



A CMS Energy Company

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 3 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 3 Bottom Ash Pond, which established the following locations for determining background groundwater quality and detection monitoring. Downgradient monitoring well JHC MW-15014 was reported damaged and inaccessible on June 24, 2016. This well has not been replaced since the remaining wells are still able to adequately detect a release from the CCR unit.

Background:

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

Downgradient:

JHC MW-15012	JHC MW-15013	JHC MW-15015
JHC MW-15016		

**“Groundwater Monitoring System Certification  
JH Campbell Bottom Unit 3 Bottom Ash Pond”**

**October 17, 2017**

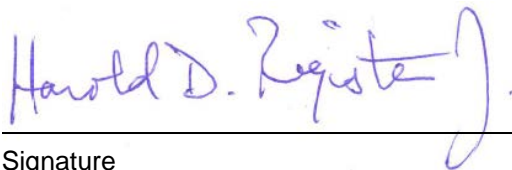
**Page 2**

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 3 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  
\_\_\_\_\_

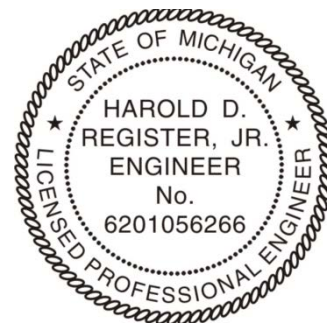
Date of Certification

Harold D. Register, Jr., P.E.  
\_\_\_\_\_

Name

6201056266  
\_\_\_\_\_

Professional Engineer Certification Number



10/17/2017

**ENCLOSURES**

ARCADIS (2016). *“Summary of Monitoring Well Design, Installation, and Development – Bottom Ash Pond 3N/3S”*

Consumers Energy Company

# **SUMMARY OF MONITORING WELL DESIGN, INSTALLATION, AND DEVELOPMENT – BOTTOM ASH POND UNIT 3N/3S**

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

May 13, 2016

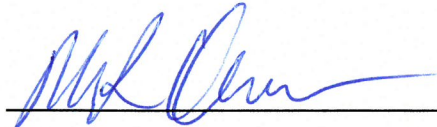
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Gregory E. Zellmer, P.G.  
Certified Project Manager/Senior Geologist


Mark Robert Klemmer, PE  
Printed Name of Registered Professional Engineer



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Signature of Registered Professional Engineer  
Registration Number: 62010-49167 State: MI

Date: 5/13/16



## Summary of Monitoring Well Design, Installation, and Development – Bottom Ash Pond Unit 3N/3S

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

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Consumers Energy Company  
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Appendix B – Photographic Log

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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 3N/3S 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-15012 through JHC MW-15016) 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-15012 through JHC MW-15016 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 rotasonic 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 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 1 to 7 foot thick bentonite 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 24-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

Groundwater Parameter	Stabilization Criteria
pH	3 readings within +/- 0.1 Standard Units
Specific Conductance (SpC)	3 readings within +/- 3% mS/cms
Temperature	3 readings within +/- 3%
Oxidation-Reduction Potential (ORP)	3 readings within +/- 10 mV
Turbidity	3 readings within +/- 10% or <1 when < 10 NTU
Dissolved Oxygen (DO)	3 readings within +/- 0.3 mg/L

### 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 completed 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 completed 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

MW ID	Former MW ID	Site Coordinates				Date Installed	Geologic Unit of Screen Interval	Well Construction	Well Screen Length (ft)	Screen Interval (ft bgs)	Development Details				
		Northing	Easting	TOC	Ground Elevation						Static DTW (ft below TOC)	Total Depth	Pumping DTW (ft below TOC)	Gallons Removed	Final Turbidity (NTU)
<b>Downgradient MW</b>															
JHC MW-15012	---	519214.84	12633675.28	632.59	635.66	9/28/2015	Sand	2" PVC, 10 slot	10	28 - 38	28.70	40.96	31.40	120	8.01
JHC MW-15013	---	519207.19	12634025.15	632.40	635.25	9/25/2015	Sand	2" PVC, 10 slot	10	28 - 38	25.94	41.15	28.06	120	5.55
JHC MW-15014	---	519419.85	12634254.12	635.13	638.18	9/25/2015	Sand	2" PVC, 10 slot	10	39 - 49	29.81	52.00	31.89	150	3.90
JHC MW-15015	---	519715.11	12634186.63	632.46	635.20	9/28/2015	Sand	2" PVC, 10 slot	10	28 - 38	28.57	41.28	29.48	90	5.09
JHC MW-15016	---	519956.79	12634198.52	631.81	634.64	9/28/2015	Sand	2" PVC, 10 slot	10	28 - 38	30.33	41.06	NR	155	0.63
<b>Background MW</b>															
JHC MW-15023	---	521927.21	12638205.16	617.01	619.98	10/1/2015	Sand	2" PVC, 10 slot	10	14 - 24	18.91	27.68	NR	130	7.94
JHC MW-15024	---	522366.01	12637322.68	613.79	616.62	10/1/2015	Sand	2" PVC, 10 slot	10	7 - 17	14.12	19.93	14.49	135	3.31
JHC MW-15025	---	522702.98	12636668.15	614.14	617.17	10/1/2015	Sand	2" PVC, 10 slot	10	7 - 17	13.50	19.94	14.42	90	2.32
JHC MW-15026	---	522495.09	12635971.82	615.09	618.04	10/2/2015	Sand	2" PVC, 10 slot	10	8 - 18	15.34	21.02	15.97	180	8.88
JHC MW-15027	---	522394.86	12635097.51	614.77	617.30	10/2/2015	Sand	2" PVC, 10 slot	10	10 - 20	15.85	22.99	16.36	90	4.31
JHC MW-15028	---	521646.20	12634105.34	611.02	613.80	10/2/2015	Sand	2" PVC, 10 slot	10	8 - 18	14.38	20.82	14.62	220	9.80
JHC MW-15029	---	520503.52	12633774.30	608.08	610.95	10/5/2015	Sand	2" PVC, 10 slot	10	8 - 18	10.03	20.96	10.26	105	4.21
JHC MW-15030	---	519760.83	12633044.37	604.05	607.17	10/5/2015	Sand	2" PVC, 10 slot	10	4 - 14	7.99	16.93	8.30	NR	8.81
<b>Hydraulic Testing MW</b>															
JHC MW-15005	---	517781.42	12633905.01	624.37	627.30	9/18/2015	Sand	2" PVC, 10 slot	10	27 - 37	33.26	40.10	33.51	45	2.11
JHC MW-15007	---	517540.50	12635742.72	624.82	627.70	9/21/2015	Sand	2" PVC, 10 slot	10	22 - 32	29.28	34.75	29.36	55	2.64
JHC MW-15015	---	519715.11	12634186.63	632.46	635.20	9/28/2015	Sand	2" PVC, 10 slot	10	28 - 38	28.57	41.28	29.48	90	5.09
JHC MW-15018	---	521075.54	12635979.61	614.26	617.02	9/28/2015	Sand	2" PVC, 10 slot	10	10 - 20	16.23	22.95	NR	80	3.99
JHC MW-15024	---	522366.01	12637322.68	613.79	616.62	10/1/2015	Sand	2" PVC, 10 slot	10	7 - 17	14.12	19.93	14.49	135	3.31
JHC MW-15028	---	521646.20	12634105.34	611.02	613.80	10/2/2015	Sand	2" PVC, 10 slot	10	8 - 18	14.38	20.82	14.62	220	9.80
JHC MW-15030	---	519760.83	12633044.37	604.05	607.17	10/5/2015	Sand	2" PVC, 10 slot	10	4 - 14	7.99	16.93	8.30	NR	8.81
JHC MW-15033	---	521075.81	12638598.12	618.08	620.99	10/6/2015	Sand	2" PVC, 10 slot	10	16 - 26	22.93	28.78	23.2	120	5.47
JHC MW-15036	MW-B6	520099.80	12638094.34	617.94	618.34	3/13/2001	Sand	2" PVC, 10 slot	10	20 - 30	NA	NA	NA	NA	NA

Notes:  
ft = feet  
bgs = below ground surface  
TOC = top of casing  
NR = Not recorded  
NA = Not applicable

**Table 3**  
**Estimated Hydraulic Conductivity (K) Values**  
**Consumers Energy Co.**  
**J.H. Campbell Generating Facility**  
**West Olive, Michigan**

Well ID	Test	H <sup>0</sup> (ft)	H <sup>1</sup> (ft)	K (ft/d)	K (cm/sec)	Slug Test Solution
JHC MW-15005	2	0.738	0.844	61	2.15E-02	KGS Model (Hyder et. al, 1994)
	3	1.422	1.69	58	2.05E-02	KGS Model (Hyder et. al, 1994)
	Average			60	2.10E-02	
JHC MW-15036	2	0.777	0.844	118	4.16E-02	KGS Model (Hyder et. al, 1994)
	3	1.219	1.69	139	4.90E-02	KGS Model (Hyder et. al, 1994)
	Average			129	4.53E-02	
JHC MW-15007	1	0.629	0.844	130	4.59E-02	KGS Model (Hyder et. al, 1994)
JHC MW-15015	2	0.879	1.15	22	7.76E-03	KGS Model (Hyder et. al, 1994)
	3	1.98	2.31	21	7.41E-03	KGS Model (Hyder et. al, 1994)
	Average			22	7.59E-03	
JHC MW-15024	2	0.801	0.844	49	1.73E-02	KGS Model (Hyder et. al, 1994)
	3	1.534	1.69	45	1.59E-02	KGS Model (Hyder et. al, 1994)
	Average			47	1.66E-02	
JHC MW-15028	1	0.704	0.844	104	3.67E-02	KGS Model (Hyder et. al, 1994)
	3	1.515	1.69	86	3.03E-02	KGS Model (Hyder et. al, 1994)
	Average			95	3.35E-02	
JHC MW-15033	2	0.669	0.844	74	2.61E-02	KGS Model (Hyder et. al, 1994)
JHC MW-15030	2	0.701	0.844	100	3.53E-02	Bouwer-Rice (1976)
	3	1.194	1.69	87	3.07E-02	Bouwer-Rice (1976)
	Average			94	3.30E-02	
JHC MW-15018	1	0.732	0.844	34	1.20E-02	KGS Model (Hyder et. al, 1994)
	3	1.486	1.69	33	1.16E-02	KGS Model (Hyder et. al, 1994)
	Average			34	1.18E-02	
<b>Over all Average</b>				<b>73</b>	<b>2.56E-02</b>	
<b>Over all Geometric mean</b>				<b>62</b>	<b>2.19E-02</b>	
<b>Minimum</b>				<b>21</b>	<b>7.41E-03</b>	
<b>Maximum</b>				<b>139</b>	<b>4.90E-02</b>	

Note:  
H<sup>0</sup> = initial displacement  
H<sup>1</sup> = expected (calculated) displacement  
cm/sec = centimeters per second  
ft = feet  
ft/d = feet per day

# FIGURES





# APPENDIX A

## Soil Boring and Monitoring Well Construction Logs



<b>Date Start:</b> 9/18/15 <b>Date Finish:</b> 9/18/15 <b>Drilling Company:</b> Mateco Drilling <b>Driller's Name:</b> John Pitsch <b>Drilling Method:</b> Air Knife/Sonic <b>Sampling Method:</b> Continuous <b>Rig Type:</b> Sonic <b>Water Level Start (ft. bgs.):</b> 29.0 <b>Water Level Finish (ft. btoc.):</b> 33.26	<b>Northing:</b> 517781.423 <b>Easting:</b> 12633905.01 <b>Casing Elevation:</b> 627.297  <b>Borehole Depth (ft. bgs.):</b> 40.0 <b>Surface Elevation:</b> 624.367  <b>Descriptions By:</b> A. Westhuis	<b>Well/Boring ID:</b> JHC MW-15005  <b>Client:</b> Consumers Energy  <b>Location:</b> JH Campbell Facility 1700 Crosswell Street Site A West Olive, MI 49460  <b>Weather Conditions:</b> 70 F Cloudy
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DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
0	625							(0.0 - 0.3') Grass, Topsoil.		
5	620	1	0.0-10.0'	10	NA		X X	(0.3 - 10.0') ASH and SAND, fine to medium; trace granules, subrounded; moist; soft to stiff; poorly sorted; brown (10YR 5/3) to dark grayish brown (10YR 4/2). NOTE: Fill material.		Concrete (0.0-1.0' bgs)
10	615						X X	(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).		
15	610	2	10.0-20.0'	6	NA		●●●●●●	(13.0 - 16.0') SAND, medium; little fine sand, subrounded; trace silt; well sorted; dry; very pale brown (10YR 7/4).		Bentonite/Cement Grout (1.0-23.0' bgs) 2" PVC Well Casing (-3.0-27.0' bgs)
							●●●●●●	(16.0 - 19.5') SAND, medium; trace fine, subrounded; trace silt; dry; light yellowish brown (10YR 6/4).		




**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

<b>Date Start:</b> 9/18/15 <b>Date Finish:</b> 9/18/15 <b>Drilling Company:</b> Mateco Drilling <b>Driller's Name:</b> John Pitsch <b>Drilling Method:</b> Air Knife/Sonic <b>Sampling Method:</b> Continuous <b>Rig Type:</b> Sonic <b>Water Level Start (ft. bgs.):</b> 29.0 <b>Water Level Finish (ft. btoc.):</b> 33.26	<b>Northing:</b> 517781.423 <b>Easting:</b> 12633905.01 <b>Casing Elevation:</b> 627.297  <b>Borehole Depth (ft. bgs.):</b> 40.0 <b>Surface Elevation:</b> 624.367  <b>Descriptions By:</b> A. Westhuis	<b>Well/Boring ID:</b> JHC MW-15005  <b>Client:</b> Consumers Energy  <b>Location:</b> JH Campbell Facility 1700 Crosswell Street Site A West Olive, MI 49460  <b>Weather Conditions:</b> 70 F Cloudy
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DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
20	605						(19.5 - 19.8') SAND, medium; trace fine, subrounded; little to some silt; moist, brown (10YR 4/3).			
							(19.8 - 29.0') SAND, medium, trace fine, subrounded; trace silt; well sorted; dry; very pale brown (10YR 7/4).			
25	600	3	20.0-30.0'	6	NA					Bentonite Pellets (23.0-25.0' bgs)
30	595						(29.0 - 31.0') SAND, medium, little fine, trace coarse, subrounded; trace silt; well sorted; wet; pale brown (10YR 6/3).			
							(31.0 - 33.0') SAND, medium to coarse, little fine, subrounded; trace silt; well sorted; wet; pale brown (10YR 6/3).			Sand Pack K&E WP1 (25.0-40.0' bgs)
35	590	4	30.0-40.0'	9	NA		(33.0 - 40.0') SAND, fine, some medium, subrounded; well sorted; wet; pale brown (10YR 6/3).			2" PVC 10 Slot Well Screen (27.0-37.0 bgs)
40	585						End of boring at 40.0' bgs.			

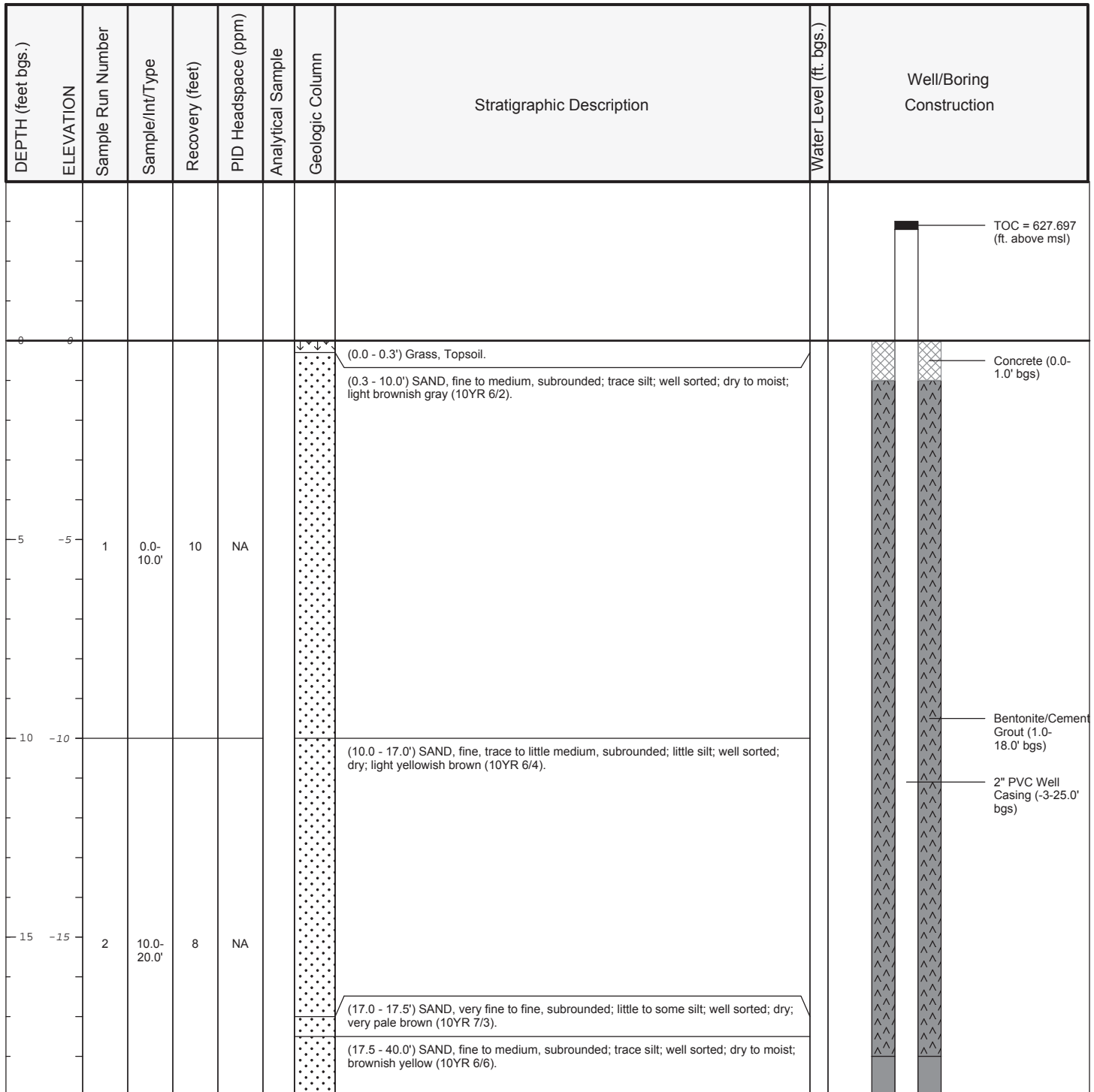
 <small>Design &amp; Consultancy for natural and built assets</small>	<b>Remarks:</b> bgs = below ground surface btoc = below top of casing  Air knife to 10.0' bgs. Groundwater encountered at 29.0' bgs during drilling. Water level at development encountered at 33.26' btoc. No odor or staining observed. Groundwater elevation measured on December 2, 2015 was 595.77 feet
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**Date Start:** 9/21/15  
**Date Finish:** 9/21/15  
**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.):** 21.0  
**Water Level Finish (ft. btoc.):** 29.28

**Northing:** 517540.502  
**Easting:** 12635742.72  
**Casing Elevation:** 627.697  
  
**Borehole Depth (ft. bgs.):** 40.0  
**Surface Elevation:** 624.817  
  
**Descriptions By:** A. Westhuis

**Well/Boring ID:** JHC MW-15007  
**Client:** Consumers Energy  
  
**Location:** JH Campbell Facility  
 1700 Crosswell Street Site A  
 West Olive, MI 49460  
  
**Weather Conditions:** 75 F Sunny



**Remarks:** bgs = below ground surface  
 btoc = 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' btoc.  
 No odor or staining observed.  
 Groundwater elevation measured on December 2, 2015 was 599.22 feet




<b>Date Start:</b> 9/21/15 <b>Date Finish:</b> 9/21/15 <b>Drilling Company:</b> Mateco Drilling <b>Driller's Name:</b> John Pitsch <b>Drilling Method:</b> Air Knife/Sonic <b>Sampling Method:</b> Continuous <b>Rig Type:</b> Sonic <b>Water Level Start (ft. bgs.):</b> 21.0 <b>Water Level Finish (ft. btoc.):</b> 29.28	<b>Northing:</b> 517540.502 <b>Easting:</b> 12635742.72 <b>Casing Elevation:</b> 627.697  <b>Borehole Depth (ft. bgs.):</b> 40.0 <b>Surface Elevation:</b> 624.817  <b>Descriptions By:</b> A. Westhuis	<b>Well/Boring ID:</b> JHC MW-15007  <b>Client:</b> Consumers Energy  <b>Location:</b> JH Campbell Facility 1700 Crosswell Street Site A West Olive, MI 49460  <b>Weather Conditions:</b> 75 F Sunny
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DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
20	-20									
25	-25	3	20.0-30.0'	5	NA			NOTE: Wet at 21.0' bgs.		
35	-35	4	30.0-40.0'	5	NA					
40	40							End of boring at 40.0' bgs.		

	<b>Remarks:</b> bgs = below ground surface btoc = 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' btoc. No odor or staining observed. Groundwater elevation measured on December 2, 2015 was 599.22 feet
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<b>Date Start:</b> 9/28/15 <b>Date Finish:</b> 9/28/15 <b>Drilling Company:</b> Mateco Drilling <b>Driller's Name:</b> John Pitsch <b>Drilling Method:</b> Air Knife/Sonic <b>Sampling Method:</b> Continuous <b>Rig Type:</b> Sonic <b>Water Level Start (ft. bgs.):</b> 33.0 <b>Water Level Finish (ft. btoc.):</b> 28.70	<b>Northing:</b> 519214.841 <b>Easting:</b> 12633675.28 <b>Casing Elevation:</b> 635.662  <b>Borehole Depth (ft. bgs.):</b> 38.0 <b>Surface Elevation:</b> 632.592  <b>Descriptions By:</b> A. Westhuis	<b>Well/Boring ID:</b> JHC MW-15012  <b>Client:</b> Consumers Energy  <b>Location:</b> JH Campbell Facility, 1700 Crosswell Street Site A, West Olive, MI 49460  <b>Weather Conditions:</b> 60 F Cloudy, Windy
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DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
635										TOC = 635.662 (ft. above msl)
0								(0.0 - 10.0') SAND, fine, subrounded; trace to little silt; well sorted; dry to moist; dark grayish brown (10YR 4/2). NOTE: Little ash.		Concrete (0.0-1.0' bgs)
5		1	0.0-10.0'	10.0	NA					
625										
10								(10.0 - 28.0') Blind drilled; no soils logged. Refer to soil boring log SB-Z.		Bentonite/Cement Grout (1.0-24.0' bgs) 2" PVC Well Casing (-3-28.0' bgs)
620										
15		2	10.0-20.0'	NA	NA					
615										

	<b>Remarks:</b> bgs = below ground surface btoc = below top of casing  Air knife to 10.0' bgs. Groundwater encountered at 33.0' bgs. Water level at development was 28.70' btoc. No odor or staining observed. Groundwater elevation measured on December 2, 2015 was 608.50 feet
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<b>Date Start:</b> 9/28/15 <b>Date Finish:</b> 9/28/15 <b>Drilling Company:</b> Mateco Drilling <b>Driller's Name:</b> John Pitsch <b>Drilling Method:</b> Air Knife/Sonic <b>Sampling Method:</b> Continuous <b>Rig Type:</b> Sonic <b>Water Level Start (ft. bgs.):</b> 33.0 <b>Water Level Finish (ft. btoc.):</b> 28.70	<b>Northing:</b> 519214.841 <b>Easting:</b> 12633675.28 <b>Casing Elevation:</b> 635.662  <b>Borehole Depth (ft. bgs.):</b> 38.0 <b>Surface Elevation:</b> 632.592  <b>Descriptions By:</b> A. Westhuis	<b>Well/Boring ID:</b> JHC MW-15012  <b>Client:</b> Consumers Energy  <b>Location:</b> JH Campbell Facility, 1700 Crosswell Street Site A, West Olive, MI 49460  <b>Weather Conditions:</b> 60 F Cloudy, Windy
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DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
20										
61.0		3	20.0-28.0'	NA	NA					
25										
60.5										
30								(28.0 - 33.0') SAND, fine to medium, subrounded; well sorted; moist to wet; very pale brown (10YR 7/4).		
60.0		4	28.0-38.0'	7.0	NA			(33.0 - 38.0') SAND, fine, subrounded; trace silt; well sorted; wet; very pale brown (10YR 7/4).		
35										
59.5										
40								End of boring at 38.0' bgs.		

	<p><b>Remarks:</b> bgs = below ground surface btoc = below top of casing</p> <p>Air knife to 10.0' bgs. Groundwater encountered at 33.0' bgs. Water level at development was 28.70' btoc. No odor or staining observed. Groundwater elevation measured on December 2, 2015 was 608.50 feet</p>
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<b>Date Start:</b> 9/24/15 <b>Date Finish:</b> 9/24/15 <b>Drilling Company:</b> Mateco Drilling <b>Driller's Name:</b> John Pitsch <b>Drilling Method:</b> Air Knife/Sonic <b>Sampling Method:</b> Continuous <b>Rig Type:</b> Sonic <b>Water Level Start (ft. bgs.):</b> NA <b>Water Level Finish (ft. btoc.):</b> 25.94	<b>Northing:</b> 519207.188 <b>Easting:</b> 12634025.15 <b>Casing Elevation:</b> 635.247  <b>Borehole Depth (ft. bgs.):</b> 38.0 <b>Surface Elevation:</b> 632.402  <b>Descriptions By:</b> A. Westhuis	<b>Well/Boring ID:</b> JHC MW-15013  <b>Client:</b> Consumers Energy  <b>Location:</b> JH Campbell Facility 1700 Crosswell Street Site A West Olive, MI 49460  <b>Weather Conditions:</b> 75 F Sunny
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DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
635										TOC = 635.247 (ft. above msl)
0								(0.0 - 0.3') GRASS, TOPSOIL.		Concrete (0.0-1.0' bgs)
630		1	0.0-10.0'	5.0	NA			(0.3 - 10.0') SAND, fine to medium, subrounded; trace to little silt; well sorted; dry to moist; pale brown (10YR 6/3) to brownish yellow (10YR 6/6).		
5										
625										
10								(10.0 - 16.0') SAND, fine, subrounded; trace to little silt; well sorted; dry to moist; light yellowish brown (10YR 6/4).		
620										Bentonite/Cement Grout (1.0-24.0' bgs)
15		2	10.0-20.0'	8.0	NA			(16.0 - 16.5') ASH and SAND, fine, subrounded; well sorted; moist; very dark grayish brown (10YR 3/2). NOTE: Fill material.		2" PVC Well Casing (-3-28.0' bgs)
615								(16.5 - 17.0') SAND, fine, subrounded; little silt; well sorted; dry; light brownish gray (10YR 6/2). NOTE: Trace ash. Soils hot; cooked by Sonic rig.		
								(17.0 - 32.0') SAND, fine, subrounded; trace silt; well sorted; yellowish brown (10YR 5/4).		

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

Air knife to 10.0' bgs.  
Water level at development was 25.94' btoc.  
No odor or staining observed.  
Groundwater elevation measured on December 2, 2015 was 610.58 feet above mean sea level.



**Date Start:** 9/24/15  
**Date Finish:** 9/24/15  
**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.):** NA  
**Water Level Finish (ft. btoc.):** 25.94

**Northing:** 519207.188  
**Easting:** 12634025.15  
**Casing Elevation:** 635.247  
  
**Borehole Depth (ft. bgs.):** 38.0  
**Surface Elevation:** 632.402  
  
**Descriptions By:** A. Westhuis

**Well/Boring ID:** JHC MW-15013  
**Client:** Consumers Energy  
  
**Location:** JH Campbell Facility  
 1700 Crosswell Street Site A  
 West Olive, MI 49460  
  
**Weather Conditions:** 75 F Sunny

DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
20										
610										
25		3	20.0-30.0'	9.0	NA					
605										
30										
600		4	30.0-35.0'	5.0	NA			(32.0 - 38.0') SAND, very fine to fine, subrounded; trace silt; well sorted; light yellowish brown (10YR 6/4).		
35										
595			35.0-38.0'	3.0	NA					
40								End of boring at 38.0' bgs.		

**Remarks:** bgs = below ground surface  
 btoc = below top of casing  
  
 Air knife to 10.0' bgs.  
 Water level at development was 25.94' btoc.  
 No odor or staining observed.  
 Groundwater elevation measured on December 2, 2015 was 610.58 feet above mean sea level.



<b>Date Start:</b> 9/25/15 <b>Date Finish:</b> 9/25/15 <b>Drilling Company:</b> Mateco Drilling <b>Driller's Name:</b> John Pitsch <b>Drilling Method:</b> Air Knife/Sonic <b>Sampling Method:</b> Continuous <b>Rig Type:</b> Sonic <b>Water Level Start (ft. bgs.):</b> 24.35 <b>Water Level Finish (ft. btoc.):</b> 29.81	<b>Northing:</b> 519419.85 <b>Easting:</b> 12634254.12 <b>Casing Elevation:</b> 638.132  <b>Borehole Depth (ft. bgs.):</b> 50.0 <b>Surface Elevation:</b> 635.132  <b>Descriptions By:</b> A. Westhuis	<b>Well/Boring ID:</b> JHC MW-15014  <b>Client:</b> Consumers Energy  <b>Location:</b> JH Campbell Facility 1700 Crosswell Street Site A West Olive, MI 49460  <b>Weather Conditions:</b> 75 F Sunny
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DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
0	635							(0.0 - 0.3') GRASS, TOPSOIL.		TOC = 638.132 (ft. above msl)
5	630	1	0.0-10.0'	5.0	NA		X X	(0.3 - 10.0') ASH; trace fine sand, subrounded; well sorted; moist to wet; soft; dark gray (10YR 4/1). NOTE: Fill material.		Concrete (0.0-1.0' bgs)
10	625							(10.0 - 35.0') ASH; well sorted; very soft; wet; gray (10YR 5/1). NOTE: Fill material.		
15	620	2	10.0-20.0'	8.0	NA		X X			Bentonite/Cement Grout (1.0-35.0' bgs)
20	615						X X			2" PVC Well Casing (-3-39.0' bgs)

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

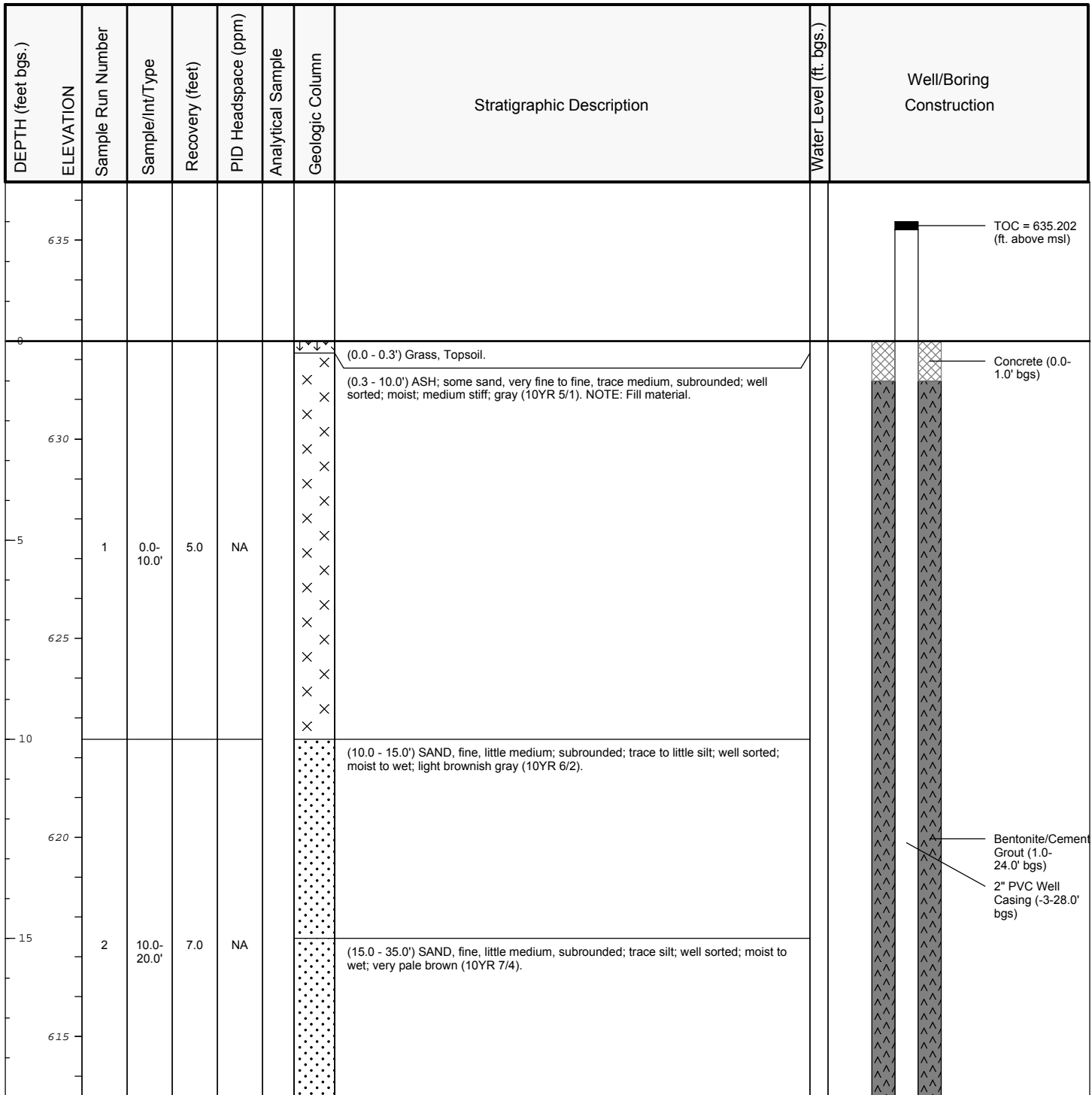
Air knifed to 10.0' bgs.  
Groundwater encountered at 24.35' bgs.  
Water level at development was 29.81' btoc.  
No odor or staining observed.  
Groundwater elevation measured on December 3, 2015 was 609.49 feet







<b>Date Start:</b> 9/25/15 <b>Date Finish:</b> 9/28/15 <b>Drilling Company:</b> Mateco Drilling <b>Driller's Name:</b> John Pitsch <b>Drilling Method:</b> Air Knife/Sonic <b>Sampling Method:</b> Continuous <b>Rig Type:</b> Sonic <b>Water Level Start (ft. bgs.):</b> 23.92 <b>Water Level Finish (ft. btoc.):</b> 28.57	<b>Northing:</b> 519715.111 <b>Easting:</b> 12634186.63 <b>Casing Elevation:</b> 635.202  <b>Borehole Depth (ft. bgs.):</b> 40.0 <b>Surface Elevation:</b> 632.462  <b>Descriptions By:</b> A. Westhuis	<b>Well/Boring ID:</b> JHC MW-15015  <b>Client:</b> Consumers Energy  <b>Location:</b> JH Campbell Facility 1700 Crosswell Street Site A West Olive, MI 49460  <b>Weather Conditions:</b> 75 F Sunny
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**Remarks:** bgs = below ground surface  
 btoc = below top of casing

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



**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

**Northing:** 519715.111  
**Easting:** 12634186.63  
**Casing Elevation:** 635.202  
**Borehole Depth (ft. bgs.):** 40.0  
**Surface Elevation:** 632.462  
**Descriptions By:** A. Westhuis

**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

DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
20										
610										
25		3	20.0-30.0'	8.0	NA			NOTE: Wet at 23.92' bgs.		Bentonite Pellets (24.0-26.0' bgs)
605										
30										
600										
35		4	30.0-40.0'	8.0	NA			(35.0 - 40.0') SAND, very fine to fine, subrounded; trace silt; well sorted; wet; pale brown (10YR 6/3).		Sand Pack K&E WP1 (26.0-40.0' bgs) 2" PVC 10 Slot Well Screen (28.0-38.0 bgs)
595										
40								End of boring at 40.0' bgs.		



**Remarks:** bgs = below ground surface  
 btoc = below top of casing  
  
 Air knife to 10.0' bgs.  
 Groundwater encountered at 23.92' bgs.  
 Water level at development was 28.57' btoc.  
 No odor or staining observed.  
 Groundwater elevation measured on December 3, 2015 was 607.68 feet

Date Start: 9/28/15  
 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.): 33.0  
 Water Level Finish (ft. btoc.): 30.34

Northing: 519956.792  
 Easting: 12634198.52  
 Casing Elevation: 634.637  
 Borehole Depth (ft. bgs.): 40.0  
 Surface Elevation: 631.807  
 Descriptions By: A. Westhuis

Well/Boring ID: JHC MW-15016  
 Client: Consumers Energy  
 Location: JH Campbell Facility  
 1700 Crosswell Street Site A  
 West Olive, MI 49460  
 Weather Conditions: 75 F Cloudy

DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
635										TOC = 634.637 (ft. above msl)
630		1	0.0-10.0'	3.0	NA		X X X X X X X X X X X X X X X X	(0.0 - 0.3') Grass, Topsoil. (0.3 - 10.0') ASH and SAND, fine to medium; subrounded; trace granules to small pebbles, subrounded; trace to little silt; poorly sorted; moist; dark grayish brown (10YR 4/2). NOTE: Fill material.		Concrete (0.0-1.0' bgs)
625								(10.0 - 12.5') SAND, fine, trace medium, subrounded; trace granules to small pebbles, subrounded; trace silt; well sorted; dry to moist; brownish yellow (10YR 6/6).		Bentonite/Cement Grout (1.0-24.0' bgs) 2" PVC Well Casing (-3-28.0' bgs)
620							(12.5 - 12.8') SAND, fine, trace medium, subrounded; trace silt; well sorted; dry to moist; dark yellowish brown (10YR 4/4).			
615							(12.8 - 15.5') SAND, fine, trace medium, subrounded; trace silt; well sorted; dry to moist; pale brown (10YR 6/3).			
							(15.5 - 17.0') SAND, very fine to fine, subrounded; trace granules to small pebbles; subrounded; trace silt; dry; well sorted; very pale brown (10YR 8/3).			
							(17.0 - 24.0') SAND, fine, subrounded; little silt; well sorted; dry to moist; pale brown (10YR 6/3).			
610		2	10.0-20.0'	8.0	NA					

**Remarks:** bgs = below ground surface  
 btoc = below top of casing  
 Air knife to 10.0' bgs.  
 Groundwater encountered at 33.0' bgs.  
 Water level at development was 30.34' btoc.  
 No odor or staining observed.  
 Groundwater elevation measured on December 3, 2015 was 604.92 feet



**Date Start:** 9/28/15  
**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.):** 33.0  
**Water Level Finish (ft. btoc.):** 30.34

**Northing:** 519956.792  
**Easting:** 12634198.52  
**Casing Elevation:** 634.637  
**Borehole Depth (ft. bgs.):** 40.0  
**Surface Elevation:** 631.807  
**Descriptions By:** A. Westhuis

**Well/Boring ID:** JHC MW-15016  
**Client:** Consumers Energy  
**Location:** JH Campbell Facility  
 1700 Crosswell Street Site A  
 West Olive, MI 49460  
**Weather Conditions:** 75 F Cloudy


DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
20	610									
25	605	3	20.0-30.0'	9.0	NA		(24.0 - 26.0') SAND, fine, subrounded; trace silt; well sorted; moist; very pale brown (10YR 7/3).			Bentonite Pellets (24.0-26.0' bgs)
							(26.0 - 27.0') SAND, fine, subrounded, trace silt; well sorted; moist; brown (10YR 5/3) to dark brown (10YR 3/3). NOTE: Trace large wood fragments.			
							(27.0 - 33.0') SAND, very fine to fine, subrounded; well sorted; moist to wet; light brownish gray (10YR 6/2).		604.92	
30	600									
35	595	4	30.0-40.0'	9.0	NA		(33.0 - 40.0') SAND, medium, trace to little fine, subrounded; trace silt; well sorted; wet; very pale brown (10YR 8/4).			Sand Pack K&E WP1 (26.0-40.0' bgs) 2" PVC 10 Slot Well Screen (28.0-38.0 bgs)
40	590						End of boring at 40.0' bgs.			

**Remarks:** bgs = below ground surface  
 btoc = below top of casing  
  
 Air knife to 10.0' bgs.  
 Groundwater encountered at 33.0' bgs.  
 Water level at development was 30.34' btoc.  
 No odor or staining observed.  
 Groundwater elevation measured on December 3, 2015 was 604.92 feet



<b>Date Start:</b> 9/29/15 <b>Date Finish:</b> 9/29/15 <b>Drilling Company:</b> Mateco Drilling <b>Driller's Name:</b> John Pitsch <b>Drilling Method:</b> Air Knife/Sonic <b>Sampling Method:</b> Continuous <b>Rig Type:</b> Sonic <b>Water Level Start (ft. bgs.):</b> 12.0 <b>Water Level Finish (ft. btoc.):</b> 16.29	<b>Northing:</b> 521075.536 <b>Easting:</b> 12635979.61 <b>Casing Elevation:</b> 617.022  <b>Borehole Depth (ft. bgs.):</b> 20.0 <b>Surface Elevation:</b> 614.262  <b>Descriptions By:</b> A. Westhuis	<b>Well/Boring ID:</b> JHC MW-15018  <b>Client:</b> Consumers Energy  <b>Location:</b> JH Campbell Facility 1700 Crosswell Street Site A West Olive, MI 49460  <b>Weather Conditions:</b> 60 F Cloudy
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DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
615										
0								(0.0 - 0.3') Grass, Topsoil.		TOC Elevation = 617.022 (ft. above msl)
5		1	0.0-10.0'	3.0	NA			(0.3 - 1.0') ASH and SAND, very fine to fine, well sorted; dry; light gray (10YR 7/2). NOTE: Fill material. (1.0 - 10.0') SAND, fine, subrounded; well sorted; dry; brownish yellow (10YR 6/6).		Concrete (0.0-1.0' bgs) Bentonite/Cement Grout (1.0-6.0' bgs) 2" PVC Well Casing (-3-10.0' bgs) Bentonite Pellets (6.0-8.0' bgs)
10								(10.0 - 17.0') SAND, fine, subrounded; trace silt; well sorted; moist to wet; very pale brown (10YR 7/3).  NOTE: Wet at 12.0' bgs.		
15		2	10.0-20.0'	7.0	NA			(17.0 - 20.0') SAND, medium, little fine, subrounded; trace granules; subrounded; trace silt; well sorted; wet; very pale brown (10YR 7/4).		Sand Pack K&E WP1 (8.0-20.0' bgs) 2" PVC 10 Slot Well Screen (10.0-20.0 bgs)
20								End of boring at 20.0' bgs.		

	<p><b>Remarks:</b> bgs = below ground surface btoc = below top of casing</p> <p>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</p>
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**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

**Northing:** 521927.205  
**Easting:** 12638205.16  
**Casing Elevation:** 619.977  
**Borehole Depth (ft. bgs.):** 25.0  
**Surface Elevation:** 617.012  
**Descriptions By:** A. Westhuis

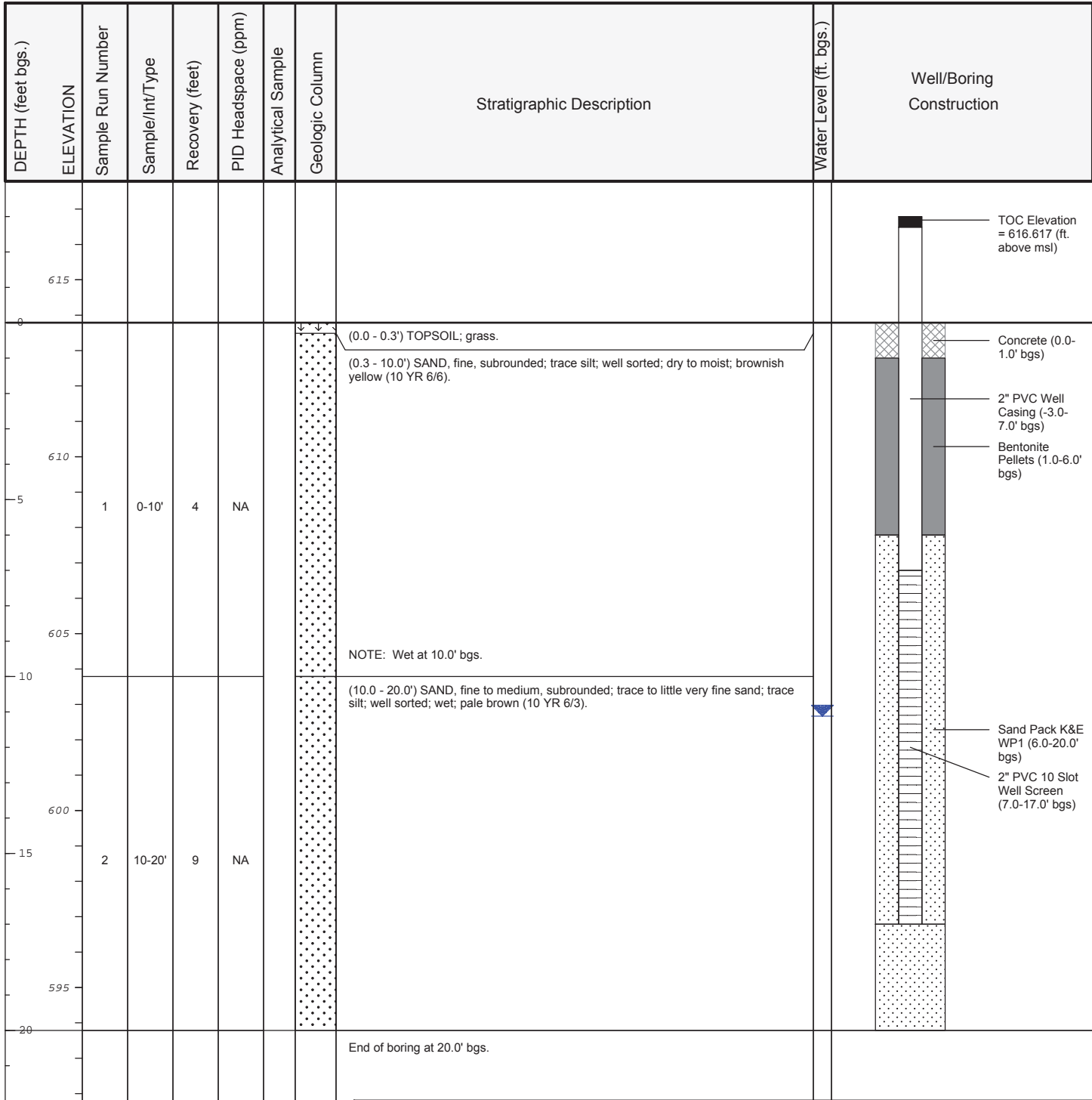
**Well/Boring ID:** JHC MW-15023  
**Client:** Consumers Energy  
**Location:** JH Campbell Facility  
 1700 Crosswell Street Site A  
 West Olive, MI 49460  
**Weather Conditions:** Sunny, 60F.

DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
620										TOC Elevation = 619.977 (ft. above msl)
0								(0.0 - 0.3') TOPSOIL; grass.		Concrete (0.0-1.0' bgs)
615		1	0-10'	10	NA			(0.3 - 10.0') SAND, very fine to fine, subrounded; trace silt; well sorted; dry; brown (10 YR 4/3). Note: Trace wood fragments from 7.0 to 10.0' bgs.		Bentonite/Cement Grout (1.0-10.0' bgs) 2" PVC Well Casing (-3.0-14.0' bgs)
610								(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).		Bentonite Pellets (10.0-12.0' bgs)
605		2	10-20'	8	NA			(16.0 - 17.0') SAND, very fine to fine, subrounded; trace silt; well sorted; moist; yellow (10 YR 7/6).	18.91	
600								(17.0 - 18.0') SAND, fine, subrounded; trace silt; well sorted; moist; brownish yellow (10 YR 6/6).		
								(18.0 - 21.0') SAND, very fine; little fine sand, subrounded; trace silt; well sorted; wet; pale brown (10 YR 6/3).		Sand Pack K&E WP1 (12.0-25.0' bgs) 2" PVC 10 Slot Well Screen (14.0-24.0' bgs)
595		3	20-25'	4	NA			(21.0 - 25.0') SAND, medium; trace fine sand, subangular; trace granules, subangular; poorly sorted; wet; pale brown (10 YR 6/3).		
25								End of boring at 25.0' bgs.		
590										

**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



<b>Date Start:</b> 10/1/15 <b>Date Finish:</b> 10/1/15 <b>Drilling Company:</b> Mateco Drilling <b>Driller's Name:</b> Dan Mourer <b>Drilling Method:</b> Air Knife/Sonic <b>Sampling Method:</b> Continuous <b>Rig Type:</b> Sonic <b>Water Level Start (ft. bgs.):</b> 10.0 <b>Water Level Finish (ft. btoc.):</b> 14.12	<b>Northing:</b> 522366.013 <b>Easting:</b> 12637322.68 <b>Casing Elevation:</b> 616.617  <b>Borehole Depth (ft. bgs.):</b> 20.0 <b>Surface Elevation:</b> 613.787  <b>Descriptions By:</b> A. Westhuis	<b>Well/Boring ID:</b> JHC MW-15024  <b>Client:</b> Consumers Energy  <b>Location:</b> JH Campbell Facility 1700 Crosswell Street Site A West Olive, MI 49460  <b>Weather Conditions:</b> Sunny, 60F.
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**Remarks:** bgs= below ground surface  
btoc = below top of casing

Air knife to 10.0' bgs.  
Groundwater encountered at 10.0' bgs during drilling.  
Water level at development was 14.12' btoc.  
No odor or staining observed.  
Groundwater elevation measured on December 2, 2015 was 602.24 feet



**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.):** 12.0  
**Water Level Finish (ft. btoc.):** 13.50

**Northing:** 522702.978  
**Easting:** 12636668.15  
**Casing Elevation:** 617.167  
**Borehole Depth (ft. bgs.):** 20.0  
**Surface Elevation:** 614.137  
**Descriptions By:** A. Westhuis

**Well/Boring ID:** JHC MW-15025  
**Client:** Consumers Energy  
**Location:** JH Campbell Facility  
 1700 Crosswell Street Site A  
 West Olive, MI 49460  
**Weather Conditions:** Sunny, 60F.

DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
615										
0								(0.0 - 0.3') TOPSOIL; grass.		TOC Elevation = 617.167 (ft. above msl)
5	610	1	0-10'	10	NA			(0.3 - 5.0') SAND, fine, subrounded; trace silt; well sorted; dry; very pale brown (10 YR 7/3).		Concrete (0.0-1.0' bgs)
								(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.		2" PVC Well Casing (-3.0-7.0' bgs) Bentonite Pellets (1.0-6.0' bgs)
10	605							(12.0 - 15.0') SAND, fine, subrounded; trace silt; well sorted; wet; pale brown (10 YR 6/3).		
15	600	2	10-20'	8	NA			(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).		
								(16.0 - 20.0') SAND, very fine to fine, subrounded; little silt; well sorted; wet; pale brown (10 YR 6/3).		Sand Pack K&E WP1 (6.0-20.0' bgs) 2" PVC 10 Slot Well Screen (7.0-17.0' bgs)
20	595							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





**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

**Northing:** 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.


DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
0	615							(0.0 - 0.3') TOPSOIL; grass.		TOC Elevation = 618.042 (ft. above msl)
5	610	1	0-10'	10	NA			(0.3 - 3.0') SAND, fine, subrounded; trace medium sand, subrounded; trace silt; well sorted; dry; very pale brown (10 YR 7/3).		Concrete (0.0-1.0' bgs)
								(3.0 - 8.0') SAND, fine, subrounded; trace silt; well sorted; dry; brownish yellow (10 YR 6/6).		2" PVC Well Casing (-3.0-8.0' bgs)
								(8.0 - 12.0') SAND, fine, subrounded; little very fine sand, subrounded; trace silt; well sorted; dry; pale brown (10 YR 6/3) to brownish yellow (10YR 6/6).		Bentonite Pellets (1.0-7.0' bgs)
15	600	2	10-20'	6	NA			(12.0 - 20.0') SAND, very fine to fine, subrounded; trace silt; well sorted; moist to wet; pale brown (10 YR 6/3).	15.34	Sand Pack K&E WP1 (7.0-20.0' bgs)
										2" PVC 10 Slot Well Screen (8.0-18.0' bgs)
20	595							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 15.34' btoc.  
 No odor or staining observed.  
 Groundwater elevation measured on December 2, 2015 was 602.32 feet



<b>Date Start:</b> 10/2/15 <b>Date Finish:</b> 10/2/15 <b>Drilling Company:</b> Mateco Drilling <b>Driller's Name:</b> Dan Mourer <b>Drilling Method:</b> Hand Auger/Sonic <b>Sampling Method:</b> Continuous <b>Rig Type:</b> Sonic <b>Water Level Start (ft. bgs.):</b> 13.0 <b>Water Level Finish (ft. btoc.):</b> 15.85	<b>Northing:</b> 522394.86 <b>Easting:</b> 1235097.51 <b>Casing Elevation:</b> 617.302  <b>Borehole Depth (ft. bgs.):</b> 20.0 <b>Surface Elevation:</b> 614.767  <b>Descriptions By:</b> A. Westhuis	<b>Well/Boring ID:</b> JHC MW-15027  <b>Client:</b> Consumers Energy  <b>Location:</b> JH Campbell Facility 1700 Crosswell Street Site A West Olive, MI 49460  <b>Weather Conditions:</b> Sunny, 50F.
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DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
0	615							(0.0 - 0.3') TOPSOIL; grass.		TOC Elevation = 617.302 (ft. above msl)
5	610	1	0-10'	10	NA			(0.3 - 2.0') SAND, very fine to fine, subrounded; trace silt; well sorted; dry; dark yellowish brown (10 YR 4/6).		Concrete (0.0-1.0' bgs)
								(2.0 - 6.0') SAND, very fine to fine, subrounded; trace silt; well sorted; dry; very pale brown (10 YR 7/3).		2" PVC Well Casing (-3.0-10.0' bgs)
								(6.0 - 16.0') SAND, fine, subrounded; trace silt; well sorted; dry; yellow (10YR 7/6).		Bentonite Pellets (1.0-8.0' bgs)
10	605							Note: Wet at 13.0' bgs.		
15	600	2	10-20'	8	NA			(16.0 - 20.0') SAND, fine; trace medium sand, subrounded; well sorted; wet; pale brown (10 YR 6/3).		Sand Pack K&E WP1 (8.0-20.0' bgs)
										2" PVC 10 Slot Well Screen (10.0-20.0' bgs)
20	595							End of boring at 20.0' bgs.		

	<b>Remarks:</b> bgs= below ground surface btoc = 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' btoc. No odor or staining observed. Groundwater elevation measured on December 2, 2015 was 601.04 feet
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**Date Start:** 10/2/15  
**Date Finish:** 10/2/15  
**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.):** 9.0  
**Water Level Finish (ft. btoc.):** 14.38

**Northing:** 521646.198  
**Easting:** 12634105.34  
**Casing Elevation:** 613.8  
  
**Borehole Depth (ft. bgs.):** 20.0  
**Surface Elevation:** 611.025  
  
**Descriptions By:** A. Westhuis

**Well/Boring ID:** JHC MW-15028  
**Client:** Consumers Energy  
  
**Location:** JH Campbell Facility  
 1700 Crosswell Street Site A  
 West Olive, MI 49460  
  
**Weather Conditions:** Sunny, 60F.


DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
0	613.80							(0.0 - 0.3') TOPSOIL; grass.		TOC Elevation = 613.80 (ft. above msl)
0.3	610.0							(0.3 - 5.0') SAND, very fine to fine, subrounded; trace silt; well sorted; dry; yellowish (10 YR 7/8).		Concrete (0.0-1.0' bgs)
5.0	605.0	1	0-10'	10	NA			(5.0 - 9.0') SAND, fine, subrounded; trace silt; well sorted; dry to moist; pale brown (10 YR 6/3).		Bentonite/Cement Grout (1.0-4.0' bgs) 2" PVC Well Casing (-3.0-8.0' bgs)
9.0	600.0							(9.0 - 20.0') SAND, medium; trace to little very fine to fine sand, subrounded; trace silt; poorly sorted; moist to wet; pale brown (10 YR 6/3).	9.0	Bentonite Pellets (4.0-6.0' bgs)
15.0	595.0	2	10-20'	9	NA					Sand Pack K&E WP1 (6.0-20.0' bgs) 2" PVC 10 Slot Well Screen (8.0-18.0' bgs)
20.0	590.0							End of boring at 20.0' bgs.		

**Remarks:** bgs= below ground surface  
 btoc = below top of casing  
  
 Air knife to 10.0' bgs.  
 Groundwater encountered at 9.0' bgs during drilling.  
 Water level at development was 14.38' btoc.  
 No odor or staining observed.  
 Groundwater elevation measured on December 3, 2015 was 599.00 feet



<b>Date Start:</b> 10/5/15 <b>Date Finish:</b> 10/5/15 <b>Drilling Company:</b> Mateco Drilling <b>Driller's Name:</b> Dan Mourer <b>Drilling Method:</b> Air knife/Sonic <b>Sampling Method:</b> Continuous <b>Rig Type:</b> Sonic <b>Water Level Start (ft. bgs.):</b> 12.0 <b>Water Level Finish (ft. btoc.):</b> 10.03	<b>Northing:</b> 520503.524 <b>Easting:</b> 12633774.3 <b>Casing Elevation:</b> 610.952  <b>Borehole Depth (ft. bgs.):</b> 20.0 <b>Surface Elevation:</b> 608.082  <b>Descriptions By:</b> A. Westhuis	<b>Well/Boring ID:</b> JHC MW-15029  <b>Client:</b> Consumers Energy  <b>Location:</b> JH Campbell Facility 1700 Crosswell Street Site A West Olive, MI 49460  <b>Weather Conditions:</b> Cloudy, Light Rain, 65F.
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DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
610										TOC Elevation = 610.952 (ft. above msl)
0							(0.0 - 0.3') TOPSOIL; grass.			Concrete (0.0-1.0' bgs)
605		1	0-10'	3	NA		(0.3 - 10.0') SAND, fine, subrounded; trace silt; well sorted; dry; yellowish brown (10 YR 5/4).			2" PVC Well Casing (-3.0-8.0' bgs) Bentonite Pellets (1.0-7.0' bgs)
5							(10.0 - 12.0') SAND, very fine to fine, subrounded; trace silt; well sorted; dry to moist; pale brown (10 YR 6/3).			
600							(12.0 - 15.0') SAND, medium; trace fine sand, subrounded; trace silt; well sorted; wet; pale brown (10 YR 6/3).			
10							(15.0 - 20.0') SAND, medium; little coarse sand; trace granules, subrounded; trace silt; well sorted; wet; pale brown (10 YR 6/4).			Sand Pack K&E WP1 (7.0-20.0' bgs) 2" PVC 10 Slot Well Screen (8.0-18.0' bgs)
595		2	10-20'	6	NA					
15										
590										
20								End of boring at 20.0' bgs.		

	<b>Remarks:</b> bgs = below ground surface btoc = 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
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**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.):** 5.0  
**Water Level Finish (ft. btoc.):** 7.99

**Northing:** 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	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
605										
0								(0.0 - 0.3') TOPSOIL; grass.		TOC Elevation = 607.167 (ft. above msl)
5		1	0-10'	3	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).  NOTE: Wet at 5.0' bgs.		Concrete (0.0-1.0' bgs) 2" PVC Well Casing (-3.0-4.0' bgs) Bentonite Pellets (1.0-3.0' bgs)
10								(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).		Sand Pack K&E WP1 (3.0-20.0' bgs) 2" PVC 10 Slot Well Screen (4.0-14.0' bgs)
15		2	10-20'	6	NA					
20								End of boring at 20.0' bgs.		

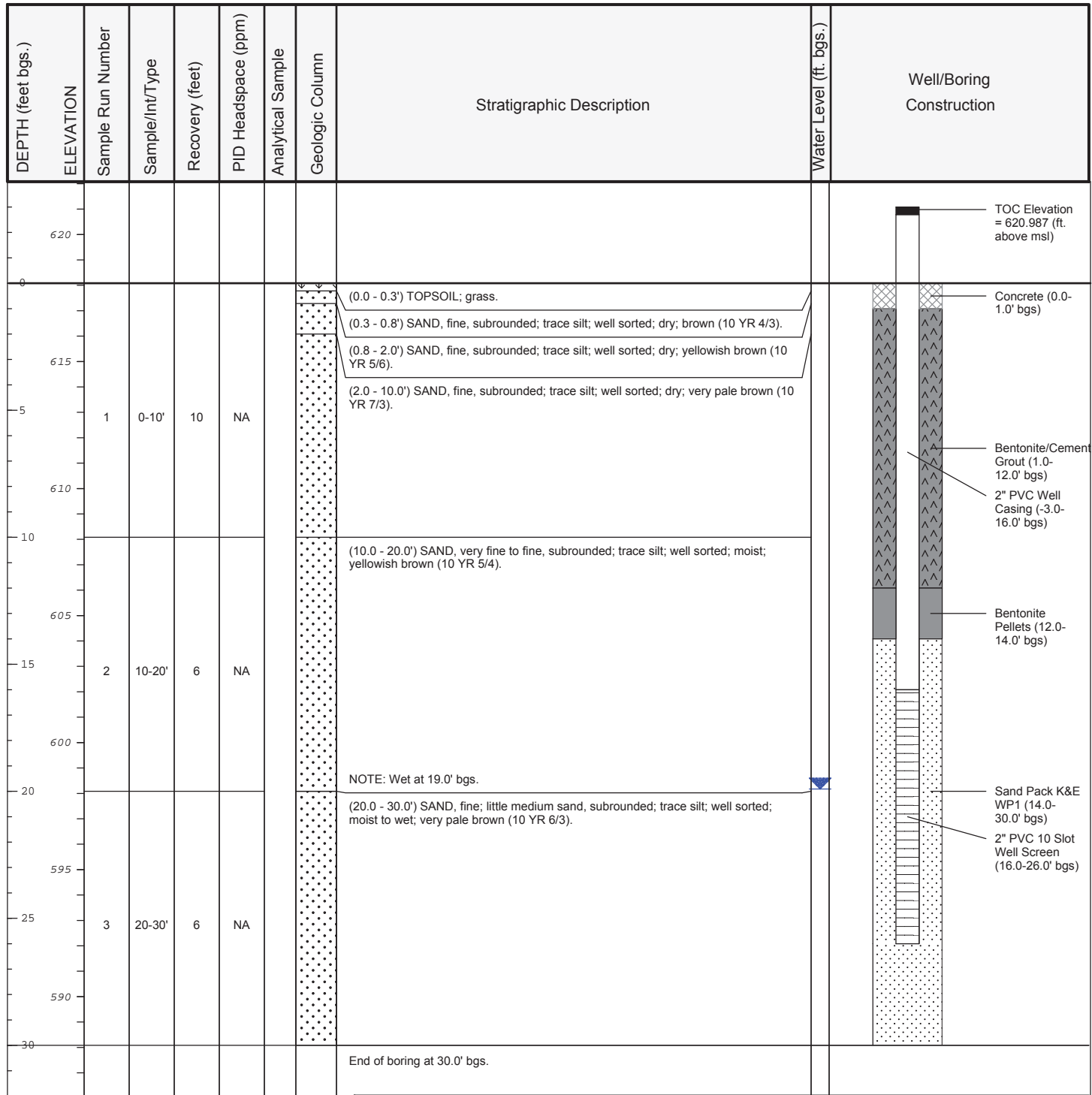
**Remarks:** bgs = below ground surface  
 btoc = below top of casing  
  
 Air knife to 10.0' bgs.  
 Groundwater encountered at 5.0' bgs during drilling.  
 Water level at development was 7.99' btoc.  
 No odor or staining observed.  
 Groundwater elevation measured on December 3, 2015 was 599.65 feet



**Date Start:** 10/6/15  
**Date Finish:** 10/6/15  
**Drilling Company:** Mateco Drilling  
**Driller's Name:** John Pitsch  
**Drilling Method:** Hand Auger/Sonic  
**Sampling Method:** Continuous  
**Rig Type:** Sonic  
**Water Level Start (ft. bgs.):** 19.0  
**Water Level Finish (ft. btoc.):** 22.93

**Northing:** 521075.809  
**Easting:** 12638598.12  
**Casing Elevation:** 620.987  
**Borehole Depth (ft. bgs.):** 30.0  
**Surface Elevation:** 618.082  
**Descriptions By:** A. Westhuis

**Well/Boring ID:** JHC MW-15033  
**Client:** Consumers Energy  
**Location:** JH Campbell Facility  
 1700 Crosswell Street Site A  
 West Olive, MI 49460  
**Weather Conditions:** Cloudy, 60F.



**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



**Date Start:** 3/13/01  
**Date Finish:** 3/13/01  
**Drilling Company:** EDC, Inc.  
**Driller's Name:** Sean Smith  
**Drilling Method:** Hollow Stem Auger  
**Sampling Method:** Split Spoon  
**Rig Type:** Hollow Stem Auger  
**Water Level Start (ft. bgs.):** NA  
**Water Level Finish (ft. btoc.):** NA

**Northing:** NA  
**Easting:** NA  
**Casing Elevation:** 615.90  
  
**Borehole Depth (ft. bgs.):** 30.5  
**Surface Elevation:** NA  
  
**Descriptions By:** Rebecca J. Koepke

**Well/Boring ID:** JHC MW-15036  
**Client:** Consumers Energy  
  
**Location:** JH Campbell Facility  
 1700 Crosswell Street Site A  
 West Olive, MI 49460  
  
**Weather Conditions:** NA

DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
0	625									TOC = 615.90 (ft. above msl) Concrete (0.0-1.0' bgs)
5	620	1	5.0-7.0'	0.9	NA		(0.0 - 0.5') SANDY ORGANIC SOIL, very dark brown, very fine to fine, loose, moist.			2" PVC Well Casing (-3.0-20.0' bgs) Bentonite Chips (1.0-18.0' bgs)
10	615	2	10.0-12.0'	1.6	NA		(0.5 - 30.5') SAND, very pale brown (10YR 7/4), poorly graded, fine, trace silt, round, loose, slightly moist.	NOTE: Very fine.		
15	610	3	15.0-17.0'	1.6	NA			NOTE: Very pale brown (10YR 8/3), fine.		
20	605	4	20.0-22.0'	1.8	NA			NOTE: Fine to medium, moist.		
25	600	5	25.0-27.0'	1.8	NA					Sand Pack Flat Rock #30 (18.0-30.5' bgs) 2" PVC 10 Slot Well Screen (20.0-30.0 bgs)
30	595							End of boring at 30.5' bgs.		

**Remarks:** bgs = below ground surface  
 btoc = below top of casing  
  
 No odor or staining observed.



# SOIL DESCRIPTION

Udden-Wenworth Scale Modified ARCADIS, 2008			
Size Class	Millimeters	Inches	Standard Sieve #
Boulder	256 – 4096	10.09+	
Large cobble	128 - 256	5.04 -10.08	
Small cobble	64 - 128	2.52 – 5.04	
Very large pebble	32 – 64	0.16 - 2.52	
Large pebble	16 – 32	0.63 – 1.26	
Medium pebble	8 – 16	0.31 – 0.63	
Small pebble	4 – 8	0.16 – 0.31	No. 5 +
Granule	2 – 4	0.08 – 0.16	No.5 – No.10
Very coarse sand	1 -2	0.04 – 0.08	No.10 – No.18
Coarse sand	½ - 1	0.02 – 0.04	No.18 - No.35
Medium sand	¼ - ½	0.01 – 0.02	No.35 - No.60
Fine sand	1/8 -¼	0.005 – 0.1	No.60 - No.120
Very fine sand	1/16 – 1/8	0.002 – 0.005	No. 120 – No. 230
Silt (subgroups not included)	1/256 – 1/16	0.0002 – 0.002	Not applicable (analyze by pipette or hydrometer)
Clay (subgroups not included)	1/2048 – 1/256	.00002 – 0.0002	

Modifier	Percent of Total Sample (by volume)
and	36 - 50
some	21 - 35
little	10 - 20
trace	<10

Description	Criteria
Nonplastic	A 1/8 inch (3 mm) thread cannot be rolled at any water content.
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

Description	Criteria
Dry	Absence of moisture, dry to touch, dusty.
Moist	Damp but no visible water.
Wet (Saturated)	Visible free water, soil is usually below the water table.

## Fine-grained soil – Consistency

Description	Criteria
Very soft	N-value < 2 or easily penetrated several inches by thumb.
Soft	N-value 2-4 or easily penetrated one inch by thumb.
Medium stiff	N-value 9-15 or indented about ¼ inch by thumb with great effort.
Very stiff	N-value 16-30 or readily indented by thumb nail.
Hard	N-value > than 30 or indented by thumbnail with difficulty

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces.
Subangular	Particles are similar to angular description but have rounded edges.
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges.
Rounded	Particles have smoothly curved sides and no edges.

## Coarse-grained soil – Density

Description	Criteria
Very loose	N-value 1- 4
Loose	N-value 5-10
Medium dense	N-value 11-30
Dense	N-value 31- 50
Very dense	N-value >50



# 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



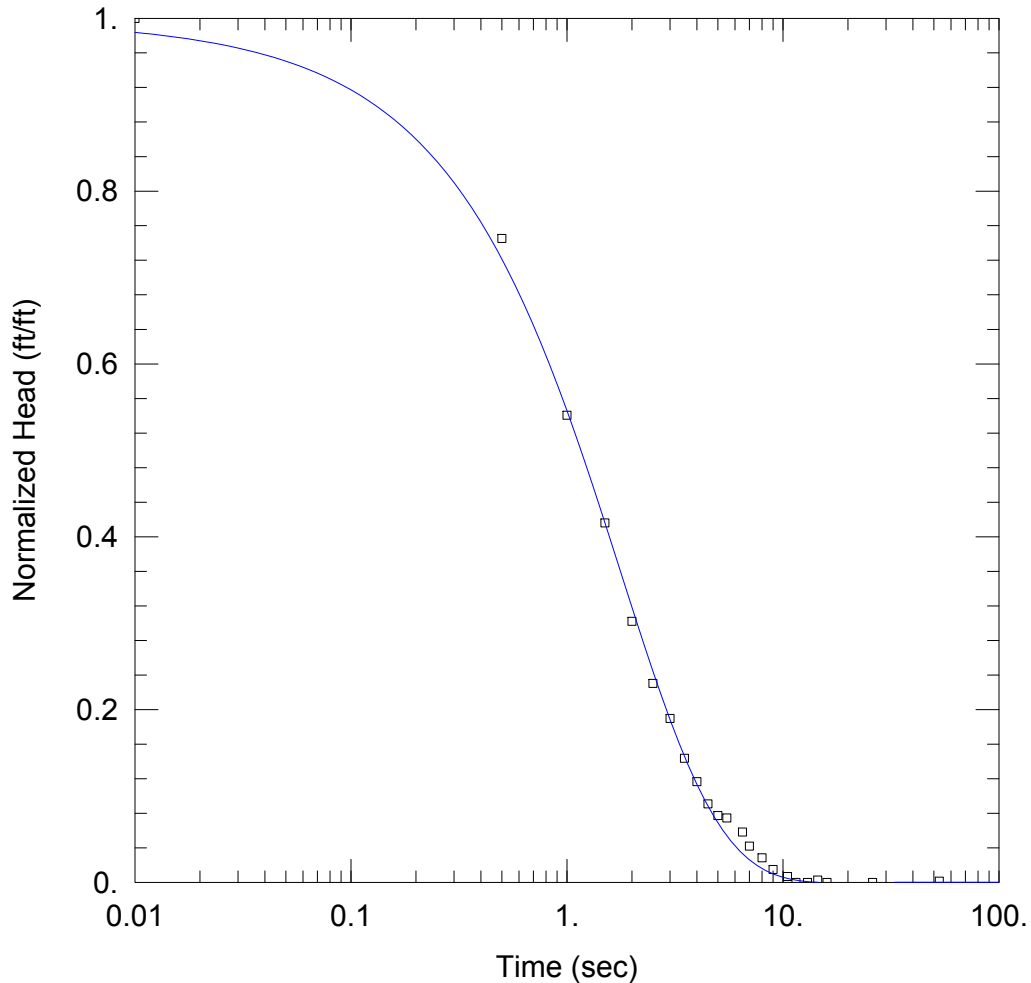
# Slug Test Analysis Result for JHC MW-15005 - Test 2

Prepared By:  
**Arcadis**

Prepared For:  
**Consumer Energy**

Project:

Location:  
**West Olive, MI**



## SOLUTION

Aquifer Model: Unconfined  
Solution Method: KGS Model

Kr = 61. ft/day      Ss = 3.7E-5 ft<sup>-1</sup>  
Kz/Kr = 1.

## 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

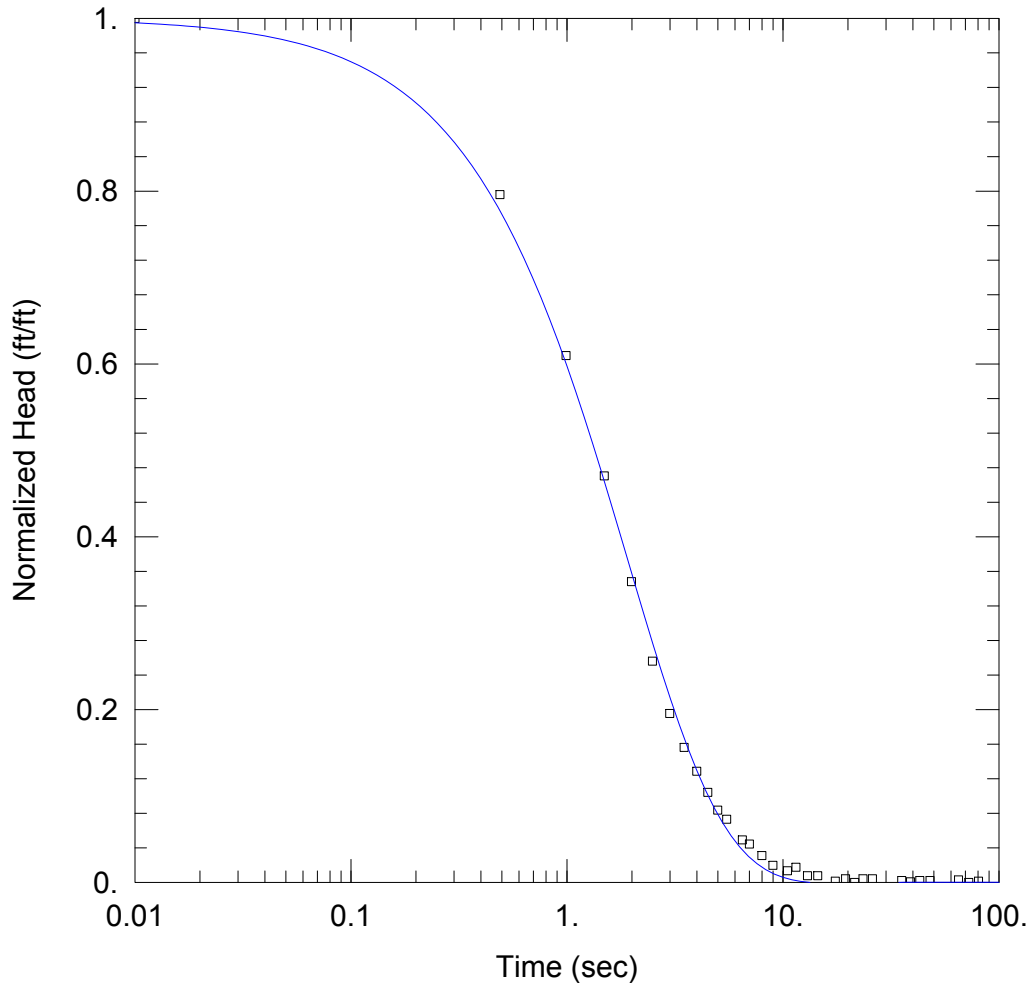
# Slug Test Analysis Result for JHC MW-15005 - Test 3

Prepared By:  
**Arcadis**

Prepared For:  
**Consumer Energy**

Project:

Location:  
**West Olive, MI**



## SOLUTION

Aquifer Model: Unconfined  
Solution Method: KGS Model

Kr = 58. ft/day      Ss = 5.05E-12 ft<sup>-1</sup>  
Kz/Kr = 1.

## 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



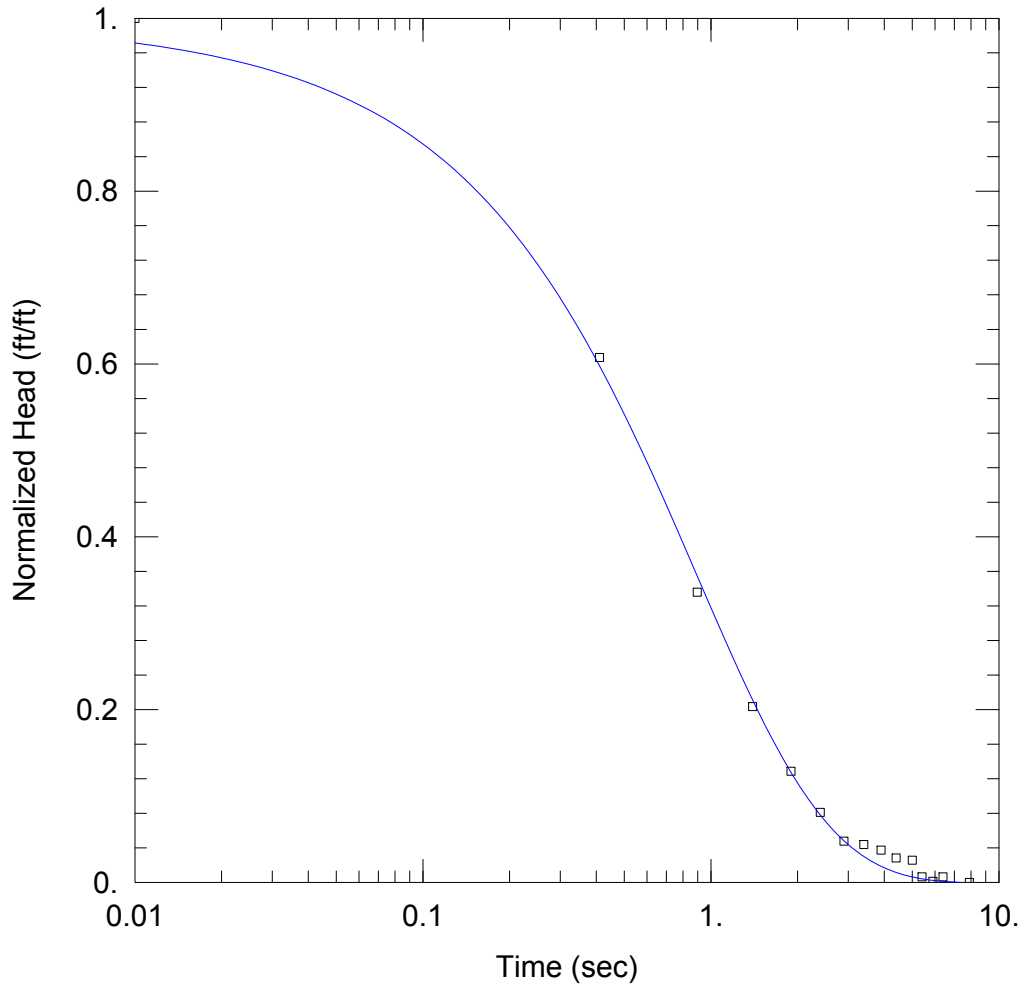
# Slug Test Analysis Result for JHC MW-B6 - Test 2

Prepared By:  
**Arcadis**

Prepared For:  
**Consumer Energy**

Project:

Location:  
**West Olive, MI**



## SOLUTION

Aquifer Model: Unconfined  
Solution Method: KGS Model

Kr = 118. ft/day      Ss = 6.03E-5 ft<sup>-1</sup>  
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

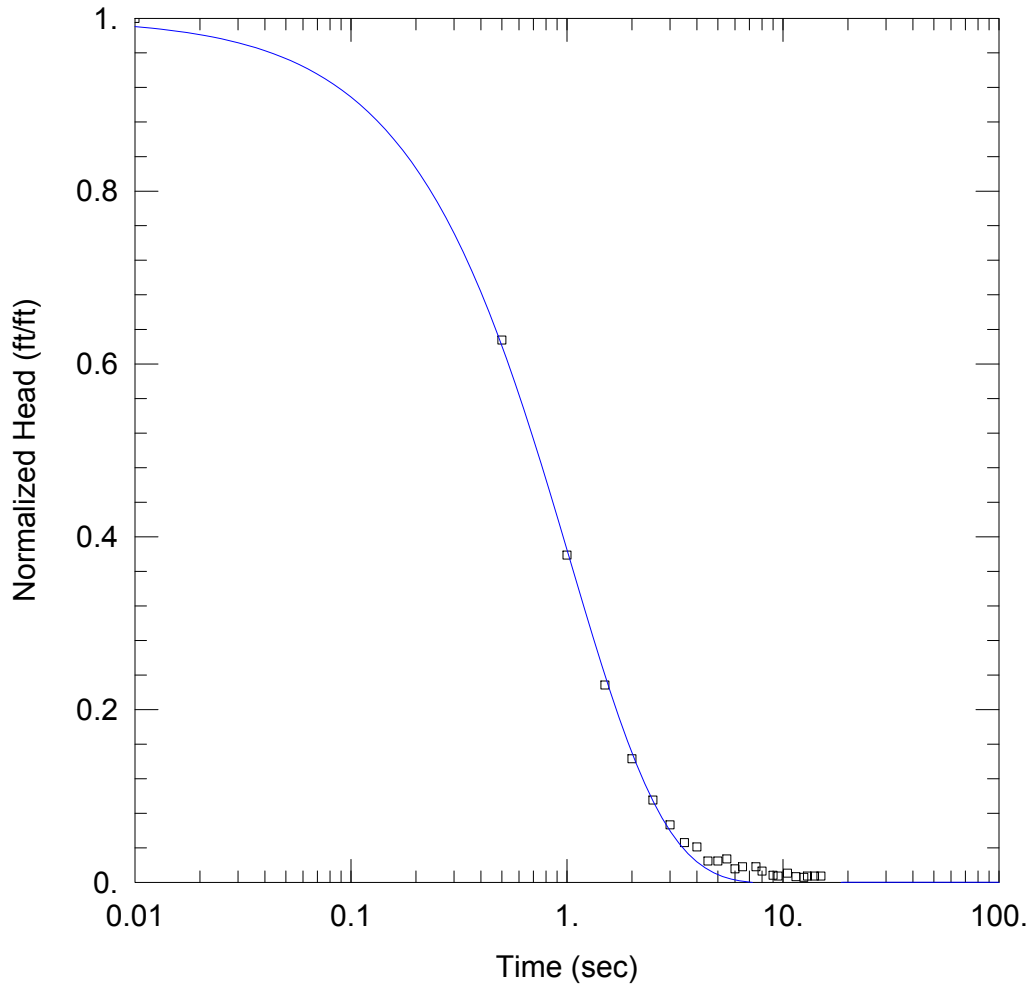
# Slug Test Analysis Result for JHC MW-B6 - Test 3

Prepared By:  
**Arcadis**

Prepared For:  
**Consumer Energy**

Project:

Location:  
**West Olive, MI**



### SOLUTION

Aquifer Model: Unconfined  
Solution Method: KGS Model

Kr = 139. ft/day      Ss = 5.05E-12 ft<sup>-1</sup>  
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





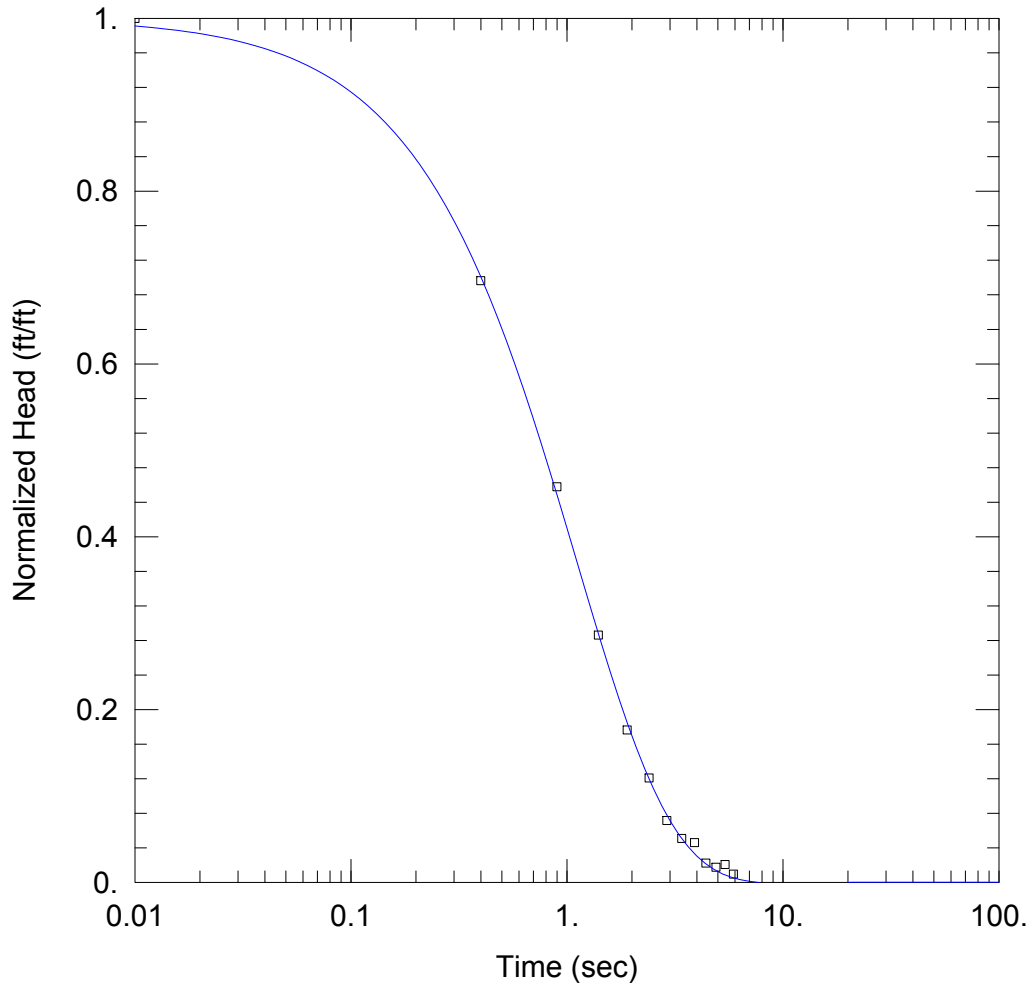
# Slug Test Analysis Result for JHC MW-15007 - Test 1

Prepared By:  
**Arcadis**

Prepared For:  
**Consumer Energy**

Project:

Location:  
**West Olive, MI**



## SOLUTION

Aquifer Model: Unconfined  
Solution Method: KGS Model

Kr = 130. ft/day      Ss = 5.05E-12 ft<sup>-1</sup>  
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

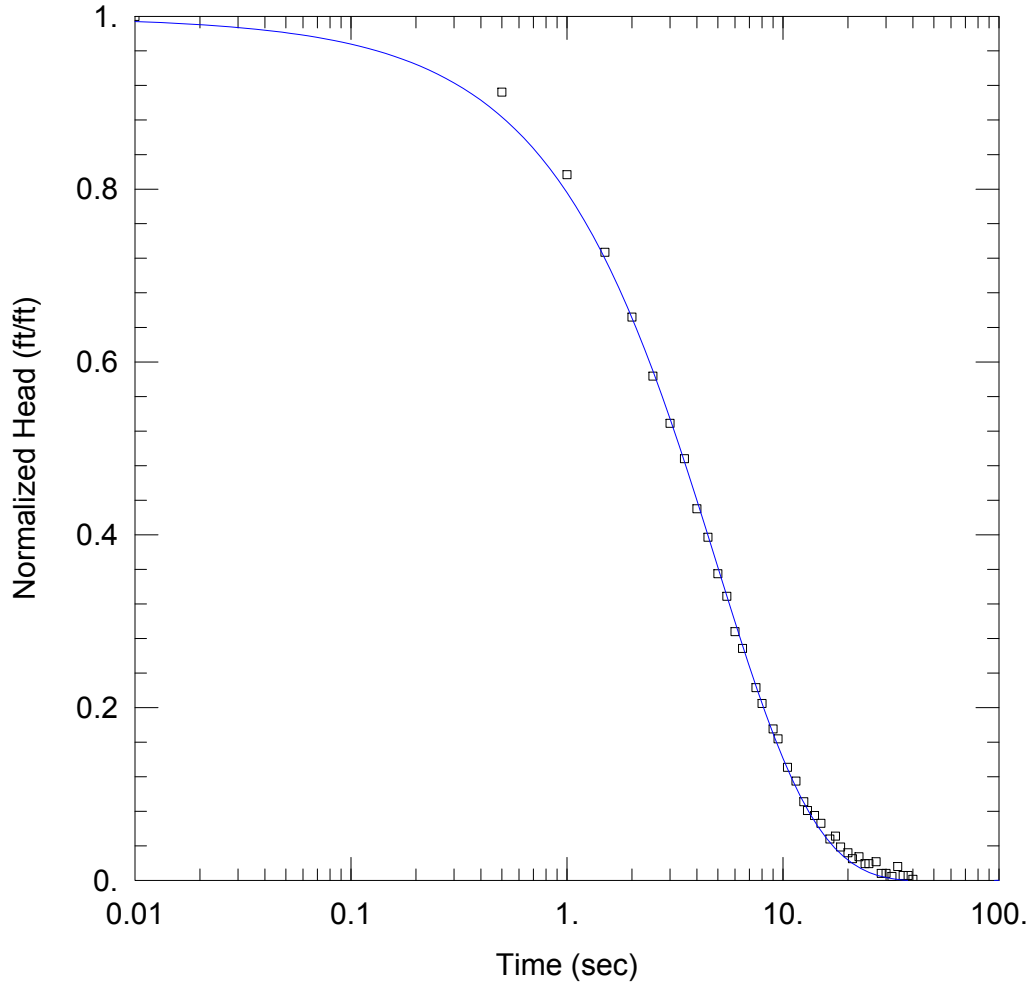
# Slug Test Analysis Result for JHC MW-15015 - Test 2

Prepared By:  
**Arcadis**

Prepared For:  
**Consumer Energy**

Project:

Location:  
**West Olive, MI**



## SOLUTION

Aquifer Model: Unconfined  
Solution Method: KGS Model

Kr = 22. ft/day      Ss = 7.0E-6 ft<sup>-1</sup>  
Kz/Kr = 1.

## 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

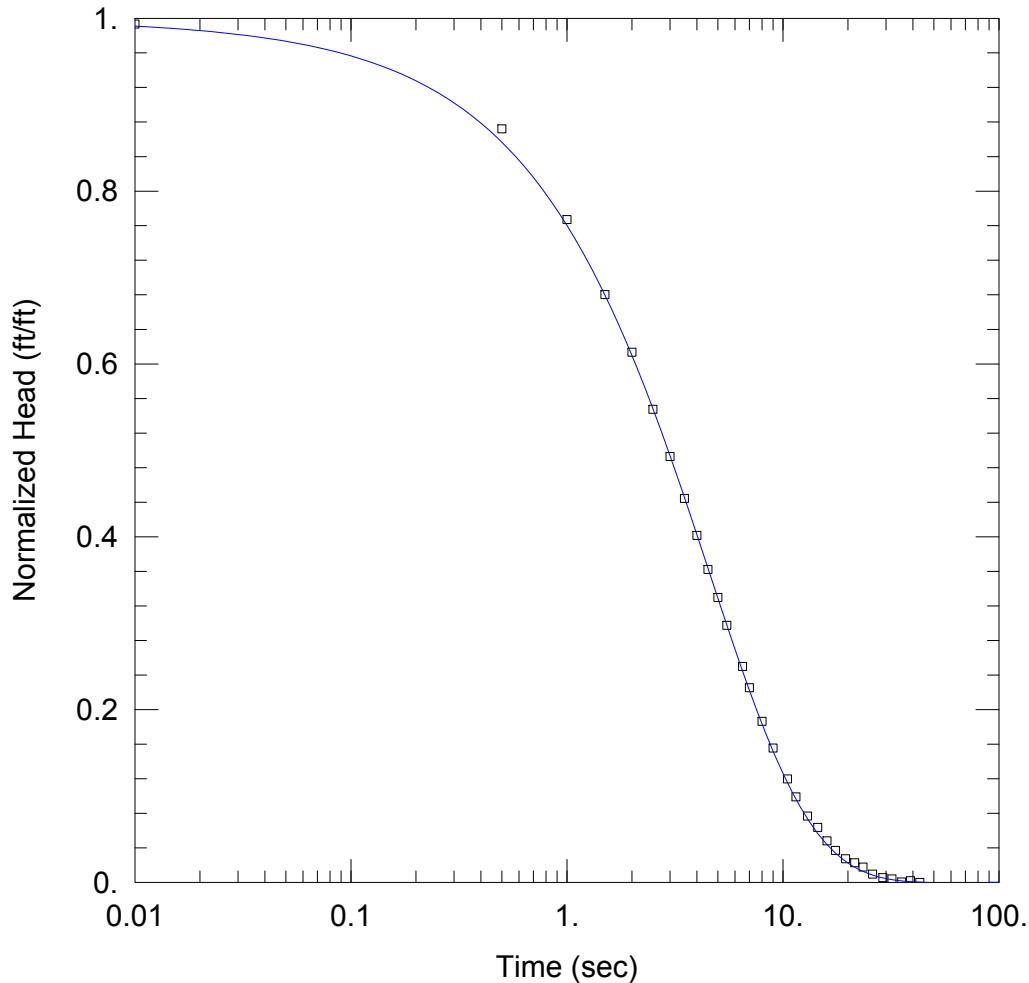
# Slug Test Analysis Result for JHC MW-15015 - Test 3

Prepared By:  
**Arcadis**

Prepared For:  
**Consumer Energy**

Project:

Location:  
**West Olive, MI**



## SOLUTION

Aquifer Model: Unconfined  
Solution Method: KGS Model

Kr = 21. ft/day      Ss = 1.9E-5 ft<sup>-1</sup>  
Kz/Kr = 1.

## 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

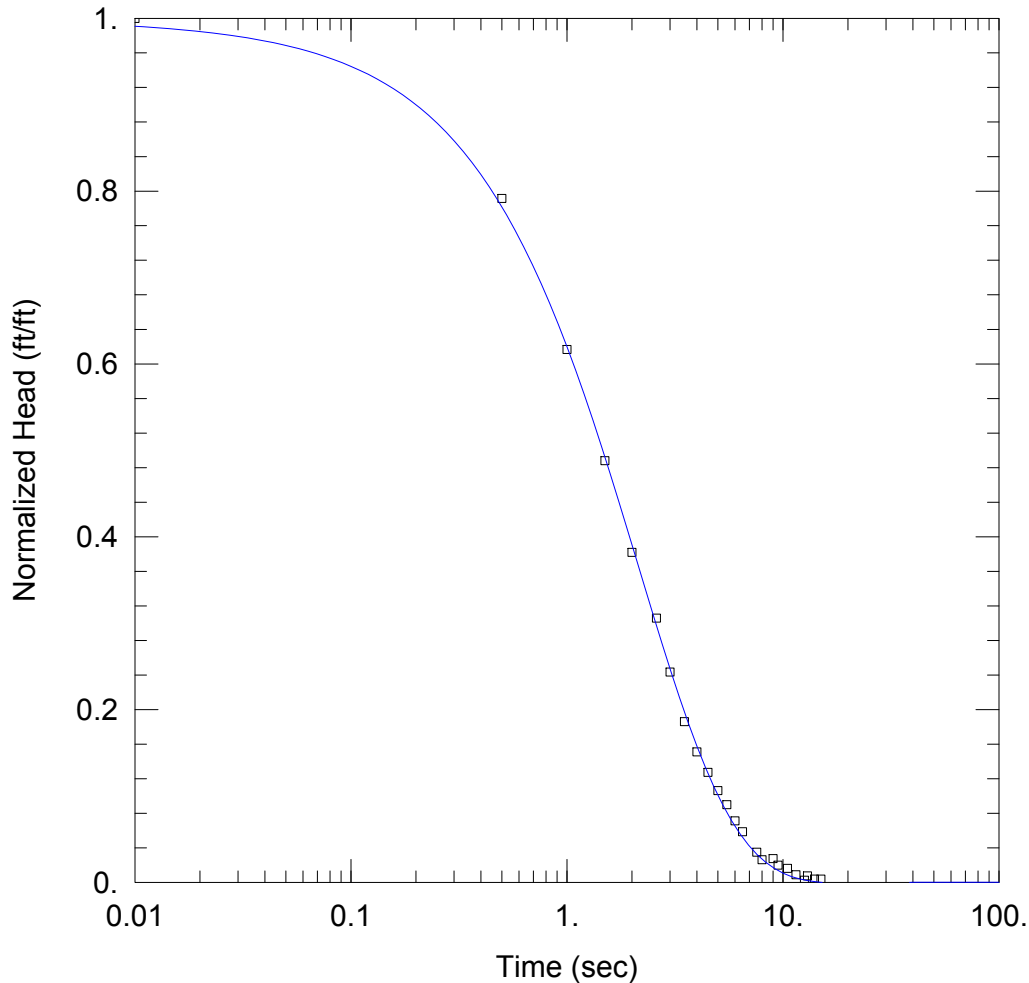
# Slug Test Analysis Result for JHC MW-15024 - Test 2

Prepared By:  
**Arcadis**

Prepared For:  
**Consumer Energy**

Project:

Location:  
**West Olive, MI**



## SOLUTION

Aquifer Model: Unconfined  
Solution Method: KGS Model

Kr = 49. ft/day      Ss = 9.8E-6 ft<sup>-1</sup>  
Kz/Kr = 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



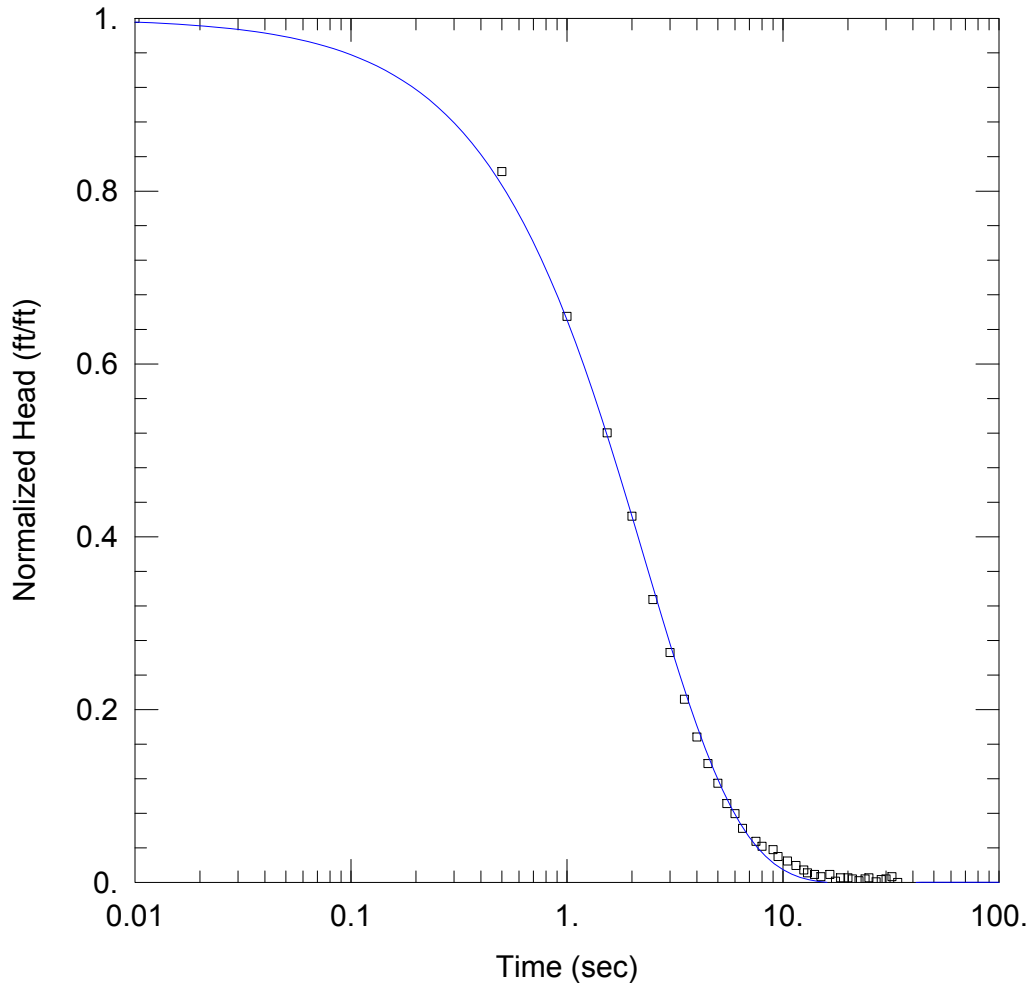
# Slug Test Analysis Result for JHC MW-15024 - Test 3

Prepared By:  
**Arcadis**

Prepared For:  
**Consumer Energy**

Project:

Location:  
**West Olive, MI**



## SOLUTION

Aquifer Model: Unconfined  
Solution Method: KGS Model

Kr = 45. ft/day      Ss = 5.05E-12 ft<sup>-1</sup>  
Kz/Kr = 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

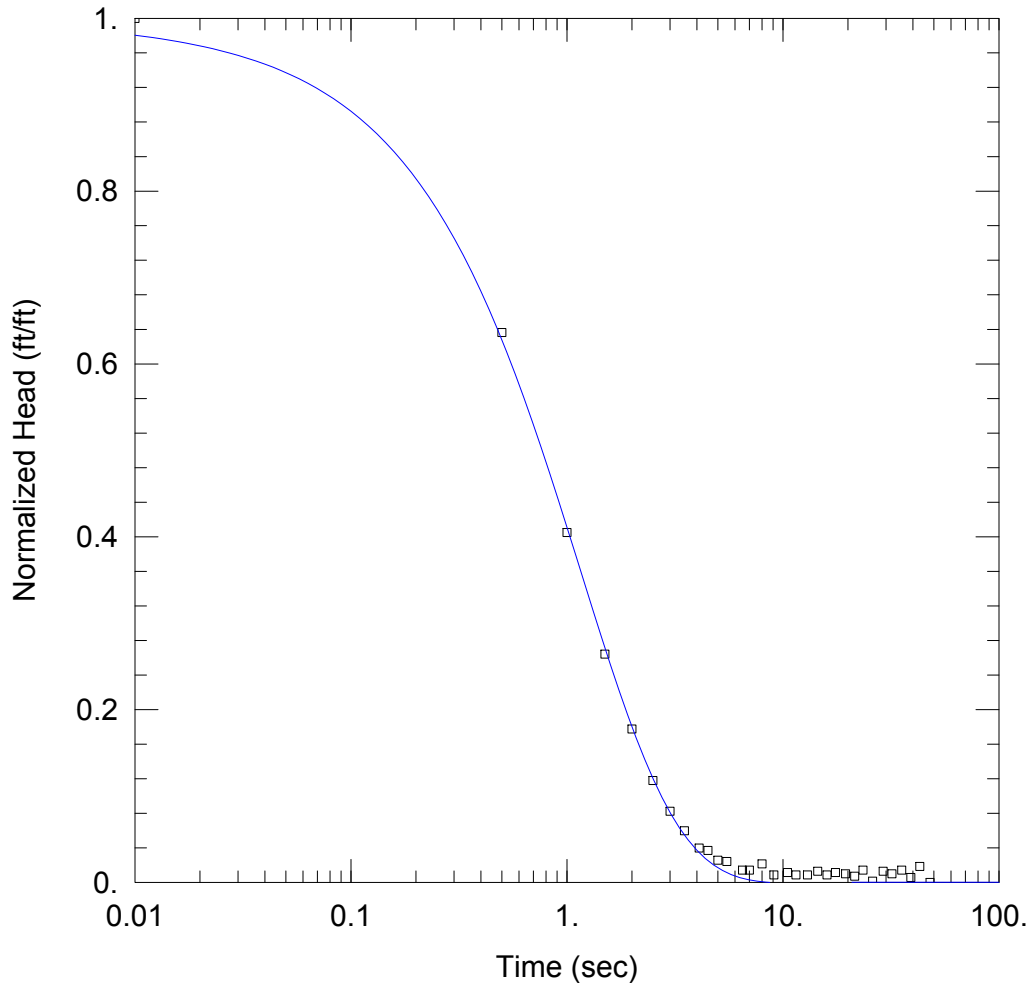
# Slug Test Analysis Result for JHC MW-15028 - Test 1

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<sup>-1</sup>  
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

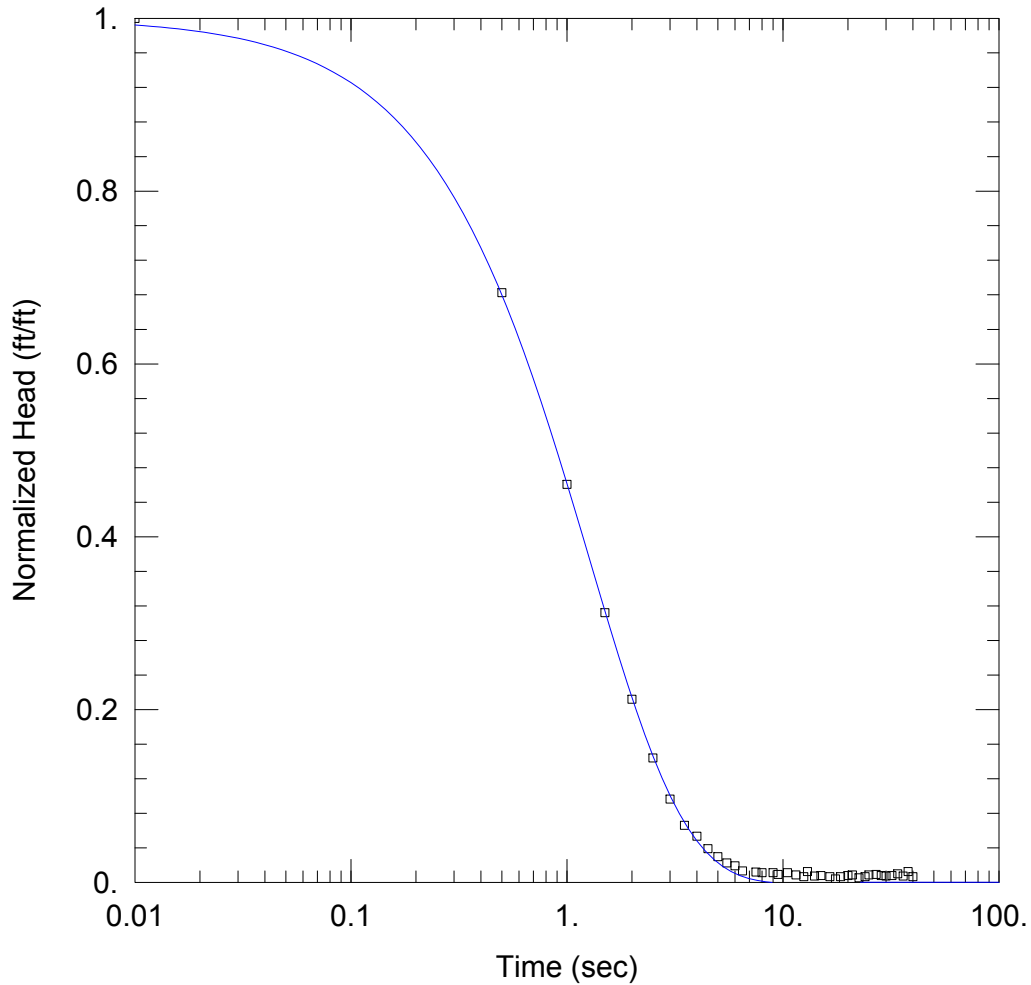
# Slug Test Analysis Result for JHC MW-15028 - Test 3

Prepared By:  
**Arcadis**

Prepared For:  
**Consumer Energy**

Project:

Location:  
**West Olive, MI**



## SOLUTION

Aquifer Model: Unconfined  
Solution Method: KGS Model

Kr = 86. ft/day      Ss = 5.05E-12 ft<sup>-1</sup>  
Kz/Kr = 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



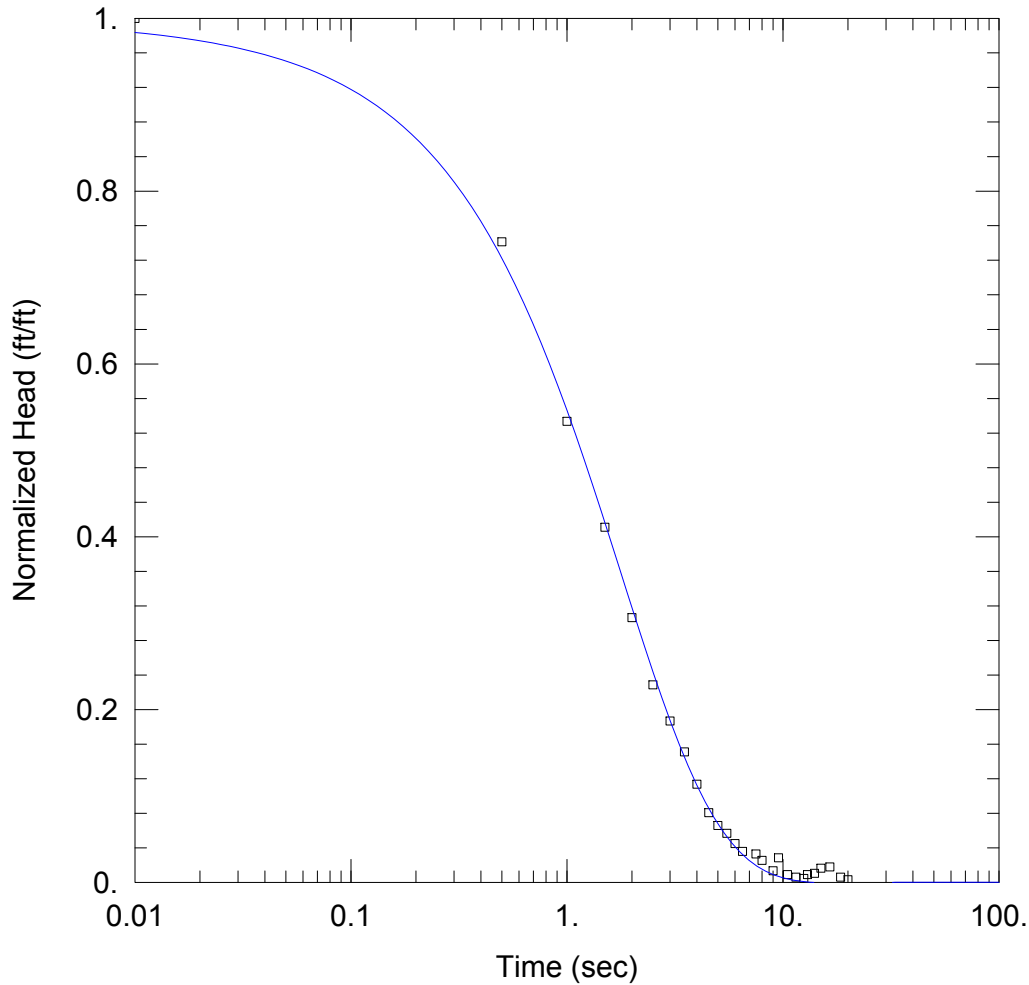
# Slug Test Analysis Result for JHC MW-15033 - Test 2

Prepared By:  
**Arcadis**

Prepared For:  
**Consumer Energy**

Project:

Location:  
**West Olive, MI**



## SOLUTION

Aquifer Model: Unconfined  
Solution Method: KGS Model

Kr = 74. ft/day      Ss = 5.3E-5 ft<sup>-1</sup>  
Kz/Kr = 1.

## AQUIFER DATA

Saturated Thickness: 29.83 ft

## WELL DATA (JHC MW-15033)

Initial Displacement: 0.669 ft  
Static Water Column Height: 5.83 ft  
Total Well Penetration Depth: 5.83 ft  
Screen Length: 5.83 ft  
Casing Radius: 0.083 ft  
Well Radius: 0.33 ft



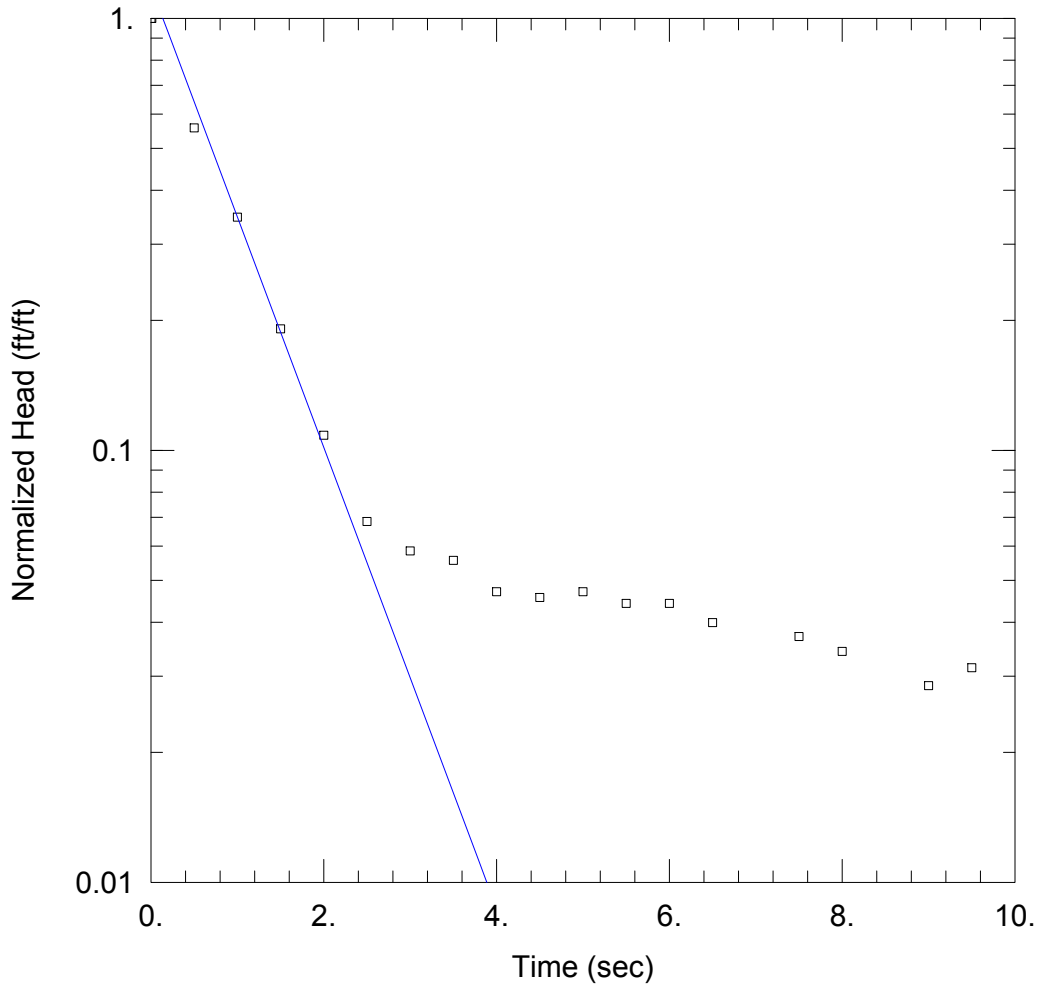
# Slug Test Analysis Result for JHC MW-15030 - Test 2

Prepared By:  
**Arcadis**

Prepared For:  
**Consumer Energy**

Project:

Location:  
**West Olive, MI**



## SOLUTION

Aquifer Model: Confined  
 Solution Method: Bouwer-Rice  
 K = 100 ft/day                      y0 = 0.83 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



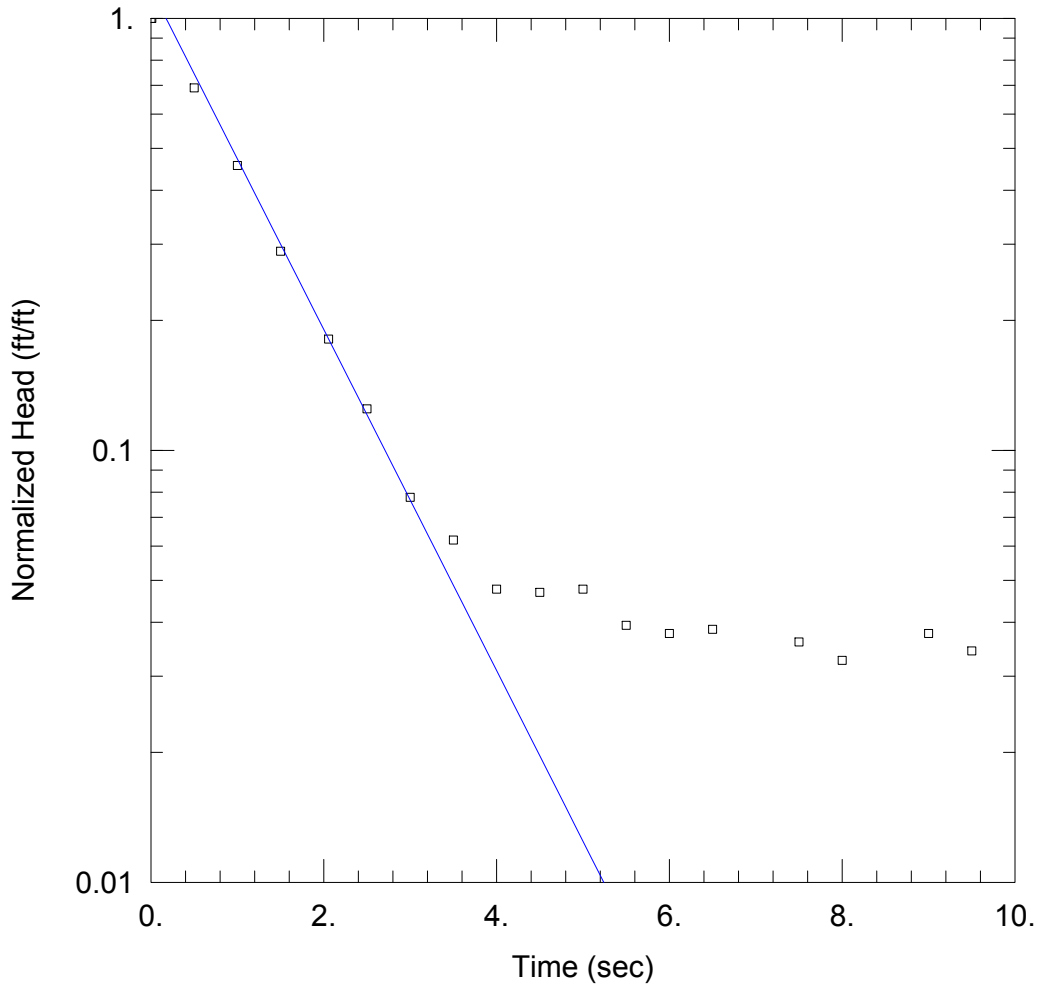
# Slug Test Analysis Result for JHC MW-15030 - Test 3

Prepared By:  
**Arcadis**

Prepared For:  
**Consumer Energy**

Project:

Location:  
**West Olive, MI**



## SOLUTION

Aquifer Model: Confined  
 Solution Method: Bouwer-Rice  
 K = 87 ft/day                      y0 = 1.4 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



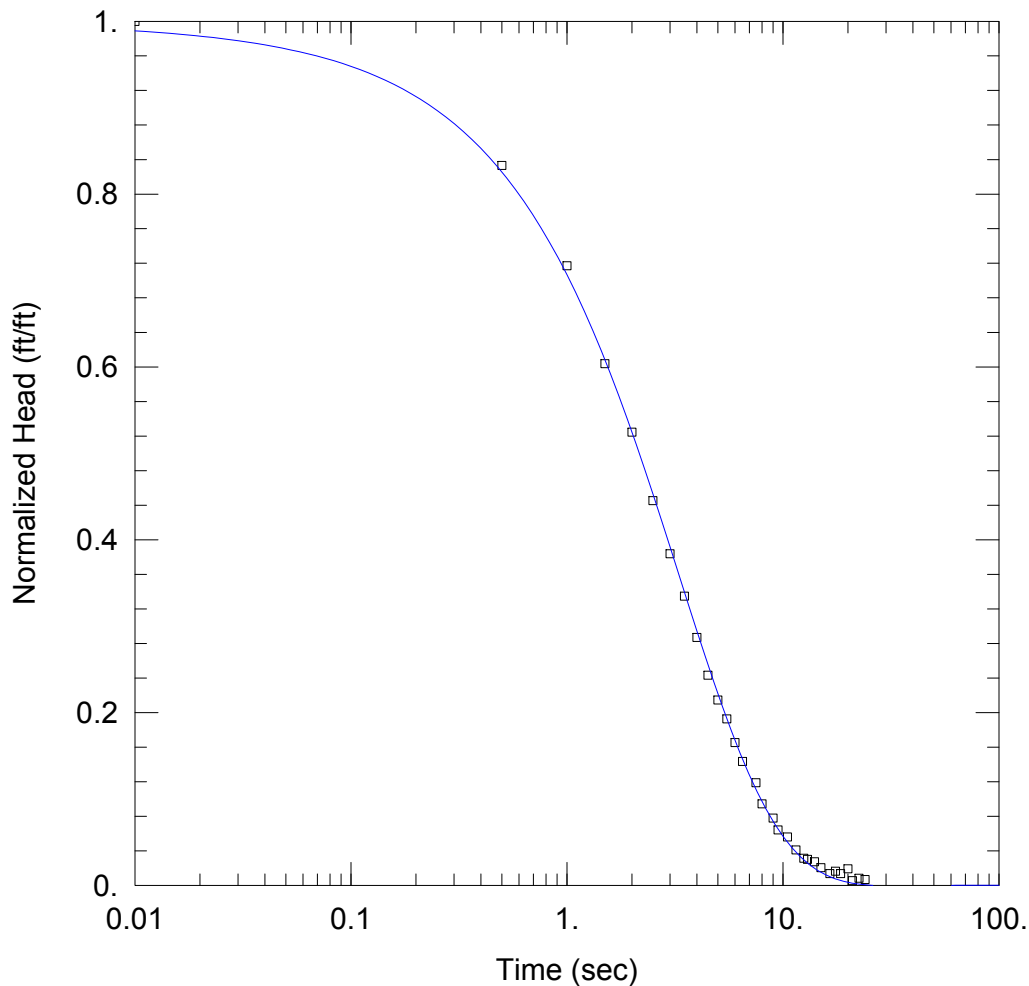
# Slug Test Analysis Result for JHC MW-15018 - Test 1

Prepared By:  
**Arcadis**

Prepared For:  
**Consumer Energy**

Project:

Location:  
**West Olive, MI**



## SOLUTION

Aquifer Model: Unconfined  
Solution Method: KGS Model

Kr = 34. ft/day      Ss = 4.0E-5 ft<sup>-1</sup>  
Kz/Kr = 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

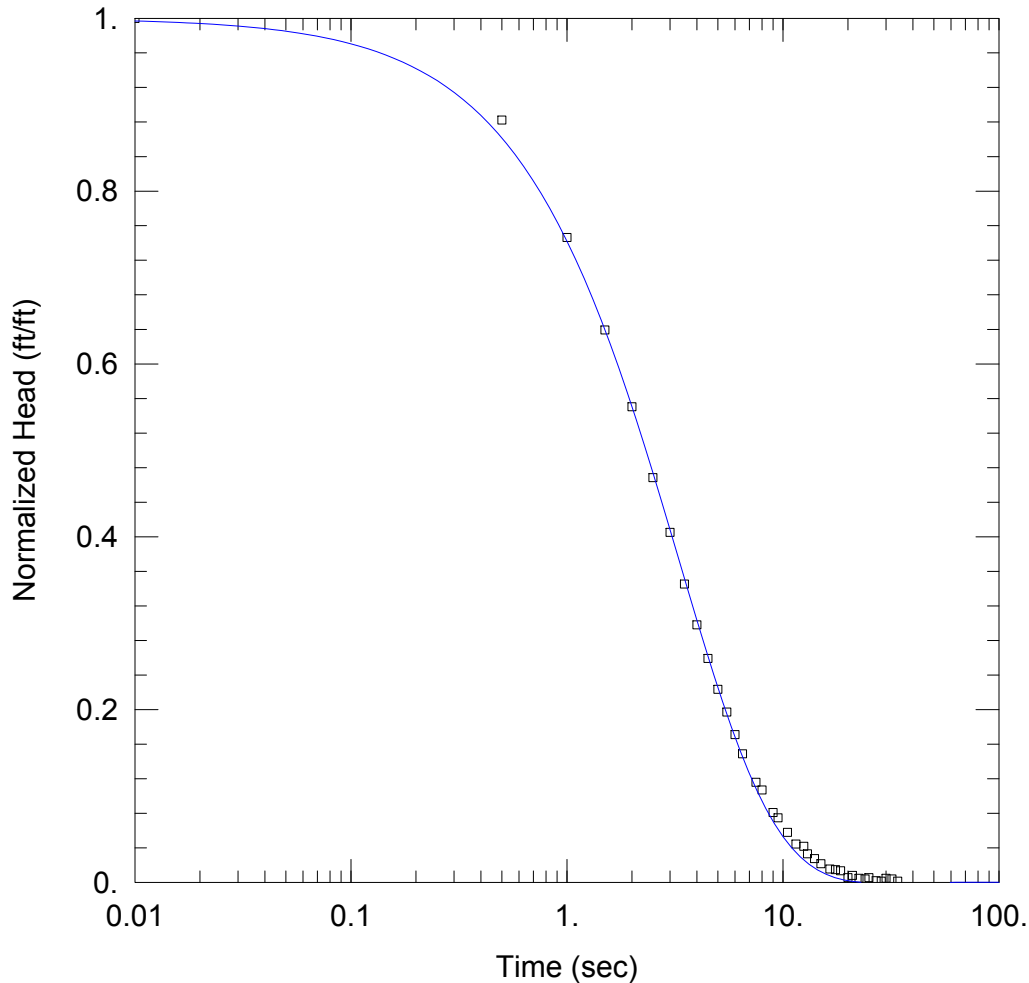
# Slug Test Analysis Result for JHC MW-15018 - Test 3

Prepared By:  
**Arcadis**

Prepared For:  
**Consumer Energy**

Project:

Location:  
**West Olive, MI**



## SOLUTION

Aquifer Model: Unconfined  
Solution Method: KGS Model

Kr = 33. ft/day      Ss = 6.2E-12 ft<sup>-1</sup>  
Kz/Kr = 1.

## AQUIFER DATA

Saturated Thickness: 36.5 ft

## WELL DATA (JHC MW-15018)

Initial Displacement: 1.486 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



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