March 8, 2016

Jessica M. Damon, Project Manager
Division of Land Use Regulation
Maine DEP
106 Hogan Road, Suite 6
Bangor, ME 04401

Re: Independent Peer Review of the Sound Assessment for the Number Nine Wind Project - Revised

Dear Jessica:

Tech Environmental, Inc. (TE) has completed an independent peer review of the acoustic impacts of the 250-MW Number Nine Wind Project in Aroostook County with regard to Maine Site Location of Development (SLOD) Regulations. The Project consists of the Turbine Area and three sections of a 345-kV generator lead, consisting of the Bridal Path Generator Lead Line (Section 1), and the North Generator Lead Line (Sections 2a and 2b). Our initial review report was issued on October 7, 2015. This revised peer review includes the applicant's responses to the initial set of review comments.

The Turbine Area will consist of 119 Gamesa G114 wind turbines to be located at 129 permitted turbine sites on ridges and hills across several unorganized townships in the vicinity of Number Nine Lake and Presque Isle Lake.[1] The Sound Assessment assumed continuous operation of turbines on all 129 sites at full-rated sound power even though a maximum of 119 turbines are planned for construction. The G114 wind turbines will be one of two types, 2.0 MW or 2.1 MW, both with a 93 meter hub height and blade pitch control to reduce noise under high wind conditions.

The documents I received for this review are found in Section 5 of the SLOD Application, Number Nine Wind Farm:

- Bodwell EnviroAcoustics, LLC, "Sound Level Assessment, Number Nine Wind Farm, LLC, Aroostook County," April 2015 (the "Bodwell Report"), as amended by an email communication with Scott Bodwell, September 29, 2015.

- Bodwell EnviroAcoustics, LLC, "Response to Peer Review Comments and Revised Sound Level Predictions," February 26, 2016 (the "Bodwell Response Letter")

- Exhibit 1, Wind Turbine Sound Warranty from Gamesa Wind US, LLC.

[1] T10 R3 WELS, E Township, T9 R3 WELS, T8 R3 WELS, and St. Croix Township.

- Commonwealth Associates, Inc., "Audible Noise Sound Level, Number Nine Wind Farm 345 kV Generator Lead Line," March 30, 2015 (the "Commonwealth Report").

- Commonwealth Associates, Inc., "Audible Noise Sound Level, Number Nine Wind Farm 345 kV Generator Lead Line," Revised February 19, 2016 (the "Revised Commonwealth Report").

A site visit was made to the Turbine Area and Number Nine Lake on October 6, 2015. Number Nine Lake is ringed by residences that will receive the highest sound level impacts from the Project.

Review Standard and Receptors

The purpose of this peer review is to determine if the acoustic studies submitted with the Application are reasonable and technically correct according to standard engineering practices and if the proposed project will comply with the Department Regulations on Control of Noise (06-096 CMR 375.10), referred to herein as the "Maine Noise Regulations". The nighttime sound limit at a Protected Location is 42 dBA (1-hour L_{eq}) and applies on portions of a Protected Location within 500 feet of a residence or other sleeping quarters, or at the property boundary of the protected location, whichever is closer to the dwelling. Beyond 500 feet, the daytime limit of 55 dBA applies 24 hours per day. There are also decibel penalties that apply when the sound generated by a wind energy development results in tonal or short duration repetitive sounds, as those terms are defined in the Maine Noise Regulations. No local noise regulations apply to the Project.

The distance from a proposed turbine to the nearest dwelling subject to the Maine Noise Regulations is 2,890 feet; this is the dwelling associated with the Protected Location labeled Receptor C1. The two Protected Locations closest to the Turbine Area and subject to the 42 dBA nighttime sound limit[2] are Receptor C1, representing a dwelling on Number Nine Lake in T9 R3 WELS, and S2, representing a dwelling in Webbertown Township.

Sound Power Levels Assumed for the Turbines

The sound power level (L_w) on a decibel scale[3] is determined by the manufacturer through a series of prescribed field measurements using the International Standard IEC 61400-11 test method.[4] The IEC-reported sound power level for a given hub-height wind speed is an average value, meaning there is a scatter of values about the average and the actual sound power level emitted in the field may either be

[2] The Project has entered into lease agreements with the owners of dwellings and/or camps, mostly seasonal, within the Project area. These recreational lease dwellings are subject to a sound easement and are not Protected Locations under the Department Regulations.

[3] The sound power level is defined as $10*\log_{10}(W/W_o)$, where W is the sound power of the source in Watts and W_o is the reference power of 10^{-12} Watts. The sound power level (energy density) and sound pressure level (what we hear) are not the same, yet both are reported using a decibel levels scale. An acoustic model uses the sound power level of a wind turbine along with other assumptions to calculate the sound pressure level heard at a receiver located a certain distance from the wind turbine.

[4] International Electrotechnical Commission, International Standard IEC 61400-11 Edition 2.1, "Wind turbine generator systems – Part 11: Acoustic noise measurement techniques," Geneva, 2006.

lower or higher. To quantify that variability in values of L_w, the IEC provides a method for assessing L_w measurement uncertainty and unit-to-unit turbine production uncertainty, combining both into a total uncertainty "K" factor (IEC Technical Specification 61400-14)[5]. The IEC method defines the "Declared Sound Power Level" as L_w + K, and the sum represents an upper-bound sound power level that, under the stated wind speed conditions, will not be exceeded 95% of the time. The Declared Sound Power Level should be used in acoustic modeling to ensure the predicted sound pressure levels are conservative estimates and reasonably account for known uncertainties.

The applicant followed this procedure in modeling sound power levels that are the IEC reported maximum value for the Gamesa G114 turbine of 106.6 dBA plus an uncertainty K factor of 2.0 dBA. This sound power level corresponds to the turbine model with the higher electrical output rating of 2.1 MW. The applicant then added a 1.0 dBA modeling uncertainty factor for the ISO 9613-2 sound propagation method[6] at an inland location, and thus a total sound power level of 109.6 dBA was modeled for the G114 turbines. The modeling uncertainty factor of 1 dBA is in the middle of the 0 to 2 dBA range for modeling uncertainty listed as a rebuttable presumption in sub-section I(7)(c)(9) of the Maine Noise Regulations.

Conservatism of the Combined Uncertainty Factor

Our review of the sound test reports for the Stetson I and II, and Bull Hill, wind energy facilities, where wind turbines are located on ridge top settings similar to Number Nine Wind, reveal use of the IEC reported sound power level plus uncertainty K factor and adding 1 dBA for modeling uncertainty is a conservative modeling approach for assessing wind turbine acoustic impacts.[7] Thus, Bodwell EnviroAcoustics's combined uncertainty factors are appropriate and should accurately predict turbine sound levels.

Turbine Acoustic Model and Assumptions

Sound levels from the wind turbines were predicted using the Cadna\A acoustic model, the International Standard ISO 9613-2 sound propagation method, and a conservative ground absorption factor of G=0.5 that represents winter frozen-ground conditions. Water bodies were modeled as reflective surfaces with G=0.0. Standard day values for temperature and relative humidity[8] (as they affect air absorption) were employed. These are the proper tools for accurately evaluating sound impacts. While the ISO method provides estimates of accuracy for mean source and receiver heights up to 30 m and the Number Nine Wind turbines are higher at 93 m, this acoustic modeling approach has been found to be accurate for

[5] International Electrotechnical Commission, Technical Specification TS 61400-14,"Wind turbines – Part 14: Declaration of apparent sound power level and tonality values," Geneva, 2005.

[6] International Organization for Standardization, Standard ISO 9613-2, "Acoustics – Attenuation of sound during propagation outdoors, Part 2: General method of calculation," Table 5.

[7] Tech Environmental, Inc., "Independent Peer Review of the Sound Level Assessment for the Oakfield Wind Project," September 1, 2011.

[8] Temperature 10^{o}C and relative humidity 70%.

utility wind turbine sounds on several past projects with similar hub heights; the method is judged to be accurate for the Number Nine Wind Project.

The project is located in an area of commercial forestland with rural residential and seasonal transient properties such as hunting camps and lakeside cottages. The majority of Protected Locations in the vicinity of the project are dwellings located around Number Nine Lake in T9 R3 WELS, labeled as receptors C1 through C6. Four other Protected Locations, dwellings in Westfield, Dudley and Webbertown, are within approximately one mile of a turbine and were also evaluated in the acoustic model; these are labeled as receptors N1, N2, S1 and S2. Four decibel contour maps were generated for Number Nine Wind to allow verification of predicted sound levels throughout the Project area.

The acoustic modeling results are conservative due to the following assumptions:

1. Sound from 129 wind turbine sites were modeled, even though only 119 turbines will be constructed, and the G114 2.1 MW model with the higher sound power level was modeled.

2. All wind turbines were assumed to be operating simultaneously and at the design wind speed, corresponding to maximum sound power.

3. All wind turbine sound power levels correspond to the IEC 61400-11 maximum rated sound power level plus a combined uncertainty factor of 3.0 dBA.

4. The acoustic model assumed the most favorable conditions for sound propagation, corresponding to a ground-based temperature inversion, such as might occur on a calm, clear night, or during a downwind condition with a moderate wind speed.

5. No attenuation from trees or other vegetation was assumed.

6. Winter frozen ground conditions were assumed for minimal ground absorption (G=0.5) and a reflective surface (G=0.0) was assumed for surface water bodies.

7. Excess attenuation from wind shadow effects and daytime air turbulence were ignored.

Turbine Acoustic Modeling Results

With 129 turbines operating at maximum sound power output, the modeling results in Table 6-2 of the Bodwell Report reveal Number Nine Wind will comply with the daytime sound level limit of 55 dBA at all Protected Locations, but will exceed the nighttime sound level limit of 42 dBA at six of the Protected Locations (receptors C1 through C6), all of which are on Number Nine Lake. The applicant is proposing curtailment of nighttime turbine operations near Number Nine Lake to achieve compliance. This plan, detailed in Table 6-1 of the Bodwell Report, consists of placing five wind turbine sites into Noise Reduced Operation (NRO) at night, using Gamesa NRO modes N1 through N5 for various turbines, which reduce sound power levels by 1.0 to 5.6 dBA. The maximum predicted nighttime sound levels with NRO mitigation are presented in Table 6-2 of the Bodwell Report and range from 36.3 dBA at Receptor N1 in Westfield to 42.0 dBA at Receptor C6 on Number Nine Lake in T9 R3 WELS. All

six residential receptors on Number Nine Lake have nighttime sound levels within 1 dBA of the Maine Noise Regulation's nighttime limit of 42.0 dBA.

The acoustic modeling results demonstrate Number Nine Wind complies with the daytime (55 dBA) and nighttime (42 dBA) limits, and with the project boundary 75 dBA limit, in the Maine Noise Regulations. Since the applicant designed the nighttime NRO operations plan so that the predicted maximum sound level at a Protected Location is exactly at the 42.0 dBA limit, the situation suggests the need for compliance sound testing at more than one Protected Location along Number Nine Lake,

Tonal Sounds

The Bodwell Report (page 26) states that an analysis of the 1/3-octave band sound power level spectrum for the G114 turbine, which is claimed as proprietary by Gamesa and not provided in the Bodwell Report, reveals no potential for creating a Tonal Sound, as defined in the Maine Noise Regulations. Although this claim could not be independently confirmed, similar size wind turbines have shown no potential for producing a "tonal sound" and the claim is likely correct. Compliance sound testing will need to verify this assumption.

Short Duration Repetitive Sound (SDRS)

The definition of SDRS in the section of the Maine Noise Regulations that pertains to Wind Energy Developments is an impulse sound that is 5 dBA or greater "on the fast meter response above the sound level observed immediately before and after the event." Typically this modulation of the turbine mid-frequency sound (the audible "swish-swish") has an amplitude range of 2 to 5 dBA, with occasional 6 dBA peaks. The 5-dBA penalty for SDRS is applied to each 10-minute period in which more than five SDRS events occur.

The three years of sound testing at the nearby Bull Hill Wind Project reveal SDRS events are uncommon and their effect on the averaged 10-minute LA_{eq} sound level used to assess compliance is typically less than 1 dBA. Given that there is no margin between projected maximum nighttime sound levels along Number Nine Lake and regulatory limits for this project, SDRS effects may increase the measured nighttime L_{eq} sound levels above 42 dBA at one or more Protected Locations, in which case the Project will be required to modify the NRO plan to provide additional nighttime sound reduction. Compliance sound testing will need to carefully document all SDRS events to verify the level of SDRS for this Project.

Construction Noise

Construction of the Number Nine Wind Project will produce sound levels similar to those generated during roadway construction, and much of the heavy equipment is similar. Daytime construction activity is not subject to the limits in the Maine Noise Regulations. Any nighttime construction activity will need to comply with the nighttime limit in the Maine Noise Regulations.

Post-Construction Sound Level Testing

To ensure that the sound level predictions submitted by the applicant are accurate for the wind turbines actually installed, and to ensure compliance with the Maine Noise Regulations, including the provisions regarding SDRS and tonal sound, the Department will require post-construction sound monitoring for the project.

The Bodwell Response Letter (page 2) suggests compliance testing be done at the three receptor points with the highest potential to exceed the nighttime sound limit, and lists these as Receptors C1A, C2 and C6, all on Number Nine Lake. Receptor C6 has the highest predicted nighttime sound level of 42.0 dBA. These three locations are close to each other at the north end of the lake. I recommend that one of the three test locations be Receptor C3 or C4 at the south end of the lake. Both C3 and C4 have predicted sound levels of 41.4 dBA, very close to the limit of 42.0 dBA. Selecting one test location at the south end will ensure testing is done on different shores of the sound-reflective lake surface. A verification of compliance at Receptors C6, C1A or C2, and C3 or C4 will ensure the Project complies at all other Protected Locations.

Generator Lead Line Acoustic Modeling

A separate analysis of the 345-kV Generator Lead Line sound impacts is presented in the Revised Commonwealth Report for three sections: Section 1(Bridal Path) Segments 1A and 1B; Section 2a (Northern) and Section 2b (Northern). Generator Lead Lines are part of a grid-scale wind energy development, as defined in 35-A MRSA § 3451, and thus the Lead Lines are subject to the Chapter 375(10)(I) nighttime sound limit of 42 dBA at Protected Locations, with adjustment for Tonal Sounds in subsection I(3) of the Maine Noise Regulations.

In response to our initial peer review comments, the applicant has made design changes to several H-pole structures along Section 1 and extended Section 2a to avoid dwellings. The Revised Commonwealth Report assumes a "wet conditions" worst case will produce Tonal Sound in the 120 Hz band, as that term is defined in the Noise Regulations, and acoustic modeling of the revised design assumed a 5-dBA Tonal Sound penalty, namely an effective broadband sound limit of 37 dBA.

The Revised Commonwealth Report presents predicted sound levels at the Lead Line right-of-way (ROW), at 500 feet from the ROW, and at 580 feet from the ROW, for both dry and wet corona discharge conditions. The TRALIN module of the CDEGS program using the EPRI/GE calculation method was employed, and this model provides reasonably accurate estimates of broadband sound impacts in dBA for the stated conditions. The revised report demonstrates that the worst-case, wet conductor condition of all lead line sections will generate a sound level of 37 dBA or less within 500 feet of a dwelling on all regulated Protected Locations. Thus, the redesigned 345-kV Lead Line complies with the Maine Noise Regulations.

Summary

A peer review was done of Section 5 of the SLOD Application for Number Nine Wind Farm, which consists of the Bodwell Report for the Turbine Area and the Commonwealth Report for the Lead Lines.

The Bodwell Report results confirm the Gamesa G114 wind turbine maximum sound power levels, with a conservative uncertainty factor, were used in the analysis; the acoustic model and its assumptions are appropriate; the sound receiver locations are appropriate; the decibel contour maps adequately cover the potential impact area; and the maximum sound levels comply with the Department Regulations on Control of Noise (06-096 CMR 375.10(I). No additional acoustic studies of the Turbine Area are required for permitting of the project.

The Revised Commonwealth Report results confirm an appropriate acoustic model was applied for maximum corona discharge noise from the Generator Lead Lines; the sound receiver locations represented by the ROW are appropriate to assess worst case impacts for nearby Protected Locations; the worst case wet condition assumed an appropriate 5-dBA Tonal Sound penalty; and the maximum sound levels comply with the Department Regulations on Control of Noise (06-096 CMR 375.10(I). No additional acoustic studies of the Generator Lead Lines are required for permitting of the project.

For the reasons stated above, I conclude that both the Turbine Area acoustic study and the revised Generator Lead Line acoustic study submitted with the SLOD Application are reasonable and technically correct according to standard engineering practices and the Department Regulations on Control of Noise (06-096 CMR 375.10).

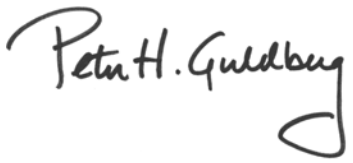
Recommendations

I recommend that any permit the Department may ultimately issue for Number Nine Wind require compliance testing at three locations around the shores of Number Nine Lake, specifically: (1) Receptor C6; (2) Either Receptor C1A or C2; and (3) either Receptor C3 or C4. Given that there is no margin between projected maximum nighttime sound levels along Number Nine Lake (42.0 dBA) and regulatory limits for this project (42 dBA), SDRS effects may increase the measured nighttime L_{eq} sound levels above 42 dBA at one or more Protected Locations, in which case the Project will be required to modify the NRO plan to provide additional nighttime sound reduction. Compliance sound testing will need to carefully document all SDRS events to verify the actual level of SDRS for this Project.

Thank you for the opportunity to provide an independent peer review of the Number Nine Wind Project application.

Sincerely yours,

TECH ENVIRONMENTAL, INC.



Peter H. Guldberg, INCE, CCM
Senior Principal
4052/Letter Report March 8 2016