Galloo Island Wind Energy Facility

Case No. 15-F-0327

1001.21 Exhibit 21

Geology, Seismology, and Soils

TABLE OF CONTENTS

LIST OF TABLES

EXHIBIT 21 GEOLOGY, SEISMOLOGY, AND SOILS

(a) Existing Slopes Map

See Figure 21-1 for a map delineating existing slopes (0-3%, 3-8%, 8-15%, 15-25%, 25-35%, 35% and over) on and within the drainage area potentially influenced by the Facility Site. Slopes within the Facility Site range from 0% to 8%.

(b) Proposed Site Plan

See the preliminary design drawings included with Exhibit 11, which includes proposed and existing contours at two-foot intervals, for the Facility Site and interconnections.

(c) Cut and Fill

Based on preliminary cut and fill calculations on 2-foot contours interpolated from publicly available 1-meter digital elevation models (DEM) and preliminary engineering of the proposed Facility, it is anticipated that 1,800,000 cubic feet of material will be excavated for the construction of the proposed Facility. Of this, approximately 630,000 cubic feet will be topsoil, with the remaining 1,170,000 cubic feet will be subsoil, substratum, and bedrock (all rough approximations). Based on this preliminary analysis, little to no subsoil or substratum will be excavated, since the majority of soils on site are topsoil on bedrock. Soil profiles of the soil map units within the Facility Site were generated from data in the Soil Survey of Jefferson County, New York (USDA 1989).

The construction of the access roads, crane pads, and other site features will require minor cut or fill to achieve the final grades of several areas of the Facility. In the initial design process, the Applicant developed a basis of design for these features. Within these design parameters, the Applicant aimed to minimize significant areas of cut or fill. However, various scenarios would potentially create areas of cut and/or fill. These include constructing access roads that traverse an existing grade that exceeds the maximum design slope, constructing on a side slope, or needing to flatten the top of an existing high point.

All soils and other fill material will be re-used on-site. No fill material other than gravel will be transported from outside the Facility Site, nor will any fill be transported offsite from the Facility Site, minimizing the potential for introduction and/or transport of invasive species. See Section (e) below for additional information. In addition, the Applicant has developed an Invasive Species Control Plan (ISCP) (Appendix Y). The stated goal of the ISCP is to have no net increase in invasive plant species coverage within the area disturbed by Facility construction resulting from construction activities. In developing the ISCP, the Applicant was informed by on-site observations of existing conditions on Galloo Island and changes regarding the spread of Pale Swallow-wort since issuance of SEQRA Findings Statement for the Hounsfield Project. The ISCP will be appended to the Facility construction contract, which will require the Balance of System BOS contractor to implement the control measures outlined within the ISCP. The principal construction-related control measures contained within the ISCP are 1) construction materials inspection, 2) target species treatment and removal, 3) construction equipment sanitation, and 4) restoration.

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

Based on preliminary calculations, approximately 1,450,000 cubic feet of gravel is anticipated to be utilized for construction and operation of the Facility. This will be retained from the borrow pit and supplemented from off-site gravel to the extent needed. Based on a balanced design, excavated cut from the Facility Site will be used as fill material throughout the project area.

Fill will be utilized to create appropriate grades for access roads, crane pads, substations, and laydown areas (see preliminary design drawings included in Appendix J). Gravel will be used as surface material for access roads, crane pads, met tower pads, and other Facility components. As stated above, with the exception of gravel, fill material will be derived from excavated material, and no new fill will need to be imported for the purposes of Facility construction and operation.

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

No native materials will be removed from the Facility Site. Stockpiled soils along the construction corridors will be used in site restoration, and all such materials will be re-graded to approximate pre-construction contours. Based on the preliminary cut and fill estimates the design will balance the cut and fill of the Facility. The Applicant will require that final engineering efforts maximize the balance of cut and fill, and ultimately any excess cut material will be utilized during site restoration.

(f) Excavation Techniques to be Employed

Pending the receipt of all required permits, construction is currently scheduled to start in winter of 2018/2019. Facility excavation and construction will be performed in several stages and will include the main elements and activities described below.

(1) Pre-Construction Activities

Before construction commences, a site survey will be performed to stake out the exact location of proposed Facility components. To assure compliance with various environmental protection commitments and permit conditions, the Applicant will provide funding for an Environmental Monitor to oversee Facility construction and restoration activities and to ensure compliance with all applicable environmental conditions. Prior to the start of construction at any given site, the Environmental Monitor and a representative of the construction contractor will conduct a walk-over of areas to be affected, or potentially affected, by proposed construction activities. This pre-construction walk-over will focus on the previously identified sensitive resources to avoid (e.g., wetlands, archaeological, or agricultural resources), as well as the limits of clearing, location of wetlands and streams, location of drainage features (e.g., culverts, ditches), location of tile lines, and layout of sedimentation and erosion control measures. Upon identification of these features, they will be marked in the field (by staking, flagging, fencing, etc.).

(2) Barge Landing Construction

The barge ramp will be a portable truss bridge supported by a pontoon so that it can be lowered onto the transport barge deck. A concrete bulkhead will be installed above ordinary high water (OHW) on the shoreline. The pontoon will have four anchor bolts drilled into the lake bed which will attach to the barge and act as mooring lines for the transport barge itself. Four additional anchors will be attached to the upland areas of the shore and act as additional mooring lines for the barge ramp and transport barge. The barge ramp will be attached to shore through a concrete footing/abutment. Excavation for this project element will be performed by a tracked excavator. No dredging in Lake Ontario will be required to install bulkhead and anchor bolts needed for the barge ramp.

(3) 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 approximately eight inches of gravel will then be installed to create a level working area.

(4) Site Preparation for Construction

Facility construction will be initiated by clearing brush/woody vegetation from all turbine sites, access roads, and electrical collection line routes. Trees cleared from the work area will be removed and disposed of on-site (outside of any wetlands, streams or floodways). It is generally assumed that a radius of up to 200 feet will be cleared around each turbine, a 75-foot wide corridor will be cleared along access roads, and a 40-foot-wide corridor will be cleared along underground electric collection lines that are not adjacent to access roads.

Actual clearing impacts on this Facility will be based on final engineering design, and are described and quantified in Exhibit 22(b).

(5) Access Road Construction

Wherever feasible, existing island roads will be upgraded for use as Facility access roads in order to minimize impacts to forest and wetland/stream areas. Where an existing island road is unavailable or unsuitable, new gravel surfaced access roads will be constructed. Road construction will involve topsoil stripping and grubbing of stumps, as necessary. Stripped topsoil will be stockpiled (and segregated from subsoil) along the road corridor for use in site restoration. Any grubbed stumps will be removed, chipped, or buried in upland areas of the site. 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.

Culverts and waterbars will be installed to maintain natural drainage patterns where necessary. Where access roads must cross wetlands with flowing water, a temporary pump-around or coffer dam will be used to install crossings "in the dry". Appropriate sediment and erosion control measures will be installed and maintained according to the Facility-specific NYSDEC-approved stormwater pollution prevention plan (SWPPP) for the Facility (see the preliminary SWPPP provided in Appendix HH). During construction, roads with a travel surface of up to 40 feet wide will be required to accommodate large cranes and oversized construction vehicles. At the completion of construction, the travel surface of access roads will not be reduced, except in those areas where access roads will cross wetlands (see Preliminary Design Drawings). In that case, the travel surface will be reduced to 16 feet. Typical access road details are included in Exhibit 11.

(6) Foundation Construction

Once the roads are complete for a particular group of turbine sites, turbine foundation construction will commence on that completed access road section. 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, tracked excavators will be used to excavate the foundation hole. Subsoil and rock will be segregated from topsoil and stockpiled for reuse as backfill. All stockpiled soils will be located outside of wetlands and will be stabilized in accordance with the final SWPPP. If necessary, dewatering of foundation excavations will involve pumping the water to a discharge point, which will include measures/devices to slow water velocities and trap any suspended sediment. Dewatering activities will not result in the direct discharge of water into any streams or wetlands, and will be conducted in accordance with the SWPPP. Where blasting is deemed necessary, all blasting operations will adhere to applicable New York State statutes and regulations governing the use of explosives, see section (i) below for more information.

Turbine foundations will be reinforced concrete, approximately 10 feet deep, and 50 to 65 feet in diameter. Any excess concrete and concrete wash water at turbine sites will be properly disposed of by pouring it into an excavation (either into the foundation excavation or "wash-out pits" created for this purpose) and then burying it or removing it from the site. No concrete will be buried or otherwise disposed of in wetlands. Once the foundation concrete is sufficiently cured, the excavation area around and over it will be backfilled with the excavated on-site material. The top of the foundation is typically an 18-foot diameter pedestal that extends six to eight inches above grade. The base of each tower will be surrounded by a 6-foot wide gravel skirt, and an area approximately 100 feet by 60 feet will remain as a permanent gravel crane pad.

(7) Electrical Collection System Installation

Direct burial methods utilizing appropriate industry equipment including, but not limited to, a cable plow, rock saw, rock wheel and/or trencher will be used during the installation of underground electrical collection system whenever possible. Direct burial involves the installation of bundled cable (electrical and fiber optic bundles) directly into a narrow cut or "rip" in the ground. The rip disturbs an area approximately 24 inches wide with bundled cable installed to a minimum depth of 36 inches in most areas. 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. Following cable installation, the trench is backfilled with suitable fill material and any additional spoils are spread out or otherwise properly disposed of. Following installation of the buried collection line, areas will be returned to pre-construction grades. Installation of buried electrical lines would typically require a width of up to 40 feet of vegetation clearing. However, in areas where buried electrical lines are collinear with proposed access roads, no additional vegetation or soil disturbance, beyond that anticipated for road construction, is typically expected. The cleared area along the buried electrical line will be restored through seeding and mulching, and allowed to regenerate naturally.

(8) Wind Turbine Assembly, Erection and Commissioning

Turbine assembly and erection involves mainly the use of large track mounted cranes, smaller rough terrain cranes, boom trucks, and rough terrain forklifts for loading and off-loading materials. The tower sections, rotor components, and nacelle for each turbine will be delivered to each site by flatbed trucks and unloaded by crane. A large erection crane will set the tower segments on the foundation, place the nacelle on top of the tower, and install the rotor either by individual blade installation or, following ground assembly, place the rotor onto the nacelle. No excavation is necessary during this stage of the Facility construction process.

(9) 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. Above-ground construction will involve the installation of structural steel, bus conductors and insulators, switches, circuit breakers, transformers, control buildings, etc. The final steps involve laying down crushed stone across the station, erecting the chain link fence, connecting the high voltage links, and testing the control systems. Restoration of the area immediately adjacent to the substations will then be completed.

(g) Temporary Cut and Fill Storage Areas

The construction of the access roads, crane pads, and other site features will require minor cut or fill to achieve the final grades of several areas of the Facility. In the initial design process, the Applicant developed a basis of design for these features. Within these design parameters, the Applicant has aimed to minimize significant areas of cut or fill. As previously noted, however, several scenarios require the creation of areas of cut and/or fill. These scenarios include constructing access roads that traverse an existing grade that is in excess of the maximum design slope, constructing on a side slope, or needing to flatten the top of an existing high point.

Proper methods for segregating stockpiled and spoil material will be implemented, and excavated soil will be reused to the maximum extent possible on the site that it was excavated from, as a means to limit opportunities for proliferation of non-native flora. Final cut and fill storage areas will be available following Certification, and included in the construction drawings.

As previously noted, no dredging is required to construct the Facility.

(h) Suitability for Construction

TRC Engineers, Inc. (TRC) conducted a Preliminary Geotechnical Evaluation to evaluate the surface and subsurface soils, bedrock, and groundwater conditions in the vicinity of the Facility. As part of this review, TRC conducted a literature review of publicly available data, to address the following:

- Surface Soils
- Subsurface Soils

- Bedrock Conditions
- Hydrogeologic Conditions
- Karst Features
- Chemical and Engineering Properties
- Laboratory Testing
- Seismic Considerations
- Construction Suitability Analysis and Recommendations

Based on TRC's findings, the Facility Site is generally suitable for the proposed Facility and the wind turbines can be supported by shallow foundations. The preliminary Geotechnical Evaluation and Foundation Evaluation is discussed further in the subparts that follow and is available in full in Appendix V.

Before construction commences, a site survey will be performed to stake out the exact location of proposed Facility components. Once the surveys are complete, a detailed geotechnical investigation will be performed to verify subsurface conditions and allow development of final wind turbine foundation, electrical design, and other facility components as necessary. The geotechnical investigation involves drill rigs obtaining borings to identify the subsurface soil and rock types, strength and chemical properties (such as establishing sulfate content etc.), and will also document the presence and depth of any groundwater encountered. Testing will also be done to measure the soil's electrical properties to ensure proper grounding system design. Geotechnical borings will be conducted as determined necessary by a professional engineer to allow foundation design to be finalized for turbine and substation locations. General descriptions of the soil groups and their effects on building materials are provided in Section (j) below.

(i) Preliminary Blasting Plan

Blasting of bedrock may be required for the construction of turbine foundations, portions of the electrical connection lines, and the mining borrow area where ripping of bedrock is not feasible. Bedrock that is excavated will be reused on the island as material for the Facility access roads. A Preliminary Blasting Plan is included as Appendix W. The Blasting Plan sets forth procedures and best management practices (BMPs) that will be utilized to ensure that blasting is conducted in a safe, consistent manner, while simultaneously reducing environmental impacts to the maximum extent practicable.

(j) Potential Blasting Impacts

Impacts to bedrock are anticipated as a result of blasting during construction of the Facility. Galloo Island is underlain by limestone of the Trenton Group, and generally overlain by relatively shallow overburden. This formation consists of fine to coarse grained gray limestone with many fossils and many thin shale beds. Numerous areas of bedrock are exposed with no overburden. Some type of blasting and/or rock excavation techniques may be necessary at certain locations based on the depth of rock. The need for these techniques is anticipated to facilitate turbine foundation construction, collection line/access road construction, and/or site grading. The method or combination of methods required will depend on the competency of the rock encountered.

According to GIS data available from the NYSDEC, there are no natural gas wells located on Galloo Island, and therefore no potential impacts to such features will occur. There is one water well located on the island used for potable water (ACP, 2009); this well supplies the existing caretaker's house, which will be owned by the Applicant. Since blasting is not anticipated to occur near the existing well, buildings, or other existing structures no impacts to the well are anticipated.

Impacts to island cliffs have been avoided through appropriate setbacks/siting. All Facility components have been located at least 100 feet from the cliff areas. As a result, blasting is not expected to impact island cliffs.

(k) Mitigation Measures for Blasting Impacts

Blasting will be conducted in accordance with the Facility-specific blasting plan, and all required blasting will receive oversight by an Environmental Monitor. As outlined in the Preliminary Blasting Plan (Appendix W), 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. With respect to possible blasting activities near structures listed on the State/National Register of Historic Places, the certified blasting professional will assess the possible impacts of blasting on the structures. If the professional determines that blasting may result in damage to the listed structures, the Applicant will consider alternative excavation techniques or other measures to address the impacts.

(l) Regional Geology, Tectonic Setting, and Seismology

The proposed Facility is located on Galloo Island in eastern Lake Ontario, which occurs within the Ontario-Lowlands Physiographic Province of New York State. The island is approximately 4.5 miles long and up to 1.5 miles wide with elevation ranging from 250 to 305 feet above mean sea level (amsl). The island is generally flat, with steep, sloping scarp at the northern end of the island, and cliffs of up to 48 feet present along the western side of the island (TRC, 2017). The remainder of the island gently slopes southwest towards the main basin of Lake Ontario. The topography of Galloo Island, and much of the surrounding region, is a result of glacial erosion from Pleistocene-era glaciers and post-glacial surface water drainage (USDA, 1989).

Galloo Island and the surrounding islands in northeastern Lake Ontario comprise part of an area known as the Galloo Rock Outcrop (USDA, 1989), which occurs within the Galloo and Stony Basin, and the Northeast Lake Ontario-St. Lawrence Basin. Within these basins a series of broad, low, northeast to southwest trending ridges combine to form a complex ridge that extends from the west near Prince Edward Point, Ontario, to the east near Stony Point, New York. This ridge complex has a relief that ranges from 20 to 30 meters, and consists of steep, northeast-facing scarps, and gently sloping southwest-facing surfaces. The cuesta features of these ridges are gently rounded to flat, and in some cases are capped by islands, such as Main Duck, Stony, and Galloo Islands.

The bedrock that comprises Galloo Island and the surrounding area is chiefly composed of limestones from the Trenton Group, which were deposited 505 to 440 million years ago during the Ordovician Period (New York State Museum, 1991). The Trenton Group is comprised of carbonate rocks that may be susceptible to dissolution and sinkhole formation.

As indicated in the Preliminary Geotechnical Evaluation (TRC, 2017), surficial geologic mapping shows the site is underlain by lacustrine silt and clay. These soils are generally laminated and calcareous silts and clays deposited in proglacial lakes. These soils have low permeability, and vary in thickness according to New York State Geological Survey published in 1986. These types of soils exhibit slow infiltration and low permeability, which results in high volume of runoff.

With respect to seismicity, earthquakes have been recorded in Jefferson County, although they are typically below 3 on the Modified Richter Scale. The only potential seismic hazard for Galloo Island and the proposed Facility would likely be seismic activity generated from the St. Lawrence Rift System, which is suspected to extend into Lakes Ontario and Erie (ACP, 2009).

The New York State Seismic Building Code Seismic Hazard Map breaks the state into four distinct zones (Seismic Zone A through D). The geographic area described as Zone A (located in south-central New York) is considered as having the lowest seismic risk, while geographic areas described as Zones B through D are considered as moderate seismic risk areas. Each zone has a corresponding seismic zone factor of “Z”. The “Z” numerically corresponds to effective peak acceleration in g, where g equals the earth’s gravity acceleration (Klaus, 1993). The building code seismic hazard map for New York State uses these four zone factors, which are based on an exceedance probability of 10% in about 100 years (Klaus, 1993). “S” takes into account differences in seismic characteristics of the soil and bedrock types found in each seismic zone. Five soil-type factors (S0-very hard rocks through S4-very soft soils) have been identified in the code (which includes a soil liquefaction screening procedure). Review of the Seismic Zoning Map for New York State indicates that Galloo Island lies within the Seismic Zone C and has a "Z" factor of 0.15. Furthermore, the Facility Site has a soil type factor designation of S2 (soft soil). This indicates that the Facility Site is in a zone of moderate seismic risk (Gergely, 1993).

Analyses of short-term and long-term seismicity models were performed in 2017 and 2014 by the U.S. Geological Survey (USGS). Both analyses presented in Figure 11 of the Preliminary Geotechnical Evaluation (TRC, 2017) indicate the potential of seismic hazards at Galloo Island to be low to medium.

The design of the Facility will account for a potentially significant seismic event. There will be no significant impacts to the public because Galloo Island is uninhabited. In addition, wind turbines are now equipped with technology that allows for operational control and emergency shut off in case of an emergency such as a significant seismic event.

(m) Facility Impacts on Regional Geology

Numerous areas of bedrock are exposed on the island with no overburden. Based on the depth of rock, blasting and/or other rock excavation techniques will be necessary to facilitate construction of turbine foundations, and the below grade portions of structures (where applicable), utility construction, and/or site grading. The method or combination of methods required will depend on the competency of the rock encountered. Examples of possible rock excavation methods that may be used at the Facility Site include mechanical excavation/ripping, pneumatic hammers, rock drills, and controlled blasting. Where blasting is required, it will be conducted by qualified specialists and in accordance with all applicable regulations and professional standards. Based on the Applicant's experience constructing other wind power Facilities, only temporary, minor impacts to geology are expected as a result of construction activities.

TRC's report indicates that the bedrock and soils on Galloo Island are structurally suitable for support of wind turbines and ancillary structures. A subsurface investigation and a laboratory testing program will be implemented prior to final turbine foundation design.

(n) Impacts of Seismic Activity on Facility Operation

The USGS Earthquake Hazards Program does not identify any young faults (including those with displacement in the Holocene epoch) within the vicinity of the Facility. Therefore, this topic will not be further addressed.

(o) Soil Types Map

See Figure 21-2 for a map delineating soil types within the Facility Site. These soils are discussed in Section (p) below.

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

The Soil Survey of Jefferson County, New York (USDA, 1989) indicates that the majority of soils found of Galloo Island consist of two general soil associations. These are the Benson-Newstead-Galoo-Rock Outcrop, and the Chaumont-Galoo-Wilpoint-Guffin associations. From these associations, there are four dominant soil series within the Facility Site, which together represent 85% of the total surface area of Galloo Island. General descriptions of the soil associations and their characteristics are described in Table 21-1 below. The four soil series and their characteristics and all 16 of the individual soil map units that occur within the Facility Site, as well as their respective acreages, are provided in Tables 21-2 and 21-3, respectively.

Table 21-1. Soil associations and their characteristics within the Facility Site

Soil Association	Characteristics
Benson-Newstead-Galoo-Rock Outcrop	• Moderately deep to very shallow • Excessively drained to poorly drained • Loamy soils and rock outcrop • Found on lowland plains and uplands
Chaumont-Galoo-Wilpoint-Guffin	• Moderately deep to very shallow • Excessively drained to very poorly drained • Clayey or loamy soils • Found on lowland plains

Table 21-2. Soil series and their characteristics within the Facility Site.

Soil Series	Characteristics
Galloo Series	• Formed in thin layer of glacial till • Very shallow, 2 to 10 inches in depth • Underlain by limestone or calcareous sandstone bedrock • Slopes range from 0 to 8 % • Somewhat excessively drained to excessively drained
Newstead Series	• Formed in glacial till dominated by limestone • Moderately deep, 20 to 40 inches in depth • Underlain by limestone bedrock • Slopes range from 0 to 3 % • Somewhat poorly drained to poorly drained soils

Soil Series	Characteristics
Benson Series	• Formed in glacial till or wind- and water-deposited mixed with till or congeliturbate • Shallow, 20 inches or less in depth • Underlain by limestone bedrock • Slopes range from 0 to 70 % • Somewhat excessively drained to excessively drained
Chaumont Series	• Formed in clayey lacustrine sediments on lake plains • Moderately deep, 20 to 40 inches in depth • Underlain by limestone bedrock • Slopes range from 0 to 8 % • Somewhat poorly drained

Source: Soil Survey of Jefferson County (USDA, 1989)

Table 21-3. Soil Map Units within the Facility Site

Soil Map Unit	Area within Facility Site (acres)	Percent of Facility Site Area
Beaches	12.5	0.6
Benson-Galoo complex, very rocky, 0 to 8 percent slopes	218	11.3
Chaumont silty clay, 0 to 3 percent slopes	56.4	2.9
Chaumont silty clay, 3 to 8 percent slopes	15.1	0.8
Collamer silt loam, bedrock substratum, 3 to 8 percent slopes	47.4	2.5
Farmington loam, 0 to 8 percent slopes	39.1	2
Galoo-Rock outcrop complex, 0 to 8 percent slopes	982.1	50.9
Galway silt loam, 0 to 3 percent slopes	6.9	0.4
Guffin clay	51.9	2.7
Hudson silt loam, 3 to 8 percent slopes	3.8	0.2
Madalin silt loam, 0 to 3 percent slopes	8.8	0.5
Rhinebeck silt loam, 0 to 3 percent slopes	4.7	0.2
Newstead silt loam	383.2	19.9
Saprists and Aquents, ponded	41.7	2.2
Wilpoint silty clay loam, 3 to 8 percent slopes	32.8	1.7
Water	22.7	1.2

Source: Soil Survey of Jefferson County (USDA, 1989)

The vast majority of soils at the Facility Site are silt loams, but textures such as silty clay, clay, loam, and loamy sand are present in small areas. Soil drainage is predominantly well drained, with approximately 28% of the on-site soils poorly drained, 5% moderately well drained and 64% well drained, (USDA, 2017). Soils that are listed as hydric by the Natural Resource Conservation Service cover approximately 6% of the Facility Site, with Guffin clay (map unit Gv) being the prominent hydric soil. Approximately 11% of the Facility Site contains soils classified as either prime farmland soils, prime farmland if drained or farmland of statewide importance (USDA, 2017). The primary impact to the physical features of the Facility Site will be the disturbance of soils during construction. Based on the assumptions outlined in Exhibit 22(b), disturbance to soils from all anticipated construction activities will total approximately 157.5 acres. Of this total, only approximately 88.5 acres will be converted to built facilities (roads, turbine foundations/cranepads, and structures), while the remaining land will be restored and stabilized following completion of construction. The area of disturbance calculations presented below assume that significant soil disturbance will occur in all areas in which construction occurs. Actual disturbance will include overlap of some components (e.g., buried collection line within the access road disturbance) and will be highly variable based on the specific construction activity, the construction techniques employed, and soil/weather conditions at the time of construction. Table 21-4 provides a summary of the anticipated impacts from construction and operation of the facility to each soil map unit.

Table 21-4. Anticipated Impacts to Facility Site Soils

Soil Series Name	Temporary (acres)	Permanent (acres)	Total (acres)
Beaches	0.6	0.0	0.6
Benson-Galoo complex, very rocky, 0 to 8 percent slopes	17.4	9.0	26.4
Chaumont silty clay, 0 to 3 percent slopes	5.5	1.6	7.1
Chaumont silty clay, 3 to 8 percent slopes	1.0	0.1	1.1
Collamer silt loam, bedrock substratum, 3 to 8 percent slopes	8.0	13.1	21.1
Farmington loam, 0 to 8 percent slopes	1.9	0.9	2.8
Galoo-Rock outcrop complex, 0 to 8 percent slopes	105.8	55.0	160.8
Galway silt loam, 0 to 3 percent slopes	0.7	0.6	1.3
Guffin clay	1.5	0.5	2.0
Hudson silt loam, 3 to 8 percent slopes	0.0	0.0	0.0
Madalin silt loam, 0 to 3 percent slopes	0.0	0.0	0.0
Newstead silt loam	11	5.3	16.3
Rhinebeck silt loam, 0 to 3 percent slopes	0.0	0.0	0.0
Saprists and Aquents, ponded	0.4	0.0	0.4
Wilpoint silty clay loam, 3 to 8 percent slopes	3.8	2.5	6.3
Water	0.0	0.0	0.0

Soil Series Name	Temporary (acres)	Permanent (acres)	Total (acres)
Total	157.6	88.6	249.2

Most of the natural surface soils on the island are moderately suitable for construction (TRC, 2017). However, there are two poorly suitable soils, Chaumont silty clay and Newstead silt loam. Following Facility certification, additional geotechnical borings will be performed, as determined necessary by a professional engineer, to verify the location of soils in relation to Facility components and help guide the finalization of the design.

Earth moving and general soil disturbance will increase the potential for wind/water erosion and sedimentation into surface waters. Based on engineering for the Facility and sediment/erosion control procedures, construction on steep slopes (i.e., in excess of 15%) has been avoided to the extent practicable within the Facility Site. The above-mentioned soils, and any other highly erodible soils will be listed and examined in more detail in the Preliminary SWPPP. This SWPPP—which was developed in accordance with the State Pollutant Discharge Elimination System (SPDES) – General Permit for Stormwater Discharges from Construction Activity will minimize impacts to 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 particular, the SWPPP requires implementation of BMPs to minimize impacts to soils. Among other things:

- 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 fence, 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.

Impacts to soil resources will be minimized by adherence to best management practices that are designed to avoid or control erosion and sedimentation and stabilize disturbed areas. In addition, erosion and sedimentation impacts during construction will be minimized by the implementation of an erosion and sedimentation control plan developed as part of the State Pollution Discharge Elimination System (SPDES) General Permit for the Facility. Erosion and sediment control measures shall be constructed and implemented in accordance with a SWPPP to be prepared and approved prior to construction, and at a minimum will include the measures set forth in the Preliminary SWPPP is provided in Appendix GG.

Soil reaction is a measure of acidity or alkalinity. Therefore, by determining the level of pH in the soil, its potential impact on the risk of corrosion can be assessed. The only location considered as high risk of concrete corrosion is the southern portion of the island mapped as soil map unit Be, or Beaches, which is defined as silty sand, and comprises less than 1% of the surface area of the island (USDA, 1989). As shown in Figure 22-2, no components are contemplated for this area. Soils containing high moisture content, acidity and electrical conductivity tend to be the candidates to corrode or weaken uncoated steel. As shown in Figure 14a of Appendix V, portions of Galloo Island are mapped as high risk of corrosion to steel (soil map units CIA, CIB, CoB, GIA, Gv, HuB, Nn, RhA, Sa and WnB). A thorough on-site review of soil acidity and electrical conductivity will be conducted post certification and prior to Facility construction.

(q) Bedrock Analyses and Maps

A general discussion of bedrock within the Facility Site is provided in Section (l) above. Bedrock in the region of the Facility Site is typified by carbonate rocks which gently tilt towards the south-southwest. See Figure 22-2 for a map of bedrock underlying the Facility Site. Based on information from the USDA Web Soil Survey, depth to bedrock is generally shallow, occurring as outcrops of within 2 to 4 feet below the subsurface soils; however, it can be greater than 6 feet below the ground surface at some locations (Figure 21-3).

With regard to water tables, the county soil survey provides the depth to the seasonally high water table, evaluated to a depth of six feet, for soils within the Facility Site. According to this information, the seasonally high water table is deeper than 6 feet from the soil surface over approximately 55% of the Facility Site, and less than 1 foot from the surface over approximately 20% of the Facility Site. (USDA, 1989, 2017). For additional information about groundwater and surface waters in the Facility Area, see Exhibit 23 of this Application.

(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.

(1) Preliminary Engineering Assessment

As previously mentioned, based on TRC's research, the overburden soils and bedrock encountered is generally considered to be structurally suitable for support of foundations for wind turbines, support buildings, and access road construction. Although shallow foundations may involve extensive bedrock excavation and dewatering, they are generally less costly and easier to construct than deep foundations. Following Facility certification, additional geotechnical borings will be performed as determined necessary by a professional engineer to allow foundation design to be finalized for each turbine location. This information will be used to support the final structural design of the Facility. All techniques used will conform to applicable building codes or industry standards.

(2) Pile Driving Assessment

The Applicant has concluded that pile driving is not needed for the Facility. Therefore, further assessment was not conducted.

(3) Mitigation Measures for Pile Driving Impacts

The Applicant has concluded that pile driving is not needed for the Facility. Therefore, mitigation measures related to pile driving are not necessary.

(s) Vulnerability to Earthquake and Tsunami Events

The USGS Earthquakes Hazards Program does not identify any young faults (including those with displacement in the Holocene epoch) within the vicinity of the Facility. Therefore, the facility appears to have minimal vulnerability associated with seismic events. Tsunamis are giant waves that are caused by earthquakes or volcanic eruptions under the sea (NOAA, 2016). Since the Facility is located over 250 miles from the Atlantic Ocean, there is no vulnerability associated with tsunami events. Therefore, further analysis was not conducted.

Meteotsunamis or meteorologically induced tsunamis, occur throughout all the Great Lakes, with 106 of these events occurring in an average year (NOAA, 2015). Of all the Great Lakes, Lake Ontario has the lowest incidence of these events, with an average of five meteotsunamis occurring annually. Usually, these events have small wave heights (1 foot or less). Available data suggests that on average, a wave with a height of 1.6 feet occurs somewhere on Lake Ontario once per year, with a 3.3 foot wave occurring once every 50 years (Bechle, 2016). No impacts are expected to occur at the Facility due to meteotsunamis since these wave heights are not dissimilar with average wave heights occurred during normal storm events (i.e., high winds) or from boat wakes. Additionally, all Facility components are located in uplands and not currently affected flooding and or wave action.

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