

**Does Weather Affect the Noise From Wind Turbines?**

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**You Bet it Does**

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**van den Berg**

- Environmental noise surveys should be focused on measuring the most serious frequently occurring noise problems at night, because this is the period where wind turbine noise will be most noticeable.
- In Environmentally Stable Wind Conditions the turbines can operate when there is no wind at ground level. This is clearly demonstrated in the Cape Vincent- Clinton Wind Park noise figure presented later.
- The effect of atmospheric stability represents the worst case scenario for assessing wind turbine noise impacts, but is seldom considered by commercial wind developers.
- In my professional opinion, NYSDEC and Planning Boards must consider this critical issue.

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So what are typical Noise Levels under Stable Operating Conditions

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Inversion Layers are Not Infrequent

Ottawa, Canada  
INTERNOISE 2009  
2009 August 23-26

Measuring background noise with an attended, mobile survey during nights with stable atmospheric conditions

Clifford P. Schneider\*  
New York State Department of Environmental Conservation - Retired  
PO Box 165  
Cape Vincent, New York 13618

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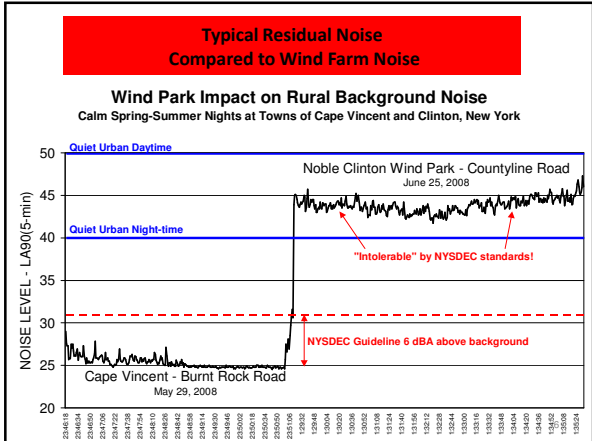
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**ABSTRACT**

In response to sound studies from commercial wind developers, a series of background noise surveys were conducted in Cape Vincent, NY between May and July 2008. The survey approach included sampling at night under stable atmospheric conditions and systematically selecting monitoring stations at 1.6 km intervals. Stable conditions occurred in 67% of nights and in 30% of those nights, wind velocities represented worst-case conditions where ground level winds were less than 2 m/s and hub-height winds were greater than wind turbine cut-in speed, 4 m/s.

The median A-weighted  $L_{90A,5-50}$  sound pressure level was 25.7 dBA for five, fixed monitoring stations. For two mobile surveys, the medians ( $L_{90A,5-50}$ ) were 25.5 and 26.7 dBA. C-weighted SPLs from two mobile surveys were 40.0 dBC and 43.9 dBC. For comparison, median  $L_{90A,5-50}$  and  $L_{90C,5-50}$  SPLs were 38.0 dBA and 52.6 dBC, respectively, for the Clinton Wind Park. Assuming 45 dBA background noise, developers of the St. Lawrence Wind Farm concluded noise impacts would not exceed local and New York guidelines. However, using 25 dBA and assuming worst-case conditions, nearly all residences within range of the St. Lawrence Wind Farm would exceed guidelines and more than half would have noise levels considered "objectionable" to "intolerable."

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**NYS DEC Noise Guideline**

- The DEC Noise Policy suggests a **3 dB(A) increase over ambient** for sensitive receptors" and a generally applicable limit of **6 dB(A) increase as acceptable under most circumstances.**

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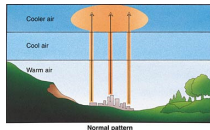
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**Temperature Inversions**

- On most days, the temperature of air in the atmosphere is cooler the higher up in altitude you go
- The sun's energy warms the air at the surface.
- The warm air rises in the atmosphere, where it expands and cools.
- Sometimes the temperature of air increases with height. The situation of having warm air on top of cooler air is referred to as a **temperature inversion**. It happens **often on clear cloudless nights, while people are sleeping**, and is due to radiation cooling of the earth to outer space.



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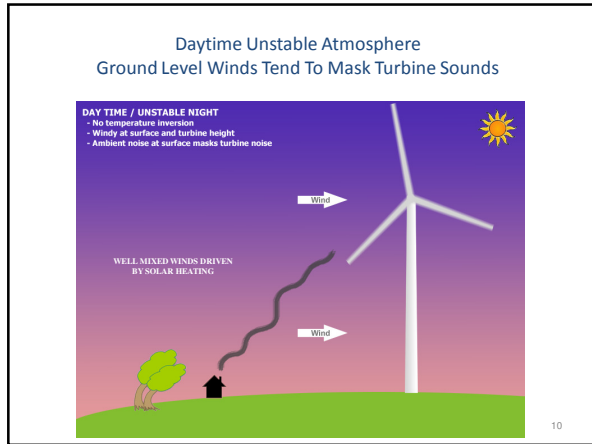
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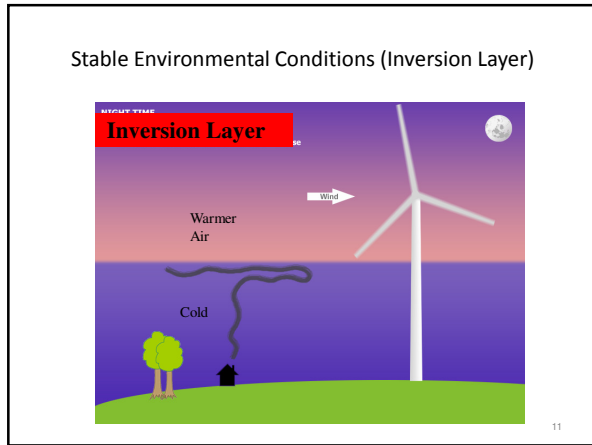
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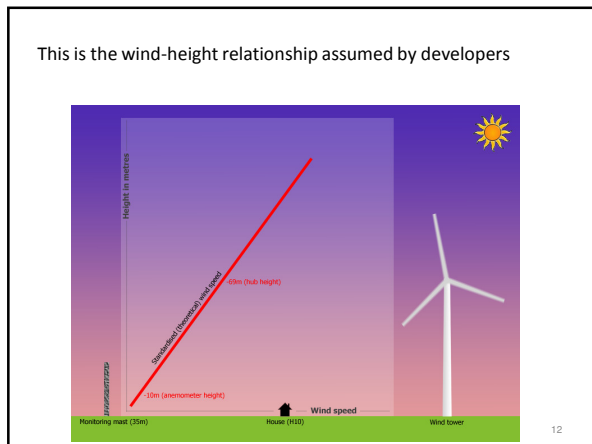
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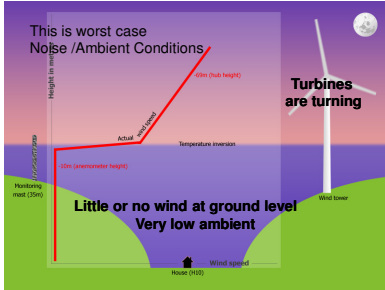
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The actual wind-height relation for a stable atmosphere



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### When there is an Inversion Layer

- Ground Winds are **Minimized**.
- **Wind** above the Trees **is still blowing**.
- This is **not** an **infrequent event**
- Turbines still turning making **Noise on the ground**
- No wind to rustle the tree leaves and raise the Ambient Noise.
- So you have **maximum turbine noise with minimum ground ambient**.
- I have yet to read a **DEIS** for a **Wind Farm** which **acknowledges** these facts.

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### Noise in Valleys

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### Noise Propagation is Complicated in a Valley with Windmills on the Ridge

Very Dependand on the Weather

Refracted and Scattered Path  
Direct Path...  
Ground-Reflected Path

Figure 6-3. Outdoor sound propagation near the earth involves direct sound (path 1), ground-reflected sound (path 2), and refracted and scattered sound (path 3).

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### 1973 Elliott Noise Control Compressor Test Noise Jeannette, Pa

**Stable Atmosphere** makes it worse

RESIDENTIAL BUILDINGS

700 ft.

LOCATION A

Figure 2—Location of the test building and stack openings relative to nearby residential areas. Location A was considered the most critical neighborhood location.

Compressor testing was producing >90 dBA on neighbors porches .

- Sound Energy *can't escape on the valley sides.*
- Sound in the **Valley** can only escape vertically and along the valley
- This is even worse when under an **inversion layer** (Stable Environmental Conditions)
- So noise radiating into the valley tends to stays in the valley.

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Wind

Noise source

Shadow

Ground surface

Figure 7-20. Effects of wind-induced refraction on acoustic rays radiating from an elevated point source [Shepherd and Hubbard 1985]

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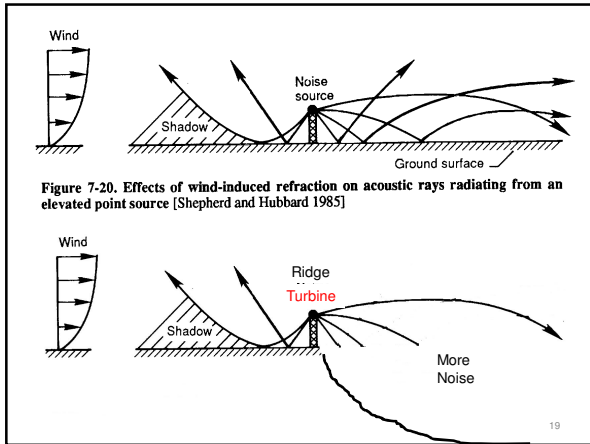
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**Wind Turbines on Ridges**  
Some Thoughts  
Teresa Drew and Roger Treagus, Golder Associates Ltd

- To account for noise, the site selection process needs to be broader than is often the case with other developments.
- **Because sound carries farther downwind**, it's important to know both the **dominant direction** and how often the wind deviates from it.
- The minimum distance, or setback, from a "receptor" such as a farm house or subdivision (including those planned for the future) **should be increased if it is frequently downwind of the wind farm.**
- A **worst case wind direction analysis** seems appropriate to determine if which operating conditions will have **most impact on intrusive noise into the community** and to control the operation of the wind farm appropriately.
- The **topography and ground conditions can significantly affect noise** propagation. Studies have shown that **lining a ridge with turbines** produces "shadow zones" on its slopes: **noise levels are actually lower near the turbines than at a distance in the valleys below.** For sites near a body of water, remember that reflections off the water's surface can amplify noise.
- Sound **level projections are more acceptable if they are based on real-world results.** Developers need to conduct thorough preconstruction projections of a project's noise impacts and **then verify them later.**

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*Location, Location, Location,*  
*An investigation into wind farms and noise by the Noise Association*  
*John Stewart*

- Mid Wales - a land of hills and valleys. A place where the wind blows frequently and the population tends to be thinly spread. Ideal for wind farms. And, not surprisingly, many are planned. **The best place very often for the turbines to catch the wind is close to the top of a hill. It means that the wind turbines can be at their most productive.**
- **But it also means that the noise may cascade down the surrounding valleys. To makes matters worse, many of the scattered hamlets within the valleys snuggle into corners protected by the hills and the mountains where the background noise level is very low indeed.**
- **You only need to visit these areas to hear the 'swish, swish, swish' of the turbines - particularly downwind - over a mile away from the wind farm.**

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### Hayes 1996

- Dwellings that are positioned within deep valleys or are sheltered from the wind in other ways may be exposed to low levels of background noise, even though the wind is strong at the position of the wind turbine.

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### Mars Hill

- Mountainous topography especially *arising from plains or rolling hills*, such as Mars Hill Ridge and its immediate surroundings, *give rise to broadly varying atmospheric conditions over relatively short distances*.
- For example, *vigorous ridgeline winds* may be consistent with *up-wind low elevation surface conditions*, but be contrasted *downwind at surface levels by light or even calm conditions*.
- Given these potential variations, *upwind receptors* would experience high level masking and "shadow" atmospheric refraction conditions minimizing ridgeline source sounds, whereas *downwind receptors* would *experience minimal masking and atmospheric refraction lapse conditions that would enhance ridgeline source sounds*.

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### Mars Hill

*Calm surface conditions do not necessarily correlate with hub level wind speed.* This is often seen in a neutral atmosphere in the evening and nighttime hours or downwind conditions on the leeward side of the ridge, when hub level wind speeds may be considerable, but *contrasting surface conditions are calm or light and variable*.

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## Summary

- *Ridgeline turbine noise into valleys* can be *significantly worse* than that of flat terrain.
- *Weather conditions have a big effect* on the *Turbine noise* intruding into the community.
- The *DEC Noise Policy* suggests a *3 dB(A) increase over ambient for sensitive receptors* and a generally applicable limit of *6 dB(A) increase as acceptable under most circumstances*.
- *Frequent stable environmental conditions at night* are to be expected when Turbines are operating on a valley ridge. This is when the *Turbines Noise will intrude most into the Residual Community Ambient Noise Level*.
- It is these conditions for which the *Residual Community Ambient Noise Level needs to be set*. It may be seasonally dependant.

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## Any Questions

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