Wind Turbine Siting Conflicts and Community Guidelines

Peter H. Guldberg, INCE, CCM

TECH environmental
FOCUSED KNOWLEDGE. REAL SOLUTIONS.

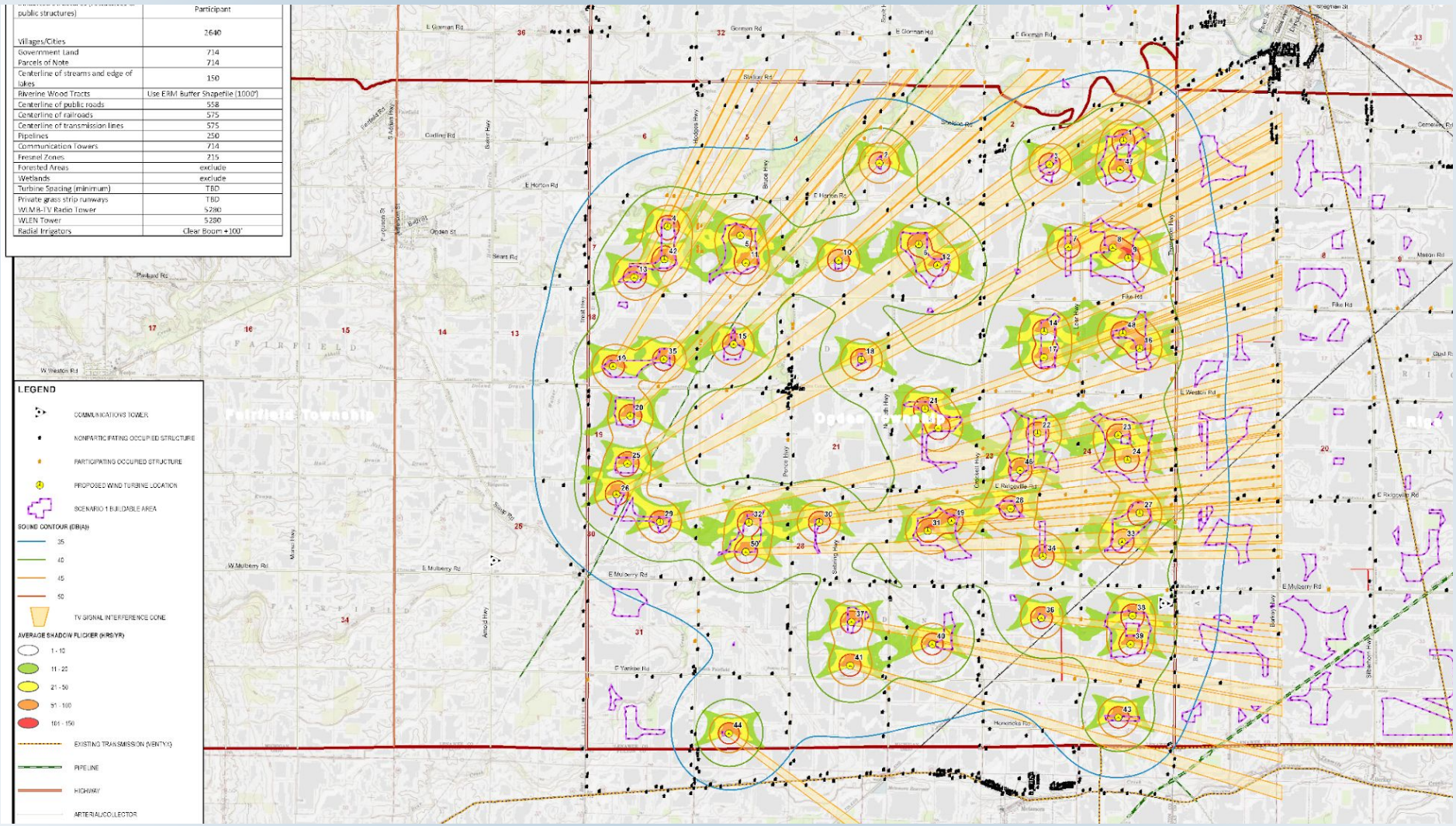
Siting Process for a Wind Farm On AG Lands - Topics

- ***Sound***
- ***Shadow Flicker***
- ***Visual Impact***
- ***Complaints: Health Impacts or Annoyance?***
- ***Recommendations***

Constraints Short List

- ***Sound***
- ***Flicker***
- ***Radio/TV Interference***
- ***Wetlands***
- ***Setbacks***
  - ***> Roads, RRs***
  - ***> Structures***
  - ***> Pipelines***
  - ***> HV Lines***

Total Constraints Map



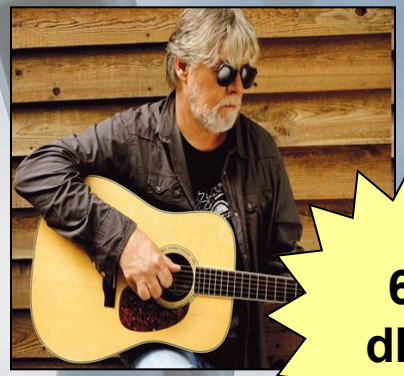
#1 SOUND

Sound Pressure Levels are expressed as A-weighted decibels (dBA)

Sound Pressure Levels are Measured in Decibels…

65 dBA

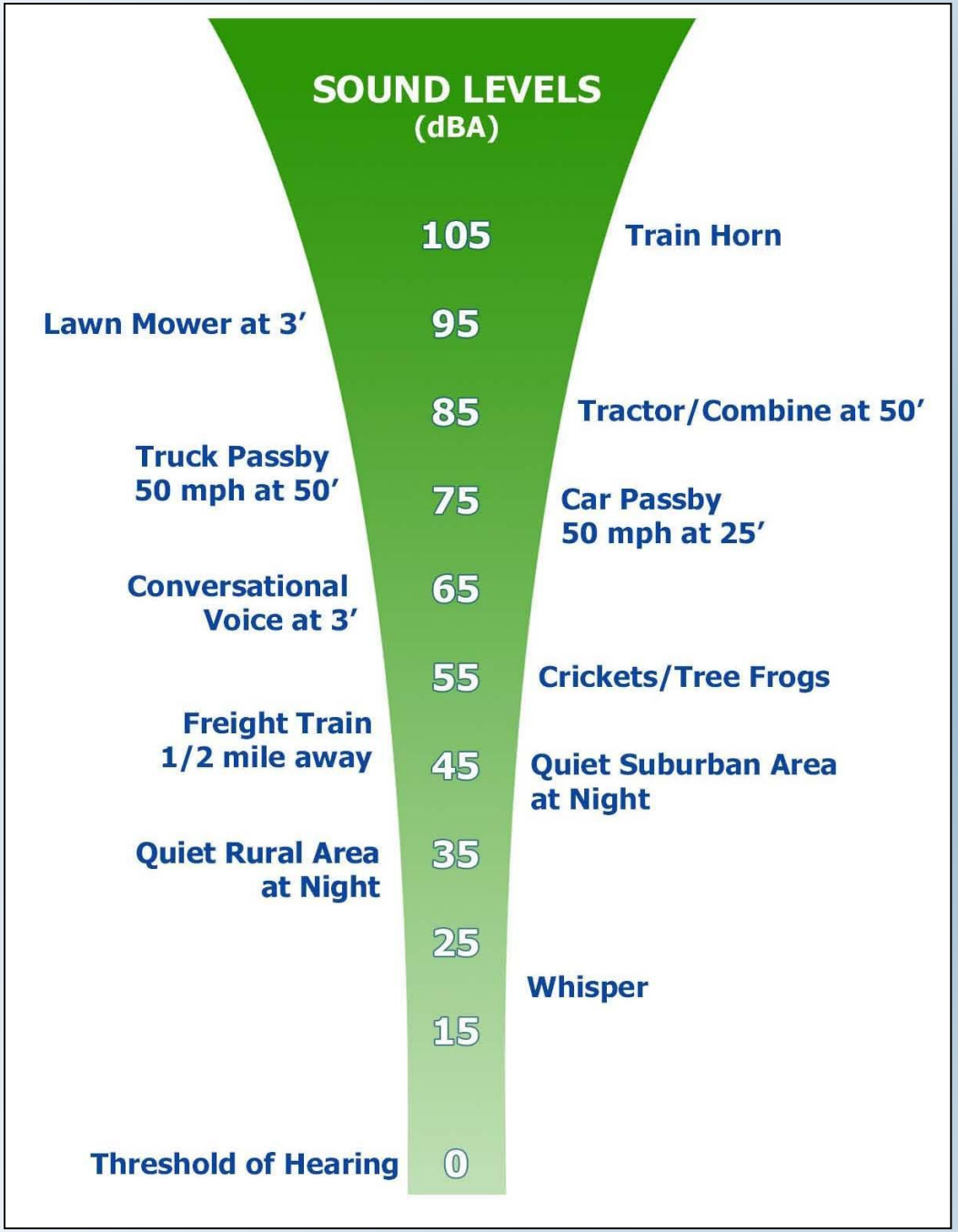
100 dBA



60 dBA

80 dBA

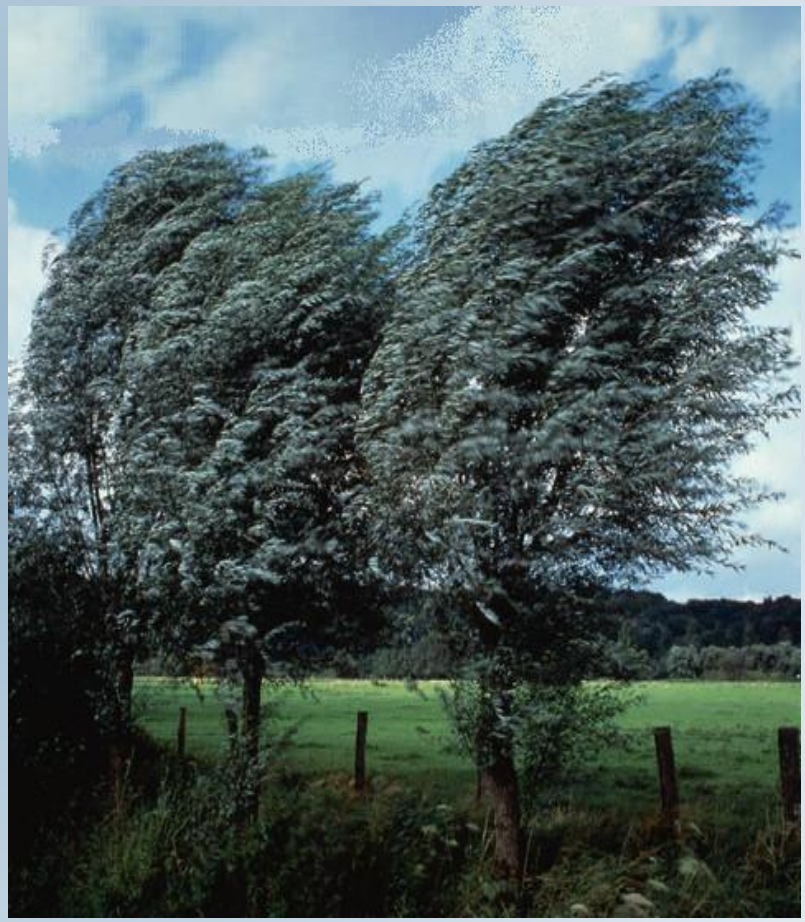
85 dBA



Every 10-dBA Change is a Doubling of Loudness

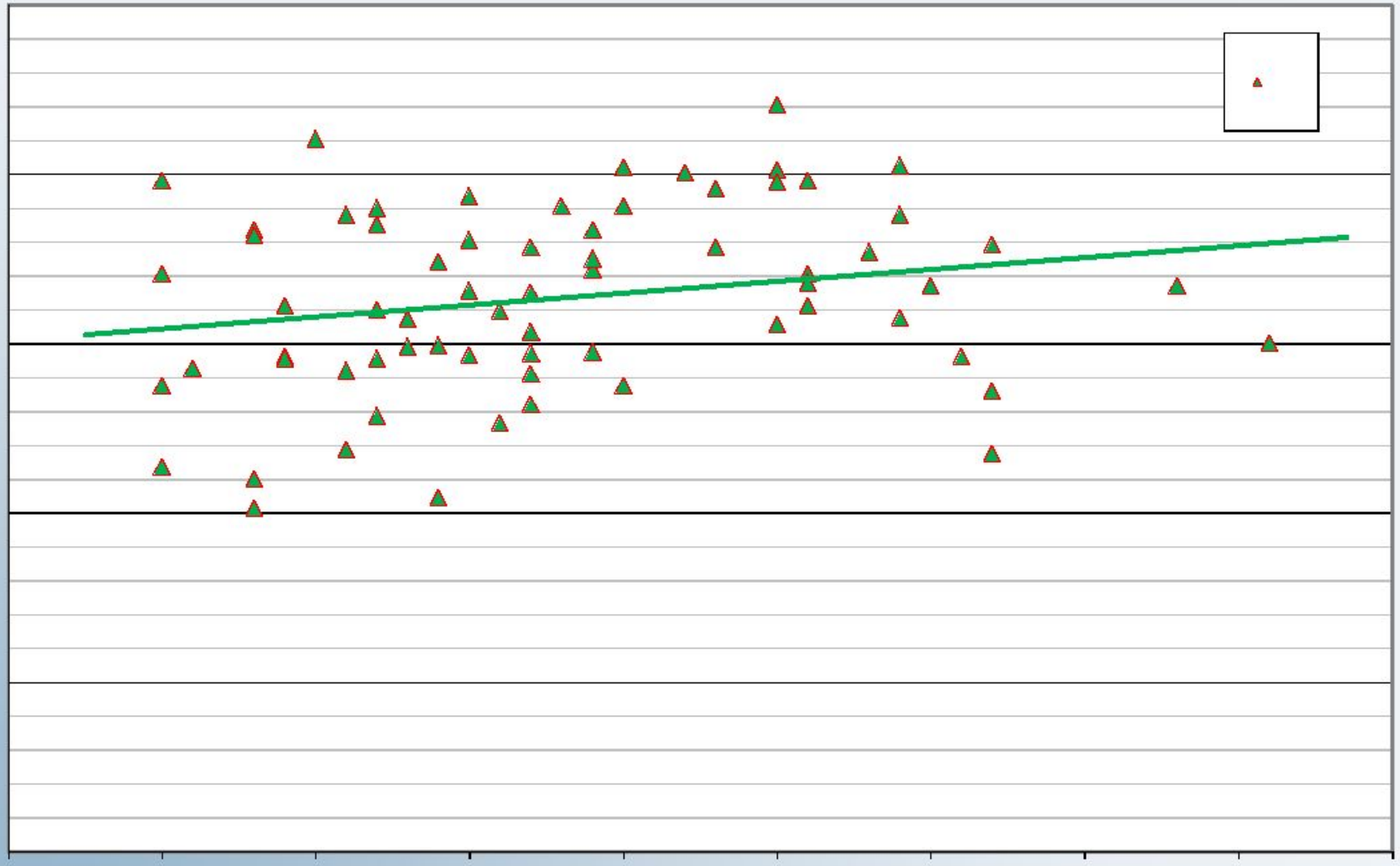
Turbines at Full Power Means Lots of Natural Wind Noise

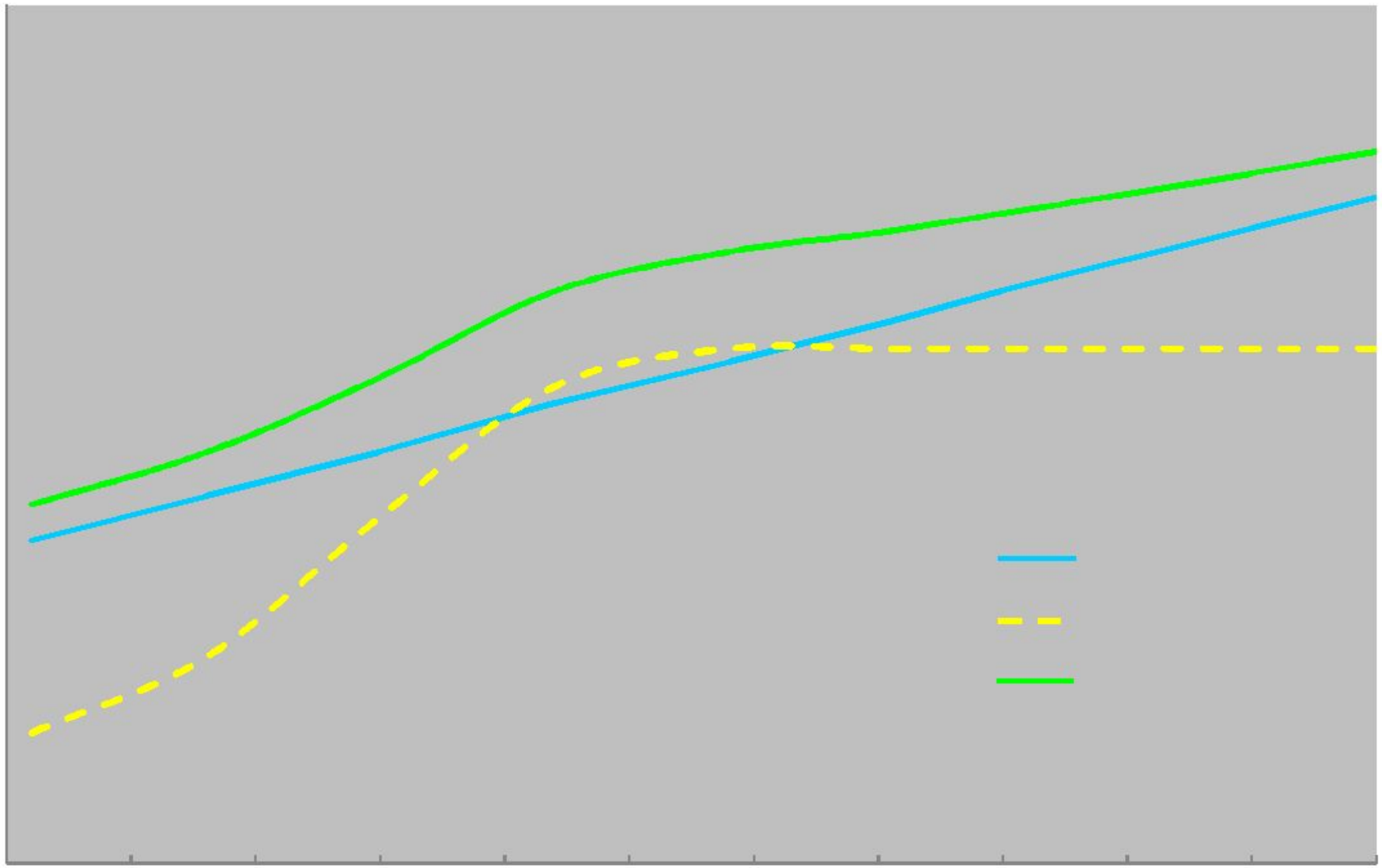
… noise from wind turbulence, wind in trees, crops, around farm buildings and terrain can be substantial

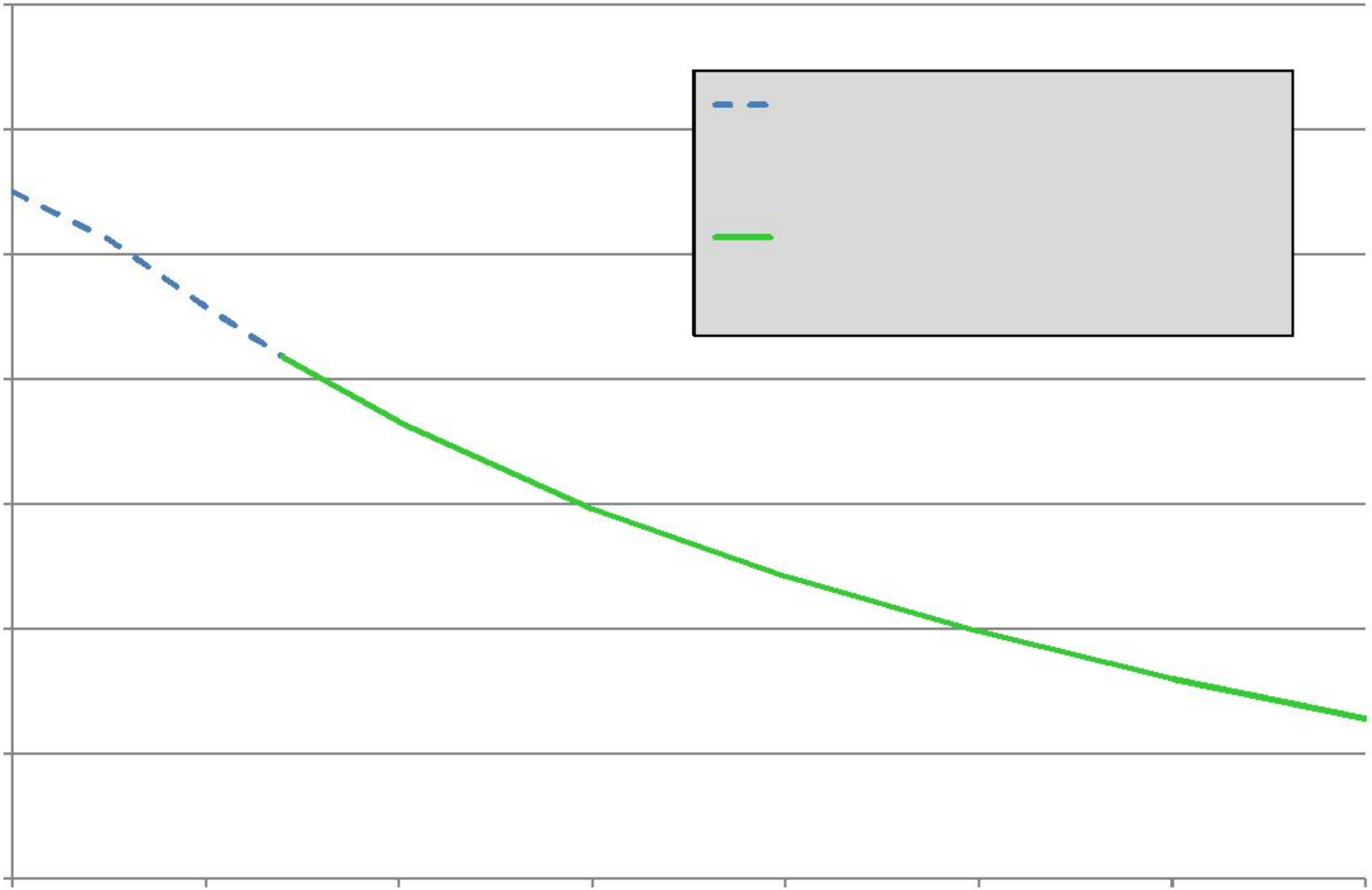


Measure Existing Sound Levels Pre- and Post-Construction

EPA States the Equivalent L_{eq} Sound Level Correlates Best with How People Perceive and React to Sound





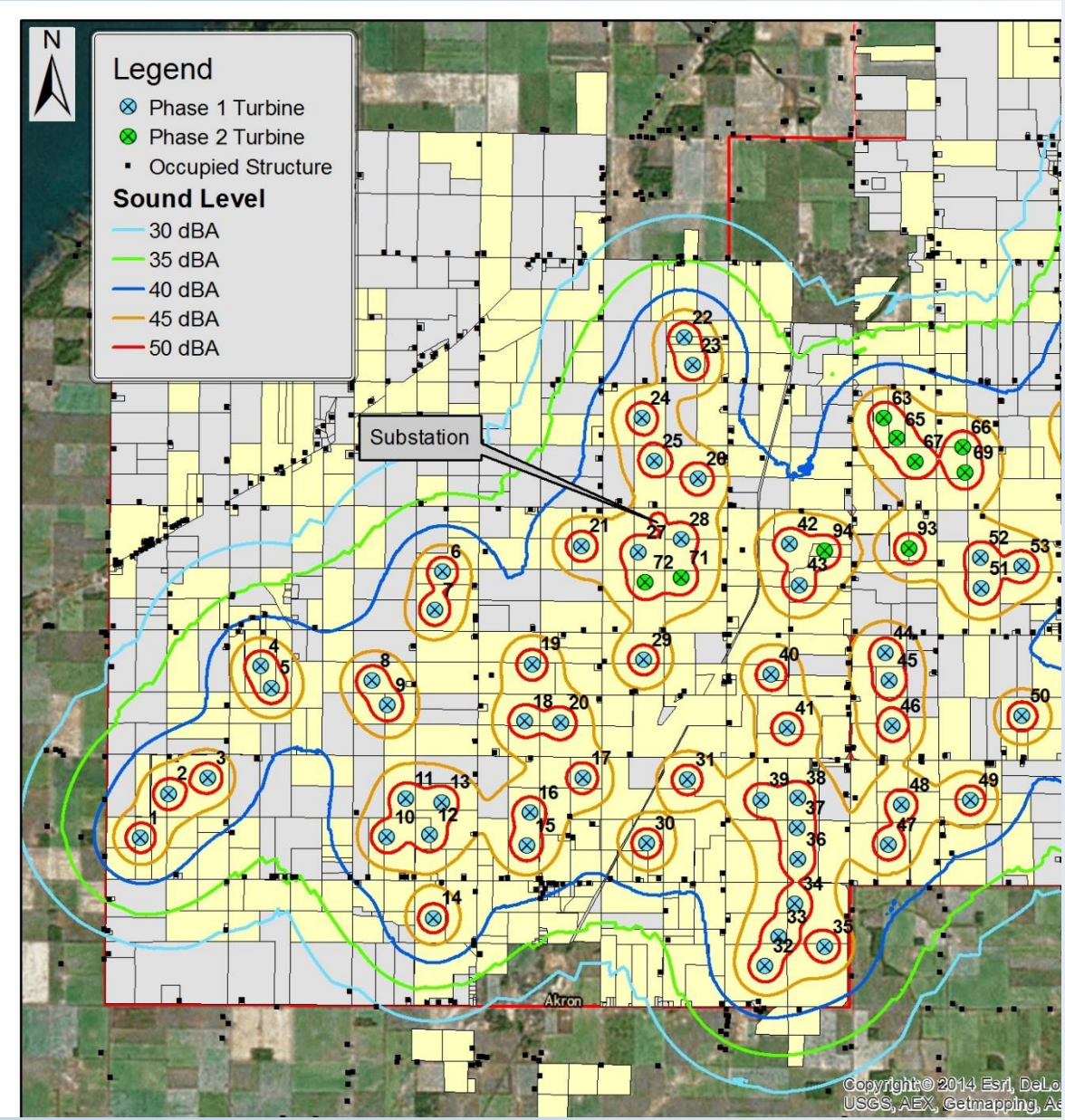


Setback Distance not an Effective Measure for Regulating Sound

- ***No simple relationship: Distance vs. dBA***
- ***Every structure receives sound from multiple turbines at different distances***
- ***Project needs the flexibility to plan in turbines using NRO***

When Designing a Wind Farm, What Sound Limit Should Be Used?

A Locally Determined Standard.



Holy Name CCHS

Located 200 feet from Classrooms and Athletic Fields

A Range of Nighttime Community Sound Standards

- ***State of Texas: none***
- ***State of Maryland: 55 dBA***
- ***West Lafayette, Indiana: 55 dBA***
- ***State of Minnesota: 50 dBA***
- ***Cohocton, New York: 50 dBA***
- ***Columbia, Michigan: 50 dBA***
- ***Mason County, Michigan: 45 dBA***
- ***State of Maine: 42 dBA***

If There is no Regulatory dBA Limit?

- ***I recommend a design goal of 45 dBA***

➢ ***Both the EPA and WHO nighttime, residential noise guidelines are 45 dBA***

➢ ***This level minimizes the chance of complaints while still allowing <u>some</u> wind farm development***

➢ ***Wind farms that achieve 45 dBA also keep Low-Frequency Sound below ANSI Standards to prevent annoyance (S12.9/P4)***

Options to Meet Sound Limit

- *Revise layout – move turbines*
- *Verify pitch-regulated turbine. Use a lower L_w turbine*
- *Apply a range of NRO to nighttime operation of certain turbines*

What about Low-Frequency and Infrasound?

- ***Human voice is 500 – 2,000 Hz***
- ***LF Sound is <200 Hz***
- ***Infrasound is <20 Hz***

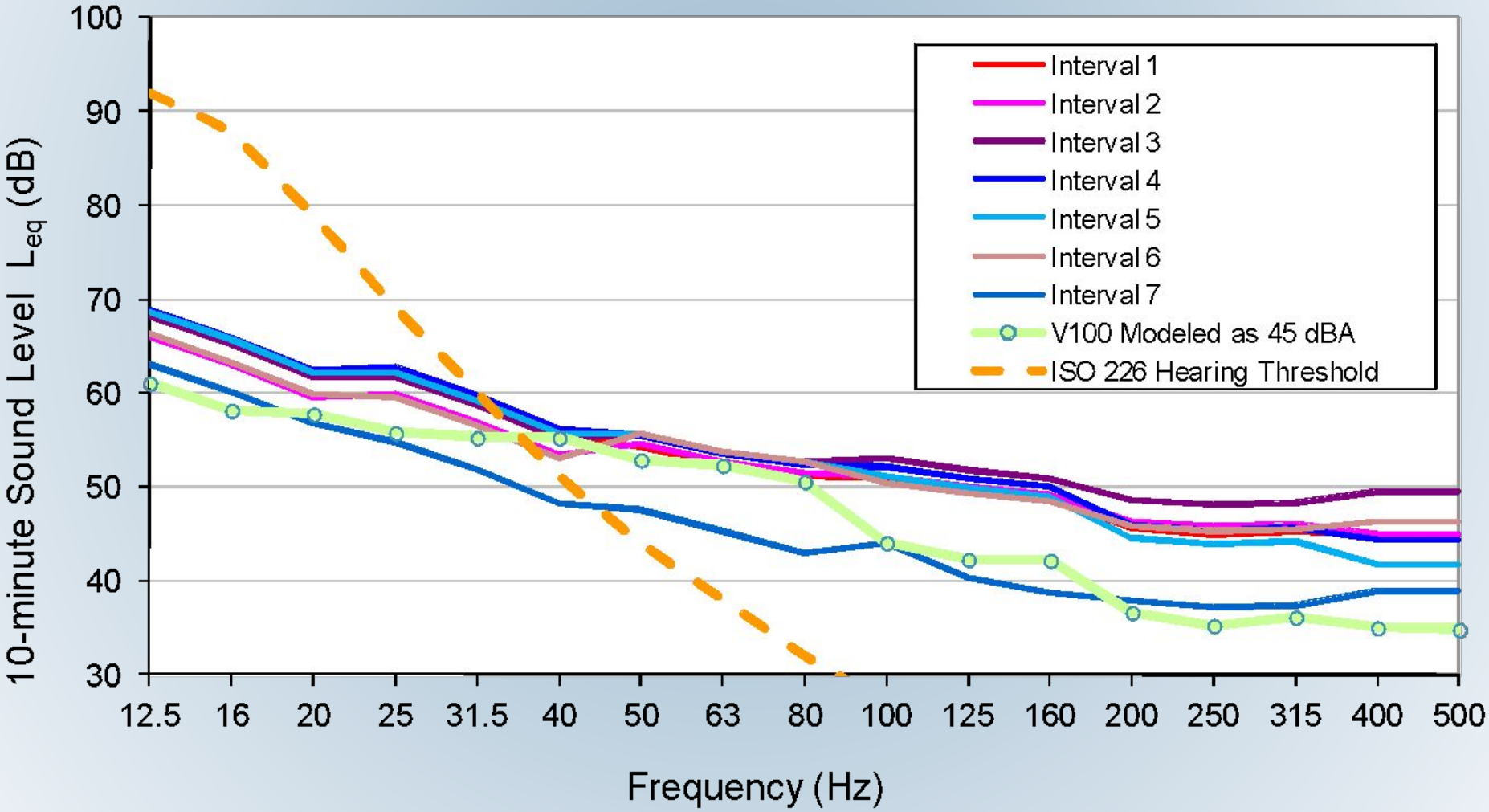
Low-Frequency and Infrasound are Always Present Outdoors

- ***Natural air turbulence***
- ***Thunderstorms***
- ***Distant traffic noise***
- ***Aircraft overhead***
- ***Waves at the shore***

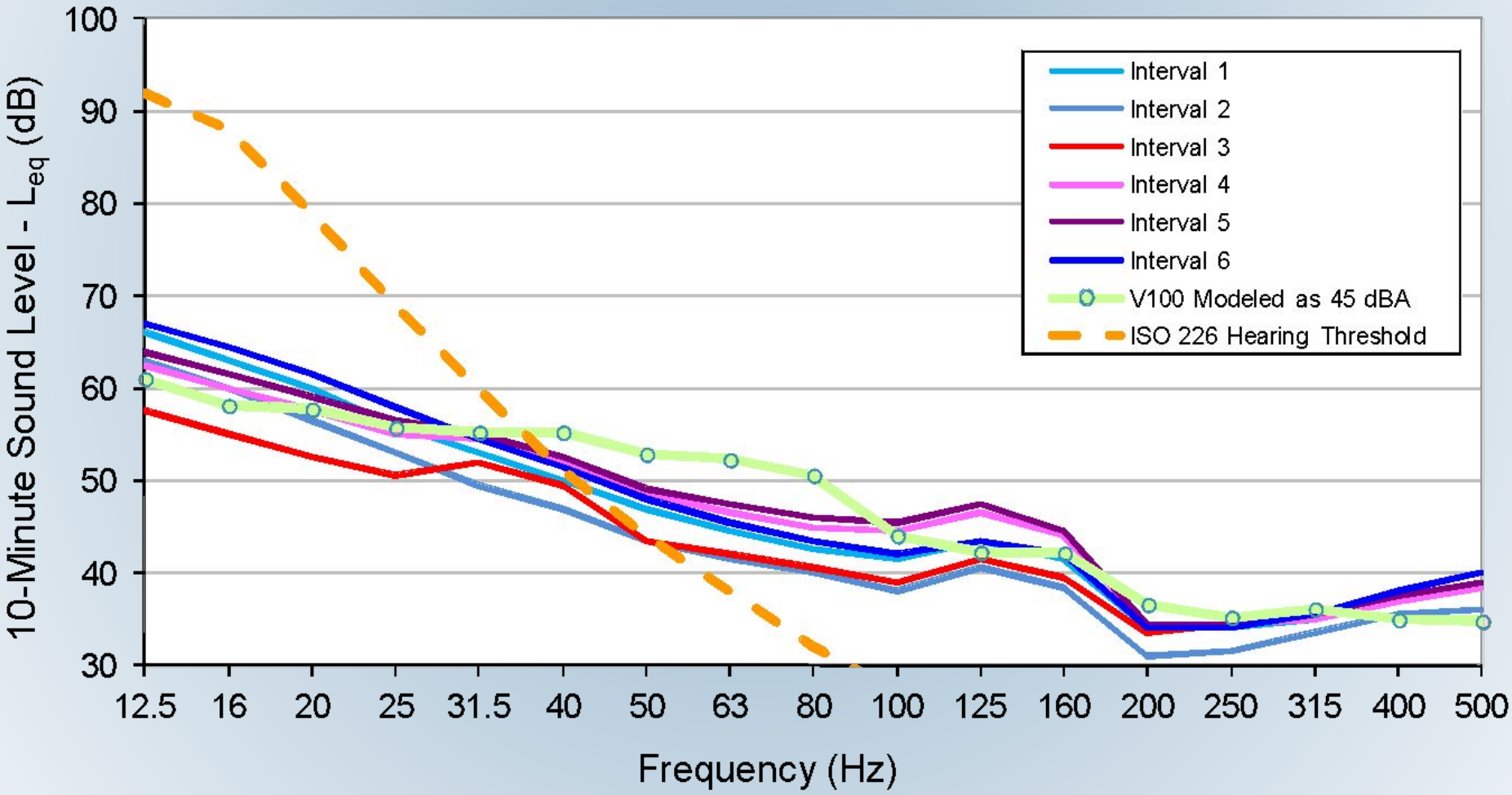
Facts about LF and Infrasound

- *LF spectrum of turbine sound is similar to that for natural background LF/IS*
- *Turbine sound < 40Hz is inaudible*
- *At 16 Hz (Infrasound), wind turbulence produces 60-65 dB, waves 70-75 dB, turbine is 60 dB, hearing threshold is 90 dB*
- *Turbine is 30 dB < hearing threshold*

LF Spectrum of Night Background (A) Sound Compared to 1.8-MW Turbine



LF Spectrum of Night Background (B) Sound Compared to 1.8-MW Turbine



Conclusions: Infrasound

- ***Wind turbine infrasound is typically 30 dB below the ISO 226 hearing threshold, below which no adverse health effects have been documented.[1,2]***
- ***Natural background levels of infrasound are often higher than those from turbines.***

1. Leventhall, G., "Infrasound from Wind Turbines – Fact, Fiction or Deception," *Canadian Acoustics*, 34(2), 2006.
2. US EPA, "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, EPA-550/9-74-004, p.G-11.

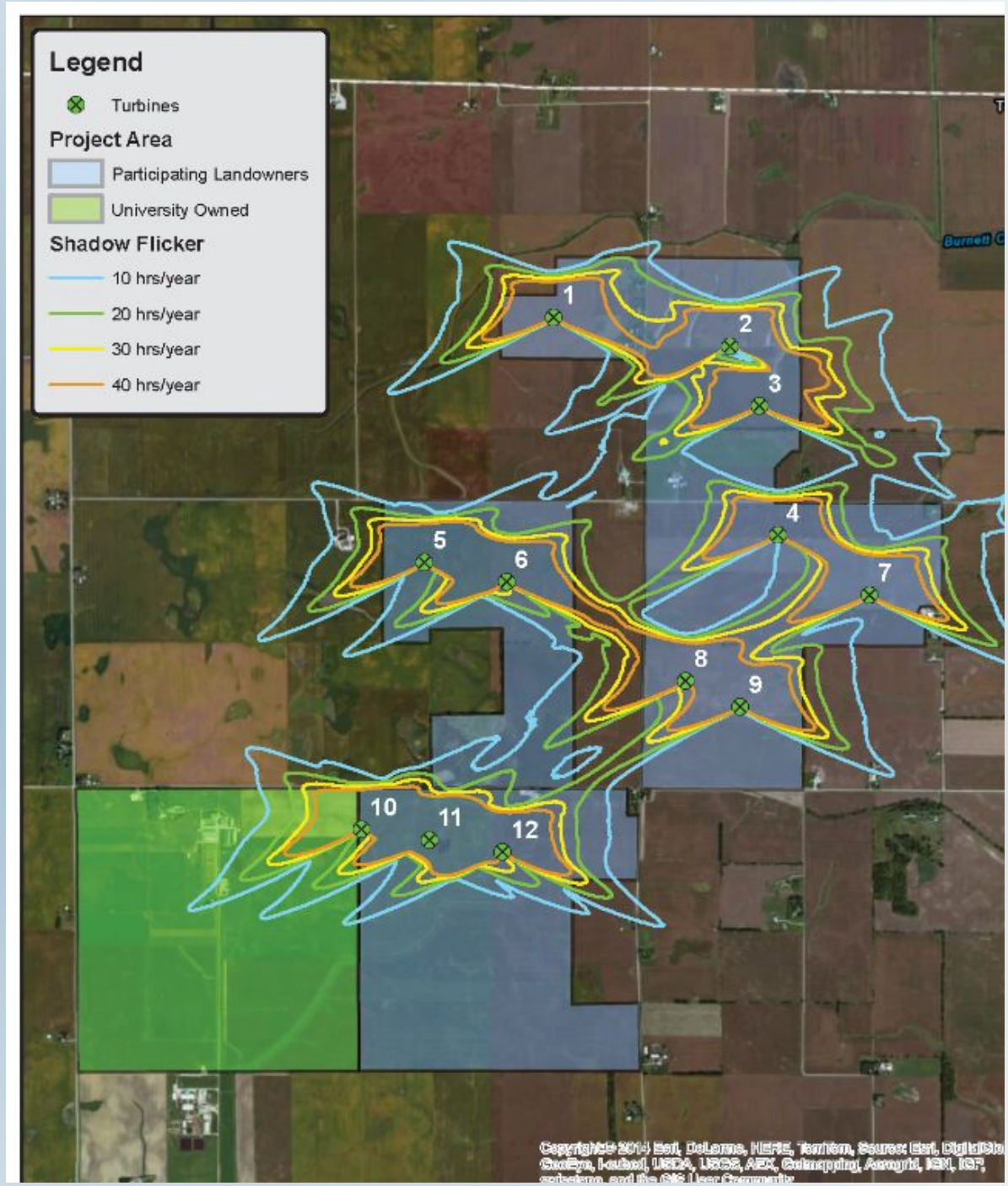
#2 SHADOW FLICKER

Alternating changes in light intensity caused by the moving blade of a wind turbine casting shadows on the ground and structures

Shadow Flicker Does Not Occur

- *Unless sun, turbine and viewer line up perfectly*
- *On cloudy days*
- *Winds < cut-in speed*
- *Beyond 10 rotor diameters, or approx. 1,000 meters (3,200 feet) for a 2-MW turbine*

Annual Shadow Pattern



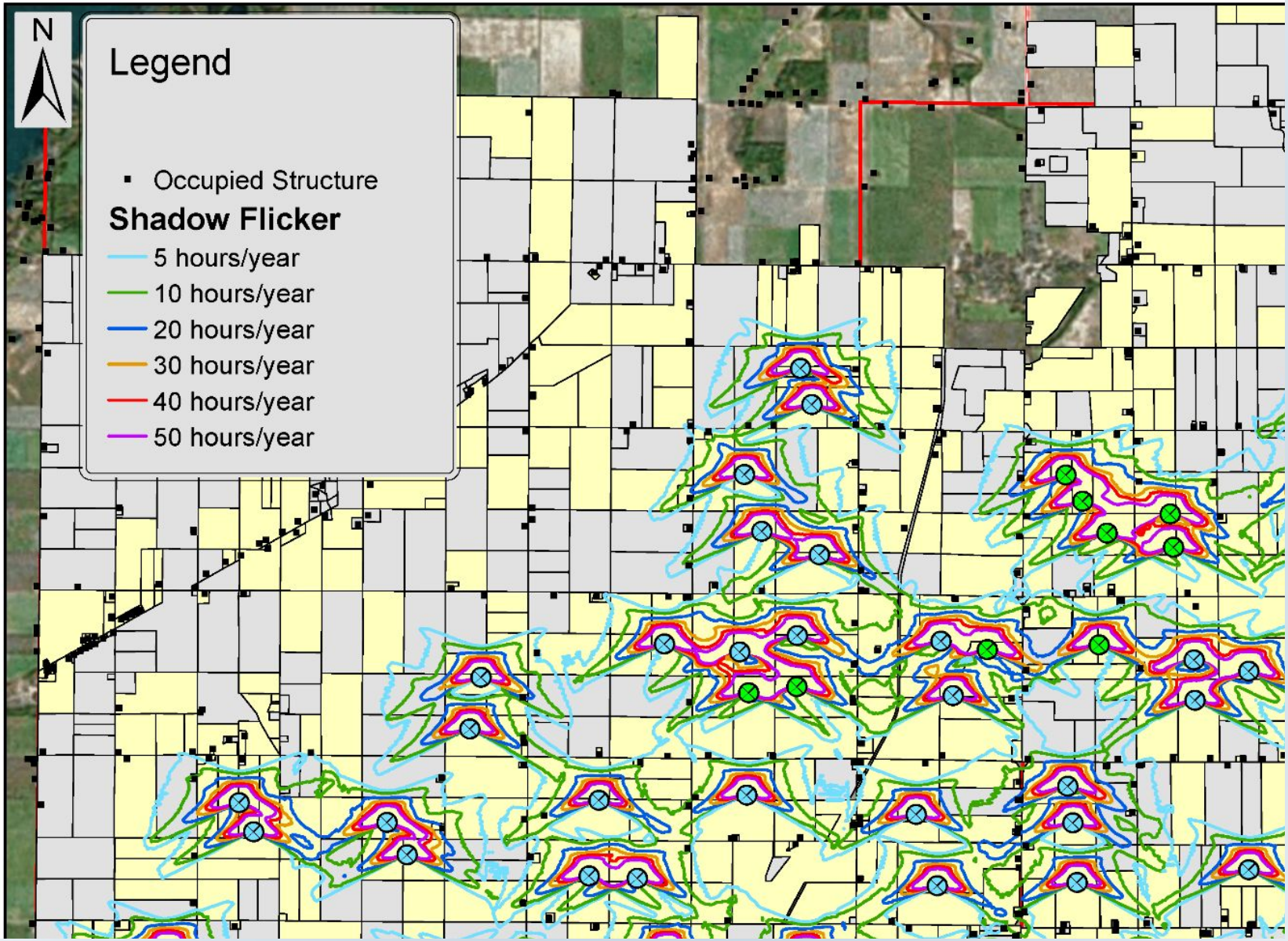
Flicker Impacts

- ***Frequency is 0.5-0.8 Hz, below the 3 Hz safety threshold for epileptics (no seizure risk)***
- ***Annoyance only, not a health concern***
- ***Rarely regulated. Guideline is 30 hr/yr (German court case ruled this acceptable to the homeowner)***

Mitigation Options

- ***Revise turbine layout***
- ***Curtailment programs based on date, time of day, solar insolation and winds***
- ***Vegetative screening***

Successful Layout



#3 VISUAL IMPACTS

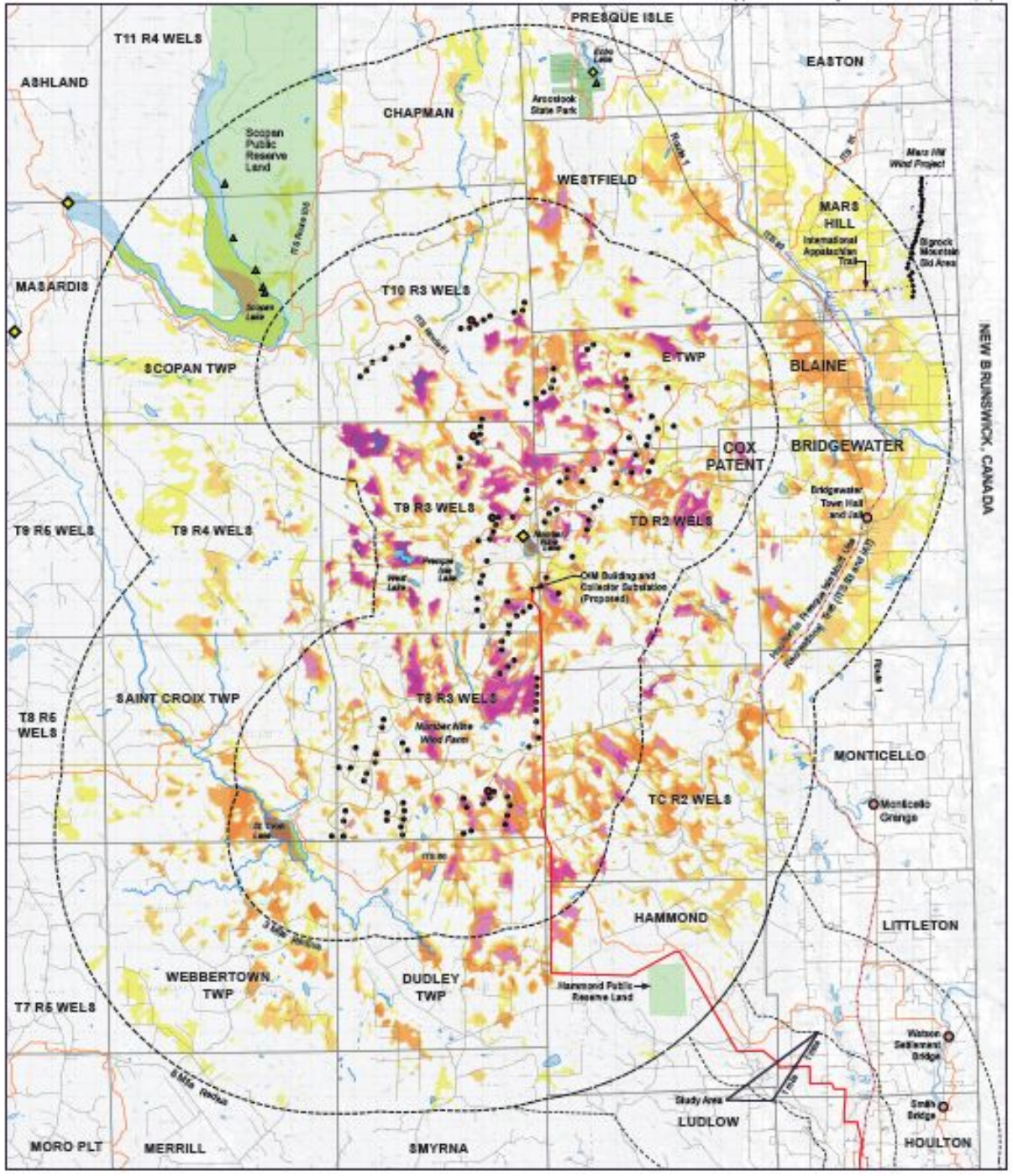
Photo documentation of existing views to the wind project, photo-simulation of future views and subjective analysis

Case Study: 250-MW Wind Farm Presque Isle, Maine

- ***State previously identified through statute Scenic Resources of Significance***
- ***Project produced Viewshed Map of SRS and # turbines visible within 8 miles (accounting for terrain and vegetation)***

Viewshed Map 120 Turbine Project

Presque Isle, Maine



#4 HEALTH EFFECTS OR ANNOYANCE?

Studies, Facts and Expert Panel Reviews

Mass. Dept. of Public Health Independent Expert Panel (2012)

- ***There is no evidence for a set of health effects characterized as "Wind Turbine Syndrome".***
- ***Available evidence shows infrasound near wind turbines cannot impact the vestibular system.***
- ***There is insufficient evidence to determine whether there is an association between noise from wind turbines and annoyance independent from the effects of seeing a wind turbine.***

Journal of Occ. And Env. Medicine
Critical Review of Scientific Literature
Wind Turbines and Health (2014)

- ***No clear association between turbine noise and any reported disease or other health indicator.***
- ***Self-reported annoyance correlates with the person's attitude toward wind turbines, turbine visibility and whether individuals benefit financially. Annoyance does not correlate well with measured sound levels.***
- ***Infrasound does not present health risks.***

Fatal Flaws of Anti-Wind Studies

- ***Rely on self-reported symptoms and claims of health problems. Self-selection bias is substantial.***
- ***No control group.***
- ***No control for confounding factors, e.g. do not account for natural LF sound.***
- ***Do not account for the Nocebo Effect: a worsening of mental or physical health based on fear or belief in adverse effects.***

Fatal Flaws of the Cooper Study

- ***Substantial self-selection bias. Six participants admitted anti-wind attitudes.***
- ***No control group.***
- ***No control for confounding factors.***
- ***No control for Nocebo Effect. In fact, the author highlights the Nocebo Effect.***
- ***Non-objective measure: "Sensations".***
- ***Not peer-reviewed.***

Fatal Flaws of the Cooper Study

- ***Info to Lancaster County Wind Energy Working Group: "Cooper found that these six subjects are able to sense attributes of the wind turbine emissions without there being an audible or visual stimulus present".***
- ***Cooper concludes (ES page ii): "For one resident, sensation, noise and vibration were observed with the wind farm shutdown".***

Recommendations for a Balanced Approach to Wind Energy

- ***If no locally-designated sound limit, 45 dBA***
- ***If LF limit desired, use ANSI 12.9/Part 4 guideline to prevent annoyance:***
  65 dB in the 16, 31.5, 63 Hz octave bands
- ***Shadow flicker limit, 30 hours/year***
- ***Pitch-regulated turbines***

Questions?

Peter Guldberg, INCE, CCM
Tech Environmental, Inc.
pguldberg@techenv.com
781-890-2220 x20