3862 Clifton Manor Place
Haymarket, Virginia 20169 USA
703-753-1602 (O)
703-753-1522 (F)
www.hesslernoise.com

Report No. 2015-062915-B

Rev: B
Date of Issue: October 23, 2015

Environmental Sound Survey and Noise Impact Assessment

Jericho Rise Wind Farm

Towns of Chateaugay and Bellmont
Franklin County, NY

Prepared for:

Environmental Design & Research
Syracuse, NY

Prepared by:

David M. Hessler, P.E., INCE
Principal Consultant
Hessler Associates, Inc.

COMMONWEALTH OF VIRGINIA
DAVID MARK HESSLER
No. 034626
PROFESSIONAL ENGINEER

Contents

1.0 Introduction

Hessler Associates, Inc. has been retained by Environmental Design & Research (EDR) on behalf of Jericho Rise Wind Farm, LLC to evaluate potential noise impacts from the proposed Jericho Rise Wind Farm, which is located in the Towns of Chateaugay and Bellmont in Franklin County, NY. Current plans call for the installation of 37 wind turbines on 43 possible sites; i.e. 6 sites will not be developed. The specific turbine type currently envisioned for the project is the Gamesa G114 2.1 MW (114 m rotor diameter, with a 2.1 MW nominal electrical output) on 93 m towers.

The study essentially consisted of two phases: a background sound level survey and a computer modeling analysis of future turbine sound levels. The field survey of existing sound levels at the site were necessary to determine how much natural masking noise there might be - as a function of wind speed - at the nearest residences to the project. The relevance of this is that high levels of background noise due to wind-induced natural sounds, such as tree rustle, would reduce or preclude the audibility of the wind farm, while low levels of natural noise would permit operational noise from the turbines to be more readily perceptible. For a broadband noise source the audibility of, and potential impact from, the new noise is a function of how much, if at all, it exceeds the pre-existing background level.

In the second phase of the project an analytical noise model of the project was developed to predict the sound level contours associated with the project over the site area and thereby determine the extent to which nearby residents might be able to discern the turbines above the pre-existing background level and what that might mean in terms of impact.

In addition to local regulatory noise limits, the primary basis for evaluating potential project noise impacts is the Program Policy *Assessing and Mitigating Noise Impacts* issued by the New York State Department of Environmental Conservation (NYSDEC), Feb. 2001. This assessment procedure looks at potential noise impacts in relative rather than absolute terms by comparing expected future sound levels (developed from modeling) to the pre-existing level of background sound (determined from field measurements). The procedure essentially defines a cumulative increase in overall sound level of 6 dBA as the threshold between no appreciable effect and a potentially adverse impact.

Apart from these state and local metrics a further assessment of the expected impact is also discussed based on the CNR, or modified Composite Noise Rating, method.

1.1 Executive Summary

A field survey of existing sound levels within the Jericho Rise Wind Farm project area under early spring conditions indicates that background sound levels are variable and dependent to a significant degree on wind speed. Noise from roadways and other man-made sources is of secondary importance over most of the site and existing sound levels are generally dominated by natural sources.

A regression analysis of sound levels vs. wind speed shows that the average, or "typical" background sound level increases with wind speed and ranges from about 38 to 43 dBA over the range of wind speeds where turbine noise is variable; i.e. from about 4 m/s (measured at a standard elevation of 10 m) to 7 m/s when the turbine rotor reaches its maximum rotational speed and the sound output becomes constant. The residual (L90) sound level increases from 31 to 38 dBA over the same wind speed range. A fairly uniform sound level was found to exist at all 8 monitoring stations despite the deliberate diversity of the settings in which the instruments were placed (wooded, open fields, remote, near roads, etc.). Consequently, the average sound levels from all positions, after the removal of obvious local contamination, reasonably characterizes the site-wide sound level.

A comparison, as a function of wind speed, between the background sound levels and the variable sound power level of the Gamesa G114 2.1 MW turbine currently planned for the project indicates that the maximum potential for an adverse impact from noise occurs at a moderate wind speed of 6 m/s, rather than at higher wind speeds as might be imagined. At 6 m/s the greatest differential exists between the turbine sound level and the amount of masking background noise available to obscure project noise. This analysis showed that the "typical" (Leq) background sound level likely to exist under these conditions was **41 dBA** and the "conservative", near-minimum (L90) sound level, was **35 dBA**. By definition L90 sound levels only occur 10% of the time, so these lower, conservative levels do not represent the permanent background sound level, but rather momentarily low levels.

In the New York State Department of Environmental Conservation's Program Policy *Assessing and Mitigating Noise Impacts* a cumulative increase in sound level of 6 dBA is characterized as having the "potential for adverse noise impact only in cases where the most sensitive of receptors are present" and is suggested as a threshold for determining what areas might be adversely impacted by a new noise source and what areas should see "no appreciable effect". For this site a 6 dBA cumulative increase is associated with a project-only sound level of **46 dBA**[1] for "typical" conditions and **40 dBA** when the background sound level is at a momentary minimum ("conservative" conditions).

A Second Level modeling study carried out per the NYSDEC guidelines showed that the region where noise impacts might occur (i.e. where an increase of 6 dBA or more is predicted) does not encompass any homes based on "typical" background levels but does potentially affect most of the homes in the immediate project area when the wind is blowing at 6 m/s and the background sound level is at a temporary minimum.

An analysis of the potential project noise impact based on the modified CNR method was also carried out. This methodology evaluates the frequency content of the background and project

[1] 41 (background) + 46 (project) = 47 dBA (total), or 6 dBA above the background level.

sound levels and considers other factors such as the temporal characteristics of the noise source, public attitude and the character of the sound. This analysis independently confirmed the findings of the modeling analysis using the NYSDEC relative increase methodology.

In theory, these analyses indicate that an adverse impact is possible in areas where a sound level of 40 dBA or higher is predicted but it should be noted that the modeling is conservative in a number of respects:

- The L90 background level that is assumed in the "conservative" analysis represents the quietest lulls between wind gusts, cars passing by, dogs barking, farm equipment, etc. As such, this level quantifies a very low value for masking environmental noise. Most of the time a substantially higher background sound level will exist.

- It is assumed that a turbine will be erected on all 43 turbines sites whereas only 37 turbines are actually planned.

- The noise model assumes that a 6 m/s wind is blowing simultaneously from all directions and that the turbine sound level experienced at any given point is the sound level that would occur downwind from all turbines in the project. Such a sound level is a physical impossibility in many situations. For example, a receptor between two turbines cannot possibly be downwind from both units at the same time.

- The ground surface is assumed to have a fairly low absorptivity – normally wooded areas and farm fields are highly absorptive.

- The predicted sound levels occur *outside*. Sound levels inside of any dwelling will be 10 to 20 dBA lower. This reduction generally puts the project sound level inside any home at or below the sleep disturbance threshold of 30 dBA published by the World Health Organization[1]

These conservative assumptions are intended to over-estimate project sound levels under most normal conditions so that some allowance or buffer exists to cover the intermittent occurrence of certain atmospheric conditions that allow turbine noise to be more readily perceived, such as during stable atmospheric conditions that sometime develop in the evening or at night.

Although the actual project sound levels are expected to be lower than the predicted levels most of the time, a mildly adverse reaction may be possible from some residents in the project area and the possibility of stronger reactions cannot be ruled out. The density of turbines, their proximity to residences and the relatively low background sound levels found during the field survey mean that some level of dissatisfaction may occur but probably only during certain wind and weather conditions.

In any case, the modeling analysis shows that full compliance is expected with the local laws in Chateaugay and Bellmont relating to wind energy facilities. The maximum allowable sound level of 50 dBA is predicted to occur well short of any residence, participating or otherwise.

Although concerns are often raised with respect to low frequency noise emissions from wind turbines, no adverse impact of any kind related to low frequency noise is expected from this project. An extensive and impartial governmental study recently completed by Health Canada shows no relationship between various health symptoms and exposure to the sound emissions from wind turbine. Other studies suggest a psychosomatic origin to the very real health issues that have inexplicably occurred at some wind farms.

Unavoidable noise impacts may occur during the construction phase of the project. Construction noise, sounding similar to that of distant farming equipment, is anticipated to be sporadically audible at most homes within the immediate project vicinity on a temporary basis. The maximum magnitude of construction noise at the nearest homes to individual turbine locations is not expected to exceed 54 to 61 dBA depending on the particular activity. Somewhat higher levels are possible where road building or trenching activities occur fairly close to homes.

2.0 Background Sound Level Survey

2.1 Objective and Measurement Quantities

The purpose of the survey was to determine what minimum environmental sound levels are consistently present and available at the nearest potentially sensitive receptors to mask or obscure potential noise from the project under cool season, early spring conditions when environmental sound levels are relatively low. A number of statistical sound levels were measured in consecutive 10 minute intervals over the entire 15 day survey. Of these, the average (Leq) and residual (L90) levels are the most meaningful.

The average, or equivalent energy sound level (Leq), is literally the average sound level over each measurement interval. This is the "typical" sound level most likely to be observed at any given moment.

The L90 statistical sound level, on the other hand, is commonly used to conservatively quantify the near-minimum background sound level. The L90 is the sound level exceeded during 90% of the measurement interval and has the quality of filtering out sporadic, short-duration noise events, like cars passing by or short-lived wind gusts, thereby capturing the quiet lulls between such events. It is this consistently present background level that forms a "conservative" basis for evaluating the audibility of a new source.

An additional factor that is important in establishing the minimum background sound level available to mask potential wind turbine noise is the natural sound generated by the wind itself. Wind turbines only operate and produce noise when the wind exceeds a minimum cut-in speed of roughly 3 m/s (measured at a standard reference elevation of 10 m). Turbine sound levels increase with wind speed up to about 7 m/s when the sound produced essentially reaches a maximum and no longer increases with wind speed. Consequently, at moderate to high speeds the level of natural masking noise is normally relatively high due to the rustling of trees or vegetation while the turbine sound level no longer increases thus reducing the perceptibility of the turbines. In order to quantify the wind-dependency of the background sound level, the 10 minute average wind speed was measured over the entire sound level survey period at a meteorological (met) tower within the site area for later correlation to the sound data.

2.2 Site Description and Measurement Positions

The proposed turbines in the Jericho Rise Wind Project are spread out over an area of very roughly 18 square miles within the Towns of Chateaugay and Bellmont, NY. The site area is rural in nature and can be characterized as consisting of numerous scattered residences, mainly along the principal roads, interspersed with farms of various sizes.

The site topography is essentially flat with only a few undulations that are irrelevant to sound propagation. In terms of vegetation, the area is a 50/50 mix of open fields and wooded areas. Many of the homes are either near wooded areas or have some trees immediately around the house.

Background sound level measurement locations were chosen to evenly cover and represent the entire area as shown in **Graphic A**. Eight positions were used for the survey. The specific positions are detailed below. As will be noted from the pictures, a variety of settings were deliberately chosen to see if background sound levels were uniform or variable over the site area. For example, some positions are in open fields, some in wooded areas, some near homes, and some in remote areas.

2.2.1 Position 1

Position 1 was located at the edge of a large farm field 1070 ft. south of CR 23 (Malone-Chateaugay Road) in the northern part of the site. A frequency analyzer and anemometer were used at this position. The general vicinity of the position and a representative photograph of the instruments are shown below.

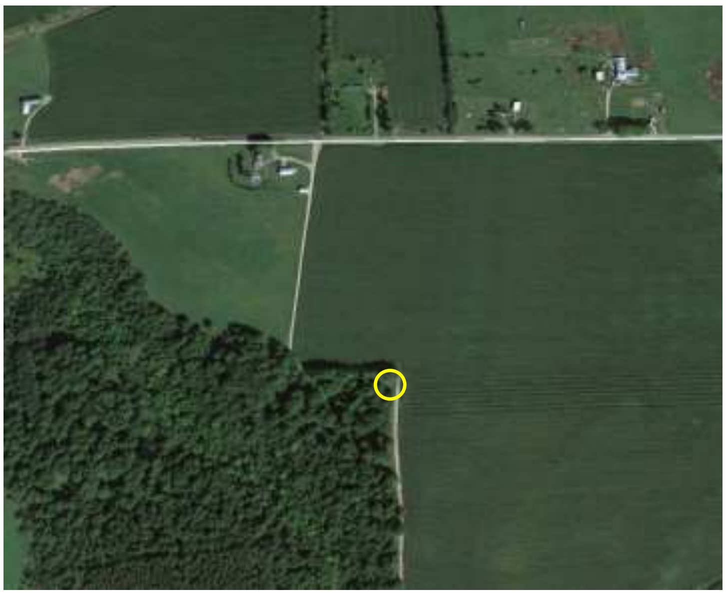


Figure 2.2.1.1
Aerial of Position 1 Vicinity

Figure 2.2.1.2

Position 1 Looking N

2.2.2 Position 2

Position 2 was set up in a large open field about 170 ft. south of Jerdon Road. This location is somewhat remote from any wooded areas or human activities and is subject to only occasional and distant vehicular traffic. The general vicinity of the position and a photograph are shown below.

Figure 2.2.2.1
Aerial of Position 2 Vicinity

Figure 2.2.2.2
Position 2 Looking S

2.2.3 Position 3

Position 3 was set up in another large open field behind a residence at 570 Hartnett. The meter was about 600 ft. from the road and therefore remote from any traffic activity.

Figure 2.2.3.1
Aerial of Position 3 Vicinity

Figure 2.2.3.2
Position 3 Looking N towards House and Barn

2.2.4 Position 4

Position 3 was at the edge of a field behind an abandoned houses at 549 Healy Road. The meter was about 260 ft. from the road.

Figure 2.2.4.1
Aerial of Position 4 Vicinity

Figure 2.2.4.2
Position 4 Looking NE towards Abandoned House

2.2.5 Position 5

Position 5 was set up within the Ponderosa Campsite property at a location behind the office where it would be somewhat removed from day to day activities and local noise events. At the time of the survey, before Memorial Day, the camp was largely unoccupied and the ponds near the measurement position (visible in Figure 2.2.5.1) had been drained down for the winter.

Figure 2.2.5.1
Aerial of Position 5 Vicinity

Figure 2.2.5.2
Position 5 Looking S towards the Campground Office

2.2.6 Position 6

Position 6 was set up in an open field behind a house at 1763 County Route 24 (Brainardsville Road) on the southern edge of the project area. Although most of the houses along this fairly major road are only set back about 50 to 60 ft., the monitor was placed 400 ft. from the road to minimize the influence of any traffic noise. A frequency analyzer was used at this position. The general vicinity of the position and a representative photograph of the instrument are shown below.

Figure 2.2.6.1
Aerial of Position 6 Vicinity

Figure 2.2.6.2
Position 6 Looking SW towards House

2.2.7 Position 7

Position 7 was set up at the edge of a wooded area just off Willis Road (CR 33). A frequency analyzer and anemometer were used at this position.

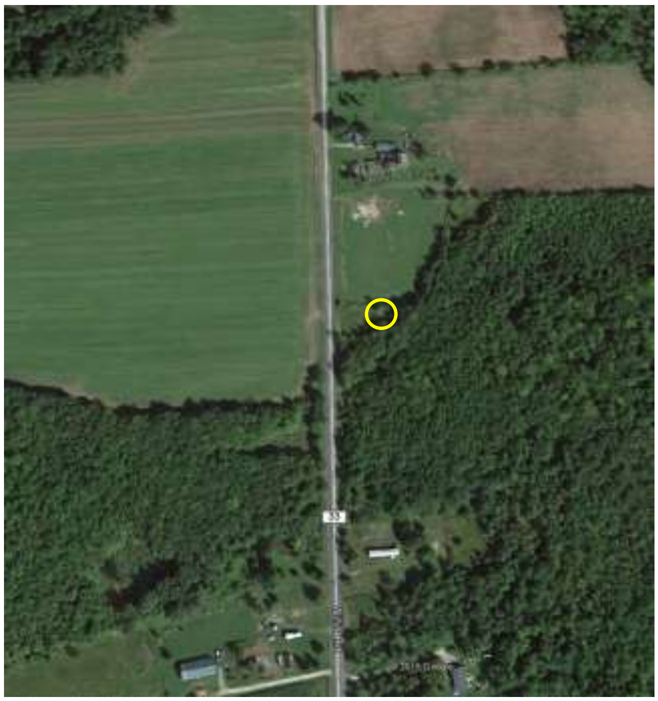


Figure 2.2.7.1
Aerial of Position 7 Vicinity

Figure 2.2.7.2
Position 7 Looking W towards Willis Road

2.2.8 Position 8

Position 8 was located in a wooded area in the southwestern corner of the project area just south of Willis Road (County Highway 33) opposite a house at 273 Willis Rd.

Figure 2.2.8.1
Aerial of Position 8 Vicinity

Figure 2.2.8.2
Position 8 Looking N towards CR 33

2.3 Instrumentation

Rion NL-22, and NL-42 ANSI Type 2 sound level meters were used at all locations except Positions 1, 6 and 7 where Norsonic N-140, ANSI Type 1, 1/3 octave band frequency analyzers were used to record the frequency content. As is evident from the photos in Section 2.2, each meter was enclosed in a watertight case and the microphone was supported on a metal post approximately 1.2 m above ground level. At Position 8 (only) an integral mic boom was used.

The microphones were protected from wind-induced self-noise by oversized 180 mm (7”) diameter foam windscreens (ACO Model WS7-80T) and were also deliberately situated at a fairly low elevation of about 1.2 m above grade so that they were exposed to relatively low wind speeds. Wind speed normally diminishes rapidly close to the ground, theoretically going to zero at the surface.

The survey was carried out during early spring conditions over a 15 day period from May 13 to 28, 2015. As is evident from the site photos in Section 2.2.8 most of the trees were leafed out.

All equipment was field calibrated at the beginning and end of the survey. The observed calibration drift of all the instruments was in the -0.3/+0.5 dB range.

2.4 Weather Conditions

The weather conditions during the survey were characterized by fairly low wind speeds for the first few days followed by moderate to high winds for the remainder of the survey. Measurable rain at the site was only detected on the 20th, 25th and at the very end of the survey on May 28.

The general conditions of temperature, barometric pressure and wind for the survey period as observed at the airport in Plattsburgh, about 35 miles southeast of the site area, are shown in the chart below (Figure 2.4.1). Thunderstorms were reported in the general area around 2 p.m. on both May 19 and 27.

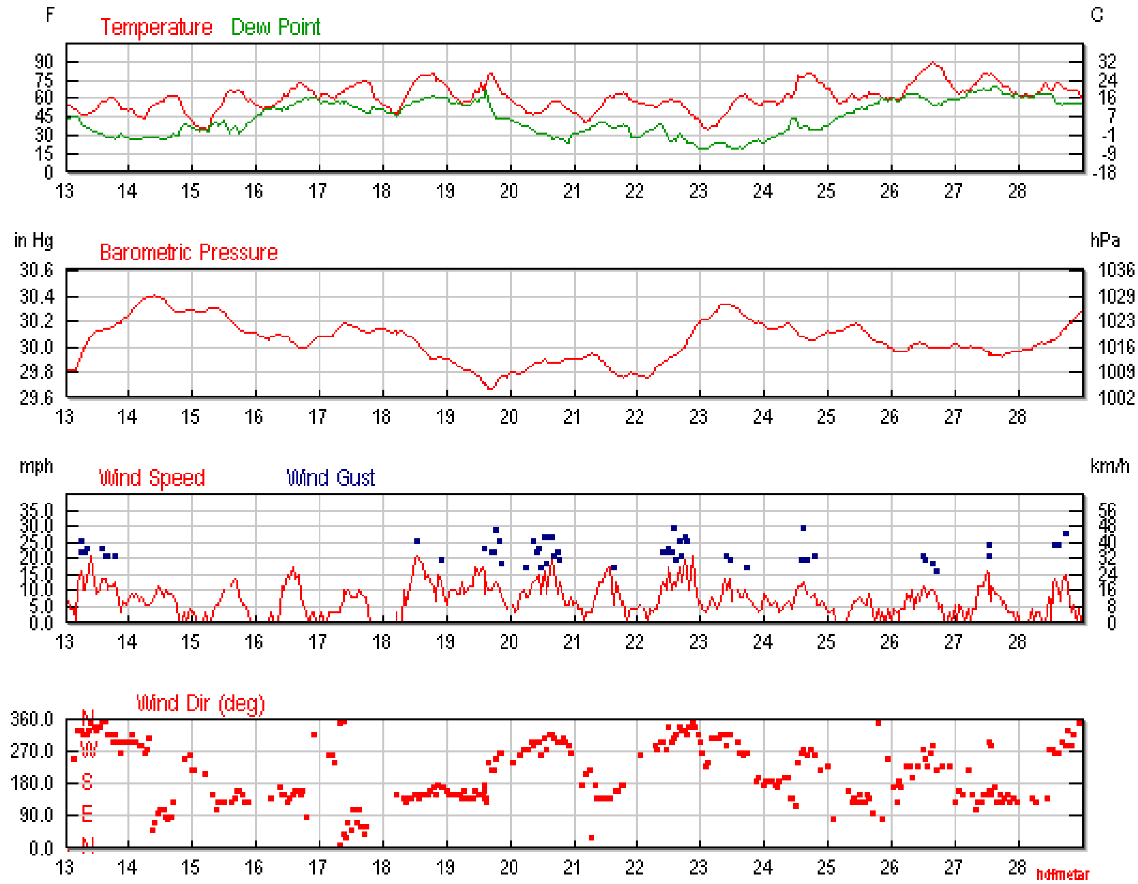


Figure 2.4.1
Weather Conditions during the Survey Period as Observed at Plattsburgh Airport

The wind speed at the site itself was measured by a met tower located in the southeastern part of the project area. Figure 2.4.2 shows the 10 minute average wind speed measured during the survey by the mast top (58 m) anemometer of Tower 946 after normalization to a standard 10 m elevation per IEC 61400-11[2], Equation 7. A roughness length of 0.05 was used, which is associated with "farmland with some vegetation". The wind speed at this elevation is important because wind turbine sound power levels are expressed as a function of wind speed at this standard height.

Also shown in Figure 2.4.2 is the approximate wind shear coefficient (or exponent) calculated from the differential between the 58 and 32 m met tower wind speed readings. The data indicate that shear was generally moderate and consistent at roughly 0.28 when the wind speed was above the operational cut-in speed of about 3 or 4 m/s, but unstable and variable during periods of relatively low wind when the turbines would not be operating.

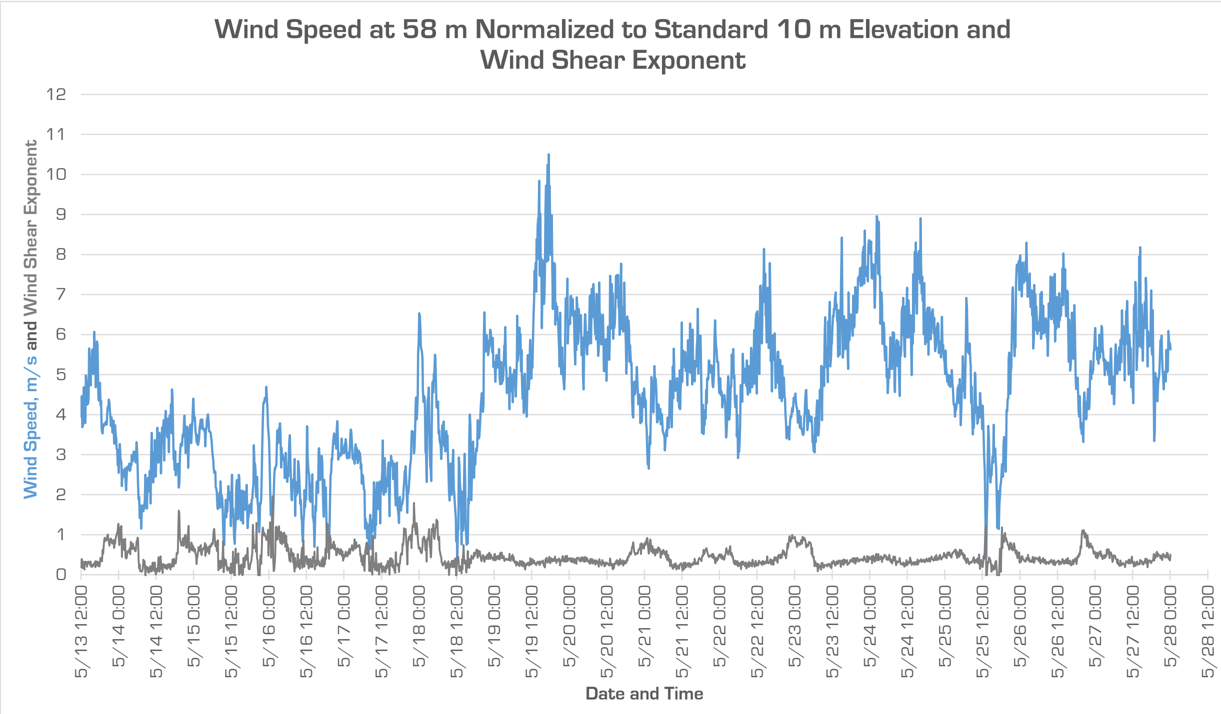


Figure 2.4.2

Figure 2.4.3 plots the average wind speed measured at microphone height (1.2 m) by anemometers at Positions 1, 2 and 7. These results show that the sound monitors were exposed to fairly innocuous wind speeds of less than 3 m/s for most of the survey and the wind only got up to around 4 m/s during some, but not all, of the windier periods. These relatively low wind speeds at the measurement positions indicate that the recorded sound levels were largely uncontaminated by wind-induced self-noise. Very high wind speeds in the vicinity of 10 m/s or higher are normally required when using a 7” windscreen before the A-weighted sound level (the quantity sought in this survey) begins to be affected in any significant way. This is because the wind blowing over the microphone affects only the extreme lower frequencies and A-weighting, which generally represents mid-frequency, audible sound, is not very sensitive to the lower frequencies. Consequently, the measured values are considered valid and free of any significant self-generated contamination.

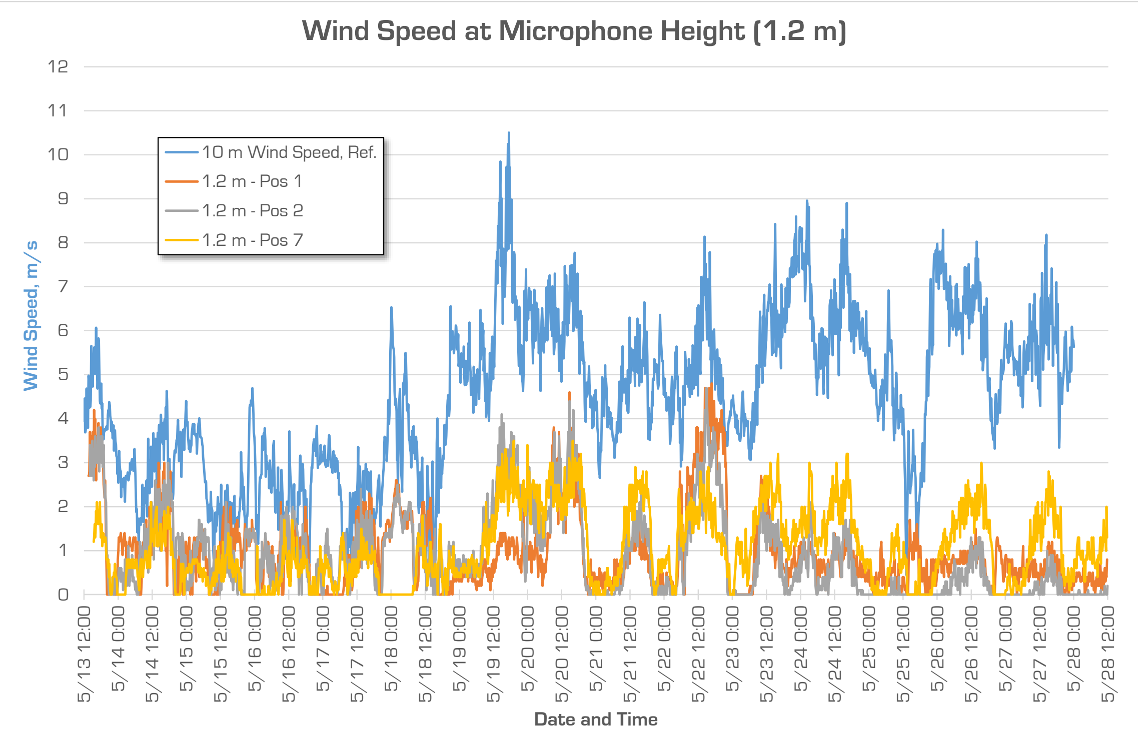


Figure 2.4.3

2.5 Overall Results

As discussed above in Section 2.1, the L90, or residual, sound level is a conservative measure of background sound levels in the sense that it filters out short-duration, sporadic noise events that cannot be relied upon to provide consistent and continual masking noise to obscure potential turbine noise. This level represents the quiet, momentary lulls between all relatively short duration events, such as cars passing by or tractor activity in a neighboring field. As such, it is a "conservative" measure of the background level with regard to evaluating potential impacts from a new source.

The as-measured L90 sound levels over consecutive 10 minute increments for all 8 positions are plotted below for the survey period.

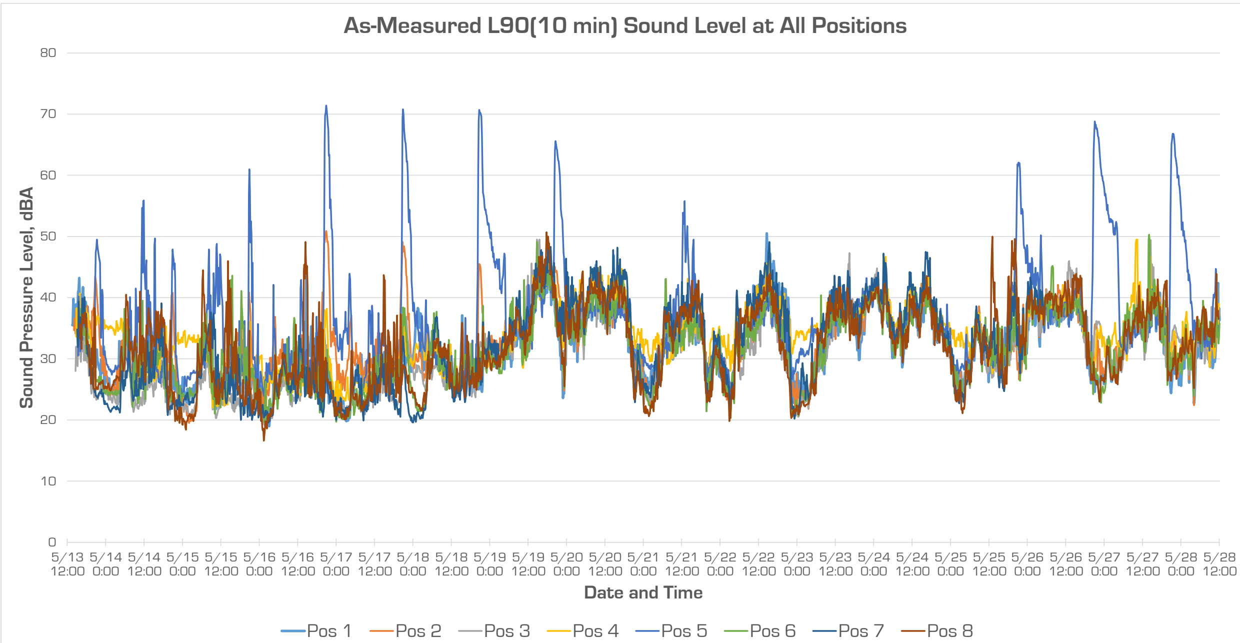


Figure 2.5.1

This plot shows that despite the variety in the settings of the monitor stations (open fields, wooded, remote from roads, near a road, etc.) the residual (L90) the sound levels at all the various positions follow the same temporal trends, although some positions were clearly subject to local contaminating noise events. The most obvious interference occurred at Position 5 (the Ponderosa Campsite) where frogs were apparently active in the nearby (largely drained) ponds starting just after 10 p.m. on most nights. Noise spikes at the other positions where generally short-lived, random and appear to be associated with human activities. All obvious contamination – i.e. events occurring at only one position at a time – have been edited out in Figure 2.5.2 along with all measurements collected during rain events and thunderstorms.

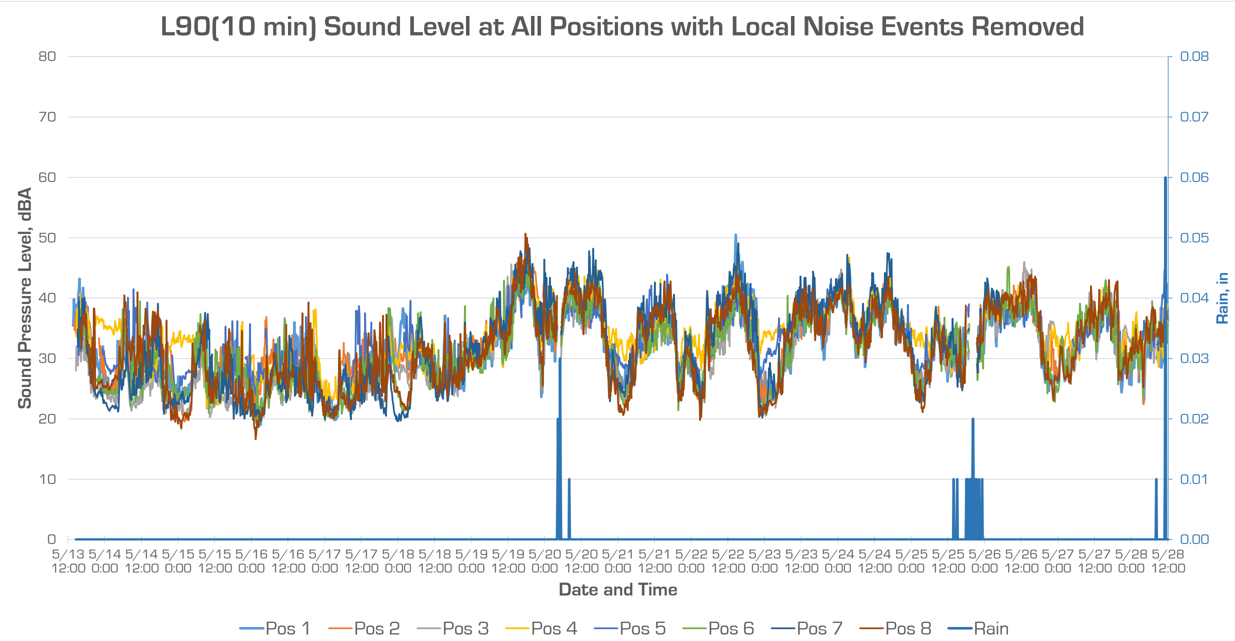


Figure 2.5.2

The consistency in sound levels across the site is more clearly evident in Figure 2.5.2. Because of this consistency the average sound level (of all 8 positions) may be considered a reasonable representation of the sound level at any point within the project area at any given time. It is also important to note in this context that the presence of leaves on the trees had no significant influence on the overall results because half of the measurement positions were in open fields remote from any wind-induced foliage sound – yet the sound levels at all positions are similar. This site-wide average level is plotted against the concurrent wind speed at 10 m in Figure 2.5.3 below.

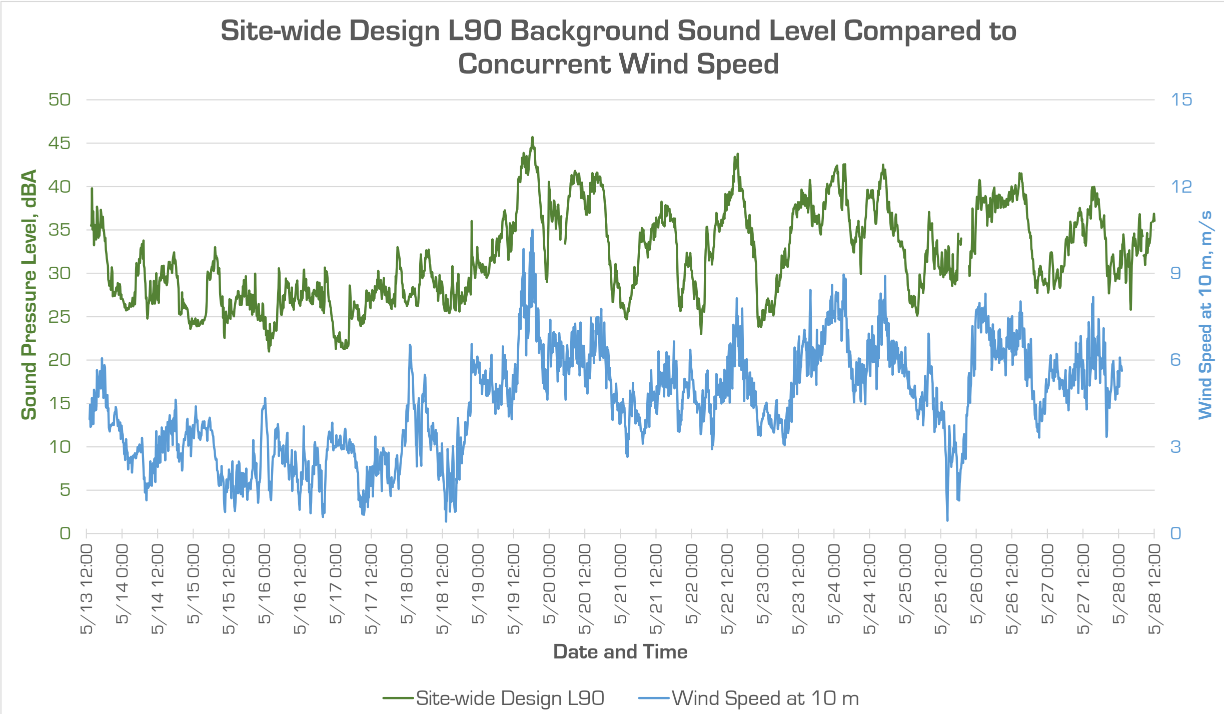


Figure 2.5.3

This plot shows that there is a definite correlation between sound and wind, meaning that the natural background sound level is relatively loud when it's windy (and when the project will be in operation), and quieter during calm periods when the project either won't be operating or will operating at a low sound level. It is important to re-iterate in this context that the wind speed in the above graphic is derived from the met mast anemometer at 58 m (190 ft.) so it represents the wind that the turbine rotors would see, while the sound levels are measured at ground level (1.2 m). Consequently, the project sound level and the background sound level are related on comparable terms.

The sound levels discussed so far are all residual, or L90, levels that capture the near minimum sound level that occurred during each 10 minute interval. As such this level can be considered a "conservative" design level for evaluating potential impacts, since it essentially represents the lowest level of masking sound. By definition, the L90 level occurs only a small fraction of the time (10% of the time) and is not a long-term or continuous phenomenon. The average, or Leq, level, on the other hand, is the "typical" sound level that might be heard at any given moment.

Figure 2.5.4 below shows the Leq(10 min) sound levels as measured at all eight monitoring stations.

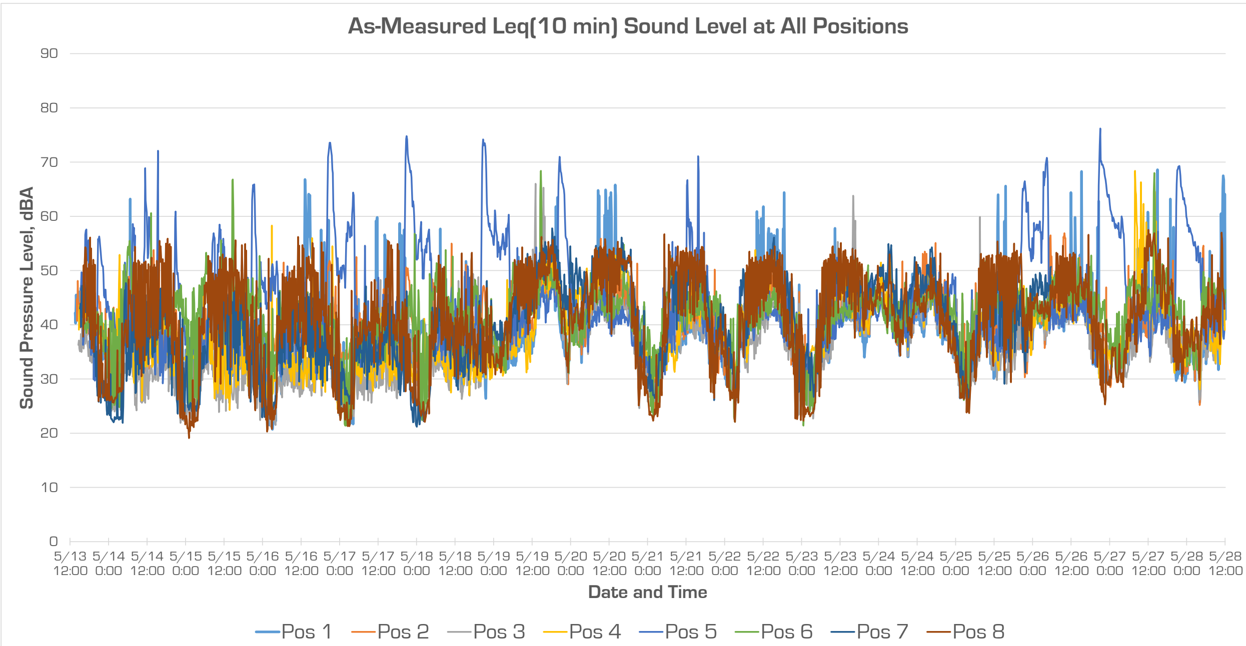


Figure 2.5.4

Because the Leq sound level tends to capture short-duration noise events much more readily than the L90 statistical level, there are more noise spikes associated with "contaminating" sounds. If the obvious noise spikes are edited out (Figure 2.5.5), as was done with the L90 data, it can be seen that the average sound level is also fairly consistent over the site area despite the different surroundings around each monitoring position. This is particularly true during the windier periods when the sound level is more clearly influenced by the global phenomenon of wind-induced sounds. During calm periods the levels are almost random because they are driven by local, mainly man-made sounds.

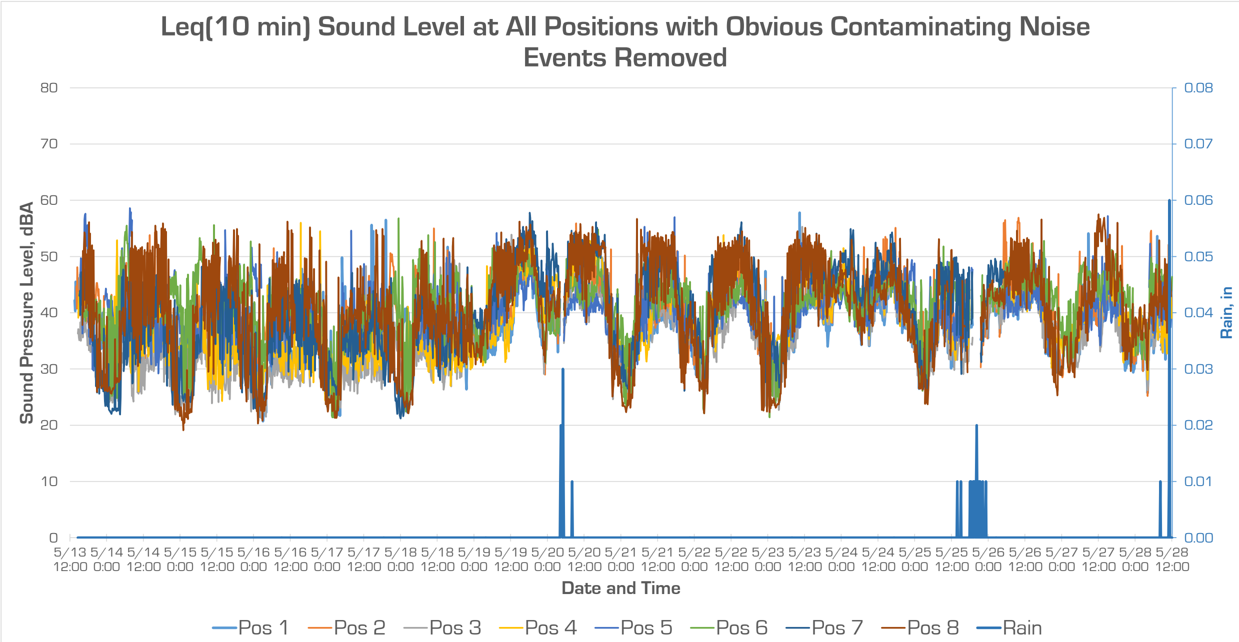


Figure 2.5.5

In any event, the average level of all eight locations may be taken as a reasonable representation of the site-wide Leq sound level. The correlation between the average Leq level and wind speed is plotted in Figure 2.5.6.

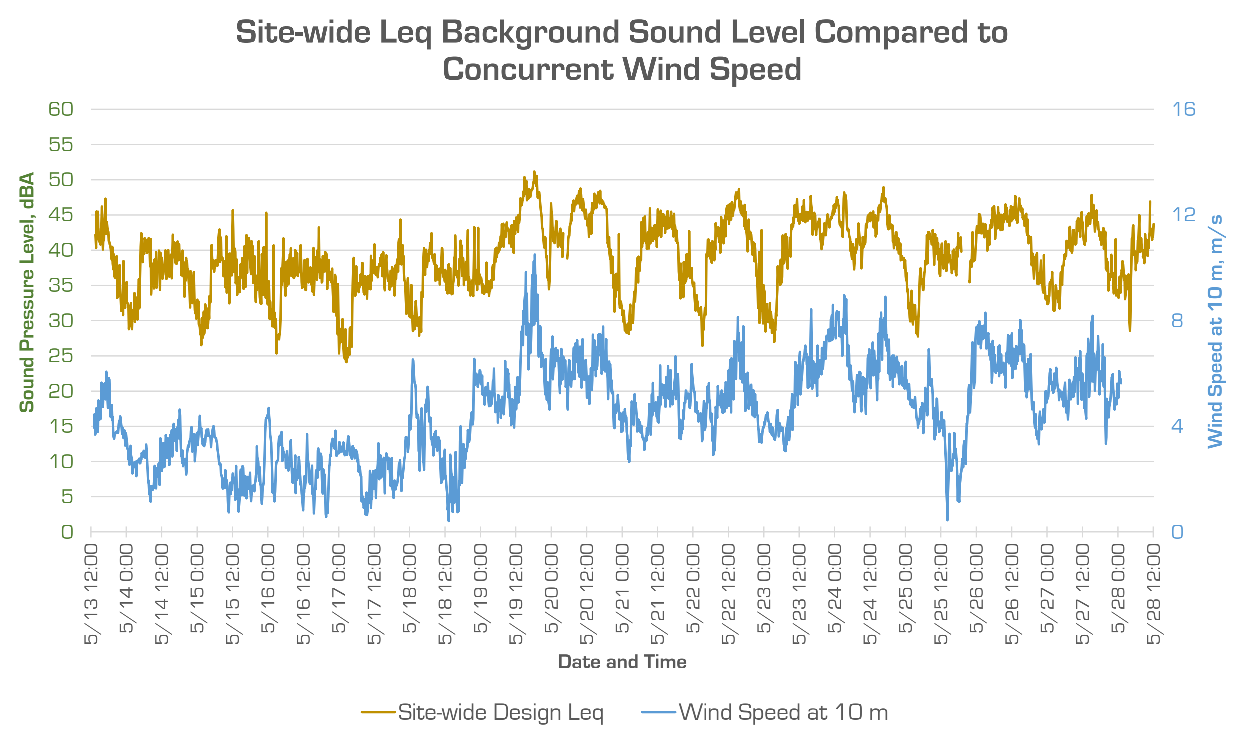


Figure 2.5.6

As with the L90 results there is an apparent correlation between sound and wind speed, although it is somewhat less obvious with the Leq. This is not unexpected since the Leq sound level is frequently driven by sounds that are unrelated to the wind.

2.6 Sound Levels as a Function of Wind Speed

From the data collected over the survey it is possible to determine the mean A-weighted L90 and Leq sound levels that are likely to occur over the wind speed range of interest – generally from 3 to 10 m/s (at 10 m). This range is important with respect to wind turbine sound emissions because turbine sound power levels are variable from cut-in around 3 or 4 m/s, where they are minimal, up to about 7 m/s when the rotor first reaches maximum speed and the maximum noise point. At higher wind speeds turbine sound levels essentially remain constant and no longer increase.

The first regression plot below, Figures 2.6.1, quantifies the relationship between wind speed and the L90, or "conservative" sound level. The second plot, Figure 2.6.2, shows the correlation between the Leq, or "typical" sound level and wind speed.

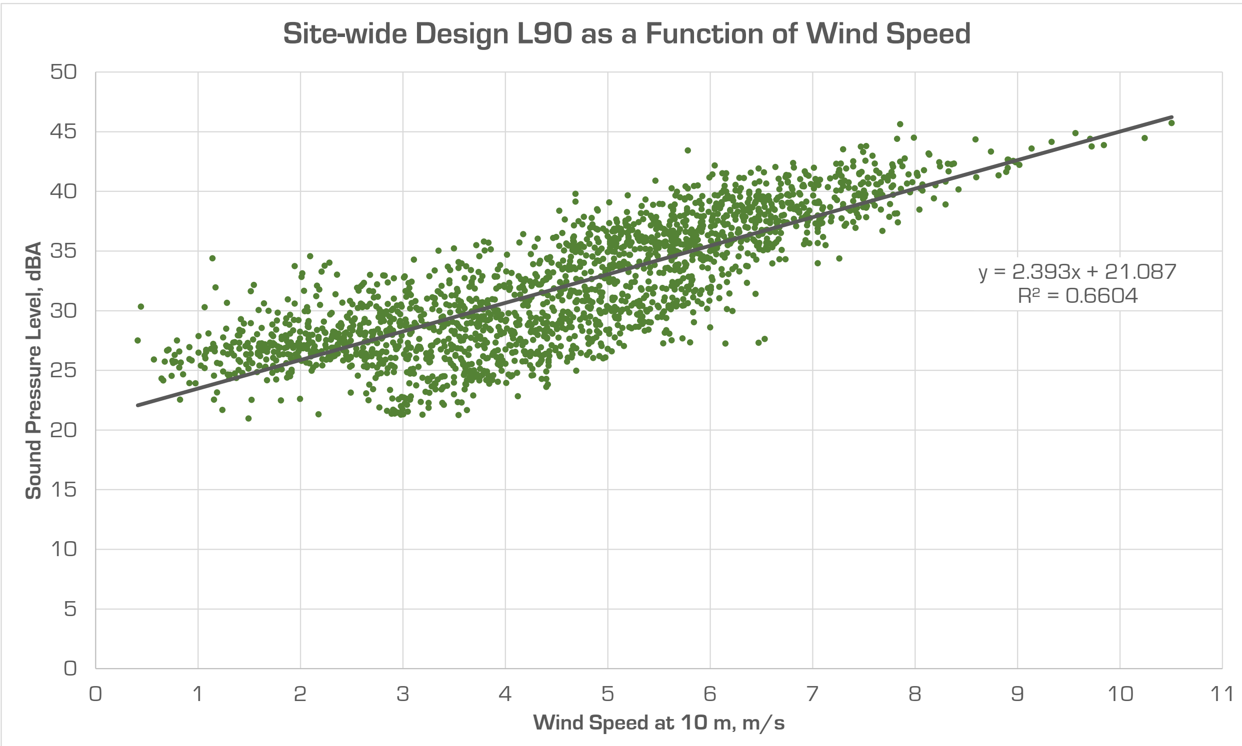

Site-wide Design L90 as a Function of Wind Speed
Sound Pressure Level, dBA
Wind Speed at 10 m, m/s
y = 2.393x + 21.087
R² = 0.6604
0
5
10
15
20
25
30
35
40
45
50
0
1
2
3
4
5
6
7
8
9
10
11

Figure 2.6.1

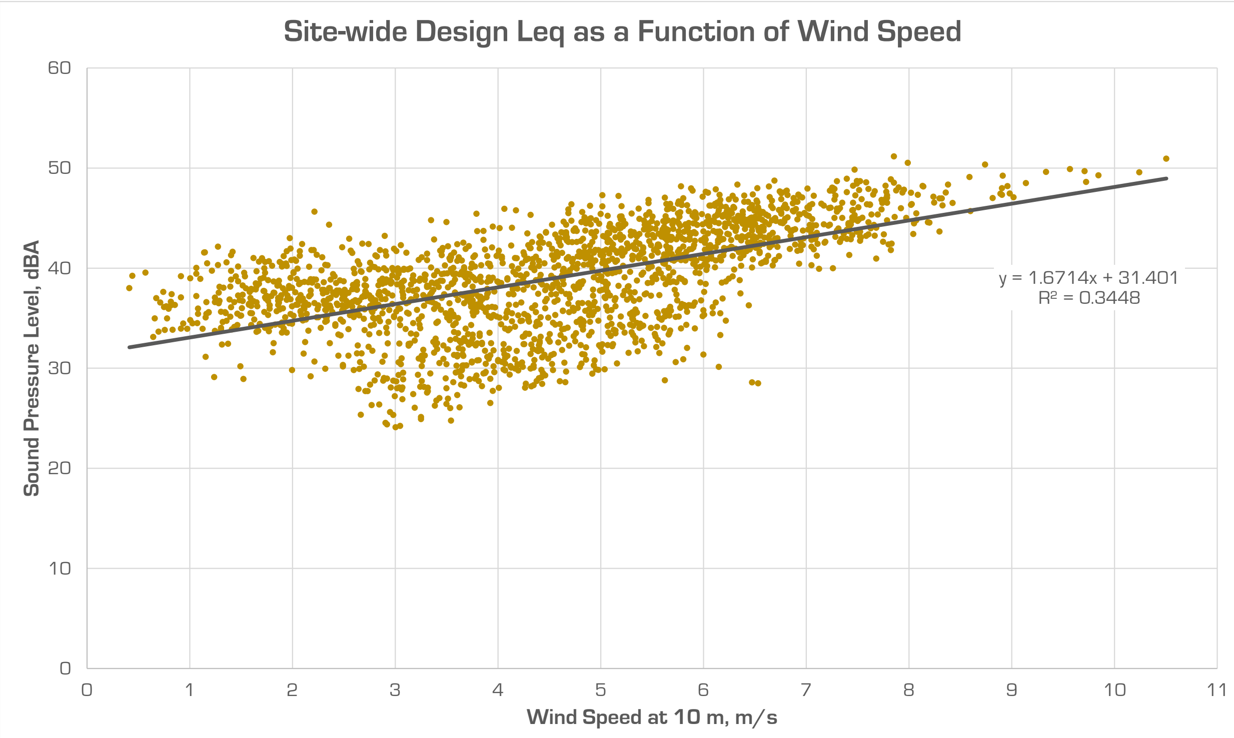


Figure 2.6.2

In general, there is a significantly tighter correlation between the L90 sound levels and wind speed as opposed to the Leq levels, as evidenced by the R^2 values of the trend lines. But in all cases it can be seen that environmental sound levels increase with wind speed. It would therefore be incorrect to associate a low background level, such as might occur on a calm night, with a project-on sound level that would only occur during moderately windy or very windy conditions. The maximum data scatter tends to occur at lower wind speeds essentially because sound levels are not driven by the wind during relatively calm conditions.

From the regression charts above the following typical and conservative mean background sound levels can be expected at integer wind speeds ranging from 3 to 10 m/s.

Table 2.6.1
Mean Measured L90 and Leq Background Sound Levels as a Function of Wind Speed

Integer Wind Speed at Standardized Hgt. of 10 m, m/s	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Conservative L90 Sound Level, dBA	28	31	33	35	38	40	43	45
Typical Leq Sound Level, dBA	36	38	40	41	43	45	46	48

3.0 Noise Modeling and Impact Assessment

3.1 Assessment Criteria

There are several metrics against which to compare the predicted noise from the project and thereby determine if any adverse environmental impacts might result from it. The first of these measures is a local regulatory noise limit; the second is a set of noise assessment guidelines published by the New York State Department of Environmental Conservation (NYSDEC); and a third approach (modified CNR) looks at the frequency content of both the masking and project sound levels to estimate community reaction.

3.1.1 Regulatory Noise Limits

Both the Towns of Chateaugay and Bellmont have established local ordinances specifically relating to wind energy facilities. With regard to noise both ordinances are identical.

Local Law No. 7 of 2006 (Chateaugay) and Local Law No. 2 of 2006 (Bellmont) limits the sound emissions from any wind energy facility to **50 dBA** "measured at the nearest Residence located off the Site", meaning at non-participating residences.

In their original form both laws expressed the noise limit in terms of the L10 statistical sound level but later amendments - Local Law No. 1 of 2008 "Amendments to Wind Energy Facility Law" (Chateaugay) and Local Law No. 1 of 2007 "Resolution to Amend Local Law No. 2 of 2006" (Bellmont) - changed that to the L90 sound level. For a reasonably constant sound source, such as the project, all statistical metrics collapse to a single value so the specific percentile level that is selected as a regulatory limit doesn't alter how much noise can be produced. What the shift from the L10 to the L90 actually does is greatly facilitate compliance measurements.

In addition to an overall sound level limit there is also a quantitative restriction on tonal sounds in both laws. Put as simply as possible a "pure tone" is said to exist if the average of the two adjoining 1/3 octave bands exceeds the intervening band by:

15 dB for frequencies less than or equal to 125 Hz
8 dB for frequencies between 160 and 400 Hz inclusive
5 dB for frequencies equal to or above 500 Hz

There are no other overarching state or federal noise regulations that are known to apply to the project.

3.1.2 NYSDEC Guidelines

In the Program Policy *Assessing and Mitigating Noise Impacts* published by the New York State Department of Environmental Conservation (2001) a methodology is described for evaluating potential community impacts from any new noise source. The method is fundamentally based on the perceptibility of the new source above the existing background sound level.

It is a well-established fact - for a new broadband, atonal noise source with a frequency spectrum similar to that of the background - that a cumulative increase in the total sound level of about 5 dBA at a given point of interest is required before the new sound begins to be clearly perceptible or noticeable to most people. Cumulative increases of between 3 and 5 dBA for a source of this kind are generally regarded as negligible or hardly audible. Lower sound levels from the new source are "buried" in the existing background sound level and become progressively less perceptible. The specific language relating to these perceptibility thresholds in the NYSDEC program policy (Section V B(7)c) is a follows:

> Increases ranging from 0-3 dB should have no appreciable effect on receptors. Increases from 3-6 dB may have potential for adverse noise impact only in cases where the most sensitive receptors are present. Sound pressure increases of more than 6 dB may require closer analysis of impact potential depending on existing SPL's [sound pressure levels] and the character of surrounding land use and receptors.

What this essentially says is that cumulative increases in the total ambient sound level of 6 dBA or less are unlikely to constitute an adverse community impact. From a practical standpoint, because decibels add logarithmically, this threshold means that noise from the project could exceed the existing background level by up to 5 dBA. For example, a background level of 40 dBA plus a project-only sound level of 45 dBA would equal a total cumulative level of 46 dBA – or 6 dBA above the original level.

3.1.3 Composite Noise Rating Method

An additional approach to evaluating potential community noise impacts that also considers the frequency content of both the background and the project sound levels is the modified Composite Noise Rating (CNR) method. This method, which is based on case histories of reaction to new noise sources (though not specifically wind turbines), dates back to 1955 and with minor modifications has been used by a number of federal agencies including the EPA[3].

The procedure involves the following steps:

- Obtain a baseline rating classification, lower-case letter grade, from the predicted sound pressure level spectrum of the new noise source at the point of reception
- Determine a background (masking noise) correction based on the average measured background sound level spectrum under comparable conditions

- Apply a number of correction factors related to such things as when the source is in operation, the character of the noise and the general attitude of the receiver
- Determine a final upper-case rating classification after the application of all corrections and adjustments. The final classification letter defines the expected reaction to the new source.

3.2 Turbine Sound Levels

The turbine model currently being considered for this project is the Gamesa G114 2.1MW.

The expected overall sound power level of this new model as a function of wind speed has been obtained from the manufacturer in the General Characteristics Manual GD229761[4], which lists the acoustical performance of various low noise operating modes but does not specifically give the sound levels associated with standard normal operation. This performance has been estimated for modeling purposes by using the maximum sound level for each wind speed. For a 93 m hub height, the following maximum sound power levels are published for this model as a function of wind speed at the standardized measurement height of 10 m.

Table 3.2.1
Sound Power Levels vs. Wind Speed for Gamesa G114 2.1MW Wind Turbine

Wind Speed at 10 m Height, m/s	Sound Power Level, dBA re 1 pW
3	95.8
4	96.8
5	101.9
6	105.0
7	106.6
>7	106.6

It is important to note in this context that a sound *power* level is not the same thing as a sound *pressure* level, which is the familiar quantity measured by instruments and perceived by the ear. A power level is a specialized, derived value, expressed in terms of Watts, that is primarily used for acoustical modeling and in design analyses. It is a function of both the sound pressure level produced by a source at a particular distance and the effective radiating area or physical size of the source. The basic mathematical relationship between power and pressure is as follows:

$$Lw = Lp + 10 \log (A)$$

Where,

Lw = Sound Power Level, dB re 1 pW
Lp = Sound Pressure Level, dB re 20 μPa
A = The effective radiating surface area at the point of the pressure level measurement, m^2

In general, the ostensible magnitude of a sound power level is always considerably higher than the sound pressure level near a source because of the (normally large) area term. For example, the sound pressure level at 100 m from a wind turbine might be about 53 dBA and the area term for that distance would be 51 dBA with a resulting total power level of 104 dBA re 1 pW (the units of power levels are always denoted as decibels with reference to 1 picoWatt, or 10^{-12} W).

The fundamental advantage of a power level is that the sound pressure level of the source can be calculated at any distance; hence its importance to noise modeling.

3.3 Critical Design Levels

From the field survey it was determined that the background sound level varies with wind speed. From Table 3.2.1 above it can be seen that the turbine sound level also varies with wind speed. In order to carry out the ambient-based NYSDEC assessment procedure some specific background level must be established against which to compare project noise and calculate cumulative increases. Both the background and project sound levels must be on a comparable footing in terms of the wind conditions.

In terms of potential noise impacts the worst-case combination of background and turbine sound levels would occur at the wind speed where the background level is lowest relative to the turbine sound level – or, in other words, where the differential between the background level and turbine sound power level is greatest. The following chart, Table 3.3.1, shows that this worst-case situation does not necessarily occur at the highest wind speeds when the turbine produces the most noise, as might be intuitively expected, but rather at an intermediate wind speed of 6 m/s where the differential between the background levels and the turbine sound power level is greatest. Although the turbine sound level is somewhat quieter than its maximum value (by 1.6 dB) the potential impact is higher under these conditions because there is less background sound available to mask the sound emissions from the project than at all other wind speeds.

Table 3.3.1
Comparison of Background and Gamesa G114 2.1MW Turbine Sound Levels to Determine Critical Design Level (at Maximum Differential)

Integer Wind Speed at Standardized Hgt. of 10 m, m/s	**4**	**5**	**6** Critical Wind Speed	**7**	**8**
G114 2.1 MW Sound Power Level, dBA re 1 pW	96.8	101.9	**105.0**	106.6	106.6
Typical Leq Sound Level, dBA	38	40	**41**	43	45
Turbine Power Level – Background Sound Level Differential	59	62	**64**	63	62
Conservative L90 Sound Level, dBA	31	33	**35**	38	40
Turbine Power Level – Background Sound Level Differential	66	69	**70**	69	66

Consequently, for design purposes, the background levels measured during a **6 m/s** wind will be used as a basis to calculate the NYSDEC cumulative increase thresholds for modeling and impact assessment purposes and the associated turbine sound power level of **105 dBA re 1 pW** at that wind speed will be used. This approach is conservative in the sense that turbine noise will be somewhat or significantly less prominent at all other wind speeds, higher and lower, relative to the background level.

The following table summarizes the NYSDEC impact thresholds based on a 6 dBA cumulative increase in the overall sound level. Because of logarithmic addition a differential of 5 dBA between the baseline background and project-only sound level leads to a total increase of 6 dBA.

Table 3.3.2
Critical Design Levels and NYSDEC Impact Thresholds

Type of Impact Threshold	**Measured Critical Background Level at 6 m/s, dBA**	**Impact Threshold - Project-only Sound Level, dBA** (5 dBA above Background Level)	**Cumulative Sound Level with Project Operating, dBA** (6 dBA above Background Level)
Typical Based on Leq, dBA	41	**46**	47
Conservative Based on L90, dBA	35	**40**	41

Because the frequency content of the turbine sound power levels at various wind speeds are not given in the Gamesa information, the octave band levels have been estimated for design purposes by subtracting 1.4 dB from the known full power spectrum of the Gamesa G87 turbine measured during 8 m/s operating conditions. The resulting spectrum below will be used in the modeling study.

Table 3.3.3
Gamesa G114 2.1 MW Octave Band Sound Power Level Spectrum during a 6 m/s Wind
Estimated **Design Level** from Measured Gamesa G87 Spectrum at 8 m/s

Octave Band Center Frequency, Hz	**31.5**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**dBA**
Lw Gamesa G87 at 8 m/s, dB re 1 pW	*112 Est.*	111.9	110.6	109.2	104.8	100.5	95.6	91.2	90.5	106.4
Adjustment Factor, dB	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	
Estimated Lw G114 2.1 MW at 6 m/s, dB re 1 pW **Design Level**	**110.6**	**110.5**	**109.2**	**107.8**	**103.4**	**99.1**	**94.2**	**89.8**	**89.1**	**105.0**

3.4 Noise Modeling Methodology

Using the design sound power level spectrum in Table 3.3.3 above, sound level contour plots for the site were calculated using the Cadna/A®, ver. 4.4.145 noise 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. In this case, the topography of the site is assumed as a flat plane because the minor undulations that do exist would have no significant effect on sound propagation. Each turbine is represented as a point noise source at a height of 93 m above the local ground surface (design hub height). The receptor height is set at a standard elevation of 1.2 m above local grade; this keeps the predicted levels on an equal footing with the background measurements, which were measured at a similar elevation.

The site plan used in the analysis is the latest known layout as of July 1, 2015 and, it is important to note, assumes that a turbine will be present at all 43 of the proposed sites whereas only 37 turbines will actually be installed.

Apart from the turbines, the only other potential source of noise associated with the project is the step up transformer in the electrical substation where output from the project is connected to an existing transmission line. This substation is located to the southwest of the intersection of Hartnett and Willis Roads in an area that is fairly remote from any homes. The substation has not been included in the model partly because it is not particularly close to any houses but, more importantly, because its A-weighted sound level, the quantity calculated by the program and depicted in the plots, does not characterize its potential noise impact in any meaningful way. Transformer sound emissions are essentially tonal in character - a buzzing sound at harmonics of 60 Hz - and the octave band sound spectrum that might be used as a model input is too broad to convey any tonal content. In any event, any tones from the relatively small transformer associated with the project are not expected to be significant at the nearest houses simply because of the intervening distance.

A somewhat conservative ground absorption coefficient of 0.5 has been assumed in the model since all of the ground between the turbines and potentially sensitive receptors essentially consists of acoustically absorptive wooded areas or open farm fields. The ISO ground absorption coefficient ranges from 0 for water or hard concrete surfaces to 1 for absorptive surfaces, such as farm fields, wooded areas or sand. Consequently, a higher coefficient on the order of 0.8 or 0.9 could be justified here; however, for conservatism a value of 0.5 has been used.

Foliage in thickly wooded areas normally provides some additional sound attenuation as a separate phenomenon from ground absorption. Even though this site is wooded in many areas, this potential propagation loss has been neglected in all calculations.

To be conservative the sound emissions from each turbine is assumed to be the downwind sound level in all directions simultaneously. In other words, although physically impossible, an omni-directional 6 m/s wind is assumed. This approach yields a contour plot that essentially shows the maximum possible sound level at any given point and sometimes also shows levels that cannot possibly occur – such as between two or more adjacent turbines, since the wind would have to be blowing in two opposing directions at the same time. In a more realistic scenario with, for example, a wind out of the west the contour lines might occur slightly closer to the turbines on the west side and would remain largely as shown on the east.

At the risk of overestimating potential project sound levels, various conservative assumptions in the modeling analysis have been applied to ensure that project noise does not exceed predicted levels under most normal conditions and also to allow some design margin for times when atmospheric conditions may occasionally favor noise propagation relative to average conditions, such as during temperature inversions. The model represents a situation at any given receptor point that would require a convergence of the following conditions:

- **Wind Direction** – from *all* the turbines towards the receptor point
- **Wind Speed** - only a 6 m/s wind nominally produces the plotted contours; under all other wind conditions the impact threshold contour lines would contract closer to the turbines
- **Low Ground Porosity** – normally woods and farm fields are more absorptive than assumed in the model
- **Observer Outside** – the plotted sound levels occur outside; sound levels inside of any dwelling will be 10 to 20 dBA lower

3.5 Model Results and Impact Assessment - NYSDEC

Preliminary noise modeling indicated that the potential for community noise impacts exists with this project. This early modeling work essentially performed the function of the First Level Noise Impact Assessment in the NYSDEC assessment procedure and indicated that a Second Level assessment was necessary. A Second Level noise model considers the actual circumstances of the site including any attenuation that might be afforded by such factors as terrain, vegetation or man-made barriers.

The overall results of the Second Level model are shown in Plots 1 and 2 where the outermost sound level contour is associated with the "Conservative" or "Typical" impact thresholds derived from the background sound level survey findings. These plots illustrate the project-only sound levels that might occur under the conservative assumptions described above in Section 3.4.

In **Plot 1** the sound emissions of the project are shown out to 40 dBA, which is the NYSDEC 6 dBA increase threshold if the background sound level is taken to be the near-minimum L90 level of 35 dBA measured during 6 m/s wind conditions. This is the background sound level that occurs for only a small percentage of the time during lulls in the wind and when all sources of man-made noise are at a temporary minimum. Under these specific circumstances project noise may be clearly perceptible at many of the homes in the immediate project area and some degree of adverse reaction is theoretically possible, although it is important to note that this increase in sound level occurs outside rather than inside homes. The table below lists all non-participating residences by map ID number and address where an increase of more than 6 dBA is anticipated based on a conservative background level of 35 dBA.

Table 3.5.1
Cumulative Sound Increases at Non-Participating Residences within the "Conservative" Noise Impact Threshold of 40 dBA

Receptor ID	Local Street Address	Town	Calculated Mean Project Sound Level, dBA	Cumulative Sound Level, dBA	Cumulative Increase Relative to 35 dBA Background Level , dBA
167	20 Taylor Rd	Chateaugay	41	42	7
154	1097 County Route 33	Chateaugay	41	42	7
463	1677 County Route 23	Chateaugay	41	42	7
91	528 Hartnett Rd	Chateaugay	41	42	7
155	1096 County Route 33	Chateaugay	41	42	7
37	1435 County Route 24	Bellmont	41	42	7
40	1449 County Route 24	Bellmont	41	42	7
137	1563 County Route 23	Chateaugay	41	42	7
61	1916 County Route 24	Bellmont	41	42	7
60	1905 County Route 24	Bellmont	41	42	7
59	1897 County Route 24	Bellmont	41	42	7
119	County Route 33	Bellmont	41	42	7
142	1163 County Route 33	Chateaugay	41	42	7
158	1074 County Route 33	Chateaugay	41	42	7
139	1578 County Route 23	Chateaugay	41	42	7
104	161 Mary Carey Rd	Chateaugay	41	42	7
172	Titus Rd	Bellmont	41	42	7
324	Titus Rd	Bellmont	41	42	7
322	165 Mary Carey Rd	Chateaugay	41	42	7
45	1540 County Route 24	Bellmont	41	42	7

Receptor ID	Local Street Address	Town	Calculated Mean Project Sound Level, dBA	Cumulative Sound Level, dBA	Cumulative Increase Relative to 35 dBA Background Level , dBA
156	1088 County Route 33	Chateaugay	41	42	7
72	158 Chase Rd	Bellmont	41	42	7
460	1729 County Route 23	Chateaugay	41	42	7
465	1670 County Route 23	Chateaugay	41	42	7
462	1695 County Route 23	Chateaugay	41	42	7
472	162 Cemetery Rd	Chateaugay	41	42	7
594	1171 County Route 33	Chateaugay	41	42	7
141	1171 County Route 33	Chateaugay	41	42	7
157	1075 County Route 33	Chateaugay	41	42	7
118	273 County Route 33	Bellmont	41	42	7
43	1501 County Route 24	Bellmont	41	42	7
93	374 Toohill Rd	Chateaugay	41	42	7
108	755 County Route 33	Chateaugay	41	42	7
171	784 County Route 33	Chateaugay	41	42	7
159	County Route 33	Chateaugay	41	42	7
143	1133 County Route 33	Chateaugay	41	42	7
5	424 Selkirk Rd	Burke	41	42	7
138	1566 County Route 23	Chateaugay	42	43	8
105	719 County Route 33	Chateaugay	42	43	8
82	574 Healey Rd	Chateaugay	42	43	8
90	572 Hartnett Rd	Chateaugay	42	43	8
38	1425 County	Bellmont	42	43	8

Receptor ID	Local Street Address	Town	Calculated Mean Project Sound Level, dBA	Cumulative Sound Level, dBA	Cumulative Increase Relative to 35 dBA Background Level , dBA
	Route 24				
134	1481 County Route 23	Chateaugay	42	43	8
106	716 County Route 33	Chateaugay	42	43	8
115	28 Legacy Rd	Bellmont	42	43	8
252	63 Legacy Rd	Chateaugay	42	43	8
114	12 Legacy Rd	Bellmont	42	43	8
312	Titus Rd	Bellmont	42	43	8
107	739 County Route 33	Chateaugay	42	43	8
73	304 Healey Rd	Chateaugay	42	43	8
44	1523 County Route 24	Bellmont	42	43	8
75	326 Healey Rd	Chateaugay	42	43	8
77	326 Healey Rd	Chateaugay	42	43	8
316	326 Healey Rd	Chateaugay	42	43	8
150	871 Healey Rd	Chateaugay	42	43	8
441	5874 State Route 11	Chateaugay	42	43	8
41	1453 County Route 24	Bellmont	42	43	8
133	1470 County Route 23	Burke	42	43	8
144	54 Jerdon Rd	Chateaugay	42	43	8
136	1529 County Route 23	Chateaugay	43	44	9
192	430 Ponderosa Rd	Bellmont	43	44	9
182	380 Jericho Rd	Chateaugay	43	44	9
596	380 Jericho Rd	Chateaugay	43	44	9
85	722 Healey Rd	Chateaugay	43	44	9
180	329 Jericho Rd	Chateaugay	43	44	9
183	398 Mahoney Rd	Chateaugay	43	44	9
83	574 Healey Rd	Chateaugay	43	44	9
181	341 Jericho Rd	Chateaugay	43	44	9

Receptor ID	Local Street Address	Town	Calculated Mean Project Sound Level, dBA	Cumulative Sound Level, dBA	Cumulative Increase Relative to 35 dBA Background Level , dBA
314	172 Chase Rd	Bellmont	43	44	9
76	338 Healey Rd	Chateaugay	43	44	9
78	356 Healey Rd	Chateaugay	43	44	9
190	396 Ponderosa Rd	Bellmont	43	44	9
79	374 Healey Rd	Chateaugay	43	44	9
254	122 Legacy Rd	Bellmont	43	44	9
80	385 Healey Rd	Chateaugay	43	44	9
135	1507 County Route 23	Chateaugay	43	44	9
74	326 Healey Rd	Chateaugay	43	44	9
315	326 Healey Rd	Chateaugay	43	44	9
185	449 Mahoney Rd	Chateaugay	43	44	9
326	449 Mahoney Rd	Chateaugay	43	44	9
309	County Route 24	Bellmont	43	44	9
111	564 County Route 33	Chateaugay	43	44	9
179	295 Jericho Rd	Chateaugay	44	45	10
186	474 Mahoney Rd	Chateaugay	44	45	10
187	507 Mahoney Rd	Chateaugay	44	45	10
87	803 Healey Rd	Chateaugay	44	45	10
256	Legacy Rd	Bellmont	44	45	10
257	176 Legacy Rd	Bellmont	44	45	10
88	620 Hartnett Rd	Chateaugay	44	45	10
255	Town Line Rd	Chateaugay	44	45	10
258	201 Legacy Rd	Chateaugay	44	45	10
189	Town Line Rd	Bellmont	44	45	10
110	618 County Route 33	Chateaugay	44	45	10
191	388 Ponderosa Rd	Bellmont	44	45	10
84	609 Healey Rd	Chateaugay	44	45	10
151	841 Healey Rd	Chateaugay	45	45	10
325	289 Jericho Rd	Chateaugay	45	45	10
188	Town Line Rd	Bellmont	45	45	10

Receptor ID	Local Street Address	Town	Calculated Mean Project Sound Level, dBA	Cumulative Sound Level, dBA	Cumulative Increase Relative to 35 dBA Background Level , dBA
176	228 Jericho Rd	Chateaugay	45	45	10
174	159 Titus Rd	Bellmont	45	45	10

Plot 2 shows the project sound levels out to a level of 46 dBA, which represents the 6 dBA cumulative increase threshold recommended by the NYSDEC based on the measured average, or Leq, sound level of 41 dBA during a 6 m/s wind. The region inside the threshold line represents the area where turbine noise might result in an adverse impact relative to the "typical" background level. In this instance, all homes are outside the 46 dBA threshold line, which occurs fairly close to each turbine and short of the minimum 1200 ft. (365 m) setback. This plot indicates that no significant adverse impact might be expected under average conditions.

In general, these plots suggest that the project is unlikely to generate sound levels above the NYSDEC 6 dBA cumulative impact threshold at residences in the project area during "typical" or average conditions, but that some adverse reaction is possible from time to time - theoretically 10% of the time - during moderate (6 m/s) wind conditions. The potential audibility of the project is less likely during all other wind conditions. During the winter the sound emissions from the project are also less likely to be noticeable, since people are inside most of the time.

As a general additional comment, it is important to note that in the particular case of wind turbines a cumulative 6 dBA increase in sound level does not represent the point of inaudibility. Operational sound emissions from wind turbines are often unsteady and variable with time largely because the wind does not always blow in a completely smooth and ideal manner. When unsettled air or gusty winds interact with the rotor, or the airflow is not perfectly perpendicular to the rotor plane, a temporary increase in turbulence and noise results. On top of this, turbines sometimes produce a periodic swishing sound. These temporal characteristics make operational noise more perceptible than it would be if it were always bland and continuous in nature. Consequently, wind turbines can commonly be discerned at fairly large distances even though the actual sound level may be relatively low and/or comparable to the magnitude of the background level; therefore the possibility of impacts at residences beyond the impact thresholds shown in the plots certainly cannot be ruled out. These possible impacts would be associated with cumulative increases of less than 6 dBA – principally in the 3 to 6 dBA range. A 3 dBA *cumulative* increase would mean that the project-only sound level was equivalent to the background level.

There may also be times, due to wind and atmospheric conditions, when project sound levels temporarily increase to levels that are significantly higher than the predicted mean levels.

During these - usually brief - periods of elevated noise the potential for complaints would also increase.

3.6 Model Results and Impact Assessment - CNR

As discussed in Section 3.1.3 above, the modified Composite Noise Rating (CNR) method for evaluating potential noise impacts compares the background level to the predicted level of intrusive noise in terms of frequency content (as opposed to the overall A-weighted sound level alone) and other factors in order to predict community reaction. The derivation of these ratings is outlined below.

The first step in the evaluation process is to plot the octave band frequency spectrum of the predicted project-only sound level at a point of interest against a set of curves that generally map the perceptibility of the noise as a function of frequency. In Figure 3.6.1 below predicted project sound level spectra under 6 m/s wind conditions ranging from 35 to 50 dBA in 5 dB increments are shown against the baseline CNR rating curves. This range covers all potential project sound levels at residences in the immediate site area. A lower-case classification letter, applicable to the regions between each curve, is assigned according to the highest region that the spectrum touches.

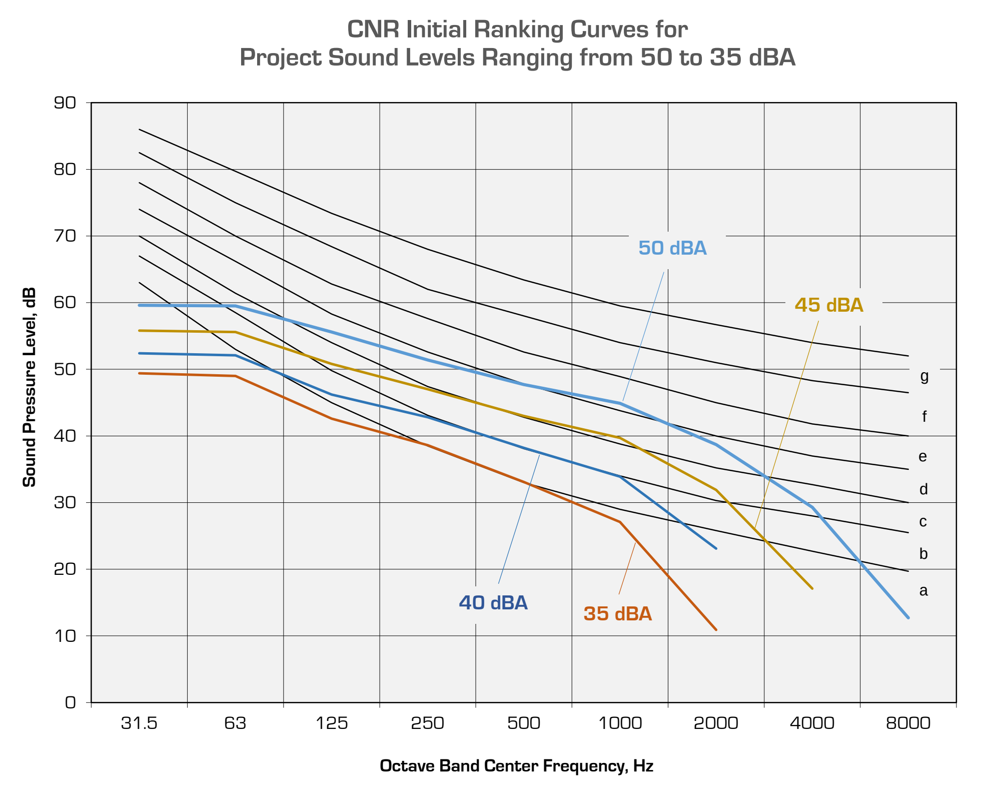


Figure 3.6.1

The baseline CNR classifications in 1 dB increments are tabulated below.

Table 3.6.1
Baseline CNR Classifications

Project-only Sound Level, dBA	**Baseline CNR Classification**
50	e
49	d
48	d
47	d
46	d
45	d
44	c
43	c
42	c
41	c
40	b
39	b
38	b
37	b
36	b
35	a

Starting from this baseline rating classification a series of corrections or adjustments are made to estimate the final classification, which, in turn, gives an indication of the potential community reaction.

The first principal correction is for background masking noise. A second chart of curves is used to determine how well or how poorly the background sound level frequency spectrum would act to mask the project sound level. The highest region intercepted determines the correction factor. Figure 3.6.2 shows the background correction for "typical" conditions based on the average Leq octave band spectrum measured when the wind speed was 6 m/s.

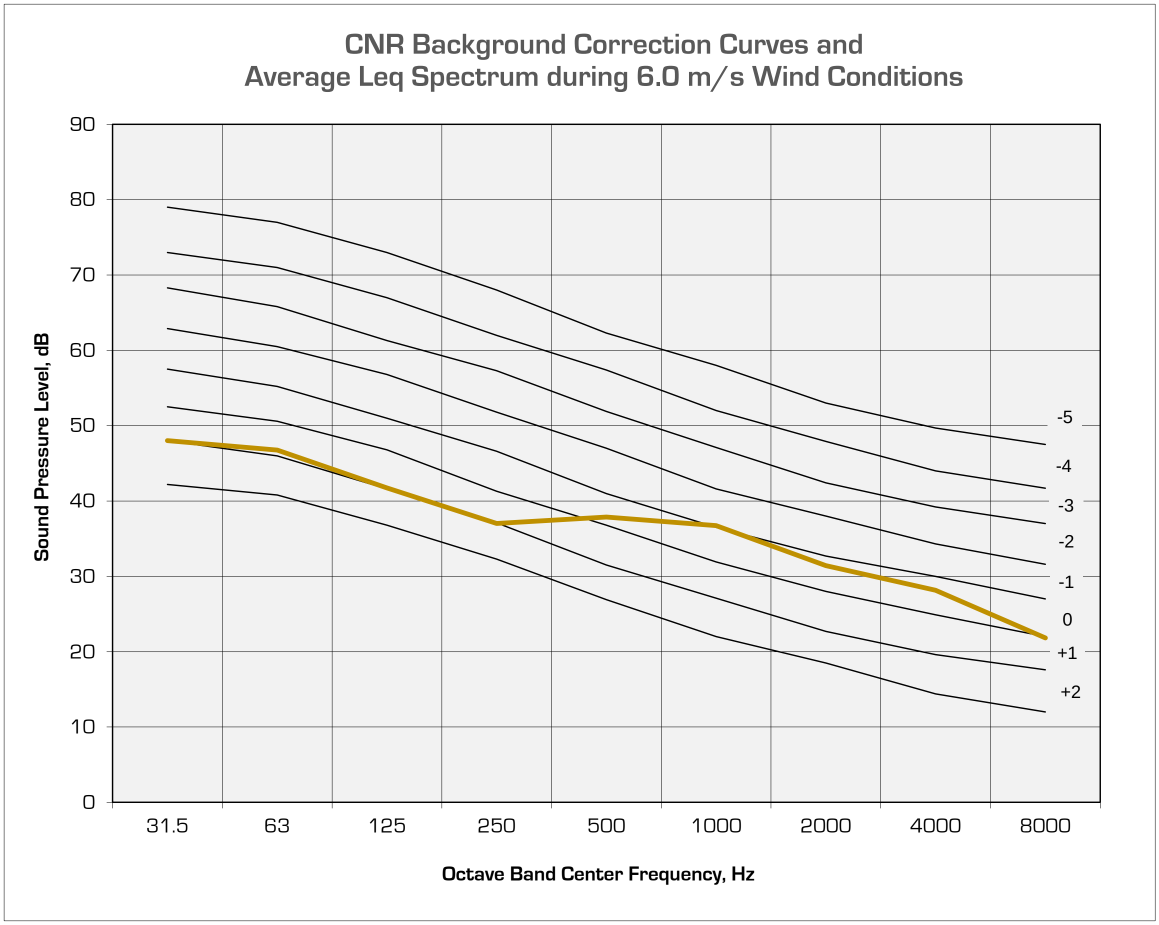


Figure 3.6.2

This chart indicates that a correction of **0** would apply during “typical” conditions.

Figure 3.6.3 shows that a background correction of **+1** would apply during “conservative” conditions based on the average measured L90 sound level spectrum.

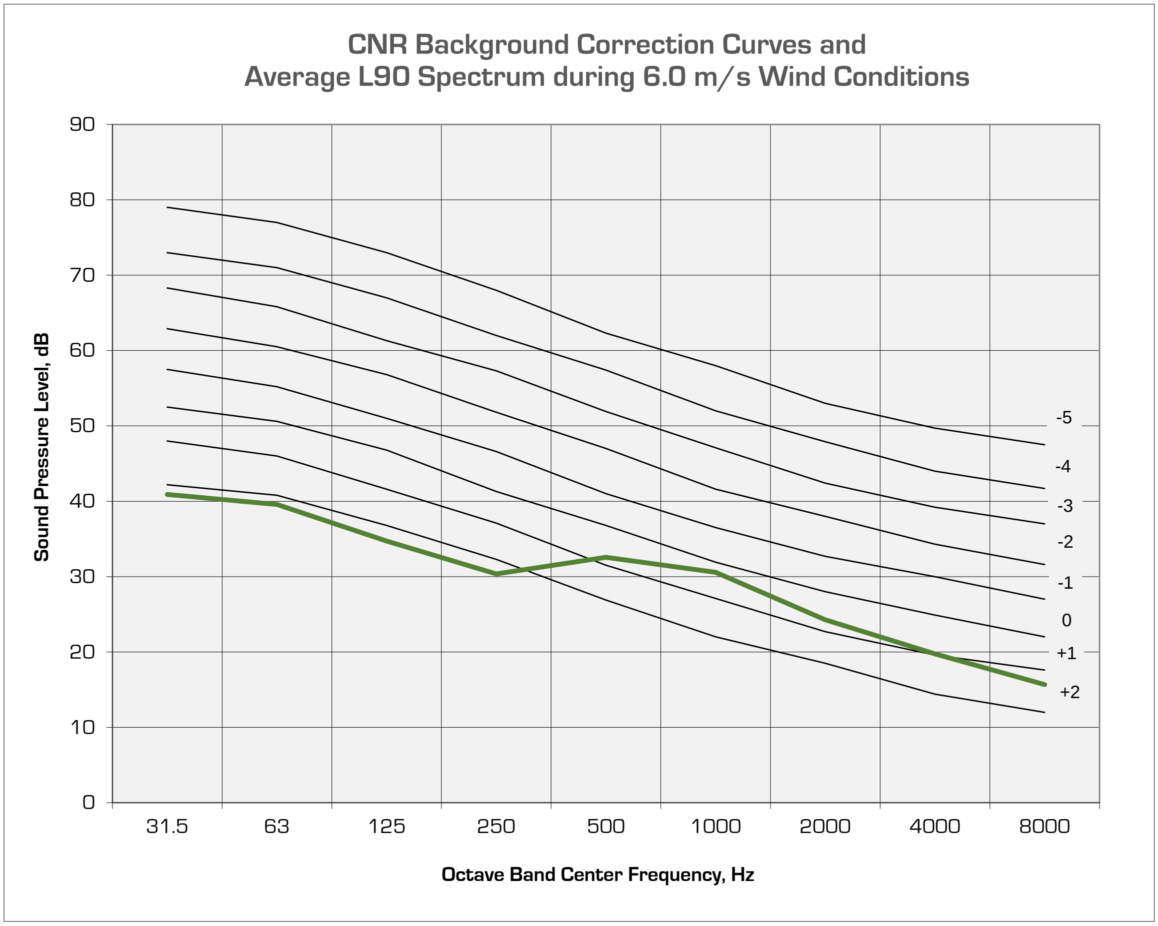


Figure 3.6.3

The remaining corrections to the baseline CNR rating relate to the temporal nature of the new noise source, its character and the general attitude of observers.

The temporal correction accounts for the duration of the ostensibly intruding noise; i.e. when it occurs during the day or night and whether it changes with the seasons. Wind turbines do not operate on a continuous basis and much of the time when they are running winds are light and no significant noise is generated; consequently, a correction factor of **-1** for partial operation has been assumed.

The character correction takes into consideration the fact that noises that contain any kind of tone, impulse or excessive low frequency content are more apt to be considered objectionable than a broadband noise of the same magnitude. In the case of wind turbines, observed from a distance of at least 1200 feet, none of these particular character features will actually be present in the sound; however, wind turbines of this type can produce a certain amplitude modulation, or intermittent whooshing sound associated with the rotor, which increases the perceptibility of the sound. Consequently, an adverse character adjustment factor of **+1** has been used in the CNR assessment.

The final correction factor, ranging from -1 to +1, is associated with previous exposure and attitude.

Table 3.6.2
CNR Correction Factors Related to Receptor Attitude

CNR Correction Factor	Previous Exposure and Attitude
-1	Considerable previous exposure and good community relations
0	Some previous exposure and good community relations
+1	No previous exposure or some previous exposure and poor community relations

The specific attitudes towards the project are not known on a house by house basis but it is our understanding that the community is largely in favor of the project. In terms of exposure it can be assumed that nearly everyone in the project area is very familiar with wind turbines because of the many nearby existing projects, such as the Noble Chateaugay Windpark immediately to the east. While these circumstances point to a correction factor of -1, **0** will be assumed to be conservative.

Table 3.6.3 summarizes each correction and gives the net total for typical and conservative background sound conditions.

Table 3.6.3
Summary of Correction Factors

Correction	Correction Factor	
	Typical Conditions	Conservative Conditions
Background Correction	0	+1
Temporal/Seasonal Correction	-1	-1
Character Correction	+1	+1
Exposure and Attitude	0	0
Net Correction	**0**	**+1**

The final CNR classification for a specific receptor location is determined by applying the net correction to the baseline letter grade. For example, a baseline rating of “c” with a net correction of -1 would result in a final rating of “B”, or one letter below the starting value. The nominal meaning of this final rating is given in the chart below.

Table 3.6.4
Final CNR Ratings and Predicted Reactions

Final CNR Rating	Significance
A	No Reaction
B	No Reaction
C	No Reaction to Sporadic Complaints
D	Sporadic Complaints
E	Widespread Complaints or Single Threat of Legal Action
F	Several Threats of Legal Action or Strong Appeals to Local Officials to Stop the Noise
G	Several Threats of Legal Action or Strong Appeals to Local Officials to Stop the Noise
H	Several Threats of Legal Action or Strong Appeals to Local Officials to Stop the Noise
I	Vigorous Action

The following table relates the predicted project-only sound levels, illustrated graphically in the sound contour plots, with CNR ratings for typical and conservative conditions.

Table 3.6.5
CNR Ratings Associated with Predicted Project Sound Levels

Predicted Project-only Sound Level, dBA	CNR Rating – Typical	CNR Rating – Conservative
46	D	E
45	D	E
44	C	D
43	C	D
42	C	D
41	C	D
40	B	C
39	B	C
38	B	C
37	B	C
36	B	C
35	A	B

The chart begins with 46 dBA because that is the maximum project sound level predicted at any residence within the site area.

What these listings generally indicate is that little or no reaction is expected under most conditions, since the CNR rating is C (no reaction to sporadic complaints) or lower in most instances. The potential for complaints and some dissatisfaction essentially begins with a D rating (sporadic complaints), which equates to a sound level of 45 dBA during "typical" conditions and 41 dBA during "conservative" conditions.

This conclusion agrees remarkably well with the NYSDEC relative increase assessment discussed in the previous section, since the impact thresholds derived using the ambient-plus-5 dBA approach were 46 dBA for typical conditions and 40 dBA for conservative conditions.

All non-participating residences where a project sound level of 45 dBA is calculated are tabulated below along with the CNR ratings for each design case.

Table 3.6.5
CNR Ratings at Non-Participating Residences with a Predicted Project Sound Level of 45 dBA or more

Receptor Id	Local Street Address	Town	Calculated Mean Project Sound Level, dBA	CNR Typical Conditions	CNR Conservative Conditions
151	841 Healey Rd	Chateaugay	45	D, Sporadic Complaints	E, Widespread Complaints
325	289 Jericho Rd	Chateaugay	45	D, Sporadic Complaints	E, Widespread Complaints
188	Town Line Rd	Bellmont	45	D, Sporadic Complaints	E, Widespread Complaints
176	228 Jericho Rd	Chateaugay	45	D, Sporadic Complaints	E, Widespread Complaints
174	159 Titus Rd	Bellmont	45	D, Sporadic Complaints	E, Widespread Complaints

While these two independent assessment methodologies point to the possibility of some complaints where the project sound level exceeds about 40 dBA, it should be noted once again that the analysis is conservative in the following ways:

- Minimal background masking noise, which occurs infrequently, is assumed in the conservative case
- 43 turbines are modeled, whereas only 37 of the proposed sites will actually be developed
- All of the turbines are assumed to be operating at a near-maximum sound power level of 105 dBA re 1 pW despite the fact momentarily calm conditions are implicit in the L90 background sound level
- A critical wind speed of 6 m/s is assumed to be blowing – at all other wind speeds the potential intrusiveness of project noise would be less
- Any given point is assumed to be simultaneously downwind of every turbine in the project and therefore experiencing a theoretical maximum project sound level
- The predicted sound levels occur outside; interior sound levels would be substantially lower
- An essentially neutral (rather than positive) public attitude is assumed in the CNR calculation

3.7 Cumulative Noise Impacts

There is an existing wind project, the Noble Chateaugay Windpark, to the east of the Jericho Rise project area but the nearest turbines are roughly 1 mile away from any residences in the vicinity of proposed future turbine locations. In most instances, the distances from residences in the eastern part of the Jericho Rise site to any of the Noble turbines is considerably further than 1 mile. Consequently, the sound emissions from the existing project would be inconsequential – approximately 30 dBA, or less - and non-additive at any potentially sensitive receptor within the proposed project area. Therefore no adverse impact from cumulative noise is expected.

3.8 Substation Noise

The electrical substation associated with the project is located on a parcel of unoccupied land to the southwest of the intersection of Hartnet and Willis Roads and will essentially be an expansion of an existing substation. The sound emissions from the new step up transformer, the only sound source of any potential consequence in the substation, have been conservatively calculated from the MVA rating of 92 using the empirically derived EEI Noise Guide methodology[5] and included in the overall project noise model. This estimate yields an overall sound power level of 98 dBA re 1 pW. Considered independently from the surrounding wind turbines, transformer noise would die down to an insignificant sound level of 35 dBA, which is comparable to the existing near-minimum background level, at a distance of just over 1000 ft. taking into account distance spreading, air absorption and moderate ground absorption. Any tonal character to the noise would also dissipate over this distance because ground absorption losses occur mainly in the same region of the frequency spectrum (200 to 500 Hz) where the core magnetostriction tones occur (120 Hz to 480 Hz). Since the nearest residences are on the order of 1500 ft. away the sound emissions from the substation transformer are not expected to be of any consequence at any potentially sensitive receptors.

3.9 Compliance with Local Law

Plot 3 shows the sound emissions from the project plotted out to the regulatory limit of 50 dBA using the maximum sound power level of 106.6 dBA re 1 pW. It is evident from this graphic that, at least under the normal weather and wind conditions depicted, a project-only sound level of 50 dBA or more will not occur at any non-participating (off site) homes or other sensitive receptors within the project area as required by the local wind energy facility laws.

3.10 Low Frequency Noise

Concerns about annoyance and/or adverse health effects from excessive low frequency noise from proposed wind farms are commonly voiced but they have apparently grown out of internet misinformation or anecdote without any real basis in fact. The widespread belief that wind turbines produce elevated or even harmful levels of low frequency and infrasonic sound has been repeatedly and independently disproven by numerous investigators[6,7,8,9,10]. These studies show that the low frequency sound emissions from wind turbines are essentially comparable to or less than the natural low frequency sound level typically present in a rural environment and well below the threshold of perceptibility.

Having said that, however, the issue of potential health effects from wind turbines is the subject of a long-running and on-going debate amongst experts in the wind turbine noise field and a final consensus has yet to be arrived at. Real symptoms have and are being experienced by some residents living in proximity to some wind projects but no plausible link to the sound emissions from the turbines, low frequency or otherwise, has ever been found.

In an effort to resolve this conundrum once and for all the Government of Canada (Health Canada) has recently completed a very extensive epidemiological study[11] using both self-reported and objectively measured health outcomes to impartially investigate and quantify the prevalence of health effects and health indicators among a large sample of residents living within 11 km of wind projects. In general, it was found that there was no statistically significant exposure-response relationship between wind turbine noise and such factors as sleep disturbance, sleep disorders, migraines, dizziness, diabetes, hypertension, hair cortisol concentrations, blood pressure, resting heart rate, perceived stress or any measure of quality of life. In many cases worse or more prevalent symptoms, such as sleep disturbance, for instance, were reported by residents living far away from any turbines.

Additional recent studies, such as Howe[12] and Tonin[13], suggest a psychosomatic origin for what appear to be legitimate and very real symptoms. In the Tonin study volunteers were split into two groups and exposed in a double blind experiment to (inaudible) infrasonic sound through special headphones and queried afterwards for their reactions. Prior to the test one group was given internet articles describing the supposed adverse effects of low frequency wind turbine noise while the other group was given different articles asserting that there is no significant impact from such sound. The results show, at least for the short-term exposures in the study, that those who were preconditioned to believe there would be an adverse effect reported them to a statistically significant extent while no effect at all was observed by the other group.

3.11 Construction Noise

Noise from construction activities associated with the project may temporarily constitute a moderate, unavoidable impact at some homes in the project area. Assessing and 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 to a few weeks of repair or repaving work occurring on a nearby road or to the sound of machinery operating on a nearby farm. More commonly (at houses that are some distance away), the sounds from project construction are likely to be faintly perceived as the far off noise of diesel-powered earthmoving equipment characterized by such things as irregular engine revs, back up alarms, gravel dumping and the clanking of metal tracks.

Construction of the project is anticipated to consist of several principal activities:

- Access road construction and electrical tie-in line trenching
- Site preparation and foundation installation at each turbine site
- Material and subassembly delivery
- Turbine erection

The individual pieces of equipment likely to be used for each of these phases and their typical noise levels as reported in the *Power Plant Construction Noise Guide* (Empire State Electric Energy Research Corp.[14]) are tabulated below in Table 3.11.1. It should be noted that this reference is quite old, dating back to 1977, and the equipment sound levels in it are somewhat higher than the values that can be found in more recent references, such as from the FHWA[15] for modern construction equipment. These older, higher values have been deliberately used just to be conservative.

Table 3.11.1 shows the maximum total sound levels due to construction at each turbine site that might temporarily occur at the closest non-participating residences at least 1200 ft. away. The distance from a specific construction site to the point where construction noise would drop to 40 dBA is also shown in the table. A bland, steady sound level of 40 dBA is generally considered so quiet (about the sound level in a library) that it is not usually viewed as objectionable even when the background, or masking, sound level is negligible. Unlike for the operational project, wind speed is irrelevant to the background level during the construction phase since there will be times when construction is occurring during calm and quiet periods.

Table 3.11.1
Construction Equipment Sound Levels by Phase

Equipment Description	Typ. Sound Level at 50 ft., dBA	Est. Maximum Total Level at 50 ft. per Phase, dBA*	Max. Sound Level at a Setback Distance of 1200 ft., dBA	Distance Until Sound Level Decreases to 40 dBA, ft.
Road Construction and Electrical Line Trenching				
Dozer, 250-700 hp	88	92	61	5500
Front End Loader, 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 Hwy Hauler, 115 ton	90	90	59	4800
Flatbed Truck	87			
Turbine Erection				
Mobile Crane, 75 ton	85	85	54	3400

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

What the values in this table generally indicate is that, depending on the particular activity, sounds from construction equipment are likely to be significant at distances of up to 5500 feet – which means that construction will occur close enough to many homes within the project area that its noise will be clearly audible.

Sound levels ranging from 54 to 61 dBA might temporarily occur at the closest homes to turbine locations over several weeks due to construction activities 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 or outside of normal daytime working hours (when all project construction is planned), but as a temporary, daytime 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 very small amount of daily 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.

4.0 Summary and Conclusions

A field survey of existing sound levels within the Jericho Rise Wind Farm project area under early spring conditions indicates that background sound levels are variable and dependent to a significant degree on wind speed. Noise from roadways and other man-made sources is of secondary importance over most of the site and existing sound levels are generally dominated by natural sources.

A regression analysis of sound levels vs. wind speed shows that the average, or “typical” background sound level increases with wind speed and ranges from about 38 to 43 dBA over the range of wind speeds where turbine noise is variable; i.e. from about 4 m/s (measured at a standard elevation of 10 m) to 7 m/s when the turbine rotor reaches its maximum rotational speed and the sound output becomes constant. The residual (L90) sound level increases from 31 to 38 dBA over the same wind speed range. A fairly uniform sound level was found to exist at all 8 monitoring stations despite the deliberate diversity of the settings in which the instruments were placed (wooded, open fields, remote, near roads, etc.). Consequently, the average sound levels from all positions, after the removal of obvious local contamination, reasonably characterizes the site-wide sound level.

A comparison, as a function of wind speed, between the background sound levels and the variable sound power level of the Gamesa G114 2.1 MW turbine currently planned for the project indicates that the maximum potential for an adverse impact from noise occurs at a moderate wind speed of 6 m/s, rather than at higher wind speeds as might be imagined. At 6 m/s the greatest differential exists between the turbine sound level and the amount of masking background noise available to obscure project noise. This analysis showed that the “typical” (Leq) background sound level likely to exist under these conditions was **41 dBA** and the “conservative”, near-minimum (L90) sound level, was **35 dBA**. By definition L90 sound levels only occur 10% of the time, so these lower, conservative levels do not represent the permanent background sound level, but rather momentarily low levels.

In the New York State Department of Environmental Conservation’s Program Policy *Assessing and Mitigating Noise Impacts* a cumulative increase in sound level of 6 dBA is characterized as having the “potential for adverse noise impact only in cases where the most sensitive of receptors are present” and is suggested as a threshold for determining what areas might be adversely impacted by a new noise source and what areas should see “no appreciable effect”. For this site a 6 dBA cumulative increase is associated with a project-only sound level of **46 dBA**[2] for

[2] 41 (background) + 46 (project) = 47 dBA (total), or 6 dBA above the background level.

"typical" conditions and **40 dBA** when the background sound level is at a momentary minimum ("conservative" conditions).

A Second Level modeling study carried out per the NYSDEC guidelines showed that the region where noise impacts might occur (i.e. where an increase of 6 dBA or more is predicted) does not encompass any homes based on "typical" background levels but does potentially affect most of the homes in the immediate project area when the wind is blowing at 6 m/s and the background sound level is at a temporary minimum.

An analysis of the potential project noise impact based on the modified CNR method was also carried out. This methodology evaluates the frequency content of the background and project sound levels and considers other factors such as the temporal characteristics of the noise source, public attitude and the character of the sound. This analysis independently confirmed the findings of the modeling analysis using the NYSDEC relative increase methodology.

In theory, these analyses indicate that an adverse impact is possible in areas where a sound level of 40 dBA or higher is predicted but it should be noted that the modeling is conservative in a number of respects:

- The L90 background level that is assumed in the "conservative" analysis represents the quietest lulls between wind gusts, cars passing by, dogs barking, farm equipment, etc. As such, this level quantifies a very low value for masking environmental noise. Most of the time a substantially higher background sound level will exist.

- It is assumed that a turbine will be erected on all 43 turbines sites whereas only 37 turbines are actually planned.

- The noise model assumes that a 6 m/s wind is blowing simultaneously from all directions and that the turbine sound level experienced at any given point is the sound level that would occur downwind from all turbines in the project. Such a sound level is a physical impossibility in many situations. For example, a receptor between two turbines cannot possibly be downwind from both units at the same time.

- The ground surface is assumed to have a fairly low absorptivity – normally wooded areas and farm fields are highly absorptive.

- The predicted sound levels occur *outside*. Sound levels inside of any dwelling will be 10 to 20 dBA lower. This reduction generally puts the project sound level inside any home at or below the sleep disturbance threshold of 30 dBA published by the World Health Organization[16]

These conservative assumptions are intended to over-estimate project sound levels under most normal conditions so that some allowance or buffer exists to cover the intermittent occurrence of certain atmospheric conditions that allow turbine noise to be more readily perceived, such as during stable atmospheric conditions that sometime develop in the evening or at night.

Although the actual project sound levels are expected to be lower than the predicted levels most of the time, a mildly adverse reaction may be possible from some residents in the project area and the possibility of stronger reactions cannot be ruled out. The density of turbines, their proximity to residences and the relatively low background sound levels found during the field survey mean that some level of dissatisfaction may occur but probably only during certain wind and weather conditions.

In any case, the modeling analysis shows that full compliance is expected with the local laws in Chateaugay and Bellmont relating to wind energy facilities. The maximum allowable sound level of 50 dBA is predicted to occur well short of any residence, participating or otherwise.

Although concerns are often raised with respect to low frequency noise emissions from wind turbines, no adverse impact of any kind related to low frequency noise is expected from this project. An extensive and impartial governmental study recently completed by Health Canada shows no relationship between various health symptoms and exposure to the sound emissions from wind turbine. Other studies suggest a psychosomatic origin to the very real health issues that have inexplicably occurred at some wind farms.

Unavoidable noise impacts may occur during the construction phase of the project. Construction noise, sounding similar to that of distant farming equipment, is anticipated to be sporadically audible at most homes within the immediate project vicinity on a temporary basis. The maximum magnitude of construction noise at the nearest homes to individual turbine locations is not expected to exceed 54 to 61 dBA depending on the particular activity. Somewhat higher levels are possible where road building or trenching activities occur fairly close to homes.

END OF REPORT TEXT

References

[1] Berglund, B., Linvall, T., Schwela, D., *Guidelines for Community Noise*, World Health Organization, 1999.

[2] International Electrotechnical Commission (IEC), International Standard 61400-11 *Wind turbine generator systems – Part II: Acoustic noise measurement techniques*, Ed. 2.1, Geneva, Switzerland, 2006.

[3] U. S. Environmental Protection Agency, Report EPA 550/9-76-003 *Model Community Noise Control Ordinance*, Washington, DC, 1975.

[4] Gamesa, Document Code GD229761-en, General Characteristics Manual, "G114 2.1MW 50/60 Hz Power and Noise curves for low noise operating mode (NRS)", July 18, 2014.

[5] Edison Electric Institute, "Electric Power Plant Environmental Noise Guide", 2nd Ed., BBN, 1984.

[6] Pederson, C. S., "An analysis of low frequency noise from large wind turbines", Wind Turbine Noise 2009, Aalborg, Denmark, June 2009.

[7] Leventhal, G., "How the mythology of low frequency noise from wind turbines may have gotten started", Wind Turbine Noise 2005, Berlin, Germany, October 2005.

[8] Sondergaard, B., Hoffmeyer, D, "Low Frequency Noise from Wind Turbines", Proceedings from Wind Turbine Noise 2007, Lyon, France, Sept. 21, 2007.

[9] Van den Berg, G. P., "Do wind turbines produce significant low frequency sound levels", 11th International Meeting on Low Frequency Noise and Vibration and its Control, Maastricht, Netherlands, August 2004.

[10] O'Neal, R. D. et al., "Low frequency noise and infrasound from wind turbines", *Noise Control Engineering Journal*, J.59 (2), March-April 2011.

[11] Summarized by David S. Michaud, PhD of Health Canada in "Wind Turbine Noise and Health Effects: Summary of Results", 6th International Conference on Wind Turbine Noise, Glasgow, Scotland, 20-23 April, 2015.

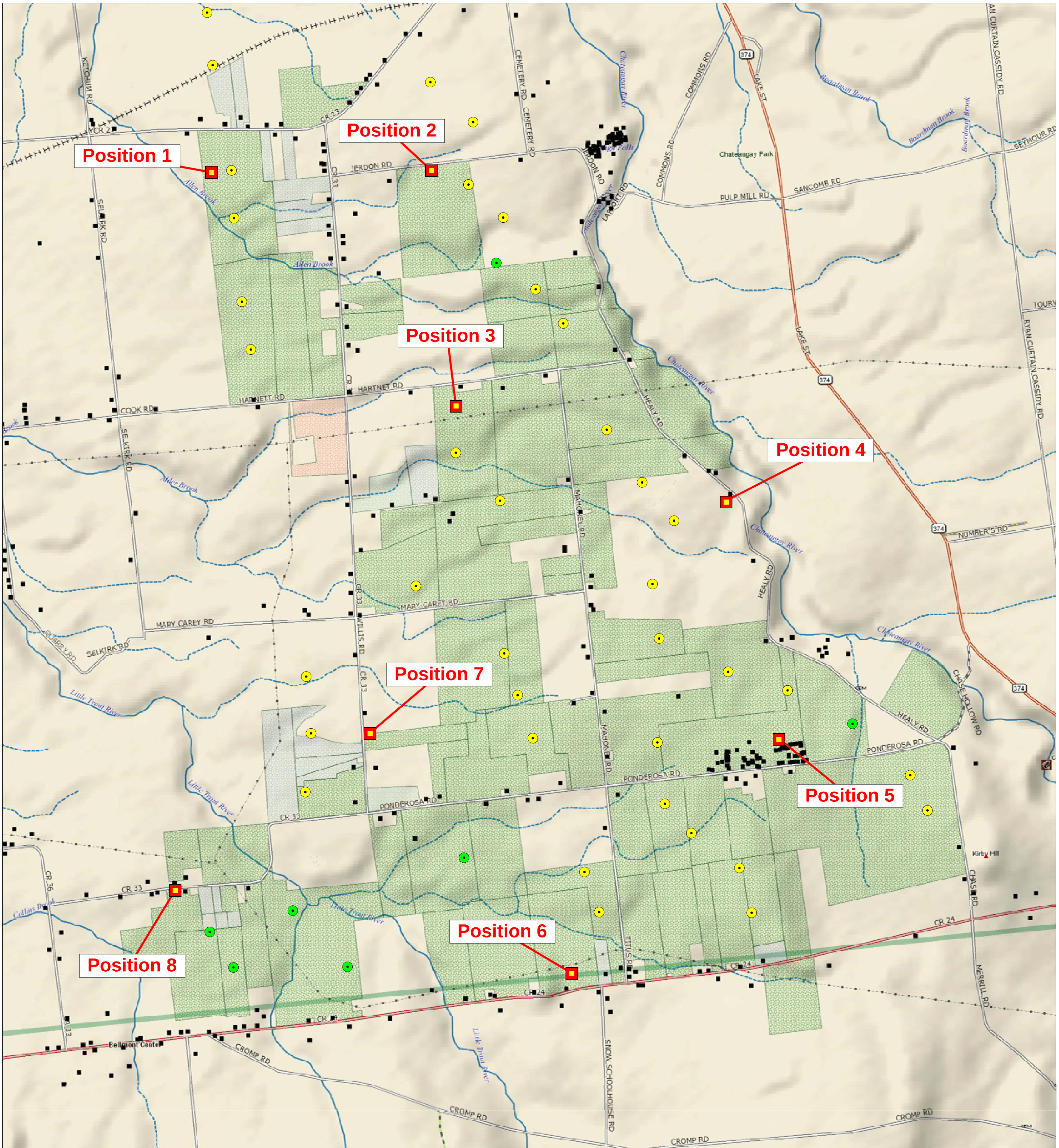
[12] Howe, B., "Findings of the Council of Canadian Academies Expert Panel on Wind Turbine Noise and Human Health", 6th International Conference on Wind Turbine Noise, Glasgow, Scotland, 20-23 April, 2015.

[13] Tonin, R., "Response to Simulated Wind Farm Infrasound Including Effect of Expectation", 6th International Conference on Wind Turbine Noise, Glasgow, Scotland, 20-23 April, 2015.

[14] Edison Electric Institute, *Electric Power Plant Environmental Noise Guide*, Vol. 1, 2nd Edition, 1984.

[15] U. S. Dept. of Transportation, Federal Highway Administration, *Roadway Construction Noise Model User's Guide*, Table 1, Jan. 2006.

[16] Berglund, B., Linvall, T., Schwela, D., *Guidelines for Community Noise*, World Health Organization, 1999.

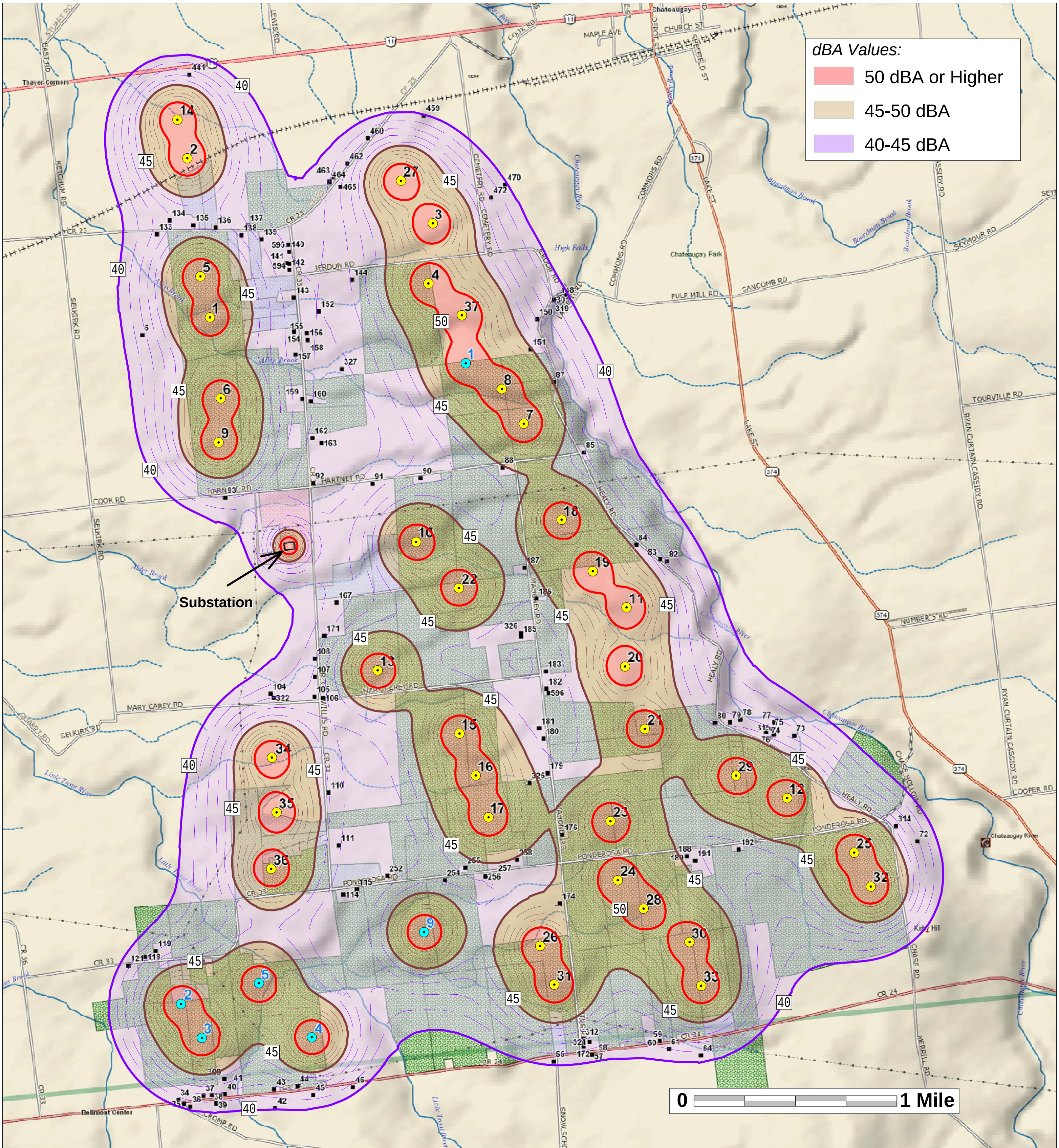


Project: **Jericho Rise**	*Description:* **Graphic A**	*Legend:*
Prepared for: **EDR**		Monitoring Position
Date: June 30, 2015 — *Drawing #:* JR-Rev-A-1-1	**Sound Monitoing Positions**	Turbine Location Alternate Turbine

Hessler Associates, Inc.
WORLDWIDE CONSULTING IN ENGINEERING ACOUSTICS

3862 Clifton Manor Place, Suite B
Haymarket VA, 20169
www.hesslernoise.com
(703) 753-2291 (703) 753-1602

N W E S



Project: Jericho Rise

Prepared for: EDR

Date: October 23, 2015

Drawing #: JR-Rev-F-1-1-1

Description:

Plot 1

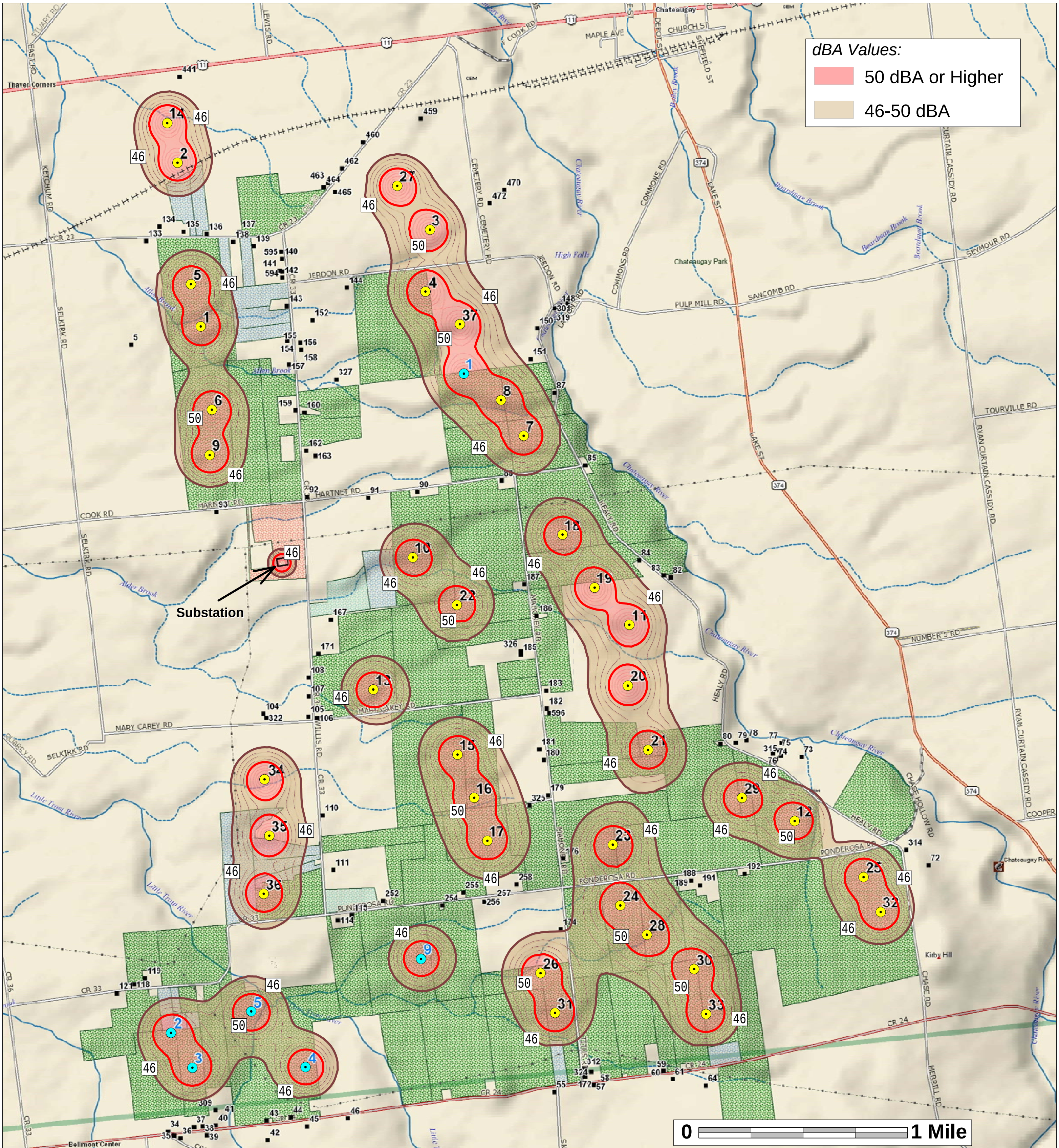
Predicted Sound Contours (dBA) Plotted to "Conservative" Impact Threshold of 40 dBA. All Units Operating Under 6 m/s Wind Conditions.

Legend:

- Turbine Location
- Alternate Turbine
- Non-Participating Residence

Hessler Associates, Inc.
WORLDWIDE CONSULTING IN ENGINEERING ACOUSTICS
3862 Clifton Manor Place, Suite B
Haymarket VA, 20169
www.hesslernoise.com
(703) 753-2291 (703) 753-1602

N
W E
S

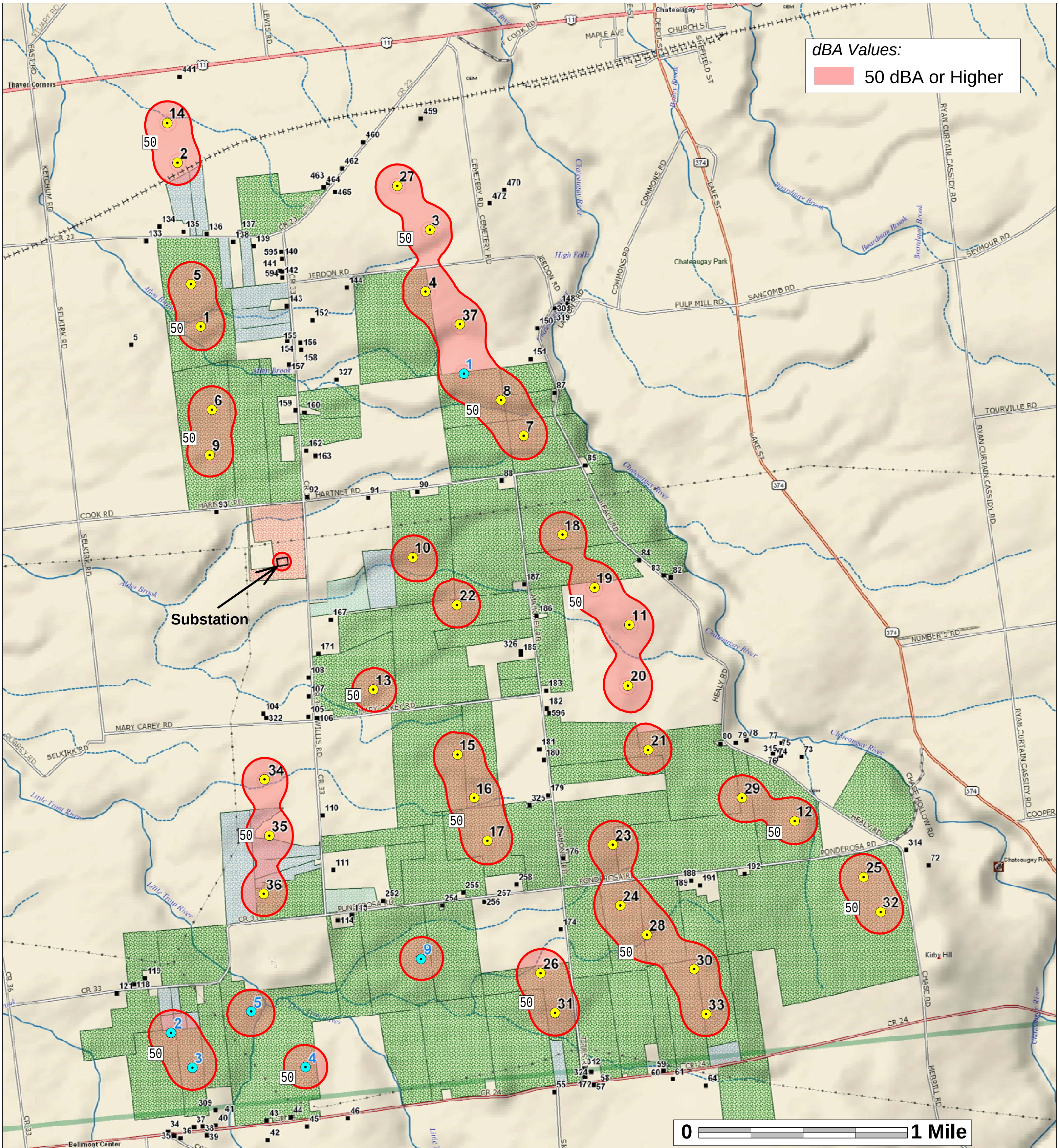


Project:	Description:	Legend:
Jericho Rise	**Plot 2**	Turbine Location
Prepared for: **EDR**	**Predicted Sound Contours (dBA) Plotted to "Typical" Impact Threshold of 46 dBA. All Units Operating Under 6 m/s Wind Conditions.**	Alternate Turbine
Date: October 23, 2015 — Drawing #: JR-Rev-F-1-2-1		Non-Participating Residence

Hessler Associates, Inc.
WORLDWIDE CONSULTING IN ENGINEERING ACOUSTICS

3862 Clifton Manor Place, Suite B
Haymarket VA, 20169
www.hesslernoise.com
(703) 753-2291 (703) 753-1602

N
W E
S



Project:	Description:	Legend:
Jericho Rise	**Plot 3**	Turbine Location
Prepared for: EDR	**Predicted Sound Contours (dBA) Plotted to Local Regulatory Limit of 50 dBA. All Units Operating Under 7 m/s Wind Conditions.**	Alternate Turbine
Date: October 23, 2015 — Drawing #: JR-Rev-F-1-3		Non-Participating Residence

Hessler Associates, Inc.
WORLDWIDE CONSULTING IN ENGINEERING ACOUSTICS

3862 Clifton Manor Place, Suite B
Haymarket VA, 20169
www.hesslernoise.com
(703) 753-2291 (703) 753-1602

N
W E
S