Coom Green Energy Park

Technical Presentation on Noise

Presentation Overview

- Project Overview
- Environmental Noise Assessment Procedure
- Background Noise Surveys
- Noise Limits and Guidelines
- Noise Predictions and Potential Impacts
- Next Stages
- Questions

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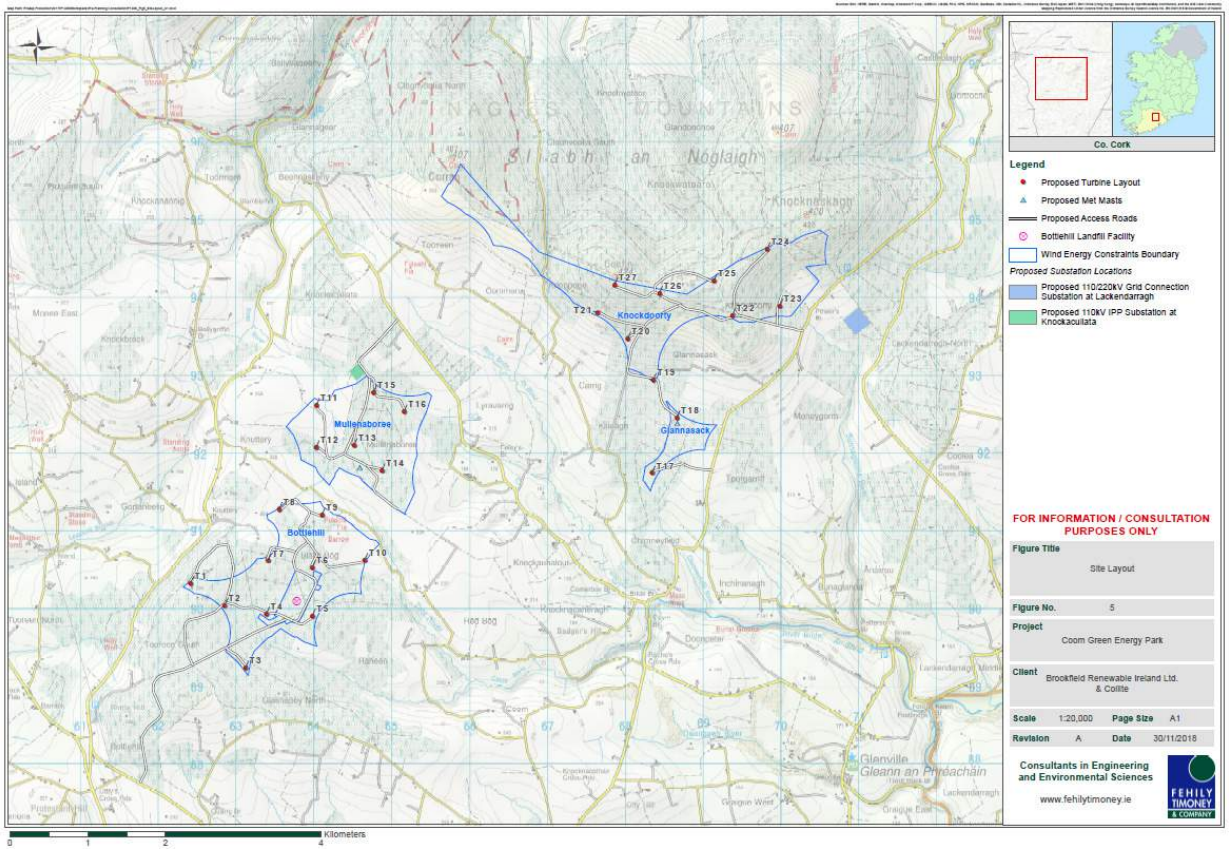
Project Overview

- Draft Layout
  - Details Presented at first Community Engagement Open Days
  - 27 Turbine Layout
- Draft Layout Redesigned
  - Various reasons including Community Noise purposes
  - Redesign to minimise environmental impacts
  - 22 Turbine Layout



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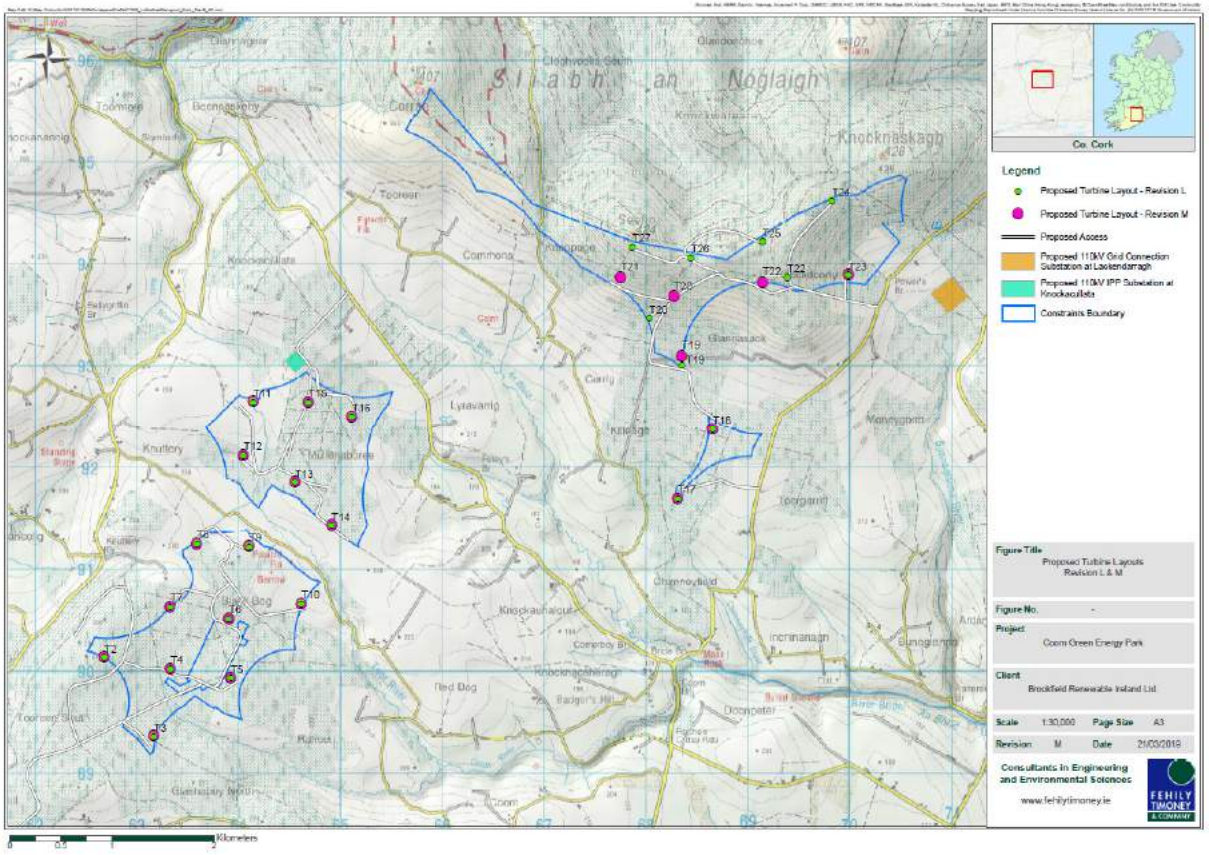

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Environmental Noise Impact Assessment Procedure

- Assessment undertaken in accordance with best practice
- Define Study Area
- Identified properties within study area and background noise monitoring locations
- Measure background noise levels
- Background noise data, and computer modelling used to inform the site layout, to ensure the project is fully compliant with noise guidelines
- Implement mitigation measures where necessary

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Assessment undertaken in accordance with best practice

- Assessment follows the EPA guidelines for preparation of EIARs - Guidelines on Information to be contained in Environmental Impact Assessment Reports, Draft EPA, 2017
- Use wind energy development guidelines (WEDG 2006)
- Preferred draft approach for WEDG (PDA 2017)
- Institute of Acoustics 'A Good Practice the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise', May 2013 (IOA GPG)

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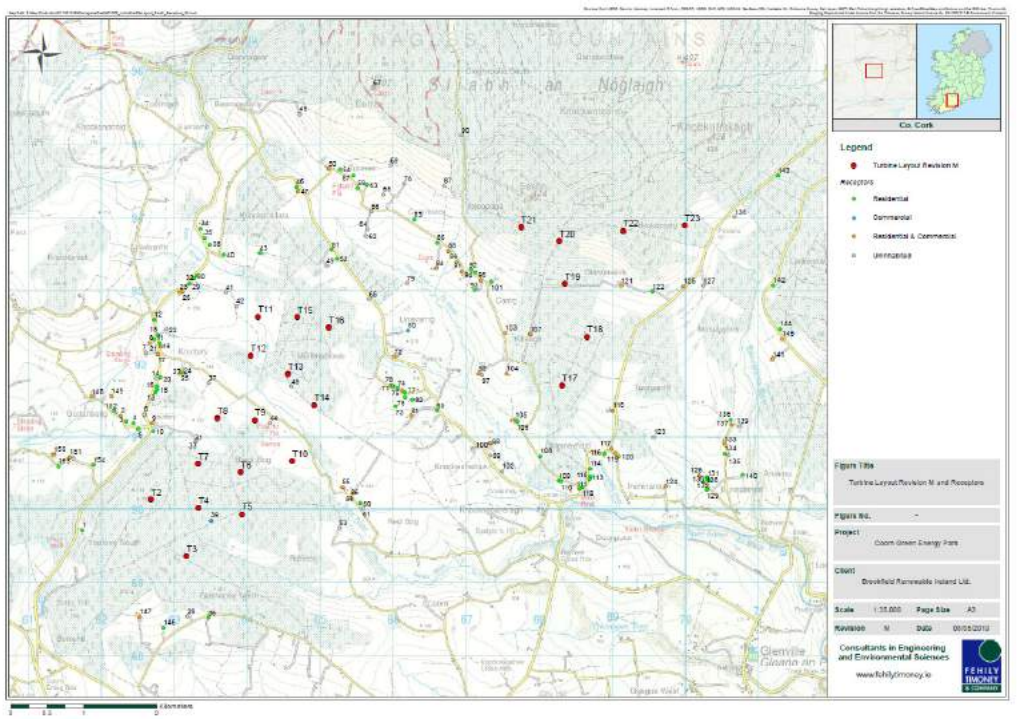
Study Area

- Institute of Acoustics Good Practice Guide
- Noise Sensitive Locations within 35 dB L_{A90} Contour
  - Over 150 Receptor Locations
  - Some Locations are Farm Buildings and Sheds
- Noise Sensitive Locations only
  - PDA… ‘residential or noise sensitive properties’



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Background Noise Surveys

- Identify Monitoring Locations in accordance with IOA GPG
- 18 Monitoring Locations around the site
- Three rounds of monitoring [8, 4 and 6 no. locations)
- Measure background noise levels (L_{A90})
  - Noise level that is exceeded 90% of the time
  - 10 minute periods
- Concurrent Measurements
  - Wind Speed (Met Mast or LIDAR Unit)
  - Wind Direction
  - Rainfall

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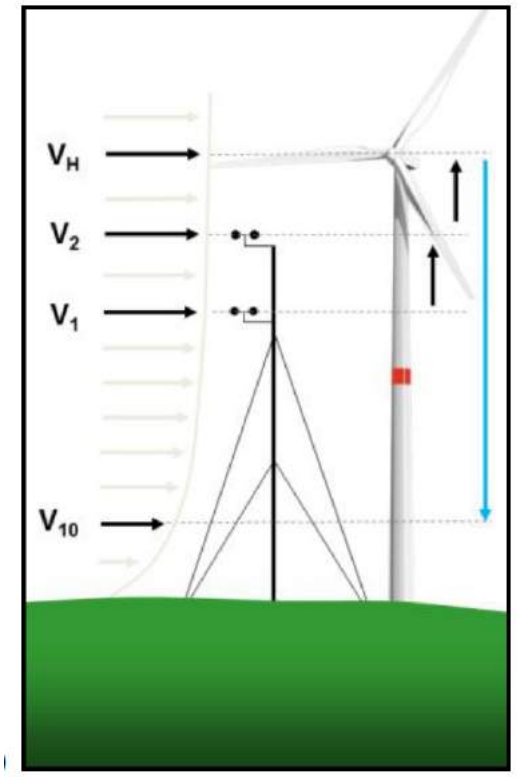
Background Noise Surveys (1)

- Wind Speed Data
  - Extrapolate to Hub Height
  - Calculate Standardised 10m Height wind Speed
- Split data
  - Daytime (07:00 – 23:00 hrs)
  - Night-time (23:00 – 07:00 hrs)
- Plot Noise Levels Against Wind Speed
- Remove Data affected by Rainfall
- Remove Atypical data
- Best Fit Curve



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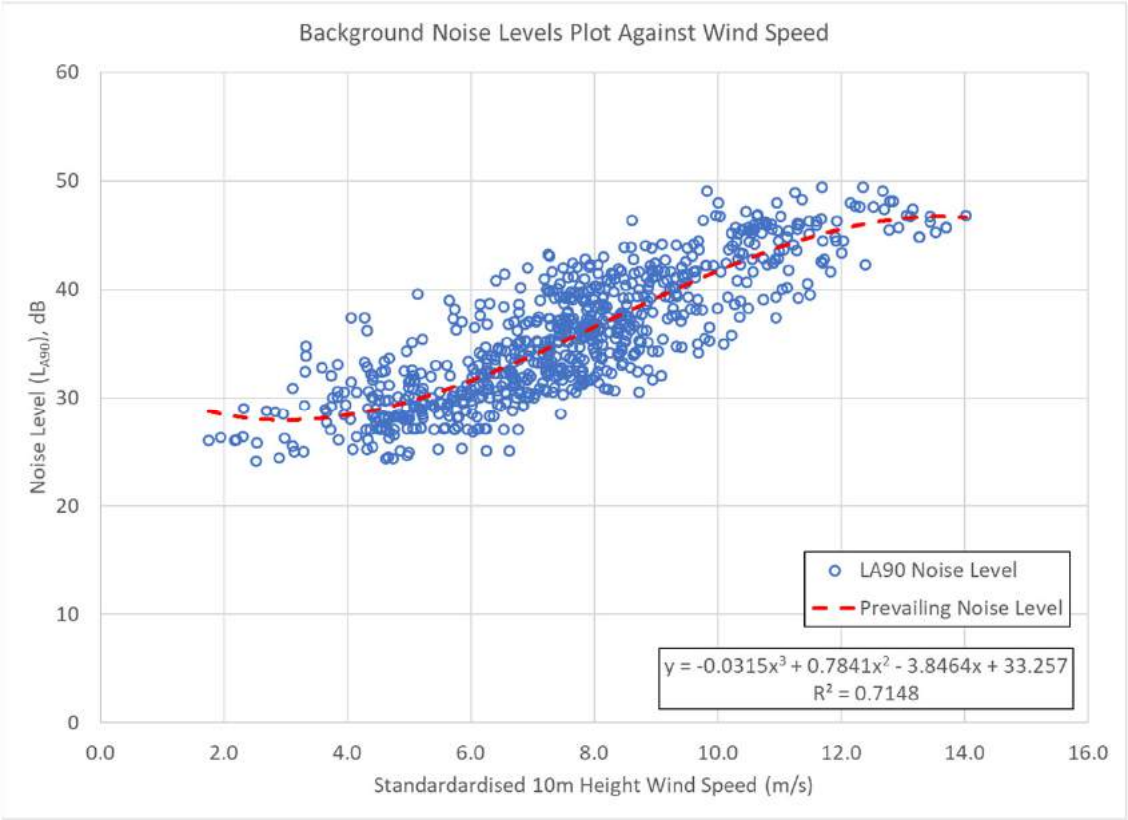
Background Noise Surveys (2)



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Noise Limits and Guidelines

- Current Guidelines
- Wind Energy Development Guidelines 2006 (WEG2006)
- Guidelines under review
- Preferred Draft Approach for the Review of the Wind Energy Development Guidelines 2006, June 2017 (PDA)
- Guidelines Expected to be published in more detail by end of the year
- Noise limits apply outside the property

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Noise Limits and Guidelines

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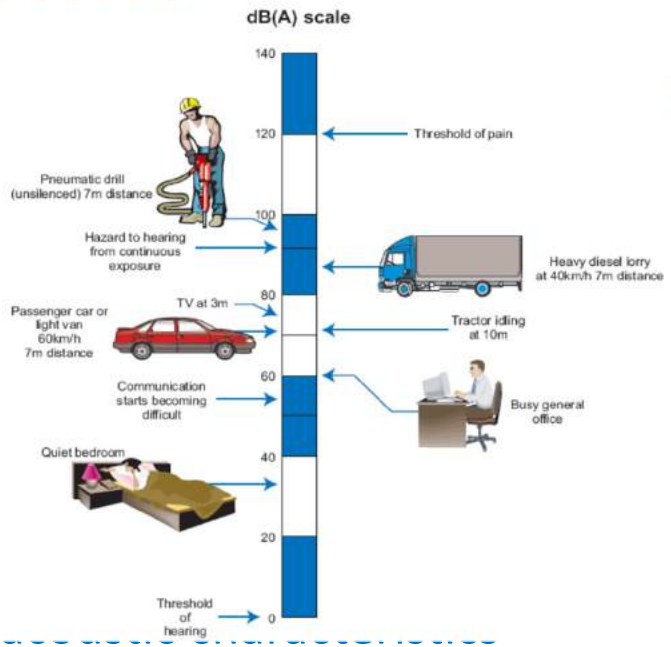

The Level of Typical Common Sounds on the dB(A) Scale (Source: for the Treatment of Noise & Vibration in National Road NRA Guidelines Schemes, 2004)

PDA

- Noise Limit – L_{A90} noise indicator
- Daytime
  - Rated Noise Limit of 5 dB(A) above background noise within the range 35 – 43 dB(A)
- Night-time
  - Rated Noise Limit of 5 dB(A) above background noise within the range 35 – 43 dB(A)
- Penalty for special acoustics characteristics
- WHO Guidelines (October 2018)
- PDA requires lower noise limits than WEG 2006

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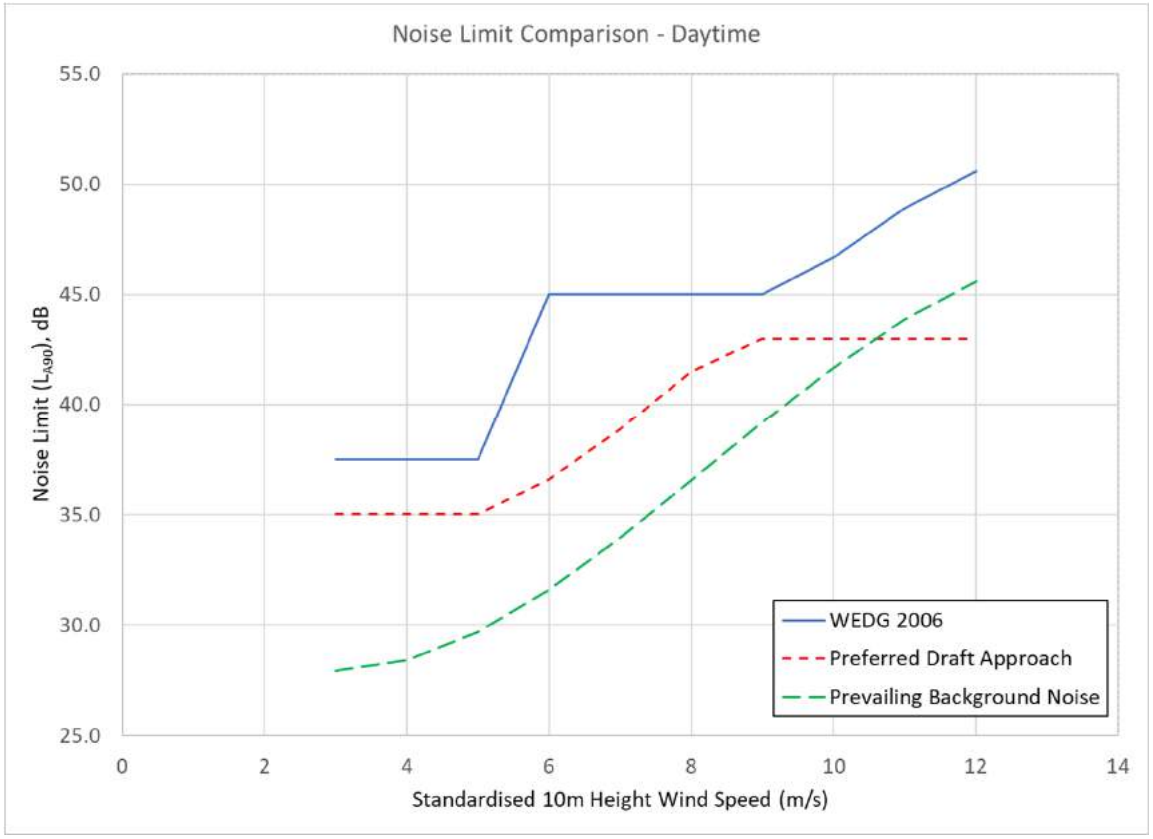
Noise Limits and Guidelines
What's the difference between WEG2006 and PDA

- Noise limit at one monitoring location
- Noise Limit will vary depending on Background Noise Environment
- Within range L_{A90} 35 – 43 dB



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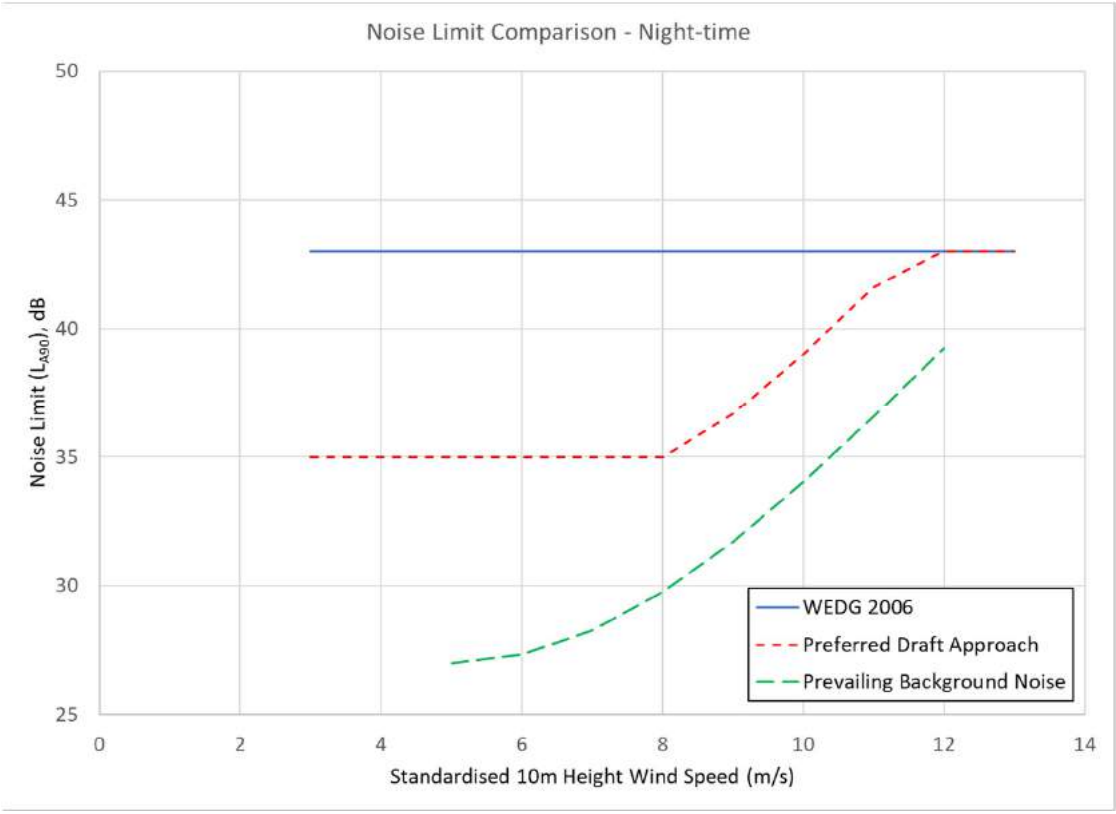

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Noise Limits and Guidelines

- WEDG 2006 Currently In place
- PDA – Better Protection for Residents
- PDA not Currently Applicable
- **Coom Green Energy Park designed to meet PDA Noise Limits**

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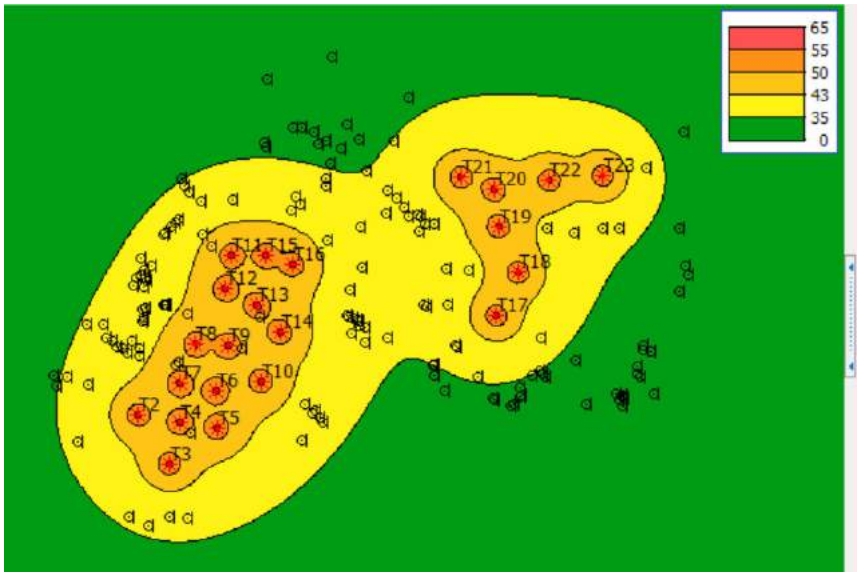
Noise Prediction Process

- Multiple Noise Models undertaken
- Detailed Noise Model for Design Iteration 1
  - 22 Wind Turbine Layout
- Noise Modelling Parameters used in accordance with IOA GPG
  - Assess Downwind Conditions (Worst Case)
- Typical Turbine Modelled
  - Measurements include + 2dB for measurement uncertainty
- Maximum Predicted noise level less than 43 dB L_{A90} at most exposed dwelling when turbines operating in normal mode of operation



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Noise Predictions - Results

- Noise Predictions Identified a number of NSLs exceeded the PDA noise limit when the turbines are operating in normal operational mode
- Noise levels are within PDA noise limits at all NSLs for most wind speeds except for wind speeds between 5 and 8 m/s (night-time between 5 and 9 m/s)
- Mitigation is required to meet the PDA noise limits

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Noise Predictions - Results (1)

- Exceedances occur when turbines in normal operation
- For each noise sensitive location, identify what are the dominant turbines

- Examine how noise limits can be met
  - Run turbines in noise reduced modes operation
    - Reduces Noise Level
    - Reduces Energy Output

- Process is repeated until compliance with PDA noise limits at **ALL** noise sensitive locations
  - For example most exposed dwelling noise level less than 43 dB L_{A90} at 7m/s
  - With mitigation, less than 38.5 dB L_{A90} during daytime and less than 35 dB L_{A90} at night-time

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Noise Predictions - Mitigation

Standardised 10m height Wind Speed (m/s)	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
5m/s	M11	NO	NO	NO	NO	M13	M11	NO	NO	NO	NO
6m/s	M13	M5	M10	M6	M8	M13	M13	M8	M13	M8	M12
7m/s	M11	M4	M1	M7	M7	M8	M13	M7	M13	M7	M11
8m/s	NO	NO	NO	NO	M1	M4	M7	NO	M8	M4	M5
9m/s	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Standardised 10m height Wind Speed (m/s)	T13	T14	T15	T16	T17	T18	T19	T20	T21	T22	T23
5m/s	NO	NO	NO	NO	NO	M11	M12	NO	NO	M13	NO
6m/s	M7	M7	M8	M8	M8	M13	M13	M11	M6	M13	M7
7m/s	M4	M8	M11	M11	M11	M13	M13	M10	M7	M13	M7
8m/s	NO	M8	NO	M6	M5	M8	M9	M5	M8	M9	M4
9m/s	NO	NO	NO	NO	M6	NO	M5	M4	M7	M4	M2

- Coom Green Energy Park designed to meet PDA Noise Limits
- Achieves this with mitigation measures for this layout

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Next Steps

- Design Iteration 1 Layout has been further revised
- Reduced from 27 to 22 turbines
- With mitigation 22 turbine layout is fully compliant with PDA noise limits

- Update Noise Model if there are further changes to the layout
  - Compare the predicted noise levels against noise limits
  - Develop mitigation measures to meet the noise limits where necessary

- Undertake noise predictions for other operational noise sources i.e. substation
- Undertake noise predictions for construction phase

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Thank You

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Shadow Flicker

- Shadow flicker occurs at certain times of the year when the sun is shining and low in the sky, and where the movement of turbine blades cast moving shadows over areas in the vicinity of the turbines. These moving shadows can periodically reduce light coming from, for example, the window of a room, causing the light to appear to flicker.

- For shadow flicker to occur, a number of conditions must be reached:
  - That there is a sufficient level of sunlight shining at a low angle in the sky;
  - That the turbine is directly between the sun and the dwelling, and;
  - That the blades are turning and no screening is obscuring views.

- Coom Energy Park will operate a zero shadow flicker policy for all houses in the area. In order to achieve this, a dedicated shadow flicker system will be installed at the windfarm to prevent shadow flicker impact from occurring at any house. The shadow flicker system will comprise of a programmed module that will monitor intensity of sunlight, position of the sun, and potential for flicker based on the location and height of houses.

- The monitoring system will send a signal to the turbine that is anticipated to cause shadow flicker effect, instructing it to shut down temporarily for the duration of the impact. This system is highly effective in preventing shadow flicker and takes advantages of emerging technologies relating to wind farm technology.

Gearbox vs Direct Drive

- Gearbox design improvements
  - Significant reductions in mechanical noise
- Direct drive machines do not have gearboxes and so do not produce significant mechanical noise
- No significant differences in noise between geared and gearless machines:
  - Aerodynamic noise is the dominant source
  - Improvements in the control of mechanical noise
- Irrespective of Gearbox or Direct Drive the wind turbine will have to meet noise limits

Wind Turbine Noise

- Aerodynamic noise
  - Blades passing through the air
  - Noise spread across the audible frequency range
  - Main source of noise from wind turbines
  - Improved design - designed to minimize noise whilst optimising power
  - Trailing Edge Serrations – reduce aerodynamic noise

- Mechanical noise
  - Gearbox, cooling fans, oil pumps
  - Significant improvements in control of mechanical noise

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Infrasound

- Frequencies below 20 Hz
- No significant infrasound from wind turbines
- Was a feature of passive yaw “downwind‟ turbines
- No longer a significant feature with modern turbines
- The UK Department of Trade and Industry Low Frequency Noise Study, W/45/00656/00/00 *The Measurement of Low Frequency Noise at Three UK Windfarms*
  - Concluded that ‘*infrasound noise emissions from wind turbines are significantly below the recognised threshold of perception for acoustic energy within this frequency range.’*
  - *‘Even assuming that the most sensitive members of the population have a hearing threshold which is 12 dB lower than the median hearing threshold, measured infrasound levels are well below this criterion’*.
  - *‘it may therefore be concluded that infrasound associated with modern wind turbines is not a source which may be injurious to the health of a wind farm neighbour’*.

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Low Frequency Noise

- Low Frequency noise 20 - 200 Hz
- Wind Turbine Noise is essentially broadband (contains similar amounts of acoustic energy in all frequency bands)
- Sound propagates from the source, attenuated due to distance and air absorption
  - Higher frequencies are better attenuated
  - Ratio of low to high frequency increases
  - Also observed with other noise sources e.g. road traffic noise.
- The UK Department of Trade and Industry Low Frequency Noise Study, W/45/00656/00/00, *The Measurement of Low Frequency Noise at Three UK*
  - '…at all the measurement sites, low frequency noise associated with traffic movement along local roads has been found to be greater than that from the neighbouring wind farm.'
  - Noise could be audible within the dwelling
- Low Frequency Noise is addressed in the PDA guidelines
  - permitted noise limits will be further reduced to mitigate for low frequency noise

Tonal Noise

- Sounds which cover a range of only a few Hz which contains a clearly audible tone, i.e. distinguishable, discrete or continuous noise (whine, hiss, screech, or hum etc.) are referred to as being 'tonal'.
- Can be associated with mechanical or aerodynamic noise
- Can contain Low Frequency tones typical range 20 – 200 Hz
- Modern turbines incorporate significant improvements in control of mechanical noise
- Tonal Noise is addressed in the PDA guidelines
  - permitted noise limits will be further reduced to mitigate for tonal noise

WHO Guidelines

- Environmental Noise Guidelines for the European Region – October 2018
- Purpose of the guidelines is to provide recommendations for protecting human health from exposure to environmental noise
- Recommends reducing noise levels produced by wind turbines below 45 dB Lden at noise sensitive locations.
- *The "preferred draft approach" proposes noise restriction limits consistent with World Health Organisation standards*
- *The guidelines explain that no studies were available to assess the exposure levels for prevalence of priority health outcomes, with the exception of annoyance. From four studies, an exposure response curve revealed an absolute percentage of "highly annoyed population" of 10% at 45 dB Lden.*
- *The Guideline Development Group (GDG) was not able to formulate a recommendation addressing sleep disturbance due to wind turbine noise at night time on account of the low quality and heterogeneous nature of the evidence. The GDG also found no studies on the health effects of existing interventions to reduce wind turbine noise.*

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Health Effects

- Wind Turbine Noise and Health Study - Health Canada 2014
  - **Illness and chronic disease** - No evidence was found to support a link between exposure to wind turbine noise and any of the self-reported illnesses
  - **Stress** - No association was found between the multiple measures of stress (such as hair cortisol, blood pressure. heart rate, self-reported stress) and exposure to wind turbine noise.
  - **Sleep** - The results of this study do not support an association between wind turbine noise and self-reported or measured sleep quality.
  - While some people reported some of the health conditions above, their existence was not found to change in relation to exposure to wind turbine noise.

Health Effects (1)

- Wind Turbine Noise and Health Study - Health Canada 2014
  - **Annoyance and quality of life** - An association was found between increasing levels of wind turbine noise and individuals reporting to be very or extremely annoyed.
  - No association was found with any significant changes in reported quality of life, or with overall quality of life and satisfaction with health. This was assessed using the abbreviated version of the World Health Organization's Quality of Life Scale.

Amplitude Modulation

- Amplitude Modulation (AM)
  - periodic fluctuations in the level of audible noise from a wind turbine (or wind turbines), the frequency of the fluctuations being related to the blade passing frequency of the turbine rotor(s)
  - 'blade swish' observed close to turbine
  - Typically not an issue at a distance from a wind turbine
- In some cases, enhanced amplitude modulation
  - periodic 'thumping' or 'whoomphing' observed at a distance from a wind turbine
- Potentially mitigated by controlling pitch of wind turbine blades or shut downs during specific conditions where AM occurs
- AM will be dealt with in the PDA guidelines
  - permitted noise limits will be further reduced to mitigate for AM

Further information on PDA

'Sounds containing certain characteristics specific to wind turbines (e.g. tonal, low frequency and amplitude modulation) are frequently perceived to be more intrusive than those that do not. The rated limit will take account of these certain noise characteristics and, where identified, permitted noise limits will be further reduced to mitigate for these.'

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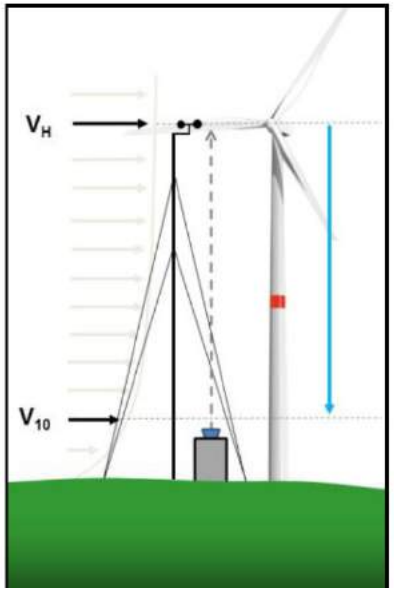
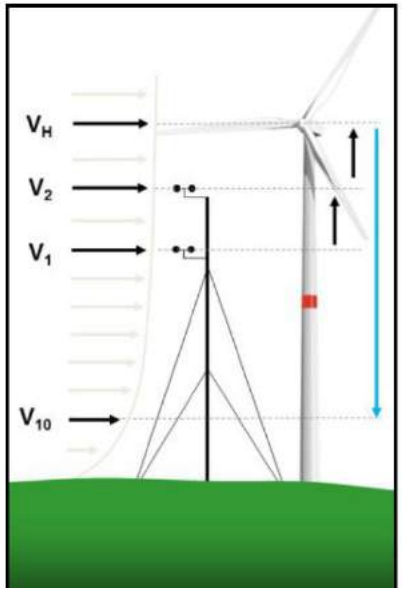
Wind Speed Measurement

- Met Mast
  - Anemometers at different heights
  - Hub height - Shear exponent profile
- LiDAR
  - Remote measurement of wind speed and direction using ground–based equipment LiDAR (Light Detection and Ranging) is an optical remote sensing technique that measures wind speeds and direction based on laser signals backscattered by particles in the atmosphere.





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Wind Turbine Sound Power Level Curve