



Cherokee Station, Denver, Colorado

Monitoring Well Installation Report

for Compliance with the Coal Combustion
Residuals (CCR) Rule

Cherokee Station

Xcel Energy

July 20, 2016



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Table of Abbreviations and Acronyms

Abbreviation	Definition
bgs	below ground surface
CCR	Coal Combustion Residuals
cm/sec	centimeter per second
HP Geotech	Hepworth-Pawlak Geotechnical, Inc.
PSCo	Public Service Company of Colorado
USCS	Unified Soil Classification System

1.0 Introduction

The purpose of this Monitoring Well Installation Report is to document details pertaining to the drilling, construction, and development of five groundwater monitoring wells installed at Cherokee Station in Denver, Colorado (**Figure 1**). The groundwater monitoring system is intended to support compliance with the U.S. Environmental Protection Agency's final Coal Combustion Residuals (CCR) Rule (40 CFR Parts 257 and 261). Cherokee Station has three incised impoundments subject to the CCR Rule: the West, Center, and East bottom ash impoundments. The drilling and well installation was performed in accordance with the State of Colorado Water Well Construction Rules (2 Code of Colorado Regulations 402-2).

HDR was contracted to locate, design, permit, and oversee the installation of the five new CCR groundwater monitoring wells at Cherokee Station. HDR retained Site Services Drilling, LLC (Site Services) to provide on-site drilling services, while HDR provided field monitoring of the drilling, well installation, and development. All on-site personnel completed the site-specific safety training. Additionally, daily safety briefs were conducted by the on-site project team prior to commencing work. The training and safety briefs were documented in accordance with the *PSCo CCR Rule Compliance Health & Safety Plan*.

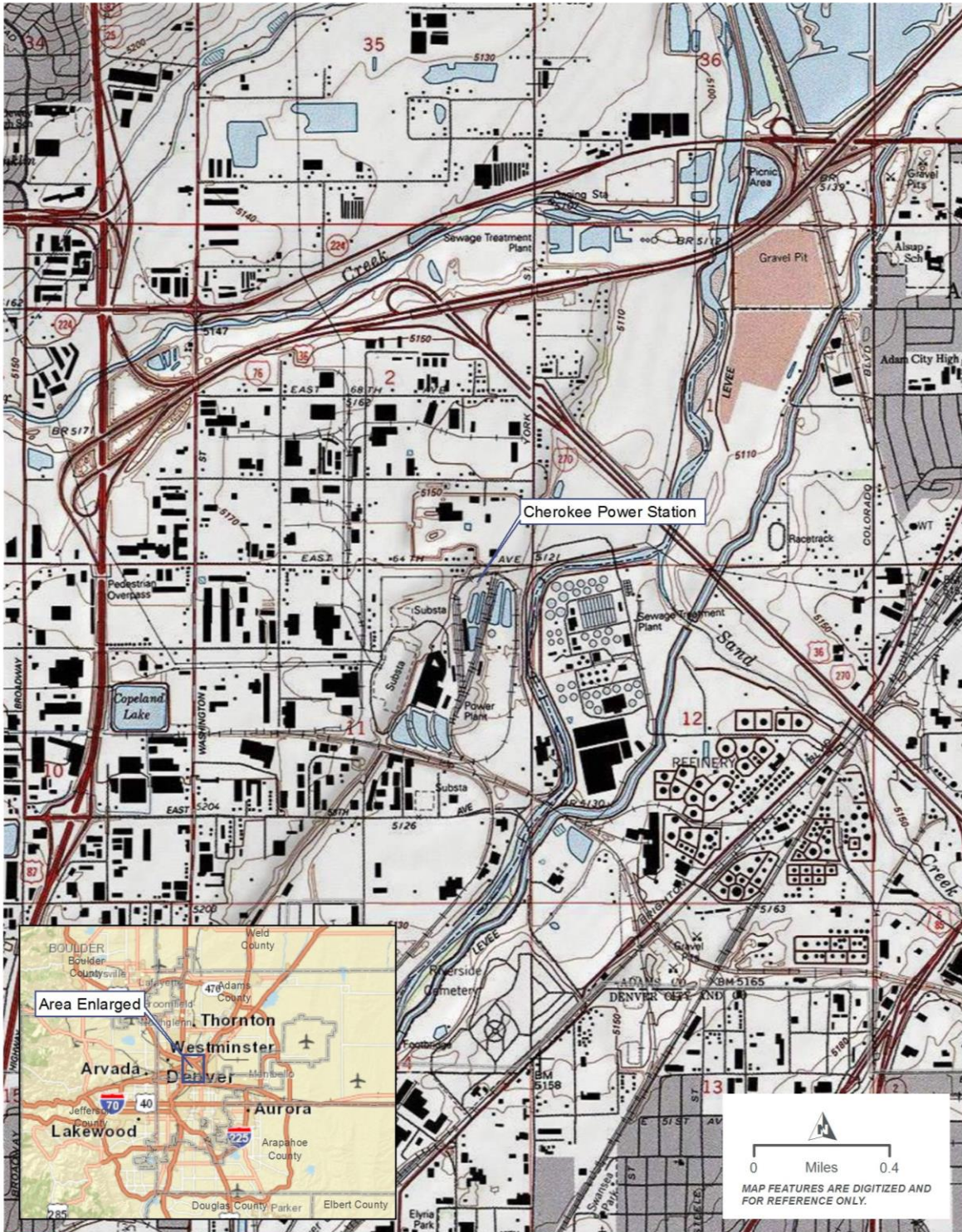
2.0 Background Information

Prior hydrogeologic and geotechnical investigations previously conducted at Cherokee Station are summarized in the Monitoring Well Installation Plan (HDR, 2015).

The uppermost aquifer under Cherokee Station is the alluvial aquifer associated with the nearby South Platte River; it is present across the site. Groundwater under the impoundments flows east, perpendicular to the South Platte River where it ultimately discharges to the river (GeoTrans, Inc., 2009). Static groundwater level is relatively shallow, with measurements from previously installed wells¹ ranging from 7 to 20 feet below the top of well casings (GeoTrans, Inc. 2009). The alluvial aquifer is underlain by low permeability claystone deposits of the Denver Formation, which is over 70 feet thick in this area (CDH, 1993). The Denver Formation inhibits vertical downward flow to the deeper, regional Arapahoe Aquifer (GeoTrans, Inc. 2009).

The five new monitoring wells installed at Cherokee Station (MW-7, MW-8, MW-9, MW-10, and MW-13; **Figure 2**) were sited based on monitoring requirements in the CCR Rule, facility design, and existing hydrogeologic data for the vicinity, as described in the Groundwater Monitoring System Certification (HDR, 2016).

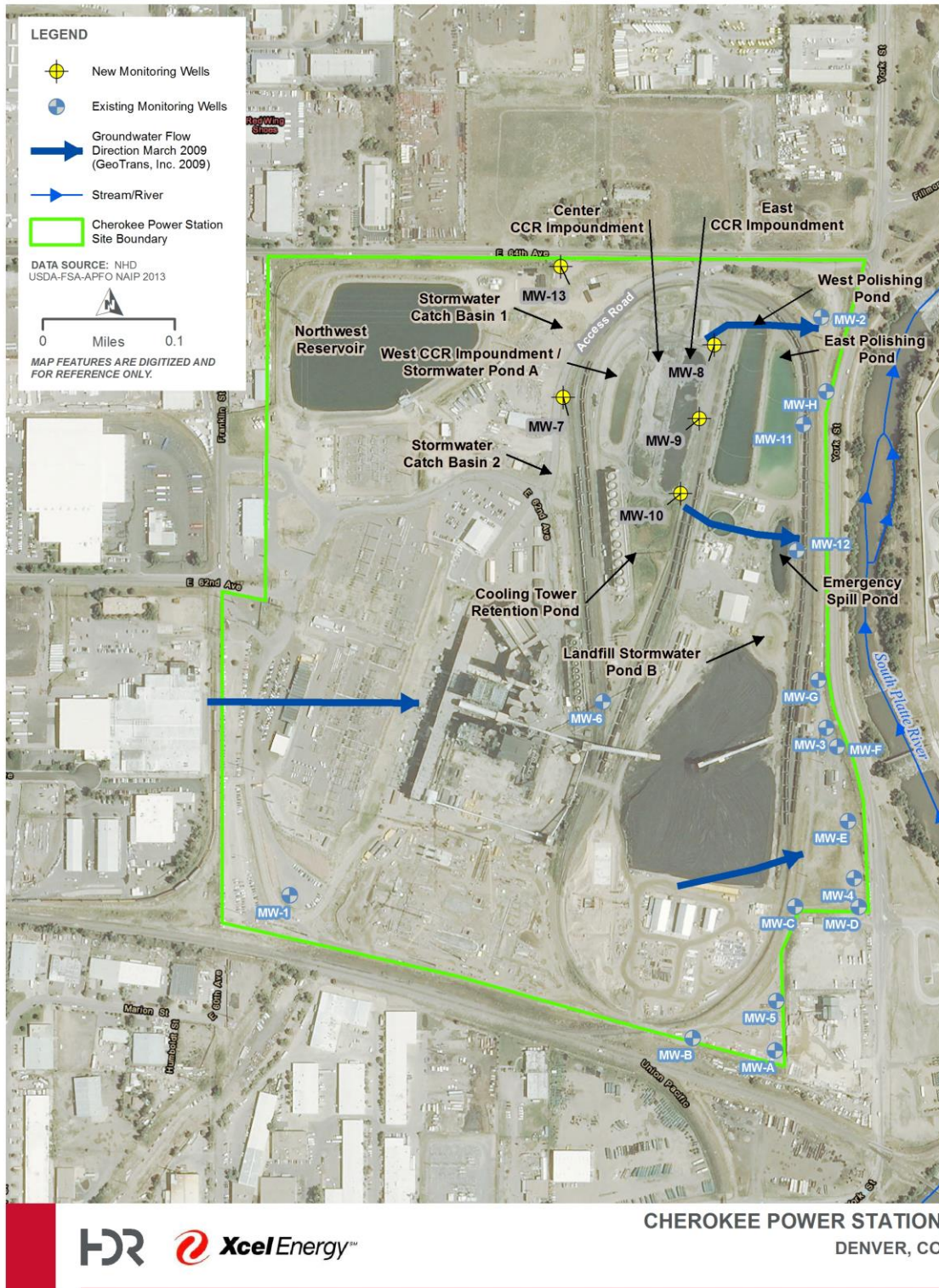
¹ A total of 14 existing monitoring wells (MW-1 to MW-6 and MW-A to MW-H) are located throughout the facility at Cherokee Station.



CHEROKEE POWER STATION
DENVER, CO

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Figure 1. Vicinity Map, Cherokee Station



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Figure 2. Well Location Map, Cherokee Station

3.0 Field and Laboratory Methods

3.1 Borehole Drilling

The boreholes for each well were drilled by Site Services using a hollow stem auger drilling method on November 9 and 10, 2015. Utility locations were identified prior to beginning drilling operations. However, to ensure the absence of any buried utilities, the driller advanced soil borings from the ground surface by using a pot-holing technique to a minimum depth of 8 feet prior to drilling. The borehole was then advanced using the hollow stem auger drilling method with a CME-75 drilling rig. The nominal borehole diameter was 6 inches to accommodate construction of 2-inch diameter wells.

Screen depth was targeted for placement at the top of the groundwater table. Therefore, as described in the Monitoring Well Installation Plan (HDR, 2015), all boreholes were drilled to a depth of at least 10 feet below the water table, or to the claystone Denver Formation, whichever was shallower. This resulted in borehole depths of between 13 and 39 feet below ground surface (bgs), as further described in **Section 4.3**.

An HDR geologist was present during drilling operations to collect samples and log the subsurface material, in addition to overseeing site safety and proper well construction. Soil samples from boreholes were collected in plastic bags and logged every 5 feet by the field geologist during drilling to document lithologic soil characteristics. The geologist visually classified soil type, consistency/relative density, color, and water content in accordance with the Unified Soil Classification System (USCS) as well as grain size, mineralogy, sorting, rounding, hardness, and matrix/clast support, among other textural properties. Boring logs for each borehole are provided in **Appendix A**. Samples were placed in sample bags labeled with the borehole identification and depth interval. One undisturbed soil sample from each well was collected within the well screen depth interval and submitted to a lab for hydraulic properties analysis, as described below in **Section 3.2**.

Soil cuttings, fluids, and potholing slurry generated during drilling were disposed of at the CCR impoundment. Drilling equipment was decontaminated with potable water before moving to the next borehole.

3.2 Soil Samples - Geotechnical Analysis

Soils were logged from the cutting returns during drilling and classified based on the USCS. During drilling, one undisturbed soil sample was obtained from each borehole at a depth typically coinciding with the well screen depth. An 18-inch long California Modified Style Split-Spoon Sampler was used to collect the undisturbed core of sediment. The undisturbed soil samples (one from each well) were submitted to Hepworth-Pawlak Geotechnical, Inc. (HP Geotech) for analysis of the following parameters:

- Grain-size: Sieve and Hydrometer (ASTM D421/422)
- Total Porosity (SW9100)
- Bulk Density (ASTM D2937)
- Moisture Content (ASTM D2216)
- Specific Gravity (ASTM D854)

Analysis was completed in accordance with the method for grain-size analysis using sieve and hydrometer described in ASTM D421/422 (ASTM D421-85, 1998 and ASTM D422-63, 2007). Chain of custody documentation is provided in **Appendix B**.

3.3 Well Construction

Once the target drilling depth was reached at each borehole, the 2-inch diameter, Schedule 40 PVC casing and well screen (0.010-inch slots) were assembled and installed. Approximately 5 feet of screen was installed in MW-7 and MW-8 due to the shallow groundwater encountered. Approximately 10 feet of screen was installed in MW-9, MW-10, and MW-13, where the groundwater was deeper.

After well placement in the borehole, the filter pack sand and the bentonite pellet seal was placed via gravity feed from the surface into the annular space. The filter pack consisted of 10-20 (sieve size) washed silica sand emplaced from the bottom of the hole to approximately 1.5 to 2.5 feet above the well screen. An annular seal of bentonite grout was placed to above the top of the filter pack and hydrated for 12 hours after placement.

All wells were finished with a 2-foot-by-2-foot concrete pad. Each well included between 1 and 2 feet of PVC stick-up. Two bollards were installed around each well. Each well was secured with a protective steel casing and lock. Well construction is further described in **Section 4.3**.

3.4 Well Development

Wells were developed to improve hydraulic connectivity in the area immediately surrounding the well and to remove any fluids that may have been introduced during drilling. Well development involves removing as much of the introduced drilling fluids, cuttings, and particulates from within and adjacent to the well as possible. Development did not begin until at least 12 hours after the wells had been grouted to ensure grout had sufficiently set.

Wells were developed by moving a submersible pump and/or BK pump up and down the well to alternately force water in and out of the screen, loosen sediment, and draw fine-grained materials into the well, then removing the purge water and fine sediment from the well using a pump. Purge water was placed into drums and/or buckets and disposed of at the CCR impoundment.

The duration of development, initial water level, well depth, method, and field parameter measurements of pH, specific conductance, temperature, and turbidity were recorded on the development record for each well. The amount of purge water removed from each well was estimated in the field. Water quality field parameters were recorded approximately every 5 minutes of discharge, and checked more often for wells with slow recharge. Well development continued until field parameters stabilized. Stabilized field parameters were defined as three consecutive readings where temperatures were within 1°C, pH readings within 0.2 standard units, conductivity within 10 percent, and turbidity values were less than 10 nephelometric turbidity units (NTU). The field manager was notified when field parameters stabilized, and development ceased. Purge water was placed into drums and/or buckets and disposed of at the CCR impoundment. All non-dedicated down-well equipment used during development was decontaminated.

3.5 Well Survey

The monitoring wells were surveyed by a professional surveyor, Joy Surveying Company, Inc., after well completion. The surveyor recorded elevations of the top of PVC casing (point at notch on the north side of the casing top) and ground surface using a level loop. The northing and easting coordinates of the wells were also surveyed.

3.6 Groundwater Level Measurement and Aquifer (Slug) Testing

HDR performed slug tests on monitoring wells MW-7, MW-8, MW-9, MW-10, and MW-13 to estimate hydraulic conductivity for the shallow unconfined aquifer. A 1.5-inch diameter by 2.7-foot long watertight slug, having an expected displacement of 1.52 feet, was used in all tests. A transducer was suspended on a communications cable near the bottom of the well and recorded water level measurements at 0.25-second or 0.5-second intervals. Both slug-in and slug-out tests were performed at MW-7 through MW-10, and slug-in tests at MW-13. Slug-in tests were completed by dropping the slug into the water column as quickly as possible and measuring the falling water level that followed. Slug-out tests were completed after each slug-in test by removing the slug from the water column as quickly as possible and measuring the rising water level that followed. Well-specific testing details are summarized below:

MW-7: One slug-in and one slug-out test were performed on December 22, 2015. The depth to water in the well was 4.96 feet below top of casing. With a well screen interval of 3.0–8.0 feet bgs and a casing stick-up of 1.16 feet, the well screen is mostly submerged with 0.8 feet of well screen above the water table.

MW-8: Two slug-in and two slug-out tests were performed on December 22, 2015. The depth to water in the well was 8.13 feet below top of casing. With a well screen interval of 8.92–13.92 feet bgs and a casing stick-up of 1.25 feet, the well screen is fully submerged with the top of the screen 2.04 feet below the water table.

MW-9: Two slug-in and two slug-out tests were performed on December 22, 2015. The depth to water in the well was 16.89 feet below top of casing. With a well screen interval of 14.75–24.75 feet bgs and a casing stick-up of 1.56 feet, the well screen is partially submerged with 0.58 feet of well screen above the water table.

MW-10: Two slug-in and two slug-out tests were performed on December 22, 2015. The depth to water in the well was 25.73 feet below top of casing. With a well screen interval of 30–40 feet bgs and a casing stick-up of 1.59 feet, the well screen is fully submerged with the top of the screen 5.86 feet below the water table.

MW-13: Two slug-in tests were performed on December 22, 2015. The first test involved adding 1 liter of potable water to the well (expected displacement of 1.62 feet), and the second test involved adding 2 liters of potable water to the well (expected displacement of 3.24 feet). The depth to water in the well was 31.39 feet below top of casing. With a well screen interval of 12–32 feet below ground surface and a casing stick-up of 2.05 feet, the well screen is partially submerged with 17.34 feet of well screen above the water table.



Slug test data were downloaded from the Rugged Reader at the end of each working day and saved locally to a laptop. All non-dedicated down-well equipment used during slug testing was decontaminated.

3.7 Decontamination of Field Equipment

Field instrumentation (such as interface probes or water quality meters) was decontaminated between sample locations by rinsing with an Alconox/distilled water solution followed by a potable water rinse and a final rinse with deionized water.

4.0 Field and Laboratory Results

4.1 Borehole Drilling

Boring logs for each borehole are provided in **Appendix A**. Soil cuttings from borehole samples consisted primarily of clayey silt and fine to coarse silty sand. Depth (bgs) to water recorded during drilling was 6 feet at MW-7, approximately 8.5 feet at MW-8, 10 feet at MW-9, 26 feet at MW-10, and 29 feet at MW-13. Bedrock was encountered at a depth (bgs) of approximately 8 feet at MW-7, 12 feet at MW-8, 22 feet at MW-9, 38 feet at MW-10, and 31 feet at MW-13. This was presumed to be the top of the Denver Formation beneath these borings. The presence of gravel was also noted in all borings with the exception of MW-7.

4.2 Soil Samples – Geotechnical Analysis

The undisturbed soil samples collected from each borehole analyzed for grain size and porosity by HP Geotech are summarized in **Table 1**. The soils laboratory results are presented in **Appendix B**. The depths at which analyzed geotechnical samples were collected correspond to the well screen depth at MW-8, MW-9, and MW-13. The geotechnical sample analyzed from MW-7 and MW-10, however, were collected above the top of the well screen placement.

Laboratory results show the well screen at MW-9 is placed within clayey sand and silty sand, which is consistent with the material noted in the drilling logs. Laboratory results confirm that the soil sample from MW-8 was collected from within the clay layer, which was encountered at approximately 12 feet bgs. The well screen was placed from 7.67 to 12.67 feet bgs. The geotechnical results correspond to the bottom portion of the screened depth interval. Boring logs document coarse silty sand above the clay layer.

The laboratory results confirm the sample at MW-10 consisted primarily of clayey sand with gravel, as identified in the boring logs. The soil sample analyzed for MW-10 was collected above the well screen interval. The majority of the screen at MW-10 was placed in sand but also extended into a silt layer, as indicated by boring logs.

Table 1. Summary of Geotechnical Testing Results for Cherokee Station, 2015

Well	Sample Depth (bgs)	Gradation			Total Porosity (%)	Moisture Content (%)
		Gravel (%)	Sand (%)	Silt and Clay (%)		
MW-7	0 to 6"	0	59	41	--	18.6



MW-8	12'4" to 12'8"	0	4	96	46.3	24.5
MW-9	19'10" to 20'2"	20	49	31	31.5	13.1
MW-10	20'4" to 20'8"	39	52	10	26.5	2.5
MW-13	25'0"-30'6"	30	57	13	--	4.2

4.3 Well Construction

A diagram for each well that documents well construction is provided in **Appendix C**. The water table was encountered in all five wells. Two wells were constructed with 5-foot screens and two with 10-foot screens. Approximately 5 feet of screen was installed in MW-7 and MW-8 due to the shallow groundwater. At MW-7, depth to water during drilling was approximately 6 feet bgs and bedrock was encountered at approximately 8 feet bgs. The screen was placed from 6.59 to 11.59 feet bgs. During drilling at MW-8, the shallow water table and bedrock were encountered at approximately 8.5 feet and 12 feet bgs, respectively. The screen was placed from 7.67 to 12.67 feet bgs.

Approximately 10 feet of screen was installed in MW-9, MW-10, and MW-13 where the groundwater and bedrock were deeper. In MW-9, the water table was encountered at approximately 10 feet bgs during drilling and bedrock at approximately 22 feet bgs. The screen was placed from approximately 13.2 feet to 23.2 feet bgs at MW-9. The screen at MW-10 was placed 28.6 feet to 38.6 feet bgs; the water table was encountered at approximately 16 feet bgs during drilling and bedrock was encountered at 38 feet bgs. Bedrock was encountered at approximately 31 feet bgs in MW-13 and water was encountered during drilling at approximately 29 feet bgs; therefore, the well screen was placed above the bedrock from approximately 23 to 33 feet.

Well construction details for all five new CCR wells are summarized in **Table 2**. State-issued well construction permits are included in **Appendix D**.



Table 2. Well Construction Details for New Groundwater Monitoring Wells Cherokee Station, 2015

Well	Northing (State Plane, NAD 1983 UTM Zone 13 N meters)	Easting (State Plane, NAD 1983 UTM Zone 13 N meters)	Elevation TOC (feet)	Well Total Depth (feet bgs)	Depth of Screen Interval (feet bgs)	Well Stickup (feet)	Casing Type	Depth to Water (feet BTOC)	Static Water Level (feet)
MW-7	503100.25399	4406795.9759	5153.86	11.59	6.6-11.6	1.16	2-inch Sch. 40 PVC	5.5	5148.36
MW-8	503284.39859	4406859.9822	5140.64	12.67	7.7-12.7	1.25	2-inch Sch. 40 PVC	8.3	5132.34
MW-9	503266.2015	4406770.1456	5141.26	23.18	13.2-23.2	1.57	2-inch Sch. 40 PVC	19.06	5122.20
MW-10	503243.54239	4406678.6084	5140.88	38.61	28.6-38.6	1.59	2-inch Sch. 40 PVC	25.41	5115.47
MW-13	503100.2539	4406795.9759	5174.497	32.75	22.8-32.8	2.05	2-inch Sch. 40 PVC	31.24	5143.257

Notes: TOC = top of casing; bgs = below ground surface; BTOC = below top of casing; Depth to water measured December 2015



4.4 Well Development

Wells were developed from November 18 through November 24, 2015. MW-9 and MW-10 were both developed within one day, on November 13, 2015, using a submersible pump. After approximately 50 gallons had been purged (in approximately 2 hours) from MW-9, field parameters stabilized and development was complete. As compared to the other 3 new CCR wells, water recharge was much faster at MW-10, the deepest of the new CCR wells. Approximately 285 gallons were purged (in approximately 2.5 hours) from MW-10, after which time field parameters stabilized.

Development at MW-7 and MW-8 also started on November 13, 2015; recharge was considered slow at both wells. Approximately 32 gallons were purged (over a 5-hour period) from MW-7 using a submersible pump. That same day, approximately 34 gallons were removed (within 1.75 hours) from MW-8 using both BK and submersible pumps. Field parameters did not stabilize that day at either well. On November 18, 2015, after an additional 50 gallons had been purged (in approximately 2 hours) from MW-8, field parameters stabilized and development was complete. Development resumed at MW-7 on November 24, 2015. After an additional 14 gallons were purged (over a 6-hour period) from MW-7, field parameters stabilized. On November 18, 2015, approximately 285 gallons of purge water were removed from MW-13 (in approximately 3 hours) using a submersible pump, field parameter stabilized and well development was complete. Water quality field parameters measured after each well was developed are summarized in **Table 3**.

Well I.D.	Conductivity (µS/cm)	pH	Temperature (degrees C)	Turbidity (NTU)
MW-7	2810	7.63	14.7	9.1
MW-8	4126	7.38	18.8	4.2
MW-9	2914	7.72	20.5	4.9
MW-10	1801	11.20	15.0	5.3
MW-13	1754	7.21	14.3	4

Notes: µS/cm = microsiemens per centimeter; NTU = nephelometric turbidity unit

4.5 Well Survey

Survey coordinates and elevations are provided in **Table 2**.

4.6 Groundwater Level Measurement and Aquifer (Slug) Testing

All slug-in and slug-out tests were analyzed using slug test solutions for unconfined aquifers and implemented using Aqtesolv® v4.5. The solution by Dagan (1978) was used to analyze the slug test data for MW-7, MW-9, and MW-13, which had well screens intersecting the water table (i.e., were partially submerged) during the slug testing. For these wells, an effective casing radius correction was applied using Aqtesolv® to account for drainage to and from the filter pack. This correction included specifying a well radius (0.25 foot) that encompasses the well screen and the filter pack, and an equipment radius (0.005 foot) for the transducer cable. The MW-8 and MW-10 well screens were below the water table (i.e., fully submerged) during the slug testing; therefore, no effective



casing radius correction was applied to account for drainage to and from the filter pack. Slug tests at these wells were analyzed using the Bouwer and Rice (1976) solution. The aquifer at each location was represented with the following estimates of saturated thickness: 8.2 feet (MW-7), 5.12 feet (MW-8), 6.67 feet (MW-9), 13.86 feet (MW-10), and 2.66 feet (MW-13). An anisotropy ratio of 1 (unitless) was assigned to the aquifer at each well location. In some tests the initial displacement did not reasonably match the expected displacement. Early 'noisy' data were not fitted during the analysis.

Initial displacement created by the slug, and hydraulic conductivity results for the slug testing are shown in **Table 4**. Plots of the analyses are included in **Appendix E**. Included in **Table 3** is the apparent soil formation resulting from the slug test analyses and the soil formation indicated on the field boring logs. The apparent formation shows good agreement with the boring logs. The geometric mean of the hydraulic conductivity calculated at all wells is 3.47×10^{-3} centimeter per second (cm/sec). This value corresponds with the textbook range for silty sand to clean sand (Freeze and Cherry, 1979).



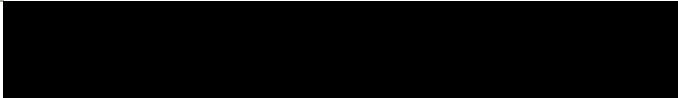

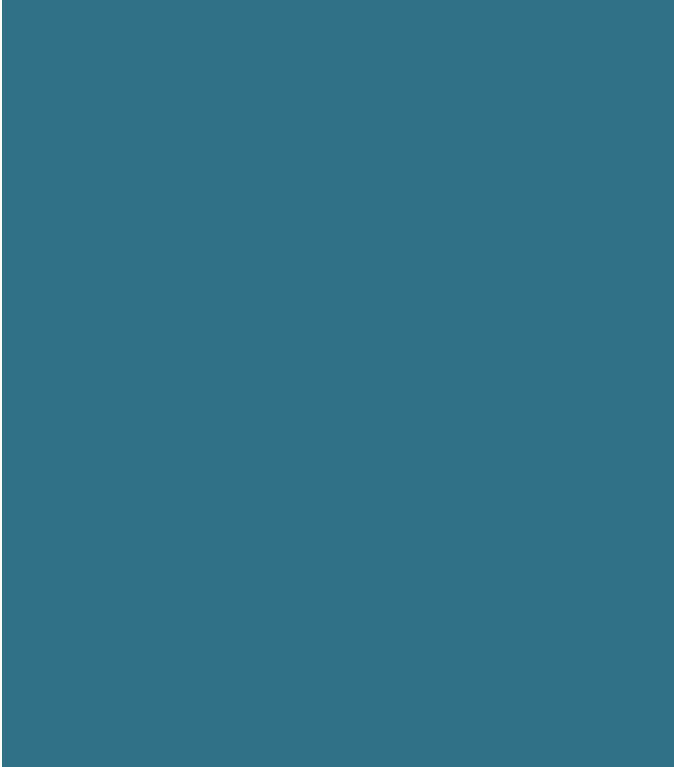

Table 4. Slug Testing Results

Well	Test Name	Initial Displacement (ft)	Hydraulic Conductivity (cm/sec)	Apparent Soil Formation (from analysis) ¹	Soil Formation (from boring log)
MW-7	Slug In	2.56	4.93E-04	Silt to silty sand	Clayey silt
MW-7	Slug Out	1.82	2.21E-04	Silt to silty sand	Clayey silt
MW-8	Slug In	2.41	7.08E-03	Silty sand to clean sand	Coarse silty sand w/ gravel
MW-8	Slug Out	1.92	8.44E-03	Silty sand to clean sand	Coarse silty sand w/ gravel
MW-8	Slug In 2	2.19	7.22E-03	Silty sand to clean sand	Coarse silty sand w/ gravel
MW-8	Slug Out 2	1.34	8.19E-03	Silty sand to clean sand	Coarse silty sand w/ gravel
MW-9	Slug In	1.32	1.21E-03	Silty sand	Fine silty sand
MW-9	Slug Out	2.25	1.18E-03	Silty sand	Fine silty sand
MW-9	Slug In 2	1.54	1.47E-03	Silty sand	Fine silty sand
MW-9	Slug Out 2	2.83	1.55E-03	Silty sand	Fine silty sand
MW-10	Slug In	1.37	9.22E-03	Silty sand to clean sand	Coarse sand to silt
MW-10	Slug Out	1.46	9.06E-03	Silty sand to clean sand	Coarse sand to silt
MW-10	Slug In 2	1.45	7.89E-03	Silty sand to clean sand	Coarse sand to silt
MW-10	Slug Out 2	1.50	8.54E-03	Silty sand to clean sand	Coarse sand to silt
MW-13	Slug In (1L)	0.39	8.56E-03	Silty sand to clean sand	Fine silty sand to medium sand
MW-13	Slug In 2 (2L)	0.66	7.33E-03	Silty sand to clean sand	Fine silty sand to medium sand
Geometric Mean			3.47E-03		

Notes: ¹Freeze and Cherry (1979)

5.0 References

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Appendix A

Borehole Logs



Boring Log

Project Name Xcel CCR		Project No. 266180-006	Drilling Company Site Services Drilling, LLC	
Boring No. MW-7		Location Cherokee Station	Drilling Rig Type and Drilling Method CME-75 Hollow Stem Auger	
Sample No.	Blow Count	Depth (feet)	Description (USCS)	Remarks
MW-7 0-6' bgs		5		Collected Sample MW-7 0-6' bgs submitted for geotechnical analysis
8-8.5' bgs	Not recorded		Gray 10YR 6/1; Clayey Silt (ML), dense weathered bedrock; friable; wet	depth to water ~6' bgs
12.5-13' bgs	Not recorded		Gray 10YR 6/1; Clayey Silt (ML), dense weathered bedrock; friable; wet; Iron mineralization	iron staining
		10		
		15		
		20		
		25		
		30		
		35		
		40		
		45		
		50		
Total Depth (feet)		Water Level (feet)		Logged By: Justin Bills
13		5.13		Drilled/Sampled By: Josh Eckhoff
		After Drilling:	Hours After:	Date Started:
		Not recorded	Not recorded	11/9/2015
				Date Completed: 11/9/2015



Boring Log

Project Name Xcel CCR		Project No. 266180-006	Drilling Company Site Services Drilling, LLC		
Boring No. MW-8		Location Cherokee Station	Drilling Rig Type and Drilling Method CME-75 Hollow Stem Auger		
Sample No.	Blow Count	Depth (feet)	Description (USCS)	Remarks	
8.5-9' bgs	Not recorded	5	Brown 7.5YR 5/4; Coarse Silty Sand (SM), well sorted with Gravel >1"; wet	Sample MW-8 12'4"-12'8" submitted for geotechnical analysis	
MW-8 12'4"-12'8" bgs	Not recorded	10	Gray 10YR 6/1; Clayey Silt (ML), bedrock; friable		
		15			
		20			
		25			
		30			
		35			
		40			
		45			
		50			
Total Depth (feet)		Water Level (feet)		Logged By: Justin Bills	Drilled/Sampled By: Josh Eckhoff
13.92		9.5		Hours After: Not recorded	Date Completed: 11/9/2015
				Date Started: 11/9/2015	



Boring Log

Project Name Xcel CCR		Project No. 266180-006	Drilling Company Site Services Drilling, LLC	
Boring No. MW-9		Location Cherokee Station	Drilling Rig Type and Drilling Method CME-75 Hollow Stem Auger	
Sample No.	Blow Count	Depth (feet)	Description (USCS)	Remarks
8' bgs	Not recorded	5	Ash, loose, dry	Depth to water ~10' bgs
8.5-9' bgs	Not recorded	10	Dark brown 10YR 4/3; Fine Silty Sand (SM), poorly sorted, medium dense; moist	
13-13.5' bgs	Not recorded	15	Dark brown 10YR 4/3; Fine Silty Sand (SM), poorly sorted, medium dense; wet at 10' bgs	
18-18.5' bgs		20	Dark brown 10YR 4/3; Silty Sand (SM), well sorted with Gravel <1"; wet	
MW-9 19'10"-20'2" bgs		25	Yellowish brown 10YR 5/4; Clayey Silt (ML); wet	
21-21.5' bgs 22' bgs		30	Silt; Grayish blue weathered bedrock; wet	
		35		
		40		
		45		
		50		
Total Depth (feet)		Water Level (feet)	Logged By:	Drilled/Sampled By:
23.18		20.6	Justin Bills	Josh Eckhoff
	After Drilling:	Hours After:	Date Started:	Date Completed:
	20.6	Not recorded	11/9/2015	11/9/2015



Boring Log

Project Name Xcel CCR		Project No. 266180-006	Drilling Company Site Services Drilling, LLC		
Boring No. MW-10		Location Cherokee Station	Drilling Rig Type and Drilling Method CME-75 Hollow Stem Auger		
Sample No.	Blow Count	Depth (feet)	Description (USCS)	Remarks	
8-8.5' bgs	Not recorded	5	Yellowish brown 10YR 5/4; Fine Sand (SM) with trace Gravel <1"; moist		
14.5-15' bgs 16' bgs	Not recorded	15	Brown 10YR 5/3; Very Fine Sand (SP), poorly sorted; moist Brown 10YR 5/3; Medium Silty Sand (SP); moist		
MW-10 20'4"- 20'8" bgs		20	Brown 10YR 5/3; Clayey Sand, well sorted with Gravel >1"	Sample MW-10 20'4"-20'8" bgs submitted for geotechnical analysis	
25.5-26' bgs		25	Light brown 7.5YR 6/4; Coarse Sand (SW); well sorted; wet	Depth to water ~26' bgs	
		30	As above		
		35	Light yellowish brown 10YR6/4; Silt (ML); stiff; moist		
		40	Silt (ML); blue gray bedrock; moist		
		45			
		50			
Total Depth (feet)		Water Level (feet)		Logged By: Justin Bills	Drilled/Sampled By: Josh Eckhoff
38.61	27.6	After Drilling:	Hours After:	Date Started: 11/10/2015	Date Completed: 11/10/2015
		Not recorded			



Boring Log

Project Name		Project No.	Drilling Company	
Xcel CCR		266180-006	Site Services Drilling, LLC	
Boring No.		Location	Drilling Rig Type and Drilling Method	
MW-13		Cherokee Station	CME-75 Hollow Stem Auger	
Sample No.	Blow Count	Depth (feet)	Description (USCS)	Remarks
10-10.5' bgs	Not recorded	10	Brownish yellow 10YR 6/6; Fine Silty Sand (SP) with Gravel <1"; moist	
15-15.5' bgs	Not recorded	15	Light brown 7.5YR 6/4; Fine Silty Sand (SP) with Gravel <2"	50% recovery
		20	No recovery (difficult drilling) 20-22' bgs	No recovery
25-25.5' bgs	Not recorded	25	Light yellowish brown 10YR 6/4; Fine Silty Sand (SW) with Gravel; well sorted; dry	Sample MW-13 25'-30'6" submitted for geotechnical analysis
30' bgs	Not recorded	30	Reddish brown 5YR 5/4; Medium Sand (SP) with Gravel <2"; well sorted; wet	Depth to water ~ 29' bgs
31-33' bgs	Not recorded		Gray 10YR 5/1; Clay and Siltstone (ML) bedrock; wet	
		35		
		40		
		45		
		50		
Total Depth (feet)		Water Level (feet)	Logged By: Justin Bills	Drilled/Sampled By: Josh Eckhoff
34		31.1	Hours After: Not recorded	Date Started: 11/6/2015
			Date Completed: 11/6/2015	



Appendix B

Geotechnical Analysis Laboratory Reports



Hepworth-Pawlak Geotechnical, Inc.
10302 South Progress Way
Parker, Colorado 80134
Phone: 303-841-7119
Fax: 303-841-7556
www.hpgeotech.com

December 14, 2015

Anna Lundin
HDR
1670 Broadway, Suite 3400
Denver, CO 80202

215333B
Anna.Lundin@HDRinc.com

Subject: Laboratory Tests Results – Xcel Coal Combustion Residuals Rule Compliance Project,
Cherokee Power Station.

Dear Ms. Lundin:

This letter presents the results of laboratory tests performed on samples submitted for the subject project. The test results are presented on the attached Figures 1-7 and Table 1.

If there are any questions, please feel free to contact us.

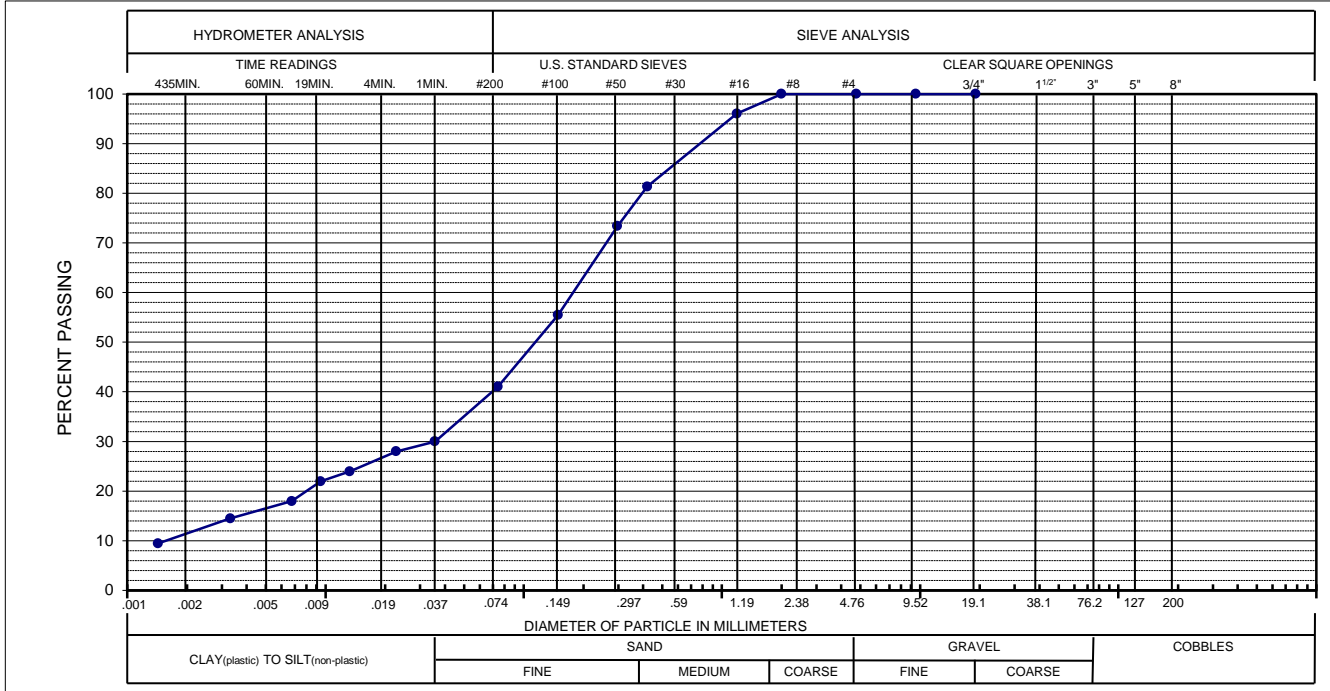
Sincerely,

HEPWORTH-PAWLAK GEOTECHNICAL, Inc.

Cuong Vu, Ph.D., P.E.

Reviewed by: Arben Kalaveshi, P.E.

215333B (Cherokee) xmittal.doc

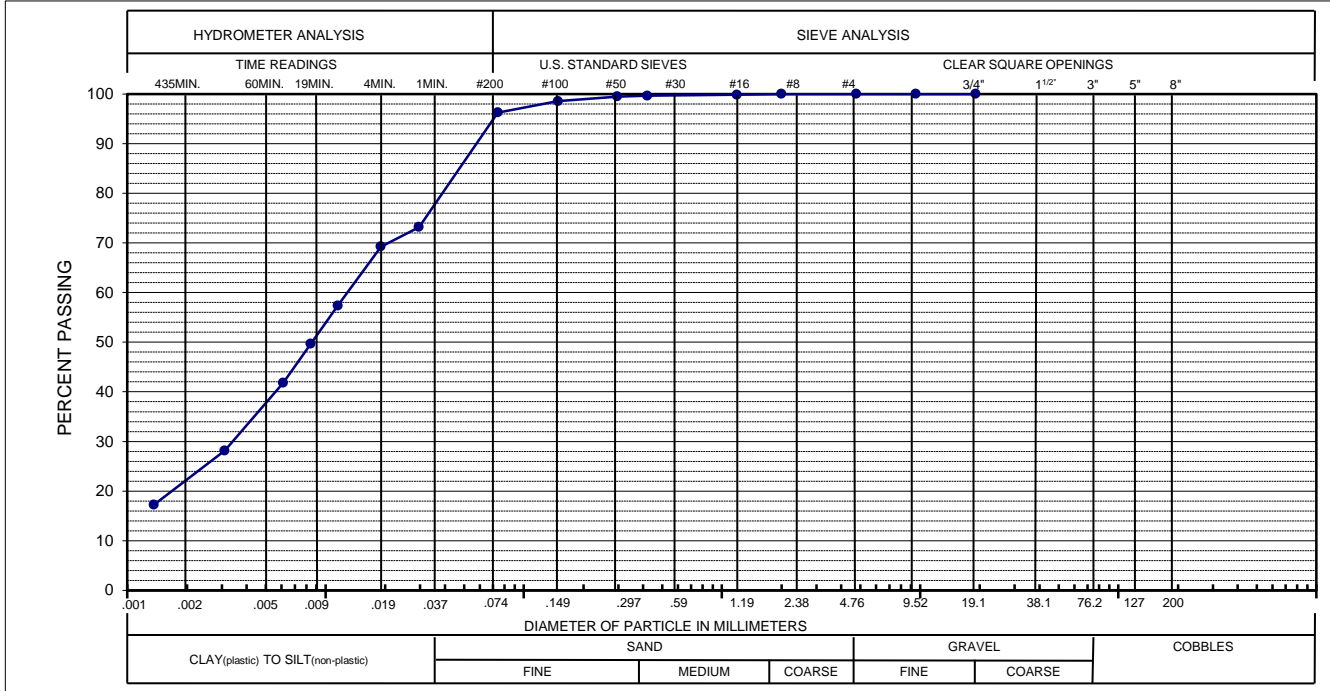


GRAVEL: 0%
 BORING : MW7
 DEPTH : 0-6 feet

SAND: 59%

SILT / CLAY: 41%
 Specific Gravity: 2.65
 Porosity :

Sieve Size / Particle Diameter	Percent Passing
(1")	100
(3/4")	100
(1/2")	100
(3/8")	100
(#4)	100
(#10)	100
(#16)	96
(#40)	81
(#50)	73
(#100)	55
(#200)	41
0.0357	30
0.0227	28
0.0133	24
0.0095	22
0.0068	18
0.0033	14
0.0014	9

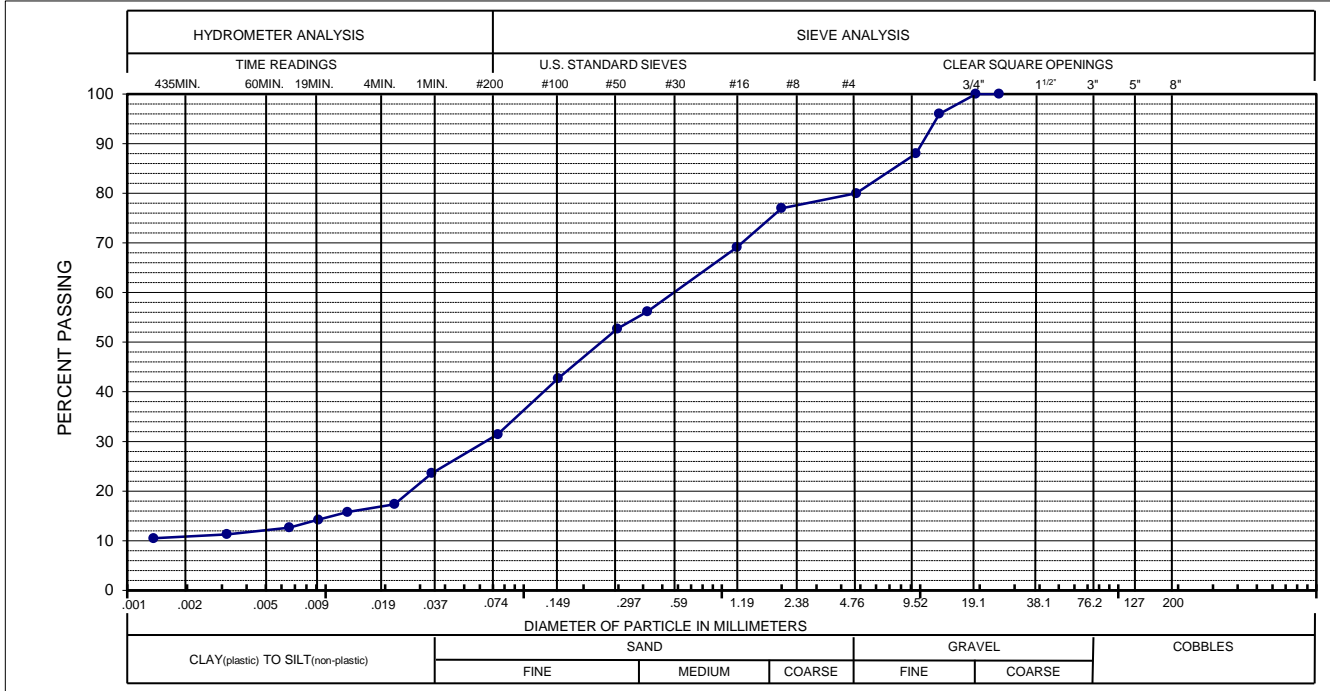


GRAVEL: 0%
 BORING : MW8
 DEPTH : 12'4"-12'8"

SAND: 4%

SILT / CLAY: 96%
 Specific Gravity: 2.73
 Porosity : 46.3%

Sieve Size / Particle Diameter	Percent Passing
(1")	100
(3/4")	100
(1/2")	100
(3/8")	100
(#4)	100
(#10)	100
(#16)	100
(#40)	100
(#50)	99
(#100)	99
(#200)	96
0.0296	73
0.0190	69
0.0115	57
0.0084	50
0.0061	42
0.0031	28
0.0014	17

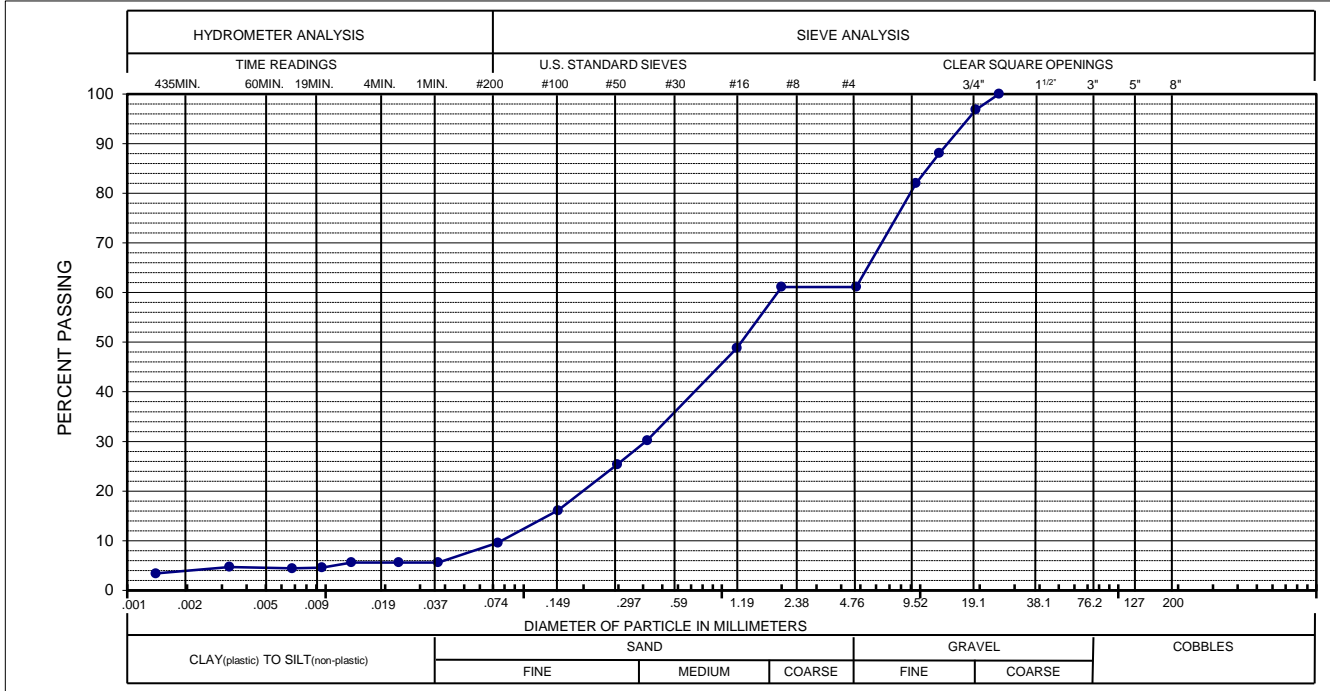


GRAVEL: 20%
 BORING: MW9
 DEPTH: 19'10"-20'2"

SAND: 49%

SILT / CLAY: 31%
 Specific Gravity: 2.78
 Porosity : 31.5%

Sieve Size / Particle Diameter	Percent Passing
(1")	100
(3/4")	100
(1/2")	96
(3/8")	88
(#4)	80
(#10)	77
(#16)	69
(#30)	56
(#50)	53
(#100)	43
(#200)	31
0.0343	24
0.0223	17
0.0129	16
0.0092	14
0.0066	13
0.0032	11
0.0014	10

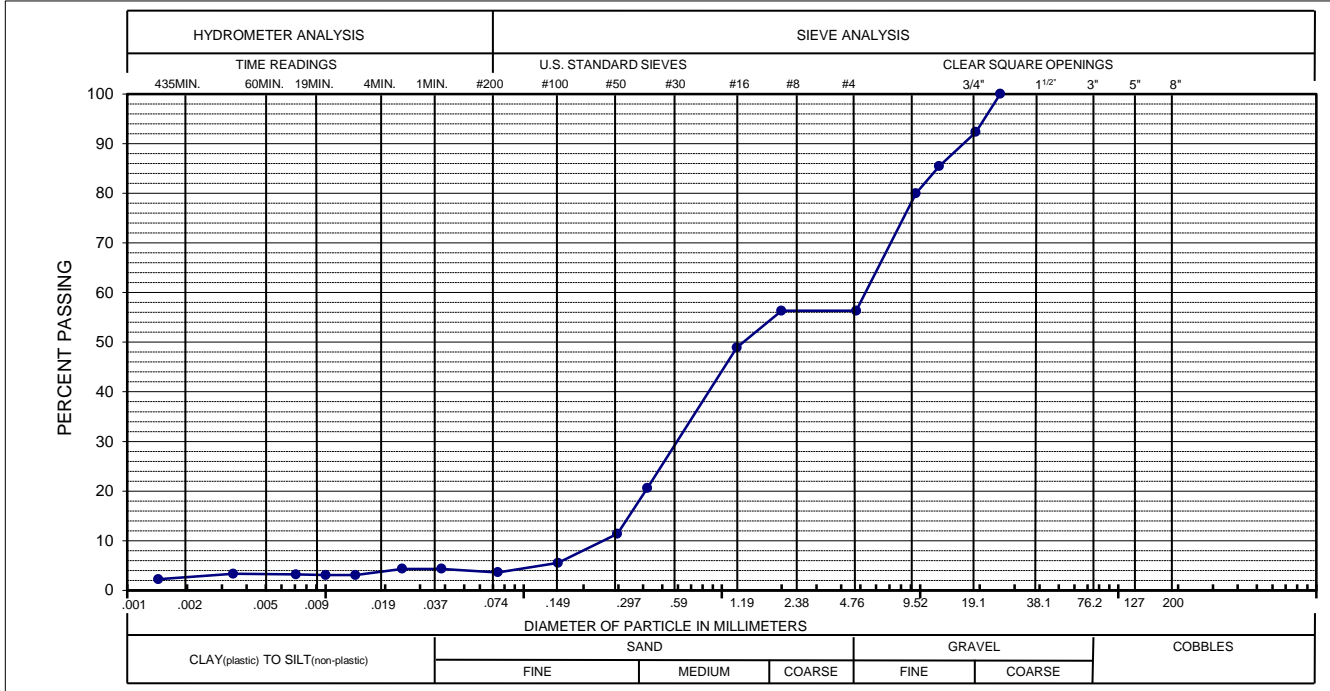


GRAVEL: 39%
 BORING : MW10
 DEPTH : 20'4 - 20'8"

SAND: 52%

SILT / CLAY: 10%
 Specific Gravity: 2.78
 Porosity : 26.5%

Sieve Size / Particle Diameter	Percent Passing
(1")	100
(3/4")	97
(1/2")	88
(3/8")	82
(#4)	61
(#10)	61
(#16)	49
(#40)	30
(#50)	25
(#100)	16
(#200)	10
0.0370	6
0.0234	6
0.0135	6
0.0096	5
0.0068	4
0.0033	5
0.0014	3

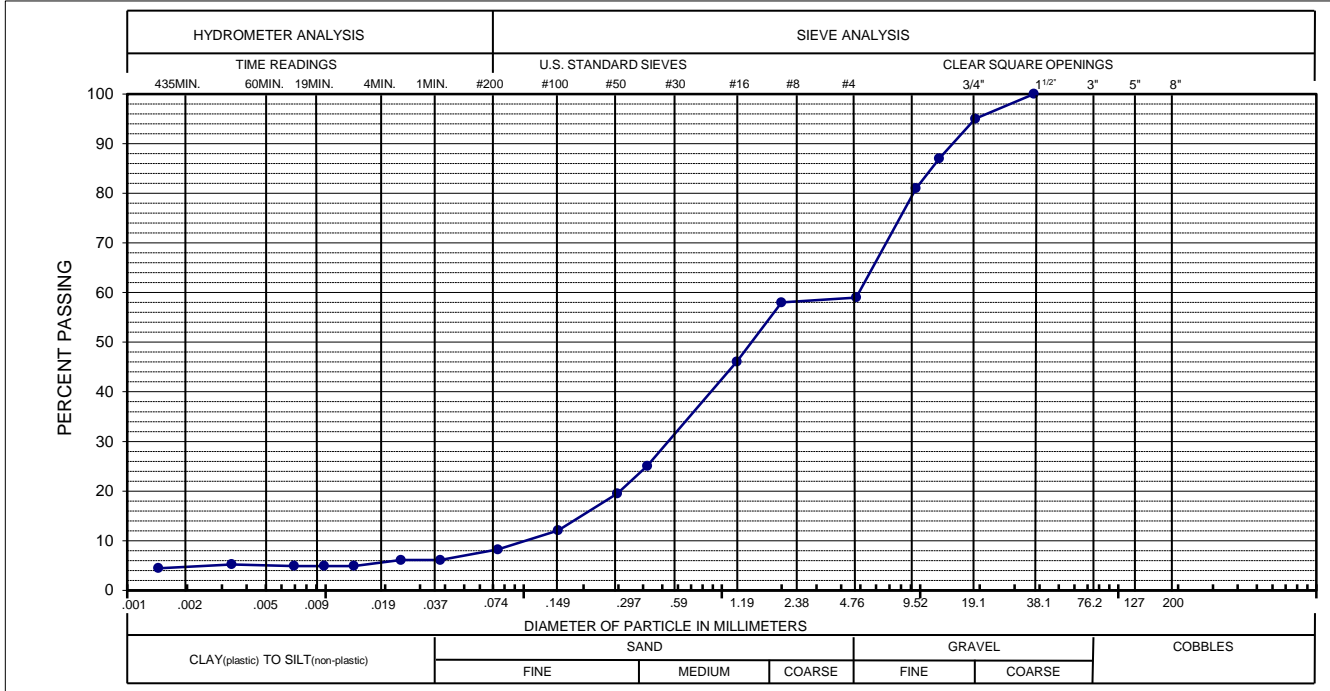


GRAVEL: 44%
 BORING: MW11
 DEPTH: 20'10"-21'2"

SAND: 53%

SILT / CLAY: 4%
 Specific Gravity: 2.65
 Porosity: 26.9%

Sieve Size / Particle Diameter	Percent Passing
(1")	100
(3/4")	92
(1/2")	85
(3/8")	80
(#4)	56
(#10)	56
(#16)	49
(#40)	21
(#50)	11
(#100)	6
(#200)	4
0.0385	4
0.0244	4
0.0142	3
0.0100	3
0.0071	3
0.0034	3
0.0014	2

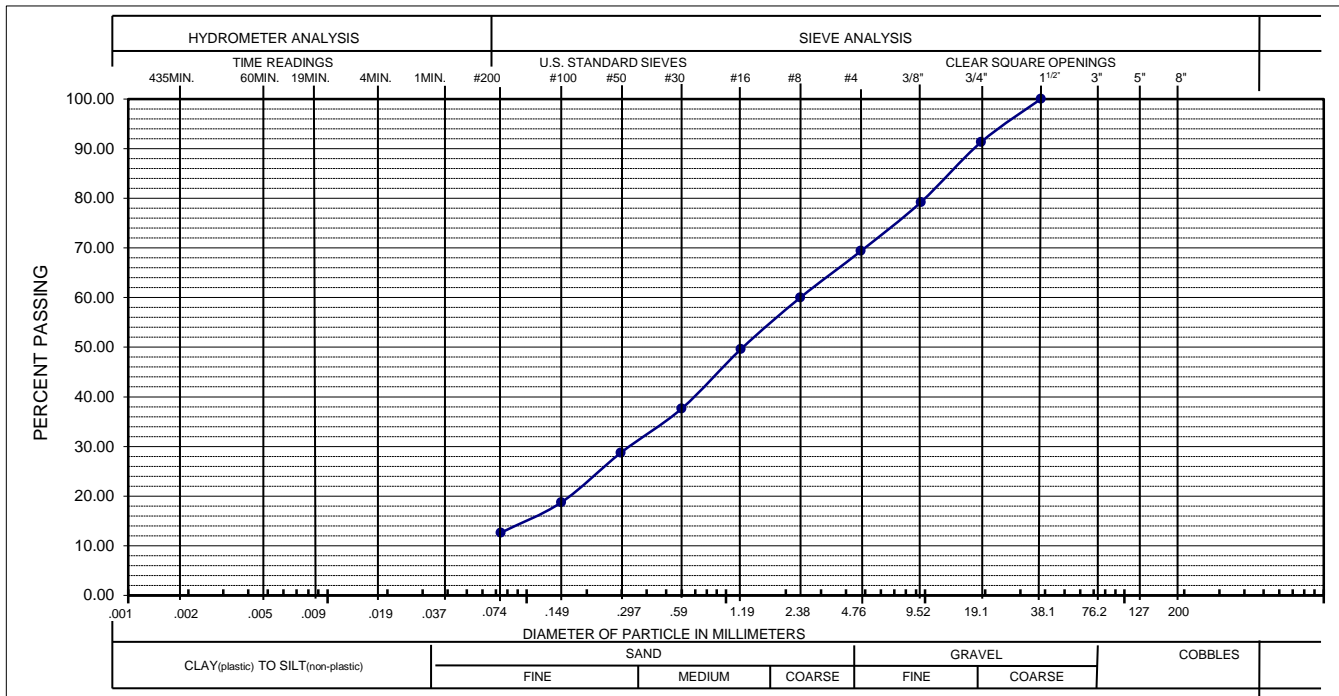


GRAVEL: 41%
 BORING : MW12
 DEPTH : 21'4"-21'8"

SAND: 51%

SILT / CLAY: 8%
 Specific Gravity: 2.66
 Porosity : 25.7%

Sieve Size / Particle Diameter	Percent Passing
(1-1/2")	100
(3/4")	95
(1/2")	87
(3/8")	81
(#4)	59
(#10)	58
(#16)	46
(#40)	25
(#50)	20
(#100)	12
(#200)	8
0.0379	6
0.0240	6
0.0139	5
0.0098	5
0.0069	5
0.0034	5
0.0014	4



GRAVEL: 30% SAND: 57% SILT AND CLAY: 13%
 FROM: B13 @ 25-30.5 feet

Sieve Size / Particle Diameter	Percent Passing
(1")	100
(3/4")	91
(3/8")	79
(#4)	69
(#10)	60
(#16)	50
(#30)	38
(#50)	29
(#100)	19
(#200)	13

HEPWORTH-PAWLAK GEOTECHNICAL, INC.

JOB NO. 215333B

PROJECT: CHEROKEE

TABLE 1
SUMMARY OF LABORATORY TEST RESULTS

SAMPLE LOCATION		NATURAL MOISTURE CONTENT (%)	NATURAL DRY UNIT WEIGHT (PCF)	GRADATION			SPECIFIC GRAVITY	POROSITY (%)
BORING	DEPTH			GRAVEL (%)	SAND (%)	SILT & CLAY (%)		
MW7	0' to 6"	18.6	-	0	59	41	2.65	-
MW8	12'4" - 12'8"	24.5	92	0	4	96	2.73	46.3
MW9	19'10" - 20'2"	13.1	119	20	49	31	2.78	31.5
MW10	20'4" - 20'8"	2.5	127	39	52	10	2.78	26.5
MW11	20'10" - 21'2"	2.3	120	44	53	4	2.65	26.9
MW12	21'4" - 21'8"	9.2	123	41	51	8	2.66	25.7
MW13	25'0" - 30'6"	4.2	-	30	57	13	-	-

GEOTECHNICAL SAMPLE CHAIN OF CUSTODY RECORD

HP GEOTECH, 10302 S. Progress Way, Parker, CO 80134. Ph 303-841-7119 Fax 303-841-7556

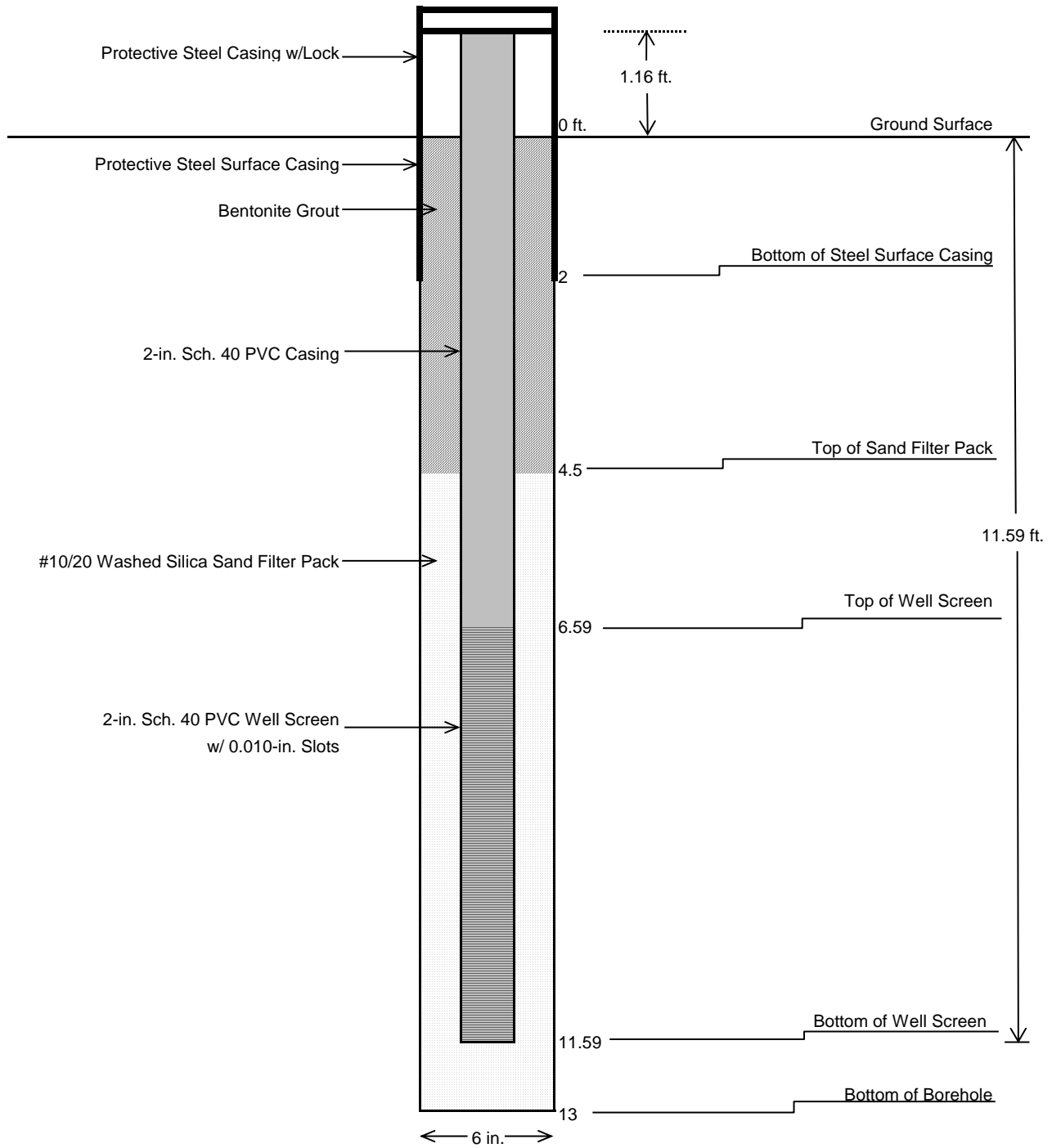
LAB #:

CLIENT NAME: HDR		PROJECT NAME: Xcel CCR		PROJECT #: 266180		SAMPLE TYPE: California													
ADDRESS: 1670 Broadway, Suite 3400 Denver, CO 80202		Date: 11/16/15		STATE FORMS? <input type="checkbox"/>		# OF SAMPLES: 9													
PROJECT MANAGER: Anna Lundin		TURN AROUND TIME: STD <input type="checkbox"/> RUSH <input type="checkbox"/>		ANALYSIS REQUESTED		PAGE ____ OF ____													
PHONE: 303.323.9805 FAX: E-MAIL: Anna.Lundin@hdrinc.com		# OF BOTTLES											REP:						
INVOICE TO: Attn: Anna Lundin HDR PO#:													ID#:						
SPECIAL MAIL <input type="checkbox"/> E-MAIL <input type="checkbox"/> FAX <input type="checkbox"/> EDT <input type="checkbox"/>													SYSTEM#:						
													GLOBAL ID#:						
DATE	TIME	WATER	COMP	SOIL	Sample ID and Depth Interval													LAB ID	REMARKS
11/9/15				X	MW-8 12'4"-12'8" Cherokee														
11/9/15				X	MW-9 19'10"-20'2" Cherokee														
11/10/15				X	MW-10 20'4"-20'8" Cherokee														
11/5/15				X	MW-11 20'10"-21'2" Cherokee														
11/6/15				X	MW-12 21'4"-21'8" Cherokee														
10/30/15				X	MW-9 18'4"-18'8" Valmont														
11/2/15				X	MW-10 20'4"-20'8" Valmont														
11/8/15				X	MW-11 18'4"-18'8" Valmont														
11/10/15				X	MW-12 15'4"-15'8" Valmont														
PRESERVED WITH:		N/A																	
SAMPLED BY: Justin Bills		DATE/TIME: 10/30-11/10		RELINQUISHED BY: <i>[Signature]</i>		DATE/TIME: 11/16/15													
RECEIVED BY: ARBEO KALAVESHI		DATE/TIME: 11/16		RELINQUISHED BY:		DATE/TIME:													
RECEIVED BY: (SAMPLES UNVERIFIED)		DATE/TIME:		RELINQUISHED BY:		DATE/TIME:													
RECEIVED BY LAB: (VERIFIED)		DATE/TIME:		SAMPLES SHIPPED VIA: UPS FEDEX POST BUS OTHER _____															



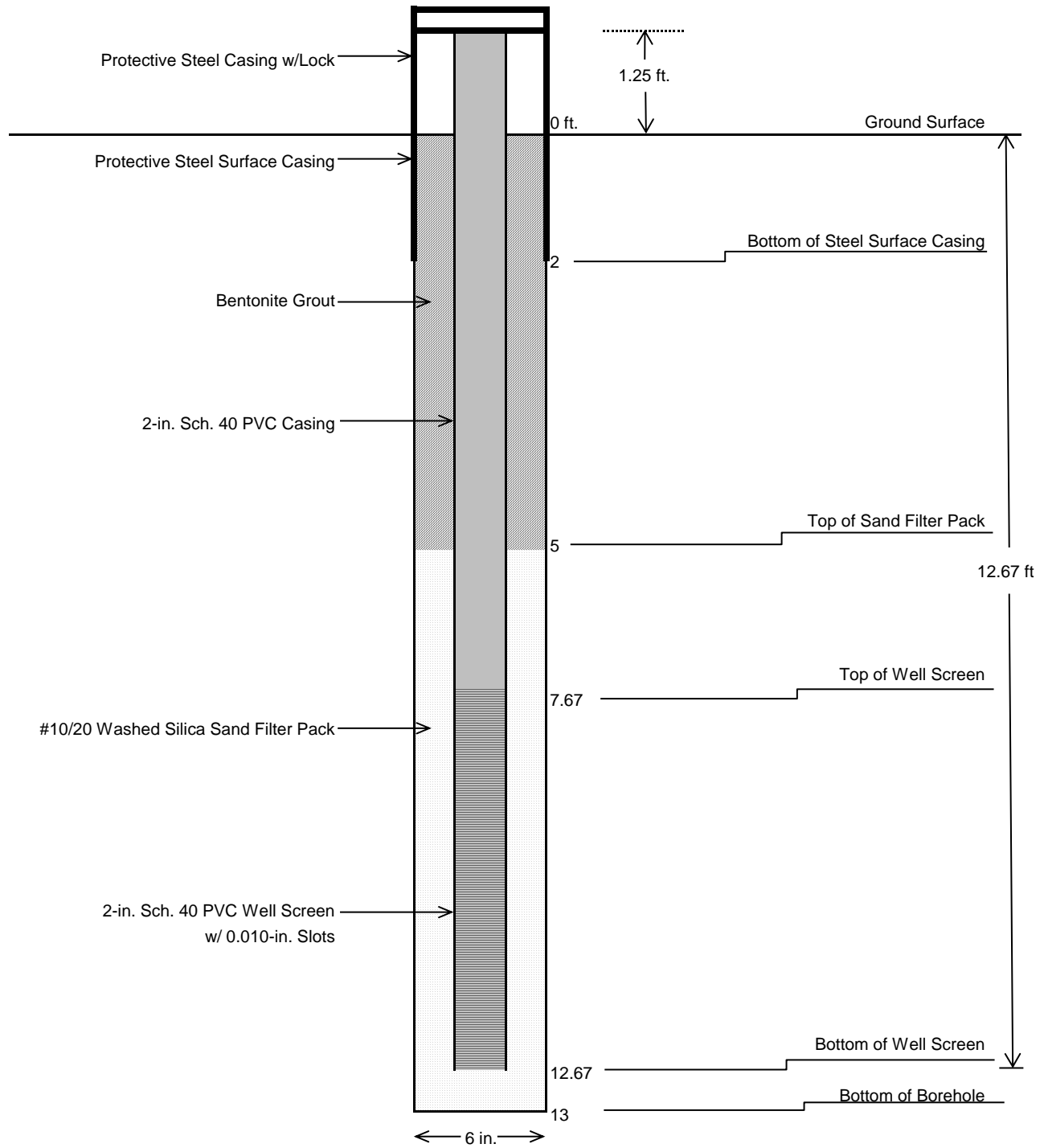
Appendix C

Well Construction Diagrams



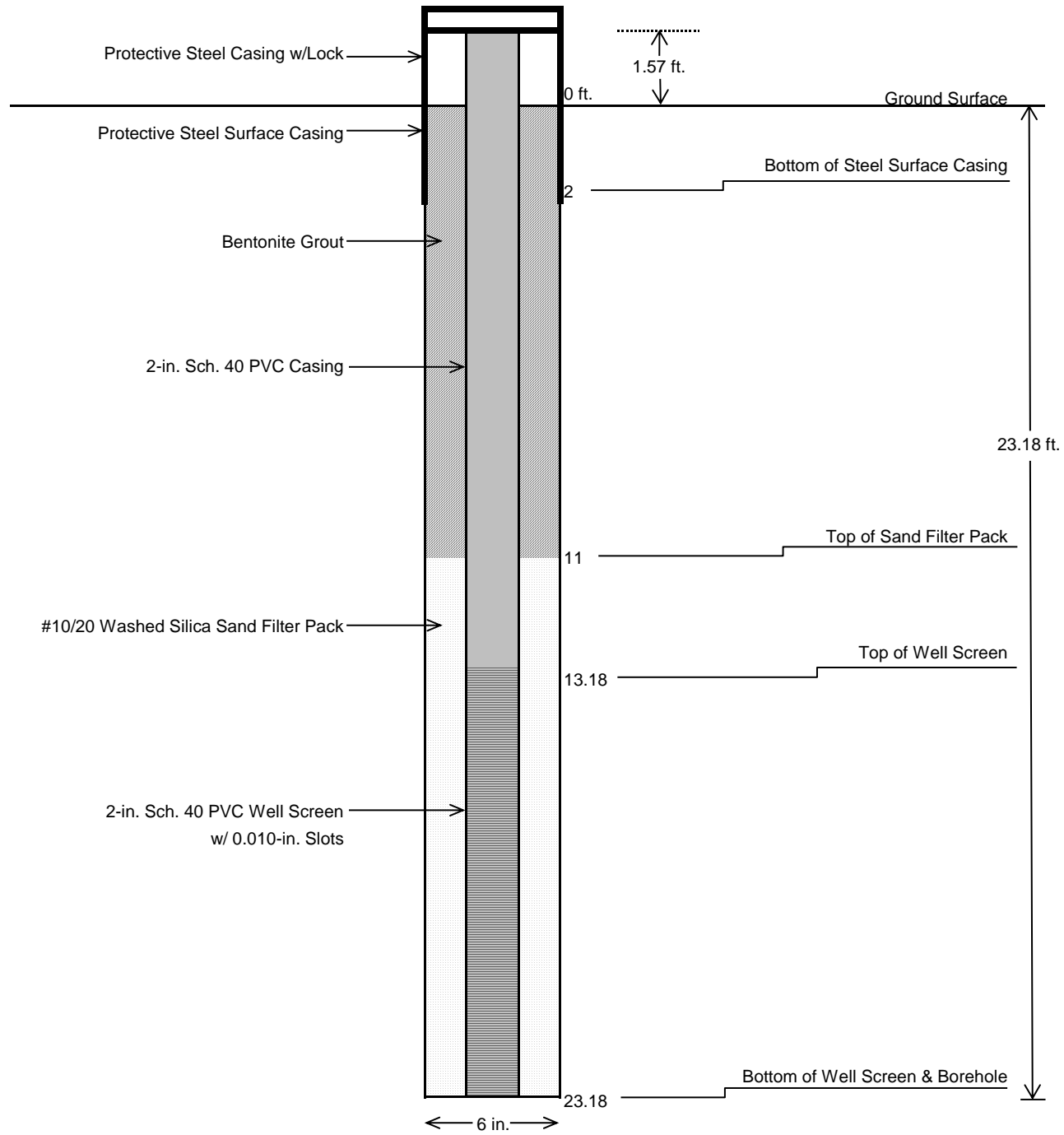
Constructed: 11/9/2015
 Drilled By: Site Services Drilling, LLC
 PVC Casing EL: 5153.86 ft amsl
 Water EL: 5148.36 ft amsl (December 2015)

Monitoring Well Construction Diagram
MW-7
Cherokee Station
Xcel Energy



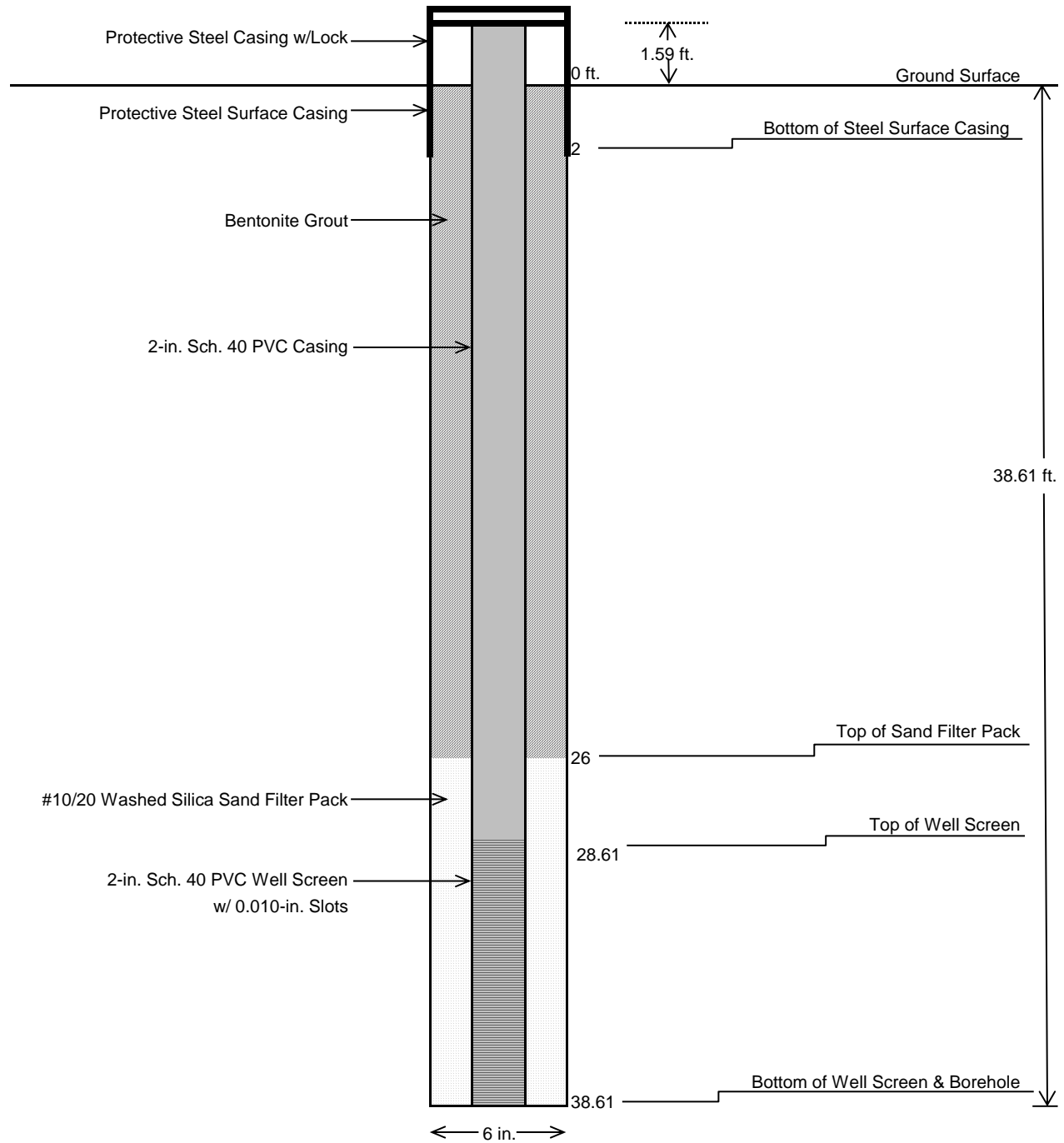
Constructed: 11/9/2015
 Drilled By: Site Services Drilling, LLC
 PVC Casing EL: 5140.64 ft amsl
 Water EL: 5132.34 ft amsl (December 2015)

Monitoring Well Construction Diagram
MW-8
Cherokee Station
Xcel Energy



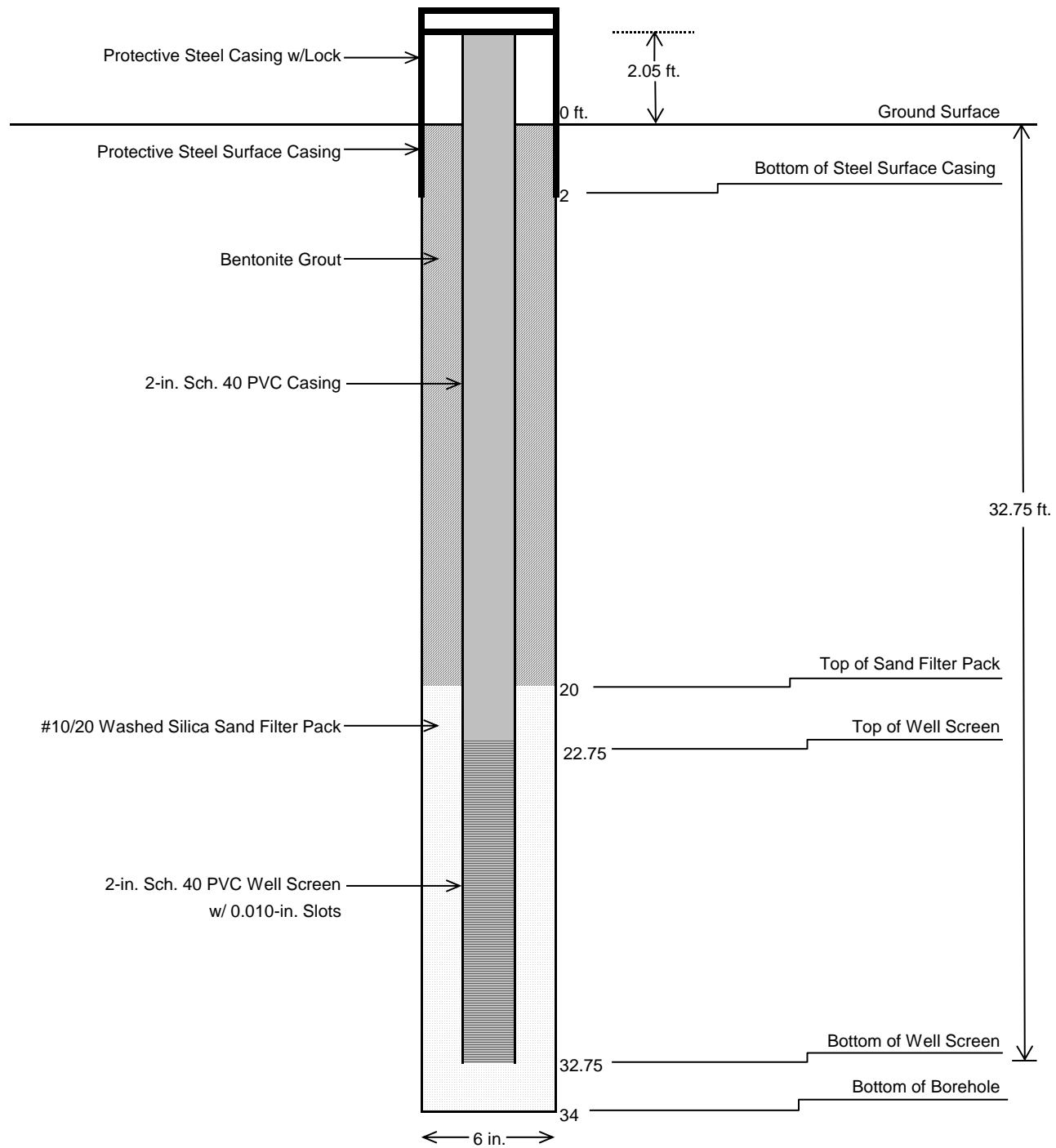
Constructed: 11/9/2015
 Drilled By: Site Services Drilling, LLC
 PVC Casing EL: 5141.26 ft amsl
 Water EL: 5122.20 ft amsl (December 2015)

Monitoring Well Construction Diagram
MW-9
Cherokee Station
Xcel Energy



Constructed: 11/9/2015
 Drilled By: Site Services Drilling, LLC
 PVC Casing EL: 5140.88 ft amsl
 Water EL: 5115.47 ft amsl (December 2015)

Monitoring Well Construction Diagram
MW-10
Cherokee Station
Xcel Energy



Constructed: 11/6/2015
Drilled By: Site Services Drilling, LLC
PVC Casing EL: 5174.50 ft amsl
Water EL: 5143.26 ft amsl (December 2015)

Monitoring Well Construction Diagram
MW-13
Cherokee Station
Xcel Energy



Appendix D

State Well Permits

Form No.
GWS-25

OFFICE OF THE STATE ENGINEER
COLORADO DIVISION OF WATER RESOURCES
818 Centennial Bldg., 1313 Sherman St., Denver, Colorado 80203
(303) 866-3581

EXST

WELL PERMIT NUMBER 299993 - -
DIV. 1 WD 8 DES. BASIN MD

APPLICANT

PUBLIC SERVICE COMPANY OF COLORADO
C/O R WALTHER/HDR INC
1670 BROADWAY
DENVER, CO 80202-

(303) 318-6303

APPROVED WELL LOCATION

ADAMS COUNTY
NE 1/4 NE 1/4 Section 11
Township 3 S Range 68 W Sixth P.M.

DISTANCES FROM SECTION LINES

14 Ft. from North Section Line
1262 Ft. from East Section Line

UTM COORDINATES (Meters, Zone: 13, NAD83)

Easting: 503096 Northing: 4406955

PERMIT TO USE AN EXISTING WELL

ISSUANCE OF THIS PERMIT DOES NOT CONFER A WATER RIGHT

CONDITIONS OF APPROVAL

- 1) This well shall be used in such a way as to cause no material injury to existing water rights. The issuance of this permit does not ensure that no injury will occur to another vested water right or preclude another owner of a vested water right from seeking relief in a civil court action.
- 2) The construction of this well shall be in compliance with the Water Well Construction Rules 2 CCR 402-2, unless approval of a variance has been granted by the State Board of Examiners of Water Well Construction and Pump Installation Contractors in accordance with Rule 18.
- 3) Approved pursuant to CRS 37-92-602(3)(b)(I) for uses as described in CRS 37-92-602(1)(f). Use of this well is limited to monitoring water levels and/or water quality sampling.
- 4) Approved for the use of an existing well acknowledged for construction under monitoring hole notice MH-54628, and known as MW-13.
- 5) This well must be equipped with a locking cap or seal to prevent well contamination or possible hazards as an open well. The well must be kept capped and locked at all times except during sampling or measuring.
- 6) Records of water level measurements and water quality analyses shall be maintained by the well owner and submitted to the Division of Water Resources upon request.
- 7) Upon conclusion of the monitoring program the well owner shall plug this well in accordance with Rule 16 of the Water Well Construction Rules. A Well Abandonment Report must be completed and submitted to the Division of Water Resources within 60 days of plugging.
- 8) The owner shall mark the well in a conspicuous place with the well permit number and name of aquifer as appropriate, and shall take necessary means and precautions to preserve these markings.
- 9) This well must have been constructed by or under the supervision of a licensed well driller or other authorized individual according to the Water Well Construction Rules.
- 10) This well must be located not more than 200 feet from the location specified on this permit.

NOTE: Issuance of this permit does not guarantee that this well can be converted to a production well under a future permit. Additionally, pursuant to Rule 14.2 of the Water Well Construction Rules (2 CCR 402-2), monitoring holes constructed pursuant to a monitoring hole notice shall not be converted to a production well. (Upon obtaining a permit from the State Engineer, a monitoring hole may be converted to a monitoring well, recovery well for remediation of the aquifer, or a dewatering system for dewatering the aquifer.)

NOTICE: This permit has been approved subject to the following changes: The distances from section lines were determined from UTM coordinate values provided with the permit application. You are hereby notified that you have the right to appeal the issuance of this permit, by filing a written request with this office within sixty (60) days of the date of issuance, pursuant to the State Administrative Procedures Act. (See Section 24-4-104 through 106, C.R.S.)

APPROVED
GAD

Dick Wolfe
State Engineer

Geoff Davis
By

Receipt No. 3672842F

DATE ISSUED 01-26-2016

EXPIRATION DATE N/A

Form No.
GWS-25

OFFICE OF THE STATE ENGINEER
COLORADO DIVISION OF WATER RESOURCES
818 Centennial Bldg., 1313 Sherman St., Denver, Colorado 80203
(303) 866-3581

EXST

WELL PERMIT NUMBER 299991 - -
DIV. 1 WD 8 DES. BASIN MD

APPLICANT

PUBLIC SERVICE COMPANY OF COLORADO
C/O R WALTHER/HDR INC
1670 BROADWAY
DENVER, CO 80202-

(303) 318-6303

APPROVED WELL LOCATION

ADAMS COUNTY
NE 1/4 NE 1/4 Section 11
Township 3 S Range 68 W Sixth P.M.

DISTANCES FROM SECTION LINES

921 Ft. from North Section Line
780 Ft. from East Section Line

UTM COORDINATES (Meters, Zone:13,NAD83)

Easting: 503243 Northing: 4406678

PERMIT TO USE AN EXISTING WELL

ISSUANCE OF THIS PERMIT DOES NOT CONFER A WATER RIGHT

CONDITIONS OF APPROVAL

- 1) This well shall be used in such a way as to cause no material injury to existing water rights. The issuance of this permit does not ensure that no injury will occur to another vested water right or preclude another owner of a vested water right from seeking relief in a civil court action.
- 2) The construction of this well shall be in compliance with the Water Well Construction Rules 2 CCR 402-2, unless approval of a variance has been granted by the State Board of Examiners of Water Well Construction and Pump Installation Contractors in accordance with Rule 18.
- 3) Approved pursuant to CRS 37-92-602(3)(b)(I) for uses as described in CRS 37-92-602(1)(f). Use of this well is limited to monitoring water levels and/or water quality sampling.
- 4) Approved for the use of an existing well acknowledged for construction under monitoring hole notice MH-54582, and known as MW-10.
- 5) This well must be equipped with a locking cap or seal to prevent well contamination or possible hazards as an open well. The well must be kept capped and locked at all times except during sampling or measuring.
- 6) Records of water level measurements and water quality analyses shall be maintained by the well owner and submitted to the Division of Water Resources upon request.
- 7) Upon conclusion of the monitoring program the well owner shall plug this well in accordance with Rule 16 of the Water Well Construction Rules. A Well Abandonment Report must be completed and submitted to the Division of Water Resources within 60 days of plugging.
- 8) The owner shall mark the well in a conspicuous place with the well permit number and name of aquifer as appropriate, and shall take necessary means and precautions to preserve these markings.
- 9) This well must have been constructed by or under the supervision of a licensed well driller or other authorized individual according to the Water Well Construction Rules.
- 10) This well must be located not more than 200 feet from the location specified on this permit.

NOTE: Issuance of this permit does not guarantee that this well can be converted to a production well under a future permit. Additionally, pursuant to Rule 14.2 of the Water Well Construction Rules (2 CCR 402-2), monitoring holes constructed pursuant to a monitoring hole notice shall not be converted to a production well. (Upon obtaining a permit from the State Engineer, a monitoring hole may be converted to a monitoring well, recovery well for remediation of the aquifer, or a dewatering system for dewatering the aquifer.)

NOTICE: This permit has been approved subject to the following changes: The distances from section lines were determined from UTM coordinate values provided with the permit application. You are hereby notified that you have the right to appeal the issuance of this permit, by filing a written request with this office within sixty (60) days of the date of issuance, pursuant to the State Administrative Procedures Act. (See Section 24-4-104 through 106, C.R.S.)

APPROVED
GAD

Dick Wolfe by

State Engineer

Geoff Davis

By

Receipt No. 3672842D

DATE ISSUED 01-26-2016

EXPIRATION DATE N/A

Form No.
GWS-25

OFFICE OF THE STATE ENGINEER
COLORADO DIVISION OF WATER RESOURCES
818 Centennial Bldg., 1313 Sherman St., Denver, Colorado 80203
(303) 866-3581

EXST

WELL PERMIT NUMBER 299990 - - -
DIV. 1 WD 8 DES. BASIN MD

APPLICANT

PUBLIC SERVICE COMPANY OF COLORADO
C/O R WALTHER/HDR INC
1670 BROADWAY
DENVER, CO 80202-

(303) 318-6303

APPROVED WELL LOCATION

ADAMS COUNTY
NE 1/4 NE 1/4 Section 11
Township 3 S Range 68 W Sixth P.M.

DISTANCES FROM SECTION LINES

619 Ft. from North Section Line
705 Ft. from East Section Line

UTM COORDINATES (Meters, Zone:13,NAD83)

Easting: 503266 Northing: 4406770

PERMIT TO USE AN EXISTING WELL

ISSUANCE OF THIS PERMIT DOES NOT CONFER A WATER RIGHT

CONDITIONS OF APPROVAL

- 1) This well shall be used in such a way as to cause no material injury to existing water rights. The issuance of this permit does not ensure that no injury will occur to another vested water right or preclude another owner of a vested water right from seeking relief in a civil court action.
- 2) The construction of this well shall be in compliance with the Water Well Construction Rules 2 CCR 402-2, unless approval of a variance has been granted by the State Board of Examiners of Water Well Construction and Pump Installation Contractors in accordance with Rule 18.
- 3) Approved pursuant to CRS 37-92-602(3)(b)(I) for uses as described in CRS 37-92-602(1)(f). Use of this well is limited to monitoring water levels and/or water quality sampling.
- 4) Approved for the use of an existing well acknowledged for construction under monitoring hole notice MH-54582, and known as MW-9.
- 5) This well must be equipped with a locking cap or seal to prevent well contamination or possible hazards as an open well. The well must be kept capped and locked at all times except during sampling or measuring.
- 6) Records of water level measurements and water quality analyses shall be maintained by the well owner and submitted to the Division of Water Resources upon request.
- 7) Upon conclusion of the monitoring program the well owner shall plug this well in accordance with Rule 16 of the Water Well Construction Rules. A Well Abandonment Report must be completed and submitted to the Division of Water Resources within 60 days of plugging.
- 8) The owner shall mark the well in a conspicuous place with the well permit number and name of aquifer as appropriate, and shall take necessary means and precautions to preserve these markings.
- 9) This well must have been constructed by or under the supervision of a licensed well driller or other authorized individual according to the Water Well Construction Rules.
- 10) This well must be located not more than 200 feet from the location specified on this permit.

NOTE: Issuance of this permit does not guarantee that this well can be converted to a production well under a future permit. Additionally, pursuant to Rule 14.2 of the Water Well Construction Rules (2 CCR 402-2), monitoring holes constructed pursuant to a monitoring hole notice shall not be converted to a production well. (Upon obtaining a permit from the State Engineer, a monitoring hole may be converted to a monitoring well, recovery well for remediation of the aquifer, or a dewatering system for dewatering the aquifer.)

NOTICE: This permit has been approved subject to the following changes: The distances from section lines were determined from UTM coordinate values provided with the permit application. You are hereby notified that you have the right to appeal the issuance of this permit, by filing a written request with this office within sixty (60) days of the date of issuance, pursuant to the State Administrative Procedures Act. (See Section 24-4-104 through 106, C.R.S.)

APPROVED
GAD

Dick Wolfe by
State Engineer

Geoff Davis
By

Receipt No. 3672842C

DATE ISSUED 01-26-2016

EXPIRATION DATE N/A

Form No.
GWS-25

OFFICE OF THE STATE ENGINEER
COLORADO DIVISION OF WATER RESOURCES
818 Centennial Bldg., 1313 Sherman St., Denver, Colorado 80203
(303) 866-3581

EXST

WELL PERMIT NUMBER 299988 - -
DIV. 1 WD 8 DES. BASIN MD

APPLICANT

PUBLIC SERVICE COMPANY OF COLORADO
C/O R WALTHER/HDR INC
1670 BROADWAY
DENVER, CO 80202-

(303) 571-7340

APPROVED WELL LOCATION

ADAMS COUNTY
NE 1/4 NE 1/4 Section 11
Township 3 S Range 68 W Sixth P.M.

DISTANCES FROM SECTION LINES

538 Ft. from North Section Line
1249 Ft. from East Section Line

UTM COORDINATES (Meters, Zone: 13, NAD83)

Easting: 503100 Northing: 4406795

PERMIT TO USE AN EXISTING WELL

ISSUANCE OF THIS PERMIT DOES NOT CONFER A WATER RIGHT

CONDITIONS OF APPROVAL

- 1) This well shall be used in such a way as to cause no material injury to existing water rights. The issuance of this permit does not ensure that no injury will occur to another vested water right or preclude another owner of a vested water right from seeking relief in a civil court action.
- 2) The construction of this well shall be in compliance with the Water Well Construction Rules 2 CCR 402-2, unless approval of a variance has been granted by the State Board of Examiners of Water Well Construction and Pump Installation Contractors in accordance with Rule 18.
- 3) Approved pursuant to CRS 37-92-602(3)(b)(I) for uses as described in CRS 37-92-602(1)(f). Use of this well is limited to monitoring water levels and/or water quality sampling.
- 4) Approved for the use of an existing well acknowledged for construction under monitoring hole notice MH-54582, and known as MW-7.
- 5) This well must be equipped with a locking cap or seal to prevent well contamination or possible hazards as an open well. The well must be kept capped and locked at all times except during sampling or measuring.
- 6) Records of water level measurements and water quality analyses shall be maintained by the well owner and submitted to the Division of Water Resources upon request.
- 7) Upon conclusion of the monitoring program the well owner shall plug this well in accordance with Rule 16 of the Water Well Construction Rules. A Well Abandonment Report must be completed and submitted to the Division of Water Resources within 60 days of plugging.
- 8) The owner shall mark the well in a conspicuous place with the well permit number and name of aquifer as appropriate, and shall take necessary means and precautions to preserve these markings.
- 9) This well must have been constructed by or under the supervision of a licensed well driller or other authorized individual according to the Water Well Construction Rules.
- 10) This well must be located not more than 200 feet from the location specified on this permit.

NOTE: Issuance of this permit does not guarantee that this well can be converted to a production well under a future permit. Additionally, pursuant to Rule 14.2 of the Water Well Construction Rules (2 CCR 402-2), monitoring holes constructed pursuant to a monitoring hole notice shall not be converted to a production well. (Upon obtaining a permit from the State Engineer, a monitoring hole may be converted to a monitoring well, recovery well for remediation of the aquifer, or a dewatering system for dewatering the aquifer.)

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APPROVED
GAD

Dick Wolfe by
State Engineer

Geoff Davis
By

Receipt No. 3672842A

DATE ISSUED 01-26-2016

EXPIRATION DATE N/A

Form No.
GWS-25

OFFICE OF THE STATE ENGINEER
COLORADO DIVISION OF WATER RESOURCES
818 Centennial Bldg., 1313 Sherman St., Denver, Colorado 80203
(303) 866-3581

EXST

WELL PERMIT NUMBER 299989 - - -
DIV. 1 WD 8 DES. BASIN MD

APPLICANT

PUBLIC SERVICE COMPANY OF COLORADO
C/O R WALTHER/HDR INC
1670 BROADWAY
DENVER, CO 80202-

(303) 571-7340

APPROVED WELL LOCATION

ADAMS COUNTY
NE 1/4 NE 1/4 Section 11
Township 3 S Range 68 W Sixth P.M.

DISTANCES FROM SECTION LINES

327 Ft. from North Section Line
645 Ft. from East Section Line

UTM COORDINATES (Meters, Zone:13,NAD83)

Easting: 503284 Northing: 4406859

PERMIT TO USE AN EXISTING WELL

ISSUANCE OF THIS PERMIT DOES NOT CONFER A WATER RIGHT

CONDITIONS OF APPROVAL

- 1) This well shall be used in such a way as to cause no material injury to existing water rights. The issuance of this permit does not ensure that no injury will occur to another vested water right or preclude another owner of a vested water right from seeking relief in a civil court action.
- 2) The construction of this well shall be in compliance with the Water Well Construction Rules 2 CCR 402-2, unless approval of a variance has been granted by the State Board of Examiners of Water Well Construction and Pump Installation Contractors in accordance with Rule 18.
- 3) Approved pursuant to CRS 37-92-602(3)(b)(l) for uses as described in CRS 37-92-602(1)(f). Use of this well is limited to monitoring water levels and/or water quality sampling.
- 4) Approved for the use of an existing well acknowledged for construction under monitoring hole notice MH-54582, and known as MW-8.
- 5) This well must be equipped with a locking cap or seal to prevent well contamination or possible hazards as an open well. The well must be kept capped and locked at all times except during sampling or measuring.
- 6) Records of water level measurements and water quality analyses shall be maintained by the well owner and submitted to the Division of Water Resources upon request.
- 7) Upon conclusion of the monitoring program the well owner shall plug this well in accordance with Rule 16 of the Water Well Construction Rules. A Well Abandonment Report must be completed and submitted to the Division of Water Resources within 60 days of plugging.
- 8) The owner shall mark the well in a conspicuous place with the well permit number and name of aquifer as appropriate, and shall take necessary means and precautions to preserve these markings.
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- 10) This well must be located not more than 200 feet from the location specified on this permit.

NOTE: Issuance of this permit does not guarantee that this well can be converted to a production well under a future permit. Additionally, pursuant to Rule 14.2 of the Water Well Construction Rules (2 CCR 402-2), monitoring holes constructed pursuant to a monitoring hole notice shall not be converted to a production well. (Upon obtaining a permit from the State Engineer, a monitoring hole may be converted to a monitoring well, recovery well for remediation of the aquifer, or a dewatering system for dewatering the aquifer.)

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APPROVED
GAD

Dick Wolfe
State Engineer

Geoff Davis
By

Receipt No. 3672842B

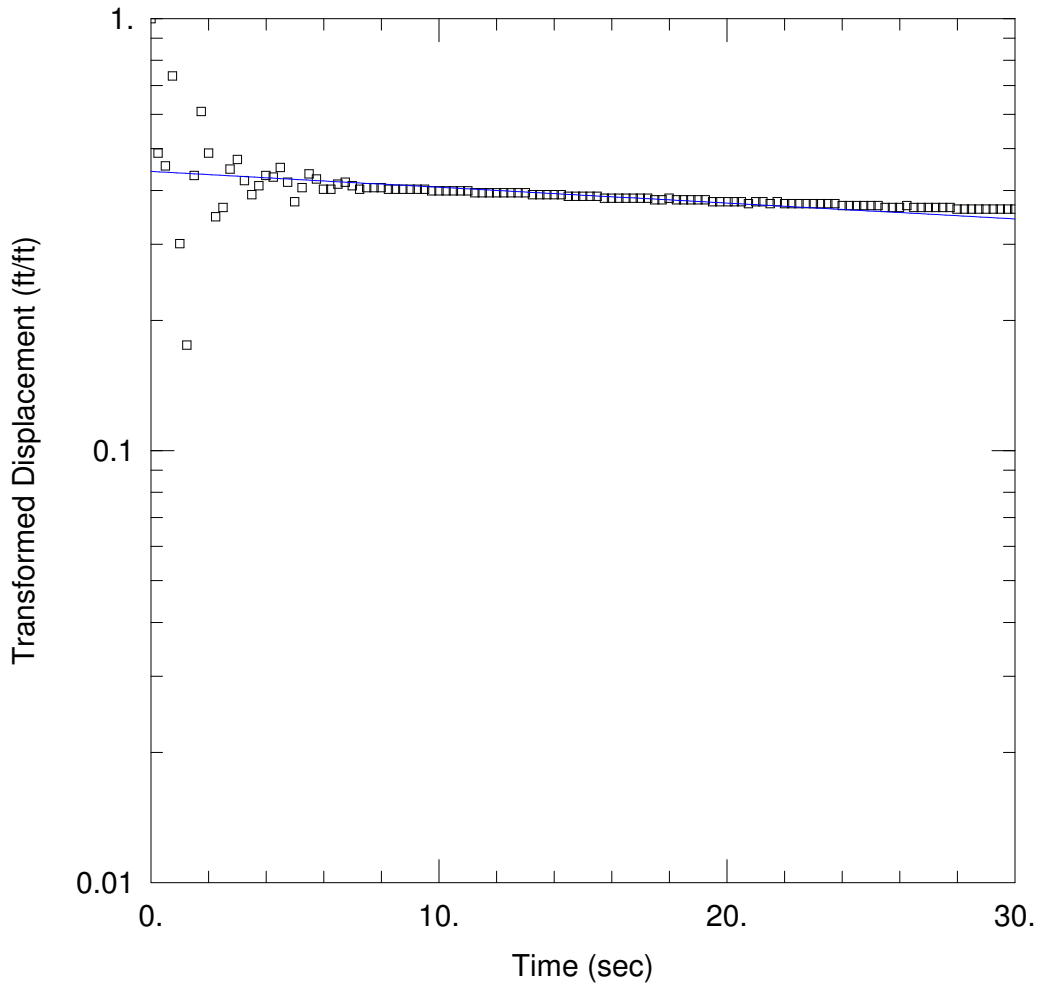
DATE ISSUED 01-26-2016

EXPIRATION DATE N/A



Appendix E

Slug Test Analyses



MW-7 SLUG IN

Data Set: P:\...\Cherokee MW-7 Slug In Dagan.aqt

Date: 01/22/16

Time: 09:32:41

PROJECT INFORMATION

Company: HDR

Client: Xcel Energy

Project: 266180

Location: Cherokee Station

Test Well: MW-7

Test Date: 12/22/2015

AQUIFER DATA

Saturated Thickness: 8.2 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-7)

Initial Displacement: 2.56 ft

Static Water Column Height: 4.2 ft

Total Well Penetration Depth: 4.2 ft

Screen Length: 4.2 ft

Casing Radius: 0.083 ft

Well Radius: 0.25 ft

Gravel Pack Porosity: 0.3

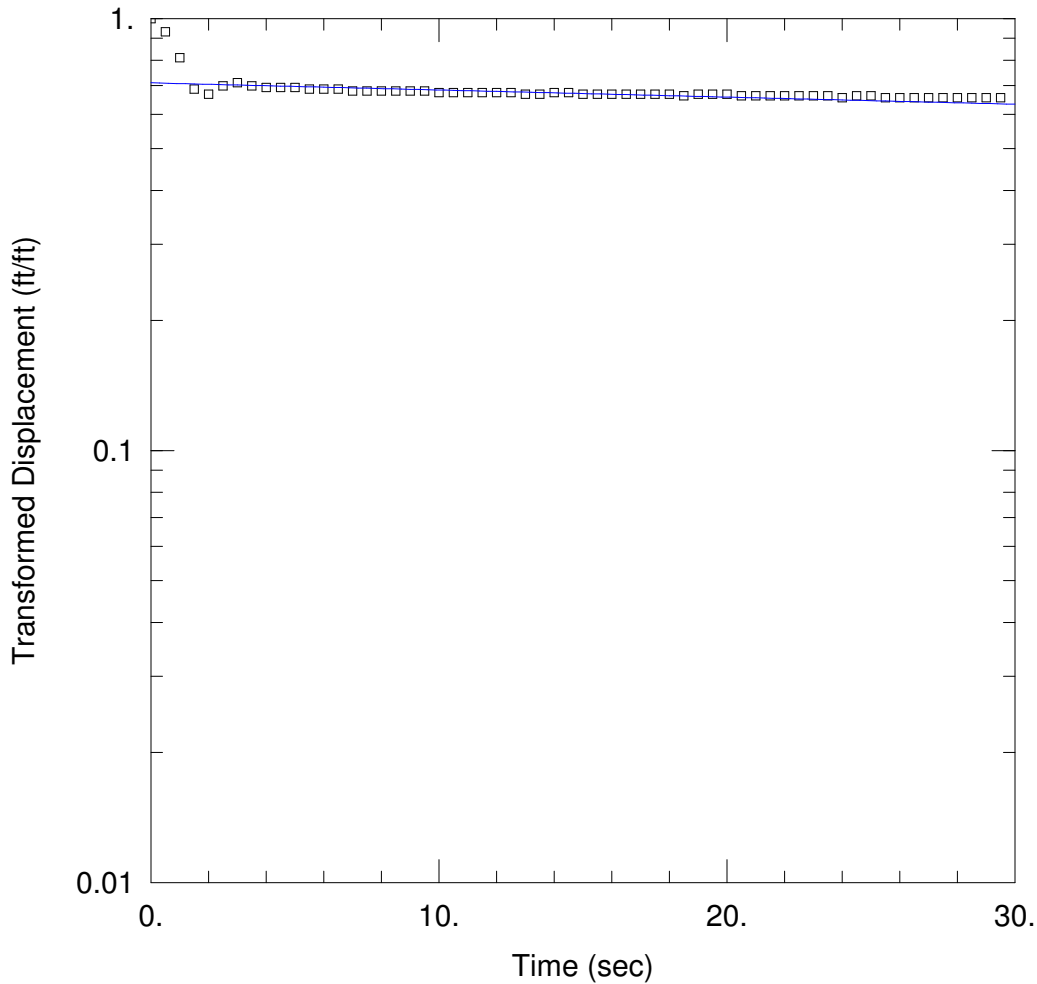
SOLUTION

Aquifer Model: Unconfined

Solution Method: Dagan

K = 0.0004925 cm/sec

y0 = 1.365 ft



MW-7 SLUG OUT

Data Set: P:\...\Cherokee MW-7 Slug Out Dagan.aqt

Date: 01/22/16

Time: 09:33:12

PROJECT INFORMATION

Company: HDR

Client: Xcel Energy

Project: 266180

Location: Cherokee Station

Test Well: MW-7

Test Date: 12/22/2015

AQUIFER DATA

Saturated Thickness: 8.2 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-7)

Initial Displacement: 1.82 ft

Static Water Column Height: 4.2 ft

Total Well Penetration Depth: 4.2 ft

Screen Length: 4.2 ft

Casing Radius: 0.083 ft

Well Radius: 0.25 ft

Gravel Pack Porosity: 0.3

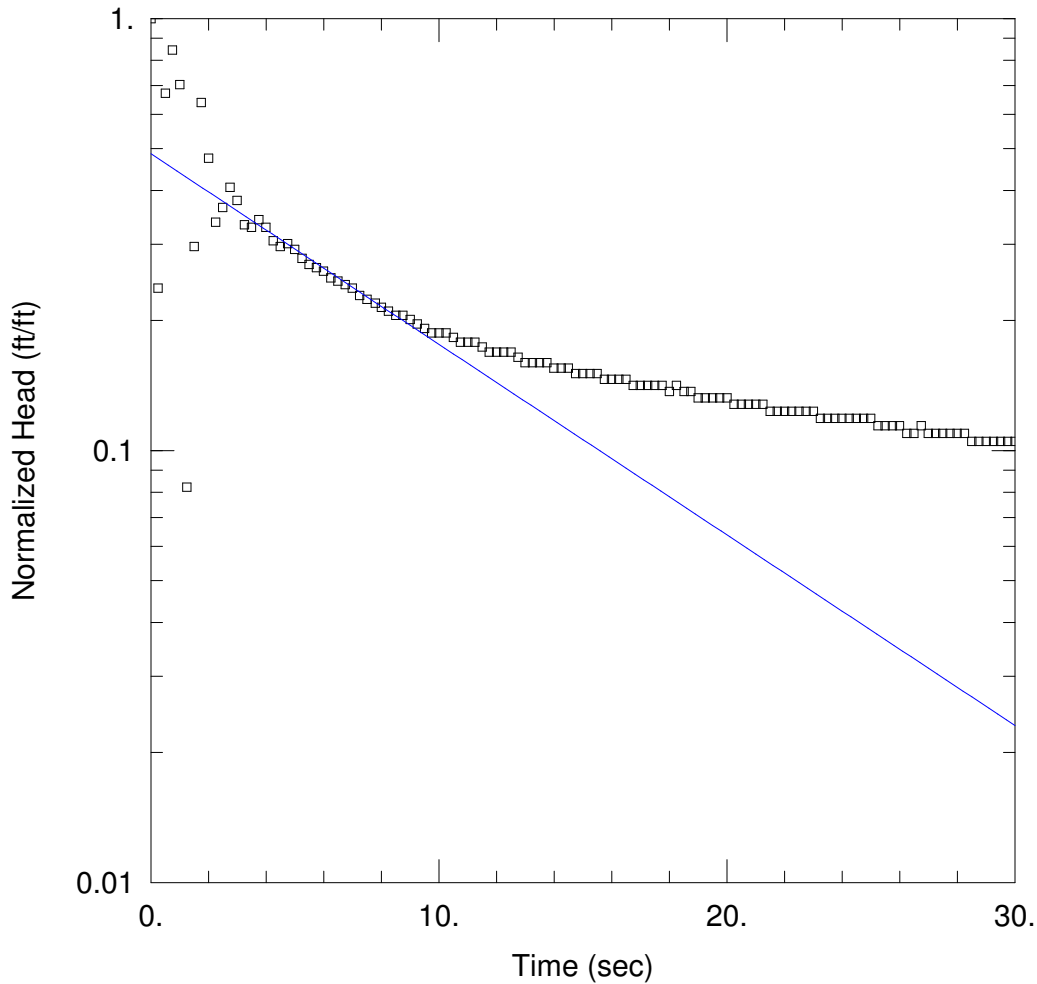
SOLUTION

Aquifer Model: Unconfined

Solution Method: Dagan

K = 0.0002205 cm/sec

y0 = 1.378 ft



MW-8 SLUG IN 2

Data Set: P:\...\Cherokee MW-8 Slug In 2 BouwerRice.aqt
 Date: 01/22/16 Time: 09:33:43

PROJECT INFORMATION

Company: HDR
 Client: Xcel Energy
 Project: 266180
 Location: Cherokee Station
 Test Well: MW-8
 Test Date: 12/22/2015

AQUIFER DATA

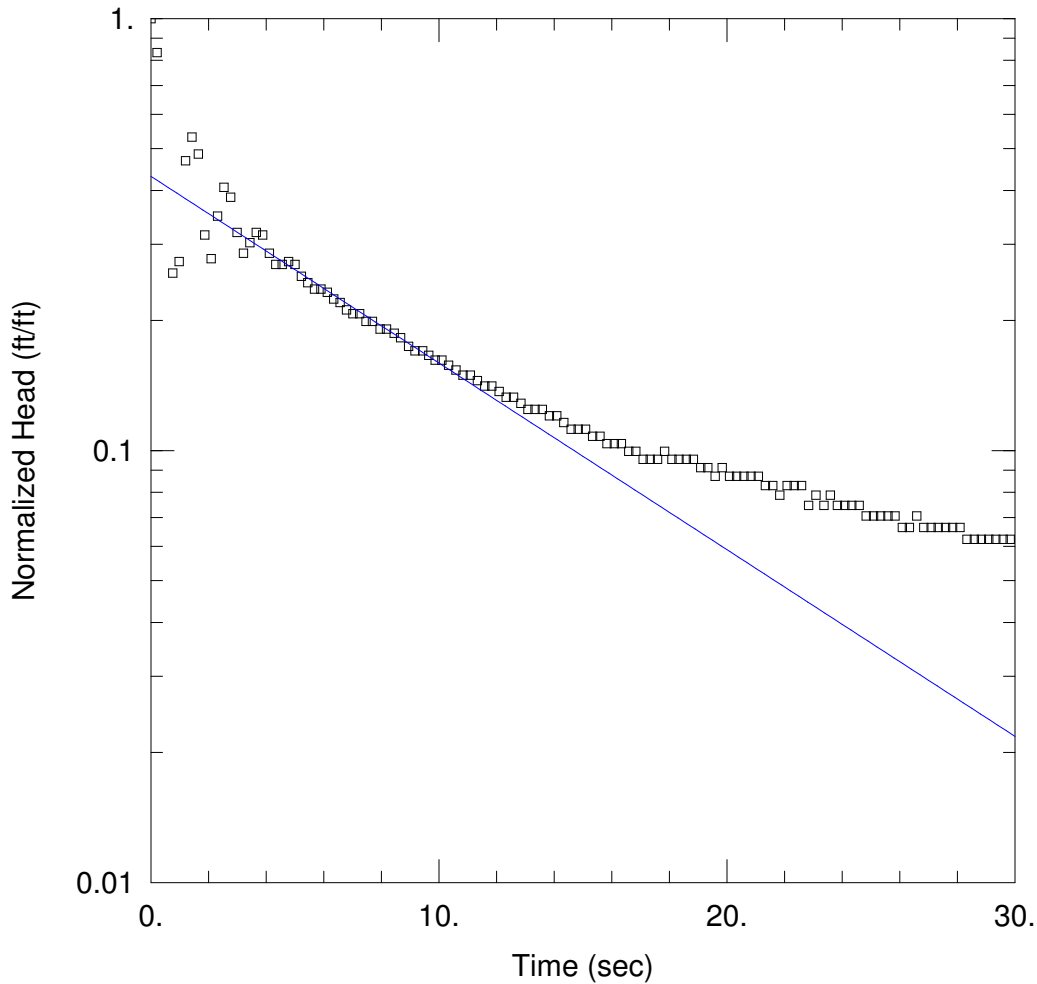
Saturated Thickness: 5.12 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-8)

Initial Displacement: 2.19 ft Static Water Column Height: 5.12 ft
 Total Well Penetration Depth: 5.12 ft Screen Length: 3.08 ft
 Casing Radius: 0.083 ft Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice
 K = 0.007224 cm/sec $y_0 =$ 1.065 ft



MW-8 SLUG IN

Data Set: P:\...\Cherokee MW-8 Slug In BouwerRice.aqt

Date: 01/22/16

Time: 09:33:59

PROJECT INFORMATION

Company: HDR

Client: Xcel Energy

Project: 266180

Location: Cherokee Station

Test Well: MW-8

Test Date: 12/22/2015

AQUIFER DATA

Saturated Thickness: 5.12 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-8)

Initial Displacement: 2.41 ft

Static Water Column Height: 5.12 ft

Total Well Penetration Depth: 5.12 ft

Screen Length: 3.08 ft

Casing Radius: 0.083 ft

Well Radius: 0.25 ft

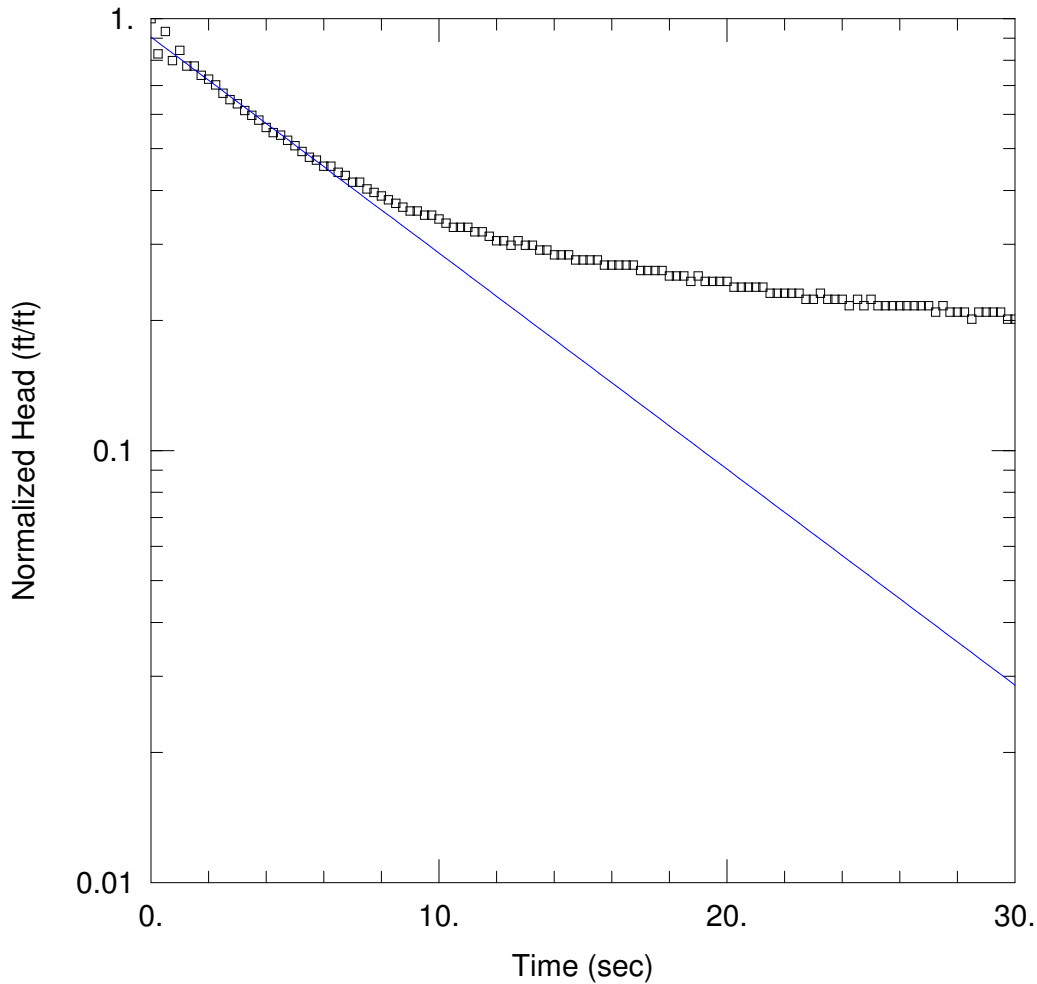
SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

K = 0.007078 cm/sec

y0 = 1.039 ft



MW-8 SLUG OUT 2

Data Set: P:\...\Cherokee MW-8 Slug Out 2 BowerRice.aqt
 Date: 01/22/16 Time: 09:34:15

PROJECT INFORMATION

Company: HDR
 Client: Xcel Energy
 Project: 266180
 Location: Cherokee Station
 Test Well: MW-8
 Test Date: 12/22/2015

AQUIFER DATA

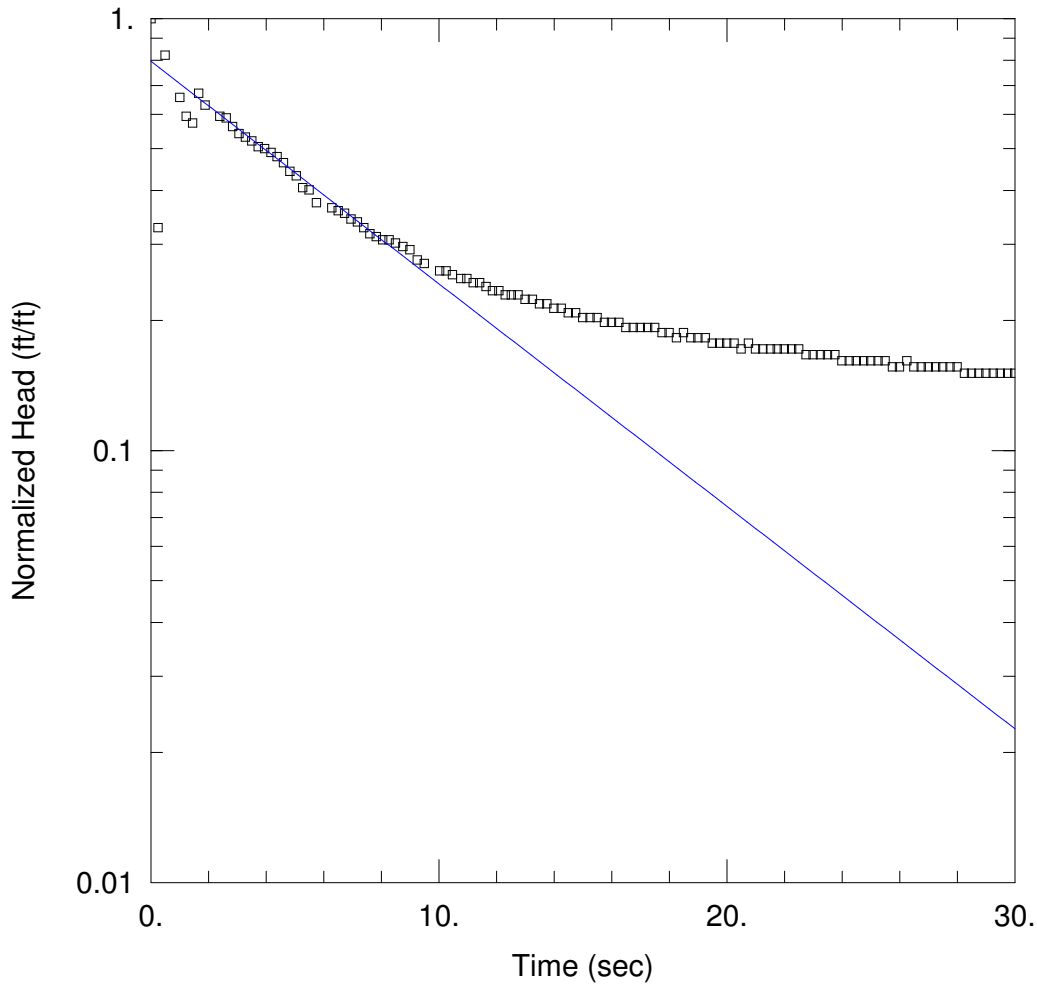
Saturated Thickness: 5.12 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-8)

Initial Displacement: 1.34 ft Static Water Column Height: 5.12 ft
 Total Well Penetration Depth: 5.12 ft Screen Length: 3.08 ft
 Casing Radius: 0.083 ft Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bower-Rice
 K = 0.00819 cm/sec $y_0 =$ 1.214 ft



MW-8 SLUG OUT

Data Set: P:\...\Cherokee MW-8 Slug Out BouwerRice.aqt

Date: 01/22/16

Time: 09:34:38

PROJECT INFORMATION

Company: HDR

Client: Xcel Energy

Project: 266180

Location: Cherokee Station

Test Well: MW-8

Test Date: 12/22/2015

AQUIFER DATA

Saturated Thickness: 5.12 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-8)

Initial Displacement: 1.92 ft

Static Water Column Height: 5.12 ft

Total Well Penetration Depth: 5.12 ft

Screen Length: 3.08 ft

Casing Radius: 0.083 ft

Well Radius: 0.25 ft

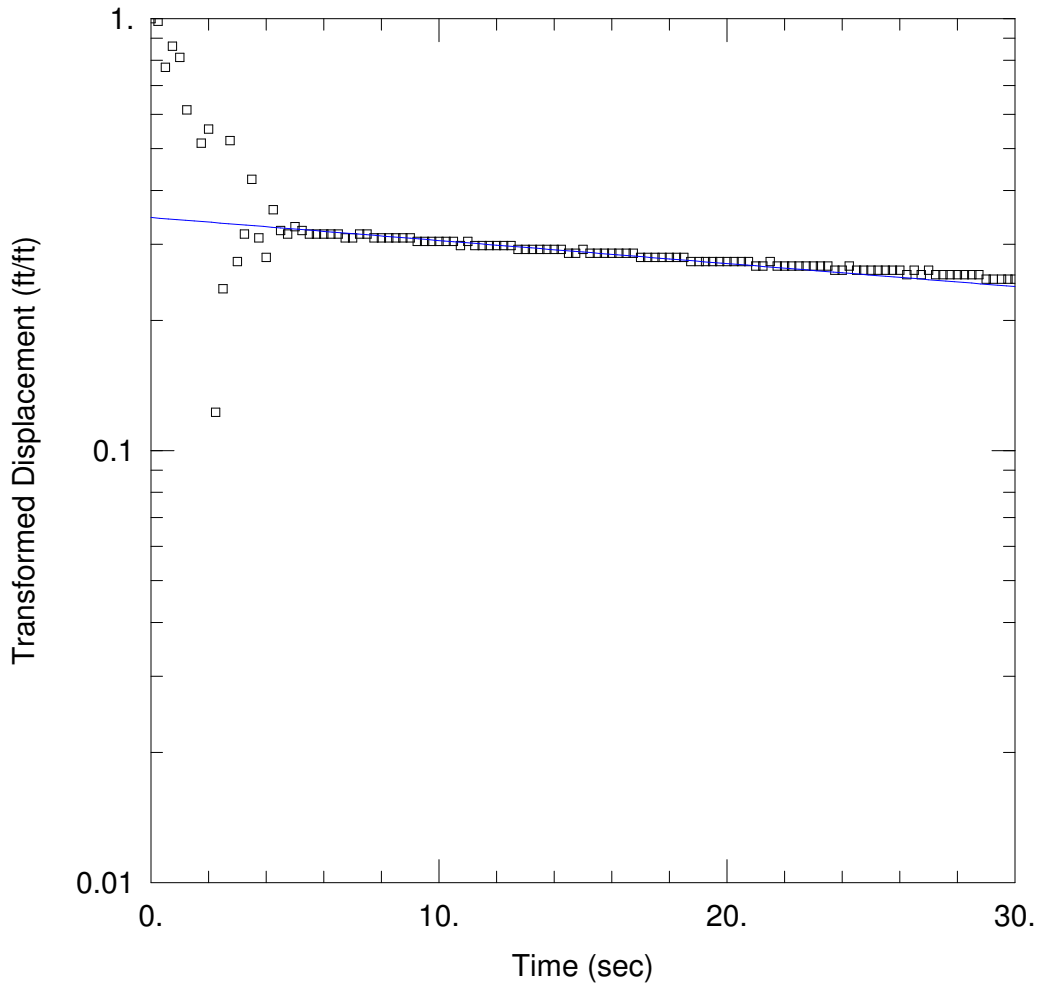
SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

K = 0.008435 cm/sec

y0 = 1.528 ft



MW-9 SLUG IN 2

Data Set: P:\...\Cherokee MW-9 Slug In 2 Dagan.aqt

Date: 01/22/16

Time: 09:34:55

PROJECT INFORMATION

Company: HDR

Client: Xcel Energy

Project: 266180

Location: Cherokee Station

Test Well: MW-9

Test Date: 12/22/2015

AQUIFER DATA

Saturated Thickness: 6.67 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-9)

Initial Displacement: 1.54 ft

Static Water Column Height: 6.67 ft

Total Well Penetration Depth: 6.67 ft

Screen Length: 6.67 ft

Casing Radius: 0.083 ft

Well Radius: 0.25 ft

Gravel Pack Porosity: 0.3

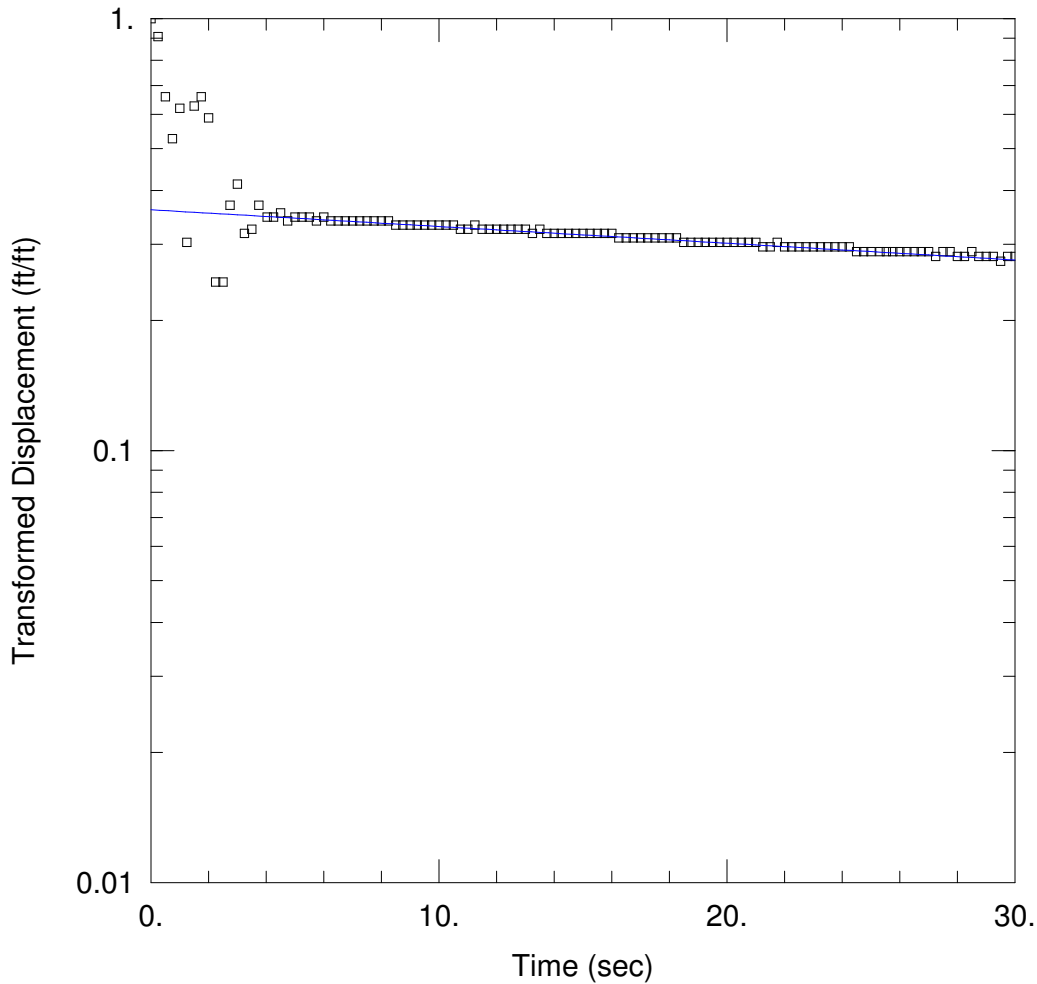
SOLUTION

Aquifer Model: Unconfined

Solution Method: Dagan

K = 0.001467 cm/sec

y0 = 0.5767 ft



MW-9 SLUG IN

Data Set: P:\...\Cherokee MW-9 Slug In Dagan.aqt

Date: 01/22/16

Time: 09:35:16

PROJECT INFORMATION

Company: HDR

Client: Xcel Energy

Project: 266180

Location: Cherokee Station

Test Well: MW-9

Test Date: 12/22/2015

AQUIFER DATA

Saturated Thickness: 6.67 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-9)

Initial Displacement: 1.32 ft

Static Water Column Height: 6.67 ft

Total Well Penetration Depth: 6.67 ft

Screen Length: 6.67 ft

Casing Radius: 0.083 ft

Well Radius: 0.25 ft

Gravel Pack Porosity: 0.3

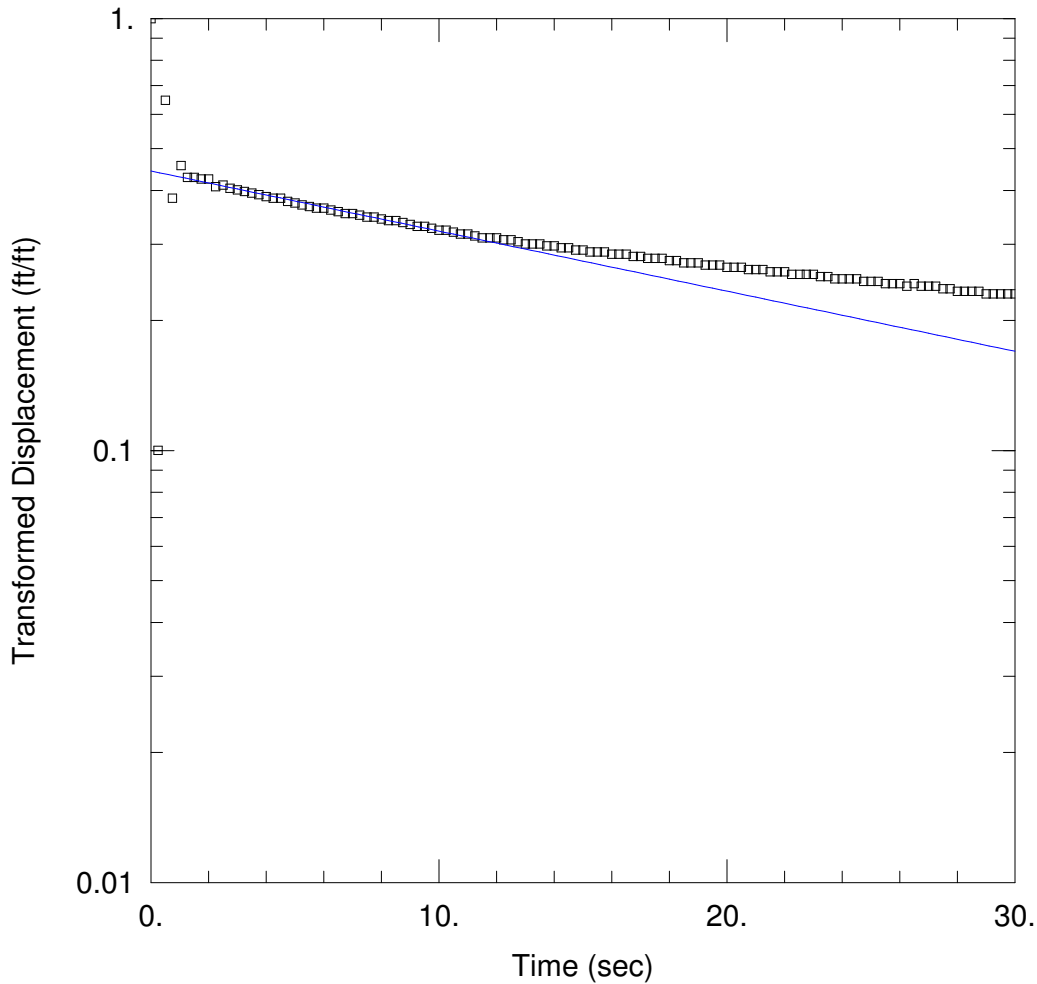
SOLUTION

Aquifer Model: Unconfined

Solution Method: Dagan

K = 0.001209 cm/sec

y0 = 0.5084 ft



MW-9 SLUG OUT 2

Data Set: P:\...\Cherokee MW-9 Slug Out 2 Dagan.aqt

Date: 01/22/16

Time: 09:35:32

PROJECT INFORMATION

Company: HDR

Client: Xcel Energy

Project: 266180

Location: Cherokee Station

Test Well: MW-9

Test Date: 12/22/2015

AQUIFER DATA

Saturated Thickness: 6.67 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-9)

Initial Displacement: 2.83 ft

Static Water Column Height: 6.67 ft

Total Well Penetration Depth: 6.67 ft

Screen Length: 6.67 ft

Casing Radius: 0.083 ft

Well Radius: 0.25 ft

Gravel Pack Porosity: 0.3

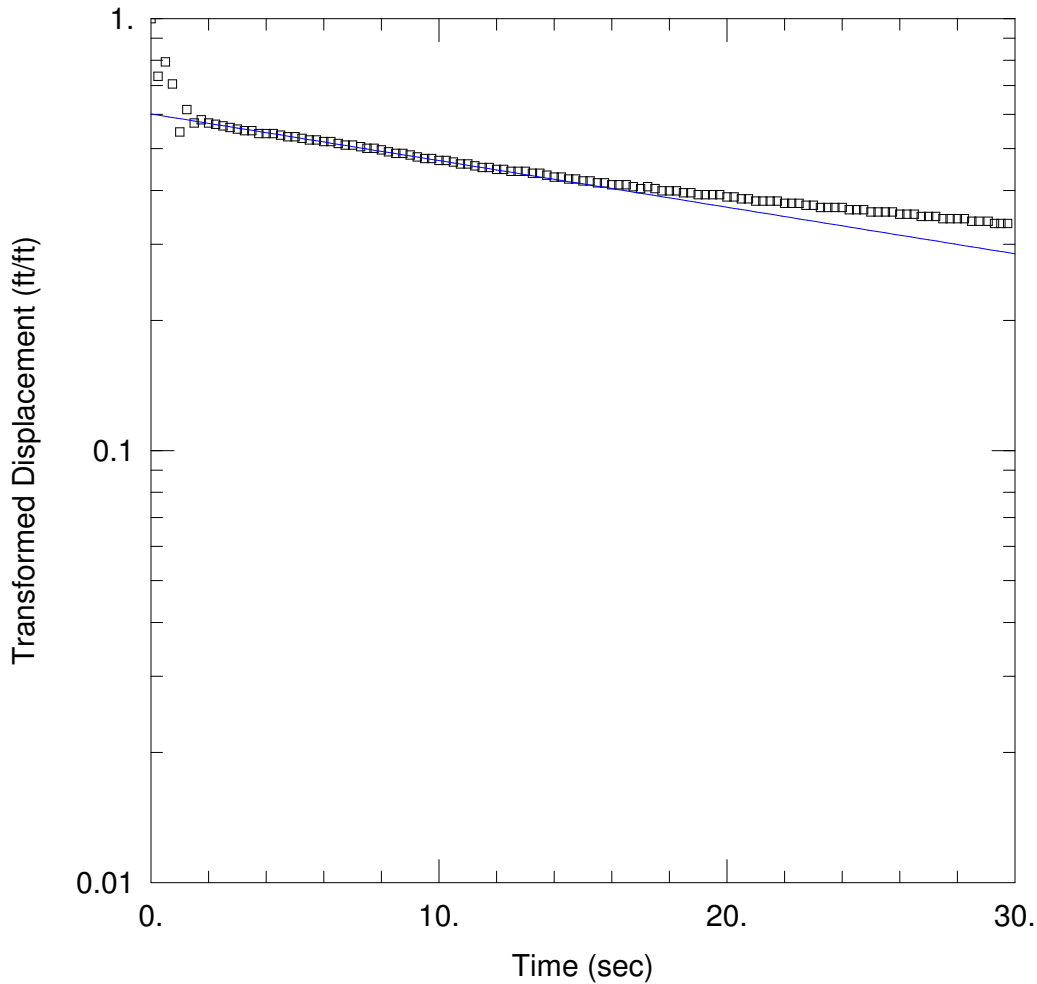
SOLUTION

Aquifer Model: Unconfined

Solution Method: Dagan

K = 0.001552 cm/sec

y0 = 1.424 ft



MW-9 SLUG OUT

Data Set: P:\...\Cherokee MW-9 Slug Out Dagan.aqt

Date: 01/22/16

Time: 09:35:52

PROJECT INFORMATION

Company: HDR

Client: Xcel Energy

Project: 266180

Location: Cherokee Station

Test Well: MW-9

Test Date: 12/22/2015

AQUIFER DATA

Saturated Thickness: 6.67 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-9)

Initial Displacement: 2.25 ft

Static Water Column Height: 6.67 ft

Total Well Penetration Depth: 6.67 ft

Screen Length: 6.67 ft

Casing Radius: 0.083 ft

Well Radius: 0.25 ft

Gravel Pack Porosity: 0.3

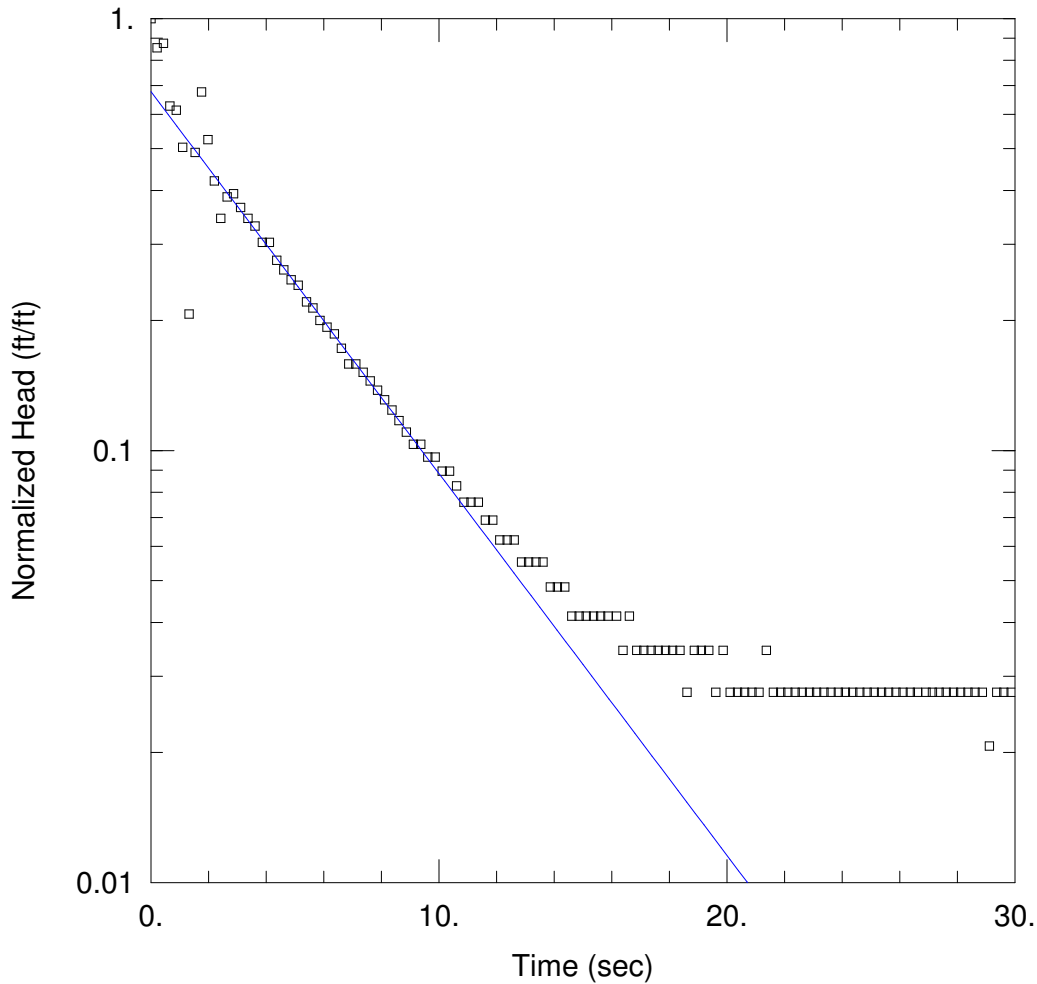
SOLUTION

Aquifer Model: Unconfined

Solution Method: Dagan

K = 0.001181 cm/sec

y0 = 1.45 ft



MW-10 SLUG IN 2

Data Set: P:\...\Cherokee MW-10 Slug In 2 BowerRice.aqt
 Date: 01/22/16 Time: 09:36:07

PROJECT INFORMATION

Company: HDR
 Client: Xcel Energy
 Project: 266180
 Location: Cherokee Station
 Test Well: MW-10
 Test Date: 12/22/2015

AQUIFER DATA

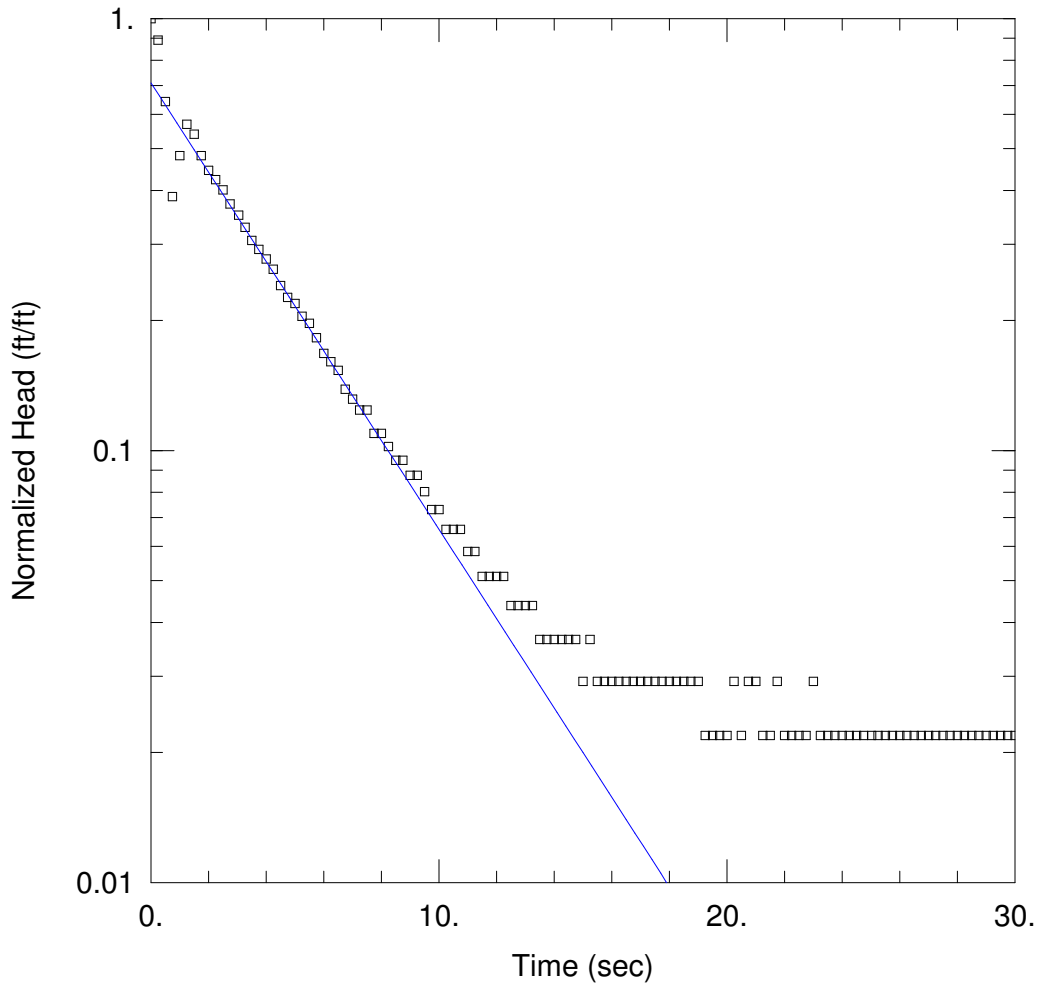
Saturated Thickness: 13.86 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-10)

Initial Displacement: 1.45 ft Static Water Column Height: 13.86 ft
 Total Well Penetration Depth: 13.86 ft Screen Length: 8. ft
 Casing Radius: 0.083 ft Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bower-Rice
 K = 0.007886 cm/sec y0 = 0.9814 ft



MW-10 SLUG IN

Data Set: P:\...\Cherokee MW-10 Slug In BouwerRice.aqt

Date: 01/22/16

Time: 09:36:23

PROJECT INFORMATION

Company: HDR

Client: Xcel Energy

Project: 266180

Location: Cherokee Station

Test Well: MW-10

Test Date: 12/22/2015

AQUIFER DATA

Saturated Thickness: 13.86 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-10)

Initial Displacement: 1.37 ft

Static Water Column Height: 13.86 ft

Total Well Penetration Depth: 13.86 ft

Screen Length: 8. ft

Casing Radius: 0.083 ft

Well Radius: 0.25 ft

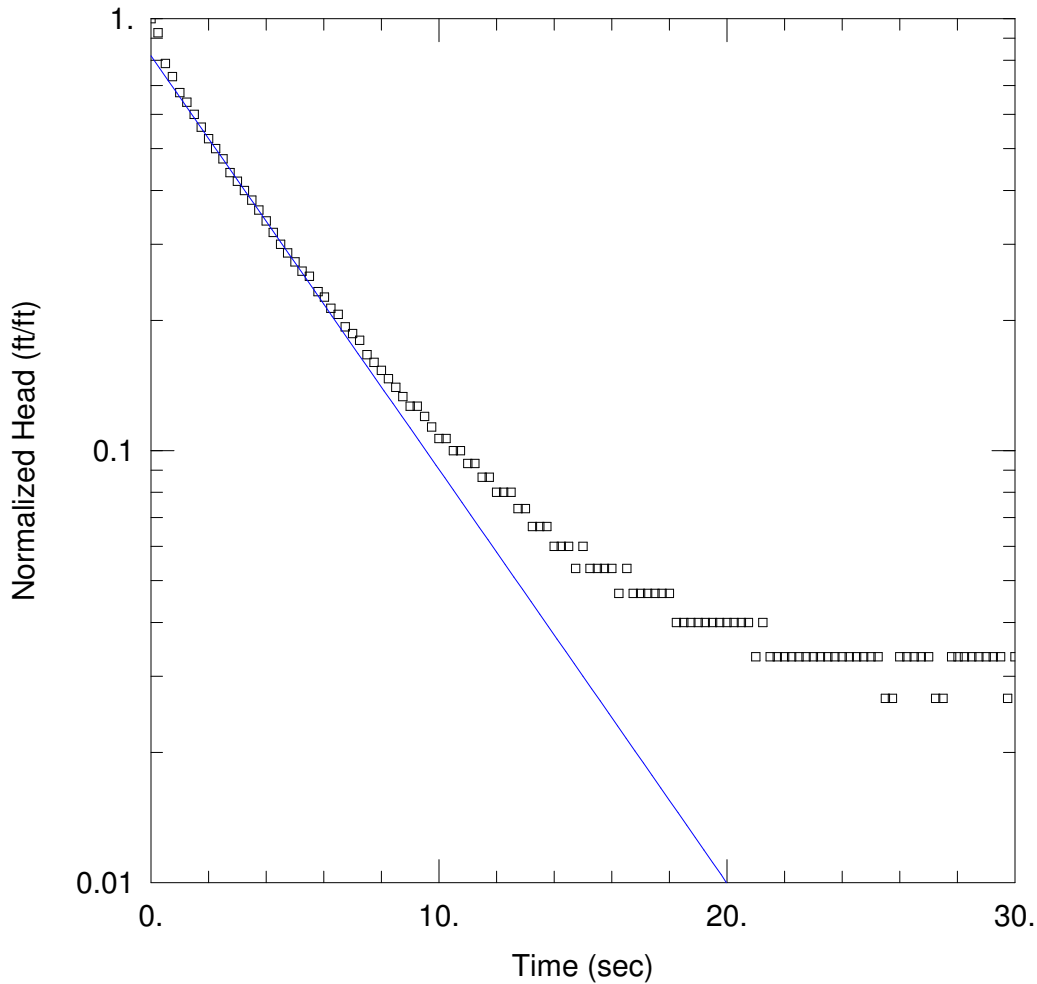
SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

K = 0.009221 cm/sec

y0 = 0.9724 ft



MW-10 SLUG OUT 2

Data Set: P:\...\Cherokee MW-10 Slug Out 2 BowerRice.aqt
 Date: 01/22/16 Time: 09:36:38

PROJECT INFORMATION

Company: HDR
 Client: Xcel Energy
 Project: 266180
 Location: Cherokee Station
 Test Well: MW-10
 Test Date: 12/22/2015

AQUIFER DATA

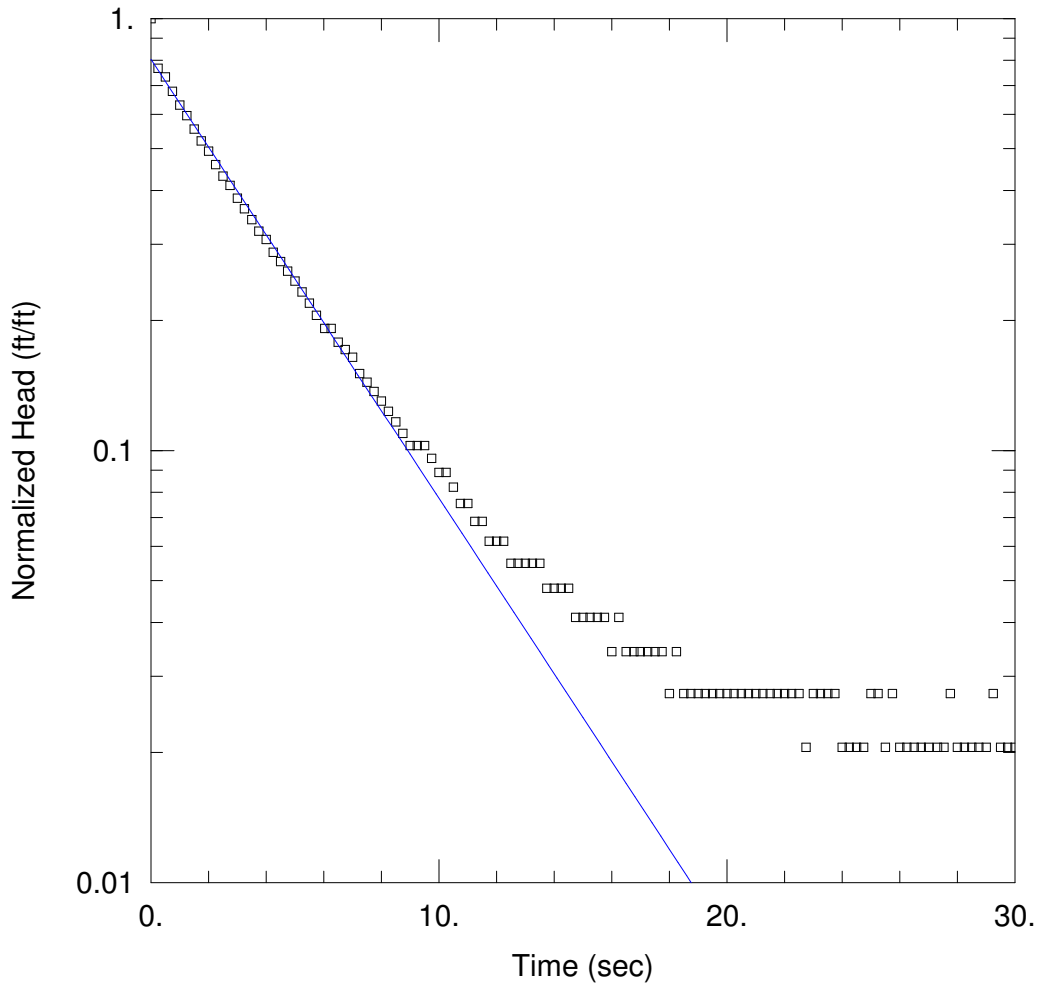
Saturated Thickness: 13.86 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-10)

Initial Displacement: 1.5 ft Static Water Column Height: 13.86 ft
 Total Well Penetration Depth: 13.86 ft Screen Length: 8. ft
 Casing Radius: 0.083 ft Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bower-Rice
 K = 0.008542 cm/sec $y_0 =$ 1.229 ft



MW-10 SLUG OUT 2

Data Set: P:\...\Cherokee MW-10 Slug Out BouwerRice.aqt
 Date: 01/22/16 Time: 09:36:56

PROJECT INFORMATION

Company: HDR
 Client: Xcel Energy
 Project: 266180
 Location: Cherokee Station
 Test Well: MW-10
 Test Date: 12/22/2015

AQUIFER DATA

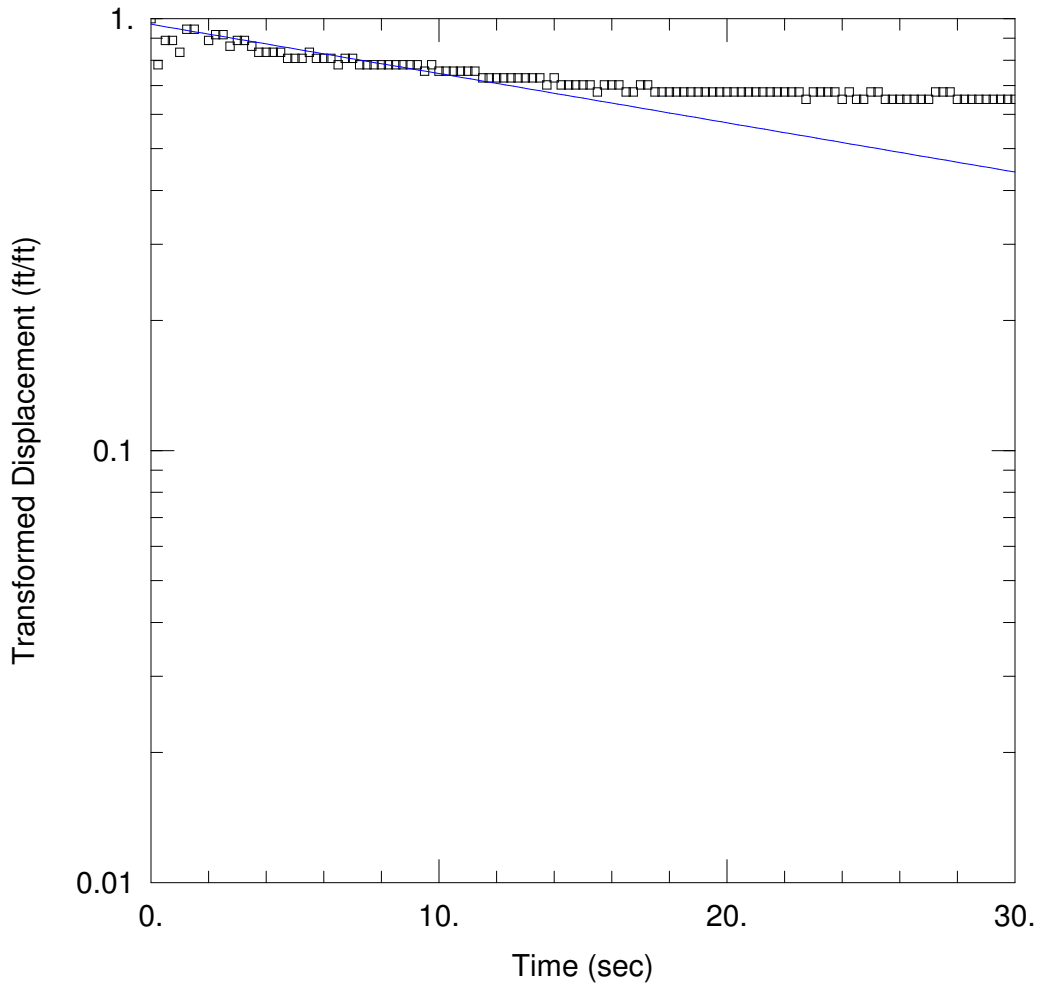
Saturated Thickness: 13.86 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-10)

Initial Displacement: 1.46 ft Static Water Column Height: 13.86 ft
 Total Well Penetration Depth: 13.86 ft Screen Length: 8. ft
 Casing Radius: 0.083 ft Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice
 K = 0.009062 cm/sec y0 = 1.174 ft



MW-13 SLUG IN (1 LITER)

Data Set: P:\...\Cherokee MW-13 Slug In 1L Dagan.aqt

Date: 01/22/16

Time: 09:39:44

PROJECT INFORMATION

Company: HDR

Client: Xcel Energy

Project: 266180

Location: Cherokee Station

Test Well: MW-13

Test Date: 12/22/2015

AQUIFER DATA

Saturated Thickness: 2.66 ft

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA (MW-13)

Initial Displacement: 0.39 ft

Static Water Column Height: 2.66 ft

Total Well Penetration Depth: 2.66 ft

Screen Length: 2.66 ft

Casing Radius: 0.083 ft

Well Radius: 0.25 ft

Gravel Pack Porosity: 0.3

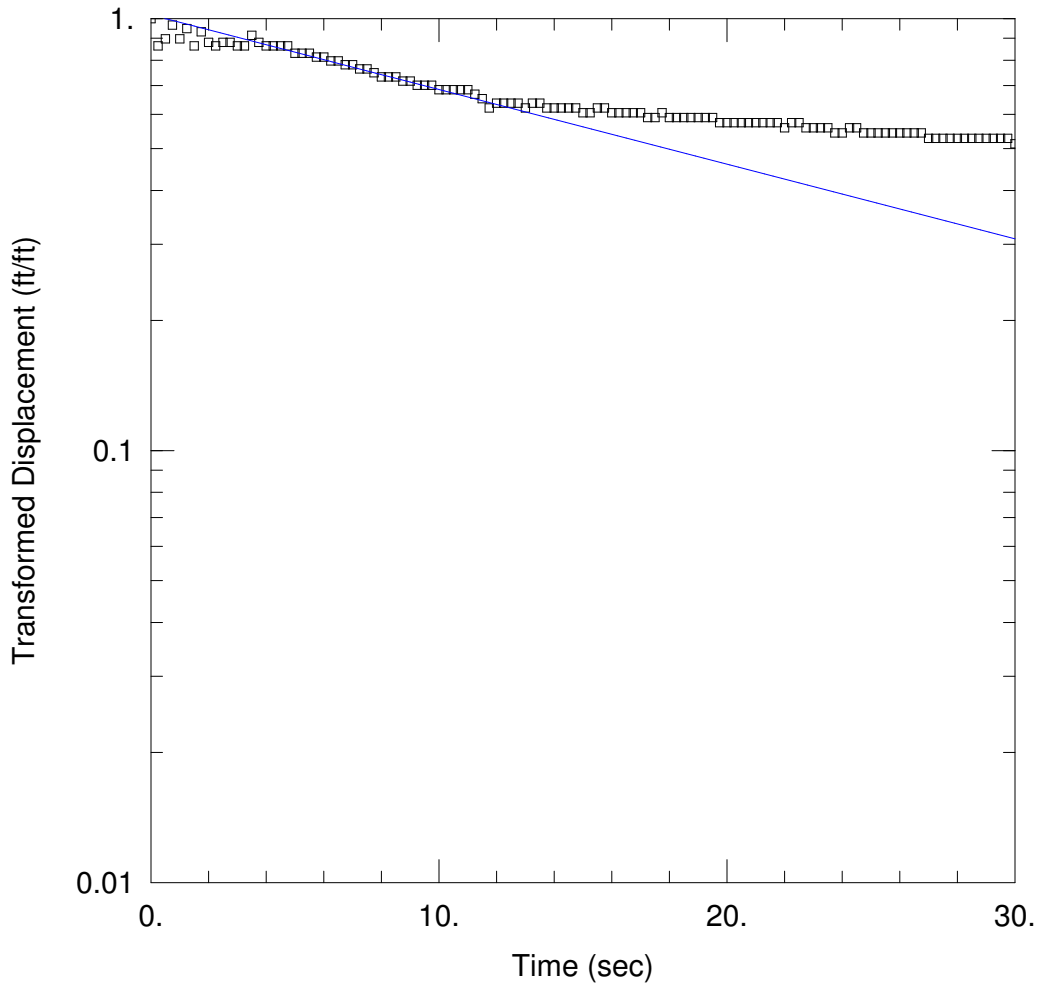
SOLUTION

Aquifer Model: Unconfined

Solution Method: Dagan

$K = 0.00856$ cm/sec

$y_0 = 0.3791$ ft



MW-13 SLUG IN (2 LITERS)

Data Set: P:\...\Cherokee MW-13 Slug In 2L Dagan.aqt

Date: 01/22/16

Time: 09:40:01

PROJECT INFORMATION

Company: HDR

Client: Xcel Energy

Project: 266180

Location: Cherokee Station

Test Well: MW-13

Test Date: 12/22/2015

AQUIFER DATA

Saturated Thickness: 2.66 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-13)

Initial Displacement: 0.66 ft

Static Water Column Height: 2.66 ft

Total Well Penetration Depth: 2.66 ft

Screen Length: 2.66 ft

Casing Radius: 0.083 ft

Well Radius: 0.25 ft

Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined

Solution Method: Dagan

K = 0.007328 cm/sec

y0 = 0.6712 ft