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October 20, 2020

VIA ELECTRONIC FILING

Ms. Tanowa Troupe
Administration/Docketing
Ohio Power Siting Board
180 East Broad Street, 11th Floor
Columbus, Ohio 43215-3793

Re: In the Matter of Hecate Energy Highland 4 LLC and Hecate Energy Highland 2, LLC for a Certificate of Environmental Liability and Public Need for a 100 MW Solar-Powered Electric Generating Facility in Clay and Whiteoak Townships in Highland County, Ohio Case No. 20-1288-EL-BGN (Before the Ohio Power Siting Board) / Supplement to Application/Preliminary Geotechnical Engineering Report

Dear Ms. Troupe:

This letter serves to supplement the Application filed on September 2, 2020 for the New Market Solar Farm, a 100 MW electric generating facility to be located on approximately 1,116 acres in Clay and Whiteoak Townships in Highland County, Ohio ("New Market Solar" or "Project"). The Project will consist of two separate and distinct facilities: (1) New Market Solar I, a 65 MW facility that will be developed, constructed and operated by Hecate Energy Highland 4 LLC and will occupy 582 acres of the Project site; and (2) New Market Solar II, a 35 MW facility that will be developed, constructed, and operated by Hecate Energy Highland 2, LLC and will occupy 222 acres of the Project site.

Attached for filing are the following documents:

- October 19, 2020 Preliminary Geotechnical Engineering Report Prepared by Terracon Consultants, Inc. for Hecate Energy Highland 4 LLC's New Market Solar I Solar Project; and

- October 19, 2020 Preliminary Geotechnical Engineering Report Prepared by Terracon Consultants, Inc. for Hecate Energy Highland 2, LLC's New Market Solar II Solar Project.

If you have questions or need additional information, please contact me.

Very truly yours,

Karen A. Winters

cc: Patti Shorr, Hecate Energy LLC
Jared Wren, Hecate Energy LLC
Emily Kosmalski, Terracon Consultants, Inc.
Danelle Gagliardi, Squire Patton Boggs (US) LLP

Preliminary Geotechnical Engineering Report

New Market Solar I - 65MW
Hillsboro, Highland Co., OH
October 19, 2020
Terracon Project No. N1205164

Prepared for:
Hecate Energy Highland 4 LLC
Chicago, Illinois

Prepared by:
Terracon Consultants, Inc.
Cincinnati, Ohio

October 19, 2020

Hecate Energy Highland 4 LLC
621 W Randolph Street
Chicago, Illinois 60661-2216

Attn: Mr. Jared Wren
P: (740) 591-1154
E: jwren@hecateenergy.com

Re: Preliminary Geotechnical Engineering Report
New Market Solar I - 65MW
West New Market Road and South Hollowtown Road
Hillsboro, Highland Co., OH
Terracon Project No. N1205164

Dear Mr. Wren:

We have completed the Preliminary Geotechnical Engineering services for the above referenced project. This study was performed in general accordance with Terracon Proposal No. PN1205164 dated August 28, 2020 and authorized on September 4, 2020. This report presents the findings of the subsurface exploration and provides preliminary geotechnical recommendations concerning earthwork and the design and construction of foundations and unpaved roads for the proposed project. Our findings and recommendations are based on subsurface explorations and associated lab test results for five 2020 borings and supplemented by subsurface conditions encountered at two boring locations performed in 2018. **Based on conditions encountered in the borings, it is our opinion the site is geotechnically suitable for the proposed development.**

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.

Nancy Dendramis, P.E.
Geotechnical Project Engineer

Jeffrey D. Dunlap, P.E.
Senior Engineer

Reviewed by Subject Matter Expert – Jimmy M. Jackson, P.E.

REPORT TOPICS

Note: This report was originally delivered in a web-based format. **Orange Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the ***GeoReport*** logo will bring you back to this page. 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

New Market Solar I - 65MW
West New Market Road and South Hollowtown Road
Hillsboro, Highland Co., OH
Terracon Project No. N1205164
October 19, 2020

INTRODUCTION

This report presents the results of our subsurface exploration and preliminary geotechnical engineering services performed for the proposed 65 MW Solar Facility to be constructed at locations in the vicinity of West New Market Road and South Hollowtown Road intersection between Buford, Ohio and Hillsboro in Highland County, Ohio. The purpose of these services is to provide information and preliminary geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions
- Preliminary site preparation and earthwork
- Preliminary access road design
- Preliminary foundation design and construction
- Thermal resistivity
- Seismic site classification per IBC
- Field Electrical resistivity

The geotechnical engineering Scope of Services for this project included the advancement of 5 test borings to depths ranging from approximately 18.9 feet to 20 feet below existing site grades. Our current field exploration scope was supplemented by two test borings (B-13 and B-17) performed in 2018.

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 and/or as separate graphs in the **Exploration Results** section. Field and laboratory testing also includes laboratory thermal resistivity testing, laboratory corrosivity testing and field electrical resistivity, which are included as separate figures, graphs or tables 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 is located primarily southwest of West New Market Road and South Hollowtown Road intersection in Hillsboro, Highland Co., OH. The New Market Solar I (65 MW) site has a footprint of about 822 acres of which about 602 acres will be developed. See **Site Location**
Existing Improvements	Agricultural farm fields, widely-spaced residential structures and other existing buildings (barns, silos, garage structures, etc.) with associated access drives, buried and overhead utilities, narrow local roadways, county 2-lane roads.
Current Ground Cover	Soybean fields, bare areas, and isolated areas of heavy vegetation
Existing Topography	The site generally slopes downward from about El. 1040 feet at the north end of the project area down to about El. 1000 feet at the south end of the project area. Proposed project footprint areas are relatively level with isolated, widely-spaced stream/swale/drainage ditch dissections, apparent pond areas, and/or other depression areas.
Geology	Based on the Highland County USDA Soil Survey, the near-surface soils are consistent with soils from the Westboro and Clermont series described as poorly-drained soils formed in loess and the underlying glacial till. These soils are found on concave flats, flats and knolls on loess-covered till plains of Illinoian age. Test borings did not encounter underlying residual soils or Ordovician Age shale and limestone bedrock belonging to the Waynesville formation. The depth of the bedrock is highly variable, according to published literature.

PROJECT DESCRIPTION

Our understanding of the project conditions is as follows:

Item	Description
Information Provided	Site plan (.kmz files) with approximate project footprint boundaries.
Project Description	The proposed site includes approximately 822 acres of primarily agricultural cropland of which about 602 acres are proposed to be developed as a 65MWac photovoltaic (PV) solar electric power plant supported on steel piles, a racking system and PV modules. The steel pile foundations for the solar array are anticipated to consist of wide flange steel piles (W6x9 or similar). The anticipated loads and maximum deflection of the piles were not available at the time of this report. Mat/slab foundations may be required for inverter or electrical equipment foundations. No substation areas or transmission towers were designated for this project area and any substation or transmission tower foundations were beyond the scope of this preliminary study.

Item	Description
Maximum Loads	Structural loads were not provided, but have been estimated based on our experience on projects using single-axis tracker rack systems. ■ Downward axial compression: 3 to 6 kips ■ Uplift: 1.5 to 2.5 kips ■ Lateral: 1.5 to 3 kips Structural loads are anticipated to be provided during the final design based on the selected tracker-rack system and final geotechnical study to be performed at a later date.
Access Roads	We understand that unpaved access roads are planned in the solar array areas. The preliminary access road designs provided in this report are based on an allowable rut depth of 2 inches with anticipated traffic consisting of one service (pick-up) truck per week and a heavy delivery vehicle (similar to an HS-20 vehicle) that will visit the site occasionally (less than 10 times throughout the life of the project). Access roads used for construction of the project will be the responsibility of the Engineering, Procurement, and Construction (EPC) company.
Estimated Start of Construction	2021-2022

GEOTECHNICAL CHARACTERIZATION

Five test borings (B-1 to B-5) were performed in 2020 to depths ranging between about 18.9 feet to 20 feet below existing grades. Two test borings (B-13 and B-17) were performed in 2018 to depths ranging between about 21.5 feet to 31.5 feet below existing grades. We have developed a general characterization of the subsurface conditions based upon our review of the 2020 and 2018 subsurface explorations, laboratory data, geologic setting, and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of site preparation and foundation options. Conditions encountered at each exploration point are indicated on the individual logs. The individual logs can be found in the **Exploration Results** section and the GeoModel can be found in the **Figures** section of this report.

Site Soils

Based on the USDA Highland County Soil Survey, the soils encountered across the nearly-level site area belong to the Clermont Silt Loam and Westboro-Schaffer Silt Loam Soil Series. These soils are described as poorly-drained soils formed in a mantle of wind-blown loess and the underlying Illinoian Age glacial till. Test borings encountered conditions consistent with the USDA County Survey that included up to 6 inches of a disturbed “plowzone” soil layer underlain by natural lean clay, lean clay with silt, and fat clay overlying brown to gray lean clay glacial till with occasional granular interlayers.

Site Bedrock Geology

The site is located within an area mapped with bedrock from the Waynesville and Arnheim Formations described as interbedded shale and limestone, thin to thickly bedded. Given the site elevations, the natural overburden soils are anticipated to overlay the Ordovician Age shale-rich Waynesville Formation (approximately 70% shale and about 30% limestone). Test borings were terminated at about 20 to 31.5 feet below existing grades and did not encounter the anticipated residual soils or the interbedded shale and limestone bedrock from the Waynesville; however, Test Boring B-3 encountered refusal at about 18.9 feet apparently on a limestone floater.

Encountered Subsurface Conditions

Our widely-spaced soil borings encountered a surface layer of approximately 2 inches to 6 inches of plowzone topsoil (agricultural topsoil). The plowzone layer is a mixture of topsoil and natural soil that have been mixed together due to agricultural activities at the site. The recent 2020 soil borings were located within bare ground areas at roadway access points where the plowzone depths were observed to be relatively shallow. Deeper plowzone depths could be encountered in areas that have been exposed to earlier deeper cultivation methods; however, previous studies in the area indicate that the depth of the plow zone is generally limited to less than 12 inches in the project vicinity due to current cultivation methods used for the soybean fields in the study area.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

Model Layer	Layer Name	General Description
1	Loess Deposits	lean clay, lean clay with silt, silty clay, light gray with reddish brown, stiff to very stiff
2	Weathered Glacial Till	lean clay, fat clay, sandy lean clay, trace concretions, dark yellowish brown with gray, mottled
3	Brown Glacial Till	lean clay, sandy lean clay, very stiff to hard
4	Gray Glacial Till	lean clay, sandy lean clay, trace gravel, gray, hard
5	Granular	poorly graded sand with silt, varying gravel content, very dense, brown and gray

A Stage 1 report was prepared earlier in 2020 for the general project area where soils consisting of silty clays, lean clays, and fat clays were anticipated. Depths to bedrock were anticipated to be as shallow as 15 feet below existing site grades. Our recent subsurface exploration generally encountered soil conditions that were consistent with those anticipated during the Stage 1 study; however, bedrock was not encountered within our maximum exploration depths of 20 to 31.5 feet.

Several of the borings encountered groundwater seepage during drilling operations and at the completion of the borings. The groundwater levels are indicated on the GeoModel found in the **Figures** section, as well as on the individual boring logs in the **Exploration Results**section.

Although no groundwater was observed in several of the test borings while drilling, or for the short duration the test borings could remain open, this does not necessarily mean these test borings terminated above groundwater. Due to the low permeability of the soils encountered in the test borings, a relatively long period may be necessary for a groundwater level to develop and stabilize in a borehole. Long term observations in piezometers or observation wells sealed from the influence of surface water are often required to define groundwater levels in materials of this type.

The soil color can also be an indicator of a long-term static water level. Gray soils are typically encountered at elevations below the static water level. The presence of water within the soil voids prevents air/oxygen infiltration and limits the oxidation process of the iron contained in the clay minerology. Brown soils are typically encountered above the static long-term water level where oxygen has infiltrated the soil voids allowing for oxidation of the iron contained in the clay minerology. The transition from brown to gray soil typically occurred at all test borings at depths of about 13.5 feet below existing grades.

It is common in glacial till soils to have seams, layers or pockets of silt, sand or gravel sandwiched between the lower permeability silty clay or lean clay soils. Oftentimes the silt, sand or gravel seams, layers or pockets are saturated and can sometimes be under pressure, as indicated by the ground water levels rising in 3 of the recent and archive test borings with time. The aerial extent of the water-bearing seams, layers and pockets can vary, and the higher permeability seams, layers and pockets can be connected or disconnected hydraulically. It is also common to encounter perched water at the soil/bedrock interface or within seams and fractures within shale and limestone bedrock.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the test borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structures may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

CORROSIVITY

The table below lists the results of laboratory soluble sulfate, soluble chloride, electrical resistivity, and pH testing. 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.

Laboratory testing to evaluate soil corrosivity were performed on 2 select near-surface bulk soil samples obtained from the test borings for the addition. The corrosivity test suite results, summarized below, included water soluble sulfate, soluble sulfide, soluble chloride, electrical resistivity (Miller soil box), Redox potential and pH. These 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. The durability requirements for concrete should be in accordance with the provisions of the ACI Design Manual, Section 318, Chapter 4.

Corrosivity Test Results Summary (TEST RESULTS PENDING)									
Boring	**Sample Depth (feet)**	**Soil Description**	**pH**	**Soluble Sulfate (mg/kg)**	**Soluble Sulfide (mg/kg)**	**Soluble Chloride (mg/kg)**	**Redox (mV)**	**Total Salts (mg/kg)**	**Resistivity (ohm-cm)**
B-1	1 to 5	Lean clay	7.98	202	Nil	135	+69-	1590	1358
B-5	1 to 5	Lean clay	7.33	124	Nil	52	+687	1238	3201

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/bedrock properties encountered at our test borings at the site and as described on the exploration logs and results, it is our professional opinion that the **Seismic Site Classification is D**. Subsurface explorations at this site were extended to a maximum depth of 31.5 feet. The site properties below the boring depths to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth.

CONTRIBUTORY RISK COMPONENTS

ITEM	DESCRIPTION
Suitability Statement	Test borings encountered up to 6 inches of a disturbed “plowzone” soil layer underlain by natural lean clay, lean clay with silt, and fat clay overlying brown to gray lean clay glacial till with occasional granular interlayers. The proposed site appears suitable for the use of driven steel W-Section steel piles for the support of the planned solar arrays.
Soil Conditions	The on-site soils typically consist of lean clays with high silt content or pockets of silt (CL), lean clays (CL), moderately plastic lean clays (CL), and fat clays (CH).

ITEM	DESCRIPTION
Access	Wet surface conditions, following extended periods of rainfall, or really dry conditions could create access issues for rubber tire vehicles. The surficial silty soils will likely need stabilization in order to provide access for rubber tire vehicles during wetter periods.
Grading	We anticipate minimal site grading will be required. On-site materials appear to generally be suitable for re-use as fill or backfill. We anticipated that grading will require less than 2± feet of excavation or fill placement.
Groundwater	Groundwater was observed in five out of the seven test borings while drilling at depths of 7 to 19 feet below grade. Due to the low permeability of the soils encountered in the test borings, a relatively long period may be necessary for a groundwater level to develop and stabilize in a borehole. The transition from brown to gray soil (typically occurring near the static water level) was encountered at all test borings at about 13.5 feet below existing grades. It is common in glacial till soils to have seams, layers or pockets of silt, sand or gravel sandwiched between the lower permeability silty clay or lean clay soils. The aerial extent of the water-bearing seams, layers and pockets can vary, and the higher permeability seams, layers and pockets can be connected or disconnected hydraulically. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.
Site Drainage	The near-surface soils are poorly-drained largely due to the relatively level and localized concave areas across the project site. The near-surface, silty clay to lean clay soils are expected to become unstable with typical earthwork and construction traffic, especially after precipitation events. Seasonally high groundwater can become trapped in the silty clay to lean clay soils, which will make earthwork difficult during the wetter seasons of the year. Effective drainage should be completed early in the construction sequence and maintained after construction to avoid potential issues with wet soils. If possible, any site grading should be performed during the warmer and drier times of the year.
Corrosion Hazard	Based on laboratory testing for electrical resistivity and chemical properties, the site soils are mildly to moderately corrosive to buried metal. The soils have a “negligible” classification for sulfate exposure according to ACI Design Manual 318, Chapter 19. The results of our laboratory testing of soil chemical properties are expected to assist a qualified engineer design corrosion protection for the production piles and other project elements.

ITEM	DESCRIPTION
Excavation Hazards	As a minimum, all temporary excavations should be sloped or braced as required by Occupational Health and Safety Administration (OSHA) regulations to provide stability and safe working conditions. Temporary excavations will probably be required during grading operations. The grading contractor, by his contract, is usually responsible for designing and constructing stable, temporary excavations and should shore, slope or bench the sides of the excavations as required, to maintain stability of both the excavation sides and bottom. All excavations should comply with applicable local, state and federal safety regulations, including the current OSHA Excavation and Trench Safety Standards.
Anticipated Pile Drivability	We anticipate fairly consistent conditions during pile driving based on the similar soil profiles at the boring locations.
General Construction Considerations	To the extent practical, earthwork should be performed during drier periods of weather (late fall to late spring) to reduce the amount of subgrade remedial measures for loose and unstable conditions beneath access roadways, equipment pads, etc. The upper loess soils generally become unstable during wet periods when they are subjected to construction traffic.

PRELIMINARY RECOMMENDATIONS FOR DRIVEN STEEL PILES

This phase of the project does not include preliminary pile load testing and our recommendations are mainly based on the results from the test borings.

We have performed preliminary geotechnical analyses for driven pile foundations to support the typical PV panel racking system. 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.** Instead, this analysis is intended to assist you in roughly evaluating construction costs and development viability for the proposed project. It should also be noted that our analyses are based on short-term conditions based on boring information. For this type of foundation system, provisions for flexible or adjustable connection between the posts and the array superstructure are recommended.

Adfreeze Stress

It is Terracon’s professional opinion that the overburden soils encountered in the borings are frost susceptible. In cold weather climates, design to resist frost heave forces exerted on foundations is often the limiting factor in the foundation design. Specifically, pile lengths will need to be long enough to counteract potential heave forces in the seasonal frost zone.

As the frost penetrates deeper into the soil and the ground swells due to freezing, the ground surface will rise due to frost heaving. The upward displacement is due to freezing water contained in the soil voids along with the formation of ice lenses in the soil. The freezing material grips the steel pile and exerts an uplift force due to the adfreeze stress developed around the surface area of the pile. The amount of upward force depends on the following:

- The thickness of ice lenses formed in the seasonal frozen ground
- The bond between the steel pile surface and the frozen ground
- The surface area of the steel pile in the seasonally frozen ground

Based on our review of soil samples, we recommend an adfreeze stress of 1,500 psf be considered when determining the frost heave load on a pile. The box perimeter of the pile (two times the depth plus two times the flange width) acting over a maximum depth of about 2 feet below ground surface should be considered when determining the frost heave load on a pile.

Uplift forces will likely govern the design and length of the panel array piles; therefore, uplift will be the primary factor in foundation costs. The factor of safety against uplift should be determined based on discussions with the owner and design engineer considering the desired level or risk, construction costs, and the long-term maintenance program.

Driven Pile 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 2 feet of soil should be neglected when calculating the ultimate capacity from skin friction.

Embedment Depth (feet-bgs)	Ultimate Skin Friction (psf)	Ultimate End Bearing Pressure (ksf)
2 to 5	750	10[1]
5 to 20	1,200	21[2]

1. This value is only applicable for piles embedded at least 5 feet.
2. This value is only applicable for piles embedded at least 8 feet

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 skin friction is appropriate for uplift and compressive loading and represents ultimate values. A factor of safety of 2 should be applied to the skin friction values. The end bearing is also an ultimate value and should have a factor of safety of 3 applied for design.

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. If the piles are designed using the above parameters, settlements are not anticipated to exceed 1 inch.

Pile Lateral Resistance

The parameters in the following table can be used for a preliminary analysis of the lateral capacity of driven steel piles in support of solar panel arrays:

Depth (feet-bgs)	p-y model	Effective Unit Weight, γ'(pcf)	Undrained Cohesion (psf)	Strain Factor ε_{50} (%)	P-Multiplier
0 to 2	Stiff Clay w/o water	124	1,200	Default	0.7
2 to 5	Stiff Clay w/o water	124	1,200	Default	1.0
5 to 20	Stiff Clay w/o water[1]	125[1]	2,400	Default	1.0

1. Refer to individual boring logs for encountered groundwater levels. Use saturated unit weight of 128 pcf below groundwater levels and Stiff Clay with water p-y model below encountered groundwater levels.

The above indicated effective unit weight and effective 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 SPT results, published values, and our experience with similar soil types. Existing p-y models typically under-predict the lateral capacity of shallow driven piles in cohesive soils. Therefore, the P-multiplier is most likely higher but would need to be confirmed based on results of site-specific load test results.

PRELIMINARY RECOMMENDATIONS FOR ISOLATED SLAB FOUNDATIONS

We understand that some equipment may be supported on mat/slab foundations while other structures may be supported on shallow foundations. Stiff to very stiff lean to fat clay soils were encountered near the. Based on the anticipated types of structures and the expected magnitude of loading, surface stiff to very stiff native soils or new structural fill overlying firm native soils are considered adequate for support of the mat/slab foundations or footings. We would expect an allowable bearing capacity of 1,500 psf with total and differential settlements of about 1 inch and ½ inch, respectively, depending on minimum foundation width and embedment.

PRELIMINARY EARTHWORK RECOMMENDATIONS

The site work conditions will be largely dependent on the weather conditions and the contractor's means and methods in controlling surface drainage and protecting the subgrade. The near-surface silt, clay and sand encountered in the borings may provide relatively wet subgrade during construction. Site preparation where mat/slab foundations, footings and access roads will be installed should include clearing and grubbing, installation of a site drainage system (where necessary), subgrade preparation, proof-rolling and vibratory/machine densification as necessary. Site preparation is not necessary in the PV Array field or where inverters will be supported on driven piles except to improve site drainage where necessary.

We would expect typical earthmoving equipment (bulldozers, excavators, padded-foot and steel drum vibratory rollers) to be suitable for completion of earthwork activities on the site. The most challenging obstacle for earthwork construction will be the control of surface and groundwater, especially during the typical wet season. The site should be graded to prevent ponding of surface water. Additionally, dewatering (rim ditches, sump pumps, well points, etc.) may be needed to lower the groundwater and allow for adequate compaction in trenches.

Unpaved Access Roads

Typical unpaved access roads in the lightly-loaded array areas consisting of about 6 inches of No. 4 or No.2 crushed stone and another 3 inches of ODOT 304 crushed stone aggregate base on compacted native soil should be suitable. If a geotextile separator fabric is placed over the prepared subgrade, the unpaved lightly-loaded road section could be reduced to about 6 inches of ODOT 304 crushed stone.

Positive drainage of surface water away from access roads and drainage of the access road subgrades will aid in the long-term performance of unpaved access roads. It is recommended that the access road subgrades be sloped toward the edges of the roads to promote drainage of the access road subgrades. The road surface should also be sloped to direct water away from the access roads and to prevent ponding of surface water on the access roads. The water drained from the sloping subgrade and access roads should be collected in drainage ditches constructed along the edges of the access roads. Where access roads are constructed by cutting below existing grades, cut-off ditches should be constructed along the edges of the access roads to prevent surface water run-off from saturating the access road subgrades.

GENERAL COMMENTS

Our preliminary analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide additional design level exploration and then observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client, and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for preliminary design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

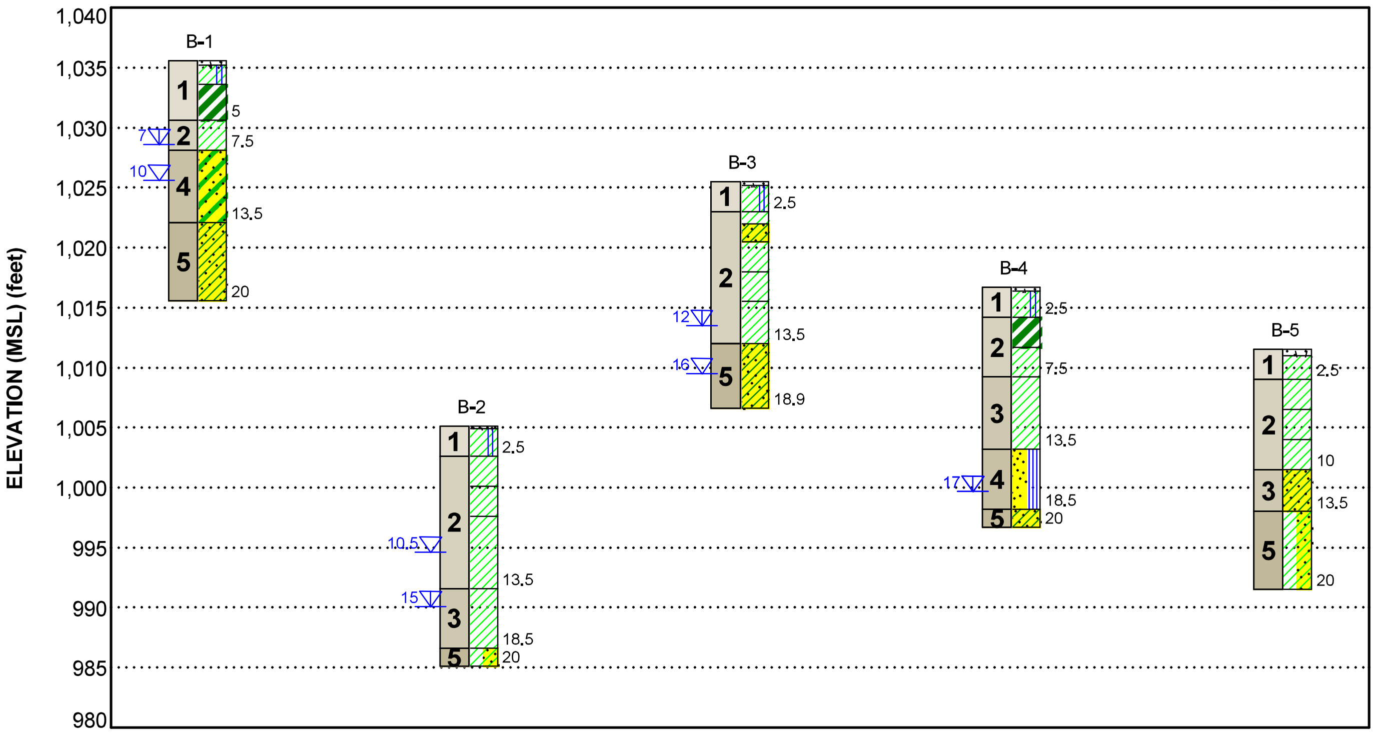
FIGURES

Contents:

GEOMODEL

Preliminary New Market Solar I - 65MW ■ Hillsboro, Highland County, OH
Terracon Project No. N1205164

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	Loess Deposits	lean clay, lean clay with silt, silty clay, light gray with reddish brown, stiff to very stiff
2	Weathered Glacial Till	lean clay, fat clay, sandy lean clay, trace concretions, dark yellowish brown with gray, mottled
3	Brown Glacial Till	lean clay, sandy lean clay, very stiff to hard
4	Granular	poorly graded sand with silt, varying gravel content, very dense, brown and gray
5	Gray Glacial Till	lean clay, sandy lean clay, trace gravel, gray, hard

LEGEND

- Topsoil
- Lean Clay
- Lean Clay with Sand
- Lean Clay with Silt
- Clayey Sand
- Poorly-graded Sand with Silt
- Fat Clay
- Sandy Lean Clay

- First Water Observation
- Second 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.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Field Exploration

Number of Borings	Boring Depth (feet)	Planned Location
5 [1]	18.9 to 20	PV Areas
2 [2]	21.5 to 31.5	PV Areas

1. Test Borings performed in 2020
2. Test Borings performed in 2018

Boring Layout and Elevations: Terracon in coordination with Hecate selected boring locations in areas accessible to our drill rig and in areas where damage to existing soybean crops would be avoided. Ground surface elevations and horizontal coordinates were determined using a Leica Zeno survey-grade GPS unit with a vertical and horizontal accuracy of about ±1 foot.

Subsurface Exploration Procedures: We advanced the borings with a track-mounted rotary drill rig using continuous-flight hollow-stem augers. Four samples were obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter. Samples were primarily obtained using the split-barrel sampling procedure whereby 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.

In addition a few relatively undisturbed thin-walled tube samples were obtained. In the thin-walled tube sampling procedure, a thin-walled, seamless steel tube with a sharp cutting edge is pushed hydraulically into the soil to obtain a relatively undisturbed sample. Grab samples were obtained in Borings B-1 and B-5 between 1 to 5 feet below the existing ground surface.

We observed and recorded groundwater levels during drilling and sampling. For safety purposes, all borings were backfilled with auger cuttings and/or bentonite chips after their completion.

The sampling depths, 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.

Field (in situ) Electrical Resistivity Testing

Two field resistivity measurements, one each in the vicinity of Test Borings B-1 and B-5, were performed on September 22, 2020 using the "Wenner Four Electrode Method" in accordance with ASTM G-57. An Advanced Geosciences, Inc. (AGI) SuperSting R8/IP DC-memory earth resistivity meter, with Serial Number SS0607179, was used for the testing program.

For this procedure, four test electrodes were driven into the ground in a straight line at equal spacings ("a"). The two "current electrodes" are placed on the outside of the electrode spread. The two inside electrodes are used to measure the resulting voltage. Electrical resistance measurements (in Ohms) are read on a resistance meter. These readings are converted to resistivity values (in Ohm-centimeters) by applying a mathematical conversion factor that incorporates the electrode spacing. To obtain readings representing various depths, the electrodes are spaced out (equidistant) and the process is repeated.

In accordance with our proposal, the field resistivity surveys were conducted according to the requirements of the ASTM G-57 test method. Electrical Resistivity was performed at two locations (B-5 and B-1) with electrode "a" spacings of 2, 5, 10, 15, 25, 40 and 50 feet. Two perpendicular lines were collected at each location to help reduce data interference.

For this project, the electrodes consisted of 18-inch-long steel grounding rods as the outside and inside electrodes. Results of the field electrical resistivity testing are included in the **Exploration Results**section.

It should be noted that the resistivity values measured in the field could vary by material type, moisture content, surface temperature, ground-water depth, and other climatic conditions. Manmade cultural features can have various effects on Wenner Survey results. The presence of buried metallic objects, metal fences, and overhead powerlines can all influence the results. The testing locations may be shifted to help avoid data interference. The interference may be minor and undetectable in the data or significant influence could cause errors in the resistivity meter readings.

Underground utilities will "steal" current from the array pin, by creating a conductive current path away from the array electrodes. For example, a metallic utility could cause the measured resistance to be less than the actual resistance at that location. The amount of interference can vary depending on utility type (i.e., material and diameter).

If the utilities are not crossed at a 90-degree angle, the array should remain ½ the maximum "a" spacing away from the underground utility to minimize the effect on the test.

Overhead transmission lines similarly interfere with resistance readings due to the induction of outside current. As a rule of thumb, a minimum clearance of 100 feet is required to prevent significant interference from overhead transmission lines. If it is unavoidable and the array crosses a transmission line, it is best to cross at a 90-degree angle.

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. Procedural standards noted below are for reference to methodology in general. In some cases, variations to methods were applied because of local practice or professional judgment. Standards noted below include reference to other, related standards. Such references are not necessarily applicable to describe the specific test performed.

- ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM D422 Standard Test Method for Particle-Size Analysis of Soils
- ASTM D2166/D2166M Standard Test Method for Unconfined Compressive Strength of Cohesive Soil
- ASTM D2850 Standard Test Method for Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils
- ASTM D698-12e2 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))
- Thermal Resistivity
- Corrosivity Suite: Sulfides (AWWA 4500-S D), Soluble Sulfate (ASTM C 1580), Soluble Chloride (ASTM D 512), Red-Ox (AWWA 2580), Electrical Resistivity (ASTM G 57-Miller Soil Box), and pH Analysis (AWWA 4500 H).

The laboratory testing program often included examination of soil samples by an engineer. Based on the material's texture and plasticity, we described and classified the soil samples in accordance with the Unified Soil Classification System.

Corrosion Testing: We performed chemical testing (pH, minimum resistivity, Red-Ox potential, total salts, water soluble sulfates, chlorides, and sulfides) on two (2) bulk samples of near-surface materials from selected borings to assist with the evaluation of corrosion to buried steel. Results of the corrosion testing are included in the **Exploration Results**section.

Thermal Resistivity Testing: Two laboratory thermal resistivity tests were performed on bulk soil samples from two selected boring locations (B-1 and B-5). The tested bulk samples of near-surface materials were remolded at 90% of the soil sample standard Proctor maximum dry density and were then tested for thermal resistivity. Results of the thermal resistivity testing are included in the **Exploration Results**section.

SITE LOCATION AND EXPLORATION PLANS

Contents:

Note: All attachments are one page unless noted above.

SITE LOCATION

Preliminary New Market Solar I - 65MW ■ Hillsboro, OH
October 19, 2020 ■ Terracon Project No. N1205164

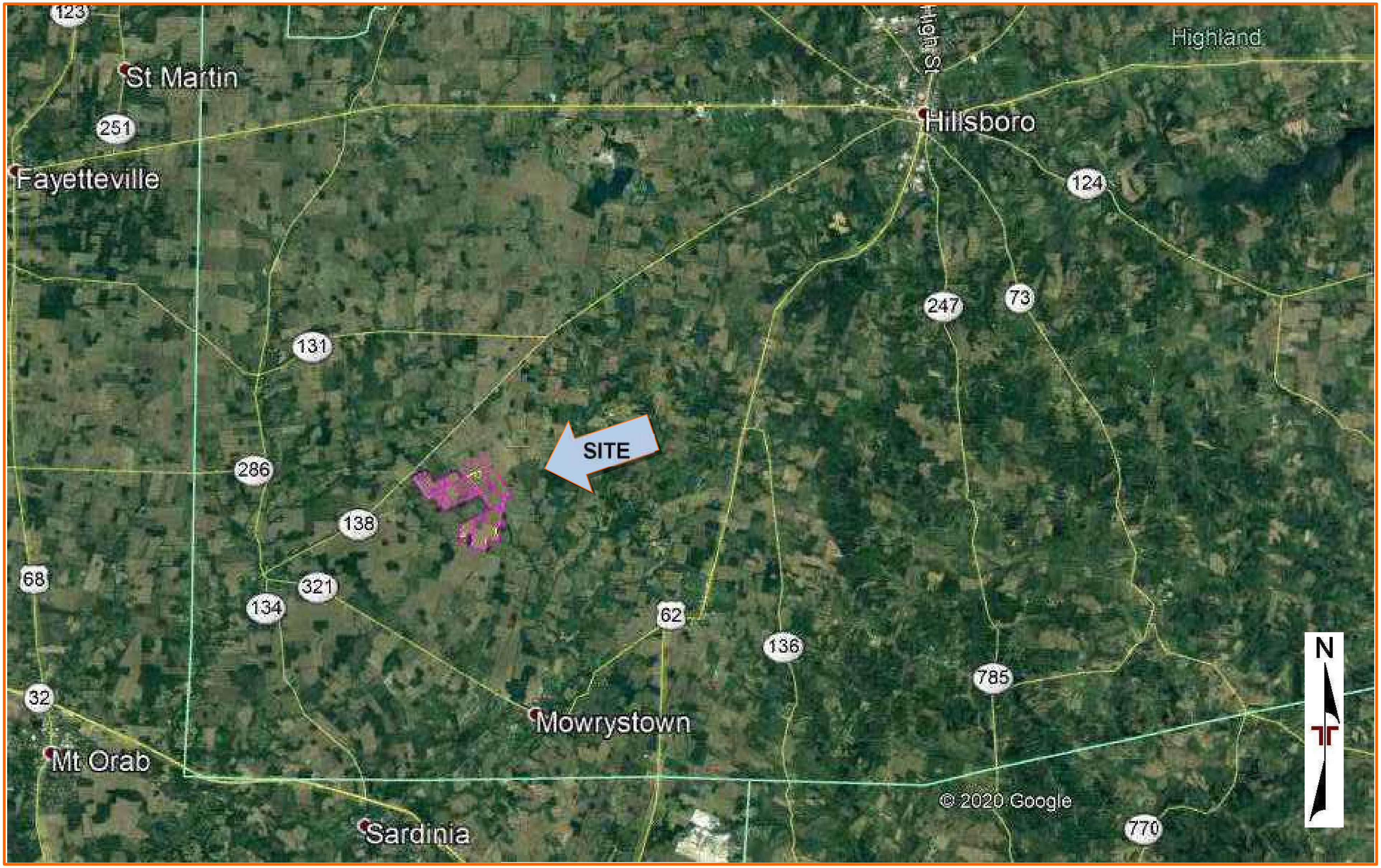


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY GOOGLE EARTH PRO IMAGERY

EXPLORATION PLAN

Preliminary New Market Solar I - 65MW ■ Hillsboro, OH
October 19, 2020 ■ Terracon Project No. N1205164

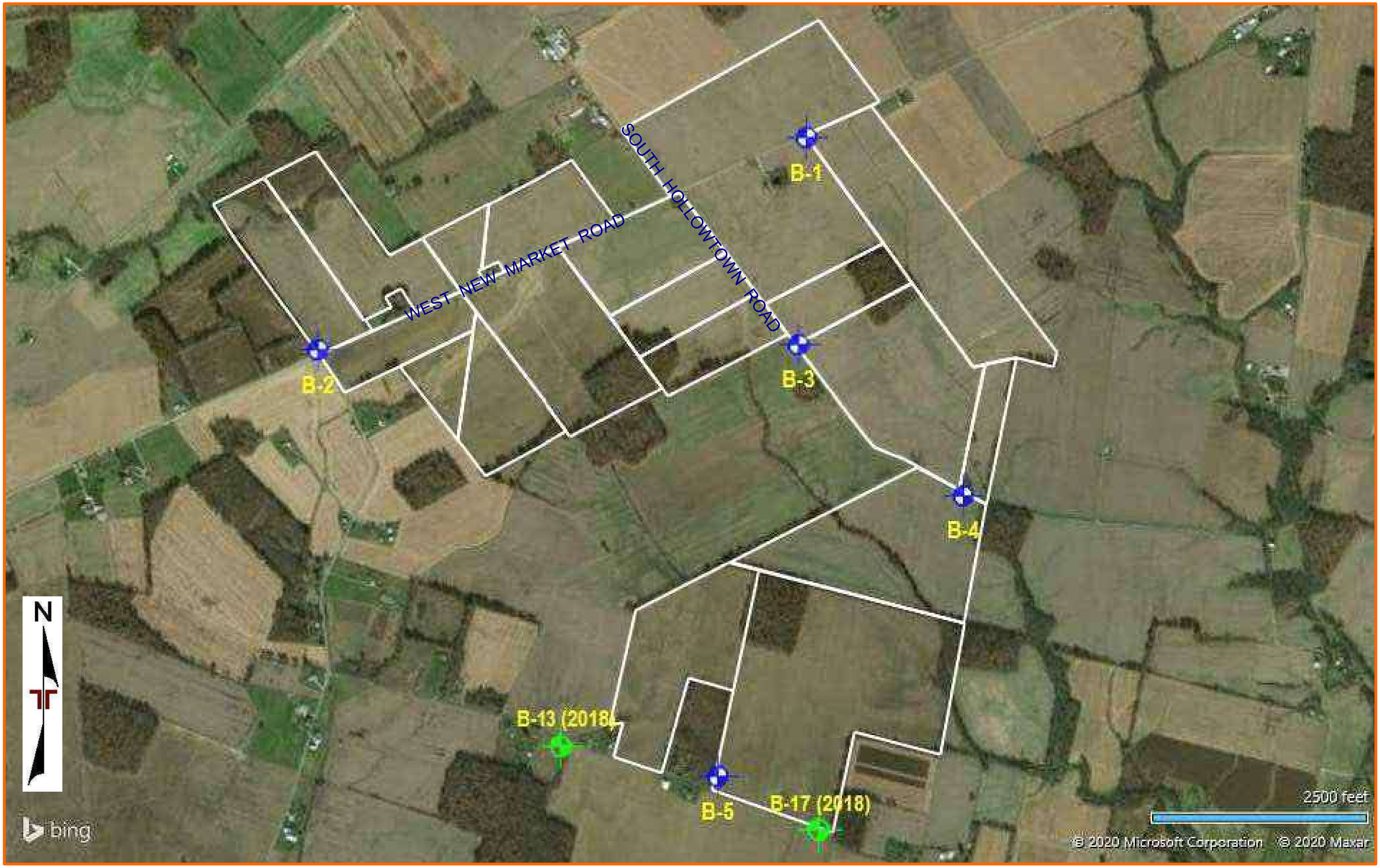


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

EXPLORATION RESULTS

Contents:

Note: All attachments are one page unless noted above.

BORING LOG NO. B-1

PROJECT: Preliminary New Market Solar I - 65MW

CLIENT: Hecate Energy Highland 4 LLC Chicago, IL

SITE: W New Market Road and S Hollowtown Road Hillsboro, Highland County, OH

LOCATION See Exploration Plan

Latitude: 39.105026° Longitude: -83.767427°

Surface Elev.: 1035.6 (Ft.)

Model Layer	Depth	Material Description	Elevation (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (%)	Field Test Results	Laboratory HP (tsf)	Test Type	Compressive Strength (tsf)	Strain (%)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
1	0.4	**AGRICULTURAL TOPSOIL (5")**, silty, trace sand, grayish brown	1035			Split Barrel	100	4-4-4 N=8	4.0/ 3.5 (HP)				21.0		
1	2.0	**LEAN CLAY WITH SILT (CL)**, light gray with reddish brown, stiff to very stiff	1033.5												
1	5.0	**FAT CLAY (CH)**, medium gray with reddish brown, stiff	1030.5			Thin-Walled Tube	100		1.75 (HP)	UC	1.24	3.1	21.4 20.1	102	50-18-32 37-15-22
2	7.5	**LEAN CLAY (CL)**, moderately plastic, dark reddish brown with bluish gray, very dark brown mottles, stiff to very stiff, (Weathered Glacial Till)	1028	5	▽	Split Barrel	100	2-3-5 N=8	3.25 (HP)				20.3		40-19-21
4	13.5	**CLAYEY SAND (SC)**, sand is fine to coarse grained, trace gravel, dark yellowish brown, very dense	1022	10	▽	Split Barrel	100	7-13-28 N=41					7.8		
						Split Barrel	100	10-17-24 N=41					9.0		
5	20.0	**SANDY LEAN CLAY (CL)**, trace fine gravel, gray, very stiff to hard, (Glacial Till)	1015.5	15		Split Barrel	100	14-21-16 N=37	1.75/ 3.0 (HP)				10.3		
				20		Split Barrel	100	9-16-11 N=27	4.5 (HP)				11.1		

Boring Terminated at 20 Feet

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

Hammer Type: Automatic

Advancement Method:
3.25-inch Continuous Flight Hollow-Stem Augers
2-inch Split Barrel Sampler
3-inch Thin-Walled Tube.

Abandonment Method:
Upon completion, boring backfilled with compacted auger cuttings.

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.

Elev. Ref.: Leica Zeno Survey-Grade GPS

Notes:

Bulk bag sample collected from auger cuttings between about 1 foot to 5 feet.

WATER LEVEL OBSERVATIONS

▽ *Water observed at about 10 feet during drilling.*

▽ *At completion of drilling, water observed at 17 feet.*

Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Started: 09-15-2020	Boring Completed: 09-15-2020
Drill Rig: Track D90 (#766)	Driller: A.Moore
Project No.: N1205164	

BORING LOG NO. B-2

PROJECT: Preliminary New Market Solar I - 65MW

CLIENT: Hecate Energy Highland 4 LLC
Chicago, IL

SITE: W New Market Road and S Hollowtown Road
Hillsboro, Highland County, OH

LOCATION See Exploration Plan

Latitude: 39.098307° Longitude: -83.787418°

Surface Elev.: 1005.1 (Ft.)

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	RECOVERY (%)	FIELD TEST RESULTS	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
1	0.2	**AGRICULTURAL TOPSOIL (2")**	1005											
1	2.5	**LEAN CLAY WITH SILT(CL)**, light gray with yellowish brown, stiff to very stiff	1002.5			100	3-3-4 N=7	3.75/ 3.5 (HP)				19.2		
2	5.0	**LEAN CLAY(CL)**, moderately plastic, medium gray with yellowish brown, stiff to very stiff, (Weathered Glacial Till)	1000			50	3-3-4 N=7	1.25 (HP)				30.6		
2	7.5	**LEAN CLAY(CL)**, moderately plastic, medium gray to light gray with yellowish brown, stiff to very stiff, (Weathered Glacial Till)	997.5	5		100		2.0/ 1.5 (HP)	UC	2.51	13.5	4.8	125	43-16-27
2	13.5	**LEAN CLAY(CL)**, trace dark yellowish brown sand, medium gray with very dark yellowish brown, stiff, (Weathered Glacial Till)	991.5			100	2-3-8 N=11	1.5 (HP)				20.5		
				10	▽	100	4-7-9 N=16	0.25 (HP)				18.3		
3	18.5	**LEAN CLAY(CL)**, trace sand, brown and gray, hard, (Glacial Till)	986.5	15	▽	100	31-37-38 N=75					11.4		
5	20.0	**LEAN CLAY WITH SAND(CL)**, trace fine gravel, gray, hard, (Glacial Till)	985	20		100	7-8-16 N=24	4.5 (HP)				11.4		

Boring Terminated at 20 Feet

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

Hammer Type: Automatic

Advancement Method:
3.25-inch Continuous Flight Hollow-Stem Augers
2-inch Split Barrel Sampler
3-inch Thin-Walled Tube.

Abandonment Method:
Upon completion, boring backfilled with compacted auger cuttings.

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.

Elev. Ref.: Leica Zeno Survey-Grade GPS

Notes:

WATER LEVEL OBSERVATIONS

▽ *Water observed at about 10.5 feet during drilling.*

▽ *At completion of drilling, water observed at 15 feet.*

Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Started: 09-15-2020	Boring Completed: 09-15-2020
Drill Rig: Track D90 (#766)	Driller: A.Moore
Project No.: N1205164	

BORING LOG NO. B-3

PROJECT: Preliminary New Market Solar I - 65MW

CLIENT: Hecate Energy Highland 4 LLC
Chicago, IL

SITE: W New Market Road and S Hollowtown Road
Hillsboro, Highland County, OH

LOCATION See Exploration Plan

Latitude: 39.098473° Longitude: -83.767753°

Surface Elev.: 1025.5 (Ft.)

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (%)	FIELD TEST RESULTS	LABORATORY HP (tsf)	TEST TYPE	COMPRESSIVE STRENGTH (tsf)	STRAIN (%)	CONFINING PRESSURE (psi)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
1	0.3	**AGRICULTURAL TOPSOIL (3")**, silty, trace sand, grayish brown	1025			Split spoon	100	8-6-4 N=10	4.5/ 4.0 (HP)					19.1		
1	2.5	**LEAN CLAY WITH SILT (CL)**, trace fine sand, gray, light gray, and reddish brown with dark yellowish brown mottles, stiff to very stiff	1023													
2	3.5	**LEAN CLAY (CL)**, light bluish gray with dark yellowish brown mottles, stiff, (Weathered Glacial Till)	1022			Split spoon	100	2-3-4 N=7	1.5 (HP)					22.0		
2	5.0	**SANDY LEAN CLAY (CL)**, dark yellowish brown with very dark brown mottles, stiff to very stiff, (Weathered Glacial Till)	1020.5	5												
2	7.5	**LEAN CLAY (CL)**, moderately plastic, reddish brown with gray, stiff to very stiff, (Weathered Glacial Till)	1018			Thin-walled tube	100		1.25/ 1.25 (HP)	UU	2.30	7.3	6	18.9	108	46-18-28
2	10.0	**LEAN CLAY (CL)**, moderately plastic, medium gray with dark yellowish brown, stiff, (Weathered Glacial Till)	1015.5	10		Split spoon	100	4-5-6 N=11	1.5 (HP)					18.9		
2	13.5	**LEAN CLAY (CL)**, trace sand, trace gravel, light gray with dark yellowish brown, soft to medium stiff, (Weathered Glacial Till)	1012		▽ (12 ft)	Split spoon	100	2-3-3 N=6	0.5 (HP)					28.4		
5		**SANDY LEAN CLAY (CL)**, trace gravel, gray, hard, (Glacial Till)		15	▽ (16 ft)	Split spoon	100	31-48-49 N=97	4.5+ (HP)					8.8		
5	18.9	-spoon refusal at about 18.9 feet on anticipated limestone floater.	1006.5			Split spoon	100	50/5"	4.5+ (HP)					2.3		

Boring Terminated at 18.9 Feet

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

Hammer Type: Automatic

Advancement Method:
3.25-inch Continuous Flight Hollow-Stem Augers
2-inch Split Barrel Sampler
3-inch Thin-Walled Tube.

Abandonment Method:
Upon completion, boring backfilled with compacted auger cuttings.

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.

Elev. Ref.: Leica Zeno Survey-Grade GPS

Notes:

WATER LEVEL OBSERVATIONS

- ▽ *Water observed at about 16 feet during drilling.*
- ▽ *At completion of drilling, water observed at 12 feet.*

Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Started: 09-15-2020	Boring Completed: 09-15-2020
Drill Rig: Track D90 (#766)	Driller: A.Moore
Project No.: N1205164	

BORING LOG NO. B-4

PROJECT: Preliminary New Market Solar I - 65MW

CLIENT: Hecate Energy Highland 4 LLC, Chicago, IL

SITE: W New Market Road and S Hollowtown Road, Hillsboro, Highland County, OH

LOCATION See Exploration Plan

Latitude: 39.093692° Longitude: -83.761041°

Surface Elev.: 1016.7 (Ft.)

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (%)	FIELD TEST RESULTS	LABORATORY HP (tsf)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
1	0.3	**AGRICULTURAL TOPSOIL (4")**, silty, trace sand, grayish brown	1016.5							
1	2.5	**LEAN CLAY WITH SILT (CL)**, trace sand, light gray with pale reddish brown, stiff to very stiff	1014		Split spoon	100	7-4-4 N=8	4.0/ 2.0	22.3	
2	5.0	**FAT CLAY (CH)**, dark yellowish brown with dark gray, very stiff, (Weathered Glacial Till)	1011.5		Split spoon	100	6-7-8 N=15	3.25 (HP)	20.5	54-19-35
2	7.5	**LEAN CLAY (CL)**, moderately plastic, trace gravel, reddish brown with gray, stiff to very stiff, (Weathered Glacial Till)	1009		Thin-walled tube	100		3.75/ 1.75 (HP)		
3	13.5	**LEAN CLAY (CL)**, trace sand, trace gravel, brown, hard, (Glacial Till)	1003		Split spoon	100	15-24-26 N=50	4.5+ (HP)	11.2	
3					Split spoon	100	17-24-28 N=52	4.5+ (HP)	8.8	
4	18.5	**POORLY GRADED SAND WITH SILT (SP-SM)**, trace clay nodules, sand is fine to coarse grained, trace chert gravel, trace fine gravel, gray, very dense	998	▽ (17 ft)	Split spoon	100	12-36-50 N=86		17.5	
5	20.0	**SANDY LEAN CLAY (CL)**, trace fine gravel, gray, hard, (Glacial Till)	996.5		Split spoon	100	6-17-18 N=35	4.5 (HP)	6.9	

Boring Terminated at 20 Feet

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

Hammer Type: Automatic

Advancement Method:
3.25-inch Continuous Flight Hollow-Stem Augers
2-inch Split Barrel Sampler
3-inch Thin-Walled Tube.

Abandonment Method:
Upon completion, boring backfilled with compacted auger cuttings.

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.

Elev. Ref.: Leica Zeno Survey-Grade GPS

Notes:

WATER LEVEL OBSERVATIONS

▽ *Water observed at about 17 feet during drilling.*

▽ *At completion of drilling, water observed at 17 feet.*

Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Started: 09-15-2020	Boring Completed: 09-15-2020
Drill Rig: Track D90 (#766)	Driller: A.Moore
Project No.: N1205164	

BORING LOG NO. B-5

PROJECT: Preliminary New Market Solar I - 65MW

CLIENT: Hecate Energy Highland 4 LLC
Chicago, IL

SITE: W New Market Road and S Hollowtown Road
Hillsboro, Highland County, OH

LOCATION See Exploration Plan

Latitude: 39.084803° Longitude: -83.771057°

Surface Elev.: 1011.5 (Ft.)

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	SAMPLE DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (%)	FIELD TEST RESULTS	LABORATORY HP (tsf)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
1	0.5	**AGRICULTURAL TOPSOIL (6")**, silty, trace sand, grayish brown	1011			X	100	0-3-1 N=4	2.5 (HP)	23.3	
1	2.5	**LEAN CLAY (CL)**, light gray with dark yellowish brown, stiff	1009								
2	5.0	**LEAN CLAY (CL)**, trace root hairs, medium gray to dark gray, with very dark brown concretions and mottles, hard	1006.5			X	100	4-5-7 N=12	4.5 (HP)	23.9 17.1	31-15-16
2	7.5	**LEAN CLAY (CL)**, moderately plastic,, medium gray with dark yellowish brown wit dark brown concretions and mottles, very stiff, (Weathered Glacial Till)	1004	5		X	100	3-8-6 N=14	3.75 (HP)	18.7	
2	10.0	**LEAN CLAY (CL)**, moderately plastic, trace sand, medium gray with dark yellowish brown, very stiff, (Weathered Glacial Till)	1001.5			X	100	3-5-7 N=12	2.5 (HP)	18.6	
3	13.5	**SANDY LEAN CLAY (CL)**, trace fine gravel, brown, very stiff, (Glacial Till)	998	10		X	100	5-7-13 N=20	3.5 (HP)	12.6	
5	20.0	**LEAN CLAY WITH SAND (CL)**, trace fine gravel, gray, hard, (Glacial Till)	991.5	15		X	100	13-17-17 N=34	4.5 (HP)	10.5	
5						X	11	22-31-42 N=73		15.0	
		Boring Terminated at 20 Feet		20							

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

Hammer Type: Automatic

Advancement Method:
3.25-inch Continuous Flight Hollow-Stem Augers
2-inch Split Barrel Sampler
3-inch Thin-Walled Tube.

Abandonment Method:
Upon completion, boring backfilled with compacted auger cuttings.

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.

Elev. Ref.: Leica Zeno Survey-Grade GPS

Notes:

Bulk bag sample collected from auger cuttings between about 1 foot to 5 feet.

WATER LEVEL OBSERVATIONS

Water not observed during drilling.

Water not observed at completion of drilling.

Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Started: 09-14-2020	Boring Completed: 09-14-2020
Drill Rig: Track D90 (#766)	Driller: A.Moore
Project No.: N1205164	

BORING LOG NO. B-13

PROJECT: Preliminary Highland Solar Project

CLIENT: Hecate Energy LLC Chicago, IL

SITE: OH 138 Buford, OH

LOCATION See Exploration Plan

Latitude: 39.08575° Longitude: -83.77740°

Surface Elev.: 1004.4 (Ft.)

MODEL LAYER	DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (%)	FIELD TEST RESULTS	RQD	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
	0.5	**CRUSHED STONE (6 inches)**	1004													
2		**LEAN CLAY (CL)**, trace sand and concretions, mottled gray and brown, stiff				X	89	3-5-3 N=8		1.25 (HP)				23		
		--medium stiff below 2.5 feet				X	83	4-2-4 N=6		0.75 (HP)				29		
	5.0		999.5	5												
3		**LEAN CLAY (CL)**, with sand, mottled brown and gray, very stiff, (GLACIAL TILL)				X	33	4-7-10 N=17		2.75 (HP)				24		
		--trace rock fragments below 7.5 feet				X	100	8-7-9 N=16		2.5 (HP)				21		
				10												
					▽ (12')											
	13.0		991.5													
4		**SILTY CLAY (CL)**, with sand and gravel, gray, very stiff to hard, (GLACIAL TILL)		15		X	100	10-20-28 N=48		4.5 (HP)				7		
					▽ (19')											
		--occasional wet silt seams below 19 feet		20		X	100	14-21-26 N=47		4.5+ (HP)				8		

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

Hammer Type: Automatic

Advancement Method:
3.25-inch Continuous-Flight Hollow-Stem Augers

Abandonment Method:
Boring backfilled with auger cuttings and sand 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.

Elevations were measured in the filed using Survey Grade GPS

Notes:

WATER LEVEL OBSERVATIONS

▽ *Water observed at 19' during drilling*

▽ *Water observed at 12' after drilling*

Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Started: 11-07-2018	Boring Completed: 11-07-2018
Drill Rig: D-90 Track	Driller: Meadows
Project No.: N1185370	

BORING LOG NO. B-13

PROJECT: Preliminary Highland Solar Project

CLIENT: Hecate Energy LLC Chicago, IL

SITE: OH 138 Buford, OH

LOCATION See Exploration Plan

Latitude: 39.08575° Longitude: -83.7774°

Surface Elev.: 1004.4 (Ft.)

MODEL LAYER	GRAPHIC LOG	DEPTH / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (%)	FIELD TEST RESULTS	RQD	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
4		**SILTY CLAY (CL)**, with sand and gravel, gray, very stiff to hard, (GLACIAL TILL) *(continued)*	25		X	67	17-30-45 N=75		3.5 (HP)				11		
			30		X	100	21-21-27 N=48		4.5 (HP)				11		
		31.5 / 973													
		Boring Terminated at 31.5 Feet													

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

Hammer Type: Automatic

Advancement Method:
3.25-inch Continuous-Flight Hollow-Stem Augers

Abandonment Method:
Boring backfilled with auger cuttings and sand 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.

Elevations were measured in the filed using Survey Grade GPS

Notes:

WATER LEVEL OBSERVATIONS

Water observed at 19' during drilling

Water observed at 12' after drilling

Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Started: 11-07-2018	Boring Completed: 11-07-2018
Drill Rig: D-90 Track	Driller: Meadows
Project No.: N1185370	

BORING LOG NO. B-17

PROJECT: Preliminary Highland Solar Project

CLIENT: Hecate Energy LLC
Chicago, IL

SITE: OH 138
Buford, OH

LOCATION See Exploration Plan

Latitude: 39.08311° Longitude: -83.76687°

Surface Elev.: 1009.4 (Ft.)

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (%)	FIELD TEST RESULTS	RQD	LABORATORY HP (tsf)	TEST TYPE	COMPRESSIVE STRENGTH (tsf)	STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
1	0.3	**TOPSOIL (3 inches)**	1009													
	2.0	**SILTY CLAY (CL-ML)**, trace sand and fine roots and root holes, mottled grayish-brown and brown, medium stiff	1007.5				89	1-2-3 N=5		0.75 (HP)				30		
2	12.0	**FAT CLAY (CH)**, trace sand and concretions, mottled brown and gray, stiff	997.5				67	4-4-6 N=10		1.75 (HP)				25		
		--very stiff below 5 feet		5			75			3.0 (HP)	UC	1.70	3	23	101	53-25-28
				10			100	6-6-9 N=15		2.75 (HP)				24		
3	20.0	**LEAN CLAY (CL)**, with sand and gravel, brown, very stiff, (GLACIAL TILL)	989.5	15			100	4-5-18 N=23		4.0 (HP)				12		
4	21.5	**LEAN CLAY (CL)**, with sand, trace gravel and rock fragments, brownish gray, hard, (GLACIAL TILL)	988	20			100	18-41-32 N=73						7		
		Boring Terminated at 21.5 Feet														

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

Hammer Type: Automatic

Advancement Method:
3.25-inch Continuous-Flight Hollow-Stem Augers

Abandonment Method:
Boring backfilled with auger cuttings and sand 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.

Elevations were measured in the filed using Survey Grade GPS

Notes:

WATER LEVEL OBSERVATIONS

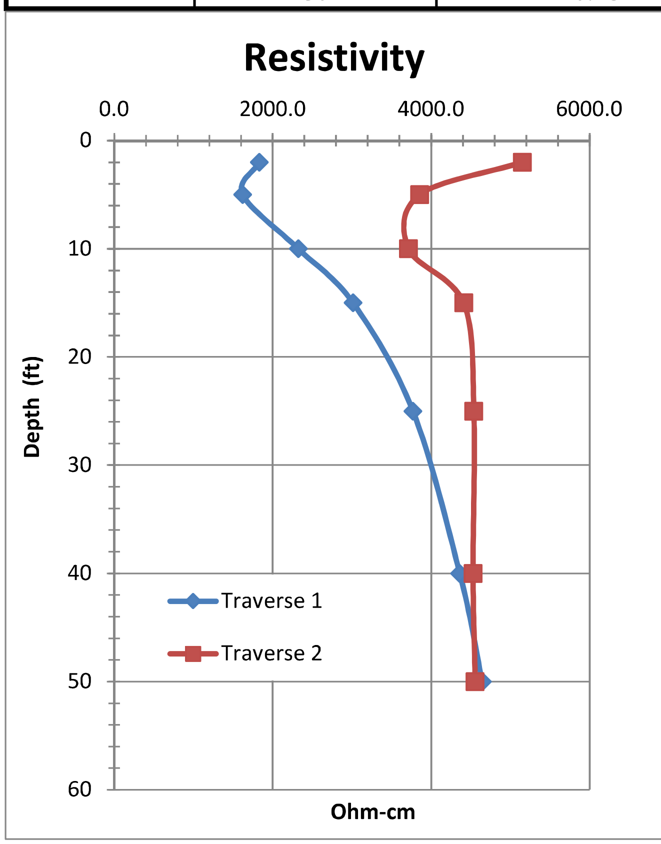
No water observed during drilling

No water observed after drilling

Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Started: 11-08-2018	Boring Completed: 11-08-2018
Drill Rig: D-90 Track	Driller: Meadows
Project No.: N1185370	

Project Name: New Market Solar I			Project Number: N1205164
Client: Hecate Energy Highland 4 LLC			Test Date: 9-22-2020
Conditions: 70 Sunny			Soil Type: Clay
Test performed by: Jared Topie, Chloe Bugni			Test Method: Wenner Four-Electrode
Test Instrument: AGI Supersting R8			Serial Number: SS0607179
Calculation: Soil resistivity (Ω-cm) = 191.5 x Probe Spacing (ft.) x R(Ω)			In accordance with ASTM G-57
Transverse No. 1 _E-W_ Direction			Transverse No. 2 _N-S_ Direction
Testing Results			
Test Location	Probe Spacing (ft.)	Meter Reading (Ω)	Calculated Soil Resistivity (Ω-cm)
1	2	4.78	1829.2
	5	1.69	1622.0
	10	1.21	2322.9
	15	1.05	3013.3
	25	0.79	3769.2
	40	0.57	4360.1
	50	0.49	4644.8
2	2	13.45	5151.4
	5	4.02	3853.0
	10	1.94	3713.2
	15	1.54	4409.3
	25	0.95	4537.6
	40	0.59	4527.8
	50	0.48	4553.9



Project Name: New Market Solar I	Project Number: N1205164
Client: Hecate Energy Highland 4 LLC	Test Date: 9-22-2020
Conditions: 70 Sunny	Soil Type: Clay
Test performed by: Jared Topie, Chloe Bugni	Test Method: Wenner Four-Electrode
Test Instrument: AGI Supersting R8	Serial Number: SS0607179
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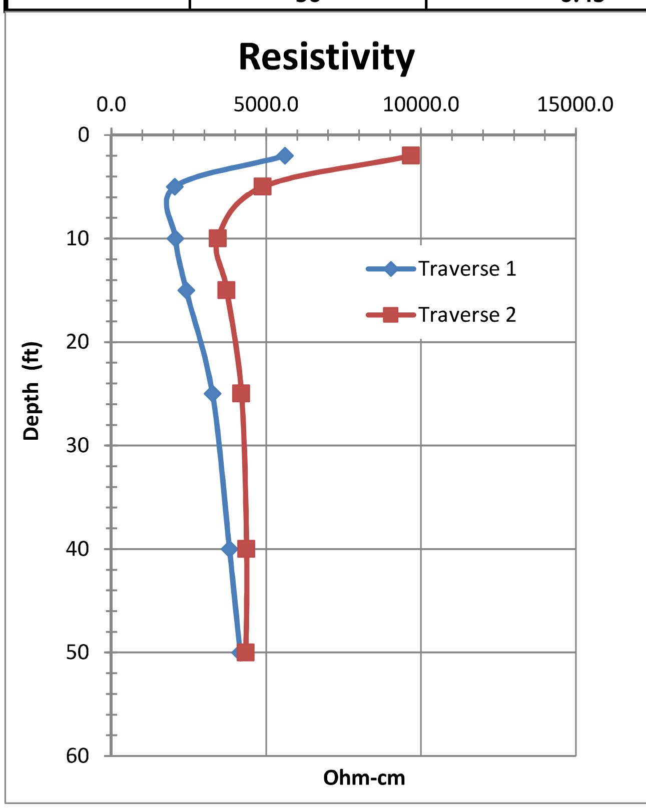
Transverse No. 1 _E-W_ Direction	Transverse No. 2 _N-S_ Direction

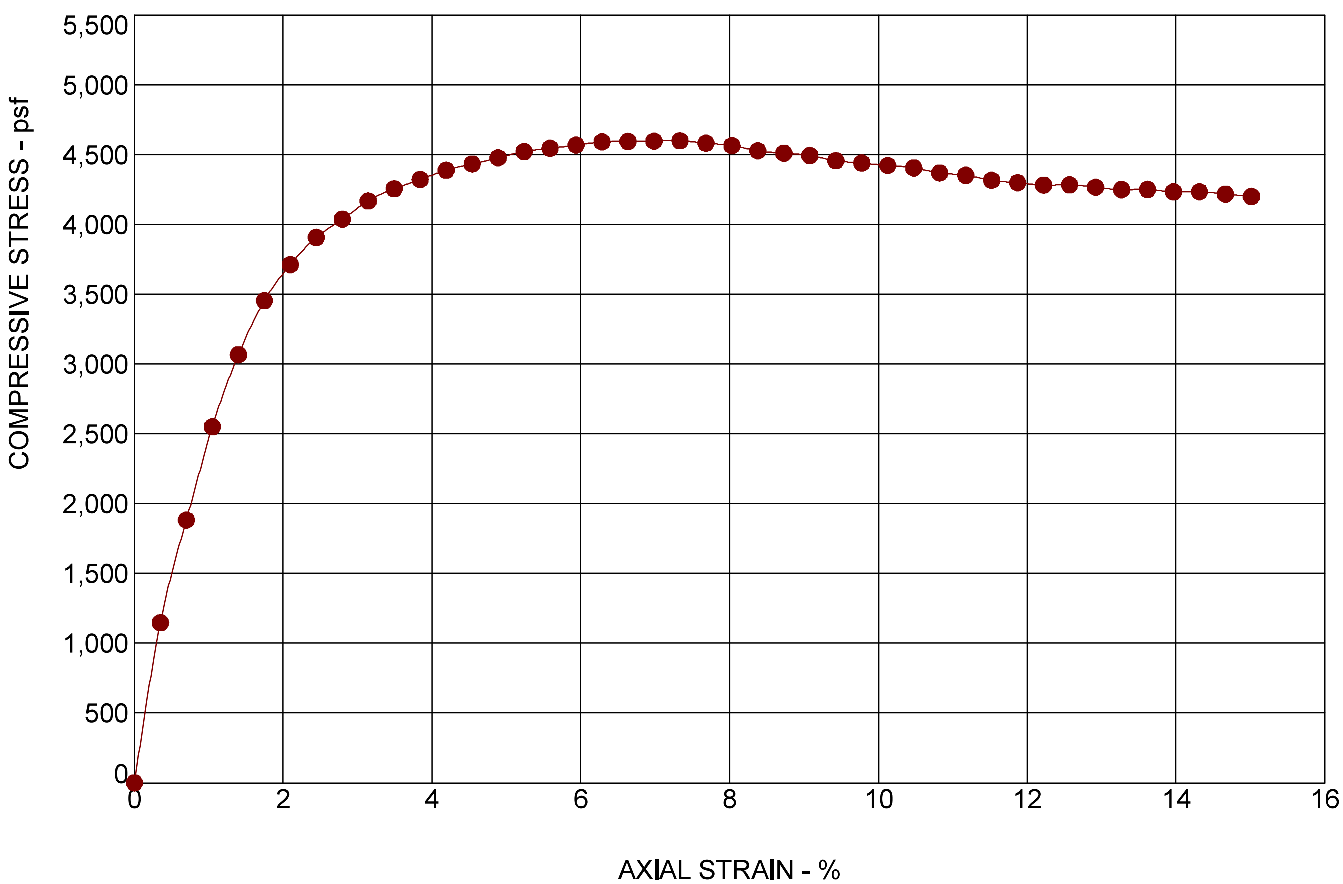
Testing Results

Test Location	Probe Spacing (ft.)	Meter Reading (Ω)	Calculated Soil Resistivity (Ω-cm)
1	2	14.64	5607.1
	5	2.13	2041.4
	10	1.08	2068.2
	15	0.84	2414.3
	25	0.68	3262.7
	40	0.50	3811.6
	50	0.43	4155.6
2	2	25.28	9682.2
	5	5.11	4888.0
	10	1.80	3437.4
	15	1.30	3725.6
	25	0.88	4201.0
	40	0.57	4365.4
	50	0.45	4345.1



UNCONSOLIDATED-UNDRAINED TEST

ASTM D2850



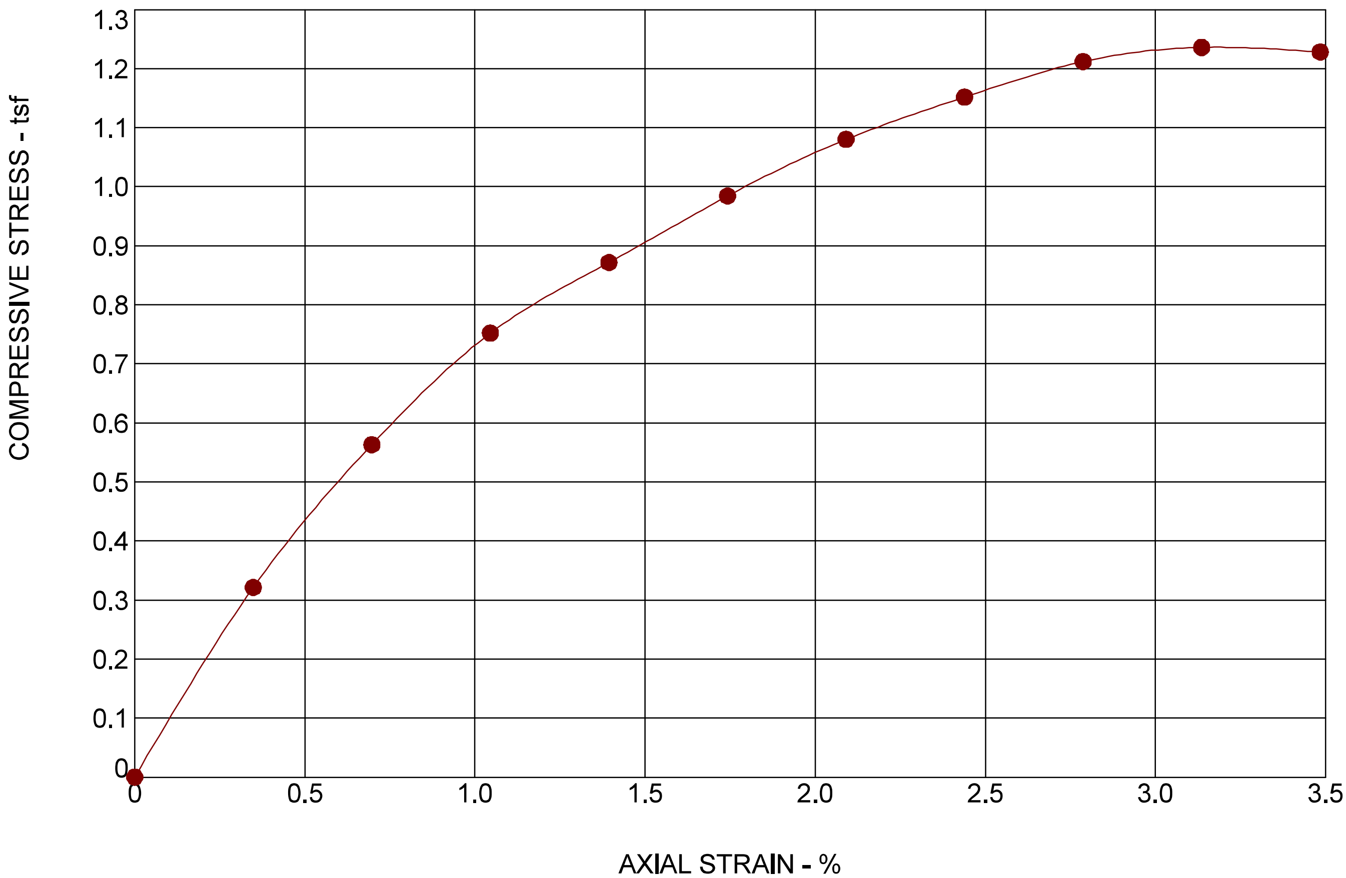
SPECIMEN FAILURE MODE	SPECIMEN TEST DATA		
	Moisture Content:	%	18.9
	Dry Density:	pcf	108.3
	Diameter:	in.	2.87
	Height:	in.	5.73
	Height / Diameter Ratio:		2.00
	Calculated Saturation:	%	91.85
	Calculated Void Ratio:		0.56
	Assumed Specific Gravity:		2.7
	Failure Strain:	%	7.33
	Compressive Strength	(tsf)	2.30
	Undrained Shear Strength:	(tsf)	1.15
	Strain Rate:	in/min	0.0573
	Cell Pressure:	psi	6.0
	Remarks: 5966		

SAMPLE TYPE: Shelby Tube	SAMPLE LOCATION: B-3 @ 5 - 7 feet			
SAMPLE DESCRIPTION: LEAN CLAY	LL 46	PL 18	PI 28	Percent < #200 Sieve

PROJECT: Preliminary New Market Solar I - 65MW	Terracon 611 Lunken Park Dr Cincinnati, OH	PROJECT NUMBER: N1205164
SITE: W New Market Road and S Hollowtown Road Hillsboro, Highland County, OH		CLIENT: Hecate Energy Highland 4 LLC Chicago, IL

UNCONFINED COMPRESSION TEST

ASTM D2166



SPECIMEN FAILURE PHOTOGRAPH

SPECIMEN TEST DATA		
Moisture Content:	%	21.4
Dry Density:	pcf	102
Diameter:	in.	2.86
Height:	in.	5.74
Height / Diameter Ratio:		2.01
Calculated Saturation:	%	89.27
Calculated Void Ratio:		0.65
Assumed Specific Gravity:		2.7
Failure Strain:	%	3.14
Unconfined Compressive Strength	(tsf)	1.24
Undrained Shear Strength:	(tsf)	0.62
Strain Rate:	in/min	0.0574
Remarks: 5936		

SAMPLE TYPE: Shelby Tube	SAMPLE LOCATION: B-1 @ 2 - 4 feet			
DESCRIPTION: GRAY BROWN FAT CLAY	LL	PL	PI	Percent < #200 Sieve
	50	18	32	

PROJECT: Preliminary New Market Solar I - 65MW

SITE: W New Market Road and S Hollowtown Road
Hillsboro, Highland County, OH

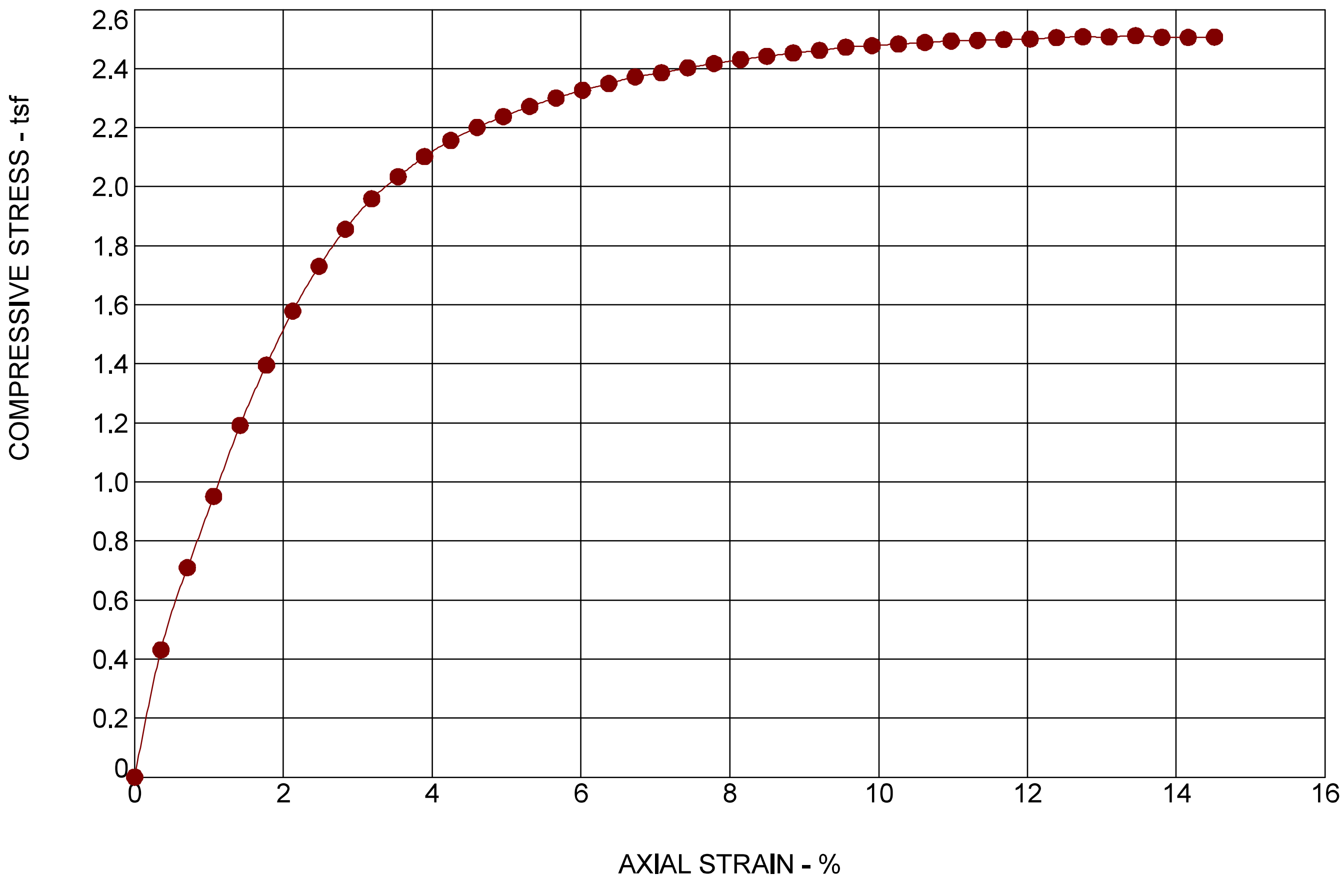
Terracon
611 Lunken Park Dr
Cincinnati, OH

PROJECT NUMBER: N1205164

CLIENT: Hecate Energy Highland 4 LLC
Chicago, IL

UNCONFINED COMPRESSION TEST

ASTM D2166



SPECIMEN FAILURE PHOTOGRAPH

SPECIMEN TEST DATA		
Moisture Content:	%	4.8
Dry Density:	pcf	125
Diameter:	in.	2.86
Height:	in.	5.65
Height / Diameter Ratio:		1.98
Calculated Saturation:	%	37.31
Calculated Void Ratio:		0.34
Assumed Specific Gravity:		2.7
Failure Strain:	%	13.45
Unconfined Compressive Strength	(tsf)	2.51
Undrained Shear Strength:	(tsf)	1.26
Strain Rate:	in/min	0.0565
Remarks: 5959		

SAMPLE TYPE: Shelby Tube	SAMPLE LOCATION: B-2 @ 5 - 7 feet			
DESCRIPTION: GRAY BROWN LEAN CLAY	LL 43	PL 16	PI 27	Percent < #200 Sieve

PROJECT: Preliminary New Market Solar I - 65MW

SITE: W New Market Road and S Hollowtown Road
Hillsboro, Highland County, OH

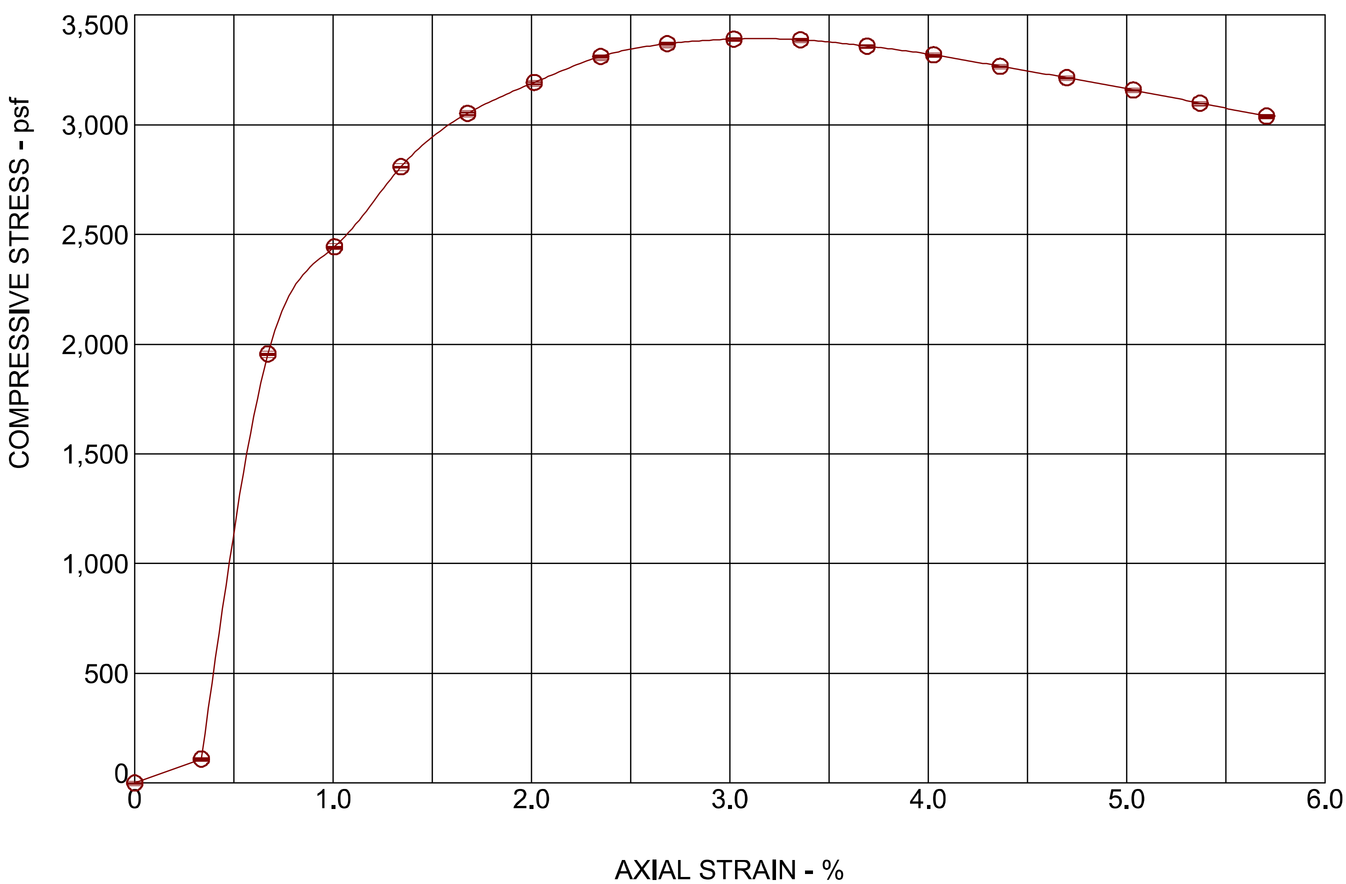
Terracon
611 Lunken Park Dr
Cincinnati, OH

PROJECT NUMBER: N1205164

CLIENT: Hecate Energy Highland 4 LLC
Chicago, IL

UNCONFINED COMPRESSION TEST

ASTM D2166



SPECIMEN FAILURE PHOTOGRAPH	SPECIMEN TEST DATA		
	Moisture Content:	%	23
	Dry Density:	pcf	101
	Diameter:	in.	2.86
	Height:	in.	5.96
	Height / Diameter Ratio:		2.08
	Calculated Saturation:	%	93.16
	Calculated Void Ratio:		0.67
	Assumed Specific Gravity:		2.7
	Failure Strain:	%	3.02
	Unconfined Compressive Strength	(psf)	3390
	Undrained Shear Strength:	(psf)	1695
	Strain Rate:	in/min	0.0596
	Remarks: 9313		

SAMPLE TYPE: Shelby Tube	SAMPLE LOCATION: B-17 @ 4 - 6 feet			
DESCRIPTION: BROWN FAT CLAY	LL 53	PL 25	PI 28	Percent < #200 Sieve

PROJECT: Preliminary Highland Solar Project

SITE: OH 138
Buford, OH

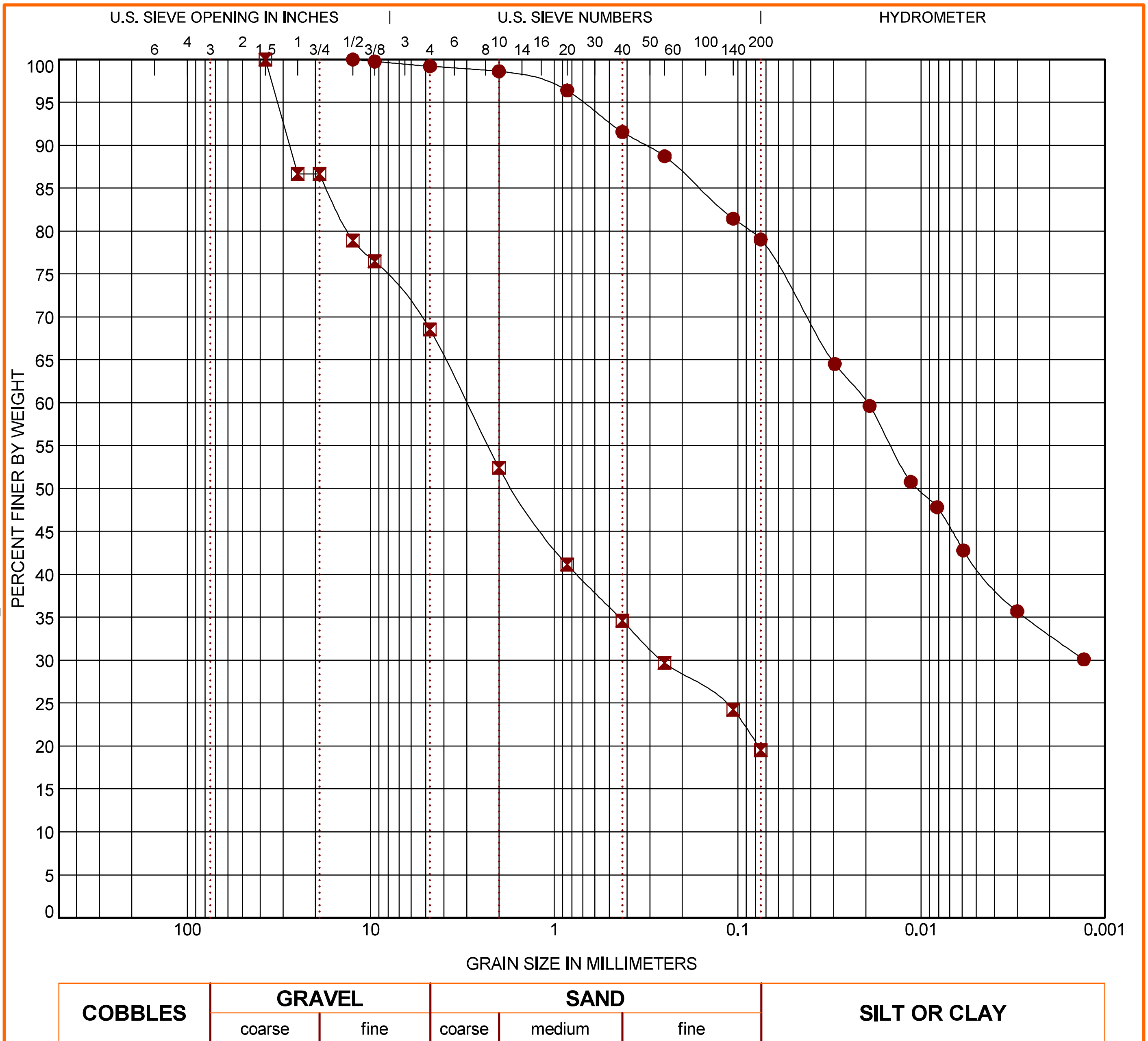
Terracon
611 Lunken Park Dr
Cincinnati, OH

PROJECT NUMBER: N1185370

CLIENT: Hecate Energy LLC
Chicago, IL

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



Boring ID		Depth	USCS Classification	WC (%)	LL	PL	PI	Cc	Cu
●	B-1	1 - 5	LEAN CLAY with SAND (CL)	20.1	37	15	22		
⊠	B-1	7.5 - 9	SILTY SAND WITH GRAVEL (SM)	7.8					

Boring ID		Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Silt	%Fines	%Clay
●	B-1	1 - 5	12.5	0.02			0.0	0.8	20.2	38.0		41.1
⊠	B-1	7.5 - 9	37.5	3.002	0.259		0.0	31.4	49.0		19.5	

PROJECT: Preliminary New Market Solar I - 65MW

SITE: W New Market Road and S Hollowtown Road
Hillsboro, Highland County, OH

Terracon
611 Lunken Park Dr
Cincinnati, OH

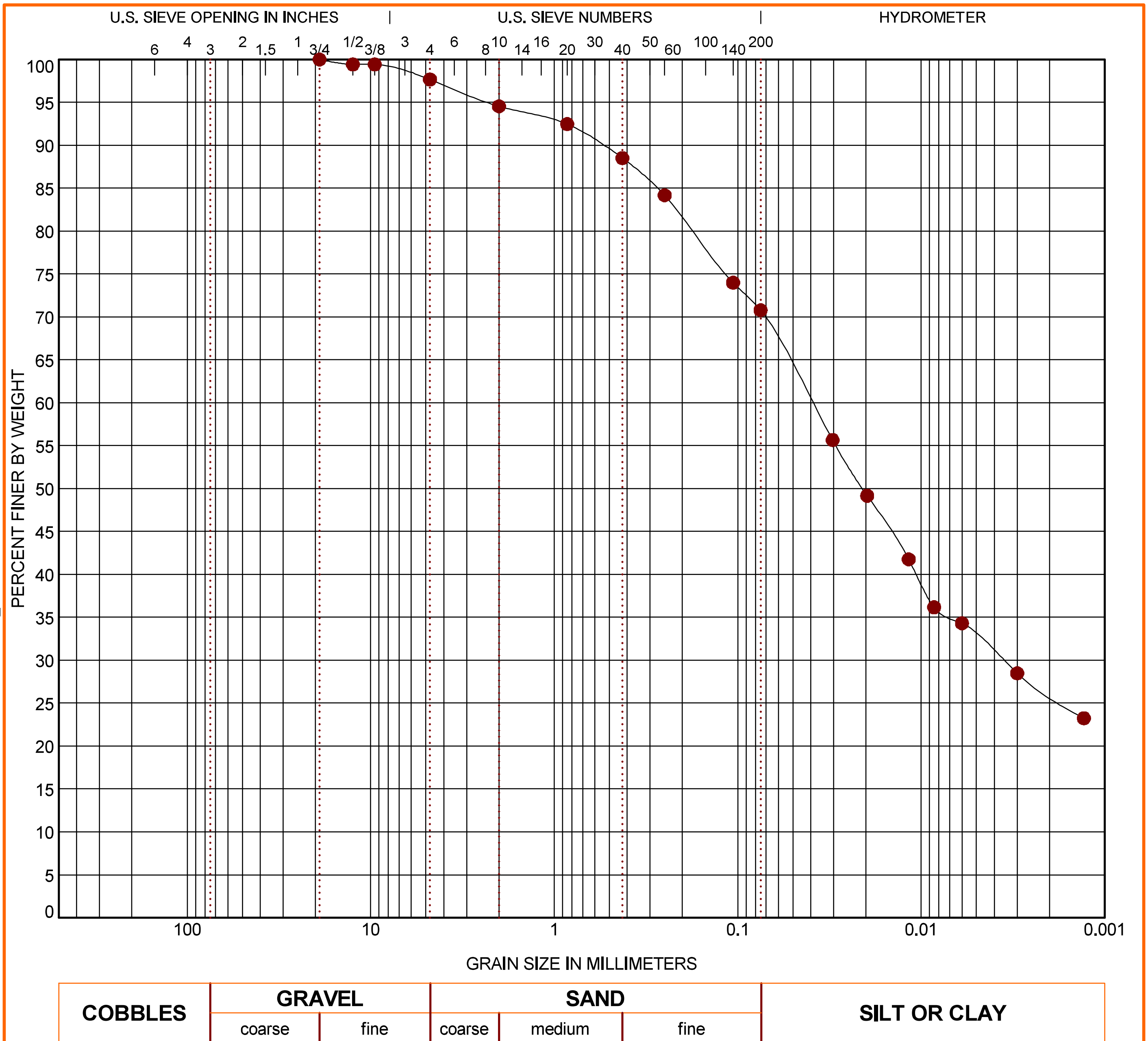
PROJECT NUMBER: N1205164

CLIENT: Hecate Energy Highland 4 LLC
Chicago, IL

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS-2 N1205164 65 MW HIGHLAND CO.GPJ TERRACON_DATATEMPLATE.GDT 10/7/20

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



Boring ID	Depth	USCS Classification	WC (%)	LL	PL	PI	Cc	Cu
● B-5	1 - 5	LEAN CLAY with SAND (CL)	23.9	31	15	16		

Boring ID	Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Silt	%Fines	%Clay
● B-5	1 - 5	19	0.039	0.004		0.0	2.3	26.9	38.0		32.8

PROJECT: Preliminary New Market Solar I - 65MW

SITE: W New Market Road and S Hollowtown Road
Hillsboro, Highland County, OH

Terracon
611 Lunken Park Dr
Cincinnati, OH

PROJECT NUMBER: N1205164

CLIENT: Hecate Energy Highland 4 LLC
Chicago, IL

750 Pilot Road, Suite F
Las Vegas, Nevada 89119
(702) 597-9393

Terracon GeoReport

Client

Hecate Energy Highland 4 LLC

Project

New Market Solar I - 65MW

Sample Submitted By: Terracon (N1) **Date Received:** 9/23/2020 **Lab No.: 20-1058**

Results of Corrosion Analysis

Sample Number	S-1	S-1
Sample Location	B-1	B-5
Sample Depth (ft.)	1- 5	1- 5
pH Analysis, ASTM G 51	7.98	7.33
Water Soluble Sulfate (SO4), ASTM C 1580 (mg/kg)	202	124
Sulfides, AWWA 4500-S D, (mg/kg)	Nil	Nil
Chlorides, ASTM D 512, (mg/kg)	135	52
Red-Ox, ASTM G 200, (mV)	+690	+687
Total Salts, AWWA 2540, (mg/kg)	1590	1238
Resistivity (Saturated), ASTM G 57, (ohm-cm)	1358	3201

Analyzed By: Trisha Campo

Trisha Campo
Chemist

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

October 2, 2020

Terracon Consultants, Inc.
611 Lunken Park Drive
Cincinnati, OH 45226
Attn: Tim Goodall

Re: Thermal Analysis of Native Soil Sample
New Market Solar I 65mW Project – Highland County, OH (Project No. N1205164)

The following is the report of thermal dryout characterization tests conducted on two (2) samples of native soil from the referenced project sent to our laboratory.

Thermal Resistivity Tests: The samples were compacted at the 'optimum' moisture content and at 90% of the maximum 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 dry out curves are presented in **Figures 1 and 2.**

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

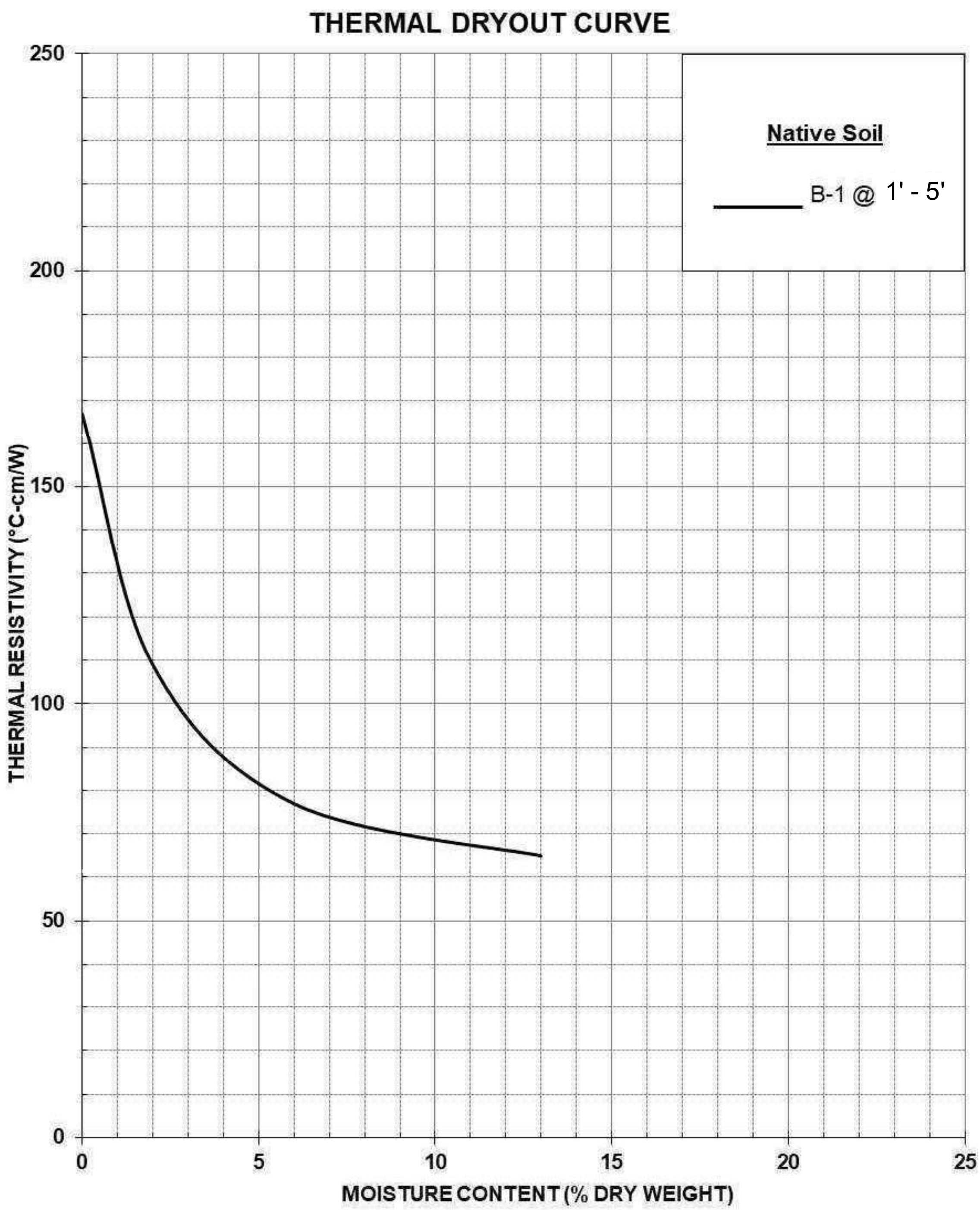
Sample ID @ 1' –5 '	Description (Terracon)	Thermal Resistivity (°C-cm/W)		Moisture Content (%)	Dry Density (lb/ft^3)
		Wet	Dry		
B-1	Brown Lean Clay	65	167	13	104
B-5	Brown Lean Clay	66	172	14	101

Comments: The thermal characteristic depicted in the dryout curve applies for the soil at the test dry density.

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

Geotherm USA

Nimesh Patel



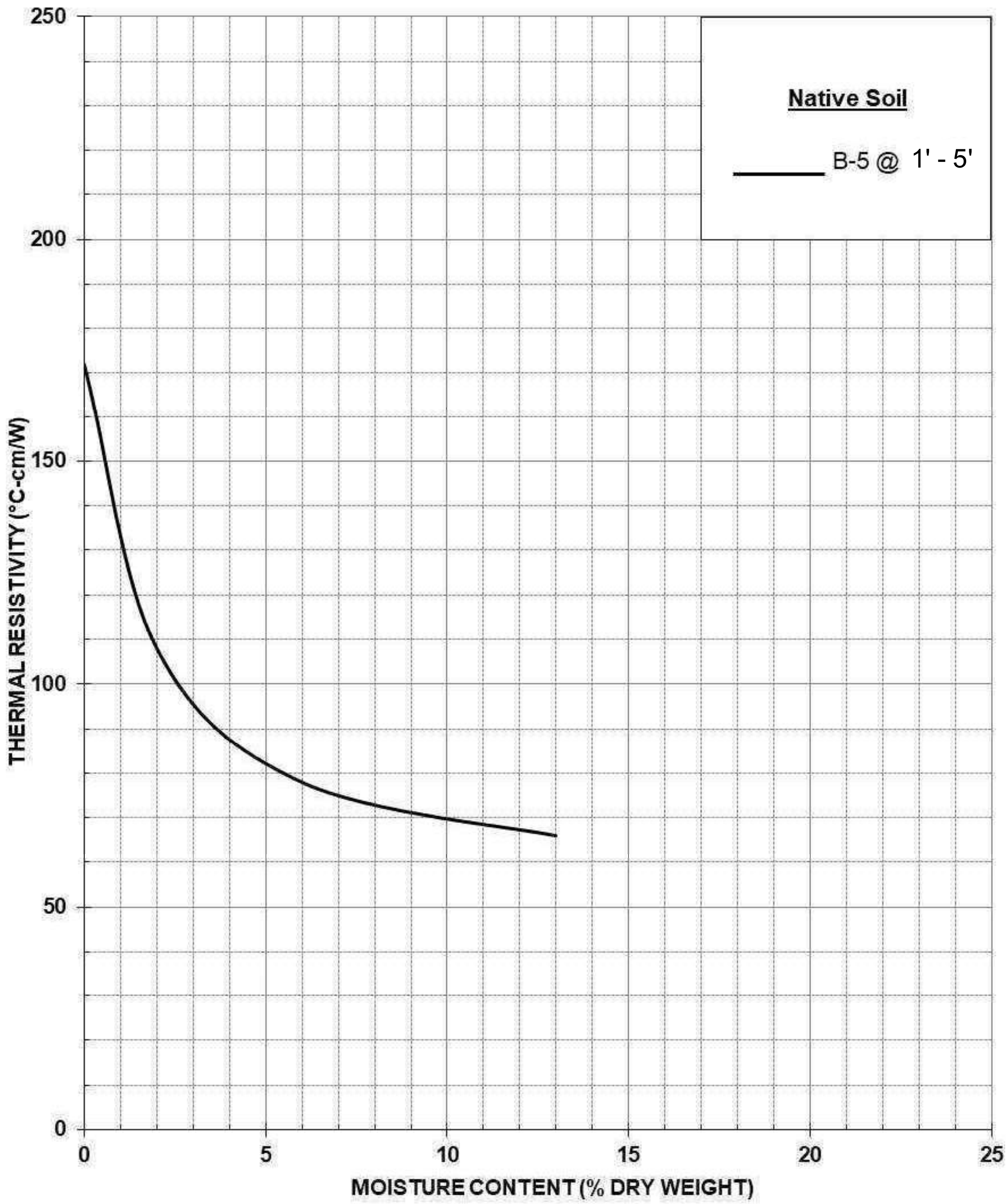
Terracon Consultants (Project No. N1205164)

Thermal Analysis of Native Soil

New Market Solar I 65mW Project – Highland County, OH

October 2020 **Figure 1**

THERMAL DRYOUT CURVE



Terracon Consultants (Project No. N1205164)

Thermal Analysis of Native Soil

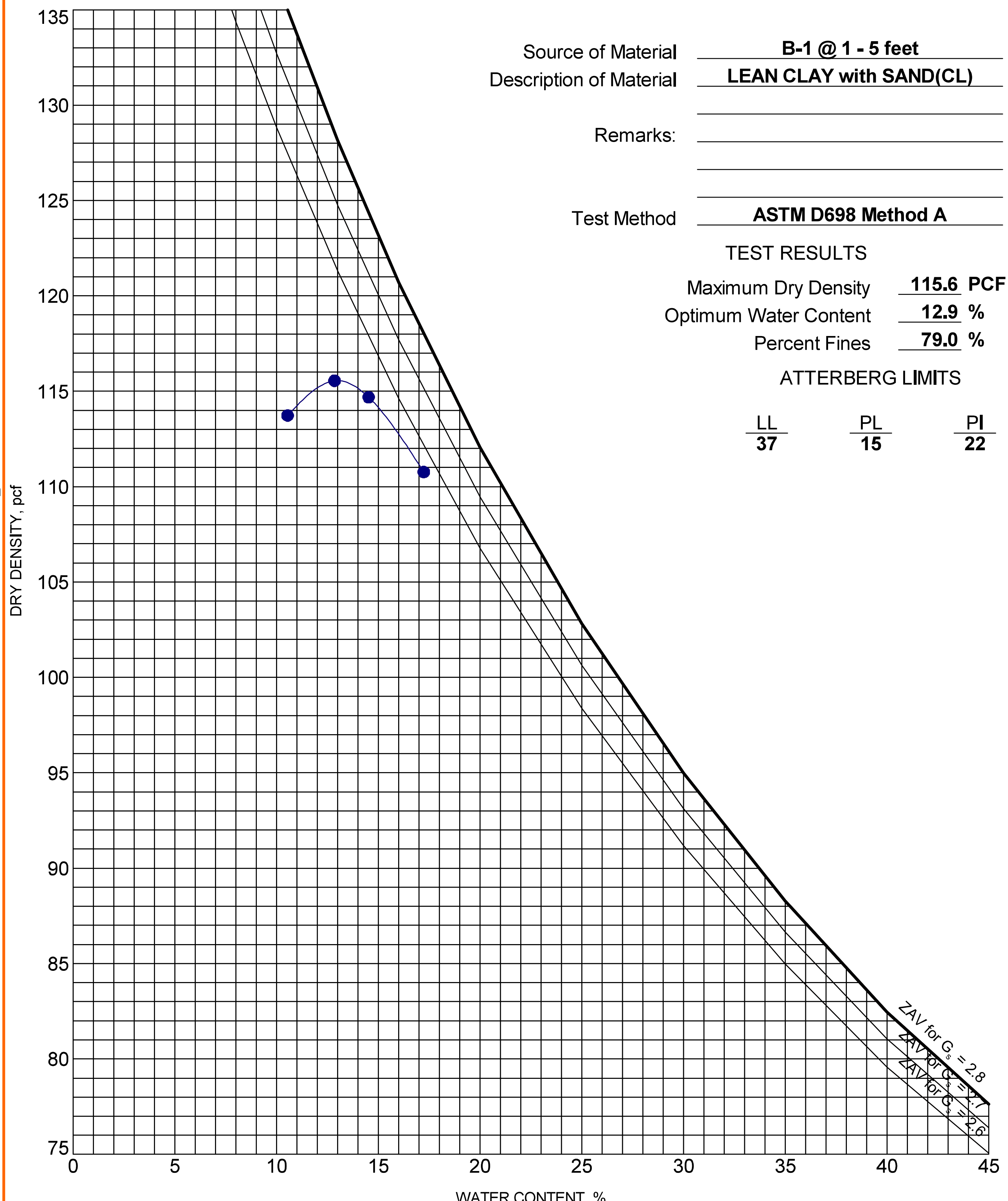
New Market Solar I 65mW Project – Highland County, OH

October 2020

Figure 2

MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557



Source of Material	**B-1 @ 1 - 5 feet**
Description of Material	**LEAN CLAY with SAND(CL)**
Remarks:	
Test Method	**ASTM D698 Method A**

TEST RESULTS

Maximum Dry Density	**115.6 PCF**
Optimum Water Content	**12.9 %**
Percent Fines	**79.0 %**

ATTERBERG LIMITS

LL	PL	PI
37	**15**	**22**

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. COMPACTION - V2 N1205164 65 MW HIGHLAND CO.GPJ TERRACON_DATATEMPLATE.GDT 10/7/20

PROJECT: Preliminary New Market Solar I - 65MW

SITE: W New Market Road and S Hollowtown Road Hillsboro, Highland County, OH

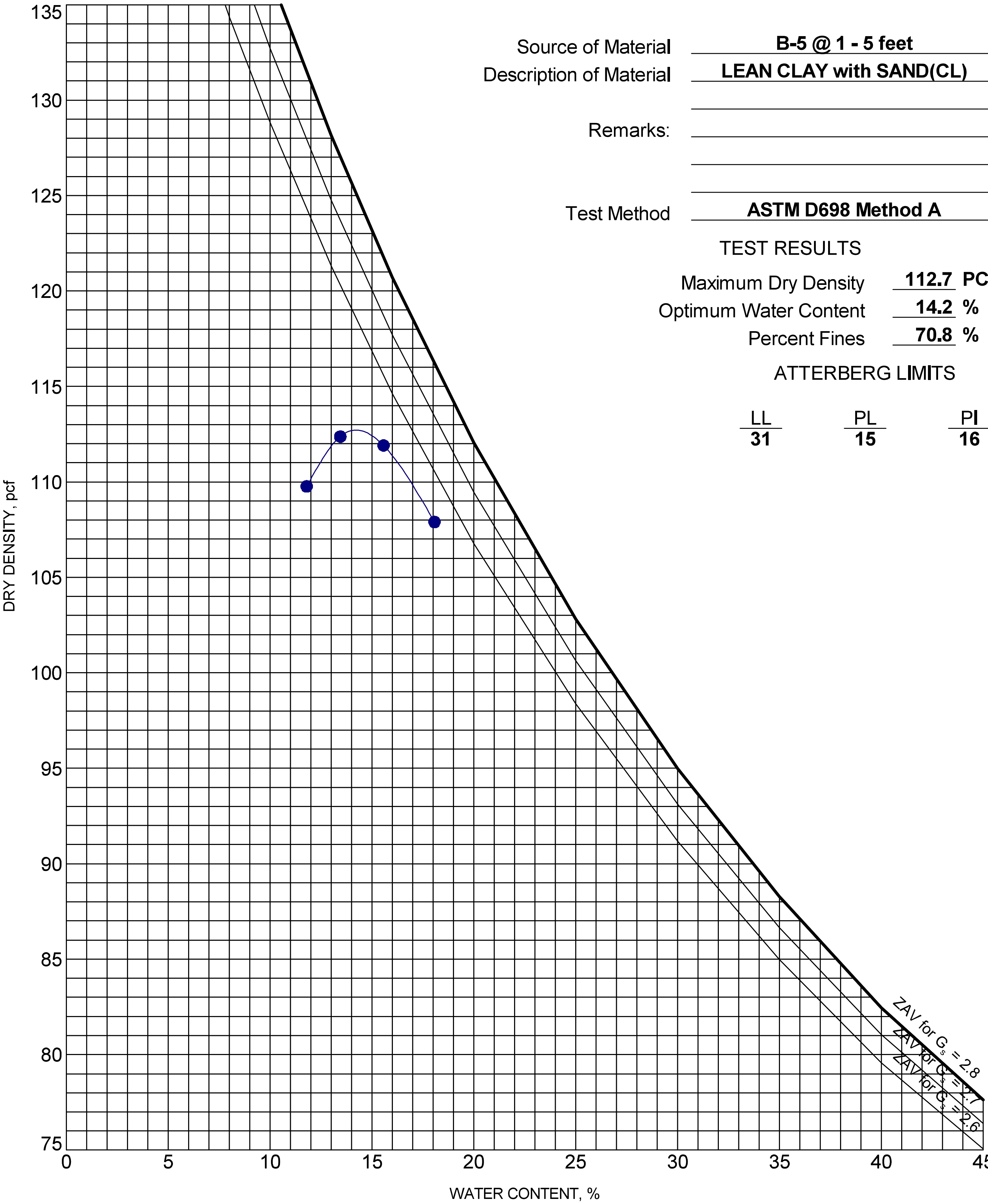
Terracon
611 Lunken Park Dr
Cincinnati, OH

PROJECT NUMBER: N1205164

CLIENT: Hecate Energy Highland 4 LLC Chicago, IL

MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557



Source of Material	**B-5 @ 1 - 5 feet**
Description of Material	**LEAN CLAY with SAND(CL)**
Remarks:	
Test Method	**ASTM D698 Method A**

TEST RESULTS

Maximum Dry Density	**112.7**	**PCF**
Optimum Water Content	**14.2**	**%**
Percent Fines	**70.8**	**%**

ATTERBERG LIMITS

LL	PL	PI
31	**15**	**16**

PROJECT: Preliminary New Market Solar I - 65MW	Terracon 611 Lunken Park Dr Cincinnati, OH	PROJECT NUMBER: N1205164
SITE: W New Market Road and S Hollowtown Road Hillsboro, Highland County, OH		CLIENT: Hecate Energy Highland 4 LLC Chicago, IL

SUPPORTING INFORMATION

Contents:

Note: All attachments are one page unless noted above.

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

Preliminary New Market Solar I - 65MW ■ Hillsboro, Highland County, OH

Terracon Project No. N1205164

Terracon GeoReport

SAMPLING	WATER LEVEL	FIELD TESTS
Shelby Tube Standard Penetration Test	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

Terracon GeoReport

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification: Group Symbol	Soil Classification: 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]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [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]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [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	<0.75	OL	Organic clay [K, L, M, N]
			Liquid limit - not dried			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	<0.75	OH	Organic clay [K, L, M, P]
			Liquid limit - not dried			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 $\geq$ 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 $\geq$ 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 $\geq$ 30% plus No. 200 predominantly sand, add "sandy" to group name.

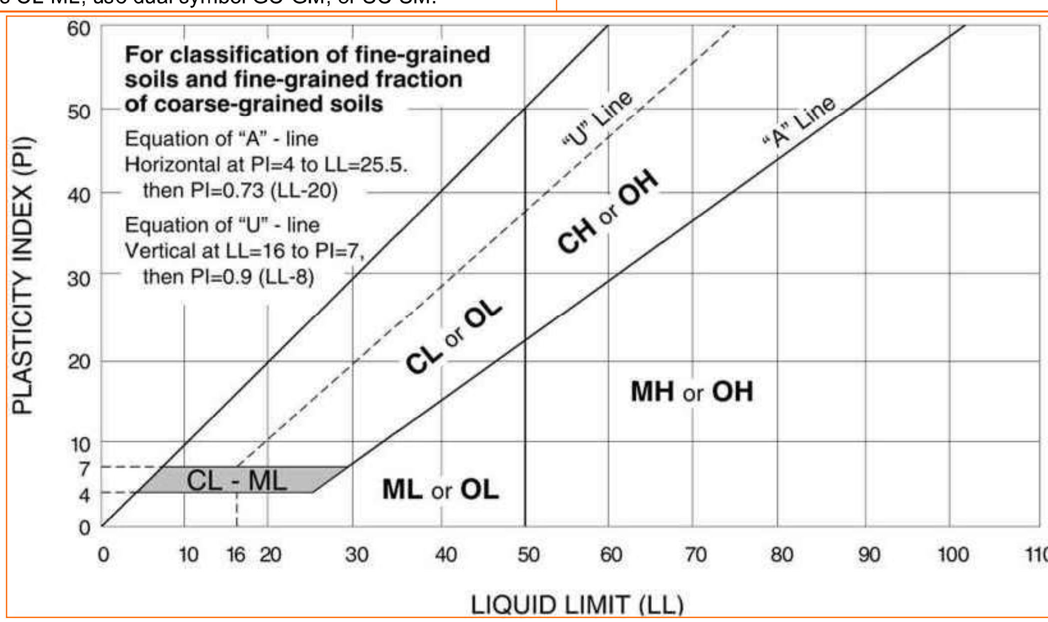
[M] If soil contains $\geq$ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] $PI \geq 4$ 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.



Preliminary Geotechnical Engineering Report

Preliminary New Market Solar II - 35MW
Hillsboro, Highland Co., OH
October 19, 2020
Terracon Project No. N1205318

Prepared for:
Hecate Energy Highland 2, LLC
Chicago, Illinois

Prepared by:
Terracon Consultants, Inc.
Cincinnati, Ohio

October 19, 2020

Hecate Energy Highland 2, LLC
621 W Randolph Street
Chicago, Illinois 60661-2216

Attn: Mr. Jared Wren
P: (740) 591-1154
E: jwren@hecateenergy.com

Re: Preliminary Geotechnical Engineering Report
Preliminary New Market Solar II - 35MW
Stringtown Road and Edwards Road
Hillsboro, Highland Co., OH
Terracon Project No. N1205318

Dear Mr. Wren:

We have completed the Preliminary Geotechnical Engineering services for the above referenced project. This study was performed in general accordance with Terracon Proposal No. PN1205318 dated August 28, 2020 and authorized on September 4, 2020. This report presents the findings of the subsurface exploration and provides preliminary geotechnical recommendations concerning earthwork and the design and construction of foundations and unpaved roads for the proposed project. Our findings and recommendations are based on subsurface explorations and associated lab test results for two 2020 borings and supplemented by subsurface conditions encountered at one boring location performed in 2018. **Based on conditions encountered in the borings, it is our opinion the site is geotechnically suitable for the proposed development.**

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.

Nancy Dendramis, P.E.
Geotechnical Project Engineer

Jeffrey D. Dunlap, P.E.
Senior Engineer

Reviewed by Subject Matter Expert – Jimmy M. Jackson, P.E.

REPORT TOPICS

Note: This report was originally delivered in a web-based format. **Orange Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the ***GeoReport*** logo will bring you back to this page. 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

Preliminary New Market Solar II - 35MW
Stringtown Road and Edwards Road
Hillsboro, Highland Co., OH
Terracon Project No. N1205318
October 19, 2020

INTRODUCTION

This report presents the results of our subsurface exploration and preliminary geotechnical engineering services performed for the proposed 35 MW Solar Facility to be constructed at locations in the vicinity of the Stringtown Road and Edwards Road intersection between Buford, Ohio and Hillsboro in Highland County, Ohio. The purpose of these services is to provide information and preliminary geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions
- Preliminary site preparation and earthwork
- Preliminary access road design
- Preliminary foundation design and construction
- Thermal resistivity
- Seismic site classification per IBC
- Field Electrical resistivity

The geotechnical engineering Scope of Services for this project included the advancement of 2 test borings to depths of about 20 feet below existing site grades. Our current field exploration scope was supplemented by one test boring (B-20) performed in 2018.

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 and/or as separate graphs in the **Exploration Results** section. Field and laboratory testing also includes laboratory thermal resistivity testing, laboratory corrosivity testing and field electrical resistivity, which are included as separate figures, graphs or tables 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 is located primarily southeast of Stringtown Road and Edwards Road intersection in Hillsboro, Highland Co., OH. The New Market Solar II (35 MW) site has a footprint of about 292 acres of which about 222 acres will be developed. See **Site Location**
Existing Improvements	Agricultural farm fields with associated access drives, buried and overhead utilities, narrow local roadways, 2-lane county roads.
Current Ground Cover	Soybean fields, bare areas, and isolated areas of heavy vegetation
Existing Topography	The site generally slopes downward from about El. 1013 feet at the northwest end of the project area down to about El. 980 feet at the northeast end of the project area. Proposed project footprint areas are relatively level with isolated, widely-spaced stream/swale/drainage ditch dissections and/or other depression areas.
Geology	Based on the Highland County USDA Soil Survey, the near-surface soils are consistent with soils from the Westboro and Clermont series described as poorly-drained soils formed in loess and the underlying glacial till. These soils are found on concave flats, flats and knolls on loess-covered till plains of Illinoian age. Test borings did not encounter underlying residual soils or Ordovician Age shale and limestone bedrock belonging to the Waynesville formation. The depth of the bedrock is highly variable, according to published literature.

PROJECT DESCRIPTION

Our understanding of the project conditions is as follows:

Item	Description
Information Provided	Site plan (.kmz files) with approximate project footprint boundaries.

Item	Description
Project Description	The proposed site includes approximately 292 acres of primarily agricultural cropland of which about 222 acres are proposed to be developed as a 35MWac photovoltaic (PV) solar electric power plant supported on steel piles, a racking system and PV modules. The steel pile foundations for the solar array are anticipated to consist of wide flange steel piles (W6x9 or similar). The anticipated loads and maximum deflection of the piles were not available at the time of this report. Mat/slab foundations may be required for inverter or electrical equipment foundations. No substation areas or transmission towers were designated for this project area and any substation or transmission tower foundations were beyond the scope of this preliminary study.
Maximum Loads	Structural loads were not provided, but have been estimated based on our experience on projects using single-axis tracker rack systems. ■ Downward axial compression: 3 to 6 kips ■ Uplift: 1.5 to 2.5 kips ■ Lateral: 1.5 to 3 kips Structural loads are anticipated to be provided during the final design based on the selected tracker-rack system and final geotechnical study to be performed at a later date.
Access Roads	We understand that unpaved access roads are planned in the solar array areas. The preliminary access road designs provided in this report are based on an allowable rut depth of 2 inches with anticipated traffic consisting of one service (pick-up) truck per week and a heavy delivery vehicle (similar to an HS-20 vehicle) that will visit the site occasionally (less than 10 times throughout the life of the project). Access roads used for construction of the project will be the responsibility of the Engineering, Procurement, and Construction (EPC) company.
Estimated Start of Construction	2021-2022

GEOTECHNICAL CHARACTERIZATION

Two test borings (B-6 and B-7) were performed in 2020 to depths of about 20 feet below existing grades. One test boring (B-20) was performed in 2018 to a depth of about 21.5 feet below existing grades. We have developed a general characterization of the subsurface conditions based upon our review of the 2020 and 2018 subsurface explorations, laboratory data, geologic setting, and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of site preparation and foundation options. Conditions encountered at each exploration point are indicated on the individual logs. The individual logs can be found in the **Exploration Results** section and the GeoModel can be found in the **Figures** section of this report.

Site Soils

Based on the USDA Highland County Soil Survey, the majority of the near-surface soils at the site are found on poorly-drained, broad concave flats. These soils are from a mixture of the Clermont Silt Loam and Westboro-Schaffer Silt Loam that were formed in loess and the underlying Illinoian Age till.

The near-surface soils at the northeast corner of the project area are from both the Hickory Series and the Jonesboro Series. The Jonesboro series consists of moderately well-drained soils formed in loess and the underlying till on till plains. Jonesboro soils are found on ridgetops and shoulders of the loess-capped till plains of Illinoian age. The depth to the top of an intermittent perched high water table ranges from 18 inches to 36 inches between January and May in normal years. The potential for surface runoff is negligible to high depending on slope gradient.

The Hickory series consists of well-drained soils on convex slopes in dissected parts of the Illinoian till plain. They formed in Illinoian glacial till that can be capped with as much as 20 inches of loess.

Test borings encountered conditions consistent with the USDA County Survey that included up to 6 inches of a disturbed "plowzone" soil layer underlain by natural lean clay, lean clay with silt, and fat clay overlying brown to gray lean clay glacial till with occasional granular interlayers. The underlying top-of-bedrock depths are anticipated to be at least 25 feet below existing grades.

Site Bedrock Geology

The western two-thirds of the site is located within an area mapped with bedrock from the Waynesville and Arnheim Formations described as interbedded shale and limestone, thin to thickly bedded. Given the site elevations, the natural overburden soils are anticipated to overlay the Ordovician Age shale-rich Waynesville Formation (approximately 70% shale and about 30% limestone).

Bedrock underlying the natural overburden soils at the eastern one-third portion of the site is from the Preacherville Member of the Drakes Formation primarily consisting of dolomitic mudstone with minor amounts of argillaceous limestone. The Preacherville Member of the Drake overlies the Waynesville.

Bedrock was not encountered within maximum depths explored before borings were terminated between 20 feet to 21.5 feet below existing grades. Bedrock depths within the project area are anticipated to be greater than 25 feet below existing grades.

Encountered Subsurface Conditions

Our widely-spaced soil borings encountered a surface layer of approximately 2 inches to 6 inches of plowzone topsoil (agricultural topsoil). The plowzone layer is a mixture of topsoil and natural soil that have been mixed together due to agricultural activities at the site. The recent 2020 soil borings were located within bare ground areas at roadway access points where the plowzone depths were observed to be relatively shallow. Deeper plowzone depths could be encountered in areas that have been exposed to earlier deeper cultivation methods; however, previous studies in the area indicate that the depth of the plow zone is generally limited to less than 12 inches in the project vicinity due to current cultivation methods used for the soybean fields in the study area.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

Model Layer	Layer Name	General Description
1	Loess Deposits	lean clay, lean clay with silt, silty clay, light gray with reddish brown, stiff to very stiff
2	Weathered Glacial Till	lean clay, fat clay, sandy lean clay, trace concretions, dark yellowish brown with gray, mottled
3	Brown Glacial Till	lean clay, sandy lean clay, very stiff to hard
4	Gray Glacial Till	lean clay, sandy lean clay, trace gravel, gray, hard
5	Granular	poorly graded sand with silt, varying gravel content, very dense, brown and gray

A Stage 1 report was prepared earlier in 2020 for the general project area where soils consisting of silty clays, lean clays, and fat clays were anticipated. Depths to bedrock were anticipated to be as shallow as 15 feet below existing site grades. Our recent subsurface exploration generally encountered soil conditions that were consistent with those anticipated during the Stage 1 study; however, bedrock was not encountered within our maximum exploration depths of 21.5 feet.

Groundwater Conditions

Groundwater was observed at Test Borings B-7 and B-20 during drilling activities. Groundwater was not observed at Test Boring B-6 while drilling, or for the short duration the test boring could remain open. This does not necessarily mean that Test Boring B-6 terminated above groundwater.

Due to the low permeability of the soils encountered in the test borings, a relatively long period may be necessary for a groundwater level to develop and stabilize in a borehole. Long term observations in piezometers or observation wells sealed from the influence of surface water are often required to define groundwater levels in materials of this type.

The soil color can also be an indicator of a long-term static water level. Gray soils are typically encountered at elevations below the static water level. The presence of water within the soil voids prevents air/oxygen infiltration and limits the oxidation process of the iron contained in the clay minerology. Brown soils are typically encountered above the static long-term water level where oxygen has infiltrated the soil voids allowing for oxidation of the iron contained in the clay minerology. The transition from brown to gray soil typically occurred at all test borings at depths ranging between about 8.5 feet and 18.5 feet below existing grades.

It is common in glacial till soils to have seams, layers or pockets of silt, sand or gravel sandwiched between the lower permeability silty clay or lean clay soils. Oftentimes the silt, sand or gravel seams, layers or pockets are saturated and can sometimes be under pressure, as indicated by the ground water levels rising in 3 of the recent and archive test borings with time. The aerial extent of the water-bearing seams, layers and pockets can vary, and the higher permeability seams, layers and pockets can be connected or disconnected hydraulically.

It is also common to encounter perched water at the soil/bedrock interface or within seams and fractures within shale and limestone bedrock. Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the test borings were performed. Water levels in the White Oak Creek, ½ mile from the east border of the project, are expected to impact the groundwater levels at eastern locations within the project area. Therefore, groundwater levels during construction or at other times in the life of the structures may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

CORROSIVITY

The table below lists the results of laboratory soluble sulfate, soluble chloride, electrical resistivity, and pH testing. 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.

Laboratory testing to evaluate soil corrosivity were performed on 2 select near-surface bulk soil samples obtained from the test borings for the addition. The corrosivity test suite results, summarized below, included water soluble sulfate, soluble sulfide, soluble chloride, electrical resistivity (Miller soil box), Redox potential and pH. These 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. The durability requirements for concrete should be in accordance with the provisions of the ACI Design Manual, Section 318, Chapter 4.

Corrosivity Test Results Summary									
Boring	**Sample Depth (feet)**	**Soil Description**	**pH**	**Soluble Sulfate (mg/kg)**	**Soluble Sulfide (mg/kg)**	**Soluble Chloride (mg/kg)**	**Redox (mV)**	**Total Salts (mg/kg)**	**Resistivity (ohm-cm)**
B-6	1 to 5	Lean clay	6.67	187	Nil	100	+691	584	3104
B-20	1 to 5	Lean clay	8.16	54	Nil	78	+684	909	3201

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/bedrock properties encountered at our test borings at the site and as described on the exploration logs and results, it is our professional opinion that the **Seismic Site Classification is D**. Subsurface explorations at this site were extended to a maximum depth of 21.5 feet. The site properties below the boring depths to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth.

CONTRIBUTORY RISK COMPONENTS

ITEM	DESCRIPTION
Suitability Statement	Test borings encountered up to 6 inches of a disturbed “plowzone” soil layer underlain by natural lean clay, lean clay with silt, and fat clay overlying brown to gray lean clay glacial till with occasional granular interlayers. The proposed site appears suitable for the use of driven steel W-Section steel piles for the support of the planned solar arrays.
Soil Conditions	The on-site soils typically consist of lean clays with high silt content or pockets of silt (CL), lean clays (CL), moderately plastic lean clays (CL), and fat clays (CH).
Access	Wet surface conditions, following extended periods of rainfall, or really dry conditions could create access issues for rubber tire vehicles. The surficial silty soils will likely need stabilization in order to provide access for rubber tire vehicles during wetter periods.
Grading	We anticipate minimal site grading will be required. On-site materials appear to generally be suitable for re-use as fill or backfill. We anticipated that grading will require less than 2± feet of excavation or fill placement.

ITEM	DESCRIPTION
Groundwater	At two out of the three test borings, groundwater was observed at depths ranging between about 6.5 feet and 10 feet. Due to the low permeability of the soils encountered in the test borings, a relatively long period may be necessary for a groundwater level to develop and stabilize in a borehole. The transition from brown to gray soil (typically occurring near the static water level) was encountered at all test borings at 18.5 feet, 13.5 feet, and 5 feet below existing grades at Test Borings B-6, B-7, and B-20 respectively. It is common in glacial till soils to have seams, layers or pockets of silt, sand or gravel sandwiched between the lower permeability silty clay or lean clay soils. The aerial extent of the water-bearing seams, layers and pockets can vary, and the higher permeability seams, layers and pockets can be connected or disconnected hydraulically. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.
Site Drainage	The near-surface soils are poorly-drained largely due to the relatively level and localized concave areas across the project site. The near-surface, silty clay to lean clay soils are expected to become unstable with typical earthwork and construction traffic, especially after precipitation events. Seasonally high groundwater can become trapped in the silty clay to lean clay soils, which will make earthwork difficult during the wetter seasons of the year. Effective drainage should be completed early in the construction sequence and maintained after construction to avoid potential issues with wet soils. If possible, any site grading should be performed during the warmer and drier times of the year.
Corrosion Hazard	Based on laboratory testing for electrical resistivity and chemical properties, the site soils are mildly to moderately corrosive to buried metal. The soils have a "negligible" classification for sulfate exposure according to ACI Design Manual 318, Chapter 19. The results of our laboratory testing of soil chemical properties are expected to assist a qualified engineer design corrosion protection for the production piles and other project elements.
Excavation Hazards	As a minimum, all temporary excavations should be sloped or braced as required by Occupational Health and Safety Administration (OSHA) regulations to provide stability and safe working conditions. Temporary excavations will probably be required during grading operations. The grading contractor, by his contract, is usually responsible for designing and constructing stable, temporary excavations and should shore, slope or bench the sides of the excavations as required, to maintain stability of both the excavation sides and bottom. All excavations should comply with applicable local, state and federal safety regulations, including the current OSHA Excavation and Trench Safety Standards.
Anticipated Pile Drivability	We anticipate fairly consistent conditions during pile driving based on the similar soil profiles at the boring locations.

ITEM	DESCRIPTION
General Construction Considerations	To the extent practical, earthwork should be performed during drier periods of weather (late fall to late spring) to reduce the amount of subgrade remedial measures for loose and unstable conditions beneath access roadways, equipment pads, etc. The upper loess soils generally become unstable during wet periods when they are subjected to construction traffic.

PRELIMINARY RECOMMENDATIONS FOR DRIVEN STEEL PILES

This phase of the project does not include preliminary pile load testing and our recommendations are mainly based on the results from the test borings.

We have performed preliminary geotechnical analyses for driven pile foundations to support the typical PV panel racking system. 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.** Instead, this analysis is intended to assist you in roughly evaluating construction costs and development viability for the proposed project. It should also be noted that our analyses are based on short-term conditions based on boring information. For this type of foundation system, provisions for flexible or adjustable connection between the posts and the array superstructure are recommended.

Adfreeze Stress

It is Terracon's professional opinion that the overburden soils encountered in the borings are frost susceptible. In cold weather climates, design to resist frost heave forces exerted on foundations is often the limiting factor in the foundation design. Specifically, pile lengths will need to be long enough to counteract potential heave forces in the seasonal frost zone.

As the frost penetrates deeper into the soil and the ground swells due to freezing, the ground surface will rise due to frost heaving. The upward displacement is due to freezing water contained in the soil voids along with the formation of ice lenses in the soil. The freezing material grips the steel pile and exerts an uplift force due to the adfreeze stress developed around the surface area of the pile. The amount of upward force depends on the following:

- The thickness of ice lenses formed in the seasonal frozen ground
- The bond between the steel pile surface and the frozen ground
- The surface area of the steel pile in the seasonally frozen ground

Based on our review of soil samples, we recommend an adfreeze stress of 1,500 psf be considered when determining the frost heave load on a pile. The box perimeter of the pile (two times the depth plus two times the flange width) acting over a maximum depth of about 2 feet below ground surface should be considered when determining the frost heave load on a pile.

Uplift forces will likely govern the design and length of the panel array piles; therefore, uplift will be the primary factor in foundation costs. The factor of safety against uplift should be determined based on discussions with the owner and design engineer considering the desired level or risk, construction costs, and the long-term maintenance program.

Driven Pile 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 2 feet of soil should be neglected when calculating the ultimate capacity from skin friction.

Embedment Depth (feet-bgs)	Ultimate Skin Friction (psf)	Ultimate End Bearing Pressure (ksf)
1 to 5	730	10[1]
5 to 20	1,200	21[2]

1. This value is only applicable for piles embedded at least 5 feet.
2. This value is only applicable for piles embedded at least 8 feet

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 skin friction is appropriate for uplift and compressive loading and represents ultimate values. A factor of safety of 2 should be applied to the skin friction values. The end bearing is also an ultimate value and should have a factor of safety of 3 applied for design.

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. If the piles are designed using the above parameters, settlements are not anticipated to exceed 1 inch.

Pile Lateral Resistance

The parameters in the following table can be used for a preliminary analysis of the lateral capacity of driven steel piles in support of solar panel arrays:

Depth (feet-bgs)	p-y model	Effective Unit Weight, γ'(pcf)	Undrained Cohesion (psf)	Strain Factor ε_{50} (%)	P-Multiplier
0 to 2	Stiff Clay w/o water	124	1,200	Default	0.7
2 to 5	Stiff Clay w/o water	124	1,200	Default	1.0
5 to 20	Stiff Clay w/o water[1]	125[1]	2,400	Default	1.0

1. Refer to individual boring logs for encountered groundwater levels. Use saturated unit weight of 128 pcf below groundwater levels and Stiff Clay with water p-y model below encountered groundwater levels.

The above indicated effective unit weight and effective 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 SPT results, published values, and our experience with similar soil types. Existing p-y models typically under-predict the lateral capacity of shallow driven piles in cohesive soils. Therefore, the P-multiplier is most likely higher but would need to be confirmed based on results of site-specific load test results.

PRELIMINARY RECOMMENDATIONS FOR ISOLATED SLAB FOUNDATIONS

We understand that some equipment may be supported on mat/slab foundations while other structures may be supported on shallow foundations. Stiff to very stiff lean to fat clay soils were encountered near the. Based on the anticipated types of structures and the expected magnitude of loading, surface stiff to very stiff native soils or new structural fill overlying firm native soils are considered adequate for support of the mat/slab foundations or footings. We would expect an allowable bearing capacity of 1,500 psf with total and differential settlements of about 1 inch and ½ inch, respectively, depending on minimum foundation width and embedment.

PRELIMINARY EARTHWORK RECOMMENDATIONS

The site work conditions will be largely dependent on the weather conditions and the contractor's means and methods in controlling surface drainage and protecting the subgrade. The near-surface silt, clay and sand encountered in the borings may provide relatively wet subgrade during construction. Site preparation where mat/slab foundations, footings or access roads will be installed should include clearing and grubbing, installation of a site drainage system (where necessary), subgrade preparation, proof-rolling and vibratory/machine densification as necessary. Site preparation is not necessary in the PV Array field or where inverters will be supported on driven piles except to improve site drainage where necessary.

We would expect typical earthmoving equipment (bulldozers, excavators, padded-foot and steel drum vibratory rollers) to be suitable for completion of earthwork activities on the site. The most challenging obstacle for earthwork construction will be the control of surface and groundwater, especially during the typical wet season. The site should be graded to prevent ponding of surface water. Additionally, dewatering (rim ditches, sump pumps, well points, etc.) may be needed to lower the groundwater and allow for adequate compaction in trenches.

Unpaved Access Roads

Typical unpaved access roads in the lightly-loaded array areas consisting of about 6 inches of No. 4 or No.2 crushed stone and another 3 inches of ODOT 304 crushed stone aggregate base on compacted native soil should be suitable. If a geotextile separator fabric is placed over the prepared subgrade, the unpaved lightly-loaded road section could be reduced to about 6 inches of ODOT 304 crushed stone.

Positive drainage of surface water away from access roads and drainage of the access road subgrades will aid in the long-term performance of unpaved access roads. It is recommended that the access road subgrades be sloped toward the edges of the roads to promote drainage of the access road subgrades. The road surface should also be sloped to direct water away from the access roads and to prevent ponding of surface water on the access roads. The water drained from the sloping subgrade and access roads should be collected in drainage ditches constructed along the edges of the access roads. Where access roads are constructed by cutting below existing grades, cut-off ditches should be constructed along the edges of the access roads to prevent surface water run-off from saturating the access road subgrades.

GENERAL COMMENTS

Our preliminary analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide additional design level exploration and then observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client, and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for preliminary design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

FIGURES

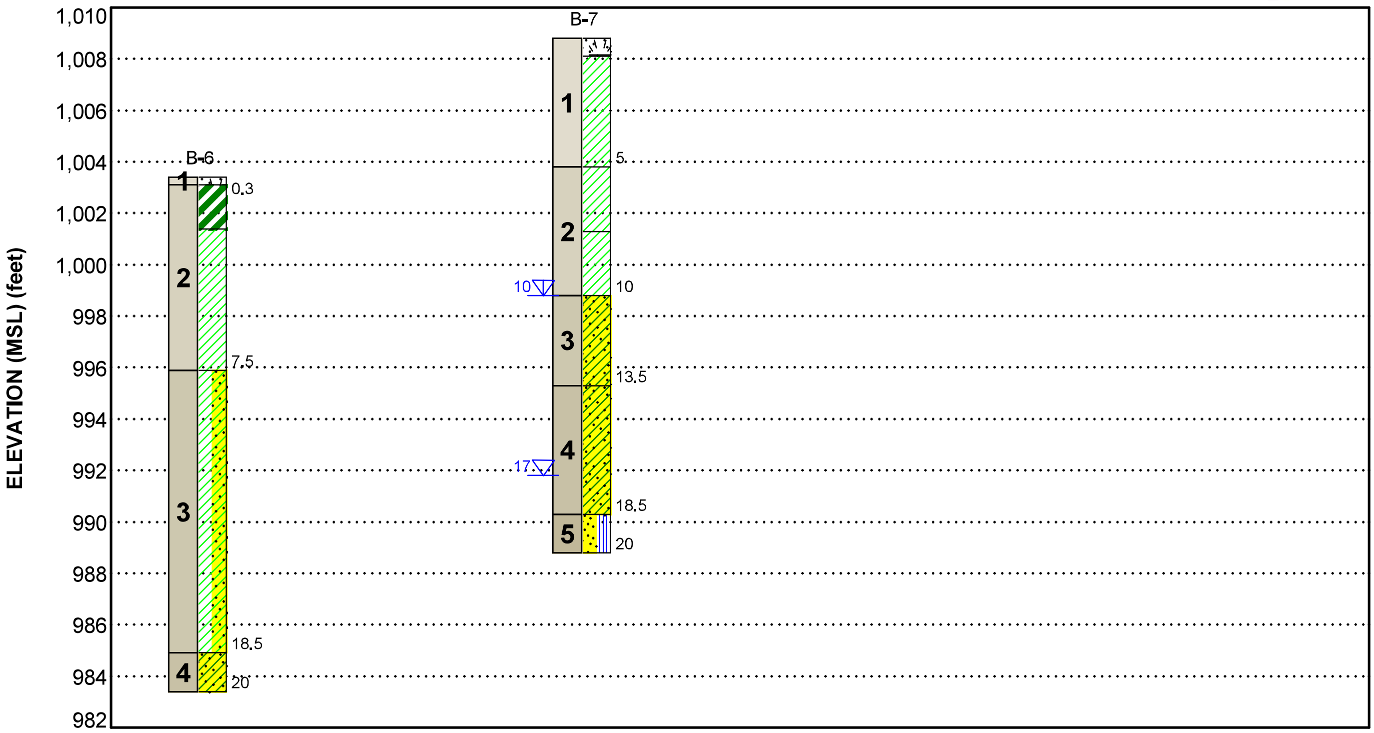
Contents:

GeoModel

GEOMODEL

Preliminary New Market Solar II - 35MW ■ Hillsboro, Highland County, OH
Terracon Project No. N1205318

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	Loess Deposits	lean clay, lean clay with silt, silty clay, light gray with reddish brown, stiff to very stiff
2	Weathered Glacial Till	lean clay, fat clay, sandy lean clay, trace concretions, dark yellowish brown with gray, mottled
3	Brown Glacial Till	lean clay, sandy lean clay, very stiff to hard
4	Gray Glacial Till	lean clay, sandy lean clay, trace gravel, gray, hard
5	Granular	Poorly graded sand with silt, varying gravel content, very dense, brown and gray

LEGEND

- Topsoil
- Fat Clay
- Lean Clay
- Lean Clay with Sand
- Sandy Lean Clay
- Poorly-graded Sand with Silt

- First Water Observation
- Second 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.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Field Exploration

Number of Borings	Boring Depth (feet)	Planned Location
2 [1]	20	PV Areas
1 [2]	21.5	PV Areas

1. Test Borings performed in 2020
2. Test Boring performed in 2018

Boring Layout and Elevations: Terracon in coordination with Hecate selected boring locations in areas accessible to our drill rig and in areas where damage to existing soybean crops would be avoided. Ground surface elevations and horizontal coordinates were determined using a Leica Zeno survey-grade GPS unit with a vertical and horizontal accuracy of about ±1 foot.

Subsurface Exploration Procedures: We advanced the borings with a track-mounted rotary drill rig using continuous-flight hollow-stem augers. Four samples were obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter. Samples were primarily obtained using the split-barrel sampling procedure whereby 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.

In addition a few relatively undisturbed thin-walled tube samples were obtained. In the thin-walled tube sampling procedure, a thin-walled, seamless steel tube with a sharp cutting edge is pushed hydraulically into the soil to obtain a relatively undisturbed sample. A grab sample was obtained in Boring B-6 between 1 to 5 feet below the existing ground surface. During the 2018 study, a grab sample was obtained in Boring B-20 between 1 to 6 feet below the existing ground surface.

We observed and recorded groundwater levels during drilling and sampling. For safety purposes, all borings were backfilled with auger cuttings and/or bentonite chips after their completion.

The sampling depths, 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.

Field (in situ) Electrical Resistivity Testing

Two field resistivity measurements, one each in the vicinity of Test Borings B-6 and B-20, were performed on September 22, 2020 and November 5, 2018, respectively, using the "Wenner Four Electrode Method" in accordance with ASTM G-57. An Advanced Geosciences, Inc. (AGI) SuperSting R8/IP DC-memory earth resistivity meter, with Serial Number SS0607179, was used for the testing program. Electrical Resistivity was performed with electrode "a" spacings of 2, 5, 10, 15, 25, 40 and 50 feet. The maximum "a" spacing for the 2018 test was 40 feet. Two perpendicular lines were collected at each location to help reduce data interference.

For this procedure, four test electrodes were driven into the ground in a straight line at equal spacings ("a"). The two "current electrodes" are placed on the outside of the electrode spread. The two inside electrodes are used to measure the resulting voltage. Electrical resistance measurements (in Ohms) are read on a resistance meter. These readings are converted to resistivity values (in Ohm-centimeters) by applying a mathematical conversion factor that incorporates the electrode spacing. To obtain readings representing various depths, the electrodes are spaced out (equidistant) and the process is repeated.

For this project, the electrodes consisted of 18-inch-long steel grounding rods as the outside and inside electrodes. Results of the field electrical resistivity testing are included in the **Exploration Results**section.

It should be noted that the resistivity values measured in the field could vary by material type, moisture content, surface temperature, ground-water depth, and other climatic conditions. Manmade cultural features can have various effects on Wenner Survey results. The presence of buried metallic objects, metal fences, and overhead powerlines can all influence the results. The testing locations may be shifted to help avoid data interference. The interference may be minor and undetectable in the data or significant influence could cause errors in the resistivity meter readings.

Underground utilities will "steal" current from the array pin, by creating a conductive current path away from the array electrodes. For example, a metallic utility could cause the measured resistance to be less than the actual resistance at that location. The amount of interference can vary depending on utility type (i.e., material and diameter).

If the utilities are not crossed at a 90-degree angle, the array should remain ½ the maximum "a" spacing away from the underground utility to minimize the effect on the test.

Overhead transmission lines similarly interfere with resistance readings due to the induction of outside current. As a rule of thumb, a minimum clearance of 100 feet is required to prevent significant interference from overhead transmission lines. If it is unavoidable and the array crosses a transmission line, it is best to cross at a 90-degree angle.

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. Procedural standards noted below are for reference to methodology in general. In some cases, variations to methods were applied because of local practice or professional judgment. Standards noted below include reference to other, related standards. Such references are not necessarily applicable to describe the specific test performed.

- ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM D422 Standard Test Method for Particle-Size Analysis of Soils
- ASTM D2166/D2166M Standard Test Method for Unconfined Compressive Strength of Cohesive Soil
- ASTM D2850 Standard Test Method for Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils
- ASTM D698-12e2 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))
- Thermal Resistivity
- Corrosivity Suite: Sulfides (AWWA 4500-S D), Soluble Sulfate (ASTM C 1580), Soluble Chloride (ASTM D 512), Red-Ox (AWWA 2580), Electrical Resistivity (ASTM G 57-Miller Soil Box), and pH Analysis (AWWA 4500 H).

The laboratory testing program often included examination of soil samples by an engineer. Based on the material's texture and plasticity, we described and classified the soil samples in accordance with the Unified Soil Classification System.

Corrosion Testing: We performed chemical testing (pH, minimum resistivity, Red-Ox potential, total salts, water soluble sulfates, chlorides, and sulfides) on two (2) bulk samples of near-surface materials from selected 2020 and 2018 borings to assist with the evaluation of corrosion to buried steel. Results of the corrosion testing are included in the **Exploration Results**section.

Thermal Resistivity Testing: Two laboratory thermal resistivity tests were performed on bulk soil samples from two selected boring locations [B-6 (2020) and B-20 (2018)]. The tested bulk samples of near-surface materials were remolded at 90% of the soil sample standard Proctor maximum dry density and were then tested for thermal resistivity. Results of the thermal resistivity testing are included in the **Exploration Results**section.

SITE LOCATION AND EXPLORATION PLANS

Contents:

Note: All attachments are one page unless noted above.

SITE LOCATION

Preliminary New Market Solar II - 35MW ■ Hillsboro, Highland County, OH

October 19, 2020 ■ Terracon Project No. N1205318

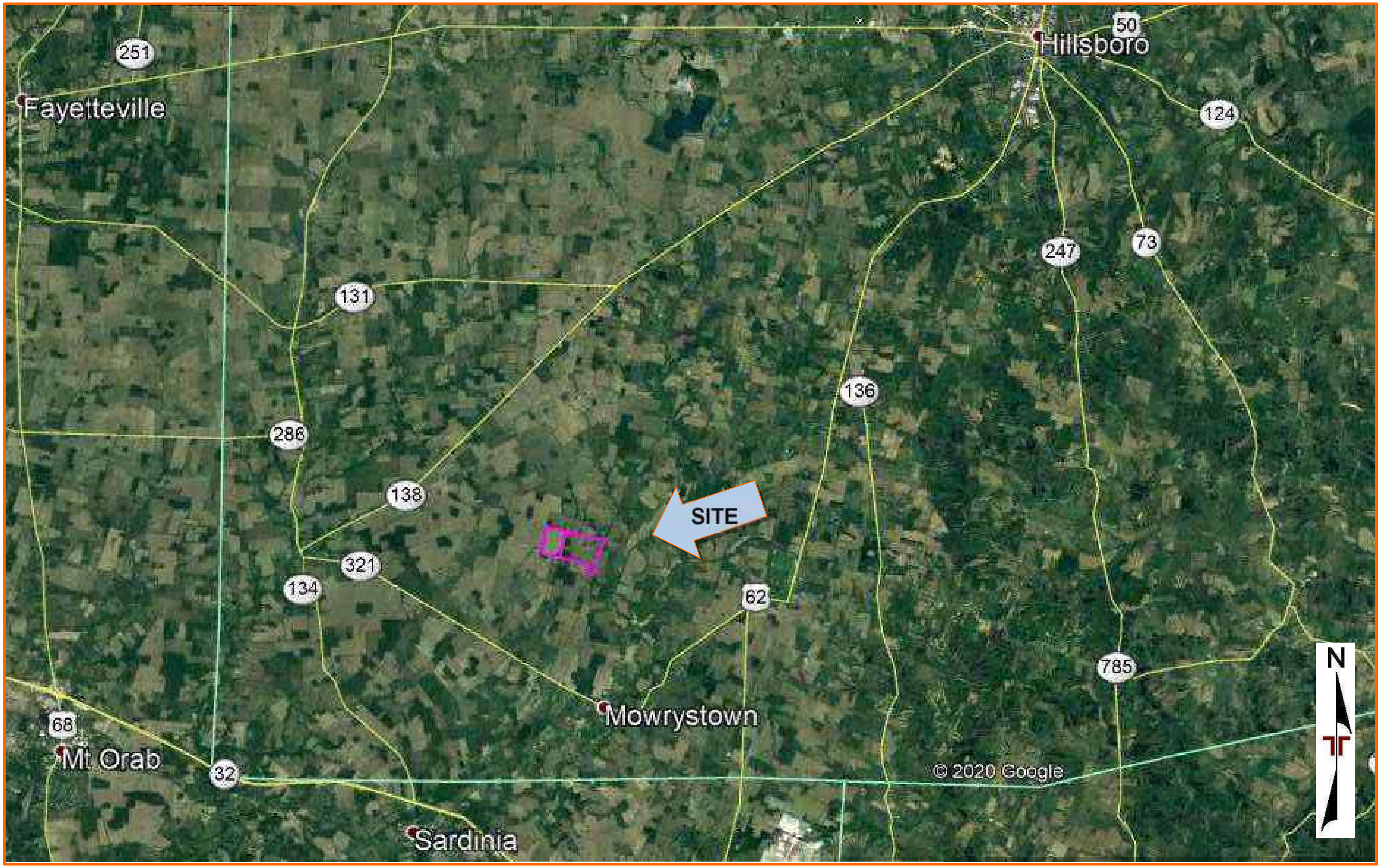


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY GOOGLE EARTH IMAGERY

EXPLORATION PLAN

Preliminary New Market Solar II - 35MW ■ Hillsboro, OH
October 19, 2020 ■ Terracon Project No. N1205318

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

EXPLORATION RESULTS

Contents:

35 MW Boring Logs (B-6 and B-7)
2018 Archive Boring Log (B-20)
Field Electrical Resistivity (2 pages)
Unconfined Compressive Strength (2 pages)
Grain Size Distribution (2 pages)
Corrosivity (2 pages)
Thermal Resistivity (4 pages)
Moisture Density Relationship (2 pages)

Note: All attachments are one page unless noted above.

BORING LOG NO. B-6

PROJECT: Preliminary New Market Solar II - 35MW

CLIENT: Hecate Energy Highland 2, LLC Chicago, IL

SITE: Stringtown Road and Edwards Road Hillsboro, Highland County, OH

LOCATION See Exploration Plan

Latitude: 39.076186° Longitude: -83.767976°

Surface Elev.: 1003.4 (Ft.)

MODEL LAYER	DEPTH	Material Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (%)	FIELD TEST RESULTS	LABORATORY HP (tsf)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
1	0.3	**AGRICULTURAL TOPSOIL (3")**	1003			Split barrel	100	4-2-4 N=6	4.0/ 2.75 (HP)	29.9	59-23-36
	2.0	**FAT CLAY (CH)**, light bluish gray with yellowish brown, stiff to very stiff	1001.5								
2		**LEAN CLAY (CL)**, moderately plastic, medium gray and dark yellowish brown with dark brown mottles, very stiff, (Weathered Glacial Till)				Thin-walled tube	38		1.25 (HP)	25.9	42-19-23
						Split barrel	100	4-4-5 N=9	2.0 (HP)	24.3	32-19-13
	7.5		996	5		Split barrel	100	4-4-5 N=9	3.25 (HP)	19.2	
3		**LEAN CLAY WITH SAND (CL)**, trace fine gravel, brown, hard, (Glacial Till)				Split barrel	100	14-19-25 N=44	4.5+ (HP)	12.8	
				10		Split barrel	100	14-18-26 N=44	4.5+ (HP)	11.1	
	18.5		985	15		Split barrel	100	25-29-38 N=67	4.5+ (HP)	11.8	
4	20.0	**SANDY LEAN CLAY (CL)**, trace gravel, gray, hard, (Glacial Till)	983.5	20		Split barrel	100	4-13-20 N=33	4.5+ (HP)	8.4	

Boring Terminated at 20 Feet

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

Hammer Type: Automatic

Advancement Method:
3.25-inch Continuous Flight Hollow-Stem Augers
2-inch Split Barrel Sampler
3-inch Thin-Walled Tube.

Abandonment Method:
Upon completion, boring backfilled with compacted auger cuttings.

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.

Elev. Ref.: Leica Zeno Survey-Grade GPS

Notes:

Tube pushed from 2 feet to 4 feet in offset hole.
Bulk bag sample collected from auger cuttings between about 2 feet to 6 feet.

WATER LEVEL OBSERVATIONS

Water not observed during drilling.

Water not observed at completion of drilling.

Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Started: 09-14-2020	Boring Completed: 09-14-2020
Drill Rig: Track D90 (#766)	Driller: A.Moore
Project No.: N1205318	

BORING LOG NO. B-7

PROJECT: Preliminary New Market Solar II - 35MW

CLIENT: Hecate Energy Highland 2, LLC Chicago, IL

SITE: Stringtown Road and Edwards Road Hillsboro, Highland County, OH

LOCATION See Exploration Plan

Latitude: 39.080948° Longitude: -83.758483°

Surface Elev.: 1008.8 (Ft.)

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (%)	FIELD TEST RESULTS	LABORATORY HP (tsf)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
1	0.7	**AGRICULTURAL TOPSOIL (8")**, trace sand, trace gravel, trace root hairs, grayish brown	1008			X	100	5-5-6 N=11	4.5/ 3.75 (HP)	20.3	
		LEAN CLAY (CL), light gray with yellowish brown, stiff to very stiff -moderately plastic at about 2.5-5 feet				X	100	2-3-5 N=8	3.5 (HP)	29.2	
2	5.0	**LEAN CLAY (CL)**, dark yellowish brown with gray, stiff to very stiff, (Weathered Glacial Till)	1004	5		X	100	3-5-6 N=11	3.0 (HP)	22.2	
	7.5	**LEAN CLAY (CL)**, trace sand, yellowish brown with brownish gray, stiff to very stiff, (Weathered Glacial Till)	1001.5			X	100	3-5-6 N=11	2.0 (HP)	20.5	
3	10.0	**SANDY LEAN CLAY (CL)**, trace gravel, brown, (Glacial Till)	999	10	▽	X	100	6-7-12 N=19	2.75 (HP)	14.2	
4	13.5	**SANDY LEAN CLAY (CL)**, trace gravel, gray, (Glacial Till)	995.5	15	▽	X	100	14-18-25 N=43	4.5+ (HP)	8.9	
5	18.5	**POORLY GRADED SAND WITH SILT (SP-SM)**, sand is fine to medium grained, gray, medium dense -clayey sand layer 3 inches thick at about 19 feet	990.5			X	100	20-17-12 N=29		19.1	
	20.0	***Boring Terminated at 20 Feet***	989	20							

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

Hammer Type: Automatic

Advancement Method:
3.25-inch Continuous Flight Hollow-Stem Augers
2-inch Split Barrel Sampler
3-inch Thin-Walled Tube.

Abandonment Method:
Upon completion, boring backfilled with compacted auger cuttings.

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.

Elev. Ref.: Leica Zeno Survey-Grade GPS

Notes:

WATER LEVEL OBSERVATIONS

▽ *Water observed at about 17 feet during drilling.*

▽ *At completion of drilling, water observed at 10 feet.*

Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Started: 09-15-2020	Boring Completed: 09-15-2020
Drill Rig: Track D90 (#766)	Driller: A.Moore
Project No.: N1205318	

BORING LOG NO. B-20

PROJECT: Preliminary Highland Solar Project

**CLIENT: Hecate Energy LLC
Chicago, IL**

**SITE: OH 138
Buford, OH**

LOCATION See Exploration Plan

Latitude: 39.07935° Longitude: -83.74919°

Surface Elev.: 977.1 (Ft.)

MODEL LAYER	DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (%)	FIELD TEST RESULTS	RQD	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
	0.3	**TOPSOIL (4 inches)**	977													
2		**LEAN CLAY (CL)**, trace fine roots, brown, stiff				Split spoon	89	5-3-4 N=7		1.5 (HP)				42		
		-- trace tree roots below 2 feet				Shelby tube	69			2.5 (HP)	UC	1.45	10.3	17	108	32-16-16 40-19-21
	5.0		972	5												
3		**LEAN CLAY (CL)**, with sand, trace gravel and rock fragments, brown with gray, hard, (GLACIAL TILL)			▽	Split spoon	78	13-36-43 N=79		4.5+ (HP)				9		
	8.5		968.5													
4		**LEAN CLAY (CL)**, with sand, trace gravel and rock fragments, gray, hard, (GLACIAL TILL)		10		Split spoon	100	10-13-14 N=27		4.5+ (HP)				9		
				15		Split spoon	100	6-10-19 N=29		4.5+ (HP)				9		
				20		Split spoon	100	10-15-26 N=41		4.5+ (HP)				9		
	21.5		955.5													

Boring Terminated at 21.5 Feet

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

Hammer Type: Automatic

Advancement Method:
3.25-inch Continuous-Flight Hollow-Stem Augers

Abandonment Method:
Boring backfilled with auger cuttings and sand 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.

Elevations were measured in the filed using Survey Grade GPS

Notes:
Grab sample 1 to 6 feet

WATER LEVEL OBSERVATIONS

▽ *Water observed at 6.5' during drilling*

No water observed after drilling

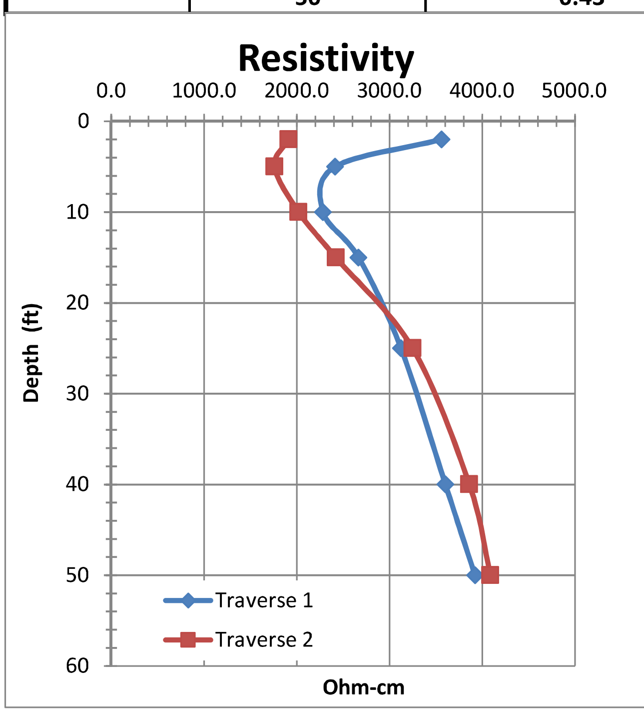
Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Started: 11-08-2018	Boring Completed: 11-08-2018
Drill Rig: D-90 Track	Driller: Meadows
Project No.: N1185370	

Project Name: New Market Solar II	**Project Number: N1205318**
Client: Hecate Energy Highland 2, LLC	**Test Date: 9-22-2020**
Conditions: 70 Sunny	**Soil Type: Clay**
Test performed by: Jared Topie, Chloe Bugni	**Test Method: Wenner Four-Electrode**
Test Instrument: AGI Supersting R8	**Serial Number: SS0607179**
Calculation: Soil resistivity (Ω-cm) = 191.5 x Probe Spacing (ft.) x R(Ω)	**In accordance with ASTM G-57**
Near Boring B-6 Transverse No. 1 _E-W_ Direction	**Transverse No. 2 _N-S_ Direction**

Testing Results

Test Location	Probe Spacing (ft.)	Meter Reading (Ω)	Calculated Soil Resistivity (Ω-cm)
1	2	9.30	3560.8
	5	2.52	2411.9
	10	1.19	2282.7
	15	0.93	2665.7
	25	0.65	3123.4
	40	0.47	3602.5
	50	0.41	3921.0
2	2	4.99	1911.2
	5	1.84	1759.9
	10	1.06	2020.3
	15	0.84	2421.5
	25	0.68	3248.8
	40	0.50	3860.6
	50	0.43	4088.5

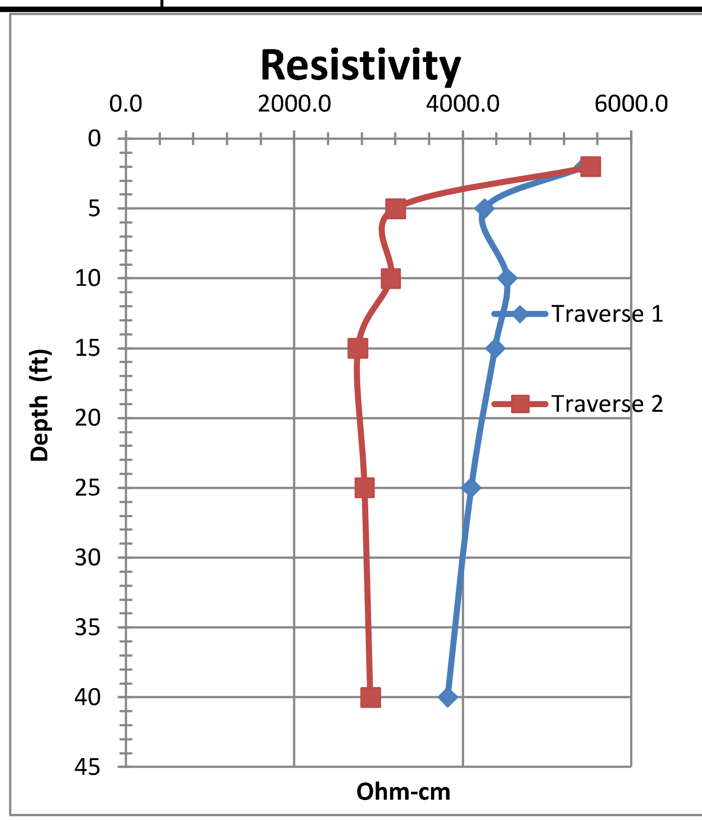


Project Name: Preliminary Highland Solar Project	Project Number: N1185370
Client:	Test Date: 11/05/18
Conditions: Sunny, 50 deg F	Soil Type: Moist, stiff, brown clay
Test performed by: Chloe Bugni & Jared Topie	Test Method: Wenner Four-Electrode
Test Instrument: AGI Supersting R8/IP	Serial Number: SS0607179
Calculation: Soil resistivity (Ω-cm) = 191.5 x Spacing (ft.) x R(Ω)	In accordance with ASTM G-57

Near borings B20 Transverse No. 1 N-S Direction Transverse No. 2 E-W Direction

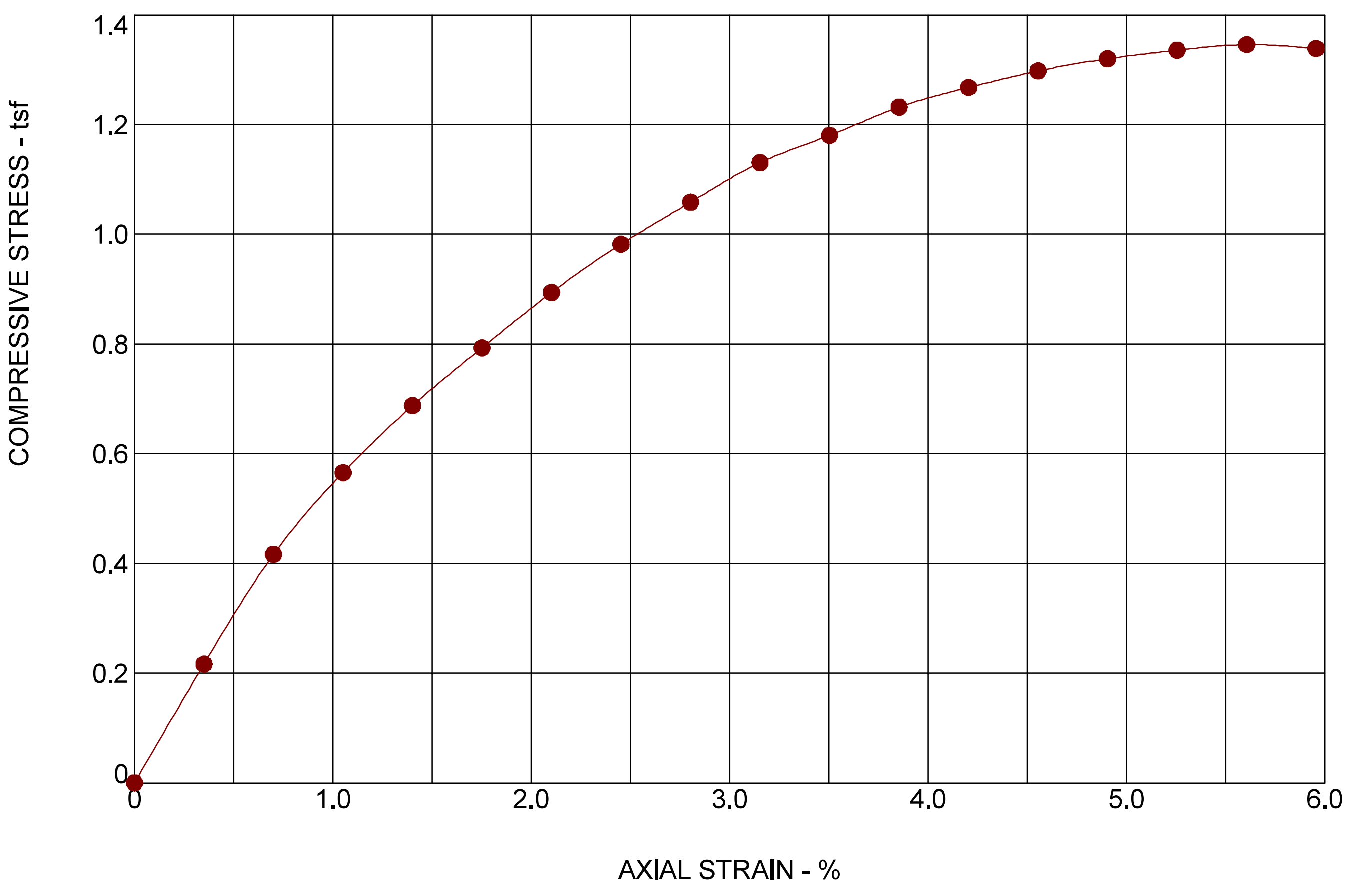
Testing Results

Test Location	Probe Spacing (ft.)	Meter Reading (Ω)	Calculated Soil Resistivity (Ω-cm)
1	2	14.21	5442.4
	5	4.45	4259.0
	10	2.37	4529.0
	15	1.53	4386.3
	25	0.86	4100.5
	40	0.50	3821.6
2	2	14.41	5519.0
	5	3.34	3199.0
	10	1.64	3146.3
	15	0.96	2755.0
	25	0.59	2832.8
	40	0.38	2903.9



UNCONFINED COMPRESSION TEST

ASTM D2166



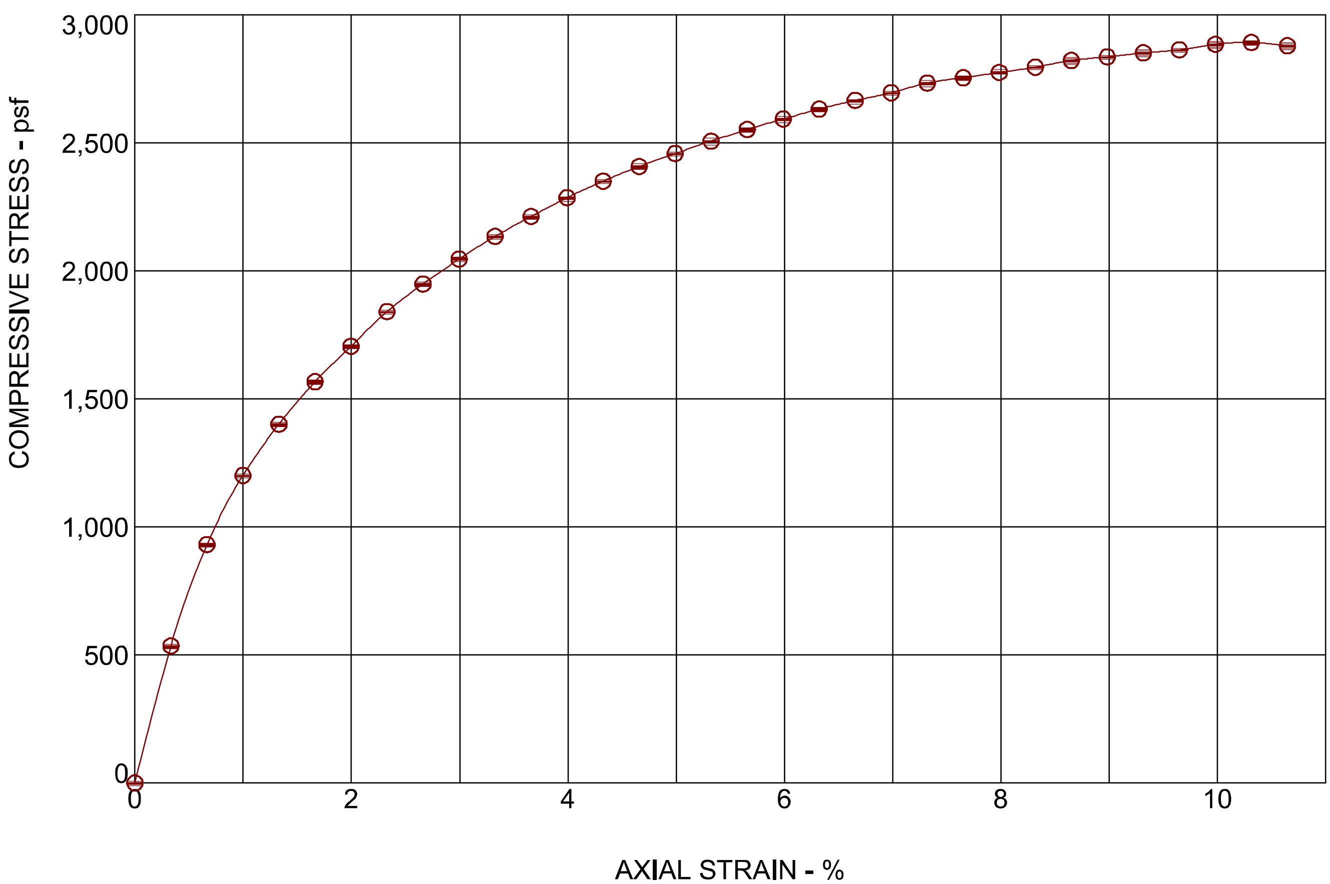
SPECIMEN FAILURE PHOTOGRAPH	SPECIMEN TEST DATA		
	Moisture Content:	%	25.9
	Dry Density:	pcf	99
	Diameter:	in.	2.84
	Height:	in.	5.71
	Height / Diameter Ratio:		2.01
	Calculated Saturation:	%	98.48
	Calculated Void Ratio:		0.71
	Assumed Specific Gravity:		2.7
	Failure Strain:	%	5.61
	Unconfined Compressive Strength	(tsf)	1.35
	Undrained Shear Strength:	(tsf)	0.67
	Strain Rate:	in/min	0.0571
	Remarks: 5919		

SAMPLE TYPE: Shelby Tube	SAMPLE LOCATION: B-6 @ 2 - 2.5 feet			
DESCRIPTION: LEAN CLAY	LL 42	PL 19	PI 23	Percent < #200 Sieve

PROJECT: Preliminary New Market Solar II - 35MW	Terracon 611 Lunken Park Dr Cincinnati, OH	PROJECT NUMBER: N1205318
SITE: Stringtown Road and Edwards Road Hillsboro, Highland County, OH		CLIENT: Hecate Energy Highland 2, LLC Chicago, IL

UNCONFINED COMPRESSION TEST

ASTM D2166



SPECIMEN FAILURE PHOTOGRAPH


SPECIMEN TEST DATA

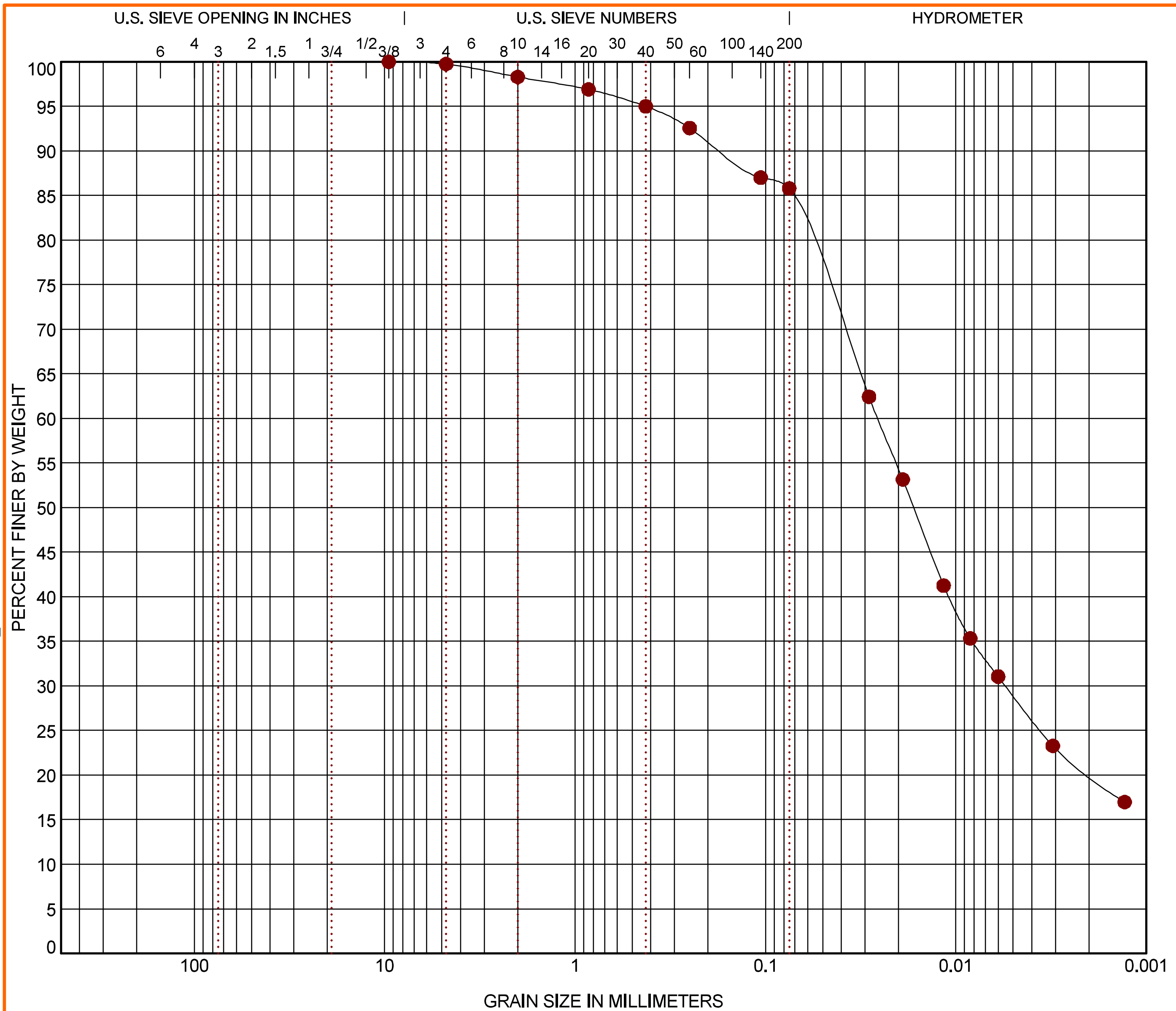
Moisture Content:	%	17
Dry Density:	pcf	108
Diameter:	in.	2.87
Height:	in.	6.01
Height / Diameter Ratio:		2.09
Calculated Saturation:	%	79.93
Calculated Void Ratio:		0.56
Assumed Specific Gravity:		2.7
Failure Strain:	%	10.31
Unconfined Compressive Strength	(psf)	2893
Undrained Shear Strength:	(psf)	1446
Strain Rate:	in/min	0.0601
Remarks: 9319		

SAMPLE TYPE: Shelby Tube	SAMPLE LOCATION:	B-20 @ 2 - 4 feet		
DESCRIPTION: BROWN LEAN CLAY WITH ORGANIC MATTER	LL	PL	PI	Percent < #200 Sieve
	32	16	16	

PROJECT: Preliminary Highland Solar Project	Terracon 611 Lunken Park Dr Cincinnati, OH	PROJECT NUMBER: N1185370
SITE: OH 138 Buford, OH		CLIENT: Hecate Energy LLC Chicago, IL

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring ID	Depth	USCS Classification	WC (%)	LL	PL	PI	Cc	Cu
●	B-6	1 - 5	LEAN CLAY (CL)		32	19	13		

	Boring ID	Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Silt	%Fines	%Clay
●	B-6	1 - 5	9.5	0.026	0.005		0.0	0.2	14.0	56.9		28.9

PROJECT: Preliminary New Market Solar II - 35MW

SITE: Stringtown Road and Edwards Road
Hillsboro, Highland County, OH

Terracon
611 Lunken Park Dr
Cincinnati, OH

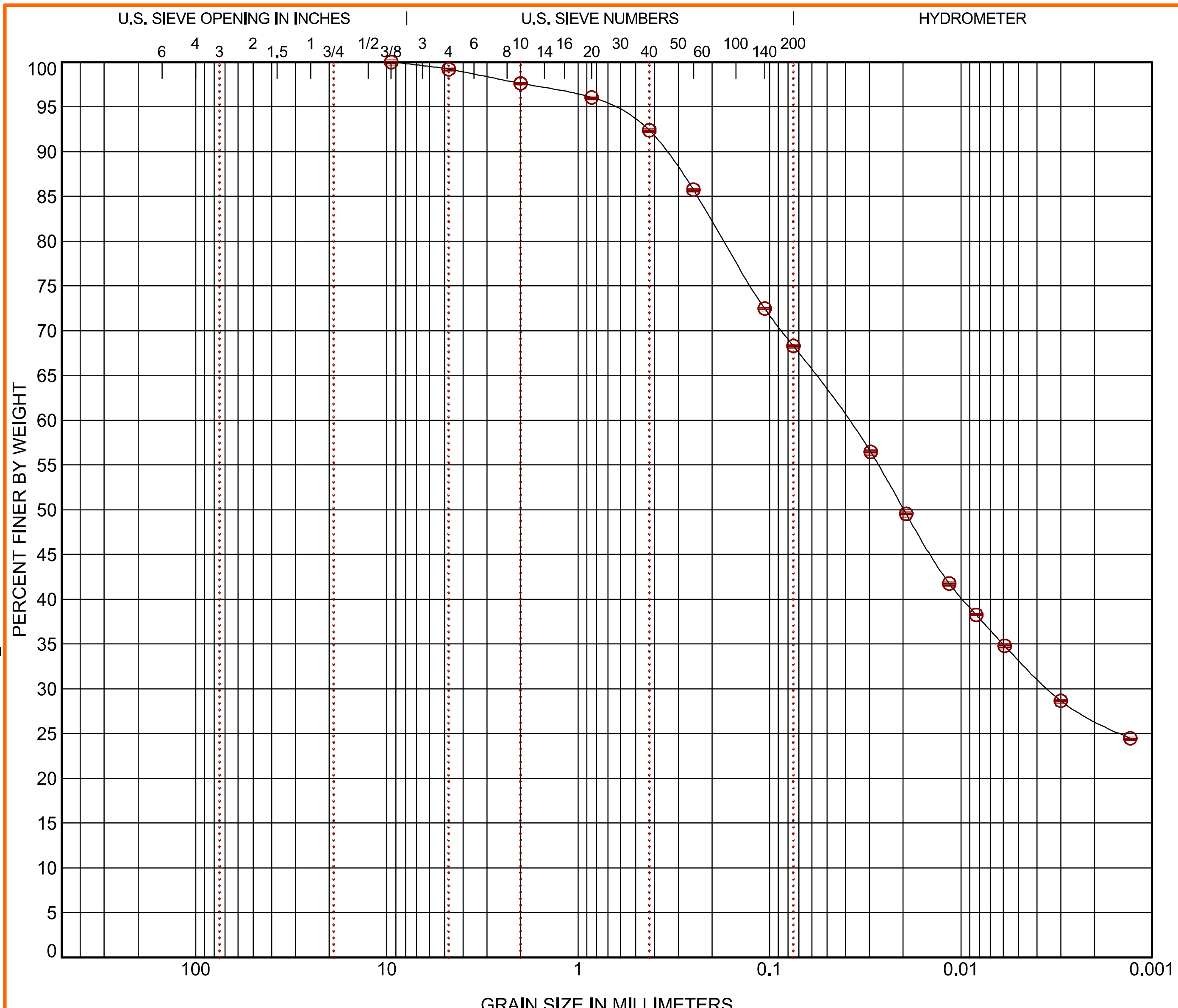
PROJECT NUMBER: N1205318

CLIENT: Hecate Energy Highland 2, LLC
Chicago, IL

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS-2 N1205318 35 MW HIGHLAND CO.GPJ TERRACON_DATATEMPLATE.GDT 10/7/20

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring ID	Depth	USCS Classification	WC (%)	LL	PL	PI	Cc	Cu
⊖	B-20	1 - 6	SANDY LEAN CLAY (CL)		40	19	21		

	Boring ID	Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Silt	%Fines	%Clay
⊖	B-20	1 - 6	9.5	0.039	0.003		0.8	30.9	35.0		33.3

PROJECT: Preliminary Highland Solar Project

SITE: OH 138
Buford, OH

Terracon
611 Lunken Park Dr
Cincinnati, OH

PROJECT NUMBER: N1185370

CLIENT: Hecate Energy LLC
Chicago, IL

750 Pilot Road, Suite F
Las Vegas, Nevada 89119
(702) 597-9393

Terracon GeoReport

Client

Hecate Energy Highland 2, LLC

Project

New Market Solar II - 35MW

Sample Submitted By: Terracon (N1) **Date Received:** 9/23/2020 **Lab No.: 20-1057**

Results of Corrosion Analysis

Lab Number	5858
Sample Location	B-6
Sample Depth (ft.)	1- 5
pH Analysis, ASTM G 51	6.67
Water Soluble Sulfate (SO4), ASTM C 1580 (mg/kg)	187
Sulfides, AWWA 4500-S D, (mg/kg)	Nil
Chlorides, ASTM D 512, (mg/kg)	100
Red-Ox, ASTM G 200, (mV)	+691
Total Salts, AWWA 2540, (mg/kg)	584
Resistivity (Saturated), ASTM G 57, (ohm-cm)	3104

Analyzed By:

Trisha Campo
Chemist

CHEMICAL LABORATORY TEST REPORT

Project Number: N1185370
Service Date: 11/20/18
Report Date: 11/30/18
Task:

Terracon
750 Pilot Road, Suite F
Las Vegas, Nevada 89119
(702) 597-9393

Client

Hecate Energy LLC
Chicago, IL

Project

Preliminary Highland Solar Project

Sample Submitted By: Terracon (N1) **Date Received:** 11/16/2018 **Lab No.: 18-1399**

Results of Corrosion Analysis

Lab Number	9327
Sample Number	B-1
Sample Location	B-20
Sample Depth (ft.)	1-5
pH Analysis, AWWA 4500 H	8.16
Water Soluble Sulfate (SO4), ASTM C 1580 (mg/kg)	54
Sulfides, AWWA 4500-S D, (mg/kg)	Nil
Chlorides, ASTM D 512, (mg/kg)	78
Red-Ox, AWWA 2580, (mV)	+684
Total Salts, AWWA 2520 B, (mg/kg)	909
Resistivity, ASTM G 57, (ohm-cm)	3201

Analyzed By: Trisha Campo

Trisha Campo
Chemist

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

October 2, 2020

Terracon Consultants, Inc.
611 Lunken Park Drive
Cincinnati, OH 45226
Attn: Tim Goodall

Re: Thermal Analysis of Native Soil Sample
New Market Solar II 35mW Project – Highland County, OH (Project No. N1205318)

The following is the report of thermal dryout characterization tests conducted on the sample of native soil from the referenced project sent to our laboratory.

Thermal Resistivity Tests: The sample was compacted at the 'optimum' moisture content and at 90% of the maximum 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 dry out curve is presented in **Figure 1.**

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

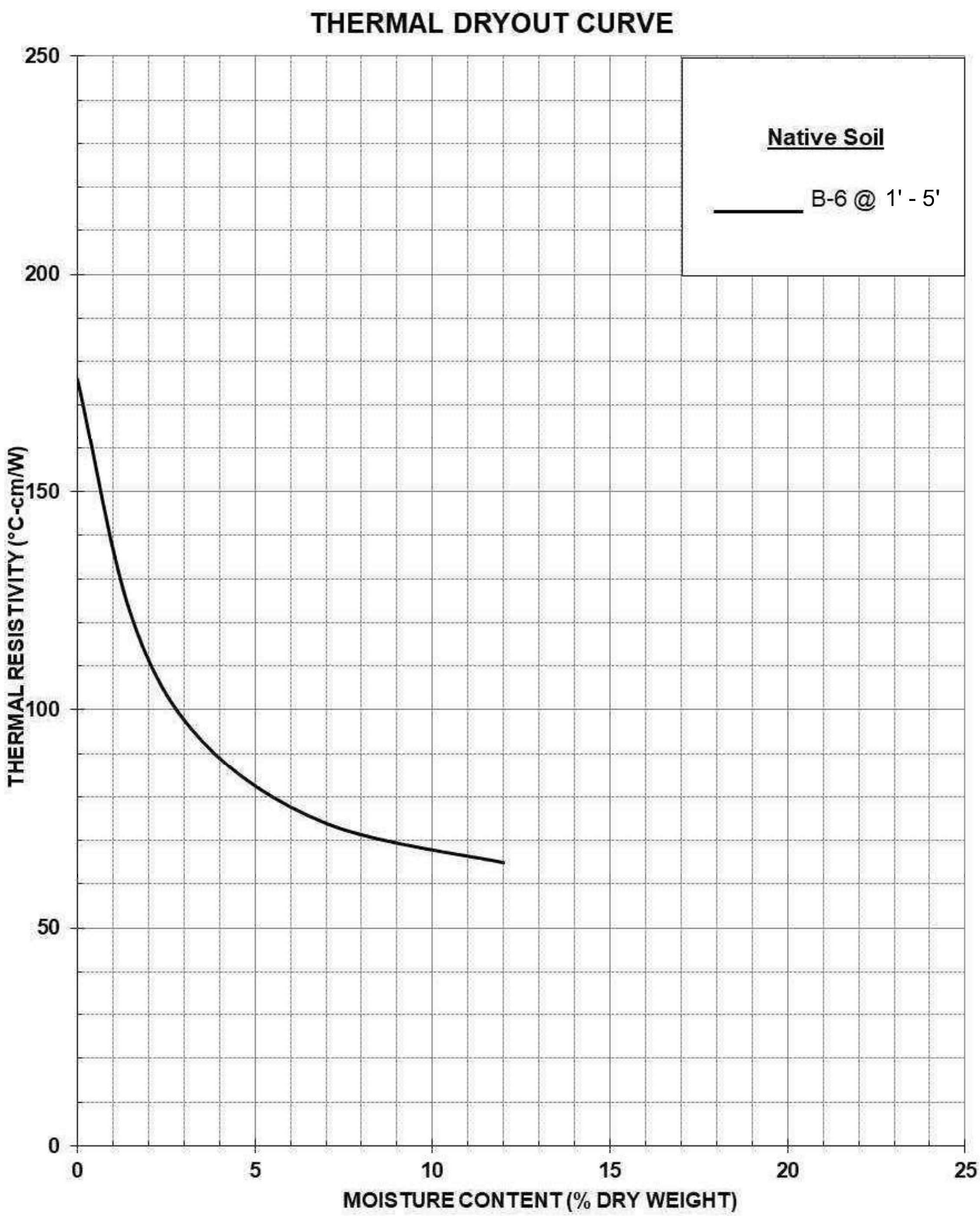
Sample ID @ 1' –5 '	Description (Terracon)	Thermal Resistivity (°C-cm/W)		Moisture Content (%)	Dry Density (lb/ft^3)
		Wet	Dry		
B-6	Brown Lean Clay	65	176	15	99

Comments: The thermal characteristic depicted in the dryout curve applies for the soil at the test dry density.

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

Geotherm USA

Nimesh Patel



Terracon Consultants (Project No. N1205318)

Thermal Analysis of Native Soil

New Market Solar II 35mW Project – Highland County, OH

October 2020 **Figure 1**

4370 Contractors Common
Livermore, CA 94551
Tel: 925-999-9232
Fax: 925-999-8837
info@geothermusa.com

December 4, 2018

Terracon Consultants, Inc.
611 Lunken Park Drive
Cincinnati, Ohio 45226
Attn: Jeffrey Dunlap, P.E.

Re: Thermal Analysis of Native Soil Samples
Highland Solar – Buford, OH (Project N1185370)

The following is the report of thermal dryout characterization tests conducted on three (3) bulk samples of native soil sent to our laboratory.

Thermal Resistivity Tests: Per your instructions, the samples were tested at '2% or 4% below optimum' moisture content and 90% of the maximum dry density ***provided by Terracon.*** A series of thermal resistivity measurements were made in stages with moisture content ranging from 'wet' to the totally dry condition. 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 **Figure 1.**

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

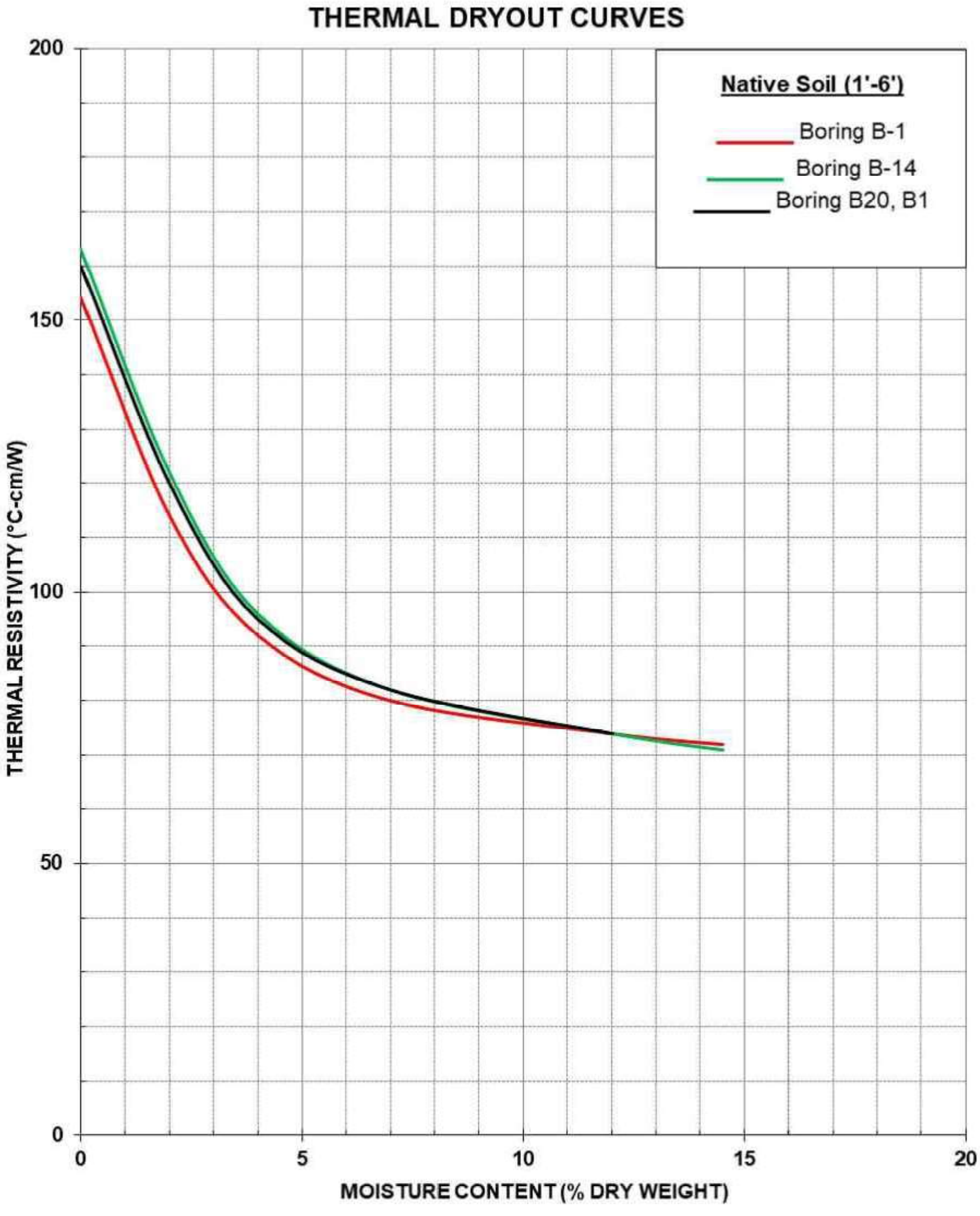
Sample ID @ 1' –6 '	Description (Terracon)	Thermal Resistivity (°C-cm/W)		Moisture Content (%)	Dry Density (lb/ft^3)
		Wet	Dry		
Boring B-1	Brown Lean Clay	72	154	14	101
Boring B-14	Lean Clay	71	163	15	98
Boring B20, B1	Brown Lean Clay	74	160	12	101

Comments: The thermal characteristic depicted in the dryout curves apply for the soils at their respective test dry density.

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

Geotherm USA

Nimesh Patel



Terracon Consultants

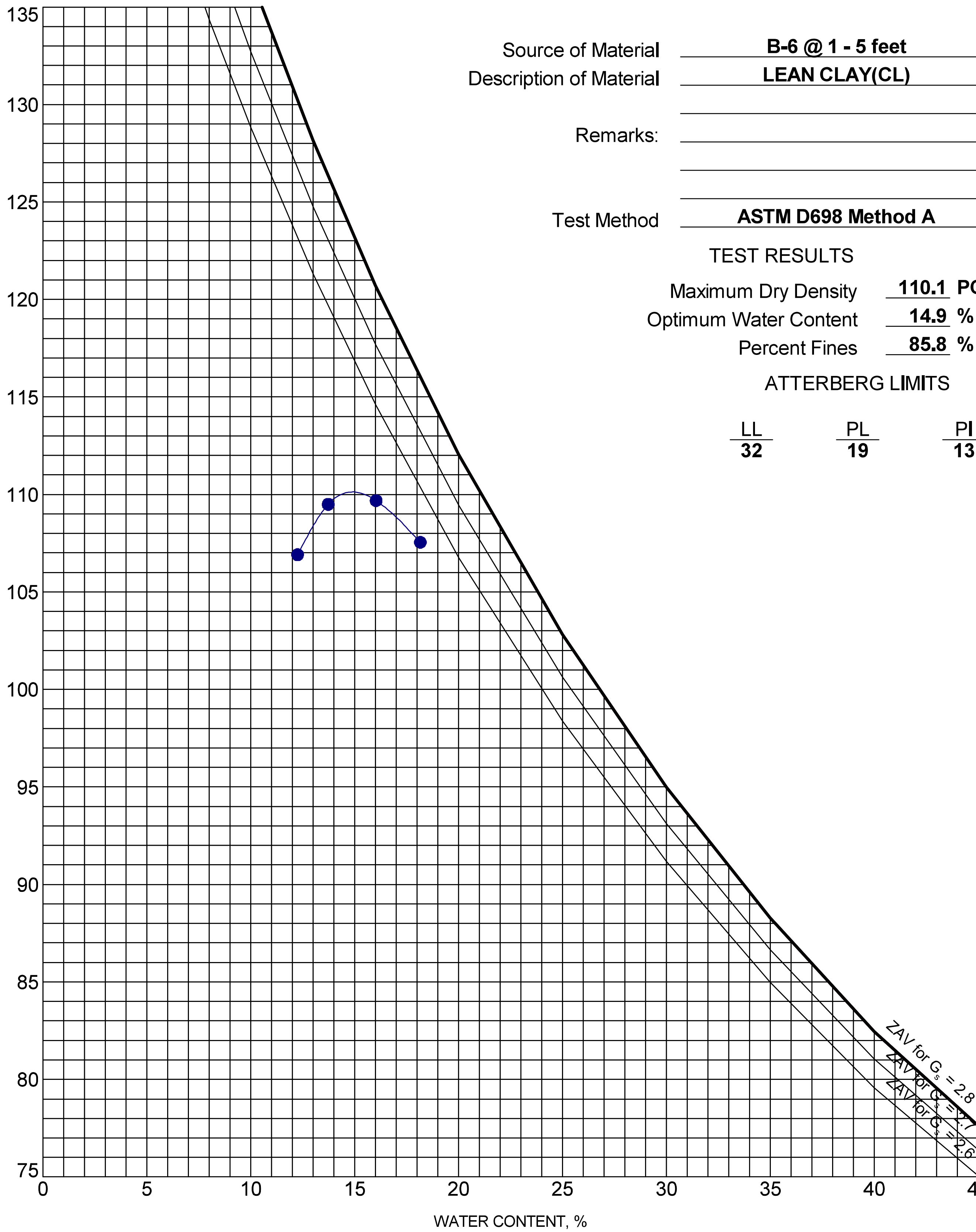
Thermal Analysis of Native Soil Samples

Highland Solar – Buford, OH (Project N1185370)

December 2018 **Figure 1**

MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557



Source of Material	**B-6 @ 1 - 5 feet**
Description of Material	**LEAN CLAY(CL)**
Remarks:	
Test Method	**ASTM D698 Method A**

TEST RESULTS

Maximum Dry Density	**110.1**	**PCF**
Optimum Water Content	**14.9**	**%**
Percent Fines	**85.8**	**%**

ATTERBERG LIMITS

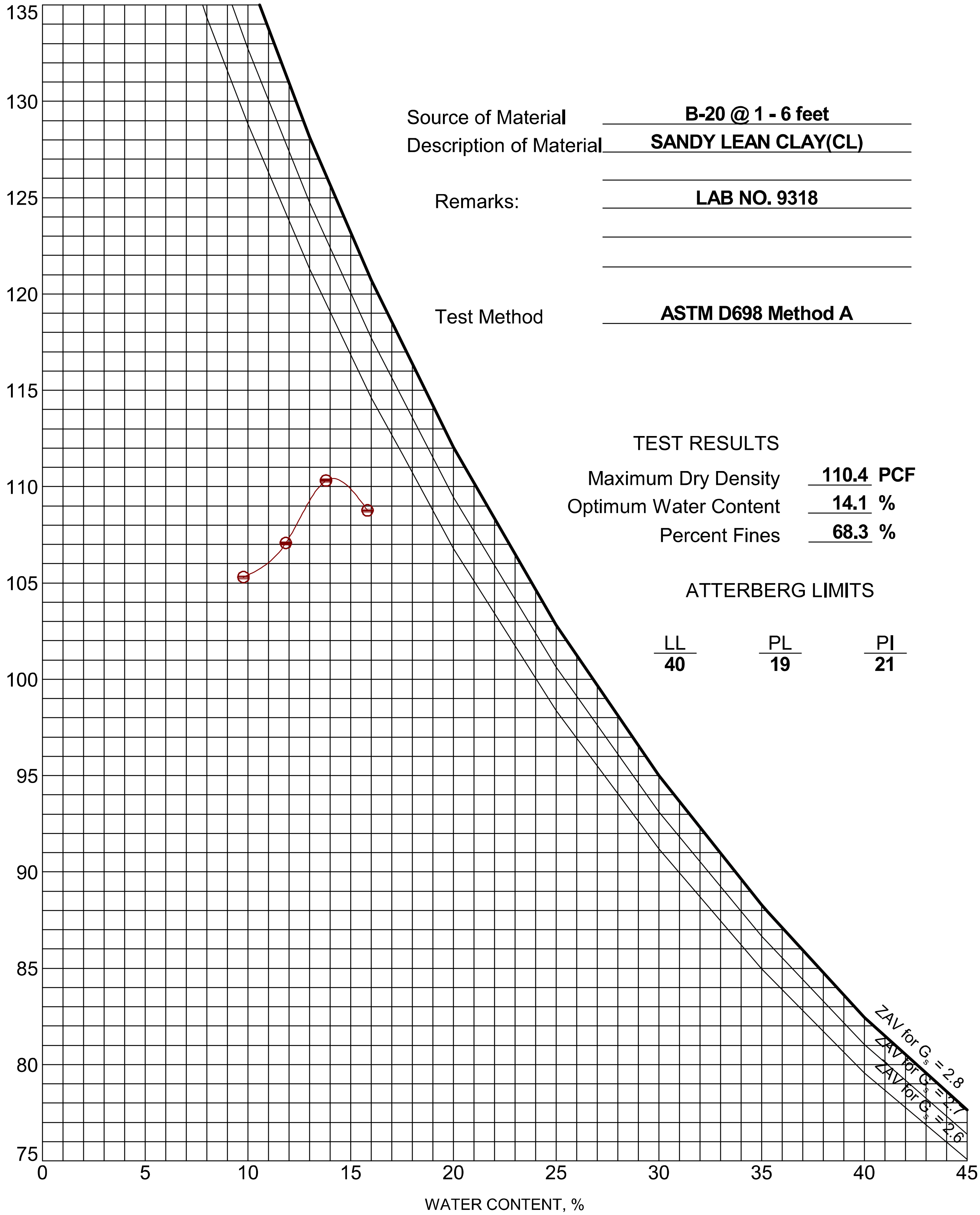
LL	PL	PI
32	**19**	**13**

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. COMPACTION - V2 N1205318 35 MW HIGHLAND CO.GPJ TERRACON_DATATEMPLATE.GDT 10/7/20

PROJECT: Preliminary New Market Solar II - 35MW	Terracon 611 Lunken Park Dr Cincinnati, OH	PROJECT NUMBER: N1205318
SITE: Stringtown Road and Edwards Road Hillsboro, Highland County, OH		CLIENT: Hecate Energy Highland 2, LLC Chicago, IL

MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557



Source of Material: **B-20 @ 1 - 6 feet**

Description of Material: **SANDY LEAN CLAY(CL)**

Remarks: **LAB NO. 9318**

Test Method: **ASTM D698 Method A**

TEST RESULTS

Maximum Dry Density **110.4 PCF**

Optimum Water Content **14.1 %**

Percent Fines **68.3 %**

ATTERBERG LIMITS

LL	PL	PI
40	**19**	**21**

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. COMPACTION - V2 N1185370 PRELIMINARY HIGHL.GPJ TERRACON_DATATEMPLATE.GDT 11/21/18

PROJECT: Preliminary Highland Solar Project	Terracon 611 Lunken Park Dr Cincinnati, OH	PROJECT NUMBER: N1185370
SITE: OH 138 Buford, OH		CLIENT: Hecate Energy LLC Chicago, IL

SUPPORTING INFORMATION

Contents:

Note: All attachments are one page unless noted above.

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

Preliminary New Market Solar II - 35MW ■ Hillsboro, Highland County, OH

Terracon Project No. N1205318

Terracon GeoReport

SAMPLING

Shelby Tube

Standard Penetration Test

WATER LEVEL

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.

FIELD TESTS

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

Terracon GeoReport

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]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [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]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [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	<0.75	OL	Organic clay [K, L, M, N]
			Liquid limit - not dried			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	<0.75	OH	Organic clay [K, L, M, P]
			Liquid limit - not dried			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 $\geq$ 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 $\geq$ 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 $\geq$ 30% plus No. 200 predominantly sand, add "sandy" to group name.

[M] If soil contains $\geq$ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] $PI \geq 4$ 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.