Date: October 17, 2017

To: Operating Record

From: Harold D. Register, Jr., P.E.

RE: Groundwater Monitoring System Certification, §257.91(f)
J.H. Campbell Generating Complex, JH Campbell Unit 1&2 Bottom Ash Pond

Introduction
According to Title 40 Code of Federal Regulations (40 CFR) Part 257, Subpart D, §257.91(f); the owner or operator of a Coal Combustion Residual (CCR) management unit must obtain a certification from a qualified professional engineer stating that the groundwater monitoring system at the CCR management unit has been designed and constructed to meet the requirements of §257.91. Additionally, §257.91(a) details a performance standard requiring the system monitor the uppermost aquifer and include a minimum of at least one upgradient and three downgradient monitoring wells, and that if the uppermost aquifer monitoring system includes the minimum number of wells, the basis supporting use of only the minimum.

Groundwater Monitoring System
A groundwater monitoring system has been established for the JHC Unit 1&2 Bottom Ash Pond, which established the following locations for determining background groundwater quality and detection monitoring.

Background:

JHC MW-15023       JHC MW-15024       JHC MW-15025
JHC MW-15026       JHC MW-15027       JHC MW-15028

Downgradient:

JHC MW-15001       JHC MW-15002       JHC MW-15003
JHC MW-15004       JHC MW-15005
Provided herein, as required by §257.91(f), is certification from a qualified professional engineer that the groundwater monitoring system at Consumers Energy JH Campbell Unit 1&2 Bottom Ash Pond meets the requirements of §257.91.

CERTIFICATION

Professional Engineer Certification Statement [40 CFR 257.91]

I hereby certify that, having reviewed the attached documentation and being familiar with the provisions of Title 40 of the Code of Federal Regulations §257.91 (40 CFR Part 257.91), I attest that this Groundwater Monitoring System has been designed and constructed to meet the requirements of 40 CFR 257.91. The report is accurate and has been prepared in accordance with good engineering practices, including the consideration of applicable industry standards, and with the requirements of 40 CFR Part 257.91.

Signature

October 17, 2017
Date of Certification

Harold D. Register, Jr., P.E.
Name

6201056266
Professional Engineer Certification Number

ENCLOSURES

Consumers Energy Company

SUMMARY OF MONITORING WELL DESIGN, INSTALLATION, AND DEVELOPMENT – BOTTOM ASH POND UNIT 1-2N/1-2S

J.H. Campbell Electric Generation Facility – West Olive, Michigan

May 13, 2016
Summary of Monitoring Well Design, Installation, and Development – Bottom Ash Pond Unit 1-2N/1-2S

J.H. Campbell Electric Generation Facility
– West Olive, MI

Prepared for:
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Jackson, Michigan

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Date:
May 13, 2016

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J.H. CAMPBELL MONITORING WELL DESIGN, INSTALLATION, AND DEVELOPMENT

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1 INTRODUCTION

ARCADIS has prepared this Summary of Monitoring Well Design, Installation, and Development (Report) to summarize monitoring well installation activities for Unit 1-2N/1-2S at the J.H. Campbell electric generation facility (JHC), located in West Olive, Michigan (Site). The groundwater monitoring system for unit consists of eight background wells (JHC MW-15023 through JHC MW-15030) and five downgradient wells (JHC MW-15001 through JHC MW-15005) as depicted on Figure 1. Monitoring wells were installed to achieve compliance under the recently published 40 CFR Part 257, Subpart D – Standards for the Disposal of Coal Combustion Residuals (CCR) from Electric Utilities (specifically Section 257.91(e)(1)). This Report summarizes the groundwater monitoring well installation activities, including drilling procedures, well locations, well construction details, development activities, and hydraulic testing results. The methodology used in the field activities conforms to federal and state guidance and industry standards.

2 OBJECTIVES

The objectives of this report are to document the work completed at the Site, including:

- Advancement of soil borings
- Monitoring well installation
- Monitoring well development
- Hydraulic testing

The following section describes each of these elements in more detail.

3 FIELD ACTIVITIES

3.1 Soil Borings

Thirteen (13) soil borings (JHC MW-15001 through JHC MW-15005 and JHC MW-15023 through JHC MW-15030) were completed using rotosonic-drilling methods operated by Mateco Drilling Company of Grand Rapids, Michigan with oversight provided by an ARCADIS geologist. Rotosonic drilling uses powered equipment to collect subsurface-soil samples. The rotosonic drill rig advances a length of pipe into the ground through a combination of hydraulic force and high-frequency vibration. The high-frequency vibrations allow the pipe to advance through various types of soil and bedrock producing a high-quality, continuous soil core within the pipe. Each length of pipe was extracted from the ground and emptied into a clear plastic liner for logging. This process was repeated until the total depth of the boring was reached.

Continuous soil cores were collected during drilling to provide detailed lithological and stratigraphic data. An on-site geologist inspected each core, classified the contents, and recorded the observations on an ARCADIS boring log field sheet (Appendix A). A photographic log showing the general soil types observed at the Site is included as Appendix B. All soil borings were completed as monitoring wells, and details of monitoring well installation are provided in the following section.
3.2 Monitoring Well Installation

Once the total depth of the soil boring was reached, a permanent monitoring well was installed in the uppermost aquifer unit for completion of monitoring wells. Monitoring wells were installed through the rotosonic drill rig piping allowing the driller to construct the monitoring well, while simultaneously removing the drill piping. Monitoring wells were constructed with 2-inch inside diameter Schedule 40, polyvinyl chloride (PVC) screens and PVC risers. The well screens have a slot size of 0.010 inch and are 5 to 10 feet in length. A medium-grained sand pack was placed around each well screen to a height 1 to 2 feet above the top of the well screen. A 0.5 to 7 foot thick bentonite grout seal was placed on top of the sand pack. Where possible, the remainder of the annular space was sealed with a cement-bentonite grout to a depth approximately 1 to 23-foot below ground surface.

The wells were finished at the surface using a 3-foot long, locking, stickup well cover set in a 24 inch by 24 inch concrete pad. Well construction logs are included in Appendix A; well construction is summarized in Table 1; well locations are shown on Drawing SG-22345. Wells were labeled according to Consumers Energy’s site-specific nomenclature provided to ARCADIS. The CE construction manager supplied keyed-alike locks for each well that match the existing well keys.

3.3 Monitoring Well Development

Newly installed monitoring wells were allowed to set for a minimum of 48 hours, after which the wells were developed. Well development consisted of the gentle swabbing of the entire screened interval with a surge block. After surging the well screen, water was evacuated using a submersible pump. A “flow-thru cell” and a turbidity meter were utilized to monitor indicator parameters (turbidity, pH, temperature, oxidation-reduction potential (ORP), and conductivity) to determine if groundwater parameters had appropriately stabilized during the development activities at each monitoring well. The stabilization parameters are provided below in Table 2. Indicator parameters were recorded in field notes and the development process continued until development water was free of visible sediment, stabilization of the field parameters, and below 10 Nephelometric Turbidity Units (NTUs). The volume of groundwater removed during development and its appearance was recorded in the field logbook. If drilling fluids were utilized during well installation, the volume of fluids used was recorded in the field logbook. This volume was removed in addition to the volume required for standard development. Monitoring well development details are included in Table 1.

Table 2. Groundwater Parameter Stabilization Criteria

<table>
<thead>
<tr>
<th>Groundwater Parameter</th>
<th>Stabilization Criteria</th>
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<tr>
<td>pH</td>
<td>3 readings within +/- 0.1 Standard Units</td>
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<tr>
<td>Specific Conductance (SpC)</td>
<td>3 readings within +/- 3% mS/cms</td>
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<tr>
<td>Temperature</td>
<td>3 readings within +/- 3%</td>
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<tr>
<td>Oxidation-Reduction Potential (ORP)</td>
<td>3 readings within +/- 10 mV</td>
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<tr>
<td>Turbidity</td>
<td>3 readings within +/- 10% or &lt;1 when &lt; 10 NTU</td>
</tr>
<tr>
<td>Dissolved Oxygen (DO)</td>
<td>3 readings within +/- 0.3 mg/L</td>
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3.4 Hydraulic Testing

On November 10, 2015, Arcadis conducted hydraulic tests (slug tests) at nine monitoring wells (JHC MW-15005, JHC MW-15007, JHC MW-15015, JHC MW-15018, JHC MW-15024, JHC MW-15028, JHC MW-15030, JHC MW-15033, and JHC MW-15036) at the Site. Well construction logs are included in Appendix A; well construction details are summarized in Table 1.

During the slug testing activities, three tests were completed at each of the monitoring wells. The slug tests at these wells were completed to estimate hydraulic conductivity (K) by introducing a water table displacement by removing a known volume of water or depressing the water level by compressed air and measuring the rate of recovery. With the exception of the tests competed at JHC MW-15015, the tests at all wells were completed using a disposable bailer to remove a known volume of water. The bailer used at all wells was 1.5-inches in diameter and 36-inches long. At all the wells where the bail-down slug was used, the first two tests were competed using half the bailer size and the last test was completed using the full size bailer. The tests at JHC MW-15015 were completed using the pneumatic slug test method where a manifold and pump was used to depress the water level. All wells have casing and screen diameters of 2-inches and filter pack diameter of 8-inches. All wells, with the exception of JHC MW-15015 were screened across the water table at the time of well development and hydraulic testing. JHC MW-15015 was screened 2.57 feet below the water table at the time of hydraulic testing. At all wells, a pressure transducer was set to record at 0.5 second intervals to measure static head, displacement and recovery data.

The slug tests at the nine monitoring wells reached full recovery within approximately 7 to 35 seconds. Recovery data collected from the wells were analyzed using the applicable analytical solution with AQTESOLV® for Windows©. Based on diagnostic analyses, the solution utilized at most of the recovery data was the unconfined KGS model (1994) that accounts for partial penetration effects. The unconfined Bouwer and Rice (1976 and 1989) solution was utilized for recovery data at JHC MW-15030. The results indicated an estimated hydraulic conductivity range from 21 to 139 feet per day (ft/d) with an average of 73 ft/d and a geometric mean of 62 ft/d. The results of this test seem to be a reasonable fit with the sandy formation of the unconfined aquifer where the wells are screened. The monitoring well locations where slug tests were conducted are shown on Drawing SG-22345 and the results of the hydraulic conductivity tests are presented in Table 3 and Appendix C.
TABLES
### Table 1
Monitoring Well Construction and Development Summary
Consumers Energy Co.
J.H. Campbell Generating Facility
West Olive, Michigan

<table>
<thead>
<tr>
<th>MW ID</th>
<th>Former MW ID</th>
<th>Site Coordinates</th>
<th>Date Installed</th>
<th>Geologic Unit of Screen Interval</th>
<th>Well Construction</th>
<th>Static DTW (ft below TOC)</th>
<th>Total Depth</th>
<th>Pumping DTW (ft below TOC)</th>
<th>Gallons Removed</th>
<th>Final Turbidity (NTU)</th>
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**Notes:**
- ft = feet
- bgs = below ground surface
- TOC = top of casing
- NR = Not recorded
- NA = Not applicable
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<th>Well ID</th>
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<td>1.515</td>
<td>1.69</td>
<td>86</td>
<td>3.03E-02</td>
<td>KGS Model (Hyder et. al, 1994)</td>
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<tr>
<td></td>
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<td>95</td>
<td></td>
<td></td>
<td>3.35E-02</td>
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<td>0.889</td>
<td>0.844</td>
<td>74</td>
<td>2.61E-02</td>
<td>KGS Model (Hyder et. al, 1994)</td>
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<td>2</td>
<td>0.701</td>
<td>0.844</td>
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<td>3.53E-02</td>
<td>Bouwer-Rice (1976)</td>
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<tr>
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<td>3</td>
<td>1.194</td>
<td>1.69</td>
<td>87</td>
<td>3.07E-02</td>
<td>Bouwer-Rice (1976)</td>
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<td></td>
<td>Average</td>
<td>94</td>
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<td></td>
<td>3.30E-02</td>
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<td>JHC MW-15018</td>
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<td>0.732</td>
<td>0.844</td>
<td>34</td>
<td>1.20E-02</td>
<td>KGS Model (Hyder et. al, 1994)</td>
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<td>3</td>
<td>1.486</td>
<td>1.69</td>
<td>33</td>
<td>1.16E-02</td>
<td>KGS Model (Hyder et. al, 1994)</td>
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<tr>
<td></td>
<td>Average</td>
<td>34</td>
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<td>1.18E-02</td>
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<td>Over all Average</td>
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<td></td>
<td></td>
<td>73</td>
<td>2.56E-02</td>
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<tr>
<td>Over all Geometric mean</td>
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<td></td>
<td></td>
<td>62</td>
<td>2.19E-02</td>
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<td>Minimum</td>
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<td>21</td>
<td>7.41E-03</td>
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<td>Maximum</td>
<td></td>
<td></td>
<td></td>
<td>139</td>
<td>4.90E-02</td>
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</table>

Note:
- H₀ = initial displacement
- H* = expected (calculated) displacement
- cm/sec = centimeters per second
- ft = feet
- ft/d = feet per day
FIGURES
BENCHMARKS

1. SURVEY REPORT
   a. BENCHMARK #161
      Set on top of top bolt on West side of Northwest tower leg of middle tower of three running North-South.
      ELEV. = 617.12 (NAVD88)
      BENCHMARK #162
      Set on top of top bolt on Southwest side of South tower leg of North-most tower.
      ELEV. = 618.84 (NAVD88)
      BENCHMARK #163
      Set on top of top bolt on West side of Northwest tower leg of middle tower of three running North-South.
      ELEV. = 614.44 (NAVD88)
      BENCHMARK #164
      Set on top of steel post holding bird house #150, across gravel road from Northeast corner of ash pond.
      ELEV. = 633.81 (NAVD88)
      BENCHMARK #165
      Set on top of JHC Control Point monument, no #, on top of bank approximately at point of intersection of gravel road to North and East.
      ELEV. = 631.70 (NAVD88)
      BENCHMARK #166
      Surrounding a pond and a metal building, approximate Southwest part of site.
      ELEV. = 628.67 (NAVD88)
      BENCHMARK #167
      South and East.
      ELEV. = 617.62 (NAVD88)
      BENCHMARK #168
      Northwest corner of ash pond and the closest pond, approximate Northwest corner of site.
      ELEV. = 616.00 (NAVD88)
      BENCHMARK #169
      East and Northwest corner of ash pond.
      ELEV. = 614.44 (NAVD88)
      BENCHMARK #170
      Northwest corner of ash pond.
      ELEV. = 611.72 (NAVD88)

LEGEND

1. CONTINUOUS MECHANICAL BUCKET MONITORING WELLS
2. CONTINUOUS MECHANICAL BUCKET MONITORING WELLS
3. CONTINUOUS MECHANICAL BUCKET MONITORING WELLS
4. RAILMONITOR MONITORING WELLS
5. RAILMONITOR MONITORING WELLS
6. RAILMONITOR MONITORING WELLS

SURVEYOR'S NOTES

The information contained herein is true and correct to the best of our knowledge and belief. The information was prepared in good faith and belief in reliance on a survey record book for the place and date indicated. It is to the best of our knowledge. We are not aware of any errors or omissions. We have no reason to doubt the accuracy of the information contained herein.
**Date Start:** 9/15/15  
**Date Finish:** 9/16/15  
**Drilling Company:** Mateco Drilling  
**Driller's Name:** Dan Mouver  
**Drilling Method:** Air Knife/Sonic  
**Sampling Method:** Continuous  
**Rig Type:** Sonic  
**Water Level Start (ft. bgs.):** NA  
**Water Level Finish (ft. btoc.):** 9.31

**Well/Boring ID:** JHC MW-15001  
**Client:** Consumers Energy  
**Location:** JH Campbell Facility  
1700 Crosswell Street Site A  
West Olive, MI 49460  
**Weather Conditions:** 75 F Sunny

<table>
<thead>
<tr>
<th>DEPTH (feet bgl.)</th>
<th>Sample Run Number</th>
<th>Sample/Ini/Type</th>
<th>Recovery (feet)</th>
<th>PID Headspace (ppm)</th>
<th>Analytical Sample</th>
<th>Geologic Column</th>
<th>Stratigraphic Description</th>
<th>Water Level (ft. bgs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>610</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>605</td>
<td>1</td>
<td>0.0-10.0'</td>
<td>10</td>
<td>NA</td>
<td></td>
<td></td>
<td>(0.0 - 0.3') Grass, Topsoil</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.3 - 10.0') SAND, fine to medium, subrounded; trace silt; well sorted.</td>
<td></td>
</tr>
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<td></td>
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<td></td>
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<tr>
<td>600</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>595</td>
<td>2</td>
<td>10.0-15.0'</td>
<td>3</td>
<td>NA</td>
<td></td>
<td></td>
<td>(10.0 - 15.0') SAND, fine to medium, subrounded; trace silt; well sorted; wet; brown (10YR 4/3) to yellowish brown (10YR 5/4).</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>590</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

**Remarks:**  
**bgs** = below ground surface  
**btoc** = below top of casing

Air Knife to 6.0’ bgs.  
Groundwater encountered at 10.0’ bgs during drilling.  
Water level at development was 9.31’ btoc  
No odor or staining observed  
Groundwater elevation measured on December 2, 2015 was 600.28 feet

---

**Project:** DE000722.0003.00006  
**Template:** ARCADIS_Analytical Boring-Well 2013_New Logo  
**Data File:** MW-15001.dat  
**Date:** 10/4/2017  
**Created/Edited by:** S.Das/C. Jeffers
**Date Start:** 9/16/15  
**Date Finish:** 9/16/15  
**Drilling Company:** Mateco Drilling  
**Driller's Name:** Dan Mouver  
**Drilling Method:** Air Knife/Sonic  
**Sampling Method:** Continuous  
**Rig Type:** Sonic  
**Water Level Start (ft. bgs.):** 11.0  
**Water Level Finish (ft. btoe):** 24.51  

**Well/Boring ID:** JHC MW-15002  
**Client:** Consumers Energy  
**Location:** JH Campbell Facility  
1700 Crosswell Street Site A  
West Olive, MI 49460  
**Weather Conditions:** 75 F Sunny

### DEPTH (feet bgs.)

<table>
<thead>
<tr>
<th>ELEVATION</th>
<th>Sample Run Number</th>
<th>Sample Int Type</th>
<th>Recovery (ft.)</th>
<th>PID Headspace (ppm)</th>
<th>Analytical Sample</th>
<th>Geologic Column</th>
<th>Stratigraphic Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>625</td>
<td>1</td>
<td>0.0-10.0</td>
<td>10</td>
<td>NA</td>
<td></td>
<td></td>
<td>(0.0 - 0.3) Grass, Topsoil.</td>
</tr>
<tr>
<td>620</td>
<td>2</td>
<td>10.0-20.0</td>
<td>1.8</td>
<td>NA</td>
<td></td>
<td></td>
<td>(0.3 - 11.0) ASH; trace fine sand, subrounded; well sorted; moist to wet; dark gray (10YR 4/1). NOTE: Fill material.</td>
</tr>
<tr>
<td>615</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(11.0 - 24.0) ASH; well sorted; soft; wet; light gray (10YR 7/1) to dark gray (10YR 4/1). NOTE: Fill material.</td>
</tr>
</tbody>
</table>

**Remarks:**  
bgs = below ground surface  
btoe = below top of casing  
Air knife to 10.0' bgs.  
Groundwater encountered at 24.0' bgs during drilling.  
Water level at development was 24.51' btoe.  
No odor or staining observed.  
Groundwater elevation measured on December 2, 2015 was 604.04 feet.

---

**Well/Boring Construction**

- TOC = 625.967 (ft. above msl)
- Concrete (0.0-1.0' bgs)
- Bentonite/Cement Grout (0.0-24.0' bgs)
- 2" PVC Well Casing (-3.0-28.0' bgs)
**Date Start:** 9/16/15  
**Date Finish:** 9/16/15  
**Drilling Company:** Mateco Drilling  
**Driller's Name:** Dan Mouver  
**Drilling Method:** Air Knife/Sonic  
**Sampling Method:** Continuous  
**Rig Type:** Sonic  
**Water Level Start (ft. bgs.):** 11.0  
**Water Level Finish (ft. bgs.):** 24.51  

**Nothign:** 518378.917  
**Easting:** 12633974.82  
**Casing Elevation:** 628.867  
**Borehole Depth (ft. bgs.):** 38.0  
**Surface Elevation:** 625.967  
**Descriptions By:** A. Westhuis  

**Well/Boring ID:** JHC MW-15002  
**Client:** Consumers Energy  
**Location:** JH Campbell Facility  
1700 Crosswell Street Site A  
West Olive, MI 49460  
**Weather Conditions:** 75 F Sunny

<table>
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<th>DEPTH (feet bgs.)</th>
<th>ELEVATION</th>
<th>Sample Run Number</th>
<th>Sample/Int/Type</th>
<th>PID Headspace (ppm)</th>
<th>Stratigraphic Description</th>
<th>Geologic Column</th>
<th>Water Level (ft. bgs.)</th>
<th>Well/Boring Construction</th>
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<td></td>
</tr>
<tr>
<td>25</td>
<td>600</td>
<td>3</td>
<td>20.0-30.0'</td>
<td>8</td>
<td>(24.0 - 25.0') SAND, fine, little very fine sand, subrounded; trace silt; well sorted; wet; yellowish brown (10YR 5/6).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>595</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>4</td>
<td>35</td>
<td>3</td>
<td>30.0-38.0'</td>
<td>6</td>
<td>(25.0 - 38.0') SAND, fine, little very fine, subrounded; trace silt; well sorted; wet; very pale brown (10YR 7/4).</td>
<td></td>
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<tr>
<td>4.5</td>
<td>39</td>
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<td>39.5</td>
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</table>

End of boring 38.0' bgs.

**Remarks:**  
- bgs = below ground surface  
- bloc = below top of casing  
  - Air knife to 10.0’ bgs.  
  - Groundwater encountered at 24.0’ bgs during drilling.  
  - Water level at development was 24.51’ bloc.  
  - No odor or staining observed.  
  - Groundwater elevation measured on December 2, 2015 was 604.04 feet
**Date Start:** 9/16/15  
**Date Finish:** 9/17/15  
**Drilling Company:** Mateco Drilling  
**Driller's Name:** John Pitsch  
**Drilling Method:** Air Knife/Sonic  
**Sampling Method:** Continuous  
**Rig Type:** Sonic  
**Water Level Start (ft. bgs.):** 28.0  
**Water Level Finish (ft. btoc.):** 30.57  
**Nothing:** 518069.863  
**Easting:** 12633990.37  
**Casing Elevation:** 630.632  
**Borehole Depth (ft. bgs.):** 38.0  
**Surface Elevation:** 628.307  
**Descriptions By:** A. Westhuis  
**Well/Boring ID:** JHC MW-15003  
**Client:** Consumers Energy  
**Location:** JH Campbell Facility  
1700 Crosswell Street Site A  
West Olive, MI 49460  
**Weather Conditions:** 75 F Sunny  

<table>
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<tr>
<th>DEPTH (feet bgs.)</th>
<th>Sample Run Number</th>
<th>Sample/Int/Type</th>
<th>PID Headspace (ppm)</th>
<th>Geologic Sample</th>
<th>Stratigraphic Description</th>
<th>Well/Boring Construction</th>
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<tr>
<td>3</td>
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</tr>
<tr>
<td>60.0 - 30.0'</td>
<td>5</td>
<td>NA</td>
<td></td>
<td></td>
<td>(20.0 - 21.0') SAND, fine, subrounded; trace silt; well sorted; moist; brownish-yellow (10YR 6/8). NOTE: Trace small roots at this depth.</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>60.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(21.0 - 28.0') SAND, fine, subrounded; trace silt; well sorted; moist; very pale brown (10YR 7/4).</td>
<td></td>
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<tr>
<td>30</td>
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</tr>
<tr>
<td>595</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td>(28.0 - 38.0') SAND, fine, little medium; trace granules, subrounded; trace silt; well sorted; wet; brownish-yellow (10YR 6/8).</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td></td>
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<td></td>
<td>End of boring at 38.0' bgs.</td>
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**Remarks:**  
- bgs = below ground surface  
- btoc = below top of casing  
- Air knife to 10.0' bgs.  
- Groundwater encountered at 28.0' bgs during drilling.  
- Water level at development was 30.57' btoc  
- No odor or staining observed  
- Groundwater elevation measured on December 2, 2015 was 602.48 feet
<table>
<thead>
<tr>
<th>DEPTH (feet bgs.)</th>
<th>ELEVATION</th>
<th>Sample Run Number</th>
<th>Sample/Int/Type</th>
<th>Recovery (feet)</th>
<th>PID Headspace (ppm)</th>
<th>Stratigraphic Description</th>
<th>Geologic Column</th>
<th>Water Level (ft. bgs.)</th>
<th>Well/Boring Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>620</td>
<td>1</td>
<td>0.0-10'</td>
<td>10</td>
<td>NA</td>
<td></td>
<td>(0.0 - 0.3) Grass, Topsoil.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>615</td>
<td>2</td>
<td>10.0-15.0'</td>
<td>4</td>
<td>NA</td>
<td></td>
<td>(0.3 - 10.0') ASH and SAND, fine to medium, subrounded; stiff, dry to moist; dark grayish brown (10YR 4/2). NOTE: Fill material.</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>610</td>
<td>3</td>
<td>15.0-20.0'</td>
<td>4</td>
<td>NA</td>
<td></td>
<td>(10.0 - 19.0') ASH and SAND, fine to medium, subrounded; soft; moist to wet; dark grayish brown (10YR 4/2). NOTE: Fill material.</td>
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<td></td>
<td>NOTE: Trace small pebbles from 12.0 to 13.0' bgs.</td>
<td></td>
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</tr>
</tbody>
</table>

**Remarks:**

- bgs = below ground surface
- boc = below top of casing

Air knife to 10.0’ bgs.

Groundwater encountered at 27.0’ bgs during drilling.

Water level at development was 31.67’ boc.

No odor or staining observed.

Groundwater elevation measured on December 2, 2015 was 598.77 feet.
Date Start: 9/17/15
Date Finish: 9/17/15
Drilling Company: Mateco Drilling
Driller's Name: John Pitsch
Drilling Method: Air Knife/Sonic
Sampling Method: Continuous
Rig Type: Sonic
Water Level Start (ft. bgs.): 27.0
Water Level Finish (ft. btoc.): 31.67

Nothing: 517864.558
Easting: 12633547.12
Casing Elevation: 628.422
Borehole Depth (ft. bgs.): 40.0
Surface Elevation: 624.917
Descriptions By: A. Westhuis

Well/Boring ID: JHC MW-15004
Client: Consumers Energy
Location: JH Campbell Facility
1700 Crosswell Street Site A
West Olive, MI 49460
Weather Conditions: 75 F Sunny

### TDR Sampling Results

<table>
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<th>ELEVATION</th>
<th>Sample Run Number</th>
<th>Sample/Int/Type</th>
<th>PID Headspace (ppm)</th>
<th>Analytical Sample</th>
<th>Geologic Column</th>
<th>Stratigraphic Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>605</td>
<td>4</td>
<td>20.0-30.0'</td>
<td>4</td>
<td>NA</td>
<td></td>
<td>(19.0 - 20.0') SAND, fine; trace medium sand, subrounded; trace silt; well sorted; dry to moist; brownish yellow (10YR 6/8).</td>
</tr>
<tr>
<td>25</td>
<td>600</td>
<td>4</td>
<td>20.0-30.0'</td>
<td>4</td>
<td>NA</td>
<td></td>
<td>(20.0 - 30.0') SAND, fine, trace medium, subrounded; trace silt; well sorted; dry; very pale brown (10YR 7/4).</td>
</tr>
<tr>
<td>30</td>
<td>595</td>
<td>5</td>
<td>30.0-40.0'</td>
<td>8</td>
<td>NA</td>
<td></td>
<td>(30.0 - 40.0') SAND, fine to medium; trace coarse sand; trace granules; subrounded; well sorted; wet; pale brown (10YR 6/3).</td>
</tr>
</tbody>
</table>

**Remarks:**
- bgs = below ground surface
- btoc = below top of casing
- Air knife to 10.0' bgs.
- Groundwater encountered at 27.0' bgs during drilling.
- No odor or staining observed.
- Groundwater elevation measured on December 2, 2015 was 598.77 feet
### Stratigraphic Description

<table>
<thead>
<tr>
<th>DEPTH (feet bgs.)</th>
<th>Sample Run Number</th>
<th>Sample Int/Type</th>
<th>Recovery (feet)</th>
<th>Analytical Sample</th>
<th>Geologic Column</th>
</tr>
</thead>
<tbody>
<tr>
<td>625</td>
<td>1</td>
<td>0.0-10.0'</td>
<td>10</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>620</td>
<td>1</td>
<td>0.0-10.0'</td>
<td>10</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>615</td>
<td>1</td>
<td>10.0-20.0'</td>
<td>6</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

- **(0.0 - 0.3) Grass, Topsoil.**
- **(0.3 - 10.0') ASH and SAND, fine to medium; trace granules, subrounded; moist to stiff; poorly sorted; brown (10YR 5/3) to dark grayish brown (10YR 4/2).**
  **NOTE:** Fill material.
- **(10.0 - 11.0') ASH; well sorted; medium stiff to stiff; moist; dark gray (10YR 4/1).**
  **NOTE:** Fill material.
- **(11.0 - 13.0') SAND, medium, little to some fine sand, subrounded; trace silt; well sorted; dry; brown (10YR 5/3) to yellowish brown (10YR 5/4).**
- **(13.0 - 16.0') SAND, medium; little fine sand, subrounded; trace silt; well sorted; dry; very pale brown (10YR 7/4).**
- **(16.0 - 19.5') SAND, medium; trace fine, subrounded; trace silt; dry; light yellowish brown (10YR 6/4).**

### Remarks:
- bgs = below ground surface
- bloc = below top of casing
- Air knife to 10.0' bgs.
- Groundwater encountered at 29.0' bgs during drilling.
- Water level at development encountered at 33.26' bloc.
- No odor or staining observed.
- Groundwater elevation measured on December 2, 2015 was 595.77 feet.
**Date Start:** 9/18/15  
**Date Finish:** 9/18/15  
**Drilling Company:** Mateco Drilling  
**Driller's Name:** John Pitsch  
**Sampling Method:** Continuous  
**Drilling Method:** Air Knife/Sonic  
**Rig Type:** Sonic  
**Water Level Start (ft. bgs.):** 29.0  
**Water Level Finish (ft. btoc.):** 33.26  
**Nothing:** 517781.423  
**Easting:** 12633905.01  
**Casing Elevation:** 627.297  
**Borehole Depth (ft. bgs.):** 40.0  
**Surface Elevation:** 624.367  
**Descriptions By:** A. Westhuis  
**Location:** JH Campbell Facility  
**1700 Crosswell Street Site A**  
**West Olive, MI 49460**  
**Weather Conditions:** 70 F Cloudy  

<table>
<thead>
<tr>
<th>DEPTH (feet bgs.)</th>
<th>ELEVATION</th>
<th>Sample/Run Number</th>
<th>Sample/Run/Type</th>
<th>PID Headspace (ppm)</th>
<th>Analytical Sample</th>
<th>Geologic Column</th>
<th>Stratigraphic Description</th>
<th>Water Level (ft. bgs.)</th>
<th>Well/Boring Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>605</td>
<td>20</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>600</td>
<td>25</td>
<td>3</td>
<td>20.0-30.0'</td>
<td>6</td>
<td>NA</td>
<td></td>
<td>(19.5 - 19.8') SAND, medium, trace fine, subrounded; little to some silt; moist, brown (10YR 4/3).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>595</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(19.8 - 29.0') SAND, medium, trace fine, subrounded; trace silt; well sorted; dry; very pale brown (10YR 7/4).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>590</td>
<td>35</td>
<td>4</td>
<td>30.0-40.0'</td>
<td>9</td>
<td>NA</td>
<td></td>
<td>(29.0 - 31.0') SAND, medium, little fine, trace coarse, subrounded; trace silt; well sorted; wet; pale brown (10YR 6/3).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>585</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(31.0 - 33.0') SAND, medium to coarse, little fine, subrounded; trace silt; well sorted; wet; pale brown (10YR 6/3).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>580</td>
<td>45</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(33.0 - 40.0') SAND, fine, some medium, subrounded; well sorted; wet; pale brown (10YR 6/3).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>575</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>End of boring at 40.0' bgs.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Remarks:**  

- bgs = below ground surface  
- btoc = below top of casing  
- Air knife to 10.0' bgs.  
- Groundwater encountered at 29.0' bgs during drilling.  
- Water level at development encountered at 33.26' btoc.  
- No odor or staining observed.  
- Groundwater elevation measured on December 2, 2015 was 595.77 feet.
<table>
<thead>
<tr>
<th>DEPTH (feet bgs.)</th>
<th>ELEVATION</th>
<th>Sample Run Number</th>
<th>Sample/Ini/Type</th>
<th>Recovery (feet)</th>
<th>PID Headspace (ppm)</th>
<th>Analytical Sample</th>
<th>Geologic Column</th>
<th>Stratigraphic Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.0 - 0.3) Grass, Topsoil.</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>1</td>
<td>0.0 - 10.0'</td>
<td>10</td>
<td>NA</td>
<td></td>
<td></td>
<td>(0.3 - 10.0') SAND, fine to medium, subrounded; trace silt; well sorted; dry to moist; light brownish gray (10YR 6/2).</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>2</td>
<td>10.0 - 20.0'</td>
<td>8</td>
<td>NA</td>
<td></td>
<td></td>
<td>(10.0 - 17.0') SAND, fine to little medium, subrounded; little silt; well sorted; dry; light yellowish brown (10YR 6/4).</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(17.0 - 17.5') SAND, very fine to fine, subrounded; little to some silt; well sorted; dry; very pale brown (10YR 7/3).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(17.5 - 40.0') SAND, fine to medium, subrounded; trace silt; well sorted; dry to moist; brownish yellow (10YR 6/6).</td>
</tr>
</tbody>
</table>

**Remarks:**
- bgs = below ground surface
- bloc = below top of casing
- Air knife to 10.0' bgs.
- Groundwater encountered at 21.0' bgs during drilling.
- Water level at development was 29.28' bloc.
- No odor or staining observed.
- Groundwater elevation measured on December 2, 2015 was 599.22 feet.
<table>
<thead>
<tr>
<th>DEPTH (feet bgs.)</th>
<th>ELEVATION</th>
<th>Sample Run Number</th>
<th>Sample/Int/Type</th>
<th>Recovery (feet)</th>
<th>PID Headspace (ppm)</th>
<th>Analytical Sample</th>
<th>Stratigraphic Description</th>
<th>Geologic Column</th>
<th>Well/Boring Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>-20</td>
<td>2</td>
<td>20.0-30.0'</td>
<td>5</td>
<td>NA</td>
<td>NA</td>
<td>NOTE: Wet at 21.0' bgs.</td>
<td>Bentonite Pellets (18.0-20.0' bgs)</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>-25</td>
<td>3</td>
<td>20.0-30.0'</td>
<td>5</td>
<td>NA</td>
<td>NA</td>
<td>Sand Pack K&amp;E WP1 (20.0-40.0' bgs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>-30</td>
<td>4</td>
<td>30.0-40.0'</td>
<td>5</td>
<td>NA</td>
<td>NA</td>
<td>2&quot; PVC 10 Slot Well Screen (22.0-32.0' bgs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>-35</td>
<td>4</td>
<td>30.0-40.0'</td>
<td>5</td>
<td>NA</td>
<td>NA</td>
<td>End of boring at 40.0' bgs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>-40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>NA</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Remarks:**
- bgs = below ground surface
- bloc = below top of casing

- Air knife to 10.0' bgs.
- Groundwater encountered at 21.0' bgs during drilling.
- Water level at development was 29.28' bloc.
- No odor or staining observed.
- Groundwater elevation measured on December 2, 2015 was 599.22 feet.
Data File:  JHC-MW-15015.dat  Date:  4/27/2016  Created/Edited by: S.Das/C. Jeffers

Date Start:  9/25/15
Date Finish:  9/28/15
Drilling Company:  Mateco Drilling
Driller's Name:  John Pitsch
Drilling Method:  Air Knife/Sonic
Sampling Method:  Continuous
Rig Type:  Sonic
Water Level Start (ft. bgs.):  23.92
Water Level Finish (ft. btoc.):  28.57

Comments:
Air knife to 10.0' bgs.
Groundwater encountered at 23.92' bgs.
Water level at development was 28.57' bgs.
No odor or staining observed.
Groundwater elevation measured on December 3, 2015 was 607.68 feet.

Well Boring ID:  JHC-MW-15015
Client:  Consumers Energy
Location:  JH Campbell Facility
1700 Crosswell Street Site A
West Olive, MI 49460
Weather Conditions:  75 F Sunny

Casing Elevation:  635.202
Surface Elevation:  632.462

Stratigraphic Description

Sample/Int/Type | Recovery (feet) | PID Headspace (ppm) | Analytical Sample | Geologic Column | Descriptions By: A. Westhuis
--- | --- | --- | --- | --- | ---
635 | 630 | 625 | 620 | 615 |

Depth (feet bgs.) | Sample Run Number | Sample/Int/Type | Recovery | PID Headspace | Geologic Column
--- | --- | --- | --- | --- | ---
635 | 630 | 625 | 620 | 615 |

Elevation | Water Level (ft. bgs.) | Well/Boring Construction
--- | --- | ---
635 | 635.202 (ft. above msl)
630 | 625 | 620 | 615

Gravel toe to 10.0' bgs.
Groundwater encountered at 23.92' bgs.
Water level at development was 28.57' bgs.
No odor or staining observed.
Groundwater elevation measured on December 3, 2015 was 607.68 feet.

Remarks: bgs = below ground surface
bloc = below top of casing

Air knife to 10.0' bgs.
Groundwater encountered at 23.92' bgs.
Water level at development was 28.57' bgs.
No odor or staining observed.
Groundwater elevation measured on December 3, 2015 was 607.68 feet.
### Stratigraphic Description

**Well/Boring Construction**

<table>
<thead>
<tr>
<th>DEPTH (feet bgs.)</th>
<th>Sample Run Number</th>
<th>Sample/Int/Type</th>
<th>Recovery (feet)</th>
<th>PID Headspace (ppm)</th>
<th>Geologic Column</th>
<th>Stratigraphic Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>3</td>
<td>20.0-30.0'</td>
<td>8.0</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>4</td>
<td>30.0-40.0'</td>
<td>8.0</td>
<td>NA</td>
<td></td>
<td>(35.0 - 40.0') SAND, very fine to fine, subrounded; trace silt; well sorted; wet; pale brown (10YR 6/3).</td>
</tr>
<tr>
<td>40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Remarks:**
- bgs = below ground surface
- bloc = below top of casing

Air knife to 10.0' bgs.
Groundwater encountered at 23.92' bgs.
Water level at development was 28.57' bloc.
No odor or staining observed.
Groundwater elevation measured on December 3, 2015 was 607.68 feet
Air knife to 10.0' bgs.
Groundwater encountered at 12.0' bgs during drilling.
Water level at development was 16.29' btoc.
No odor or staining observed.
Groundwater elevation measured on December 2, 2015 was 600.45 feet
## Summary

**Date Start:** 10/1/15  
**Date Finish:** 10/1/15  
**Drilling Company:** Mateco Drilling  
**Driller's Name:** Dan Mourer  
**Drilling Method:** Hand Auger/Sonic  
**Sampling Method:** Continuous  
**Rig Type:** Sonic  
**Water Level Start (ft. bgs.):** 18.0  
**Water Level Finish (ft. btoc.):** 18.91  

**Well/Boring ID:** JHC MW-15023  
**Client:** Consumers Energy  
**Location:** JH Campbell Facility  
1700 Crosswell Street Site A  
West Olive, MI 49460  
**Weather Conditions:** Sunny, 60F.

## Stratigraphic Description

<table>
<thead>
<tr>
<th>DEPTH (ft. bgs.)</th>
<th>Sample Run Number</th>
<th>Sample/Int/Type</th>
<th>Recovery (feet)</th>
<th>PID Headspace (ppm)</th>
<th>Analytical Sample</th>
<th>Stratigraphic Description</th>
<th>Geologic Column</th>
</tr>
</thead>
<tbody>
<tr>
<td>620</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.0 - 0.3') TOPSOIL; grass.</td>
<td></td>
</tr>
<tr>
<td>615</td>
<td>1</td>
<td>0-10'</td>
<td>10</td>
<td>NA</td>
<td></td>
<td>(0.3 - 10.0') SAND, very fine to fine, subrounded; trace silt; well sorted; dry to moist; brownish yellow (10 YR 4/3).</td>
<td></td>
</tr>
<tr>
<td>610</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Note: Trace wood fragments from 7.0 to 10.0' bgs.</td>
<td></td>
</tr>
<tr>
<td>605</td>
<td>2</td>
<td>10-20'</td>
<td>8</td>
<td>NA</td>
<td></td>
<td>(10.0 - 16.0') SAND, very fine to fine, subrounded; trace to little silt; well sorted; dry to moist; brownish yellow (10 YR 6/8).</td>
<td></td>
</tr>
<tr>
<td>600</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(16.0 - 17.0') SAND, very fine to fine, subrounded; trace silt; well sorted; moist; yellow (10 YR 7/6).</td>
<td></td>
</tr>
<tr>
<td>595</td>
<td>3</td>
<td>20-25'</td>
<td>4</td>
<td>NA</td>
<td></td>
<td>(17.0 - 18.0') SAND, fine, subrounded; trace silt; well sorted; moist; brownish yellow (10 YR 6/6).</td>
<td></td>
</tr>
<tr>
<td>590</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(18.0 - 21.0') SAND, very fine; little fine sand, subrounded; trace silt; well sorted; wet; pale brown (10 YR 6/3).</td>
<td></td>
</tr>
<tr>
<td>585</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(21.0 - 25.0') SAND, medium; trace fine sand, subangular; trace granules, subangular; poorly sorted; wet; pale brown (10 YR 6/3).</td>
<td></td>
</tr>
<tr>
<td>580</td>
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<td></td>
<td></td>
<td></td>
<td>End of boring at 25.0' bgs.</td>
<td></td>
</tr>
</tbody>
</table>

## Remarks:
- bgs = below ground surface  
- btoc = below top of casing

Hand auger to 10.0' bgs.  
Groundwater encountered at 18.0' bgs during drilling.  
Water level at development was 18.91' btoc.  
No odor or staining observed  
Groundwater elevation measured on December 2, 2015 was 592.53 feet
### DEPTH (feet bgs.)

<table>
<thead>
<tr>
<th>ELEVATION</th>
<th>Sample Run Number</th>
<th>Sample/Inj Type</th>
<th>Recovery (feet)</th>
<th>PID Headspace (ppm)</th>
<th>Geologic Column</th>
<th>Stratigraphic Description</th>
<th>Water Level (ft. bgs.)</th>
<th>Well/Boring Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>615</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>610</td>
<td>1</td>
<td>0-10'</td>
<td>4</td>
<td>NA</td>
<td></td>
<td>(0.0 - 0.3') TOPSOIL; grass.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>605</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.3 - 10.0') SAND, fine, subrounded; trace silt; well sorted; dry to moist; brownish yellow (10 YR 6/6).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>600</td>
<td>2</td>
<td>10-20'</td>
<td>9</td>
<td>NA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>595</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(10.0 - 20.0') SAND, fine to medium, subrounded; trace to little very fine sand; trace silt; well sorted; wet; pale brown (10 YR 6/3).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>550</td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>

**Remarks:**
- bgs = below ground surface
- bloc = below top of casing

Aird knife to 10.0' bgs.
Groundwater encountered at 10.0' bgs during drilling.
Water level at development was 14.12' bloc.
No odor or staining observed.
Groundwater elevation measured on December 2, 2015 was 602.24 feet.
### Well/Boring Information

**Date Start:** 10/1/15  
**Date Finish:** 10/1/15  
**Drilling Company:** Mateco Drilling  
**Driller’s Name:** Dan Mouser  
**Drilling Method:** Hand Auger/Sonic  
**Sampling Method:** Continuous  
**Rig Type:** Sonic  
**Water Level Start (ft. bgs.):** 12.0  
**Water Level Finish (ft. btoc.):** 13.50  
**Sample Run Number:** 1  
**Sample/Int/Type:**  
**Recovery (feet):** 10  
**PID Headspace (ppm):** NA  
**Geologic Column:**  

### Stratigraphic Description

<table>
<thead>
<tr>
<th>Depth (ft bgs.)</th>
<th>Sample/Int/Type</th>
<th>Recovery (feet)</th>
<th>PID Headspace (ppm)</th>
<th>Geologic Column</th>
</tr>
</thead>
<tbody>
<tr>
<td>615</td>
<td></td>
<td></td>
<td></td>
<td>(0.0 - 0.3) TOPSOIL; grass.</td>
</tr>
<tr>
<td>610</td>
<td>0-10’</td>
<td>10</td>
<td>NA</td>
<td>(0.3 - 5.0’) SAND, fine, subrounded; trace silt; well sorted; dry; very pale brown (10 YR 7/3).</td>
</tr>
<tr>
<td>605</td>
<td></td>
<td></td>
<td></td>
<td>(5.0 - 12.0’) SAND, fine, subrounded; trace silt; well sorted; dry; brownish yellow (10 YR 6/6). Note: Color change to brownish yellow (10YR 6/8) at 6.0’ bgs.</td>
</tr>
<tr>
<td>600</td>
<td>10-20’</td>
<td>8</td>
<td>NA</td>
<td>(12.0 - 15.0’) SAND, fine, subrounded; trace silt; well sorted; wet; pale brown (10 YR 6/3).</td>
</tr>
<tr>
<td>595</td>
<td></td>
<td></td>
<td></td>
<td>(15.0 - 16.0’) SAND, fine to medium, subrounded; trace coarse sand, subrounded; trace granules, subrounded; trace silt; well sorted; wet; pale brown (10 YR 6/3).</td>
</tr>
<tr>
<td>590</td>
<td></td>
<td></td>
<td></td>
<td>(16.0 - 20.0’) SAND, very fine to fine, subrounded; little silt; well sorted; wet; pale brown (10 YR 6/3).</td>
</tr>
</tbody>
</table>

End of boring at 20.0’ bgs.

### Remarks:

- bgs= below ground surface  
- btoc = below top of casing

Hand auger to 10.0’ bgs.  
Groundwater encountered at 12.0’ bgs during drilling.  
Water level at development was 13.50’ btoc.  
No odor or staining observed  
Groundwater elevation measured on December 2, 2015 was 603.36 feet.

---

**Location:** JH Campbell Facility  
1700 Crosswell Street Site A  
West Olive, MI 49460  
**Client:** Consumers Energy  
**Weather Conditions:** Sunny, 60F.
Date Start: 10/2/15
Date Finish: 10/2/15
Drilling Company: Mateco Drilling
Driller's Name: Dan Mourer
Drilling Method: Hand Auger/Sonic
Sampling Method: Continuous
Rig Type: Sonic
Water Level Start (ft. bgs.): 12.0
Water Level Finish (ft. btoc.): 15.34

Node: 522495.091
Easting: 12635971.82
Casing Elevation: 618.042
Borehole Depth (ft. bgs.): 20.0
Surface Elevation: 615.087

Descriptions By: A. Westhuis

Well/Boring ID: JHC MW-15026
Client: Consumers Energy
Location: JH Campbell Facility
1700 Crosswell Street Site A
West Olive, MI 49460
Weather Conditions: Sunny, 45F.

DEEPH (ft. bgs.)
Sample Run Number
Sample/Int/Type
PID Headspace (ppm)
Geologic Column
Stratigraphic Description

Water Level (ft. bgs.)

Remarks: bgs= below ground surface
bloc = below top of casing

Hand auger to 10.0' bgs.
Groundwater encountered at 12.0' bgs during drilling.
Water level at development was 15.34' bloc.
No odor or staining observed.
Groundwater elevation measured on December 2, 2015 was 602.32 feet

TOC Elevation = 618.042 (ft. above msl)
Concrete (0.0-1.0' bgs)
2" PVC Well Casing (3.0-8.0' bgs)
Bentonite Pellets (1.0-7.0' bgs)
Sand Pack K&E WP1 (7.0-20.0' bgs)
2" PVC 10 Slot Well Screen (8.0-18.0' bgs)

End of boring at 20.0' bgs.
Date Start: 10/2/15  
Date Finish: 10/2/15  
Drilling Company: Mateco Drilling  
Driller's Name: Dan Mourer  
Drilling Method: Hand Auger/Sonic  
Sampling Method: Continuous  
Rig Type: Sonic  
Water Level Start (ft. bgs.): 13.0  
Water Level Finish (ft. bgs.): 15.85  

Nothing: 522394.86  
Easting: 1235097.51  
Casing Elevation: 617.302  
Borehole Depth (ft. bgs.): 20.0  
Surface Elevation: 614.767  
Descriptions By: A. Westhuis  
Well/Boring ID: JHC-MW-15027  
Client: Consumers Energy  
Location: JH Campbell Facility  
1700 Crosswell Street Site A  
West Olive, MI 49680  
Weather Conditions: Sunny, 50F.

DEPT (feet bgs.)  
Sample Run Number  
Sample/IntType  
Recovery (feet)  
PID Headspace (ppm)  
Analytical Sample  
Geologic Column  
Stratigraphic Description  
Water Level (ft. bgs.)  
Well/Boring Construction

615
(0.0 - 0.3') TOPSOIL: grass.  

610
(0.3 - 2.0') SAND, very fine to fine, subrounded; trace silt; well sorted; dry; dark yellowish brown (10 YR 4/6).

605
(2.0 - 6.0') SAND, very fine to fine, subrounded; trace silt; well sorted; dry; very pale brown (10 YR 7/3).

600
(6.0 - 16.0') SAND, fine, subrounded; trace silt; well sorted; dry; yellow (10YR 7/6).

595
Note: Wet at 13.0' bgs.

590
(16.0 - 20.0') SAND, fine; trace medium sand, subrounded; well sorted; wet; pale brown (10 YR 6/3).

585
End of boring at 20.0' bgs.

Remarks:  
bgs= below ground surface  
bloc = below top of casing

Hand auger to 10.0' bgs.  
Groundwater encountered at 13.0' bgs during drilling.  
Water level at development was 15.85' bloc.  
No odor or staining observed.  
Groundwater elevation measured on December 2, 2015 was 601.04 feet.
**Date Start:** 10/5/15  
**Date Finish:** 10/5/15  
**Drilling Company:** Mateco Drilling  
**Driller's Name:** Dan Mourer  
**Drilling Method:** Air knife/Sonic  
**Sampling Method:** Continuous  
**Rig Type:** Sonic  
**Water Level Start (ft. bgs.):** 12.0  
**Water Level Finish (ft. btoc.):** 10.03  

**Well/Boring ID:** JHC MW-15029  
**Client:** Consumers Energy  
**Location:** JH Campbell Facility  
1700 Crosswell Street Site A  
West Olive, MI 49460  
**Weather Conditions:** Cloudy, Light Rain, 65F.

<table>
<thead>
<tr>
<th>DEPTH (feet bgs.)</th>
<th>Sample Run Number</th>
<th>Sample/Int/Type</th>
<th>Recovery (feet)</th>
<th>PID Headspace (rpm)</th>
<th>Stratigraphic Description</th>
<th>Geologic Column</th>
<th>Water Level (ft. bgs.)</th>
<th>Well/Boring Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>610</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>605</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>600</td>
<td>1</td>
<td>0-10'</td>
<td>3</td>
<td>NA</td>
<td>(0.0 - 0.3) TOPSOIL; grass.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>595</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.3 - 10.0') SAND, fine, subrounded; trace silt; well sorted; dry; yellowish brown (10 YR 5/4).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>590</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>585</td>
<td>2</td>
<td>10-20'</td>
<td>6</td>
<td>NA</td>
<td>(10.0 - 12.0') SAND, very fine to fine, subrounded; trace silt; well sorted; dry to moist; pale brown (10 YR 6/3).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>580</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(12.0 - 15.0') SAND, medium; trace fine sand, subrounded; trace silt; well sorted; wet; pale brown (10 YR 6/3).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>575</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(15.0 - 20.0') SAND, medium; little coarse sand; trace granules, subrounded; trace silt; well sorted; wet; pale brown (10 YR 6/4).</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

End of boring at 20.0' bgs.

**Remarks:**  
bgs = below ground surface  
etbloc = below top of casing  
Air knife to 10.0' bgs.  
Groundwater encountered at 12.0' bgs during drilling.  
Water level at development was 10.03' btoc.  
No odor or staining observed.  
Groundwater elevation measured on December 3, 2015 was 601.18 feet.
Date Start: 10/5/15
Date Finish: 10/5/15
Drilling Company: Mateco Drilling
Driller's Name: Dan Mourer
Drilling Method: Air knife/Sonic
Rig Type: Sonic
Water Level Start (ft. bgs.): 5.0
Water Level Finish (ft. btoc.): 7.99

Nothing: 519760.827
Easting: 12633044.37
Casing Elevation: 607.167
Borehole Depth (ft. bgs.): 20.0
Surface Elevation: 604.047
Descriptions By: A. Westhuis

Well/Boring ID: JHC MW-15030
Client: Consumers Energy
Location: JH Campbell Facility
1700 Crosswell Street Site A
West Olive, MI 49460
Weather Conditions: Cloudy, Light Rain, 65F.

DEPTH (feet bgs.) | ELEVATION | Sample Run Number | Sample/Int/Type | Recovery (feet) | PID Headspace (ppm) | Analytical Sample | Stratigraphic Description | Water Level (ft. bgs.) | Well/Boring Construction
--- | --- | --- | --- | --- | --- | --- | --- | --- | ---
605 | | | | | | | | | TOC Elevation = 607.167 (ft. above msl)
600 | | | | | | | 0.0 - 0.3) TOPSOL; grass. | |
550 | | 1 | 0-10' | 3 | NA | | | |
510 | | 2 | 10-20' | 6 | NA | | (0.3 - 10.0') SAND, fine, subrounded; trace silt; well sorted; dry to moist; dark brown (10 YR 3/3) to very pale brown (10YR 7/3). |
500 | | | | | | | NOTE: Wet at 5.0' bgs. |
495 | | | | | | | |
450 | | 3 | 20-30' | 4 | NA | | | |
400 | | 4 | 30-40' | 5 | NA | | (10.0 - 20.0') SAND, fine, subrounded; little medium sand, subrounded; trace silt; well sorted; wet; very pale brown (10 YR 7/3) to light gray (10YR 7/2). |
350 | | 5 | 40-50' | 5 | NA | | | |
300 | | 6 | 50-60' | 5 | NA | | End of boring at 20.0' bgs. |
250 | | 7 | 60-70' | 5 | NA | | | |
200 | | 8 | 70-80' | 5 | NA | | | |
150 | | 9 | 80-90' | 5 | NA | | | |
100 | | 10 | 90-100' | 5 | NA | | | |
50 | | 11 | 100-110' | 5 | NA | | | |

Remarks: bgs = below ground surface
btoc = below top of casing
Air knife to 10.0' bgs.
Groundwater encountered at 5.0' bgs during drilling.
Water level at development was 7.99' btoc.
No odor or staining observed.
Groundwater elevation measured on December 3, 2015 was 599.65 feet
**Date Start:** 10/6/15  
**Date Finish:** 10/6/15
**Drilling Company:** Mateco Drilling  
**Driller’s Name:** John Pitsch  
**Sampling Method:** Continuous  
**Rig Type:** Sonic  
**Water Level Start (ft. bgs.):** 19.0  
**Water Level Finish (ft. btoc.):** 22.93

<table>
<thead>
<tr>
<th>DEPTH (feet bgs.)</th>
<th>ELEVATION</th>
<th>Sample Run Number</th>
<th>Sample/Int/Type</th>
<th>Recovery (feet)</th>
<th>PID Headspace (ppm)</th>
<th>Analytical Sample</th>
<th>Geologic Column</th>
<th>Stratigraphic Description</th>
<th>Well/Boring Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>620</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.0 - 0.3) TOPSOIL; grass.</td>
<td></td>
</tr>
<tr>
<td>625</td>
<td></td>
<td>1</td>
<td>0-10’</td>
<td>10</td>
<td>NA</td>
<td></td>
<td></td>
<td>(0.3 - 0.8’) SAND, fine, subrounded; trace silt; well sorted; dry; brown (10 YR 4/3).</td>
<td></td>
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<tr>
<td>630</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>(0.8 - 2.0’) SAND, fine, subrounded; trace silt; well sorted; dry; yellowish brown (10 YR 6/6).</td>
<td></td>
</tr>
<tr>
<td>635</td>
<td></td>
<td>1</td>
<td>10-20’</td>
<td>6</td>
<td>NA</td>
<td></td>
<td></td>
<td>(2.0 - 10.0’) SAND, fine, subrounded; trace silt; well sorted; dry; very pale brown (10 YR 7/3).</td>
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<tr>
<td>640</td>
<td></td>
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<td></td>
<td></td>
<td>(10.0 - 20.0’) SAND, very fine to fine, subrounded; trace silt; well sorted; moist; yellowish brown (10 YR 5/4).</td>
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<tr>
<td>645</td>
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<td>NOTE: Wet at 19.0’ bgs.</td>
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<tr>
<td>650</td>
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<td></td>
<td></td>
<td>(20.0 - 30.0’) SAND, fine; little medium sand, subrounded; trace silt; well sorted; moist to wet; very pale brown (10 YR 6/3).</td>
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</tr>
<tr>
<td>655</td>
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<tr>
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<td>670</td>
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<tr>
<td>680</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

**Remarks:**  
- bgs = below ground surface  
- btoc = below top of casing  

Hand auger to 10.0’ bgs.  
Groundwater encountered at 19.0’ bgs during drilling.  
Water level at development was 22.93’ btoc.  
No odor or staining observed  
Groundwater elevation measured on December 2, 2015 was 598.05 feet
DEEP (feet bgs.)

Sample Run Number
Sample/IntType
Recovery (feet)
PID Headspace (ppm)
Geologic Column

Depth (feet bgs.)

Stratigraphic Description

Water Level (ft. bgs.)

Well/Boring Construction

1
5.0-7.0
0.9
NA

(0.0 - 0.5) SANDY ORGANIC SOIL, very dark brown, very fine to fine, loose, moist.

(0.5 - 30.5) SAND, very pale brown (10YR 7/4), poorly graded, fine, trace silt, round, loose, slightly moist.

NOTE: Very fine.

NOTE: Very pale brown (10YR 8/3), fine.

NOTE: Fine to medium, moist.

End of boring at 30.5' bgs.

Remarks:

bgs = below ground surface
bloc = below top of casing

No odor or staining observed.
### Udden-Wentworth Scale

**Modified ARCADIS, 2008**

<table>
<thead>
<tr>
<th>Size Class</th>
<th>Millimeters</th>
<th>Inches</th>
<th>Standard Sieve #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boulder</td>
<td>256 - 4096</td>
<td>10.08+</td>
<td></td>
</tr>
<tr>
<td>Large cobble</td>
<td>128 - 256</td>
<td>5.04 - 10.08</td>
<td></td>
</tr>
<tr>
<td>Small cobble</td>
<td>64 - 128</td>
<td>2.52 - 5.04</td>
<td></td>
</tr>
<tr>
<td>Very large pebble</td>
<td>32 - 64</td>
<td>0.16 - 2.52</td>
<td></td>
</tr>
<tr>
<td>Large pebble</td>
<td>16 - 32</td>
<td>0.63 - 1.26</td>
<td></td>
</tr>
<tr>
<td>Medium pebble</td>
<td>8 - 16</td>
<td>0.31 - 0.63</td>
<td></td>
</tr>
<tr>
<td>Small pebble</td>
<td>4 - 8</td>
<td>0.16 - 0.31</td>
<td>No. 5 +</td>
</tr>
<tr>
<td>Granule</td>
<td>2 - 4</td>
<td>0.08 - 0.16</td>
<td>No. 5 - No. 10</td>
</tr>
<tr>
<td>Very coarse sand</td>
<td>1 - 2</td>
<td>0.04 - 0.08</td>
<td>No. 10 - No. 18</td>
</tr>
<tr>
<td>Coarse sand</td>
<td>1/8 - 1</td>
<td>0.02 - 0.04</td>
<td>No. 18 - No. 35</td>
</tr>
<tr>
<td>Medium sand</td>
<td>1/4 - 1/2</td>
<td>0.01 - 0.02</td>
<td>No. 35 - No. 60</td>
</tr>
<tr>
<td>Fine sand</td>
<td>1/8 - 1/4</td>
<td>0.005 - 0.1</td>
<td>No. 60 - No. 120</td>
</tr>
<tr>
<td>Very fine sand</td>
<td>1/16 - 1/8</td>
<td>0.002 - 0.005</td>
<td>No. 120 - No. 230</td>
</tr>
<tr>
<td>Silt (subgroups not included)</td>
<td>1/256 - 1/16</td>
<td>0.0002 - 0.0002</td>
<td>Not applicable (analyze by pipette or hydrometer)</td>
</tr>
<tr>
<td>Clay (subgroups not included)</td>
<td>1/2048 - 1/256</td>
<td>0.00002 - 0.0002</td>
<td></td>
</tr>
</tbody>
</table>

### Fine-grained soil - Consistency

<table>
<thead>
<tr>
<th>Description</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very soft</td>
<td>N-value &lt; 2 or easily penetrated several inches by thumb.</td>
</tr>
<tr>
<td>Soft</td>
<td>N-value 2-4 or easily penetrated one inch by thumb.</td>
</tr>
<tr>
<td>Medium stiff</td>
<td>N-value 6-15 or indented about ¼ inch by thumb with great effort.</td>
</tr>
<tr>
<td>Very stiff</td>
<td>N-value 16-30 or readily indented by thumb nail.</td>
</tr>
<tr>
<td>Hard</td>
<td>N-value &gt; 30 or indented by thumbnail with difficulty.</td>
</tr>
</tbody>
</table>

### Coarse-grained soil - Density

<table>
<thead>
<tr>
<th>Description</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very loose</td>
<td>N-value 1-4</td>
</tr>
<tr>
<td>Loose</td>
<td>N-value 5-10</td>
</tr>
<tr>
<td>Medium dense</td>
<td>N-value 11-30</td>
</tr>
<tr>
<td>Dense</td>
<td>N-value 31-50</td>
</tr>
<tr>
<td>Very dense</td>
<td>N-value &gt;50</td>
</tr>
</tbody>
</table>

### Modifier Percent of Total Sample (by volume)

<table>
<thead>
<tr>
<th>Modifier</th>
<th>Percent of Total Sample (by volume)</th>
</tr>
</thead>
<tbody>
<tr>
<td>and</td>
<td>30 - 50</td>
</tr>
<tr>
<td>some</td>
<td>21 - 35</td>
</tr>
<tr>
<td>little</td>
<td>10 - 20</td>
</tr>
<tr>
<td>trace</td>
<td>&lt;10</td>
</tr>
</tbody>
</table>

### Criteria

- **Nonplastic**
  - A 1/4 inch (3 mm) thread cannot be rolled at any water content.
  - The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
- **Low**
  - The thread is easy to roll and not much time is required to reach the plastic limit. The lump can be rolled even when drier than the plastic limit.
- **Medium**
  - It takes considerable time rolling and inverting to reach the plastic limit. The thread can be rolled several times after exceeding the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.
- **High**
  - Absence of moisture, dry to touch, dusty.
  - Damp but no visible water.
  - Visible free water, soil is usually below the water table.
APPENDIX B
Photographic Log
Photograph #1

Description of Photograph:
View of the various soil types encountered during the monitoring well installation activities at the Site.

Site Location:
Consumers Energy Co.
J.H. Campbell Generating Facility
West Olive, Michigan

Photograph Taken By:
Austin Westhuis

Date of Photograph:
September 17, 2015

Photograph #2

Description of Photograph:
View of the various soil types encountered during the monitoring well installation activities at the Site.

Site Location:
Consumers Energy Co.
J.H. Campbell Generating Facility
West Olive, Michigan

Photograph Taken By:
Austin Westhuis

Date of Photograph:
September 23, 2015
Photograph #3

Description of Photograph:
View of the various soil types encountered during the monitoring well installation activities at the Site.

Site Location:
Consumers Energy Co.
J.H. Campbell Generating Facility
West Olive, Michigan

Photograph Taken By:
Austin Westhuis

Date of Photograph:
September 25, 2015

Photograph #4

Description of Photograph:
View of the typical sand layer encountered at the Site where monitoring well screens were installed.

Site Location:
Consumers Energy Co.
J.H. Campbell Generating Facility
West Olive, Michigan

Photograph Taken By:
Austin Westhuis

Date of Photograph:
September 18, 2015
APPENDIX C

Hydraulic Test Logs
Slug Test Analysis Result for JHC MW-15005 - Test 2

Prepared By: Arcadis
Prepared For: Consumer Energy

Project: Location:
West Olive, MI

SOLUTION
Aquifer Model: Unconfined
Solution Method: KGS Model

\[ \begin{align*}
Kr & = 61. \text{ ft/day} \\
Ss & = 3.7E-5 \text{ ft}^{-1} \\
Kz/Kr & = 1
\end{align*} \]

AQUIFER DATA

Saturated Thickness: 19.82 ft

WELL DATA (JHC MW-15005)

Initial Displacement: 0.738 ft
Static Water Column Height: 6.82 ft
Total Well Penetration Depth: 6.82 ft
Screen Length: 6.82 ft
Casing Radius: 0.083 ft
Well Radius: 0.33 ft
Slug Test Analysis Result for JHC MW-15005 - Test 3

Prepared By: Arcadis
Prepared For: Consumer Energy

Project: West Olive, MI

SOLUTION
Aquifer Model: Unconfined
Solution Method: KGS Model

\[
\begin{align*}
Kr &= 58. \text{ ft/day} \\
Ss &= 5.05E-12 \text{ ft}^{-1} \\
Kz/Kr &= 1
\end{align*}
\]

AQUIFER DATA
Saturated Thickness: 19.82 ft

WELL DATA (JHC MW-15005)
Initial Displacement: 1.422 ft
Static Water Column Height: 6.82 ft
Total Well Penetration Depth: 6.82 ft
Screen Length: 6.82 ft
Casing Radius: 0.083 ft
Well Radius: 0.33 ft
### Slug Test Analysis Result for JHC MW-B6 - Test 2

- **Prepared By:** Arcadis
- **Prepared For:** Consumer Energy
- **Project:** West Olive, MI

### SOLUTION
- **Aquifer Model:** Unconfined
- **Solution Method:** KGS Model
- \( Kr = 118. \text{ ft/day} \)
- \( Ss = 6.03E-5 \text{ ft}^{-1} \)
- \( Kz/Kr = 1 \)

### AQUIFER DATA
- **Saturated Thickness:** 25.71 ft

### WELL DATA (JHC MW-B6)
- **Initial Displacement:** 0.777 ft
- **Static Water Column Height:** 5.71 ft
- **Total Well Penetration Depth:** 5.71 ft
- **Screen Length:** 5.71 ft
- **Casing Radius:** 0.083 ft
- **Well Radius:** 0.33 ft
Slug Test Analysis Result for JHC MW-B6 - Test 3

Prepared By: Arcadis
Prepared For: Consumer Energy
Project: Location: West Olive, MI

SOLUTION
Aquifer Model: Unconfined
Solution Method: KGS Model

\[ Kr = 139. \text{ ft/day} \]
\[ Ss = 5.05E-12 \text{ ft}^{-1} \]
\[ Kz/Kr = 1 \]

AQUIFER DATA
Saturated Thickness: 25.71 ft

WELL DATA (JHC MW-B6)
Initial Displacement: 1.217 ft
Static Water Column Height: 5.71 ft
Total Well Penetration Depth: 5.71 ft
Screen Length: 5.71 ft
Casing Radius: 0.083 ft
Well Radius: 0.33 ft
Slug Test Analysis Result for JHC MW-15007 - Test 1

Prepared By: Arcadis
Prepared For: Consumer Energy

Project: Location:
West Olive, MI

SOLUTION
Aquifer Model: Unconfined
Solution Method: KGS Model

\[ \text{Kr} = 130. \text{ ft/day} \]
\[ \text{Ss} = 5.05E-12 \text{ ft}^{-1} \]
\[ \frac{Kz}{Kr} = 1. \]

AQUIFER DATA
Saturated Thickness: 23.37 ft

WELL DATA (JHC MW-15007)
Initial Displacement: 0.629 ft
Static Water Column Height: 5.37 ft
Total Well Penetration Depth: 5.37 ft
Screen Length: 5.37 ft
Casing Radius: 0.083 ft
Well Radius: 0.33 ft
Slug Test Analysis Result for JHC MW-15015 - Test 2

Prepared By: Arcadis
Prepared For: Consumer Energy

Project: Location: West Olive, MI

SOLUTION
Aquifer Model: Unconfined
Solution Method: KGS Model

\[ Kr = 22. \text{ ft/day} \]
\[ Ss = 7.0E-6 \text{ ft}^{-1} \]
\[ Kz/Kr = \_ \_ \_ \]

AQUIFER DATA
Saturated Thickness: 24.57 ft

WELL DATA (JHC MW-15015)
Initial Displacement: 0.879 ft
Static Water Column Height: 12.57 ft
Total Well Penetration Depth: 12.57 ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.33 ft

ARCADIS
 Slug Test Analysis Result for JHC MW-15015 - Test 3

Prepared By: Arcadis
Prepared For: Consumer Energy
Project: Location: West Olive, MI

### SOLUTION

Aquifer Model: Unconfined  
Solution Method: KGS Model

\[
\begin{align*}
Kr &= 21. \text{ ft/day} \\
\frac{Kz}{Kr} &= 1. \\
Ss &= 1.9E-5 \text{ ft}^{-1}
\end{align*}
\]

### AQUIFER DATA

Saturated Thickness: 24.57 ft

### WELL DATA (JHC MW-15015)

- Initial Displacement: 1.98 ft
- Static Water Column Height: 12.57 ft
- Total Well Penetration Depth: 12.57 ft
- Screen Length: 10. ft
- Casing Radius: 0.083 ft
- Well Radius: 0.33 ft
Slug Test Analysis Result for JHC MW-15024 - Test 2

**Prepared By:** Arcadis

**Prepared For:** Consumer Energy

**Project:** Location:

West Olive, MI

---

**SOLUTION**

Aquifer Model: Unconfined
Solution Method: KGS Model

\[ K_r = 49 \text{ ft/day} \]

\[ K_z/K_r = 1 \]

\[ S_s = 9.8E-6 \text{ ft}^{-1} \]

---

**AQUIFER DATA**

Saturated Thickness: 38.71 ft

**WELL DATA (JHC MW-15024)**

Initial Displacement: 0.801 ft
Static Water Column Height: 5.71 ft
Total Well Penetration Depth: 5.71 ft
Screen Length: 5.71 ft
Casing Radius: 0.083 ft
Well Radius: 0.33 ft
Slug Test Analysis Result for JHC MW-15024 - Test 3

Prepared By: Arcadis
Prepared For: Consumer Energy

Project: Location:
West Olive, MI

---

**SOLUTION**

Aquifer Model: Unconfined
Solution Method: KGS Model

\[ K_r = 45. \text{ ft/day} \]
\[ S_s = 5.05 \times 10^{-12} \text{ ft}^{-1} \]
\[ K_z/K_r = \underline{1} \]

---

**AQUIFER DATA**

Saturated Thickness: 38.71 ft

**WELL DATA (JHC MW-15024)**

Initial Displacement: 1.534 ft
Static Water Column Height: 5.71 ft
Total Well Penetration Depth: 5.71 ft
Screen Length: 5.71 ft
Casing Radius: 0.083 ft
Well Radius: 0.33 ft
Slug Test Analysis Result for JHC MW-15028 - Test 1

Prepared By: Arcadis
Prepared For: Consumer Energy

Project: Location: West Olive, MI

SOLUTION
Aquifer Model: Unconfined
Solution Method: KGS Model
Kr = 104. ft/day Ss = 3.1E-5 ft \(^{-1}\)
Kz/Kr = 1

AQUIFER DATA
Saturated Thickness: 38.22 ft

WELL DATA (JHC MW-15028)
Initial Displacement: 0.704 ft
Static Water Column Height: 6.22 ft
Total Well Penetration Depth: 6.22 ft
Screen Length: 6.22 ft
Casing Radius: 0.083 ft
Well Radius: 0.33 ft
Slug Test Analysis Result for JHC MW-15028 - Test 3

Prepared By: Arcadis  Prepared For: Consumer Energy

Project:  Location: West Olive, MI

SOLUTION
Aquifer Model: Unconfined
Solution Method: KGS Model

\[ Kr = 86. \text{ ft/day} \]
\[ Kz/Kr = 1. \]
\[ Ss = 5.05 \times 10^{-12} \text{ ft}^{-1} \]

AQUIFER DATA
Saturated Thickness: 38.22 ft

WELL DATA (JHC MW-15028)
Initial Displacement: 1.515 ft
Static Water Column Height: 6.22 ft
Total Well Penetration Depth: 6.22 ft
Screen Length: 6.22 ft
Casing Radius: 0.083 ft
Well Radius: 0.33 ft
Slug Test Analysis Result for JHC MW-15033 - Test 2

Prepared By: Arcadis
Prepared For: Consumer Energy
Project: Location: West Olive, MI

<table>
<thead>
<tr>
<th>SOLUTION</th>
<th>AQUIFER DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquifer Model: Unconfined</td>
<td>Saturated Thickness: 29.83 ft</td>
</tr>
<tr>
<td>Solution Method: KGS Model</td>
<td>WELL DATA (JHC MW-15033)</td>
</tr>
<tr>
<td>$K_r = 74. \text{ ft/day}$</td>
<td>Initial Displacement: 0.669 ft</td>
</tr>
<tr>
<td>$K_z/K_r = 1$.</td>
<td>Static Water Column Height: 5.83 ft</td>
</tr>
<tr>
<td>$S_s = 5.3E-5 \text{ ft}^{-1}$</td>
<td>Total Well Penetration Depth: 5.83 ft</td>
</tr>
</tbody>
</table>

Graph showing normalized head (ft/ft) over time (sec).
### Slug Test Analysis Result for JHC MW-15030 - Test 2

**Prepared By:** Arcadis  
**Prepared For:** Consumer Energy  
**Project:**  
**Location:** West Olive, MI

**SOLUTION**
- Aquifer Model: **Confined**  
- Solution Method: **Bouwer-Rice**
- \( K = 100 \text{ ft/day} \)
- \( y_0 = 0.83 \text{ ft} \)

**AQUIFER DATA**
- Saturated Thickness: 45.12 ft

**WELL DATA (JHC MW-15030)**
- Initial Displacement: 0.701 ft
- Static Water Column Height: 9.12 ft
- Total Well Penetration Depth: 9.12 ft
- Screen Length: 9.12 ft
- Casing Radius: 0.083 ft
- Well Radius: 0.33 ft
Slug Test Analysis Result for JHC MW-15030 - Test 3

Prepared By: Arcadis
Prepared For: Consumer Energy

Project: Location:
West Olive, MI

SOLUTION
Aquifer Model: Confined
Solution Method: Bouwer-Rice

\[ K = 87 \text{ ft/day} \quad y_0 = 1.4 \text{ ft} \]

AQUIFER DATA
Saturated Thickness: 45.12 ft

WELL DATA (JHC MW-15030)
Initial Displacement: 1.194 ft
Static Water Column Height: 9.12 ft
Total Well Penetration Depth: 9.12 ft
Screen Length: 9.12 ft
Casing Radius: 0.083 ft
Well Radius: 0.33 ft
Slug Test Analysis Result for JHC MW-15018 - Test 1

Prepared By: Arcadis
Prepared For: Consumer Energy

Project: Location:

West Olive, MI

SOLUTION
Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 34. ft/day
Kz/Kr = 1

Ss = 4.0E-5 ft⁻¹

AQUIFER DATA
Saturated Thickness: 36.5 ft

WELL DATA (JHC MW-15018)
Initial Displacement: 0.732 ft
Static Water Column Height: 6.5 ft
Total Well Penetration Depth: 6.5 ft
Screen Length: 6.5 ft
Casing Radius: 0.083 ft
Well Radius: 0.33 ft
Slug Test Analysis Result for JHC MW-15018 - Test 3

Prepared By: Arcadis
Prepared For: Consumer Energy

Project: Location: West Olive, MI

<table>
<thead>
<tr>
<th>SOLUTION</th>
<th>AQUIFER DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquifer Model: Unconfined</td>
<td>Saturated Thickness: 36.5 ft</td>
</tr>
<tr>
<td>Solution Method: KGS Model</td>
<td>WELL DATA (JHC MW-15018)</td>
</tr>
<tr>
<td>Kr = 33. ft/day</td>
<td>Initial Displacement: 1.486 ft</td>
</tr>
<tr>
<td>Kz/Kr = 1.</td>
<td>Static Water Column Height: 6.5 ft</td>
</tr>
<tr>
<td>Ss = 6.2E-12 ft⁻¹</td>
<td>Total Well Penetration Depth: 6.5 ft</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WELL DATA (JHC MW-15018)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screen Length: 6.5 ft</td>
</tr>
<tr>
<td>Casing Radius: 0.083 ft</td>
</tr>
<tr>
<td>Well Radius: 0.33 ft</td>
</tr>
</tbody>
</table>

![Graph showing normalized head over time for a slug test analysis.](image)

Normalized Head (ft/ft) vs Time (sec)