

**PARKHILL INTERCONNECT - NOISE  
IMPACT ASSESSMENT**

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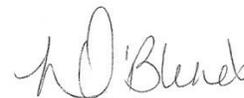
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### REVISION HISTORY

Issue	Date	Summary
A	22 February 2012	Original Version (electronic only). Issued as R-08-A under project 1008.
B	24 July 2012	Change in project number. New substation configuration and transformer specifications.
C	20 September 2012	Updates requested by MOE
D	05 November 2012	New transformer specification sheet

## TABLE OF CONTENTS

<b>1</b>	<b>INTRODUCTION</b>	<b>1</b>
<b>2</b>	<b>GENERAL DESCRIPTION OF PROJECT AREA</b>	<b>2</b>
2.1	General Characteristics	2
2.2	Land Use Description	2
2.3	Baseline Ambient Noise Conditions	3
2.4	Points of Reception	3
<b>3</b>	<b>PROJECT DESCRIPTION</b>	<b>6</b>
3.1	Life of the Project	6
3.2	Operating Hours	6
3.3	Noise Sources	7
3.3.1	Approach to the Study	7
3.3.2	Noise Sources Summary	7
3.3.3	Main Transformers	7
3.3.4	Sound Barrier	8
3.3.5	Summary Tables	8
<b>4</b>	<b>NOISE IMPACT ASSESSMENT</b>	<b>9</b>
4.1	Results	10
4.2	Mitigation Measures	11
<b>5</b>	<b>CONCLUSION</b>	<b>12</b>
<b>6</b>	<b>REFERENCES</b>	<b>13</b>
<b>APPENDIX A</b>	<b>MUNICIPALITY OF NORTH MIDDLESEX LAND USE MAP</b>	
<b>APPENDIX B</b>	<b>PROPOSED LOCATION AND TOPOGRAPHIC MAP</b>	
<b>APPENDIX C</b>	<b>NOISE SOURCES</b>	
<b>APPENDIX D</b>	<b>SAMPLE CALCULATION FOR NOISE MODELING</b>	
<b>APPENDIX E</b>	<b>SIMULATED NOISE ISO-CONTOURS</b>	
<b>APPENDIX F</b>	<b>POINT OF RECEPTION NOISE IMPACT TABLE</b>	

## LIST OF FIGURES

Figure 2-1: Land Features of the Parkhill Interconnect Site	2
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## LIST OF TABLES

Table 2-1: Permissible sound levels for a Class 3 area	3
Table 2-2: List of identified Points of Reception	4
Table 3-1: Noise Source Summary Table	8
Table 4-1: Acoustic assessment summary	10
Table C-1: Noise sources	18
Table C-2: 225 MVA substation main transformer octave band spectrum (including 5 dB penalty) <sup>1</sup>	18
Table C-3: Transformer octave band calculation details	18
Table F-1: Point of reception noise impact table	24

## 1 INTRODUCTION

Jericho Wind, Inc. is proposing to develop the Jericho Wind Energy Centre and the Parkhill Interconnect Project (“Parkhill Interconnect”), which are subject to Ontario Regulation 359/09 (Renewable Energy Approvals (REA) under Part V.0.1 of the Ontario Environmental Protection Act (EPA)) [1]. Jericho Wind, Inc. is seeking a Renewable Energy Approval from the Ontario Ministry of the Environment (MOE) for the Jericho Wind Energy Centre and its related Parkhill Interconnect Project.

The Parkhill Interconnect will consist of a switchyard, approximately 11.5 km of 115 kV transmission line and a substation. The substation will consist of two (2) 135/225 MVA transformers. The 115 kV line will run from the Parkhill Interconnect’s switchyard, known as the Bornish Switchyard, to the Parkhill Interconnect’s substation, known as the Parkhill Substation. The Parkhill Substation will then be interconnected to a Hydro One-owned switchyard, known as the Evergreen Switchyard, and to an existing Hydro One 500 kV transmission line that is common to the Jericho Wind Energy Centre, the Adelaide Wind Energy Centre (owned by Kerwood Wind, Inc.), and the Bornish Wind Energy Centre (owned by Bornish Wind, LP). The Point of Common Coupling will be the interface between the Parkhill Substation and Hydro One’s Evergreen Switchyard. The Parkhill Interconnect will be owned by Bornish Wind LP, Kerwood Wind, Inc., and Jericho Wind, Inc. These three companies are wholly-owned subsidiaries of NextEra Energy Canada, ULC (“NextEra”).

At the request of Jericho Wind, Inc. (the “Client”), GL Garrad Hassan Canada, Inc. (GL GH), prepared a Noise Impact Assessment (NIA) as per the requirements of the REA, Technical Guide to Renewable Energy Approvals and in accordance with Appendix A of the Ministry of the Environment’s publication entitled, “Basic Comprehensive Certificates of Approval (Air) – User Guide”, as amended periodically and available from the Ministry [2].

The purpose of this study is to verify compliance of the Parkhill Interconnect to current Ontario noise guidelines by calculating the noise levels generated by the Parkhill Interconnect at all Points of Reception in the vicinity of the main power transformers.

This study comprises 3 main sections: (i) a general description of the project area, noise sources and noise receptors, (ii) a description of the Parkhill Interconnect’s components including noise sources and acoustic barriers, and (iii) noise impact assessment results.

## 2 GENERAL DESCRIPTION OF PROJECT AREA

### 2.1 General Characteristics

The proposed Parkhill Interconnect is located in the Municipality of North Middlesex, Middlesex County, Ontario. The Study Area comprises a 115 kV transmission line from the Bornish Switchyard to the Point of Common Coupling (PCC) on Hydro One's 500 kV transmission line. The electricity generated from the Adelaide, Bornish and Jericho Wind Energy Centres will converge at the Bornish Switchyard. From this point, the proposed 115 kV line will carry electricity generated by all three projects to the Parkhill Substation, then to a second Hydro One-owned Switchyard onto an existing Hydro One 500 kV transmission line. Approximately 11.5 km in length, the transmission line is proposed to be mounted on new hydro poles within the road rights-of-way along Kerwood, Elginfield and Nairn Roads. There may be occasional locations where the transmission is below ground for technical reasons.

The Parkhill Interconnect consists of a switchyard, a transmission line and a substation. The substation includes two (2) 135/225 MVA -121/525 kV LTC transformers with ONAN/ONAF/ONAF cooling rating. The switchyard and substation have been strategically sited on lands that the Proponent holds under lease or purchase agreement options.

The landscape in the study area is predominantly characterized by agricultural fields and associated farms punctuated with numerous hedgerows, isolated woodlands, and the occasional watercourse. Photographs included in Figure 2-1 show typical views of the land and features of the study area.



**Figure 2-1: Land features of the Parkhill Interconnect Site**

### 2.2 Land Use Description

The site is located within two two-tiered municipal systems. The County of Middlesex makes up the upper tier of the region, while Adelaide Metcalfe, North Middlesex and Strathroy-Caradoc, along with five additional townships and municipalities, have lower tier municipal status. Agriculture is the predominant economic activity and land use throughout the County of Middlesex; however, the municipalities that comprise the study area each have features creating distinct community character. The municipal zoning map is shown in Appendix A.

### 2.3 Baseline Ambient Noise Conditions

The MOE categorizes Points of Reception into three classes: 1, 2, and 3. Class 1 refers to an acoustic environment typical of a major population centre where the background noise is dominated by the urban hum. These areas are highly urbanized and have moderate to high noise levels throughout the day and night. Class 2 areas have an acoustic environment characterized by low ambient sound levels between 19:00 and 07:00, whereby the evening and night-time levels are defined by natural sounds, infrequent human activity and no clearly audible sounds from stationary sources (e.g. industrial and commercial facilities). Class 3 areas are typical of rural and/or small communities (i.e. with populations of less than 1000) and an acoustic environment that is dominated by natural sounds with little or no road traffic.

Within the study area, the main sources of ambient sound that currently exist include:

- Vehicular traffic noise from nearby roads;
- Vehicular traffic on the local concession and side roads, some of which are gravel roads;
- Occasional sounds stemming from agricultural activities;
- Occasional sounds due to anthropogenic domestic activities; and
- Natural sounds.

Based on these conditions, all Points of Reception are considered as having a Class 3 acoustical environment, which corresponds to the permissible sound levels outlined in Table 2-1 below.

**Table 2-1: Permissible sound levels for a Class 3 area**

Time of Day	One Hour $L_{eq}$ [dBA]
07:00 – 19:00	45
19:00 – 23:00	40
23:00 – 07:00	40

### 2.4 Points of Reception

The Parkhill Interconnect has been evaluated using the “Basic Comprehensive Certificates of Approval (Air) – User Guide”[2], due its proximity to the wind farm being greater than 5 km, and as such requires a search radius of up to 1,000 m for Points of Reception (POR). This study includes Points of Reception found within 2,000 m of the proposed main power transformer locations. A total of 19 buildings were identified and provided by the Client; all buildings identified were considered Points of Reception for this NIA. GL GH did not validate the Points of Reception on site.

Twenty-four vacant lots with a zoning designation that considers houses as a permitted use were also found within 2,000 m of each of the main power transformers, by using available Ontario base mapping, satellite imagery, and parcel fabric data. In accordance with REA requirements, “vacant lot receptors” (VLR) were placed on these vacant lots, in a location consistent with the building pattern of the area, which is typically alongside the road frontage. For the sake of consistency and given the unknown location of any future houses on these lots, VLRs were placed half-way on the front yard lot line abutting the road.

Table 2-2 below provides all PoR locations that were analyzed in this study.

**Table 2-2: List of identified Points of Reception**

POR ID#	Type	Coordinates ( NAD83 UTM17)		Receptor Height [m]
		X	Y	
1	House	452289	4774238	4.5
2	House	452732	4773916	4.5
3	House	453143	4773794	1.5
4	House	451800	4773370	4.5
5	House	451722	4773275	4.5
6	House	452249	4776141	1.5
7	House	452395	4776228	1.5
8	House	452661	4776120	4.5
9	House	453132	4775871	4.5
10	House	452995	4776038	4.5
11	House	454095	4775726	4.5
12	House	453676	4774131	1.5
13	House	453528	4773124	4.5
14	House	453943	4773387	4.5
15	House	453959	4773465	1.5
16	House	454243	4773436	1.5
17	House	453854	4774336	1.5
18	House	454243	4775758	4.5
19	House	451903	4773535	1.5
22	VLR	451970	4774059	4.5
23	VLR	452484	4773944	4.5
24	VLR	453079	4773935	4.5
25	VLR	453416	4773737	4.5
26	VLR	453932	4774552	4.5
27	VLR	454328	4775638	4.5
28	VLR	453895	4775738	4.5
29	VLR	453521	4775823	4.5
30	VLR	453254	4776020	4.5
31	VLR	453557	4775954	4.5
32	VLR	453928	4775864	4.5
33	VLR	453019	4775939	4.5
34	VLR	452721	4776005	4.5
35	VLR	451923	4776192	4.5
36	VLR	452067	4776295	4.5
37	VLR	451882	4776342	4.5
39	VLR	451660	4776255	4.5

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POR ID#	Type	Coordinates ( NAD83 UTM17)		Receptor Height [m]
		X	Y	
40	VLR	451469	4774311	4.5
41	VLR	451970	4774199	4.5
42	VLR	451467	4774169	4.5
43	VLR	451085	4774407	4.5
44	VLR	450886	4774303	4.5
45	VLR	450779	4774477	4.5
52	VLR	454180	4775776	4.5

### 3 PROJECT DESCRIPTION

The Parkhill Substation will “step-up” the electricity conveyed via a 115 kV transmission to 500 kV and will connect via a switchyard to an existing Hydro One 500 kV line that runs adjacent to the Parkhill Interconnect location. The substation equipment will include an isolation switch, a circuit breaker, two step-up transformers, a transmission switch gear, instrument transformers, grounding and metering equipment. All substation and switchyard grounding equipment will meet the Ontario Electrical Safety Code.

It is important to note that the 115 kV line running to the project and connecting to Hydro One’s existing 500 kV line is common to three of wind farms, i.e. Adelaide, Bornish and Jericho Wind Energy Centre.

Based on the classification system outlined in Part II of O. Reg. 359/09, the Parkhill Interconnect is located in a Class 3 rural area.

Wind turbines belonging to three different projects (Adelaide, Bornish, Jericho) will convert wind into Alternating Current (AC) electricity. The local transformers of each project will raise the voltage to 115 kV. The combined power of the three projects will then be directed to the Parkhill Substation that will elevate the voltage to 500 kV. The Parkhill Interconnect will be made up of the following key facilities and equipment:

- Access roads;
- Transmission line;
- Substation; and
- Switchyard.

A scaled location map, indicating the topography, nature of the neighborhood surrounding the facility, location of adjacent buildings, structures and receptors has been attached as Appendix B.

#### 3.1 Life of the Project

The expected life of the Parkhill Interconnect is will be approximately 30 years. At the end of the project life the Parkhill Interconnect will be decommissioned in accordance with the Decommissioning Plan Report.

#### 3.2 Operating Hours

The main transformers in the Parkhill Substation will be operating continuously throughout the day and is assumed to emit the same amount of noise during the daytime as it does during night-time. Therefore, no changes will be made to the sound power level of the main transformers when running the model to account for time of day. The sound pressure level that will be compared to the permissible noise levels in Table 2-1 will be the same for daytime operation and night time operation.

### **3.3 Noise Sources**

#### **3.3.1 Approach to the Study**

The sound pressure level at each Point of Reception for the Parkhill Interconnect Project was calculated based on the ISO 9613-2 method [4]. This is a widely used and generally accepted standard for the evaluation of noise impact in environmental assessments. The desired sound pressure level of the proposed main power transformers was obtained from the Client and can be found in Appendix C, while the transformer sound power level (PWL) was estimated on the basis of the technical specifications and dimensions. The software package CadnaA, which implements ISO-9613-2, was used to predict the sound pressure levels at the PoRs.

#### **3.3.2 Noise Sources Summary**

The primary noise sources of the current Parkhill Interconnect design are the main power transformers located in the central portion of the Parkhill Interconnect area. A sample calculation for POR ID# 1 and 2 appears in Appendix D.

The cumulative noise impact from the nearby proposed wind farm project, Bornish Wind LP, has not been included in the analysis since the closest proposed with turbine for this project is >5 km away.

No other equipment at the substation and at the switchyard has been included in the present NIA. Any ancillary equipment installed is considered to have a significantly lower acoustical level compared to the main power transformers.

#### **3.3.3 Main Transformers**

The Parkhill Interconnect uses two (2) main step-up transformers located at the Parkhill substation. The electrical and physical specifications for the substation's transformers were provided by the Client [3] and are shown in Appendix C. Details are presented in Table 3-1 below. This study assumes that the 225 MVA / 525 kV main transformers at the substation are fluid-immersed devices with forced air cooling (rated ONAN/ONAF/ONAF).

The transformer walls were modeled as vertical area sources and the transformer top was modeled as a horizontal area source. The base of each transformer has been raised to 1m above ground level to account for the 1m concrete slab they will be placed on, as requested by the Client. The vertical area sources used to represent the transformer walls were given a height of 4.5m and placed atop the concrete slab.

The Proponent is currently in talks with the manufacturer to ensure that the broadband Sound Pressure Level (SPL) value of each transformer will not exceed 75 dBA when measured according to IEEE Std C57.12.90-2006 [5]. The proposed audible sound level of 75 dB was then converted to a PWL value of 100.8 dBA using ISO 3744:1994 [6]. A 5 dBA penalty for tonality, as per Publication NPC-104 (Sound Level Adjustments) was applied for a resulting PWL of 105.8 dBA. A typical transformer octave band sound distribution for a large transformer from the Handbook of Acoustics [7] was used and fitted to match the broadband value of 105.8 dBA.

Details on each noise source are presented in Table 3-1 below.

Coordinates of the transformers and a table with the derived octave band spectra are listed in Appendix C.

### 3.3.4 Sound Barrier

In order to achieve compliance with the current noise propagation model, both transformers will require a noise barrier. The type of barrier used in this noise study is one that can be described as of absorptive type with an Absorptive Coefficient of 0.85. The acoustic barriers should have a surface density of at least 20 kg/m<sup>2</sup> and have a closed surface free of gaps and cracks, such as Armtec’s Durisol. A 5.5 m tall barrier (equal to the height of the transformer raised by 1 m) was modeled on the south side of each transformer, 6 m away from the southern edge of the transformer. The barriers are illustrated on the noise map in Appendix D. The coordinates of the barrier can be found in Table 3-2.

### 3.3.5 Summary Tables

**Table 3-1: Noise source summary table**

Source ID	Source Description	Sound Power Level [dBA] <sup>1</sup>	Source Location	Sound Characteristics	Noise Control Measures
T1	Main Transformer	105.8	O	S-T	B
T2	Main Transformer	105.8	O	S-T	B

1. 5 dBA tonal penalty included  
 Source location: (O): Outside building  
 Sound Characteristics: (S): Steady; (T): Tonal  
 Noise Control: (B): Barrier

**Table 3-2: Coordinates of barrier edges (UTM 17 NAD83)**

ID	Description	Easting	Northing
B1a	Barrier 1, point a	452720	4774653
B1b	Barrier 1, point b	452747	4774646
B2a	Barrier 2, point a	452761	4774643
B2b	Barrier 2, point b	452788	4774637

## 4 NOISE IMPACT ASSESSMENT

As stated in MOE's publication NPC 232, the sound level limit at a point of reception must be established based on the principle of "predictable worst case" noise impact.

The sound pressure level at each Point of Reception for the aggregate of all noise sources associated with the Parkhill Interconnect Project was calculated based on the ISO 9613-2 method.

The ISO 9613 standard [4] provides a prediction of the equivalent continuous A-weighted sound pressure levels at a distance from one or more point sources under meteorological conditions favourable to propagation of sound emissions.

The method consists of octave-band algorithms (i.e. with nominal mid-band frequencies from 63 Hz to 8 kHz) for calculating the attenuation of the emitted sound. The algorithm takes into account the following physical effects:

- Geometrical divergence – attenuation due to spherical spreading from the sound source;
- Atmospheric absorption – attenuation due to absorption by the atmosphere; and
- Ground effect – attenuation due to the acoustic properties of the ground.

ISO-9613-2 parameters were set as follows:

- Ambient air temperature: 10°C;
- Ambient barometric pressure: 101.32 kPa;
- Humidity: 70%;
- Ground factor: 0.7 (soft ground);
- Transformer height and dimensions: see Appendix C;
- PoR height: 1.5m and 4.5 m; and
- The effect of topography was considered.

Additional calculations concerning attenuation from foliage were not performed in this report, implying that the values calculated for sound attenuation are likely to be conservative in areas where there is foliage present in the line of sight between any noise source and a Point of Reception. The estimated accuracy of the ISO 9613 method, as stated in ISO 9613-2, is  $\pm 3$  dB. However, due to the several conservative assumptions made during modeling, as described above (and in Section 3.3.4), the likelihood of obtaining results greater than the predicted values is significantly reduced.

First order acoustic reflections were not included in the study since it is assumed that the sound reflection coefficient is lower than 0.2 [4].

The transformer noise emission ratings used for each octave band are specified in Appendix C. The noise impact was calculated for each Point of Reception located within 2,000 m of a source of sound from the Parkhill Interconnect, and the calculated noise level was then compared with the applicable permissible sound level for each receptor, as presented in Table 4-1.

## 4.1 Results

Table 4-1 presents the sound pressure level at each point of reception within 2,000 m of the Main Power Transformers, and all are found to be compliant with daytime and night-time permissible sound levels per the MOE guidelines. The simulated noise iso-contour map is presented in Appendix D.

The shortest distance between a Main Power Transformer and a house is approximately 610 m (PoR #1 and T1). This distance was calculated starting from the center of the transformer. The shortest distance between a noise source at the Parkhill Interconnect Project and a vacant lot receptor is approximately 760 m (PoR #23 and T2).

**Table 4-1: Acoustic assessment summary**

Point of Reception ID	Description	Sound Level at PoR Level Lr [dBA]	Verified by Acoustic Audit	Performance Limit, Night/Day [dBA]	Compliance with Performance Limit
1	House	37.5	NO	40/45	YES
2	House	33.6	NO	40/45	YES
3	House	32.1	NO	40/45	YES
4	House	27.3	NO	40/45	YES
5	House	26.4	NO	40/45	YES
6	House	28.0	NO	40/45	YES
7	House	27.9	NO	40/45	YES
8	House	31.5	NO	40/45	YES
9	House	33.2	NO	40/45	YES
10	House	32.1	NO	40/45	YES
11	House	29.7	NO	40/45	YES
12	House	32.7	NO	40/45	YES
13	House	27.1	NO	40/45	YES
14	House	28.3	NO	40/45	YES
15	House	25.7	NO	40/45	YES
16	House	25.4	NO	40/45	YES
17	House	31.6	NO	40/45	YES
18	House	28.8	NO	40/45	YES
19	House	26.3	NO	40/45	YES
22	VLR	33.4	NO	40/45	YES
23	VLR	33.3	NO	40/45	YES
24	VLR	35.5	NO	40/45	YES
25	VLR	32.5	NO	40/45	YES
26	VLR	34.0	NO	40/45	YES
27	VLR	28.8	NO	40/45	YES
28	VLR	30.8	NO	40/45	YES
29	VLR	32.1	NO	40/45	YES

Point of Reception ID	Description	Sound Level at PoR Level Lr [dBA]	Verified by Acoustic Audit	Performance Limit, Night/Day [dBA]	Compliance with Performance Limit
30	VLR	31.7	NO	40/45	YES
31	VLR	31.1	NO	40/45	YES
32	VLR	29.9	NO	40/45	YES
33	VLR	32.8	NO	40/45	YES
34	VLR	32.5	NO	40/45	YES
35	VLR	28.0	NO	40/45	YES
36	VLR	28.5	NO	40/45	YES
37	VLR	26.0	NO	40/45	YES
39	VLR	26.6	NO	40/45	YES
40	VLR	29.5	NO	40/45	YES
41	VLR	34.9	NO	40/45	YES
42	VLR	29.5	NO	40/45	YES
43	VLR	26.9	NO	40/45	YES
44	VLR	25.4	NO	40/45	YES
45	VLR	25.5	NO	40/45	YES
52	VLR	29.1	NO	40/45	YES

## 4.2 Mitigation Measures

The overall predicted noise levels for all identified Points of Reception, based on site operations, comply with performance limits for daytime and night-time operations. As a result, no additional mitigation measures to the proposed noise barrier are deemed required to ensure compliance with MOE guidelines.

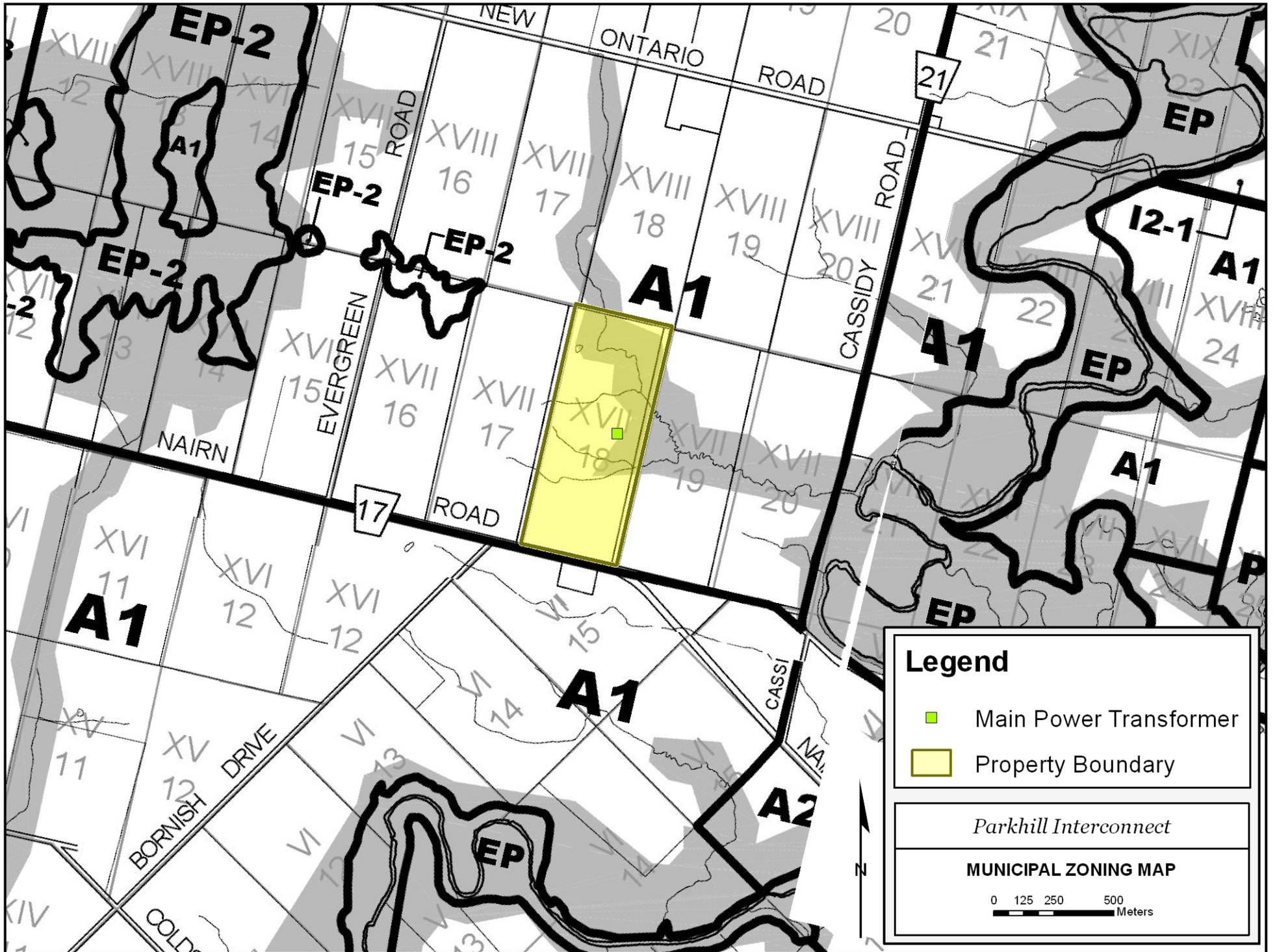
## 5 CONCLUSION

GL GH calculated the predicted noise levels generated by the Parkhill Interconnect Project based on the ISO-9613-2 model using CadnaA software. Based on the approach presented in this study and a set of assumptions related to noise sources of the Parkhill Interconnect and noise receptors, the Parkhill Interconnect is considered to be compliant with the daytime and night-time MOE permissible sound limits for Class 3 areas.

## 6 REFERENCES

- [1] Ontario Regulation 359/09 (Renewable Energy Approvals (REA) [1] under Part V.0.1 of the Ontario Environmental Protection Act (EPA)).
- [2] Ministry of the (MOE). 2011. Basic Comprehensive Certificates of Approval (Air) – User Guide (Appendix A). Environmental Assessment and Approval Branch.
- [3] Email sent by Gabe Henehan to GL GH, July 20 2012.
- [4] ISO 9613-2 (1996), Acoustics – Attenuation of sound during propagation outdoors.
- [5] C57.12.90-2006 IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers.
- [6] ISO3744 (1994), Acoustics – Determination of sound power levels of noise sources using sound pressure – Engineering method in an essentially free field over a reflecting plane.
- [7] Handbook of Acoustics – Edited by Malcolm J. Crocker, 1998.

## **APPENDIX A      MUNICIPALITY OF NORTH MIDDLESEX LAND USE MAP**



## **APPENDIX B      PROPOSED LOCATION AND TOPOGRAPHIC MAP**



### Legend

**Project Components**

- Power Transformer
- Substation Footprint
- Project Location
- Property Boundary

**Other Components**

- Dwelling
- Vacant Lot Receptor
- Existing Transmission Line
- Road
- Watercourse
- Contours (Interval: 5 m)
- Wetland



Parkhill Interconnect

**PROJECT LOCATION & TOPOGRAPHY MAP**



1008-35-200712-RG  
November 5, 2012

Projection: UTM Zone 17, NAD83  
Sources: NextEra Energy Resources, Ontario Base Mapping, Ontario Road Network, Land Information Ontario, Geobase, CanVec.  
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## APPENDIX C NOISE SOURCES

**Table C-1: Noise sources**

Source ID	Description	Sound Power Level <sup>1</sup> [dBA]	Coordinates (NAD83-UTM17)	
			X	Y
T1	Main Transformer	105.8	452735	4774658
T2	Main Transformer	105.8	452777	4774648

Includes 5dBA Tonal Penalty

### Specifications of Noise Sources

#### 225 MVA Main Power Transformer

Maximum Audible Sound Level: 75 dBA,  
as per manufacturer documentation  
Total Perimeter: 49.1 m  
Effective Height: 4.75 m  
Top Area: 145 m<sup>2</sup>  
Estimated Total Surface Area (S): 378.5 m<sup>2</sup>  
Estimated Sound Power Level (without penalty): 100.8 dBA

**Table C-2: 225 MVA substation main transformer octave band spectrum (including 5 dB penalty)<sup>1</sup>**

31.5	63	125	250	500	1000	2000	4000	8000	Overall Sound Power Level [dBA]
63.0	82.2	94.3	96.8	102.2	99.4	95.6	90.4	81.3	<b>105.8</b>

1. Generic octave band for similar size transformer. Scaled to 105.8 dBA

**Table C-3: Transformer octave band calculation details**

31.5	63	125	250	500	1000	2000	4000	8000	
-1	5	7	2	2	-4	-9	-14	-21	<b>Typical Outdoor Transformer Octave band relative distribution [7] [dB Lin]</b>
-39.4	-26.2	-16.1	-8.6	-3.2	0	1.2	1	-1.1	<b>dB Lin to dBA Conversion Scale</b>
-40.4	-21.2	-9.1	-6.6	-1.2	-4	-7.8	-13	-22.1	<b>Typical Outdoor Transformer Octave band relative distribution [dBA]</b>
63.0	82.2	94.3	96.8	102.2	99.4	95.6	90.4	81.3	<b>Scaled to 105.8 dBA for 225 MVA Transformer</b>