Bright Mountain Solar Project
Site Assessment Report
Case No. 2022-00274

Exhibit D – Preliminary Geotechnical Engineering Report

Preliminary Geotechnical Engineering Report, Rev. 1

Bright Mountain Solar
Busy, Perry County, Kentucky
September 12, 2023
Terracon Project No. N3225022.R1

Prepared for:
Avangrid Renewables
Portland, Oregon

Prepared by:
Terracon Consultants, Inc.
Lexington, Kentucky

Environmental ■ Facilities ■ Geotechnical ■ Materials

September 12, 2023

Avangrid Renewables
1125 NW Couch Street, Suite 700
Portland, Oregon 97209-4129

Attn: Ms. Nautasha Gupta
P: (512) 939 5100
E: ngupta@avangrid.com

Re: Preliminary Geotechnical Engineering Report
Bright Mountain Solar
Busy, Perry County, Kentucky
Terracon Project No. N3225022.R1

Dear Ms. Gupta:

Terracon Consultants, Inc. (Terracon) has completed the preliminary Geotechnical Engineering services for the above referenced project. This study was performed in general accordance with Terracon's Master Services Agreement (MSA) Task Order dated April 28, 2022. This report presents the findings of the subsurface exploration and provides preliminary geotechnical recommendations for design and construction of foundations for the proposed solar project and the associated site work. The initial report was issued on September 13, 2022. Based on request received from Ms. Gupta via email on April 25, 2023, Terracon performed a Pile Embedment Analysis (PEA) for a fixed tilt racking system with appropriate loading assumptions. The current report reflects the results of PEA analysis.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

STATE OF KENTUCKY
SAMUEL G. GUY
31298
LICENSED
PROFESSIONAL ENGINEER

9/13/2023

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REPORT TOPICS

Note: This report was originally delivered in a web-based format. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

Note: Refer to each individual Attachment for a listing of contents.

Preliminary Geotechnical Engineering Report
Bright Mountain Solar
Busy, Perry County, Kentucky
Terracon Project No. N3225022.R1
September 12, 2023

INTRODUCTION

This report presents the results of our subsurface exploration, pile load testing, and preliminary geotechnical engineering services performed for the proposed Bright Mountain Solar project to be constructed in Busy, Perry County, Kentucky. The purpose of these services was to develop preliminary information and recommendations for:

- Subsurface soil conditions
- Groundwater conditions
- Site preparation and earthwork
- Contributory risk components
- Seismic site classification per IBC
- Driven pile recommendations

The geotechnical exploration Scope of Services for this project included the advancement of 10 soil borings, 10 electrical earth resistivity locations, pile load testing at 4 locations. Maps showing the site and boring locations are shown in the **Site Location** and **Exploration Plan** sections, respectively. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included on the boring logs in the **Exploration Results** section.

SITE CONDITIONS

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Parcel Information	The project site is approximately 800 acres, located in Busy, Perry County, Kentucky. Approximate coordinates: 37.2931° N, 83.2924° W. See **Site Location**.
Existing Improvements	The project area is located at the existing mining site with access roads throughout. The site has been mass graded, generally, within the boundaries of the reclaimed Jakes Branch Job Surface Mine. Surface mining was by the mountaintop mining technique creating valley fills and moderately level expanses of area. For more information, please refer to our **Mining Desktop Study and Field Observations** report dated April 25, 2022.

Item	Description
Current Ground Cover	Localized tall grasses and low-lying ground cover, with bare soil/rock surface/slopes and haul roads at some part of the project site. Moderately sized shrubs throughout large portions of the site.
Existing Topography (Google Earth PRO™ and CAD File 65480_BrightMountain_KY_S_Contours (1).dwg)	Gently sloping graded areas and alternating topography. Existing grades range from Elevation 1,160 to 1,240 feet around the majority of the center of the site sloping down to about elevation 960 on the west and sloping up to about elevation 1400 feet to the northeast.

PROJECT DESCRIPTION

Our initial understanding of the project was provided in our proposal and was discussed during project planning. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

Item	Description
Information Provided	Project information (including the *Bright Mountain lease area with adjoining areas.kmz* file) and requested scope of geotechnical desktop study services was provided in email on December 13, 2021 by Mr. Mark Mullen, P.E. with Avangrid Renewables. A contour map was also provided in email on July 27, 2022 by Ms. Nautasha Gupta, with Avangrid Renewables.
Project Description	Based on the project area, we understand the solar project to be approximately 80 MWac in size with a 3.5-mile T-Line. Ultimately, the power plant will consist of solar panels and various other equipment and appurtenances (e.g. switchgears, transformers, inverters, overhead and underground electrical conveyances, substations, and operations and maintenance buildings).
Structures Construction	We understand the solar structures and inverters will be supported by driven steel piles. Electrical equipment and substation elements are anticipated to be supported on concrete slabs-on-grade, spread footings, or drilled piers.
Estimated Maximum Loads	Structural loads were not provided, but have been estimated based on our experience on projects using single axis tracking rack systems: ■ Downward: 1 ½ to 4 kips ■ Lateral: 1 to 3 ½ kips ■ Uplift: 1 ½ kips ■ Structure load: 250 kips Loads for the substation structures are unknown.

Item	Description
Grading/Slopes	Grading plans were not provided; however, based on conversations with the client, it is anticipated significant fills (up to 45 feet) may occur in some areas of the site to optimize the footprint of the array area. Note that our design parameters for pile foundations are applicable to areas of up to about 3 feet of cut/fill. For the substation and operations and maintenance building we have considered up to 3 feet of cut and/or fill may be required to develop final grades in areas. Once a grading plan is available it should be provided for our review so we may modify our recommendations, where appropriate, for the design-level phase of this project.
Access Roads	We understand that access road plans used for construction of the project will be the responsibility of the EPC, and that only post-construction traffic with an allowable rut depth of 2 inches is what we are considering for in this report. We anticipate low-volume (two vehicles per day), aggregate-surfaced and native soil access roads will have a maximum vehicle load of 30,000 lbs. and will travel over the access roads only once per week.

SUBSURFACE CONDITIONS

Geology

The site is located within the Appalachian Plateaus Physiographic Province of Kentucky and is mapped by the United States Geological Survey (USGS) and Kentucky Geological Survey (KGS) to consist of Pennsylvanian age Sandstone, Siltstone, Shale, Underclay, and Coal of the Four Corners and Hyden geologic formations. Based on the NRCS SSURGO Soil Parent Material Mapping, surficial units consist of loamy coal extraction mine soils, fine-loamy colluvium derived from sandstone and shale, loamy residuum, and sandy alluvium. Light gray, fine- to medium-grained sandstone has thick to very thick bedding and generally cross-bedded forming low cliffs or steep slopes. Light to dark gray shale and siltstone are commonly interbedded with thin beds of sandstone. The Francis coal bed occurs 40 to 95 feet below the Hindman bed and is characterized by one or more thick shale partings. The Interval between the Francis and Hazard No. 7 coal beds range from 25 feet in north-central part of Krypton quadrangle to 85 feet near head of Forked Mouth Creek at south border of Krypton quadrangle. The site is mapped by the KGS mapped in the Four Corners Formation and the Hyden Formation. These units consist of Sandstone, Siltstone, Shale, Underclay, and Coal. NRCS mapping indicates that depth to bedrock throughout the site ranges from 2 to 4 feet below ground surface (bgs). Bedrock is anticipated to vary across the site and along the transmission line particularly given the active and reclaimed surface mining.

Typical Subsurface Profile

The subsurface materials encountered in our exploration are generally described below based on our interpretation of the few, widely-spaced borings performed at the project site. Geotechnical borings were extended to 21½ to 51½ feet below the existing site grade without encountering refusal within the explored depth. The subsurface profile generally consisted of reclaimed surface mine spoils from mining of the of the Hazard No.5A, Hazard No.7, Hazard No.8, and Hazard No,9 coal seams containing gravel, clay, sand, and boulders. For more information, please refer to our **Mining Desktop Study and Field Observations** report dated April 25, 2022.

Conditions encountered at each boring location are indicated on the individual boring logs. Stratification boundaries on the logs represent the approximate location of changes in soil types; in situ, the transition between materials may be gradual. Details for each of the borings can be found in **Exploration Results**.

The subsurface conditions at the boring locations can be generalized as follows:

Layer	Layer Name	General Description
1	**Surficial**	Topsoil
2	**Soil-Rock Fill**	Silty and clayey sand with gravel to cobble-sized rock
3	**Boulder Fill**	Silty and clayey sand with gravel to boulder-sized rock

Groundwater

The borings were observed while drilling for the presence and level of groundwater. Groundwater was encountered only in boring B-2 at a depth of about 41 feet while drilling, and at a depth of about 36½ feet after completion of drilling. Groundwater was not observed in the remaining borings while drilling or for the short duration that the borings were allowed to remain open. However, this does not necessarily mean these borings terminated above groundwater. Perched water conditions are common in the area due to the inconsistent profile of mine spoils. It should be noted that the observed groundwater during our field exploration may not be representative of the actual groundwater table.

The mine spoil is expected to consist of poorly graded rock and soil. In areas that the fill profile consists of fine grain soils with low permeability, a relatively long period of time may be necessary for the groundwater/perched water level to develop and stabilize in a borehole in these materials. Long term observations in piezometers or observation wells sealed from the influence of surface water are often required to define the field or in-situ groundwater level in materials of this type.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may differ than indicated on the boring logs. Exhibit 11 presented in the attachments provides minimum depth to groundwater from NRCS data as an example of potential seasonal fluctuations. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

SEISMIC CONSIDERATIONS

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7 and the International Building Code (IBC). Based on the soil properties encountered at the site and as described on the exploration logs and results, it is our opinion that the **Seismic Site Classification is D**. Subsurface explorations at this site were extended to a maximum depth of 51½ feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic and anticipated fill conditions of the general area. Due to the inconsistent nature of the mine spoil, we recommend additional deeper borings or geophysical testing be performed to confirm the conditions below the current boring depth and seismic site class.

CORROSIVITY

Mined coal often contains sulfur and sulfates which can be corrosive to building materials. The table below lists the corrosivity test results performed on samples collected from the borings. The values may be used to estimate potential corrosive characteristics of the on-site soils with respect to contact with the various underground materials which will be used for project construction.

Corrosivity Test Results Summary							
Boring	**Sample Depth (feet bgs)**	**pH**	**Sulfate (mg/kg)**	**Chlorides (mg/kg)**	**Red-Ox (mV)**	**Total Salts (mg/kg)**	**Electrical Resistivity (Ω-cm)**
B-1	0 to 5	7.0	238	50	+443	909	2,168
B-2	0 to 5	7.7	14	38	+410	74	17,553
B-3	0 to 5	7.5	43	44	+430	225	10,015
B-4	0 to 5	7.0	1,479	44	+430	2,870	1,136
B-5	0 to 5	7.1	22	81	+391	927	2,581
B-6	0 to 5	7.1	308	44	+407	1,315	1,755
B-7	0 to 5	7.3	185	38	+409	637	2,581

Corrosivity Test Results Summary							
Boring	**Sample Depth (feet bgs)**	**pH**	**Sulfate (mg/kg)**	**Chlorides (mg/kg)**	**Red-Ox (mV)**	**Total Salts (mg/kg)**	**Electrical Resistivity (Ω-cm)**
B-8	0 to 5	7.6	49	50	+372	878	2,065
B-9	0 to 5	7.5	286	38	+406	986	2,478
B-10	0 to 5	7.8	77	50	+395	644	2,375

These test results are provided to assist in determining the type and degree of corrosion protection that may be required. We recommend that a certified corrosion engineer be retained to analyze the need for corrosion protection and to design appropriate protective measures, if required.

As discussed in Section 10.7.5 of the AASHTO LRFD Bridge Manual, 8th Edition, 2017, the following soil or site conditions should be considered as indicative of potential deterioration or corrosion situation for steel piles:

- Soil electrical resistivity less than 2,000 Ω-cm (noted in samples from explorations B-4, and B-6)
- pH less than 5.5
- pH between 5.5 and 8.5 with high organic content
- Sulfate concentration greater than 1,000 ppm (mg/kg) (noted in samples from exploration B-4)

Our comments and opinions regarding corrosion of buried on-site features such as foundations and utility pipes are presented below and in the **Contributory Risk Components** section. Based on the corrosivity test results, the mine spoil soils at the project site is corrosive to the buried metals and these elements will need corrosion protection.

There are many site-specific factors that can also significantly impact corrosion of buried metals and sulfate attack on concrete. No single soil property can be used as a determining factor for evaluating corrosion potential, although the pH and resistivity of the soils is a good indicator. If a more detailed evaluation is needed, we suggest contacting firms that specialize in corrosion evaluation and cathodic protection. These test results are provided to assist in determining the type and degree of corrosion protection that may be required. We recommend that a certified corrosion engineer be retained to analyze the need for corrosion protection and to design appropriate protective measures, if required.

CONTRIBUTORY RISK COMPONENTS

Item	Description
Supplemental Exploration and Testing	Additional subsurface exploration and a full-scale pile load testing program should be performed to adequately explore the site as part of a design-level study. Final geotechnical exploration should include additional borings/test pits, geophysical exploration to understand the property and characteristics of mine spoil material across the site. The results of a full scale PLT program in conjunction with soil test boring/test pit results are often successful in reducing the design embedment depth when compared to designs solely based on explorative results and analytical results. Past subsidence from mining operations, can be investigated through review of Interferometric Synthetic Aperture Radar (InSAR) data. INSAR is a technique that measures millimeter displacements of the ground's surface using radar satellite images. Terracon can provide a proposal for the InSAR review, upon request.
Anticipated Pile Drivability	During preliminary pile load testing, we were able to drive our test piles without encountering shallow refusal. However, due to the presence cobbles, boulders, and rock slabs within the mine-spoil fill, there is an increased likelihood of encountering difficulties during pile driving. Pre-drilling is expected to be required at some locations throughout the site.
Soil Conditions	The project site is located reclaimed coal mine. Our exploration encountered existing fill associated with previous surface mining to the termination depth of our deepest boring at 51½ feet. All the borings were terminated within the layer. The encountered mine spoil fills varied in nature, consisting of soil mixed with boulders to rock slab zones which is typical of mine spoil fills.

Item	Description
Suitability Statement	Development of reclaimed coal-mine areas require special considerations. The large-scale surface mining and reclamation operations have altered the landforms at the site. The reclaimed land is composed of deep soil and rock/boulder fills associated with mine-spoils. the principal concern with development of the site is the presence and variable depth of uncontrolled mine spoil fill material. The mine spoils are generally end-dumped with minimal compaction and are susceptible to long-term settlement. Volume reduction of this fill can occur owing to various processes such as collapse compression from crushing of rock-to-rock contact points upon wetting or long-term creep associated with self-weight of the fill. Hydro consolidation settlement can also occur from the presence of water (saturating or percolating through the fill). Softening, squeezing, consolidation, and internal migration of particles into open voids can also occur. Differential settlement rather than the magnitude of total settlement causes distortion and damage to structures. Total settlements of the mine spoil fills could range from several inches to several feet. Due to the highly variable composition and consistency, it is impossible to accurately predict settlement of such soils. The mine was reportedly "reclaimed" between 2004 and 2015 and we would expect that some of the settlement has already occurred. However, there were no records made available to us to indicate the magnitude of spoil placement and compaction. Fill settlement diminishes with time. However, settlements can continue for many years, even decades, especially when aggravated by water. Hydro-consolidation accounts for a large portion of the long-term settlement.
Suitability Statement (continued)	Any site grading activities that increase the change of water build-up within the fill (construction of ponds or detention basins), can increase settlement potential. Design and construction of surface drainage features that prevent a build-up of water in the fill should be considered. To help assess the potential settlement of the reclaimed mine area, review of satellite InSAR data is recommended to evaluate ground displacements that may have occurred since reclamation. The design-level geotechnical exploration should include additional borings at anticipated structure locations to assess the differential settlement potential. Support of structures and access roads on existing fill is discussed in this report. However, even with the recommended construction procedures, there is inherent risk for the owner that compressible fill or unsuitable material, within or buried by the fill, will not be discovered. There is also risk associated with unreliable lateral, uplift, and axial support within the fill due to its uncontrolled nature. Based on provided information, the solar arrays for this project are anticipated to be supported on driven H piles. For this type of foundation system, provisions for flexible or adjustable connection between the posts and the array superstructure are recommended. Additionally, our review of the available mining documents for the site indicates that no underground mining permits were noted in the permit review. However, the landowner indicated a possible abandoned underground mine to the north side of the area of interest. Further investigation is warranted to understand what, if any, affect this mine will have on the solar development.

Item	Description
Grading	Based on information provided by the client, we anticipate significant filling will be required to match the proposed surface grades at some portions of the site (up to 45 feet). Fills with depths greater than 10 feet should be monitored to confirm the rate of settlement is at or below acceptable levels prior to proposed solar improvements being implemented. On-site materials that are used as fill or backfill will likely require sorting to remove deleterious materials, large rock fragments, breaking down of weathered rock into particle sizes that acceptable as fill, and drying prior to re-compaction as engineered fill. Alternatively, these materials could be replaced with imported soils containing appropriate materials and moisture contents. We expect areas of unsuitable conditions will be encountered prior to placing fill and within the subgrade for roadways and foundations that are planned. Stabilization measures, such as over-excavation and replacement, should be expected. Construction traffic should be limited after rain events as the clayey soil could become unstable under those conditions.
Excavation Hazards	Based on our exploration results, we expect that difficult excavation conditions could be encountered during construction due to the uncontrolled nature of the mine spoils which may contain large rocks, rock slabs and boulders. As previously noted, groundwater may be encountered during shallow excavations. Additionally, we expect general instability in the form of caving, sloughing, and raveling to be encountered in excavations due to the presence of mine-spoil fill. Excavations will likely require bracing, sloping, and/or other means to create safe and stable working conditions.
Slope Hazards	Review of the provided topographic map indicates existing slopes range from less than 10H:1V to about 2.5H:1V, with slope heights of less than 20 feet to greater than 300 feet in some areas. Design-level Geotechnical Engineering Services should include exploration and analysis of slope stability for existing slopes, cut, and fill slopes proposed for the site development.
Groundwater	Groundwater was encountered only in Borings B-2 at a depth of about 41 feet below existing site grades while drilling and at a depth of about 36½ feet below existing site grades after completion of drilling. Groundwater was not observed in the remaining borings while drilling or for the short duration that the borings were allowed to remain open. However, this does not necessarily mean these borings terminated above groundwater. Perched water conditions are common in the area due to the inconsistent profile of mine spoils. It should be noted that the observed groundwater during our field exploration may not be representative of the actual groundwater table. Excavations for shallow foundations could also encounter groundwater, especially if construction is performed during wet periods of the year.

Item	Description
Corrosion Potential	Two of the electrical resistivity tests were less than 2,000 Ω-cm, and Sulfate concentration greater than 1,000 ppm (mg/kg) was noted in one soil sample, which are indicative of a potential pile deterioration or corrosion per corrosion guideline from U.S. Department of Transportation Federal Highway Administration. The results of our laboratory testing of soil chemical properties (provided in the attachment) are expected to assist a qualified engineer to design corrosion protection for the production piles and other project elements.
General Construction Considerations	The near surface soils at the project site will be subject to rainfall and could become unstable with typical earthwork and construction traffic. Effective drainage should be completed early in the construction sequence and maintained after construction to avoid potential issues. If possible, the grading should be performed during the warmer and drier times of the year. If grading is performed during the winter months, an increased risk for possible mitigation of unstable subgrade will persist.

DRIVEN PILE FOUNDATIONS

Pile load tests were performed at 4 locations across the site. The test piles consisted of wide flange W6x9 steel piles. Subsequent analyses will be required once design-level geotechnical information is available and once other design considerations are more fully defined. **THEREFORE, THE RESULTS OF THE ANALYSES DESCRIBED BELOW ARE NOT SUITABLE FOR FINAL DESIGN.** It should be noted that our analyses are based on short-term conditions based on pile load testing and boring information. For this type of foundation system, provisions for flexible or adjustable connection between the posts and the array superstructure are recommended.

The test piles were installed to embedment depths of 5 to 8 feet. The piles are identified in this report as text “PLT” followed by test number followed by letter “A” (piles embedded to depth of 8 feet below existing ground surface) and “B” (piles embedded to 5 feet below existing ground surface) and “C” (piles embedded to depth of 5 feet below existing ground surface). Piles A and B were tested for axial tension first and lateral load next. Piles C were tested for compression loads.

Pile Driving

The pile driving operation was performed with a track-mounted, Vermeer 10 pile driver. The pile driving hammer was set up to run at 75 percent of the full driving capacity. The piles were installed to the depths as shown in table below. A summary of the time required to advance each pile to its specified embedment depth is summarized in the following table.

Test Location	PILE (A)			PILE (B)			PILE (C)		
	Embedment Depth	Total Drive Time	Avg. Drive Time	Embedment Depth	Total Drive Time	Avg. Drive Time	Embedment Depth	Total Drive Time	Avg. Drive Time
	ft	sec	sec/ft	ft	sec	sec/ft	ft	sec	sec/ft
PLT-1	8	56.0	7.0	5	143.0	28.6	5	116.0	23.2
PLT-2	8	90.0	11.3	5	22.0	4.4	---	---	---
PLT-3	8	49.0	6.1	5	22.0	4.4	5	87.0	17.4
PLT-4	8	90.0	11.3	5	56.0	11.2	---	---	---

PILE LOAD TEST PROCEDURES AND EQUIPMENT

The pile load tests were performed 3 days after the piles were installed. An Enerpac 10-ton hydraulic pull jack and an Enerpac hydraulic pump were used to apply the test loads using chains and other accessories all rated for at least a 10-ton safe working capacity. Deflections were measured with digital dial gauges with magnetic bases. Loads were measured with a Dillon ED Junior Dynamometer 25-kip electronic load cell for tension, compression, and lateral loads. The following types of load tests were performed:

- Axial Tension Load Tests for skin friction evaluation;
- Lateral Load Tests;
- Axial Compression test for tip resistance evaluation.

The sequence of testing is as follows: Axial tension load testing was performed on piles designated as A and B at each location. For axial tension testing, Terracon's proprietary steel tri-pod system or a backhoe was used to develop the vertical tension reaction. A locking "E"- plate clamp was used to grip the top of the web. Terracon set up a 10-foot long, steel reference beam to rest the gauges and record movements relative to the test pile. The ends of the reference beam were supported such that they were 6-inches above ground and seated firmly on the ground surface. Magnetic bases were attached to the web of the test pile approximately 4 inches above the ground surface to provide a suitable surface for the deflection gauges to rest against. The test loads were applied following a pre-determined load sequence. Deflections and loads were measured using a pair of calibrated Starrett dial gauges.

Following the axial tension tests, the A and B piles were tested for lateral capacity by connecting the 2 test piles together to test both piles simultaneously with each pile being the reaction pile for the other. The piles were spaced at an approximate horizontal distance of 10 feet. A flange clamp was set on each of the W-section piles to apply horizontal loading approximately 36 inches above the ground surface. Two reference beams were positioned near the outside edge of each test pile flange. Two calibrated two-inch stroke dial gauges were positioned on each pile along the strong axis horizontally with the magnetic base approximately 6 inches above ground surface to bear on the reference beam. The test loads were applied using a pre-determined cyclic-type load sequence. The load was measured using the electronic readout device from the load cell. The bottom and top deflections were recorded using the electronic readout device. The lateral load was applied in increments and decrements (i.e., loading and unloading cycles). The sequence of loading and unloading cycle includes 500-, 1000-, 1500-, 0-, 1500-, 2000-, 2500-, 0-, 2500-, 3000-, 3500-, and 0- lb, and so on. The loads were applied until the maximum lateral load of 7,000 lbs. was reached or the pile reached 2-inch of lateral displacement measured at 6 inches above the ground surface.

The axial compression tests were performed using a ½ inch plate being placed on the top of the pile (C piles) followed by the Rice Lake DC-390 compression load cell, which was used to record the loads. The compression tests were performed in the shallower embedment piles only. These piles were designated as C piles. The deflection was measured using two calibrated Starrett dial gages. An Enerpac 5-ton cylinder jack was then placed on top of the load cell. The bucket of an excavator was used to provide the reaction load. The axial compression load was applied in load increments of 500 lbs. to a maximum of 13,000 lbs was reached or until the pile reached ¾ of an inch of vertical displacement.

SUMMARY OF PILE LOAD TEST RESULTS

The following table provides a summary of the axial tension loads for pile movements of about ¼ inch.

Pile Load Test Location (A)	Embedment Depth	Tension Load at ¼-inch Disp.	Pile Load Test Location (B)	Embedment Depth	Tension Load at ¼-inch Disp. [1]
	(feet)	(lbs.)		(feet)	(lbs.)
PLT-1	8	8,170	PLT-1	5	9,110
PLT-2	8	>10,000	PLT-2	5	3,380
PLT-3	8	4,260	PLT-3	5	2,260
PLT-4	8	5,790	PLT-4	5	4,610

1. The “>” symbol indicates the load was achieved prior to reaching the noted displacement.

The following table provides a summary of the pile embedment depth and lateral load at ½-inch lateral displacement at 6 inches above ground surface.

Pile Load Test Location (A)	Embedment Depth	Lateral Load at ½-inch Disp.	Pile Load Test Location (B)	Embedment Depth	Lateral Load at ½-inch Disp.
	(feet)	(lbs.)		(feet)	(lbs.)
PLT-1	8	1,230	PLT-1	5	1,570
PLT-2	8	1,500	PLT-2	5	1,840
PLT-3	8	1,460	PLT-3	5	1,320
PLT-4	8	1,780	PLT-4	5	1,210

Pile Load Test Location (A)	Embedment Depth (feet)	Lateral Load at ½-inch Disp. (lbs.)	Pile Load Test Location (B)	Embedment Depth (feet)	Lateral Load at ½-inch Disp. (lbs.)

1. Encountered refusal at a depth of 8 feet below the ground surface for the A-pile and 5 feet below the ground surface for the B-pile.

The following table provides a summary of the axial compression loads for pile movements of about ¼ inch.

Pile Load Test Location (C)	Embedment Depth (feet)	Compression Load at 1¼-inch Disp. [1] (lbs.)
PLT-1	5	8,770
PLT-3	5	12,100

Geotechnical Axial Capacity

The following preliminary geotechnical parameters can be used to estimate the capacity of driven W-section pile foundations. These values should also be suitable to prepare a full-scale pile load testing program which is recommended as part of the overall project design. Final design values will vary from the preliminary estimates below. The upper 1 foot of soil should be neglected when calculating the ultimate capacity from skin friction.

Based on the results of the pile load testing program, the site appears to be variable and therefore we have developed three zones for the various axial capacities. Below is a table of values recommended for the areas in proximity to the pile load tests:

Axial Zone ID	Pile ID	Depth (feet)	Ultimate Side Friction (psf)	Ultimate End Bearing (lbs)
1	PLT-1	1 – 8	625	70
2	PLT-2 & 4	1 – 5	415	3,000
		5 – 8	450	
3	PLT-3	1 - 5	275	3,000
		5 – 8	325	

The above values are to be used in the following equations to obtain the ultimate uplift or compression load capacity of a pile:

$$Q_{ult\ (compressive)} = q_t \times A + H \times P \times q_s$$
$$Q_{ult\ (uplift)} = H \times P \times q_s$$

Q_{ult} = Ultimate uplift or compression capacity of post (lbs.)
$Q_{ult\ (end)}$ = Ultimate end bearing capacity per table above (lbs.)

H = Depth of embedment of pile (ft.)
P = Perimeter area/ft. of pile. (i.e. W6x9 = 1.64 sf/ft.)
q_s = Skin friction per depth per table above (psf)
q_t = unit toe-bearing resistance per table above (psf)
A = cross sectional area of pile (i.e. W6x9 = 0.019 sf).

The provided preliminary skin friction values are applicable for piles that are driven using a Vermeer PD-10 pile driver with a hydraulically operated hammer. If a smaller or larger drive hammer is used, we recommend that Terracon be consulted to determine the minimum drive time based on the actual equipment to be used.

For Allowable Stress Design (ASD), we recommend the allowable skin friction and allowable end bearing capacity values be determined by applying a factor of safety (FOS) of at least 1.5 to the ultimate values.

Piles should have a minimum center-to-center spacing of at least 3 times their largest cross-sectional dimension to prevent reduction in the axial capacities due to group effects.

Final pile design to be completed by an engineering licensed in the State of Kentucky based upon information contained in this geotechnical report and independent pile load testing.

Geotechnical Lateral Capacity

Lateral load response of pile foundations was calculated using the computer program *L-Pile 2019*, by Ensoft, Inc. The stiffness of the pile and the stress-strain properties of the surrounding soils determine the lateral resistance of the foundation. We modeled the lateral response of the tested piles to evaluate L-Pile input parameters that can be used for design of the production piles. Recommended L-Pile input parameters for driven pile foundations are shown in the following table:

All Zones

Depth (feet bgs)	LPILE Soil Model	Effective Unit Weight γ, (pcf)	Estimated Cohesion, c (psf)	Estimated Friction Angle, ϕ (°)	Strain Factor, (ε_{50}) and Static Lateral Subgrade Modulus (k)
0 – 20	Sand (Reese)	115	--	29	default

The above indicated effective unit weight and friction angle have no factor of safety and may be used to analyze suitability of the proposed section and serviceability requirements. These parameters are based on correlations with laboratory test results, SPT results, published values, and our experience with similar soil types.

L-PILE analyses were performed by applying the field test load that resulted in approximately ½-inch deflection at a point about 6-inches above the ground surface. The shear load was applied at approximately 3 feet above the ground surface. The effective unit weight, friction angle was based on the results of the SPT borings. The p-multiplier was then adjusted (by trial-and-error method) such that the applied load resulted in a deflection value that matched the load test results. Please note that this procedure was based on only one discrete set of data determined at about six inches from the ground surface during the field load testing. These results should be used for L-PILE analysis only using the 2019 version of L-Pile. These parameters are only applicable to piles embedded between five to twelve feet below grade. In our evaluation, the piles were modeled as a Steel AISC Section Strong Axis. The lateral load test results were varied between the different embedment depths. Therefore, we are providing the following table of p-multiplier values that should be used for the corresponding embedment depth:

Minimum Embedment Depth (feet)	P- Multiplier[1, 2]
5	2.2
8	1.1

1. Within the upper 1.4 feet, the p-multiplier should be 70% of the value shown in the table.
2. Linearly interpolate the P-Multiplier values shown in the table for embedment depths between the discussed depths.

The structural engineer should evaluate the moment capacity of the pile as part of their structural evaluation. Piles should have a minimum center-to-center spacing of at least five times their largest cross-sectional dimension in the direction of the lateral loads, or the lateral capacities should be reduced due to group effects. If piles will be spaced closer than five times their largest cross-sectional dimension, we should be notified to provide supplemental recommendations regarding resistance to lateral loads.

Preliminary Pile Embedment Analysis

The approximate structural load conditions were analyzed based on top-of-pile load documents for the Sunlink Fixed-Tilt racking system from 2016. We did not receive a response back from Sunlink (a NOV company) from a query for updated loads. Design conditions utilized for this racking system is for 110 mph, 3-second wind gusts. The actual top-of-pile structural loads will vary based on the selected racking system and the manufacturer's load information as determined in accordance with requirements by the applicable building codes and local municipality.

For the Sunlink Fixed-Tilt racking system, the following table outlines the top-of-pile loads used in our structural analysis and the resulting preliminarily recommended pile section and embedment depths for the pile locations at around the load test locations. The pile reveal height used in the analysis for the Sunlink pile array is 5.25 feet.

Sunlink-110 – Entire Site								
Pile Type	Approximate Factored Loads						Structural Analysis Results	
	Compression (kips)	Dead Load (kips)	Uplift (kips)	Adfreeze Uplift (kips)	Shear (kips)	Moment (kip-ft.)	Recommended Pile Section	Recommended Pile Embedment (ft.)
N. Row	1.385	0.435	0.745	0.000	0.480	1.330	W6x8.5	5.0
E/W Edge	1.385	0.435	0.725	0.000	0.470	1.024	W6x8.5	5.0
N23 Rows	1.415	0.435	0.765	0.000	0.490	1.237	W6x8.5	5.0
S. Row	1.045	0.435	0.595	0.000	0.410	1.000	W6x8.5	5.0
Interior	1.455	0.435	0.805	0.000	0.510	0.315	W6x8.5	5.0

The analyses were performed by starting out with the design pile shape and minimum embedment depth to support the compression and/or tension load for each pile type. The pile embedment was deepened as necessary until a lateral deflection less than or equal to approximately 0.6-inches was achieved at the ground surface. If the deflection criteria could not be met by deepening the pile embedment due to the pile reaching a point of fixity, the next larger size of pile was modeled.

It should be noted that greater quantities of steel (i.e. thicker sections, greater pile lengths) may be required for foundation support depending on the results of the corrosion analysis. A report of *Corrosion Engineering Services* is included in the attachments.

The design of foundations for the solar panel racking system will depend on a number of factors including the actual structural loading conditions, the structural serviceability requirements, anticipated corrosion losses, and other factors where complete and final information is not available at this time.

Construction Considerations

During construction pile driving operation should be observed. Each pile should be observed and checked for buckling, crimping and alignment in addition to recording penetration resistance, depth of embedment, and general pile driving operations.

Pile Design Recommendations for Other Structures

Other structures (i.e. inverters and embedded poles) may be supported on driven pile foundations similar to that of the solar panels If embedment depths of greater than 8 feet are required or piles will be located outside the currently provided pile zones, additional pile load testing should be performed.

SHALLOW FOUNDATIONS

If the site has been prepared in accordance with the requirements noted in **Preliminary Earthwork Considerations**, the following preliminary design parameters may be considered for shallow foundations.

Item	Description
Maximum Net Allowable Bearing pressure [1, 2]	1,000 psf
Required Bearing Stratum [3]	Engineered fill
Minimum Foundation Dimensions	Columns: 30 inches Continuous: 18 inches
Ultimate Passive Resistance [4] **(equivalent fluid pressures)**	350 pcf
Ultimate Coefficient of Sliding Friction [5]	0.40
Minimum Embedment below Finished Grade [6]	24 inches
Estimated Total Settlement from Structural Loads [2]	About 1 inch

1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. An appropriate factor of safety has been applied. Values assume that exterior grades are no steeper than 20% within 10 feet of structure.
2. Values provided are for maximum loads noted in **Project Description**.
3. Unsuitable (including mine spoil materials) or soft soils should be over-excavated and replaced per the recommendations presented in **Preliminary Earthwork Considerations**.
4. Use of passive earth pressures require the sides of the excavation for the spread footing foundation to be nearly vertical and the concrete placed neat against these vertical faces or that the footing forms be removed and compacted engineered fill be placed against the vertical footing face. Passive resistance should be neglected in the uppermost 24 inches below grade.
5. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Should be neglected for foundations subject to net uplift conditions.
6. Embedment necessary to minimize the effects of frost and/or seasonal water content variations. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure.

SUBSTATION FOUNDATION

Deep foundations, including drilled shafts and/or direct embedment foundations with concrete backfill, may be utilized for support of the more heavily loaded substation and transmission line structures. However, to prevent collapse of the sidewalls and/or to control groundwater seepage, the use of temporary steel casing and/or slurry drilling procedures may be required for construction of the drilled shaft foundations.

Geotechnical design parameters are provided below in the **Drilled Shaft Design Summary** table for the design of drilled shaft foundations and they are based on exploration results obtained from boring B-10. The values presented for allowable side friction and end bearing include a factor of safety of 3 to preclude the necessity of a pile load test.

Substation – Drilled Shaft Foundation Design Parameters							
Depth [1] (feet)	L-Pile Soil Type	Unit Weight, γ (pcf) [4]	Allowable Skin Friction [2] (psf)	Allowable End Bearing Pressure [3] (psf)	Internal Angle of Friction, ϕ (Degree)	Cohesion, c (psf)	Lateral Subgrade Modulus, k (pci)
0 to 35	Sand (Reese)	115	1,000	10,000	29	--	135
35 to 50	Sand (Reese)	125	1,100	15,000	32	--	225

1. Depth below ground surface
2. Applicable for compressive loading only. Reduce to 2/3 of values shown for uplift loading. Effective weight of shaft can be added to uplift load capacity.
3. Shafts should extend at least one diameter into the bearing stratum for end bearing to be considered.
4. Effective unit weight should be used below the water table; assumed at a depth of 35 ft below ground surface.

Additional borings should be completed along the transmission line alignment to develop design-level parameters.

PRELIMINARY EARTHWORK CONSIDERATIONS

We anticipate that earthwork for the project will include clearing and grubbing, trenching for cables and conduits, excavations for stormwater management, and cut/fill for site grading. Grading plans were not available at the time of this report, however, discussion with the client indicates significant grading (up to approximately 15 to 45 feet of fill) may be required in some areas. We anticipated little to no grading (up to about 3 feet of cut/fill) will be performed for the array areas. Once available, grading plans should be provided for our review so may provide more detailed site preparation recommendations related to excavation and fill placement, settlement monitoring, and cut/fill slope stability, where appropriate.

The earthwork described in the following sections is preliminary in nature and intended for planning general site grading in the solar array areas, access roadways, drainage, and equipment structure areas.

General

It is recommended that areas of proposed access roadway and shallow foundation structures be stripped of any topsoil, or soft/loose overburden soils containing organic matter. In access roadway, solar array and new fill areas of the site, the tilled soils/topsoil soils will create difficult access issues, particularly when the soils possess high moisture content. These materials can be modified to increase their strength and any planned approaches to improve the strength of these soils should be tested. Please note that any soil placed over topsoil will settle with time with the magnitude of the settlement being directly related to the thickness of these types of soils. Therefore, any materials consisting of topsoil, tilled soils, vegetation and organic matter should be stripped and wasted off site or could be re-spread in landscaped areas after completion of grading operations. Stripping depths between our boring locations and across the site could vary considerably. We recommend actual stripping depths be evaluated by a representative of Terracon during construction to aid in preventing removal of excess material.

Removal and/or relocation of any “to be abandoned” utilities should also be performed prior to rough site grading activities. We would anticipate removal and relocation, or re-routing, of any existing utilities that may currently exist within the footprint of the proposed development area and would interfere with new construction. Where abandoned underground pipes are located beneath any shallow foundations, they should be fully grouted if left in place. Excavations created due to utility relocations should be backfilled with engineered fill material, placed and compacted in accordance with the recommendations provided in the following paragraphs, or with lean concrete or flowable fill if lean concrete or controlled density fill (CDF) is used as backfill. The contractor should refer to all of the new build Mechanical-Electrical-Plumbing (MEP) and foundation drawings to confirm that concrete backfill materials will not conflict with any new item installations or construction.

Subgrade Preparation

As noted in **Subsurface Condition** section, mine spoil was encountered at all boring locations to the termination depth (ranging from about 21½ to 51½ feet). The mine spoil appears to have been placed during the previous coal mining activities. Support of the proposed development elements, on or above existing mine spoil soils, is discussed in this report. However, even with the recommended construction procedures, there is inherent risk for the owner that compressible fill or unsuitable material, within or buried by the mine spoil will not be discovered. This risk of unforeseen conditions cannot be eliminated without completely removing the existing mine spoil.

Existing mine spoil materials are not recommended for direct support of shallow foundations, and roadway subgrade due to their composition and non-uniform compaction. Due to the depths of the existing fill, soft compressible zones within the deep existing fill soils may not become evident until after construction has occurred due to the limited number of soil borings and the unknown specific location of the structures. Removal of mine spoil materials and replacement with engineered fill is recommended where encountered during construction of the proposed shallow foundations and support structures in addition to roadways. For foundations and support structures, once the planned grading has been completed, any areas of proposed improvements (i.e. substation improvements and any proposed buildings) located outside of the solar array footprint should be undercut a depth of 5 feet, extending 10 feet beyond the lateral limits of the planned structure area and replaced with engineered fill. If the owner elects to construct roadways above the existing mine spoil, the following protocol should be followed. Once the planned subgrade elevation has been reached the entire roadway area should be partially undercut to at least 1-foot below the design subgrade elevation and replaced with engineered fill.

The site soils could become unstable with typical earthwork and construction traffic, especially after precipitation events. The effective drainage should be completed early in the construction sequence and maintained after construction to avoid potential issues. If possible, the grading should be performed during the warmer and drier times of the year. If grading is performed during the winter months, an increased risk for possible undercutting and replacement of unstable subgrade will persist.

Following undercutting and prior to fill placement, the subgrade should be proof-rolled with an adequately loaded vehicle such as a fully-loaded tandem-axle dump truck. The proof-rolling should be performed under the direction of the Geotechnical Engineer. Areas excessively deflecting under the proof-roll should be delineated and subsequently addressed by the Geotechnical Engineer.

Grading and Fill/Cut Slopes

We understand that up to 45 feet of engineered fill may be placed in some areas. The settlement of any new fill over 10 feet of depth should be monitored to ascertain that the majority of the settlement associated with the fill placement is completed prior to commencing construction development supported by the fill. Typically, the construction may commence once the rate of settlement drops below 1/8 of an inch per week for at least 2 consecutive weeks.

A grading plan was not available for our review at the time this report was prepared. However, we understand that significant amounts of fill may be placed near existing slopes as part of efforts to reach design grade for the array areas. Typically, it is recommended that fill slopes, buildings and other structures maintain enough distance from the crest of any existing slopes to prevent crown loading of the slope due to area loads associated with the earthen fill and building structures, which could lead to slope instability. Additionally, this zone should provide adequate buffer against ground movement due to slope movement.

When placing engineered fill on existing slopes, care must be given to make sure that adequate interlock occurs between the proposed embankment and sloping foundation to minimize the risk of developing slip planes. Benching is recommended for slopes of 5H:1V or steeper. For existing or proposed cut and fill slopes, slope stability analysis should be undertaken to confirm an acceptable factor of safety of the proposed modifications once the grading plan is available for our review.

Reuse of Existing Fill Material

It is our understanding that there is a desire to reuse existing fill encountered during our geotechnical investigation as engineered fill for the project development. The existing mine spoil fill consists of apparent blasted/excavated rock (gravel- to boulder-size) with silt, clay, and sand.

The existing fill is generally considered suitable for reuse as structural fill, excluding boulders greater than or equal to 18-inches in dimension. The existing fill can be considered for use as engineered fill by selective stockpiling, and placement of materials meeting requirements in the **Fill Material Types** and **Fill Compaction Requirements** section of this report. Reuse of soil-rock fill should note the following considerations:

1. It is possible that excavation and stockpiling of existing fill would involve extensive, possibly difficult, excavation if/where boulder-sized rock is encountered.
2. Clay soils encountered within the existing fill included low-plasticity (lean) clay with variable moisture contents. While no high-plasticity (fat) clays were encountered in our borings, separation of the lean clays from any fat clays that might be encountered during earthwork activities and moisture conditioning would be required to prepare for use as engineered fill.

3. Coal fragments, where encountered in high concentrations, are not considered suitable for reuse as engineered fill and would need to be removed.
4. Separation and processing of rock will be required for use as engineered fill.
5. Rock exceeding 6-inches in dimension should not be placed in the upper 5 feet of subgrade and should be excluded from placement within zone of excavations for utilities or any below grade areas.
6. Rock exceeding about 18 inches in dimension would not be suitable for use in engineered fill and would need to be or processed to reduce size for placement as engineered fill, as discussed in the **Earthwork** section of the report.

Fill Material Types

Fill required to achieve design grade should be classified as engineered fill. Engineered fill is material used below, or within 10 feet of structures, or constructed slopes. Earthen materials used for engineered fill should meet the following material property requirements:

Soil Type [1, 2]	USCS Classification	Acceptable Parameters
Lean clay	CL (LL<40 & PI<22)	All locations and elevations
Well graded granular	SW or GW [3]	All locations and elevations
On-site soils	N/A	The on-site soils consisted of silt, clay, sand, and rock (gravel to boulder size). The soils and gravel typically appear suitable for use as fill. Any high-plasticity fat clays should not be used within the upper 2 feet of subgrade. Rock may need to be processed to meet maximum size requirements.
Soil-Rock Fill [4, 5]	N/A	Reuse of existing soil-rock fill Maximum particle size of 1½-feet Less than 50% soil fraction.

Soil Type [1, 2]	USCS Classification	Acceptable Parameters

1. Controlled, compacted fill should consist of approved materials that are free of organic matter. Frozen materials should not be used, and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to the Geotechnical Engineer for evaluation.
2. If additional sources of engineered fill are required, it is recommended that any off-site sources conform to these general recommendations.
3. Crushed limestone aggregate, limestone screenings, or granular material such as sand, gravel or crushed stone.
4. Rock within fill shall be well-graded material, comprised of durable limestone or sandstone to resist breakdown under tracking by a D-8 dozer. Shale and weathered limestone and/or sandstone should not be used. Rock fragments shall be roughly equi-dimensional in shape, and thin, slabby, or platey material will not be acceptable.
5. Classification and approval of any shot rock material should be made prior to placement to verify gradation and maximum particle size

Best practices for use of rock fill are to use durable un-weathered rock, control the rock size and gradation, limit the soil fraction (percent passing No. 4 sieve), limit the fines (percent passing the No. 200 sieve) content, modify moisture content for soil fraction, and provide drainage. The existing soil-rock mine spoil material may contain a large percentage of cobbles, boulders, and rock slabs. Larger rock slabs/boulders should be broken down into size that can be incorporated into the fill lifts.

Note that risks associated with poor performance of rock fill increase with increasing soil fraction content. The concern with increasing soil content within shot rock is that neither the rock nor the soil fraction can be tested for density. It will be important to check the moisture content of soil fraction during placement and verify soil fraction is distributed evenly throughout the soil-rock matrix.

Project stakeholders should understand and be willing to accept the risks associated with reuse of the existing soil and rock fill. Improperly graded and placed rock fill poses a risk for subsidence due to migration of fines and water into the rock or settlement due to compressible soils being buried between the rock fill.

Fill Compaction Requirements

Engineered fill should meet the following compaction requirements.

Item	Engineered fill
Maximum Lift Thickness	8 inches or less in loose thickness when heavy, self-propelled compaction equipment is used 4 to 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or dry compactor) is used
Minimum Compaction Requirements [1, 2]	98% of maximum dry density (Standard proctor)
Water Content Range [2]	Low plasticity cohesive: -2% to +3% of optimum Granular: Workable moisture levels

1. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved. The compacted subgrade should also not indicate rutting and pumping under construction traffic.
2. Specifically, moisture levels should be maintained low enough to allow for satisfactory compaction to be achieved without the cohesionless fill material pumping when proof-rolled. Soils removed which will be used as engineered fill should be protected to aid in preventing an increase in moisture content due to rain.

Earthwork efforts should be monitored under the direction of the Geotechnical Engineer or their representative. Monitoring should include documentation of adequate removal of vegetation and top soil, proof-rolling and mitigation of unstable areas delineated by the proof-roll.

Reuse of existing mine spoil, soil-rock should be observed on a full-time basis by project geotechnical engineer or their representative. Each lift should be observed by geotechnical personnel and compacted, evaluated, and reworked as necessary until approved before the next lift is placed. Each lift of compacted fill should be tested by the Geotechnical Engineer prior to placement of additional lifts.

The soil-rock fill can be placed in up to 18 to 24-inch thick horizontal layers, depending on particle size, material quality, and compaction equipment weight. The thickness of the loose lifts should not exceed 24-inches. Generally, lifts should be 6-inches thicker than the largest particle in the fill when compacted with a Caterpillar D-8 sized equipment.

The rock fill should all be placed with soil fraction evenly distributed within the fill and not isolated within pockets or layers. Soil fraction should be within about 3 percent of its optimum moisture content. For soil-rock fill having less than 25% soil fraction, a geotextile filter fabric should be placed between the shot rock and any surrounding soils or smaller diameter aggregate, to prevent soil from migrating into void space within the shot rock.

Soil-rock fill should be compacted under heavy construction equipment, such as a D-8 class Dozer and 10-ton class vibratory roller or equivalent. Soil-rock fill with more than 15% fines shall additionally include sheepsfoot roller to compact soil fraction. Each lift should be compacted with eight to ten passes of a 15 to 20-ton smooth drum vibratory roller until no yielding of the fill mass is observed. Four to five of these passes should be in a perpendicular direction. A complete pass consists of complete coverage of the surface with the tracks. Following compaction, each lift should demonstrate stable, non-yielding conditions when subjected to a proof-roll using a heavy-duty dump truck loaded to at least 20 tons. The surface should not pump, rut, and rock pieces should not shift under the equipment.

Construction Considerations

It is anticipated that excavations for the proposed construction can be accomplished with conventional earthmoving equipment. Tracked equipment should be considered in areas of the site where wet surface soil conditions are present to help reduce rutting and disturbance of the near surface soils.

Tracked equipment should be considered in areas of the site where wet surface soil conditions are present to help reduce rutting and disturbance of the near surface soils.

Particular attention should be given to the methods for subgrade drainage in consideration of the wet conditions observed on site. The gravel access road should not be recessed into the existing subgrade without methods to drain the subgrade moisture. Roads should incorporate subgrade drainage methods. Maintenance activities should be increased onsite to address the development of rutting in a timely manner. The risk of damaging the underlaying geogrid layers and/or rutting the subgrade soils is significantly increased if delays in grading and other maintenance activities result in the progression of rutting beyond the original design assumptions. More frequent maintenance will be required in areas subject to turning traffic.

We understand the construction of new gravel access roads above grade may inhibit the surface flow drainage capabilities of the site. The use of open graded aggregate on above grade portions of the gravel access roads can be considered as a means of allowing some water flow across the above grade gravel access roads. Based on our observation of roadway performance on previous phases of this project, open graded aggregate may be used in above grade portions of the gravel access roads, provided they are fractured/angular and our recommendations for subgrade drainage are implemented. The open graded aggregate will be less stable than aggregate base course, therefore additional thickness and frequency of maintenance activities should be expected. Open graded aggregates are more stable if confined, therefore exposed gravel layer edges may need to be widened to develop stability at the wheel path. Terracon has not performed any surface flow drainage analysis to determine the effect of the open graded aggregate on site drainage, nor do we guarantee that the open graded aggregate will facilitate surface drainage.

Upon completion of filling and grading, care should be taken to maintain the subgrade moisture content prior to construction of the access roads. Construction traffic over the completed subgrade should be avoided to the extent practical. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. If the subgrade should become desiccated, saturated, or disturbed, the affected material should be removed, or these materials should be scarified, moisture conditioned, and re-compacted prior to access road construction.

The individual contractors are responsible for designing and constructing stable, temporary excavations (including utility trenches) as required to maintain stability of both the excavation sides and bottom. Excavations should be sloped or shored in the interest of safety following local, and federal regulations, including current OSHA excavation and trench safety standards.

The geotechnical engineer should be retained during the construction phase of the project to observe earthwork and to perform necessary tests and observations during subgrade preparation; proof-rolling; placement and compaction of controlled compacted fills; backfilling of excavations to the completed subgrade. Some manipulation of the moisture content (such as wetting, drying) may be required during the filling operation to obtain the required degree of compaction. The manipulation of the moisture content is highly dependent on weather conditions and site drainage conditions.

Where proposed equipment structures and array areas are located, these structures should not be placed without implementation of ground improvement of the mine spoil fill to reduce potential adverse total and differential settlement response to any foundation as discussed in **Subgrade Preparation** section. Engineered fill should be placed over a stable subgrade prepared and proof-rolled as discussed above.

Utility Trench Backfill

All trench excavations should be made with sufficient working space to permit construction, including backfill placement and compaction. If utility trenches are backfilled with relatively clean granular material, they should be capped with at least 18 inches of low plasticity cohesive fill in non-access roadways areas to reduce the infiltration and conveyance of surface water through the trench backfill.

Compaction requirements for bedding and backfilling around utilities may need to be adjusted to the pipe material type and the pipe manufacturer bedding and backfill material recommendation. If utility trenches in non-access roadways areas are backfilled with relatively clean granular material, they should be capped with at least 18 inches of cohesive fill to reduce the infiltration and conveyance of surface water through the trench backfill. Granular backfill is recommended for use as backfill in utility trenches in areas beneath access roadways.

Subsurface and Surface Drainage

Since subsidence of uncontrolled mine spoils can occur when water is introduced to the soil, control of subsurface and surface water is very important. Surface grades should be directed away from any structure and pavement areas to suitable collection points (drainage swales and storm sewers) that are capable of removing the surface water from the site, so that infiltration into the mine spoils does not occur.

PRELIMINARY ACCESS ROAD RECOMMENDATIONS

Some improvement of the access roadways subgrade soils will be required. At a minimum, a shallow partial undercut and replacement with engineered fill is recommended. However even with this measure some long-term total and differential settlement should be expected. The amount and location of the long-term settlements cannot be predicted due to the heterogeneous nature of the uncontrolled fill/mine spoil materials.

On most project sites, the site grading is accomplished relatively early in the construction phase. However, as construction proceeds, excavations are made into these areas, rainfall and surface water saturates some areas, heavy construction traffic disturbs the subgrade and many surface irregularities are filled in with loose soils to improve trafficability temporarily. As a result, the roadways subgrades should be carefully evaluated as the time of construction.

We recommend the moisture content and density of the upper 12 inches of the subgrade be evaluated and the road subgrades be proof-rolled. Areas not in compliance with the required ranges of moisture or density should be moisture conditioned and recompacted. Particular attention should be paid to anticipated high traffic areas and to areas where backfilled trenches are located. Areas where unsuitable conditions are located should be repaired by removing and replacing the materials with properly compacted fills.

After proof-rolling and repairing subgrade deficiencies, the entire subgrade should be scarified and compacted as recommended in **Earthwork** section to provide a uniform subgrade for gravel road construction. Areas that appear severely desiccated following site stripping may require further undercutting and moisture conditioning. If a significant precipitation event occurs after the evaluation or if the surface becomes disturbed, the subgrade should be reviewed by qualified personnel immediately prior to application of the gravel surfacing. The subgrade should be in its finished form at the time of final review.

We understand that the proposed gravel access road will be primarily used by light duty maintenance vehicles. We recommend the proposed gravel access roads should have minimum 6-inch-thick aggregate base course with geotextile over the final prepared subgrade.

DESIGN-LEVEL STUDY GEOTECHNICAL ENGINEERING SERVICES

The following table presents recommendations for exploration and testing for the design-level phase of this project.

Exploration Type	Number of Locations	Depth / Spacing / Length (feet)	Planned Location
InSAR	Overall Site	N/A	Overall Site
Geophysical Seismic	10	300 to 600	Overall Site
Geophysical ERI	10	300 to 600	Overall Site
SPT Borings	9	20 or refusal [1]	Array
	14	50 or refusal [1, 2, 3]	
	2 [4]	50 bgs or refusal [1]	Substation
	7	30 bgs or refusal [1, 5]	T-Line ROW
Axial (Uplift) Pile Load Testing	16	5 to 8	Array
Axial (Compression) Pile Load Testing	8	5 to 8	Array
Lateral Pile Load Testing	16	5 to 8	Array
CBR	3	0 to 2 bgs	Roadway
Thermal Resistivity Testing [6]	7	0 to 5	Array
	1		Substation
Corrosion Suite	14	0 to 5	Array
	1		Substation
In Situ Resistivity Test Location	14	1, 2, 4, 8, 15, 25, 50, 75, 100, 150, and 200	Array
	1	1, 2, 4, 8, 15, 25, 50, 75, 100, 150, 200, 300, and 400	Substation

1. Whichever is shallower
2. Select borings may be extended beyond auger refusal to explore refusal conditions at the discretion of the geotechnical engineer.
3. If feasible and appropriate, consideration may be given to extending a portion of these borings through mine spoil fill to bedrock
4. An additional 3 to 5 borings may be considered for the substation, depending on its size and proposed improvements
5. Minimum 10 feet of rock core to be performed at T-Line locations if auger refusal encountered above planned termination depth
6. Dryout curves (Remolded 85%; and an undisturbed sample)

GENERAL COMMENTS

Terracon should be consulted to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the project design and specifications. Terracon should also be retained to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

The analyses and recommendations presented in this report are based upon the data obtained from the explorations performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between exploration locations, across the site, or may be caused due to the modifying effects of construction or weather. Bear in mind that the nature and extent of such variations may not become evident until construction has started or until construction activities have ceased. If variations do appear, Terracon should be notified immediately so that further evaluation and supplemental recommendations can be provided. The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, and bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or hazardous conditions. If the owner is concerned about the potential for such contamination or pollution, please advise so that additional studies may be undertaken.

Moderate to high plasticity clay soils were encountered in some of the borings drilled at the site. These soils have the potential for volume change (shrink-swell potential) due to fluctuation in soil moisture conditions. This report provides recommendations to help mitigate the effects of shrinkage and swell. However, even if these procedures are followed, some movement and cracking in the structures and pavements should be anticipated. The severity of cracking and other damage, such as uneven floor slabs may increase if any modification of the site results in excessive wetting or drying of the shrink/swell prone soils.

This report has been prepared for the exclusive use of our client for specific application to the project and site discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either expressed or implied, are intended or made. Site safety, excavation support and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes, and then either verifies or modifies the conclusions of this report in writing.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Field Exploration

Number of Borings	Boring Depth (feet)	Planned Location
9	21½ to 51½	Array Area
1	51	Substation Area

Boring Layout: The boring locations are shown on the **Exploration Plan**, and the coordinates were obtained with a handheld GPS unit (estimated horizontal accuracy of about ±10 feet).

Subsurface Exploration Procedures: We advanced the borings with an ATV-mounted rotary drill rig using continuous flight augers (solid stem and rotary wash methods, as necessary). In the thin-walled tube sampling procedure, a thin-walled, seamless steel tube with a sharp cutting edge was pushed hydraulically into the soil to obtain a relatively undisturbed sample. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. We observed and recorded groundwater levels during drilling and sampling. For safety purposes and in accordance with Kentucky State Regulations, Borings were backfilled with auger cuttings after their completion.

The sampling depths, hand penetrometer readings, penetration distances, and other sampling information was recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials encountered during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Electrical Earth Resistivity Testing: Electrical resistivity testing was performed using the 4-point Wenner array method at 10 locations; 9 in the array areas and 1 in the substation area. Two perpendicular survey testing lines generally in the ordinate compass directions. The maximum "A" spacing was 200 feet was performed in the array areas. The maximum "A" spacing in the substation area was 400 feet.

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests to understand the engineering properties of the various soil strata, as necessary, for this project. The laboratory testing for this project included the following:

- Water content
- Atterberg limits
- Grain size analysis

Based on the material's texture and plasticity, we described and classified the soil samples in accordance with the Unified Soil Classification System.

Corrosivity Testing: Samples of the near surface soils (9 from PV array areas and 1 from the substation area) were tested in the laboratory for the following properties:

- pH analysis
- Chloride, sulfate, sulfide content
- Oxidation-reduction potential
- Electrical resistivity testing
- Total salts

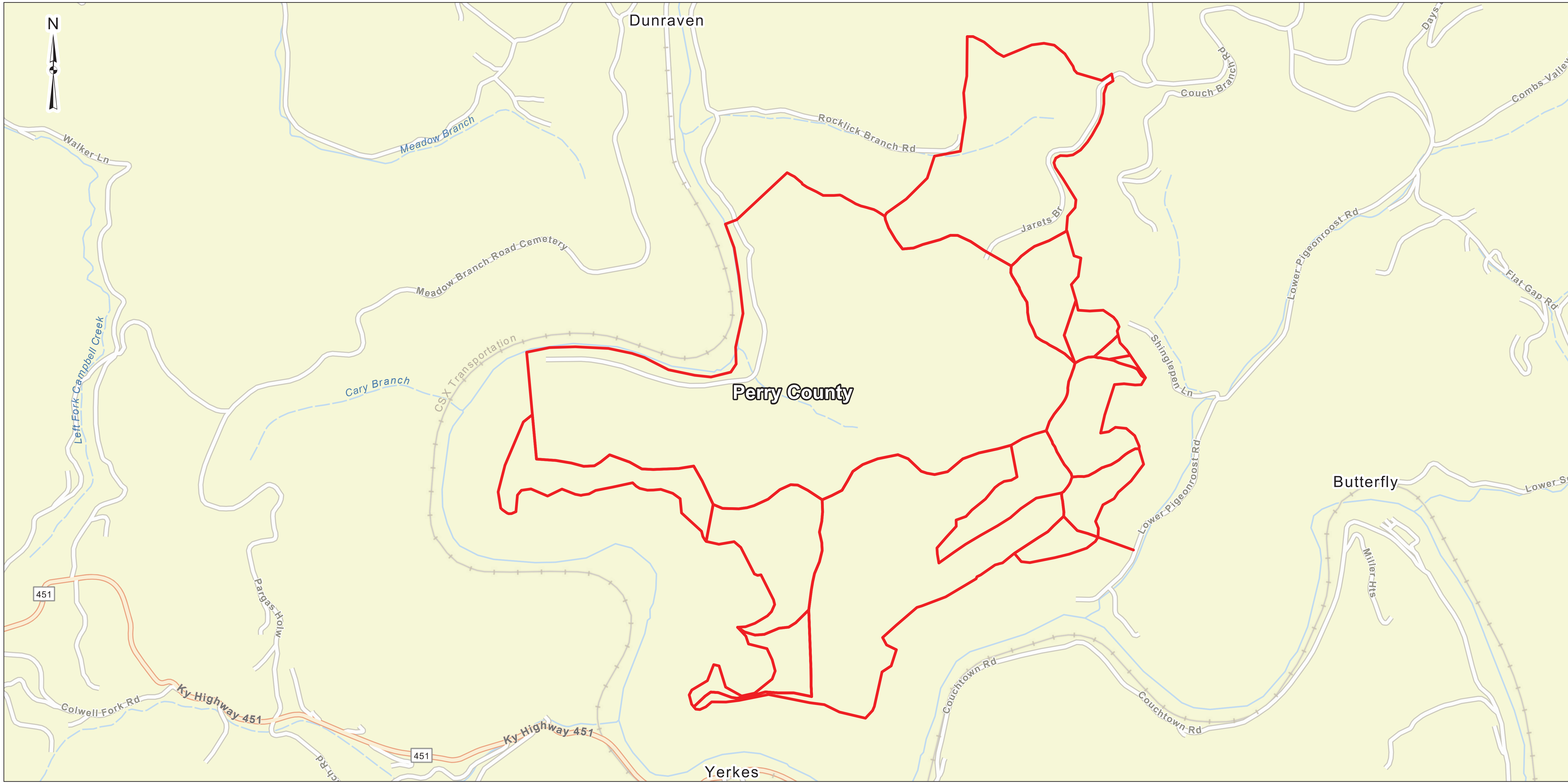
These results are presented in **Corrosivity** as well as in **Exploration Results**.

Laboratory Thermal Resistivity Testing: Thermal resistivity tests were performed on samples from 4 locations across the array areas and 1 location within the substation. At each test location, Terracon collected 1 bulk sample from the upper 5 feet. Each bulk sample was tested for thermal resistivity tests on samples remolded to 85 percent of the material's maximum dry density as determined by the standard Proctor and at the material's natural water content. Results of the thermal resistivity testing are presented in **Exploration Results**.

SITE LOCATION AND EXPLORATION PLANS

Contents:

Note: All attachments are one page unless noted above.



Project Site

DATA SOURCES:
ESRI WMS - Streets
Site Boundary: Bright Mountain lease area with adjoining areas.kmz

Feet
0 650 1,300 2,600

Project No.:	N3225022
Date:	Jul 2022
Drawn By:	PJS
Reviewed By:	SGG

Terracon
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Lexington, KY
PH. 859-303-9000 terracon.com

Site Location

Bright Mountain Solar
Aurora Solar LLC
Perry County, KY

Exhibit

1

Project Site

DATA SOURCES:
ESRI WMS - World Aerial Imagery, OpenStreetMap
Site Boundary: Bright Mountain lease area with adjoining areas.kmz

Feet
0 650 1,300 2,600

Project No.: N3225022
Date: Jul 2022
Drawn By: PJS
Reviewed By: SGG

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Aerial Imagery

Bright Mountain Solar
Aurora Solar LLC
Perry County, KY

Exhibit

2

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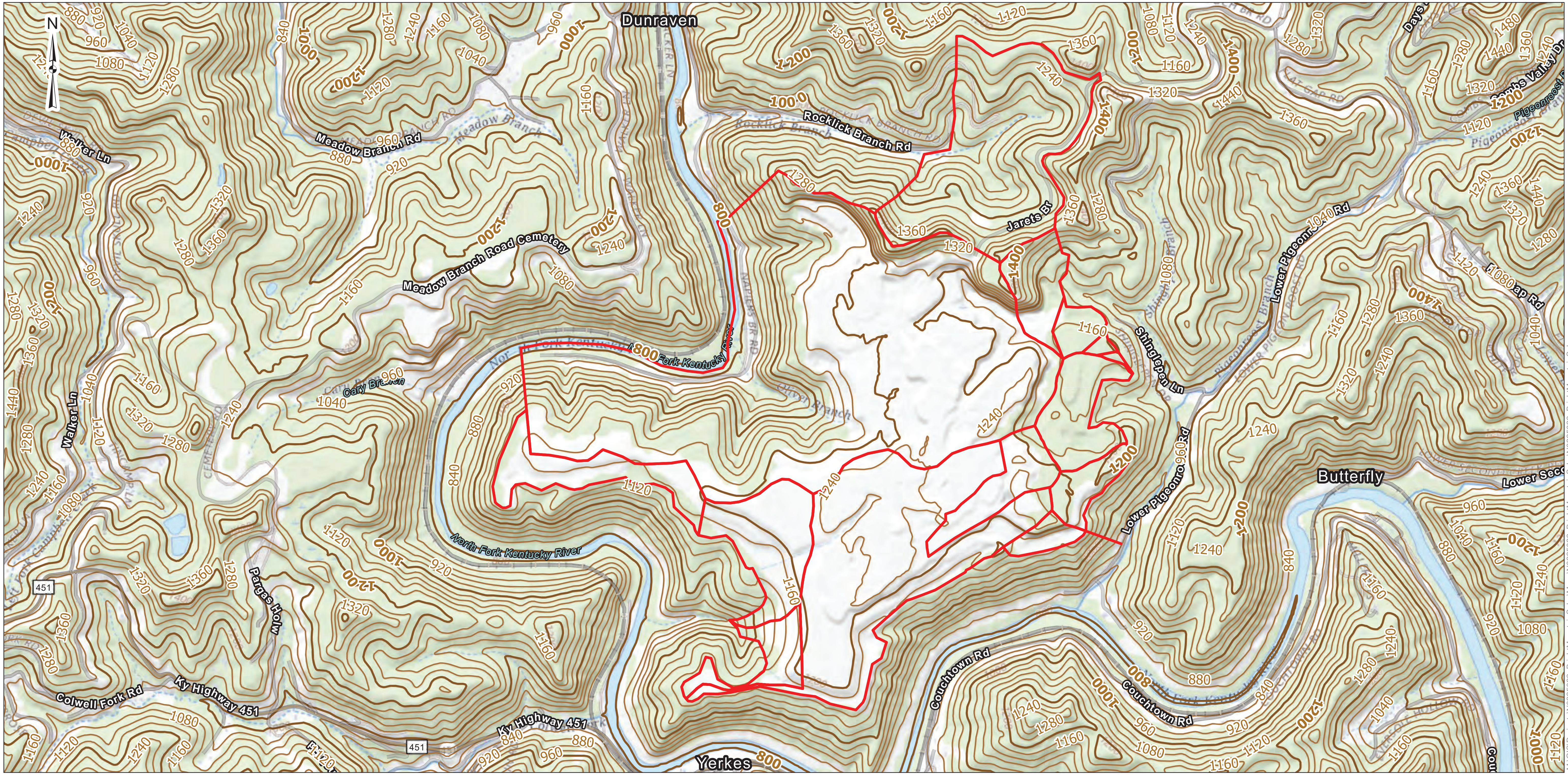

- Project Site
- Intermediate Elevation Contour (40 ft)
- Index Elevation Contour (200 ft)

DATA SOURCES:
ESRI WMS - USGS Topographic Map, OpenStreetMap
Site Boundary: Bright Mountain lease area with adjoining areas.kmz

Feet
0 650 1,300 2,600

Project No.:	N3225022
Date:	Jul 2022
Drawn By:	PJS
Reviewed By:	SGG

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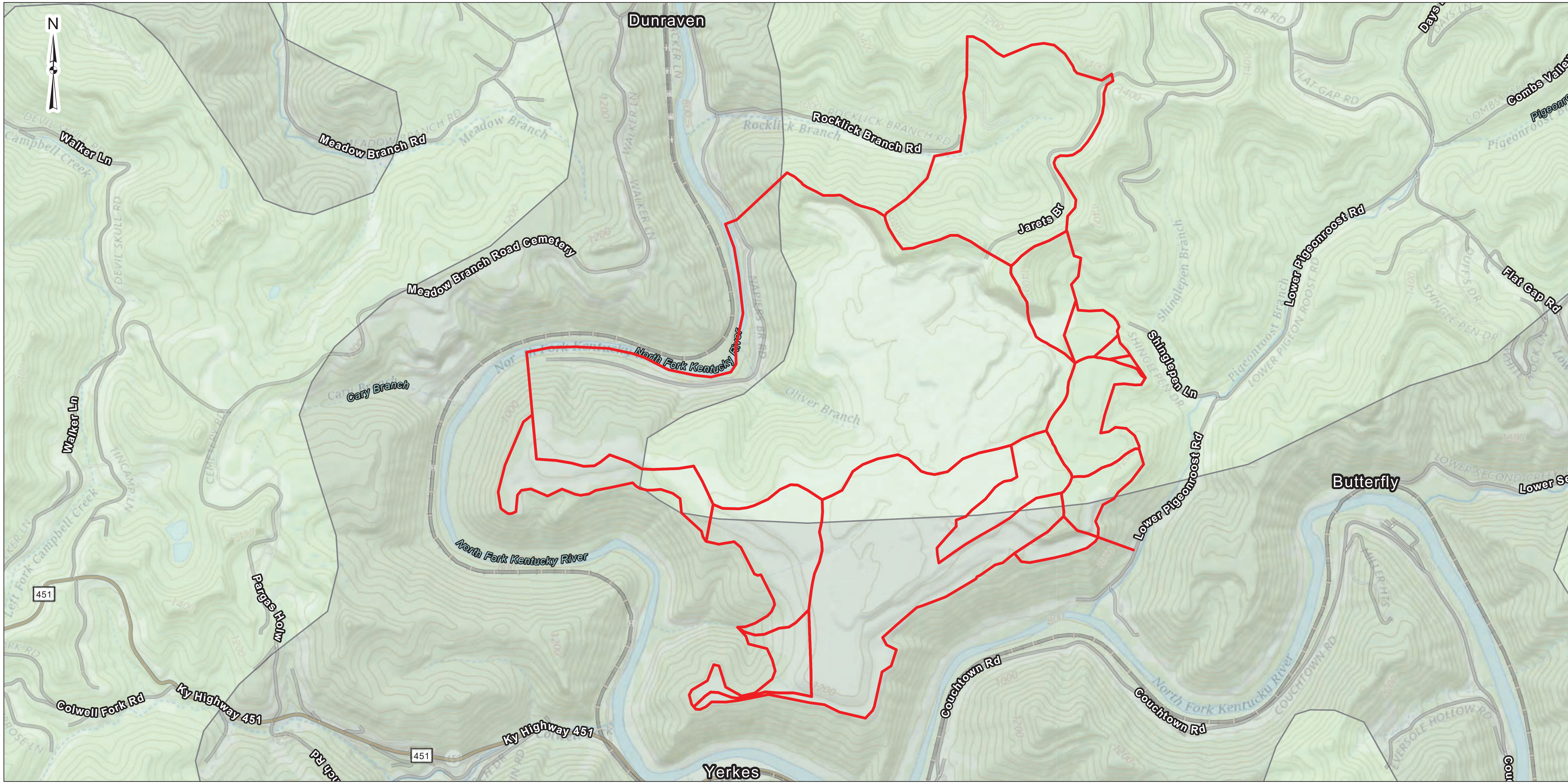
Topographic Overview

Bright Mountain Solar
Aurora Solar LLC
Perry County, KY

Exhibit

3



Project Site

USGS Geology

sandstone

shale

DATA SOURCES:
ESRI WMS - Topographic
USGS - Topographic Basemap, Geology
Site Boundary: Bright Mountain lease area with adjoining areas.kmz

Feet
0 650 1,300 2,600

Project No.:	N3225022
Date:	Jul 2022
Drawn By:	PJS
Reviewed By:	SGG

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Geologic Map

Bright Mountain Solar
Aurora Solar LLC
Perry County, KY

Exhibit

4

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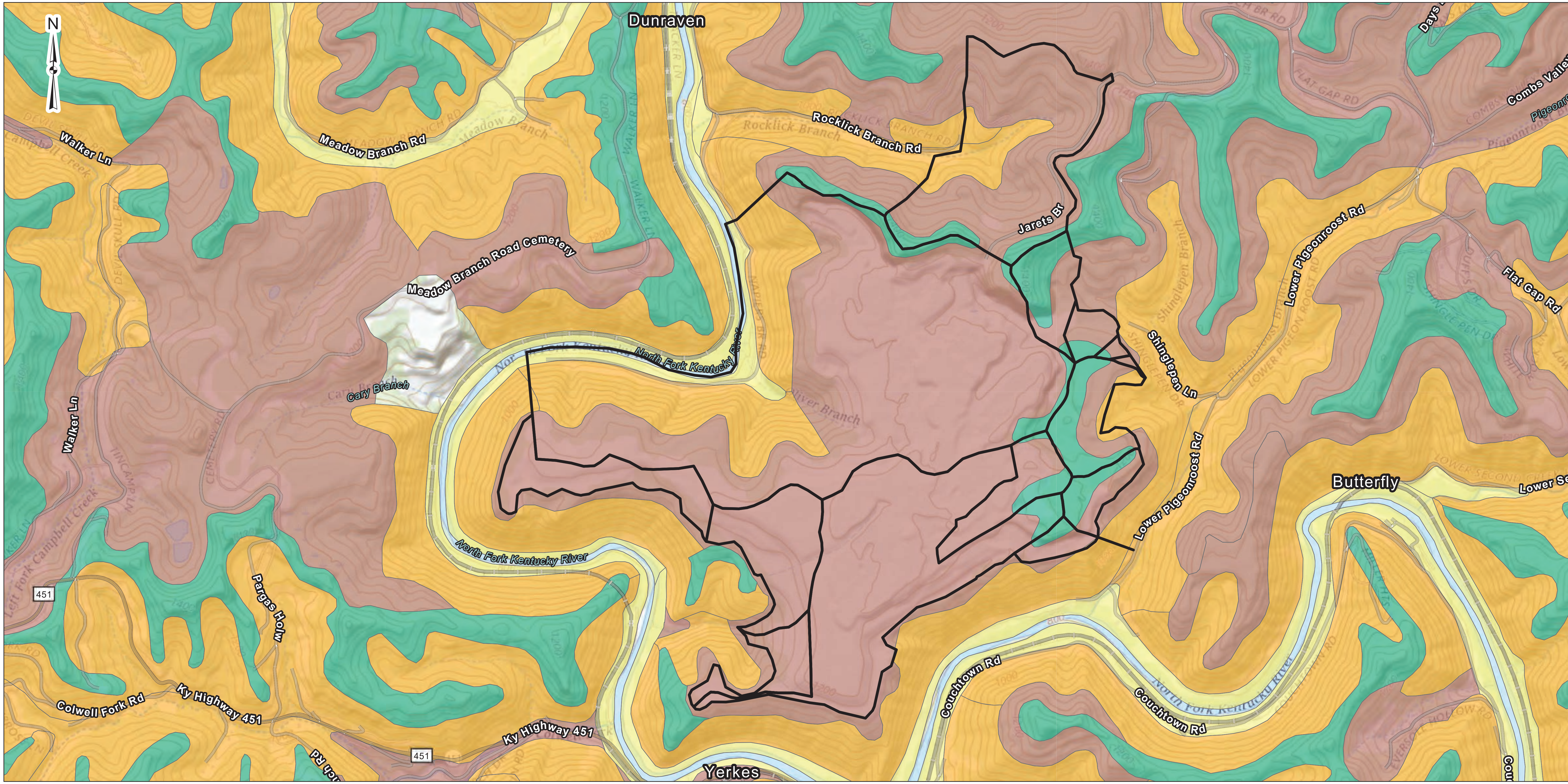

— Project Site

Soil Parent Materials

- Alluvium
- Colluvium
- Residuum
- Mine spoil or earthy fill

DATA SOURCES:
ESRI WMS - Topographic
USGS - Topographic Basemap
NRCS - USCS Soil Classifications
Site Boundary: Bright Mountain lease area with adjoining areas.kmz

Feet
0 650 1,300 2,600

Project No.:	N3225022
Date:	Jul 2022
Drawn By:	PJS
Reviewed By:	SGG

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USDA Soil Map Unit Names

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Perry County, KY

Exhibit

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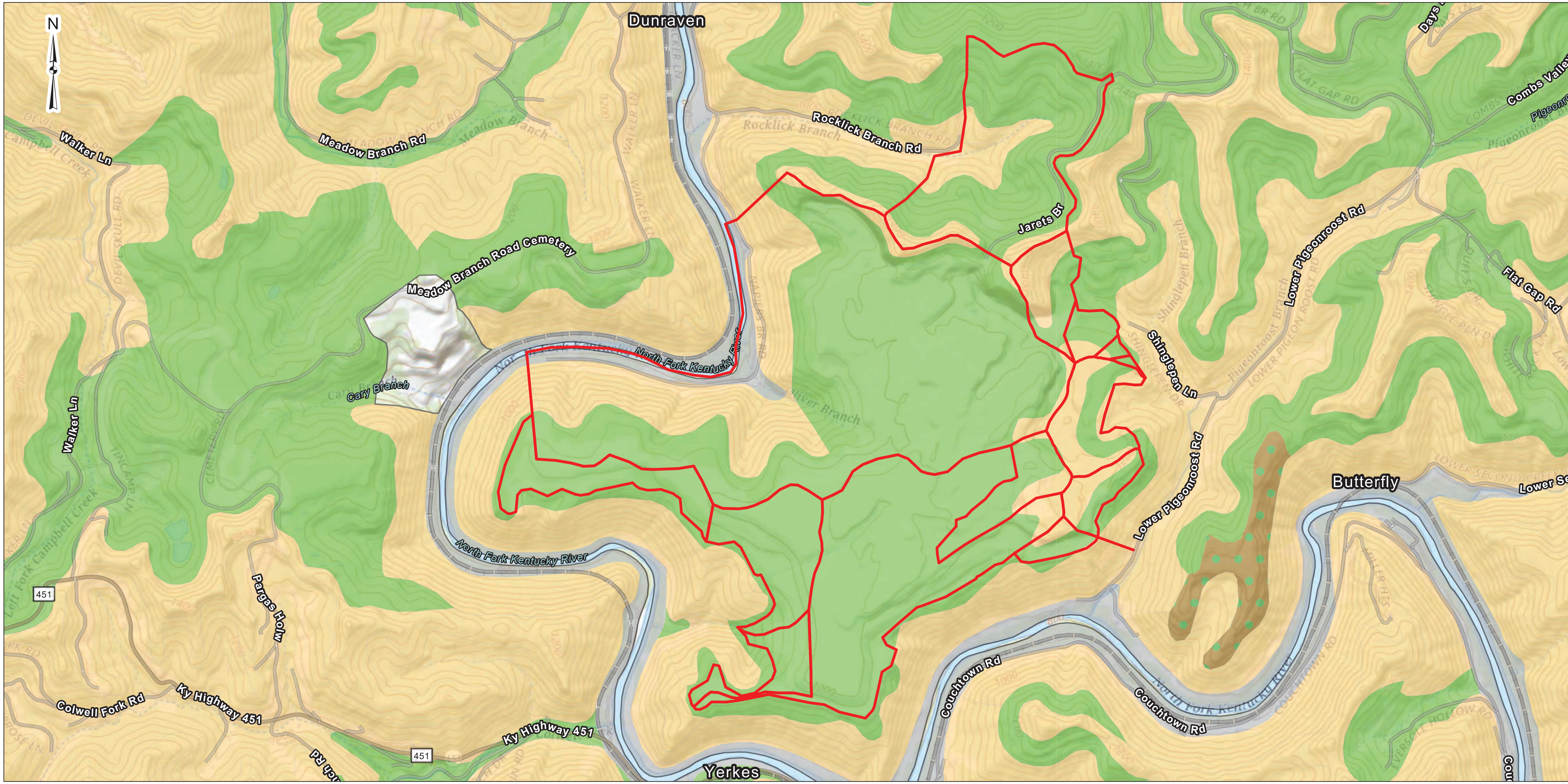

Project Site

USCS Soil Classification

- CL: Clay of Low Plasticity, Lean Clay
- GC: Clayey Gravel
- ML: Silt
- PT: Peat
- Null

DATA SOURCES:
ESRI WMS - Topographic
USGS - Topographic Basemap
NRCS - USCS Soil Classifications
Site Boundary: Bright Mountain lease area with adjoining areas.kmz

Feet
0 650 1,300 2,600

Project No.:	N3225022
Date:	Jul 2022
Drawn By:	PJS
Reviewed By:	SGG

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USCS Soil Classifications

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Perry County, KY

Exhibit

6

Project Site

Flood Hazard Zones

1% Annual Chance Flood Hazard

DATA SOURCES:
ESRI WMS - Topographic
USGS - Topographic Basemap
FEMA - National Flood Hazard Layer
Site Boundary: Bright Mountain lease area with adjoining areas.kmz

Feet
0 650 1,300 2,600

Project No.:	N3225022
Date:	Jul 2022
Drawn By:	PJS
Reviewed By:	SGG

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FEMA Flood Zones

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Aurora Solar LLC
Perry County, KY

Exhibit

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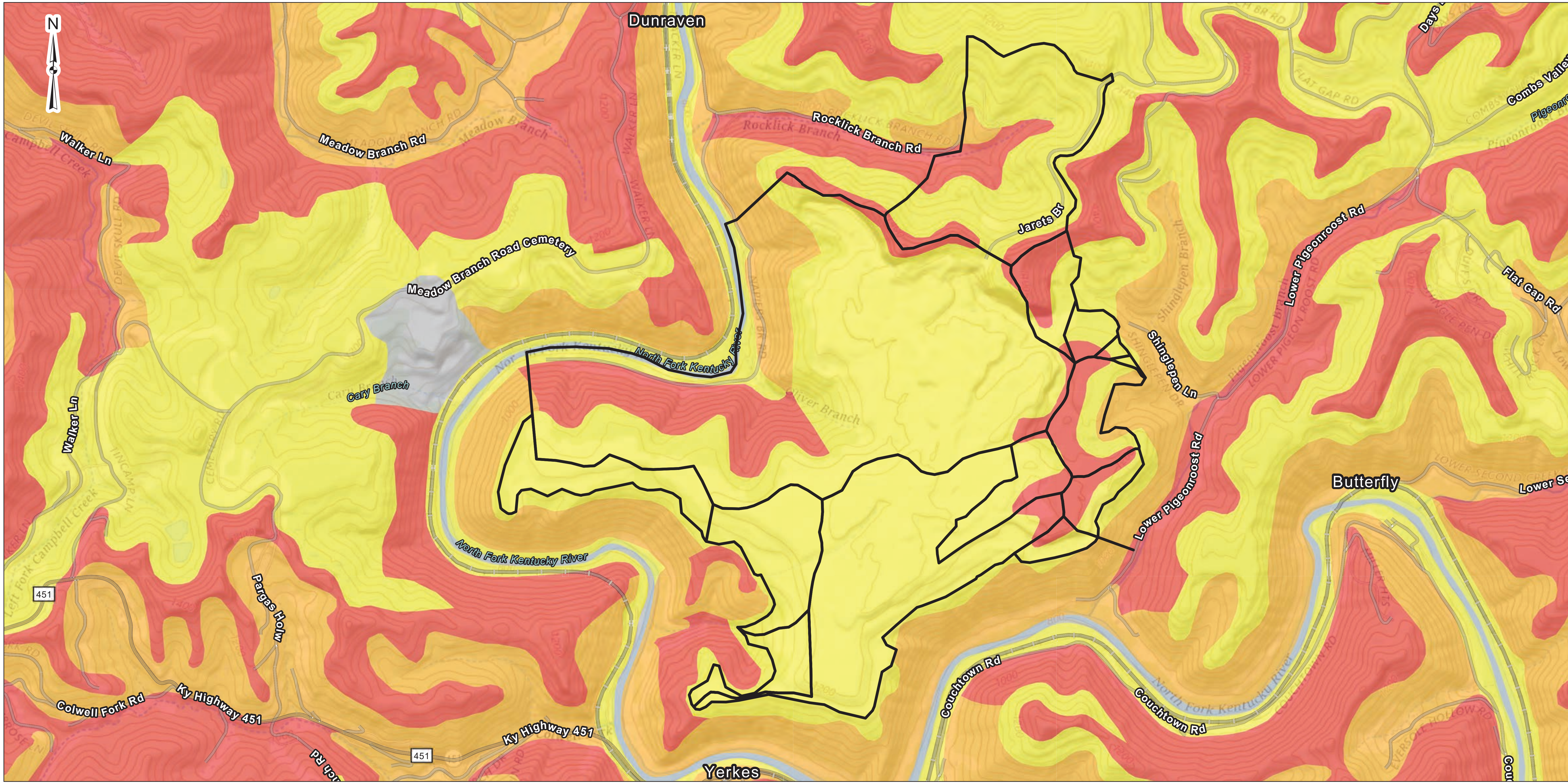

— Project Site

Corrosion of Concrete

- High
- Moderate
- Low
- Null

DATA SOURCES:
ESRI WMS - Topographic
NRCS - Corrosion of Concrete
Site Boundary: Bright Mountain lease area with adjoining areas.kmz

Feet
0 650 1,300 2,600

Project No.:	N3225022
Date:	Jul 2022
Drawn By:	PJS
Reviewed By:	SGG

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Concrete Corrosion Risk

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Aurora Solar LLC
Perry County, KY

Exhibit
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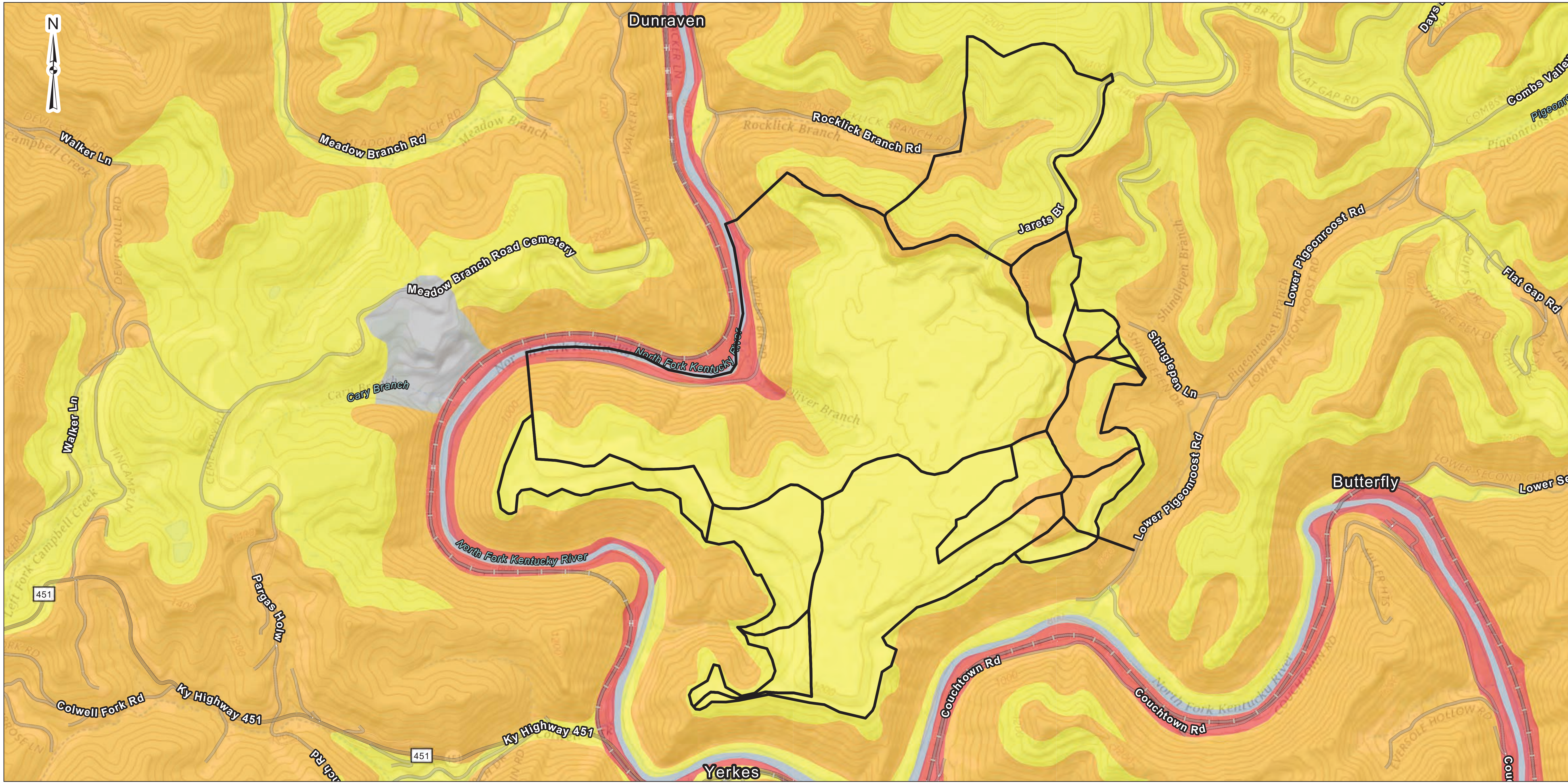

— Project Site

Corrosion of Steel

- High
- Moderate
- Low
- Null

DATA SOURCES:
ESRI WMS - Topographic
NRCS - Corrosion of Steel
Site Boundary: Bright Mountain lease area with adjoining areas.kmz

Feet
0 650 1,300 2,600

Project No.: N3225022
Date: Jul 2022
Drawn By: PJS
Reviewed By: SGG

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Steel Corrosion Risk

Bright Mountain Solar
Aurora Solar LLC
Perry County, KY

Exhibit

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Project Site

Minimum Depth to Bedrock

2 to 3 feet

No Bedrock Identified

DATA SOURCES:
ESRI WMS - Topographic
USGS - Topographic Basemap
NRCS - Depth to Bedrock
Site Boundary: Bright Mountain lease area with adjoining areas.kmz

Feet
0 650 1,300 2,600

Project No.:	N3225022
Date:	Jul 2022
Drawn By:	PJS
Reviewed By:	SGG

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Depth to Bedrock

Bright Mountain Solar
Aurora Solar LLC
Perry County, KY

Exhibit

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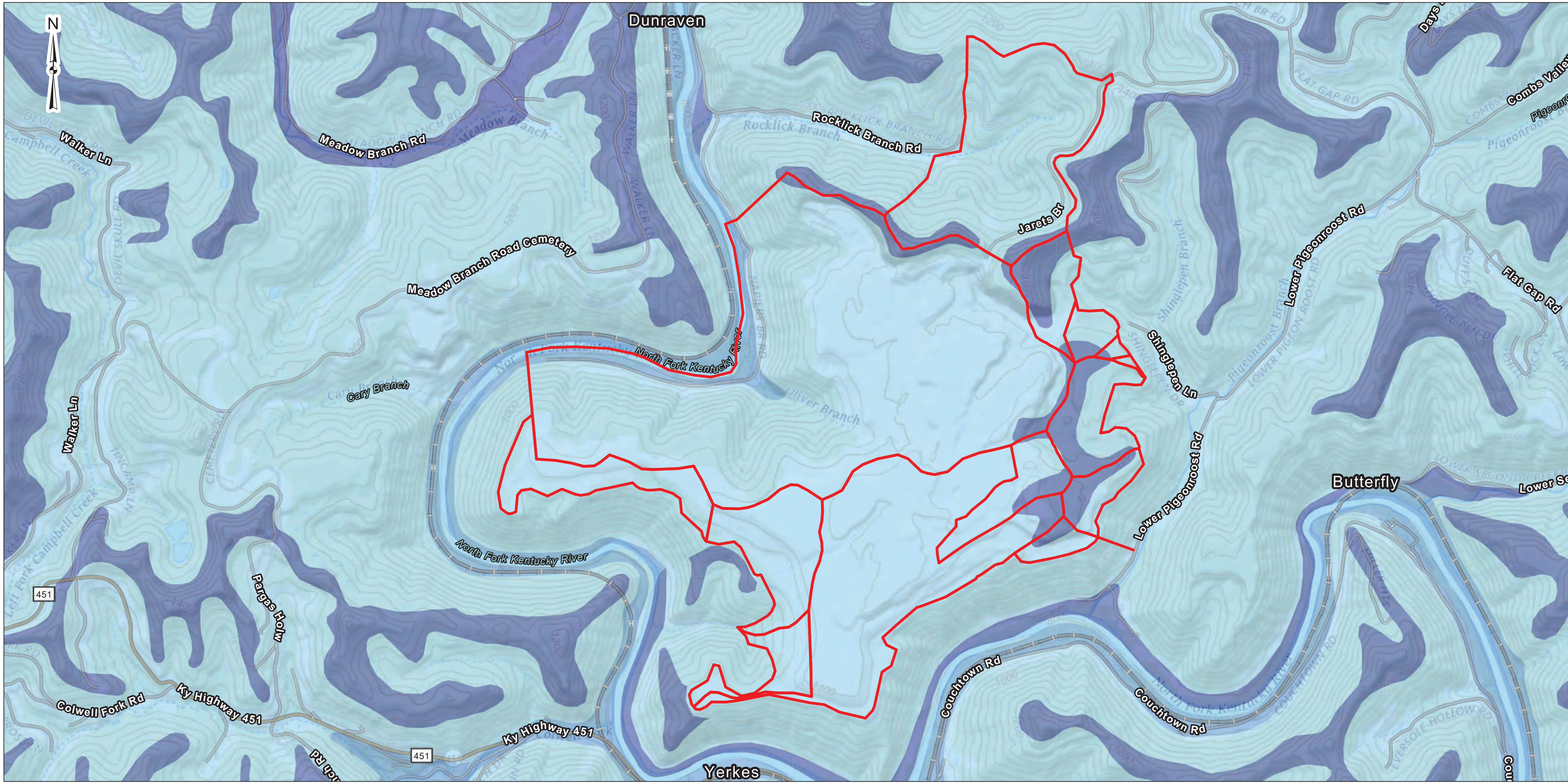

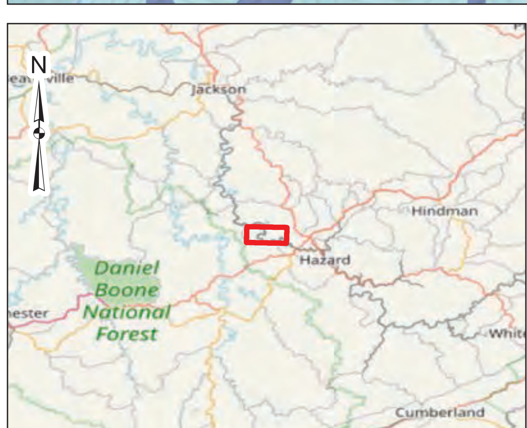

Project Site

Depth to Water

- Less than 1 ft
- 1 ft - 2 ft
- 4 ft - 5 ft
- 6 ft - 7 ft

DATA SOURCES:
ESRI WMS - Topographic
USGS - Topographic Basemap
NRCS - Depth to Groundwater
Site Boundary: Bright Mountain lease area with adjoining areas.kmz

Feet
0 650 1,300 2,600

Project No.:	N3225022
Date:	Jul 2022
Drawn By:	PJS
Reviewed By:	SGG

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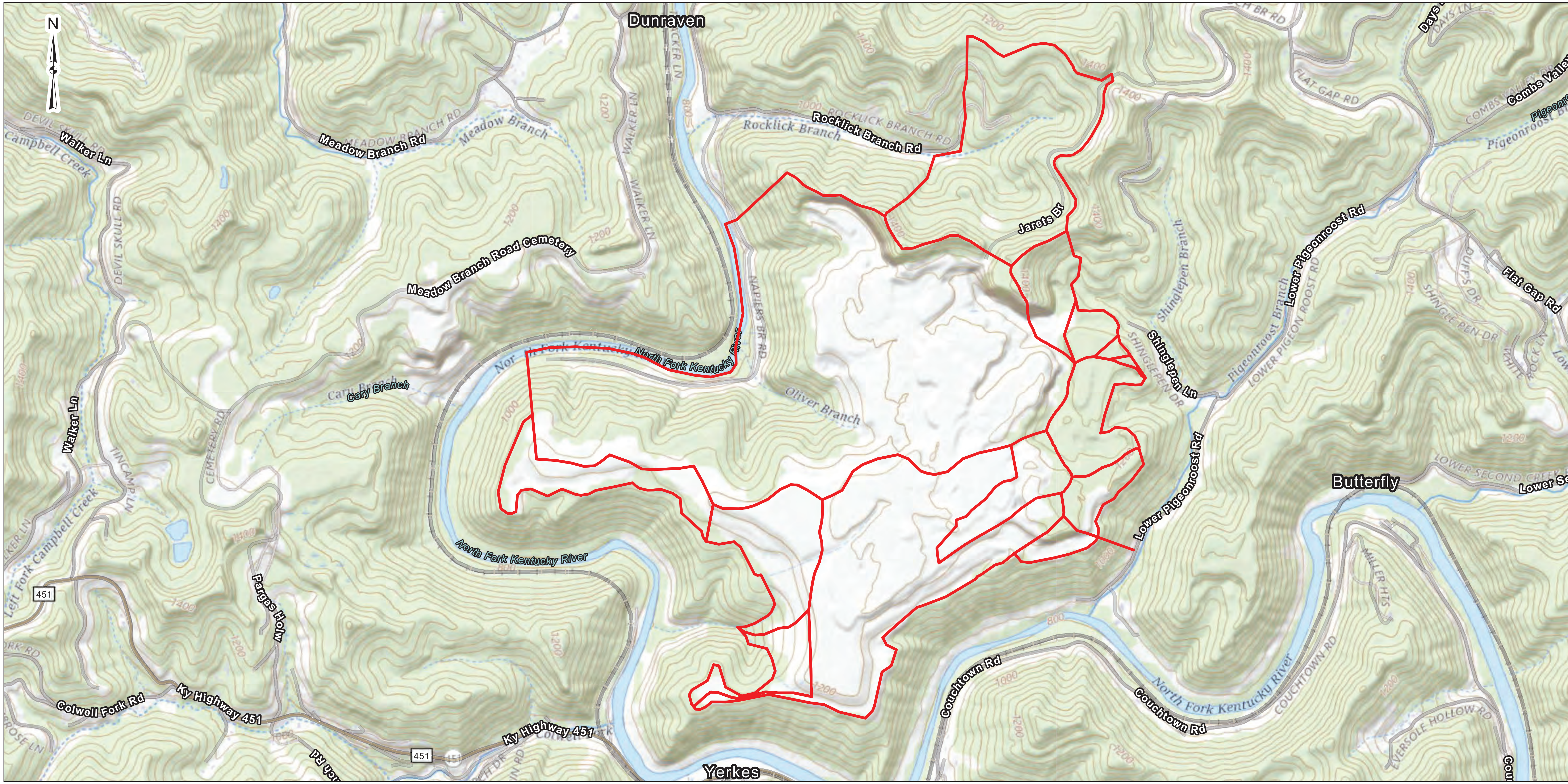
Depth to Groundwater

Bright Mountain Solar
Aurora Solar LLC
Perry County, KY

Exhibit
11



Project Site

No karst hazards in map area.

DATA SOURCES:
ESRI WMS - Topographic
USGS - Topographic Basemap, Karst
Site Boundary: Bright Mountain lease area with adjoining areas.kmz

Feet
0 650 1,300 2,600

Project No.:	N3225022
Date:	Jul 2022
Drawn By:	PJS
Reviewed By:	SGG

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Karst Hazards

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Aurora Solar LLC
Perry County, KY

Exhibit

12

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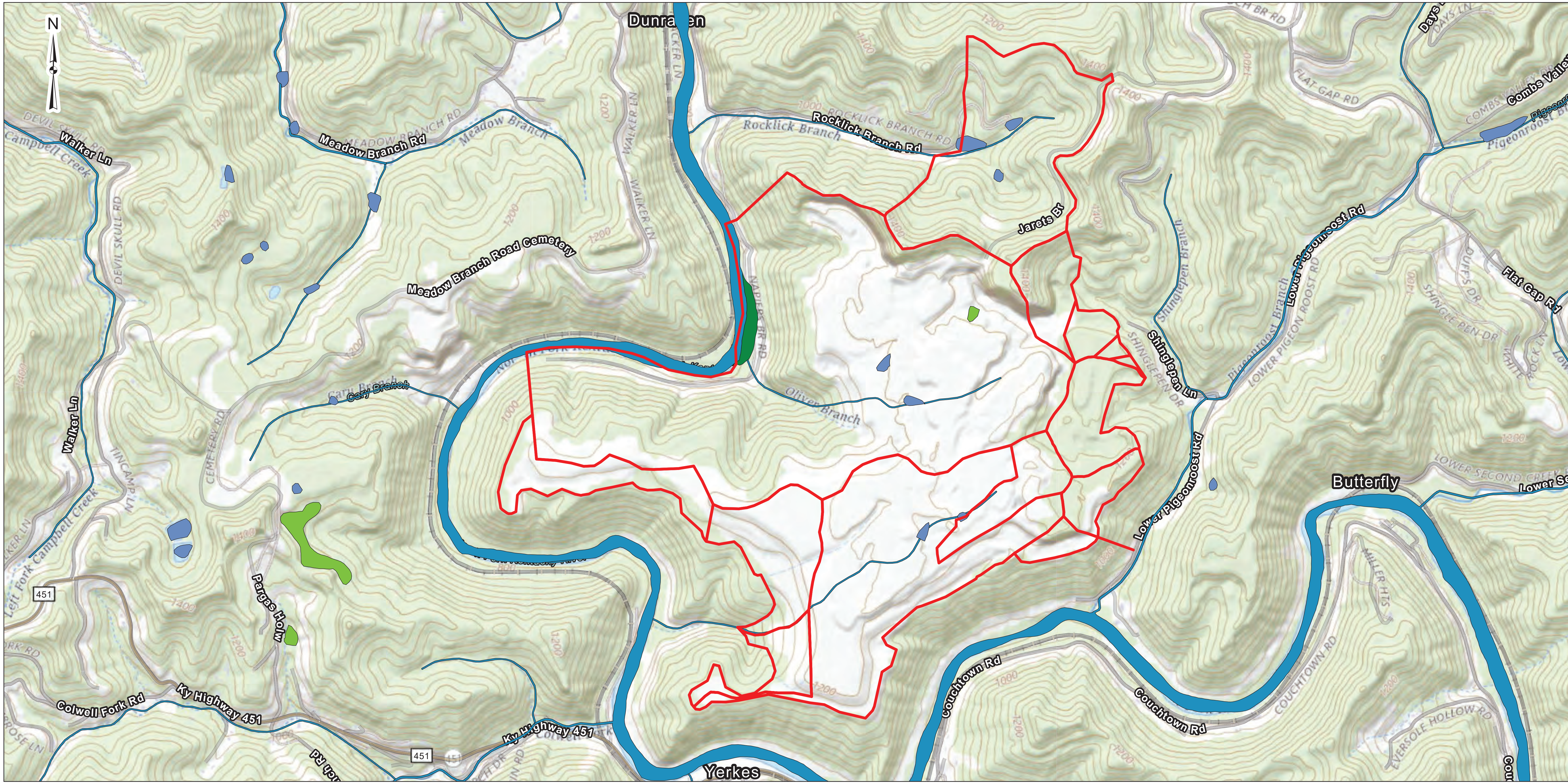

- Project Site

Wetlands

- Estuarine and Marine Deepwater
- Estuarine and Marine Wetland
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Lake
- Other
- Riverine

DATA SOURCES:
ESRI WMS - USGS Topographic Map, OpenStreetMap
USFWS - National Wetlands Inventory
Site Boundary: Bright Mountain lease area with adjoining areas.kmz

Feet
0 650 1,300 2,600

Project No.:	N3225022
Date:	Jul 2022
Drawn By:	PJS
Reviewed By:	SGG

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NWI Wetland Classification

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Perry County, KY

Exhibit

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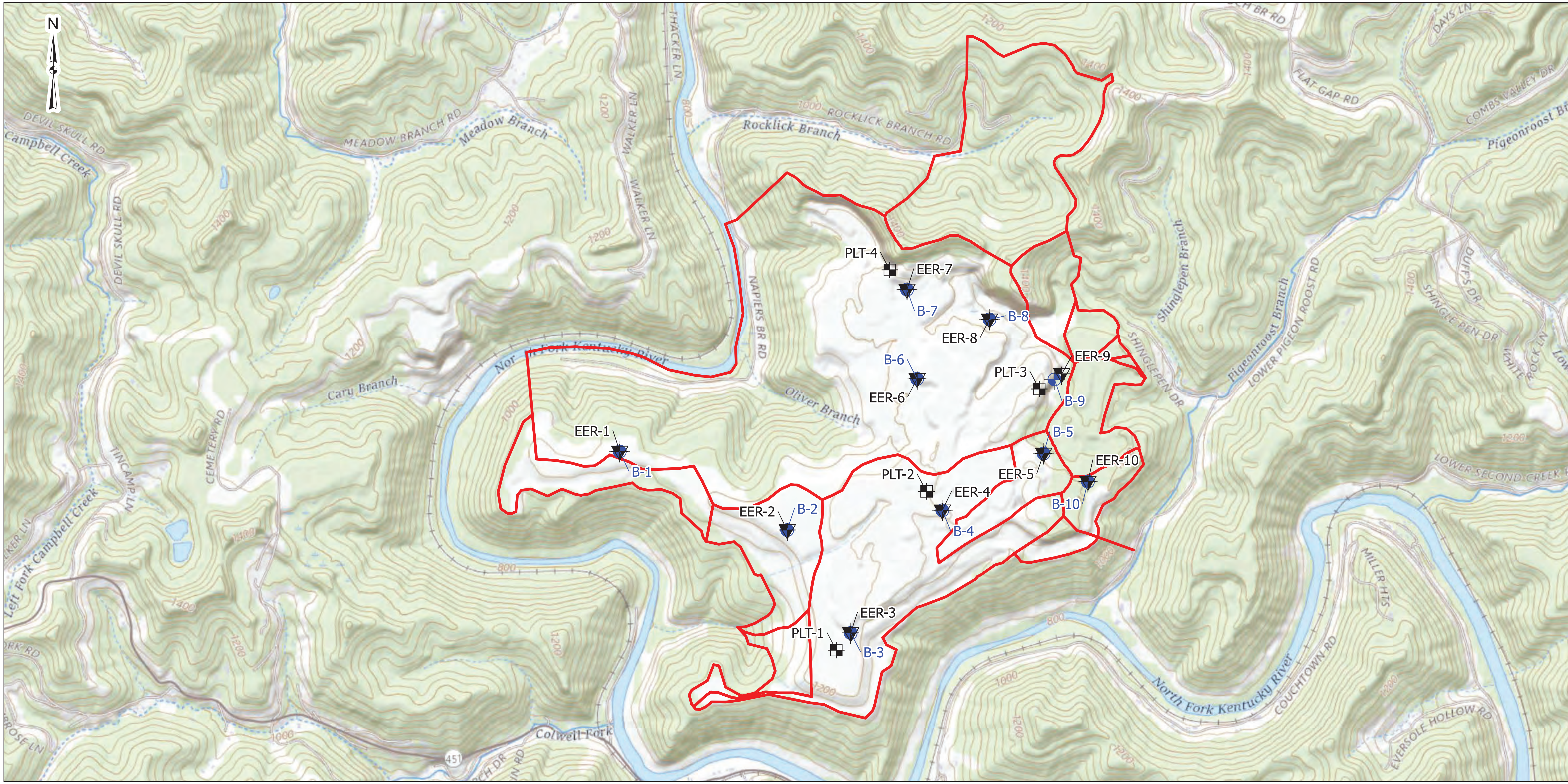

- Project Site
- Resistivity Line Location
- PLT Location
- Boring Location

DATA SOURCES:
ESRI WMS - Streets, Topographic
Site Boundary: Bright Mountain lease area with adjoining areas.kmz

Feet
0 650 1,300 2,600

Project No.:	N3225022
Date:	Jul 2022
Drawn By:	PJS
Reviewed By:	SGG

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Exploration Plan

Bright Mountain Solar
Aurora Solar LLC
Perry County, KY

Exhibit

14

EXPLORATION RESULTS

Contents:

Note: All attachments are one page unless noted above.

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

Bright Mountain Solar ■ Hazard, KY

Terracon Project No. N3225022

SAMPLING	WATER LEVEL	FIELD TESTS
Grab Sample; Split Spoon	Water Initially Encountered Water Level After a Specified Period of Time Water Level After a Specified Period of Time Cave In Encountered Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.	**N** Standard Penetration Test Resistance (Blows/Ft.) **(HP)** Hand Penetrometer **(T)** Torvane **(DCP)** Dynamic Cone Penetrometer **UC** Unconfined Compressive Strength **(PID)** Photo-Ionization Detector **(OVA)** Organic Vapor Analyzer

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

LOCATION AND ELEVATION NOTES

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength Qu, (tsf)**	**Standard Penetration or N-Value Blows/Ft.**
Very Loose	0 - 3	Very Soft	less than 0.25	0 - 1
Loose	4 - 9	Soft	0.25 to 0.50	2 - 4
Medium Dense	10 - 29	Medium Stiff	0.50 to 1.00	4 - 8
Dense	30 - 50	Stiff	1.00 to 2.00	8 - 15
Very Dense	> 50	Very Stiff	2.00 to 4.00	15 - 30
		Hard	> 4.00	> 30

RELEVANCE OF SOIL BORING LOG

The soil boring logs contained within this document are intended for application to the project as described in this document. Use of these soil boring logs for any other purpose may not be appropriate.

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification	
				Group Symbol	**Group Name** [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	Cu ≥ 4 and 1 ≤ Cc ≤ 3 [E]	GW	Well-graded gravel [F]
			Cu < 4 and/or [Cc<1 or Cc>3.0] [E]	GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel [F, G, H]
			Fines classify as CL or CH	GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	Cu ≥ 6 and 1 ≤ Cc ≤ 3 [E]	SW	Well-graded sand [I]
			Cu < 6 and/or [Cc<1 or Cc>3.0] [E]	SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand [G, H, I]
			Fines classify as CL or CH	SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above “A”	CL	Lean clay [K, L, M]
			PI < 4 or plots below “A” line [J]	ML	Silt [K, L, M]
		Organic:	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay [K, L, M, N]
					Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above “A” line	CH	Fat clay [K, L, M]
			PI plots below “A” line	MH	Elastic Silt [K, L, M]
		Organic:	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OH	Organic clay [K, L, M, P]
					Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add “with cobbles or boulders, or both” to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add “with sand” to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add “with organic fines” to group name.

[I] If soil contains ≥ 15% gravel, add “with gravel” to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add “with sand” or “with gravel,” whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add “sandy” to group name.

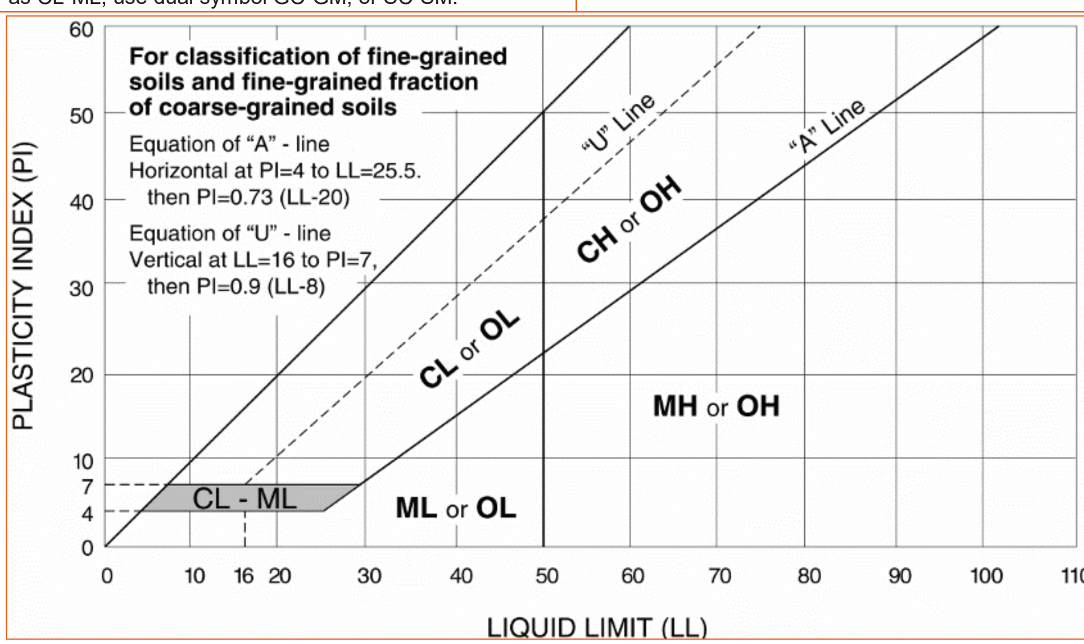
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add “gravelly” to group name.

[N] PI ≥ 4 and plots on or above “A” line.

[O] PI < 4 or plots below “A” line.

[P] PI plots on or above “A” line.

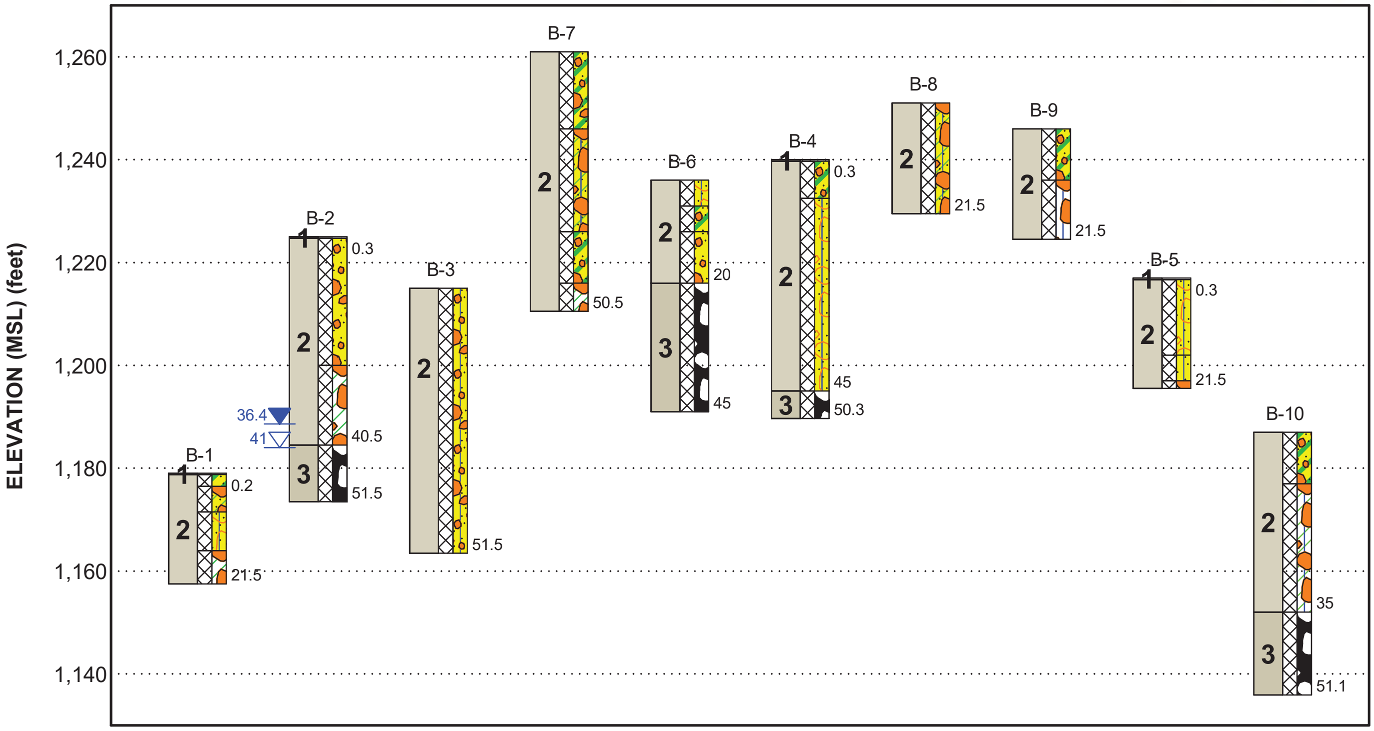
[Q] PI plots below “A” line.



GEOMODEL

Bright Mountain Solar ■ Hazard, KY
Terracon Project No. N3225022

Terracon GeoReport



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description
1	**Surficial**	Topsoil
2	**Existing Soil Fill**	Generally, silty and clayey sand and gravel to cobble-sized rock
3	**Existing Boulder Fill**	Generally, silty and clayey cobble to boulder-sized rock

LEGEND

- Topsoil
- Silty Gravel with Sand
- Boulders and Cobbles
- Silty Sand
- Silty Gravel
- Clayey Sand
- Clayey Gravel
- Silty Sand with Gravel
- Silty Clayey Gravel with Sand
- Silty Clayey Gravel
- Clayey Gravel with Sand
- Poorly-graded Sand with Gravel
- Clayey Sand with Gravel
- Poorly-graded Gravel with Clay

▽ First Water Observation

▼ Third Water Observation

Groundwater levels are temporal. The levels shown are representative of the date and time of our exploration. Significant changes are possible over time. Water levels shown are as measured during and/or after drilling. In some cases, boring advancement methods mask the presence/absence of groundwater. See individual logs for details.

NOTES:
Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project. Numbers adjacent to soil column indicate depth below ground surface.

BORING LOG NO. B-1

PROJECT: Bright Mountain Solar

CLIENT: Aurora Solar LLC
Portland, OR

SITE: Couch Br Rd
Hazard, KY

LOCATION See Exploration Plan

Latitude: 37.2902° Longitude: -83.3054°

Approximate Surface Elev.: 1179 (Ft.) +/-

MODEL LAYER	DEPTH	Description	ELEVATION (Ft.)
1	0.2	**TOPSOIL/ROOT MAT**	1178.8+/-
2	2.5	**FILL**, clayey sand with trace sandstone and shale fragments and cobbles, brown	1176.5+/-
2	7.5	**FILL**, sandstone and shale fragments and cobbles, with clay and sand, brown	1171.5+/-
2	15.0	**FILL**, sandstone and shale fragments and cobbles, with silt, clay, and sand, gray	1164+/-
2	21.5	**FILL**, sandstone and shale fragments and cobbles, with clay, sand, and silt, gray	1157.5+/-

Boring Terminated at 21.5 Feet

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
0–1.5			18	7-7-8 N=15	13.4	28-18-10
2.5–4			18	7-7-11 N=18	16.0	
5–6.5			18	10-10-10 N=20	15.5	
7.5–9			18	10-11-13 N=24		
10–11.5			14	9-7-5 N=12		
15–16.5			15	5-5-7 N=12		
20–21.5			16	12-16-9 N=25		

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25" Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation obtained from Google Earth

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered while drilling

Terracon
2460 Palumbo Dr
Lexington, KY

Boring Started: 05-19-2022	Boring Completed: 05-19-2022
Drill Rig: #621	Driller: D. Smith
Project No.: N3225022	

BORING LOG NO. B-2

PROJECT: Bright Mountain Solar

CLIENT: Aurora Solar LLC
Portland, OR

SITE: Couch Br Rd
Hazard, KY

LOCATION See Exploration Plan

Latitude: 37.2872° Longitude: -83.2979°

Approximate Surface Elev.: 1225 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
1		0.3 **TOPSOIL/ROOT MAT** 1224.7+/-							
2		**FILL**, sand with sandstone fragments and cobbles, brown - trace coal at 0.5 feet					6-6-7 N=13		
							7-7-8 N=15		
			5				6-6-10 N=16		
							3-4-6 N=10		
			10				6-6-6 N=12		
			15				7-5-4 N=9		
			20				4-4-4 N=8		
		25.0 1200+/-							
		FILL, sandstone fragments and cobbles, with clay, sand, and silt, gray to brown	25				11-12-6 N=18	13.4	
			30						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25" Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation obtained from Google Earth

Notes:

The groundwater observed can be perched groundwater due to rain on previous day
The groundwater observed can be perched groundwater due to rain on previous day

WATER LEVEL OBSERVATIONS

Ground water encountered at 41 feet while drilling

Ground water encountered at 36.4 feet after completion

Terracon
2460 Palumbo Dr
Lexington, KY

Boring Started: 05-19-2022	Boring Completed: 05-20-2022
Drill Rig: #621	Driller: D. Smith
Project No.: N3225022	

BORING LOG NO. B-2

PROJECT: Bright Mountain Solar

CLIENT: Aurora Solar LLC
Portland, OR

SITE: Couch Br Rd
Hazard, KY

LOCATION See Exploration Plan

Latitude: 37.2872° Longitude: -83.2979°

Approximate Surface Elev.: 1225 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH / DESCRIPTION / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
2		**FILL**, sandstone fragments and cobbles, with clay, sand, and silt, gray to brown *(continued)*			X		5-5-6 N=11	12.0	31-22-9
			35	▼	X		5-8-7 N=15	16.5	
		40.5 — 1184.5+/-							
3		**FILL**, sandstone boulders and cobbles, with shale fragments and clay, gray to brown, dense	40	▽	X		7-30-12 N=42		
			45		X		7-8-8 N=16	7.8	
		- coal at 50 feet	50		X		3-5-7 N=12		
		51.5 — 1173.5+/-							
		Boring Terminated at 51.5 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25" Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation obtained from Google Earth

Notes:

The groundwater observed can be perched groundwater due to rain on previous day

WATER LEVEL OBSERVATIONS

▽ *Ground water encountered at 41 feet while drilling*

▼ *Ground water encountered at 36.4 feet after completion*

Terracon
2460 Palumbo Dr
Lexington, KY

Boring Started: 05-19-2022	Boring Completed: 05-20-2022
Drill Rig: #621	Driller: D. Smith
Project No.: N3225022	

BORING LOG NO. B-3

PROJECT: Bright Mountain Solar

CLIENT: Aurora Solar LLC
Portland, OR

SITE: Couch Br Rd
Hazard, KY

LOCATION See Exploration Plan

Latitude: 37.2835° Longitude: -83.2951°

Approximate Surface Elev.: 1215 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
2		**FILL**, silty sand with sandstone fragments and cobbles, brown				18	10-17-17 N=34	7.4	NP
						16	9-10-15 N=25		
			5			13	8-9-9 N=18		
						11	9-4-3 N=7		
			10			7	12-17-5 N=22		
		-coal at 15.5 feet	15			15	31-33-50 N=83		
			20			16	11-21-15 N=36		
		-coal at 26 feet	25			18	11-10-6 N=16		
			30						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25" Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation obtained from Google Earth

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered while drilling

Terracon
2460 Palumbo Dr
Lexington, KY

Boring Started: 05-19-2022	Boring Completed: 05-19-2022
Drill Rig: #621	Driller: D. Smith
Project No.: N3225022	

BORING LOG NO. B-3

PROJECT: Bright Mountain Solar

CLIENT: Aurora Solar LLC
Portland, OR

SITE: Couch Br Rd
Hazard, KY

LOCATION See Exploration Plan

Latitude: 37.2835° Longitude: -83.2951°

Approximate Surface Elev.: 1215 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH / DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
2		**FILL**, silty sand with sandstone fragments and cobbles, brown *(continued)*				X	15	6-8-7 N=15		
		-gray below 35 feet		35		X	14	14-16-12 N=28		
		-with clay below 40 feet -coal at 40.5 feet		40		X	17	12-15-17 N=32		
				45		X	16	11-15-17 N=32		
		51.5	1163.5+/-	50		X	16	13-16-19 N=35	12.9	29-16-13
		Boring Terminated at 51.5 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25" Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation obtained from Google Earth

Notes:

WATER LEVEL OBSERVATIONS
Groundwater not encountered while drilling

Terracon
2460 Palumbo Dr
Lexington, KY

Boring Started: 05-19-2022	Boring Completed: 05-19-2022
Drill Rig: #621	Driller: D. Smith
Project No.: N3225022	

BORING LOG NO. B-4

PROJECT: Bright Mountain Solar

CLIENT: Aurora Solar LLC
Portland, OR

SITE: Couch Br Rd
Hazard, KY

LOCATION See Exploration Plan

Latitude: 37.2878° Longitude: -83.2908°

Approximate Surface Elev.: 1240 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
1	0.3	**TOPSOIL/ROOT MAT**	1239.7+/-			4-7-21 N=28	8.5	34-22-12
2		**FILL**, clayey sand with sandstone fragments and cobbles, gray					9.0	27-16-11
						21-11-10 N=21	8.7	
		-coal at 5 feet		5		9-12-13 N=25		
	7.5		1232.5+/-			8-16-12 N=28		
		FILL, sandstone and shale fragments and cobbles, with sand, gray		10		6-8-12 N=20		
				15		10-8-11 N=19		
				20		50/4"		
				25		20-29-37 N=66		
				30				

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25" Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation obtained from Google Earth

Notes:

WATER LEVEL OBSERVATIONS
Groundwater not encountered while drilling

Terracon
2460 Palumbo Dr
Lexington, KY

Boring Started: 05-19-2022	Boring Completed: 05-19-2022
Drill Rig: #621	Driller: D. Smith
Project No.: N3225022	

BORING LOG NO. B-4

PROJECT: Bright Mountain Solar

CLIENT: Aurora Solar LLC
Portland, OR

SITE: Couch Br Rd
Hazard, KY

LOCATION See Exploration Plan

Latitude: 37.2878° Longitude: -83.2908°

Approximate Surface Elev.: 1240 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
2		**FILL**, sandstone and shale fragments and cobbles, with sand, gray *(continued)*				X		12-13-14 N=27		
				35		X		10-7-7 N=14		
		-clayey below 40 feet		40		X		20-22-30 N=52	8.8	
		45.0	1195+/-	45				50/1"		
3		**FILL**, sandstone boulders and cobbles, gray								
		50.3	1189.7+/-	50				50/4"		
		Boring Terminated at 50.3 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25" Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation obtained from Google Earth

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered while drilling

Terracon
2460 Palumbo Dr
Lexington, KY

Boring Started: 05-19-2022	Boring Completed: 05-19-2022
Drill Rig: #621	Driller: D. Smith
Project No.: N3225022	

BORING LOG NO. B-5

PROJECT: Bright Mountain Solar

CLIENT: Aurora Solar LLC
Portland, OR

SITE: Couch Br Rd
Hazard, KY

LOCATION See Exploration Plan

Latitude: 37.2898° Longitude: -83.2862°

Approximate Surface Elev.: 1217 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
1	0.3	**TOPSOIL/ROOT MAT**	1216.7+/-							
2		**FILL**, sandstone and shale fragments and cobbles, with silt, gray				X	14	8-14-15 N=29		
						Hand auger / X	18	10-14-16 N=30		
				5		X	14	12-13-14 N=27		
		-no recovery at 7.5 feet				X	0	6-6-10 N=16		
				10		X	16	10-10-11 N=21		
	15.0	**FILL**, silty sand with trace sandstone fragments and boulders, gray	1202+/-	15		X	16	8-8-9 N=17		
					Hole cave in (17 ft)					
	20.0	**FILL**, sandstone and shale fragments and cobbles, with clay, silt, and sand, gray	1197+/-	20		X	16	10-14-16 N=30		
	21.5	***Boring Terminated at 21.5 Feet***	1195.5+/-							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25" Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation obtained from Google Earth

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered while drilling

Hole cave in at 17 feet

Terracon
2460 Palumbo Dr
Lexington, KY

Boring Started: 05-17-2022	Boring Completed: 05-17-2022
Drill Rig: #621	Driller: D. Smith
Project No.: N3225022	

BORING LOG NO. B-6

PROJECT: Bright Mountain Solar

CLIENT: Aurora Solar LLC
Portland, OR

SITE: Couch Br Rd
Hazard, KY

LOCATION See Exploration Plan

Latitude: 37.2926° Longitude: -83.2918°

Approximate Surface Elev.: 1236 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)
2	0.0–5.0	**FILL**, sandstone and shale fragments and cobbles, with silt and sand, gray	1231+/-
2	5.0–10.0	**FILL**, clayey sand with sandstone fragments and cobbles, gray	1226+/-
2	10.0–20.0	**FILL**, sandstone and shale fragments and cobbles, brown -with silt and sand below 15 feet	1216+/-
3	20.0–	**FILL**, sandstone cobbles and boulders, with shale fragments, gray	

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
0–1.5		Split spoon	18	9-13-18 N=31		
2.5–4		Hand sample / Split spoon	18	10-14-17 N=31	4.2	
5–6.5		Split spoon	16	10-16-21 N=37		
7.5–9		Split spoon	18	12-17-22 N=39		
10–11.5		Split spoon	18	6-9-10 N=19	7.8	
15–16.5		Split spoon	16	14-16-19 N=35		
20–21.2		Split spoon	10	14-50		
25–26.5		Split spoon	12	7-15-10 N=25		

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25" Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation obtained from Google Earth

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered while drilling

Terracon
2460 Palumbo Dr
Lexington, KY

Boring Started: 05-18-2022	Boring Completed: 05-18-2022
Drill Rig: #621	Driller: D. Smith
Project No.: N3225022	

BORING LOG NO. B-6

PROJECT: Bright Mountain Solar

CLIENT: Aurora Solar LLC
Portland, OR

SITE: Couch Br Rd
Hazard, KY

LOCATION See Exploration Plan

Latitude: 37.2926° Longitude: -83.2918°

Approximate Surface Elev.: 1236 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
3		**FILL**, sandstone cobbles and boulders, with shale fragments, gray *(continued)*				3	50/4"		
			35			2	50/2"		
			40			2	50/2"		
		45.0 / 1191+/-	45			0	50/0"		
		Boring Terminated at 45 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25" Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation obtained from Google Earth

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered while drilling

Terracon
2460 Palumbo Dr
Lexington, KY

Boring Started: 05-18-2022	Boring Completed: 05-18-2022
Drill Rig: #621	Driller: D. Smith
Project No.: N3225022	

BORING LOG NO. B-7

PROJECT: Bright Mountain Solar

CLIENT: Aurora Solar LLC
Portland, OR

SITE: Couch Br Rd
Hazard, KY

LOCATION See Exploration Plan

Latitude: 37.2958° Longitude: -83.2922°

Approximate Surface Elev.: 1261 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
		FILL, clayey sand with sandstone fragments and cobbles, gray				X	18	6-8-9 N=17	7.9	
						Hand / X	13	12-15-17 N=32	8.2	25-16-9
		-coal fragments at 3.5 feet		5		X	6	11-13-14 N=27		
						X	11	9-11-12 N=23	11.5	30-18-12
				10		X	14	9-9-11 N=20	11.3	
2	15.0	**FILL**, sandstone fragments and cobbles with silt and clay, gray	1246+/-	15		X	14	7-7-11 N=18		
				20		X	11	6-9-10 N=19	11.8	27-17-10
				25		X	18	9-9-12 N=21	12.3	
				30						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25" Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation obtained from Google Earth

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered while drilling

Terracon
2460 Palumbo Dr
Lexington, KY

Boring Started: 05-18-2022	Boring Completed: 05-18-2022
Drill Rig: #621	Driller: D. Smith
Project No.: N3225022	

BORING LOG NO. B-7

PROJECT: Bright Mountain Solar

CLIENT: Aurora Solar LLC
Portland, OR

SITE: Couch Br Rd
Hazard, KY

LOCATION See Exploration Plan

Latitude: 37.2958° Longitude: -83.2922°

Approximate Surface Elev.: 1261 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
2			**FILL**, sandstone fragments and cobbles with silt and clay, gray *(continued)*				X	15	5-7-11 N=18		
		35.0	**FILL**, clayey sand with sandstone and shale fragments and cobbles, brown	1226+/-	35		X	18	13-20-20 N=40	8.1	
					40		X	16	14-18-21 N=39	8.1	
		45.0	**FILL**, sandstone fragments and cobbles, with clay, brown	1216+/-	45		X	14	10-8-5 N=13		
		50.5	***Boring Terminated at 50.5 Feet***	1210.5+/-	50		X		50/5"		

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25" Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation obtained from Google Earth

Notes:

WATER LEVEL OBSERVATIONS
Groundwater not encountered while drilling

Terracon
2460 Palumbo Dr
Lexington, KY

Boring Started: 05-18-2022	Boring Completed: 05-18-2022
Drill Rig: #621	Driller: D. Smith
Project No.: N3225022	

BORING LOG NO. B-8

PROJECT: Bright Mountain Solar

CLIENT: Aurora Solar LLC
Portland, OR

SITE: Couch Br Rd
Hazard, KY

LOCATION See Exploration Plan

Latitude: 37.2947° Longitude: -83.2885°

Approximate Surface Elev.: 1251 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
2		**FILL**, sandstone and shale fragments and cobbles, with silt and clay, gray			X	16	12-14-15 N=29		
					X	16	12-18-15 N=33		
			5		X	12	7-8-7 N=15		
					X	15	17-19-22 N=41		
			10		X	14	7-7-8 N=15	9.8	24-16-8
			15		X	13	8-8-11 N=19	8.8	
		21.5 / 1229.5+/-	20		X	16	7-7-9 N=16	10.1	

Boring Terminated at 21.5 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25" Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation obtained from Google Earth

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered while drilling

Terracon
2460 Palumbo Dr
Lexington, KY

Boring Started: 05-18-2022	Boring Completed: 05-18-2022
Drill Rig: #621	Driller: D. Smith
Project No.: N3225022	

BORING LOG NO. B-9

PROJECT: Bright Mountain Solar

CLIENT: Aurora Solar LLC
Portland, OR

SITE: Couch Br Rd
Hazard, KY

LOCATION See Exploration Plan

Latitude: 37.2924° Longitude: -83.2856°

Approximate Surface Elev.: 1246 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH / DESCRIPTION / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
2		**FILL**, clayey sand with sandstone and shale fragments and cobbles, gray			X	14	11-10-12 N=22		
					Hand			7.9	25-16-9
					X	18	12-15-17 N=32	7.1	
			5		X	16	10-11-14 N=25	13.7	27-17-10
					X	11	10-9-6 N=15	7.9	
		10.0 — 1236+/-	10						
		FILL, sandstone and shale fragments and cobbles, with silt, gray			X	11	8-9-11 N=20		
			15		X	9	7-9-33 N=42		
			20		X	9	8-6-6 N=12		
		21.5 — 1224.5+/-							
		Boring Terminated at 21.5 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25" Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation obtained from Google Earth

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered while drillling and
Groundwater not observed after 24 hours

Terracon
2460 Palumbo Dr
Lexington, KY

Boring Started: 05-17-2022	Boring Completed: 05-17-2022
Drill Rig: #621	Driller: D. Smith
Project No.: N3225022	

BORING LOG NO. B-10

PROJECT: Bright Mountain Solar

CLIENT: Aurora Solar LLC
Portland, OR

SITE: Couch Br Rd
Hazard, KY

LOCATION See Exploration Plan

Latitude: 37.2887° Longitude: -83.2842°

Approximate Surface Elev.: 1187 (Ft.) +/-

MODEL LAYER: 2

DEPTH	ELEVATION (Ft.)	Description
0.0–10.0		**FILL**, clayey sand with sandstone and shale fragments and cobbles, gray -coal fragments at 2.5 to 5 feet
10.0	1177+/-	**FILL**, sandstone and shale fragments and cobbles, with silt and clay, gray

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
0–1.5		Split spoon	18	7-10-10 N=20	6.9	
1.5–5		Grab sample			5.5	27-19-8
2.5–4		Split spoon	18	8-10-12 N=22		
5–6.5		Split spoon	18	6-6-6 N=12		
7.5–9		Split spoon	18	6-6-9 N=15	5.5	
10–11.5		Split spoon	16	5-7-8 N=15	7.1	
15–16.5		Split spoon	14	12-12-15 N=27	5.6	
20–21.5		Split spoon	14	12-12-14 N=26		
25–26.5		Split spoon	18	15-17-17 N=34		

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25" Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation obtained from Google Earth

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Hole cave in at 31 feet

Terracon
2460 Palumbo Dr
Lexington, KY

Boring Started: 05-17-2022	Boring Completed: 05-17-2022
Drill Rig: #621	Driller: D. Smith
Project No.: N3225022	

BORING LOG NO. B-10

PROJECT: Bright Mountain Solar

CLIENT: Aurora Solar LLC
Portland, OR

SITE: Couch Br Rd
Hazard, KY

LOCATION See Exploration Plan

Latitude: 37.2887° Longitude: -83.2842°

Approximate Surface Elev.: 1187 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
2		**FILL**, sandstone and shale fragments and cobbles, with silt and clay, gray *(continued)*			Hole cave in	X	16	18-21-24 N=45		
	35.0		1152+/-	35						
3		**FILL**, sandstone boulders and cobbles, with shale fragments, gray				X	14	28-36-40 N=76		
				40		X	12	33-43-47 N=90		
				45		X	12	37-43-50/0"		
				50		X	13	39-46-50/1"		
	51.1		1135.9+/-							
		Boring Terminated at 51.1 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25" Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation obtained from Google Earth

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

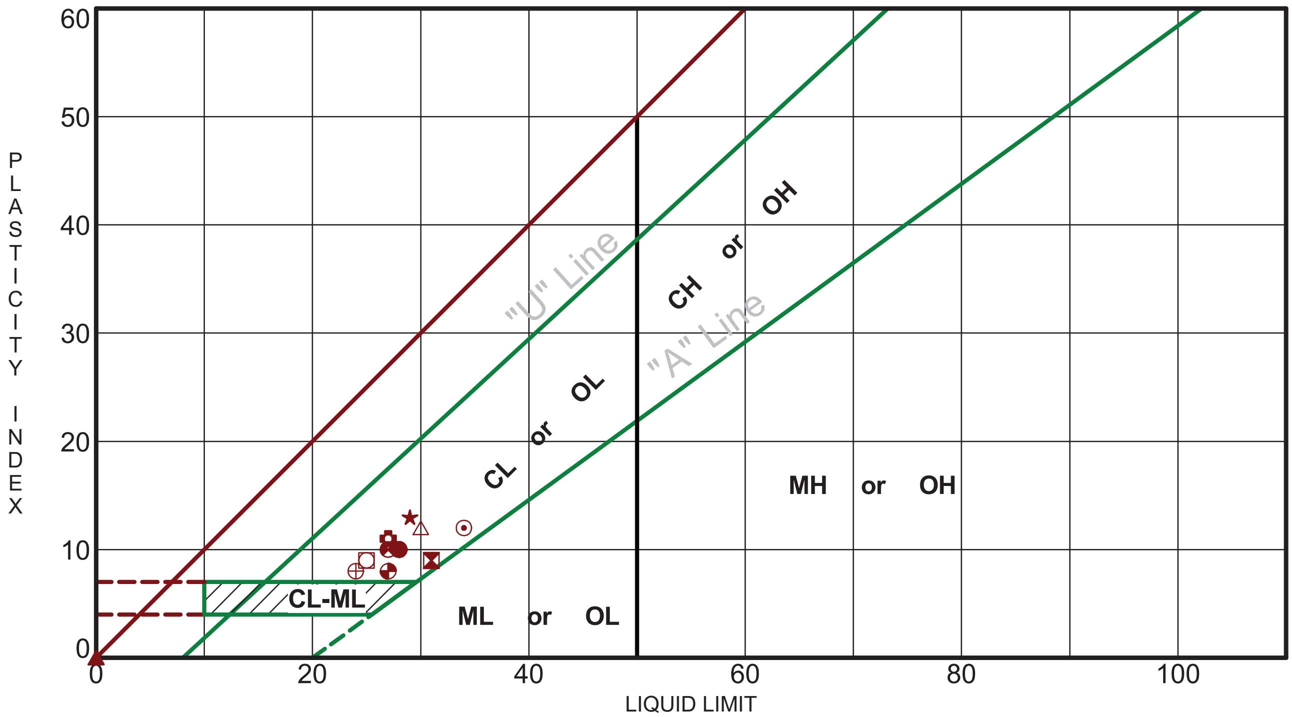
Hole cave in at 31 feet

Terracon
2460 Palumbo Dr
Lexington, KY

Boring Started: 05-17-2022	Boring Completed: 05-17-2022
Drill Rig: #621	Driller: D. Smith
Project No.: N3225022	

ATTERBERG LIMITS RESULTS

ASTM D4318



Boring ID		Depth (Ft)	LL	PL	PI	Fines	USCS	Description
●	B-1	0 - 1.5	28	18	10	48.0	SC	CLAYEY SAND
⊠	B-2	30 - 31.5	31	22	9	26.5	GC	CLAYEY GRAVEL with SAND
▲	B-3	0.1 - 5.1	NP	NP	NP	25.2	SM	SILTY SAND
★	B-3	50 - 51.5	29	16	13			
⊙	B-4	0 - 1.5	34	22	12	31.4	SC	CLAYEY SAND with GRAVEL
✿	B-4	0.1 - 5.1	27	16	11	44.7	SC	CLAYEY SAND with GRAVEL
○	B-7	0.1 - 5.1	25	16	9	34.4	SC	CLAYEY SAND with GRAVEL
△	B-7	7.5 - 9	30	18	12	31.3	SC	CLAYEY SAND with GRAVEL
⊗	B-7	20 - 21.5	27	17	10			
⊕	B-8	10 - 11.5	24	16	8			
□	B-9	0.1 - 5.1	25	16	9	43.1	SC	CLAYEY SAND with GRAVEL
◉	B-9	5 - 6.5	27	17	10	23.7	SC	CLAYEY SAND
◕	B-10	0.1 - 5.1	27	19	8	46.0	SC	CLAYEY SAND with GRAVEL

PROJECT: Bright Mountain Solar

SITE: Couch Br Rd
Hazard, KY

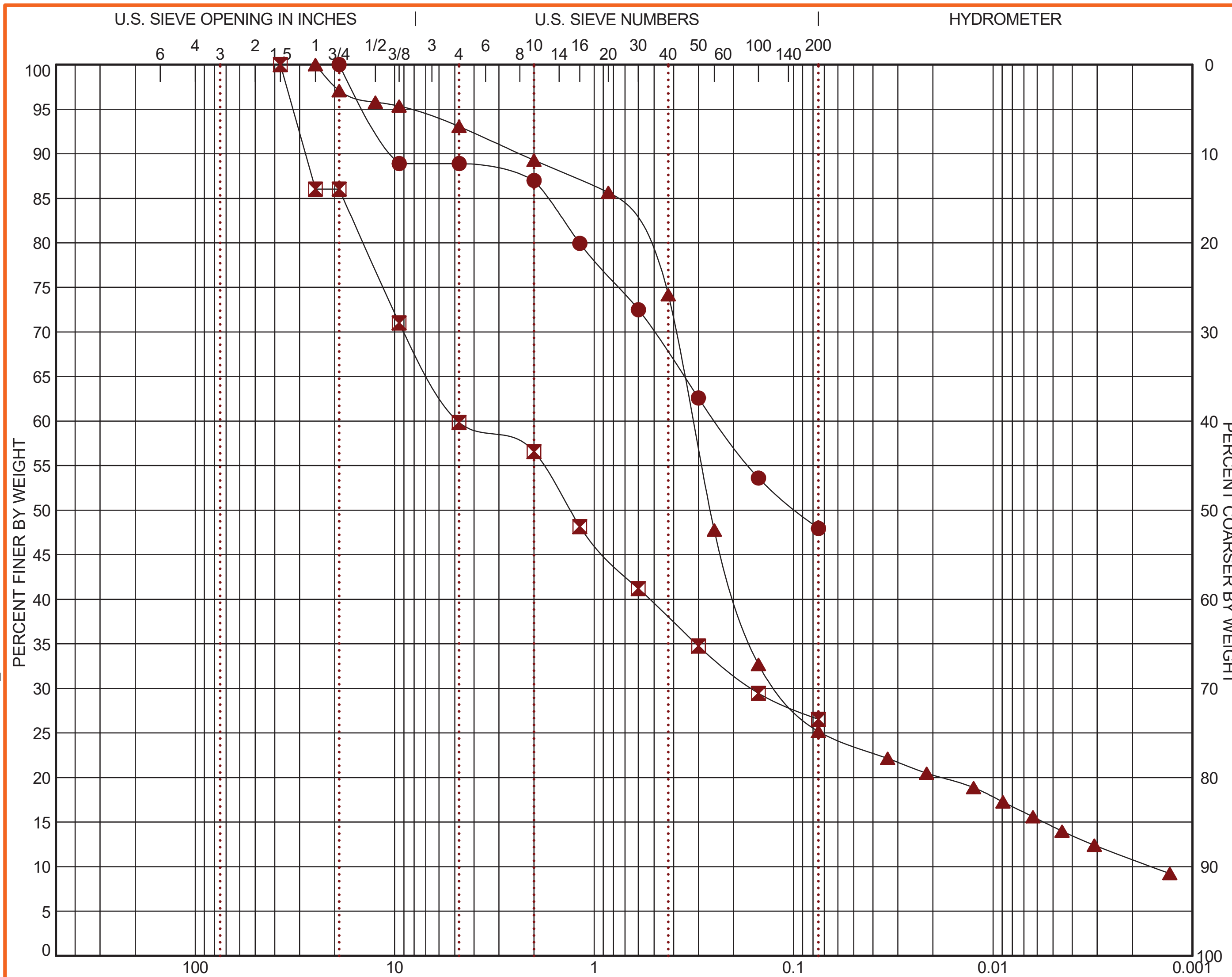
Terracon
2460 Palumbo Dr
Lexington, KY

PROJECT NUMBER: N3225022

CLIENT: Aurora Solar LLC
Portland, OR

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	B-1	0 - 1.5	0.0	11.1	40.9		48.0		SC
⊠	B-2	30 - 31.5	0.0	40.2	33.3		26.5		GC
▲	B-3	0.1 - 5.1	0.0	6.9	67.9	10.7		14.5	SM

GRAIN SIZE

	●	⊠	▲
D_{60}	0.246	4.798	0.32
D_{30}		0.161	0.117
D_{10}			0.002

COEFFICIENTS

	●	⊠	▲
C_C			26.73
C_U			199.58

● Sieve	● % Finer	⊠ Sieve	⊠ % Finer	▲ Sieve	▲ % Finer
3/4"	100.0	1 1/2"	100.0	1"	100.0
3/8"	88.89	1"	86.03	3/4"	97.09
#4	88.89	3/4"	86.03	1/2"	95.78
#10	87.0	3/8"	71.02	3/8"	95.34
#16	79.94	#4	59.84	#4	93.06
#30	72.49	#10	56.57	#10	89.26
#50	62.59	#16	48.17	#20	85.66
#100	53.61	#30	41.2	#40	74.17
#200	47.95	#50	34.76	#60	47.77
		#100	29.46	#100	32.7
		#200	26.54	#200	25.17

SOIL DESCRIPTION

●	CLAYEY SAND (SC)
⊠	CLAYEY GRAVEL with SAND (GC)
▲	SILTY SAND (SM)

REMARKS

●	
⊠	
▲	

PROJECT: Bright Mountain Solar

SITE: Couch Br Rd
Hazard, KY

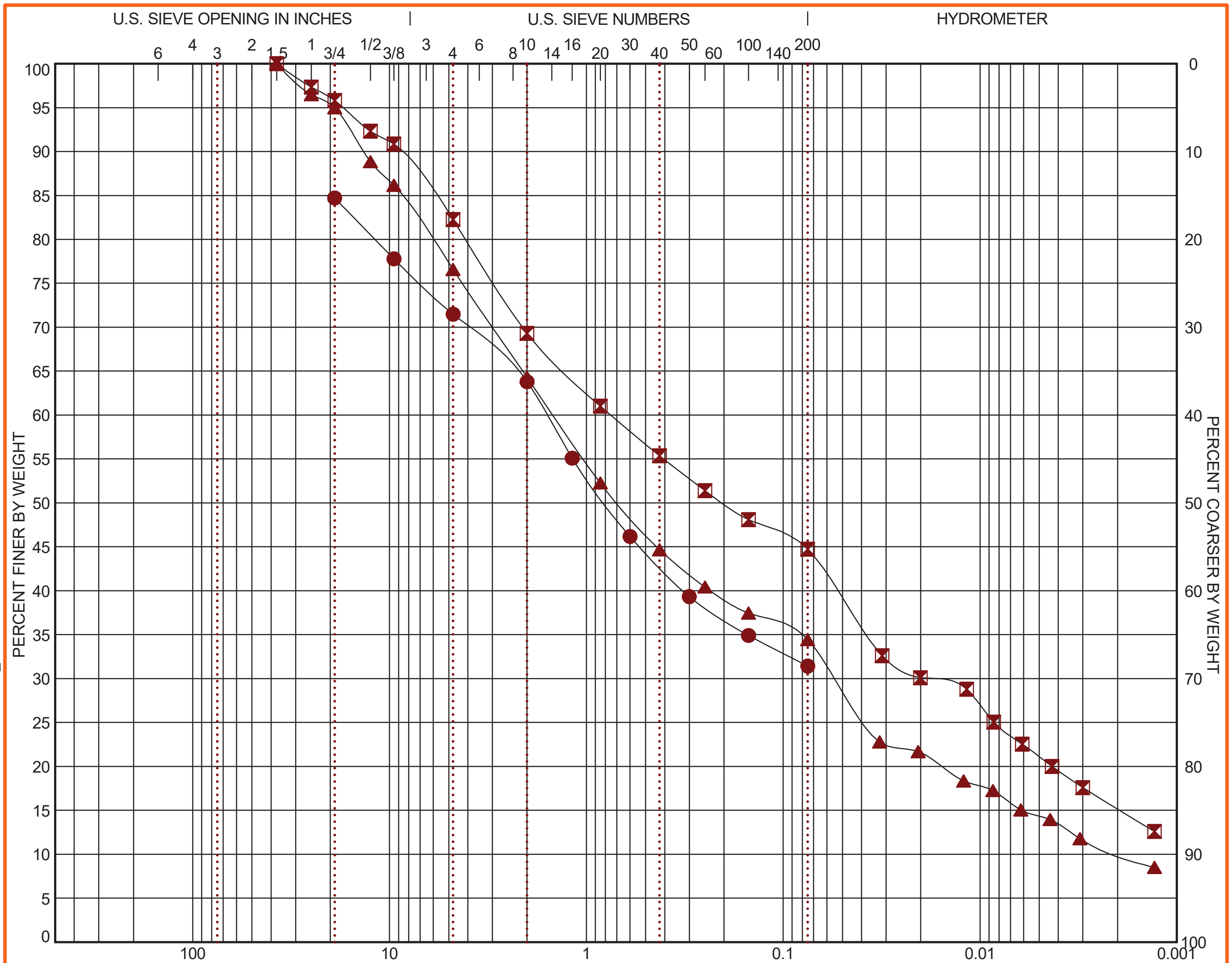
Terracon
2460 Palumbo Dr
Lexington, KY

PROJECT NUMBER: N3225022

CLIENT: Aurora Solar LLC
Portland, OR

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	B-4	0 - 1.5		13.2	40.1		31.4		SC
☒	B-4	0.1 - 5.1	0.0	17.7	37.5	23.6		21.1	SC
▲	B-7	0.1 - 5.1	0.0	23.4	42.2	20.1		14.4	SC

GRAIN SIZE

	●	☒	▲
D_{60}	1.589	0.75	1.474
D_{30}		0.019	0.054
D_{10}			0.002

COEFFICIENTS

	●	☒	▲
C_C			1.04
C_U			762.44

● Sieve	● % Finer	☒ Sieve	☒ % Finer	▲ Sieve	▲ % Finer
3/4"	84.71	1 1/2"	100.0	1 1/2"	100.0
3/8"	77.78	1"	97.35	1"	96.48
#4	71.48	3/4"	95.8	3/4"	94.97
#10	63.79	1/2"	92.3	1/2"	88.84
#16	55.09	3/8"	90.84	3/8"	86.16
#30	46.18	#4	82.26	#4	76.58
#50	39.33	#10	69.3	#10	64.28
#100	34.91	#20	61.02	#20	52.26
#200	31.43	#40	55.37	#40	44.67
		#60	51.4	#60	40.43
		#100	48.11	#100	37.46
		#200	44.72	#200	34.43

SOIL DESCRIPTION

●	CLAYEY SAND with GRAVEL (SC)
☒	CLAYEY SAND with GRAVEL (SC)
▲	CLAYEY SAND with GRAVEL (SC)

REMARKS

●	
☒	
▲	

PROJECT: Bright Mountain Solar

PROJECT NUMBER: N3225022

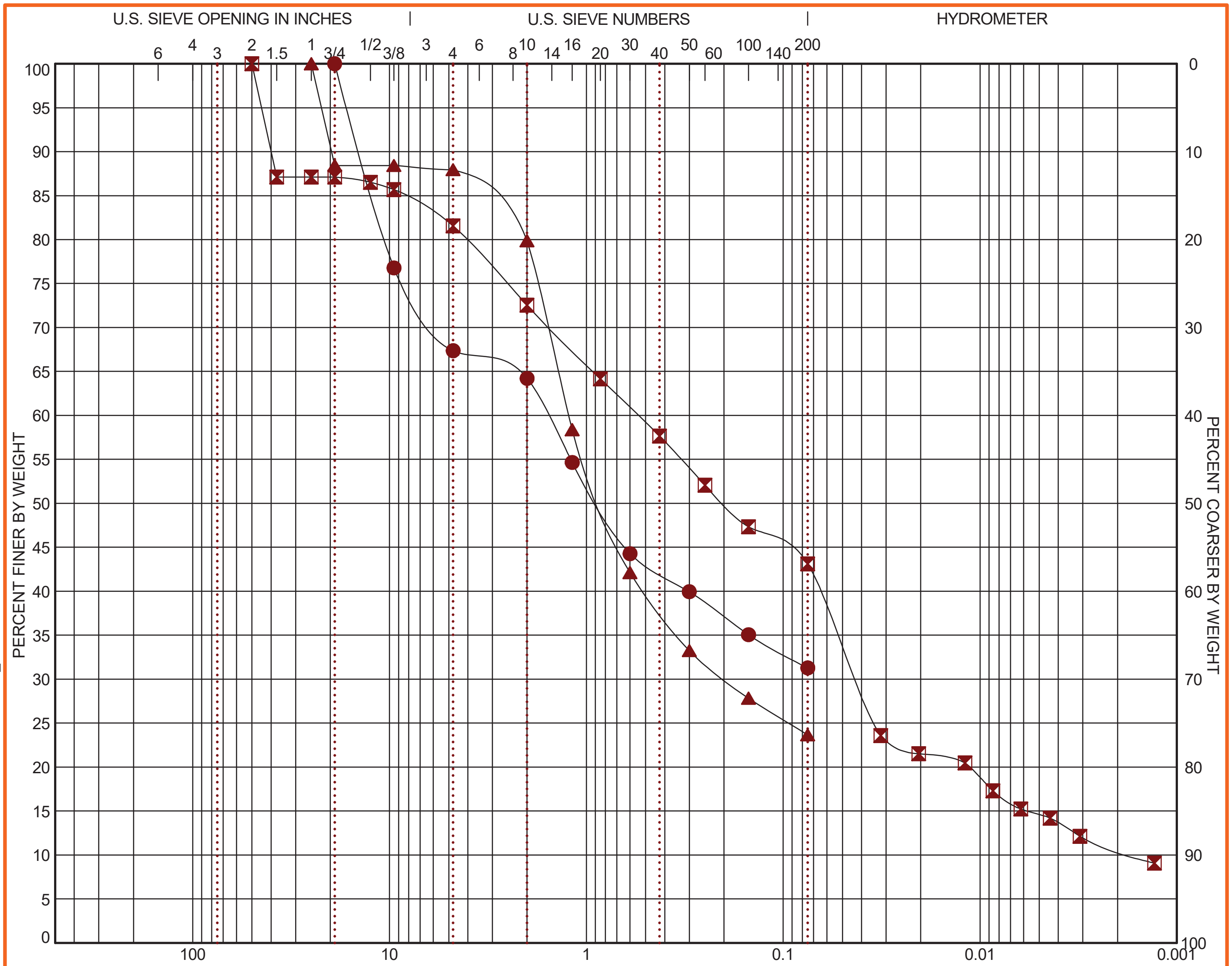
SITE: Couch Br Rd
Hazard, KY

Terracon
2460 Palumbo Dr
Lexington, KY

CLIENT: Aurora Solar LLC
Portland, OR

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	B-7	7.5 - 9	0.0	32.6	36.1		31.3		SC
⊠	B-9	0.1 - 5.1	0.0	18.4	38.5	28.5		14.6	SC
▲	B-9	5 - 6.5	0.0	12.1	64.3		23.7		SC

GRAIN SIZE	●	⊠	▲
D_{60}	1.585	0.546	1.228
D_{30}		0.042	0.198
D_{10}		0.002	

COEFFICIENTS	●	⊠	▲
C_C		1.94	
C_U		323.13	

● Sieve	● % Finer	⊠ Sieve	⊠ % Finer	▲ Sieve	▲ % Finer
3/4"	100.0	1 1/2"	100.0	1"	100.0
3/8"	76.78	1"	87.1	3/4"	88.43
#4	67.36	3/4"	87.1	3/8"	88.43
#10	64.21	1/2"	87.1	#4	87.95
#16	54.64	3/8"	86.52	#10	79.87
#30	44.28	#4	85.68	#16	58.37
#50	39.95	#10	81.56	#30	42.12
#100	35.06	#20	72.53	#50	33.25
#200	31.28	#40	64.16	#100	27.84
		#60	57.66	#200	23.67
		#100	52.06		
		#200	47.33		
			43.1		

	SOIL DESCRIPTION
●	CLAYEY SAND with GRAVEL (SC)
⊠	CLAYEY SAND with GRAVEL (SC)
▲	CLAYEY SAND (SC)

	REMARKS
●	
⊠	
▲	

PROJECT: Bright Mountain Solar

SITE: Couch Br Rd
Hazard, KY

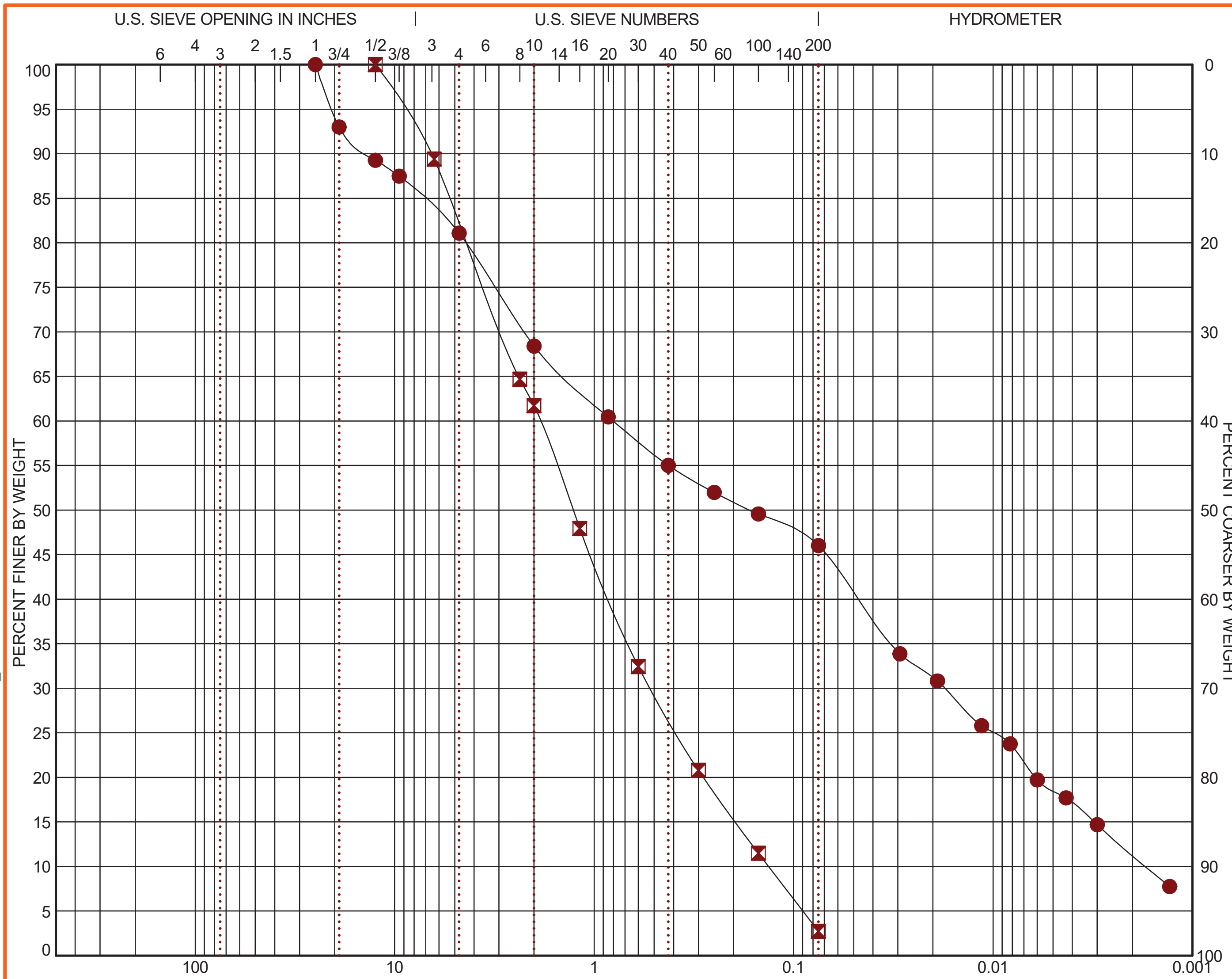
Terracon
2460 Palumbo Dr
Lexington, KY

PROJECT NUMBER: N3225022

CLIENT: Aurora Solar LLC
Portland, OR

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	B-10	0.1 - 5.1	0.0	18.9	35.1	27.4		18.6	SC
⊠	B-10	10 - 11.5	0.0	17.8	79.4		2.7		SW

GRAIN SIZE

	●	⊠	
D_{60}	0.802	1.873	
D_{30}	0.017	0.519	
D_{10}	0.002	0.133	

COEFFICIENTS

	●	⊠	
C_C	0.22	1.08	
C_U	470.63	14.04	

●		⊠			
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
1"	100.0	1/2"	100.0		
3/4"	92.99	1/4"	89.4		
1/2"	89.27	#8	64.7		
3/8"	87.48	#10	61.72		
#4	81.08	#16	47.94		
#10	68.41	#30	32.44		
#20	60.46	#50	20.8		
#40	55.02	#100	11.49		
#60	51.99	#200	2.72		
#100	49.56				
#200	46.02				

SOIL DESCRIPTION

●	CLAYEY SAND with GRAVEL (SC)
⊠	WELL-GRADED SAND with GRAVEL (SW)

REMARKS

●	
⊠	

PROJECT: Bright Mountain Solar

PROJECT NUMBER: N3225022

SITE: Couch Br Rd
Hazard, KY

Terracon
2460 Palumbo Dr
Lexington, KY

CLIENT: Aurora Solar LLC
Portland, OR

ELECTRICAL EARTH RESISTIVITY TEST DATA

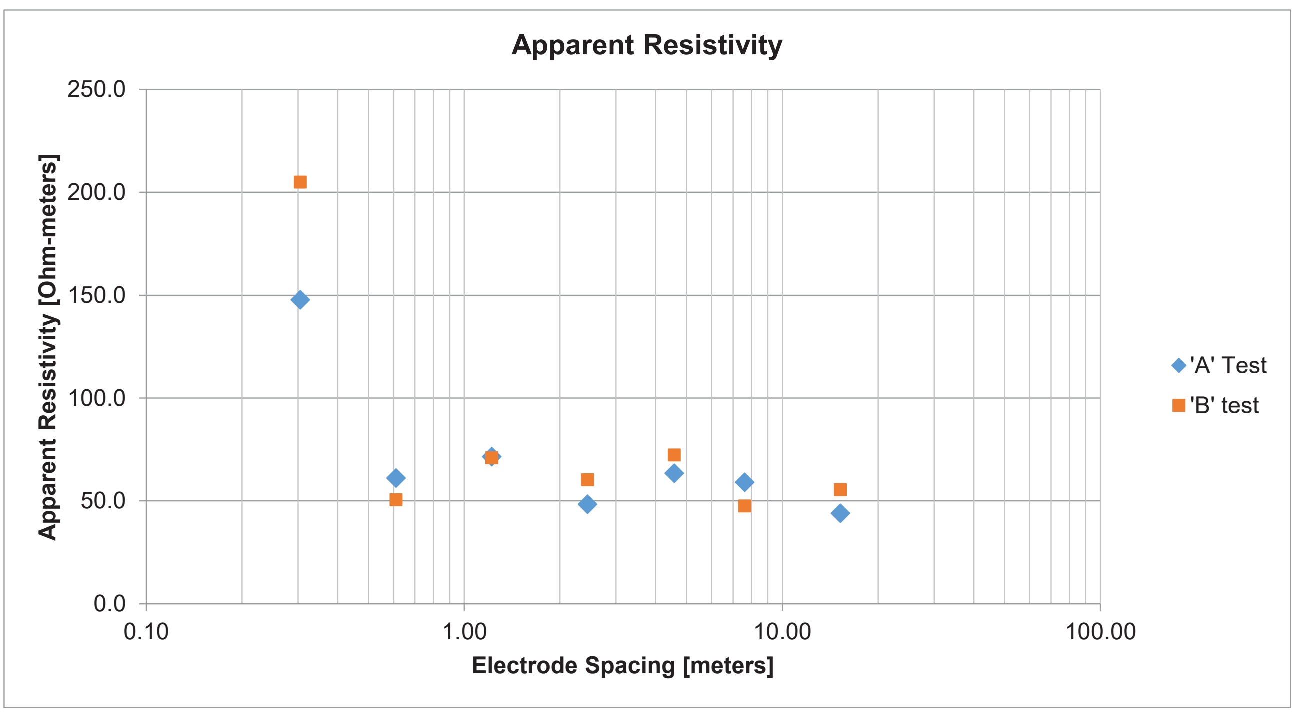
Test Line at EER-1 location with approximate center point: 37.290233°, -83.305368°

Project Bright Mountain Solar
Location Hazard, Kentucky
Project # N3225022
Test Date June 14, 2022

Weather Sunny
Surface Soil Clayey Sand with sandstone fragments and cobbles
Instrument AEMC Model 6471
Tested By Nazife Onaral

Electrode Spacing "a"		Electrode Depth "b"		"A" Test (Extended E-W)		"B" Test (Extended N-S)	
[feet]	[meters]	[feet]	[meters]	Measured Resistance "R" [Ohms]	Apparent Resistivity "ρ" [Ohm-meters]	Measured Resistance "R" [Ohms]	Apparent Resistivity "ρ" [Ohm-meters]
1	0.30	0.5	0.1524	58.60	147.7	81.30	204.9
2	0.61	0.5	0.1524	14.50	61.1	12.00	50.5
4	1.22	0.5	0.1524	9.09	71.5	9.03	71.0
8	2.44	0.5	0.1524	3.14	48.4	3.91	60.3
15	4.57	1	0.3048	2.19	63.4	2.50	72.4
25	7.62	1	0.3048	1.23	59.1	0.99	47.5
50	15.24	1	0.3048	0.46	44.1	0.58	55.6
75	22.86	1	0.3048	0.35	50.3	0.42	60.3
100	30.48	1	0.3048	0.33	63.2	0.25	47.9
150	45.72	1	0.3048	0.27	77.6	0.27	77.6
200	60.96	1	0.3048	0.26	99.6	0.25	95.8

Apparent resistivity p is calculated as : $$\rho = \frac{4\pi a R}{1 + \frac{2a}{\sqrt{a^2 + 4b^2}} - \frac{a}{\sqrt{a^2 + b^2}}}$$



ELECTRICAL EARTH RESISTIVITY TEST DATA

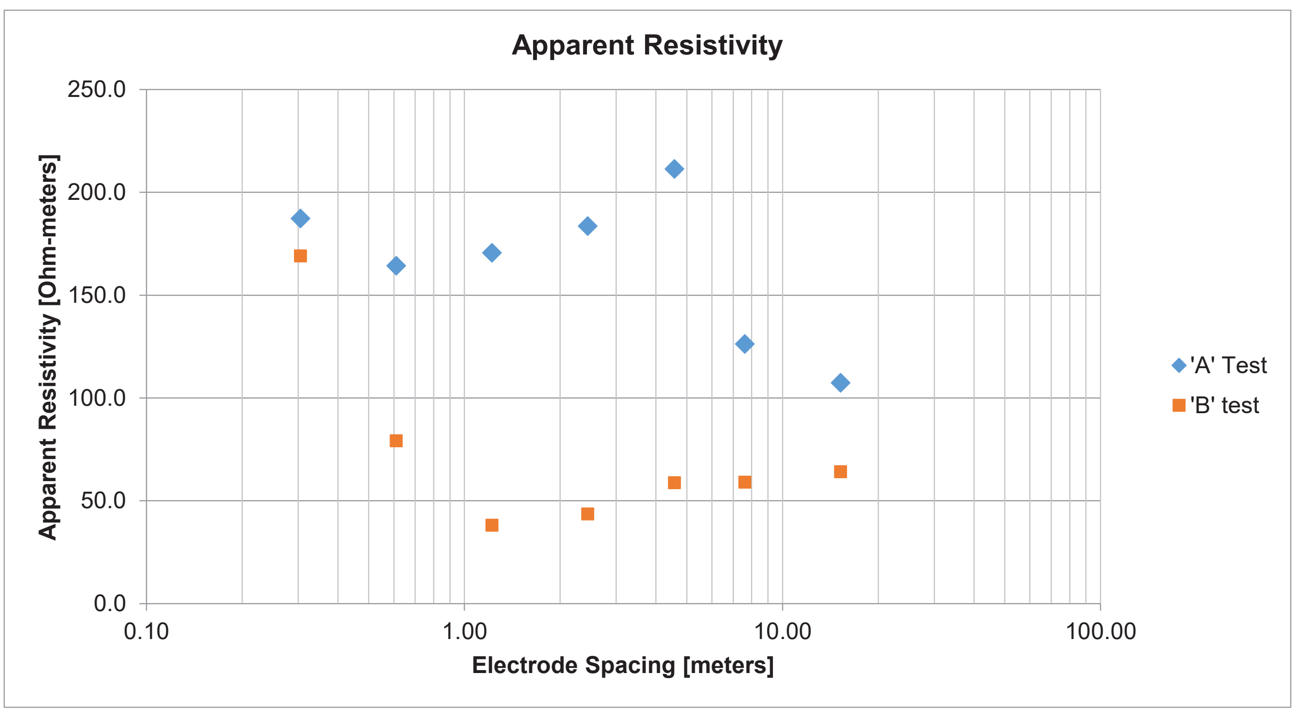
Test Line at EER-2 location with approximate center point: 37.289167°, -83.292222°

Project	Bright Mountain Solar	**Weather**	Sunny
Location	Hazard, Kentucky	**Surface Soil**	Sand with sandstone fragments and cobbles
Project #	N3225022	**Instrument**	AEMC Model 6471
Test Date	June 14, 2022	**Tested By**	Nazife Onaral

Electrode Spacing "a"		Electrode Depth "b"		"A" Test (Extended E-W)		"B" Test (Extended N-S)	
[feet]	[meters]	[feet]	[meters]	Measured Resistance "R" [Ohms]	Apparent Resistivity "ρ" [Ohm-meters]	Measured Resistance "R" [Ohms]	Apparent Resistivity "ρ" [Ohm-meters]
1	0.30	0.5	0.1524	74.30	187.3	67.10	169.1
2	0.61	0.5	0.1524	39.00	164.3	18.80	79.2
4	1.22	0.5	0.1524	21.70	170.7	4.85	38.1
8	2.44	0.5	0.1524	11.90	183.6	2.83	43.7
15	4.57	1	0.3048	7.30	211.3	2.03	58.8
25	7.62	1	0.3048	2.63	126.3	1.23	59.1
50	15.24	1	0.3048	1.12	107.3	0.67	64.2
75	22.86	1	0.3048	0.51	73.3	0.42	60.3
100	30.48	1	0.3048	0.31	59.4	0.29	55.5
150	45.72	1	0.3048	0.23	66.1	0.19	54.6
200	60.96	1	0.3048	0.19	72.8	0.18	68.9

Apparent resistivity p is calculated as :

$$\rho = \frac{4\pi a R}{1 + \frac{2a}{\sqrt{a^2 + 4b^2}} - \frac{a}{\sqrt{a^2 + b^2}}}$$



Terracon

ELECTRICAL EARTH RESISTIVITY TEST DATA

Test Line at EER-3 location with approximate center point: 37.283462°, -83.295135°

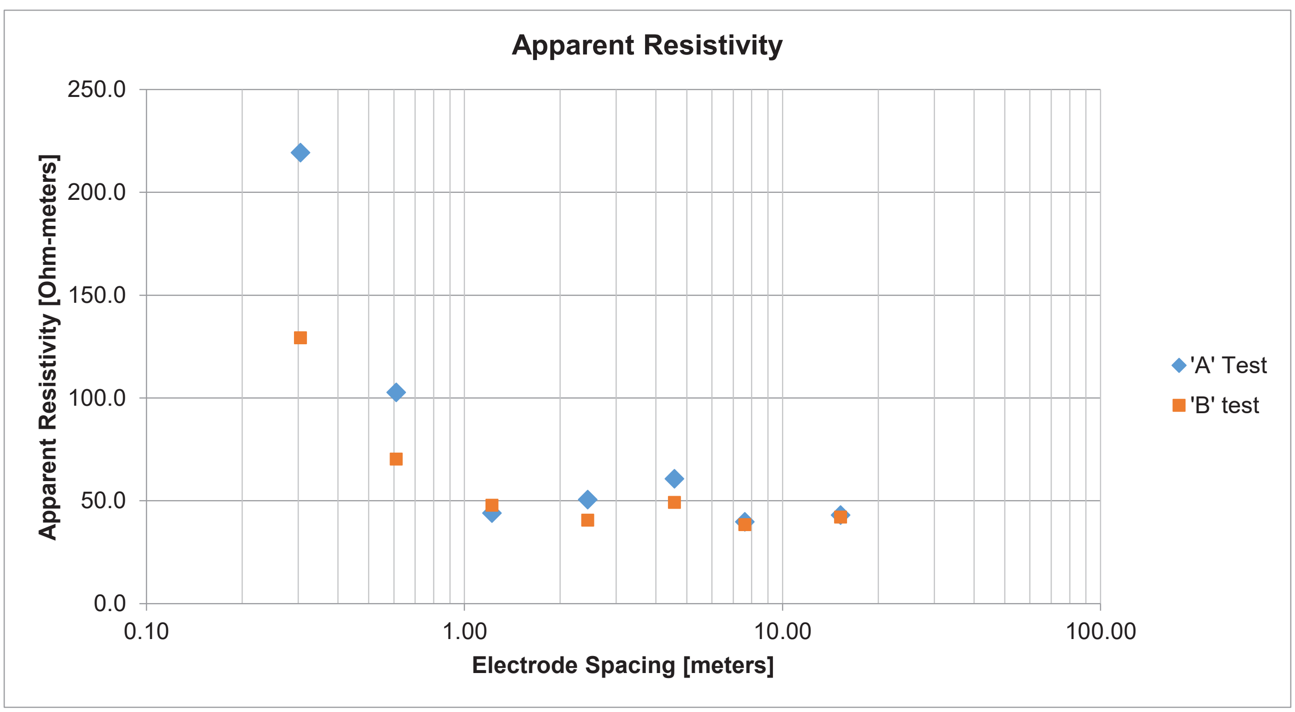
Project Bright Mountain Solar
Location Hazard, Kentucky
Project # N3225022
Test Date June 14, 2022

Weather Sunny
Surface Soil Silty Sand with sandstone fragments and cobbles
Instrument AEMC Model 6471
Tested By Nazife Onaral

Electrode Spacing "a"		Electrode Depth "b"		"A" Test (Extended E-W)		"B" Test (Extended N-S)	
[feet]	[meters]	[feet]	[meters]	Measured Resistance "R" [Ohms]	Apparent Resistivity "ρ" [Ohm-meters]	Measured Resistance "R" [Ohms]	Apparent Resistivity "ρ" [Ohm-meters]
1	0.30	0.5	0.1524	87.00	219.3	51.30	129.3
2	0.61	0.5	0.1524	24.40	102.8	16.70	70.3
4	1.22	0.5	0.1524	5.59	44.0	6.09	47.9
8	2.44	0.5	0.1524	3.28	50.6	2.63	40.6
15	4.57	1	0.3048	2.10	60.8	1.70	49.2
25	7.62	1	0.3048	0.83	39.8	0.80	38.4
50	15.24	1	0.3048	0.45	43.1	0.44	42.2
75	22.86	1	0.3048	0.31	44.5	0.31	44.5
100	30.48	1	0.3048	0.23	44.1	0.25	47.9
150	45.72	1	0.3048	0.20	57.5	0.20	57.5
200	60.96	1	0.3048	0.15	57.5	0.16	61.3

Apparent resistivity p is calculated as :

$$\rho = \frac{4\pi aR}{1 + \frac{2a}{\sqrt{a^2 + 4b^2}} - \frac{a}{\sqrt{a^2 + b^2}}}$$



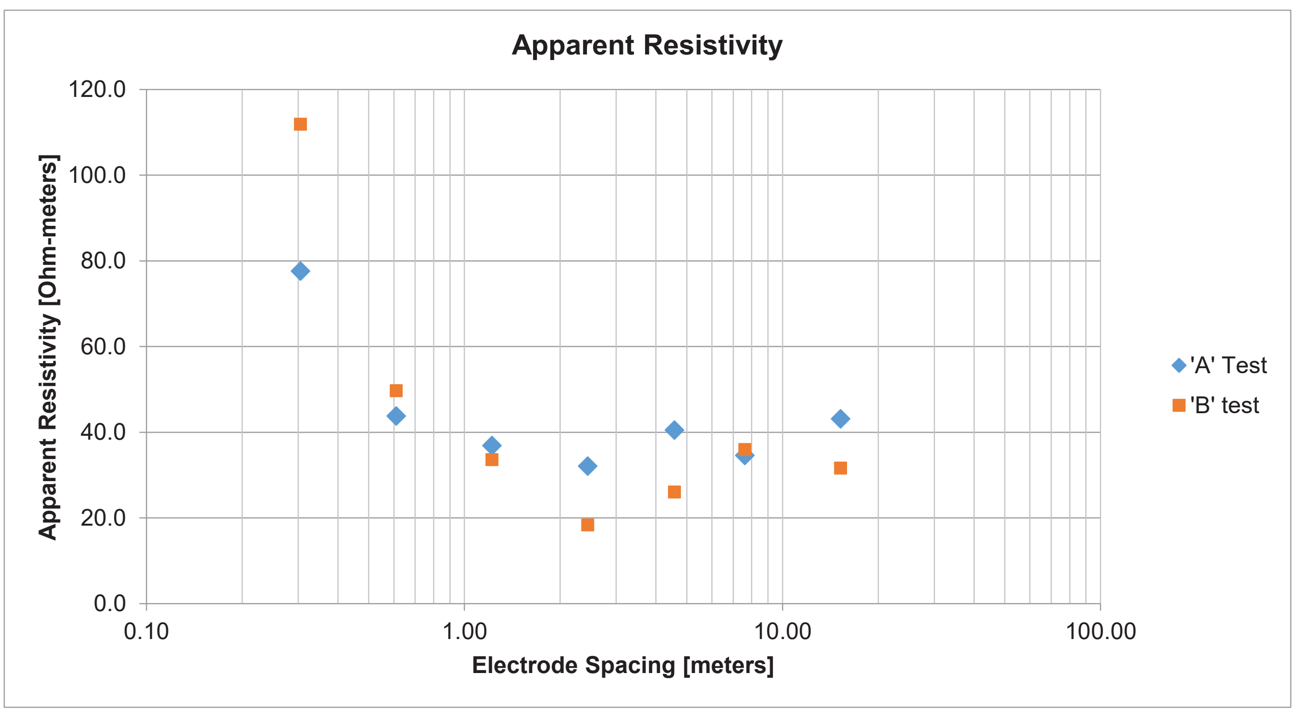
ELECTRICAL EARTH RESISTIVITY TEST DATA

Test Line at EER-4 location with approximate center point: 37.287826°, -83.290818°

Project	Bright Mountain Solar	**Weather**	Sunny
Location	Hazard, Kentucky	**Surface Soil**	Clayey Sand with sandstone fragments and cobbles
Project #	N3225022	**Instrument**	AEMC Model 6471
Test Date	June 14, 2022	**Tested By**	Nazife Onaral

Electrode Spacing "a"		Electrode Depth "b"		"A" Test (Extended E-W)		"B" Test (Extended N-S)	
[feet]	[meters]	[feet]	[meters]	Measured Resistance "R" [Ohms]	Apparent Resistivity "ρ" [Ohm-meters]	Measured Resistance "R" [Ohms]	Apparent Resistivity "ρ" [Ohm-meters]
1	0.30	0.5	0.1524	30.80	77.6	44.40	111.9
2	0.61	0.5	0.1524	10.40	43.8	11.80	49.7
4	1.22	0.5	0.1524	4.69	36.9	4.27	33.6
8	2.44	0.5	0.1524	2.08	32.1	1.19	18.4
15	4.57	1	0.3048	1.40	40.5	0.90	26.1
25	7.62	1	0.3048	0.72	34.6	0.75	36.0
50	15.24	1	0.3048	0.45	43.1	0.33	31.6
75	22.86	1	0.3048	0.36	51.7	0.27	38.8
100	30.48	1	0.3048	0.28	53.6	0.24	46.0
150	45.72	1	0.3048	0.21	60.3	0.17	48.8
200	60.96	1	0.3048	0.18	68.9	0.17	65.1

Apparent resistivity p is calculated as : $$\rho = \frac{4\pi a R}{1 + \frac{2a}{\sqrt{a^2 + 4b^2}} - \frac{a}{\sqrt{a^2 + b^2}}}$$



ELECTRICAL EARTH RESISTIVITY TEST DATA

Test Line at EER-5 location with approximate center point: 37.289793°, -83.286181°

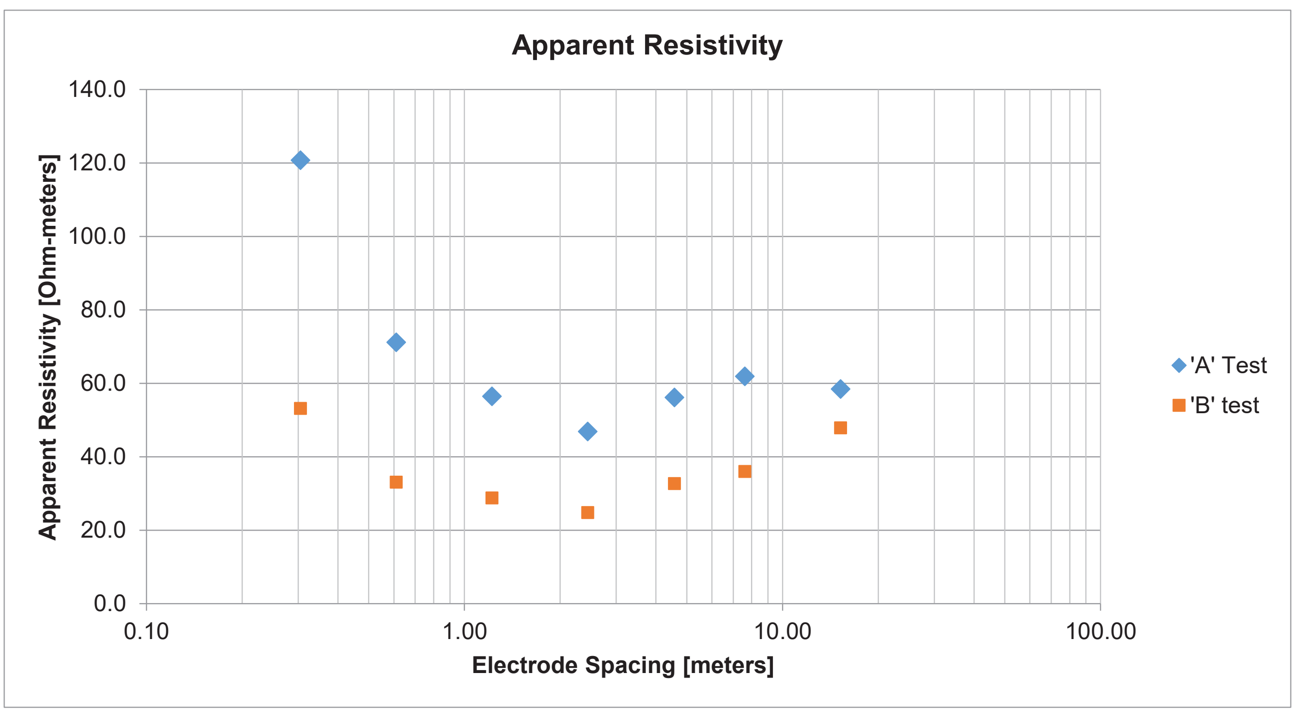
Project Bright Mountain Solar
Location Hazard, Kentucky
Project # N3225022
Test Date June 13, 2022

Weather Sunny
Surface Soil Sandstone/shale fragments and cobbles with silt
Instrument AEMC Model 6471
Tested By Nazife Onaral

Electrode Spacing "a"		Electrode Depth "b"		"A" Test (Extended E-W)		"B" Test (Extended N-S)	
[feet]	[meters]	[feet]	[meters]	Measured Resistance "R" [Ohms]	Apparent Resistivity "ρ" [Ohm-meters]	Measured Resistance "R" [Ohms]	Apparent Resistivity "ρ" [Ohm-meters]
1	0.30	0.5	0.1524	47.90	120.7	21.10	53.2
2	0.61	0.5	0.1524	16.90	71.2	7.85	33.1
4	1.22	0.5	0.1524	7.18	56.5	3.66	28.8
8	2.44	0.5	0.1524	3.04	46.9	1.61	24.8
15	4.57	1	0.3048	1.94	56.2	1.13	32.7
25	7.62	1	0.3048	1.29	61.9	0.75	36.0
50	15.24	1	0.3048	0.61	58.5	0.50	47.9
75	22.86	1	0.3048	0.36	51.7	0.31	44.5
100	30.48	1	0.3048	0.30	57.5	0.28	53.6
150	45.72	1	0.3048	0.25	71.8	0.25	71.8
200	60.96	1	0.3048	0.26	99.6	0.21	80.4

Apparent resistivity p is calculated as :

$$\rho = \frac{4\pi a R}{1 + \frac{2a}{\sqrt{a^2 + 4b^2}} - \frac{a}{\sqrt{a^2 + b^2}}}$$



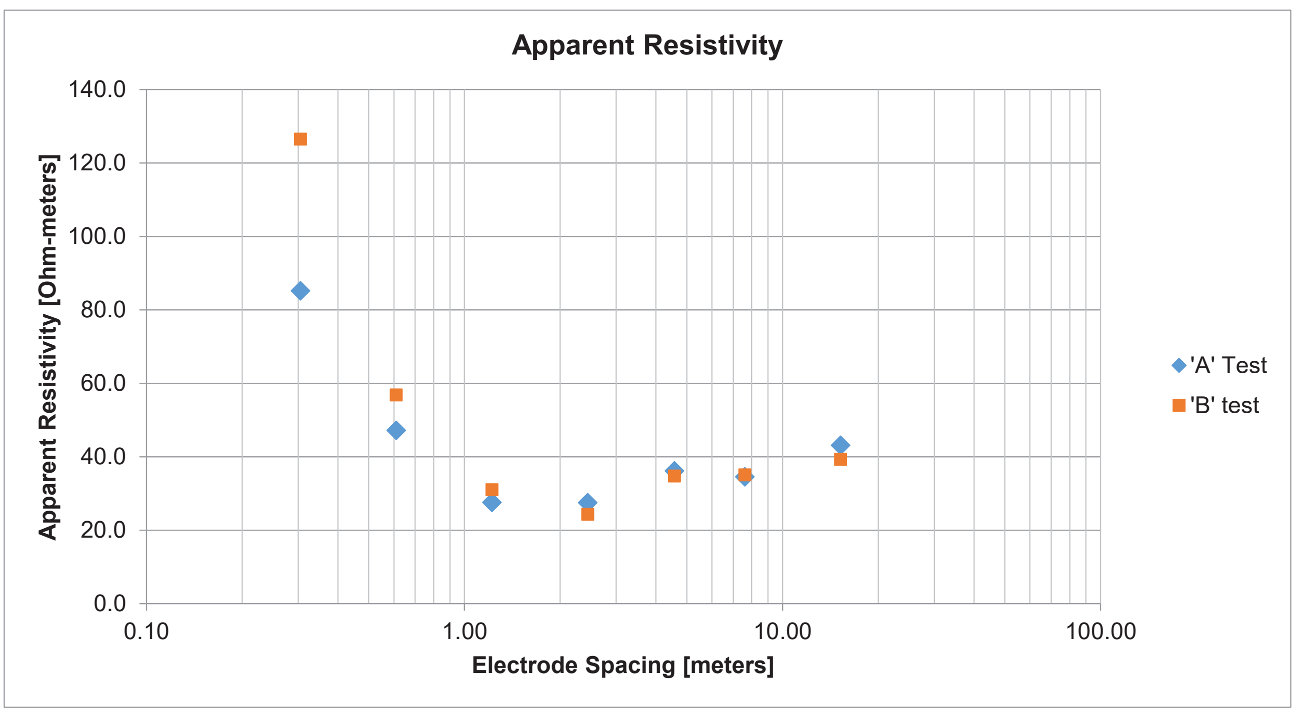
ELECTRICAL EARTH RESISTIVITY TEST DATA

Test Line at EER-6 location with approximate center point: 37.292640°, -83.291864°

Project	Bright Mountain Solar	**Weather**	Sunny
Location	Hazard, Kentucky	**Surface Soil**	Sandstone/shale fragments and cobbles with silt/sand
Project #	N3225022	**Instrument**	AEMC Model 6471
Test Date	June 15, 2022	**Tested By**	Nazife Onaral

Electrode Spacing "a"		Electrode Depth "b"		"A" Test (Extended E-W)		"B" Test (Extended N-S)	
[feet]	[meters]	[feet]	[meters]	Measured Resistance "R" [Ohms]	Apparent Resistivity "ρ" [Ohm-meters]	Measured Resistance "R" [Ohms]	Apparent Resistivity "ρ" [Ohm-meters]
1	0.30	0.5	0.1524	33.80	85.2	50.20	126.5
2	0.61	0.5	0.1524	11.20	47.2	13.50	56.9
4	1.22	0.5	0.1524	3.51	27.6	3.94	31.0
8	2.44	0.5	0.1524	1.78	27.5	1.58	24.4
15	4.57	1	0.3048	1.25	36.2	1.20	34.7
25	7.62	1	0.3048	0.72	34.6	0.73	35.0
50	15.24	1	0.3048	0.45	43.1	0.41	39.3
75	22.86	1	0.3048	0.35	50.3	0.32	46.0
100	30.48	1	0.3048	0.27	51.7	0.33	63.2
150	45.72	1	0.3048	0.21	60.3	0.15	43.1
200	60.96	1	0.3048	0.18	68.9	0.51	195.4

Apparent resistivity p is calculated as :
$$\rho = \frac{4\pi a R}{1 + \frac{2a}{\sqrt{a^2 + 4b^2}} - \frac{a}{\sqrt{a^2 + b^2}}}$$



ELECTRICAL EARTH RESISTIVITY TEST DATA

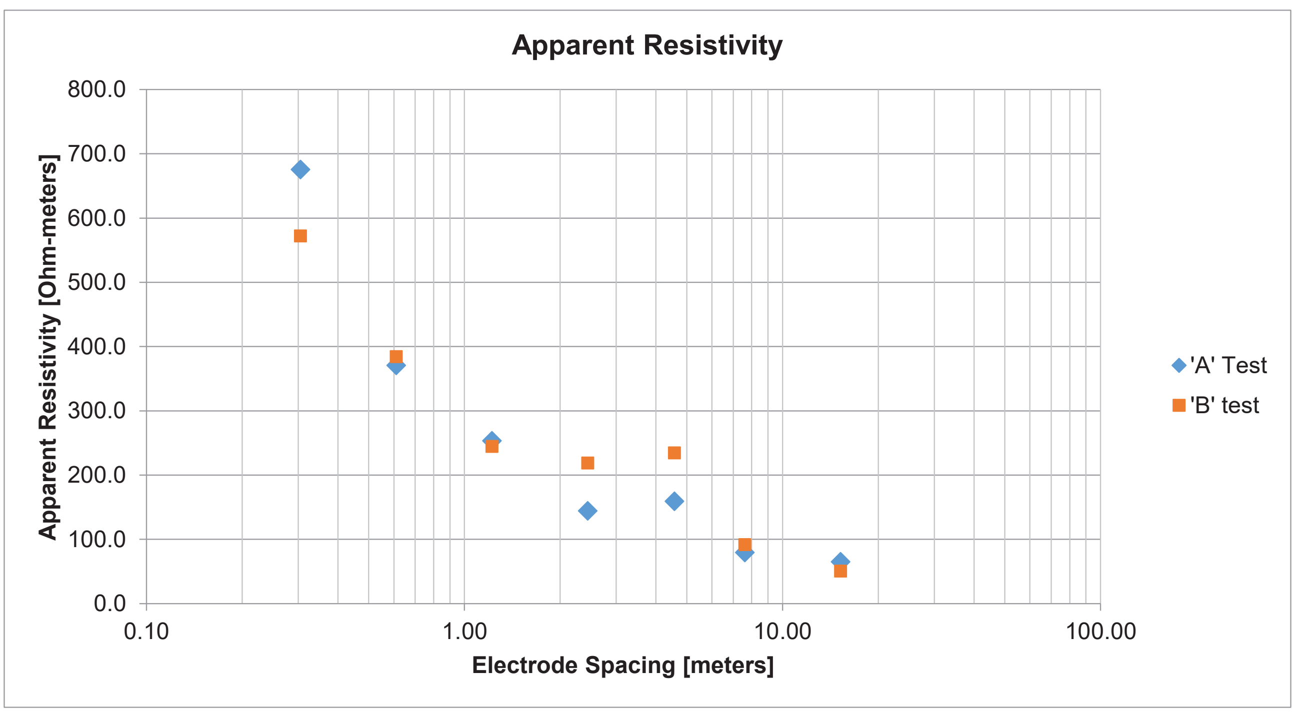
Test Line at EER-7 location with approximate center point: 37.295860°, -83.292171°

Project Bright Mountain Solar
Location Hazard, Kentucky
Project # N3225022
Test Date June 14, 2022

Weather Sunny
Surface Soil Clayey Sand with sandstone fragments and cobbles
Instrument AEMC Model 6471
Tested By Nazife Onaral

Electrode Spacing "a"		Electrode Depth "b"		"A" Test (Extended E-W)		"B" Test (Extended N-S)	
[feet]	[meters]	[feet]	[meters]	Measured Resistance "R" [Ohms]	Apparent Resistivity "ρ" [Ohm-meters]	Measured Resistance "R" [Ohms]	Apparent Resistivity "ρ" [Ohm-meters]
1	0.30	0.5	0.1524	268.00	675.4	227.00	572.1
2	0.61	0.5	0.1524	88.00	370.7	91.30	384.6
4	1.22	0.5	0.1524	32.20	253.3	31.10	244.6
8	2.44	0.5	0.1524	9.36	144.4	14.20	219.0
15	4.57	1	0.3048	5.50	159.2	8.10	234.5
25	7.62	1	0.3048	1.66	79.7	1.91	91.7
50	15.24	1	0.3048	0.68	65.2	0.53	50.8
75	22.86	1	0.3048	0.36	51.7	0.34	48.9
100	30.48	1	0.3048	0.29	55.5	0.23	44.1
150	45.72	1	0.3048	0.18	51.7	0.18	51.7
200	60.96	1	0.3048	0.16	61.3	0.16	61.3

Apparent resistivity p is calculated as : $\rho = \dfrac{4\pi a R}{1 + \dfrac{2a}{\sqrt{a^2 + 4b^2}} - \dfrac{a}{\sqrt{a^2 + b^2}}}$



ELECTRICAL EARTH RESISTIVITY TEST DATA

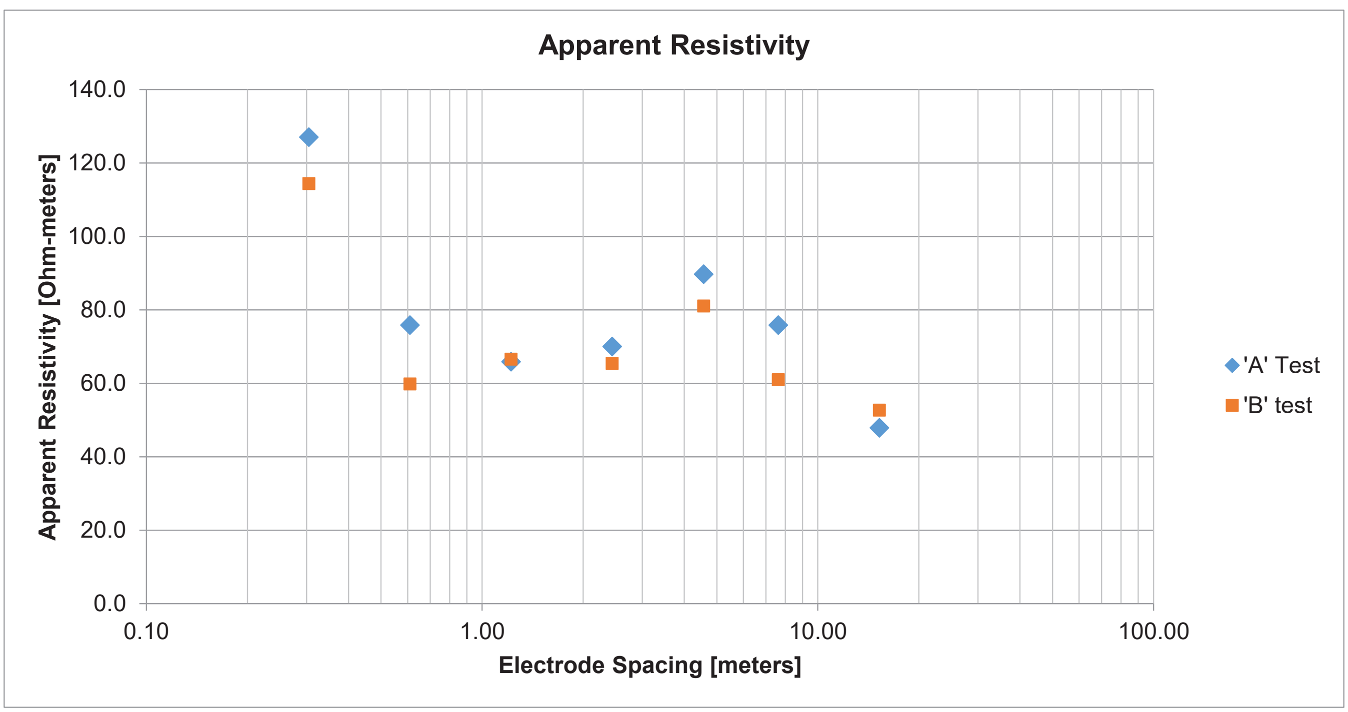
Test Line at EER-8 location with approximate center point: 37.293056°, -83.29°

Project	Bright Mountain Solar	**Weather**	Sunny
Location	Hazard, Kentucky	**Surface Soil**	Sandstone/shale fragments and cobbles, with silt/clay
Project #	N3225022	**Instrument**	AEMC Model 6471
Test Date	June 14, 2022	**Tested By**	Nazife Onaral

Electrode Spacing "a"		Electrode Depth "b"		"A" Test (Extended E-W)		"B" Test (Extended N-S)	
[feet]	[meters]	[feet]	[meters]	Measured Resistance "R" [Ohms]	Apparent Resistivity "ρ" [Ohm-meters]	Measured Resistance "R" [Ohms]	Apparent Resistivity "ρ" [Ohm-meters]
1	0.30	0.5	0.1524	50.40	127.0	45.40	114.4
2	0.61	0.5	0.1524	18.00	75.8	14.20	59.8
4	1.22	0.5	0.1524	8.38	65.9	8.46	66.5
8	2.44	0.5	0.1524	4.54	70.0	4.24	65.4
15	4.57	1	0.3048	3.10	89.7	2.80	81.1
25	7.62	1	0.3048	1.58	75.9	1.27	61.0
50	15.24	1	0.3048	0.50	47.9	0.55	52.7
75	22.86	1	0.3048	0.36	51.7	0.33	47.4
100	30.48	1	0.3048	0.27	51.7	0.24	46.0
150	45.72	1	0.3048	0.20	57.5	0.19	54.6
200	60.96	1	0.3048	0.18	68.9	0.16	61.3

Apparent resistivity p is calculated as :

$$\rho = \frac{4\pi a R}{1 + \frac{2a}{\sqrt{a^2 + 4b^2}} - \frac{a}{\sqrt{a^2 + b^2}}}$$



ELECTRICAL EARTH RESISTIVITY TEST DATA

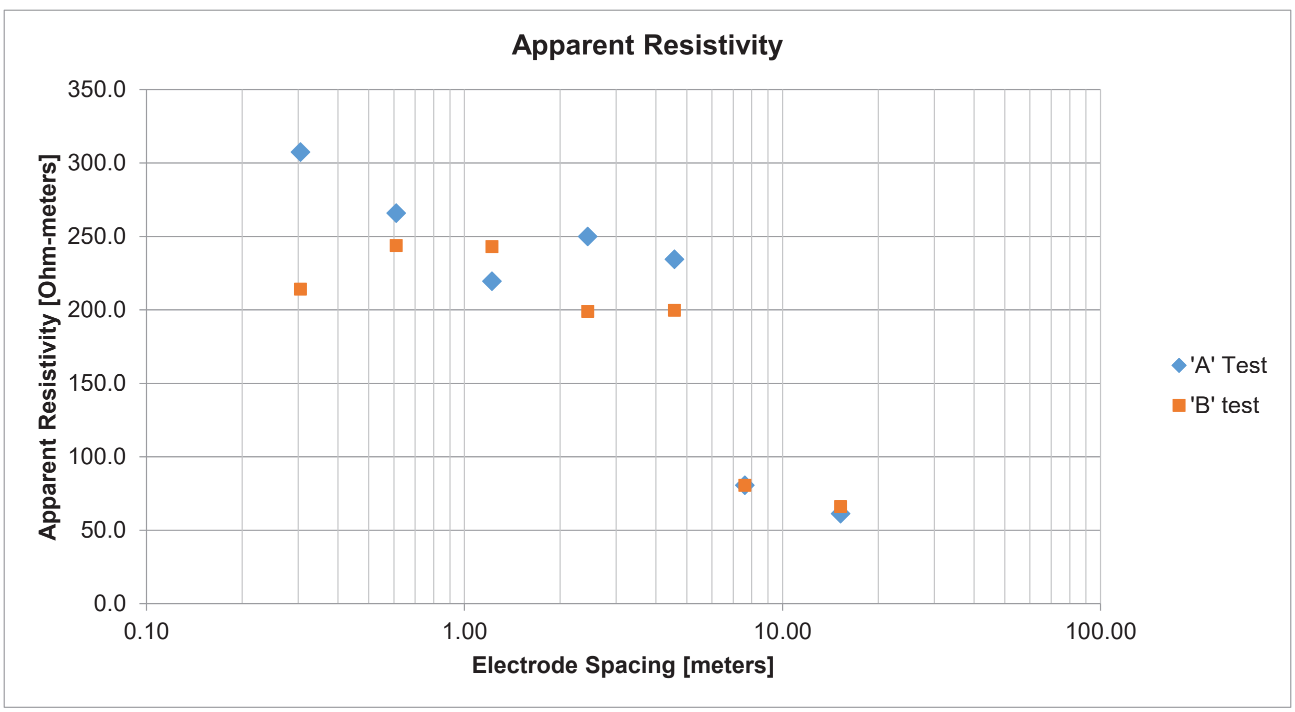
Test Line at EER-9 location with approximate center point: 37.292778°, -83.285278°

Project Bright Mountain Solar
Location Hazard, Kentucky
Project # N3225022
Test Date June 13, 2022

Weather Sunny
Surface Soil Clayey sand with sandstone/shale fragments&cobbles
Instrument AEMC Model 6471
Tested By Nazife Onaral

Electrode Spacing "a"		Electrode Depth "b"		"A" Test (Extended E-W)		"B" Test (Extended N-S)	
[feet]	[meters]	[feet]	[meters]	Measured Resistance "R" [Ohms]	Apparent Resistivity "ρ" [Ohm-meters]	Measured Resistance "R" [Ohms]	Apparent Resistivity "ρ" [Ohm-meters]
1	0.30	0.5	0.1524	122.00	307.5	85.00	214.2
2	0.61	0.5	0.1524	63.10	265.8	57.90	243.9
4	1.22	0.5	0.1524	27.90	219.4	30.90	243.0
8	2.44	0.5	0.1524	16.20	249.9	12.90	199.0
15	4.57	1	0.3048	8.10	234.5	6.90	199.7
25	7.62	1	0.3048	1.68	80.7	1.68	80.7
50	15.24	1	0.3048	0.64	61.3	0.69	66.1
75	22.86	1	0.3048	0.47	67.5	0.51	73.3
100	30.48	1	0.3048	0.40	76.6	0.45	86.2
150	45.72	1	0.3048	0.33	94.8	0.37	106.3
200	60.96	1	0.3048	0.29	111.1	0.33	126.4

Apparent resistivity p is calculated as : $\rho = \dfrac{4\pi a R}{1 + \dfrac{2a}{\sqrt{a^2 + 4b^2}} - \dfrac{a}{\sqrt{a^2 + b^2}}}$



ELECTRICAL EARTH RESISTIVITY TEST DATA

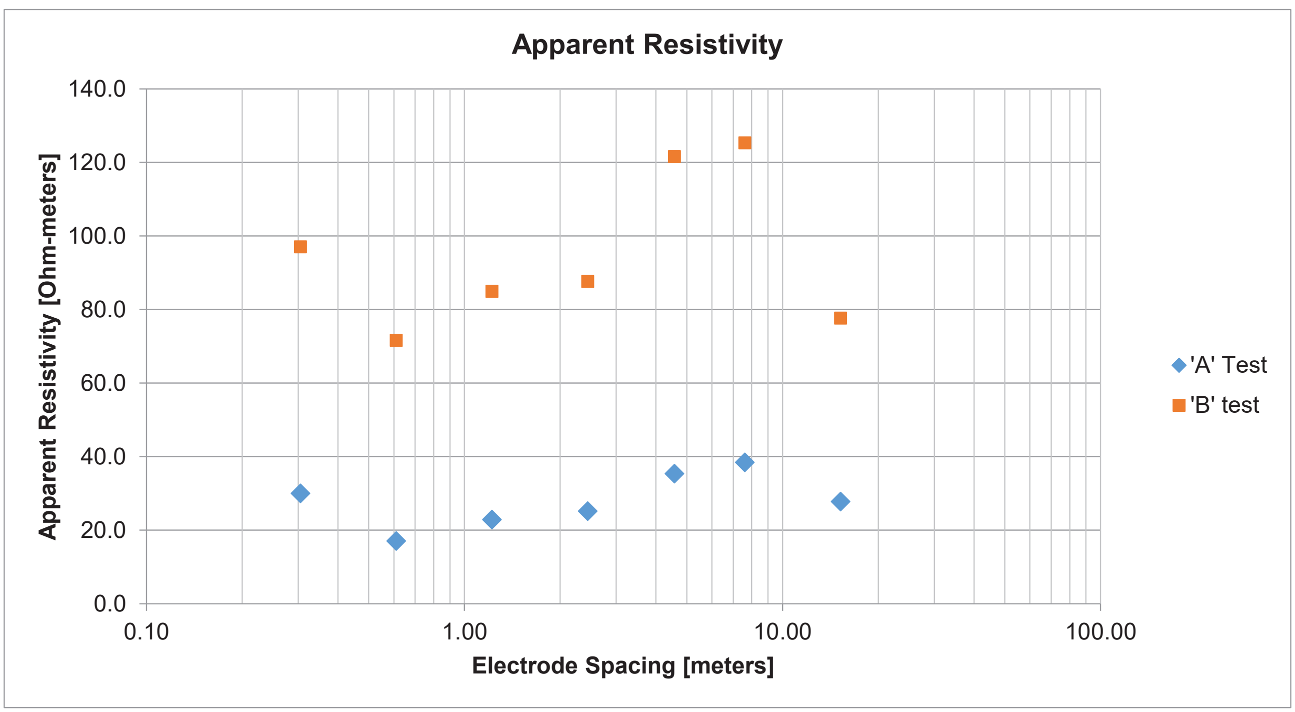
Test Line at EER-10 location with approximate center point: 37.836389°, 86.163611°

Project Bright Mountain Solar
Location Hazard, Kentucky
Project # N3225022
Test Date June 15, 2022

Weather Sunny
Surface Soil Clayey sand with sandstone/shale fragments&cobbles
Instrument AEMC Model 6471
Tested By Nazife Onaral

Electrode Spacing "a"		Electrode Depth "b"		"A" Test (Extended E-W)		"B" Test (Extended N-S)	
[feet]	[meters]	[feet]	[meters]	Measured Resistance "R" [Ohms]	Apparent Resistivity "ρ" [Ohm-meters]	Measured Resistance "R" [Ohms]	Apparent Resistivity "ρ" [Ohm-meters]
1	0.30	0.5	0.1524	11.90	30.0	38.50	97.0
2	0.61	0.5	0.1524	4.04	17.0	17.00	71.6
4	1.22	0.5	0.1524	2.91	22.9	10.80	84.9
8	2.44	0.5	0.1524	1.63	25.1	5.68	87.6
15	4.57	1	0.3048	1.22	35.3	4.20	121.6
25	7.62	1	0.3048	0.80	38.4	2.61	125.3
50	15.24	1	0.3048	0.29	27.8	0.81	77.6
75	22.86	1	0.3048	0.15	21.6	0.49	70.4
100	30.48	1	0.3048	0.10	19.2	0.29	55.5
150	45.72	1	0.3048	0.08	23.0	0.32	91.9
200	60.96	1	0.3048	0.05	19.2	0.28	107.3
300	91.44	1	0.3048	0.07	40.2	0.22	126.4
400	121.92	1	0.3048	0.06	46.0	0.6	459.6

Apparent resistivity p is calculated as : $$\rho = \frac{4\pi a R}{1 + \frac{2a}{\sqrt{a^2 + 4b^2}} - \frac{a}{\sqrt{a^2 + b^2}}}$$



CHEMICAL LABORATORY TEST REPORT

Project Number: N3225022
Service Date: 06/04/22
Report Date: 06/09/22

Terracon
10400 State Highway 191
Midland, Texas 79707
432-684-9600

Client

Aurora Solar LLC
1125 NW Couch Street, Suite 600
Portland, OR 97209-4129

Project

Bright Mountain Solar
Couch Br Road
Hazard, KY

Sample Location	B-1	B-2	B-3	B-4	B-5	B-6	B-7	B-8
Sample Depth (ft.)	0-5	0-5	0-5	0-5	0-5	0-5	0-5	0-5
pH Analysis, ASTM - G51-18	7.0	7.7	7.5	7.0	7.1	7.1	7.3	7.6
Water Soluble Sulfate (SO4), ASTM C 1580 (mg/kg)	238	14	43	1,479	22	308	185	49
Sulfides, ASTM - D4658-15, (mg/kg)	nil	nil	nil	nil	nil	nil	nil	nil
Chlorides, ASTM D 512 , (mg/kg)	50	38	44	44	81	44	38	50
RedOx, ASTM D-1498, (mV)	+443	+410	+430	+430	+391	+407	+409	+372
Total Salts, ASTM D1125-14, (mg/kg)	909	74	225	2,870	927	1,315	637	878
Resistivity, ASTM G187, (ohm-cm)	2,168	17,553	10,015	1,136	2,581	1,755	2,581	2,065

Analyzed By: Zach Robertson

Zach Robertson
Engineering Technician III

CHEMICAL LABORATORY TEST REPORT

Project Number: N3225022
Service Date: 06/04/22
Report Date: 06/09/22

Terracon
10400 State Highway 191
Midland, Texas 79707
432-684-9600

Client

Aurora Solar LLC
1125 NW Couch Street, Suite 600
Portland, OR 97209-4129

Project

Bright Mountain Solar
Couch Br Road
Hazard, KY

Sample Location	B-9	B-10
Sample Depth (ft.)	0-5	0-5
pH Analysis, ASTM - G51-18	7.5	7.8
Water Soluble Sulfate (SO4), ASTM C 1580 (mg/kg)	286	77
Sulfides, ASTM - D4658-15, (mg/kg)	nil	nil
Chlorides, ASTM D 512 , (mg/kg)	38	50
RedOx, ASTM D-1498, (mV)	+406	+395
Total Salts, ASTM D1125-14, (mg/kg)	986	644
Resistivity, ASTM G187, (ohm-cm)	2,478	2,375

Analyzed By: Zach Robertson

Zach Robertson
Engineering Technician III

MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557

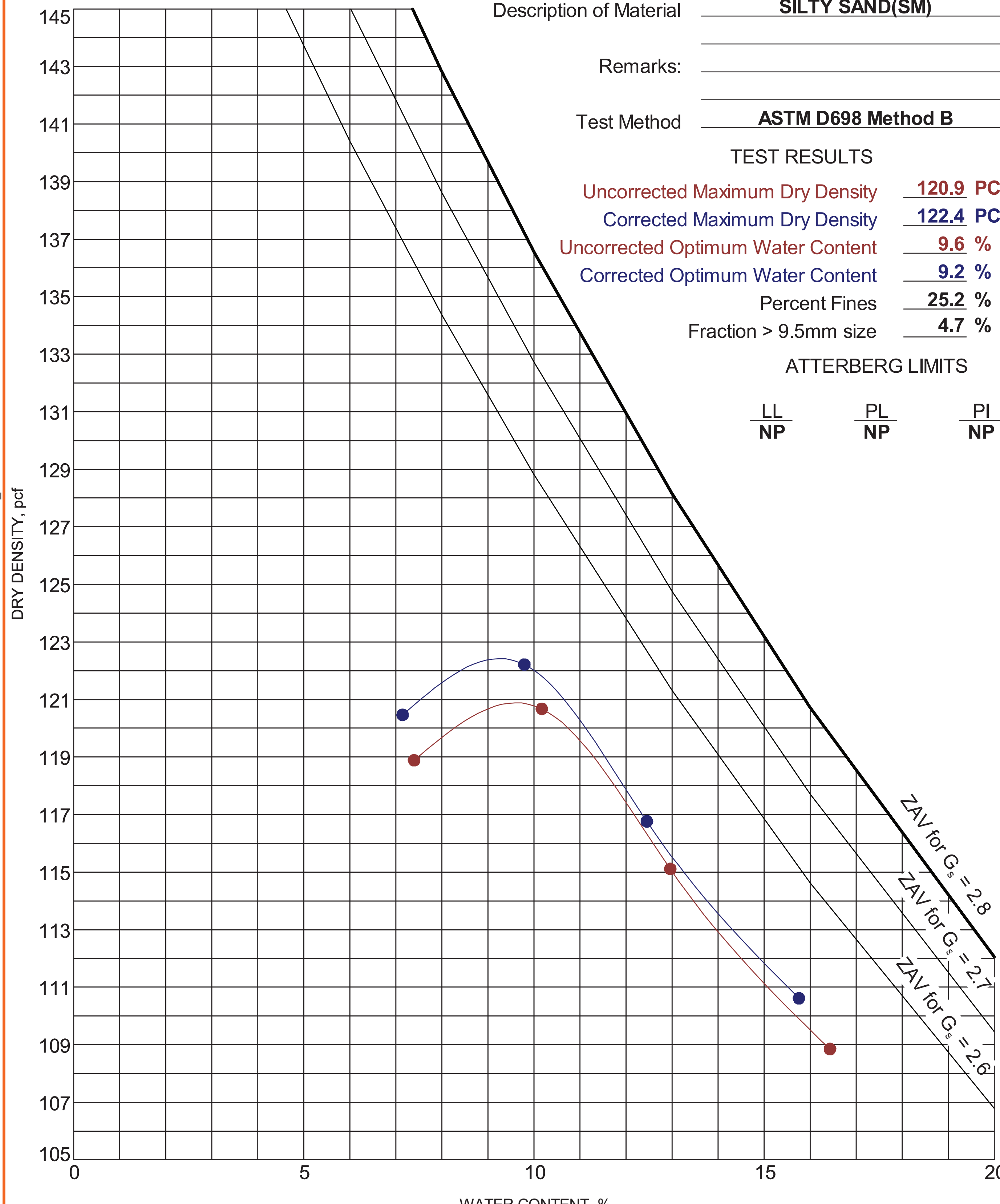
Source of Material	**B-3 @ 0.1 - 5.1 feet**
Description of Material	**SILTY SAND(SM)**
Remarks:	
Test Method	**ASTM D698 Method B**

TEST RESULTS

Uncorrected Maximum Dry Density	120.9	PCF
Corrected Maximum Dry Density	122.4	PCF
Uncorrected Optimum Water Content	9.6	%
Corrected Optimum Water Content	9.2	%
Percent Fines	25.2	%
Fraction > 9.5mm size	4.7	%

ATTERBERG LIMITS

LL	PL	PI
NP	NP	NP



LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. COMPACTION - V1 N3225022 BRIGHT MOUNTAIN S.GPJ TERRACON_DATATEMPLATE.GDT 6/14/22

PROJECT: Bright Mountain Solar	Terracon	PROJECT NUMBER: N3225022
SITE: Couch Br Rd Hazard, KY	2460 Palumbo Dr Lexington, KY	CLIENT: Aurora Solar LLC Portland, OR

MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557

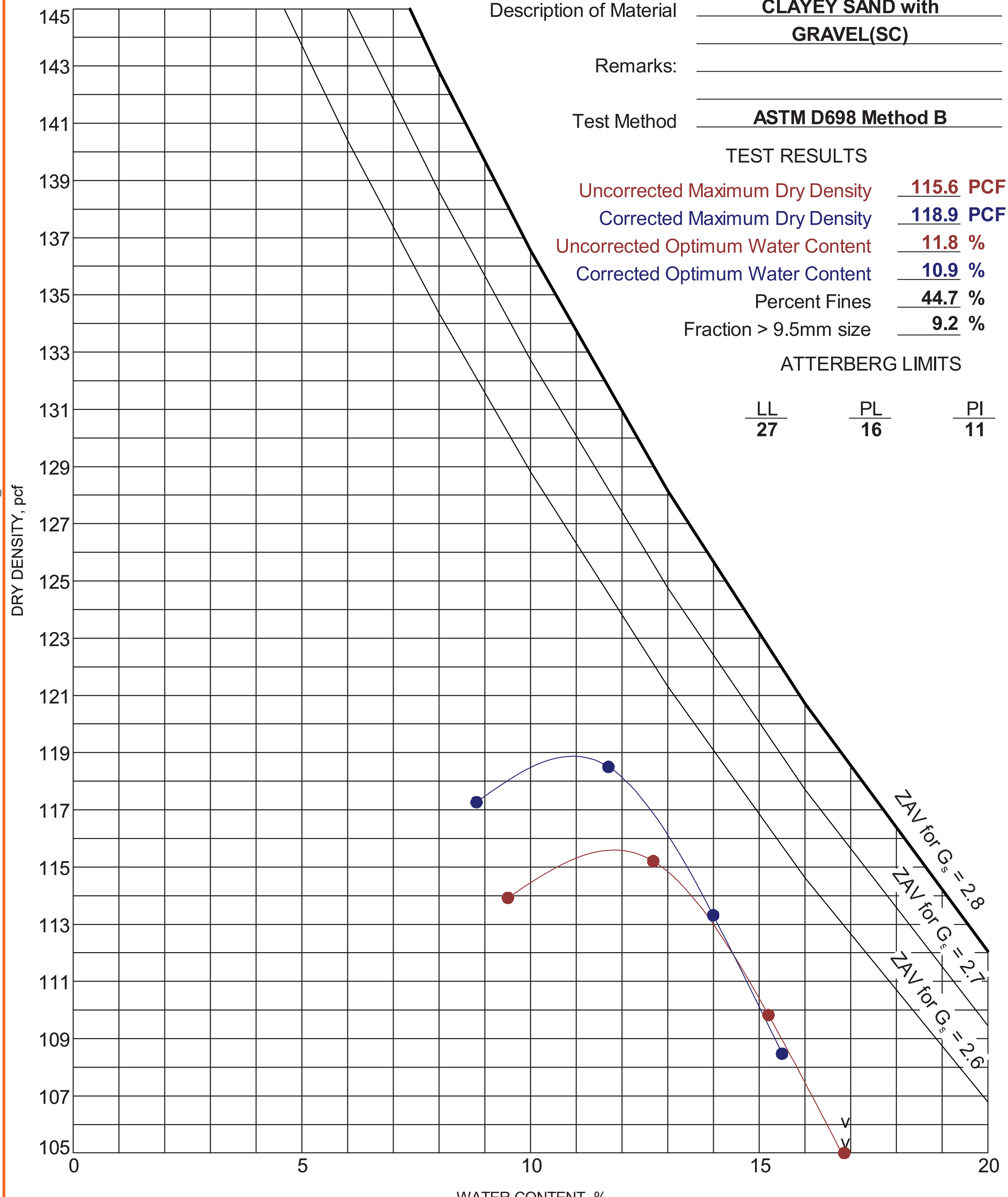
Source of Material	**B-4 @ 0.1 - 5.1 feet**
Description of Material	**CLAYEY SAND with GRAVEL(SC)**
Remarks:	
Test Method	**ASTM D698 Method B**

TEST RESULTS

Uncorrected Maximum Dry Density	**115.6**	**PCF**
Corrected Maximum Dry Density	**118.9**	**PCF**
Uncorrected Optimum Water Content	**11.8**	**%**
Corrected Optimum Water Content	**10.9**	**%**
Percent Fines	**44.7**	**%**
Fraction > 9.5mm size	**9.2**	**%**

ATTERBERG LIMITS

LL	PL	PI
27	**16**	**11**



LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. COMPACTION - V1 N3225022 BRIGHT MOUNTAIN S.GPJ TERRACON_DATATEMPLATE.GDT 6/14/22

PROJECT: Bright Mountain Solar	Terracon	PROJECT NUMBER: N3225022
SITE: Couch Br Rd Hazard, KY	2460 Palumbo Dr Lexington, KY	CLIENT: Aurora Solar LLC Portland, OR

MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557

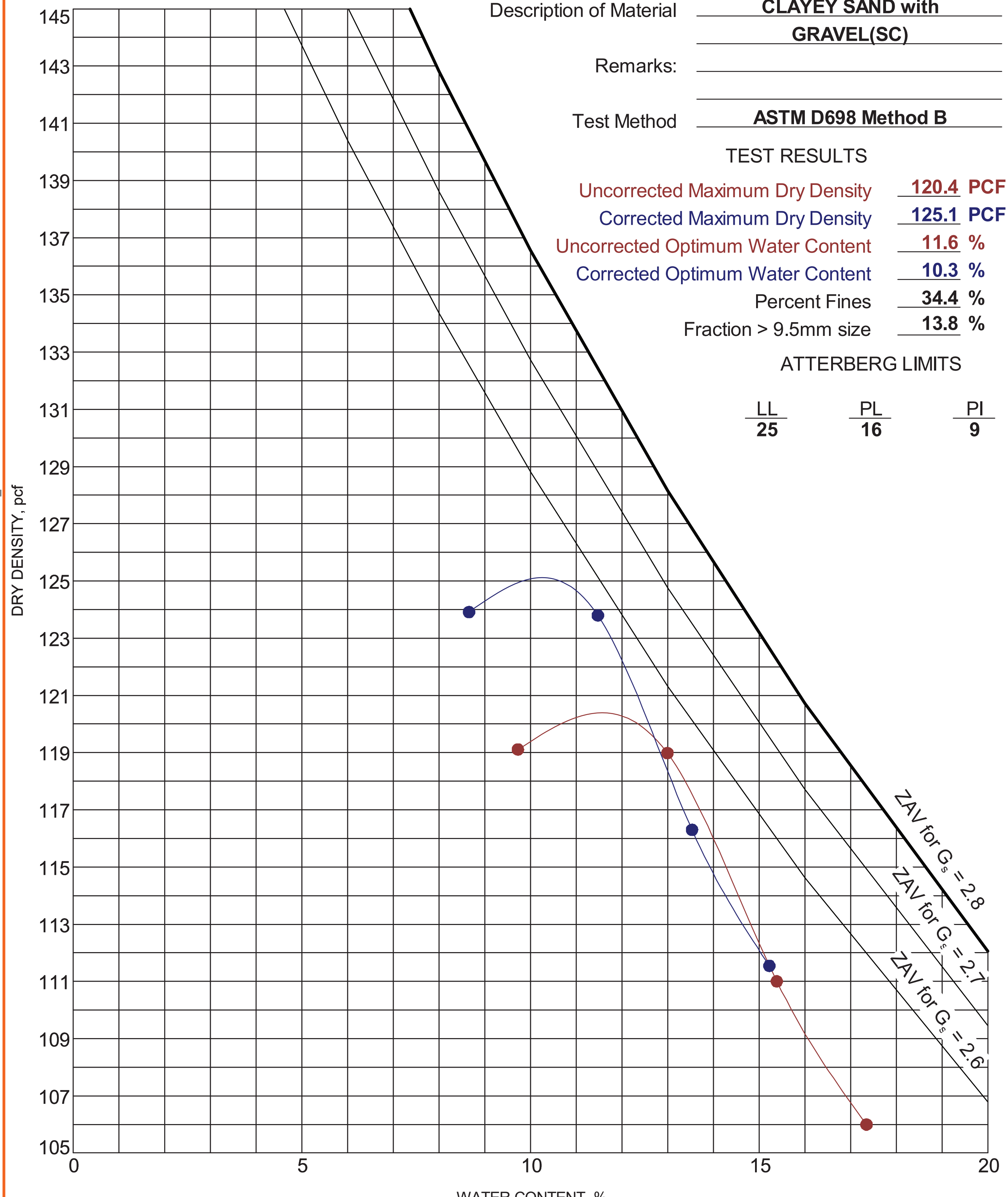
Source of Material	**B-7 @ 0.1 - 5.1 feet**
Description of Material	**CLAYEY SAND with GRAVEL(SC)**
Remarks:	
Test Method	**ASTM D698 Method B**

TEST RESULTS

Uncorrected Maximum Dry Density	**120.4**	**PCF**
Corrected Maximum Dry Density	**125.1**	**PCF**
Uncorrected Optimum Water Content	**11.6**	**%**
Corrected Optimum Water Content	**10.3**	**%**
Percent Fines	**34.4**	**%**
Fraction > 9.5mm size	**13.8**	**%**

ATTERBERG LIMITS

LL	PL	PI
25	**16**	**9**



LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. COMPACTION - V1 N3225022 BRIGHT MOUNTAIN S.GPJ TERRACON_DATATEMPLATE.GDT 6/14/22

PROJECT: Bright Mountain Solar	Terracon	PROJECT NUMBER: N3225022
SITE: Couch Br Rd Hazard, KY	2460 Palumbo Dr Lexington, KY	CLIENT: Aurora Solar LLC Portland, OR

MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557

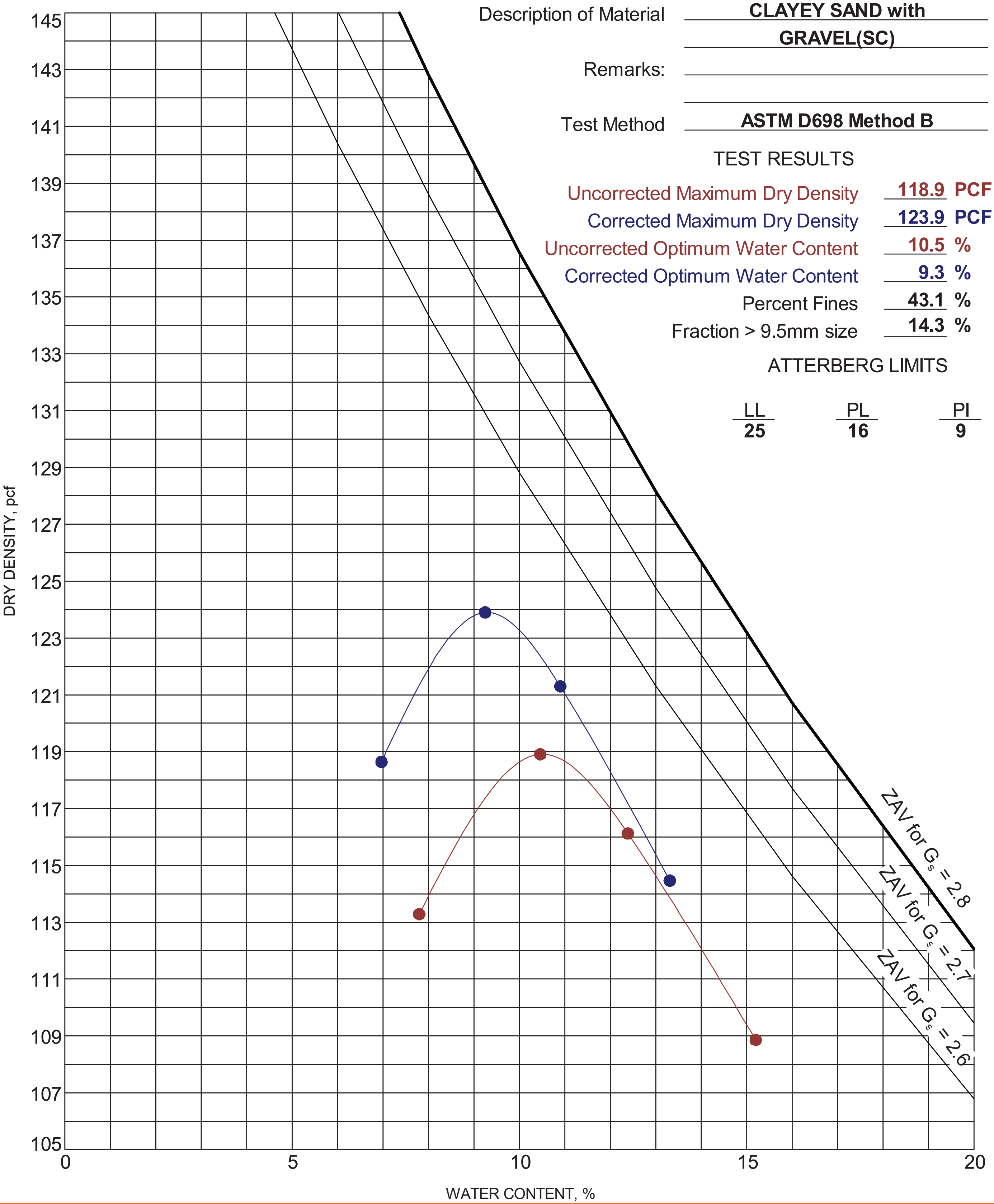
Source of Material	**B-9 @ 0.1 - 5.1 feet**
Description of Material	**CLAYEY SAND with GRAVEL(SC)**
Remarks:	
Test Method	**ASTM D698 Method B**

TEST RESULTS

Uncorrected Maximum Dry Density	**118.9**	**PCF**
Corrected Maximum Dry Density	**123.9**	**PCF**
Uncorrected Optimum Water Content	**10.5**	**%**
Corrected Optimum Water Content	**9.3**	**%**
Percent Fines	**43.1**	**%**
Fraction > 9.5mm size	**14.3**	**%**

ATTERBERG LIMITS

LL	PL	PI
25	**16**	**9**



LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. COMPACTION - V1 N3225022 BRIGHT MOUNTAIN S.GPJ TERRACON_DATATEMPLATE.GDT 6/14/22

PROJECT: Bright Mountain Solar	Terracon 2460 Palumbo Dr Lexington, KY	PROJECT NUMBER: N3225022
SITE: Couch Br Rd Hazard, KY		CLIENT: Aurora Solar LLC Portland, OR

MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557

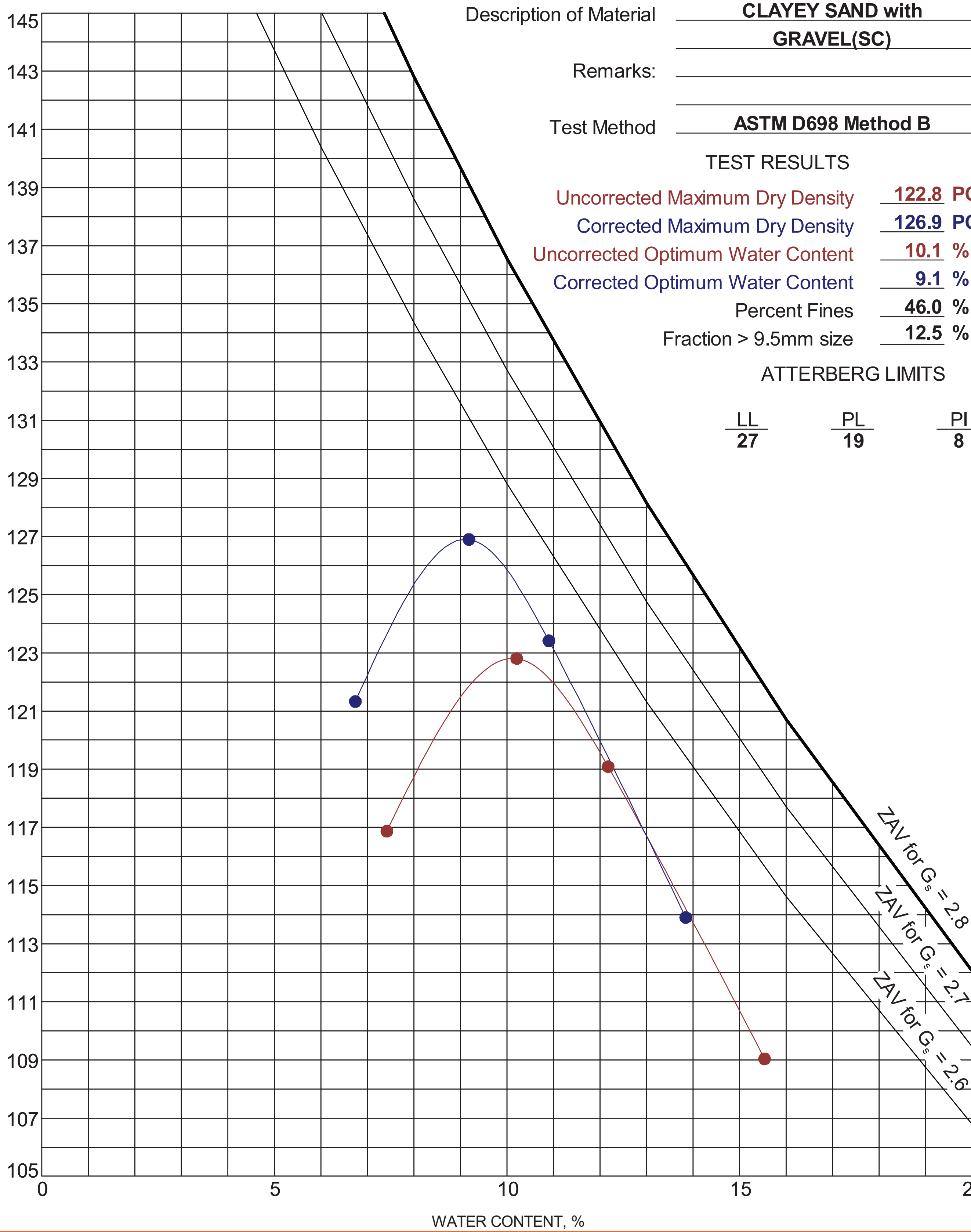
Source of Material	**B-10 @ 0.1 - 5.1 feet**
Description of Material	**CLAYEY SAND with GRAVEL(SC)**
Remarks:	
Test Method	**ASTM D698 Method B**

TEST RESULTS

Uncorrected Maximum Dry Density	**122.8 PCF**
Corrected Maximum Dry Density	**126.9 PCF**
Uncorrected Optimum Water Content	**10.1 %**
Corrected Optimum Water Content	**9.1 %**
Percent Fines	**46.0 %**
Fraction > 9.5mm size	**12.5 %**

ATTERBERG LIMITS

LL	PL	PI
27	**19**	**8**



LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. COMPACTION - V1 N3225022 BRIGHT MOUNTAIN S.GPJ TERRACON_DATATEMPLATE.GDT 6/14/22

PROJECT: Bright Mountain Solar	Terracon 2460 Palumbo Dr Lexington, KY	PROJECT NUMBER: N3225022
SITE: Couch Br Rd Hazard, KY		CLIENT: Aurora Solar LLC Portland, OR

Geotherm USA

21239 FM529 Rd., Bldg. F
Cypress, TX 77433
Tel: 281-985-9344
Fax: 832-427-1752
info@geothermusa.com
http://www.geothermusa.com

June 24, 2022

Terracon
2460 Palumbo Drive
Lexington, Kentucky 40509
Attn: Samuel G. Guy, P.E.

Re: Thermal Analysis of Native Soil Samples
Bright Mountain Solar – Busy, Kentucky (Project No. N3225022)

The following is the report of thermal dryout characterization tests conducted on five (5) samples of native soil from the referenced project sent to our laboratory.

Thermal Resistivity Tests: The samples were tested at the 'optimum' moisture content and 85% of the standard Proctor dry density ***provided by Terracon***. The tests were conducted in accordance with the IEEE standard 442-2017. The results are tabulated below and the thermal dryout curves are presented in **Figures 1 to 5.**

Sample ID, Description, Thermal Resistivity, Moisture Content and Density

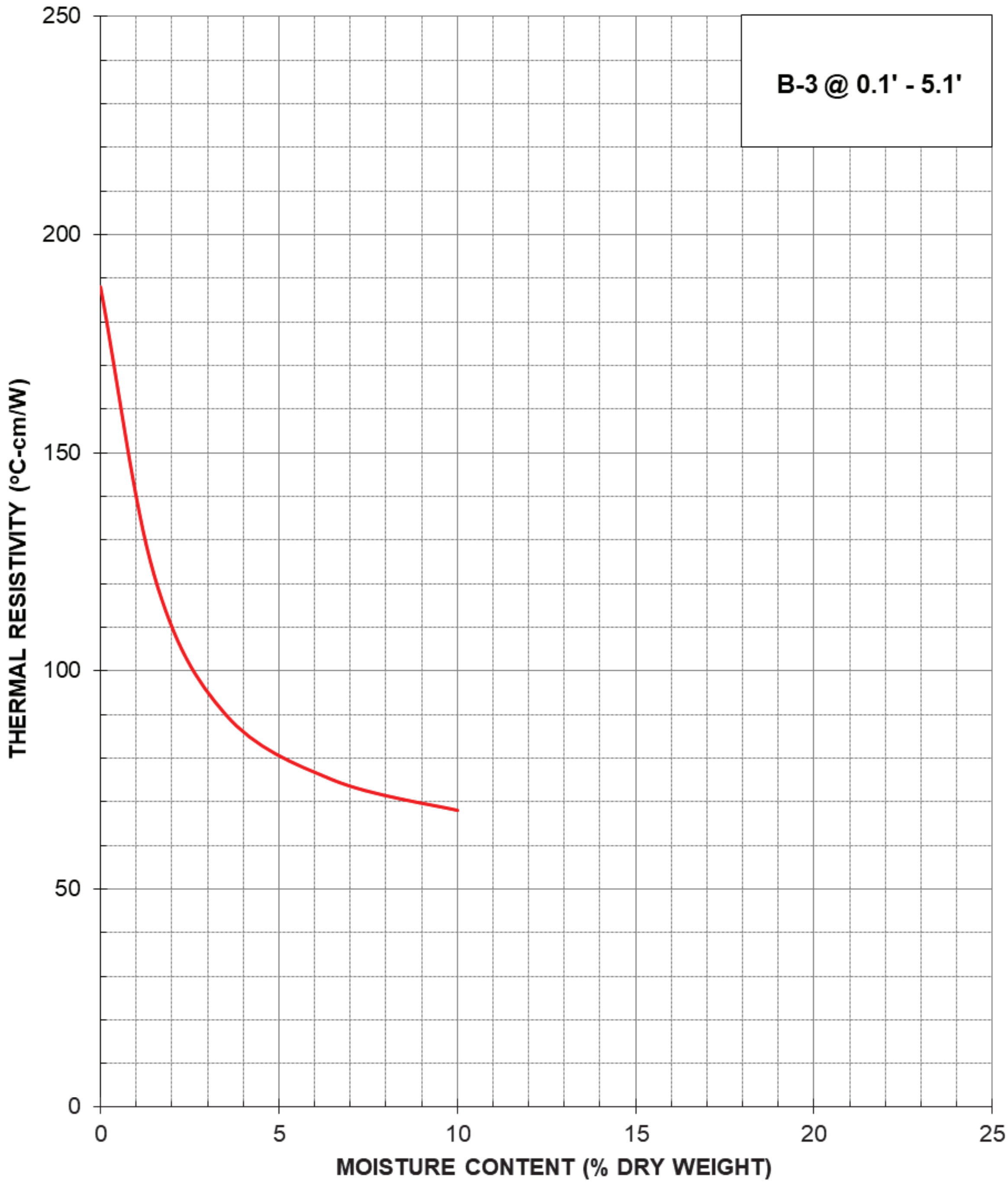
Sample ID	Depth (ft)	Description (*Terracon*)	Thermal Resistivity (°C-cm/W)		Moisture Content (%)	Dry Density (lb/ft^3)
			Wet	Dry		
B-3	0.1-5.1	Silty sand (SM)	68	188	10	103
B-4	0.1-5.1	Clayey sand w/ gravel (SC)	84	246	12	98
B-7	0.1-5.1	Clayey sand w/ gravel (SC)	80	212	12	102
B-9	0.1-5.1	Clayey sand w/ gravel (SC)	85	228	11	101
B-10	0.1-5.1	Clayey sand w/ gravel (SC)	90	203	10	104

Please contact us if you have any questions or if we can be of further assistance.

Geotherm USA

Nimesh Patel

THERMAL DRYOUT CURVE



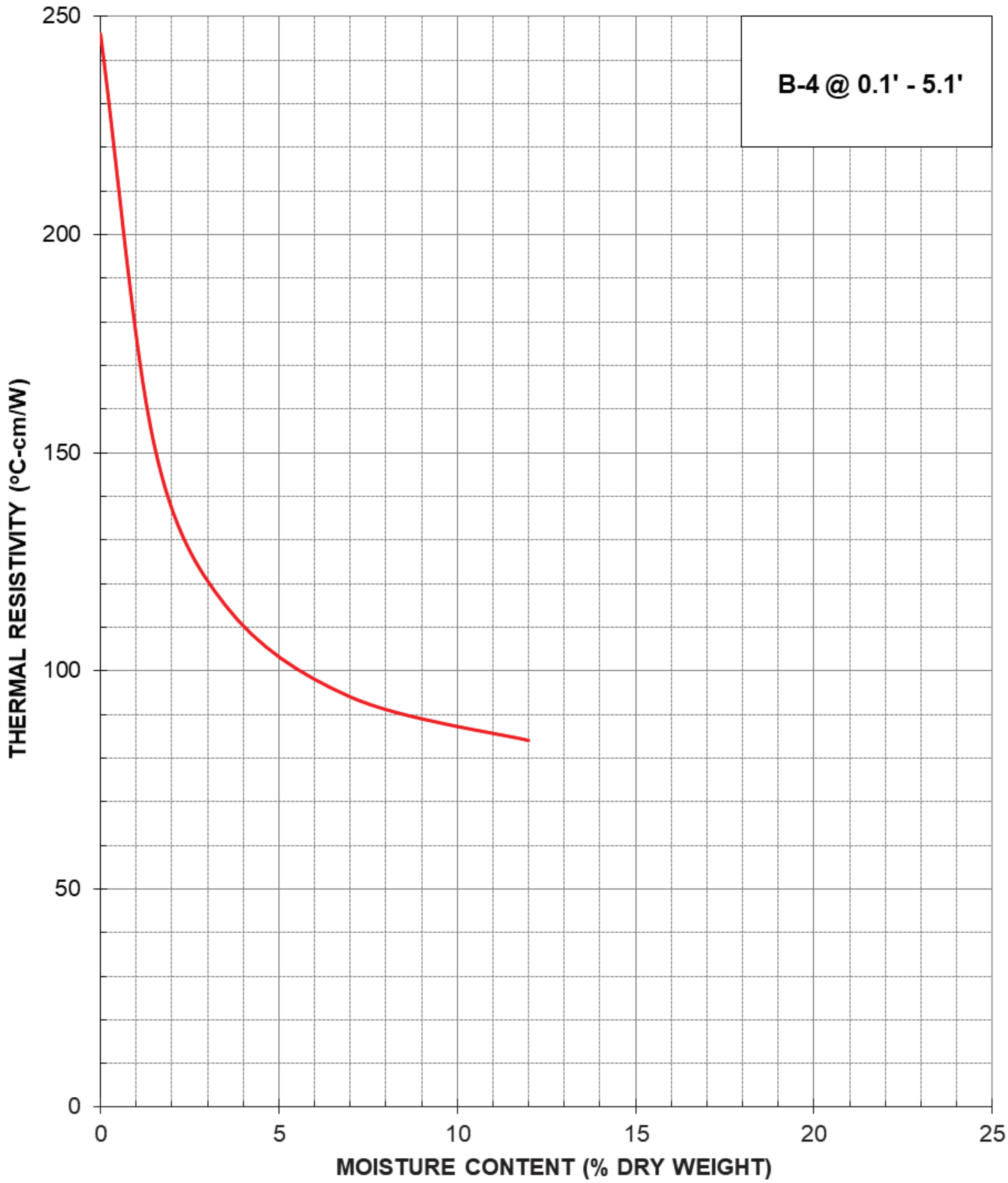
Terracon (Project No. N3225022)

Bright Mountain Solar – Busy, Kentucky

Thermal Analysis of Native Soil Samples

June 2022 **Figure 1**

THERMAL DRYOUT CURVE



Terracon (Project No. N3225022)

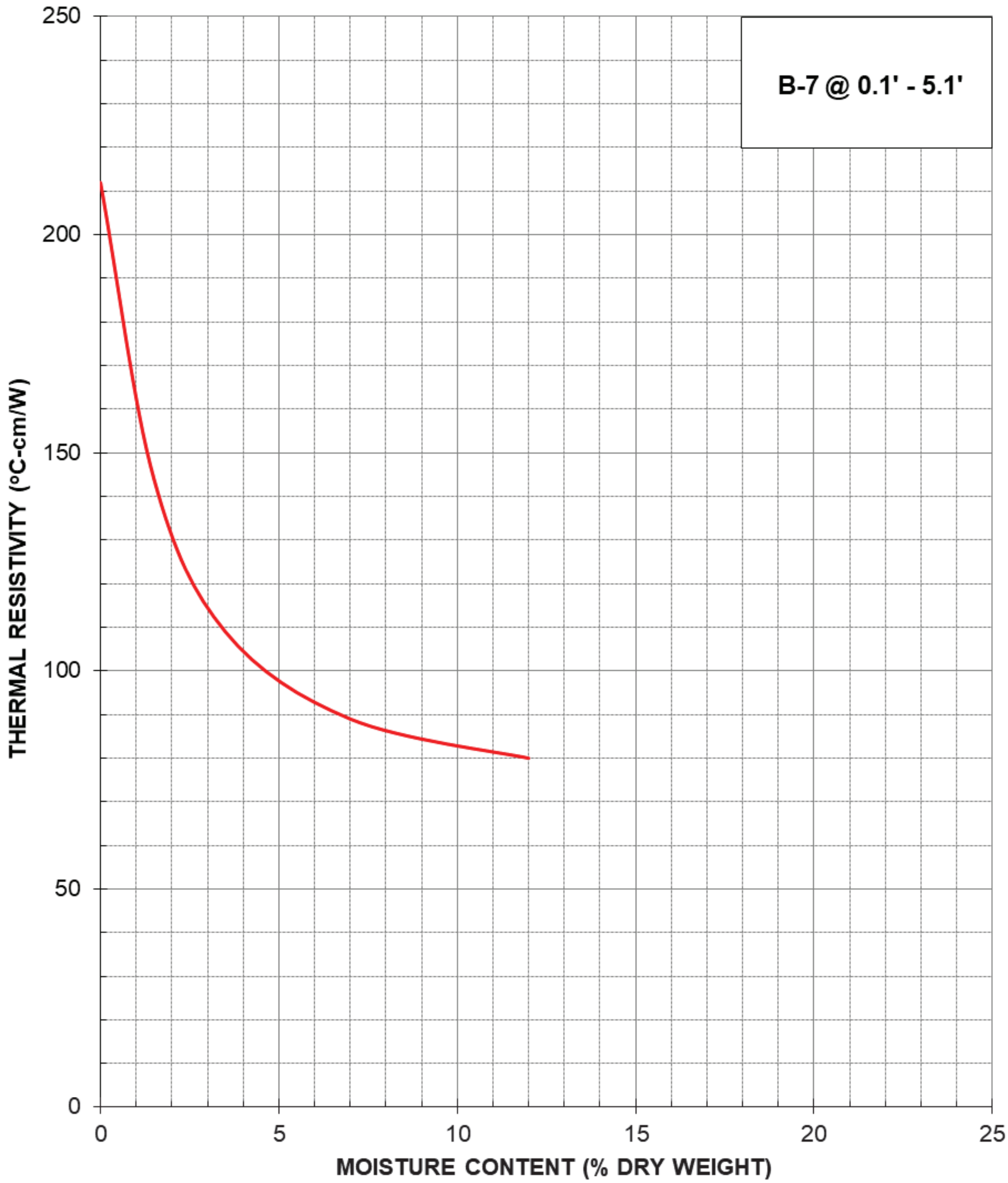
Bright Mountain Solar – Busy, Kentucky

Thermal Analysis of Native Soil Samples

June 2022 **Figure 2**

Geotherm USA

THERMAL DRYOUT CURVE



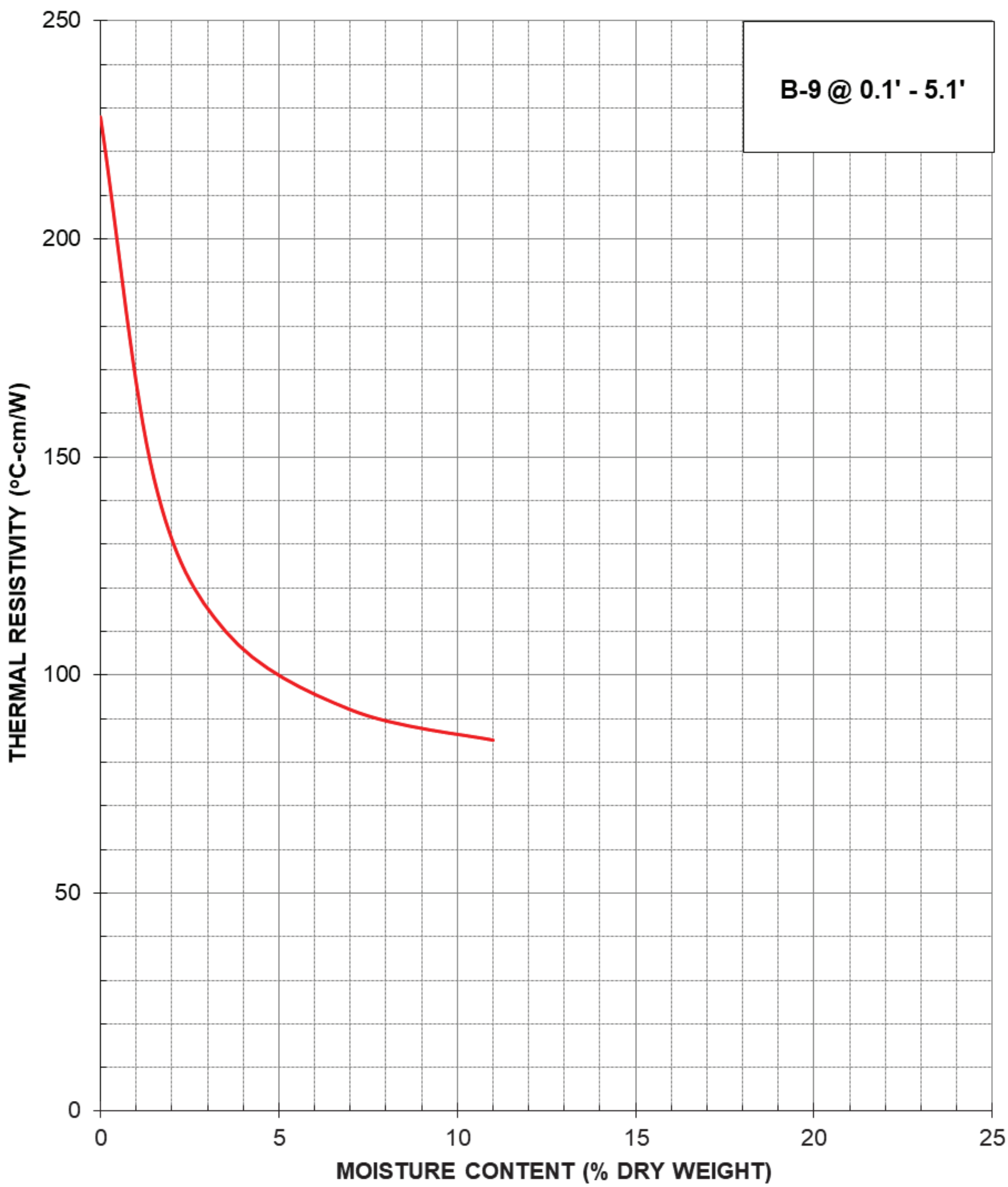
Terracon (Project No. N3225022)

Bright Mountain Solar – Busy, Kentucky

Thermal Analysis of Native Soil Samples

June 2022 **Figure 3**

THERMAL DRYOUT CURVE



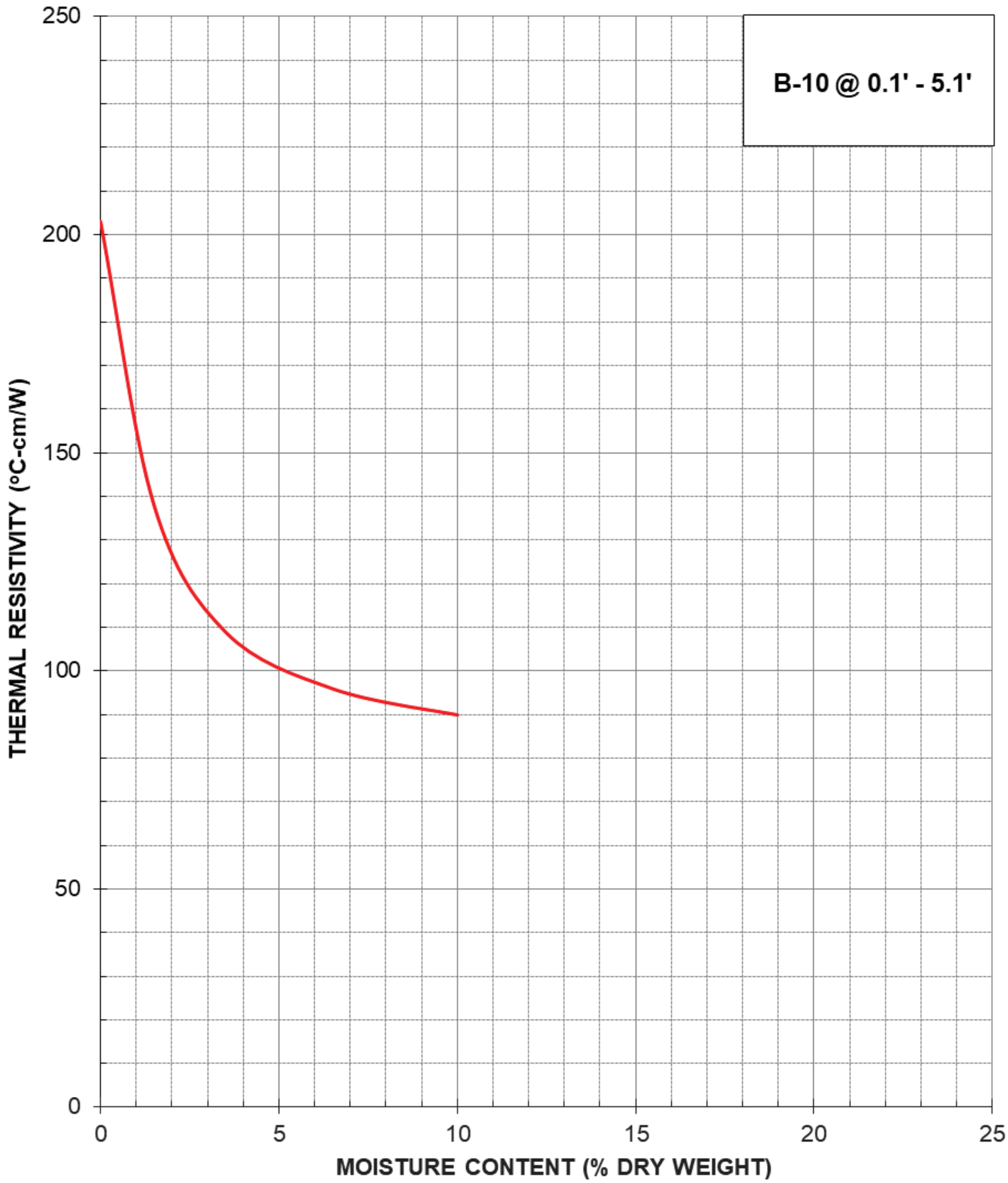
Terracon (Project No. N3225022)

Bright Mountain Solar – Busy, Kentucky

Thermal Analysis of Native Soil Samples

June 2022 **Figure 4**

THERMAL DRYOUT CURVE



Terracon (Project No. N3225022)

Bright Mountain Solar – Busy, Kentucky

Thermal Analysis of Native Soil Samples

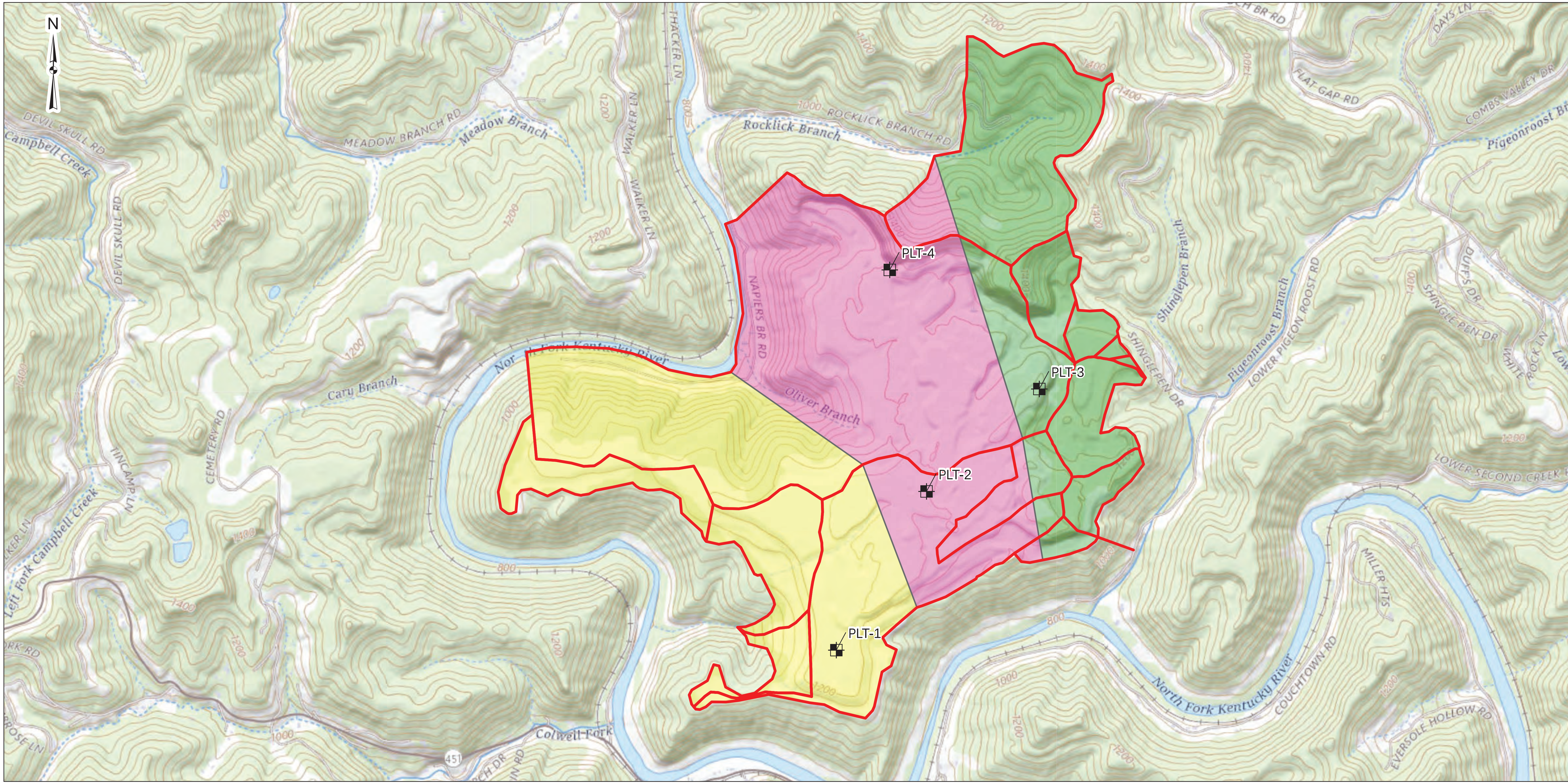
June 2022 **Figure 5**

PILE DRIVING AND LOAD TESTING RESULTS

PILE LOAD TEST & ZONE PLANS

Contents:

Note: All attachments are one page unless noted above.



Project Site

PLT Location

Axial Pile Zones

Zone 1

Zone 2

Zone 3

DATA SOURCES:
ESRI WMS - Streets, Topographic
Site Boundary: Bright Mountain lease area with adjoining areas.kmz

Feet

0 650 1,300 2,600

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Project No.:	N3225022
Date:	Jul 2022
Drawn By:	PJS
Reviewed By:	SGG

Terracon
2460 Palumbo Dr
Lexington, KY
PH. 859-303-9000 terracon.com

Axial Pile Zone Plan

Bright Mountain Solar
Aurora Solar LLC
Perry County, KY

Exhibit

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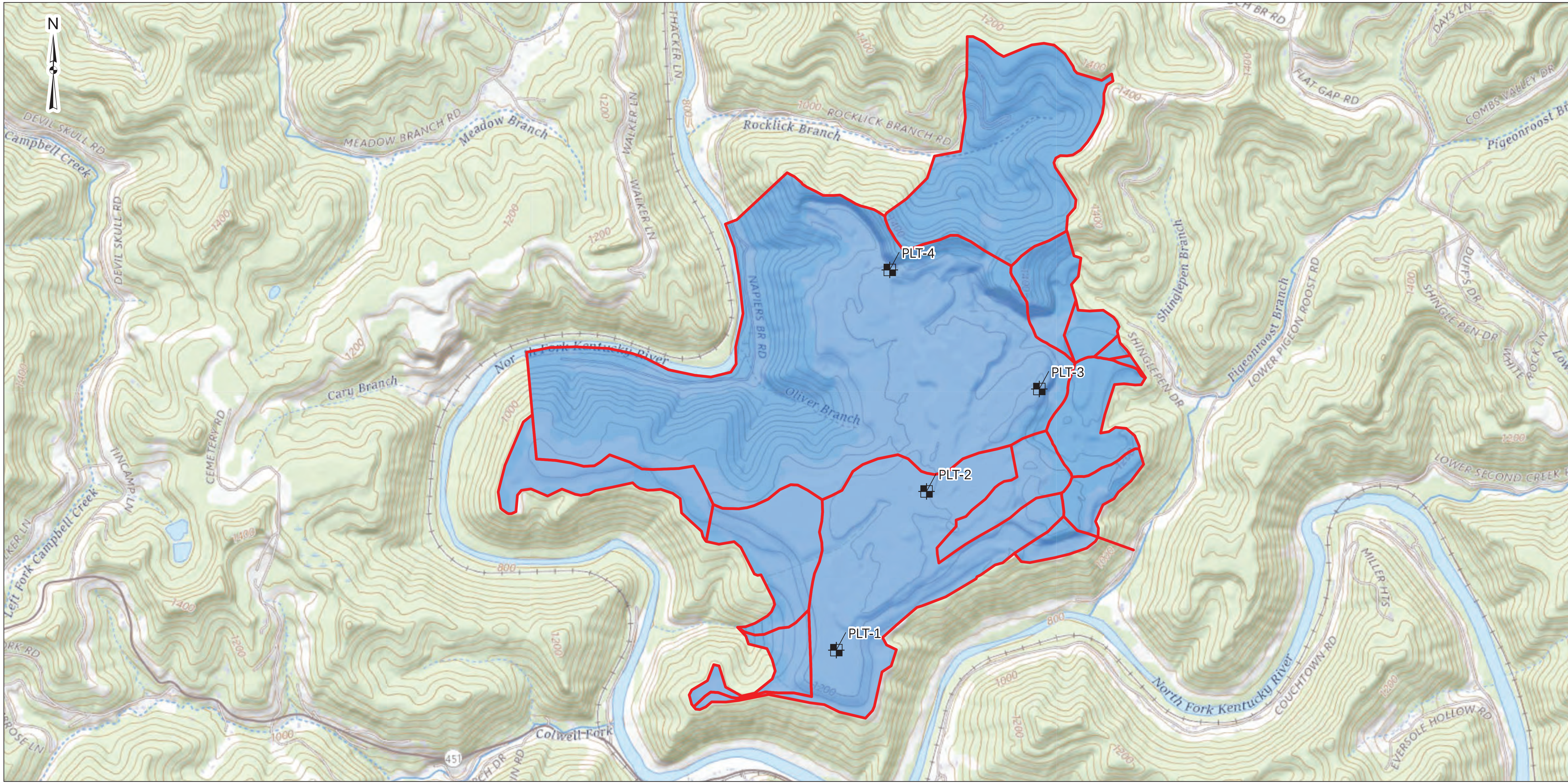

- Project Site
- PLT Location

Lateral Pile Zones

- Zone A

DATA SOURCES:
ESRI WMS - Streets, Topographic
Site Boundary: Bright Mountain lease area with adjoining areas.kmz

Feet
0 650 1,300 2,600

Project No.:	N3225022
Date:	Jul 2022
Drawn By:	PJS
Reviewed By:	SGG

Terracon
2460 Palumbo Dr
Lexington, KY
PH. 859-303-9000 terracon.com

Lateral Pile Zone Plan

Bright Mountain Solar
Aurora Solar LLC
Perry County, KY

Exhibit

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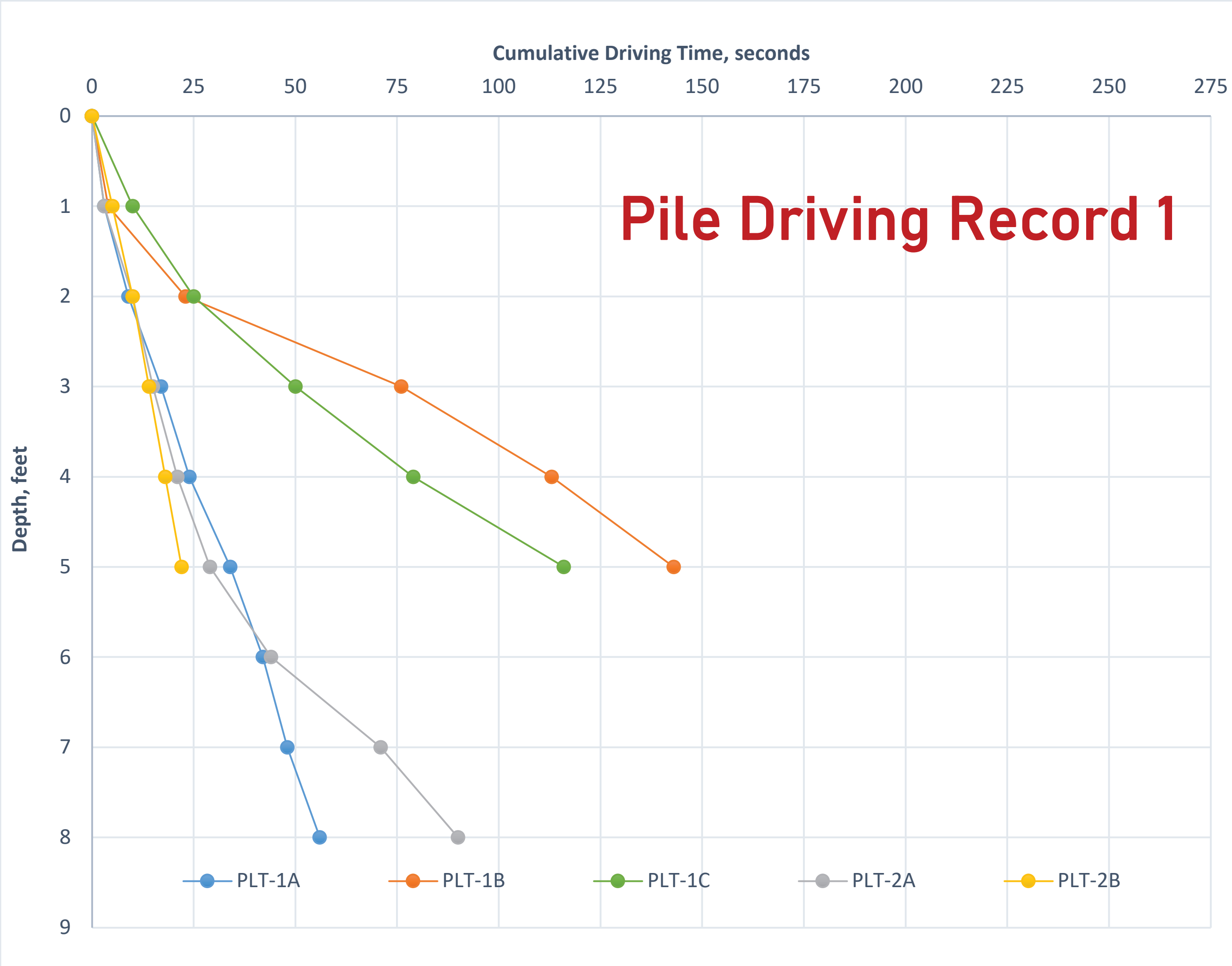
PILE LOAD TESTING RESULTS

Contents:

Note: All attachments are one page unless noted above.

PILE DRIVING TIME GRAPHS

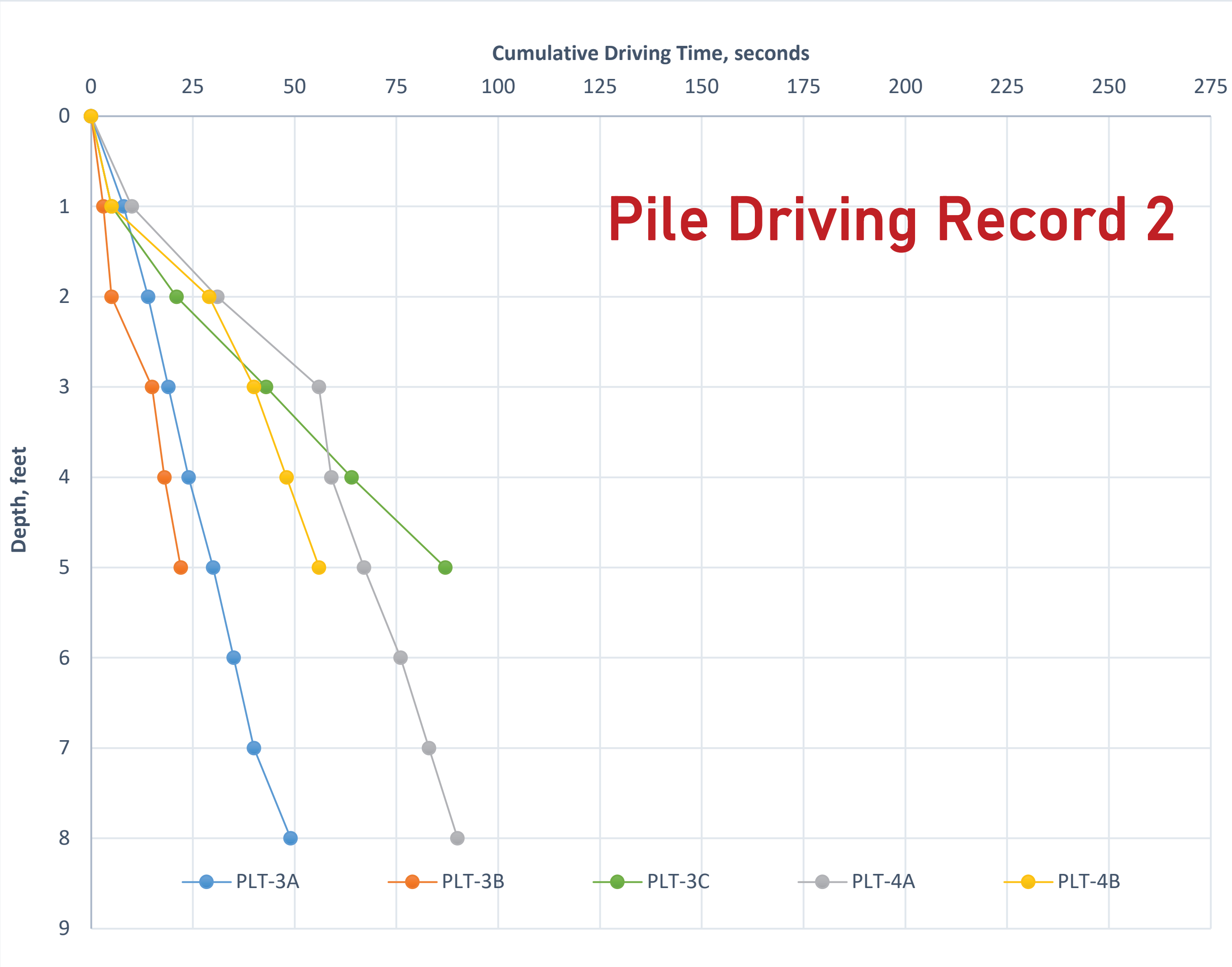


Depth (feet)	Cumulative Driving Time, seconds							
	PLT-1A	PLT-1B	PLT-1C	PLT-1D	PLT-2A	PLT-2B	PLT-2C	PLT-2D
0	0	0	0		0	0		
1	3.0	4.0	10.0		3.0	5.0		
2	9.0	23.0	25.0		10.0	10.0		
3	17.0	76.0	50.0		15.0	14.0		
4	24.0	113.0	79.0		21.0	18.0		
5	34.0	143.0	116.0		29.0	22.0		
6	42.0				44.0			
7	48.0				71.0			
8	56.0				90.0			
Embedment Depth, ft	8.0	5.0	5.0		8.0	5.0		
Total Drive Time, sec	56.0	143.0	116.0		90.0	22.0		
Average, sec/ft	7.0	28.6	23.2		11.3	4.4		

NOTES:

Piles advanced with Vermeer PD-10 hydraulic ram. Installation depth started at the ground surface

Terracon



Depth (feet)	Cumulative Driving Time, seconds							
	PLT-3A	PLT-3B	PLT-3C	PLT-3D	PLT-4A	PLT-4B	PLT-4C	PLT-4D
0	0	0	0		0	0		
1	8.0	3.0	5.0		10.0	5.0		
2	14.0	5.0	21.0		31.0	29.0		
3	19.0	15.0	43.0		56.0	40.0		
4	24.0	18.0	64.0		59.0	48.0		
5	30.0	22.0	87.0		67.0	56.0		
6	35.0				76.0			
7	40.0				83.0			
8	49.0				90.0			
Embedment Depth, ft	8.0	5.0	5.0		8.0	5.0		
Total Drive Time, sec	49.0	22.0	87.0		90.0	56.0		
Average, sec/ft	6.1	4.4	17.4		11.3	11.2		

NOTES:

Piles advanced with Vermeer PD-10 hydraulic ram. Installation depth started at the ground surface

Terracon

AXIAL TENSION LOAD TEST RESULT

Tension Load Test Result for PLT-001A

Project Information

Project Name:	Bright Mountain Solar
Project Location:	Hazard, KY
Project Number:	N3225022

Axial Load Test Set Up

Number of Gauges:	2
Height of Gauges [in]:	6
Load Cell:	Dillon ED jr 10,000lb

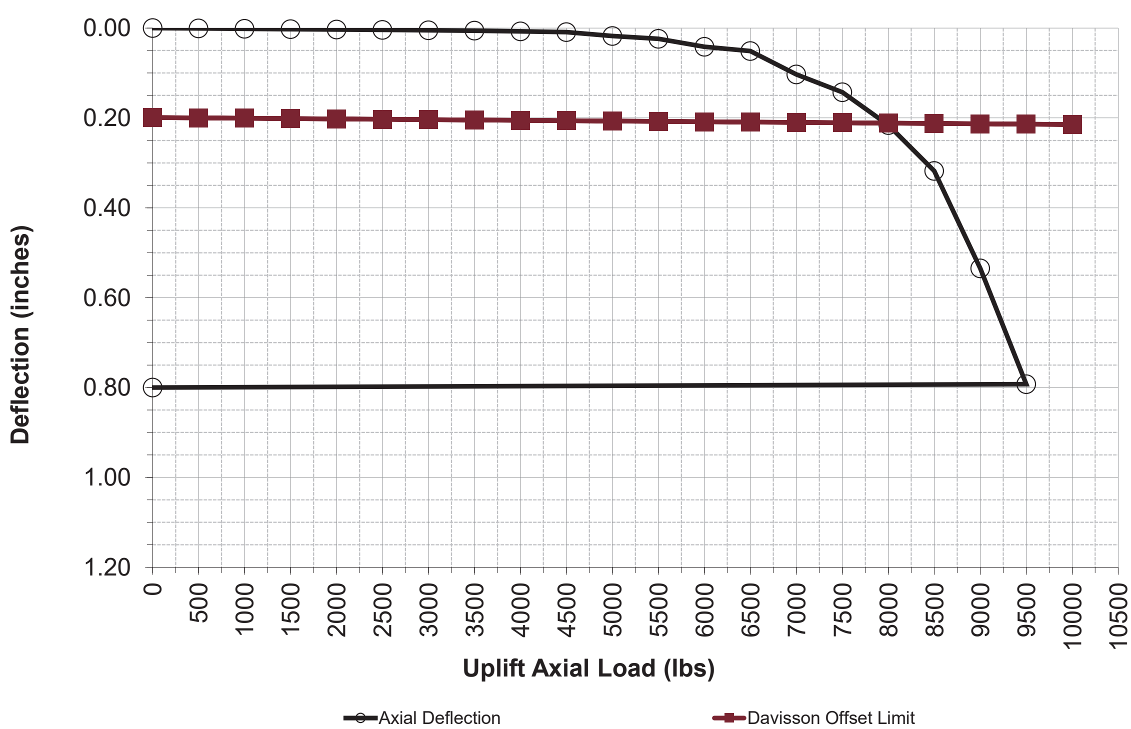
Test Date and Representative

Tested By Terracon Rep:	JL
Date Tested:	6/15/2022

Pile Information

Pile ID:	PLT-001A
Latitude:	37.28350
Longitude:	-83.29510
Pile Type:	W6X9
Pile Embedment Depth [in]:	120
Pile Diameter [in]:	5.9
Pile Stick-Up [in]:	36
Axial Design Load [lbs]:	10000
Pile Area [sq. in]:	2.68
Elastic Modulus [ksi]:	29,000
Drive Time [sec]:	56

Tension Test Results			Davisson Offset Limit Lines		
% of Design Load	Axial Load [lbs]	Deflection Δ (in.) Gauges #1 & #2	Elastic Data (in) (PL/AE)	Davisson Offest Limit (in) (0.15+D/120+(PL/AE))	Comments
0%	0	0.000	0.000	0.199	
5%	500	0.001	0.001	0.200	
10%	1000	0.002	0.002	0.201	
15%	1500	0.002	0.002	0.201	
20%	2000	0.003	0.003	0.202	
25%	2500	0.004	0.004	0.203	
30%	3000	0.005	0.005	0.204	
35%	3500	0.006	0.005	0.205	
40%	4000	0.008	0.006	0.205	
45%	4500	0.009	0.007	0.206	
50%	5000	0.018	0.008	0.207	
55%	5500	0.024	0.008	0.208	
60%	6000	0.042	0.009	0.208	
65%	6500	0.051	0.010	0.209	
70%	7000	0.103	0.011	0.210	
75%	7500	0.143	0.012	0.211	
80%	8000	0.216	0.012	0.212	
85%	8500	0.318	0.013	0.212	
90%	9000	0.535	0.014	0.213	
95%	9500	0.793	0.015	0.214	
100%	10000		0.015	0.215	
50%	5000		0.008	0.207	
0%	0	0.800	0.000	0.199	



Tension Load Test Result for PLT-001B

Project Information

Project Name:	Bright Mountain Solar
Project Location:	Hazard, KY
Project Number:	N3225022

Axial Load Test Set Up

Number of Gauges:	2
Height of Gauges [in]:	6
Load Cell:	Dillon ED jr 10,000lb

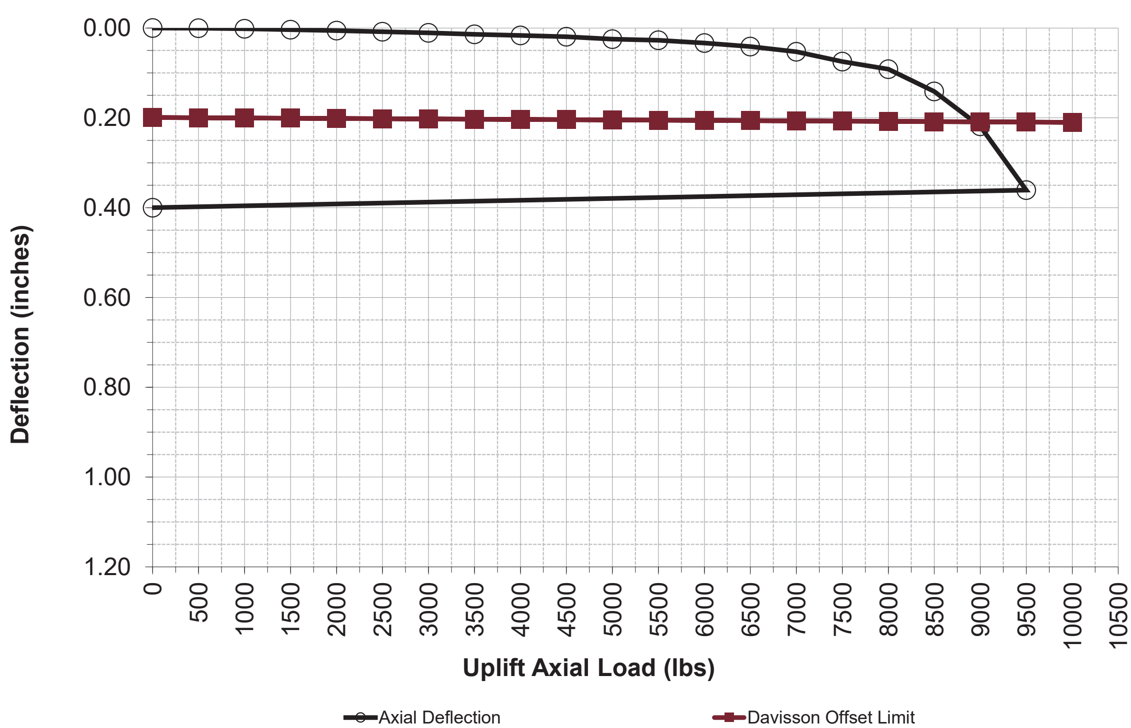
Test Date and Representative

Tested By Terracon Rep:	JL
Date Tested:	6/15/2022

Pile Information

Pile ID:	PLT-001B
Latitude:	37.28350
Longitude:	-83.29510
Pile Type:	W6X9
Pile Embedment Depth [in]:	84
Pile Diameter [in]:	5.9
Pile Stick-Up [in]:	36
Axial Design Load [lbs]:	10000
Pile Area [sq. in]:	2.68
Elastic Modulus [ksi]:	29,000
Drive Time [sec]:	143

Tension Test Results			Davisson Offset Limit Lines		
% of Design Load	Axial Load [lbs]	Deflection Δ (in.) Gauges #1 & #2	Elastic Data (in) (PL/AE)	Davisson Offest Limit (in) (0.15+D/120+(PL/AE))	Comments
0%	0	0.000	0.000	0.199	
5%	500	0.000	0.001	0.200	
10%	1000	0.002	0.001	0.200	
15%	1500	0.004	0.002	0.201	
20%	2000	0.006	0.002	0.201	
25%	2500	0.008	0.003	0.202	
30%	3000	0.011	0.003	0.202	
35%	3500	0.014	0.004	0.203	
40%	4000	0.016	0.004	0.203	
45%	4500	0.019	0.005	0.204	
50%	5000	0.025	0.005	0.205	
55%	5500	0.027	0.006	0.205	
60%	6000	0.034	0.006	0.206	
65%	6500	0.041	0.007	0.206	
70%	7000	0.053	0.008	0.207	
75%	7500	0.075	0.008	0.207	
80%	8000	0.092	0.009	0.208	
85%	8500	0.141	0.009	0.208	
90%	9000	0.219	0.010	0.209	
95%	9500	0.361	0.010	0.209	
100%	10000		0.011	0.210	
50%	5000		0.005	0.205	
0%	0	0.400	0.000	0.199	



Tension Load Test Result for PLT-002A

Project Information

Project Name:	Bright Mountain Solar
Project Location:	Hazard, KY
Project Number:	N3225022

Axial Load Test Set Up

Number of Gauges:	2
Height of Gauges [in]:	6
Load Cell:	Dillon ED jr 10,000lb

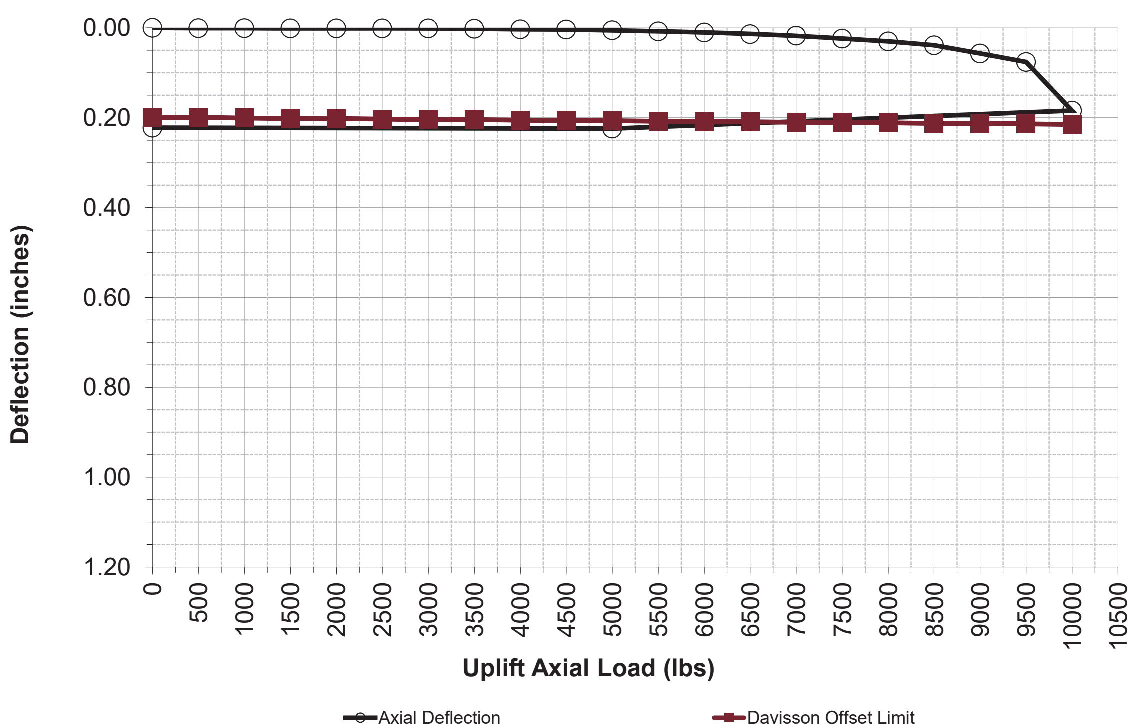
Test Date and Representative

Tested By Terracon Rep:	JL
Date Tested:	6/15/2022

Pile Information

Pile ID:	PLT-002A
Latitude:	37.28780
Longitude:	-83.29080
Pile Type:	W6X9
Pile Embedment Depth [in]:	120
Pile Diameter [in]:	5.9
Pile Stick-Up [in]:	36
Axial Design Load [lbs]:	10000
Pile Area [sq. in]:	2.68
Elastic Modulus [ksi]:	29,000
Drive Time [sec]:	90

Tension Test Results			Davisson Offset Limit Lines		
% of Design Load	Axial Load [lbs]	Deflection Δ (in.) Gauges #1 & #2	Elastic Data (in) (PL/AE)	Davisson Offest Limit (in) (0.15+D/120+(PL/AE))	Comments
0%	0	0.000	0.000	0.199	
5%	500	0.001	0.001	0.200	
10%	1000	0.001	0.002	0.201	
15%	1500	0.001	0.002	0.201	
20%	2000	0.001	0.003	0.202	
25%	2500	0.001	0.004	0.203	
30%	3000	0.001	0.005	0.204	
35%	3500	0.002	0.005	0.205	
40%	4000	0.003	0.006	0.205	
45%	4500	0.004	0.007	0.206	
50%	5000	0.005	0.008	0.207	
55%	5500	0.008	0.008	0.208	
60%	6000	0.010	0.009	0.208	
65%	6500	0.014	0.010	0.209	
70%	7000	0.017	0.011	0.210	
75%	7500	0.024	0.012	0.211	
80%	8000	0.030	0.012	0.212	
85%	8500	0.039	0.013	0.212	
90%	9000	0.057	0.014	0.213	
95%	9500	0.076	0.015	0.214	
100%	10000	0.184	0.015	0.215	
50%	5000	0.224	0.008	0.207	
0%	0	0.222	0.000	0.199	



Tension Load Test Result for PLT-002B

Project Information

Project Name:	Bright Mountain Solar
Project Location:	Hazard, KY
Project Number:	N3225022

Axial Load Test Set Up

Number of Gauges:	2
Height of Gauges [in]:	6
Load Cell:	Dillon ED jr 10,000lb

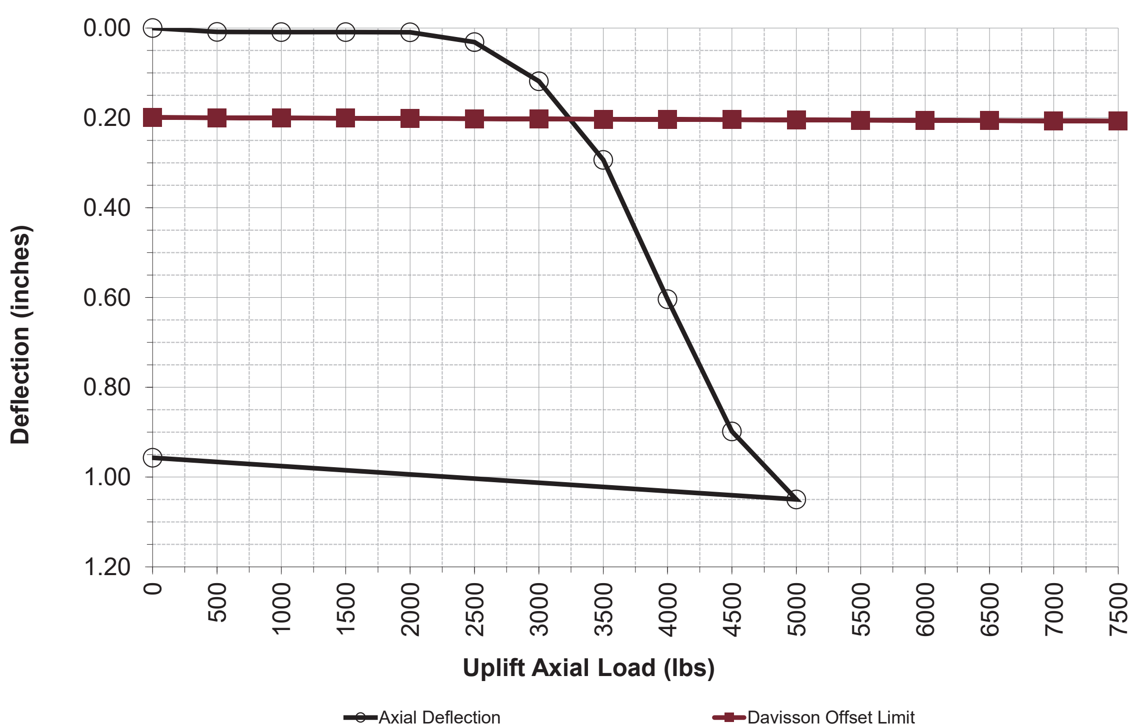
Test Date and Representative

Tested By Terracon Rep:	JL
Date Tested:	6/15/2022

Pile Information

Pile ID:	PLT-002B
Latitude:	37.28780
Longitude:	-83.29080
Pile Type:	W6X9
Pile Embedment Depth [in]:	84
Pile Diameter [in]:	5.9
Pile Stick-Up [in]:	36
Axial Design Load [lbs]:	10000
Pile Area [sq. in]:	2.68
Elastic Modulus [ksi]:	29,000
Drive Time [sec]:	22

Tension Test Results			Davisson Offset Limit Lines		
% of Design Load	Axial Load [lbs]	Deflection Δ (in.) Gauges #1 & #2	Elastic Data (in) (PL/AE)	Davisson Offset Limit (in) (0.15+D/120+(PL/AE))	Comments
0%	0	0.000	0.000	0.199	
5%	500	0.009	0.001	0.200	
10%	1000	0.009	0.001	0.200	
15%	1500	0.009	0.002	0.201	
20%	2000	0.009	0.002	0.201	
25%	2500	0.031	0.003	0.202	
30%	3000	0.119	0.003	0.202	
35%	3500	0.294	0.004	0.203	
40%	4000	0.604	0.004	0.203	
45%	4500	0.899	0.005	0.204	
50%	5000		0.005	0.205	
55%	5500		0.006	0.205	
60%	6000		0.006	0.206	
65%	6500		0.007	0.206	
70%	7000		0.008	0.207	
75%	7500		0.008	0.207	
80%	8000		0.009	0.208	
85%	8500		0.009	0.208	
90%	9000		0.010	0.209	
95%	9500		0.010	0.209	
100%	10000		0.011	0.210	
50%	5000	1.050	0.005	0.205	
0%	0	0.957	0.000	0.199	



Tension Load Test Result for PLT-003A

Project Information

Project Name:	Bright Mountain Solar
Project Location:	Hazard, KY
Project Number:	N3225022

Axial Load Test Set Up

Number of Gauges:	2
Height of Gauges [in]:	6
Load Cell:	Dillon ED jr 10,000lb

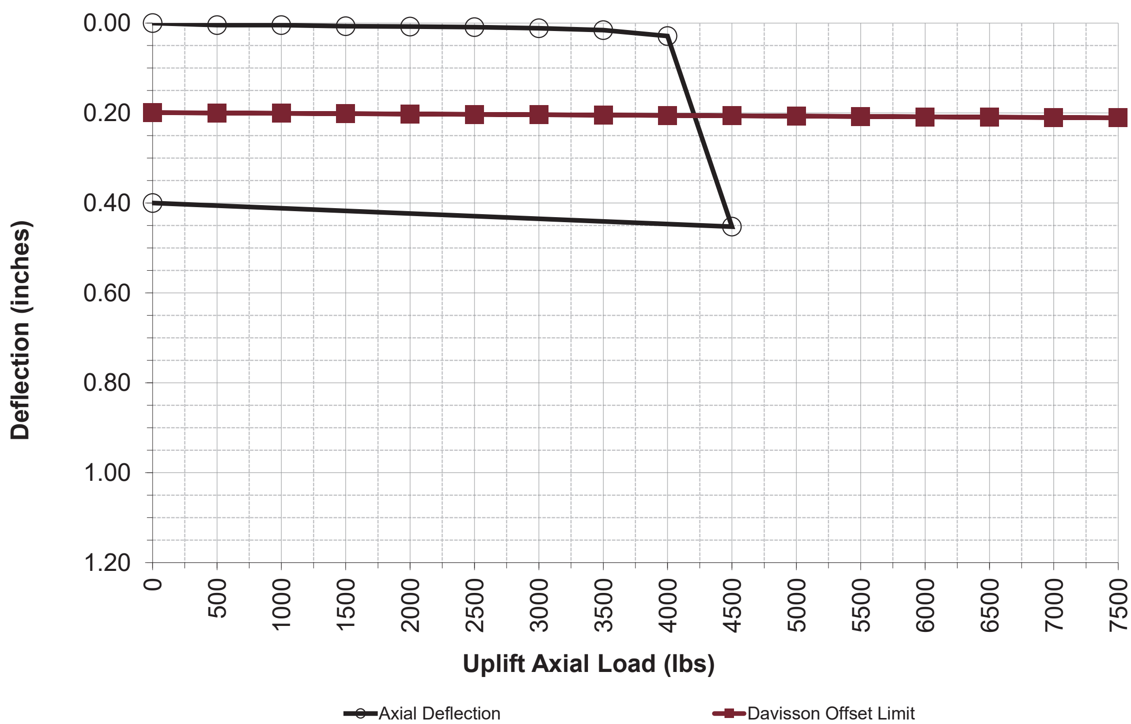
Test Date and Representative

Tested By Terracon Rep:	JL
Date Tested:	6/15/2022

Pile Information

Pile ID:	PLT-003A
Latitude:	37.29240
Longitude:	-83.28560
Pile Type:	W6X9
Pile Embedment Depth [in]:	120
Pile Diameter [in]:	5.9
Pile Stick-Up [in]:	36
Axial Design Load [lbs]:	10000
Pile Area [sq. in]:	2.68
Elastic Modulus [ksi]:	29,000
Drive Time [sec]:	49

Tension Test Results			Davisson Offset Limit Lines		
% of Design Load	Axial Load [lbs]	Deflection Δ (in.) Gauges #1 & #2	Elastic Data (in) (PL/AE)	Davisson Offset Limit (in) (0.15+D/120+(PL/AE))	Comments
0%	0	0.000	0.000	0.199	
5%	500	0.005	0.001	0.200	
10%	1000	0.005	0.002	0.201	
15%	1500	0.007	0.002	0.201	
20%	2000	0.008	0.003	0.202	
25%	2500	0.009	0.004	0.203	
30%	3000	0.011	0.005	0.204	
35%	3500	0.016	0.005	0.205	
40%	4000	0.029	0.006	0.205	
45%	4500	0.453	0.007	0.206	
50%	5000		0.008	0.207	
55%	5500		0.008	0.208	
60%	6000		0.009	0.208	
65%	6500		0.010	0.209	
70%	7000		0.011	0.210	
75%	7500		0.012	0.211	
80%	8000		0.012	0.212	
85%	8500		0.013	0.212	
90%	9000		0.014	0.213	
95%	9500		0.015	0.214	
100%	10000		0.015	0.215	
50%	5000		0.008	0.207	
0%	0	0.400	0.000	0.199	



Tension Load Test Result for PLT-003B

Project Information

Project Name:	Bright Mountain Solar
Project Location:	Hazard, KY
Project Number:	N3225022

Axial Load Test Set Up

Number of Gauges:	2
Height of Gauges [in]:	6
Load Cell:	Dillon ED jr 10,000lb

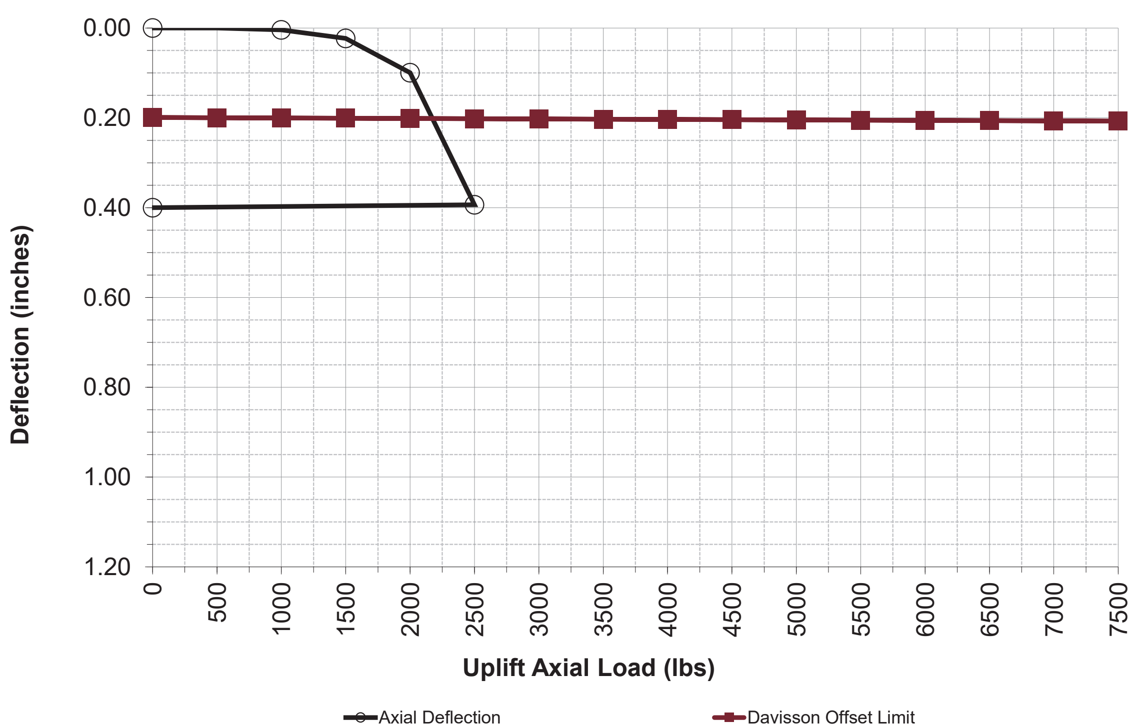
Test Date and Representative

Tested By Terracon Rep:	JL
Date Tested:	6/15/2022

Pile Information

Pile ID:	PLT-003B
Latitude:	37.29240
Longitude:	-83.28560
Pile Type:	W6X9
Pile Embedment Depth [in]:	84
Pile Diameter [in]:	5.9
Pile Stick-Up [in]:	36
Axial Design Load [lbs]:	10000
Pile Area [sq. in]:	2.68
Elastic Modulus [ksi]:	29,000
Drive Time [sec]:	22

Tension Test Results			Davisson Offset Limit Lines		
% of Design Load	Axial Load [lbs]	Deflection Δ (in.) Gauges #1 & #2	Elastic Data (in) (PL/AE)	Davisson Offset Limit (in) (0.15+D/120+(PL/AE))	Comments
0%	0	0.000	0.000	0.199	
5%	500	0.000	0.001	0.200	
10%	1000	0.004	0.001	0.200	
15%	1500	0.023	0.002	0.201	
20%	2000	0.099	0.002	0.201	
25%	2500	0.393	0.003	0.202	
30%	3000		0.003	0.202	
35%	3500		0.004	0.203	
40%	4000		0.004	0.203	
45%	4500		0.005	0.204	
50%	5000		0.005	0.205	
55%	5500		0.006	0.205	
60%	6000		0.006	0.206	
65%	6500		0.007	0.206	
70%	7000		0.008	0.207	
75%	7500		0.008	0.207	
80%	8000		0.009	0.208	
85%	8500		0.009	0.208	
90%	9000		0.010	0.209	
95%	9500		0.010	0.209	
100%	10000		0.011	0.210	
50%	5000		0.005	0.205	
0%	0	0.400	0.000	0.199	



Terracon

Tension Load Test Result for PLT-004A

Project Information

Project Name:	Bright Mountain Solar
Project Location:	Hazard, KY
Project Number:	N3225022

Axial Load Test Set Up

Number of Gauges:	2
Height of Gauges [in]:	6
Load Cell:	Dillon ED jr 10,000lb

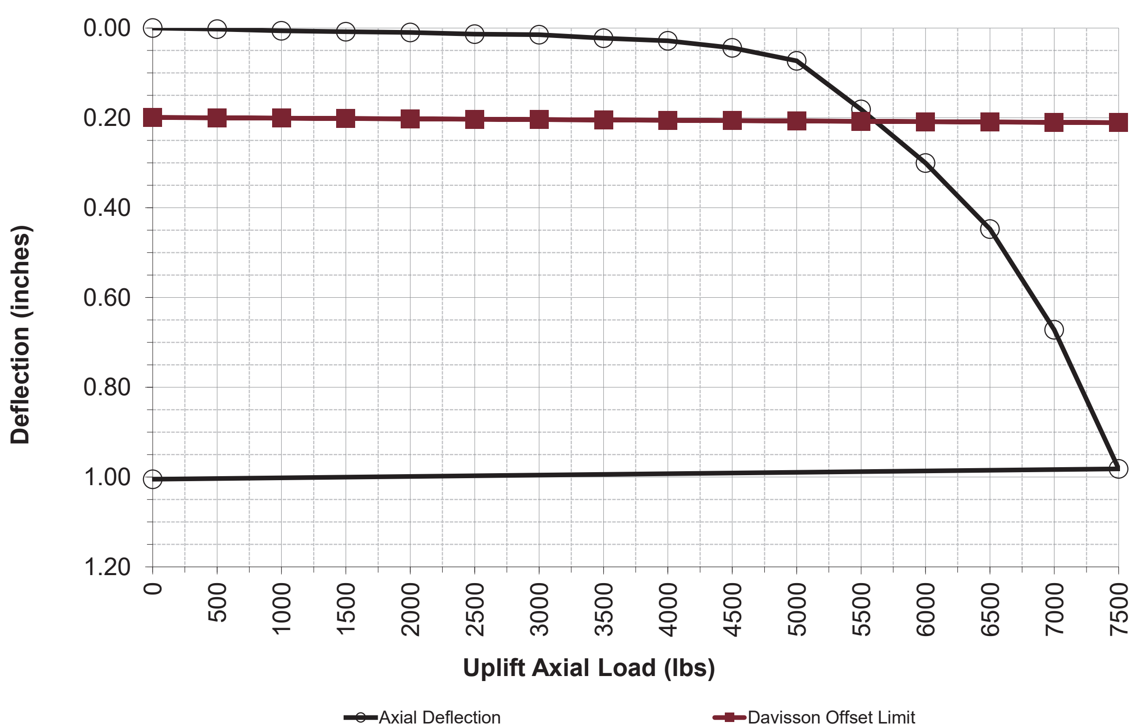
Test Date and Representative

Tested By Terracon Rep:	JL
Date Tested:	6/15/2022

Pile Information

Pile ID:	PLT-004A
Latitude:	37.29580
Longitude:	-83.29220
Pile Type:	W6X9
Pile Embedment Depth [in]:	120
Pile Diameter [in]:	5.9
Pile Stick-Up [in]:	36
Axial Design Load [lbs]:	10000
Pile Area [sq. in]:	2.68
Elastic Modulus [ksi]:	29,000
Drive Time [sec]:	90

Tension Test Results			Davisson Offset Limit Lines		
% of Design Load	Axial Load [lbs]	Deflection Δ (in.) Gauges #1 & #2	Elastic Data (in) (PL/AE)	Davisson Offest Limit (in) (0.15+D/120+(PL/AE))	Comments
0%	0	0.000	0.000	0.199	
5%	500	0.003	0.001	0.200	
10%	1000	0.006	0.002	0.201	
15%	1500	0.008	0.002	0.201	
20%	2000	0.010	0.003	0.202	
25%	2500	0.014	0.004	0.203	
30%	3000	0.015	0.005	0.204	
35%	3500	0.023	0.005	0.205	
40%	4000	0.028	0.006	0.205	
45%	4500	0.044	0.007	0.206	
50%	5000	0.073	0.008	0.207	
55%	5500	0.181	0.008	0.208	
60%	6000	0.301	0.009	0.208	
65%	6500	0.448	0.010	0.209	
70%	7000	0.672	0.011	0.210	
75%	7500	0.982	0.012	0.211	
80%	8000		0.012	0.212	
85%	8500		0.013	0.212	
90%	9000		0.014	0.213	
95%	9500		0.015	0.214	
100%	10000		0.015	0.215	
50%	5000		0.008	0.207	
0%	0	1.005	0.000	0.199	



Tension Load Test Result for PLT-004B

Project Information

Project Name:	Bright Mountain Solar
Project Location:	Hazard, KY
Project Number:	N3225022

Axial Load Test Set Up

Number of Gauges:	2
Height of Gauges [in]:	6
Load Cell:	Dillon ED jr 10,000lb

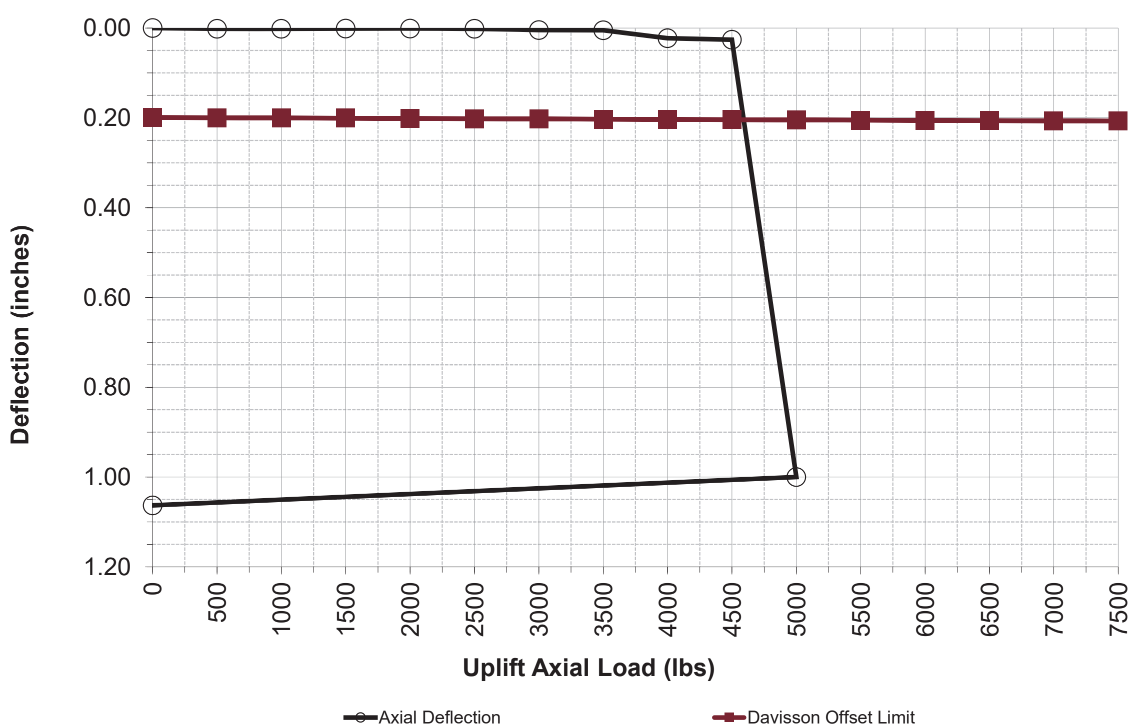
Test Date and Representative

Tested By Terracon Rep:	JL
Date Tested:	6/15/2022

Pile Information

Pile ID:	PLT-004B
Latitude:	37.29580
Longitude:	-83.29220
Pile Type:	W6X9
Pile Embedment Depth [in]:	84
Pile Diameter [in]:	5.9
Pile Stick-Up [in]:	36
Axial Design Load [lbs]:	10000
Pile Area [sq. in]:	2.68
Elastic Modulus [ksi]:	29,000
Drive Time [sec]:	56

Tension Test Results			Davisson Offset Limit Lines		
% of Design Load	Axial Load [lbs]	Deflection Δ (in.) Gauges #1 & #2	Elastic Data (in) (PL/AE)	Davisson Offset Limit (in) (0.15+D/120+(PL/AE))	Comments
0%	0	0.000	0.000	0.199	
5%	500	0.002	0.001	0.200	
10%	1000	0.002	0.001	0.200	
15%	1500	0.001	0.002	0.201	
20%	2000	0.001	0.002	0.201	
25%	2500	0.002	0.003	0.202	
30%	3000	0.005	0.003	0.202	
35%	3500	0.005	0.004	0.203	
40%	4000	0.023	0.004	0.203	
45%	4500	0.026	0.005	0.204	
50%	5000		0.005	0.205	
55%	5500		0.006	0.205	
60%	6000		0.006	0.206	
65%	6500		0.007	0.206	
70%	7000		0.008	0.207	
75%	7500		0.008	0.207	
80%	8000		0.009	0.208	
85%	8500		0.009	0.208	
90%	9000		0.010	0.209	
95%	9500		0.010	0.209	
100%	10000		0.011	0.210	
50%	5000	1.000	0.005	0.205	
0%	0	1.063	0.000	0.199	



AXIAL COMPRESSION LOAD TEST RESULT

Compression Load Test Result for PLT-1C

Project Information

Project Name:	Bright Mountain Solar
Project Location:	Hazard, KY
Project Number:	N3225022

Axial Load Test Set Up

Number of Gauges:	2
Height of Gauges [in]:	6
Load Cell:	Custom Scale 25lb

Test Date and Representative

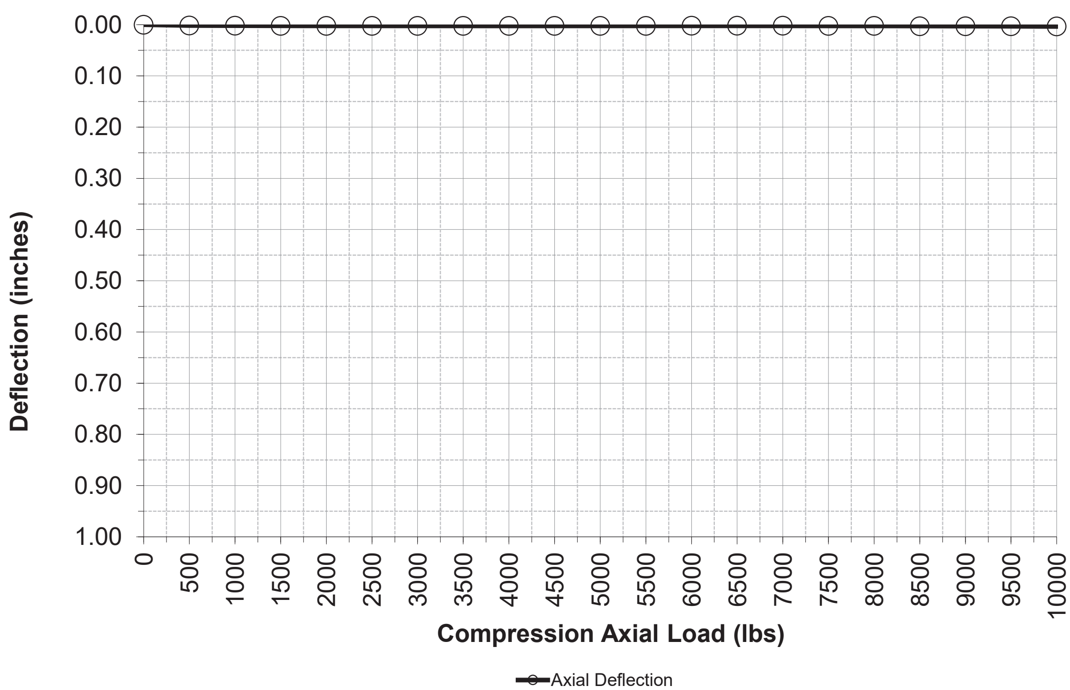
Tested By Terracon Rep:	JL
Date Tested:	6/15/2022

Pile Information

Pile ID:	PLT-1C
Latitude:	37.28350
Longitude:	-83.29510
Pile Type:	W6X9
Pile Embedment Depth [in]:	84
Pile Diameter [in]:	5.9
Pile Stick-Up [in]:	36
Axial Design Load [lbs]:	13000
Pile Area [sq. in]:	2.68
Elastic Modulus [ksi]:	29,000
Drive Time [sec]:	116

Compression Test Results

% of Design Load	Axial Load [lbs]	Deflection Δ (in.) Gauges #1 & #2	Comments
0%	0	0.000	
4%	500	0.002	
8%	1000	0.002	
12%	1500	0.002	
15%	2000	0.002	
19%	2500	0.002	
23%	3000	0.002	
27%	3500	0.002	
31%	4000	0.002	
35%	4500	0.003	
38%	5000	0.003	
42%	5500	0.002	
46%	6000	0.002	
50%	6500	0.002	
54%	7000	0.002	
58%	7500	0.003	
62%	8000	0.003	
65%	8500	0.003	
69%	9000	0.003	
73%	9500	0.003	
77%	10000	0.003	
81%	10500	0.004	
85%	11000		
88%	11500		
92%	12000		
96%	12500		
100%	13000		
50%	6500		
0%	0		



Compression Load Test Result for PLT-3C

Project Information

Project Name:	Bright Mountain Solar
Project Location:	Hazard, KY
Project Number:	N3225022

Axial Load Test Set Up

Number of Gauges:	2
Height of Gauges [in]:	6
Load Cell:	Custom Scale 25lb

Test Date and Representative

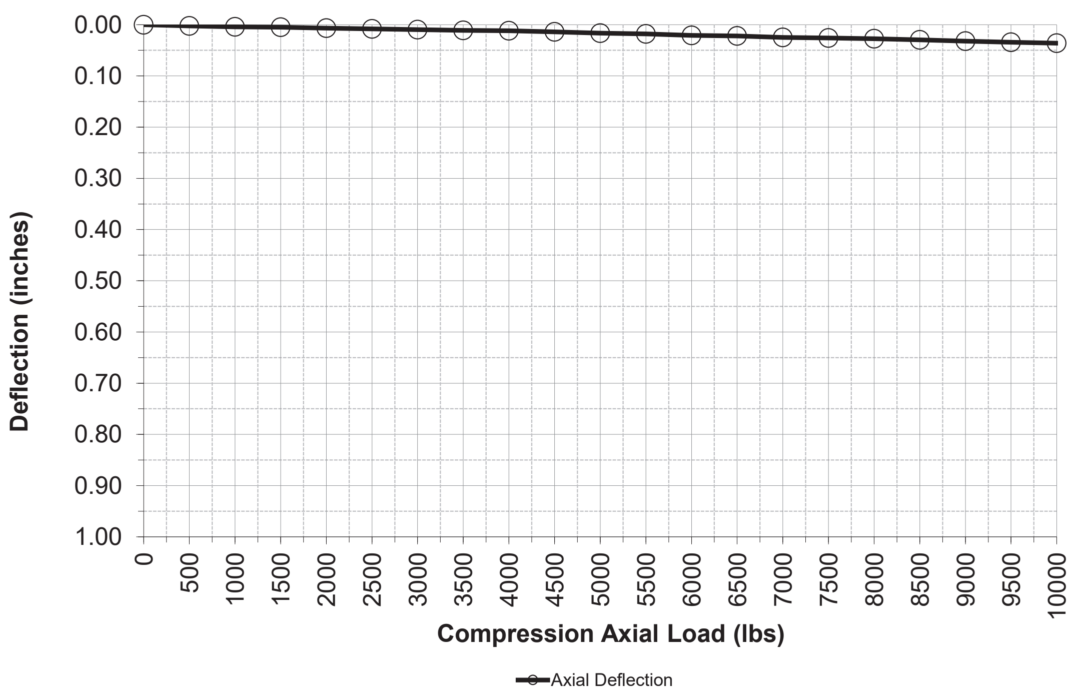
Tested By Terracon Rep:	JL
Date Tested:	6/15/2022

Pile Information

Pile ID:	PLT-3C
Latitude:	37.29240
Longitude:	-83.28560
Pile Type:	W6X9
Pile Embedment Depth [in]:	84
Pile Diameter [in]:	5.9
Pile Stick-Up [in]:	36
Axial Design Load [lbs]:	13000
Pile Area [sq. in]:	2.68
Elastic Modulus [ksi]:	29,000
Drive Time [sec]:	87

Compression Test Results

% of Design Load	Axial Load [lbs]	Deflection Δ (in.) Gauges #1 & #2	Comments
0%	0	0.000	
4%	500	0.003	
8%	1000	0.004	
12%	1500	0.005	
15%	2000	0.007	
19%	2500	0.008	
23%	3000	0.010	
27%	3500	0.011	
31%	4000	0.012	
35%	4500	0.014	
38%	5000	0.017	
42%	5500	0.018	
46%	6000	0.021	
50%	6500	0.022	
54%	7000	0.025	
58%	7500	0.026	
62%	8000	0.028	
65%	8500	0.030	
69%	9000	0.032	
73%	9500	0.034	
77%	10000	0.036	
81%	10500	0.038	
85%	11000	0.039	
88%	11500		
92%	12000		
96%	12500		
100%	13000		
50%	6500		
0%	0		



LATERAL LOAD TEST RESULT

Lateral Load Test Result for PLT-001A

Project Information

Project Name:	Bright Mountain Solar
Project Location:	Hazard, KY
Project Number:	N3225022

Lateral Load Test Set Up

Number of Top Gauges:	0
Number of Bottom Gauges:	2
Height of Top Gauges [in]:	1
Height of Bottom Gauges [in]:	2
Height of Applied Load [in]:	24
Load Cell:	Dillon ED jr 10,000lb

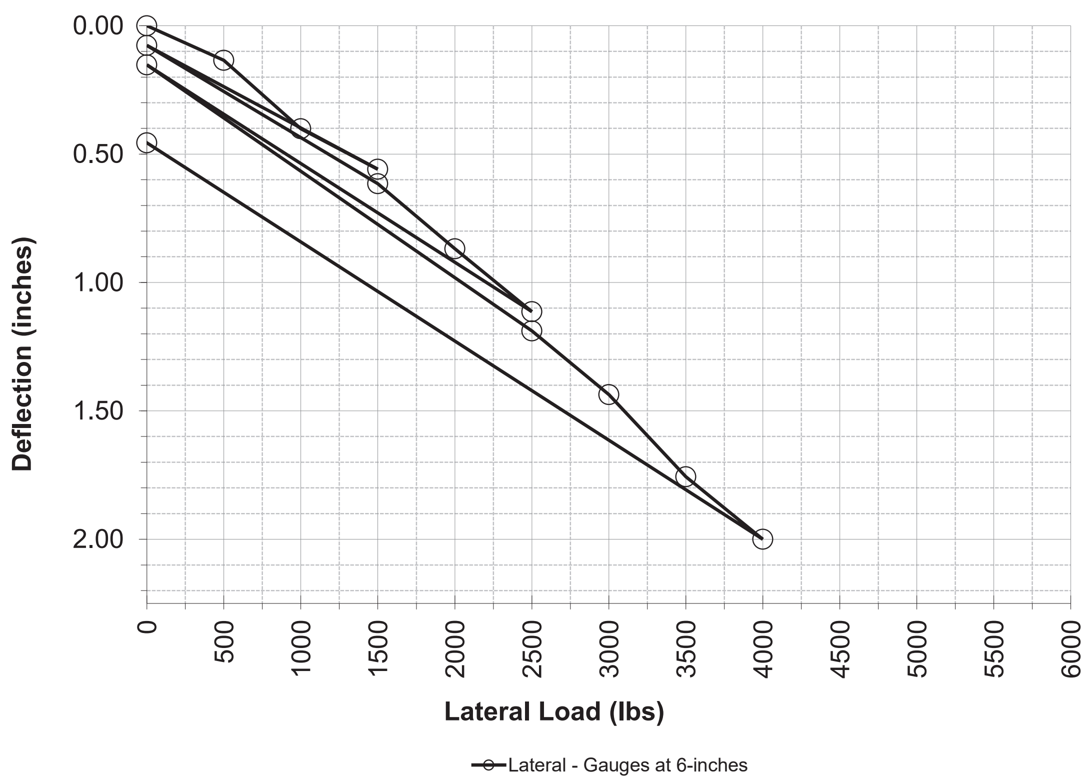
Test Date and Representative

Tested By Terracon Rep:	JL
Date Tested:	6/15/2022

Pile Information

Pile ID:	PLT-001A
Latitude:	37.28350
Longitude:	-83.29510
Pile Type:	W6X9
Pile Embedment Depth [in]:	120
Pile Stick-Up [in]:	36
Lateral Design Load [lbs]:	7000
Drive Time [sec]:	56

% of Design Load	Lateral Load [lbs]	Deflection Δ (in.) Gauges #1 & #2	Comments
0%	0	0.000	
7%	500	0.135	
14%	1000	0.401	
21%	1500	0.559	
0%	0	0.076	
21%	1500	0.615	
29%	2000	0.868	
36%	2500	1.114	
0%	0	0.153	
36%	2500	1.189	
43%	3000	1.437	
50%	3500	1.756	
57%	4000	2.000	
0%	0	0.456	
57%	4000		
64%	4500		
71%	5000		
79%	5500		
0%	0		
79%	5500		
86%	6000		
93%	6500		
100%	7000		
0%	0		



Lateral Load Test Result for PLT-001B

Project Information

Project Name:	Bright Mountain Solar
Project Location:	Hazard, KY
Project Number:	N3225022

Lateral Load Test Set Up

Number of Top Gauges:	0
Number of Bottom Gauges:	2
Height of Top Gauges [in]:	1
Height of Bottom Gauges [in]:	2
Height of Applied Load [in]:	24
Load Cell:	Dillon ED jr 10,000lb

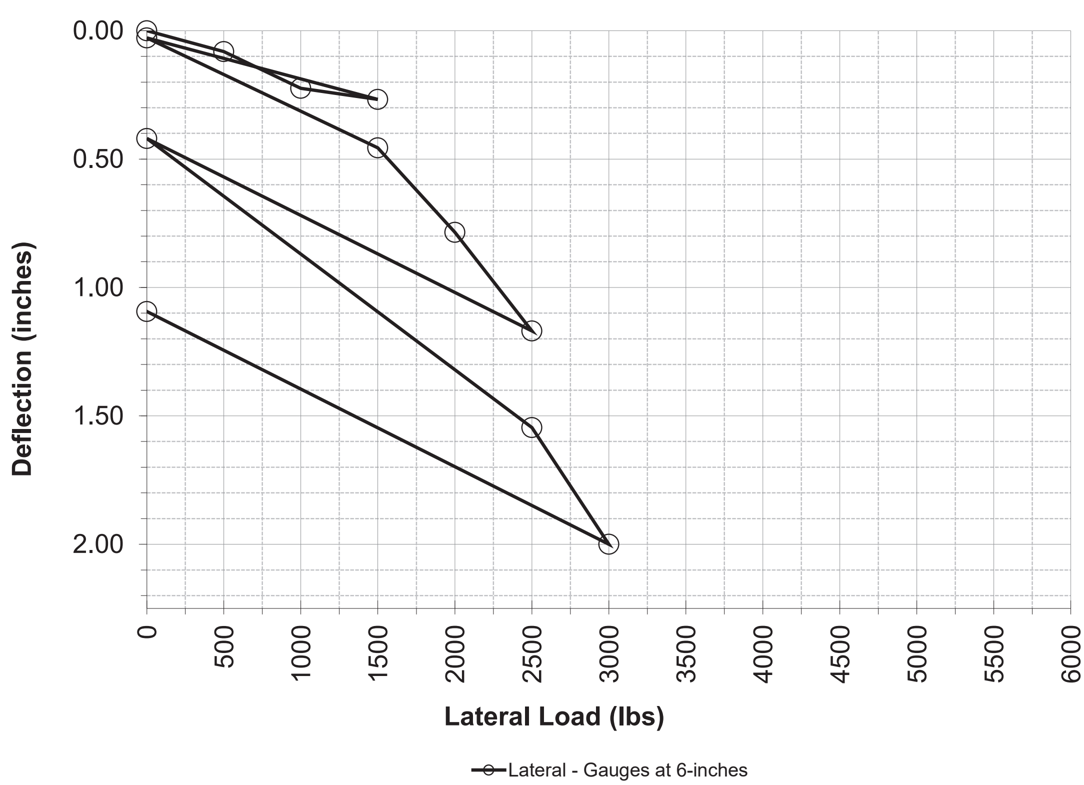
Test Date and Representative

Tested By Terracon Rep:	JL
Date Tested:	6/15/2022

Pile Information

Pile ID:	PLT-001B
Latitude:	37.28350
Longitude:	-83.29510
Pile Type:	W6X9
Pile Embedment Depth [in]:	84
Pile Stick-Up [in]:	36
Lateral Design Load [lbs]:	7000
Drive Time [sec]:	143

% of Design Load	Lateral Load [lbs]	Deflection Δ (in.) Gauges #1 & #2	Comments
0%	0	0.000	
7%	500	0.081	
14%	1000	0.224	
21%	1500	0.268	
0%	0	0.028	
21%	1500	0.456	
29%	2000	0.785	
36%	2500	1.169	
0%	0	0.420	
36%	2500	1.546	
43%	3000	2.000	
50%	3500		
57%	4000		
0%	0	1.093	
57%	4000		
64%	4500		
71%	5000		
79%	5500		
0%	0		
79%	5500		
86%	6000		
93%	6500		
100%	7000		
0%	0		



Lateral Load Test Result for PLT-002A

Project Information

Project Name:	Bright Mountain Solar
Project Location:	Hazard, KY
Project Number:	N3225022

Lateral Load Test Set Up

Number of Top Gauges:	0
Number of Bottom Gauges:	2
Height of Top Gauges [in]:	1
Height of Bottom Gauges [in]:	2
Height of Applied Load [in]:	24
Load Cell:	Dillon ED jr 10,000lb

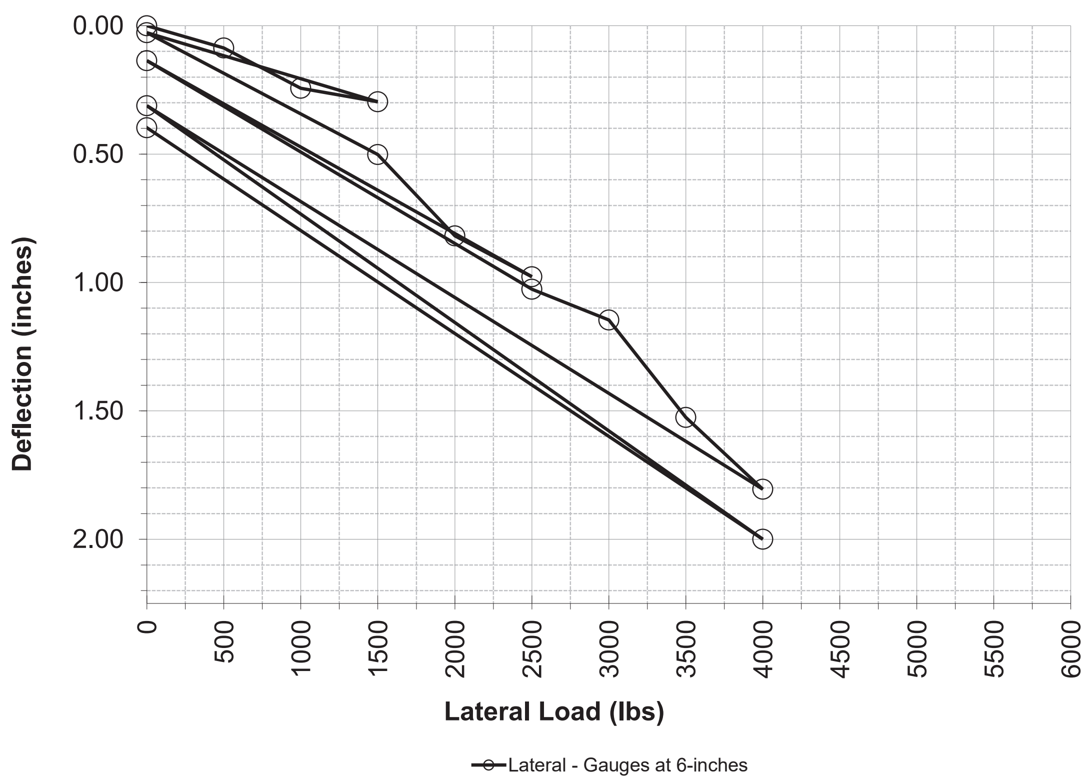
Test Date and Representative

Tested By Terracon Rep:	JL
Date Tested:	6/15/2022

Pile Information

Pile ID:	PLT-002A
Latitude:	37.28780
Longitude:	-83.29080
Pile Type:	W6X9
Pile Embedment Depth [in]:	120
Pile Stick-Up [in]:	36
Lateral Design Load [lbs]:	7000
Drive Time [sec]:	90

% of Design Load	Lateral Load [lbs]	Deflection Δ (in.) Gauges #1 & #2	Comments
0%	0	0.000	
7%	500	0.087	
14%	1000	0.244	
21%	1500	0.296	
0%	0	0.027	
21%	1500	0.501	
29%	2000	0.818	
36%	2500	0.977	
0%	0	0.136	
36%	2500	1.026	
43%	3000	1.146	
50%	3500	1.526	
57%	4000	1.805	
0%	0	0.311	
57%	4000	2.000	
64%	4500		
71%	5000		
79%	5500		
0%	0	0.397	
79%	5500		
86%	6000		
93%	6500		
100%	7000		
0%	0		



Lateral Load Test Result for PLT-002B

Project Information

Project Name:	Bright Mountain Solar
Project Location:	Hazard, KY
Project Number:	N3225022

Lateral Load Test Set Up

Number of Top Gauges:	0
Number of Bottom Gauges:	2
Height of Top Gauges [in]:	1
Height of Bottom Gauges [in]:	2
Height of Applied Load [in]:	24
Load Cell:	Dillon ED jr 10,000lb

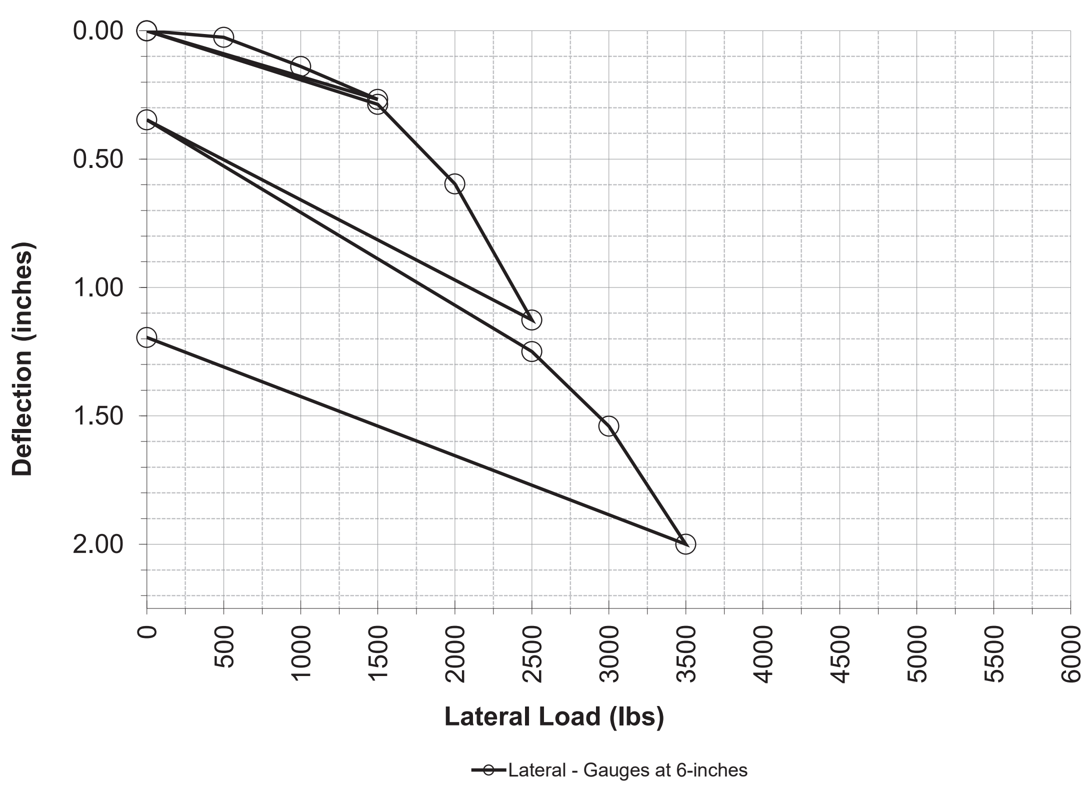
Test Date and Representative

Tested By Terracon Rep:	JL
Date Tested:	6/15/2022

Pile Information

Pile ID:	PLT-002B
Latitude:	37.28780
Longitude:	-83.29080
Pile Type:	W6X9
Pile Embedment Depth [in]:	84
Pile Stick-Up [in]:	36
Lateral Design Load [lbs]:	7000
Drive Time [sec]:	22

% of Design Load	Lateral Load [lbs]	Deflection Δ (in.) Gauges #1 & #2	Comments
0%	0	0.000	
7%	500	0.026	
14%	1000	0.139	
21%	1500	0.267	
0%	0	0.001	
21%	1500	0.287	
29%	2000	0.597	
36%	2500	1.126	
0%	0	0.347	
36%	2500	1.250	
43%	3000	1.540	
50%	3500	2.000	
57%	4000		
0%	0	1.195	
57%	4000		
64%	4500		
71%	5000		
79%	5500		
0%	0		
79%	5500		
86%	6000		
93%	6500		
100%	7000		
0%	0		



Terracon

Lateral Load Test Result for PLT-003A

Project Information

Project Name:	Bright Mountain Solar
Project Location:	Hazard, KY
Project Number:	N3225022

Lateral Load Test Set Up

Number of Top Gauges:	0
Number of Bottom Gauges:	2
Height of Top Gauges [in]:	1
Height of Bottom Gauges [in]:	2
Height of Applied Load [in]:	24
Load Cell:	Dillon ED jr 10,000lb

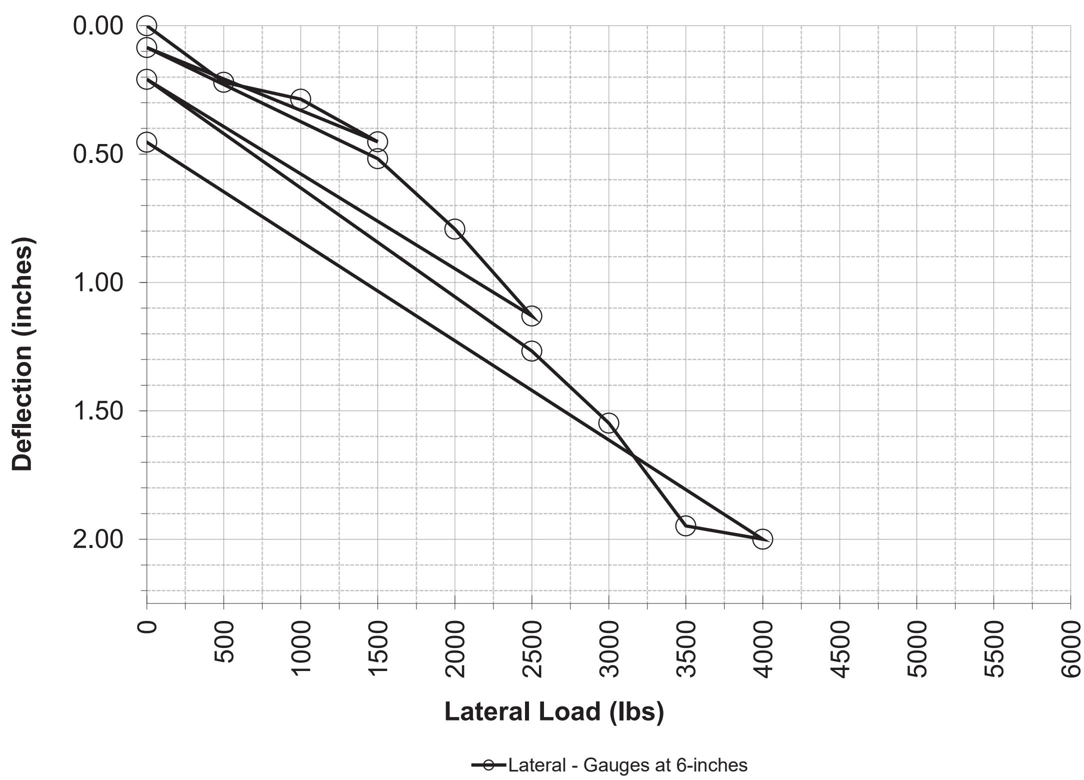
Test Date and Representative

Tested By Terracon Rep:	JL
Date Tested:	6/15/2022

Pile Information

Pile ID:	PLT-003A
Latitude:	37.29240
Longitude:	-83.28560
Pile Type:	W6X9
Pile Embedment Depth [in]:	120
Pile Stick-Up [in]:	36
Lateral Design Load [lbs]:	7000
Drive Time [sec]:	49

% of Design Load	Lateral Load [lbs]	Deflection Δ (in.) Gauges #1 & #2	Comments
0%	0	0.000	
7%	500	0.221	
14%	1000	0.286	
21%	1500	0.452	
0%	0	0.085	
21%	1500	0.518	
29%	2000	0.792	
36%	2500	1.130	
0%	0	0.209	
36%	2500	1.267	
43%	3000	1.548	
50%	3500	1.948	
57%	4000	2.000	
0%	0	0.454	
57%	4000		
64%	4500		
71%	5000		
79%	5500		
0%	0		
79%	5500		
86%	6000		
93%	6500		
100%	7000		
0%	0		



Lateral Load Test Result for PLT-003B

Project Information

Project Name:	Bright Mountain Solar
Project Location:	Hazard, KY
Project Number:	N3225022

Lateral Load Test Set Up

Number of Top Gauges:	0
Number of Bottom Gauges:	2
Height of Top Gauges [in]:	1
Height of Bottom Gauges [in]:	2
Height of Applied Load [in]:	24
Load Cell:	Dillon ED jr 10,000lb

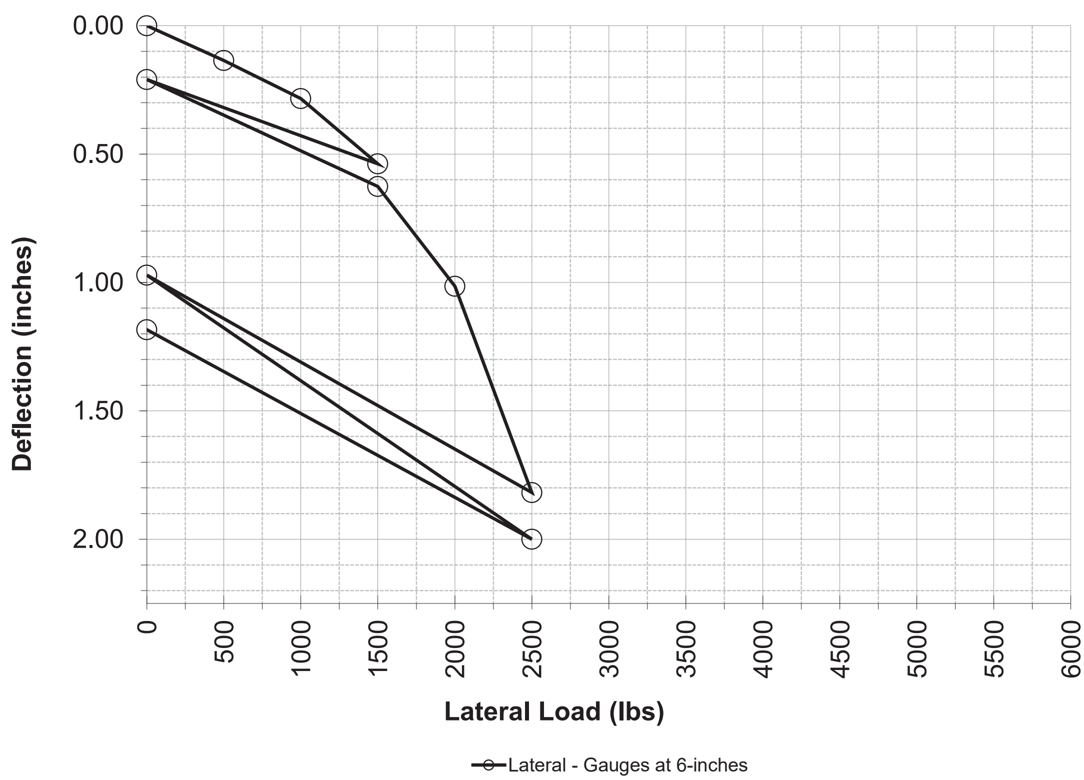
Test Date and Representative

Tested By Terracon Rep:	JL
Date Tested:	6/15/2022

Pile Information

Pile ID:	PLT-003B
Latitude:	37.29240
Longitude:	-83.28560
Pile Type:	W6X9
Pile Embedment Depth [in]:	84
Pile Stick-Up [in]:	36
Lateral Design Load [lbs]:	7000
Drive Time [sec]:	22

% of Design Load	Lateral Load [lbs]	Deflection Δ (in.) Gauges #1 & #2	Comments
0%	0	0.000	
7%	500	0.136	
14%	1000	0.284	
21%	1500	0.538	
0%	0	0.210	
21%	1500	0.626	
29%	2000	1.015	
36%	2500	1.819	
0%	0	0.971	
36%	2500	2.000	
43%	3000		
50%	3500		
57%	4000		
0%	0	1.184	
57%	4000		
64%	4500		
71%	5000		
79%	5500		
0%	0		
79%	5500		
86%	6000		
93%	6500		
100%	7000		
0%	0		



Lateral Load Test Result for PLT-004A

Project Information

Project Name:	Bright Mountain Solar
Project Location:	Hazard, KY
Project Number:	N3225022

Lateral Load Test Set Up

Number of Top Gauges:	0
Number of Bottom Gauges:	2
Height of Top Gauges [in]:	1
Height of Bottom Gauges [in]:	2
Height of Applied Load [in]:	24
Load Cell:	Dillon ED jr 10,000lb

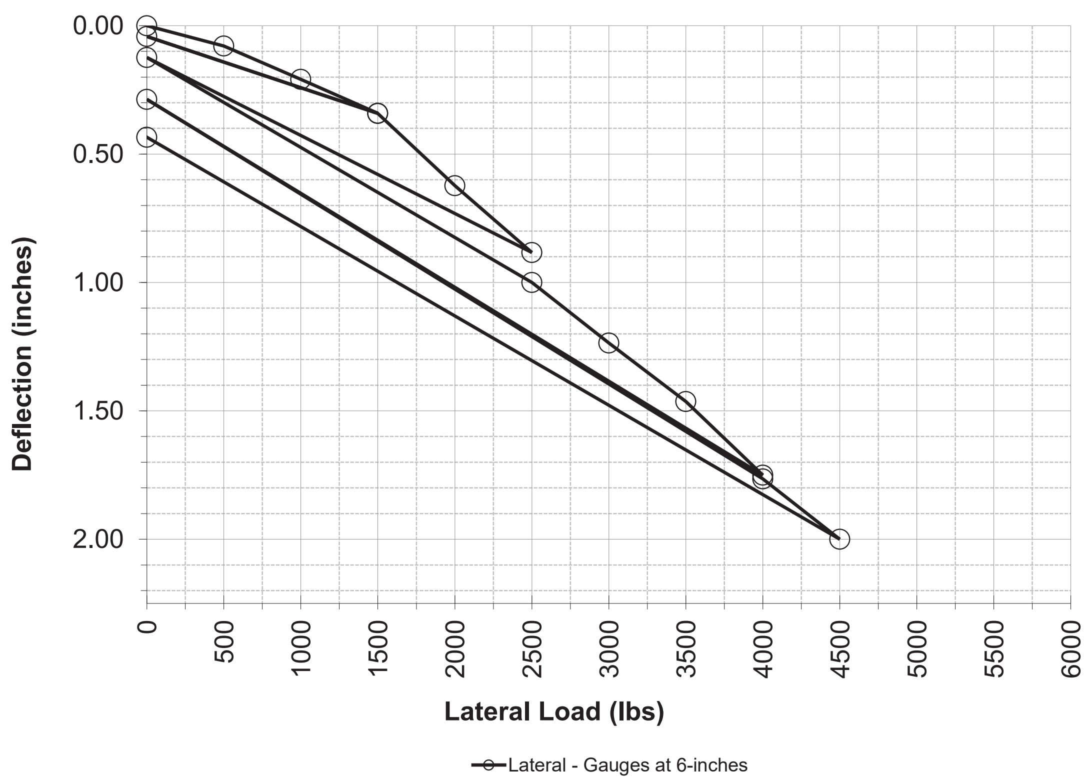
Test Date and Representative

Tested By Terracon Rep:	JL
Date Tested:	6/15/2022

Pile Information

Pile ID:	PLT-004A
Latitude:	37.29580
Longitude:	-83.29220
Pile Type:	W6X9
Pile Embedment Depth [in]:	120
Pile Stick-Up [in]:	36
Lateral Design Load [lbs]:	7000
Drive Time [sec]:	90

% of Design Load	Lateral Load [lbs]	Deflection Δ (in.) Gauges #1 & #2	Comments
0%	0	0.000	
7%	500	0.079	
14%	1000	0.209	
21%	1500	0.341	
0%	0	0.042	
21%	1500	0.342	
29%	2000	0.623	
36%	2500	0.883	
0%	0	0.124	
36%	2500	1.000	
43%	3000	1.236	
50%	3500	1.464	
57%	4000	1.750	
0%	0	0.287	
57%	4000	1.765	
64%	4500	2.000	
71%	5000		
79%	5500		
0%	0	0.435	
79%	5500		
86%	6000		
93%	6500		
100%	7000		
0%	0		



Lateral Load Test Result for PLT-004B

Project Information

Project Name:	Bright Mountain Solar
Project Location:	Hazard, KY
Project Number:	N3225022

Lateral Load Test Set Up

Number of Top Gauges:	0
Number of Bottom Gauges:	2
Height of Top Gauges [in]:	1
Height of Bottom Gauges [in]:	2
Height of Applied Load [in]:	24
Load Cell:	Dillon ED jr 10,000lb

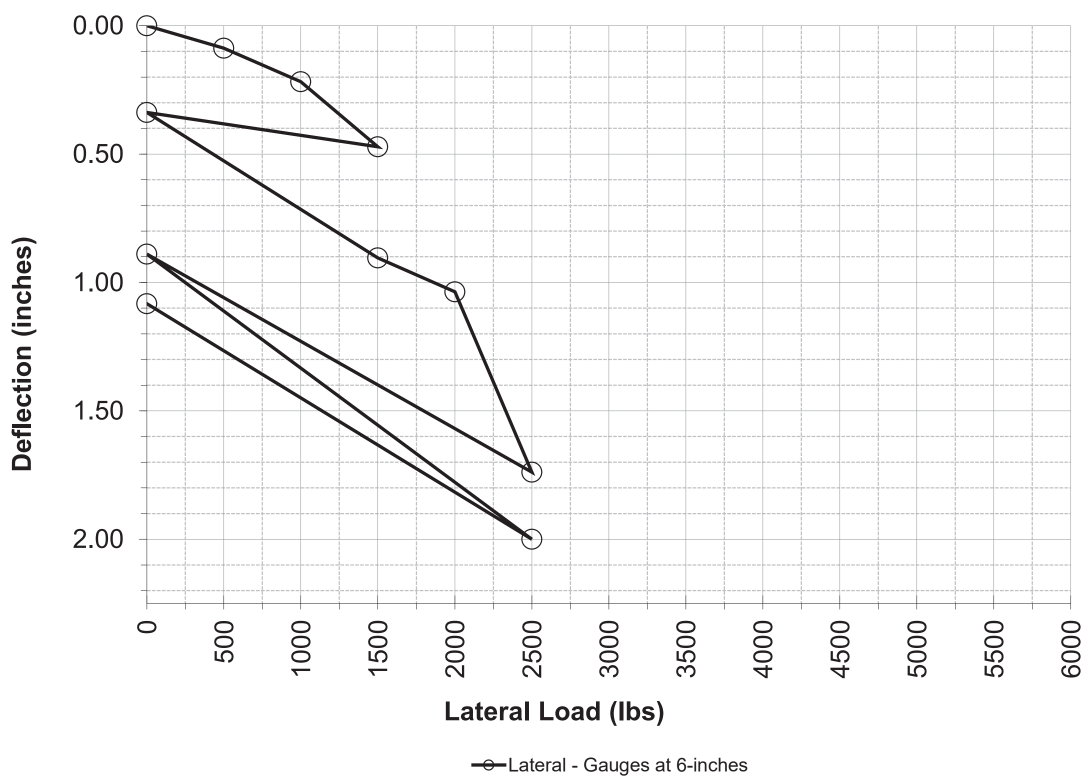
Test Date and Representative

Tested By Terracon Rep:	JL
Date Tested:	6/15/2022

Pile Information

Pile ID:	PLT-004B
Latitude:	37.29580
Longitude:	-83.29220
Pile Type:	W6X9
Pile Embedment Depth [in]:	84
Pile Stick-Up [in]:	36
Lateral Design Load [lbs]:	7000
Drive Time [sec]:	56

% of Design Load	Lateral Load [lbs]	Deflection Δ (in.) Gauges #1 & #2	Comments
0%	0	0.000	
7%	500	0.087	
14%	1000	0.219	
21%	1500	0.472	
0%	0	0.338	
21%	1500	0.904	
29%	2000	1.037	
36%	2500	1.739	
0%	0	0.889	
36%	2500	2.000	
43%	3000		
50%	3500		
57%	4000		
0%	0	1.083	
57%	4000		
64%	4500		
71%	5000		
79%	5500		
0%	0		
79%	5500		
86%	6000		
93%	6500		
100%	7000		
0%	0		



Bright Mountain Solar Project
Site Assessment Report
Case No. 2022-00274

Exhibit E – Preliminary Hydrologic and Hydraulic Evaluation

gai consultants

Pittsburgh Office
385 East Waterfront Drive
Homestead, Pennsylvania 15120

T 412.476.2000
F 412.476.2020

May 10, 2022

Project R210750.01

Ms. Nautasha Gupta
Avangrid Renewables, LLC
1125 NW Couch, Suite 700
Portland, Oregon 97209

Preliminary Hydrologic and Hydraulic Evaluation
Avangrid Renewables, LLC
Bright Mountain Solar Project
Perry County, Kentucky

Dear Ms. Gupta:

GAI Consultants, Inc. (GAI) has conducted a preliminary evaluation of the Hydrologic and Hydraulic (H&H) conditions at the proposed location of the Bright Mountain Solar Project, located in Perry County, Kentucky (KY) (Project) for Avangrid Renewables, LLC (Avangrid). This preliminary evaluation consisted of:

- A desktop review of applicable Federal, State, and local regulations that may govern the design of proposed drainage features; and
- The development of a two-dimensional surface water runoff model to identify existing runoff patterns.

This evaluation and letter report are intended to show potential areas of flow concentration and ponding within the project site (see Figure 1 for a Project Location Map). This information is intended to be used as a planning tool for locating these areas and is not intended for design or permitting of any individual feature. This letter report summarizes the means and methods used to develop the two-dimensional model and a summary of the results.

Regulatory Review

GAI conducted a desktop review of applicable regulatory agencies that may enforce design criteria related to site drainage and/or construction of facilities near water bodies and/or surface water runoff features. Table 1 provides a summary of the regulatory review and the applicable design criteria. This evaluation did not include direct correspondence with representatives from these agencies and is intended to provide an overview for planning purposes. During the design stages of the project, additional information should be obtained from these agencies. Note that Avangrid has client-specific design criteria regarding drainage-related features that should also be provided to selected design and construction contractors.

As presented in Table 1, Perry County participates in the National Flood Insurance Program (NFIP). Flood Insurance Studies (FIS) and associated Flood Insurance Rate Maps (FIRMs) have been published by the Federal Emergency Management Agency (FEMA). A FEMA Special Flood Hazard Area (SFHA) subject to inundation by the 1 percent annual chance flood (100-year flood) has been mapped within the project boundary. This area is identified as SFHA Zone A, which represents an area of approximate study with no flood elevations determined. This area is presented on Figure 2.

Two-Dimensional Surface Water Runoff Model

The computer program FLO-2D and its associated software package was utilized to model conditions at the project site.

Model Input

The following data sources were used to build the FLO-2D model:

- Topography – Digital Elevation Model (DEM) created from flown LiDAR (from Avangrid) inside of the project boundary, and ten-meter DEM (from Geospatial Data Gateway) outside of the project boundary;
- Watersheds – Hydrologic Unit Maps (HUC-12) and site-specific topography;
- Rainfall data – National Oceanic and Atmospheric Administration (NOAA) Atlas-14 (see Appendix A of this letter report);
- Land cover/land use data – 2019 National Land Cover Data Base (NLCD) (see Appendix B of this letter report for information on NLCD land uses listed within the project area and associated watersheds, as well as Figures 2 and 3 for a visual representation of the NLCD land uses and aerial, respectively); and
- Soil data – the United States Department of Agriculture's Natural Resources Conservation Service Soil Survey Geographic (SSURGO) database for Perry County, KY (see Appendix C of this letter report).

According to an environmental study conducted for the project site (*Environmental Desktop Due Diligence Summary*, GAI, November 2021), strip mining began on the property by 1973, and it continued within and around the project site into the 2010s. Since then, the mined areas within the project site appear to have been largely reclaimed. Due to the topography changes from the mining, the flown LiDAR data provided by Avangrid (collected in January 2022) was utilized within the project boundary to represent current site conditions. The DEM created from the flown LiDAR data inside the project boundary was merged with the ten-meter DEM from Geospatial Data Gateway outside of the project boundary.

The HUC-12 watershed boundaries were consulted and included on the Maximum Flow Depth and Peak Velocity Maps Sheet Index for reference. The project boundary falls within the Colwell Fork-North Fork Kentucky River (HUC12: 051002010402) and Big Willard Creek-North Fork Kentucky River (HUC12: 051002010401) Watersheds. However, due to the historical topographic changes associated with the mining operations, as described above, the drainage areas within the project boundary were delineated utilizing the site-specific LiDAR data provided by Avangrid.

Table 2 summarizes the runoff Curve Numbers (CNs) used throughout the study area, which were based on the land cover/land use data and soil data. Most of the study area is underlain by soils of Hydrologic Soil Group (HSG) C, which is considered to have a slow infiltration rate when thoroughly wet, or soils that have a slow rate of water transmission. For this evaluation, HSG C soil was assumed for the entire study area except for wetland areas, for which HSG D soil, which has high runoff potential when thoroughly wet, was assumed to account for hydric soils.

FLO-2D uses Manning's roughness coefficients to evaluate overland and channel flow between adjacent areas. Roughness coefficients throughout the project area were selected based on the NLCD cover type. Values were estimated considering guidance provided in the FLO-2D user's manual and research of past projects utilizing FLO-2D to represent overland flow scenarios. No specific channel or stream features were delineated for this study outside of topographic features identified by the Digital Elevation Model. Refer to Table 2 for a summary of the Manning's coefficients.

The FLO-2D model utilized a 50-foot by 50-foot computational grid. No hydraulic structures (culverts or bridges) were included in the model.

The project area geographically falls within a SCS Type II 24-hour rainfall distribution area. Therefore, the SCS Type II rainfall distribution has been utilized in the model.

The project site is bounded by the North Fork Kentucky River to the west. The drainage area of the river is approximately 561 square miles (24,437,160 acres) at the downstream limit of the project. Due to the large size of the watershed, the river was not included as part of the FLO-2D model. The North Fork Kentucky River has been studied by FEMA and a 100-year floodplain boundary is mapped on the FIRM (Figure 2). This boundary is utilized to represent areas of inundation associated with the North Fork Kentucky River.

Model Output

The FLO-2D model was executed for the 2-year, 10-year, 25-year, 50-year, and 100-year storm events. Maps showing maximum anticipated flow depths and velocities for each of these events across the study are provided in this letter report.

There appear to be a few small ponds within the study boundary. These ponds were incorporated into the FLO-2D model solely through the topographic data presented in the DEM created from the flown LiDAR and land use data. Initial water surface elevations within the ponds at the commencement of modeling are equivalent to the water surface elevations that were present when the elevation data was recorded (and subsequently incorporated into the DEM). Information on outlet structures or spillways associated with the ponds was not available and this information has not been incorporated into the modeling. Due to the absence of defined outlet features, the model may be overestimating the extent of runoff storage (and associated inundated area) upstream of the ponds. Similarly, the model may be underestimating the flow and inundation areas downstream of the ponds. A more detailed analysis, including field and desktop investigation of their embankments and outlet works, would need to be conducted in order to provide a more detailed representation of flow conditions.

In locations where SFHAs have been mapped by FEMA, the FEMA mapping should be consulted and compared to the results of the FLO-2D model.

As previously presented, the North Fork Kentucky River has not been modeled as part of this study and the FEMA 100-year boundary has been adopted to represent areas of inundation associated with the river. The portion of the project boundary that is within the FEMA floodplain boundary occurs at the base of a steep wooded hillside, likely not suitable for future development. If additional information is required to represent flooding conditions along the North Fork Kentucky River, a supplemental analysis will be required.

In addition to the maps included in this letter report, digital shapefiles and KMZ files of flow depth and velocity are also being provided to Avangrid.

Closing

GAI has conducted a preliminary evaluation of the H&H conditions at the Bright Mountain Solar Project site. The information presented in this letter report is based on conditions at the time of the evaluation and on the reference information, assumptions, and limitations identified in this report. Should proposed conditions change, or additional information becomes available, GAI requests the opportunity to review, and if applicable, revise its findings under a supplemental scope of services. This evaluation is preliminary, and further analyses are required to design drainage features at the Project. These analyses may include a more detailed two-dimensional model, utilizing project topography and/or conventional one-dimensional approaches to culvert and channel design.

GAI appreciates the opportunity to provide our professional services to Avangrid in support of the Bright Mountain Solar Project. Should you have any questions regarding our evaluation or require additional information, please feel free to contact Mr. Adam Scheller at 412.399.5166 or Mr. Enrique Bazan-Arias at 412.399.5465.

Sincerely,

GAI Consultants, Inc.

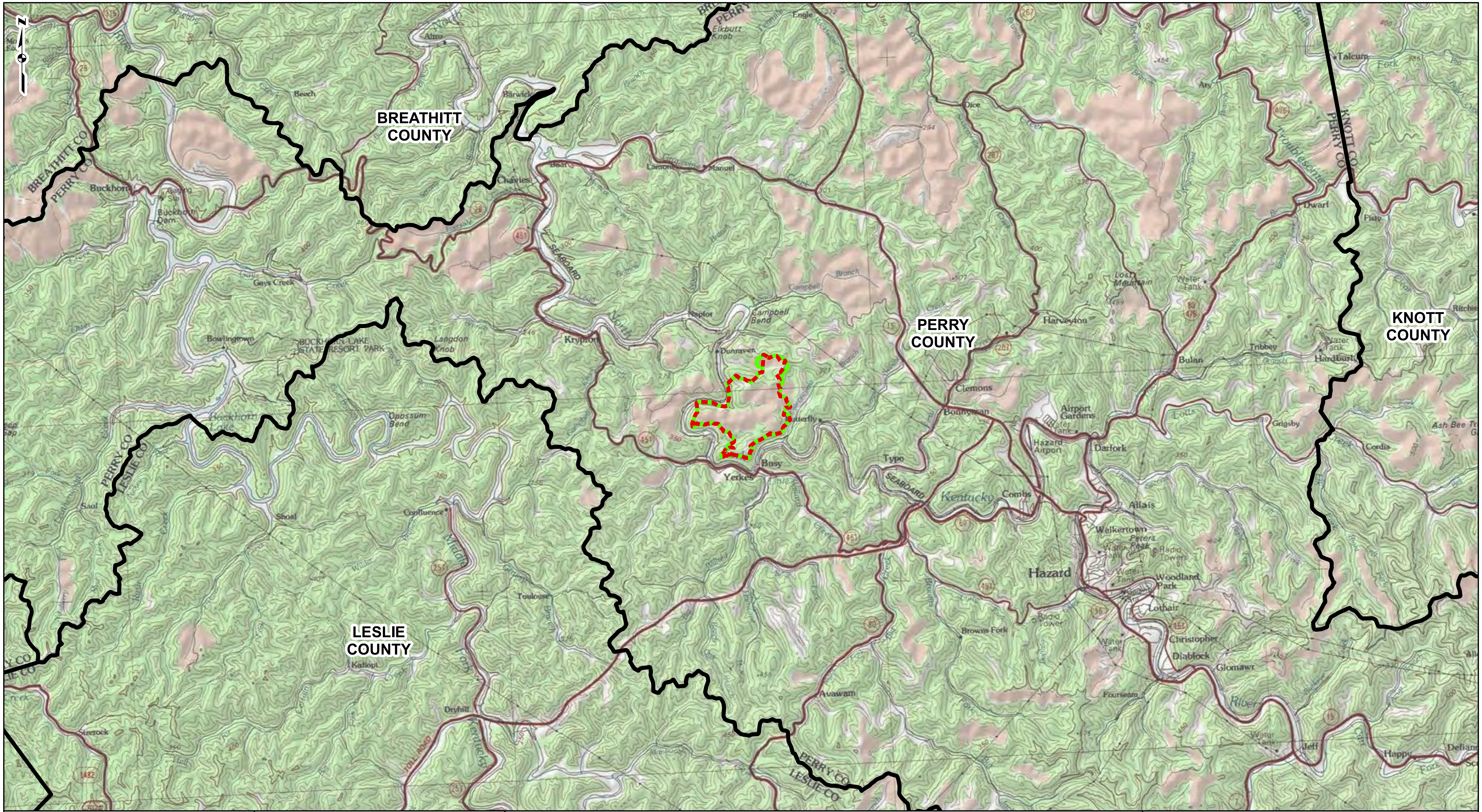
Adam B. Scheller, PE
Engineering Manager

Enrique J. Bazan-Arias, PE, EMBA
Engineering Manager

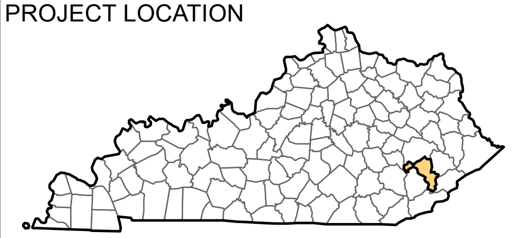
ABS:EJB/lmt

Attachments: Figure 1 (Project Location Map)
Figure 2 (FEMA Floodplain Boundaries Map)
Figure 3 (Land Use Map)
Figure 4 (Project Area Imagery Map)
Flow Depth and Velocity Maps
Table 1 (Regulatory Review Summary)
Table 2 (Runoff and Roughness Value Summary)
Appendix A (NOAA Rainfall Data)
Appendix B (NLCD Land Use Summary)
Appendix C (SSURGO Soil Report)

FIGURES



PROJECT LOCATION



PERRY COUNTY, KENTUCKY

REFERENCES:

1. BACKGROUND TOPOGRAPHY: 7.5' TOPOGRAPHIC QUADRANGLE FOR PROJECT BOUNDARY: KRYPTON (1973), KENTUCKY, OBTAINED THROUGH ESRI USA. TOPO MAPS, NATIONAL GEOGRAPHIC TOPO AND USGS, ACCESSED 02/2022.

2. PROJECT BOUNDARY FROM AVANGRID, 09/2021.

NOTES:

1. THE FLO-2D BOUNDARY WAS DEVELOPED FROM THE HUC-12 WATERSHED BOUNDARIES AND TOPOGRAPHY IN THE VICINITY OF THE PROJECT.

LEGEND

- PROJECT BOUNDARY (REF. 2)
- FLO-2D BOUNDARY (NOTE 1)
- COUNTY BOUNDARY

0 0.75 1.5 3 Miles

FIGURE 1
PROJECT LOCATION MAP

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BRIGHT MOUNTAIN SOLAR PROJECT
AVANGRID RENEWABLES, LLC

AVANGRID RENEWABLES

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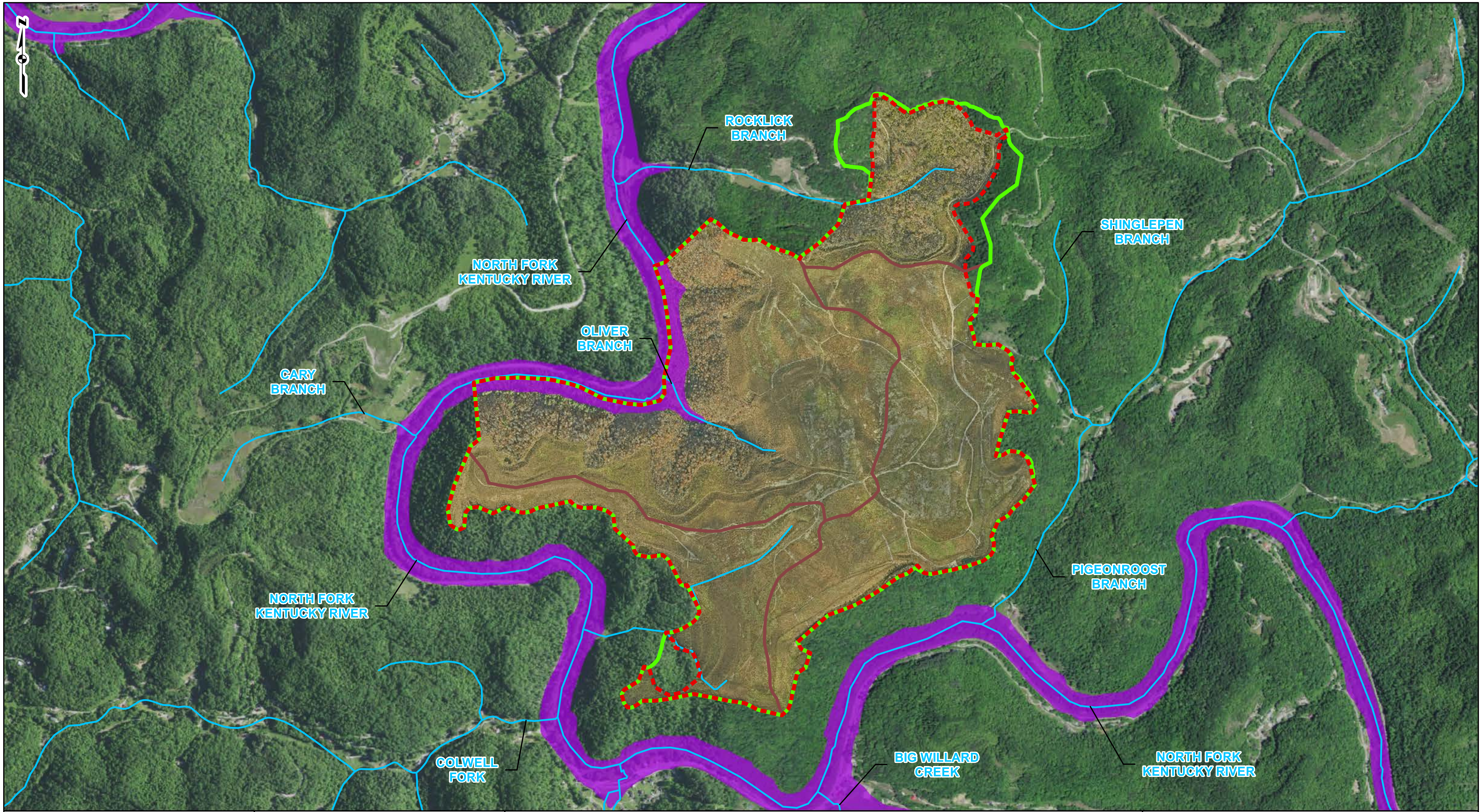

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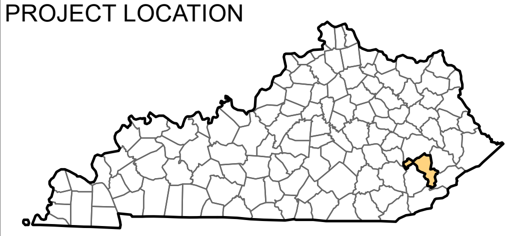

PERRY COUNTY, KENTUCKY

REFERENCES:

1. AERIAL INSIDE OF PROJECT BOUNDARY: FLOWN, FROM AVANGRID, 01/2022. AERIAL OUTSIDE OF PROJECT BOUNDARY: NATIONAL AGRICULTURAL IMAGERY PROGRAIM (NAIP), USDA, FSA, 06/2020, ACCESSED 02/2022.

2. PROJECT BOUNDARY FROM AVANGRID, 09/2021.

3. FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA) 100-YEAR FLOODPLAINS: FEMA, NATIONAL FLOOD HAZARD LAYER (NFHL) ARCGIS VIEWER, KENTUCKY, ACCESSED 02/2022.

NOTES:

1. THE FLO-2D BOUNDARY WAS DEVELOPED FROM THE HUC-12 WATERSHED BOUNDARIES AND TOPOGRAPHY IN THE VICINITY OF THE PROJECT. SEE H&H REPORT NARRATIVE FOR ADDITIONAL DISCUSSION.

2. THE DRAINAGE DIVIDES WITHIN THE PROJECT BOUNDARY WERE MANUALLY DELINEATED BASED ON THE TOPOGRAPHY WITHIN THE PROJECT BOUNDARY, WHICH WAS GATHERED IN THE FORM OF FLOWN LIDAR (FROM AVANGRID, 01/2022).

LEGEND

- NHD FLOWLINE
- PROJECT BOUNDARY *(REF. 2)*
- FLO-2D BOUNDARY *(NOTE 1)*
- DRAINAGE DIVIDE WITHIN PROJECT BOUNDARY *(NOTE 2)*
- FEMA 100-YR FLOODPLAIN (ZONE A) *(REF. 3)*

0 0.125 0.25 0.5 Miles

FIGURE 2
FEMA FLOODPLAIN BOUNDARIES MAP

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BRIGHT MOUNTAIN SOLAR PROJECT
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AVANGRID RENEWABLES

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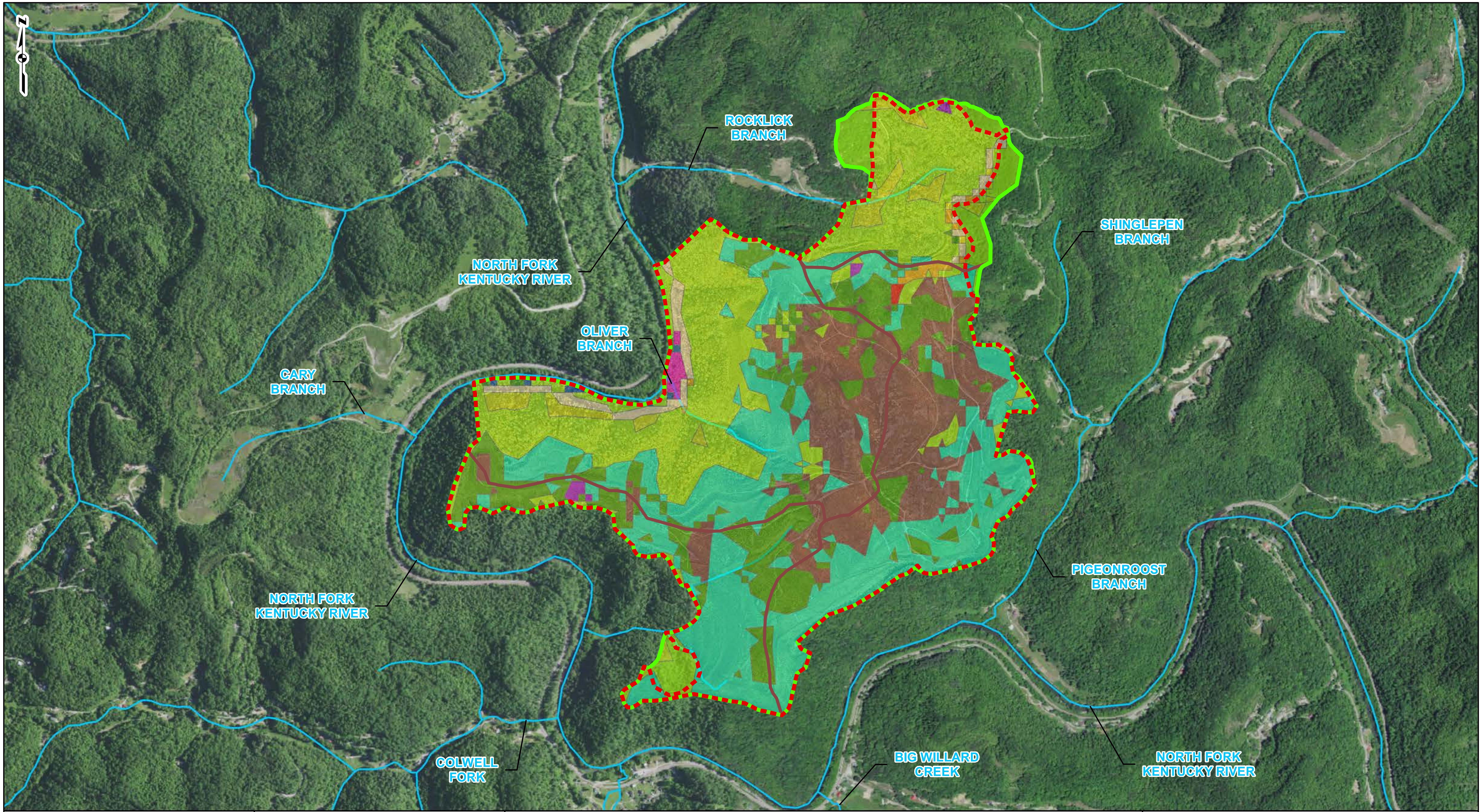
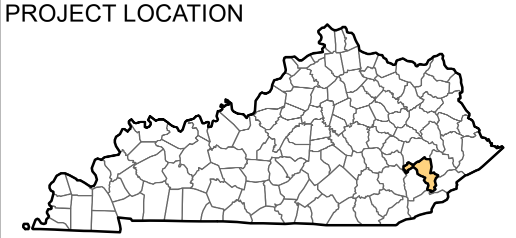


PROJECT LOCATION



PERRY COUNTY, KENTUCKY

REFERENCES:

1. AERIAL INSIDE OF PROJECT BOUNDARY: FLOWN, FROM AVANGRID, 01/2022. AERIAL OUTSIDE OF PROJECT BOUNDARY: NATIONAL AGRICULTURAL IMAGERY PROGRAIM (NAIP), USDA, FSA, 06/2020, ACCESSED 02/2022.

2. PROJECT BOUNDARY FROM AVANGRID, 09/2021.

3. LAND USE TYPES: NATIONAL LAND COVER DATABASE (NLCD), MULTI-RESOLUTION LAND CHARACTERISTICS (MRLC) CONSORTIUM, 2019, ACCESSED 02/2022.

NOTES:

1. THE FLO-2D BOUNDARY WAS DEVELOPED FROM THE HUC-12 WATERSHED BOUNDARIES AND TOPOGRAPHY IN THE VICINITY OF THE PROJECT. SEE H&H REPORT NARRATIVE FOR ADDITIONAL DISCUSSION.

2. THE DRAINAGE DIVIDES WITHIN THE PROJECT BOUNDARY WERE MANUALLY DELINEATED BASED ON THE TOPOGRAPHY WITHIN THE PROJECT BOUNDARY, WHICH WAS GATHERED IN THE FORM OF FLOWN LIDAR (FROM AVANGRID, 01/2022).

LEGEND

- NHD FLOWLINE
- PROJECT BOUNDARY (REF. 2)
- FLO-2D BOUNDARY (NOTE 1)
- DRAINAGE DIVIDE WITHIN PROJECT BOUNDARY (NOTE 2)

LAND USE TYPES:

- OPEN WATER
- DEVELOPED, OPEN SPACE
- DEVELOPED, LOW INTENSITY
- DEVELOPED, MEDIUM INTENSITY
- DEVELOPED, HIGH INTENSITY
- DECIDUOUS FOREST
- MIXED FOREST
- SHRUB/SCRUB
- GRASSLAND/ HERBACEOUS
- PASTURE/HAY
- WOODY WETLANDS
- BARREN LAND (ROCK/SAND/CLAY)

0 0.125 0.25 0.5 Miles

FIGURE 3
LAND USE MAP

BRIGHT MOUNTAIN SOLAR PROJECT
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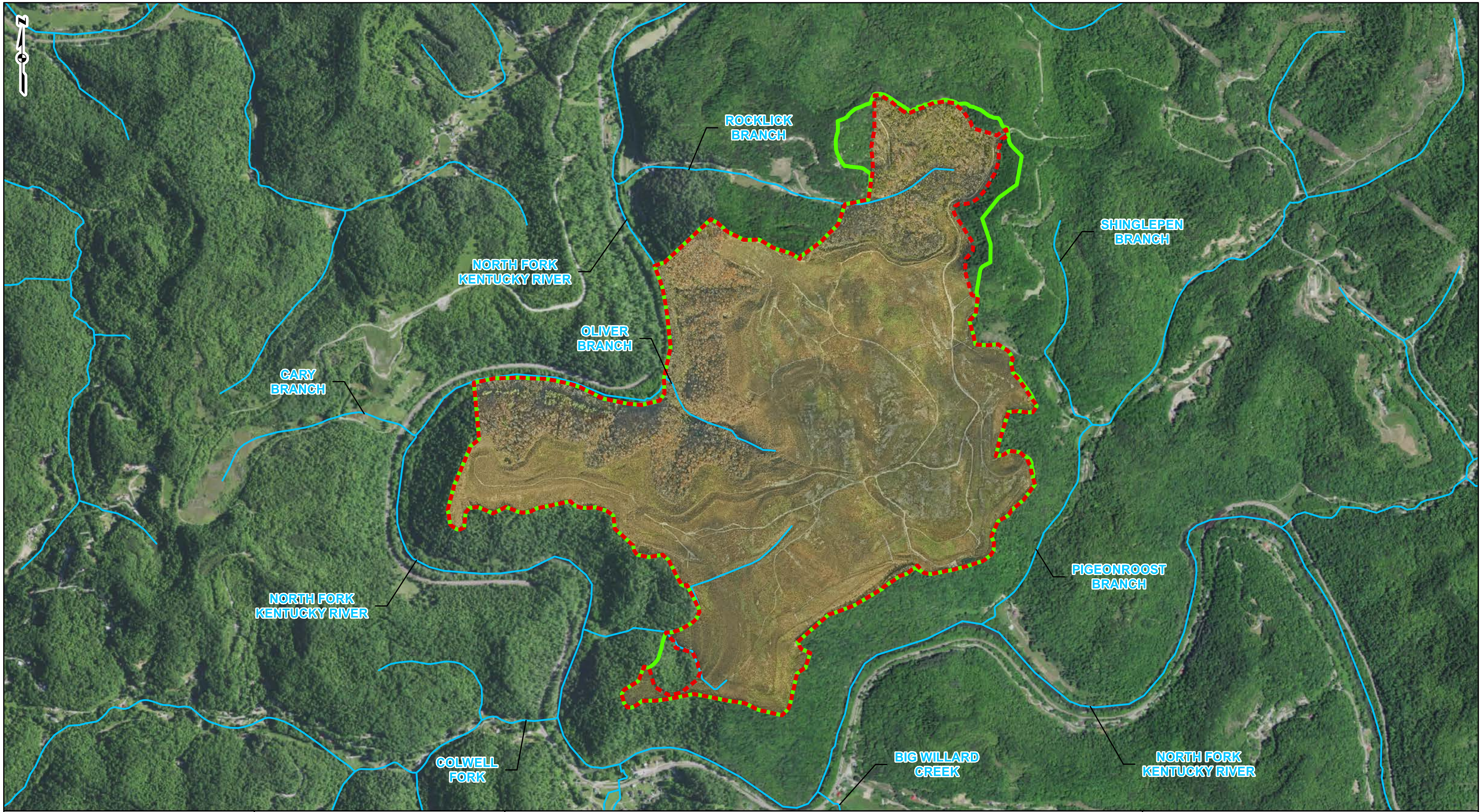
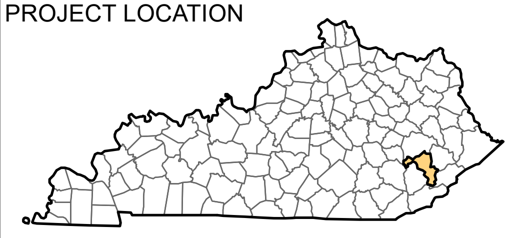


PROJECT LOCATION



PERRY COUNTY, KENTUCKY

REFERENCES:

1. AERIAL INSIDE OF PROJECT BOUNDARY: FLOWN, FROM AVANGRID, 01/2022.
AERIAL OUTSIDE OF PROJECT BOUNDARY: NATIONAL AGRICULTURAL IMAGERY PROGRAM (NAIP), USDA, FSA, 06/2020, ACCESSED 02/2022.

2. PROJECT BOUNDARY FROM AVANGRID, 09/2021.

NOTES:

1. THE FLO-2D BOUNDARY WAS DEVELOPED FROM THE HUC-12 WATERSHED BOUNDARIES AND TOPOGRAPHY IN THE VICINITY OF THE PROJECT. SEE H&H REPORT NARRATIVE FOR ADDITIONAL DISCUSSION.

LEGEND

- PROJECT BOUNDARY (REF. 2)
- FLO-2D BOUNDARY (NOTE 1)
- NHD FLOWLINE

0 0.125 0.25 0.5 Miles

FIGURE 4
PROJECT AREA IMAGERY MAP

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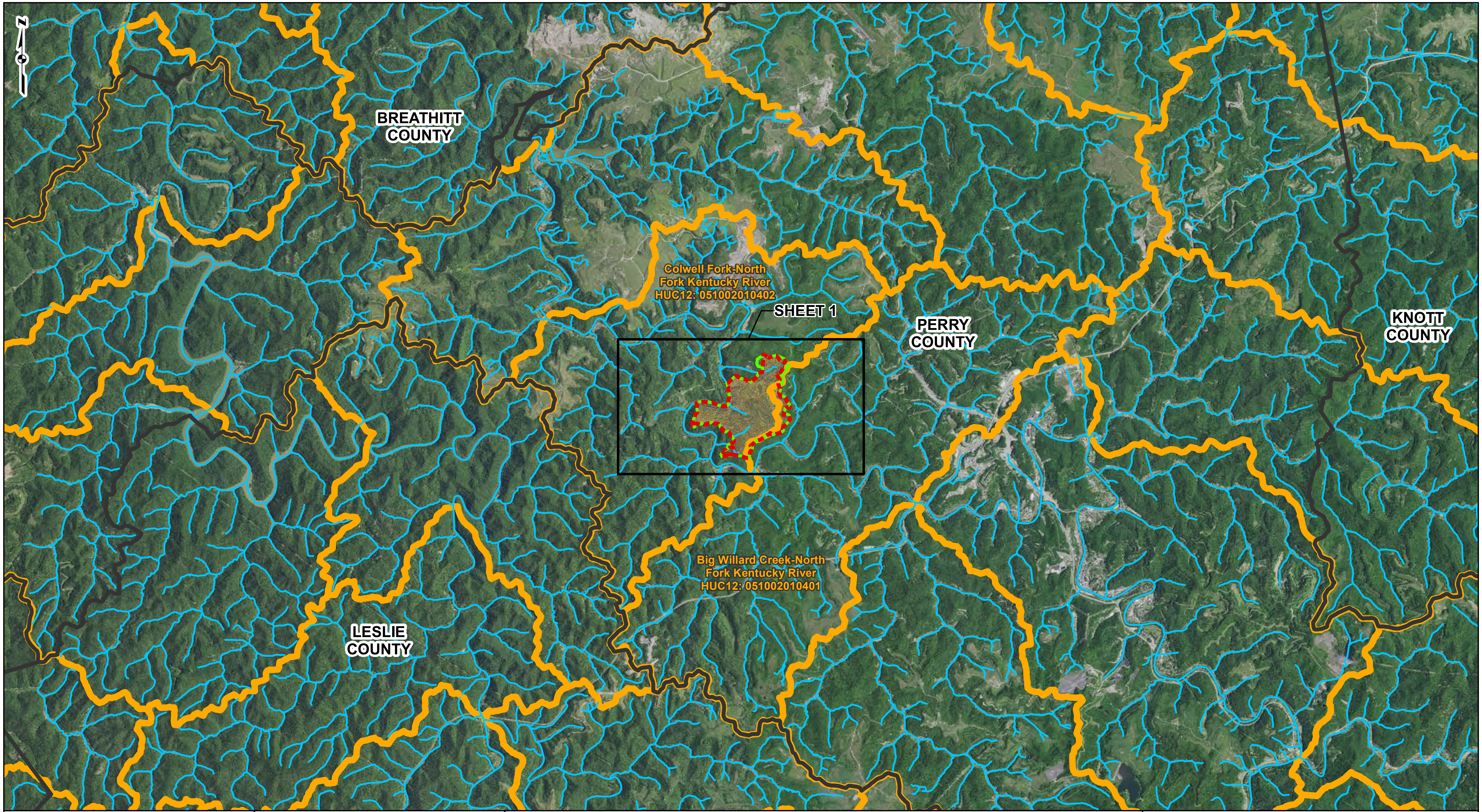
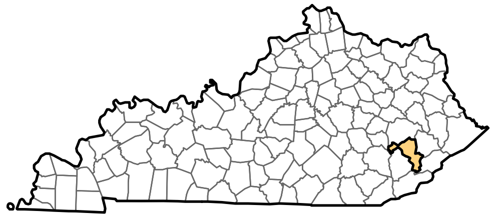
FLOW DEPTH AND VELOCITY MAPS



PROJECT LOCATION



PERRY COUNTY, KENTUCKY

REFERENCES:

1. AERIAL INSIDE OF PROJECT BOUNDARY: FLOWN, FROM AVANGRID, 01/2022. AERIAL OUTSIDE OF PROJECT BOUNDARY: NATIONAL AGRICULTURAL IMAGERY PROGRAIM (NAIP), USDA, FSA, 06/2020, ACCESSED 02/2022.

2. PROJECT BOUNDARY FROM AVANGRID, 09/2021.

3. HUC-12 WATERSHED BOUNDARIES: USGS NHD, HYDROLOGIC UNIT MAPS (HUC-12), ACCESSED 02/2022.

NOTES:

1. THE FLO-2D BOUNDARY WAS DEVELOPED FROM THE HUC-12 WATERSHED BOUNDARIES (REF. 3) AND TOPOGRAPHY IN THE VICINITY OF THE PROJECT. SEE H&H REPORT NARRATIVE FOR ADDITIONAL DISCUSSION.

LEGEND

NHD FLOWLINE
COUNTY BOUNDARY
HUC-12 WATERSHED BOUNDARY (REF. 3)
PROJECT BOUNDARY (REF. 2)
FLO-2D BOUNDARY (NOTE 1)
SHEET INDEX

0 0.75 1.5 3 Miles

MAXIMUM FLOW DEPTH AND PEAK VELOCITY MAPS SHEET INDEX

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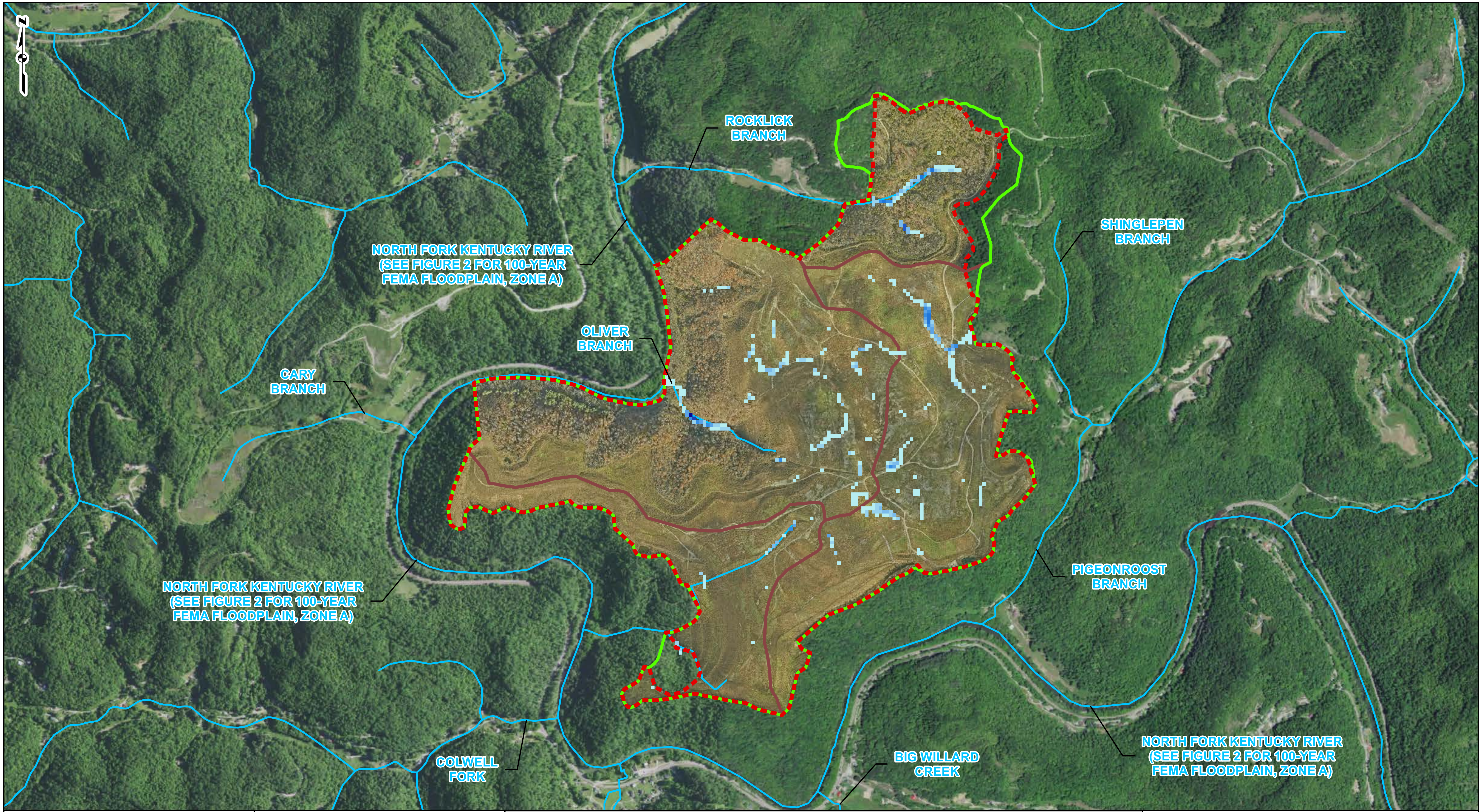
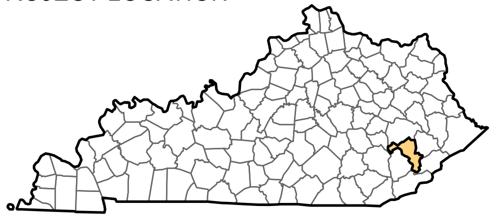


PROJECT LOCATION



PERRY COUNTY, KENTUCKY

REFERENCES:

1. AERIAL INSIDE OF PROJECT BOUNDARY: FLOWN, FROM AVANGRID, 01/2022. AERIAL OUTSIDE OF PROJECT BOUNDARY: NATIONAL AGRICULTURAL IMAGERY PROGRAIM (NAIP), USDA, FSA, 06/2020, ACCESSED 02/2022.

2. PROJECT BOUNDARY FROM AVANGRID, 09/2021.

NOTES:

1. THE FLO-2D BOUNDARY WAS DEVELOPED FROM THE HUC-12 WATERSHED BOUNDARIES AND TOPOGRAPHY IN THE VICINITY OF THE PROJECT. SEE H&H REPORT NARRATIVE FOR ADDITIONAL DISCUSSION.

2. THE DRAINAGE DIVIDES WITHIN THE PROJECT BOUNDARY WERE MANUALLY DELINEATED BASED ON THE TOPOGRAPHY WITHIN THE PROJECT BOUNDARY, WHICH WAS GATHERED IN THE FORM OF FLOWN LIDAR (FROM AVANGRID, 01/2022).

3. THERE APPEAR TO BE A NUMBER OF PONDS IN THE PROJECT VICINITY. SEE H&H REPORT NARRATIVE FOR ADDITIONAL DISCUSSION OF THESE FEATURES AND FLOW DEPTHS WITHIN THE PROJECT BOUNDARY.

LEGEND

- NHD FLOWLINE
- PROJECT BOUNDARY (REF. 2)
- FLO-2D BOUNDARY (NOTE 1)
- DRAINAGE DIVIDE WITHIN PROJECT BOUNDARY (NOTE 2)

FLOW DEPTH (FT) (NOTE 3): 0.50 - 1.00, 1.01 - 1.50, 1.51 - 2.00, 2.01 - 2.50, 2.51 - 3.00, 3.01 - 3.50, 3.51 - 4.00, 4.01 - 4.50, 4.51 - 5.00, 5.01+

0 0.125 0.25 0.5 Miles

100-YEAR STORM EVENT MAXIMUM FLOW DEPTH MAP

BRIGHT MOUNTAIN SOLAR PROJECT
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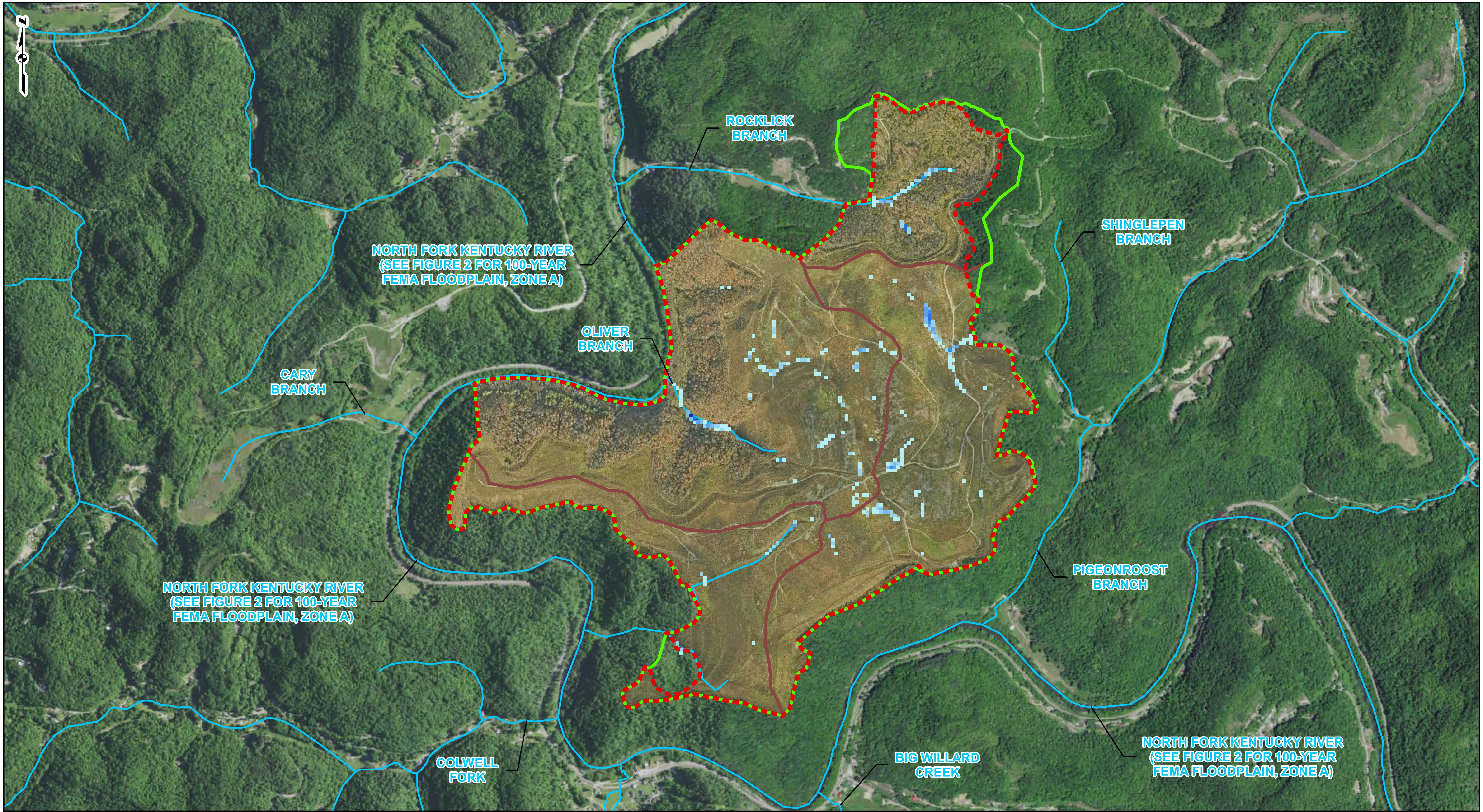
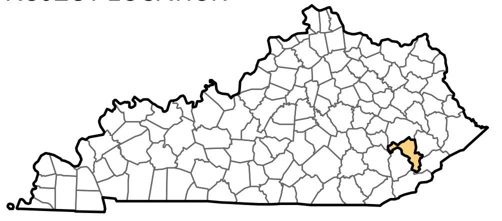


PROJECT LOCATION



PERRY COUNTY, KENTUCKY

REFERENCES:

1. AERIAL INSIDE OF PROJECT BOUNDARY: FLOWN, FROM AVANGRID, 01/2022. AERIAL OUTSIDE OF PROJECT BOUNDARY: NATIONAL AGRICULTURAL IMAGERY PROGRAIM (NAIP), USDA, FSA, 06/2020, ACCESSED 02/2022.

2. PROJECT BOUNDARY FROM AVANGRID, 09/2021.

NOTES:

1. THE FLO-2D BOUNDARY WAS DEVELOPED FROM THE HUC-12 WATERSHED BOUNDARIES AND TOPOGRAPHY IN THE VICINITY OF THE PROJECT. SEE H&H REPORT NARRATIVE FOR ADDITIONAL DISCUSSION.

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LEGEND

- NHD FLOWLINE
- PROJECT BOUNDARY (REF. 2)
- FLO-2D BOUNDARY (NOTE 1)
- DRAINAGE DIVIDE WITHIN PROJECT BOUNDARY (NOTE 2)

FLOW DEPTH (FT) (NOTE 3): 0.50 - 1.00, 1.01 - 1.50, 1.51 - 2.00, 2.01 - 2.50, 2.51 - 3.00, 3.01 - 3.50, 3.51 - 4.00, 4.01 - 4.50, 4.51 - 5.00, 5.01+

0 0.125 0.25 0.5 Miles

50-YEAR STORM EVENT MAXIMUM FLOW DEPTH MAP

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BRIGHT MOUNTAIN SOLAR PROJECT
AVANGRID RENEWABLES, LLC

AVANGRID RENEWABLES

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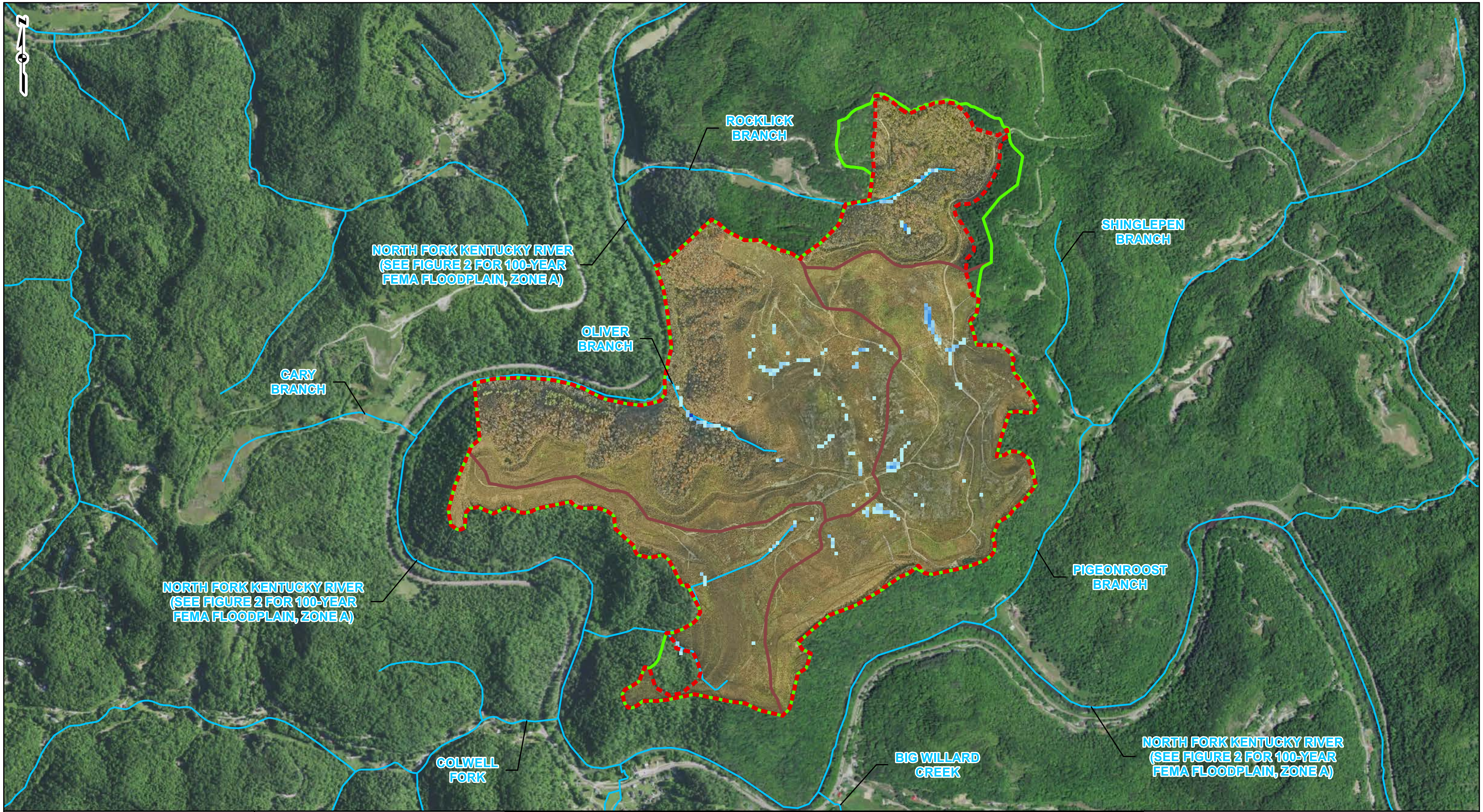
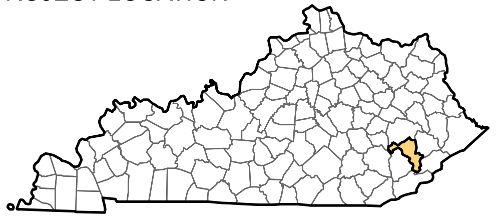


PROJECT LOCATION



PERRY COUNTY, KENTUCKY

REFERENCES:

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2. PROJECT BOUNDARY FROM AVANGRID, 09/2021.

NOTES:

1. THE FLO-2D BOUNDARY WAS DEVELOPED FROM THE HUC-12 WATERSHED BOUNDARIES AND TOPOGRAPHY IN THE VICINITY OF THE PROJECT. SEE H&H REPORT NARRATIVE FOR ADDITIONAL DISCUSSION.

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3. THERE APPEAR TO BE A NUMBER OF PONDS IN THE PROJECT VICINITY. SEE H&H REPORT NARRATIVE FOR ADDITIONAL DISCUSSION OF THESE FEATURES AND FLOW DEPTHS WITHIN THE PROJECT BOUNDARY.

LEGEND

NHD FLOWLINE

PROJECT BOUNDARY *(REF. 2)*

FLO-2D BOUNDARY *(NOTE 1)*

DRAINAGE DIVIDE WITHIN PROJECT BOUNDARY *(NOTE 2)*

FLOW DEPTH (FT) *(NOTE 3)*

0.50 - 1.00 | 1.01 - 1.50 | 1.51 - 2.00 | 2.01 - 2.50 | 2.51 - 3.00 | 3.01 - 3.50 | 3.51 - 4.00 | 4.01 - 4.50 | 4.51 - 5.00 | 5.01+

0 0.125 0.25 0.5 Miles

25-YEAR STORM EVENT MAXIMUM FLOW DEPTH MAP

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BRIGHT MOUNTAIN SOLAR PROJECT
AVANGRID RENEWABLES, LLC

AVANGRID RENEWABLES

DRAWN BY: JONESAR	DATE: 5/10/2022
CHECKED: SCHELAB	APPROVED: BORTZKM

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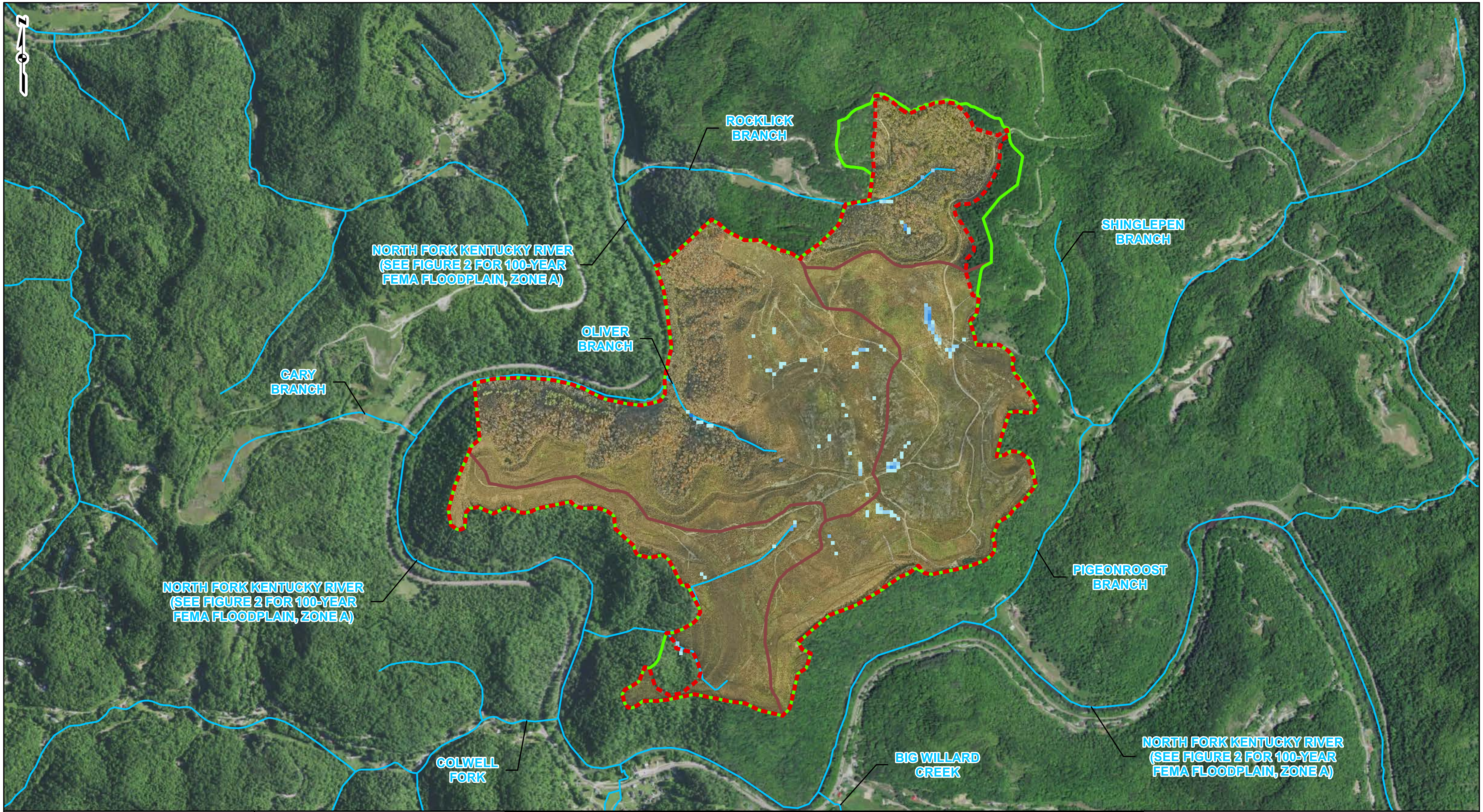

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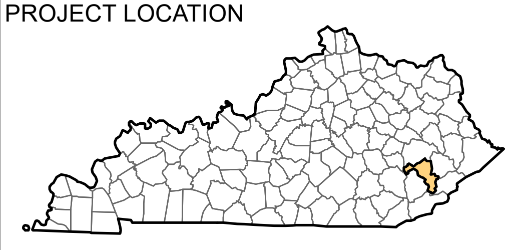

PERRY COUNTY, KENTUCKY

REFERENCES:

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2. PROJECT BOUNDARY FROM AVANGRID, 09/2021.

NOTES:

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2. THE DRAINAGE DIVIDES WITHIN THE PROJECT BOUNDARY WERE MANUALLY DELINEATED BASED ON THE TOPOGRAPHY WITHIN THE PROJECT BOUNDARY, WHICH WAS GATHERED IN THE FORM OF FLOWN LIDAR (FROM AVANGRID, 01/2022).

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LEGEND

NHD FLOWLINE

PROJECT BOUNDARY *(REF. 2)*

FLO-2D BOUNDARY *(NOTE 1)*

DRAINAGE DIVIDE WITHIN PROJECT BOUNDARY *(NOTE 2)*

FLOW DEPTH (FT) *(NOTE 3)*

0.50 - 1.00 | 1.01 - 1.50 | 1.51 - 2.00 | 2.01 - 2.50 | 2.51 - 3.00 | 3.01 - 3.50 | 3.51 - 4.00 | 4.01 - 4.50 | 4.51 - 5.00 | 5.01+

0 | 0.125 | 0.25 | 0.5 Miles

10-YEAR STORM EVENT MAXIMUM FLOW DEPTH MAP

gai consultants

BRIGHT MOUNTAIN SOLAR PROJECT
AVANGRID RENEWABLES, LLC

AVANGRID RENEWABLES

DRAWN BY: JONESAR
CHECKED: SCHELAB
DATE: 5/10/2022
APPROVED: BORTZKM

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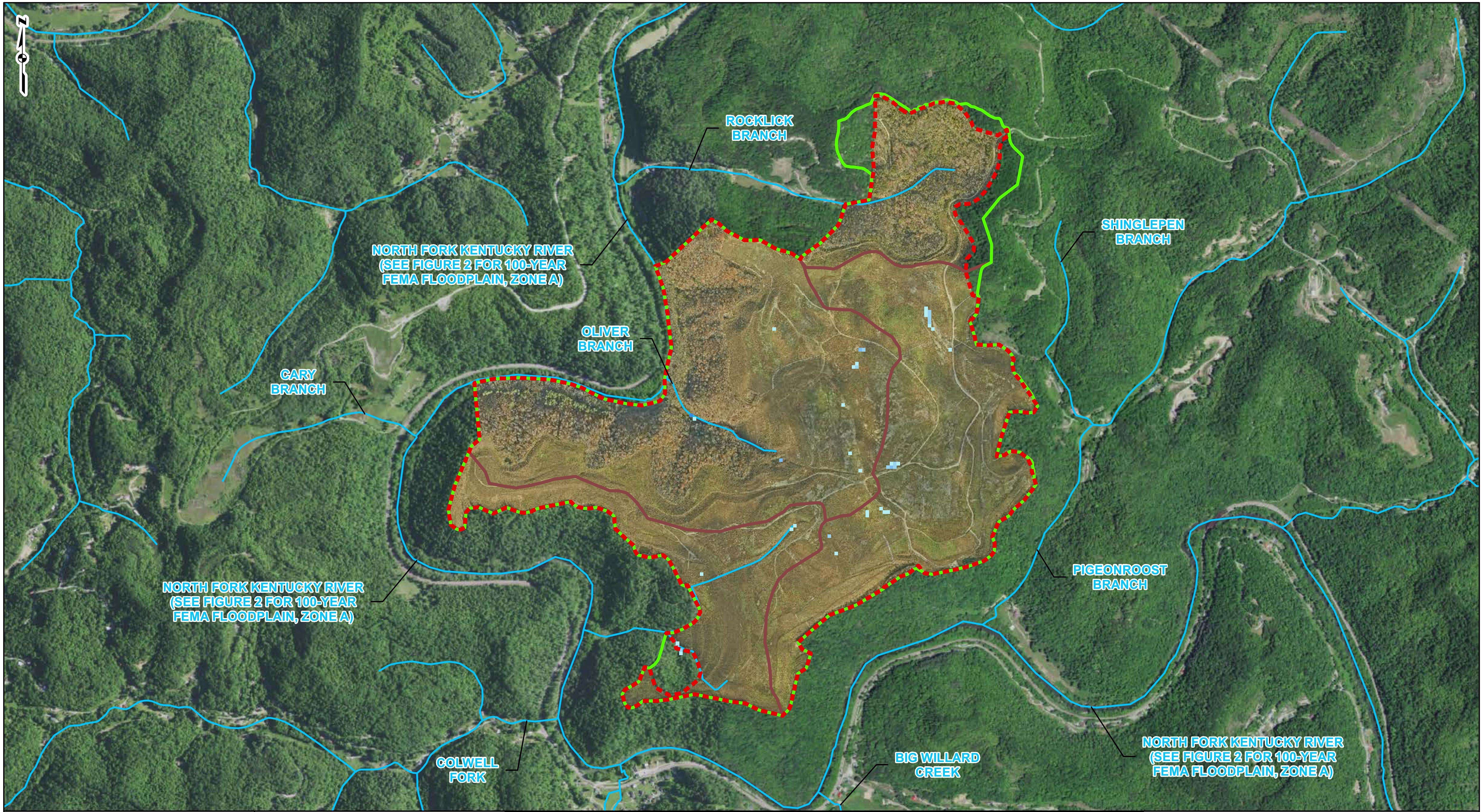

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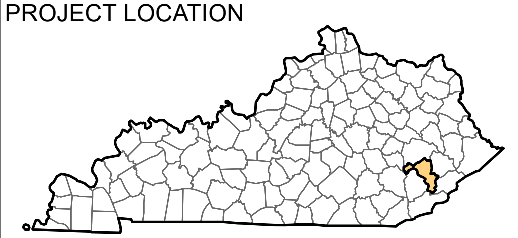

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LEGEND

- NHD FLOWLINE
- PROJECT BOUNDARY (REF. 2)
- FLO-2D BOUNDARY (NOTE 1)
- DRAINAGE DIVIDE WITHIN PROJECT BOUNDARY (NOTE 2)

FLOW DEPTH (FT) (NOTE 3): 0.50 - 1.00; 1.01 - 1.50; 1.51 - 2.00; 2.01 - 2.50; 2.51 - 3.00; 3.01 - 3.50; 3.51 - 4.00; 4.01 - 4.50; 4.51 - 5.00; 5.01+

0 0.125 0.25 0.5 Miles

2-YEAR STORM EVENT MAXIMUM FLOW DEPTH MAP

gai consultants

BRIGHT MOUNTAIN SOLAR PROJECT
AVANGRID RENEWABLES, LLC

AVANGRID RENEWABLES

DRAWN BY: JONESAR | DATE: 5/10/2022
CHECKED: SCHELAB | APPROVED: BORTZKM

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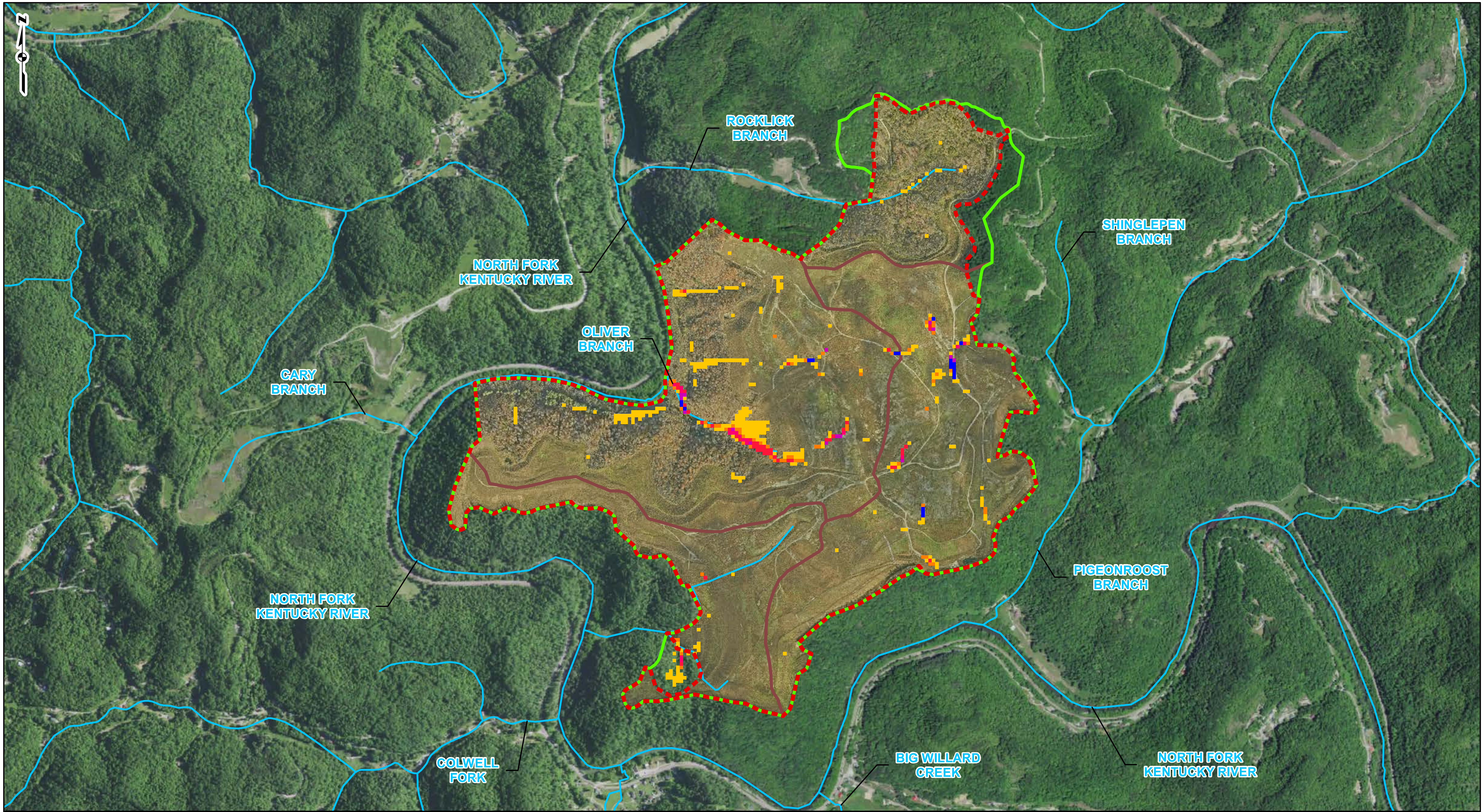

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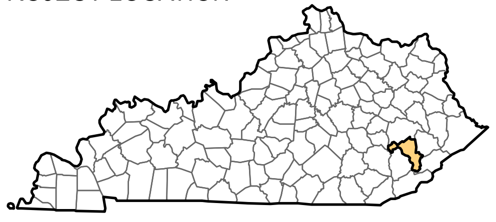

PERRY COUNTY, KENTUCKY

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LEGEND

NHD FLOWLINE

PROJECT BOUNDARY (REF. 2)

FLO-2D BOUNDARY (NOTE 1)

DRAINAGE DIVIDE WITHIN PROJECT BOUNDARY (NOTE 2)

VELOCITY (FPS) (NOTE 3)

1.00 - 1.50 | 1.51 - 2.00 | 2.01 - 2.50 | 2.51 - 3.00 | 3.01 - 4.00 | 4.01+

0 | 0.125 | 0.25 | 0.5 Miles

100-YEAR STORM EVENT PEAK VELOCITY MAP

gai consultants

BRIGHT MOUNTAIN SOLAR PROJECT
AVANGRID RENEWABLES, LLC

AVANGRID RENEWABLES

DRAWN BY: JONESAR | DATE: 2/16/2022
CHECKED: SCHELAB | APPROVED: BORTZKM

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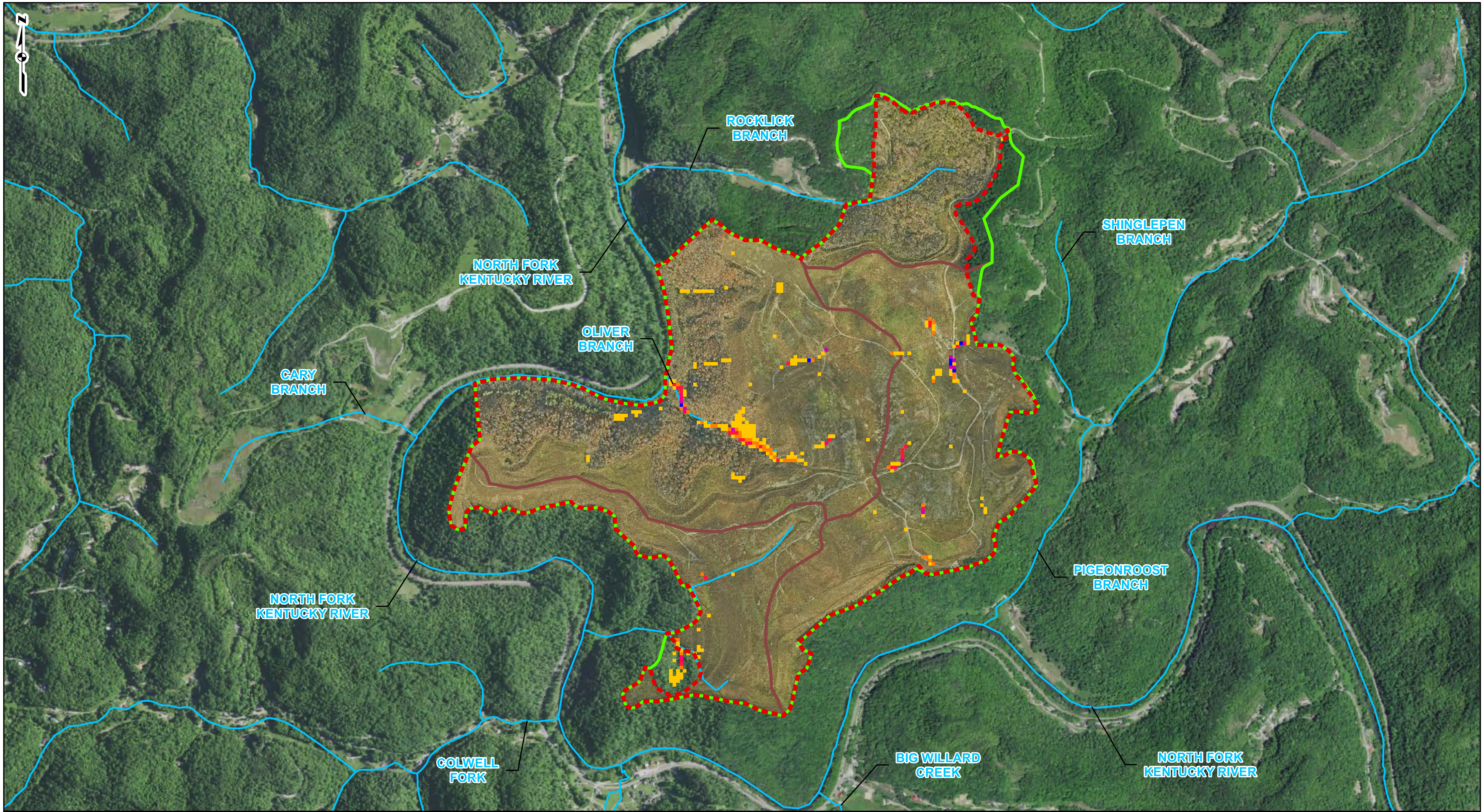

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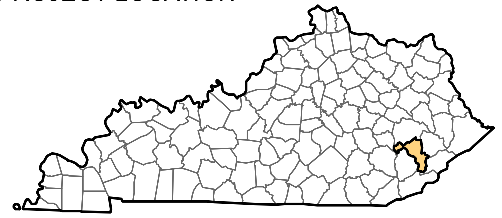

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LEGEND

NHD FLOWLINE

PROJECT BOUNDARY (REF. 2)

FLO-2D BOUNDARY (NOTE 1)

DRAINAGE DIVIDE WITHIN PROJECT BOUNDARY (NOTE 2)

VELOCITY (FPS) (NOTE 3)

1.00 - 1.50 | 1.51 - 2.00 | 2.01 - 2.50 | 2.51 - 3.00 | 3.01 - 4.00 | 4.01+

0 | 0.125 | 0.25 | 0.5 Miles

50-YEAR STORM EVENT PEAK VELOCITY MAP

gai consultants

BRIGHT MOUNTAIN SOLAR PROJECT
AVANGRID RENEWABLES, LLC

AVANGRID RENEWABLES

DRAWN BY: JONESAR | DATE: 2/16/2022
CHECKED: SCHELAB | APPROVED: BORTZKM

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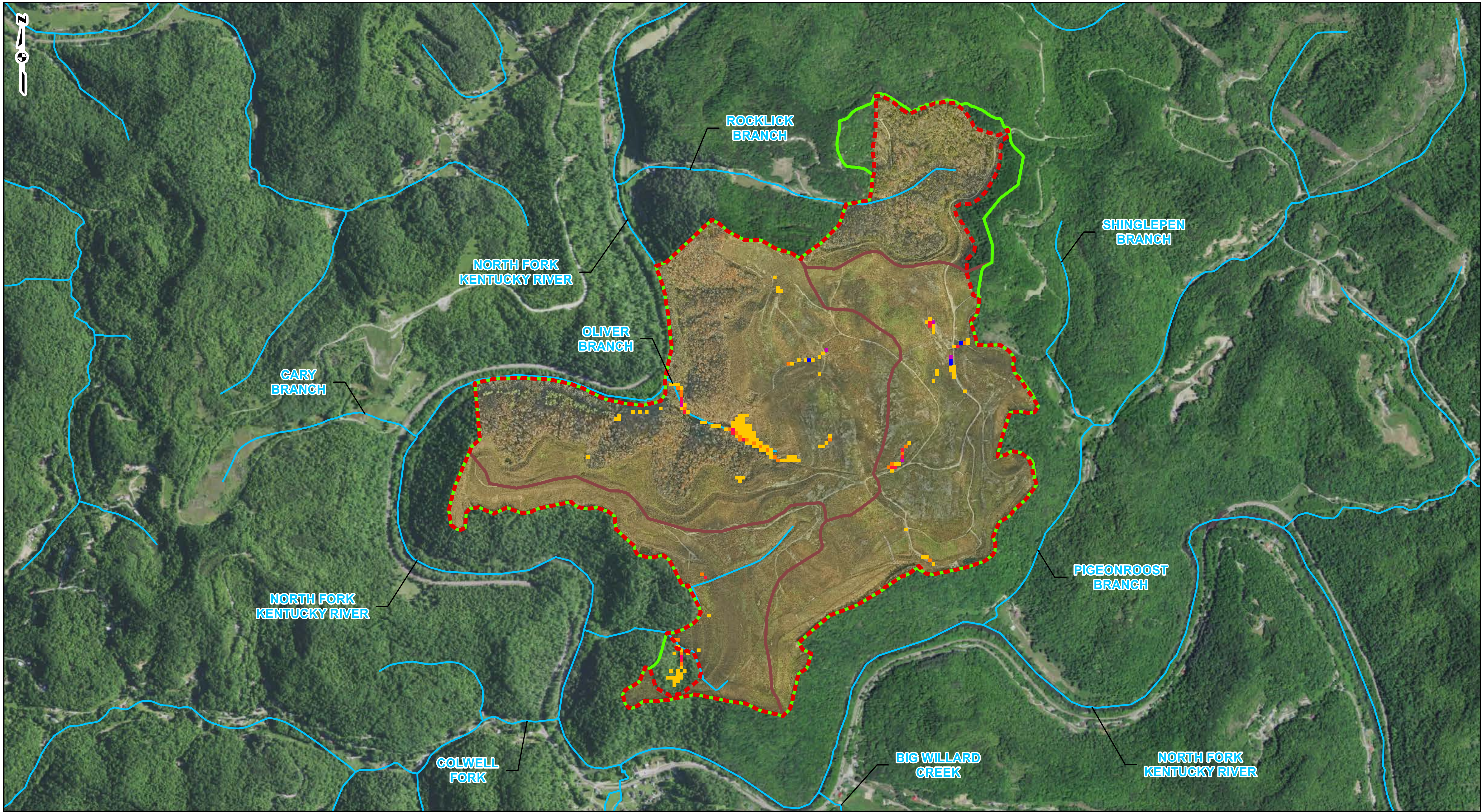

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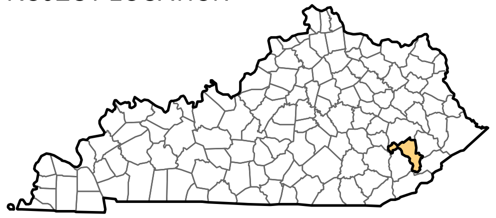

PERRY COUNTY, KENTUCKY

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LEGEND

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- PROJECT BOUNDARY (REF. 2)
- FLO-2D BOUNDARY (NOTE 1)
- DRAINAGE DIVIDE WITHIN PROJECT BOUNDARY (NOTE 2)

VELOCITY (FPS) (NOTE 3)

1.00 - 1.50 | 1.51 - 2.00 | 2.01 - 2.50 | 2.51 - 3.00 | 3.01 - 4.00 | 4.01+

0 | 0.125 | 0.25 | 0.5 Miles

25-YEAR STORM EVENT PEAK VELOCITY MAP

gai consultants

BRIGHT MOUNTAIN SOLAR PROJECT
AVANGRID RENEWABLES, LLC

AVANGRID RENEWABLES

DRAWN BY: JONESAR	DATE: 2/16/2022
CHECKED: SCHELAB	APPROVED: BORTZKM

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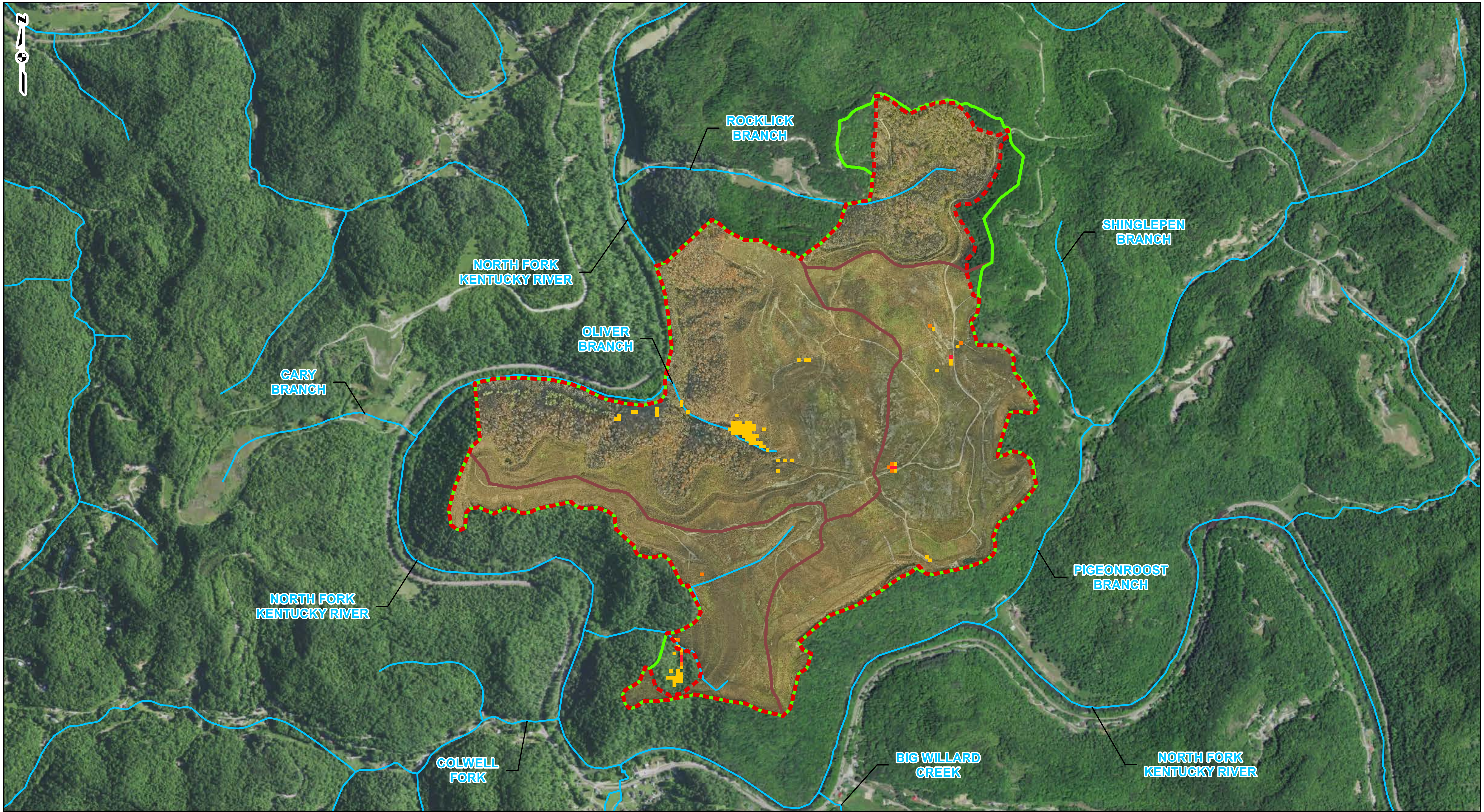
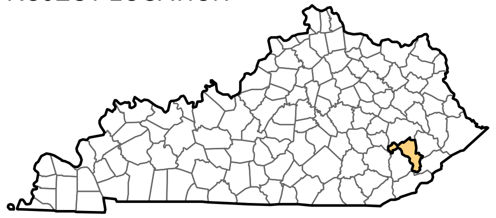


PROJECT LOCATION



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1.00 - 1.50 | 1.51 - 2.00 | 2.01 - 2.50 | 2.51 - 3.00 | 3.01 - 4.00 | 4.01+

0 | 0.125 | 0.25 | 0.5 Miles

10-YEAR STORM EVENT PEAK VELOCITY MAP

BRIGHT MOUNTAIN SOLAR PROJECT
AVANGRID RENEWABLES, LLC

gai consultants

AVANGRID RENEWABLES

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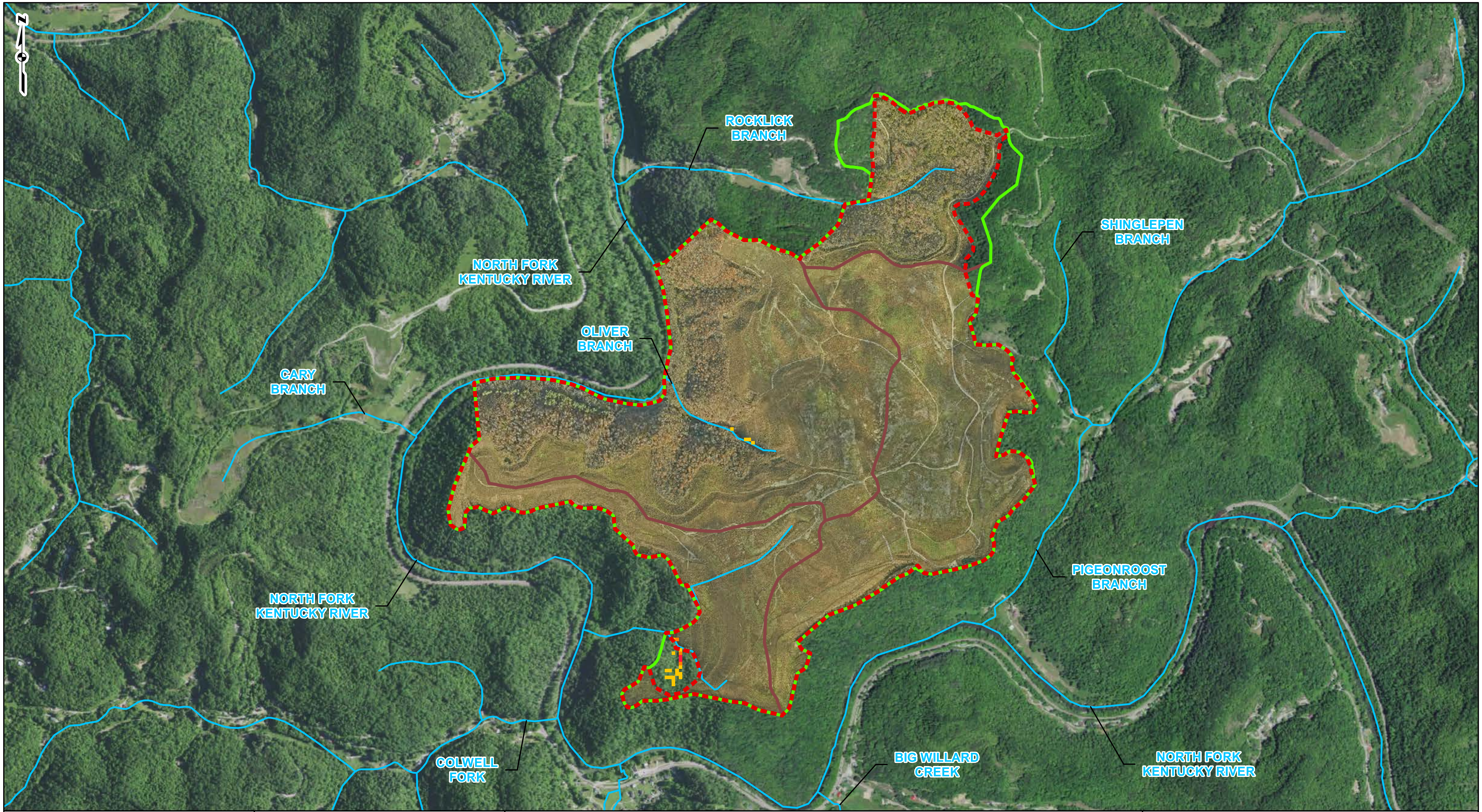
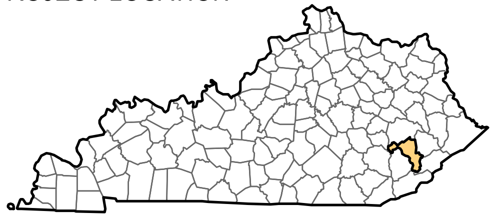


PROJECT LOCATION



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1.00 - 1.50
1.51 - 2.00
2.01 - 2.50
2.51 - 3.00
3.01 - 4.00
4.01+

0 0.125 0.25 0.5 Miles

2-YEAR STORM EVENT PEAK VELOCITY MAP

BRIGHT MOUNTAIN SOLAR PROJECT
AVANGRID RENEWABLES, LLC

gai consultants

AVANGRID RENEWABLES

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TABLE 1
REGULATORY REVIEW SUMMARY

Table 1
Summary of Hydrologic and Hydraulic Design Criteria
Bright Mountain Solar Project, Perry County, Kentucky
Avangrid Renewables, LLC

Regulatory Level	Regulatory Agency	Design Criteria	Reference	Notes
Local	N/A	N/A	N/A	The project is in an unincorporated part of the county. Local ordinances or other regulatory documents, at a level below the county, were not identified for the project via online investigation.
County	Perry County	No structures or land in a special flood hazard area can be located, extended, converted or structurally altered without compliance. This requires obtaining a floodplain permit for development from the County Judge/Executive/Mayor and the Kentucky Division of Water (DOW).	Perry County Floodplain Ordinance	Also noted in more recent sources by the Kentucky Energy and Environment Cabinet (KEEC).
		All new construction and substantial improvements in the floodplain must be constructed with materials and utility equipment resistant to flood damage.		
State	KEEC	Coverage under a Kentucky Pollutant Discharge Elimination System (KPDES) General Permit KYR10 (Stormwater Construction) is required for construction activities that will result in land disturbance of one or more acres.	KPDES KYR10 - Stormwater Construction	A Stormwater Pollution Prevention Plan (SWPPP) and Notice of Intent (NOI) must be prepared/submitted, as part of the permit application.
	DOW	The DOW is designated as the state coordinating agency for the National Flood Insurance Program (NFIP). The DOW Floodplain Management Section is responsible for the approval or denial of proposed development and other activities in the floodplain of all streams in the Commonwealth, and ensures that permitted development in floodplains complies with applicable requirements and limitations. Permits are issued for proposed actions in floodplains that meet all state floodplain statutes, regulations, and standards.	N/A	State floodplain requirements are outlined in 401 KAR 4:060 of the Kentucky Administrative Regulations (KAR), and should be reviewed prior to construction.
	Kentucky Transportation Cabinet (KYTC), Stormwater and Floodplain Management	Planning for drainage and stormwater management facilities should include a consideration of the potential problems associated with stormwater quality, including: Maximize stable open channels, maximize use of vegetated linings, minimize curb and gutter sections and their associated storm sewers, and minimize culvert lengths.	KYTC Drainage Manual - DR 200 (Stormwater and Floodplain Management)	KYTC requirements serve as a guidance standard for design of non-KYTC facilities. Design criteria presented for local roads and streets.
		Existing and post-developed flood flow characteristics should be studied for the site to determine the effect construction has in the area and on adjacent properties.		
		Applicable water-related permits are as follows: KPDES stormwater discharge permit for construction projects, United States Army Corps of Engineers Section 404 Permits (Nationwide and/or Individual), and Kentucky Natural Resources and Environmental Protection Cabinet DOW Section 401 Water Quality Certification.		
		Environmental studies will be performed for all projects. These studies will be initiated by the Division of Environmental Analysis (DEA) and will comply with all Federal, State, and local laws and regulations related to environmental quality. Use these studies to determine special water quality requirements that may be needed for the drainage design.		
		Discharge into waterways is regulated under the KPDES through the DOW, in the Environmental and Public Protection Cabinet.		
	KYTC, Hydrologic Criteria	The "Check Storm" is used to determine the off-site impacts to surrounding property and to evaluate the facilities performance under more severe flooding conditions. The 100 year storm is the most used to determine the impacts to surrounding properties.	KYTC Drainage Manual - DR 400 (Hydrology)	KYTC requirements serve as a guidance standard for design of non-KYTC facilities. Design criteria presented for local roads and streets.

<table>
<tr>
<td rowspan="12">State (Continued)</td>
<td>KYTC, Hydrologic Criteria (Continued)</td>
<td>KYTC has prepared Table 402-1 (provided below), which lists the various design storms to be used to analyze drainage systems. These were determined by balancing the costs of designing and constructing drainage facilities with the benefits and risks associated with the structure.
<table>
<tr><th colspan="9">Table 402-1, Return Intervals for Drainage Analysis</th></tr>
<tr><th colspan="2">Situation</th><th colspan="7">Return Interval (years)</th></tr>
<tr><th>Structure</th><th>ADT Limits</th><th>2</th><th>5</th><th>10</th><th>25</th><th>50</th><th>100</th><th>500</th></tr>
<tr><td rowspan="4">Bridge Size Structure (Span ≥ 20')</td><td>ADT< 400</td><td></td><td></td><td>D</td><td></td><td></td><td>C</td><td></td></tr>
<tr><td>400< ADT<2,000</td><td></td><td></td><td></td><td>D</td><td></td><td>C</td><td></td></tr>
<tr><td>2,000< ADT</td><td></td><td></td><td></td><td></td><td>D</td><td>C</td><td></td></tr>
<tr><td>Interstate</td><td></td><td></td><td></td><td></td><td>D</td><td>C</td><td></td></tr>
<tr><td rowspan="4">Culvert or Lateral Storm Sewer in a Sag</td><td>ADT< 400</td><td></td><td></td><td>D</td><td></td><td></td><td>C</td><td></td></tr>
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<tr><td colspan="2">Bridge Scour Analysis</td><td></td><td></td><td></td><td></td><td></td><td>D(1)</td><td>C</td></tr>
<tr><td colspan="2">Storm Sewer</td><td></td><td></td><td>D (2)</td><td></td><td></td><td>X</td><td></td></tr>
<tr><td colspan="2">Inlet Spread</td><td></td><td></td><td>D (3)</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Channel Change</td><td>X</td><td></td><td>D</td><td></td><td></td><td>C</td><td></td></tr>
<tr><td colspan="2">Roadway Ditch capacity / Ditch Lining shear</td><td></td><td></td><td>D</td><td></td><td></td><td>X</td><td></td></tr>
<tr><td colspan="2">Drop Inlet</td><td></td><td></td><td>D</td><td></td><td></td><td>X</td><td></td></tr>
<tr><td colspan="2">Detention or Retention Basin</td><td>D</td><td></td><td>D</td><td></td><td></td><td>D, X</td><td></td></tr>
<tr><td colspan="2">Risk Analysis</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td></td></tr>
<tr><td colspan="2">No Impact Certification</td><td></td><td></td><td></td><td></td><td></td><td>X</td><td></td></tr>
<tr><td colspan="2">Letter of Map Revision (FEMA)</td><td></td><td></td><td>X</td><td></td><td>X</td><td>X</td><td>X</td></tr>
</table>
(1) If the overtopping storm is less than the 100 year storm (1%), it should be used as the design storm to calculate scour.
(2) Storm sewer pipes which drain at sag points where runoff can only be removed through the storm system should be designed for a 25-year storm (4%). Storm Sewers on interstates should be checked to ensure that the hydraulic grade line resulting from the 50 year storm (2%) does not surcharge into the roadway.
(3) Pavement inlet spacing spread calculations shall be based on four (4) in/hr Rainfall intensity.</td>
<td>KYTC Drainage Manual - DR 400 (Hydrology) (Continued)</td>
<td>Within Table 402-1, "D" indicates design storm return intervals, "C" indicates check storms, and "X" indicates other storms that are required to meet a specific purpose.</td>
</tr>
<tr>
<td rowspan="6">KYTC, Open Channel Criteria</td>
<td>Channels should maintain a minimum grade of 0.5%.</td>
<td rowspan="6">KYTC Drainage Manual - DR 500 (Open Channels)</td>
<td></td>
</tr>
<tr><td>KYTC provides specific design criteria regarding channel geometry, clearance of adjacent features, and acceptable lining materials.</td><td></td></tr>
<tr><td>Stream channels include any drainage feature that is currently or has ever been a natural drainage feature. Impacts to any stream channel that exceed certain thresholds require coordination with other state and federal agencies. Projects that have stream impacts to stream channels exceeding the following thresholds shall be coordinated with the Division of Environmental Analysis: Disturbances to stream channels that exceed 300 linear feet or disturbances to stream channels that result in a loss of waters of more than 0.1 acres.</td><td></td></tr>
<tr><td>Provide a freeboard of 1’ between the 10 year water surface elevation and the shoulder elevation.</td><td></td></tr>
<tr><td>Stream-bank stabilization shall be provided, when appropriate, as a result of any stream disturbance.</td><td></td></tr>
<tr><td>Stream impacts are quantified either linearly or as an area bounded by the high water marks.</td><td></td></tr>
<tr>
<td rowspan="2">KYTC, Culvert Criteria</td>
<td>The following materials are used for pipes on KYTC projects: Reinforced concrete, steel with a protective metallic coating (galvanized Zinc or Aluminum Type 2), aluminum alloy, high density polyethylene, and polyvinyl chloride.</td>
<td rowspan="2">KYTC Drainage Manual - DR 600 (Culverts)</td>
<td></td>
</tr>
<tr><td>Culvert size limits.
<table>
<tr><th colspan="3">Table 610-1 Culvert Size Limits</th></tr>
<tr><th>Structure Type</th><th>Minimum Size</th><th>Maximum Size</th></tr>
<tr><td>Entrance Pipe [1]</td><td>15 “</td><td>48 “</td></tr>
<tr><td>Culvert Pipe</td><td>18 “</td><td>120 “</td></tr>
<tr><td>Culvert or Storm Sewer Pipe, Fill Height 30’ – 65’</td><td>24”</td><td>120”</td></tr>
<tr><td>Culvert or Storm Sewer Pipe, Fill Height > 65’</td><td>54”</td><td>120”</td></tr>
<tr><td>Precast Reinforced Concrete Box Culvert</td><td>3’ x 2’</td><td>12’ x 12’</td></tr>
<tr><td>Cast In Place Concrete Box Culvert</td><td>See Below</td><td>See Below</td></tr>
</table></td><td></td></tr>
</table>

<table>
<tr>
<td rowspan="5">State (Continued)</td>
<td rowspan="4">KYTC, Culvert Criteria (Continued)</td>
<td>Cover height limits.
<table>
<tr><th colspan="3">Table 610-2 Cover Height Limits</th></tr>
<tr><th>Structure Type</th><th>Minimum / Desirable Cover Height</th><th>Maximum Cover Height</th></tr>
<tr><td>Entrance Pipe[1]</td><td>0.5' / 1'</td><td>15'</td></tr>
<tr><td>Culvert Pipe</td><td>1.0' / 2.0'</td><td>See Standard Drawings</td></tr>
<tr><td>Precast Reinforced Concrete Box Culvert</td><td>1.0' / 2.0' [2]</td><td>See Standard Drawings</td></tr>
<tr><td>Cast In Place Concrete Box Culvert</td><td>Dictated by Structural Design</td><td>Dictated by Structural Design</td></tr>
</table>
1. Entrance pipe larger than 48" or with fill heights exceeding 15' are classified as culvert pipe
2. Although not advisable, Precast Reinforced Concrete Box Culverts, and Cast in Place Box Culverts can have traffic directly on the top slab. See DR 608-6 for further discussion.
3. Cover height is measured from the top of the pipe to the bottom of the subgrade elevation. The bottom of subgrade will usually be taken as the elevation of the bottom of DGA. Rock roadbed is not considered part of the subgrade.</td>
<td rowspan="4">KYTC Drainage Manual - DR 600 (Culverts) (Continued)</td>
<td></td>
</tr>
<tr>
<td>Headwater elevations calculated for the design storm should maintain 1' of freeboard below the elevation of the lowest point on shoulder in the vicinity of the culvert inlet. This criteria may be disregarded on projects determined by the project team to be low volume routes.</td>
<td></td>
</tr>
<tr>
<td>KYTC Floodplain Management Criteria apply to crossings that have a drainage area larger than one square mile or encroach onto floodplains that are shown on an NFIP map. For such cases, the following design criteria must be met:
• For projects that encroach onto FEMA mapped floodplains, but do not encroach on a floodway, the allowable increase will be one of the following: Defined by local ordinance or one (1) foot for projects not subject to a local ordinance.
• For projects that encroach on unidentified floodplains the allowable increase will be one (1) foot.</td>
<td></td>
</tr>
<tr>
<td>Size limits for Cast-In-Place concrete box culverts are as follows: Minimum height - (4') four feet, maximum height - (16') sixteen feet, minimum span - (4') four feet, maximum single span - (20') twenty feet.</td>
<td></td>
</tr>
<tr>
<td>KYTC</td>
<td>If development will create additional surface drainage runoff so that the existing downstream drainage facilities (such as cross-drain pipes or culverts, storm drain systems, entrance pipes, open ditches, paved ditches, special channels, or any other drainage facility) become inadequate to accommodate the increased flow or causes negative impacts, the permittee shall, to the Department's satisfaction: Modify or replace the downstream drainage facility or facilities so the increased flow is adequately accommodated, and provide on-site runoff mitigation (such as a detention basin) of appropriate capacity and discharge design that enables the existing downstream drainage facilities to continue to function adequately with no negative impacts.</td>
<td>KYTC Permits Guidance Manual - PE-800 (Drainage)</td>
<td>Retention of storm water is not permitted on the right of way.</td>
</tr>
<tr>
<td rowspan="3">Federal</td>
<td>U.S. Fish and Wildlife Service (USFWS)</td>
<td>N/A</td>
<td>N/A</td>
<td>No direct design criteria identified. May need to consult with USFWS depending on project environmental impacts.</td>
</tr>
<tr>
<td rowspan="2">Federal Emergency Management Agency (FEMA)</td>
<td>Development within FEMA SFHA must be in accordance with the requirements of the National Flood Insurance Program (NFIP).</td>
<td>FEMA Map Service Center</td>
<td>FEMA flood hazards are presented on the Flood Insurance Rate Map (FIRM) 21193C0175D. One SFHA (Zone A, no base flood elevations determined) exists within the project area. The SFHA is located along North Fork Kentucky River.</td>
</tr>
<tr>
<td>N/A</td>
<td>KYTC Drainage Manual - DR 200 (Stormwater and Floodplain Management)</td>
<td>No local floodplain coordinator has been identified via online investigation at this time. If construction is proposed within a FEMA floodplain, this should be further reviewed prior to the start of construction, so that they are involved in the early phases of the project.</td>
</tr>
</table>

TABLE 2
RUNOFF AND ROUGHNESS VALUE SUMMARY

Table 2
Runoff and Roughness Value Summary
Bright Mountain Solar Project, Perry County, Kentucky
Avangrid Renewables, LLC

Land Use						
Value	Type	Description	Soil Type	CN Value	Manning's n	Percentage Area of Flo-2D Boundary
11	Open Water	All areas of open water, gerenally with less than 25% cover or vegetation or soil.	N/A	98	0.018	0.20%
21	Developed, Open Space	Includes areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20 percent of total cover. These areas most commonly include large-lot single family housing units, parks, golf courses, and vegetation plnated indeveloped settings for recreation, erosion control, or aesthetic puposes.	C	79	0.040	2.05%
22	Developed, Low Intensity	Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20-49 percent of the total cover. These areas most commonly include single-family housing units.	C	79	0.068	0.11%
23	Developed, Medium Intensity	Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50-79 percent of the total cover. These areas most commonly include single-family hosuing units.	C	81	0.068	0.49%
24	Developed, High Intensity	Includes highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses, and commercial/industrial. Impervious surfaces account for 80 to 100 percent of the total cover.	C	90	0.068	0.11%
31	Barren Land (Rock/Sand/Clay)	Barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.	C	91	0.011	18.400%
41	Deciduous Forest	Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75 percent of the tree species shed foliage simultaneously in response to seasonal change.	C	73	0.360	29.39%
43	Mixed Forest	Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neighter deciduous nor evergreen species are greater than 75 percent of total tree cover.	C	72	0.400	2.78%
52	Shrub/Scrub	Areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.	C	65	0.100	30.67%
71	Grassland/Herbaceous	Areas dominated by grammanoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensitve management such as tilling, but can be utilized for grazing.	C	71	0.368	15.03%
81	Pasture/Hay	Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a periennial cycle. Pasture/hay vegetation accounts for greater than 20 percent of total vegetation.	C	79	0.130	0.34%
90	Woody Wetlands	Areas where forest or shrub land vegetation accounts for greater than 20 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.	D	86	0.086	0.43%

APPENDIX A
NOAA RAINFALL DATA

NOAA Atlas 14, Volume 2, Version 3
Location name: Bonnyman, Kentucky, USA*
Latitude: 37.2918°, Longitude: -83.2932°
Elevation: 1198.64 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.313 (0.283-0.348)	0.369 (0.334-0.411)	0.436 (0.394-0.484)	0.492 (0.443-0.546)	0.569 (0.510-0.629)	0.631 (0.561-0.696)	0.696 (0.615-0.768)	0.765 (0.668-0.841)	0.859 (0.740-0.944)	0.936 (0.797-1.03)
10-min	0.500 (0.453-0.556)	0.590 (0.534-0.657)	0.698 (0.631-0.776)	0.786 (0.708-0.873)	0.907 (0.812-1.00)	1.00 (0.894-1.11)	1.11 (0.977-1.22)	1.21 (1.06-1.33)	1.36 (1.17-1.49)	1.47 (1.25-1.62)
15-min	0.625 (0.566-0.695)	0.741 (0.672-0.826)	0.883 (0.798-0.981)	0.995 (0.895-1.10)	1.15 (1.03-1.27)	1.27 (1.13-1.40)	1.40 (1.23-1.54)	1.53 (1.34-1.68)	1.71 (1.47-1.88)	1.85 (1.58-2.04)
30-min	0.857 (0.776-0.953)	1.02 (0.928-1.14)	1.25 (1.13-1.39)	1.44 (1.30-1.60)	1.70 (1.53-1.88)	1.92 (1.71-2.11)	2.14 (1.89-2.36)	2.38 (2.08-2.62)	2.72 (2.34-2.99)	3.00 (2.55-3.30)
60-min	1.07 (0.967-1.19)	1.29 (1.16-1.43)	1.61 (1.45-1.79)	1.88 (1.69-2.08)	2.27 (2.03-2.51)	2.60 (2.31-2.86)	2.95 (2.60-3.25)	3.34 (2.92-3.67)	3.90 (3.36-4.29)	4.37 (3.72-4.82)
2-hr	1.26 (1.14-1.39)	1.51 (1.37-1.67)	1.88 (1.70-2.07)	2.19 (1.98-2.42)	2.66 (2.39-2.93)	3.07 (2.73-3.36)	3.51 (3.10-3.85)	3.99 (3.49-4.37)	4.71 (4.06-5.16)	5.32 (4.53-5.82)
3-hr	1.35 (1.23-1.49)	1.61 (1.47-1.78)	1.99 (1.81-2.19)	2.32 (2.11-2.55)	2.80 (2.53-3.07)	3.22 (2.87-3.52)	3.67 (3.25-4.00)	4.16 (3.65-4.54)	4.89 (4.22-5.32)	5.50 (4.69-5.99)
6-hr	1.63 (1.50-1.78)	1.93 (1.78-2.11)	2.36 (2.17-2.57)	2.72 (2.50-2.97)	3.25 (2.97-3.54)	3.70 (3.36-4.02)	4.18 (3.76-4.53)	4.70 (4.19-5.09)	5.46 (4.80-5.91)	6.08 (5.29-6.59)
12-hr	1.95 (1.80-2.13)	2.32 (2.14-2.53)	2.81 (2.60-3.07)	3.23 (2.97-3.51)	3.83 (3.51-4.16)	4.33 (3.95-4.69)	4.86 (4.40-5.27)	5.43 (4.88-5.89)	6.25 (5.55-6.78)	6.91 (6.08-7.51)
24-hr	2.40 (2.23-2.60)	2.86 (2.66-3.10)	3.45 (3.21-3.73)	3.93 (3.64-4.24)	4.59 (4.23-4.94)	5.11 (4.70-5.52)	5.65 (5.17-6.10)	6.21 (5.64-6.71)	6.98 (6.28-7.56)	7.58 (6.76-8.23)
2-day	2.89 (2.70-3.12)	3.45 (3.21-3.71)	4.16 (3.87-4.47)	4.72 (4.39-5.08)	5.48 (5.08-5.90)	6.09 (5.62-6.56)	6.71 (6.15-7.23)	7.33 (6.69-7.92)	8.18 (7.40-8.88)	8.84 (7.94-9.62)
3-day	3.12 (2.92-3.35)	3.71 (3.47-3.98)	4.45 (4.15-4.77)	5.02 (4.68-5.39)	5.80 (5.39-6.22)	6.40 (5.93-6.87)	7.01 (6.45-7.53)	7.61 (6.98-8.20)	8.43 (7.66-9.11)	9.04 (8.16-9.81)
4-day	3.34 (3.13-3.58)	3.97 (3.72-4.25)	4.74 (4.43-5.07)	5.33 (4.98-5.70)	6.11 (5.69-6.54)	6.71 (6.24-7.19)	7.31 (6.76-7.84)	7.90 (7.26-8.48)	8.67 (7.93-9.34)	9.24 (8.39-10.00)
7-day	3.99 (3.75-4.27)	4.74 (4.45-5.07)	5.66 (5.30-6.05)	6.37 (5.95-6.80)	7.31 (6.82-7.81)	8.04 (7.47-8.60)	8.76 (8.11-9.38)	9.48 (8.74-10.2)	10.4 (9.53-11.2)	11.2 (10.1-12.1)
10-day	4.63 (4.37-4.93)	5.48 (5.16-5.83)	6.44 (6.07-6.84)	7.17 (6.74-7.61)	8.09 (7.60-8.59)	8.78 (8.22-9.33)	9.45 (8.82-10.1)	10.1 (9.39-10.8)	10.9 (10.1-11.7)	11.5 (10.6-12.4)
20-day	6.41 (6.06-6.79)	7.59 (7.17-8.03)	8.86 (8.38-9.38)	9.78 (9.24-10.3)	10.9 (10.3-11.6)	11.8 (11.1-12.5)	12.5 (11.8-13.3)	13.3 (12.4-14.1)	14.2 (13.2-15.1)	14.8 (13.7-15.8)
30-day	7.94 (7.52-8.39)	9.38 (8.89-9.91)	10.9 (10.3-11.5)	12.0 (11.3-12.6)	13.3 (12.5-14.0)	14.2 (13.4-15.0)	15.1 (14.2-15.9)	15.9 (14.9-16.8)	16.8 (15.7-17.9)	17.5 (16.3-18.6)
45-day	10.1 (9.55-10.6)	11.8 (11.2-12.4)	13.5 (12.9-14.2)	14.7 (14.0-15.5)	16.1 (15.3-17.0)	17.1 (16.2-18.0)	18.0 (17.0-19.0)	18.8 (17.8-19.9)	19.8 (18.6-20.9)	20.4 (19.1-21.6)
60-day	12.2 (11.6-12.8)	14.3 (13.6-15.0)	16.2 (15.5-17.0)	17.6 (16.7-18.5)	19.2 (18.2-20.2)	20.3 (19.3-21.3)	21.2 (20.2-22.4)	22.1 (21.0-23.3)	23.1 (21.8-24.4)	23.8 (22.4-25.2)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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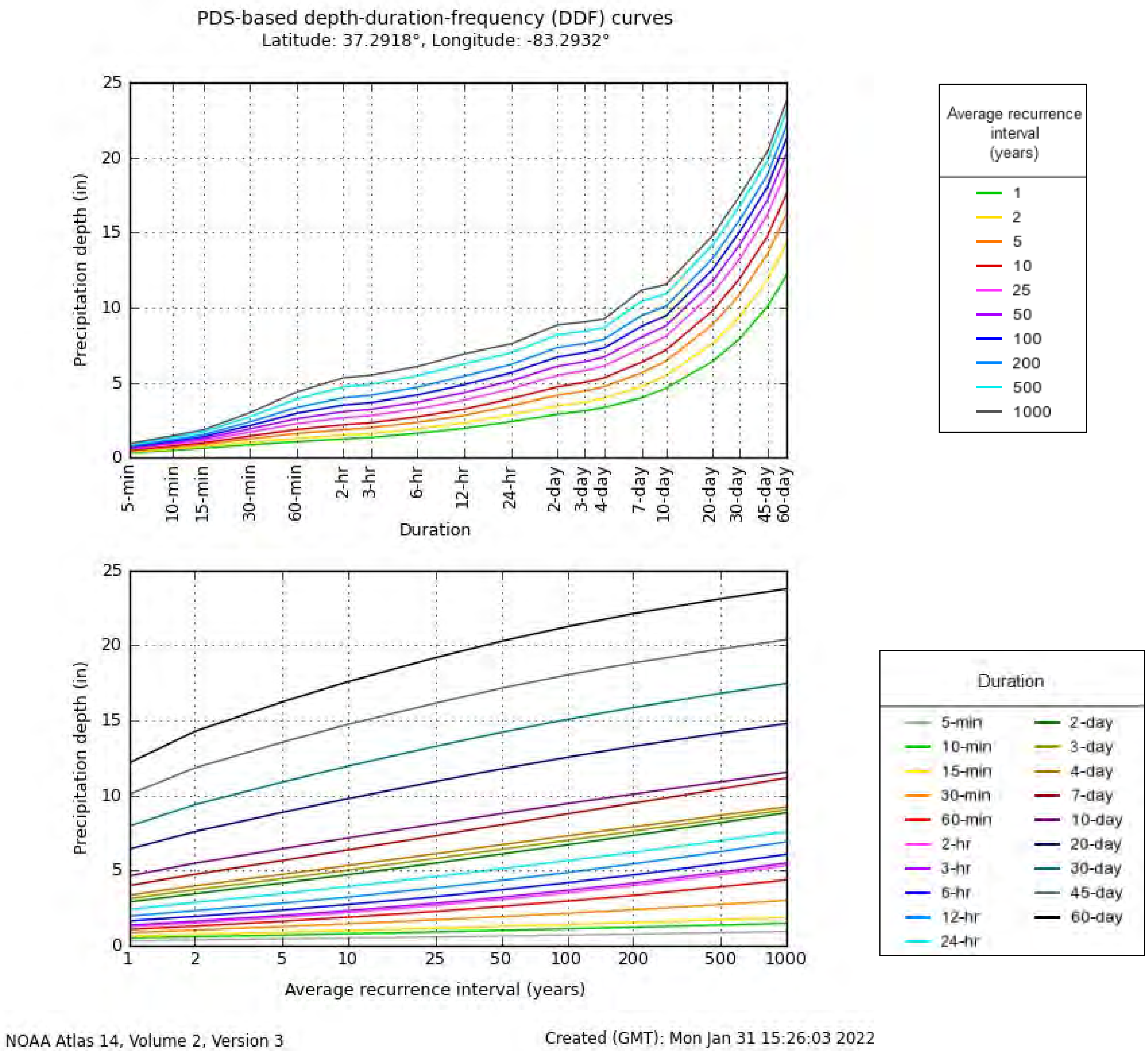
PF graphical



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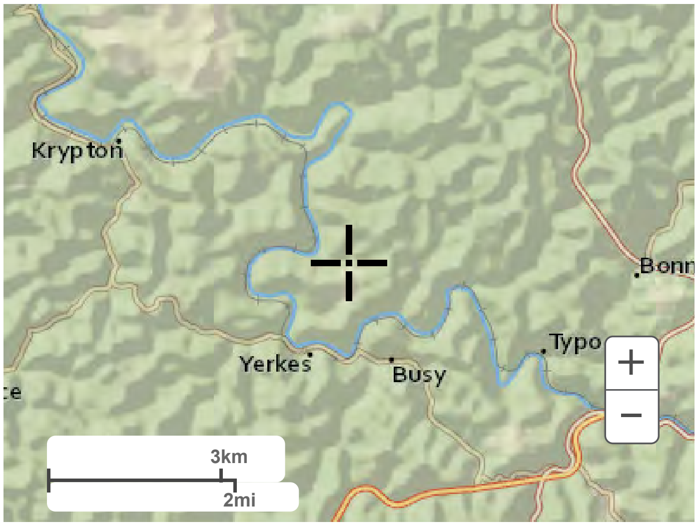
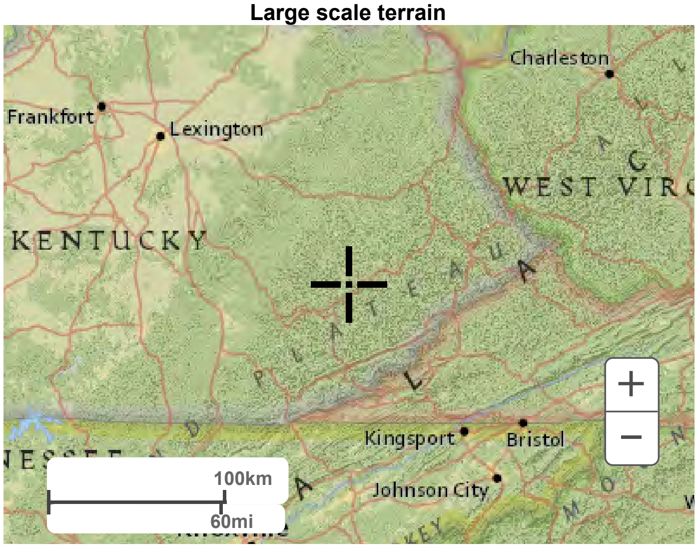
Maps & aerials

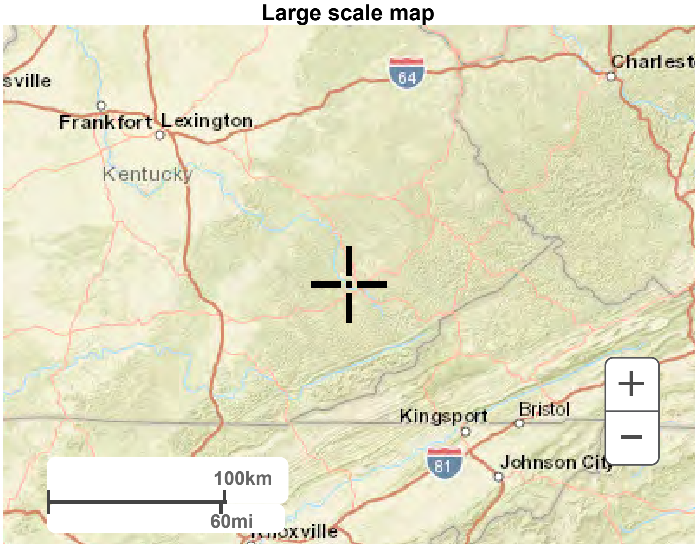
Small scale terrain



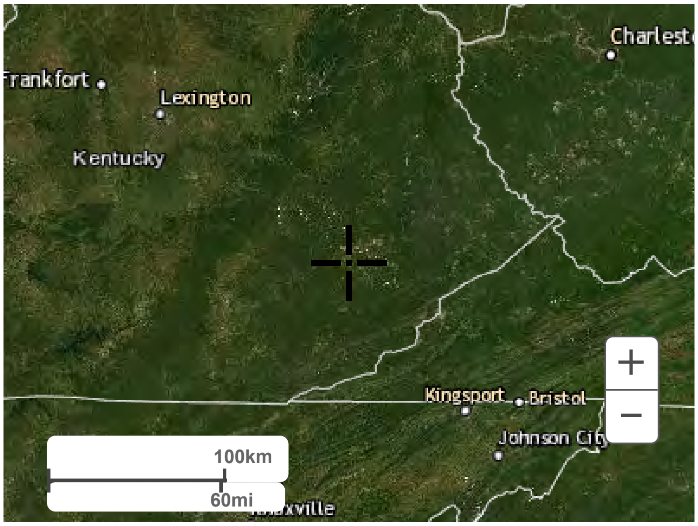
Large scale terrain



Large scale map



Large scale aerial



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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

APPENDIX B
NLCD LAND USE SUMMARY

Land Cover Class Code Value. (Source: NLCD Legend Land Cover Class Descriptions)

Value	Definition
11	Open Water - All areas of open water, generally with less than 25% cover or vegetation or soil
12	Perennial Ice/Snow - All areas characterized by a perennial cover of ice and/or snow, generally greater than 25% of total cover.
21	Developed, Open Space - Includes areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20 percent of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.
22	Developed, Low Intensity -Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20-49 percent of total cover. These areas most commonly include single-family housing units.
23	Developed, Medium Intensity - Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50-79 percent of the total cover. These areas most commonly include single-family housing units.
24	Developed, High Intensity - Includes highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80 to 100 percent of the total cover.
31	Barren Land (Rock/Sand/Clay) - Barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.
41	Deciduous Forest - Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75 percent of the tree species shed foliage simultaneously in response to seasonal change.
42	Evergreen Forest - Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75 percent of the tree species maintain their leaves all year. Canopy is never without green foliage.
43	Mixed Forest - Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75 percent of total tree cover.
51	Dwarf Scrub - Alaska only areas dominated by shrubs less than 20 centimeters tall with shrub canopy typically greater than 20% of total vegetation. This type is often co-associated with grasses, sedges, herbs, and non-vascular vegetation.

52	Shrub/Scrub - Areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.
71	Grassland/Herbaceous - Areas dominated by grammanoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.
72	Sedge/Herbaceous - Alaska only areas dominated by sedges and forbs, generally greater than 80% of total vegetation. This type can occur with significant other grasses or other grass like plants, and includes sedge tundra, and sedge tussock tundra.
73	Lichens - Alaska only areas dominated by fruticose or foliose lichens generally greater than 80% of total vegetation.
74	Moss - Alaska only areas dominated by mosses, generally greater than 80% of total vegetation.
81	Pasture/Hay - Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20 percent of total vegetation.
82	Cultivated Crops - Areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20 percent of total vegetation. This class also includes all land being actively tilled.
90	Woody Wetlands - Areas where forest or shrub land vegetation accounts for greater than 20 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.
95	Emergent Herbaceous Wetlands - Areas where perennial herbaceous vegetation accounts for greater than 80 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

APPENDIX C
SSURGO SOIL REPORT

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Leslie and Perry Counties, Kentucky

January 27, 2022

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

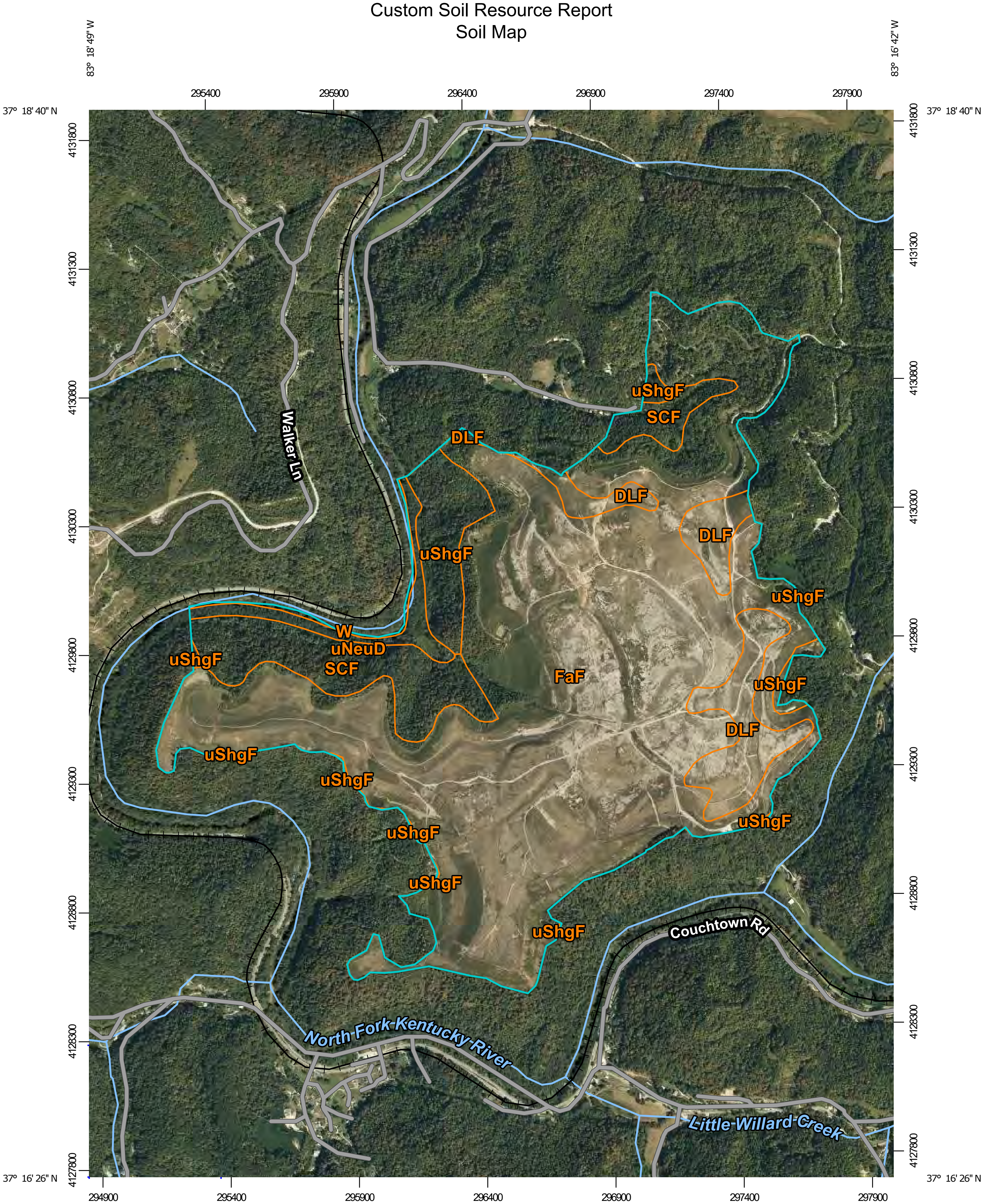
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map



Map Scale: 1:20,200 if printed on A portrait (8.5" x 11") sheet.

Meters: 0 250 500 1000 1500

Feet: 0 500 1000 2000 3000

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Leslie and Perry Counties, Kentucky
Survey Area Data: Version 18, Sep 8, 2021

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Oct 9, 2016—Sep 15, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
DLF	Matewan-Marrowbone-Latham complex, 20 to 80 percent slopes, very rocky	63.1	7.6%
FaF	Fairpoint and Bethesda soils, 2 to 70 percent slopes, benched, stony	623.8	75.6%
SCF	Shelocta-Cutshin-Gilpin complex, 20 to 75 percent slopes, very stony	75.3	9.1%
uNeuD	Nelse, frequently flooded-Urban land, rarely flooded complex, 4 to 25 percent slopes	17.9	2.2%
uShgF	Shelocta-Highsplint-Gilpin complex, 20 to 70 percent slopes, very stony	41.8	5.1%
W	Water	3.4	0.4%
Totals for Area of Interest		**825.3**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Leslie and Perry Counties, Kentucky

DLF—Matewan-Marrowbone-Latham complex, 20 to 80 percent slopes, very rocky

Map Unit Setting

National map unit symbol: 2tqh8
Elevation: 700 to 2,400 feet
Mean annual precipitation: 37 to 54 inches
Mean annual air temperature: 42 to 68 degrees F
Frost-free period: 155 to 220 days
Farmland classification: Not prime farmland

Map Unit Composition

Matewan, very stony, and similar soils: 30 percent
Marrowbone, very stony, and similar soils: 25 percent
Latham, very stony, and similar soils: 15 percent
Minor components: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Matewan, Very Stony

Setting

Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Mountaintop
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Loamy-skeletal residuum weathered from sandstone

Typical profile

Oi - 0 to 1 inches: channery slightly decomposed plant material
A - 1 to 3 inches: channery fine sandy loam
BA - 3 to 7 inches: channery fine sandy loam
Bw1 - 7 to 21 inches: very channery fine sandy loam
Bw2 - 21 to 28 inches: extremely channery fine sandy loam
R - 28 to 37 inches: bedrock

Properties and qualities

Slope: 20 to 80 percent
Surface area covered with cobbles, stones or boulders: 1.0 percent
Depth to restrictive feature: 24 to 40 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.01 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 1 percent
Sodium adsorption ratio, maximum: 1.0
Available water supply, 0 to 60 inches: Very low (about 2.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e

Hydrologic Soil Group: A
Hydric soil rating: No

Description of Marrowbone, Very Stony

Setting

Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Mountaintop
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Coarse-loamy residuum weathered from sandstone

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 5 inches: fine sandy loam
Bw1 - 5 to 10 inches: loam
Bw2 - 10 to 17 inches: fine sandy loam
Bw3 - 17 to 23 inches: loam
BC - 23 to 28 inches: channery loam
R - 28 to 38 inches: bedrock

Properties and qualities

Slope: 20 to 80 percent
Surface area covered with cobbles, stones or boulders: 1.0 percent
Depth to restrictive feature: 24 to 32 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.01 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Hydric soil rating: No

Description of Latham, Very Stony

Setting

Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Mountaintop
Down-slope shape: Convex
Across-slope shape: Concave
Parent material: Clayey residuum weathered from shale and siltstone

Typical profile

Oi - 0 to 1 inches: channery slightly decomposed plant material
A - 1 to 2 inches: silt loam
BA - 2 to 6 inches: silty clay loam
Bt - 6 to 20 inches: silty clay
BC - 20 to 25 inches: silty clay loam
Cr - 25 to 36 inches: bedrock

R - 36 to 46 inches: bedrock

Properties and qualities

Slope: 20 to 80 percent
Surface area covered with cobbles, stones or boulders: 1.0 percent
Depth to restrictive feature: 24 to 34 inches to paralithic bedrock; 34 to 45 inches to lithic bedrock
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.01 in/hr)
Depth to water table: About 6 to 24 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 2.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C/D
Hydric soil rating: No

Minor Components

Gilpin, very stony

Percent of map unit: 10 percent
Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Mountaintop
Down-slope shape: Convex
Across-slope shape: Linear
Hydric soil rating: No

Shelocta, very stony

Percent of map unit: 7 percent
Landform: Ridges
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Upper third of mountainflank
Down-slope shape: Convex, concave
Across-slope shape: Linear
Hydric soil rating: No

Fedscreek, very stony

Percent of map unit: 5 percent
Landform: Ridges
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Upper third of mountainflank
Down-slope shape: Convex
Across-slope shape: Linear
Hydric soil rating: No

Rock outcrop

Percent of map unit: 5 percent

Ramsey, very stony

Percent of map unit: 3 percent
Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Mountaintop

Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

FaF—Fairpoint and Bethesda soils, 2 to 70 percent slopes, benched, stony

Map Unit Setting

National map unit symbol: 2tqhd
Elevation: 720 to 1,510 feet
Mean annual precipitation: 45 to 57 inches
Mean annual air temperature: 43 to 68 degrees F
Frost-free period: 169 to 203 days
Farmland classification: Not prime farmland

Map Unit Composition

Fairpoint, unstable fill, and similar soils: 55 percent
Bethesda, unstable fill, and similar soils: 30 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Fairpoint, Unstable Fill

Setting

Landform: Mountain slopes
Landform position (three-dimensional): Mountainflank
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy-skeletal coal extraction mine spoil derived from sandstone and shale

Typical profile

Ap - 0 to 11 inches: channery loam
C1 - 11 to 32 inches: very channery loam
C2 - 32 to 41 inches: extremely channery loam
C3 - 41 to 51 inches: extremely flaggy loam
C4 - 51 to 58 inches: extremely flaggy silt loam
C5 - 58 to 72 inches: extremely flaggy loam

Properties and qualities

Slope: 2 to 70 percent
Surface area covered with cobbles, stones or boulders: 0.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None

Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 5.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: C
Hydric soil rating: No

Description of Bethesda, Unstable Fill

Setting

Landform: Mountain slopes
Landform position (three-dimensional): Mountainflank
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy-skeletal coal extraction mine spoil derived from sandstone and shale

Typical profile

Ap - 0 to 12 inches: channery silt loam
C1 - 12 to 36 inches: very channery loam
C2 - 36 to 58 inches: very channery loam
C3 - 58 to 72 inches: very channery loam

Properties and qualities

Slope: 2 to 70 percent
Surface area covered with cobbles, stones or boulders: 0.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 5.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Udorthents, unstable fill

Percent of map unit: 5 percent
Landform: Mountain slopes
Landform position (three-dimensional): Mountainflank
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Matewan, very stony

Percent of map unit: 3 percent
Landform: Ridges
Landform position (three-dimensional): Mountaintop
Down-slope shape: Convex

Across-slope shape: Linear
Hydric soil rating: No

Shelocta, very stony

Percent of map unit: 3 percent
Landform: Mountain slopes
Landform position (three-dimensional): Mountainflank
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: No

Dumps, mine (tailings & tipples)

Percent of map unit: 2 percent
Landform: Ridges
Landform position (three-dimensional): Mountaintop
Down-slope shape: Linear
Across-slope shape: Convex, linear
Hydric soil rating: No

Urban land

Percent of map unit: 2 percent
Landform: Mountain slopes
Landform position (three-dimensional): Mountainflank
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

SCF—Shelocta-Cutshin-Gilpin complex, 20 to 75 percent slopes, very stony

Map Unit Setting

National map unit symbol: 2tqhb
Elevation: 680 to 2,400 feet
Mean annual precipitation: 40 to 54 inches
Mean annual air temperature: 42 to 69 degrees F
Frost-free period: 147 to 196 days
Farmland classification: Not prime farmland

Map Unit Composition

Shelocta, very stony, and similar soils: 35 percent
Cutshin, very stony, and similar soils: 25 percent
Gilpin, very stony, and similar soils: 15 percent
Minor components: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Shelocta, Very Stony

Setting

Landform: Mountain slopes

Landform position (three-dimensional): Mountainflank
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Fine-loamy colluvium derived from sandstone and shale over clayey residuum weathered from shale and siltstone

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 3 inches: silt loam
BA - 3 to 7 inches: loam
Bt1 - 7 to 23 inches: channery silt loam
2Bt2 - 23 to 34 inches: channery silt loam
2Bt3 - 34 to 45 inches: very channery silt loam
2C - 45 to 59 inches: very parachannery silt loam
2Cr - 59 to 69 inches: bedrock

Properties and qualities

Slope: 20 to 80 percent
Surface area covered with cobbles, stones or boulders: 1.0 percent
Depth to restrictive feature: 48 to 65 inches to paralithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Hydric soil rating: No

Description of Cutshin, Very Stony

Setting

Landform: Mountain slopes
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Lower third of mountainflank
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Fine-loamy colluvium derived from sandstone and shale

Typical profile

Oi - 0 to 2 inches: very channery slightly decomposed plant material
A - 2 to 10 inches: very channery loam
AB - 10 to 19 inches: channery loam
Bw1 - 19 to 30 inches: channery loam
Bw2 - 30 to 50 inches: channery loam
Cr - 50 to 60 inches: bedrock

Properties and qualities

Slope: 20 to 80 percent
Surface area covered with cobbles, stones or boulders: 1.0 percent
Depth to restrictive feature: 40 to 60 inches to paralithic bedrock
Drainage class: Well drained

Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Sodium adsorption ratio, maximum: 1.0
Available water supply, 0 to 60 inches: Low (about 5.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Hydric soil rating: No

Description of Gilpin, Very Stony

Setting

Landform: Mountain slopes
Landform position (three-dimensional): Upper third of mountainflank
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Fine-loamy residuum weathered from sandstone and shale

Typical profile

Oi - 0 to 1 inches: channery slightly decomposed plant material
A - 1 to 5 inches: channery silt loam
Bt1 - 5 to 11 inches: channery silt loam
Bt2 - 11 to 20 inches: channery silt loam
Bt3 - 20 to 28 inches: channery loam
R - 28 to 38 inches: bedrock

Properties and qualities

Slope: 20 to 80 percent
Surface area covered with cobbles, stones or boulders: 1.0 percent
Depth to restrictive feature: 24 to 40 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.01 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Cloverlick, very stony

Percent of map unit: 8 percent
Landform: Mountain slopes
Landform position (three-dimensional): Center third of mountainflank
Down-slope shape: Concave
Across-slope shape: Concave

Hydric soil rating: No

Marrowbone, very stony

Percent of map unit: 7 percent
Landform: Mountain slopes
Landform position (three-dimensional): Upper third of mountainflank
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Highsplint, very stony

Percent of map unit: 5 percent
Landform: Mountain slopes
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Lower third of mountainflank
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: No

Sequoia, very stony

Percent of map unit: 3 percent
Landform: Mountain slopes
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Upper third of mountainflank
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Rock outcrop

Percent of map unit: 2 percent

uNeuD—Nelse, frequently flooded-Urban land, rarely flooded complex, 4 to 25 percent slopes

Map Unit Setting

National map unit symbol: 2qdmf
Elevation: 700 to 1,400 feet
Mean annual precipitation: 28 to 54 inches
Mean annual air temperature: 42 to 68 degrees F
Frost-free period: 156 to 222 days
Farmland classification: Not prime farmland

Map Unit Composition

Nelse, frequently flooded, and similar soils: 45 percent
Urban land, rarely flooded: 25 percent
Minor components: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Nelse, Frequently Flooded

Setting

Landform: Flood plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Riser
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy alluvium derived from sandstone and shale

Typical profile

A - 0 to 12 inches: stratified loamy fine sand to loam
C1 - 12 to 30 inches: fine sandy loam
C2 - 30 to 63 inches: loamy fine sand
C3 - 63 to 80 inches: loamy fine sand

Properties and qualities

Slope: 4 to 25 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: NoneFrequent
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 6.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Hydric soil rating: No

Description of Urban Land, Rarely Flooded

Setting

Landform: Flood plains

Properties and qualities

Slope: 0 to 25 percent
Depth to water table: About 42 to 80 inches

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

Minor Components

Combs, occasionally flooded

Percent of map unit: 10 percent
Landform: Stream terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Udorthents, unstable fill

Percent of map unit: 10 percent
Landform: Flood plains
Landform position (two-dimensional): Toeslope
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Grigsby, frequently flooded

Percent of map unit: 5 percent
Landform: Flood plains
Landform position (two-dimensional): Toeslope
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Yeager, frequently flooded

Percent of map unit: 5 percent
Landform: Flood plains
Landform position (three-dimensional): Riser
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

uShgF—Shelocta-Highsplint-Gilpin complex, 20 to 70 percent slopes, very stony

Map Unit Setting

National map unit symbol: 2x5k0
Elevation: 680 to 2,680 feet
Mean annual precipitation: 28 to 58 inches
Mean annual air temperature: 42 to 68 degrees F
Frost-free period: 147 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

Shelocta, very stony, and similar soils: 50 percent
Highsplint, very stony, and similar soils: 20 percent
Gilpin, very stony, and similar soils: 15 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Shelocta, Very Stony

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope

Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Fine-loamy colluvium derived from sandstone and shale

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 3 inches: silt loam
BA - 3 to 7 inches: loam
Bt1 - 7 to 23 inches: channery silt loam
2Bt2 - 23 to 34 inches: channery silt loam
2Bt3 - 34 to 45 inches: very channery silt loam
2C - 45 to 59 inches: very parachannery silt loam
2Cr - 59 to 69 inches: bedrock

Properties and qualities

Slope: 20 to 70 percent
Surface area covered with cobbles, stones or boulders: 1.0 percent
Depth to restrictive feature: 48 to 65 inches to paralithic bedrock
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 7.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Hydric soil rating: No

Description of Highsplint, Very Stony

Setting

Landform: Hillslopes
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Loamy-skeletal fine-loamy colluvium derived from sandstone and shale

Typical profile

Oi - 0 to 1 inches: very channery slightly decomposed plant material
A - 1 to 4 inches: very channery silt loam
BA - 4 to 11 inches: very channery silt loam
Bw1 - 11 to 28 inches: very channery clay loam
Bw2 - 28 to 48 inches: very channery loam
BC - 48 to 85 inches: very channery loam

Properties and qualities

Slope: 20 to 70 percent
Surface area covered with cobbles, stones or boulders: 1.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained

Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Hydric soil rating: No

Description of Gilpin, Very Stony

Setting

Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Head slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Fine-loamy residuum weathered from sandstone and shale

Typical profile

Oi - 0 to 1 inches: channery slightly decomposed plant material
A - 1 to 5 inches: channery silt loam
Bt1 - 5 to 11 inches: channery silt loam
Bt2 - 11 to 20 inches: channery silt loam
Bt3 - 20 to 28 inches: channery loam
R - 28 to 38 inches: bedrock

Properties and qualities

Slope: 20 to 70 percent
Surface area covered with cobbles, stones or boulders: 1.0 percent
Depth to restrictive feature: 24 to 40 inches to lithic bedrock
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.01 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Marrowbone, very stony

Percent of map unit: 6 percent
Landform: Hillslopes
Landform position (two-dimensional): Summit

Landform position (three-dimensional): Nose slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Fedscreek, very stony
Percent of map unit: 4 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: No

Ramsey, very stony
Percent of map unit: 3 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Nose slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Rock outcrop
Percent of map unit: 2 percent

W—Water

Map Unit Composition
Water: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

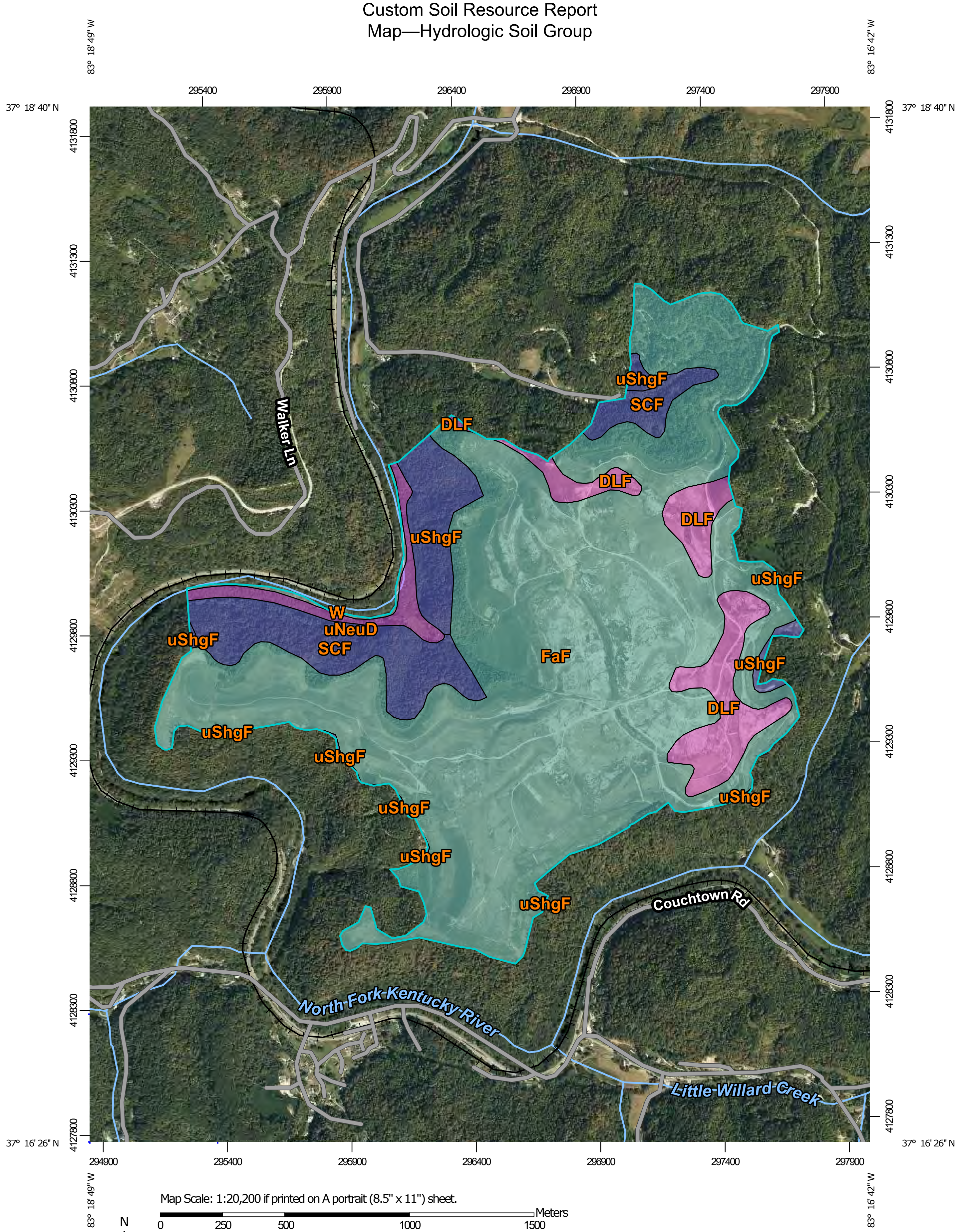
Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Map—Hydrologic Soil Group



Map Scale: 1:20,200 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 250, 500, 1000, 1500

Feet: 0, 500, 1000, 2000, 3000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Lines

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Points

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Leslie and Perry Counties, Kentucky
Survey Area Data: Version 18, Sep 8, 2021

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Oct 9, 2016—Sep 15, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
DLF	Matewan-Marrowbone-Latham complex, 20 to 80 percent slopes, very rocky	A	63.1	7.6%
FaF	Fairpoint and Bethesda soils, 2 to 70 percent slopes, benched, stony	C	623.8	75.6%
SCF	Shelocta-Cutshin-Gilpin complex, 20 to 75 percent slopes, very stony	B	75.3	9.1%
uNeuD	Nelse, frequently flooded-Urban land, rarely flooded complex, 4 to 25 percent slopes	A	17.9	2.2%
uShgF	Shelocta-Highsplint-Gilpin complex, 20 to 70 percent slopes, very stony	B	41.8	5.1%
W	Water		3.4	0.4%
Totals for Area of Interest			**825.3**	**100.0%**

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

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