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FALL ACOUSTIC AUDIT - IMMISSION REPORT

Grand Bend Wind Farm

Grand Bend, Ontario

Prepared for:

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March 10, 2017

VERSION CONTROL

Version	Date	Version Description
1	March 10, 2017	Initial Report

EXECUTIVE SUMMARY

Howe Gastmeier Chapnik Limited ("HGC Engineering") was retained by Grand Bend Wind Limited Partnership to complete an acoustic immission audit of the Grand Bend Wind Farm ("Wind Project"). The Wind Project includes 40 Siemens wind turbine generators, each rated at 2483 kW. The acoustic immission audit is required as a condition of Renewable Energy Approval number 5186-9HBJXR, issued by the Ontario Ministry of the Environment and Climate Change ("MOECC") on June 26, 2014 and amended on March 24, 2015. HGC Engineering has assessed the acoustic impact against the acoustic criteria of the MOECC in accordance with the requirements of the MOECC's Compliance Protocol for Wind Turbine Noise. This report summarizes the first of two seasonal immission audits to be conducted at the Wind Project. This fall immission audit was completed between October 25, 2016 and February 1, 2017.

The sound level measurements and analysis, as performed in accordance with the MOECC's Compliance Protocol for Wind Turbine Noise, indicate that the Wind Project is operating in compliance of the applicable sound level criteria. Details of the measurements and analysis are provided herein.

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1 INTRODUCTION

Howe Gastmeier Chapnik Limited ("HGC Engineering") was retained by Grand Bend Wind Limited Partnership to complete an Acoustic Audit – Immission of the Grand Bend Wind Farm ("Wind Project"). The Wind Project is located northeast of the town of Grand Bend, Ontario and consists of 40 Siemens wind turbine generators, each rated at 2483 kW and with a hub height of 99.5 m.

The audit is required as part of the Renewable Energy Approval ("REA") number 5186-9HBJXR [1] issued for the project by the Ontario Ministry of the Environment and Climate Change ("MOECC") on June 26, 2014 and amended on March 24, 2015. Specifically, this report summarizes measurements that were conducted in the fall in order to satisfy the first of two seasonal audits required under Condition E of the REA.

2 MONITORING LOCATIONS

The Environmental Noise Impact Assessment ("ENIA") report released by Aercoustics [2] on April 15, 2014 includes sound level predictions for locations within 1500 m of the Wind Project wind turbine generators. Condition E1 (2) in the REA requires that immission measurements be completed at five receptor locations which are selected using the following criteria:

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

A summary of the monitoring location selection and the historical wind rose for the area can be found in Appendix A.

The monitoring locations were selected based on their downwind location, predicted sound level, and consultation with the land owners. Detailed overviews of the selected monitoring locations are shown in Figures 1a to 1e and photos of the installations are provided in Appendix B.

HGC Engineering developed an acoustic predictive model of the site to determine the sound levels at the five selected monitoring and receptor locations. The predicted sound levels at the receptor and monitoring locations, along with UTM coordinates of the locations can be found in Table 1.

Table 1: Predicted Sound Levels and UTM Coordinates of Selected Locations

Location		Easting	Northing	Predicted Sound Level [dBA]
R0258	Receptor	444967	4809319	39.1
	Monitoring Location	444979	4809237	38.6
R0792	Receptor	444440	4805109	38.2
	Monitoring Location	444375	4805037	39.1
R1857	Receptor	441861	4797033	37.1
	Monitoring Location	446676	4805325	37.4
R2960	Receptor	442457	4798653	38.0
	Monitoring Location	442432	4798623	38.0
R2972	Receptor	446728	4805245	41.0
	Monitoring Location	441775	4797014	39.7

Receptor R0258 is a single storey home located at 73217 Blackbush Line. Turbine T-09 is approximately 790 m to the southwest and T-07 is approximately 1000 m to the west. The sound level meter was installed in an adjacent lot south of the residential property, approximately 760 m from T-09, designated Monitoring Location R0258.

Receptor R0792 is a single storey home located at 35602 Sararas Road. The closest turbine, T-22 is approximately 660 m to the southwest and T-18 is approximately 760 m to the west. The sound level meter was installed in a field on the south edge of the property, approximately 560 m from turbine T-22, designated Monitoring Location R0792.

Receptor R1857 is a single storey home located at 70966 B Line. The closest turbine, T-44 is approximately 760 m to the west. The sound level meter was installed in a vacant lot west of the property, approximately 670 m from turbine T-44, designated Monitoring Location R1857.

Receptor R2960 is a vacant lot north of the intersection of Dashwood Road and Concession 19. The closest turbine, T-38 is approximately 840 m to the north and T-43 is approximately 850 m to the southwest. The sound level meter was installed on the south edge of the lot, approximately 810 m from turbine T-43, designated Monitoring Location R2960.

Receptor R2972 is a vacant lot south of 37404 Sararas Road. The closest turbine, T-20 is approximately 605 m to the southeast and T-19 is approximately 625 m to the southwest. The sound level meter was installed on the north side of the lot, approximately 560 m from turbine T-20, designated Monitoring Location R2972. This location is representative of R0776.

All microphones were placed at a height of 4.5 m, consistent with the receptor heights used in the ENIA.

The Wind Project area is generally rural in nature with infrequently travelled gravel and asphalt roads, with the exception of receptors along Highway 21 and Dashwood Road which are frequently travelled.

3 INSTRUMENTATION

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

Audio frequency sound levels were measured using Svantek 977 sound level meters, each connected to ½" microphones. The microphones were set at a height of approximately 4.5 m and equipped with 175 mm diameter windscreens to minimize wind-induced microphone self-noise.

The energy-equivalent average sound level, denoted $L_{EQ,}$ was recorded by the instrumentation. 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, meteorological instruments were used. A Davis weather station was deployed at Monitoring Location R0792 to collect ground weather conditions including temperature, humidity, and precipitation. NRG anemometers and wind vanes were used at each monitoring location to collect 10 m height wind speed and direction.

The various instruments deployed by HGC Engineering are summarized in Table 2, and their respective locations are shown in Figures 1a to 1e.

Table 2: Measurement Instrumentation

Monitoring Location	Instrumentation Make and Model	Serial Number
R0258	Svantek 977 sound level meter	36439
	NRG #40C anemometer connected to a Campbell Scientific datalogger	179500262946
R0792	Svantek 977 sound level meter	36426
	NRG #40C anemometer connected to a Campbell Scientific datalogger	179500244824
R1857	Svantek 977 sound level meter	36827
	NRG #40C anemometer connected to a Campbell Scientific datalogger	179500266979
R2960	Svantek 977 sound level meter	45419
	NRG #40C anemometer connected to a Campbell Scientific datalogger	179500244813
R2972	Svantek 977 sound level meter	36816
	NRG #40C anemometer connected to a Campbell Scientific datalogger	179500265230

The sound level meters were configured to measure and record spectral (frequency-dependent) one-minute L_{EQ} sound level measurements. For identification of dominant sources, the sound level meters also recorded audio files.

Correct calibration of the acoustic instrumentation was verified using an acoustic calibrator manufactured by Brüel & Kjær (B&K). Calibration verification was carried out on a weekly basis throughout the measurement period.

Windscreens were used on the microphones, consistent with the requirements of MOECC technical publication NPC-103, *Procedures* [4]. A large wind screen, 175 mm in diameter, was used on each sound level meter 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.

All the equipment was within its annual or bi-annual calibration, and the calibration certificates can be found in Appendix C.

4 ASSESSMENT CRITERIA

The MOECC 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 and the REA approval include the same sound level limits which are shown in Table 3.

Table 3: Wind Turbine Noise Criteria [dBA]

10 m Height Wind Speed [m/s]	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 MOECC 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 a receptor 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 MOECC to complete an assessment of a wind energy project 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 collected with (“ON”) and without (“OFF”) the turbines operating. Simultaneously, wind speed and direction at 10 m height are measured and collected 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 MOECC protocol requires at least 120 one-minute intervals be measured for each 10 m 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 m 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 one hour of the measurement interval), and data where the maximum wind speed measured at a 10 m height did not differ from the average by more than 2 m/s.

The MOECC 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 TONALITY ASSESSMENT

Based on our site observations and measurements up close to the wind turbine generators (emission testing) there were no tones identified/observed at the turbines or the monitoring locations.

7 MEASUREMENTS AND RESULTS

Sound level measurements were conducted between October 25, 2016 and February 1, 2017. The weather during the monitoring period varied, including several days with rain or snow. Temperatures ranged from -30°C to 15°C. Wind speeds at 10 m height ranged from 0 m/s up to 17 m/s. The prevailing wind direction during the measurement campaign was from the south and southeast. Figures 2a through 6b show the wind roses for the monitoring locations during the ON and OFF conditions.

The sound level summary for data collected at Monitoring Location R0258 is shown in Tables 4a and 4b. Data were collected between October 25 and December 20, 2016.

Table 4a: Monitoring Location R0258 – Sound Level Summary

	10 m Height Wind Speed [m/s]							
LEQ Sound Level [dBA]	**4**		**5**		**6**		**7**	
Average Operating (ON) / Std Dev.	38	2.6	41	1.7	42	2.2	44	2.7
Average Ambient (OFF) / Std Dev.	37	3.2	37	2.3	41	2.9	44	2.3
Wind Project Only / Std Dev.	30*	2.7	38	2.5	35*	2.4	36*	2.6
Criteria	40.0		40.0		40.0		43.0	
Excess	**0**		**0**		**0**		**0**	

* The collected sound level represents an estimate of the wind project at this location, as the operating and ambient sound levels are essentially equal.

Table 4b: Monitoring Location R0258 - Summary of Valid Data Points

	10 m Height Wind Speed [m/s]			
Wind Project Condition	**4**	**5**	**6**	**7**
Operating (ON)	609	493	247	188
Ambient (OFF)	85	180	79	98

Based on the data presented above and in Figures 7a and 7b, the Wind Project is compliant with the MOECC sound level criteria at Monitoring Location R0258.

The sound level summary for data collected at Monitoring Location R0792 is shown in Tables 5a and 5b. Data were collected between October 25, 2016 and February 1, 2017.

Table 5a: Monitoring Location R0792 - Sound Level Summary

	10 m Height Wind Speed [m/s]							
LEQ Sound Level [dBA]	**4**		**5**		**6**		**7**	
Average Operating (ON) / Std Dev.	40	2.9	43	2.8	45	2.8	48	2.3
Average Ambient (OFF) / Std Dev.	37	3.3	40	3.3	45	3.0	47	3.0
Wind Project Only / Std Dev.	37	3.2	38	3.0	33*	2.8	41*	2.5
Criteria	40.0		40.0		40.0		43.0	
Excess	**0**		**0**		**0**		**0**	

* The collected sound level represents an estimate of the wind project at this location, as the operating and ambient sound levels are essentially equal.

Table 5b: Monitoring Location R0792 - Summary of Valid Data Points

	10 m Height Wind Speed [m/s]			
Wind Project Condition	**4**	**5**	**6**	**7**
Operating (ON)	1424	908	396	201
Ambient (OFF)	203	163	67	60

Based on the data presented above and in Figures 8a and 8b, the Wind Project is compliant with the MOECC sound level criteria at Monitoring Location R0792.

The sound level summary for data collected at Monitoring Location R1857 is shown in Tables 6a and 6b. Data were collected between October 26, 2016 and December 20, 2017.

Table 6a: Monitoring Location R1857 - Sound Level Summary

	10 m Height Wind Speed [m/s]							
LEQ Sound Level [dBA]	**4**		**5**		**6**		**7**	
Average Operating (ON) / Std Dev.	38	2.6	40	1.7	43	2.2	46	2.7
Average Ambient (OFF) / Std Dev.	36	3.2	39	2.3	42	2.9	46	2.3
Wind Project Only / Std Dev.	34	2.8	35*	2.0	35*	2.4	36*	2.6
Criteria	40.0		40.0		40.0		43.0	
Excess	**0**		**0**		**0**		**0**	

* The collected sound level represents an estimate of the wind project at this location, as the operating and ambient sound levels are essentially equal.

Table 6b: Receptor Location R1857 - Summary of Valid Data Points

	10 m Height Wind Speed [m/s]			
Wind Project Condition	**4**	**5**	**6**	**7**
Operating (ON)	623	465	324	198
Ambient (OFF)	161	207	92	78

Based on the data presented above and in Figures 9a and 9b, the Wind Project is compliant with the MOECC sound level criteria at Monitoring Location R1857.

The sound level summary for data collected at Monitoring Location R2960 is shown in Tables 7a and 7b. Data were collected between October 25 and December 20, 2016.

Table 7a: Monitoring Location R2960 - Sound Level Summary

	10 m Height Wind Speed [m/s]							
LEQ Sound Level [dBA]	**4**		**5**		**6**		**7**	
Average Operating (ON) / Std Dev.	40	2.4	43	2.8	45	2.7	47	1.9
Average Ambient (OFF) / Std Dev.	39	3.4	42	3.7	43	3.8	45	4.0
Wind Project Only / Std Dev.	29	2.8	38	3.3	40	3.1	42	2.7
Criteria	40.0		40.0		40.0		43.0	
Excess	**0**		**0**		**0**		**0**	

Table 7b: Monitoring Location R2960 - Summary of Valid Data Points

	10 m Height Wind Speed [m/s]			
Wind Project Condition	**4**	**5**	**6**	**7**
Operating (ON)	465	232	210	223
Ambient (OFF)	209	172	70	71

Based on the data presented above and in Figures 10a and 10b, the Wind Project is compliant with the MOECC sound level criteria at Monitoring Location R2960.

The sound level summary for data collected at receptor location R2972 is shown in Tables 8a and 8b. Data were collected between October 25, 2016 and February 1, 2017.

Table 8a: Monitoring Location R2972 - Sound Level Summary

	10 m Height Wind Speed [m/s]							
LEQ Sound Level [dBA]	**4**		**5**		**6**		**7**	
Average Operating (ON) / Std Dev.	39	2.7	42	2.3	44	2.2	46	2.0
Average Ambient (OFF) / Std Dev.	37	3.3	39	3.6	42	3.0	44	2.0
Wind Project Only / Std Dev.	35	2.9	39	2.8	40	2.4	41	2.1
Criteria	40.0		40.0		40.0		43.0	
Excess	**0**		**0**		**0**		**0**	

Table 8b: Monitoring Location R2972 - Summary of Valid Data Points

	10 m Height Wind Speed [m/s]			
Wind Project Condition	**4**	**5**	**6**	**7**
Operating (ON)	1311	1185	721	339
Ambient (OFF)	286	217	109	89

Based on the data presented above and in Figures 11a and 11b, the Wind Project is compliant with the MOECC sound level criteria at Monitoring Location R2972.

Appendix D includes a statement from Grand Bend Wind Farms Limited Partnership indicating the wind turbine generators were operating normally from October 25, 2016 to February 1, 2017.

8 CONCLUSIONS

The measurements and analysis, performed in accordance with the methods prescribed by the Ontario Ministry of the Environment and Climate Change publication *Compliance Protocol for Wind Turbine Noise* indicates that the Wind Project is operating in compliance of the MOECC's sound level criteria at all selected monitoring locations. This report summarizes the measurements collected as part of the first of two immission audits.

REFERENCES

1. Ontario Ministry of the Environment and Climate Change Renewable Energy Approval Number 5186-9HBJXR, June 26, 2014, amended March 24, 2015.
2. Aercoustics Engineering Limited, *environmental noise impact assessment, Grand Bend Wind Farm*, April 15, 2014.
3. Ontario Ministry of the Environment and Climate Change, *Compliance Protocol for Wind Turbine Noise Guideline for Acoustic Assessment and Measurement*.
4. Ontario Ministry of the Environment and Climate Change Publication, NPC-103, *Procedures.*
5. Ontario Ministry of the Environment and Climate Change 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. WinderFinder.com, *Annual Wind Direction Distribution.* February 23, 2017. Retrieved from http://www.windatlas.ca/en/rose.php?field=EU&height=80&season=ANU&no=24&ni=930&nj=189

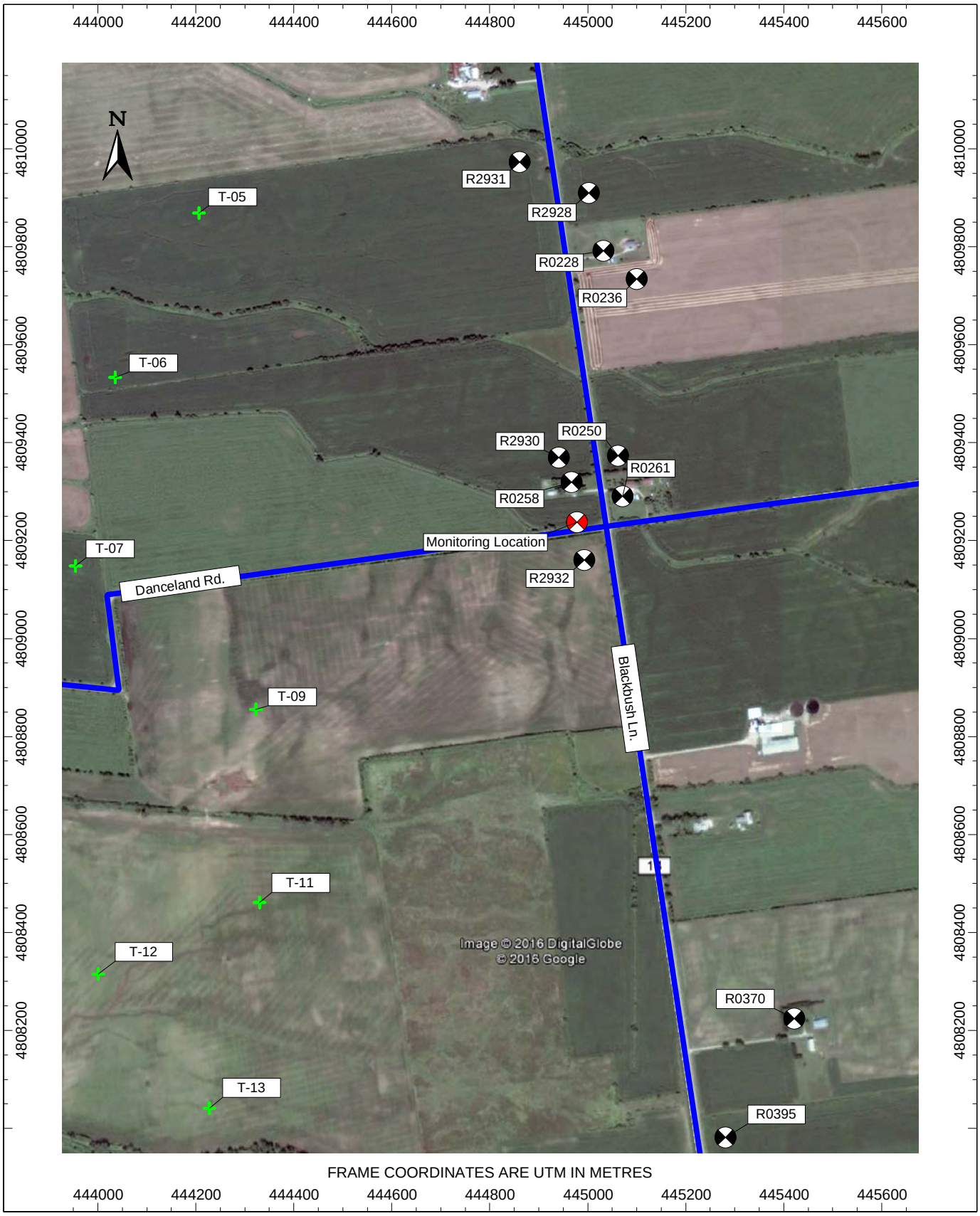


Figure 1a: Monitoring Location R0258
Grand Bend Wind Farm

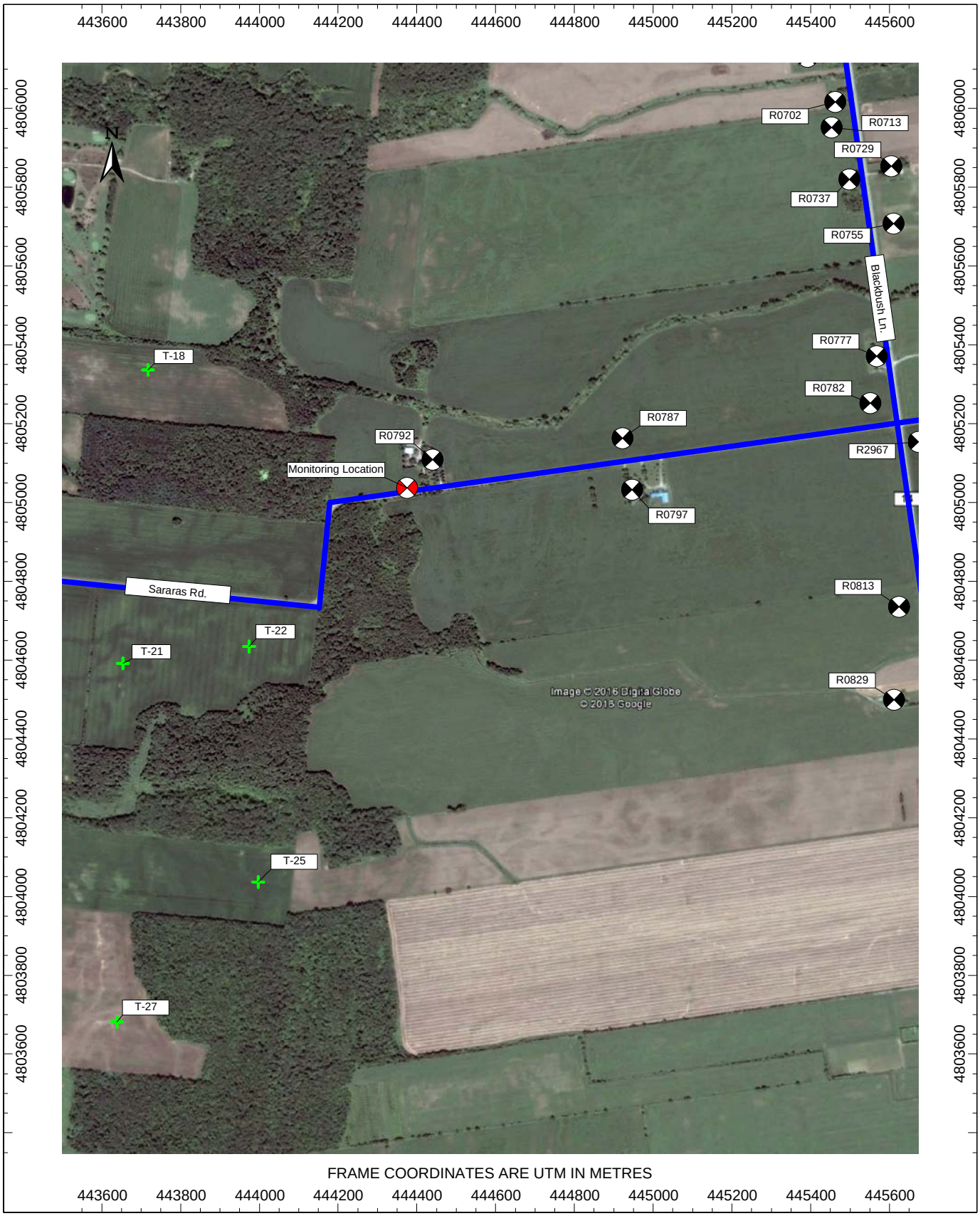


Figure 1b: Monitoring Location R0792
Grand Bend Wind Farm

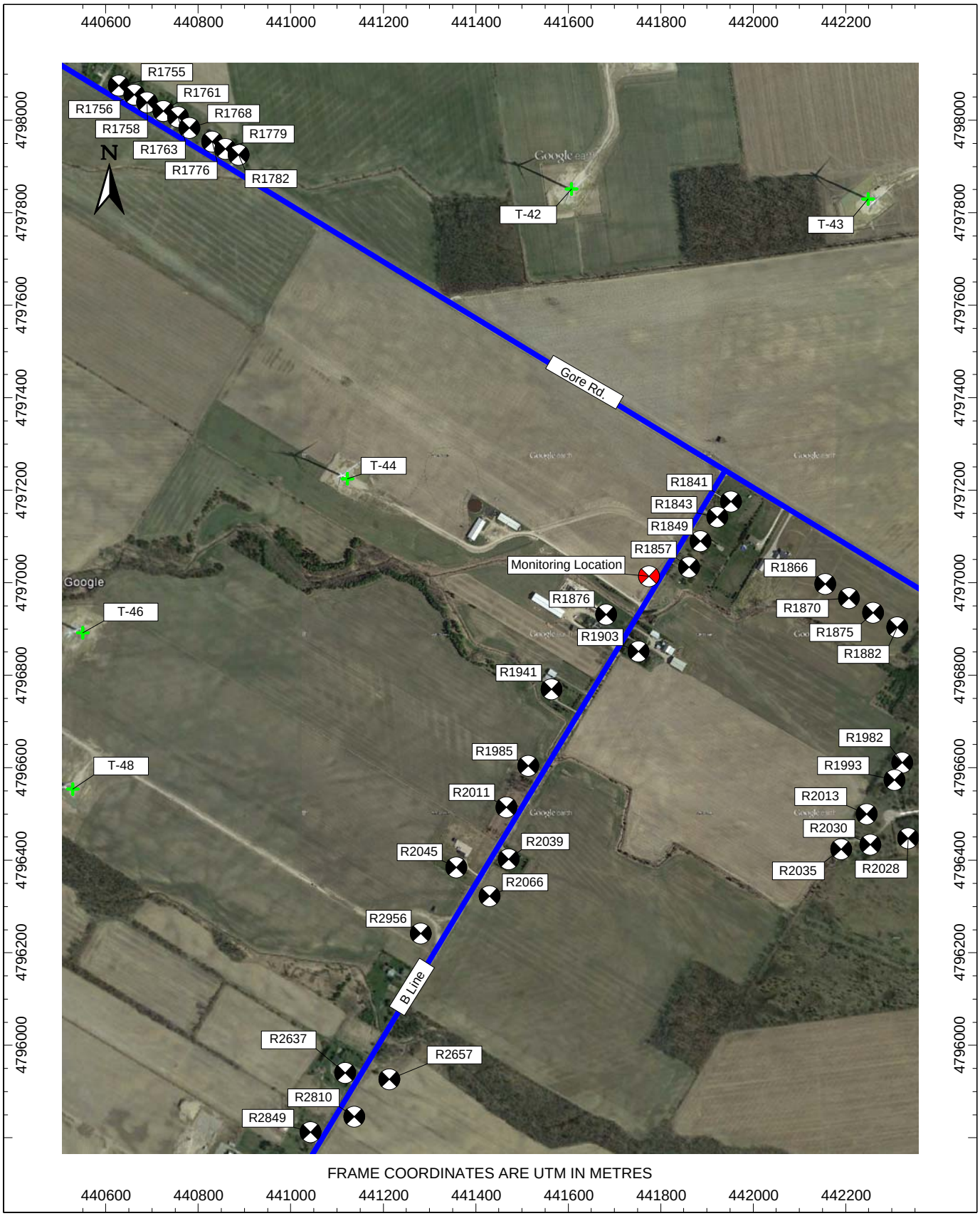


Figure 1c: Monitoring Location R1857
Grand Bend Wind Farm

Figure 1d: Monitoring Location R2960
Grand Bend Wind Farm

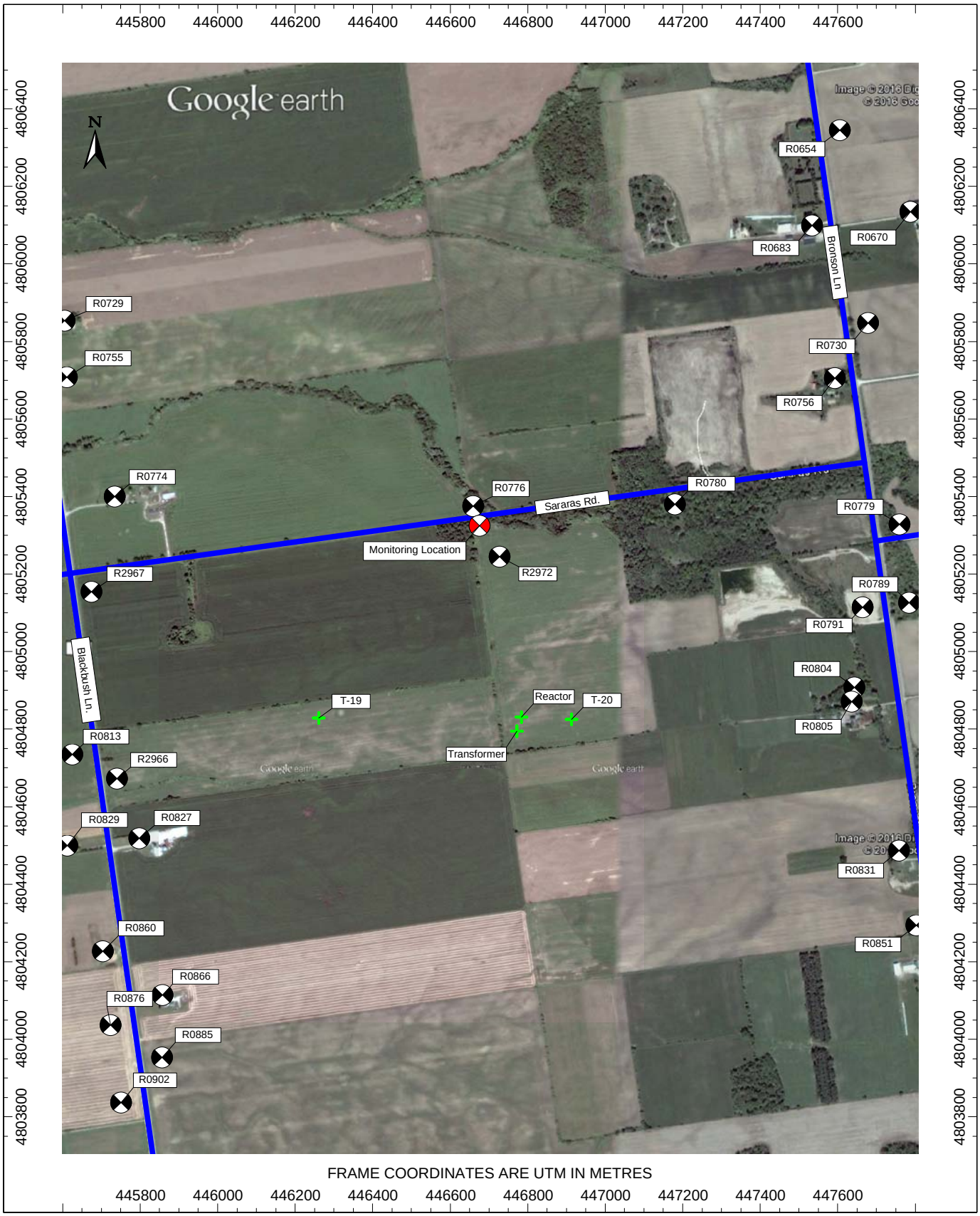


Figure 1e: Monitoring Location R2972
Grand Bend Wind Farm

Figure 2a: Wind Direction - Grand Bend Wind Farm
Monitoring Location R0258,10 m Height, Wind Speeds 4-7 m/s
ON Condition, October 25 to December 20, 2016

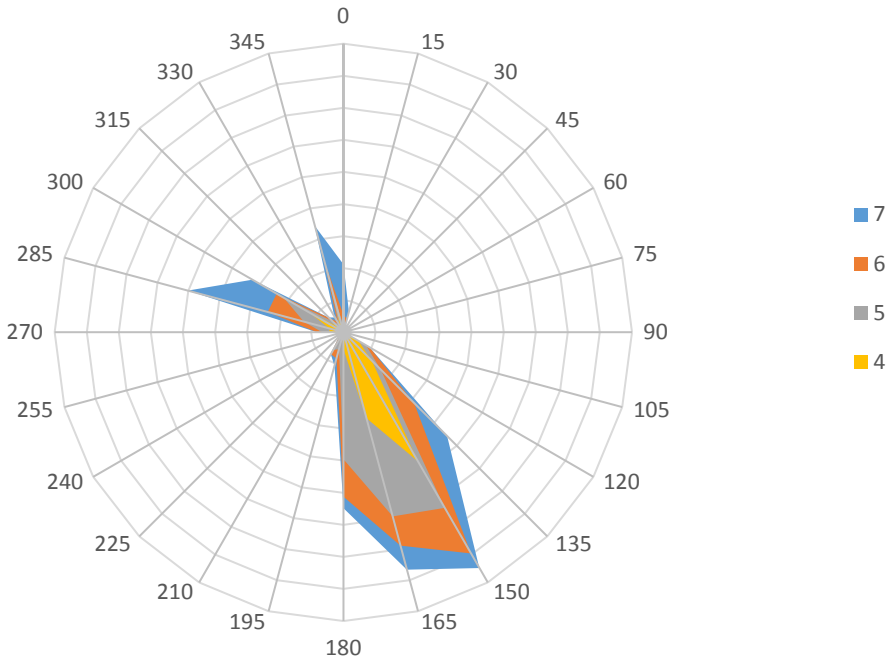


Figure 2b: Wind Direction - Grand Bend Wind Farm
Monitoring Location R0258,10 m Height, Wind Speeds 4-7 m/s
OFF Condition, October 25 to December 20, 2016

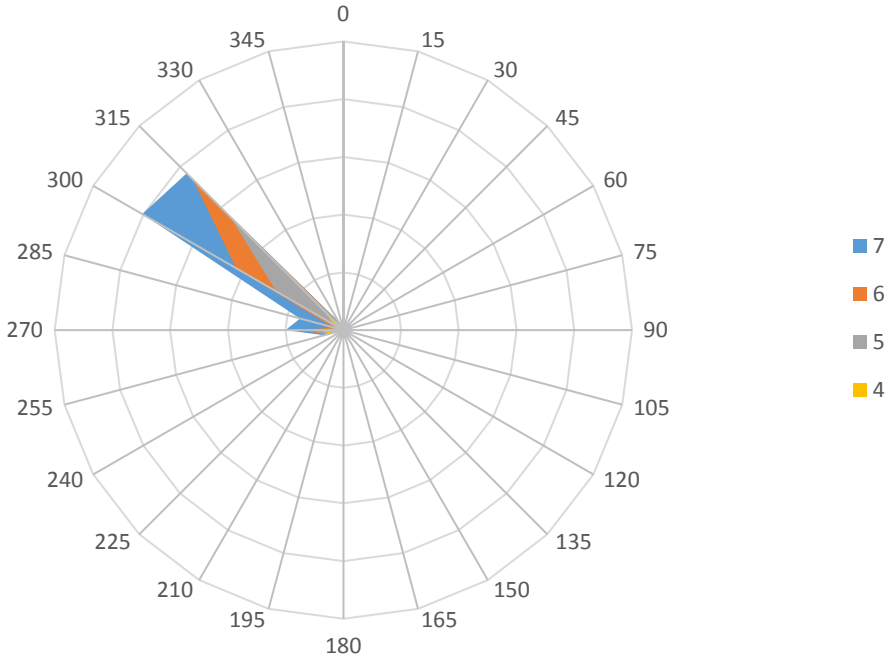


Figure 3a: Wind Direction - Grand Bend Wind Farm
Monitoring Location R0792,10 m Height, Wind Speeds 4-7 m/s
ON Condition, October 25, 2016 to February 1, 2017

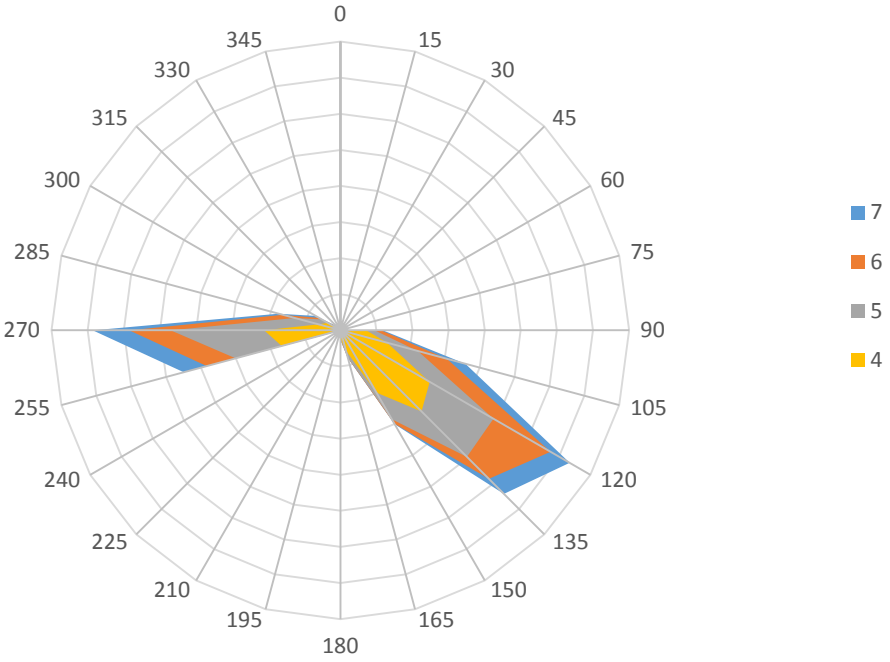


Figure 3b: Wind Direction - Grand Bend Wind Farm
Monitoring Location R0792,10 m Height, Wind Speeds 4-7 m/s
OFF Condition, October 25, 2016 to February 1, 2017

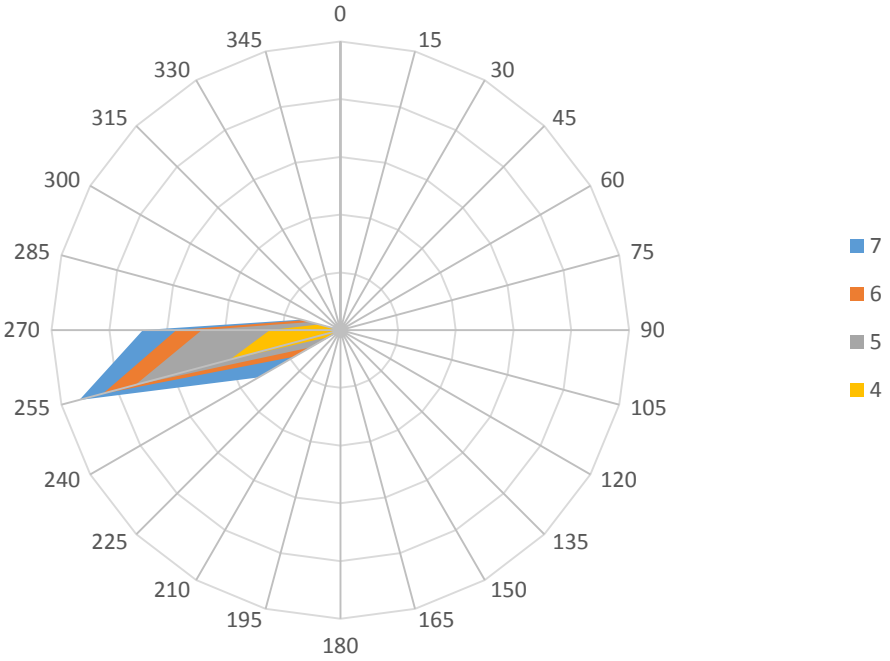


Figure 4a: Wind Direction - Grand Bend Wind Farm
Monitoring Location R1857,10 m Height, Wind Speeds 4-7 m/s
ON Condition, October 26 to December 20, 2016

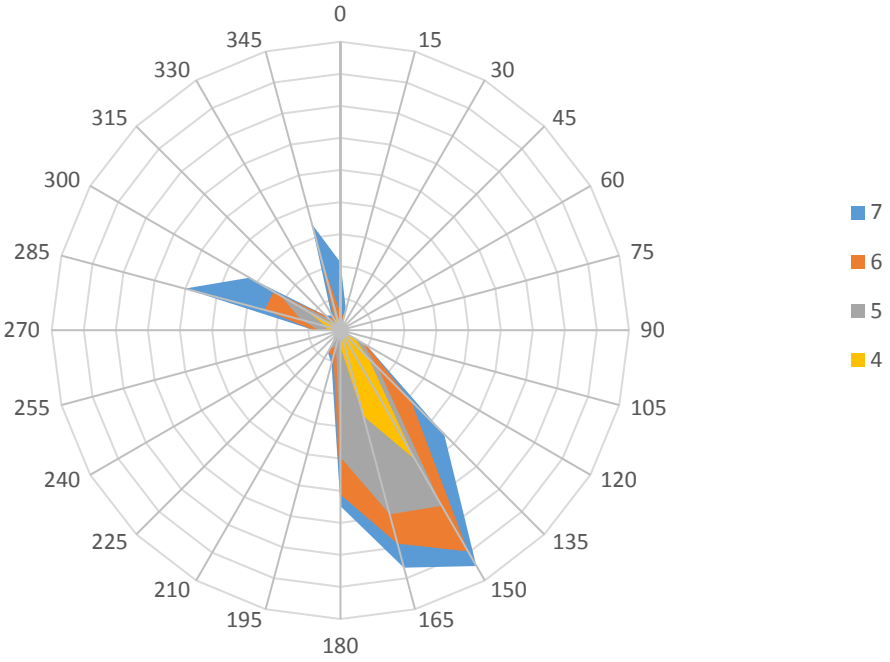


Figure 4b: Wind Direction - Grand Bend Wind Farm
Monitoring Location R1857,10 m Height, Wind Speeds 4-7 m/s
OFF Condition, October 26 to December 20, 2016

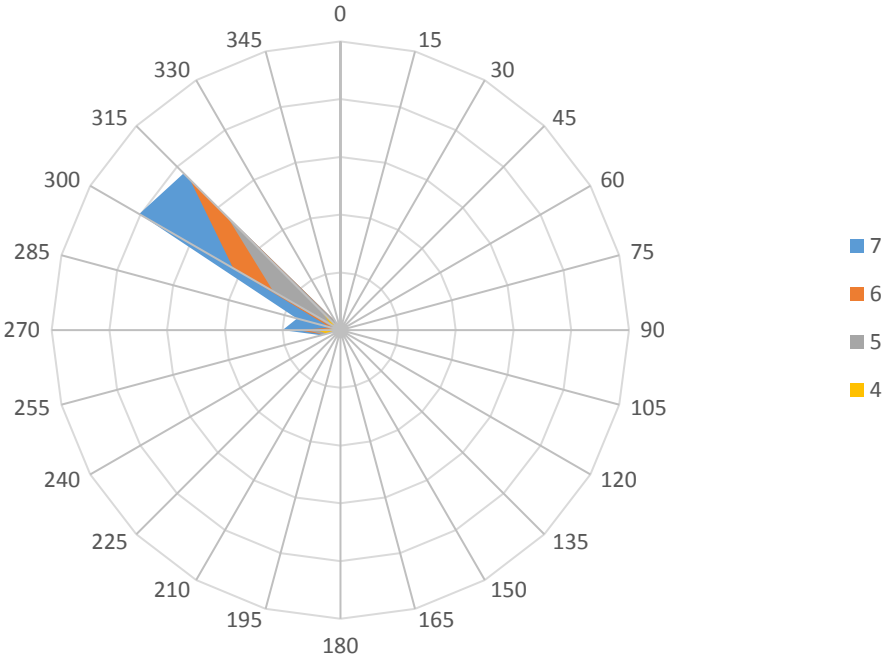


Figure 5a: Wind Direction - Grand Bend Wind Farm
Monitoring Location R2960,10 m Height, Wind Speeds 4-7 m/s
ON Condition, October 25 to December 20, 2016

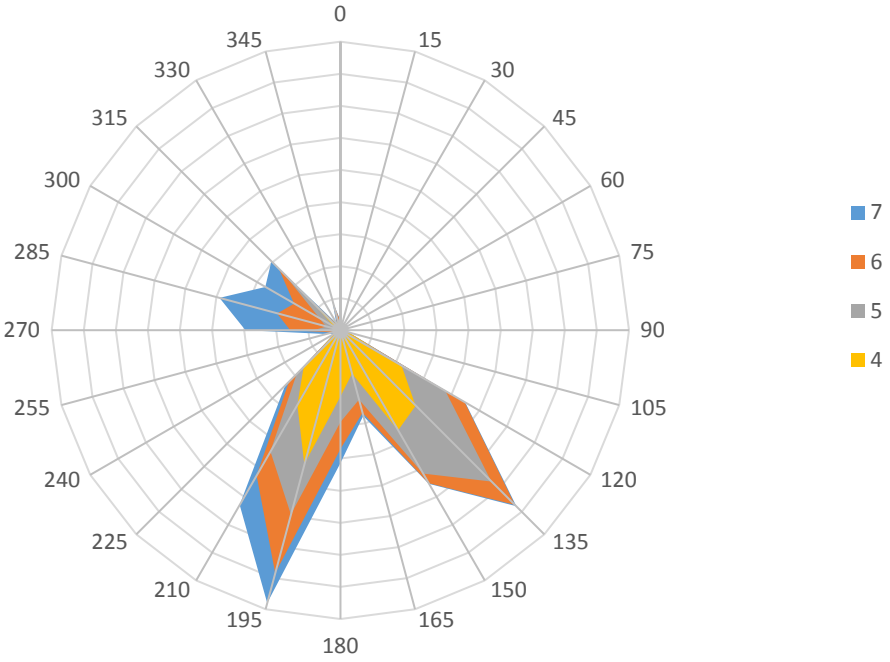


Figure 5b: Wind Direction - Grand Bend Wind Farm
Monitoring Location R2960,10 m Height, Wind Speeds 4-7 m/s
OFF Condition, October 25 to December 20, 2016

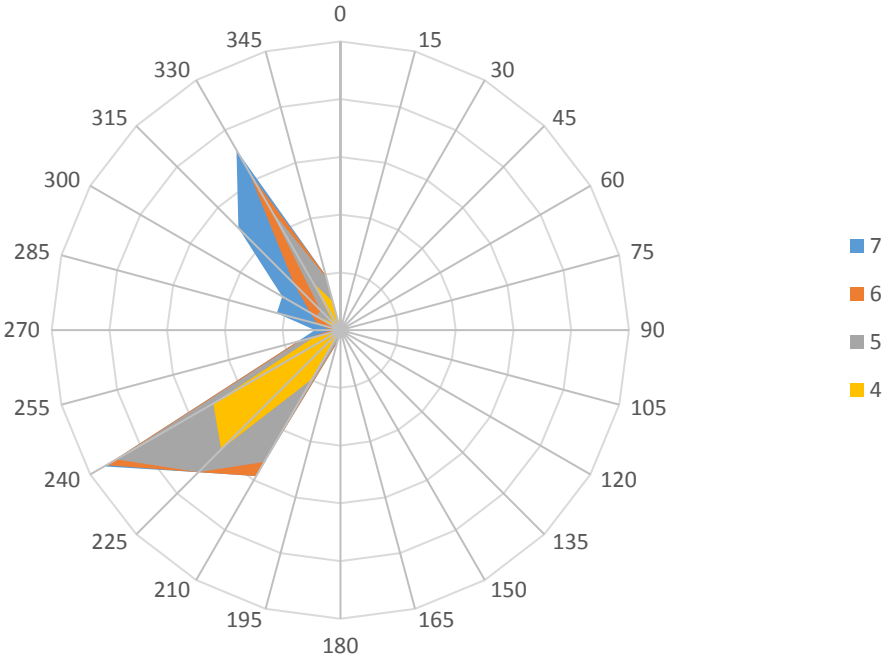


Figure 6a: Wind Direction - Grand Bend Wind Farm
Monitoring Location R2972,10 m Height, Wind Speeds 4-7 m/s
ON Condition, October 25, 2016 to February 1, 2017

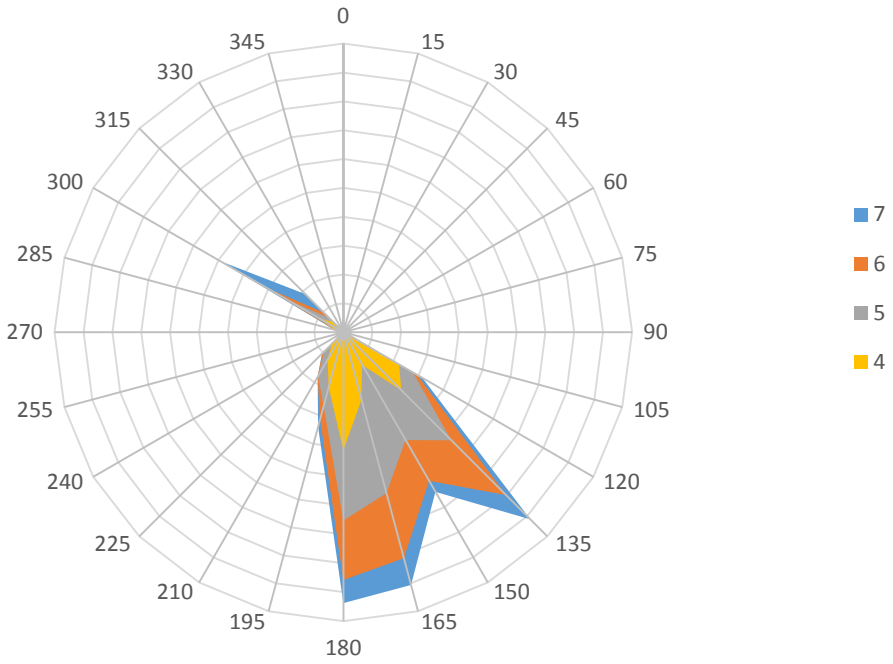


Figure 6b: Wind Direction - Grand Bend Wind Farm
Monitoring Location R2972,10 m Height, Wind Speeds 4-7 m/s
OFF Condition, October 25, 2016 to February 1, 2017

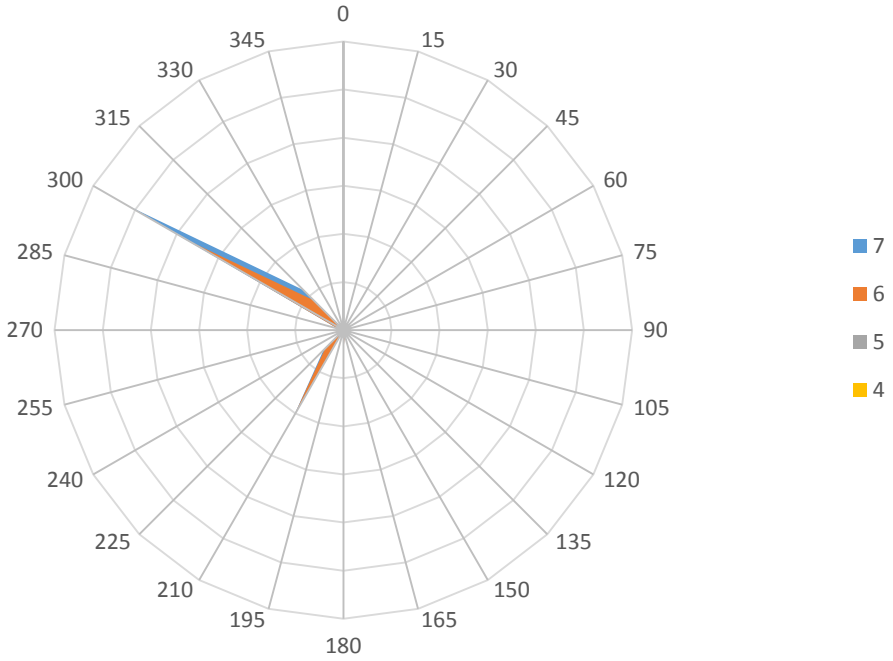


Figure 7a: Grand Bend Wind Farm, Fall Immission Results
Monitoring Location R0258, October 25 to December 20, 2016

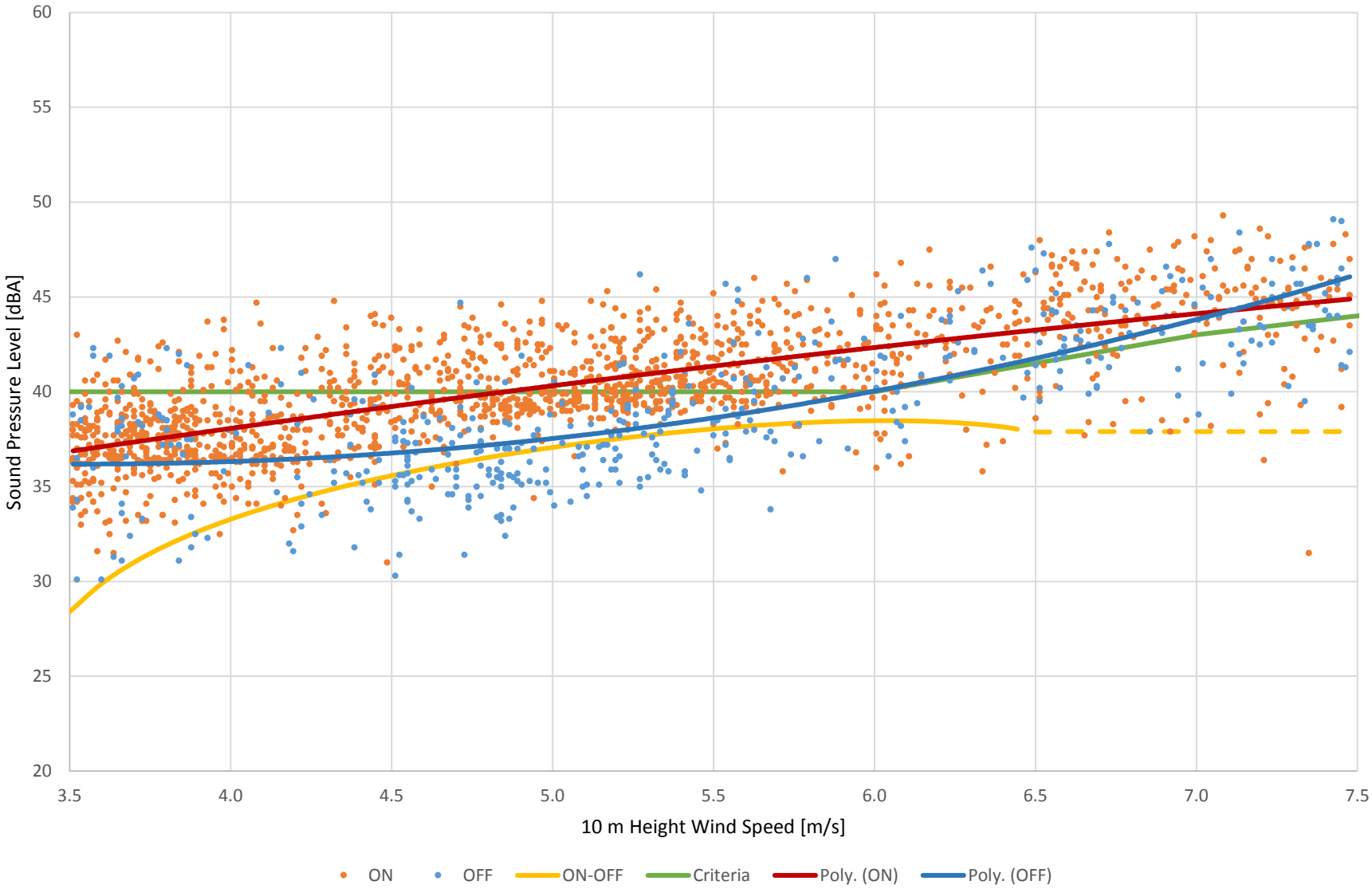


Figure 7b: Grand Bend Wind Farm, Fall Immission Results
Monitoring Location R0258, October 25 to December 20, 2016

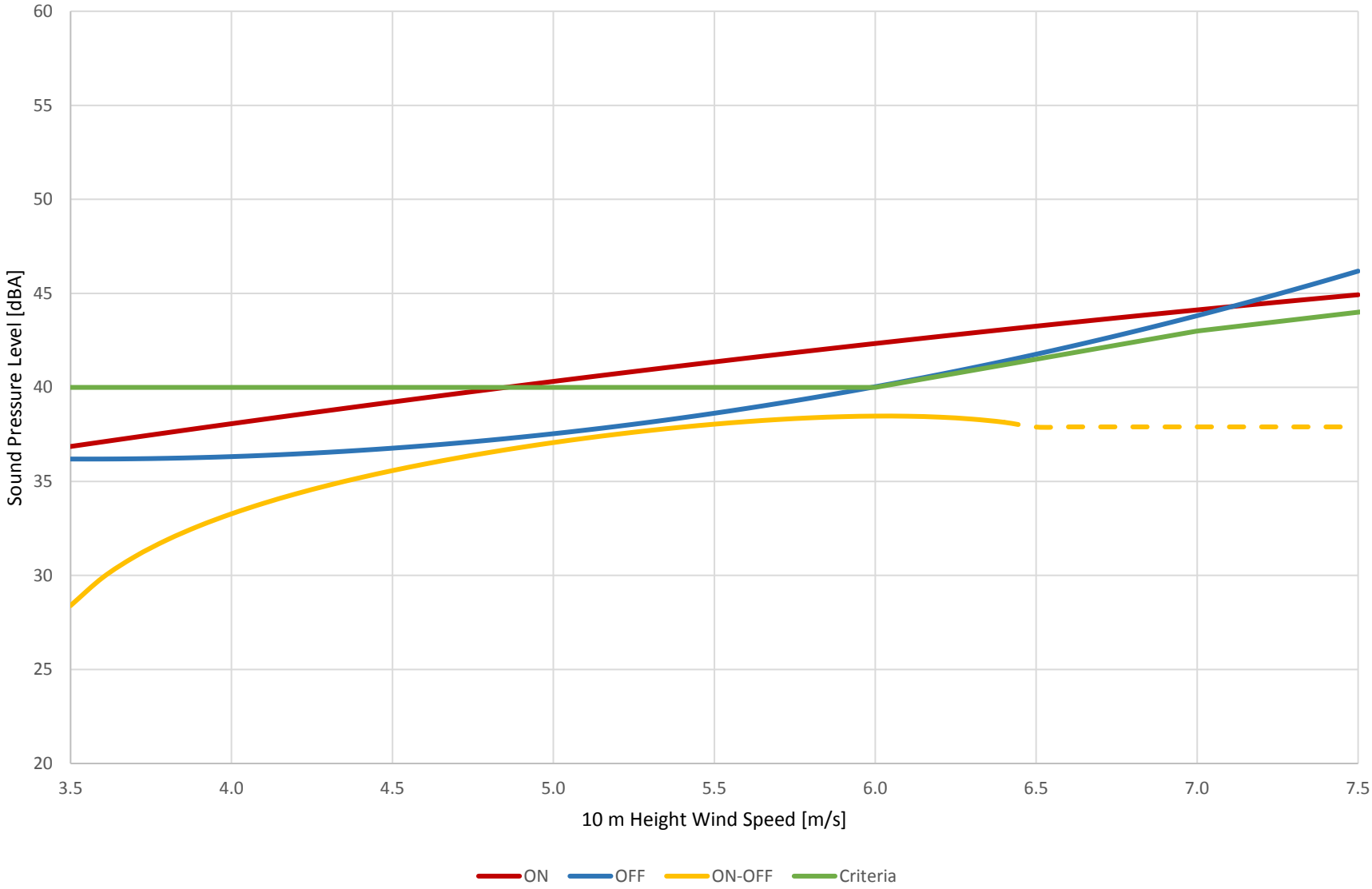


Figure 8a: Grand Bend Wind Farm, Fall Immission Results
Monitoring Location R0792, October 25, 2016 to February 1, 2017

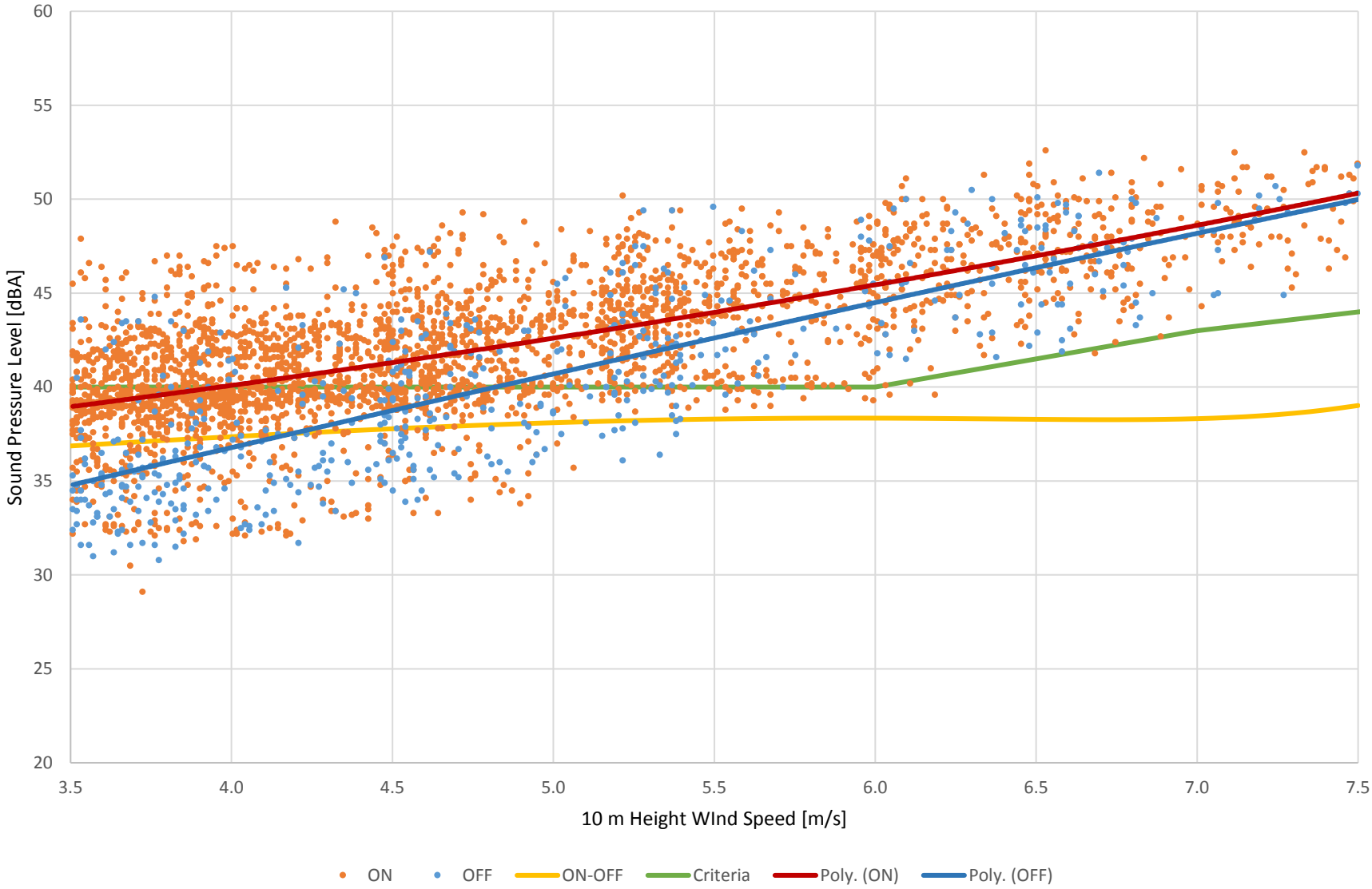


Figure 8b: Grand Bend Wind Farm, Fall Immission Results
Monitoring Location R0792, October 25, 2016 to February 1, 2017

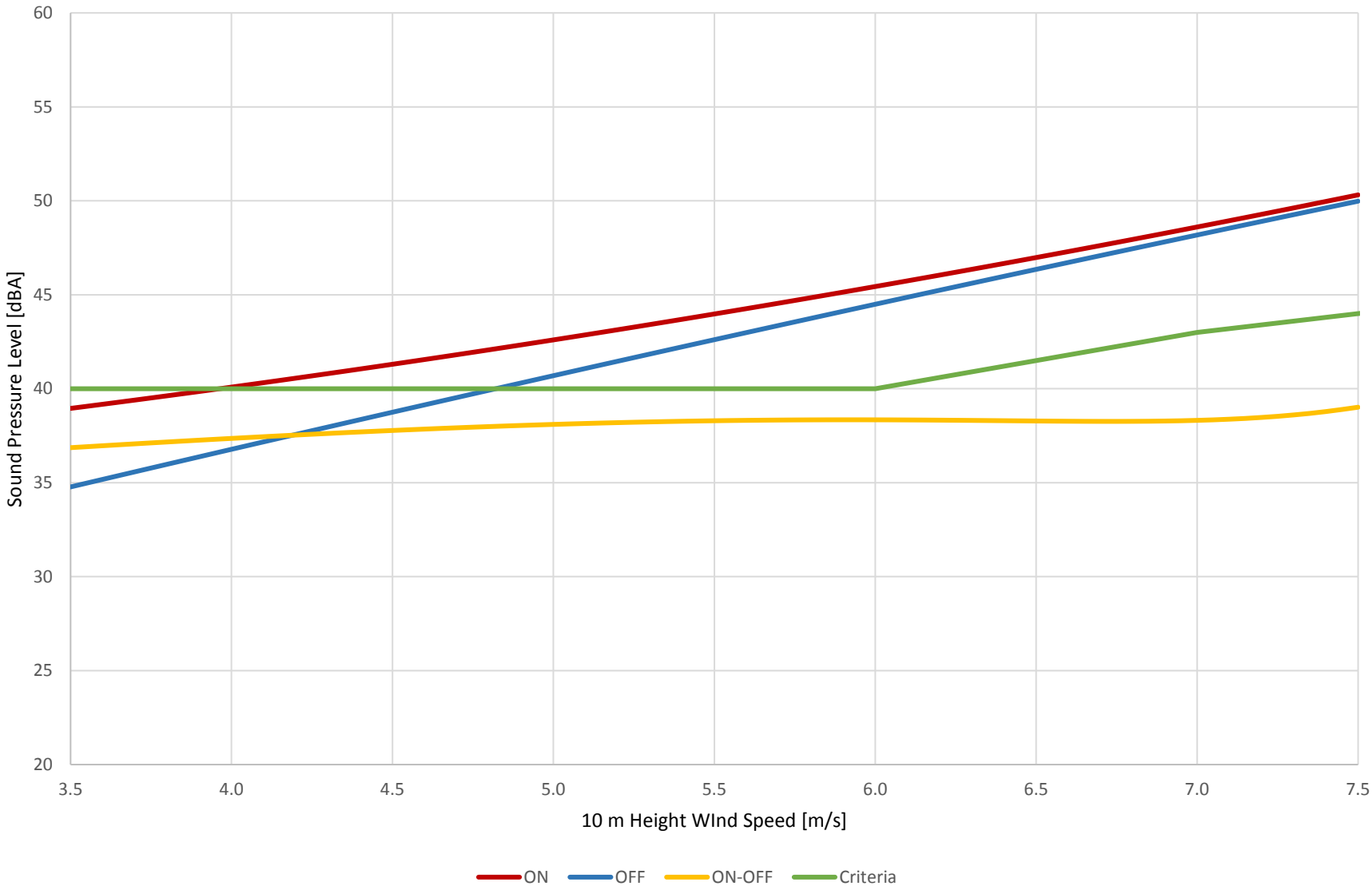


Figure 9a: Grand Bend Wind Farm, Fall Immission Results
Monitoring Location R1857, October 26 to December 20, 2016

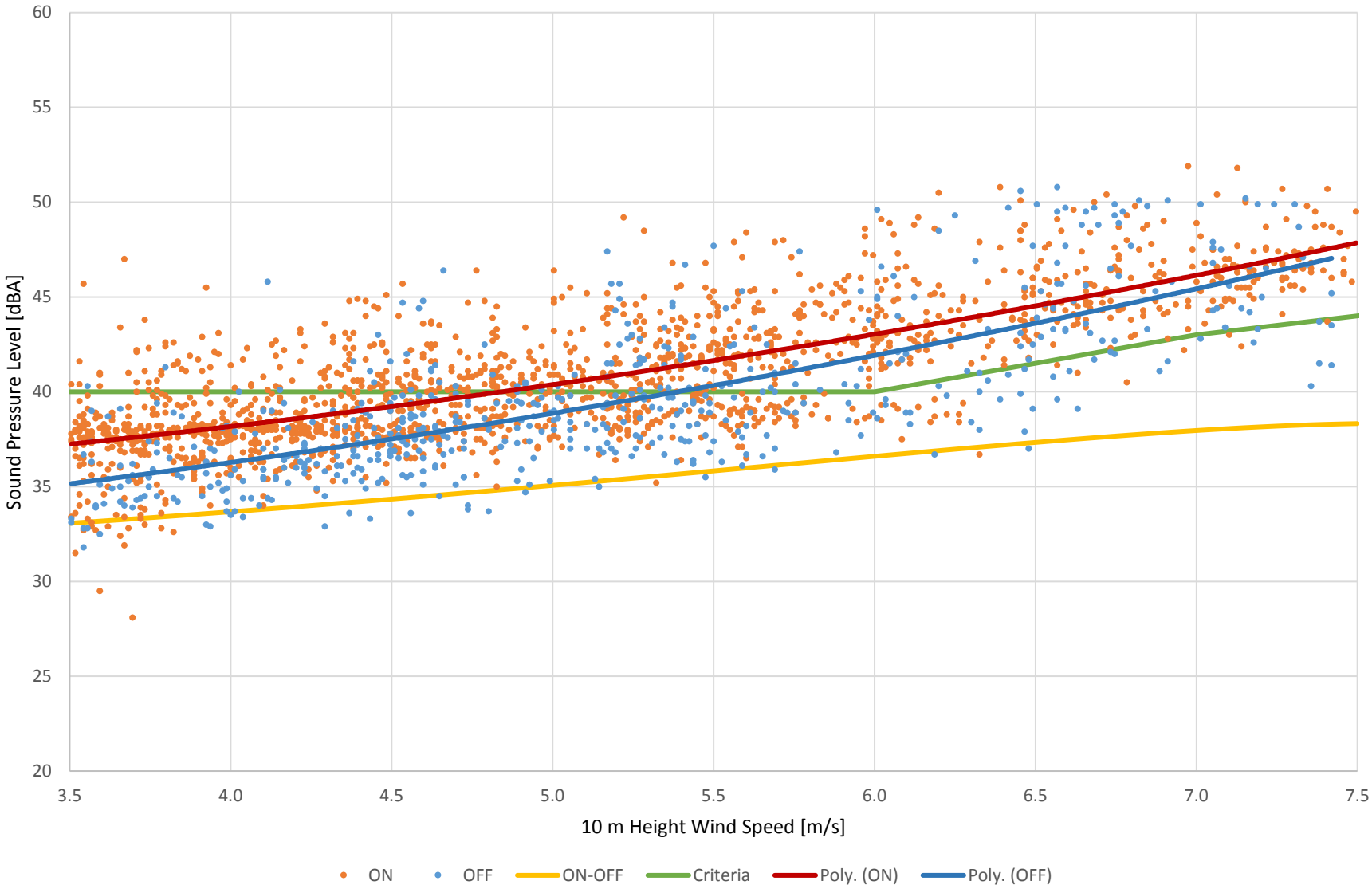


Figure 9b: Grand Bend Wind Farm, Fall Immission Results
Monitoring Location R1857, October 26 to December 20, 2016

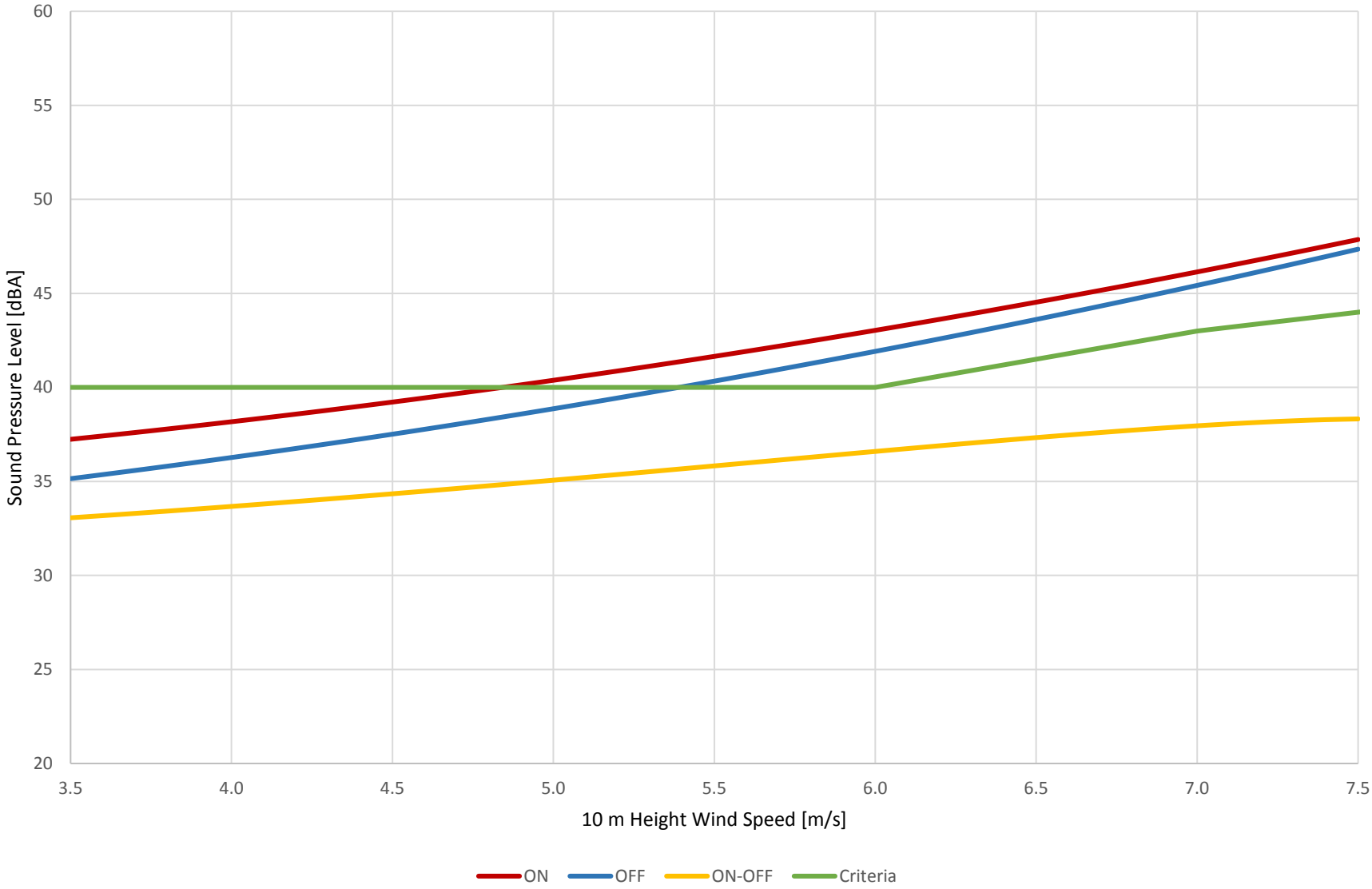


Figure 10a: Grand Bend Wind Farm, Fall Immission Results
Monitoring Location R2960, October 25 to December 20, 2016

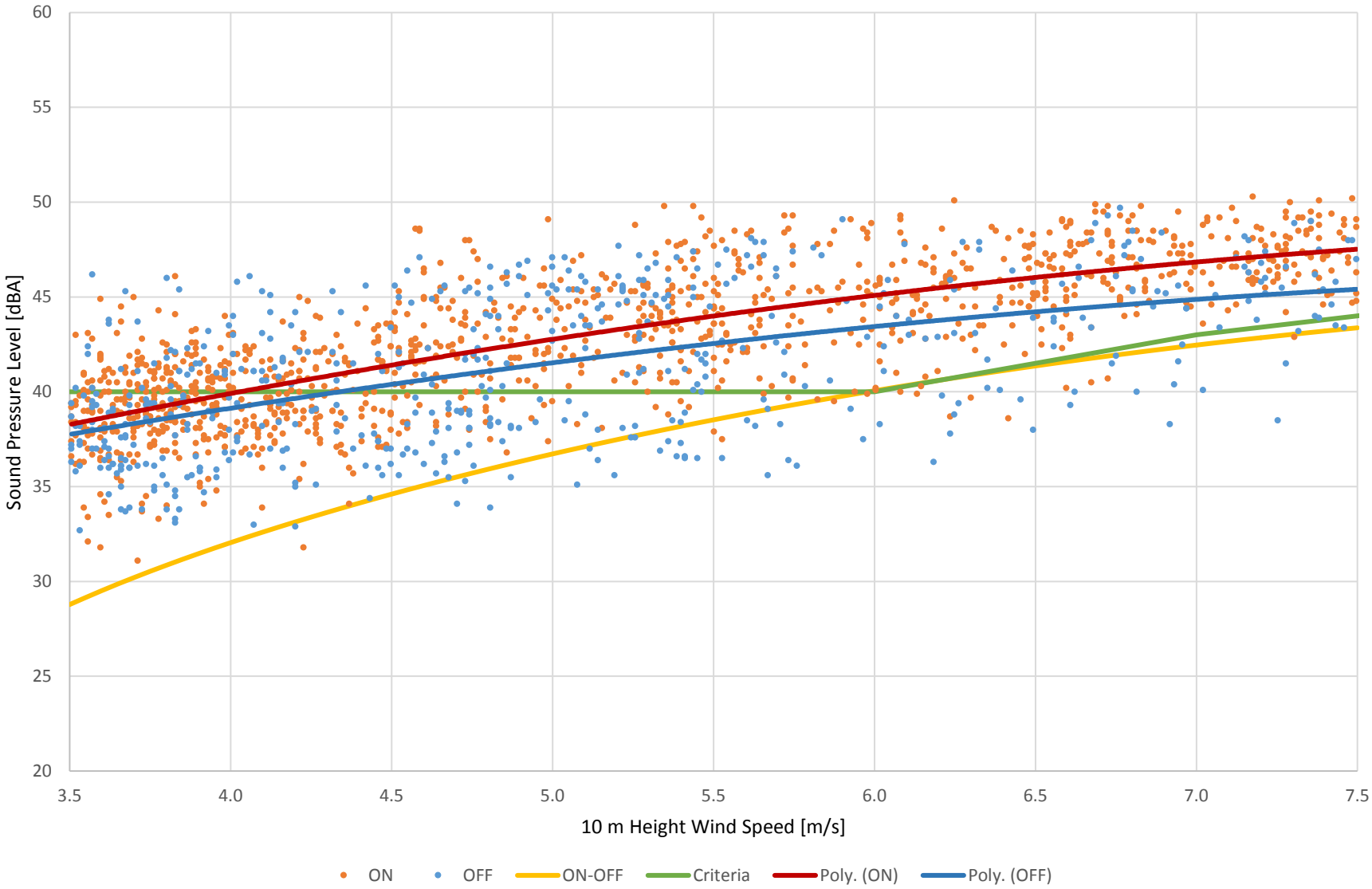


Figure 10b: Grand Bend Wind Farm, Fall Immission Results
Monitoring Location R2960, October 25 to December 20, 2016

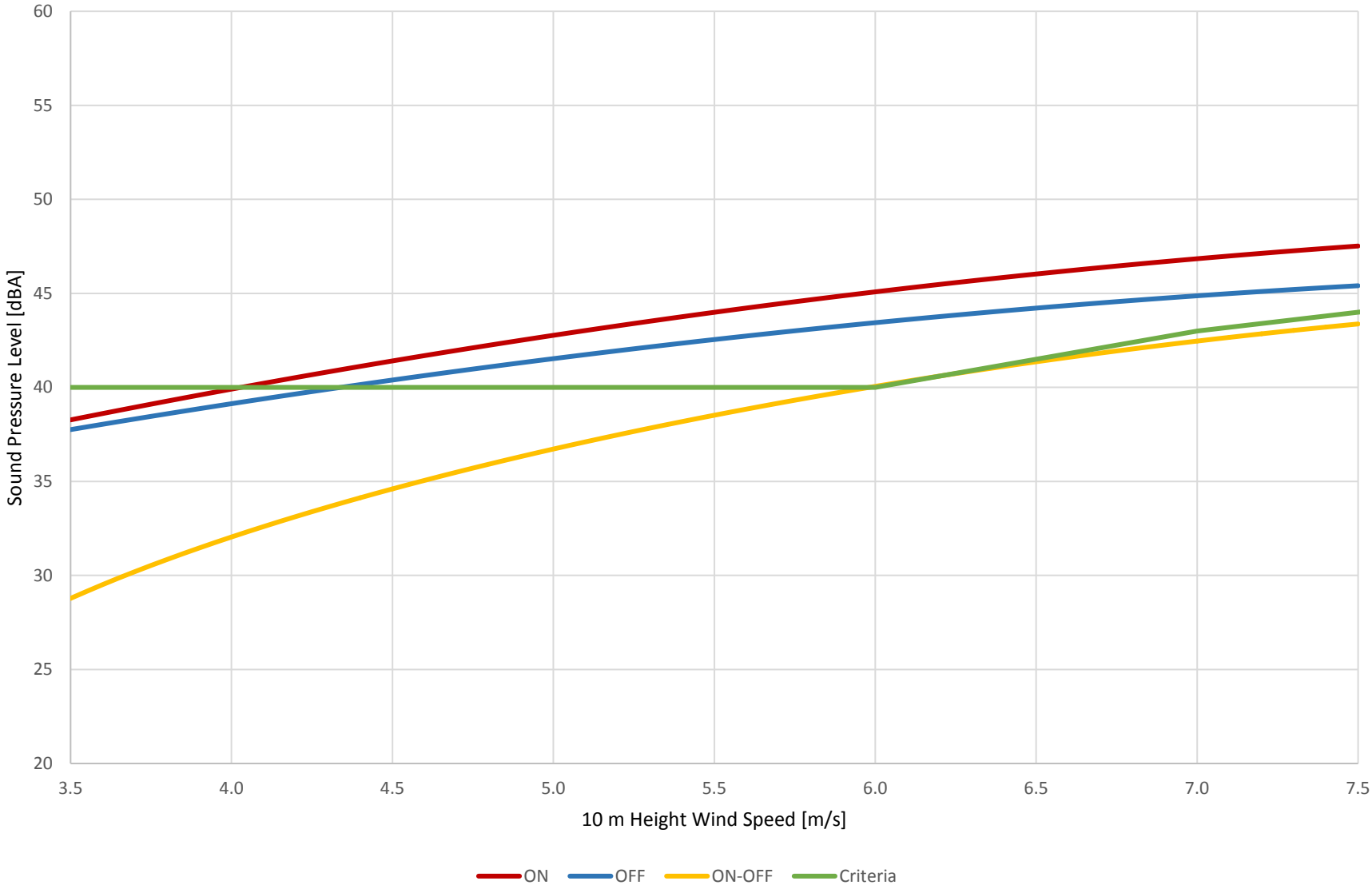


Figure 11a: Grand Bend Wind Farm, Fall Immission Results
Monitoring Location R2972, October 25, 2016 to February 1, 2017

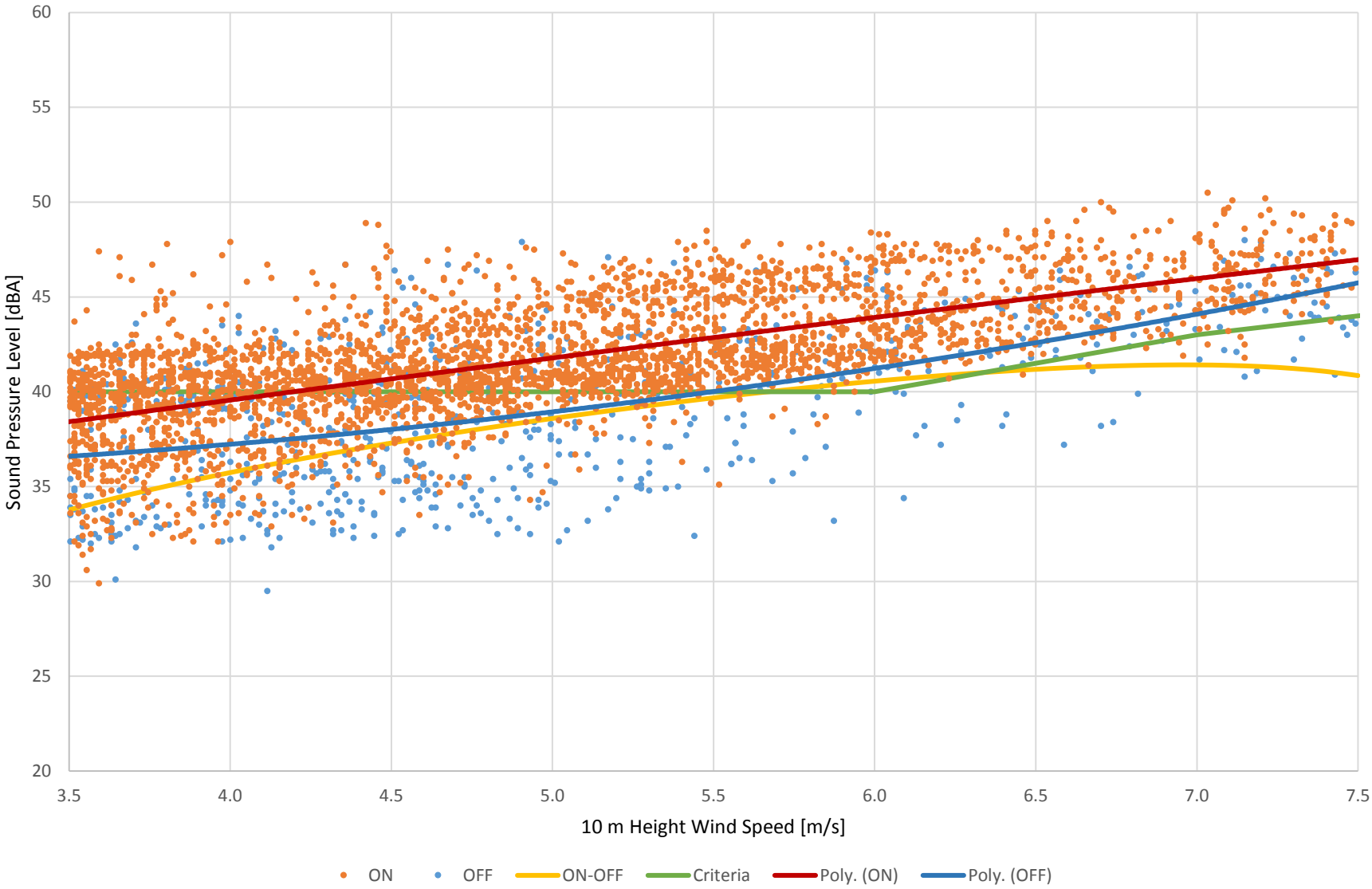
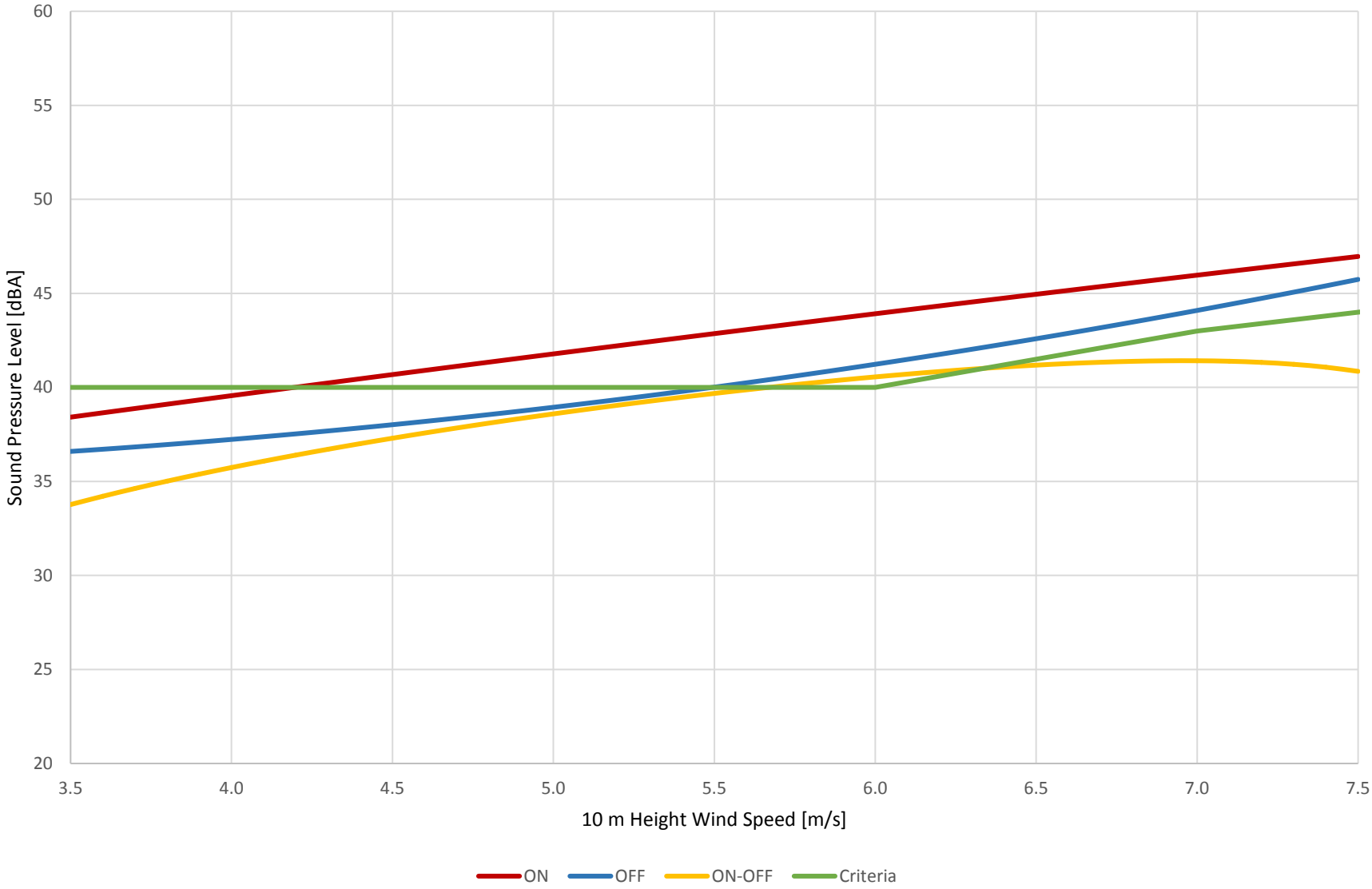


Figure 11b: Grand Bend Wind Farm, Fall Immission Results
Monitoring Location R2972, October 25, 2016 to February 1, 2017



APPENDIX A:
MONITORING LOCATION SELECTION

Figure A1: Annual Wind Rose [7]

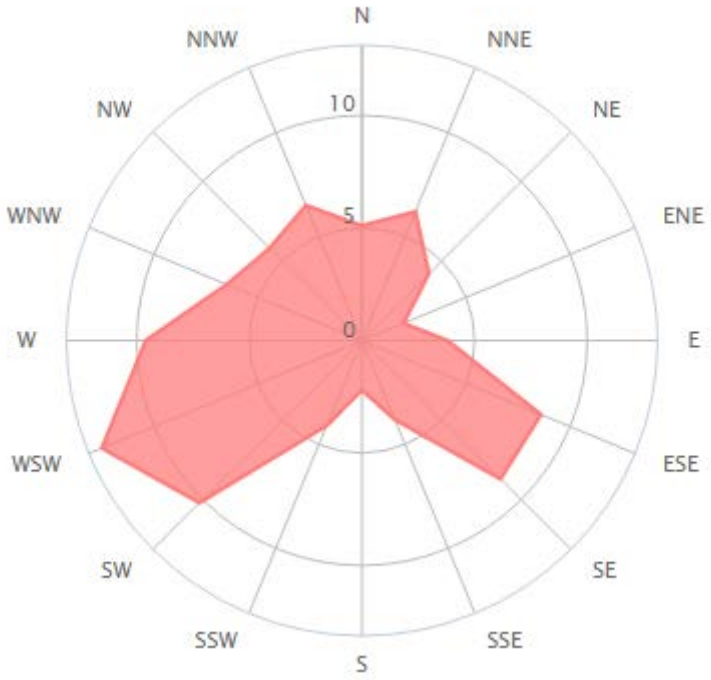


Table A1: Potential Receptor Locations

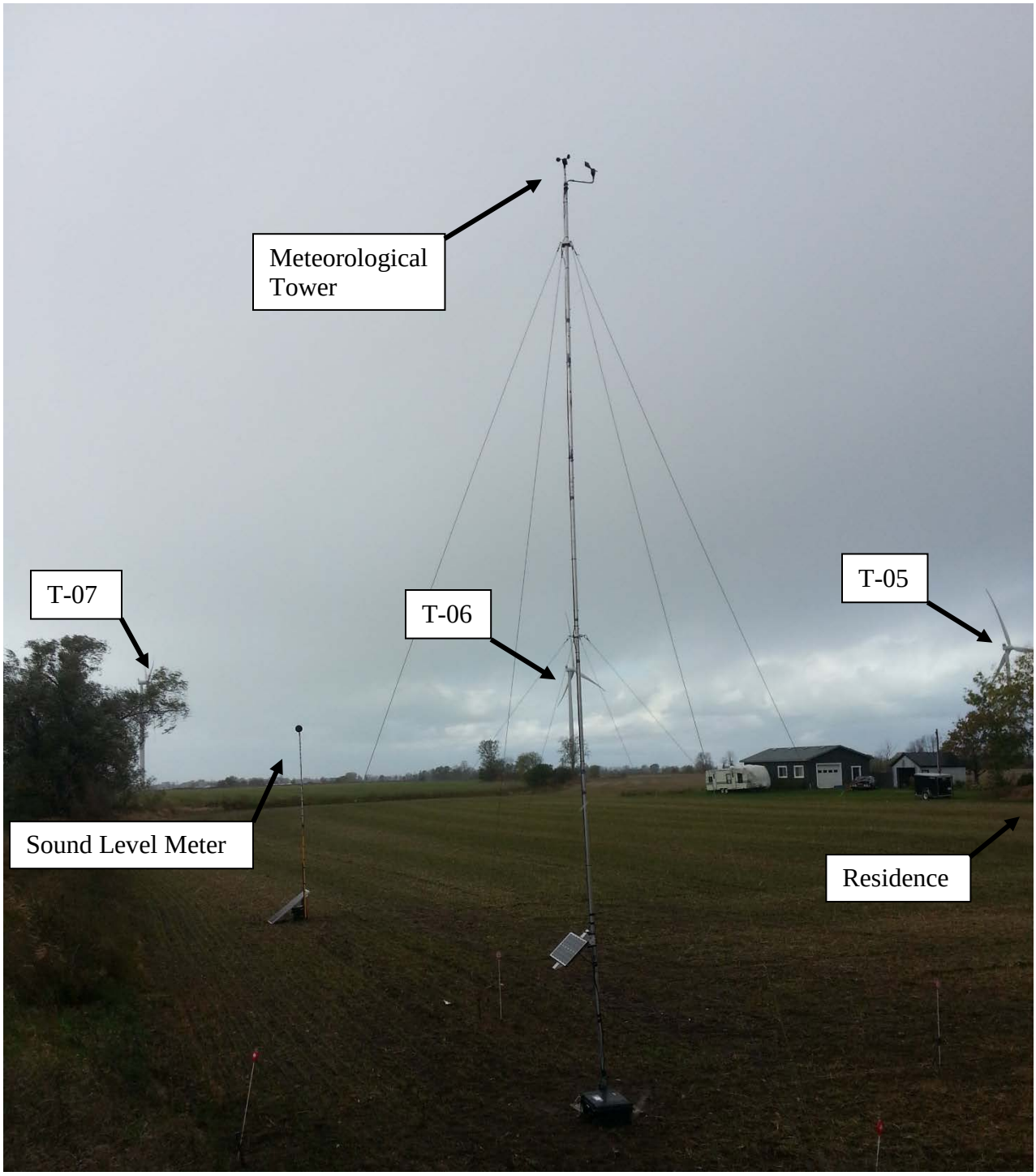
ID	Distance to Nearest Turbine [m]	Nearest Turbine ID	Predicted Sound Pressure Level [dBA]		Comments
			Updated Model*	ENIA**	
R0346	1974	T-03	42.1	39.7	Other Project Dominant
R2972	460	T-20	41	41.4	Selected Receptor - Representative of R0776
Monitoring Location R2972	560	T-20	39.7	N/A	Monitoring Location
R0812	555	T-21	40.6	41.1	Upwind
R2953	337	T-40	40.5	42.9	Participating
R1628	555	T-41	39.3	40.3	Permission Not Granted
R0776	606	T-20	39	39.4	Represented by R2972
R1581	631	T-40	39	40.3	Participating
R0108	1162	T-02	38.6	38.7	Other Project Dominant
R2930	804	T-09	38.6	39.2	Participating
R2932	736	T-09	38.6	39.2	Participating
R0258	794	T-09	38.5	39.1	Selected Receptor
Monitoring Location R0258	760	T-09	38.6	N/A	Monitoring Location
R0127	1217	T-03	38.4	38.5	Other Project Dominant
R0121	1308	T-02	38.3	38.4	Other Project Dominant
R0263	808	T-03	38.3	38.4	Upwind
R2931	663	T-05	38.3	38.9	Represented by R0258
R0101	1381	T-03	38.2	38.3	Other Project Dominant
R0792	665	T-22	38.2	38.7	Selected Receptor
Monitoring Location R0792	560	T-22	39.1	N/A	Monitoring Location
R1146	636	T-32	38.2	38.6	Upwind
R0202	654	T-05	38.1	38.7	Upwind
R0228	829	T-05	38.1	38.6	Other Project Dominant
R0236	850	T-03	38.1	38.5	Other Project Dominant
R0250	902	T-09	38.1	38.7	Represented by R0258
R0316	640	T-08	38.1	38.9	Upwind
R1138	638	T-32	38.1	38.6	Upwind
R0359	823	T-14	38.0	38.7	Upwind
R2928	797	T-05	38.0	38.6	Participating

* Predicted from updated acoustic model that includes only the constructed with turbine generators
** Obtained from ENIA [2] that includes optional wind turbine generators

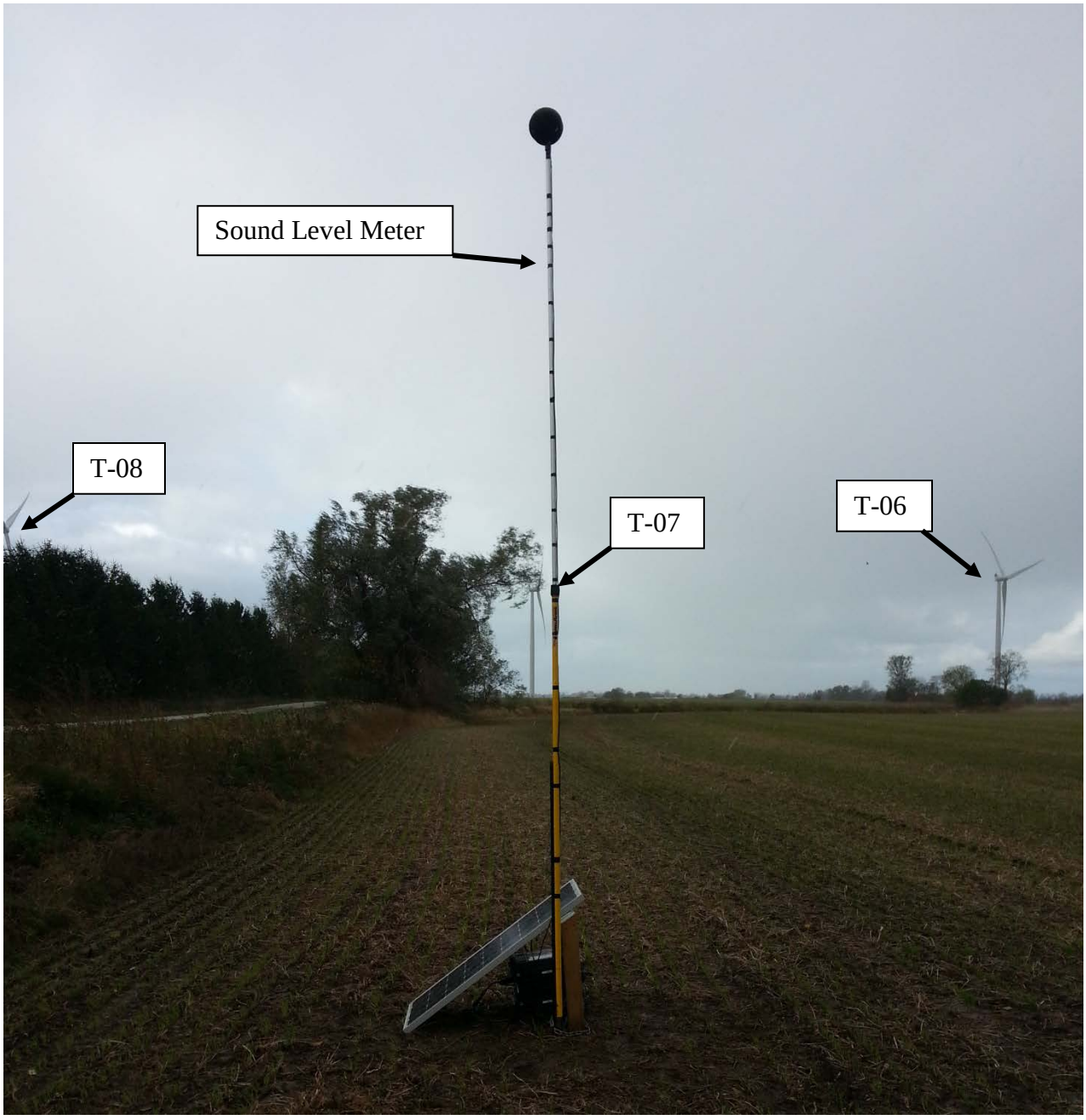
ID	Distance to Nearest Turbine [m]	Nearest Turbine ID	Predicted Sound Pressure Level [dBA]		Comments
			Updated Model*	ENIA**	
R2929	554	T-02	38.0	38.2	Participating
R2960	841	T-38	38.0	38.9	Selected Receptor
Monitoring Location R2960	810	T-43	38.0	N/A	Monitoring Location
R0297	660	T-08	37.9	38.7	Upwind
R1612	746	T-43	37.9	38.8	Represented by R2960
R1782	724	T-42	37.9	38.7	Upwind
R2957	495	T-43	37.9	38.3	Participating
R0278	695	T-08	37.8	38.7	Participating
R0340	747	T-08	37.8	38.6	Upwind
R0867	681	T-23	37.8	38.8	Participating
R0328	720	T-08	37.7	38.5	Upwind
R1196	645	T-31	37.7	38.1	Permission Not Granted
R1779	753	T-42	37.7	38.5	Upwind
R1841	719	T-43	37.7	38.3	Represented by R1857
R0529	658	T-16	37.6	38.9	Crosswind
R0906	703	T-26	37.6	38.8	Participating
R1179	756	T-34	37.6	38.2	Upwind
R1282	656	T-39	37.6	38.4	Upwind
R1843	761	T-43	37.6	38.2	Represented by R1857
R2950	766	T-32	37.6	38.1	Participating
R0130	1071	T-02	37.5	37.7	Other Project Dominant
R1551	770	T-38	37.5	38.4	Represented by R2960
R1776	784	T-42	37.5	38.3	Upwind
R1876	632	T-44	37.5	38.4	Participating
R1857	763	T-44	37.1	37.9	Selected Receptor
Monitoring Location R1857	670	T-44	37.4	N/A	Monitoring Location

* Predicted from updated acoustic model that includes only the constructed with turbine generators
** Obtained from ENIA [2] that includes optional wind turbine generators

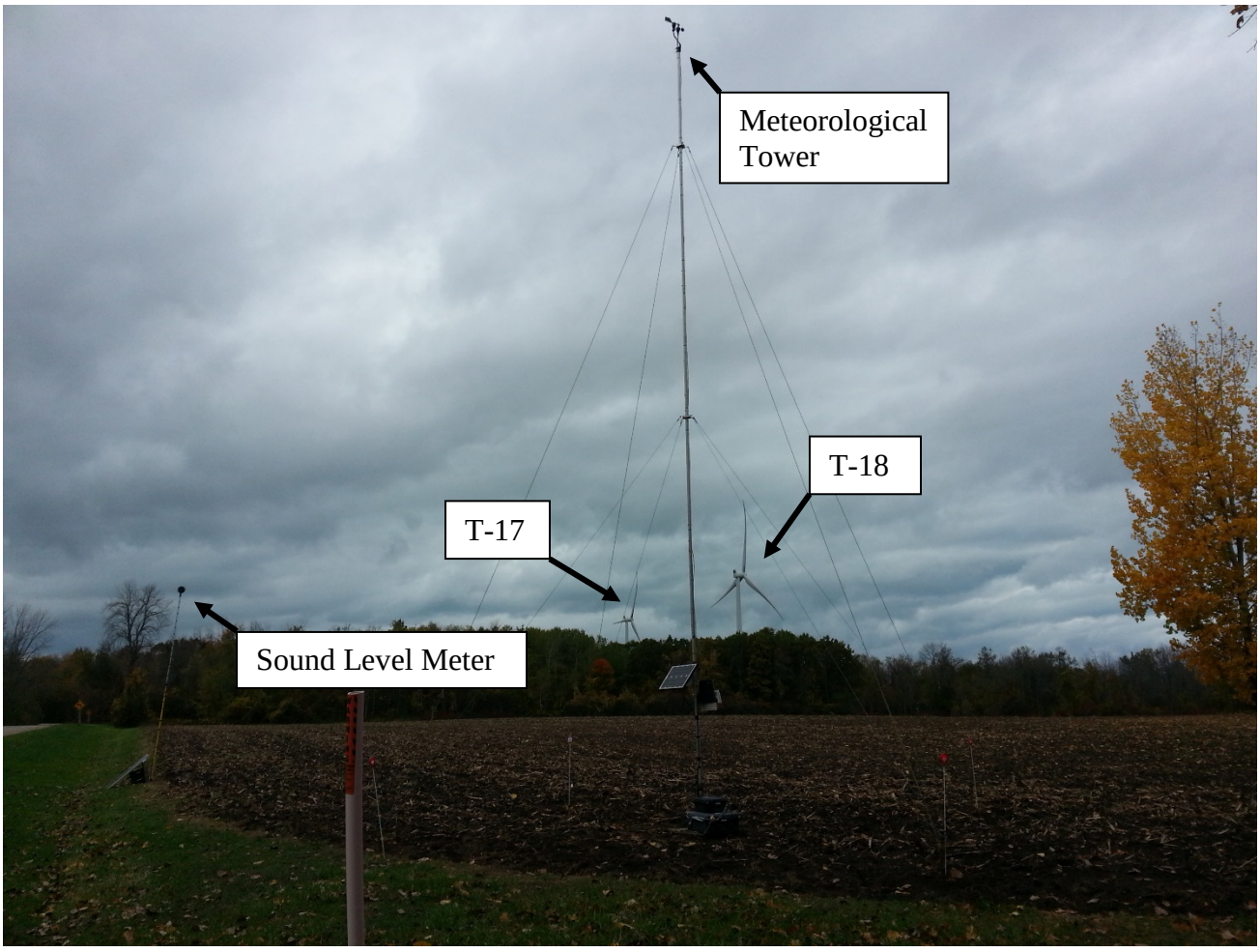
APPENDIX B:
MONITORING LOCATION PHOTOS



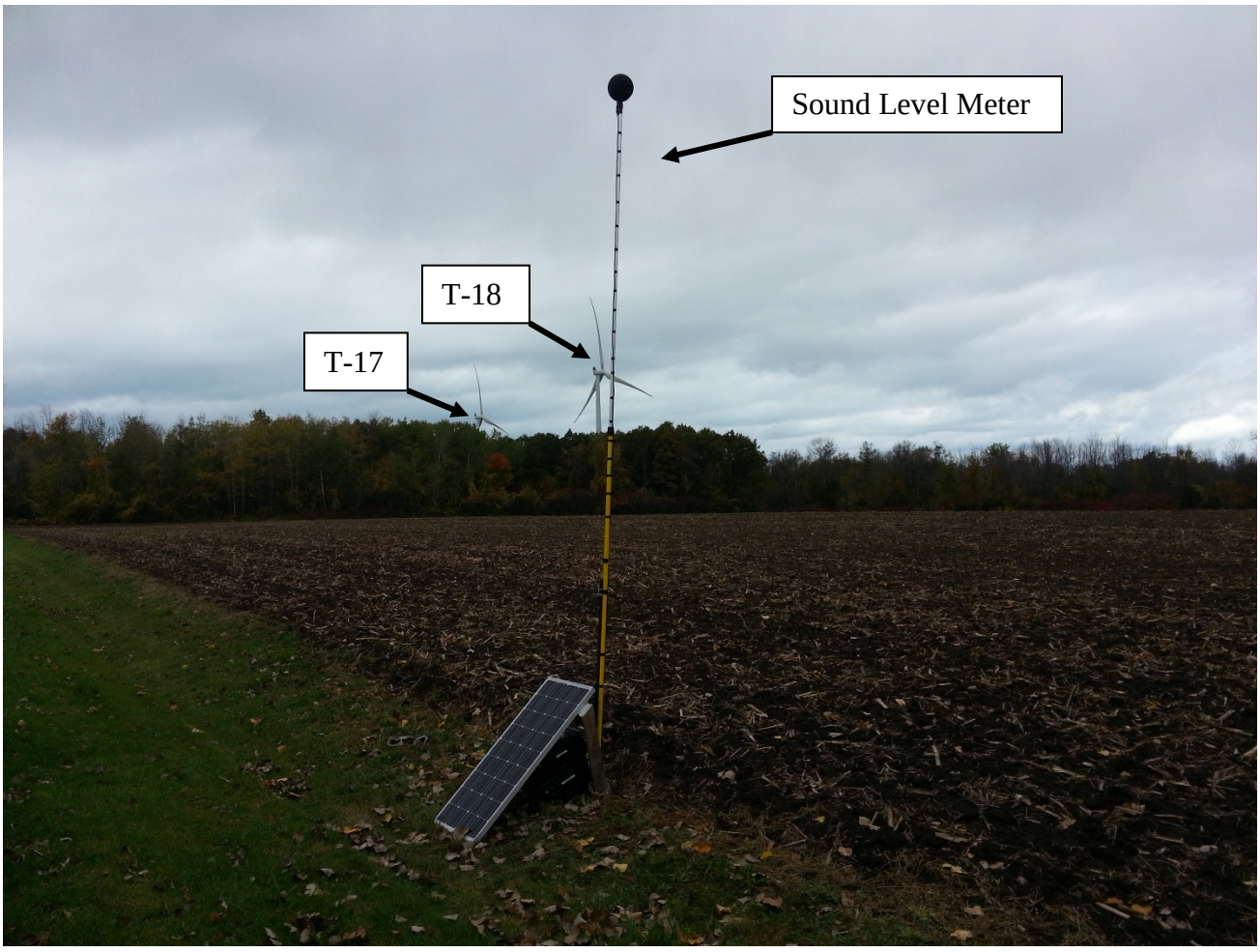
Sound Level Meter and Meteorological Tower at Monitoring Location R0258 (looking northwest)



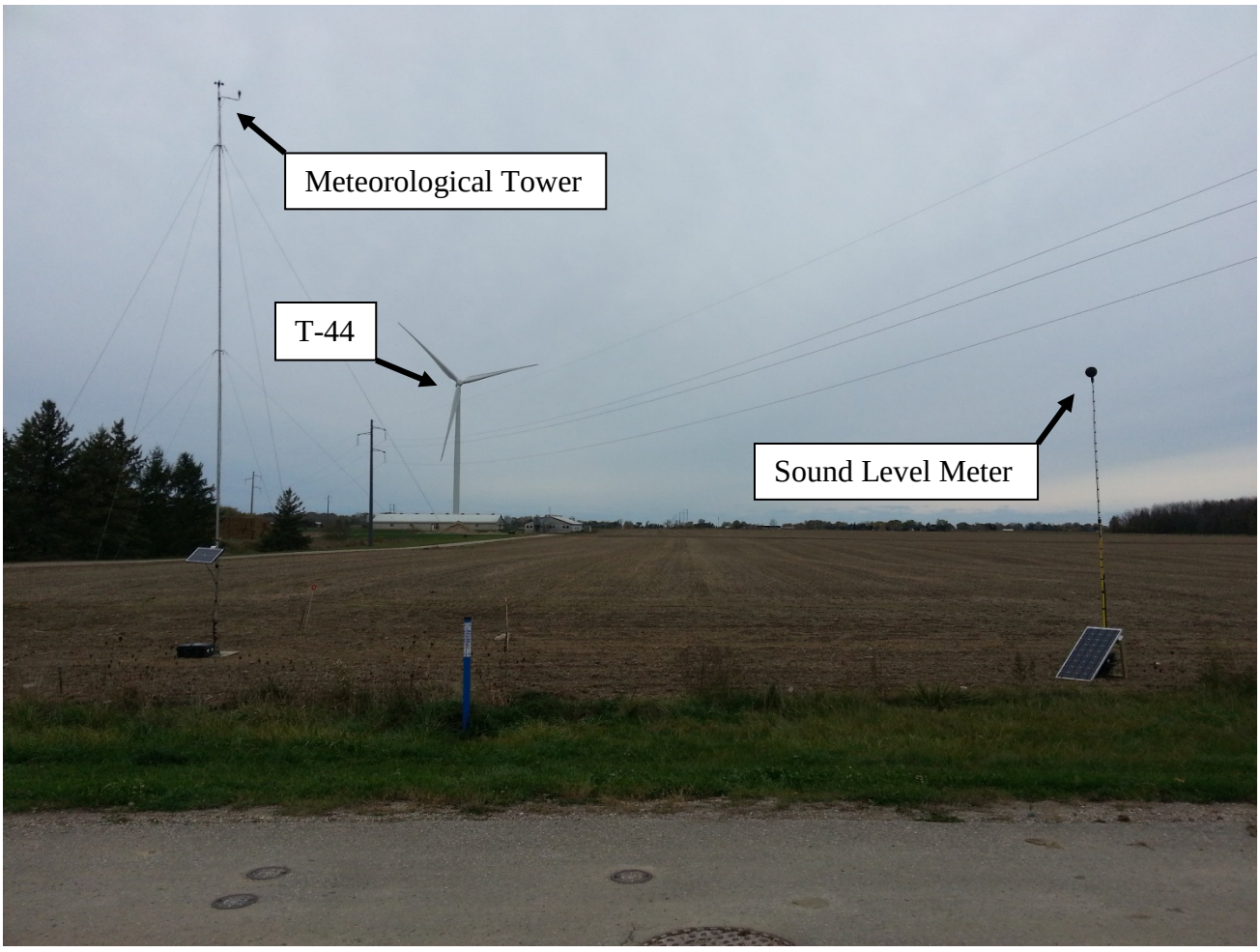
Sound Level Meter at Monitoring Location R0258 (looking west)



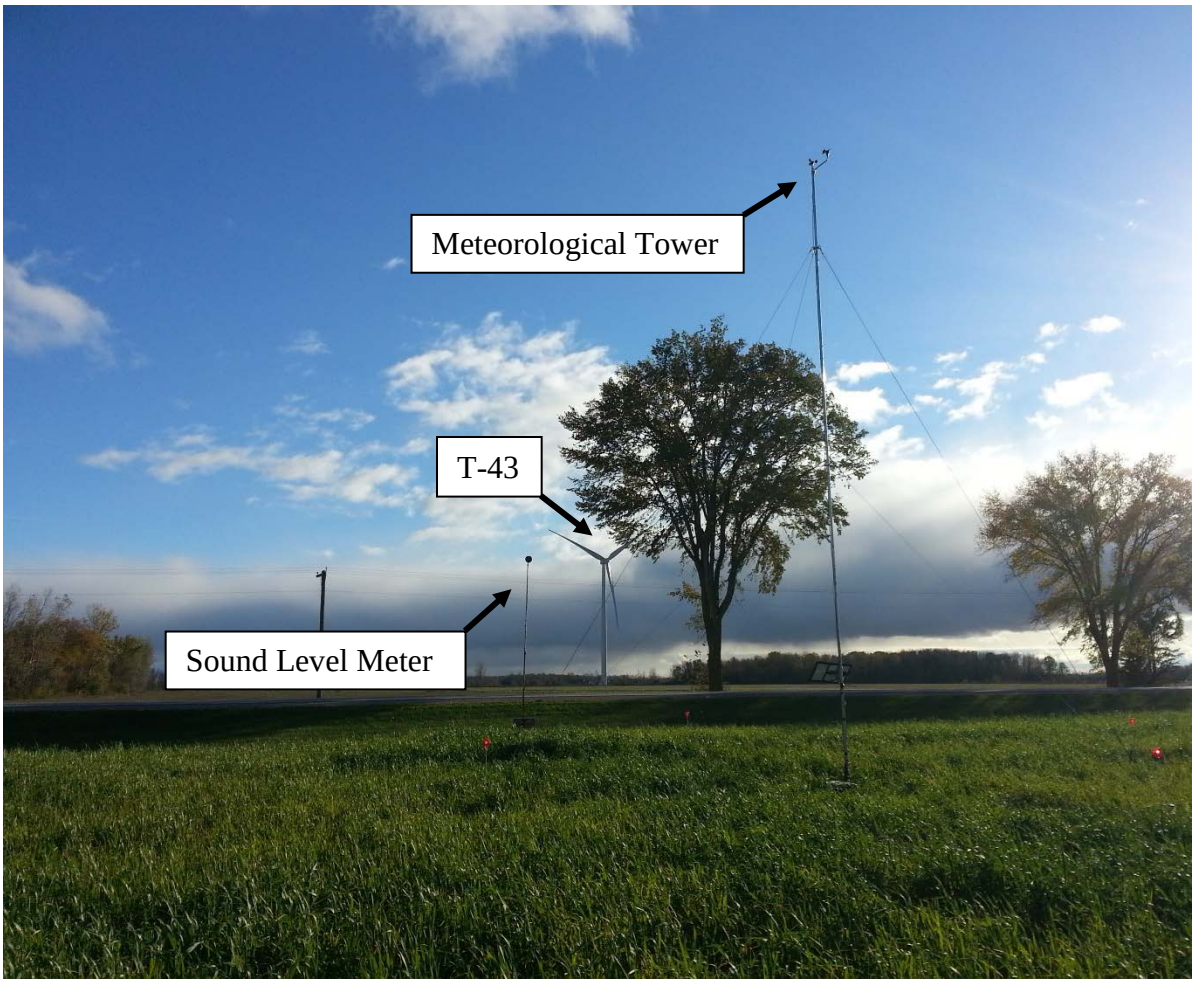
Meteorological Tower and Sound Level Meter at Monitoring Location R0792 (looking northwest)



Sound Level Meter at Monitoring Location R0792 (looking northwest)



Sound Level Meter and Meteorological Tower at Monitoring Location R1857 (looking west)



Sound Level Meter and Meteorological Tower at Monitoring Location R2960 (looking south)

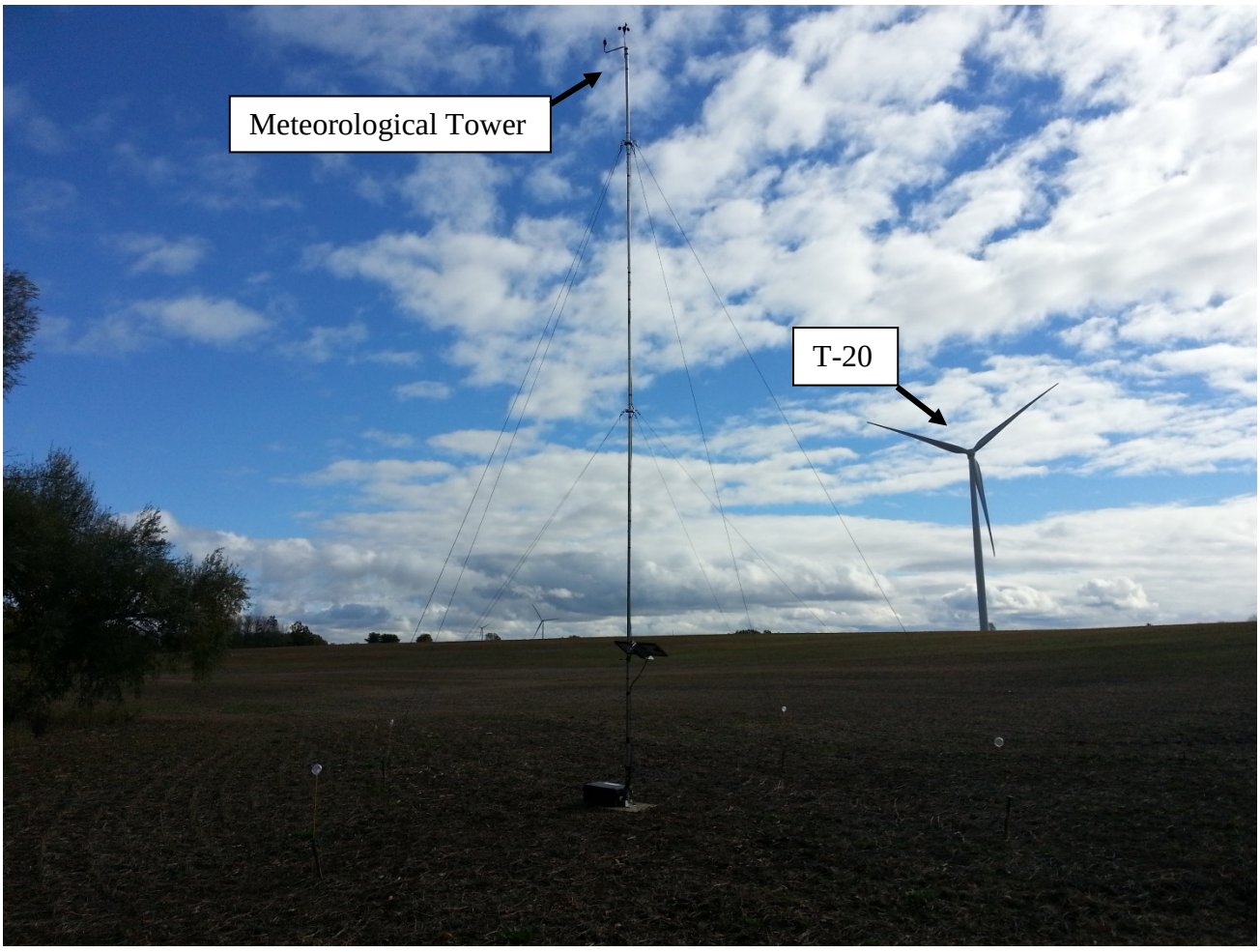


Photo of Meteorological Tower at Monitoring Location R2972 (looking southeast)

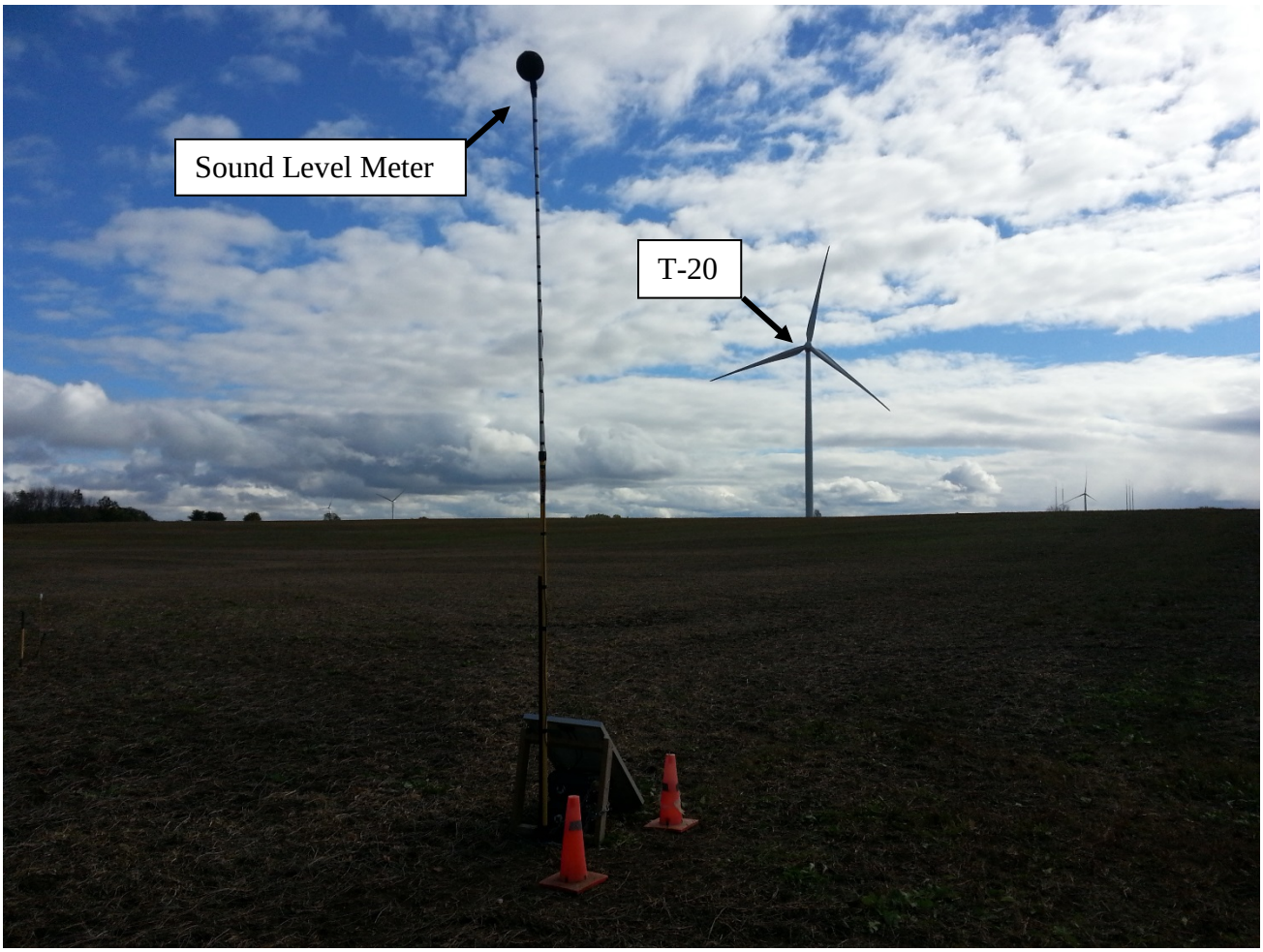


Photo of Sound Level Meter at Monitoring Location R2972 (looking southeast)

APPENDIX C:

CALIBRATION CERTIFICATES

Svend Ole Hansen ApS

SCT. JØRGENS ALLÉ 5C · DK-1615 KØBENHAVN V · DENMARK
TEL: (+45) 33 25 38 38 · WWW.SOHANSEN.DK

WIND
ENGINEERING
FLUID
DYNAMICS

CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

Certificate number: 15.02.04174 **Date of issue:** June 15, 2015

Type: NRG #40 **Serial number:** 179500244813

Manufacturer: Renewable NRG Systems, Inc., 110 Riggs Road, Hinesburg, VT 05461, USA

Client: Renewable NRG Systems, Inc., 110 Riggs Road, Hinesburg, VT 05461, USA

Anemometer received: December 15, 2014 **Anemometer calibrated:** June 8, 2015

Calibrated by: efs **Procedure:** MEASNET, referring to IEC 61400-12-1

Certificate prepared by: cea **Approved by:** Calibration engineer, jsk

Calibration equation obtained: v [m/s] = 0.77254 · f [Hz] + 0.29995

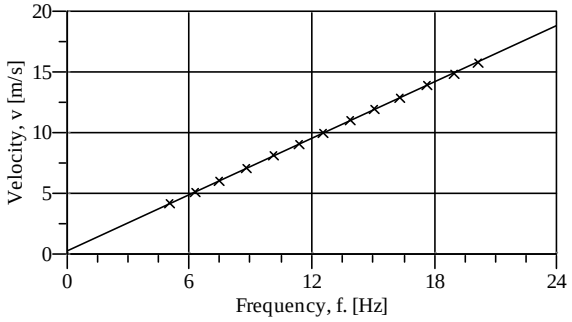
Standard uncertainty, slope: 0.00180 **Standard uncertainty, offset:** 0.06232

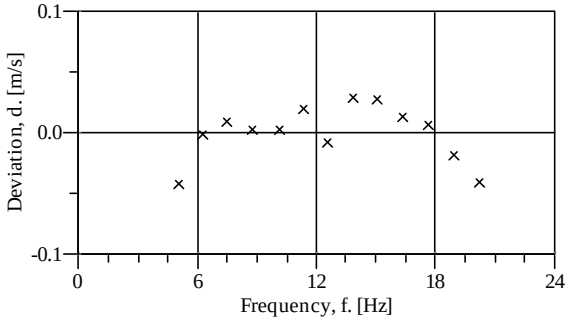
Covariance: -0.0000243 (m/s)²/Hz **Coefficient of correlation:** $\rho = 0.999982$

Absolute maximum deviation: -0.042 m/s at 4.156 m/s

Barometric pressure: 1025.5 hPa **Relative humidity:** 26.3%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	Temperature in control room [°C]	Wind velocity, v. [m/s]	Frequency, f. [Hz]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	10.15	29.6	24.5	4.156	5.0456	-0.042	0.021
4	15.54	29.4	24.4	5.140	6.2666	-0.001	0.025
6	21.71	29.3	24.4	6.075	7.4637	0.009	0.029
8	29.62	29.2	24.4	7.094	8.7918	0.002	0.033
10	38.75	29.1	24.4	8.114	10.1117	0.002	0.038
12	48.57	29.1	24.4	9.083	11.3446	0.019	0.042
13-last	58.93	29.0	24.4	10.005	12.5716	-0.008	0.046
11	71.65	29.1	24.4	11.033	13.8543	0.030	0.051
9	84.54	29.1	24.4	11.985	15.0887	0.028	0.055
7	98.61	29.2	24.4	12.946	16.3526	0.013	0.060
5	114.20	29.3	24.4	13.934	17.6400	0.006	0.064
3	130.84	29.5	24.5	14.918	18.9451	-0.018	0.069
1-first	147.59	29.7	24.5	15.851	20.1831	-0.041	0.073





Accreditation to ISO 17025

CAL Reg.nr. 452

Svend Ole Hansen ApS

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WIND
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DYNAMICS

CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

Certificate number: 15.02.04163 **Date of issue:** June 15, 2015

Type: NRG #40 **Serial number:** 179500244824

Manufacturer: Renewable NRG Systems, Inc., 110 Riggs Road, Hinesburg, VT 05461, USA

Client: Renewable NRG Systems, Inc., 110 Riggs Road, Hinesburg, VT 05461, USA

Anemometer received: December 15, 2014 **Anemometer calibrated:** May 26, 2015

Calibrated by: jjj **Procedure:** MEASNET, referring to IEC 61400-12-1

Certificate prepared by: cea **Approved by:** Calibration engineer, jsk

Calibration equation obtained: v [m/s] = 0.76523 · f [Hz] + 0.33154

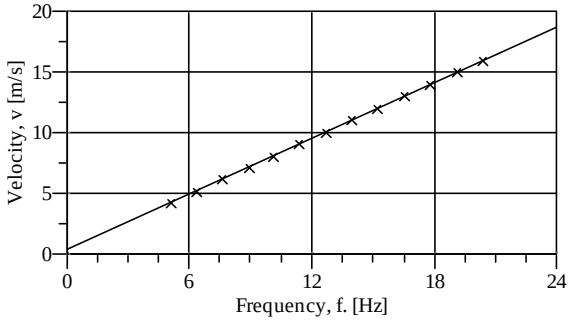
Standard uncertainty, slope: 0.00211 **Standard uncertainty, offset:** 0.06619

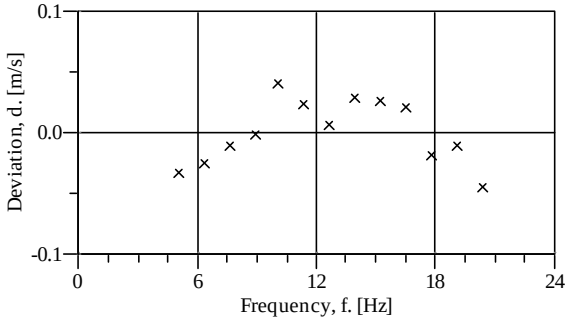
Covariance: -0.0000332 (m/s)²/Hz **Coefficient of correlation:** $\rho = 0.999975$

Absolute maximum deviation: -0.045 m/s at 15.890 m/s

Barometric pressure: 1010.4 hPa **Relative humidity:** 23.7%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	control room [°C]	Wind velocity, v. [m/s]	Frequency, f. [Hz]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	10.20	31.3	23.0	4.209	5.1107	-0.033	0.021
4	15.48	31.2	23.0	5.186	6.3764	-0.025	0.025
6	21.76	31.1	23.0	6.146	7.6116	-0.010	0.029
8	29.41	31.1	22.9	7.145	8.9058	-0.001	0.033
10	37.73	31.0	22.9	8.092	10.0889	0.040	0.038
12	47.42	30.9	22.9	9.071	11.3895	0.023	0.042
13-last	58.13	30.9	22.9	10.042	12.6814	0.006	0.046
11	70.27	31.0	22.9	11.042	13.9586	0.029	0.051
9	82.83	31.0	22.9	11.989	15.2002	0.026	0.055
7	97.35	31.1	23.0	12.999	16.5267	0.021	0.060
5	112.15	31.2	23.0	13.954	17.8262	-0.019	0.064
3	128.68	31.2	23.0	14.949	19.1166	-0.011	0.069
1-first	145.34	31.3	23.0	15.890	20.3912	-0.045	0.073





Accreditation to ISO 17025

CAL Reg.nr. 452

SOH Wind Engineering LLC

141 Leroy Road · Williston, VT 05495 · USA

Tel 802.316.4368 · Fax 802.735.9106 · www.sohwind.com

CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

Certificate number: 16.US2.01527 **Date of issue:** February 9, 2016

Type: RNRG 40C Anemometer **Serial number:** 179500262946

Manufacturer: Renewable NRG Systems Inc, 110 Riggs Road, Hinesburg, VT 05461, USA

Client: Renewable NRG Systems Inc, 110 Riggs Road, Hinesburg, VT 05461, USA

Anemometer received: February 2, 2016 **Anemometer calibrated:** 16:51 February 9, 2016

Calibrated by: ncm **Procedure:** MEASNET, IEC 61400-12-1:2005(E) Annex F

Certificate prepared by: Software Revision 7 **Approved by:** Calibration engineer, rds

Calibration equation obtained: v [m/s] = 0.76022 · f [Hz] + 0.35579

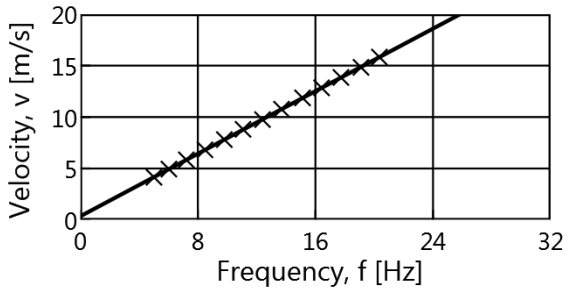
Standard uncertainty, slope: 0.00146 **Standard uncertainty, offset:** 0.04188

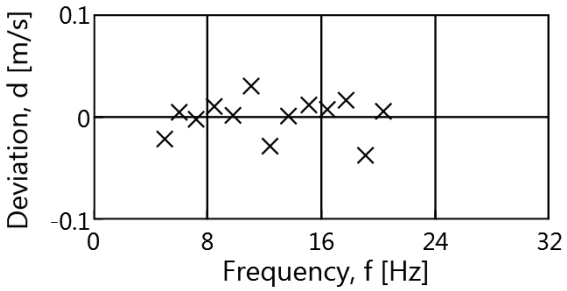
Covariance: -0.0000154 (m/s)²/Hz **Coefficient of correlation:** ρ = 0.999988

Absolute maximum deviation: 0.037 m/s at 14.838 m/s

Barometric pressure: 988.5 hPa **Relative humidity:** 11.8%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	d.p. box [°C]	Wind velocity, v. [m/s]	Frequency, f. [Hz]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	9.96	24.1	27.5	4.149	5.0172	-0.021	0.026
4	14.15	24.2	27.5	4.946	6.0312	0.005	0.026
6	19.72	24.2	27.5	5.839	7.2156	-0.002	0.028
8	26.89	24.2	27.5	6.818	8.4869	0.010	0.030
10	35.29	24.1	27.4	7.810	9.8036	0.002	0.032
12	44.87	24.1	27.4	8.807	11.0769	0.030	0.035
13-last	55.06	24.1	27.5	9.756	12.4022	-0.028	0.038
11	67.07	24.1	27.4	10.768	13.6953	0.001	0.042
9	81.45	24.1	27.4	11.867	15.1267	0.012	0.045
7	95.42	24.2	27.5	12.845	16.4187	0.007	0.048
5	110.99	24.2	27.5	13.854	17.7341	0.016	0.052
3	127.30	24.1	27.5	14.838	19.0987	-0.037	0.055
1-first	144.98	24.1	27.5	15.834	20.3533	0.006	0.058





AC-1746

SOH Wind Engineering LLC

141 Leroy Road · Williston, VT 05495 · USA

Tel 802.316.4368 · Fax 802.735.9106 · www.sohwind.com

CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

Certificate number: 16.US2.03537 **Date of issue:** March 29, 2016

Type: RNRG 40C Anemometer **Serial number:** 179500265230

Manufacturer: Renewable NRG Systems Inc, 110 Riggs Road, Hinesburg, VT 05461, USA

Client: Renewable NRG Systems Inc, 110 Riggs Road, Hinesburg, VT 05461, USA

Anemometer received: March 22, 2016 **Anemometer calibrated:** 19:30 March 29, 2016

Calibrated by: ncm **Procedure:** MEASNET, IEC 61400-12-1:2005(E) Annex F

Certificate prepared by: Software Revision 7 **Approved by:** Calibration engineer, rds

Calibration equation obtained: v [m/s] = 0.76461 · f [Hz] + 0.31796

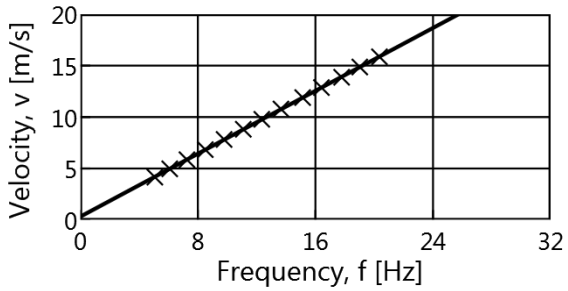
Standard uncertainty, slope: 0.00180 **Standard uncertainty, offset:** 0.05789

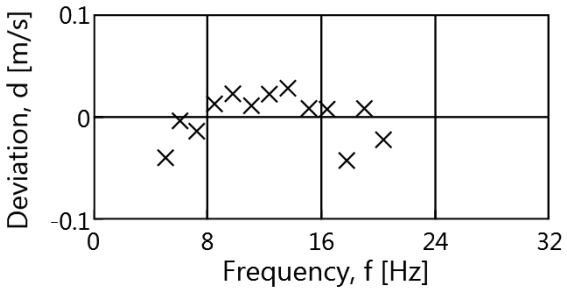
Covariance: -0.0000236 (m/s)²/Hz **Coefficient of correlation:** ρ = 0.999982

Absolute maximum deviation: 0.042 m/s at 13.873 m/s

Barometric pressure: 1005.9 hPa **Relative humidity:** 18.5%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	d.p. box [°C]	Wind velocity, v. [m/s]	Frequency, f. [Hz]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	10.18	24.0	31.4	4.159	5.0755	-0.040	0.024
4	14.54	24.0	31.4	4.970	6.0893	-0.004	0.025
6	20.17	24.0	31.4	5.854	7.2578	-0.014	0.027
8	27.51	24.0	31.4	6.837	8.5089	0.013	0.029
10	36.04	24.0	31.5	7.825	9.7884	0.023	0.032
12	45.70	23.9	31.5	8.811	11.0937	0.011	0.035
13-last	56.35	23.9	31.4	9.784	12.3511	0.022	0.038
11	68.48	23.9	31.4	10.786	13.6543	0.028	0.041
9	83.29	24.0	31.5	11.897	15.1322	0.008	0.045
7	97.46	24.0	31.4	12.870	16.4059	0.008	0.048
5	113.23	24.0	31.4	13.873	17.7828	-0.042	0.052
3	130.05	24.0	31.4	14.868	19.0183	0.008	0.055
1-first	148.02	23.9	31.4	15.861	20.3573	-0.022	0.058





AC-1746

SOH Wind Engineering LLC

141 Leroy Road · Williston, VT 05495 · USA

Tel 802.316.4368 · Fax 802.735.9106 · www.sohwind.com

NG

NRG #15

CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

May 25 2016

Certificate number: 16.US2.04724 **Date of issue:** April 26, 2016

Type: RNRG 40C Anemometer **Serial number:** 179500266979

Manufacturer: Renewable NRG Systems Inc, 110 Riggs Road, Hinesburg, VT 05461, USA

Client: Renewable NRG Systems Inc, 110 Riggs Road, Hinesburg, VT 05461, USA

Anemometer received: April 19, 2016 **Anemometer calibrated:** 23:14 April 26, 2016

Calibrated by: laj **Procedure:** MEASNET, IEC 61400-12-1:2005(E) Annex F

Certificate prepared by: Software Revision 7 **Approved by:** Calibration engineer, rds

Calibration equation obtained: v [m/s] = 0.76262 · f [Hz] + 0.34046

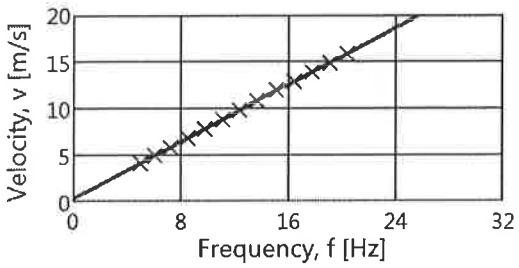
Standard uncertainty, slope: 0.00118 **Standard uncertainty, offset:** 0.03536

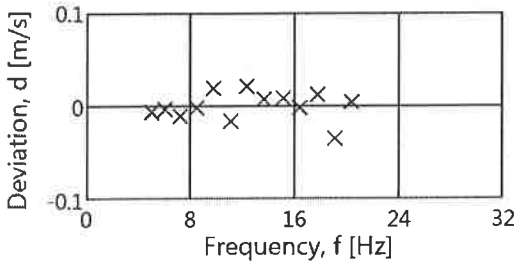
Covariance: -0.0000101 (m/s)²/Hz **Coefficient of correlation:** ρ = 0.999992

Absolute maximum deviation: 0.034 m/s at 14.846 m/s

Barometric pressure: 998.8 hPa **Relative humidity:** 18.9%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	Temperature in d.p. box [°C]	Wind velocity, v. [m/s]	Frequency, f. [Hz]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	10.21	23.0	30.0	4.171	5.0318	-0.006	0.024
4	14.49	23.0	30.1	4.971	6.0762	-0.003	0.025
6	20.04	23.0	30.1	5.846	7.2335	-0.011	0.027
8	27.32	23.0	30.1	6.826	8.5063	-0.002	0.029
10	35.83	23.0	30.1	7.818	9.7793	0.019	0.032
12	45.37	23.0	30.1	8.798	11.1099	-0.015	0.035
13-last	56.12	23.0	30.1	9.784	12.3556	0.021	0.038
11	68.10	23.0	30.1	10.778	13.6770	0.007	0.041
9	83.02	23.0	30.1	11.901	15.1479	0.008	0.045
7	96.91	23.0	30.1	12.858	16.4159	-0.002	0.048
5	112.99	23.0	30.1	13.884	17.7421	0.013	0.052
3	129.20	23.0	30.0	14.846	19.0655	-0.034	0.055
1-first	147.61	22.9	30.0	15.867	20.3533	0.005	0.058





AC-1746

CERTIFICATE of CALIBRATION

Make :	Svantek	Reference # :	142676
Model :	SVAN977	Customer :	HGC Engineering Mississauga, ON
Descr. :	Sound Level Meter Type 1		
Serial # :	36426	P. Order :	Sean Richardson
Asset # :	SV977-2		

Cal. status : Received in spec's, no adjustment made.

24 FEB 2016

Navair Technologies certifies that the above listed instrument was calibrated on date noted and was released from this laboratory performing in accordance with the specifications set forth by the manufacturer.

Unless otherwise noted in the calibration report a 4:1 accuracy ratio was maintained for this calibration.

Our calibration system complies with the requirements of ISO-17025 standard, working standards used for calibration are certified by or traceable to the National Research Council of Canada or the National Institute of Standards and Technology.

Calibrated : Feb 18, 2016 By : T. Beilin

Cal. Due : Feb 18, 2017

Temperature : 23 °C ± 2 °C Relative Humidity : 30% to 70%

Standards used : J-216 J-303 J-512

Navair Technologies

REPAIR AND CALIBRATION TRACEABLE TO NRC AND NIST

6375 Dixie Rd. Mississauga, ON, L5T 2E7
Phone : 905 565 1584 Fax: 905 565 8325
http: // www.navair.com
e-Mail: navair @ navair.com

CERTIFICATE of CALIBRATION

Make : Svantek

Model : SVAN977

Descr. : Sound Level Meter Type 1

Serial # : 36439

Asset # : SV977-4

Reference # : 142679

Customer : HGC Engineering
Mississauga, ON

P. Order : Sean Richardson

Cal. status : Received in spec's, no adjustment made.

24 FEB 2016

Navair Technologies certifies that the above listed instrument was calibrated on date noted and was released from this laboratory performing in accordance with the specifications set forth by the manufacturer.

Unless otherwise noted in the calibration report a 4:1 accuracy ratio was maintained for this calibration.

Our calibration system complies with the requirements of ISO-17025 standard, working standards used for calibration are certified by or traceable to the National Research Council of Canada or the National Institute of Standards and Technology.

Calibrated : Feb 18, 2016

Cal. Due : Feb 18, 2017

By : T. Beilin

Temperature : 23 °C ± 2 °C Relative Humidity : 30% to 70%

Standards used : J-216 J-303 J-512

Navair Technologies

REPAIR AND CALIBRATION TRACEABLE TO NRC AND NIST

6375 Dixie Rd. Mississauga, ON, L5T 2E7
Phone : 905 565 1584 Fax: 905 565 8325
http: // www.navair.com
e-Mail: navair @ navair.com

CERTIFICATE of CALIBRATION

Make : Svantek

Model : SVAN977

Descr. : Sound Level Meter Type 1

Serial # : 36816

Asset # : SV977-5

Reference # : 142683

Customer : HGC Engineering
Mississauga, ON

P. Order : Sean Richardson

Cal. status : Received in spec's, no adjustment made.

24 FEB 2016

Navair Technologies certifies that the above listed instrument was calibrated on date noted and was released from this laboratory performing in accordance with the specifications set forth by the manufacturer.

Unless otherwise noted in the calibration report a 4:1 accuracy ratio was maintained for this calibration.

Our calibration system complies with the requirements of ISO-17025 standard, working standards used for calibration are certified by or traceable to the National Research Council of Canada or the National Institute of Standards and Technology.

Calibrated : Feb 18, 2016

Cal. Due : Feb 18, 2017

By : T. Beilin

Temperature : 23 °C ± 2 °C Relative Humidity : 30% to 70%

Standards used : J-216 J-303 J-512

Navair Technologies

REPAIR AND CALIBRATION TRACEABLE TO NRC AND NIST

6375 Dixie Rd. Mississauga, ON, L5T 2E7
Phone : 905 565 1584 Fax: 905 565 8325
http: // www.navair.com
e-Mail: navair @ navair.com

CERTIFICATE of CALIBRATION

Make : Svantek

Model : SVAN977

Descr. : Sound Level Meter Type 1

Serial # : 36827

Asset # : SV977-6

Reference # : 142682

Customer : HGC Engineering
Mississauga, ON

P. Order : Sean Richardson

Cal. status : Received in spec's, no adjustment made.

24 FEB 2016

Navair Technologies certifies that the above listed instrument was calibrated on date noted and was released from this laboratory performing in accordance with the specifications set forth by the manufacturer.

Unless otherwise noted in the calibration report a 4:1 accuracy ratio was maintained for this calibration.

Our calibration system complies with the requirements of ISO-17025 standard, working standards used for calibration are certified by or traceable to the National Research Council of Canada or the National Institute of Standards and Technology.

Calibrated : Feb 18, 2016

By : T. Beilin

Cal. Due : Feb 18, 2017

Temperature : 23 °C ± 2 °C Relative Humidity : 30% to 70%

Standards used : J-216 J-303 J-512

Navair Technologies

REPAIR AND CALIBRATION TRACEABLE TO NRC AND NIST

6375 Dixie Rd. Mississauga, ON, L5T 2E7
Phone : 905 565 1584 Fax: 905 565 8325
http: // www.navair.com
e-Mail: navair @ navair.com

CERTIFICATE of CALIBRATION

Make : Svantek

Model : SVAN977

Descr. : Sound Level Meter Type 1

Serial # : 45419

Asset # : SV977-7

Reference # : 142681

Customer : HGC Engineering
Mississauga, ON

P. Order : Sean Richardson

Cal. status : Received in spec's, no adjustment made.

24 FEB 2016

Navair Technologies certifies that the above listed instrument was calibrated on date noted and was released from this laboratory performing in accordance with the specifications set forth by the manufacturer.

Unless otherwise noted in the calibration report a 4:1 accuracy ratio was maintained for this calibration.

Our calibration system complies with the requirements of ISO-17025 standard, working standards used for calibration are certified by or traceable to the National Research Council of Canada or the National Institute of Standards and Technology.

Calibrated : Feb 18, 2016

Cal. Due : Feb 18, 2017

By : T. Beilin

Temperature : 23 °C ± 2 °C Relative Humidity : 30% to 70%

Standards used : J-216 J-303 J-512

Navair Technologies

REPAIR AND CALIBRATION TRACEABLE TO NRC AND NIST

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e-Mail: navair @ navair.com

APPENDIX D:

STATEMENT OF OPERATION

Date: March 10, 2017

Re: Statement of Operation
Grand Bend Wind Farm
Grand Bend, Ontario

To whom it may concern,

This letter is to confirm that the wind turbine generators at Grand Bend Wind Farm were functioning in their standard operational mode during the post-construction acoustic audit, conducted between October 25, 2016 and February 1, 2017.

Yours Truly,

Ben Becking
Site Supervisor
Grand Bend Wind LP