Monitoring Well Installation Report

for Compliance with the Coal Combustion Residuals (CCR) Rule

Valmont Station

Xcel Energy

May 25, 2016
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<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
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<tbody>
<tr>
<td>bgs</td>
<td>below ground surface</td>
</tr>
<tr>
<td>CCR</td>
<td>Coal Combustion Residuals</td>
</tr>
<tr>
<td>cm/sec</td>
<td>centimeter per second</td>
</tr>
<tr>
<td>HP Geotech</td>
<td>Hepworth-Pawlak Geotechnical, Inc.</td>
</tr>
<tr>
<td>µS/cm</td>
<td>microsiemens per centimeter</td>
</tr>
<tr>
<td>NTU</td>
<td>nephelometric turbidity unit</td>
</tr>
<tr>
<td>PSCo</td>
<td>Public Service Company of Colorado</td>
</tr>
<tr>
<td>Site Services</td>
<td>Site Services Drilling, LLC</td>
</tr>
<tr>
<td>USCS</td>
<td>Unified Soil Classification System</td>
</tr>
</tbody>
</table>
1.0 Introduction
The purpose of this Monitoring Well Installation Report is to document details pertaining to the drilling, construction, and development of four groundwater monitoring wells installed at the Xcel Energy Valmont Generating Station (Valmont Station) in Boulder, 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). Valmont Station has three units subject to the CCR Rule: an ash landfill and two incised 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 four new CCR groundwater monitoring wells at Valmont 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 Valmont Station are identified and summarized in the Valmont Station Monitoring Well Installation Plan for Compliance with the CCR Rule (HDR, 2015).

The CCR landfill at Valmont Station is located adjacent to and north of Leggett Reservoir on the flanks of Valmont Butte, on Slocum Alluvium (gravel and cobbles) above the Pierre Shale bedrock. The Pierre Shale is approximately 2,000 feet thick in this area and consists of claystone with interbeds of siltstone and discontinuous cemented layers. The existing monitoring wells located around the CCR landfill are sufficient to meet the groundwater monitoring requirements in the CCR Rule.

Valmont Station is in an area where the localized water table may occur within unconsolidated and fractured, consolidated materials. There is evidence of perched water beneath the landfill, coincident with the top of the Pierre Shale and the water surface of Leggett Reservoir. Due to the Pierre Shale thickness and low permeability, underlying formations do not receive significant recharge from above (Kumar and Associates, Inc., 2011).

The two CCR impoundments (3a and 3b) at Valmont Station are located west of Leggett Reservoir. The depth to groundwater and the flow direction below impoundments 3a and 3b is unknown, but likely coincides with the seasonally fluctuating Leggett Reservoir water surface. The flow direction may flow radially out from the impoundments. In the nearby MW-1 (different from MW-1 at the landfill), just south of the impoundments near the hot water canal, the depth to groundwater was approximately 3 to 7 feet below ground surface (bgs) (APEX, 2015).

Four new monitoring wells (MW-9, MW-10, MW-11, and MW-12; Figure 2) were installed around the two CCR impoundments (3a and 3b) at Valmont Station. The wells 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).
Figure 1. Vicinity Map, Valmont Station
Figure 2. Well Location Map, Valmont 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 October 30 and November 2, 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 groundwater table, or to the Pierre Shale Formation, whichever was shallower. This resulted in borehole depths of between 21 and 26 feet bgs, as further described in Section 4.3. Boring logs for each borehole are provided in Appendix A.

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. 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 in Section 3.2.

Soil cuttings, fluids, and potholing slurry generated during drilling were disposed of at the existing evaporation pond within the CCR landfill. 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 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 lowered into each borehole. Approximately 10 feet of screen was installed in each well.

After PVC casing and screen 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 2 to 3 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 about 2 feet of PVC stick-up. Each well was secured with a protective steel casing and lock. Well construction is further described in Section 4.3 and depicted in diagrams provided in Appendix C.

3.4 Well Development
Wells were developed to improve hydraulic connectivity in the area immediately surrounding the well. 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 landfill.

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. 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 when the water was visually free of suspended solids. Purge water was placed into drums and/or buckets and disposed of at the CCR landfill. All non-dedicated down-well equipment used during development was decontaminated. Well development at Valmont Station is further described in Section 4.4.

3.5 Well Survey
Surveying of the monitoring wells was performed by professional surveyor, Flatirons, 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-9, MW-10, MW-11, and MW-12 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 water level measurements were recorded at 0.25-second intervals. Both slug-in and slug-out tests were performed at each well. 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-9: Two slug-in and two slug-out tests were performed on December 21, 2015. The depth to water in the well was 7.58 feet below top of casing, and the well screen is fully submerged with the top of the screen 2.4 feet below the water table.

MW-10: One slug-in and one slug-out test were performed on December 21, 2015. The depth to water in the well was 6.91 feet below top of casing, and the well screen is fully submerged with the top of the screen 5.01 feet below the water table.

MW-11: One slug-in and one slug-out test were performed on December 21, 2015. The depth to water in the well was 8.58 feet below top of casing, and the well screen is fully submerged with the top of the screen 5.58 feet below the water table.

MW-12: Two slug-in and two slug-out tests were performed on December 21, 2015. The depth to water in the well was 8.42 feet below top of casing, and the well screen is fully submerged with the top of the screen 6.83 feet below the water table.

Slug test data were downloaded 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, silt, and silty clay. Bedrock was encountered during drilling at approximately 18 feet bgs at MW-9, 19 feet bgs at MW-10, and 24 feet bgs at MW-11 and MW-12. This bedrock was presumed to be the top of the Pierre Shale Formation.
4.2 Soil Samples – Geotechnical Analysis

The undisturbed soil samples collected from the well screen depth interval of each borehole were analyzed for grain size and porosity by HP Geotech, and are summarized in Table 1. The soils laboratory results are presented in Appendix B.

Laboratory results show the wells are screened in sandy silt, with porosities between 40 and 45 percent, which is consistent with the silt and clay sand material noted in the drilling logs.

<table>
<thead>
<tr>
<th>Well</th>
<th>Sample Depth (bgs)</th>
<th>Gradation</th>
<th>Total Porosity (%)</th>
<th>Moisture Content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MW-9</td>
<td>18'4&quot;-18'8&quot;</td>
<td>0 1 99</td>
<td>44.5</td>
<td>23.7</td>
</tr>
<tr>
<td>MW-10</td>
<td>20'4&quot;-20'8&quot;</td>
<td>0 1 99</td>
<td>42.0</td>
<td>24.0</td>
</tr>
<tr>
<td>MW-11</td>
<td>18'4&quot;-18'8&quot;</td>
<td>0 24 76</td>
<td>43.3</td>
<td>23.6</td>
</tr>
<tr>
<td>MW-12</td>
<td>15'4&quot;-15'8&quot;</td>
<td>0 47 53</td>
<td>40.8</td>
<td>23.3</td>
</tr>
</tbody>
</table>

4.3 Well Construction

A diagram for each well documenting well construction is provided in Appendix C. The water table was encountered in all four wells. The 10 feet of screen installed at each well extended at least 10 feet below the water table to the approximate top of bedrock. The Pierre Shale bedrock was encountered at approximately 18 feet bgs at MW-9, 19 feet bgs at MW-10, and 24 feet bgs at MW-11 and MW-12. Well construction details for all four new CCR wells are summarized in Table 2. State-issued well construction permits are included in Appendix D.
## Table 2. Well Construction Details for Groundwater Monitoring Wells, Valmont Station, 2015

<table>
<thead>
<tr>
<th>Well ID</th>
<th>Northing(^1)</th>
<th>Easting(^1)</th>
<th>Elevation TOC(^2) (feet)</th>
<th>Well Total Depth (feet bg)</th>
<th>Depth of Screen Interval (feet bgs)</th>
<th>Well Stickup (feet)</th>
<th>Casing Type(^3)</th>
<th>Depth to Water (feet (^4)BTOC)</th>
<th>Static Water Level (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MW-9</td>
<td>482916.0858</td>
<td>4430133.974</td>
<td>5234.25</td>
<td>18.83</td>
<td>8.83-18.83</td>
<td>1.98</td>
<td>2&quot; PVC</td>
<td>7.76</td>
<td>5226.49</td>
</tr>
<tr>
<td>MW-10</td>
<td>482795.7423</td>
<td>4430255.585</td>
<td>5233.81</td>
<td>20</td>
<td>10-20</td>
<td>1.92</td>
<td>2&quot; PVC</td>
<td>7.09</td>
<td>5226.72</td>
</tr>
<tr>
<td>MW-11</td>
<td>482871.9677</td>
<td>4430300.494</td>
<td>5235.22</td>
<td>22</td>
<td>12-22</td>
<td>2.16</td>
<td>2&quot; PVC</td>
<td>9.72</td>
<td>5225.5</td>
</tr>
<tr>
<td>MW-12</td>
<td>482959.2548</td>
<td>4430214.045</td>
<td>5235.05</td>
<td>23.6</td>
<td>13.6-23.6</td>
<td>2.25</td>
<td>2&quot; PVC</td>
<td>9.02</td>
<td>5226.03</td>
</tr>
</tbody>
</table>

Notes: \(^1\) State Plane, NAD 1983 UTM Zone 13 N meters; \(^2\) TOC=top of casing; \(^3\) Sch-40; \(^4\) BTOC=below top of casing, measured December 2015
4.4 Well Development

Wells were developed over multiple days from November 3 through November 20, 2015. After a total of approximately 293 gallons of water had been purged from MW-10 over two days, water quality field parameters stabilized and development was complete at this well. Field parameters stabilized and development at MW-12 was complete within two days after removing a combined total of 295 gallons of water. Development of MW-9 was complete after three days and removing approximately 658 gallons of water. Development at MW-11 also occurred over a three-day period. Compared to the other new wells, water recharge was slower at MW-11. Field parameters at MW-11 stabilized after development and removal of 127 gallons of water. Water quality field parameters measured after each well was developed are summarized in Table 3.

<table>
<thead>
<tr>
<th>Well I.D.</th>
<th>Conductivity (µS/cm)</th>
<th>pH</th>
<th>Temperature (degrees C)</th>
<th>Turbidity (NTU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MW-9</td>
<td>1541</td>
<td>7.54</td>
<td>19.8</td>
<td>0.7</td>
</tr>
<tr>
<td>MW-10</td>
<td>1597</td>
<td>7.63</td>
<td>19.1</td>
<td>7.2</td>
</tr>
<tr>
<td>MW-11</td>
<td>2760</td>
<td>7.13</td>
<td>15.7</td>
<td>4.7</td>
</tr>
<tr>
<td>MW-12</td>
<td>1325</td>
<td>6.92</td>
<td>16.7</td>
<td>4.9</td>
</tr>
</tbody>
</table>

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 the Bouwer and Rice (1976) slug test solution for unconfined aquifers, and implemented using Aqtesolv® v4.5. All 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. The aquifer at each location was represented with the following estimates of saturated thickness: 18.4 feet (MW-9), 15.01 feet (MW-10), 17.58 feet (MW-11), and 17.83 feet (MW-12). 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. The geometric mean of the hydraulic conductivity calculated at all wells is 1.82 x 10-3 centimeter per second (cm/sec). This value corresponds with the textbook range for silty sand (Freeze and Cherry, 1979), which generally agrees with the clayey silt to clayey silt with sand indicated on the field boring logs.
Table 4. Slug Testing Results

<table>
<thead>
<tr>
<th>Well</th>
<th>Test Name</th>
<th>Initial Displacement (feet)</th>
<th>Hydraulic Conductivity (cm/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MW-9</td>
<td>Slug In</td>
<td>2.23</td>
<td>2.78E-03</td>
</tr>
<tr>
<td>MW-9</td>
<td>Slug Out</td>
<td>2.63</td>
<td>4.16E-03</td>
</tr>
<tr>
<td>MW-9</td>
<td>Slug In 2</td>
<td>2.55</td>
<td>2.66E-03</td>
</tr>
<tr>
<td>MW-9</td>
<td>Slug Out 2</td>
<td>2.91</td>
<td>4.22E-03</td>
</tr>
<tr>
<td>MW-10</td>
<td>Slug In</td>
<td>2.40</td>
<td>5.76E-04</td>
</tr>
<tr>
<td>MW-10</td>
<td>Slug Out</td>
<td>1.82</td>
<td>6.94E-04</td>
</tr>
<tr>
<td>MW-11</td>
<td>Slug In</td>
<td>2.82</td>
<td>4.29E-04</td>
</tr>
<tr>
<td>MW-11</td>
<td>Slug Out</td>
<td>2.30</td>
<td>4.25E-04</td>
</tr>
<tr>
<td>MW-12</td>
<td>Slug In</td>
<td>2.59</td>
<td>3.33E-03</td>
</tr>
<tr>
<td>MW-12</td>
<td>Slug Out</td>
<td>1.89</td>
<td>3.81E-03</td>
</tr>
<tr>
<td>MW-12</td>
<td>Slug In 2</td>
<td>2.05</td>
<td>3.15E-03</td>
</tr>
<tr>
<td>MW-12</td>
<td>Slug Out 2</td>
<td>3.20</td>
<td>3.59E-03</td>
</tr>
</tbody>
</table>

Geometric Mean 1.82E-03

Notes: ¹ From Freeze and Cherry (1979).

5.0 References


Appendix A

Borehole Logs
### Boring Log

**Project Name:** Xcel CCR  
**Project No.:** 266180-006  
**Drilling Company:** Site Services Drilling, LLC

**Boring No.:** MW-9  
**Location:** Walmont Station  
**Drilling Rig Type and Drilling Method:** CME-75 Hollow Stem Auger (6-inch diameter)

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Blow Count</th>
<th>Depth (feet)</th>
<th>Description (USCS)</th>
<th>Elevation (feet)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-0.5' bgs</td>
<td></td>
<td></td>
<td>Fill: Dark brown 10YR 3/3; Sandy silt with gravel (ML)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5-5.5' bgs</td>
<td>5, 8, 8, 9</td>
<td>5</td>
<td>Dark yellow-ish brown 10YR 4/4; Silty clay (ML) with trace gravel; moist</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-10.5' bgs</td>
<td>1, 2, 4, 9</td>
<td>10</td>
<td>Brown 10YR 5/3; Silty clay (ML); wet</td>
<td></td>
<td>Depth to water ~10' bgs</td>
</tr>
<tr>
<td>18-19' bgs, MW-9:</td>
<td>1, 8, 24</td>
<td>20</td>
<td>Brown 10YR 5/3; Clay (CL) dense, weathered bedrock; wet</td>
<td></td>
<td>clay at 18' bgs. Soil sample (MW-9: 18'4&quot;-18'8&quot;) submitted for geotech analysis</td>
</tr>
<tr>
<td>25-25.5' bgs</td>
<td>Not recorded</td>
<td>25</td>
<td>Brown 10YR 5/3; Clay (CL) dense, weathered Pierre Shale; wet</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Depth (feet)</th>
<th>Water Level (feet)</th>
<th>Logged By:</th>
<th>Drilled/Sampled By:</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>8.23' btoc</td>
<td>Justin Bills</td>
<td>Josh Eckhoff</td>
</tr>
<tr>
<td></td>
<td>72</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10/30/2015</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10/30/2015</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample No.</td>
<td>Blow Count</td>
<td>Depth (feet)</td>
<td>Description (USCS)</td>
</tr>
<tr>
<td>------------</td>
<td>------------</td>
<td>--------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>5-5.5' bgs</td>
<td>5, 8, 9, 11</td>
<td>5</td>
<td>Grayish brown 10YR 5/2; Silt with some fine sands (ML); stiff; moist</td>
</tr>
<tr>
<td>10-10.5' bgs</td>
<td>2, 4, 5, 6</td>
<td>10</td>
<td>Brown 10YR 5/3; Clayey silt with gravel (ML); moist</td>
</tr>
<tr>
<td>MW-10: 15-16' bgs</td>
<td>Not recorded</td>
<td>15</td>
<td>Brown 10YR 5/3; Clayey silt with trace gravel (ML); moist</td>
</tr>
<tr>
<td>16-16.5' bgs</td>
<td>Not recorded</td>
<td>20</td>
<td>Brown 10YR 5/3; Clayey silt (ML); wet</td>
</tr>
<tr>
<td>MW-10 20'4&quot;-20&quot;8&quot;</td>
<td>Not recorded</td>
<td>25</td>
<td>Brown 10YR 4/3; Clayey silt (ML), weathered Pierr Shale; wet</td>
</tr>
</tbody>
</table>

**Total Depth (feet):** 21

**Water Level (feet):** 8.68’ btoc

**Logged By:** Justin Bills

**Drilled/Sampled By:** Josh Eckhoff

**Date Started:** 11/2/2015

**Date Completed:** 11/2/2015
# Boring Log

**Project Name:** Xcel CCR  
**Project No.:** 266180-006  
**Drilling Company:** Site Services Drilling, LLC

**Boring No.:** MW-11  
**Location:** Valmont Station  
**Drilling Rig Type and Drilling Method:** CME-75 Hollow Stem Auger (6-inch diameter)

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Blow Count</th>
<th>Depth (feet)</th>
<th>Description (USCS)</th>
<th>Elevation (feet)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-2.5' below ground surface (bgs)</td>
<td>2, 17, 22, 12</td>
<td>5</td>
<td>Brown 10YR 4/3; Silt (ML), rootlets; trace gravel; moist</td>
<td></td>
<td>4-6' bgs no recovery</td>
</tr>
<tr>
<td>10.5-11' bgs</td>
<td>0, 13, 6</td>
<td>10</td>
<td>Dark grayish brown 10YR 4/2; Clayey silt, mostly silt (ML); trace gravels &lt;1&quot;; moist</td>
<td></td>
<td>9-11' bgs 50% recovery</td>
</tr>
<tr>
<td>14.5-15.5' bgs</td>
<td>Not recorded</td>
<td>15</td>
<td>Brown 10YR 4/3; Clayey silt, mostly silt (ML); some gravel; moist</td>
<td></td>
<td>50% recovery soil sample 14.5-15.5' bgs collected but not submitted for geotech analysis</td>
</tr>
<tr>
<td>17-17.5' bgs</td>
<td>Not recorded</td>
<td></td>
<td>Very dark gray 10YR 3/1; Clayey silt (ML); rootlets; moist</td>
<td></td>
<td>soil sample MW-11: 18'4&quot;-18'8&quot; submitted for geotech analysis depth to Pierre Shale ~21-24' bgs</td>
</tr>
<tr>
<td>24-24.5' bgs</td>
<td>Not recorded</td>
<td>25</td>
<td>Brown 10YR 5/3; Clayey, weathered Pierre Shale (ML); wet</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Total Depth (feet):** 25.5  
**Water Level (feet):** 2-2.5' below ground surface  
**Logged By:** Justin Bills  
**Drilled/Sampled By:** Josh Eckhoff

**Date Started:** 11/2/2015  
**Date Completed:** 11/2/2015

---

- **Date Started:** 2, 17, 22, 12
- **Date Completed:** 0, 13, 6, 30
- **Depth to water:** ~10' bgs
- **Soil sample MW-11:** 18'4"-18'8" submitted for geotech analysis
## Boring Log

**Project Name:** Xcel CCR  
**Project No.:** 266180-006  
**Drilling Company:** Site Services Drilling, LLC

**Boring No.:** MW-12  
**Location:** Valmont Station  
**Drilling Rig Type and Drilling Method:** CME-75 Hollow Stem Auger (6-inch diameter)

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Blow Count</th>
<th>Depth (feet)</th>
<th>Description (USCS)</th>
<th>Elevation (feet)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2' bgs</td>
<td></td>
<td></td>
<td>Fill: Dark brown 10YR 3/3; Sandy silt with gravel (ML); moist</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5-5.5' bgs</td>
<td>38, 24, 32</td>
<td>5</td>
<td>Dark gray 10YR 4/1; Fine silty sand (SM); moist</td>
<td>&lt;25% recovery, cobbles prevented recovery</td>
<td></td>
</tr>
<tr>
<td>9' bgs</td>
<td>01, 4, 15</td>
<td>10</td>
<td>Brown 10YR 5/3; Clayey silty (ML), trace gravel; moist</td>
<td>Depth to water ~11' bgs</td>
<td></td>
</tr>
<tr>
<td>10-10.5' bgs</td>
<td></td>
<td></td>
<td>Black 10YR 2/1; Clayey silt, trace gravel (ML); moist</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11' bgs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MW-12: 15'4&quot;-15'8&quot;</td>
<td>01, 44, 65</td>
<td>15</td>
<td>Very dark gray 10YR 3/1; Clayey silt some fine sand (ML); wet</td>
<td>soil sample (MW-12: 15'4&quot;-15'8&quot;) submitted for geotech analysis</td>
<td></td>
</tr>
<tr>
<td>01, 15, 22</td>
<td>20</td>
<td>no recovery 19-21' bgs</td>
<td>no recovery 19-21' bgs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not recorded</td>
<td>25</td>
<td>Brown 10YR 5/3; Clay (CL), weathered Pierre Shale, shale fragments; wet</td>
<td>total boring sample depth 26 bgs</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Depth (feet)</th>
<th>Water Level (feet)</th>
<th>Logged By:</th>
<th>Drilled/Sampled By:</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td></td>
<td>Justin Bills</td>
<td>Josh Eckhoff</td>
</tr>
</tbody>
</table>

**Date Started:** 11/2/2015  
**Date Completed:** 11/2/2015
Appendix B

Geotechnical Analysis Chain of Custody and Laboratory Reports
<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Water</th>
<th>Soil</th>
<th>Sample ID and Depth Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/4/15</td>
<td></td>
<td>X</td>
<td>Md-w</td>
<td>12'4&quot;-13'3&quot; Cherokee</td>
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<tr>
<td>11/9/15</td>
<td></td>
<td>X</td>
<td>Md-w</td>
<td>19'10&quot;-20'2&quot; Cherokee</td>
</tr>
<tr>
<td>11/9/15</td>
<td></td>
<td>X</td>
<td>Md-10</td>
<td>20'4&quot;-20'8&quot; Cherokee</td>
</tr>
<tr>
<td>11/15/15</td>
<td></td>
<td>X</td>
<td>Md-11</td>
<td>19'10&quot;-21'2&quot; Cherokee</td>
</tr>
<tr>
<td>11/16/15</td>
<td></td>
<td>X</td>
<td>Md-12</td>
<td>21'4&quot;-21'3&quot; Cherokee</td>
</tr>
<tr>
<td>10/15/15</td>
<td></td>
<td>X</td>
<td>Md-w</td>
<td>18'5&quot;-18'9&quot; Volcanost</td>
</tr>
<tr>
<td>11/22/15</td>
<td></td>
<td>X</td>
<td>Md-w</td>
<td>18'4&quot;-18'8&quot; Volcanost</td>
</tr>
<tr>
<td>11/26/15</td>
<td></td>
<td>X</td>
<td>Md-w</td>
<td>15'4&quot;-15'9&quot; Volcanost</td>
</tr>
</tbody>
</table>

PRESERVED WITH: N/A

SAMPLED BY: Justin Bills
RECEIVED BY: ARPAD KALNAF
RECEIVED BY: (SAMPLES UNVERIFIED)
RECEIVED BY LAB: (VERIFIED)
LAB ID: REMARKS

DATE/TIME: 10/28-11/10
RELINQUISHED BY: DATE/TIME: 11/16/15

DATE/TIME: 11/16/15
RELINQUISHED BY: DATE/TIME: 

SAMPLES SHIPPED VIA: UPS FEDEX POST BUS OTHER
December 14, 2015

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

Subject: Laboratory Tests Results – Xcel Coal Combustion Residuals Rule Compliance Project, Valmont 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 1-4 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 (Valmont) xmittal.doc
GRAVEL: 0%  SAND: 1%  SILT / CLAY: 99%
BORING: MW9  Specific Gravity: 2.87
DEPTH: 18'4"-18'8"  Porosity: 44.5%

**Sieve Analysis**

<table>
<thead>
<tr>
<th>Sieve Size / Particle Diameter</th>
<th>Percent Passing</th>
</tr>
</thead>
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<tr>
<td>(1&quot;)</td>
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</table>
GRAVEL: 0%  
SAND: 1%  
SILT / CLAY: 99%

BORING: MW10  
DEPTH: 20'4"-20'8"

Specific Gravity: 2.74  
Porosity: 42.0%

<table>
<thead>
<tr>
<th>Sieve Size / Particle Diameter</th>
<th>Percent Passing</th>
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<tbody>
<tr>
<td>(1&quot;)</td>
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</table>
GRAVEL: 0%  SAND: 24%  SILT / CLAY: 76%
BORING: MW11  Specific Gravity: 2.81
DEPTH: 18'4"-18'8"  Porosity: 43.3%

### Sieve Analysis

<table>
<thead>
<tr>
<th>Sieve Size / Particle Diameter</th>
<th>Percent Passing</th>
</tr>
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<tbody>
<tr>
<td>(1&quot;)</td>
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GRAVEL: 0%  
SAND: 47%  
SILT / CLAY: 53%  
BORING: MW12  
DEPTH: 15'4"-15'8"  
Specific Gravity: 2.71  
Porosity: 40.8%  

### Sieve Analysis

<table>
<thead>
<tr>
<th>Sieve Size / Particle Diameter</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1&quot;)</td>
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</table>
## TABLE 1

**SUMMARY OF LABORATORY TEST RESULTS**

<table>
<thead>
<tr>
<th>SAMPLE LOCATION</th>
<th>BORING</th>
<th>DEPTH</th>
<th>NATURAL MOISTURE CONTENT (%)</th>
<th>NATURAL DRY UNIT WEIGHT (PCF)</th>
<th>GRADATION</th>
<th>SPECIFIC GRAVITY</th>
<th>POROSITY (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>GRAVEL (%)</td>
<td>SAND (%)</td>
<td>SILT &amp; CLAY (%)</td>
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<tr>
<td>MW9</td>
<td>18'4&quot;-18'8&quot;</td>
<td>23.7</td>
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<td>99</td>
<td>2.74</td>
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<td>MW11</td>
<td>18'4&quot;-18'8&quot;</td>
<td>23.6</td>
<td>96</td>
<td>0</td>
<td>24</td>
<td>76</td>
<td>2.81</td>
</tr>
<tr>
<td>MW12</td>
<td>18'4&quot;-18'8&quot;</td>
<td>23.3</td>
<td>100</td>
<td>0</td>
<td>47</td>
<td>53</td>
<td>2.71</td>
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</tbody>
</table>
Appendix C
Well Construction Diagrams
Monitoring Well Construction Diagram
MW-9
Valmont Station
Xcel Energy

Constructed: 10/30/2015
Drilled By: Site Services Drilling, LLC
PVC Casing EL: 5234.25 ft amsl
Water EL: 5226.49 ft amsl (December 2015)
**Monitoring Well Construction Diagram**

**MW-10**

**Valmont Station**

**Xcel Energy**

**Constructed:** 11/2/2015

**Drilled By:** Site Services Drilling, LLC

**PVC Casing EL:** 5233.81 ft amsl

**Water EL:** 5226.72 ft amsl (December 2015)
Monitoring Well Construction Diagram

MW-11
Valmont Station
Xcel Energy

Construct: 11/2/2015
Drilled By: Site Services Drilling, LLC
PVC Casing EL: 5235.22 ft amsl
Water EL: 5225.5 ft amsl (December 2015)
Appendix D
State Well Permits
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)(f) 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-54576, and known as MW-12.

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 calculated 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 108, C.R.S.)
OFFICE OF THE STATE ENGINEER
COLORADO DIVISION OF WATER RESOURCES
818 Centennial Bldg., 1313 Sherman St., Denver, Colorado 80203
(303) 356-3581

WELL PERMIT NUMBER 299969 -
DIV. 1 WD 6 DES. BASIN MD

APPLICANT

PUBLIC SERVICE COMPANY OF COLORADO
1800 N 63RD ST
BOULDER, CO 80302-

(303) 571-7340

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 16.

3) Approved pursuant to CRS 37-92-602(3)(b)(i) for use 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-54576, and known as MW-11.

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.

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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 calculated 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
DG2

State Engineer

Receipt No. 3672751C
DATE ISSUED 01-25-2016

By
EXPIRATION DATE N/A
APPLICANT

PUBLIC SERVICE COMPANY OF COLORADO
1800 N 63RD ST
BOULDER, CO 80302

(303) 571-7340

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-54576, 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 calculated 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
DG2

State Engineer

Receipt No. 3672751B DATE ISSUED 01-25-2016

By EXPIRATION DATE N/A

WOLF

299968
WELL PERMIT NUMBER 299967
DIV. 1 WD 6 DES. BASIN MD

APPLICANT
PUBLIC SERVICE COMPANY OF COLORADO
1800 N 53RD ST
BOULDER, CO 80302-
(303) 571-7340

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 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 calculated from UTM coordinate values provided with the permit application. In addition M-54576 was referenced on this permit since it is not located in the NE1/4 of the SW1/4 of Sec. 26, Twp. 1 N, Rng. 70 W, 6th P.M. 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 108, C.R.S.)

APPROVED
DG2

Receipt No. 3672751A DATE ISSUED 01-25-2016

State Engineer

By
EXPIRATION DATE N/A
Appendix E
Slug Test Analyses
MW-9 SLUG IN

Data Set: P:\...\Valmont_MW-9_Slug_In_BouwerRice.aqt
Date: 01/22/16
Time: 14:08:13

PROJECT INFORMATION

Company: HDR
Client: Xcel Energy
Project: 266180
Location: Valmont Station
Test Well: MW-9
Test Date: 12/21/2015

AQUIFER DATA

Saturated Thickness: 18.4 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-9)

Initial Displacement: 2.23 ft
Total Well Penetration Depth: 12.4 ft
Casing Radius: 0.083 ft
Static Water Column Height: 12.4 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Unconfined
K = 0.002783 cm/sec
y0 = 0.6307 ft

Solution Method: Bouwer-Rice
Data Set: P:\...\Valmont_MW-9_Slug_Out_BouwerRice.aqt
Date: 01/22/16 Time: 14:08:58

Project Information

Company: HDR
Client: Xcel Energy
Project: 266180
Location: Valmont Station
Test Well: MW-9
Test Date: 12/21/2015

Aquifer Data

Saturated Thickness: 18.4 ft
Anisotropy Ratio (Kz/Kr): 1.

Well Data (MW-9)

Initial Displacement: 2.63 ft
Total Well Penetration Depth: 12.4 ft
Casing Radius: 0.083 ft
Static Water Column Height: 12.4 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

Solution

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.004157 cm/sec
y0 = 0.8595 ft
**PROJECT INFORMATION**

- Company: HDR
- Client: Xcel Energy
- Project: 266180
- Location: Valmont Station
- Test Well: MW-9
- Test Date: 12/21/2015

**AQUIFER DATA**

- Saturated Thickness: 18.4 ft
- Anisotropy Ratio (Kz/Kr): 1.

**WELL DATA (MW-9)**

- Initial Displacement: 2.55 ft
- Total Well Penetration Depth: 12.4 ft
- Casing Radius: 0.083 ft
- Static Water Column Height: 12.4 ft
- Screen Length: 10. ft
- Well Radius: 0.25 ft

**SOLUTION**

- Aquifer Model: Unconfined
- Solution Method: Bouwer-Rice
- \( K = 0.002657 \text{ cm/sec} \)
- \( y_0 = 0.5984 \text{ ft} \)
**PROJECT INFORMATION**

Company: HDR  
Client: Xcel Energy  
Project: 266180  
Location: Valmont Station  
Test Well: MW-9  
Test Date: 12/21/2015

**AQUIFER DATA**

Saturated Thickness: 18.4 ft  
Anisotropy Ratio (Kz/Kr): 1.

**WELL DATA (MW-9)**

Initial Displacement: 2.91 ft  
Total Well Penetration Depth: 12.4 ft  
Casing Radius: 0.083 ft  
Static Water Column Height: 12.4 ft  
Screen Length: 10. ft  
Well Radius: 0.25 ft

**SOLUTION**

Aquifer Model: Unconfined  
Solution Method: Bouwer-Rice  
\( K = 0.004221 \text{ cm/sec} \)  
\( y_0 = 0.7852 \text{ ft} \)
**MW-10 SLUG IN**

Data Set: P:\...\Valmont_MW-10_Slug_In_BouwerRice.aqt  
Date: 01/22/16  Time: 14:09:17

**PROJECT INFORMATION**

Company: HDR  
Client: Xcel Energy  
Project: 266180  
Location: Valmont Station  
Test Well: MW-10  
Test Date: 12/21/2015

**AQUIFER DATA**

Saturated Thickness: 15.01 ft  
Anisotropy Ratio (Kz/Kr): 1.

**WELL DATA (MW-10)**

Initial Displacement: 2.4 ft  
Total Well Penetration Depth: 15.01 ft  
Casing Radius: 0.083 ft  
Static Water Column Height: 15.01 ft  
Screen Length: 10. ft  
Well Radius: 0.25 ft

**SOLUTION**

Aquifer Model: Unconfined  
Solution Method: Bouwer-Rice  
K = 0.0005758 cm/sec  
y0 = 0.9293 ft
**PROJECT INFORMATION**

Company: HDR  
Client: Xcel Energy  
Project: 266180  
Location: Valmont Station  
Test Well: MW-10  
Test Date: 12/21/2015

**AQUIFER DATA**

Saturated Thickness: **15.01 ft**  
Anisotropy Ratio (Kz/Kr): 1.

**WELL DATA (MW-10)**

Initial Displacement: **1.82 ft**  
Total Well Penetration Depth: **15.01 ft**  
Casing Radius: **0.083 ft**  
Static Water Column Height: **15.01 ft**  
Screen Length: **10. ft**  
Well Radius: **0.25 ft**

**SOLUTION**

Aquifer Model: Unconfined  
Solution Method: Bouwer-Rice  
K = **0.0006944 cm/sec**  
y0 = **0.9715 ft**
MW-11 SLUG IN
Data Set: P:\...\Valmont_MW-11_Slug_In_BouwerRice.aqt
Date: 01/22/16  Time: 14:09:54

PROJECT INFORMATION
Company: HDR
Client: Xcel Energy
Project: 266180
Location: Valmont Station
Test Well: MW-11
Test Date: 12/21/2015

AQUIFER DATA

WELL DATA (MW-11)
Initial Displacement: 2.82 ft  Static Water Column Height: 15.58 ft
Total Well Penetration Depth: 15.58 ft  Screen Length: 10. ft
Casing Radius: 0.083 ft  Well Radius: 0.25 ft

SOLUTION
Aquifer Model: Unconfined  Solution Method: Bouwer-Rice
K = 0.0004293 cm/sec  y0 = 1.182 ft
MW-11 SLUG OUT

Data Set: P:\...\Valmont_MW-11_Slug_Out_BouwerRice.aqt
Date: 01/22/16  Time: 14:10:15

PROJECT INFORMATION

Company: HDR
Client: Xcel Energy
Project: 266180
Location: Valmont Station
Test Well: MW-11
Test Date: 12/21/2015

AQUIFER DATA

Saturated Thickness: 17.58 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-11)

Initial Displacement: 2.3 ft
Total Well Penetration Depth: 15.58 ft
Casing Radius: 0.083 ft
Static Water Column Height: 15.58 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

\[ K = 0.0004245 \text{ cm/sec} \]

\[ y_0 = 1.226 \text{ ft} \]
PROJECT INFORMATION

Company: HDR
Client: Xcel Energy
Project: 266180
Location: Valmont Station
Test Well: MW-12
Test Date: 12/21/2015

AQUIFER DATA

Saturated Thickness: 17.83 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-12)

Initial Displacement: 2.59 ft
Total Well Penetration Depth: 16.83 ft
Casing Radius: 0.083 ft
Static Water Column Height: 16.83 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Unconfined
K = 0.003328 cm/sec
Solution Method: Bouwer-Rice
y0 = 1.126 ft
MW-12 SLUG OUT
Data Set: P:\...\Valmont_MW-12_Slug_Out_BouwerRice.aqt
Date: 01/22/16 Time: 14:11:42

PROJECT INFORMATION

Company: HDR
Client: Xcel Energy
Project: 266180
Location: Valmont Station
Test Well: MW-12
Test Date: 12/21/2015

AQUIFER DATA

Saturated Thickness: 17.83 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-12)

Initial Displacement: 1.89 ft
Total Well Penetration Depth: 16.83 ft
Casing Radius: 0.083 ft
Static Water Column Height: 16.83 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
\[ K = 0.003809 \text{ cm/sec}, \quad y_0 = 1.228 \text{ ft} \]
MW-12 SLUG IN 2

Data Set: P:\...\Valmont_MW-12_Slug_In_2_BouwerRice.aqt
Date: 01/22/16 Time: 14:10:37

PROJECT INFORMATION

Company: HDR
Client: Xcel Energy
Project: 266180
Location: Valmont Station
Test Well: MW-12
Test Date: 12/21/2015

AQUIFER DATA

Saturated Thickness: 17.83 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-12)

Initial Displacement: 2.05 ft
Total Well Penetration Depth: 16.83 ft
Casing Radius: 0.083 ft
Static Water Column Height: 16.83 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

\[ K = \frac{0.003147}{1.083} \text{ cm/sec} \]

\[ y_0 = 1.083 \text{ ft} \]
**PROJECT INFORMATION**

**Company:** HDR  
**Client:** Xcel Energy  
**Project:** 266180  
**Location:** Valmont Station  
**Test Well:** MW-12  
**Test Date:** 12/21/2015

**AQUIFER DATA**

- Saturated Thickness: 17.83 ft  
- Anisotropy Ratio (Kz/Kr): 1.

**WELL DATA (MW-12)**

- Initial Displacement: 3.2 ft  
- Total Well Penetration Depth: 16.83 ft  
- Casing Radius: 0.083 ft  
- Static Water Column Height: 16.83 ft  
- Screen Length: 10. ft  
- Well Radius: 0.25 ft

**SOLUTION**

- Aquifer Model: Unconfined  
- Solution Method: Bouwer-Rice  
- $K = 0.003589$ cm/sec  
- $y_0 = 1.227$ ft