

**2017 ANNUAL GROUNDWATER  
MONITORING AND CORRECTIVE  
ACTION REPORT  
FEDERAL CCR RULE**

**BRANDYWINE ASH MANAGEMENT FACILITY  
PHASE II, BRANDYWINE, MARYLAND**

**GenOn MD Ash Management LLC**  
25100 Chalk Point Road  
Aquasco, Maryland 20608



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Prepared by:

Geosyntec Consultants, Inc.  
10211 Wincopin Circle  
4<sup>th</sup> Floor  
Columbia, Maryland 21044

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## 1. INTRODUCTION

The Federal Coal Combustion Residuals (CCR) Rule (40 Code of Federal Regulations [CFR] Part 257.90(e)) (USEPA, 2015) requires owners and or operators of existing CCR landfills to prepare a Groundwater Monitoring and Corrective Action Report (Report) no later than 31 January 2018. Geosyntec Consultants (Geosyntec) has prepared this Report for Phase II at the Brandywine Ash Management Facility in Brandywine, Maryland (Site). This Report summarizes the groundwater monitoring activities conducted pursuant to the CCR Rule through December 31, 2017

## 2. SITE DESCRIPTION

### 2.1 Site Description

The Site is located in Brandywine, Prince George's County, Maryland (**Figure 1**) and is operated by GenOn MD Ash Management LLC (MD Ash). The Site is a dry ash management operation and does not have CCR surface impoundments (SI) as defined in the CCR Rule. The Site encompasses 217 acres of which approximately 29 acres have been used to manage CCR at landfill Phase II. Phase I, Historical Area 1, and Historical Area 2 are located adjacent to Phase II, are inactive, and therefore are not regulated by the Federal CCR Rule. Phase II was constructed with a geosynthetic bottom liner and associated leachate collection system that directs leachate to Pond 006, located directly to the east. Non-contact storm water runoff is directed away from Phase II through perimeter ditches. In addition to leachate, Pond 006 is used to manage contact storm water. Pond 006 is exempt from the Federal CCR Rule. Features of the Site and their locations are presented on **Figure 2**.

### 2.2 Regional Physiographic Setting

The Site is located on the Atlantic Coastal Plain province of Maryland and was previously used for sand and gravel mining operations. The sand and gravel unit is the upper aquifer at the Site as defined in the CCR Rule. A regional aquitard (the Calvert Formation) underlies the sand and gravel.

Regional groundwater flow in the upper aquifer in the site vicinity is to the north/northeast toward the Mataponi Creek which is incised into the Calvert Formation confining unit and is considered to be the discharge location for shallow groundwater above the Calvert Formation confining unit. Groundwater flow directions are locally variable and are influenced by nearby tributaries to Mataponi Creek that are localized groundwater discharge zones.

## 3. GROUNDWATER MONITORING SYSTEM

This section describes the groundwater monitoring well network for the CCR Rule at Phase II. This network utilizes some monitoring wells initially installed as part of a separate site-wide hydrogeologic investigation as well as additional wells installed explicitly for the CCR Rule. As

described in the *Basis for Groundwater Monitoring Network* (Geosyntec, 2017a), the groundwater monitoring network around Phase II was designed to comply with 40 CFR 257.91.

Groundwater quality is monitored around Phase II through a network of seven monitoring wells (**Figure 2**).

Background groundwater quality is monitored through four monitoring wells (B34, B35, B36, and B41). These background locations were selected in consultation with Maryland Department of Environment (MDE) under a separate regulatory program. Monitoring well construction and soil boring logs were provided in *Basis for Groundwater Monitoring Network* (Geosyntec, 2017a). Compliance and background monitoring well construction details are summarized in **Table 1**.

#### **4. CCR RULE GROUNDWATER KEY ACTIVITIES COMPLETED (2015 – 2017)**

##### **4.1 Monitoring Well Installation**

Seven permanent compliance groundwater monitoring wells (B15S, B16, B26, B27, B37, B38, and B39) and four permanent background groundwater monitoring wells (B34, B35, B36, and B41) were installed at the Site between June 2015 and September 2016 using either a Geoprobe 8140 or Fraste XL 250 Max track-mounted drill rigs. An 8-inch diameter sonic core barrel was utilized to install the eleven new soil borings. Continuous core samples were obtained at each monitoring well location in order to log the geology.

In general, the monitoring wells were installed above the Calvert Formation. In February 2016, hydraulic testing was conducted in a select number of new monitoring wells. Hydraulic slug testing utilized a removable slug and pressure transducer to measure the hydraulic conductivity of the upper aquifer material surrounding the monitoring well screen. Calculated hydraulic conductivity data for the screened intervals were used in **Appendix A** herein to estimate the groundwater flow velocity at the Site.

New monitoring wells were constructed inside each borehole using 10-feet of 2-inch diameter 0.01-inch machine slotted Schedule 40 poly vinyl chloride (PVC) screen and 2-inch diameter PVC riser pipe. A #2 Filpro® sand pack was installed around each screen and extended two to three feet above the top of the screen. A minimum 2-foot thick bentonite chip seal was installed over the sand pack. The bentonite was allowed to swell for approximately one hour before grouting the overlying well annulus. The grout mixture consisted of 95 pounds sulfate resistant Type V Portland cement, five pounds bentonite powder, and five to six gallons of water. The borehole was pressure grouted from the bottom to the top via a tremie pipe lowered to the top of the bentonite seal. Final well construction details are included in the *Basis for Groundwater Monitoring Network* (Geosyntec, 2017a) and are summarized in **Table 1**.

Each monitoring well was developed using a “purge and surge” method following installation to reduce turbidity and to enhance communication between the well screen, filter pack, and the surrounding aquifer. The well was surged periodically using a surge block during the development

process while an electric submersible pump was used to remove suspended sediments from within the well. The field scientist monitored the development process and recorded turbidity and water quality measurements during development.

The monitoring system was certified by a Professional Engineer (P.E.) as meeting the performance standard in the 40 CFR 257.91(a) (Geosyntec, 2017a).

## **4.2 Sampling and Analysis Plan**

A Sampling and Analysis Plan (SAP) was prepared for the Baseline Monitoring Program and the Detection Monitoring Program prior to collection of any groundwater samples (Geosyntec, 2015). The SAP was posted to the operating record. The SAP documents the monitoring locations, sample collection and analysis protocol, and the quality assurance protocol employed.

## **4.3 Groundwater Monitoring**

Baseline groundwater monitoring was conducted on a quarterly basis and Detection Monitoring has begun on a semi-annual basis at the Site using the monitoring well network consisting of seven compliance monitoring wells and four background monitoring wells. Groundwater monitoring was conducted in accordance with the *Sampling and Analysis Plan* (SAP) provided in Geosyntec (2015). As shown in **Table 2**, there were eight baseline monitoring program events (September 2015 through April 2017 at most wells) and one detection monitoring program event (October 2017). Well B15S and B26 were not yet installed when the first monitoring event was completed. Therefore, an additional monitoring event was completed in July 2017 at those two wells. New background wells were added to the program at the end of 2016 and monthly monitoring was completed at those wells through August 2017 to generate eight baseline rounds at those wells.

### *4.3.1 Groundwater Elevation and Flow Velocities*

Groundwater elevation monitoring commenced in August 2015. A synoptic round of water level measurements was made in the monitoring wells prior to each monitoring event. Groundwater elevation measurements were collected in accordance with the SAP. Potentiometric surface maps based on the elevations measured during the August 2015 through January 2017 monitoring events are presented on **Figures 3 through 9**. Groundwater elevation data are summarized in **Table 3**. **Figure 3 through Figure 9** show groundwater under the eastern half of Phase II flows from west to east but the groundwater gradient is very low under the western half of Phase II and therefore the groundwater flow directions is uncertain at this time. The groundwater elevations and flow directions are very stable among the various monitoring events. It should be noted that a potentiometric surface map was not generated for the April 2017 and October 2017 groundwater monitoring events because only the monitoring wells around Phase II were measured for depth to water and the other Site-wide water levels were not collected.

As shown in **Appendix A** and on **Figures 3 through 9**, the average hydraulic gradient around Phase II ranged from 0.025 ft/ft between monitoring wells B16 and B28 to 0.00237 ft/ft between

monitoring wells B16 and B29. **Table A-1** shows groundwater flow velocities at the Site ranged from  $1.42 \times 10^{-4}$  centimeters per second (cm/sec) (147 inches/month; 147 feet/year) between monitoring wells B16 and B28 to  $3.72 \times 10^{-6}$  cm/sec (3.85 inches/month; 3.85 feet/year) between monitoring wells B26 and B27.

#### 4.3.2 Baseline Monitoring Program

As shown in **Table 2**, the Baseline Monitoring Program began in August 2015 and continued through August 2017. Most monitoring wells were sampled eight times during the baseline sampling period.

In accordance with 40 CFR 257.94(b), groundwater samples collected during the Baseline Monitoring Program were analyzed for 40 CFR 257 Appendix III and Appendix IV list parameters. Analytical results are presented in **Tables 4** through **7**

Background groundwater samples collected during the Baseline Monitoring Program were used to calculate statistical estimates of the range of background concentrations for Appendix III list constituents. The background concentration for each constituent was derived from the aggregated background dataset (i.e., combined background wells B34, B35, B36, and B40). A parametric upper prediction limit (UPL) was calculated for normally distributed constituents (chloride, pH, and total dissolved solids) of the background dataset using 95% parametric prediction limit (EPA Unified Guidance, 2009). Per the Unified Guidance (USEPA, 2009), the maximum detected background value in each dataset was selected as the UPL for nonparametric datasets. The calculated background concentrations for Appendix III list constituents are presented in **Table 8**.

#### 4.3.3 Detection Monitoring Program

In October 2017, the first Detection Monitoring Program event was conducted. In accordance with 40 CFR 257.94(a) of the CCR Rule, samples were analyzed for Appendix III list parameters only. Prior to sampling, a synoptic round of groundwater measurements was collected from the compliance and background monitoring wells. Groundwater elevation data are presented in **Table 3**. Analytical results are summarized in **Tables 9** and **10**.

### 4.4 Data Usability

Upon receipt of laboratory analytical reports, the data were evaluated for usability. Analytical data were checked for the following:

- Samples were analyzed within the method specified hold times;
- Samples were received within holding temperature;
- The chain of custody was complete;
- Precision was within SAP control limits using relative percent differences of blind duplicate samples;

- Matrix spike and matrix spike duplicate recoveries and laboratory control samples were within the SAP control limits; and
- Potential for positive bias was evaluated using method blanks concentrations.

Upon completion of the data usability assessment the data were qualified as needed and added to the data tables. Some of the initial Baseline Monitoring Program results at the background wells were not used to calculate the estimated range of background concentrations. Those censored results are identified by shading on **Table 4** and **Table 5**. These data were identified as high-end outliers and were associated with higher turbidity and suspended solids in the initial samples from these wells compared to the other Baseline Monitoring Program background samples. All other data received were considered complete and usable.

#### **4.5 Selection of Background Statistical Methods**

The baseline monitoring data from the four background wells were used to select statistical methods for calculating the range of background concentrations for Appendix III parameters. The resulting background concentrations are summarized in **Table 8** based upon upper prediction limit (UPL) methods. The calculations are documented and certified by a P.E. as being appropriate for the background data set in Geosyntec (2017b).

### **5. DETECTION MONITORING STATISTICS**

In accordance with 40 CFR 257.93(b)(2), detection monitoring statistics were not required to be evaluated until the first quarter of 2018 (i.e. within 90 days after completion of sampling and analysis) and therefore are not included in this report. Detection monitoring statistics will be calculated in the required timeframe and included in the next annual report.

### **6. ASSESSMENT MONITORING STATISTICS**

The Site is not in Assessment Monitoring.

### **7. PROBLEMS ENCOUNTERED AND RESOLUTIONS**

The following section discusses problems encountered during the Baseline Monitoring Program and the first Detection Monitoring Program event. Additionally, this section discusses the resolutions to those problems encountered.

**Problem 1:** CCR constituents were potentially present in the groundwater samples from proposed background monitoring wells B15S and B26. Under another regulatory program, MDE did not consider B15S and B26 to be clearly representative of background conditions.

**Resolution 1:** New background monitoring wells locations were identified in consultation with MDE under another regulatory program. In September 2016, monitoring wells B40 and B41 were installed at off-site locations that were hydraulically separated from the Site (see **Figure 2**).



Additionally, a review of groundwater quality data indicated monitoring wells B34, B35, and B36 as potential background locations and based upon the data available at that time MDE concurred. Based on those data, monitoring wells B34, B35, B36, B40, and B41 were used as background groundwater monitoring wells.

**Problem 2:** Due to the selection of new potential background monitoring wells (B34, B35, B36, B40, and B41) the minimum number of baseline samples would not be met at a quarterly groundwater sampling frequency.

**Resolution 2:** The groundwater sampling schedule for new potential background monitoring wells was accelerated to monthly sampling. Starting in October 2016 monitoring wells B40 and B41 were sampled monthly through August 2017 and in March 2017 monitoring wells B34, B35, and B36 were sampled monthly through August 2017. Ultimately eight samples were collected from each new potential background monitoring well.

**Problem 3:** Outliers in the background groundwater concentrations were observed during the statistical evaluation of the background data set in monitoring wells B36, B40 and B41. Review of the data indicated higher turbidity and suspended solids in those samples.

**Resolution 3:** The suspect data were censored from the background data set used to select statistical methods and to calculate the range of background concentrations (see Geosyntec, 2017b).

## **8. STATUS OF MONITORING PROGRAM**

In October 2017, the Site transitioned from baseline monitoring to detection monitoring. The Site was in the baseline monitoring program from September 2015 through August 2017.

## **9. PLANNED KEY ACTIVITIES FOR 2018**

The following section discusses the planned activities for 2018.

**January 2018:** The 2017 Annual Groundwater Monitoring and Corrective Action Report will be entered into the facility's operating record and notification will be sent to the Maryland Department of Environment (MDE).

**January 2018:** Testing of the October 2017 Detection Monitoring Program sample results for a statistically significant increase (SSI) over background will be completed.

**February 2018:** The 2017 Annual Groundwater Monitoring and Corrective Action Report will be posted to the public internet site.

**April 2018:** The first 2018 semi-annual groundwater Detection Monitoring Program event will be conducted.

**August 2018:** Testing of the April 2018 Detection Monitoring Program sample results for a SSI over background will be completed.

**October 2018:** The second 2018 semi-annual groundwater Detection Monitoring Program event will be conducted.

**December 2018:** Preparation of the 2018 Annual Groundwater Monitoring and Corrective Action Report will begin.

## **10. REFERENCES**

Driscoll, F.G., 1986. Groundwater and Wells, Second Edition. St. Paul, Minnesota, H.M. Smyth Company.

Geosyntec Consultants, Inc., 2015. Sampling and Analysis Plan, Brandywine Ash Management Facility, Brandywine Maryland, September.

Geosyntec Consultants, Inc., 2017a. Basis for Groundwater Monitoring Network, Brandywine Ash Management Facility, Brandywine, Maryland, October.

Geosyntec Consultants, Inc. 2017b. Statistical Analysis Calculations Package for Background Groundwater - Cell B, Brandywine Ash Storage Facility, Brandywine, MD

U.S. EPA, 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities - Unified Guidance. March.

U.S. EPA, 2015. Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities (Final Rule). Fed. Reg. 80 FR 21301, pp. 21301-21501, 40 CFR Parts 257 and 261, April.

# TABLES

**TABLE 1  
WELL CONSTRUCTION DETAILS**

**FEDERAL CCR RULE - 2017 ANNUAL GROUNDWATER AND CORRECTIVE ACTION REPORT  
Brandywine Facility Phase II - MD**

Well ID	Compliance / Background	Permit Number	Installation Date	Northing feet Maryland State Plane 1900 NAD 1983	Easting feet Maryland State Plane 1900 NAD 1983	Ground Surface Elevation (ft msl)	Top of Casing Elevation (ft msl)	Inner Casing Diameter (inches)	Top of Sand Pack (ft bgs)	Screen Interval (ft bgs)	Screen Length (feet)	Screen Slot Size (inch)
B15S	Compliance	PG-11-0414	10/20/2015	376978.815	1368413.012	212.71	214.95	2	6	7.75 - 17.75	10	0.01
B16	Compliance	PG-11-0431	6/2/2015	378557.6383	1368348.641	233.73	236.11	2	23.5	24.75 - 34.75	10	0.010
B26	Compliance	PG-11-0416	10/21/2015	377144.555	1367902.054	216.00	218.41	2	14	16.75 - 26.75	10	0.01
B27	Compliance	PG-11-0417	6/3/2015	377411.8764	1369043.668	212.05	214.77	2	13	14.75 - 24.75	10	0.010
B34	Background	PG-11-0437	6/9/2015	378729.3841	1369777.659	212.73	215.34	2	8	10.00 - 20.00	10	0.010
B35	Background	PG-11-0438	6/9/2015	379488.9853	1369866.212	204.31	206.82	2	5	7.00 - 17.00	10	0.010
B36	Background	PG-11-0439	6/18/2015	380323.7961	1369560.447	204.25	206.68	2	7.6	9.75 - 19.75	10	0.010
B37	Compliance	PG-11-0461	8/12/2015	377761.92	1367808.354	220.29	220.00 [1]	2	17.5	19.75 - 29.75	10	0.010
B38	Compliance	PG-11-0460	8/12/2015	378210.411	1368043.469	233.59	233.27	2	27.5	29.75 - 39.75	10	0.010
B39	Compliance	PG-11-0462	8/10/2015	378222.643	1368948.299	200.56	202.71	2	8.5	10.75 - 20.75	10	0.010
B41	Background	PG-14-0171	9/16/2016	377307.030	1369709.911	209.00	211.50 [1]	2	18	20.00 - 30.00	10	0.010

Notes:

ft msl feet above mean sea level

ft bgs feet below ground surface

Professional land survey performed week of 19 October 2015 by Ben Dyer and Associates, Inc.

[1] Elevation is an estimated value

**TABLE 2  
SUMMARY OF 2015-2017 MONITORING EVENTS**

**FEDERAL CCR RULE - 2017 ANNUAL GROUNDWATER AND CORRECTIVE ACTION REPORT  
Brandywine Facility Phase II - MD**

Monitoring Program: Monitoring Event: Sample Date: Well ID	Baseline Monitoring																				
	3Q 2015			4Q 2015			1Q 2016			2Q 2016			3Q 2016			4Q 2016			1Q 2017		
	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Jan-17	Feb-17	Mar-17
<b>Background Wells</b>																					
B34												III,IV [1,2]					III,IV	III,IV		III,IV	
B35												III,IV [1,2]					III,IV	III,IV	III,IV		
B36												III,IV [1,2]					III,IV	III,IV		III,IV	
B41												[4]			III,IV [1,2]	[3]	III,IV [1]		III,IV [1,2]	III,IV	
<b>Compliance Wells</b>																					
B15S		[4]			III,IV		III,IV		III,IV			III,IV			III,IV			III,IV			
B16		III,IV [2]			III,IV		III,IV		III,IV			III,IV			III,IV			III,IV	III,IV [1]		
B26		[4]			III,IV		III,IV		III,IV			III,IV			III,IV			III,IV			
B27		III,IV			III,IV		III,IV		III,IV			III,IV			III,IV			III,IV			
B37		III,IV			III,IV		III,IV		III,IV			III,IV			III,IV			III,IV		III,IV	
B38		III,IV			III,IV		III,IV		III,IV			III,IV			III,IV			III,IV		III,IV	
B39		III,IV			III,IV		III,IV		III,IV			III,IV			III,IV			III,IV		III,IV	

Monitoring Program: Monitoring Event: Sample Date: Well ID	Baseline Monitoring						Total Baseline Sampling Events [5]	Detection Monitoring			Total Detection Sampling Events
	2Q 2017		3Q 2017			4Q 2017					
	Apr-17	May-17	Jun-17	Jul-17	Aug-17	Sep-17		Oct-17	Nov-17	Dec-17	
<b>Background Wells</b>											
B34	III,IV	III,IV	III,IV	III,IV	III,IV		≥8	III			1
B35	III,IV	III,IV	III,IV	III,IV	III,IV		≥8	III			1
B36	III,IV	III,IV	III,IV	III,IV	III,IV		≥8	III			1
B41	III,IV	III,IV	III,IV	III,IV	III,IV		≥6	III			1
<b>Compliance Wells</b>											
B15S	III,IV			III,IV			8	III			1
B16	III,IV						8	III			1
B26	III,IV			III,IV			8	III			1
B27	III,IV						8	III			1
B37	III,IV						8	III			1
B38	III,IV						8	III			1
B39	III,IV						8	III			1

Notes:

- III Groundwater samples collected for laboratory analysis of Appendix III parameters.
- IV Groundwater samples collected for laboratory analysis of Appendix IV parameters.
- [1] Radium was omitted from sampling or the well went dry before sampling of these parameters could be completed.
- [2] Fluoride was omitted from analysis.
- [3] Monitoring well was dry at the time of sampling, no samples were collected.
- [4] Monitoring well not yet installed.
- [5] All background and compliance monitoring wells met the minimum number of samples collected, except for B41. Monitoring well B41 that went dry during went dry during sampling and only a partial sample set was collected over nine sampling events, which resulted in 6 complete sample sets.

**TABLE 3  
GROUNDWATER ELEVATION MEASUREMENTS**

**FEDERAL CCR RULE - 2017 ANNUAL GROUNDWATER AND CORRECTIVE ACTION REPORT  
Brandywine Facility Phase II - MD**

Well ID	Top of Casing Elevation [1] (ft msl)	Depth to Water Measurement Date	Depth to Water (ft btoic)	Groundwater Elevation (ft msl)
B15S	214.95	11/9/2015	13.33	201.62
		1/21/2016	10.61	204.34
		4/12/2016	9.24	205.71
		7/18/2016	10.95	204.00
		10/4/2016	13.50	201.45
		1/25/2017	11.83	203.12
		4/5/2017	11.08	203.87
		7/25/2017	12.95	202.00
B16	236.11	10/23/2017	13.08	201.87
		8/21/2015	28.75	207.36
		11/9/2015	29.08	207.03
		1/21/2016	28.98	207.13
		4/12/2016	28.61	207.50
		7/18/2016	28.79	207.32
		10/4/2016	29.04	207.07
		1/25/2017	29.01	207.10
B26	218.41	4/5/2017	28.78	207.33
		10/23/2017	29.28	206.83
		11/9/2015	14.22	204.19
		1/21/2016	13.41	205.00
		4/12/2016	13.12	205.29
		7/18/2016	13.27	205.14
		10/4/2016	13.72	204.69
		1/25/2017	13.84	204.57
B27	214.77	4/5/2017	13.29	205.12
		7/25/2017	14.02	204.39
		10/23/2017	15.49	202.92
		8/21/2015	20.57	194.20
		11/9/2015	21.45	193.32
		1/21/2016	19.60	195.17
		4/12/2016	19.50	195.27
		7/18/2016	20.33	194.44
B34	215.34	10/4/2016	21.50	193.27
		1/25/2017	20.86	193.91
		4/5/2017	19.86	194.91
		10/23/2017	21.54	193.23
		8/21/2015	15.26	200.08
		11/9/2015	16.31	199.03
		1/21/2016	15.27	200.07
		4/12/2016	14.49	200.85
		7/18/2016	15.08	200.26
		10/4/2016	16.27	199.07
		1/25/2017	16.19	199.15
		3/1/2017	15.91	199.43
		4/5/2017	15.44	199.90
B35	206.82	5/12/2017	15.35	199.99
		6/13/2017	15.32	200.02
		7/25/2017	16.40	198.94
		8/28/2017	15.78	199.56
		10/23/2017	16.61	198.73
		8/21/2015	7.89	198.93
		11/9/2015	8.05	198.77
		1/21/2016	4.50	202.32
		4/12/2016	6.05	200.77
		7/18/2016	6.86	199.96
		10/4/2016	5.30	201.52
		1/25/2017	3.81	203.01
		2/28/2017	5.86	200.96
4/5/2017	4.25	202.57		
5/12/2017	3.81	203.01		
6/13/2017	6.30	200.52		
7/25/2017	8.40	198.42		
8/28/2017	5.33	201.49		
10/23/2017	7.72	199.10		

**TABLE 3  
GROUNDWATER ELEVATION MEASUREMENTS**

**FEDERAL CCR RULE - 2017 ANNUAL GROUNDWATER AND CORRECTIVE ACTION REPORT  
Brandywine Facility Phase II - MD**

Well ID	Top of Casing Elevation [1] (ft msl)	Depth to Water Measurement Date	Depth to Water (ft btoic)	Groundwater Elevation (ft msl)
B36	206.68	8/21/2015	18.12	188.56
		11/9/2015	19.31	187.37
		1/21/2016	18.93	187.75
		4/12/2016	17.60	189.08
		7/18/2016	18.21	188.47
		10/4/2016	19.17	187.51
		1/25/2017	19.97	186.71
		2/28/2017	19.53	187.15
		4/5/2017	19.29	187.39
		5/12/2017	19.65	187.17
		6/13/2017	18.46	188.22
		7/25/2017	19.71	186.97
8/28/2017	19.29	187.39		
10/23/2017	19.14	187.54		
B37	220.00	8/21/2015	12.21	207.79
		11/9/2015	12.92	207.08
		1/21/2016	13.20	206.80
		4/12/2016	13.34	206.66
		7/18/2016	12.07	207.93
		10/4/2016	12.85	207.15
		1/25/2017	12.70	207.30
		4/5/2017	12.42	207.58
		10/23/2017	12.74	207.26
		8/21/2015	26.03	207.24
B38	233.27	11/9/2015	26.13	207.14
		1/21/2016	26.02	207.25
		4/12/2016	25.54	207.73
		7/18/2016	25.59	207.68
		10/4/2016	26.08	207.19
		1/25/2017	26.13	207.14
		4/5/2017	26.02	207.25
		10/23/2017	26.20	207.07
B39	202.71	8/21/2015	12.13	190.58
		11/9/2015	10.73	191.98
		1/21/2016	10.31	192.40
		4/12/2016	10.66	192.05
		7/18/2016	11.40	191.31
		10/4/2016	10.60	192.11
		1/25/2017	10.98	191.73
		4/5/2017	10.48	192.23
		10/23/2017	10.43	192.28
B41	211.5	10/12/2016	26.89	184.61
		11/7/2016	28.40	183.10
		12/7/2016	27.50	184.00
		1/25/2017	28.01	183.49
		2/28/2017	28.19	183.31
		4/5/2017	27.75	183.75
		5/12/2017	26.99	184.51
		6/13/2017	26.39	185.11
		7/26/2017	27.07	184.43
		8/28/2017	27.05	184.45
10/23/2017	27.54	183.96		

Notes:

ft bgs feet below ground surface

ft msl feet above mean sea level

ft btoic feet below top of inner case

NM Not measured

[1] Top of casing elevations for B37 and B41 are estimated values based on ground elevation.

**TABLE 4**  
**BASELINE APPENDIX III MONITORING PROGRAM ANALYTICAL DATA - BACKGROUND WELLS**

**FEDERAL CCR RULE - 2017 ANNUAL GROUNDWATER AND CORRECTIVE ACTION REPORT**  
**Brandywine Facility Phase II - MD**

Analyte:		Boron	Calcium	Chloride	Fluoride	pH	Sulfate	TDS
Well ID	Sample Date	µg/L	mg/L	mg/L	mg/L	S.U.	mg/L	mg/L
B34	7/26/2016	16.7 J	0.519	4.6	NS	NS	5.6	38.0
	12/21/2016	<8.3 U	0.497	4.6	<0.25 U	5.6 J	4.9 J	35.5 [2]
	1/27/2017	<8.3 U	0.484	4.7	<0.25 U	4.8 J	5.2	28.5 J
	3/1/2017	<8.3 U	0.474	5.5	<0.25 UJ	5.5	5.6	47.5 [2]
	4/10/2017	<8.3 U	0.447	5.2	<0.25 U	5.4	6.2	37.0
	4/10/2017 [1]	<8.3 U	0.451	5.6	<0.25 U	5.5	5.7	23.5 J
	5/12/2017	<8.3 U	0.410	4.2	<0.25 U	5.6 J	6.8	43.0
	6/13/2017	<8.3 U	0.389	4.6	<0.25 U	5.2	5.8	21.0 J
	7/27/2017	10.5 J	0.421	4.0	<0.25 U	5.2 J	4.9 J	23.0 J
	8/30/2017	11.7 J	0.417	4.7	<0.25 U	5.0	8.2	22.0 J
B35	7/26/2016	<8.3 U	1.83	2.7	NS	NS	8.6	51.5 [2]
	12/20/2016	10.4 J	2.07	2.9	<0.25 U	5.6 J	10.3	43.5 [2]
	1/27/2017	<8.3 U	1.98	3.3	<0.25 U	5.5 J	9.6	36.5
	2/28/2017	10.2 J	2.07	2.5	<0.25 U	5.3	8.8	35.5
	4/10/2017	<8.3 U	2.25	3.0	<0.25 U	5.6	8.5	36.5
	5/12/2017	<8.3 U	1.91	3.6	<0.25 U	5.6 J	9.0	63.0 [2]
	6/13/2017	9.8 J	1.94	3.3	<0.25 U	5.4	7.8	31.0
	7/27/2017	12.7 J	1.92	2.9	<0.25 U	5.6 J	7.3	49.5 [2]
	8/28/2017	12.8 J	1.98	3.8	<0.25 U	5.1	8.5	45.0 [2]
B36	7/26/2016	9.9 J	7.25	8.0	NS	NS	6.0	98.5
	12/21/2016	137 J	32.3	7.6	<0.25 U	4.6 J	20.1	98.5 [2]
	1/31/2017	30.6 J	8.18	8.1	<0.25 U	4.6	20.5	89.0
	3/1/2017	10.0 J	5.23	8.5	<0.25 U	4.8	10.7	114
	4/11/2017	16.2 J	4.87	7.4	<0.25 U	4.6 J	8.2	78.0
	5/15/2017	9.8 J	4.82	8.9	<0.25 U	4.7 J	10.4	94.5
	6/14/2017	10.1 J	4.79	8.0	<0.25 U	4.6	6.9	66.0
	7/31/2017	<10.1 U	4.94	7.9	<0.25 U	4.5 J	7.4	103
	8/30/2017	17.0 J	6.32	7.6	<0.25 U	4.1	18.6	85.0
B41	10/12/2016	40.6 J	19.7	2.8	NS	NS	35.4	143
	11/7/2016	NS	NS	NS	NS	NS	NS	NS
	12/9/2016	89.3 J	47.8	4.4	<0.25 U	NS	5.3	156 [2] J
	2/2/2017	11.5 J	11.6	NS	NS	NS	NS	NS
	3/1/2017 [3]	12.6 J	5.85	4.9	<0.25 U	6.2	5.6	65.0
	4/10/2017	<8.3 U	3.34	5.0	<0.25 U	6.3	2.2 J	121 [2]
	5/15/2017	<8.3 U	4.65	14.1	<0.25 U	6.6 J	5.0	56.0
	6/14/2017	<8.3 U	3.07	5.4	<0.25 U	6.1	2.7 J	34.5
	7/31/2017	<10.1 U	5.14	5.4	<0.25 U	6.3 J	2.6 J	81.5 [2]
	8/30/2017	<10.1 U	2.75	5.7	<0.25 U	6.1	<1.5 U	38.0

## Notes:

µg/L micrograms per Liter

mg/L milligrams per Liter

S.U. Standard Units

J Constituent detected below reportable quantitation limit; result is an estimated value.

U Constituent not detected above method detection limit.

NS Not Sampled, well was dry or went dry before all jars were filled and did not recover within 24-hours

Shaded Data in shaded cells were not used in background calculation.

[1] Duplicate sample collected.

[2] The result is inconsistent with the specific conductivity values recorded at the time of groundwater sampling.

[3] Fluoride sample collected on 2/28/2017.



**TABLE 5**  
**BASELINE APPENDIX IV MONITORING PROGRAM ANALYTICAL DATA - BACKGROUND WELLS**  
**FEDERAL CCR RULE - 2017 ANNUAL GROUNDWATER AND CORRECTIVE ACTION REPORT**  
**Brandywine Facility Phase II - MD**

Well ID	Sample Date	Analyte:	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium (III+VI)	Cobalt	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Radium-226	Radium-228
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L
B34	7/26/2016	<0.48 U	<0.40 U	27.8	0.22 J	<0.19 U	<0.59 U	<1.9 U	NS	0.17 J	5.8 J	<0.050 U	9.1 J	<0.44 U	<0.16 U	NS	NS	
	12/21/2016	<0.48 U	0.60 J	28.5	0.21 J	0.24 J	3.7	<1.9 U	<0.25 U	0.56 J	<4.8 U	<0.050 U	<1.7 U	<0.44 U	<0.16 U	0.511	<1.24 U	
	1/27/2017	<0.48 U	0.50 J	27.0	0.18 J	0.36 J	2.5	2.1 J	<0.25 U	0.33 J	<4.8 U	<0.050 U	<1.7 U	<0.44 U	<0.16 U	1.13	<1.09 U	
	3/1/2017	<0.48 U	0.60 J	29.8	0.21 J	0.21 J	2.5	<1.9 U	<0.25 U	0.63 J	<4.8 U	<0.050 U	2.3 J	<0.44 U	<0.16 U	0.598	<0.535 U	
	4/10/2017	<0.48 U	<0.40 U	28.1	0.20 J	<0.19 U	<0.59 U	<1.9 U	<0.25 U	0.15 J	<4.8 U	<0.050 U	1.7 J	<0.44 U	<0.16 U	<0.326 U	<0.494 U	
	4/10/2017 [1]	<0.48 U	<0.40 U	28.5	0.19 J	<0.19 U	<0.59 U	2.2 J	<0.25 U	0.18 J	<4.8 U	<0.050 U	<1.7 U	<0.44 U	<0.16 U	0.848	<0.449 U	
	5/12/2017	<0.48 U	<0.40 U	28.1	0.20 J	0.20 J	0.83 J	<1.9 U	<0.25 U	0.19 J	<4.8 U	<0.050 U	6.9 J	<0.44 U	<0.16 U	0.785	<0.175 U	
	6/13/2017	<0.48 U	<0.40 U	28.1	0.16 J	0.28 J	<0.59 U	2.2 J	<0.25 U	0.13 J	<4.8 U	<0.050 U	2.5 J	<0.44 U	<0.16 U	1.07	1.89	
	7/27/2017	<0.45 U	<0.40 U	25.1	0.21 J	0.22 J	<0.87 U	2.1 J	<0.25 U	0.14 J	<9.0 U	<0.050 U	<3.4 U	<0.50 U	<0.12 U	<0.284 U	<1.15 U	
8/30/2017	<0.45 U	<0.40 U	26.7	0.20 J	0.20 J	<0.87 U	<1.7 U	<0.25 U	0.41 J	<9.0 U	<0.050 U	<3.4 U	<0.50 U	<0.12 U	1.10	<0.58 U		
B35	7/26/2016	<0.48 U	<0.40 U	35.0	0.24 J	1.0	1.0 J	8.5	NS	0.26 J	<4.8 U	<0.050 U	<1.7 U	<0.44 U	0.22 J	NS	NS	
	12/20/2016	<0.48 U	<0.40 U	43.8	0.28 J	0.94	1.6 J	8.7	<0.25 U	0.31 J	<4.8 U	<0.050 U	2.4 J	<0.44 U	0.18 J	1.37	<1.09 U	
	1/27/2017	<0.48 U	<0.40 U	41.4	0.24 J	1.1	1.4 J	8.7	<0.25 U	0.26 J	<4.8 U	<0.050 U	<1.7 U	<0.44 U	0.19 J	<0.519 U	<0.091 U	
	2/28/2017	<0.48 U	<0.40 U	42.9	0.24 J	0.79	1.4 J	7.9	<0.25 U	0.23 J	<4.8 U	<0.050 U	7.5 J	<0.44 U	0.16 J	0.758	<1.77 U	
	4/10/2017	<0.48 U	<0.40 U	44.5	0.23 J	0.76	0.84 J	8.6	<0.25 U	0.15 J	<4.8 U	<0.050 U	4.0 J	<0.44 U	0.16 J	0.463	<2.06 U	
	5/12/2017	<0.48 U	<0.40 U	41.6	0.22 J	0.81	1.0 J	8.5	<0.25 U	0.12 J	<4.8 U	<0.050 U	<1.7 U	<0.44 U	0.16 J	0.813	<0.0121 U	
	6/13/2017	<0.48 U	<0.40 U	41.2	0.26 J	0.71	1.0 J	7.9	<0.25 U	0.11 J	<4.8 U	<0.050 U	<1.7 U	<0.44 U	<0.16 U	0.815	3.03	
	7/27/2017	<0.45 U	<0.40 U	37.9	0.36 J	0.75	1.1 J	7.4	<0.25 U	0.17 J	<9.0 U	<0.050 U	<3.4 U	<0.50 U	0.19 J	0.328	<0.907 U	
8/28/2017	<0.45 U	0.43 J	42.4	0.29 J	0.76	1.2 J	7.1	<0.25 U	0.17 J	<9.0 U	<0.050 U	<3.4 U	<0.50 U	0.24 J	1.77	<0.36 U		
B36	7/26/2016	<0.48 U	12.8	95.9	1.1	20.3	90.4	24.6	NS	19.6	6.6 J	0.10 J	5.9 J	2.60	2.0	NS	NS	
	12/21/2016	<2.4 U	189	661	11.8	197	1,240	180	<0.25 U	187	90.3 J	0.79 J	46.1 J	35.6	16.6	3.72	2.09	
	1/31/2017	<0.48 U	45.7	130	2.2	51.8	243	48.2	<0.25 U	36.5	17.5 J	0.079 J	19.8	16.3	4.4	2.54	<0.387 U	
	3/1/2017	<0.48 U	0.45 J	47.0	0.23 J	21.3	3.5	17.4	<0.25 U	1.2	<4.8 U	<0.050 U	<1.7 U	0.67 J	0.86	1.40	<1.33 U	
	4/11/2017	<0.48 U	0.55 J	42.6	0.23 J	17.1	2.4	16.7	<0.25 U	0.98 J	6.1 J	<0.050 U	3.3 J	0.69 J	0.70	1.26	<1.17 U	
	5/15/2017	<0.48 U	1.0 J	43.9	0.23 J	15.2	20.1	0.74 J	<0.25 U	1.3	<4.8 U	<0.050 U	<1.7 U	0.68 J	0.70	0.987	1.74	
	6/14/2017	<0.48 U	<0.40 U	43.8	0.18 J	16.0	1.4 J	14.8	<0.25 U	0.94 J	<4.8 U	<0.050 U	<1.7 U	0.54 J	0.69	1.17	2.33	
	7/31/2017	<0.45 U	<0.40 U	43.5	0.22 J	15.3	1.7 J	15.2	<0.25 U	0.68 J	<9.0 U	<0.050 U	<3.4 U	<0.5 U	0.72	0.640	<3.0 U	
	8/30/2017	<0.45 U	4.8	61.7	0.44 J	48.5	19.8	26.0	<0.25 U	4.0	<9.0 U	<0.050 U	4.4 J	1.4 J	1.4	1.63	<0.598 U	
B41	10/12/2016	<0.48 U	9.1	100	0.70	0.24 J	52.4	3.6 J	NS	8.3	<4.8 U	<0.050 U	17.4	0.63 J	<0.16 U	NS	NS	
	11/7/2016	[2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]	
	12/9/2016	<0.48 U	9.9	1,130	0.53	0.42 J	50.7	47.5	<0.25 U	7.7	55.9 J	0.15 J	205	<0.44 U	0.31 J	NS	NS	
	2/2/2017	<0.48 U	22.4	235	2.9	1.0	465	10.5	NS	37.9	7.9 J	0.16 J	25.5	0.83 J	1.4	NS	NS	
	3/1/2017 [3]	<0.48 U	7.9	101	0.67	0.23 J	72.4	4.2 J	<0.25 U	8.4	<4.8 U	0.055 J	20.1	0.61 J	0.26 J	1.23	1.43	
	4/10/2017	<0.48 U	0.71 J	39.5	<0.11 U	<0.19 U	1.9 J	1.9 J	<0.25 U	0.48 J	<4.8 U	<0.050 U	<1.7 U	<0.44 U	<0.16 U	0.415	<0.897 U	
	5/15/2017	<0.48 U	0.90 J	43.9	<0.11 U	<0.19 U	2.1	2.1 J	<0.25 U	0.28 J	<4.8 U	<0.050 U	<1.7 U	<0.44 U	<0.16 U	<0.428 U	<0.558 U	
	6/14/2017	<0.48 U	<0.40 U	42.3	<0.11 U	<0.19 U	<0.59 U	2.0 J	<0.25 U	<0.09 U	<4.8 U	<0.050 U	<1.7 U	<0.44 U	<0.16 U	<0.219 U	<1.22 U	
	7/31/2017	<0.48 U	2.7	77.9	0.26 J	0.18 J	20.6	2.2 J	<0.25 U	2.5	<9.0 U	<0.050 U	<10.2 U	<0.50 U	0.15 J	<1.00 U	1.83	
8/30/2017	<0.45 U	1.5 J	40.9	<0.071 U	<0.15 U	<0.87 U	1.9 J	<0.25 U	<0.11 U	<9.0 U	<0.050 U	<3.4 U	<0.50 U	<0.12 U	<0.348 U	<0.469 U		

Notes:

µg/L micrograms per Liter  
 mg/L milligrams per Liter  
 pCi/L picocurie per Liter

Shaded Data in shaded cells were not used in background calculation.

- [1] Duplicate sample collected.
- [2] Monitoring well was dry at the time of sampling; no samples were collected.
- [3] Fluoride and radium samples collected on 2/28/2017.

J Constituent detected below reportable quantitation limit; result is an estimated value.  
 J- Constituent detected below reporting limit; result is an estimated value with a low bias.  
 U Constituent not detected above method detection limit.  
 NS Not Sampled, well was dry or went dry before all jars were filled and did not recover within 24-hours

**TABLE 6**  
**BASELINE APPENDIX III MONITORING PROGRAM ANALYTICAL DATA - COMPLIANCE WELLS**  
**FEDERAL CCR RULE - 2017 ANNUAL GROUNDWATER AND CORRECTIVE ACTION REPORT**  
**Brandywine Facility Phase II - MD**

Well ID	Analyte: Sample Date	Boron µg/L	Calcium mg/L	Chloride mg/L	Fluoride mg/L	pH S.U.	Sulfate mg/L	TDS mg/L
B15S	11/16/2015	<8.3 U	20.7	11.7	<0.25 U	4.1	74.6	135
	2/1/2016	10.1 J	2.41	7.0	<0.25 U	5.0	27.2	77.0
	4/18/2016	11.7 J	1.66	7.5	<0.25 U	5.8	17.5	60.5
	7/25/2016	24.3 J	2.01	5.6	<0.25 U	5.3	14.5	71.0
	10/6/2016	19.0 J	2.57	4.3	<0.25 U	5.1	20.4	65.5
	1/31/2017	13.5 J	3.61	7.8	1.5	5.0	21.1	75.0
	1/31/2017 [1]	12.3 J	2.89	4.5	<0.25 U	5.2	18.2	72.0
	4/7/2017	12.3 J	2.82	4.1	<0.25 U	5.6	18.2	57.5
	7/27/2017	15.0 J	1.82	3.7	<0.25 U	5.4	11.9	56.5
7/27/2017 [1]	23.9 J	2.61	3.6	<0.25 U	5.2	12.0	50.0 J	
B16	8/26/2015	49,000	436	1,630	<0.25 U	6.5	4,740	10,100
	8/26/2015 [1]	47,400	437	1,580	NS	6.5	4,700	10,600
	11/17/2015	47,700	413	1,890	<0.25 U	6.9	4,620	9,510
	1/29/2016	48,000	395	1,640	<0.25 U	6.5	4,540	8,580
	4/14/2016	48,800	391	1,950	<0.25 U	6.5	4,960	7,420 [2]
	7/25/2016	47,500	402	1,620	<0.25 U	6.5	5,130	9,750
	7/25/2016 [1]	48,300	428	1,560	<0.25 U	6.6	5,130	10,500
	10/7/2016	53,600	396	1,510	<0.25 U	7.1	5,430	8,500 [2]
	10/7/2016 [1]	48,300	385	1,480	<0.25 U	6.6	5,330	7,870 [2]
	1/26/2017	51,200	366	1,470	<0.25 U	6.4	4,480	9,820 [2]
4/10/2017	49,200	394	2,950	<0.25 U	6.7	5,440	6,340	
4/10/2017 [1]	50,800	397	1,640	<0.25 U	6.8	5,580	5,070	
B26	11/16/2015	48.8 J	8.00	14.4	<0.25 U	4.2	32.7	106
	2/1/2016	21.2 J	6.45	10.6	<0.25 U	5.6	33.6	115
	4/14/2016	21.7 J	6.54	12.8	<0.25 U	5.4	29.0	112
	7/25/2016	69.0	5.18	9.4	<0.25 U	5.7	19.1	108
	10/7/2016	8.4 J	5.06	9.7	<0.25 U	5.3	15.5	106
	1/31/2017	13.4 J	5.39	11.0	<0.25 U	5.5	15.7	83
	4/7/2017	15.4 J	5.27	10.9	<0.25 U	5.9	18.6	78
7/27/2017	<10.1 U	4.35	8.0	<0.25 U	5.5	12.5	54 J	
B27	8/26/2015	701	42.1	111	<0.25 U	6.7	276	820
	11/17/2015	625	36.1	130	<0.25 U	6.5	338	776
	1/29/2016	961	46.6	57.2	0.47 J	7.0	106	520
	4/19/2016	871	44.1	62.2	<0.25 U	7.0	135	553 [2]
	4/19/2016 [1]	946	46.5	61.3	<0.25 U	6.9	120	525
	7/25/2016	1,020	39.0	75.0	<0.25 U	6.8	211	608
	10/7/2016	779	37.4	108	<0.25 U	6.5	310	664
	1/26/2017	749	36.0	80.6	<0.25 U	6.4	212	533
4/11/2017	857	42.8	37.3	<0.25 U	7.0	86.9	427	
B37	8/26/2015	2,310	125	121	1.4 J-	4.04 [3]	779	1,330
	11/16/2015	2,240	131	111	1.0	4.5	736	1,340
	1/29/2016	2,320	124	147	0.63	4.3	750	1,350
	4/15/2016	1,970	108	148	0.92	4.6	715	1,220
	7/22/2016	2,490	128	168	0.95	4.3	746	1,170
	10/7/2016	1,800	132	123	0.84	3.9 J	746	1,630
	2/2/2017	1,250	75.6	148	0.41 J	4.7	336	710
	2/2/2017 [1]	1,100	68.5	158	0.77 J-	4.8	293	698
4/10/2017	1,560	90.8	166	0.46 J	4.7	524	876	
B38	8/26/2015	18,000	440	240	<0.25 U	7.1	2,020	3,730
	11/16/2015	19,900	396	295	<0.25 U	7.3	2,540	3,970
	11/16/2015 [1]	20,100	431	287	0.56	7.2	2,520	3,800
	1/29/2016	19,700	357	250	0.44 J	6.6	2,450	3,810
	4/15/2016	16,800	334	231	0.54	6.6	2,350	3,640 [2]
	7/22/2016	15,900	322	264	0.34 J	6.9	2,460	3,600
	10/7/2016	14,600	323	275	<0.25 U	6.5	2,470	3,080 [2]
	2/2/2017	15,000	336	354	0.51	5.7	2,520	3,760 [2]
4/10/2017	18,100	399	545	<0.25 U	6.0	2,420	3,020 [2]	

**TABLE 6**  
**BASELINE APPENDIX III MONITORING PROGRAM ANALYTICAL DATA - COMPLIANCE WELLS**  
**FEDERAL CCR RULE - 2017 ANNUAL GROUNDWATER AND CORRECTIVE ACTION REPORT**  
**Brandywine Facility Phase II - MD**

Well ID	Analyte:	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	TDS
	Sample Date	µg/L	mg/L	mg/L	mg/L	S.U.	mg/L	mg/L
B39	8/26/2015	1,410	28.1	231	0.47 J	3.1 J	801	1,620
	11/16/2015	2,750	67.2	301	0.74	3.3 J	1,010	2,100
	2/2/2016	3,230	73.1	347	0.57	3.2 J	1,170	2,110
	4/15/2016	3,330	66.0	306	<0.25 U	3.0 J	1,110	1,910
	7/22/2016	4,790	76.6	381	0.71	2.9 J	1,350	2,220
	10/7/2016	3,700	49.3	337	<0.25 U	3.3 J	1,320	1,930
	2/2/2017	4,030	78.2	388	<0.25 U	2.8 J	1,300	2,450
	4/10/2017	5,680	117	446	<0.25 U	3.0 J	1,500	2,220

## Notes:

µg/L micrograms per Liter

mg/L milligrams per Liter

S.U. Standard Units

J Constituent detected below reportable quantitation limit; result is an estimated value.

J- Constituent detected below reporting limit; result is an estimated value with a low bias.

U Constituent not detected above method detection limit.

NS Not Sampled

[1] Duplicate sample collected.

[2] The result is inconsistent with the specific conductivity values recorded at the time of groundwater sampling.

[3] The result is a field measurement.

**TABLE 7  
BASELINE APPENDIX IV MONITORING PROGRAM ANALYTICAL DATA - COMPLIANCE WELLS  
FEDERAL CCR RULE - 2017 ANNUAL GROUNDWATER AND CORRECTIVE ACTION REPORT  
Brandywine Facility Phase II - MD**

Analyte:		Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium (III+VI)	Cobalt	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Radium-226	Radium-228
Well ID	Sample Date	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	
B15S	11/16/2015	<0.33 U	72.7	729	10.8	10.4	322	81.2	<0.25 U	74.3	96.2 J	0.23	<1.7 U	5.2	4.0	2.90	2.74
	2/1/2016	<0.33 U	0.74 J	69.2	0.36 J	0.63	1.6 J	11.3	<0.25 U	0.56 J	<8.0 U	<0.050 U	<2.1 U	<0.50 U	<0.15 U	3.81	<1.16 U
	4/18/2016	<0.33 U	3.1	57.8	0.40 J	0.35 J	7.7	9.1	<0.25 U	2.5	<8.0 U	<0.050 U	<2.1 U	<0.50 U	<0.15 U	0.920	<1.74 U
	7/25/2016	<0.48 U	29.2	147	2.4	0.74	92.7	11.4	<0.25 U	32.9	<4.8 U	0.12 J	9.6 J	3.0	0.51	2.69	<-0.114 U
	10/6/2016	<0.48 U	3.9	74.2	0.48 J	0.59	9.8	8.0	<0.25 U	3.0	<4.8 U	<0.050 U	5.1 J	0.45 J	<0.16 U	<0.122 U	<-0.254 U
	1/31/2017	<0.48 U	2.4	85.8	0.33 J	0.99	7.6	9.2	1.5	1.8	<4.8 U	<0.050 U	<1.7 U	<0.44 U	<0.16 U	0.542	1.63
	1/31/2017 [1]	<0.48 U	4.0	96.8	0.62	0.81	16.4	8.6	<0.25 U	4.2	<4.8 U	<0.050 U	1.9 J	<0.44 U	<0.16 U	1.03	<1.32 U
	4/7/2017	<0.48 U	0.61 J	62.9	0.19 J	0.68	1.1 J	7.3	<0.25 U	0.48 J	<4.8 U	<0.050 U	<1.7 U	<0.44 U	<0.16 U	0.601	<0.396 U
7/27/2017	<0.45 U	3.8	71.3	0.50 J	0.55	10.4	5.5	<0.25 U	3.3	<9.0 U	<0.050 U	<3.4 U	<0.50 U	<0.12 U	0.948	1.35	
7/27/2017 [1]	<0.45 U	46.1	281	3.8	1.3	162	20.9	<0.25 U	46.2	31.6	0.15 J	8.9 J	4.0	1.0	1.12	<0.731 U	
B16	8/26/2015	<0.33 U	10.2	29.5	0.19 J	2.5	6.3	53.4	<0.25 U	1.2	298	0.073 J	<1.7 U	2.8	1.6	1.36	2.82
	8/26/2015 [1]	<0.33 U	10.7	25.1	<0.071 U	2.4	<0.70 U	2.2	NS	0.22 J	293	<0.050 U	<1.7 U	3.1	1.6	0.854	2.80
	11/17/2015	<0.33 U	7.4	28.8	0.30 J	3.0	<0.70 U	50.8	<0.25 U	0.31 J	370	<0.050 U	<1.7 U	1.8 J	1.7	1.02	<3.00 U
	1/29/2016	0.34 J	5.5	30.3	0.28 J	3.1	<0.70 U	55.3	<0.25 U	0.16 J	357	<0.050 U	2.8 J	2.2	1.8	NS	NS
	4/14/2016	<0.33 U	9.5	26.6	0.23 J	3.4	1.9 J	56.3	<0.25 U	0.37 J	375	<0.050 U	<2.1 U	2.6	2.0	0.506	<1.64 U
	7/25/2016	<2.4 U	18.2	25.5	<0.54 U	4.0	3.0 J	61.4	<0.25 U	0.98 J	363	<0.050 U	<1.7 U	3.9 J	1.8 J	0.971	<1.36 U
	7/25/2016 [1]	<0.48 U	8.7	28.0	0.11 J	3.8	2.4	63.4	<0.25 U	0.77 J	399	<0.050 U	<1.7 U	2.8	2.1	3.29	<1.36 U
	10/7/2016	<0.48 U	12.2	26.1	<0.11 U	2.9	<0.59 U	53.5	<0.25 U	0.14 J	369	<0.050 U	<1.7 U	3.4	2.1	1.66	2.53
	10/7/2016 [1]	<0.48 U	11.4	25.4	<0.11 U	2.9	1.4 J	51.3	<0.25 U	0.16 J	352	<0.050 U	<1.7 U	3.5	2.2	1.35	3.64
	1/26/2017	<0.48 U	6.4	29.1	<0.11 U	3.2	16.0	55.7	<0.25 U	0.31 J	398	<0.050 U	<1.7 U	2.6	2.2	<0.328 U	4.77
4/10/2017	<2.4 U	7.0 J	25.8	<0.54 U	4.0	<0.59 U	54.5	<0.25 U	<0.45 U	413	0.07 J	<1.7 U	3.7	2.2 J	<0.0927 U	1.44	
4/10/2017 [1]	<2.4 U	5.6 J	26.4	<0.54 U	3.7	<3.0 U	57.7	<0.25 U	<0.45 U	417	0.073 J	<1.7 U	3.8 J	2.3 J	0.385	<1.50 U	
B26	11/16/2015	<0.33 U	6.7	137	1.2	1.6	113	20.2	<0.25 U	19.2	21.8	0.66	<1.7 U	0.60 J	0.38 J	1.53	<3.00 U
	2/1/2016	<0.33 U	8.7	87.1	0.16 J	0.34 J	7.4	7.1	<0.25 U	1.6	<8.0 U	0.052 J	<2.1 U	<0.50 U	<0.15 U	<0.184 U	<0.247 U
	4/14/2016	<0.33 U	10.6	111	0.31 J	0.28 J	15.3	8.3	<0.25 U	5.5	<8.0 U	<0.050 U	<2.1 U	<0.50 U	<0.15 U	0.729	<1.22 U
	7/25/2016	<0.48 U	7.9	90.3	0.49 J	0.25 J	10.0	8.2	<0.25 U	3.2	<4.8 U	0.069 J	2.2 J	<0.44 U	<0.16 U	0.517	<1.10 U
	10/7/2016	<0.48 U	4.3	90.1	<0.54 U	0.54	9.0	9.6	<0.25 U	2.2	<4.8 U	<0.050 U	7.7 J	<0.44 U	<0.16 U	1.12	1.37
	1/31/2017	<0.48 U	17.3	122	0.67	0.55	36.4	12.7	<0.25 U	11.4	6.0 J	<0.050 U	8.1 J	0.57 J	0.30 J	0.724	<-0.0386 U
	4/7/2017	<0.48 U	2.9	92.5	0.20 J	0.67	6.5	14.8	<0.25 U	1.7	<4.8 U	0.071 J	5.9 J	<0.44 U	<0.16 U	1.73	1.21
7/27/2017	<0.45 U	5.3	76.6	0.39 J	0.61	15.9	11.5	<0.25 U	2.9	<9.0 U	0.88	<3.4 U	<0.50 U	0.14 J	<0.236 U	<0.288 U	

**TABLE 7**  
**BASELINE APPENDIX IV MONITORING PROGRAM ANALYTICAL DATA - COMPLIANCE WELLS**  
**FEDERAL CCR RULE - 2017 ANNUAL GROUNDWATER AND CORRECTIVE ACTION REPORT**  
**Brandywine Facility Phase II - MD**

Analyte:		Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium (III+VI)	Cobalt	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Radium-226	Radium-228
Well ID	Sample Date	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	
B27	8/26/2015	<0.33 U	6.9	95.9	0.89	1.2	17.0	17.9	<0.25 U	3.8	118	<0.050 U	39.8	308	0.76	1.60	2.94
	11/17/2015	<0.33 U	6.0	74.9	0.67	1.1	18.7	12.1	<0.25 U	4.0	125	<0.050 U	23.6	360	1.6	1.60	1.68
	1/29/2016	<0.33 U	1.5 J	72.6	0.092 J	1.3	1.4 J	5.5	0.47 J	0.85 J	135	<0.050 U	81.1	642	0.59	1.46	2.24
	4/19/2016	<0.33 U	0.61 J	68.6	0.089 J	1.4	2.2	7.3	<0.25 U	0.61 J	126	<0.050 U	70.3	540	0.60	1.33	1.95
	4/19/2016 [1]	<0.33 U	1.3 J	75.3	0.10 J	1.1	3.1	4.8 J	<0.25 U	1.0	132	<0.050 U	94.4	626	0.38 J	1.23	<0.654 U
	7/25/2016	<0.48 U	25.6	141	2.1	7.1	87.1	31.9	<0.25 U	16.5	140	0.081 J	65.8	471	2.2	1.79	<0.320 U
	10/7/2016	<0.48 U	6.4	87.5	0.50	3.4	4.7	22.6	<0.25 U	2.3	141	<0.050 U	31.6	283	1.8	1.41	1.54
	1/26/2017	<0.48 U	2.2	65.8	0.230 J	1.1	11.5	5.8	<0.25 U	2.2	129	<0.050 U	35.9	507	1.2	2.69	2.65
4/11/2017	<0.48 U	3.5	92.2	0.33 J	0.86	6.6	4.2 J	<0.25 U	3.1	138	<0.050 U	50.9	433	0.73	1.15	<1.51 U	
B37	8/26/2015	<0.33 U	32.0	45.6	3.4	42.5	16.4	364	1.4 J-	3.5	3,350	0.077 J	<1.7 U	6.6	0.88	<0.556 U	<1.36 U
	11/16/2015	<0.33 U	27.7	77.4	2.5	14.1	6.2	277	1.0	1.5	2,770	<0.050 U	8.3 J	0.84 J	0.34 J	1.63	3.58
	1/29/2016	<0.33 U	23.3	59.9	2.6	9.4	3.0	327	0.63	0.72 J	3,430	<0.050 U	6.2 J	0.83 J	0.23 J	1.12	<1.14 U
	4/15/2016	<0.33 U	32.2	56.6	2.9	9.9	4.6	314	0.92	0.77 J	3,000	<0.050 U	2.3 J	3.4	0.24 J	2.15	<0.22 U
	7/22/2016	<0.48 U	53.0	64.1	2.7	12.2	2.6	331	0.95	0.98 J	3,630	<0.050 U	<1.7 U	4.2	0.35 J	1.78	<1.09 U
	10/7/2016	<0.48 U	34.0	55.5	2.7	16.2	2.7	233	0.84	1.3	2,560	<0.050 U	<1.7 U	4.3	0.52	2.25	1.98
	2/2/2017	<0.48 U	12.9	70.5	2.8	19.0	1.8 J	243	0.41 J	2.0	2,060	<0.050 U	<1.7 U	0.50 J	0.55	0.610	<1.41 U
	2/2/2017 [1]	<0.48 U	11.0	78.0	2.9	22.0	2.8	220	0.77 J-	2.5	1,830	<0.050 U	<1.7 U	0.56 J	0.53	2.06	<0.714 U
4/10/2017	<0.48 U	12.1	73.2	3.1	14.8	3.1	292	0.46 J	2.2	2,340	0.055 J	1.9 J	0.58 J	0.66	1.05	<-1.79 U	
B38	8/26/2015	<0.33 U	6.0	39.3	0.080 J	0.33 J	2.6	10.6	<0.25 U	0.38 J	9,200	<0.050 U	6,220	0.93 J	1.1	0.796	<0.870 U
	11/16/2015	<0.33 U	15.2	41.9	0.41 J	0.46 J	2.1	9.8	<0.25 U	0.41 J	10,000	<0.050 U	5,310	3.4	<0.15 U	1.74	2.29
	11/16/2015 [1]	<0.33 U	11.2	44.6	0.38 J	0.27 J	<0.7 U	10.1	0.56	0.21 J	10,100	<0.050 U	5,710	2.2	<0.15 U	1.38	3.01
	1/29/2016	<0.33 U	21.5	35.7	0.94	1.0	1.2 J	12.0	0.44 J	0.35 J	9,420	<0.050 U	3,850	0.60 J	<0.15 U	<0.427 U	3.27
	4/15/2016	<0.33 U	23.0	33.6	0.72	0.59	8.7	12.8	0.54	1.4	7,800	0.086 J	3,390	3.0	0.44 J	0.788	4.38
	7/22/2016	<0.48 U	47.0	34.7	0.77 J	1.6	7.6	13.9	0.34 J	2.8	7,030	0.250	4,410	4.1	0.50 J	1.96	3.74
	10/7/2016	<0.48 U	24.8	31.4	0.70	0.58	1.8 J	12.5	<0.25 U	0.89 J	7,760	<0.050 U	4,300	3.2	0.64	1.48	3.90
	2/2/2017	<0.48 U	53.7	34.8	1.7	1.4	14.8	27.4	0.51	3.9	9,780	0.18 J	2,990	0.8 J	0.83	0.861	2.59
4/10/2017	<0.48 U	20.2	36.2	1.0	0.97	1.7 J	17.5 J	<0.25 U	0.89 J	9,980	0.063 J	4,710	<0.44 U	0.82	0.453	3.02	
B39	8/26/2015	<0.33 U	30.6	21.3	12.1	49.4	24.8	313	0.47 J	3.2	<8.0 U	<0.050 U	<1.7 U	4.3	0.85	1.69	<1.45 U
	11/16/2015	0.36 J	38.1	22.9	8.1	11.9	40.5	208	0.74	8.0	<40.0 U	<0.050 U	<1.7 U	5.7	1.1	1.52	4.06
	2/2/2016	0.44 J	30.8	21.2 J	5.4	4.9	41.7	243	0.57	4.6	<40.0 U	<0.050 U	<10.5 U	0.94 J	1.1	4.98	2.02
	4/15/2016	<0.33 U	48.5	14.1 J	4.9	2.4	48.3	155	<0.25 U	4.7	<40.0 U	<0.050 U	<10.5 U	5.0	1.4	1.09	<0.122 U
	7/22/2016	<0.48 U	119	61.1	4.4	3.5	73.0	192	0.71	14.1	<24.0 U	0.14 J	15.0 J	7.4	2.0	2.19	2.94
	10/7/2016	<0.48 U	67.3	27.4	8.8	10.6	65.6	294	<0.25 U	19.1	<24.0 U	<0.050 U	14.4 J	8.0	1.9	1.24	3.98
	2/2/2017	<0.48 U	55.5	14.0 J	5.3	5.6	42.7	228	<0.25 U	5.6	<24.0 U	<0.050 U	<8.5 U	0.90 J	1.6	1.27	2.62
	4/10/2017	<0.48 U	32.7	18.0 J	4.0	2.2	42.2	170	<0.25 U	7.8	<24.0 U	0.085 J	14.7 J	0.75 J	1.8	0.902	2.50

Notes:

µg/L micrograms per Liter  
 mg/L milligrams per Liter  
 pCi/L picocurie per Liter

[1] Duplicate sample collected.

J Constituent detected below reportable quantitation limit; result is an estimated value.  
 J- Constituent detected below reporting limit; result is an estimated value with a low bias.  
 U Constituent not detected above method detection limit.  
 NS Not Sampled

**TABLE 8**  
**BACKGROUND CONCENTRATIONS FOR APPENDIX III PARAMETERS**

**FEDERAL CCR RULE - 2017 ANNUAL GROUNDWATER AND CORRECTIVE ACTION REPORT**  
**Brandywine Facility Phase II - MD**

Appendix III Parameter	Unit	UPL [1]
Boron	µg/L	25
Calcium	mg/L	6.32
Chloride	mg/L	14.1 [2]
Fluoride	mg/L	[3]
pH	S.U.	3.1-7.7
Sulfate	mg/L	18.6
Total Dissolved Solids	mg/L	239

## Notes:

UPL Upper Prediction Limit

µg/L micrograms per Liter

mg/L milligrams per Liter

S.U. Standard Units

[1] provided in Statistical Analysis Calculations Package for Background Groundwater – Phase II, Brandywine Ash Storage Facility, Brandywine, MD (Geosyntec, 2017)

[2] The background dataset has a lognormal distribution but does not display equal variance; thus, were calculated using nonparametric methods (Unified Guidance, 2009).

[3] The Double Quantification Rule (DQR) is used for background data sets with no detections.

**TABLE 9**  
**DETECTION MONITORING PROGRAM APPENDIX III ANALYTICAL DATA - BACKGROUND WELLS**  
**FEDERAL CCR RULE - 2017 ANNUAL GROUNDWATER AND CORRECTIVE ACTION REPORT**  
**Brandywine Facility Phase II - MD**

Analyte:		Boron	Calcium	Chloride	Fluoride	pH	Sulfate	TDS
Well ID	Sample Date	µg/L	mg/L	mg/L	mg/L	S.U.	mg/L	mg/L
B34	10/23/2017	17.3 J	0.449	4.2	<0.25 U	5.0	4.8 J	16.0 J
B35	10/23/2017	19.6 J	1.86	3.1	<0.25 U	5.2	7.7	24.5 J
B36	10/24/2017	10.2 J	5.49	7.1	<0.25 U	4.3	30.2	88.5
B41	10/24/2017	<10.1 U	5.91	4.6	<0.25 U	6.4	1.6 J	44.5

## Notes:

µg/L micrograms per Liter

mg/L milligrams per Liter

S.U. Standard Units

J Constituent detected below reportable quantitation limit; result is an estimated value.

U Constituent not detected above method detection limit.

NS Not Sampled

**TABLE 10**  
**DETECTION MONITORING PROGRAM APPENDIX III ANALYTICAL DATA - COMPLIANCE WELLS**

**FEDERAL CCR RULE - 2017 ANNUAL GROUNDWATER AND CORRECTIVE ACTION REPORT**  
**Brandywine Facility Phase II - MD**

Analyte:		Boron	Calcium	Chloride	Fluoride	pH	Sulfate	TDS
Well ID	Sample Date	µg/L	mg/L	mg/L	mg/L	S.U.	mg/L	mg/L
B15S	10/24/2017	13.6 J	1.93	3.9	<0.25 U	5.0	13.3	39.5
B16	10/25/2017	49,500	377	1,580	<0.25 U	6.8	6,410	11,000
B26	10/25/2017	17.0 J	4.08	8.8	<0.25 U	4.3	13.2	53.0
B27	10/25/2017	632	42.7	426	<0.25 U	5.9	1,500	519
B37	10/24/2017	2,050	104	157	1.0	4.3	624	1,120
B38	10/24/2017	14,900	360	203	0.45 J	6.3	2,530	3,580
B39	10/25/2017	4,850	69.2	402	<0.25 U	2.9 J	1,310	2,120
	10/25/2017 [1]	4,870	69.4	426	0.51 J+	7.2	1,500	2,200

## Notes:

µg/L micrograms per Liter

mg/L milligrams per Liter

S.U. Standard Units

J Constituent detected below reportable quantitation limit; result is an estimated value.

J+ Constituent detected below reporting limit; result is an estimated value with a high bias.

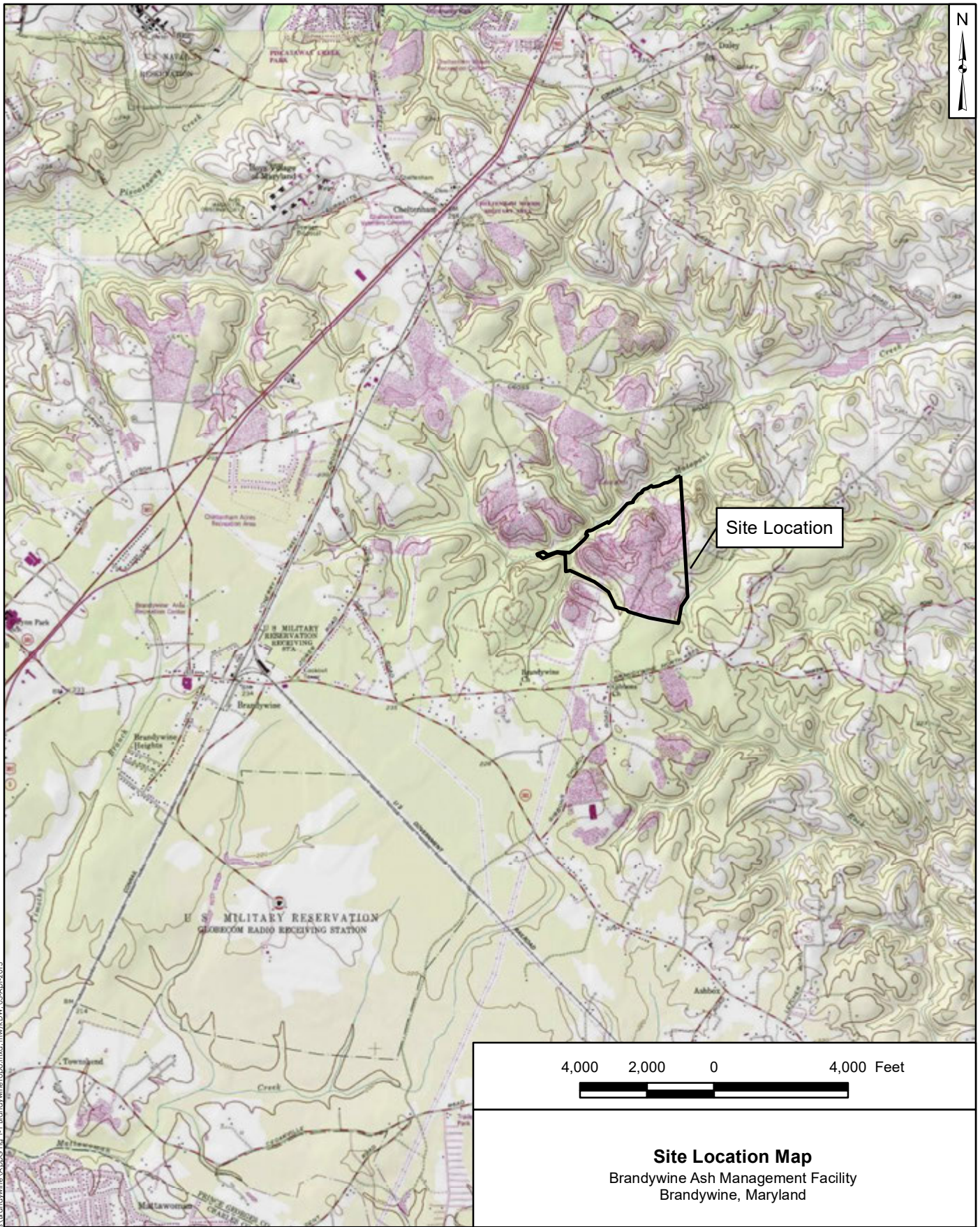
U Constituent not detected above method detection limit.

NS Not Sampled

[1] Duplicate sample collected.



# FIGURES



Site Location

4,000 2,000 0 4,000 Feet

**Site Location Map**  
 Brandywine Ash Management Facility  
 Brandywine, Maryland

Source:  
 USGS Topographic Quadrangle - Brandywine, Maryland,  
 provided by the National Geographic Society and i-cubed. © 2011  
 National Geographic Society, i-cubed

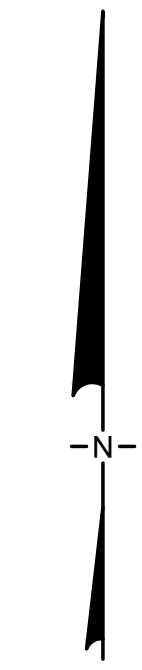
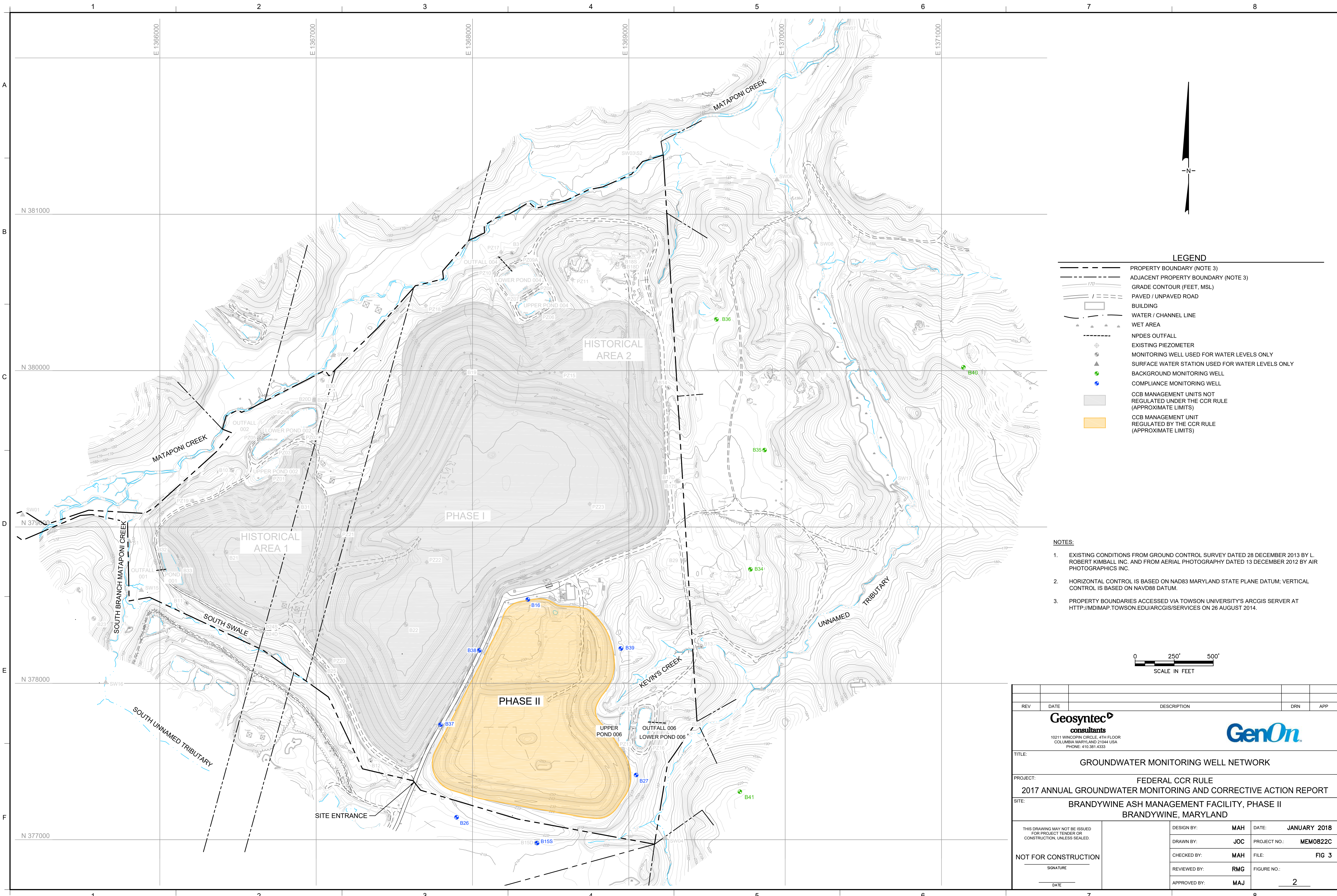
**Geosyntec**  
 consultants

Figure  
**1**

Columbia, Maryland

January 2018

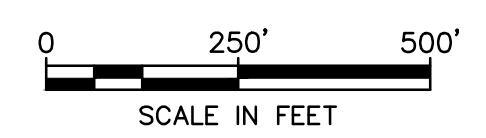
Path: P:\GIS\NFG\GenCon\Monr\Brandywine\A\ppc\Fig\_1\_Brandywine10pp.mxd; mw/DW\_03\_Apr\_2015



**LEGEND**

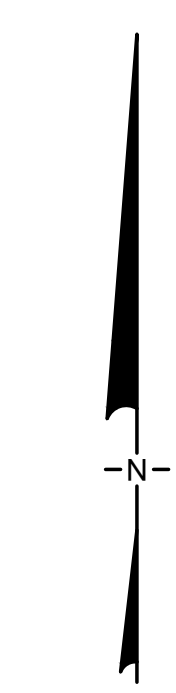
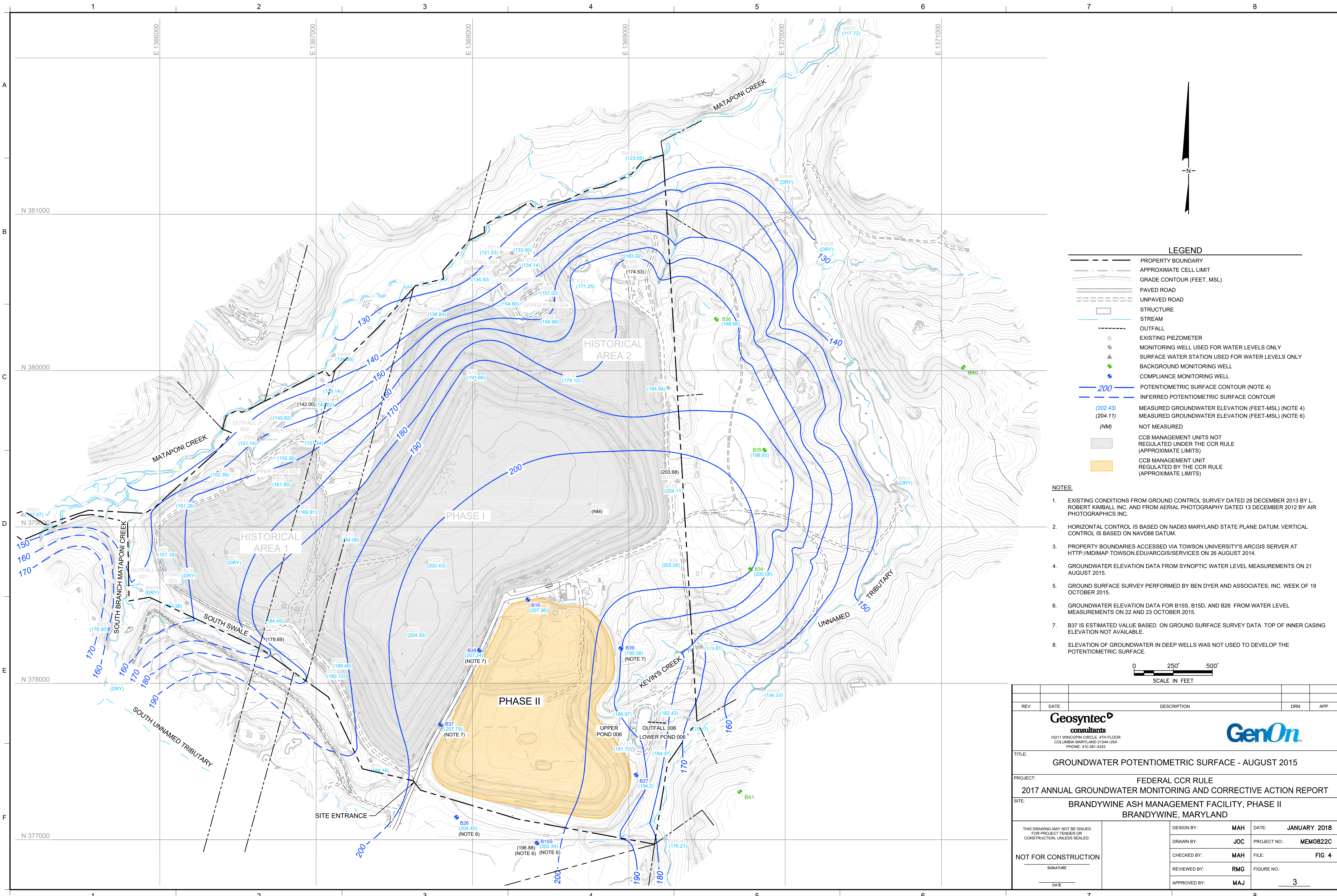
	PROPERTY BOUNDARY (NOTE 3)
	ADJACENT PROPERTY BOUNDARY (NOTE 3)
	GRADE CONTOUR (FEET, MSL)
	PAVED / UNPAVED ROAD
	BUILDING
	WATER / CHANNEL LINE
	WET AREA
	NPDES OUTFALL
	EXISTING PIEZOMETER
	MONITORING WELL USED FOR WATER LEVELS ONLY
	SURFACE WATER STATION USED FOR WATER LEVELS ONLY
	BACKGROUND MONITORING WELL
	COMPLIANCE MONITORING WELL
	CCB MANAGEMENT UNITS NOT REGULATED UNDER THE CCR RULE (APPROXIMATE LIMITS)
	CCB MANAGEMENT UNIT REGULATED BY THE CCR RULE (APPROXIMATE LIMITS)

- NOTES:**
- EXISTING CONDITIONS FROM GROUND CONTROL SURVEY DATED 28 DECEMBER 2013 BY L. ROBERT KIMBALL INC. AND FROM AERIAL PHOTOGRAPHY DATED 13 DECEMBER 2012 BY AIR PHOTOGRAPHICS INC.
  - HORIZONTAL CONTROL IS BASED ON NAD83 MARYLAND STATE PLANE DATUM; VERTICAL CONTROL IS BASED ON NAVD88 DATUM.
  - PROPERTY BOUNDARIES ACCESSED VIA TOWSON UNIVERSITY'S ARCGIS SERVER AT [HTTP://MDIMAP.TOWSON.EDU/ARCGIS/SERVICES](http://mdimap.towson.edu/arcgis/services) ON 26 AUGUST 2014.



REV	DATE	DESCRIPTION	DRN	APP
<p>TITLE: <b>GROUNDWATER MONITORING WELL NETWORK</b></p>				
<p>PROJECT: <b>FEDERAL CCR RULE</b></p> <p><b>2017 ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT</b></p>				
<p>SITE: <b>BRANDYWINE ASH MANAGEMENT FACILITY, PHASE II</b></p> <p><b>BRANDYWINE, MARYLAND</b></p>				
<p>THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION UNLESS SEALED.</p>		<p>DESIGN BY: <b>MAH</b></p>	<p>DATE: <b>JANUARY 2018</b></p>	
<p><b>NOT FOR CONSTRUCTION</b></p>		<p>DRAWN BY: <b>JOC</b></p>	<p>PROJECT NO.: <b>MEM0822C</b></p>	
<p>SIGNATURE _____</p>		<p>CHECKED BY: <b>MAH</b></p>	<p>FILE: <b>FIG 3</b></p>	
<p>DATE _____</p>		<p>REVIEWED BY: <b>RMG</b></p>	<p>FIGURE NO.: _____</p>	
		<p>APPROVED BY: <b>MAJ</b></p>	<p><b>2</b></p>	

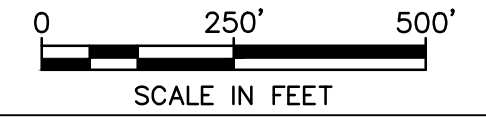
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**LEGEND**

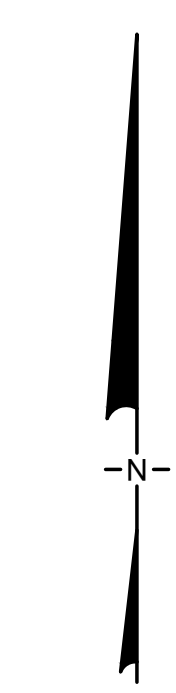
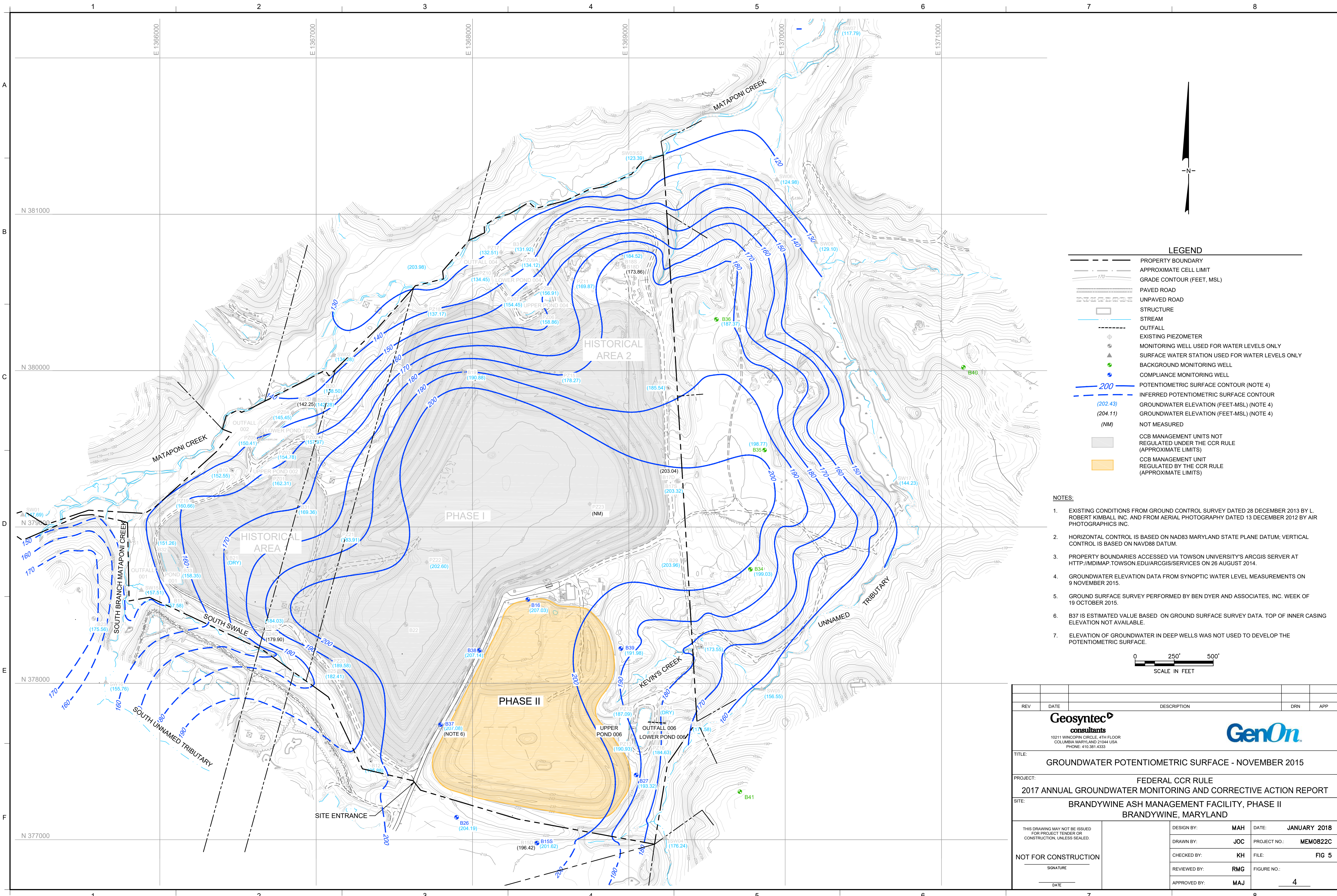
	PROPERTY BOUNDARY
	APPROXIMATE CELL LIMIT
	GRADE CONTOUR (FEET, MSL)
	PAVED ROAD
	UNPAVED ROAD
	STRUCTURE
	STREAM
	OUTFALL
	EXISTING PIEZOMETER
	MONITORING WELL USED FOR WATER LEVELS ONLY
	SURFACE WATER STATION USED FOR WATER LEVELS ONLY
	BACKGROUND MONITORING WELL
	COMPLIANCE MONITORING WELL
	POTENTIOMETRIC SURFACE CONTOUR (NOTE 4)
	INFERRED POTENTIOMETRIC SURFACE CONTOUR
	MEASURED GROUNDWATER ELEVATION (FEET-MSL) (NOTE 4)
	MEASURED GROUNDWATER ELEVATION (FEET-MSL) (NOTE 6)
	NOT MEASURED
	CCB MANAGEMENT UNITS NOT REGULATED UNDER THE CCR RULE (APPROXIMATE LIMITS)
	CCB MANAGEMENT UNIT REGULATED BY THE CCR RULE (APPROXIMATE LIMITS)

- NOTES:**
- EXISTING CONDITIONS FROM GROUND CONTROL SURVEY DATED 28 DECEMBER 2013 BY L. ROBERT KIMBALL INC. AND FROM AERIAL PHOTOGRAPHY DATED 13 DECEMBER 2012 BY AIR PHOTOGRAPHICS INC.
  - HORIZONTAL CONTROL IS BASED ON NAD83 MARYLAND STATE PLANE DATUM; VERTICAL CONTROL IS BASED ON NAVD88 DATUM.
  - PROPERTY BOUNDARIES ACCESSED VIA TOWSON UNIVERSITY'S ARCGIS SERVER AT [HTTP://MDIMAP.TOWSON.EDU/ARCCGIS/SERVICES](http://mdimap.towson.edu/arccgis/services) ON 26 AUGUST 2014.
  - GROUNDWATER ELEVATION DATA FROM SYNOPSIS WATER LEVEL MEASUREMENTS ON 21 AUGUST 2015.
  - GROUND SURFACE SURVEY PERFORMED BY BEN DYER AND ASSOCIATES, INC. WEEK OF 19 OCTOBER 2015.
  - GROUNDWATER ELEVATION DATA FOR B15S, B15D, AND B26 FROM WATER LEVEL MEASUREMENTS ON 22 AND 23 OCTOBER 2015.
  - B37 IS ESTIMATED VALUE BASED ON GROUND SURFACE SURVEY DATA. TOP OF INNER CASING ELEVATION NOT AVAILABLE.
  - ELEVATION OF GROUNDWATER IN DEEP WELLS WAS NOT USED TO DEVELOP THE POTENTIOMETRIC SURFACE.



REV	DATE	DESCRIPTION	DRN	APP
<b>TITLE:</b> GROUNDWATER POTENTIOMETRIC SURFACE - AUGUST 2015				
<b>PROJECT:</b> FEDERAL CCR RULE 2017 ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT				
<b>SITE:</b> BRANDYWINE ASH MANAGEMENT FACILITY, PHASE II BRANDYWINE, MARYLAND				
<small>THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION UNLESS SEALED.</small>		<b>DESIGN BY:</b> MAH	<b>DATE:</b> JANUARY 2018	
<b>NOT FOR CONSTRUCTION</b>		<b>DRAWN BY:</b> JOC	<b>PROJECT NO.:</b> MEM0822C	
SIGNATURE _____ DATE _____		<b>CHECKED BY:</b> MAH	<b>FILE:</b> FIG 4	
		<b>REVIEWED BY:</b> RMG	<b>FIGURE NO.:</b>	
		<b>APPROVED BY:</b> MAJ	<b>3</b>	

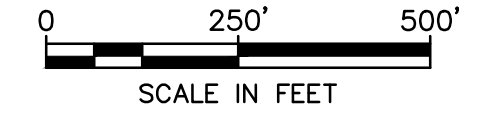
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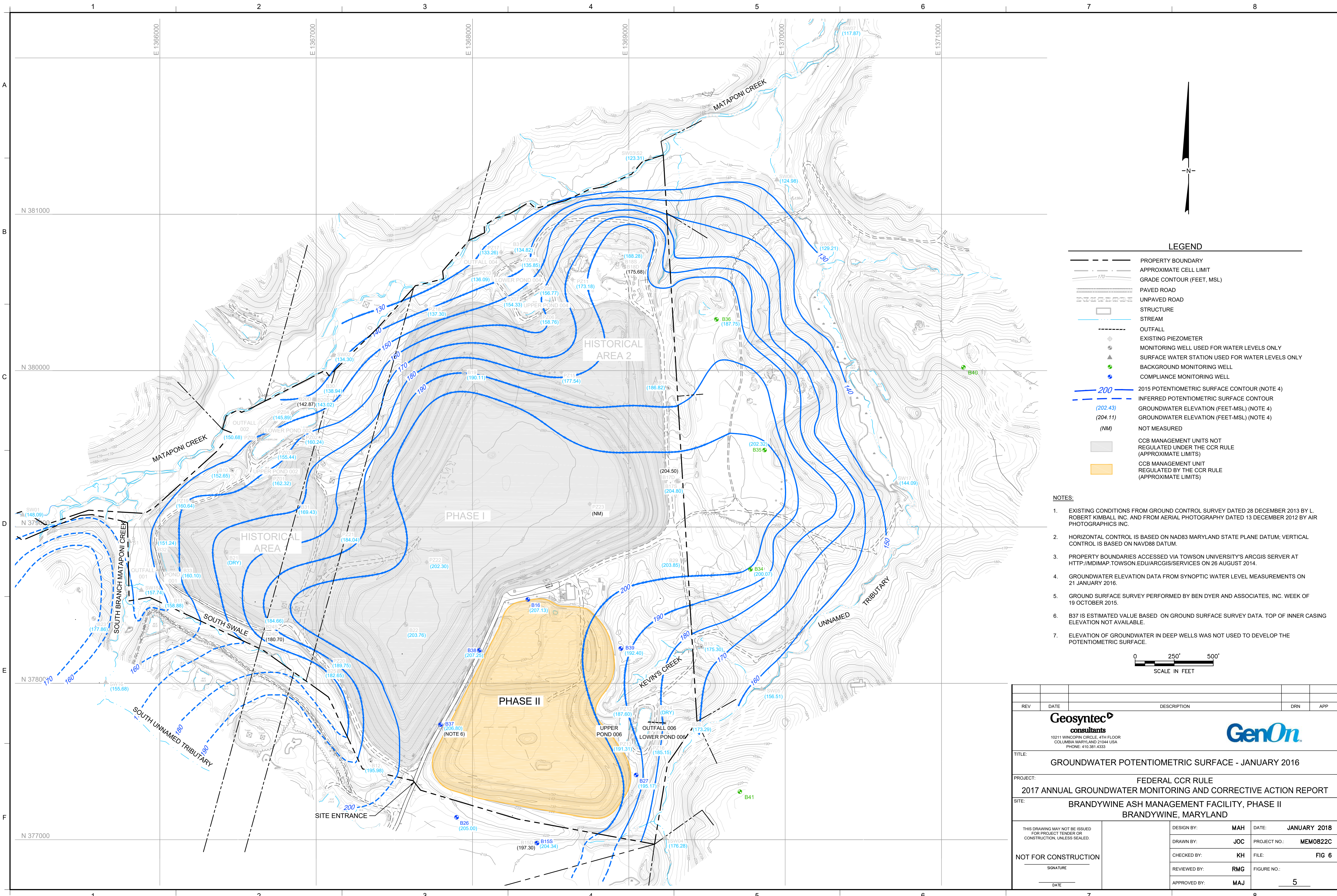
**LEGEND**

	PROPERTY BOUNDARY
	APPROXIMATE CELL LIMIT
	GRADE CONTOUR (FEET, MSL)
	PAVED ROAD
	UNPAVED ROAD
	STRUCTURE
	STREAM
	OUTFALL
	EXISTING PIEZOMETER
	MONITORING WELL USED FOR WATER LEVELS ONLY
	SURFACE WATER STATION USED FOR WATER LEVELS ONLY
	BACKGROUND MONITORING WELL
	COMPLIANCE MONITORING WELL
	POTENTIOMETRIC SURFACE CONTOUR (NOTE 4)
	INFERRED POTENTIOMETRIC SURFACE CONTOUR
	GROUNDWATER ELEVATION (FEET-MSL) (NOTE 4)
	GROUNDWATER ELEVATION (FEET-MSL) (NOTE 4)
	NOT MEASURED
	CCB MANAGEMENT UNITS NOT REGULATED UNDER THE CCR RULE (APPROXIMATE LIMITS)
	CCB MANAGEMENT UNIT REGULATED BY THE CCR RULE (APPROXIMATE LIMITS)

- NOTES:**
- EXISTING CONDITIONS FROM GROUND CONTROL SURVEY DATED 28 DECEMBER 2013 BY L. ROBERT KIMBALL INC. AND FROM AERIAL PHOTOGRAPHY DATED 13 DECEMBER 2012 BY AIR PHOTOGRAPHICS INC.
  - HORIZONTAL CONTROL IS BASED ON NAD83 MARYLAND STATE PLANE DATUM; VERTICAL CONTROL IS BASED ON NAVD88 DATUM.
  - PROPERTY BOUNDARIES ACCESSED VIA TOWSON UNIVERSITY'S ARCGIS SERVER AT [HTTP://MDIMAP.TOWSON.EDU/ARCGIS/SERVICES](http://mdimap.towson.edu/arcgis/services) ON 26 AUGUST 2014.
  - GROUNDWATER ELEVATION DATA FROM SYNOPTIC WATER LEVEL MEASUREMENTS ON 9 NOVEMBER 2015.
  - GROUND SURFACE SURVEY PERFORMED BY BEN DYER AND ASSOCIATES, INC. WEEK OF 19 OCTOBER 2015.
  - B37 IS ESTIMATED VALUE BASED ON GROUND SURFACE SURVEY DATA. TOP OF INNER CASING ELEVATION NOT AVAILABLE.
  - ELEVATION OF GROUNDWATER IN DEEP WELLS WAS NOT USED TO DEVELOP THE POTENTIOMETRIC SURFACE.



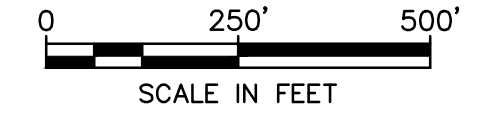
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<b>PROJECT:</b> FEDERAL CCR RULE 2017 ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT				
<b>SITE:</b> BRANDYWINE ASH MANAGEMENT FACILITY, PHASE II BRANDYWINE, MARYLAND				
THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION UNLESS SEALED.		<b>DESIGN BY:</b> MAH	<b>DATE:</b> JANUARY 2018	
<b>NOT FOR CONSTRUCTION</b>		<b>DRAWN BY:</b> JOC	<b>PROJECT NO.:</b> MEM0822C	
SIGNATURE _____		<b>CHECKED BY:</b> KH	<b>FILE:</b> FIG 5	
DATE _____		<b>REVIEWED BY:</b> RMG	<b>FIGURE NO.:</b>	
_____		<b>APPROVED BY:</b> MAJ	<b>4</b>	



**LEGEND**

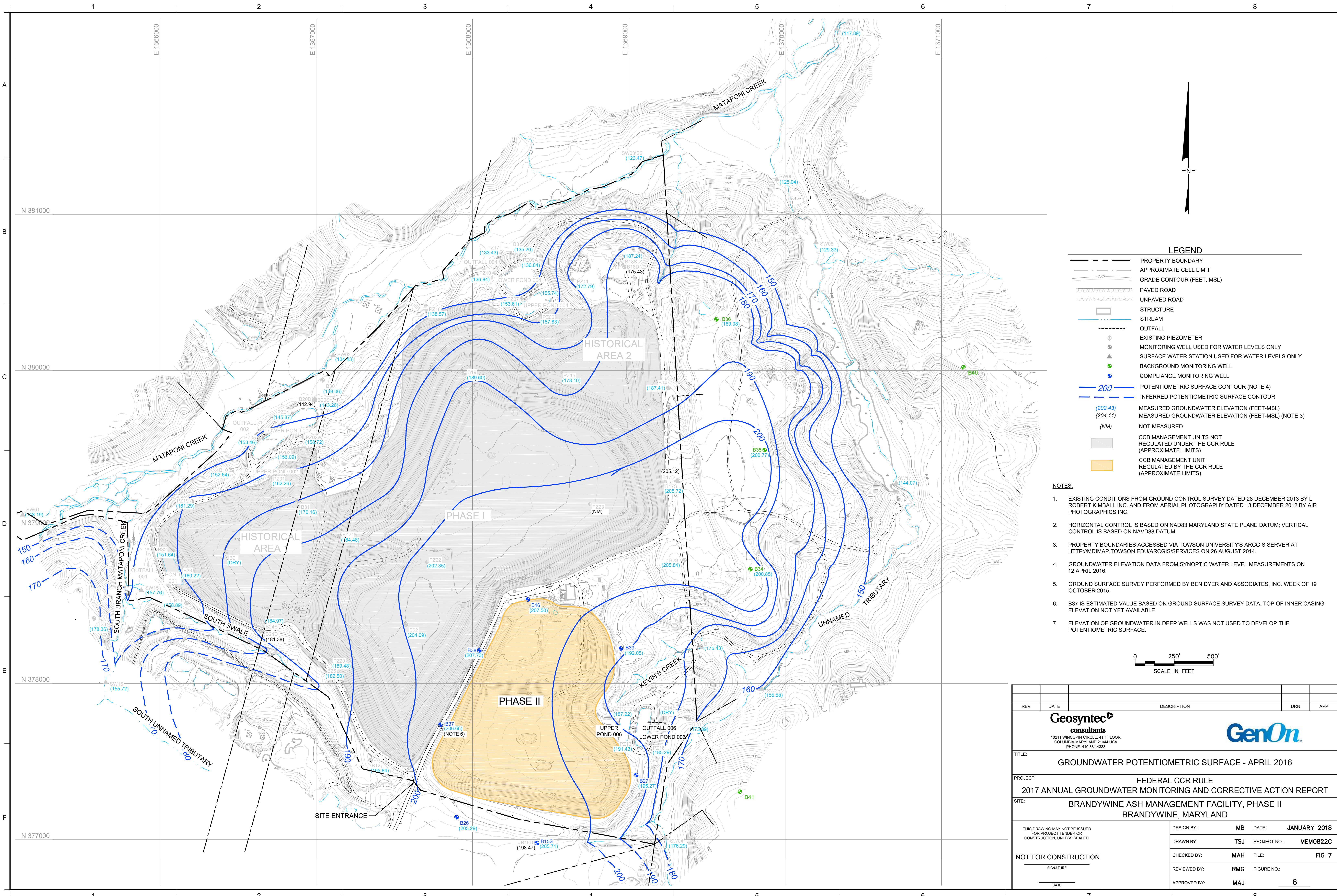
- PROPERTY BOUNDARY
- APPROXIMATE CELL LIMIT
- GRADE CONTOUR (FEET, MSL)
- PAVED ROAD
- UNPAVED ROAD
- STRUCTURE
- STREAM
- OUTFALL
- EXISTING PIEZOMETER
- MONITORING WELL USED FOR WATER LEVELS ONLY
- SURFACE WATER STATION USED FOR WATER LEVELS ONLY
- BACKGROUND MONITORING WELL
- COMPLIANCE MONITORING WELL
- 200 2015 POTENTIOMETRIC SURFACE CONTOUR (NOTE 4)
- (202.43) INFERRER POTENTIOMETRIC SURFACE CONTOUR
- (204.11) GROUNDWATER ELEVATION (FEET-MSL) (NOTE 4)
- (NM) GROUNDWATER ELEVATION (FEET-MSL) (NOTE 4)
- (NM) NOT MEASURED
- CCB MANAGEMENT UNITS NOT REGULATED UNDER THE CCR RULE (APPROXIMATE LIMITS)
- CCB MANAGEMENT UNIT REGULATED BY THE CCR RULE (APPROXIMATE LIMITS)

- NOTES:**
- EXISTING CONDITIONS FROM GROUND CONTROL SURVEY DATED 28 DECEMBER 2013 BY L. ROBERT KIMBALL INC. AND FROM AERIAL PHOTOGRAPHY DATED 13 DECEMBER 2012 BY AIR PHOTOGRAPHICS INC.
  - HORIZONTAL CONTROL IS BASED ON NAD83 MARYLAND STATE PLANE DATUM; VERTICAL CONTROL IS BASED ON NAVD88 DATUM.
  - PROPERTY BOUNDARIES ACCESSED VIA TOWSON UNIVERSITY'S ARCGIS SERVER AT [HTTP://MDIMAP.TOWSON.EDU/ARCGIS/SERVICES](http://mdimap.towson.edu/arcgis/services) ON 26 AUGUST 2014.
  - GROUNDWATER ELEVATION DATA FROM SYNOPTIC WATER LEVEL MEASUREMENTS ON 21 JANUARY 2016.
  - GROUND SURFACE SURVEY PERFORMED BY BEN DYER AND ASSOCIATES, INC. WEEK OF 19 OCTOBER 2015.
  - B37 IS ESTIMATED VALUE BASED ON GROUND SURFACE SURVEY DATA. TOP OF INNER CASING ELEVATION NOT AVAILABLE.
  - ELEVATION OF GROUNDWATER IN DEEP WELLS WAS NOT USED TO DEVELOP THE POTENTIOMETRIC SURFACE.



REV	DATE	DESCRIPTION	DRN	APP
<b>TITLE:</b> GROUNDWATER POTENTIOMETRIC SURFACE - JANUARY 2016				
<b>PROJECT:</b> FEDERAL CCR RULE 2017 ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT				
<b>SITE:</b> BRANDYWINE ASH MANAGEMENT FACILITY, PHASE II BRANDYWINE, MARYLAND				
THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION UNLESS SEALED.		<b>DESIGN BY:</b> MAH	<b>DATE:</b> JANUARY 2018	
<b>NOT FOR CONSTRUCTION</b>		<b>DRAWN BY:</b> JOC	<b>PROJECT NO.:</b> MEM0822C	
SIGNATURE _____ DATE _____		<b>CHECKED BY:</b> KH	<b>FILE:</b> FIG 6	
_____		<b>REVIEWED BY:</b> RMG	<b>FIGURE NO.:</b>	
_____		<b>APPROVED BY:</b> MAJ	<b>5</b>	

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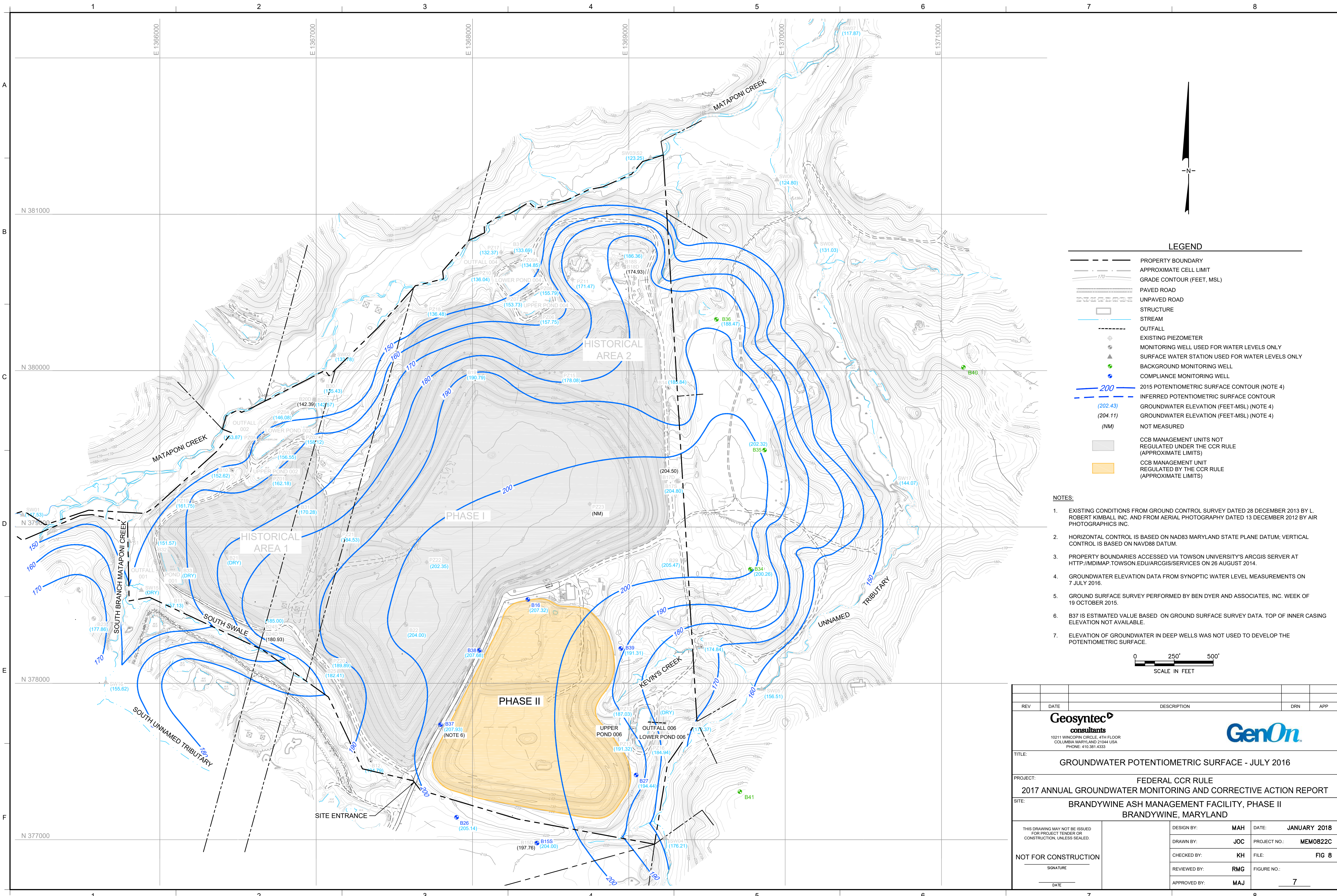
**LEGEND**

	PROPERTY BOUNDARY
	APPROXIMATE CELL LIMIT
	GRADE CONTOUR (FEET, MSL)
	PAVED ROAD
	UNPAVED ROAD
	STRUCTURE
	STREAM
	OUTFALL
	EXISTING PIEZOMETER
	MONITORING WELL USED FOR WATER LEVELS ONLY
	SURFACE WATER STATION USED FOR WATER LEVELS ONLY
	BACKGROUND MONITORING WELL
	COMPLIANCE MONITORING WELL
	POTENTIOMETRIC SURFACE CONTOUR (NOTE 4)
	INFERRED POTENTIOMETRIC SURFACE CONTOUR
	MEASURED GROUNDWATER ELEVATION (FEET-MSL)
	MEASURED GROUNDWATER ELEVATION (FEET-MSL) (NOTE 3)
	NOT MEASURED
	CCB MANAGEMENT UNITS NOT REGULATED UNDER THE CCR RULE (APPROXIMATE LIMITS)
	CCB MANAGEMENT UNIT REGULATED BY THE CCR RULE (APPROXIMATE LIMITS)

- NOTES:**
- EXISTING CONDITIONS FROM GROUND CONTROL SURVEY DATED 28 DECEMBER 2013 BY L. ROBERT KIMBALL INC. AND FROM AERIAL PHOTOGRAPHY DATED 13 DECEMBER 2012 BY AIR PHOTOGRAPHICS INC.
  - HORIZONTAL CONTROL IS BASED ON NAD83 MARYLAND STATE PLANE DATUM; VERTICAL CONTROL IS BASED ON NAVD88 DATUM.
  - PROPERTY BOUNDARIES ACCESSED VIA TOWSON UNIVERSITY'S ARCGIS SERVER AT [HTTP://MDIMAP.TOWSON.EDU/ARCGIS/SERVICES](http://mdimap.towson.edu/arcgis/services) ON 26 AUGUST 2014.
  - GROUNDWATER ELEVATION DATA FROM SYNOPTIC WATER LEVEL MEASUREMENTS ON 12 APRIL 2016.
  - GROUND SURFACE SURVEY PERFORMED BY BEN DYER AND ASSOCIATES, INC. WEEK OF 19 OCTOBER 2015.
  - B37 IS ESTIMATED VALUE BASED ON GROUND SURFACE SURVEY DATA. TOP OF INNER CASING ELEVATION NOT YET AVAILABLE.
  - ELEVATION OF GROUNDWATER IN DEEP WELLS WAS NOT USED TO DEVELOP THE POTENTIOMETRIC SURFACE.

REV	DATE	DESCRIPTION	DRN	APP
<b>TITLE:</b> GROUNDWATER POTENTIOMETRIC SURFACE - APRIL 2016				
<b>PROJECT:</b> FEDERAL CCR RULE 2017 ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT				
<b>SITE:</b> BRANDYWINE ASH MANAGEMENT FACILITY, PHASE II BRANDYWINE, MARYLAND				
THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION UNLESS SEALED.		<b>DESIGN BY:</b> MB <b>DATE:</b> JANUARY 2018		<b>PROJECT NO.:</b> MEM0822C
<b>NOT FOR CONSTRUCTION</b>		<b>DRAWN BY:</b> TSJ		<b>FILE:</b> FIG 7
SIGNATURE _____ DATE _____		<b>CHECKED BY:</b> MAH		<b>FIGURE NO.:</b> 6
		<b>REVIEWED BY:</b> RMG		
		<b>APPROVED BY:</b> MAJ		

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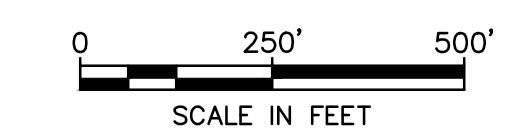


**LEGEND**

- PROPERTY BOUNDARY
- APPROXIMATE CELL LIMIT
- GRADE CONTOUR (FEET, MSL)
- PAVED ROAD
- UNPAVED ROAD
- STRUCTURE
- STREAM
- OUTFALL
- EXISTING PIEZOMETER
- MONITORING WELL USED FOR WATER LEVELS ONLY
- SURFACE WATER STATION USED FOR WATER LEVELS ONLY
- BACKGROUND MONITORING WELL
- COMPLIANCE MONITORING WELL
- 200 2015 POTENTIOMETRIC SURFACE CONTOUR (NOTE 4)
- (202.43) INFERRER POTENTIOMETRIC SURFACE CONTOUR
- (204.11) GROUNDWATER ELEVATION (FEET-MSL) (NOTE 4)
- (NM) GROUNDWATER ELEVATION (FEET-MSL) (NOTE 4)
- (NM) NOT MEASURED
- CCB MANAGEMENT UNITS NOT REGULATED UNDER THE CCR RULE (APPROXIMATE LIMITS)
- CCB MANAGEMENT UNIT REGULATED BY THE CCR RULE (APPROXIMATE LIMITS)

**NOTES:**

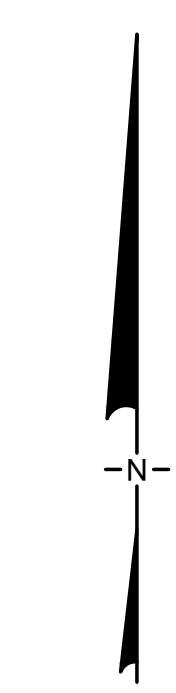
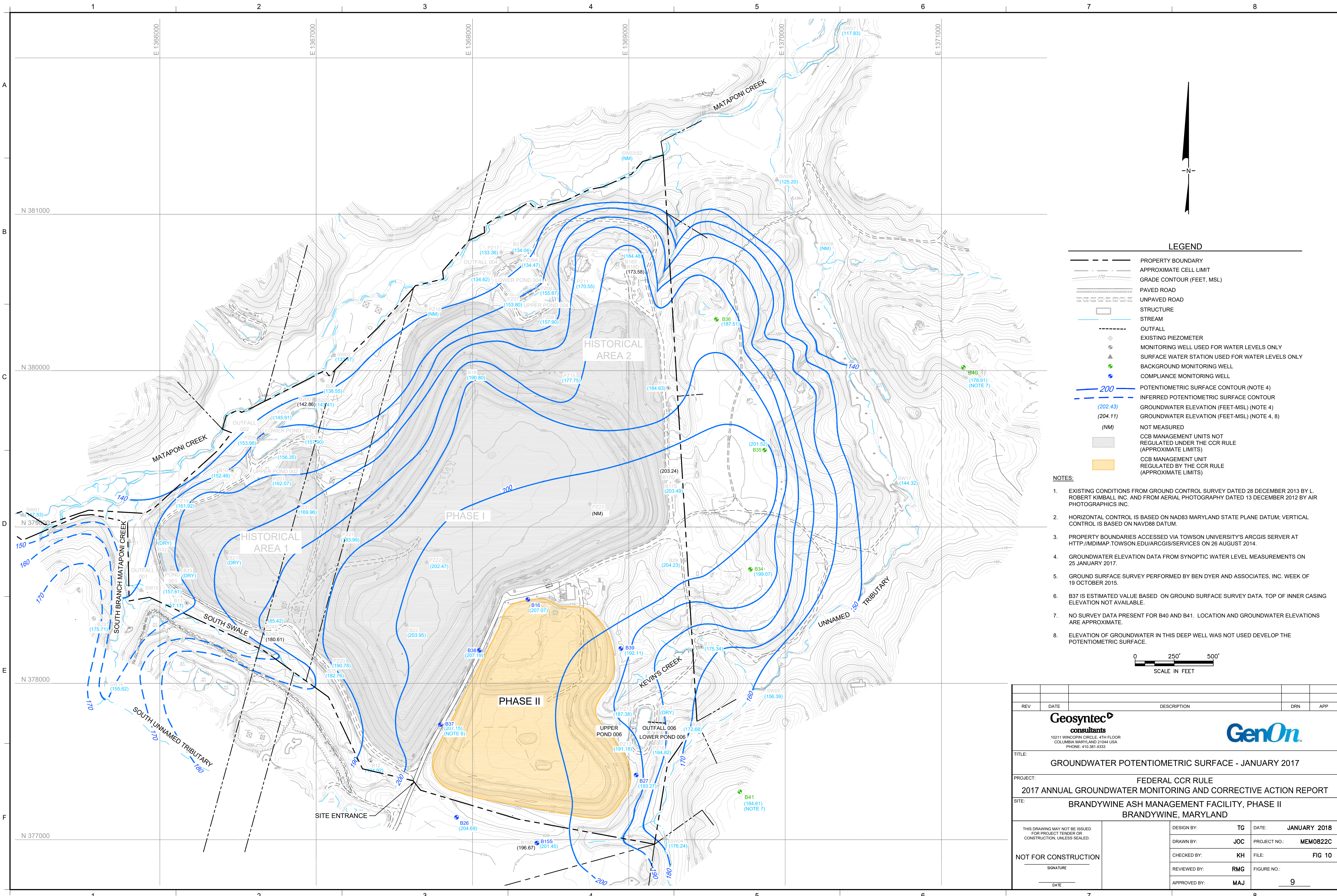
1. EXISTING CONDITIONS FROM GROUND CONTROL SURVEY DATED 28 DECEMBER 2013 BY L. ROBERT KIMBALL INC. AND FROM AERIAL PHOTOGRAPHY DATED 13 DECEMBER 2012 BY AIR PHOTOGRAPHICS INC.
2. HORIZONTAL CONTROL IS BASED ON NAD83 MARYLAND STATE PLANE DATUM; VERTICAL CONTROL IS BASED ON NAVD88 DATUM.
3. PROPERTY BOUNDARIES ACCESSED VIA TOWSON UNIVERSITY'S ARCGIS SERVER AT [HTTP://MDIMAP.TOWSON.EDU/ARCGIS/SERVICES](http://mdimap.towson.edu/arcgis/services) ON 26 AUGUST 2014.
4. GROUNDWATER ELEVATION DATA FROM SYNOPTIC WATER LEVEL MEASUREMENTS ON 7 JULY 2016.
5. GROUND SURFACE SURVEY PERFORMED BY BEN DYER AND ASSOCIATES, INC. WEEK OF 19 OCTOBER 2015.
6. B37 IS ESTIMATED VALUE BASED ON GROUND SURFACE SURVEY DATA. TOP OF INNER CASING ELEVATION NOT AVAILABLE.
7. ELEVATION OF GROUNDWATER IN DEEP WELLS WAS NOT USED TO DEVELOP THE POTENTIOMETRIC SURFACE.



REV	DATE	DESCRIPTION	DRN	APP
<p>TITLE: <b>GROUNDWATER POTENTIOMETRIC SURFACE - JULY 2016</b></p>				
<p>PROJECT: <b>FEDERAL CCR RULE 2017 ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT</b></p>				
<p>SITE: <b>BRANDYWINE ASH MANAGEMENT FACILITY, PHASE II BRANDYWINE, MARYLAND</b></p>				
<p>THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION UNLESS SEALED.</p>		<p>DESIGN BY: <b>MAH</b>    DATE: <b>JANUARY 2018</b></p>		
<p>NOT FOR CONSTRUCTION</p>		<p>DRAWN BY: <b>JOC</b>    PROJECT NO.: <b>MEM0822C</b></p>		
<p>SIGNATURE _____</p>		<p>CHECKED BY: <b>KH</b>    FILE: <b>FIG 8</b></p>		
<p>DATE _____</p>		<p>REVIEWED BY: <b>RMG</b>    FIGURE NO.: _____</p>		
		<p>APPROVED BY: <b>MAJ</b>    <u>7</u></p>		



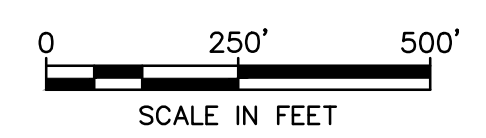




**LEGEND**

	PROPERTY BOUNDARY
	APPROXIMATE CELL LIMIT
	GRADE CONTOUR (FEET, MSL)
	PAVED ROAD
	UNPAVED ROAD
	STRUCTURE
	STREAM
	OUTFALL
	EXISTING PIEZOMETER
	MONITORING WELL USED FOR WATER LEVELS ONLY
	SURFACE WATER STATION USED FOR WATER LEVELS ONLY
	BACKGROUND MONITORING WELL
	COMPLIANCE MONITORING WELL
	POTENTIOMETRIC SURFACE CONTOUR (NOTE 4)
	INFERRED POTENTIOMETRIC SURFACE CONTOUR
	GROUNDWATER ELEVATION (FEET-MSL) (NOTE 4)
	GROUNDWATER ELEVATION (FEET-MSL) (NOTE 4, 8)
	NOT MEASURED
	CCB MANAGEMENT UNITS NOT REGULATED UNDER THE CCR RULE (APPROXIMATE LIMITS)
	CCB MANAGEMENT UNIT REGULATED BY THE CCR RULE (APPROXIMATE LIMITS)

- NOTES:**
- EXISTING CONDITIONS FROM GROUND CONTROL SURVEY DATED 28 DECEMBER 2013 BY L. ROBERT KIMBALL INC. AND FROM AERIAL PHOTOGRAPHY DATED 13 DECEMBER 2012 BY AIR PHOTOGRAPHICS INC.
  - HORIZONTAL CONTROL IS BASED ON NAD83 MARYLAND STATE PLANE DATUM; VERTICAL CONTROL IS BASED ON NAVD88 DATUM.
  - PROPERTY BOUNDARIES ACCESSED VIA TOWSON UNIVERSITY'S ARCGIS SERVER AT [HTTP://MDIMAP.TOWSON.EDU/ARCGIS/SERVICES](http://mdimap.towson.edu/arcgis/services) ON 26 AUGUST 2014.
  - GROUNDWATER ELEVATION DATA FROM SYNOPTIC WATER LEVEL MEASUREMENTS ON 25 JANUARY 2017.
  - GROUND SURFACE SURVEY PERFORMED BY BEN DYER AND ASSOCIATES, INC. WEEK OF 19 OCTOBER 2015.
  - B37 IS ESTIMATED VALUE BASED ON GROUND SURFACE SURVEY DATA. TOP OF INNER CASING ELEVATION NOT AVAILABLE.
  - NO SURVEY DATA PRESENT FOR B40 AND B41. LOCATION AND GROUNDWATER ELEVATIONS ARE APPROXIMATE.
  - ELEVATION OF GROUNDWATER IN THIS DEEP WELL WAS NOT USED DEVELOP THE POTENTIOMETRIC SURFACE.



REV	DATE	DESCRIPTION	DRN	APP
<b>TITLE:</b> GROUNDWATER POTENTIOMETRIC SURFACE - JANUARY 2017				
<b>PROJECT:</b> FEDERAL CCR RULE 2017 ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT				
<b>SITE:</b> BRANDYWINE ASH MANAGEMENT FACILITY, PHASE II BRANDYWINE, MARYLAND				
THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION UNLESS SEALED.		<b>DESIGN BY:</b> TG		<b>DATE:</b> JANUARY 2018
<b>NOT FOR CONSTRUCTION</b>		<b>DRAWN BY:</b> JOC		<b>PROJECT NO.:</b> MEM0822C
SIGNATURE _____ DATE _____		<b>CHECKED BY:</b> KH		<b>FILE:</b> FIG 10
		<b>REVIEWED BY:</b> RMG		<b>FIGURE NO.:</b> 9
		<b>APPROVED BY:</b> MAJ		

# APPENDIX A

## Groundwater Flow Velocity Calculation

## Appendix A

### Groundwater Velocity Calculation

Brandywine Ash Management Facility Phase II

Brandywine, Maryland

#### 1. Governing Equation

Groundwater flow velocity at the Site was calculated between several monitoring wells around Phase II of the Site. The calculations were performed using the following equation.

$$V_{\eta} = \frac{K}{\eta} \times \frac{\Delta h}{\Delta l}$$

Where:

$V_{\eta}$  = Groundwater velocity (cm per second)

$K$  = Hydraulic conductivity estimated through aquifer slug tests

$\eta$  = Effective porosity %

$\Delta h$  = Change in groundwater elevation between two points

$\Delta l$  = Distance between two points

This equation is for Darcy flow through porous media.

#### 2. Hydraulic Conductivity Estimated

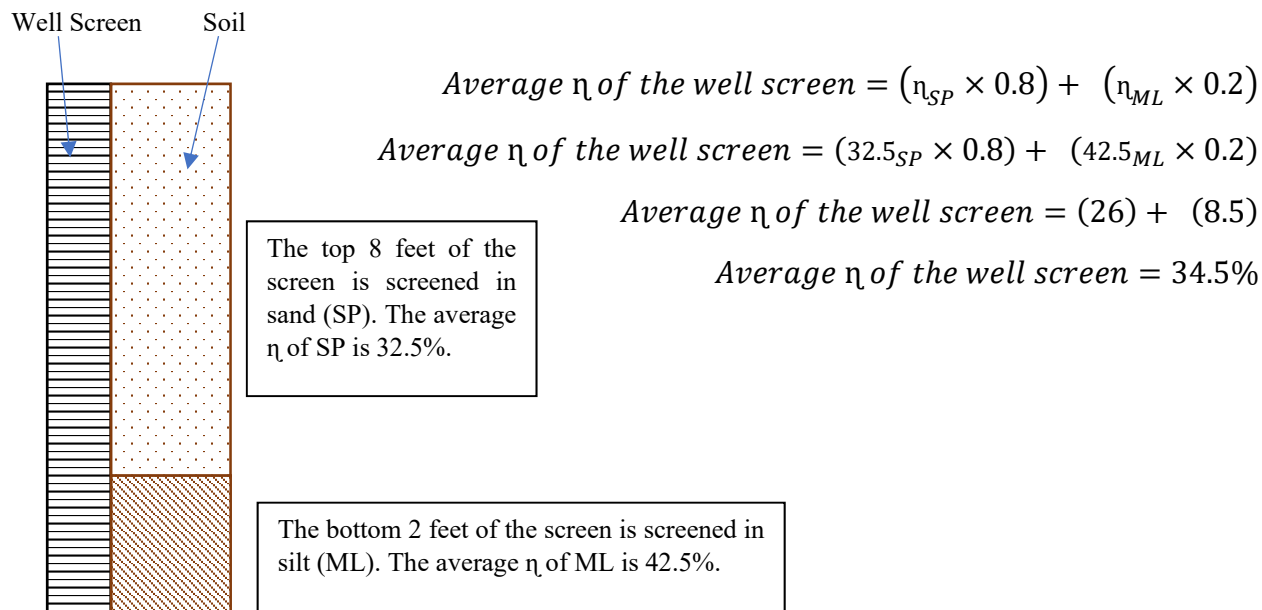
Hydraulic conductivity ( $K$ ) was calculated at select monitoring wells around Phase II. Monitoring wells B15S, B16, B26, B27, and B28 were slug tested. The location of the slug tested wells are shown on **Figure 3**. The  $K$  value for each slug test at a given well was averaged, which generated an average  $K$  for each monitoring well.  $K$  values are presented in **Table A-1**. The average of the  $K$  value between two monitoring wells is presented on **Table A-2**.

#### 3. Average Porosity

As shown on **Table A-1**, each monitoring well has an average porosity ( $\eta$ ) calculated for each screen interval. The averaged  $\eta$  values were obtained from *Groundwater and Wells, Second Edition, Driscoll* [Driscoll, 1986]. A range for  $\eta$  is presented in [Driscoll, 1986] and the average for each  $\eta$  range was used in the calculation. The published  $\eta$  values and the calculated average  $\eta$  values are presented on **Table A-1**.

The averaged  $\eta$  value was then used to estimate an  $\eta$  value for each screen based on the geology observed during the well installation. See diagram below to see how  $\eta$  was estimated for each monitoring well screen.

### EXAMPLE POROSITY ESTIMATION FOR WELL SCREEN



Boring logs were provided in *Basis for Groundwater Monitoring Network* [Geosyntec, 2017a].

After the average  $\eta$  value was calculated for each well screen, the average of the  $\eta$  values between the two monitoring wells along a groundwater flow path was calculated. See **Table A-1** for the calculated average  $\eta$  for each monitoring well screen. The average  $\eta$  value between the two monitoring wells was then used to calculate the groundwater velocity. Average  $\eta$  value between monitoring wells is presented on **Table A-2**.

#### **4. Monitoring Well Selection**

To estimate groundwater velocity, monitoring wells upgradient and downgradient of Phase II were selected. Ideally, monitoring wells should be along a groundwater flow path. Based on that requirement, the groundwater velocity was calculated between B16 to B27, B16 to B28, B26 to B27, and B26 to B28. See **Figure 4** to **Figure 11** for the selected well locations relative to groundwater flow.

#### **5. Groundwater Velocity**

Groundwater velocity around Phase II ranged from  $1.42 \times 10^{-4}$  centimeters per second (cm/sec) (147 inches/month) between monitoring wells B16 and B28 to  $3.72 \times 10^{-6}$  cm/sec (3.85 inches/month) between monitoring wells B26 and B27. The average groundwater velocity around Phase II was calculated at  $2.52 \times 10^{-5}$  cm/sec (26 inches/month). **Table A-2** of **Appendix A** presents the calculated groundwater velocities. Therefore, to be considered independent samples, groundwater monitoring events should be at least 2 weeks apart for groundwater to completely travel through the 8-inch diameter borehole.

**APPENDIX A**  
**TABLE A-1**  
**Groundwater Flow Velocity Variables**

**Brandywine CCR Management Facility Phase II**  
**Brandywine, Maryland**

Groundwater Velocity Equation

$$V_{\eta} = \frac{K}{\eta} \times \frac{\Delta h}{\Delta l}$$

$V_{\eta}$  = linear groundwater velocity

$K$  = hydraulic conductivity (cm/sec)

$\eta$  = effective porosity (unitless)

$\Delta h$  = change in head between wells (ft)

$\Delta l$  = distance between wells (ft)

Upgradient Well	Downgradient Well	$\Delta l$ (ft)	$\Delta h$ (ft)
B16	B27	1315	10.42
B16	B28	1270	32.74
B26	B27	1172.5	9.15
B26	B28	1612.5	31.47

Well ID:	Average Hydraulic Conductivity ( $K$ ) (cm/sec) [1]
B16	2.81E-03
B26	5.50E-06
B27	3.85E-04
B28	8.17E-04

Well Location	Soil Observed in the Screen	Average $\eta$ of Screen
B16	(SP/GP) (75%),(SP/ML) (25%)	24.5
B26	ML 100%	42.5
B27	ML/SP 50% and CL/SP 50%	39.4
B28	SP/CL 100%	41.3

Seiment Size	Effective Porosity % ( $\eta$ )	Average $\eta$ [2]
Clay (CL)	45-55	50
Silt (ML)	35-50	42.5
Sand (SP)	25-40	32.5
Gravel (GP)	25-40	32.5
Sand and Gravel (SP/GP)	10-35	22.5

Notes:

ft - feet

cm/sec - centimeters per second

[1] Average hydraulic conductivity is an average result of the falling and rising head slug tests.

[2] Average effective porosity is an average of the published effective porosities for each soil type.

**APPENDIX A**  
**Table A-2**  
**Groundwater Flow Velocity Calculation**

**Brandywine CCR Management Facility Phase II**  
**Brandywine, Maryland**

Upgradient Well	Downgradient Well	Hydraulic Conductivity (K) (cm/sec)	Groundwater Elevation (ft-msl)	Average K (cm/sec) [1]	Average $\eta$	$\Delta h$ (ft)	$\Delta l$ (ft)	$\Delta h/\Delta l$	Linear Velocity (cm/sec)	Linear Velocity (inches/month)
B16	NA	2.81E-03	207.30	NA	NA	NA	NA	NA	NA	NA
B16	B27	3.85E-04	196.88	1.60E-03	0.3195	10.42	1,315	0.0079	<b>3.96E-05</b>	<b>4.10E+01</b>
B16	B28	8.17E-04	174.56	1.81E-03	0.329	32.74	1,270	0.0258	<b>1.42E-04</b>	<b>1.47E+02</b>

Upgradient Well	Downgradient Well	Hydraulic Conductivity (K) (cm/sec)	Groundwater Elevation (ft-msl)	Average K (cm/sec) [1]	Average $\eta$	$\Delta h$ (ft)	$\Delta l$ (ft)	$\Delta h/\Delta l$	Linear Velocity (cm/sec)	Linear Velocity (inches/month)
B26	NA	5.50E-06	206.03	NA	NA	NA	NA	NA	NA	NA
B26	B27	3.85E-04	196.88	1.95E-04	0.4095	9.15	1,173	0.0078	<b>3.72088E-06</b>	<b>3.85E+00</b>
B26	B28	8.17E-04	174.56	4.11E-04	0.419	31.47	1,613	0.0195	<b>1.91553E-05</b>	<b>19.81894589</b>

Groundwater Velocity Equation

$$V_{\eta} = \frac{K}{\eta} \times \frac{\Delta h}{\Delta l}$$

$V_{\eta}$  = linear groundwater velocity

$K$  = hydraulic conductivity (cm/sec)

$\eta$  = effective porosity (unitless)

$\Delta h$  = change in head between wells (ft)

$\Delta l$  = distance between wells (ft)

[1] Average hydraulic conductivity is the average hydraulic conductivities between B16 or B26 and identified well.

<b>Groundwater Velocity Mean</b>	<b>2.52E-05 cm/sec</b>	<b>2.60E+01 inches/month</b>
<b>Groundwater Velocity Median</b>	<b>2.94E-05 cm/sec</b>	<b>3.04E+01 inches/month</b>