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February 5, 2011

Mr. Reg Karg, Chairman
Riga Township Planning Commission
12164 Riga Hwy.
Ottawa Lake, MI 49267

Mr. Karg,

On request of interested parties in Riga Township, I am writing to provide important information about siting wind turbines to protect public health with an adequate margin of safety. I am a Member of the Institute of Noise Control Engineering with over thirty years of experience in acoustics including many years working in industrial power generation noise control. I have conducted independent studies of wind turbine noise including actual field measurements of operating wind turbines in the State of Maine over the last year, where significant community reaction has occurred near wind turbine facilities equipped with smaller wind turbines than proposed for the Riga Township.

I understand that there have been suggestions of using a wind turbine noise limit of 45 dBA at a distance of 1300 feet or so in Riga Township. Experience in New England has proven that these noise levels at these distances for wind turbines sited in rural areas are associated with significant adverse community reactions, widespread complaints, appeals to stop the noise, and legal action. When siting large industrial wind turbines in quiet rural areas, lower maximum noise levels and farther distances are recommended to prevent adverse community reaction and protect public health and welfare with an adequate margin of safety.

This letter presents a discussion of community reactions to noise, guidelines for appropriate maximum permissible noise limits in rural areas, measured noise levels versus distance and observed community responses. I appreciate your consideration of this letter and believe you will find this information useful in your determinations of how to protect the health and welfare of Riga Township.

Please call me if you have any questions.

Respectfully submitted,

Community reactions to noise

People react to changes in noise level and to unusual or unpredictable noise character. People respond to the change in the sound level from the background to which they are accustomed, as follows:

Figure 1. Estimated Community Response to Noise Increase

Community Response

Increase in Noise	Estimated Community Response
5 dB	Sporadic Complaints
10 dB	Widespread Complaints
15 dB	Threats of Community Action
20 dB	Vigorous Community Action

In *rural* areas (such as Riga Township) it is generally found that background sound levels *in the absence of industrial noise, traffic or insects* falls in around 35 dBA or lower during the day and 25 dBA or lower at night. An adverse community response could occur if a new and unfamiliar noise source was introduced at night at levels of 35 dBA or higher in a quiet rural area.

In contrast for example, consider Hull Massachusetts, a city that experiences pervasive noise from auto traffic and aircraft flyovers from Logan Airport, with typical background sound levels of 40 to 55 dBA at night [1]. With two large industrial wind turbines operating in Hull and sited close to residential neighborhoods, there are few or no complaints from the wind turbine noise there. Does this make sense? Actually, it does. Hull experiences *urban and aircraft* sound levels that are *much higher* than those found in rural areas.

Let's say that a wind turbine produces a sound level of 45 dBA at 1300 feet. In a *rural* area with a nighttime background sound level of 25 dBA or less, the

increase is 20 dBA and the expected community reaction is strong, with "Vigorous Community Action" ranging to "Threats of Community Action" and "Widespread Complaints" with farther distances from the wind turbine. In contrast, in an *urban residential* area like Hull, Massachusetts, with background sound levels similar to or higher than the wind turbines (depending on distance) and a sound signature similar to jet aircraft, there may be no perceptible noise change at nearby residential neighborhoods due to the wind turbine and thus, no reaction.

Noise criteria for noise-producing facilities

Noise-producing facilities are usually required to meet certain noise limits or "criteria" when operating in order to protect the welfare of nearby residents. In many cases criteria are taken directly from local ordinances or State regulations that specify noise limits at specific locations such as property lot lines. However "just meeting" these limits may not prevent an adverse community reaction, depending on the apparent loudness of the noise source when compared to the existing expected background sound levels.

By now most people are aware of the reports of adverse community reactions near some wind turbine facilities. From investigations made around New England, adverse community reactions appear to occur mostly when there are residential homes in quiet rural areas within a mile or so of a wind turbine facility. The noise limits for these sites are always above 35 dBA. Coincidence? No.

Many ordinances and regulations in the United States developed in the last thirty years took their guidance from the EPA's 1974 "Levels Document" [2] and used the EPA's "guideline" of the *Ldn55* (55 dBA day, 45 dBA night), maximum permissible sound level (for urban residential areas) as a noise limit or criterion, whether the ordinance or regulation was applied to urban residential, rural, or wilderness areas. In developing its guidelines, the EPA's primary focus (as expressed in the Levels Document) was on preventing hearing loss and speech interference, writing that "*The level of 55 dB [note: Ldn- 55 dBA day, 45 dBA night] is identified as maximum level compatible with adequate speech*

communication indoors and outdoors. With respect to complaints and long-term annoyance, this level is clearly a maximum serving a large majority of the population. However specific local situations, attitudes and conditions may make lower levels desirable for some locations."

The "large majority" that the EPA wrote of can be seen below in Figure 2. Of the roughly 214 million people living in the US in 1974, some *100 million* lived in areas with existing background sound levels *above* Ldn 55. Over *10 million* lived with background sound levels above *Ldn 70.*

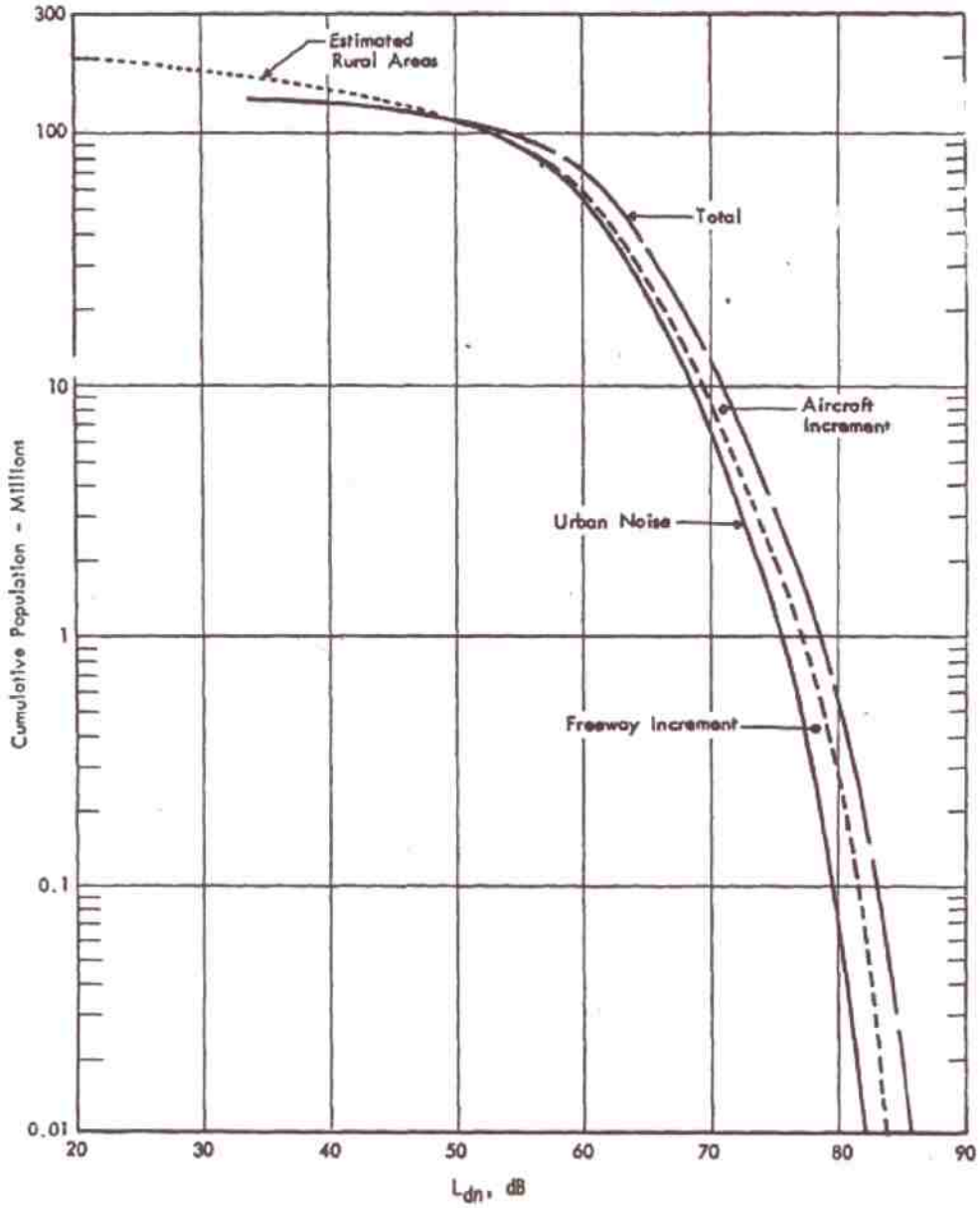


Figure 2 Residential Noise Environment of the National Population As A Function of Exterior Day-Night Average Sound Level (Ref B-5)

For those living with elevated background sound levels in urban areas, the EPA's guideline of a maximum Ldn 55 was well positioned to assure no hearing loss, nor any speech interference within a reasonable speaking distance. However, for the some 100 million people living *outside* urban areas, with existing background sound levels *below* Ldn 55, the EPA's guideline has no protective effect. Indeed, the use of Ldn 55 as a "permitted" maximum level can serve to *degrade* the acoustic environment in quiet rural and wilderness areas by allowing *much higher* intrusive sound levels where existing background sound levels were much lower. *This was never the EPA's intent.*

For an *urban residential* area like Hull, a 45-dBA nighttime limit (the nighttime limit in Ldn55) *could* be effective at producing a "No Reaction" community response. However, if a criteria of 45 dBA were selected for a *rural* area with minimum background sound levels of 25 dBA or less, that allows a *20 dB increase* over the pre-existing night time levels. The predicted community reaction would be strong and adverse, and the ordinance would not be experienced as a protection to well-being in the much quieter rural setting.

With this general framework now presented to you, how can community reactions to wind turbine sound levels be assessed and appropriate criteria developed for rural areas such as Riga Township? Fortunately there is an established method for determining community reaction to noise.

Noise impact assessment: EPA

The USEPA's 1974 "Levels Document" recognized the range of community reactions in different areas and presented a well-researched community reaction prediction methodology, sometimes referred to as the "Normalized Ldn" method for noise impact assessment. The EPA noise impact assessment method includes correction factors for background sound level, previous experience to the noise and sound character in terms of impulsive noise (Attachment 1). The community impact reaction can be predicted for wind turbines located in quiet areas with the EPA methodology. Using the EPA's modeling corrections allow the reviewer to

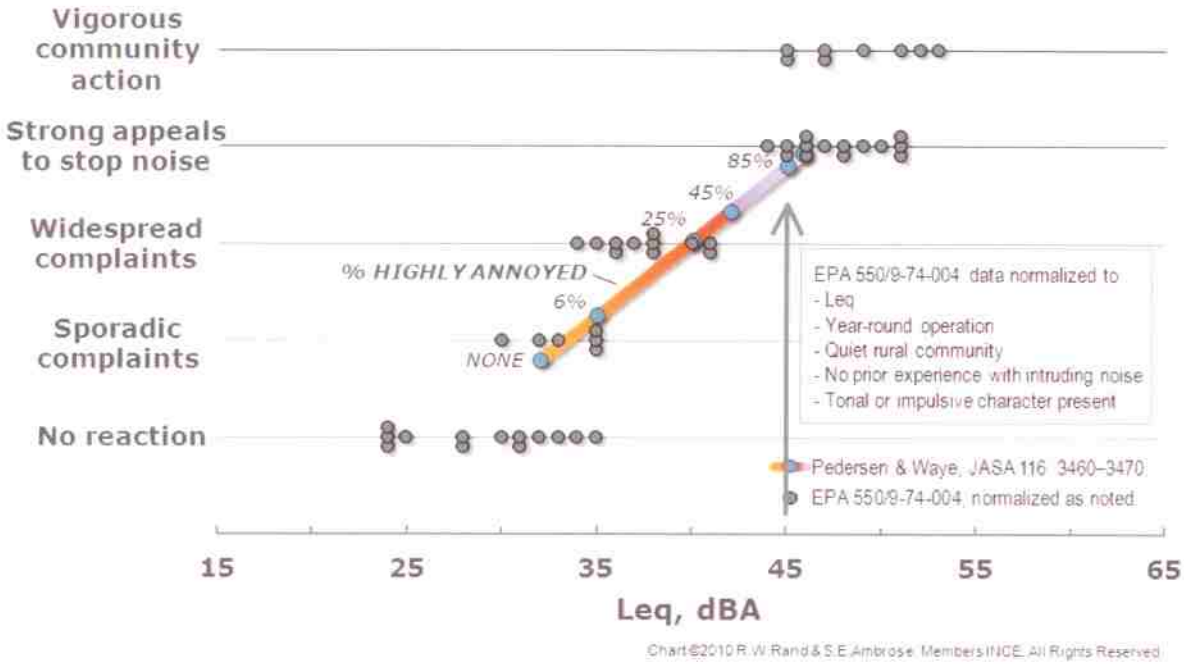
account for the features of wind turbine noise that distinguish it from other noise sources.

Figure D-7 in Attachment 1 shows the EPA normalized Ldn values with no corrections. The process used for this review analysis starts with converting the EPA's Ldn data to Leq (the *energy-average* sound level). To convert the EPA data from Ldn to Leq, a 6 dB factor is employed assuming steady operation day and night. For example, Ldn 51 equals an Leq of 45 dBA for a steady-state noise source. Then, the community noise impact assessment for a wind turbine facility uses the following normalizing correction factors to the EPA's data to bring them into an Leq chart:

0 dB for year round operation,
10 dB for being located in a quiet or rural area,
5 dB for no prior experience and,
5 dB for tonal or impulsive character.

With the conversion to Leq and the correction factors applied, the EPA data now appear at the normalized Leq values shown in Figure 3. Now, the predicted wind turbine Leq can be assessed directly with the EPA's normalized data, which is now expressed in a normalized Leq with associated normalized community reactions. Figure 3 shows the Leq noise level on the 'X-axis' and normalized EPA community reactions on the 'Y-axis'. The community reaction is determined by finding, as an example, the proposed 45 dBA on the figure as shown and moving straight up the chart to find the occurrences of community reaction. The Leq 45 value actually intersects the normalized community reactions at two reaction levels: "Strong appeals to stop the noise" and the highest level "Vigorous action".

Figure 3 – Community Impact Assessment



The EPA method indicates that the 45-dBA limit suggested for nearest neighbors in the quiet areas of Riga Township is associated with the EPA-based normalized community impact reactions of "Strong Appeals To Stop Noise" to "Vigorous Community Action." The proper way to design noise-producing facilities is to perform a community noise impact assessment to ensure that noise emissions result in "No Reaction" or no more than "Sporadic Complaints."

How can the EPA's guideline of Ldn 55 (55 dBA day, 45 dBA night) be adjusted for noise impacts from wind turbines in the quiet, rural setting? Accounting for ALL the correction factors in the EPA's community reaction assessment method as discussed above, the resulting total correction of 20 dB leads to the conclusion that the EPA's maximum permissible noise limits should be adjusted downward from their urban residential guideline of Ldn 55 to a *rural* Ldn 35, or 35 dBA, day and 25 dBA, night. These levels are consistent with background sound levels normally found in rural areas and would be expected to produce "No Reaction."

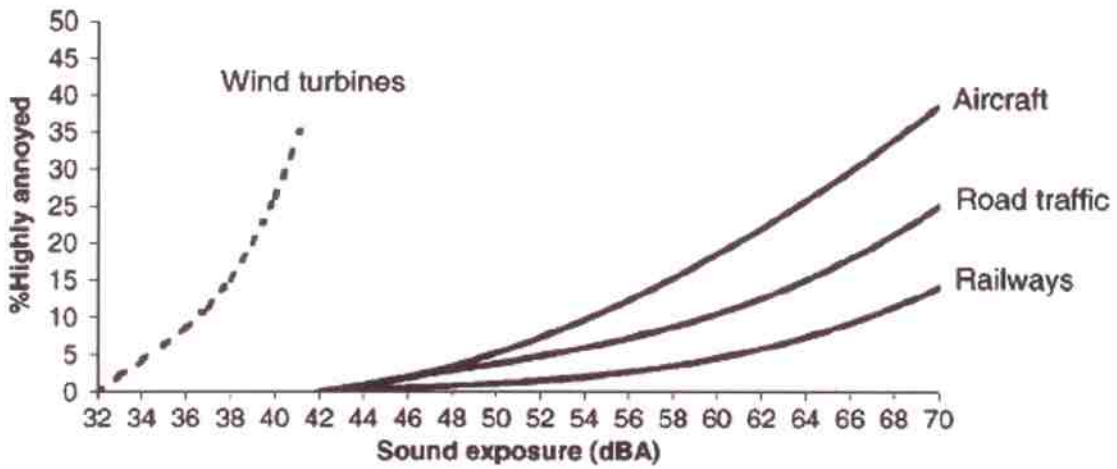
If a criterion were developed by making EPA's 10 dB correction from urban residential to *rural*, without considering the impact of 1) a new noise and 2) the

impulsive, low-frequency sound character, it follows that the EPA's Ldn 55 (55 day, 45 night) maximum permissible noise limits would be corrected to Ldn 45, with a night limit *not to exceed 35 dBA*. The predicted community reaction at the nearest neighbors could be "Sporadic Complaints" to "Widespread Complaints".

Does a maximum permissible limit of 45 dBA provide adequate provision to prevent an adverse noise impact from the wind turbines on public welfare (well-being) in *rural* areas? The answer is clearly, no, and this is why.

Figure 3 includes the results of independent wind turbine noise research by Pedersen & Waye in 2004 [3]. Their data confirm that there can be an adverse community reaction, with associated *activity interference*, including and especially *sleep interference*, for wind turbine noise levels above 32 dBA in rural areas. It should be noted that Pedersen & Waye data included on Figure 3 were obtained around multiple wind turbine sites with sizes ranging from 150kw to 600kw, much smaller than the Vestas V100 wind turbines proposed for Riga Township. The original Pedersen & Waye chart is provided as Figure 4 below showing the adverse community response ramping up quickly starting around 32 dBA, a full *10 dB below* the level where an adverse response from transportation noise starts up.

Figure 4 – Wind turbine noise compared to transportation



When the wind turbine sound level increases from 35 to 42 dBA, Pedersen & Waye found that increasingly, 6 to 45 percent of the community were highly annoyed, with the associated adverse health effects of *"psychological distress, stress, difficulties to fall asleep and sleep interruption."*[4]. Their 2004 best-fit equation suggests the *potential* for most of the community to be highly annoyed for noise levels around 45 dBA. This inference is noted in this letter's Figure 2 as a light extension through 45 dBA. The Pedersen & Waye research strongly suggests that wind turbine noise levels at 45 dBA in the *quiet rural* areas will result in the highest possible negative community response, with essentially all who can be affected highly annoyed, and the associated adverse health effects and activity interferences noted.

When the EPA and Pedersen & Waye assessments are taken together, there is strong evidence that the state of *well-being* (welfare) and being in a state of "*highly annoyed*" cannot coexist.

Have such adverse community noise reactions been observed near wind turbine facilities in quiet rural areas? *Yes.* Operating sound levels compiled for Mars Hill, Maine as well as field data acquired at Freedom, Maine and Vinalhaven, Maine have been charted for community reaction with sound level versus distance and, these clearly illustrate community reactions to those sites well known from news reports as correlated with the predicted community reactions from the EPA method. The charts are provided in Attachment 2.

<u>What criteria to use?</u>

A 45-dBA noise limit at 1/4 mile or so appears to be ineffective to prevent an adverse community reaction or protect public welfare at nearest neighbors from wind turbine noise in quiet rural areas. As a Member of INCE, I am pledged to protect public health as outlined in the INCE Canon of Ethics. The first Fundamental Canon reads as follows.

1. Hold paramount the safety, health and welfare of the public.

Therefore, suitable criteria should be sought.

The US defunded its Office of Noise Abatement in the early 1980s and has had marginal oversight on noise issues since then, primarily aircraft noise. However it is a member of the World Health Organization and we may look to the WHO and its concerted work over the last fifteen years to establish noise guidelines for public health. In 2009 the WHO-Europe published guidelines for outdoor noise levels in residential areas, based on comprehensive peer review of medical evidence of health effects from noise [5]. WHO-Europe published a yearly average sound level of 30 dBA, night, outdoors is the level below which there are no observed health effects, the "No Observed Effects Level" or NOEL. Above the 30 dBA NOEL, health effects including sleep disturbance were found, mild at lower levels for healthy individuals and more adverse with higher levels for "vulnerable groups"; children, the elderly, and people with disease or pre-existing health conditions. Above 40 dBA, the "No Observed Adverse Effects Level" (NOAEL), adverse health impacts are clearly evident and more severe for vulnerable groups.

While there has been debate among acousticians as to how to correlate WHO's 2009 yearly-averaged noise level guidelines to a wind turbine noise level and unique sound character that fluctuates minute to minute depending on wind speed, wind shear, and other factors, there can be little question that adverse health impacts are certain for average noise levels above 40 dBA and health effects including sleep disturbance are possible with average noise levels above 30 dBA.

It doesn't take a year to decide if recurring sleep loss is a problem. Most people have experienced fatigue and other health effects from one poor night's sleep, or perhaps a few nights of interrupted sleep. Some living near wind turbines have to leave their homes and go to another location to get a good night's sleep, and are unable to sell their homes to move away (Mars Hill, Freedom, Vinalhaven).

The night noise guidelines are summarized in Figure 4 shown below.

Figure 4. WHO 2009 Night Noise Guidelines Summary

Average night noise level over a year $L_{night,outside}$	Health effects observed in the population
Up to 30 dB	Although individual sensitivities and circumstances may differ, it appears that up to this level no substantial biological effects are observed. $L_{night,outside}$ of 30 dB is equivalent to the NOEL for night noise.
30 to 40 dB	A number of effects on sleep are observed from this range: body movements, awakening, self-reported sleep disturbance, arousals. The intensity of the effect depends on the nature of the source and the number of events. Vulnerable groups (for example children, the chronically ill and the elderly) are more susceptible. However, even in the worst cases the effects seem modest. $L_{night,outside}$ of 40 dB is equivalent to the LOAEL for night noise.
40 to 55 dB	Adverse health effects are observed among the exposed population. Many people have to adapt their lives to cope with the noise at night. Vulnerable groups are more severely affected.
Above 55 dB	The situation is considered increasingly dangerous for public health. Adverse health effects occur frequently, a sizeable proportion of the population is highly annoyed and sleep-disturbed. There is evidence that the risk of cardiovascular disease increases.

Others advocate for lower noise limit criteria than 45 dBA

Other researchers have recommended quieter wind turbine noise levels than the 45 dBA suggested for nearest neighbors in Riga Township. In 2006 the Hayes McKenzie Group, UK recommended a maximum of 33 dBA when the impulsive character is audible [6]. Dan Driscoll, a recognized acoustic professional formerly with the NYDEC recommended 33 dBA in 2009 [7]. Dr. Michael Nissenbaum of Fort Kent, Maine conducted an independent medical control study for residents living near the Mars Hill wind turbines, with a medical recommendation in 2010 for a minimum separation distance of 2200 meters [8], which roughly correlates to wind turbine noise levels in the mid- to high 30s dBA, depending on number of wind turbines, alignment and other factors.

Because there are no reliable engineering noise controls at the source, the use of separation distance may be needed to meet noise criteria. In field measurements at operating facilities in rural Maine (see Appendix 3), distances of one to two miles were found for wind turbine noise levels of 35 dBA or lower. In noisier areas such as Hull, Massachusetts or near an interstate highway that is busy day and night, adverse community reaction would emerge at higher sound levels, and separation distances to prevent adverse reactions would be reduced.

Conclusions

1. A 45-dBA noise limit at 1/4 mile or so appears to be ineffective to prevent an adverse community reaction or protect public welfare at nearest neighbors from wind turbine noise in *quiet rural* areas, and could allow much higher sound levels than existing, potentially provoking adverse community reaction and complaints.

2. The predicted community reaction to wind turbine noise in *quiet rural* areas based on the EPA normalized community reaction assessment method is "Widespread Complaints" or stronger at 34 dBA or higher.

3. When the EPA community reaction and Pedersen & Waye assessments are taken together, there is strong evidence that the state of *well-being* (welfare) and being in a state of "*highly annoyed*" cannot coexist.

4. Long-term average intrusive noise levels over 40 dBA outside at night are linked to adverse health effects (WHO 2009). Intrusive noise levels between 30 and 40 dBA outside at night *may* produce sleep interference or health effects, especially for health risk groups. The LOAEL of 40 dBA yearly average is the WHO guideline for preventing for preventing adverse health effects from noise. The NOEL of 30 dBA yearly average is the WHO guideline below which there are no observed health effects from noise.

5. A recommended criteria for siting wind turbines in quiet rural areas would be a maximum permissible noise level of 30 to 35 dBA at nearest neighbors properties to prevent adverse community reactions and protect public health and welfare.

This range is consistent with a) the WHO 2009 LOAEL of 40 dBA with a conservative 5 dB design safety factor, b) the recommendations of other professionals, c) a design to approximately no more than "Sporadic Complaints" in quiet rural areas based on the EPA community reaction assessment method, and d) protecting vulnerable groups (children, elderly, those with pre-existing conditions) who may be more susceptible to sleep interference or other health effects between 35 and 40 dBA.

6. Because there are no reliable engineering noise controls at the source, the use of adequate separation distance during facility planning is needed.

7. Distances of one to two miles are needed to meet quiet rural noise criteria of 35 dBA or less (based on actual sites, Attachment 3). Shorter distances can be adequate if wind turbine facilities are located in noisy areas such as urban areas, industrial areas or near busy highways.

1. Assessment Of Airport Noise Monitoring At Hull, Ma, Paul Schomer, May 31, 2001.
2. Information On Levels Of Environmental Noise Requisite To Protect Public Health And Welfare With An Adequate Margin Of Safety, 550/9-74-004, March 1974.
3. Pedersen, E. and K. Pedersson Waye, Perception and annoyance due to wind turbine noise: A dose–response relationship, Journal of the Acoustical Society of America 116, 2004.
4. As described in the conclusions of the Pedersen & Waye 2008 report, Project WindFarmPerception (FP6-2005-Science-and-Society-20, Specific Support Action, Project no. 044628).
5. Night Noise Guidelines For Europe, 2009. ISBN 978 92 890 4173 7.
6. "Officials cover up wind farm noise report", J. Leake and H. Byford, The Sunday Times, December 13, 2009, http://www.timesonline.co.uk/tol/news/environment/article6954565.ece.
7. Dan Driscoll, Environmental Stakeholder Roundtable on Wind Power, June 16, 2009. http://www.powernaturally.org/programs/wind/Daniel%20A.%20Driscoll_Wind%20Roundtable%20Presentation%20w%20Figs.pdf.
8. Prefiled Testimony Of Dr. Michael Nissenbaum, On Behalf Of Albany, Vermont, State of Vermont Public Service Board, Docket No. 7628. http://www.kingdomcommunitywind.com/filemanager/download/21431/.

ATTACHMENT 1

COMMUNITY REACTION TO ENVIRONMENTAL NOISE

Excerpt From: Information On Levels Of Environmental Noise Requisite To Protect Public Health And Welfare With An Adequate Margin Of Safety, 550/9-74-004, March 1974.

There are two methods of indirectly assessing the cumulative effects of environmental noise on people. These are examining the reactions of individuals or groups of individuals to specific intruding noises, either (a) with respect to actions taken (complaints, suits, etc.), or (b) in terms of responses made to social survey questionnaires. The first category, involving overt action by individuals or groups, is summarized in this section, and key data regarding the second category, involving responses indicating annoyance, is summarized in the next section.

In the last 25 years, many new types of noise sources have been introduced into suburban and urban residential communities. These sources, such a jet aircraft, urban freeways, new industrial plants, and homeowner equipment, have created numerous community problems with environmental noise. These problems have provided significant data and insight relating to community reaction and annoyance and stimulated the development of several indices for measurement of the magnitude of intruding noises.

Various U.S. Governmental agencies began to investigate the relationships between aircraft noise and its effect on people in communities in the early 1950's. This early research resulted in the proposal of a model by Bolt, Rosenblith and Stevens for relating aircraft noise intrusion and the probable community reaction. This model, first published by the Air Force, accounted for the following seven factors:

1. Magnitude of the noise with a frequency weighting relating to human response.
2. Duration of the intruding noise.
3. Time of year (windows open or closed).
4. Time of day noise occurs.
5. Outdoor noise level in community when the intruding noise is not present.
6. History of prior exposure to the noise source and attitude toward its owner.
7. Existence of pure-tone or impulsive character in the noise.

Correction for these factors were initially made in 5 dB intervals since the magnitudes of many of the corrections were based solely on the intuition of the authors, and it was considered difficult to assess the response to any greater degree of accuracy. This model was incorporated in the first Air Force Land Use Planning Guide in 1957 and was later simplified for ease of application by the Air Force and the Federal Aviation Administration.

Recently the day-night sound level has been derived for a series of 55 community noise problems to relate the normalized measured Ldn with the observed community reaction. The normalization procedure followed the Bolt, Rosenblith and Stevens method with a few minor

modifications. The correction factors which were added to the measured Ldn to obtain the normalized Ldn are given in Table D-7. The distribution of the cases among the various noise sources having impact on the community are listed in Table D-8. The results are summarized in Figure D-7.

The "no reaction" response in Figure D-7 corresponds to a normalized outdoor day-night sound level which ranges between 50 and 61 dB with a mean of 55 dB. This mean value is 5 dB below the value that was utilized for categorizing the day-night sound level for a "residential urban community," which is the baseline category for the data in the figure. Consequently, from these results, it appears that no community reaction to an intruding noise is expected, on the average, when the normalized day-night sound level of an identifiable intruding noise is approximately 5 dB less than the day-night sound level that exists in the absence of the identifiable intruding noise. This conclusion is not surprising; it simply suggests that people tend to judge the magnitude of an intrusion with reference to the noise environment that exists without the presence of the intruding noise source.

The data in Figure D-7 indicate that widespread complaints may be expected when the normalized value of the outdoor day-night sound level of the intruding noise exceeds that existing without the intruding noise by approximately 5 dB, and vigorous community reaction may be expected when the excess approaches 20 dB. The standard deviation of these data is 3.3 dB about their means and an envelope of +5 dB encloses approximately 90 percent of the cases. Hence, this relationship between the normalized outdoor day-night sound level and community reaction appears to be a reasonably accurate and useful tool in assessing the probable reaction of a community to an intruding noise and in obtaining one type of measure of the impact of an intruding noise on a community.

The methodology applied to arrive at the correlation between normalized Ldn and community complaint behavior illustrated in Figure D-7 is probably the best available at present to predict the most likely community reaction in the U.S. Unfortunately, readiness to complain and to take action is not necessarily an early indicator of interference with activities and annoyance that the noise creates. The fact that correction for the normal background noise level without intruding noise results in better correlation of the data points might be interpreted to mean that urban communities have adapted to somewhat higher residual noise levels that are not perceived as interfering or annoying. On the other hand, it is more likely that the higher threshold for complaining is caused by the feeling that higher residual noise is unavoidable in an urban community and that complaining about "normal" noise would be useless.

Table D-7

CORRECTIONS TO BE ADDED TO THE MEASURED DAY-NIGHT SOUND LEVEL (Ldn) OF INTRUDING NOISE TO OBTAIN NORMALIZED Ldn[1]

Type of Correction	Description	Amount of Correction to be Added to Measured L_{dn} in dB
Seasonal Correction	Summer (or year-round operation)	0
	Winter only (or windows always closed)	-5
Correction for Outdoor Noise Level Measured in Absence of Intruding Noise	Quiet suburban or rural community (remote from large cities and from industrial activity and trucking)	+10
	Normal suburban community (not located near industrial activity)	+5
	Urban residential community (not immediately adjacent to heavily traveled roads and industrial areas)	0
	Noisy urban residential community (near relatively busy roads or industrial areas)	-5
	Very noisy urban residential community	-10
Correction for Previous Exposure & Community Attitudes	No prior experience with the intruding noise	+5
	Community has had some previous exposure to intruding noise but little effort is being made to control the noise. This correction may also be applied in a situation where the community has not been exposed to the noise previously, but the people are aware that bona fide efforts are being made to control the noise.	0
	Community has had considerable previous exposure to the intruding noise and the noise maker's relations with the community are good	-5
	Community aware that operation causing noise is very necessary and it will not continue indefinitely. This correction can be applied for an operation of limited duration and under emergency circumstances.	-10
Pure Tone or Impulse	No pure tone or impulsive character	0
	Pure tone or impulsive character present	+5

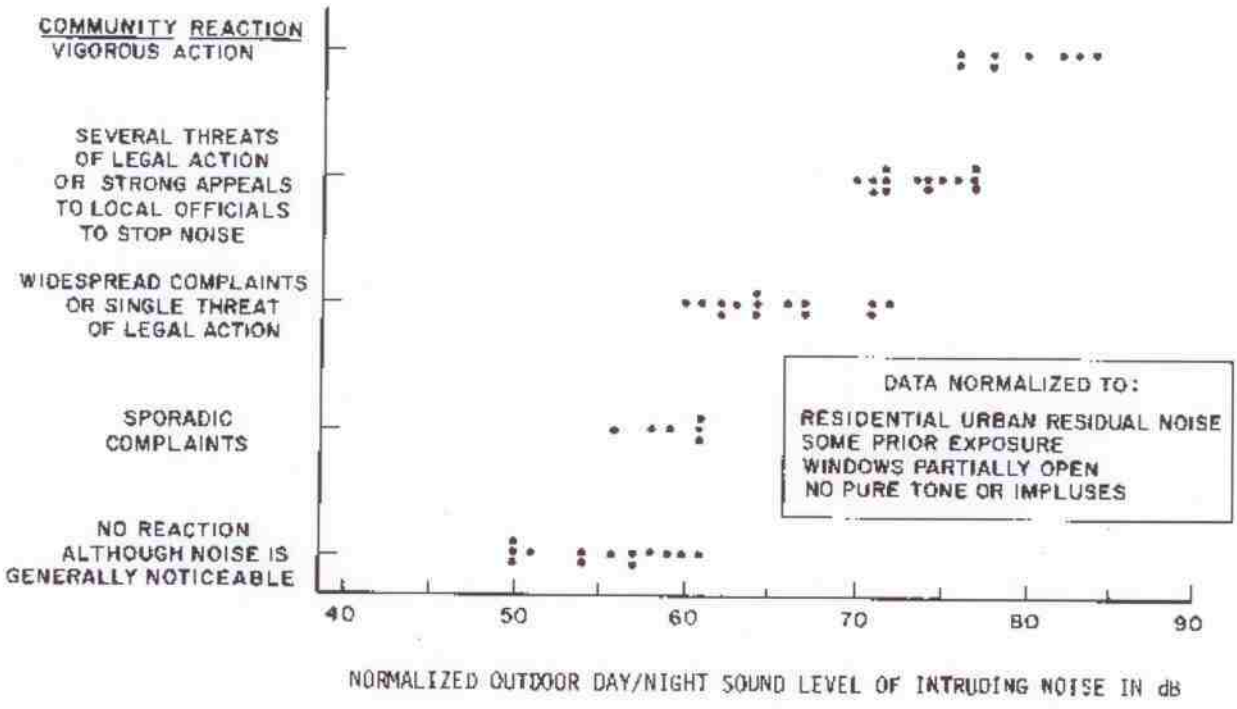
Table D-8

NUMBER OF COMMUNITY NOISE REACTION CASES AS A FUNCTION OF NOISE SOURCE TYPE AND REACTION CATEGORY

Type of Source	Community Reaction Categories			Total Cases
	Vigorous Threats of Legal Action	Wide Spread Complaints	No Reaction or Sporadic Complaints	
Transportation vehicles, including:	6	2	4	12
Aircraft operations			3	3
Local traffic	1			1
Freeway		1		1
Rail	2			2
Auto race track				
Total Transportation	9	3	7	19
Other single-event or intermittent operations, including circuit breaker testing, target shooting, rocket testing and body shop	5			
Steady state neighborhood sources, including transformer substations, residential air conditioning	1	4	2	7
Steady state industrial operations, including blowers, general manufacturing, chemical, oil refineries, et cetera	7	7	10	24
Total Cases	22	14	19	55

Figure D-7

Community Reaction to Intensive Noises of Many Types as a Function of the Normalized Outdoor Day Night Sound Level of the Intruding Noise[1]



1. Eldred, K. M., "Community Noise", Environmental Protection Agency NTID 300.3, December 1971.

ATTACHMENT 2

COMMUNITY REACTIONS TO WIND TURBINE NOISE FACILITIES IN MAINE

Currently in December 2010, neighbors living near Mars Hill, Freedom, and Vinalhaven wind facilities are complaining vigorously about wind turbine noise and have been doing so since facility operation commenced. Data compiled for Mars Hill as well as data acquired at Freedom and Vinalhaven have been charted for community reaction with sound level versus distance using the EPA's community noise impact assessment method provided in the 1974 Levels Document [A.2-1] and are provided in this attachment for comparison with community reactions from nearby neighbors at the three facilities.

The process used for this review analysis starts with converting the EPA's Ldn data to Leq. To convert the EPA data from Ldn to Leq, which is used by the Maine DEP, a 6 dB factor is employed assuming steady operation day and night. For example, Ldn 55 equals an Leq of 49 dBA for a steady-state noise source. Then, the community noise impact assessment for this wind turbine site uses the following normalizing correction factors to the EPA's data to bring them into an analysis for Leq from wind turbines sited in rural areas:

0 dB for year round operation,
10 dB for being located in a quiet area,
5 dB for no prior experience and,
5 dB for impulsive character.

The resulting ranges of sound level for the normalized community noise reactions to wind turbines sited in rural areas were as follows. The Levels Document [A.3-1] indicates that the standard deviation of these data is 3.3 dB about their means and an envelope of +5 dB encloses approximately 90 percent of the cases.

"Vigorous action"	45 to 53 dBA
"Strong appeals to stop the noise"	44 to 51 dBA
"Widespread complaints"	34 to 41 dBA
"Sporadic complaints"	30 to 35 dBA
"No reaction"	24 to 35 dBA

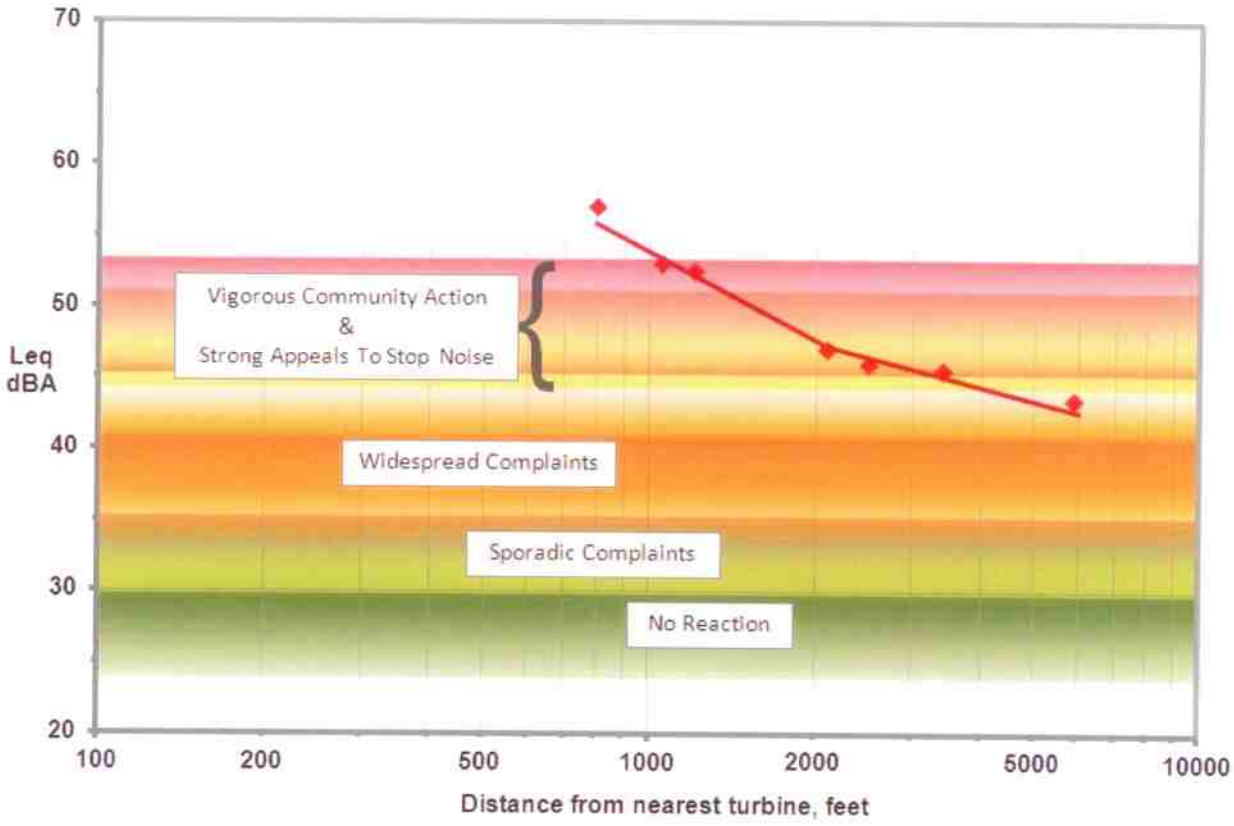
Then, the resulting community reactions were graphed by ranges of noise level listed above, and correlated to the measured sound levels versus distance, in the charts below for Mars Hill, Freedom, and Vinalhaven. The charts clearly illustrate the community reactions to those sites that are now well known from news coverage.

A.2-1. Information On Levels Of Environmental Noise Requisite To Protect Public Health And Welfare With An Adequate Margin Of Safety, 550/9-74-004, March 1974.

MARS HILL

Data for Mars Hill were obtained from the Sound Level Study, Compilation Of Ambient & Quarterly Operations Sound Testing, Maine Department of Environmental Protection Order No. L-21635-26-A-N. Highest measured hourly Leq levels are charted in Figure A.3-1 below as sound level versus distance from the nearest turbine. Nearby neighbors live as close as 800 feet out to several thousand feet from the turbine line.

Figure A.3-1. – Noise Impact By Predicted Community Reaction, Mars Hill.

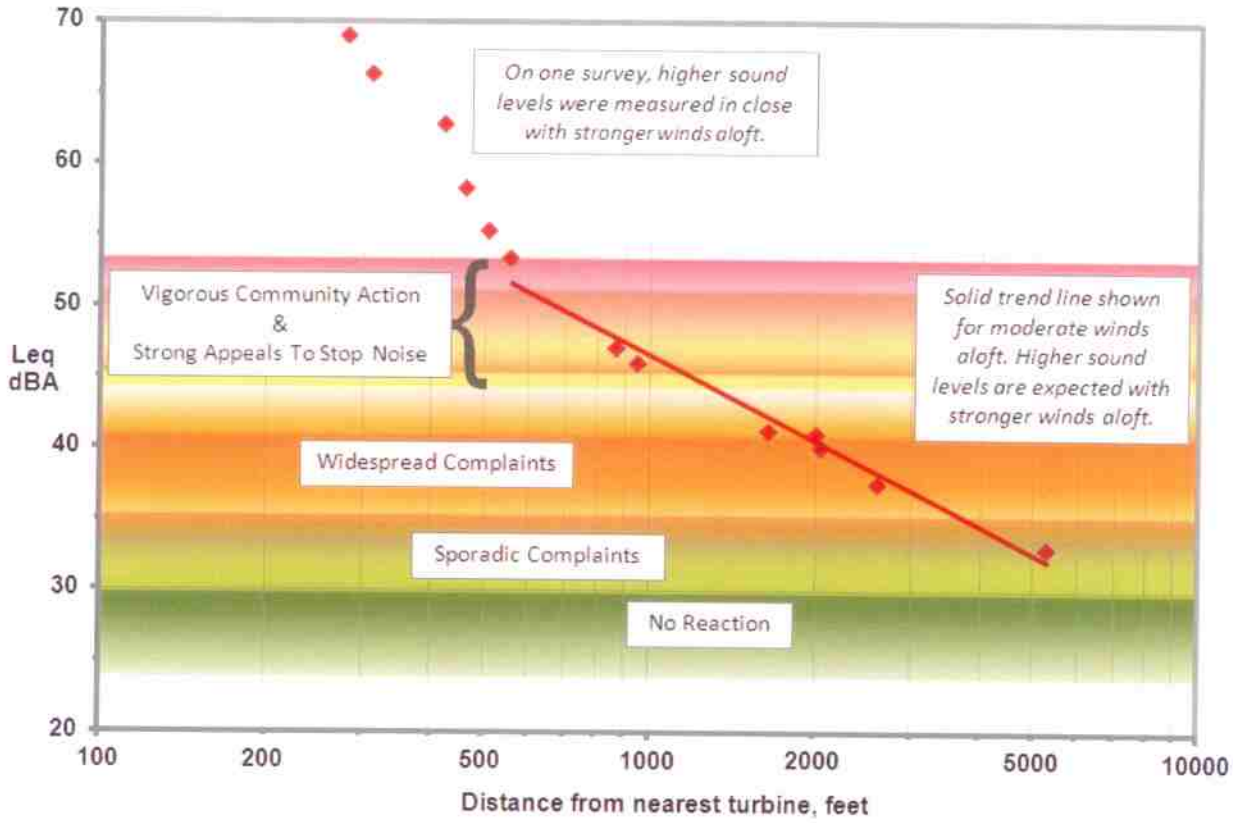


DEP permitted wind turbine noise levels of 50 dBA at nearby neighbors, and with an administrative letter, then allowed noise levels above 50 dBA, which elicited the highest negative community responses, "Strong appeals" and "Vigorous community action". Neighbors launched a lawsuit in March 2009 that is still underway as of the date of this report.

FREEDOM

Data for Freedom were acquired in 2010 during several independent field surveys by the authors. Field measurements were made with Type 1 instrumentation with calibration traceable to NIST, and all measurements were attended, with winds light or non-existent at the sound meter and in trees nearby, but with *moderate* winds aloft turning the wind turbines. Sound levels are expected to be higher with stronger winds aloft. The wind turbine noise was dominant in the levels reported in the Figure 3-2 below.

Figure 3-2. – Noise Impact By Predicted Community Reaction, Freedom.

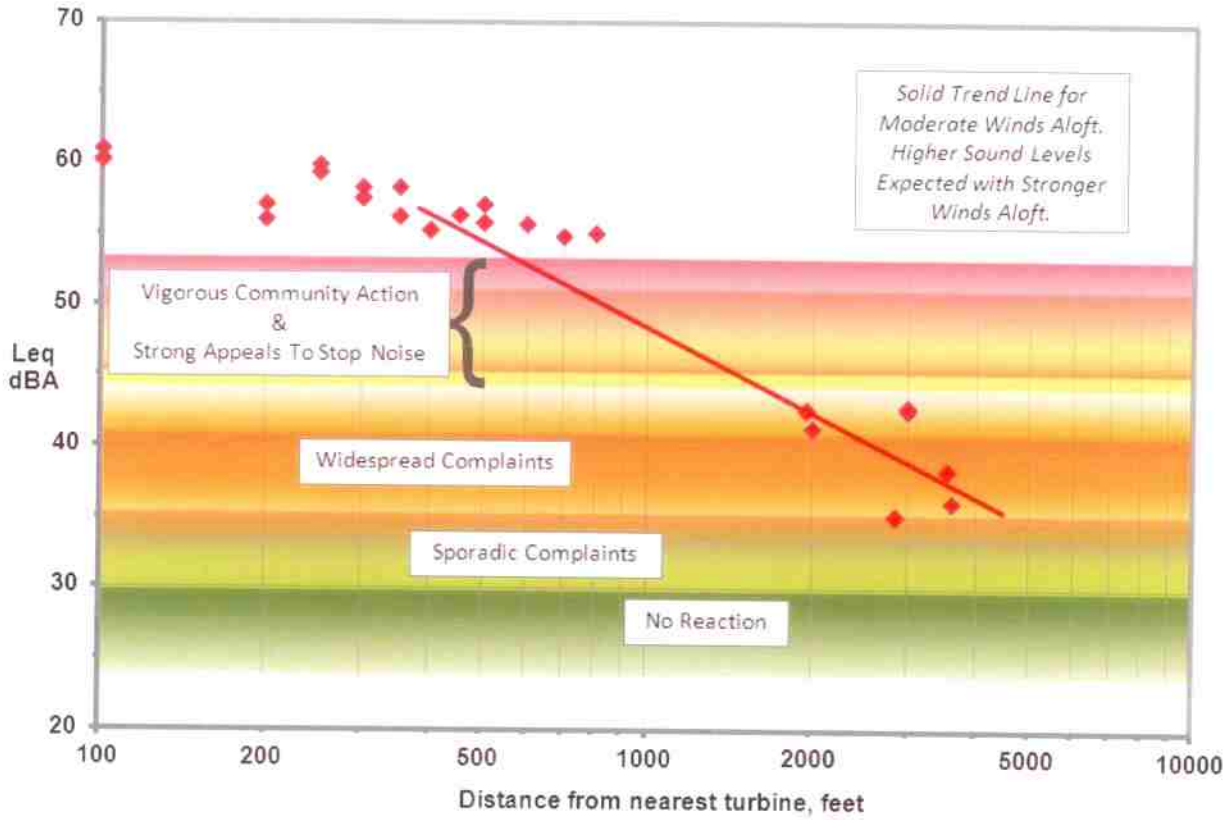


Counter to the Legislature's intent, the DEP chose not to regulate the Beaver Ridge Wind facility at all. Sound levels exceed 34 dBA within 4000 feet, resulting in "Widespread complaints" for those neighbors living within that range. For neighbors experiencing noise levels above 44 dBA, "Strong appeals" and "Vigorous community action" ensued with very expensive litigation borne by the residents from their own savings, and no relief to date.

VINALHAVEN

Data for Freedom were acquired in February 2010 during an independent field survey by the authors. Field measurements were made with Type 1 instrumentation with calibration traceable to NIST, and all measurements were attended, with winds light or non-existent at the sound meter and in trees nearby, but with *moderate* winds aloft turning the wind turbines. Sound levels are expected to be higher with stronger winds aloft. The wind turbine noise was dominant in the levels reported in the Figure 3-3 below.

Figure 3-3. – Noise Impact By Predicted Community Reaction, Vinalhaven.



Sound levels exceed 34 dBA within several thousand feet, resulting in "Widespread complaints" for nearby neighbors living within that range. DEP permitted noise levels of 45 dBA at nearest neighbors (900 feet), who have also experienced noise levels exceeding 45 dBA, exhibiting reactions including "Strong appeals to stop the noise" and "Vigorous community action." retaining counsel, acquiring sound levels at their own expense and filing complaints to the DEP. It should be noted that Vinalhaven residents living *more than a couple of miles away* would have a predicted "No reaction" to the wind turbine facility noise emissions, and *that has been the case.*