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ASSESSMENT REPORT - **Project: 17283.04**

North Kent Wind 1 LP
NAAP Verification Acoustic Immission Audit
R3408

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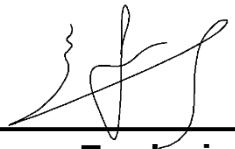

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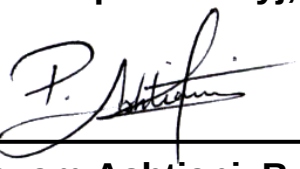

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Revision History

Version	Description	Author	Reviewed	Date
-	Initial Report	DSF	CB	December 2, 2020
1	Correction to Table 2 Correction to Appendix F – Calibration Certificates.	DSF	CB	January 15, 2021

Important Notice and Disclaimer

Executive Summary

Aercoustics Engineering Limited (Aercoustics) has been retained by North Kent Wind 1 LP to complete acoustic immission audit (I-audit) measurements at the North Kent 1 Wind Power Project (NKWPP). NKWPP operates under Renewable Energy Approval (REA) #5272-A9FHRL, issued on June 29, 2016 [1].

A Noise Abatement Action Plan (NAAP) was implemented at NKWPP to address the non-compliant cumulative sound impact calculated at receptor R3408 during Phase 2 of the prior I-audit campaign [2].

In order to verify that the NAAP is effective, the Ministry of the Environment, Conservation and Parks (MECP) has requested an I-audit be completed. This report summarises the results of I-audit testing completed at receptor R3408.

The monitoring near receptor R3408 spanned the following dates:

Location	Monitoring Start Date	Monitoring End Date	Monitoring Duration (weeks)
R3408	September 17, 2020	November 5, 2020	6.9

The audit has been completed as per the methodology outlined in Parts D and E5.5 RAM-I (Revised Assessment Methodology) of the "*MECP Compliance Protocol for Wind Turbine Noise*" (Updated: April 21, 2017) [3].

Based on the results presented in Section 10.2 of this report, the cumulative sound impact calculated at R3408 complies with the MECP sound level limits at all wind bins having sufficient data for assessment.

1 Introduction

Aercoustics Engineering Limited (Aercoustics) has been retained by North Kent Wind 1 LP to complete acoustic immission audit (I-audit) measurements at the North Kent 1 Wind Power Project (NKWPP), as requested by the Ministry of the Environment, Conservation and Parks (MECP). NKWPP operates under Renewable Energy Approval (REA) #5272-A9FHRL, issued on June 29, 2016 [1].

A Noise Abatement Action Plan (NAAP) was implemented at NKWPP to address the non-compliant cumulative sound impact calculated at receptor R3408 during Phase 2 of the prior I-audit campaign [2]. As requested by the Ministry of the Environment, Conservation and Parks (MECP), one (1) measurement location is required to verify the Noise Abatement Action Plan (NAAP); this report summarises the results of the I-audit testing at Receptor R3408. Measurements were conducted per the Compliance Protocol for Wind Turbine Noise (the Protocol) [3].

2 Facility Description

The North Kent 1 Wind Power Project is located in Chatham-Kent, Ontario. The site is bound by Corktown Line to the north, Pioneer Line to the south, Bear Line Rd to the west, and Centre Side Road to the east.

The NKWPP consists of 34 Siemens SWT-113 wind turbines for power generation, with a total nameplate capacity of 100 MW. Each turbine has a hub height of 99.5 meters, a rotor diameter of 113 meters, and an individual nameplate capacity of either 2.628 MW, 2.772 MW, 2.942 MW, or 3.2 MW. The facility operates 24 hours per day, 7 days per week. A Site Plan of the facility and the surrounding area are provided in Appendix A.1.

As per the NAAP issued on May 11, 2020 [4], turbines T3 and T4 operate on a reduced noise mode with a capacity of 2.628 MW during night-time hours (19:00 to 07:00). During all other hours, T3 and T4 operate on the 2.772 MW operating mode.

There are two wind facilities within 10 kilometres of the NKWPP: East Lake St. Clair Wind (“ELSC”) and Marsh Line Wind Farm (“Marsh Line”). With respect to the monitor location, the nearest ELSC turbine is Turbine T138, 5.2 km to the west of monitor R3408. The nearest Marsh Line turbine is Turbine T5, 8.5 km to the south west of monitor R3214.

3 Audit Receptor Selection

As requested by the MECP, one receptor[1] location was chosen to verify the NAAP: R3408. Noise monitoring equipment was erected near this receptor. This report addresses the measurements conducted at R3408 between September 17, 2020 and November 5, 2020.

During the receptor selection process in the prior campaign, NKWPP consulted with the MECP District and Approvals branches regarding the inclusion of a complaint location in the I-audit. It was agreed upon by the MECP that Receptor R3408 could be included as a receptor location, despite it not fulfilling the specific selection criteria in the REA. The MECP was also consulted regarding the specific location of the monitoring equipment for R3408. Approval regarding this measurement location was confirmed in an email from the MECP on December 6, 2018, which also stipulated that for this location both the Crosswind and Downwind conditions should be included in the final report.

A full summary of the results of the receptor selection process for the prior I-audit campaign is included in Appendix B, with some pertinent information included in Section 3.1. Details regarding the land access permission activities for this project are available upon request.

3.1 Receptor Selection Criteria

Receptor selection criteria are outlined in REA Section E1 and paraphrased below. “Predicted noise impact” refers to the predicted cumulative impact using the sound model outlined in the noise assessment report [5][2], updated to only include the turbines that were constructed. “Primary Turbine” refers to the turbine having the highest predicted impact at a given receptor location. “Downwind” refers to the direction from monitor to primary turbine being within +/-45° of the direction of the prevailing winds.

E1(3): *- Selected receptors should have the highest possible predicted noise impacts*
- Selected receptors should be in the direction of the prevailing winds

The prevailing wind direction used for receptor selection was determined using historical weather data for the site. This data was filtered to isolate for the conditions during which the facility would generate over 85% power, to match the conditions required to fulfill the filtering requirements of the Protocol. A wind rose showing the historical wind direction at the site is included Figure 1. The predominant wind direction is southwest, specifically 235°.

[1] In this report, the term “receptor” refers to the Points of Reception outlined in Section E.1(2) of the REA. The term “monitor” refers to the location of the measurement equipment used to assess the worst-case impact at the associated receptor.
[2] It is noted that the noise assessment report in [5] included 45 turbines, but only 34 turbines were constructed. As such, the receptor selections for the I-audit measurements in this report were conducted using the predicted sound impact of 34 turbines (as-built), modelled by DNV-GL.

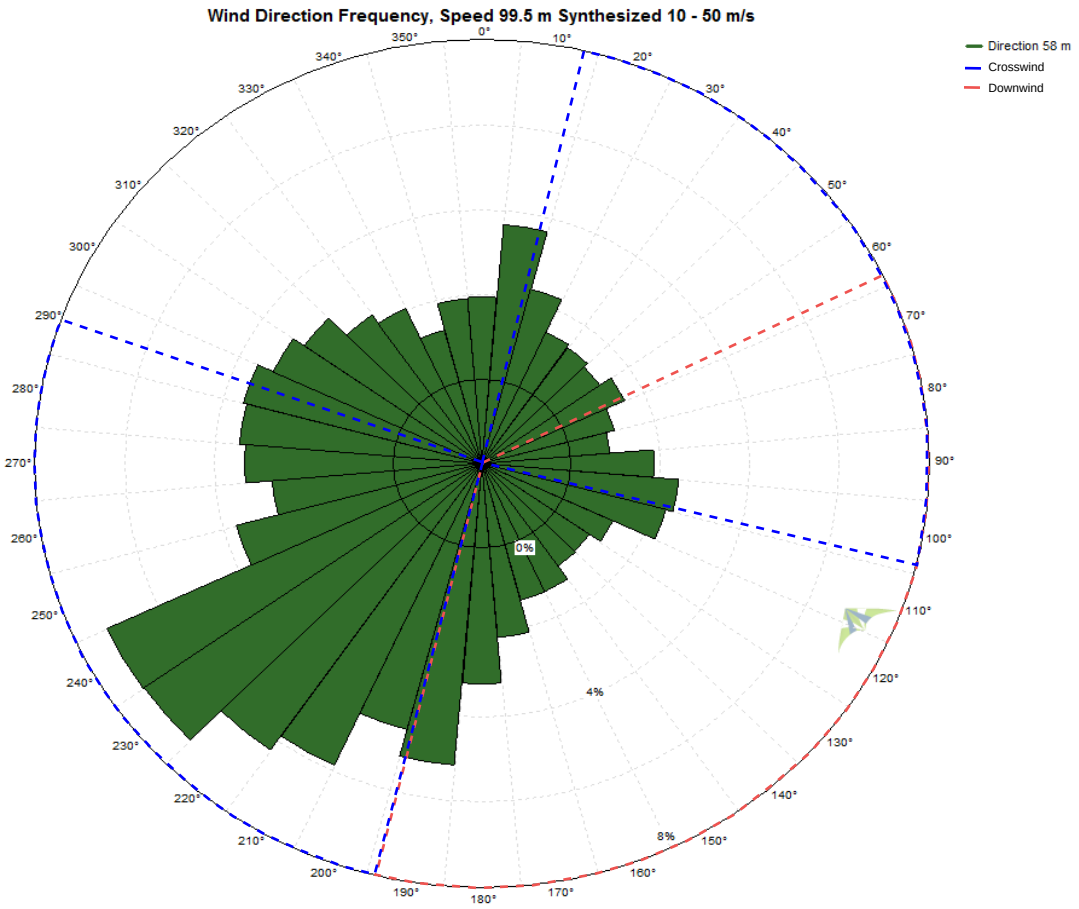

Figure 1: Historical Wind Roses for NKWPP, filtered for hub-height wind speeds above 10 m/s

4 Audit Measurement Locations

The following section describes the measurement location used for R3408 and provides context to the ambient acoustic environment observed at the NKWPP.

4.1 Existing Ambient Environment

The ambient acoustical environment measured at R3408 was observed to be dominated by wind-related and animal noise. These factors are described below.

4.1.1 Wind-Related Ambient Noise

Wind-related noise is comprised of two sources: self-noise and foliage noise. Self-noise results from wind blowing over objects associated with the monitoring equipment and is similar to what one might observe when wind blows over the ear on a windy day. Self-noise is present in all monitoring campaigns at high wind speeds. Conversely, foliage noise depends on the vegetation in the area surrounding the monitor. Measures to reduce the impact of wind-related noise were employed at the monitor location, as prescribed in the Protocol; a secondary wind screen was installed to reduce self-noise, and the monitoring equipment was located away from trees as much as practically possible.

Monitor R3408 was situated within soy crops and approximately 60 meters from a row of large trees. The soy was harvested during the monitoring campaign. This crop was not observed to affect the measured sound levels significantly.

Despite the presence of nearby foliage, the influence of foliage noise on the measured sound levels was observed to be relatively minimal at lower wind speeds when compared to monitors more closely situated to crops or tall trees. Measurement data at higher wind speeds is expected to be impacted by both foliage noise as well as wind self-noise.

4.1.2 Traffic Noise

Greenvalley Line, located 20 meters southeast of R3408, was not observed to be a significant ambient noise source at this location, both through observations during site visits and listening analysis of the measured data. The effect of any residual traffic noise in this dataset is expected to be minimal.

4.1.3 Noise from Local Fauna

Noise from fauna refers to noise typically arising from the activity of insects, birds, livestock, or dogs. Noise of this nature may be concentrated at high frequencies (such as crickets chirping) or limited to short-term events (such as dogs barking). Noise from fauna is considered extraneous noise.

Animal activity contributed significantly to the ambient noise in the area around receptor R3408, specifically insect noise and dogs. Dog barking is characterized by elevated sound pressure levels in the 400 to 1250 Hz range. Cricket noise was especially prominent throughout the campaign.

Instances of transient noise from fauna were filtered out either manually by listening analysis or automatically by the transient (LAeq - L90) filter, described in Section 6.1. Periods of steady, high-frequency extraneous noise from fauna, such as insect noise, were filtered out by excluding high-frequency 1/3rd-octave data, as described in Section 6.5.

4.2 Monitoring Location

Table 1 provides specific details of the receptor and monitoring equipment locations. The immediate surroundings of the monitor location are also described below. Photos of the surrounding area and measurement setup are included in Appendix A.3 and A.4.

Table 1: Receptor and Monitor Locations

Audit Receptor	Measurement Duration	Location	UTM Coordinates [m] (Zone 17T)	Distance to Primary Turbine [m]	Predicted Level (dBA)†
R3408	*September 17, 2020 – November 5, 2020*	*Receptor*	394,394 E 4,709,342 N	713	35.7
		Monitor	394,493 E 4,709,376 N	683	36.0

† Predicted sound pressure level determined using an as-built sound model created by DNV-GL

The closest turbine to Receptor R3408 is Turbine T3. Monitor R3408 was located roughly 20 meters from Greenvalley Line on the same side of the road as Receptor R3408 and 683 meters to the northwest of Turbine T3. The ground cover between the measurement location and Turbine T3 was predominantly fields of soy which was harvested during the measurement campaign. The monitoring equipment was situated approximately 100 meters east of Receptor R3408. The noise monitor was located sufficiently far from the foliage present at Receptor R3408 as to minimize its impact on the ambient sound levels at the monitor location, however, data measured at higher windspeeds is still expected to be impacted by this foliage noise in addition to wind self-noise.

5 Measurement Methodology

The acoustic audit was conducted at receptor R3408 and spanned from September 17, 2020 to November 5, 2020.

Measurements and data analyses were conducted per the Protocol. Specific details regarding the methodology are presented in this section.

5.1 Test Equipment

Measurement equipment used for the I-audit campaign, both acoustic and non-acoustic, is detailed below. Equipment specifications and measurement positions comply with MECP Protocol sections *D2 – Instrumentation* and *D3 – Measurement Procedure*, respectively. Each remote monitoring unit is comprised of the following:

- One (1) Type 1 sound level meter, with microphone and pre-amplifier installed at a height of 3 meters (1.5 m higher than the receptor height modelled for R3408 for Approval purposes[3]), at least 5 meters from any large reflecting surfaces.
- One (1) primary and one (1) secondary windscreen for the microphone. The 1/3-octave band insertion loss of the secondary windscreen has been tested and was accounted for in the measurement analysis.
- One (1) anemometer, installed 10 metres above ground level (10-m AG").

Table 2 lists the specific model and serial numbers for the equipment used during the measurement campaign.

Table 2: Equipment Details

Monitor	Equipment	Make/Model	Serial Number
R3408	Data Acquisition Card	NI 9234	1B3CDE4
	Signal Conditioner	480E09	33659
	Microphone/ Pre-Amplifier Pair	378B02	122654
	Microphone	377B02	155181
	Pre-Amplifier	426E01	040835
	Weather Anemometer	WXT 536	M2130088

Equipment lab calibration follows the guidance provided in Section D2.3 of the Protocol for sound level meters and acoustic calibrators, and Section 6.3 of the IEC 61400-11 Edition 3.0 standard for weather anemometers.

The measurement chain was field calibrated before and after the measurement campaign using a type 4231 Brüel & Kjær acoustic calibrator. Calibration certificates have been included in Appendix F.

5.2 **Measurement Parameters**

During the measurement campaign, acoustic and weather data were logged simultaneously in one-minute intervals.

Measured acoustic data includes A-weighted overall equivalent sound levels (LA_{eq}), 90th percentile statistical levels (L_{90})[4], and 1/3-octave band levels between 20 Hz and 10,000 Hz (inclusive). Raw signal recordings were also stored for listening and post-

[3] The increased measurement height represents a conservative assessment based on the higher predicted sound pressure level and reduced impact of wind-generated foliage noise from crops situated directly below the measurement position.
[4] L_{90} refers to the sound level that is exceeded for 90% of samples in the measurement interval.

processing. Measured weather data includes average wind direction, wind speed, temperature, relative humidity, and atmospheric pressure. The maximum and minimum wind speed for each one-minute interval was also stored.

To account for the effect of wind speed on the measured sound level, intervals are sorted into integer wind bins based on their measured 10-m AGL wind speeds. Each wind bin ranges from 0.5 m/s below to 0.5 m/s above each integer wind speed (i.e. the 5 m/s wind bin comprises all intervals having average wind speeds between 4.5 m/s and 5.5 m/s).

6 Assessment Methodology

6.1 Data Reduction and Filtering

Data reduction procedures have been employed to remove invalid and extraneous data points from the measured dataset to form a refined assessment dataset. Specific filters are described below.

A measurement interval is excluded if any of the following criteria are not satisfied:

- The interval occurred between 10 pm – 5 am
- No precipitation was detected within 60 minutes before or after the interval
- The ambient temperature was above -20˚C
- The measured LA_{eq} was no more than 6 dB greater than the L_{90} value

Significant extraneous transient events are often detectable by comparing the LA_{eq} with the L_{90} level for the same interval. At this location, if the measured L_{90} differed from the LA_{eq} by more than 6 dB, the interval was automatically excluded. If necessary, listening tests are conducted to identify contaminated intervals not excluded by the filters listed above.

6.2 Manual Exclusion of Data

The application of the filtering methodology outlined in the Protocol and summarized throughout Section 6.1 of this report results in a dataset with significantly less acoustic contamination than is present in the unfiltered dataset. Despite this, however, it has been found that these automatic filters are not always sufficient to remove all contaminated data intervals. In situations where contamination is suspected in the assessment dataset, listening tests are conducted on the audio recordings to confirm and, if possible, to identify the contamination. Intervals containing significant contamination are manually excluded from the assessment data. This follows the guidance from the Protocol to assess sound levels without extraneous ambient noise.

Data are also manually excluded if it is suspected that any of the measurement equipment is not functioning according to its specification, which may occur during extreme weather conditions such as freezing rain.

6.3 Exclusion of High-Frequency Data – Ambient Contamination

Steady acoustical contamination from nearby insects, mainly crickets, and wind-related noise is present in the measurement data at R3408 at higher acoustical frequencies. Consequently, this high-frequency contamination was removed from the 1/3-octave spectra of each measurement interval, per the guidance provided in Section D5.3 of the Protocol.

The exclusion of this high-frequency data allows for the assessment of measurement intervals which would otherwise be manually invalidated and does so while accounting for the acoustical impact of the relevant wind turbine facilities. The high frequency acoustical contribution from the relevant wind facilities is small – this is because high frequency sound is more easily absorbed by the atmosphere as it propagates across long distances.

The contribution from NKWPP as well as its neighbours at these excluded frequencies was predicted at the monitoring location using the as-built turbine model and was found to be 26 dBA at the monitor location. This contribution was then added logarithmically to the calculated Turbine-Only sound level at the monitor location.

6.4 Wind Gusting

High levels of wind-related noise have been observed during intervals where the maximum measured 10-m AGL wind speed differed greatly from the average value for the same interval. An automatic filter has been applied to remove intervals of gusting at this monitor.

6.5 Turbine Power & Wind Direction

Intervals that pass the filtering criteria listed above are sorted into Total Noise[5] or Background periods according to the conditions listed below. If neither Total Noise nor Background conditions are met, the data point is excluded.

- **Total Noise:** All facility turbines within 3 km must be rotating and generating power. For receptor R3408 these turbines were:
    - T3, T4, T5, T14, T20, T26, T27, T33, T44, T45, T46, T52.

- **Background:** Facility turbines must be parked and not generating power such that the predicted impact at the measurement location is less than 30 dBA. For receptor R3408 these turbines were:
    - T3, T4.

[5] Total Noise refers to the measured sound level with the turbines running prior to the correction for Background sound (i.e. the total sound level of the turbines plus the ambient).

The Protocol also requires additional criteria be met by each Total Noise data point based on the conditions of the nearest turbine to each monitor location. Specifically,

> "*Only downwind data will be considered in the analysis. With reference to the Turbine location, downwind directions are ±45 degrees from the line of sight between the Turbine and receptor/measurement location*." *{Section D5.2(4)}*

and

> *"Only data when the turbine's electrical output sound power level is approximately equal to or greater than 85% of its rated electrical power output should be included in the analysis. In addition, the turbine should also be operating at approximately 90% or more of its maximum sound power level; (percentage based on energy/logarithmic calculation)." {Section D5.2(5)}*

Based on the E-Audit test results at NKWPP, the project turbines reach 90% of their maximum measured sound power level at a power output significantly below that which corresponds to 85% of the turbine's rated electrical power. Further to this, the power output corresponding to the *maximum* sound power level is also below that which corresponds to 85% of rated electrical power for all three turbine variants at NKWPP. For these reasons, using the 85% turbine power threshold alone will not effectively capture the worst-case impact at NKWPP, which was found to occur at an operating condition which corresponds to a lower power output.

For this reason, the 90% sound power condition has been selected to determine the power threshold corresponding to the worst-case impact from the turbine-type closest to R3408. In this case the closest turbine is T3, with a NAAP rated power of 2.628 MW. Based on the E-audit test conducted at T3 [6], the 90% sound power condition for this turbine type is reached at a power output of 1.253 MW. This is the power threshold that has been used for filtering this dataset. Details regarding the measured sound power levels of the NKWPP turbines and the 90% sound power calculations are included in Appendix G.

Regarding the downwind condition, R3408 was selected as a measurement location because of complaints received by North Kent Wind 1 and the MECP District Office. Based on consultation with the MECP District and Approvals branch, both the downwind and crosswind case has been assessed at this monitor location. This was done for this location because it is situated in a predominantly crosswind location relative to the closest turbines, T3 and T4.

6.6 Turbine Operating Conditions

Wind facility SCADA information was provided for the duration of the measurement campaign by the North Kent 1 Wind Power Project. This data was used to verify that the NKWPP wind turbines were operational for Total Noise intervals and parked for Background intervals. The turbine operating conditions were verified by the NKWPP for the duration of the campaign; see Appendix D.

Despite turbines meeting the operational criteria for Total Noise intervals, the SCADA information provided indicated that the wind farm was curtailed for a large portion of the Total Noise data during the campaign. Based on the measurement data collected, the inclusion of curtailed periods resulted in lower average sound pressure levels compared to normal operating conditions. As a result, curtailed periods as well as the subsequent 5-minute ramp-up period were excluded from the final dataset as they do not capture normal turbine operating conditions and may artificially reduce the calculate noise impact of the wind farm.

6.7 **Aggregate Angle**

Section E5.5(10) of the RAM-I assessment methodology allows for the consideration of more than one turbine when determining the downwind angle, stating:

> *"In unique circumstances, the Ministry will consider not only the individual turbine with the highest predicted impact at the subject receptor, but a group of turbines that represent the greatest contribution at the receptor. Greatest contribution means turbines that have sound pressure levels that are up to two (2) dB lower at the receptor/measurement location than the turbine with the highest predicted impact at the receptor/measurement location. In addition, with reference to the measurement location (vertex), only turbine configuration that are within an angle of 90 degrees can be considered in the assessment."*

Appendix F11 of the Protocol provides further guidance on the application of this assessment methodology.

R3408 is not located in the predominant downwind direction from the closest turbines, and so the collection of sufficient downwind data was hindered by limited downwind (easterly) conditions over the course of the measurement campaign. For this reason, the aggregate angle analysis option was exercised at this location. Specifically, both turbine T3 and T4 were used for the purposes of downwind direction filtering. The position of the closest turbine, Turbine T3, was used for the purposes of crosswind direction filtering, as is standard practice.

6.8 **Sample Size Requirements**

Section D3.8 of the Protocol requires at least 120 Total Noise intervals and 60 Background intervals in a wind bin for that bin to be deemed complete.

RAM-I analysis, described in Section E5.5 of the Protocol, is employed in cases where insufficient data is collected after an extended monitoring campaign lasting 6-weeks or more. The NKWPP NAAP verification campaign lasted longer than 6-weeks at all monitors and therefore RAM-I analysis was applied. The RAM-I methodologies used in this assessment, in addition to those already mentioned are detailed below. Further details regarding the data analysis methodology are provided in Section 9.

Section E5.5(1)

The range of wind bins which may be used to assess compliance is expanded to include a minimum of one of the following conditions:

a. *"three (3) of the wind speed bins between 1 and 7 m/s (inclusive), or*
b. *two (2) of the wind speed bins between 1 and 4 m/s (inclusive)"*

Section E5.5(5)

The RAM-I assessment methodology relaxes the sample size requirements, stating:

> "*The Ministry may accept a reduced number of data points for each wind speed bin with appropriate justification. […] The acceptable number of data points will be influenced by the quality of the data (standard deviation)"*

The threshold of 60 data points for Total Noise measurements and 30 data points for Background measurements is used in this assessment.

6.9 Contribution from Adjacent Wind Facilities

The nearest wind facility to NKWPP is East Lake St. Clair Wind. The closest ELSC turbine to a monitoring location is Turbine T138, 5.2 km to the west of monitor R3408. At this distance, sound impact from ELSC is considered to be negligible and thus no contributions from adjacent wind facilities were considered in this study.

7 Sound Level Limits

Sound level limits are set by the MECP and vary based on the classification of the surrounding acoustic environment as well as the measured background sound level (if available). The area surrounding the facility has been deemed in the original Noise Assessment Report to be Class III, having exclusion limits based on 10-m AGL wind speed as noted in Table 3 below.

Table 3: MECP Sound Level Limits for Wind Turbines

Wind speed at 10m height [m/s]	MECP Sound level limit [dBA]
≤ 6	40
7	43

Sections D3.5 and D6 of the Protocol state that in wind bins where the measured background sound levels are greater than the applicable exclusion limits, the sound level limit for that wind bin is the background sound level without extraneous noise sources. In effect, the exclusion limits outline the minimum sound level limit by wind bin, with increases in sound level limit permissible if it can be shown through measurements that the existing background sound level is higher than the exclusion limit. Any complete wind bins where the measured background sound level exceeded the exclusion limit are noted in Table 5 and Table 6.

8 Audit Results

Acoustic and weather data measured during the I-audit campaign are summarized in the following section.

8.1 Weather Conditions

General weather conditions observed in the assessment dataset during the NAAP verification I-audit are summarized in Table 4.

Table 4: General Weather Conditions – Range of Measured Values

		10-m AGL				*Hub height*
		Atmospheric Pressure [hPa]	Wind Speed [m/s]	Relative Humidity [%]	Temperature [°C]	Wind speed [m/s]
R3408	Minimum	980	0	40.0	-1.1	0
	Maximum	1010	15.1	93.9	20.9	21.0

8.2 Wind Direction

A wind rose was created for R3408 using the yaw angle from the nearest wind turbines and the wind speeds from the 10-m AGL anemometer. As noted in Section 6.8 of this report, RAM-I methodology is being used, and thus all 10-m AGL wind speeds from 1 m/s to 7 m/s can be used in the assessment.

The wind rose is provided in Figure 2. The distribution of wind directions observed during the measurement campaign roughly agrees with the historical wind rose (see Section 3.1), especially considering that the historical wind rose in Figure 1 is based on hub-height wind speeds, and is filtered for 10 m/s and greater. It is worth noting that the winds from the west appear to be diminished at this location. It is suspected that this is due to localized shielding from the trees located on the R3408 property. Supplementary wind roses for the specific valid Total Noise and Background datasets are included in Appendix E.

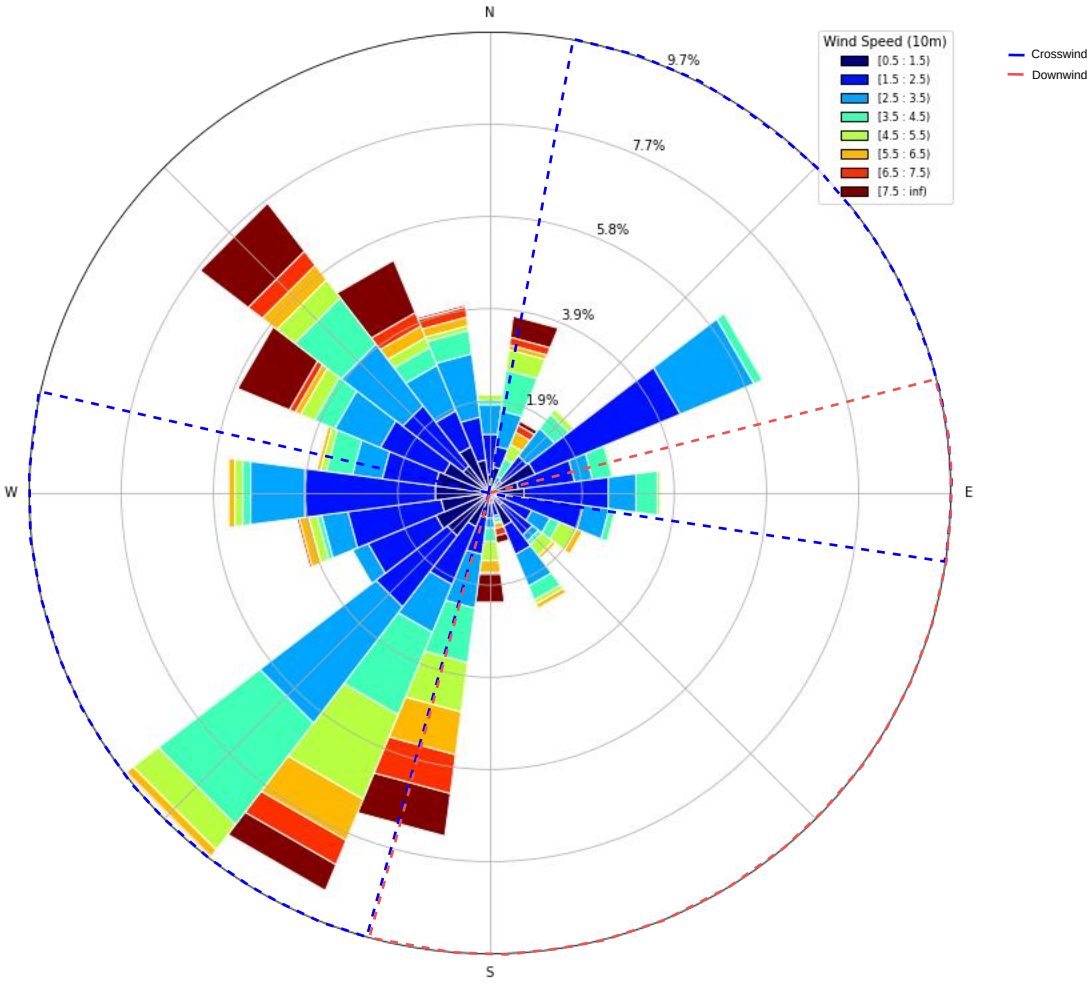

Figure 2: Measured wind rose for R3408 for the NAAP verification I-audit campaign[6]

8.3 **Sound Levels**

R3408 was originally selected as a measurement location because of complaints received by North Kent Wind 1 and the MECP District Office. Based on consultation with the MECP District and Approvals branch, both the downwind and crosswind cases have been

[6] The Wind Rose in this figure reflects all measured data across the entirety of the measurement campaign at R3408, as detailed in Table 1. The turbine from which the yaw angle information was taken is T3.

assessed at this monitor location. This was done for this location because it is situated in a predominantly crosswind location relative to the closest turbines, T3 and T4.

8.3.1 Downwind Sound Levels

Table 5 presents the average downwind measured sound levels at monitor R3408. Results are separated by wind bin into Total Noise and Background periods.

Table 5: Average Downwind Measured Sound Levels at R3408, RAM-I Analysis

Receptor	Period	Measurement Parameter	I-audit Wind Bins (m/s) 1	2	3	4	5	6	7
R3408	*Total Noise*	Number of Samples	10	105	149	88	40	17	4
		Average LAeq [dBA]	-	39.0	39.7	39.1	-	-	-
		Standard Deviation [dB]	-	0.7	2.1	1.6	-	-	-
	Background	Number of Samples	105	56	31	7	0	0	0
		Average LAeq [dBA]	30.8	28.6	27.8	-	-	-	-
		Standard Deviation [dB]	4.3	2.5	1.4	-	-	-	-

- Significantly fewer than the minimum data counts outlined in Section 6.8 were attained in this wind bin.

A visualization of the downwind assessment datasets for R3408 is presented in Figure 3 below.

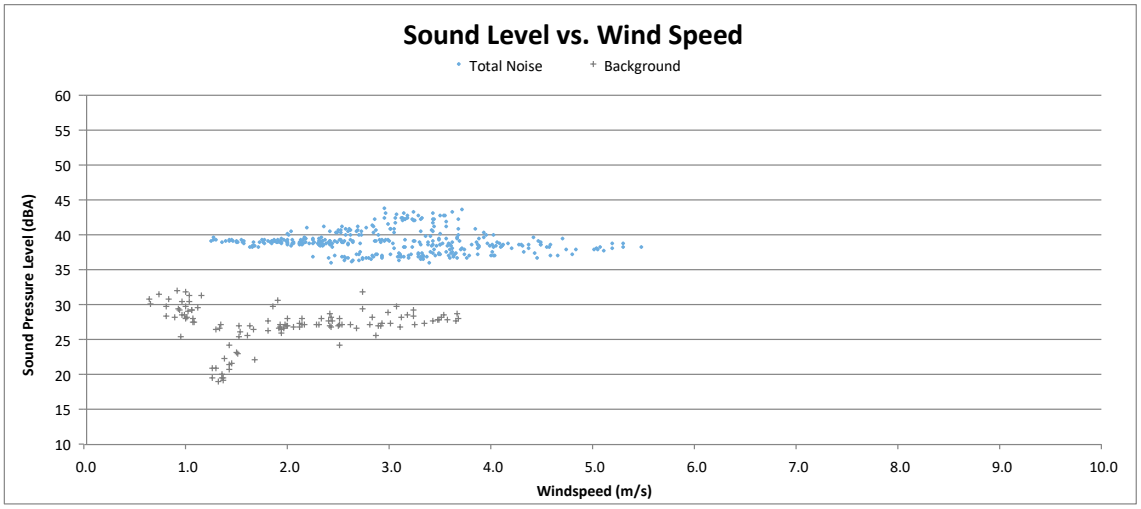

Figure 3: R3408 - Measured Downwind Sound Levels for Turbine ON and Background vs Wind Speed

8.3.2 Crosswind Sound Levels

Table 6 presents the average crosswind measured sound levels at monitor R3408. Results are separated by wind bin into Total Noise and Background periods.

Table 6: Average Crosswind Measured Sound Levels at R3408, RAM-I Analysis

Receptor	Period	Measurement Parameter	I-audit Wind Bins (m/s) 1	2	3	4	5	6	7
R3408	*Total Noise*	Number of Samples	10	110	73	47	39	7	6
		Average LAeq [dBA]	-	38.6	38.2	-	-	-	-
		Standard Deviation [dB]	-	0.7	1.1	-	-	-	-
	Background	Number of Samples	105	56	31	7	0	0	0
		Average LAeq [dBA]	30.8	28.6	27.8	-	-	-	-
		Standard Deviation [dB]	4.3	2.5	1.4	-	-	-	-

- Significantly fewer than the minimum data counts outlined in Section 6.6 were attained in this wind bin.

A visualization of the crosswind assessment datasets for R3408 is presented in Figure 4 below.

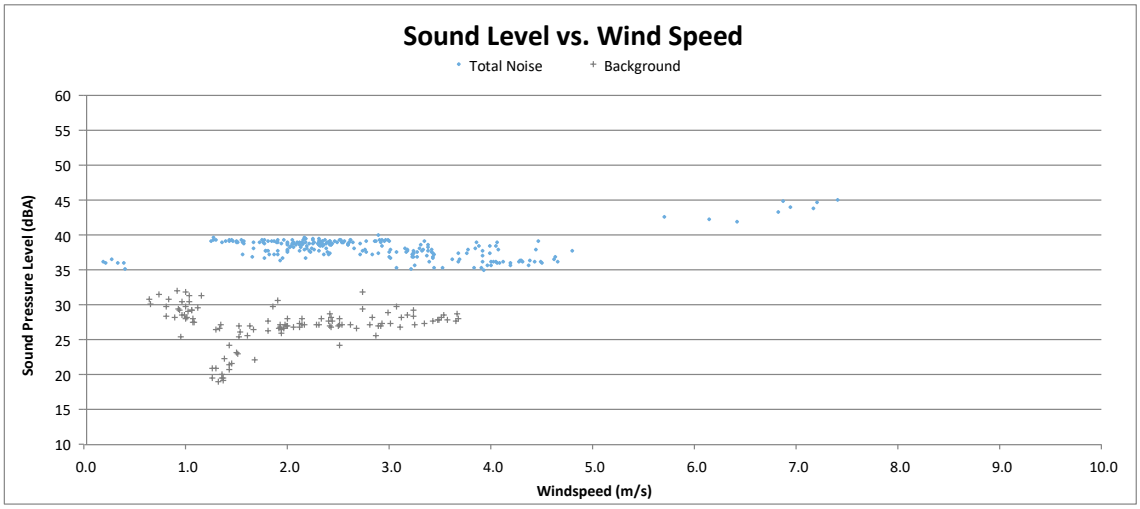

Figure 4: R3408 - Measured Crosswind Sound Levels for Turbine ON and Background vs Wind Speed

9 Discussion

Interpretation and discussion of the measured sound levels are provided in this section.

9.1 Effect of Filtering

The measurement data was assessed according to Part D of the Protocol with the incorporation of the RAM-I data reduction methodology per Section E5.5 of the Protocol. The effect of each filter on the measurement datasets, as well as the total portion of measurement data excluded from the assessment data, are summarized in Table 7.

Table 7: Effect of Data Filtering on Measurement Dataset

Data Filter	*% Data Excluded*	
	Downwind	Crosswind
Turbine Power Threshold	90%	90%
Wind Direction	79%	42%
Rain	6%	6%
Temperature	0%	0%
Wind Gust	0%	0%
Transient Contamination	15%	15%
Curtailment	47%	47%
Excluded from Total Noise	94%	96%

Table 7 illustrates the proportion of measurement time during the campaign that did not meet the criteria for worst-case noise impact at each receptor. Data not excluded by automatic or manual filters are used in the assessment of compliance. It is important to note that the data remaining after these filters are applied represents the times when the turbines were generating high power output in a downwind or crosswind condition without significant transient contamination or inclement environmental conditions (such as rain or low temperature). In other words, this remaining data represents the portion of time that the immission impact from the facility is at its highest for the given monitor location.

9.2 Variability in Total Noise

As evident from Figure 3 for downwind conditions, there is around 5 dB variation of measured Total Noise levels at wind speeds of 2 m/s to 4 m/s. The standard deviation for the 3 m/s case was computed at 2.1 dB (see Table 5). This level of variation is more than anticipated for this wind speed and may be an indication of inconsistent noise emission from the wind farm. While the average Total Noise level in the bin was still found to be compliant with the Sound Level Limit, the scatter in the data prompted further investigation. It was determined that most elevated sound levels within the scatter occurred during a single night. At this time the cause of this variation is unclear.

10 Assessment of Compliance

The following section presents an assessment of compliance for the NKWPP based on the results of the immission audit.

10.1 Tonality Assessment

The tonality analysis results of the Emission audit measurements for T3 [6] and T4 [7] were used as a basis for tones at receptors which were likely to have been generated by the closest turbine rather than an external source.

Based on discussions with North Kent Wind 1 LP. it was determined that to be consistent with Sections 3.8.3 and Section 5.1 of the Compliance protocol, the tonal assessment should be completed using IEC 61400-11 Ed. 3.0, with modifications to adapt the method to immission measurements and the tonal penalty structure taken from ISO 1996-2:2007 Annex C. Namely, Section 5.1 of the compliance protocol states:

> *"If a tonal assessment … indicates a tonal audibility value that exceeds 4 dB, the Ministry will require that a tonal penalty be applied at all Receptors in accordance with the penalties described in Annex C of ISO 1996-2, Reference" {Section D5.1}*

For the tonal assessment, narrowband data was acquired and calculated for each 1-minute interval used in the immission analysis and binned by wind speed. Each minute was analysed in order to detect any tones with tonal audibility values greater than -3 dB at any of the assessed frequencies. Similar to the methodology in IEC 61400-11, a tone would have to be present in at least 20% of the valid measurement intervals to be classified as relevant. This reduces the possibility of intermittent tones related to either the unsteady operation of the turbines, or from other contaminating sources, being attributed to the steady state operation of the turbines. The tonal audibility (L_{ta}) for the most prominent tones in each wind bin were then evaluated to determine if a tonal penalty would be applicable. The penalty structure was taken from ISO1996-2 Annex C: namely that the tonal penalty would be a positive number between 0 dB and 6 dB based on the degree of tonal audibility of the worst-case tone. A tonal penalty is calculated as L_{ta} - 4 dB. i.e. a tonal audibility of 6.5 would incur a penalty of 2.5 dBA on the overall Turbine Only level.

68 Hz and 130 Hz tones were observed at receptor R3408 but were not prevalent nor prominent enough for a tonal penalty to be applicable. A tonal assessment summary table is provided in Appendix E.

No tonal penalty was found to be applicable at R3408 based on detailed tonal audibility analysis.

10.2 Assessment Tables

Cumulative Turbine-Only sound levels at R3408 are presented in the tables below. The cumulative noise impact in the table is calculated using the data presented in Table 5 and Table 6. Wind bins having insufficient data with which to determine the cumulative sound

impact are marked with a "-". The signal-to-noise for each complete wind bin is also presented. The *Cumulative Sound Impact* is the difference between the average Total Noise and Background sound levels from Table 8 and Table 9 unless otherwise noted.

Table 8: R3408 Assessment Table – Cumulative Downwind Turbine-only Sound Impact

Audited Receptor	Wind speed at 10-m AGL [m/s]	1	2	3	4	5	6	7
R3408	Tonal Adjustment [dB]	0	0	0	0	0	0	0
	Cumulative Sound Impact - Receptor Location [dBA]	-	39	40	39	-	-	-
	Signal-to-noise [dB]	-	*10.5*	*11.9*	*(9.1)*	-	-	-
Background Sound Level [dBA]		31	29	28	(30)	-	-	-
MECP Exclusion Limit [dBA]		40	40	40	40	40	40	43
Compliance? (Y/N)		-	Yes	Yes	Yes*	-	-	-

- Significantly fewer than the minimum data counts outlined in Section 6.8 were attained in this wind bin.
* Per Table 5, Background data counts are significantly deficient from the required count of 30 in the 5 m/s bin. In accordance with Section E5.5(6b) of the Protocol, an assumed background level of 30 dBA has been used in the assessment of compliance in this wind bin.

Table 9: R3408 Assessment Table – Cumulative Crosswind Turbine-only Sound Impact

Audited Receptor	Wind speed at 10-m AGL [m/s]	1	2	3	4	5	6	7
R3408	Tonal Adjustment [dB]	0	0	0	0	0	0	0
	Cumulative Sound Impact - Receptor Location [dBA]	-	38	38	-	-	-	-
	Signal-to-noise [dB]	-	*10.0*	*10.4*	-	-	-	-
Background Sound Level [dBA]		31	29	28	-	-	-	-
MECP Exclusion Limit [dBA]		40	40	40	40	40	40	43
Compliance? (Y/N)		-	Yes	Yes	-	-	-	-

10.3 **Assessment of Compliance**

Based on the results presented in Section 10.2, the cumulative sound impact calculated at R3408 complies with the MECP sound level limits during both Downwind and Crosswind conditions.

11 Conclusion

Aercoustics Engineering Limited has completed acoustic immission audit measurements at the North Kent 1 Wind Power Project, as requested by the Ministry of the Environment, Conservation and Parks. NKWPP operates under Renewable Energy Approval (REA) #5272-A9FHRL, issued on June 29, 2016 [1]. Testing was conducted in accordance with the methodology outlined in Part D and Part E of the MECP Compliance Protocol for Wind Turbine Noise. Based on the results presented in this report, the cumulative sound impact calculated at R3408 complies with the MECP sound level limits during both Downwind and Crosswind conditions.

12 References

[1] M. Keyvani, “Renewable Energy Approval #5272-A9FHRL,” Ontario Ministry of the Environment, Toronto, ON, June 29, 2016.

[2] A. Denison, C. Bosyj and P. Ashtiani, “North Kent Wind 1 LP Phase 2 Acoustic Immission Audit - Part 1 of 5 R3408,” Aercoustics Engineering Ltd., Mississauga, ON, February 28, 2020.

[3] Ministry of the Environment and Climate Change, “Compliance Protocol for Wind Turbine Noise,” Government of Ontario, Toronto, 2017.

[4] A. Nercessian, “Proposed Noise Abatement Action Plan (NAAP) for the North Kent Wind Project,” DNV-GL, Ottawa, ON, May 11, 2020.

[5] S. Dokouzian, A. Nercessian and A. Danaitis, “North Kent 1 Wind Project Renewable Energy Approval Application - Noise Impact Assessment,” DNV-GL, Ottawa, ON, May 9, 2016.

[6] C. Bosyj and P. Ashtiani, “North Kent Wind 1 LP / Turbine T03 IEC 64100-11 Edition 3.0 Measurement Report,” Aercoustics Engineering Ltd., Mississauga, ON, November 27, 2020.

[7] C. Bosyj and P. Ashtiani, “North Kent Wind 1 LP / Turbine T04 IEC 61400-11 Edition 3.0 Measurement Report,” Aercoustics Engineering Ltd., Mississauga, ON, November 27, 2020.

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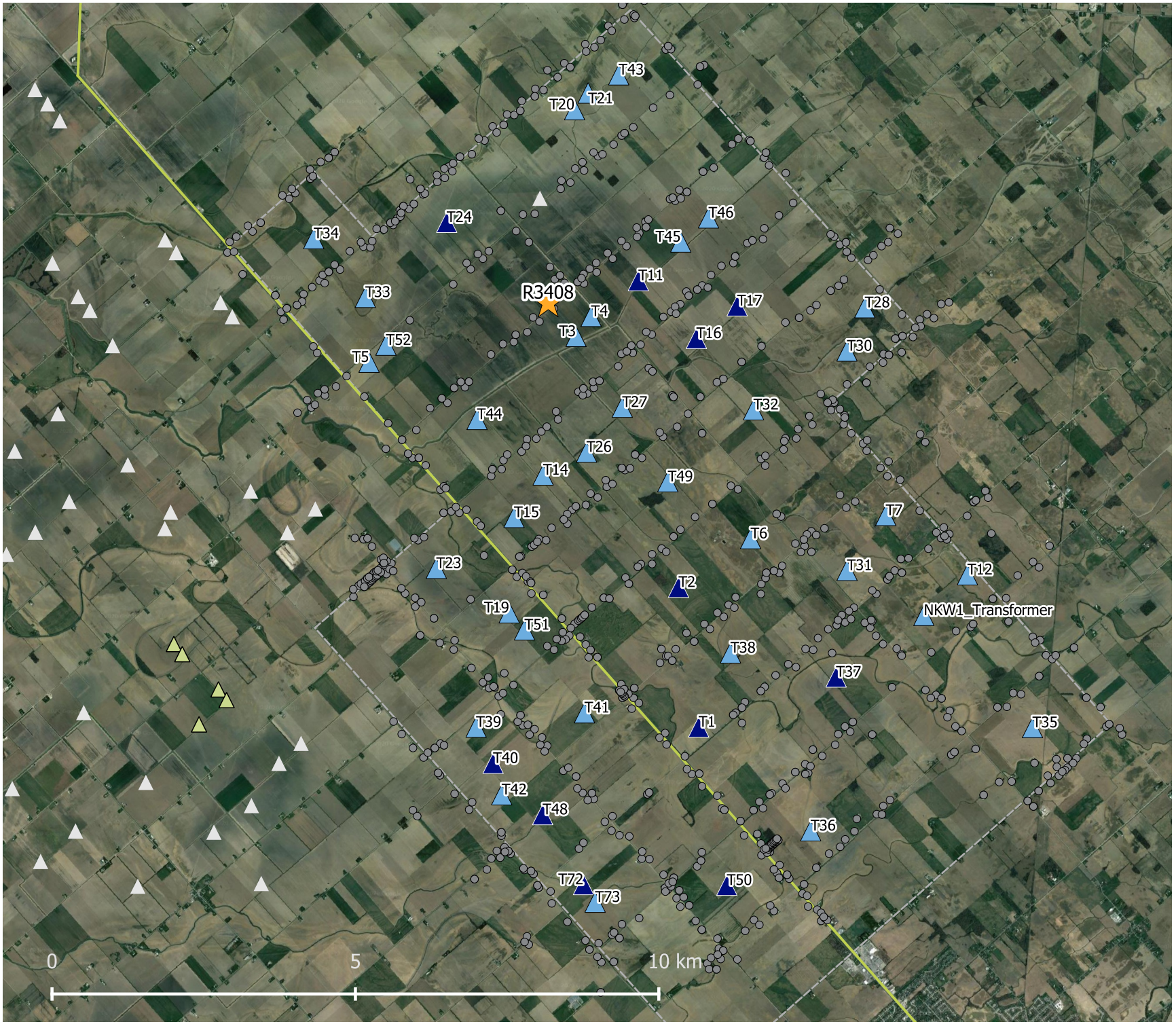
Appendix A
Location Details



Legend

- Campaign Receptor
- Receptor
- St Clair Road
- North Kent Wind Project Boundary

North Kent Turbines

- Turbine - Not Built
- Turbine - Built

Other Turbines

- ELSC Turbines
- ML Turbines

N

Project ID: 17283.04
Drawn by: DSF
Reveiwed by: CB
Date: December 1, 2020
Revision: 1

Scale: As Indicated

North Kent Wind Project
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Appendix A.1

Site Plan Overview

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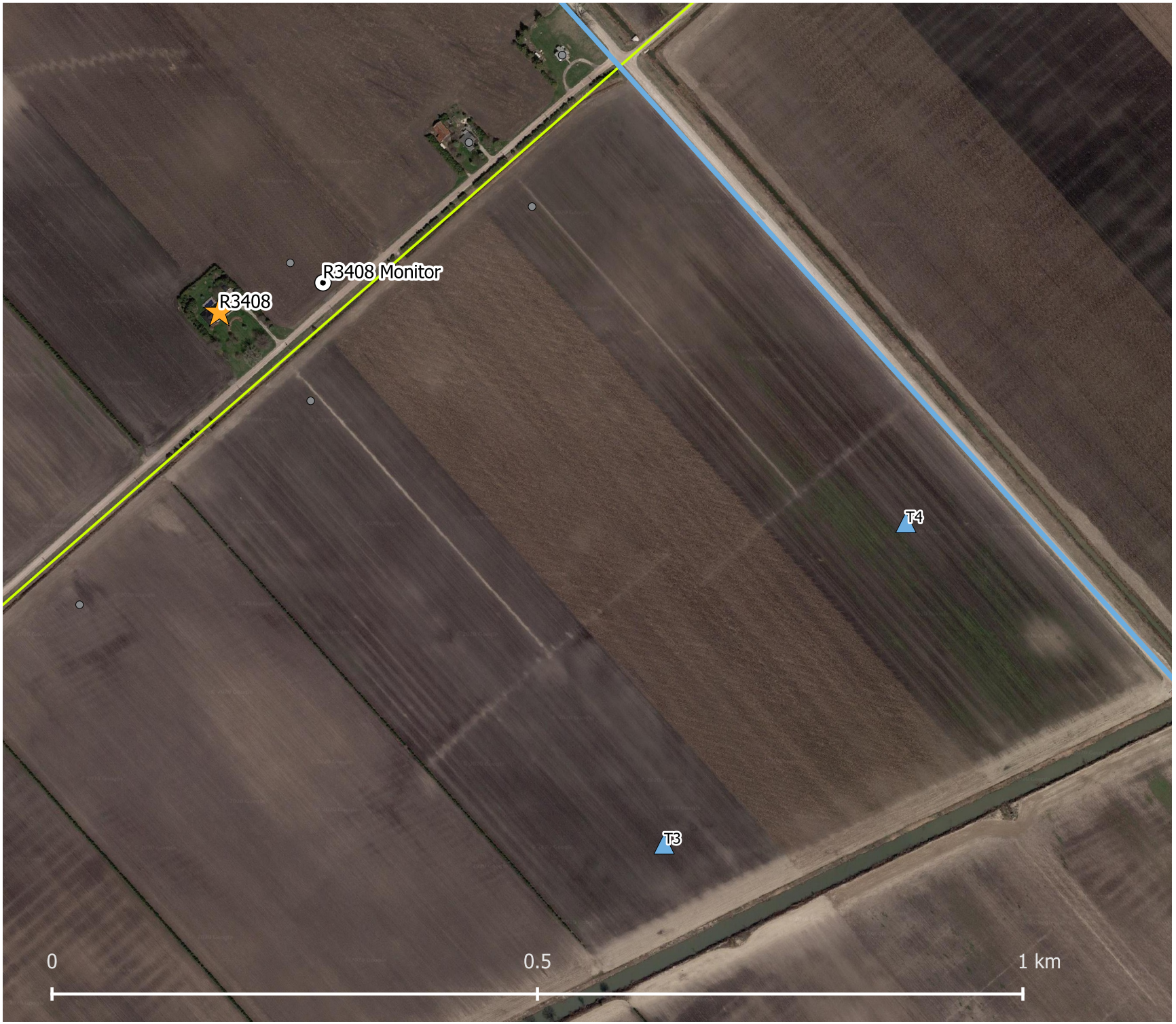

Legend

- Noise Monitor
- Campaign Receptor
- Receptor
- Green Valley Ln
- Prince Albert Rd

North Kent Turbines

- Turbine - Built

N

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Appendix A.2

Monitor and Receptor Location

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Appendix A.3

Site Photo - R3408 to T3

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Appendix A.4

Site Photo - R3408 to Receptor

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Appendix B
Full Receptor Selection Table

Table 1: Receptors Sorted by Sound Level

SPL Rank	Point of Reception ID	Height (m)	Distance to Nearest Turbine (m)	Nearest Turbine	Calculated Sound Level (dBA)	Wind Direction	Notes
*****	**R3408**	**1.5**	**713**	**T3**	**36.7**	**CW**	**Selected** – This receptor has been requested by the district office to be included in the audit
1	V6306	4.5	385	T28	42.3	DW	Participating
2	R3375	4.5	458	T30	41.2	CW	Participating, Crosswind
3	R3372	4.5	436	T5	41.1	UW	Participating, Upwind
4	V6314	4.5	483	T19	40.6	DW	Participating
5	R3539	4.5	518	T21	40.4	CW	Participating, Crosswind
6	V6323	4.5	460	T51	40.1	CW	Participating, Crosswind
7	V6286	4.5	523	T14	39.9	CW	Participating, Crosswind
8	V6008	4.5	504	T4	39.8	CW	Participating, Crosswind
9	R3426	4.5	1312	T34	39.6	UW	Upwind
10	R2998	4.5	458	T39	39.6	DW	Participating
11	**V6322**	**4.5**	**550**	**T19**	**39.6**	**DW**	**Excluded –** Exclusion advised by the MECP, since two other proposed measurement locations (R3099, R3214) are in close proximity to this location (cluster of receptors)
12	V6325	4.5	551	T23	39.6	CW	Participating, Crosswind
13	R3219	4.5	551	T23	39.5	CW	Crosswind
14	V6300	4.5	551	T30	39.5	CW	Crosswind
15	V6269	4.5	551	T7	39.5	CW	Crosswind
16	R3547	4.5	605	T43	39.5	CW	Crosswind
17	V6038	4.5	1837	T20	39.5	UW	Upwind
18	R3381	4.5	605	T30	39.5	DW	**Excluded** – Area surrounding receptor is heavily forested. Locations sufficiently set back from trees will place the monitor significantly closer to the turbine, or into a crosswind position.
19	R3544	4.5	660	T43	39.4	CW	Participating, Crosswind

SPL Rank	Point of Reception ID	Height (m)	Distance to Nearest Turbine (m)	Nearest Turbine	Calculated Sound Level (dBA)	Wind Direction	Notes
20	R3352	7.5	573	T5	39.4	CW	Crosswind
21	V6065	4.5	551	T34	39.4	CW	Participating, Crosswind
22	V6289	4.5	566	T27	39.4	CW	Participating, Crosswind
23	V6136	4.5	562	T28	39.3	CW	Crosswind
24	V6061	4.5	618	T33	39.3	CW	Participating, Crosswind
25	V6007	4.5	583	T3	39.3	CW	Participating, Crosswind
26	R3535	1.5	565	T21	39.3	CW	Participating, Crosswind
27	V6321	4.5	673	T19	39.3	CW	Crosswind
28	V6282	4.5	609	T14	39.2	CW	Crosswind
29	V6277	4.5	579	T49	39.2	CW	Participating, Crosswind
30	V6465	4.5	560	T26	39.2	CW	Participating, Crosswind
31	R3159	4.5	605	T19	39.1	DW	**Excluded** – See comment for V6322 (rank 11)
32	V6216	4.5	565	T7	39.1	DW	**Denied Access** – Resident was not interested in participating in study
33	R3149	4.5	600	T19	39.1	DW	**Excluded** – See comment for V6322 (rank 11)
34	V6250	4.5	680	T14	39.1	CW	Participating, Crosswind
35	V6299	4.5	543	T15	39.0	CW	Participating, Crosswind
36	**R3099**	**4.5**	**554**	**T51**	**39.0**	**DW**	**Selected**
37	R3315	4.5	645	T14	39.0	CW	Crosswind
38	V6284	4.5	617	T27	39.0	CW	Crosswind
39	R3423	4.5	576	T28	39.0	CW	Crosswind
40	V6088	4.5	627	T21	38.9	CW	Crosswind
41	R3294	4.5	698	T14	38.9	CW	Crosswind

SPL Rank	Point of Reception ID	Height (m)	Distance to Nearest Turbine (m)	Nearest Turbine	Calculated Sound Level (dBA)	Wind Direction	Notes
42	V6295	4.5	660	T49	38.9	CW	Crosswind
43	V6298	4.5	690	T14	38.9	UW	Upwind
44	R3529	4.5	607	T20	38.9	CW	Crosswind
45	V6381	4.5	621	T19	38.9	DW	**Excluded** – Located too close to receptor already selected (R3099)
46	R3550	7.5	644	T43	38.9	CW	Crosswind
47	V6447	4.5	624	T30	38.9	CW	Crosswind
48	R3289	4.5	700	T26	38.9	CW	Crosswind
49	V6003	4.5	559	T44	38.8	CW	Crosswind
50	V6195	4.5	520	T38	38.8	CW	Participating, Crosswind
51	V6153	4.5	543	T35	38.8	CW	Participating, Crosswind
52	V6057	4.5	560	T46	38.8	CW	Participating, Crosswind
53	R3125	4.5	598	T23	38.8	UW	Upwind
54	**R3214**	**4.5**	**751**	**T23**	**38.8**	**DW**	**Selected**
55	V6070	4.5	617	T34	38.8	CW	Crosswind
56	R3225	4.5	614	T23	38.7	CW	Crosswind
57	**V6202**	**4.5**	**620**	**T6**	**38.7**	**DW**	**Selected – Monitor erected in adjacent property due to land access restriction on resident's property.**
58	V6028	4.5	567	T44	38.7	CW	Crosswind
59	V6336	4.5	611	T23	38.7	UW	Upwind
60	R3321	4.5	717	T14	38.7	CW	Crosswind
61	R3201	4.5	798	T15	38.7	UW	Upwind
62	V6313	4.5	659	T19	38.6	DW	**Excluded** – Located too close to receptor already selected (R3099)
63	V6278	4.5	614	T15	38.6	UW	Upwind

SPL Rank	Point of Reception ID	Height (m)	Distance to Nearest Turbine (m)	Nearest Turbine	Calculated Sound Level (dBA)	Wind Direction	Notes
64	V6296	4.5	676	T27	38.6	CW	Crosswind
65	V6331	4.5	588	T51	38.6	CW	Crosswind
66	V6442	4.5	554	T4	38.6	CW	Crosswind
67	R3414	4.5	596	T4	38.5	CW	Crosswind
68	V6200	4.5	531	T31	38.5	CW	Participating, Crosswind
69	R3308	1.5	553	T14	38.5	CW	Crosswind
70	V6060	4.5	709	T33	38.5	CW	Crosswind
71	R3170	4.5	690	T19	38.5	DW	**Excluded** – Located to close to receptor already selected (R3099)
72	R5023	4.5	652	T15	38.5	CW	Crosswind
73	R4001	4.5	618	T46	38.5	CW	Crosswind
74	R3328	4.5	777	T26	38.4	CW	Crosswind
75	V6305	4.5	623	T28	38.4	CW	Crosswind
76	V6283	4.5	687	T26	38.4	CW	Crosswind
77	V6281	4.5	643	T15	38.4	CW	Crosswind
78	V6443	4.5	715	T26	38.4	CW	Crosswind
79	**R3398**	**1.5**	**566**	**T52**	**38.4**	**DW**	**Denied Access** – Land owner indicated that he was no longer interested in allowing land access
80	V6466	4.5	676	T26	38.4	CW	Crosswind
81	R3251	4.5	662	T7	38.3	CW	Crosswind
82	R3272	4.5	662	T26	38.3	CW	Crosswind
83	**R3281**	**7.5**	**632**	**T7**	**38.3**	**DW**	**Selected – was originally listed as Optional Alternative – MECP requested that this location be included**

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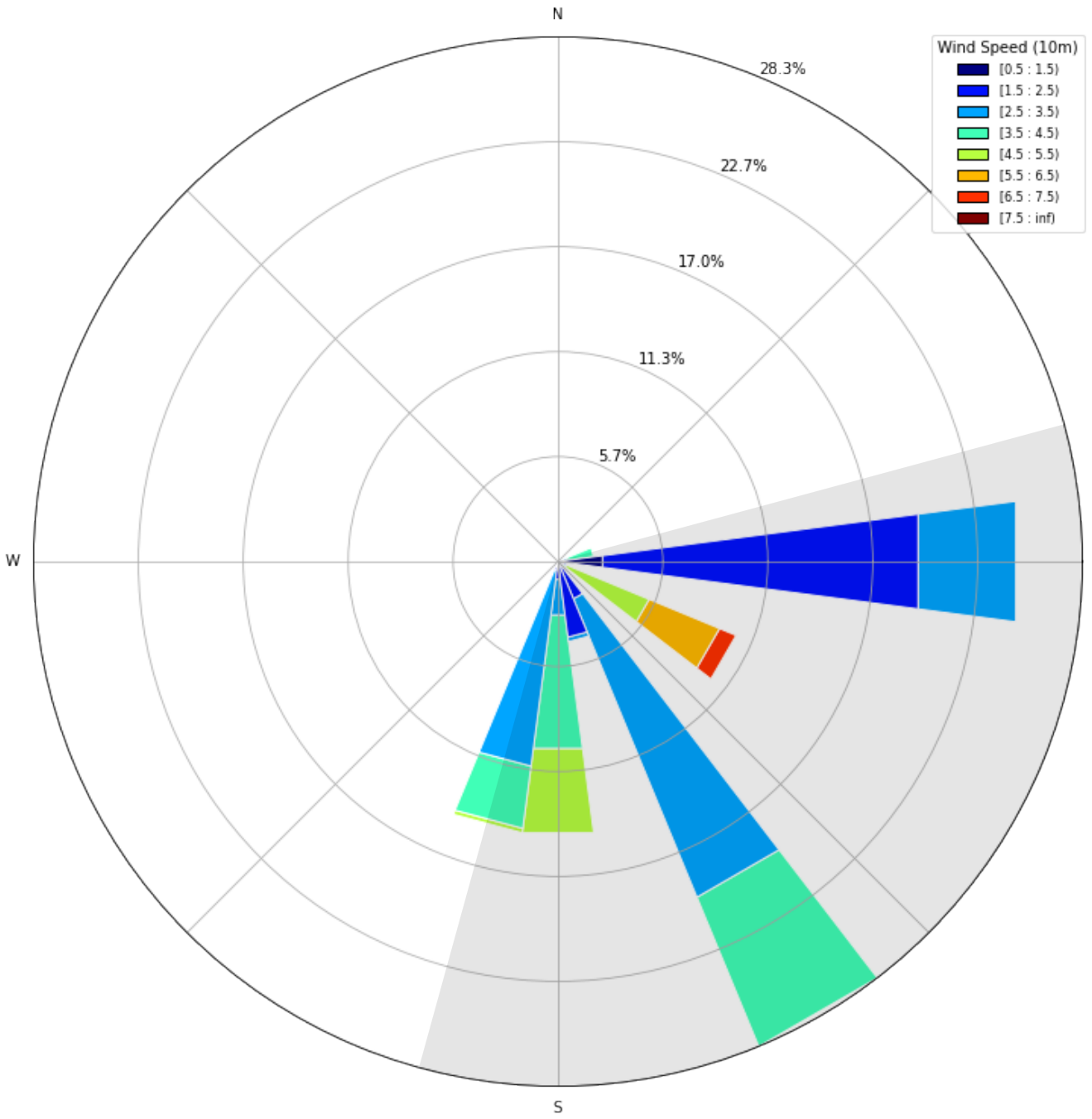
Appendix C
Wind Roses



Project ID: 17283.04
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Reveiwed by: CB
Date: January 12, 2021
Revision: 1

Scale: N/A

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Appendix C.1

Supplementary Wind Rose based on Assessment Data Downwind Total Noise

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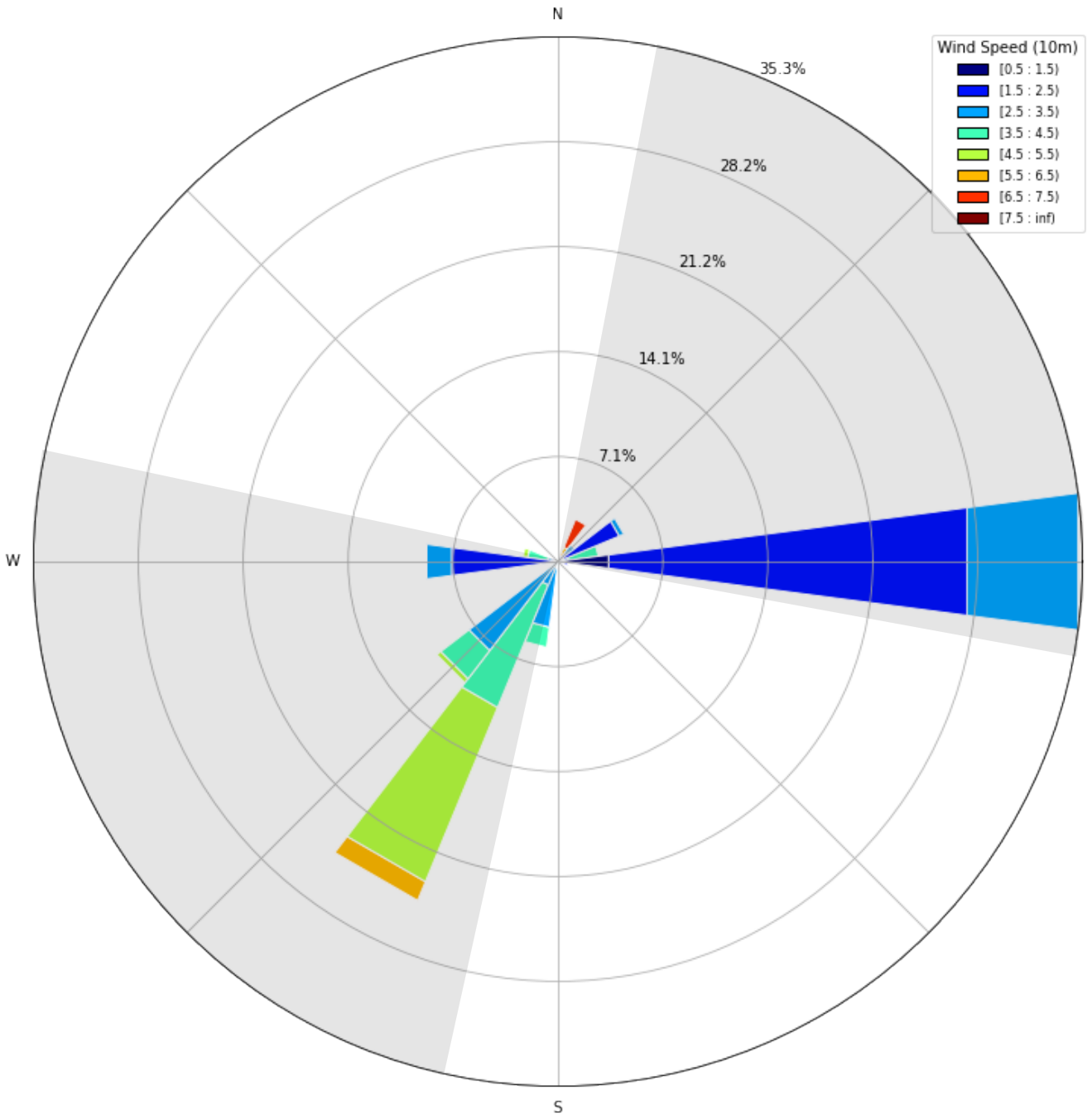

Project ID: 17283.04
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Revision: 1

Scale: N/A

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Appendix C.2

Supplementary Wind Rose based on Assessment Data
Crosswind Total Noise

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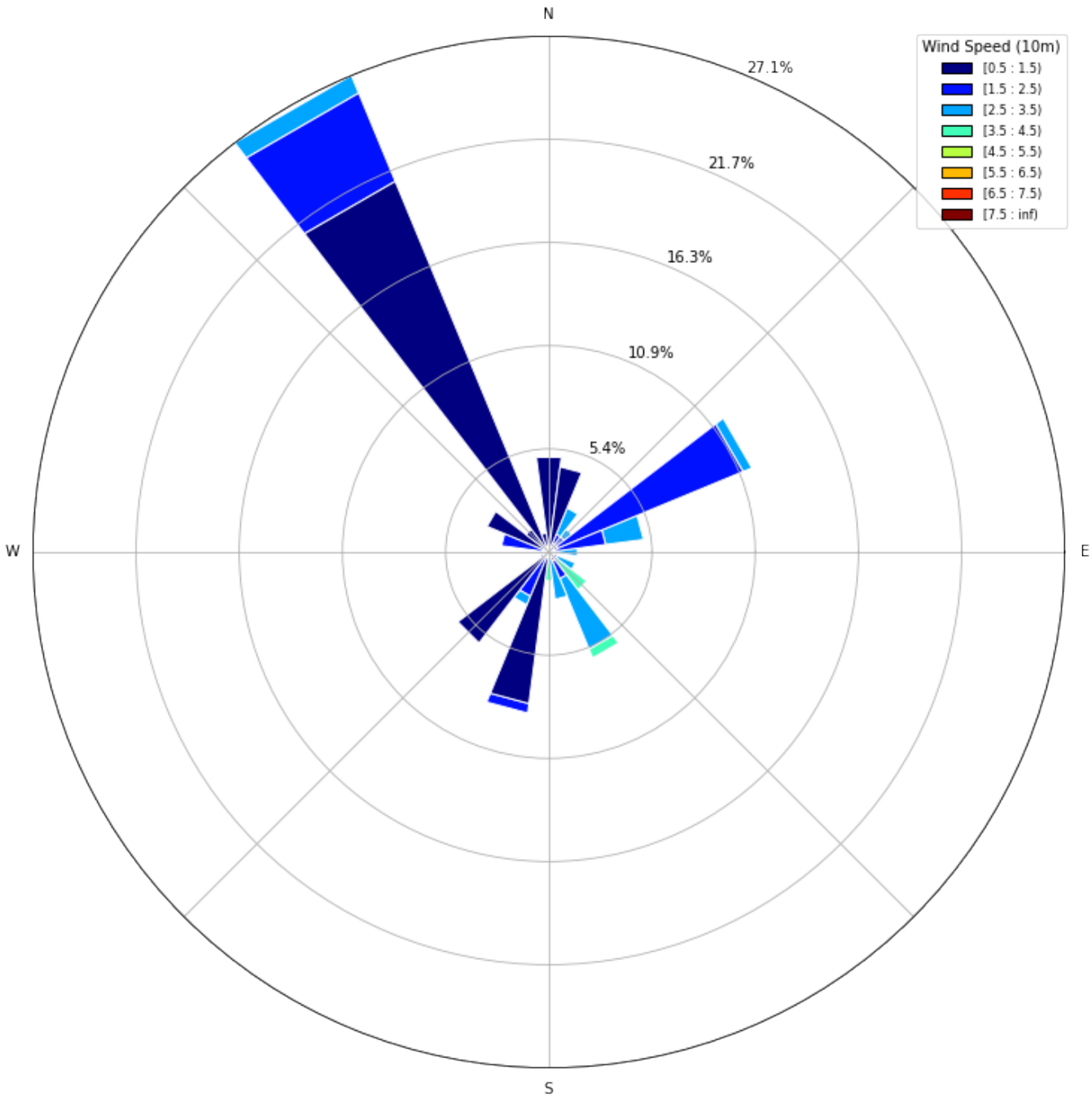

Project ID: 17283.04
Drawn by: DSF
Reveiwed by: CB
Date: January 12, 2021
Revision: 2

Scale: N/A

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Appendix C.3

Supplementary Wind Rose based on Assessment Data Background Noise

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Appendix D
Turbine Operational Statement from Operator

North Kent Wind 1 LP
2050 Derry Road West, 2nd Floor
Mississauga, Ontario L5N 0B9

www.northkentwind.ca

November 26, 2020

Director, Environmental Approvals Access and Service Integration Branch
Ministry of the Environment
2 St. Clair Avenue West, Floor 12A
Toronto ON M4V1L5

Subject: North Kent Wind 1 LP Renewable Energy Approval number 5272-A9FHRL
Condition- Receptor "Phase 2 Receptor I- Audit" to "NAAP Verification I-Audit

Dear Director

Please accept this letter as confirmation that all turbines tested during the NAAP Verification I-Audit measurement campaign conducted by Aercoustics Engineering Ltd. from September 17, 2020 to November 05, 2020 were operating normally for the duration of the campaign.

The turbines verified for operational measurements at the R3408 measurement location were as follows:

T3, T4, T5, T14, T20, T26, T27, T33, T44, T45, T46, and T52

Sincerely,

Jonathan Miranda
Facility Manager
North Kent Wind

C: (289) - 407-8387

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Appendix E
Tonality Assessment

R3048 65 Hz (40 - 90 Hz) IEC Tonality Summary							
Wind Bin (m/s)	Data Count	Tone Count	Tonal Presence (%)	Turbine ONLY (dBA)	MECP Sound Level Limit (dBA)	Average Tonal Audibility (dB)	Applicable Tonal Penalty (dB)
0	6	3	50%	**	40	-0.7	0.0
1	10	0	0%	**	40	0.0	0.0
2	110	23	21%	38	40	-1.8	0.0
3	73	5	7%	38	40	-4.9	0.0
4	47	5	11%	**	40	-4.5	0.0
5	39	1	3%	**	40	-3.0	0.0
6	7	0	0%	**	40	0.0	0.0
7	6	0	0%	**	43	0.0	0.0

- No data points at wind speed

** Insuffcient amount of data points as per RAM-I protocol

R3048 65 Hz (40 - 90 Hz) IEC Tonality Summary							
Wind Bin (m/s)	Data Count	Tone Count	Tonal Presence (%)	Turbine ONLY (dBA)	MECP Sound Level Limit (dBA)	Average Tonal Audibility (dB)	Applicable Tonal Penalty (dB)
0	0	0	0%	-	40	0.0	0.0
1	10	0	0%	**	40	0.0	0.0
2	105	0	0%	39	40	0.0	0.0
3	149	0	0%	40	40	0.0	0.0
4	88	0	0%	39	40	0.0	0.0
5	40	2	5%	**	40	4.1	0.1
6	17	0	0%	**	40	0.0	0.0
7	4	0	0%	**	43	0.0	0.0

- No data points at wind speed

** Insuffcient amount of data points as per RAM-I protocol

R3048 130 Hz (106 - 154 Hz) IEC Tonality Summary							
Wind Bin (m/s)	Data Count	Tone Count	Tonal Presence (%)	Turbine ONLY (dBA)	MECP Sound Level Limit (dBA)	Average Tonal Audibility (dB)	Applicable Tonal Penalty (dB)
0	6	1	17%	**	40	-0.5	0.0
1	10	0	0%	**	40	0.0	0.0
2	110	0	0%	38	40	0.0	0.0
3	73	2	3%	38	40	-6.2	0.0
4	47	8	17%	**	40	-4.7	0.0
5	39	4	10%	**	40	0.0	0.0
6	7	0	0%	**	40	0.0	0.0
7	6	0	0%	**	43	0.0	0.0

- No data points at wind speed

** Insuffcient amount of data points as per RAM-I protocol

R3048 130 Hz (106 - 154 Hz) IEC Tonality Summary							
Wind Bin (m/s)	Data Count	Tone Count	Tonal Presence (%)	Turbine ONLY (dBA)	MECP Sound Level Limit (dBA)	Average Tonal Audibility (dB)	Applicable Tonal Penalty (dB)
0	0	0	0%	-	40	0.0	0.0
1	10	0	0%	**	40	0.0	0.0
2	105	0	0%	39	40	0.0	0.0
3	149	1	1%	40	40	-5.0	0.0
4	88	1	1%	39	40	-5.3	0.0
5	40	2	5%	**	40	0.0	0.0
6	17	0	0%	**	40	0.0	0.0
7	4	0	0%	**	43	0.0	0.0

- No data points at wind speed

** Insuffcient amount of data points as per RAM-I protocol

aercoustics

Aercoustics Engineering Ltd.
1004 Middlegate Road, Suite 1100
Mississauga, ON L4Y 0G1

Tel: 416-249-3361
Fax 416-249-3613
aercoustics.com

Appendix F
Calibration Certificates

Calibration Certificates –

Details are disclosed in the table below regarding the calibration of the equipment used for the Phase 1 I-Audit campaign at monitor location R3048. The associated calibration certificates are provided in this appendix.

Location	Equipment	Make/Model	Serial Number	Date Calibrated [YYYY-MM-DD]
R3048	Data Acquisition Card	NI 9234	1B3CDE4	2020.08.20
	Signal Conditioner	PCB 480E09	33659	2020.08.17
	Microphone/ Pre-Amplifier Pair	PCB 378B02	122654	2020.07.31
	Microphone	PCB 377B02	155181	2020.07.31
	Pre-Amplifier	PCB 426E01	040835	2020.07.31
	Weather Anemometer	Vaisala WXT 536	M2130088	2018.08.23

Compliant Calibration Certificate

NI CALIBRATED
SN/ID: 1B3CDE4
DATE: 20-AUG-2020
DUE: 20-AUG-2021
ni.com/calibration

Certificate Number:	6490251.1	**OE Number:**	21971451
Date Printed:	20-AUG-2020	**Page:**	1 of 14
Customer:	Aercoustics Engineering Ltd (CA) 5335 Lucas Court ONTARIO Mississauga, L4Z 4A9 CANADA		
Manufacturer:	National Instruments	**Model:**	NI 9234
Serial Number:	1B3CDE4		
Part Number:	195551C-01L	**Description:**	MODULE ASSY,NI 9234, 4 AI CONFIGURABLE
Calibration Date:	20-AUG-2020	**Issued Date:**	20-AUG-2020
Procedure Name:	NI 9234	**Recommended Calibration Due:**	20-AUG-2021
Procedure Version:	3.6.1.0	**Verification Results:**	As Found: Passed As Left: Passed
Lab Technician:	Pamela Rotan	**Calibration Executive Version:**	5.2.0.0
		Driver Info:	NI-DAQmx:19.0.0
Temperature:	23.0° C	**Humidity:**	43.9% RH

The data found in this certificate must be interpreted as:

As Found The calibration data of the unit as received by National Instruments, if the unit is functional.

As Left The calibration data of the unit when returned from National Instruments.

The As Found and As Left readings are identical for units not adjusted or repaired.

This calibration conforms to ANSI/NCSL Z540.1 requirement.

The TUR (Test Uncertainty Ratio) of this calibration is maintained at a ratio of 4:1 or greater, unless otherwise indicated in the measurements. A TUR determination is not possible for singled sided specification limits and therefore the absence of a value should not be interpreted as a TUR of 4:1 or greater, but rather undetermined. When provided, the expanded measurement uncertainty is calculated according to the Guide to the Expression of Uncertainty in Measurement (GUM) for a confidence level of approximately 95%.

Measured values greater than the Manufacturer's specification limits are marked as 'Failed', measured values within the Manufacturer's specifications are marked as 'Passed'. NI Service Labs do not consider uncertainties when making statements of compliance to a specification.

This certificate applies exclusively to the item identified above and shall not be reproduced except in full, without National Instruments written authorization. Calibration certificates without signatures are not valid.

The Calibration Certificate can be viewed or downloaded online at www.ni.com/calibration/. To request a hard copy, contact NI Customer Service at Tel:(800) 531-5066 or Email orders@ni.com.

Ted Talley
Technical Manager

NI Calibration Services Austin
Building A
11500 N MoPac Expwy
AUSTIN, TX 78759-3504
USA
Tel: (800) 531-5066

Calibration Notes

Type	Note
Asset	Verification and adjustment were performed.

Standards Used

Manufacturer	Model	Type	Tracking Number	Calibration Due	Notes
FLUKE	5700A	Calibrator	2554	19-SEP-2020	
National Instruments	PXI-4461	Function generator	9383	05-MAY-2021	
National Instruments	PXI-4071	Digital multimeter	9433	28-AUG-2020	
National Instruments	PXI-4132	SMU	9166	19-MAY-2021	

The standards used in this calibration are traceable to NIST and/or other National Measurement Institutes (NMI's) that are signatories of the International Committee of Weights and Measures (CIPM) mutual recognition agreement (MRA).

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Calibration Results

As Found

Verify Accuracy

Lower Range	Upper Range	Channel	Test Value	Low Limit	Reading	High Limit	Status	Notes
-5 V	5 V	0	4.00000 V	3.99520 V	4.00002 V	4.00480 V	Passed	
-5 V	5 V	0	0.00000 V	-0.00120 V	0.00002 V	0.00120 V	Passed	
-5 V	5 V	0	-4.00000 V	-4.00480 V	-3.99997 V	-3.99520 V	Passed	
-5 V	5 V	1	4.00000 V	3.99520 V	4.00003 V	4.00480 V	Passed	
-5 V	5 V	1	0.00000 V	-0.00120 V	0.00003 V	0.00120 V	Passed	
-5 V	5 V	1	-4.00000 V	-4.00480 V	-3.99994 V	-3.99520 V	Passed	
-5 V	5 V	2	4.00000 V	3.99520 V	4.00001 V	4.00480 V	Passed	
-5 V	5 V	2	0.00000 V	-0.00120 V	0.00001 V	0.00120 V	Passed	
-5 V	5 V	2	-4.00000 V	-4.00480 V	-3.99995 V	-3.99520 V	Passed	
-5 V	5 V	3	4.00000 V	3.99520 V	4.00005 V	4.00480 V	Passed	
-5 V	5 V	3	0.00000 V	-0.00120 V	0.00000 V	0.00120 V	Passed	
-5 V	5 V	3	-4.00000 V	-4.00480 V	-4.00003 V	-3.99520 V	Passed	

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As Found

Verify Gain Matching

Max Gain Difference for Channel	Rate	Samples per Channel	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	10240	10240	4 V	-0.040 dB	-0.000 dB	0.040 dB	Passed	
1	10240	10240	4 V	-0.040 dB	-0.000 dB	0.040 dB	Passed	
2	10240	10240	4 V	-0.040 dB	-0.000 dB	0.040 dB	Passed	
3	10240	10240	4 V	-0.040 dB	0.000 dB	0.040 dB	Passed	

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As Found

Verify Phase Matching

Max Phase Difference for Channel	Rate	Samples per Channel	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	51200	16384	1000 Hz	-0.085 Degrees	-0.003 Degrees	0.085 Degrees	Passed	
1	51200	16384	1000 Hz	-0.085 Degrees	0.003 Degrees	0.085 Degrees	Passed	
2	51200	16384	1000 Hz	-0.085 Degrees	-0.003 Degrees	0.085 Degrees	Passed	
3	51200	16384	1000 Hz	-0.085 Degrees	-0.002 Degrees	0.085 Degrees	Passed	
0	51200	16384	10000 Hz	-0.490 Degrees	-0.023 Degrees	0.490 Degrees	Passed	
1	51200	16384	10000 Hz	-0.490 Degrees	0.024 Degrees	0.490 Degrees	Passed	
2	51200	16384	10000 Hz	-0.490 Degrees	-0.024 Degrees	0.490 Degrees	Passed	
3	51200	16384	10000 Hz	-0.490 Degrees	-0.013 Degrees	0.490 Degrees	Passed	

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As Found

Verify Common Mode Rejection Ratio

Channel	Rate	Samples per Channel	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	51200	16384	1000 Hz	40.000 dB	51.243 dB	100.000 dB	Passed	
1	51200	16384	1000 Hz	40.000 dB	49.890 dB	100.000 dB	Passed	
2	51200	16384	1000 Hz	40.000 dB	50.923 dB	100.000 dB	Passed	
3	51200	16384	1000 Hz	40.000 dB	50.885 dB	100.000 dB	Passed	

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As Found

Verify IEPE Current

Channel	Rate	DMM Range	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	51200	0.01 A	2.000 mA	2.000 mA	2.082 mA	2.200 mA	Passed	
1	51200	0.01 A	2.000 mA	2.000 mA	2.064 mA	2.200 mA	Passed	
2	51200	0.01 A	2.000 mA	2.000 mA	2.066 mA	2.200 mA	Passed	
3	51200	0.01 A	2.000 mA	2.000 mA	2.070 mA	2.200 mA	Passed	

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As Found

Verify IEPE Compliance Voltage

Channel	Rate	SMU Voltage Limit	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	51200	24 V	2 mA	19.000 V	20.875 V	24.000 V	Passed	
1	51200	24 V	2 mA	19.000 V	20.885 V	24.000 V	Passed	
2	51200	24 V	2 mA	19.000 V	20.884 V	24.000 V	Passed	
3	51200	24 V	2 mA	19.000 V	20.886 V	24.000 V	Passed	

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As Left

Verify Accuracy

Lower Range	Upper Range	Channel	Test Value	Low Limit	Reading	High Limit	Status	Notes
-5 V	5 V	0	4.00000 V	3.99520 V	4.00003 V	4.00480 V	Passed	
-5 V	5 V	0	0.00000 V	-0.00120 V	0.00001 V	0.00120 V	Passed	
-5 V	5 V	0	-4.00000 V	-4.00480 V	-4.00000 V	-3.99520 V	Passed	
-5 V	5 V	1	4.00000 V	3.99520 V	4.00001 V	4.00480 V	Passed	
-5 V	5 V	1	0.00000 V	-0.00120 V	0.00001 V	0.00120 V	Passed	
-5 V	5 V	1	-4.00000 V	-4.00480 V	-3.99998 V	-3.99520 V	Passed	
-5 V	5 V	2	4.00000 V	3.99520 V	4.00001 V	4.00480 V	Passed	
-5 V	5 V	2	0.00000 V	-0.00120 V	-0.00000 V	0.00120 V	Passed	
-5 V	5 V	2	-4.00000 V	-4.00480 V	-4.00001 V	-3.99520 V	Passed	
-5 V	5 V	3	4.00000 V	3.99520 V	4.00000 V	4.00480 V	Passed	
-5 V	5 V	3	0.00000 V	-0.00120 V	-0.00001 V	0.00120 V	Passed	
-5 V	5 V	3	-4.00000 V	-4.00480 V	-4.00000 V	-3.99520 V	Passed	

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As Left

Verify Gain Matching

Max Gain Difference for Channel	Rate	Samples per Channel	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	10240	10240	4 V	-0.040 dB	-0.000 dB	0.040 dB	Passed	
1	10240	10240	4 V	-0.040 dB	-0.000 dB	0.040 dB	Passed	
2	10240	10240	4 V	-0.040 dB	0.000 dB	0.040 dB	Passed	
3	10240	10240	4 V	-0.040 dB	-0.000 dB	0.040 dB	Passed	

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As Left

Verify Phase Matching

Max Phase Difference for Channel	Rate	Samples per Channel	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	51200	16384	1000 Hz	-0.085 Degrees	-0.003 Degrees	0.085 Degrees	Passed	
1	51200	16384	1000 Hz	-0.085 Degrees	0.003 Degrees	0.085 Degrees	Passed	
2	51200	16384	1000 Hz	-0.085 Degrees	-0.003 Degrees	0.085 Degrees	Passed	
3	51200	16384	1000 Hz	-0.085 Degrees	0.002 Degrees	0.085 Degrees	Passed	
0	51200	16384	10000 Hz	-0.490 Degrees	-0.023 Degrees	0.490 Degrees	Passed	
1	51200	16384	10000 Hz	-0.490 Degrees	0.024 Degrees	0.490 Degrees	Passed	
2	51200	16384	10000 Hz	-0.490 Degrees	-0.024 Degrees	0.490 Degrees	Passed	
3	51200	16384	10000 Hz	-0.490 Degrees	-0.013 Degrees	0.490 Degrees	Passed	

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As Left

Verify Common Mode Rejection Ratio

Channel	Rate	Samples per Channel	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	51200	16384	1000 Hz	40.000 dB	51.172 dB	100.000 dB	Passed	
1	51200	16384	1000 Hz	40.000 dB	49.884 dB	100.000 dB	Passed	
2	51200	16384	1000 Hz	40.000 dB	50.948 dB	100.000 dB	Passed	
3	51200	16384	1000 Hz	40.000 dB	50.887 dB	100.000 dB	Passed	

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As Left

Verify IEPE Current

Channel	Rate	DMM Range	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	51200	0.01 A	2.000 mA	2.000 mA	2.073 mA	2.200 mA	Passed	
1	51200	0.01 A	2.000 mA	2.000 mA	2.064 mA	2.200 mA	Passed	
2	51200	0.01 A	2.000 mA	2.000 mA	2.066 mA	2.200 mA	Passed	
3	51200	0.01 A	2.000 mA	2.000 mA	2.070 mA	2.200 mA	Passed	

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As Left

Verify IEPE Compliance Voltage

Channel	Rate	SMU Voltage Limit	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	51200	24 V	2 mA	19.000 V	20.878 V	24.000 V	Passed	
1	51200	24 V	2 mA	19.000 V	20.886 V	24.000 V	Passed	
2	51200	24 V	2 mA	19.000 V	20.888 V	24.000 V	Passed	
3	51200	24 V	2 mA	19.000 V	20.887 V	24.000 V	Passed	

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CERTIFICATE of CALIBRATION

Make :	PCB Piezotronics	Reference # :	162442
Model :	480E09	Customer :	Aercoustics Engineering Ltd Mississauga, ON
Descr. :	Conditioning Amplifier		
Serial # :	00033659	P. Order :	2020.08.10C
Asset # :	00209		

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

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 Quality System system complies with the requirements of ISO-9001-2015 and is registered under certificate CA96/269, 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 : Aug 17, 2020 By : Petro Onasko

Cal. Due : Aug 17, 2022

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

Standards used : J-255 J-367 J-512

Navair Technologies

REPAIR AND CALIBRATION TRACEABLE TO NRC AND NIST

6375 Dixie Rd. Mississauga, ON, L5T 2E7
Phone : 800-668-7440 Fax: 905 565 8325
http: // www.navair.com
e-Mail: service @ navair.com

NAVAIR TECHNOLOGIES

6375 Dixie Rd Unit # 7
Mississauga ON L5T 2E7
Tel: (905) 565-1583
Fax: (905) 565-8325

Form: 480E09	Approved by: J. Raposo	Jun-19	Ver 2.0

Calibration Report for Certificate : 162442

Make	Model	Serial №	Asset	Cal by
PCB Piezotronics	480E09	00033659	00209	P.O.

Test	Setting	Input	Min	Reading	Max		In/Out
Excitation Voltage							
• 1			25 Vdc	26.8 Vdc	29 Vdc		In
Constant Current Excitation							
• 1			2.0 mA	2.95 mA	3.2 mA		In
Voltage Gain Accuracy at 1 kHz							
• 1	1.000 V		0.98	1.000	1.02		In
• 10	0.100 V		9.80	10.00	10.20		In
• 100	0.010 V		98.0	99.9	102.0		In

CERTIFICATE of CALIBRATION

Make : PCB Piezotronics

Reference # : 162359

Model : 378B02

Customer : Aercoustics Engineering Ltd
Mississauga, ON

Descr. : Microphone System 1/2" Free Field

Serial # : 122654

P. Order : 2020.07.29C

Asset # : 00810

Cal. status : Received in spec's, no adjustment made.
Preamp System with Mic 377B02 s/n 155181

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 Quality System system complies with the requirements of ISO-9001-2015 and is registered under certificate CA96/269, 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 : Jul 31, 2020

By : Petro Onasko

Cal. Due : Jul 31, 2022

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

Standards used : J-216 J-324 J-333 J-420 J-512

Navair Technologies

REPAIR AND CALIBRATION TRACEABLE TO NRC AND NIST

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http: // www.navair.com
e-Mail: service @ navair.com

NAVAIR TECHNOLOGIES

6375 Dixie Rd Unit # 7
Mississauga ON L5T 2E7
Tel: (905) 565-1583
Fax: (905) 565-8325

Form: 378B02	Approved by: J.R.	Feb-16	Ver 1.0

Calibration Report for Certificate : 162359

Make			Model	Serial	Asset		
PCB Piezotronics			378B02	**122654**	00810		
PCB Piezotronics			426E01	**040835**	00810		
PCB Piezotronics			377B02	**155181**	00810		

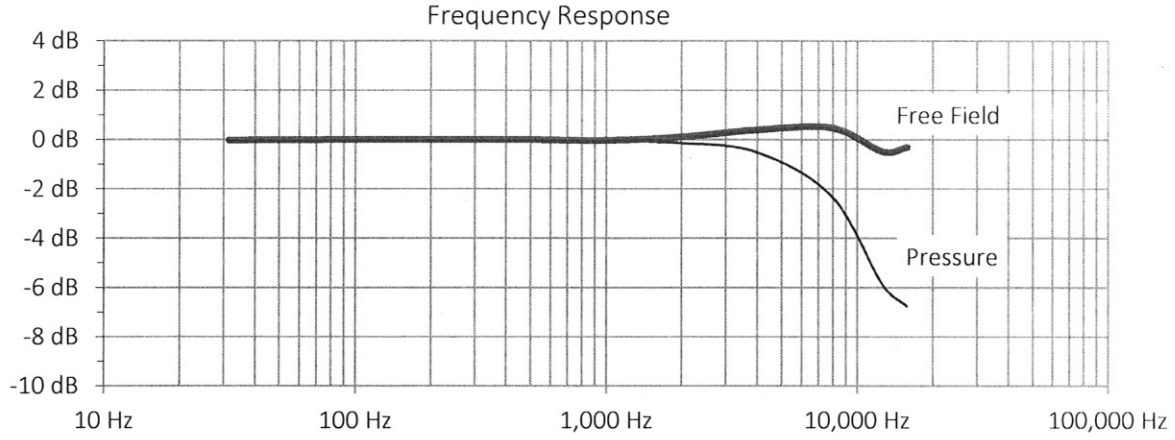
Sensitivity at 250 Hz

Specs Nom	Unit		Min	Reading	Max		In/Out
50.0 mV/Pa			39.72	**53.81**	62.94		In
−26.02 dB	re 1 V/Pa		-28.02	**-25.38**	-24.02		In
0 dB	re 50 mV/Pa		-2	**0.64**	2		In

Ambient Conditions: Static Pressure 99.2 kPa
Temperature 24.7°C
Rel.Humidity 46%

Frequency response

	Lower	Upper	
Freq	Pressure	Free Field	
Hz	dB	dB	
31.5	−0.03	−0.03	
63.1	−0.01	−0.01	
125.9	−0.00	0.00	
251.3	**0.00**	**0.00**	ref
502.5	−0.01	−0.01	
1005.1	−0.06	−0.03	
1978.7	−0.14	+0.10	
3957.5	−0.51	+0.39	
7914.9	−2.30	+0.48	
12663	−5.89	−0.49	
15830	−6.76	−0.31	



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 SONIC ANEMOMETER

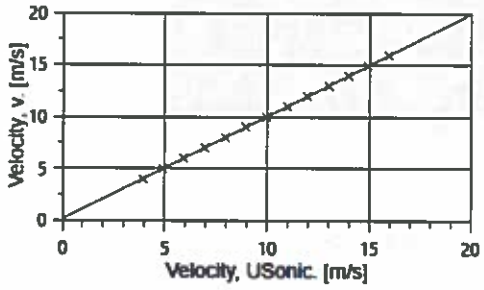
Certificate number: 18.US1.04604 **Date of issue:** August 23, 2018
Type: Vaisala Weather Transmitter, WXT536 **Serial number:** M2130088
Manufacturer: Vaisala, Oyj, Pl 26, FIN-00421 Helsinki, Finland
Client: Aercoustics Engineering Ltd., 1004 Middlegate RD, Suite 1100, S.Tower, Mississauga, ON L4Y 1M4, Canada

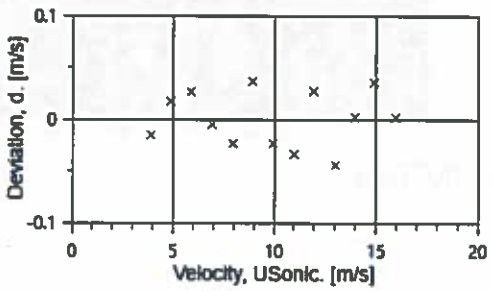
Anemometer received: August 21, 2018 **Anemometer calibrated:** August 23, 2018
Calibrated by: MEJ **Procedure:** MEASNET, IEC 61400-12-1:2017 Annex F
Certificate prepared by: RDS **Approved by:** Calibration engineer, RDS

Calibration equation obtained: v [m/s] = 0.99085 · f [m/s] + 0.10953

Standard uncertainty, slope: 0.00210 **Standard uncertainty, offset:** 0.20220
Covariance: -0.0000431 (m/s)²/m/s **Coefficient of correlation:** ρ = 0.999976
Absolute maximum deviation: -0.044 m/s at 12.963 m/s
Barometric pressure: 999.3 hPa **Relative humidity:** 42.1%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	d.p. box [°C]	Wind velocity, v. [m/s]	Anemometer Output, f. [m/s]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	9.09	26.4	26.3	3.965	3.9067	-0.015	0.021
4	14.29	26.4	26.3	4.972	4.8897	0.017	0.023
6	20.64	26.4	26.3	5.975	5.8933	0.026	0.026
8	28.14	26.4	26.3	6.978	6.9367	-0.005	0.029
10	36.72	26.4	26.3	7.970	7.9567	-0.024	0.033
12	46.84	26.4	26.4	9.001	8.9367	0.036	0.037
13-last	57.35	26.4	26.4	9.960	9.9655	-0.023	0.041
11	69.54	26.4	26.4	10.968	10.9933	-0.034	0.045
9	82.87	26.4	26.3	11.974	11.9467	0.027	0.049
7	97.11	26.4	26.3	12.963	13.0167	-0.044	0.053
5	112.46	26.4	26.3	13.950	13.9667	0.002	0.057
3	128.74	26.4	26.3	14.927	14.9183	0.035	0.061
1-first	146.42	26.3	26.3	15.918	15.9533	0.001	0.065





AC-1746

EQUIPMENT USED

Serial Number	Description
Njord1	Wind tunnel, blockage factor = 1.0035
2254	Control cup anemometer
-	Mounting tube, D = 19 mm
TT002	Summit Electronics, 1XPT100, 0-10V Output, wind tunnel temp.
TP001	PR Electronics 5102, 0-10V Output, differential pressure box temp.
DP005	Setra Model 239, 0-1inWC, differential pressure transducer
HY003	Dwyer RHP-2D20, 0-10V Output, humidity transmitter
BP003	Setra M278, 0-5VDC Output, barometer
PL8	Pitot tube
XB002	Computer Board. 16 bit A/D data acquisition board
9PRZRW1	PC dedicated to data acquisition

Traceable calibrations of the equipment are carried out by external accredited institutions: Atlantic Scale, Essco Calibration Labs & Furness Controls. A real-time analysis module within the data acquisition software detects pulse frequency.

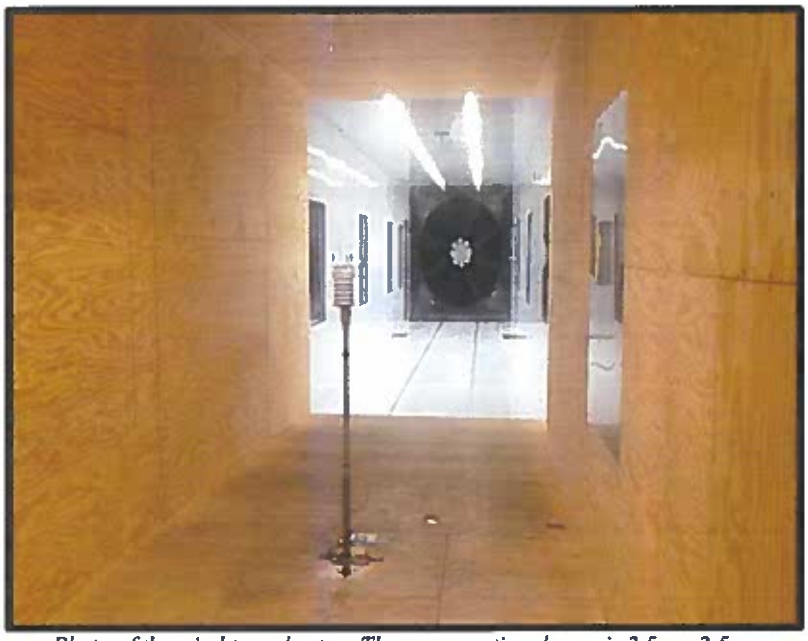


Photo of the wind tunnel setup. The cross-sectional area is 2.5m x 2.5m.

UNCERTAINTIES

The documented uncertainty is the total combined uncertainty at 95% confidence level (k=2) in accordance with EA-4/02. The uncertainty at 10 m/s comply with the requirements in the IEC 61400-12-1:2005 procedure. See Document US.12.01.004 for further details.

COMMENTS

This sensor was calibrated at the 0° position.

Certificate number: 18.US1.04604

SOH Wind Engineering LLC
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CERTIFICATE FOR CALIBRATION OF SONIC ANEMOMETER

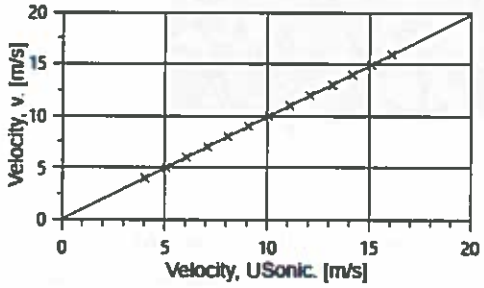
Certificate number: 18.US1.04603 **Date of issue:** August 23, 2018
Type: Vaisala Weather Transmitter, WXT536 **Serial number:** M2130088
Manufacturer: Vaisala, Oyj, Pl 26, FIN-00421 Helsinki, Finland
Client: Aercoustics Engineering Ltd., 1004 Middlegate RD, Suite 1100, S.Tower, Mississauga, ON L4Y 1M4, Canada

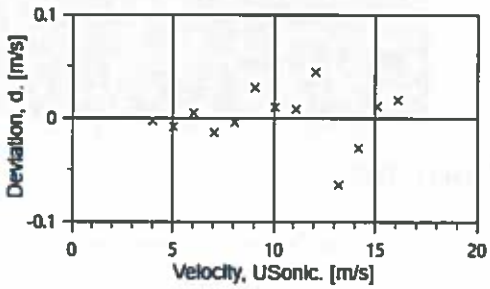
Anemometer received: August 21, 2018 **Anemometer calibrated:** August 23, 2018
Calibrated by: MEJ **Procedure:** MEASNET, IEC 61400-12-1:2017 Annex F
Certificate prepared by: RDS **Approved by:** Calibration engineer, RDS

Calibration equation obtained: v [m/s] = 0.98776 · f [m/s] + 0.00615

Standard uncertainty, slope: 0.00210 **Standard uncertainty, offset:** 3.62701
Covariance: -0.0000433 (m/s)²/m/s **Coefficient of correlation:** ρ = 0.999976
Absolute maximum deviation: -0.065 m/s at 12.975 m/s
Barometric pressure: 999.5 hPa **Relative humidity:** 41.9%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	d.p. box [°C]	Wind velocity, v. [m/s]	Anemometer Output, f. [m/s]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	9.07	26.4	26.3	3.961	4.0067	-0.003	0.021
4	14.28	26.4	26.3	4.970	5.0345	-0.009	0.023
6	20.61	26.4	26.3	5.970	6.0333	0.005	0.026
8	28.15	26.4	26.3	6.979	7.0733	-0.014	0.029
10	36.84	26.4	26.3	7.983	8.0800	-0.005	0.033
12	46.74	26.4	26.3	8.991	9.0667	0.029	0.037
13-last	57.34	26.4	26.3	9.959	10.0655	0.010	0.041
11	69.68	26.4	26.3	10.979	11.1000	0.008	0.045
9	82.99	26.4	26.3	11.982	12.0800	0.044	0.049
7	97.30	26.4	26.3	12.975	13.1950	-0.065	0.053
5	112.79	26.4	26.3	13.970	14.1667	-0.029	0.057
3	128.74	26.4	26.3	14.926	15.0933	0.011	0.061
1-first	146.52	26.4	26.3	15.923	16.0967	0.017	0.065





AC-1746

EQUIPMENT USED

Serial Number	Description
Njord1	Wind tunnel, blockage factor = 1.0035
2254	Control cup anemometer
-	Mounting tube, D = 19 mm
TT002	Summit Electronics, 1XPT100, 0-10V Output, wind tunnel temp.
TP001	PR Electronics 5102, 0-10V Output, differential pressure box temp.
DP005	Setra Model 239, 0-1inWC, differential pressure transducer
HY003	Dwyer RHP-2D20, 0-10V Output, humidity transmitter
BP003	Setra M278, 0-5VDC Output, barometer
PL8	Pitot tube
XB002	Computer Board. 16 bit A/D data acquisition board
9PRZRW1	PC dedicated to data acquisition

Traceable calibrations of the equipment are carried out by external accredited institutions: Atlantic Scale, Essco Calibration Labs & Furness Controls. A real-time analysis module within the data acquisition software detects pulse frequency.

Photo of the wind tunnel setup. The cross-sectional area is 2.5m x 2.5m.

UNCERTAINTIES

The documented uncertainty is the total combined uncertainty at 95% confidence level (k=2) in accordance with EA-4/02. The uncertainty at 10 m/s comply with the requirements in the IEC 61400-12-1:2005 procedure. See Document US.12.01.004 for further details.

COMMENTS

This sensor was calibrated at the 90° position.

Certificate number: 18.US1.04603

aercoustics

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Appendix G
Power Thresholds for 90% Sound Power

Appendix G - Power Thresholds for 90% Sound Power

Project: North Kent Wind Power Project - NAAP Verification I-Audit
Report ID: 17283.04

Created on: 1/12/2021

*Wind bins for interpolation are highlighted in light blue

Table G.1: NKWPP 2.628 MW Turbine - Measured Power and Sound Power

T03 (2.628 MW) E-Audit Test Results Summary [7]												
IEC 61400-11 Test	7.5	8	8.5	9	9.5	10	10.5	11	11.5	12	12.5	13
Power (kW)	1232	1474	1745	2015	2230	2444	2521	2597	2611	2625	2626	#N/A
SPL (dBA)	101.4	102.1	102.0	101.8	101.7	101.5	101.2	101.5	101.3	101.3	101.5	#N/A

Table G.1: NKWPP 2.772 MW Turbine - Measured Power and Sound Power

T36 (2.772 MW) E-Audit Test Results Summary												
IEC 61400-11 Test	7.5	8	8.5	9	9.5	10	10.5	11	11.5	12	12.5	13
Power (kW)	1236	1481	1766	2051	2291	2530	2629	2727	2748	2768	2770	#N/A
SPL (dBA)	101.4	102.9	103.3	103.3	103.2	103.1	103.0	102.6	102.4	102.4	102.1	#N/A

Table G.2: NKWPP 2.942 MW Turbine - Measured Power and Sound Power

T33 (2.942 MW) E-Audit Test Results Summary												
IEC 61400-11 Test	7.5	8	8.5	9	9.5	10	10.5	11	11.5	12	12.5	13
Power (kW)	#N/A	1483	1774	2065	2328	2591	2728	2865	2900	2934	2938	2942
SPL (dBA)	#N/A	103.0	104.1	104.4	104.5	104.3	104.0	103.9	103.8	103.6	103.6	103.3

Table G.3: NKWPP 3.2 MW Turbine - Measured Power and Sound Power

T06 (3.2 MW) E-Audit Test Results Summary												
IEC 61400-11 Test	7.5	8	8.5	9	9.5	10	10.5	11	11.5	12	12.5	13
Power (kW)	#N/A	1485	1785	2085	2384	2683	2879	3074	3130	3186	3193	3199
SPL (dBA)	#N/A	103.9	105.3	106.1	106.1	105.6	105.5	105.6	105.5	105.5	105.2	105.4

Table G.4: Power Thresholds for 90% Sound Power

	maximum sound power level (dBA)	90% sound power level (dBA)	electrical power at 90% sound level	percentage of rated power
2.628 MW	102.2	101.7	1261	48%
2.772 MW	103.3	102.9	1489	54%
2.942 MW	104.5	104.0	1749	59%
3.2 MW	106.1	105.7	1923	60%

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Appendix H
I-Audit Checklist

Appendix H7: I-Audit checklist

Wind Energy Project – Screening Document – Acoustic Audit Report – Immission

Information Required in the Acoustic Audit Report – Immission

Item #	Description	Complete?	Comment
1	Did the Sound level Meter meet the Type 1 Sound level meter requirements according to the IEC standard 61672-1 Sound level Meters, Part 1: Specifications? Section D2.1.1	✓	
2	Was the complete sound measurement system, including any recording, data logging or computing systems calibrated immediately before and after the measurement session at one or more frequencies using an acoustic calibrator on the microphone (must not exceed ±0.5dB)? Section D2.1.3	✓	
3	Are valid calibration certificate(s) of the noise monitoring equipment and calibration traceable to a qualified laboratory? Is the validity duration of the calibration stated for each item of equipment? Section D2.3	✓	
4	Was the predictable worst case parameters such as high wind shear and wind direction toward the Receptor considered? Section D3.2	✓	
5	Is there a Wind Rose showing the wind directions at the site? Section D7 (1e)	✓	
6	Did the results cover a wind speed range of at least 4-7 m/s as outlined in section D 3.8.?	✓	
7	Was the weather report during the measurement campaign included in the report? Section D7 (1c)	✓	
8	Did the audit state there was compliance with the limits at each wind speed category? Section D6	✓	
9	Are pictures of the noise measurement setup near Point of reception provided? Section D3.3.2 & D3.4	✓	
10	Was there justification of the Receptor location choice(s) prior to commencement of the I-Audit? Section D4.1	✓	
11	Was there sufficient valid data for different wind speeds? Section D5.2 # 3	✓	
12	Was the turbine (operational) specific information during the measurement campaign in tabular form (i.e. wind speed at hub height, anemometer wind speed at 10 m height, air temperature and pressure and relative humidity) Section D3.7	✓	
13	Were all the calculated standard deviations at all relevant integer wind speeds provided? Section D7 (2d)	✓	
14	Compliance statement	✓	
15	All data included in an Excel spreadsheet	✓	
16	If deviations from standard; was justification of the deviations provided	⊘	To ensure conservative results, 90% Sound Power filter was used in place of 85% Power filter: See Section 6.5 and Appendix G for justification.