<u>Tables</u>

2.7 Sound

Potential noise impacts from the proposed Project are evaluated in the Noise Impact Assessment (NIA) completed by Hessler Associates, Inc. The acoustic study was conducted in two phases. First, the existing acoustic environment was documented by conducting baseline sound level surveys during both summer (foliate) and winter (defoliate) seasonal periods. The second phase of the study consisted of a computer modeling analysis of future WTG operational sound levels using engineering noise prediction software. Noise contour maps of the Project Site visually presenting the results of the modeling were completed to determine whether the Project will operate in compliance with the applicable state and local guidelines and standards. Construction noise impacts are also qualitatively addressed. The full environmental NIA is located in Appendix I of this DEIS.

The results of the ambient sound monitoring program and characterization of the existing acoustic environment is presented in Section 2.7.1, future operational sound levels are discussed in Section 2.7.2, and identification of possible candidate noise mitigation options are provided in Section 2.7.3.

2.7.1 Existing Conditions

The purpose of the baseline noise surveys was to determine existing ambient environmental sound levels within the acoustic study area. Measurements were completed during defoliate conditions and during summertime conditions when the trees are fully leafed out. In order to accomplish this, two separate surveys were carried out for the Project to evaluate seasonal differences in existing sound levels: during foliate summertime conditions, from September 9 to September 25, 2007, and during wintertime conditions with trees bare, from November 29 to December 12, 2007. The sound monitoring data was then used to compare existing ambient sound levels to future operational levels and to assess compliance with applicable criteria.

2.7.1.1 Measurement Locations

The Project Area is rural in nature, consisting of numerous scattered residences, mainly along the principal roads, interspersed with farms of various sizes. Turbines are planned in the largely uninhabited areas between local roads. The Project Site topography is moderately hilly. In terms of vegetation, the area is a largely even mix of open fields and wooded areas. Most of the homes are either near wooded areas or have some trees immediately around the house.

Baseline sound level measurement locations were chosen to evenly cover and represent the entire area as shown in Graphic A (*Environmental Sound Survey and Noise Impact Statement*, Appendix I). Five positions were used for the summertime survey and an additional three locations (making eight altogether) were used to document the worst-case wintertime defoliate survey. A variety of settings were deliberately chosen to see if ambient sound levels were uniform or variable over the Project Area. For example, some positions are in open fields, some in wooded areas, some near homes, and some in more remote areas.

2.7.1.2 Instrumentation

Documentation of the existing acoustic environment were completed using Rion NL Series broadband sound level meters (NL-06, NL-22, and NL-32) which are rated as either ANSI Type 1 and Type 2, except at measurement Position 1 where a Norsonic 118, ANSI Type 1, 1/3 octave band analyzer was used to record frequency content. Each meter was enclosed in a watertight weather-proof case. The Rion monitors were fitted with a 12-inch microphone boom. A Norsonic Model 1212 environmental microphone protection kit was used at Position 1 for the summertime survey only—in the winter survey a boom and large windscreen was used. The microphones were protected from wind-induced self-noise by oversized 180 mm (7-inch) diameter foam windscreens (ACO Model WS7-80T). The position of the microphone was at a reduced height to further minimize the potential of wind induced microphone noise. All equipment was field calibrated at the beginning of the survey and repeated at the end of each survey.

2.7.1.3 Sound Survey Results

Sound level measurements were taken and data logged in ten minute intervals at all monitoring locations and survey periods. Multiple monitoring locations were used to accurately characterize the existing acoustic environment across the entire Project Site. Meteorological conditions, including wind speed data, were also collected in concurrent ten minute intervals. Measurement results showed that sound levels over the site area are of the same general order of magnitude, with some local variation dependant on several factors, the most prevalent being insect noise during the summer foliate monitoring period.

The wind speeds during the periods of sound data collection ranged from mostly under 8 m/s in the summertime, to up to 14 m/s during the wintertime survey. This range of wind speeds is important with respect to wind turbine sound because turbine sound levels are variable from cut-in (around 3 or 4 m/s), where WTG generated sound is minimal, up to about 8 m/s when the rotor first reaches maximum speed and sound levels are approaching or at maximum levels. Beyond wind seeds of 8 m/s, wind turbine sound generation essentially remains steady and no longer increases with increased wind speed. The wind turbine sound power levels were normalized to wind speed assuming a representative roughness length coefficient and reported at a reference height of 10 meters in accordance with the International Electrotechnical Commission (IEC) Standard 61400-11.

The sound measurement equipment was programmed to calculate A-weighted sound levels including ambient equivalent (L_{eq}) as defined by the NYSDEC and other important statistical descriptors such as the residual (L_{90}) and intrusive (L_{10}) sound levels. The use of the L_{eq} level is the metric for establishing baseline conditions, as described in the NYSDEC guideline document in Section V B (1) a (7):

> "Expression of Overall Sound – Part of the overall assessment of sound is the equivalent sound level (L_{eq}) which assigns a single value of sound level for a period of time in which varying levels are experienced over that time period. The L_{eq} value provides an indication of the effects of sound on people. It is also useful in establishing the ambient sound levels at a potential noise source."

From the data collected over the two surveys, ambient L_{eq} sound levels for each seasonality were determined over the entire range of WTG operational wind speeds. During summertime foliate conditions, the ambient L_{eq} will range from 42 dBA at 4 m/s, representative of the approximate WTG cut-in wind speed, and increase to 46 dBA at 9 m/s, representative of WTG full rotational speed. Similarly, during wintertime conditions, the ambient L_{eq} was determined to range from 41 dBA at 4 m/s to 49 dBA at 9 m/s. At higher wind speeds, the summer and winter levels are not considerably different with the warm weather levels being just slightly higher. A summary of ambient sound levels at reference wind speeds is shown in Table 2.7-1. These measured L_{eq} data were used to provide the basis for identifying the maximum net increase in ambient sound levels that would occur during the worst-case WTG operational condition.

Table 2.7-1. L_{eq} Ambient Sound Levels as a Function of Wind Speed Referenced to Standardized Height of 10 meters

Wind Speed (m/s)	4	5	6	7	8	9
Ambient L_{eq} Sound Level, Defoliate (dBA)	41	42	44	45	47	49
Ambient L_{eq} Sound Level, Foliate (dBA)	42	43	44	45	46	46

2.7.1.4 Regulatory Standards and Guidelines

There are currently no federal noise regulations that are directly applicable to this proposed Project. The Town of Arkwright has established a wind energy local law that limits maximum received decibel levels within residential areas. The NYSDEC has issued environmental noise criteria under the SEQR that is defined as incremental increase criteria relative to existing ambient conditions. This guideline was implemented by the Project to further assess the potential for adverse impacts within the acoustic study area to occur. However, the Town of Arkwright noise ordinance is considered controlling law for this Project.

2.7.1.4.1 Arkwright Noise Regulations

The Town of Arkwright has established a local law specifically relating to wind energy facilities (Local Law No. 2 of 2007). The local law limits sound from any wind energy conversion system (WECS) to 50 dBA measured in terms of the L_{10} statistical level at "the nearest residence existing at the time of application." In addition,

> "If the ambient sound level exceeds 50 dBA, the standard shall be ambient dBA plus 5 dBA. Independent certification shall be provided before and after construction demonstrating compliance with this requirement."

A minimum setback of 1,200 feet from all residences is also required in the law. The Town of Arkwright also has a tonal noise provision.

2.7.1.4.2 NYSDEC Noise Guidelines

In 2001, NYSDEC published Program Guidelines titled *Assessing and Mitigating Noise Impacts* (NYSDEC Guidelines), which describes a methodology for the evaluation of potential community impacts from any new noise sources. The NYSDEC Guidelines focus on an incremental increase in dBA sound levels relative to existing conditions. The NYSDEC Guidelines state the following principle for evaluating when noise impacts that occur at existing residences, or other potentially sensitive receptors (i.e., schools, churches, etc.), may be considered significant:

> "The goal for any permitted operation should be to minimize increases in sound pressure level above ambient levels at the chosen point of sound reception. Increases ranging from 0 to 3 dB should have no appreciable effect on receptors. Increases from 3 to 6 dB may have potential for adverse noise impact *only in cases where the most sensitive receptors are present*[1]. Sound pressure increases of more than 6 dB may require closer analysis of impact potential depending on existing sound pressure levels (SPLs) and the character of surrounding land use and receptors."

Thus, incremental increases of 3 to 6 dBA are considered to have impacts only when the most sensitive receptors are present and no impacts are anticipated from incremental increases below 3 dBA. Cumulative increases in the total ambient sound level of 6 dBA or less are unlikely to constitute an adverse community impact. Because decibels add logarithmically, this threshold means that the Project may generate sound levels that exceed the existing ambient level by up to 5 dBA. For example, an ambient level of 40 dBA plus a Project-only sound level of 45 dBA would equal a total cumulative level of 46 dBA—or a 6 dBA incremental increase above the existing ambient.

2.7.2 Anticipated Impacts

Sound levels associated with both Project construction (Section 2.7.2.1) and Project operations (Section 2.7.2.2) were assessed. Sound levels resulting from construction activities were estimated at the closest non-participating residences. Operating sound impacts were predicted using the CadnaA model and incorporating the proposed Project site plan, manufacturer WTG source sound power level data, and terrain elevation data. Results were presented visually as noise contour isopleths maps and results compared to the applicable noise criteria limits.

2.7.2.1 Construction Noise Impacts

Noise from construction activities associated with the Project may temporarily result in short-term unavoidable noise impacts at noise sensitive areas within the Project Area. Assessing and

[1] Italics added by DEIS author.

quantifying these impacts is difficult because construction activities will constantly be moving from place to place around the site leading to highly variable impacts with time, at any given point. In general, the maximum potential noise impact at any single residence might be analogous to a few days or up to a few weeks for repair or roadway repaving work or to the sound of construction equipment operating on a nearby farm. More commonly (at houses that are some distance away), the sounds from Project construction are likely periodically perceptible noise from diesel-powered earthmoving equipment, specifically variable engine loads, back-up safety alarms, gravel dumping, and the clanking of metal tracks.

The individual pieces of equipment likely to be used and their typical noise levels as reported in the *Power Plant Construction Noise Guide* (Empire State Electric Energy Research Corp.) are tabulated in Table 2.7-2. This table shows the maximum total sound levels that might temporarily occur at the closest non-participating residences (at least 1,200 feet away) and the distance from a specific construction site at which its sound would drop to 40 dBA. Although considered when assessing operational noise, wind speed is irrelevant to the background level during the construction phase, as there will be construction occurring during both calm and elevated wind conditions.

Table 2.7-2. Typical Noise Emission Levels of Construction Equipment

Construction Equipment	Sound Level at 50 feet (dBA)	Estimated Maximum Total Level at 50 feet per Phase (dBA) a/	Maximum Sound Level at a Setback Distance of 1,200 feet (dBA)	Distance Until Sound Level Decreases to 40 dBA (feet)
Road Construction and Electrical Line Trenching				
Dozer, 250-700 hp	88	92	61	5500
Front End Load, 300-750 hp	88			
Grader, 13-16 ft. blade	85			
Excavator	86			
Foundation Work, Concrete Pouring				
Piling Auger	88	88	57	4200
Concrete Pump, 150 cu yd/hr	84			
Material and Subassembly Delivery				
Off Highway Hauler, 115 ton	90	90	59	4800
Flatbed Truck	87			
Erection				
Mobile Crane, 75 ton	85	85	54	3400

a/ Not all vehicles are likely to be in simultaneous operation. Maximum level represents the highest level realistically likely at any given time.

Table 2.7-2 shows that, depending on the particular activity, noise from construction equipment is likely to be significant at distances of up to 5,500 feet; therefore, construction will occur close enough to many homes within the site area that its noise will be clearly audible. Noise levels ranging from 54 to 61 dBA might temporarily occur at the closest homes over several weeks due to construction activities at each turbine location and somewhat higher levels might be temporarily experienced at homes that are very close to road construction or trenching operations. Such levels would not generally be considered acceptable on a permanent basis, but as a temporary occurrence, construction noise of this magnitude may go unnoticed by many in the Project Area. For others, Project construction noise may be an unavoidable temporary impact.

Noise from the low volume of vehicular traffic to and from the current site of construction should be negligible in magnitude relative to normal traffic levels (even given the rural nature of the roads in the Project Area) and temporary in duration at any given location.

2.7.2.2 Operational Sound Impacts

Though the Applicant plans to utilize the Vestas V-90 1.8 MW turbine, the NIA also considers the GE 1.5 sle. Section 2.7.2.2.1 presents source sound power level data for both models, followed by the determination of the WTG worst-case operational acoustic condition. When evaluating the differences in turbine sound level relative to ambient level, the GE 1.5 sle produced a differential equal or greater than that of the Vestas V-90 1.8 MW for the range of wind speeds. Therefore, modeling of operational sound levels was only completed for the GE 1.5 sle WTG, as it represents the design model with higher sound impacts.

2.7.2.2.1 Turbine Source Data

The sound emissions of each model, as a function of wind speed, are known from field tests carried out by independent acoustical engineers in accordance with IEC 61400-11. The values for the GE sle 1.5 unit are reported in a document entitled *Technical Documentation, Wind Turbine Generator System GE 1.5sl/sle 50 & 60 Hz, Noise Emission Characteristics*. For the Vestas turbine, the information is provided in the *General Specification V90-1.8/2.0 MW Optispeed Wind Turbine*. Both are provided in Appendix B. For an 80-meter hub height, as is planned for this Project, the following overall sound power levels are published for each model as a function of wind speed at the standardized measurement height of 10 meters (Table 2.7-3).

Table 2.7-3. Sound Power Levels Correlated with Wind Speed for GE and Vestas Turbine Models Being Considered for the Project

	L_{max} Sound Power Level (L_W) at Reference Wind Speed, dBA re 1 pW							
Wind Speed (m/s)	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s
GE 1.5 MW sle	<96	<96	99.1	103.0	104.0	104.0	104.0	104.0
Vestas V-90 1.8 MW	-	94.3	99.7	102.2	104.0	103.7	103.7	103.5

2.7.2.2.2 Defining WTG Worst-Case Operational Acoustic Condition

In terms of potential sound impacts, the worst-case combination of background and turbine sound levels would occur at the wind speed where the background level was lowest relative to the turbine sound level. Table 2.7-4 shows that this worst-case situation does not occur at the highest wind speeds when the turbines produce the most sound, but rather at intermediate wind speeds of 6 m/s and 7 m/s where the differential between the L_w and the ambient sound level is the greatest. Consequently, ambient levels measured during a 6 m/s wind were used as a basis to calculate the NYSDEC incremental increase threshold guidelines (see Appendix I for further details).

Table 2.7-4. Comparison of Background and GE Turbine Sound Levels to Determine Critical Design Level (dBA)

Wind Speed (m/s)	4	5	**6**	7	8	9
GE 1.5 sle L_W (dBA re 1 pW)	<96	99	**103**	104	104	104
Ambient L_{eq} Sound Level, Winter Defoliate	41	42	**44**	45	47	49
Net Differential	55	57	**59**	59	57	55
Ambient L_{eq} Sound Level, Summer Foliate	42	43	**44**	45	46	46
Net Differential	54	56	**59**	59	59	58

* **Bold** type indicates worst-case design wind speed.

2.7.2.3 Acoustic Modeling Methodology

Using the design sound power level in Table 2.7-4, sound pressure level contour plots were calculated using the CadnaA (version 3.5) sound modeling program developed by DataKustik, GmbH (Munich). This software enables the Project and its surroundings, including terrain features, to be realistically modeled in three-dimensions. Each turbine was modeled at the design hub height of 80 meters above the local ground surface using the proposed Project layout. A somewhat conservative ground absorption coefficient was applied given that all of the intervening ground between the turbines and potentially sensitive receptors is open farm fields, pasture land or wooded areas. In addition, sound attenuation from wooded areas (foliage) has been completely ignored for all calculations. Further conservatism is introduced by assuming a downwind propagation in all geographical directions *simultaneously*. This approach yields a contour plot that shows the maximum possible sound level at any given point and sometimes also shows levels that are a physical impossibility; for example, sound levels presented at locations between two or more adjacent turbines, since the wind would have to be blowing in two opposing directions at the same time for these worst-case sound levels to occur. These various conservative assumptions in the modeling analysis have been applied to ensure that Project sound levels do not exceed predicted levels under most normal atmospheric and meteorological conditions and also to allow some design margin for times when atmospheric conditions may occasionally favor sound propagation relative to standard day conditions. Future operational sound levels are expected to be lower than those presented in the NIA the majority of the time.

2.7.2.4 Noise Impact Analysis Results

Noise modeling was completed for two different scenarios to accurately quantify worst-case sound levels on both an absolute and incremental increase basis to provide a compliance determination with all applicable regulatory criteria. The Project operational modeling results are shown in Plots 1 and 3 (*Environmental Sound Survey and Noise Impact Statement*, Appendix I), where the outermost sound level contour is associated with a specific limit or threshold based on the assumed background level and season. Detailed noise impact analysis results for the GE 1.5 sle WTG are provided in Appendix I.

Scenario 1 predicts operational sound levels for the GE 1.5 sle at its worst-case operational design wind speed in wintertime conditions. Plot 1 shows the Project sound levels out to a level of 49 dBA, which represents the 6 dBA cumulative increase threshold recommended by the NYSDEC based on the measured average, or L_{eq}, sound level (44 dBA) during a 6 m/s wind in the wintertime. The region inside the threshold line represents the area where turbine sound may result in a potential adverse noise impact relative to the measured ambient level. All residences are well outside the NYSDEC 49 dBA threshold isopleths, which occurs at a relatively close distance to each turbine and well short of the minimum 1,200 feet (365 meters) setback limit. This plot demonstrates no significant adverse noise impacts under the winter defoliate conditions.

Scenario 2 predicts operational sound levels for the GE 1.5 sle at its worst-case operation design wind speed in summertime conditions. In Plot 3, the NYSDEC impact threshold of 49 dBA for warm weather conditions is illustrated. Since the equivalent (L_{eq}) ambient sound level was found to be the same in the summer as it is in the winter, the small regions of potential impact immediately around each turbine are the same as Plot 1.

The GE 1.5 sle did not show any predicted exceedances of the cumulative increase threshold recommended by NYSDEC, which means a secondary assessment of the potential for adverse impacts is not necessary according to NYSDEC Guidelines. In addition, it is evident from the noise contour plots that a Project-only sound level of 50 dBA or more will not occur at any homes or other sensitive receptors within the Project Area. However, the Applicant requested a secondary analysis to be performed by Hessler Associates using the much more conservative residual L_{90} statistical descriptor, with results provided for informational purposes in Appendix I.

The noise contour plots conservatively represent each scenario, since for the predicted sound levels to actually occur, the following conditions would be necessary:

- The wind would need to be blowing from all the nearest turbines towards the point of observation;

- The wind would need to be blowing at a speed of 6 m/s (note – the wind blows between 5.5 m/s and 6.5 m/s about 13 percent of the year);
- The ground surface would need to be semi-reflective (as might happen when it is frozen or partially covered with ice or glazed snow);
- No leaves on the trees;
- Observer outside; and
- Environmental noise temporarily at a minimum (for worst-case impacts).

These conservative assumptions and worst-case conditions have been consciously adopted for the analysis because the perceptibility of turbine sound varies with atmospheric conditions and time of day. Even with conservative assumptions, there may be a small number of times when the actual impact may approach or even exceed the conservatively predicted levels in the plots under certain conditions. Of course, the majority of the time the perceptibility of Project sound will be less than indicated in the graphics because of the conservative assumptions in the noise model. The model predicts that Project sound may be perceptible *outside* (not inside) a number of houses throughout the Project Area, but the circumstances required for the worst-case levels shown in the contour plots would occur infrequently, when all conditions favoring noise propagation are in place (i.e., leaves off trees, observers outside, 6 m/s wind, etc.). The analysis generally indicates that annoyance could result outside some homes in the Project Area—particularly during certain atmospheric and seasonal conditions.

Modern wind turbines of the type proposed for this Project do not generate low frequency or infrasonic noise to any significant extent and no impact related to low frequency noise is expected. The results of a carefully controlled field study are given demonstrating that a typical 1.5 MW wind turbine produces no significant noise below about 40 Hz. In addition, the maximum (conservatively) predicted C-weighted sound level at any receptor is at least 15 dBC below the minimum threshold of perception. Operation of either the Vestas or GE wind turbines will not result in a steady state pure tone or impulsive noise conditions at any noise sensitive area location, as per the IEC definitions. Compliance with the local limits and the Arkwright tonal provisions are expected.

2.7.3 Mitigation

2.7.3.1 Project Construction

Construction noise will occur during site leveling and grading, pile driving, excavation, concrete pouring, and component erection. Noise emitted during the construction phase of the Project is exempted from numerical decibel limits of the Town of Arkwright; however, reasonable measures will be undertaken to reduce the impact of construction noise at nearby residences. The following mitigation measures will be applied to Project construction, as necessary and practicable:

- Construction activity will be limited to daytime hours to reduce the potential impact of construction noise, whenever possible;
- Nearby residents will be advised of significant noise-causing activities and efforts will be made to schedule such activities to create the least disruption to receptors;
- All construction equipment will be maintained in good working condition in order to reduce general noise emissions;
- When practical, heavy equipment will be shut down when not active, to minimize idling noise;
- All internal combustion engines will be fitted with appropriate muffler systems;
- Stationary equipment will be located and oriented so that natural noise screening/dampening features such as cut slopes are used to prevent noise from traveling directly to nearby noise sensitive areas; and
- When practicable, temporary noise barriers (e.g., berms, kit-of-parts barriers, and equipment enclosures) will be utilized to obstruct the direct sound pathway between source and noise sensitive areas.

If construction activities are scheduled during nighttime hours (20:00 – 07:00), they will be limited to “quiet” operations when possible, except as necessary for safety reasons. Specific nighttime operations deemed “acceptable” to nearby residents may be modified as construction operations proceed.

2.7.3.2 Project Operation

The Project has been purposely designed to minimize environmental noise by siting wind turbines as far away from existing residential receptor locations as practicable, while keeping the Project economically viable. The Project will operate in full compliance with the applicable noise standards and State Guidelines. Despite these findings, the Applicant understands that the control of environmental noise has become increasingly important in the siting and operation of wind energy projects.

Site configuration modifications, including reducing the number of turbines or changing the location of turbines, are not expected as a result of the Project operational modeling showing no exceedances of the applicable noise regulations. Noise assessment analysis results show that mitigative measures will not likely be required other than conducting regular operation maintenance visits to ensure the WTGs are functioning properly; however, as a further mitigative measure, the Applicant has committed to the following, as necessary:

- Encouraging potentially affected residences (none currently identified) to become Project participants by signing these receptors to become Project participants;

- Implementing the complaint resolution program set forth in (Appendix N) whereby neighboring residents (or others) can contact the Applicant with their concerns. Such complaints will be logged and investigated in order to resolve the identified issue; and
- Complete sound testing after commissioning to ensure WTGs are meeting manufacturer's noise specifications.