Silverton Wind Farm Presentation on Noise

Rhys Brown

November, 2012

Agenda

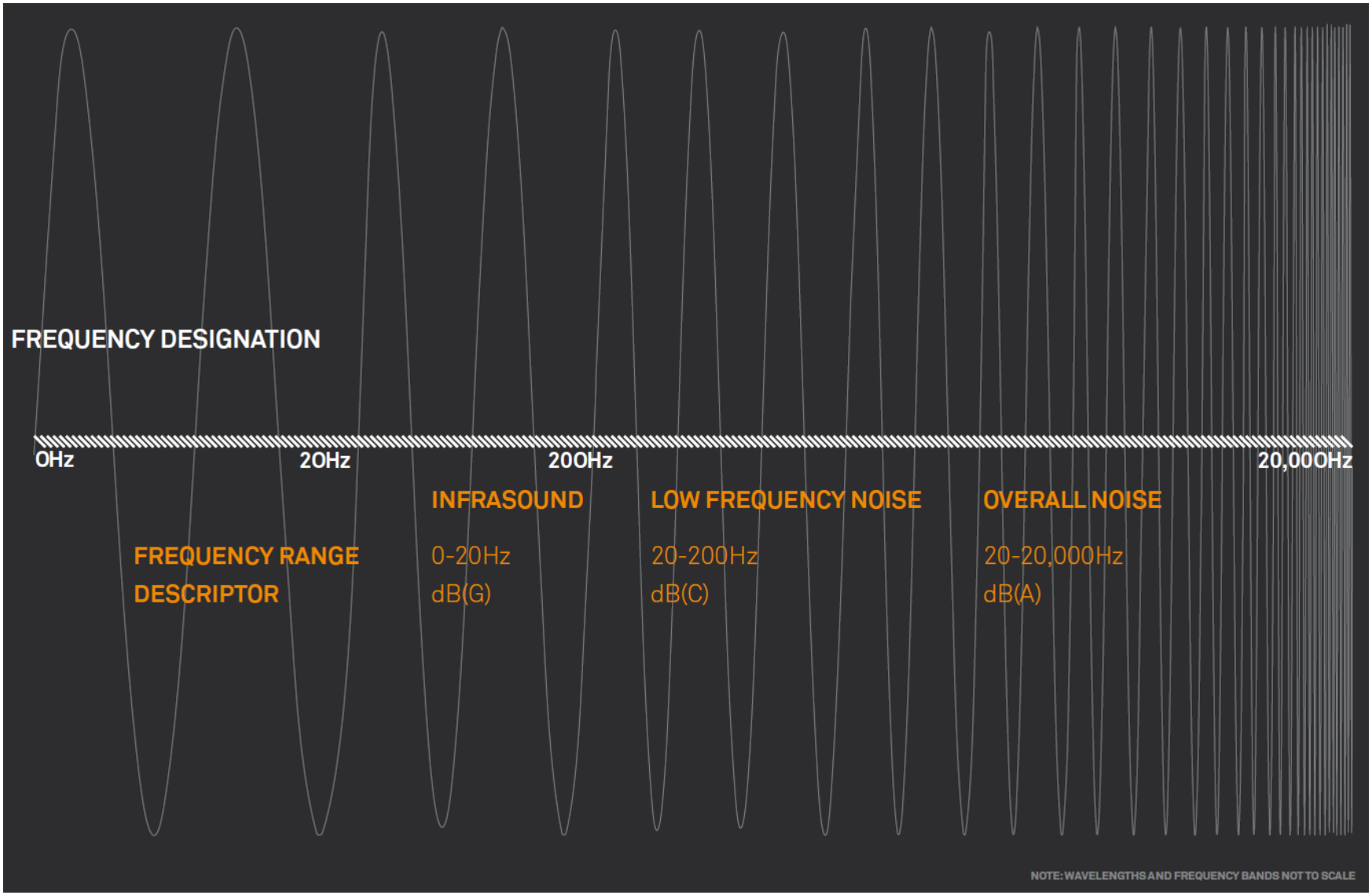
- Discuss some general principles related to noise and wind farms
- Review the process:
  - Background noise monitoring
  - Noise modelling and forecasting
  - Determining compliance
- What does a wind farm sound like?
- Questions and Discussion

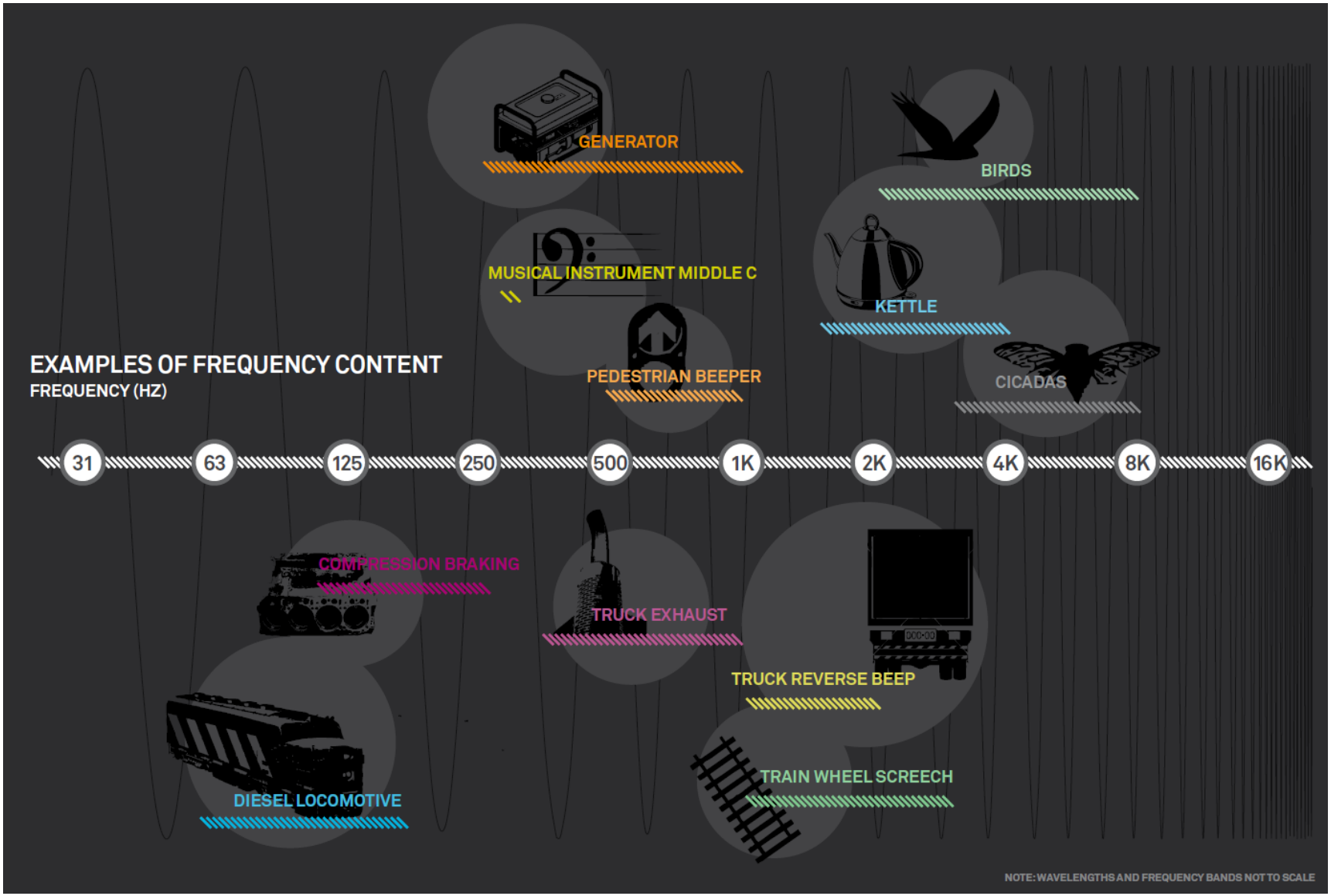
Wind farm noise

- Wind Farms only generate noise when the wind is blowing at sufficient speed to generate electricity
- Is typically assessed and measured using specific guidelines which take this into consideration
- The two primary noise generating mechanisms are mechanical noise (gearbox, generator) and aerodynamic noise (rotation of blades passing through air)
- Background noise – the existing ambient noise at a site without the introduction of a new industry. For a wind farm this is described in relation to wind speed

Classification of noise

- dB(A) or “A-weighted” – audible frequency range between 20Hz – 20 000Hz. Weighting applied to represent how humans hear sounds
- “Low Frequency Noise” – used to describe noise at the low end of the human hearing range, often categorized between 20Hz – 200Hz
- “Infrasound” – used to describe sound energy below the human hearing range, often categorized between 0Hz – 20Hz


FREQUENCY DESIGNATION
0Hz
20Hz
200Hz
20,000Hz
INFRASOUND
LOW FREQUENCY NOISE
OVERALL NOISE
FREQUENCY RANGE
0-20Hz
20-200Hz
20-20,000Hz
DESCRIPTOR
dB(G)
dB(C)
dB(A)
NOTE: WAVELENGTHS AND FREQUENCY BANDS NOT TO SCALE


GENERATOR
BIRDS
MUSICAL INSTRUMENT MIDDLE C
KETTLE
PEDESTRIAN BEEPER
CICADAS
EXAMPLES OF FREQUENCY CONTENT
FREQUENCY (HZ)
31
63
125
250
500
1K
2K
4K
8K
16K
COMPRESSION BRAKING
TRUCK EXHAUST
TRUCK REVERSE BEEP
TRAIN WHEEL SCREECH
DIESEL LOCOMOTIVE
NOTE: WAVELENGTHS AND FREQUENCY BANDS NOT TO SCALE

Why are wind farms assessed using specific guidelines?

- Wind Farms only generate noise when the wind is blowing at sufficient speed to generate electricity, and they typically generate higher noise levels during periods of high wind
- They differ from most other sources of environmental noise emission, where noise measurements are only undertaken during still or low wind periods
- Wind farm guidelines are developed based these factors and specific noise measurement procedures are developed

Silverton Noise Criteria

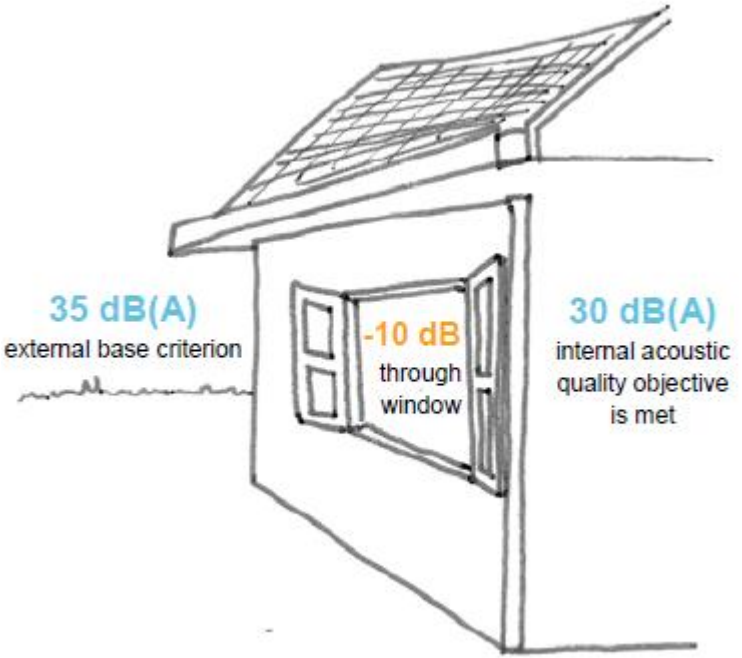
- Operational noise criteria for Silverton is outlined in clause 2.20 of the Project Approval and is based on the South Australian *"Wind Farms Environmental Noise Guidelines"* 2003.
  - 35 dB(A); or
  - The existing background noise level ($L_{A90\ (10min)}$) by more than 5 dB(A), correlated to each integer wind speed
- The criteria is more stringent than what is applied in other states of Australia and the base noise criterion is consistent with that presented in the Draft *NSW Planning Guidelines Wind Farms*.

Development of criteria for wind farms

- Criteria for environmental noise is often developed based on background noise levels, guidelines for noise levels for the protection of the general population, or a combination of both
- The World Health Organization and others set such guidance for the protection of the general population – these noise levels are set indoors
- Measureable external noise criteria are often developed based on these internal guidelines by considering the noise reducing properties of a typical dwelling

Noise reduction of a façade with open windows

- When sound hits a façade, the energy is either transmitted into the house, absorbed by the building or reflected back towards the source
- The World Health Organization provides a estimate of a 15dB reduction from outside to inside with a partly open window



Noise reduction of a façade with open windows

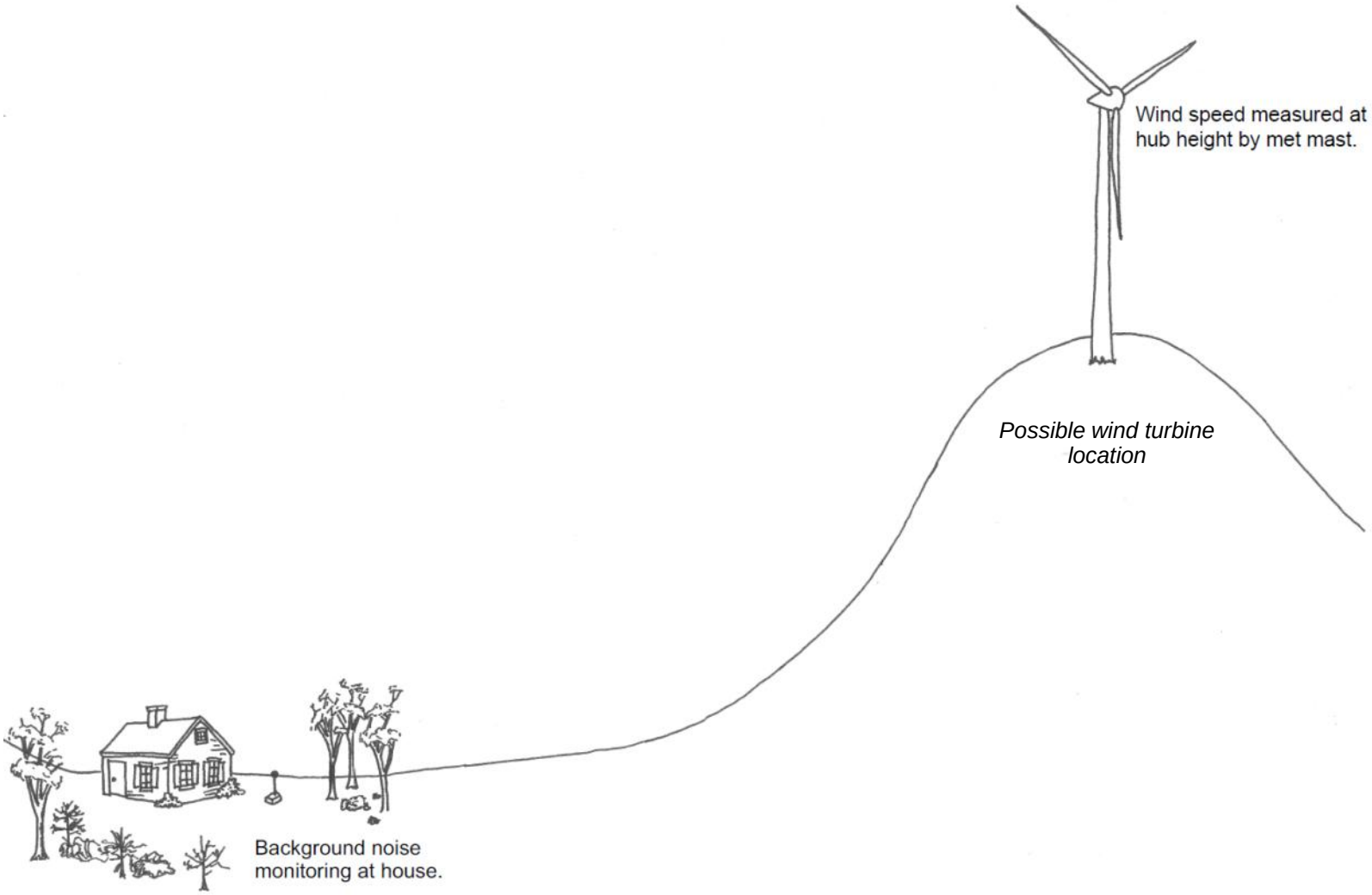
- A review of literature consistently shows that the assumption of a 10 dB(A) reduction for an open or partially open window is an appropriate assumption for a majority of dwellings
- In excess of the 5 dB(A) required to satisfy the WHO guideline for internal noise levels with an external base criterion of 35 dB(A)
- A recent study by another acoustic consultancy showed that:
  - For all dwellings tested with an open area of 10% of the façade or less, the reduction was greater than 10 dB(A)
  - There was no correlation between dwelling construction and noise reduction

Industrial Noise Assessment Process

- Background noise monitoring – determining the existing environmental characteristics
- Noise Predictions/Modelling – Predicting the impacts from the proposed industry
- Compliance – Once industry is operating, checking if the operation is in compliance with it's operating conditions

This section explains how this process is applied specifically to wind farms

Background noise monitoring



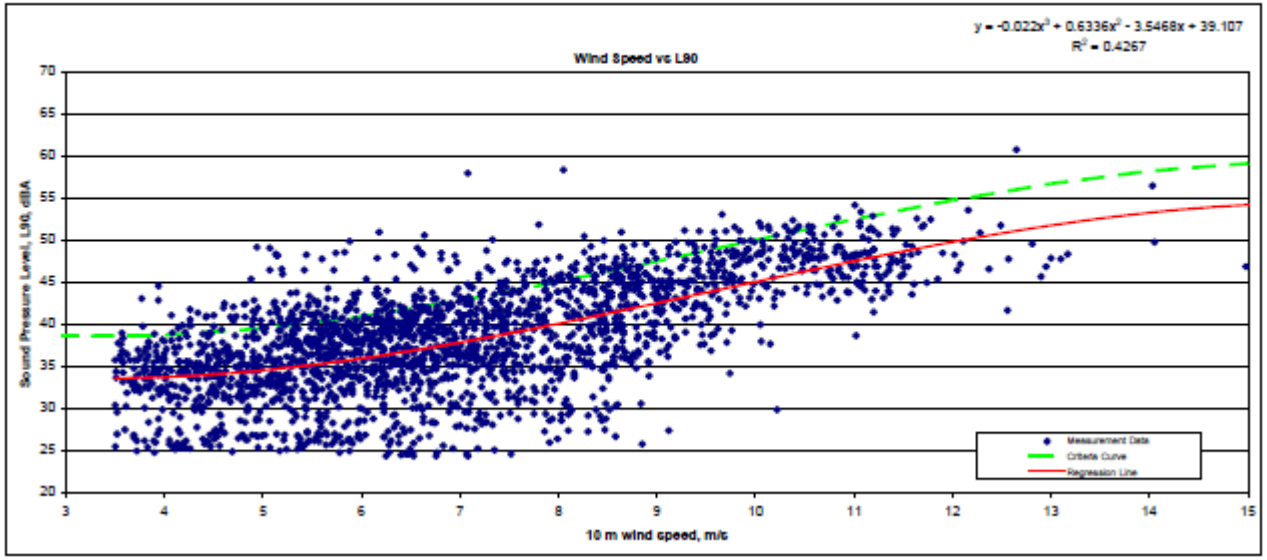
Background noise monitoring

- Background noise monitoring was undertaken in November – December 2007 by acoustic consultancy Heggies Pty Ltd
- Undertaken at three locations considered representative of the closest locations to proposed turbine locations

Source: Silverton Wind Farm Noise Impact Assessment Report 40-1487 Heggies Pty Ltd

Background noise monitoring

Figure 10 Background noise measurements and noise criteria curve – Umberumberka



Source: Silverton Wind Farm Noise Impact Assessment Report 40-1487 Heggies Pty Ltd

Noise predictions/modelling

- Undertaken to determine if the proposed wind farm layout can be constructed and comply with noise criteria
- Undertaken to inform the area required to construct a wind farm

Noise modelling process

- Is undertaken using a computer modelling package
- Is based on a number of inputs and assumptions
- The modelling is conservative as some effects which could reduce noise levels are not included in the model, including:
  - Shielding from buildings
  - Reduction due to dense foliage
  - Meteorological conditions other than the worst case
  - Wind directions other than the worst case

Noise modelling inputs

Input	Source
Topography	Ground contours generated by a laser survey (typically at a 1 metre resolution)
Noise source data	Typically taken from a contract entered into with a turbine supplier
Source location (turbines)	Developed as the project has progressed, represents the physical turbine location
Receiver location (houses)	Usually taken from aerial photography and cadastral information, confirmed via ground surveys
Modelling methodology	See slide over

Noise modelling process

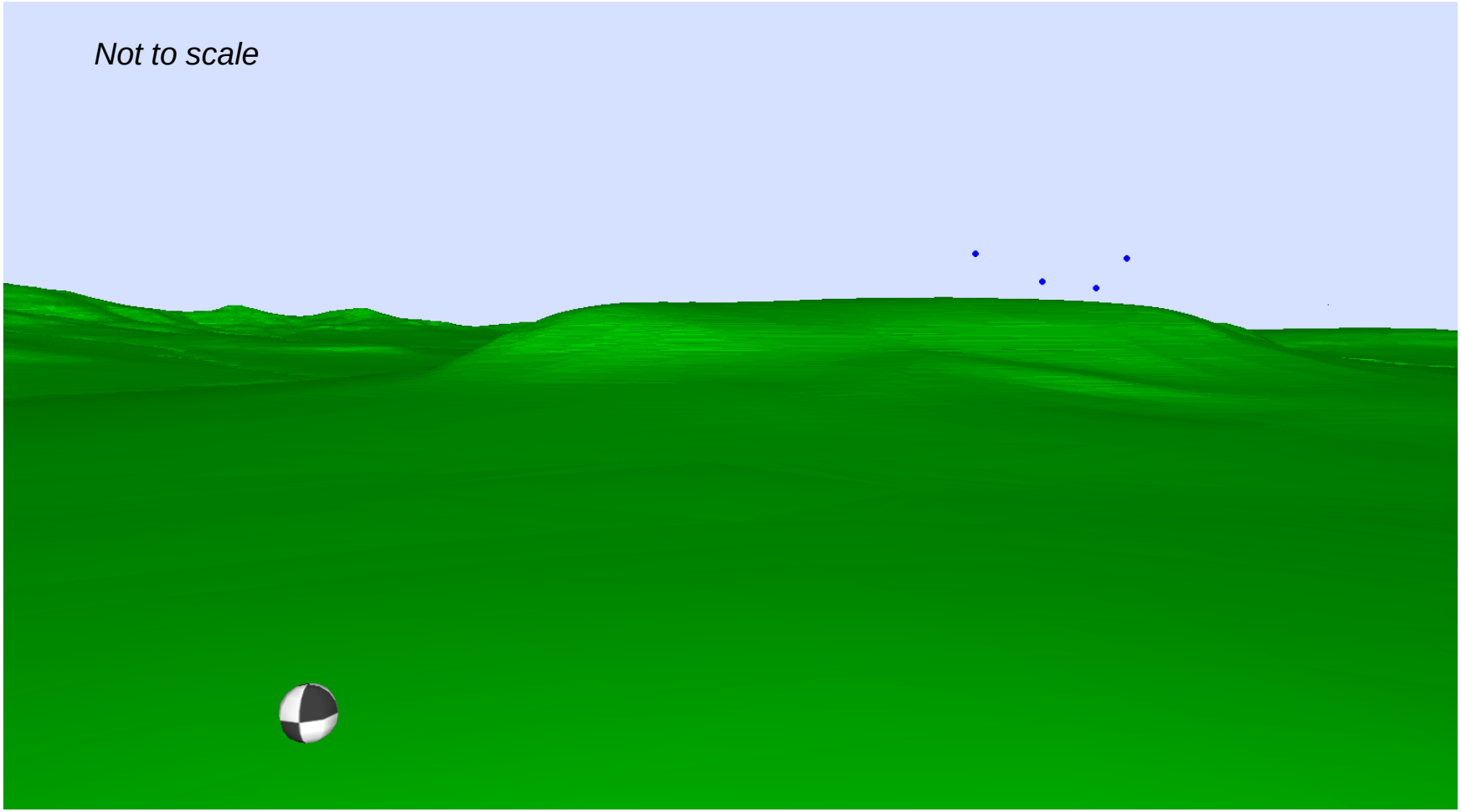
- Noise modelling methodologies used for modelling wind farm noise are validated by modelling the noise emission from existing wind farms and comparing the results against noise levels measured at the same wind farms

- AECOM undertook one such study which compared four modelling methodologies against measured wind farm noise levels, The paper found that the common methods used in Australia (and that required under SA2003) generally forecast higher noise levels than the noise levels measured from the wind farm

REF: Evans, T and Cooper, J “Comparison of predicted and measured wind farm noise levels and implications for assessments of new wind farms” Paper Number 30, Proceedings of Acoustics 2011.

Noise modelling process

- Blue = turbine hub height, Black and White ball = house



Predicted noise levels

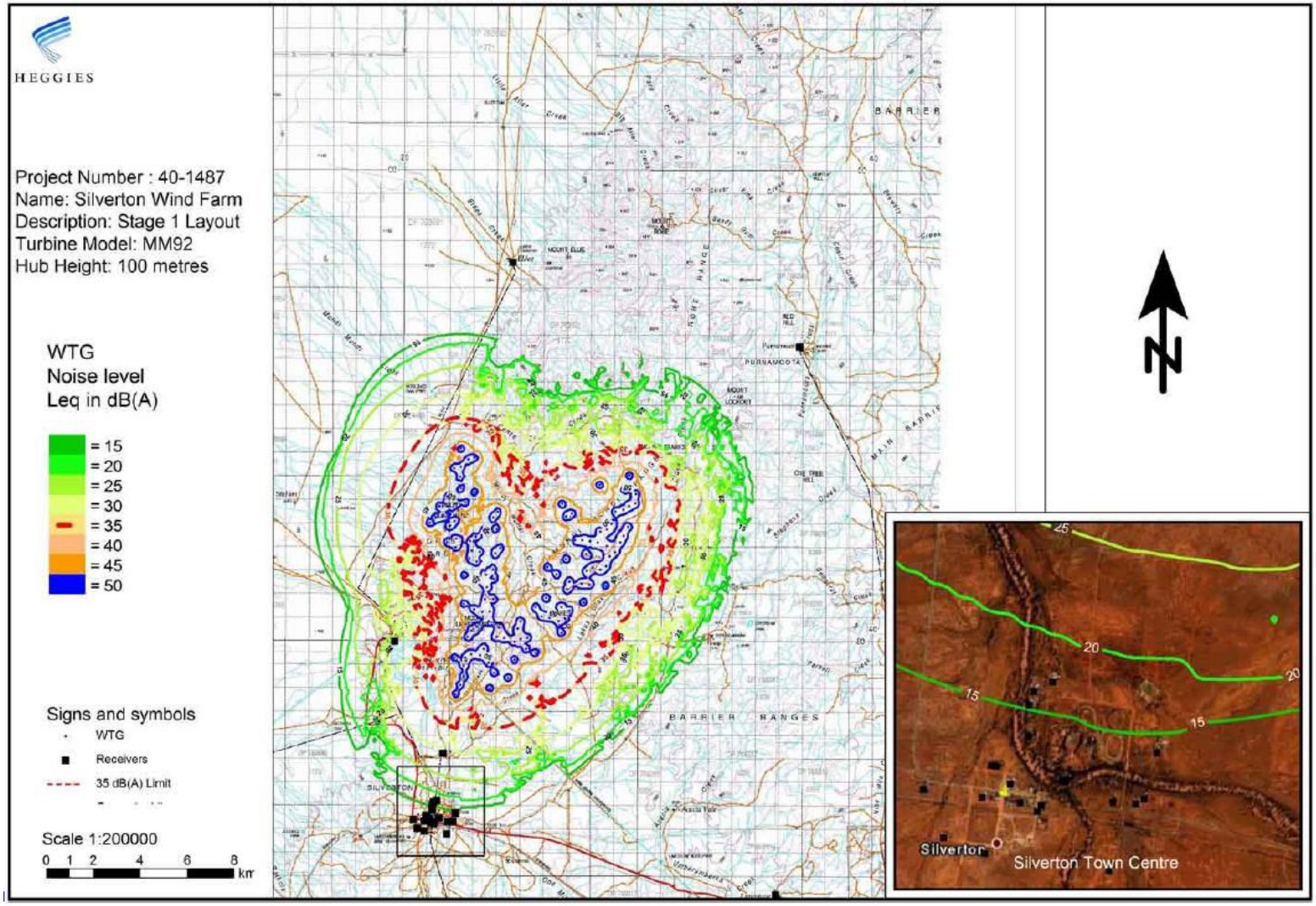


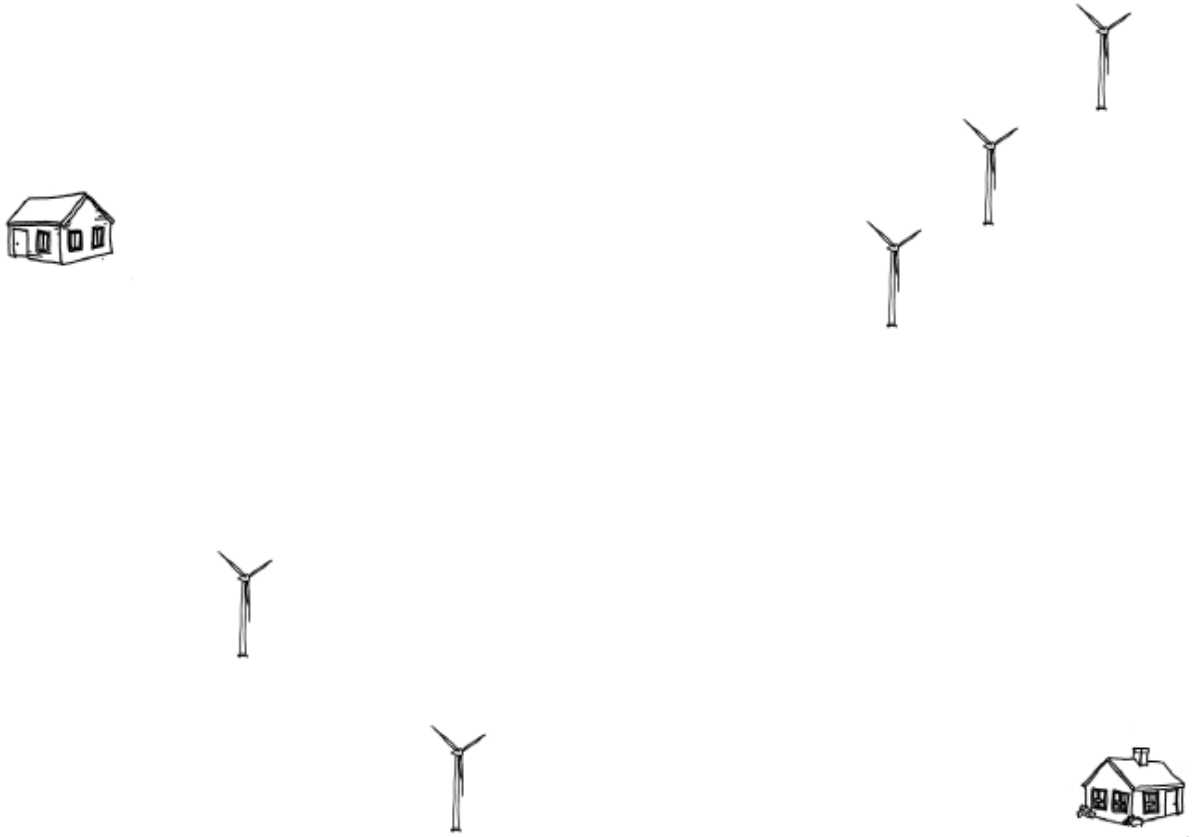
Figure 7.8: Stage 1 layout – L_{Aeq} noise contour map at V_{ref} = 8 m/s

Source: Environmental Assessment (EA) prepared by Silverton Wind Farm Developments Pty Ltd (www.agk.com.au/silverton)

Occurrence of worst case forecast noise levels

- Computer modelling is based on the worst case forecast noise level
- In reality the noise from the wind turbines will be reduced under different wind conditions, e.g. with wind blowing perpendicular to the line in between the nearest turbine and receiver, or the wind blowing from the receiver towards the nearest turbine
- The occurrence of the worst case noise level is the turbine layout and prevailing winds in the area. For one site it was found that the worst case forecast noise level will occur less than 35% during the night time period for 8 of the 11 dwellings analysed.

Worst case wind direction



Plan View – Sketch is not to scale

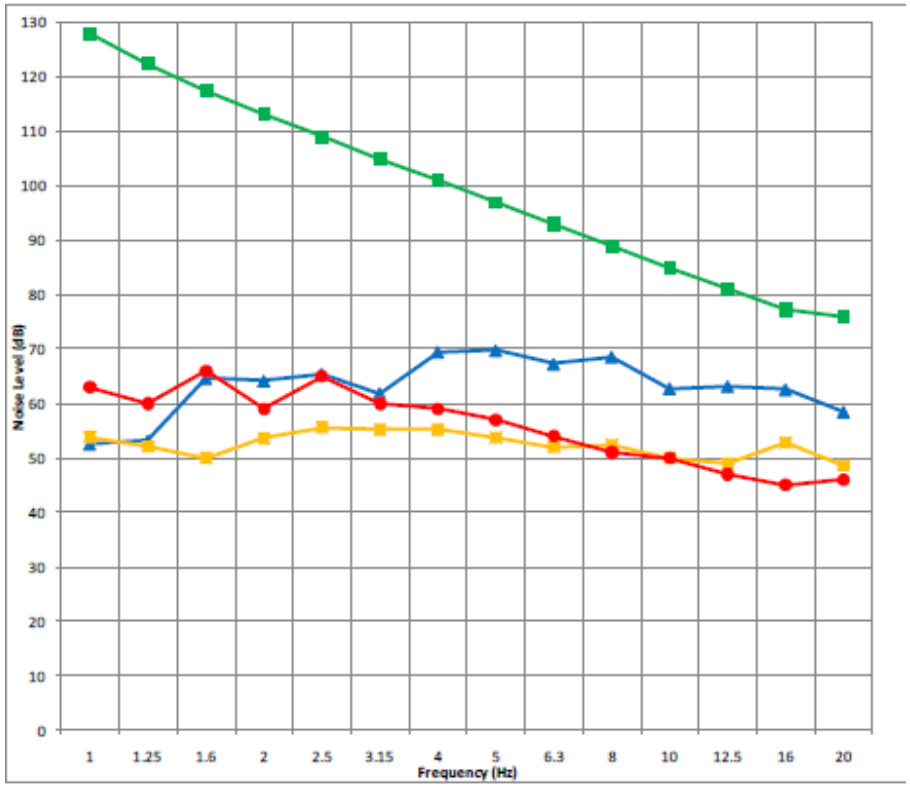
Infrasound noise levels

- Infrasound categorized between 0 – 20Hz
- Infrasound is audible only at very high levels
- Studies have shown that other parts of the body do not respond to infrasound below the audible range
- Noise assessment stated that
  - *"It is noted that, in general, modern WTGs do not exhibit significant infrasound emissions"*

Sources: Moeller, H, and C. S. Pedersen. "Hearing at Low and Infrasonic Frequencies", Noise and Health 2004
Silverton Wind Farm Noise Impact Assessment Report 40-1487 Heggies Pty Ltd

Infrasound noise levels

- Infrasound levels predicted to be inaudible outside of 200 metres from a turbine



	85 dB(G) Criteria
	Infrasound measured at the beach 25m from water – 75 dB(G)
	Infrasound measured 200m from a turbine at Cape Bridgewater – 63 dB(G)
	Infrasound measured 200m from a turbine at Clements Gap – 61 dB(G)

Source: *"Infrasound measurements from wind farms and other sources"* – Sonus Pty Ltd

Compliance Monitoring – once wind farm is operating

- Once the wind farm is operational, it must comply with its operating conditions outlined in the Project Approval
- Compliance monitoring determines if a constructed wind farm is operating in accordance with its operating conditions, this is based on actual measured wind farm noise levels (not computer modeled levels)
- The Project Approval requires the development of a Noise Compliance Plan to be submitted to the Director-General
- Under the Project Approval, noise monitoring is required within three months of:
  - Commissioning of each grouping
  - Commissioning of a complete substage
  - Commissioning of the entire project

Determining Compliance

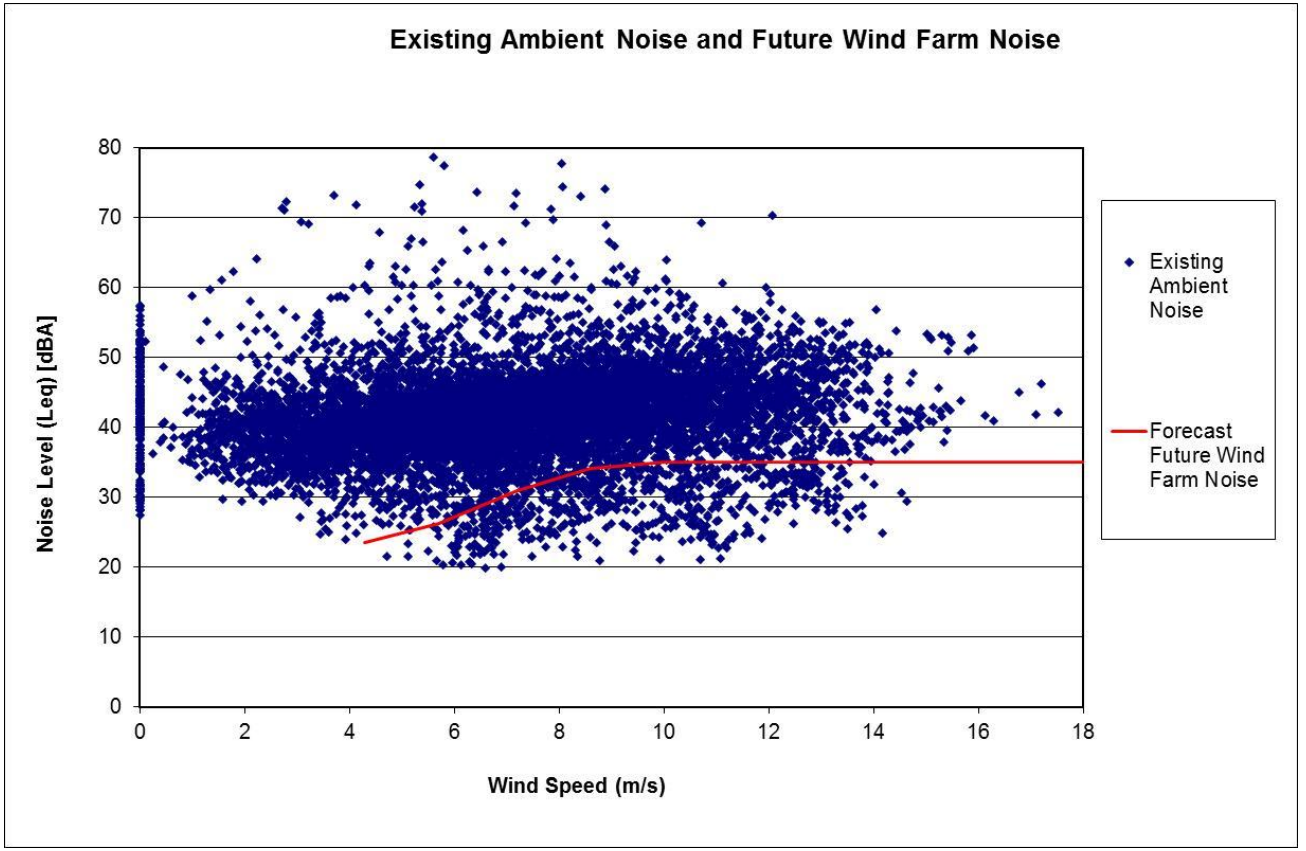
- The Noise Compliance Plan will cover off such information as:
  - Monitoring methodology (SA 2003)
  - Locations for monitoring
  - Assessment of Special Audible Characteristics (SACs)
- The Project Approval also contains conditions on the proponent should the measured noise level exceed the Planning Approval criteria

Compliance Monitoring – once wind farm is operating

- Compliance monitoring procedures are described in SA2003 guidelines
- It is common for compliance monitoring to be undertaken in the same or similar locations to background logging locations

Compliance Monitoring – once wind farm is operating

- Noise monitoring undertaken after a wind farm is constructed will capture a combination of wind farm noise and background noise

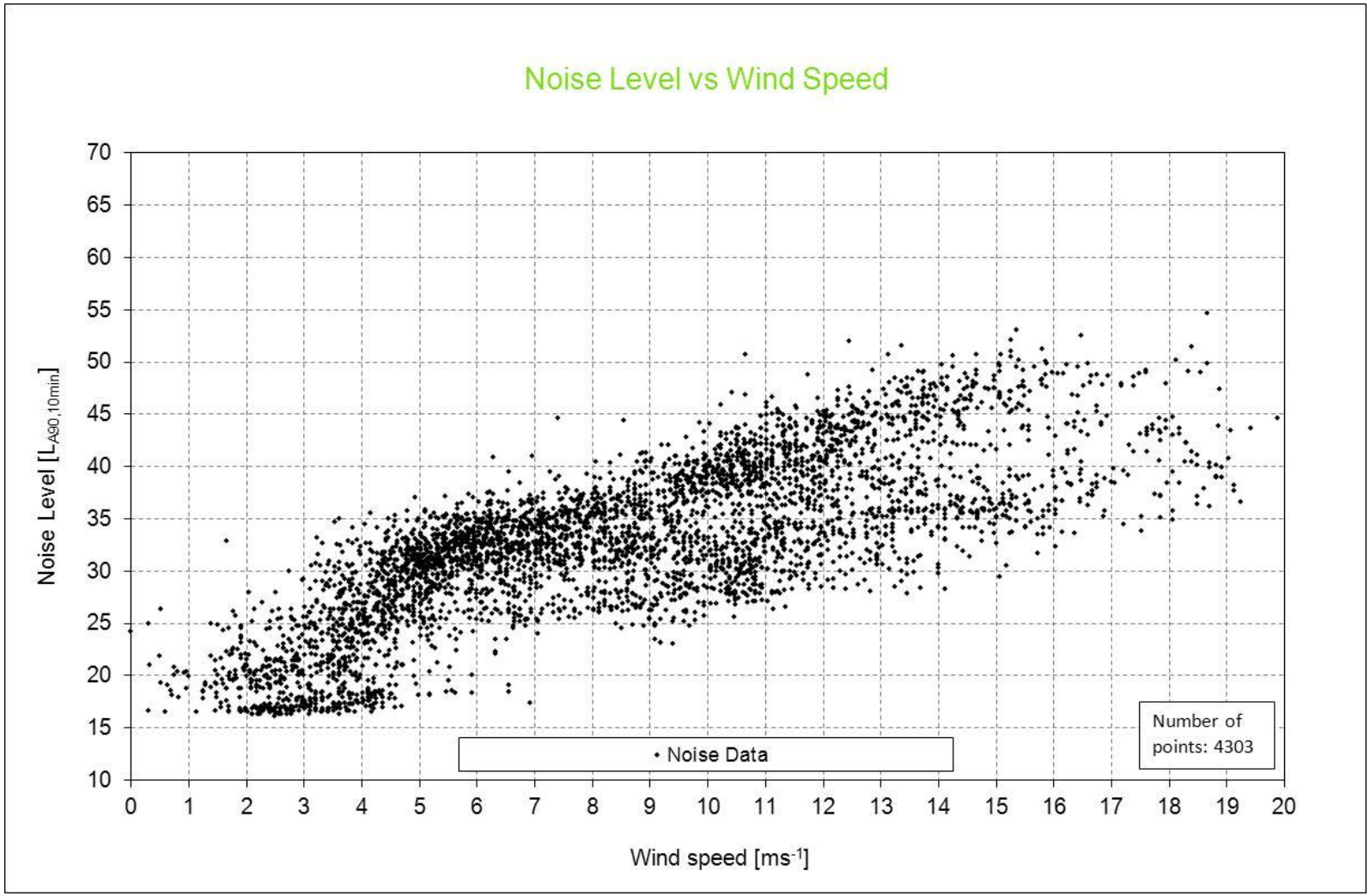


Existing Ambient Noise data taken from background noise measurements at a location adjacent a proposed wind farm

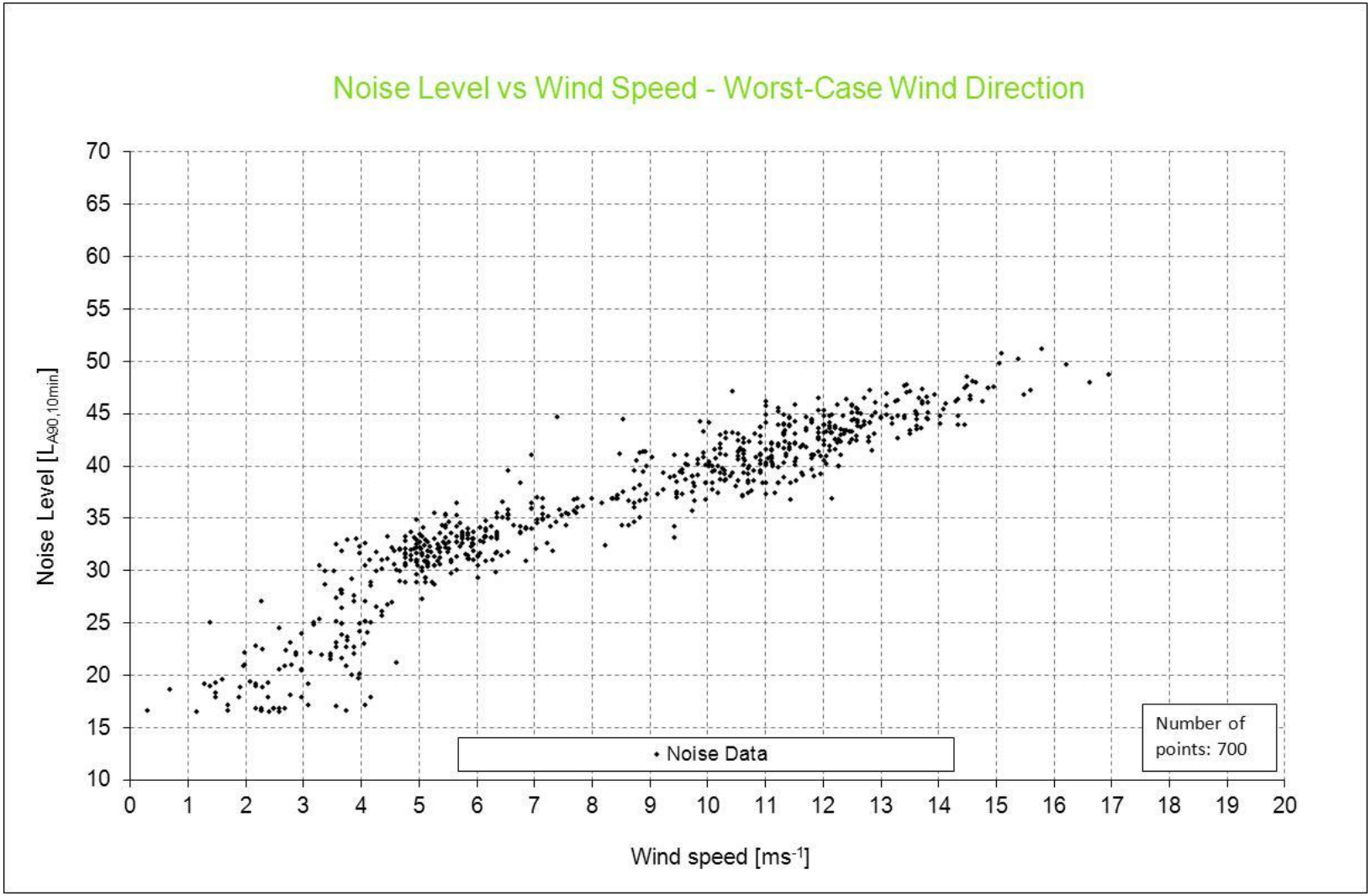
Compliance monitoring calculation procedure

- A minimum number of 2000 10-minute data points are required under SA2003
- Compliance checking should collect data associated with the worst case wind direction from the wind farm to the relevant receiver
- Regression (averaging) is then undertaken on this dataset
- The regression analysis does not average periods of low wind speed with periods of high wind speed

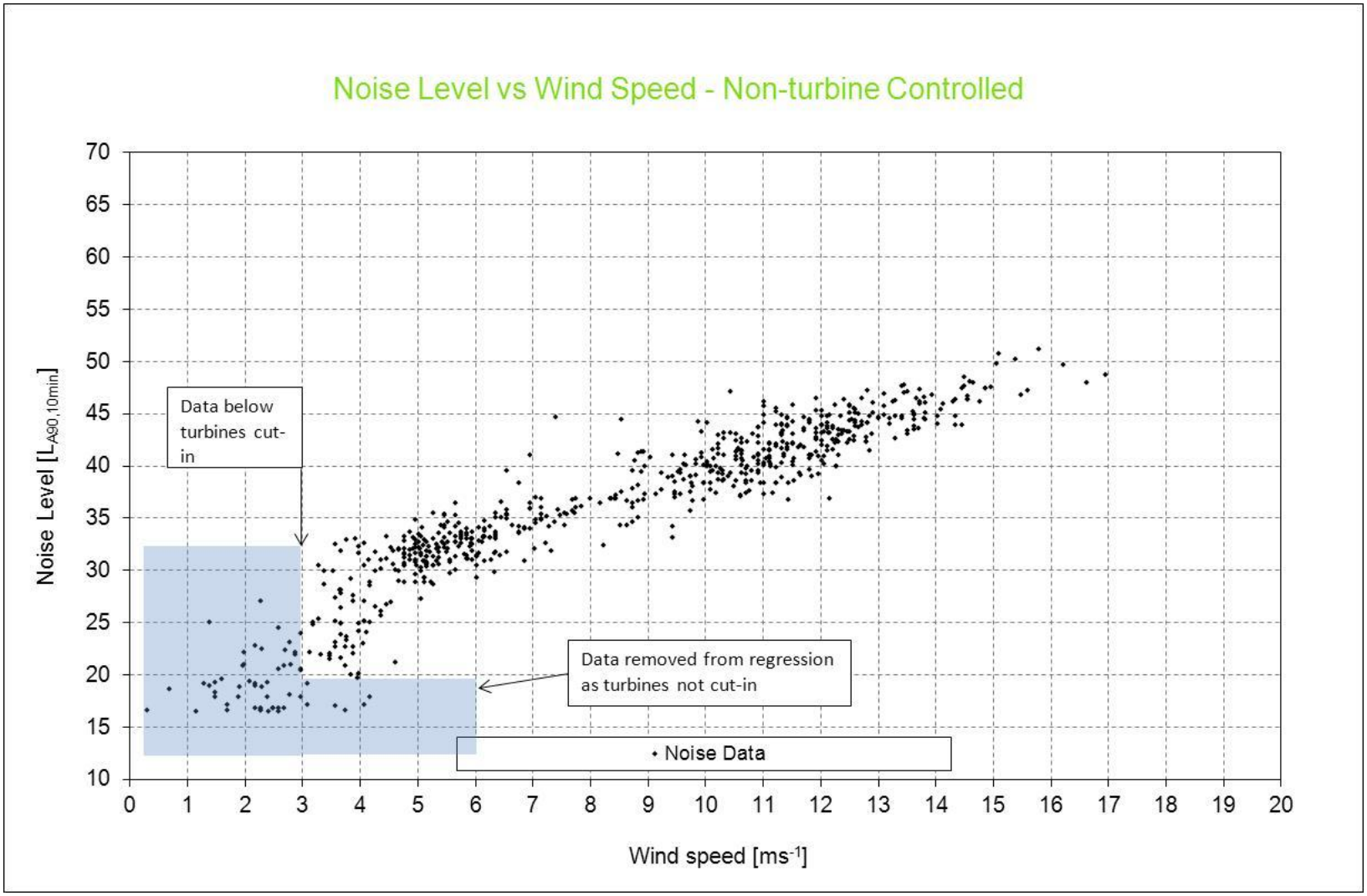
Compliance monitoring calculation procedure



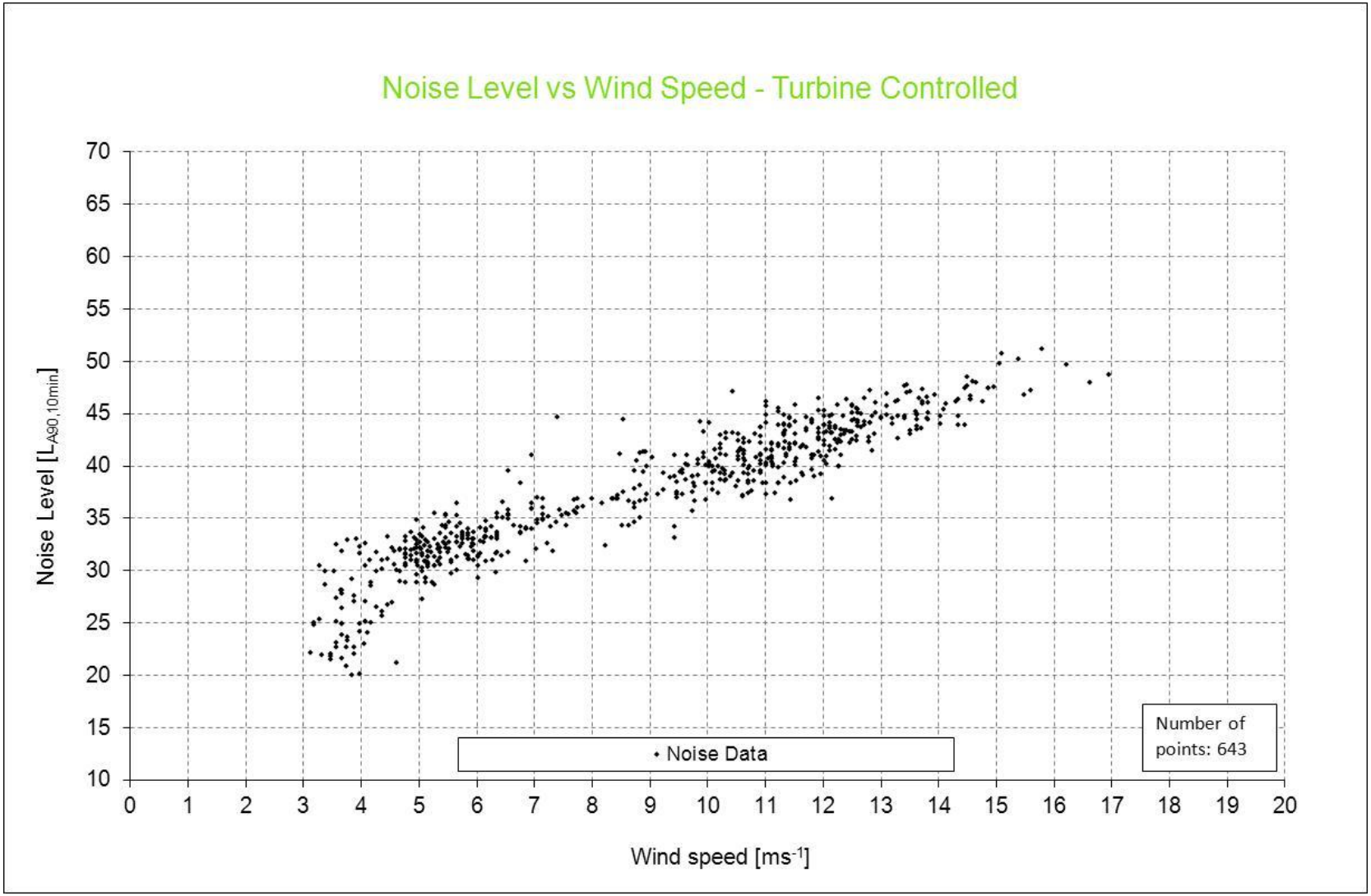
Compliance monitoring calculation procedure



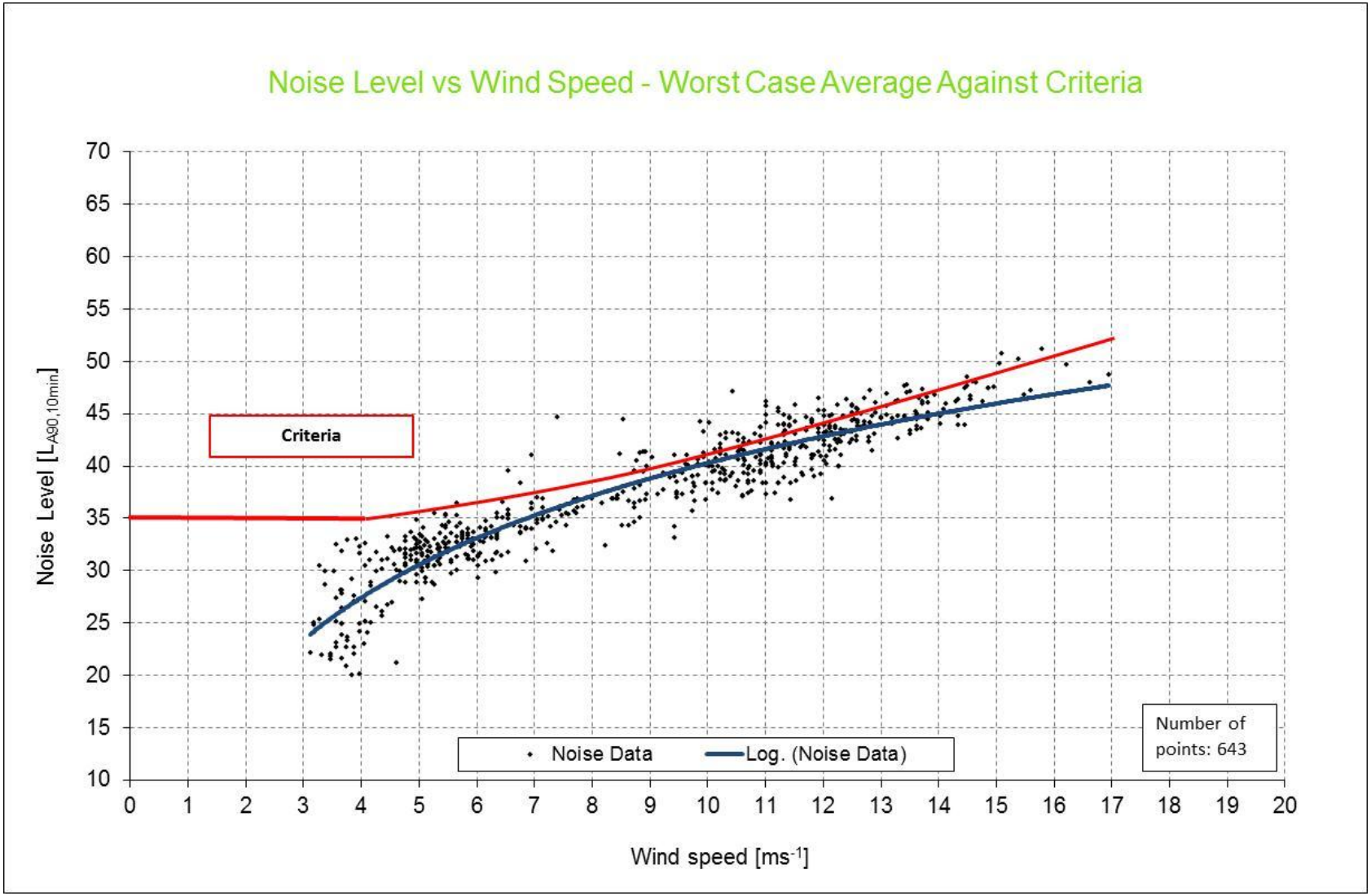
Compliance monitoring calculation procedure



Compliance monitoring calculation procedure

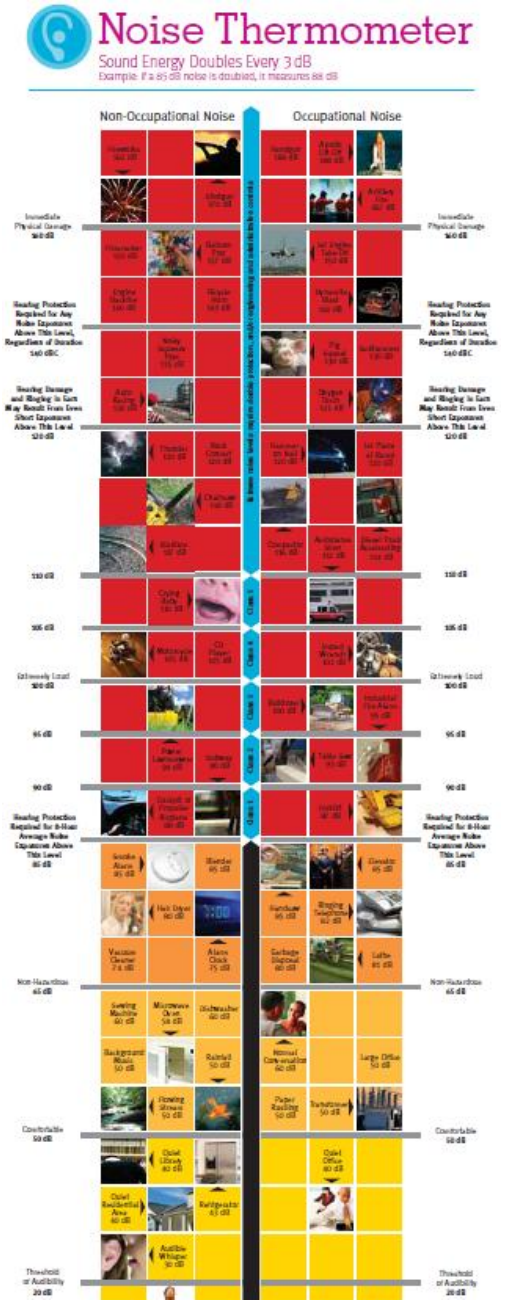


Compliance monitoring calculation procedure



What does a wind farm sound like?

- At the base of the turbine the noise from a wind turbine is approximately 60 - 65 dB(A)
- L_{Aeq} noise exposure from standing at the base of a turbine for 8 hours continuous is around 20 dB(A) below the exposure limit for occupational health and safety noise
- At a distance of 150 meters from a 3MW turbine the measured noise level was around 55 – 57 dB(A) at high wind speeds



AECOM

What does a wind farm sound like?

- Demonstration of wind farm sound levels
- Recording was taken outside a house approximately 1.5 kilometres from a large wind farm in South Australia
- Was selected for this demonstration due to minimal background noise (e.g. wind through trees, birds, crickets etc.)

Thank You

Rhys Brown
rhys.brown@aecom.com
(07) 3553 3078