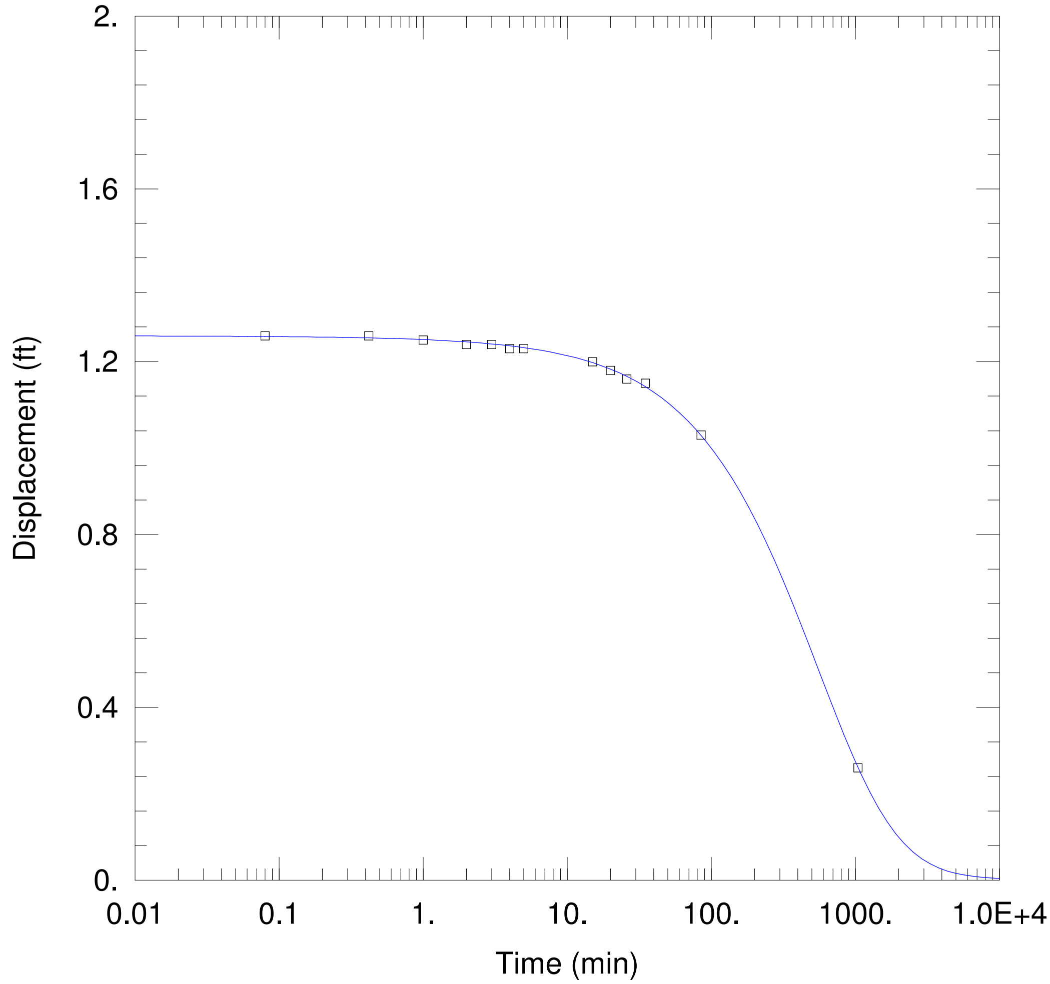
WELL DATA (DR-20)

Initial Displacement: 1.22 ft
Total Well Penetration Depth: 17.9 ft
Casing Radius: 0.125 ft
Static Water Column Height: 17.9 ft
Screen Length: 17.9 ft
Well Radius: 0.234 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 2.694E-6 cm/sec
y0 = 1.055 ft



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr20h.aqt
Date: 12/14/11 Time: 10:44:11

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 17.9 ft

WELL DATA (DR-20)

Initial Displacement: 1.26 ft
Total Well Penetration Depth: 17.9 ft
Casing Radius: 0.125 ft

Static Water Column Height: 17.9 ft
Screen Length: 17.9 ft
Well Radius: 0.234 ft
Gravel Pack Porosity: 0.3

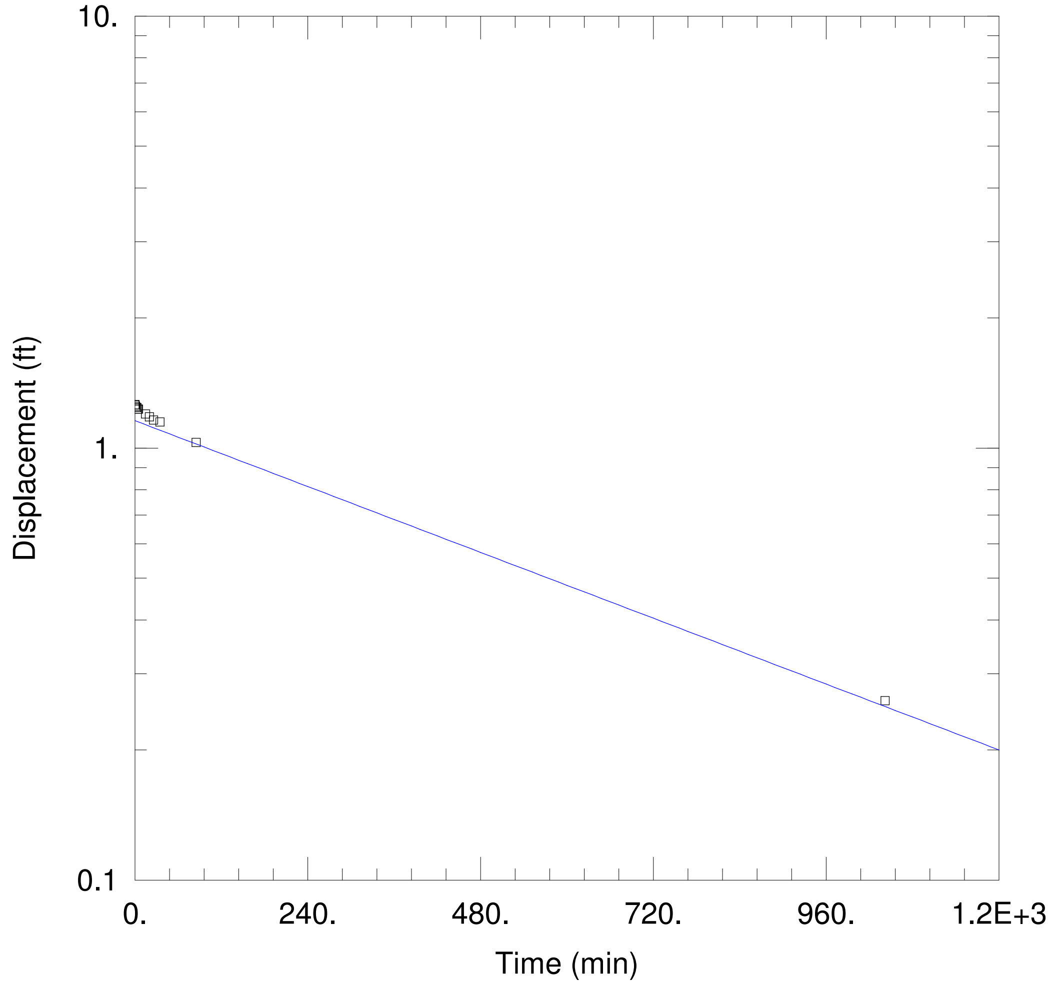
SOLUTION

Aquifer Model: Unconfined

Solution Method: KGS Model

Kr = 1.435E-6 cm/sec
Kz/Kr = 0.1

Ss = 1.904E-5 ft^{-1}



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr20hbr.aqt
Date: 12/14/11 Time: 10:44:41

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 17.9 ft Anisotropy Ratio (Kz/Kr): 0.1

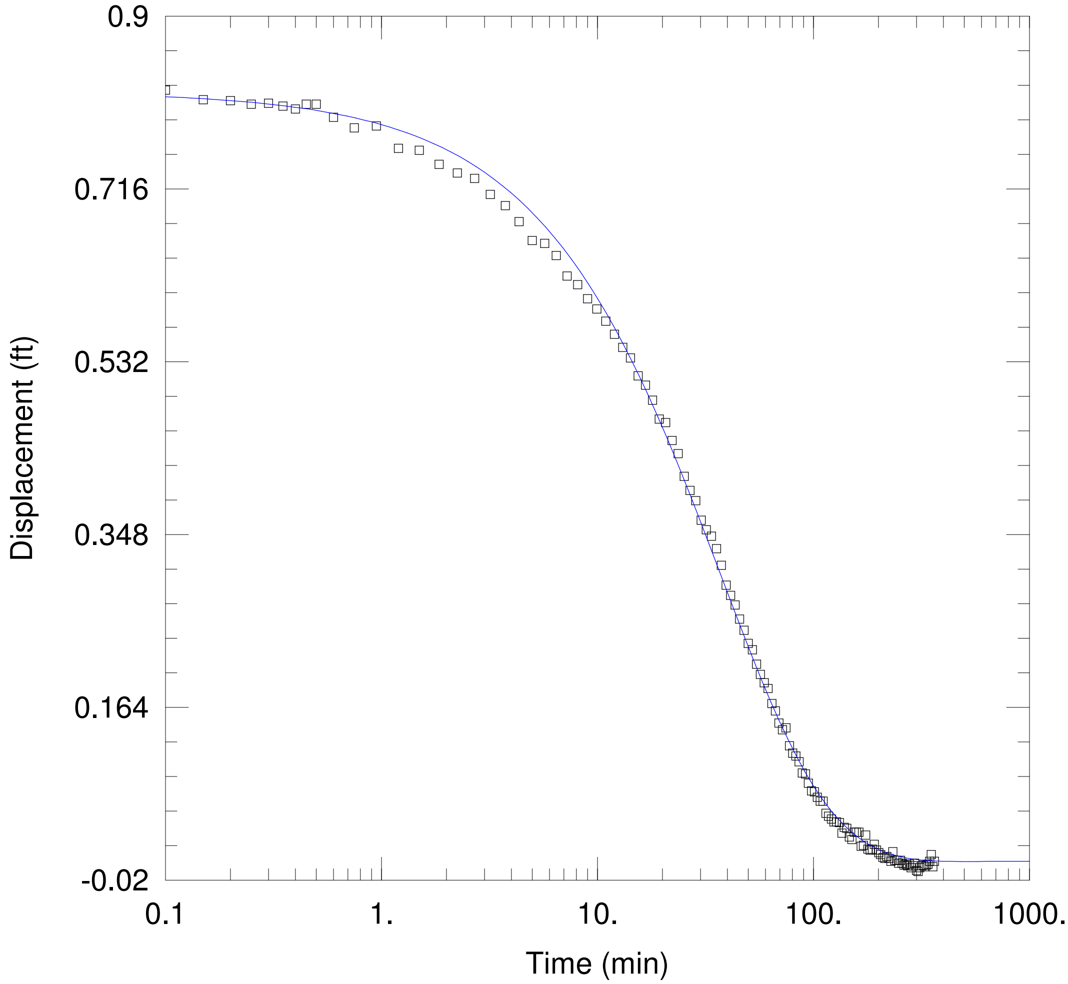
WELL DATA (DR-20)

Initial Displacement: 1.26 ft
Total Well Penetration Depth: 17.9 ft
Casing Radius: 0.125 ft
Static Water Column Height: 17.9 ft
Screen Length: 17.9 ft
Well Radius: 0.234 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 1.892E-6 cm/sec y0 = 1.157 ft



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr21.aqt
Date: 12/14/11 Time: 10:45:11

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 13.5 ft

WELL DATA (DR-21)

Initial Displacement: 0.82 ft
Total Well Penetration Depth: 13.5 ft
Casing Radius: 0.125 ft

Static Water Column Height: 13.5 ft
Screen Length: 13.5 ft
Well Radius: 0.234 ft
Gravel Pack Porosity: 0.3

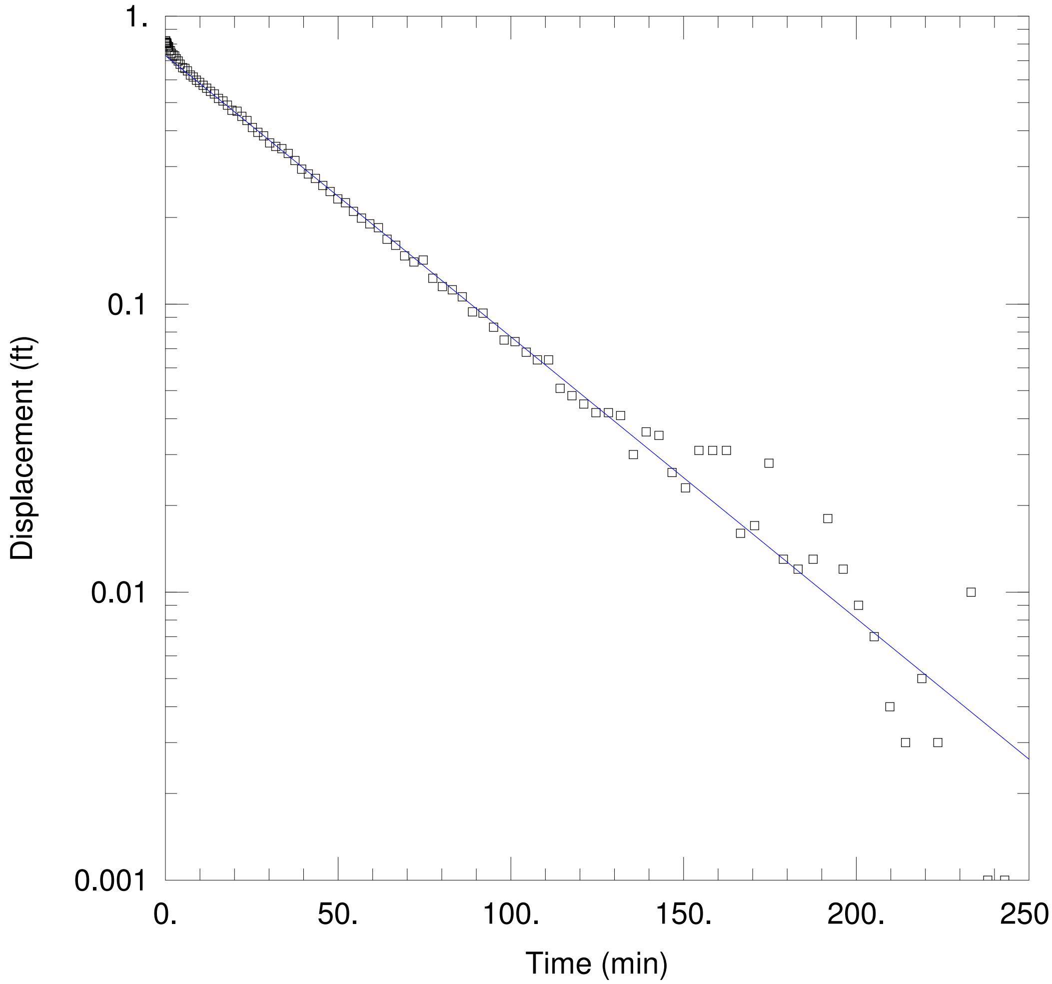
SOLUTION

Aquifer Model: Unconfined

Solution Method: KGS Model

Kr = 3.286E-5 cm/sec
Kz/Kr = 0.1

Ss = 7.173E-6 ft^{-1}



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr21br.aqt
Date: 12/14/11 Time: 10:45:34

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 13.5 ft
Anisotropy Ratio (Kz/Kr): 0.1

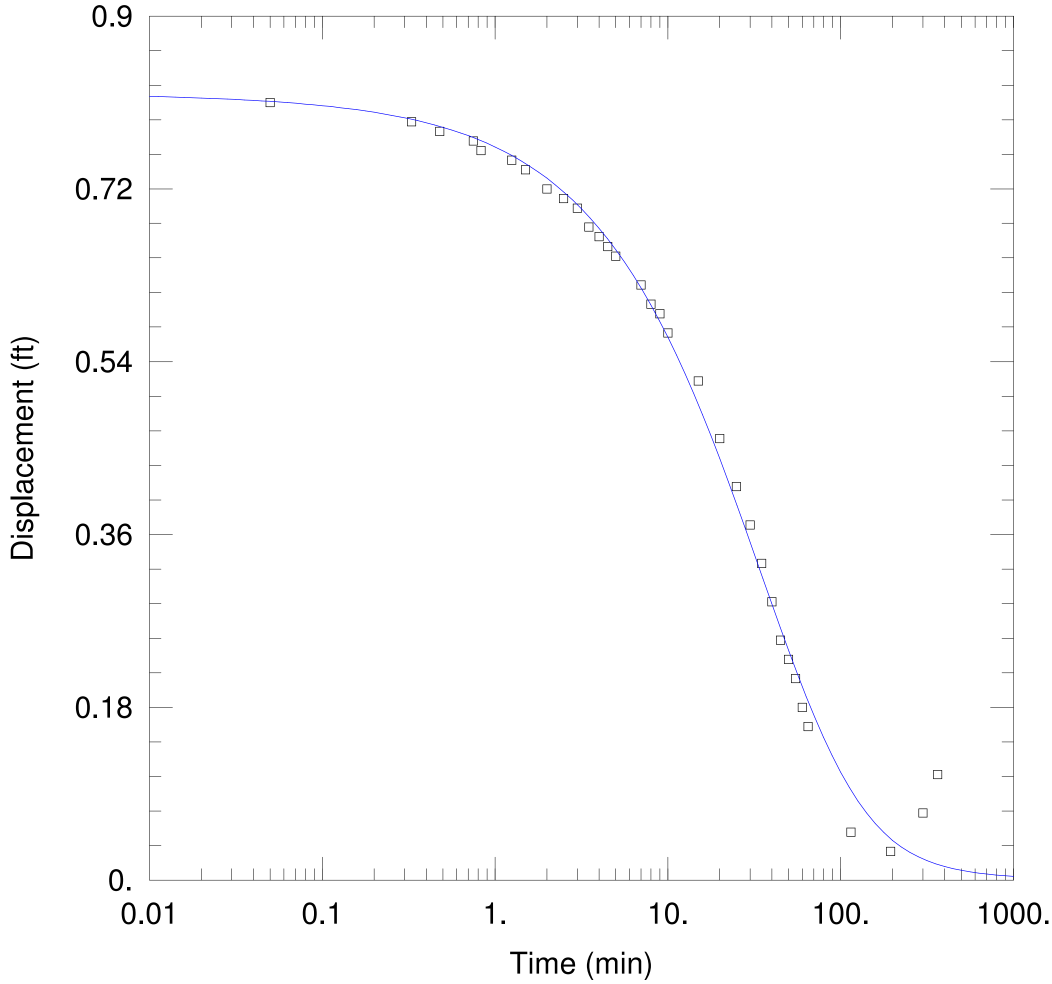
WELL DATA (DR-21)

Initial Displacement: 0.82 ft
Total Well Penetration Depth: 13.5 ft
Casing Radius: 0.125 ft
Static Water Column Height: 13.5 ft
Screen Length: 13.5 ft
Well Radius: 0.234 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 3.603E-5 cm/sec
y0 = 0.7299 ft



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr21h.aqt
Date: 12/14/11 Time: 10:46:01

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 13.5 ft

WELL DATA (DR-21)

Initial Displacement: 0.82 ft
Total Well Penetration Depth: 13.5 ft
Casing Radius: 0.125 ft

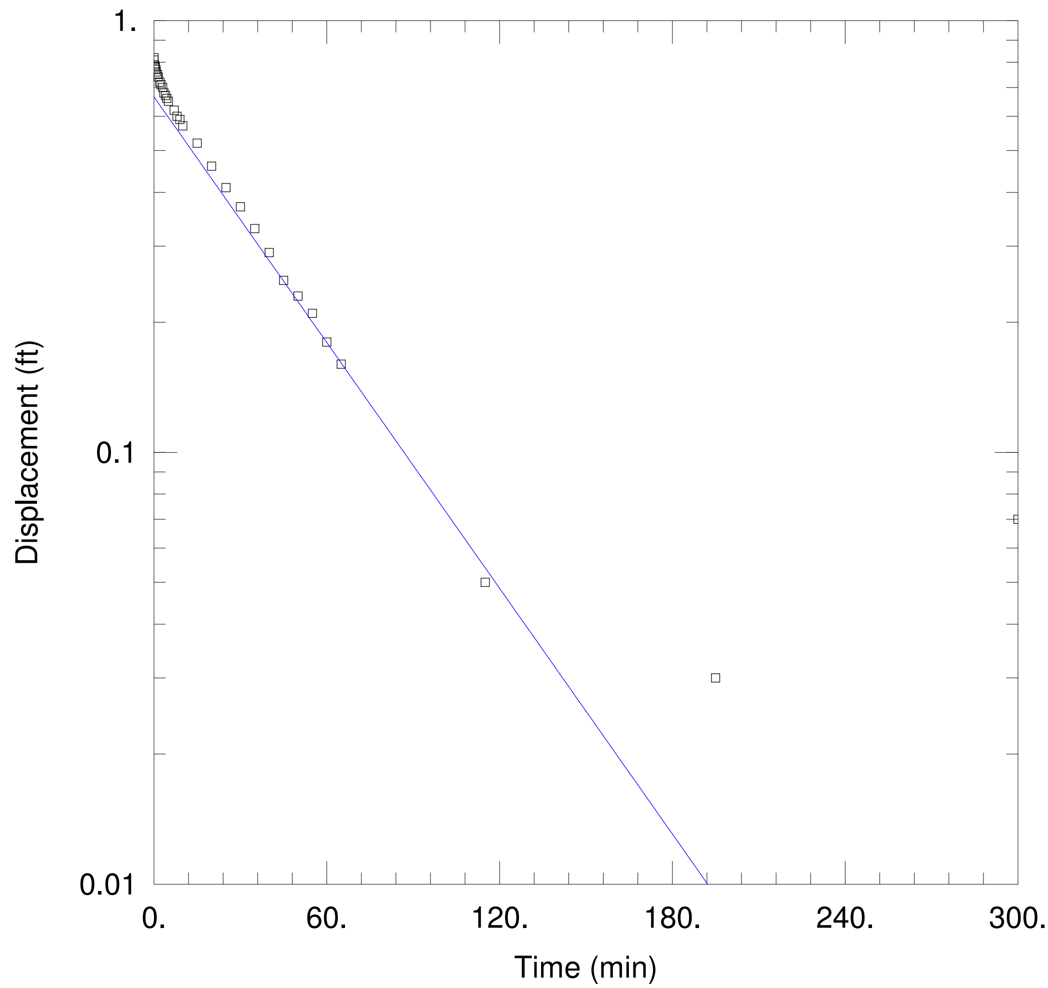
Static Water Column Height: 13.5 ft
Screen Length: 13.5 ft
Well Radius: 0.234 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 2.206E-5 cm/sec
Kz/Kr = 0.1

Ss = 0.0001869 ft^{-1}



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr21hbr.aqt
Date: 12/14/11 Time: 10:48:37

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 13.5 ft
Anisotropy Ratio (Kz/Kr): 0.1

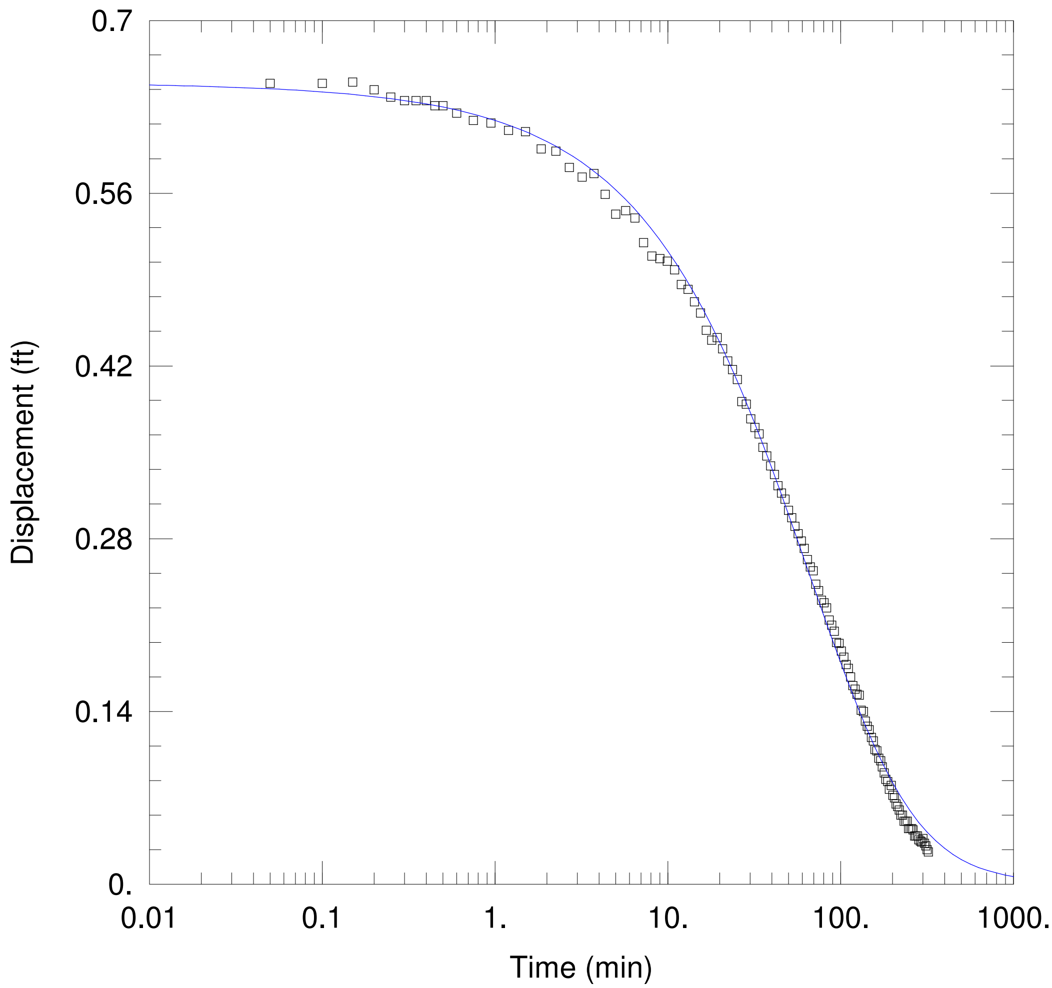
WELL DATA (DR-21)

Initial Displacement: 0.82 ft
Total Well Penetration Depth: 13.5 ft
Casing Radius: 0.125 ft
Static Water Column Height: 13.5 ft
Screen Length: 13.5 ft
Well Radius: 0.234 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 3.496E-5 cm/sec
y0 = 0.6656 ft



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr23.aqt
Date: 12/14/11 Time: 10:49:17

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 7.5 ft

WELL DATA (DR-23)

Initial Displacement: 0.65 ft
Total Well Penetration Depth: 7.5 ft
Casing Radius: 0.125 ft

Static Water Column Height: 7.5 ft
Screen Length: 7.5 ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

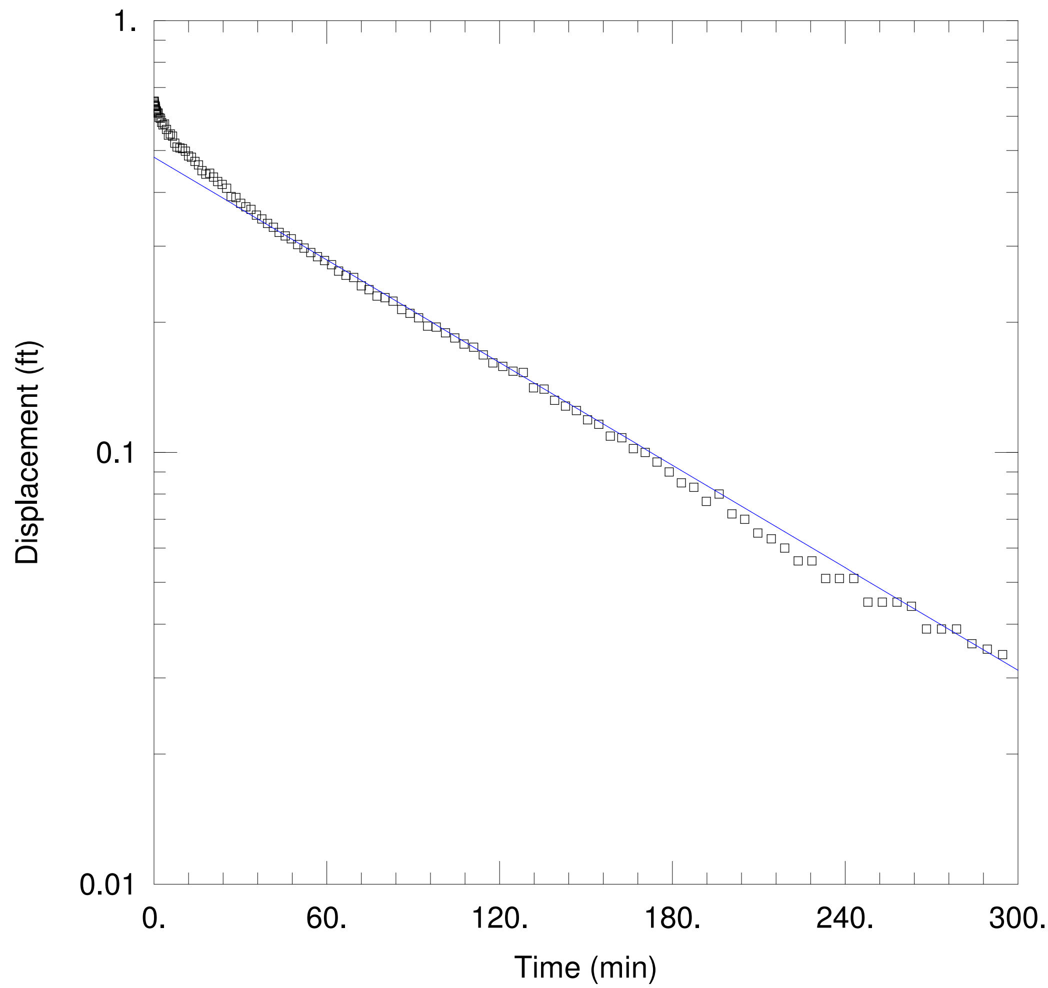
SOLUTION

Aquifer Model: Unconfined

Solution Method: KGS Model

Kr = 1.96E-5 cm/sec
Kz/Kr = 0.1

Ss = 0.0003854 ft^{-1}



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr23br.aqt
Date: 12/14/11 Time: 10:49:46

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 7.5 ft
Anisotropy Ratio (Kz/Kr): 0.1

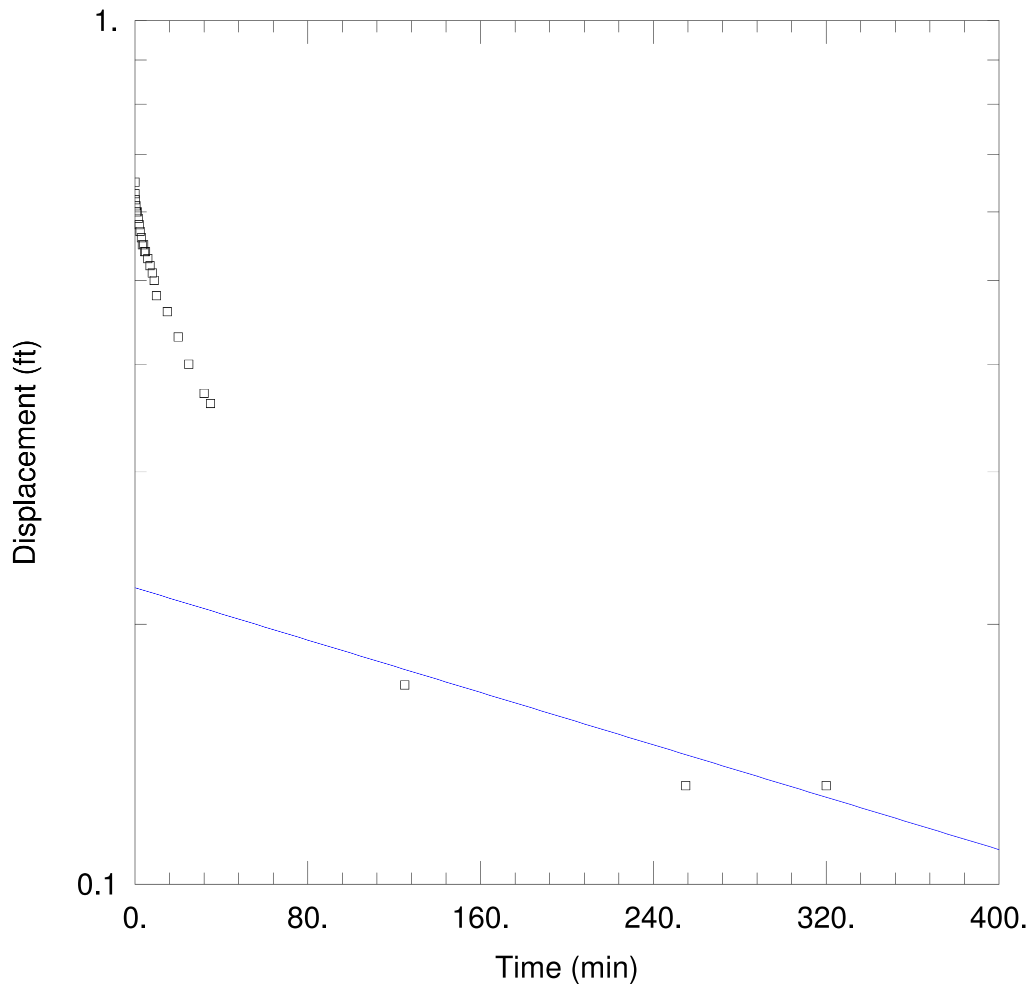
WELL DATA (DR-23)

Initial Displacement: 0.65 ft
Total Well Penetration Depth: 7.5 ft
Casing Radius: 0.125 ft
Static Water Column Height: 7.5 ft
Screen Length: 7.5 ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 2.357E-5 cm/sec
y0 = 0.4822 ft



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr23hbr.aqt
Date: 12/14/11 Time: 10:50:23

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 7.5 ft
Anisotropy Ratio (Kz/Kr): 0.1

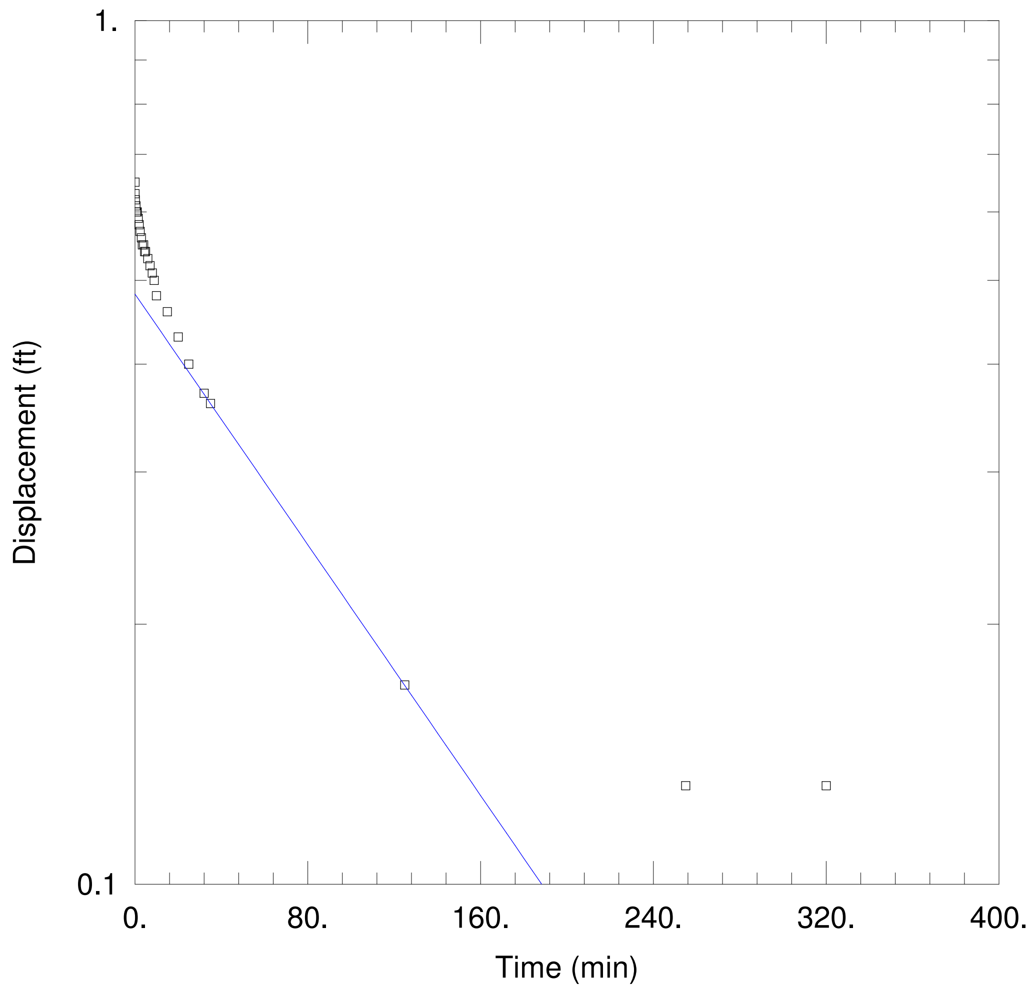
WELL DATA (DR-23)

Initial Displacement: 0.65 ft
Total Well Penetration Depth: 7.5 ft
Casing Radius: 0.125 ft
Static Water Column Height: 7.5 ft
Screen Length: 7.5 ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 4.512E-6 cm/sec
y0 = 0.2204 ft



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr23hbret.aqt
Date: 12/14/11 Time: 10:50:58

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 7.5 ft Anisotropy Ratio (Kz/Kr): 0.1

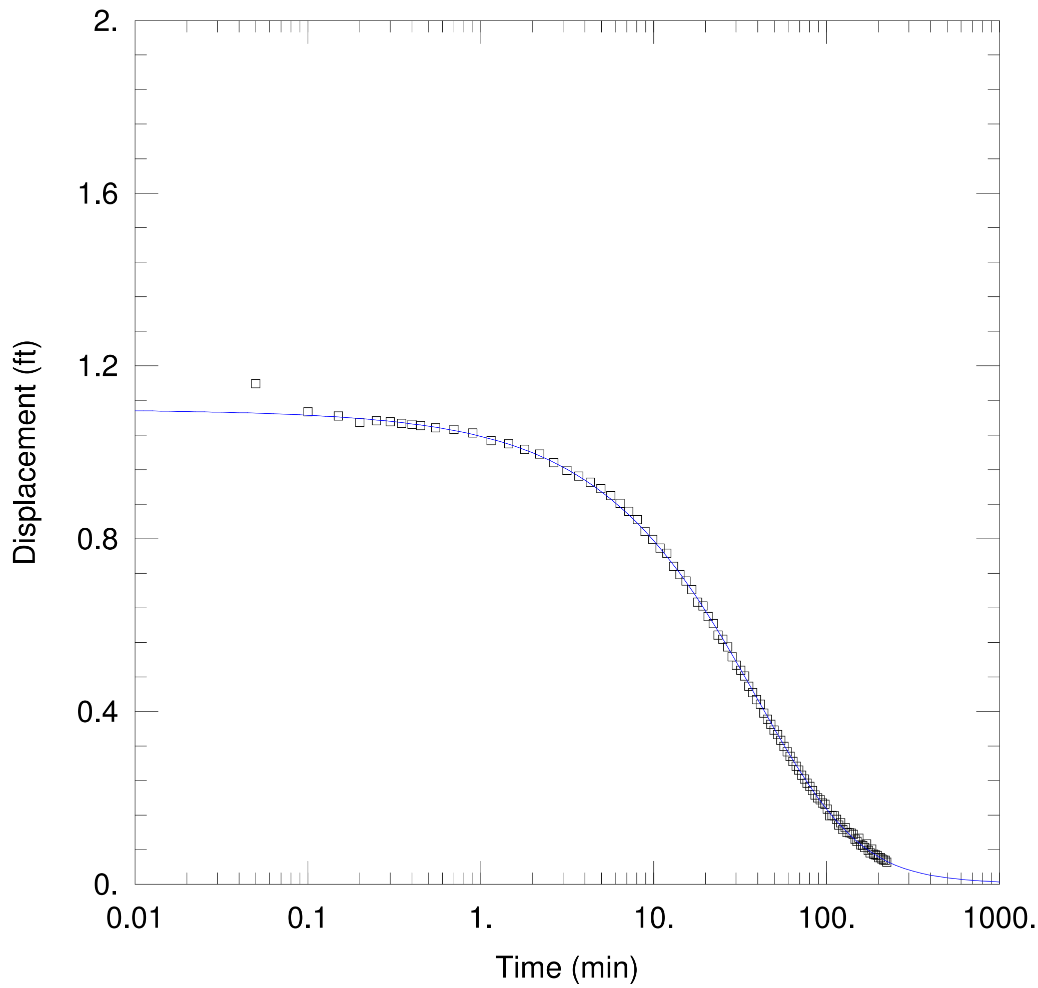
WELL DATA (DR-23)

Initial Displacement: 0.65 ft
Total Well Penetration Depth: 7.5 ft
Casing Radius: 0.125 ft
Static Water Column Height: 7.5 ft
Screen Length: 7.5 ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 2.16E-5 cm/sec y0 = 0.4822 ft



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr24.aqt
Date: 12/14/11 Time: 10:51:41

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 17.4 ft

WELL DATA (DR-24)

Initial Displacement: 1.1 ft
Total Well Penetration Depth: 17.4 ft
Casing Radius: 0.125 ft

Static Water Column Height: 17.4 ft
Screen Length: 17.4 ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

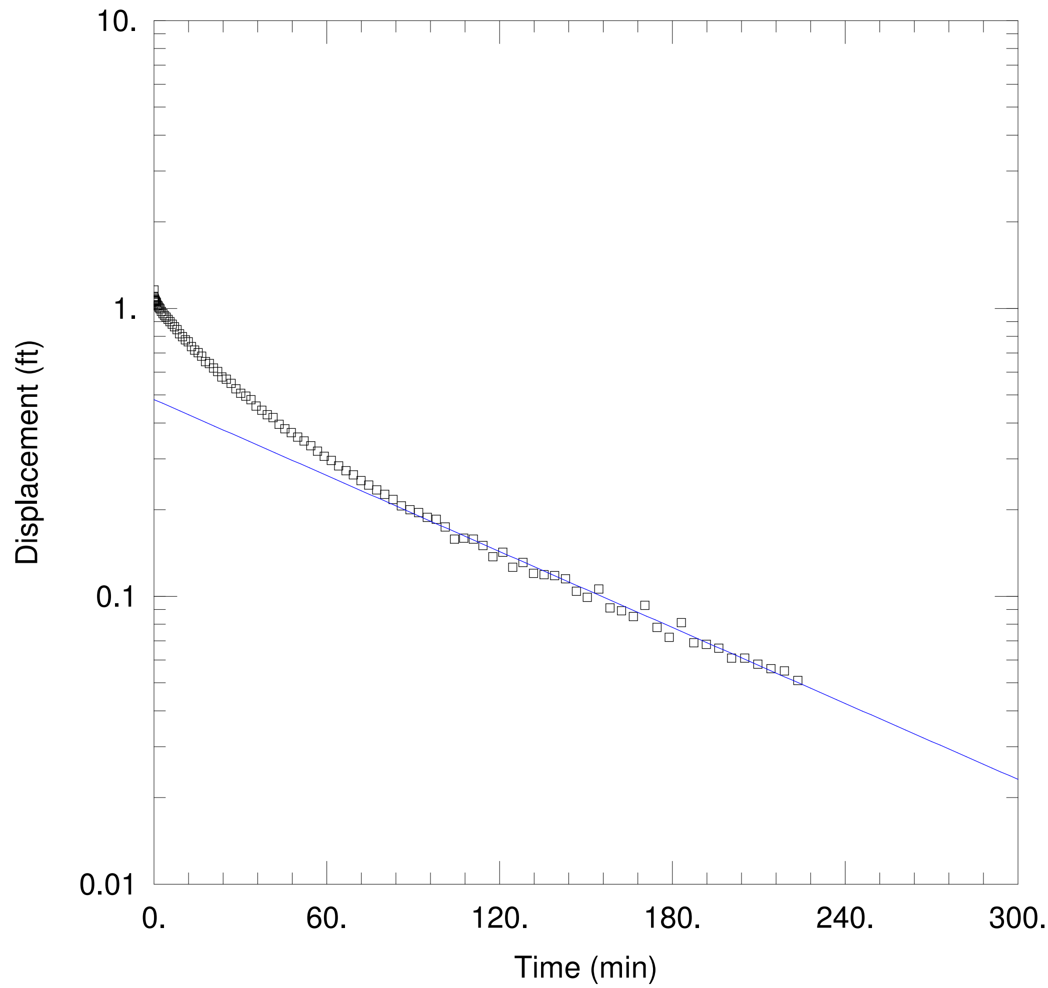
SOLUTION

Aquifer Model: Unconfined

Solution Method: KGS Model

Kr = 1.642E-5 cm/sec
Kz/Kr = 0.1

Ss = 7.489E-5 ft^{-1}



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr24br.aqt
Date: 12/14/11 Time: 10:52:09

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 17.4 ft
Anisotropy Ratio (Kz/Kr): 0.1

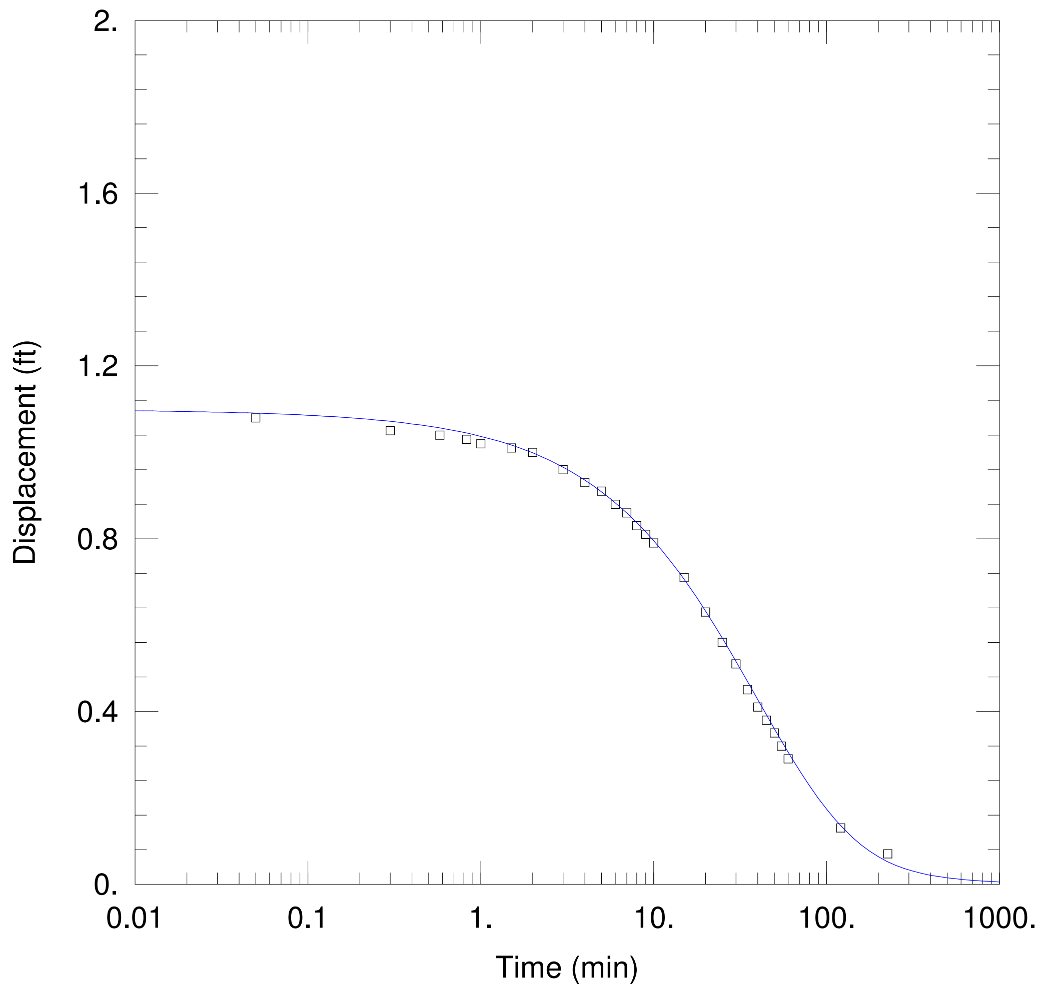
WELL DATA (DR-24)

Initial Displacement: 1.1 ft
Total Well Penetration Depth: 17.4 ft
Casing Radius: 0.125 ft
Static Water Column Height: 17.4 ft
Screen Length: 17.4 ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.43E-5 cm/sec
y0 = 0.4822 ft



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr24h.aqt
Date: 12/14/11 Time: 10:52:39

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 17.4 ft

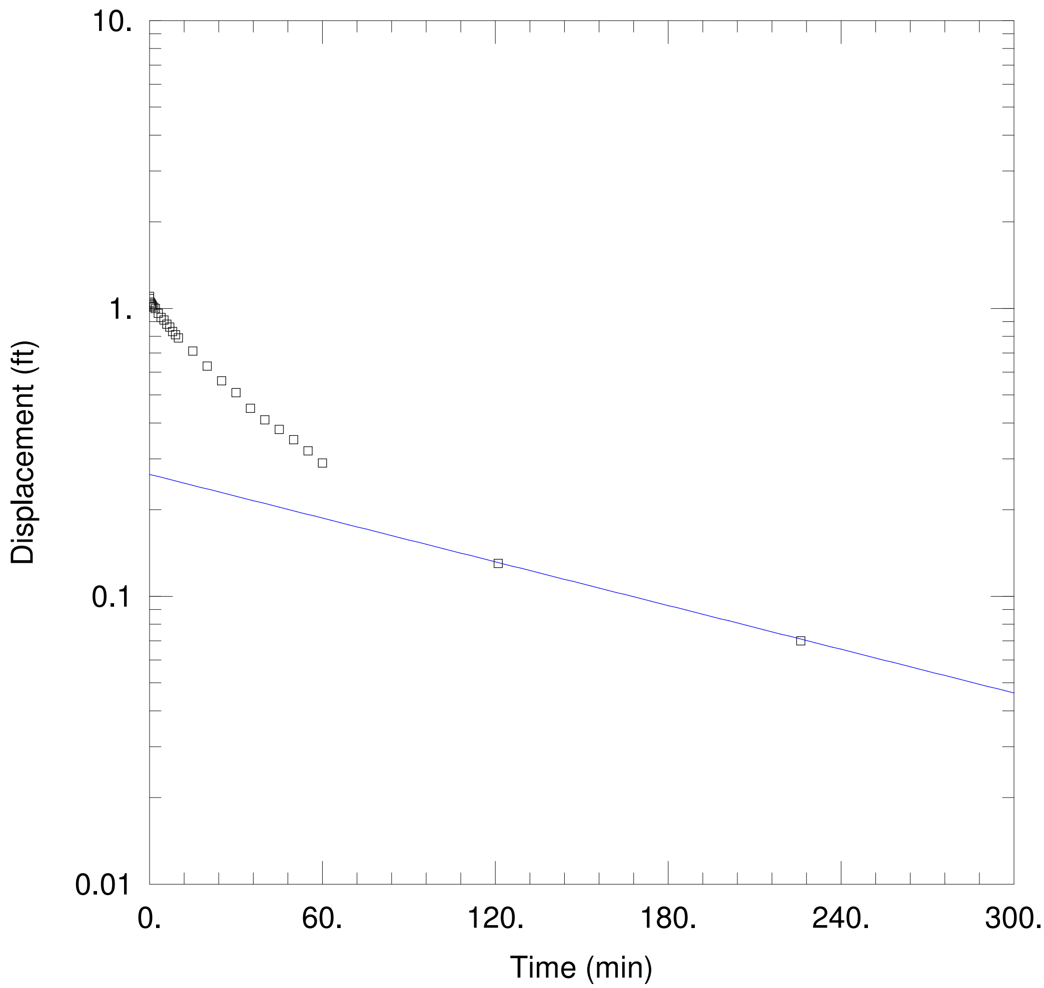
WELL DATA (DR-24)

Initial Displacement: 1.1 ft
Total Well Penetration Depth: 17.4 ft
Casing Radius: 0.125 ft
Static Water Column Height: 17.4 ft
Screen Length: 17.4 ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 1.642E-5 cm/sec
Kz/Kr = 0.1
Ss = 7.489E-5 ft^{-1}



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr24hbr.aqt
Date: 12/14/11 Time: 10:53:08

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 17.4 ft
Anisotropy Ratio (Kz/Kr): 0.1

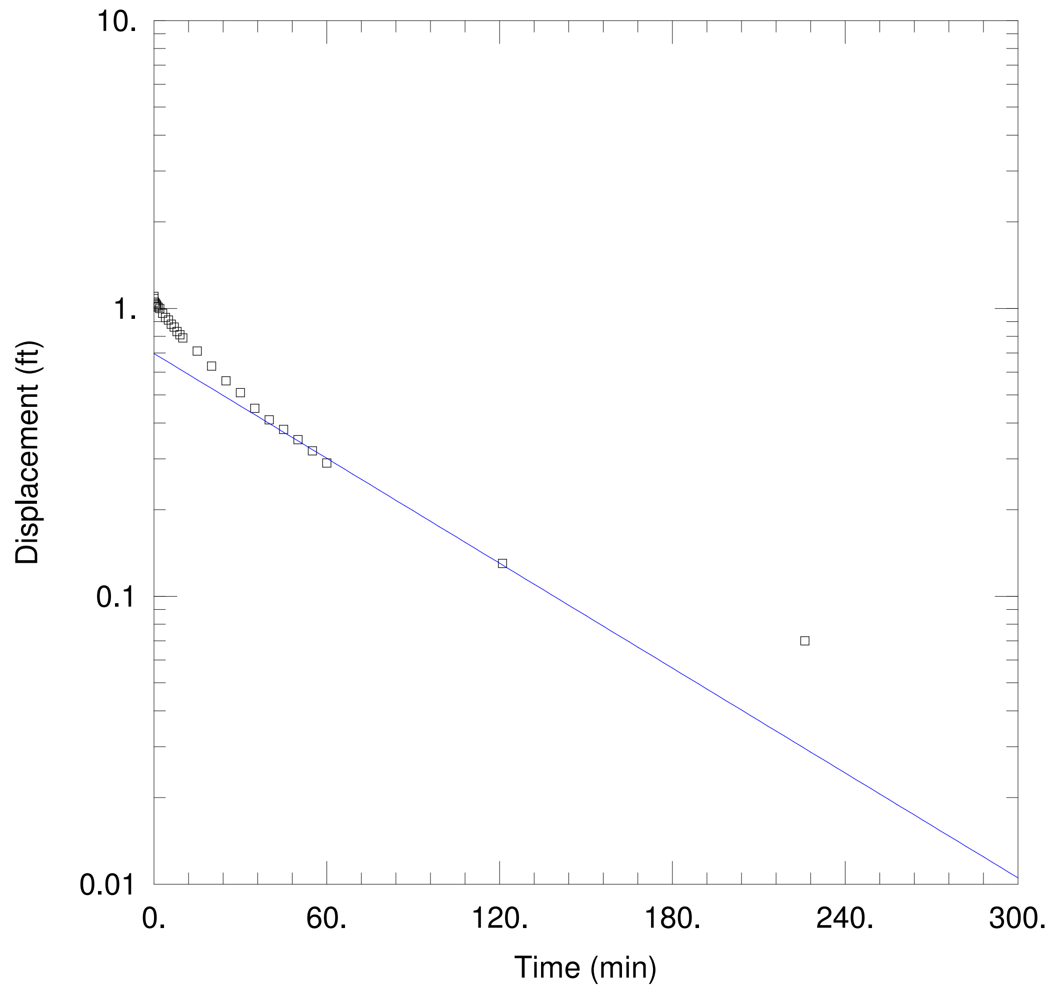
WELL DATA (DR-24)

Initial Displacement: 1.1 ft
Total Well Penetration Depth: 17.4 ft
Casing Radius: 0.125 ft
Static Water Column Height: 17.4 ft
Screen Length: 17.4 ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 8.228E-6 cm/sec
y0 = 0.265 ft



WELL TEST ANALYSIS

Data Set: H:\718000\hydtst11b\aqtesolv\results\dr24hbret.aqt
Date: 12/14/11 Time: 10:53:42

PROJECT INFORMATION

Company: HGC
Client: Denison
Location: White Mesa

AQUIFER DATA

Saturated Thickness: 17.4 ft Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (DR-24)

Initial Displacement: 1.1 ft
Total Well Penetration Depth: 17.4 ft
Casing Radius: 0.125 ft

Static Water Column Height: 17.4 ft
Screen Length: 17.4 ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

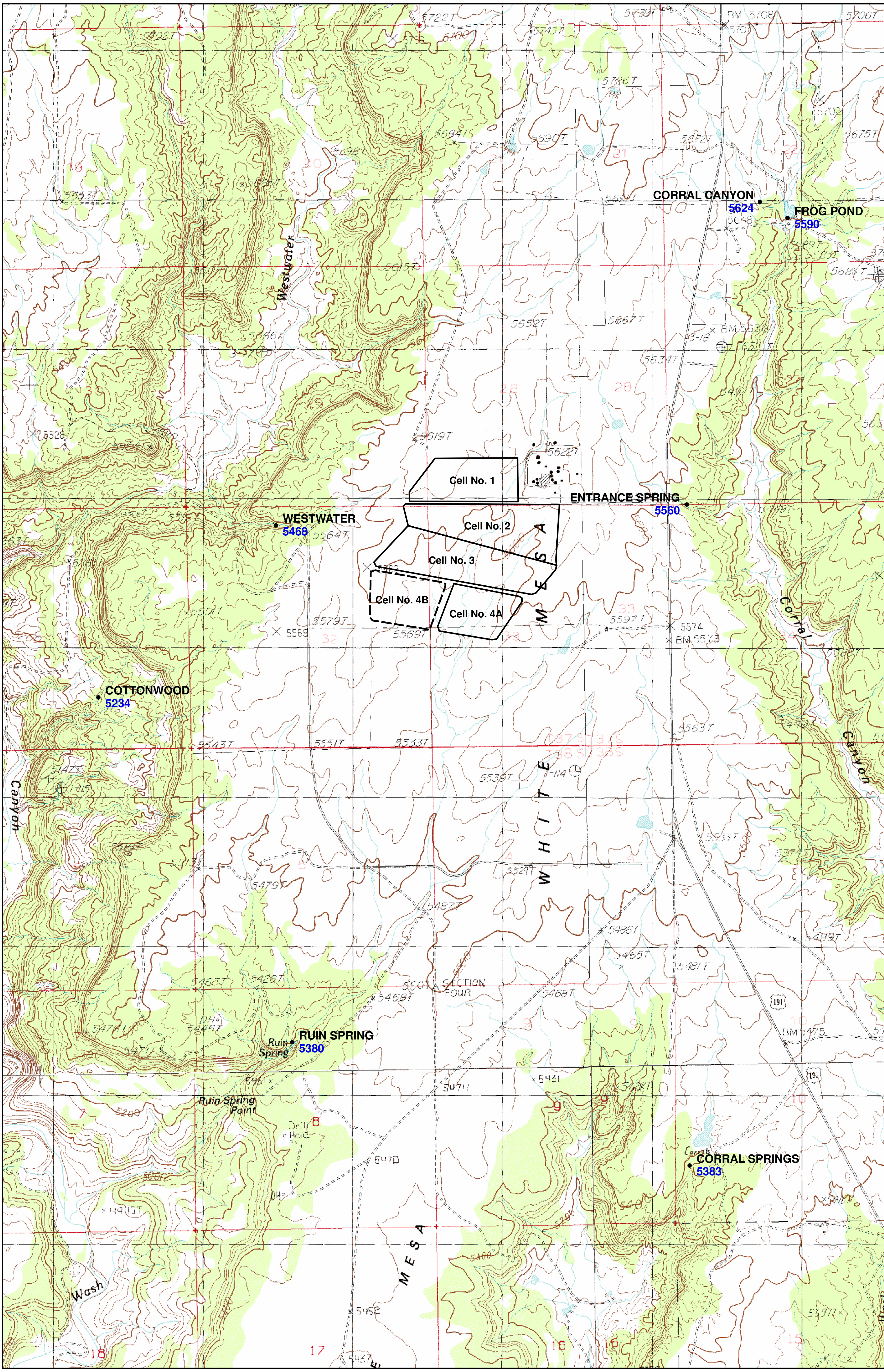
SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 1.974E-5 cm/sec y0 = 0.697 ft

APPENDIX E

TOPOGRAPHIC AND GEOLOGIC MAPS



0.5 0.25 0 0.5 1 Mile

● **WESTWATER** **Seep or Spring**
5468 **Elevation (feet) above mean sea level**

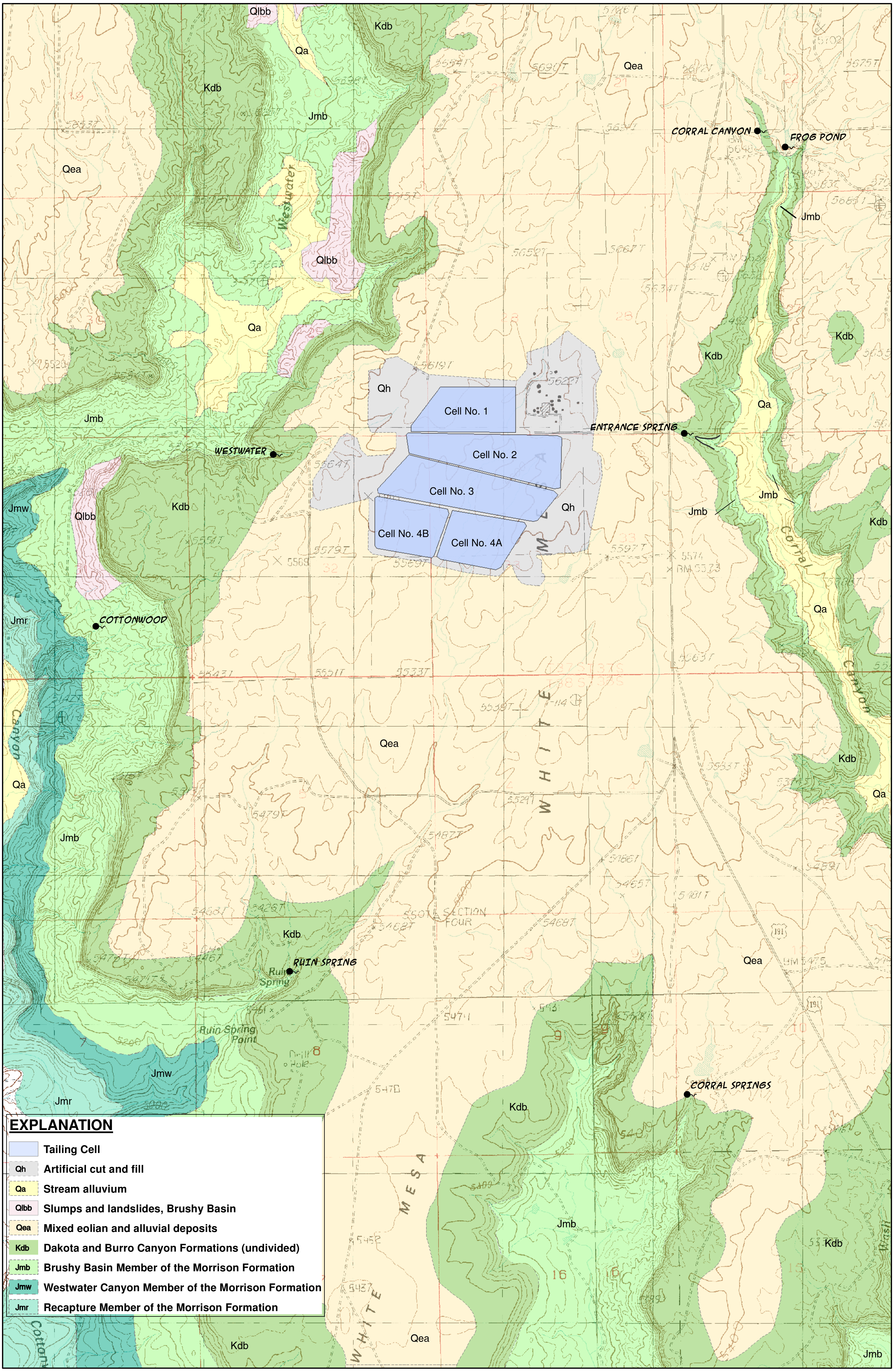
NORTH

HYDRO GEO CHEM, INC.

SEEPS AND SPRINGS ON USGS TOPOGRAPHIC BASE WHITE MESA

Approved	Date	Author	Date	File Name	Figure
SJS	09/17/10	DRS	07/16/10	7180002G	E.1

K:\718000\GIS\7180002G.mxd: Friday, September 17, 2010 1:02:59 PM



0.5 0 1 Mile

N

Seep or Spring

Contact - dashed where uncertain

HYDRO GEO CHEM, INC.

GEOLOGIC MAP
WHITE MESA, UTAH

Approved	Date	File	Figure
SJS	12/28/11	K:\718000\GIS\Geology	E.2

Geological Map of the Blanding Area, San Juan County, Utah (modified from Haynes et al., 1962; Dames & Moore, 1978 and Kirby, 2008)
Base Map Prepared from Portions of the Blanding South, Black Mesa Butte, Big Bench and No Mans Land U.S.G.S. 7.5' Quadrangles.