DNV·GL

GUNN'S HILL WIND FARM

Second Acoustic Immission Audit - 2018/2019

Gunn's Hill LP

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Task and objective:

This report presents the results of second acoustic immission audit at the Gunn's Hill Wind Farm conducted by DNV GL on behalf of Gunn's Hill LP

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1 INTRODUCTION

GL Garrad Hassan Canada Inc. (“DNV GL”) was retained by Gunn's Hill LP (the “Proponent” or “Prowind”) to conduct an acoustic immission audit at the Gunn's Hill Wind Farm (the “Project”). The requirement to complete an audit is detailed under Part E of the Renewable Energy Approval, number 6862-9RDJZX dated 9 April 2015 (“REA”). The purpose of the assessment is to determine the noise contribution of the wind turbine generators on the nearby Receptors, and to compare the levels against the permissible sound levels in Ontario.

The Project has been operational since fall 2016, and is comprised of ten Senvion MM92 1.88 MW wind turbines, for a total nameplate capacity of 18 MW. Project is located in the township of Norwich, within Oxford County, Ontario. The area consists of flat terrain with farming activities and isolated woodlots. A pre-construction Noise Impact Assessment (NIA) was prepared [1] as per the Ontario Noise Guidelines in effect at the time (Noise Guidelines) [2].

As per the REA, the audit shall follow Part D of the latest Compliance Protocol for Wind Turbine Noise (“Compliance Protocol”) [3], and be completed at two Receptors.

Two separate and distinct audits were conducted; one in Spring [4] and one in Fall 2018. The audit being presented in this report was started in November 2018 and completed in April 2019.

2 METHODLOGY

2.1 Measurement Locations

On-site monitoring was conducted at two locations, nearest to R55 and R80 in the NIA. As per Appendix F3 of the Compliance Protocol, a careful selection of audit receptors was undertaken, with the following criteria:

1. Receptors with highest modelled sound levels and higher than 37 dBA;
2. Receptors that are generally downwind from the prevailing wind direction(s) during the audit timeline (Spring and Fall);
3. Receptors that agree to host an audit; and
4. Consideration for other constraints that could impede with audit (ex. prevalent domestic sound, trees, etc.).

The list of considered Receptors, as well as the selection rationale, is shown in Appendix A of this document.

Receptor R55 is located in the central area of the Project. It is comprised of a dwelling and several sheds. The monitoring location (M55) was positioned 54 m to the southwest of the dwelling on the adjacent lot, towards the nearest turbines T4 and T5, in order to clear the trees and sheds. The ground cover was an open field between the monitoring station and the nearest turbines. The sound level at R55 in the NIA was modelled at 37.0 dBA. The predicted sound level at the monitoring station which was closer to the wind turbines, was 37.2 dBA when modelled by DNV GL based on the parameters of the NIA. As mentioned in Section 2.3 below, all the data in this assessment (i.e. when the turbines are operational and but also parked) were filtered for downwind conditions from the nearest turbines to the monitoring stations.

Receptor R80 is located in the eastern area of the Project. The monitoring location (M83) was positioned 160 m to the southwest of the R80 dwelling, closer to T9, on the land owned by Participant P83. The ground cover was an open field between the monitoring station and the nearest turbines. The sound level at R80 was modelled at 38.4 dBA in the NIA. The predicted sound level at the monitoring station, as modelled by DNV GL based on the parameters of the NIA, was 39.3 dBA.

The recommended monitoring locations were provided to the MOECC prior to mobilization and were deemed acceptable based on the rationale presented [5]. The same monitoring locations were used in the first Immission audit [4].

Table 2-1 provides a summary of the Receptors and selected monitoring locations.

Table 2-1 Receptor and Measurement Locations

Location	Easting	Northing	Distance to nearest turbine	DNV GL Modelled sound level
R55	525949	4769269	733 m from T5	37.0 dBA
M55	525904	4769239	702 m from T5	37.2 dBA
R80	527612	4769608	675 m from T10	38.3 dBA
M83 (for R80)	527515	4769482	549 m from T9	39.3 dBA

All coordinates in UTM NAD83 zone 17

Figure 2-1 presents a general overview map of the measurement locations in relation to the Project. Figure 2-2 provides locations for the equipment on the properties. Pictures of the monitoring locations are included in Appendix B.

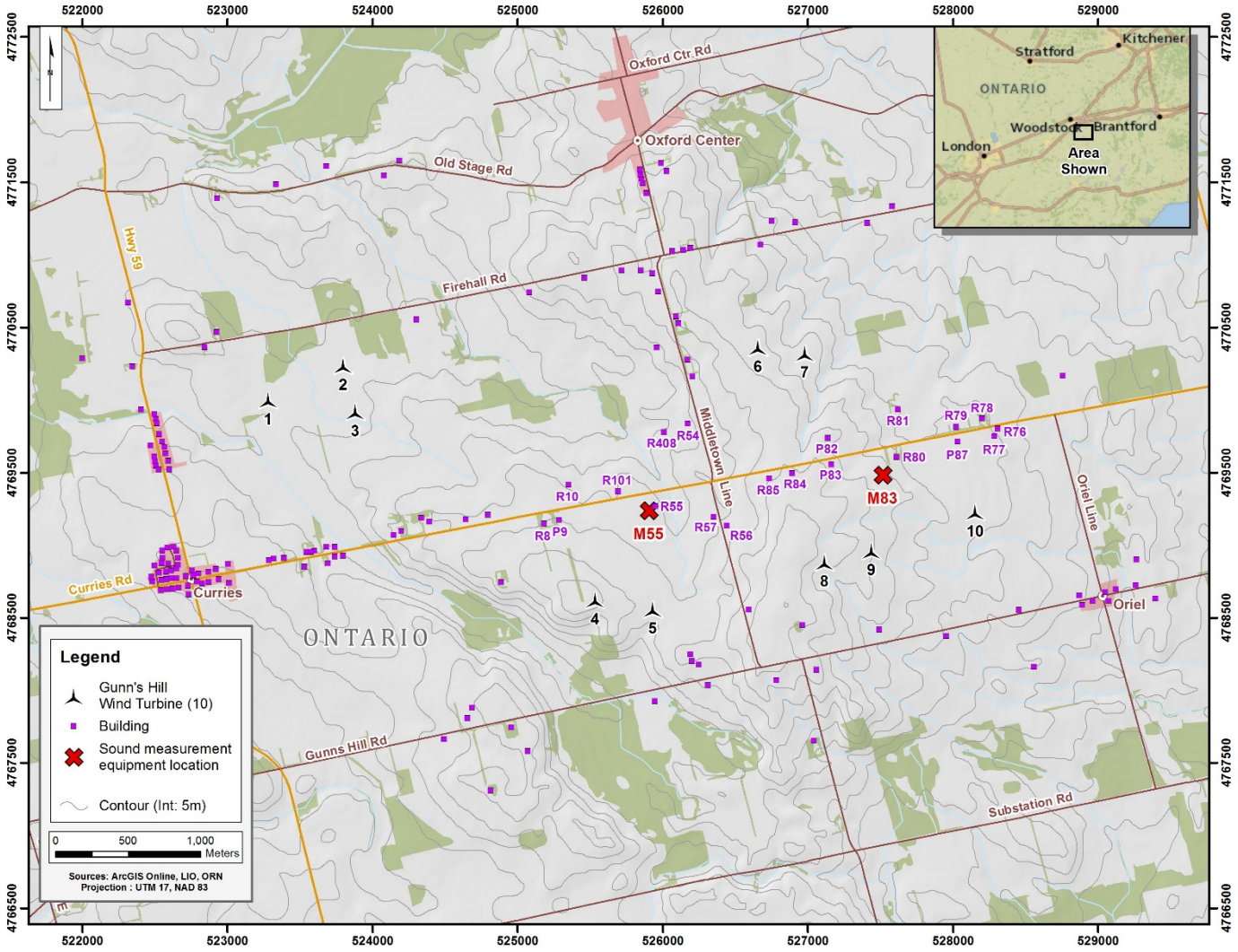

Figure 2-1 Map of Project and Monitoring Locations

Figure 2-2 Equipment Locations on Properties

2.2 Instrumentation

The instrumentation used for the post-construction noise monitoring included the following:

- Larson Davis Class 1 sound meter models: 831 & 831C;
- FreeField ½ inch Class 1 microphone model 377B02;
- Preamplifier model PRM831;
- Vaisala Weather Transmitter model SEN-031;
- Larson Davis Precision Acoustic on-site Calibrator model CAL200; and
- Complete kit for outside sound measurement (including 10m mast, primary and secondary wind screens, protective case, solar panels, and long range batteries).

In addition to the primary wind screens, secondary wind screens were installed over the microphones. The secondary wind screens consisted of a 600 mm (24 in) outer diameter sphere, composed of a 25 mm (1 in) layer of open cell foam fastened over a slender aluminum cage. The screens were tested in an anechoic wind tunnel prior to deployment of the first I-Audit campaign. The wind tunnel tests showed negligible insertion loss and good performance under high winds.

The Vaisala weather sensor provided in-situ data for wind speed, wind direction, temperature, humidity and precipitation. The weather data was directly connected to the sound meter with synchronized data. The weather sensor contains a built-in heater for wintry environments. The user guide for the weather sensor states it is rated to perform at temperatures down to -52 °C [6].

The sound meters met IEC 61672 and IEC 61260 Class 1 specifications, and were compliant with the Ministry of the Environment and Climate Change (MOECC) instrument requirements detailed under Section D2.1 of the Compliance Protocol. Pictures of the monitoring set-ups are including in Appendix B. All sound level instruments had valid calibrations, within the year of monitoring, and calibration sheets are included in Appendix C of this document. User manuals state that the sound level meters' lower temperature range for operational conditions are -25 °C for the 831 [7] and -30 °C for the 831C. [8]

Table 2-2 provides the serial numbers of the equipment used at each monitoring location. Multiple serial numbers are listed, as equipment was replaced during the survey.

Table 2-2 Equipment Serial Numbers by Monitoring Location

Monitoring location	Sound Level Meter	Preamplifier	Microphone	Weather sensor
M55	10434, 10368	025994, 051224	164236, 303859	H4720003
M83	10465, 10433, 10364	023787, 051225	152155, 303856	K2010136, P1320473

2.3 Data Collection

Data collection ran for more than 6 weeks at both locations, as stipulated in the Compliance Protocol. The start and end of both datasets were the following:

- M55: from 5 November 2018 to 15 March 2019 (18 weeks);
- M83: from 5 November 2018 to 22 April 2019 (24 weeks).

Throughout the campaign, operational data and ambient data (i.e. with the turbines parked) were collected, and subsequently binned per wind speed at a height of 10 m. Sound measurements were made using a

FAST response setting and statistics were derived by the sound meter and stored every second and every minute. Audio recordings were collected continuously throughout the campaign for future analysis. Sound events louder than 60 dBA were logged as events.

Only nighttime data (10pm-5am) were retained for further analysis. Extraneous events such as rain, or other atypical sounds such as an airplane flyover, agricultural noise, dog barking or gunshots, were filtered out of the dataset. The onset of the campaign was delayed due to a late harvest of nearby crops. At location M83, a grain dryer was operational during some nighttime periods in November and December. Measurements with the grain dryer running were removed the operational and ambient measurements.

Equipment was serviced throughout the period by on-site staff and checked for proper performance. Additional solar panels and batteries were added to the monitoring equipment to counter effects of the cold weather. However, due to environmental factors, monitoring equipment was replaced and equipment was not able to run continuously throughout the survey duration.

2.3.1 Operational data

Operational data represents total noise, i.e. the ambient noise plus the wind turbine cumulative contribution. Due to the relatively small size of the wind farm, all turbines near the monitoring stations were required to be operational in order for the operational dataset to be considered valid.

For directional filtering, only downwind data with a yaw angle of ± 45 degrees from the nearest wind turbines to the monitoring stations, were considered valid. Furthermore, due to the proximity of two turbines to each station, both proximate turbines were considered for operational data. As per Appendix F11 of the Compliance Protocol, considering a cluster of wind turbines is acceptable with the condition that the modelled sound levels from each turbine were within 2 dB at the receptor/measurement location, and the two turbines were within a 90 degrees' window from the monitoring stations. In summary, operational data were filtered for the following direction criteria:

- M55: downwind from turbine T4 (i.e. yaw angle of 165° to 255°) or from turbine T5 (i.e. yaw angle of 135° to 225°);
- M83: downwind from turbine from turbine T9 (i.e. yaw angle of 144° to 234°) or T10 (i.e. yaw angle 68° to 158°).

As per the Compliance Protocol, operational data were finally filtered for when the nearest relevant turbines were producing at least 85% of rated power. This consisted in a power production of more than 1,598 kW at turbines T4 and T5 (for M55) or at turbines T9 and T10 (for M83). The remaining valid dataset therefore only considered periods with high shear and/or high wind speeds.

The sound and weather data at the monitoring stations were coupled with the SCADA data obtained from Prowind. The data was obtained in 10 min timestamp averages, and included power production, nacelle wind speed, rotor rpm and yaw angle for all wind turbines. It was confirmed by the turbine vendor that smaller increments (i.e. 1 minute) were not possible with the current SCADA system.

2.3.2 Ambient Data

The ambient data represents measured sound levels without the contribution of the wind turbines. For the ambient data, the wind turbines which would result in the predicted sound level to fall below 30 dBA at the

monitoring stations, were required to be parked. As estimated by DNV GL's modelling, this consisted in the following turbines:

- M55: Turbines T4, T5, T6, T8 to be parked;
- M83: Turbines T5, T7, T8, T9 and T10 to be parked.

In addition, the same directional filtering criteria as for the operational data was applied for the ambient data, which consisted of an overall range of 135° to 255° for M55 and 68° to 234° for M83. The turbine yaw may not correlate to wind direction during ambient periods or when curtailed. Therefore, wind direction was based on each monitoring station's Vaisala weather sensor at a 10 m height. This provided comparisons of operational and ambient data from the similar directions which typically produces more conclusive results.

In order to ensure relevant wind turbines were parked during these periods, DNV GL filtered the SCADA power production *and* rotor speed to ensure wind turbines were not contributing to the ambient measurements. A wind farm operator statement can also be found under Appendix D.

2.3.3 Field Calibration

On-site maintenance visits were performed approximately every 2 weeks in order to verify the integrity of the monitoring stations, download data and field calibrate the sound meters. The field calibrations were performed with the Larson Davis CAL-200 calibrator. As required, calibration was performed at the beginning of the monitoring campaign and after the measurement campaign was finished.

The campaigns were started on November 5 for both points . Equipment was also calibrated during all subsequent visits when feasible. The sound level meter was replaced at M83 on November 19th. At both sites, equipment was changed on December 20. For the December date, two calibrations are shown, one for the initial equipment and one for the replacement equipment. The campaign was suspended in January and no calibrations were made.

The table differential calibrations are shown in Table 2-3.

Table 2-3 Site Calibration Log

Monitoring location	Date / Calibration differential (Decibel dB)										
	5 Nov	19 Nov	29 Nov	10 Dec	20 Dec	6 Feb	Feb 13	Mar 18	Mar 25	Apr 8	Apr 24
M55	0.01	-0.57	0.05	0.02	0.02/0.04	-0.18	0.21	N/A	0.11		
M83	0.17	0.13	0.07	0.09	0.17/0.00	-0.13	0.19	-0.01	0.01	-0.18	-0.09

2.4 Compliance Requirements

The sound level limits are outlined in the Nosie Guidelines and under Condition C1. of the REA. The sound level limits are based on the cumulative contribution of the Project, excluding ambient sound. The sound level limits are shown in Table 2-4 and increase at higher wind speeds.

Table 2-4 Ontario Permissible Sound Levels

Wind speed at 10 m height	Up to 6 m/s	7 m/s	8 m/s	9 m/s	10 m/s
Sound level limit (dBA)	40	43	45	49	51

Per the Compliance Protocol, the sample size requirements for a revised assessment methodology (RAM I-Audit) is to acquire data in three (3) wind speed bins between 1 and 7 m/s (inclusive) or two (2) wind speed bins between 1 and 4 m/s. The number of data points for each wind speed bin is 60 one-minute data points for turbine operational measurements and 30 one-minute data points for ambient measurements. To demonstrate compliance, the RAM I-Audit criteria is the most appropriate method for evaluating for this extended measurement campaign.

Compliance was determined at the nearby Receptors. The sound level was calculated at the measurement location, and then adjusted for sound levels at the Receptor locations. To determine the turbine only contribution at the measurement location, valid ambient data results were logarithmically subtracted from operational data results in each discrete wind speed bin relevant to the audit. Acoustic propagation modeling with CadnaA software was used to assess the difference in noise levels at the measurement locations and their corresponding Receptor locations. Results were rounded to the nearest integer, as per the Compliance Protocol, and compared against the levels in Table 2-4.

3 ANALYSIS AND RESULTS

3.1 Audit results

During the overall campaign, sound was measured and recorded under various meteorological conditions. The following range of conditions were encountered:

- Temperature range of -14.0 to 10.0 °C;
- Humidity range from 40 % to 92 %;
- Wind speed range at the wind turbines hub height from 0 to 24 m/s;
- Wind speed range at the 10 m towers from 0 to 23 m/s.

Wind rose plots for the duration of the campaign at both 10 m towers can also be found in Appendix E.

As detailed under Section 2.3, the data was filtered as per the Compliance Protocol requirements. The following provides the filtering summary;

All data:

- Nighttime only (10 pm – 5 am);
- Removal of rain events, within one hour of the measurement interval, as recorded by in-situ weather sensor;
- Removal of extraneous events (For example: airplanes, agricultural machinery and fireworks).

Operational data:

- Power production of more than 1,598 kW at turbines T4 or T5 (for M55), or at turbines T9 or T10 (for M83);
- Neighboring turbines operational;
- Downwind from turbine T4 (yaw angle of 165° to 255°) or from turbine T5 (yaw angle of 135° to 255°) for M55;
- Downwind from turbine T9 (yaw angle of 144° to 234°) or turbine T10 (yaw angle of 68° to 158°) for M83.

Ambient data:

- Turbines T4, T5, T6, and T8 to be parked for M55;
- Turbines T5, T7, T8, T9 and T10 to be parked for M83;
- Wind direction at the 10 m mast between 135° to 255° for M55.
- Wind direction at the 10 m mast between 68° to 234° for M83.

The remaining valid data were then grouped per wind speed bin, measured at a height of 10 m above ground. Table 3-1 and Table 3-2 below provide the number of valid samples, the logarithmically averaged sound levels, the standard deviations, and the resulting wind turbine contributions.

Table 3-1 M55 Audit Results

	Operational			Ambient				
Wind Speed at 10 m (m/s)	**Number of Valid 1 min samples**	**LAeq (dBA)**	**Standard deviation (dBA)**	**Number of Valid 1 min samples**	**LAeq (dBA)**	**Standard Deviation (dBA)**	**Turbine Contribution at Monitor (dBA)**	**Turbine Contribution at Receptor R55 (dBA)**
4	344	43.5	2.7	57	45.1	4.7	<40 [1]	<40 [1]
5	330	44.8	2.7	73	49.4	5.1	<40 [1]	<40 [1]
6	440	48.2	3.2	86	53.1	4.1	<40 [1]	<40 [1]

Note 1: <40 indicates operational results lower than ambient results. Turbine contribution was negligible in comparison to ambient sound, and can be considered at least 10 dB lower than operational results, which would be below 40 dBA at 6 m/s.

Table 3-2 M83 Audit Results

	Operational			Ambient				
Wind Speed at 10 m (m/s)	**Number of Valid 1 min samples**	**LAeq (dBA)**	**Standard deviation (dBA)**	**Number of Valid 1 min samples**	**LAeq (dBA)**	**Standard Deviation (dBA)**	**Turbine Contribution at Monitor (dBA)**	**Turbine Contribution at Receptor R80 (dBA)**
3	85	41.7	1.4	136	34.8	3.1	40.7	39.7
4	321	42.8	1.4	102	40.5	4.1	38.9	37.9
5	345	44.2	1.6	94	45.5	3.9	<40 [1]	<40 [1]
6	170	48.0	2.5	111	48.4	3.7	<40 [1]	<40 [1]

Note 1: <40 indicates operational results lower than ambient results. Turbine contribution was negligible in comparison to ambient sound, and can be considered at least 10 dB lower than operational results, which would be below 40 dBA at 5 and 6 m/s.

As can be noted from the above Tables, the extended survey period provided sufficient sample sizes for all bins. The required weather and operating conditions occurred rarely during the survey period, which is why the survey had to be extended to reach the required number of samples and concluded 24 weeks after the installation date. Ambient and operational data were gathered across multiple months. The acoustic environment varied during this extended period, which caused higher standard deviations than the first acoustic Immission audit [4]. For the M55 location, measured ambient levels were higher than operational levels. Therefore, the turbine contribution was negligible in comparison to ambient sound.

Furthermore, as detailed under Section 2.1, the monitoring location near Receptor R55 was situated closer to the nearest wind turbines from the receptor. DNV GL modeling showed a decrease of approximately 0.2 dB between the monitoring location and Receptor R55. Similarly, audit results at monitoring location M83 were measured at an adjacent Participant parcel and would decrease by 1.0 dB when extrapolated to Receptors R80 according to the sound propagation model. It is noted that since directional filtering was applied to both operational and ambient data for the M83 receptor, there is increased accuracy in extrapolating the audit results downwind to nearby Receptors.

The Figure 3-1 and Figure 3-2 provide graphs depicting the operational and ambient measured sound levels, as well as the resulting wind turbine only contributions. The standard deviations are also shown as a dashed line.

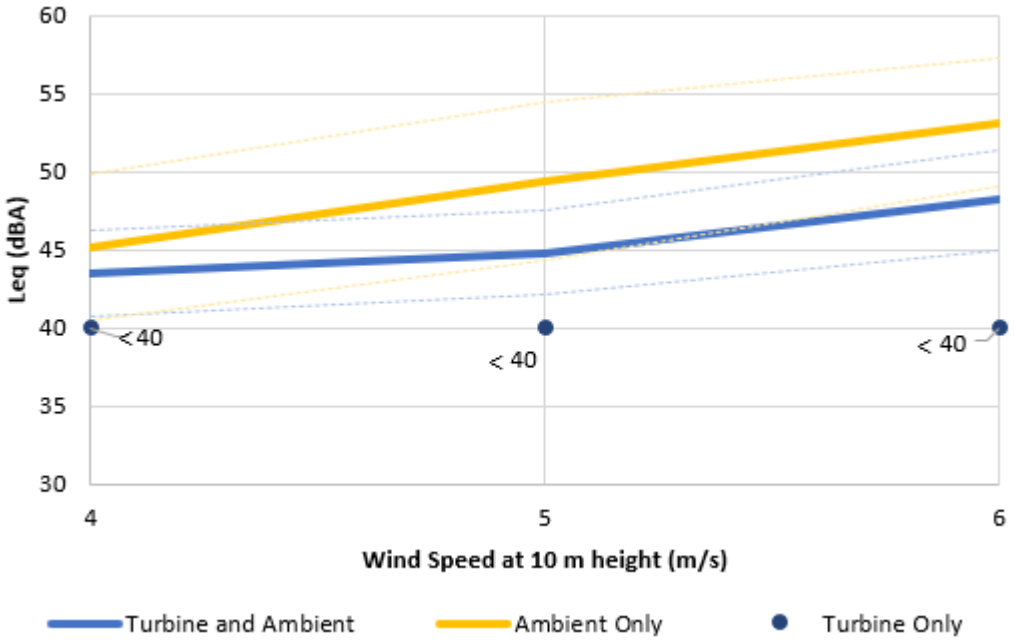

Figure 3-1 M55 Sound Level Graph ("Turbine Only" adjusted to Receptor R55)

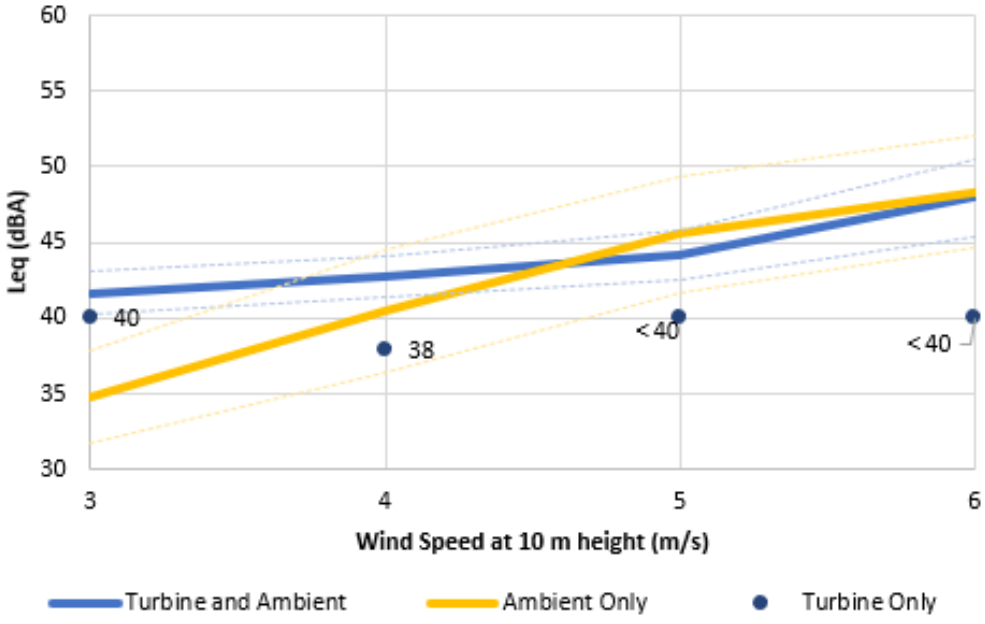

Figure 3-2 M83 Sound Level Graph ("Turbine Only" adjusted to Receptor R80)

Figure 3-3 and Figure 3-4 provide scatter plots for all the valid data.

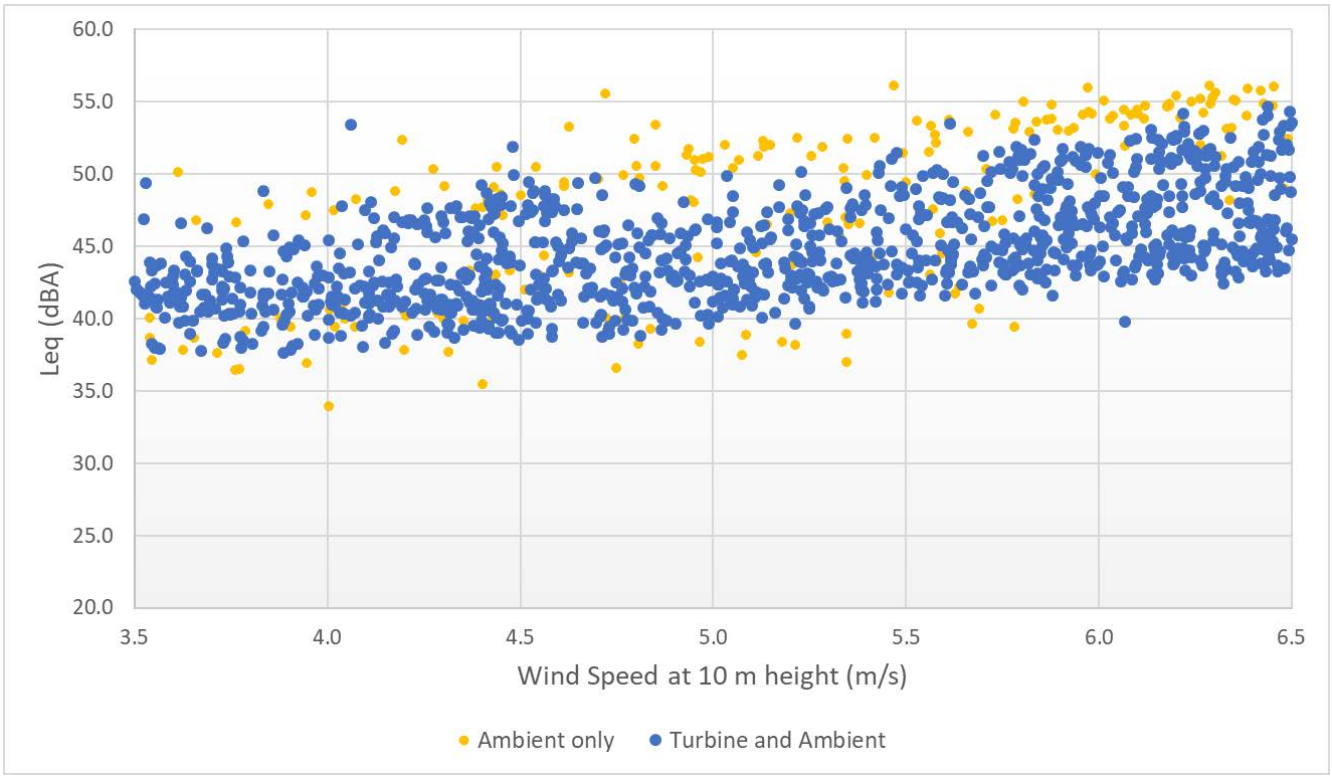

Figure 3-3 M55 Sound Level Scatter Plot

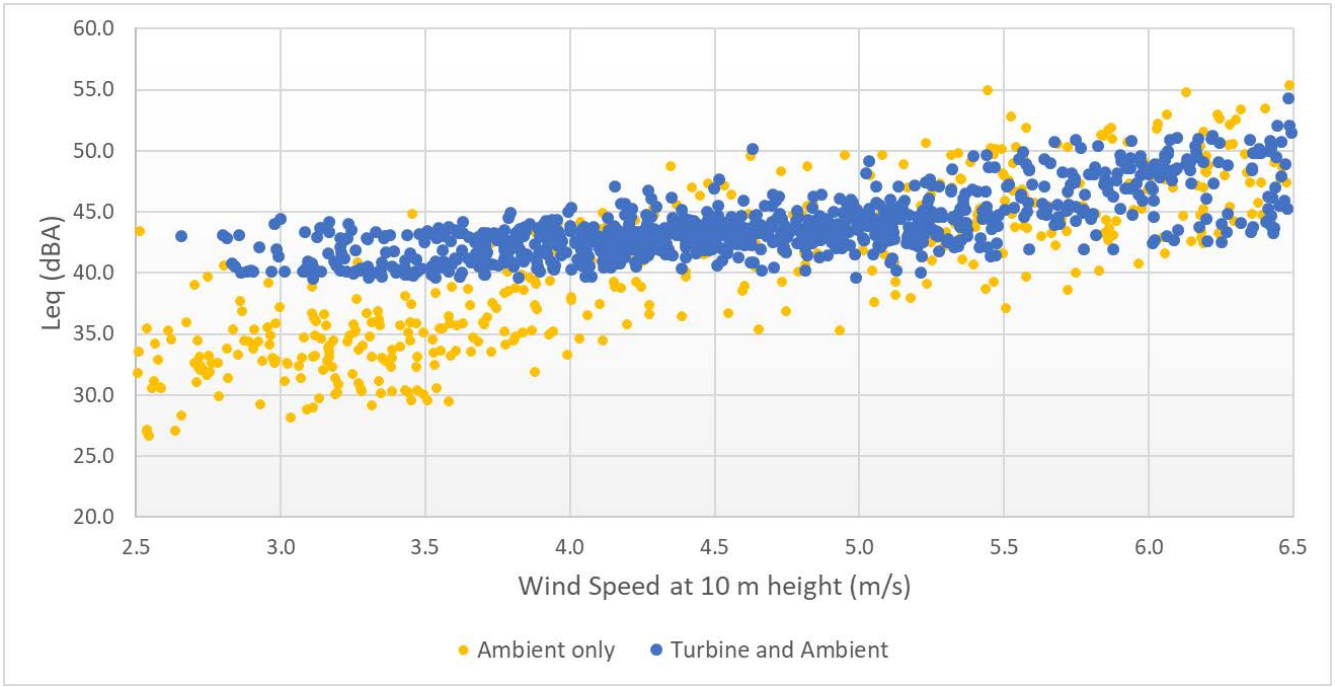

Figure 3-4 M83 Sound Level Scatter Plot

3.2 Tonality

On site observations during installations, numerous site visits and demobilizations, as well as a summary review of 1/3rd octave bands, indicated no tone from the wind turbines. As well, prior wind turbine Emission testing by DNV GL, as per IEC 61400-11 Ed 3, at the Gunn's Hill Wind Farm indicated no relevant tone from the wind turbine [9].

4 COMPLIANCE ASSESSMENT

Table 4-1 and Table 4-2 below compare the audit results to the permissible sound level limits in Ontario. As discussed under Section 3.1, the audit results presented are at the monitoring stations, and with extrapolated results to the nearby Receptor locations. The monitor locations are closer to the turbines from the Receptors. DNV GL's modelling indicates a decrease of 0.2 dB at Receptor R55 and 1.0 dB at R80, which is based on the additional distance between the turbines and the actual Receptors.

Considering the additional decrease at the nearby Receptors, and the fact that the ambient environment was measured louder with the turbines parked than with the turbines operational for certain wind speed bins, the Gunn's Hill Wind Farm is considered compliant with Condition C1. of the REA at the relevant Receptors.

Table 4-1 M55 Compliance Assessment

Wind Speed at 10 m (m/s)	Turbine Contribution at Monitor M55 (dBA)	Turbine Contribution at Receptor R55 (dBA)	MOECC Limit (dBA)	Compliant (Yes/No)
4	**< 40**	**< 40**	40	**Yes**
5	**< 40**	**< 40**	40	**Yes**
6	**< 40**	**< 40**	40	**Yes**

Table 4-2 M83 Compliance Assessment

Wind Speed at 10 m (m/s)	Turbine Contribution at Monitor M83 (dBA)	Turbine Contribution at Receptor R80 (dBA)	MOECC Limit (dBA)	Compliant (Yes/No)
3	**41**	**40**	40	**Yes**
4	**39**	**38**	40	**Yes**
5	**< 40**	**< 40**	40	**Yes**
6	**< 40**	**< 40**	40	**Yes**

5 CONCLUSION

DNV GL completed an Immission audit at the Gunn's Hill Wind Farm during Fall 2018, as per REA requirements. The audit was conducted per Part D the MOECC Compliance Protocol at two locations. The campaign ran for an extended duration covering over 18 weeks at both monitoring locations, under various meteorological conditions when the wind turbines were operational or parked.

The monitoring equipment was gathering sound level data until the project captured sufficient data to meet the RAM-I audit minimum criteria per the Compliance Protocol. Since the required conditions did not occur often, the campaign was extended significantly to fill the required bins. Audit results at the monitoring stations demonstrate compliance, and with the additional expected sound level decrease at the nearby Receptors, the Gunn's Hill Wind Farm is considered compliant with Condition C1. of the REA, at the measured Receptors.

The entire set of acoustic surveys performed at Gunn's Hill have demonstrated compliance. The highest modelled Receptor was selected amongst the measurement locations. Measurement results from the Spring 2018 and this Fall campaign were below the required sound limits set forth with Condition C1. of the REA. Results of the Emission test demonstrate that the turbines are in compliance with their permitted sound power levels [9]. Given that the measurement data supports that the turbine sound power level, and the Immission monitoring campaigns demonstrated compliance at the Receptors, it can reasonably be concluded that all other Receptors are in compliance as well.

6 REFERENCES

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APPENDIX A – AUDIT RECEPTOR SELECTION RATIONALE

Receptor ID	Description	Height (m) [1]	Distance to Closest Turbine (m)	Closest Turbine ID	Modelled sound level (dBA) [2]	Rationale
P83	**Participant**	**4.5**	**583**	**T10**	**38.9**	**Permission Granted. Monitoring location near R80 selected.**
R84	Residence	4.5	673	T8	38.6	Not in prevailing wind directions
R80	Residence	4.5	675	T10	38.4	Permission not granted
R85	Residence	4.5	709	T8	38.1	Not in prevailing wind directions
R56	Residence	4.5	729	T8	37.7	Not in prevailing wind direction
R57	Residence	4.5	788	T05	37.3	Permission not granted
V107	VLR	4.5	680	T10	37.3	Not in prevailing wind directions
R55	**Residence**	**4.5**	**733**	**T5**	**37.0**	**Permission Granted.**
R81	Residence	4.5	737	T7	37.0	Less favorable wind direction
R36	Residence	4.5	609	T2	37.0	No receptor on this location based on aerial imagery, only a farm building. (VLR)

Note 1: All receptors are modelled at 4.5 m in NIA [1]. The Compliance Protocol requires measuring at NIA modelled height regardless if an existing dwelling is 1-storey [1].

Note 2: As per NIA [1].

APPENDIX B – MEASUREMENT POINT PHOTOS

M55 facing Southwest

M55 facing East

M83 facing Southwest

M83 facing West

APPENDIX C – CALIBRATION SHEETS

Calibration Certificate

Certificate Number 2018002631
Customer:
GL Garrad Hassan Canada
4100 Rue Molson Suite 100
Montreal, QC H1Y 2X4, Canada

Model Number	831C	***Procedure Number***	D0001.8384		
Serial Number	10364	***Technician***	Ron Harris		
Test Results	**Pass**	***Calibration Date***	13 Mar 2018		
Initial Condition	As Manufactured	***Calibration Due***			
Description	Larson Davis Model 831C Class 1 Sound Level Meter Firmware Revision: 03.0.6R0	***Temperature***	23.43	°C	± 0.25 °C
		Humidity	50.9	%RH	± 2.0 %RH
		Static Pressure	86.51	kPa	± 0.13 kPa

Evaluation Method ***Tested with:*** ***Data reported in dB re 20 µPa.***

Larson Davis PRM831. S/N 051225
PCB 377B02. S/N 303856
Larson Davis CAL200. S/N 9079
Larson Davis CAL291. S/N 0203

Compliance Standards Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8378:

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61260:2014 Class 1	ANSI S1.11-2014 Class 1
IEC 61672:2013 Class 1	ANSI S1.43 (R2007) Type 1

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005.
Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.

The quality system is registered to ISO 9001:2008.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

Correction data from Larson Davis SoundAdvisor Model 831C Reference Manual, I831C.01 Rev B, 2017-03-31

For 1/4" microphones, the Larson Davis ADP024 1/4" to 1/2" adaptor is used with the calibrators and the Larson Davis ADP043 1/4" to

Calibration Certificate

Certificate Number 2018002632
Customer:
GL Garrad Hassan Canada
4100 Rue Molson Suite 100
Montreal, QC H1Y 2X4, Canada

Model Number	831C	***Procedure Number***	D0001.8384		
Serial Number	10368	***Technician***	Ron Harris		
Test Results	**Pass**	***Calibration Date***	13 Mar 2018		
Initial Condition	As Manufactured	***Calibration Due***			
Description	Larson Davis Model 831C Class 1 Sound Level Meter Firmware Revision: 03.0.6R0	***Temperature***	22.95	°C	± 0.25 °C
		Humidity	50.9	%RH	± 2.0 %RH
		Static Pressure	86.51	kPa	± 0.13 kPa

Evaluation Method ***Tested with:*** ***Data reported in dB re 20 µPa.***

Larson Davis PRM831. S/N 051224
PCB 377B02. S/N 303859
Larson Davis CAL200. S/N 9079
Larson Davis CAL291. S/N 0203

Compliance Standards Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8378:

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61260:2014 Class 1	ANSI S1.11-2014 Class 1
IEC 61672:2013 Class 1	ANSI S1.43 (R2007) Type 1

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005.
Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.

The quality system is registered to ISO 9001:2008.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

Correction data from Larson Davis SoundAdvisor Model 831C Reference Manual, I831C.01 Rev B, 2017-03-31

For 1/4" microphones, the Larson Davis ADP024 1/4" to 1/2" adaptor is used with the calibrators and the Larson Davis ADP043 1/4" to

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1681 West 820 North
Provo, UT 84601, United States
716-684-0001

ilac-MRA ACCREDITED Cert. #3622.01

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Calibration Certificate

Certificate Number 2018005754
Customer:
The Modal Shop
3149 East Kemper Road
Cincinnati, OH 45241, United States

Model Number	831C	***Procedure Number***	D0001.8384
Serial Number	10433	***Technician***	Ron Harris
Test Results	**Pass**	***Calibration Date***	8 Jun 2018
Initial Condition	As Manufactured	***Calibration Due***	
Description	Larson Davis Model 831C Class 1 Sound Level Meter Firmware Revision: 03.1.0R20	***Temperature***	23.33 °C ± 0.25 °C
		Humidity	49.7 %RH ± 2.0 %RH
		Static Pressure	86.27 kPa ± 0.13 kPa

Evaluation Method ***Tested with:*** ***Data reported in dB re 20 µPa.***

Larson Davis PRM831, S/N 051283
PCB 377B02, S/N 305082
Larson Davis CAL200, S/N 9079
Larson Davis CAL291, S/N 0108

Compliance Standards Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8378:

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61260:2014 Class 1	ANSI S1.11-2014 Class 1
IEC 61672:2013 Class 1	ANSI S1.43 (R2007) Type 1

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005.
Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.

The quality system is registered to ISO 9001:2008.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

Correction data from Larson Davis SoundAdvisor Model 831C Reference Manual, I831C.01 Rev B, 2017-03-31

For 1/4" microphones, the Larson Davis ADP024 1/4" to 1/2" adaptor is used with the calibrators and the Larson Davis ADP043 1/4" to

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ACCREDITED Cert. #3672.01

LARSON DAVIS
A PCB PIEZOTRONICS DIV.

Calibration Certificate

Certificate Number 2018010064
Customer:
The Modal Shop
3149 East Kemper Road
Cincinnati, OH 45241, United States

Model Number	831C	***Procedure Number***	D0001.8378	
Serial Number	10434	***Technician***	Ron Harris	
Test Results	**Pass**	***Calibration Date***	5 Oct 2018	
Initial Condition	Inoperable	***Calibration Due***	5 Oct 2019	
		Temperature	23.34 °C	± 0.25 °C
Description	Larson Davis Model 831C Class 1 Sound Level Meter Firmware Revision: 03.2.1R0	***Humidity***	51.6 %RH	± 2.0 %RH
		Static Pressure	86.47 kPa	± 0.13 kPa

Evaluation Method Tested electrically using Larson Davis PRM831 S/N 015279 and a 12.0 pF capacitor to simulate microphone capacitance. Data reported in dB re 20 µPa assuming a microphone sensitivity of 50.0 mV/Pa.

Compliance Standards Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8384:

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61260:2014 Class 1	ANSI S1.11-2014 Class 1
IEC 61672:2013 Class 1	ANSI S1.43 (R2007) Type 1

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005. **Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.**

The quality system is registered to ISO 9001:2008.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

Correction data from Larson Davis SoundAdvisor Model 831C Reference Manual, I831C.01 Rev B, 2017-03-31

Calibration Check Frequency: 1000 Hz; Reference Sound Pressure Level: 114 dB re 20 µPa; Reference Range: 0 dB gain

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Provo, UT 84601, United States
716-684-0001

ACCREDITED Cert. #3627.01

LARSON DAVIS
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Calibration Certificate

Certificate Number 2018006454
Customer:
The Modal Shop
3149 East Kemper Road
Cincinnati, OH 45241, United States

Model Number	831C		***Procedure Number***	D0001.8384	
Serial Number	10465		***Technician***	Ron Harris	
Test Results	**Pass**		***Calibration Date***	27 Jun 2018	
Initial Condition	As Manufactured		***Calibration Due***		
Description	Larson Davis Model 831C Class 1 Sound Level Meter Firmware Revision: 03.1.0R21		***Temperature***	23.6 °C	± 0.25 °C
			Humidity	49 %RH	± 2.0 %RH
			Static Pressure	86.22 kPa	± 0.13 kPa

Evaluation Method ***Tested with:*** ***Data reported in dB re 20 µPa.***

Larson Davis PRM831, S/N 051310
PCB 377B02, S/N 305811
Larson Davis CAL200, S/N 9079
Larson Davis CAL291, S/N 0108

Compliance Standards Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8378:

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61260:2014 Class 1	ANSI S1.11-2014 Class 1
IEC 61672:2013 Class 1	ANSI S1.43 (R2007) Type 1

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005.
Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.

The quality system is registered to ISO 9001:2008.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

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Correction data from Larson Davis SoundAdvisor Model 831C Reference Manual, I831C.01 Rev B, 2017-03-31

For 1/4" microphones, the Larson Davis ADP024 1/4" to 1/2" adaptor is used with the calibrators and the Larson Davis ADP043 1/4" to

VAISALA

TEST REPORT

Instrument WXT520 AAB1BA30B0
Serial number H4720003
Manufacturer Vaisala Oyj, Finland
Test date 20th November 2012

This test report certifies that the instrument was thoroughly tested and inspected, and found to meet its published test limits when it was shipped from Vaisala.

Test results

Test	Result	Limit	Passed
Rain response	1113.0 mV	(950...1600) mV	OK
Zero wind speed	0.00 m/s	(0...0.4) m/s	OK
Pressure	1015.7 hPa	PASS/FAIL	OK
Temperature	23.1 °C	PASS/FAIL	OK
Humidity	29.8 %RH	PASS/FAIL	OK
Heating	PASS	PASS/FAIL	OK
Current (service port)	0.54	(0.2...0.7) mA	OK
Communication (service port)	PASS	PASS/FAIL	OK
Current (main port)	0.30	(0.1...0.4) mA	OK
Communication (main port)	PASS	PASS/FAIL	OK

Signature COPY

Technician

 DOC216638.doc

Vaisala Oyj | PO Box 26, FI-00421 Helsinki, Finland
Phone +358 9 894 91 | Fax +358 9 8949 2227
Email firstname.lastname@vaisala.com | www.vaisala.com
Domicile Vantaa, Finland | VAT FI01244162 | Business ID 0124416-2

VAISALA

Test report no. H31-14200103

TEST REPORT

Instrument WXT520 AAB1BA30B0
Serial number K2010136
Manufacturer Vaisala Oyj, Finland
Test date 13th May 2014

This test report certifies that the instrument was thoroughly tested and inspected, and found to meet its published test limits when it was shipped from Vaisala.

Test results

Test	Result	Limit	Passed
Rain response	365.0 mV	(345...575) mV	OK
Zero wind speed	0.00 m/s	(0...0.4) m/s	OK
Pressure	997.3 hPa	PASS/FAIL	OK
Temperature	22.8 °C	PASS/FAIL	OK
Humidity	39.1 %RH	PASS/FAIL	OK
Heating	PASS	PASS/FAIL	OK
Current (service port)	0.57	(0.2...0.7) mA	OK
Communication (service port)	PASS	PASS/FAIL	OK
Current (main port)	0.34	(0.1...0.4) mA	OK
Communication (main port)	PASS	PASS/FAIL	OK

Signature COPY

Technician

Vaisala Oyj | PO Box 26, FI-00421 Helsinki, Finland
Phone +358 9 894 91 | Fax +358 9 8949 2227
Email firstname.lastname@vaisala.com | www.vaisala.com
Domicile Vantaa, Finland | VAT FI01244162 | Business ID 0124416-2

VAISALA

1(1)
Test report no. H31-18130045

TEST REPORT

Product family	WXT530 series
Product type	WXT536
Order code	6B1B2A1D1A1B
Serial number	P1320473
Manufacturer	Vaisala Oyj, Finland
Test date	27 March 2018

This test report certifies that the product was thoroughly tested and inspected, and found to meet its published test limits when it was shipped from Vaisala.

Test results

Test	Result	Lower limit	Upper limit	Unit
Rain response	394	345	575	mV
Zero wind speed	0	0	0.4	m/s
Pressure difference	-0.14	-1	1	hPa
Temperature difference	0.04	-2	2	°C
Humidity difference	-1	-10	10	%RH
Heating current	0.72	0.6	0.8	A
Current (service port)	0.96	0.5	2	mA
Communication (service port)	pass	PASS	PASS	-
Current (main port)	0.61	0.5	2	mA
Communication (main port)	pass	PASS	PASS	-

Ambient conditions / Humidity 15.7 ±5 %RH, Temperature 23.2 ±1 °C, Pressure 1013.07 ±1 hPa.

Signature

Technician

 DOC233154-A.doc

Vaisala Oyj | PO Box 26, FI-00421 Helsinki, Finland

Calibration Certificate

Certificate Number 2018002853

Customer:
GL Garrad Hassan Canada
4100 Rue Molson Suite 100
Montreal, QC H1Y 2X4, Canada

Model Number	CAL200	***Procedure Number***	D0001.8386
Serial Number	5593	***Technician***	Scott Montgomery
Test Results	**Pass**	***Calibration Date***	21 Mar 2018
Initial Condition	Adjusted	***Calibration Due***	21 Mar 2019
Description	Larson Davis CAL200 Acoustic Calibrator	***Temperature***	22 °C ± 0.3 °C
		Humidity	41 %RH ± 3 %RH
		Static Pressure	101.3 kPa ± 1 kPa

Evaluation Method The data is aquired by the insert voltage calibration method using the reference microphone's open circuit sensitivity. Data reported in dB re 20 µPa.

Compliance Standards Compliant to Manufacturer Specifications per D0001.8190 and the following standards:
IEC 60942:2017 ANSI S1.40-2006

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the SI through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005.
Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.

The quality system is registered to ISO 9001:2008.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

Standards Used

Description	Cal Date	Cal Due	Cal Standard
Agilent 34401A DMM	09/06/2017	09/06/2018	001021
Larson Davis Model 2900 Real Time Analyzer	04/10/2017	04/10/2018	001051
Microphone Calibration System	03/07/2018	03/07/2019	005446
1/2" Preamplifier	10/05/2017	10/05/2018	006506
Larson Davis 1/2" Preamplifier 7-pin LEMO	08/08/2017	08/08/2018	006507
1/2 inch Microphone - RI - 200V	04/24/2017	04/24/2018	006510
Pressure Transducer	06/01/2017	06/01/2018	007310

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APPENDIX D – OPERATOR STATEMENT

From: Labbate, Antonio
Sent: May 15, 2019 5:44 PM
Subject: RE: Gunn's Hill -Statement Letter for Immission Report

To whom it may concern,

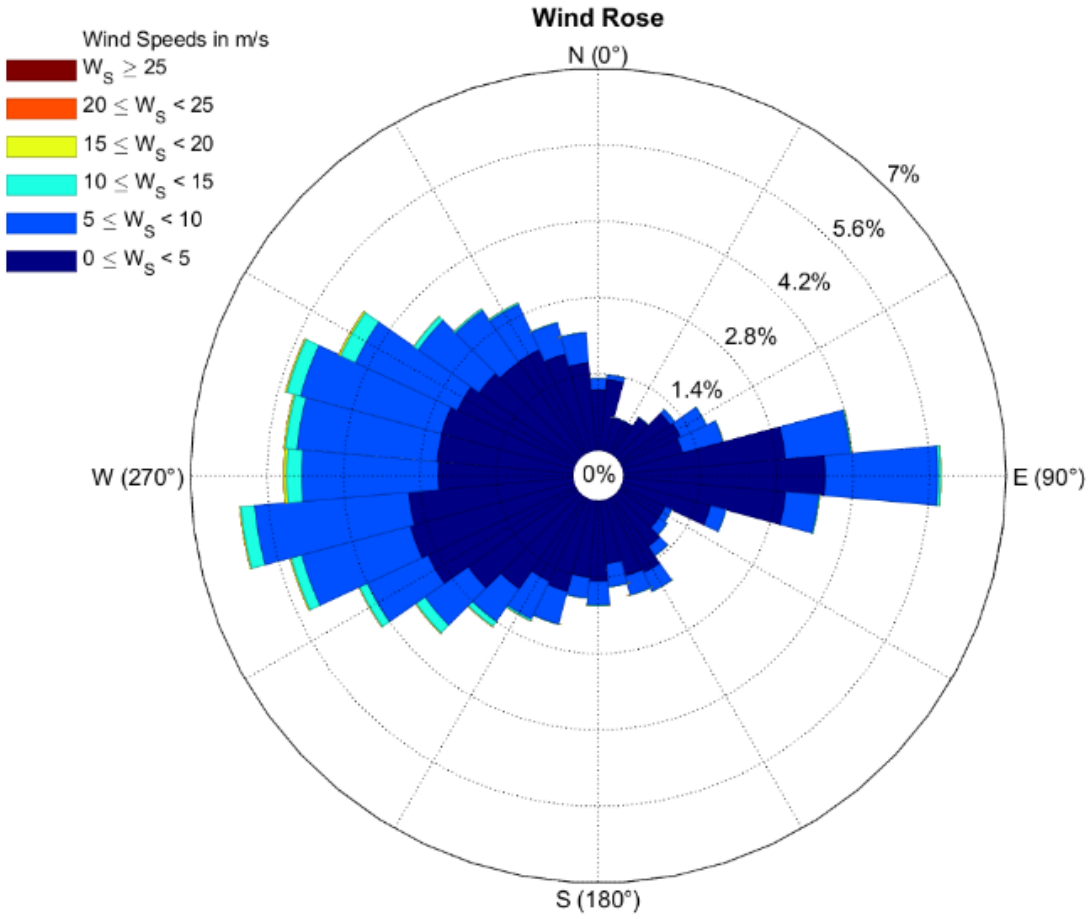
I am writing this email as a confirmation that Gunn's Hill Wind Farm WEC 4-93626, WEC 5 – 93623, WEC 9-93624 and WEC 10 – 93621 were operating normally during the acoustic measurement campaign that took place between 5 November 2018 to 22 April 2019. No alteration or modification were made to any operating parameters at any time. The turbine were not curtailed and not had any operations altered for the course of the audit.

Gunn's Hill Wind Farm was placed in "Manual Stop" during ambient sound level measurement periods specified by the client. In manual stop condition, all wind turbine generators are disconnected from grid and not generating power. "Manual Stop" is used to park the Turbine. During this period, the blades are set to 92.5°, which will allow the turbine to idle at 1 rpm or less with no brake applied. Components of a wind turbine are extremely heavy and the repeated use of the holding brake for long period of time, can damage bearing. As an example, 1 turbine blade weights about 11 tons with the 3 blade set being 33 tons.

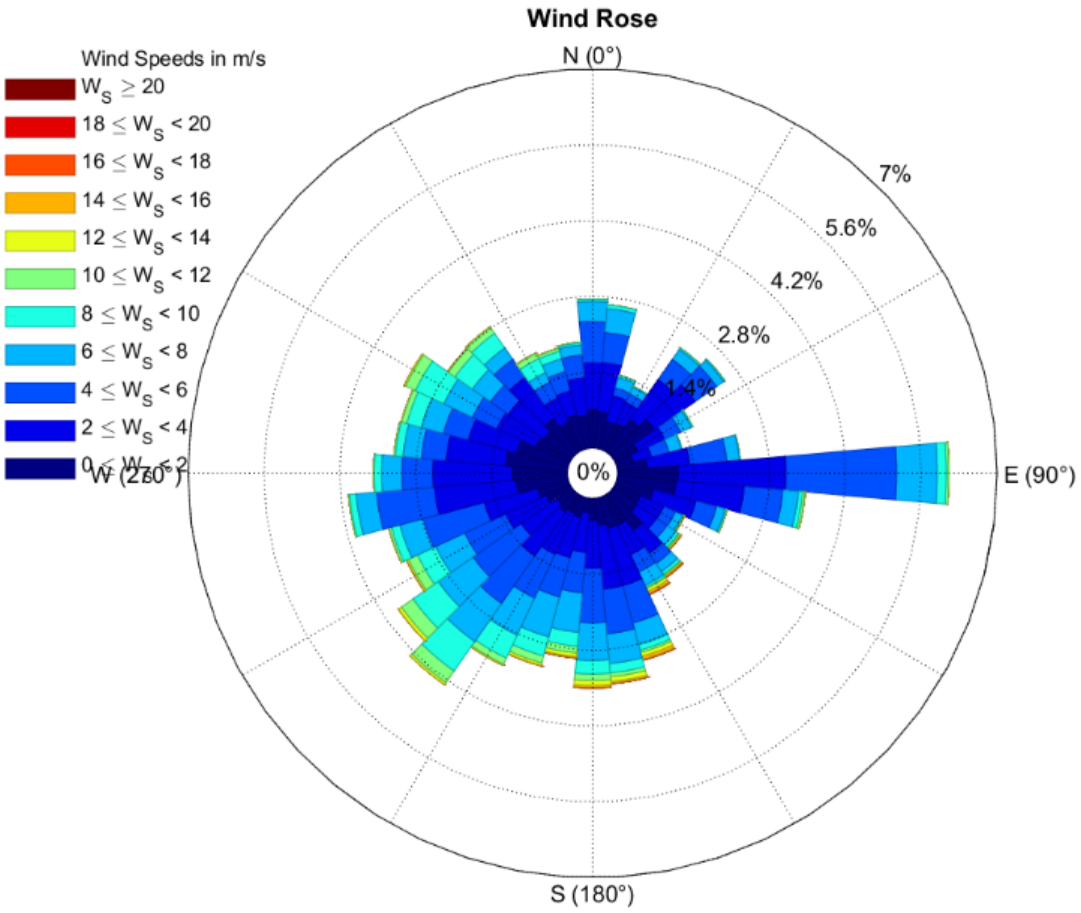
Best regards,

Antonio Labbate
Site Manager Operations & Maintenance
Senvion Canada Inc.
5-545 Trillium Dr.
Kitchener, ON, N2R 1J4

APPENDIX E – OVERALL CAMPAIGN WIND ROSES



M55 Wind Rose at 10m mast



M83 Wind Rose at 10m Mast

About DNV GL

Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification, technical assurance, software and independent expert advisory services to the maritime, oil & gas and energy industries. We also provide certification services to customers across a wide range of industries. Combining leading technical and operational expertise, risk methodology and in-depth industry knowledge, we empower our customers' decisions and actions with trust and confidence. We continuously invest in research and collaborative innovation to provide customers and society with operational and technological foresight. Operating in more than 100 countries, our professionals are dedicated to helping customers make the world safer, smarter and greener.