

# HYDROGEOLOGIC EVALUATION



RITNER HIGHWAY WAREHOUSES  
3485 RITNER HIGHWAY  
NEWVILLE, CUMBERLAND COUNTY, PENNSYLVANIA

ECS PROJECT NO. 47:20270

FOR

APPALACHIAN ASSET MANAGEMENT

DECEMBER 9, 2024





December 9, 2024

Mr. Andrew Kronenberg  
Appalachian Asset Management  
1514 Commerce Avenue  
Carlisle, Pennsylvania 17015

ECS Project No. 47:20270

Reference: Hydrogeologic Evaluation, Ritner Highway Warehouses, 3485 Ritner Highway, Newville, Pennsylvania

Dear Mr. Kronenberg:

ECS Mid-Atlantic, LLC (ECS) is pleased to provide you with the results of the Hydrogeologic Evaluation for the above-referenced property. Our services were provided in general accordance with ECS Proposal No. 47:36442 authorized on November 19, 2024. ECS appreciates the opportunity to assist you with this project. If you have any questions or comments regarding this report, or any other aspect of the project, please contact us at 717-589-9610.

Respectfully submitted,

ECS Mid-Atlantic, LLC

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## 1.0 INTRODUCTION

The purpose of this study was to conduct a hydrogeologic investigation to support permitting of a warehouse development at the site located at 3486 Ritner Highway, Newville, Cumberland County, Pennsylvania. Our services were provided in accordance with ECS Proposal No. 47:35179-EP, dated November 18, 2024, as authorized on November 19, 2024, which includes our terms and Conditions of Service.

The scope of work completed with the second proposal was in response to comments from the Pennsylvania Department of Environmental Protection (PADEP) *Technical Deficiency Letter* dated November 4, 2024, and the determination by ECS and the design team that additional study and testing was warranted to address the comments. Specifically, this report includes the results of a hydrogeologic assessment that was performed to further evaluate current hydrogeologic conditions at the site and the potential impacts of the proposed development on groundwater.

The scope of our evaluation includes a review of geology and hydrogeologic literature for the site area, a review of previous geotechnical and hydrogeological studies of the site, a review of local well records, the installation of a new monitoring well, and the monitoring of water levels. This report is intended to support the response to the PADEP comments on the hydrogeologic impact of the proposed development.

## 2.0 SITE DESCRIPTION AND PROPOSED DEVELOPMENT

A site location map is provided in as Figure 1. The site is currently developed with two single-story homes along Ritner Highway, 3497 and 3499 Ritner Highway. The home at 3497 Ritner Highway is vacant. The home at 3499 is occupied by the property owner. A well serves each of the homes, but the well at 3497 Ritner Highway does not have a functioning pump. A vacant farmstead is located on the center of the property and includes a vacant house in poor condition and a collapsed barn. A well is located near the farmhouse but does not have a functioning pump and is covered and inaccessible. The remainder of the site is farmland with some wooded sections.

The proposed construction is comprised of a Proposed Warehouse Development consisting of three (3) Warehouses with associated pavement areas, retaining walls, and stormwater management (SWM) facilities. An aerial site plan showing current conditions and the development concept is included as Figure 2. Based on the provided "Preliminary/Final Land Development and Subdivision Plan for AAMPA Holdings – Ritner Hwy", dated November 15, 2023, by Frederick, Seibert & Associates, Inc. (FSA) the SWM facilities are comprised of a combination of below grade and at-grade facilities. Specifically, seven (7) facilities are proposed to consist of below-pavement facilities while seven (7) of the facilities are proposed to consist of at-grade basins.

## 3.0 GEOLOGY AND HYDROGEOLOGY

The site is located within the Great Valley Section of the Ridge and Valley Province (Pennsylvania Department of Conservation and Natural Resources [PA DCNR], 2023). The Great Valley section is a broad karst valley in the site area underlain by limestone and dolomite. The stratigraphic units are highly folded and faulted.



According to PA DCNR, Bureau of Geologic Survey mapping (2024), the site bedrock consists of the Rockdale Run Formation, the Shadygrove Formation, and the Stonehenge Formation. A geologic map is provided as Figure 3. When a site is located near existing geologic contacts, the site often exhibits characteristics of those rock types. These formations are described as having the following characteristics (Geyer and Wilshusen, 1982):

- The Rockdale Run Formation consists of very light gray, finely laminated, fine-grained limestone with pink to brown lenses of chert, minor dolomite beds, and abundant quartz. The bottom portion of the formation is medium-bedded and thick bedded in the upper portion. Jointing and fracturing is moderately well developed in a blocky manner, regularly spaced, and open and steeply dipping throughout the formation. It is moderately resistant to weathering. Prolonged exposure and weathering has formed a highly uneven and pinnacled soil-rock interface. It should be expected that the depth to bedrock and/or large cobbles and boulders will be variable. Solution channel openings provide moderate to high secondary porosity.
- The Shadygrove Formation consists of light gray to pinkish gray, finely crystalline limestone, with abundant nodules of brown chert, few sandstone beds, and few beds of laminated dolomite. Jointing and fracturing is moderately well developed in a blocky manner, regularly spaced, and open and steeply dipping throughout the formation. It is moderately resistant to weathering. Prolonged exposure and weathering have formed a highly uneven and pinnacled soil-rock interface. It should be expected that the depth to bedrock and/or large cobbles and boulders will be variable. Solution channel openings provide moderate to high secondary porosity.
- The Stonehenge Formation is included within the Beekmantown Group (ob) and is composed of gray, finely crystalline limestone and dark gray laminated limestone with numerous flat-pebble breccia and shale interbeds. The formation is moderately well to well bedded in a thin to flaggy manner. Fracturing and jointing is poorly to moderately well-developed and abundant, seamy, open, and steeply dipping. Moderate weathering to a shallow depth takes the form of rectangular fragments. Due to the pinnacled nature of the bedrock surface the soil mantle varies greatly. The formation has good subsurface drainage due to joint-, bedding-, solution channel openings providing moderate to high magnitude secondary porosity.

Limestone is carbonate based, and therefore, prone to dissolution in water and karst processes including sinkhole formation. PA DCNR (2024) does not map any karst features on the site, but surface depressions are mapped on surrounding properties, as shown on Figure 3.

Becher and Root (1981) and the PA DCNR (2024) map an anticline axis running north-south through the center of the site, with bedding orientation varying due to this fold. A fault is also mapped through the western corner of the site. Three fracture traces are mapped by Becher and Root extending to the eastern portion of the site trending northwest-southeast. Nearby mapped fold axis, faults and fracture traces are shown on Figure 3.

There are no surface water features on-site. The closest water bodies to the site are Big Spring Creek which is 3,300 feet west of the site and flows northward, Big Spring which is located 4,000 feet west of the site and is a source to Big Spring Creek. The surface water features are shown on the topographic map included as Figure 1.

A regional groundwater contour map in Becher and Root (1981) shows the elevation of groundwater at the site, ranging from approximately 560 along Newville Road to 540 at the northern property boundary. The groundwater gradient in the site area is mapped to the northwest towards Big Spring Creek.

#### 4.0 PREVIOUS REPORTS

ECS prepared a "Geotechnical Engineering Report" dated June 30, 2023 and a "Geotechnical Engineering Report for Stormwater Management, Proposed Ritner Highway Warehouses" dated May 20, 2023 and revised on December 6, 2024. The reports are provided under separate cover. During these investigations, ECS conducted soil and rock borings, test pits, conducted infiltration testing, conducted a karst assessment and installed piezometers. Overburden material consisted of generally lean clay, fat clay or silt with varying amount of gravel and sand. The underlying bedrock was highly to moderately weathered gray limestone. The thickness of overburden varied, at some locations the bedrock was exposed at the ground surface and in other locations the overburden was greater than 15 feet below ground surface (bgs). At most locations, the bedrock was encountered at depths of less than 10 feet bgs. Several animal borings and four subsurface depressions were observed, along with two sinkholes near the western property line. The stormwater infiltration testing found infiltration rates of 0.0 to 6.85 inches per hour.

ECS also conducted a limited geophysical investigation, as summarized in the December 6, 2024 report, to evaluate potential karst features in the areas of planned stormwater management basins. An electromagnetic survey was conducted across the site and electrical resistivity survey lines were conducted in areas where significant excavation is planned to install stormwater management basins. Wildcat probes were advanced in areas where geophysical anomalies were identified that had not been previously evaluated through borings or test pits. Refusal on bedrock was found at 12 feet bgs or less, and extensive areas of loose soil were not observed; significant karst features were not identified.

ECS received a memorandum to Robert J. Sabatini dated November 27, 2024 from Dr. William Seaton, PhD of ARM Group, LLC. A copy of this memorandum is included in Appendix I. This memorandum describes the geology and hydrogeology of the site area and potential concerns for groundwater impacts related to the proposed development of the site. Dr. Seaton conducted a fracture trace analysis using mapped faults and fractures from geologic literature as well as interpolated faults and fractures using digital topographic data. Dr. Seaton interpolated several fracture traces across the site. The potential for groundwater impacts are related to the karst bedrock conditions and the potential for rapid downward vertical infiltration through relatively porous overburden, karst features and fractures in the bedrock. Dr. Seaton concluded the potential contamination could impact Big Spring (4,000 feet west of the site), Big Spring Creek (3,300 feet west of the site) and Cool Spring (about 12,300 feet north from the site). Dr. Seaton recommended conducting a detailed hydrogeological investigation to evaluate groundwater conditions.

## 5.0 FRACTURE TRACE ANALYSIS

ECS conducted a fracture trace analysis to search for lineaments on the property that may indicate underlying fractures in the bedrock. ECS reviewed LiDAR topography data, as shown in Figure 3 in Appendix I, historic topographic and aerial photographs on Historic Aerials' on-line database (<https://www.historicaerials.com/>), aerial photographs from Google Earth, and geologic maps. Faults and fracture traces identified by others are discussed in Sections 3 and 4.

ECS identified three parallel potential fracture traces oriented northeast-southwest extending to the western portion of the site, as shown on a map of contour LiDAR topographic data provided as Figure 4. These traces were also identified by Dr. Seaton of ARM Group LLC (2024). ECS did not identify the other fracture traces interpolated by Dr. Seaton or Becher and Root (1981) on-site based on the references reviewed.

## 6.0 ON-SITE AND NEARBY WELL INFORMATION

Information from nearby wells was obtained from the online Pennsylvania Drinking Water Reporting System. Well records from the five closest wells are included in Appendix II. Two wells are mapped on-site. These include:

- A well owned by William Miller was installed in August 1988. The well was a six-inch diameter well with an open hole from 109 to 260 feet. The geologic layers recorded included: clay to nine feet bgs, broken limestone from 9 to 34 feet bgs, limestone and voids from 34 to 92 feet and limestone from 93 to 260 feet. A water-bearing zone was noted at 228 feet bgs. The well yield was 8 gallons per minute (gpm).
- A well owned by Fred Miller was installed in 2007. The well was a six-inch diameter well with an open hole from 100 to 245 feet bgs. The geologic layers recorded included: clay to two feet below ground surface, fractured limestone with mud and voids from 2 to 68 feet bgs, limestone from 68 to 205 feet, fractured limestone with mud and water at 205 to 210 feet bgs, and limestone from 210 to 245. A water-bearing zone was noted at 205 to 210 feet bgs. The water level of the well was reported at 80 feet bgs and the well yield was 20 feet bgs.

The three nearest off-site mapped wells, located south of Ritner Highway, also reported similar conditions, with water-bearing zones not encountered until depths of 145 feet or greater in the limestone bedrock. Well yields in these wells were reported as 20 to 50 gpm.

## 7.0 MONITORING WELL INSTALLATION

ECS subcontracted Negley's Well Drilling of Newburg, PA to install a monitoring well on the property on November 19, 2024. The monitoring well, PZ-01 was installed in the northern portion of site, as shown on Figure 2. The well was drilled using air rotary drilling techniques. A nine-inch boring was drilled to 40 feet bgs. Six-inch steel casing was installed to 40 feet below ground surface and the annular space was sealed with bentonite. An six-inch open rock hole was drilled from 40 to 150 feet below ground surface. A well construction summary with a geologic log is included in Appendix IV.

Brown silt and clay was encountered from ground surface to 10 feet bgs. Weathered limestone was encountered from 10 feet to 15 feet bgs. Limestone was encountered with from 15 to 150 feet bgs. No water-bearing zones were encountered the following weathered zones and fractures were encountered:

- A softer, weathered zone from 30 to 35 feet bgs,
- A soft zone from 75 to 78 feet bgs
- A fracture or void from 88 to 89 feet bgs, quick drop in rods
- A fracture or void at 104 feet bgs.

At the end of drilling, the driller flushed out the hole with water and removed the water with compressed air. The well was completed with a stickup cover and bolted cap. No water was in the boring immediately after drilling but a few inches of water was encountered in the well after an hour wait. After an overnight wait, water had risen to a depth of 85 feet below the top of casing and was continuing to rise. Groundwater monitoring is discussed in Section 8.0.

## 8.0 GROUNDWATER MONITORING

ECS monitored the water level in PZ-01 and the well at the vacant house at 3497 Ritner Highway. The locations of these wells are shown on Figure 2. ECS was not permitted to access the domestic well currently used to supply the home at 3499 Ritner Highway and could not access the farmhouse well. Photographs of the wells and the site are provided in Appendix III.

The depth-to-water measurements are provided in Table 1. ECS returned to the site multiple times to confirm that the water table had stabilized in well PZ-01, as it was slow to stabilize due to the poor well yield. During this time, the depth of water in the well at 3497 Ritner Highway was consistent at about 117 feet below top of the well casing, corresponding to an elevation of about 528 feet. The water level in PZ-01 stabilized to about 78 feet below top of casing, corresponding to an elevation of about 519 feet. The groundwater elevation is lower in the northern portion of the site, which is consistent with a groundwater flow to the northwest, as reported by Becher and Root (1981).

## 9.0 FINDING AND CONCLUSIONS

The bedrock in the site area is limestone of the Rockdale Run Formation, the Shadygrove Formation, and the Stonehenge Formation. The overburden thickness varies, as is common in karst areas, but is generally is less than 10 feet across the site. Rock outcrops have been observed in several areas of the site.

The limestone underlying the site is subject to karst weathering. ECS observed four surface depressions on the site and two sinkholes along the western property line. Fracture traces have been identified on the site as part of a fracture trace analysis conducted during this evaluation by Becher and Root (1981) and ARM Group, LLC (2024). An electromagnetic survey was conducted across the site and electrical resistivity survey lines were conducted in areas where significant excavation is planned to install stormwater management basins. Wildcat probes were advanced in areas where geophysical anomalies were identified in the electrical resistivity lines that had not been previously evaluated through borings or test pits. Refusal on bedrock was found at 12 feet bgs or less,

and extensive areas of loose soil were not observed. Significant karst features or bedrock fracture zones extending to the surface that could provide a potential for rapid movement of surface water to groundwater were not identified.

ECS evaluated the depth of groundwater at the site. A new monitoring well, PZ-1 was installed to 150 feet deep in the northern portion of the site. At PZ-1, weathered bedrock was encountered at 10 feet below ground surface and competent limestone was encountered at 25 feet bbs. Consistent with nearby well records from a PA DCNR database; no significant water-bearing zones were found to a depth of 150 feet bbs. Water slowly entered the PZ-1 over at least a day, and the water depth stabilized at about 78 feet below the top of casing, corresponding to an elevation of about 519 feet. ECS also monitored the water level at an unused well at 3497 Ritner Highway, which was at a depth of about 117 feet below the top of the well casing, corresponding to an elevation of about 528 feet. The groundwater elevation is lower in the northern portion of the site, which is consistent with a groundwater flow to the northwest, as reported in the hydrogeologic literature.

Based on this investigation, ECS concludes that the proposed development will have little effect on the underlying hydrogeologic conditions. Groundwater at the site is encountered at depths of greater than 75 feet bbs and significant water-bearing zones in site wells and nearby wells have not been encountered until depths of 145 feet bbs or greater. In most areas of the site, the top of bedrock is less than 10 feet bbs. The proposed construction will have little effect on the underlying groundwater flow, given the depth to groundwater and water-bearing zones in bedrock.

Recharge of the underlying aquifer will be maintained through the stormwater basins planned on-site. Significant karst features or bedrock fracture zones extending to the surface that could provide a potential for rapid movement of surface water to groundwater were not identified in the limited geophysical study conducted. For basins that are going to be excavated into rock, a minimum of two feet of soil blend is recommended to be added at the bottom of the excavation, as recommended in ECS's Geotechnical Engineering Report for Stormwater Management, Proposed Ritner Highway Warehouses" dated May 20, 2023 and revised on December 6, 2024. This soil will provide filtration of any sediment in the stormwater.

## 10.0 RECOMMENDATIONS

To mitigate potential groundwater impacts from karst features, the recommendations in ECS's "Geotechnical Engineering Report for Stormwater Management, Proposed Ritner Highway Warehouses" dated May 20, 2023 and revised on December 6, 2024. These include recommendations for drainage features to minimize the potential for future sinkhole development and guidelines for sinkhole repair.

ECS also recommends the following:

- If the monitoring and supply wells are no longer to be used at the property, they should be properly abandoned in accordance with PA DCNR and PADEP guidance.
- The existing sinkholes observed on the western boundary of the site should be repaired under the guidance of ECS's Geotechnical Engineer.

## 11.0 QUALIFICATIONS

The conclusions presented within this report are based upon a reasonable level of investigation within normal bounds and standards of professional practice for a site in this particular geographic and geologic setting, and the areas of the site accessible for observation.

All observations, conclusions, and recommendations pertaining to environmental conditions at the subject site are limited to conditions observed and/or materials reviewed at the time this study was undertaken. No other warranty, express or implied, is made with regard to the conclusions and recommendations presented within this report. ECS has not completed or used any form of predetermined language to report the conclusions of this work, and it is our understanding that we will not be required to do so. Compensation for this investigation is not contingent upon results, and ECS has conducted this study objectively without reference to any particular outcome desired by the client.

This letter is provided for the exclusive use of Appalachian Asset Management. This report is not intended to be used or relied upon in connection with other projects or by other unidentified third parties. The use of this letter by any undesignated third party or parties would be at such party's sole risk and ECS disclaims liability for any such third party use or reliance.

## 12.0 REFERENCES

Becher, A. E. and Root, S. I., Groundwater and Geology of the Cumberland Valley, Cumberland County, Pennsylvania, Commonwealth of Pennsylvania, Department of Environmental Resources, Topographic and Geologic Survey, Water Resources Report 50, 1981.

Geyer, A. R., and Wilshusen, J. P., Engineering Characteristics of the Rocks of Pennsylvania (Second Edition), Pennsylvania Geologic Survey, Environmental Geology Report 1, 1982.

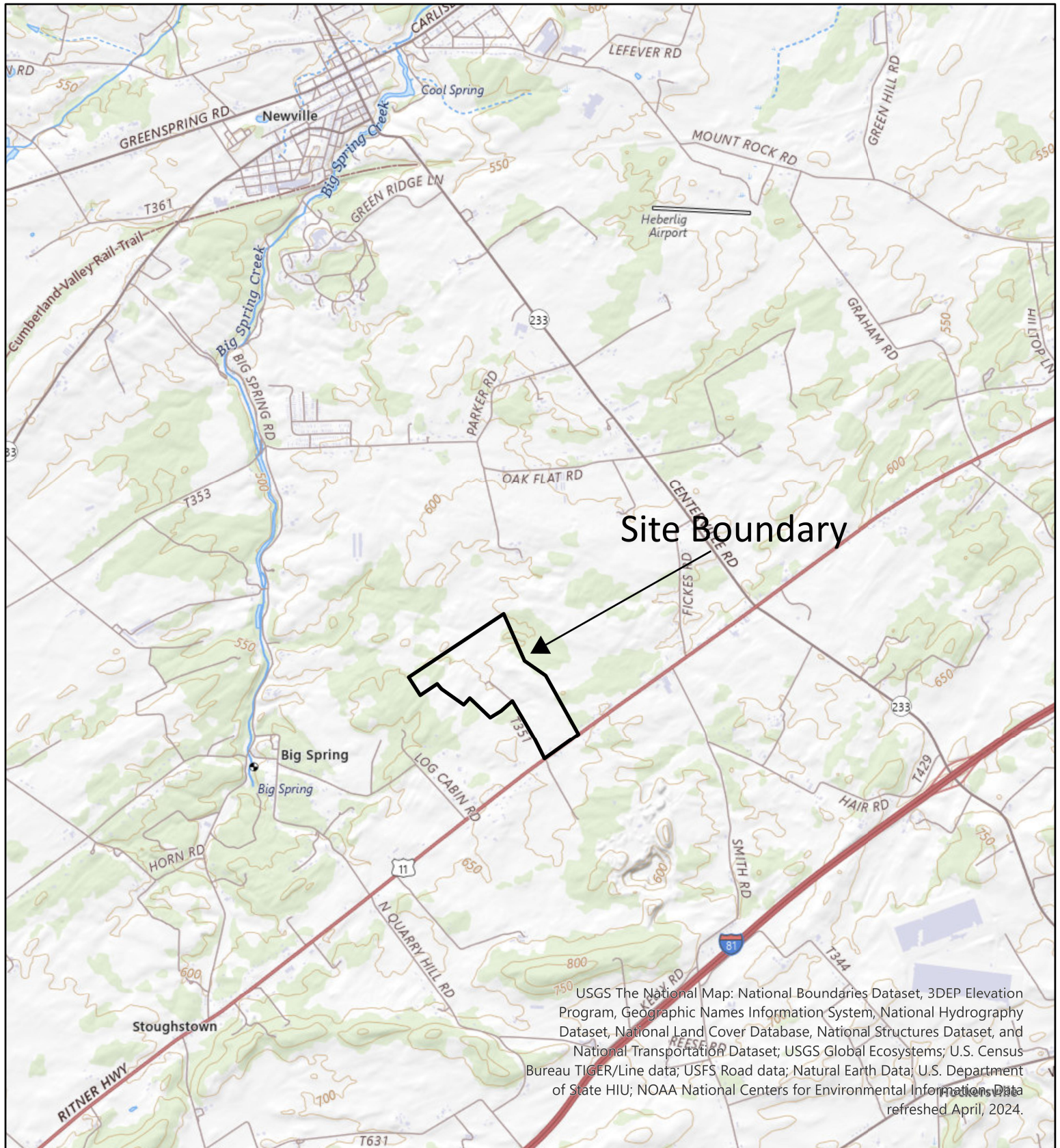
Pennsylvania Department of Conservation and Natural Resources, Bureau of Geological Survey, Pennsylvania Geologic Data Exploration online map, <https://maps.dcnr.pa.gov/pageode/> , accessed December 6, 2024.

Pennsylvania Department of Conservation and Natural Resources, Bureau of Geological Survey, Physiographic Provinces of Pennsylvania, Map 13, 2023.

Seaton, W. Memorandum to Robert J. Sabatini, Newville Borough Manager. RE: AAMPA Holdings - Ritner Hwy Project, West Pennsboro Township, Cumberland County, Pennsylvania. November 18, 2024.

# FIGURES





## Legend

 Site Boundary



## Figure 1: Site Location Map

ECS Project No. 20270  
Ritner Highway Hydrogeologic Assessment  
3501 Ritner Highway,  
Newville, PA 17241

0 1,500 3,000 6,000  
Feet

Credit:  
-Topographic Map Obtained from the USGS





## Legend

- Monitoring Well
- ▲ Supply Well 3497 Ritner Hwy
- Site Boundary



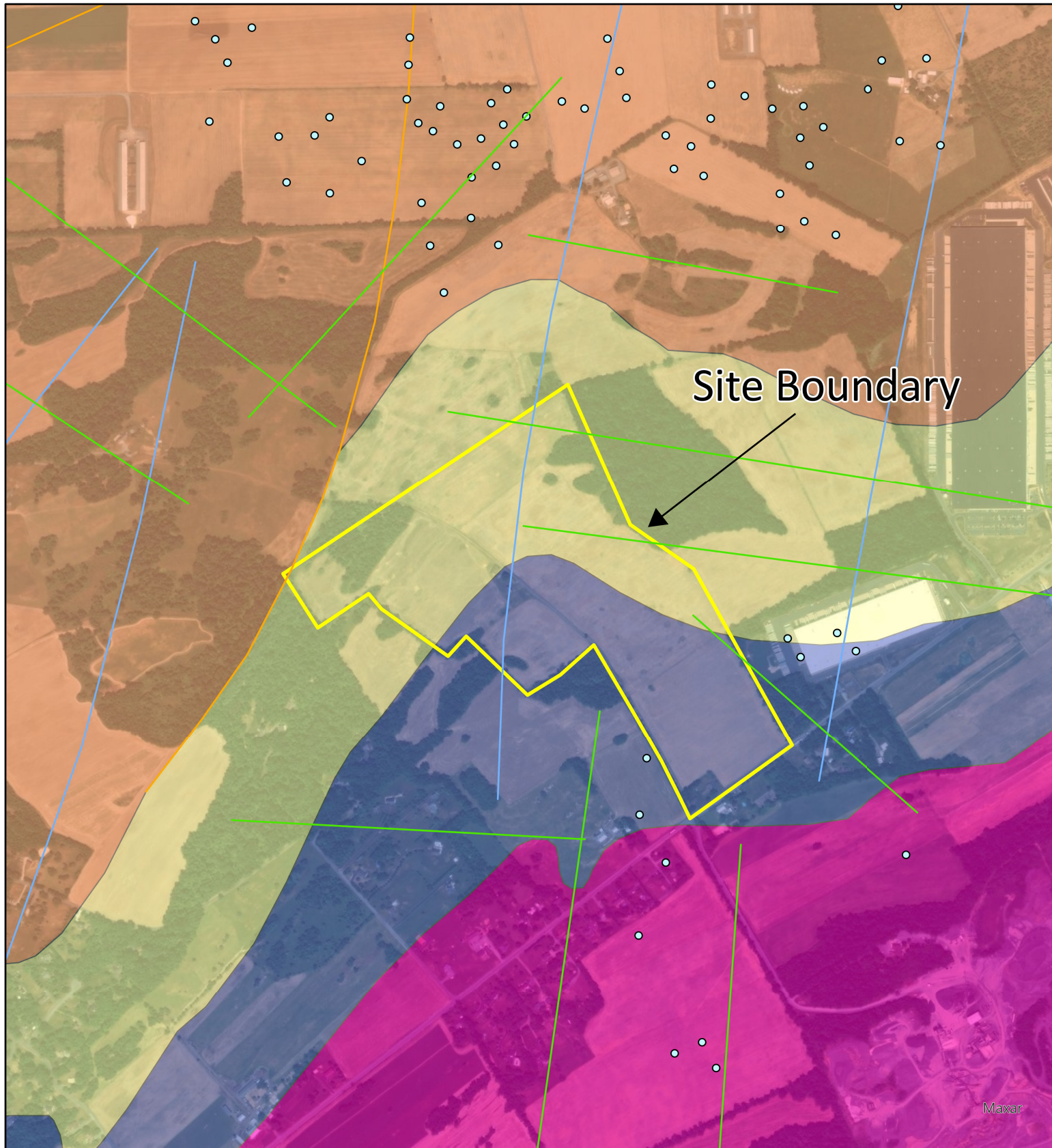
## Figure 2: Site Plan

ECS Project No. 20270  
 Ritner Highway Hydrogeologic Assessment  
 3501 Ritner Highway,  
 Newville, PA 17241

0 500 1,000 2,000  
 Feet

Credit:  
 -Aerial image obtained from Pennsylvania Imagery Navigator  
 -Development crop created by FSA INC.





### Legend

- PA DCNR Karst Features- Surface Depression
- PA DCNR Mapped Folds
- PA DCNR Mapped Faults
- Fracture Trace from Becher and Root (1982)
- Rockdale Run Formation
- Shadygrove Formation
- Stonehenge Formation
- Zullinger Formation
- Site Boundary



### Figure 3: Bedrock Geology Map

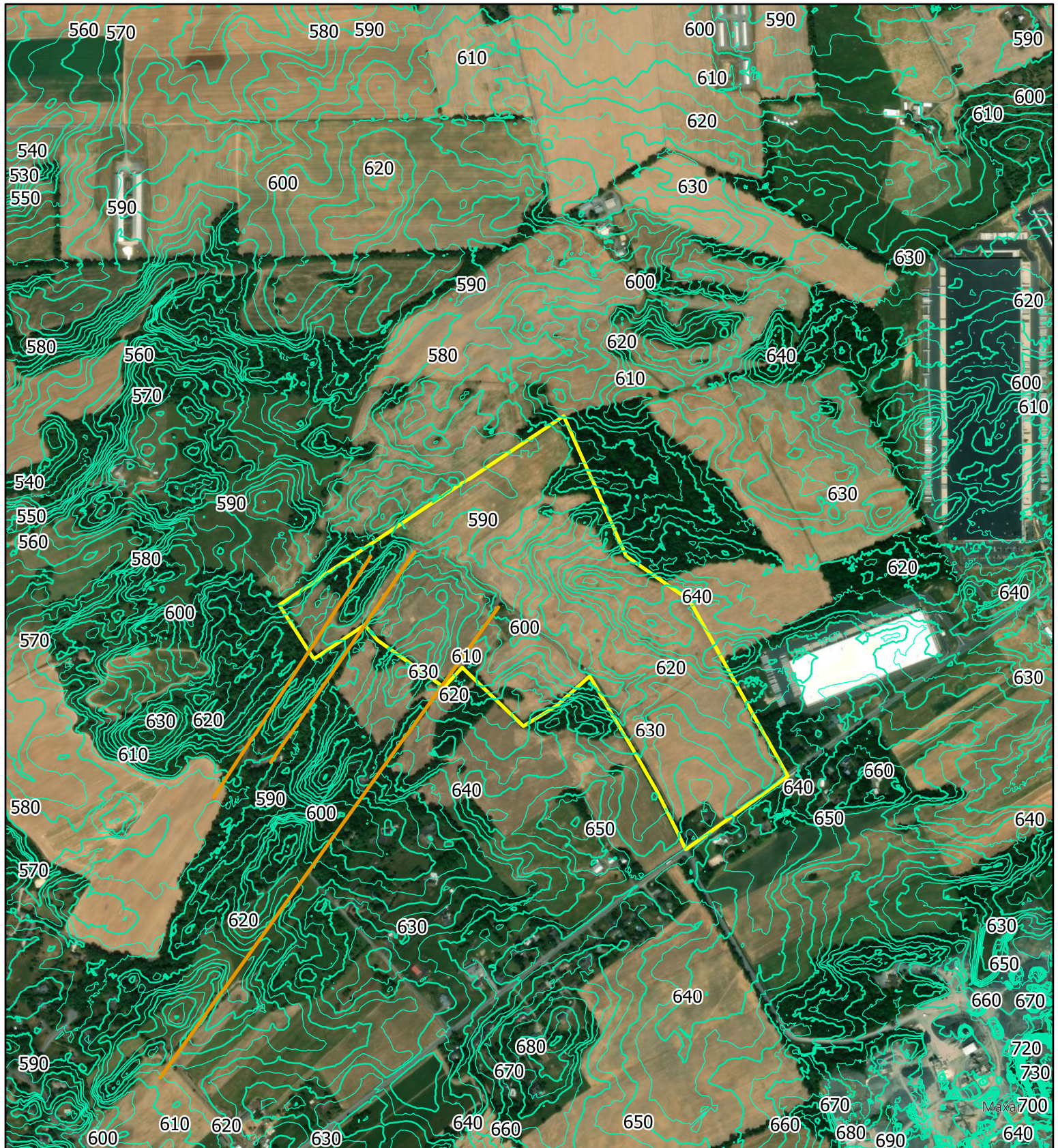
ECS Project No. 20270  
 Ritner Highway Hydrogeologic Assessment  
 3501 Ritner Highway,  
 Newville, PA 17241

0 500 1,000 2,000  
 Feet

#### Credit:

-Aerial image obtained from Pennsylvania Imagery Navigator  
 -PA Bedrock, Faults, Folds, and Karst Features obtained from the PA DCNR Pa Geode Map





## Legend

- ECS Interpolated Fracture Trace
- Contour - 10ft
- Contour - 5ft
- Site Boundary

Credit:  
 -Aerial image obtained from Pennsylvania Imagery Navigator  
 -Lidar data obtained from the PASDA and published by PA DCNR



## Figure 4: Lidar Contour Map

ECS Project No. 20270  
 Ritner Highway Hydrogeologic Assessment  
 3501 Ritner Highway,  
 Newville, PA 17241

0 500 1,000 2,000  
 Feet



# TABLES

Table 1  
Groundwater Elevation Data Summary  
3501 Ritner Highway, Newville, PA

| Well Identifier                    | Open Hole Depth (feet) | Approximate Top of Casing Elevation (feet MSL) | Measurement Date | Depth to Water (feet below top of casing) | Groundwater Elevation (feet MSL) |
|------------------------------------|------------------------|------------------------------------------------|------------------|-------------------------------------------|----------------------------------|
| PZ-01                              | 40-150                 | 597.76                                         | 11/20/2024 *     | 149.90                                    | 447.86                           |
|                                    |                        |                                                | 11/21/2024       | 85.08                                     | 512.68                           |
|                                    |                        |                                                | 11/27/2024       | 78.81                                     | 518.95                           |
|                                    |                        |                                                | 12/2/2024        | 77.89                                     | 519.87                           |
| Supply Well 3497<br>Ritner Highway | Unknown                | 645.40                                         | 11/20/2024       | 116.79                                    | 528.61                           |
|                                    |                        |                                                | 11/21/2024       | 116.81                                    | 528.59                           |
|                                    |                        |                                                | 11/27/2024       | 117.21                                    | 528.19                           |
|                                    |                        |                                                | 12/2/2024        | 117.41                                    | 527.99                           |

Notes:  
Elevations for all wells were collected using site topographic information  
MSL - Mean Sea Level  
\* - Well installed on this date.

# **Appendix I: Previous Reports**



LAW OFFICES  
**IRWIN & McKNIGHT, P.C.**

MARCUS A. McKNIGHT, III  
MATTHEW A. McKNIGHT

WEST POMFRET PROFESSIONAL BUILDING  
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CARLISLE, PENNSYLVANIA 17013-3222

Of Counsel:  
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HAROLD S. IRWIN (1925-1977)  
HAROLD S. IRWIN, JR. (1954-1986)  
IRWIN, IRWIN & IRWIN (1956-1986)  
IRWIN, IRWIN & McKNIGHT (1986-1994)  
IRWIN, McKNIGHT & HUGHES (1994-2003)  
IRWIN & McKNIGHT (2003-2008)

November 27, 2024

**HUBERT X. GILROY, ESQUIRE  
MARTSON LAW OFFICE  
TEN EAST HIGH STREET  
CARLISLE, PA 17013**

**RE: AAMPA SITE  
REPORT OF WILLIAM J. SEATON, Ph.D., P.G.,  
SENIOR HYDROGEOLOGIST/PROJECT MANAGER,  
ARM GROUP, LLC**

Dear Hubert:

Enclosed please find a copy of the report of William J. Seaton, Senior Hydrogeologist/Project Manager, for ARM Group, LLC., which outlines his recommendations for the AAMPA site located in West Pennsboro Township. Please review this report with your experts.

Please call me if you have any questions.

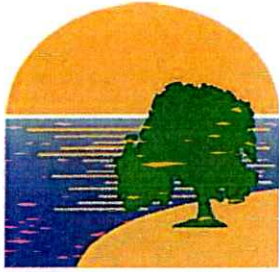
Very truly yours,

**IRWIN & McKNIGHT, P.C.**



Marcus A. McKnight, III

MAM:sls  
Enclosure  
cc: Borough of Newville  
William J. Seaton, Ph.D., P.G.



# ARM GROUP LLC

## MEMO

To: Robert J. Sabatini, Newville Borough Manager, Newville, PA  
From: William Seaton, Senior Hydrogeologist, ARM Group LLC  
Date: November 18, 2024  
Re: AAMPA Holdings – Ritner Hwy Project, West Pennsboro Township, Cumberland County, Pennsylvania

Robert,

ARM Group LLC (ARM) has conducted a hydrogeologic review and analysis of the suitability of the AAMPA Holdings – Ritner Hwy Project (AAMPA Site), a proposed commercial development located

within the Big Spring / Cool Spring Topographic Watershed in West Pennsboro Township, Cumberland County, PA (Figure 1, Site Area Topographic Map).

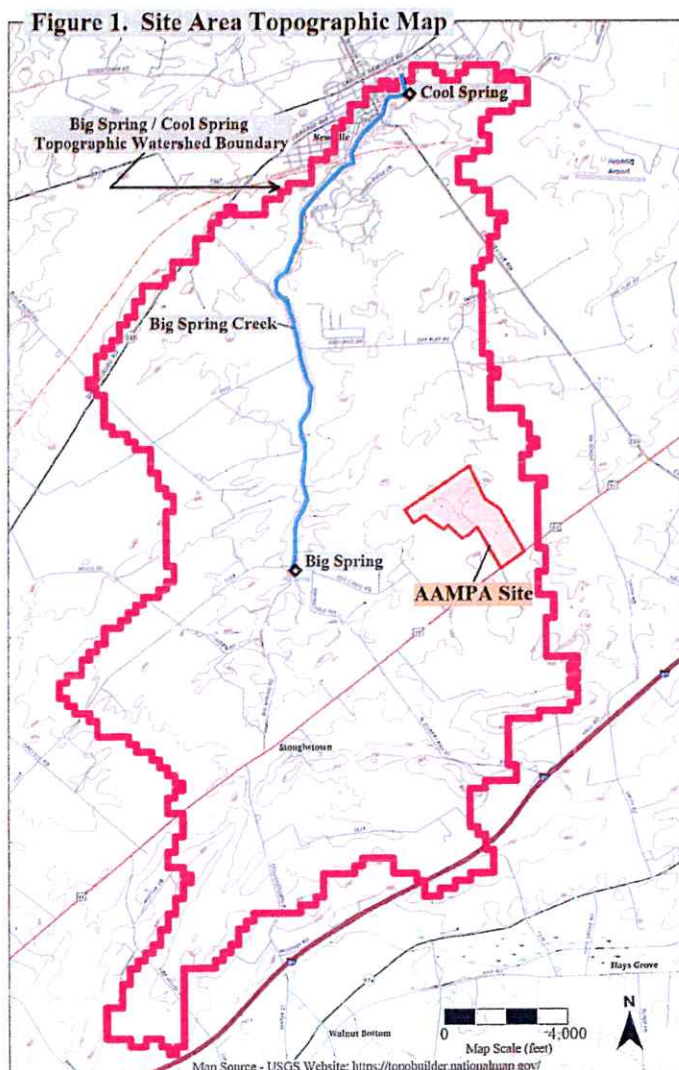
ARM conducted a review of the following sources of information for this project:

1) AAMPA Site Documents

- Geotechnical Engineering Report, ECS Mid-Atlantic LLC, June 20, 2023.
- Geotechnical Engineering Report for Stormwater Management, ECS Mid-Atlantic LLC, May 30, 2023.
- Post Construction Stormwater Management Report for the AAMPA Site, June 2024.
- Erosion and Sediment Control Plan, 2/26/24
- Post Construction Stormwater Management Plan, 11/15/23

2) Relevant published information regarding the geology and hydrogeology of Cumberland County and the Site area (see **References** section below).

3) ARM also conducted a fracture trace / bedrock structural analysis of the AAMPA Site area using digital topographic data and published information.

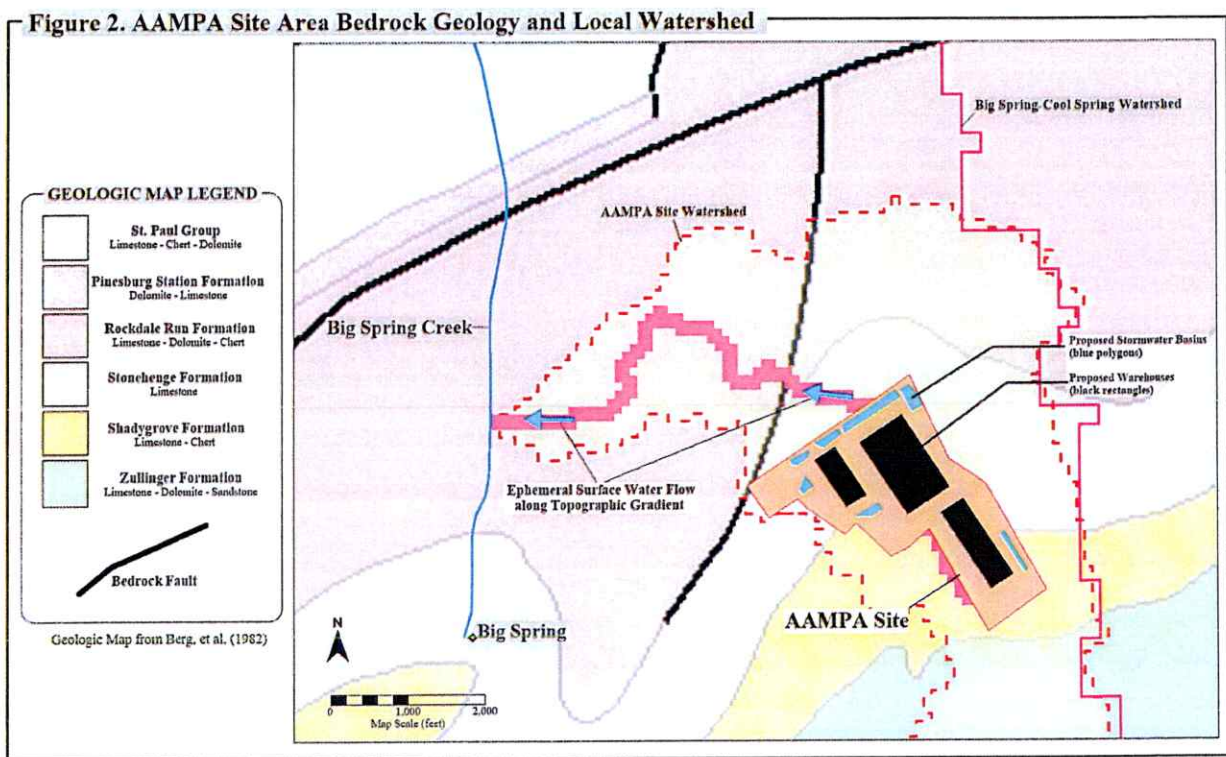




The following represents our concerns regarding the development of the AAMPA Site:

### Potential for Groundwater Contamination

- The AAMPA Site is located within the Big Spring – Cool Spring Watershed (refer to **Figures 1-4**) which is underlain by faulted and fractured carbonate (karst) bedrock geology. The karst bedrock conditions provide for relatively rapid downward vertical infiltration of precipitation through relatively porous overburden and bedrock as noted by the absence of significant wetlands, streams, or related surface water features in the site area. In addition, the presence of a relatively continuous water table aquifer throughout the Big Spring – Cool Spring Watershed (Becher & Root, 1981) is likely due to higher regional hydraulic transmissivities in the overlying overburden and bedrock.
- Ephemeral surface drainage following precipitation events or snow melt tends to flow westward toward Big Spring Creek (**Figure 2, AAMPA Site Area Bedrock Geology and Local Watershed**).



- Groundwater flow is controlled by open fractures and fault zones in the bedrock. Mapped faults (Berg, et al, 1982, **Figures 2 and 3**) and interpreted faults and fractures (**Figure 3, ARM**) indicate a complexly faulted and fractured subsurface (Becher & Root, 1981).
- Groundwater recharge is estimated to be > 10 inches per year in the site area (Reese and Risser, 2010). Groundwater recharge associated with bedrock faults or fractures may focus significant volumes of surface water runoff through localized high transmissivity zones in deeper bedrock aquifers.
- Groundwater flows west – northwest from the AAMPA Site toward Big Spring Creek as indicated by water table mapping in Becher & Root, 1981 (refer to **Figure 4**).
- The AAMPA Site is underlain and adjacent to several interpreted fault/fracture zones, dipping bedrock, and associated bedding planes that can serve as localized conduits to rapidly move surface water into the

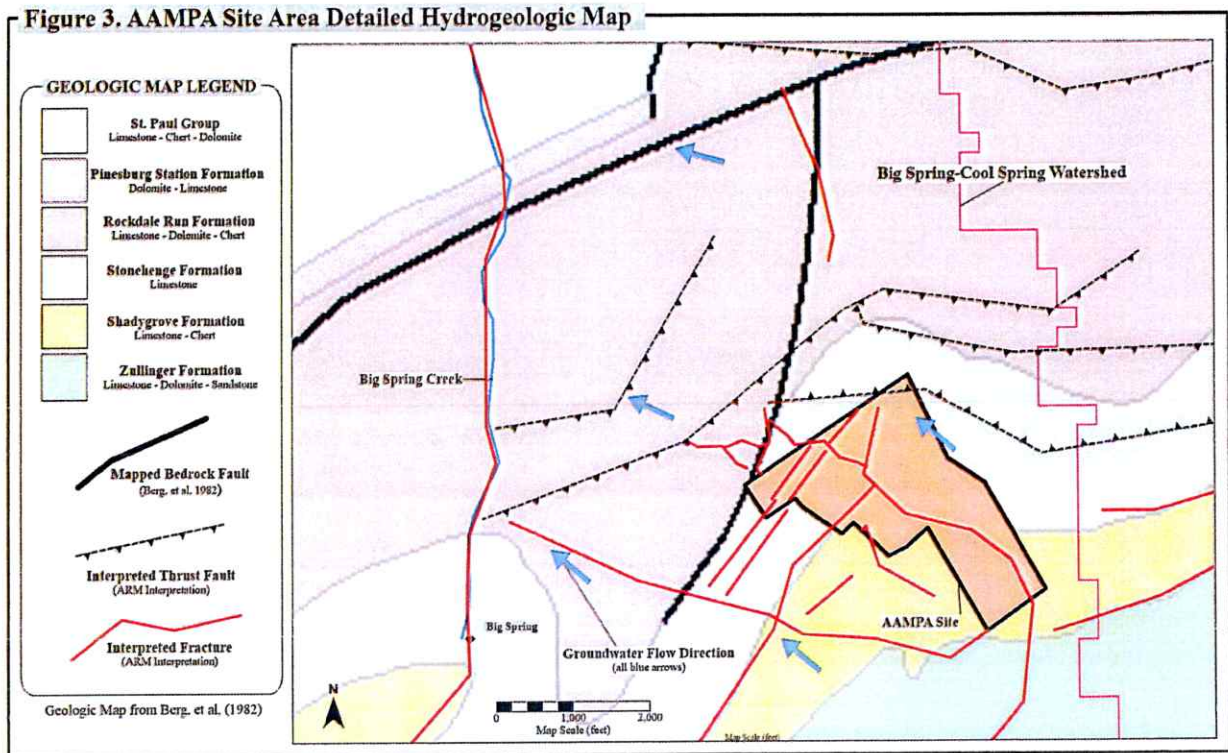


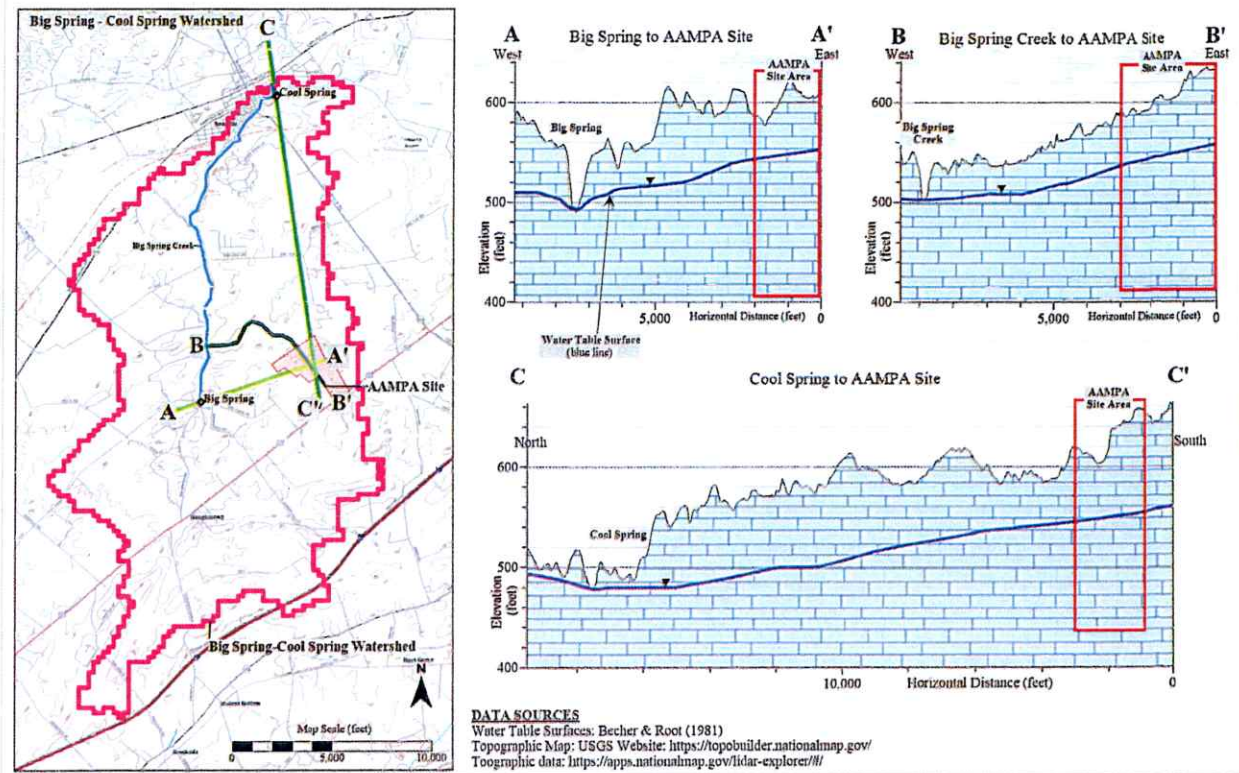


subsurface and to downgradient water resources such as Big Spring, Big Spring Creek, Cool Spring, homeowner wells, local springs, etc.

- Significant proposed ground cover removal (nearly 100% of the site area, ~ 112 acres) and blasting of bedrock is planned for the construction phase at the AAMPA Site.
- Significant / serious risks of downgradient contamination exist following precipitation events that may occur during the construction phase of this project or following potential malfunctions in the planned stormwater management measures (e.g., stormwater basins, conveyances, etc.).
- Sources of groundwater contamination may include unconsolidated bedrock weathering products (mud, silt, rock fragments, etc.), dissolved solids, chlorides, nitrates, bacteria, and other potentially harmful substances that are introduced into the bedrock aquifers by surface disturbances (excavation, blasting, etc.). These types of water quality issues can persist beyond a potential contamination event in karst terranes.

**Figure 3. AAMPA Site Area Detailed Hydrogeologic Map**



**Figure 4. Hydrogeologic Cross Sections**

### Potential Degradation of Big Spring, Big Spring Creek, and Cool Spring

Potential contamination as described above could impact water quality in the downgradient Big Spring, Big Spring Creek (a high-quality cold-water fishery), and Cool Spring.

### Potential for Increased Water Treatment Costs

Potential contamination in Big Spring, Big Spring Creek, or Cool Spring could increase the cost of water treatment at the Cool Spring Water Treatment Plant in Newville, PA.

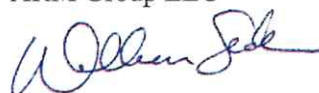




### Recommendations

1. The Big Spring – Cool Spring Watershed should be treated as a protected “capture zone” (similar to a Wellhead Protection Zone) for the existing valuable water resources in the site area.
2. Proposed land development plans within the Big Spring – Cool Spring Watershed should include a Detailed Hydrogeological Evaluation of surface and subsurface conditions to understand and evaluate the potential for significant changes in groundwater quality caused by construction activities such as soil stripping, excavation, blasting, regrading, altering the existing infiltration (quantities / rates / water quality), etc.
3. The goals of a Detailed Hydrogeological Evaluation include gaining an understanding of subsurface (bedrock) recharge pathways and the potential unintended consequences to water quality that may occur by altering existing surface conditions.
4. A Detailed Hydrogeological Evaluation would include development of a three-dimensional subsurface model using existing hydrogeological data, information from new monitoring wells, and new geophysical data across the AAMPA Site and downgradient areas. The new geophysical data, when combined with other information, could identify the locations of localized groundwater recharge surface areas, deep subsurface groundwater recharge pathways, potential contamination threats, and related factors.
5. As of this writing, no site specific detailed hydrogeological studies investigating the deep pathways for groundwater movement from the AAMPA site to Big Spring, Big Spring Creek, or Cool Spring are known to this author.
6. Among the Pennsylvania Department of Environmental Protection (PADEP) recommendations for Best Management Practices (BMPs) in karst terranes are: Detailed Geologic Investigations, Groundwater Monitoring, Geophysical Surveys and Professional Expertise (PADEP, 2006 and PADEP, 2022). These BMPs would be met by a comprehensive Detailed Hydrogeological Evaluation as described above.
7. Approval of proposed land development plans within the Big Spring – Cool Spring Watershed should be contingent upon mitigation of potential threats to downgradient sources as identified by a Detailed Hydrogeological Evaluation.

Respectfully submitted,  
ARM Group LLC



William Seaton, Ph.D.  
Senior Hydrogeologist / Project Manager

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- Geyer, A. R., and Wilshusen, J. P., 1982, Engineering characteristics of the rocks of Pennsylvania (2nd ed.): Pennsylvania Geological Survey, 4th ser., Environmental Geology Report 1, 300 p.





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## **Appendix II: Groundwater Well Information**

## Department of Environmental Resources

## TOPOGRAPHIC AND GEOLOGIC SURVEY

## Water Well Inventory Report

| OFFICE USE ONLY |      |       |                 |
|-----------------|------|-------|-----------------|
| St. 42 Co.      | Lat. | Long. | Hydrologic Unit |
| Sec.            | Act. | Map   | Topo.           |
|                 |      |       | Aquifer         |
|                 |      |       | Aquifer         |

| Well Log             | From | To  |
|----------------------|------|-----|
| Materials penetrated |      |     |
| Clay                 | 0    | 9   |
| Broken Limestone     | 9    | 34  |
| Limestone            | 34   | 61  |
| Opening              | 61   | 64  |
| Limestone            | 64   | 79  |
| Opening              | 79   | 93  |
| Blue Limestone       | 93   | 228 |
| Brown Limestone      | 228  | 229 |
| Blue Limestone       | 229  | 260 |

Well Site Township West Pennsboro  
County Cumberland  
Address/or P.O. Box R.O.S. Newville  
Well Owner last name Miller first name William

If owner's address is other than well site address indicate on reverse.

Ownership (CIRCLE ONE)

private, city, county, state, federal, county

(CIRCLE ONE)

Water Use (CIRCLE ONE)

domestic, public, industry, irrigation, stock, institution, bottled, commercial

Well Use (CIRCLE ONE)

water supply, dry brine recharge, test, heat pump, observation, monitoring, destroyed

Saltwater zones ☒ No ☐ Yes depthChemical/Biological Analysis made: Yes ☐ No ☒Well Depth 260 ft. Well Diameter 6 in.Casing Length 109 ft. Casing Length      ft.Casing Dia. 6 in. Casing Dia.      in.

Casing material (CIRCLE ONE)

steel, plastic, other

Casing material - steel, plastic, other

Type Construction (CIRCLE ONE)

Rotary, Cable, Other

Well Finish (CIRCLE ONE)

open hole, screen, perforated, slotted, other

Well Grouted: Yes ☐ No ☒Date Drilled month 2 year 88Water Level Before Test      ft.Level at End of Test      ft.Yield 8 gpm

Test Yield Method (CIRCLE ONE)

bailed, blow, or pumped, meter, driller, watch and bucket

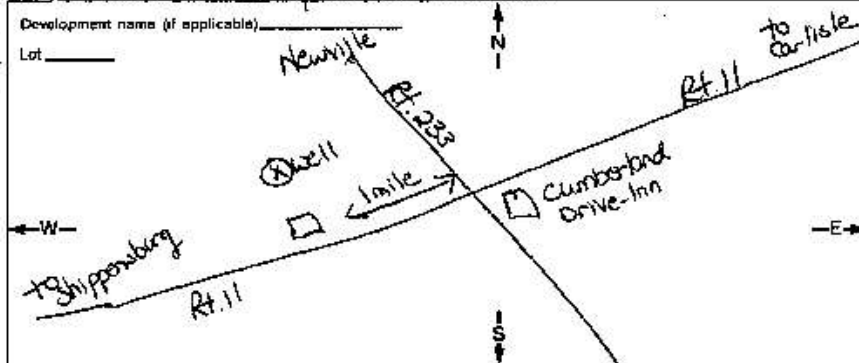
Drawdown      ft.Length of Test      hr.      min

Depth to Bedrock 93 ft. Landform at Site (CIRCLE ONE)  
level, hilltop, valley, alluvial

Driller's License 1512 Licensed Driller's Name Negley

Depth to Water Bearing Zones (1) 228 ft.  
(2)      ft. (3)      ft. (4)      ft.

Written Well Location Directions from Newville take Rt 233 SE to Rt 11 - turn  
left 1 mile South towards Shippensburg - well site is on right side  
of road about 500 yds back from road.



SKETCH MAP Indicate route no's, intersections, schools, churches, cemeteries, streams, towns, and any notable feature such as quarries, bridges, railroads, etc. Be sure to show distances between these features, (miles/feet).

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ER-TGS-15 REV. 8/86



Date Printed:  
12/08/2024

Pennsylvania Department of Conservation and Natural Resources  
Bureau of Geological Survey  
Water Well Program  
3240 Schoolhouse Road  
Middletown, PA 17057  
717-702-2017

WATER WELL RECORD

PA Well ID:

422239

Local Well ID:

Local Permit#:

LOCATION INFORMATION

Owner:

FRED MILLER

Original Paper Record Image Available:

No

Address of Well:

3516 RITNER HIGHWAY

County:

CUMBERLAND

Municipality:

PENN

Latitude:

40.13556

Coordinate Method:

GPS - Global Positioning System

Longitude:

-77.38778

Data Reliability:

WELL CONSTRUCTION INFORMATION

Well Drilled By:

C E SUNDAY & SON WATER WELL DRILLING

License:

0526

Date Drilled:

12/07/2007

Driller Well ID:

Type of Activity:

New Well

Drilling Method:

AIR PERCUSSION

Well Depth (ft):

245

Well Finish:

OPEN HOLE

Notes:

1.2 mi. s. on rt. 11 from intersect w/ rt. 233

WELL SIZE

Section 1

Top (ft):

0

Bottom (ft):

100

Diameter (in):

9

Section 2

Top (ft):

100

Bottom (ft):

245

Diameter (in):

6

CASING

Section 1

Top (ft):

0

Bottom (ft):

100

Diameter (in):

6.625

Casing Material:

COATED STEEL

Seal Top:

90

Seal Bottom:

100

Seal Type:

BENTONITE CHIPS/PELLETS

SEAL

Section 1

Seal Top:

90

Seal Bottom:

100

Seal Type:

BENTONITE CHIPS/PELLETS

Installation Method:

Volume/Weight Used:

Section 2

Seal Top:

0

Seal Bottom:

90

Seal Type:

CLAY OR CUTTINGS

Installation Method:

Volume/Weight Used:

GROUNDWATER AND GEOLOGICAL INFORMATION

Well Yield (GPM - gal per min):

20

Yield Measurement Method:

ESTIMATED

Water Level when not pumped: (ft below land surface):

80

Water Level after yield test: (ft below land surface):

245

Length of Yield Test (minutes):

60

Saltwater Zone (ft):

Use of Well

WITHDRAWAL

Use of Water:

DOMESTIC

Depth to Bedrock (ft):

68

Was Well Drilled Into Bedrock?

Yes

MATERIALS WELL PENETRATES

| Top (ft) | Bottom (ft) | Description                            |
|----------|-------------|----------------------------------------|
| 0        | 2           | CLAY                                   |
| 2        | 68          | FRACTURED LIMESTONE W/MUD/VOIDS        |
| 68       | 205         | GREY LIMESTONE                         |
| 205      | 210         | FRACTURED LIMESTONE W/MUD/WATER 20 GPM |
| 210      | 245         | GREY LIMESTONE                         |

LEVELS WHERE WATER ENTERS WELL

| Top (ft) | Bottom (ft) | Yield (GPM) |
|----------|-------------|-------------|
| 205      | 210         | 20          |



## Department of Environmental Resources

## TOPOGRAPHIC AND GEOLOGIC SURVEY

## Water Well Inventory Report

| OFFICE USE ONLY |      |         |               |
|-----------------|------|---------|---------------|
| Sta. or Co.     | Lat. | Long.   | Physio. Prov. |
| Sec.            | Acq. | Map     | Well          |
| U.S. Basin      |      | Topo.   |               |
| Aquifer         |      | Aquifer |               |

Well Site—Township Penn.  
 County Cumberland  
 Well Owner SEA Homes first initial   
 Address/or P.O. Box McMillan Job

Ownership (CIRCLE ONE) private, city, corp/co. state, federal, county  
 Water Use (CIRCLE ONE) open public, industry, irrigation, stock, institution, bottled  
 Well Use (CIRCLE ONE) water supply dry hole, recharge, test, abandoned, heat pump

Saltwater zones ✓ No;     Yes     depth    

Chemical/Biological Analysis made:     Yes; ✓ No

Well Depth 250 ft.

Casing Length 60 ft.

Casing Material steel plastic, other    

Well Diameter 6 to nearest inch

Well Finish (CIRCLE ONE) open hole screen, perforated/slotted, other    

Well Grouted     Yes; ✓ No

Date Drilled month     year 6-90

Water Level Before Test     ft.

Level at End of Test     ft.

Yield 20 gpm

Test Yield Method     bailed (CIRCLE ONE)     or pumped

Drawdown     ft.

Length of Test     hr.     min.

ER-TGS-15 REV. 07/83

Depth to Bedrock 40 ft. Landform at Site      
 Surface     OFFICE USE ONLY (CIRCLE ONE) hill hilltop, valley, hillside  
 Driller's License 1005 Driller's Name Westbrook  
 Depth to Water Bearing Zones (1) 150 ft.  
 (2) 200 ft. (3)     ft. (4)     ft.  
 Pa. Basin     OFFICE USE ONLY      
 Written Well Location Directions Rt #11 south of Rt #235  
1 mile on left.

Development name (if applicable)    

Lot    

SKETCH MAP

Indicate route no's, intersections, schools, churches, cemeteries, streams, towns, and any notable feature such as quarries, bridges, railroads, etc. Be sure to show distances between these features. (miles/feet).

MAIL 1ST COPY TO PA. GEOLOGICAL SURVEY

| Well Log<br>(materials penetrated) | From | To |
|------------------------------------|------|----|
|                                    | 0    | —  |
|                                    | —    | —  |
|                                    | —    | —  |
|                                    | —    | —  |
|                                    | —    | —  |
|                                    | —    | —  |
|                                    | —    | —  |
|                                    | —    | —  |
|                                    | —    | —  |

Limestone

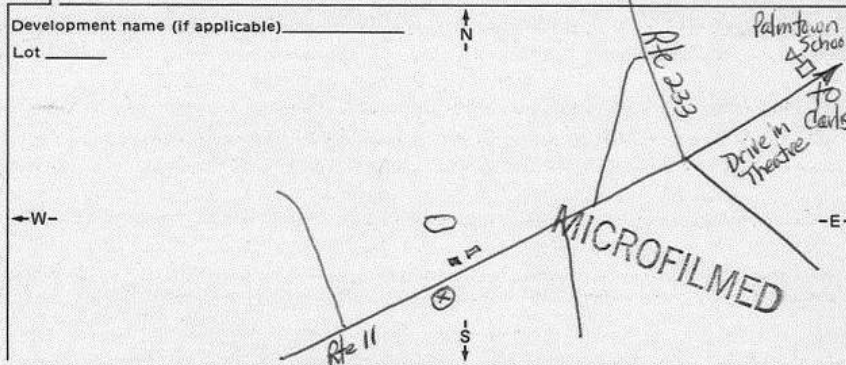
N

S

W

E

| Department of Environmental Resources                                    |               | TOPOGRAPHIC AND GEOLOGIC SURVEY                 |                       | Water Well Inventory Report                                                                                                                                                                             |                            |
|--------------------------------------------------------------------------|---------------|-------------------------------------------------|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| OFFICE USE ONLY                                                          |               |                                                 |                       | CU 1480                                                                                                                                                                                                 |                            |
| St. 42                                                                   | Co. <u>CH</u> | Lat <u>40°07'52"</u>                            | Long <u>77°22'47"</u> | Physio. Prov. _____                                                                                                                                                                                     | U.S. Basin _____           |
| Seq: _____                                                               | Acc. <u>I</u> | Map <u>NEWVILLE</u>                             | Well <u>1480</u>      | Aquifer _____                                                                                                                                                                                           | Aquifer <u>371SD&amp;V</u> |
| Well Site—Township _____                                                 |               | Penn                                            |                       | Color and Rock Type                                                                                                                                                                                     |                            |
| County <u>Cumberland</u>                                                 |               | Hydrologic Unit <u>02050305</u>                 |                       | From _____ To _____                                                                                                                                                                                     |                            |
| Well Owner last name <u>Angle</u> first initial <u>J</u>                 |               | Depth to Bedrock <u>106</u> ft                  |                       | Landform at Site <u>Limestone</u>                                                                                                                                                                       |                            |
| Address <u>RD #4, Box 386</u>                                            |               | Surface _____                                   |                       | Overburden <u>0</u> to <u>-106</u>                                                                                                                                                                      |                            |
| <u>Newville, PA 17241</u>                                                |               | Driller's License <u>0198-1</u>                 |                       | Driller's Name <u>Eichelberger/Books</u>                                                                                                                                                                |                            |
| Ownership <u>(CIRCLE ONE)</u>                                            |               | Depth to Water Bearing Zones (1) <u>145</u> ft. |                       |                                                                                                                                                                                                         |                            |
| <u>private</u> city, corp/co, state, federal, county                     |               | (2) <u>180</u> ft. (3) _____ ft. (4) _____ ft.  |                       |                                                                                                                                                                                                         |                            |
| Water Use <u>(CIRCLE ONE)</u>                                            |               | Pa. Basin _____                                 |                       | Written Well Location Directions _____                                                                                                                                                                  |                            |
| <u>home</u> public, industry, irrigation, stock, institution             |               |                                                 |                       |                                                                                                                                                                                                         |                            |
| Well Use <u>(CIRCLE ONE)</u>                                             |               |                                                 |                       |                                                                                                                                                                                                         |                            |
| <u>frequent use</u> dry hole, recharge, test, abandoned                  |               |                                                 |                       |                                                                                                                                                                                                         |                            |
| Saltwater Zone <u>yes</u> <u>X</u> <u>no</u> (CHECK ONE)                 |               | Development name (if applicable) _____          |                       |                                                                                                                                                                                                         |                            |
| Well Depth <u>185</u> ft.                                                |               | Lot _____                                       |                       |                                                                                                                                                                                                         |                            |
| Casing Length <u>126 1/2</u> ft.                                         |               |                                                 |                       |                                                                                                                                                                                                         |                            |
| Well Diameter <u>6</u> to nearest inch                                   |               |                                                 |                       |                                                                                                                                                                                                         |                            |
| Well Finish <u>(CIRCLE ONE)</u>                                          |               |                                                 |                       |                                                                                                                                                                                                         |                            |
| <u>open hole</u> screen, perforated/slotted, other                       |               |                                                 |                       |                                                                                                                                                                                                         |                            |
| Date Drilled month year <u>10/25/77</u>                                  |               |                                                 |                       |                                                                                                                                                                                                         |                            |
| Water Level Before Test _____ ft.                                        |               |                                                 |                       |                                                                                                                                                                                                         |                            |
| Level at End of Test _____ ft.                                           |               |                                                 |                       |                                                                                                                                                                                                         |                            |
| Yield <u>20</u> gpm                                                      |               |                                                 |                       |                                                                                                                                                                                                         |                            |
| Flow Measure Method <u>watch and bucket</u> estimate, other (CIRCLE ONE) |               |                                                 |                       |                                                                                                                                                                                                         |                            |
| Drawdown _____ ft.                                                       |               |                                                 |                       |                                                                                                                                                                                                         |                            |
| Length of Test _____ hr. _____ min.                                      |               |                                                 |                       |                                                                                                                                                                                                         |                            |
| ER-TGS-15 REV. 07/77 <u>CT</u>                                           |               | SKETCH MAP                                      |                       | Indicate route no's, intersections, schools, churches, cemeteries, streams, towns, and any notable feature such as quarries, bridges, railroads, etc. Be sure to show distances between these features. |                            |
|                                                                          |               | MAIL 1ST COPY TO PA. GEOLOGICAL SURVEY          |                       |                                                                                                                                                                                                         |                            |



98086 DEPARTMENT OF ENVIRONMENTAL RESOURCES - TOPOGRAPHIC AND GEOLOGIC SURVEY Cu 655

Well Owner: ROBERT LINDSAY Well Depth: 200 Ft. Depth Cased: 100 ft. Diameter: 1 1/4 in.

Address: RD 1 NEW VILHE Casing Material: STEEL Screened, Perforated \_\_\_\_\_

Well Location (County): CUMB. Cement Grout: Yes \_\_\_\_\_ No \_\_\_\_\_ Depth \_\_\_\_\_ Ft.

(Township): PENNY Method Drilled: Air Rot. ☒ , Cable \_\_\_\_\_ , Other (Specify) \_\_\_\_\_

Well Location Description: \_\_\_\_\_ Pump Intake Setting Depth \_\_\_\_\_ ft.

Type of Pump: Centrifugal \_\_\_\_\_ , Jet \_\_\_\_\_ , Piston \_\_\_\_\_ , Rotary \_\_\_\_\_ , Submersible \_\_\_\_\_

Depth To Water Before Pump Test: \_\_\_\_\_ ft.

Date Measured: 3/13/75 Test Yield 50 gpm

Method of Determining Yield AIR

Depth to Water Near End of Yield Test \_\_\_\_\_ ft.

Drawdown \_\_\_\_\_ ft. Pumping Period \_\_\_\_\_ hrs.

Date Well Completed 3/13/75

Water Use: Home ☒ , Industry \_\_\_\_\_ , Livestock \_\_\_\_\_ , Irrigation \_\_\_\_\_ , Public Supply \_\_\_\_\_ , Other (Specify) \_\_\_\_\_

Well Use: Water Supply \_\_\_\_\_ , Unused \_\_\_\_\_ , Test \_\_\_\_\_ , Recharge \_\_\_\_\_ , Waste \_\_\_\_\_ , Abandoned & Plugged \_\_\_\_\_

Type of Water-Bearing Rock: Shale \_\_\_\_\_ , Sandstone \_\_\_\_\_ , Limestone \_\_\_\_\_ , Sand and Gravel \_\_\_\_\_ , Schist \_\_\_\_\_ , Slate \_\_\_\_\_ , Gneiss \_\_\_\_\_ , Other (Specify) \_\_\_\_\_

Depth of Water Bearing Zones:

First 170 ft. Second \_\_\_\_\_ ft.

Third \_\_\_\_\_ ft. Fourth \_\_\_\_\_ ft.

Date Sampled: \_\_\_\_\_

Quality Chemical/Biological Analysis: Yes \_\_\_\_\_ No \_\_\_\_\_

Temperature \_\_\_\_\_ \*F Comments \_\_\_\_\_

Driller: JOHN THANN Name \_\_\_\_\_ Address \_\_\_\_\_

License No. 0760-1 Depth to Bedrock \_\_\_\_\_

Type of Surficial Material: \_\_\_\_\_

LOG OF FORMATIONS

| Rock Type | Feet From - - To |
|-----------|------------------|
| BOLDFEST  |                  |
| CLAY      | 0-170            |
| LIMESTONE | 170-200          |
| 128       | A                |
| 40 07 44  |                  |
| 77 23 04  |                  |
| 60 40 7B  |                  |
| Ø-V-8     |                  |
| CODD      |                  |

Sketch Map of Well Location  
(Include nearest state, county, or twp. route no.)

WW 1 Revised 1974

MAIL 3RD COPY TO PA. GEOLOGICAL SURVEY



## **Appendix III: Photographs**



1 - Unused well at 3497 Ritner Highway.



2 - Inaccessible well at the vacant farmstead house.



3 - Monitoring well PZ01.



# **Appendix IV: Well Construction Summary**

# ECS Mid-Atlantic, LLC

52-6 Grumbacher Road, York, PA 17406

## MONITORING WELL DIAGRAM - PZ-1

|                                          |  |                                                      |  |                                            |  |                                                  |  |
|------------------------------------------|--|------------------------------------------------------|--|--------------------------------------------|--|--------------------------------------------------|--|
| Client: Appalachian Asset Management     |  | Job No.: 47:20270                                    |  | Depth to Water<br>(ft. from measuring pt.) |  | Site Elevation Datum<br>Ground Elevation         |  |
| Site Name: Ritner Highway Warehouses     |  | Address: 3485 Ritner Highway, Newville, Pennsylvania |  | Date                                       |  | DTW                                              |  |
| Drilling Company: Negley's Well Drilling |  | Method: Truck Mounted Drill Rig                      |  | 11/27/24                                   |  | 78.81 feet<br>BTOC                               |  |
| Date Started: 11/20/2024                 |  | Date Completed: 11/20/2024                           |  |                                            |  | Measuring Point Elevation<br>Top of Casing (TOC) |  |
| Completion Depth: ~150 feet              |  | ECS Scientist: Jake Goudswaard                       |  |                                            |  | 597.76 feet                                      |  |

| MONITORING WELL<br>CONSTRUCTION<br>(NTS) | DEPTH<br>(ft below<br>grade) | SAMPLES                |                      |              |      | SOIL DESCRIPTION            |                                                      |
|------------------------------------------|------------------------------|------------------------|----------------------|--------------|------|-----------------------------|------------------------------------------------------|
|                                          |                              | Reco-<br>very<br>(ft.) | Blow<br>per<br>6 in. | OVM<br>(ppm) | USCS |                             |                                                      |
|                                          | 0                            |                        |                      |              |      | 0'-6'<br>Medium brown silts |                                                      |
|                                          | 5                            |                        |                      |              |      |                             |                                                      |
|                                          | 10                           |                        |                      |              |      |                             | 6'-10'<br>Brown clay                                 |
|                                          | 15                           |                        |                      |              |      |                             | 10'-15'<br>Rock, weatherd limestone, dark grey       |
|                                          | 20                           |                        |                      |              |      |                             | 15'-30' limestone                                    |
|                                          | 25                           |                        |                      |              |      |                             |                                                      |
|                                          | 30                           |                        |                      |              |      |                             | 30'-35'<br>Weathered rock layer                      |
|                                          | 35                           |                        |                      |              |      |                             |                                                      |
|                                          | 40                           |                        |                      |              |      |                             |                                                      |
|                                          | 45                           |                        |                      |              |      |                             |                                                      |
|                                          | 50                           |                        |                      |              |      |                             |                                                      |
|                                          | 55                           |                        |                      |              |      |                             | 56'-57' - Change in dust color, white to light brown |
|                                          | 60                           |                        |                      |              |      |                             |                                                      |
|                                          | 65                           |                        |                      |              |      |                             |                                                      |
|                                          | 70                           |                        |                      |              |      |                             |                                                      |
|                                          | 75                           |                        |                      |              |      |                             | 75'-78'<br>Soft zone, increased drill speed          |
|                                          | 80                           |                        |                      |              |      |                             |                                                      |
|                                          | 85                           |                        |                      |              |      |                             |                                                      |
|                                          | 90                           |                        |                      |              |      |                             | 89'- Fracture                                        |
|                                          | 95                           |                        |                      |              |      |                             |                                                      |
|                                          | 100                          |                        |                      |              |      |                             |                                                      |
|                                          | 105                          |                        |                      |              |      |                             | 104'- Fracture                                       |
|                                          | 110                          |                        |                      |              |      |                             |                                                      |
|                                          | 115                          |                        |                      |              |      |                             |                                                      |
|                                          | 120                          |                        |                      |              |      |                             |                                                      |
|                                          | 125                          |                        |                      |              |      |                             |                                                      |
|                                          | 130                          |                        |                      |              |      |                             |                                                      |
|                                          | 135                          |                        |                      |              |      |                             |                                                      |
| 140                                      |                              |                        |                      |              |      |                             |                                                      |
| 145                                      |                              |                        |                      |              |      |                             |                                                      |
| 150                                      |                              |                        |                      |              |      |                             |                                                      |

| LEGEND: |                   |
|---------|-------------------|
|         | Native Soils/Rock |
|         | End/Top Cap       |
|         | Bentonite         |
|         | Casing            |
|         | Cement            |

| WELL CONSTRUCTION DETAILS:                 |
|--------------------------------------------|
| Well Construction Details                  |
| Bottom of Well: 151.26'                    |
| Casing Zone: -1.25'-39.25'                 |
| Casing material: 6" diameter, steel casing |
| Seal: Bentonite 35.25' - 39.25'            |
| Surface: Stick up well protector           |

NTS - Not to scale

NA - Not Available