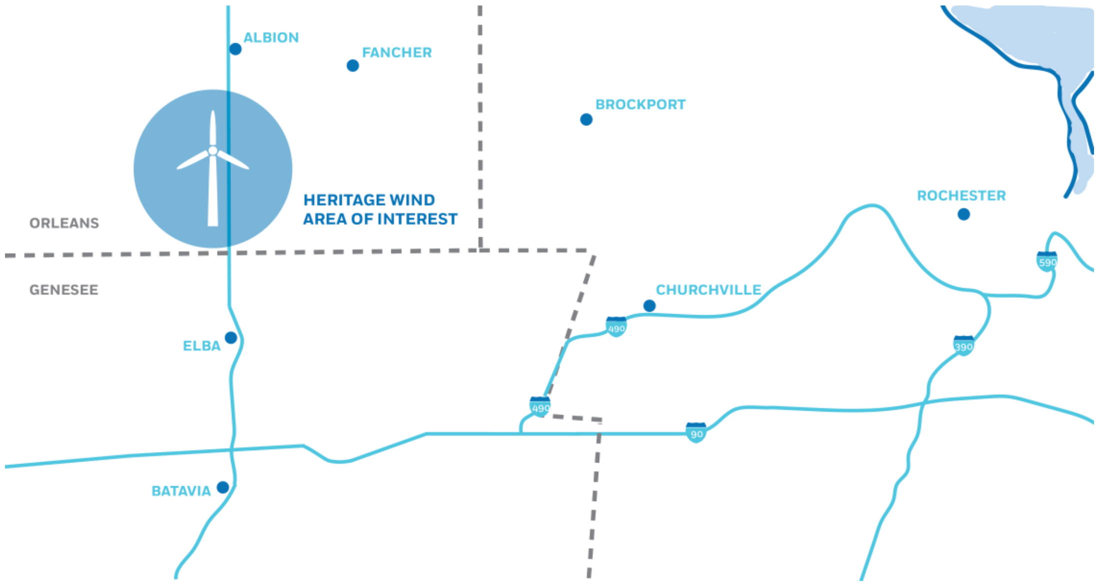
Heritage Wind Community Forum

Project Update and Overview



APEX CLEAN ENERGY

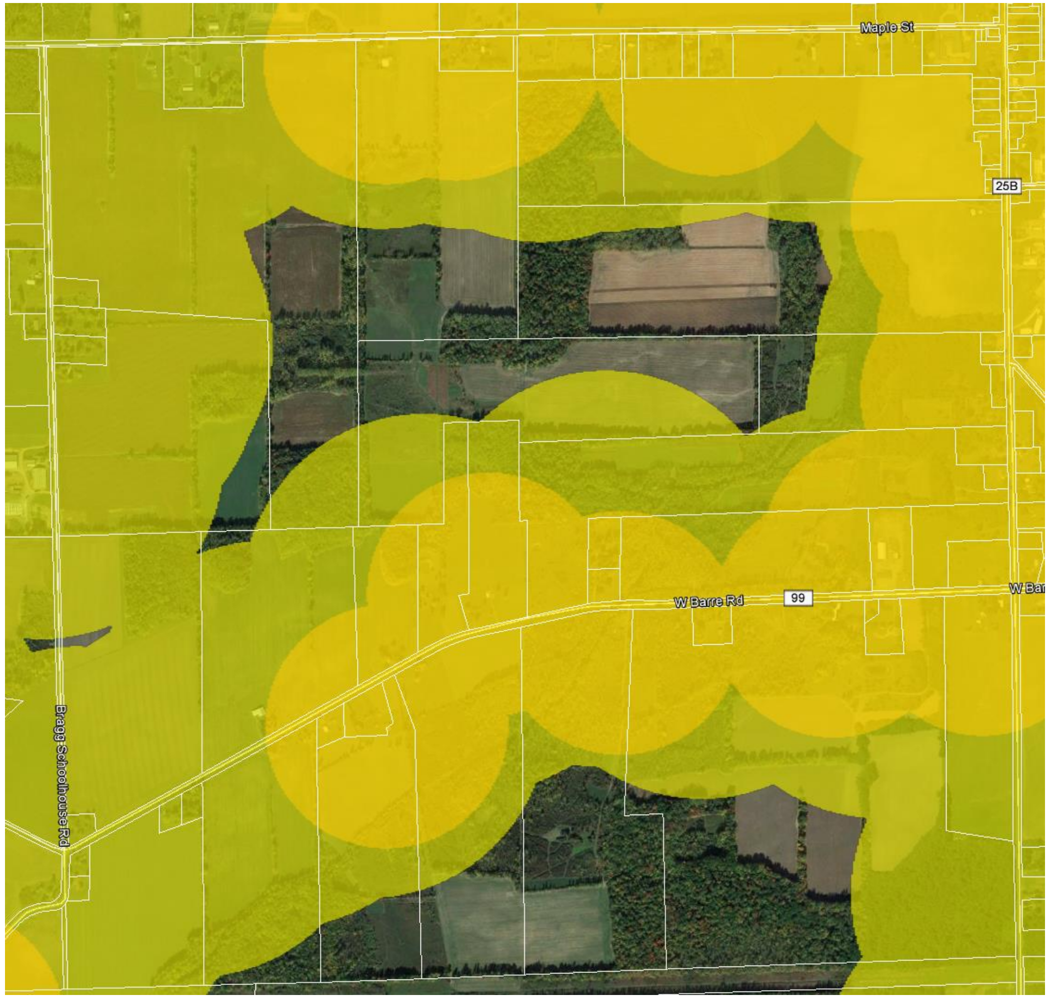
Project Design

Feature	Standard
Sound	45 dba at residences
Shadow Flicker	25 hours per year at nonparticipating residences
Homes	1,500 feet
Roads	1,000 feet
Non-participating Parcel Boundary	1.5 x Turbine Tip Height

Project Design: Setbacks to stationary features like buildings

Setback around all homes: 1,500 feet

Setback around barns: 1,000 feet



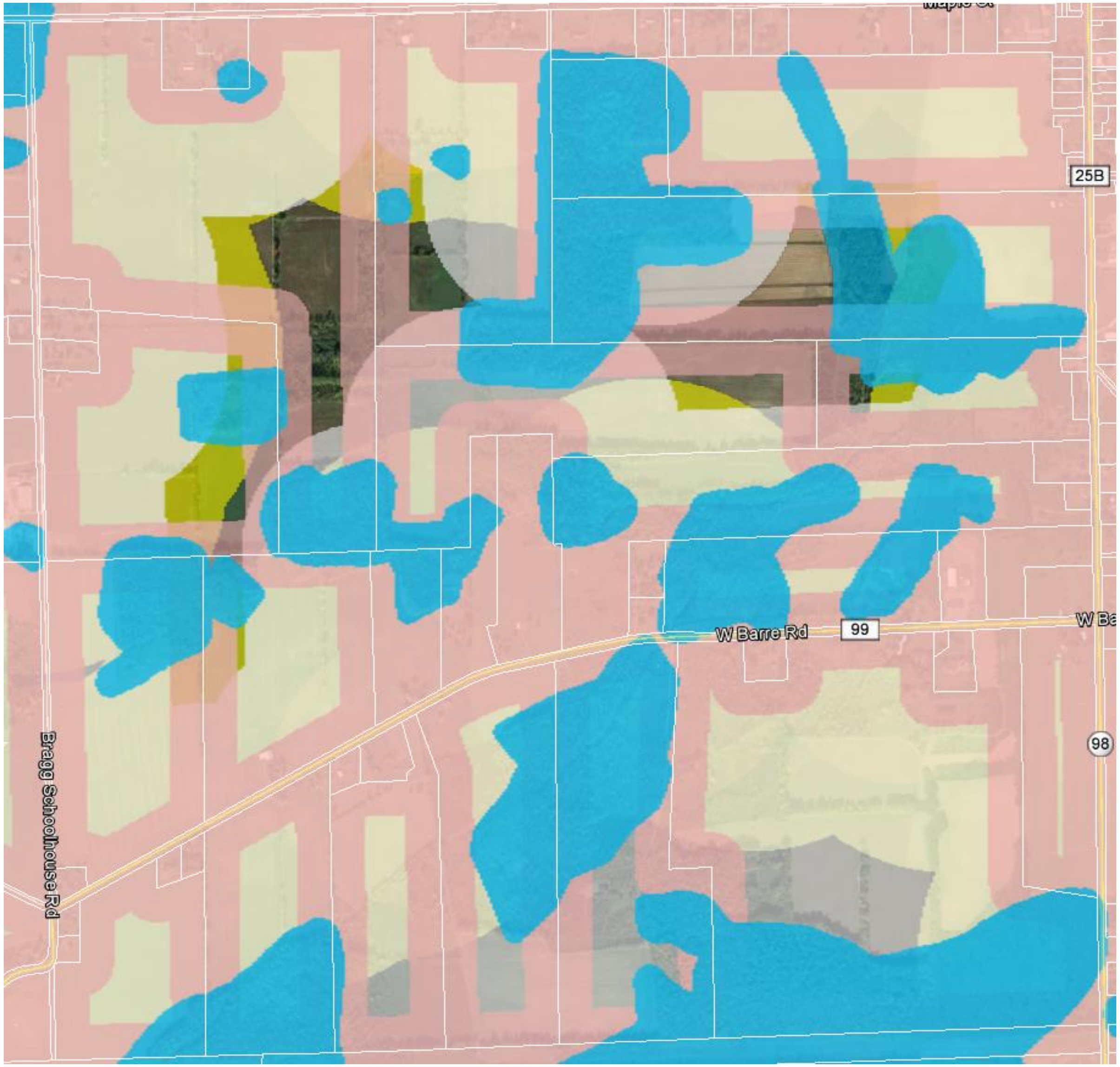
Setback to roads: 1,000 feet

Project design: Setbacks based on turbine dimensions

Setback to non-participating properties: Tip Height x 1.5

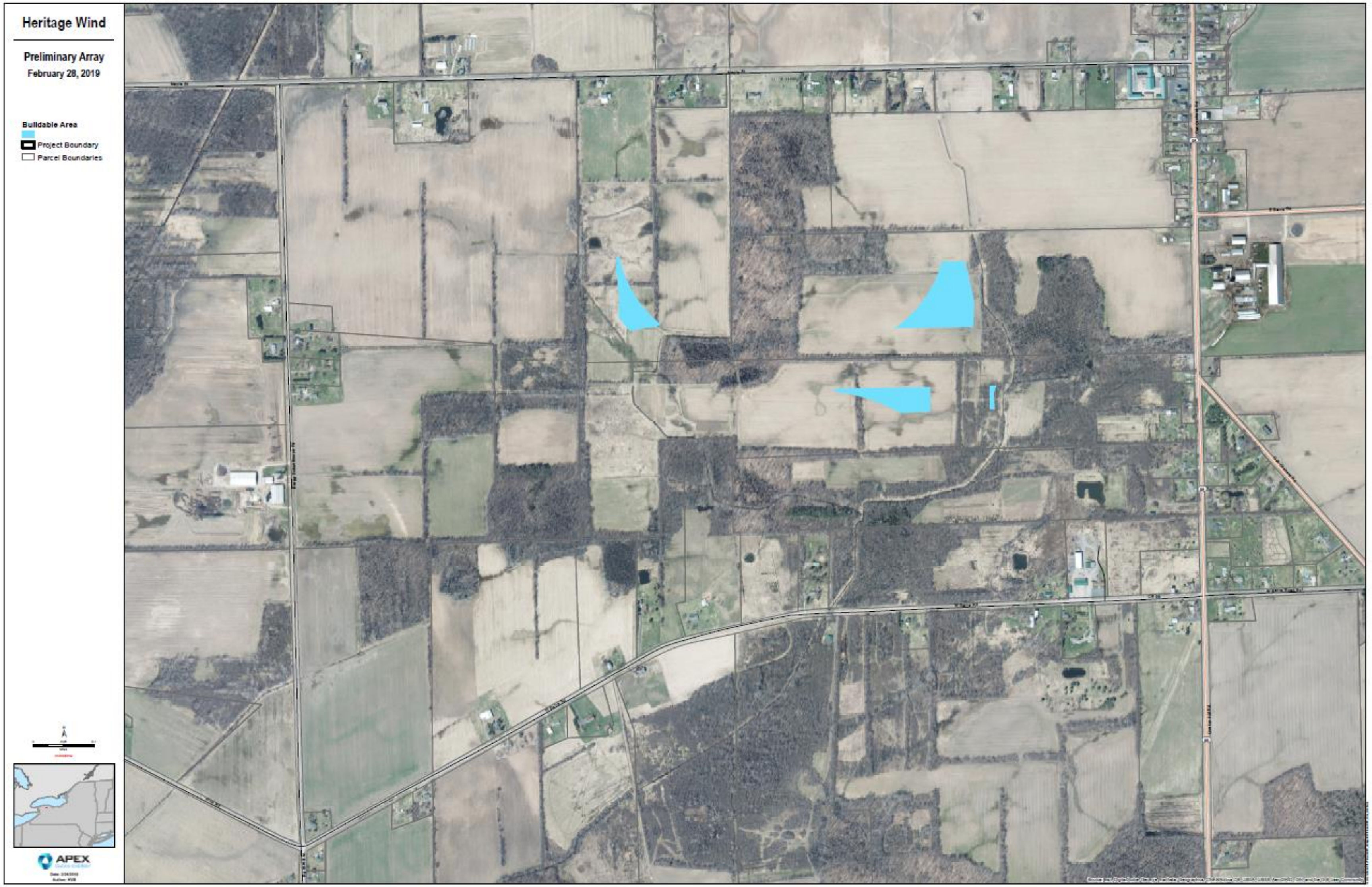
Setback to all parcel boundaries: blade length/rotor radius

Project Design: Wetlands and Streams Added



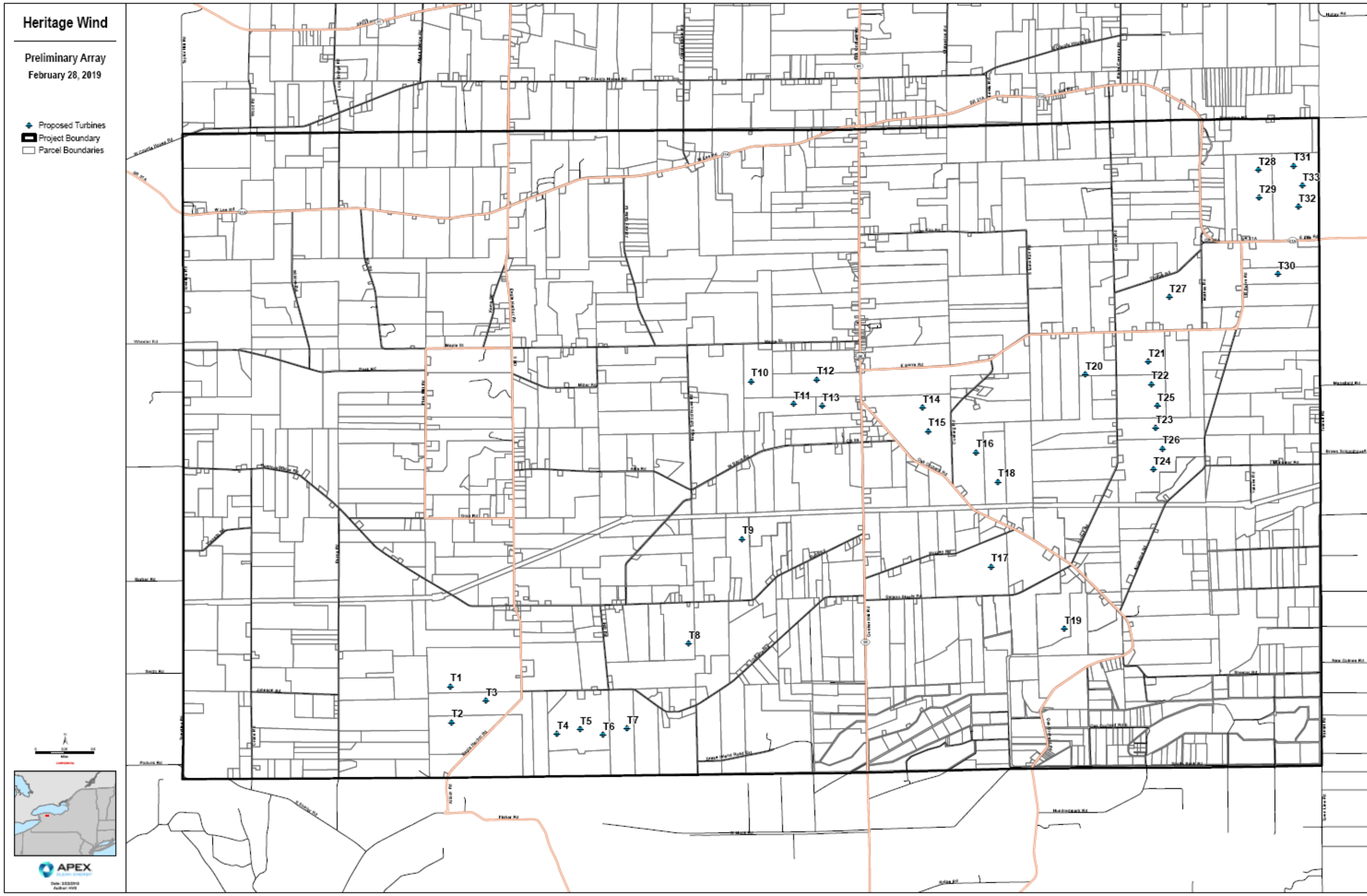
APEX CLEAN ENERGY

Buildable Area



APEX CLEAN ENERGY

Heritage Wind Preliminary Layout: February 28, 2019



How Wind Projects Benefit Host Communities

Orangeville Wind Farm

94 MW • 58 turbines • March 2014 • Wyoming County • Town of Orangeville

- The 2018 Orangeville Town Budget included $517,342.44 in Host Community payments
- Payments continue to increase with inflation over the lifespan of the project

Noble Bliss Farm

101 MW • 67 turbines • March 2008 • Wyoming County • Towns of Eagle & Arcade

- County, towns, and schools investment of $1,758,941.22 tax payments to date
- In addition, Eagle Host Community Agreement ($6,400 per megawatt) eliminated taxes and garbage fees

Cohocton/Dutch Hill Wind Farm

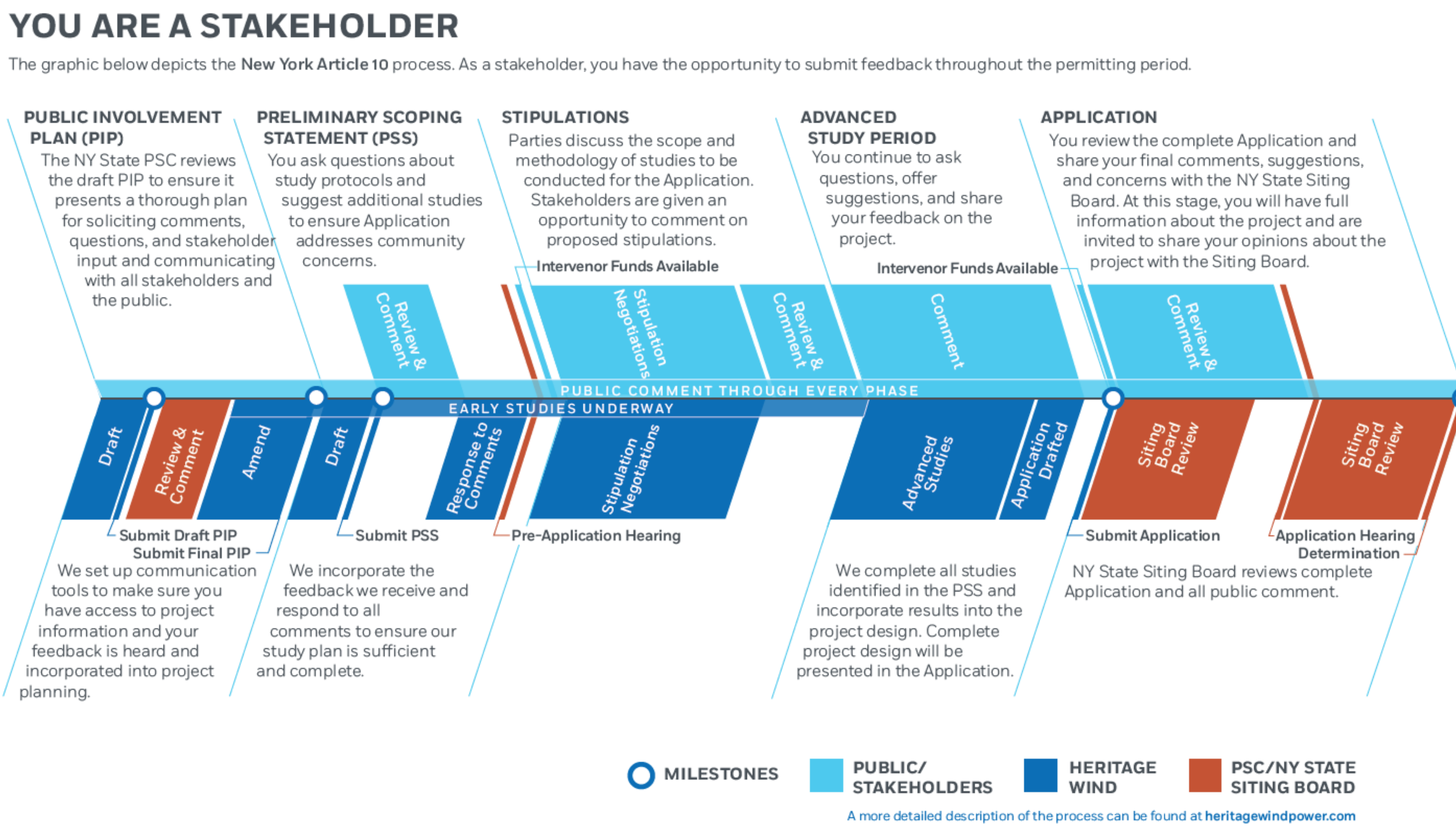
87.5 MW • 35 turbines • January 2009 • Steuben County • Towns of Cohocton, Avoca & Prattsburgh

- County towns and schools have received $3,734,937.50 from tax payments to date
- Cohocton Community Benefit Payments: $3,915,604
- Reduced property tax by 60%

Assuming a total community benefit pool (HCA + PILOT) of $7,500/MW, a 150MW project would bring the community $1.1 million per year

APEX CLEAN ENERGY

Permitting Status



Environmental and Wildlife

Natural Resources

- Numerous ecological and environmental studies are being conducted to support various Article 10 Application Exhibits (especially Exhibits 22 and 23)

- The results of these studies are used to inform Facility design to avoid and minimize impacts to sensitive resources

- Studies completed or underway include:

  1. Wildlife Surveys
  2. Vernal Pool Surveys
  3. Wetland and Stream Delineations
  4. Habitat Fragmentation Analysis
  5. Invasive Species Baseline Survey
  6. Plant and Wildlife Species Inventory

APEX CLEAN ENERGY

Natural Resources

Wildlife Surveys (Exhibit 22)

- Study plans developed in consultation with NYSDEC
- All surveys completed between fall 2016 and fall 2018
- Studies included:
  1. Small bird use
  2. Large bird use
  3. Eagle use
  4. Fall migratory raptors
  5. Wintering raptors
  6. Spring migratory raptors
  7. Breeding birds

Natural Resources

Vernal Pool Surveys (Exhibit 22)

- Completed in spring 2018
- Purpose: identify potentially sensitive vernal pool habitats; use results to avoid impacts

APEX CLEAN ENERGY

Natural Resources

Wetland and Stream Delineations

- Initiated during 2018 growing season
- To be completed spring 2019
- Boundaries of all wetlands and streams within 500 feet of proposed Facility components will be identified
- Used to inform impact avoidance and minimization
- Wetland and Stream Delineation Report will be prepared for Article 10 Application

APEX CLEAN ENERGY

Natural Resources

Habitat Fragmentation Analysis

- To be completed spring 2019
- Based on results of wildlife studies and detailed GIS analysis of habitat/ecological community types within Facility Site
- Will evaluate amount of forested and grassland habitat that will be affected by Facility construction and operation
- Will assess the level of indirect effects to these habitats and wildlife species that use these areas

Natural Resources

Invasive Species Baseline Report

- To be completed spring 2019
- Will document pre-construction occurrence and extent of invasive plant species
- Density codes will be used to describe each occurrence/patch (sparse, patchy, dense, monoculture)
- Results will be used to develop the invasive species control plan for the Facility

APEX CLEAN ENERGY

Natural Resources

Plant and Wildlife Species Inventory

- To be completed spring 2019
- Will include plant and wildlife species that are reasonably likely to occur in the vicinity of the Facility Site
- Species observed during all ecological/environmental studies will be included
- Additional species will be included based on publicly available data sources

Shadow Flicker

What Is Shadow Flicker?

- Shadow flicker is caused by sunlight passing through the rotor sweep area of the wind turbine
- Modern wind turbines have a light flickering frequency below 1Hz
- The amount of shadow flicker diminishes rapidly with distance from the turbine, and should be minimal at 10RD from a turbine

Why Do the Lengths of Shadows Change?

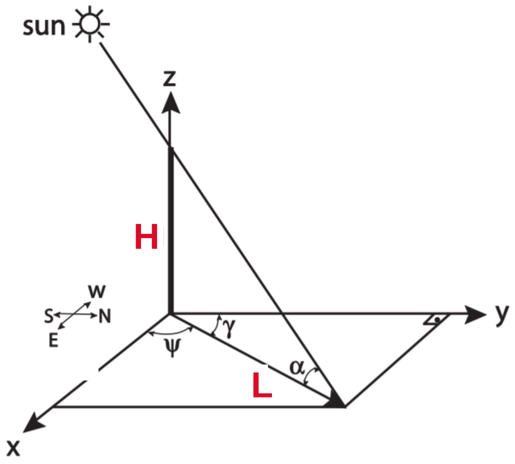


Fig. 1. Shadow components of a vertical pole.

$$L = H/\tan(\alpha)$$

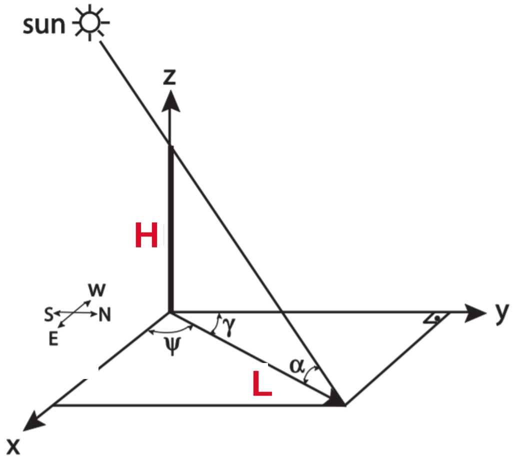
Where,

L is the Total Shadow Length
H is the height of the object
α is the sun elevation angle

Image Source: Mamia, I. & Appelbaum, J. *Renew. Sustain. Energy Rev.* 55, 713–718 (2016).

APEX CLEAN ENERGY

Why Do the Lengths of Shadows Change?



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Geometry of the Sun!

APEX CLEAN ENERGY

Angle Between the Earth and Sun

$$L = H/\tan(\alpha)$$

$$\sin(\alpha) = \cos(\delta)\cos(\phi)\cos(\omega) + \sin(\delta)\sin(\phi)$$

Where,

α is the sun elevation angle
δ is the declination of the earth axis
φ is the latitude
ω is the sun hour

$$\delta = 23.45\sin\left(360\frac{284+n}{365}\right)$$

n is the day of the year

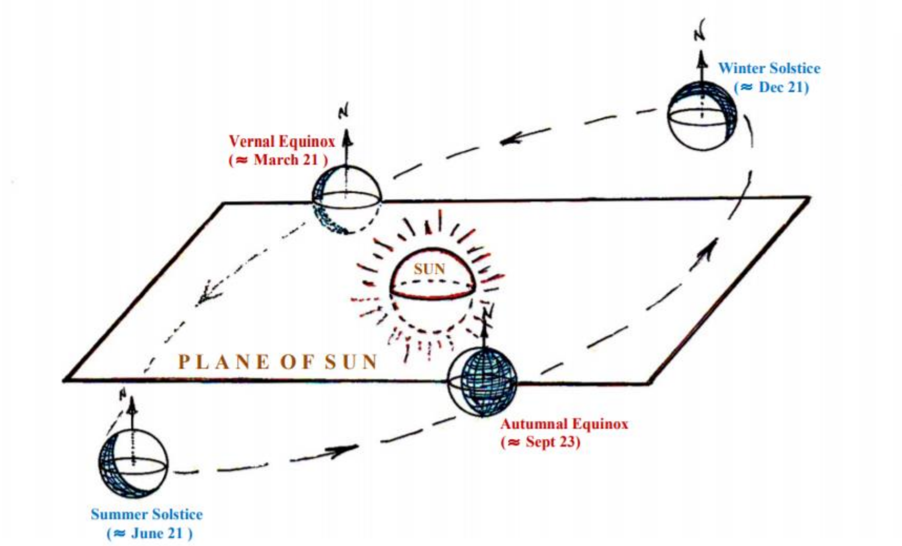


Image Source: Illinois Institute of Technology, D. Maslanka

Earth's Latitude

$$L = H/\tan(\alpha)$$

$$\sin(\alpha) = \cos(\delta)\cos(\phi)\cos(\omega) + \sin(\delta)\sin(\phi)$$

Where,

α is the sun elevation angle
δ is the declination of the earth axis
φ is the latitude
ω is the sun hour

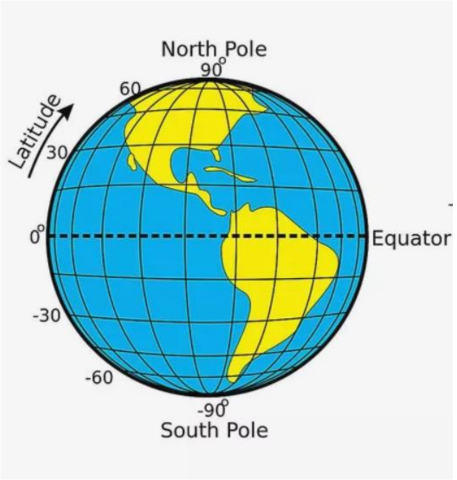


Image Source: https://www.thoughtco.com/degree-of-latitude-and-longitude-distance-4070616

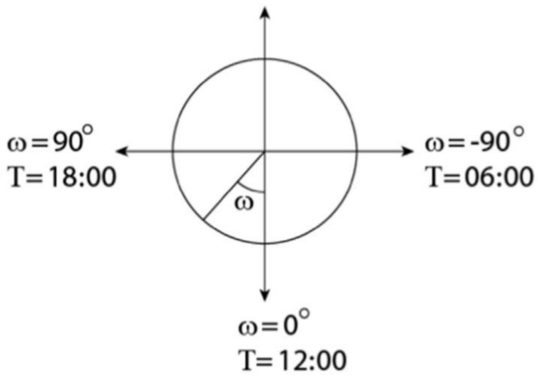
Time of Day

$$L = H/\tan(\alpha)$$

$$\sin(\alpha) = \cos(\delta)\cos(\phi)\cos(\omega) + \sin(\delta)\sin(\phi)$$

Where,

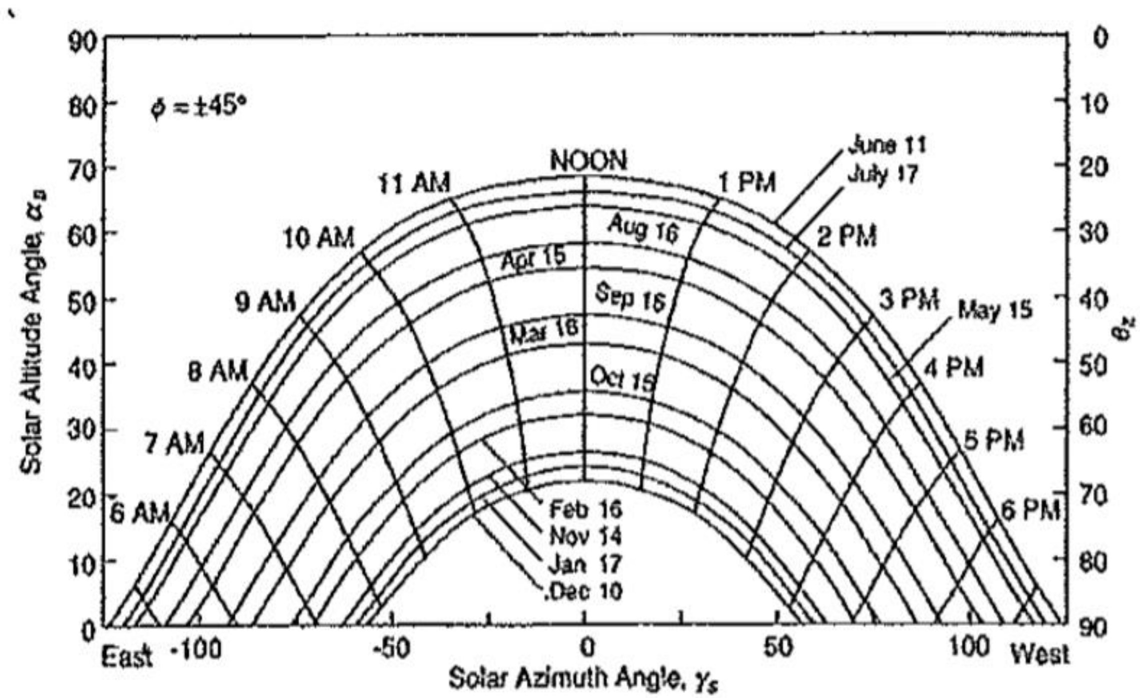
α is the sun elevation angle
δ is the declination of the earth axis
φ is the latitude
ω is the sun hour



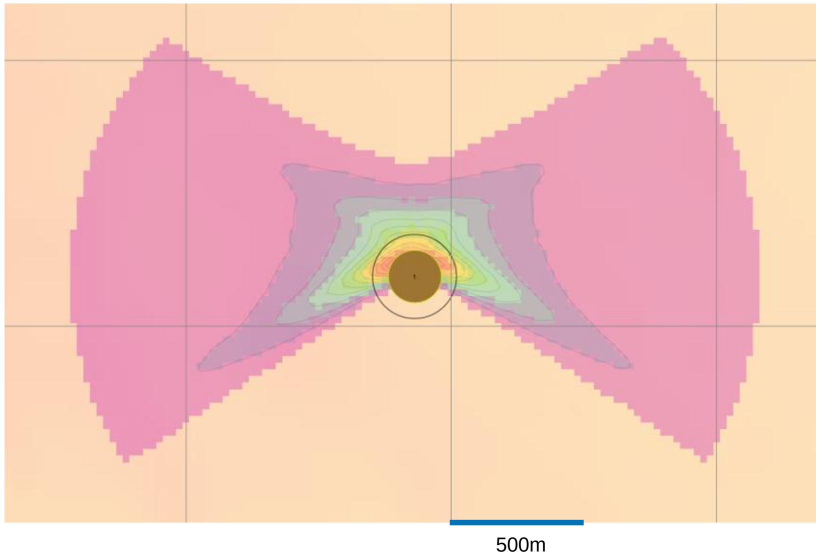
T is time of day (0:00 to 23:59)

Image Source: Mamia, I. & Appelbaum, J. Renew. Sustain. Energy Rev. 55, 713–718 (2016).

Sun Path Diagram

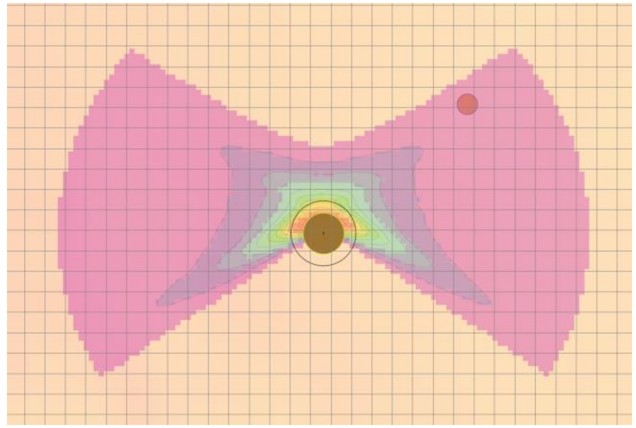


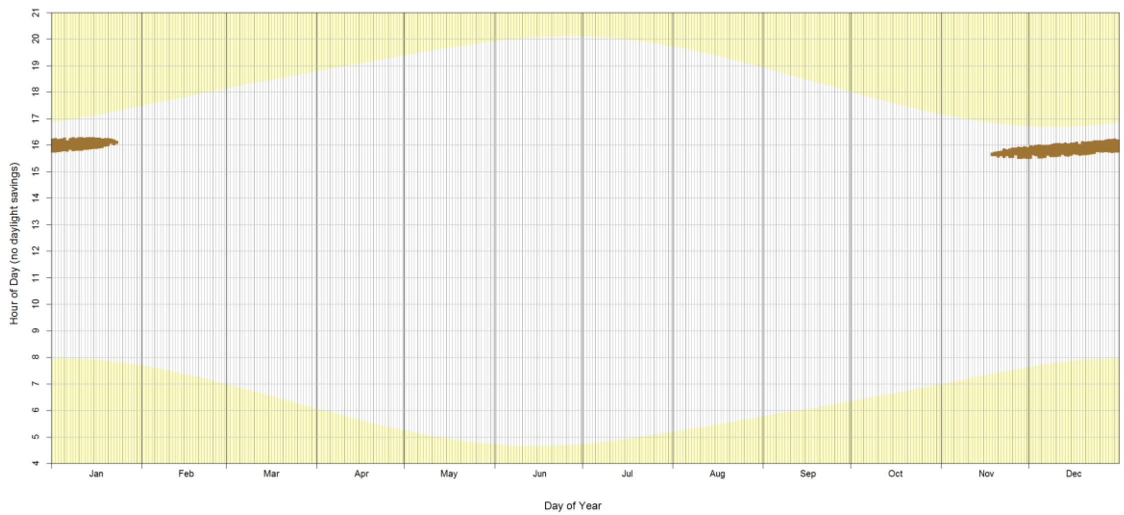
Modeling a Turbine



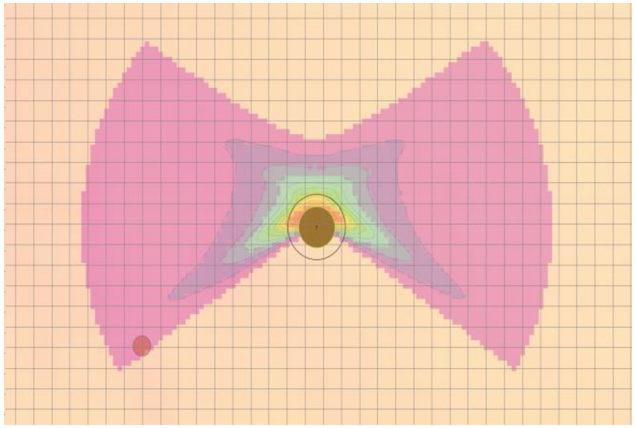
>	12000	
10800.1	12000	
9600.2	10800.1	
8400.3	9600.2	
7200.4	8400.3	
6000.5	7200.4	
4800.6	6000.5	
3600.7	4800.6	
2400.8	3600.7	
1200.9	2400.8	
1	1200.9	

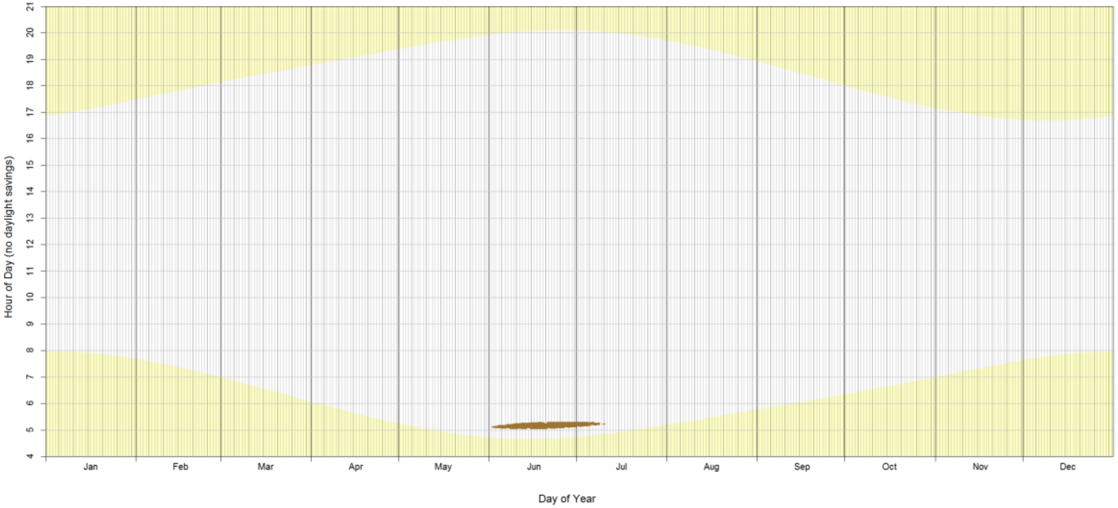
Modeling a Turbine





Modeling a Turbine



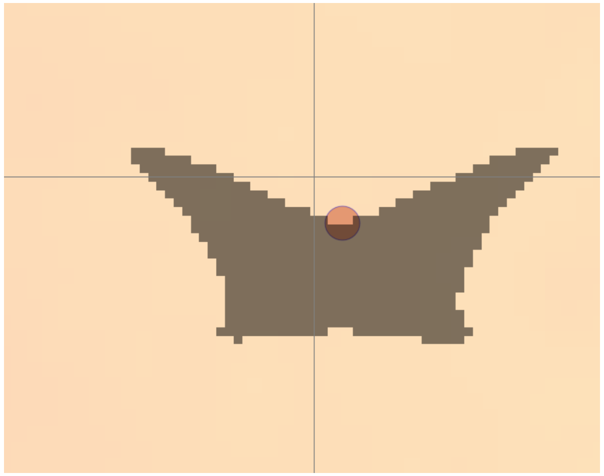


What Does This Assume?

- No clouds or fog
- Turbine continuously operates
- Turbine perpendicular to the sun at all times
- No trees or buildings obscuring the shadow
- House orientation
- Sun very diffuse at low angles

How to Site for Shadow Flicker

We ensure that all non-participating homes do not exceed the maximum allowable shadow flicker standard.



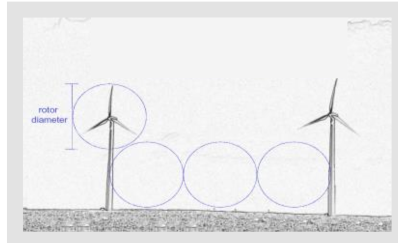
Engineering and Construction

Wind Farm Engineering

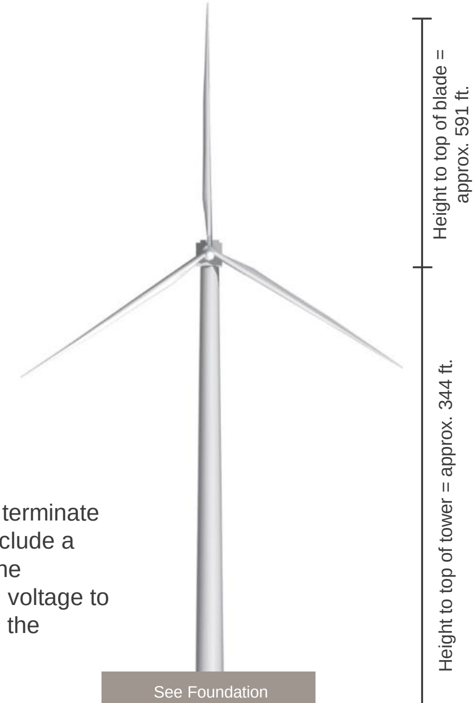
Wind Farm Design and Construction

The project as planned will consist of up to 40 individual, three-bladed wind turbines, generating up to 168 megawatts (MWs) of electricity.

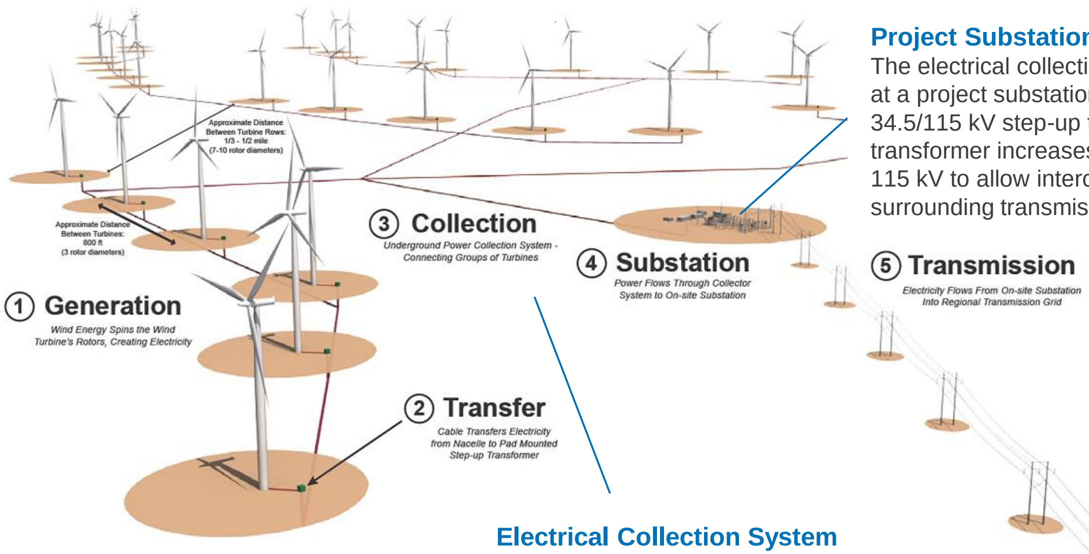
As planned, each turbine will be mounted on a segmented tubular steel tower.



The turbines will be erected in clusters generally following the higher topography on the site. They will be spaced approximately 1,600 feet apart.



See Foundation Diagram for More Detail

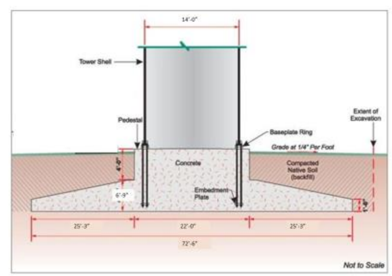


Project Substation

The electrical collection system will terminate at a project substation, which will include a 34.5/115 kV step-up transformer. The transformer increases the collection voltage to 115 kV to allow interconnection into the surrounding transmission system.

Electrical Collection System

An underground 34.5 kV electrical collection system will gather the electricity from each wind turbine generator and route it to a project substation in the project area.



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Building a Wind Farm

1. Mobilization

- Set up offices and other facilities for the construction staff and a staging area for equipment storage
- Survey project site and stake roads and wind turbine locations

2. Access Roads and Foundations

- Construct access roads
- Excavate and construct the wind turbine foundations

3. Collection Cable Installation

- Trench and bury underground electrical collection cable

4. Wind Turbine Installation

- Stack and bolt tower sections together
- Lift nacelle, which contains the main shaft, gearbox, generator, and auxiliary equipment into place
- Assemble rotor on the ground and lift into place on the nacelle
- Complete installation and connect all the electrical and mechanical systems
- Verify all work and electrical connections inside the nacelle and tower are done to the appropriate standards
- Test the wind turbines systems to ensure they are functioning correctly

5. Substation and Transmission Line Erection

- The project substation will house the circuit breakers, switches, transformer, instrumentation, and control building
- The transmission line will carry the electricity to the point of interconnection

APEX CLEAN ENERGY

Wind Turbine Sound Levels

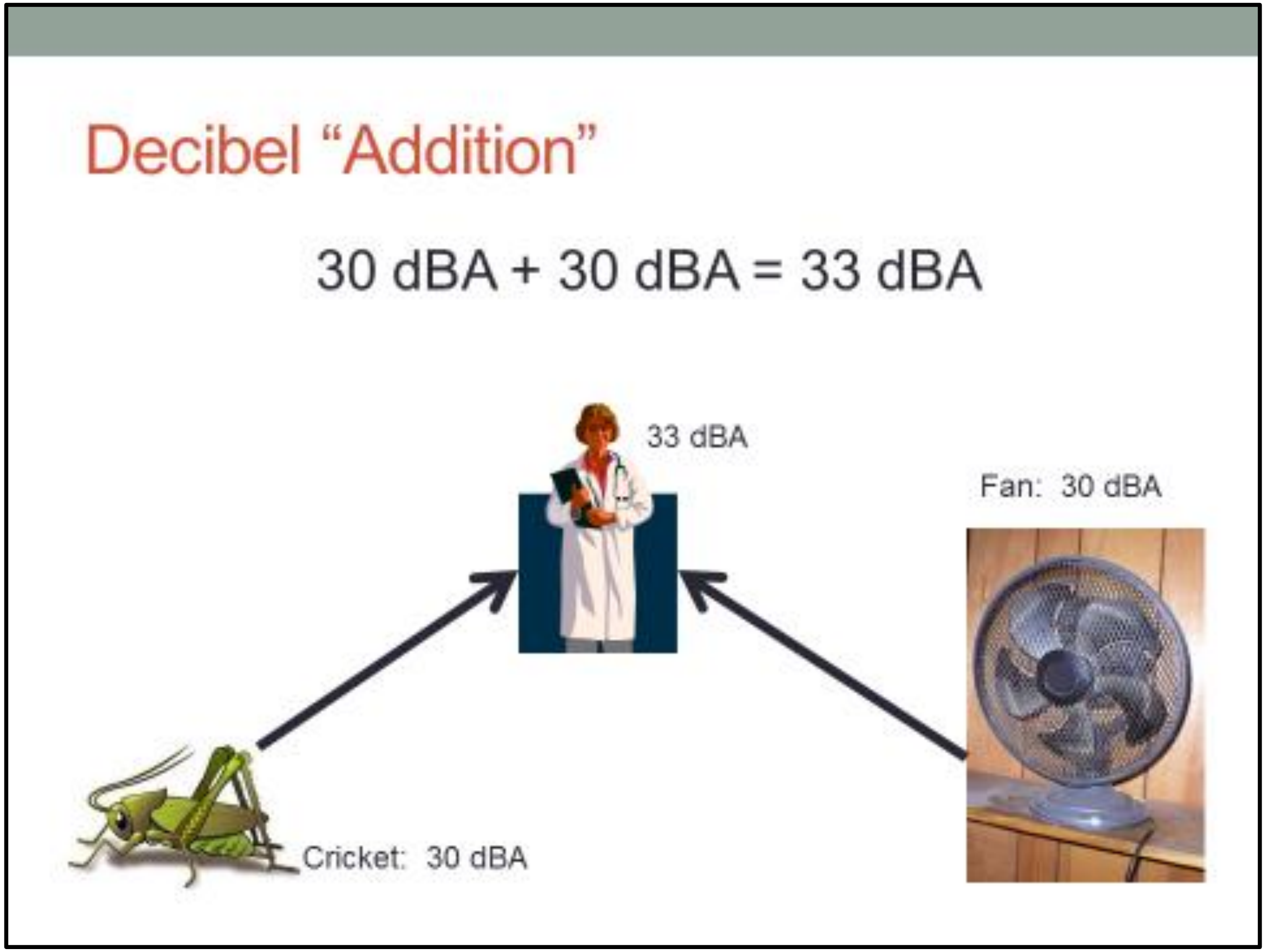
Prepared for Public Education Event

February 28, 2019

Robert D. O’Neal, CCM, INCE Bd. Cert.

Epsilon Associates, Inc.

Basic Concepts of Sound



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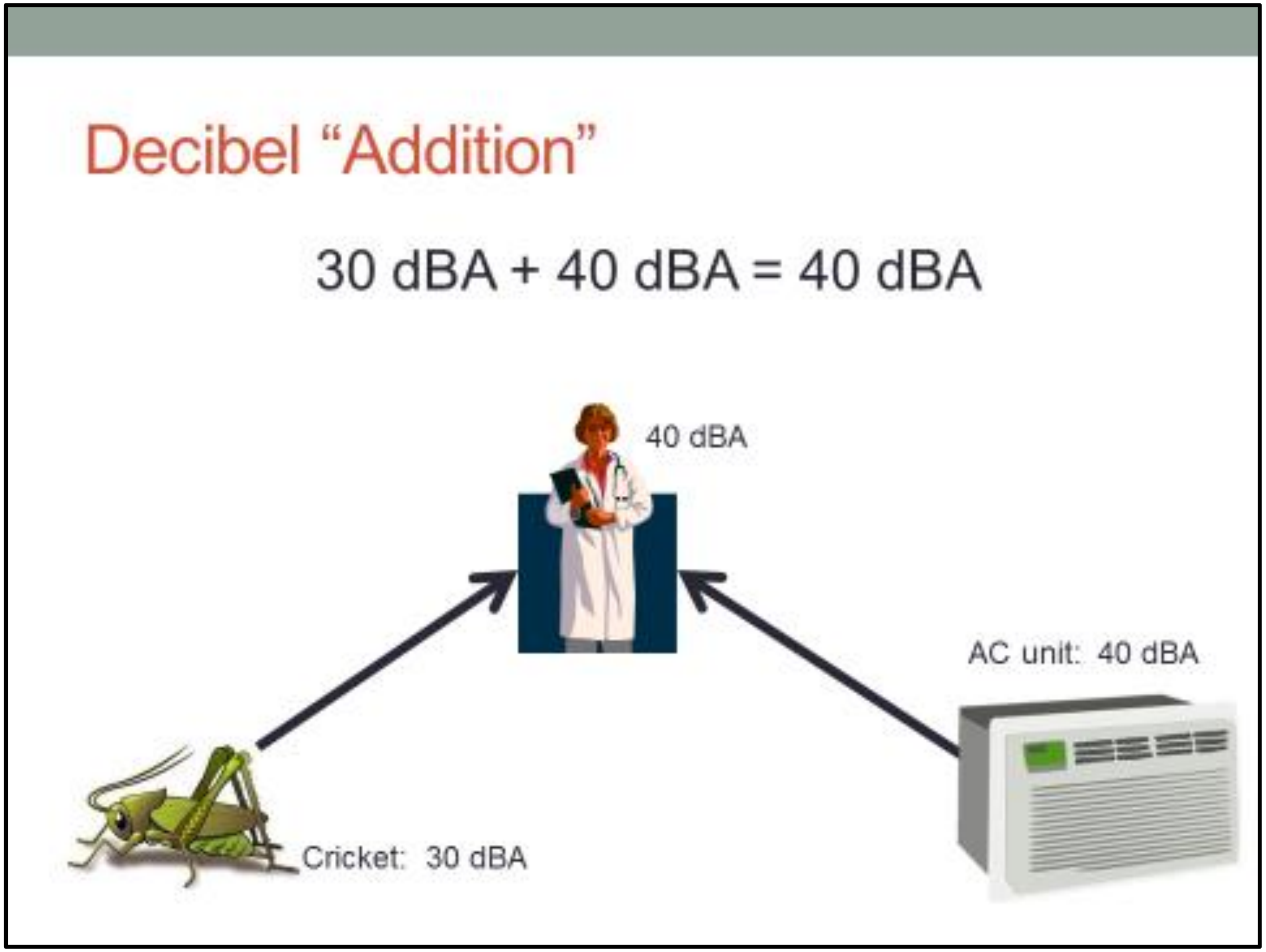
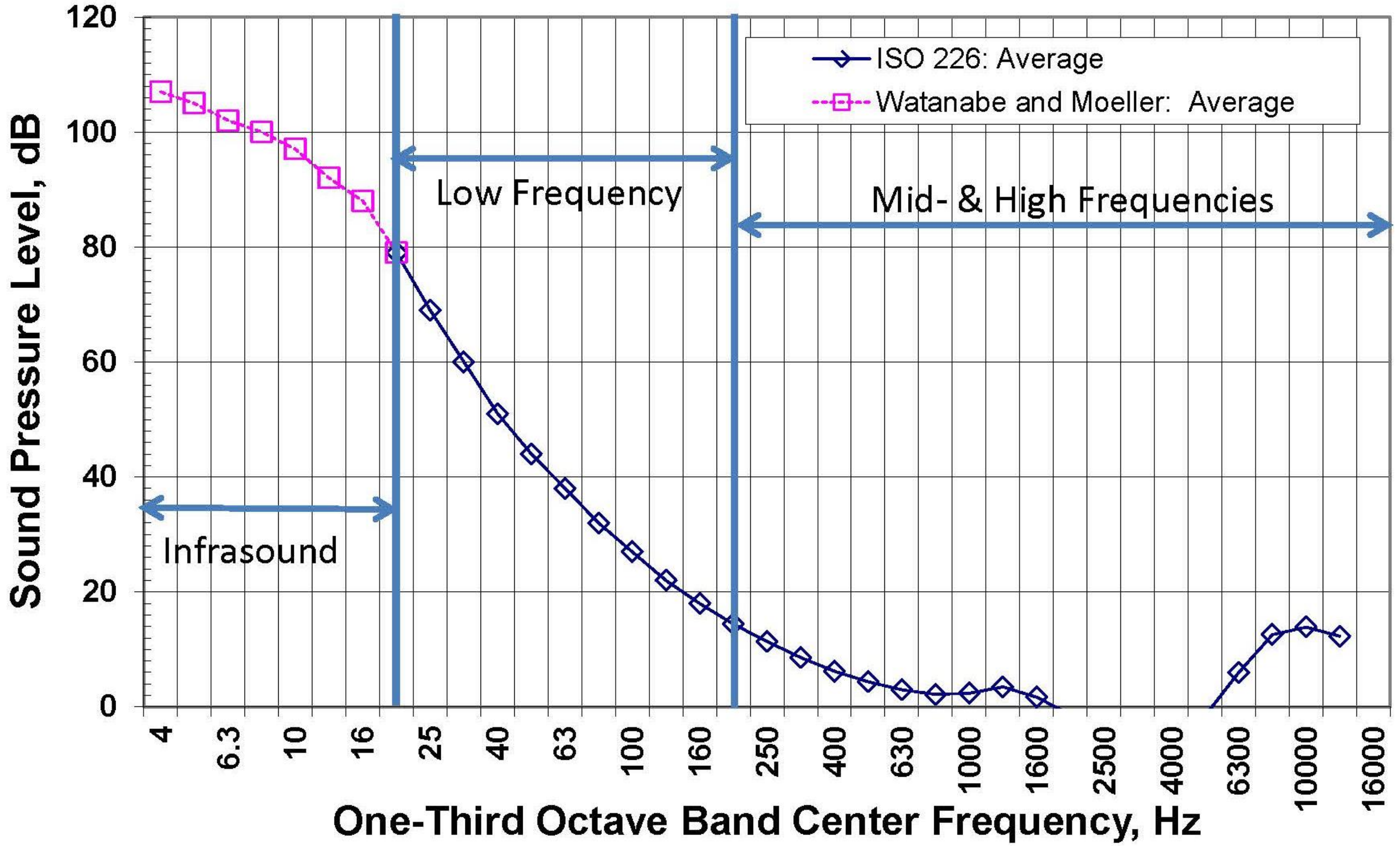
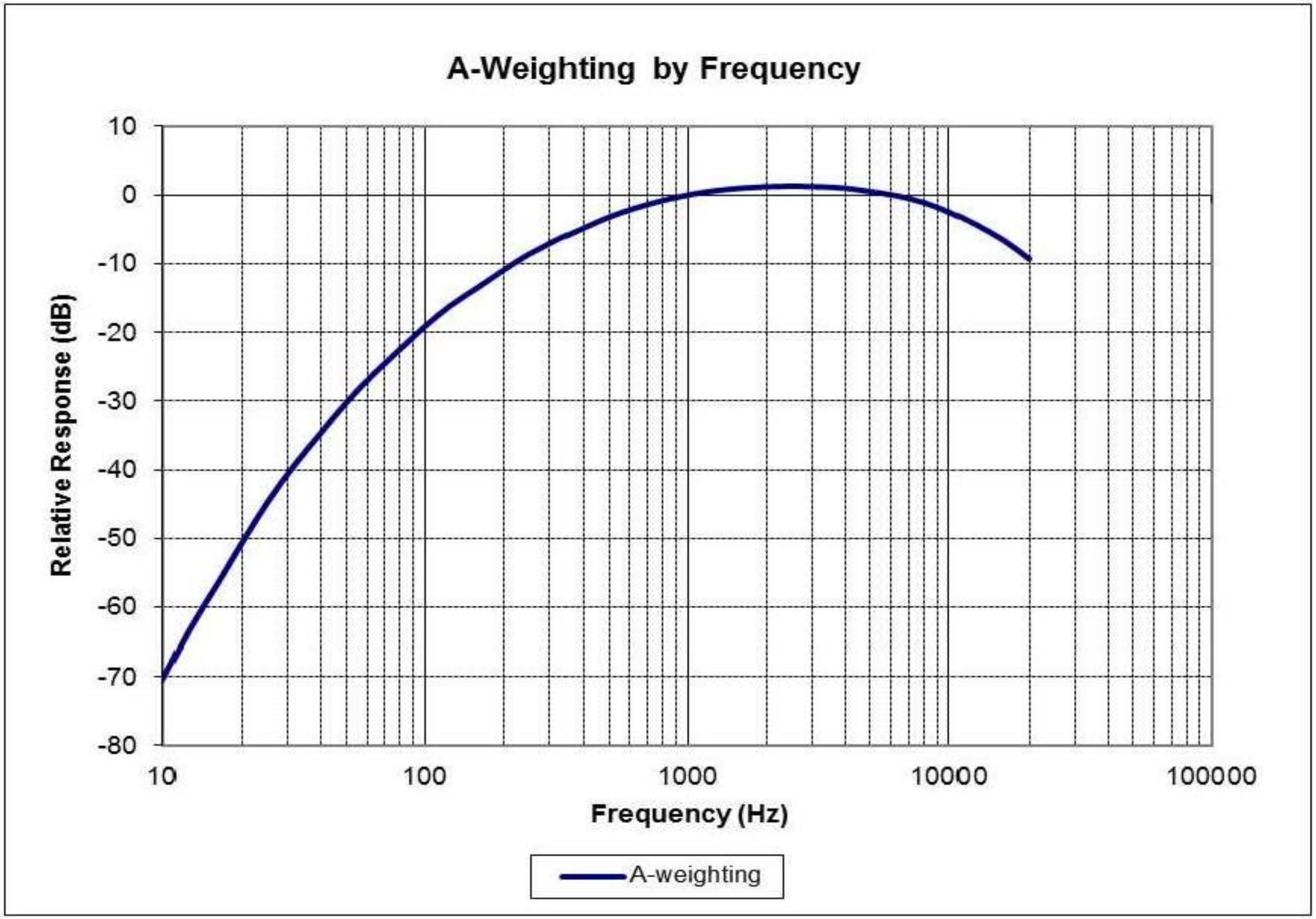


One-Third Octave Band Frequencies

Figure 1. Threshold of Audibility vs. Frequency (4 Hz--16,000 Hz)



A-Weighting Curve

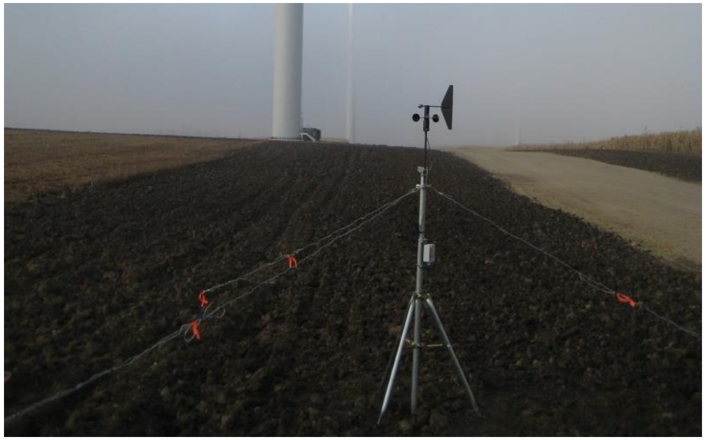


Sound Level Monitoring

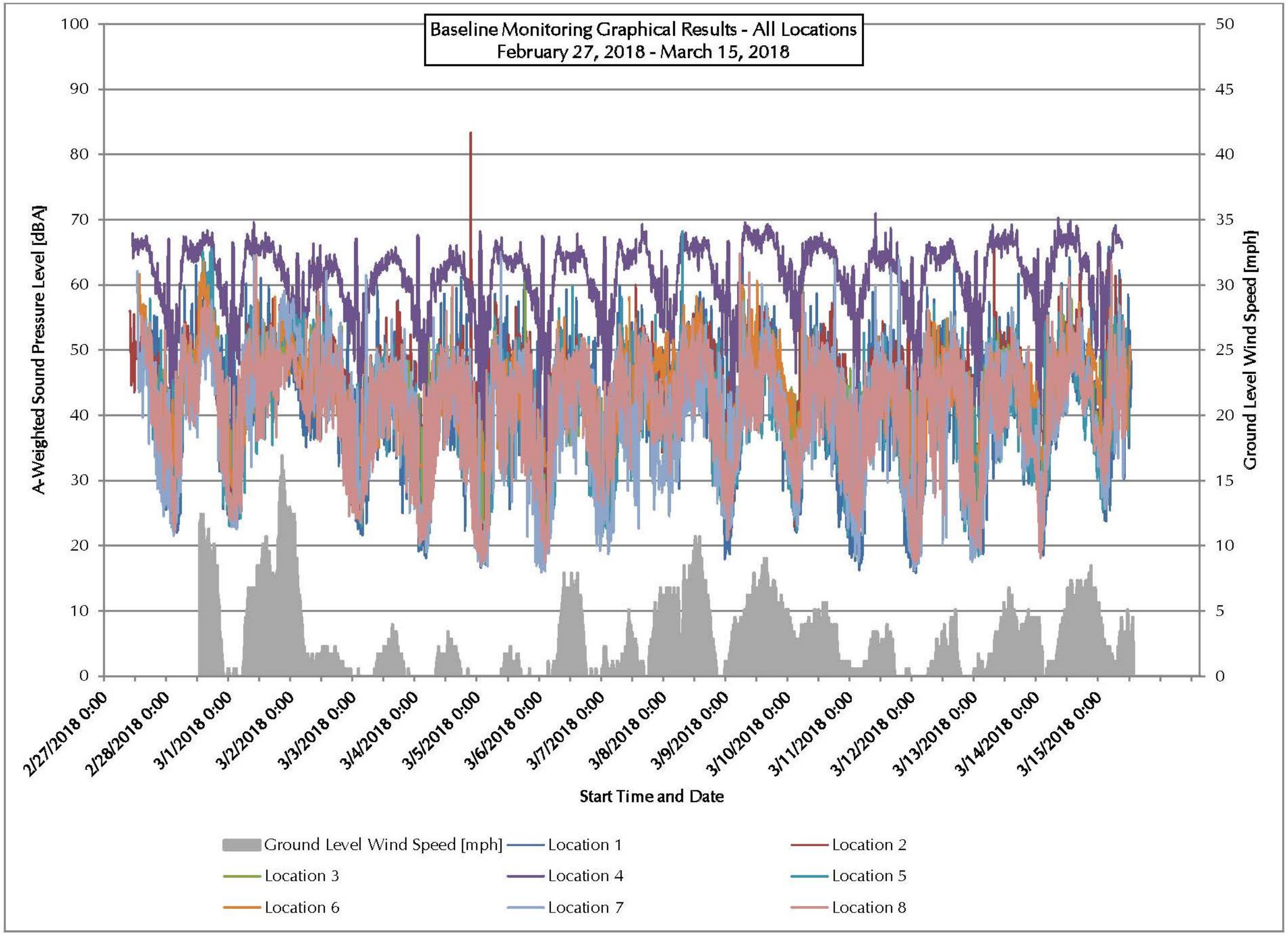
Measurements

- Sound
  - Larson Davis 831
  - Norsonic 140

- Meteorological
  - 2-meter tower
  - Primarily wind speed



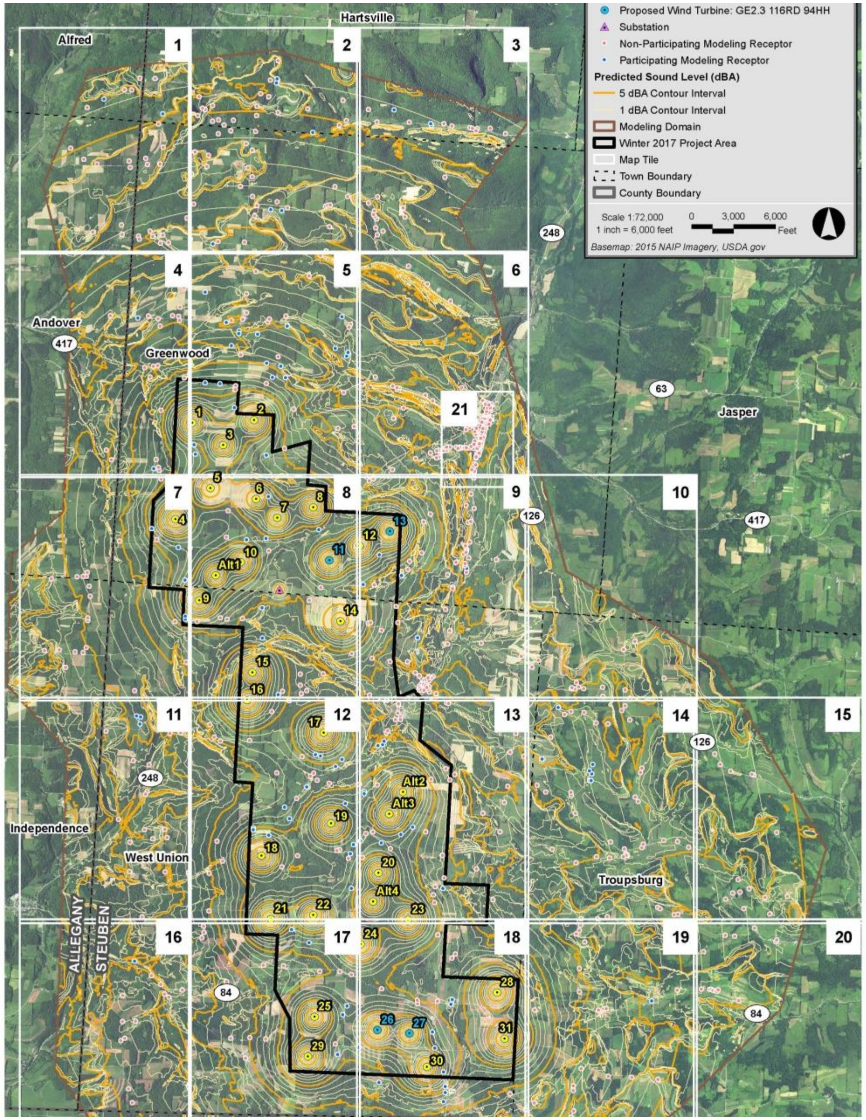
Existing Background: 2-Week Example



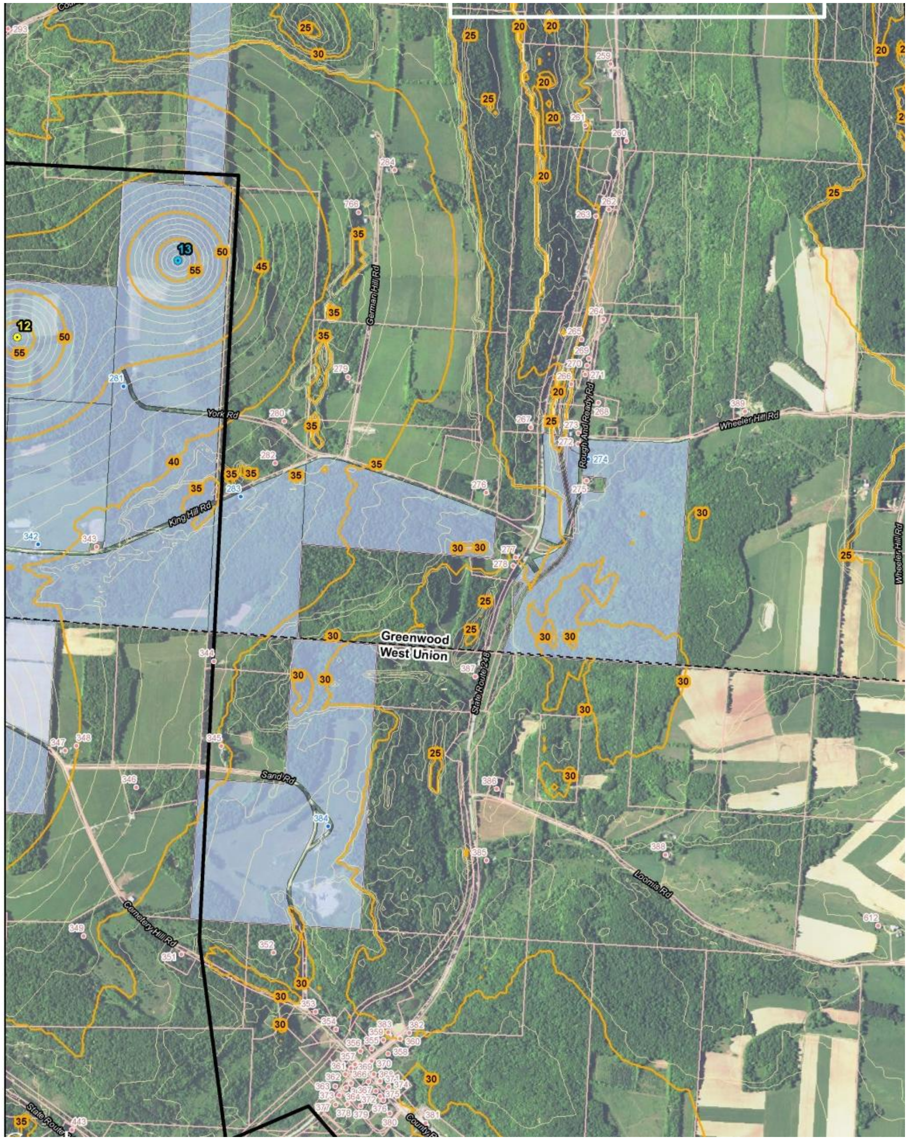
Sound Level Prediction Process

- Uses International Standards Organization (ISO) 9613-2 methodology (CadnaA software)
- Uses Project layout—WTG and receptors
- Incorporates elevation data in community
- Maximum sound level from each wind turbine
- Wind turbine height included in model
- Meteorological conditions—inversion, T, RH
- Drop-off with distance
- Wind always blowing from turbine to house

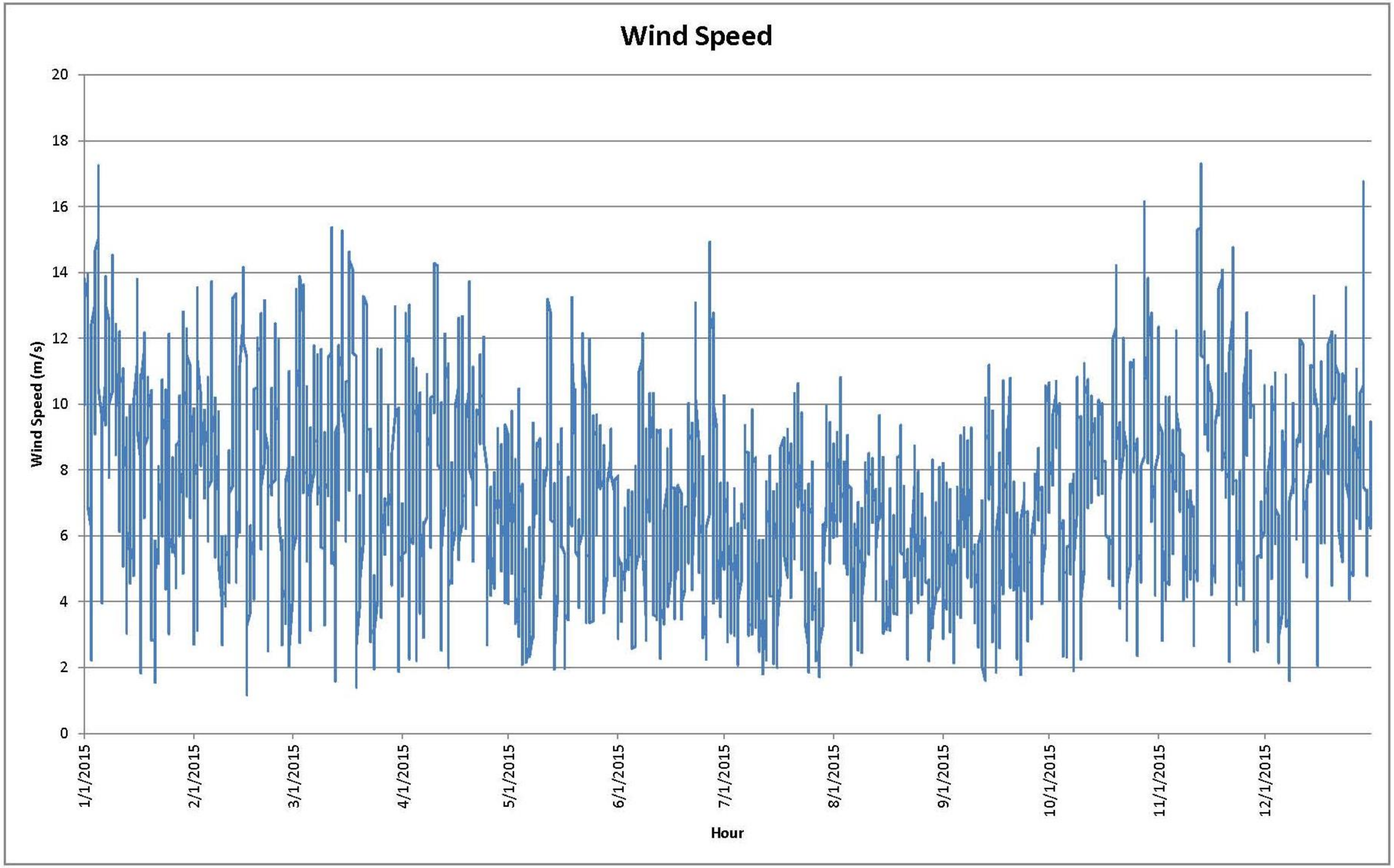
Sound Level Prediction Process: Example



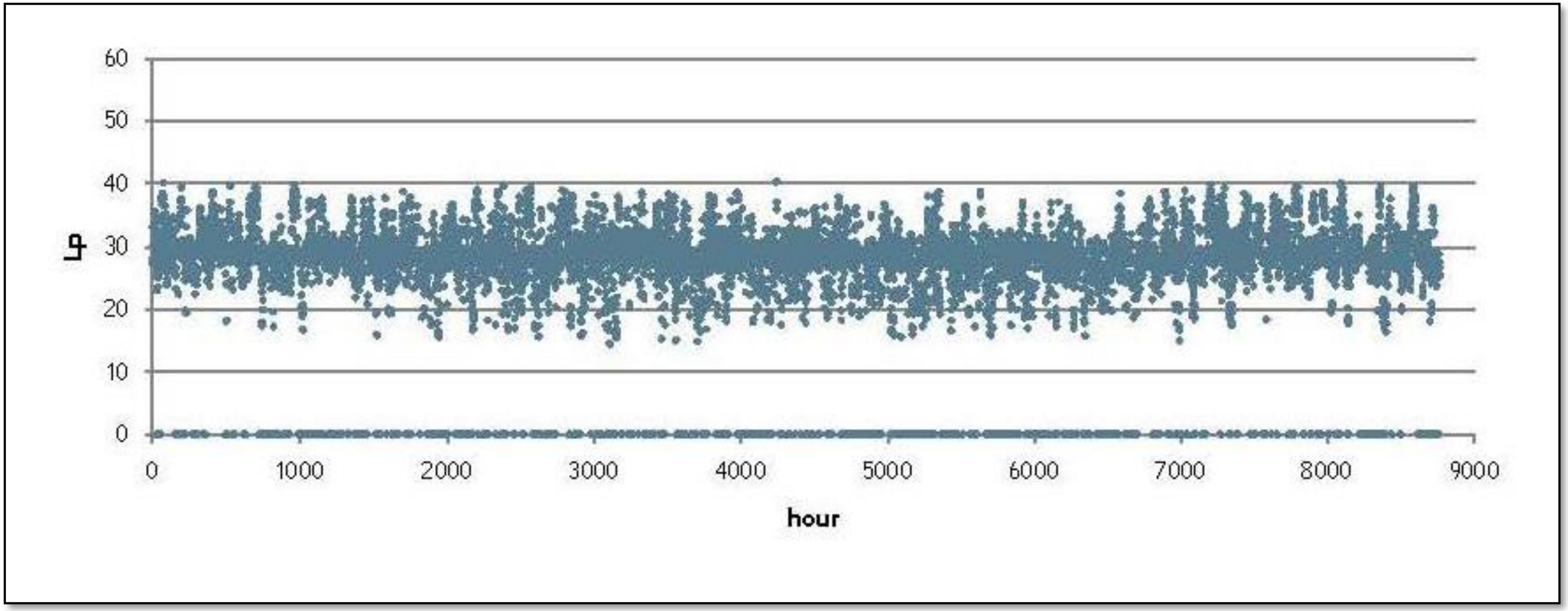
Sound Level Modeling: Sample



Hub Height Wind Speeds: Sample Site



Annual Sound Modeling: Sample Site



Sound Level Predictions: Verification

- How accurate are the models?
- Worst-case conditions assumed in the modeling occur infrequently
- Post-construction sound measurement programs confirm model results
- Actual sound levels are typically a few decibels <u>lower</u> than predicted

Sound Level Predictions: Verification

Fort Lauderdale, Florida
NOISE-CON 2014
2014 September 8-10

Wind Energy Sound Monitoring Under High Shear Conditions

Robert D. O'Neal
Epsilon Associates, Inc.
3 Clock Tower Place, Suite 250
Maynard
MA 01754
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ABSTRACT

Sound level compliance measurements were recently made at a wind energy facility. Detailed data were collected under conditions of high wind shear which kept ground-level wind contributions to a minimum while maximum sound power was realized from the wind turbines. Sound levels were measured with and without the wind turbines operating under similar meteorological conditions to better understand the influence of background sources on the total sound levels. High wind shear conditions are important as those are typically when noise complaints arise from wind turbine operation. In addition, post-construction sound level measurements were compared to pre-construction modeling to evaluate the effectiveness of this prediction tool.

Sound Level Predictions: Verification

RSG
the science of insight

MASSACHUSETTS STUDY ON
WIND TURBINE ACOUSTICS

REPORT
2.18.2016

MASSACHUSETTS
CLEAN ENERGY
CENTER

MassDEP
Commonwealth of Massachusetts
Department of Environmental Protection

PREPARED FOR:
MASSACHUSETTS CLEAN ENERGY CENTER AND
DEPARTMENT OF ENVIRONMENTAL PROTECTION

SUBMITTED BY:
RSG (RESOURCE SYSTEMS GROUP, INC)

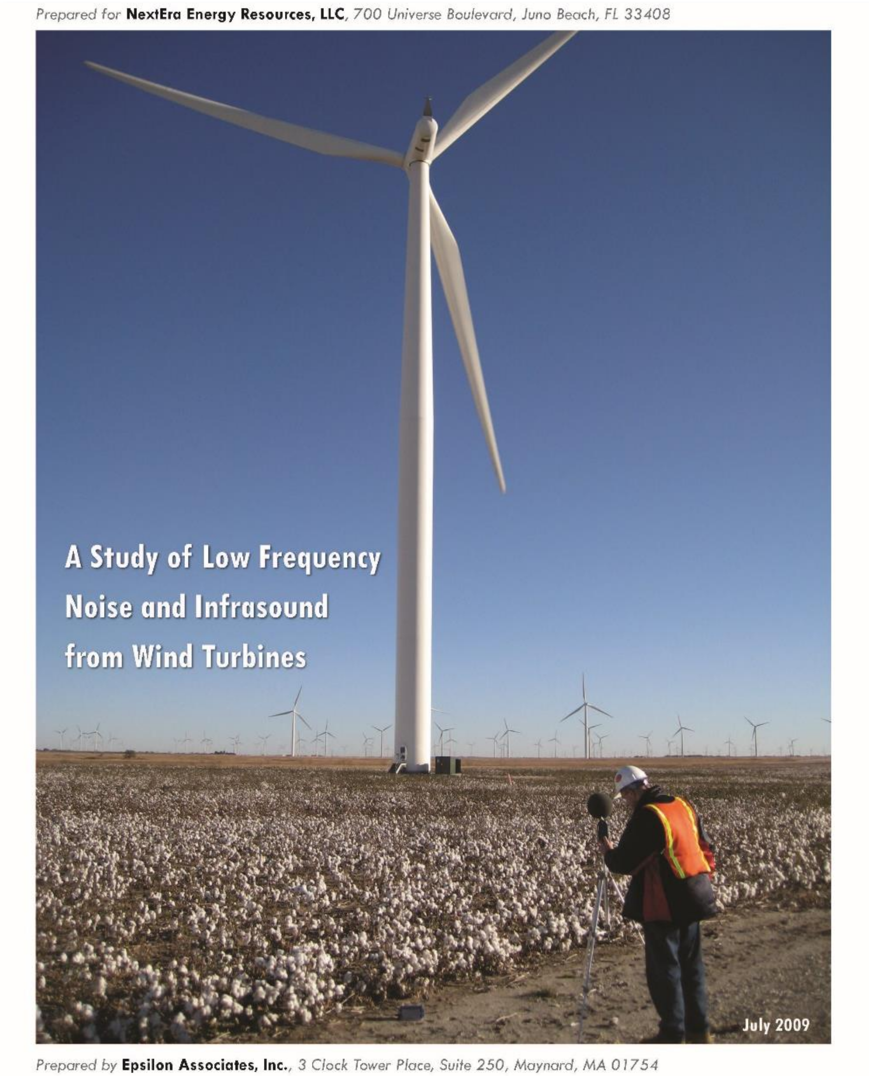
IN COOPERATION WITH:
EPSILON ASSOCIATES, INC.
NORTHEAST WIND

55 Railroad Row
White River Junction, VT 05001
802.295.4999
www.rsginc.com

Low Frequency & Infrasound

- No regulatory limits; guidelines available
- It will be calculated as part of Article 10 process
- Infrasound not audible—not disputed
- Low frequency audible—not disputed
- ANSI/ASA S12.2 = perceptible vibration/rattle
- ANSI/ASA S12.2 = bedroom criteria
- ANSI/ASA S12.9-Part 4 = annoyance

Low Frequency & Infrasound



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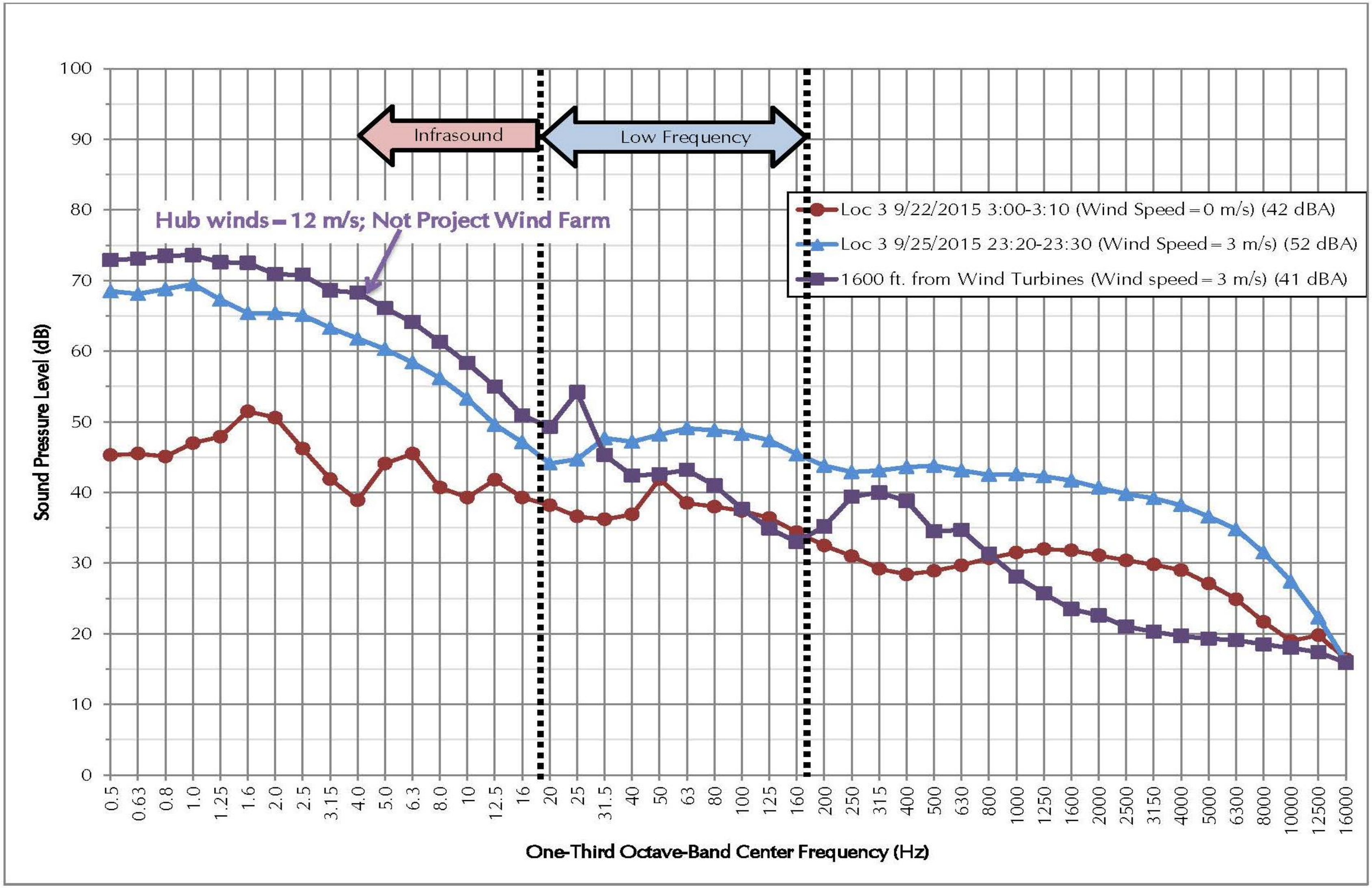
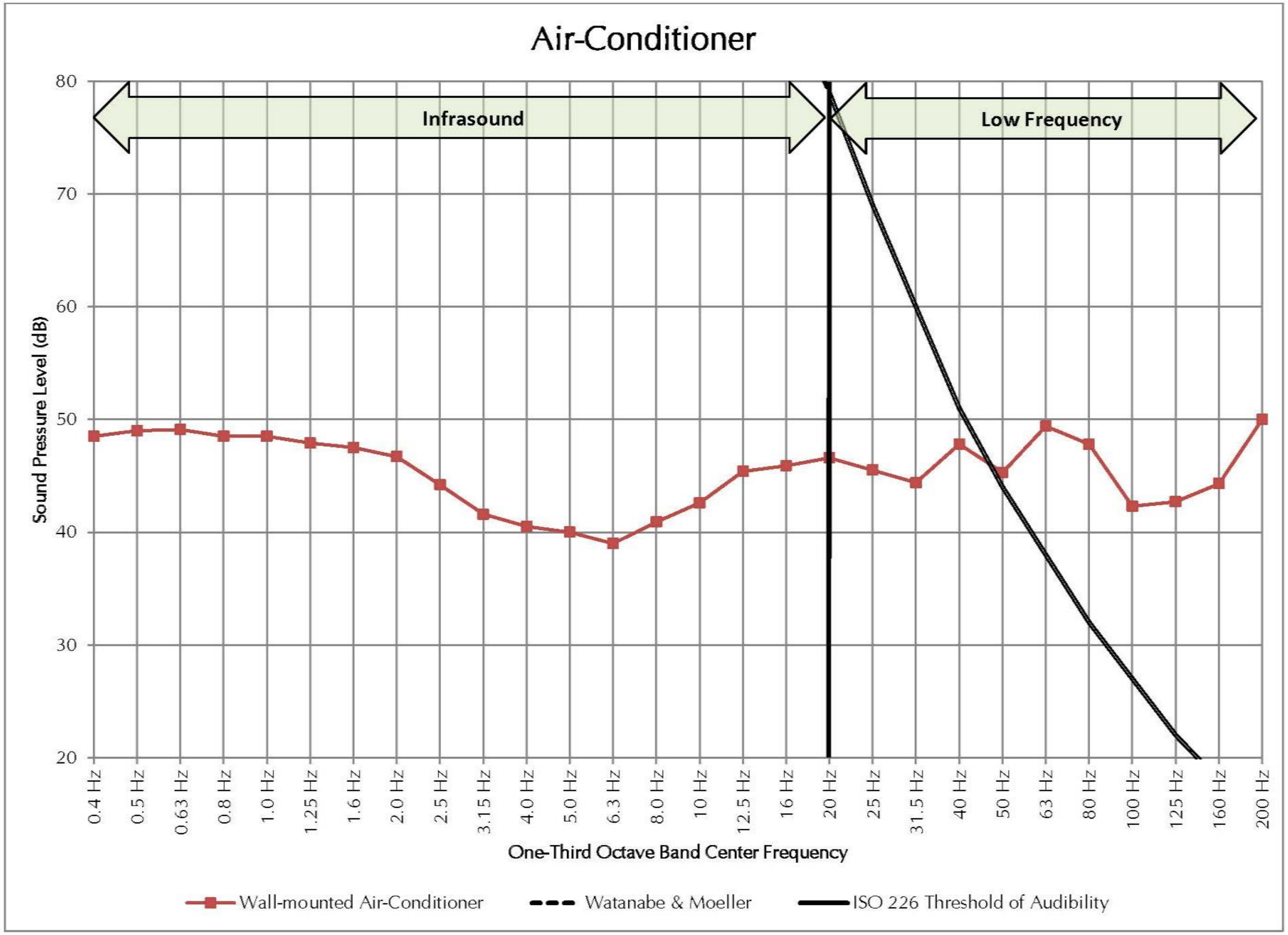
Low Frequency & Infrasound



Infrasound Is Not New



Noise Design Goals (Exterior)

- Sleep = 45 dBA [8-hr Leq]
- Limits on low frequency and infrasound
- No “tonal” sound