Hydrogeologic Assessment
Enoree Hannah Site
Enoree, Spartanburg County, South Carolina
S&ME Project No. 4261-19-156

PREPARED FOR:

Luck Companies
Post Office Box 29682
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PREPARED BY:

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February 15, 2020

February 15, 2021

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Attention: Mr. Bruce Smith

Submitted via email: brucesmith@luckcompanies.com

Reference: **Hydrogeologic Assessment**
Enoree Hannah Site
Enoree, Spartanburg County South Carolina
S&ME Project No. 4261-19-156

Dear Mr. Smith:

S&ME, Inc. has completed a Hydrogeologic Assessment for the referenced property (i.e. the subject property). The attached report presents the findings of the Hydrogeologic Assessment, which was performed in general accordance with S&ME Proposal No. 42-1900438 Change Order 01, dated August 7, 2019.

S&ME appreciates the opportunity to provide this Hydrogeologic Assessment for this project. Please contact us at your convenience if there are questions regarding the information contained in this report.

Sincerely,
S&ME, Inc.

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SOUTH CAROLINA LICENSED PROFESSIONAL ENGINEER No. 27 DAVID R. LOFTIS 2/15/21

SOUTH CAROLINA CERTIFICATE OF AUTHORIZATION S&ME, INC. NO. C00473

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Mining Reclamation
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Columbia, South Carolina 29201
Attention: Mr. Joe Koon (via email koonjm@dhec.sc.gov)

Table of Contents

List of Tables

Appendices

1.0 INTRODUCTION

S&ME, Inc. (S&ME) conducted a Hydrogeologic Assessment of the subject property located at Lawrence Road (also known as Old Rock Quarry Road) and Frontier Road, in Spartanburg County, South Carolina. A site vicinity is shown on **Figure 1, Appendix I.** The Hydrogeologic Assessment was conducted in general accordance with S&ME, Inc. Proposal No. 42-1900438 Change Order 01, dated August 7, 2019.

1.1 Purpose

S&ME understands that Luck is considering the purchase of the subject property for the purpose of developing the property as a construction aggregate mine. The mining operations will use dry mining techniques; therefore, the proposed mining area will be dewatered via groundwater extraction points/sumps. The purpose of the hydrogeologic assessment requested by Luck was to provide information on groundwater flow into the pit area during dewatering, and understand potential impacts within the dewatering cone of influence, on neighboring wells, bodies of water, streams, and nearby wetlands. An additional purpose was to estimate the potential impacts of make-up water supply wells Luck may use during quarry operation.

1.2 Methodology

This hydrogeology assessment relied on a process that began with the development of a preliminary site conceptual model. The preliminary model was based on known or expected main features of geology, hydrogeology, mine pit location and development, and site-specific relationships between geologic structures and groundwater flow. The preliminary site conceptual model was utilized to develop field data collection needs for this assessment. The collected data included geologic, geophysical, and hydrogeologic information. Site specific data was then collected to further characterize the hydrogeologic system and the resultant data analyzed to refine the site conceptual model. A computer aided mathematical model was then employed to provide predictive simulations of effects of future mine dewatering scenarios.

2.0 Site Setting

The approximate 395-acre site is located west of I-26 near the intersection of Lawrence Road (also known as Old Rock Quarry Road) and Frontier Road in Spartanburg County, South Carolina. The parcel is identified as parcel number 4-55-00-076.00 and is owned by Hanna Holdings Group LLC. Limited research performed by S&ME indicates that the parcel was operated as a former vermiculite mine. On May 30, 2019, Mr. Craig Kennedy with KCS Consulting Services LLC provided S&ME with an excerpt from a 1969 Enoree, SC USGS Topographic Map noting the locations of the former mining areas.

The subject site is identified on the United States Geological Survey (USGS) 7.5-minute series Topographic Maps titled Enoree, South Carolina Quadrangle dated 1969. The original map has a scale of one-inch equals 2,000 feet. A USGS Topographic Map of the site vicinity is included as **Figure 2, Appendix I**.

The subject property appears to be mostly wooded with partially cleared areas that were part of the former mining operations and a natural gas pipeline easement. Remnants of the former Lawrence Road bisect the subject property, and the proposed mine development appears to involve water features identified on the aerial photograph provided by Luck. A hunting cabin and several deer stands are located on the Property. Topography on the Property is generally undulating with a slope towards the on-site surface water tributaries. Multiple drainage features and potential wetland areas were observed throughout the Property. Surface elevations on the subject site range from approximately 660 to 550 feet above Mean Sea Level.

Properties surrounding the subject site consist of forestland, a winery operating out of a residence, and residential land. An unnamed pond is located approximately 1,100 feet east of the proposed mine site on the parcel identified by PIN 4-50-00-036.00. This pond is approximately 0.9 acres in surface area.

2.1 Planned Quarry Operations

The planned mining operations will take place in the central portion of the subject property with the land north of the pit and south of the plant to be used for overburden storage. The primary infrastructure (i.e., settling ponds, clean water pond, pumps, etc.) for the facility will be south of the proposed mine pit. The entrance to the mine facility will be from Old Rock Quarry Road to the east of the site and will extend south along the eastern property boundary to the primary infrastructure area south of the proposed mine pit.

The planned mining operations will begin with the excavation and removal of overburden and rock from the Phase I pit (38 acres). The Phase I pit will be mined to an approximate depth of 150 feet below grade, which, for the purpose of this evaluation, is assumed to occur 11 years after mining operations begin. At that point, the pit will begin to be expanded to form the Phase II pit (59 acres total), to an approximate depth of 200 feet below grade after 25 years of operations. The mining operation will begin to be expanded into the Phase III pit (93 acres total) after 30 years of operation. The total depth of the Phase III pit will be approximately 300 feet below grade after 40 years and 550 feet below grade after 75 years. The life of the aggregate mine is estimated to be approximately 75 years.

Please reference **Figure 3, Appendix I** regarding the planned operations.

2.2 Geology and Lineament Mapping

2.2.1 Geology

According to the Geology of the Carolinas, (Horton, Jr. J. Wright and Zulu A. Victor, University of Tennessee Press, 1991), the Property lies in the Piedmont Physiographic Province. The Piedmont is characterized by rolling relief drained by numerous creeks. Generally, soils in the Piedmont formed by the weathering of the underlying rock. Parent material is felsic/mafic residuum weathered from metamorphic and igneous rocks. In general vicinity of the subject site, the soils are gently sloping or sloping sandy loams or loamy sands with red, brown or yellow subsoil.

Figure 4, Appendix I represents a portion of the USGS *Preliminary Digital Geologic map of the Appalachian Piedmont and Blue Ridge, South Carolina Segments* (Open-File Report 2001-298) with mapped local geologic units in the vicinity of the subject site shown. According to this map and accompanying text, the subject site and vicinity are likely underlain by the following rock type.

- Gneiss of Laurens Area, of Upper Proterozoic to Cambrian Age. This unit is described as "Biotite-quartz-plagioclase gneiss and interlayers locally containing hornblende, sillimanite, microcline, and muscovite.

> Locally contains feldspar porphyroblasts, schist interlayers rich in biotite and/or sillimanite, and granitic gneiss interlayers."

A review of core drilling data provided by Luck indicated that the site is underlain by bedrock primarily described as biotite gneiss, with lesser zones of diabase; consistent with geologic units previously mapped for this area. Significant quantities of groundwater were not noted, although rock coring focused primarily on the proposed open pit mine site area.

The thickness of the soil/saprolite overburden is highly variable throughout the subject site ranging from a depth of 8 feet to 86 feet below grade (BG). The soil saprolite overburden thickness in the planned mine pit area ranges from 3 feet to 76 feet.

2.2.2 Lineament Study

Fractures are often the primary sources of permeability in crystalline bedrock aquifers. When these features cannot be observed directly, they can often be inferred by examining topographic maps, aerial and satellite images. As an ancillary tool for predicting the location of possible geologic structures in the study area, a lineament (or facture trace) study was prepared. The lineament study entailed a qualitative and subjective visual analysis of the topographic map features in the study area and surrounding vicinity, searching of apparent linear features (i.e. lineaments) embedded in the map data. For example, straight stream segments or draws arranged in somewhat parallel patterns or aligned at roughly 90-degree angles to main streams may indicate that the drainage features would be controlled by high-angle fractures. Other non-man-made linear features may also provide indications of the structural fabric and compositional variations in the underlying bedrock.

As depicted in **Figure 5, Appendix I**, the recognized lineaments are generally oriented north 25 degrees west and north 35-80 degrees east. The lineaments identified may be indicative of geologic structures or zones of contrasting strength due to differences in the composition of adjoining rock types. Lineaments and lineament intersections can represent possible targets for water well drilling, and/or identify areas warranting further examination during hydrogeologic studies. Considering the map scale used for this lineament study, fractures inferred by this method may or may not directly underlie the lines shown. Because a lineament study is a qualitative analysis, the actual presence and dip of features cannot be determined without additional investigations.

2.3 Hydrogeology

The hydrogeology of the Piedmont is typically characterized by surficial soils underlain by a weathered rock zone referred to as saprolite, which can range from a few feet to tens of feet thick. The saprolite transitions into bedrock with increased depth. In places, the lowermost portion of saprolite transition zone, just above bedrock, can be more permeable. Groundwater within the Piedmont generally moves from topographically high areas (recharge zones) to topographically low areas within and along stream valleys (discharge areas). Hannah Creek, and its unnamed tributaries that bisect portions of the site, are the expected discharge zones for the shallow saprolite aquifer beneath the site.

The site conceptual model presented below provides further discussion of local hydrogeology.

2.4 Site Conceptual Model

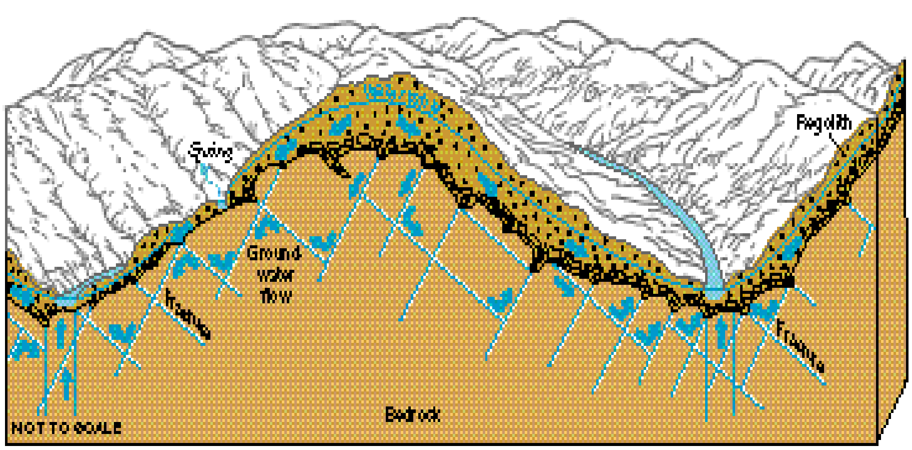
The generally accepted model for the Piedmont aquifers is a two layered system, built on the premise of an unconsolidated layer of soil and saprolite containing an unconfined aquifer that has a relatively high storage capacity supplying water to an underlying variably fractured crystalline bedrock aquifer that has low overall porosity and storage (Heath 1989). The low overall porosity and storage are due to the dense, somewhat impermeable bedrock that yields water primarily from secondary porosity and permeability provided by fractures, faults, joints and foliations. The saprolite aquifer and bedrock fractures zone are common targets for residential, industrial and irrigation water wells. It is important to emphasize that crystalline bedrock aquifers are irregular and heterogeneous in distribution, often highly localized, and exhibit discontinuous water bearing zones.

Although far more complex, the local aquifer system can be conceptually simplified and viewed as a two-layered system consisting of a shallow, unconsolidated, unconfined, porous regolith water aquifer that can supply water to surface water features and to the second layer, the underlying fractured bedrock aquifer.

Aquifer recharge in the Piedmont region is provided by precipitation which occurs in the form of rainfall and snow melt. Depending on factors such as ground saturation, ground cover and slope, a portion of the precipitation forms runoff. This runoff flows to areas of lower elevation where some of the runoff water infiltrates in the unconsolidated material (i.e. soil), and some of the water flows into local surface waters. The precipitation that does not form runoff infiltrates through the unsaturated zone where it can merge with underlying aquifers.

Most of the recharge in this region takes place in inter-stream areas. In general, recharge from precipitation enters the aquifer system through the saprolite zone. It is believed that much of the recharge water moves laterally through the saprolite zone and discharges to nearby streams. Under some conditions shallow groundwater can discharge at the ground surface down slope as seeps or permanent springs above these surface water bodies. Some of these seeps may occur on a seasonal basis or as short-term temporal responses to precipitation. This unconfined saprolite aquifer is generally expected to act as a storage reservoir for the underlying fractured bedrock aquifer.

Figure 2-1 Simplified Illustration of Groundwater Movement



Heath 1980

Some of the water moves vertically downward through the saprolite until it reaches bedrock where it enters fractures in the crystalline rock. Groundwater within the consolidated fractured bedrock aquifer flows in accordance with hydraulic (i.e. pressure) gradients in the fracture network. Because of this, the groundwater does not necessarily flow in the direction of topographic gradients. Based on the site geology and Very Low Frequency (VLF) imaged fractures, flow likely occurs along rock fabric and fracture zones. Significant fracture zones have the potential to substantially influence groundwater flow and velocities.

Published geologic data, lineament study findings, site geologic data, and the VLF survey findings were reviewed for the selection of test well and observation well locations.

3.0 Water Well Inventory

3.1 Freedom of Information Request

On December 3, 2019, S&ME requested to review available environmental regulatory files pertaining to water supply wells located in Spartanburg County from the South Carolina Department of Health and Environmental Control (SCDHEC) through its Freedom of Information (FOI) office. he Freedom of Information Request Form is included in **Appendix II**.

On December 11, 2019, S&ME received two spreadsheets (Spartanburg-1.csv and Spartanburg-2.csv) containing information regarding registered water supply wells in Spartanburg County, South Carolina. In an electronic mail message from Mr. Greg Withycombe, with the SCDHEC Bureau of Water Private Well Program, to our David R. Loftis, P.E., Mr. Withycombe indicated that the older of the two database files (Spartanburg-1.csv) contains wells supposedly installed from 1985 to 2006. SCDHEC did not start permitting wells until 2000. Because of this, older non-permitted wells installed between 1985 and 1999 were given a log number only. Wells noted in the old database that were installed from 2000 to 2006 were permitted and given both a log number and a permit number.

The newer database (Spartanburg -2.csv) has been in use since 2006. When data was being migrated from the old database to the new, the wells with permit numbers (those installed from 2000 to 2006) were included in this new database. This makes for some duplication in the database of wells permitted between 2000 to 2006. From past experience, we understand that wells included in the database are only the wells that were reported and should not be considered a complete inventory of all wells in Spartanburg County.

Due the volume of information provided by SCDHEC via S&ME's FOI request, the data was not included in this report but can be submitted electronically upon request by S&ME.

A review of database information showed that there are 17 wells present in the database that are located within a one-mile radius of the site. The majority of these wells are residential water supply wells and are located off of Ball Park Road and Mount Shoals Road. These wells range in depth from 54 to 560 feet BG, with most of the wells being 400 feet BG or less in depth.

3.2 Local Water Supply Well Registration Data

On October 30, 2020, Mr. Bradley Keyse, contacted Spartanburg County and spoke to Ms. Cynthia Veta, Permit Clerk with the Building Codes department, via telephone regarding the availability of water supply well registration records for Spartanburg County. According to Ms. Veta, well permits and registrations are not handled at the local level and are done by SCDHEC. Based on the information from Ms. Veta, Spartanburg County does not have water supply well registration information.

3.3 Site Reconnaissance

During a site reconnaissance on October 8, 2020, by S&ME Staff Professional Laura Beth Slagle, no evidence of municipal water lines such as water meter vaults or fire hydrants were observed on the roads located within a one-mile radius west of the proposed mine site. Water meter vaults and/or fire hydrants were observed along the following roads within a one-mile radius of the proposed mine site and are suspected to indicate the presence of a municipal water lines.

- Hanna Creek Road
- Frontier Road
- Long Branch Road
- Rock Quarry Road
- Liberty Ridge Road
- Dillard Road
- Highway 92
- Jones Road
- Mount Shoals Road

3.4 Municipal Water Accounts

On October 5, 2020, Mr. Charlie Wilson, Operations Manager with Meansville Riley Water Company (MRWC) provided S&ME with a list of properties in the area of the proposed mine that are currently connected to municipal water system. On September 29, 2020, Mr. Paul Hammer with Woodruff Roeback Water District (WRWD) provided S&ME with Geographic Information Systems (GIS) data for the properties in the area of the proposed mine that are currently connected to municipal water system.

3.5 Data Summary

The findings of our water well Survey, including the parcels with water supply wells located within a 1-mile radius of the site, and parcels with active water accounts with the WRWC and MRWD water system, are summarized on **Figure 6, Appendix I**. It should be noted that the well information discussed in Section 3.1 was mapped using addresses provided by the databases and their georeferenced locations provided by Google Earth®. As such, the well symbols are shown on the parcels of interest to indicate that a well is present on the parcel, but the symbols do not indicate the location of the wells.

4.0 Field Methods

4.1 Geophysical Survey

The site conceptual model assumed that bedrock fractures would provide primary control over groundwater movement in the bedrock aquifer. Characterization of fractured bedrock aquifers can be aided by the utilization of certain non-invasive geophysical survey tools. For this project a VLF survey was employed for imaging steeply dipping fractures in the immediate vicinity of the proposed mine site.

S&ME subcontract THG Geophysics for the collection of VLF profile data across select portions of the site. The VLF survey utilizes very low frequency military radio signals to measure electrical properties of near surface soil and shallow bedrock. Electrically conductive features include fault zones and fractures, which tend to be more conductive than the surrounding bedrock. VLF is used to collect conductivity data, which is analyzed for contrasting electrical conductivities among underlying geologic units. The results of the analysis allow identification of more conductive zones (e.g. suspect fracture zones) in the underlying bedrock. The data is collected by walking a series of lines (e.g. profiles) with a backpack VLF receiver and stopping to collect data at points roughly every 10 meters along each line. The location of each data point along the profile is determined and recorded using a non-survey grade GPS. The VLF method is sensitive to cultural interference from items such as pipelines, utilities, fences, and other conductive objects. If observed, cultural features were noted at the time of data collection.

From September 24, 2019 through September 28, 2019, THG Geophysics collected data along ten profiles covering approximately 34,500 feet, as depicted in **Figure 7, Appendix I**. The profile locations and orientations were selected based on regional and local geologic information, as well as inferences made from the lineament study.

Following field data collection, the VLF data was post-processed. **Appendix III** contains the THG Geophysics report which includes figures illustrating the VLF profiles and the points along each profile where factures were imaged. The post-processed VLF data was presented in both plan and cross-sectional view to illustrate the interpreted dip of the imaged fractures. The VLF data was examined and utilized to make interpretations of the subsurface fracture patterns within the study area. The black lines depicted on **Figure 7, Appendix I** illustrate the interpreted location and orientation of the imaged fractures, with arrows depicting the dip of these features. Although the lines shown are straight and continuous, actual fracture patterns are not always linear and/or as laterally continuous as shown.

4.2 Well Installations

Site-specific field data collection needs were influenced by the conceptual site model. Well drilling locations were selected based on the VLF geophysical survey findings, with the goals of installing wells that intersect dominant fractures and development of an observation well network to be used during pump tests for monitoring aquifer responses and estimating aquifer parameters. In selecting drilling locations, consideration was given to anticipated mining infrastructure placement and the to the option of using one or more of the drilled wells as production wells for mining operations.

The well network provided for two primary pumping wells and six observation wells. Well drilling targeted installation of a pumping wells in primary fracture zones and installation of secondary wells (observation wells) intersecting the same apparent fracture zone, but at some distance from the pumping well. Additional observation wells were installed to examine the influences of pumping in the aquifer system away from the fracture zone intersected by the pumping well. Given the dipping orientation of the fractures, this arrangement allowed for the possibility of a single fracture being intersected by two wells located along a line perpendicular to the trace of the fracture. This approach would provide an opportunity to measure hydraulic conductivity along the same fracture, the degree of hydraulic connection between parallel fractures, and test the conceptual site model

On behalf of Luck, S&ME obtained a well installation permit (Permit) from the SCDHEC Mining and Reclamation Program. The permit is included in **Appendix IV**. S&ME notified SCDHEC of the schedule for these field activities, as required by the Permit.

Wendell J. Lee Well Services, Inc. and S&ME, South Carolina licensed well drillers, installed one 2-inch diameter groundwater monitoring wells to a depth of 25 feet below ground surface, and seven 6-inch diameter groundwater monitoring wells, with depths ranging from 102 feet to 450 feet below ground surface. The wells are identified as MW-1, MW-2, MW-3A, MW-4, MW-5, MW-6, MW-7 and MW-8. Each well was installed using 6.25-inch diameter air hammer/rotary drilling, with the exception of MW-2, which was installed by S&ME using hollow stem augers. Depth to bedrock varied from 18 feet below ground surface at well MW-5 to 110 feet below ground surface at well MW-1. Based on the drill cuttings, bedrock encountered consisted primarily of biotite gneiss, with lesser zones of diabase. Veins of quartz were noted at varying depths throughout the bedrock as noted on the well logs. Well locations are depicted in **Figure 8, Appendix I**. **Table 4-1** summarizes the dominant water bearing fracture zones recognized during drilling of monitoring wells.

Table 4-1 Dominant Fracture Zones Encountered

Well ID	Depth to Dominant Water Bearing Fractures or Fracture Zones (feet below grade)	Driller Estimate of Well Yield At Time of Drilling (GPM)
MW-1	160, 240, 400	0.5
MW-3A	55-56, 57, 115, 205	7
MW-4	57-57.3, 65-66, 130-131, 155-155.3, 175-175.5, 195-195.5	7
MW-5	65-70, 130-131, 158-158.3, 178-178.5	4
MW-6	46, 80, 140, 180,	7
MW-7	68, 115, 195	25
MW-8	75, 90, 110, 205	0.75

GPM = gallons per minute

After drilling was completed, each bedrock well was constructed using 6-inch diameter PVC or galvanized steel surface casing that extended from less than three feet above grade to the top of bedrock. An inner well casing was not installed into bedrock; the borehole was left open. After installation of the surface casing, each well was secured with a lockable, stick-up well protector.

S&ME documented the installation and development of the groundwater extraction wells, prepared a geologist's log, and developed a well completion report for each well installed. These logs are included in **Appendix IV.** A Water Well Record (SCDHEC Form 1903) was also completed and submitted to the SCDHEC within 30 days of completion of each well. These well records are included in **Appendix IV.**

4.3 Aquifer Pump Testing

Aquifer pump testing was performed in the following two areas.

- Northern Pump Test Area: Well MW-7 was the pumping well, whereas wells MW-6 and MW-8 functioned as observation wells. Testing included a variable rate (step) test and a constant rate test.
- Southern Pump Test Area: Well MW-3A was the pumping well, whereas wells MW-1, MW-2, MW4, and MW-5 functioned as observation wells. Testing included a constant rate test.

Details regarding each test are summarized in the following sections.

4.3.1 Variable Rate Test – Northern Pump Test Area

On March 23, 2020, to determine the target flow rate for the constant rate aquifer pumping test, S&ME conducted a variable flow rate pump test (step test) on the pumping well (MW-7). A 4-inch diameter, 3-horsepower submersible electric pump rated at a maximum flow rate of 35 gallons per minute (gpm) was installed on a 1-inch diameter galvanize pipe and positioned at a depth of approximately 200 feet BG. A flow control device was installed on the discharge line to maintain a controlled flow rate. A digital flow meter capable of providing instantaneous flow rate data and flow totalizer data was installed to document flow rates and the total volume of water pumped. After the pump and discharge were configured, S&ME installed a Level Troll 700® pressure transducer/datalogger into the pumping well to collect height of water column data during the step test, from which drawdown levels were calculated.

Based on field observations during well installation, the flow rates chosen for the step test were 15, 25, and 30 gpm. The pump test began with an initial flow rate of 15 gpm, which was maintained using the flow control valves. The pump was operated at 15 gpm for 46 minutes, during which the change in drawdown in the pumping well became asymptotic. Approximately 46 minutes after starting the test, the flow rate was increased to 25 gpm and maintained at this rate for approximately 97 minutes, during which the change in drawdown in the pumping well became asymptotic. Approximately 144 minutes after starting the test, the flow rate was increased to 30 gpm and maintained for 18 minutes. The rate of drawdown increased; however, the rate of change observed at 30 gpm suggested that it was unlikely to produce drawdown that would exceed the available water column during the pending constant rate test. Approximately 162 minutes after starting the test, the flow rate was increased to 34 gpm, the apparent capacity of the pump under the current head conditions. The step test was terminated approximately 175 minutes after starting the test, 13 minutes into the last step, given that data obtained by the pump test was sufficient for planning the pending constant rate test.

The drawdown data collected and recorded by the transducers was analyzed following the test. Based on an analysis of the flow rate employed and drawdown data obtained, a target flow rate of 30 gallons per minute was selected for the constant rate pumping test. A chart depicting the pressure transducer data collected at pumping well MW-7 during the step test is included in **Appendix V**.

4.3.2 Constant Rate Pumping Test – Northern Pump Test Area

From March 24 through March 25, 2020, a constant rate pumping test was performed using well MW-7 as the pumping well and wells MW-6 and MW-7 as observation wells. This test was configured and conducted in a similar manner to the step test, though the pumping rate would be constant at 30 gpm. The same four-inch diameter, 3-horsepower submersible electric pump installed on a 1-inch diameter galvanized pipe and positioned at a depth of approximately 200 feet BG was used for the constant rate pump test. The flow control device and electronic flow meter utilized during the step test were employed during the constant rate test. **Figure 8, Appendix I** depicts the well locations.

Date3/24/2020

Photographer: Gary Simcox

Location / Orientation	MW-7 Pump Test Site
Remarks	Flow Control Device, Flow Meter, and Discharge Line Setup

Prior to staring the pump test, S&ME installed Level Troll 700® pressure transducers in the pumping well (MW-7) and the two observation wells (MW-6 and MW-8). These transducers were set to record height of water column data during the pump test, from which drawdown levels were calculated. In addition to transducer data, manual water level readings were collected from each of the two observation wells during the test. **Table 4-2** provides a summary of the transducer types, locations deployed, and logging intervals utilized.

Table 4-2 Transducers, Device Type, and Logging Intervals

Well ID	Device Type	Logging Interval (minutes)
MW-7 (Pumping Well)	LevelTROLL 700®	30 second
MW-6 and MW-8 (Observation Wells)	LevelTROLL 700®	5 minutes
Not Applicable (ambient atmospheric pressure monitoring)	BaroTROLL®	5 minutes

Maximum drawdown observed in each of the wells is summarized in **Table 4-3** below:

Table 4-3 Summary of Maximum Drawdown

Well ID	Maximum Drawdown During Pump Test (feet)
MW-6 (Observation Well)	0
MW-7 (Pumping Well)	29.62
MW-8 (Observation Well)	0

The pumping phase for the constant rate test was run for approximately 26 hours, with pumping terminated at 12:15 PM on March 25, 2020. The pump rate was held generally constant throughout the test at approximately 30 gpm, with a total of 47,330 gallons pumped from the well during the test.

After the pumping phase of the test was completed and the pump was deactivated, the transducers in each of the wells continued to record data during the aquifer recovery phase, to monitor post-pumping water levels responses at the pumping and observation wells. On March 25, 2020, around 6 PM the transducer logging was terminated, and the transducers were removed from the wells. Rainfall events did occur during the pumping phase of the test but not during the recovery phase. Charts depicting pump test drawdown data collected are included in **Appendix V.** Drawdown data obtained for each of the three wells utilized for the constant rate pump test were subsequently analyzed as part of the groundwater modeling task.

4.3.3 Constant Rate Pumping Test – Southern Pump Test Area

From March 26 through March 27, 2020, a constant rate pumping test was performed using well MW-3A as the pumping well and wells MW-1, MW-2, MW-4, and MW-5 as observation wells. This test was configured and conducted with a pumping rate that would be constant at approximately 5 gpm, based on well yield observations made at the time of well installation. A four-inch diameter, 3-horsepower submersible electric pump installed on a 1-inch diameter galvanized pipe and positioned at a depth of approximately 200 feet BG was used for the constant rate pump test. The flow control device and electronic flow meter utilized during the step test were employed during the constant rate test. **Figure 8, Appendix I** depicts the well locations.

Prior to staring the pump test, S&ME installed Level Troll 500® pressure transducers in the pumping well (RW-2) and the three observation wells (RW-1, RW-3, RW-4). These transducers were set to record height of water column data during the pump test, from which drawdown levels were calculated. In addition to transducer data, manual water level readings were collected from each of the three observation wells during the test. **Table 4-4** provides a summary of the transducer types, locations deployed, and logging intervals utilized.

Table 4-4 Transducers, Device Type, and Logging Intervals

Well ID	Device Type	Logging Interval (minutes)
MW-3A (Pumping Well)	LevelTROLL 700®	30 second
MW-1, MW-2, MW-4, MW-5 (Observation Wells)	LevelTROLL 700®	5 minutes
Not Applicable (ambient atmospheric pressure monitoring)	BaroTROLL®	5 minutes

Maximum drawdown observed in each of the wells is summarized in **Table 4-5** below:

Table 4-5 Summary of Maximum Drawdown

Well ID	Maximum Drawdown During Pump Test (feet)
MW-1 (Observation Well)	0.63
MW-2 (Observation Well)	0.80
MW-3A (Pumping Well)	44.95
RW-4 (Observation Well)	17.13
RW-5 (Observation Well)	17.49

The pumping phase for the constant rate test was run for approximately 24 hours. The pump rate was held generally constant for seven and one-half hours at 5 GPM. Based on the drawdown observed in the pumping wells, a decision was made to increase the flow rate to 7 gpm at 5:30 PM on March 26, 2020. The 7 gpm flow rate was then maintained until the pump was terminated after 24 hours of pumping, at 10:02 AM on March 27, 2020. Based on the totalizing flow meter, a total of 9,312 gallons were pumped from the well during the test.

After the test was completed and the pump was deactivated, the transducers in each of the wells continued to record data during the aquifer recovery phase, to monitor post-pumping water levels responses at the pumping and observation wells. On March 30, 2020, the transducer logging was terminated, and the transducers were removed from the wells. No rainfall events occurred a minimum 48-hours prior to the pumping phase of the test or during the constant rate pump test. Charts depicting pump test drawdown data collected are included in **Appendix V**.

Drawdown data obtained for each of the five wells utilized for the constant rate pump test were subsequently analyzed as part of the groundwater modeling task.

5.0 Pump Test Analysis, Groundwater Modeling, and Reporting

The analysis of pumping tests and development of projections for the dewatering operations were performed utilizing groundwater flow simulation models. Groundwater simulations were performed using MODFLOW-2000 or MODFLOW-2005 through the graphical user interface Groundwater Vistas, version 7.22. Groundwater Vistas is a reliable and commonly used graphical user interface for MODFLOW and the MODFLOW family of groundwater modeling codes. It aids in the construction of model input files and is particularly helpful for data organization for three-dimensional models with multiple hydrogeologic zones. It also facilitates model calibration and the rapid visualization of simulation results.

In preparation for development of a regional model for the simulation of site and regional effects of the proposed mine dewatering, a model was constructed with calibration to the site-specific aquifer pumping test data. Use of a discretized model to evaluate site-specific variables pertaining to fracture zones and pit configurations. Fracture orientations at the site define two distinct trends: a primary trend, generally northeast to southwest, which includes Fractures 1, 2, 3, 4, 5, and 6; and a secondary trend, which includes 7, 8, and 9 (**Figure 7, Appendix I**). Inspection of VLF profiles indicates that the primary fractures exhibit stronger, more consistent expression in the VLF profiles than the secondary fractures. Similarly, correlation of pumping test flow rates with fracture intersection indicates that primary fractures are more productive than secondary fractures. The pumping test calibration model simulated the primary and secondary fractures as part of an equivalent porous media (EPM) domain limited to the area of the VLF profiles and pumping test well locations. The purpose of the pumping test calibration model was to derive input parameters for the regional model simulations.

Following pump test calibration, the equivalent porous media (EPM) model was expanded for the purpose of simulating specific phases of the proposed mining operations, over time. The regional model applied aquifer parameters derived from the pumping test to a larger, more regional domain that included residential wells in the vicinity of the planned mining area.

5.1 Pumping Test Calibration

5.1.1 Model Construction

Figure 5-1, Appendix VI is a map of the southern area pumping test model domain and grid, placed on a site map. The model is rotated so that the x-direction is generally parallel to the northeast-southwest trending primary fracture and the y-direction is generally parallel to the secondary fractures. The model is rotated 40 degrees west of north (counterclockwise) to better align model columns with fracture traces. The model covers 2400 feet in the x-direction and 2900 feet in the y-direction. The model has 5-foot by 5-foot cells in the refined area covering the southern pumping test and 25-foot by 25-foot cells in the remainder of the grid.

The model has two layers. Layer 1 is 50 feet thick and contains MW-2 and the streams. Layer 2 is 650 feet thick because that is also the thickness of the regional model to accommodate the 550-foot deep mining excavation. The top layer generally represents partially weathered rock. Model cells are perfect 25-ft square or 5-foot square cubes.

5.1.2 Aquifer Storage Properties

The pumping test calibration yields specific storage (S_s) in the range of 1 x 10^{-7} per foot to 5 x 10^{-7} per foot, varying spatially across the model. These values represent a narrow range as specific storage can vary by orders of magnitude. Specific yield, S_y, is consistently 1 x 10^{-5}. The low value of *Sy* reflects fractures intersecting the water table. Storage properties were derived from both the southern and northern area pumping tests.

5.1.3 Hydraulic Conductivity Zones

The EPM model has a consistent set of directional hydraulic conductivity values representing vertical and horizontal anisotropy introduced by the regional fracture trends. The horizontal hydraulic conductivity in the *x*-direction, K_x, reflects flow in the direction of the primary fracture trend. The horizontal hydraulic conductivity in the *y*-direction, K_y, reflects flow in the direction of the secondary fracture trend. The vertical hydraulic conductivity, K_z, reflects the aggregate effect of flow along the steeply dipping fractures and through intervening matrix rock. The three hydraulic conductivity values representing the three principal directions of the EPM model are as follows.

1. K_x = 0.25 feet per day
2. K_y = 0.005 feet per day
3. K_z = 0.5 feet per day

The contrast between K_x and K_y was critical to calibrating water levels in MW-4 and MW-5. The comparatively higher value of K_z was necessary to calibrating water levels in MW-1. Minor subzones in the vicinity of wells accommodated localized effects of the interaction between wellbores and fractures.

5.1.4 Boundary Conditions

The model applied a general head boundary (GHB) along the southwestern edge of the model, where the stream runs. The other edges of the model and the base of the model have constant head boundaries (CHB). These boundaries are critical to model calibration.

5.1.5 Calibration Charts

Figure 5-2, Appendix VI shows plots of observed and modeled drawdown over time for all five test wells (MW-1, MW-2, MW-3, MW-4, and MW-5) during the pumping and recovery phases of the pumping test. The model matches the large drawdown in the pumping well, MW-3; moderate amount of drawdown in observation wells MW-4 and MW-5; minimal drawdown in MW-1, and no measurable drawdown response in MW-2. **Figure 5-3, Appendix VI** shows observed and modeled drawdown plots only for the observation wells (MW-1, MW-2, MW-4, and MW-5). Achieving close match with the small drawdown in MW-1 is particularly important for the EPM model. **Figure 5-4, Appendix VI** is a closeup of observed and modeled drawdown in the observation wells. Improvement of the calibration would entail localized hydraulic conductivity zonation which would not affect the regional EPM hydraulic conductivity and therefore additional calibration refinement would not be productive.

5.1.6 Drawdown Simulation

Figure 5-5, Appendix VI shows simulated drawdown at the water table, in model Layer 1. Drawdown exceeds 10 feet within an elliptical, approximately 60-foot wide and 440-foot long area encompassing the pumping well (MW-3A) and observation wells MW-4 and MW-5, which are aligned along the primary fracture trend. Drawdown exceeds 5 feet within an elliptical area twice as long and wide, approximately 830 feet by 160 feet in the primary and secondary fracture trend directions, respectively. The drawdown cone is elongated in the direction parallel to the northeast-southwest trending primary fracture trend that includes Fractures 1 through 9. In the direction perpendicular to the primary fracture trend, drawdown diminishes to 1 foot approximately 200 feet away from the pumping well and observation wells MW-4 and MW-5. The strip of land where drawdown is greater than 1 foot narrows only gradually as it extends along the primary fracture trend, maintaining a width of approximately 220 feet over a distance beyond 2000 feet along the primary fracture trend.

Figure 5-6, Appendix VI shows simulated drawdown within fractured bedrock, in model Layer 2. The drawdown cone is larger and more elongated than drawdown at the water table. Drawdown exceeds 10 feet within an elliptical, approximately 60-foot wide and 610-foot long area encompassing the pumping well and observation wells MW-4 and MW-5. The 10-foot cone within fractured bedrock is just as wide as at the water table, but 50 percent longer. Drawdown exceeds five feet within a 160-foot wide strip extending at least 400 feet away from the pumping well, in the direction of the primary fracture trend, but diminishing to zero within 670 feet of the pumping well along the primary fracture direction. The 1-foot drawdown contour in bedrock is virtually the same as at the water table, except for curvature of the contour at the water table in the vicinity of the stream that does not extend downward into bedrock.

6.0 Regional Model

6.1 Regional Model Construction and Aquifer Parameters

Figure 9, Appendix I shows the regional model domain and grid. The regional model domain is oriented the same way as the pumping test grid, 40 degrees counterclockwise from north, to align with the primary and secondary fracture trends. The model covers an area 40,000 feet wide in the northeast-southwest direction, generally parallel to the primary fracture trend, and 34,000 ft wide in the northwest-southeast direction, parallel to the secondary fracture trend.

The model is anisotropic in the horizontal plane. By being aligned with the primary and secondary fracture trends, the model axes coincide with the principal directions of hydraulic conductivity in the horizontal plane.

A 100-ft x 100-ft grid was used over a roughly 24,000-ft x 19,000-ft area that extends beyond the project site and includes all mapped water wells. The grid expands smoothly to a 500-ft x 500-ft spacing toward the edges of the model.

The regional model is a lateral extension of the EPM pumping test model. The regional model has the same two layers as the pumping test model, expanded laterally. Layer 1 is 50 feet thick and contains the water table and streams. The 650-foot thickness of Layer 2 is appropriate to simulate dewatering of the 550-foot deep mine. Both model layers have the same hydraulic conductivity and aquifer storage properties as in the pumping test model (see **Section 5**). These values represent the bulk or macroscale EPM properties of the fractured aquifer.

6.1.1 Boundary Conditions

Figure 10, Appendix I shows the network of creeks and streams that are represented as boundary condition cells in the model grid. Grid resolution is sufficient for distant effects. The impact of creeks and streams in the model is controlled by the conductance term of the creek, not cell width. The flow between a stream and an aquifer in contact with the stream is proportional to the head difference between the stream and the aquifer, and river conductance, a compound parameter conceptually representing the length and width of a river, the thickness of the stream bed, and its hydraulic conductivity. In addition, river conductance factors in convergent flow toward streams.

River conductance in the regional model is:

- 2000 square feet per day to the Enoree River;
- 200 square feet per day to other streams in the model.

The river conductance of the Enoree River represents a range of combinations of river width, stream bed thickness, and stream bed hydraulic conductivity, but the combination of 100 feet width, one foot thickness, and 20 feet per day conductivity is a representative set of average values. Likewise, the stream conductance is consistent with average values of 20 feet stream width, one foot of stream bed thickness, and 10 feet per day stream bed hydraulic conductivity, although other combinations of the three parameters are also consistent with the assigned stream conductance. Stream conductance significantly dampens drawdown development in the model.

Constant head boundaries along the edges of the model domain and at the base of the model are the same as in the pumping test model. Model results (Section 6.2) indicate that the model domain is large compared to the zone of influence of the mine, and therefore the constant head boundaries are appropriate. The network of creeks in a large area surrounding the mine serves as a barrier to outward propagation of drawdown.

6.1.2 Transient Model Simulation

Model runs are transient to realistically represent gradual increases in mine depth over time. Steady state runs risk over-predicting drawdown, unless there is a well-connected source of water within the model that is known to create equilibrium in a certain number of years. The depth of pumping at the mine site and low K values in the rock and fractured rock limit the influence of streams, making steady-state predictions unrealistic.

The model simulates the progression of the three mining phases—Phase 1, Phase 2 and Phase 3—with a sequence of six model stress periods:

1. Stress Period 1: Day 1. The first day of mining is simulated as a separate stress period to initiate the dewatering process and begin lowering the mine elevation from the initial average ground elevation of 600 feet MSL.
2. Stress Period 2: Day 2 – Year 11. The next 4014 days (about 11 years) covers the period when mining is confined to the Phase 1 Pit and the mine elevation is brought down to 450 feet MSL.
3. Stress Period 3: Years 12 – 25. Day 4016 through 9125 is the 14-year period during which both the Phase 1 Pit and Phase 2 pit are mined. The final elevation at the end of this stress period is 400 feet MSL.
4. Stress Period 4: Years 26 – 30. The model uses a transitional period of 5 years, from day 9126 through 10950, to initiate mining in Phase 3 while continuing to mine Phases 1 and 2. At the end of the stress period the full mine area drops to an elevation of 367 feet MSL.
5. Stress Period 5: Years 31 – 40. Mining operations continue in Phases 1, 2 and 3 from day 10951 through 14600. At the end of this 10-year period the whole mine is brought down to elevation 300 feet MSL.
6. Stress Period 6: Years 41 – 75. Mining operations continue for another 35 years (day 14601 – 27375) until the mine reaches the final elevation of 50 feet MSL. At this point the mine is 550 feet deep.

6.2 Phase I Mine Pit Drawdown Predictions

6.2.1 Mine Pit Dewatering

Figure 6-1, Appendix VI shows a graph of water levels in the mine pit as a function of time. To limit unnecessary model complexity that does not improve drawdown predictions across the model domain, each new mining phase begins with rapid mining to "catch up" with the previous phase. Rapidly dropping water levels at the beginning of mining in the Phase 2 Pit at year 11, and at the beginning of mining in the Phase 3 Pit in year 30 are reflected in the steep initial water level graphs for the Phase 2 and Phase 3 pits. The rate of water level drop is steeper during Phase 1 Pit mining and remains constant over most of the remaining phases.

The black graph in **Figure 6-2, Appendix VI** measures the total dewatering rate of the mining operation as the mine expands and deepens with time. The green graph measures the dewatering rate as a function of time for the combined Phase 1 and Phase 2 Pits, and the blue graph is for the Phase 1 Pit individually. Dewatering rates increase with time as the mine expands. The increase in the dewatering rate is most rapid during the first decade of mining and the dewatering rate increases at a steady rate over the remaining 65 years of mine operation.

6.2.2 Drawdown Predictions

Figure 11, Appendix I shows drawdown contours for the Phase 1 Pit after 11 years. Drawdown exceeds 100 feet within the property boundary, around the Phase 1 Pit. The area where drawdown exceeds 50 feet is mostly confined within the site boundary. The drawdown trough is elongated, with northeast-southwest orientation.

Figure 12, Appendix I shows drawdown contours after 30 years of mining, when the pits of all three phases of mining are in operation. Drawdown exceeding 100 feet is confined within the property boundary.

Figure 13, Appendix I shows drawdown contours when the mine reaches its maximum depth of elevation 50 feet MSL (500 feet deep from original ground surface), after 75 years. The drawdown cone has essentially the same shape as after 30 years, with little change in width but a 40 percent increase in length along the northeast-southwest primary fracture trend direction. Drawdown exceeding 100 feet continues to be confined generally to the property boundary.

6.3 Significant Assumptions

- The assessment assumes that the proposed mine pit and operations would be configured as provide by Luck and outlined in this report.

6.4 Limitations and Exceptions of Assessment

- Information obtained regarding off-site water supply wells was limited to that provided by the Meansville Riley Water Company and by the Woodruff Roebuck Water District.
- This evaluation is based on data available at this time. The estimates and opinions contained herein may need to be revised if significant additional information becomes available. Nevertheless, the opinions are well-founded and consistent with observed conditions at the site.
- S&ME used generally accepted industry practices to characterize site conditions.
- The techniques used in preparing the modeling evaluation were based upon generally-accepted industry standards, the current understanding of site conditions, and literature values for some model parameters. Subsurface data is always limited in its spatial coverage and subsurface hydraulic testing produces only approximate results. Furthermore, numerical models are simplified approximations of a complex subsurface. Estimates and projections about groundwater and subsurface behavior have inherent and unavoidable uncertainties. This is particularly true for potential local-scale variations in bedrock depth, fracture distribution and subsurface permeability. By using good, industry standard, generally-accepted methods and best practices, we believe this assessment provides useful and reasonable guidance concerning expected site behavior. Model simulation data outputs should be viewed as predictions. Contour lines shown depicting future groundwater drawdowns scenarios should be viewed as reasonably anticipated conditions, not actual. Results for actual mine operations may be different from model simulated results.
- This report does not warrant against future operations or conditions, nor does it warrant against operations or conditions of a type or at a specific location not evaluated.
- This evaluation was prepared by S&ME specifically for use by the Client and SCDHEC. Use of or reliance upon this information by any other party without express written permission granted by S&ME and the Client is not authorized and is completely at the risk of the user.

7.0 CONCLUSIONS

S&ME has completed a hydrogeologic assessment at the approximate 395-acre site near Enoree, in Spartanburg County, South Carolina. The purpose of the assessment requested by Luck was to provide information on groundwater flow into the pit area during dewatering, and to help understand potential impacts within the dewatering cone of influence, on neighboring wells, bodies of water, streams, and nearby wetlands.

This hydrogeologic assessment relied on a process that began with the development of a preliminary site conceptual model. The preliminary model was based on known or expected main features of geology, hydrogeology, mine pit location and development, and site-specific relationships between geologic structures and groundwater flow. The preliminary site conceptual model was utilized to develop field data collection needs for this assessment. Site specific data was collected for the purpose of further characterizing the hydrogeologic system and refining the site conceptual model. A standard computer aided three-dimensional mathematical model was then employed to provide predictive simulations of effects of future mine dewatering scenarios. The model used conservative assumptions about aquifer properties and is consistent with standard best practice in numerical finite-difference modeling of flow in porous and fractured media.

S&ME modeled three future mine pit development scenarios. The Phase I pit scenarios involved the expansion and gradual dewatering of the Phase I pit down 150 feet after 11 years. The pit will begin to be expanded to form the Phase II pit to an approximate depth of 200 feet below grade after 25 years of operations. The mining operation will begin to be expanded into the Phase III pit after 30 years of operation. The total depth of the Phase III pit will be approximately 300 feet below grade after 40 years and 550 feet below grade after 75 years. The life of the aggregate mine is estimated to be approximately 75 years.

The model predicts a drawdown cone elongate in the northeast-southwest direction, consistent with the orientation of dominant fractures imaged on the subject site using geophysical tools. The model predicts significant drawdown on the mine property. After 11 years of operation of the Phase I pit, the regional model simulations predict a 100-foot drawdown cone of influence that is predominantly confined to the proposed mine. All mine dewatering simulation results are approximate.

The area within approximately 5,000 feet northeast of the proposed mine is predominantly undeveloped woodland and agricultural land with homes not visible from recent aerial photographs. Properties with structures that occur within the estimated 50-foot drawdown contour line associated with the 75-year simulation southwest of the mine pit are reportedly served by municipal water. Areas outside of the property with predicted drawdowns of 10 feet or greater are located in the vicinity of municipal water lines.

Potential impacts to surface waters and wetlands are predicted to vary depending on type and for some, distance from the proposed mine pit. The stream segments in the areas of greatest predicted drawdown are forecast to experience an increase in the fraction of water lost to the underlying aquifer. Given the limited length of the stream segments encompassed by the area of greatest predicted groundwater drawdown, the overall impact to natural stream flow rates is estimated to be minimal. If steam flow impacts are minimal, impacts to bed and bank wetland should also be limited. Potential impacts to ponds and upland wetlands are estimated to be insignificant.

S&ME understands that future mine operations will likely include reintroducing a portion of the groundwater extracted by dewatering into on-site stream segments, to lessen the predicted stream flow impacts.

8.0 REFERENCES

Preliminary Digital Geologic Map of the Appalachian Piedmont and Blue Ridge, South Carolina Segment, U.S. Geological Survey Open-File Report 01-298

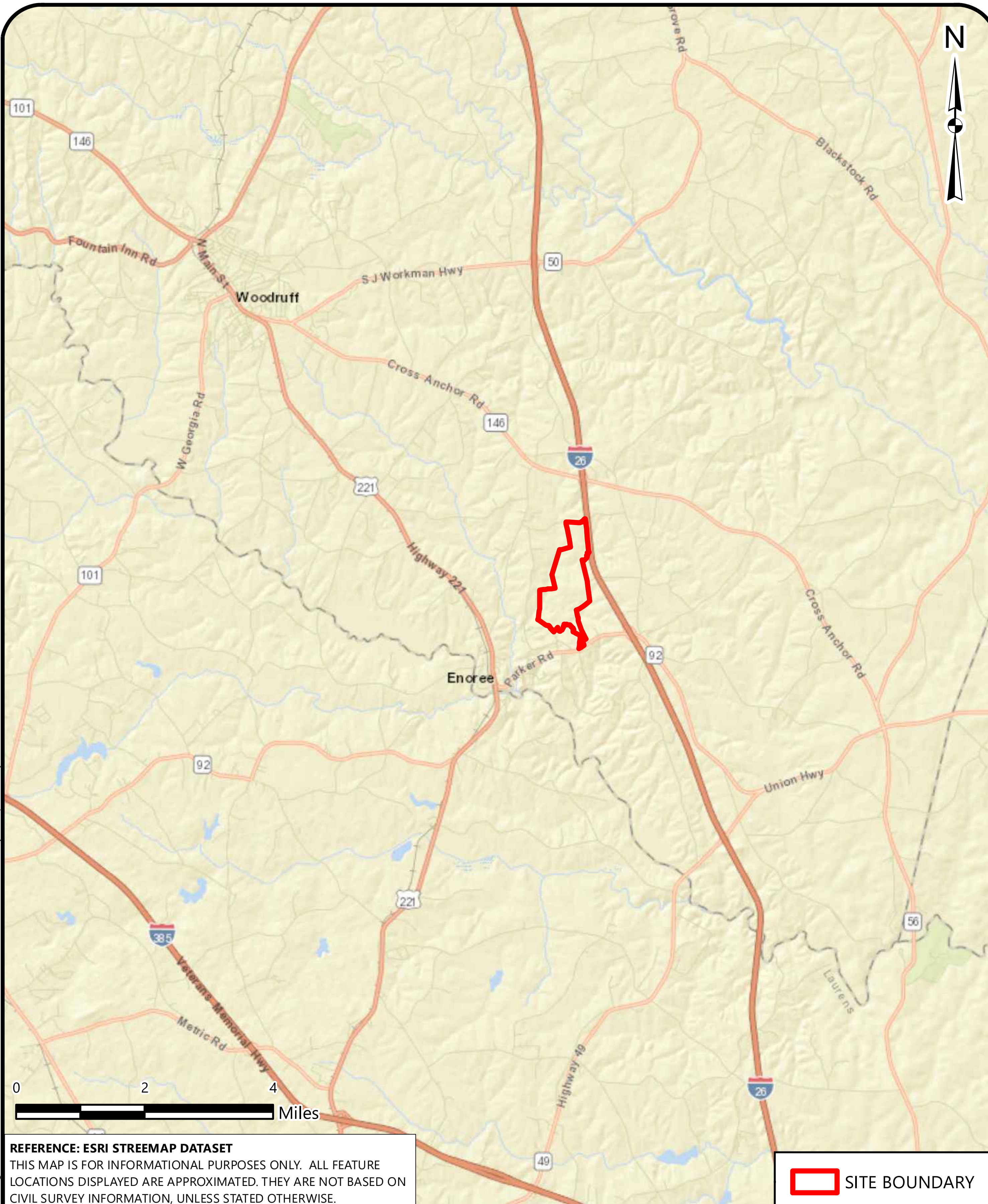
Geology of the Carolinas (1991), Horton, Jr. J. Wright, and Zulu A. Victor, University of Tennessee Press

Heath, R.C. (1989), Ground Water in the Piedmont: Proceedings of a conference on ground water in the Piedmont of the eastern United States: Clemson University, October 16-18, 1989: Clemson, South Carolina.

Heath, R.C. (1990), Basic Elements of Ground-Water Hydrology with Reference to Conditions in North Carolina: USGS Water-Resources Investigations Open File Report 80-44, page 86.

Appendices

Appendix I – Figures



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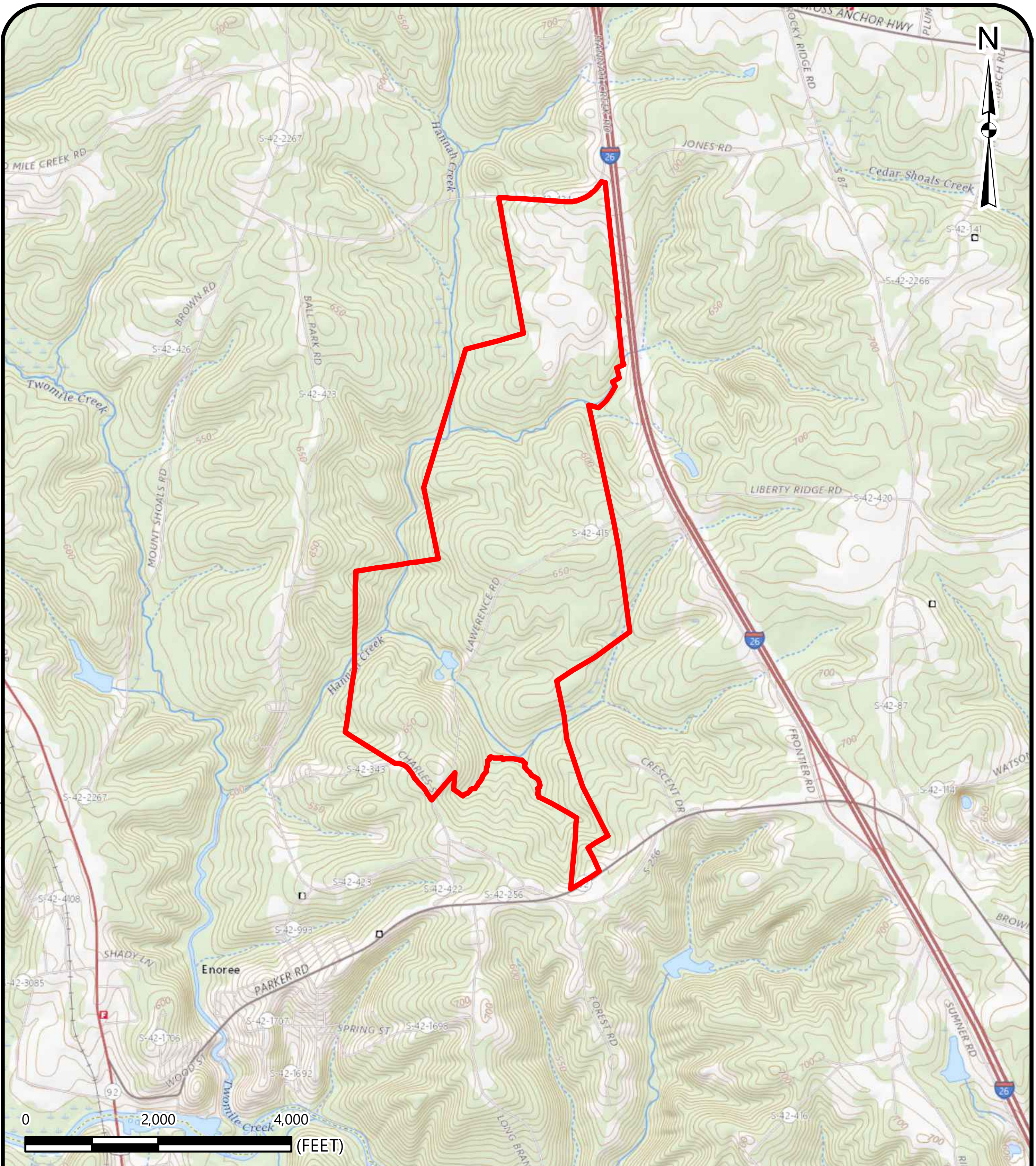
REFERENCE: ESRI STREEMAP DATASET
THIS MAP IS FOR INFORMATIONAL PURPOSES ONLY. ALL FEATURE LOCATIONS DISPLAYED ARE APPROXIMATED. THEY ARE NOT BASED ON CIVIL SURVEY INFORMATION, UNLESS STATED OTHERWISE.

S&ME	**SITE VICINITY**	SCALE: 1 " = 10,560 '	FIGURE NO.
		DATE: 2-12-21	**1**
	LUCK STONE - HANNA SITE ENOREE, SPARTANBURG COUNTY, SOUTH CAROLINA	PROJECT NUMBER 4261-19-156	



REFERENCE: USGS USA TOPO STREAMING DATASET
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SITE BOUNDARY

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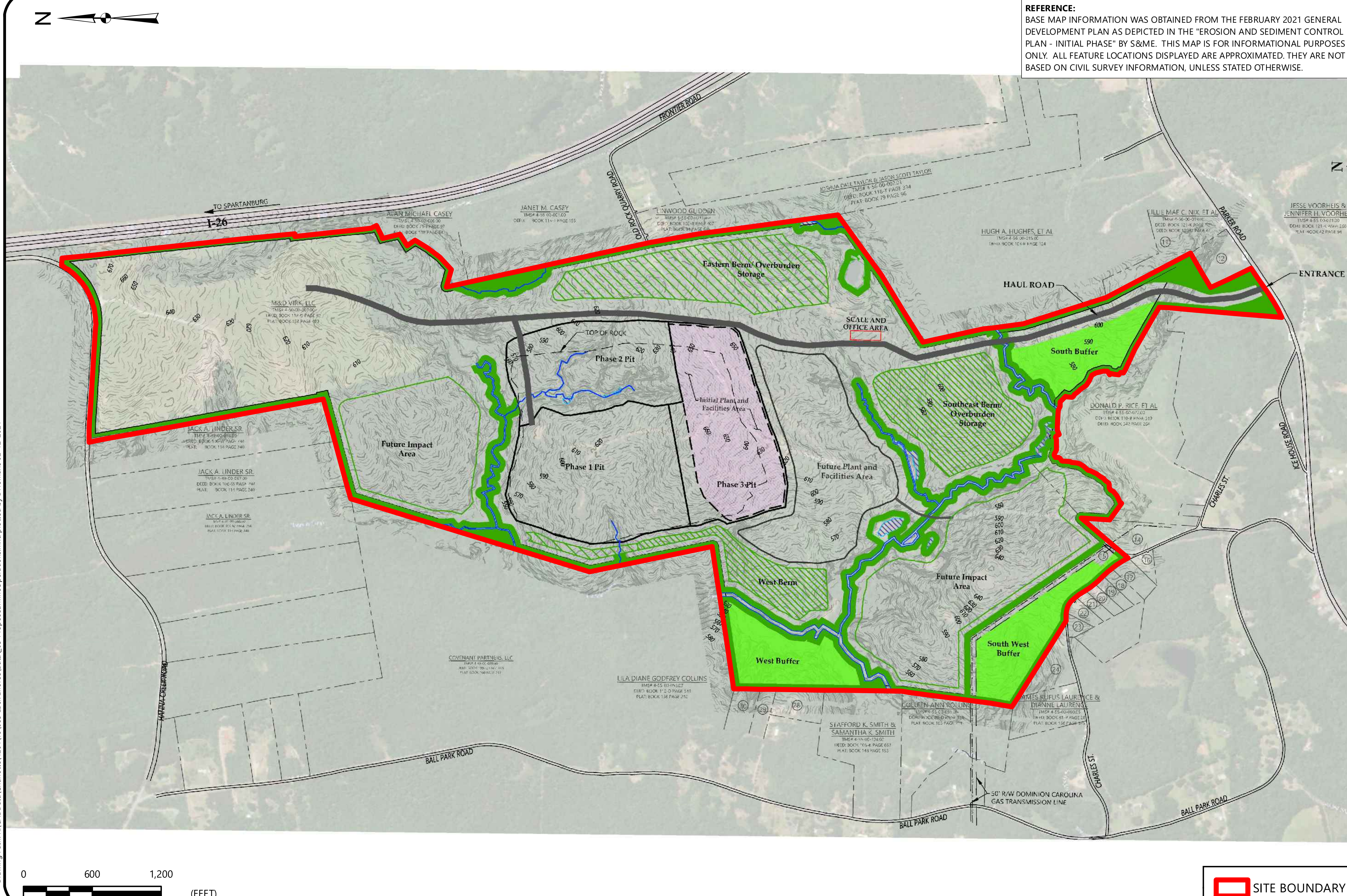
S&ME	**USGS TOPOGRAPHIC MAP**	SCALE: 1 " = 2,000 '	FIGURE NO.
		DATE: 2-12-21	**2**
	LUCK STONE - HANNA SITE ENOREE, SPARTANBURG COUNTY, SOUTH CAROLINA	PROJECT NUMBER 4261-19-156	

REFERENCE:
BASE MAP INFORMATION WAS OBTAINED FROM THE FEBRUARY 2021 GENERAL DEVELOPMENT PLAN AS DEPICTED IN THE "EROSION AND SEDIMENT CONTROL PLAN - INITIAL PHASE" BY S&ME. THIS MAP IS FOR INFORMATIONAL PURPOSES ONLY. ALL FEATURE LOCATIONS DISPLAYED ARE APPROXIMATED. THEY ARE NOT BASED ON CIVIL SURVEY INFORMATION, UNLESS STATED OTHERWISE.



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PROPOSED MINE OPERATION AREAS

LUCK STONE - HANNA SITE
ENOREE, SPARTANBURG COUNTY, SOUTH CAROLINA

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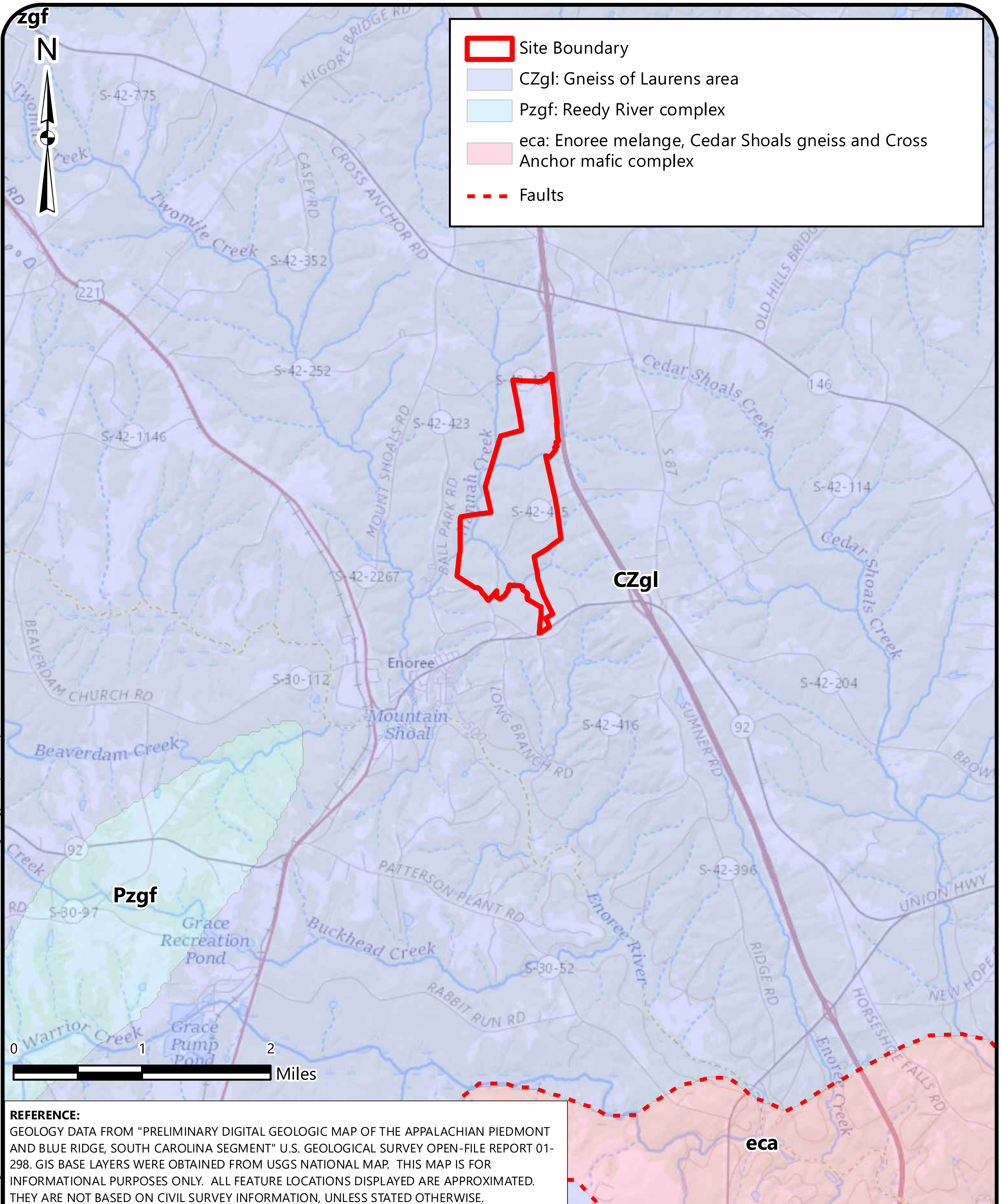
DATE:	2-12-21
PROJECT NUMBER	4261-19-156
FIGURE NO.	3



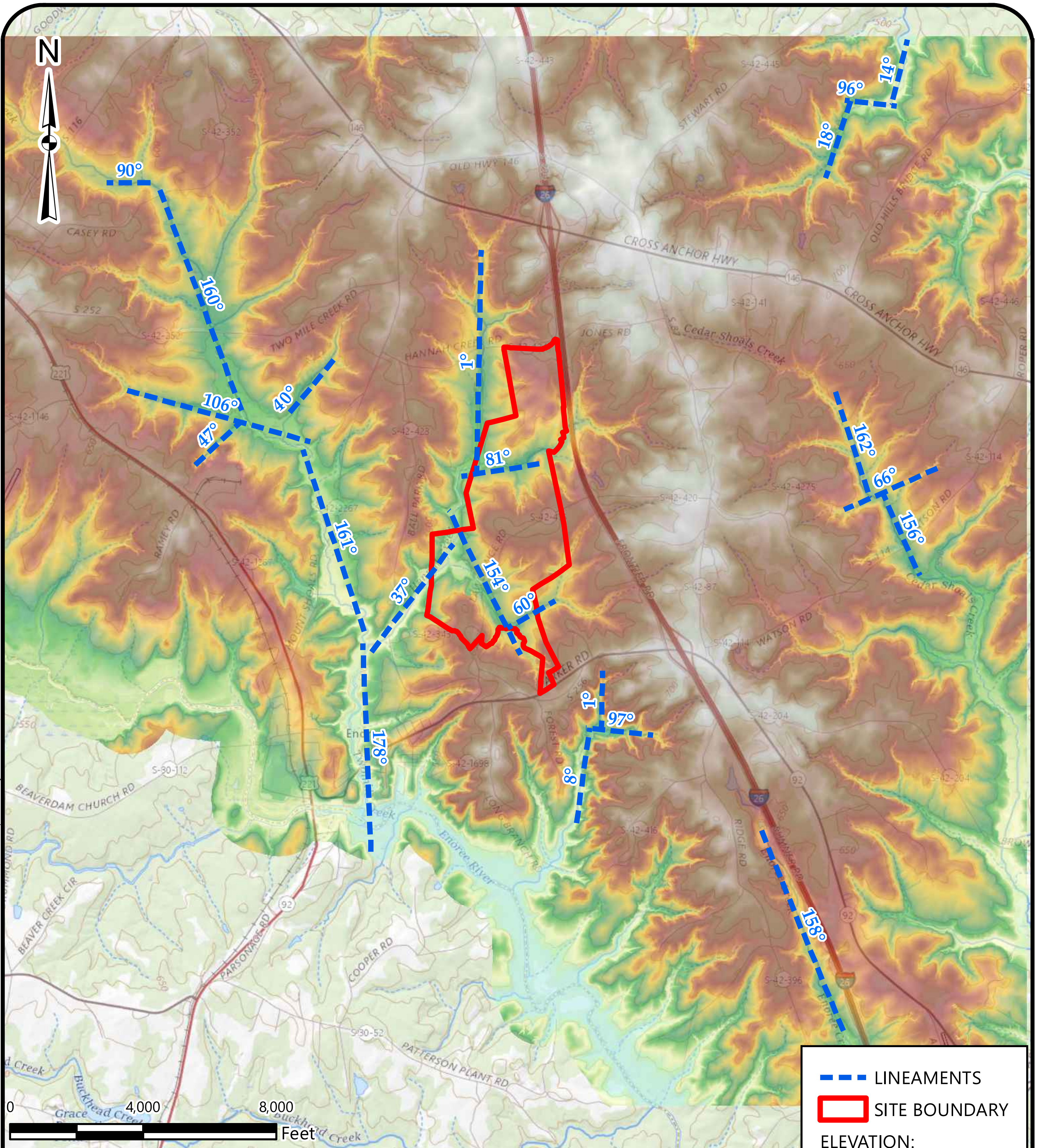
REFERENCE:
GEOLOGY DATA FROM "PRELIMINARY DIGITAL GEOLOGIC MAP OF THE APPALACHIAN PIEDMONT AND BLUE RIDGE, SOUTH CAROLINA SEGMENT" U.S. GEOLOGICAL SURVEY OPEN-FILE REPORT 01-298. GIS BASE LAYERS WERE OBTAINED FROM USGS NATIONAL MAP. THIS MAP IS FOR INFORMATIONAL PURPOSES ONLY. ALL FEATURE LOCATIONS DISPLAYED ARE APPROXIMATED. THEY ARE NOT BASED ON CIVIL SURVEY INFORMATION, UNLESS STATED OTHERWISE.

Drawing Path: R:\CADData\Charlotte\4261\19\083 Luck Enoree\data_04-local geology.mxd plotted by DHomans 02-12-2021

LOCAL GEOLOGY

LUCK STONE - HANNA SITE
ENOREE, SPARTANBURG COUNTY, SOUTH CAROLINA

SCALE: 1 " = 1 mile
DATE: 2-12-21
PROJECT NUMBER: 4261-19-156
FIGURE NO. 4



REFERENCE:

ELEVATION FROM 2013 SOUTH CAROLINA LIDAR CONSORTIUM DATA. GIS BASE LAYERS WERE OBTAINED FROM USGS NATIONAL MAP. THIS MAP IS FOR INFORMATIONAL PURPOSES ONLY. ALL FEATURE LOCATIONS DISPLAYED ARE APPROXIMATED. THEY ARE NOT BASED ON CIVIL SURVEY INFORMATION, UNLESS STATED OTHERWISE.

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	LINEAMENT STUDY MAP	SCALE: 1 " = 4,000 '	FIGURE NO.
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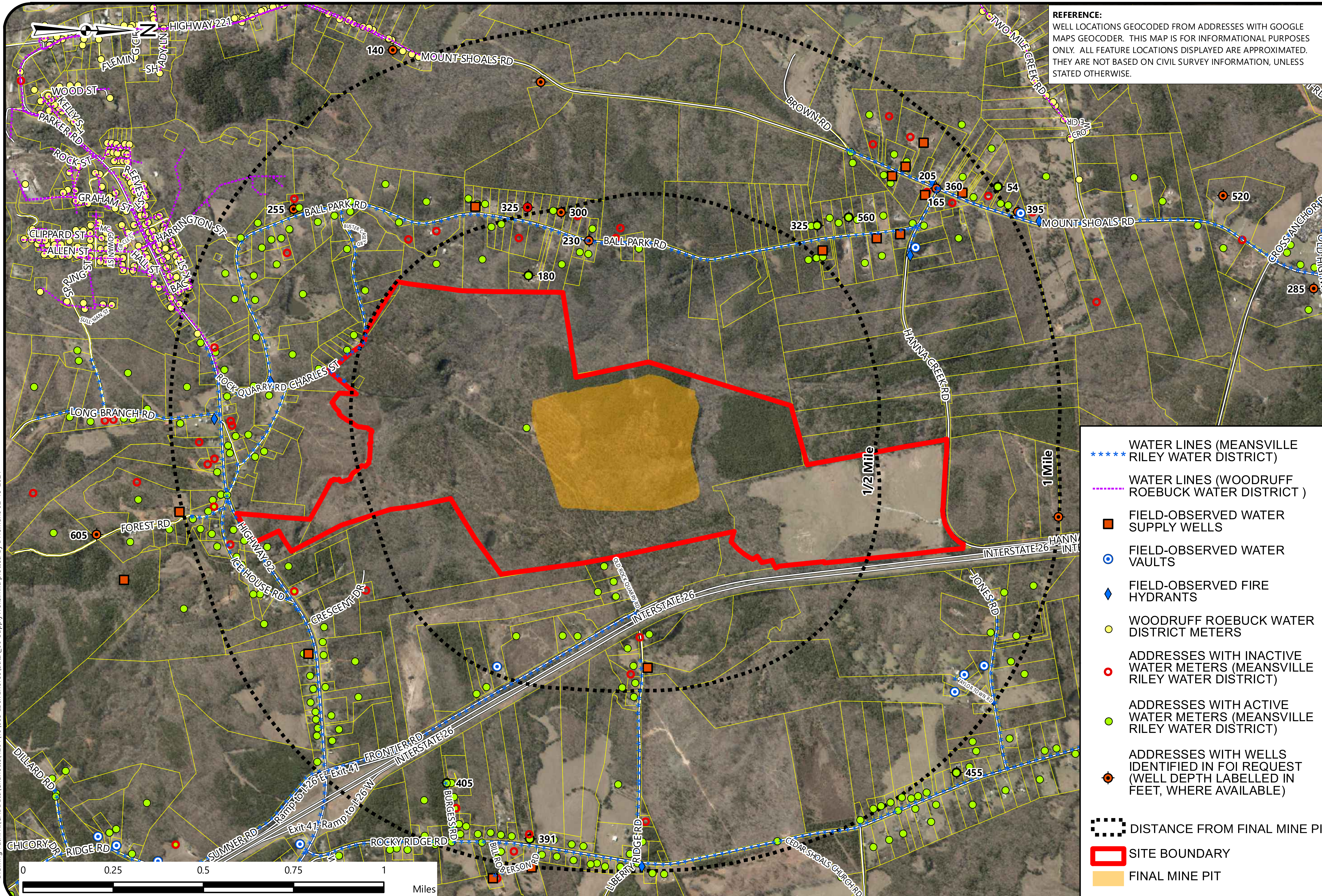
	LUCK STONE - HANNA SITE ENOREE, SPARTANBURG COUNTY, SOUTH CAROLINA	PROJECT NUMBER 4261-19-156	



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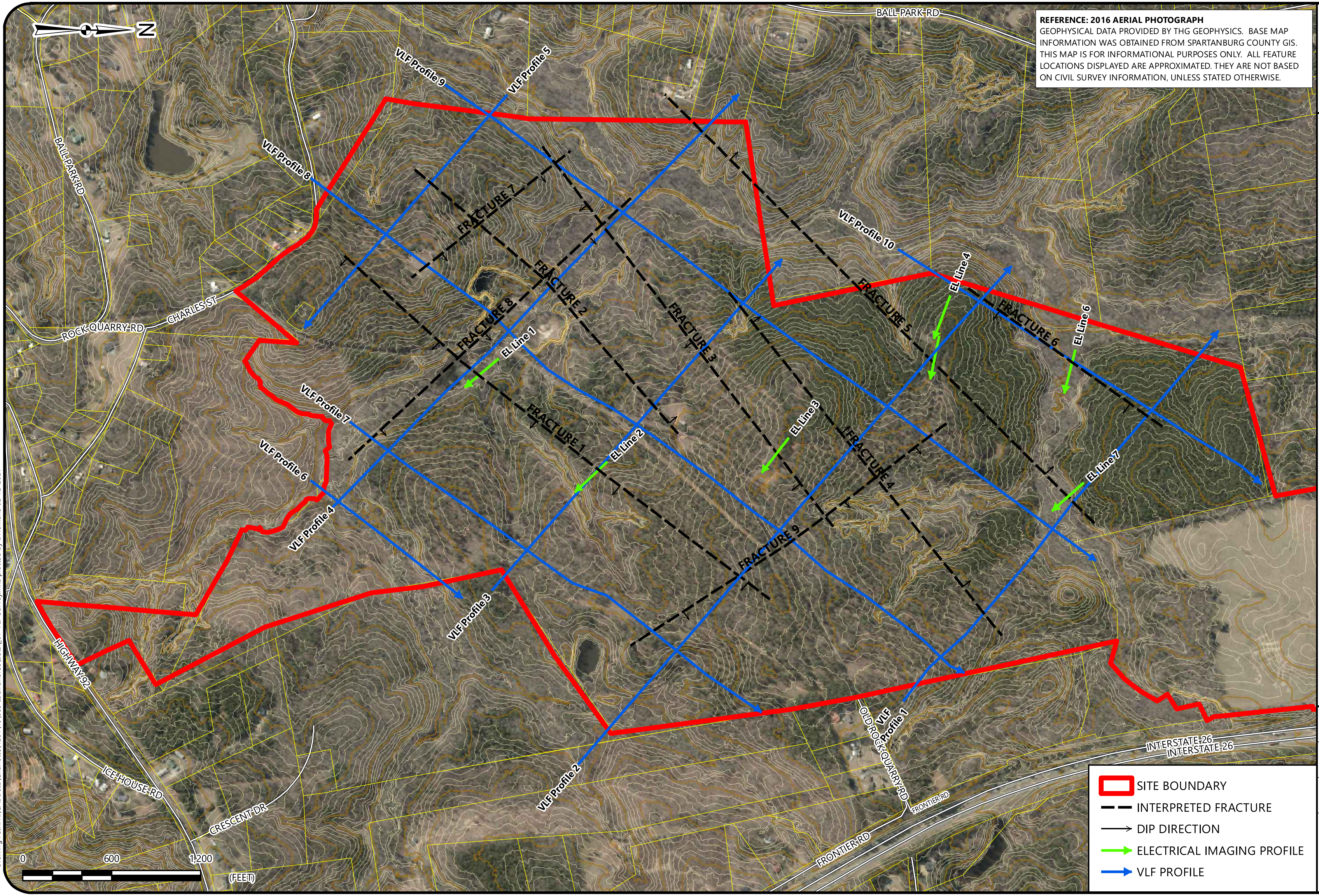
SUPPLY WELL LOCATION MAP

LUCK STONE - HANNA SITE
ENOREE, SPARTANBURG COUNTY, SOUTH CAROLINA

SCALE:	1" = 1/4 Mi.
DATE:	2-13-21
PROJECT NUMBER	4261-19-156
FIGURE NO.	6



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VLF SURVEY - BEDROCK FRACTURE MAP

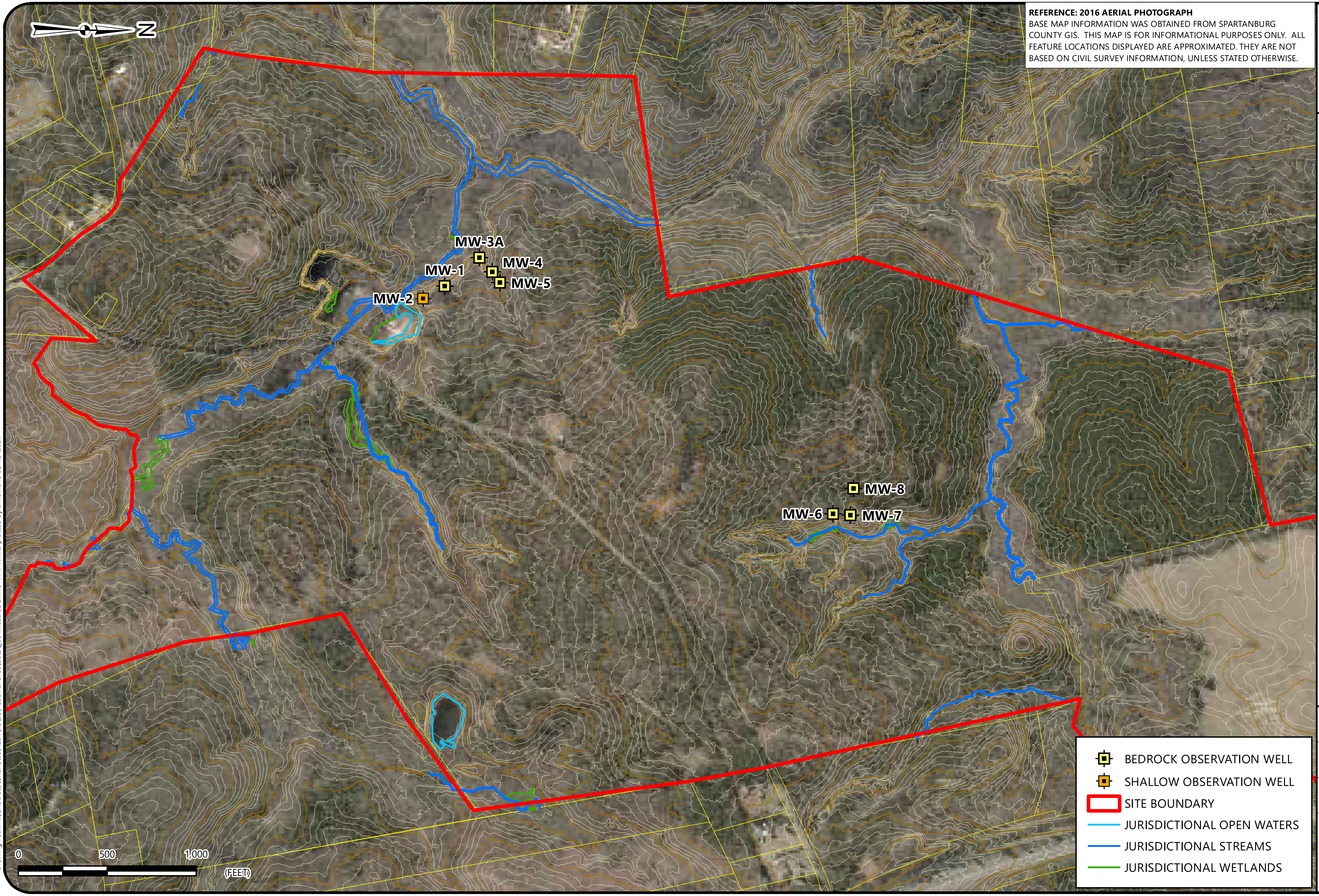
LUCK STONE - HANNA SITE
ENOREE, SPARTANBURG COUNTY, SOUTH CAROLINA

SCALE: 1 " = 600 '

DATE: 2-12-21

PROJECT NUMBER: 4261-19-156

FIGURE NO. 7



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S&ME

WELL LOCATION MAP

LUCK STONE - HANNA SITE
ENOREE, SPARTANBURG COUNTY, SOUTH CAROLINA

SCALE:
1 " = 500 '

DATE:
2-12-21

PROJECT NUMBER
4261-19-156

FIGURE NO.
8

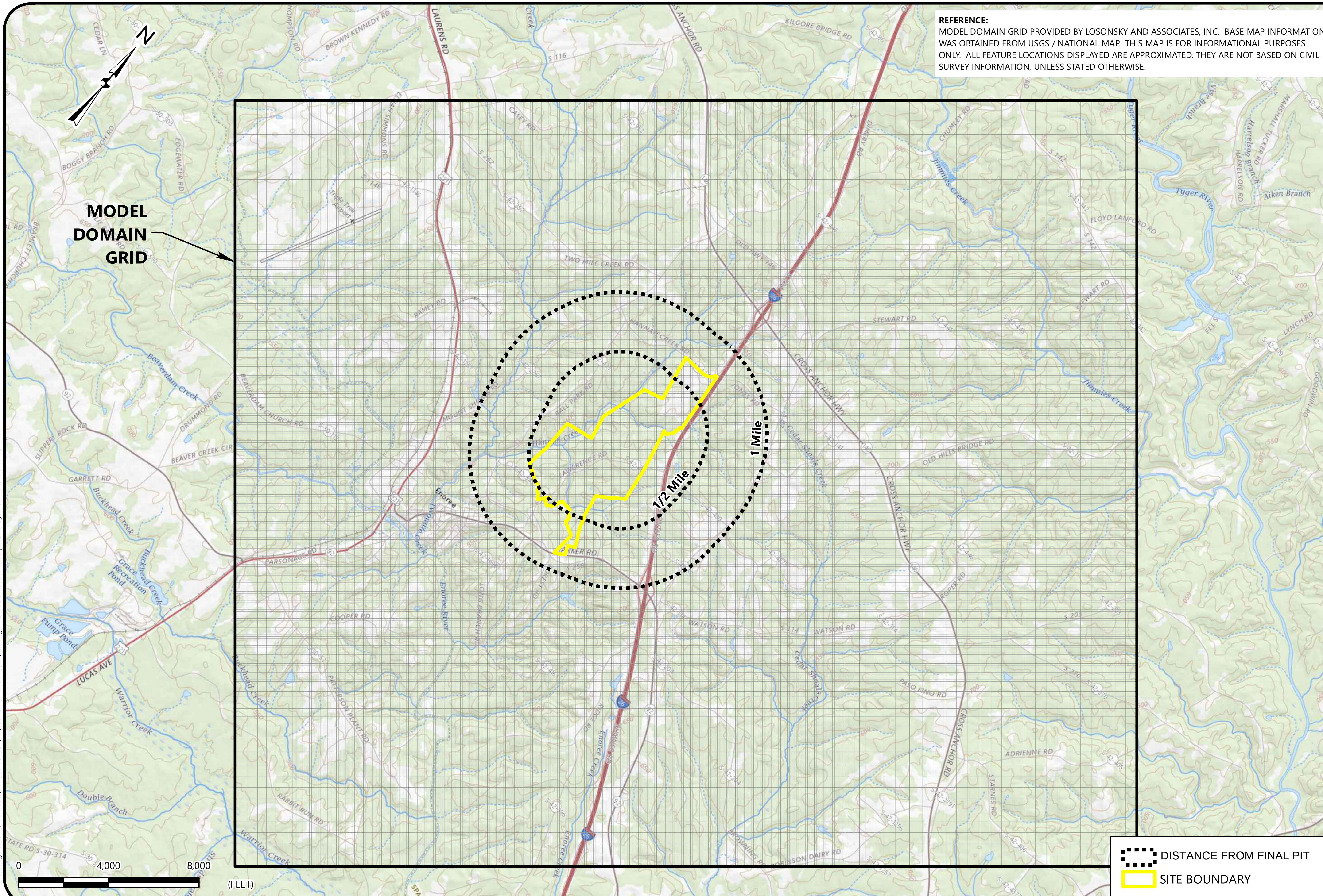
Drawing Path: R:\CADData\Charlotte\4261\19\083 Luck Enoree\data_09-pumptestdomain.mxd plotted by DHomans 02-12-2021

S&ME

MODEL DOMAIN:
PUMP TEST CALIBRATION

LUCK STONE - HANNA SITE
ENOREE, SPARTANBURG COUNTY, SOUTH CAROLINA

SCALE:	1 " = 500 '
DATE:	2-12-21
PROJECT NUMBER	4261-19-156
FIGURE NO.	9



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MODEL DOMAIN GRID PROVIDED BY LOSONSKY AND ASSOCIATES, INC. BASE MAP INFORMATION WAS OBTAINED FROM USGS / NATIONAL MAP. THIS MAP IS FOR INFORMATIONAL PURPOSES ONLY. ALL FEATURE LOCATIONS DISPLAYED ARE APPROXIMATED. THEY ARE NOT BASED ON CIVIL SURVEY INFORMATION, UNLESS STATED OTHERWISE.

REGIONAL MODEL GRID MAP

LUCK STONE - HANNA SITE
ENOREE, SPARTANBURG COUNTY, SOUTH CAROLINA

SCALE:
1 " = 4,000 '

DATE:
2-12-21

PROJECT NUMBER
4261-19-156

FIGURE NO.
10

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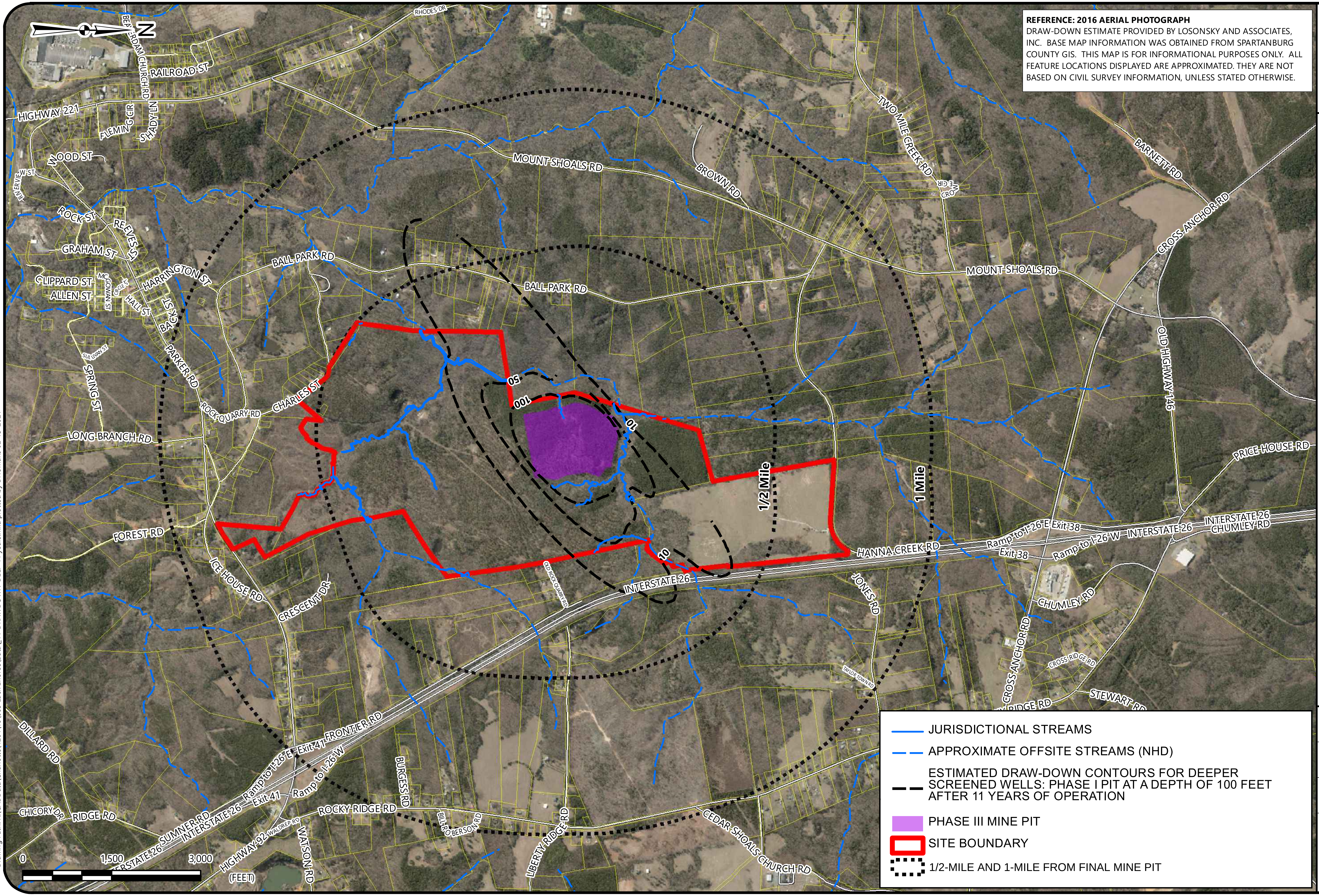


REFERENCE: 2016 AERIAL PHOTOGRAPH
DRAW-DOWN ESTIMATE PROVIDED BY LOSONSKY AND ASSOCIATES, INC. BASE MAP INFORMATION WAS OBTAINED FROM SPARTANBURG COUNTY GIS. THIS MAP IS FOR INFORMATIONAL PURPOSES ONLY. ALL FEATURE LOCATIONS DISPLAYED ARE APPROXIMATED. THEY ARE NOT BASED ON CIVIL SURVEY INFORMATION, UNLESS STATED OTHERWISE.

- JURISDICTIONAL STREAMS
- APPROXIMATE OFFSITE STREAMS (NHD)
- ESTIMATED DRAW-DOWN CONTOURS FOR DEEPER SCREENED WELLS: PHASE I PIT AT A DEPTH OF 100 FEET AFTER 11 YEARS OF OPERATION
- PHASE III MINE PIT
- SITE BOUNDARY
- 1/2-MILE AND 1-MILE FROM FINAL MINE PIT

REGIONAL MODEL DRAW DOWN: DEEPER SCREENED WELLS AFTER 11 YEARS

LUCK STONE - HANNA SITE
ENOREE, SPARTANBURG COUNTY, SOUTH CAROLINA

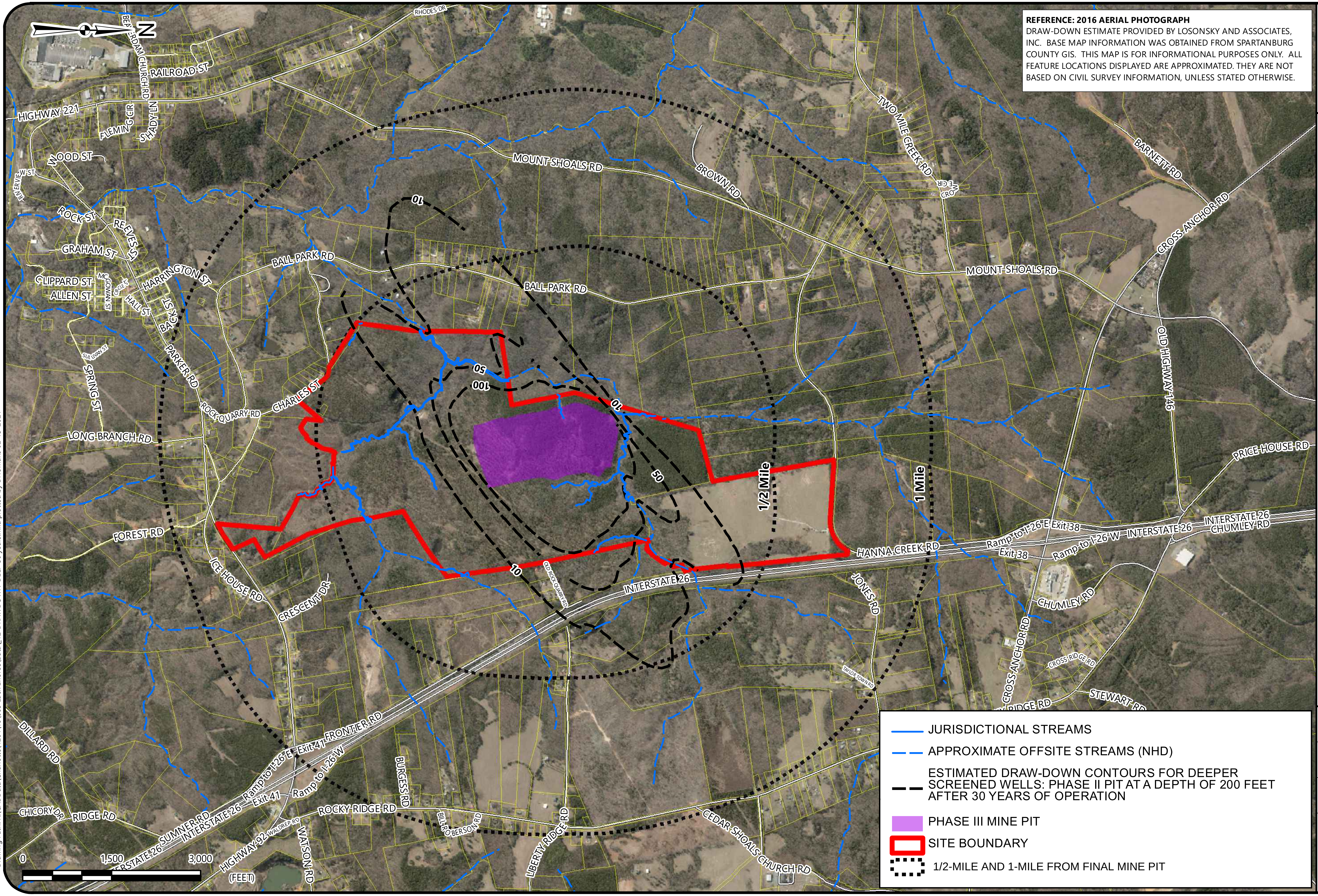
SCALE: 1 " = 1,500 '

DATE: 2-13-21

PROJECT NUMBER 4261-19-156

FIGURE NO. 11

Drawing Path: R:\CADData\Charlotte\4261\19\083 Luck Enoree\data_11-DRAWDOWN-DEEP 11 years.mxd plotted by DHomans 02-13-2021



Drawing Path: R:\CADData\Charlotte\4261\19\083 Luck Enoree\data_12-DRAWDOWN-DEEP 30 years.mxd plotted by DHomans 02-13-2021

S&ME

REGIONAL MODEL DRAW DOWN: DEEPER SCREENED WELLS AFTER 30 YEARS

LUCK STONE - HANNA SITE
ENOREE, SPARTANBURG COUNTY, SOUTH CAROLINA

SCALE: 1 " = 1,500 '

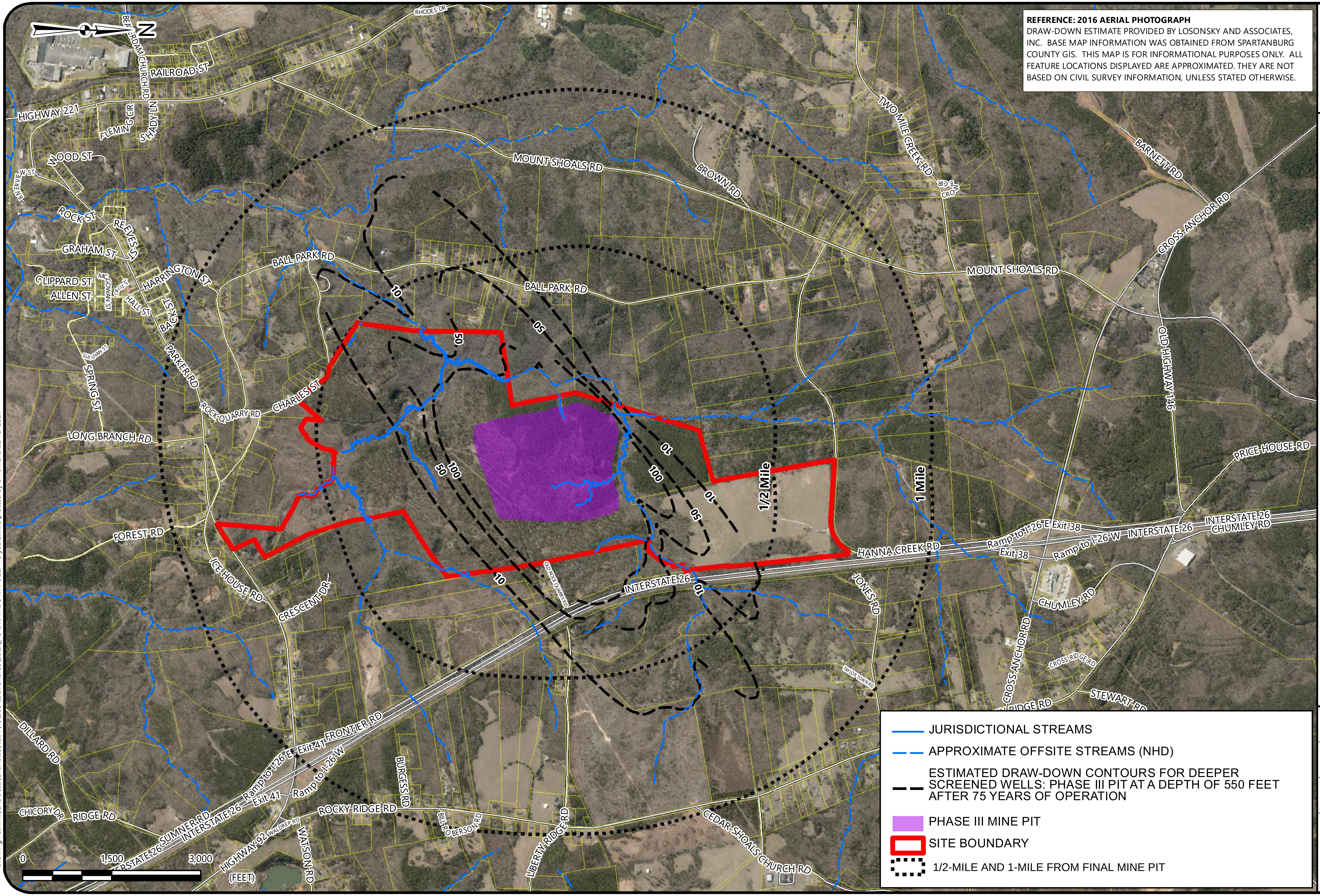
DATE: 2-13-21

PROJECT NUMBER: 4261-19-156

FIGURE NO. 12

REGIONAL MODEL DRAW DOWN: DEEPER SCREENED WELLS AFTER 75 YEARS

LUCK STONE - HANNA SITE
ENOREE, SPARTANBURG COUNTY, SOUTH CAROLINA



REFERENCE: 2016 AERIAL PHOTOGRAPH
DRAW-DOWN ESTIMATE PROVIDED BY LOSONSKY AND ASSOCIATES, INC. BASE MAP INFORMATION WAS OBTAINED FROM SPARTANBURG COUNTY GIS. THIS MAP IS FOR INFORMATIONAL PURPOSES ONLY. ALL FEATURE LOCATIONS DISPLAYED ARE APPROXIMATED. THEY ARE NOT BASED ON CIVIL SURVEY INFORMATION, UNLESS STATED OTHERWISE.

- JURISDICTIONAL STREAMS
- APPROXIMATE OFFSITE STREAMS (NHD)
- ESTIMATED DRAW-DOWN CONTOURS FOR DEEPER SCREENED WELLS: PHASE III PIT AT A DEPTH OF 550 FEET AFTER 75 YEARS OF OPERATION
- PHASE III MINE PIT
- SITE BOUNDARY
- 1/2-MILE AND 1-MILE FROM FINAL MINE PIT

SCALE:	1 " = 1,500 '
DATE:	2-13-21
PROJECT NUMBER	4261-19-156
FIGURE NO.	13

Drawing Path: R:\CADData\Charlotte\4261\19\083 Luck Enoree\data_13-DRAWDOWN-DEEP 75 years.mxd plotted by DHomans 02-13-2021

Appendix II – Receptor Survey

dhec

Freedom of Information Request Form
Customer Service: (803) 898-3882

Date: December 3, 2019 Internal request number: ______________________

Contact information

Name: David R. Loftis Company/Organization: S&ME, Inc.
Street address: 44 Buck Shoals Road, Ste C3 City: Arden State: NC Zip Code: 28704
Phone number: 828-483-3012 (direct) Email address: dloftis@smeinc.com

Request information

I'm requesting: ☑ **Specific documents** ☐ **File review**

Facility or project name: Spartanburg County Water Well Records

Facility address: ______________________

County: Spartanburg

DHEC file custodian/staff contact if known: ______________________

Description of documents or files requested:

Please send me the Microsoft Excel database reports for water wells in Spartanburg County, South Carolina

Family Privacy Protection Act statement

The Family Privacy Protection Act, SC Code Section 30-2-50, prohibits any person or private entity from knowingly obtaining or using any personal information obtained from our agency for commercial solicitation directed to any person in the State. Violation of this law is a crime.

I have read and understand this statement. I am not requesting personal information for the purposes of commercial solicitation or in violation of law.

Signed: [signature]

Submit requests: Email: foi@dhec.sc.gov • **Fax:** (803) 898-3816 • **Mail:** FOI Office, 2600 Bull St., Columbia, S.C. 29201

Office Use Only: Date completed: ______________

Billing info: Research: Time: __________ Cost: __________

Description: ______________________

____

Services: ☐ Scan #: ______ ☐ WebX documents #: ______ ☐ Hard copies #: ______ ☐ CD duplication #: ______

☐ Other: ______________________

Delivery options: ☐ Pick up ☐ Emailed ☐ Mailed ☐ Other: ______________ **Total charge**: ______

From:	Haire, Candice B.
To:	David Loftis
Subject:	FOI 818371
Date:	Wednesday, December 11, 2019 11:39:40 AM
Attachments:	spartanburg-1.csv spartanburg-2.csv

Good Morning Mr. Loftis,

I have attached the excel reports requested. Please let me know if you need anything else. This request is now considered closed.

Kindest Regards,

Candice Haire, FOI Coordinator
Freedom of Information Office
S.C. Dept. of Health & Environmental Control
Office: (803) 898-8137

From:	Paul Hammer
To:	cdillard@wrwd.org
Cc:	mmorgan@wrwd.org; David Loftis
Subject:	RE: Lawrence Road Enoree Site - Active Water Accounts and Water Line Locations
Date:	Thursday, September 24, 2020 10:40:44 AM
Attachments:	Waterlines.cpg Waterlines.dbf Waterlines.prj Waterlines.sbn Waterlines.sbx Waterlines.shp Waterlines.shp.xml Waterlines.shx
Importance:	High

Please find attached the Woodruff Roebuck Water District water system lines for and around Enoree in this shapefile

If you need anything else please let me know

Regards

Paul Hammer, GISP

From: cdillard@wrwd.org [mailto:cdillard@wrwd.org]
Sent: Wednesday, September 23, 2020 3:32 PM
To: paulhammer@bellsouth.net
Cc: mmorgan@wrwd.org; DLoftis@smeinc.com
Subject: FW: Lawrence Road Enoree Site - Active Water Accounts and Water Line Locations

Paul,
Could you provide David the shapefiles of our water system that overlaps the area in question on the attached maps?
Curt

From: David Loftis <DLoftis@smeinc.com>
Sent: Wednesday, September 23, 2020 11:26 AM
To: cdillard@wrwd.org
Cc: Dave Homans <DHomans@smeinc.com>
Subject: Lawrence Road Enoree Site - Active Water Accounts and Water Line Locations

Good afternoon Mr. Dillard,
I am an environmental engineer with S&ME, Inc. in Arden, North Carolina. I understand from talking with Mr. Charlie Wilson with Meansville Riley Road Water Company, Inc. (MRRWC) that MRRWC along with Woodruff Roebuck Water District provides water to properties in the Enoree, SC area.

Ms. Wilson also indicated that you would be the person I need to contact for assistance with our project.

We are assisting a property owner in Enoree with due diligence work associated with a proposed industrial development on the owner's property. We are in need of knowing what parcels in the vicinity of the property contain connections to the water system. Furthermore, we would like to know the location of the water lines so we can determine what properties would have access to the water system should they currently receive water from a well.

I have attached two maps that depict the area we are evaluating. Can you send me a GIS shapefile or list of the parcels (address and PIN number, if possible) that are connected the Woodruff Roebuck water system and are located within the area of interest? Can you also send me a map (or shapefile) showing where the water lines are located within the area of interest?

My contact information can be found below. Please contact me at your earliest convenience to discuss.

Thank you,

David R. Loftis, P.E.
Senior Engineer

S&ME
44 Buck Shoals Road, Suite C-3
Arden, NC 28704 map
O: 828.483.3012
M: 828.337.1923
www.smeinc.com
LinkedIn | Twitter | Facebook

From:	Paul Hammer
To:	cdillard@wrwd.org
Cc:	David Loftis
Subject:	RE: Lawrence Road Enoree Site - Active Water Accounts and Water Line Locations
Date:	Monday, September 28, 2020 11:41:04 AM
Attachments:	parcels.cpg parcels.dbf parcels.prj parcels.sbn parcels.sbx parcels.shp parcels.shp.xml parcels.shx Supply_Meters.cpg Supply_Meters.dbf Supply_Meters.prj Supply_Meters.sbn Supply_Meters.sbx Supply_Meters.shp Supply_Meters.shx
Importance:	High

This message originated outside of S&ME. Please report this as phishing if it implies it is from an S&ME employee.

Attached are parcels in the southern part of the Woodruff Roebuck Water District, and three supply meters where water is metered into the MRWD from Woodruff.

If you need anything else please let me know.

Paul

From: David Loftis <DLoftis@smeinc.com>
Sent: Friday, September 25, 2020 1:11 PM
To: mmorgan@wrwd.org
Cc: cdillard@wrwd.org; Dave Homans <DHomans@smeinc.com>
Subject: RE: Lawrence Road Enoree Site - Active Water Accounts and Water Line Locations

Marshall,
Thank you so much for directing Paul to send that information to me. Can you provide me with a list or shapefile that would indicate what parcels/properties within this service area have active water accounts? This is helpful in us understanding what properties are actually connected to the water line(s).

Thank you,

David R. Loftis, P.E.
Senior Engineer

S&ME
44 Buck Shoals Road, Suite C-3
Arden, NC 28704 map

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We are assisting a property owner in Enoree with due diligence work associated with a proposed industrial development on the owner's property. We are in need of knowing what parcels in the vicinity of the property contain connections to the water system. Furthermore, we would like to know the location of the water lines so we can determine what properties would have access to the water system should they currently receive water from a well.

I have attached two maps that depict the area we are evaluating. Can you send me a GIS shapefile or list of the parcels (address and PIN number, if possible) that are connected the Woodruff Roebuck water system and are located within the area of interest? Can you also send me a map (or shapefile) showing where the water lines are located within the area of interest?

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LinkedIn | Twitter | Facebook

From:	Paul Hammer
To:	David Loftis
Cc:	cdillard@wrwd.org; mmorgan@wrwd.org; Dave Homans
Subject:	RE: Lawrence Road Enoree Site - Active Water Accounts and Water Line Locations
Date:	Tuesday, September 29, 2020 8:46:03 AM
Attachments:	meters.cpg meters.dbf meters.prj meters.sbn meters.sbx meters.shp meters.shp.xml meters.shx
Importance:	High

Attached are the meters you have requested

From: David Loftis [mailto:DLoftis@smeinc.com]
Sent: Monday, September 28, 2020 1:21 PM
To: Paul Hammer
Cc: cdillard@wrwd.org; mmorgan@wrwd.org; Dave Homans
Subject: RE: Lawrence Road Enoree Site - Active Water Accounts and Water Line Locations

Thank you Paul. We are need of a shapefile or list of properties that currently have **active** water meters. Do you have a shape file that would give us this information? This is helpful in us understanding what properties are actually connected to the water line(s).

Thank you,

David R. Loftis, P.E.
Senior Engineer

S&ME
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Arden, NC 28704   map
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Importance: High

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If you need anything else please let me know

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Appendix III – Geophysical Survey Report

GEOPHYSICAL INVESTIGATION

Luck Stone Corporation Proposed Quarry Site
Old Rock Quarry Road

Enoree, South Carolina

Prepared for:
S&ME, Inc.
8646 W. Market Street, Suite 105
Greensboro, NC 27409

Octoboer 10, 2019

Prepared by:

THG Geophysics, Ltd.
4280 Old William Penn Highway
Murrysville, Pennsylvania 15668
724-325-3996
www.thggeophysics.com
THG Project No. 459-10249

TABLE OF CONTENTS

FIGURES

1.0 INTRODUCTION

1.1 BACKGROUND

The project site, located in Enoree, South Carolina **(Figure 1),** is undergoing a mine dewatering study in preparation for development of a proposed rock quarry. As part of the study, S&ME, Inc. contracted with THG Geophysics, Ltd. to perform a series of geophysical surveys to investigate the subsurface of the site. The objective of this investigation was to image the subsurface of the site for potential bedrock fractures.

1.2 WORK SCOPE

THG collected ten very low frequency (VLF) electromagnetic survey profiles and seven 2-D electrical resistivity (EI) profiles at the site **(Figure 1).** VLF was chosen as the best method to image the site based on its exceptional ability to locate bedrock fractures and its efficient data collection and high resolution. EI was chosen to supplement the characterization of fractures in the shallow subsurface. Geophysical data were collected September 24-28, 2019.

2.0 GEOPHYSICAL INVESTIGATION

2.1 ELECTRICAL IMAGING THEORY

2.1.1 Introduction

Electrical resistance is based upon Ohm's Law:

$$R = \frac{V}{I} \quad [ohms]$$

Where, resistance, **R**, is equal to the ratio of potential, **V** (volts) to current flow, **I** (amperes).

Resistivity is the measure of the resistance along a linear distance of a material with a known cross-sectional area. Consequently, resistivity is measured in Ohm-meters. This report presents the geophysical results as geo-electrical profiles of modeled resistance plotted as 2-dimensional profiles of distance and depth, in units of feet.

Electrical currents propagate as a function of three material properties (1) ohmic conductivity, (2) electrolytic conductivity, and (3) dielectric conductivity. Ohmic conductivity is a property exhibited by metals. Electrolytic conductivity is a function of the concentration of total dissolved solids and chlorides in the groundwater that exists in the pore spaces of a material. Dielectric conductivity is a function of the permittivity of the matrix of the material. Therefore, the matrix of most soil and bedrock is highly resistive. Of these three properties, electrolytic conductivity is the dominant material characteristic that influences the apparent resistivity values collected by this method. In general, resistivity values decrease in water-bearing rocks and soil with increasing:

a. Fractional volume of the rock occupied by groundwater;
b. Total dissolved solid and chloride content of the groundwater;
c. Permeability of the pore spaces; and,
d. Temperature.

Materials with minimal primary pore space (i.e., limestone, dolomite) or those which lack groundwater in the pore spaces will exhibit high resistivity values (Mooney, 1980). Highly porous, moist, or saturated soil will exhibit very low resistivity values.

In homogeneous ground, the apparent resistivity is the true ground resistivity; however, in heterogeneous ground, the apparent resistivity represents a weighted average of all formations through which the current passes. Many electrode placements (arrays) have been proposed (for examples see Reynolds, 1997); however, the Schlumberger array has proven to be an effective configuration for imaging bedrock. The following Schlumberger array was used in the collection of data:

$$R_i = \frac{\pi a^2}{b}\left[1 - \frac{b^2}{4a^2}\right]R; a = 5b$$

Where, $\boldsymbol{R_i}$, resistivity, is related to the number of poles, ***n***, the separation distance between the current source and current sink ***b***, and the pole spacing, **a.**

2.1.2 Methods

The resistivity survey was performed using the ARES II multi-electrode cable system (GF Instruments, s.r.o., Brno, Czech Republic). The survey was conducted using stainless steel electrodes and passive multi-electrode cables with switch boxes. The locations of all 1seven EI profiles were recorded in the field using a Trimble Geo-7XH global positioning system (GPS).

2.1.3 PROCESSING

A forward modeling subroutine was used to calculate the apparent resistivity values using the EarthImager2D program (AGI, 2002). This program is based on the smoothness-constrained least-squares method (deGroot-Hedlin and Constable, 1990; Loke and Barker, 1996). The smoothness-constrained least-squares method is based upon the following equation:

$$J^T g = (J^T J + \mu F) d$$

Where, **F** is a function of the horizontal and vertical flatness filter, **J** is the matrix of partial derivatives, **µ** is the damping factor, **d** is the model perturbation vector, and **g** is the discrepancy vector.

The EarthImager2D program divides the subsurface 2-D space into a number of rectangular blocks. Resistivities of each block are then calculated to produce an apparent resistivity pseudo section. The pseudo section is compared to the actual measurements for consistency. A measure of the difference is given by the root-mean-squared (rms) error.

2.2 Very Low Frequency Electromagnetics

The VLF method can be used to find steeply dipping structures that differ from their surroundings with regard to electrical conductivity. VLF transmitters send out low frequency military radio signals (15-30 kHz). When the low frequency field emitted by one of the transmitters strikes an anomaly, secondary currents are created that can be read and recorded by the WADI VLF instrument. The VLF transmitter located in Cutler, Maine, was used for this survey and maintained a good average signal strength of 25.

When a field emitted by a transmitter strikes a body having low electrical resistance, secondary circuits are created in the body. Fraser filtering, a numeric algorithm is performed on the real part of the VLF data to enhance the anomaly indication. Fraser filtering is based upon the work of Karous and Hjelt (1983):

$$F_o = -0.102\, H_{-3} + 0.059\, H_{-2} - 0.561\, H_{-1} + H_0 + 0.561\, H_1 - 0.059\, H_2 + 0.102\, H_3$$

Where; F_0 is the filtered result and H-3 to H3 are the original VLF data.

Ten VLF profiles were collected using an ABEM WADI VLF meter **(Figure 2).** Data was processed using Ramag VLF modeling software and locational data was collected using a Trimble GEO-7XH GPS.

2.3 QUALITY ASSURANCE AND CONTROL

The interpretation of geophysical data is not an exact science since responses to induced disturbance are affected by many phenomena including buried metals, operator error, precipitation, and net changes in ground saturation conditions. Some sources of spurious data can be overcome through a QA/QC program and use of multiple geophysical methods. The quality control program employed with this study included frequent checks of the equipment and daily calibrations. The QA/QC program indicates that all geophysical equipment functioned as designed during the survey.

3.0 GEOLOGY

The site is regionally located in the Western Piedmont and locally upon the Cambrian to Neoproterozoic Laurens thrust stack. The bedrock is predominantly porphyroblastic biotite-quartz-plagioclase gneiss interlayered with biotite schist, sillimanite-mica schist, amphibolite and small bodies of marble (SCDNR, 2019). Fractures within the bedrock have been described as steeply dipping, intersecting and generally more numerous at shallower depths (USGS, 2019).

4.0 GEOPHYSICAL ANALYSES

4.1 INTRODUCTION

Ten VLF profiles were collected across the site in parallel and perpendicular orientations (southeast-northwest & southwest-northeast). In order to efficiently survey the entire 427-acre site, parallel VLF profiles were spaced approximately 1,000-1,400 feet from one another **(Figure 2).** The VLF profiles imaged to a depth of 300 feet below grade; however, this does not take into account topography.

VLF Profiles 1, 2, 3, 4 and 5 were acquired southeast to northwest **(Figure 3).** VLF profiles 6, 7, 8, 9, and 10 were acquired southwest to northeast **(Figure 4).** All profiles were collected using a 10-meter (32 feet) station separation.

In addition to fractures, anomalies can be generated by cultural sources. For example, powerlines, subsurface utilities and metal fencing can also cause very strong anomalies. Some overhead powerlines and one subsurface gas utility were identified at the site but appear to have introduced little signal noise into the VLF data. Overall, the VLF data quality is very good.

Electrical imaging data were collected at seven locations across the site. Profiles were generally oriented west to east and centered on field-interpreted fractures identified from field processed VLF data. Each profile was collected using a 3-meter (9.84 feet) electrode spacing in 4-cable configurations. The resulting 2-D profiles were able to image to depths of 60 feet below grade **(Figure 5).**

Generally, individual geologic units have a common apparent resistivity value. Low apparent resistivity values are typically associated with soils, saturated materials, and highly weathered bedrock; whereas, high apparent resistivity values are associated with rock (also increasing with rock competence). Clay materials can exhibit a range of apparent resistivity from 1-20 Ohm-m, sand can exhibit a range from 20-200 Ohm-m, and metamorphic units can exhibit a range from 10-5,000 Ohm-m.

4.2 DISCUSSION

Numerous fractures are interpreted to exist within the site footprint. From the VLF data, fractures 1-6 were interpreted trending N35°E to N55°E and dipping either to the northwest or southeast. Fractures 7-9 were identified trending N35°W to N45°W and dipping either to the northeast or southwest **(Figure 6).**

Fractures were located on the map based on where they would theoretically intercept the ground surface based on their dip as interpreted from the VLF profiles. Some fractures were interpreted on VLF profiles but did not show a trending repetition in other profiles and therefore were not mapped. Many of the interpreted fractures extend through the entire VLF profile while others appear to terminate before reaching the full 300-foot depth of the VLF profile **(Figures 3 & 4).**

Apparent resistivity values at the project site range from approximately 10-4,500 Ohm-m; which is consistent with the geology of the site. Ground conditions were variable from location to location; ranging from metamorphic rock such as gneiss to sandy and silty floodplain deposits. These lithologic variations resulted in a wide range of observed resistivity values.

The location where an interpreted fracture from the VLF data crosses an EI profile is marked on the EI profiles **(Figure 5)**. The orientation and dip of the fractures interpreted from the VLF data were placed on the EI profiles targeting apparent resistivity anomalies that may be indicative of fractures. EI profile 2 appears to show a well-developed fracture, however, the remaining EI profiles are not as conclusive. The EI data are dominated by anomalies likely resulting from variations in formation saturation and lithology.

5.0 CONCLUSION

The majority of the interpreted fractures generally trend N35°E to N55°E but some fractures, approximately perpendicular to the dominant trend, were identified trending N35°W to N45°W **(Figure 6)**. Fracture dips were interpreted in both directions perpendicular, respectively, to the trend of a fracture.

Several proposed drilling locations were identified across the site. Considering VLF anomaly strength, proposed drilling locations were chosen along VLF profiles and down-dip approximately 100-feet from the fracture location. Intersections of interpreted fractures are likely to be subject to the most well-developed fracturing and were specifically targeted.

6.0 REFERENCES

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deGroot-Hedlin, C. and Constable, S. (1990), Occam's inversion to generate smooth, two-dimensional models from magnetotelluric data. Geophysics, V. 55, 1613-1624.

Karous and Hjelt (1983). Linear filtering of VLF dip-angle measurements: Geophysical Prospecting, v. 31, p. 782-794.

Loke, M. N., and Barker, R. D. (1996). Rapid least-squares inversion of apparent resistivity pseudosection by quasi-Newton method. Geophysical Prospecting, V. 44, 131-152.

Mooney, H. M. (1980). Handbook of Engineering Geophysics: Volume 2: Electrical Resistivity, Bison Instruments, Inc.

Reynolds, J. M. (1997). An Introduction to Applied and Environmental Geophysics. New York, NY, Wiley.

SCDNR (2019). Interactive Map of the geology of South Carolina. American Geosciences Institute."http://scdnr.maps.arcgis.com/apps/Viewer/index.html?appid=735411a2f5714f28a424422296f77bb1".

USGS (2019). Ground Water Atlas of the United States; Alabama, Florida, Georgia, South Carolina. "https://pubs.usgs.gov/ha/ha730/ch_g/G-text8.html".

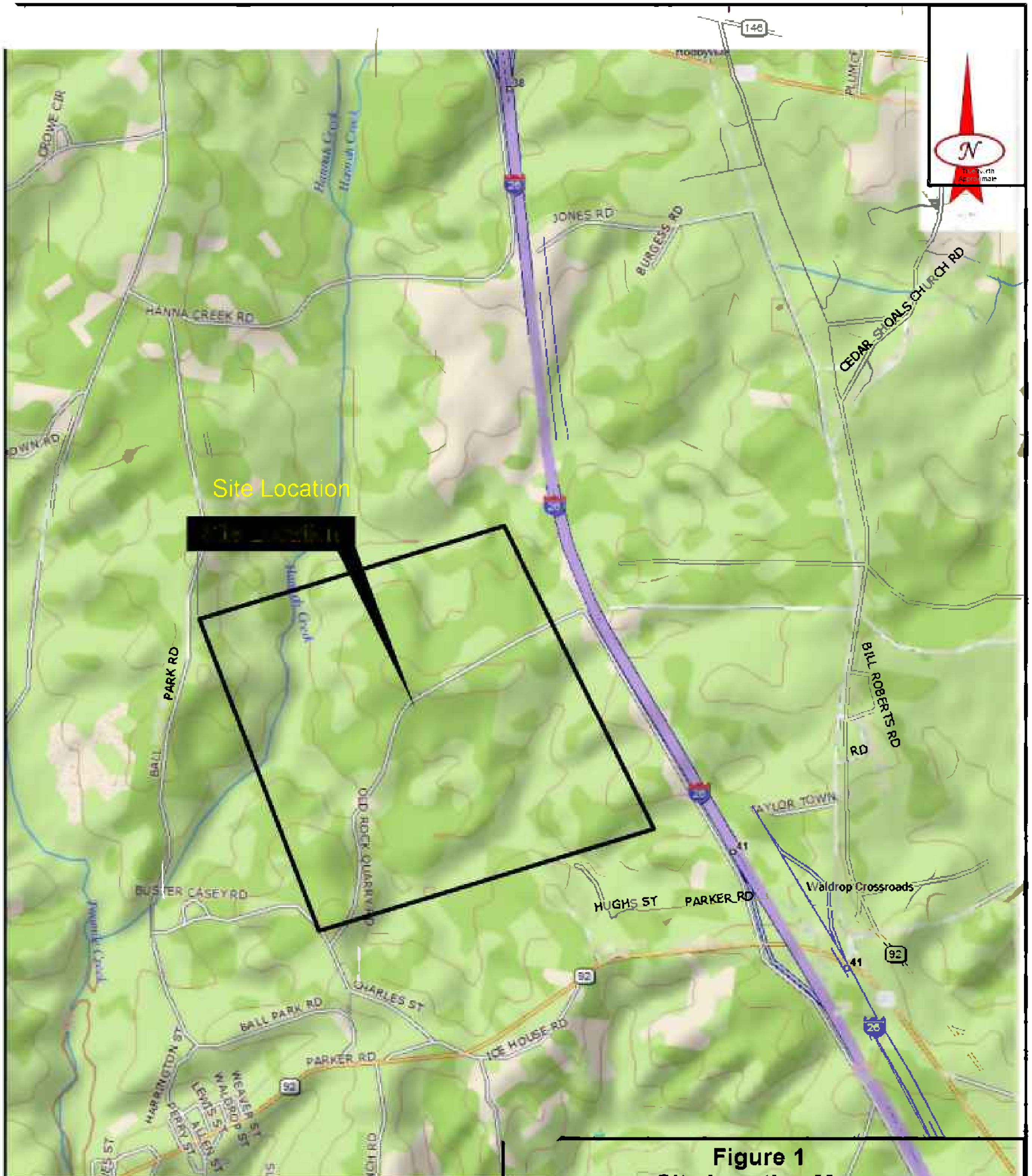


Figure 1
Site Location Map

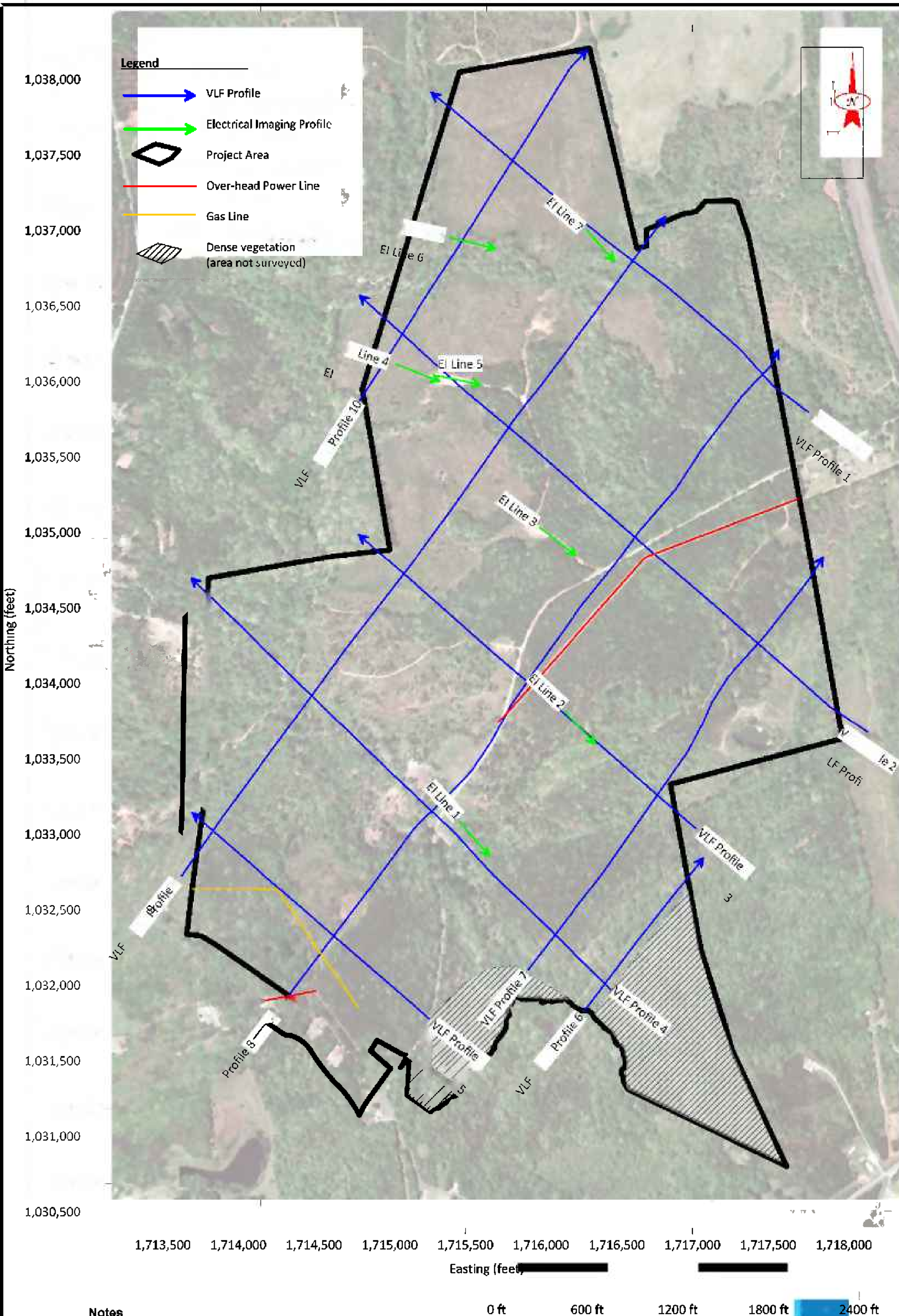
4280 Old William Penn Hwy
Murrysville, Pennsylvania 15668
(724) 325-3996 Fax: (724) 733-7901

www.thggeophysics.com

Geophysical Investigation
VLF Survey
Enoree, South Carolina

SCALE: 1:24,000	PROJECT NO.: 459-10249	DRAWING NO.: DWG10249F1
DATE : 09/19/2019		
DRAWN BY: DJH	SOURCE: 1983 Enoree (SC) USGS 7.5 Minute Topographic Quadrangle	
CHECKED BY: PJH		

0 ft 1000 ft 2000 ft 3000 ft 4000 ft 5000 ft



Notes

Geophysical survey conducted September 24-28, 2019 using GF Instruments ARES II electrical resistivity meter and an ABEM WADI very low frequency electromagnetic instrument.

Real-time positioning of data collected using a Trimble GEO-7XH global positioning system set to NAD83 US State Plane coordinate system (South Carolina) in US Survey Feet.

Locations are approximate.

4285 Old William Penn Hwy
Murrysville, Pennsylvania 15668
(724) 325 3996 Fax: (724) 733 7801
www.tggeophysics.com

DRN	MLT	[illegible]
DES	MLT	[illegible]
CHK	PJH	[illegible]
REV		
PROJ. MGR.	MLT	[illegible]

SCALE: 1 in = 600 ft

SOURCE: USGS

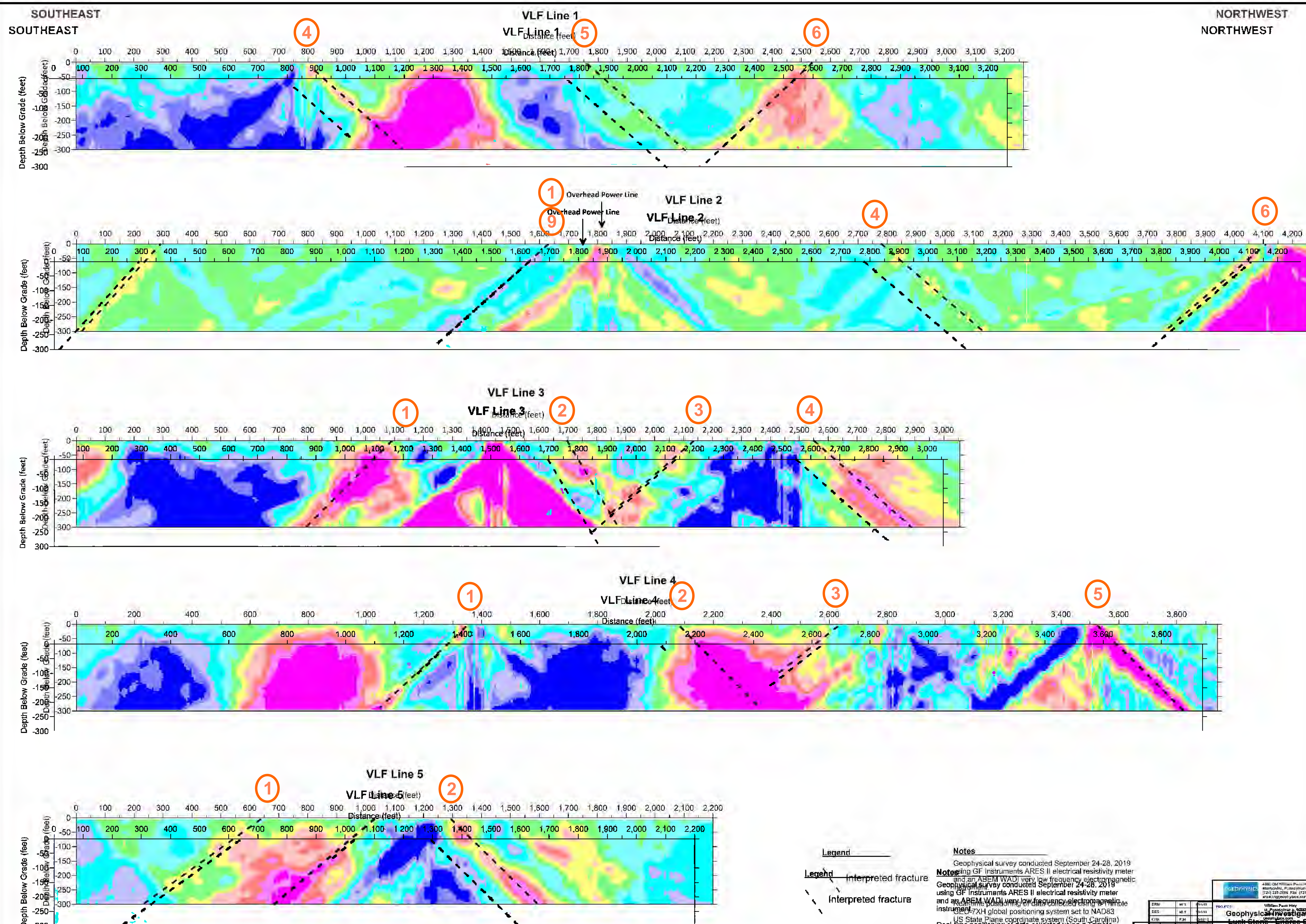
PROJECT: Geophysical Investigation Luck Stone - Enoree Site Enoree, South Carolina

DRAWING NO.: Figure 2 Survey Map

PREPARED FOR: LUCK STONE

PROJECT NO.: 459-10249

DWG10249F2



Legend

Interpreted fracture

Notes

Geophysical survey conducted September 24-28, 2019 using GF Instruments ARES II electrical resistivity meter and an ABEM WADI very low frequency electromagnetic instrument.

Real-time positioning of data collected using a Trimble GEO-7XH global positioning system set to NAD83 US State Plane coordinate system (South Carolina) in US Survey Feet.

Locations are approximate.

No Vertical Exaggeration
Horizontal 1" = 200'
Vertical 1" =200'

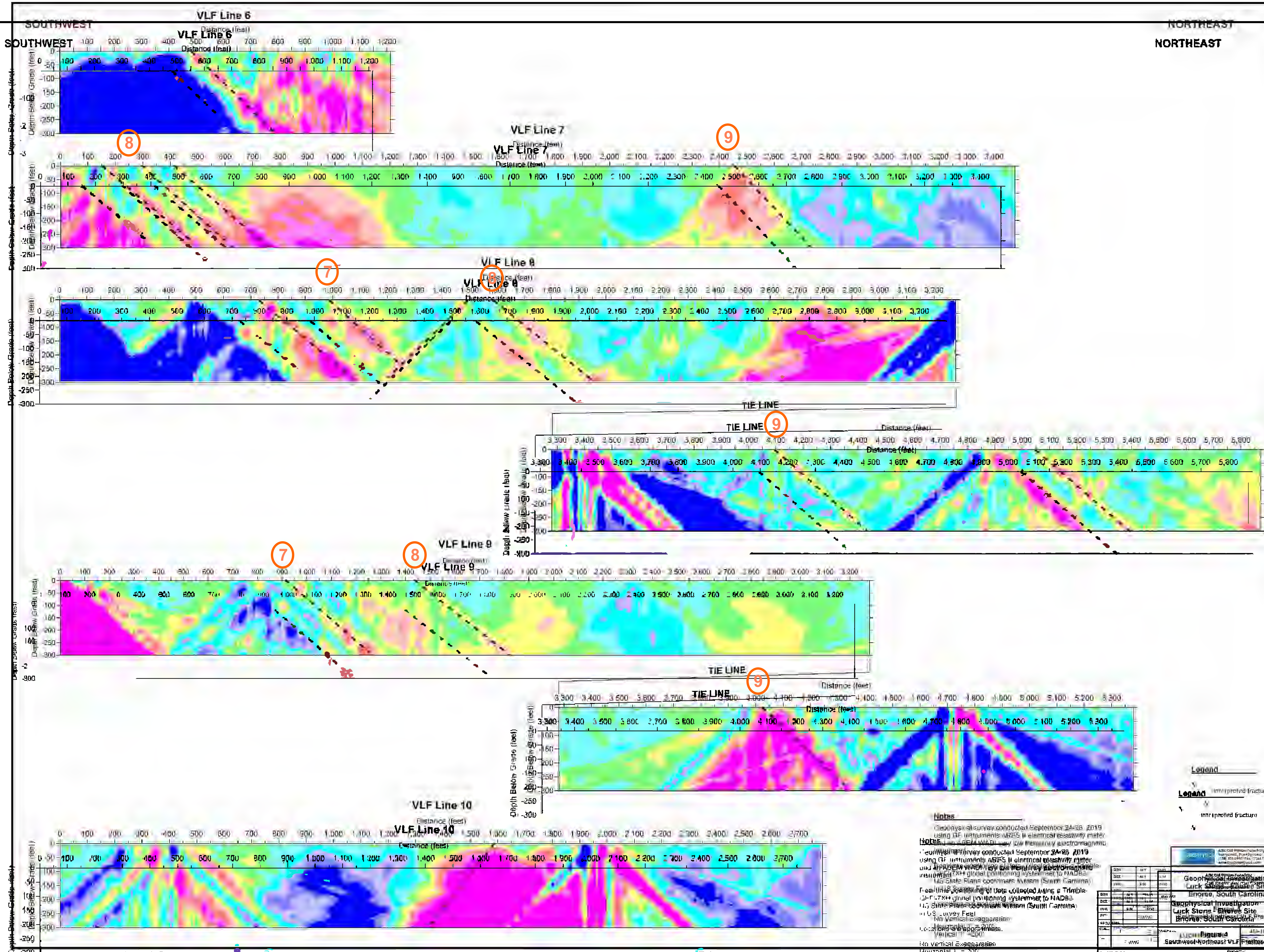
Legend
Interpreted fracture
Notes
Geophysical survey conducted September 24-28, 2019 using GF Instruments ARES II electrical resistivity meter and an ABEM WADI very low frequency electromagnetic instrument.
Real-time positioning of data collected using a Trimble GEO-7XH global positioning system set to NAD83 US State Plane coordinate system (South Carolina) in US Survey Feet.
Locations are approximate.
No Vertical Exaggeration
Horizontal 1" = 200'
Vertical 1" =200'

GEOPHYSICS

PROJECT: Geophysical Investigation
Luck Stone - Enoree Site
Enoree, South Carolina

Figure 3
Southeast-Northwest VLF Profiles

459-10249
DWG10249F3



Legend

interpreted fracture

Notes

Geophysical survey conducted September 24-28, 2019 using GF Instruments ARES II electrical resistivity meter and an ABEM WADI very low frequency electromagnetic instrument.

Real-time positioning of data collected using a Trimble GEO 7X global positioning system set to NAD83 US State Plane coordinate system (South Carolina) in US Survey Feet.

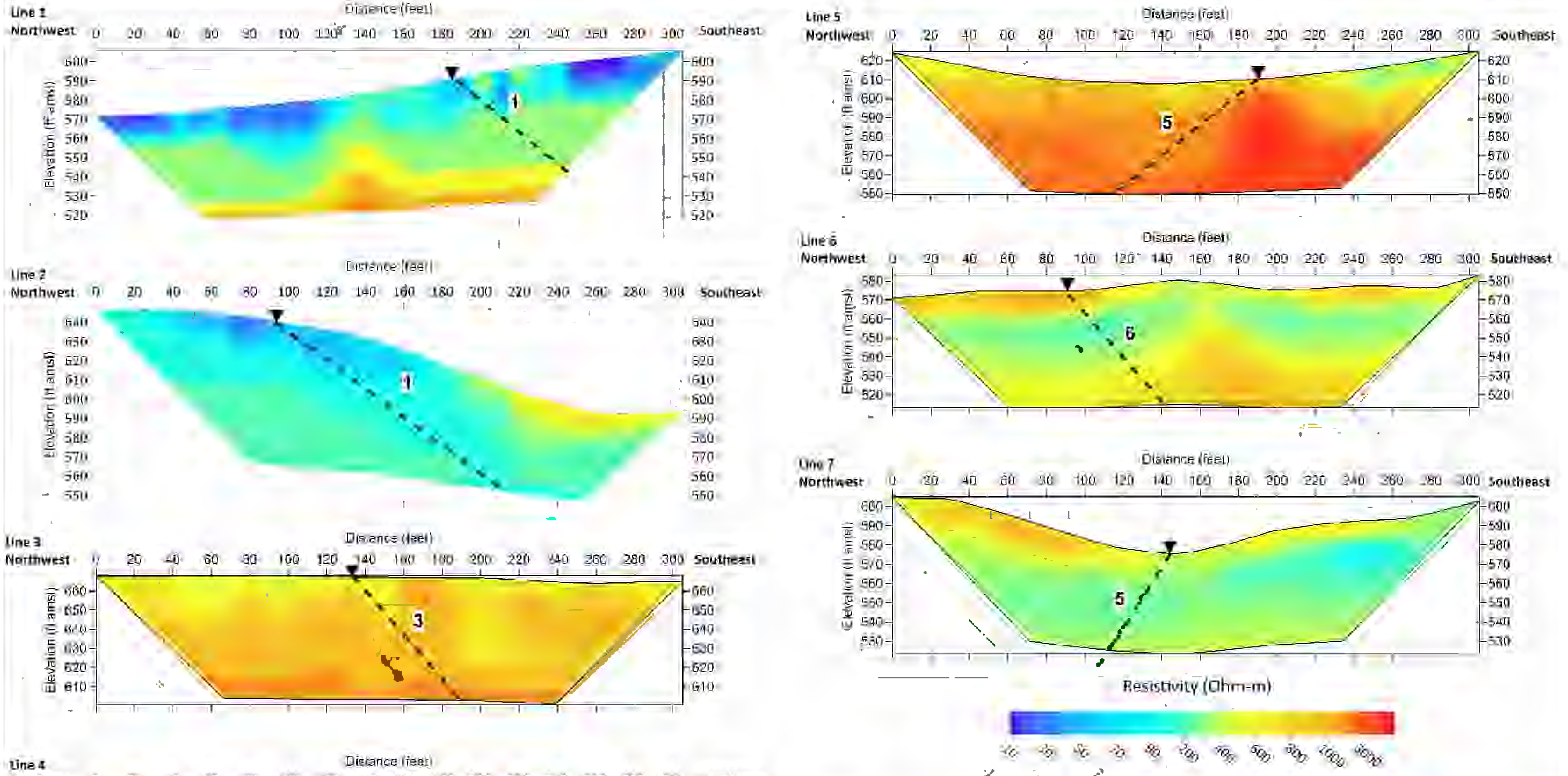
Locations are approximate.

No Vertical Exaggeration
Horizontal 1" = 200'
Vertical 1" = 200'

Geophysical Investigation
Luck Stone - Enoree Site
Enoree, South Carolina

Figure 4
Southwest-Northeast VLF Profiles

LUCK STONE



Legend

▼ Interpreted VLF Fracture

Interpreted EI Fracture

5 Lineament (See Figure 6)

Notes

Geophysical survey conducted September 24-28, 2019 using GF Instruments ARES II electrical resistivity meter and an ABEM WADI very low frequency electromagnetic instrument.

Real-time positioning of data collected using a Trimble GEO-7XH global positioning system set to NAD83 US State Plane coordinate system (South Carolina) in US Survey Feet.

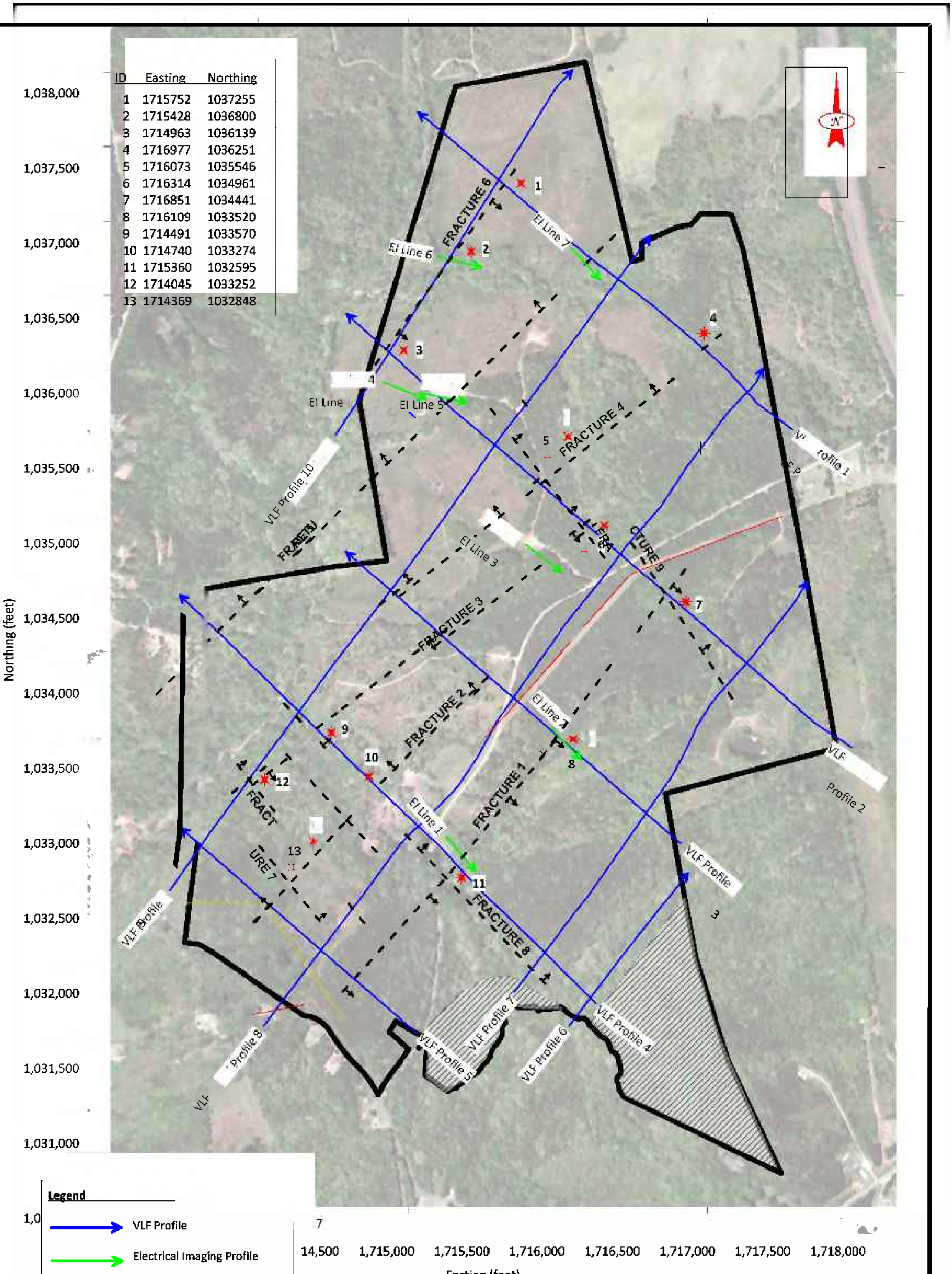
Locations are approximate.

PROJECT:
Geophysical Investigation
Luck Stone - Enoree Site
Enoree, South Carolina

Figure 5
Electrical Imaging Profiles

LUCK STONE

DWG1924SF5



ID	Easting	Northing
1	1715752	1037255
2	1715428	1036800
3	1714963	1036139
4	1716977	1036251
5	1716073	1035546
6	1716314	1034961
7	1716851	1034441
8	1716109	1033520
9	1714491	1033570
10	1714740	1033274
11	1715360	1032595
12	1714045	1033252
13	1714369	1032848

Legend

- VLF Profile
- Electrical Imaging Profile
- Interpreted Fracture (arrow indicates dip direction)
- Project Area
- Over-head Power Line
- Gas Line
- Dense vegetation (area not surveyed)
- Proposed Boring Location

Notes

Geophysical survey conducted September 24-28, 2019 using GF Instruments ARES II electrical resistivity meter and an ABEM WADI very low frequency electromagnetic instrument.

Real-time positioning of data collected using a Trimble GEO-7XH global positioning system set to NAD83 US State Plane coordinate system (South Carolina) in US Survey Feet.

Locations are approximate.

4256 Old William Penn Hwy
Murrysville, Pennsylvania 15668
(724) 325 3996 Fax: (724) 733 7801
www.tggeophysics.com

DRN	MLT	10.7.19
DES	MLT	10.1.19
CHK	PJH	10/14/19
REV		
PROJ. MGR.	MLT	10/14/19

SCALE: 1 in ~ 602 ft

SOURCE: USGS

PROJECT: Geophysical Investigation Luck Stone - Enoree Site Enoree, South Carolina

DRAWING NO.: Figure 6 Fracture & Proposed Boring Location M

PREPARED FOR: LUCK STONE

0249

DWG10249F6

Appendix IV – Well Permit and Well Records

Monitoring Well Approval

Approval is hereby granted to: Hanna Holdings Group, LLC
Attention: Charles B. Hanna

Facility: Hanna Holdings Group, LLC
Spartanburg County

This approval is for the installation of eight (8) monitoring wells, identified and located as specified and in accordance with the construction plans and specifications described in the monitoring well application (enclosed). These wells are to be used for water quantity monitoring prior to a quarry construction and operation.

Conditions:

1. The well shall be drilled, constructed, and abandoned by a South Carolina certified well driller per R.61-71.D.1.

2. The well shall be properly developed per R.61-71.H.2.d. A Water Well Record Form (DHEC 1903) and drillers/geologists logs shall be completed and submitted within 30 days after well completion or abandonment unless another schedule has been approved by DHEC. The form should contain the "as-built" construction details and all other information required by R.61-71.H.1.f.

3. All analytical data and water levels obtained from the monitoring wells shall be submitted to the author of the approval within 30 days of receipt of laboratory results unless another schedule has been approved by DHEC as required by R.61-71.H.1.d.

4. The monitoring well shall be labeled, as required by R.61-71.H.2.c.

This approval is pursuant to the provisions of Section 44-55-40 of the 1976 South Carolina Code of Laws and R.61-71 of the South Carolina Well Standards and Regulations, effective May 27, 2016.

Date of Issuance: **March 02, 2020**

Jeremy E. Eddy

Jeremy Eddy, GIT
Mining & Reclamation Program
Division of Mining and Solid Waste Management
Bureau of Land & Waste Management

February 25, 2020

South Carolina Department of Health and Environmental Control
Mining Reclamation
2600 Bull Street
Columbia, South Carolina 29201

Attention: Mr. Joe Koon, Mining Section Manager koonjm@dhec.sc.gov

Reference: **Well Permit Submittal**
Hanna Site
Enoree, Spartanburg County, South Carolina
S&ME Project No. 4341-19-156

Dear Mr. Koon:

S&ME, Inc. (S&ME) is assisting Hanna Holdings Group, LLC, the subject property owner, with site evaluation services associated with a proposed aggregate mine in Spartanburg County, North Carolina. Included in our evaluation services will be the completion of two aquifer pump tests and development of a numerical groundwater model to evaluate the potential impacts of dewatering and groundwater extraction activities at the site.

Prior to performing the pump test, S&ME will install six groundwater extraction/bedrock observation wells to a depth on the order of 500 feet below grade or less. An alternate location for Well #3 has been presented as Well #3A as access to the target location has not be determined. The wells will be constructed with a 6-inch diameter galvanized steel surface casing (to rock) and the remaining portion of the well will be comprised of 6-inch open borehole within the competent rock formation. S&ME will also install one shallow observation wells to the depth of hollow stem auger refusal with a drill rig. S&ME anticipates the depth of the shallow observations wells to be less than 75 feet below grade.

Groundwater pump testing will be performed to gather pertinent aquifer data. Drilling activities are tentatively scheduled to begin in March 2020. I have attached the completed D-3736 form and supporting figures to aid in your review of the application. S&ME appreciates your assistance with this project. We are providing this as proprietary information and would request that it be kept confidential until such time as a mine permit application is filed. Once a permit for this property is filed, the information can be utilized as supporting data for the mine permit application and we understand it would be provided to the public for their use. Please do not hesitate to contact David Loftis at (828) 483-3012 with any questions.

Sincerely,

S&ME, Inc.

David R. Loftis, P.E.
Senior Engineer (SC #27867)

Edmund Q.B. Henriques
Principal Geologist (NC)

Attachments: D-3736
Supporting Figures (5)

cc: Mr. Charles Hanna

Attachment I – D-3736

Monitoring Well Application

1. Proposed Location of Monitoring Well(s):

Street Address: **Lawrence Rd and Frontier Rd (PIN 4-55-00-076.00)**

City (including Zip): **Enoree (29335)**

County: **Spartanburg**

Please attach Scaled Map or Plat

2. Well Owner's Information:

Name (Last then First): **Hanna, Charles B.**

Company: **Hanna Holdings Group, LLC**

Complete Address: **1821 Old Furnace Road Boiling Springs, SC 29316**

Telephone Number: **(864) 327-5201**

3. Property Owner's Information:

☑ Check if same as Well Owner

Name (Last then First):

Company:

Address:

Telephone Number:

4. Proposed Drilling Date: **03/09/2020**

5. Intended Purpose of Well(s):

Pre-Purchase ☐

Investigation ☑

NOTE: If this request is for an existing DHEC project, please enter the Program area and ID number below.

Program Area:
Project or Site ID #:

6. Proposed number of monitoring wells: **7**

7. Proposed parameters to be analyzed (check all that apply), please specify analytical method beside check box:

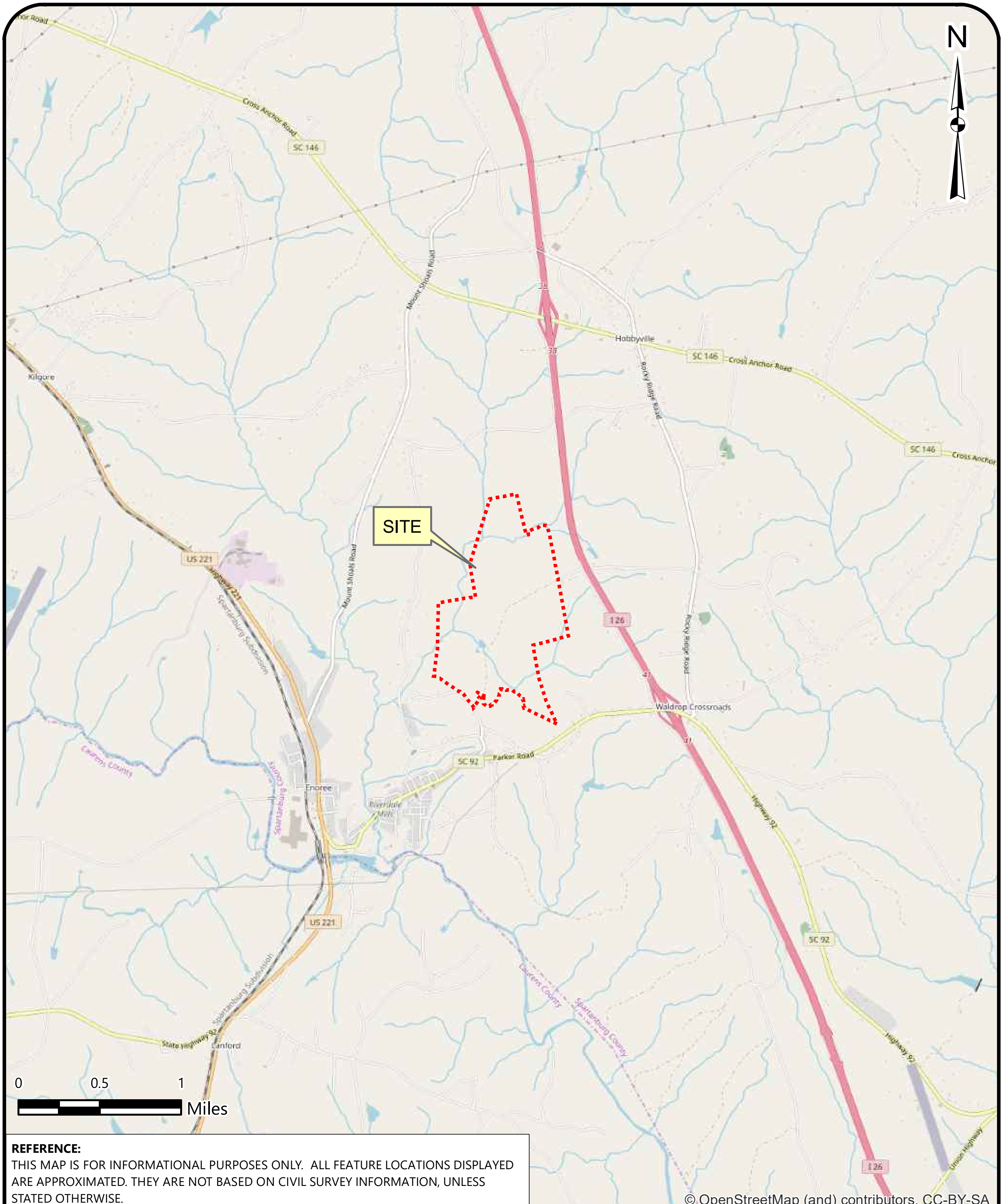
VOCs	☐
BTEX	☐
MtBE	☐
Naphthalene	☐
PAHs	☐
Metals	☐
Nitrates	☐
Base, Neutral & Acid Ex.	☐
Pesticides/Herbicides	☐
Phenols	☐
Radionuclides	☐
PCBs	☐
Other (specify below)	☐

No groundwater analyses are planned.

8. Proposed construction details (complete and attach proposed monitoring well schematics):

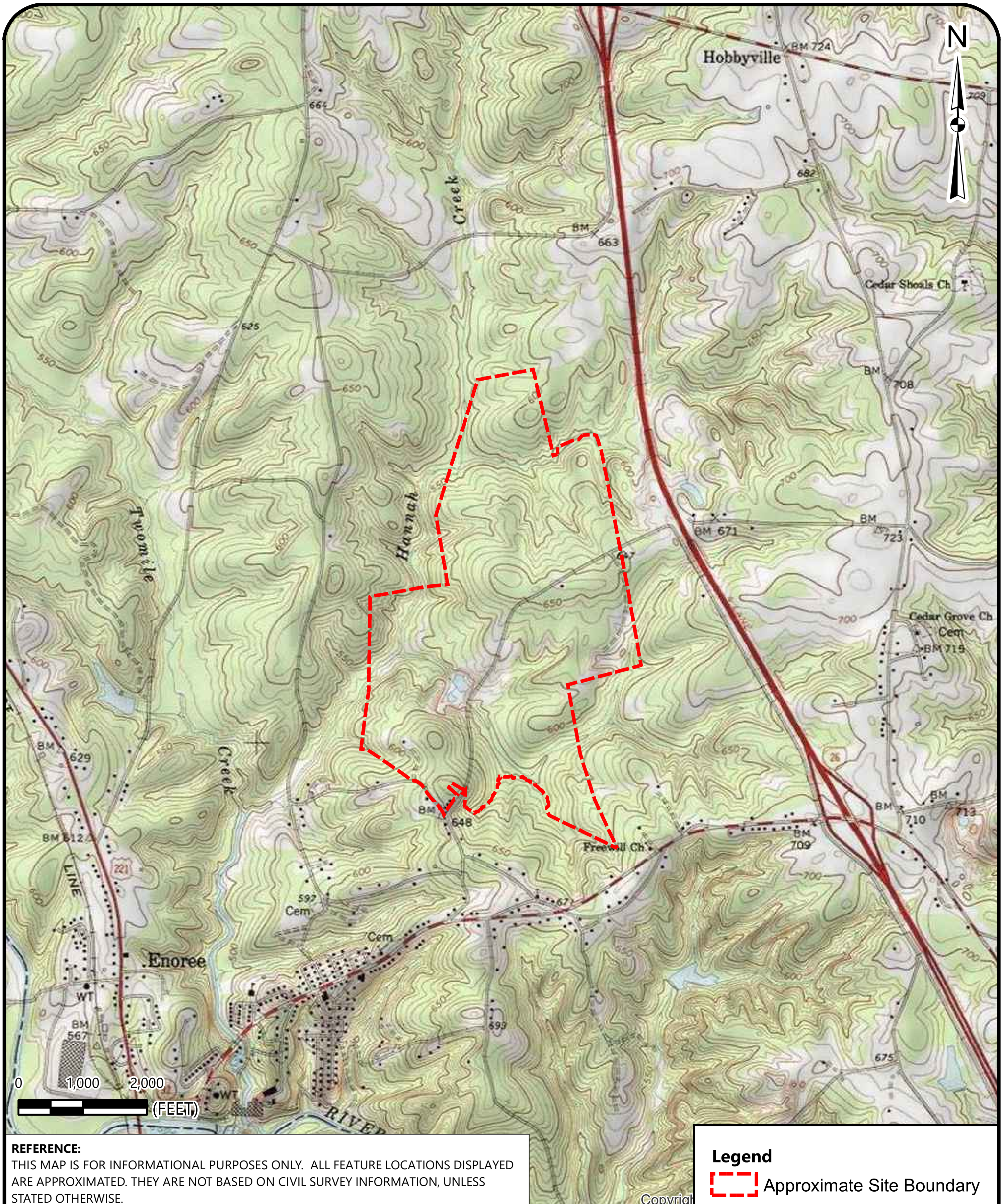
See Figures 4 and 5

Attachment II – Supporting Figures



REFERENCE:
THIS MAP IS FOR INFORMATIONAL PURPOSES ONLY. ALL FEATURE LOCATIONS DISPLAYED ARE APPROXIMATED. THEY ARE NOT BASED ON CIVIL SURVEY INFORMATION, UNLESS STATED OTHERWISE.

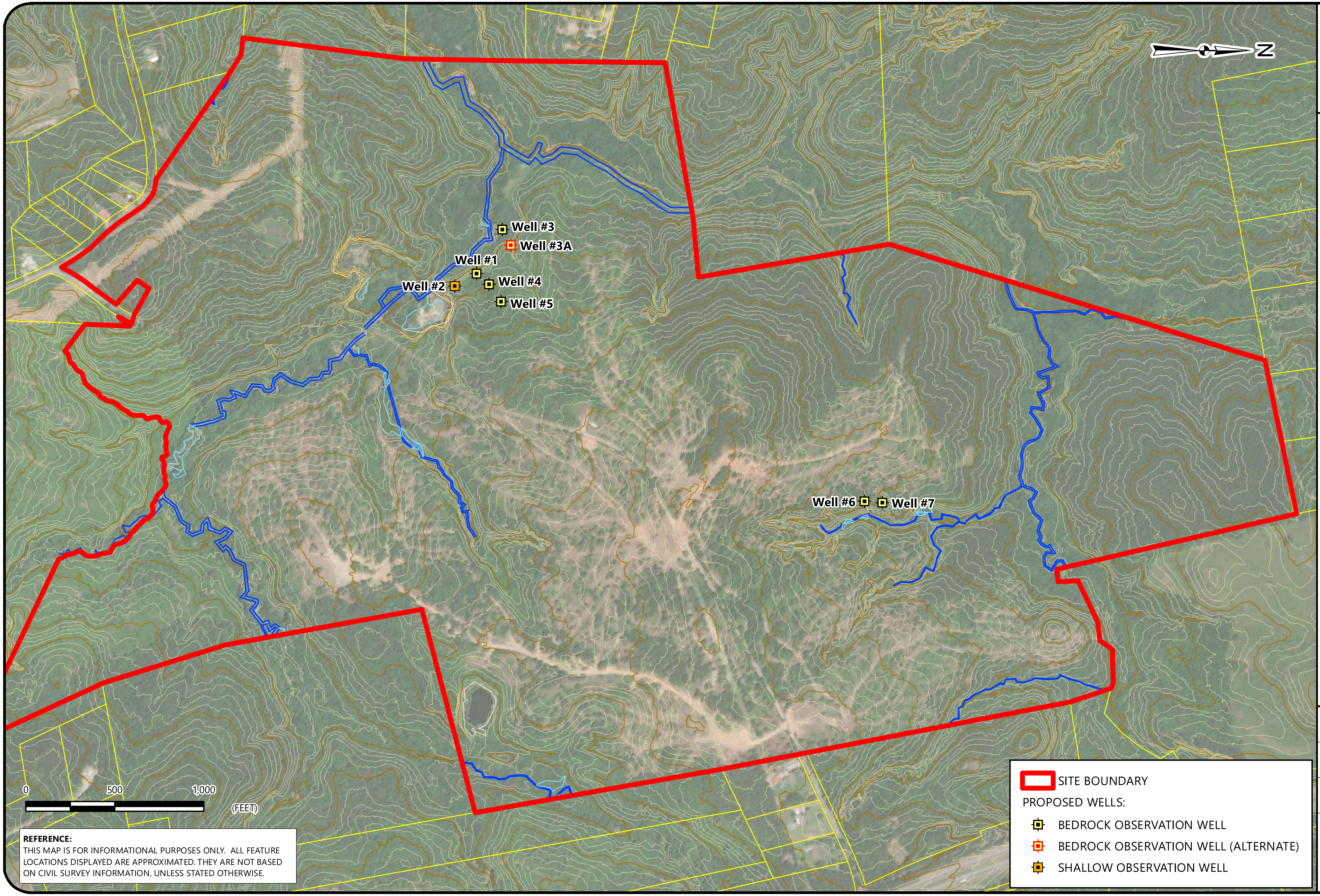
	SITE LOCATION MAP	SCALE: AS NOTED	EXHIBIT NO.
		DATE: JAN. 2020	**1**
	HANNA SITE ENOREE, SPARTANBURG COUNTY, SOUTH CAROLINA	PROJECT NUMBER 4261-19-156	



REFERENCE:
THIS MAP IS FOR INFORMATIONAL PURPOSES ONLY. ALL FEATURE LOCATIONS DISPLAYED ARE APPROXIMATED. THEY ARE NOT BASED ON CIVIL SURVEY INFORMATION, UNLESS STATED OTHERWISE.

Legend
Approximate Site Boundary

S&ME	**USGS TOPOGRAPHIC MAP**	SCALE: 1 " = 2,000 '	EXHIBIT NO.
		DATE: JAN. 2020	**2**
	HANNA SITE ENOREE, SPARTANBURG COUNTY, SOUTH CAROLINA	PROJECT NUMBER 4261-19-156	



PROPOSED WELL LOCATION MAP

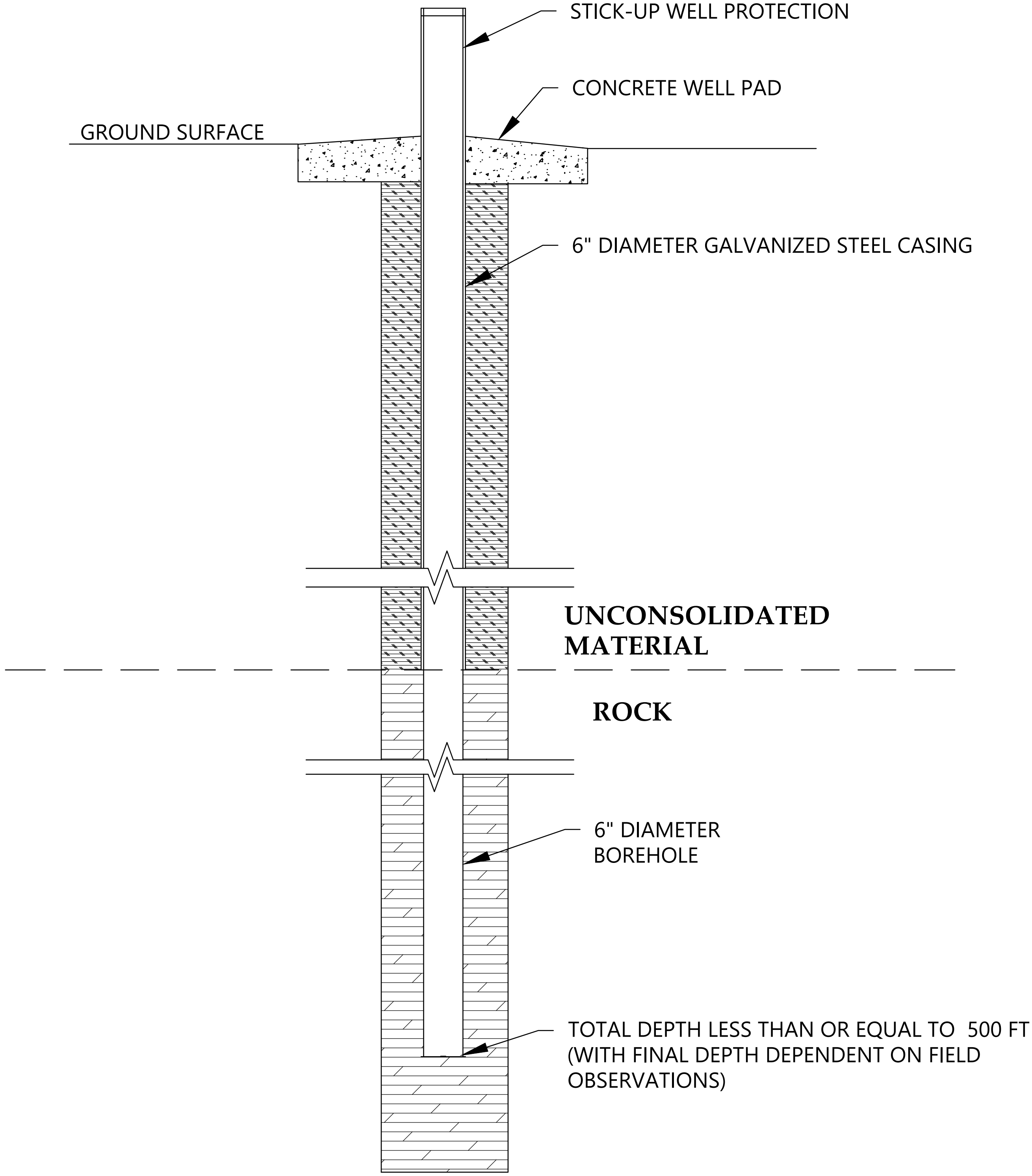
HANNA SITE
ENOREE, SPARTANBURG COUNTY, SOUTH CAROLINA

SCALE:
1 " = 500 '

DATE:
2-21-20

PROJECT NUMBER
4261-19-156

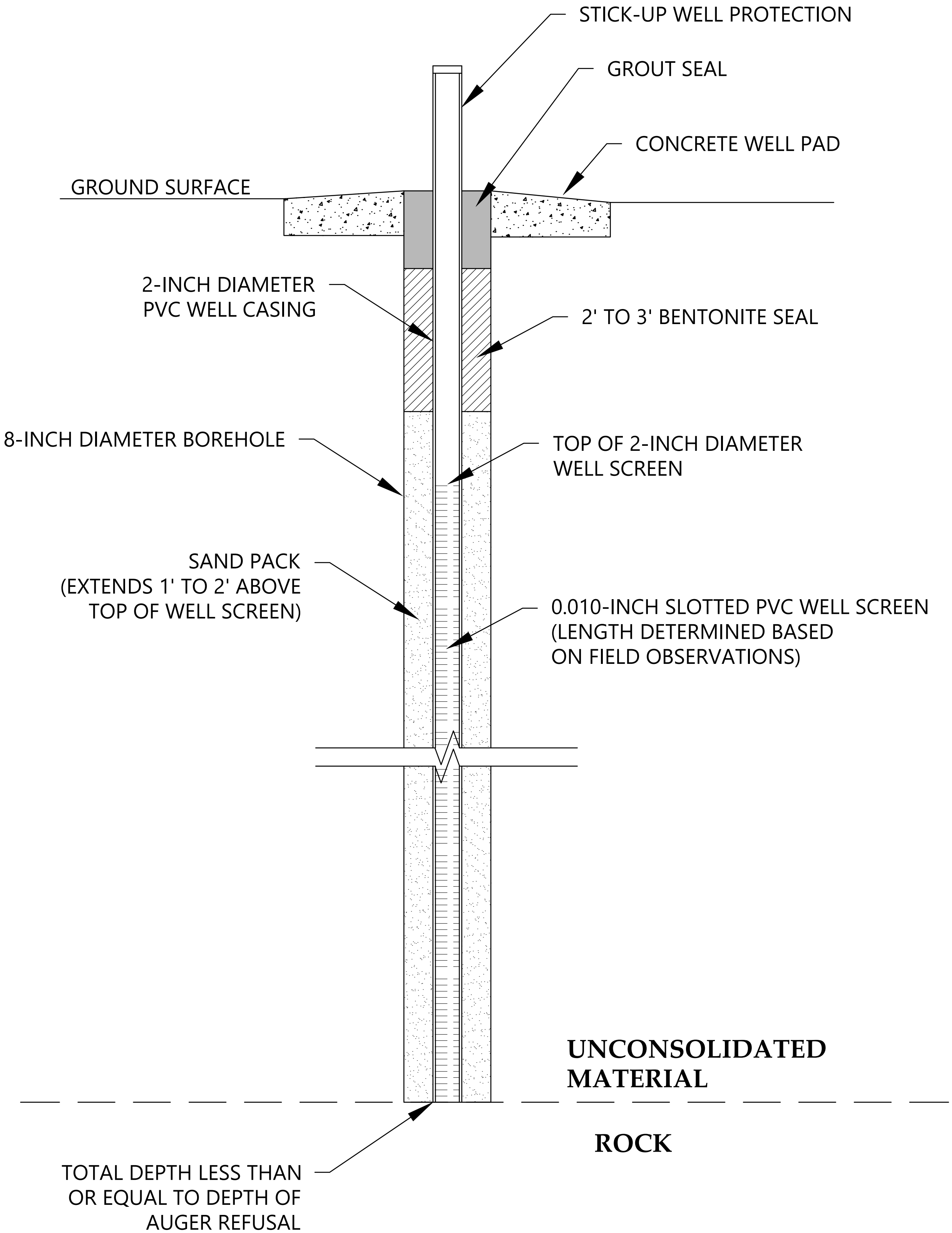
FIGURE NO.
3



PROPOSED BEDROCK WELL SCHEMATIC

HANNA SITE
ENOREE, SPARTANBURG COUNTY, SOUTH CAROLINA

SCALE:	FIGURE NO.
NTS	4
DATE:	
JAN. 2020	
PROJECT NUMBER	
4261-19-156	



PROPOSED SHALLOW WELL SCHEMATIC

HANNA SITE
ENOREE, SPARTANBURG COUNTY, SOUTH CAROLINA

SCALE:	NTS
DATE:	JAN. 2020
PROJECT NUMBER	4261-19-156
FIGURE NO.	5

David Loftis

From: Koon, Joe <koonjm@dhec.sc.gov>
Sent: Friday, March 13, 2020 12:52 PM
To: David Loftis; Eddy, Jeremy E.
Cc: charlesbhanna@gmail.com; Edmund Q B Henriques
Subject: Re: Well Permit Package for Enoree, SC Site

{This message originated outside of S&ME. Please report this as phishing if it implies it is from an S&ME employee.}

David,
This email is sufficient and the changes are approved with the same conditions as the March 2, 2020 approval.
Thanks,

Joe Koon
Manager, Mining and Reclamation Section
Division of Mining & Solid Waste Management
S.C. Dept. of Health & Environmental Control
Office: (803) 898-1371
Connect: www.scdhec.gov Facebook Twitter

From: David Loftis <DLoftis@smeinc.com>
Sent: Friday, March 13, 2020 12:44 PM
To: Eddy, Jeremy E. <eddyje@dhec.sc.gov>
Cc: charlesbhanna@gmail.com <charlesbhanna@gmail.com>; Edmund Q B Henriques <EHenriques@smeinc.com>; Koon, Joe <koonjm@dhec.sc.gov>
Subject: RE: Well Permit Package for Enoree, SC Site

*** Caution. This is an EXTERNAL email. DO NOT open attachments or click links from unknown senders or unexpected email. ***

Good afternoon Jeremy,
We began drilling activities at the Enoree Hanna site on March 9. It has been challenging to find sufficient water producing fractures for our hydrogeologic testing and analysis. For this reason, we are needing to shift the location of Wells #4 and #5 to the location on the attached figure. The original locations are presented in a “greyed-out” fashion for reference.

We may also need to install an additional well identified as Well #8, also shown on the same figure. We envision Well #8 to have the same construction details as the other bedrock wells.

Is this email notification sufficient from a permitting standpoint? If not, please let me know what you would like me to provide. Our tentative plan is to install Well #4 on March 16, Well #5 on March 16, and Well #8 on March 17.

Thank you,

David R. Loftis, P.E.
Senior Engineer

S&ME
44 Buck Shoals Road, Suite C-3
Arden, NC 28704 map
O: 828.483.3012
M: 828.337.1923
www.smeinc.com
LinkedIn | Twitter | Facebook

From: Eddy, Jeremy E. <eddyje@dhec.sc.gov>
Sent: Monday, March 9, 2020 8:35 AM
To: David Loftis <DLoftis@smeinc.com>
Cc: charlesbhanna@gmail.com; Edmund Q B Henriques <EHenriques@smeinc.com>; Koon, Joe <koonjm@dhec.sc.gov>
Subject: Re: Well Permit Package for Enoree, SC Site

Mr. Loftis,

This was mailed out last Monday, but here is an electronic copy for your records.

Respectfully,
Jeremy Eddy, GIT
Project Manager, Mining and Reclamation Section
Division of Mining & Solid Waste Management
S.C. Dept. of Health & Environmental Control
Office: (803) 898-7609
Connect: www.scdhec.gov Facebook Twitter

From: David Loftis <DLoftis@smeinc.com>
Sent: Friday, March 6, 2020 3:59 PM
To: Koon, Joe <koonjm@dhec.sc.gov>
Cc: charlesbhanna@gmail.com <charlesbhanna@gmail.com>; Edmund Q B Henriques <EHenriques@smeinc.com>; Eddy, Jeremy E. <eddyje@dhec.sc.gov>
Subject: RE: Well Permit Package for Enoree, SC Site

Thank you Joe. I really appreciate it.

David R. Loftis, P.E.
Senior Engineer

S&ME
44 Buck Shoals Road, Suite C-3
Arden, NC 28704 map
O: 828.483.3012
M: 828.337.1923
www.smeinc.com
LinkedIn | Twitter | Facebook

From: David Loftis
Sent: Friday, March 6, 2020 3:37 PM
To: Koon, Joe <koonjm@dhec.sc.gov>
Cc: charlesbhanna@gmail.com; Edmund Q B Henriques <EHenriques@smeinc.com>; eddyje@dhec.sc.gov
Subject: RE: Well Permit Package for Enoree, SC Site
Importance: High

Good afternoon Joe,
We are scheduled to start drilling on Monday, March 9 at the Enoree site. Jeremy had called me on Monday and said that the permit approval would like be sent out that day. Can you confirm that we have a permit? Can you email me a PDF version? I guess I should have asked but I thought we would have received a PDF version like before.

Thank you,

David R. Loftis, P.E.
Senior Engineer

S&ME
44 Buck Shoals Road, Suite C-3
Arden, NC 28704 map
O: 828.483.3012
M: 828.337.1923
www.smeinc.com
LinkedIn | Twitter | Facebook

From: David Loftis
Sent: Tuesday, February 25, 2020 4:27 PM
To: Koon, Joe <koonjm@dhec.sc.gov>
Cc: charlesbhanna@gmail.com; Edmund Q B Henriques <EHenriques@smeinc.com>
Subject: Well Permit Package for Enoree, SC Site

Mr. Koon
Attached is a well installation permit package associated with a proposed aggregate mine in Spartanburg County, South Carolina. Please do not hesitate to contact me with any questions.

Thank you,

David R. Loftis, P.E.
Senior Engineer

S&ME
44 Buck Shoals Road, Suite C-3
Arden, NC 28704 map
O: 828.483.3012
M: 828.337.1923
www.smeinc.com
LinkedIn | Twitter | Facebook

Water Well Record
Bureau of Water
2600 Bull Street, Columbia, SC 29201-1708; (803) 898-4300

***Note:** Personal information provided on this document is subject to public scrutiny or release.*

1. WELL OWNER INFORMATION:
Name: HANNA, CHARLES B. (last) (first)
Address: 1821 OLD FURNACE ROAD
City: BOILING SPRINGS State: SC Zip:
Telephone: Work: (864) 327-5201 Home:

2. LOCATION OF WELL: **COUNTY:** SPARTANBURG
Name: HANNA HOLDINGS GROUP LLC
Street Address: LAWRENCE ROAD AND FRONTIER
City: ENOREE, SC Zip:
Latitude: Longitude:

3. PUBLIC SYSTEM NAME: **PUBLIC SYSTEM NUMBER:**

4. ABANDONMENT: ☐ Yes ☑ No
Give Details Below
Grouted Depth: from ___________ ft. to ______________ ft.

Formation Description	*Thickness of Stratum	Depth to Bottom of Stratum
OVERBURDEN	102	102
*GRANITE ROCK	298	400
*1/4 GPM AT 150 FEET		

*Indicate Water Bearing Zones

(Use a 2nd sheet if needed)

5. REMARKS:
MONITORING WELL
APPROVAL GRANTED BY
JEREMY EDDY ON 3/2/2020

6. TYPE: ☐ Mud Rotary ☐ Jetted ☐ Bored ☐ Dug ☑ Air Rotary ☐ Driven ☐ Cable tool ☐ Other

7. PERMIT NUMBER: S&ME WELL #1

8. USE:
☑ Residential ☐ Public Supply ☐ Process
☐ Irrigation ☐ Air Conditioning ☐ Emergency
☐ Test Well ☑ Monitor Well ☐ Replacement

9. WELL DEPTH (completed) Date Started: 3-11-2020
400 ft. Date Completed: 3-11-2020

10. CASING: ☐ Threaded ☐ Welded
Diam.: ______________
Type: ☐ PVC ☑ Galvanized ☐ Steel ☐ Other
6 1/4 in. to 102 ft. depth
________ in. to ________ ft. depth
Height: Above/Below Surface 1.5 ft.
Weight ______________ lb./ft.
Drive Shoe? ☐ Yes ☑ No

11. SCREEN:
Type: ______________ Diam.: ______________
Slot/Gauge: ______________ Length: ______________
Set Between: ________ ft. and ________ ft. **NOTE: MULTIPLE SCREENS**
________ ft. and ________ ft. **USE SECOND SHEET**
Sieve Analysis ☐ Yes (please enclose) ☑ No

12. STATIC WATER LEVEL 25 ft. below land surface after 24 hours

13. PUMPING LEVEL Below Land Surface.
________ ft. after ________ hrs. Pumping ________ G.P.M.
Pumping Test: ☐ Yes (please enclose) ☑ No
Yield: ______________

14. WATER QUALITY
Chemical Analysis ☐ Yes ☑ No Bacterial Analysis ☐ Yes ☑ No
Please enclose lab results.

15. ARTIFICIAL FILTER (filter pack) ☐ Yes ☑ No
Installed from ______________ ft. to ______________ ft.
Effective size ______________ Uniformity Coefficient ______________

16. WELL GROUTED? ☑ Yes ☐ No
☐ Neat Cement ☑ Bentonite ☐ Bentonite/Cement ☐ Other ________
Depth: From 0 ft. to 20 ft.

17. NEAREST SOURCE OF POSSIBLE CONTAMINATION: 100 ft. W direction
Type CREEK
Well Disinfected ☑ Yes ☐ No Type: HTH Amount: 16 OZ.

18. PUMP: Date installed: ______________ Not installed ☑
Mfr. Name: ______________ Model No.: ______________
H.P.________ Volts________ Length of drop pipe________ ft. Capacity ____ gpm
TYPE: ☐ Submersible ☐ Jet (shallow) ☐ Turbine ☐ Jet (deep) ☐ Reciprocating ☐ Centrifugal

19. WELL DRILLER: GRANT FLOYD **CERT. NO.:** 2198
Address: (Print) Level: A B ✓ C D (circle one)
P.O. BOX 205 ROEBUCK, SC 29376
Telephone No.: 864-576-6655 Fax No.:

20. WATER WELL DRILLER'S CERTIFICATION: This well was drilled under my direction and this report is true to the best of my knowledge and belief.

Signed: [signature] Date: 3-11-2020
Well Driller

If D Level Driller, provide supervising driller's name:

BORING LOG FOR WELL 1

PROJECT: **Enoree Hanna Site**
PROJECT NO: **4261-19-156**
PROJECT LOCATION: **Enoree, South Carolina**

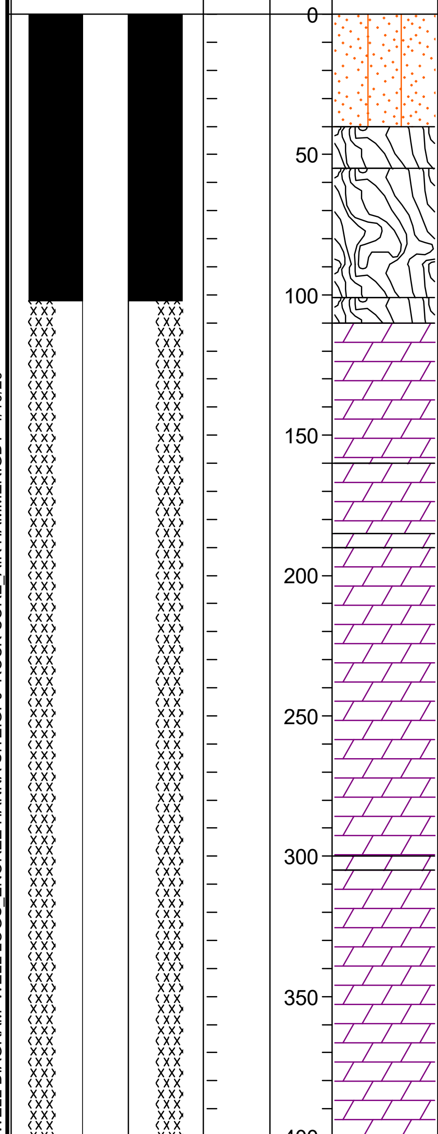
WATER LEVEL: **28.3ft - 3/16/2020 @ 1347**

DATE COMPLETED: **3/11/20**
DRILLING CONTRACTOR: **Wendell J. Lee**
DRILLER: **Grant Floyd - SC Cert 2198**
DRILLING METHOD: **Air Hammer**
SAMPLING METHOD: **Rock Chips**

GROUND SURFACE ELEVATION:
DATUM:
LOGGED BY: **S. Goretoy**

This log is part of the report prepared for the named project and should be read together with that report for complete interpretation. This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

WELL CONSTRUCTION DIAGRAM | ELEVATION (ft.) | DEPTH (ft.) | GRAPHIC SYMBOL



DESCRIPTION	REMARKS
0' - 40' : Silty Sand Residual. Brown Gray. Moist at 10'. Wet at 20'. Organic matter 0-20'	0-102' - 6 1/4" galvanized steel casing 40' - Roller Bit Chatter
40'-55': Silty Sand with soft highly weathered biotite gneiss rock lenses.	55' - Difficult tri-cone drilling
55' - 101' : Soft highly weathered rock. Biotite-Plagioclase-Quartz-Gneiss. Rock chips can be broken with finger pressure and crumbled with hand pressure.	102' - Begin Air Hammering
101' - 110' : Hard weathered rock. Biotite-Plagioclase-Quartz-Gneiss with moderate to slightly weathered rock lenses.	Water Production 160' - <0.2 gpm 240' - 0.5 gpm 400' - 0.5 gpm
110' - 160' : Rock. Biotite-Plagioclase-Quartz-Gneiss. Some modererate to slightly weathered zones.	
160' - 185' : Rock. Biotite-Plagioclase-Quartz-Gneiss.	
185' - 190' : Rock. Diabase / Metadiabase. Black.	
190' - 300' : Rock. Biotite-Plagioclase-Quartz-Gneiss.	
300' - 305' : Rock. Diabase / Metadiabase. Black	
305' - 400' : Rock. Biotite-Plagioclase-Quartz-Gneiss.	

LEGEND
WELL CONSTRUCTION DIAGRAM
BENTONITE GROUT
BEDROCK

NOTES: Well log presents suspect dominant minerals identified from rock chips yielded during drilling.

S&ME, Inc.
Spartanburg, SC
864.574.2360

BORING LOG FOR WELL 1

Water Well Record
Bureau of Water

2600 Bull Street, Columbia, SC 29201-1708; (803) 898-4300

***Note:** Personal information provided on this document is subject to public scrutiny or release.*

1. WELL OWNER INFORMATION:
Name: Hanna (last) Charles (first)
Address: 1821 Old Furnace Road
City: Boiling Springs State: SC Zip:
Telephone: Work: Home:

2. LOCATION OF WELL: **COUNTY:** Spartanburg
Name: Hanna Holdings Group LLC
Street Address: Lawrence Rd & Frontier
City: Enoree, SC Zip:
Latitude: Longitude:

3. PUBLIC SYSTEM NAME: **PUBLIC SYSTEM NUMBER:**

4. ABANDONMENT: ☐ Yes ☑ No
Give Details Below
Grouted Depth: from ______ ft. to ______ ft.

Formation Description	*Thickness of Stratum	Depth to Bottom of Stratum
Overburden	25.5	25.5

*Indicate Water Bearing Zones

(Use a 2nd sheet if needed)

5. REMARKS:

6. TYPE: ☐ Mud Rotary ☐ Jetted ☐ Bored ☐ Dug ☐ Air Rotary ☐ Driven ☐ Cable tool ☐ Other

7. PERMIT NUMBER: S&ME Well #2

8. USE:
☐ Residential ☐ Public Supply ☐ Process
☐ Irrigation ☐ Air Conditioning ☐ Emergency
☐ Test Well ☑ Monitor Well ☐ Replacement

9. WELL DEPTH (completed) 25.5 ft.
Date Started: 3-11-2020
Date Completed: 3-11-2020

10. CASING: ☑ Threaded ☐ Welded
Diam.: 2"
Type: ☑ PVC ☐ Galvanized ☐ Steel ☐ Other
2" in. to 15 ft. depth
______ in. to ______ ft. depth
Height: Above/Below Surface 2.5 ft.
Weight ______ lb./ft.
Drive Shoe? ☐ Yes ☑ No

11. SCREEN:
Type: PVC Diam.: 2"
Slot/Gauge: .01 Length: 10'
Set Between: 25.5 ft. and 15 ft.
______ ft. and ______ ft.
NOTE: MULTIPLE SCREENS USE SECOND SHEET
Sieve Analysis ☐ Yes (please enclose) ☑ No

12. STATIC WATER LEVEL 21.95 ft. below land surface after 24 hours

13. PUMPING LEVEL Below Land Surface.
NA ft. after NA hrs. Pumping NA G.P.M.
Pumping Test: ☐ Yes (please enclose) ☑ No
Yield: NA

14. WATER QUALITY
Chemical Analysis ☐ Yes ☑ No Bacterial Analysis ☐ Yes ☑ No
Please enclose lab results.

15. ARTIFICIAL FILTER (filter pack) ☑ Yes ☐ No
Installed from 12.7 ft. to 25.5 ft.
Effective size #2 Uniformity Coefficient NA

16. WELL GROUTED? ☑ Yes ☐ No
☐ Neat Cement ☐ Bentonite ☑ Bentonite/Cement ☐ Other ______
Depth: From ______ ft. to ______ ft.

17. NEAREST SOURCE OF POSSIBLE CONTAMINATION: NA ft. NA direction
Type NA
Well Disinfected ☐ Yes ☑ No Type: NA Amount: NA

18. PUMP: Date installed: ______ Not installed ☑
Mfr. Name: ______ Model No.: ______
H.P. ______ Volts ______ Length of drop pipe ______ ft. Capacity ______ gpm
TYPE: ☐ Submersible ☐ Jet (shallow) ☐ Turbine ☐ Jet (deep) ☐ Reciprocating ☐ Centrifugal

19. WELL DRILLER: Anthony Millwood **CERT. NO.:** 1840
Address: (Print) Level: A B C D (circle one) ✓D
S&ME, Inc
301 Zima Park Rd, Spartanburg, SC
Telephone No.: 864-208-9366 Fax No.:

20. WATER WELL DRILLER'S CERTIFICATION: This well was drilled under my direction and this report is true to the best of my knowledge and belief.

Signed: Anthony Millwood Date: 3-20-20
Well Driller

If D Level Driller, provide supervising driller's name:

BORING LOG FOR WELL 2

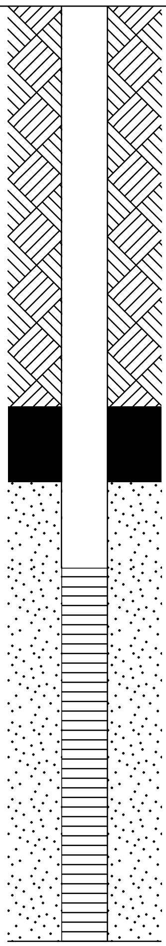
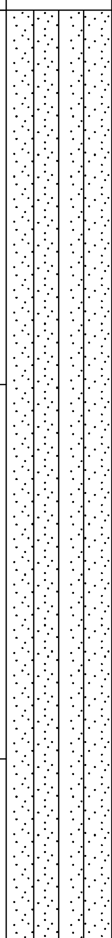
PROJECT: **Enoree Hanna Site**
PROJECT NO: **4261-19-156**
PROJECT LOCATION: **Enoree, South Carolina**

WATER LEVEL: **21.95ft - 3/25/2020 @ 1600**

DATE COMPLETED: **3/11/20**
DRILLING CONTRACTOR: **S&ME**
DRILLER: **Justin Millwood, SC Cert #1840C**
DRILLING METHOD: **HSA (4 1/4")**
SAMPLING METHOD: **Cuttings**

GROUND SURFACE ELEVATION:
DATUM:
LOGGED BY: **N. Williams**

This log is part of the report prepared for the named project and should be read together with that report for complete interpretation. This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

WELL CONSTRUCTION DIAGRAM	ELEVATION (ft.)	DEPTH (ft.)	GRAPHIC SYMBOL	DESCRIPTION	REMARKS
		0, 5, 10, 15, 20, 25		0' - 25' Green silty fine to coarse sand with increasing rock fragments with depth.	0'-15' soft drilling 15'-15.5' rock lens/boulder 18.5'-25.5' hard drilling, softer drilling at 21.5'-22.5' 25.5 auger refusal Well Construction Details grout: 0'-10.7' bentonite seal: 10.7'-12.7' filter pack: 12.7'-25' screen: 15'-25'

LEGEND
WELL CONSTRUCTION DIAGRAM
- GROUT
- BENTONITE
- FILTER PACK
- SCREEN

NOTES: Well log presents suspect dominant minerals identified from auger cuttings yielded during drilling.

S&ME, Inc.
Spartanburg, SC
864.574.2360

Water Well Record
Bureau of Water
2600 Bull Street, Columbia, SC 29201-1708; (803) 898-4300

Note: Personal information provided on this document is subject to public scrutiny or release.

1. WELL OWNER INFORMATION:
Name: HANNA, CHARLES B. (last) (first)
Address: 1821 OLD FURNACE ROAD
City: BOILING SPRINGS State: SC Zip:
Telephone: Work: (864) 327-5201 Home:

2. LOCATION OF WELL: **COUNTY:** SPARTANBURG
Name: HANNA HOLDINGS GROUP LLC
Street Address: LAWRENCE ROAD AND FRONTIER
City: ENOREE, SC Zip:
Latitude: Longitude:

3. PUBLIC SYSTEM NAME: **PUBLIC SYSTEM NUMBER:**

4. ABANDONMENT: ☐ Yes ☑ No
Give Details Below
Grouted Depth: from ____ ft. to ____ ft.

Formation Description	*Thickness of Stratum	Depth to Bottom of Stratum
OVERBURDEN	38	38
*GRANITE ROCK	362	400
*2 GPM AT 55 FEET		
*5 GPM AT 115 FEET		
TOTAL: 7 GPM		
PUMPED FOR 24 HOURS ON		
3-27-2020 AT 5 GPM, THEN		
INCREASED TO 7 GPM. NEVER		
PULLED DOWN BELOW 80 FT.		
*Indicate Water Bearing Zones (Use a 2nd sheet if needed)		

5. REMARKS:
MONITORING WELL
APPROVAL GRANTED BY
JEREMY EDDY ON 3/2/2020

6. TYPE: ☐ Mud Rotary ☐ Jetted ☐ Bored ☐ Dug ☑ Air Rotary ☐ Driven ☐ Cable tool ☐ Other

7. PERMIT NUMBER: S&ME WELL #3A

8. USE:
☑ Residential ☐ Public Supply ☐ Process
☐ Irrigation ☐ Air Conditioning ☐ Emergency
☐ Test Well ☑ Monitor Well ☐ Replacement

9. WELL DEPTH (completed) Date Started: 3-12-2020
400 ft. Date Completed: 3-12-2020

10. CASING: ☐ Threaded ☐ Welded
Diam.:
Type: ☐ PVC ☑ Galvanized ☐ Steel ☐ Other
6 1/4 in. to 38 ft. depth
____ in. to ____ ft. depth
Height: Above/Below Surface 1.5 ft.
Weight ____ lb./ft.
Drive Shoe? ☐ Yes ☑ No

11. SCREEN:
Type: Diam.:
Slot/Gauge: Length:
Set Between: ____ ft. and ____ ft. ____ ft. and ____ ft.
NOTE: MULTIPLE SCREENS USE SECOND SHEET
Sieve Analysis ☐ Yes (please enclose) ☑ No

12. STATIC WATER LEVEL 25 ft. below land surface after 24 hours

13. PUMPING LEVEL Below Land Surface.
____ ft. after ____ hrs. Pumping ____ G.P.M.
Pumping Test: ☐ Yes (please enclose) ☑ No
Yield:

14. WATER QUALITY
Chemical Analysis ☐ Yes ☑ No Bacterial Analysis ☐ Yes ☑ No
Please enclose lab results.

15. ARTIFICIAL FILTER (filter pack) ☐ Yes ☑ No
Installed from ____ ft. to ____ ft.
Effective size ____ Uniformity Coefficient ____

16. WELL GROUTED? ☑ Yes ☐ No
☐ Neat Cement ☑ Bentonite ☐ Bentonite/Cement ☐ Other ____
Depth: From 0 ft. to 20 ft.

17. NEAREST SOURCE OF POSSIBLE CONTAMINATION: 150 ft. W direction
Type CREEK
Well Disinfected ☑ Yes ☐ No Type: HTH Amount: 16 OZ.

18. PUMP: Date installed: ____ Not installed ☑
Mfr. Name: ____ Model No.: ____
H.P. ____ Volts ____ Length of drop pipe ____ ft. Capacity ____ gpm
TYPE: ☐ Submersible ☐ Jet (shallow) ☐ Turbine ☐ Jet (deep) ☐ Reciprocating ☐ Centrifugal

19. WELL DRILLER: GRANT FLOYD **CERT. NO.:** 2198
Address: (Print) Level: A B ✓ C D (circle one)
P.O. BOX 205 ROEBUCK, SC 29376
Telephone No.: 864-576-6655 Fax No.:

20. WATER WELL DRILLER'S CERTIFICATION: This well was drilled under my direction and this report is true to the best of my knowledge and belief.

Signed: [signature] Date: 3-12-2020
Well Driller

If D Level Driller, provide supervising driller's name:

BORING LOG FOR WELL 3A

PROJECT: **Enoree Hanna Site**
PROJECT NO: **4261-19-156**
PROJECT LOCATION: **Enoree, South Carolina**

WATER LEVEL: **29.3ft - 3/16/2020 @ 1349**

DATE COMPLETED: **3/12/20**
DRILLING CONTRACTOR: **Wendell J. Lee**
DRILLER: **Grant Floyd - SC Cert 2198**
DRILLING METHOD: **Air Hammer**
SAMPLING METHOD: **Rock Chips**

GROUND SURFACE ELEVATION:
DATUM:
LOGGED BY: **S. Goretoy**

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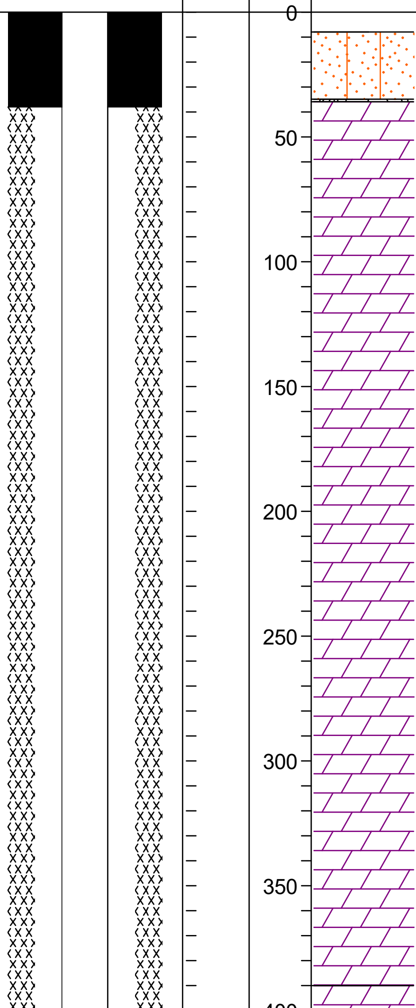
WELL CONSTRUCTION DIAGRAM | ELEVATION (ft.) | DEPTH (ft.) | GRAPHIC SYMBOL



DESCRIPTION	REMARKS
0' - 8' : Silty Clay to Silty Sand Residual. Red	0-38' - 6 1/4" Galvanized Casing set
8' - 35' : Silty Sand Residual. Brown Gray. Moist at 20'. Wet at 35'.	35'-36' - Hard tri-cone drilling
35' - 36' : Hard weathered rock. Biotite-Plagioclase-Quartz-Gneiss.	Fractures 55' - one foot wide 57' 115' 205' Water Production 60': 2 gpm 120': 6 gpm 200': 6 gpm 300': 6 gpm 400': 6-7 gpm
36' - 390' : Rock. Biotite-Plagioclase-Quartz-Gneiss. 285'-295' rock more felsic, little biotite, secondary green mineralization.	
390' - 400' : Rock. Diabase / Metadiabase with quartz veins. Black. Secondary green mineralization.	

LEGEND
WELL CONSTRUCTION DIAGRAM
BENTONITE GROUT
BEDROCK

NOTES: Well log presents suspect dominant minerals identified from rock chips yielded during drilling.

S&ME, Inc.
Spartanburg, SC
864.574.2360

BORING LOG FOR WELL 3A

Water Well Record
Bureau of Water
2600 Bull Street, Columbia, SC 29201-1708; (803) 898-4300

***Note:** Personal information provided on this document is subject to public scrutiny or release.*

1. WELL OWNER INFORMATION:
Name: HANNA, CHARLES B. (last) (first)
Address: 1821 OLD FURNACE ROAD
City: BOILING SPRINGS State: SC Zip:
Telephone: Work: (864) 327-5201 Home:

2. LOCATION OF WELL: **COUNTY:** SPARTANBURG
Name: HANNA HOLDINGS GROUP LLC
Street Address: LAWRENCE ROAD AND FRONTIER
City: ENOREE, SC Zip:
Latitude: Longitude:

3. PUBLIC SYSTEM NAME: **PUBLIC SYSTEM NUMBER:**

4. ABANDONMENT: ☐ Yes ☑ No
Give Details Below
Grouted Depth: from ____ ft. to ____ ft.

Formation Description	*Thickness of Stratum	Depth to Bottom of Stratum
OVERBURDEN	26	26
*GRANITE ROCK	234	260
*6 GPM AT 65 FEET		
*1/2 GPM AT 195 FEET		
TOTAL: 7 GPM		

*Indicate Water Bearing Zones

(Use a 2nd sheet if needed)

5. REMARKS:
MONITORING WELL
APPROVAL GRANTED BY
JEREMY EDDY ON 3/2/2020

6. TYPE: ☐ Mud Rotary ☐ Jetted ☐ Bored ☐ Dug ☑ Air Rotary ☐ Driven ☐ Cable tool ☐ Other

7. PERMIT NUMBER: S&ME WELL #4

8. USE:
☑ Residential ☐ Public Supply ☐ Process
☐ Irrigation ☐ Air Conditioning ☐ Emergency
☐ Test Well ☑ Monitor Well ☐ Replacement

9. WELL DEPTH (completed) Date Started: 3-16-2020
260 ft. Date Completed: 3-16-2020

10. CASING: ☐ Threaded ☐ Welded
Diam.:
Type: ☑ PVC ☑ Galvanized ☐ Steel ☐ Other
6 1/4 in. to 6 ft. depth
6 1/8 in. to 26 ft. depth
Height: Above/Below ☑
Surface 1.5 ft.
Weight ____ lb./ft.
Drive Shoe? ☐ Yes ☑ No

11. SCREEN:
Type: ____ Diam.: ____
Slot/Gauge: ____ Length: ____
Set Between: ____ ft. and ____ ft.
____ ft. and ____ ft.
NOTE: MULTIPLE SCREENS USE SECOND SHEET
Sieve Analysis ☐ Yes (please enclose) ☑ No

12. STATIC WATER LEVEL 25 ft. below land surface after 24 hours

13. PUMPING LEVEL Below Land Surface.
____ ft. after ____ hrs. Pumping ____ G.P.M.
Pumping Test: ☐ Yes (please enclose) ☑ No
Yield:

14. WATER QUALITY
Chemical Analysis ☐ Yes ☑ No Bacterial Analysis ☐ Yes ☑ No
Please enclose lab results.

15. ARTIFICIAL FILTER (filter pack) ☐ Yes ☑ No
Installed from ____ ft. to ____ ft.
Effective size ____ Uniformity Coefficient ____

16. WELL GROUTED? ☑ Yes ☐ No
☐ Neat Cement ☑ Bentonite ☐ Bentonite/Cement ☐ Other ____
Depth: From 0 ft. to 20 ft.

17. NEAREST SOURCE OF POSSIBLE CONTAMINATION: 250 ft. W direction
Type CREEK
Well Disinfected ☑ Yes ☐ No Type: HTH Amount: 8 OZ.

18. PUMP: Date installed: ____ Not installed ☑
Mfr. Name: ____ Model No.: ____
H.P. ____ Volts ____ Length of drop pipe ____ ft. Capacity ____ gpm
TYPE: ☐ Submersible ☐ Jet (shallow) ☐ Turbine ☐ Jet (deep) ☐ Reciprocating ☐ Centrifugal

19. WELL DRILLER: GRANT FLOYD **CERT. NO.:** 2198
Address: (Print) Level: A B ✓ C D (circle one)
P.O. BOX 205 ROEBUCK, SC 29376
Telephone No.: 864-576-6655 Fax No.:

20. WATER WELL DRILLER'S CERTIFICATION: This well was drilled under my direction and this report is true to the best of my knowledge and belief.

Signed: [signature] Date: 3-16-2020
Well Driller

If D Level Driller, provide supervising driller's name:

BORING LOG FOR WELL 4

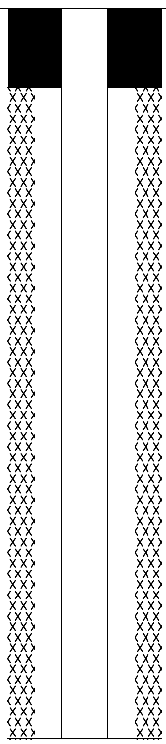
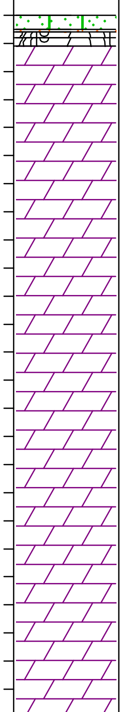
PROJECT: **Enoree Hanna Site**
PROJECT NO: **4261-19-156**
PROJECT LOCATION: **Enoree, South Carolina**

WATER LEVEL: **27.13ft - 3/25/2020 @ 1600**

DATE COMPLETED: **3/16/20**
DRILLING CONTRACTOR: **Wendell J. Lee**
DRILLER: **Grant Floyd - SC Cert 2198**
DRILLING METHOD: **Air Hammer**
SAMPLING METHOD: **Rock Chips**

GROUND SURFACE ELEVATION:
DATUM:
LOGGED BY: **S. Goretoy**

This log is part of the report prepared for the named project and should be read together with that report for complete interpretation. This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

WELL CONSTRUCTION DIAGRAM	ELEVATION (ft.)	DEPTH (ft.)	GRAPHIC SYMBOL	DESCRIPTION	REMARKS
		0 50 100 150 200 250		0' - 00' : Silty Clay to Silty Sand Residual. Red brown. 10' - 15' : Sandy Silt. Light Brown 15' - 16' : Silty Sand Residual. Brown Gray. Moist at 20'. Wet at 35'. 16' - 18' : Soft highly weathered rock. Biotite-Plagioclase-Quartz-Gneiss 18' - 21' : Moderate to slightly weathered rock. Biotite-Plagioclase-Quartz-Gneiss. 21' - 260' : Rock. Biotite-Plagioclase-Quartz-Gneiss. 215'-225' Plagioclase rich zone with little biotite and secondary green mineralization.	0-28' - 6 1/4" PVC Casing set Fractures 57' - 4" wide 65' - 1' wide, producing water 130 - 1' wide, initial surge of water, drain and flow levels back to 80' depth measurement 155' - 4" wide 175' - 6" wide 195' - 5" wide Water Production 80': 6 gpm 140': 6 gpm 200': 6-7 gpm 260': 6-7 gpm 400': 6-7 gpm

LEGEND
WELL CONSTRUCTION DIAGRAM
BENTONITE GROUT
BEDROCK

NOTES: Well log presents suspect dominant minerals identified from rock chips yielded during drilling.

S&ME, Inc.
Spartanburg, SC
864.574.2360

BORING LOG FOR WELL 4

Water Well Record
Bureau of Water

dhec

2600 Bull Street, Columbia, SC 29201-1708; (803) 898-4300

Note: Personal information provided on this document is subject to public scrutiny or release.

1. WELL OWNER INFORMATION:
Name: HANNA, CHARLES B.
(last) (first)
Address: 1821 OLD FURNACE ROAD
City: BOILING SPRINGS State: SC Zip:
Telephone: Work: (864) 327-5201 Home:

2. LOCATION OF WELL: **COUNTY:** SPARTANBURG
Name: HANNA HOLDINGS GROUP LLC
Street Address: LAWRENCE ROAD AND FRONTIER
City: ENOREE, SC Zip:
Latitude: Longitude:

3. PUBLIC SYSTEM NAME: **PUBLIC SYSTEM NUMBER:**

4. ABANDONMENT: ☐ Yes ☑ No
Give Details Below
Grouted Depth: from ___________ ft. to ______________ ft.

Formation Description	*Thickness of Stratum	Depth to Bottom of Stratum
OVERBURDEN	26	26
*GRANITE ROCK	234	260
*4 GPM AT 130 FEET		

*Indicate Water Bearing Zones

(Use a 2nd sheet if needed)

5. REMARKS:
MONITORING WELL
APPROVAL GRANTED BY
JEREMY EDDY ON 3/2/2020

6. TYPE: ☐ Mud Rotary ☐ Jetted ☐ Bored ☐ Dug ☑ Air Rotary ☐ Driven ☐ Cable tool ☐ Other

7. PERMIT NUMBER: S&ME WELL #5

8. USE:
☑ Residential ☐ Public Supply ☐ Process
☐ Irrigation ☐ Air Conditioning ☐ Emergency
☐ Test Well ☑ Monitor Well ☐ Replacement

9. WELL DEPTH (completed) Date Started: 3-16-2020
260 ft. Date Completed: 3-16-2020

10. CASING: ☐ Threaded ☐ Welded
Diam.: ______________
Type: ☑ PVC ☐ Galvanized ☐ Steel ☐ Other
6 1/4 in. to 6 ft. depth
6 1/8 in. to 26 ft. depth

Height: Above/Below
Surface 1.5 ft.
Weight __________ lb./ft.
Drive Shoe? ☐ Yes ☑ No

11. SCREEN:
Type: ______________ Diam.: ______________
Slot/Gauge: ______________ Length: ______________
Set Between: ______ ft. and ______ ft. **NOTE: MULTIPLE SCREENS**
______ ft. and ______ ft. **USE SECOND SHEET**
Sieve Analysis ☐ Yes (please enclose) ☑ No

12. STATIC WATER LEVEL 25 ft. below land surface after 24 hours

13. PUMPING LEVEL Below Land Surface.
__________ ft. after ______ hrs. Pumping __________ G.P.M.
Pumping Test: ☐ Yes (please enclose) ☑ No
Yield: ______________

14. WATER QUALITY
Chemical Analysis ☐ Yes ☑ No Bacterial Analysis ☐ Yes ☑ No
Please enclose lab results.

15. ARTIFICIAL FILTER (filter pack) ☐ Yes ☑ No
Installed from ______________ ft. to ______________ ft.
Effective size ______________ Uniformity Coefficient ______________

16. WELL GROUTED? ☑ Yes ☐ No
☐ Neat Cement ☑ Bentonite ☐ Bentonite/Cement ☐ Other ______________
Depth: From 0 ft. to 20 ft.

17. NEAREST SOURCE OF POSSIBLE CONTAMINATION: 325 ft. W direction
Type CREEK
Well Disinfected ☑ Yes ☐ No Type: HTH Amount: 8 OZ.

18. PUMP: Date installed: ______________ Not installed ☑
Mfr. Name: ______________ Model No.: ______________
H.P.______ Volts______ Length of drop pipe______ ft. Capacity ____ gpm
TYPE: ☐ Submersible ☐ Jet (shallow) ☐ Turbine ☐ Jet (deep) ☐ Reciprocating ☐ Centrifugal

19. WELL DRILLER: GRANT FLOYD **CERT. NO.:** 2198
Address: (Print) Level: A B ✓ C D (circle one)
P.O. BOX 205 ROEBUCK, SC 29376
Telephone No.: 864-576-6655 Fax No.:

20. WATER WELL DRILLER'S CERTIFICATION: This well was drilled under my direction and this report is true to the best of my knowledge and belief.

Signed: [signature] Date: 3-16-2020
Well Driller

If D Level Driller, provide supervising driller's name:

COPY 1 MAIL TO SCDHEC, COPY 2 TO WELL OWNER, COPY 3 TO WELL DRILLER

BORING LOG FOR WELL 5

PROJECT: **Enoree Hanna Site**
PROJECT NO: **4261-19-156**
PROJECT LOCATION: **Enoree, South Carolina**

WATER LEVEL: **30.51ft - 3/25/2020 @ 1601**

DATE COMPLETED: **3/16/20**
DRILLING CONTRACTOR: **Wendell J. Lee**
DRILLER: **Grant Floyd - SC Cert 2198**
DRILLING METHOD: **Air Hammer**
SAMPLING METHOD: **Rock Chips**

GROUND SURFACE ELEVATION:
DATUM:
LOGGED BY: **S. Goretoy**

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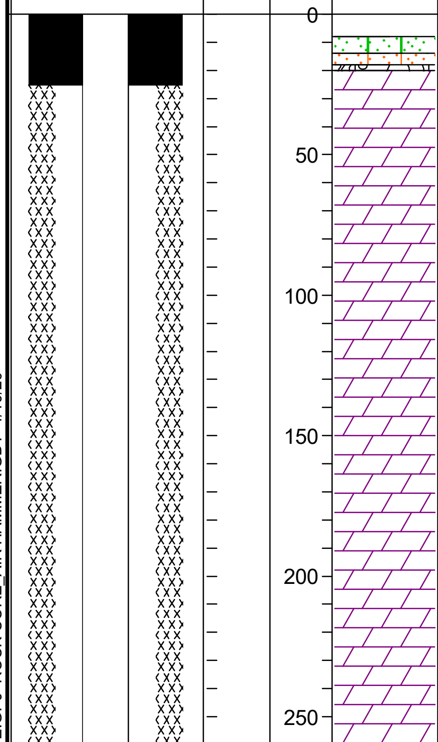
WELL CONSTRUCTION DIAGRAM | ELEVATION (ft.) | DEPTH (ft.) | GRAPHIC SYMBOL



DESCRIPTION

0' - 8' : Silty Clay to Silty Sand Residual. Red brown.

8' - 14' : Sandy Silt. Light Brown

14' - 18' : Silty Sand Residual. Brown Gray.

18' - 20' : Soft highly weathered rock. Biotite-Plagioclase-Quartz-Gneiss. Sandy silt lenses.

20' - 260' : Rock. Biotite-Plagioclase-Quartz-Gneiss. 215'-225' Pink plagioclase rich zone with secondary green mineralization.

REMARKS

0-25' - 6 1/4" PVC Casing set

Fractures
65' to 70' - 1' to 1.5' wide, fracture produced an initial surge of water for several minutes, water production dropped back to previous levels.
130 - 0.5'-1' wide, initial surge of water, increase in water production
158' - 4" wide
178' - 6" wide

Water Production
80': 1/4 gpm
140': 4 gpm
260': 4 gpm

LEGEND
WELL CONSTRUCTION DIAGRAM
BENTONITE GROUT
BEDROCK

NOTES: Well log presents suspect dominant minerals identified from rock chips yielded during drilling.

S&ME, Inc.
Spartanburg, SC
864.574.2360

BORING LOG FOR WELL 5

dhec

Water Well Record
Bureau of Water

2600 Bull Street, Columbia, SC 29201-1708; (803) 898-4300

***Note:** Personal information provided on this document is subject to public scrutiny or release.*

1. WELL OWNER INFORMATION:
Name: HANNA, CHARLES B.
(last) (first)
Address: 1821 OLD FURNACE ROAD
City: BOILING SPRING: State: SC Zip:
Telephone: Work: (864) 327-5201 Home:

2. LOCATION OF WELL: **COUNTY:** SPARTANBUR
Name: HANNA HOLDINGS GROUP LLC
Street Address: LAWRENCE ROAD AND FRONTIER
City: ENOREE, SC Zip:
Latitude: Longitude:

3. PUBLIC SYSTEM NAME: **PUBLIC SYSTEM NUMBER:**

4. ABANDONMENT: ☐ Yes ☑ No
Give Details Below
Grouted Depth: from ____ ft. to ____ ft.

Formation Description	*Thickness of Stratum	Depth to Bottom of Stratum
OVERBURDEN	26	26
GRANITE ROCK	9	35
BROWN ROCK	10	45
*GRANITE ROCK	3	48
BROWN ROCK	7	55
*GRANITE ROCK	395	450
*2 GPM AT 48 FEET		
*3 GPM AT 80 FEET		
*1 GPM AT 130 FEET		
*1 GPM AT 365 FEET		
TOTAL: 7 GPM		
*Indicate Water Bearing Zones (Use a 2nd sheet if needed)		

5. REMARKS:
MONITORING WELL APPROVAL GRANTED BY JEREMY EDDY ON 3/2/2020

6. TYPE: ☐ Mud Rotary ☐ Jetted ☐ Bored ☐ Dug ☑ Air Rotary ☐ Driven ☐ Cable tool ☐ Other

7. PERMIT NUMBER: S&ME WELL #6

8. USE:
☑ Residential ☐ Public Supply ☐ Process
☐ Irrigation ☐ Air Conditioning ☐ Emergency
☐ Test Well ☑ Monitor Well ☐ Replacement

9. WELL DEPTH (completed) 450 ft.
Date Started: 3-9-2020
Date Completed: 3-9-2020

10. CASING: ☐ Threaded ☐ Welded
Diam.:
Type: ☐ PVC ☑ Galvanized ☐ Steel ☐ Other
6 1/4 in. to 26 ft. depth
____ in. to ____ ft. depth
Height: Above/Below Surface 1.5 ft.
Weight ____ lb./ft.
Drive Shoe? ☐ Yes ☑ No

11. SCREEN:
Type: ____ Diam.: ____
Slot/Gauge: ____ Length: ____
Set Between: ____ ft. and ____ ft.
____ ft. and ____ ft.
NOTE: MULTIPLE SCREENS USE SECOND SHEET
Sieve Analysis ☐ Yes (please enclose) ☑ No

12. STATIC WATER LEVEL 35 ft. below land surface after 24 hours

13. PUMPING LEVEL Below Land Surface.
____ ft. after ____ hrs. Pumping ____ G.P.M.
Pumping Test: ☐ Yes (please enclose) ☑ No
Yield:

14. WATER QUALITY
Chemical Analysis ☐ Yes ☑ No Bacterial Analysis ☐ Yes ☑ No
Please enclose lab results.

15. ARTIFICIAL FILTER (filter pack) ☐ Yes ☑ No
Installed from ____ ft. to ____ ft.
Effective size ____ Uniformity Coefficient ____

16. WELL GROUTED? ☑ Yes ☐ No
☐ Neat Cement ☑ Bentonite ☐ Bentonite/Cement ☐ Other
Depth: From 0 ft. to 20 ft.

17. NEAREST SOURCE OF POSSIBLE CONTAMINATION: 125 ft. E direction
Type CREEK
Well Disinfected ☑ Yes ☐ No Type: HTH Amount: 16 OZ.

18. PUMP: Date installed: ____ Not installed ☑
Mfr. Name: ____ Model No.: ____
H.P. ____ Volts ____ Length of drop pipe ____ ft. Capacity ____ gpm
TYPE: ☐ Submersible ☐ Jet (shallow) ☐ Turbine ☐ Jet (deep) ☐ Reciprocating ☐ Centrifugal

19. WELL DRILLER: GRANT FLOYD **CERT. NO.:** 2198
Address: (Print) P.O. BOX 205 ROEBUCK, SC 29376
Level: A B ✓ C D (circle one)
Telephone No.: 864-576-6655 Fax No.:

20. WATER WELL DRILLER'S CERTIFICATION: This well was drilled under my direction and this report is true to the best of my knowledge and belief.

Signed: [signature] Date: 3-9-2020
Well Driller

If D Level Driller, provide supervising driller's name:

BORING LOG FOR WELL 6

PROJECT: **Enoree Hanna Site**
PROJECT NO: **4261-19-156**
PROJECT LOCATION: **Enoree, South Carolina**

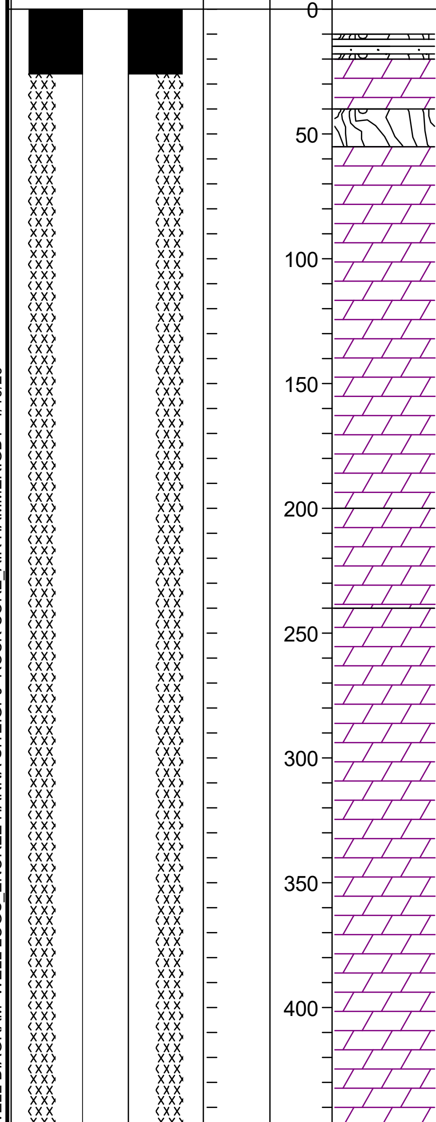
WATER LEVEL: **33.1ft - 3/10/2020 @ 0837**

DATE COMPLETED: **3/9/20**
DRILLING CONTRACTOR: **Wendell J. Lee**
DRILLER: **Grant Floyd - SC Cert 2198**
DRILLING METHOD: **Air Hammer**
SAMPLING METHOD: **Rock Chips**

GROUND SURFACE ELEVATION:
DATUM:
LOGGED BY: **S. Goretoy**

This log is part of the report prepared for the named project and should be read together with that report for complete interpretation. This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

WELL CONSTRUCTION DIAGRAM | ELEVATION (ft.) | DEPTH (ft.) | GRAPHIC SYMBOL



DESCRIPTION	REMARKS
0' - 10' : Silty Clay to Silty Sand Residual. Red brown.	0-26' : 6 1/4" Galvanized Casing set
10' - 20' : Hard weathered rock/boulder. Biotite-Plagioclase-Quartz-Gneiss.	20'-34' - Hard Tri-cone drilling
12' - 15' : Silty Clay to Silty Sand Residual. Red brown.	Fractures 46' 80' 140' 180'
15' - 18' : Poorly graded sand. Alluvial. Fine to very coarse. Tannish Brown. Micaceous	Water Production 46' - 2 gpm 80' - 5 gpm 100'- 5 gpm 200' - 6 gpm 300' - 6 gpm 350' - 7 gpm 450' - 7 gpm
18' - 20' : Hard weathered rock. Biotite-Plagioclase-Quartz-Gneiss	
20' - 40' : Biotite-Plagioclase-Quartz-Gneiss.	
40' - 55' : Soft highly weathered rock. Biotite-Plagioclase-Quartz-Gneiss	
55' - 200' : Rock. Biotite-Plagioclase-Quartz-Gneiss.	
200' - 240' : Rock. Biotite-Plagioclase-Quartz Gneiss with Amphibolite.	
240' - 450' : Rock. Biotite-Plagioclase-Quartz-Gneiss. 340'-345' biotite rich zone	

LEGEND

WELL CONSTRUCTION DIAGRAM

BENTONITE GROUT

BEDROCK

NOTES: Well log presents suspect dominant minerals identified from rock chips yielded during drilling.

S&ME, Inc.
Spartanburg, SC
864.574.2360

BORING LOG FOR WELL 6

Water Well Record
Bureau of Water

2600 Bull Street, Columbia, SC 29201-1708; (803) 898-4300

***Note:** Personal information provided on this document is subject to public scrutiny or release.*

1. WELL OWNER INFORMATION:
Name: HANNA, CHARLES B.
(last) (first)
Address: 1821 OLD FURNACE ROAD
City: BOILING SPRINGS State: SC Zip:
Telephone: Work: (864) 327-5201 Home:

2. LOCATION OF WELL: **COUNTY:** SPARTANBURG
Name: HANNA HOLDINGS GROUP LLC
Street Address: LAWRENCE ROAD AND FRONTIER
City: ENOREE, SC Zip:
Latitude: Longitude:

3. PUBLIC SYSTEM NAME: **PUBLIC SYSTEM NUMBER:**

4. ABANDONMENT: ☐ Yes ☑ No
Give Details Below
Grouted Depth: from ____ ft. to ____ ft.

Formation Description	*Thickness of Stratum	Depth to Bottom of Stratum
OVERBURDEN	58	58
*GRANITE ROCK	292	350
*25 GPM AT 68 FEET		
*PUMP TESTED FOR 24 HOURS		
AT 30 GPM ON 3-24-2020,		
NEVER PULLED WATER		
LEVEL DOWN BELOW 67 FEET		
*Indicate Water Bearing Zones (Use a 2nd sheet if needed)		

5. REMARKS:
MONITORING WELL
APPROVAL GRANTED BY
JEREMY EDDY ON 3/2/2020

6. TYPE: ☐ Mud Rotary ☐ Jetted ☐ Bored ☐ Dug ☑ Air Rotary ☐ Driven ☐ Cable tool ☐ Other

7. PERMIT NUMBER: S&ME WELL #7

8. USE:
☑ Residential ☐ Public Supply ☐ Process
☐ Irrigation ☐ Air Conditioning ☐ Emergency
☐ Test Well ☑ Monitor Well ☐ Replacement

9. WELL DEPTH (completed) Date Started: 3-10-2020
350 ft. Date Completed: 3-10-2020

10. CASING: ☐ Threaded ☐ Welded
Diam.:
Type: ☐ PVC ☑ Galvanized ☐ Steel ☐ Other
6 1/4 in. to 58 ft. depth
in. to ft. depth
Height: Above/Below
Surface 1.5 ft.
Weight lb./ft.
Drive Shoe? ☐ Yes ☑ No

11. SCREEN:
Type: Diam.:
Slot/Gauge: Length:
Set Between: ft. and ft.
ft. and ft.
NOTE: MULTIPLE SCREENS USE SECOND SHEET
Sieve Analysis ☐ Yes (please enclose) ☑ No

12. STATIC WATER LEVEL 25 ft. below land surface after 24 hours

13. PUMPING LEVEL Below Land Surface.
ft. after hrs. Pumping G.P.M.
Pumping Test: ☐ Yes (please enclose) ☑ No
Yield:

14. WATER QUALITY
Chemical Analysis ☐ Yes ☑ No Bacterial Analysis ☐ Yes ☑ No
Please enclose lab results.

15. ARTIFICIAL FILTER (filter pack) ☐ Yes ☑ No
Installed from ft. to ft.
Effective size Uniformity Coefficient

16. WELL GROUTED? ☑ Yes ☐ No
☐ Neat Cement ☑ Bentonite ☐ Bentonite/Cement ☐ Other
Depth: From 0 ft. to 20 ft.

17. NEAREST SOURCE OF POSSIBLE CONTAMINATION: 100 ft. E direction
Type CREEK
Well Disinfected ☑ Yes ☐ No Type: HTH Amount: 12 OZ.

18. PUMP: Date installed: Not installed ☑
Mfr. Name: Model No.:
H.P. Volts Length of drop pipe ft. Capacity gpm
TYPE: ☐ Submersible ☐ Jet (shallow) ☐ Turbine ☐ Jet (deep) ☐ Reciprocating ☐ Centrifugal

19. WELL DRILLER: GRANT FLOYD **CERT. NO.:** 2198
Address: (Print) Level: A B ✓ C D (circle one)
P.O. BOX 205 ROEBUCK, SC 29376
Telephone No.: 864-576-6655 Fax No.:

20. WATER WELL DRILLER'S CERTIFICATION: This well was drilled under my direction and this report is true to the best of my knowledge and belief.

Signed: [signature] Date: 3-10-2020
Well Driller

If D Level Driller, provide supervising driller's name:

BORING LOG FOR WELL 7

PROJECT: **Enoree Hanna Site**
PROJECT NO: **4261-19-156**
PROJECT LOCATION: **Enoree, South Carolina**

WATER LEVEL: **35.5ft - 3/11/2020 @ 0840**

DATE COMPLETED: **3/10/20**
DRILLING CONTRACTOR: **Wendell J. Lee**
DRILLER: **Grant Floyd - SC Cert 2198**
DRILLING METHOD: **Air Hammer**
SAMPLING METHOD: **Rock Chips**

GROUND SURFACE ELEVATION:
DATUM:
LOGGED BY: **S. Goretoy**

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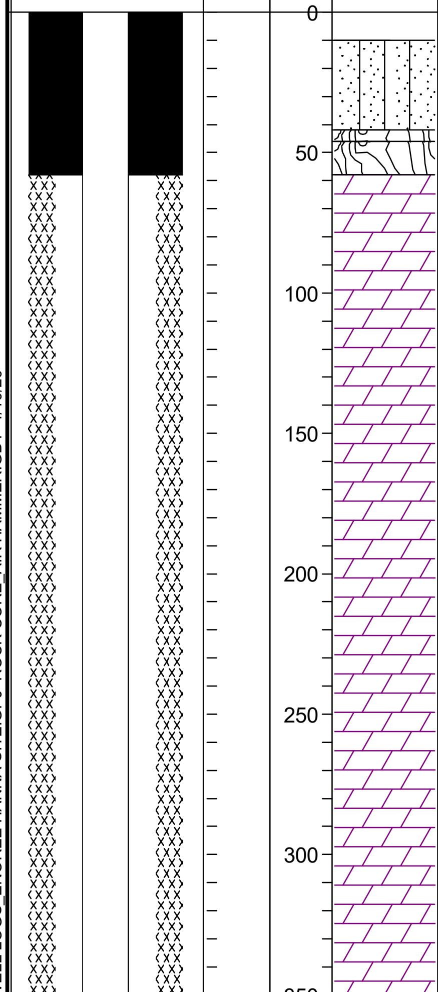
WELL CONSTRUCTION DIAGRAM | ELEVATION (ft.) | DEPTH (ft.) | GRAPHIC SYMBOL



DESCRIPTION	REMARKS
0' - 10' : Silty Clay to Silty Sand Residual. Red brown.	0-58' - 6 1/4" Galvanized casing set
10' - 42' : Silty Sand. Tan	57' - Hard Tri-cone drilling
42' - 46' : Soft highly weathered rock. Biotite-Plagioclase-Quartz-Gneiss	Fractures 68' - water producing 115' 195'
46' - 58' : Hard weathered rock. Biotite-Plagioclase-Quartz-Gneiss	Water Production 80' - 25 gpm 140'- 25 gpm 300' - 25 gpm 350' - 25 gpm
58' - 350' : Rock. Biotite-Plagioclase-Quartz-Gneiss. 58'-80' and 240'-350' Biotite Rich Zones.	

LEGEND
WELL CONSTRUCTION DIAGRAM
BENTONITE GROUT
BEDROCK

NOTES: Well log presents suspect dominant minerals identified from rock chips yielded during drilling.

Water Well Record
Bureau of Water
dhec

2600 Bull Street, Columbia, SC 29201-1708; (803) 898-4300

Note: Personal information provided on this document is subject to public scrutiny or release.

1. WELL OWNER INFORMATION:
Name: HANNA, CHARLES B.
(last) (first)
Address: 1821 OLD FURNACE ROAD
City: BOILING SPRINGS State: SC Zip:
Telephone: Work: (864) 327-5201 Home:

2. LOCATION OF WELL: **COUNTY:** SPARTANBURG
Name: HANNA HOLDINGS GROUP LLC
Street Address: LAWRENCE ROAD AND FRONTIER
City: ENOREE, SC Zip:
Latitude: Longitude:

3. PUBLIC SYSTEM NAME: **PUBLIC SYSTEM NUMBER:**

4. ABANDONMENT: ☐ Yes ☑ No
Give Details Below
Grouted Depth: from ___________ ft. to ______________ ft.

Formation Description	*Thickness of Stratum	Depth to Bottom of Stratum
OVERBURDEN	47	47
*GRANITE ROCK	193	240
*3/4 GPM AT 200 FEET		

*Indicate Water Bearing Zones

(Use a 2nd sheet if needed)

5. REMARKS:
MONITORING WELL
APPROVAL GRANTED BY
JEREMY EDDY ON 3/2/2020

6. TYPE: ☐ Mud Rotary ☐ Jetted ☐ Bored ☐ Dug ☑ Air Rotary ☐ Driven ☐ Cable tool ☐ Other

7. PERMIT NUMBER: S&ME WELL #8

8. USE:
☐ Residential ☐ Public Supply ☐ Process
☐ Irrigation ☐ Air Conditioning ☐ Emergency
☐ Test Well ☑ Monitor Well ☐ Replacement

9. WELL DEPTH (completed) Date Started: 3-20-2020
240 ft. Date Completed: 3-20-2020

10. CASING: ☐ Threaded ☐ Welded
Diam.:
Type: ☑ PVC ☐ Galvanized ☐ Steel ☐ Other
6 1/4 in. to 27 ft. depth
6 1/8 in. to 47 ft. depth
Height: Above/Below
Surface 1.5 ft.
Weight ______ lb./ft.
Drive Shoe? ☐ Yes ☑ No

11. SCREEN:
Type: Diam.:
Slot/Gauge: Length:
Set Between: ______ ft. and ______ ft. ______ ft. and ______ ft.
NOTE: MULTIPLE SCREENS USE SECOND SHEET
Sieve Analysis ☐ Yes (please enclose) ☑ No

12. STATIC WATER LEVEL 30 ft. below land surface after 24 hours

13. PUMPING LEVEL Below Land Surface.
______ ft. after ______ hrs. Pumping ______ G.P.M.
Pumping Test: ☐ Yes (please enclose) ☑ No
Yield:

14. WATER QUALITY
Chemical Analysis ☐ Yes ☑ No Bacterial Analysis ☐ Yes ☑ No
Please enclose lab results.

15. ARTIFICIAL FILTER (filter pack) ☐ Yes ☑ No
Installed from ______ ft. to ______ ft.
Effective size ______ Uniformity Coefficient ______

16. WELL GROUTED? ☑ Yes ☐ No
☐ Neat Cement ☑ Bentonite ☐ Bentonite/Cement ☐ Other
Depth: From 0 ft. to 20 ft.

17. NEAREST SOURCE OF POSSIBLE CONTAMINATION: 225 ft. W direction
Type CREEK
Well Disinfected ☑ Yes ☐ No Type: HTH Amount: 8 OZ.

18. PUMP: Date installed: Not installed ☑
Mfr. Name: Model No.:
H.P. ______ Volts ______ Length of drop pipe ______ ft. Capacity ____ gpm
TYPE: ☐ Submersible ☐ Jet (shallow) ☐ Turbine ☐ Jet (deep) ☐ Reciprocating ☐ Centrifugal

19. WELL DRILLER: GRANT FLOYD **CERT. NO.:** 2198
Address: (Print) Level: A B ✓ C D (circle one)
P.O. BOX 205 ROEBUCK, SC 29376
Telephone No.: 864-576-6655 Fax No.:

20. WATER WELL DRILLER'S CERTIFICATION: This well was drilled under my direction and this report is true to the best of my knowledge and belief.

Signed: Date: 3-20-2020
Well Driller

If D Level Driller, provide supervising driller's name:

BORING LOG FOR WELL 8

PROJECT: **Enoree Hanna Site**
PROJECT NO: **4261-19-156**
PROJECT LOCATION: **Enoree, South Carolina**

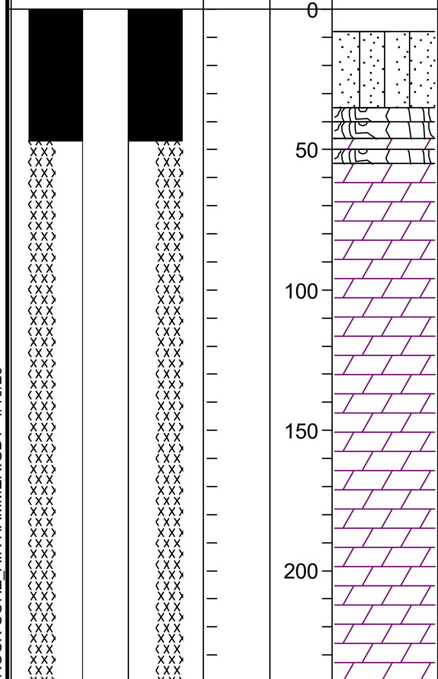
WATER LEVEL: **35.81ft - 3/30/2020 @ 1303**

DATE COMPLETED: **3/20/20**
DRILLING CONTRACTOR: **Wendell J. Lee**
DRILLER: **Grant Floyd - SC Cert 2198**
DRILLING METHOD: **Air Hammer**
SAMPLING METHOD: **Rock Chips**

GROUND SURFACE ELEVATION:
DATUM:
LOGGED BY: **S. Goretoy**

This log is part of the report prepared for the named project and should be read together with that report for complete interpretation. This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

WELL CONSTRUCTION DIAGRAM	ELEVATION (ft.)	DEPTH (ft.)	GRAPHIC SYMBOL	DESCRIPTION	REMARKS



	Description
0' - 8'	Silty Clay to Silty Sand Residual. Red brown.
8' - 35'	Silty Sand. Tan
35' - 40'	Soft moderately weathered rock. Biotite-Plagioclase-Quartz-Gneiss
40' - 46'	Hard weathered rock. Biotite-Plagioclase-Quartz-Gneiss
46' - 50'	Rock. Biotite-Plagioclase-Quartz-Gneiss. 50'-55'
50' - 55'	Hard weathered rock. Biotite-Plagioclase-Quartz-Gneiss
55' - 240'	Rock. Biotite-Plagioclase-Quartz-Gneiss.

REMARKS

0-47' - 6 1/4" PVC casing set

46' - Hard tri-cone drilling

Fractures
75' - <0.5'
90' - <0.5'
110' - initial surge of water
205' - initial surge of water

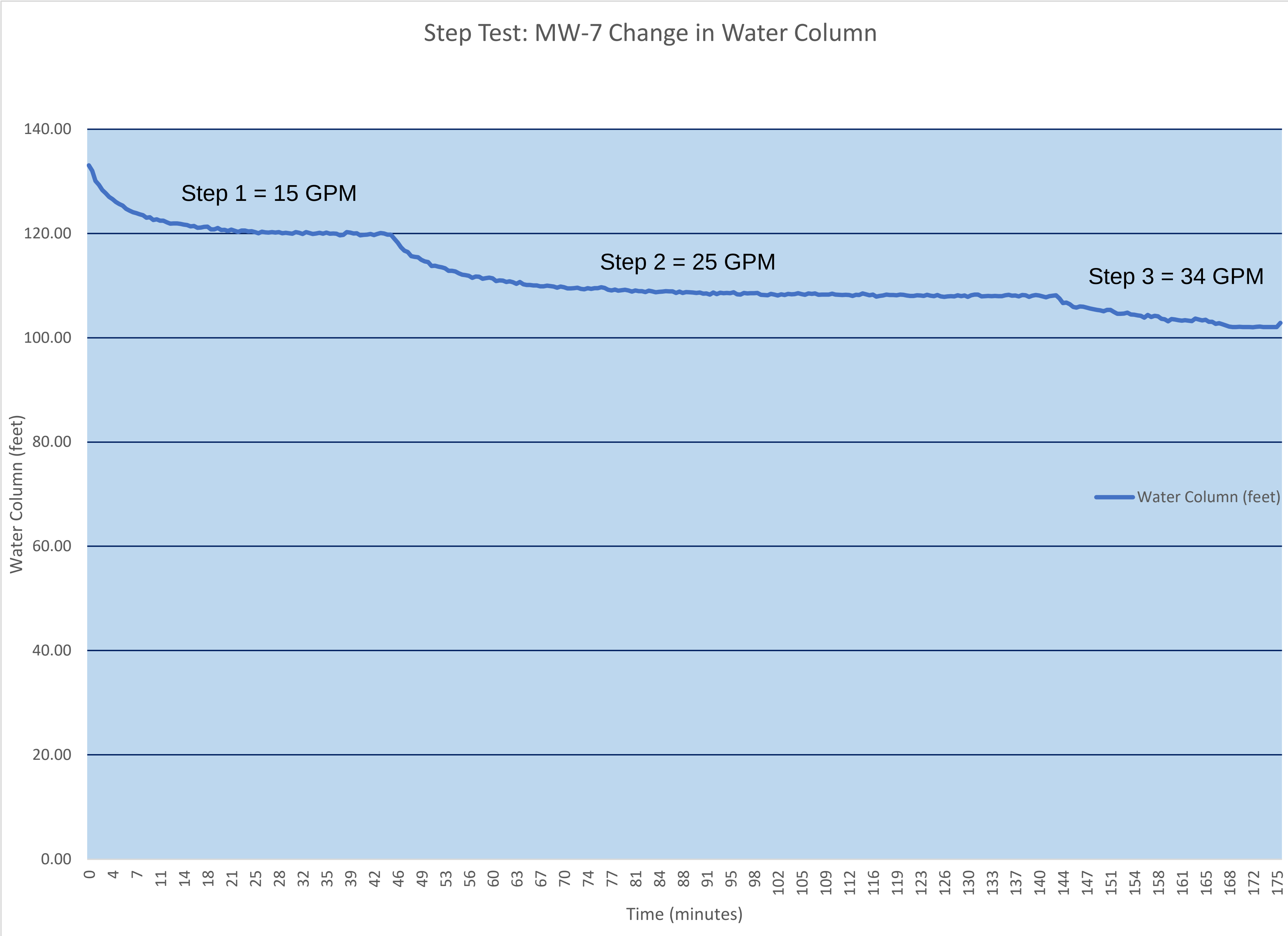
Water Production
100' - 1/4 gpm
120'- 1/2 gpm
220' - 3/4 gpm
240' - 3/4 gpm

LEGEND
WELL CONSTRUCTION DIAGRAM
BENTONITE GROUT
BEDROCK

NOTES: Well log presents suspect dominant minerals identified from rock chips yielded during drilling.

S&ME, Inc.
Spartanburg, SC
864.574.2360

Appendix V – Pump Test Charts



Step Test: MW-7 Change in Water Column
Step 1 = 15 GPM
Step 2 = 25 GPM
Step 3 = 34 GPM
Water Column (feet)
Time (minutes)
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
0
4
7
11
14
18
21
25
28
32
35
39
42
46
49
53
56
60
63
67
70
74
77
81
84
88
91
95
98
102
105
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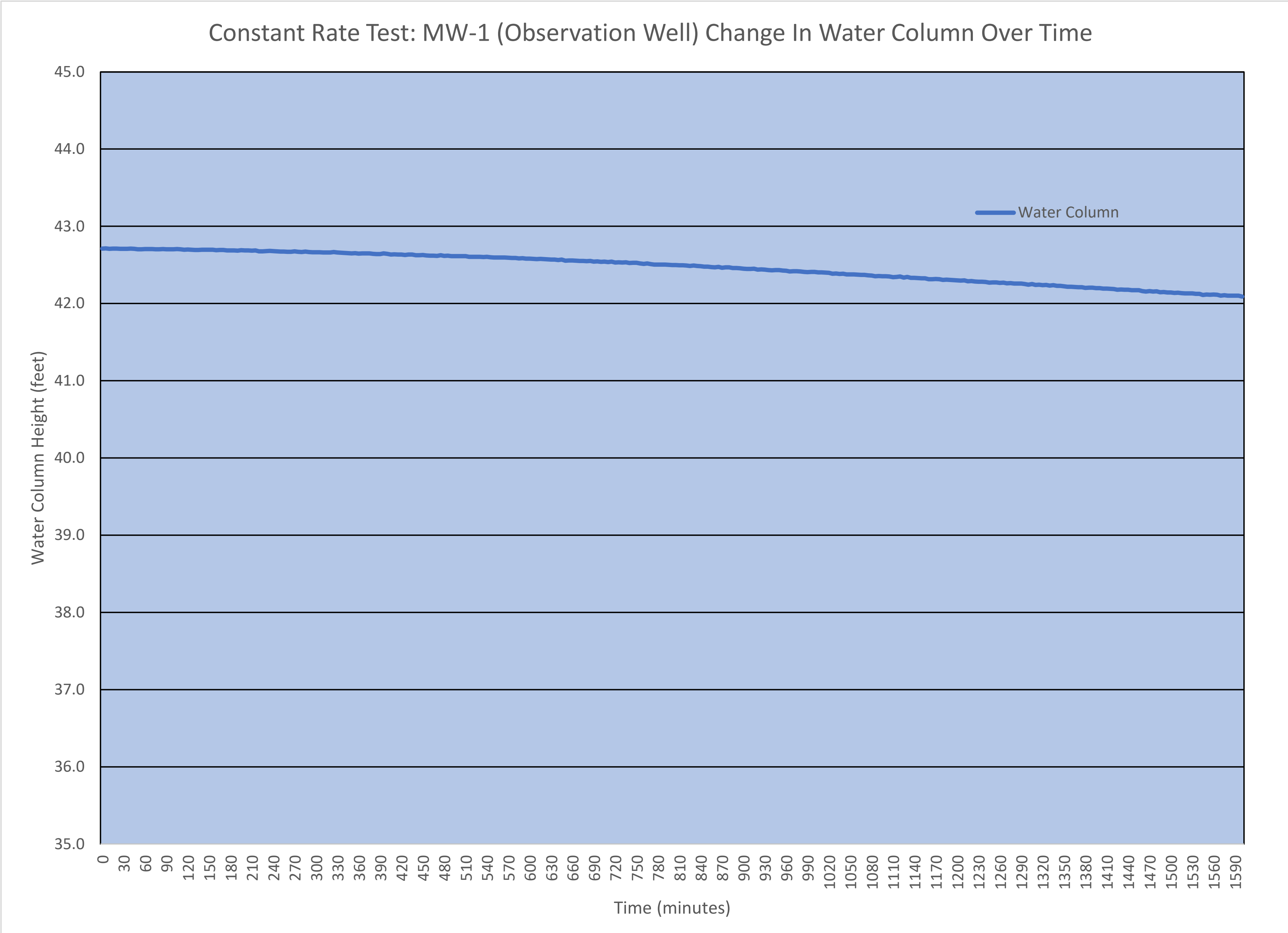
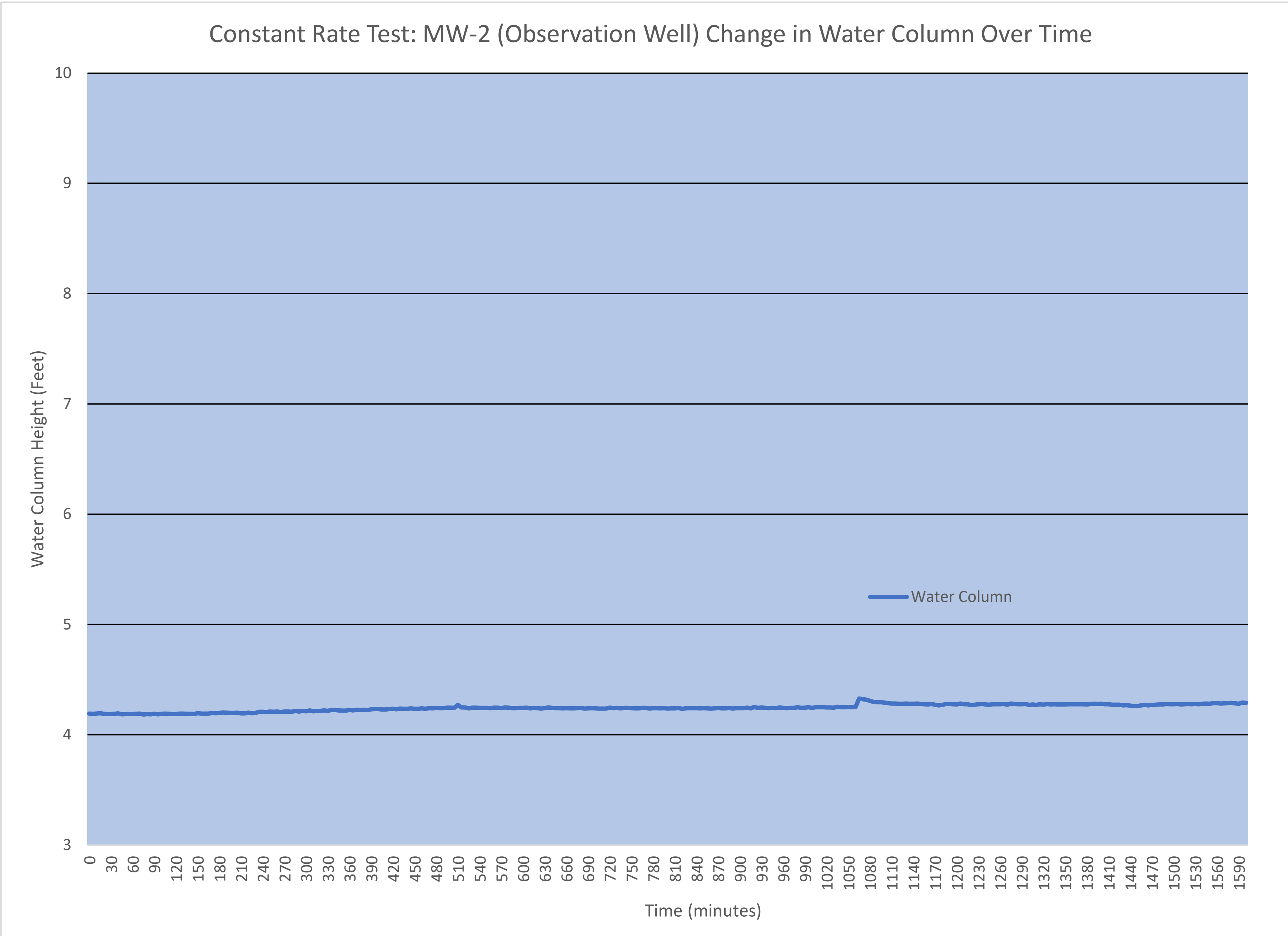
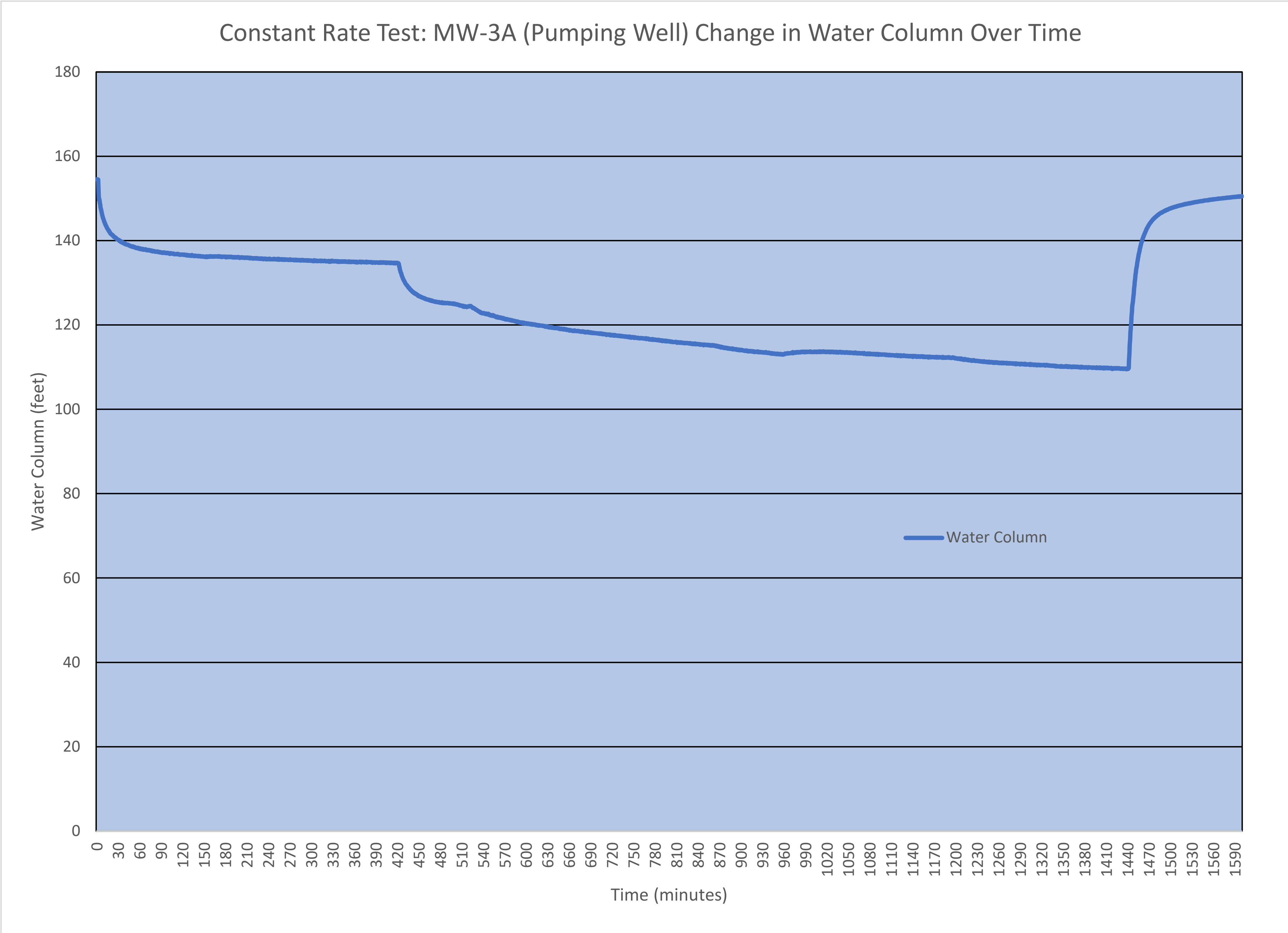
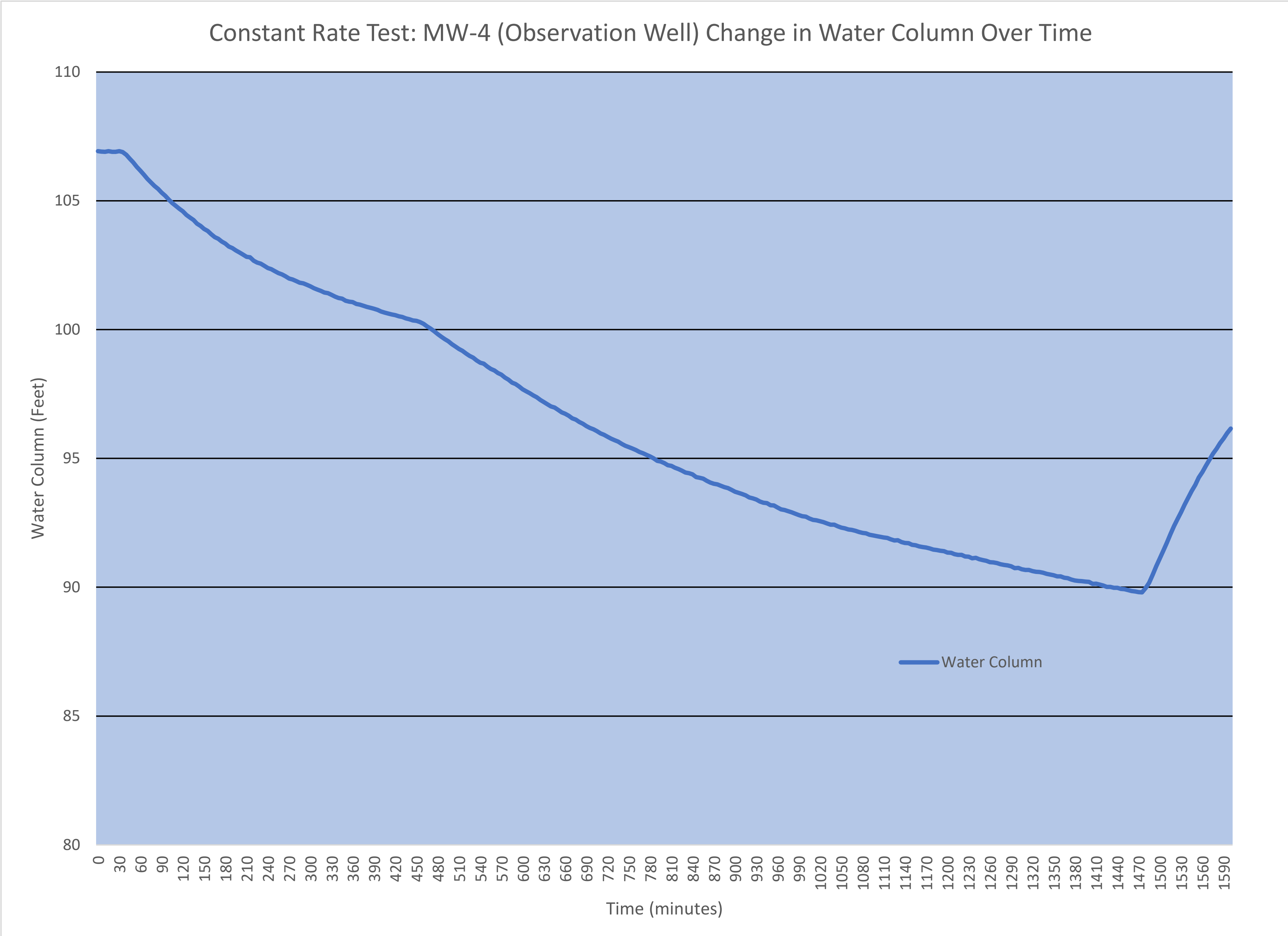
158
161
165
168
172
175

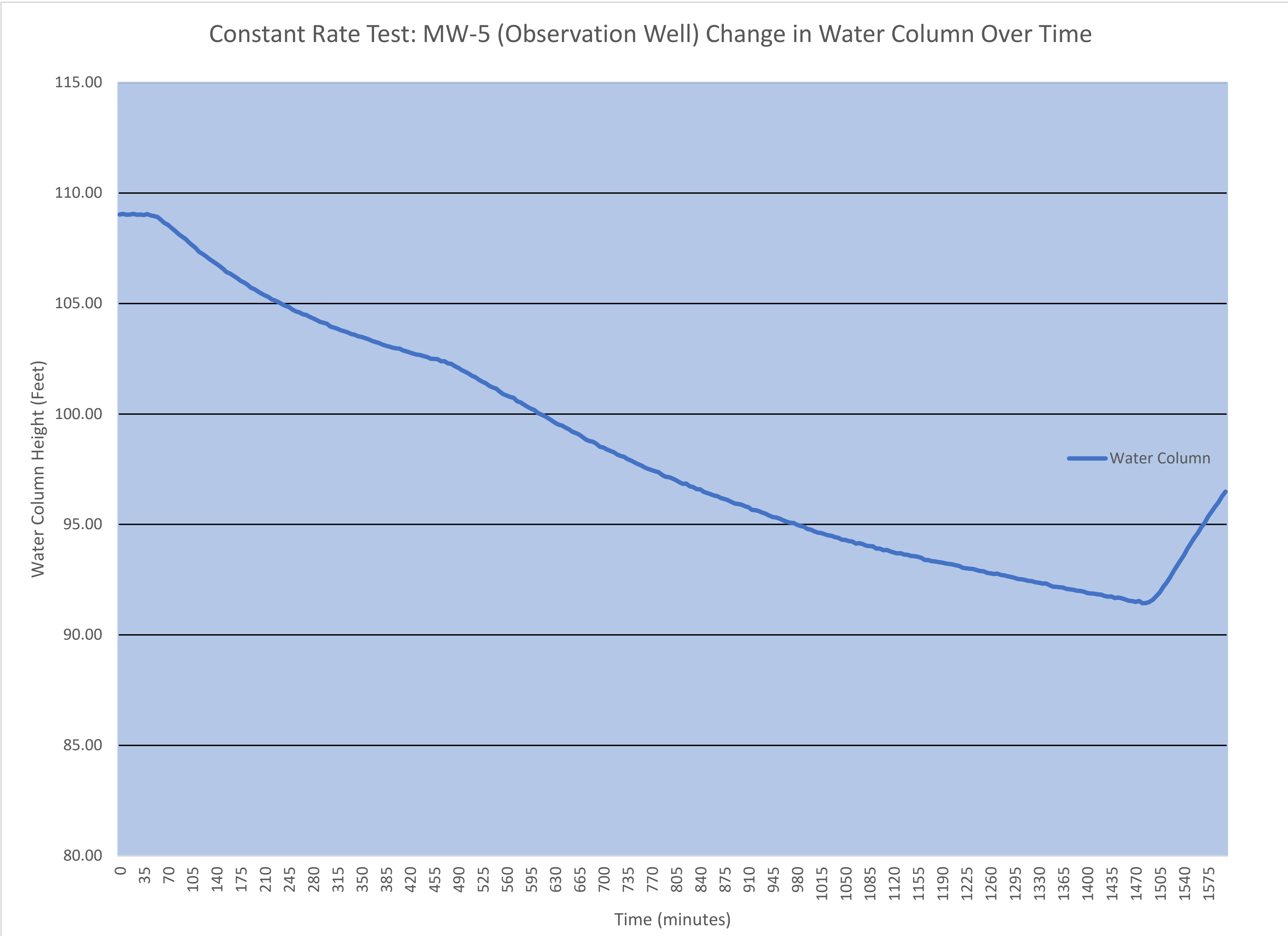

Constant Rate Test: MW-1 (Observation Well) Change In Water Column Over Time
Water Column Height (feet)
45.0
44.0
43.0
42.0
41.0
40.0
39.0
38.0
37.0
36.0
35.0
Water Column
0 30 60 90 120 150 180 210 240 270 300 330 360 390 420 450 480 510 540 570 600 630 660 690 720 750 780 810 840 870 900 930 960 990 1020 1050 1080 1110 1140 1170 1200 1230 1260 1290 1320 1350 1380 1410 1440 1470 1500 1530 1560 1590
Time (minutes)



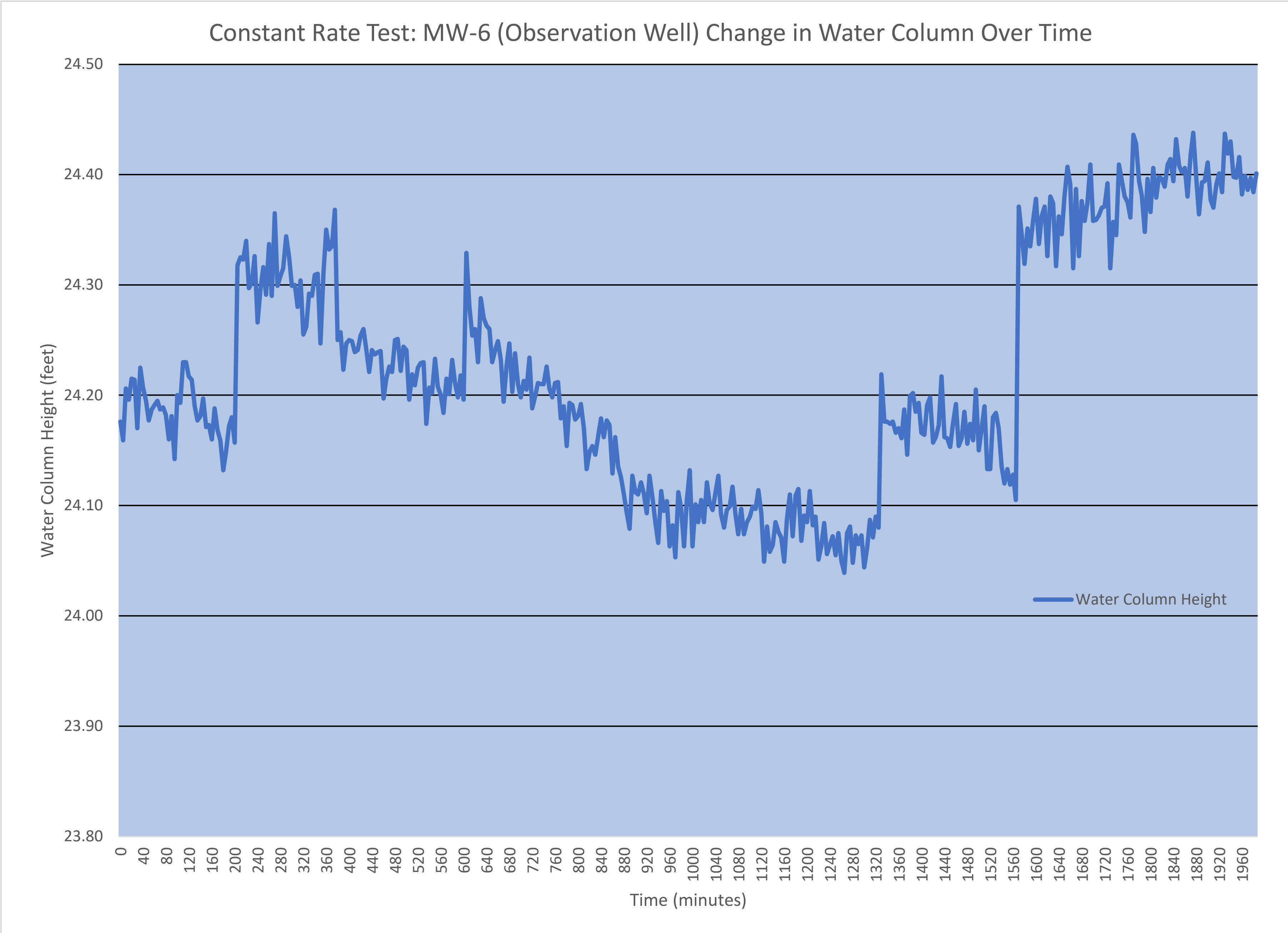
Constant Rate Test: MW-2 (Observation Well) Change in Water Column Over Time
Water Column Height (Feet)
10
9
8
7
6
5
4
3
Water Column
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
450
480
510
540
570
600
630
660
690
720
750
780
810
840
870
900
930
960
990
1020
1050
1080
1110
1140
1170
1200
1230
1260
1290
1320
1350
1380
1410
1440
1470
1500
1530
1560
1590
Time (minutes)


Constant Rate Test: MW-3A (Pumping Well) Change in Water Column Over Time
Water Column (feet)
180
160
140
120
100
80
60
40
20
0
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
450
480
510
540
570
600
630
660
690
720
750
780
810
840
870
900
930
960
990
1020
1050
1080
1110
1140
1170
1200
1230
1260
1290
1320
1350
1380
1410
1440
1470
1500
1530
1560
1590
Time (minutes)
Water Column

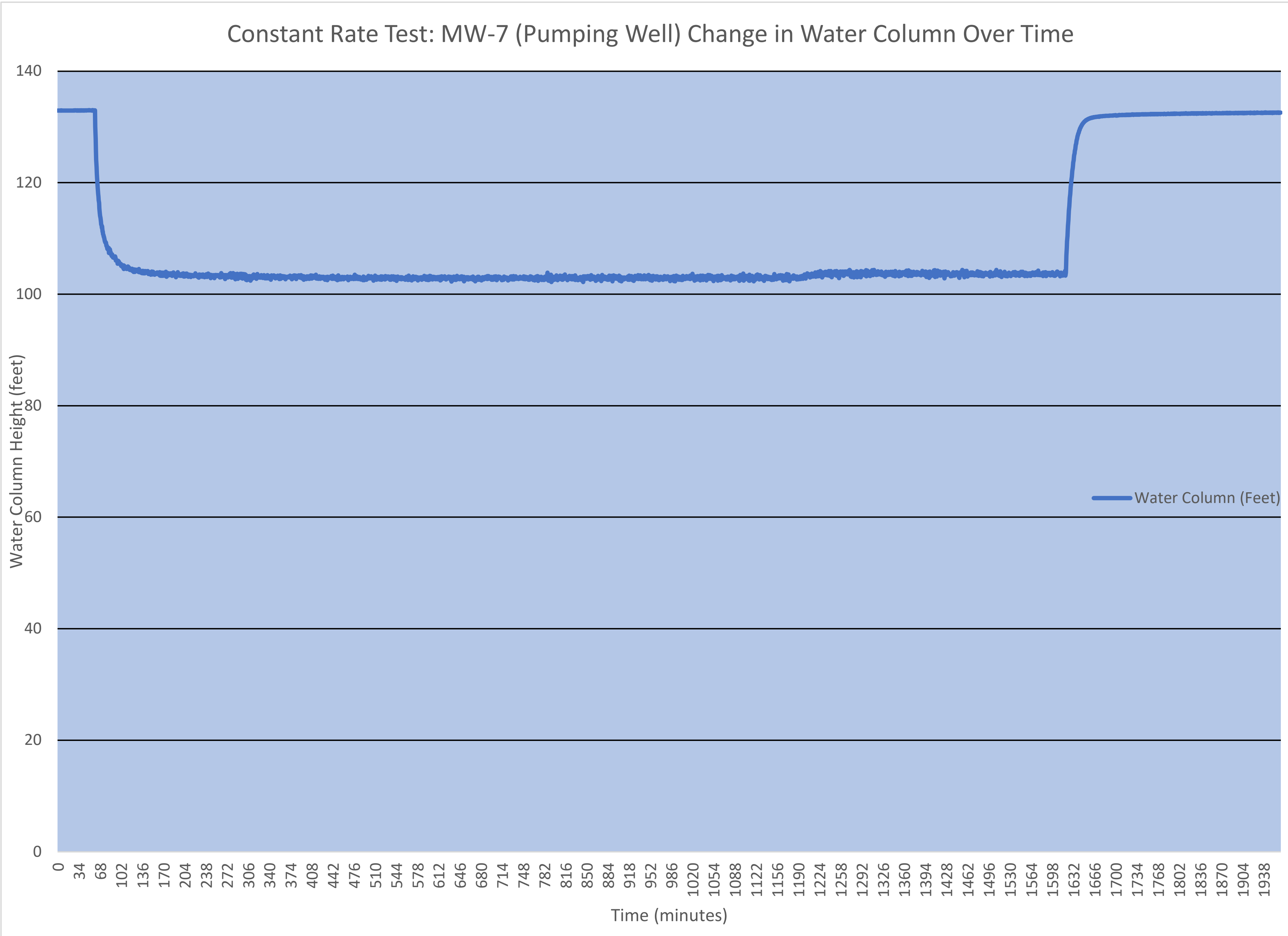

Constant Rate Test: MW-4 (Observation Well) Change in Water Column Over Time
Water Column (Feet)
110
105
100
95
90
85
80
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
450
480
510
540
570
600
630
660
690
720
750
780
810
840
870
900
930
960
990
1020
1050
1080
1110
1140
1170
1200
1230
1260
1290
1320
1350
1380
1410
1440
1470
1500
1530
1560
1590
Time (minutes)
Water Column



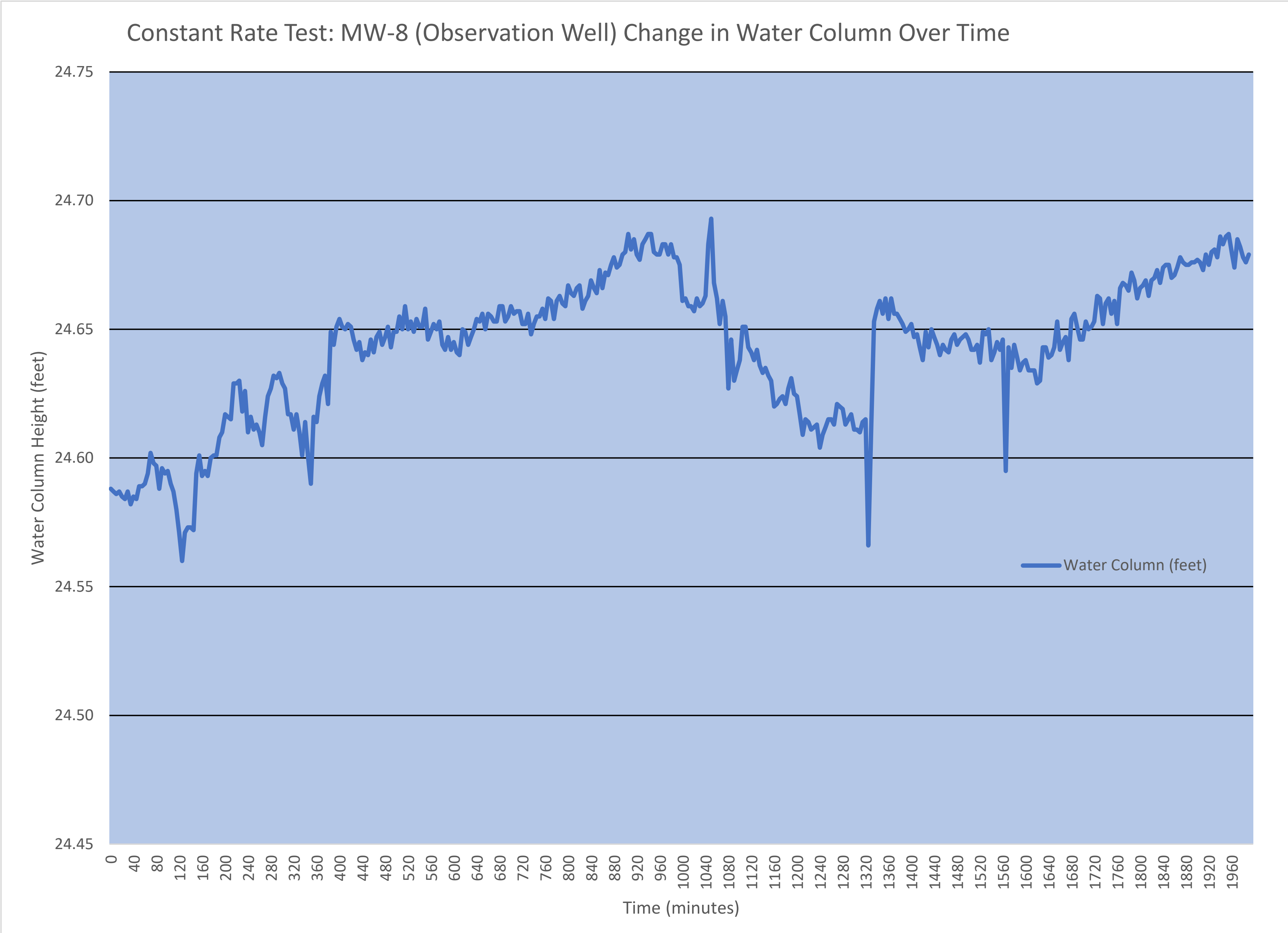
Constant Rate Test: MW-5 (Observation Well) Change in Water Column Over Time
Water Column Height (Feet)
115.00
110.00
105.00
100.00
95.00
90.00
85.00
80.00
0
35
70
105
140
175
210
245
280
315
350
385
420
455
490
525
560
595
630
665
700
735
770
805
840
875
910
945
980
1015
1050
1085
1120
1155
1190
1225
1260
1295
1330
1365
1400
1435
1470
1505
1540
1575
Time (minutes)
Water Column



Constant Rate Test: MW-6 (Observation Well) Change in Water Column Over Time
Water Column Height (feet)
24.50
24.40
24.30
24.20
24.10
24.00
23.90
23.80
0
40
80
120
160
200
240
280
320
360
400
440
480
520
560
600
640
680
720
760
800
840
880
920
960
1000
1040
1080
1120
1160
1200
1240
1280
1320
1360
1400
1440
1480
1520
1560
1600
1640
1680
1720
1760
1800
1840
1880
1920
1960
Time (minutes)
Water Column Height



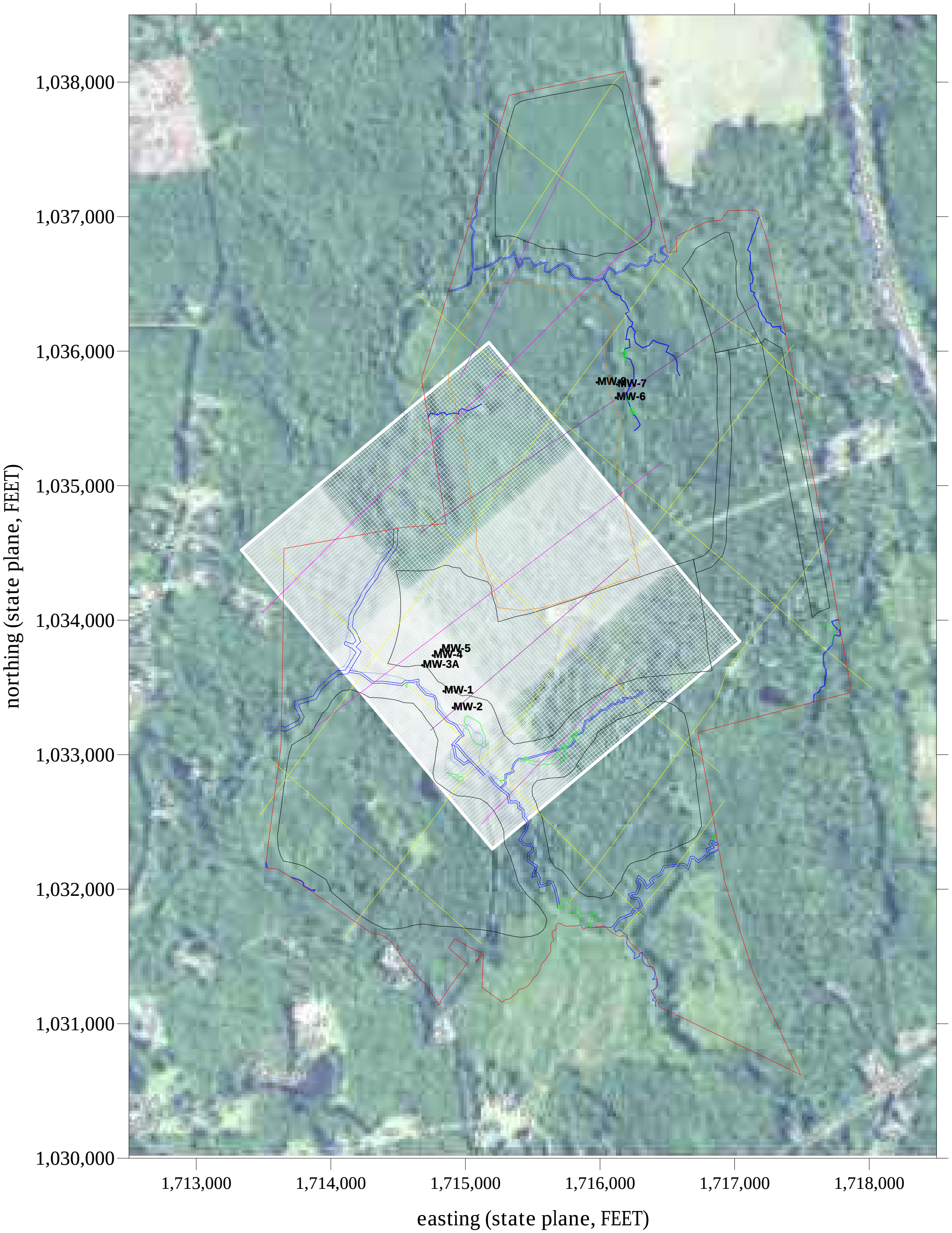
Constant Rate Test: MW-7 (Pumping Well) Change in Water Column Over Time
Water Column Height (feet)
0
20
40
60
80
100
120
140
Time (minutes)
0
34
68
102
136
170
204
238
272
306
340
374
408
442
476
510
544
578
612
646
680
714
748
782
816
850
884
918
952
986
1020
1054
1088
1122
1156
1190
1224
1258
1292
1326
1360
1394
1428
1462
1496
1530
1564
1598
1632
1666
1700
1734
1768
1802
1836
1870
1904
1938
Water Column (Feet)



Constant Rate Test: MW-8 (Observation Well) Change in Water Column Over Time
24.75
24.70
24.65
24.60
24.55
24.50
24.45
Water Column Height (feet)
Water Column (feet)
0
40
80
120
160
200
240
280
320
360
400
440
480
520
560
600
640
680
720
760
800
840
880
920
960
1000
1040
1080
1120
1160
1200
1240
1280
1320
1360
1400
1440
1480
1520
1560
1600
1640
1680
1720
1760
1800
1840
1880
1920
1960
Time (minutes)

Appendix VI – Groundwater Model Charts

Figure 5-1. Pumping Test Model Grid



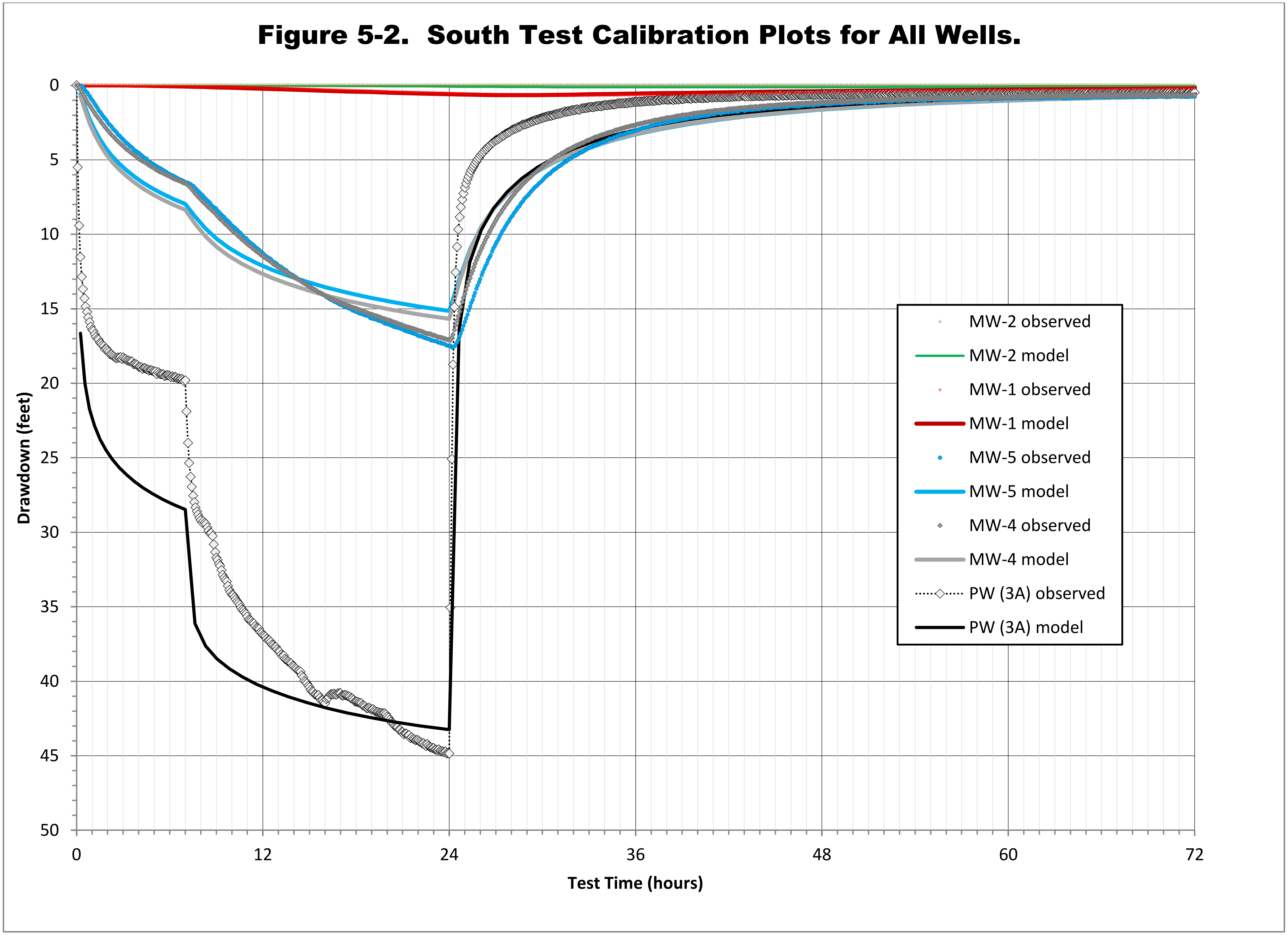


Figure 5-2. South Test Calibration Plots for All Wells.
0
5
10
15
20
25
30
35
40
45
50
Drawdown (feet)
0
12
24
36
48
60
72
Test Time (hours)
MW-2 observed
MW-2 model
MW-1 observed
MW-1 model
MW-5 observed
MW-5 model
MW-4 observed
MW-4 model
PW (3A) observed
PW (3A) model

Figure 5-3. South Test Calibration Plots for Observation Wells

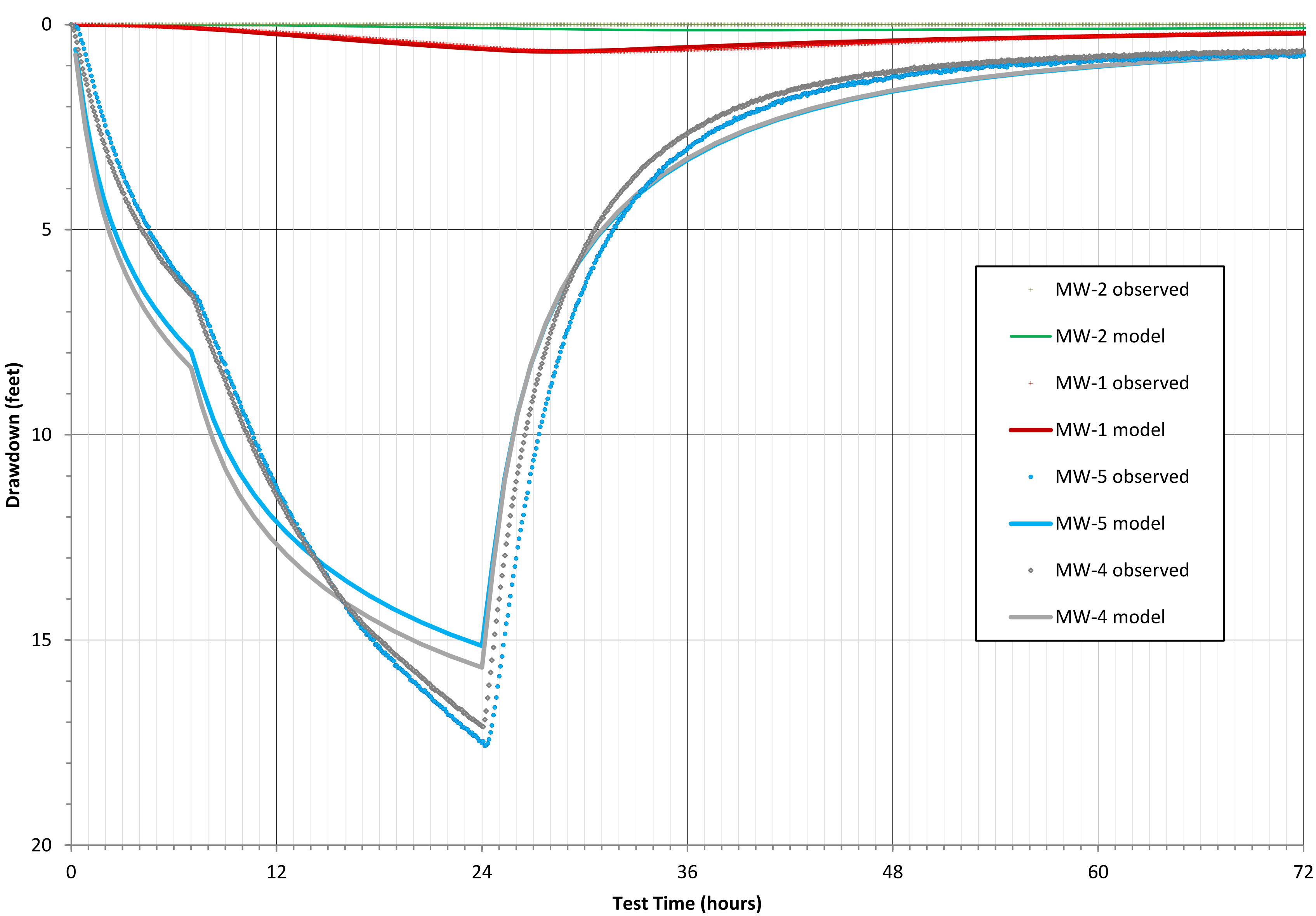


Figure 5-4. South Test Calibration Plot Close-Up

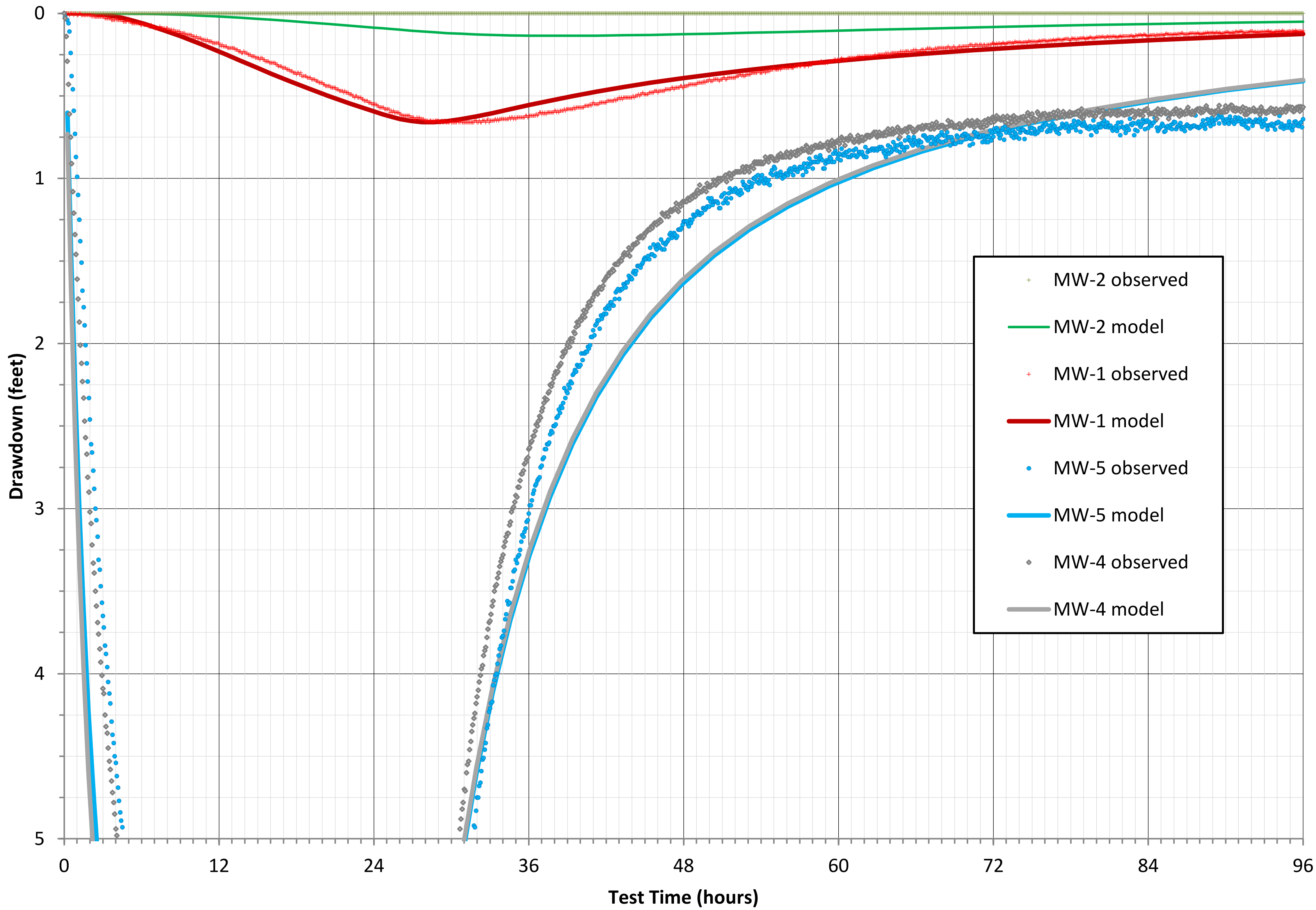


Figure 5-5. South Test Simulated Drawdown in Bedrock

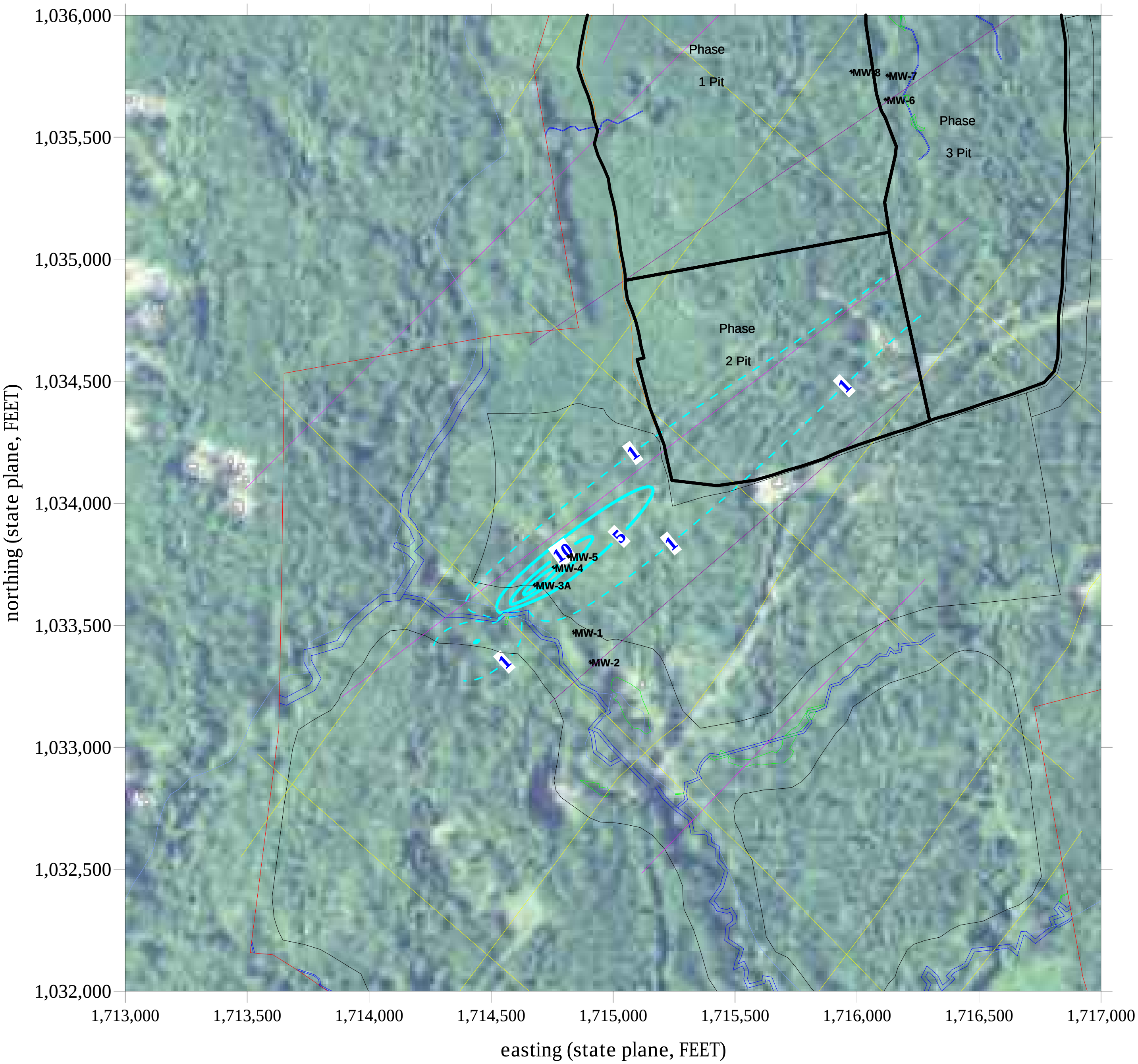
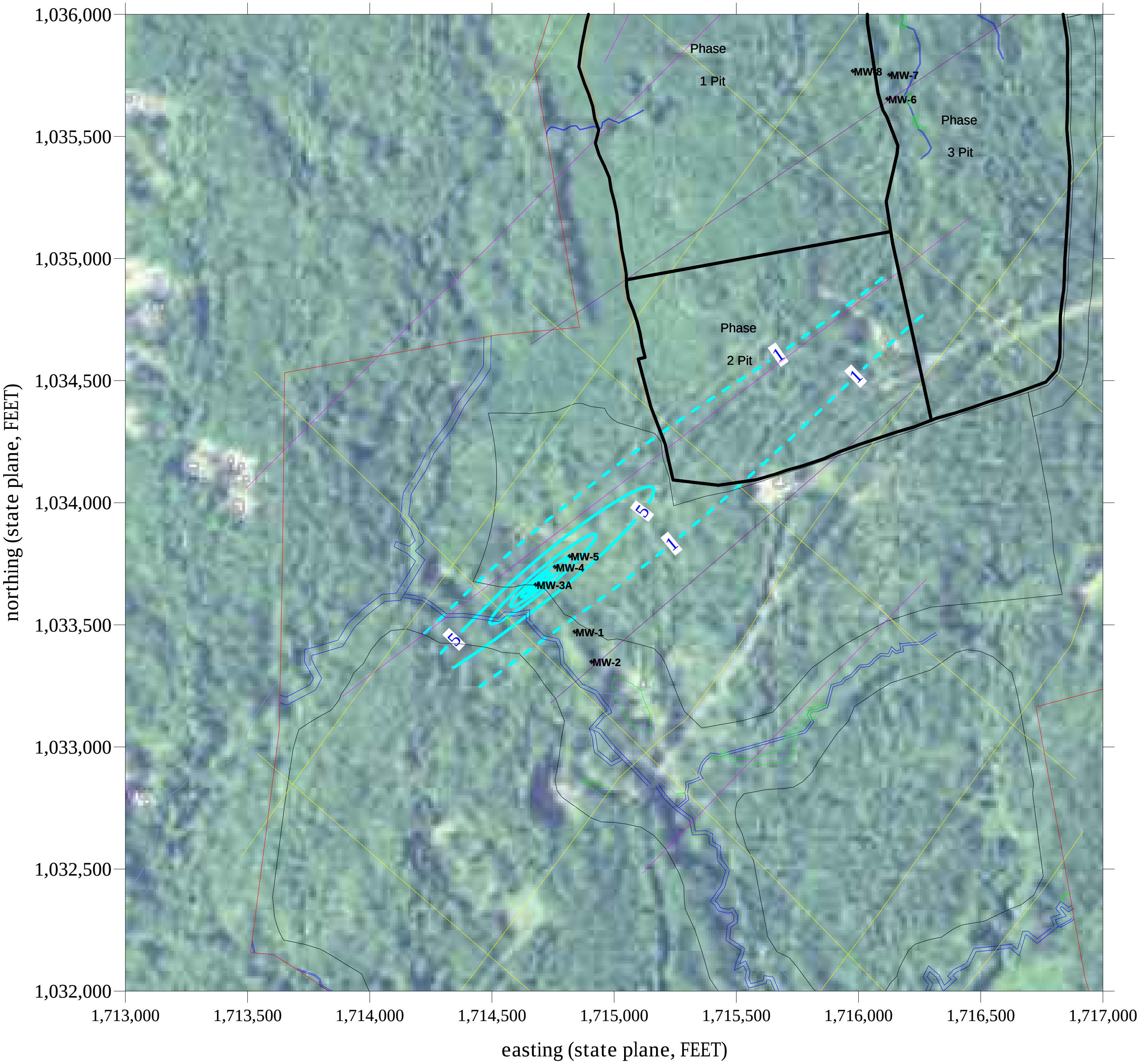


Figure 5-6. South Test Simulated Drawdown at the Water Table



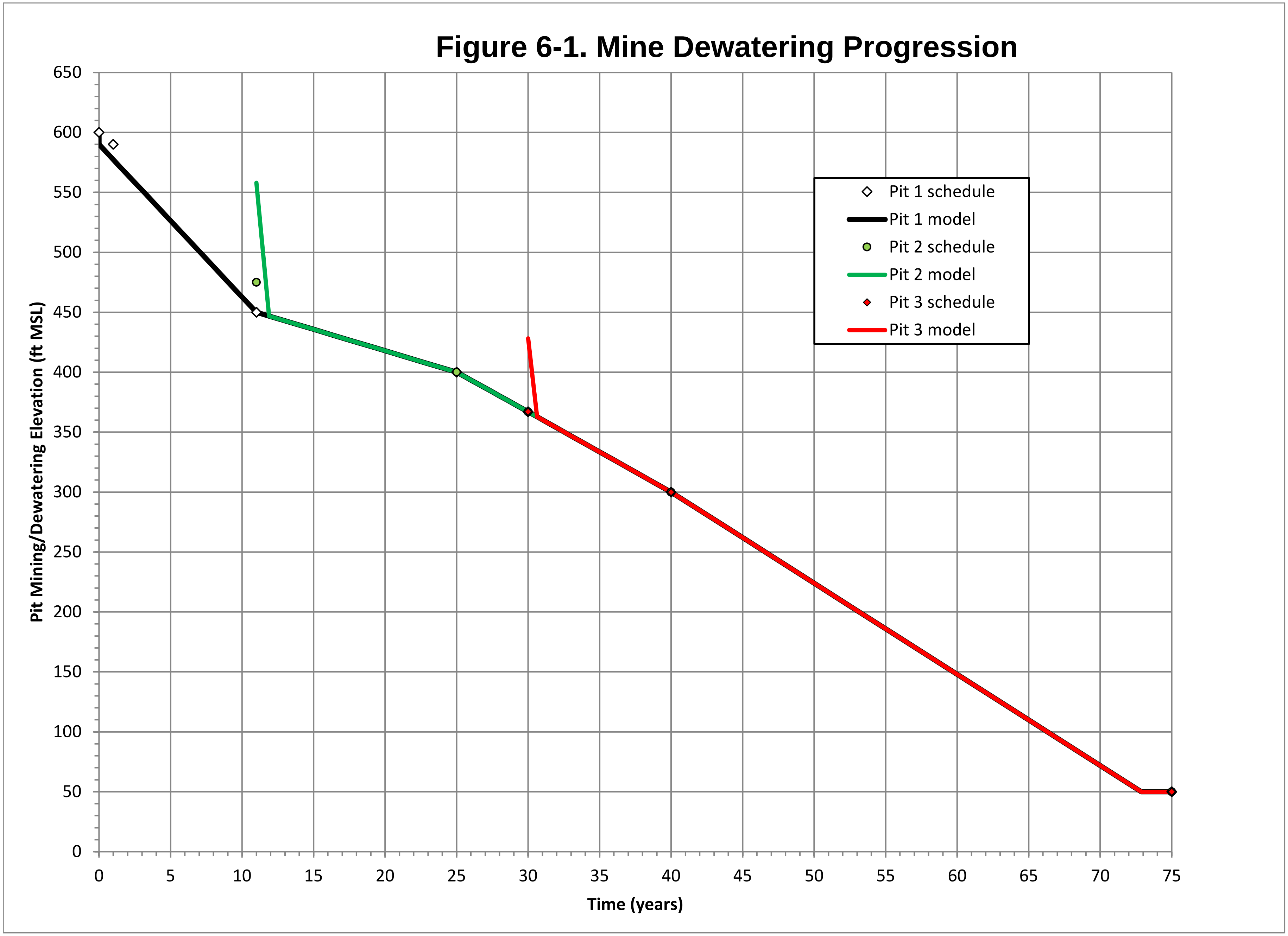


Figure 6-1. Mine Dewatering Progression
Pit Mining/Dewatering Elevation (ft MSL)
650
600
550
500
450
400
350
300
250
200
150
100
50
0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
Time (years)
Pit 1 schedule
Pit 1 model
Pit 2 schedule
Pit 2 model
Pit 3 schedule
Pit 3 model

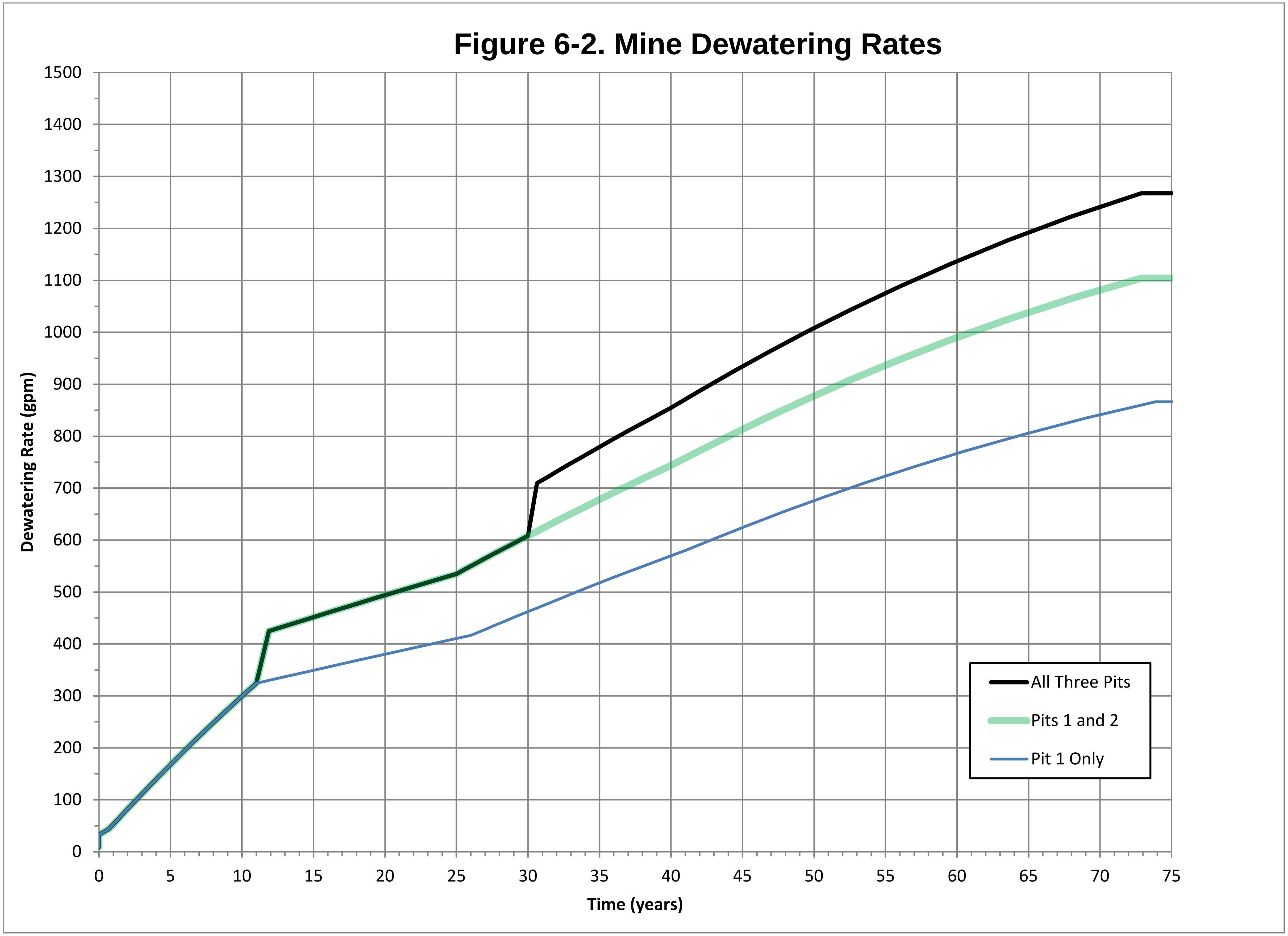


Figure 6-2. Mine Dewatering Rates
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
Dewatering Rate (gpm)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
Time (years)
All Three Pits
Pits 1 and 2
Pit 1 Only