Report of Expected Geotechnical Conditions

Mohawk Solar
Marshville, Montgomery County, New York

April 10, 2019
Terracon Project No. J5185006

(Image above downloaded from https://communityenergysolar.com/mohawk-solar/ in November 2018)

Prepared for:
Avangrid Renewables
Portland, Oregon

Prepared by:
Terracon Consultants-NY, Inc.
Rochester, NY

April 10, 2019

Avangrid Renewables
1125 NW Couch Street
Portland, Oregon 97209

Attn: Mr. Mark Mullen
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E: mark.mullen@avangrid.com

Re: Report of Expected Geotechnical Conditions
Mohawk Solar Project
Marshville Road and Clinton Road, Marshville, New York
Terracon Project No. J5185006

Dear Mr. Mullen:

We are pleased to present this Report of Expected Geotechnical Conditions for the project referenced above. This report includes:

Exhibit 21	1001.21 Exhibit 21 (Terracon response for applicable requirements)
Table 21-1	SSURGO Database Summary
Exhibits	Exhibit A through H
Appendix A	Preliminary Geotechnical Engineering Report

This report references a web-based, GIS portal that has been developed specifically for this project using Terracon's proprietary GIS platform providing you with dynamic access to the information complied for this project. Access to this information can be gained by using this link: https://portal.gis.terracon.com/Login/?project=Avangrid_J5175143

If you have questions, or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants-NY, Inc.

Michele A. Fiorillo, P.E.
Geotechnical Department Manager

Lawrence J. Dwyer
Principal

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Exhibits:

EXHIBIT 21 – GEOLOGY, SEISMOLOGY, AND SOILS

(a) Existing Slopes Map

See Exhibit E for a map delineating existing slopes in degrees (0-2, 2-5, 5-10, 10-15, 15-21, 21-31, and 31-90) on and within the drainage area potentially influenced by the new solar project. This information is derived from digital elevation models (DEM) produced by the U.S. Geological Survey (USGS) and the New York State Department of Environmental Conservation (NYSDEC). According to this source, slopes within the site are generally less than 5 degrees; some isolated areas present slopes in the range of 5 to 15 degrees.

(b) Proposed Site Plan

Not included in our scope of services. To be provided by others.

(c) Cut and Fill

Not included in our scope of services. To be provided by others.

(d) Fill, Gravel, Asphalt, and Surface Treatment Material

Not included in our scope of services. To be provided by others.

(e) Type and Amount of Cut Materials or Spoil to be Removed from the Facility and Interconnection Sites

Not included in our scope of services. To be provided by others.

(f) Excavation Techniques to be Employed

Not included in our scope of services. To be provided by others.

(g) Temporary Cut and Fill Storage Areas

Not included in our scope of services. To be provided by others.

(h) Suitability of Soils and Excavated Materials for Construction Purposes

Terracon-NY, Inc. (Terracon) conducted a Preliminary Geotechnical Investigation, which included widely spaced test borings, to evaluate the surface and subsurface soils, bedrock, and groundwater conditions within the project site (herein after referred to as the Site). As part of this evaluation, we conducted a literature review of publicly available data and made site visits to observe surficial features. Based on Terracon's findings, the subsurface materials that would be encountered within the Site are suitable for construction of the proposed structures.

Surficial Soils

Glacial-drift deposits of Pleistocene age blanket bedrock over much of the region. Some surficial materials formed because of deposition from glacial meltwater, such as kame deposits and sand and gravel outwash. Accumulations of outwash deposits occur along Otsquago Creek and its tributaries. Kame deposits occur along the Mohawk valley near Mindenville, Sand Hill, and Fort Plain. Kame moraine deposits are highly variable, composed of sand and gravel beds with boulders and lenses of silt and clay. These deposits mark the former position of a glacial ice margin. As the glacial ice receded, a glacial lake formed in the Mohawk Valley and extended into the Otsquago Creek Valley. Silt and clay sediments were deposited into this lake, eventually covering existing till deposits to depths of up to 20 feet. In some locations, meltwater streams built small outwash deltas into this lake. After deglaciation, modern-day drainage patterns developed. Alluvium, consisting of sand, gravel, and silt formed along floodplains. Some of these floodplains were above present-day levels. This is evident along the Mohawk River. Alluvial fans formed at the mouths of some upland streams. These consist of silt, sand, and boulders that accumulate in fan shaped landforms.

Surficial soils may broadly be divided into two main deposits:

- **Stratified Deposits**: Stratified deposits of ice-contact and non-ice-contact fluvial, deltaic, and lacustrine origin that are present largely within valleys, which generally consist of:
    - **Assorted fine-grained deposits:** Materials transported by water and deposited in a quiet environment, generally in glacial lakes. Some deposits are floodplain deposits from slack-water environments. Distinct layers of laminations, generally of silt- and clay-sized particles, occur. Although most of these deposits are silty, there is generally enough clay to make them plastic and sticky. Soils that formed in deep, lake-laid silt and clay deposits are those of the Fonda, Hudson, Madalin, and Rhinebeck series. The Raynham, Scio, and Unadilla series are silty, lake-laid soils; Hamlin, Teel, and Wayland soils are alluvial in origin. Unadilla soils are generally underlain by deposits of sand and gravel at a depth of 50 inches. Because of their fine texture, these deposits have relatively low- strengths.
    - **Assorted coarse-grained deposits**: Materials sorted by water into layered or stratified deposits, dominantly of gravel and sand, are included in this category. They occupy such geologic landforms as outwash terraces; ice-contact deposits; and coarse parts of deltas, dunes, flood plains, and alluvial fans. The strata within these deposits may be “well sorted” or "poorly sorted”, and particle sizes range from cobbles to silt. Fredon, Herkimer, Howard, Palmyra, and Phelps soils formed in the gravelly deposits of outwash, ice-contact, or alluvial fan origin. Coarse-grained deposits generally have relatively high strengths and low settlement characteristics. However, where vibratory loads are applied to the soil, particle rearrangement causes settlement. Because of their loose and porous nature, most of these deposits are not highly erodible.

- **Glacial Till (Till):** Unsorted mixture of sediments deposited directly by glacial ice are included in this category. Glacial till deposits are highly variable mixtures of all soil particle sizes ranging from boulder to silt/clay. As a rule, no sorting has occurred, although isolated pockets of sorted material may exist. These soils are derived from local sources and, in general, reflect the properties of the underlying bedrock. Bedrock is usually more than 40 inches beneath the surface, but some shallow rock or outcrop may occur. Soils formed in unsorted, heterogeneous glacial till deposits are those of the Appleton, Burdett, Darien, Ilion, Lansing, Manheim, Mardin, Mohawk, and Nunda series. Churchville soils formed in fine-grained, assorted material underlain by glacial till at depths of 20 to 36 inches. Soils that formed in glacial till are the most dense and compact of the unconsolidated materials of the area, because most of the till deposits have been subjected to the compactive weight of overriding ice. These soils provide stable, relatively incompressible foundations for engineering works. When properly compacted, fill material from these soils provides stable embankments.

Terracon reviewed available soil resource data from the United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) Web Soil Survey (SSURGO) to identify the major soil units present within the Site. Refer to Item (p) - **Characteristics of Each Soil Type and Suitability for Construction** for more details. The published available geological and soil information published data include georeferenced digital map data and computerized attribute data from a century's worth of soil surveys throughout the United States. However, not all areas have been field-verified. Some discrepancy with actual field and laboratory data obtained from soil samples recovered from the borings completed at the Facility Site should be anticipated as a possible lack of field verification of published geologic and SSURGO data in this region of New York State. The boring logs within the Preliminary Geotechnical Study accurately display the measurements of depth to bedrock and depth to the water table at the locations where the borings took place.

Table 1 lists the main soil units (greater than 1 percent present within the Site), their parent materials, soil classification by the Unified Classification System (UCS), depth to bedrock and seasonal minimum water table, risk of soil corrosion (express as "low", "moderate" or "high"), and frost and shrink-swell potential (express as "low", "moderate" or "high"). Refer to **Table 21-1**: SSURGO Database Summary presented at the end of this document for more detailed information's.

Table 1. Dominant Soil Series within the Facility Site

Map Symbol	Map Unit Name	Parent Material	UCS	Minimum Bedrock Depth	Seasonal Minimum Water Table Depth	Potential for Corrosion of		Organic Matter	Frost Action Potential	Shrink-Swell Potential	Site
					(inches)	Concrete	Steel	%			%
DaB	Darien silt loam, 3 to 8 percent slopes	Till	ML	No bedrock identified	7	Low	High	5.5	High	Low	20.2
ApB	Appleton silt loam, 3 to 8 percent slopes	Till	ML	No bedrock identified	11	Low	High	5.1	High	Low	13.0
LaC	Lansing silt loam, 8 to 15 percent slopes	Till	ML	No bedrock identified	0	Low	Low	3.1	Moderate	Low	8.6
Ma	Madalin silty clay loam	Glacio-lacustrine deposits	MH	No bedrock identified	0	Low	High	8.1	High	Moderate	7.3
LaB	Lansing silt loam, 3 to 8 percent slopes	Till	ML	No bedrock identified	0	Low	Low	3.1	Moderate	Low	4.7
IlB	Ilion silt loam, 3 to 8 percent slopes	Till	ML	No bedrock identified	0	Low	High	5.5	High	Low	4.6
IlA	Ilion silt loam, 0 to 3 percent slopes	Till	ML	No bedrock identified	0	Low	High	5.5	High	Low	4.5
HoB	Hornell silt loam, 3 to 8 percent slopes	Till	ML	2 to 3 feet	8	High	High	4	High	Moderate	4.4
BuB	Burdett channery silt loam, 3 to 8 percent slopes	Till	ML	No bedrock identified	9	Low	High	4.5	High	Low	3.7
Fo	Fonda mucky silty clay loam	Glacio-lacustrine deposits	PT	No bedrock identified	0	Low	High	75	High	Moderate	3.7
LaD	Lansing silt loam, 15 to 25 percent slopes	Till	ML	No bedrock identified	0	Low	Low	3.1	Moderate	Low	3.4
ChB	Churchville silty clay loam, 3 to 8 percent slopes	Glacio-lacustrine deposits	ML	No bedrock identified	7	Low	High	4	High	Low	2.3

Table 1. Dominant Soil Series within the Facility Site											
Map Symbol	Map Unit Name	Parent Material	UCS	Minimum Bedrock Depth	Seasonal Minimum Water Table Depth	Potential for Corrosion of		Organic Matter	Frost Action Potential	Shrink-Swell Potential	Site
					(inches)	Concrete	Steel	%			%
BuC	Burdett channery silt loam, 8 to 15 percent slopes	Till	ML	No bedrock identified	9	Low	High	4.5	High	Low	2.2
FL	Fluvaquents, loamy	Alluvium	SC	No bedrock identified	6	High	High	2.5	High	Low	1.9
RhA	Rhinebeck silty clay loam, 0 to 3 percent slopes	Glacio-lacustrine deposits	CH	No bedrock identified	7	Low	High	5	High	Moderate	1.9
AnB	Angola silt loam, 3 to 8 percent slopes	Till	CL	2 to 3 feet	9	Low	High	4.5	High	Low	1.8
RhB	Rhinebeck silty clay loam, 3 to 8 percent slopes	Glacio-lacustrine deposits	CH	No bedrock identified	7	Low	High	5	High	Moderate	1.4
PaC	Palatine silt loam, 8 to 15 percent slopes	Till	ML	2 to 3 feet	0	Low	Low	6	Moderate	Low	1.4

Notes:
UCS – Unified Classification System
Minimum Bedrock Depth – If no bedrock layer is described in a map, it is represented by the "No bedrock identified" depth class
Organic Matter - Organic matter percent is the weight of decomposed plant, animal, and microbial residues exclusive of non-decomposed plant and animal residues. Weighted Average.
Seasonal Minimum Water Table Depth - The shallowest depth to a wet soil layer (water table) during the months of April through June expressed in centimeters from the soil surface for components whose composition in the map unit is equal to or exceeds 15%.

In general, approximately 80 percent of the surficial soil encountered at the Site consists of loamy till derived from sedimentary bedrock, which may generally be classified in accordance with the UCS as Silt (ML) with gravel. The remainder generally consist of alluvial and glacio-fluvial/lacustrine deposits, generally classified as Sandy/Silty Clay (SC-SM), Sandy Gravel (GM), Silt (ML; MH), and Clay (CL; CH; CL-ML).

Soil Corrosivity

As presented in **Table 1** above, the SSURGO database categorizes risk for concrete and steel corrosion at the Site range from "low to high". Per the SSURGO data, its assessment of risk of concrete and steel corrosion considers the potential for soil-induced electrochemical or chemical action that corrodes or weakens concrete. The rate of corrosion of concrete and steel is based mainly on the sulfate, chloride, and sodium content, texture, moisture content, acidity, and electrical resistivity of the soil. **Table 2** below summarizes the risk level for percent of the Site by SSURGO corrosion risk for concrete and steel.

Table 2. Soil Corrosion Risk for Concrete and Steel

Risk Level	Concrete Corrosion	Steel Corrosion
	Percent of Site	Percent of Site
Low	92	21
Moderate	2	3
High	6	76

Some discrepancy with actual field and laboratory data obtained from soil samples recovered from the borings completed at the Facility Site should be anticipated as a possible lack of field verification of published geologic and SSURGO data in this region of New York State.

Corrosivity tests (field and laboratory electrical resistivity, pH, oxidation-reduction; sulfates; sulfides; chlorides; total salts), were performed on soil samples obtained at several boring locations completed for the preliminary geotechnical investigation (refer to Terracon's Preliminary Geotechnical Engineering Report included in **Appendix A**). It is Terracon's professional opinion that the laboratory tests completed for the Preliminary Geotechnical Study should be more reliable than the published SSURGO data. Based upon the results of the soil tests, the soil tested may be classified as having a low corrosion potential to both concrete and steel.

As part of the pre-construction geotechnical tests, the Geotechnical Engineer should perform additional corrosion analysis at every site to be developed with the PV panels and associated structures to check for potential for concrete and steel corrosion. For areas where the Geotechnical Engineer or foundation designer concludes the risk warrants measures to prevent concrete and steel corrosion, it will specify that the contractor build foundations for the proposed structure with a concrete mixture or additives known to minimize the risk of soil-induced concrete corrosion, and also using epoxy-coated reinforcing steel. Corrosion protection should be applied to the steel piers, as required.

Frost Action and Shrink/Well Potential

Frost action is generally considered to be moderate to high risk for soils with seasonally high water or perched water table due to low permeability soil. As shown in **Table 21-1**, 77 percent of the soils encountered at the project site are rated for high frost action potential, and the remainder 23 percent of soils are rated for moderate frost action potential. Foundations for the PV panels and associated structures will be constructed at a suitable depth below the frost line, assumed 4 feet below ground surface. Therefore, further assessment was not conducted.

The soils observed in the test borings generally consists of non-plastic silt with varying amounts of sand and gravel. As shown in **Table 21-1**, approximately 80 percent of the soils encountered at the project site are rated for low shrink-swell potential, and the remainder 20 percent of soils are rated for moderate shrink-swell potential. It is our opinion the on-site soils in general should have minimal shrink/swell potential. As a result, we do not anticipate that specific construction procedures associated with potential expansive clays are required for this project. Therefore, further assessment was not conducted.

Bedrock

Our review of geological maps and water well data indicate bedrock is generally deeper than 9 feet across most of the Site; however, bedrock may be encountered at several locations generally within 1 to 3 feet below existing ground surface. See **Exhibit D** for a map delineating depth to bedrock. As shown in **Table 21-1**, the SSURGO data indicate that no bedrock is identified in approximately 90 percent of the Site, and in only 10 percent of the Site bedrock should be encountered in at depths of 1 to 3 feet.

The predominant bedrock lithology underlying the Site is anticipated to consists of Utica Shale of the Lorraine, Trenton, and Black River Group of Middle-Ordovician age. The bedrock units dip gently to the south, which causes the oldest units to be exposed in the north and progressively younger units exposed to the south.

Six of the 25 borings completed for the preliminary geotechnical investigation (refer to Terracon's Preliminary Geotechnical Engineering Report included in **Appendix A**) encountered decomposed to competent shale bedrock at depths ranging from 2 to 10 feet below existing ground surface. Competent bedrock, confirmed by bedrock coring was encountered in B-7, B-8, B-15 and B-25 at depths of approximately 9 to 10 feet below existing ground surface. The remainder of the borings where generally completed at depths ranging from approximately 13 to 15 feet within the glacial till deposits.

We anticipate the bearing capacity for the bedrock encountered at the project site is more than adequate to support foundations for the proposed photovoltaic (PV) panels and associated structures. Detailed design requirements will be determined during the final engineering phase.

Preliminary Investigation

A supplemental preliminary geotechnical investigation consisting of test borings was performed by Terracon. The results of the geotechnical investigation are presented in Terracon's Preliminary Geotechnical Engineering Report included in **Appendix A**.

The preliminary subsurface investigations by Terracon included subsurface soil and bedrock sampling and limited geotechnical laboratory testing at 25 boring locations located across the Site. The borings were completed between June 1 and June 15, 2018. As a result of the consistent surficial and bedrock geology across the Site, the information obtained from these locations are representative of the overall Site. The preliminary geotechnical investigation included borings to test for subsurface soil, bedrock, and groundwater properties. Laboratory tests included moisture content, gradation, corrosion (electrical resistivity, pH, oxidation-reduction; sulfates; sulfides; chlorides; total salts), thermal analysis. The soil boring logs and laboratory test results are included in **Appendix A**: Preliminary Geotechnical Engineering Report.

Construction of the proposed PV array fields and associated structures are not anticipated to be located on geologic unit or soils that are unstable, or that would become unstable because of the project or located on expansive soils. Also, the project is not underlain by active or potentially active faults based on published records and geological maps. Based on Terracon's findings, the Site is generally suitable for the proposed development, because the encountered soils and bedrock can support structures on typical foundations using conventional construction equipment.

Terracon recommends a detailed geotechnical investigation be performed prior to construction to verify subsurface conditions within the footprint of each PV array fields and associated structures to allow development of final foundation and electrical design, and other facility components as necessary.

(i) Preliminary Blasting Plan

According to the Preliminary Geotechnical Engineering Report (see **Appendix A**), based on the depth of bedrock and its observed weathered and very poor rock quality conditions, blasting would likely not be necessary for construction of proposed foundations and associated equipment.

The photovoltaic solar panels will be supported on driven piers or ground screws (Krinner, or similar). The shallow bedrock encountered at several locations across the site may prevent the installation of driven steel piers or ground screws to a depth sufficient enough to resist overturning or uplift forces. At shallow rock locations, predrilling would be performed to properly set and install the steel piers.

If bedrock or boulders are encountered for associated structures and connection lines, and require removing, the bedrock and boulders are assumed to be rippable with an excavator and/or able to be broken with a pneumatic hammer.

After review of this information, and based on its experience, the Applicant has determined that blasting is not anticipated, and therefore a Preliminary Blasting Plan is not necessary.

(j) Potential Blasting Impacts

As indicated above, blasting will not be necessary for this Facility due to the anticipated construction as well as depth of bedrock and very poor rock quality conditions. Therefore, blasting-related impacts will not occur.

(k) Mitigation Measures for Blasting Impacts

No blasting will be required, and therefore mitigation related to blasting will not be necessary.

(l) Regional Geology, Tectonic Setting, and Seismology

Information regarding geology, tectonic setting, and seismology was obtained from existing published sources, including the Soil Survey of Montgomery and Schenectady Counties (USDA, 1972), statewide bedrock geology mapping, New York State surficial geology mapping, 2014 New York State Hazard Map (USGS, 2014b), USGS Earthquake Hazards Program (USGS, 2017), and the DMA 2000 Hazard Mitigation Plan Update for Montgomery County (June 2016).

Area Geology and Hydrogeology

The Site is located within the Mohawk Valley portion of the Hudson-Mohawk Lowlands. The foothills of the Adirondack Mountains are to the north of the county. The Helderberg Escarpment, the northern edge of the Allegheny Plateau, lies to the south. The Mohawk River cut across Montgomery County in an east-west direction and extends through the north-east corner of Schenectady County. The land adjacent to the river is generally level; however, away from the river the topography becomes rolling. The topography across the county changes in elevation from 200 feet on the Mohawk River to 1,450 feet in southern Montgomery County.

As the name implies, the Hudson-Mohawk physiographic province consist of valleys of the Hudson and Mohawk Rivers. Surficial deposits distributed throughout the Mohawk Valley consist of almost all the types of glacial deposits that are associated with continental glaciation. The ice deposited a thick sequence of till over much of the area in the form of ground moraine, drumlins, and later, ablation till.

The valley of the Mohawk River is broad and U-shaped. Most of the valley wall rises abruptly for 200 to 300 feet to the gently rolling upland in Montgomery County. The relief of the uplands within the Site is gently sloping, with elevations ranging from about 660 feet to 960 feet from northeast to southwest, respectively. The general features have been smoothed by glaciation. Thus, the landscape has smooth curves rather than sharp, abrupt features. The soils in the Site are nearly level or gently sloping.

Montgomery County is drained by the Mohawk River. The Mohawk River joins the Hudson River at Cohoes. The main tributaries to the Mohawk in this area are the Canajoharie Creek, Otsquago Creek and the Schoharie Creek. Two types of stream patterns are prevalent in Montgomery County. The common pattern is dendritic, but in parts of Montgomery County some streams approach a trellis pattern. The shape of most of the stream valleys is broad, but some are young enough to be deeply incised.

Terracon

Seismicity

The following section addresses seismic considerations pertaining to the above referenced project area. Historical information for the region as well as generally accepted seismic interpretations are presented. This section is not intended to be an in-depth discussion or prediction of earthquake frequency, probable intensity, or seismic risk. However, adequate consideration should be given to the possible influence of seismic activity for the structural design of the structural components.

Tectonic

In describing the seismic characteristics of the region, most of New York State is relatively inactive. However, areas which are located along the Buffalo-Attica Region (Western New York) and the St. Lawrence River Valley are moderately active. Our review of published literature indicates the following:

- The northeast United States lies within the relatively tectonically stable and geologically old North American plate.
- The Clarendon-Linden Fault System is a major fault located in Western New York. The fault system trends northward from Allegany County, New York, toward Lake Ontario, extending west of Picton, and continuing toward Wellington, Ontario. The fault system has no more than 100 meters (328 feet) of total displacement across its breadth, exposed at the surface north of Attica, New York. Investigations performed by several authors (Hutchinson, Pomeroy[1]) suggest the fault system may extend across Lake Ontario.
- The St. Lawrence rift system[2] is a seismically active zone paralleling the St. Lawrence River. The rift system extends more than 1000 km along the St. Lawrence Valley from the Ottawa-Montreal area. Two significant historically active seismic zones occur along this system associated with northwest trending intersecting graben structures. The Charlevoix region has been the location of at least five Magnitude 6 or larger earthquakes over the last 350 years, including the 1925 Charlevoix-Kamouraska earthquake. At the Lower St. Lawrence zone, the largest recorded earthquakes are about Magnitude 5. Seismic studies indicate a crustal convergence across the Saint Lawrence Valley of about 0.5 mm per year.

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[1] Hutchinson, D.R.; Pomeroy, P.W.; Wold,R.J. " Investigation of the possible continuation of the Clarendon-Linden Fault under lake Ontario. Geological Society of America Abstracts with programs, volume 9, number 7, 1977, page 1031.

[2] Alain Tremblay and Yvon Lemieux, "Supracrustal faults of the St. Lawrence rift system between Cap-Tourmente and Baie-Saint Paul, Quebec. Geological Survey of Canada. Available at http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.518.4277&rep=rep1&type=pdf (Accessed November 2018)

Earthquakes

The recorded history of earthquakes in New York State is geologically short, dating from the 1633 St. Lawrence Valley Earthquake in Canada which was also felt in New York State. Mapping of all earthquakes that occurred in New York State from 1900 to present time, as well as the "2014 USGS Seismic Hazard Map", are available online at the United States Geological Survey (USGS) website[3]. Our review of the seismic hazard map indicates the areas with higher probability of earthquake occurrences are located along the northern (St. Lawrence River Valley), western (Buffalo-Attica regions) and southern (New York City region) portions of New York State, with the lowest probability in the central portions of the State. The Site is located within the area of lowest probability of earthquake occurrence. The USGS Earthquake Hazards Program does not list young faults, or faults that have had displacement in the Holocene epoch, near the Site.

In terms of specific activities, at least two high-intensity earthquakes have occurred in modern times in the St. Lawrence River Valley and Buffalo-Attica regions. The first of these occurring in 1929 and centered near Attica, New York. The second, which was considered as the most damaging earthquake in New York State, occurred in the St. Lawrence River Valley on September 5, 1944. The Cornwall-Massena Earthquake was registered as a magnitude 5.6 on the Richter Scale (VIII on the Modified Mercalli Scale or MMI), and resulted in significant damage in Massena, Cornwall, and surrounding areas. The epicenter was localized near Massena Center. Many chimneys in this area required rebuilding, and several structures were unsafe for occupancy until repaired. Residents of St. Lawrence County reported many water wells went dry. This severe earthquake was felt from Canada south to Maryland and from Maine west to Indiana. Many smaller earthquakes have been detected in this region before and since the 1944 event.

The most recent high-intensity earthquake recorded in New York State was the April 20, 2002 earthquake with epicenter located at approximately 15 miles southwest (44.512N;73.697W) of Plattsburgh, New York in northeastern Adirondack Mountains. The epicenter of the main shock was about 8 km north of the town of Au Sable Forks and the focal depth of the main shock was about 11 km from the surface. Hence, the earthquake on April 20, 2002 is formally called Au Sable Forks Earthquake. The earthquake had a Magnitude 5.3 on the Richter Scale, and was felt from Cleveland, Ohio, to Maine and from Ontario and Quebec to Maryland. Some damage to roads, bridges, chimneys and water mains in Clinton and Essex Counties were observed. Many people reported cracked walls and foundations, small items knocked from shelves and some broken windows. The earthquake caused substantial damage above 10 million dollars and Federal Disaster Area status was granted to the affected Clinton and Essex Counties.

New York State is not associated with a major fault along a tectonic boundary, but as discussed above seismic events are common in New York. The 2014 New York State (NYS) Seismic Hazard Map[4] shows levels of horizontal shaking, in terms of percent of the gravitational acceleration

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[3] Seismicity and Hazard by Region – New York. Available at http://earthquake.usgs.gov/earthquakes/byregion/newyork.php (Accessed November 2018).
[4] Available at: https://earthquake.usgs.gov/earthquakes/byregion/newyork.php (Accessed November 2018)

constant (%g) that is associated with a 2% probability of occurring during a 50-year period. Our review of the NYS Seismic Hazard Map indicates that the Site is located in an area with the lowest seismic hazard class rating in New York (2 percent probability of exceeding 0.04 to 0.08g in a 50-year period).

Landslide

Review of USGS topographic maps and available aerial photographs suggests much of the project area consists of a generally rolling relief. The valley of the Mohawk River is broad and U-shaped. Most of the valley wall rises abruptly for 200 to 300 feet to the gently rolling upland in Montgomery County. The relief of the uplands within the Site is gently sloping, with elevations ranging from about 660 feet to 960 feet from northeast to southwest, respectively. The general features have been smoothed by glaciation. Thus, the landscape has smooth curves rather than sharp, abrupt features. The soils in the Site are nearly level or gently sloping.

We have reviewed local geological data regarding soil types and seismic considerations (i.e. review of soil survey information; seismicity of the site; geologic map of New York State; USGS for fault zones), the NYSDOT GDM Chapter 16, “Landslide Analysis and Mitigation” (available online at the NYSDOT Department website), and the “Landslide Inventory Map of New York.” [5] Based upon the results of our review, and the existing and anticipated topography, it is our opinion the Site is in an area of low to moderate landslide incidence.

Sinkholes

The project area is underlain by sedimentary shale, siltstone, and sandstone bedrock, which are not known to cause solution cavities and sinkholes. Sinkhole development due to natural solution of the underlying bedrock formations is not anticipated to be a concern in the Site.

(m) Facility Impacts on Regional Geology

The glacial till deposits and/or bedrock encountered at the Site are structurally suitable for support of PV panel foundations and associated structures. A more detailed subsurface geotechnical investigation should be completed in the footprint of each of the PV array fields prior to final design. The proposed PV array development is not anticipated to result in significant impacts to the regional geology. However, depth to bedrock in the Site is expected to be variable and it is possible some PV panels foundations may be required to be drilled into bedrock.

Based on the Applicant’s experience constructing other solar power facilities (including in New York State), only temporary, minor impacts to geology are expected because of construction activities. For example, where PV panels and associated structures and access road sites are not located on completely level terrain, some cut and fill will be required; however, the impact to overall

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[5] *Landslide Inventory Map of New York*, 1989; Fickies, RH, Brabb, EE; New York State Museum Circular 52, Albany, NY.

topography will be minor. Once operational, the new development impacts to geology will be minimal.

(n) Impacts of Seismic Activity on Facility Operation

As previously indicated, the Site is located within the area of lowest probability of earthquake occurrence. The USGS Earthquake Hazards Program does not list young faults, or faults that have had displacement in the Holocene epoch, near the Project Site. Therefore, this topic will not be further addressed.

(o) Soil Types Map

See Exhibit G for a map delineating soil types within the Site. Soils within the Site are discussed in the following subpart. Data from United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) Web Soil Survey (SSURGO), was used to map the locations of prime farmland, prime farmland if drained, and farmland of statewide importance.

(p) Characteristics of Each Soil Type and Suitability for Construction

Our review of the Soil Survey of Montgomery County, New York (USDA, 1978) and the SSURGO data, indicates the Site predominantly consists of 45 individual soil map units. Thirteen soil series (Angola, Appleton, Burdett, Churchville, Darien, Fluvaquents, Fonda, Hornell, Ilion, Lansing, Madalin, Palatine, and Rhinebeck), comprise approximately 90 percent of the soils by area within the Facility Site. General descriptions of the soil map units are provided in **Table 21-1**: SSURGO Database Summary presented at the end of this document.

The vast majority of soils by area in the Site are silt loam and Channery silt loam, but textures such as silty clay loam and gravelly silty loam are present in small areas.

The relief of the uplands within the Site is gently sloping, with elevations ranging from about 660 feet to 960 feet from northeast to southwest, respectively. The soils in the Facility Site are nearly level or gently sloping. Based on engineering for the project and sediment/erosion control procedures, construction on steep slopes (i.e., more than 15 percent) is not anticipated. Erosion and sediment control measures will be implemented to minimize impacts to steep slopes and highly erodible soils that may occur in the event of extreme rainfall or other event that could potentially lead to severe erosion and downstream water quality issues. In addition, impacts to soils will be further minimized by the following means:

- Public road ditches and other locations where facility-related runoff is concentrated will be armored (if necessary) with riprap to dissipate the energy of flowing water and hold the soils in place.
- Prior to commencing construction activities, erosion control devices will be installed between the work areas and downslope areas to reduce the risk of soil erosion and

siltation. Erosion control devices will be monitored continuously throughout construction and restoration for function and effectiveness.

- During construction activities, hay bales, silt fences, and/or other appropriate erosion control measures will be placed as needed around disturbed areas and stockpiled soils.
- Following construction, all temporarily disturbed areas will be stabilized and restored in accordance with approved plans.

Construction procedures for ensuring excavation stability include:

- Excavation will be completed using conventional construction equipment, including bulldozers, track hoes, and possible pan excavators.
- The subsurface conditions encountered in the test borings included in Terracon's Preliminary Geotechnical Investigation were observed to be generally consistent with the mapped surficial and bedrock geology at those locations. Based on the document review and preliminary soil boring investigation, the photovoltaic solar panels will be supported on driven piers or ground screws. The shallow bedrock encountered across the site may prevent the installation of driven steel piers or ground screws to a depth sufficient enough to resist overturning or uplift forces. At shallow rock locations, predrilling may be required to properly set and install the steel piers. Prior to construction, additional soil borings will be completed within the footprint of the PV arrays and associated structures to evaluate and design specific foundation requirements and bearing depths.
- Prior to construction of access roads and structures associated with the PV arrays, topsoil will be stripped from the excavation area (access roads and foundation areas). Loose or unstable soils encountered during preparation of the subgrade will be replaced with compacted approved granular fill.
- Following topsoil stripping and removal of unsuitable fill soils, the exposed undisturbed soils will be proof rolled with a drum roller. Weak or soft spots identified during proof rolling will be replaced with compacted approved granular fill.

Impacts to soil resources will be minimized by adherence to best management practices designed to avoid or control erosion and sedimentation and stabilize disturbed areas.

As discussed in Item (h) - **Suitability of Soil and Excavated Materials for Construction Purposes-Soil Corrosivity**, some soil units found within the Site are mapped as corrosive to steel. For areas where the Geotechnical Engineer or foundation designer concludes the risk warrants measures to prevent concrete and steel corrosion, it will specify the contractor build foundations for the proposed structure with a concrete mixture or additives known to minimize the risk of soil-induced concrete corrosion, and also using epoxy-coated reinforcing steel. Corrosion protection should be applied to the steel piers, as required. Detailed design requirements will be determined during the final engineering phase.

The anticipated Seismic Site Class definition for consideration under the New York State Building Code will be C or D, indicating very dense soil/soft rock and medium dense to dense soil, respectively. The actual Seismic Site Class will be determined after a geotechnical investigation is performed for final design.

Based on information from the Montgomery County Soil Survey, construction excavations may encounter areas of perched groundwater if construction occurs during a time when a seasonally high-water table may be present (spring and fall). In addition, construction during rainy periods may see an increase in perched groundwater due to the low hydraulic conductivity within the facility site. Construction dewatering may be required for surface water control and for excavations that encounter perched groundwater conditions, groundwater or seepage. Open sump pumping method is a common and economical method of dewatering and is anticipated to be sufficient based on relatively low permeability soils. The determination whether long-term dewatering is necessary will be addressed during final geotechnical investigations.

During Terracon's preliminary subsurface investigation, groundwater was not encountered at the test boring locations. It is unlikely that foundation construction activities associated with the PV panels and associated structures will impact subsurface groundwater. Additionally, based on at least 1,000-foot setback of the PV arrays from residential structures, it is unlikely foundation construction activities will have an impact on quality or quantity of shallow aquifers or residential groundwater wells.

Design and construction of the proposed foundations, roadways, and work pads should anticipate surficial topsoil and subsoil overlying generally poor draining and frost-susceptible overburden glacial till overlying highly weathered to unweathered bedrock. The highly weathered bedrock may be characterized as soil similar to the glacial till for engineering purposes. Foundations and associated buried interconnect cables are typically placed at depths below the frost zone.

Prior to construction, a geotechnical investigation will be completed within the footprint of the proposed PV array fields and associated structures. Soil samples will be collected and tested for typical corrosivity parameters (e.g., sulfates, chlorides) for verification. Test results will be used by the foundation designers for consideration of concrete and steel design requirements.

(q) Bedrock Analyses and Maps

Our review of geological maps and water well data indicate bedrock is generally deeper than 9 feet across most of the Site; however, bedrock is mapped at several locations generally within 1 to 3 feet below existing ground surface. See **Exhibit D** for a map delineating depth to bedrock. As shown in **Table 21-1**, the SSURGO data indicate no bedrock is identified in approximately 90 percent of the Site, and in only 10 percent of the Site bedrock should be encountered at depths of 1 to 3 feet. Bedrock depths within the footprint of the proposed PV array fields and associated structures need to be confirmed during the final geotechnical investigation.

Six of the 25 borings completed for the preliminary geotechnical investigation (refer to Terracon's Preliminary Geotechnical Engineering Report included in **Appendix A**) encountered decomposed to competent shale bedrock at depths ranging from 2 to 10 feet below existing ground surface. Competent bedrock, confirmed by bedrock coring was encountered in B-7, B-8, B-15 and B-25 at depths of approximately 9 to 10 feet below existing ground surface. The remainder of the borings where generally completed at depths ranging from approximately 13 to 15 feet within the glacial till deposits.

The predominant bedrock lithology underlying the Site is anticipated to consists of Utica Shale of the Lorraine, Trenton, and Black River Group of Middle-Ordovician age. The bedrock units dip gently to the south.

We expect mechanical excavation (e.g., pneumatic hammer, large ripper) may be possible for the rock encountered, particularly in the upper weathered zone. Based on the depth of bedrock and its observed weathered and very poor rock quality conditions, blasting will not be necessary for construction of proposed foundations and associated equipment.

The photovoltaic solar panels will be supported on driven piers or ground screws (Krinner, or similar). The shallow bedrock encountered at several locations across the Site may prevent the installation of driven steel piers or ground screws to a depth sufficient enough to resist overturning or uplift forces. At shallow rock locations, predrilling will be performed to properly set and install the steel piers. If bedrock or boulders are encountered for associated structures and connection lines, and require removing, bedrock and boulders should be rippable with an excavator and/or able to be broken with a pneumatic hammer.

The bedrock encountered is anticipated to be structurally suitable for support of foundations for PV panels, associated structures, and access road construction. However, we recommend PV panel array fields undergo additional subsurface investigation prior to construction.

(r) Foundation Evaluation

Foundation construction occurs in several stages, which typically include installation of driven piers for the PV panels; excavation, pouring of concrete, removal of the forms for associated structures; and backfilling, compaction, and site restoration. Excavation and foundation construction will be conducted in a manner that will minimize the size and duration of excavated areas required to install foundations. In addition, foundations will be constructed and inspected in accordance with relevant portions of the New York State Building Code and in conformance with the design recommendations to be included in the final geotechnical report.

Preliminary Engineering Assessment

Foundation construction will be primarily associated with the PV mounts, collection and point of interconnection substations, and electronic equipment (e.g., switchgear and transformers). As detailed in Section (h), the Facility Site has been analyzed and found to be suitable to the foundation types proposed.

The PV panels will be supported on driven piers, which should be structurally designed to resist compression, uplift, and bending forces. The project Structural Engineer should determine the actual pier lengths considering frost heave forces, and other loads on the piers. We expect driven piers could encounter refusal above the required embedment depth. Therefore, pre-drilling of oversized holes to allow for the installation of the piers to the required embedment depth may be required. Ground screws may also be used to support the racking system that supports the panels. If ground screws cannot penetrate the bedrock sufficiently, installation will include pre-drilling of a pilot hole or an oversize hole to facilitate the screw installation. Foundation design assume piers will be installed in pre-drilled oversized holes backfilled with grout or lean concrete, where shallow bedrock is encountered.

Based on the results of the subsurface conditions encountered in the preliminary borings, the support structures (collection and point of interconnection substations, O&M building, and equipment pads) proposed within the Facility Site may be supported on cast-in-place concrete spread and/or continuous foundations, drilled concrete shafts, and/or reinforced concrete mats, depending on the requirements of the individual structure. Typically, foundations widths may range from 1.5 to 4 feet for continuous and spread footings, and less than 5 feet in diameter for drilled shafts. Reinforced concrete mats supporting equipment are generally less than 40 feet in any dimension. The bases of the foundations will be placed below frost depth, which is anticipated to be 4 feet in this area. Excavation and foundation construction will be conducted in a manner that will minimize the side and duration of excavated areas required to install foundations.

The soils encountered in the borings completed for the preliminary investigation are anticipated to be frost susceptible. Frozen soils can exert heaving forces on the piers. If the anchorage of the foundations and the deadweight of the structures are not sufficient to resist heave forces, they can cause structures to uplift. In cold weather climates, design to resist frost heave forces exerted on foundations is often the limiting factor in the foundation design. Specifically, pier lengths will need to counteract potential heave forces in the seasonal frost zone. Thawing soils typically have significantly less strength than frozen or fully thawed soils. Therefore, the upper 4 feet of soil will be ignored for use in resisting axial tension or compression loads. Foundations for associated structures will be constructed at a suitable depth below the frost line, assumed 4 feet below ground surface. Therefore, further assessment was not conducted.

The soil observed in the test borings generally consists of non-plastic silt with varying amounts of sand and gravel. It is our opinion the Site soil should have minimal shrink/swell potential. As a result, we do not anticipate specific construction procedures associated with potential expansive clays are required for this project. Therefore, further assessment was not conducted.

Pier Driving Assessment

The pier driving contractor should select a driving hammer and cushion combination which can install the selected piling without overstressing the pier material. The contractor should submit the pier driving plan and the pier hammer-cushion combination to the engineer for evaluation of the driving stresses in advance of pier installation. Each pier should be observed and checked for buckling, crimping and alignment in addition to recording penetration resistance, depth of embedment, and general pier driving operations by the Geotechnical Engineer.

Load carrying capacity of the piers will vary when installed by different methods, i.e. driving vs pre-drilled, grout filled holes. Production pier testing will be performed on piers installed using each installation method to confirm their capability to carry the foundation loads.

The pier driving process should be performed under the direction of the Geotechnical Engineer. The Geotechnical Engineer should document the pier installation process including soil/rock and groundwater conditions encountered, consistency with expected conditions, and details of the installed pier.

Mitigation Measures for Pier Driving Impacts

Piers typically driven into the ground for a solar facility are light capacity as compared to typical-driving applications, such as bridges and buildings. High-speed impact hammers are the most widely used application for this type of projects. Vibrations generated by a high-speed hammer are typically low and transfer at short distance. Vibratory driver extractors, down-the-hole (DTH) hammers, and auger drills (for pre-drilling or installing ground screws) may also be used for this project as supplemental tools to the impact hammer.

Although vibrations from pier driving in solar applications may be significantly below levels associated with typical driving applications, such as for bridges or building, vibration monitoring should be performed for all pier driving within 200 feet of existing structures and utilities sensitive to vibrations, or until monitoring results indicate pier driving is occurring at a sufficient distance from the existing structures to result in peak particle velocity (PPV) values less than or equal to 0.5 inch per second.

(s) Vulnerability to Earthquake and Tsunami Events

As previously indicated, the proposed development appears to have minimal vulnerability associated with seismic events based on review of publicly available data. In addition, because the development is located approximately 90 miles southeast from the nearest large water body (Lake Ontario), there is no vulnerability associated with tsunamis. Therefore, further analysis was not conducted.

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TABLE 21-1:
SSURGO Database Summary

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TABLE 21-1: SSURGO Database Summary

Map Symbol	Map Unit Name	Parent Material	UCS	Minimum Bedrock Depth	Seasonal Minimum Water Table Depth	Potential for Corrosion of		Drainage Class	Hydrologic Group	Organic Matter	Potential for Frost Action	Shrink-Swell Potential	Percent of Site
					(inches)	Concrete	Steel			%			
DaB	Darien silt loam, 3 to 8 percent slopes	Till	ML	No bedrock identified	7	Low	High	Somewhat poorly drained	C/D	5.5	High	Low	20.15
ApB	Appleton silt loam, 3 to 8 percent slopes	Till	ML	No bedrock identified	11	Low	High	Somewhat poorly drained	C/D	5.1	High	Low	12.98
LaC	Lansing silt loam, 8 to 15 percent slopes	Till	ML	No bedrock identified	0	Low	Low	Well drained	C	3.1	Moderate	Low	8.60
Ma	Madalin silty clay loam	Glacio-lacustrine deposits	MH	No bedrock identified	0	Low	High	Poorly drained	C/D	8.1	High	Moderate	7.26
LaB	Lansing silt loam, 3 to 8 percent slopes	Till	ML	No bedrock identified	0	Low	Low	Well drained	C	3.1	Moderate	Low	4.68
IlB	Ilion silt loam, 3 to 8 percent slopes	Till	ML	No bedrock identified	0	Low	High	Poorly drained	C/D	5.5	High	Low	4.62
IlA	Ilion silt loam, 0 to 3 percent slopes	Till	ML	No bedrock identified	0	Low	High	Poorly drained	C/D	5.5	High	Low	4.52
HoB	Hornell silt loam, 3 to 8 percent slopes	Till	ML	2 to 3 feet	8	High	High	Somewhat poorly drained	D	4	High	Moderate	4.41
BuB	Burdett channery silt loam, 3 to 8 percent slopes	Till	ML	No bedrock identified	9	Low	High	Somewhat poorly drained	C/D	4.5	High	Low	3.66
Fo	Fonda mucky silty clay loam	Glacio-lacustrine deposits	PT	No bedrock identified	0	Low	High	Very poorly drained	C/D	75	High	Moderate	3.65

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TABLE 21-1: SSURGO Database Summary													
Map Symbol	Map Unit Name	Parent Material	UCS	Minimum Bedrock Depth	Seasonal Minimum Water Table Depth	Potential for Corrosion of		Drainage Class	Hydrologic Group	Organic Matter	Potential for Frost Action	Shrink-Swell Potential	Percent of Site
					(inches)	Concrete	Steel			%			
LaD	Lansing silt loam, 15 to 25 percent slopes	Till	ML	No bedrock identified	0	Low	Low	Well drained	C	3.1	Moderate	Low	3.37
ChB	Churchville silty clay loam, 3 to 8 percent slopes	Glacio-lacustrine deposits	ML	No bedrock identified	7	Low	High	Somewhat poorly drained	C/D	4	High	Low	2.29
BuC	Burdett channery silt loam, 8 to 15 percent slopes	Till	ML	No bedrock identified	9	Low	High	Somewhat poorly drained	C/D	4.5	High	Low	2.16
FL	Fluvaquents, loamy	Alluvium	SC	No bedrock identified	6	High	High	Poorly drained	B/D	2.5	High	Low	1.91
RhA	Rhinebeck silty clay loam, 0 to 3 percent slopes	Glacio-lacustrine deposits	CH	No bedrock identified	7	Low	High	Somewhat poorly drained	C/D	5	High	Moderate	1.88
AnB	Angola silt loam, 3 to 8 percent slopes	Till	CL	2 to 3 feet	9	Low	High	Somewhat poorly drained	D	4.5	High	Low	1.75
RhB	Rhinebeck silty clay loam, 3 to 8 percent slopes	Glacio-lacustrine deposits	CH	No bedrock identified	7	Low	High	Somewhat poorly drained	C/D	5	High	Moderate	1.39
PaC	Palatine silt loam, 8 to 15 percent slopes	Till	ML	2 to 3 feet	0	Low	Low	Well drained	C	6	Moderate	Low	1.39
PaB	Palatine silt loam, 3 to 8 percent slopes	Till	ML	2 to 3 feet	0	Low	Low	Well drained	C	6	Moderate	Low	0.96

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TABLE 21-1: SSURGO Database Summary													
Map Symbol	Map Unit Name	Parent Material	UCS	Minimum Bedrock Depth	Seasonal Minimum Water Table Depth	Potential for Corrosion of		Drainage Class	Hydrologic Group	Organic Matter	Potential for Frost Action	Shrink-Swell Potential	Percent of Site
					(inches)	Concrete	Steel			%			
MmB	Manheim silt loam, 3 to 8 percent slopes	Till	ML	No bedrock identified	9	Low	High	Somewhat poorly drained	C/D	4.5	High	Low	0.89
MnB	Manlius silt loam, 3 to 8 percent slopes	Till	ML	2 to 3 feet	0	Moderate	Low	Well drained	C	3.5	Moderate	Low	0.80
MoC	Manlius shaly silt loam, 8 to 15 percent slopes	Till	ML	2 to 3 feet	0	Moderate	Low	Well drained	C	3.5	Moderate	Low	0.75
PpB	Phelps gravelly loam, 3 to 8 percent slopes	Glacio-fluvial deposits	SC-SM	No bedrock identified	21	Low	Moderate	Moderately well drained	B/D	4.5	High	Low	0.71
MsB	Mohawk silt loam, 3 to 8 percent slopes	Till	ML	No bedrock identified	72	Low	Moderate	Well drained	B	6	Moderate	Low	0.66
ChA	Churchville silty clay loam, 0 to 3 percent slopes	Glacio-lacustrine deposits	ML	No bedrock identified	7	Low	High	Somewhat poorly drained	C/D	4	High	Low	0.61
ApA	Appleton silt loam, 0 to 3 percent slopes	Till	ML	No bedrock identified	11	Low	High	Somewhat poorly drained	C/D	5.1	High	Low	0.52
Pr	Phelps gravelly loam, fan	Glacio-fluvial deposits	SC-SM	No bedrock identified	30	Low	Moderate	Moderately well drained	C	4.5	Moderate	Low	0.49
DaC	Darien silt loam, 8 to 15 percent slopes	Till	ML	No bedrock identified	7	Low	High	Somewhat poorly drained	C/D	5.5	High	Low	0.45

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TABLE 21-1: SSURGO Database Summary

Map Symbol	Map Unit Name	Parent Material	UCS	Minimum Bedrock Depth	Seasonal Minimum Water Table Depth	Potential for Corrosion of		Drainage Class	Hydrologic Group	Organic Matter	Potential for Frost Action	Shrink-Swell Potential	Percent of Site
					(inches)	Concrete	Steel			%			
MsD	Mohawk silt loam, 15 to 25 percent slopes	Till	ML	No bedrock identified	72	Low	Moderate	Well drained	B	6	Moderate	Low	0.32
PaD	Palatine silt loam, 15 to 25 percent slopes	Till	ML	2 to 3 feet	0	Low	Low	Well drained	C	6	Moderate	Low	0.25
UnD	Unadilla silt loam, 15 to 25 percent slopes	Eolian deposits	CL-ML	No bedrock identified	0	Moderate	Low	Well drained	B	4.5	High	Low	0.23
MsC	Mohawk silt loam, 8 to 15 percent slopes	Till	ML	No bedrock identified	72	Low	Moderate	Well drained	B	6	Moderate	Low	0.23
VaB	Varick silt loam, 3 to 8 percent slopes	Till	CL	2 to 3 feet	0	Low	High	Poorly drained	D	4.5	High	Low	0.22
DaA	Darien silt loam, 0 to 3 percent slopes	Till	ML	No bedrock identified	7	Low	High	Somewhat poorly drained	C/D	5.5	High	Low	0.20
InB	Ilion very stony silt loam, 0 to 8 percent slopes	Till	ML	No bedrock identified	0	Low	High	Poorly drained	C/D	5.5	High	Low	0.20
LMF	Lansing and Mohawk silt loams, very steep	Till	ML	No bedrock identified	72	Low	Low	Well drained	C	4.3	Moderate	Low	0.18
W	Water			No bedrock identified	0							Low	0.17

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TABLE 21-1: SSURGO Database Summary

Map Symbol	Map Unit Name	Parent Material	UCS	Minimum Bedrock Depth	Seasonal Minimum Water Table Depth	Potential for Corrosion of		Drainage Class	Hydrologic Group	Organic Matter	Potential for Frost Action	Shrink-Swell Potential	Percent of Site
					(inches)	Concrete	Steel			%			
Wy	Wayland soils complex, 0 to 3 percent slopes, frequently flooded	Alluvium	MH	No bedrock identified	0	Low	Moderate	Poorly drained	B/D	10.3	High	Low	0.12
BuA	Burdett channery silt loam, 0 to 3 percent slopes	Till	ML	No bedrock identified	9	Low	High	Somewhat poorly drained	C/D	4.5	High	Low	0.11
Br	Brockport silt loam	Till	CL	2 to 3 feet	8	Low	High	Somewhat poorly drained	D	5	Moderate	Moderate	0.08
Fr	Fredon silt loam	Glacio-fluvial deposits	CL-ML	No bedrock identified	0	Low	Low	Poorly drained	B/D	4	High	Low	0.08
MoD	Manlius shaly silt loam, 15 to 25 percent slopes	Till	ML	2 to 3 feet	0	Moderate	Low	Well drained	C	3.5	Moderate	Low	0.07
AoB	Angola channery silt loam, 3 to 8 percent slopes	Till	CL	2 to 3 feet	9	Low	High	Somewhat poorly drained	D	4.5	High	Low	0.03
AtC	Arnot channery silt loam, 8 to 15 percent slopes, rocky	Till	ML	1 to 2 feet	0	High	Low	Well drained	D	4.5	Moderate	Low	0.01
HrD	Howard gravelly silt loam, 15 to 25 percent slopes	Glacio-fluvial deposits	SC	No bedrock identified	0	Low	Low	Well drained	A	5	Moderate	Low	<0.01

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TABLE 21-1: SSURGO Database Summary														
Map Symbol	**Map Unit Name**	**Parent Material**	**UCS**	**Minimum Bedrock Depth**	**Seasonal Minimum Water Table Depth**	**Potential for Corrosion of**		**Drainage Class**	**Hydrologic Group**	**Organic Matter**	**Potential for Frost Action**	**Shrink-Swell Potential**	**Percent of Site**
					(inches)	**Concrete**	**Steel**			**%**			
AZF	Arnot-Rock outcrop association, very steep	Till	ML	Exposed bedrock	0	High	Low	Well drained	D	4.5	Moderate	Low	<0.01

Notes:

UCS – Unified Classification System

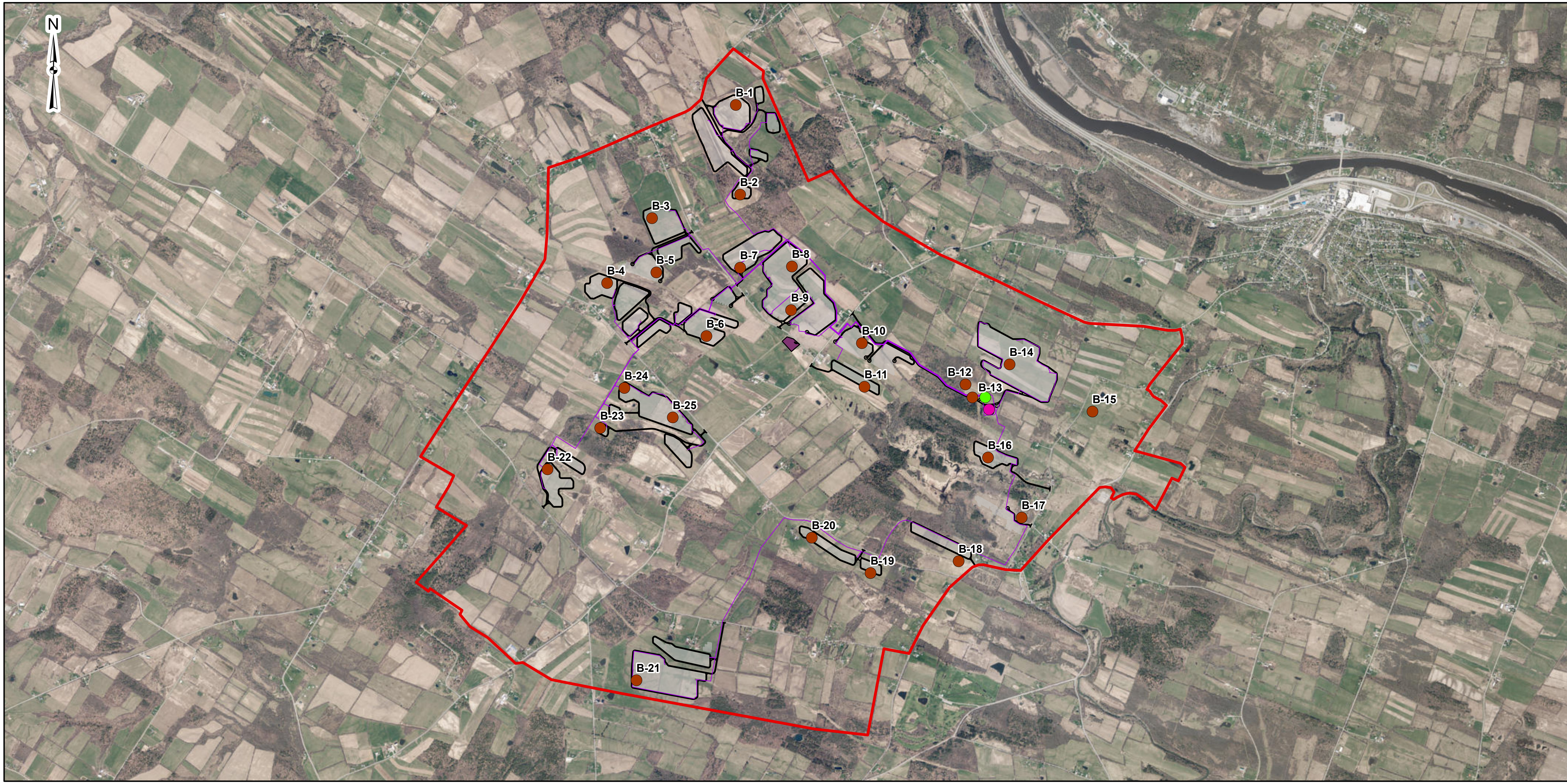
Minimum Bedrock Depth – If no bedrock layer is described in a map, it is represented by the “No bedrock identified” depth class

Organic Matter - Organic matter percent is the weight of decomposed plant, animal, and microbial residues exclusive of non-decomposed plant and animal residues. Weighted Average.

Seasonal Minimum Water Table Depth - The shallowest depth to a wet soil layer (water table) during the months of April through June expressed in centimeters from the soil surface for components whose composition in the map unit is equal to or exceeds 15%.

EXHIBITS:

Exhibit A: Aerial Overview
Exhibit B: Topographic Overview
Exhibit C: Soil Parent Material
Exhibit D: Depth to Bedrock
Exhibit E: Slope Map
Exhibit F: Bedrock Geology
Exhibit G: Soil Types
Exhibit H: Surficial Geology



Project Site
Borings
Collection Substation
POI Substation
Buried Collection Lines
PV Panel Layout
Access Roads
OM Facility Parcel

DATA SOURCES:
ESRI WMS - World Aerial Imagery, OpenStreetMap

Feet
0 1,250 2,500 5,000

1:50,000

Project No.:	J5185006
Date:	Mar 2019
Drawn By:	PNM
Reviewed By:	JRG

Terracon
77 Sundial Ave, Suite 401W Manchester, NH 03103
PH. (603) 647 9700 terracon.com

Aerial Overview

Avangrid Renewables
Mohawk Solar Geotechnical Investigation
Marshville, NY

Exhibit

A

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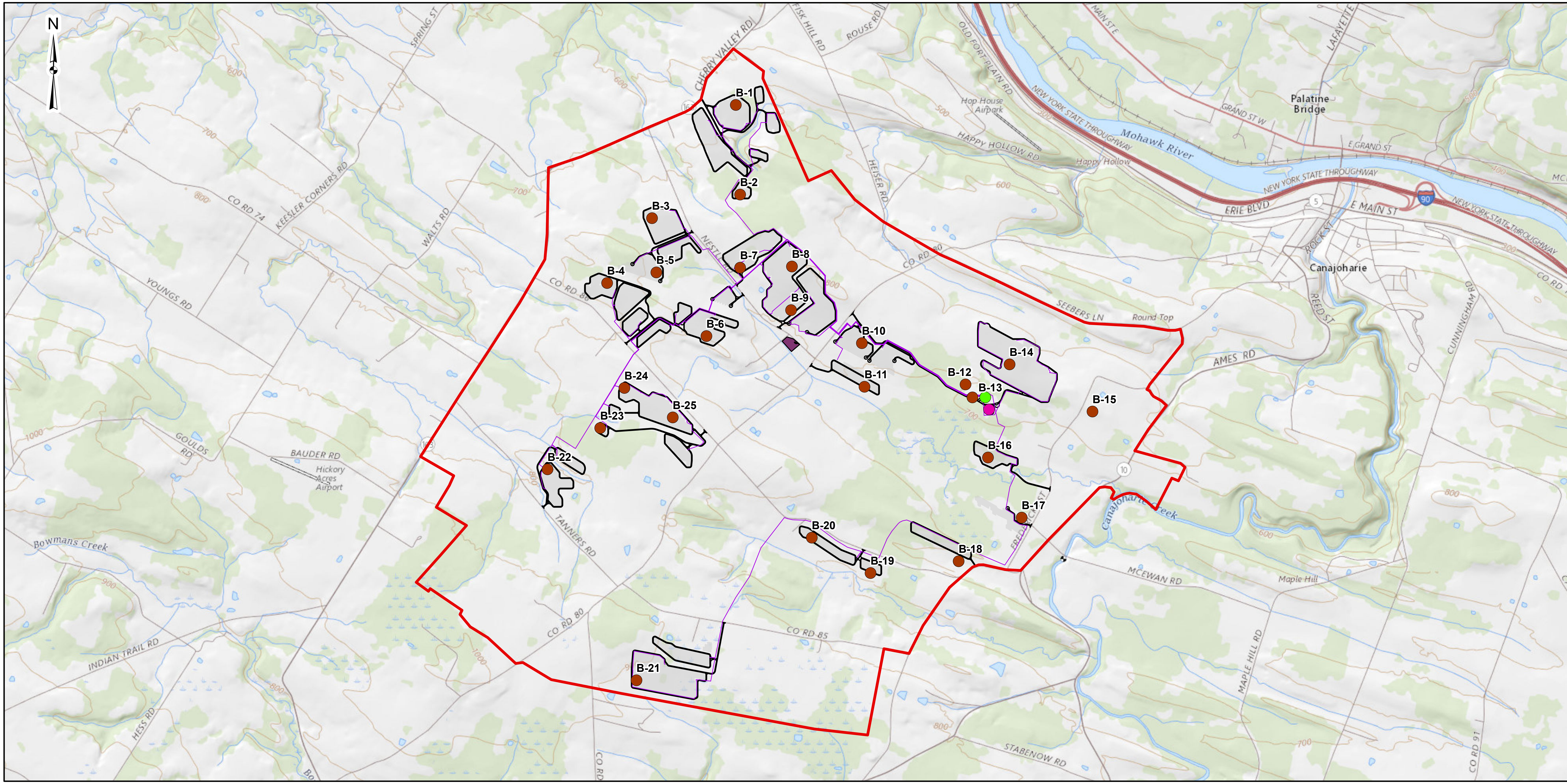

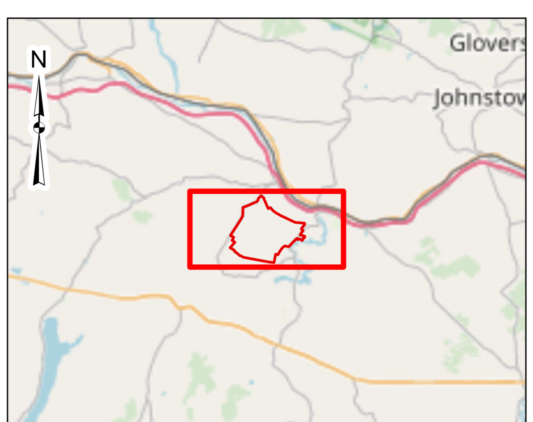

- Project Site
- Borings
- Collection Substation
- POI Substation
- Buried Collection Lines
- PV Panel Layout
- Access Roads
- OM Facility Parcel

DATA SOURCES:
USGS Topo
ESRI WMS - OpenStreetMap

Feet
0 1,250 2,500 5,000

1:50,000

Project No.:	J5185006
Date:	Mar 2019
Drawn By:	PNM
Reviewed By:	JRG

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Topographic Overview

Avangrid Renewables
Mohawk Solar Geotechnical Investigation
Marshville, NY

Exhibit

B

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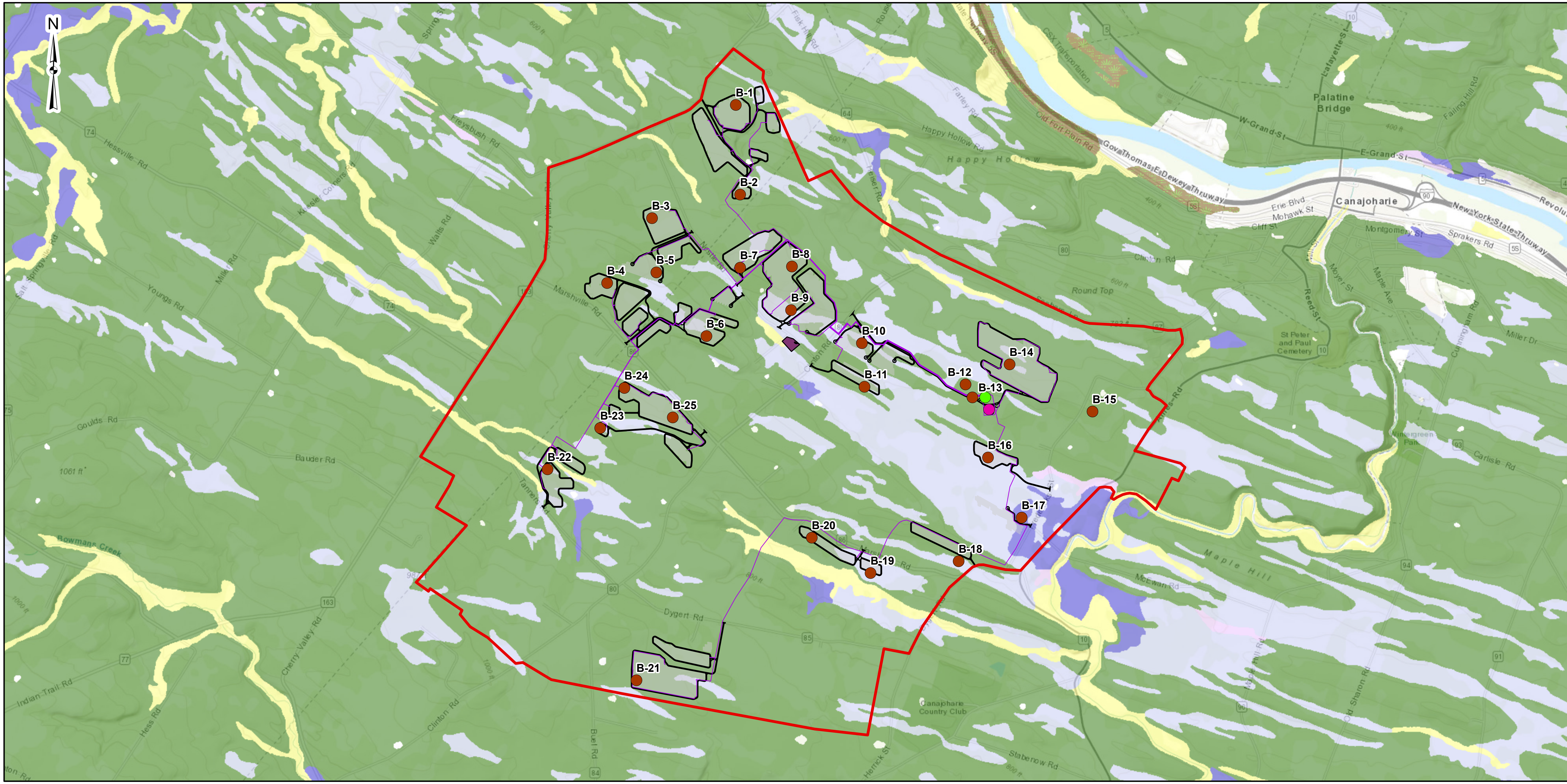

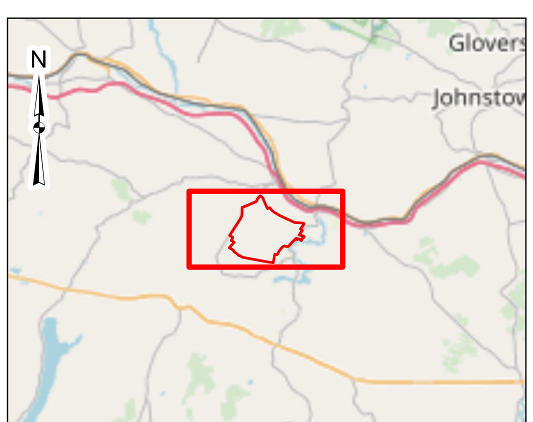

Project Site

Borings

Collection Substation

POI Substation

Buried Collection Lines

PV Panel Layout

Access Roads

OM Facility Parcel

Soil Parent Materials

Alluvium

Eolian deposits

Organic material

Till

Glaciofluvial deposits

Glaciolacustrine deposits

DATA SOURCES:
SSURGO
ESRI WMS - Topographic, OpenStreetMap

Feet
0 1,250 2,500 5,000

1:50,000

Project No.:	J5185006
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Soil Parent Materials

Avangrid Renewables
Mohawk Solar Geotechnical Investigation
Marshville, NY

Exhibit

C

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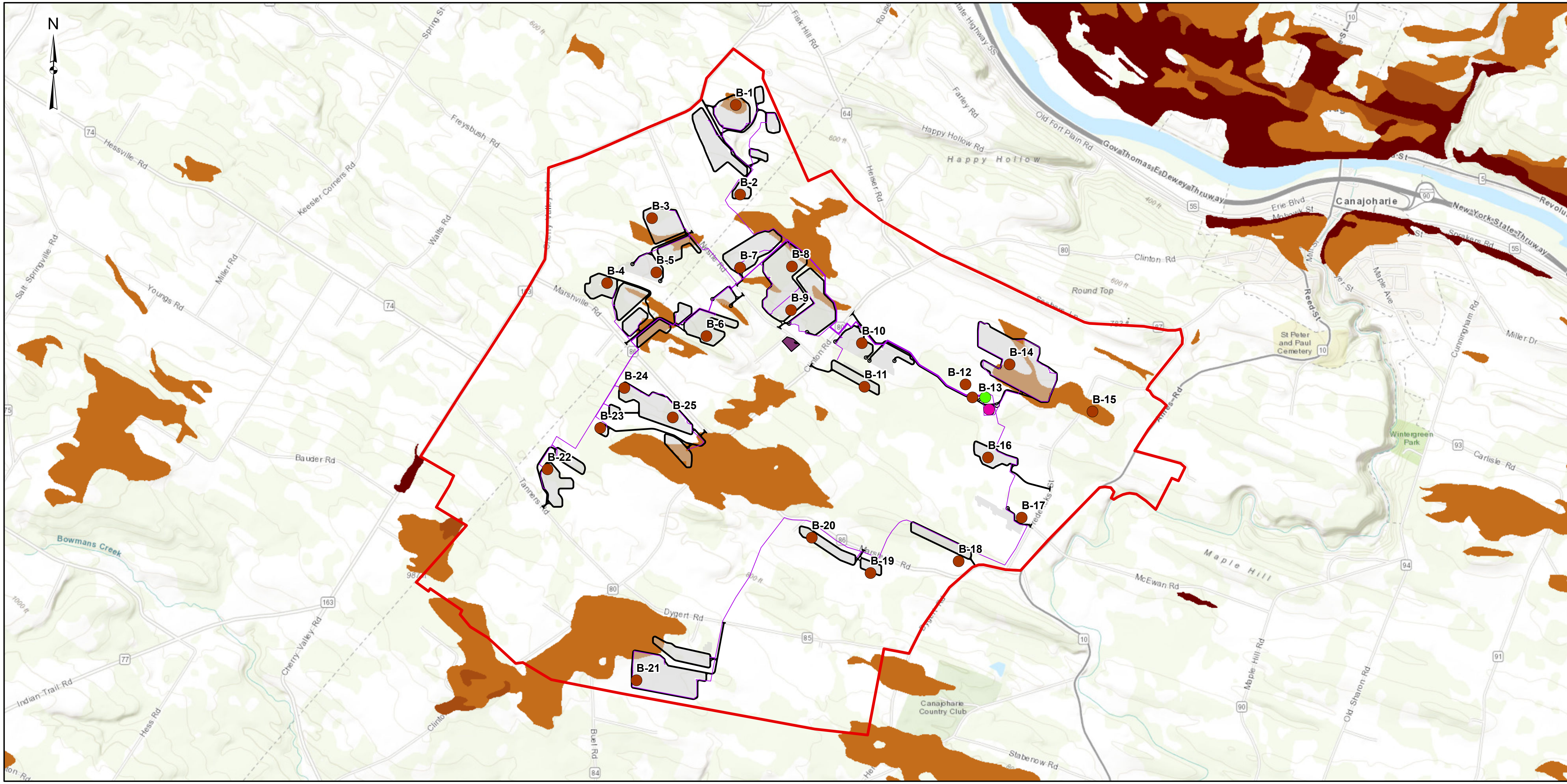

Project Site

Borings

Collection Substation

POI Substation

Buried Collection Lines

PV Panel Layout

Access Roads

OM Facility Parcel

Minimum Depth to Bedrock

- Exposed bedrock
- Shallow rock (depth not defined)
- Less than 1 foot
- 1 to 2 feet
- 2 to 3 feet
- 3 to 4 feet
- 4 to 5 feet
- 5 to 6 feet
- 6 to 7 feet
- 7 to 8 feet
- 8 to 9 feet
- More than 9 feet

DATA SOURCES:
SSURGO
ESRI WMS - Topographic, OpenStreetMap

0 1,250 2,500 5,000 Feet

1:50,000

Project No.:	J5185006
Date:	Mar 2019
Drawn By:	PNM
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Depth to Bedrock

Avangrid Renewables
Mohawk Solar Geotechnical Investigation
Marshville, NY

Exhibit

D

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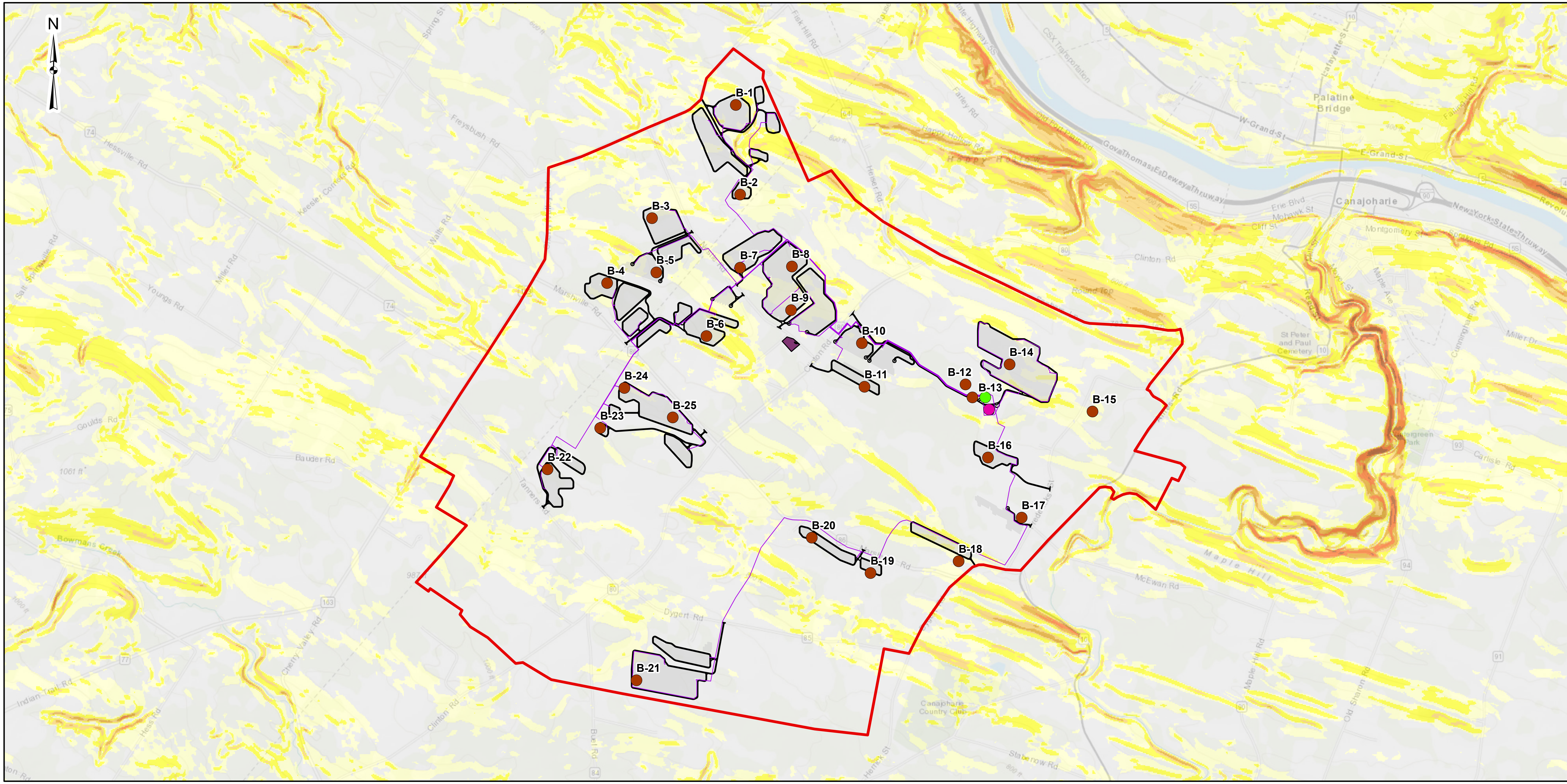

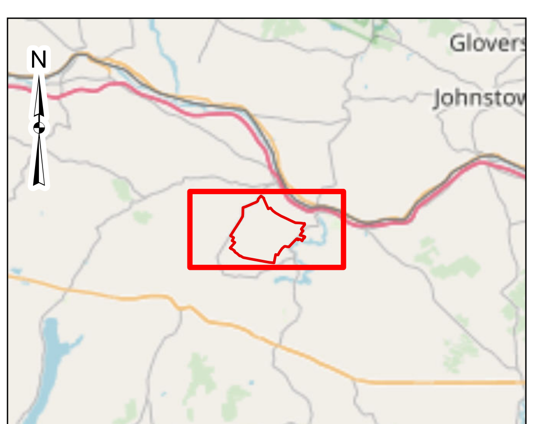

Project Site
Borings
Collection Substation
POI Substation
Buried Collection Line
PV Panel Layout
Access Roads
OM Facility Parcel

Slope of Terrain (Degrees)

Value

0 - 2
2 - 5
5 - 10
10 - 15
15 - 21
21 - 31
31 - 90

DATA SOURCES:
SSURGO
ESRI WMS - Topographic, OpenStreetMap

0 1,250 2,500 5,000 Feet

1:50,000

Project No.:	J5185006
Date:	Mar 2019
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Slope

Avangrid Renewables
Mohawk Solar Geotechnical Investigation
Marshville, NY

Exhibit

E

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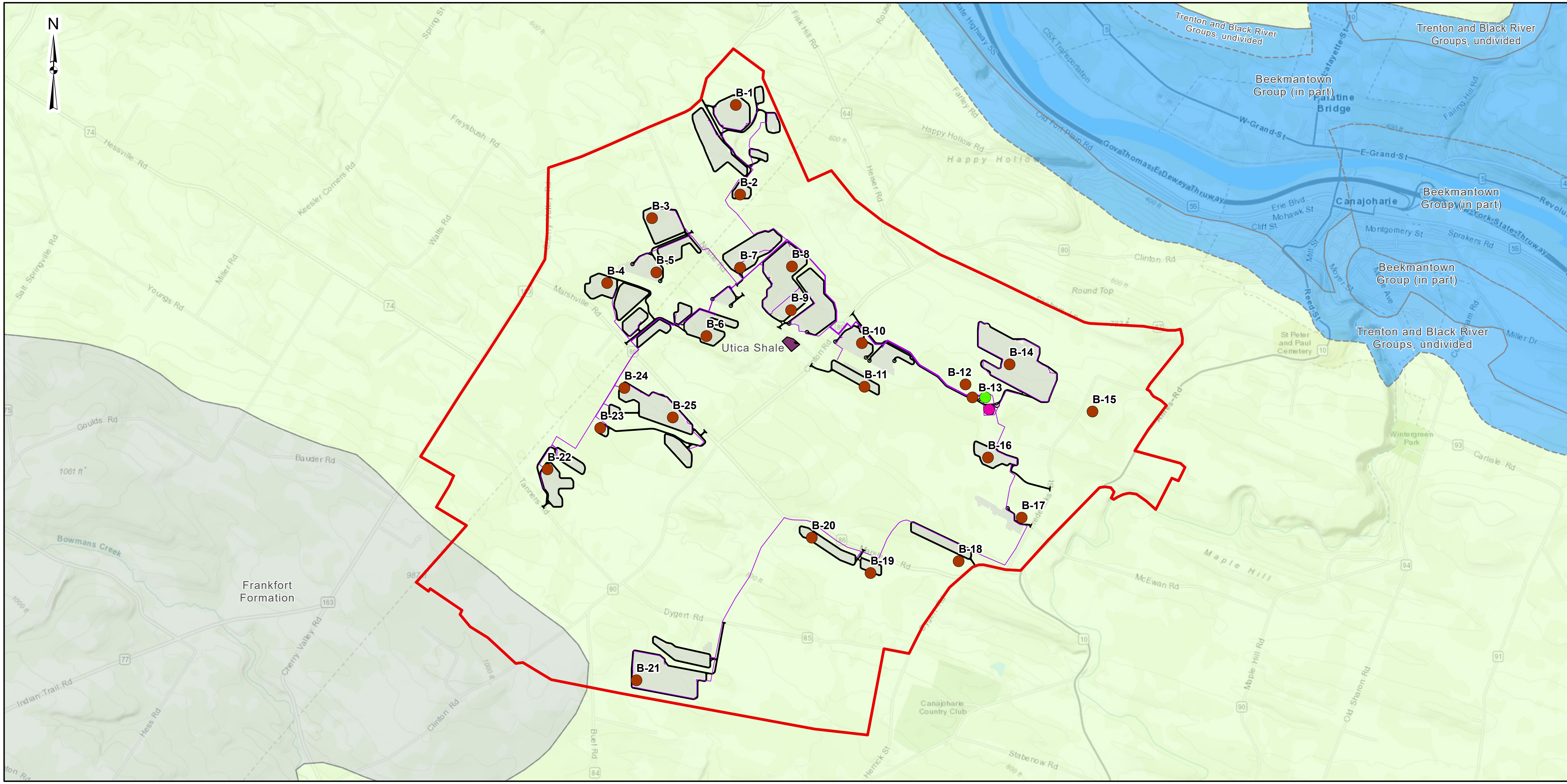

Project Site

Borings

Collection Substation

POI Substation

Buried Collection Lines

PV Panel Layout

Access Roads

OM Facility Parcel

USGS Geology

Geologic Units

black shale

dolostone (dolomite)

limestone

shale

DATA SOURCES:
SSURGO
ESRI WMS - World Aerial Imagery, OpenStreetMap

Feet
0 1,250 2,500 5,000

1:50,000

Project No.:	J5185006
Date:	Mar 2019
Drawn By:	PNM
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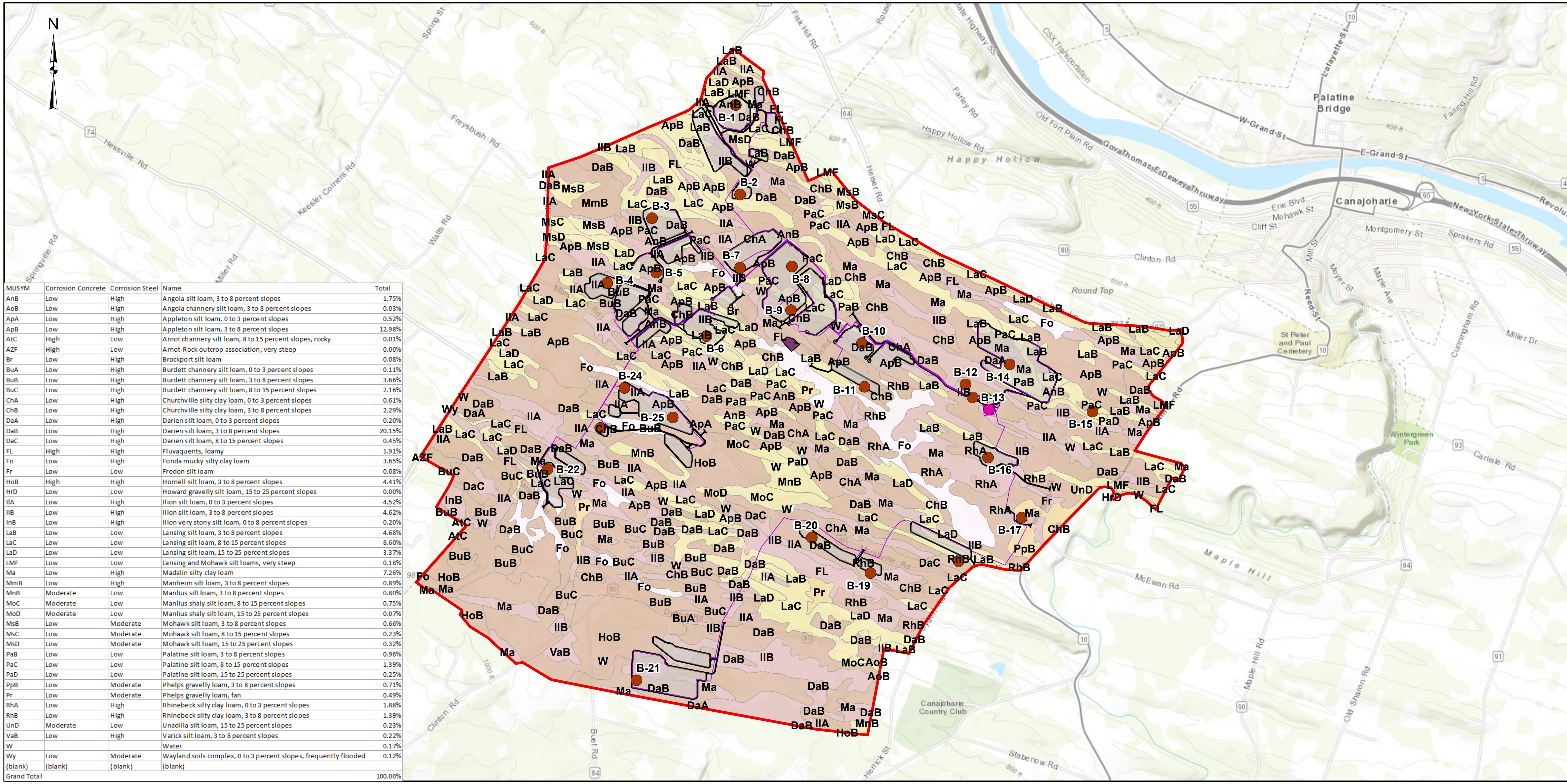
Bedrock Geology

Avangrid Renewables
Mohawk Solar Geotechnical Investigation
Marshville, NY

Exhibit

F



MUSYM	Corrosion Concrete	Corrosion Steel	Name	Total
AnB	Low	High	Angola silt loam, 3 to 8 percent slopes	1.75%
AoB	Low	High	Angola channery silt loam, 3 to 8 percent slopes	0.03%
ApA	Low	High	Appleton silt loam, 0 to 3 percent slopes	0.52%
ApB	Low	High	Appleton silt loam, 3 to 8 percent slopes	12.98%
AtC	High	Low	Arnot channery silt loam, 8 to 15 percent slopes, rocky	0.01%
AZF	High	Low	Arnot-Rock outcrop association, very steep	0.00%
Br	Low	High	Brockport silt loam	0.08%
BuA	Low	High	Burdett channery silt loam, 0 to 3 percent slopes	0.11%
BuB	Low	High	Burdett channery silt loam, 3 to 8 percent slopes	3.66%
BuC	Low	High	Burdett channery silt loam, 8 to 15 percent slopes	2.16%
ChA	Low	High	Churchville silty clay loam, 0 to 3 percent slopes	0.61%
ChB	Low	High	Churchville silty clay loam, 3 to 8 percent slopes	2.29%
DaA	Low	High	Darien silt loam, 0 to 3 percent slopes	0.20%
DaB	Low	High	Darien silt loam, 3 to 8 percent slopes	20.15%
DaC	Low	High	Darien silt loam, 8 to 15 percent slopes	0.45%
FL	High	High	Fluvaquents, loamy	1.91%
Fo	Low	High	Fonda mucky silty clay loam	3.65%
Fr	Low	Low	Fredon silt loam	0.08%
HoB	High	High	Hornell silt loam, 3 to 8 percent slopes	4.41%
HrD	Low	Low	Howard gravelly silt loam, 15 to 25 percent slopes	0.00%
IlA	Low	High	Ilion silt loam, 0 to 3 percent slopes	4.52%
IlB	Low	High	Ilion silt loam, 3 to 8 percent slopes	4.62%
InB	Low	High	Ilion very stony silt loam, 0 to 8 percent slopes	0.20%
LaB	Low	Low	Lansing silt loam, 3 to 8 percent slopes	4.68%
LaC	Low	Low	Lansing silt loam, 8 to 15 percent slopes	8.60%
LaD	Low	Low	Lansing silt loam, 15 to 25 percent slopes	3.37%
LMF	Low	Low	Lansing and Mohawk silt loams, very steep	0.18%
Ma	Low	High	Madalin silty clay loam	7.26%
MmB	Low	High	Manheim silt loam, 3 to 8 percent slopes	0.89%
MnB	Moderate	Low	Manlius silt loam, 3 to 8 percent slopes	0.80%
MoC	Moderate	Low	Manlius shaly silt loam, 8 to 15 percent slopes	0.75%
MoD	Moderate	Low	Manlius shaly silt loam, 15 to 25 percent slopes	0.07%
MsB	Low	Moderate	Mohawk silt loam, 3 to 8 percent slopes	0.66%
MsC	Low	Moderate	Mohawk silt loam, 8 to 15 percent slopes	0.23%
MsD	Low	Moderate	Mohawk silt loam, 15 to 25 percent slopes	0.32%
PaB	Low	Low	Palatine silt loam, 3 to 8 percent slopes	0.96%
PaC	Low	Low	Palatine silt loam, 8 to 15 percent slopes	1.39%
PaD	Low	Low	Palatine silt loam, 15 to 25 percent slopes	0.25%
PpB	Low	Moderate	Phelps gravelly loam, 3 to 8 percent slopes	0.71%
Pr	Low	Moderate	Phelps gravelly loam, fan	0.49%
RhA	Low	High	Rhinebeck silty clay loam, 0 to 3 percent slopes	1.88%
RhB	Low	High	Rhinebeck silty clay loam, 3 to 8 percent slopes	1.39%
UnD	Moderate	Low	Unadilla silt loam, 15 to 25 percent slopes	0.23%
VaB	Low	High	Varick silt loam, 3 to 8 percent slopes	0.22%
W			Water	0.17%
Wy	Low	Moderate	Wayland soils complex, 0 to 3 percent slopes, frequently flooded	0.12%
(blank)	(blank)	(blank)	(blank)	
Grand Total				100.00%

- Project Site
- Borings
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- Buried Collection Lines
- PV Panel Layout
- Access Roads
- OM Facility Parcel

Drainage Class - Dominant Condition

- Excessively drained
- Somewhat excessively drained
- Well drained
- Moderately well drained
- Somewhat poorly drained
- Poorly drained
- Very poorly drained

DATA SOURCES:
USGS Topo
SSURGO
ESRI WMS - World Aerial Imagery, OpenStreetMap

0 1,250 2,500 5,000 Feet

1:50,000

Project No.:	J5185006
Date:	Mar 2019
Drawn By:	PNM
Reviewed By:	JRG

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Soil Type

Avangrid Renewables
Mohawk Solar Geotechnical Investigation
Marshville, NY

Exhibit

G

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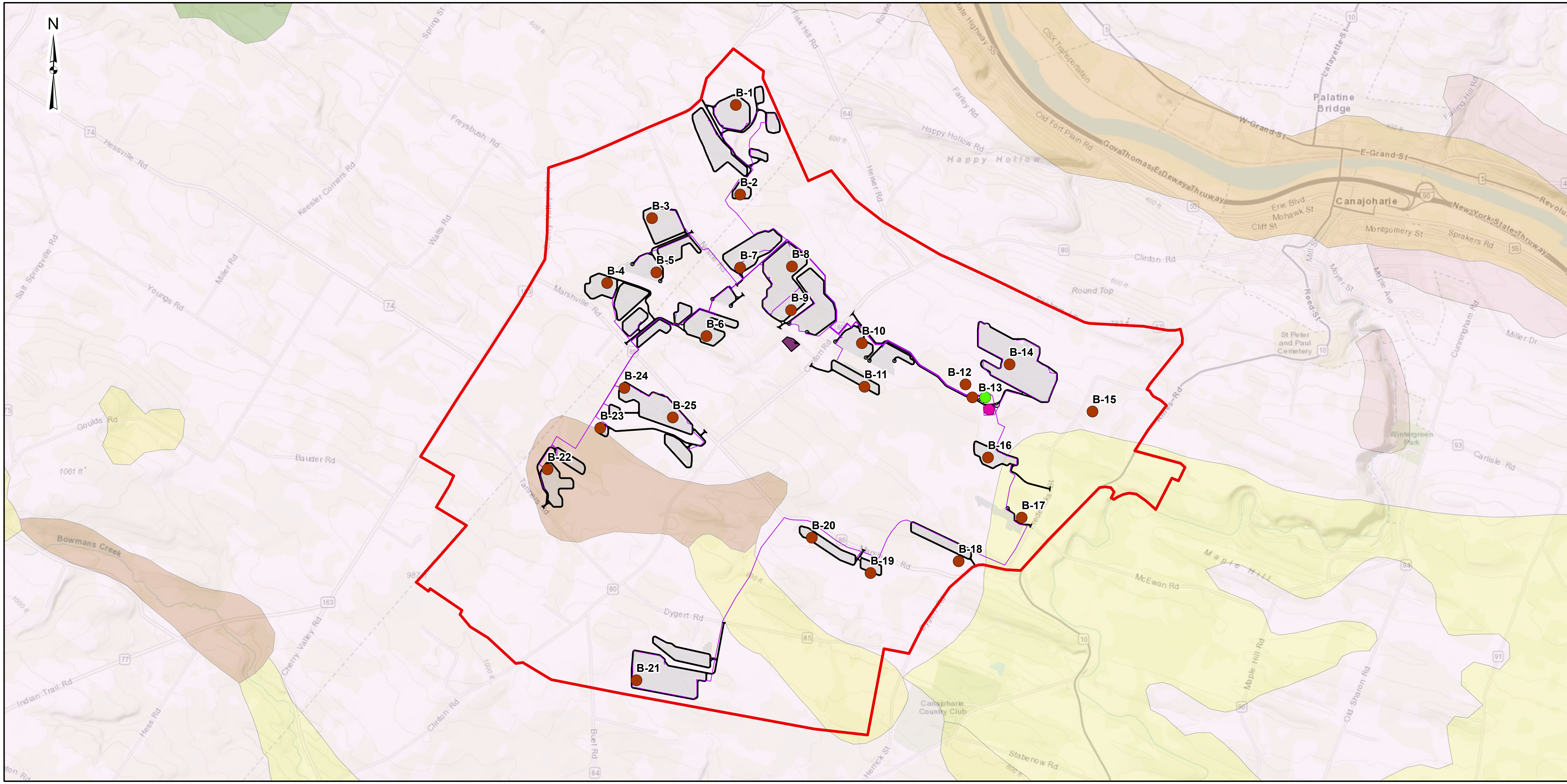

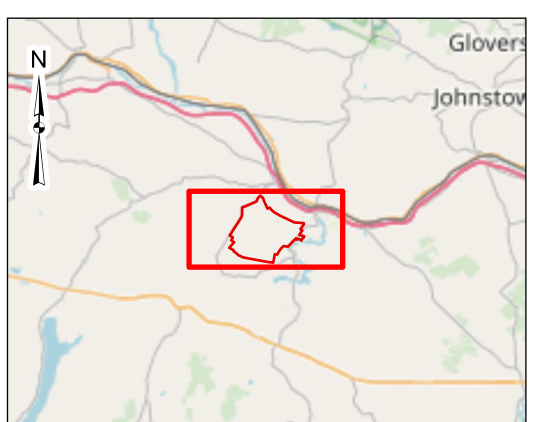

Project Site

Borings

Collection Substation

POI Substation

Buried Collection Lines

PV Panel Layout

Access Roads

OM Facility Parcel

Surficial Geology

MATERIAL, Name

- al, Recent alluvium
- k, Kame deposits
- km, Kame moraine
- lb, Lacustrine beach
- ld, Lacustrine delta
- ls, Lacustrine sand
- og, Outwash sand and gravel
- r, Bedrock
- t, Till

DATA SOURCES:
SSURGO
ESRI WMS - Topographic, OpenStreetMap
New York State Musuem

Feet
0 1,250 2,500 5,000

1:50,000

Project No.:	J5185006
Date:	Mar 2019
Drawn By:	PNM
Reviewed By:	JRG

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Surficial Geology

Avangrid Renewables
Mohawk Solar Geotechnical Investigation
Marshville, NY

Exhibit

H

APPENDIX A:
Preliminary Geotechnical Engineering Report

Terracon GeoReport

Preliminary Geotechnical Engineering Report

Mohawk Solar

Marshville, New York

September 4, 2018 - Rev. April 10, 2019

Terracon Project No. J5185006

Prepared for:

Avangrid Renewables
Portland, Oregon

Prepared by:

Terracon Consultants-NY, Inc.
Rochester, New York

September 4, 2018 - Rev. April 10, 2019

Avangrid Renewables
1125 NW Couch Street
Portland, Oregon 97209

Attn: Mr. Mark Mullen
P: (503) 241 3201
E: mark.mullen@avangrid.com

Re: Preliminary Geotechnical Engineering Report
Mohawk Solar
Marshville Road and Clinton Road
Marshville, New York
Terracon Project No. J5185006

Dear Mr. Mullen:

We have completed the Preliminary Geotechnical Engineering services for the above referenced project. This study was performed in general accordance with Terracon Proposal No. PJ5185006 dated February 28, 2018. This report presents the findings of the subsurface exploration and provides preliminary geotechnical recommendations concerning earthwork and the design and construction of foundations for the proposed project. These recommendations are preliminary in nature and should not be used for final design purposes.

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

Sincerely,
Terracon Consultants-NY, Inc.

Michele A. Fiorillo, P.E.
Geotechnical Department Manager

Lawrence J. Dwyer
Principal

C/C: Travis M. Wooden, E.I.T., Staff Engineer

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 logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

Preliminary Geotechnical Engineering Report

Mohawk Solar
Marshville Road and Clinton Road
Marshville, New York
Terracon Project No. J5185006
September 4, 2018 - Rev. April 10, 2019

INTRODUCTION

This report presents the results of our preliminary subsurface exploration and geotechnical engineering services performed for the proposed solar facility to be located at Marshville Road and Clinton Road in Marshville, New York. The purpose of these services is to provide preliminary information and preliminary geotechnical engineering recommendations relative to:

- Subsurface soil and rock conditions
- Groundwater conditions
- Site preparation and earthwork
- Excavation considerations
- Foundation design and construction
- Frost considerations
- Seismic site classification per IBC
- Access roadways

The geotechnical engineering scope of services for this project included the advancement of 25 test borings to depths ranging from approximately 8.5 to 15.4 feet below existing site grades.

This report references a web-based, GIS portal that has been developed specifically for this project using Terracon's proprietary GIS platform providing you with dynamic access to the information complied for this project. We have updated the GIS platform to include borings performed for this preliminary report. Access to this information can be gained by using this link: https://portal.gis.terracon.com/Login/?project=Avangrid_J5175143

The aerial and topographic overview maps showing the site and boring locations, as well as a map showing the soil parent material and depth to bedrock (based on the Soil Survey Geographic Database - SSURGO) are shown in the **Figures** section. The boring logs and 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 of this report.

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 approximate centroid of the site is located at: Latitude: 42.889213° N, Longitude: -74.640722° W See **Site Location**
Existing Improvements	Undeveloped in the project area
Current Ground Cover	Agricultural land
Existing Topography	The project area is gently sloping from about elevation (El) 660 feet to El 960 feet from northeast to southwest, respectively. The predominant slope of terrain is less than 2 percent.
Geology	The project is located within the south-middle portion of Montgomery County, and is part of the Hudson-Mohawk physiographic province. Surficial geologic deposits distributed throughout the Hudson Valley consist of almost all the types of glacial deposits that are associated with continental glaciation. Based upon the Surficial Geologic Map of New York, Hudson-Mohawk Sheet, the surficial deposits at the project site may be classified as “glacial till”. The Geologic Map of New York, Hudson-Mohawk Sheet, classifies the underlying bedrock as Utica Shale of the Middle Ordovician geologic period.

PROJECT DESCRIPTION

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

Item	Description
Project Description	The approximate 6,594-acre site will be developed as a 90 MW photovoltaic (PV) solar power facility. The power facility will also include invertors, transformers, switchgear and buried or overhead power lines. In addition, a substation may be a part of this project.
Planned Construction	We anticipate the solar array field will follow the existing site grade with minimum grading required to bring the site to finished grade. The PV array field is anticipated to be comprised of PV modules attached to a racking system supported on driven steel piers.

Item	Description
Foundation Loads	Axial compression and tension loads are anticipated to range from 1,500 lbs. to 4,000 lbs. ■ Shear (lateral) loads are anticipated to range from 1,000 lbs. to 3,500 lbs.
Expected Foundations	PV modules and invertors are expected to be supported on driven W-Section steel piers. Switchgear, transformers and other electronic equipment are expected to be supported on mat foundations. We anticipate there will be pole mounted equipment inside of the substation, and large diameter drilled shafts for dead-end transmission line structures within or near the substation.

GEOTECHNICAL CHARACTERIZATION

Subsurface Profile

We have developed a general characterization of the subsurface soil and groundwater conditions based upon our review of the data and our understanding of the geologic setting. The page providing a graphical representation of characterization (Geotechnical Model) can be found in the **Exploration Results**. The geotechnical characterization forms the basis of our geotechnical calculations and evaluation of site preparation and foundation options. As noted in the **General Comments**, the characterization is based upon widely-spaced exploration points across the site, and variations are likely.

Conditions encountered at each boring location are indicated on the individual boring logs shown in the **Exploration Results** section and are attached to this report. Stratification boundaries on the boring logs represent the approximate location of changes in native soil types; in situ, the transition between materials may be gradual.

Groundwater Conditions

The boreholes were observed while drilling and after completion for the presence and level of groundwater. Groundwater was not observed in the borings while drilling, or for the short duration the borings could remain open. However, this does not necessarily mean the borings terminated above groundwater. Due to the low permeability of the soils encountered in the 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.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may 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.

Soil Electrical Resistivity

On July 19, 2018, a Terracon field engineer completed *in-situ* soil electrical resistivity testing. Resistivity testing was performed in general accordance with ASTM G57 by the Wenner Four Probe Method using a MEGGER DET5/4R. Two locations with two soil resistivity lines were completed with electrodes spaced at approximately 1, 1.5, 2, 3, 4.5, 7, 10, 15, 22.5, 35, 50, 75, 100, and 150 feet. The two mutually perpendicular lines were performed originating at the approximate center of the substation borings B-12 and B-13. The *in-situ* resistivity test results are tabulated below:

Electrical Resistivity (ohm-cm)				
Electrode Spacing (ft.)	B-12		B-13	
	Line 1 (N-S)	Line 2 (E-W)	Line 1 (N-S)	Line 2 (E-W)
1	14,133	12,965	13,061	13,884
1.5	17,581	15,168	16,288	14,823
2	12,065	14,823	15,359	12,563
3	10,594	11,548	10,152	11,083
4.5	10,936	10,273	11,298	11,402
7	11,596	12,306	9,893	11,154
10	11,835	8,637	12,544	10,916
15	11,519	8,273	14,421	11,290
22.5	11,117	7,153	10,514	12,367
35	12,333	6,589	13,808	10,188
50	9,260	6,914	16,566	9,767
75	10,040	7,354	15,656	10,629
100	9,192	5,860	10,974	12,869
150	10,830	8,532	12,841	8,934

Various factors may influence field resistivity testing results, including proximity to overhead power lines, metal chain-link fence, other electrical equipment, flooding, the presence of large gravel or cobbles, variation in soil density, or the degree of compaction, moisture content, soil constituent solubility, and temperature. Field resistivity values may vary depending upon season, precipitation, and other conditions, which may be different from those at the time of testing. Field resistivity values should be evaluated based on the measured data in conjunction with published values for the material.

GEOTECHNICAL OVERVIEW

Subsurface conditions below the site can be generalized as loose to medium dense sand, silt, and clay underlain by shale bedrock, which was encountered at depths ranging from approximately 2 to 10 feet below ground surface.

We recommend the photovoltaic solar panels be supported on driven piers or ground screws (Krinner, or similar). The shallow bedrock encountered across the site may prevent the installation of driven steel piers or ground screws to a depth sufficient enough to resist overturning or uplift forces. At these locations, predrilling may be required to properly set and install the steel piers. Design recommendations and construction considerations for the foundations are presented in the **Foundations** section of this report. These recommendations are preliminary in nature and should not be used for final design purposes.

The **General Comments** section provides an understanding of the report limitations.

EARTHWORK

We anticipate earthwork will include the removal of topsoil, and the placement of fill for site grading. The following sections provide recommendations for use in the preparation of specifications for the work. These recommendations include critical quality criteria as necessary to render the site in the state considered in our geotechnical engineering evaluation for foundations, and access roadways.

Site Preparation

Topsoil, organic subsoil (subsoil with visible roots), and any otherwise unsuitable or disturbed materials should be removed prior to placing any required fill. The exposed subgrade should be proof-compacted with a heavy vibratory roller in static mode. Unstable subgrades should be removed and replaced with compacted Structural Fill, as necessary. Structural Fill may then be placed to attain the required grade. Should Crushed Stone be used instead of Structural Fill, a geotextile separation fabric (Mirafi 140, or similar) should be placed on the native material prior to placing the Crushed Stone.

Stripped materials consisting of vegetation and organic materials should be wasted from the site, or used to revegetate landscaped areas or exposed slopes after completion of grading operations. If it is necessary to dispose of organic materials on-site, they should be placed in non-structural areas, and in fill sections not exceeding 5 feet in height.

It is our understanding that no to minimal grading will be performed within the solar arrays. Proposed grades will generally follow existing natural ground elevations. Except in areas to be excavated, stump holes and other holes caused by removal of tree roots and obstructions in wooded areas should be backfilled with suitable material and compacted in accordance with **Fill Compaction Requirements**.

Native soils will be susceptible to disturbance due to a combination of precipitation/surface runoff and construction activity. A flat bladed bucket may be appropriate when excavating the native silts and clays in order to reduce disturbance to the soil at subgrade level.

Reuse of On-Site Materials

The laboratory moisture test results indicate that natural water contents for the samples tested ranged from 7 to 28 percent. The average natural water content for the soils in the upper 8 to 10 feet is approximately 17 percent. The average natural water content for the denser soils (generally encountered below a depth of 8 to 10 feet) is approximately 6 percent. Please note that the moisture tests were performed on samples obtained from the split-spoon sampler, which may not be completely representative of the in-situ material moisture content.

Based on our visual classification of the materials, it is our opinion that the surficial native silts and clays are generally less desirable for reuse as Structural Fill due to their elevated fines content. Imported material meeting the gradation requirements below for Structural Fill below should be used instead.

It is our opinion that excavated non-organic soils (clean from roots, oversized particles, and vegetation) may likely be suitable for reuse as Common Fill to attain proposed subgrade elevation, provided during construction proper compaction and optimum moisture content can be achieved. If construction is performed during the wet season, it is possible that the moisture content of the excavated soils is in excess of the optimum moisture content required to achieve proper compaction, and that proper compaction of the on-site soils may be very difficult to achieve. We anticipate that imported Structural Fill may then be required. Saturated soils which cannot achieve compaction should be removed or used in non-structural areas where significant post construction settlement is acceptable. The contractor is ultimately responsible for moisture conditioning of fill/backfill materials to achieve proper compaction.

Fill Material Types

Fill and backfill should meet the following material property requirements:

Fill Type [1]	USCS Classification	Acceptable Location for Placement
Structural Fill [2]	GW, GW-GM, SW, SW-SM, SP, GP	All locations and elevations. Imported structural fill should meet the gradation requirements in Note 2 (below). Cobbles and boulders should be culled prior to reuse.
Common Fill [3]	Varies	Common fill may be used for general site grading. Common fill should not be used under settlement or frost-sensitive structures. Cobbles and boulders should be culled prior to reuse.
Non-Frost Susceptible (NFS) Fill [4]	GW, GP, SW, SP	All locations and elevations.
Crushed Stone	GP	For use on wet subgrades, as a replacement Structural Fill and NFS Fill (if desired), and as drainage fill. Should be uniform ¾-inch angular crushed stone wrapped in a geotextile separation fabric (Mirafi 140N, or similar).
Lean Concrete	Not applicable	Can be used to level subgrades between foundations and native soils. Lean concrete should be flowable, self-compacting concrete with a compressive strength between 300 and 2,000 psi.

1. Compacted fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used. Fill should not be placed on a frozen subgrade.
2. Imported Structural Fill should meet the following gradation specifications:

Percent Passing by Weight

Sieve Size	Structural Fill
6″	100
3″	70 to 100
2″	(100)*
¾″	45 to 95
No. 4	30 to 90
No. 10	25 to 80
No. 40	10 to 50
No. 200	0 to 12

* Maximum 2-inch particle size within 12 inches of concrete elements

3. Common Fill should have a maximum particle size of 6 inches and no more than 25 percent by weight passing the No. 200 sieve.
4. NFS Fill should contain less than 5 percent material passing No. 200 sieve size.

Fill Compaction Requirements

Structural and Common Fill should meet the following compaction requirements.

Item	Description
Maximum Fill Lift Thickness	■ 12 inches or less in loose thickness when heavy, self-propelled compaction equipment is used. ■ 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used.
Compaction Requirements [1]	95 percent maximum modified Proctor dry density (ASTM D1557, Method C).
Moisture Content – Granular Material	Workable moisture levels.

1. We recommend that fill be tested for moisture content and compaction during placement. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested, as required, until the specified moisture and compaction requirements are achieved.

Utility Trench Backfill

All trench excavations should be made with sufficient working space to permit construction including backfill placement and compaction. As utility trenches can provide a conduit for groundwater flow, trenches should be backfilled with material that approximately matches the permeability characteristics of the surrounding soil. Should higher permeability fill be used in trenches, consideration should be given to installing seepage collars and/or check dams to reduce the likelihood of migration of water through the trenches.

Grading and Drainage

We anticipate that minor cuts and fills, less than two feet, or so, may be required to achieve finished grade throughout portions of the site. Adequate drainage should be provided at the site to reduce the likelihood of an increase in moisture content of the foundation soils. Surface drainage would likely consist of limited swales to control erosion and flow of runoff towards the equipment.

Design of permanent soil slopes should be based on a grade no steeper than 3H:1V, which would be suitable for slopes in the native soils or for fill slopes of embankment fill. Steeper slopes should be evaluated by the geotechnical engineer and would likely require stone slope protection and/or reinforcement.

We recommend that permanent slope surfaces not subjected to possible scour be vegetated to reduce erosion. Vegetated slopes should be protected with erosion mats until the vegetation is established. Permanent slope subject to scour potential should be covered with riprap stone underlain by bedding material and a geotextile separation fabric (Mirafi 140N, or equivalent). Temporary sedimentation and erosion control methods should be implemented during construction and left in place until the slope surfaces have become stabilized.

Surface drainage should be provided away from the edge of foundations (i.e. equipment pads) to reduce moisture transmission into the subgrade.

Earthwork Construction Considerations

Although the exposed soil subgrade is anticipated to be relatively stable upon initial exposure, unstable subgrade conditions could develop during general construction operations, particularly if the soils are wetted and/or subjected to repetitive construction traffic. Should unstable subgrade conditions develop, stabilization measures will need to be employed.

Construction traffic over the completed subgrade should be avoided to the extent practical. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. If the subgrade should become frozen, wet, or disturbed, the affected material should be removed, or should be scarified, moisture conditioned, and recompacted.

As a minimum, temporary excavations should be sloped or braced, as required by Occupational Safety and Health Administration (OSHA) regulations, to provide stability and safe working conditions. The 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.

Terracon should be retained during the construction phase of the project to observe earthwork and to perform necessary tests and observations during subgrade preparation; proof-rolling; placement and compaction of controlled compacted fills; backfilling of excavations in the completed subgrade; and for construction of foundations.

Construction Observation and Testing

The earthwork efforts should be monitored under the direction of the Geotechnical Engineer. Monitoring should include documentation of adequate removal of vegetation and top soil, proofrolling and mitigation of areas delineated by the proofroll to require mitigation.

Each lift of compacted fill should be tested, evaluated, and reworked as necessary until approved by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content at a frequency of at least one test for every 2,500 square feet of compacted fill in the building areas and 5,000 square feet in pavement areas. One density and water content test for every 50 linear feet of compacted utility trench backfill.

In areas of foundation excavations, the bearing subgrade should be evaluated under the direction of the Geotechnical Engineer. In the event that unanticipated conditions are encountered, the Geotechnical Engineer should prescribe mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer's evaluation of subsurface conditions, including assessing variations and associated design changes.

FOUNDATIONS

Competent bedrock, confirmed by bedrock coring was encountered in B-7, B-8, B-15 and B-25 at depths of approximately 9 to 10 feet below existing ground surface. Decomposed bedrock was encountered in most the borings across the project site at shallower depths.

We expect driven piers could encounter refusal above the required embedment depth. Therefore, pre-drilling of oversized holes to allow for the installation of the piers to the required embedment depth may be required. Ground screws (Krinner or similar) may also be used to support the racking system that supports the panels. If ground screws cannot penetrate the bedrock sufficiently, we recommend installation include pre-drilling of a pilot hole or an oversize hole to facilitate the screw installation. We recommend the foundation design assume piers will be installed in pre-drilled oversized holes backfilled with grout or lean concrete, where shallow bedrock is encountered.

Design recommendations and construction considerations for the recommended foundation systems are presented below. These recommendations are preliminary in nature and should not be used for final design purposes.

Pier Design Recommendations

The panels may be supported on driven piers, which should be structurally designed to resist compression, uplift, and bending forces. The project Structural Engineer should determine the actual pier lengths considering frost heave forces, and other loads on the piers.

The soils on this site are anticipated to be frost susceptible. Frozen soils can exert a heaving force on the piers. If the anchorage of the foundations and the deadweight of the structures are not sufficient to resist these forces, they can cause uplift to structures. In cold weather climates, design to resist frost heave forces exerted on foundations is often the limiting factor in the foundation design. Specifically, pier lengths will need to be long enough to counteract potential heave forces in the seasonal frost zone. Thawing soils typically have significantly less strength than frozen or fully thawed soils. Therefore, the upper four feet of soils should be ignored for use in resisting axial tension or compression loads. Fully thawed soils in the upper 4 feet are suitable for resistance of lateral loads, but at the reduced values provided in the table below. The lateral load parameters in the table below have already been reduced to account for their reduced strength condition under spring thaw conditions. For design purposes, weathered bedrock should be treated as soil. Competent bedrock is not frost susceptible.

Based on our review of soil samples and available published soil maps of the area, we recommend an adfreeze stress of 1,000 psf be considered when determining the frost heave load on a pier. The box perimeter of the pier (two times the depth plus two times the flange width) acting over a maximum depth of 4 feet should be considered when determining the frost heave load on a pier. Lateral capacity of vertically installed driven piers is primarily dependent on the type and relative density/consistency of the soil against which the pier is pushed by the horizontal load(s). Pier deflection under lateral loading should not exceed ½ inch at the ground surface.

We recommend the pier embedment depth not be determined by using the Tsytovich empirical rule of 3 x FD (Frost Depth) as this empirical rule would only apply to locations with permafrost, and there is no permafrost at this site.

We anticipate the design length of the pier will be primarily dependent on the embedment/lateral capacity required to resist live loading, such as the combination of wind and ice loads. Technical specifications should be prepared that require material and installation detail submittals, and proof of experience in pier installation. A summary of our preliminary design parameters is provided in the table below.

Soil Description	p-y model [3]	Depth (ft.)	Ultimate End Bearing Capacity (psf) [1]	Ultimate Side Friction (psf) [2]	Effective Unit Weight, γ' (pcf) [3]	Friction Angle, Φ' [3]	Modulus Parameter (soil), k (pci)[3,4]
Native Soils/Decomposed Shale	Sand (Reese)	0 to 4	---	---	110	30°	25
		4 to 15	4,000	500	120	32°	90
Bedrock [4]	Weak Rock (Reese)	2 to 15.4	8,000	4,000	140	---	---[4]

1. A minimum factor of safety of at least 3 should be applied to end bearing.
2. Applicable to compression and uplift loading. Contribution to pier capacity from within the frost zone depth of 4 feet should be ignored. A factor of safety of at least 2 should be applied to the side resistance.
3. For use with L-Pile™ design program.
4. We recommend a preliminary Uniaxial Compressive Strength (q_u) values of 2,000 psi and an Equivalent Rock Mass Modulus (E_m) value of 100,000 psi.

Load carrying capacity of the piers will vary when installed by different methods, i.e. driving vs pre-drilled, grout filled holes. Production pier testing should be performed on piers installed using each installation method to confirm their capability to carry the foundation loads.

Oversize Holes Design Recommendations

If/where refusal is encountered, we recommend pier design be completed assuming the piers will be installed within an oversized hole drilled into the bedrock using percussion drilling methods to the minimum design embedment depth prior to the installation of piers. For this approach, the pier would be set in the pre-drilled hole and then the hole is backfilled using cement grout, i.e. controlled low-strength material (CLSM). This method is appropriate for the anticipated shallow bedrock conditions encountered on the southern portion of the site and may result in shorter embedment depths, as compared to driven piers, due to increased side resistance along the pier length within the bedrock.

We anticipate and recommend a pier load test program will be developed to better assess the ultimate skin friction and L-Pile parameters for design of the pier embedment depths on this project. If compression loading will control the design embedment depths of the piers, we would also recommend compression load testing be performed as part of the pier load test program. The design values obtained from a pier load test program are anticipated to be less conservative than the values provided in this report, and the factor of safety is also expected to be reduced. Design values from a pier load test program will be contingent upon obtaining a minimum drive time for each pier driven based on a specific hammer and equipment used during the driving of the piers during the pier load test program. If a different pier hammer and equipment are used by the contractor during construction, the minimum drive time will be adjusted accordingly.

Pier Construction Considerations

Shallow decomposed to competent shale bedrock was encountered in B-1, B-4, B-7, B-8, B-15 and B-25 and is expected throughout the site. Difficult drilling/driving conditions as a result of encountering dense soils/decomposed shale bedrock, and possible large cobbles and/or boulders should be anticipated on a majority of the site. Should shallow refusal be encountered, uplift load testing on the pier should be performed, and pre-drilling or alternative foundations should be considered. Water may become temporarily perched above the relatively low permeability soils and/or bedrock. Grout backfill should be placed using tremie methods if water is present in the bottom of the drill hole.

Ground Screw Foundation Recommendations

The photovoltaic panels may be supported on a ground screw system (Krinner, or similar) deriving support from the native soil and/or bedrock. The ground screws should be structurally designed to resist vertical loading and uplift, and also bending forces. The upper 4 feet should not be relied upon for resistance because it is within the active frost zone.

The ground screws should be designed by the design-build engineer. Full-scale pull-out and lateral load testing should be performed on selected screws to assess uplift and lateral capacities. Lateral capacity of vertically installed ground screws is primarily dependent on the type and relative density/consistency of the soil against which the screw is pushed by the horizontal load.

Ground Screw Construction Considerations

Ground screws should be installed by a contractor experienced in this type of foundation construction and licensed by the manufacturer of the foundation components. The allowable load carrying capacity of ground screws depends mainly on the final torque resistance. Each screw installation should be independently monitored and the depth and final torque resistance checked against the calculations by the engineer for the manufacturer. Ground screws may need to penetrate the native soils into the underlying weathered or competent shale bedrock to achieve the required resistance. As discussed above for driven pier, if the ground screw cannot penetrate the bedrock to the minimum embedment depth required, we expect that pre-drilling holes to allow for the installation of piers would be the most economical foundation alternative. The designer and contractor should keep these aspects in mind in completing the design and choosing installation methods.

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 7-10.

Description	Value
2015 International Building Code Site Classification	D [2]
Site Latitude	42.8892° N
Site Longitude	-74.6407° W
S_{DS} Spectral Acceleration for a Short Period [3]	0.194g
S_{D1} Spectral Acceleration for a 1-Second Period [3]	0.112g

1. Seismic site classification in general accordance with the *2015 International Building Code*, which refers to ASCE 7-10.
2. The 2015 International Building Code (IBC) uses a site profile extending to a depth of 100 feet for Seismic Site Classification. Borings at this site were extended to a maximum depth of approximately 15 feet. The site properties below the boring depth 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.
3. These values were obtained using online seismic design maps and tools provided by the USGS (http://earthquake.usgs.gov/hazards/designmaps/).

ACCESS ROADWAYS

General Comments

Surficial materials below the topsoil at the site primarily consists of mixtures of silt, sand, and clay. It is expected that the proposed site grades will be established near the existing site grades using small amounts of engineered fill material similar to the surficial soils to level the planned access road areas. Reportedly, the planned access roads will experience light traffic load, primarily during construction stage, with very little maintenance traffic thereafter.

We understand that proposed access roads consist of aggregate sections with no asphalt or concrete surface. Recommendations are presented below for two alternative aggregate sections: one assuming the aggregate section placed over stable, proofrolled native subgrade materials; the second for the case where achieving a stabilized subgrade may be difficult or not possible due to weather conditions at the time of construction.

The access road area subgrades should be properly sloped to direct water from beneath the drive area gravel section toward the edge, and/or down gradient. Collected water should be channeled away from the access road. Adequate sloping of the gravel surface will minimize the potential for ponding of water on or within proximity to the drive area, which will shorten the life of the unpaved roadways.

Aggregate sections presented in this report are considered minimal sections based upon the expected traffic and the composite subgrade conditions; however, they are expected to function with periodic maintenance if good drainage is provided and maintained.

Aggregate Section Over Stable Subgrade

Access road subgrades should be prepared in accordance with the recommendations provided in **EARTHWORK** section, above, including proof-rolling and removal/replacement of soft/unstable areas identified by the proofrolling. These subgrades should be prepared immediately prior to the time of aggregate placement to reduce the risk of disturbance due to weather or construction vehicle traffic. If this cannot be done, the subgrades should be reevaluated by a qualified Geotechnical Engineer for disturbance or softening immediately prior to aggregate placement. For subgrades prepared in accordance with **EARTHWORK** section, we recommend that the aggregate section consist of a minimum 12 inches of NYSDOT Type 2 Subbase Course Aggregate compacted to 95 percent of its maximum dry density as determined by the ASTM D1557 test procedure (Modified Proctor Test).

To maintain surface drainage, the subgrade should have a minimum ¼-inch per foot slope and the final grade adjacent to the road should slope down from road edges at a minimum 2 percent.

Aggregate Section Over Weak Subgrades

The requested access roads could also be established over a relatively weak subgrade (i.e. CBR less than 3), which would allow placement of the roadway section over on-site soils with minimal subgrade preparation activities, without the need for proofrolling with a heavy construction equipment.

For this scenario, we recommend that the aggregate section consist of a minimum of 12 inches of compacted NYSDOT Type 2 Subbase Course Aggregate placed over high-performance geotextile Mirafi RS380i, or equivalent, installed over the existing subgrade. The high-performance geotextile will provide reinforcement strength to the aggregate material and will limit migration from the underlying subgrade, which may contribute to its degradation and loss of strength.

In areas where fill materials are required to level the proposed pavement subgrade, we recommend that these fill materials be compacted at least to the density of the existing subgrade soils.

Access Road Maintenance

Regardless of the design, unsurfaced roadways will display varying levels of wear and deterioration. We recommend implementation of a site inspection program at a frequency of at least once per year to verify the adequacy of the roadways. Preventative measures should be applied as needed for erosion control and regrading. An initial site inspection should be completed approximately three months following construction. For planning purposes, we recommend assuming that over time the placement of additional aggregate material will likely be required to level depressions and long-term rutting. These areas should be filled with additional aggregate rather than scalping of material from adjacent areas.

Shoulder build-up on both sides of proposed roadways should match the road surface elevation and slope outwards at a minimum grade of 10 percent for five feet. Surface drainage should be provided away from the edge of roadways to reduce lateral moisture transmission into the subgrade.

When potholes, ruts, depressions or yielding subgrades develop, they must be repaired prior to applying additional traffic loads. Typical repairs could consist of placing additional Crushed Stone in ruts or depressed areas and, in some cases, complete removal of Crushed Stone surfacing, repair of unstable subgrade, and replacement of the Crushed Stone surfacing. Potholes and depressions should not be filled by blading adjacent ridges or high areas into the depressed areas. New material should be added to the depressed areas as they develop. Failure to make timely repairs will result in more rapid deterioration of the roadways, making more extensive repairs necessary.

GENERAL COMMENTS

Our 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 the final report, to provide 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 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.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Field Exploration

Exploration Number	Boring Depth (feet)	Location
25 (B-1 to B-25)	8.5 to 15.4	Solar array

Exploration Layout and Elevations: Unless otherwise noted, Terracon personnel provided the exploration layout. Coordinates were obtained with a handheld GPS unit (estimated horizontal accuracy of about ±10 feet) and approximate elevations were obtained by interpolation from the 2-foot contour plan provided for this project, which is also included on-line on our GIS platform. If elevations and a more precise exploration layout are desired, we recommend explorations be surveyed following completion of fieldwork.

Subsurface Exploration Procedures: We advanced the borings with a track-mounted rotary drill rig using hollow stem flight augers. Five to six samples were obtained in the upper 10 to 12 feet of each boring and at intervals of 5 feet thereafter. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon is 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 middle 12 inches of a normal 24-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. We observed and recorded groundwater levels during drilling and sampling. For safety purposes, all borings were backfilled with auger cuttings after their completion.

Upon encountering bedrock in boring B-7, B-8, B-15, and B-25, rock coring using NQ rock core barrel was performed. A 5-foot long rock core was performed at each of these borings. Water was used as a drilling fluid for rock coring and the spent water was discharged on site. The percent recovery and the Rock Quality Designation (RQD) for the recovered sample were recorded. The percent recovery is the ratio of the length of rock recovered over the length of coring. The RQD is the ratio of the sum of the length of recovered rock core 4 inches or greater in length, over the length of rock core recovered. The RQD is useful is providing a qualitative and quantitative evaluation of the engineering quality of bedrock. Representative portions of the soil samples and rock cores recovered from the test borings were transported to our office for visual classification by a geotechnical engineer.

The sampling depths, penetration distances, and other sampling information are recorded on the field boring logs. The samples are placed in appropriate containers and taken to our soil laboratory for testing and classification by a geotechnical engineer. Our exploration team prepares field boring logs as part of the drilling operations. These field logs include visual classifications of the materials encountered during drilling and our interpretation of the subsurface conditions between samples.

Final boring logs are 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.

Resistivity Testing: Field soil resistivity testing is performed in accordance with the Wenner Four Probe method. The test was completed along mutually perpendicular lines within the proposed substation location.

Laboratory Testing

The project engineer reviews the field data and assigns various laboratory tests to better understand the engineering properties of the various soil and rock strata as necessary for this project. Procedural standards noted below are for reference to methodology in general. In some cases, variations to methods are 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
- Thermal Conductivity of Soils by Thermal Needle Probe Procedure (ASTM D5334)
- Soil pH Analysis (ASTM G51)
- Water Soluble Sulfate Ion Concentration (ASTM C1580)
- Sulfide Concentration (AWWA 4500-S D)
- Chloride Ion in Water (ASTM D512)
- Total Salts / Conductivity (AWWA 2540)
- Oxidation – Reduction Potential (AWWA 2580)
- Soil Electrical Resistivity (ASTM G57)

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

Rock classification was conducted using locally accepted practices for engineering purposes; petrographic analysis may reveal other rock types. Boring log rock classification is determined using the Description of Rock Properties.

EXPLORATION PLAN

EXPLORATION PLAN

Mohawk Solar Geotechnical Investigation ■ Marshville, NY
April 10, 2018 ■ Terracon Project No. J5185006

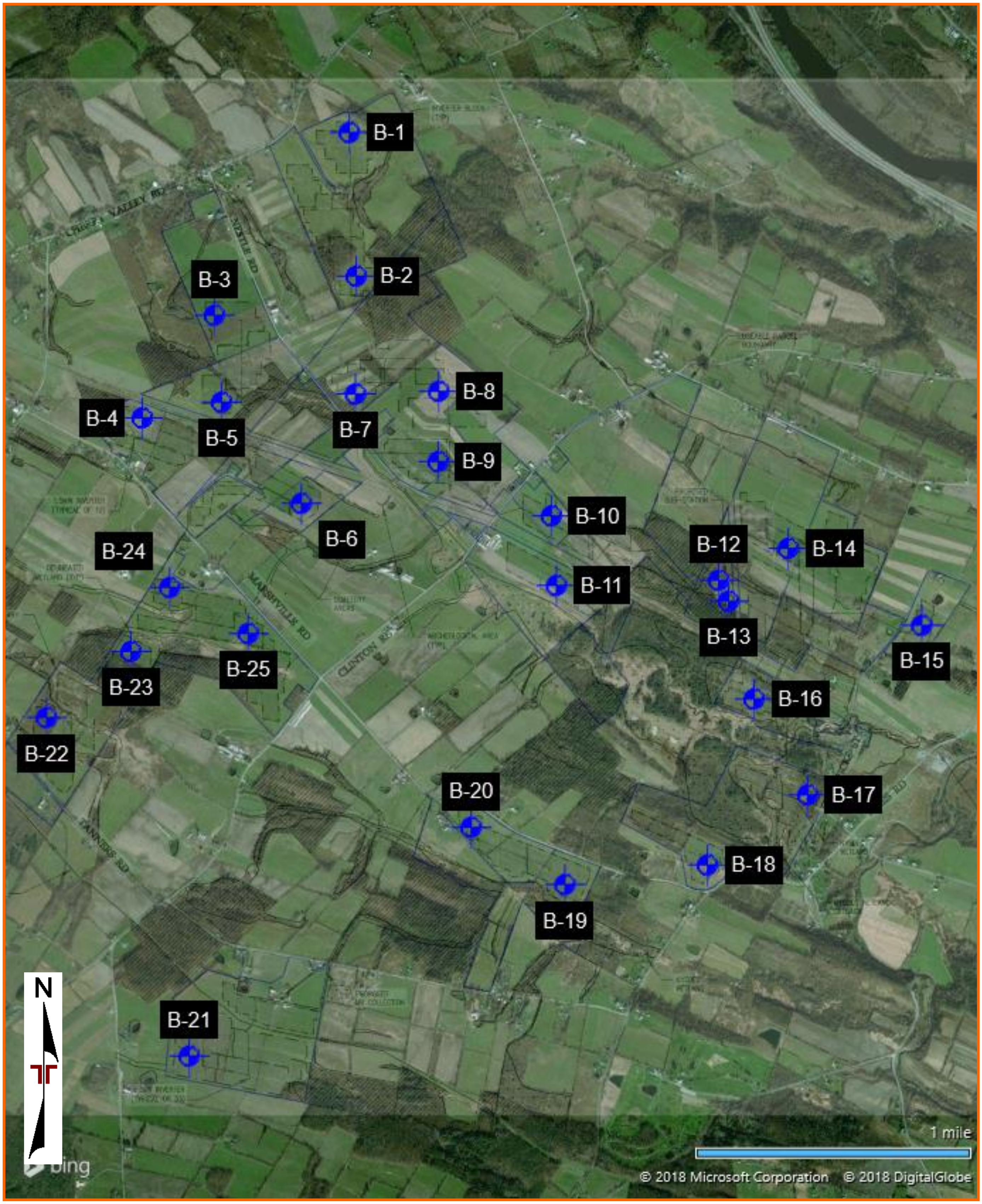
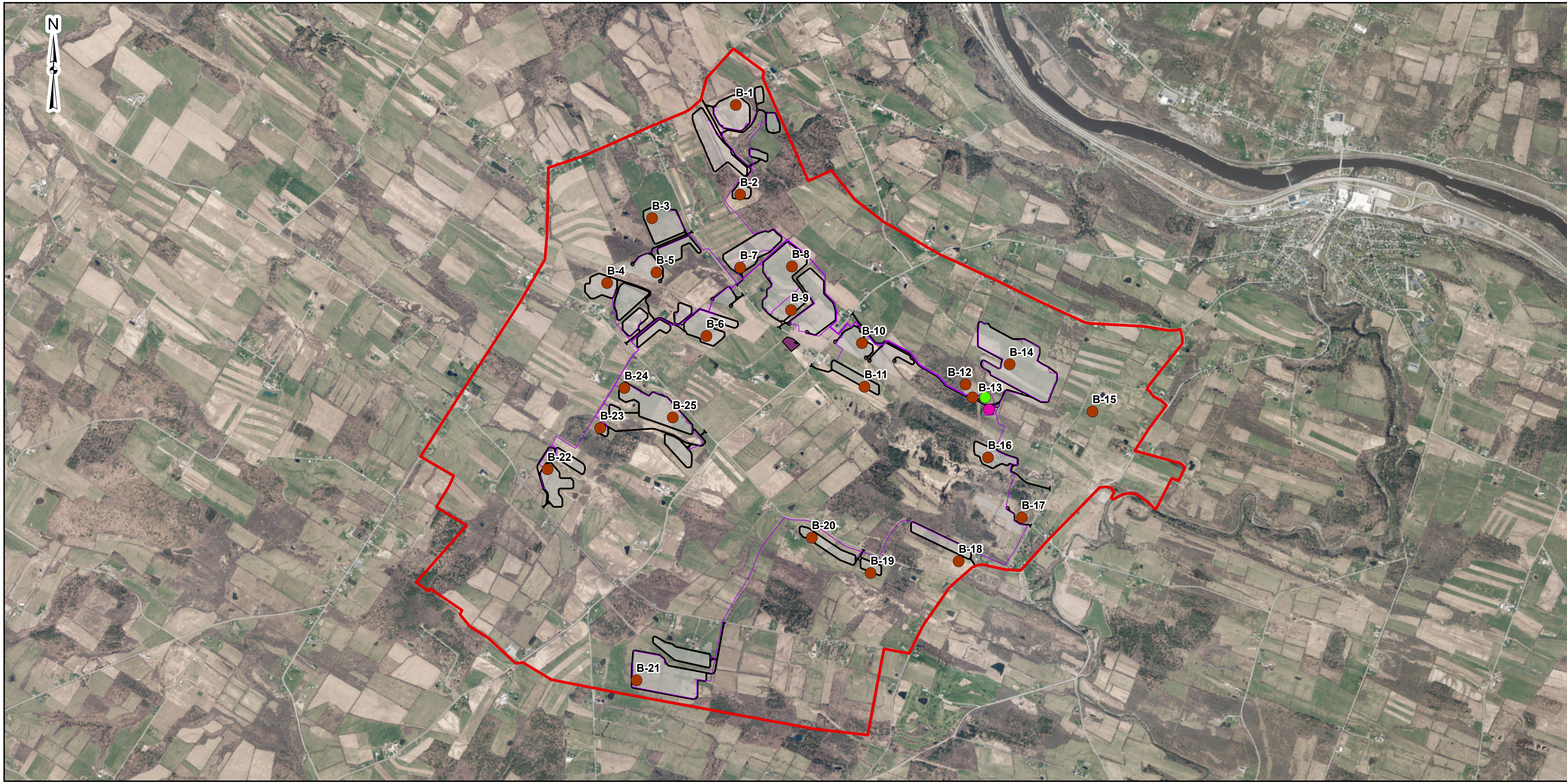


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

FIGURES:



- Project Site
- Borings
- Collection Substation
- POI Substation
- Buried Collection Lines
- PV Panel Layout
- Access Roads
- OM Facility Parcel

DATA SOURCES:
ESRI WMS - World Aerial Imagery, OpenStreetMap

Feet
0 1,250 2,500 5,000

1:50,000

Project No.:	J5185006
Date:	Mar 2019
Drawn By:	PNM
Reviewed By:	JRG

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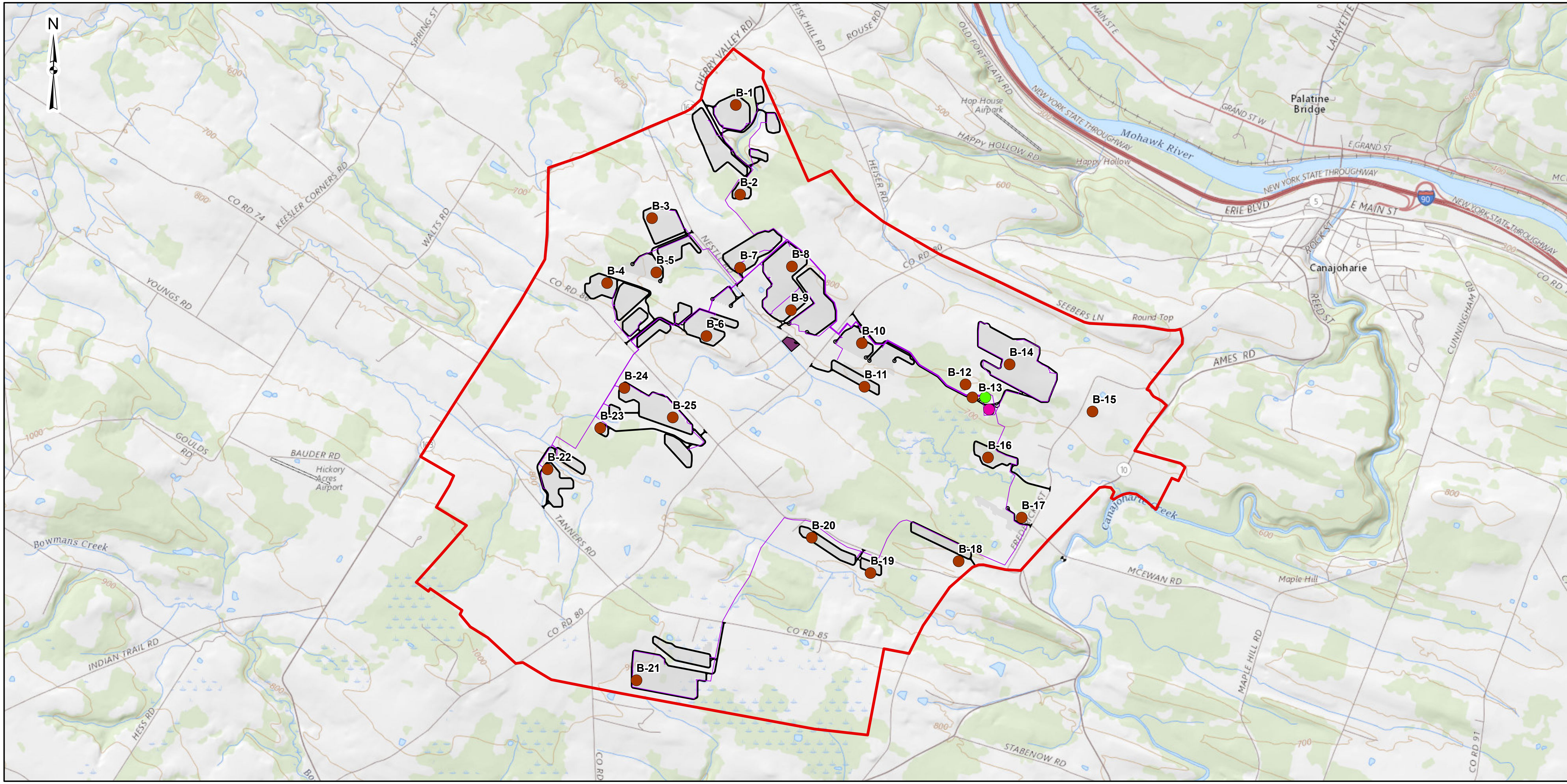
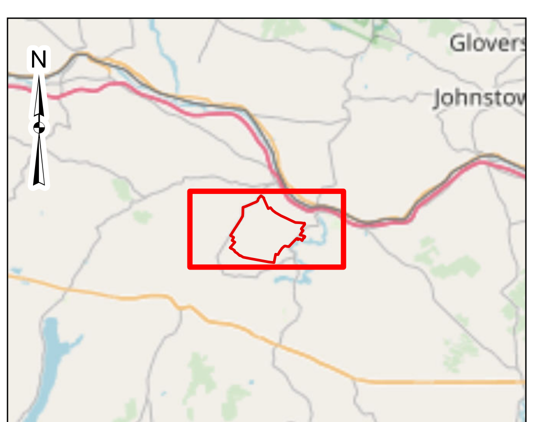
Aerial Overview

Avangrid Renewables
Mohawk Solar Geotechnical Investigation
Marshville, NY

Exhibit

A





- Project Site
- Borings
- Collection Substation
- POI Substation
- Buried Collection Lines
- PV Panel Layout
- Access Roads
- OM Facility Parcel

DATA SOURCES:
USGS Topo
ESRI WMS - OpenStreetMap

Feet
0 1,250 2,500 5,000

1:50,000

Project No.:	J5185006
Date:	Mar 2019
Drawn By:	PNM
Reviewed By:	JRG

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Topographic Overview

Avangrid Renewables
Mohawk Solar Geotechnical Investigation
Marshville, NY

Exhibit

B

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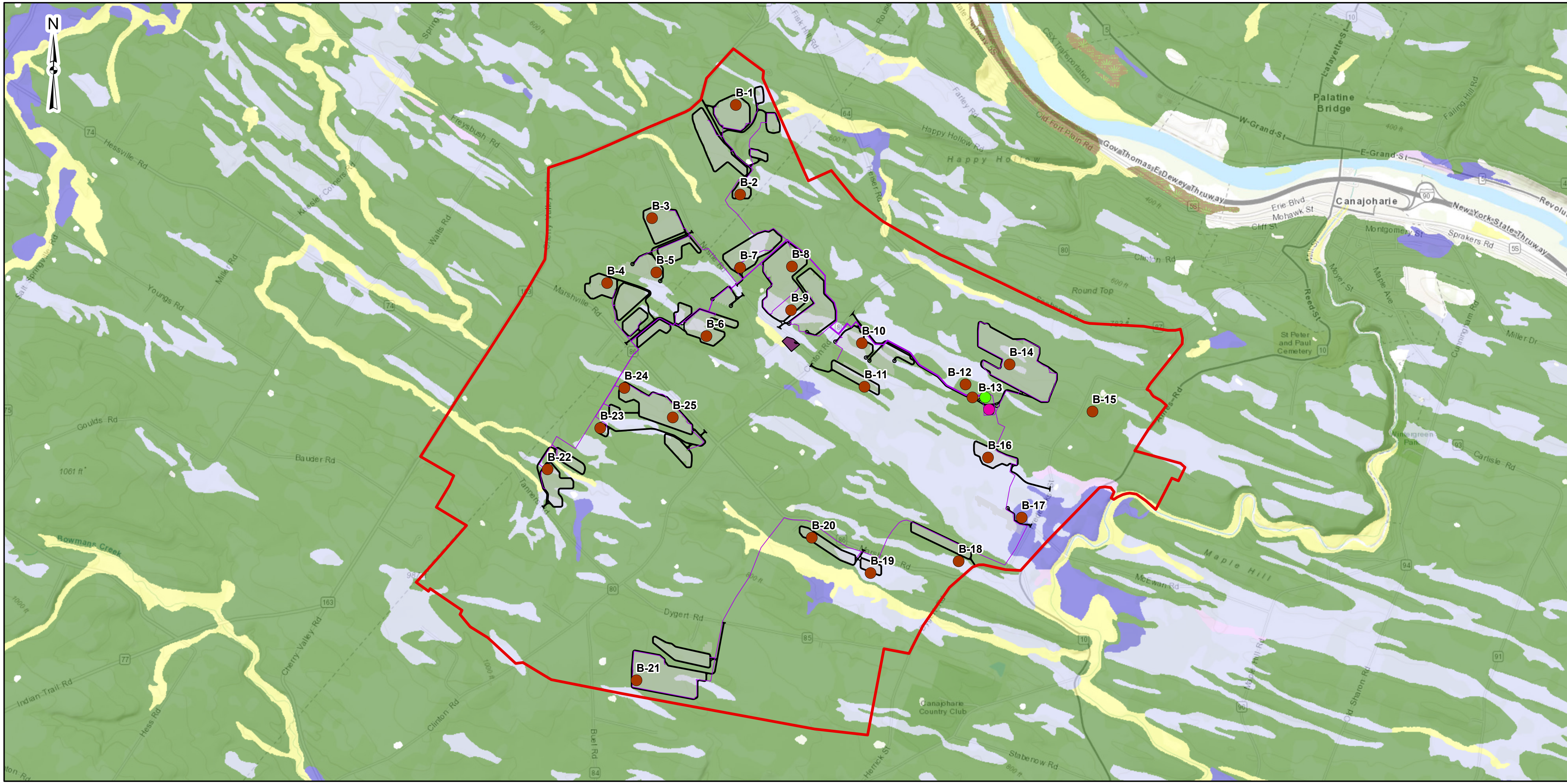

- Project Site
- Borings
- Collection Substation
- POI Substation
- Buried Collection Lines
- PV Panel Layout
- Access Roads
- OM Facility Parcel

Soil Parent Materials

- Alluvium
- Eolian deposits
- Organic material
- Till
- Glaciofluvial deposits
- Glaciolacustrine deposits

DATA SOURCES:
SSURGO
ESRI WMS - Topographic, OpenStreetMap

0 1,250 2,500 5,000 Feet

1:50,000

Project No.:	J5185006
Date:	Mar 2019
Drawn By:	PNM
Reviewed By:	JRG

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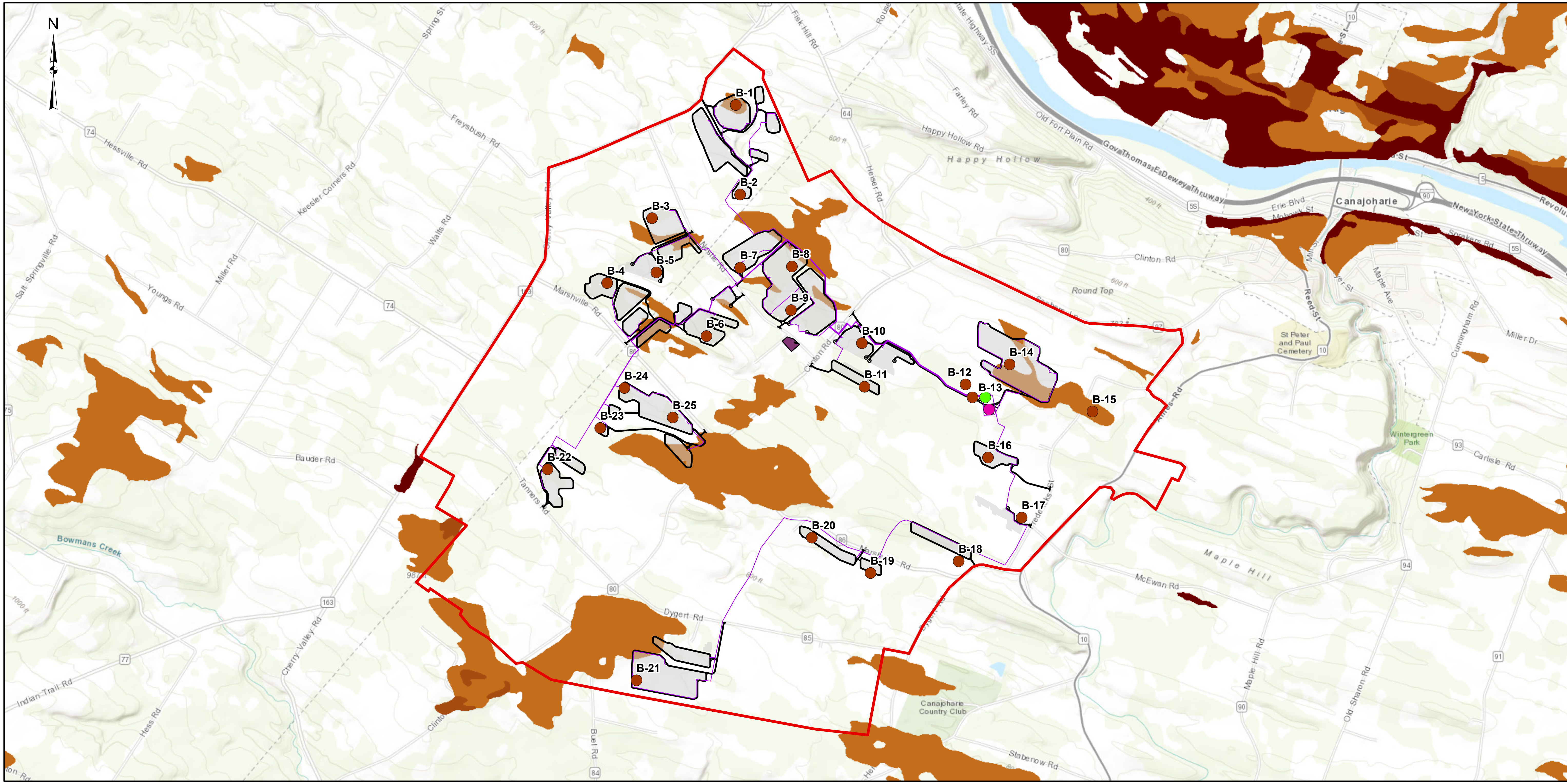
Soil Parent Materials

Avangrid Renewables
Mohawk Solar Geotechnical Investigation
Marshville, NY

Exhibit

C

M:\GIS\REGC_J5185006_Avangrid_MohawkSolar\J5185006_Avangrid_MohawkSolar\Maps\ExplorationPlanExhibits\J5185006_Avangrid_MohawkSolar.aprx



Project Site
Borings
Collection Substation
POI Substation
Buried Collection Lines
PV Panel Layout
Access Roads
OM Facility Parcel

Minimum Depth to Bedrock

- Exposed bedrock
- Shallow rock (depth not defined)
- Less than 1 foot
- 1 to 2 feet
- 2 to 3 feet
- 3 to 4 feet
- 4 to 5 feet
- 5 to 6 feet
- 6 to 7 feet
- 7 to 8 feet
- 8 to 9 feet
- More than 9 feet

DATA SOURCES:
SSURGO
ESRI WMS - Topographic, OpenStreetMap

Feet
0 1,250 2,500 5,000

1:50,000

Project No.:	J5185006
Date:	Mar 2019
Drawn By:	PNM
Reviewed By:	JRG

Terracon
77 Sundial Ave, Suite 401W Manchester, NH 03103
PH. (603) 647 9700 terracon.com

Depth to Bedrock

Avangrid Renewables
Mohawk Solar Geotechnical Investigation
Marshville, NY

Exhibit

D

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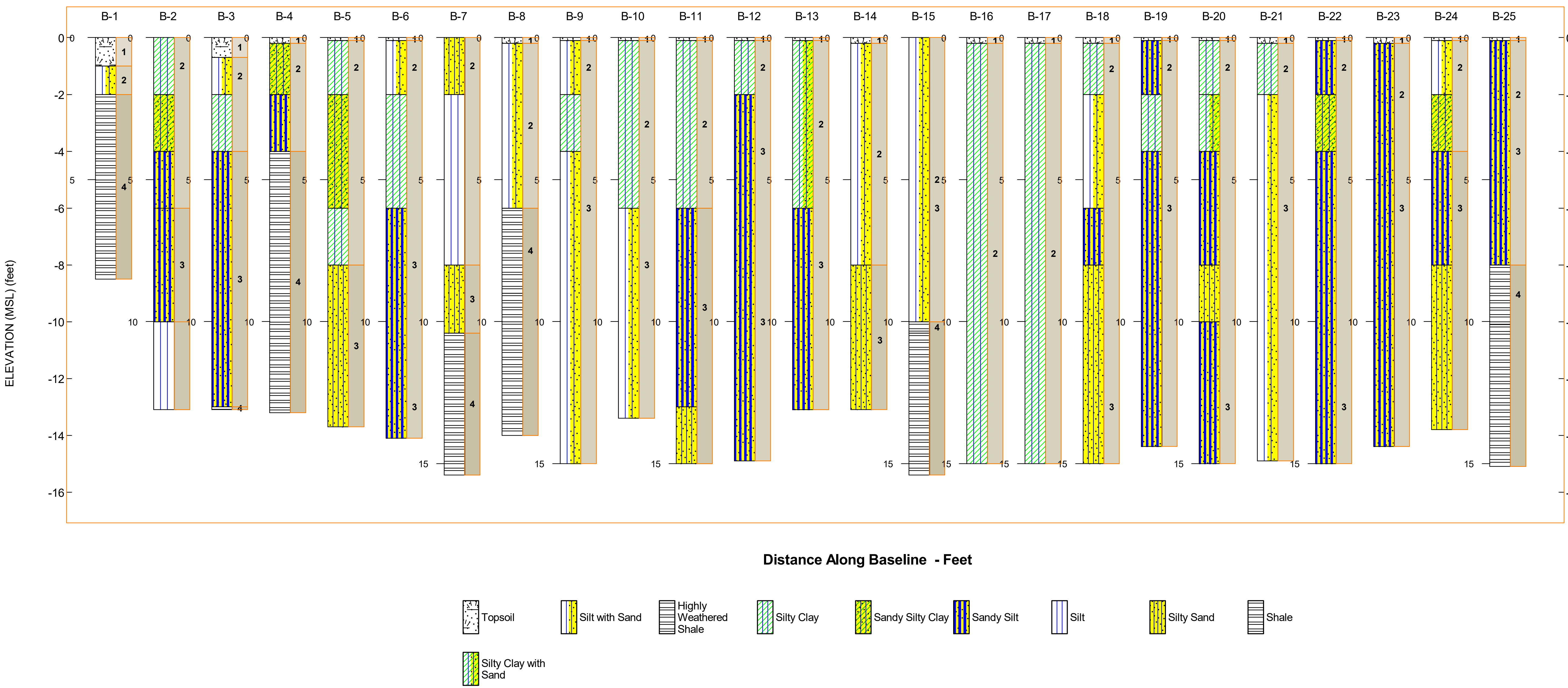
EXPLORATION RESULTS

GEOTECHNICAL MODEL

Mohawk Solar Geotechnical Investigation ■ Marshville, NY

9/4/2018 ■Terracon Project No. J5185006



Model Layer	Termed	General Description
1	**Topsoil**	Topsoil
2	**Native soil 1**	Native Soil - Loose to Medium Dense
3	**Native Soil 2**	Native Soil - Dense to Very Dense
4	**Shale Bedrock**	Decomposed Shale Bedrock and Shale Bedrock

NOTES:
See boring logs for more detailed conditions specific to each boring.
GeoModel provided for illustration purposes only. Actual subsurface conditions between borings will vary.

Layering shown on this figure has been developed by the geotechnical engineer for purposes of characterization of subsurface conditions as required for the subsequent geotechnical engineering for this project.

LEGEND
- First Water Observation
- Second Water Observation
- Final Water Observation

BORING LOG NO. B-1

PROJECT: Mohawk Solar Geotechnical Investigation

CLIENT: Avangrid Renewables Portland, OR

SITE: Various locations throughout town Marshville, NY

LOCATION See Exploration Plan

Latitude: 42.9146° Longitude: -74.641°

Approximate Surface Elev: 672 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH / ELEVATION (Ft.)	DESCRIPTION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RDQ (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
1		1.0 / 671+/-	**TOPSOIL**								
2		2.0 / 670+/-	**SILT WITH SAND (ML)**, trace gravel, trace organic matter, brown, loose			X	12	2-3-4-9 N=7			
4		8.5 / 663.5+/-	**DECOMPOSED SHALE**, black and brown			X	10	23-50/5"			
				5		X	4	50/5"			
						X	4	50/5"			
							0	50/0"			

Sample Spoon Penetration refusal Encountered at 8.0' BGS.
Auger Penetration refusal Encountered at 8.5 Feet

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

Hammer Type: Automatic

Advancement Method:
4.25 inch ID Hollow Stem Augers and 2 inch OD Split Barrel Sampler

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

None Encountered at Completion of Sampling

Terracon
15 Marway Cir, Ste 2B
Rochester, NY

Boring Started: 06-01-2018	Boring Completed: 06-01-2018
Drill Rig: Diedrich D-50	Driller: J. Tojdowski
Project No.: J5185006	

BORING LOG NO. B-2

PROJECT: Mohawk Solar Geotechnical Investigation

CLIENT: Avangrid Renewables
Portland, OR

SITE: Various locations throughout town
Marshville, NY

LOCATION See Exploration Plan

Latitude: 42.907° Longitude: -74.6405°

Approximate Surface Elev: 738 (Ft.) +/-

MODEL LAYER	DESCRIPTION	DEPTH (Ft.)	ELEVATION (Ft.)
2	**SANDY LEAN CLAY (CL)**, trace sand, trace organic matter, brown, medium stiff	2.0	736+/-
2	**SANDY SILTY CLAY (CL-ML)**, trace gravel, orange and brown, stiff	4.0	734+/-
3	**SANDY SILT WITH GRAVEL (ML)**, trace clay, brown, medium dense to dense Contains frequent cobble fragments	10.0	728+/-
3	**SILT (ML)**, with highly weathered shale fragments, black, very dense	13.1	725+/-

Sample Spoon Penetration refusal Encountered at 13.0' BGS. Auger Penetration refusal Encountered at 13.1 Feet

SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RDQ (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
Split spoon	13	3-3-4-4 N=7		13	
Split spoon	16	5-5-10-11 N=15		15	
Split spoon	17	3-2-8-10 N=10		11	
Split spoon	15	10-18-18-27 N=36			
Split spoon	8	4-18-33-46 N=51			
Split spoon	12	7-18-34-50/1" N=52		6	
	0	50/0"			

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

Hammer Type: Automatic

Advancement Method:
4.25 inch ID Hollow Stem Augers and 2 inch OD Split Barrel Sampler

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

None Encountered at Completion of Sampling

Terracon
15 Marway Cir, Ste 2B
Rochester, NY

Boring Started: 06-04-2018	Boring Completed: 06-04-2018
Drill Rig: Diedrich D-50	Driller: J. Tojdowski
Project No.: J5185006	

BORING LOG NO. B-3

PROJECT: Mohawk Solar Geotechnical Investigation

CLIENT: Avangrid Renewables Portland, OR

SITE: Various locations throughout town Marshville, NY

LOCATION See Exploration Plan

Latitude: 42.905° Longitude: -74.6507°

Approximate Surface Elev: 778 (Ft.) +/-

MODEL LAYER	DEPTH (Ft.)	ELEVATION (Ft.)	DESCRIPTION
1	0.7	777.5+/-	**TOPSOIL**
2	2.0	776+/-	**SILT WITH SAND (ML)**, trace clay, brown, loose
2	4.0	774+/-	**SILTY CLAY (CL-ML)**, trace sand, brown, very stiff
3	13.0	765+/-	**SANDY SILT (ML)**, trace clay, trace gravel, occasional cobble fragments, brown, dense to very dense
4	13.1	765+/-	**SHALE**, black

Sample Spoon Penetration Refusal Encountered at 13.1 Feet

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RDQ (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
0–2		Split spoon	12	2-2-4-4 N=6			
2–4		Split spoon	11	5-6-14-8 N=20			
4–6		Split spoon	12	15-21-9-22 N=30			
6–8		Split spoon	24	28-24-25-30 N=49			
8–10		Split spoon	11	20-15-23-50/5" N=38			
10		Split spoon	1	50/1"			
13		Split spoon	1	50/1"			

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

Hammer Type: Automatic

Advancement Method:
4.25 inch ID Hollow Stem Augers and 2 inch OD Split Barrel Sampler

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

None Encountered at Completion of Sampling

Terracon
15 Marway Cir, Ste 2B
Rochester, NY

Boring Started: 06-04-2018	Boring Completed: 06-04-2018
Drill Rig: Diedrich D-50	Driller: J. Tojdowski
Project No.: J5185006	

BORING LOG NO. B-4

PROJECT: Mohawk Solar Geotechnical Investigation

CLIENT: Avangrid Renewables
Portland, OR

SITE: Various locations throughout town
Marshville, NY

LOCATION See Exploration Plan

Latitude: 42.8995° Longitude: -74.6559°

Approximate Surface Elev: 824 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH / MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RDQ (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
1		0.2 **TOPSOIL**	824+/-								
2		**SANDY SILTY CLAY (CL-ML)**, trace shale fragments, brown, medium stiff				X	12	2-3-3-4 N=6			
		2.0	822+/-								
2		**SANDY SILT (ML)**, brown and black, medium dense				X	6	9-11-15-15 N=26			
		4.0	820+/-								
4		**SHALE**, black				X	9	6-47-50/1"			
				5		X	0	50/2"			
						X	0	50/2"			
				10		X	2	27-50/2"			
		13.2	811+/-			X	2	50/2"			

Sample Spoon Penetration Refusal Encountered at 13.2 Feet

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

Hammer Type: Automatic

Advancement Method:
4.25 inch ID Hollow Stem Augers and 2 inch OD Split Barrel Sampler

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

None Encountered at Completion of Sampling

Terracon
15 Marway Cir, Ste 2B
Rochester, NY

Boring Started: 06-05-2018 | Boring Completed: 06-05-2018

Drill Rig: Diedrich D-50 | Driller: J. Tojdowski

Project No.: J5185006

BORING LOG NO. B-5

PROJECT: Mohawk Solar Geotechnical Investigation

CLIENT: Avangrid Renewables Portland, OR

SITE: Various locations throughout town Marshville, NY

LOCATION See Exploration Plan

Latitude: 42.9004° Longitude: -74.6502°

Approximate Surface Elev: 788 (Ft.) +/-

MODEL LAYER	DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RDQ (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
1	0.1	**TOPSOIL**	788+/-								
2		**SILTY CLAY (CL-ML)**, trace sand, trace gravel, trace organic matter, brown and black, medium stiff				X	13	2-3-4-4 N=7		18	
2	2.0	**SANDY SILTY CLAY (CL-ML)**, trace shale fragments, dark brown, very stiff	786+/-			X	12	4-12-7-8 N=19		13	
2				5		X	8	9-10-11-13 N=21			31-17-14
2	6.0	**SILTY CLAY (CL-ML)**, trace sand, trace gravel, ocasional cobble fragments, dark brown, very stiff	782+/-			X	24	14-15-14-19 N=29		13	
3	8.0	**SILTY SAND WITH GRAVEL (SM)**, trace cobble fragments, brown, dense to very dense	780+/-			X	12	17-22-33-37 N=55		6	
3		Becomes dark brown to black, contains trace shale fragments		10		X	8	12-21-23-22 N=44			
3	13.7		774.5+/-			X	6	42-50/2"		5	

Sample Spoon Penetration Refusal Encountered at 13.7 Feet

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

Hammer Type: Automatic

Advancement Method:
4.25 inch ID Hollow Stem Augers and 2 inch OD Split Barrel Sampler

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

None Encountered at Completion of Sampling

Terracon
15 Marway Cir, Ste 2B
Rochester, NY

Boring Started: 06-05-2018	Boring Completed: 06-05-2018
Drill Rig: Diedrich D-50	Driller: J. Tojdowski
Project No.: J5185006	

BORING LOG NO. B-6

PROJECT: Mohawk Solar Geotechnical Investigation

CLIENT: Avangrid Renewables
Portland, OR

SITE: Various locations throughout town
Marshville, NY

LOCATION See Exploration Plan

Latitude: 42.895° Longitude: -74.6444°

Approximate Surface Elev: 792 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH / DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RDQ (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
1		0.1 **TOPSOIL**	792+/-								
		SILT WITH SAND (ML), trace gravel, trace organic matter, brown, loose				X	16	3-4-4-4 N=8			
		2.0	790+/-								
		SILTY CLAY (CL-ML), trace sand, dark brown, medium stiff to stiff				X	17	4-4-5-6 N=9			
		Becomes brown, contains trace shale fragments		5		X	8	3-2-3-8 N=5			
		6.0	786+/-								
2		**SANDY SILT (ML)**, trace clay, brown, medium dense to dense				X	17	5-6-12-18 N=18			
3 2		Contains frequent cobble fragments				X	18	14-22-17-23 N=39			
				10		X	6	35-50/5"			
3		Becomes brown-black				X	11	48-49-50/1"			
		14.1	778+/-								

Sample Spoon Penetration Refusal Encountered at 14.1 Feet

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

Hammer Type: Automatic

Advancement Method:
4.25 inch ID Hollow Stem Augers and 2 inch OD Split Barrel Sampler

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

None Encountered at Completion of Sampling

Terracon
15 Marway Cir, Ste 2B
Rochester, NY

Boring Started: 06-05-2018	Boring Completed: 06-05-2018
Drill Rig: Diedrich D-50	Driller: J. Tojdowski
Project No.: J5185006	

BORING LOG NO. B-7

PROJECT: Mohawk Solar Geotechnical Investigation

CLIENT: Avangrid Renewables
Portland, OR

SITE: Various locations throughout town
Marshville, NY

LOCATION See Exploration Plan

Latitude: 42.9008° Longitude: -74.6405°

Approximate Surface Elev: 736 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH / ELEVATION (Ft.)	DESCRIPTION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RDQ (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
2		2.0 / 734+/-	**SILTY SAND (SM)**, trace gravel, brown, loose				9	2-3-3-4 N=6			
		8.0 / 728+/-	**SILT (ML)**, trace sand, trace clay, brown, loose to medium dense				14	3-4-6-5 N=10			
				5			15	5-4-4-5 N=8			
							18	5-5-6-4 N=11			
3		10.4 / 725.5+/-	**SILTY SAND (SM)**, trace shale fragments, brown and black, very dense				8	3-9-50/2"			
				10			1	50/5"			
4		15.4 / 720.5+/-	**SHALE**, black, fine-grained, moderately fractured, thin bedding, unweathered, medium strong, occasionally laminated	15			53	RUN # 1 10.4' - 15.4'	70		
			Boring Terminated at 15.4 Feet								

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

Hammer Type: Automatic

Advancement Method:
4.25 inch ID Hollow Stem Augers and 2 inch OD Split Barrel Sampler to 10.4' BGS.
NQ-'2' size rock core barrel 10.4' - 15.4' BGS

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

None Encountered at Completion of Sampling

Terracon
15 Marway Cir, Ste 2B
Rochester, NY

Boring Started: 06-06-2018	Boring Completed: 06-06-2018
Drill Rig: Diedrich D-50	Driller: J. Tojdowski
Project No.: J5185006	

BORING LOG NO. B-8

PROJECT: Mohawk Solar Geotechnical Investigation

CLIENT: Avangrid Renewables
Portland, OR

SITE: Various locations throughout town
Marshville, NY

LOCATION See Exploration Plan

Latitude: 42.9009° Longitude: -74.6345°

Approximate Surface Elev: 788 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RDQ (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
1	0.2	**TOPSOIL**	788+/-								
2		**SILT WITH SAND (ML)**, trace gravel, brown, medium dense					12	2-5-6-6 N=11			
							12	4-6-10-11 N=16			
				5			11	8-10-7-11 N=17			
	6.0		782+/-								
4		**DECOMPOSED SHALE ROCK**, black					5	23-50/2"			
							0	50/0"			
	9.0		779+/-								
		SHALE, black, fine-grained, close fracture spacing, very thin bedding, unweathered, medium strong		10			59	RUN # 1 9.0' - 14.0'	46		
	14.0		774+/-								

Boring Terminated at 14 Feet

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

Hammer Type: Automatic

Advancement Method:
4.25 inch ID Hollow Stem Augers and 2 inch OD Split Barrel Sampler to 10.4' BGS.
NQ-'2' size rock core barrel 9.0' - 14.0' BGS

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

None Encountered at Completion of Sampling

Terracon
15 Marway Cir, Ste 2B
Rochester, NY

Boring Started: 06-06-2018	Boring Completed: 06-06-2018
Drill Rig: Diedrich D-50	Driller: J. Tojdowski
Project No.: J5185006	

BORING LOG NO. B-9

PROJECT: Mohawk Solar Geotechnical Investigation

CLIENT: Avangrid Renewables
Portland, OR

SITE: Various locations throughout town
Marshville, NY

LOCATION See Exploration Plan

Latitude: 42.8972° Longitude: -74.6346°

Approximate Surface Elev: 714 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RDQ (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
1	0.1	**TOPSOIL**	714+/-			X	7	3-15-50/1"			
		SILT WITH SAND (ML), trace gravel trace cobble fragments, dark brown, very dense									
	2.0		712+/-								
		SILTY CLAY (CL-ML), trace sand, brown gray, very stiff				X	20	5-9-10-10 N=19			
	4.0		710+/-								
		SILT WITH SAND (ML), trace gravel, brown, medium dense to dense		5		X	12	5-7-9-11 N=16			
3		Contains occasional shale fragments				X	7	14-14-16-20 N=30			
2						X	12	10-18-29-28 N=47			
3		Becomes black, contains numerous shale fragments		10		X	9	5-12-13-12 N=25			
						X	13	9-11-12-12 N=23			
	15.0		699+/-	15							

Boring Terminated at 15 Feet

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

Hammer Type: Automatic

Advancement Method:
4.25 inch ID Hollow Stem Augers and 2 inch OD Split Barrel Sampler

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

None Encountered at Completion of Sampling

Terracon
15 Marway Cir, Ste 2B
Rochester, NY

Boring Started: 06-07-2018	Boring Completed: 06-07-2018
Drill Rig: Diedrich D-50	Driller: J. Tojdowski
Project No.: J5185006	

BORING LOG NO. B-10

PROJECT: Mohawk Solar Geotechnical Investigation

CLIENT: Avangrid Renewables
Portland, OR

SITE: Various locations throughout town
Marshville, NY

LOCATION See Exploration Plan

Latitude: 42.8944° Longitude: -74.6264°

Approximate Surface Elev: 721 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH / DESCRIPTION / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RDQ (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
1		0.1 **TOPSOIL** 721+/-								
		SILTY CLAY (CL-ML), trace sand, trace organic matter, dark brown, stiff			X	15	3-4-5-6 N=9			
					X	12	5-4-8-8 N=12			
			5		X	15	3-5-8-10 N=13			
		6.0 715+/-								
2		**SILT WITH SAND (ML)**, trace gravel, dark brown to black, medium dense			X	24	8-8-15-24 N=23			
3		Becomes very dense			X	14	13-22-30-18 N=52			
2 3		Contains numerous cobble fragments	10		X	11	24-45-50/2"			
		13.4 707.5+/-			X	4	50/5"			

Sample Spoon Penetration Refusal Encountered at 13.4 Feet

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

Hammer Type: Automatic

Advancement Method:
4.25 inch ID Hollow Stem Augers and 2 inch OD Split Barrel Sampler

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

None Encountered at Completion of Sampling

Terracon
15 Marway Cir, Ste 2B
Rochester, NY

Boring Started: 06-07-2018	Boring Completed: 06-07-2018
Drill Rig: Diedrich D-50	Driller: J. Tojdowski
Project No.: J5185006	

BORING LOG NO. B-11

PROJECT: Mohawk Solar Geotechnical Investigation

CLIENT: Avangrid Renewables
Portland, OR

SITE: Various locations throughout town
Marshville, NY

LOCATION See Exploration Plan

Latitude: 42.8907° Longitude: -74.6261°

Approximate Surface Elev: 686 (Ft.) +/-

MODEL LAYER	DEPTH (Ft.)	DESCRIPTION	ELEVATION (Ft.)
1	0.1	**TOPSOIL**	686+/-
2	6.0	**SILTY CLAY (CL-ML)**, trace sand, brown gray, stiff	680+/-
3	13.0	**SANDY SILT (ML)**, trace gravel, trace cobble fragments, brown, dense to very dense Contains frequent cobble fragments	673+/-
3	15.0	**SILTY SAND (SM)**, with sahle fragments, black, medium dense	671+/-

Boring Terminated at 15 Feet

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RDQ (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
		X	15	2-5-4-4 N=9			
		X	17	5-6-8-10 N=14			
5		X	16	3-5-5-9 N=10			
		X	24	10-17-17-24 N=34			
		X	5	9-20-50/2"			
10		X	11	9-22-25-34 N=47			
15		X	15	13-10-14-15 N=24			

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

Hammer Type: Automatic

Advancement Method:
4.25 inch ID Hollow Stem Augers and 2 inch OD Split Barrel Sampler

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

None Encountered at Completion of Sampling

Terracon
15 Marway Cir, Ste 2B
Rochester, NY

Boring Started: 06-08-2018	Boring Completed: 06-08-2018
Drill Rig: Diedrich D-50	Driller: J. Tojdowski
Project No.: J5185006	

BORING LOG NO. B-12

PROJECT: Mohawk Solar Geotechnical Investigation

CLIENT: Avangrid Renewables
Portland, OR

SITE: Various locations throughout town
Marshville, NY

LOCATION See Exploration Plan

Latitude: 42.8909° Longitude: -74.6144°

Approximate Surface Elev: 703 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH / MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RDQ (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
1		0.1 **TOPSOIL**	703+/-								
		SILTY CLAY (CL-ML), trace sand, trace gravel, trace organic matter, brown, medium stiff				X	14	2-2-5-4 N=7		20	
		2.0	701+/-								
		SANDY SILT (ML), with shale fragments, dark brown to black, medium dense				X	20	5-7-7-12 N=14		11	
3		Contains frequent cobble fragments				X	0	50/1"		5	
				5							
		Becomes very dense				X	15	17-39-19-22 N=58			
2						X	1	50/2"			
3		Becomes black		10		X	10	19-37-50/5"		6	
						X	18	22-31-42-50/5" N=73		8	
		14.9	688+/-								

Sample Spoon Penetration Refusal Encountered at 14.9 Feet

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

Hammer Type: Automatic

Advancement Method:
4.25 inch ID Hollow Stem Augers and 2 inch OD Split Barrel Sampler

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

None Encountered at Completion of Sampling

Terracon
15 Marway Cir, Ste 2B
Rochester, NY

Boring Started: 06-11-2018	Boring Completed: 06-11-2018
Drill Rig: Diedrich D-50	Driller: J. Tojdowski
Project No.: J5185006	

BORING LOG NO. B-13

PROJECT: Mohawk Solar Geotechnical Investigation

CLIENT: Avangrid Renewables Portland, OR

SITE: Various locations throughout town Marshville, NY

LOCATION See Exploration Plan

Latitude: 42.8898° Longitude: -74.6136°

Approximate Surface Elev: 714 (Ft.) +/-

MODEL LAYER	DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RDQ (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
1	0.1	**TOPSOIL**	714+/-								
		SILTY CLAY WITH SAND (CL-ML), trace gravel, trace organic matter, brown, stiff to very stiff				X	12	2-4-5-6 N=9			
						X	17	5-7-9-12 N=16			
	6.0		708+/-	5		X	17	3-6-15-7 N=21			
2		**SANDY SILT (ML)**, trace gravel, trace clay, occasional cobble fragments, brown, medium dense				X	16	5-5-5-8 N=10			
3						X	13	7-17-12-35 N=29			
2											
3		Contains trace shale fragments, Becomes very dense		10		X	14	8-22-50/5"			
	13.1		701+/-			X	0	50/1"			
		Sample Spoon Penetration Refusal Encountered at 13.1 Feet									

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

Hammer Type: Automatic

Advancement Method:
4.25 inch ID Hollow Stem Augers and 2 inch OD Split Barrel Sampler

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

None Encountered at Completion of Sampling

Terracon
15 Marway Cir, Ste 2B
Rochester, NY

Boring Started: 06-11-2018	Boring Completed: 06-11-2018
Drill Rig: Diedrich D-50	Driller: J. Tojdowski
Project No.: J5185006	

BORING LOG NO. B-14

PROJECT: Mohawk Solar Geotechnical Investigation

CLIENT: Avangrid Renewables
Portland, OR

SITE: Various locations throughout town
Marshville, NY

LOCATION See Exploration Plan

Latitude: 42.8926° Longitude: -74.6093°

Approximate Surface Elev: 756 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH (Ft.)	ELEVATION (Ft.)	DESCRIPTION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RDQ (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
1		0.2	756+/-	**TOPSOIL**								
2				**SILT WITH SAND (ML)**, trace clay, tace organic matter, brown, medium dense				14	5-5-5-6 N=10			
								16	4-5-7-5 N=12			
					5			15	9-6-8-11 N=14			
				Contains frequent cobble fragments				1	50/1"			
		8.0	748+/-									
3				**SILTY SAND (SM)**, numerous cobble fragments, brown, very dense				6	29-39-50/2"			
				Becomes dark brown	10			7	11-26-50/1"			
		13.1	743+/-					1	50/1"			
				Sample Spoon Penetration Refusal Encountered at 13.1 Feet								

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

Hammer Type: Automatic

Advancement Method:
4.25 inch ID Hollow Stem Augers and 2 inch OD Split Barrel Sampler

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

None Encountered at Completion of Sampling

Terracon
15 Marway Cir, Ste 2B
Rochester, NY

Boring Started: 06-12-2018	Boring Completed: 06-12-2018
Drill Rig: Diedrich D-50	Driller: J. Tojdowski
Project No.: J5185006	

BORING LOG NO. B-15

PROJECT: Mohawk Solar Geotechnical Investigation

CLIENT: Avangrid Renewables
Portland, OR

SITE: Various locations throughout town
Marshville, NY

LOCATION See Exploration Plan

Latitude: 42.8886° Longitude: -74.5997°

Approximate Surface Elev: 770 (Ft.) +/-

MODEL LAYER	DEPTH (Ft.) / ELEVATION (Ft.)	DESCRIPTION	SAMPLE DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RDQ (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
2, 3		**SILT WITH SAND (ML)**, trace organic matter, brown, medium dense to dense			Split spoon	1	5-6-5-7 N=11			
					Split spoon	12	18-12-8-8 N=20			
			5		Split spoon	17	9-9-12-14 N=21			
					Split spoon	20	16-14-20-50/2" N=34			
		Becomes black, contains numerous shale fragments			Split spoon	0	50/1"			
	10.0 / 760+/-									
4	10.4 / 759.5+/-	**DECOMPOSED SHALE**, black	10		Split spoon	4	50/5"			
		SHALE, black, fine-grained, close fracture spacing, thin bedding, unweathered, medium strong			Rock core	52	RUN # 1 10.4' - 15.4'	54		
	15.4 / 754.5+/-		15							

Boring Terminated at 15.4 Feet

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

Hammer Type: Automatic

Advancement Method:
4.25 inch ID Hollow Stem Augers and 2 inch OD Split Barrel Sampler to 10.0' BGS.
NQ-'2' size rock core barrel 10.4' - 15.4' BGS

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

None Encountered at Completion of Sampling

Terracon
15 Marway Cir, Ste 2B
Rochester, NY

Boring Started: 06-12-2018	Boring Completed: 06-12-2018
Drill Rig: Diedrich D-50	Driller: J. Tojdowski
Project No.: J5185006	

BORING LOG NO. B-16

PROJECT: Mohawk Solar Geotechnical Investigation

CLIENT: Avangrid Renewables
Portland, OR

SITE: Various locations throughout town
Marshville, NY

LOCATION See Exploration Plan

Latitude: 42.8847° Longitude: -74.6118°

Approximate Surface Elev: 666 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DESCRIPTION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RDQ (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
1		0.2	666+/-	**TOPSOIL**								
2				**SILTY CLAY (CL-ML)**, trace sand, trace organic matter, brown, medium stiff to stiff			X	12	1-2-3-4 N=5		24	
							X	15	5-6-8-9 N=14		19	
					5		X	17	3-5-7-7 N=12			
				contains occasional silt seams and partings, becomes very stiff			X	24	10-9-7-7 N=16			
							X	20	3-3-5-7 N=8			49-23-26
				Becomes gray, saturated, stiff	10		X	24	4-5-5-7 N=10		17	
							X	16	4-5-5-5 N=10		15	
		15.0	651+/-	*Boring Terminated at 15 Feet*	15							

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

Hammer Type: Automatic

Advancement Method:
4.25 inch ID Hollow Stem Augers and 2 inch OD Split Barrel Sampler

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

None Encountered at Completion of Sampling

Terracon
15 Marway Cir, Ste 2B
Rochester, NY

Boring Started: 06-13-2018	Boring Completed: 06-13-2018
Drill Rig: Diedrich D-50	Driller: J. Tojdowski
Project No.: J5185006	

BORING LOG NO. B-17

PROJECT: Mohawk Solar Geotechnical Investigation

CLIENT: Avangrid Renewables Portland, OR

SITE: Various locations throughout town Marshville, NY

LOCATION See Exploration Plan

Latitude: 42.8796° Longitude: -74.6079°

Approximate Surface Elev: 676 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RDQ (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
1	0.2	**TOPSOIL**	676+/-								
2		**SANDY LEAN CLAY (CL)**, trace sand, occasional silt seams, trace organic matter, orange and brown, medium stiff to stiff				X	13	1-2-3-3 N=5		23	
	2.0		674+/-								
		SILTY CLAY (CL-ML), Contains occasional fine to medium sand lenses				X	13	3-3-5-7 N=8		14	
		Becomes brown, very stiff		5		X	18	3-6-9-12 N=15		13	
						X	19	8-11-14-15 N=25			60-27-33
		Becomes dark gray, stiff				X	20	3-5-6-7 N=11		16	
		Becomes medium stiif, saturated		10		X	20	3-3-4-4 N=7		28	
						X	24	4-4-4-4 N=8		22	
	15.0		661+/-	15							
		Boring Terminated at 15 Feet									

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

Hammer Type: Automatic

Advancement Method:
4.25 inch ID Hollow Stem Augers and 2 inch OD Split Barrel Sampler

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

None Encountered at Completion of Sampling

Terracon

15 Marway Cir, Ste 2B
Rochester, NY

Boring Started: 06-13-2018	Boring Completed: 06-13-2018
Drill Rig: Diedrich D-50	Driller: J. Tojdowski
Project No.: J5185006	

BORING LOG NO. B-18

PROJECT: Mohawk Solar Geotechnical Investigation

CLIENT: Avangrid Renewables
Portland, OR

SITE: Various locations throughout town
Marshville, NY

LOCATION See Exploration Plan

Latitude: 42.8759° Longitude: -74.6152°

Approximate Surface Elev: 674 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	Depth	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RDQ (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
1		0.2	**TOPSOIL**	674+/-								
2		2.0	**SILTY CLAY (CL-ML)**, trace sand, trace gravel, trace organic matter, brown, medium stiff	672+/-			X	16	3-3-4-7 N=7			
		6.0	**SILT WITH SAND (ML)**, trace gravel, frequent cobble fragments, brown, medium dense	668+/-			X	17	8-10-14-14 N=24			
					5		X	7	7-12-11-12 N=23			
		8.0	**SANDY SILT (ML)**, trace gravel, frequent cobble fragments, dark brown, medium dense	666+/-			X	18	14-14-14-17 N=28			
3		15.0	**SILTY SAND (SM)**, with cobble fragments, brown, medium dense	659+/-			X	7	5-7-11-14 N=18			
			Contains trace clay		10		X	13	9-9-9-9 N=18			
							X	11	9-49-19-9 N=68			
			Boring Terminated at 15 Feet		15							

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

Hammer Type: Automatic

Advancement Method:
4.25 inch ID Hollow Stem Augers and 2 inch OD Split Barrel Sampler

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

None Encountered at Completion of Sampling

Terracon
15 Marway Cir, Ste 2B
Rochester, NY

Boring Started: 06-11-2018	Boring Completed: 06-11-2018
Drill Rig: Diedrich D-50	Driller: J. Tojdowski
Project No.: J5185006	

BORING LOG NO. B-19

PROJECT: Mohawk Solar Geotechnical Investigation

CLIENT: Avangrid Renewables
Portland, OR

SITE: Various locations throughout town
Marshville, NY

LOCATION See Exploration Plan

Latitude: 42.8749° Longitude: -74.6254°

Approximate Surface Elev: 704 (Ft.) +/-

MODEL LAYER	DEPTH	ELEVATION (Ft.)	DESCRIPTION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RDQ (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
1	0.1	704+/-	**TOPSOIL**								
	2.0	702+/-	**SANDY SILT (ML)**, trace gravel, trace organic matter, brown, loose			X	14	3-4-3-2 N=7		16	
	4.0	700+/-	**SILTY CLAY (CL-ML)**, trace sand, trace shale, dark brown to black, stiff			X	17	4-6-6-8 N=12		12	
3			**SANDY SILT WITH GRAVEL (ML)**, trace cobble fragments, brown, medium dense to dense	5		X	17	6-11-13-16 N=24		9	
2						X	18	21-22-28-28 N=50			
3 2			Becomes dark gray to black, contains numerous shale fragments			X	20	7-16-24-27 N=40			
				10		X	6	10-22-24-25 N=46		10	
3	14.4	689.5+/-	Contains trace clay			X	14	32-36-50/5"		9	

Sample Spoon Penetration Refusal Encountered at 14.4 Feet

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

Hammer Type: Automatic

Advancement Method:
4.25 inch ID Hollow Stem Augers and 2 inch OD Split Barrel Sampler

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

None Encountered at Completion of Sampling

Terracon
15 Marway Cir, Ste 2B
Rochester, NY

Boring Started: 06-12-2018	Boring Completed: 06-12-2018
Drill Rig: Diedrich D-50	Driller: J. Tojdowski
Project No.: J5185006	

BORING LOG NO. B-20

PROJECT: Mohawk Solar Geotechnical Investigation

CLIENT: Avangrid Renewables Portland, OR

SITE: Various locations throughout town Marshville, NY

LOCATION See Exploration Plan

Latitude: 42.8779° Longitude: -74.6322°

Approximate Surface Elev: 724 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RDQ (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
1	0.1	**TOPSOIL**	724+/-								
	2.0	**SILTY CLAY (CL-ML)**, trace sand, trace organic matter, brown, stiff	722+/-				13	3-5-4-6 N=9			
	4.0	**SILTY CLAY WITH SAND (CL-ML)**, trace gravel, brown and black, very stiff	720+/-				14	4-7-9-15 N=16			
2	8.0	**SANDY SILT (ML)**, trace gravel, trace cobble fragments, brown, medium dense to dense	716+/-	5			17	5-11-13-16 N=24			
							21	15-19-21-26 N=40			
	10.0	**SILTY SAND (SM)**, trace gravel, trace cobble fragments, black, medium dense	714+/-	10			24	6-12-14-15 N=26			
3	15.0	**SANDY SILT (ML)**, trace gravel, black, medium dense	709+/-				17	6-10-11-14 N=21			
		Contains numerous cobble fragments		15			21	17-19-31-27 N=50			
		Boring Terminated at 15 Feet									

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

Hammer Type: Automatic

Advancement Method:
4.25 inch ID Hollow Stem Augers and 2 inch OD Split Barrel Sampler

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

None Encountered at Completion of Sampling

Terracon
15 Marway Cir, Ste 2B
Rochester, NY

Boring Started: 06-12-2018	Boring Completed: 06-12-2018
Drill Rig: Diedrich D-50	Driller: J. Tojdowski
Project No.: J5185006	

BORING LOG NO. B-21

PROJECT: Mohawk Solar Geotechnical Investigation

CLIENT: Avangrid Renewables
Portland, OR

SITE: Various locations throughout town
Marshville, NY

LOCATION See Exploration Plan

Latitude: 42.8658° Longitude: -74.6525°

Approximate Surface Elev: 886 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH / DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RDQ (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
1		0.2 **TOPSOIL**	886+/-								
		SILTY CLAY (CL-ML), trace sand, brown and black, medium stiff					10	3-3-2-4 N=5		19	
		2.0	884+/-								
		SILT WITH SAND (ML), trace gravel, brown, medium dense to dense					15	6-8-8-11 N=16		12	
				5			17	5-8-10-13 N=18		10	
3											
2							24	17-19-21-26 N=40		7	
							22	11-14-22-27 N=36		7	
3		Contains frequent cobble fragments		10			24	7-21-14-16 N=35		8	
		Becomes very dense					20	19-21-38-50/5" N=59		6	
		14.9	871+/-								

Sample Spoon Penetration Refusal Encountered at 14.9 Feet

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

Hammer Type: Automatic

Advancement Method:
4.25 inch ID Hollow Stem Augers and 2 inch OD Split Barrel Sampler

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

None Encountered at Completion of Sampling

Terracon
15 Marway Cir, Ste 2B
Rochester, NY

Boring Started: 06-14-2018	Boring Completed: 06-14-2018
Drill Rig: Diedrich D-50	Driller: J. Tojdowski
Project No.: J5185006	

BORING LOG NO. B-22

PROJECT: Mohawk Solar Geotechnical Investigation

CLIENT: Avangrid Renewables Portland, OR

SITE: Various locations throughout town Marshville, NY

LOCATION See Exploration Plan

Latitude: 42.8837° Longitude: -74.6628°

Approximate Surface Elev: 800 (Ft.) +/-

MODEL LAYER	DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RDQ (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
1	0.1	**TOPSOIL**	800+/-								
	2.0	**SANDY SILT (ML)**, trace gravel, trace organic matter, brown, loose	798+/-				16	2-3-4-3 N=7			
	4.0	**SANDY SILTY CLAY (CL-ML)**, trace gravel, brown, stiff	796+/-				20	4-5-6-8 N=11			
2		**SANDY SILT (ML)**, trace gravel, brown, medium dense to dense		5			12	2-7-10-13 N=17			
							15	12-16-16-19 N=32			
		Contains numerous cobble fragments					17	4-11-13-32 N=24			
		Becomes dark brown to black		10			13	4-10-15-18 N=25			
3	15.0	Becomes black	785+/-	15			24	15-19-21-26 N=40			

Boring Terminated at 15 Feet

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

Hammer Type: Automatic

Advancement Method:
4.25 inch ID Hollow Stem Augers and 2 inch OD Split Barrel Sampler

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

None Encountered at Completion of Sampling

Terracon
15 Marway Cir, Ste 2B
Rochester, NY

Boring Started: 06-14-2018	Boring Completed: 06-14-2018
Drill Rig: Diedrich D-50	Driller: J. Tojdowski
Project No.: J5185006	

BORING LOG NO. B-23

PROJECT: Mohawk Solar Geotechnical Investigation

CLIENT: Avangrid Renewables Portland, OR

SITE: Various locations throughout town Marshville, NY

LOCATION See Exploration Plan

Latitude: 42.8872° Longitude: -74.6567°

Approximate Surface Elev: 828 (Ft.) +/-

MODEL LAYER	DEPTH	ELEVATION (Ft.)	MATERIAL DESCRIPTION
1	0.2	828+/-	**TOPSOIL**
2			**SANDY SILT (ML)**, trace gravel, yellow brown, medium dense to dense
2			Contains frequent cobble fragments
			Becomes brown
3			
2			
3			Becomes very dense
	14.4	813.5+/-	Becomes gray, contains trace shale fragments

Sample Spoon Penetration Refusal Encountered at 14.4 Feet

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RDQ (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
		X	12	4-5-5-3 N=10			
		X	20	5-8-11-14 N=19			
5		X	16	5-7-10-11 N=17			
		X	24	15-21-21-27 N=42			
		X	16	7-14-32-50/4" N=46			
10		X	4	13-50/2"			
		X	13	32-38-50/5"			

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

Hammer Type: Automatic

Advancement Method:
4.25 inch ID Hollow Stem Augers and 2 inch OD Split Barrel Sampler

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

None Encountered at Completion of Sampling

Terracon
15 Marway Cir, Ste 2B
Rochester, NY

Boring Started: 06-14-2018	Boring Completed: 06-14-2018
Drill Rig: Diedrich D-50	Driller: J. Tojdowski
Project No.: J5185006	

BORING LOG NO. B-24

PROJECT: Mohawk Solar Geotechnical Investigation

CLIENT: Avangrid Renewables Portland, OR

SITE: Various locations throughout town Marshville, NY

LOCATION See Exploration Plan

Latitude: 42.8906° Longitude: -74.6539°

Approximate Surface Elev: 830 (Ft.) +/-

MODEL LAYER	DEPTH / ELEVATION (Ft.)	MATERIAL DESCRIPTION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RDQ (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
1	0.1 / 830+/-	**TOPSOIL**								
	2.0 / 828+/-	**SILT WITH SAND (ML)**, trace gravel, brown, medium dense			X	13	2-5-5-4 N=10			
2	4.0 / 826+/-	**SANDY SILTY CLAY (CL-ML)**, trace gravel, brown, stiff			X	12	5-6-4-3 N=10			
	8.0 / 822+/-	**SANDY SILT (ML)**, trace gravel, brown, dense to very dense	5		X	16	9-14-20-21 N=34			
					X	10	21-27-50/5"			
3	13.8 / 816+/-	**SILTY SAND (SM)**, trace gravel, trace cobble fragments, brown, very dense			X	12	5-21-50/5"			
		Becomes dark brown to black	10		X	11	21-48-50/5"			
					X	7	23-50/4"			

Sample Spoon Penetration Refusal Encountered at 13.8 Feet

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

Hammer Type: Automatic

Advancement Method:
4.25 inch ID Hollow Stem Augers and 2 inch OD Split Barrel Sampler

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

None Encountered at Completion of Sampling

Terracon
15 Marway Cir, Ste 2B
Rochester, NY

Boring Started: 06-14-2018	Boring Completed: 06-14-2018
Drill Rig: Diedrich D-50	Driller: J. Tojdowski
Project No.: J5185006	

BORING LOG NO. B-25

PROJECT: Mohawk Solar Geotechnical Investigation

CLIENT: Avangrid Renewables
Portland, OR

SITE: Various locations throughout town
Marshville, NY

LOCATION See Exploration Plan

Latitude: 42.8881° Longitude: -74.6483°

Approximate Surface Elev: 832 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RDQ (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
1		0.1	**TOPSOIL**	832+/-								
2			**SANDY SILT (ML)**, trace gravel, trace organic matter, brown, medium dense to dense					11	2-6-7-6 N=13			
			Contains frequent cobble fragments					13	20-8-19-23 N=27			
3 2					5			6	12-16-16-23 N=32			
								4	50/5"			
		8.0		824+/-								
4			**SHALE**, black					1	50/2"			
		10.1		822+/-	10			1	50/1"			
			SHALE, gray and black, fine-grained, moderately fractured, very thin bedding, slightly weathered, medium strong					53	RUN # 1 10.1' - 15.1'	10		
		15.1		817+/-	15							

Boring Terminated at 15.1 Feet

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

Hammer Type: Automatic

Advancement Method:
4.25 inch ID Hollow Stem Augers and 2 inch OD Split Barrel Sampler to 10.1' BGS.
NQ-'2' size rock core barrel 10.1' - 15.1' BGS

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

None Encountered at Completion of Sampling

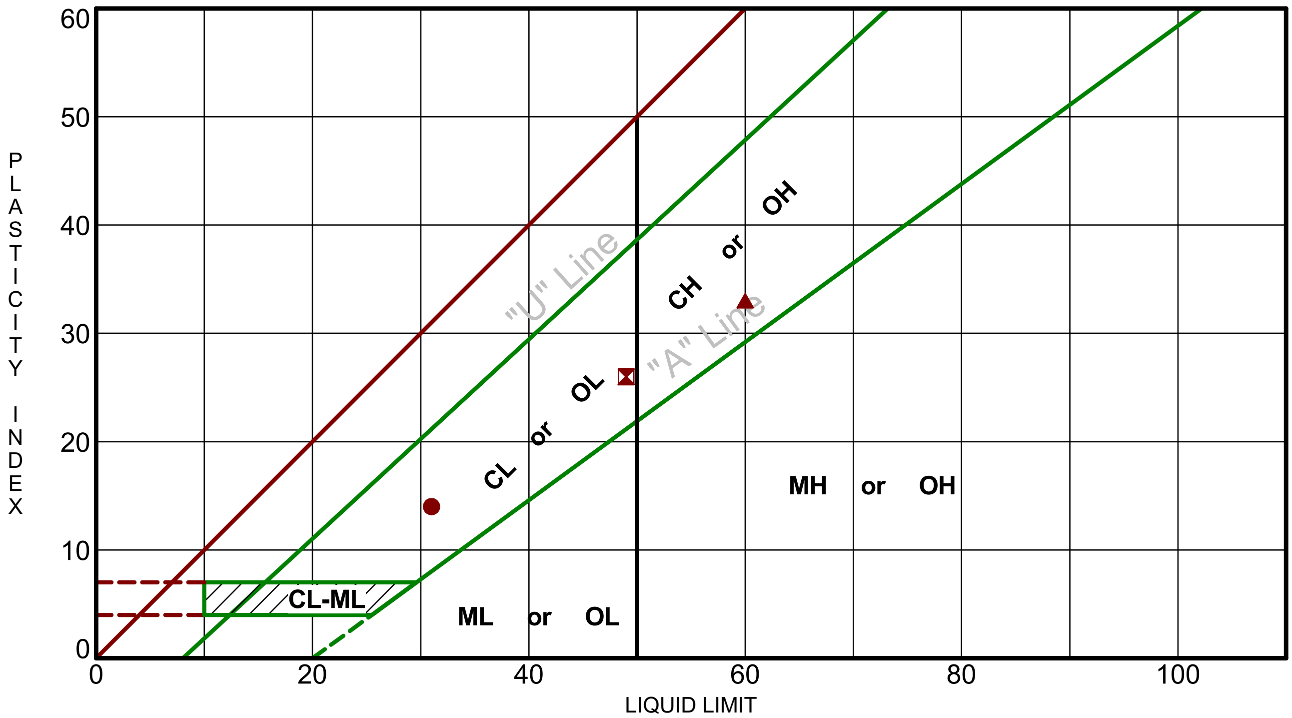
Terracon
15 Marway Cir, Ste 2B
Rochester, NY

Boring Started: 06-15-2018	Boring Completed: 06-15-2018
Drill Rig: Diedrich D-50	Driller: J. Tojdowski
Project No.: J5185006	

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL J5185006 MOHAWK SOLAR GEOT.GPJ TERRACON_DATATEMPLATE.GDT 9/4/18

ATTERBERG LIMITS RESULTS

ASTM D4318



Boring ID		Depth	LL	PL	PI	Fines	USCS	Description
●	B-5	4 - 6	31	17	14			
⊠	B-16	8 - 10	49	23	26			
▲	B-17	6 - 8	60	27	33			

PROJECT: Mohawk Solar Geotechnical Investigation

SITE: Various locations throughout town Marshville, NY

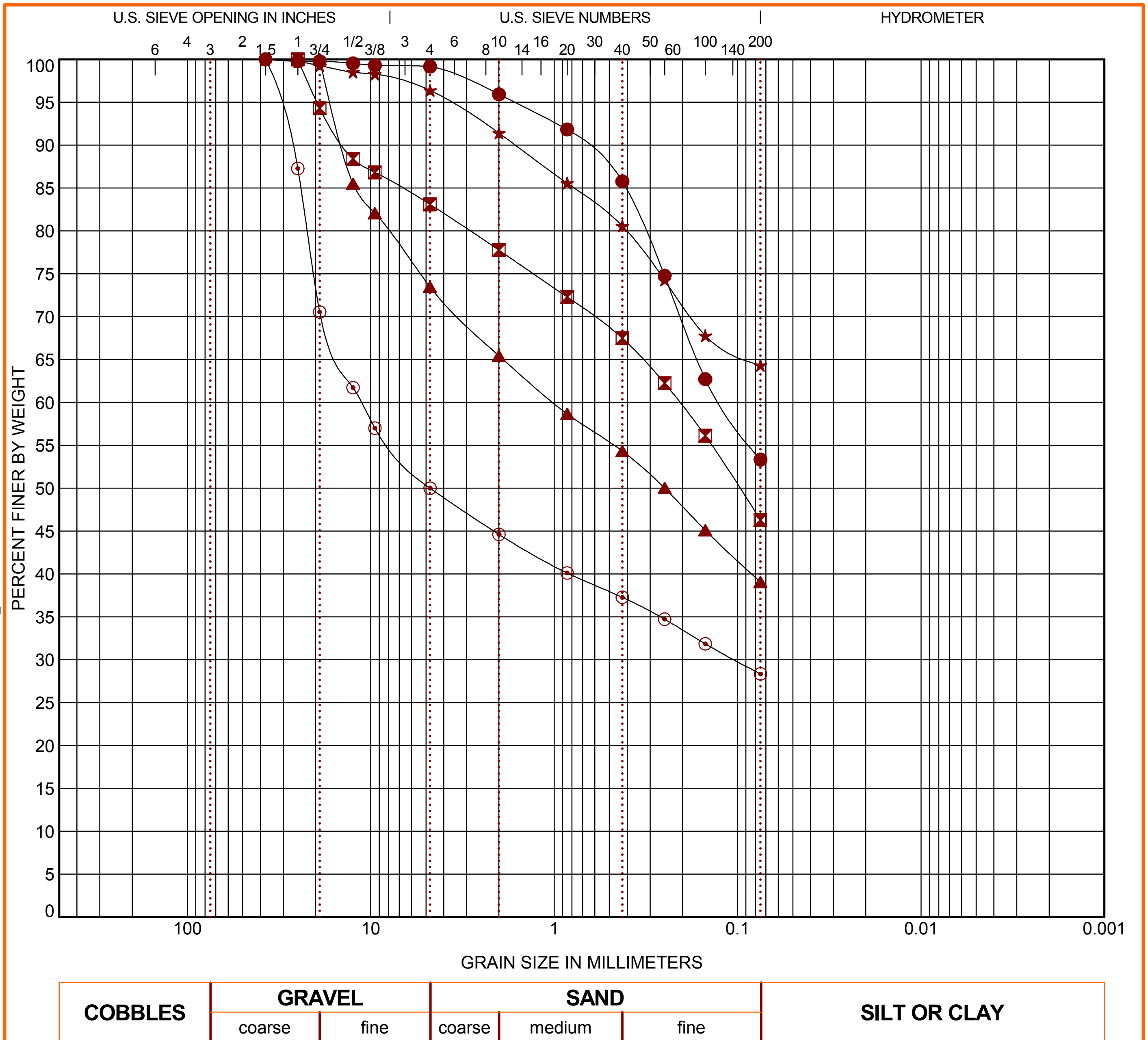
Terracon
15 Marway Cir, Ste 2B
Rochester, NY

PROJECT NUMBER: J5185006

CLIENT: Avangrid Renewables Portland, OR

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



Boring ID		Depth	USCS Classification	WC (%)	LL	PL	PI	Cc	Cu
●	B-2+B-17	0 - 2	Sandy LEAN CLAY (CL)	13					
⊠	B-2	4 - 6	Sandy SILT with gravel (ML)	11					
▲	B-5	8 - 10	Silty SAND with gravel (SM)	6					
★	B-9 +B-19	0 - 2	Sandy SILT (ML)						
⊙	B-12	4 - 6	Silty GRAVEL with sand (GM)	5					

Boring ID		Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Silt	%Fines	%Clay
●	B-2	0 - 2	37.5	0.123			0.8	45.8		53.3	
⊠	B-2	4 - 6	25	0.207			16.9	36.8		46.3	
▲	B-5	8 - 10	19	1.006			26.5	34.4		39.1	
★	B-9	0 - 1.1	37.5				3.6	32.1		64.3	
⊙	B-12	4 - 4.1	37.5	11.311	0.104		50.0	21.7		28.3	

PROJECT: Mohawk Solar Geotechnical Investigation

PROJECT NUMBER: J5185006

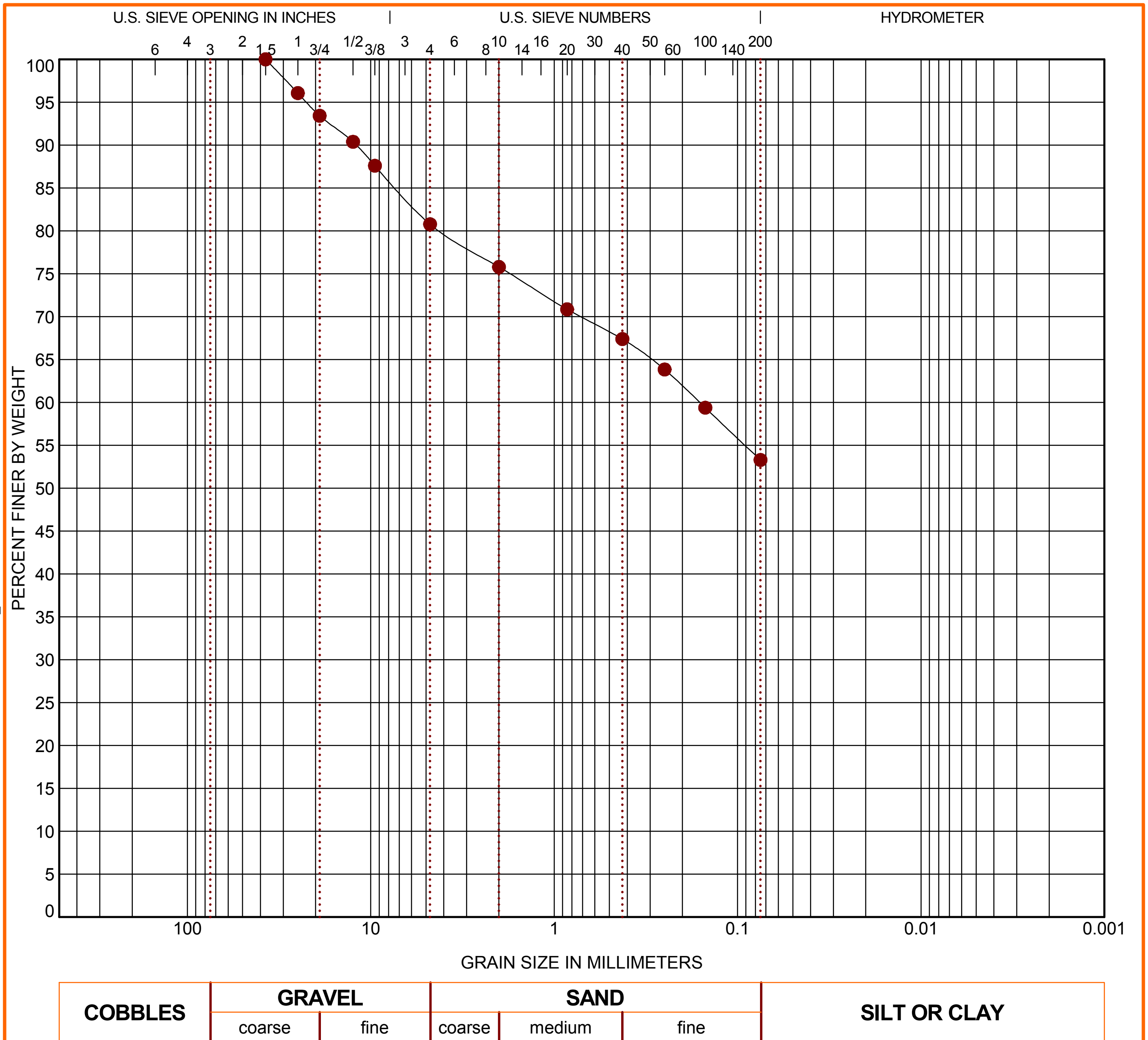
SITE: Various locations throughout town Marshville, NY

CLIENT: Avangrid Renewables Portland, OR

Terracon
15 Marway Cir, Ste 2B
Rochester, NY

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



	Boring ID	Depth	USCS Classification	WC (%)	LL	PL	PI	Cc	Cu
●	B-19	4 - 6	Sandy SILT with gravel (ML)	9					

	Boring ID	Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Silt	%Fines	%Clay
●	B-19	4 - 6	37.5	0.161			19.2	27.5		53.3	

PROJECT: Mohawk Solar Geotechnical Investigation

SITE: Various locations throughout town Marshville, NY

Terracon
15 Marway Cir, Ste 2B
Rochester, NY

PROJECT NUMBER: J5185006

CLIENT: Avangrid Renewables Portland, OR

CHEMICAL LABORATORY TEST REPORT

Project Number: J5185006
Service Date: 07/23/18
Report Date: 07/31/18
Task:

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

Client

Avangrid Renewables
Portland, OR

Project

Mohawk Solar Farm

Sample Submitted By: Terracon (J5) **Date Received:** 7/20/2018 **Lab No.: 18-0910**

Results of Corrosion Analysis

Sample Number				
Sample Location	B-2	B-4	B-13	B-17
Sample Depth (ft.)	2-5	2-5	2-5	2-5
pH Analysis, ASTM G 51	8.43	8.20	8.14	8.21
Water Soluble Sulfate (SO4), ASTM C 1580 (mg/kg)	32	199	197	41
Sulfides, AWWA 4500-S D, (mg/kg)	Nil	Nil	Nil	Nil
Chlorides, ASTM D 512, (mg/kg)	45	67	43	43
Red-Ox, AWWA 2580, (mV)	+711	+706	+708	+698
Total Salts, AWWA 2540, (mg/kg)	557	705	751	251
Resistivity, ASTM G 57, (ohm-cm)	4268	3298	4074	6402

Analyzed By: Trisha Campo

Trisha Campo
Chemist

CHEMICAL LABORATORY TEST REPORT

Project Number: J5185006
Service Date: 07/23/18
Report Date: 07/31/18
Task:

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

Client

Avangrid Renewables
Portland, OR

Project

Mohawk Solar Farm

Sample Submitted By: Terracon (J5) **Date Received:** 7/20/2018 **Lab No.: 18-0910**

Results of Corrosion Analysis

Sample Number		
Sample Location	B-21	B-23
Sample Depth (ft.)	2-5	2-5
pH Analysis, ASTM G 51	8.04	8.05
Water Soluble Sulfate (SO4), ASTM C 1580 (mg/kg)	51	36
Sulfides, AWWA 4500-S D, (mg/kg)	Nil	Nil
Chlorides, ASTM D 512, (mg/kg)	50	25
Red-Ox, AWWA 2580, (mV)	+702	+708
Total Salts, AWWA 2540, (mg/kg)	673	695
Resistivity, ASTM G 57, (ohm-cm)	3395	4656

Analyzed By:

Trisha Campo
Chemist

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

July 23, 2018

Terracon Consultants – NY, Inc.
15 Marway Circle, Suite 2B
Rochester, New York 14624
Attn: Michele A. Fiorillo

Re: Thermal Analysis of Native Soil Samples
Mohawk Solar – Marshville, NY (Project No. J5185006)

The following is the report of thermal dryout characterization tests conducted on eight (8) native soil samples from the referenced project sent to our laboratory.

Thermal Dryout Tests: Per your request, the samples were tested at the 'as received' moisture contents and dry densities ***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 (@ 3'-5')	Non-classified Visual Description	Thermal Resistivity (°C-cm/W)		Moisture Content (%)	Dry Density (lb/ft³)
		Wet	Dry		
B-2	Sandy Silty Clay	52	121	19	99
B-4	Sandy Silt	103	216	13	87
B-9	Silty Clay	93	266	20	87
B-13	Silty Clay with Sand	94	251	15	87
B-17	Silty Clay	50	128	21	99
B-19	Silty Clay	101	244	15	87
B-21	Silt with Sand	119	287	14	87
B-23	Sandy Silt	96	234	15	87

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

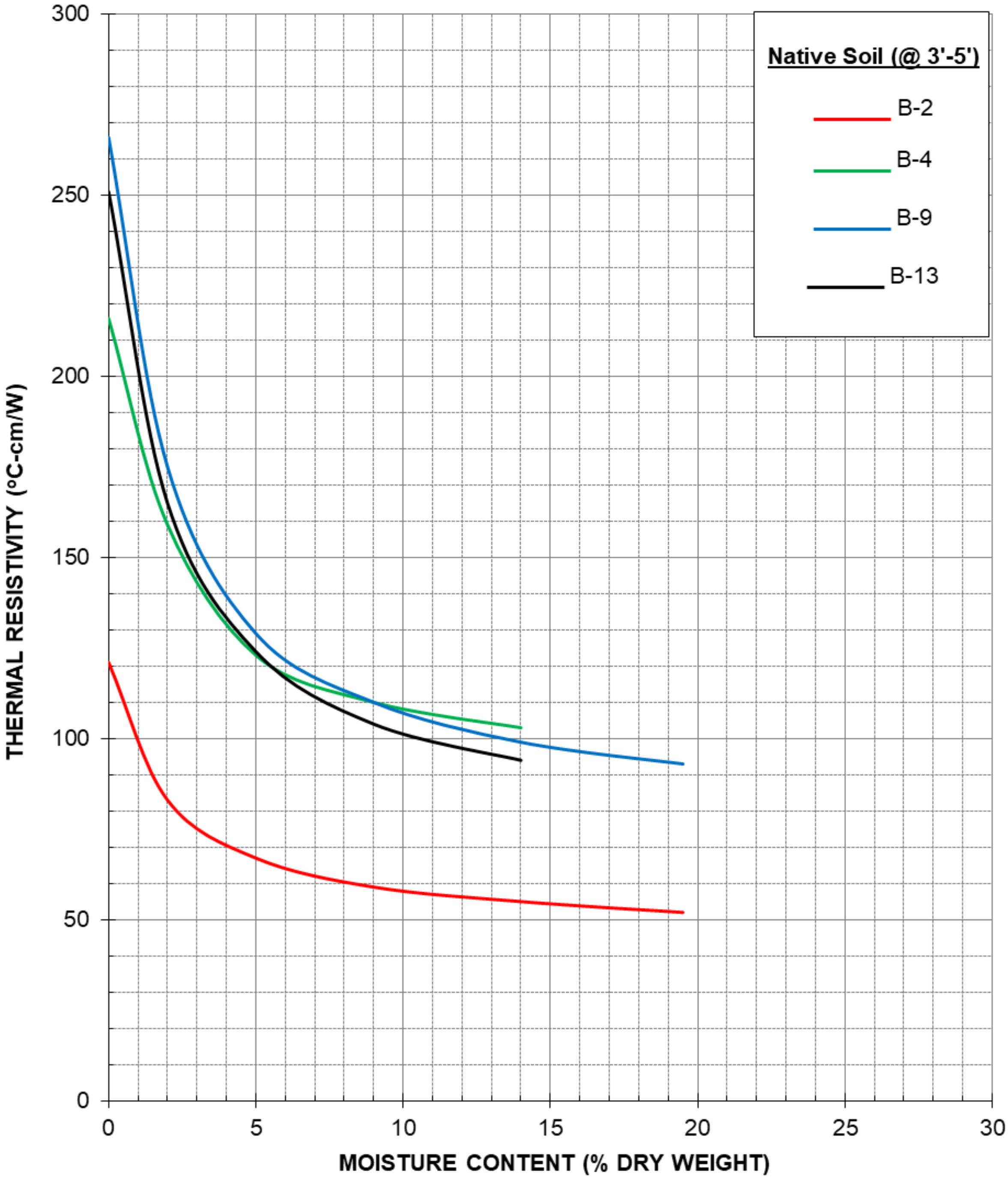
Please contact us if you have any questions or if we can be of further assistance.

Geotherm USA LLC

Nimesh Patel

Geotherm USA

THERMAL DRYOUT CURVES



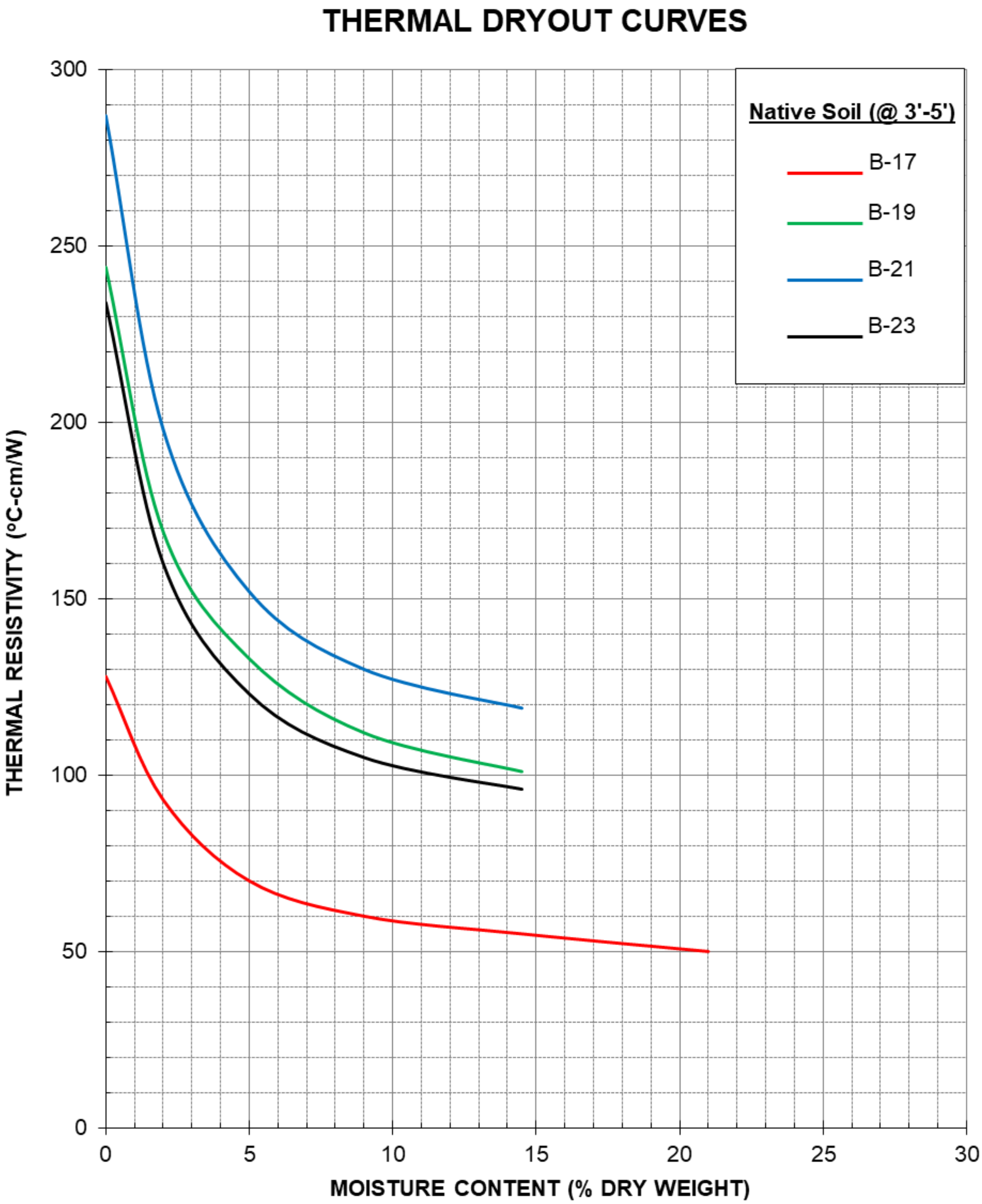
Terracon Consultants -NY, Inc. (Project No. J5185006)

Thermal Analysis of Native Soil Samples

Mohawk Solar – Marshville, NY (Project No. J5185006)

July 2018 **Figure 1**

Geotherm USA



Terracon Consultants -NY, Inc. (Project No. J5185006)

Thermal Analysis of Native Soil Samples

Mohawk Solar – Marshville, NY (Project No. J5185006)

July 2018 **Figure 2**

SUPPORTING INFORMATION

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

Mohawk Solar Geotechnical Investigation ■ Marshville, NY

9/4/2018 ■ Terracon Project No. J5185006

SAMPLING

Rock Core

Standard Penetration Test

WATER LEVEL

Water Initially Encountered

Water Level After a Specified Period of Time

Water Level After a Specified Period of Time

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 is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. 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

RELATIVE PROPORTIONS OF SAND AND GRAVEL		RELATIVE PROPORTIONS OF FINES	
Descriptive Term(s) of other constituents	Percent of Dry Weight	**Descriptive Term(s) of other constituents**	**Percent of Dry Weight**
Trace	<15	Trace	<5
With	15-29	With	5-12
Modifier	>30	Modifier	>12

GRAIN SIZE TERMINOLOGY		PLASTICITY DESCRIPTION	
Major Component of Sample	**Particle Size**	**Term**	**Plasticity Index**
Boulders	Over 12 in. (300 mm)	Non-plastic	0
Cobbles	12 in. to 3 in. (300mm to 75mm)	Low	1 - 10
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)	Medium	11 - 30
Sand	#4 to #200 sieve (4.75mm to 0.075mm	High	> 30
Silt or Clay	Passing #200 sieve (0.075mm)		

UNIFIED SOIL CLASSIFICATION SYSTEM

Mohawk Solar ■ Marshville, New York

September 4, 2018 ■ Terracon Project No. J5185006

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 ≥ 4 and 1 ≤ Cc ≤ 3 [E]	GW	Well-graded gravel [F]
			Cu < 4 and/or 1 > Cc > 3 [E]	GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel [F, G, H]
			Fines classify as CL or CH	GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	Cu ≥ 6 and 1 ≤ Cc ≤ 3 [E]	SW	Well-graded sand [I]
			Cu < 6 and/or 1 > Cc > 3 [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" line	CL	Lean clay [K, L, M]
			PI < 4 or plots below "A" line [J]	ML	Silt [K, L, M]
		Organic:	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay [K, L, M, N]
					Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line	CH	Fat clay [K, L, M]
			PI plots below "A" line	MH	Elastic Silt [K, L, M]
		Organic:	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OH	Organic clay [K, L, M, P]
					Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat

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

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

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

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

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

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

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

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

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

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

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

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

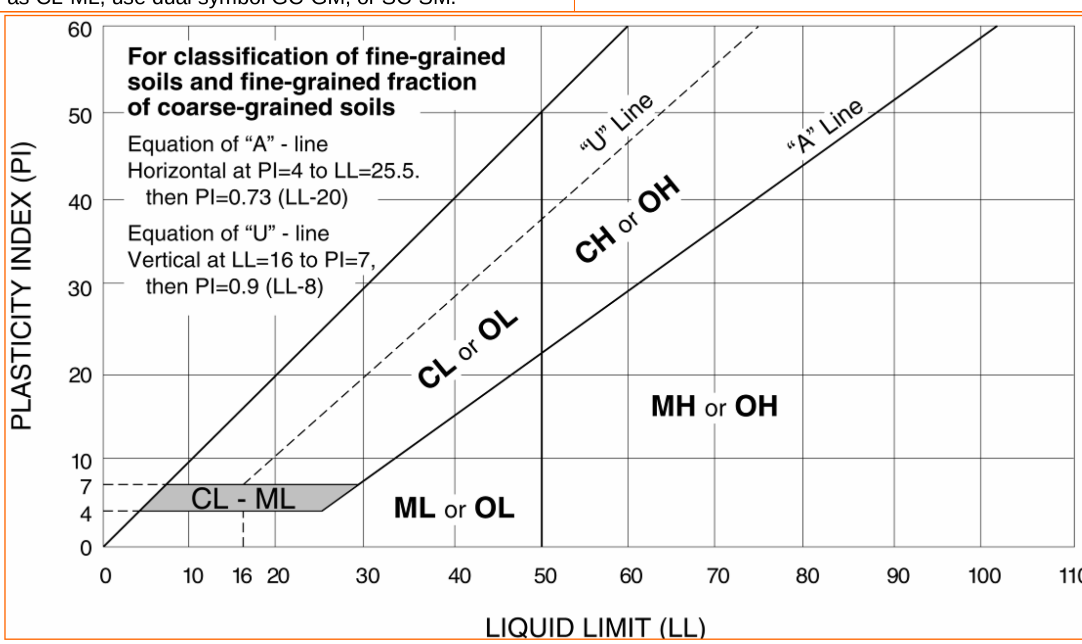
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

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

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



DESCRIPTION OF ROCK PROPERTIES

Mohawk Solar ■ Marshville, New York

September 4, 2018 ■ Terracon Project No. J5185006

Terracon GeoReport

WEATHERING	
Term	**Description**
Unweathered	No visible sign of rock material weathering, perhaps slight discoloration on major discontinuity surfaces.
Slightly weathered	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discolored by weathering and may be somewhat weaker externally than in its fresh condition.
Moderately weathered	Less than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a continuous framework or as corestones.
Highly weathered	More than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones.
Completely weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.
Residual soil	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.

STRENGTH OR HARDNESS		
Description	**Field Identification**	**Uniaxial Compressive Strength, psi (MPa)**
Extremely weak	Indented by thumbnail	40-150 (0.3-1)
Very weak	Crumbles under firm blows with point of geological hammer, can be peeled by a pocket knife	150-700 (1-5)
Weak rock	Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with point of geological hammer	700-4,000 (5-30)
Medium strong	Cannot be scraped or peeled with a pocket knife, specimen can be fractured with single firm blow of geological hammer	4,000-7,000 (30-50)
Strong rock	Specimen requires more than one blow of geological hammer to fracture it	7,000-15,000 (50-100)
Very strong	Specimen requires many blows of geological hammer to fracture it	15,000-36,000 (100-250)
Extremely strong	Specimen can only be chipped with geological hammer	>36,000 (>250)

DISCONTINUITY DESCRIPTION			
Fracture Spacing (Joints, Faults, Other Fractures)		**Bedding Spacing (May Include Foliation or Banding)**	
Description	**Spacing**	**Description**	**Spacing**
Extremely close	< ¾ in (<19 mm)	**Laminated**	< ½ in (<12 mm)
Very close	¾ in – 2-1/2 in (19 - 60 mm)	**Very thin**	½ in – 2 in (12 – 50 mm)
Close	2-1/2 in – 8 in (60 – 200 mm)	**Thin**	2 in – 1 ft. (50 – 300 mm)
Moderate	8 in – 2 ft. (200 – 600 mm)	**Medium**	1 ft. – 3 ft. (300 – 900 mm)
Wide	2 ft. – 6 ft. (600 mm – 2.0 m)	**Thick**	3 ft. – 10 ft. (900 mm – 3 m)
Very Wide	6 ft. – 20 ft. (2.0 – 6 m)	**Massive**	> 10 ft. (3 m)

Discontinuity Orientation (Angle): Measure the angle of discontinuity relative to a plane perpendicular to the longitudinal axis of the core. (For most cases, the core axis is vertical; therefore, the plane perpendicular to the core axis is horizontal.) For example, a horizontal bedding plane would have a 0-degree angle.

ROCK QUALITY DESIGNATION (RQD) [1]	
Description	**RQD Value (%)**
Very Poor	0 - 25
Poor	25 – 50
Fair	50 – 75
Good	75 – 90
Excellent	90 - 100

1. The combined length of all sound and intact core segments equal to or greater than 4 inches in length, expressed as a percentage of the total core run length.

Reference: U.S. Department of Transportation, Federal Highway Administration, Publication No FHWA-NHI-10-034, December 2009 Technical Manual for Design and Construction of Road Tunnels – Civil Elements