Samsung Renewable Energy Inc. and

Pattern Renewable Holdings Canada ULC

10 Wind Turbine Specifications Report

For

Armow Wind Project

Summary of Report Revisions

Section of Report	Report Date: August, 2012	Report Date: September, 2012	Report Date: November, 2012
Appendix A	Appendix A: Acoustic Emissions Data (Provided under Separate Cover for Agency Review)	Appendix A: Included Acoustic Emissions Data under Appendix A	
Table 2		Project Lifespan (approval to decommissioning)	Revised: Project Lifespan (commercial operation)
General Update		A total of 99 turbines will be permitted to provide contingency positions.	Revised: A total of 98 turbines will be permitted to provide contingency positions.

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November, 2012

SP ARMOW ONTARIO LP - ARMOW WIND PROJECT

Wind Turbine Specifications Report

Director, Ministry of Environment
2 St. Clair West, Floor 12A
Toronto, ON M4V 1L5

Report Number: 11-1151-0247 DOC044 Rev3

Distribution:

3 copies: Ministry of Environment
1 copy: Samsung Renewable Energy Inc.
1 copy: Pattern Renewable Canada ULC.
1 copy: Golder Associated Ltd.

REPORT

Golder Associates

Table of Contents

1.0 GENERAL INFORMATION

The Armow Wind Project (the "Project") is an up to 180 megawatt (MW) commercial wind energy generation facility located substantially on leased privately owned lands in the Municipality of Kincardine, Bruce County, Ontario (see Figure 3). The Project is being developed by SP Armow Wind Ontario GP Inc., in its capacity as general partner of SP Armow Wind Ontario LP (the "Proponent"). The Proponent is a joint venture limited partnership owned by affiliates of Pattern Renewable Holdings Canada ULC ("Pattern") and Samsung Renewable Energy Inc. ("Samsung"). The Proponent is proposing to develop, construct, and operate the Project in response to the Government of Ontario's plan to integrate more renewable energy into the province's power grid.

In 2009, the Government of Ontario introduced the *Green Energy and Green Economy Act* and Ontario Regulation (O. Reg.) 359/09. The regulatory amendments to O.Reg. 359/09 came into force on July 1, 2012 as O. Reg 195/12[1]. The Renewable Energy Approval ("REA") integrates previous requirements under the *Environmental Assessment Act* with clear provincial rules and standards in a new regulation under the *Environmental Protection Act*. This Wind Turbine Specifications Report has been prepared to provide details of the Project as part of the REA.

Table 1, below, highlights the requirements and how they are addressed in this Wind Turbine Specifications Report.

Table 1: Wind Turbine Specifications Report Requirements under O. Reg. 359/09, as amended

O. Reg. 359/09, as amended, Requirements	Report Section
Make and model	Section 1.2; Section 2.1
Nameplate capacity	Section 1.2; Section 2.1
Hub height above grade	Section 1.2; Section 2.1
Rotational speeds	Section 1.2; Section 2.1
Acoustic emission data[1]	Section 2.2, Appendix A

Note:
[1] Acoustic emission data includes the overall sound power level, measurement uncertainty value, octave-band sound power levels (linear weighted), tonality and tonal audibility.

This Wind Turbine Specifications Report will be provided to Aboriginal communities, the Municipality of Kincardine, County of Bruce and the public following the distribution requirements and timing constraints outlined in O. Reg. 359/09, as amended, and the Draft Technical Guide to Renewable Energy Approvals (MOE, 2012; MOE, 2012).

[1] All references to Ontario Regulation 359/09 refer to the Regulation as amended Regulation 195/12 which came into force July 1, 2012

1.1 The Project Location

The proposed Project is situated in Bruce County, 3 km from Lake Huron, approximately 2 km northeast of Kincardine, Ontario (see Figure 3).

The Project location, is defined in O. Reg. 359/09, as amended, (in relation to a renewable energy project) to mean "a part of land and all or part of any building or structure in, on or over which a person is engaging in or proposes to engage in the project and any air space in which a person is engaging in or proposed to engage in the project". The Project location is bounded by Highway 21 to the west, Concession 4 to the north, County Road 1 to the east and the North Line to the south. The area encompassed by these boundaries is referred to in this document as the "Project Study Area".

The proposed Project Study Area, covering approximately 18,800 hectares of land in the Municipality of Kincardine, Ontario, is primarily comprised of agricultural lands with fragmented blocks of forest and riparian areas associated with small creeks and farm drains (see Figure 3). The Project will be located primarily within portions of privately owned land parcels with collection cables being placed in public road allowances. Portions of privately owned land parcels that contain Project infrastructure will be under lease or easement to the Proponent for the duration of the Project.

The location of the Project was established based on interest expressed by local landowners, its proximity to high-voltage transmission lines, and its excellent wind resource.

1.2 Project Vital Statistics

Table 2: Summary of Project Vital Statistics

General	
Project Name	Armow Wind Project
Project Ownership and Operation	SP Armow Wind Ontario LP
Project Lifespan (commercial operation)	20 years
Project Nameplate Capacity	Up to 180 MW
Project Area (as shown in Figure 3)	
Location of Project	Privately-owned land and Public Road Allowances, Municipality of Kincardine, County of Bruce
Total Project Study Area	18,800 ha
Total Area of Project Location (total disturbance area)	472.9 ha
Wind Turbine Generators	
Model	Siemens SWT-2.3-101
Total Number Permitted	98
Approximate Number Constructed	90
Nominal Power	1.8 to 2.3 MW
Number of Blades	3
Blade Length	49 m

General	
Hub Height	99.5 m
Rotor Diameter	101 m
Cut-in Wind Speed	3 m/s
Cut-out Wind Speed	25 m/s
Rated Wind Speed	12 – 13 m/s
Swept Area	8,000 m^2
Foundation Dimensions	20 m in diameter
Access Roads	
Operation Roads (includes shoulder, travel width and ditch)	58 km x 4-8 m
Construction Roads (with shoulder)	58 km x 7-15 m
Temporary Roads / Crane Walks	3 km x 7-15 m
Collector Lines	
34.5 kV Collector Lines in public ROW (total combined length of proposed underground and/or overhead)	132 km x 2-6 m
34.5 kV Collector Lines on private lands (underground)	60 km x 2-6 m
Project Structures and Facilities	
Collector Substation	200 m x 150 m
Operations and Maintenance Building	50 m x 30 m
Point of Interconnect	1 acre
Temporary Land Use (Construction and Installation)	
Construction Staging Areas	10 acres
Wind Turbine Laydown Area (each turbine)	5000 m^2
Crane Pads	40 m x 20 m

1.3 Contact Information

Applicant

The proponent for the Project is SP Armow Wind Ontario LP, by its general partner SP Armow Wind Ontario GP Inc. The Proponent is a joint venture limited partnership owned by affiliates of Pattern Renewable Holdings Canada ULC and Samsung Renewable Energy Inc. The contacts for the Project are as follows:

Brian Edwards
Manager, Project Development
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55 Standish Court, 9th Floor
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Phone: (519) 396-9433
Email: info@armowwind.com

Jody Law
Project Developer
Pattern Energy
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Toronto, ON M5H 3G2
Phone: (519) 396-9433
Fax: (416) 979-8428
Email: info@armowwind.com

Consultant

The Proponent has retained Golder Associates Ltd. (Golder) to prepare an REA Application under O. Reg. 359/09, as amended. Contact information for the Golder Project Manager is as follows:

Ian Callum, Project Manager
Golder Associates Ltd.
2390 Argentia Road
Mississauga, Ontario L5N 5Z7
Phone: (905) 567-4444
Fax: (905) 567-6561
E-mail: Ian_Callum@golder.com

Project

Project email: info@armowwind.com
Project website: www.armowwind.com

2.0 WIND TURBINE TECHNICAL SPECIFICATIONS

2.1 Make and Model

To generate the total installed nameplate capacity of up to 180 MW the Project will utilize the Siemens SWT-2.3-101 wind turbine generator. The Siemens SWT-2.3-101 wind turbine model is especially suited to areas with low to medium wind speeds and offers support for grid connections in all major markets. A summary of the technical specifications for this wind turbine is presented in Table 3.

Table 3: Summary of Siemens SWT-2.3-101 Wind Turbine Generator Technical Specifications[1]

Wind Turbine Attribute	Specification
Make and Model	Siemens SWT-2.3-101
Nominal Power	1.8 to 2.3 MW
Hub Height (above grade)	99.5 m
Rotor Diameter	101 m
Number of Blades	3
Blade Length	49 m
Swept Area	8,000 m^2
Cut-in Wind Speed	3 m/s
Cut-out Wind Speed	25 m/s
Rated Wind Speed	12-13 m/s

Note:
[1] *Modified from Siemens, 2011.*

As shown on Figure 1, the Siemens SWT-2.3-101 wind turbine is made up of four main components: the foundation, tower, nacelle (i.e., hub, or generator housing) and blades. The nacelle will be mounted on a 99.5 m high tubular steel tower fitted with internal personnel hoists and lifts. A prefabricated power module is located at the bottom of the tower and provides the platform for the power converter. The turbine pad-mounted transformer will be located beside the WTG tower base.

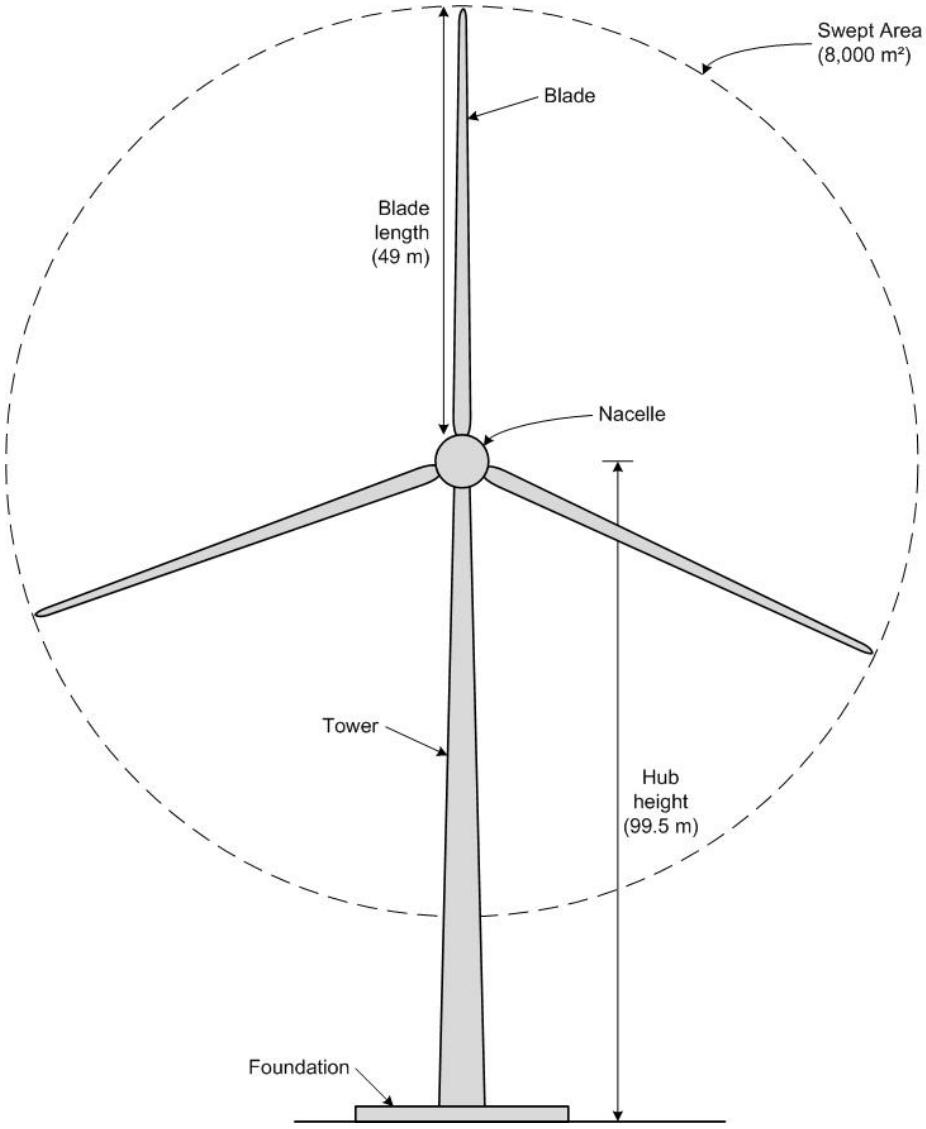
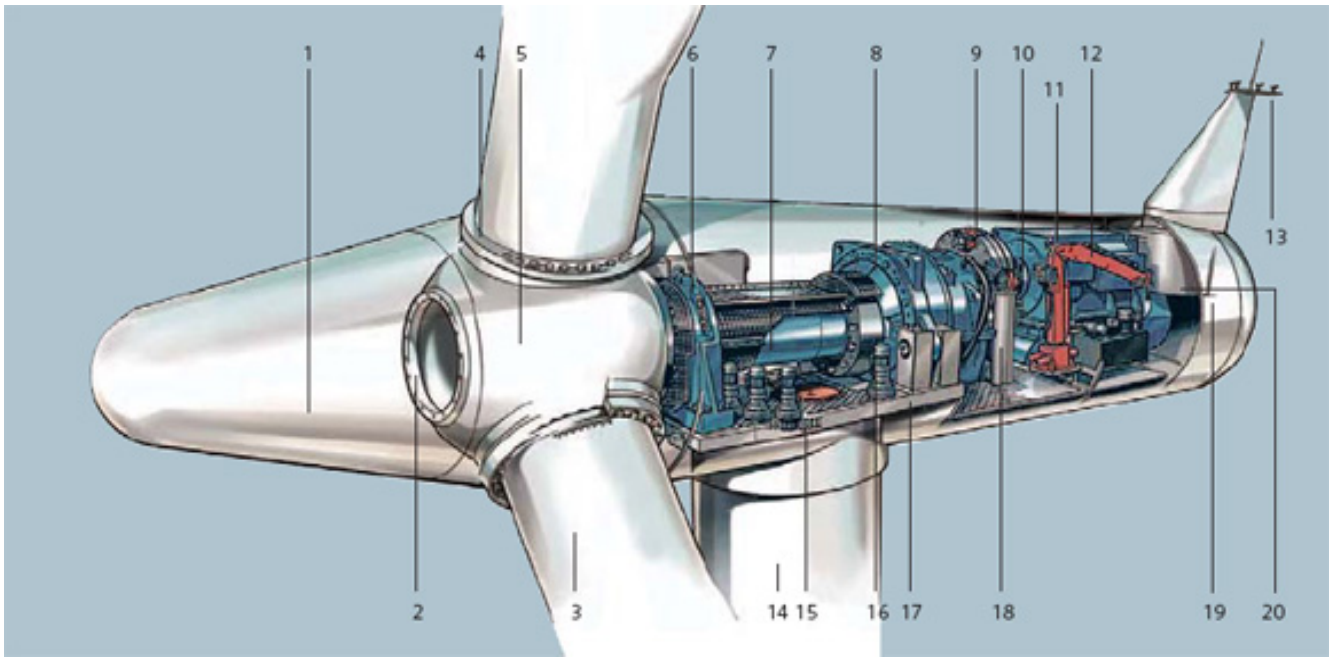


Figure 1: Basic Wind Turbine Generator Specifications

The three 49 m blades of the Siemens SWT-2.3-101 wind turbine will generate electricity between the wind speeds of 3 m/s (i.e., the cut-in wind speed) and 25 m/s (i.e., the cut-out wind speed) and will reach its nameplate capacity of 2.3 MW when wind speeds reach approximately 12-13 m/s (Siemens, 2011). As shown on Figure 2, most of the equipment used to convert wind energy into electricity is contained in the nacelle of the turbine, which will also act as a sound enclosure to reduce noise emissions. In order to maximize electricity production, the wind turbine is designed to automatically rotate (yaw) into the wind and adjust the pitch of the blades. In low and medium wind speed conditions, the blade pitch setting is slowly adjusted to provide maximum power output. Limitation of the power output in high winds is necessary on all wind turbines in order to prevent the generator from overloading.



1 Spinner	6 Main bearing	11 Generator	16 Yaw gear
2 Spinner bracket	7 Main shaft	12 Service crane	17 Nacelle bedplate
3 Blade	8 Gearbox	13 Meteorological sensors	18 Oil filter
4 Pitch bearing	9 Brake disc	14 Tower	19 Canopy
5 Rotor hub	10 Coupling	15 Yaw ring	20 Generator fan

Figure 2: Nacelle Arrangement (Siemens, 2009)

The nacelle includes major wind turbine components such as the main shaft and bearing, gearbox, brake disc and generator. The nacelle is climate controlled and is constructed from steel and fibreglass to protect against the elements (e.g., lightning). The wind turbine is equipped with lightning protection to protect from the effects of direct and nearby strikes. The overall design basis refers to the international standard IEC 61400-24 Lightning Protection Level I, and includes (Siemens, 2010b):

- Protection of the blades with a lightning termination pad system. A flexible down conductor located inside the blade provides a dedicated conductor path to the main shaft;
- Protection of the main shaft by a 5-mm steel plate, acting as a Faraday cage for the nacelle. The meteorological instruments are protected by a separate lightning protection system. All main components are effectively grounded;
- Protection of the turbine controller by surge protection devices installed with mechanical overload protection; and
- Conduction from the nacelle to the earth via the tower and heavy bounding of the foundation.

2.2 Acoustic Emissions Data

The Siemens SWT-3.2-101 wind turbine generator has a maximum broadband sound power level of 106.0 dBA. Additional acoustic emissions data supplied by Siemens, including typical octave band spectra, are provided in Appendix A.

3.0 REFERENCES

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Report Signature Page

GOLDER ASSOCIATES LTD.

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EA Project Manager

Anthony D. Ciccone, Ph.D., P.Eng.
Principal

KM/IC/AC/gf/ch

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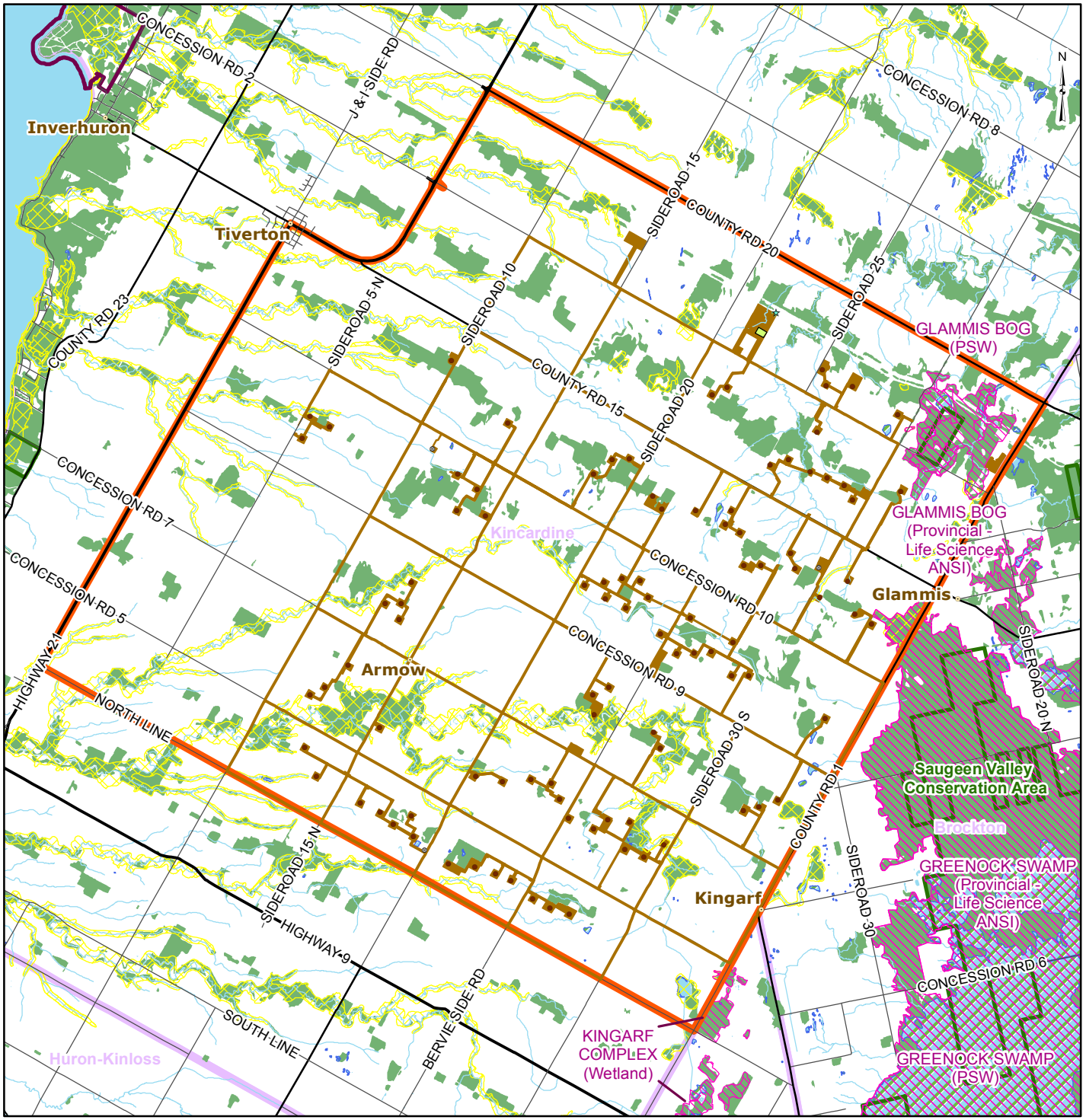
FIGURE 3

Project Location



LEGEND

- Turbine
- MET Tower
- Point Of Interconnect (POI)
- Community
- Railway
- Highway
- Major Road
- Local Road
- Watercourse
- Project Study Area
- Project Location
- Substation
- Provincial Park
- Conservation Area
- Natural Feature
- Kincardine Hazard Land
- Wetland
- Waterbody
- Wooded Area
- Municipal Boundary

NOTES:

All potential project collector routes are shown on this figure, final design will likely reduce overall footprint.

DRAFT

REFERENCE

1. Base Data - MNR NRVIS, obtained 2004, CANMAP v2008.4
2. Natural Features compiled by Golder from NRVIS base data, NHIC Natural Areas and MNR Wetland and ANSI data, obtained 2010
3. Hazard Lands - Bruce County, obtained 2010

Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, © Queens Printer 2010
Projection: UTM Datum: NAD 83 Coordinate System: UTM Zone 17

0 0.75 1.5 3 4.5 6

SCALE 1:110,000 KILOMETRES

PROJECT

ARMOW WIND PROJECT

TITLE

PROJECT LOCATION

Golder Associates
Mississauga, Ontario

PROJECT NO. 11-1151-0247			SCALE AS SHOWN	REV.
DESIGN	ME	23 Jul. 2012		
GIS	ME	23 Jul. 2012		
CHECK	KM	23 Jul. 2012		
REVIEW				

FIGURE: 3

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APPENDIX A

Acoustic Emissions Data

SWT-2.3-101, Max. Power 1824 kW
Contract Acoustic Emission, Hub Height 99.5 m

Sound Power Levels

The warranted sound power level is presented with reference to the code IEC 61400-11:2002 with amendment 1 dated 2006-05 based on a hub height of 99.5 m and a roughness length of 0.05 m as described in the IEC code. The sound power levels (L_{WA}) presented are valid for the corresponding wind speeds referenced to a height of 10 m above ground level.

Wind speed [m/s]	3	4	5	6	7	8	9	10	11	12	Up to cut-out
Sound power level	91.4	95.3	98.1	100.5	101.0	101.0	101.0	101.0	101.0	101.0	101.0

Table 1: Noise emission, L_{WA} [dB(A) re 1 pW]

Octave Band

Octave band spectra are tabulated below for 6 and 8 m/s referenced to 10 m height.

Octave band, centre frequency [Hz]	63	125	250	500	1000	2000	4000	8000
Sound power level	83.0	92.1	92.5	92.8	94.3	93.5	87.4	84.0

Table 2: Octave band for 6 m/s, L_{WA} [dB(A) re 1 pW]

Octave band, centre frequency [Hz]	63	125	250	500	1000	2000	4000	8000
Sound power level	81.9	91.3	91.4	94.7	96.1	92.7	87.4	83.7

Table 3: Octave band for 8 m/s, L_{WA} [dB(A) re 1 pW]

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SWT-2.3-101, Max. Power 1903 kW
Contract Acoustic Emission, Hub Height 99.5 m

Sound Power Levels
The warranted sound power level is presented with reference to the code IEC 61400-11:2002 with amendment 1 dated 2006-05 based on a hub height of 99.5 m and a roughness length of 0.05 m as described in the IEC code. The sound power levels (L_{WA}) presented are valid for the corresponding wind speeds referenced to a height of 10 m above ground level.

Wind speed [m/s]	3	4	5	6	7	8	9	10	11	12	Up to cut-out
Sound power level	91.4	95.5	99.0	101.5	102.0	102.0	102.0	102.0	102.0	102.0	102.0

Table 1: Noise emission, L_{WA} [dB(A) re 1 pW]

Octave Band
Octave band spectra are tabulated below for 6 and 8 m/s referenced to 10 m height.

Octave band, centre frequency [Hz]	63	125	250	500	1000	2000	4000	8000
Sound power level	83.4	93.3	94.5	93.7	94.4	94.7	87.3	83.5

Table 2: Octave band for 6 m/s, L_{WA} [dB(A) re 1 pW]

Octave band, centre frequency [Hz]	63	125	250	500	1000	2000	4000	8000
Sound power level	82.1	91.8	92.5	95.8	97.2	93.7	88.1	84.3

Table 3: Octave band for 8 m/s, L_{WA} [dB(A) re 1 pW]

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SWT-2.3-101, Max. Power 2030 kW
Contract Acoustic Emission, Hub Height 99.5 m

Sound Power Levels
The warranted sound power level is presented with reference to the code IEC 61400-11:2002 with amendment 1 dated 2006-05 based on a hub height of 99.5 m and a roughness length of 0.05 m as described in the IEC code. The sound power levels (L_{WA}) presented are valid for the corresponding wind speeds referenced to a height of 10 m above ground level.

Wind speed [m/s]	3	4	5	6	7	8	9	10	11	12	Up to cut-out
Sound power level	91.4	95.6	99.8	102.5	103.0	103.0	103.0	103.0	103.0	103.0	103.0

Table 1: Noise emission, L_{WA} [dB(A) re 1 pW]

Octave Band
Octave band spectra are tabulated below for 6 and 8 m/s referenced to 10 m height.

Octave band, centre frequency [Hz]	63	125	250	500	1000	2000	4000	8000
Sound power level	83.1	93.7	95.5	95.5	95.7	95.4	87.4	83.2

Table 2: Octave band for 6 m/s, L_{WA} [dB(A) re 1 pW]

Octave band, centre frequency [Hz]	63	125	250	500	1000	2000	4000	8000
Sound power level	82.2	92.2	93.7	97.2	98.2	94.7	88.6	84.8

Table 3: Octave band for 8 m/s, L_{WA} [dB(A) re 1 pW]

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SWT-2.3-101, Max. Power 2126 kW
Contract Acoustic Emission, Hub Height 99.5 m

Sound Power Levels

The warranted sound power level is presented with reference to the code IEC 61400-11:2002 with amendment 1 dated 2006-05 based on a hub height of 99.5 m and a roughness length of 0.05 m as described in the IEC code. The sound power levels (L_{WA}) presented are valid for the corresponding wind speeds referenced to a height of 10 m above ground level.

Wind speed [m/s]	3	4	5	6	7	8	9	10	11	12	Up to cut-out
Sound power level	91.4	95.7	100.3	103.5	104.0	104.0	104.0	104.0	104.0	104.0	104.0

Table 1: Noise emission, L_{WA} [dB(A) re 1 pW]

Octave Band

Octave band spectra are tabulated below for 6 and 8 m/s referenced to 10 m height.

Octave band, centre frequency [Hz]	63	125	250	500	1000	2000	4000	8000
Sound power level	82.6	93.6	96.1	97.3	97.4	96.0	87.9	83.5

Table 2: Octave band for 6 m/s, L_{WA} [dB(A) re 1 pW]

Octave band, centre frequency [Hz]	63	125	250	500	1000	2000	4000	8000
Sound power level	82.2	92.5	94.8	96.5	99.1	95.5	89.0	85.1

Table 3: Octave band for 8 m/s, L_{WA} [dB(A) re 1 pW]

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SWT-2.3-101, Max. Power 2221 kW
Contract Acoustic Emission, Hub Height 99.5 m

Sound Power Levels

The warranted sound power level is presented with reference to the code IEC 61400-11:2002 with amendment 1 dated 2006-05 based on a hub height of 99.5 m and a roughness length of 0.05 m as described in the IEC code. The sound power levels (L_{WA}) presented are valid for the corresponding wind speeds referenced to a height of 10 m above ground level.

Wind speed [m/s]	3	4	5	6	7	8	9	10	11	12	Up to cut-out
Sound power level	91.4	95.7	100.5	104.5	105.0	105.0	105.0	105.0	105.0	105.0	105.0

Table 1: Noise emission, L_{WA} [dB(A) re 1 pW]

Octave Band

Octave band spectra are tabulated below for 6 and 8 m/s referenced to 10 m height.

Octave band, centre frequency [Hz]	63	125	250	500	1000	2000	4000	8000
Sound power level	82.1	93.3	96.5	99.0	99.1	96.6	88.8	84.4

Table 2: Octave band for 6 m/s, L_{WA} [dB(A) re 1 pW]

Octave band, centre frequency [Hz]	63	125	250	500	1000	2000	4000	8000
Sound power level	82.4	93.0	96.0	99.8	100.1	96.5	89.6	85.7

Table 3: Octave band for 8 m/s, L_{WA} [dB(A) re 1 pW]

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SWT-2.3-101
Contract Acoustic Emission, Hub Height 99.5 m

Sound Power Levels
The warranted sound power level is presented with reference to the code IEC 61400-11:2002 with amendment 1 dated 2006-05 based on a hub height of 99.5 m and a roughness length of 0.05 m as described in the IEC code. The sound power levels (L_{WA}) presented are valid for the corresponding wind speeds referenced to a height of 10 m above ground level.

Wind speed [m/s]	3	4	5	6	7	8	9	10	11	12	Up to cut-out
Sound power level	91.4	95.7	100.6	105.4	106.0	106.0	106.0	106.0	106.0	106.0	106.0

Table 1: Noise emission, L_{WA} [dB(A) re 1 pW]

Octave Band
Octave band spectra are tabulated below for 6 and 8 m/s referenced to 10 m height.

Octave band, centre frequency [Hz]	63	125	250	500	1000	2000	4000	8000
Sound power level	81.4	92.6	96.7	100.3	100.5	97.1	89.7	85.4

Table 2: Octave band for 6 m/s, L_{WA} [dB(A) re 1 pW]

Octave band, centre frequency [Hz]	63	125	250	500	1000	2000	4000	8000
Sound power level	82.5	93.4	97.1	101.1	101.1	97.4	90.2	86.2

Table 3: Octave band for 8 m/s, L_{WA} [dB(A) re 1 pW]

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