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Wind Turbine Noise Regulation

Perspectives in New England

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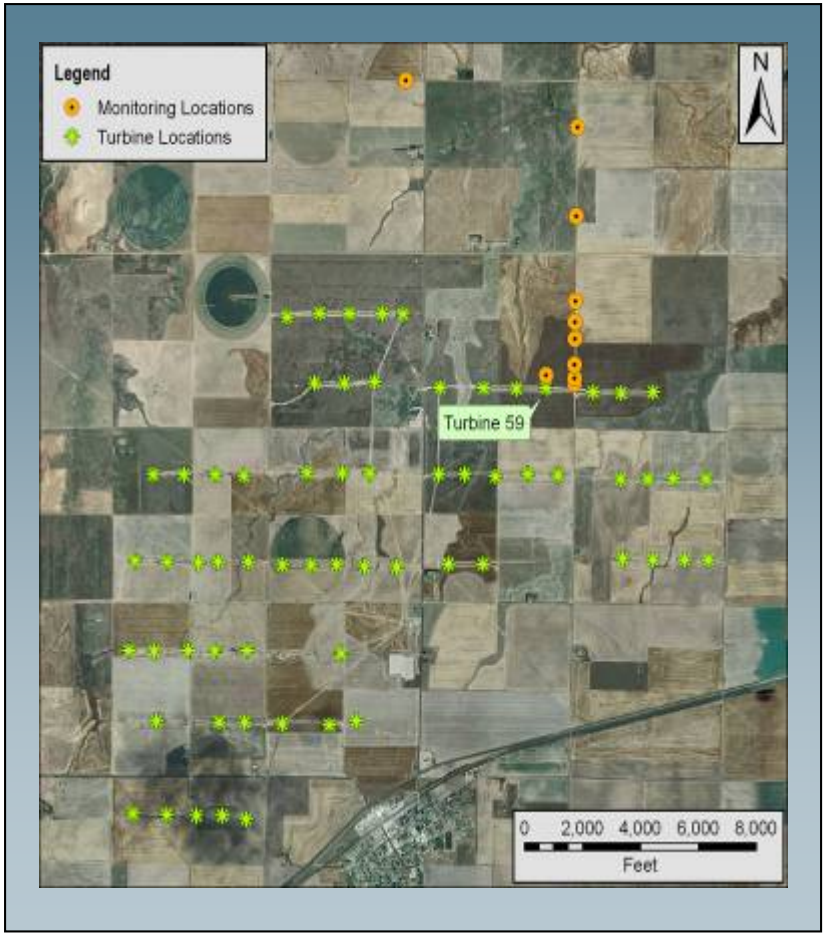
Webinar #2

July 2010

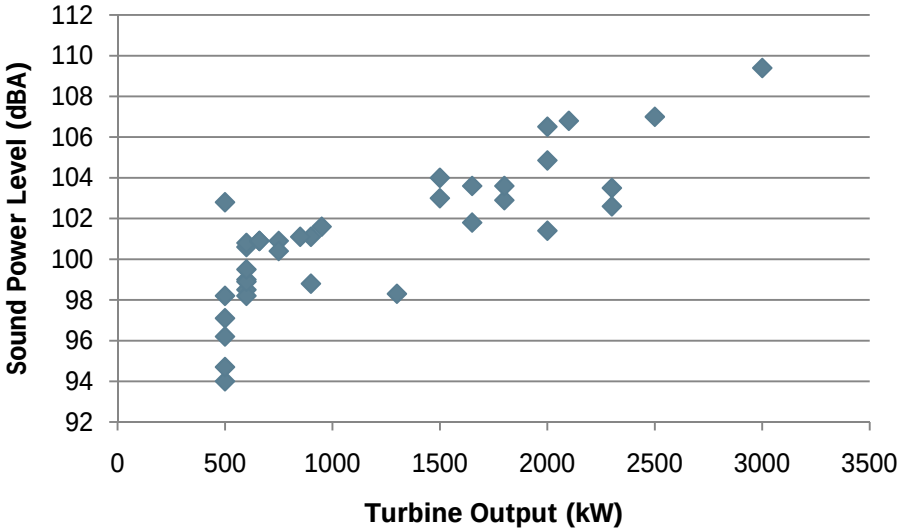
Typical noise impact study process

- Identify preliminary turbine locations and sound power of turbine
- Monitor background sound levels in representative areas (protocol-depending)
- Conduct sound propagation modeling
- Compare results to standards or guidelines
- Refine turbine locations and remodel
- Prepare report
- Present testimony

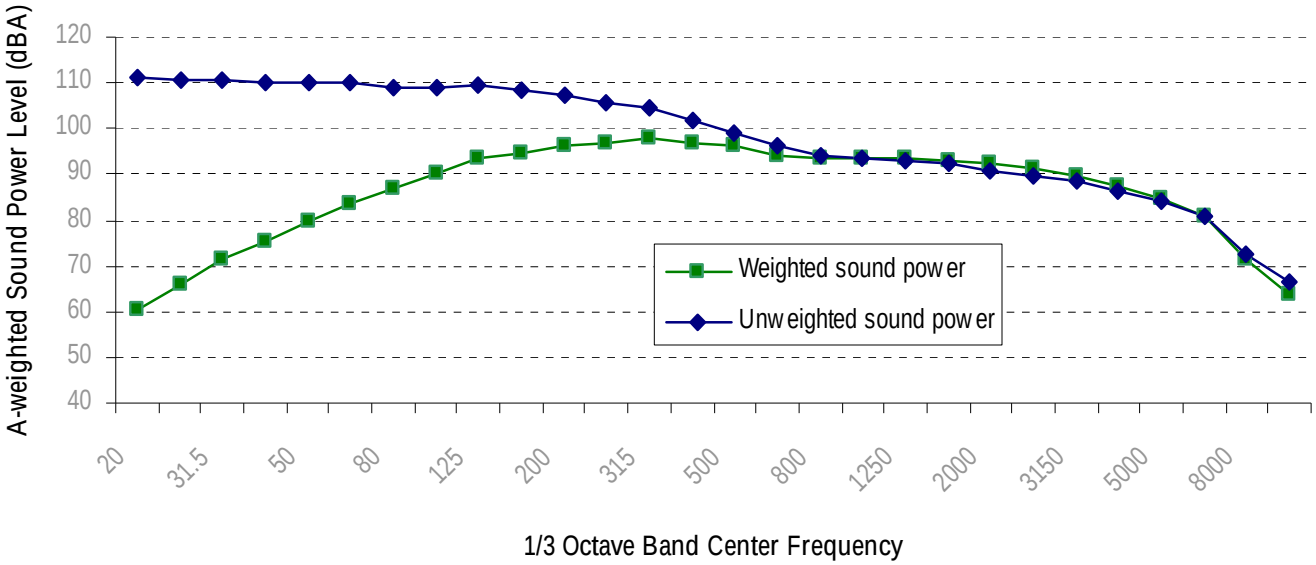


Determine sound power level of the turbine

Sound power of various turbines



Sound power by frequency



Background sound monitoring

- **Identify sensitive receivers –**
  - homes, places of worship, schools, wilderness areas, campgrounds, etc.
- **Set up sound level monitoring**
  - Shorter time frame if background levels are not critical to the standard
  - Longer time frame for relative standards
  - Seasonal, if important

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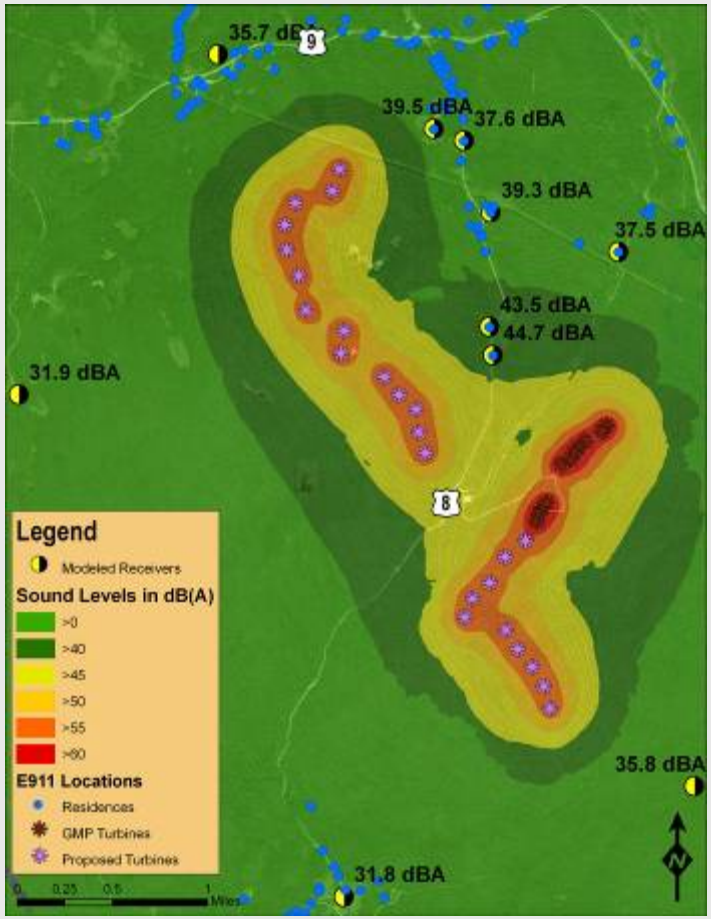
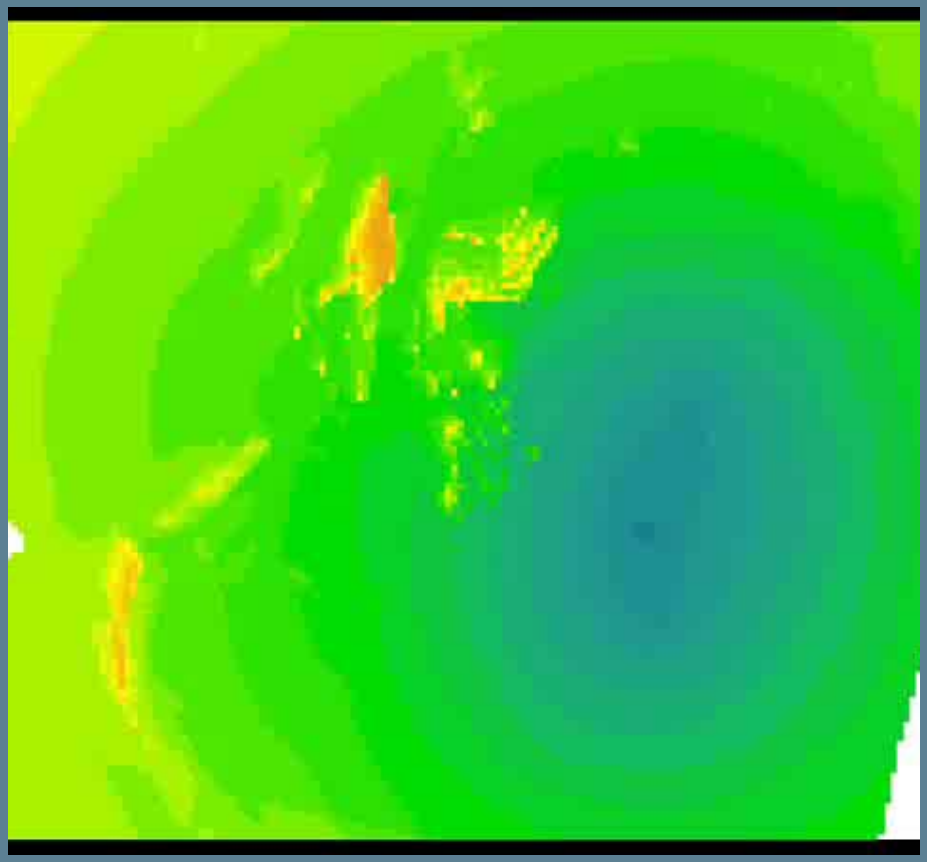
Propagation modeling

- ISO 9613
  - Sound power
  - Spreading Loss
  - Atmospheric attenuation
  - Barriers
  - Ground attenuation
    - Has significant impact on model results
  - Meteorology



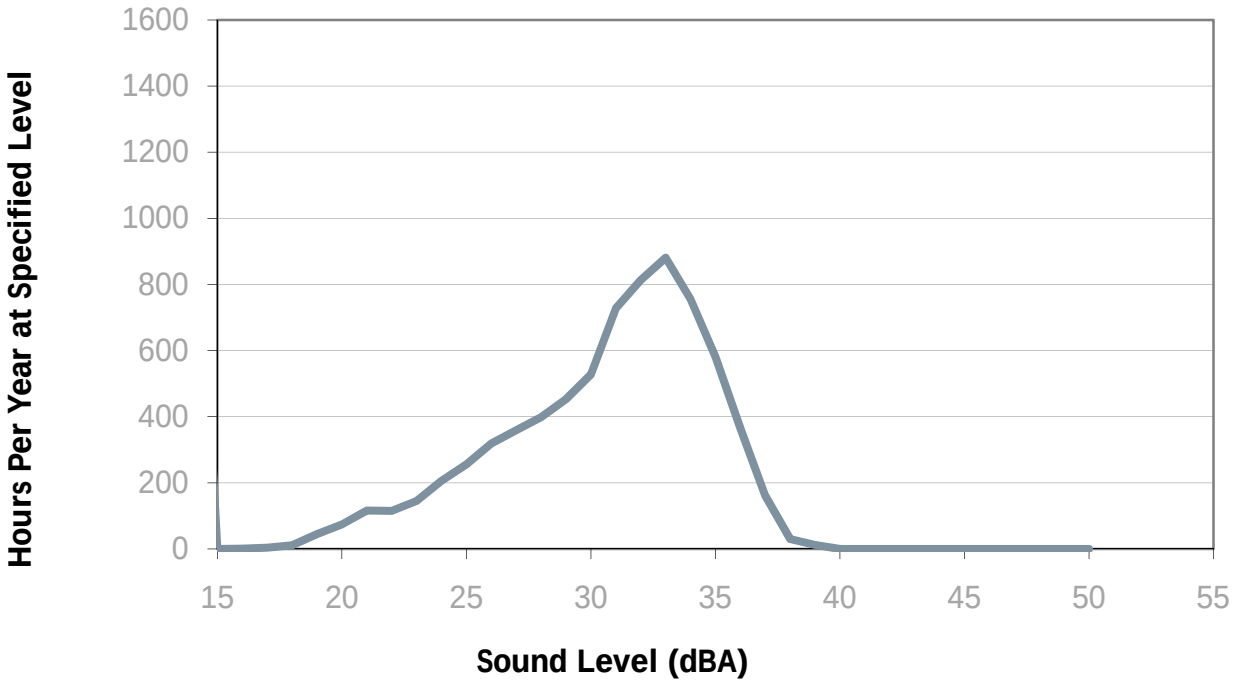
Wind direction and speed effects

- Sound generally propagates worse (i.e. lower levels at receivers)
  - Upwind
  - Under an unstable atmosphere, like sunny days
  - With lower wind speeds and flatter vertical wind speed gradients



What is being modeled

- Modeling is typically done to estimate the maximum level, but we can also estimate sound levels under other conditions



What has been regulated

- **Total level**
  - Usually expressed in units of A-weighted decibels
- **Level by frequency**
  - Full or 1/3 octave bands
- **Tonality**
  - Pure tone penalties and limitations
- **Impulsiveness**

Components of good regulations

- **Detail noise limits and parameters**
- **Include application requirements**
- **Detail components of pre-construction noise studies, including**
  - Details of background sound monitoring
  - Acceptable models and parameters
  - Spatial limits of monitoring and modeling
  - Modeled receivers
- **Address post-constructions issues**

Components of good regulations

- **Sound level limits**
  - Absolute
  - Relative
  - Hybrid
- **Low frequency sound**
  - Limit noise-induced vibration (ANSI S12.2)
- **Tonality (ANSI S12.9 Part 4)**
- **Time-averaging**
  - 1-second, 10-minute, 1-hour, nighttime, daytime
- **Time above**
  - Percent of any hour, day, or month

Additional components of regulations

- **Exemptions and exceptions**
  - Construction noise
  - Maintenance
  - Emergencies
  - Waivers
- **Complaint response procedure**
- **Post-construction monitoring**
- **Participation guidelines**

Examples of regulatory approaches

- **New Zealand**
  - Specific to wind turbine sound
  - Monitoring and modeling protocols
  - Hybrid standard (greater of an absolute and relative level) with no maximum
  - Uses regression to determine wind speed/SPL correlation
  - Penalties for tonality and impulsiveness
  - Details compliance protocol

Examples of regulatory approaches

- **Oregon 340-035-0035 statewide noise rules**
  - Existing regulation modified to address wind turbines
  - Existing regulations consisted of hybrid standard– greater of a relative and absolute level, with a maximum
  - Existing regulations included tonal penalties and provided optional standard for octave bands
  - Wind turbine portion of standard established rules on participation and identified options for evaluating existing levels.

New England States' Wind Turbine Noise Regs

- **Maine**
  - Statewide "Site Law" not specific to wind turbines
    - Absolute limits with lower "quiet area" limits
    - Measurement procedures
    - Penalties for
      - Tonality
      - Short duration repetitive sounds
    - Includes submission requirements
    - Exemptions
    - Variances
    - Waivers

New England States' Wind Turbine Noise Regs

- **Connecticut**
  - Statewide noise regulations not specific to wind turbines
    - Absolute standard (except in high noise areas)
    - Penalties for
      - Impulse noise
      - Tones
      - Infrasound and ultrasound
    - Measurement procedures
    - Exclusions and exemptions
    - Variances
    - Violations and Enforcement provisions

New England States' Wind Turbine Noise Regs

- **Massachusetts**
  - Wind farm precedents
    - Varied approaches to setting standards
  - Massachusetts Dept. of Air Quality Control Policy
    - Relative standard at property line and home
    - No pure tones allowed
    - No consistent approach on whether an how it applies to wind turbines

New England States' Wind Turbine Noise Regs

- **New Hampshire**
  - No statewide noise regulations
  - Site Evaluation Committee Precedent
    - Absolute limit
    - Post-construction monitoring required
- **Vermont**
  - No statewide noise regulations
  - Public Service Board Section 248 precedents
    - Absolute limit measured inside and outside home
    - No pure tones allowed
    - Post-construction monitoring required

Mitigation

- **Re-siting project turbines**
  - Increase setbacks
  - Reduce turbulence
  - Identify quieter turbines or components
- **Automatic controls to slow tip speeds/reduce noise under specific conditions**
- **Improve noise insulation on target homes**
- **Increase the number of project participants**

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Different modeling parameters yield different results