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January 30, 2008 ***(Revised February 6, 2008)***

Mr. Kris D. Dimmick, P.E.
Bernier Carr & Associates, P.C
327 Mullin Street
Watertown, NY 13601

Subject: Cape Vincent Wind Power Project
Cape Vincent, New York

Dear Kris,

We have reviewed the Draft Environmental Impact Statement dated December 7, 2007 for the Cape Vincent Wind Power Project, Cape Vincent, New York. In addition, we have reviewed a number of technical papers and documents pertinent to the impact statement section on noise. These documents include the following:

1. IEC Standard 61400-11 Wind turbine generator systems – Part11: Acoustic noise measurement techniques, Edition 2.1 dated November 2006.
2. Assessing and Mitigating Noise Impacts, New York State Department of Environmental Conservation, dated October 6, 2000 (revised February 2, 2001).
3. van den Berg, Frits G.P., "Wind Turbines at night: Acoustical practice and sound research," Proceedings of Euronoise, Naples 2003, paper ID 160.
4. Bajdek, Christopher J., "Communicating the Noise Effects of Wind Farms to Stakeholders," Proceedings of Noise-Con 2007, Reno, Nevada, October 2007.
5. *Selected Reprints from Technical Reviews*, Bruel & Kjaer, September 1972.
6. Pierpont, Nina; *"Health, hazard, and quality of life near wind power installations—How close is too close?"*, Malone, NY Telegram, March 2, 2005, p. 5.

Appendix H – Noise Impact Assessment

As the DEIS text is drawn wholly from Appendix H Noise Impact Assessment, comments below are made specifically on Appendix H figures and data. These same comments apply to the DEIS section on noise impacts as well.

Omission of Sound Levels Measured at Position 4

The data shown plotted in Figure 2.15-2 are the average of the L_{90} (10 minute) sound levels measured at positions 1 to 3 and 5 to 7. Sound levels measured at position 4 were omitted from the average as they were judged to be anomalous since they *"...are consistently lower than at all other locations."* The text continues..."*The reason for this anomalous behavior is not clear, but may be associated with a relative lack of vehicle noise on seldom used Fox Creek Road, a relative lack of insect noise, or the fact that the monitor was not particularly close to any trees and was exposed to less wind-induced noise."* The last quote is an explanation of why sound levels at position 4 are quiet, not an argument for eliminating it from the average. Data collected at position 4 should be included in the average. The fact that it is quieter at this location than at all others, in our opinion, is not sufficient reason for excluding it from the average, although we have other objections to the way data in Figure 2.15-2 are analyzed, as discussed below.

Wind Speed

Wind speeds were measured at two locations at elevations 60 meters above grade—one location near position 1 on the north side of the site and near position 4 on the south side of the site. Using the standard wind gradient recommended in IEC 64100-11, the wind speed at a reference elevation of 10 meters above grade was estimated. Figure 2.4.2 reports the average wind speeds at the two towers measured at an elevation of 60 meters and adjusted to the reference 10-meter elevation using IEC 64100-11. Our comments are as follows:

1. Wind speeds at the microphone locations were not reported, but are presumed to be below those at the reference elevation of 10-meters above grade as would be concluded from IEC 64100-11 (see Figure 2.3.1 in Appendix H). Based on IEC 64100-11, it would appear that wind speeds of 6 m/s at 10 meters above grade would be about 3 to 4 m/s at-grade. According to data published by Bruel & Kjaer (B & K, 1972), wind generated sound at this lower speed, with wind impinging on a 1" microphone outfitted with a 120 mm diameter windscreen, would be 50 to 55 dBA. This is higher than noted in the L_{90} data reported in Figure 2.5.5, possibly suggesting that the 10-meter reference height wind speeds measured at the towers were different from those actually occurring at microphone locations.

2. As measured wind speeds at the two towers are not reported, only the average of wind speeds measured at the two towers is reported, it is not possible to observe how wind speed varies over the site.

   This is important since wind speed is applied to sound monitoring positions quite far from the wind speed measurement locations. If there is significant difference between wind speeds at the two towers, then it stands to reason that wind speeds measured at the towers would not represent wind speeds at sound measurement locations, especially those furthest away. Accordingly, it makes sense that the further the sound measurement location from the wind measurement location, the more uncertain the relationship between sound levels and wind speeds measured.

3. The reliance on the method of IEC 64100-11 for adjusting wind speed at one elevation to determine the wind speed at another may be inaccurate as noted in van den Berg, 2003. The author maintains that at night, as compared with the day, the upper elevation wind speeds are skewed higher than wind speeds at lower elevations. The effect on the Cape Vincent Wind Power Project is that for a given wind condition at the hub, the ground wind speed may be lower than would be determined using IEC 64100-11. The result would be a greater difference between the wind turbine sound and background corresponding to a higher noise impact than estimated using IEC 64100-11 for adjusting wind speed.

4. Figure 2.5.4 seems to exhibit at times almost a reverse correlation between wind speed and background sound.

5. Figure 2.5.5 shows the lack of correlation between wind speed and background sound level. The very low R^2 value (coefficient of determination) indicates very little dependence of measured sound levels on measured wind speeds.

   Impact as defined in the DEIS is the difference between wind turbine sound and background sound. As the DEIS indicates, as long as the wind turbine sound does not exceed the background sound by more than 6 dBA, noise impact would deemed to be acceptable under NYSDEC guidelines.

   Were the sound level and wind speed data to fall very close to a regression curve ($R^2 \cong 1.0$), then the use of the regression curve to estimate background sound for purposes of evaluating the potential noise impact produced by a wind turbine would be generally acceptable—at times the impact might then be slightly overestimated or slightly underestimated, but by small amounts.

   In the case at hand, R^2 is very near zero and suggests that little or no relationship exists between wind speed and background sound. Hence, the regression curve should not be used because it does not account for background sound. This stands to reason since there are several sources of uncertainty that make their way into the analysis of background sound and wind data including the uncertainty that wind measured at one location corresponding to that at a distant sound measurement location, the averaging of background sound levels measured at several disparate locations, the uncertainty associated with adjusting wind speed measured at 60-meters to a wind speed at a 10-meter reference elevation above grade, distance of microphones from foliage noise sources, and the presence of other significant sources such as traffic and insect noise (see spectral data in Figure 2.6.2 of Appendix H).

   Looking at the data, use of the regression fit given in the DEIS for estimating background sound level for a given wind speed would mean that for a significant number of instances the impact of wind turbine noise would be overestimated by a large margin; correspondingly, for a significant number of instances the impact of wind turbine noise would be underestimated.

   Statistically, this would be interpreted as an indication that there are one or more other factors that affect background sound level in addition to wind speed, and that these should be measured and included in a multiple regression. What these other factors are and how they are measured to be included in a multiple regression analysis would be very difficult to determine.

6. It is our opinion that trying to relate wind speed to background sound for purposes of evaluating wind turbine noise impact in accordance with NYSDEC guidelines is not appropriate since the relationship is nearly non-existent or is more predominantly influenced by other sources and factors. This is not to say that wind speed does not affect background sound, but only to say that the approach taken—attempting to relate background noise wholly to wind speed—does not provide an accurate background for purposes of implementing the NYSDEC guideline for evaluating noise impact.

   Instead, we recommend that the noise data be considered irrespective of wind speed. The NYSDEC guide does not provide specific methods for evaluating background sound. However, on the basis of our experience, we suggest that the 90th percentile of the L_{90} sound levels measured at each representative building (positions 1-7) be used as the background. It is to each of these that estimate wind turbine sound should be compared to evaluate noise impact.

Sound Measurement Positions (Figures 2.2.1-14)

In measuring foliage noise, one objective is to locate microphones at building locations, or located similarly juxtaposed to foliage sound sources as building locations. From the photographs in Figures 2.2.1 through 2.2.14, this appears to be achieved with the possible exception of positions 3 and 7 which appear to be relatively close to foliage sound sources as compared with buildings. It would then appear that foliage sound produced by wind at these locations might be higher than foliage sound at residences intended to represented by this measurement position. It is worthwhile that the authors of the Appendix H report comment on this.

Comments on the DEIS Section 2.16.2

Equation 1

The constant in the relationship shown between sound pressure levels and source sound power level should be 0.5 rather than 0.05 as shown. This error, however, is immaterial to the analysis.

Table 2.16-2 and 2.13-3

The data in these tables are for one wind turbine operating and are of questionable relevance since many wind turbines would operate simultaneously producing more sound than reported in these tables.

Section 2.16.4

The third bullet of Section 2.16.4 lists as a proposed mitigation *"Addition of sound dampening* [sic] *materials to the nacelles to mask generator noise…"* The addition of damping to components of the wind turbine may help reduce some sound, but no information is given in the DEIS, presumably because the wind turbine vendor was not selected at the time the DEIS was issues. The bullet mentions that damping materials would *"…mask generator noise…"* This would not be the case; it would reduce, mitigate, or otherwise lessen sound produced by the wind turbine generator, but not produce sound that would "mask", i.e. cover-up sound produced by the wind turbine generator.

The fourth bullet suggests modifying the blade design to reduce aerodynamic noise. It would be assumed that any wind turbine selected would have incorporated the quietest design possible, and the developer's purchase specification should at least consider the use of the quietest wind turbines available.

It is worthwhile noting that there are two largely separate sources of wind turbine blade noise: boundary layer turbulence and vortex shedding. Boundary layer turbulence is constant broadband sound mostly produced at the trailing edge of the wind turbine blades.

Vortices shed from the tips of the wind turbine blades are blown back behind the rotating blades by the wind. When these eddies cut across the wind turbine support structure, they produce a pressure pulse. The repeating train of these pulses is the mechanism behind the generation of low frequency sound. When modern wind turbines were originally designed, their blades were located downwind of the support structure. As the blades of these original wind turbines pass through the vortex shed behind the tower supports, the blade is excited, i.e. deflected or displaced slightly momentarily while passing through the vortex. The large blade area thus becomes an efficient radiator of low frequency sound. Designing wind turbines so that the blades are upstream of the tower support has mostly eliminated low frequency excitation in newer wind turbines.

Because the remaining concern about low frequency sound produced by wind turbines based on problem experiences with the older designs, it is recommended that the authors comment on this and present low frequency sound data for the turbine design to be installed. This should include estimates of low frequency sound at nearest receptors and comparison with applicable low frequency criteria. These low frequency criteria should also address the widely cited risk of vibroacoustic disease.

Town of Cape Vincent – Public Hearing January 26, 2008

On January 26, 2008, a public hearing was convened to air community concerns about the proposed Cape Vincent Wind Power Project. During the hearing there were four major areas of comment. The following summarizes these and presents our response.

Noise vs. Annoyance

It is the purpose of noise criteria to relate noise levels with anticipated community complaints. The NYSDEC criteria are irrespective of noise source type. Figure 1 of Bajdek, 2007 suggests that wind turbine noise creates more annoyance than for a given level of sound than does other types of environmental noise. For a given level of "percent highly annoyed", wind turbine sound levels are 20 dBA or more lower than for sound produced by road traffic.

A commenter suggested that noise data should include "peak and minimum". It is assumed that this refers to measured ambient sound data. It is our opinion that use of the 90th percentile is proper for evaluating existing ambient sound levels and establishing a limit in accordance with NYSDEC guidelines.

A reference to "ambient as published 20 dB higher than his measurements" was mentioned and has been addressed in our comments regarding wind speed.

It appears that sound monitoring equipment used to measure ambient sound was questioned by a commenter. In our estimation the sound monitoring equipment used was appropriate and installed correctly with the exception of sound monitors at positions 3 and 7 possibly being too close to foliage noise sources as noted above.

A member of the community expressed some concern that the summer noise study was not long enough. It is our opinion that the length of monitoring presented in the DEIS is sufficient to properly evaluate existing ambient sound as discussed in our above review of the DEIS noise analysis.

A concern was expressed for child sleep disturbance produced by wind power project noise. It is our opinion that, if the DEIS criteria are revised as we have suggested, child sleep disturbance should not be an issue.

The greater sensitive of women to noise may be true, but there is little in the technical literature suggesting that this should affect how community noise is evaluated.

Structureborne Sound and Vibration

Structureborne noise has been a significant issue with older-design wind turbines as has been discussed. This excitation is through the air and would be of lesser concern with newer upwind designs; however, sound data for low frequency sound produced by the wind turbines to be installed should be presented in the final EIS.

Bedrock does not normally transmit vibration, even when a tower structure is in direct contact with it. In cases where vibration is transmitted, it is transmitted through the soil lying above the bedrock. If this soil layer is shallow, vibration is constrained between the soil top surface and the bedrock below, causing vibration to transmit with less attenuation with distance. When bedrock is deeply situated, the reduction in vibration in the soil with distance from the tower is greater. Nevertheless, excitation of soil by wind turbine tower structures is not expected to be a significant issue, but should be addressed through vibration measurements in the ground near wind turbines of the type to be installed at the proposed Cape Vincent Wind Power Project.

Resonances or standing waves inside enclosed spaces was cited as a phenomenon of concern. It is true that low frequency sound produced by wind turbine blade passage can be, in a sense, amplified inside building spaces because of standing wave effects. By amplified, it is meant that low frequency wind turbine sound may actually be at a higher level inside a building than outside. Such an effect occurs when frequency, room size, and wall sound transmission loss characteristics serendipitously match in a way that produces an amplification of low frequency sound.

Vibroacoustic Disease (VAD)

A comment was posed regarding vibroacoustic disease (VAD). There has been much written on VAD, but it is our opinion that the effect of low frequency sound produced by wind turbines, is still under medical investigation, and criteria identifying acceptable levels of low frequency sound produced by wind turbines, that can be used for evaluating facilities such as the Cape Vincent Wind Power Project, are yet to be developed. A newspaper article published by Pierpont (Malone Telegram, 2005) suggests that 31% of the residences within ½ to 1 mile from a wind turbine facility in Lincoln, WI *"found noise to be a problem in their households"* and 4% found the same within 1 to 2 miles. Though this cannot be used as a criterion since it applies to a wind power project possibly differing significantly from the proposed Cape Vincent project, the comments made in the article do provide some perspective on potential community concerns.

Radio Frequency Interference

Several comments related to radio frequency (RF) interference produced by wind turbines and their ancillary equipment. This is outside our expertise and would need to addressed separately.

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If we can provide any further information, please do not hesitate to contact us. Thank you.

Yours sincerely,
CAVANAUGH TOCCI ASSOCIATES, INC.

Gregory C. Tocci

cc.: William Elliot

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