HGC ENGINEERING

Howe Gastmeier Chapnik Limited
2000 Argentia Road, Plaza One, Suite 203
Mississauga, Ontario, Canada L5N 1P7
t: 905.826.4044

SPRING ACOUSTIC AUDIT - IMMISSION REPORT

Ernestown Wind Park

Loyalist Township, Ontario

Prepared for:

Ernestown Windpark, LP
2300 Yonge Street, Suite 801
Toronto, ON
M4P 1E4

Prepared by

Nathan Gara

and

Ian R. Bonsma, PEng

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EXECUTIVE SUMMARY

Howe Gastmeier Chapnik Limited ("HGC Engineering") was retained by Ernestown Windpark, LP to complete an Acoustic Immission Audit of the Ernestown Wind Park. The project includes five Enercon E82 wind turbine generators, each rated at 2.0 MW. The Acoustic Immission Audit is required as a condition of Renewable Energy Approval number 8798-998GRW issued by the Ontario Ministry of the Environment ("MOE"). HGC Engineering has assessed the acoustic impact against the acoustic criteria of the MOE in accordance with the requirements of the MOE's Compliance Protocol for Wind Turbine Noise. The spring measurement campaign was completed between March 17 and May 22, 2015.

The sound level measurements and analysis, as performed in accordance with the MOE's Compliance Protocol for Wind Turbine Noise, indicate that the project meets the applicable sound level limits at the chosen monitoring location. Details of the measurements and analysis are provided herein.

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1 INTRODUCTION

Howe Gastmeier Chapnik Limited ("HGC Engineering") was retained by Ernestown Windpark, LP to complete an Acoustic Audit – Immission of the Ernestown Wind Park. The project is located in the town of Ernestown, Ontario and consists of five Enercon E82 wind turbine generators, each rated at 2.0 MW and each with a hub height of 98 metres.

The Audit is required as part of the Renewable Energy Approval ("REA") number 8798- 98GRW [1] issued for the project by the Ontario Ministry of the Environment ("MOE"). Specifically, this report summarizes measurements that were conducted in the spring in order to satisfy the first of two seasonal audits required under Condition E of the REA.

2 MONITORING LOCATION

The Acoustic Assessment Report prepared by GL Garrad Hassan [2] provided sound level predictions for locations within 1500 metres of the project wind turbine generators. The condition in the REA requires that measurements be completed at one monitoring location which is selected using the following criteria:

- The monitoring location should represent the location of the greatest predicted noise impact.
- The monitoring location should be in the direction of prevailing winds from the facility.

A number of locations were considered for use as sound level monitoring locations for the audit, as shown in Table 1.

Table 1: Potential Monitoring Locations

ID	Distance to nearest turbine [m]	Nearest turbine ID	Calculated Sound Pressure Level at Receptor [dBA] at selected Wind Speed in m/s					Suitable Monitoring Location	Comments
			6	7	8	9	10		
R205	611	4	39.9	39.9	39.9	39.9	39.9	N	Industrial zoned land, not in prevailing wind direction
VLR258	625	3	38.5	38.5	38.5	38.5	38.5	N	Not accessible
VLR302	671	3	38.1	38.1	38.1	38.1	38.1	N	Not accessible
M1	580	1	37.9*	37.9*	37.9*	37.9*	37.9*	Y	Selected Location
VLR259	701	3	37.8	37.8	37.8	37.8	37.8	N	Not accessible
VLR301	867	3	36.3	36.3	36.3	36.3	36.3	N	Not accessible
VLR282	1034	4	36.2	36.2	36.2	36.2	36.2	N	Not accessible
R92	657	1	36.1	36.1	36.1	36.1	36.1	Y	Permission not granted
R303	681	1	35.7	35.7	35.7	35.7	35.7	Y	Permission not granted
R65	783	2	35.4	35.4	35.4	35.4	35.4	Y/N	Low sound level
R52	791	1	35.0	35.0	35.0	35.0	35.0	Y/N	Low sound level
R55	881	1	34.9	34.9	34.9	34.9	34.9	Y/N	Participating, Low sound level
R53	796	1	33.8	33.8	33.8	33.8	33.8	Y/N	Low sound level
R59	906	1	33.5	33.5	33.5	33.5	33.5	Y/N	Low sound level
R51	788	1	33.4	33.4	33.4	33.4	33.4	Y/N	Low sound level

* Predicted without topography

The monitoring location (M1) was selected based on the downwind location, predicted sound level, and consultation with the land owners. The annual wind rose for the area is provided in Appendix A. The location has a predicted sound level of 37.9 dBA, not including topography. The monitoring location is 220 meters south of receptor R53 and 580 meters northwest of wind turbine generator 1 (T1). The location is approximately 4 km south of HWY 401, and 2 km north of a CN mainline carrying substantial rail traffic. Photos of the selected monitoring location can be found in Appendix B.

3 INSTRUMENTATION

The MOE document, *Compliance Protocol for Wind Turbine Noise – Guidelines for Acoustic Assessment and Measurement* [3] ("Compliance Protocol") provides requirements for instrumentation for Acoustical Audits of wind energy projects. Instrumentation used for this acoustic audit satisfies the requirements provided in the Compliance Protocol.

Audio frequency sound level measurements were taken using a Norsonic NOR140 sound level meter connected to a ½" microphone. The microphone was set at a height of approximately 4.5 m and equipped with a 175 mm diameter windscreen to minimize wind-induced microphone self-noise.

The energy-equivalent average sound level, denoted $L_{EQ,}$ and also the L_{90} sound level, the level exceeded 90% of the time during the measurement, were recorded by the instrumentation. The L_{90} sound level is commonly used to represent the background or steady-state sound level because it minimizes transient sounds such as occasional human voices, brief animal activity, and car or train noise. The audio-frequency measurements are presented as A-weighted sound levels as they are intended to represent the loudness of sounds as perceived by the human ear. The overall audio-frequency sound level monitoring results are summarized in this report.

In addition to the acoustic instrumentation, two meteorological instruments were used. A Davis weather station was deployed to collect ground weather conditions including temperature, humidity, and precipitation. An NRG anemometer and wind vane was used to collect 10 metre height wind speed and direction at the monitoring location.

The various instruments deployed by HGC Engineering are summarized in Table 2, and their relative locations are shown in Figure 1.

Table 2: Sound Level Measurement Instrumentation

Instrumentation Make and Model	Serial Number
Norsonic NOR140 Sound Level Meter	1404511
NRG#40 Anemometer connected to a Campbell Scientific Datalogger	179500239663
Davis VantagePro2 Weather Station	3788A-6312

The Norsonic sound level meter was configured to measure and document spectral (frequency-dependent) 1 minute L_{EQ} and 10 minute L_{90} sound level measurements at the monitoring location. For identification of dominant sources, the sound level meter also recorded audio files.

Correct calibration of the acoustic instrumentation was verified using an acoustic calibrator manufactured by Brüel & Kjær (B&K). Calibration was carried out at the start and end of the measurement period.

A wind screen was used on the microphone, consistent with the requirements of MOE technical publication NPC-103, *Procedures* [4]. A large wind screen, 175 mm in diameter, was used on each sound level monitor to minimize wind-induced microphone self-noise at higher wind speeds. Sound level data included herein has not been adjusted for the sound insertion loss of the large wind screen.

4 ASSESSMENT CRITERIA

The MOE publication *Noise Guidelines for Wind Farms – Interpretation for Applying MOE NPC Publications to Wind Power Generation Facilities* [5] indicates the applicable sound level limit for wind energy projects. Additionally, the Compliance Protocol document and the REA approval include the same sound level limits which are shown in Table 3.

Table 3: Wind Turbine Noise Criteria [dBA]

Wind Speed (m/s) at 10 m Height	4	5	6	7	8	9	10
Wind Turbine Sound Level Limits Class 3 Area [dBA]	40.0	40.0	40.0	43.0	45.0	49.0	51.0

It should be noted that the sound level limits of the MOE apply only to the sound level contribution of the sound source under assessment, in this case the sound from the wind turbine generators. Thus, where a sound level measured at the monitoring location includes significant sound due to the relevant sound source and unrelated background sound sources (i.e., road vehicles, trains, air traffic, farming machinery, wind, etc.), some form of evaluation must be made to determine the sound level contribution of the source under assessment in the absence of

the background sounds. Methodology prescribed by the MOE to complete an assessment of wind energy projects is discussed in the following section.

5 METHODOLOGY

The REA requires the acoustic audit be completed in accordance with Part D of the Compliance Protocol for Wind Turbine Noise. Part D includes requirements for instrumentation, measurement and data reduction procedures to assist with determining compliance.

A series of one-minute energy equivalent sound level measurements are conducted with and without the turbines operating. Simultaneously, wind speed and direction at 10 metre height are measured in one minute intervals. The measured sound level data is separated into integer wind speed "bins" where the sound levels corresponding to each integer wind speed are arithmetically averaged to determine the average sound level when the wind turbines are operational and when they are parked. The ambient L_{EQ} (turbines parked) is logarithmically subtracted from the overall L_{EQ} (turbines operational) to determine the sound level contribution of the wind turbines alone. Supplementary data including wind speed at turbine hub height, wind speed at noise measurement height, turbine electrical power output, temperature, humidity, and statistical noise indices (Ln) can also be measured during the monitoring campaign to aid in the analysis.

The MOE protocol requires at least 120 one minute intervals be measured for each 10 metre height wind speed between 4 and 7 m/s when the turbines are operating and at least 60 one minute intervals be measured for each 10 metre height wind speed between 4 and 7 m/s when the turbines are parked. Prior to determining the number of data points measured in each wind speed bin, the data is filtered to only include night time hours (between 22:00 and 05:00), data outside of rainfall (no rain within an hour of the measurement interval), and the maximum wind speed measured at a 10 metre height should not differ from the average by more than 2 m/s.

The MOE protocol allows for the removal of individual events to improve the signal to noise ratio. A review of the audio recordings allows for the identification of the dominant noise source within a given one minute interval, and the subsequent removal of data points that contain interference.

Adjustments to the measured sound levels may be required based on wind turbine tonality, if any. If during the acoustic measurement campaign the project wind turbines exhibit tonal characteristics (a whine, screech, buzz or hum) then an assessment of the tonal audibility is required according to International Standards Organization 1996-2 [6]. The average tonal audibility correction must be determined for each integer wind speed and the correction added to the final noise contribution of the wind turbine at those wind speeds.

6 MEASUREMENTS AND RESULTS

Sound level measurements were conducted between March 17 and May 22, 2015. The weather during the monitoring period varied, including several days with rain and snow. Temperatures ranged from -5 to 20° Celsius. Wind speeds at 10 metres in height ranged from 0 m/s up to 24 m/s. The prevailing wind direction during the measurement campaign was from the west. Figures 2a and 2b show the wind roses for the monitoring location during the ON and OFF conditions. Observations during the attended measurements conducted on a number of occasions throughout the measurement campaign indicated that the turbines were not tonal.

The sound level summary for data collected at the monitoring location is shown in Tables 4a and 4b.

Table 4a: Sound Level Summary L_{EQ} [dBA]

	10 metre Wind Speed							
	4 m/s		5 m/s		6 m/s		7 m/s	
L_{EQ} Average Operating (ON) / std dev.	40.2	3.5	41.6	3.3	43.2	2.9	45.6	2.4
L_{EQ} Average Ambient (OFF) / std dev.	37.1	3.6	38.7	3.5	40.5	3.5	42.3	3.5
L_{EQ} Wind Project Only / std dev.	37.3	3.6	38.4	3.6	39.9	3.4	43.0	3.2
Criteria	40.0		40.0		40.0		43.0	
Excess	**0**		**0**		**0**		**0**	

Table 4b: Summary of Valid Data Points

	10 metre Wind Speed			
Wind Project Condition	**4 m/s**	**5 m/s**	**6 m/s**	**7 m/s**
Operating (ON)	2046	973	328	152
Ambient (OFF)	250	303	180	65

Based on the data presented above and in Figures 3a and 3b, the wind energy facility is compliant with the MOE sound level criteria at the monitoring location.

Appendix C includes a statement from Ernestown Windpark, LP indicating the wind turbines were operating normally for the duration of the measurement campaign.

7 CONCLUSIONS AND RECOMMENDATIONS

The measurements and analysis, performed in accordance with the methods prescribed by the Ontario Ministry of the Environment in publication *Compliance Protocol for Wind Turbine Noise* indicates that the wind energy facility is operating within compliance of the MOE's sound level criteria at the monitoring location.

REFERENCES

1. Ontario Ministry of the Environment Renewable Energy Approval Number 8798-998GRW, August 12, 2013.
2. GL Garrad Hassan, *Renewable Energy Approval – Noise Impact Assessment, Ernestown Wind Power Project, Ontario*, June, 2013.
3. Ontario Ministry of the Environment Publication, *Compliance Protocol for Wind Turbine Noise Guideline for Acoustic Assessment and Measurement*.
4. Ontario Ministry of the Environment Publication, NPC-103, *Procedures.*
5. Ontario Ministry of the Environment Publication, *Noise Guidelines for Wind Farms, Interpretation for Applying MOE NPC Publications to Wind Power Generation Facilities*, October 2008.
6. International Standards Organization 1996-2, *Acoustics – Description, assessment and measurement of environmental noise – Part 2: Determination of environmental noise levels*, 2007.
7. Environment Canada, *Wind Atlas*. June 11, 2015. Retrieved from http://www.windatlas.ca/en/rose.php?field=E1&height=30&season=ANU&no=17&ni=999&nj=235.

Figure 1: Sound Level Monitor and Wind Turbine Locations

Ernestown Wind Park

Figure 2a: Wind Direction - Ernestown Wind Park

10 m Height, Wind Speeds 4-7 m/s

ON Condition, March 17 to May 22, 2015

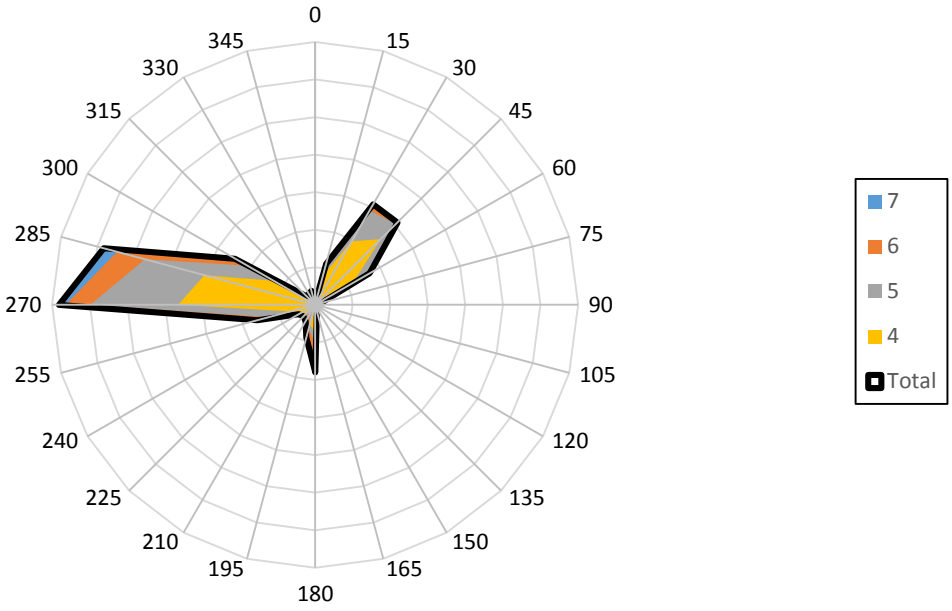


Figure 2b: Wind Direction - Ernestown Wind Park

10 m Height, Wind Speeds 4-7 m/s

OFF Condition, March 17 to May 22, 2015

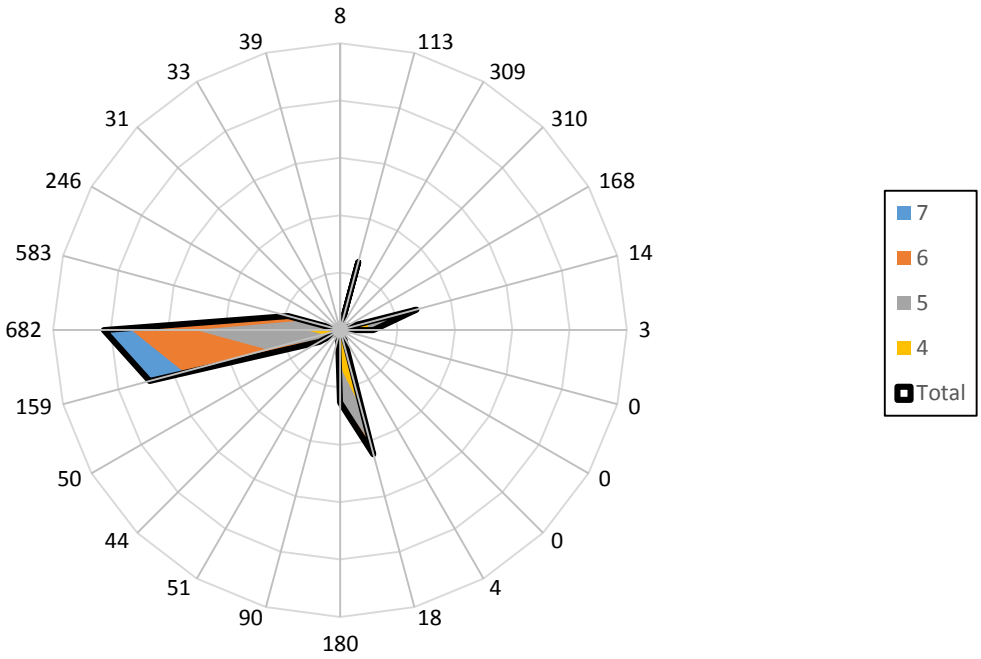


Figure 3a: Ernestown Wind Park, Spring Immission Results
March 17 to May 22, 2015

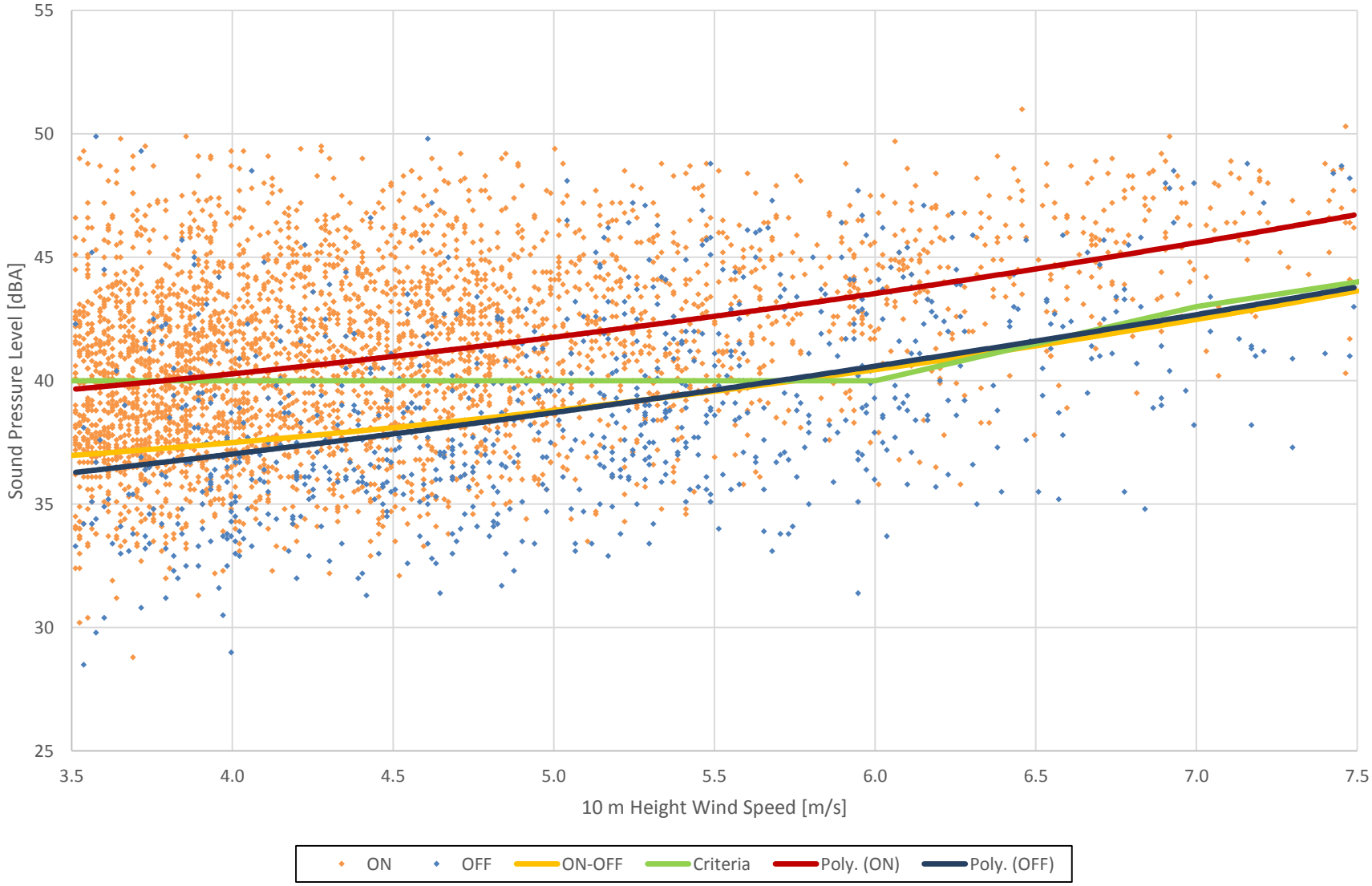
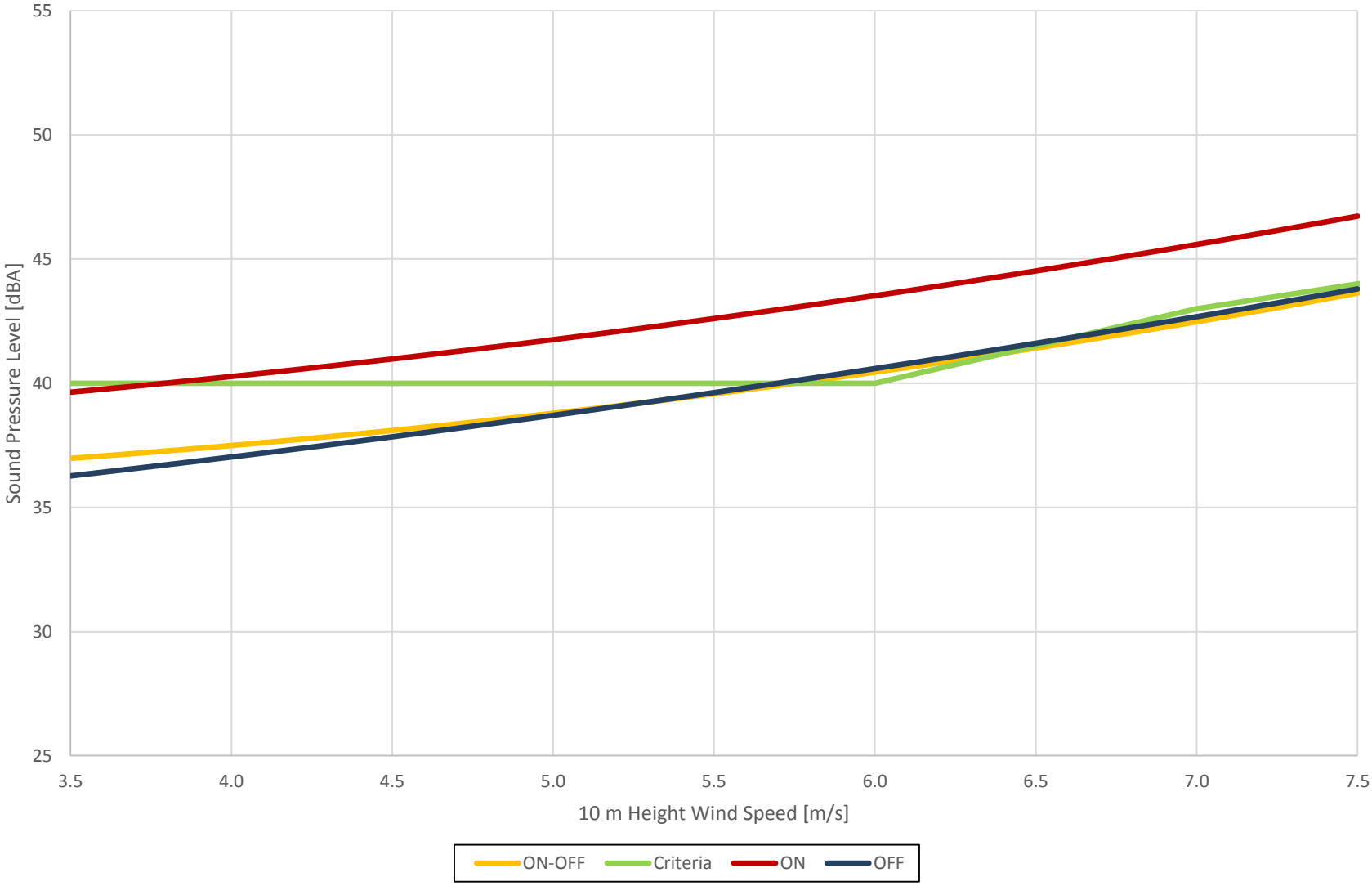
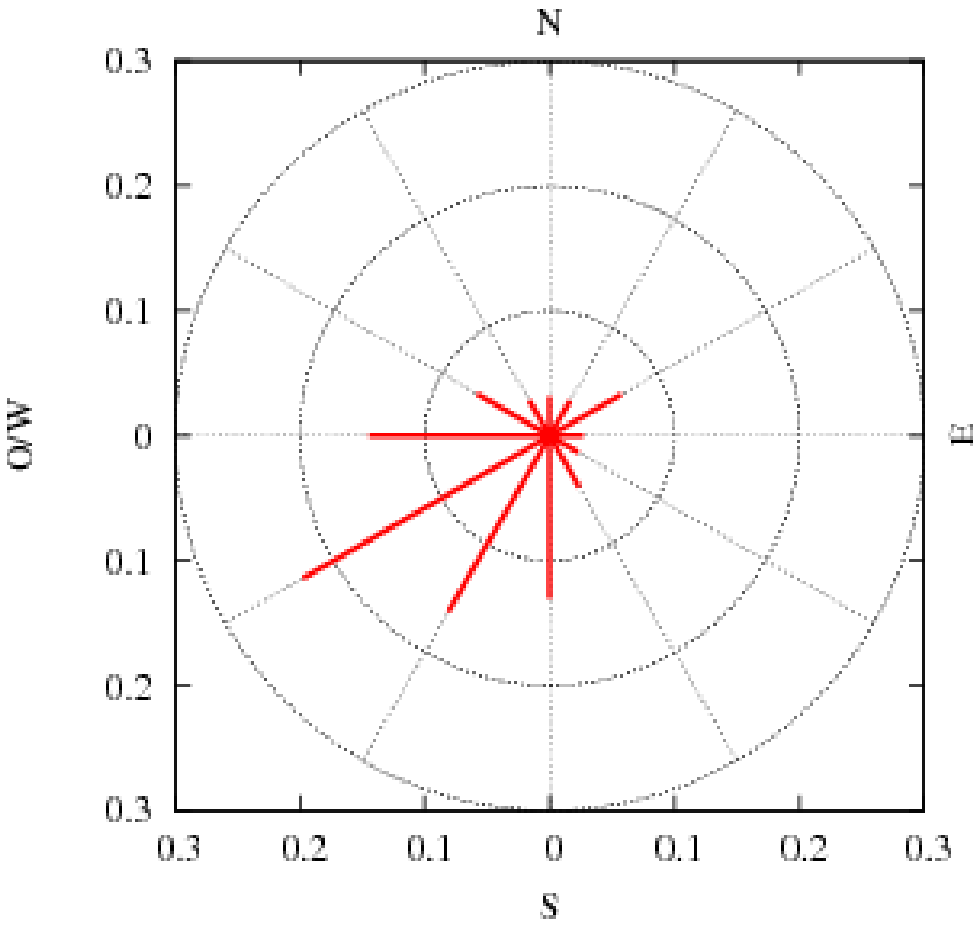


Figure 3b: Ernestown Wind Park, Spring Immission Results
March 17 to May 22, 2015

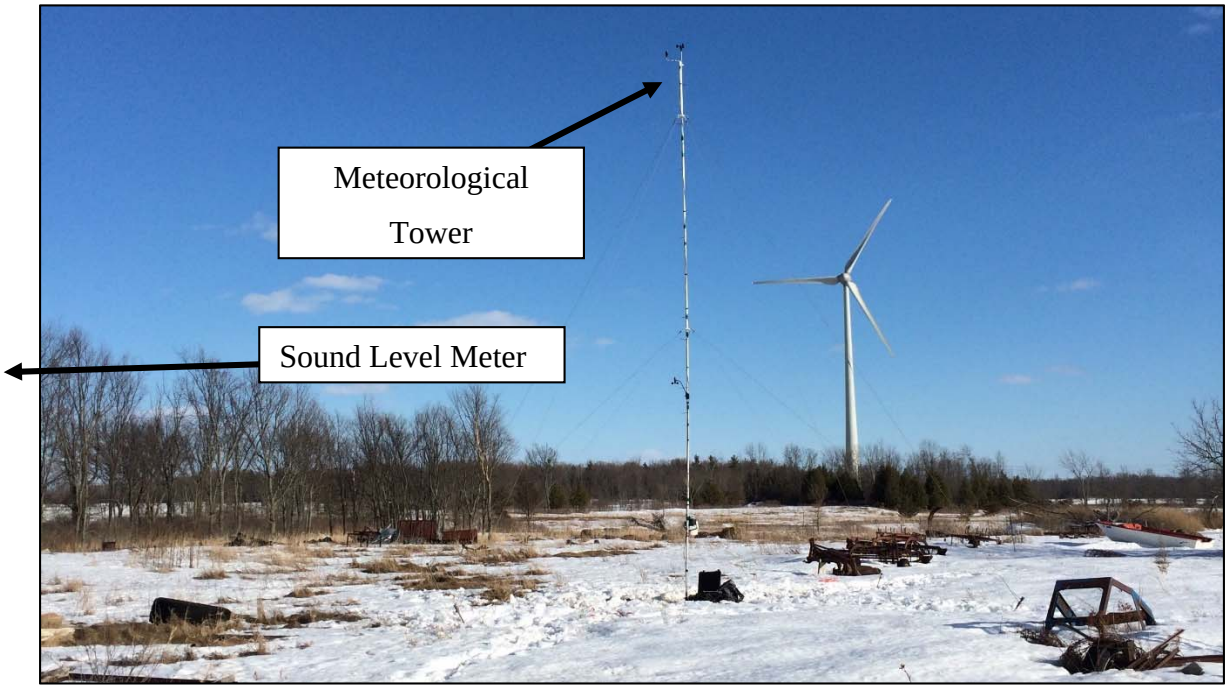


APPENDIX A:
HISTORICAL WIND ROSE

Figure A1: Annual Wind Rose [7]



APPENDIX B:
MONITORING LOCATION PHOTOS


Meteorological Tower
Sound Level Meter


Sound Level Meter

APPENDIX C:

STATEMENT OF OPERATION

ERNESTOWN
Windpark Inc.

June 17, 2015

STATEMENT OF OPERATION

Ernestown Wind Park Project, Loyalist Township, Ontario

To Whom It May Concern,

This letter is to confirm that the wind turbine generators at the Ernestown Wind Park Project were functioning in their standard operational mode during the post-construction acoustic audit, conducted between March 17 and May 22, 2015.

Yours Truly,

Ernestown Windpark Inc. as general partner and on behalf of Ernestown Windpark LP

Gary Thomas
Chief Financial Officer

Ernestown Windpark Inc. as general partner of Ernestown Windpark LP
2300 Yonge Street Suite 801, PO Box 2300, Toronto, Ontario, Canada M4P 1E4
phone: (416) 864-9977 fax: (416) 864-9568 web: www.ernestownwind.com