TULLOCH
ENGINEERING

GEOTECHNICAL REPORT

Nation Rise Wind Farm Project

Substation

December 2018

TULLOCH Project #: 18-4022

LICENSED PROFESSIONAL ENGINEER
S. D. HINCHBERGER
DEC.18,2018
PROVINCE OF ONTARIO

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Date	**Rev.**	**Status**	**Prepared By**	**Checked By**	**Approved By**	**Received By**
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December 11, 2018
18-4022

EDP Renewables North American LLC
808 Travis Street, Suite 700
Houston, Texas
ZIP: 77002

Attention: Ryan McDonner, Civil Engineering Manager

Re: Geotechnical Report for the Nation Rise Wind Farm Substation Project

Dear Mr. McDonner:

Please find enclosed our Draft Geotechnical Report for the proposed Nation Rise 235kV/34.5kV electrical substation for the Nation Rise Wind Farm Project located in the Township of North Stormont, United Counties of Stormont, Dundas and Glengarry, Ontario, Canada.

This report outlines the results of the geotechnical investigations, which were completed on the site and it provides geotechnical recommendations for the proposed substation design and construction.

We trust the enclosed is adequate for your current needs. If there is anything further, we can assist with, please contact us at your convenience.

Sincerely,
Tulloch Engineering Inc.

Sean Hinchberger, Ph.D., P.Eng.
General Manager, Geotechnical Specialist

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1 INTRODUCTION AND SCOPE

TULLOCH Engineering Inc. (TULLOCH) was retained by Nation Rise Wind Farm Limited Partnership (the Client) to complete a geotechnical investigation for the proposed 230 kV/34.5 kV substation at the Nation Rise Wind Farm Project located in the Township of North Stormont, Ontario, Canada. The site location plan is shown in Appendix A.

The Nation Rise Wind Project (Project) consists of twenty-nine Enercon E138 (3.44 MW) wind turbine generators (WTGs) with an installed capacity of up to 99.76 MW and a 230 kV/34.5 kV substation (Substation) that will connect the Nation Rise Wind Project to the existing Hydro One Networks Inc. (HONI) distribution system. The Substation is located in the northeast sector of the Project on land parcel 60106-0076 between Shane Road and Ouderkirk Road, North Stormont, Ontario. The facility will include a 230-kV dead end structure, transformers, control building and other supporting structures.

The purpose of the geotechnical investigation was to evaluate the subsurface conditions at the location of the substation and to provide geotechnical and foundation design recommendations for the substation foundations and civil site design. This report summarizes the factual geotechnical investigation data collected during the field program as well as design recommendations, which are based on engineering analysis of the data and our experience and judgement. Abbreviations, terminology and principal symbols commonly used throughout the report are enclosed in Appendix B.

2 SITE DESCRIPTION AND GEOLOGY

Based on the Surficial Geology of Southern Ontario Maps as published by the Ontario Geological Survey (OGS), the primary surficial geological setting at the project site is fine-textured glaciomarine deposits (OGS 2010), which primarily consist of silt and clay and minor sand and gravel; These sediments are massive to well laminated in structure (OGS 2010). The bedrock at the site consists of Limestone, Dolostone, Shale, Arkose or Sandstone of the Ottawa Groupe, Simcoe Group and Shadow Lake Formation (OGS 2011).

3 SITE INVESTIGATIONS AND METHODOLOGY

The geotechnical investigations were completed from April 25th to April 27th, 2018. The site work consisted of advancing four (4) Boreholes referenced as boreholes BH-S-1 to S-4 through the overburden to depths ranging from 12.8 m to 15.9 m. Drawing P-0100, in Appendix A, shows the borehole location plan. The boreholes were advanced using a CME

55 track-mounted drill rig equipped with 200 mm diameter continuous flight hollow stem augers and standard soil sampling equipment. The drilling was executed by Marathon Drilling Co. Ltd. of Greeling, ON. TULLOCH completed utility locates for the work through Ontario One Call prior to commencing the drilling.

Soil samples were retrieved from the overburden soils at the site using a standard 51 mm outside diameter (OD) split spoon sampler advanced in conjunction with Standard Penetration Tests (SPTs – ASTM D 1586). SPT "N" values were measured at 0.76 metre intervals in the upper 3.0 m of the ground, and at 1.52 m intervals below a depth of 3.0 m. Field vane tests (ATSM D2573) were also conducted in all boreholes using a standard 125 mm Ministry of Transportation of Ontario (MTO) vane to measure the *in situ* undrained shear strength of the clayey soils encountered during the drilling. Thin-walled Shelby tube samples were retrieved in accordance with ATSM Standard D1587 in order to provide undisturbed samples for laboratory compression tests.

Upon completion of the drilling program, the groundwater level was measured in the open boreholes and then the boreholes were backfilled and sealed with coated bentonite pellets. The drilling and soil sampling were completed under the full-time supervision of a TULLOCH representative, who logged the drilling operations and identified the soil samples as they were retrieved. The recovered soil samples were sealed in plastic bags and transported to TULLOCH's Geotechnical Laboratory for detailed examination and testing. All samples will be stored for six (6) months and then disposed unless directed otherwise by the Client.

4 LABORATORY TESTING

Atterberg limits, hydrometer, grainsize and moisture content tests were conducted on selected samples from the project site. The laboratory results are presented in Appendix D and the results of the Atterberg limits testing are summarized below in Table 4-1.

Table 4-1: Atterberg Limits

Borehole ID	Depth (mbgs)	Natural Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Plasticity Index (%)	Liquidity Index
BH S-3	1.52 – 2.13	-	23	65	42	N/A
BH S-4	4.57 – 5.18	43.9	22	53	31	0.1

The results in Table 4-1 indicate that the silty clay encountered at the site has a plasticity index range of 31 – 42 percent, classifying the soil as highly plastic clay (CH). Furthermore, the liquidity index is 1.4, which is typical for Champlain Sea Clay deposits in this region.

5 SUBSURFACE CONDITIONS

The detailed subsurface conditions and laboratory test results are included on the borehole logs attached in Appendix C. Appendix B provides a list of standard terminology. In this report, the Unified Soil Classification System (USCS) has been used for soil classification. Additionally, the soil boundaries indicated on the borehole logs were inferred from discontinuous sampling and observations made during the drilling program. These boundaries are intended to reflect approximate transition zones to support geotechnical design and should not be interpreted as exact planes of geological change. The following is a brief description of the subsurface conditions encountered at the project site during the investigation.

5.1 Silty Clay Topsoil

Silty Clay topsoil was present at the ground surface and extended to a depth of approximately 0.76 m below ground surface (bgs) in all Boreholes (BH-S-1 to BH-S-4). The average SPT “N” value in this layer was 7 blows per 300 mm advancement indicating a firm soil consistency.

5.2 Silty Clay (CH)

A surficial deposit of high plasticity Silty Clay (CH) was encountered below the topsoil in all of the boreholes advanced at the Substation site. This soil strata extends from 0.76 m to 6.10 m bgs in Boreholes BH-S-1 to BH-S-3, inclusive, and from 0.76 m to 7.62 m bgs in Borehole BH-S-4. SPT “N” values range from 0 to 8 blows per 30 cm penetration; the field vane shear tests indicate that the undrained shear strength of the Silty Clay values from 19 to 73 kPa indicating a soft to firm consistency.

5.3 Silt Till (ML)

Silt Till, with some sand and gravel, and trace clay was encountered in all boreholes at a depth of about 6.10 m bgs in BH-S-1 to BH-S-3 and at 7.62 m bgs in BH-S-4. SPT “N” values in this layer generally ranged from 8 to 39 with occasional lower values between 2 and 3 blows/30cm. Based on the “N” values, this layer varies from loose to very dense.

5.4 Groundwater Conditions

Groundwater was encountered in all of the open boreholes at 12.24 m bgs, 6.55 m bgs, 6.1 m bgs and 2.44 m bgs in Boreholes BH-S-1, S-2, S-3 and S-4, respectively. Based on these initial water level readings as well as piezometers installed at adjacent WTG sites, the depth to the groundwater table should be taken as 2.0 m bgs for design. Seasonal variation so the groundwater table should be anticipated.

6 GEOTECHNICAL RECOMMENDATIONS

6.1 Site Preparation

Site preparation should consist of stripping the topsoil at the site and placing Ontario Provincial Standard Specification 1010 (OPSS 1010) Granular B fill on the firm Silty Clay crust to create an engineered fill pad. In order to minimize settlement, the site grade should not be raised by more than 500 mm. The Granular B fill should be compacted to 98% Standard Proctor Maximum Dry Density (SPMDD) and a 250 g/m^2 non-woven geotextile should be placed between the subgrade and the Granular B fill.

The frost penetration depth at the site is 1.8 m. Accordingly, foundations should be situated at least 1.8 m below the final ground surface to avoid frost heave. Alternatively, insulation can be used to reduce the foundation burial depth. The designer should contact TULLOCH for guidance if insulation is used for frost protection.

TULLOCH understands that the project prefers shallow foundations perched within the Granular B fill. This option is also feasible and will simplify the site earthworks. For this option:

- excavate the Silty Clay to a depth of at least 1.8 m below the finished ground surface,
- place a non-woven geotextile (250 g/m^2) on the base of the excavation;
- place and compact Granular B fill to 98% SPMDD from the base of the excavation to the underside of the footings.
- construct the foundations and
- complete the final grading using Granular B fill topped with Granular A fill and yard stone.

To ensure acceptable freeze-thaw performance, the fines content of the Granular B fill (i.e. the percentage of particles smaller than 75 microns) should not exceed 5%. This limit is more stringent that the OPSS 1010.

Ideally, the site earthworks should be scheduled during the dry summer months and construction methods should be adopted that avoid running tracked or tired equipment directly on the clayey subgrade to avoid disturbing the subgrade. During the site preparation work, contractors should ensure that the exposed subgrade is slope adequately to perimeter ditches to ensure positive drainage of the site at all times. Standing water on the subgrade will lead to softening, which should be avoided. If zones of the subgrade become disturbed, the Contractor should excavate and remove the disturbed material to expose firm clay and then backfill the excavation with Granular B fill. If the depth of excavation becomes excessive and soft clay is exposed, ground stabilizing measures may be required such as placing Geogrid Reinforcement (i.e. Tensar TX130S) over the non-woven geotextile and on the excavation base prior to placing the Granular B fill. A qualified geotechnical engineer should inspect and approve the subgrade preparation.

If the native soil is excavated and replaced with non-frost susceptible Granular B fill, there will be a tendency for rainfall and snow melt to infiltrate into the fill and collect there. In order to control the amount of infiltration, the finished site surface should be adquately sloped to the perimeter to maximize runoff. Also, a layer of Granular A fill (minimum 15 cm) should be placed on top of the Granular B fill to reduce the infiltration. Then, yard stone can be placed directly on the Granular A.

6.2 Subsurface Soil Properties

Based on the geotechnical investigation data, Table 6-1 summarizes the engineering properties of the Silty Clay deposit encountered at the site. Also, the field vane shear strength, moisture content and SPT “N” values are plotted versus depth in Figure 6-1. Referring to Table 6-1, the Silty Clay is soft to very soft, and normally consolidated at a depth of 6 m. Excavations within the upper 2 m of the soil deposit are expected to be within the firm to stiff crust.

Table 6-1: Design Properties of Silty Clay (CI) Deposit

\Depth (mbgs)	Undrained Shear Strength (kPa)	Preconsolidation Pressure (kPa)	OCR	Recompression Index, Cr	Compression Index, Cc
0.76	48	190	13	1.1	0.15
2.0	48	190	5.1	1.1	0.15
4.0	20	80	1.5	1.1	0.15
6.0	20	80	1.1	0.7	0.1
12.0	70	280	2.2	0.7	0.1

6.3 Foundation Recommendations

The Substation site is challenging from the standpoint of earthworks and foundation design because of the low undrained shear strength and pre-consolidation pressure of the Silty Clay deposit between 4 and 6m depth. Considering this, the following foundation recommendations are provided.

6.3.1 Shallow Foundations

Provided the footing width is less than 1.8 m, then lightly loaded equipment and structures can be founded on conventional strip or spread footings constructed in the upper crust at the site at a depth of 1.8 m below the finished grade to avoid frost heave. Alternatively, non-frost susceptible engineered fill may be used under the foundation to reduce the foundation depth below the finished grade (see Section 6.1).

The following bearing capacities are recommended for use in this case:

- Factored Ultimate Limit States (ULS) Bearing Pressure: 90 kPa;
- Serviceability Limit States (SLS): 50 kPa, corresponding to 25 mm settlement.

For small footings situated in the upper crust, an SLS bearing pressure of 50 kPa is required to ensure that the settlement does not exceed 25 mm accounting for raising the site grade by 500 mm maximum. At 50 kPa bearing pressure, the vertical stress acting on the normally consolidated zone of the Silt Clay (CI) will not significantly exceed the preconsolidation pressure of the deposit. For heavier loaded settlement sensitive structures, deep foundations will be required as discussed below.

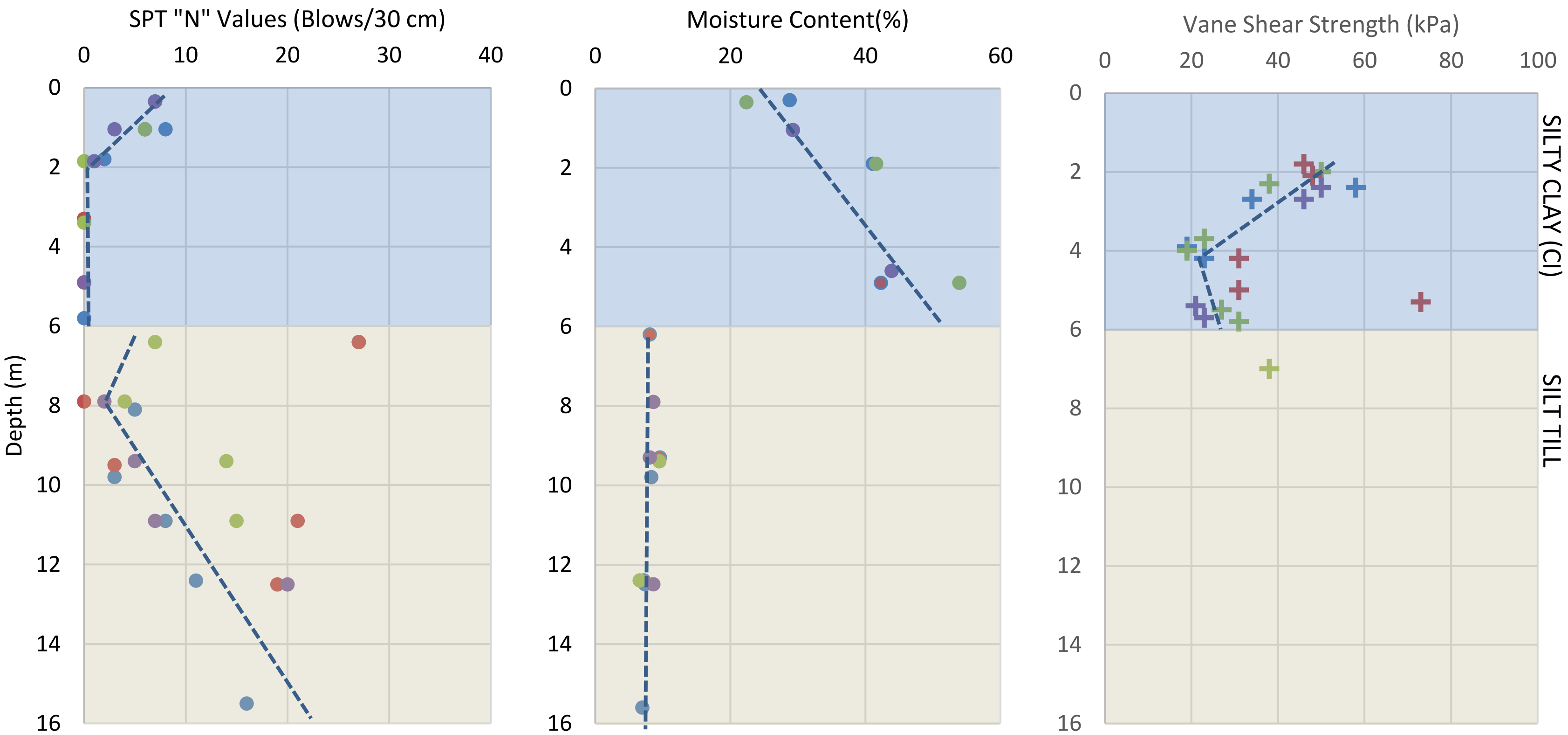


Figure 6-1: Subsurface Conditions and Soil Vane Shear Strength Profile

6.3.2 Raft or Mat Foundations

Raft or mat foundations are not recommended for this site due to the soft compressible nature of the upper Silty Clay (CH) layer.

6.3.3 Deep Foundations

It is understood that deep foundations are required for the transformers and dead-end structures. For these structures, pile capacities of between 150 and 250 kN and 1,000 kN are required for the dead-end structures and transformer, respectively. Furthermore, due to permitting constraints, the project has chosen to avoid the use of steel pipe piles or H-piles driven to bedrock. As a result, helical screw piles or micropiles will need to be considered.

6.3.3.1 Helical Piles

The following geotechnical design loads can be utilized for helical piles advanced into the compact to dense Silt Till deposit below 12 m depth. It is assumed that single and double helix piles will be required; the bottom and top helix will have a diameter of 45.7 cm; the assumed shaft diameter is 16.8 cm. Helical pile foundations should be specified as a design-build service during construction. The capacities listed in Table 6-2 are provided by TULLOCH for the issued-for-tender drawings and to estimate foundation costs for the project. The designers should contact the author of this report for guidance on alternative piles and installation depths, if required.

Table 6-2: Factored Geotechnical Resistance of Helical Screw Piles

Helix Dia (mm)	Shaft Dia (mm)	Min. Helix Depth (m)	Unfactored Skin Adhesion[4] (kN)	Unfactored End-bearing[5]		Factored ULS[3] Resistance (kN)	
				Helix 1 (kN)	Helix 2 (kN)	Axial Comp[1].	Axial Tension[2]
457	168	12	190	235	0	170	125
457, 457			190	235	235	265	200

Notes: [1,2]The resistant factors of 0.4 and 0.3 are used for compression and extension, respectively; [3]The estimated SLS corresponding to 25mm settlement does not govern the design. [4]Unfactored adhesion in the clay is 21 kPa; Ultimate skin friction in the Silt Till is 48 kPa; [5]Based on N_q of 13.

The following should be accounted for during the helical pile design and construction:

- The helical piles should be drilled into dense Silt Till at a depth of approximately 12m bgs to the upper helix.

- Although none of the boreholes drilled at the site encountered refusal, cobbles were found to be present during drilling in the Silt Till. As such, there is a slight risk that helical piles might reach refusal prior to reaching the design tip elevation due to cobbles in the Till. The risk, however, is judged to be low and it can be mitigated by designing the helical piles to resist high installation torques.
- Due to groundwater fluctuations, the upper portions of the pile shaft from the pile cap to a depth of about 2 m must be designed with appropriate allowances for corrosion loses. The lower helixes will penetrate low permeable fine-grained materials and should not be subject to significant corrosion.
- Pile caps should be situated 1.8m below the finished ground surface to prevent frost damage.
- If less burial depth is required, then insulation can be provided under the concrete pile caps to mitigate frost heave. Alternatively, the native soil can be excavated and replaced with non-frost susceptible Granular B fill as described in Section 6.1.
- Adfreeze uplift forces should be checked if any potion of the pile penetrates frost susceptible soil in the freeze-thaw zone. An adfreeze bond stress of 100 kPa can be used for design between steel and frozen soil.
- The capacities listed in should be adequate for preliminary design purposes. The actual installed capacity should be verified during construction by performing pile load tests and/or monitoring the installation torque.
- Helical piles should be battered to resist lateral loads due to the low lateral stiffness of the soft Silty Clay (CH) material. Batters in the range of 1H:7V to 1H:4V should be feasible.
- The full compression and pullout capacity can be utilized for foundation design provided the helixes are installed at least 2 m apart (i.e. centre to centre spacing). If the center-to-center spacing is less than 2 m, then the capacity will reduce due to group interaction between the piles. The substation designer should contact TULLOCH for guidance if closely spaced helical piles are required.

6.3.3.2 *Micropiles*

Micropiles are also a feasible foundation option for the substation. Micropiles are likely costlier than helical piles; however, they can be advanced through boulders without the risk of refusal or damage to the piles. Table 6-3 lists the recommended geotechnical design loads for 178 and 273 mm diameter HSS micropiles extending from the pile cap to a depth of approximately 12 m bgs in the lower dense Silt Till deposit (see Figure 6-1). For high capacity micropiles, the piles should be socketed at least 0.6 m into the bedrock.

Table 6-3: Geotechnical Capacity of Micropiles

Pile Size	Casing Length (m)	Socket Details		Factored ULS Design Load (kN)		SLS Load[3] (kN)
		Length (m)	Material	Comp[2]	Tension[2]	
HSS 178	0-6	6	SILT TILL	150	110	Does not govern
HSS 178[1]	0-16	0.6	BEDROCK	550	400	Does not govern
HSS 228	0-6	6	SILT TILL	200	150	Does not govern
HSS 228[1]	0-16	0.6	BEDROCK	850	650	Does not govern
HSS 273	0-6	6	SILT TILL	240	180	Does not govern
HSS 273[1]	0-16	0.6	BEDROCK	1100	560	Does not govern

Notes:
[1]Piles are socketed 0.6 m into rock; [2]Resistance factors are 0.4 and 0.3 for the factored design loads in compression and tension, respectively. The post-grout bond strength in Silt Till is 110 kPa; the tip resistance is ignored. The rock UCS is 50 MPa and RQD is 30%; Bond strength is rock is 730 kPa; Tip bearing pressure in rock is 40 MPA; [3]The estimated SLS corresponding to 25 mm settlement does not govern the design.

The following summarizes the probable construction technique for micropiles:

- A casing advancing system will be required to advance the HSS steel casing to approximate 12 m bgs or into the bedrock, whichever is required.
- At 12 m bgs, the casing will be tremie filled with structural grout and then retraced incrementally in approximately 1.5m intervals while post-grouting the Silt Till deposit. This will be done until the bottom elevation of the casing is just below the top of the till layer.
- For piles socketed into the bedrock, the casing should be advanced at least 0.1 m into the bedrock and a 0.6 m rock socket should be drilled into the rock using a down hole hammer.

- A steel bar will then be inserted and centred in the pile extending from the pile top to the toe.
- Pile that terminate in the Silt Till will comprise an HSS steel casing, structural grout and a central steel bar from about 0 to about 6m bgs, and structural grout and a steel bar below 6m to the pile toe (i.e. the socket).
- Piles that are socketed into bedrock will comprise an HSS steel casing, grout and steel bar from the pile cap to 0.1 m into the bedrock; A centralized steel bar and grout from the bottom of the casing to 0.6m into rock for the socket.
- A specialty contractor will be required to design-build the micropiles. Additionally, contractors may choose to use the hollow core bar method to build the pile, which is acceptable.
- Ideally, pile load tests should be conducted to confirm the socket depth in the till and the design axial capacity of the micropiles in bedrock.

The ULS design loads listed in Table 6-3 can be used for piles spaced at least 1m apart center-to-center. The designer should contact TULLOCH if closer spacing is required.

6.4 Open Cut Excavations

Excavation safety including the stability of temporary construction slopes and lateral support systems are the Contractor's responsibility. Where workers must enter excavations deeper than 1.2 metres, the trench excavations may be suitably sloped and/or braced in accordance with the Occupational Health and Safety Act (OHSA), Ontario Regulation 213/9, Construction Projects, January 1, 2010, Part Ill - Excavations, Section 226. Alternatively, the excavation walls should be supported by engineered close shoring, bracing, or trench boxes complying with Sections 235 to 239 and 241 under 0. Reg. 231/91, s. 234(1).

Based on the OHSA, the in-situ soils are classified as Type 3 soil and hence temporary excavation side slopes should remain stable at a slope of 1H:1V. The in-situ soils can be excavated using conventional earthmoving equipment.

Based on the borehole investigations, groundwater can be expected at a depth of 2.0 m below ground surface. Excavations above the groundwater table and within the native soils should be relatively straight forward and should remain stable at a slope of 1H:1V. Excavations below 2.0 m are not planned for this site.

Due to the low permeability of the Silty Clay (CH) deposits, the quantity of groundwater entering the excavations should be minimal. Standard sump and pump techniques can be used to remove precipitation and what little groundwater enters the trench or excavations. Additionally, due to the low permeability of the native soils at this site, site excavations and dewatering efforts will not have a significant impact on the local groundwater regime in the upper soils or bedrock.

Excavations in Champlain Sea Clays can cause large retrogressive liquefaction landslides in very sensitive clays. However, the excavation depth at the substation site are not expected to exceed 1.8m, and because they will remain within the firm to stiff crust, the factor of safety is very high and liquefaction is not of concern.

6.5 Site Classification for Seismic Response

The 2015 National Building Code of Canada (NBCC) stipulates the methodology for earthquake design analysis. The determination of the type of analysis is predicated on the importance of the structure, the spectral response acceleration and the site classification for seismic site response.

The parameters for determination of Site Classification for Seismic Site Response are set out the 2015 NBCC. The site classification is based on the average shear wave velocity in the top 30 metres of the site stratigraphy. If the average shear wave velocity is not known, the site class can be estimated from energy corrected Standard Penetration Resistance (N60) and/or the average undrained shear strength of the soil in the top 30 metres. Based on the 2015 NBCC and MASW testing performed for the Turbine sites, the Substation site has been classified as a Class E, soft soil site. These seismic design parameters should be reviewed in detail by the structural engineer and incorporated into the design as required by 2015 NBCC.

6.6 Soil Corrosivity

Soil corrosivity testing at the project site is included in this geotechnical investigation program. The measured soil resistivities are (see Appendix E for the Soil Resistivity Testing Report):

- 0-8m: 1- to 200 Ω. m;
- >8m: 200 to 1500 Ω. M;

Based on the soil resistivity values, the corrosion rating for the native soils at the project site is considered as a mildly to highly corrosive.

Furthermore, based on analytical test results from historical geotechnical investigations (SENES Consultants, 2015), the soils underlying the site have the potential to act as a severe corrosive environment to embedded steel foundation systems. It is recommended that corrosion control measures be adopted in the structural design to ensure its foundation during the service life of the foundation system. Protection measures for concrete may include the utilization of sulfate resistant concrete mix. Protection measures for steel piles may include additional sacrificial steel or painting systems such as epoxy resins, polyester coatings or polyurethane based coatings or cathodic protection.

7 CLOSURE

TULLOCH has prepared this geotechnical report for the exclusive use of EDP Renewables and their authorized agents for the construction of the proposed Nation Rise Wind Farm.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practises in the field of geotechnical engineering, for the above noted location. Classification and identification of soils, and geologic units have been based upon commonly accepted methods employed in professional geotechnical practice. No warranty or other conditions, expressed or implied, should be understood. Please refer to Appendix D, Report Limitations and Guidelines for Use, which pertains to this report.

We trust that the information and recommendations in this draft report will be found to be complete and adequate for your consideration. Should further elaboration be required for any portion of this project, we would be pleased to provide assistance.

8 REFERENCES

National Building Code of Canada, NRC, 2015.

Ontario Geological Survey 2010. Surficial geology of Southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 128-REV

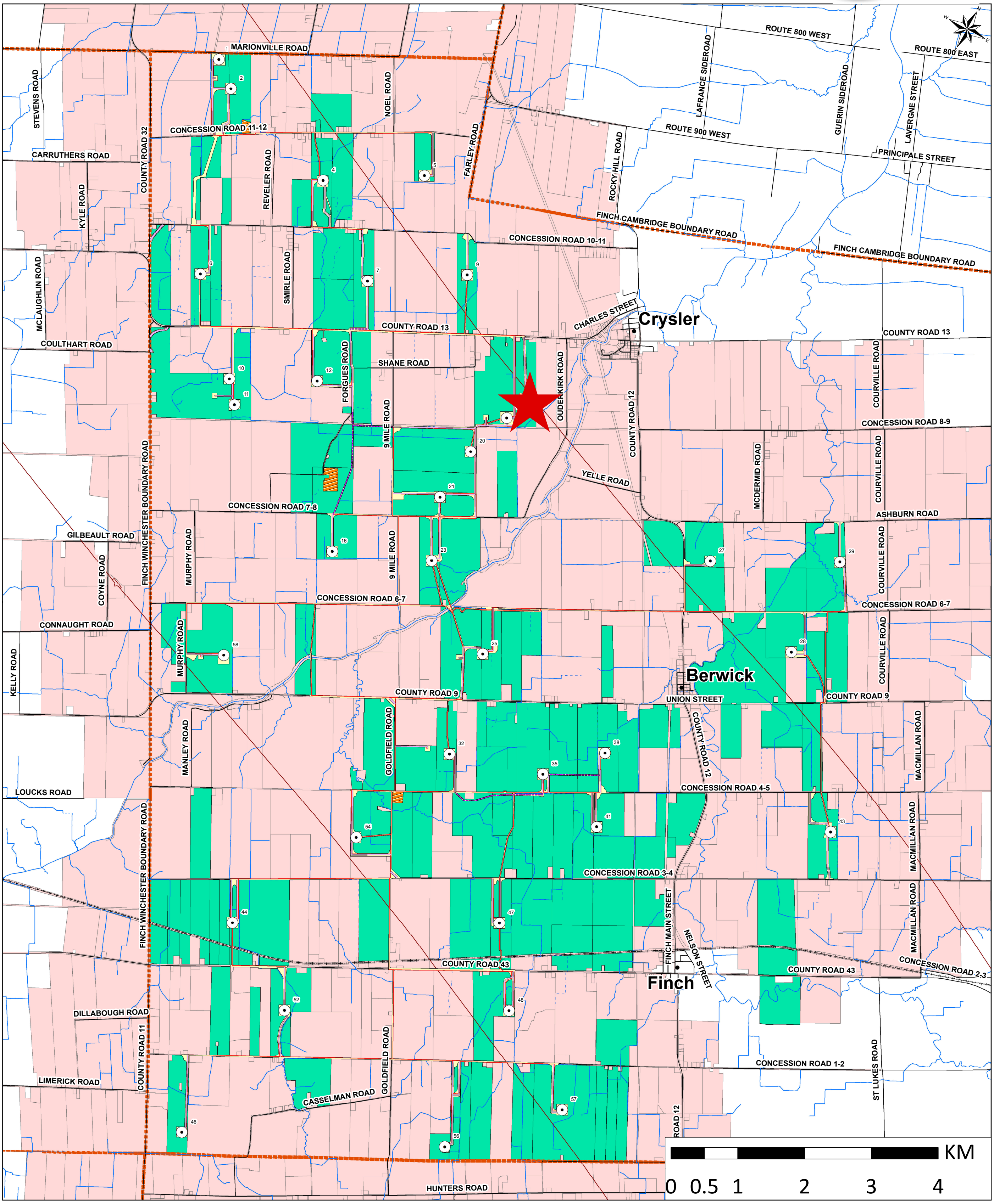
Ontario Geological Survey 2011. 1:250 000 scale bedrock geology of Ontario; Ontario Geological Survey, Miscellaneous Release---Data 126-Revision 1.

Occupational Health and Safety Act (OHSA), Ontario Regulation 213/9, Construction Projects, January 1, 2010, Part Ill - Excavations, Section 226.

SENES Consultants, 2015

APPENDIX A

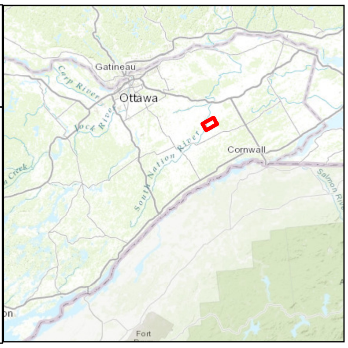
SITE LOCATION PLAN

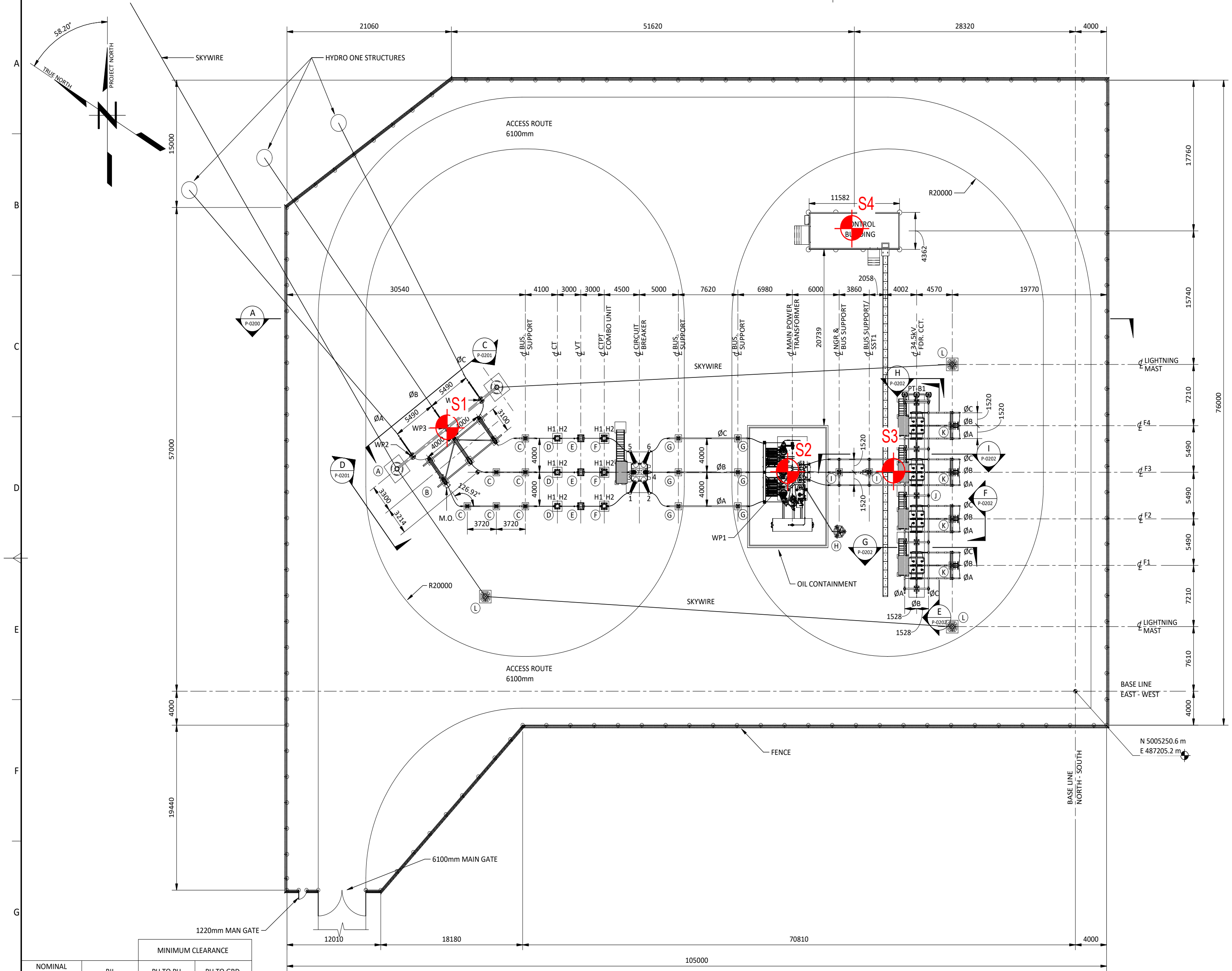


Legend

- ● Towns
- ⊙ 33 WTG Layout
- ▪ Substation Location
- ═ Turning Radii
- — Access Road
- ---- Crane Path
- — Collection Route - Butternut Tree Avoidance
- ★ Substation Location
- ▨ Laydown Areas
- ☐ Project Location Footprint
- ☐ Substation Area
- --- Municipal Drains
- — Municipal and County Roads
- 🟩 Leased Parcels
- ☐ Non-Leased Parcels

Author: Nathan Roscoe
Date / Time: 20 April 2018 / 03:58 PM
Version:
Datum: North American 1983
Projection: NAD 1983 UTM Zone 18N
Scale: 1:26,969
Sources: EDPR, ESRI, Ventyx





REFERENCE DRAWINGS:

NRS1-E-0100	SUBSTATION SWITCHING ONE-LINE DIAGRAM
NRS1-C-0100	SITE LAYOUT
NRS1-P-0200	ELEVATION SECTIONS
NRS1-P-0201	ELEVATION SECTIONS
NRS1-P-0202	ELEVATION SECTIONS
NRS1-P-0900	FOUNDATION PLAN
NRS1-P-0300	CONDUIT LAYOUT
NRS1-P-0400	GROUNDING LAYOUT
NRS1-P-0901	FENCE DETAILS

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS
2. MICROWAVE TOWER HAS NOT BEEN INDICATED ON THIS DRAWING. IT WILL BE FINALIZED DURING DETAIL DESIGN WHEN TELEPROTECTION TECHNOLOGY HAS BEED SELECTED.
3. LIGHTNING MAST LOCATIONS AND NUMBERS WILL BE FINALIZED DURING DETAIL DESIGN STAGE.
4. ACCESS ROUTE SHOWN TO DEPICT APPROXIMATE ACCESS ROUTE THROUGH SUBSTATION YARD FOR CONSTRUCTION, OPERATION AND MAINTENANCE, INCLUDING TRANSFORMER DELIVERY. ROUTE SHALL BE VERIFIED UPON CONFIRMATION OF FINAL DELIVERY VEHICLE SPECIFICATIONS.
5. WHEN INSTALLING BREAKERS VERIFY BUSHING ORIENTATION IS AS SHOW ON 230kV BREAKER.
6. WHEN INSTALLING THE 230kV CT'S VERIFY TERMINAL CONNECTIONS ARE AS SHOWN.
7. INSTALL WEEP HOLES AT ALL MIDPOINTS OF EVERY HORIZONTAL BUS SPAN. DRILL 6mm DIA. WEEP HOLES ON THE BOTTOM OF THE TUBULAR BUS.
8. THE PEDESTRIAN TRENCH IS 40000mm LONG. CONTRACTOR SHALL WORK WITH MANUFACTURER TO PROVIDE A MATERIAL LIST AND DETAIL DRAWINGS FOR THE TRENCH WHICH INCLUDES ALL SECTIONS.

STEEL STRUCTURE SCHEDULE

STRUCT.	DESCRIPTION	QTY	DWG. NO.
Ⓐ	230kV DEADEND STRUCTURE	1	NRS1-S-0200
Ⓑ	230kV 3-PHASE SWITCH SUPPORT	1	NRS1-S-0203
Ⓒ	230kV 1-PHASE BUS SUPPORT 1	6	NRS1-S-0208
Ⓓ	230kV 1-PHASE CT SUPPORT	3	NRS1-S-0205
Ⓔ	230kV 1-PHASE VT SUPPORT	3	NRS1-S-0206
Ⓕ	230kV 1-PHASE CTPT SUPPORT	3	NRS1-S-0202
Ⓖ	230kV 1-PHASE BUS SUPPORT 2	6	NRS1-S-0208
Ⓗ	NEUTRAL GROUNDING STRUCTURE	1	NRS1-S-0410
Ⓘ	34.5kV 3-PHASE BUS SUPPORT	2	NRS1-S-0407
Ⓙ	34.5kV 4-BAY DISTRIBUTION STRUCTURE	1	NRS1-S-0403
Ⓚ	34.5kV RISER STRUCTURE	4	NRS1-S-0405
Ⓛ	80' SHIELD POLE	3	NRS1-S-0500

WORKPOINT COORDINATES

LOCATION	X(EASTING) (m)	Y(NORTHING) (m)
WP1	487208.0	5005295.0
WP2	487184.0	5005337.4
WP3	487189.1	5005335.4
WP4	487194.2	5005333.4

SOIL BORING LOCATIONS

S-1	487189	5005335
S-2	487208	5005295
S-3	487219	5005279
S-4	487240	5005297

NOMINAL VOLTAGE	BIL	MINIMUM CLEARANCE	
		PH TO PH	PH TO GRD
230kV	1050kV	2260 mm	1930 mm
34.5kV	200kV	457 mm	381 mm

FOR CLIENT REVIEW

NOT FOR CONSTRUCTION

VER.	DATE	DRAWN	CHECKED	APPROVED	MODIFICATION
F	10/24/2018	RML	HEH	HEH	ISSUED FOR 100% REVIEW
E	09/13/2018	RML	HEH	HEH	PROGRESS REVISION
D	08/02/2018	RML	HEH	HEH	ISSUED FOR 75% REVIEW
C	08/01/2018	RML	HEH	HEH	ISSUED FOR REVIEW
B	05/10/2018	RML	HEH	HEH	ISSUED FOR REVIEW - UPDATED AS PER EDPR COMMENTS
A	05/02/2018	RML	HEH	HEH	ISSUED FOR REVIEW

DATE	SCALE 1 : 250	
05/18	DRAWN	RML
05/18	CHECKED	HEH
05/18	APPROVED	HEH

Format ANSI D

NATION RISE WIND FARM
NORTH STORMONT, ONTARIO, CANADA

GENERAL ARRANGEMENT
PROJECT SUBSTATION

Proj. № 18002-01
Doc. № NRS1-P-0100

NORDMIN
RESOURCE & INDUSTRIAL
ENGINEERING

Rev. F
Page: 1 of 1
Drawing № P-0100

APPENDIX B

ABBREVIATIONS, TERMINOLOGY, AND PRINCIPAL SYMBOLS USED

ABBREVIATIONS, TERMINOLOGY AND PRINCIPAL SYMBOLS USED IN REPORT AND BOREHOLE LOGS

BOREHOLES AND TEST PIT LOGS

AA	Auger Sample	W	Washed Sample
SS	Split Spoon	HQ	Rock Core (63.5 mm dia.)
ST	Thin-walled Tube Sample	NQ	Rock Core (36.5 mm dia.)
BS	Block Sample	BQ	Rock Core (36.5 mm dia.)

IN SITU SOIL TESTING

Standard Penetration Test (SPT) "N" value. The number of blows required to drive a 51 mm OD split barrel sampler into the soil a distance of 300 mm with a 63.5kg weight free falling a distance of 760mm after an initial penetration of 150mm has been achieved.

Dynamic Cone Penetration Test (DCPT) is the number of blows required to drive a cone with a 60 degree apex attached to "A" size drill rods continuously into the soil for each 300mm penetration with a 63.5 kg weight free falling a distance of 760mm.

Cone Penetration Test (CPT) is an electronic cone point with a 10 cm' base area with a 60 degree apex pushed through the soil at a penetration rate of 2cm/s.

Field Vane Test (FVT) consists of a vane blade, a set of rods and torque measuring apparatus used to determine the undrained shear strength of cohesive soils.

SOIL DESCRIPTIONS

The soil descriptions and classifications are based on an expanded Unified Soil Classification System (USCS). The USCS classifies soils on the basis of engineering properties. The system divides soils into three major categories; coarse grained and highly organrc soils. The soil is then subdivided based on either gradation or plasticity characteristics. The classification excludes particles larger than 75mm. To aid in quantifying materal amounts by eight within the respective grain size fractions the following terms have been included to expand the USCS:

Soil Classification		Terminology	Proportion
Clay	<0.002 mm	“trace”	1%to 10%
Silt	0.002 to 0.06 mm	"some"	10% to 20%
Sand	0.075 to 4.75 mm	Sandy, Gravelly, etc.	20% to 35%
Gravel	4.751o 75 mm	“and”	>35%
Cobbles	75 to 200 mm	Noun, SAND, SILT, etc.	>35%
Boulders	>200 mm		

Notes:

1. Soil properties, such as strength, gradation, plasticity, structure, etc. dictate the soils engineering behaviour over the grain size fractions;
2. With the exception of soil samples tested for grain size distribution or plasticity, all soil samples have been classified based on visual and tactile observations and is therefore an approximate description.

The following table outlines the qualitative terms used to describe the relative density condition of cohesionless soil:

Cohesionless Soils

Compactness	SPT “N” Value (blows/30cm)
Very Loose	0 to 4
Loose	5 to 10
Compact	11 to 30
Dense	31 to 50
Very Dense	>50

The following table outlines the qualitative terms used to describe the consistency of cohesive soils related to undrained shear strength and SPT, N-Index:

Cohesive Soils

Consistency	Undrained Shear Strength (kPa)	SPT “N” Value (blows/30 cm)
Very Soft	<12.5	< 2
Soft	12.5 to 25	2 to 4
Firm	25 to 50	5 to 8
Stiff	50 to 100	9 to 15
Very Stiff	100 to 200	16 to 30
Hard	> 200	>30

Note: Utilizing the SPT, “N” value to correlate the consistency and undrained shear strength of cohesive soils is very approximate and needs to be used with caution.

ROCK CORING

Rock Quality Designation (RQD) is an indirect measure of the number of fractures within a rock mass, Deere et al. (1967). It is the sum of sound pieces of rock core equal to or greater than 100 mm recovered from the core run, divided by the total length of the core run, expressed as a percentage. If the core section rs broken due to mechanical or handling, the pieces are fitted together and if 100 mm or greater included in the total sum.

Intact Rock Strength

Intact Strength (Mpa)	Description
< 1	Extremely low strength
1-5	Very low strength
5-25	Low strength
25-50	Medium strength
50-100	High strength
100-250	Very high strength
>250	Extremely high strength

Rock Mass Quality

RQD Classification	RQD Value (%)
Very poor quality	<25
Poor Quality	25 to 50
Fair Qualty	50 to 75
Good Quality	75 to 90
Excellent Quality	90 to 100

Rock Mass Weathering

Term	Grade	Description
Unweathered (Fresh)	I	No visible sign of material weathering to discoloration on major discontinuity surfaces.
Slightly Weathered	II	Discoloration indicates weathering of rock material and discontinuity of surfaces. All the rock material may be discolored by weathering and may be somewhat weaker than its fresh condition.
Moderatly Weathered	III	Less than half the rock material is decomposed and/or disintegrates to soil. Fresh or discolored rock is present either as a continuous frame work of as core stones.
Highly Weathered	IV	More than half the rock material is decomposed and/or disintegrated to soil. Fresh or discolored rock is present either as a discontinuous frame work or as core stones.
Completely Weathered	V	All rock material is decomposed and/or disintegrated to soil. The original mass structure is largely intact.
Residual Soil	VI	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.

SYMBOLS

General

w_N	Natural water content within the soil sample
γ	Unit weight
γ'	Effective unit weight
γ_D	Dry unit weight
γ_{SAT}	Saturated unit weight
ρ	Density
ρ_s	Density of solid particles
ρ_w	Density of water
ρ_D	Dry density
ρ_{SAT}	Saturated density
e	Void ratio
n	Porosity
S	Degree of saturation
E_{50}	Fifty percent secant modulus

Consistency

w_L	Liquid Limit
w_P	Plastric Limit
I_P	Plasticity Index
w_S	Shrinkage limit
I_L	Liquidity index
I_C	Consistency index
e_{max}	Void ratio in loosest state
e_{min}	Void ratio in densest state
I_D	Density index (formerly relative density)

Shear Strength

S_u	Undrained shear strength parameter (total stress)
c'	Effective cohesion intercept
ϕ'	Effective friction angle
τ_R	Peak shear strength
τ_R	Residual shear strength
δ	Angle of interface friction
μ	Coefficient of friction = tan ϕ'

Consolidation

C_c	Compression index (normally consolidated range)
C_r	Recompression index (over consolidated range)
m_v	Coefficient of volume change
c_v	Coefficient of consolidation
T_v	Time factor (vertical direction)
U	Degree of consolidation
σ'_v	Effictive overburden pressure
OCR	Overconsolidation ratio

APPENDIX C

BOREHOLE LOGS

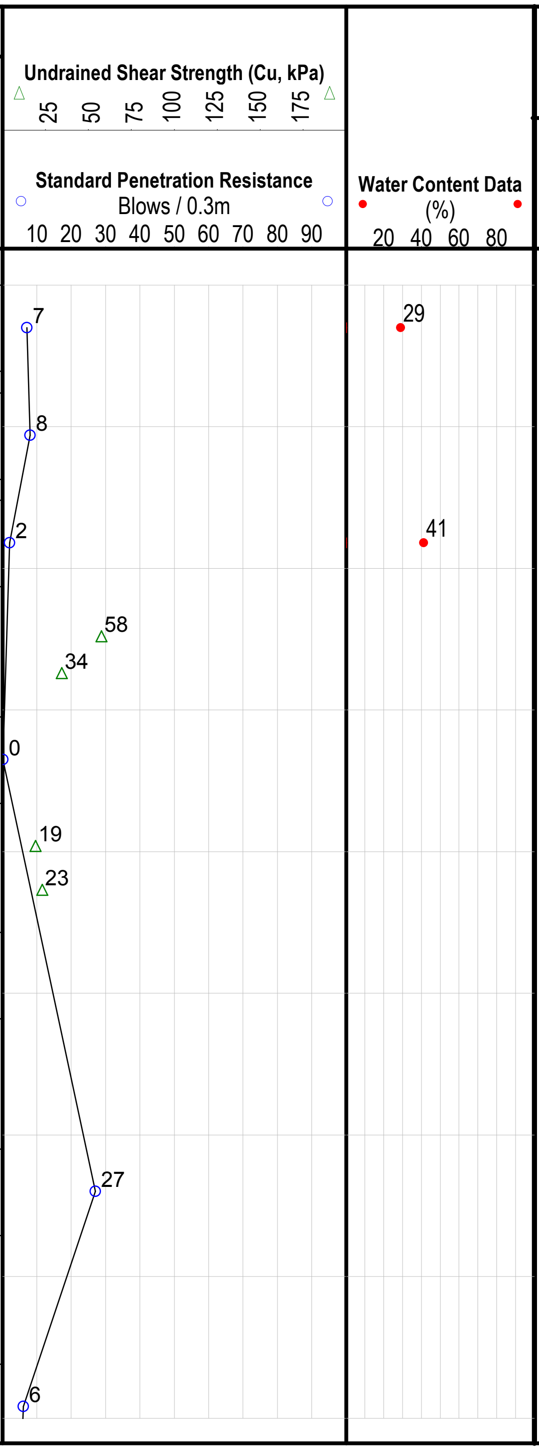
Borehole Log: BH S-1

Project No: 18-4022
Project: Nation Rise Wind Farm
Site Location: Substation Area, County Road 13
Client: EDP

Logged By: S.deBortoli
Compiled By: D.A.Mousseau
Reviewed By: E.Giles

SUBSURFACE PROFILE / SAMPLE

DESCRIPTION	Elevation (m)	Sample Number	Sample Type	Recovery (%)	Blows / 0.3m	Gr	Sa	Si	Cl
Geodetic Ground Elevation	0.00								
Clayey Topsoil- Trace To Some Silt, Firm, Brown, Moist	-0.76	1	SS	67	7				
SILTY CLAY (C1)- Trace Sand, Firm, Brown / Grey, Moist	-1.52	2	SS	96	8				
SILTY CLAY (C1)- Soft, Grey, Moist	-3.05	3	SS	100	2	0.8	34.7	64.5	
SILTY CLAY (C1)- Trace Silt, Very Soft, Grey / Brown, Moist	-6.10	5	SS	50	WH				
		6	TWS	100	-				
		7	SS	29	27				
		8	SS	38	6				



Drilled By: Marathon Drilling

Drill Method: HSA / SS

Drill Date: April 25, 2018

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ - Rock Core
W - Water Content
WL- Liquid Limit
WP- Plastic Limit
△ - Field Vane

w - Wash
○- SPT(Standard Penetration Test)
WH - Weight Of Hammer

WP W WL

Datum:

Location: UTM 18T
E=487208
N=5005284

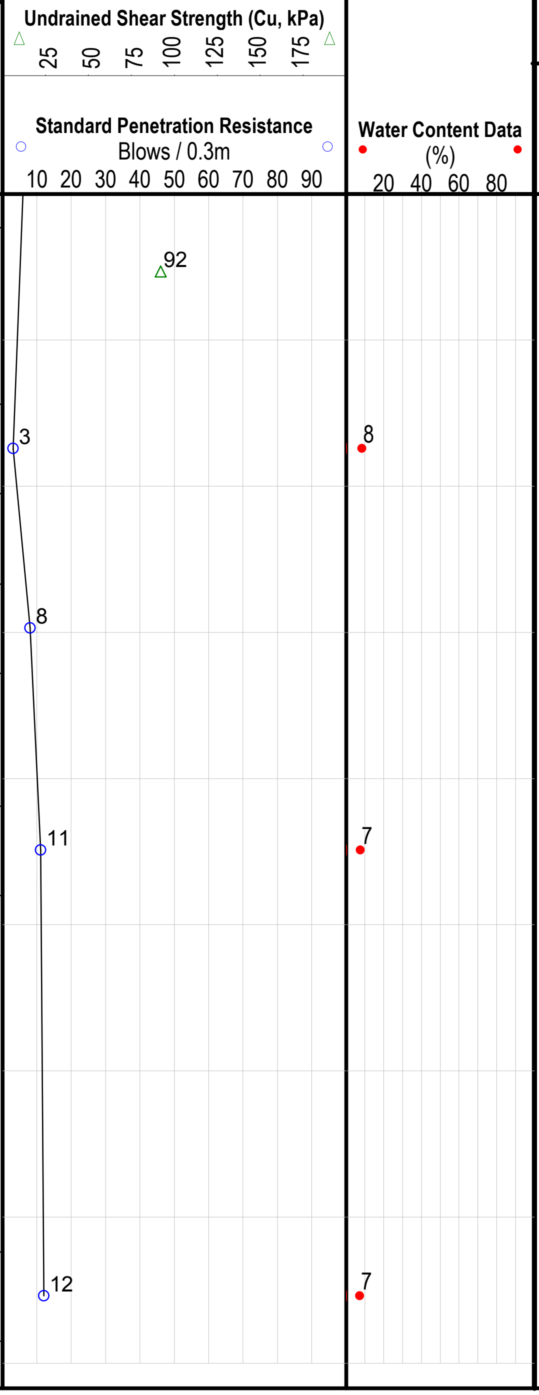
Sheet: 1 of 2

Borehole Log: BH S-1

Project No: 18-4022
Project: Nation Rise Wind Farm
Site Location: Substation Area, County Road 13
Client: EDP

Logged By: S.deBortoli
Compiled By: D.A.Mousseau
Reviewed By: E.Giles

SUBSURFACE PROFILE					SAMPLE				Remarks
Well	Strata Plot (m)	Depth (m)	DESCRIPTION	Elevation (m)	Sample Number	Sample Type	Recovery (%)	Blows / 0.3m	
		9							
					9	SS	50	3	
		10							
		11			10	SS	44	8	
		12	SILT TILL- Trace Clay, Trace Silt, Presence Of Cobbles, Loose To Very Dense, Stiff, Grey / Brown, Moist To Wet						
					11	SS	50	11	Water @ 12.24m Below Ground Surface
		13							
		14							At 14.0m BGS Hard Till Layer Encountered (Cobbles)
		15							
				-15.85	12	SS	42	16	
		16	End of Borehole						



Grain Size (%)

Gr Sa Si Cl

Drilled By: Marathon Drilling

Drill Method: HSA / SS

Drill Date: April 25, 2018

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ - Rock Core
W - Water Content
WL- Liquid Limit
WP- Plastic Limit
△ - Field Vane

w - Wash
○- SPT(Standard Penetration Test)
WH - Weight Of Hammer

WP W WL

Datum:

Location: UTM 18T
E=487208
N=5005284

Sheet: 2 of 2

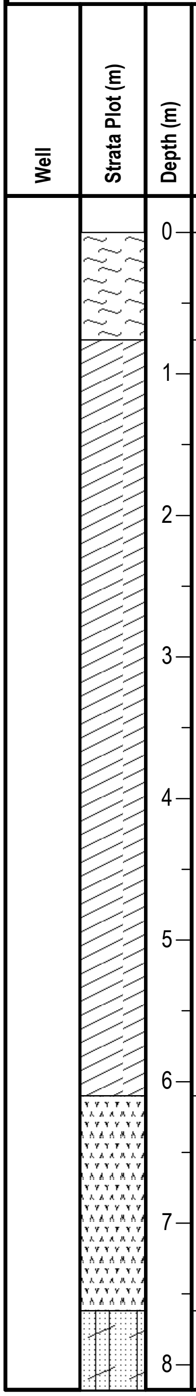
Borehole Log: BH S-2

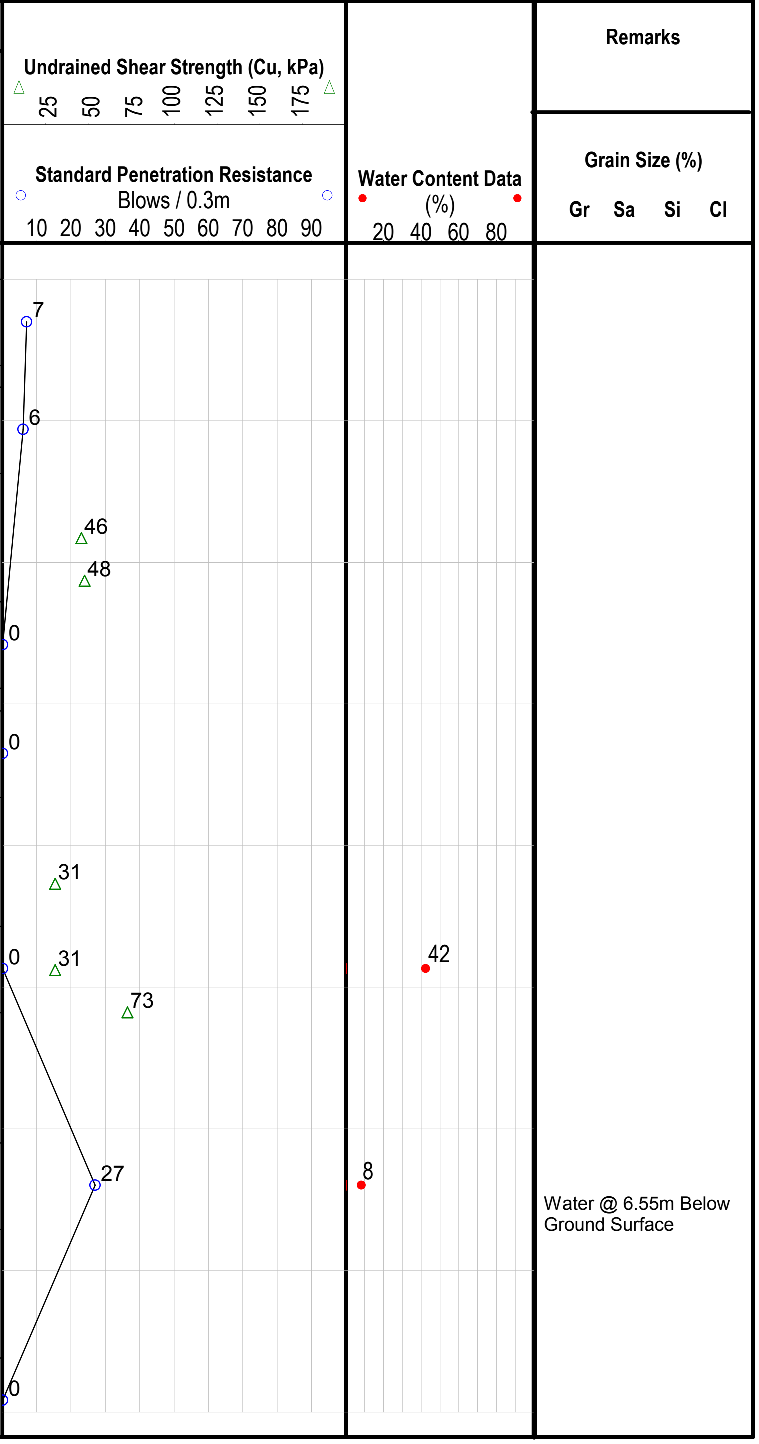
Project No: 18-4022
Project: Nation Rise Wind Farm
Site Location: Crysler, Ontario / Substation
Client: EDP

Logged By: S.deBortoli
Compiled By: D.A.Mousseau
Reviewed By: E.Giles

SUBSURFACE PROFILE / SAMPLE

Depth (m)	DESCRIPTION	Elevation (m)	Sample Number	Sample Type	Recovery (%)	Blows / 0.3m	Remarks
0	Geodetic Ground Elevation	0.00					
	Clayey Topsoil, Trace Silt, Trace Organics, Firm, Brown, Moist	-0.76	1	SS	46	7	
	SILTY CLAY (C1)- Trace Sand, Soft To Very Soft, Grey / Brown, Moist To Wet	-6.10	2	SS	96	6	
			4	TWS	100	-	
			5	SS	100	WH	
			6	SS	100	WH	
	SILT TILL- Some Sand and Gravel, Very Dense, Grey, Wet	-7.62	7	SS	29	27	Water @ 6.55m Below Ground Surface
			8	SS	58	WH	





Drilled By: Marthon Drilling

Drill Method: HSA / SS

Drill Date: April 26, 2018

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ - Rock Core
W - Water Content
WL- Liquid Limit
WP- Plastic Limit
△ - Field Vane

w - Wash
○- SPT(Standard Penetration Test)
WH - Weight Of Hammer

Datum:

Location: UTM 18T
E=487228
N=5005284

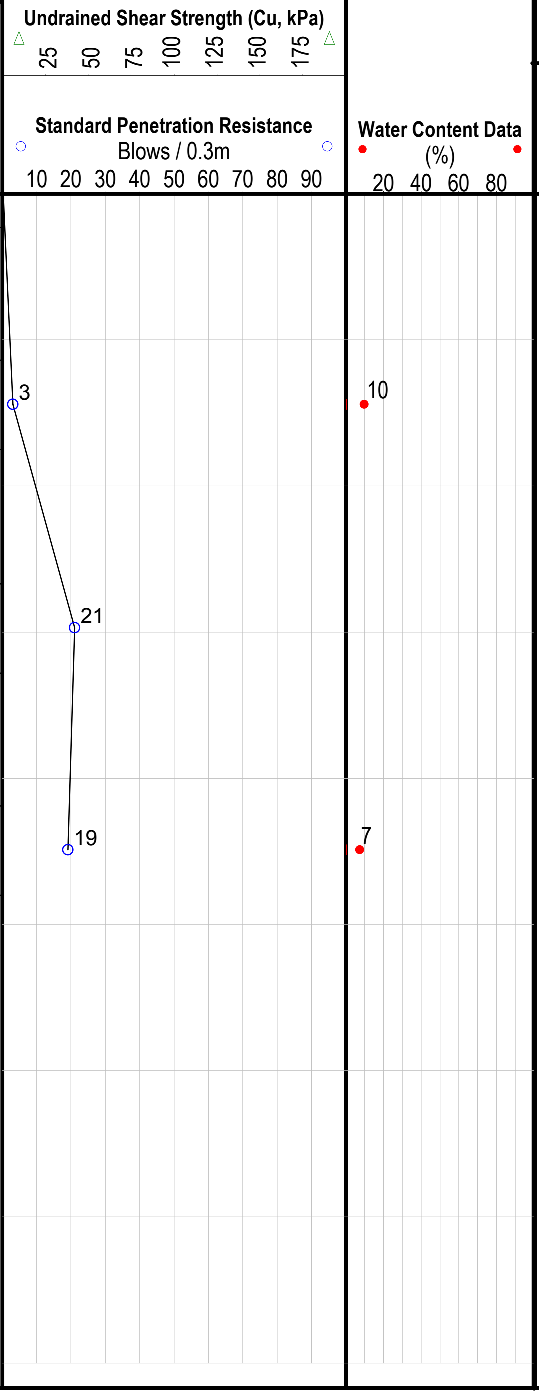
Sheet: 1 of 2

Borehole Log: BH S-2

Project No: **18-4022**
Project: **Nation Rise Wind Farm**
Site Location: **Crysler, Ontario / Substation**
Client: **EDP**

Logged By: **S.deBortoli**
Compiled By: **D.A.Mousseau**
Reviewed By: **E.Giles**

SUBSURFACE PROFILE			SAMPLE				Remarks			
Depth (m)	DESCRIPTION	Elevation (m)	Sample Number	Sample Type	Recovery (%)	Blows / 0.3m	Grain Size (%) Gr	Sa	Si	Cl
9.4	SILT TILL- Presence Of Cobbles, Till, Loose To Dense, Grey To Grey / Brown, Wet		9	SS	100	3	29.2	27.1	43.3	
11.0			10	SS	54	21				
12.5		-12.80	11	SS	58	19				
12.8	End of Borehole									



Drilled By: **Marthon Drilling**

Drill Method: **HSA / SS**

Drill Date: **April 26, 2018**

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ - Rock Core
W - Water Content
WL- Liquid Limit
WP- Plastic Limit
△ - Field Vane

w - Wash
○- SPT(Standard Penetration Test)
WH - Weight Of Hammer

Datum:

Location: **UTM 18T**
E=487228
N=5005284

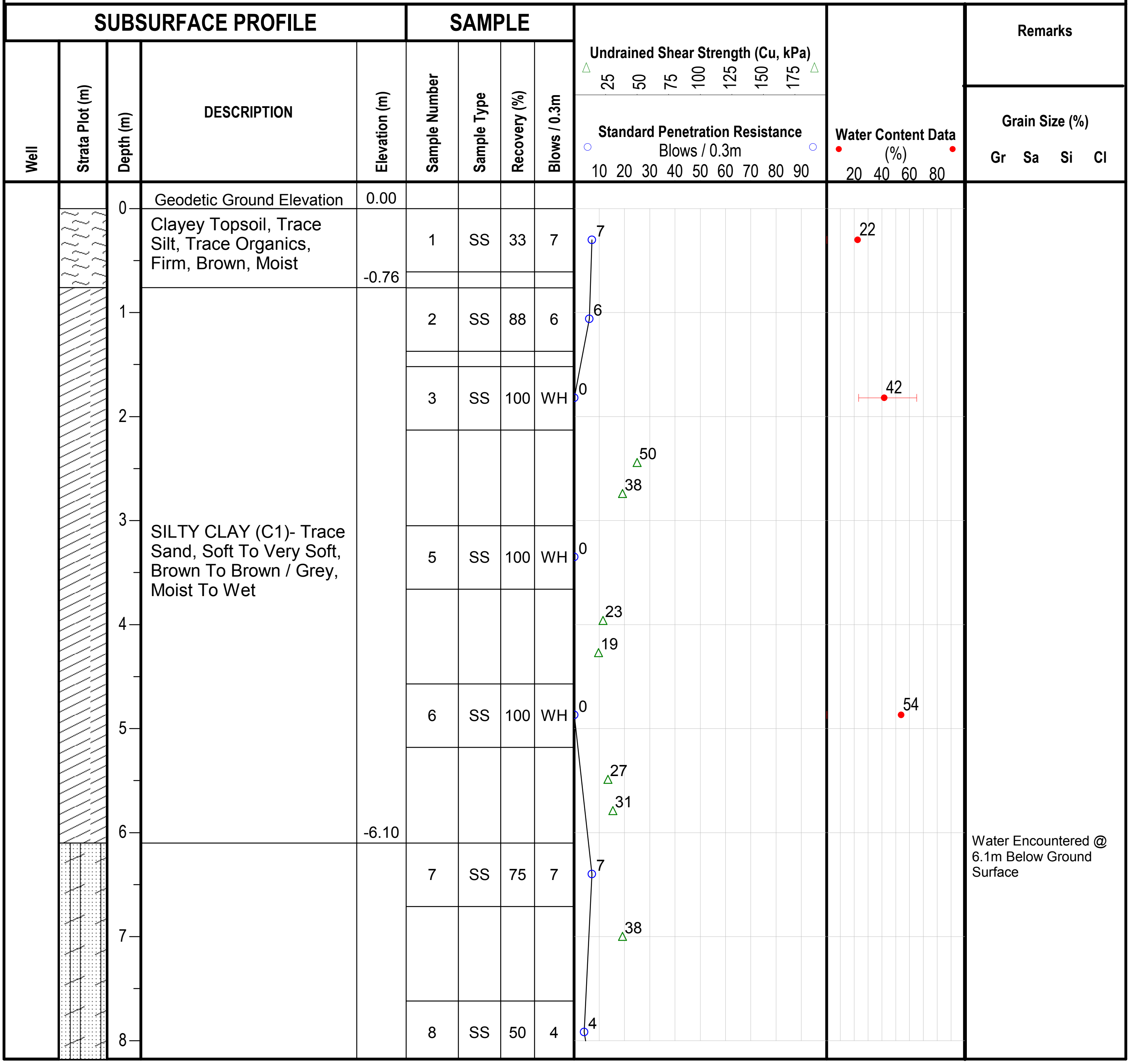
Sheet: **2 of 2**

Borehole Log: BH S-3

Project No: **18-4022**
Project: **Nation Rise Wind Farm**
Site Location: **Crysler, Ontario / Substation**
Client: **EDP**

Logged By: **S.deBortoli**
Compiled By: **D.A.Mousseau**
Reviewed By: **E.Giles**

Depth (m)	DESCRIPTION	Elevation (m)	Sample Number	Sample Type	Recovery (%)	Blows / 0.3m	Remarks
0	Geodetic Ground Elevation	0.00					
	Clayey Topsoil, Trace Silt, Trace Organics, Firm, Brown, Moist	-0.76	1	SS	33	7	
	SILTY CLAY (C1)- Trace Sand, Soft To Very Soft, Brown To Brown / Grey, Moist To Wet	-6.10	2	SS	88	6	
			3	SS	100	WH	
			5	SS	100	WH	
			6	SS	100	WH	
			7	SS	75	7	Water Encountered @ 6.1m Below Ground Surface
			8	SS	50	4	



Drilled By: **Marthon Drilling**

Drill Method: **HSA / SS**

Drill Date: **April 26, 2018**

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ - Rock Core
W - Water Content
WL- Liquid Limit
WP- Plastic Limit
△ - Field Vane

w - Wash
○- SPT(Standard Penetration Test)
WH - Weight Of Hammer

WP W WL

Datum:

Location: **UTM 18T**
E=487241
N=5005295

Sheet: **1 of 2**

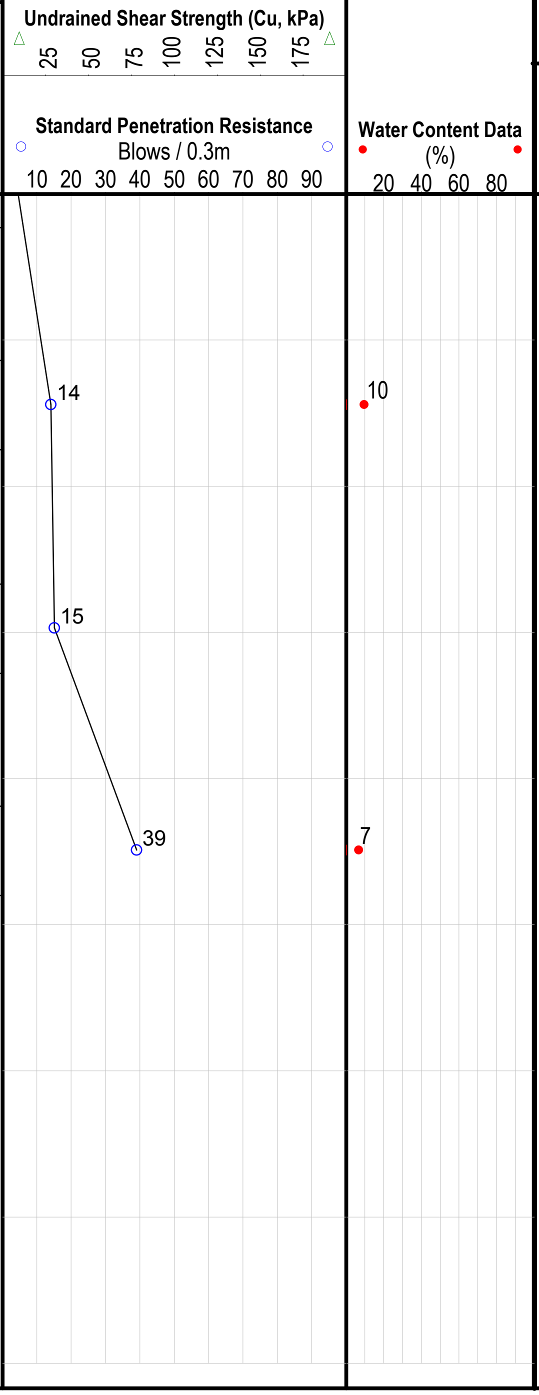
Borehole Log: BH S-3

Project No: **18-4022**
Project: **Nation Rise Wind Farm**
Site Location: **Crysler, Ontario / Substation**
Client: **EDP**

Logged By: **S.deBortoli**
Compiled By: **D.A.Mousseau**
Reviewed By: **E.Giles**

SUBSURFACE PROFILE | **SAMPLE**

Well	Strata Plot (m)	Depth (m)	DESCRIPTION	Elevation (m)	Sample Number	Sample Type	Recovery (%)	Blows / 0.3m
		9	SILT TILL,-Some Sand And Gravel, Trace To No Clay, Compact To Very Dense, Grey, Wet		9	SS	75	14
		10–11			10	SS	67	15
		12		-12.80	11	SS	67	39
		13	End of Borehole					
		14						
		15						
		16						



Remarks

Grain Size (%)

Gr Sa Si Cl

Drilled By: Marthon Drilling

Drill Method: HSA / SS

Drill Date: April 26, 2018

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ - Rock Core
W - Water Content
WL- Liquid Limit
WP- Plastic Limit
△ - Field Vane

w - Wash
○- SPT(Standard Penetration Test)
WH - Weight Of Hammer

Datum:

Location: UTM 18T
E=487241
N=5005295

Sheet: 2 of 2

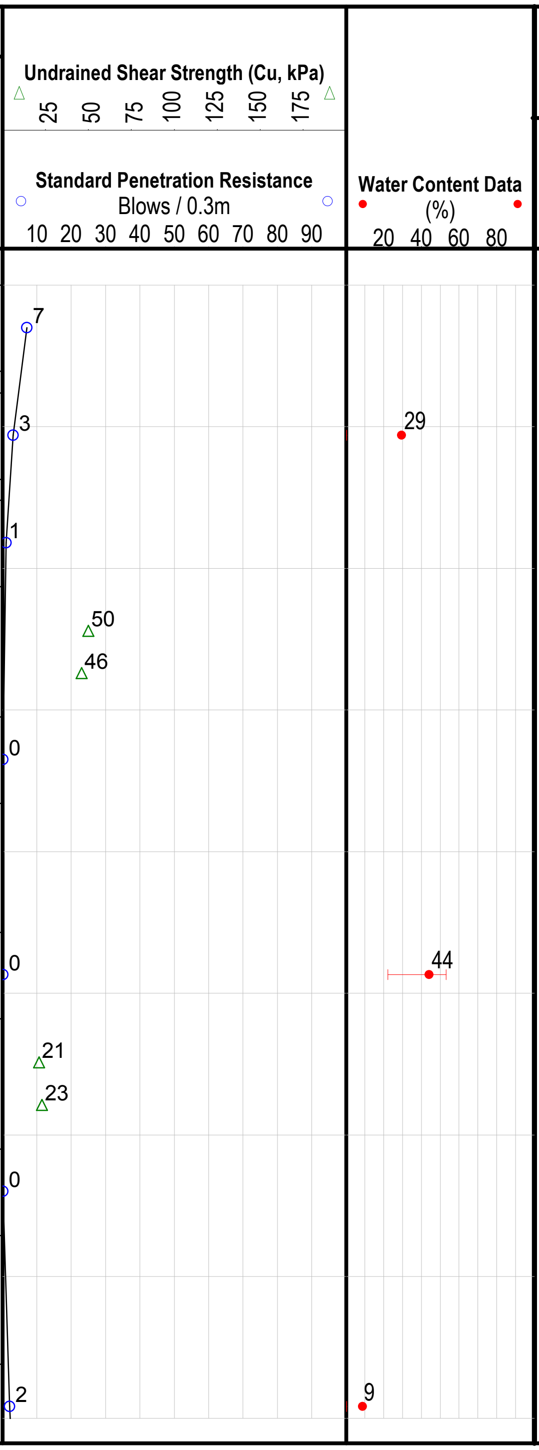
Borehole Log: BH S-4

Project No: 18-4022
Project: Nation Rise Wind Farm
Site Location: Crysler, Ontario / Substation
Client: EDP

Logged By: S.deBortoli
Compiled By: D.A.Mousseau
Reviewed By: E.Giles

SUBSURFACE PROFILE / SAMPLE

Well	Depth (m)	DESCRIPTION	Elevation (m)	Sample Number	Sample Type	Recovery (%)	Blows / 0.3m	Remarks
	0	Geodetic Ground Elevation	0.00					
		Clayey Topsoil, Firm, Brown, Moist	-0.76	1	SS	38	7	
	1	SILTY CLAY (C1)- Trace Sand, Soft To Very Soft, Brown To Grey, Moist To Wet	-7.62	2	SS	98	3	
	2			3	SS	100	1	Water Encountered @ 2.44m BGS
	3			5	TWS	100	-	
	5			6	SS	100	WH	
	6			7	TWS	100	-	
	8			8	SS	54	2	



Grain Size (%)
Gr Sa Si Cl

Drilled By: Marthon Drilling

Drill Method: HSA / SS

Drill Date: April 27, 2018

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ - Rock Core
W - Water Content
WL- Liquid Limit
WP- Plastic Limit
△ - Field Vane

w - Wash
○- SPT(Standard Penetration Test)
WH - Weight Of Hammer

Datum:

Location: UTM 18T
E=487193
N=5005317

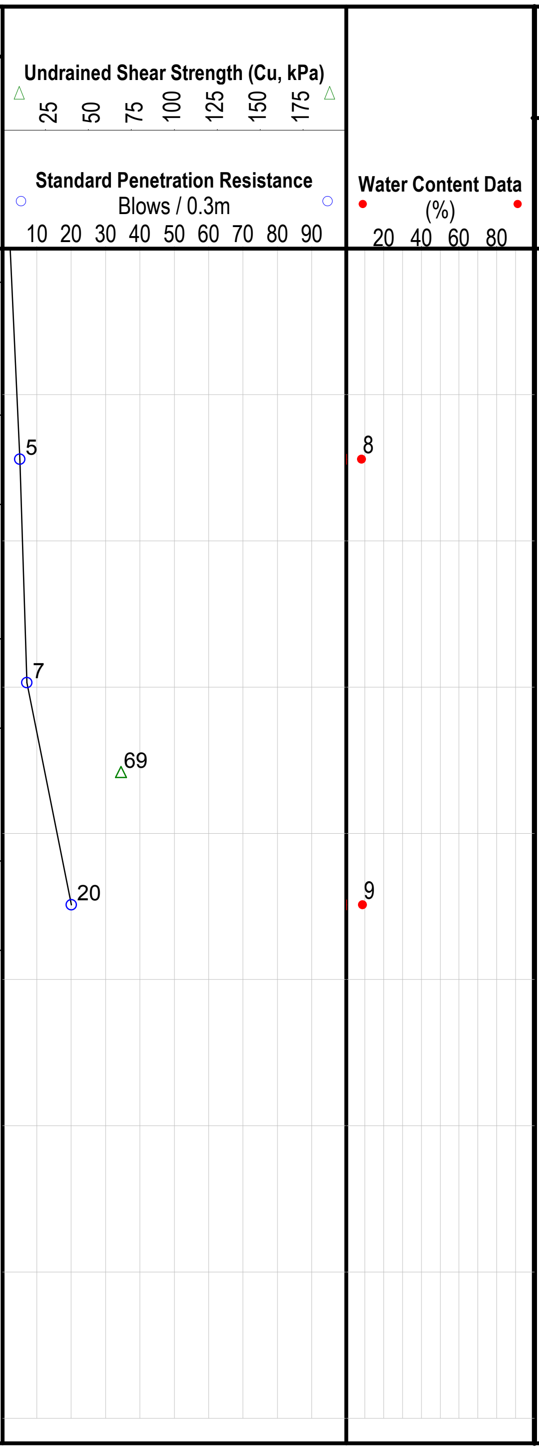
Sheet: 1 of 2

Borehole Log: BH S-4

Project No: 18-4022
Project: Nation Rise Wind Farm
Site Location: Crysler, Ontario / Substation
Client: EDP

Logged By: S.deBortoli
Compiled By: D.A.Mousseau
Reviewed By: E.Giles

SUBSURFACE PROFILE					SAMPLE			
Well	Strata Plot (m)	Depth (m)	DESCRIPTION	Elevation (m)	Sample Number	Sample Type	Recovery (%)	Blows / 0.3m
		9	SILT TILL- Some Sand And Gravel, Trace To No Clay, Presence Of Cobbles & Boulders, Till, Soft To Very Soft, Grey To Brown, Moist To Wet		9	SS	58	5
		10						
		11			10	SS	54	7
		12		-12.80	11	SS	71	20
		13	End of Borehole					
		14						
		15						
		16						



Remarks

Grain Size (%)

Gr Sa Si Cl

Drilled By: Marthon Drilling

Drill Method: HSA / SS

Drill Date: April 27, 2018

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ - Rock Core
W - Water Content
WL- Liquid Limit
WP- Plastic Limit
△ - Field Vane

w - Wash
○- SPT(Standard Penetration Test)
WH - Weight Of Hammer

Datum:

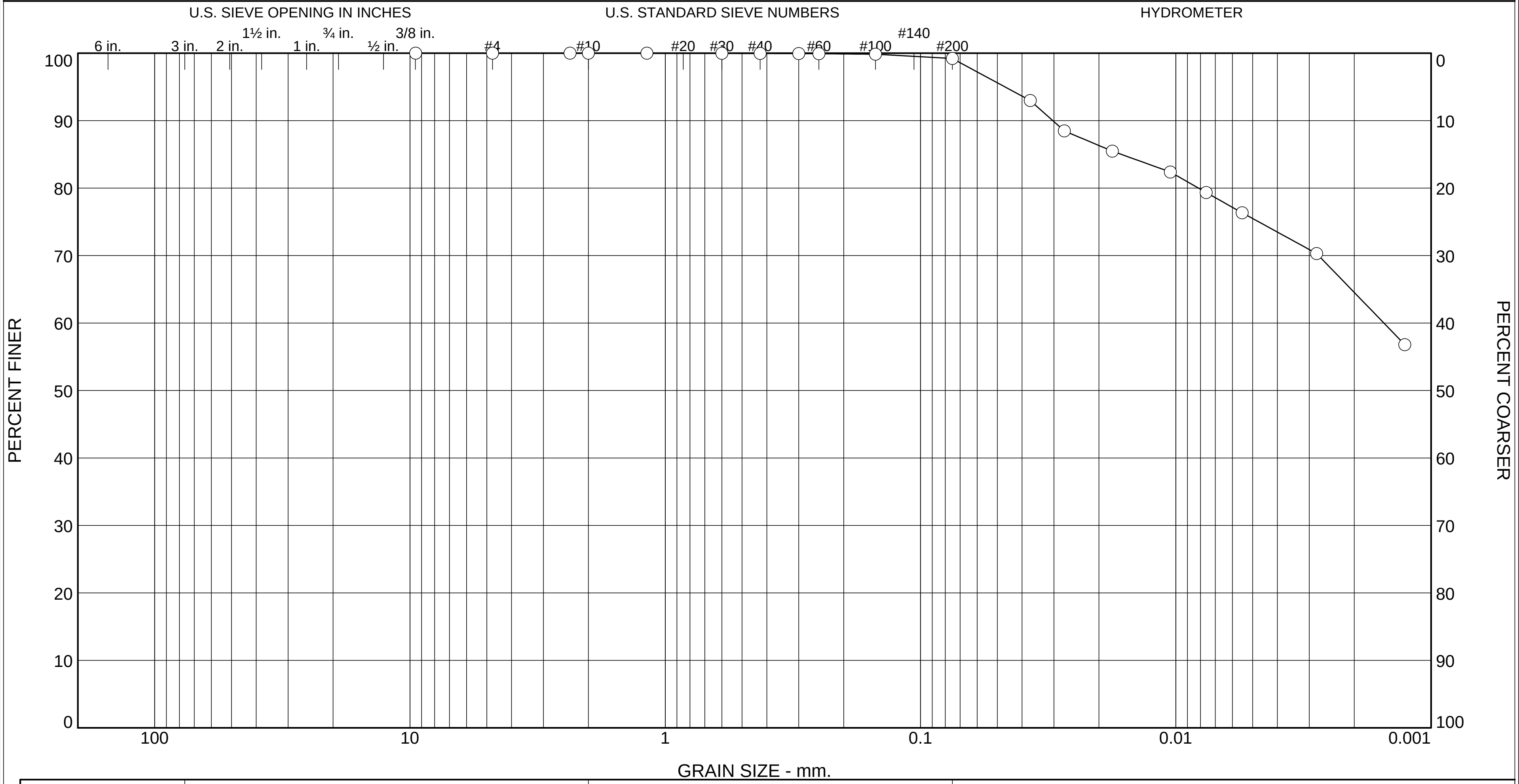
Location: UTM 18T
E=487193
N=5005317

Sheet: 2 of 2

APPENDIX D

LAB RESULTS

Particle Size Distribution Report



	% +75mm	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0.0	0.0	0.0	0.8	34.7	64.5

Identification	Date Sampled	Date Received	Date Tested
Source of Sample: BH Sub-1 Depth: 0.76m - 1.37m Sample Number: SS3	4/25/18		5/28/18

Client EDP

Project Nation Rise Wind Farm

Project No. 18-4022

TULLOCH ENGINEERING

71 Black Road
Unit 3
Sault Ste.
Marie, ON
P6B 0A3

T. 705 949.1457
F. 705 949.9606
TF. 866 806.6602
adam.byers@TULLOCH.ca

○ SA 7125

Tested By: T.Linley **Checked By:** S.Hoffman

GRAIN SIZE DISTRIBUTION TEST DATA

5/31/2018

Client: EDP
Project: Nation Rise Wind Farm
Project Number: 18-4022
Location: BH Sub-1
Depth: 0.76m - 1.37m **Sample Number:** SS3
Date Sampled: 4/25/18 **Date Tested:** 5/28/18
Testing Remarks: SA 7125
Tested by: T.Linley **Checked by:** S.Hoffman

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
736.10	0.00	9.5mm	0.00	0.00	100.0	0.0
		#4	0.00	0.00	100.0	0.0
		#8	0.00	0.00	100.0	0.0
		#10	0.00	0.00	100.0	0.0
		#16	0.10	0.00	100.0	0.0
		#30	0.10	0.00	100.0	0.0
		#40	0.10	0.00	100.0	0.0
		#50	0.20	0.00	99.9	0.1
		#60	0.10	0.00	99.9	0.1
		#100	0.60	0.00	99.8	0.2
		#200	4.70	0.00	99.2	0.8

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 100.0
Weight of hydrometer sample =76.1
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -3
Meniscus correction only = -1.0
Specific gravity of solids = 2.2
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 **-** 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1.00	24.1	64.0	62.0	0.0152	63.0	6.0	0.0372	93.0	7.0
2.00	24.1	61.0	59.0	0.0152	60.0	6.5	0.0273	88.5	11.5
5.00	24.1	59.0	57.0	0.0152	58.0	6.8	0.0177	85.5	14.5
15.00	23.9	57.0	54.9	0.0153	56.0	7.1	0.0105	82.4	17.6
30.00	23.8	55.0	52.9	0.0153	54.0	7.4	0.0076	79.3	20.7
60.00	23.8	53.0	50.9	0.0153	52.0	7.8	0.0055	76.3	23.7
250.00	23.7	49.0	46.9	0.0153	48.0	8.4	0.0028	70.3	29.7
1440.00	23.7	40.0	37.9	0.0153	39.0	9.9	0.0013	56.8	43.2

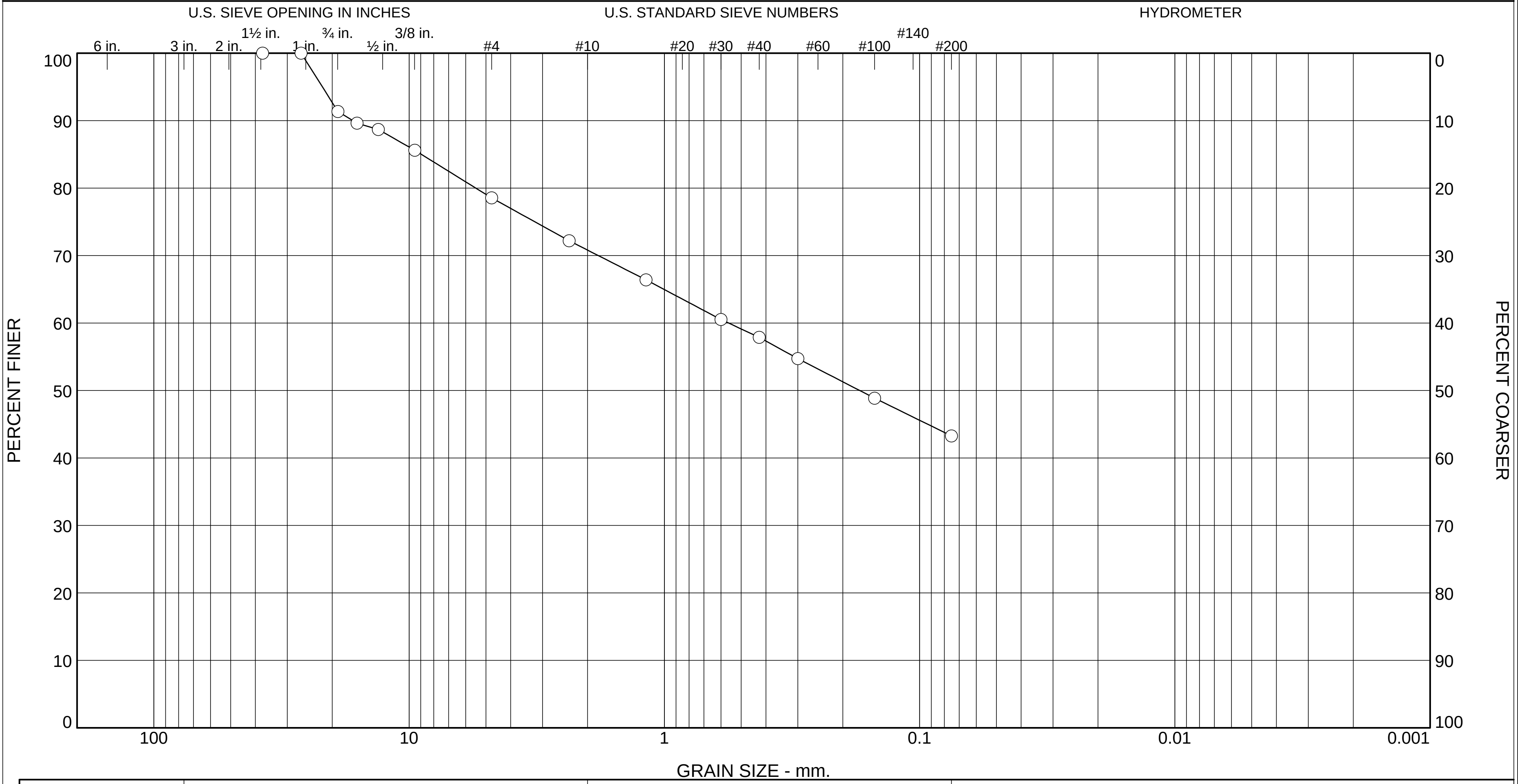
Fractional Components

Cobbles	Gravel	Sand			Fines		
		Coarse	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.8	0.8	34.7	64.5	99.2

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
							0.0015	0.0082	0.0164	0.0303	0.0467

Fineness Modulus
0.00

Particle Size Distribution Report



	% +75mm	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0.0	29.2	12.9	14.6	43.3	

Identification	Date Sampled	Date Received	Date Tested
Source of Sample: BH Sub-2 Depth: 9.14m - 9.75m Sample Number: SS9	4/26/18		5/30/18

Client EDP

Project Nation Rise Wind Farm

Project No. 18-4022

TULLOCH ENGINEERING

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TF. 866 806.6602
adam.byers@TULLOCH.ca

○ SA 7126

Tested By: T.Linley **Checked By:** S.Hoffman

GRAIN SIZE DISTRIBUTION TEST DATA

5/31/2018

Client: EDP
Project: Nation Rise Wind Farm
Project Number: 18-4022
Location: BH Sub-2
Depth: 9.14m - 9.75m **Sample Number:** SS9
Date Sampled: 4/26/18 **Date Tested:** 5/30/18
Testing Remarks: SA 7126
Tested by: T.Linley **Checked by:** S.Hoffman

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
998.80	168.80	37.5mm	0.00	0.00	100.0	0.0
		26.5mm	0.00	0.00	100.0	0.0
		19mm	71.80	0.00	91.3	8.7
		16mm	14.40	0.00	89.6	10.4
		13.2mm	7.70	0.00	88.7	11.3
		9.5mm	25.60	0.00	85.6	14.4
		#4	58.60	0.00	78.5	21.5
		#8	52.70	0.00	72.2	27.8
		#16	48.10	0.00	66.4	33.6
		#30	48.80	0.00	60.5	39.5
		#40	21.90	0.00	57.9	42.1
		#50	26.20	0.00	54.7	45.3
		#100	48.70	0.00	48.9	51.1
		#200	46.40	0.00	43.3	56.7

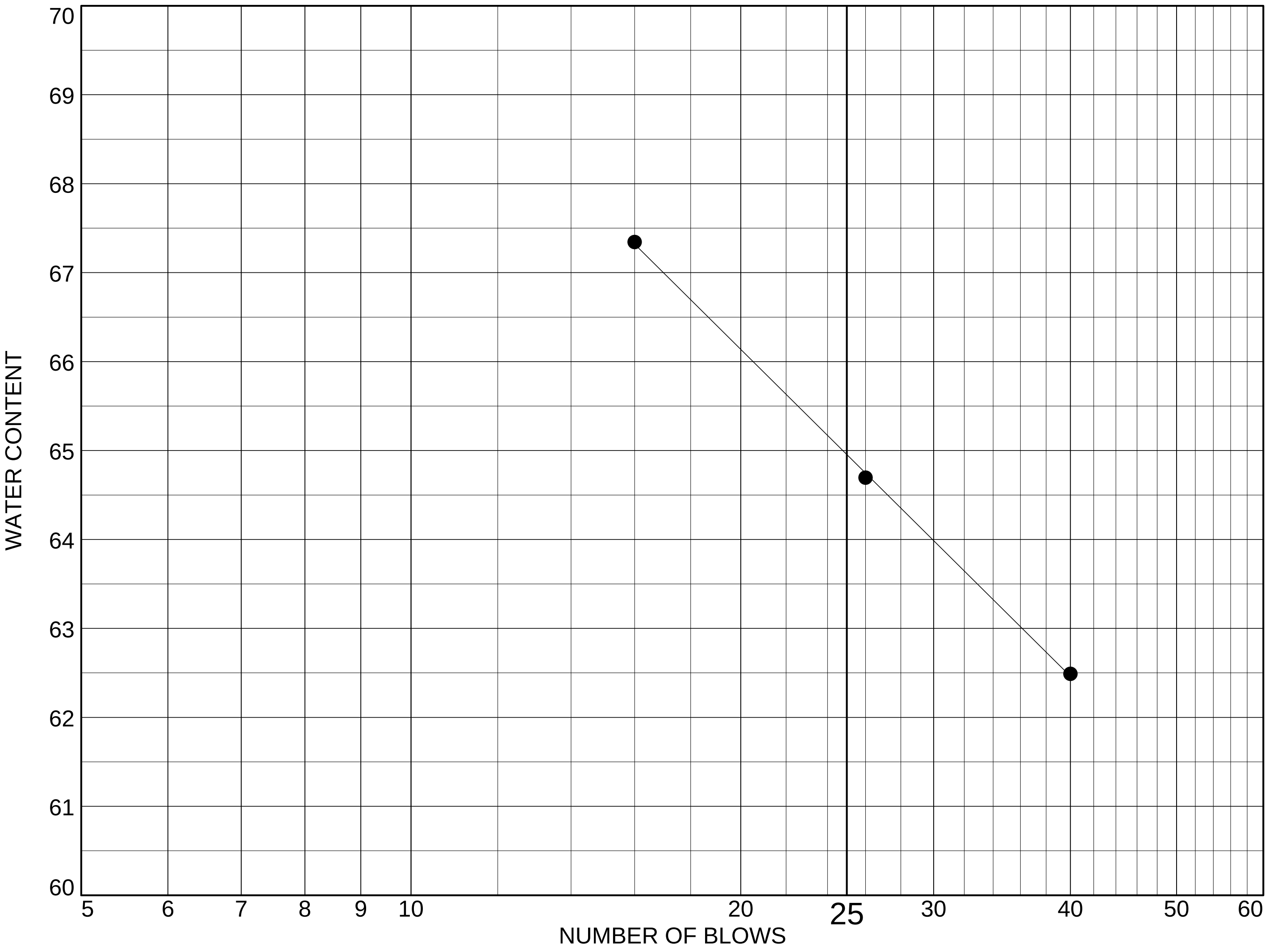
Fractional Components

Cobbles	Gravel	Sand			Fines		
		Coarse	Fine	Total	Silt	Clay	Total
0.0	29.2	12.9	14.6	27.5			43.3

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
						0.1717	0.5607	5.4809	8.9544	16.6228	21.8640

Fineness Modulus
2.42

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	BH Sub-3	SS3	1.52m - 2.13m		23	65	42	

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Client: EDP
Project: Nation Rise Wind Farm

Project No.: 18-4022

Tested By: S.Hoffman **Checked By:** J.Draper

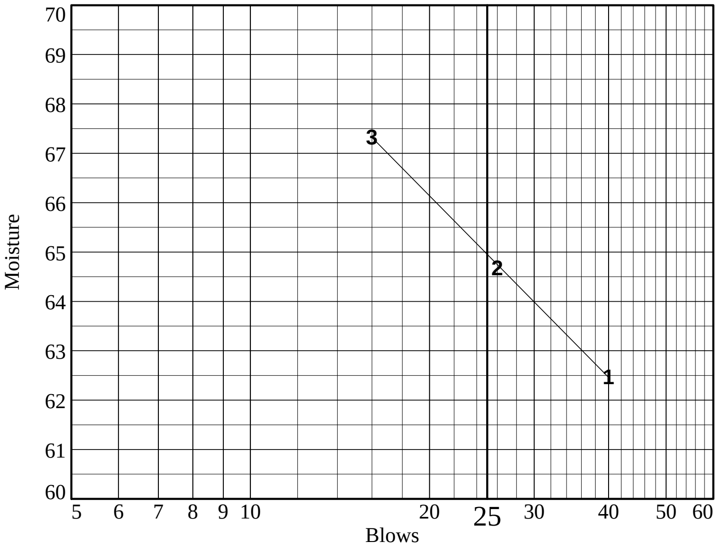
LIQUID AND PLASTIC LIMIT TEST DATA

5/31/2018

Client: EDP
Project: Nation Rise Wind Farm
Project Number: 18-4022
Location: BH Sub-3
Depth: 1.52m - 2.13m
Sample Number: SS3
Tested by: S.Hoffman
Checked by: J.Draper

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	32.27	31.53	31.77			
Dry+Tare	25.19	24.53	24.49			
Tare	13.86	13.71	13.68			
# Blows	40	26	16			
Moisture	62.5	64.7	67.3			

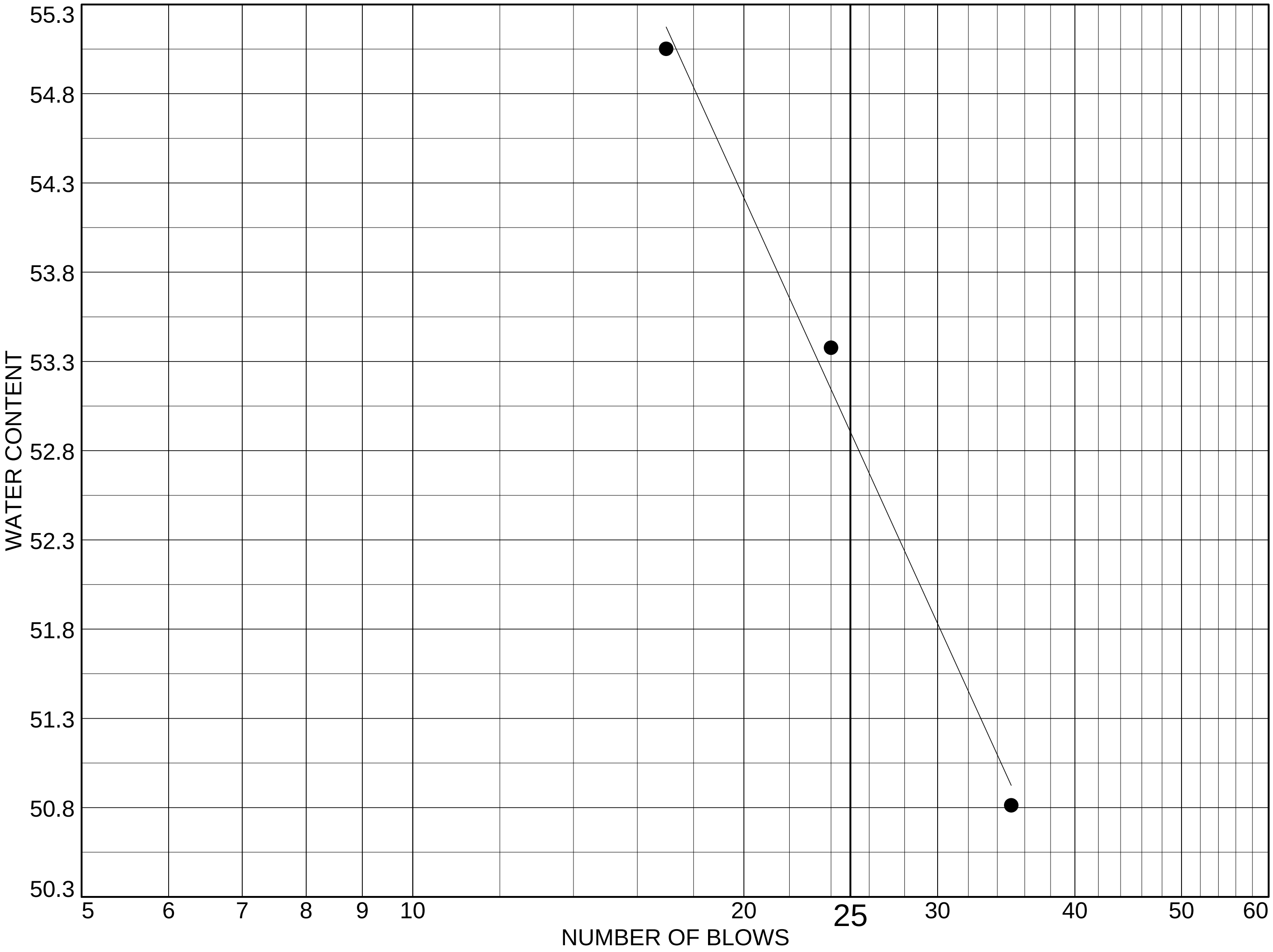


Liquid Limit= 65
Plastic Limit= 23
Plasticity Index= 42

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	19.45	19.88			
Dry+Tare	18.38	18.75			
Tare	13.73	13.66			
Moisture	23.0	22.2			

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	BH Sub-4	SS6	4.57m 5.18m		22	53	31	

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Client: EDP
Project: Nation Rise Wind Farm

Project No.: 18-4022

Tested By: J.Draper **Checked By:** S.Hoffman

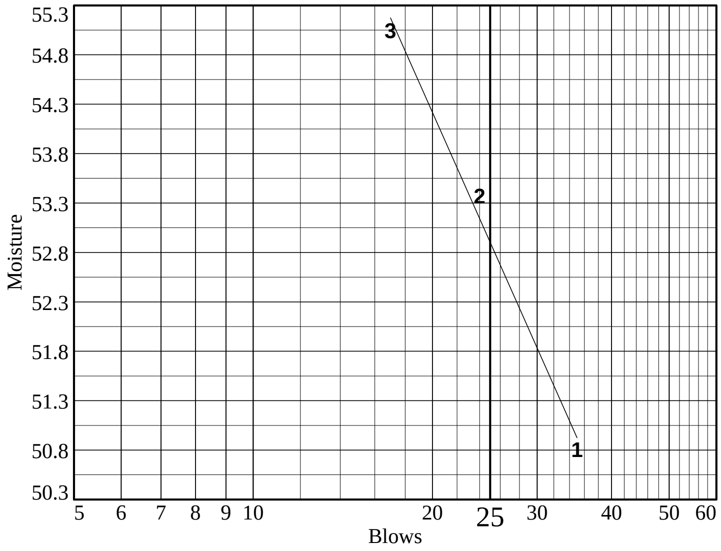
LIQUID AND PLASTIC LIMIT TEST DATA

5/31/2018

Client: EDP
Project: Nation Rise Wind Farm
Project Number: 18-4022
Location: BH Sub-4
Depth: 4.57m 5.18m
Sample Number: SS6
Tested by: J.Draper
Checked by: S.Hoffman

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	32.46	34.63	31.31			
Dry+Tare	26.21	27.36	25.48			
Tare	13.91	13.74	14.89			
# Blows	35	24	17			
Moisture	50.8	53.4	55.1			



Liquid Limit= 53
Plastic Limit= 22
Plasticity Index= 31

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	20.8	22.83			
Dry+Tare	19.74	21.43			
Tare	14.86	15.05			
Moisture	21.7	21.9			

WATER CONTENT TEST

TEST METHOD: LS 701 / ASTM C 566 / D 2216

CONTRACT NO:	18-4022	DATE SAMPLED:	4/25/18
PROJECT:	Nation Rise Wind Farm	SOURCE:	Boreholes
DATE TESTED:	5/28/18	TESTED BY:	T.Linley

Sample ID	Depth (m)	SA #	Wet Weight	Dry Weight	TARE	Mass Lost	Water %
BH Sub-1 SS1	0.29-0.9		61.3	47.6	13.9	13.7	29.2%
BH Sub-1 SS5	3.05-3.66		61.8	43.7	13.6	18.1	31.1%
BH Sub-1 SS6	Not present						
BH Sub-1 SS9	9.14-9.75		64.9	59.9	13.7	5.0	22.9%
BH Sub-1 SS11	12.19-12.8		70.7	65.8	13.7	4.9	20.8%
BH Sub-1 SS12	15.24-15.85		87.2	81.5	14.7	5.7	18.0%
BH Sub-2 SS4	Not present						
BH Sub-2 SS6	4.57-5.18		50.1	35.2	13.7	14.9	38.9%
BH Sub-2 SS7	6.10-6.71		67.8	62.7	13.9	5.1	22.2%
BH Sub-2 SS9	9.14-9.75	7126	93.2	85.1	13.9	8.1	16.3%
BH Sub-2 SS11	12.19-12.8		83.1	77.5	13.9	5.6	17.9%
BH Sub-3 SS1	0-0.29		49.1	40.1	13.7	9.0	34.2%
BH Sub-3 SS3	1.52-2.13	AT-014	62.0	13.8	15.0	48.2	108.7%
BH Sub-3 SS6	4.57-5.18		57.1	37.1	15.0	20.0	40.4%
BH Sub-3 SS9	9.14-9.75		96.5	88.1	15.0	8.4	17.0%
BH Sub-3 SS11	12.19-12.8		116.1	108.9	14.6	7.2	13.4%
BH Sub-4 SS2	0.76-1.37		49.4	38.2	14.7	11.2	38.5%
BH Sub-4 SS5	Not present						
BH Sub-4 SS6	4.57-5.18	AT-015	896.2	623.0	212.7	273.2	34.1%
BH Sub-4 SS8	7.62-8.23		91.7	84.4	13.6	7.3	16.1%
BH Sub-4 SS9	9.14-9.75		81.6	75.5	13.7	6.1	18.1%
BH Sub-4 SS11	12.19-12.8		107.2	98.7	13.8	8.5	14.0%

REMARKS:

CLIENT:

COPIES TO:

APPENDIX E

SOIL RESISTIVITY TESTING REPORT

GEOPHYSICS GPR INTERNATIONAL INC.
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Fax: (905) 696-0570
gprtor@gprtor.com
www.geophysicsgpr.com

May 16th, 2018 GPR File: T18577

Usman Khan
Geotechnical Engineer
Tulloch Engineering
1100 South Service Road, Suite 420
Stoney Creek, ON
L8E 0C5

RE: Soil Electrical Resistivity Testing at the Nation Rise Wind Farm in North Stormont, Ontario

Dear Usman Khan:

Geophysics GPR International Inc. was requested by Tulloch Engineering to conduct soil resistivity soundings at the site above in North Stormont, Ontario. The field survey was conducted on September 25th, 2018.

Four electrical resistivity soundings were performed at the site. Figure 1 shows the approximate locations of the soundings. The following letter will outline the theory and methodology of the soil electrical resistivity survey. Included in this letter is a summary of the results for the four soundings.

Figure 1: Approximate site location

Electrical Resistivity Soundings Theory and Methodology

Electrical resistivity sounding measurements involve placing four electrodes (stainless steel probes) in a straight line. A current (I) is injected into the outer two probes and the potential difference (ΔV) is measured across the inner two probes. The resistance (R) is calculated from the known current and the measured voltage,

$$R = \Delta V / I$$

The measured resistance (R) is then converted into an apparent resistivity (ρ_a). This apparent resistivity is an average of the different true resistivities crossed by the current over the investigated volume. It provides a good indication of the variation of soil and/or rock resistivity with depth as the electrode spacing increases.

The data were recorded with an ABEM Terrameter LS and used a standard Wenner array configuration. This array has an even spacing, called a-spacing, between electrodes. Ideally a total of 24 readings were taken for each sounding in 12 different configurations. Two readings were recorded in order to observe the repeatability at each setup. The apparent resistivity for a Wenner array at each station is given by

$$\rho_a = 2\pi a \left(\frac{V}{I}\right)$$

where ‘a’ is the distance between electrodes, ΔV is the measured voltage and I is the injected current.

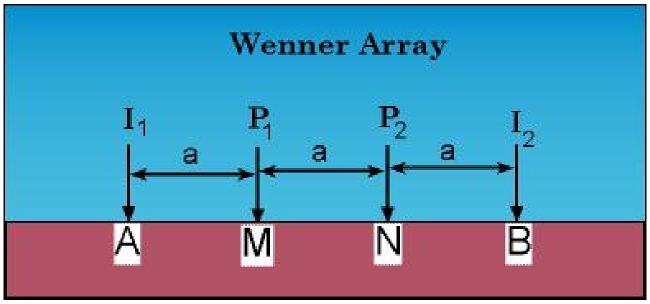

Figure 2: Wenner Array Electrode Schmatic

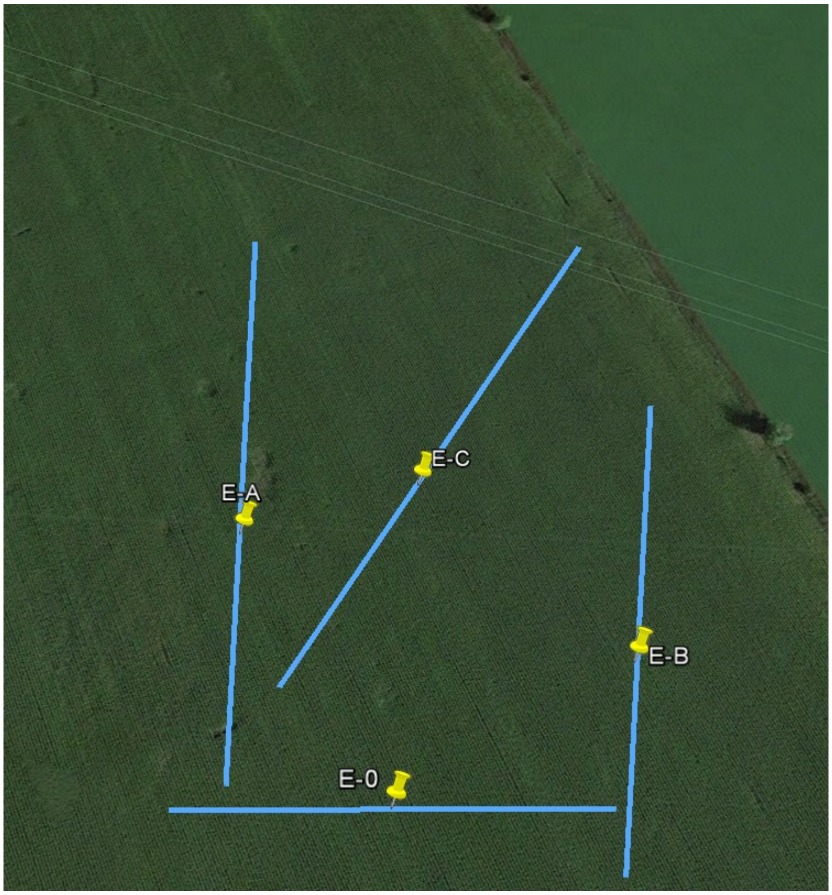

Figure 3: Approximate Direction and locations of soundings

RESULTS

The results of the resistivity soundings are summarized in the Tables and Figures below.

The collected resistivity values were observed to have an average error of approximately 0.10%, which is considered very good.

In order to determine the resistivity of the underlying layers and the approximate layer thickness, the data can be modeled by inversion. 1D inversion models were generated for the sounding using IPI2win software package. The resulting layered model derived from the 1D inversion is non-unique, implying that different models can arrive at the same solution. Since no borehole data was available to calibrate layer depths multi layer models were created while keeping in mind the resistivity results of the surrounding surveys.

The results of the simplified multi-layer 1D inversion models are presented in tabular form.

The RMS error measures how well simulated data created by the simulated model matches the actual data. All the sounding locations have models with an RMS error of less than 4%, which is considered excellent.

Table 1: Resistivity Sounding Results for E-C

Client: Tulloch
Date: 2018-04-25
Site: E-A, N.S (Dir)
Sounding: Wenner

A-spacing	Current	Vol			
0.5	687	5.			
1.0	642	2.			
2.0	707	1			
4.0	818	1.			
6.0	796	0.			
10.0	802	0.			
15.0	793	0.			
25.0	783	0.			

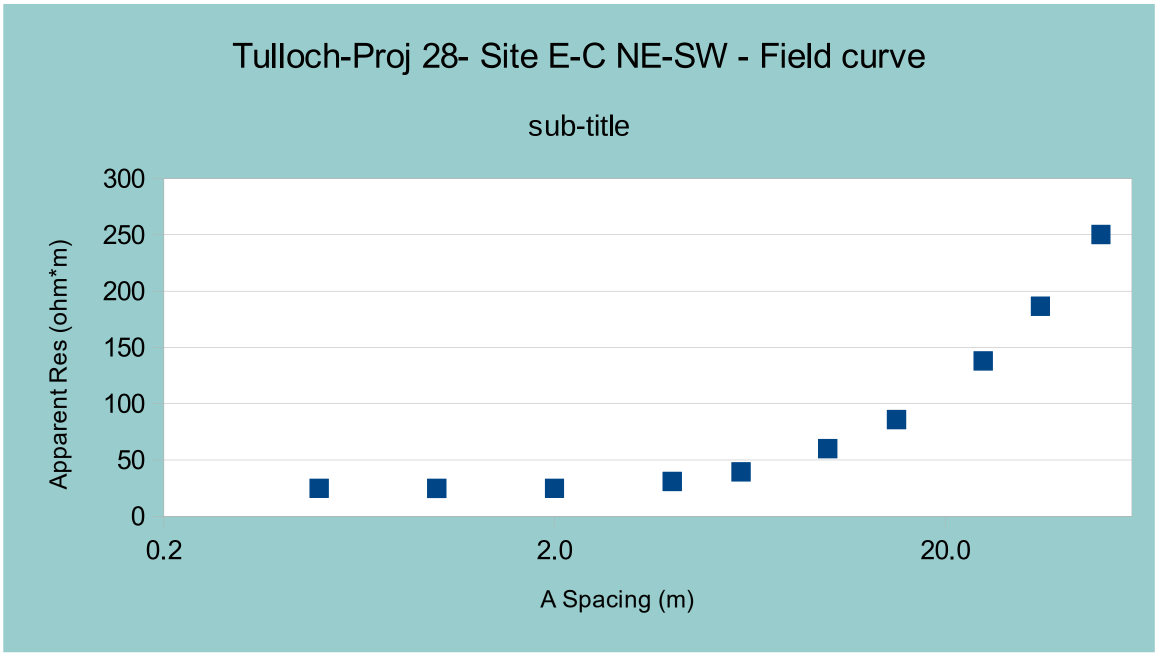

Figure 4: Apparent Resistivity Field Curve (E-C)

Table 2: Inversion Model Results for Resistivity Sounding E-C

		E		
Layer	**Resistivity (Ω•m)**	**Con**		
1	25.09			
2	19.46			
3	40.22			
4	171.8			
5	1315			

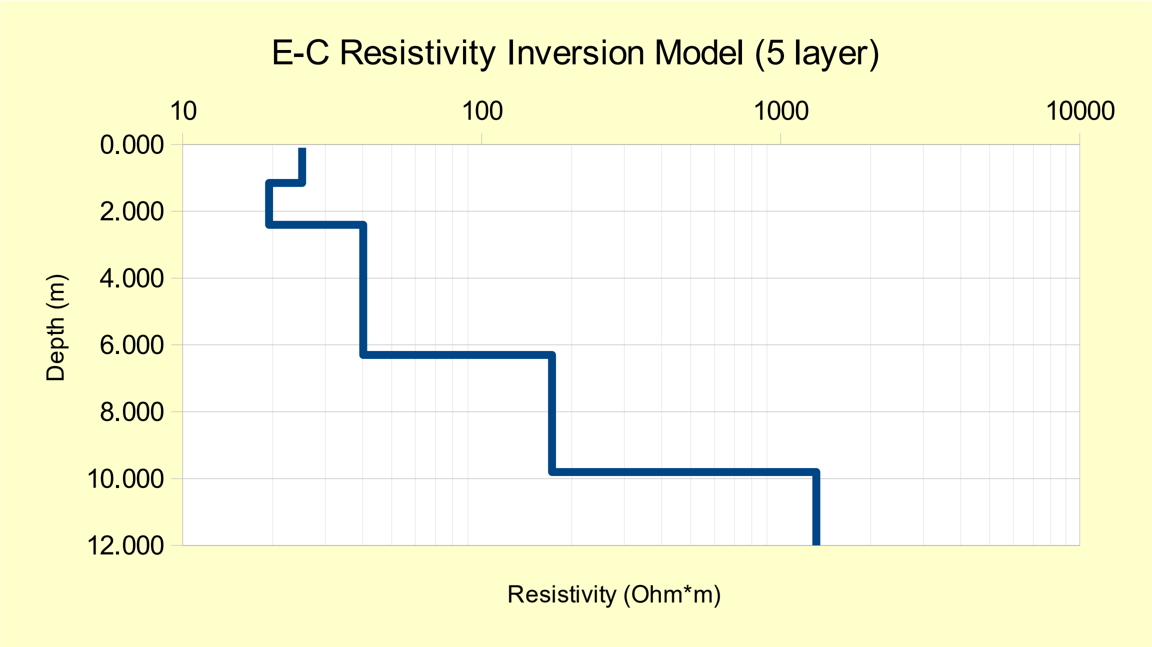

Figure 5: 1D Inverted Model (E-C)

Table 3: Resistivity Sounding Results for E-A

Client: Tulloch
Date: 2018-04-25
Site: E-A, N.S (Dir)
Sounding: Wenner

A-spacing	Current	Volt			
0.5	624	4.			
1.0	641	2.			
2.0	678	1.			
4.0	702	1.			
6.0	716	0.9			
10.0	822	0.9			
15.0	800	0.8			
25.0	918	0.8			

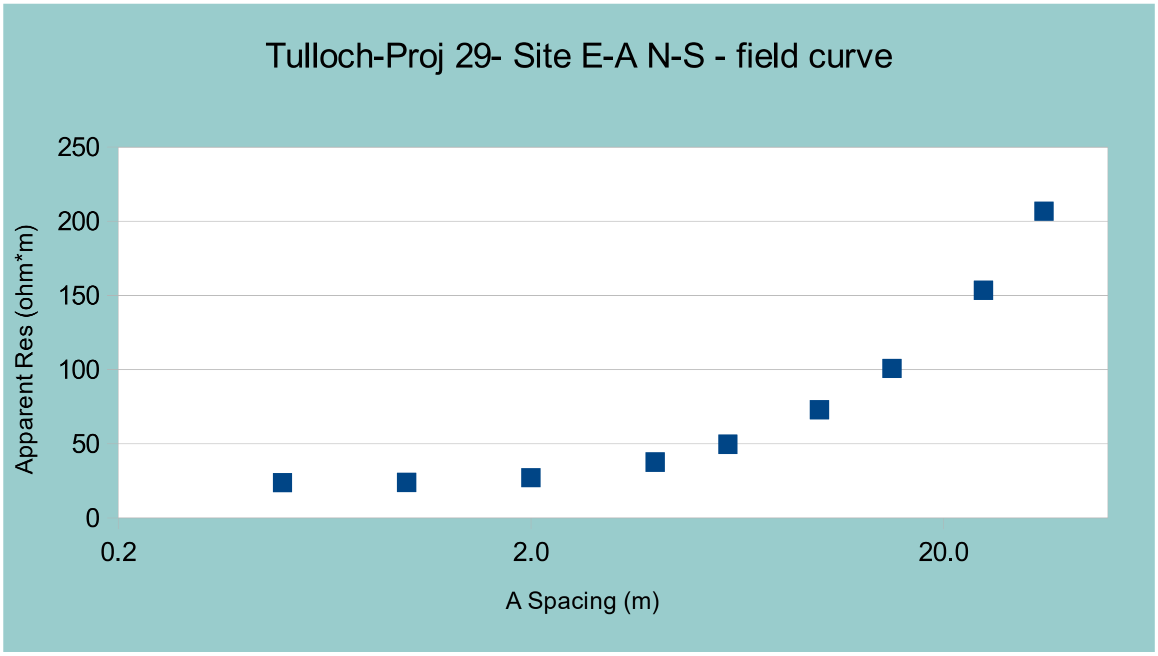

Figure 6: Apparent Resistivity Field Curve (E-A)

Table 4: Inversion Model Results for E-A

	E-A N-		
	3		
Layer	Resistivity (Ω•m)		
1	23.56		
2	112.3		
3	1198		

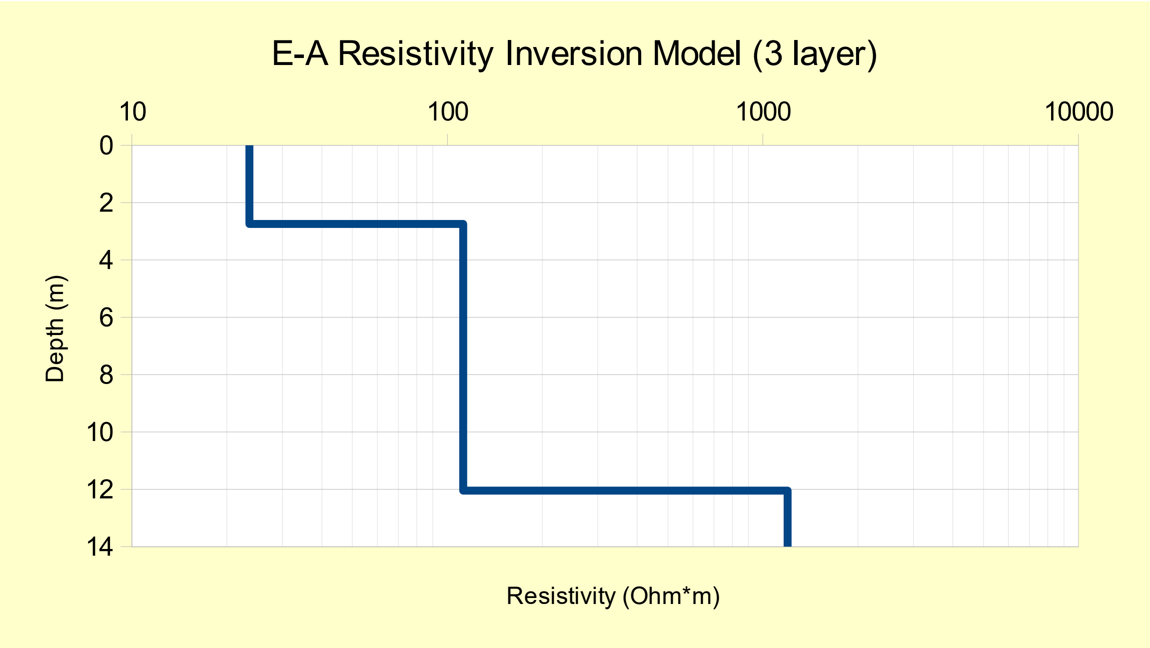

Figure 7: 1D Inverted Model (E-A)

Table 5: Resistivity Sounding Results for E-B

Client: Tulloch
Date: 2018-04-25
Site: E-B, N.S (Dir)
Sounding: Wenner

A-spacing	Current	Volt			
0.5	757	5.			
1.0	770	2.			
2.0	822	1.			
4.0	839	1.			
6.0	806	0.			
10.0	765	0.			
15.0	784	0.			

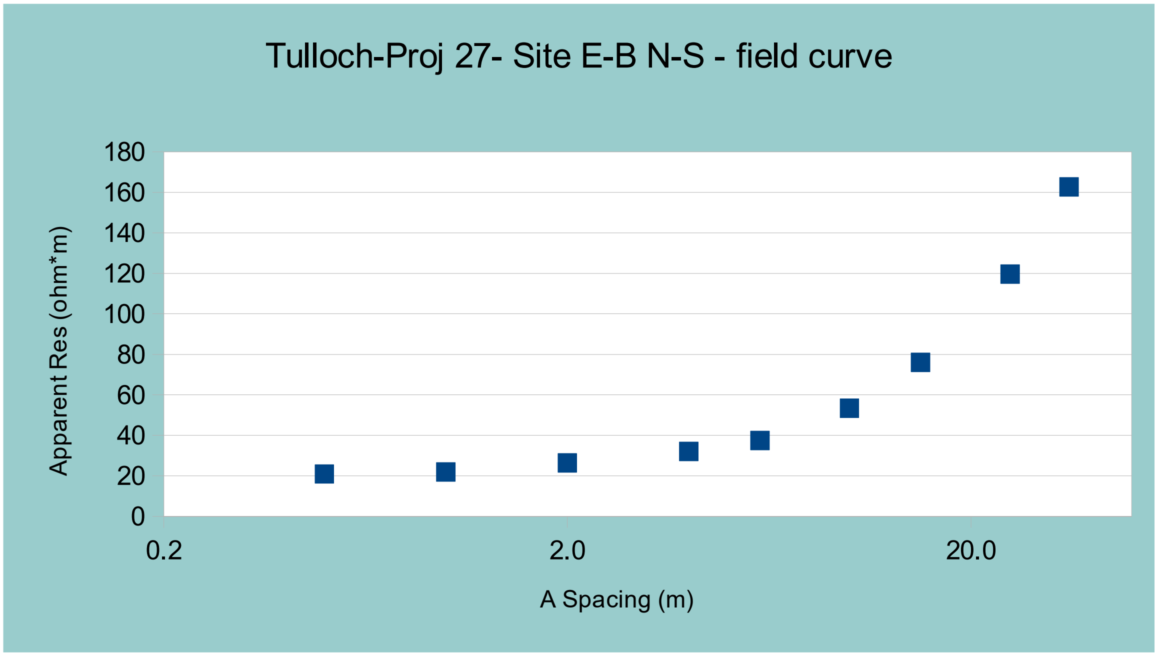

Figure 8: Apparent Resistivity Field Curve (E-B)

Table 6: Inversion Model Results for E-B

<table>
<tr><th colspan="5">E-b N-S PROJECT 27– Inversion Results</th></tr>
<tr><td colspan="5"></td></tr>
<tr><th>Layer</th><th>Resistivity (Ω•m)</th><th></th><th></th><th></th></tr>
<tr><td>1</td><td>20.34</td><td></td><td></td><td></td></tr>
<tr><td>2</td><td>33.39</td><td></td><td></td><td></td></tr>
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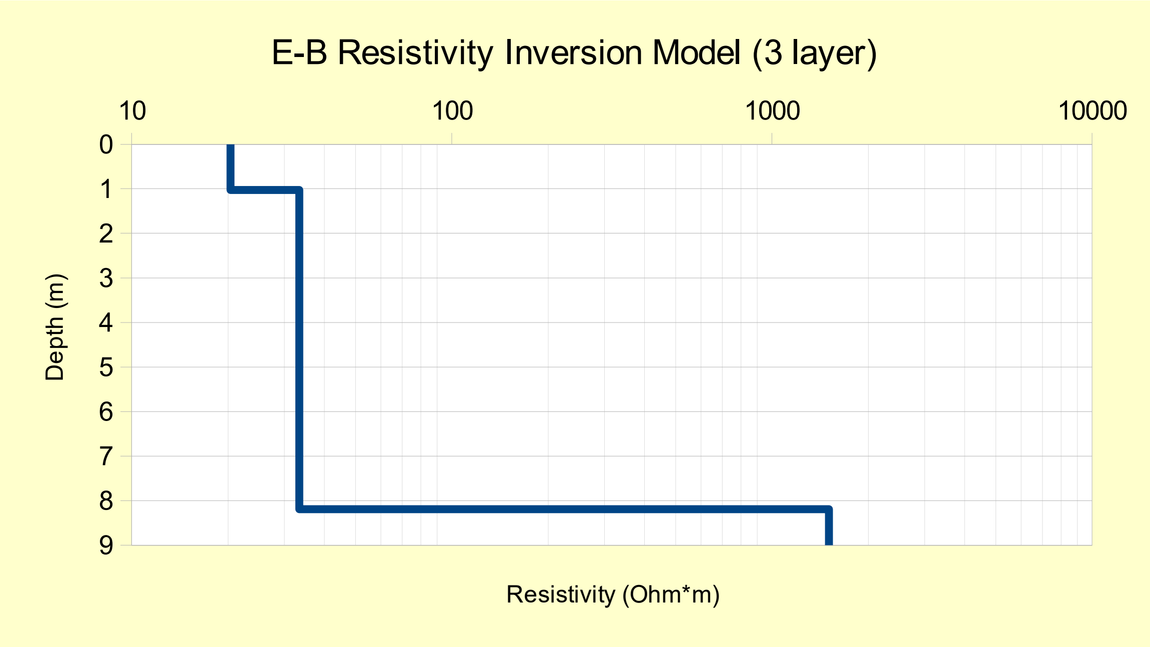

Figure 9: 1D Inverted Model (E-B)

Table 7: Resistivity Sounding Results for E-0

Client: Tulloch
Date: 2018-04-25
Site: E-0, E.W (Dir)
Sounding: Wenner

A-spacing	Current	Voltag			
0.5	735	19.1			
1.0	669	2.46			
2.0	689	1.44			
4.0	702	0.93			
6.0	721	0.805			
10.0	752	0.738			
15.0	717	0.662			
25.0	800	0.698			

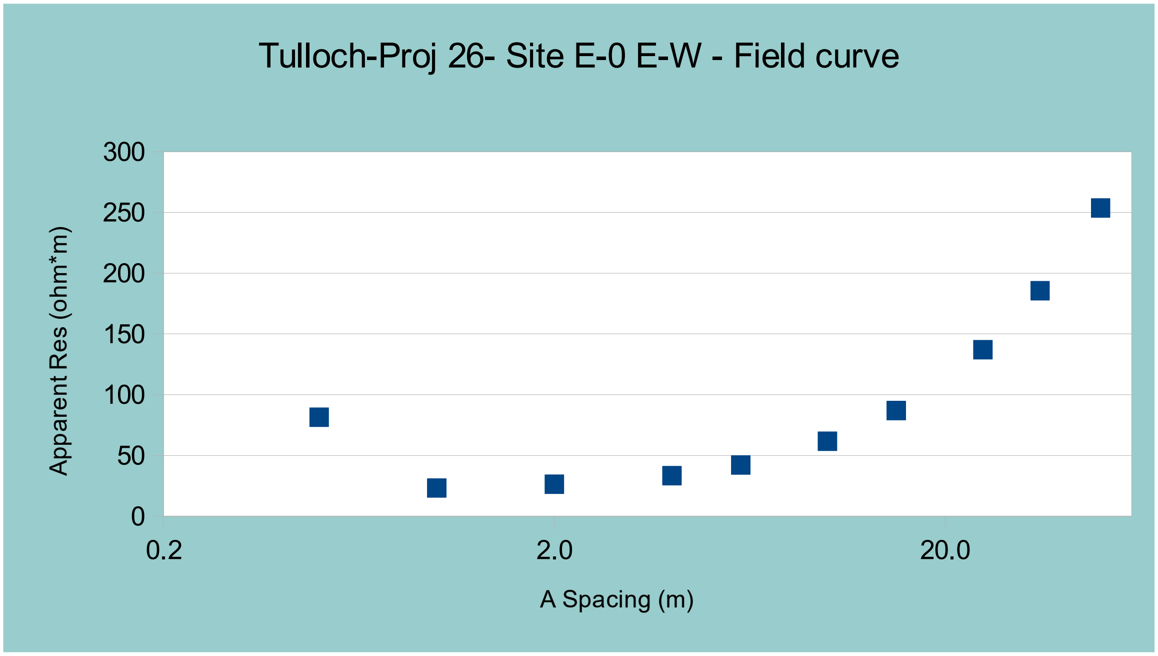

Figure 10: Apparent Resistivity Field Curve (E-0)

Table 8: Inversion Model Results for E-0

E-0 E-W PROJECT 26– Inversion Results				
4 Layer Model – RMS 1.14%				
Layer	**Resistivi**			
1	35			
2	13			
3	36			
4	12			

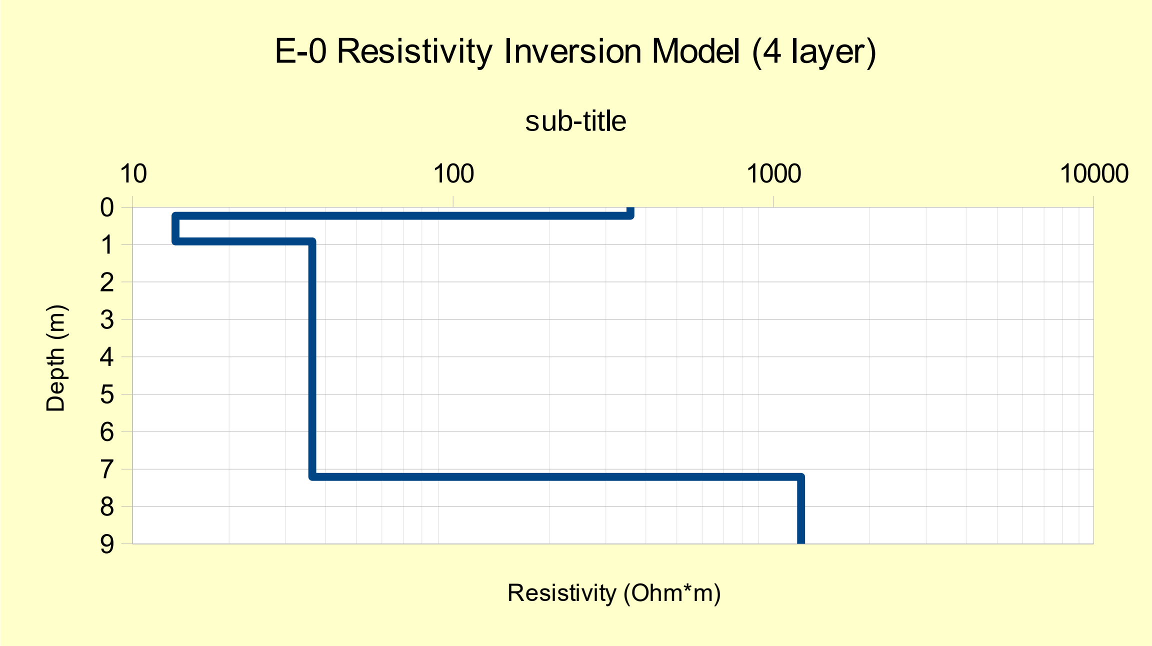

Figure 11: 1D Inverted Model (E-0)

CONCLUSIONS

A total of four resistivity soundings were performed at the Nation Rise Wind Farm in North Stormont, Ontario on April 25th, 2018 (Figures 1 and 3).

The results of the four resistivity soundings are presented in Tables 1 to 8 along with the inversion models shown in Figures 5, 7, 9 and 11.

There were 10 readings taken at each sounding with increasing a-spacing. The RMS error, which is the how close the data from the calculated model matches the actual data, was always less than 4%, which is considered excellent. The inversion models varied from a 5 layer to a 3 layer model.

My duties with regards to this project do not necessarily end here. If you have any additional questions, please do not hesitate to call.

Sincerely,

Milan Situm

Milan Situm P.Geo
Manager

APPENDIX F

REPORT LIMITATIONS AND GUIDELINES FOR USE

REPORT LIMITATIONS AND GUIDELINES FOR USE

This information has been provided to help manage risks with respect to the use of this report.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES, PERSONS AND PROJECTS

This geotechnical report has been prepared for the exclusive use of the client, their authorized agents, and other members of the design team. It is not intended for use by others, and the information contained herein is not applicable to other sites, or for purposes other than those specified in the report.

Tulloch Engineering (Tulloch) cannot be held responsible for reliance on the information contained in this report, by persons other than the client or 'authorized' agent without prior written approval.

SUBSURFACE CONDITIONS CAN CHANGE

This geotechnical investigation report is based on existing conditions at the time the study was performed, and our opinion of soil conditions are strictly based on soil samples collected at specific borehole locations. The findings and conclusions of our reports may be affected by the passage of time, by manmade events such as construction on or adjacent to the site, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations.

LIMITATIONS TO PROFESSIONAL OPINIONS

Interpretations of subsurface conditions are based on field observations from boreholes and/or test pits that were spaced to capture a 'representative' snap shot of subsurface conditions. Site exploration identifies subsurface conditions only at points of sampling. Tulloch reviews field and laboratory data and then applies our professional judgment to formulate an opinion of subsurface conditions throughout the site. Actual subsurface conditions may differ, between sampling locations, from those indicated in this report.

LIMITATIONS OF RECOMMENDATIONS

Subsurface soil conditions should be verified by a qualified geotechnical engineer during construction. Tulloch should be notified if any discrepancies to this report or unusual conditions are found during construction.

Sufficient monitoring, testing and consultation should be provided by Tulloch during construction and/or excavation activities, to confirm that the conditions encountered are consistent with those indicated by the borehole and/or test pit investigation, and to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated. In addition, monitoring, testing and consultation by Tulloch should be completed to evaluate whether or not earthwork activities are completed in accordance with our recommendations. Retaining Tulloch for construction observation for this project is the most effective method of managing the risks associated with unanticipated conditions. However, please be advised that any construction/excavation observations by Tulloch is over and above the mandate of this geotechnical investigation and therefore, additional fees would apply.

MISINTERPRETATION OF GEOTECHNICAL ENGINEERING REPORT

Misinterpretation of our report by other design team members can result in costly problems. You could lower that risk by having Tulloch confer with appropriate members of the design team after submitting the report. Also retain Tulloch to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering or geologic report. Reduce that risk by having Tulloch participate in pre-bid and preconstruction conferences, and by providing construction observation. Please be advised that retaining Tulloch to participation in any ‘other’ activities associated with this project is over and above the mandate of this geotechnical investigation and therefore, additional fees would apply.

CONTRACTORS RESPONSIBILITY FOR SITE SAFETY

This geotechnical report is not intended to direct the contractor's procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and to adjacent properties. It is ultimately the contractor’s responsibility that the Ontario Occupational Health and Safety Act is adhered to, and site conditions satisfy all ‘other’ acts, regulations and/or legislation that may be mandated by federal, provincial and/or municipal authorities.

SUBSURFACE SOIL AND/OR GROUNDWATER CONTAMINATION

This report is geotechnical in nature and specifically excludes the investigation, detection, prevention or assessment of the presence of subsurface contaminants. Accordingly, the scope of services does not include any interpretations, recommendations, findings, or conclusions regarding the detection, assessment, prevention or abatement of contaminants, and no conclusions or inferences should be drawn regarding contamination, as they may relate to this project. The term "contamination" includes, but is not limited to, molds, fungi, spores, bacteria, viruses, PCBs, petroleum hydrocarbons, inorganics, pesticides/insecticides, volatile organic compounds, polycyclic aromatic hydrocarbons and/or any of their byproducts.