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**Title:** CONSTRUCTION PLAN REPORT

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## 1.0 Project Overview

The HAF Wind Energy Project (“the Project”) Construction Plan Report is prepared in accordance with the requirements of the Ministry of the Environment’s Renewable Energy Approvals Regulation (“the Regulation”), O.Reg 359/09, specifically with consideration of *Item 1* of the requirements outlined in *Table 1* of the Regulation.

The proposed HAF Wind Energy Project is to be situated in the Township of West Lincoln, in Niagara Region of Ontario. The Project would consist of five (5) Vestas V-100 1.8 megawatt wind turbines producing a nameplate capacity of 9.0 megawatts. If approved, the wind turbines would be erected for the purpose of capturing energy from the wind, a renewable resource, and converting it into clean, useable electricity. This electricity will be transported to consumers via interconnection facilities, including transformers and distribution lines. The footprint of these facilities is captured and described in reports prepared for this Renewable Energy Approval (REA).

The proposed undertaking includes three (3) phases: 1) Construction; 2) Operation and Maintenance, and 3) Decommissioning of the facility and its associated infrastructure. Each of these phases is described in separate reports.

Infrastructure for the purposes of the REA and this Project includes turbines, foundations, access roads, underground collector system, switching station, temporary staging areas, and an operations/SCADA building. Low voltage step-up transformers are found inside each wind turbine’s nacelle housing and therefore pad mounted transformers are not part of the footprint of this facility. The project location including all associated infrastructure will be located as described in project mapping (refer to Site Plan and Land Use Mapping).

This report will detail the construction activities, the duration, the environmental effects, and mitigation measures. The wind turbine locations are presented in **Table 1-A**. The general project schedule is found in **Table 1-B**, with the description of each phase of the project found in **Table 1-C**.

Table 1-A: Coordinates of Each Turbine (NAD 83, UTM Zone 17)		
Turbine Number	Northing	Easting
1	604718	4775553
2	604889	4775173
3	606291	4774905
4	604359	4774307
5	606233	4773420

### ***1.1. General Project Schedule***

**Table 1-B** provides an overview of key project activities and projected dates.

<b>Table 1-B: General Project Schedule</b>	
<b>Activity</b>	<b>Date (Month, Year)</b>
Begin Environmental Field Surveys	October, 2009
Begin Renewable Energy Approval	April, 2010
Submit Renewable Energy Approval Application	June, 2012
Obtain Renewable Energy Approval	January, 2013
Commence Construction	March, 2013
Commercial Operation	August, 2013

## 2.0 Construction Details

The activities required for the construction phase will be discussed in this section on a per turbine basis. All activities found listed under “Construction” in **Table 1-C** will be described in this report.

The project is expected to begin construction during **March, 2013** pursuant to REA approval and subject to the requirements of government agencies. Construction activities will be initiated and completed at each turbine location between then and **September, 2013**. All construction work and associated activities will meet or exceed local regulations and standards (such as the Ontario Building Code and Ontario Electrical Safety Code, etc.).

This phase of the project includes the following activities:

- Surveying and geotechnical work
- Access road construction and modification
- Delivery of equipment
- Foundation construction
- Tower and turbine assembly and installation
- Interconnection from turbines to switching station (Construction of Underground Collector System)
- Switching Station Construction
- Testing and commissioning of switching station and collection system
- Turbine testing and commissioning
- Site clean-up and restoration

The scope of this project is summarized in **Table 1-C**, which provides each phase (Construction, Operation and Maintenance, and Decommissioning) with the corresponding activities that will be undertaken. The construction phase is most relevant to this report; however, the Operations and Maintenance, and Decommissioning phases are presented to demonstrate the relationships among all phases of the project.

Table 1-C: Description of Each Phase	
Phase	Activities
<b>Construction</b>	<ul style="list-style-type: none"> <li>• Surveying and geotechnical work</li> <li>• Access road construction and modification</li> <li>• Delivery of equipment</li> <li>• Foundation construction</li> <li>• Tower and turbine assembly and installation</li> <li>• Interconnection from turbines to Switching Station</li> <li>• Switching Station construction</li> <li>• Turbine commissioning</li> <li>• Site clean-up and restoration</li> </ul>

<b>Operation &amp; Maintenance</b>	<ul style="list-style-type: none"> <li>• Environmental effects monitoring</li> <li>• Turbine operation and electricity production</li> <li>• Annual and semi-annual maintenance</li> <li>• Repairs, as required</li> <li>• Community relations</li> </ul>
<b>Decommissioning</b>	<ul style="list-style-type: none"> <li>• Land clearing</li> <li>• Road construction/modification</li> <li>• Removal of turbines and ancillary equipment</li> <li>• Site restoration and rehabilitation</li> </ul>

### **1.1. Construction Schedule**

The approximate construction schedule is presented in **Table 1-D**. The schedule provided is based upon a successful REA approval by **January, 2013**. This schedule may be adapted as dictated by regulatory approvals and permitting requirements. Additional timing requirements with respect to significant natural features and waterbodies has been provided in the Environmental Impact Study and Water Assessment reports.

<b>Table 1-D: Approximate Construction Schedule</b>	
<b>Activity</b>	<b>Date</b>
Surveying and geotechnical	March, 2013
Building Permit	March, 2013
Access Road Construction and Modification	April, 2013
Foundation Construction	April, 2013
Electrical Tapline Construction	May, 2013
Delivery of Turbines	May, 2013
Tower and Turbine Assembly and Installation	June, 2013
Switching Station Construction	June, 2013
Interconnection of Turbines to Switching Station	July, 2013
Turbine Testing and Commissioning	August, 2013
Site Restoration and Clean-up	September, 2013

### **2.1. Surveying and Geotechnical Study**

A land survey will be completed prior to construction by a registered Ontario Land Surveyor to identify the exact locations and positions of turbines, access roads, interconnection routes (i.e. underground collector system), switching station, temporary crane pads and laydown areas.

A geotechnical survey involving bore-hole samples and in situ testing will be undertaken before the construction of the tower foundations. It is anticipated that these studies will take place during **March, 2013**. A preliminary geotechnical investigation was completed by Soil-Mat Engineering & Consultants Ltd. to confirm the general site specific sub-surface conditions within the project study area. The findings of this preliminary assessment are provided in Appendix A.

A Stage 1 Archaeological Assessment of the study area was undertaken by A.M. Archaeological Associates Limited (AMA) in **May, 2010**. The Stage 1 assessment determined that the study area possessed potential for significant archaeological remains. Based upon this assessment, AMA was retained to undertake Stage 2 Archaeological Assessments. The Stage 2 studies were completed in **August, 2010, October, 2011, and March 2012**. These reports have been forwarded to the Ministry of Tourism and Culture (MTC) for approval. During the Stage 2 Archaeological Assessment all of the proposed turbine locations were determined to have low potential for archaeological remains.

If, during construction, deeply buried archaeological remains are discovered, the proponent will cease construction and immediately notify MTC and the Niagara Regional Police (*if human remains are found*).

### **2.1.1. Roads and Land Clearing**

Access roads are purpose built roads that connect the site entrance to the existing municipal road. Access roads will be built to provide the required access for construction and transportation vehicles to each turbine and substation site throughout the construction, operation/maintenance, and decommissioning phases of the project. All turbine locations and corresponding access roads are proposed on open agricultural lots; therefore, minimal vegetation clearing will be required. The underground collector system will follow the proposed access roads when on private property and be contained within the municipal right-of-way, where possible. The Natural Heritage Assessment (NHA), Environmental Impact Study (EIS), and Waterbodies reports prepared for the HAF Wind Energy Project documents the pre-existing conditions of the land, air, and water within 120 metres of the project location and provides appropriate mitigation to be implemented during construction to minimize and avoid negative environmental effects.

Clearing will be required for each turbine location, laydown areas, temporary staging areas, switching station, and for the construction of access roads and underground collector system. Areas associated with these project components, where land clearing is required are identified in project **Land Use and Site Plan Mapping** and further described in the Design and Operations Report. At each location, gravel surfaced roads will be constructed. The roads will be designed and constructed to support heavy equipment and vehicles required for the transportation, construction and erection of the project's turbines. Access roads will be a maximum width of 7 metres, including shoulders.

Road construction includes the excavation of topsoil and some subsoil and installation of geotextile and/or aggregate materials. Excavated materials, such as topsoil and subsoil will be stored separately and will be reused as appropriate during post-construction restorations. The results of the final geotechnical assessment, undertaken prior to construction will determine the best approach based on the existing in-situ soil conditions for each site.

The proponent will seek to minimize road construction impacts by minimizing the required area of road construction and by adhering to REA setbacks. It should be noted that during the design of the project, significant effort was undertaken to avoid constructing new roads. Where possible existing driveways and roads will be used or improved, thus reducing the amount of land required to access the project's facilities. Roads were also



located to avoid interactions with natural features and setbacks, where possible.

Any public road upgrades required for the delivery of construction equipment and turbine components will be subject to the terms and agreements made between the Proponent and the Township. Any damages to public roads as a result of construction activities will be repaired.

All access roads will conform to and be compliant with provincial and municipal regulations and will be built to support the weight of the equipment and heavy machinery required to build each wind turbine location. Municipal and provincial permits and approvals will be obtained, as required, prior to construction.

All access roads will be constructed before any wind turbine components will be delivered to or installed on the site. The construction of access roads will observe the following design constraints:

- All roads will be five (5) meters wide with an additional 1 one (1) meter compacted shoulder on each side for a total width of seven (7) meters.
- Roads will be compacted for either a) fifteen (15) metric ton per axle load in wet or dry conditions. This value is based upon a single axle equipped with dual wheels or super-single tires, tire pressure of eight hundred (800) kPa and a maximum rut depth of thirteen (13) millimeters; or, b) a minimum load bearing capacity of two hundred and fifteen (215) nominal kPa.
- Roads will have a vertical grade of no greater than eight percent (8%).
- Roads must have a maximum lateral cross-fall grade of two percent (2%) and a minimum lateral cross-fall grade of zero point five percent (0.5%) to allow for positive drainage away from the road surface.
- All vertical curves must have longitudinal radii (convex or concave) must not be less than two hundred (200) meters and irregularities in access roads shall have a maximum relative rise or fall of no more than one hundred and fifty (15) millimeters within and thirty meter (30m) section.
- The intersection of access roads and public roads should be modified to accommodate long loads by constructing temporary access with a minimum forty five (45) meter outside turning radius and a maximum inside turning radius of forty (40) meters with suitable culverts.
- Culverts will conform to municipal and NPCA requirements and approvals. Temporary access will be removed and restored following construction.
- Road paths will be clear of vegetation and free from overhead obstructions
- Roads, crane pads, and laydown drainage systems must be designed to control and dissipate the flow of surface water along the roads so as to self drain.
- Roads must be maintained in good condition for site traffic (graded, watered, flat, rut free, etc...) through out the life of the project.
- Roads must be marked with snow poles where and when applicable.

- Embankments will be constructed to maintain stability through out the project life span.

### 2.1.2. Turbine Site and Crane Pad Construction

Each wind turbine's access road will terminate at a crane pad where the turbine will be constructed. A crane will be required to erect the turbine during construction. A crane pad will be used to support the crane and will be temporary. The crane pad will be made of the same construction material as the access roads and subject to the conditions of the geotechnical assessment. Following construction, the crane pad will be restored using standard industry practices and subject to provincial and municipal requirements as applicable. Restoration is anticipated to be completed in **September, 2013**.

Each turbine location will need to be cleared and levelled before construction. The lay down of turbine components will take place within the proposed access road and may extend into a 50 meter by 50 meter area located around each turbine location. This area will be cleared, levelled, and be made accessible during the Construction Phase. Normally, topsoil is removed and stored for restoration and reclamation efforts.

Crane pads will be constructed in conjunction with access roads at each turbine location. Each crane pad is approximately 20 meters by 40 meters in area. The topsoil at the crane pad will be removed and 600 millimetres of crushed gravel will be compacted.

If any deeply buried archaeological remains are found, then the Ministry of Tourism and Culture will be contacted. If archaeological remains are found, then turbine locations may be relocated, in coordination with appropriate agencies and stakeholders.

Excavated materials, such as topsoil will be reused as appropriate during post-construction restoration. Construction equipment for turbines and associated infrastructure generally includes graders, bulldozers, trucks, and cranes.

The turbine site plan is shown in **Tabs 2 and 3**.

Construction of the turbine site and crane pad will observe the following design constraints:

- Crane pad working surface dimensions will be constructed at each location will be a minimum of twenty (20) meters by forty (40) meters.
- Crane pads will have a minimum inside turning radius on curves of eight (8) meters and a minimum outside turning radius of twenty (20) meters when using a crane with an aspect ratio of 1:1. Cranes with larger aspect ratios must be modified to accommodate the crane turning radius.
- Crane pads will be compacted for a ground bearing capacity for a one point five (1.5) meter wide strip load of two hundred and forty (240) kPa in wet or dry conditions.
- Crane pads on grades of greater than six percent (6%) must have a ground bearing capacity of two hundred and seventy (270) kPa in wet or dry conditions.
- Crane pad shoulders will be compacted to the same grade as the centre of the pad

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- Crane pads will have a maximum side slope grade of two percent (2%)
- The grade of direction will not exceed eight percent (8%)
- Shoulder slopes must be no greater than forty-five ( $45^{\circ}$ ) degrees.
- Crane pads and shoulders will be graded so as to self drain, and must not allow water to accumulate
- Crane pads must be free of obstruction and shall provide a clear corridor of no less than ten (10) meters wide.
- Crane pad must be maintained through out construction to ensure snow removal, dust prevention, and re-compaction after environmental conditions or mechanical damage.
- The crane pad, turbine site, and laydown/storage areas will conform to Vestas Site Preparation Specifications and Installation Manual.

## ***2.2. Delivery of Equipment***

The wind turbines components (tower, blades, and nacelle) will be transported to the site by cargo truck, and will be stored and assembled on site. Turbine components will be delivered on authorized oversized vehicles. Heavy construction equipment used to assemble the tower and turbine will also be delivered by truck and assembled on site.

Vestas, as the selected turbine manufacturer for the HAF Wind Energy Project will be responsible for transporting the turbine components to the project site and acquiring the necessary transportation and safety permits, from the appropriate authorities (i.e. Ministry of Transportation) for the delivery of turbine components. Turbine components will be delivered to the project site by individual oversized vehicles. It is anticipated that Ten (10) heavy hauling trucks will be required for the delivery of each turbine and will consist of the following:

- Three (3) for the blades;
- One (1) for the nacelle;
- One (1) for the hub;
- One (1) for the controllers and converters; and
- Four (4) for the tower.

A preliminary Transportation Survey has been prepared for the project by Transera International Logistics to evaluate potential transportation routes for the delivery of turbine components to the project location and has been provided in Appendix B. The preliminary transportation survey provides the weight information for each turbine component. It is expected that one complete turbine will be delivered per day.

## ***2.3. Foundation Construction***

Topsoil will be removed and stockpiled before excavation for construction of the turbine foundations. A backhoe will be used to excavate an area of approximately 3 meters deep by

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20 meters wide by 20 meters long for the foundation. Topsoil and subsoil will not be mixed and will be stored separately. Where possible, excess fill will be used for on-site grading purposes. Excavation work is expected to be above the water table at all times of the year.

The foundation will be constructed of poured concrete and reinforcing rebar steel. Wooden forms will be used to contain wet concrete and will be removed once the concrete is cured. A mounting ring for the turbine tower will be attached to the foundation. The mounting ring is used to support and connect the turbine tower to the foundation. Foundation construction will take approximately one month for all five turbine locations.

Each foundation will be left to cure for approximately one month before tower erection. Quick curing foundation methods may be employed at some sites where appropriate to geotechnical conditions. Quick curing foundations will conform to provincial building standards.

The final foundation design, including the foundation type and dimensions, will depend on the results of a site specific geotechnical assessment of the turbine locations. For the HAF Wind Energy Project the turbine foundations are anticipated to be concrete spread footing type.

- At each wind turbine location, a Lay-Down area must be provided adjacent to the access road of sufficient area to permit any turbine equipment being delivered to the Crane Pad to be offloaded and stored pending erection and installation of the same. Vegetation from this area must be cut short and a graded working area must be provided with a forty-five (45) meter radius from the center of the turbine foundation with burms removed.
- Any portion of the lay-down area, or other travel paths between the access roads and the lay-down area, over which delivery trucks are expected to travel in order to deliver the relevant turbine equipment must satisfy the requirements set for site access roads.
- The maximum construction site required by the constructor at each foundation is seventy (70) meters by seventy-six (76) meters (the "Construction Site"); the Construction Site includes a Crane Pad area of twenty (20) meters by Forty (40) meters, which may have a maximum slope of two percent (2%) in any direction.
- The Crane Pad, the construction site and the access road parallel to the construction site should be all be at the same grade
- The remainder of the Construction Site must be clear of vegetation, rocks and other obstructions that may impede access by erection equipment.
- Any areas utilized for main component storage should be designed to provide a nominal ground bearing capacity of two hundred and fifteen (215) kPa.
- Shoulder slopes, if required, for Crane Pad must be no greater than forty-five degrees (45°). The Pad area must be graded to drain all water away from Crane Pad.
- The Proponent is responsible for ensuring that the construction site at each tower foundation is frequently and routinely maintained as necessary to ensure that the

surface remains in good condition suitable for truck and tracked crane traffic; such maintenance includes snow removal and dust prevention.

## **2.4. *Turbine Assembly and Installation***

The turbines will be erected using a large crane supported on the crane pad area adjacent to each turbine site. The wind turbine (including the tower, blades, and nacelle) will be assembled using the crane. This activity will take approximately one month for five turbines. Following construction, the crane pad will be restored for agricultural use.

- Provision will be made for the safe and proper lay-down and storage of wind turbine components at, or adjacent to the crane pad, within the operating radius of the main crane and operating radius of the assist crane.
- If the main crane has a Lattice Boom, then a boom construction area will be required. This must be along side the crane path, with a width of fifteen (15) meters and a length of one hundred forty (140) meters.
- When lattice jib is used, the rigging area for the main crane must have a minimum length equal to wind turbine hub height plus twenty percent (20%) of the hub height added to this length parallel to the site road. The usable width must be a minimum of seven (7) meters.
- Off-loading area for nacelle must be a minimum five (5) meters by fifty (50) meters and within the working radius of the main crane.
- Off-loading area for blades must be twelve (12) meters by fifty-eight (58) meters and within the working radius of the main crane.
- Provisions must be made for the safe and proper lay-down and storage of parts in a suitable secure location. Parts include and are not limited to: lifting tools, service platforms (lifts), uninterruptable power supply, tower cables, nose cone parts, stairs, steps, ladders, boxes of bolts, and thirteen point eight (13.8) meter parts containers.
- Compounds, storage and lay-down areas must be clear of all debris, and the area must be level and free draining, and to have the same bearing capacity and proof testing as the crane pad.

## **2.5. *Interconnection from Switching Station***

The generated power from the Project will be collected via underground cabling and directed to a switching station. The switching station will connect directly to the Hydro One distribution system. The turbine will generate power at the 690 volts, which will then be stepped up to the 27.6 kilovolt level of the local collector system. The local collector system gathers the power generated by turbines via underground cables and delivers it to a switching station, which represents the operating demarcations point between the hydro utility and the generator. This station is also used for housing metering, line communication, and operating controls.

## ***2.6. Electrical Switching Station***

The switching station site will be excavated to allow for the installation of gravel substrate and the construction of a concrete foundation. The switching station foundation will be approximately 7 meters by 8 meters. Substation equipment will be grounded to a grounding grid installed in the gravel substrate. Substation equipment will be mounted on the concrete foundation and connected to the adjacent outgoing distribution line. The substation will be fenced, locked, and secured to prevent unauthorized access. The site plan provided in **Tab 2** provides the location of the electrical substation.

## ***2.7. Electrical Tapline and Distribution System***

The power generated at each of the wind turbine generators is transported through an underground collector system. The underground collector system will consist of direct buried or directionally drilled underground cabling in trefoil format routed in trenches along access roads when on private property and within existing municipal and public road right of ways. Depths and location of the underground collector system will adhere to municipal requirements and existing utility setbacks. If required, there may be some shared use with existing Hydro One lines and poles. The collector system will be built to applicable standards and codes.

Any excavated soil associated with the installation of the underground collector system will be temporarily stored and then reused as backfill.

Electricity collected at the switching station will be connected to Hydro One's distribution grid. The existing Hydro One distribution line may have to be extended to connect the switching station location to the existing distribution grid. An appropriate protection system, as per the best industry practices as well as utility guidelines will be provided.

## ***2.8. Site Clean-up and Restoration***

After the turbines have been constructed and the crane pad is no longer required, all construction areas will be rehabilitated. Any disturbed portions of the site will be remediated and re-vegetated. Any waste or debris generated during construction will be collected and disposed of at an approved waste facility. Topsoil removed during construction will be replaced/re-applied. Erosion prone areas will receive new plantings or seeding. Natural regeneration will be encouraged to achieve regeneration. This activity will take approximately one month with new vegetation growth taking longer. Sediment and erosion control plans will be implemented during construction activities. Once inspections have determined that the threat of erosion has diminished sediment and erosion control equipment will be removed.

## ***2.9. Temporary Storage Facilities***

Temporary storage of topsoil may be required during construction. Excavated topsoil that is required for site clean-up and restoration will be stored on lands immediately adjacent to the turbine location. While excess topsoil may be stored off site until decommissioning. Topsoil and subsoil will not be mixed, nor will topsoil be contaminated with any other material.



### ***2.10. Operations and Maintenance Building***

The operations and maintenance requirements for this project will be minimal. A small 10 meter by 10 meter building will be used for housing switches, DVAR, metering, Supervision, Control and Data Acquisition (SCADA). The purpose of this building is to monitor and control the operation of the facility. The operations building will be located within the fenced area of the switching station. There will be no permanent staff presence; therefore, a sanitation system will not be required. Only trained personnel will be permitted within the fenced in enclosure, including the operations building. The building is prefabricated and will be transported to the site.

A separate storage building will be located to the southwest of Turbine 4. This will be a small prefabricated storage shed (approximately 8 metres by 10 metres). This building will be used to store spare parts and maintenance tools. The storage shed will be placed on top of a slab at grade level.

### ***2.11. Turbine Commissioning***

Turbine commissioning takes place before the turbine begins producing electricity for the grid. This includes interconnection testing between the turbine and point of interconnection. Before the turbine can begin providing electricity to the grid, a battery of tests must be undertaken to confirm that the system conforms to regulatory and technical requirements. Interconnection to the electrical grid will be undertaken as a final step. Any required physical or technical adjustments may be carried out on the turbine at this point. The purpose of these tests is to confirm that the turbine is operating within technical specifications, codes and contractual expectations. This activity will be scheduled, but will ultimately depend on weather conditions. Turbine commissioning will take approximately two weeks for five turbines.

### ***2.12. Traffic Management***

A Traffic Management Plan will be prepared and implemented by the proponent in accordance with all applicable Provincial and Municipal laws and standards. This plan will be developed using the Ontario Traffic Manual Book 7 Temporary Conditions. The plan will ensure that access for emergency vehicles will be maintained at all times. Use of municipal roads during construction will be subject to municipal design and operating restrictions.

Any required maintenance/repairs of municipal roads will be discussed in consultation with the Township of West Lincoln. The Proponent will repair any damages occurred as a result of construction related traffic and activities.

### 3.0 Construction Equipment

Construction of each turbine will require heavy equipment. Some equipment typical of construction includes *backhoes, trucks, cranes, air compressors, concrete pump, concrete vibrator, concrete breaker, bull dozers, generators, loaders, etc...* Heavy equipment will produce noise and **Table 1-F** describes potential noise emissions for each type of equipment. It should be noted that not all of the equipment listed in Table 1-F will be used at each turbine. Construction equipment will vary depending on the tasks required for each activity (road construction, taplines, or the turbine itself).

The Noise Assessment Report provides greater detail on noise emissions for this project. All construction noise will be temporary in nature. Late night construction is not anticipated for this project and, if required, a Noise By-law exemption will be requested from the Township. The constructor will minimize noise disturbance impacts by restricting the use of noise emitting equipment to normal daytime hours.

Table 1-E: Typical Equipment and Noise Generated During Construction	
Equipment	Noise (dBa)
Air Compressor	81
Backhoe	85
Concrete Pump	82
Concrete Vibrator	76
Concrete Breaker	82
Dozer	80
Generator	78
Load	79
Paver	88
Water Pump	76
Trucks	88
Pile Drivers	101

Source: Bolt, Beranek and Newman, 1971

#### 3.1 Required Turbine Components and Construction Materials

Turbine components include tower, nacelle, blades, generator, hub, transformers, electrical cabling, and interconnection equipment. Construction materials include wood, steel, poles, concrete, gravel aggregate, geotextiles, and culverts. Where possible, materials will be obtained locally from within Niagara Region. Materials will be selected by the constructor and will be suitable for the site specific conditions. Construction equipment and machinery will be powered with diesel or gasoline. Portable generators and pumps may be required.

All Materials will be stored at each individual turbine site and, if required, at the staging areas. Trucks will bring all materials to the project site. Oversized trucks will be required to transport turbine structures and blades. The number of trips made by delivery vehicles will depend on the final selection of transport vendors, their location and the capacity and availability of their vehicles. Transport of materials will occur between **April 2013** and **September 2013**. The frequency of delivery will be dependent upon the construction



staging listed in **Table 1-D** and determined by the constructor.

Some chemicals will be required on-site for construction. These include concrete mixtures required for foundations and fuel for heavy equipment. Fuel will be handled in accordance with the mitigation measures provided for in **S.5.0** of this report and commitments made in the Environmental Impact Study.

The Environmental Effects Monitoring Plan (EEMP) contained within the Design and Operations Report provide clarification on handling and storage requirements for chemicals. This report also specifies response measures to be followed in the event of a hazardous materials spill.

## **4.0 Additional Procedures**

### **4.1. *Disposal of Construction Materials***

The project will not produce toxic or hazardous materials during construction. Some petroleum, oils, and lubricants (POL) and other fluids, that may be considered toxic, may be brought on site for turbine maintenance. Excess POL waste removed from the project site will be disposed or recycled according to provincial and municipal environmental waste management standards. Non-hazardous waste material will be handled by the municipal waste management system.

Excess construction materials will be reused where possible and recycled as an alternative to reuse. Some materials may be sent to the municipal landfill where necessary. The constructor will conform to municipal and provincial disposal requirements for landfill waste and transport of excess construction materials.

### **4.2. *Waste Management***

The project will not produce toxic or hazardous materials during construction. Some petroleum, oils, and lubricants (POL) and other fluids, that may be considered toxic, may be brought on site for turbine construction. Excess POL waste removed from the project site will be disposed or recycled according to provincial and municipal environmental waste management standards. Non-hazardous waste material will be handled by the municipal waste management system.

Excess materials required during construction will be reused where possible and recycled as an alternative to reuse. Some materials may be sent to the municipal landfill where necessary. The constructor will conform to municipal and provincial disposal requirements for landfill waste and transport of excess construction materials.

#### **4.2.1. Solid Waste**

Any solid waste generated as a result of construction of the HAF Wind Energy Project will be produced from the assembly of the turbine and tower structures, foundations, subsurface cables, and vegetation cleared as required for equipment access to the site. The preferred method of disposing of solid waste for the constructed facility is reuse and recycling. In the event that materials cannot be reused or recycled, waste materials will be transported to the nearest waste disposal site as required.

Cranes will be necessary to assemble the turbines and towers. All associated components will be brought onsite using a flatbed truck. Any concrete sections and associated structural steel remaining from the turbine foundation will be transported off-site. All holes created from the construction of the turbine foundations will be filled, and top-soil will be re-applied.

Waste materials generated from the assembly of the turbine foundation will be reused, recycled or transported to the nearest waste disposal facility will be made in consultation with a waste management company at the time construction activities occur.

Clearing of the surrounding environment during the construction phase will be kept to a minimum. The clearing of land to undertake construction activities will not utilize any slash and burn methods.

Upon the completion of construction activities, the turbine assembly areas, access roads, and other areas cleared as required for construction activities will be reseeded or replanted with species similar to those found in the surrounding area. These areas will undergo natural regeneration to their original state. Where erosion prone areas exist, replanting in the surrounding area may be required to minimize the impacts of erosion.

#### **4.2.2. Liquid Waste**

Liquid waste generated as a result of construction activities of the HAF Wind Energy Project may include fuel, oil and lubricants found inside the wind turbines, as well as the machinery equipment brought onsite during the construction process.

The storage and use of any fuels, oils and lubricants during the operation of the project's facility will comply with all applicable provincial and federal regulations, codes, and guidelines. The disposal and cleanup of any liquid waste will be in accordance to the procedures outlined in the Design and Operations Report for the HAF Wind Energy Project.

#### **4.3. Abandonment Procedures**

In the event that construction of the facility and associated work is not completed, exposed soils may be subject to erosion due to wind or storm water run-off, which may respectively result in the creation of dust and sedimentation impacts. Vineland Power Inc. is responsible to undertake environmental effects monitoring as part of the EEMP following construction and through the life of the project. Where erosion prone areas have become evident revegetation and replanting may be required. Sediment and erosion control plans will be implemented during construction and decommissioning activities. Once inspections have determined that the threat of erosion has diminished sediment and erosion control equipment will be removed.

#### **4.4. Consultation and Construction**

Vineland Power Inc. will consult with adjacent land users, local municipality, federal agencies, provincial agencies, police and emergency services, and otherwise make suitable notice of the construction of the facility to those impacted by such activities.

#### **4.5. Emergency Response and Communications Plan**

In the event an emergency occurs during construction phase of the HAF Wind Energy Project all appropriate authorities will be notified. Any Emergency Response and Communication required during the construction phase of the project will follow the guidelines and procedures documented in the *Design and Operations Report*.

## 5.0 Environmental Impacts and Mitigation of Construction

**An Environmental Impact Study (EIS) has been prepared for this project and is included as part of the REA Package. Please review the EIS in conjunction to this report.** This report has been prepared in combination with the Natural Heritage Assessment to evaluate the significance of natural heritage features at the project site and to document how mitigation measures will ensure that there will be no negative environmental effects. The evaluation is based on information obtained during the records review, agency consultation and field studies conducted on-site. This document outlines the potential negative impacts on natural heritage features as a result of constructing and operating wind turbines and the supporting project infrastructure and proposes mitigation measures to address these impacts. Monitoring plans will also be established to evaluate the success of the mitigation measures proposed (Also, see the **Environmental Effects Monitoring Report**).

The project complies with Ontario Regulation 359/09 – Renewable Energy Approvals (REA) under Part V.0.1. of the Environmental Protection Act. The EIS document satisfies the reporting required under the Natural Heritage Section. As the lands are not within the Oak Ridges Moraine, Protected Countryside, or the Niagara Escarpment, those sections of Ontario Regulation 359/09 do not apply. Site investigations and background information checks identified all natural heritage features, and confirmed whether these features were significant. Where the project was within the required setbacks given under Ontario Regulation 359/09, mitigations measures are proposed to address and eliminate negative environmental effects to natural heritage features.

The EIS identifies any environmental effects monitoring requirements to be included in the environmental effects monitoring plan report and describes how the construction plan report will address any negative environmental effects. These mitigations and requirements ensure that there will be no negative effects as a result of the proposed project.

## 6.0 Environmental Monitoring

Environmental monitoring involves providing good leadership and management structures to maintain a situational understanding of the environmental effects that occur during construction. This section describes how environmental monitoring, as described in the Environmental Effects Monitoring Plan (EEMP) relates to the Construction Phase of the project.

### 6.1. *Leadership and Management Structures*

The Proponent is responsible for providing leadership and management for the implementation of the Environmental Effects Monitoring Plan (EEMP). The Proponent and their agents or representatives are responsible to ensure that they diligently adhere to the procedures and practices outlined in the EEMP as well as legal and regulatory conditions of approvals. Once construction is completed, the proponent will confirm that environmental restoration efforts were accurately completed.

The Proponent will appoint a Project Manager to oversee the environmental monitoring for this project. During all phases and stages of the project, the Proponent must retain qualified professionals to confirm that environmental monitoring is correctly conducted. The qualified environmental monitoring professional(s) must regularly report and document the execution of the EEMP.

Vineland Power Inc. is committed to working with all stakeholders to reduce or eliminate the impacts of this proposed project. Vineland Power Inc. affirms its commitment to implement the EEMP and ensure the effectiveness of the Environmental Study. Vineland Power Inc. will ensure that the environmental concerns and mitigation measures described in the Renewable Energy Approval Application are addressed and implemented in the field.

### 6.2. *Environmental Effects Monitoring Plan (EEMP)*

The Environmental Effects Monitoring Plan is found as part of the **Design and Operations Report**. The HAF Wind Energy Project's *Environmental Effects Monitoring Plan* (EEMP) has been developed by Morrison Hershfield (MH) to describe the environmental protection measures required for all activities associated with the HAF Wind Energy Project. The *Environmental Effects Monitoring Plan* outlines the necessary monitoring protocols required to make certain that mitigations measures are effective and adequate. This plan should be considered a supporting document to the rest of the *REA Package* and fulfills the requirements outlined by *Ontario Regulation 359/09 - Renewable Energy Approvals* under the *Green Energy Act*.

This *EEMP* is applicable to all employees of Vineland Power Inc. working on the operation and maintenance phases of the HAF Wind Energy Project and provides guidance to Vineland Power Inc.'s contractors and subcontractors on environmentally safe standards for project activities during operation and environmental monitoring of the project.

### **6.3. *Project Commissioning and Scheduling***

Vineland Power Inc. is expecting project operations to commence by August, 2013. During the construction, operation and decommissioning phases of the HAF Wind Energy Project environmental monitoring procedures will be carried out.

### **6.4. *Purpose and Objectives of the EEMP***

This *Environmental Effects Monitoring Plan* has been prepared to provide the required protection measures for all project activities associated with HAF Wind Energy Project.

The purpose of the *Environmental Effects Monitoring Plan* is:

- To ensure that Vineland Power Inc.'s commitments to minimizing environmental effects are met.
- To provide a description of the environmental concerns related to the operation, maintenance, and decommissioning of the HAF Wind Energy Project and instructions for mitigation of the potential impacts of these activities.
- To provide concise and clear instructions for implementing mitigation measures for the protection of environmental resources, and minimizing potential adverse environmental effects. To provide a means of tracking and recording actual effects of the project on valued ecosystem components.
- To ensure that the HAF Wind Energy Project operations meet all provincial, federal and municipal requirements.
- To provide a reference document for planning and/or conducting operation, maintenance or decommissioning activities that may have an impact on the environment.

The Environmental Effects Monitoring Plan is intended to be a supporting document of the REA application that provides guidelines for the protection of valued ecosystem components during operation, maintenance and decommissioning activities. Background information contained within the Environmental Effects Monitoring Plan is covered in more detail in the other technical reports of the REA Package

## 7.0 Summary

The proposed HAF Wind Energy Project can be constructed with minimal impacts to the environment provided that the constructor adheres to the environmental mitigation measures provided here and within the Environmental Impact Study and Water Assessment and Impact Reports. Furthermore, environmental monitoring will reduce the risk of potential environmental impacts by outlining procedures based on regulations and good construction practices for waste management, health and safety, emergency response and training.

The Environmental Impact Study (EIS) of the REA application package describes the potential impacts of the project on significant natural features and where the project interacts with REA setbacks. The EIS provides mitigation and impact reduction measures where applicable. Impacts resulting from construction of underground crossings of watercourses by electrical lines are discussed in the Water Bodies Impact Assessment Report, where appropriate mitigation measures to reduce these impacts are also described. Environmental monitoring plans have been developed and are discussed in the Environmental Effects Monitoring Plan included within the Design and Operations Report included in the REA package.

## 8.0 Consultant Legal Statement

Morrison Hershfield Limited (“MH”) produced this report in accordance with our Proposal and information provided by IPC Energy (“the Client”) and is based upon statements by the Client on the proposed design, construction, operations, maintenance, and decommissioning of the proposed wind energy project. The information and statements contained herein are for the sole benefit of the Client for the purposes of the Renewable Energy Approval.

The contents of this report are based upon our understanding of guidelines, regulations, and statutes which we believe to be current at this time. Changes in guidelines, regulations, statutes, and enforcement policies can occur at any time, and such changes could affect the conclusions and recommendations of this report.

While we have referred to and made use of reports and specifications prepared by others, we assume no liability for the accuracy of the information contained within those reports and specifications.



## **Appendix A: Geotechnical Investigation**

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## SOIL-MAT ENGINEERS & CONSULTANTS LTD.

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PROJECT No.: SM 103793-G

July 20, 2010

IPC ENERGY  
2550 Argentia Road, Suite 105  
Mississauga, Ontario  
L5N 5R1

Attention: Mr. Sunny Galia  
Project Manager

**GEOTECHNICAL INVESTIGATION  
PROPOSED HAF WIND POWER PROJECT  
WEST LINCOLN, ONTARIO**

Dear Sir ,

Further to your authorisation we have completed the fieldwork and laboratory testing, and report preparation, in accordance with our Geotechnical Investigation Program proposal dated May 14, 2010. Our comments and recommendations, based on our findings at the five borehole locations, are presented herein.

### 1. INTRODUCTION

We understand that the project will consist of the construction of 5 wind turbines situated in the western portion of the Township of West Lincoln. Specifically the project area is bounded by Twenty Road, Abingdon Road, Concession Road 5 and Westbrook Road. The wind turbine units will have tower heights on the order of 100 to 110 metres, and rotor diameter of approximately 100 metres. The project will also involve the construction of access roadways and temporary construction work areas at the tower locations. The purpose of this investigation program was to conduct an assessment of the subsurface conditions at each of the proposed turbine locations, evaluate these conditions with respect to the proposed wind turbines, and provide our comments and recommendations for design of foundations and related earth works for the project, from a geotechnical point of view.

This report is based on the above summarised project description, and on the assumption that the design and construction will be performed in accordance with applicable codes and standards. Any significant deviations from the proposed project design may void the recommendations given in this report. If significant changes, such as additional turbines or revised locations, are made to the proposed design, then this office must be consulted to review the new design with respect to the results of this investigation. The information contained in this report does not reflect upon the environmental aspects of the site and therefore they have not been addressed in this document.

**PROJECT No.: SM 103793-G**GEOTECHNICAL INVESTIGATION  
PROPOSED HAF WIND POWER PROJECT  
WEST LINCOLN, ONTARIO**2. PROCEDURE**

A total of five [5] sampled boreholes were advanced at the locations illustrated on the enclosed Drawing No. 1, Borehole Location Plan. Borehole Nos. 2 and 3 were advanced using solid stem continuous flight augers and Borehole Nos. 1, 4 and 5 were advanced using solid stem continuous flight auger equipment on July 5 and 6, 2010 under the supervision of SOIL-MAT ENGINEERS. The borings were extended to termination at auger refusal at depths of 3.5 to 17.0 metres below the existing ground surface level. In Borehole Nos. 1 and 4 the bedrock was cored using Nq diamond core barrel equipment to depths of 7.60 and 21.30 metres below the surrounding ground surface, respectively.

Representative samples of the subsoils were recovered from the borings at selected depth intervals using split barrel sampling equipment driven in accordance with the requirements of the ASTM test specification D1586, Standard Penetration Resistance Testing. After undergoing a general field examination, the soil samples were preserved and transported to the Soil-Mat laboratory for visual, tactile, and olfactory classifications. Routine moisture content tests were performed on all soil samples recovered from the borings.

The five proposed turbine locations were marked with stakes by representatives of IPC Energy in advance of the fieldwork, and the UTM co-ordinates provided. The boreholes were located at the stake locations, with the UTM co-ordinates checked using a hand held GPS unit. The boreholes were referenced to the existing ground elevation at their locations.

The results of the subsurface investigation are detailed in Borehole Logs Nos. 1 to 5, inclusive, which can be found following the text of this report. It is noted that the boundaries of soil types indicated on the borehole logs are inferred from non-continuous soil sampling and observations made during drilling. These boundaries are intended to reflect transition zones for the purpose of geotechnical design and therefore should not be construed as the exact planes of geological change.

**3. SITE DESCRIPTION AND SUBSURFACE CONDITIONS**

The project area consists of a number of properties in the west portion of the Township of West Lincoln. The project area is bounded by Twenty Road to the north, Abingdon Road to the east, Concession Road 5 to the south, and Westbrook Road to the west. Each of the proposed tower locations are within open agricultural fields.

The locations are summarised as follows:

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9508 Twenty Road –

Turbine 1 [604801E 4775531N] and Turbine 2 [604931E 4775190N]

9319 Sixteen Road – Turbine 3 [606300E 4774927N]

9321 Concession Road 5 – Turbine 4 [606238E 4773269N]

9573 Concession Road 5 – Turbine 5 [604299E 4774306N]

The subsurface conditions identified at the borehole locations are summarised in the following paragraphs:

**Topsoil**

A surficial veneer of topsoil approximately 100 to 200 millimetres thick is present at the borehole locations. It should be noted that the depth of topsoil might vary over the project area and from the depths encountered at the borehole locations.

**Silty Clay/Clayey Silt**

Native Silty Clay/Clayey Silt was encountered beneath the topsoil veneer in all boreholes. The Silty Clay/Clayey Silt is brown, transitioning to grey below a depth of about 3 to 5 metres, has traces of to some fine Sand and Gravel, is weathered in the upper few metres with oxidized seams, and is generally stiff to very stiff in consistency. The Silty Clay/Clayey Silt was proven to auger refusal in each of the boreholes, with the exception of Borehole No. 3.

**Silt**

In the lower levels of Borehole No. 3, at a depth of approximately 2.9 metres, the Silty Clay/Clayey Silt transitioned to a Silt layer. The Silt layer is grey, with a trace to some Clay and fine Sand, occasional fine Gravel, and is in a compact condition.

**Limestone/Dolostone Bedrock**

Each of the boreholes was advanced to auger refusal on assumed bedrock at depths of 3.5, 5.3, 3.5, 17.0 and 15.2 metres in Borehole Nos. 1 to 5, respectively. In Borehole No. 1 the bedrock was cored from 3.5 to 7.6 metres, and in Borehole No. 4 the bedrock was cored from 17.0 to 21.3 metres.

From published information and the recovered rock cores the bedrock consists of Limestone and Dolostone of the Guelph and Eramosa formations. The bedrock is grey to tan, relatively fractured in the upper levels, with occasional minor solution cavities. Discontinuities in the bedrock are generally closely spaced at 0.1 to 0.5 metres, with a small aperture. As noted in the recovered rock cores, the Limestone/Dolostone of the Hamilton area is documented to have occasional minor solution cavities. Rock core recoveries were measure on the order of approximately 95 to 100 percent, with Rock Quality Designation [RQD] values of 59 to 94 percent. Unconfined compressive strength testing performed on two selected specimens yielded strengths of 95.6 and 110.3 MPa. Overall the Limestone/Dolostone is considered to be of good quality, in a relatively sound condition, with good strength characteristics.

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**Groundwater Observations**

On completion of drilling, and prior to any rock coring, each of the boreholes was noted to be dry. However, insufficient time would have passed for groundwater to stabilise in the low permeability Silty Clay/Clayey Silt soils. Based on observed soil conditions and past experience the static groundwater level is estimated to be at a depth of approximately 3.5 to 5 metres.

**4. FOUNDATION CONSIDERATIONS**

The conditions encountered at the borehole locations demonstrate a relatively consistent overburden condition of stiff to very stiff Silty Clay/Clayey Silt extending to the bedrock. The stiff to very stiff cohesive soils have clay contents in the range of 12 to 37 percent, plastic limit from 12.9 to 21.4 percent and liquid limit from 24.9 to 32.2 percent, and are characteristic of over-consolidated clays and silty clays of low plasticity, to silts and clayey silts of low compressibility. These soils afford sufficient strength characteristics that shallow spread foundation options may be considered for the proposed structures.

The depth to bedrock varies from the north to south of the project area, at roughly 3.5 to 5.3 metres over the three northern turbine locations and 15.2 to 17.0 metres at the two southern locations. The bedrock is generally of good quality and will afford excellent support conditions for a variety of shallow and deep foundation schemes. Where the depth to bedrock is relatively shallow a conventional spread foundation option may be considered, or possibly short pier (caisson) foundations. Where the depth to bedrock is greater a deep foundation scheme consisting of driven piles is likely to present the preferred option.

**Spread Foundations**

The near surface weathered Silty Clay/Clayey Silt are considered competent to support conventional shallow spread foundations. The proposed wind turbine towers may be supported on raft slab foundations, with a founding depth in the range of 1.5 to 2.5 metres. The founding level must extend below any near surface disturbed material into the competent native soils, and may be design using the following bearing values:

Silty Clay/Clayey Silt:	SLS	= 200 kPa [4,000 psf]
	ULS [factored]	= 350 kPa [7,000 psf]

Alternatively, where bedrock is at relatively shallow depths of 3.5 metres it may be prudent to extend the founding level of a spread foundation scheme to take advantage of the higher available bearing capacity of the Limestone/Dolostone bedrock. In this case the following design bearing values are recommended:

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Limestone/Dolostone Bedrock:

$$\text{SLS} = \text{ULS} [\text{factored}] = 1,500 \text{ kPa} [30,000 \text{ psf}]$$

The SLS value represents the Serviceability Limit State, which is governed by the tolerable deflection (settlement) of the structure, using unfactored load combinations. The ULS value represents the Ultimate Limit State and is intended to reflect an upper limit of the available bearing capacity of the founding soils in terms of geotechnical design, using factored load combinations. There is no direct relationship between ULS and SLS, rather they are a function of the soil type and the tolerable deflections for serviceability, respectively. In the case of foundations on bedrock, the bedrock would be required to fail to realise the SLS settlements and thus the SLS and ULS values are the same.

The potential settlements for a spread foundation scheme in the overburden soil will be a function of the final arrangement, size and loading of the foundation. Most notably, as the width of the raft slab foundation increases, the depth of stress influence increases, and, correspondingly, the potential total settlement will increase as well. Foundations bearing directly on the bedrock are anticipated to experience relatively negligible settlement. This office should be consulted to review the proposed foundation schemes with respect to the site conditions and the recommendations of this report.

The raft slab foundation should be designed to be sufficiently rigid to account for potential differential settlements. In addition the mass of the raft slab should be utilised in the design to resist the high overturning moments generated by the very tall wind towers. Should rock anchors be considered for the provision of overturning capacity, this office should be contacted to provide additional design parameters.

The native Silty Clay/Clayey Silt soils are sensitive to moisture and disturbance, such as from construction traffic. It may be prudent to protect the base of footing excavations with the placement of a thin, perhaps 50 millimetre thick, concrete 'mud' slab as soon as possible after excavation and evaluation. This will serve to protect the founding soils from disturbance and provide a clean working surface for the placement of reinforcing steel.

All foundations exposed to the environment must be provided with a minimum of 1.2 metres of earth cover or equivalent insulation to protect against frost damage. This frost protection would also be required if construction were undertaken during the winter months. All foundations should be designed and constructed in accordance with the current Ontario Building Code. All footing beds must be cleaned of any loose, wet or disturbed material immediately prior to the placement of concrete.

It is imperative that a soils engineer be retained from this office to provide geotechnical engineering services during the excavation and foundation construction phases of the project. This is to observe compliance with the design concepts and recommendations of this report and to allow changes to be made in the event that subsurface conditions differ from the conditions identified at the Borehole locations.



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**Short Pier (Caisson) Foundations**

Where bedrock is beyond the reasonable depth for spread foundations, such as the location of Turbine 2 with bedrock at 5.3 metres, a short pier foundation scheme may be considered. The piers must extend to the bedrock and may be designed on the basis of the bearing values noted above for foundations on bedrock. The tops of the piers should be connected with a sufficiently rigid grade beam.

The caissons should be a minimum diameter of 0.9 metres and the base cleaned of all loose or disturbed material prior to the placement of concrete. A representative of Soil-Mat should be retained to the site to evaluate/monitor the caisson construction.

**Pile Foundations**

Where the depth to bedrock is significantly greater, such as at the locations of Turbine Nos. 4 and 5, the use of a driven pile foundation scheme may be a preferred option to take advantage of the high capacity available in the bedrock. The use of driven piles would likely be preferred over bored caissons, since they do not require the removal of large volumes of soil and the corresponding placement of concrete.

Driven steel H-piles may be driven to the underlying bedrock at depths of 15.2 to 17.0 metres to develop ULS capacities on the order of 2000 kN [~250 tons]. For piles bearing on the bedrock, the SLS condition does not apply, i.e., the SLS capacity would equal to the ULS capacity, since the load required on the piles to achieve SLS condition would exceed the ULS value. Settlement of the piles in the loading range specified would be primarily due to elastic compression of the piles. Deflection of the bedrock under the pile loading should be very small. Negative skin friction on the steel "H" piles is considered negligible.

Such piles would typically consist of an HP310x110 section fitted with a driving shoe as per OPSD 3000.100 (Type I). The piles should be battered to resist both the vertical and horizontal forces generated by the wind towers. Batter piles should have suitable rock-points on their tips to ensure that the piles penetrate the rock surface rather than slip along the bedrock surface.

The piles should be driven to 'practical refusal' into the underlying bedrock with a pile hammer that can generate sufficient effective driving energy compatible with the bearing capacity required. It is important that the piles are not over-stressed during pile driving as structural damage to the piles can occur as a result of over-driving. Piles driven to rock reach "practical refusal" quickly, and it is important to stop the driving when rock is reached to avoid 'overdriving' and damaging the piles.

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The final set to which the piles are driven would be determined as a function of the bearing capacity required, the rated energy of the pile driver, weight of pile, etc. We recommend that the piles be driven to the design capacity based on the Hiley Formula using the applicable equipment, pile, etc. parameters. In addition, rebound traces should be made on all piles during the final few centimetres of driving. It is expected that the piles will fetch up fairly quickly in the bedrock. Should Hiley Formula calculations fail to provide a definitive bearing capacity, the use of a Pile Driving Analyser and CAPWAP analysis may be required to confirm the specified pile capacity and pile driving set criteria, or alternatively a pile load test.

It is noted that the performance of deep foundation schemes is greatly dependent on the method, equipment, and workmanship utilised during construction. It is therefore essential that installation procedures for the deep foundations be monitored/evaluated by Soil-Mat Engineers.

**5. SEISMIC DESIGN CONSIDERATIONS**

The structures shall be designed according to Section 4.1.8 of the Ontario Building Code, Ontario Regulation 350/06. Based on the subsurface soil conditions encountered in this investigation the applicable Site Classification for the seismic design is as follows:

Turbine Nos. 1, 2 and 3 where bedrock is present within relative shallow depths may be designed on the basis of Site Class B - Rock.

Turbine Nos. 4 and 5 where the depth of overburden soil is approximately 15 to 17 metres may be designed on the basis of Site Class D – Stiff Soil.

The seismic data, from Supplementary Standard SB-1 of the Ontario Building Code, for Smithville [West Lincoln] are as follows.

$S_a(0.2)$	$S_a(0.5)$	$S_a(1.0)$	$S_a(2.0)$	PGA
0.40	0.190	0.069	0.020	0.290

**6. EXCAVATION CONSIDERATIONS**

Excavations for the installation of foundations and underground services through the predominately Clayey Silt/Silty Clay soils should be relatively straightforward, with the sides remaining stable for the short construction period at 60 degrees to the horizontal or steeper. Nevertheless, all excavations must comply with the current Occupational Health and Safety Act and Regulations for Construction Projects. Excavation slopes steeper than those required in the Safety Act must be supported or a trench box must be provided, and a senior geotechnical engineer from this office should monitor the work.



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WEST LINCOLN, ONTARIO



As noted above, some minor infiltration of groundwater into open excavations should be anticipated, however the volume of water to be controlled is expected to be relatively small. It should be possible to control any water that may seep into the excavations from surface runoff and more permeable seams in the native soils using conventional construction 'dewatering' techniques, such as pumping from sumps and ditches. Surface water should be directed away from the excavations.

The base of the excavations in the Clayey Silt/Silty Clay should remain firm and stable. However, as noted above, these soils are sensitive to excessive moisture and disturbance from construction traffic. Care should be taken to minimise or avoid construction traffic on the exposed soils.

**7. ACCESS ROADWAYS AND CONSTRUCTION STAGING AREAS**

As noted above construction of the wind towers will require access roadways and construction staging areas for the delivery of the materials and erection of the towers. These areas will be subjected to heavy loading from heavy trucks and large mobile crane units.

It is recommended that access roadways and construction staging areas be stripped of all topsoil and unsuitable soft, wet, or disturbed soil to expose competent native soil. In the case of an exposed soil subgrade the area should be nominally compacted with a large smooth drum vibratory compactor. Where possible, the areas should be shaped to promote good drainage of the subgrade to the edges of the access roads, and to prevent water from collecting and ponding under the granular base materials.

A nominal construction access road may consist of 450 millimetres of OPSS Granular B compacted to 98 percent of standard Proctor maximum dry density. This structure is considered adequate for the temporary support of heavy construction equipment. As with all granular roadways some level of regular maintenance will be required, such as re-grading of the surface and occasional placement of additional granular material for re-levelling. For the short duration of tower construction the maintenance requirements should be minimal, depending on the weather conditions, time of year, and volume of construction traffic.

At the location for the set-up of large mobile crane units for the erection of the tower sections it is recommended that a similar subgrade preparation as for the access roadways be undertaken. The depth of granular material should be increased to 600 millimetres and be compacted to 100 percent of Standard Proctor.

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The subgrade conditions should be assessed by a representative of this office prior to the placement of granular materials. This evaluation will allow changes to be made, if necessary, based on the actual conditions present at the time of construction.

It is anticipated that after construction a limited access roadway will be left in place to allow for routine maintenance of the wind turbines. The construction access roadway granular base may be left in place to serve for this purpose, with the addition of perhaps 100 to 150 millimetres of OPSS Granular A compacted to 98 percent to provide a smoother driving surface for maintenance vehicles. All other granular materials could be removed and re-used on subsequent wind tower locations and the abandoned roadways returned to pre-construction conditions.

**8. GENERAL COMMENTS**

The comments provided in this document are intended only for the guidance of the design team. The subsoil descriptions and borehole information are intended to describe conditions at the borehole locations. Contractors tendering or undertaking this project should carry out due diligence in order to verify the results of this investigation and to determine how the subsurface conditions will effect their operations.

We trust that this geotechnical report is sufficient for your present requirements. Should you require any additional information or clarification as to the contents of this document, then please do not hesitate to contact the undersigned.

Yours very truly,  
SOIL-MAT ENGINEERS & CONSULTANTS LTD.

Ian Shaw, P. Eng.  
Project Engineer



Re-assured

Stephen R. Sears, B. Eng. Mgmt., P. Eng.  
Review Engineer

Enclosures: Drawing No. 1: Borehole Location Plan  
Log of Borehole Nos. 1 to 5, inclusive  
Drawing No. 2: Summary of Grain Size Analyses  
Grain Size Analyses Nos. 1 to 5, inclusive  
Drawing No. 3: Summary of Atterberg Limits

Distribution: IPC Energy [3]





Project No: SM 103793-G

Project: HAF Wind Power

Location: 9508 Twenty Road

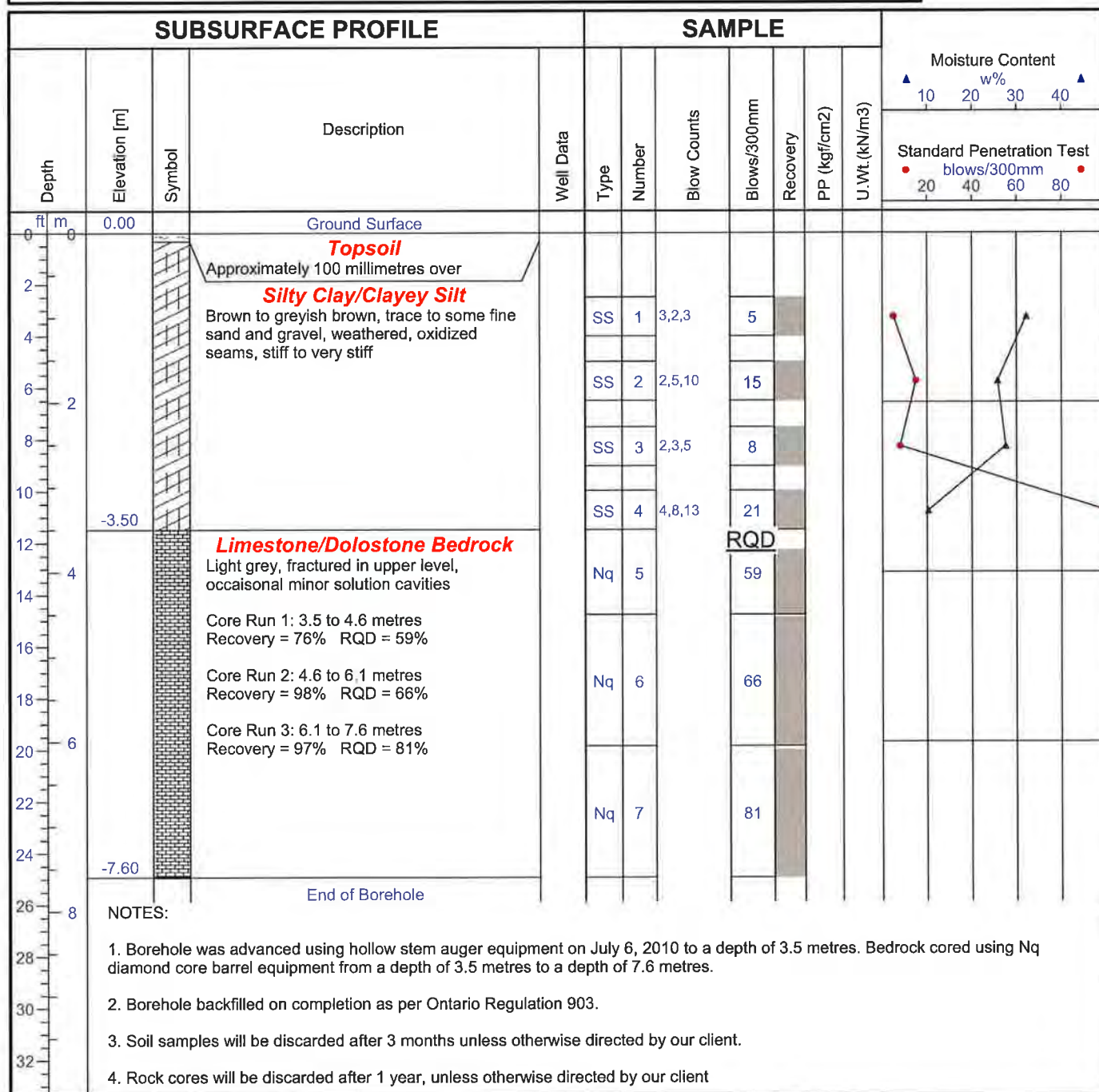
Client: IPC Energy

**Log of Borehole No. 1**

Borehole Location: See Drawing No. 1

: 604801 E  
:: 4775531 N

Project Manager: Ian Shaw, P.Eng.



Drill Method: Hollow Stem Augers

Drill Date: July 6, 2010

Hole Size: 200 millimetres

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Datum: Existing Ground Surface

Checked by: IS

Sheet: 1 of 1

Project No: SM 103793-G

Project: HAF Wind Power

Location: 9508 Twenty Road

Client: Independent Power Corp

**Log of Borehole No. 2**

Borehole Location: See Drawing No. 1

: 604931 E

:: 4775190 N

Project Manager: Ian Shaw, P.Eng.



SUBSURFACE PROFILE					SAMPLE						
Depth	Elevation [m]	Symbol	Description	Well Data	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm <sup>2</sup> )	U. Wt. (kN/m <sup>3</sup> )
ft m	0.00		Ground Surface								
0			<b>Topsoil</b> Approximately 100 millimetres over								
2			<b>Silty Clay/Clayey Silt</b> Brown, transitioning to brownish grey below 3.5 metres, trace to some fine sand and gravel, weathered, coarse sand seam at approximately 4.7 metre depth, stiff to hard		SS	1	2,2,3	5		3.0	
4											
6					SS	2	4,5,7	12		4.0	
8											
10											
12					SS	3	3,5,8	13		3.0	
14											
16											
18			Auger Refusal on Assumed Bedrock		SS	4	8,24,20	44			
20			End of Borehole								
22			NOTES:								
24			1. Borehole was advanced using solid stem auger equipment on July 5, 2010 to auger refusal on assumed bedrock at a depth of 5.3 metres.								
26			2. Test borehole advanced 2 metres west of borehole location to confirm the depth to bedrock.								
28			3. Borehole 'dry' on completion and backfilled as per Ontario Regulation 903. Test borehole had groundwater present upon completion at a depth of approximately 1.5 metres.								
30			4. Soil samples will be discarded after 3 months unless otherwise directed by our client.								
32											

Drill Method: Solid Stem Augers

Drill Date: July 5, 2010

Hole Size: 150 millimetres

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Sheet: 1 of 1

Project No: SM 103793-G

Project: HAF Wind Power

Location: 9319 Sixteen Road

Client: Independent Power Corp

**Log of Borehole No. 3**

Borehole Location: See Drawing No. 1

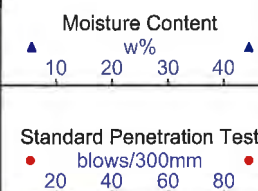
: 606300 E

:: 4774927 N

Project Manager: Ian Shaw, P.Eng.



SUBSURFACE PROFILE					SAMPLE						
Depth	Elevation [m]	Symbol	Description	Well Data	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm <sup>2</sup> )	U. Wt. (kN/m <sup>3</sup> )
0	0.00		Ground Surface								
0	-0.20		<b>Topsoil</b> Approximately 200 millimetres over								
2			<b>Silty Clay/Clayey Silt</b> Brown, grey below 3 metres, interbedded with fine sandy silt layers, trace to some fine sand and gravel, weathered, stiff to hard		SS	1	2,4,4	8		3.0	
4											
6					SS	2	2,3,4	7			
8											
10	-2.90				SS	3	6,14,21	35			
12											
14	-3.50		<b>Silt</b> Grey, trace of clay and fine sand, compact		SS	4	11,14,14	28		4.5	
16											
18											
20											
22											
24											
26											
28											
30											
32											



## NOTES:

1. Borehole was advanced using solid stem auger equipment on July 5, 2010 to auger refusal on assumed bedrock at a depth of 3.5 metres.
2. Test borehole advanced 2 metres west of borehole location to confirm the depth to bedrock.
3. Borehole 'dry' on completion and backfilled as per Ontario Regulation 903.
4. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid Stem Augers

Drill Date: July 5, 2010

Hole Size: 150 millimetres

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Sheet: 1 of 1



Project No: SM 103793-G

Project: HAF Wind Power

Location: 9321 Concession 5 Road

Client: Independent Power Corp

**Log of Borehole No. 4**

Borehole Location: See Drawing No. 1

: 606238 E

: 4773269 N

Project Manager: Ian Shaw, P.Eng.



SUBSURFACE PROFILE					SAMPLE					Moisture Content w% ▲ 10 20 30 40 ▲		Standard Penetration Test blows/300mm ● 20 40 60 80 ●	
Depth	Elevation [m]	Symbol	Description	Well Data	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm <sup>2</sup> )	U Wt. (kN/m <sup>3</sup> )		
ft m	0.00		Ground Surface										
0			<b>Topsoil</b> Approximately 200 millimetres over										
2			<b>Clayey Silt/Silty Clay</b> Brown, transitioning to brownish grey in colour below 4.5 metres, trace to some fine sand and gravel, weathered, very stiff to stiff										
4													
6	2				SS	1	5,11,15	26		4.5+			
8													
10					SS	2	4,9,13	27		4.5+			
12													
14	4												
16					SS	3	2,3,6	9		3.0			
18													
20	6				SS	4	6,8,10	18		3.0+			
22													
24													
26	8				SS	5	3,6,7	13		3.5			
28													
30													
32	10				SS	6	5,6,9	15		3.0			
34													
36													
38													
	-12.00												

Drill Method: Hollow Stem Augers

Drill Date: July 6, 2010

Hole Size: 200 millimetres

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Datum: Existing Ground Surface

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Sheet: 1 of 2

Project No: SM 103793-G

Project: HAF Wind Power

Location: 9321 Concession 5 Road

Client: Independent Power Corp

**Log of Borehole No. 4**

Borehole Location: See Drawing No. 1

: 606238 E

:: 4773269 N

Project Manager: Ian Shaw, P.Eng.



SUBSURFACE PROFILE					SAMPLE					Moisture Content	
Depth	Elevation [m]	Symbol	Description	Well Data	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm <sup>2</sup> )	U.Wt. (kN/m <sup>3</sup> )
41			<b>Clayey Silt/Silty Clay</b> Brownish grey, trace to some fine sand and gravel, very stiff		SS	7	4,8,11	19		4.5	
43											
45	14										
47											
49											
51					SS	8	8,10,13	23		4.5+	
53	16										
55	-17.00										
57			<b>Limestone/Dolostone Bedrock</b> Light grey, fractured in upper level, occasional minor solution cavities		Nq	9		73			
59	18		Core Run 1: 17.05 to 18.25 metres Recovery = 88% RQD = 73%								
61			Core Run 2: 18.25 to 19.8 metres Recovery = 100% RQD = 94%		Nq	10		94			
63			Core Run 3: 19.8 to 21.3 metres Recovery = 100% RQD = 78%								
65	20										
67					Nq	11		78			
69	-21.30										
71			End of Borehole								
73	22		NOTES:								
75			1. Borehole was advanced using hollow stem auger equipment on July 6, 2010 to a depth of 17.0 metres. Bedrock cored using Nq diamond core barrel equipment from a depth of 17.0 metres to a depth of 21.3 metres.								
77			2. Borehole backfilled on completion as per Ontario Regulation 903.								
79			3. Soil samples will be discarded after 3 months unless otherwise directed by our client.								
			4. Rock cores will be discarded after 1 year, unless otherwise directed by our client								

Drill Method: Hollow Stem Augers

Drill Date: July 6, 2010

Hole Size: 200 millimetres

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Sheet: 2 of 2



Project No: SM 103793-G

Project: HAF Wind Power

Location: 9573 Concession 5 Road

Client: Independent Power Corp

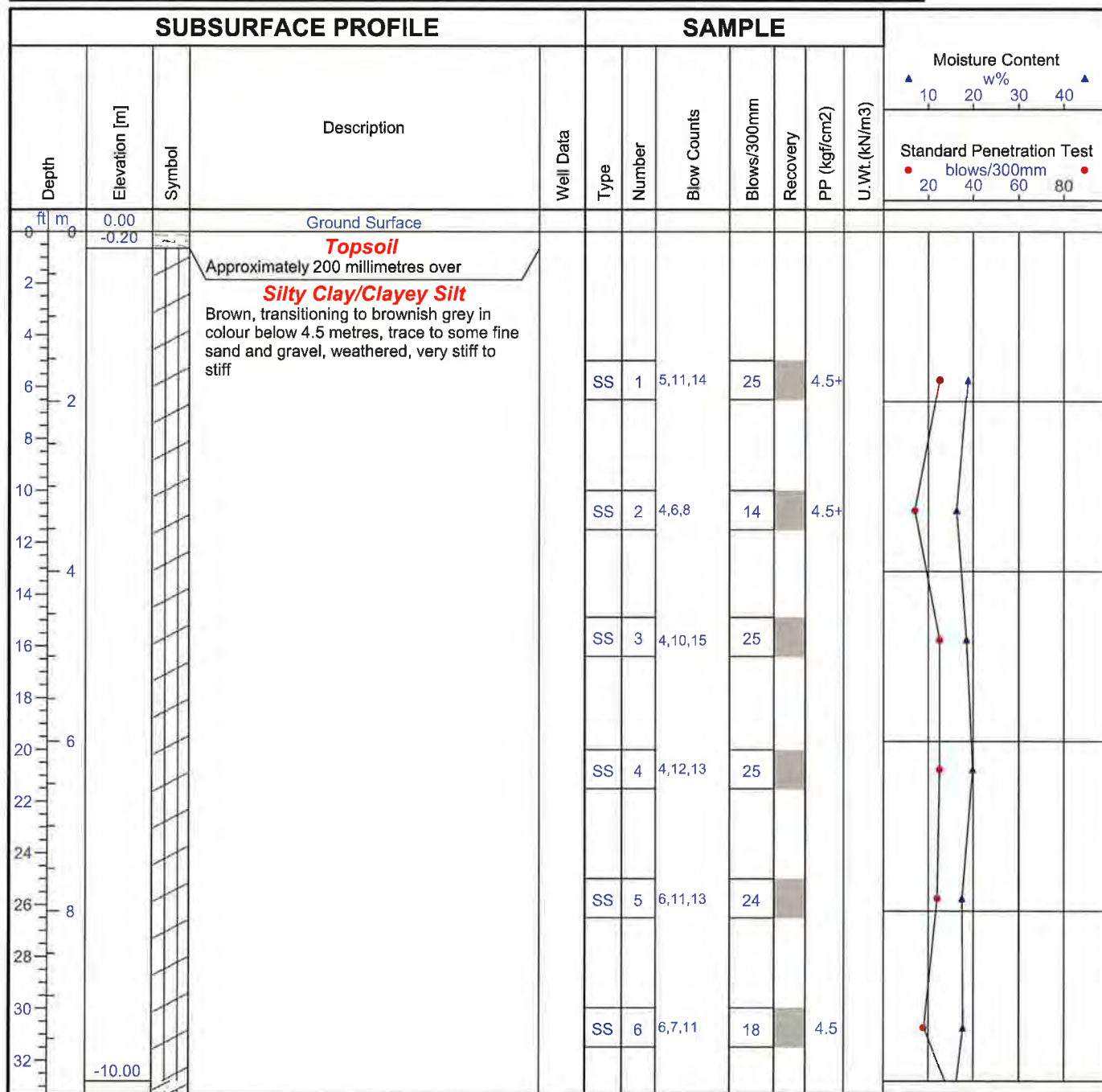
**Log of Borehole No. 5**

Borehole Location: See Drawing No. 1

: 604299 E

:: 4774306 N

Project Manager: Ian Shaw, P.Eng.



Drill Method: Hollow Stem Augers

Drill Date: July 5, 2010

Hole Size: 200 millimetres

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Datum: Existing Ground Surface

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Sheet: 1 of 2

Project No: SM 103793-G

Project: HAF Wind Power

Location: 9573 Concession 5 Road

Client: Independent Power Corp

**Log of Borehole No. 5**

Borehole Location: See Drawing No. 1

: 604299 E

:: 4774306 N

Project Manager: Ian Shaw, P.Eng.



SUBSURFACE PROFILE					SAMPLE							Moisture Content				
Depth	Elevation [m]	Symbol	Description	Well Data	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt. (kN/m3)	w%				
												Standard Penetration Test				
												blows/300mm				
												10	20	30	40	
												20	40	60	80	
34			<b>Clayey Silt/Silty Clay</b> Grey, trace to some fine sand and gravel, occasional cobbles, very stiff to hard													
36					SS	7	9,18,23	41								
38																
40	12				SS	8	6,9,11	20		4.0+						
42																
44																
46	14				SS	9	11,18,16	34		1.0+						
48																
50	-15.20		Auger Refusal on Assumed Bedrock													
52			End of Borehole													
54	16															
56			NOTES:													
58			1. Borehole was advanced using hollow stem auger equipment on July 5, 2010 to auger refusal at a depth of 15.2 metres.													
60	18		2. Borehole 'dry' on completion and backfilled as per Ontario Regulation 903.													
62			3. Soil samples will be discarded after 3 months unless otherwise directed by our client.													
64																

Drill Method: Hollow Stem Augers

Drill Date: July 5, 2010

Hole Size: 200 millimetres

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e-mail: info@soil-mat.on.ca

Datum: Existing Ground Surface

Checked by: IS

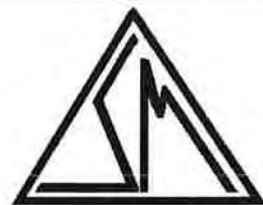
Sheet: 2 of 2

BH	Sample	Depth [m]	Particle Distribution [%]				C <sub>u</sub>	C <sub>c</sub>	D <sub>10</sub> [mm]
			Clay	Silt	Sand	Gravel			
2	SS3	3.05-3.5	31	37	24	8	34	0.4	<0.0005
3	SS3	2.3-2.75	21	69	9	1	17.6	3.1	<0.0005
4	SS4	6.1-6.55	37	54	6	3	12.8	0.5	<0.0005
5	SS2	3.05-3.5	34	58	7	1	14.4	0.6	<0.0005
5	SS4	6.1-6.55	12	87	1	0	2.2	0.8	0.001

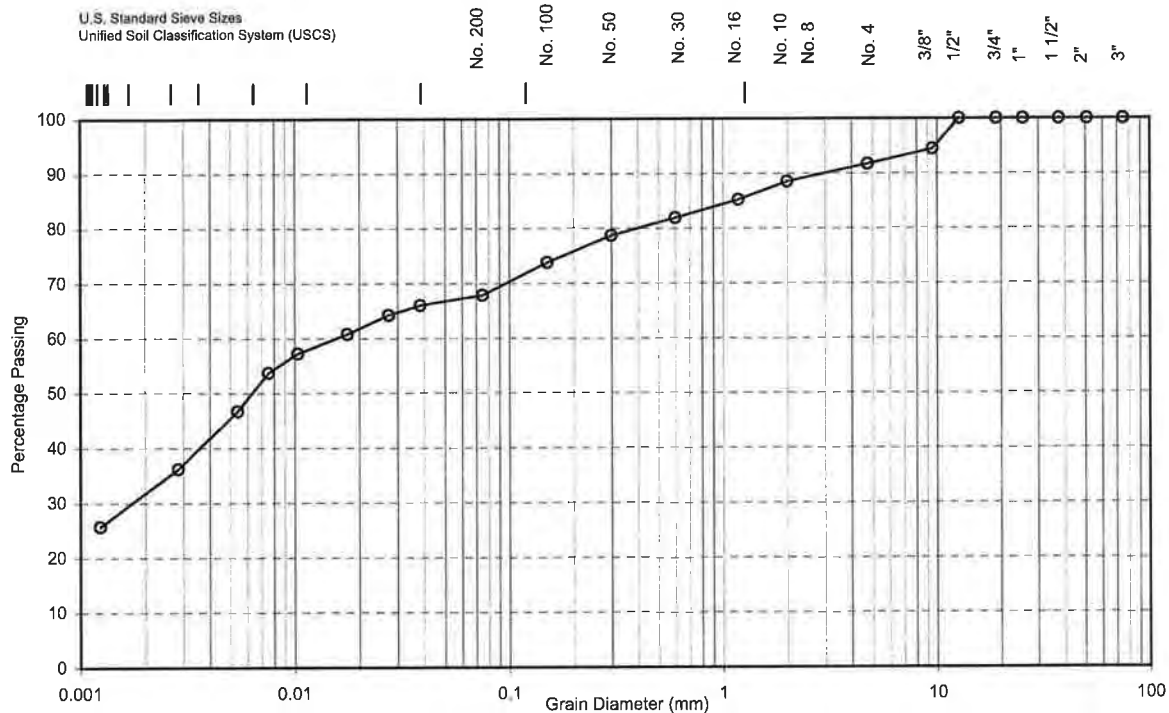
**SOIL-MAT ENGINEERS & CONSULTANTS LTD.**
**Grain Size Analyses**
**HAF Wind Power Project**
**Client:** IPC Energy

**Project No.:** SM 103793-G

July 2010


**Drawing No. 2**

## Mechanical &amp; Hydrometer Analyses



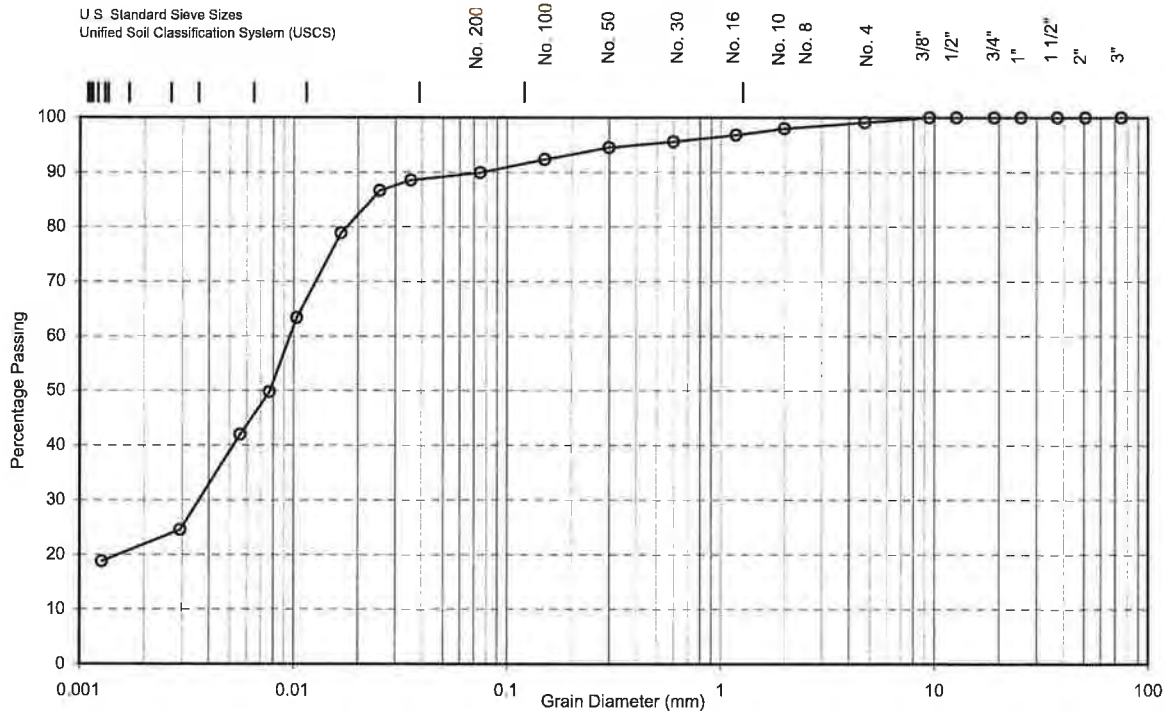
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	COARSE
		SAND			GRAVEL	

Sample No.:	3	Notes: Sample retrieved by Soil-Mat laboratory on July 5 <sup>th</sup> and 6 <sup>th</sup> , 2010	
Borehole No.:	2		
Depth [ft]:	10-11.5		
CLAY [%]:	31	Soil Description: <b>Brown Sandy SILT and CLAY with trace Gravel</b> <b>CL - Inorganic Clays, silty clays with low to medium plasticity</b> <b>ML - Inorganic Silts very fine sands, clayey silts with slight plasticity</b>	
SILT [%]:	37		
SAND [%]:	24		
GRAVEL [%]:	8	Estimated <i>T</i> Time [min/cm]:	Estimated Permeability, <i>k</i> [cm/s] <b>10<sup>-8</sup></b>
D <sub>10</sub> (Effective Diam. in mm):	0.0005	Coefficient of Uniformity C <sub>u</sub> :	Coefficient of Curvature C <sub>c</sub> :
		34.0	0.4
<b>SOIL-MAT ENGINEERS &amp; CONSULTANTS LTD.</b>  <b>HAF Wind Power Project</b>			
July 22, 2010		Grain Size Analysis No. 1	Project No.: SM 103793-G






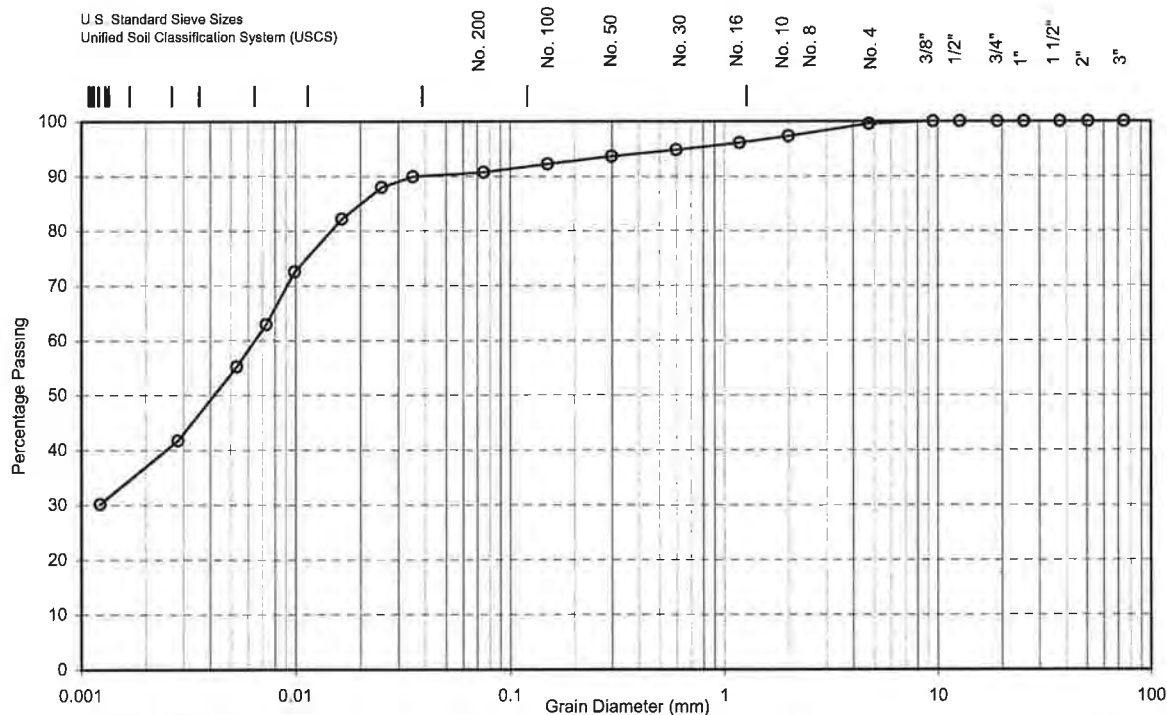
## Mechanical &amp; Hydrometer Analyses



CLAY	SILT	FINE	MEDIUM	COARSE	FINE	COARSE
		SAND			GRAVEL	

Sample No.:	3	Notes:  Sample retrieved by Soil-Mat laboratory on July 5 <sup>th</sup> and 6 <sup>th</sup> , 2010			
Borehole No.:	3				
Depth (ft):	7.5-9				
CLAY [%]:	21	Soil Description: <b>Brown SILT and CLAY with trace Sand and Gravel</b> <b>CL - inorganic Clays, silty clays with low to medium plasticity</b> <b>ML - Inorganic Silts very fine sands, clayey silts with slight plasticity</b>			
SILT [%]:	69				
SAND [%]:	9				
GRAVEL [%]:	1				
D <sub>10</sub> (Effective Diam. in mm):	0.0005	Estimated <i>T</i> Time (min/cm) :	Estimated <i>Permeability</i> , <i>k</i> [cm/s]	10 <sup>-8</sup>	
		Coefficient of Uniformity C <sub>u</sub> :	17.6	Coefficient of Curvature C <sub>c</sub> :	3.1
SOIL-MAT ENGINEERS & CONSULTANTS LTD.					
HAF Wind Power Project					
July 22, 2010		Grain Size Analysis No. 2		Project No.: SM 103793-G	

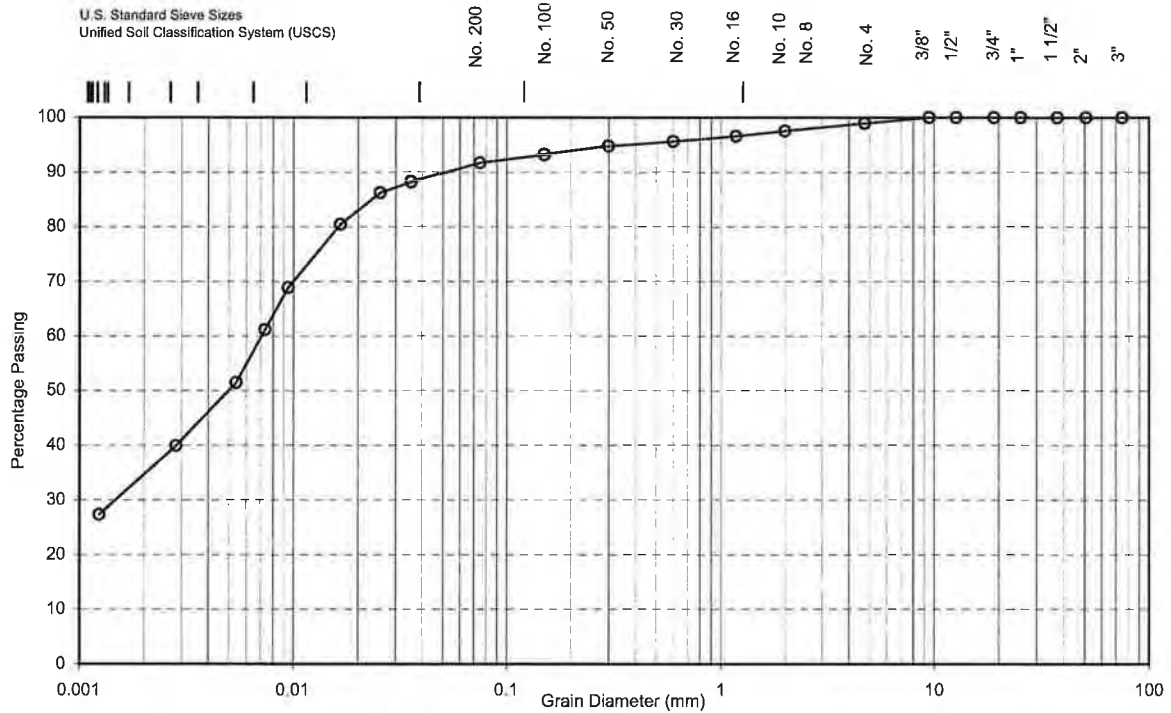
## Mechanical &amp; Hydrometer Analyses




CLAY	SILT	FINE	MEDIUM	COARSE	FINE	COARSE
		SAND			GRAVEL	

Sample No.:	4	Notes:  Sample retrieved by Soil-Mat laboratory on July 5 <sup>th</sup> and 6 <sup>th</sup> , 2010			
Borehole No.:	4				
Depth [ft]:	20-21.5				
CLAY [%]:	37	Soil Description: <b>Grey SILT and CLAY with trace Sand and Gravel</b> <b>CL - inorganic Clays, silty clays with low to medium plasticity</b> <b>ML - Inorganic Silts very fine sands, clayey silts with slight plasticity</b>			
SILT [%]:	54				
SAND [%]:	6				
GRAVEL [%]:	3				
D <sub>10</sub> (Effective Diam. in mm):	0.0005	Estimated T Time [min/cm] :	Estimated Permeability, k [cm/s]	10 <sup>-8</sup>	
		Coefficient of Uniformity C <sub>u</sub> :	12.8	Coefficient of Curvature C <sub>c</sub> :	0.5
<b>SOIL-MAT ENGINEERS &amp; CONSULTANTS LTD.</b>					
<b>HAF Wind Power Project</b>					
July 22, 2010		Grain Size Analysis No. 3		Project No.: SM 103793-G	

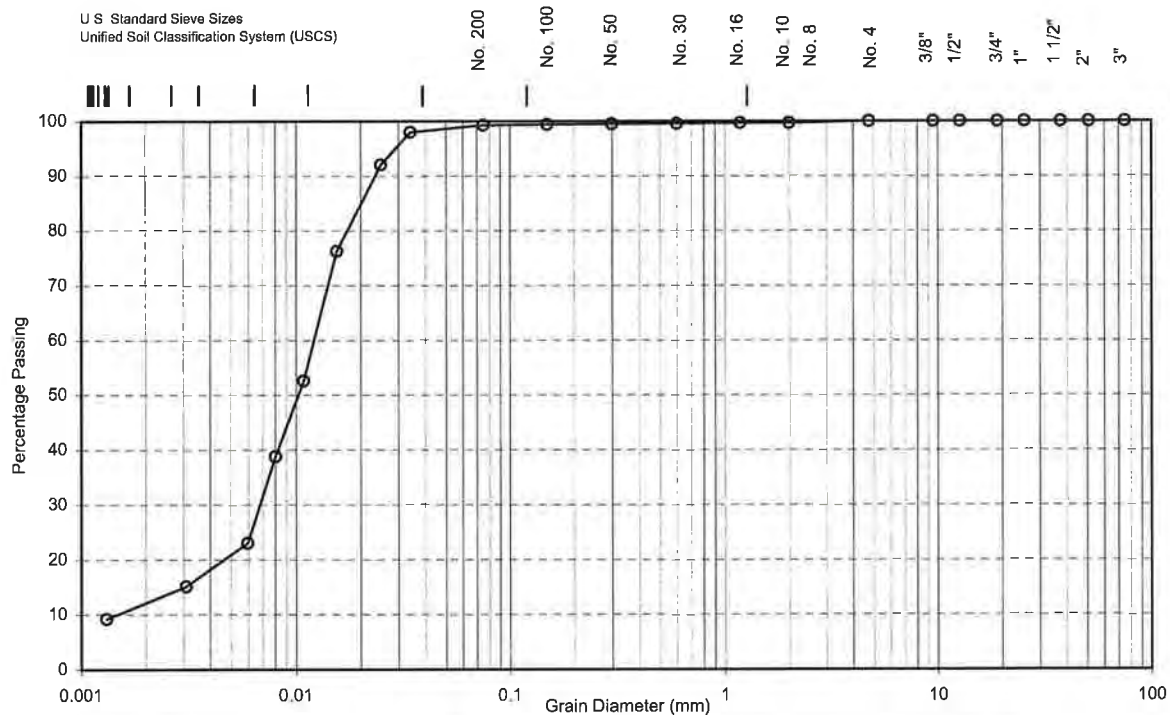
## Mechanical &amp; Hydrometer Analyses



CLAY	SILT	FINE	MEDIUM	COARSE	FINE	COARSE
		SAND			GRAVEL	

Sample No.:	2	Notes:  Sample retrieved by Soil-Mat laboratory on July 5 <sup>th</sup> and 6 <sup>th</sup> , 2010			
Borehole No.:	5				
Depth [ft]:	10-11.5				
CLAY [%]:	34	Soil Description: <b>Brown SILT and CLAY with trace Sand and Gravel</b> <b>CL - inorganic Clays, silty clays with low to medium plasticity</b> <b>ML - Inorganic Silts very fine sands, clayey silts with slight plasticity</b>			
SILT [%]:	58				
SAND [%]:	7				
GRAVEL [%]:	1				
D <sub>10</sub> (Effective Diam. in mm):	0.0005	Estimated T Time [min/cm] :	Estimated Permeability, k [cm/s]	10 <sup>-8</sup>	
		Coefficient of Uniformity C <sub>u</sub> :	14.4	Coefficient of Curvature C <sub>c</sub> :	0.6
<b>SOIL-MAT ENGINEERS &amp; CONSULTANTS LTD.</b>					
<b>HAF Wind Power Project</b>					
July 22, 2010		Grain Size Analysis No. 4		Project No.: SM 103793-G	

## Mechanical &amp; Hydrometer Analyses



CLAY	SILT	FINE	MEDIUM	COARSE	FINE	COARSE
		SAND			GRAVEL	

Sample No.:	4	Notes:  Sample retrieved by Soil-Mat laboratory on July 5 <sup>th</sup> and 6 <sup>th</sup> , 2010			
Borehole No.:	5				
Depth [ft]:	20-21.5				
CLAY [%]:	12	Soil Description: <b>Grey Clayey SILT with trace Sand</b> <b>ML - Inorganic Silts very fine sands, clayey silts with slight plasticity</b>			
SILT [%]:	87				
SAND [%]:	1				
GRAVEL [%]:	0				
D <sub>10</sub> (Effective Diam. in mm):	0.001	Estimated T Time [min/cm] :	Estimated Permeability, k [cm/s]	10 <sup>-7</sup>	
		Coefficient of Uniformity C <sub>U</sub> :	13.0	Coefficient of Curvature C <sub>C</sub> :	4.7

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HAF Wind Power Project

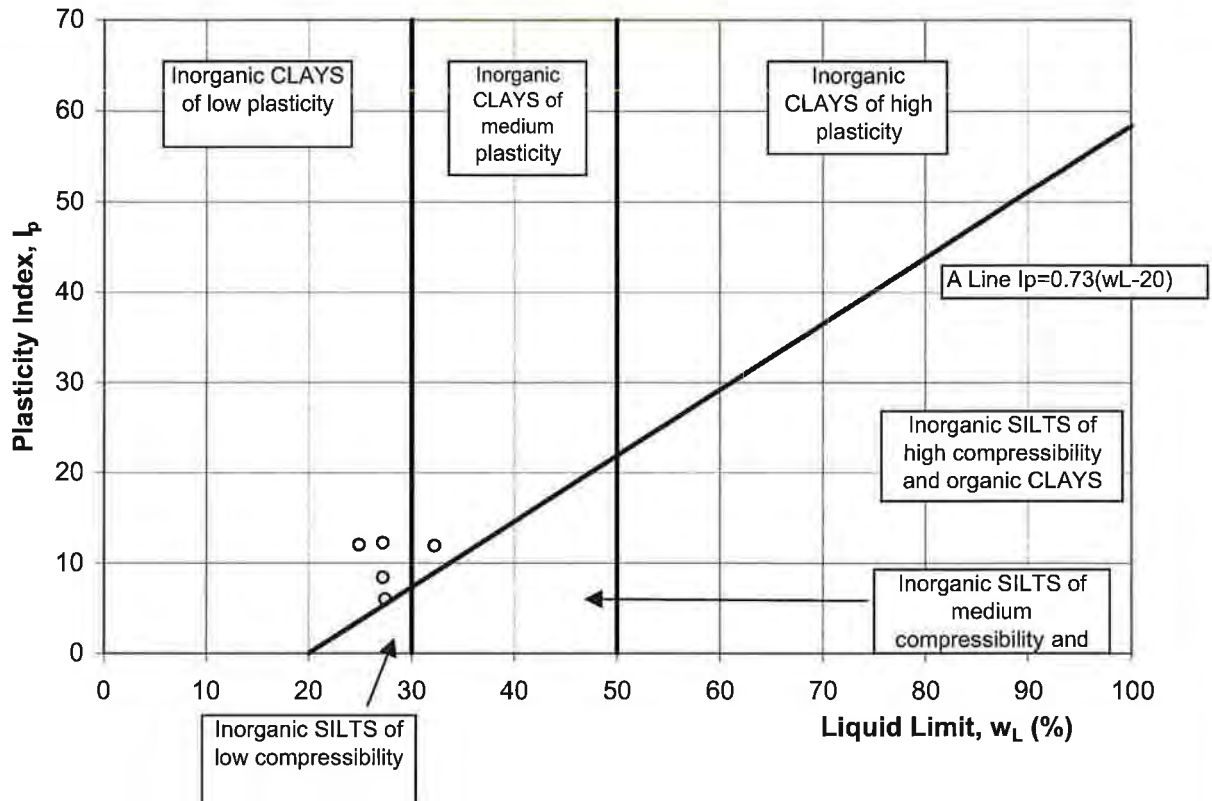


July 22, 2010

Grain Size Analysis No. 5

Project No.: SM 103793-G





Atterberg Limits					
Sample No.	Sample ID	Depth [m]	Liquid Limit $w_L$	Plastic Limit $w_p$	Plasticity Index $I_p$
1	BH2SS3	3.05-3.5	24.9	12.9	12.0
2	BH3SS3	2.3-2.75	27.2	18.8	8.4
3	BH4SS4	6.1-6.55	27.2	15.0	12.2
4	BH5SS2	3.05-3.5	32.2	20.3	11.9
5	BH5SS4	6.1-6.55	27.4	21.4	6.0

SOIL-MAT ENGINEERS &amp; CONSULTANTS LTD.

Atterberg Limits - Plasticity Chart

HAF Wind Power Project

Client: IPC Energy

Project No.: SM 103793-G

July 2010



Drawing No. 3

## **Appendix B: Preliminary Transportation Survey**



# HAF & Wainfleet Transportation Survey

<b>Date:</b>	Nov. 11, 2010
<b>Project Scope:</b>	Transportation of components from Trillium Rail Terminal located near Welland, ON to site HAF near Abingdon, ON and/or to site Wainfleet near Ostrtyhon Corners, ON. (Expect Base section. To be shipped from Vestas Pueblo, CO.)
<b>Destination:</b>	Abingdon, ON is located approximately 90 kms SW of Toronto, ON and Wainfleet, ON is located approximately 130kms SW of Toronto, ON
<b>Turbine Type:</b>	5 x 1.8MW V100 Turbines and 95m Towers for each project
<b>Survey Dates:</b>	<b>Transera's</b> Craig Ball conducted the preliminary survey of the rail siding and primary roads to proposed wind farm sites.

## Survey Review

The transportation of a V100 Wind Turbine can be broken down into the following service categories. Each of these categories represents a phase of the ground operations. These categories are:

1. Turbine specifications.
2. Trillium Rail siding layout.
3. Offloading of rail car specifications and requirements.
4. Routing of turbines to site.
5. Turbine transport obstacles along the route.
6. Proposed site report.
7. Conclusion.
8. Picture Summary.

## 1. Turbine Specifications

### V90 Turbine Specifications

Commodity: V100 1.8MW Wind Turbines – Graph A

		Dimensions (Meters and Kgs)					Dimensions (Feet and lbs)			
Qty	Description	Length	Width	Height	Weight	Volume	Length	Width	Height	Weight
5	Nacelle	10.45	3.51	3.82	72,300	140.116	34.29	11.52	12.53	159,465
15	Blade	49.18	3.10	3.00	9,700	457.374	161.35	10.17	9.84	21,394
5	Hub	3.98	3.51	3.37	21,400	47.114	13.07	11.52	11.06	47,200
5	Cooler Top	3.90	3.38	2.37	1,000	31.241	12.80	11.09	7.78	2,206
CBM each						675.845				
Total CBM						7,952.964				
Total KGS						619,000.00				

Commodity: V90 1.8MW Wind 95M Towers – Graph B

		Dimensions (Meters and Kgs)					Dimensions (Feet and lbs)			
Qty	Description	Length	Width	Height	Weight	Volume	Length	Width	Height	Weight
5	Top Section	24.38	3.12	3.12	28,000	237.325	79.99	10.24	10.24	61,729
5	Upper Mid Section	24.36	3.37	3.37	43,500	276.654	79.92	11.06	11.06	95,901
5	Lower Mid Section	24.36	3.93	3.93	63,500	376.238	79.92	12.89	12.89	139,994
5	Base Section	20.00	4.48	4.48	70,500	401.408	65.62	14.70	14.70	155,426
CBM each						1,291.625				
Total CBM						6,458.123				
Total KGS						1,027,500.00				

## 2. Rail Siding Layout.

Trillium Rail Terminal – (Welland, ON)

Trillium Rail Terminal is located approx 135 km S of Toronto, ON or 40 km NW of Buffalo, NY. The rail yard is accessible from O'Reilly's Rd and Niagara #27. It is a secure facility with access to switches by engines. It has two offloading spurs and some acreage for operation and storage. It has multiple tracks available for storage of loaded and empty cars. It is a gated facility, but does not have 24hr security. Transera has performed a survey on this rail siding and is available upon request.

### A. Storage Area

There is approximately 6 acres of land available owned by the rail terminal located in northwest corner of the yard. It would require some minor modification (leveling, gravel). .

In addition to the above acreage, there is also a small parcel of land located directly west. This area is approximately 3 acres. It is surrounded by a small, barbed wire fence. It contains debris, rail ties, and various rail materials, all of which would have to be removed or relocated. It is gravel base and would only require minor modifications.

There is another area that could be developed for storage. The acreage is unknown at this point. This area would require modifications such as deforestation, leveling and addition of material for compaction.

### 3. Offloading of rail car specifications and requirements.

The rail yard is currently a gravel base that has been in place for a number of years. Both potential offloading spurs would require minor modifications/cleanup. There are piles of debris/materials/equipment that would have to be relocated/removed prior to operations.

### 4. Routing of towers/turbines to site.

#### From Welland-HAF Project

All loads from Trillium Rail Siding

- Turn left on County Rd #27 and travel 19.5kms
- Turn left on County Rd #65 and travel 13.2kms
- Turn right at Caistor Centre Rd and travel 3.0kms
- Turn left at Sixteen Rd and travel 5.3kms

This routing brings all loads from Trillium Rail Siding near O'Reillys Bridge, ON to site near Abingdon, ON. This routing would put all loads east of Turbines 1, 2, & 4 and west of Turbines 3 and 5 based on map provided. This is not routing for base section that would be coming from Pueblo, CO.

#### From Welland-Wainfleet Project

All loads from Trillium Rail Siding

- Turn left on County Rd #27 and travel 5.3kms
- Turn left on County Rd #24 and travel 3.9kms
- Continue on Hwy #3 East and travel 4.1kms

For Turbines 1, 2, and 3

- Turn right on Abbey Road for turbines 1, 2 and 3

For Turbines 4, and 5

- Continue on Hwy #3 east for 2kms
- Turn right on Concession 1 and travel 750m
- Turn left on Station road and travel 1-2kms

This routing brings all loads except base sections to each pad entrance as per the map provided. This routing is not for base section that would be coming from Pueblo, CO

### 5. Turbine transport obstacles along the route.

All components exiting Trillium Railhead will be required to make westbound turn onto County Rd#27. This turn will require some modifications. Modifications required include widening of turn (both inside and outside radius) and the addition of gravel.

Once on County Rd #27, components will make multiple turns to sites near Abingdon and Wainfleet, ON. Transera feels that all of these turns can be made. All based on MTO permit approval, which will dictate routing for all components.

## 6. Proposed site report.

### A. Site road.

The site roads have yet to be built. Based on the map provided, Transera was able to get to the general wind farm boundaries. Transera feels that cargo can reach general area, however, once site entrances are selected, another survey would have to be performed.

## 7. Conclusion.

The overall perspective for the route from Trillium-Welland to the proposed site is in good order. There are some bridges along routes to both sites. The MTO may require inspections and approval. Transera has witnessed other cargo use some of these bridges, indicating that permitting could be obtained. All information is based on the assumption that Ministry of Transportation Ontario will issue permits for the intended equipment for which we are not expecting any issues to arise. **NOTE: THIS PRELIMINARY SURVEY DOES NOT INCLUDE THE 95M BASE SECTION ROUTING FROM PUEBLO, CO TO SITE.**

## 8. Picture Summary.

1. Trillium Rail Siding Layout.
2. Trillium Rail Siding Offloading Spur
3. Trillium Rail Siding Storage
4. Trillium Rail Siding Entrance Exit
5. Corner O'Reillys Rd and County Rd #27
6. Corner of County Rd #27 and County Rd #65
7. Corner of County Rd #65 Caistor Centre Rd
8. Corner of Caistor Centre Rd and Sixteen
9. Corner of Hwy #3 and Abbey Rd
10. Corner of Concession 1 and Station Rd
11. Maps

Trillium Rail Siding - Welland





Offloading Spurs  
Spur 1



Spur 2





Storage/Laydown  
Main



Additional Storage



Entrance





Corner of County Rd #27 & O'Reillys Rd



Corner of County Rd #27 & County Rd #65





Corner of County Rd #65 & Caistor Centre Rd



Caistor Centre Rd & Sixteen





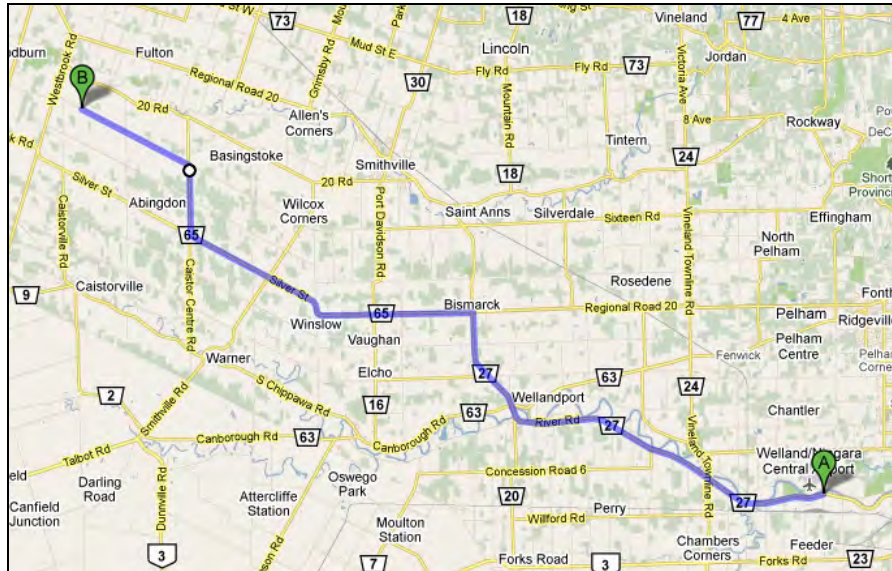
Hwy #3 & Abbey Rd



Concession 1 & Station Rd



Maps  
Trillium to HAF



Trillium to Wainfleet

