ANNEXE C

ÉTUDE GÉOTECHNIQUE PRÉLIMINAIRE

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REPORT

Preliminary Geotechnical Investigation
Saint-Blaise / Saint-Valentin, Quebec

TCI RENEWABLES

PROJECT NO. 1023239

PROJECT NO. 1023239

REPORT TO **TCI Renewables**
227 Des Pyrenees Avenue, Suite 2
Saint-Lambert
Montreal, Quebec
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FOR **Preliminary Geotechnical Investigation**

ON **Saint-Blaise / Saint-Valentin, Quebec**

April 16, 2007

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1.0 INTRODUCTION

This report presents the results of a Preliminary Geotechnical Investigation carried out for four potential wind farm sites near the communities of Saint-Valentin and Saint-Blaise-sur-Richelieu in the province of Quebec. The work was carried out in general accordance with our proposal No. 1019274 dated November 9, 2006, issued to TCI Renewables (TCI).

This report has been prepared specifically and solely as a preliminary investigation for the four potential wind farm sites described herein. It presents the factual results of the preliminary geotechnical investigation, an assessment of potential geotechnical challenges or constraints for the proposed type of development, and preliminary geotechnical recommendations for use in conceptual designs. Additional geotechnical investigation work and analysis will be required as part of future detailed design work for each of the potential sites.

2.0 PROPOSED DEVELOPMENT

The four potential wind farm sites are located near the communities of Saint-Valentin and Saint-Blaise-sur-Richelieu and occupy approximately a 10 km radius area. The site locations are shown on the Key Plan, Drawing No. 1. The site locations are described as follow:

Street	1st Intersection	2nd Intersection	Details	Borehole
Rang Pir-Vir	Chemin de la 4ième Ligne	35ième Avenue	Lot 391	BH07-1
Chemin de la 4ième Ligne	Chemin Louis-Cyr	Montée Guay	Lot 305	BH07-2
Chemin de la 3ième Ligne	Chemin Louis-Cyr	Montée du petit rang	Lot 292	BH07-3
Chemin de la 3ième Ligne	Chemin Louis-Cyr	Montée du petit rang	Lot 282	BH07-4

All four of the potential wind farm sites are currently occupied by agricultural lands.

3.0 SCOPE OF WORK

The scope of work for this preliminary geotechnical investigation included the following:

- Conducting a field investigation consisting of four boreholes;
- Supplementing the field information with limited in situ and laboratory testing, as required, to provide preliminary characterization of the subsurface conditions;
- Summarizing the field and laboratory information in a report including borehole records, a borehole location plan, preliminary geotechnical recommendations for foundations, and a discussion of potential geotechnical challenges or constraints for the proposed development.

4.0 REGIONAL GEOLOGY, HYDROGEOLOGY AND TOPOGRAPHY

Based on available surficial geology maps (Appalachian mineral deposit Map DV87-19, Quaternary geology of the great Montreal region Map2), the regional surficial soils generally consist of marine deposits including gravel, sand, silt and clay. The bedrock varies from a calcareous mudstone of the Stony Point Formation to a crystalline limestone/shale from the Laval Formation.

5.0 METHOD OF INVESTIGATION

Prior to the commencement of the investigation, Jacques Whitford personnel made arrangements to verify the locations of underground utilities near the proposed borehole locations.

The field work for the preliminary geotechnical investigation consisting of drilling four boreholes was carried out on March 13th, 15th, 16th and 17th, 2007, using a track mounted CME 75 drill.

The subsurface stratigraphy encountered in the boreholes was recorded in the field by our geotechnical personnel. Split spoon soil samples were collected during the performance of Standard Penetration Tests (SPT).

All soil samples were returned to our laboratory where they were subjected to detailed visual classification by a geotechnical engineer. Soil description and identification were made in accordance with ASTM Standard D2488 (Visual-Manual Method) and D2487 (Classification of Soils for Engineering Purposes). Selected soil samples were tested for moisture content and grain size distribution. Samples remaining after testing will be stored for a period of one (1) month after issuance of this report. Samples will then be discarded unless we are otherwise directed.

Borehole locations were established in the field by Jacques Whitford personnel using a GPS device. Groundwater levels were measured on March 25, 2006. The ground surface elevations at the borehole locations are to be determined by TCI and forwarded to Jacques Whitford.

6.0 RESULTS OF THE INVESTIGATION AND PRELIMINARY RECOMMENDATION

The results of the investigation and associated preliminary recommendations are provided separately for each site within **Appendix A, B, C** and **D**.

7.0 CLOSURE

This report has been prepared for the sole benefit of TCI, and may not be used by any third party without the express written consent of Jacques Whitford Limited and TCI. Any use which a third party makes of this report is the responsibility of such third party.

This report is based on the site conditions encountered by Jacques Whitford at the time of the work, and at the specific testing and/or sampling locations, and can only be extrapolated to a limited extent around these locations. The extent depends on the variability of soil / rock and groundwater conditions

as influenced by geological processes, construction activities and site use. Should any conditions at the site be encountered which differ from those at the test locations, we require that we be notified immediately in order to permit reassessment of our findings. It is noted that further field investigation will be required prior to final design.

We trust the above information meets with your present requirements. Should you have any questions or require further information, please do not hesitate to contact us at your convenience.

We thank you for the opportunity to be of service to you.

Yours very truly,

JACQUES WHITFORD LIMITED

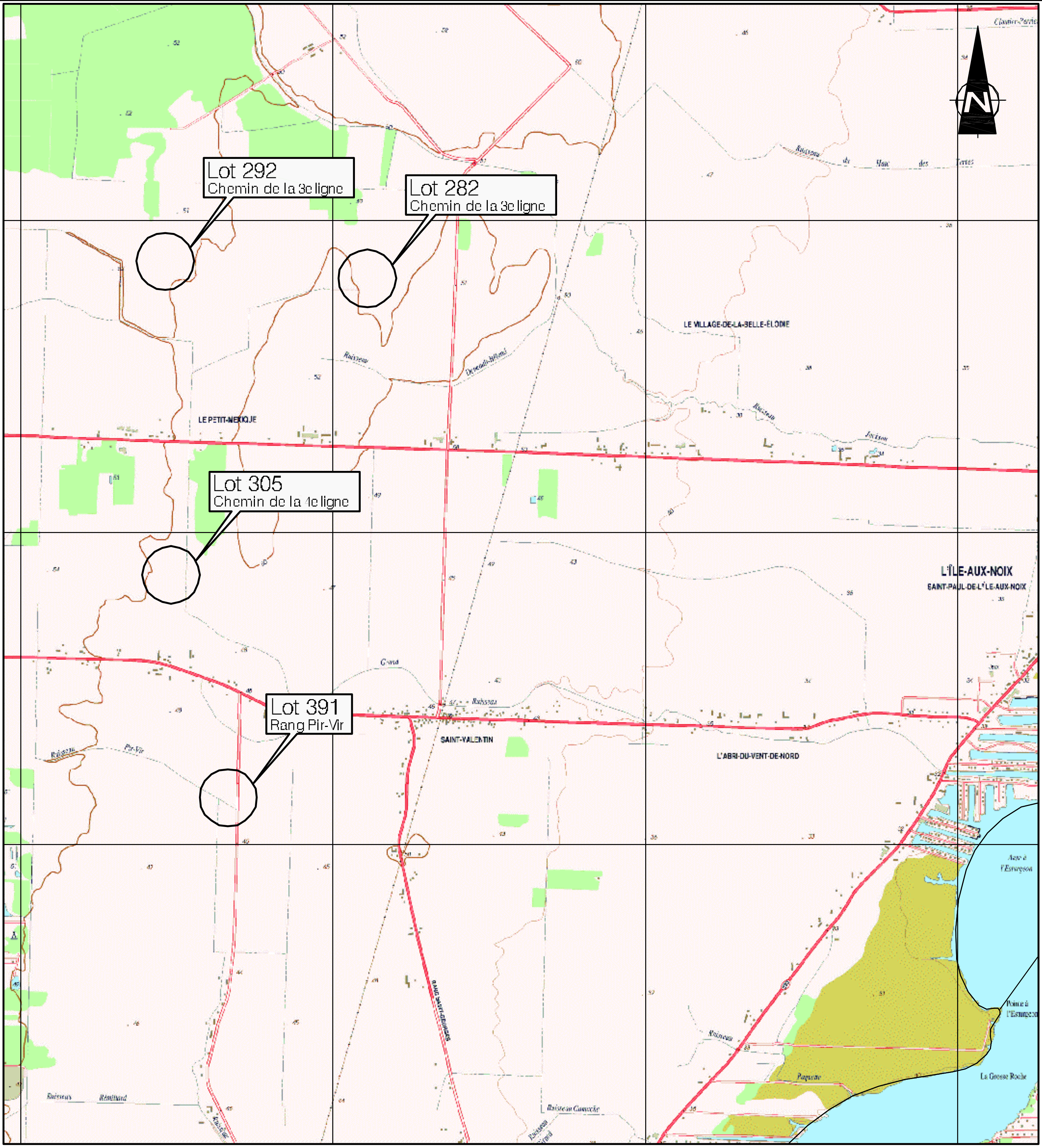
Original Signed By

Afif El-Dana, ing.jr.
Project Manager

Original Signed By

J.G.A. Raymond Haché, M.Sc., P.Eng., ing., PMP
Principal and Senior Service Director,
Geotechnical and Materials Engineering

AED/RH/sk



SOURCE:
Quebec Topographic Data Base
Map no. 31H03-200-0101 and 31H03-200-0201

0 500 1 000 1 500 2 000 m

Date:	2007-03-27	Scale:	graphic
Drawn by:	M.T.	Checked by:	A.E.D.
Approved by:	R.H.		
Drawing no:	1023239-000-01	Project no:	1023239

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Jacques Whitford

GEOTECHNICAL INVESTIGATION
WIND TURBINE PROJECT
SAINT-BLAISE / SAINT-VALENTIN, QC

KEY PLAN
SITE LOCATIONS

FIGURE
1

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

Topsoil	-	mixture of soil and humus capable of supporting vegetative growth
Peat	-	mixture of visible and invisible fragments of decayed organic matter
Till	-	unstratified glacial deposit which may range from clay to boulders
Fill	-	material below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

Desiccated	-	having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
Fissured	-	having cracks, and hence a blocky structure
Varved	-	composed of regular alternating layers of silt and clay
Stratified	-	composed of alternating successions of different soil types, e.g. silt and sand
Layer	-	> 75 mm in thickness
Seam	-	2 mm to 75 mm in thickness
Parting	-	< 2 mm in thickness

Terminology describing soil types:
The classification of soil types are made on the basis of grain size and plasticity in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 or D 2488). The classification excludes particles larger than 76 mm (3 inches). The USCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):
Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter, construction debris) is based upon the proportion of these materials present:

Trace, or occasional	Less than 10%
Some	10-20%
Frequent	> 20%

Terminology describing compactness of cohesionless soils:
The standard terminology to describe cohesionless soils includes compactness (formerly "relative density"), as determined by the Standard Penetration Test N-Value (also known as N-Index). A relationship between compactness condition and N-Value is shown in the following table.

Compactness Condition	SPT N-Value
Very Loose	<4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

Terminology describing consistency of cohesive soils:
The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by *in situ* vane tests, penetrometer tests, or unconfined compression tests.

Consistency	Undrained Shear Strength	
	kips/sq.ft.	kPa
Very Soft	<0.25	<12.5
Soft	0.25 - 0.5	12.5 - 25
Firm	0.5 - 1.0	25 - 50
Stiff	1.0 - 2.0	50 – 100
Very Stiff	2.0 - 4.0	100 - 200
Hard	>4.0	>200

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ROCK DESCRIPTION

Terminology describing rock quality:

RQD	Rock Mass Quality
0-25	*Very Poor*
25-50	*Poor*
50-75	*Fair*
75-90	*Good*
90-100	*Excellent*

Rock quality classification is based on a modified core recovery percentage (RQD) in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be due to close shearing, jointing, faulting, or weathering in the rock mass and are not counted. RQD was originally intended to be done on NW core; however, it can be used on different core sizes if the bulk of the fractures caused by drilling stresses are easily distinguishable from *in situ* fractures. The terminology describing rock mass quality based on RQD is subjective and is underlain by the presumption that sound strong rock is of higher engineering value than fractured weak rock.

Terminology describing rock mass:

Spacing (mm)	Joint Classification	Bedding, Laminations, Bands
> 6000	*Extremely Wide*	-
2000-6000	*Very Wide*	*Very Thick*
600-2000	*Wide*	*Thick*
200-600	*Moderate*	*Medium*
60-200	*Close*	*Thin*
20-60	*Very Close*	*Very Thin*
<20	*Extremely Close*	*Laminated*
<6	-	*Thinly Laminated*

Terminology describing rock strength:

Strength Classification	Unconfined Compressive Strength (MPa)
Extremely Weak	< 1
Very Weak	1 – 5
Weak	5 – 25
Medium Strong	25 – 50
Strong	50 – 100
Very Strong	100 – 250
Extremely Strong	> 250

Terminology describing rock weathering:

Term	Description
Fresh	No visible signs of rock weathering. Slight discolouration along major discontinuities
Slightly Weathered	Discolouration indicates weathering of rock on discontinuity surfaces. All the rock material may be discoloured.
Moderately Weathered	Less than half the rock is decomposed and/or disintegrated into soil.
Highly Weathered	More than half the rock is decomposed and/or disintegrated into soil.
Completely Weathered	All the rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact.

STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.

Boulders Cobbles Gravel | Sand | Silt | Clay | Organics | Asphalt | Concrete | Fill | Igneous Bedrock | Meta-morphic Bedrock | Sedi-mentary Bedrock

SAMPLE TYPE

SS	Split spoon sample (obtained by performing the Standard Penetration Test)
ST	Shelby tube or thin wall tube
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ, NQ, BQ, etc.	Rock core samples obtained with the use of standard size diamond coring bits.

WATER LEVEL MEASUREMENT

measured in standpipe, piezometer, or well

inferred

RECOVERY

For soil samples, the recovery is recorded as the length of the soil sample recovered. For rock core, recovery is defined as the total cumulative length of all core recovered in the core barrel divided by the length drilled and is recorded as a percentage on a per run basis.

N-VALUE / RQD

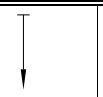
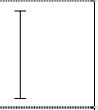
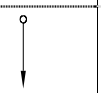
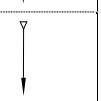
Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 140 pound (64 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (305 mm) into the soil. For split spoon samples where insufficient penetration was achieved and N-values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75). Some design methods make use of N value corrected for various factors such as overburden pressure, energy ratio, borehole diameter, etc. No corrections have been applied to the N-values presented on the log. RQD is based on a modified core recovery percentage in which all pieces of sound core over 100 mm long are counted as recovery.

DYNAMIC CONE PENETRATION TEST (DCPT)

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to A size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone one foot (305 mm) into the soil. The DCPT is used as a probe to assess soil variability. Soil type may be inferred from adjacent boreholes and test pits.

OTHER TESTS

S	Sieve analysis
H	Hydrometer analysis
k	Laboratory permeability
γ	Unit weight
G_s	Specific gravity of soil particles
CD	Consolidated drained triaxial
CU	Consolidated undrained triaxial with pore pressure measurements
UU	Unconsolidated undrained triaxial
DS	Direct Shear
C	Consolidation
Q_u	Unconfined compression
I_p	Point Load Index (I_p on Borehole Record equals $I_p(50)$ in which the index is corrected to a reference diameter of 50 mm)

	Single packer permeability test; test interval from depth shown to bottom of borehole
	Double packer permeability test; test interval as indicated
	Falling head permeability test using casing
	Falling head permeability test using well point or piezometer

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APPENDIX A

BH07-1 Lot 391, Rang Pir-Vir

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1.0 FINDINGS

The subsurface conditions encountered at the Lot 391, Rang Pir-Vir, location are described in detail on the attached Borehole Record and are summarized in the following paragraphs. An explanation of the symbols and terms used to describe the Borehole Records is also provided.

1.1 Subsurface Information

Borehole BH07-1 was extended to practical SPT refusal at a depth of 15.35 m. The observed stratigraphy consisted of 0.3 m of topsoil over 1.2 m of loose brown sand with silt (SP-SM) layer. Underlying the sand was around 6.7 m of inorganic lean clay (CL) of medium plasticity with in situ shear strength values ranging from 55 to 60 kPa followed by 7.65 m of granular soil ranging from loose silt (MH) to sand and gravel (SP) becoming coarser and denser with depth.

The groundwater level was measured at a depth of 0.45 m below existing ground surface on March 25, 2007. Groundwater levels typically vary with seasonal changes, therefore the groundwater conditions at the time of construction may differ from those encountered during the investigation.

Laboratory testing of representative samples consisted of Atterberg Limits testing conducted on the clay in addition to moisture contents testing. The average Liquid Limit of representative samples was 42 with a Plasticity Index of 24.The moisture content ranged from 22% to 72%.

2.0 DISCUSSION AND RECOMMENDATIONS

It is understood that a concrete pad type foundation is proposed to support the wind turbine tower. The pad would be octagonal and would be placed at a depth of around 2.4 m. The proposed turbine has a height (at the hub) of 70 m.

2.1 Geotechnical resistance - Spread Footings

The clay encountered from 2.3 m to 8.2 m is a stiff lean clay. Based on the results of the in situ undrained shear strength testing and laboratory tasting, it is estimated that the geological preconsolidation on this clay is in the order of 150 to 170 kPa above the existing overburden pressures. For preliminary foundation design purposes, the following geotechnical bearing resistances may be considered for footings founded on the clay at the site:

Geotechnical Resistances		
Footing Size	**ULS [1]**	**SLS [2]**
6 m Diameter	170 kPa	130 kPa
10 m Diameter	170 kPa	110 kPa

Notes:

1) *The geotechnical resistance at Ultimate Limit States (ULS) is based on the nominal ultimate resistance multiplied by a geotechnical resistance factor of 0.5.*

2) *The geotechnical resistance at the Serviceability Limit States (SLS) is based on calculated settlements of less than 25 mm using unfactored characteristic resistance values. Also included in the calculated values is the impact of lowering the groundwater level to 2.4 m below existing grade.*

Where required, structural Fill placed beneath the foundation should consist of a virgin granular soil with no recycled materials, such as asphaltic concrete or Portland cement concrete. This granular soil should be tested and approved by a geotechnical engineer prior to delivery to the site. Structural Fill should be placed in lifts no thicker than 300 mm and compacted to at least 95 % of Modified Proctor maximum dry density (MPMDD) using suitable compaction equipment.

2.2 Geotechnical Resistance – Piled Foundations

Should the geotechnical bearing resistances provided above be insufficient for the support of the proposed wind turbine foundations, the foundations could be supported on piles driven to refusal within the till or on bedrock.

For preliminary design purposes the following geotechnical resistance may be considered:

Pile Type	Geotechnical resistance ULS	Anticipated Lengths
HP 310 x 110	2000 kPa	15 to 17 m

It is noted that from a geotechnical perspective, piles driven to refusal are generally considered relatively unyielding and geotechnical resistances at Serviceability Limit State (SLS) is considered to be non-applicable.

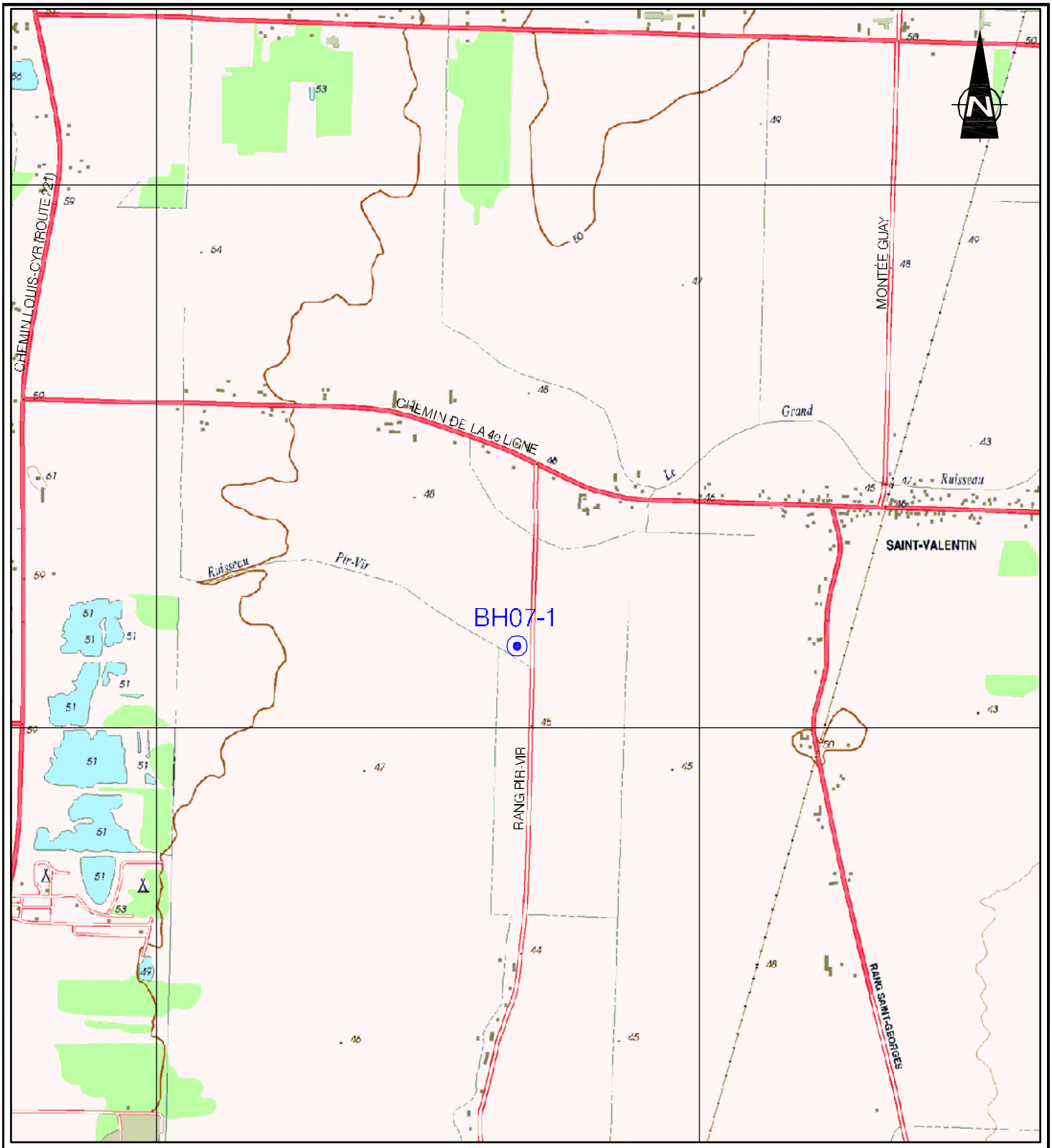
2.3 Construction Considerations

The groundwater level is near the ground surface; therefore drainage must be provided to control groundwater flow into excavations during construction with an appropriate pump and sump arrangements. Additional site-specific recommendations can be provided at the time of construction.

Temporary excavations in the overburden should be sloped at 1 horizontal to 1 vertical from 1.2 m above the base of the excavation and as per the requirements of the provincial “Commission de la santé et sécurité au travail” (CSST). Excavations must be inspected regularly for signs of instability and flattened as required.

2.4 Earthquake Considerations

As outlined in the National Building Code of Canada (NBCC), building and its foundations must be designed to resist a minimum earthquake force. In accordance with the new 2005 NBCC, this site is classified as a Class D.



SOURCE:
Quebec Topographic Data Base
Map no. 31H03-200-0101 and 31H03-200-0201

LEGEND:
BH07-1 Borehole

0 300 600 900 1200 m

Date:	2007-03-27	Scale:	graphic
Drawn by:	M.T.	Checked by:	A.E.D.
Approved by:	R.H.		
Drawing no:	1023239-000-BH1	Project no:	1023239

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GEOTECHNICAL INVESTIGATION
WIND TURBINE PROJECT
SAINT-BLAISE / SAINT-VALENTIN, QC

BOREHOLE LOCATION PLAN

FIGURE
2

BOREHOLE RECORD

BH07-1

CLIENT TCI Renewables

LOCATION Saint-Valentin and St-Blaise-sur-Richelieu, Qc

DATES: BORING 2007-03-17 WATER LEVEL 2007-03-25

BOREHOLE No. BH07-1

PROJECT No. 1023239

DATUM Arbitrary

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (lenght/610mm)	SAMPLES N-VALUE OR RQD
0		TOPSOIL		▼	SS	1	610	19
1		Loose brown poorly graded SAND with silt, moist (SP-SM)			SS	2	256	6
2		Stiff brown lean CLAY, traces of gravel and shells, wet (CL)			SS	3	506	1
3		- Grey below 2.3m			SS	4	610	0
4					SS	5	610	0
5					SS	6	610	1
6					SS	7	610	0
7					SS	8	610	0
8					SS	9	610	0
9		Loose to compact grey elastic SILT, traces of clay, wet (MH)			SS	10	610	0
10					SS	11A	610	7
11					SS	11B	610	13
12		Loose grey poorly graded SAND with silt, traces of cobbles, wet (SP-SM)			SS	12	458	5
13		Dense grey poorly graded SAND with gravel, wet (SP)			SS	13	281	8
14		Very dense grey SILT with gravel, moist (ML)			SS	14	305	42
15					SS	15	130/130mm	50/5"
16		Pratical SPT refusal at 15.4m on inferred bedrock or boulder			SS	16	115/115mm	50/4.5"

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m

STANDARD PENETRATION TEST, BLOWS/0.3m

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd

Date

JWL-OLD 1023239-LOGS.GPJ JWEL.GDT 07-04-17

APPENDIX B

BH07-2 Lot 305, Chemin de la 4ième Ligne

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1.0 FINDINGS

The subsurface conditions encountered at the Lot 305, Chemin de la 4ème Ligne site location are described in detail on the attached Borehole Record and are summarized in the following paragraphs. An explanation of the symbols and terms used to describe the Borehole Records is also provided.

1.1 Subsurface Information

Borehole BH07-2 was extended to practical refusal at a depth of 7.4 m, then was extended by coring for a total length of 9.32 m. The observed stratigraphy consisted of 0.2 m of topsoil over 4.4 m of loose to compact silt and sand layers extending to 5.3 m below ground surface. Below 5.3 m, the soil deposit consist of a compact to dense till which extends down to bedrock at 7.4m.

The groundwater level could not be measured because the standpipe was removed. Nevertheless the ground water elevation is anticipated to be around 1 m from ground surface. Groundwater levels typically vary with seasonal changes, therefore the groundwater conditions at the time of construction may differ from those encountered during the investigation.

Laboratory testing of representative samples consisted of a sieve analysis in addition to moisture contents testing. The representative sample (sample spoons SS4-SS6) tested for grain size distribution consisted of 79% sand, 16% gravel and 5% silt classifying it as poorly graded sand with gravel (SP). The moisture content ranged from 12% to 28%.

2.0 DISCUSSION AND RECOMMENDATIONS

It is understood that a concrete pad type foundation is proposed to support the wind turbine tower. The pad would be octagonal and would be placed at a depth of around 2.4 m. The proposed turbine has a height (at the hub) of 70 m.

2.1 Bearing Capacity

The silt and sand encountered beneath the topsoil becomes loose from 1.8 m to 5.3 m with N values between 4 and 9. These values are considered too low to support the proposed foundation. Based on the soil conditions observed at the site, the following foundation options may be considered.

- Option 1:

  Remove and replace the loose soils from beneath the wind turbine foundations. Based on Borehole BH07-2, the excavation would extend to 3.0 m below the proposed foundation level and would need to extend laterally 3.0 m beyond the edge of the proposed foundations. The replacement material would consist of structural fill made of MG-112 material (granular soil with little fines) placed and compacted in 300 mm lifts to 95% of Modified Proctor Maximum Dry Density (MPMDD). The following bearing pressures would then be suitable:

Geotechnical Resistances		
Footing Size	**ULS**	**SLS**
6 m Diameter	650 kPa	200 kPa
10 m Diameter	800 kPa	200 kPa

The ULS values incorporate a resistance factor of 0.5 against the nominal ultimate resistance and the SLS values are based on settlements of up to 25 mm.

- Option 2:

  Advance augered caissons to refusal into the underlying bedrock. It is anticipated that caissons sizes of 0.9 m to 1.2 m in diameter, augered to 0.5 m within the bedrock, would provide geotechnical resistance at ULS at 5000 kPa, which incorporates a resistance factor of 0.4 against the nominal ultimate resistance. The bedrock is generally considered unyielding and therefore a geotechnical resistance at SLS is not considered applicable.

- Option 3:

  Engage a specialist contractor to dynamically compact the soils, using a large free falling weight, to improve the soils in situ. Dynamic compaction would need to be carried out to at least 4 m beyond the foundation footprint and would need to be designed by the specialist contractor. This option would improve the geotechnical bearing resistance at ULS to at least 500 kPa and at SLS to at least 200 kPa.

Due to the presence of the very permeable sand at BH07-2, which would impose some difficulties on options 1 and 2, option 3 is recommended as the preferred option.

2.2 Construction Considerations

The extent of dewatering required for this project will depend on which option is considered most cost effective. Option 1 will require the removal of close to 3.0 m of potentially high permeable sand. Prior to excavating to remove this material, it would be necessary to dewater the sand using a well point system. This level of effort would suggest that options 2 and 3 may be more feasible.

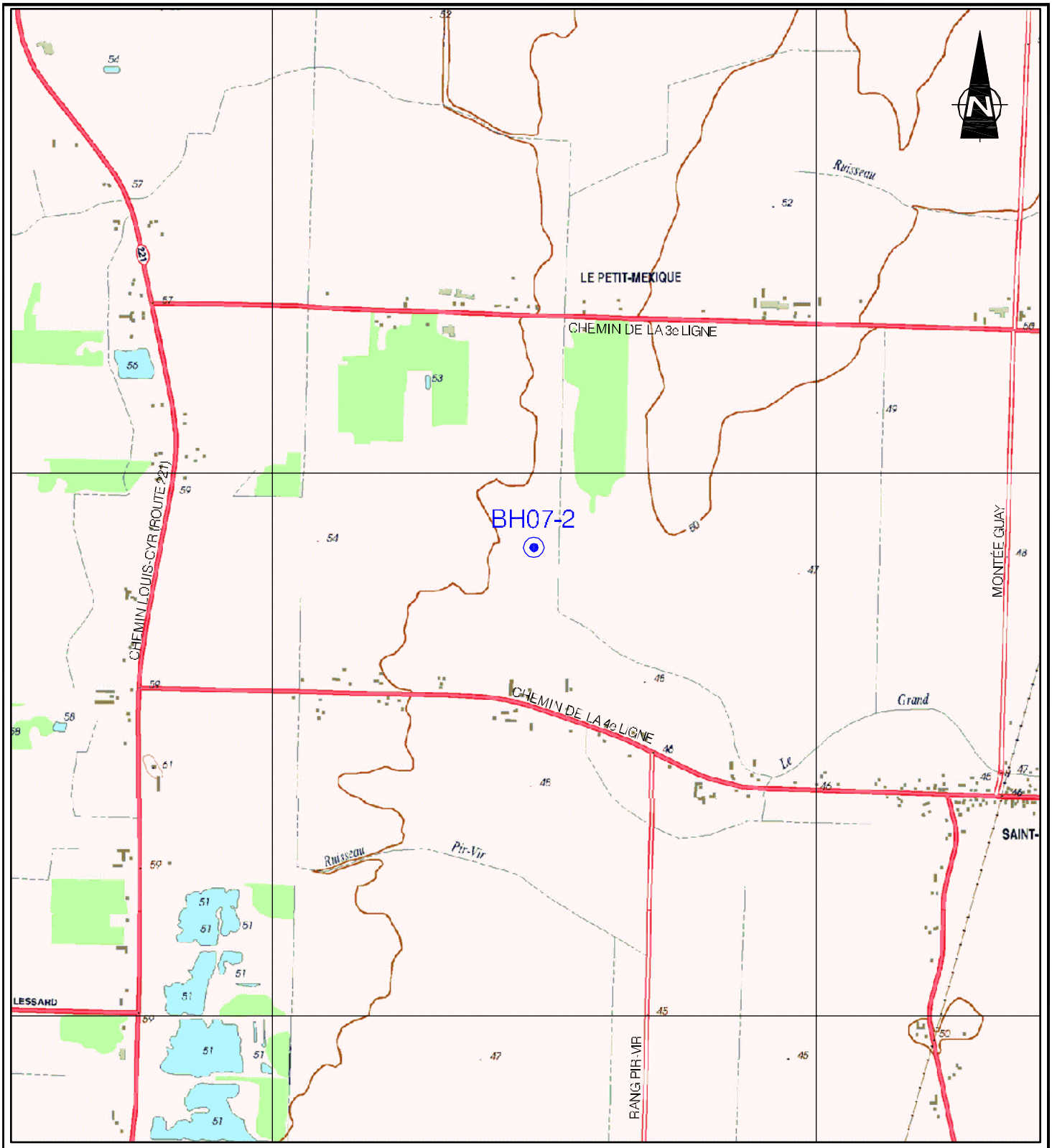
Should option 2 be carried forward, it will be necessary to case the holes with a temporary or permanent liner to ensure that the sand does not flow into the auger hole.

Option 3, where dynamic compaction is carried out, would require the least strenuous dewatering activities within the very permeable sands present at the site.

Temporary excavations in the overburden shall be sloped at 1 horizontal to 1 vertical from 1.2 m above the base of the excavation and as per the requirements of the provincial “Commission de la santé et sécurité au travail” (CSST). Excavations must be inspected regularly for signs of instability and flattened as required.

2.3 Earthquake Considerations

As outlined in the National Building Code of Canada (NBCC), building and its foundations must be designed to resist a minimum earthquake force. In accordance with the new 2005 NBCC, this site is classified as a Class E. The classification would be upgraded to Class D should option 3, dynamic compaction, be carried out.



SOURCE:
Quebec Topographic Data Base
Map no. 31H03-200-0101 and 31H03-200-0201

LEGEND:
BH07-2 Borehole

0 300 600 900 1200 m

Date:	2007-03-27	Scale:	graphic
Drawn by:	M.T.	Checked by:	A.E.D.
Approved by:	R.H.		
Drawing no:	1023239-000-BH2	Project no:	1023239

TCI RENEWABLES

Jacques Whitford

GEOTECHNICAL INVESTIGATION
WIND TURBINE PROJECT
SAINT-BLAISE / SAINT-VALENTIN, QC

BOREHOLE LOCATION PLAN

FIGURE
2

Jacques Whitford

BOREHOLE RECORD

BH07-2

CLIENT TCI Renewables

LOCATION Saint-Valentin and St-Blaise-sur-Richelieu, Qc

DATES: BORING 2007-03-16 WATER LEVEL 2007-03-25 / Standpipe removed

BOREHOLE No. BH07-2

PROJECT No. 1023239

DATUM Arbitrary

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (lenght/610mm)	SAMPLES N-VALUE OR RQD
0		TOPSOIL			SS	1A	610	12
					SS	1B	610	20
1		Compact brown SILT with sand, moist (ML)			SS	2	506	14
		- Traces of gravel						
2		Loose to compact grey poorly graded SAND with silt and gravel, wet (SP-SM)			SS	3	561	14
					SS	4	458	6
3		- Traces of cobbles			SS	5	482	4
4					SS	6	201	9
5		Loose grey SILT with gravel, traces of cobbles, wet (ML)			SS	7	506	7
		Compact to dense grey well graded sand with gravel, traces of cobbles, wet (SW): TILL			SS	8	201	28
6					SS	9	150/410mm	10-7-50/4"
7					SS	10	40/115mm	50/4.5"
8		Limestone BEDROCK - grey - closely space joints from 7.30 to 8.20m			NQ		610	97%
9		- excellent rock mass quality below 8.20m						
10		End of borehole at 9.3m						
11								
12								
13								
14								
15								
16								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m

STANDARD PENETRATION TEST, BLOWS/0.3m

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd

Date

8170 Montview Rd. suite 100
Mount Royal QC, H4P 2L7
Tel: 514 739-0708
Fax: 514 739-8499

Sieve Analysis

Client: **TCI Renewables**
Project: **Saint Blaise / Saint Valentin, QC**
Project No: **1023239**
Material Type: **Soils/Aggregrates:**
Proposed Use: **Fill/Granulars:**
Supplier:
Source:
Sampled From: **Borehole**
Sampled By: **Chantal Marcoux**
Date Sampled:

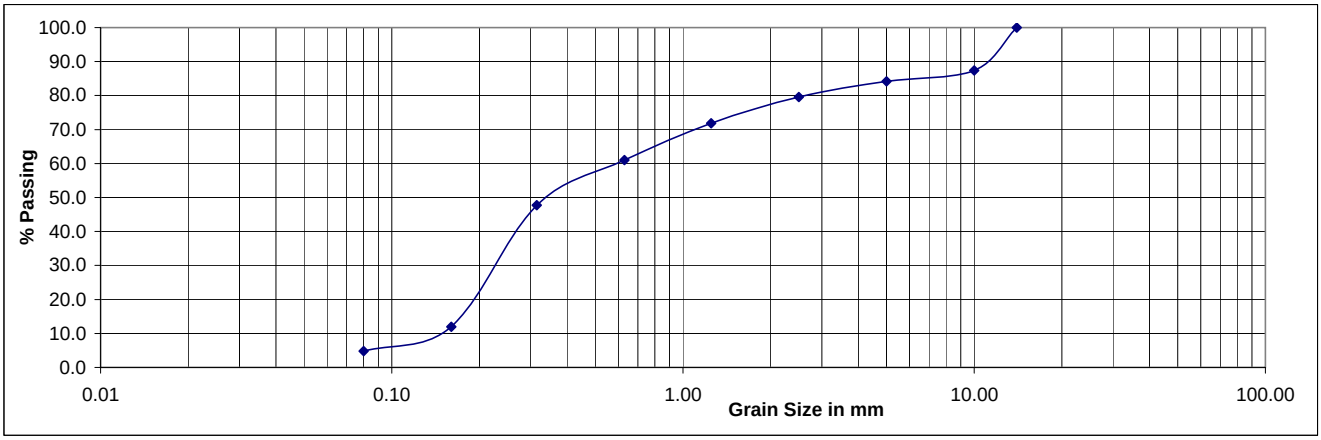
Test Method: **ASTM C136**
Sample No: **BH07-2; SS 4-SS 6**
Tested By: **Steve Bernardi**
Date Tested: **2-Apr-07**

Results

Sample Weight Before Sieve (g)	316.3
Sample Weight After Sieve (g)	315.4
% Loss in Sieve	0.28

Sieve Analysis

Sieve No.	Size of Opening		Weight	Amount	Cumulative	% Passing	Specifications	
	inches	mm	Retained(g)	Retained(wt %)	Amt.Retained(%)		Min	Max
	1	**28.00**	0.00	0.00	0.00	100.00		
	3/4	**20.00**	0.00	0.00	0.00	100.00		
	1/2	**14.00**	0.00	0.00	0.00	100.00		
	3/8	**10.00**	40.00	12.65	12.65	87.35		
4.75	**0.187**	**5.00**	10.10	3.19	15.84	84.16		
8	**0.0937**	**2.50**	14.50	4.58	20.42	79.58		
16	**0.0469**	**1.25**	24.50	7.75	28.17	71.83		
30	**0.0234**	**0.630**	34.20	10.81	38.98	61.02		
50	**0.0117**	**0.315**	42.10	13.31	52.29	47.71		
100	**0.0059**	**0.160**	113.10	35.76	88.05	11.95		
200	**0.0029**	**0.080**	22.50	7.11	95.16	4.84		
		Pan	14.40	4.55	99.72	-		
Classification of Sample		**% Gravel:**	**15.8**	**% Sand:**	**79.3**	**% Silt & Clay:**		**4.8**



Remarks: Poorly graded sand with gravel (SP).

APPENDIX C

BH07-3 Lot 292, Chemin de la 3ième Ligne

1.0 FINDINGS

The subsurface conditions encountered at the Lot 292, Chemin de la 3ième Ligne site location are described in detail on the attached Borehole Record and are summarized in the following paragraphs. An explanation of the symbols and terms used to describe the Borehole Records is also provided.

1.1 Subsurface Information

Borehole BH07-3 was extended to practical refusal to further auger advancement at 8.4 m then extended by coring for a total length of 12.24 m. The observed stratigraphy consisted of 0.35 m of topsoil over 0.4 m of dense brown sand with gravel (SP) layer. Underlying this layer is a generally compact sand extending to 8.4 m below the ground surface. Below is a very dense till consisting primarily of a silt with sand and cobbles.

The groundwater level was measured at a depth of 0.6 m below existing ground surface on March 25, 2007. Groundwater levels typically vary with seasonal changes, therefore the groundwater conditions at the time of construction may differ from those encountered during field-testing.

Laboratory testing of representative samples consisted of a sieve analysis in addition to moisture contents testing. The representative sample (SS4) consisted of 74% sand, 20% gravel and 6 % silt classifying it as well graded sand with silt and gravel (SW-SM). The moisture content ranged from 8 to 17%.

2.0 DISCUSSION AND RECOMMENDATIONS

It is understood that concrete pad type foundation is proposed to support the wind turbine tower. The pad is octagonal and will be placed at a depth of around 2.4 m. The turbine has a height (hub) of 70 m.

2.1 Bearing Capacity

The encountered sand had standard penetration test N values ranging from 9 to 30 within the zone of influence of the footing. Based on the observed soil conditions, the following two foundations alternatives may be considered as part of the preliminary design.

- Option 1:

  Place the foundations on the native soils in their present state. The following geotechnical resistances would apply:

Geotechnical Resistances		
Footing Size	**ULS**	**SLS**
6 m Diameter	500 kPa	100 kPa
10 m Diameter	600 kPa	90 kPa

- Option 2:

  Engage a specialist contractor to dynamically compact the soils, using a large free falling weight, to improve the soils in situ. Dynamic compaction would need to be carried out to at least 5 m beyond the foundation footprint and would need to be designed by the specialist contractor. This option would improve the geotechnical bearing resistance at ULS to above 700 kPa and at SLS to at least 200 kPa.

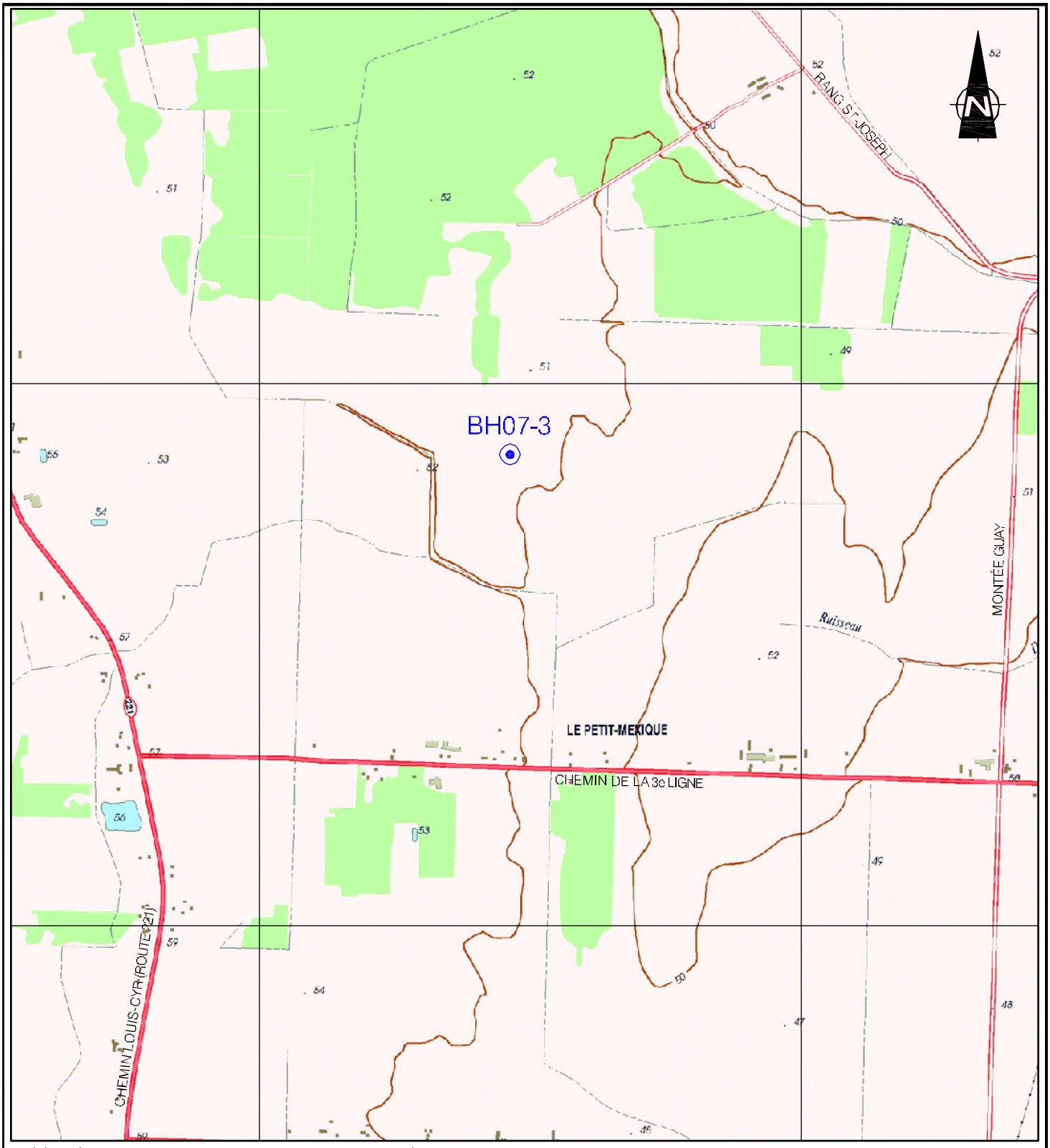
2.2 Construction Considerations

Underground water level being near the ground surface, drainage must be provided to control groundwater flow into excavations during construction with an appropriate pump and sump arrangement. Additional site-specific recommendations can be provided at the time of construction.

Temporary excavations in the overburden shall be sloped at 1 horizontal to 1 vertical from 1.2 m above the base of the excavation and as per the requirements of the provincial “Commission de la santé et sécurité au travail” (CSST). Excavations must be inspected regularly for signs of instability and flattened as required.

2.3 Earthquake Considerations

As outlined in the National Building Code of Canada (NBCC), building and its foundations must be designed to resist a minimum earthquake force. In accordance with the new 2005 NBCC, this site is classified as a Class D.



SOURCE:
Quebec Topographic Data Base
Map no. 31H03-200-0101 and 31H03-200-0201

LEGEND:
BH07-3 Borehole

Date:	2007-03-27	Scale:	graphic
Drawn by:	M.T.	Checked by:	A.E.D.
Approved by:	R.H.		
Drawing no:	1023239-000-BH3	Project no:	1023239

TCI RENEWABLES

Jacques Whitford

GEOTECHNICAL INVESTIGATION
WIND TURBINE PROJECT
SAINT-BLAISE / SAINT-VALENTIN, QC

BOREHOLE LOCATION PLAN

FIGURE
2

Jacques Whitford

BOREHOLE RECORD

BH07-3

CLIENT TCI Renewables

LOCATION Saint-Valentin and St-Blaise-sur-Richelieu, Qc

DATES: BORING 2007-03-15 WATER LEVEL 2007-03-25

BOREHOLE No. BH07-3

PROJECT No. 1023239

DATUM Arbitrary

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (lenght/610mm)	N-VALUE OR RQD
0		TOPSOIL			SS	1	610	29
1		Dense brown poorly graded SAND with gravel, moist (SP)			SS	2	561	38
2		Compact to dense brown to grey well graded SAND with silt and gravel, traces of cobbles, wet (SW-SM)			SS	3	281	14
3					SS	4	305	30
4					SS	5	201	13
5					SS	6	305	21
6					SS	7	305	13
7					SS	8	458	9
8					SS	9	458	11
					SS	10	384	10
		Auger refusal at 8.4m			SS	11	230/ 530mm	9-10-10-50/3"
9		Very dense grey wet SILT with sand and cobbles (ML): TILL - Borehole advanced by coring below 8.40m			SS	12	130/ 130mm	50/5"
10					SS	13	510	28-43-29-50/6"
11					SS	14	40/ 65mm	50/2.5"
12		End of borehole at 12.2m						
13								
14								
15								
16								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd

Date

JWL-OLD 1023239-LOGS.GPJ JWEL.GDT 07-04-17

8170 Montview Rd. suite 100
Mount Royal QC, H4P 2L7
Tel: 514 739-0708
Fax: 514 739-8499

Sieve Analysis

Client: **TCI Renewables**
Project: **Saint Blaise / Saint Valentin, QC**
Project No: **1023239**
Material Type: **Soils/Aggregrates:**
Proposed Use: **Fill/Granulars:**
Supplier:
Source:
Sampled From: **Borehole**
Sampled By: **Chantal Marcoux**
Date Sampled:

Test Method: **ASTM C136**

Sample No: **BH07-3; SS 4**
Tested By: **Steve Bernardi**
Date Tested: **2-Apr-07**

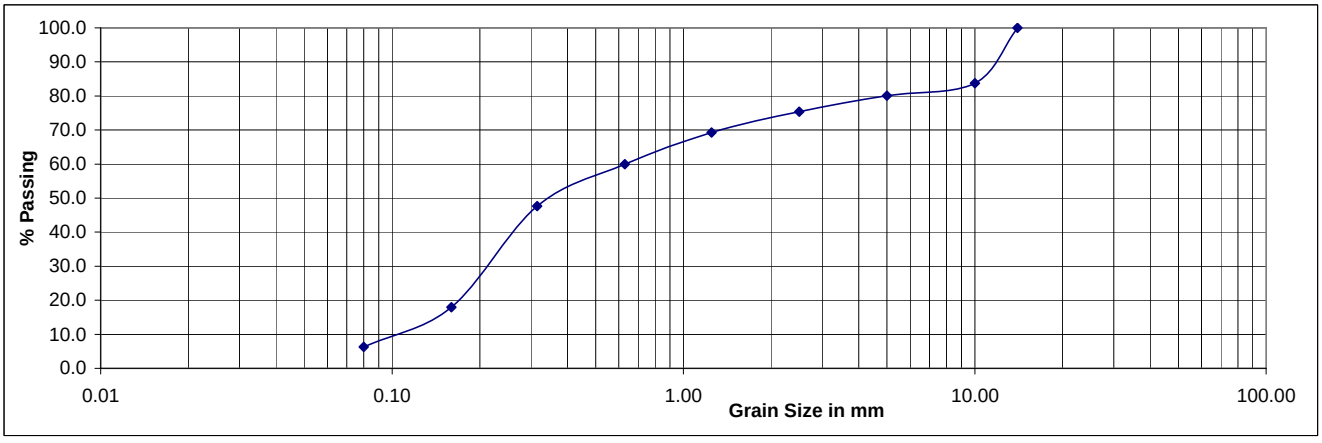
Results

Sample Weight Before Sieve (g)	310.0
Sample Weight After Sieve (g)	309.7
% Loss in Sieve	0.10

Sieve Analysis

Sieve No.	Size of Opening		Weight	Amount	Cumulative	% Passing	Specifications	
	inches	mm	Retained(g)	Retained(wt %)	Amt.Retained(%)		Min	Max
	1	**28.00**	0.00	0.00	0.00	100.00		
	3/4	**20.00**	0.00	0.00	0.00	100.00		
	1/2	**14.00**	0.00	0.00	0.00	100.00		
	3/8	**10.00**	50.40	16.26	16.26	83.74		
4.75	**0.187**	**5.00**	11.50	3.71	19.97	80.03		
8	**0.0937**	**2.50**	14.40	4.65	24.61	75.39		
16	**0.0469**	**1.25**	19.10	6.16	30.77	69.23		
30	**0.0234**	**0.630**	28.80	9.29	40.06	59.94		
50	**0.0117**	**0.315**	38.10	12.29	52.35	47.65		
100	**0.0059**	**0.160**	92.00	29.68	82.03	17.97		
200	**0.0029**	**0.080**	36.20	11.68	93.71	6.29		
		Pan	19.20	6.19	99.90	-		

Classification of Sample **% Gravel:** **20.0** **% Sand:** **73.7** **% Silt & Clay:** **6.3**



Remarks: Well-graded sand with silt and gravel (SW-SM).

APPENDIX D

BH07-4 Lot 282, Chemin de la 3ième Ligne

Jacques Whitford

1.0 FINDINGS

The subsurface conditions encountered at the Lot 282, Chemin de la 3ième Ligne site location are described in detail on the attached Borehole Record and are summarized in the following paragraphs. An explanation of the symbols and terms used to describe the Borehole Records is also provided.

1.1 Subsurface Information

Borehole BH07-4 was extended to practical refusal to further auger advancement at 9.75 m, then was extended by coring for a total length of 10.76 m. The observed stratigraphy consisted of 0.45 m of topsoil over 0.3 m of lean clay with sand (CL) layer. Underlying this layer was around 9.0 m of granular soil from loose to very dense sand with silt and gravel (SM-SW) becoming coarser and denser with depth. A very dense glacial till was encountered beneath the sand.

The groundwater level was measured at a depth of 0.8 m below existing ground surface on March 25, 2007. Groundwater levels may vary with seasonal changes, therefore the groundwater conditions at the time of construction may differ from those encountered during the investigation.

Laboratory testing of representative samples consisted of a sieve analysis in addition to moisture contents testing. The representative sample (SS5) consisted of 76 % sand, 16% gravel and 68% silt classifying it as well graded sand with silt and gravel (SW-SM). The moisture content ranged from 6 to 13%.

2.0 DISCUSSION AND RECOMMENDATIONS

It is understood that concrete pad type foundation is proposed to support the wind turbine tower. The pad would octagonal and would be placed at a depth of around 2.4 m. The proposed turbine has a height (at the hub) of 70 m.

2.1 Bearing Capacity

The encountered sand had the standard penetration test N values ranging from 5 to 36 within the zone of influence of the footing. Based on the observed soil conditions, the following two foundations alternatives may be considered as part of the preliminary design.

- Option 1:

  Place the foundations on the native soils in their present state. The following geotechnical resistances would apply:

Geotechnical Resistances		
Footing Size	**ULS**	**SLS**
6 m Diameter	400 kPa	70 kPa
10 m Diameter	500 kPa	70 kPa

- Option 2:

  Engage a specialist contractor to dynamically compact the soils, using a large free falling weight, to improve the soils in situ. Dynamic compaction would need to be carried out to at least 5 m beyond the foundation footprint and would need to be designed by the specialist contractor. This option would improve the geotechnical bearing resistance at ULS to above 700 kPa and at SLS to at least 200 kPa.

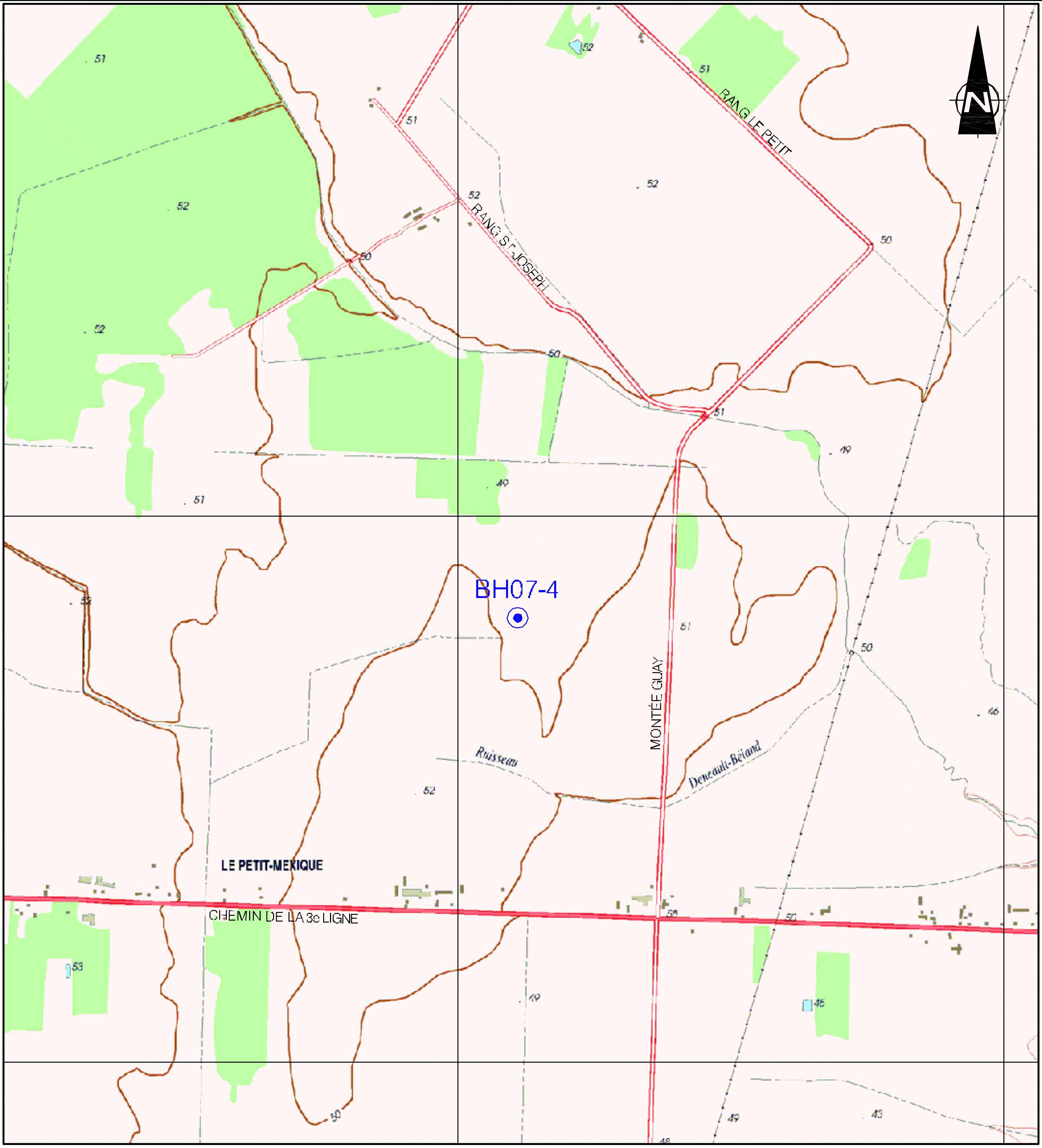
2.2 Construction Considerations

Underground water level being near the ground surface, drainage must be provided to control groundwater flow into excavations during construction with an appropriate pump and sump arrangement. Additional site-specific recommendations can be provided at the time of construction.

Temporary excavations in the overburden shall be sloped at 1 horizontal to 1 vertical from 1.2 m above the base of the excavation and as per the requirements of the provincial “Commission de la santé et sécurité au travail” (CSST). Excavations must be inspected regularly for signs of instability and flattened as required.

2.3 Earthquake Considerations

As outlined in the National Building Code of Canada (NBCC), building and its foundations must be designed to resist a minimum earthquake force. In accordance with the new 2005 NBCC, this site is classified as a Class D.



SOURCE:
Quebec Topographic Data Base
Map no. 31H03-200-0101 and 31H03-200-0201

LEGEND:
BH07-1 Borehole

0 300 600 900 1200 m

Date:	2007-03-27	Scale:	graphic
Drawn by:	M.T.	Checked by:	A.E.D.
Approved by:	R.H.		
Drawing no:	1023239-000-BH4	Project no:	1023239

TCI RENEWABLES

Jacques Whitford

GEOTECHNICAL INVESTIGATION
WIND TURBINE PROJECT
SAINT-BLAISE / SAINT-VALENTIN, QC

BOREHOLE LOCATION PLAN

FIGURE 2

Jacques Whitford

BOREHOLE RECORD

BH07-4

CLIENT TCI Renewables

LOCATION Saint-Valentin and St-Blaise-sur-Richelieu, Qc

DATES: BORING 2007-03-13 WATER LEVEL 2007-03-25

BOREHOLE No. BH07-4

PROJECT No. 1023239

DATUM Arbitrary

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (lenght/610mm)	N-VALUE OR RQD
0		TOPSOIL			SS	1A	610	
					SS	1B	610	18
1		Brown lean CLAY with sand, traces of organics, nearly dry (CL)		▼	SS	2	409	10
2		Loose to compact olive grey to grey well graded SAND with silt, moist (SW-SM)			SS	3	244	12
					SS	4	342	7
3		- Grey and wet with gravel below 3.00m			SS	5	409	5
4					SS	6	458	7
5					SS	7	256	36
					SS	8	384	26
6		- Cobbles below 6.00m			SS	9	232	34
7					SS	10	458	39
		- Very dense below 7.50m			SS	11	305	93
8					SS	12	40/130mm	50/5"
9					SS	13	40/50mm	50/2"
10		Very dense silt and sand with gravel and boulders (ML): TILL						
11		End of borehole at 10.7m						
12								
13								
14								
15								
16								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd

Date

JWL-OLD 1023239-LOGS.GPJ JWEL.GDT 07-04-17

8170 Montview Rd. suite 100
Mount Royal QC, H4P 2L7
Tel: 514 739-0708
Fax: 514 739-8499

Sieve Analysis

Client: **TCI Renewables**
Project: **Saint Blaise / Saint Valentin, QC**
Project No: **1023239**
Material Type: **Soils/Aggregrates:**
Proposed Use: **Fill/Granulars:**
Supplier:
Source:
Sampled From: **Borehole**
Sampled By: **Chantal Marcoux**
Date Sampled:

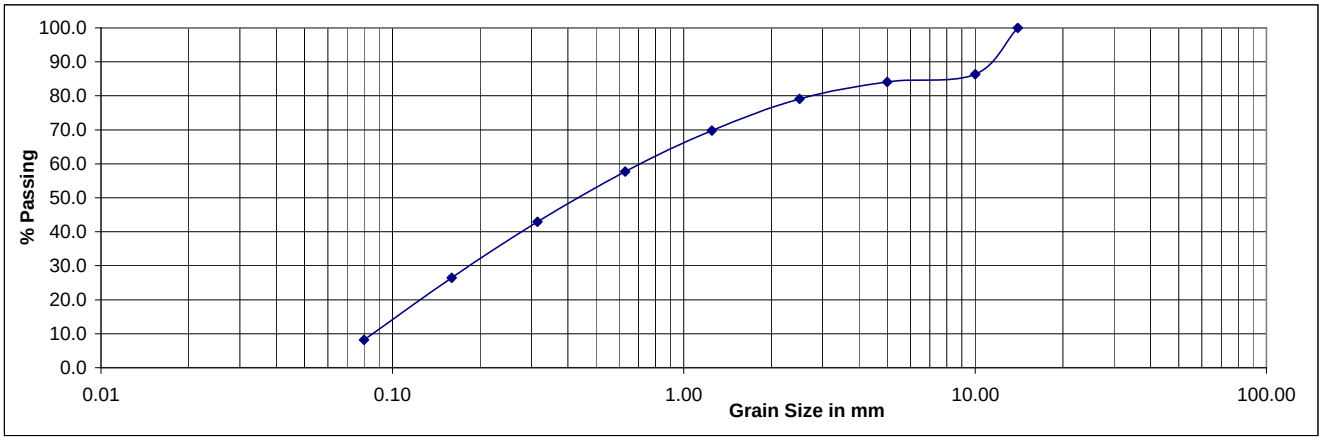
Test Method: **ASTM C136**
Sample No: **BH07-4; SS 3-SS 5**
Tested By: **Steve Bernardi**
Date Tested: **2-Apr-07**

Results

Sample Weight Before Sieve (g)	317.5
Sample Weight After Sieve (g)	316.8
% Loss in Sieve	0.22

Sieve Analysis

Sieve No.	Size of Opening		Weight	Amount	Cumulative	% Passing	Specifications	
	inches	mm	Retained(g)	Retained(wt %)	Amt.Retained(%)		Min	Max
	1	**28.00**	0.00	0.00	0.00	100.00		
	3/4	**20.00**	0.00	0.00	0.00	100.00		
	1/2	**14.00**	0.00	0.00	0.00	100.00		
	3/8	**10.00**	43.40	13.67	13.67	86.33		
4.75	**0.187**	**5.00**	7.00	2.20	15.87	84.13		
8	**0.0937**	**2.50**	15.90	5.01	20.88	79.12		
16	**0.0469**	**1.25**	29.70	9.35	30.24	69.76		
30	**0.0234**	**0.630**	38.30	12.06	42.30	57.70		
50	**0.0117**	**0.315**	46.80	14.74	57.04	42.96		
100	**0.0059**	**0.160**	52.50	16.54	73.57	26.43		
200	**0.0029**	**0.080**	58.00	18.27	91.84	8.16		
		Pan	25.20	7.94	99.78	-		
Classification of Sample		**% Gravel:**	**15.9**	**% Sand:**	**76.0**	**% Silt & Clay:**		**8.2**



Remarks: Well graded sand with silt and gravel (SW-SM).