Heritage Wind Project

Case No. 16-F-0546

1001.21 Exhibit 21

Geology, Seismology, and Soils

TABLE OF CONTENTS

EXHIBIT 21 GEOLOGY, SEISMOLOGY, AND SOILS

(a) Existing Slopes Map

Figure 21-1 delineates existing slopes (0-3%, 3-8%, 8-15%, 15-25%, and over 25%) within Facility Site. This figure was prepared using digital elevation model (DEM) data provided by the U.S. Geological Survey (USGS) and the New York State Department of Environmental Conservation (NYSDEC). The data was processed using ESRI ArcGIS® software. Slopes within the Facility Site generally average between 3% - 4%. Although there are isolated locations slopes in excess of 10% located east of Eagle Harbor Rd and west of Hill Rd, these are not considered to be steep (i.e., in excess of 15%-25%). Additionally, no work is proposed directly at these locations and the majority of proposed ground disturbance will be on flatter slopes (i.e., less than 10%).

No excavation or collection lines will be installed along steep slopes (i.e., slopes in excess of 15%-25%). Therefore, special considerations for erosion and sediment control and/or trench installation protection measures (i.e., breakers, plugs, etc.) are anticipated, but can be utilized if and where needed.

Existing and proposed grades are also identified in the Preliminary Design Drawings prepared in support of Exhibit 11.

(b) Proposed Site Plan

See the Preliminary Design Drawings included with Exhibit 11, which include existing and proposed contours at two-foot intervals based on publicly available Light Detection and Ranging (LIDAR) data for the Facility Site and interconnection.

(c) Cut and Fill

Cut and fill calculations discussed in this Section are preliminary and are based on the above-described contour data. Topsoil, sub-soil, and bedrock data were approximated based on publicly available data from the Orleans County Soil Survey, Natural Resources Conservation Service's (NRCS) WebSoil Survey, and the results of the preliminary geotechnical investigation. Profiles of the soil map units within the Facility Site were generated from the Soil Survey of Orleans County, New York (USDA NRCS, 2019). Cut calculations for each soil map unit were generated using ArcGIS software by overlaying a layer containing preliminary cut and fill data with a layer containing the profiles of soils within the Facility Site.

In the initial design process, the Applicant developed design parameters for Facility components, as shown in the preliminary design drawings in Exhibit 11. These design parameters minimize areas of cut and fill wherever possible; however, there are various scenarios where cut and fill will be unavoidable. For example, cut and fill may be required where access roads traverse existing grades that exceed the maximum design slope, if crane pads must be located in areas with excessive slopes, if variances in adjacent slopes prevent the traversing of delivery vehicles, and in creating pads for the collection and point of interconnection substations that meet design standards.

Given the relatively flat topography at the Facility Site, substantial excavation and extensive cut and fills are not anticipated. It is estimated that 125,000 cubic yards of material will be excavated for the construction of the proposed Facility, based on 2-foot contours interpolated from publicly available Orleans County LIDAR data. Except for gravel, fill material will be generally derived from excavated material to the maximum extent practicable. Excess fill materials from site excavations will be regraded within the Facility Site, limiting the need for off-site disposal. Fill to be used in the construction of the Facility will consist of approximately 105,000 cubic yards (of which 103,000 cubic yards will be gravel).

The final footprint of the Facility will not be known until post-Certification, after a final turbine model has been determined, and may include less than 33 turbines (and correspondingly less infrastructure, e.g., access roads). Once the final footprint of the Facility is established, the Applicant will finalize engineering with the objective of balancing cut and fill requirements to the maximum extent practicable to minimize the need to import/export material to/from the Facility Site.

Proper methods for segregating stockpiled and spoil material will be implemented. Excavated soil will be reused to the maximum extent practicable on the site from which it was excavated as a means of limiting opportunities for spreading of non-native flora and other invasive species. See Exhibit 22(b) for a discussion of invasive species management. Specific locations where cut and fill materials will be temporarily stockpiled have not been identified. Topsoil and subsoil spoils will be separated and placed in locations best suited to their storage, adjacent to the sites where they are excavated (e.g., turbine work areas, access roads, and trenches). Final cut and fill storage areas will be available following Certification and will be included in the final construction drawings.

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

As previously noted, approximately 105,000 cubic yards of fill (of which 103,000 cubic yards will be gravel) will be used in the construction of the Facility. Fill will be used to create appropriate grades for access roads, crane pads, substations, and laydown areas. Gravel, and possibly fill material, will be brought onto the Facility Site and used as surface material for access roads, crane pads, meteorological tower pads, and other Facility components. A total of 103,000 cubic yards of gravel will be needed to surface Facility access roads, crane pads, substations, met tower pads, O&M building, and laydown yard. The length of all Facility access roads will be approximately 12 miles. These roads will be a minimum of 16 feet wide, with gravel approximately 12 inches deep. Temporary crane pads are assumed to be 100 feet by 65 feet and gravel will be 12 inches deep. Final thicknesses of the access roads and crane pads will be determined during final design.

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

No cut material or spoil will be removed from the Facility Site. These materials will be used as fill or will otherwise be used in site restoration, and all such materials will be re-graded to approximate pre-construction contours.

(f) Excavation Techniques to be Employed

Pending the receipt of all required permits, pre-construction is anticipated to start in September 2022, and full construction in March 2023. Facility construction will be performed in several stages. Stages involving excavation are described below. Excavation will be completed using conventional construction equipment, including, but not limited to, bulldozers, track hoes, pan excavators, cable plows, rock saws, rock wheels, and trenchers. This description of the excavation techniques to be employed is based on the site-specific Geotechnical Desktop Study (Appendix 21-A) and the Preliminary Geotechnical Report (Appendix 21-B) discussed in Section (h) below. In addition, as discussed in Exhibit 21(i)-(k) construction of the Facility may require some blasting.

(1) Laydown Yard Construction

The construction laydown yard will be developed by stripping and stockpiling the topsoil and grading and compacting the subsoil. Geotextile fabric and gravel will then be installed to create a level working area.

(2) Road Improvements

Road improvements, including improvements to establish appropriate turning radii for oversize/overweight (OS/OW) vehicles, will generally require soil stripping and the temporary placement of gravel over geotextile fabric.

(3) Access Road Construction

Wherever feasible, existing roads will be upgraded for use as Facility access roads to minimize impacts to active agricultural areas, cultural resources, forests, and wetland/stream areas. Where an existing road drive is unavailable or unsuitable, new gravel surfaced access roads will be constructed. Road construction will involve grubbing of stumps, topsoil stripping, and grading, as necessary. Any grubbed stumps will be removed from the site, chipped, or buried in upland areas of the Facility Site. Stripped topsoil will be stockpiled (and segregated from subsoil) along the road corridor for use in site restoration. Following removal of topsoil, subsoil will be graded, compacted, and surfaced with gravel or crushed stone. A geotextile fabric or grid will be installed beneath the road surface, if necessary, to provide additional support.

(4) Foundation Construction

Once the access roads are complete for a particular group of turbine sites, turbine foundation construction will commence for that group. Initial activity at each tower site will typically involve clearing and leveling (as needed) up to a 200-foot radius around each tower location. Topsoil will be stripped from the excavation area and stockpiled for future site restoration. Following topsoil removal, excavators will be used to excavate the foundation hole. Subsoil and rock will be segregated from topsoil and stockpiled for reuse as backfill. Turbine foundations will be approximately 12 feet deep and 100 feet in diameter. Blasting may be required at some turbine foundation sites and will occur in accordance with the Preliminary Blasting Plan (see Appendix 21-C) and as discussed in Section (i) below.

(5) Electrical Collection System Installation

Direct burial methods utilizing typical industry equipment (e.g., cable plow) will be used during installation of the underground electrical collection system. Direct burial involves the installation of bundled cable directly into a narrow cut or "rip" in the ground. The rip disturbs an area approximately 24 inches wide. Bundled cable will be installed to a minimum depth of 36 inches in most areas and 48 inches in active agriculture and pasture lands. Where direct burial is not possible, an open trench will be excavated. Using this installation technique, topsoil and subsoil are excavated, segregated, and stockpiled adjacent to the trench.

At locations where an electrical collection line crosses public roads, floodplains, streams, or wetlands, horizontal directional drilling (HDD) may be used to avoid impacts. HDD involves installing the cable under the road, floodplain, wetland, or stream using boring equipment set up on either side of the crossing. No surface disturbance is required between the bore pits, and all existing vegetation along the streams and within the wetlands (including mature trees) can remain in place. The only potential impact associated with trenchless technologies (i.e., HDD, jack and bore) is a surface release of drilling mud, i.e., "inadvertent return." Such inadvertent returns or "frac-outs" are rare, and the contractor will be required to develop a final inadvertent return plan that will be implemented during construction. A Draft Inadvertent Return Plan is included as Appendix 21-D. For more information on exact locations where HDD will be utilized to avoid impacts to streams and wetlands, see Exhibits 22 and 23.

(6) Substation

Substation construction will begin with clearing the site and stockpiling topsoil for later use in site restoration. The site will be graded, and a laydown area for construction equipment, materials, and parking will be prepared. Concrete foundations for major equipment and structural supports will be placed, followed by the installation of various conduits, cable trenches, and grounding grid conductors. The area will then receive aggregate surfacing.

(7) O&M Building

Construction of the O&M building will begin with clearing the site and stockpiling topsoil for later use in site restoration. The site will be graded, an area for the building will be prepared, and concrete foundations for the building will be placed. The area will then receive aggregate surfacing for parking and movement around the building.

(8) Blasting

Based on preliminary geotechnical analysis performed to date, the Applicant anticipates mechanical excavation with a pneumatic hammer or large ripper may be possible for some of the bedrock encountered. However, blasting may also be required and is described in section (i).

(g) Temporary Cut and Fill Storage Areas

Excavation and temporary cut and fill will be primarily associated with the construction of the access roads, crane pads, and other site features as shown on the Preliminary Design Drawings (Appendix 11-A). Proper methods for segregating stockpiled and spoil material will be implemented. Excavated soil will be reused to the maximum extent possible on the site from which it was excavated as a means of limiting opportunities for the spread of non-native flora and other invasive species.

Temporary stockpiles associated with localized excavation at work areas will be in place for short durations to facilitate cut and fill operations. These stockpiles will be located and protected in accordance with the Project Stormwater Pollution Prevention Plan (SWPPP) (Appendix 21-E). Storage of aggregate is anticipated to be at the main laydown area and/or at the O&M facility site. Final cut and fill storage areas will be determined prior to construction and included in the final construction drawings, which will be submitted as compliance filings.

(h) Suitability for Construction

TRC Companies, Inc. (TRC) conducted a Geotechnical Desktop Study to evaluate the surface and subsurface soils, bedrock, groundwater conditions, and chemical and physical properties within the Facility Site. The results of the investigation are summarized in TRC's Geotechnical Desktop Study (see Appendix 21-A). As part of this evaluation, TRC:

1. Conducted a desktop review of publicly available data regarding surface and subsurface soil, bedrock and groundwater conditions, including: Surficial Geologic Map of New York, Geologic (Bedrock) Map of New York, Soil Survey of Orleans County, Deep Wells in New York State, Geology of Orleans County, and New York State Building Code.

2. Evaluated the suitability of existing soils for re-use as backfill, including assessing the risk of turbine foundation corrosion and degradation. TRC found that turbines would be supported through either shallow or deep foundations. TRC also found that some soil units within the Facility Site are considered slightly acidic and may be corrosive to steel and concrete. Steel may need a protective coating and concrete may require additives in the mixture to protect against corrosion. Detailed design requirements will be determined during the final engineering phase. See the Geotechnical Desktop Study (Appendix 21-A) for a full discussion of soil corrosivity and an identification of corrosive soil units.

In addition to the desktop analysis, soil borings were performed by Terracon at a subset of turbine location. These are summarized in their Preliminary Geotechnical Report (Appendix 21-B). As part their analysis, Terracon performed the following:

1. Investigated subsurface soil and bedrock conditions through sampling and limited geotechnical laboratory testing at 6 boring sites. Boring locations were sited to be proximal to the proposed turbine sites, substations, O&M facility, point of interconnection, and collection lines. The subsurface conditions encountered in the test borings were generally consistent with the mapped surficial and bedrock geology at those locations as described in the Geotechnical Desktop Study (Appendix 21-A). Bedrock and groundwater were encounter at each boring location as listed below:

    - T-3: bedrock not encountered; groundwater observed at approximately 25.5 feet
    - T-7: bedrock encountered at approximately 30 feet; groundwater observed at approximately 26 feet
    - T-11: bedrock encountered at approximately 9 feet; groundwater observed at approximately 5 feet

- T-18: bedrock encountered at approximately 33.5 feet; groundwater observed at approximately 5.5 feet
- T-26: bedrock encountered at approximately 15 feet; groundwater not observed
- T-30: bedrock encountered at approximately 5.5 feet; groundwater observed at approximately 5 feet
- Substation: bedrock encountered below 40 feet; groundwater not observed.

Based on the subsurface conditions encountered at the test borings, the glacial till deposits and/or bedrock encountered at the Facility Site are structurally suitable for support of wind turbine foundations and Facility components. See Appendix 21-B for a detailed discussion of the preliminary geotechnical investigations performed and a rationale for the selection of boring locations.

During the geotechnical field work (winter 2019), a perched water table was generally encountered during drilling within boring depths. Dense glacial till, high fine content soils, and sedimentary rock were generally encountered, and as such, the test pits would be considered relatively impermeable. Therefore, considering a seasonal fluctuation of groundwater levels, perched groundwater conditions could be encountered in excavations, particularly after rainfall events or irrigation.

Before construction commences, a site survey will be performed to stake out the exact location of proposed Facility components. Once site surveys are complete, additional detailed geotechnical investigations will be performed to verify subsurface conditions and facilitate the development of final foundation and electrical designs for the wind turbines and other Facility components. Geotechnical borings will be conducted as determined necessary by a professional engineer to identify the strength and chemical properties (e.g., sulfate content) of subsurface soil and rock types. The presence and depth of any groundwater encountered during boring will be documented. The soil's electrical properties will be tested to ensure proper grounding system design.

In addition to evaluating soil conditions for constructability, the Applicant also identified and assessed other geological features including gas and water wells, gas pipelines, and quarries. These are summarized below:

- Gas wells – A review NYSDEC GIS data indicates only one gas well near the Facility. NYSDEC has mapped a dry exploratory well located roughly 1,000 feet from the nearest turbine (see Figure 4-3). Given this distance and the dry nature of the exploratory well, adverse effects are not anticipated, and this is not considered to affect the construction suitability of the site.
- Water wells – The Applicant submitted a Freedom of Information Law (FOIL) request to State and local agencies to obtain information about water wells. In addition, a private well survey was sent to the owners of

over 400 parcels. Based on the information received, direct impacts to water wells will be avoided. See Exhibit 23(b) for additional information.

- Gas pipelines – No gas pipelines were identified on the Facility Site following a review of available NYSDEC data (see Figure 4-3). The nearest identified gas line is located approximately 1.9 miles south of the Facility Site.
- Quarries – A review of NYSDEC data identified no permitted mines or quarries on the Facility Site. While there are permitted mines within the 5-mile Study Area, the nearest is located 1.2 miles northwest of the Facility Site (see Figure 4-3).

(i) Preliminary Blasting Plan

Depth to bedrock underlaying the Facility Site varies between 5 feet and greater than 40 feet below ground surface (bgs) based on the desktop analysis (Appendix 21-A) and confirmed via on the soil borings (Appendix 21-B). Although mechanical excavation with a pneumatic hammer or large ripper may be possible for some of the bedrock encountered, particularly the upper few feet, in many cases, blasting may be required. In these cases, blasting will likely generate less noise and take less time than constructing via pneumatic hammer. At the time of construction, the Applicant will determine where blasting is required, the extent required, potential noise impacts, construction schedule and costs, the volume and hardness of rock encountered, safety precautions, and other applicable factors.

A Preliminary Blasting Plan (Appendix 21-C) has been prepared that addresses contractor qualification requirements; warning measures, including procedures and timeframes for notifying host communities and property owners within a one-half mile radius of blasting locations prior to blasting; safe transportation, handling, and storage of blasting materials; use of blasting mats; coordination with local fire and emergency medical services (EMS) districts; pre-blasting condition surveys of nearby buildings; impacts to drinking water wells; and notifications to nearby business and residential owners of 24-hour contact information for reporting any impacts occurring after blasting operations.

The Preliminary Blasting Plan is intended to serve as an overall guide with procedures for all the blasting required for the Facility. The blasting contractor will generate a written site-specific Blasting Plan with variations as needed to address differences in the blasting sites, including bedrock depth, bedrock quality, and proximity to adjacent structures or utilities. This site-specific Blasting Plan will cover pre-blast surveys, notifications, use of explosives, security, monitoring, and documentation.

(j) Potential Blasting Impacts

With respect to potential blasting impacts to water wells, see Section (j)(2) below and Exhibit 23(a) and (b) for additional information. With respect to blasting impacts to gas pipelines, see Section (j)(2). One oil or gas well was identified within the Facility Site; however, it is deemed a dry wildcat well originally drilled in August of 1965. The status of the well is identified as "unknown" by the NYSDEC (NYSDEC, 2019).

The area of rock fractured by a blast is generally confined to an area with a radius 70 times that of the blast-hole radius. However, the depth of the blast-hole can modify this relationship (i.e., all else being equal, a deeper blast-hole will have a larger rock fracture area than a shallower blast-hole). Vibration waves created by the blast continue beyond the rock fracture area but diminish in amplitude with distance. Facility engineers will adjust the weight of the charge and other parameters to control the amplitude of the vibration to diminish its force at distances where sensitive structures exist. Standards developed by the U.S. Bureau of Mines set limits on vibration magnitudes that will prevent damage to above and below-ground structures.[1] These standards will be followed during Facility construction.

(1) Blasting Impacts to Above-Ground Structures

In designing blasts, Applicant's blasting contractor will consider locations of residences, seasonal cabins and historic structures within 500 feet of the blast site. It will design the blast to limit vibration amplitudes at these locations to be less than limits set to prevent cosmetic damage in plaster walls, which the Society of Explosives Engineers has determined are typically the most vulnerable to blasting. Limits set to prevent damage to plaster walls will ensure no damage occurs to drywall walls, residential structures or foundations.

(2) Blasting Impacts to Below-Ground Structures

Blasting, if needed, is likely to be isolated to the turbine locations and used to facility foundation construction. In designing blasts, the blasting contractor will consider locations of below-grade structures and utilities within 500 feet of the blast site (i.e., from turbine location). No known, existing water supply wells are located within 500 feet of wind turbine locations (see Exhibit 23). Additionally, water lines which are present in the Facility Site are primarily located along roadways within the RO; thus, these are anticipated to be within 500 feet of wind turbines. No gas pipelines or gas wells are located within 500 feet of wind turbine locations or within a half mile of the Facility Site.

[1] Based on USBM Report RI 8507 – Structure Response and Damage Produced by Ground Vibration from Surface Mine Blasting, 1980.

Several published studies have been carried out to investigate the effects of blasting near water wells. One study evaluated performance of 25 test wells drilled at four sites in Ohio, Pennsylvania, and West Virginia where companies were using blasting to mine coal (Robertson et al., 1980). Test wells, ranging from 80 to 200 feet deep, were drilled 1,000 feet or more from active blasting, and researchers monitored the wells as the blasting progressed to as close as 50 feet from the wells. Blasting caused maximum ground vibration levels at the well sites ranging from 20 mm/sec (0.84 in/sec) to 138 mm/sec (5.44 in/sec). Based on monitoring of the well performance during and after the ground vibrations, the study concluded ground level vibrations of 51 mm/sec (2.0 in/sec) or less are not substantial enough to damage wells. Consistent with this, the Society of Explosives Engineers has concluded that standards that protect houses will also protect below-ground structures, including groundwater wells and gas pipelines (USBM, 1980).

(k) Mitigation Measures for Blasting Impacts

Blasting will be conducted in accordance with the final Blasting Plan. As stated in Exhibit 21(j), blasting impacts to above and belowground structures will be avoided and minimized through adherence to appropriate setbacks and the implementation of established Bureau of Mines vibration standards. As outlined in the Preliminary Blasting Plan (Appendix 21-C), all blasting operations adjacent to residences, buildings, structures, utilities or other facilities will be carefully planned with full consideration for all forces and conditions involved. The minimum amount of blasting material will be used to effectively fracture the competent rock for the excavation depth. Independent monitoring of vibration and air concussion levels will be carried out by the contractor during all blasting operations. Any necessary blasting will be overseen by the Facility Environmental Monitor.

To mitigate potential adverse impacts resulting from blasting operations, blasts will comply with the following requirements:

- Code of Federal Regulations Title 27 (Alcohol, Tobacco Products and Firearms);
- New York State Industrial Code Rule 53;
- Directive 495 standards of the National Fire Protection Association (NFPA);
- Occupational Safety and Health Administration (OSHA) standards, 29 CFR 1926.900 – 1926.914 and 1910.109;
- New York State Industrial Code Title 12, Part 39;
- Article 16 of the Labor Law of the State of New York.

The Applicant will conduct a pre- and post-blasting survey as described in the Preliminary Blasting Plan. The pre-blast survey will document existing conditions including, but not limited to, buildings/structures, water supply wells and utilities (above and below ground), within 500 feet of blasting locations. The survey will include written and photographic documentation of existing conditions. Although not anticipated, any impacts identified through these inspections will be addressed on a case-by-case basis. Corrective actions will be developed in consultation with the affected party, and will set forth the method, procedures, and timing of implementation.

The Preliminary Blasting Plan describes proposed structural, water quality and water quantity inspections of wells located within 500 feet of blasting, as well as the notification and complaint resolution procedures for well owner/operators potentially affected by blasting operations. As stated in Section (j)(2) above, several studies indicate that at this distance, adverse impacts to wells can be avoided during blasting. Also, consistent with recent Article 10 proceedings, if environmental or engineering constraints require blasting within 500 feet of a known existing, active water supply well on a non-participating parcel, the Applicant will engage a qualified third party to collect pre- and post-blasting water samples of the well, provided the Applicant is granted access by the property owner. These water samples will be sent to a New York State Department of Health (NYSDOH)-certified laboratory for potability testing. Should the NYSDOH-certified laboratory testing conclude that the water supplied by an existing, active water supply well met applicable federal and New York State standards for potable water prior to construction, but failed to meet such standards post-construction, the Applicant will cause a new water well to be constructed.

(l) Regional Geology, Tectonic Setting, and Seismology

Regional geology, tectonic setting, and seismology are discussed in detail in the Geotechnical Desktop Study (Appendix 21-A) and the Preliminary Geotechnical Report (see Appendix 21-B), a summary of which is provided below.

The Facility Site is located within the Erie and Ontario-Lowlands physiographic province. Surficial deposits consist of glacial till of varying texture materials such as clay, silt-clay, boulder clay, and more. This physiographic province is characterized primarily by subdued topography, with the exception of the Niagara escarpment and swarms of drumlins south of Lake Ontario. Elevation within Orleans County ranges from 246 feet above mean sea level (amsl) near Lake Ontario, to 737 feet amsl at the southwestern portion of the Town of Barre (USDA, 1973). Orleans County is located in two major drainage basins, the Lake Ontario River Basin and Genesee River Basin (NYSDEC, 2012).

New York is largely tectonically inactive. Based on fault line GIS data from the New York State Museum, the closest fault line is located approximately one-half mile from the nearest turbine. Additional faults are found within Orleans County. These faults are associated with the Clarendon-Linden fault system, a major series of fault lines in western New York. Based on the 2014 New York State Hazard Map (NYDHSES, 2014), the Facility is in an area of low seismic hazard, with a 3% to 4% chance that peak ground acceleration[2] in a 50-year period will exceed 10% of standard gravity. Additional discussion of seismic and earthquake activity is provided in Sections (n) and (s), below.

Multiple sand and gravel mines are located in Orleans County; however, none are located within the Facility Site. The closest mine is located approximately 1.5 miles from the turbines, so the Facility will not have a direct impact on the operation of those quarries. It is possible that during Facility construction quarry operators may see temporary minor impacts to their operations because of construction activities and use of local roads (e.g., transportation delays) (see Exhibit 25). Blasting impacts will be mitigated through coordination with the quarry landowner and implementation of the measures outlined in the Preliminary Blasting Plan (Appendix 21-C).

The project area is underlain by limestone and dolostone bedrock with interbedded shale layers. The borings advanced within the bedrock did not encounter indications of voids or solution features. The shear-wave profiles obtained from the geophysical survey completed at four locations (T-3, T-11, T-18, and T-30) across the site were also examined for changes in seismic wave velocities to indicate potential for karst features within the bedrock. Potential karst anomalies, generally identified by low velocity zones, were not identified at any of the 1-D and 2-D profiles completed for this project. As a result, we do not anticipate that specific construction procedures associated with karst geology are required for this project. Therefore, further assessment was not conducted.

(m) Facility Impacts on Regional Geology

The glacial till deposits and/or bedrock encountered at the Facility Site are structurally suitable for support of wind turbines foundations and support buildings as detailed in the Geotechnical Desktop Study (Appendix 21-A). Prior to commencing construction, the Applicant will carry out additional subsurface investigation activities, consisting of soil boring and rock coring, as determined necessary by a professional engineer. Test pits, seismic testing, and additional laboratory testing may also be performed to further evaluate the subsurface soil, bedrock, and groundwater conditions. These additional investigations will inform the final Facility design (including the turbine foundation designs) and determine if additional analyses are needed.

Based on soil borings conducted at a subset of turbine locations, bedrock ranges between 5 feet and greater than 40 feet bgs across the Facility Site. The depth of bedrock has direct implications on facility construction, including impacting foundations depths and installation methods for the turbines. Larger depths may require some turbine foundations be anchored into bedrock (see Appendix 21-B). Where bedrock is encountered it will be removed as described in Section (i). Based on the Applicant’s experience in constructing major energy generating facilities, only

[2] Peak acceleration is the largest increase in velocity recorded by a particular station during an earthquake.

temporary, minor impacts to physiography and geology are expected because of construction activities. For example, where turbine and access road sites are not located on completely level terrain, some cut-and-fill will be required. However, the impact to overall topography will be minor. Once operational, Facility impacts to geology will be minimal.

Overall, Facility components will be designed, sited, and constructed in a manner that avoids and minimizes temporary or permanent impacts to physiography, geology, and soils, to the extent practicable. Accordingly, the Facility is not anticipated to result in any significant impacts to the regional geology. See Section (l) above for a description of the impacts of the Facility on local mining operations.

(n) Impacts of Seismic Activity on Facility Operation

Several fault lines run through Orleans County, but none are anticipated to pose an imminent threat. Faults in the vicinity of the Facility Site are part of the Clarendon-Linden fault system. The USGS Earthquakes Hazards map (earthquakes.usgs.gov) shows two historic earthquakes occurring in 2007 and 2009 along the Clarendon-Linden fault line. Earthquakes centered nearby have been felt in Orleans County.

The USGS Earthquake Hazards map shows the geographic area affected, the probability of an earthquake of each given level of severity (10% chance in 50 years), and the severity. Areas with the least earthquake risk are shown in green and areas with the greatest risk are shown in purple. As the map indicates, the Facility Site is in an area of low seismic hazard, with a PGA value of less than 10% gravity (g) for earthquakes with a 2% probability of occurring within 50 years. This probability indicates a very low risk to the Facility Site from being impacted by an earthquake for the life of the Project.

(o) Soil Types Map

See Figure 21-2 for a map delineating soil types within the Facility Site in relation to the proposed Facility layout. The map was prepared using data from the USDA Natural Resource Conservation Service (NRCS) Web Soil Survey. The Prime Farmland, Prime Farmland if Drained, and Farmland of Statewide Importance geospatial data contained in this map were obtained from the Soil Survey Geographic Database (SSURGO). According to the NRCS, these three farmland classes are the only farmland classes recognized in New York. Accordingly, Unique Farmland and Farmland of Local Importance were not mapped. Where known, the location of drainage tile in designated farmland is depicted on Figure 21-2.

The Applicant's program for avoiding and mitigating impacts to agricultural soils is contained in Exhibit 4 of the Application. Information about changes in Facility layout to minimize impacts to agricultural land is contained in Exhibit 9.

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

Information regarding on-site soils is described in the Geotechnical Desktop Study (Appendix 21-A) and confirmed by the ground soil borings summarized in the Preliminary Geotechnical Report (Appendix 21-B). As indicated in the Geotechnical Desktop Study, the surface texture of subsurface soils within the Facility Site are classified as Silt Loam, Very Fine Sandy Loam, Muck, Fine Sandy Loam, Loamy Fine Sand, Mucky Silt Loam, Loam, Gravelly Loam, and Silty Clay Loam. The Desktop Geotechnical Study also provides descriptions and a table describing the soil series characteristics found at the proposed wind turbine locations, a summary of which is presented in Table 21-1 below:

Table 21-1. Predominant Soil Series Within the Facility Site and their Characteristics.

USDASC[1]	Description[2]	Possible USCS	Hydrologic Soil Group	Infiltration	Runoff	Depth to GW (in.)	Corrosion Concrete	Corrosion Steel	pH	Organic Matter (%)	Suitability for Roadway
HbB	Hilton Loam	ML	B/D	Most limited	Low	21	Moderate	High	7.7	0.75	Moderately suited
Ca	Canandaigua soils	SM	C/D	Most limited	--	0	Low	High	7.8	0.75	Poorly suited
AnA	Appleton silt loam	ML	B/D	Most limited	Very High	8	Low	High	7.5	0.62	Poorly suited
OnC	Ontario loam	ML	B	Somewhat limited	Medium	79	Moderate	Low	7.4	0.81	Moderately suited
HbB/ChA	Hilton Loam/Churchville silt loam	ML	C/B/D	Most limited	Low	21 / 15	Moderate/Low	High	7.7/7.8	0.75/0.64	Moderately suited
OnC	Ontario loam	ML	B	Somewhat limited	Medium	79	Moderate	Low	7.4	0.81	Moderately suited
Ly	Lyons soils	ML	C/D	Most limited	Negligible	0	Low	High	8.1	0.61	Poorly suited
ChA	Churchville silt loam	ML	C/D	Most limited	--	15	Low	High	7.8	0.64	Moderately suited
HpC	Howard soils	SM	A	Most limited	--	79	Low	High	6.6	0.42	Poorly suited
HnB	Hilton-Cazenovia complex	SM	B/D	Most limited	Low	21	Moderate	High	7.7	0.75	Moderately suited
KaA	Kendaia and Appleton soils	ML	B/D	Most limited	Very High	8	Moderate	High	7.9	0.5	Poorly suited
HnB	Hilton-Cazenovia complex	SM	B/D	Most limited	Low	21	Moderate	High	7.7	0.75	Moderately suited

Notes:

[1] United States Department of Agriculture Soil Classification (USDA).

[3] Best estimates using Unified Soil Classification System (USCS).

The Geotechnical Desktop Study addresses the suitability and limitations of these soils for the proposed site development, including excavation stability, erosion hazard, corrosion potential, and foundation integrity. The Geotechnical Desktop Study and the Preliminary Design Drawings discuss best management practices (BMPs) that will be employed relative to items above to help minimize risks and hazards. Temporary excavations will be sloped or braced, as required by Occupational Safety and Health Administration (OSHA) regulations, to provide stability and safe working conditions. All excavations will comply with applicable local, State, and federal safety regulations, including the current OSHA Excavation and Trench Safety Standards.

For information regarding agricultural soil designations within the Facility Site, including designated Agricultural District lands, see Exhibits 4(a) and 22(q) of this Application. For a detailed discussion of anticipated soil disturbance, see Exhibit 22(q).

Erosion and sediment control measures identified in the Preliminary SWPPP (Appendix 21-E) will be implemented to minimize erosional impacts. Excavation stability will be ensured through the implementation of the measures and BMPs identified in the Geotechnical Desktop Study and the Preliminary Design Drawings.

As discussed in Section (h), some soil units found within the Facility Site may be corrosive to steel and concrete. Steel may need a protective coating and concrete may require additives in the mixture to protect against corrosion. Detailed design requirements for addressing excavation stability, erosion hazard, corrosion potential and foundation integrity will be determined during the final engineering phase.

Based on information from NRCS's WebSoil Survey, and the Preliminary Geotechnical Report (Appendix 21-B), perched groundwater, particularly during spring or fall, may be encountered during construction or excavation. If groundwater is encountered, or the need arises to control surface water during the construction phase, dewatering may be required. Open sump pumping is anticipated to be a sufficient dewatering method based on the relatively low permeability of soils found within the Facility Site. For a discussion of how pumped water will be managed, see Exhibit 23(a)(3)(ii). The final geotechnical investigations conducted at each turbine location will determine whether long-term dewatering will be necessary.

As soils within the Facility Site have low permeability, risk of frost action is likely to be moderate to high (see Section (r)(1) below for a discussion of how frost action impacts will be avoided). Specific to the Facility Site, the anticipated Seismic Site Class definition for consideration under the New York State Building Code for the proposed turbine locations will be C or D, indicating very dense soil/soft rock and medium dense to dense soil, respectively. The actual

Seismic Site Class at each turbine location will be determined after the supplemental geotechnical investigation is performed for final design.

Prior to commencing construction, the Applicant will carry out additional subsurface investigation activities, consisting of soil boring and rock coring, as determined necessary by a professional engineer. Test pits, seismic testing, and additional laboratory testing may also be performed to further evaluate the subsurface soil, bedrock, and groundwater conditions. Typical corrosivity parameters (e.g., sulfates, chlorides) will be tested for. These additional investigations will inform the final Facility design (including the turbine foundation designs and steel and concrete designs) and determine if additional analyses are needed.

(q) Bedrock Analyses and Maps

Maps, figures, and analyses on depth to bedrock, underlying bedrock types, and vertical profiles of soils, bedrock, water table, seasonal high groundwater are provided in the Desktop Geotechnical Study (Appendix 21-A), Preliminary Geotechnical Report (Appendix 21-B) and typical foundation plans (Appendix 11-B). In addition, Figure 21-3 shows depth to bedrock, bedrock formation, and depth to the high water table across the Facility Site relative to Facility components, including access roads and off-site interconnections.

As indicated in the soil boring logs, depth to bedrock ranges from 5 feet to greater than 40 feet bgs. Predominate bedrock lithology consists of dolostone, limestone, and shale of the Akron Dolostone and Salina Group, and the Lockport Group. Both groups originate from the Silurian geologic period. The bedrock encountered is anticipated to be structurally suitable for support of foundations for wind turbines, support buildings, and access road construction. However, turbine locations will undergo additional subsurface investigation prior to turbine construction. See Exhibit 21(h) and (i) and the Preliminary Blasting Plan (Appendix 21-C) for a discussion of blasting anticipated to be conducted as part of Facility construction.

Final foundation systems for the Facility may vary based on the competency of subsurface soil and rock. A shallow foundation system, as shown in the preliminary foundation drawings, is generally suitable for wind turbines. If subsurface conditions at a particular location are deemed unsuitable for a shallow foundation system, a deep foundation system (e.g., micropiles or drilled shafts) will be a viable alternative. Prior to construction, a detailed subsurface study will be conducted to determine the final foundation design for each turbine.

The depth to groundwater within the Facility Site, as indicated by the soil borings, is 5 feet- 25 feet and may vary from location to location. Groundwater may be encountered during foundation construction in areas of shallow water table, especially during wet periods of the year. Residence and community groundwater wells are generally assumed to be set deeper than the proposed wind turbine foundations and buried electrical collection lines within fractured bedrock or granular till soil. Additionally, turbines are set back from residential structures as outlined Exhibit 6. Therefore, based on the data reviewed and the planned setback distances, it is unlikely construction of the proposed turbines will have an impact on shallow aquifer or residential water well groundwater quality or quantity. To ensure construction and operation of the Facility does not adversely affect nearby groundwater wells, structural, water quality, and water quantity investigations of any water wells within 500 feet of proposed blasting will be conducted prior to and after blasting activities.. Any adverse impacts identified based on this testing will be mitigated in accordance with the measures identified in Section (k).

Crushed stone and/or gravel stockpiles will generally be located at the O&M facility. Topsoil will be stockpiled at various locations near each work site to facilitate cut and cover operation and minimize transporting of excess soils. As indicated previously, the Applicant anticipates balancing cut and fill. Although specific locations where topsoil and soil materials will be temporarily stockpiled have not been developed, these will be maintained per the Project SWPPP. Topsoil and subsoil spoils will be separated and placed in locations best suited to their storage adjacent to the turbine, access road, and trench sites where they are excavated.

(r) Foundation Evaluation

Foundation construction occurs in several stages, which typically include excavation, pouring of concrete mud mat, rebar and bolt cage assembly, outer form setting, casting and finishing of the concrete, removal of the forms, backfilling and compacting, 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 NYS Building Code and in conformance with the Geotechnical Desktop Study and preconstruction site-specific studies.

(1) Preliminary Engineering Assessment

The wind turbines can be supported by shallow or deep foundations. Typically, the foundations are required to sustain both compressive, lateral and tensile loads imposed from the wind turbine structure, which typically results in a large footing foundation. A deep foundation system can be a viable alternate for the wind turbine structure. Based on anticipated subsurface and structure loading conditions, most suitable deep foundation systems for this particular Facility would likely consist of drilled shafts (caissons) or micropiles. Both of these deep foundation systems basically involve drilling, reinforcement and concrete/grout. Depending on the structure loads, the drilled shafts or micropiles can be multiple diameters with various shaft/pile lengths. To provide suitable support for deep foundations it is anticipated that each drilled shaft or micropile will be embedded into competent bedrock.

A shallow foundation system is generally suitable for wind turbine structures providing they are bearing in competent soils or rock if encountered at relatively shallow depths at the project site, but a deep foundation system such as drilled shaft or micropile is a suitable alternative where subsurface conditions warrant. Whichever of the foundation systems is selected, a comprehensive project specific subsurface investigation program will be performed for each turbine location prior to final foundation selection and design.

(2) Pile Driving Assessment

Pile driving is not anticipated to be needed for this Facility.

(3) Mitigation Measures for Pile Driving Impacts

Pile driving is not anticipated to be needed for this Facility.

(s) Vulnerability to Earthquake and Tsunami Events

As previously indicated, the Facility appears to have minimal vulnerability associated with seismic events based on review of publicly available data. Based on the 2014 New York State Hazard Map, the Facility is in an area of low seismic hazard. Additional information is presented in the Preliminary Geotechnical Report (Appendix 21-B).

Tsunamis are giant waves that are caused by earthquakes or volcanic eruptions under the sea (NOAA, 2015). Though the Facility is located over 250 miles from the Atlantic Ocean, meteotsunamis have occurred within the Great Lakes. A meteotsunami is caused by air pressure disturbances, often associated with fast-moving weather systems, such as squall lines (NOAA, 2015). Although the Great Lakes have provided favorable conditions for meteotsunamis, severe cases have only been documented for Lake Erie and Lake Michigan. No impacts are expected to occur at the Facility due to meteotsunamis because the Facility Site is located approximately 11 miles inland, well outside the shoreline that would be impacted by meteotsunamis.

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