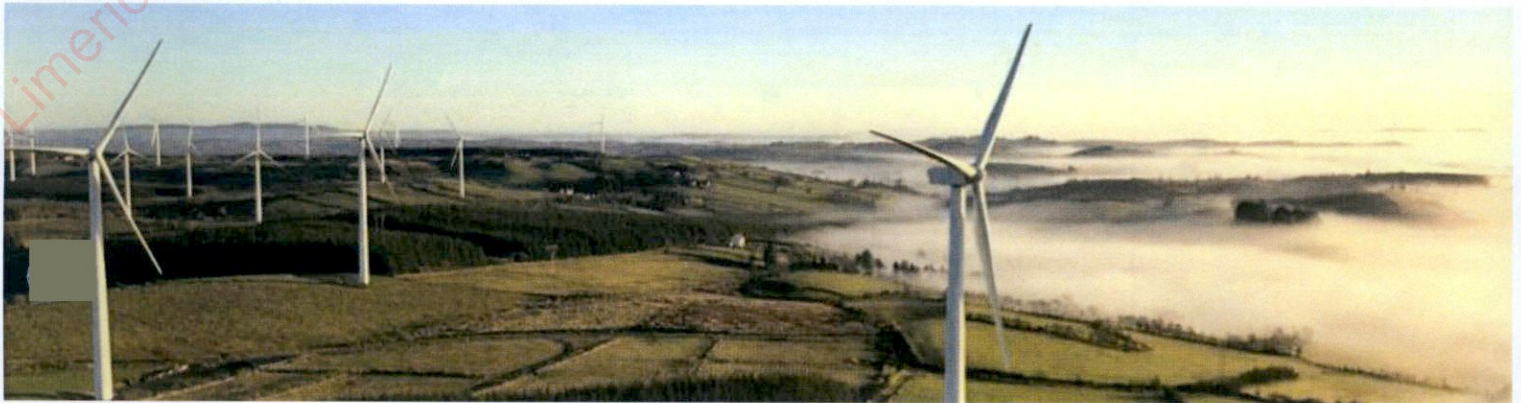


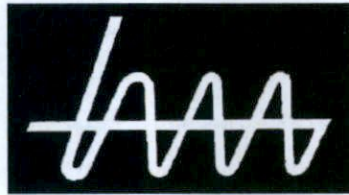
## Annex 11.1

Limerick City & County Council  
08 JUN 2022  
Planning and Environmental Services



# HAYES MCKENZIE

PARTNERSHIP LTD



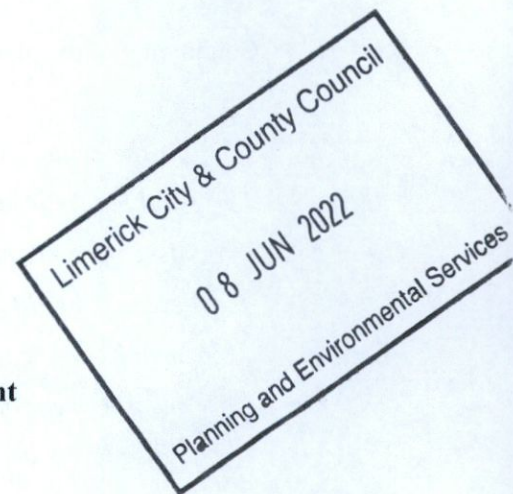
*Prepared for:*

*Airtricity House  
Ravenscourt Office Park  
Sandyford  
Dublin 18  
IRELAND*

**Knockastanna Wind Farm**

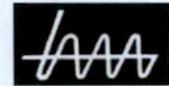
**Planning Conditions Compliance Assessment  
HM: 2144/R2**

**Version 1.0  
28<sup>th</sup> October 2009**



16a The Courtyard, Dean Hill Park, West Dean, Salisbury SP5 1EY, UK  
Tel. +44 (0)1794 342343, Fax +44 (0)1794 342344, [salisbury@hayesmckenzie.co.uk](mailto:salisbury@hayesmckenzie.co.uk)  
● Offices in Salisbury & Machynlleth ●





**KNOCKASTANNA WIND FARM**  
**PLANNING CONDITIONS COMPLIANCE ASSESSMENT**  
**Report HM:2144/R2**  
**Version 1.0 – 28<sup>th</sup> October 2009**

**1. Introduction**

- 1.1 The Knockastanna Wind Farm site became fully operational in 2009. Airtricity have subsequently asked Hayes McKenzie to check compliance with the noise limits prescribed by the Planning Conditions. This report describes these measurements and the subsequent analysis and results.

**2. Planning Conditions**

- 2.1 The noise limits for the site are detailed at condition 9 contained within the Planning Conditions of the site, which relates to noise from the wind farm.

Condition 9 of the planning conditions states:

*At the critical wind speed (that is, the speed at which the noise of wind turbines and blades is most in excess of ambient noise levels), the noise from the proposed development shall not, when measured externally at the nearest occupied house, exceed 40 dB(A)Leq when measured over any five minute period. Within six months of commissioning the turbines the developer shall undertake the measurement of noise levels in order to determine the extent and characteristics of noise levels arising from the wind farm in the vicinity of the nearest two occupied residential properties. The results of such noise measurement shall be forwarded to the planning authority. In the event of a failure to meet the above limit, the wind farm operation shall be stopped until written agreement is reached with the planning authority on design or operational alteration intended to reduce the noise accordingly.*

- 2.2 Baseline noise monitoring was carried out in January/February 2006 and the critical wind speed was determined to be 7m/s as measured 10m above ground. Details of the derivation of the





critical wind speed can be found in Hayes McKenzie report HM:1601/R2, dated 24<sup>th</sup> February 2006.

### 3. Wind Turbine Noise Measurement Procedure

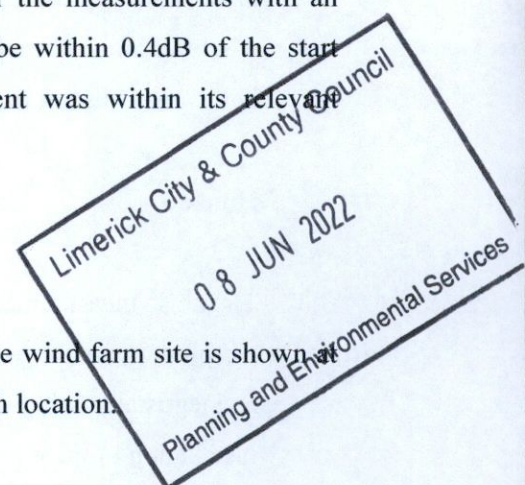
- 3.1 Noise monitoring was carried out for a period of 55 days from 11<sup>th</sup> June to 5<sup>th</sup> August, 2009 at 4 nearby inhabited residential properties. The data was checked, batteries changed and the data downloaded on 3<sup>rd</sup> July.
- 3.2 The noise measurements were made with Larson Davis model LD-820 Precision Integrating Sound Level Meters fitted with ½" microphones which comply with the type 1 standard in IEC 651-1:1979. The microphones were fitted with double-skin windshields based on the Gracey & Associates model 8310 design and mounted on tripods at a height of 1.2 metres.
- 3.3 Calibration was carried out before, at the interim visit, and after the measurements with an appropriate acoustic calibrator, and all equipment was found to be within 0.4dB of the start calibration, which is within allowable tolerances. All equipment was within its relevant laboratory calibration period.

#### Description of Measurement Locations

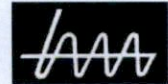
- 3.4 The location of the 4 noise measurement locations in relation to the wind farm site is shown in Figure 1. The following paragraphs describe the installations at each location.

##### House B

- 3.5 The noise measurement equipment was installed in a yard to the north of the property on the wind farm side, as shown at Figure 2. The measurement location was close to some relatively tall trees. At installation of the equipment, birdsong, occasional distant vehicles, and wind in the trees were noted; at the interim visit wind in the trees and birdsong were noted; and at collection of the equipment wind in the trees, birdsong, and turbine noise were noted.







### **House E**

- 3.6 The noise measurement equipment was installed on a grassed area to the side of the property in a position where the nearest turbine blades were visible, as shown at Figure 3. At installation of the equipment, birdsong, occasional vehicles on the adjacent road, and distant wind in the trees were noted; at the interim visit birdsong, wind in the trees, and an aircraft fly-over were noted; and at collection of the equipment wind in the trees, dogs barking, an aircraft fly-over, and just audible wind turbine noise were noted.

### **House H**

- 3.7 The noise measurement equipment was installed in the rear garden of the property on the wind farm side, as shown at Figure 4. The exact location was selected to both be in the position to maximise the chances of measuring wind farm noise, whilst minimising noise from a nearby stream. At installation of the equipment, running water from a nearby stream was just audible, insect noise, birdsong, and wind in the trees were noted; at the interim visit wind in the trees, wind turbine noise, and an aircraft fly-over were noted; and at collection of the equipment wind in the trees, distant road traffic noise, and turbine noise were noted.

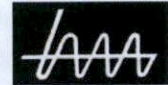
### **House J**

- 3.8 The noise measurement equipment was installed adjacent to the vegetable patch in the garden of the property, as shown at Figure 5, and was moved at the interim visit to a location where the resident stated wind turbine noise was more detectable on the opposite side of the property. At installation of the equipment, birdsong, occasional vehicles on the adjacent road, an aircraft fly-over, and a distant tractor were noted; at the interim visit wind in the trees birdsong, an aircraft fly-over, and a distant tractor were noted; and at collection of the equipment wind in the trees, birdsong, occasional cars passing on the adjacent road, and dogs barking were noted.

### **Wind Data**

- 3.9 Data recorded for wind turbines is usually measured in 10-minute periods. The planning conditions for the site state, however, that measurements should be carried out in consecutive 5-minute periods. The noise data was recorded in 10-minute intervals in order to correlate with the





turbine data. This will not affect the critical wind speed noise limit, which will remain 40 dB  $L_{Aeq}$ , and will have minimal affect on the results of the measurements.

- 3.10 The meters were programmed to measure a number of statistical noise indices, including the  $L_{Aeq}$ , together with the maximum ( $L_{Amax}$ ) and minimum ( $L_{Amin}$ ) levels and  $L_{A90}$  over consecutive 10-minute periods. Results were automatically stored at the end of each period.
- 3.11 Wind speed was both taken from the nacelle anemometer, and derived from the rotational speed or power output, of the nearest turbine to the residential property, and wind direction from the recorded yaw data for that turbine.
- 3.12 The critical wind speed of 7m/s relates to wind speeds at 10m-height above ground level, therefore the measured hub height wind speed has been scaled down to 'standardised' 10m-height wind speeds using the formula:

$$V_{10} = V_h \times (\ln(h_{10}/z_0) / \ln(h_h/z_0)),$$

where  $V_{10}$  and  $V_h$  are the 'standardised' 10m height ( $h_{10}$ ) and hub height ( $h_h$ ) wind speeds respectively, and  $z_0$  is the reference ground roughness length ( $=0.05m$ ).

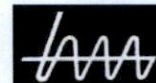
- 3.13 A rain gauge was installed at House H, set up to measure rainfall in 10-minute periods synchronised with the noise and wind measurements.

#### 4. Assessment Methodology

- 4.1 It is difficult to measure wind farm noise levels at residential properties using the  $L_{Aeq}$  noise descriptor as it is easily affected by transient and local noise sources. Wind turbine noise is usually measured and assessed in term of the  $L_{A90}$  noise descriptor. The noise limits have therefore been converted to  $L_{A90}$  equivalent noise limits from  $L_{Aeq}$  noise limits, by subtracting 2 dB<sup>1</sup> to give 38 dB  $L_{A90}$  at the critical wind speed.

<sup>1</sup> ETSU-R-97, The Assessment and Rating of Noise from Wind Farms ETSU for the UK Department of Trade and Industry, 1996





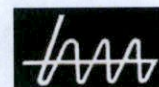
- 4.2 In order to present a worst case assessment, the measured noise data has been filtered to include only data corresponding to downwind propagation from the turbines to the nearest houses. Downwind has been specified as the bearings between the outer turbines from the assessment location plus an additional 30° at each side. The calculated downwind angles for each assessment location are shown in Table 1 below.

**Table 1 – Calculated Downwind Angles**

Property	Easting	Northing	Nearest Turbine	Distance to nearest Turbine	min angle	max angle	Min -30°	max +30°
B	184878	155679	T03	1266m	45°	73°	15°	103°
E	186725	155437	T05	833m	320°	322°	290°	352°
H	186471	157217	T02	949m	193°	228°	163°	258°
J	185120	156710	T02	659m	101°	119°	71°	149°

- 4.3 It should be noted that the measured noise levels include background noise as well as turbine noise. Turbine noise levels are therefore likely to be lower than the levels recorded. Measured noise levels are likely to be more representative of actual turbine noise levels at night time when other sources of noise, such as animals, birds, and road traffic, are at a minimum. Therefore the noise data used in the assessment has been filtered to include only night hours data recorded between 23:00 and 07:00.
- 4.4 Periods of rainfall may affect the measured noise levels, and therefore any period of measured rainfall in a 10-minute period has been excluded from the analysis.
- 4.5 For each noise measurement location the wind speed used in the assessment has been taken from the nearest turbine, as detailed in Table 1, either from the nacelle anemometer or derived from the power output and published power curve for the turbines.
- 4.1 The average 10-minute noise level has been calculated at each of the properties for downwind wind direction and for the critical wind speed of 7 m/s +/- 0.5 m/s (standardised 10m-height wind speed), for all data and for night-time data only. The results are shown in Table 2 below.





**Table 2 – Average results for Critical Wind Speed**

House	Time Period	10m height Wind Speed Derived From Nacelle Anemometer Wind Speed or Electrical Power Output	Average Noise Level in 6.5 – 7.5 10m-height wind speed range (dB L <sub>A90</sub> )	Number of Data Points in 6.5 – 7.5 m/s range
House B	Night Hours (2300-0700)	Nacelle Anemometer	34.0	1
		Power Output	33.6	3
House E	Night Hours (2300-0700)	Nacelle Anemometer	31.6	43
		Power Output	31.3	57
House H	Night Hours (2300-0700)	Nacelle Anemometer	36.0	134
		Power Output	35.8	193
House J	Night Hours (2300-0700)	Nacelle Anemometer	37.8	2
		Power Output	37.8	5

- 4.2 Table 2 shows that the relevant critical wind speed noise limit is met at the four locations assessed, thus showing compliance with the Planning Condition relating to noise.

## 5. Conclusions

- 5.1 Noise measurements have been carried out at 4 nearby properties to the operational Knockastanna Wind Farm to check compliance with the imposed noise planning conditions.
- 5.2 Analysis of the results shows that the wind farm is compliant with the noise limits described in the Planning Conditions for the site.

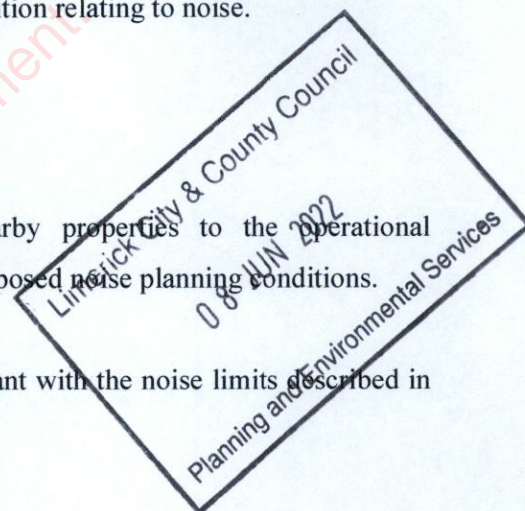
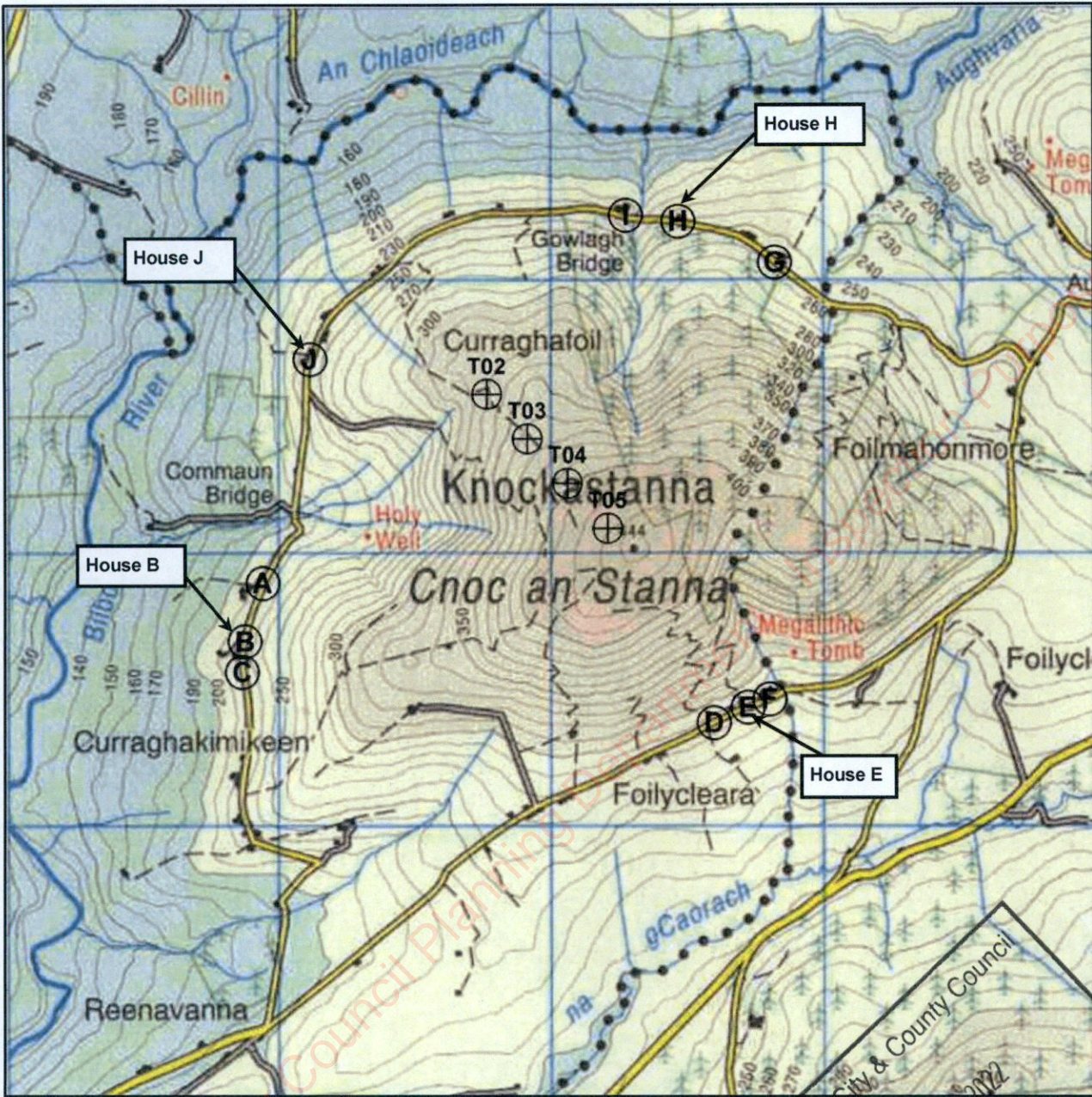




Figure 1 – Noise Monitoring and Turbine Locations



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Figure 2 – House B Noise Monitoring Location Photos





Figure 3 – House E Noise Monitoring Location Photos



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Figure 4 – House H Noise Monitoring Location Photos





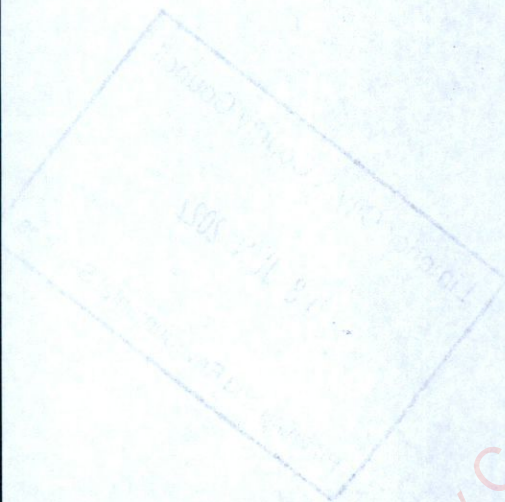
Figure 5 – House J Noise Monitoring Location Photos



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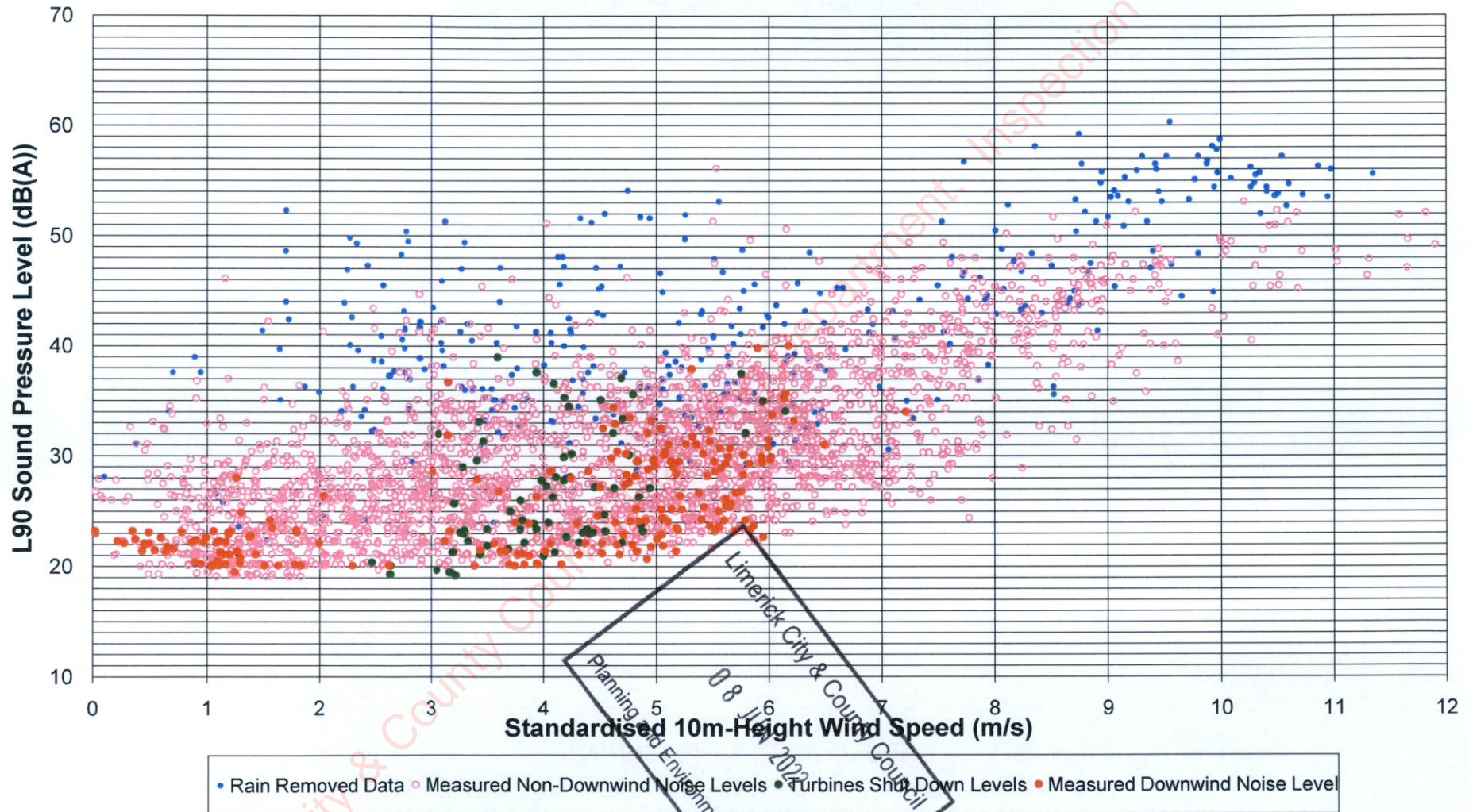
**Appendix A**  
**Noise Assessment Charts**  
**Filtered to Include only Night Hours Data**



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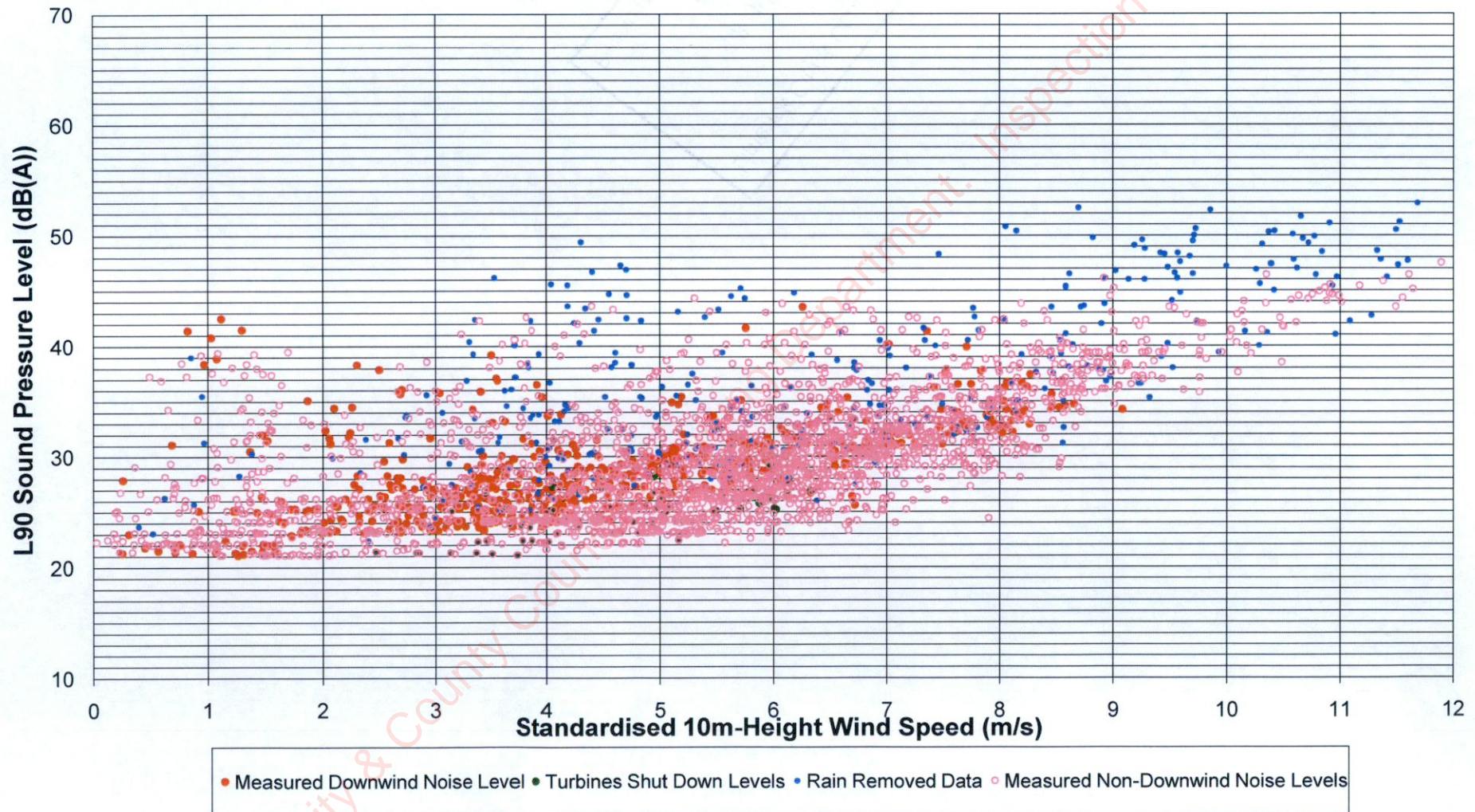


**Knockastanna W/F Noise Compliance Assessment  
House B - Measured Noise Levels vs Wind Speed  
(Night Hours 2300-0700)**



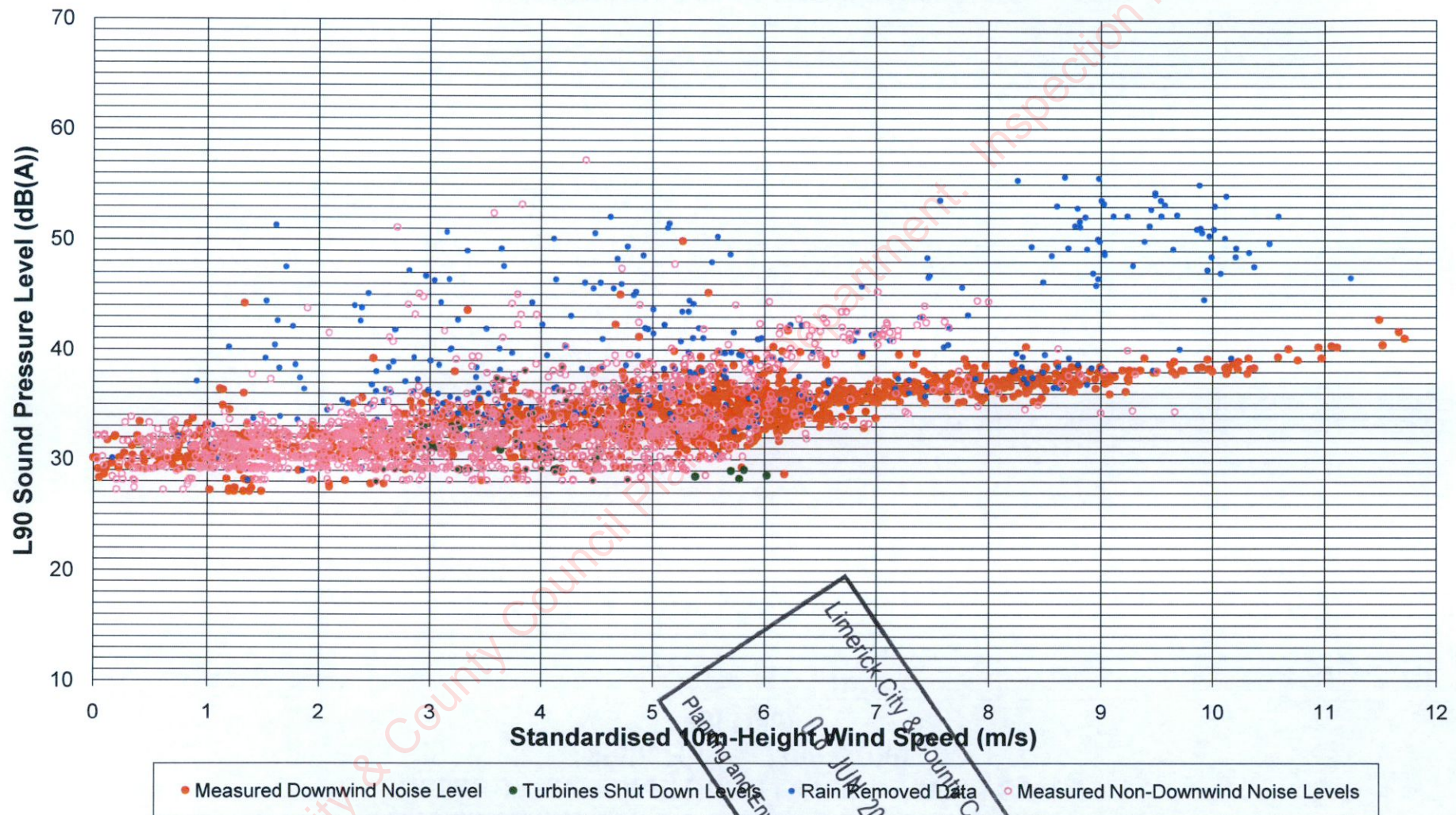


**Knockastanna W/F Noise Compliance Assessment  
House E - Measured Noise Levels vs Wind Speed  
(Night Hours 2300-0500)**



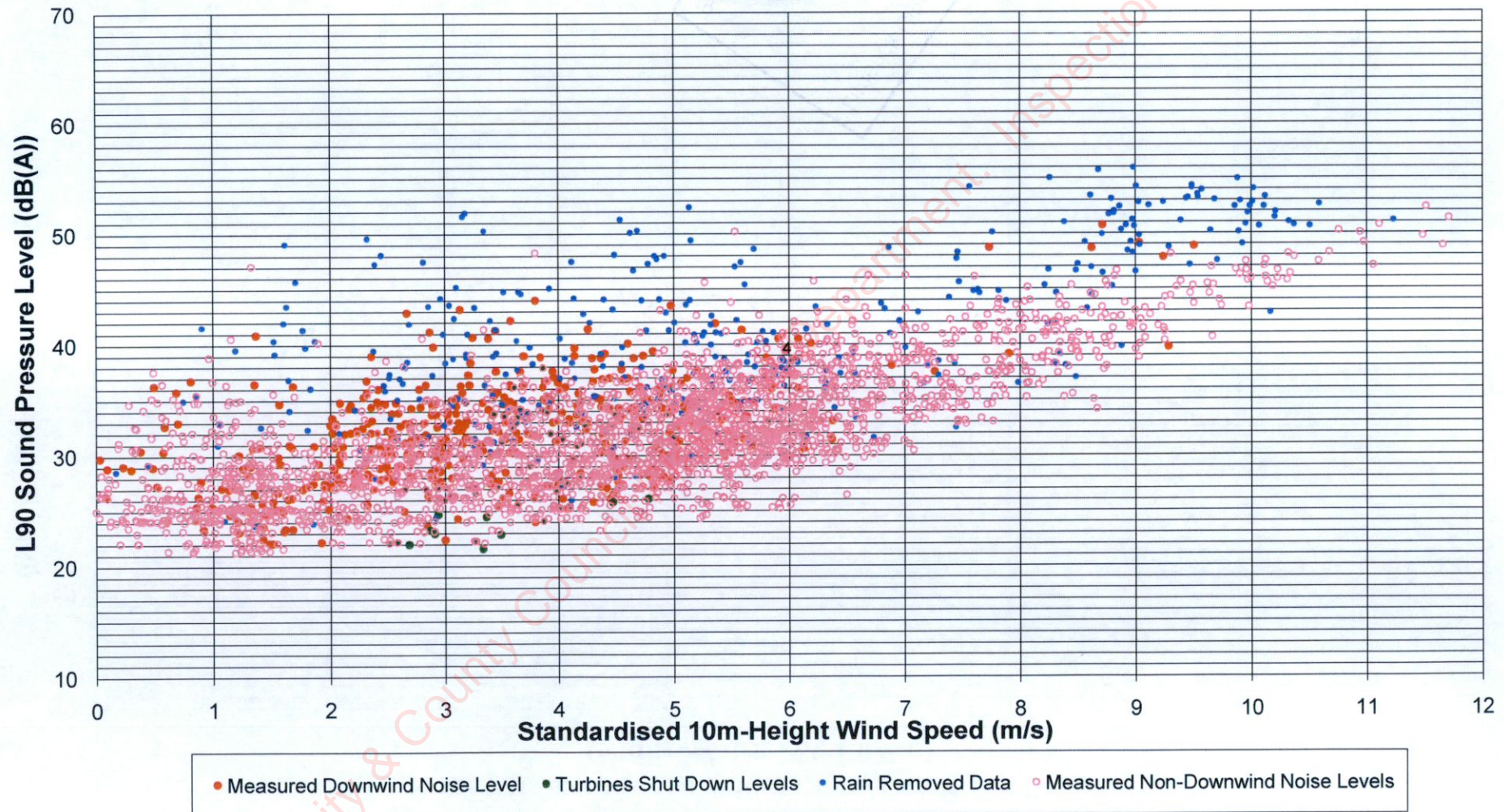


**Knockastanna W/F Noise Compliance Assessment  
House H - Measured Noise Levels vs Wind Speed  
(Night Hours 2300-0700)**



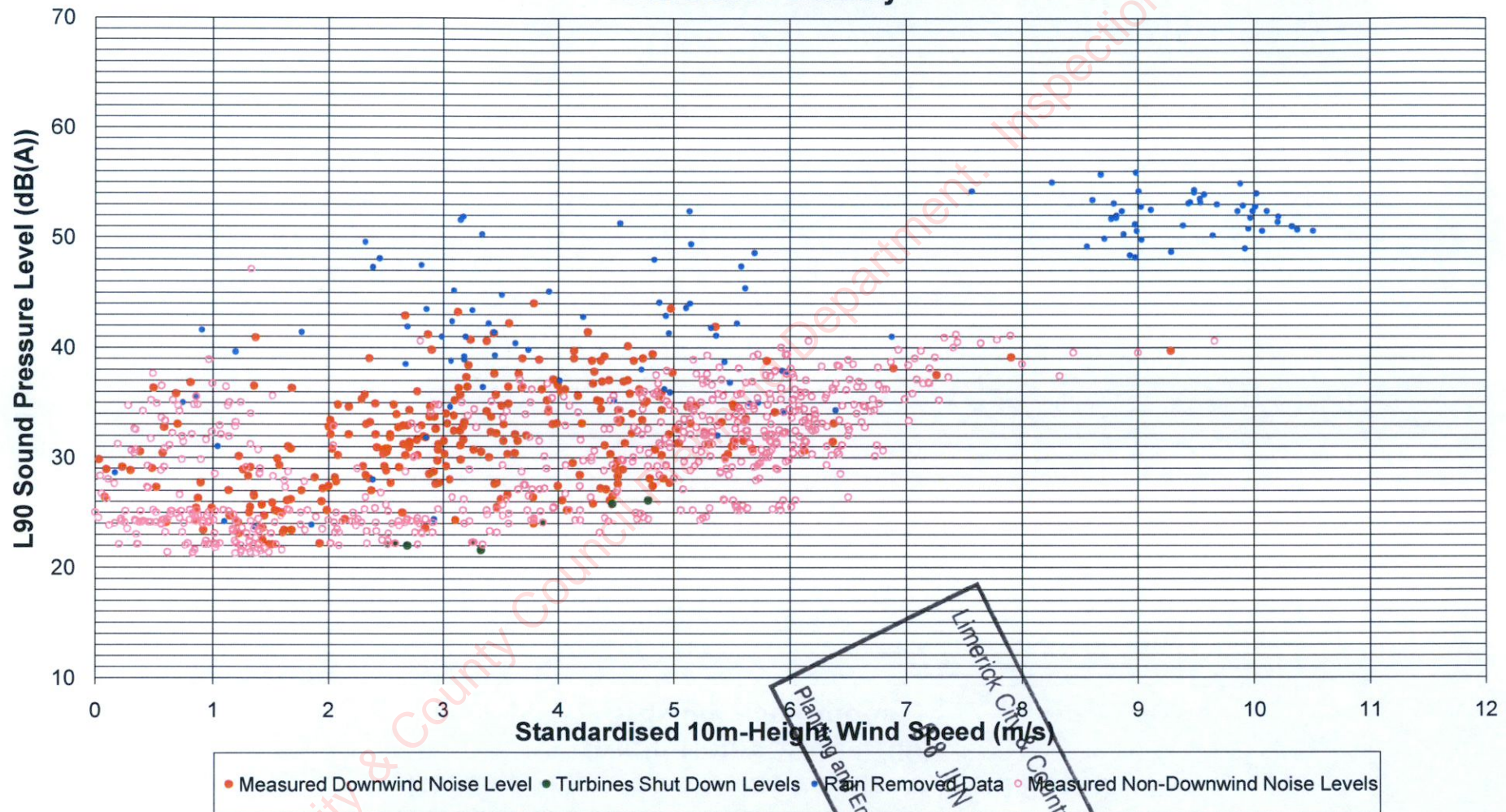


**Knockastanna W/F Noise Compliance Assessment  
House J - Measured Noise Levels vs Wind Speed  
(Night Hours 2300-0700)  
All Data**



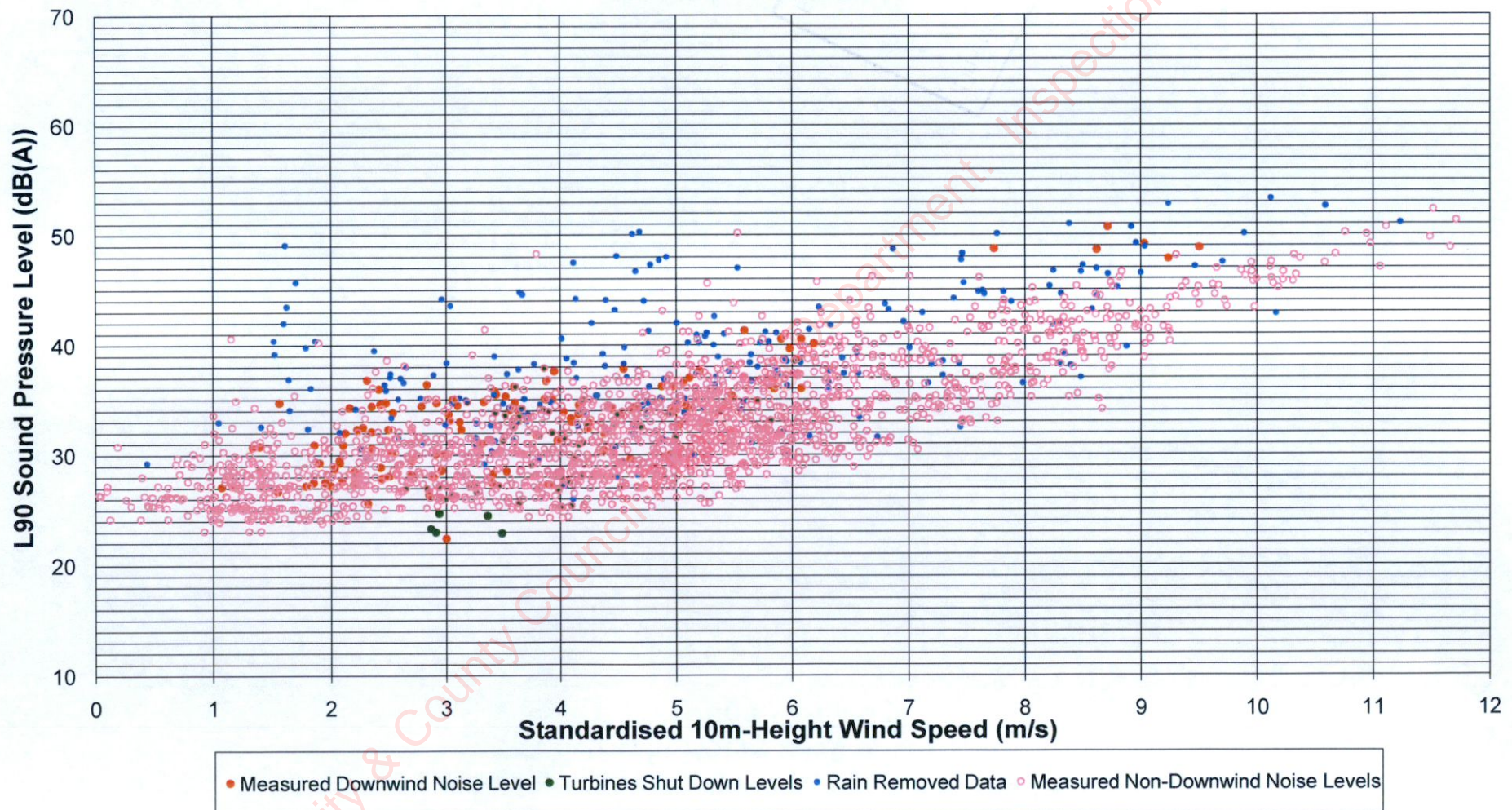


**Knockastanna W/F Noise Compliance Assessment  
House J - Measured Noise Levels vs Wind Speed  
(Night Hours 2300-0700)  
11th June - 3rd July**





**Knockastanna W/F Noise Compliance Assessment  
House J - Measured Noise Levels vs Wind Speed  
(Night Hours 2300-0700)  
3rd July - 5th August**





## **Appendix B**

### **Noise Assessment Charts**

#### **Night Filtered Downwind and Shut-Down Data**

#### **Wind Speed Taken from Nacelle Anemometer**

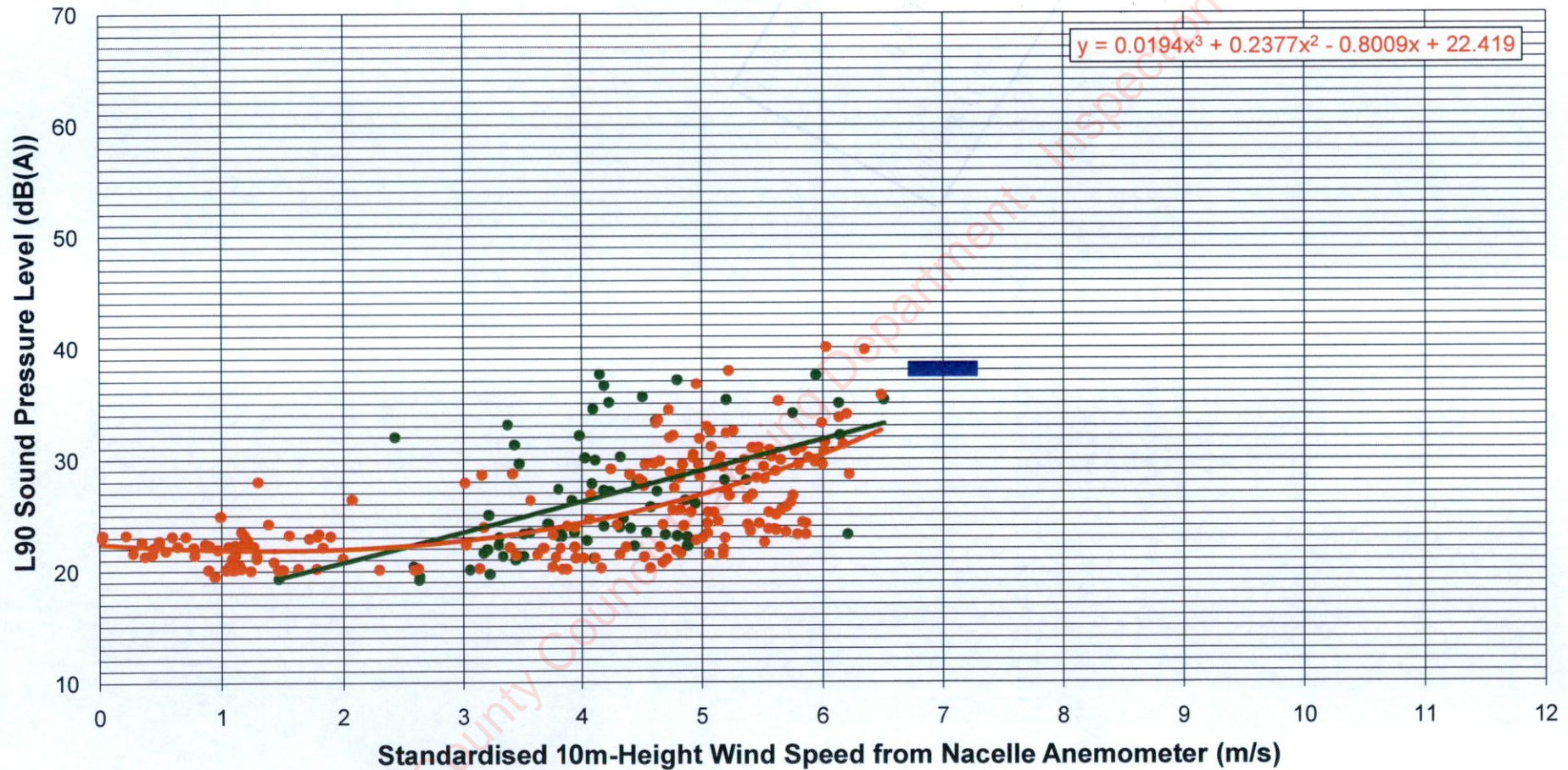
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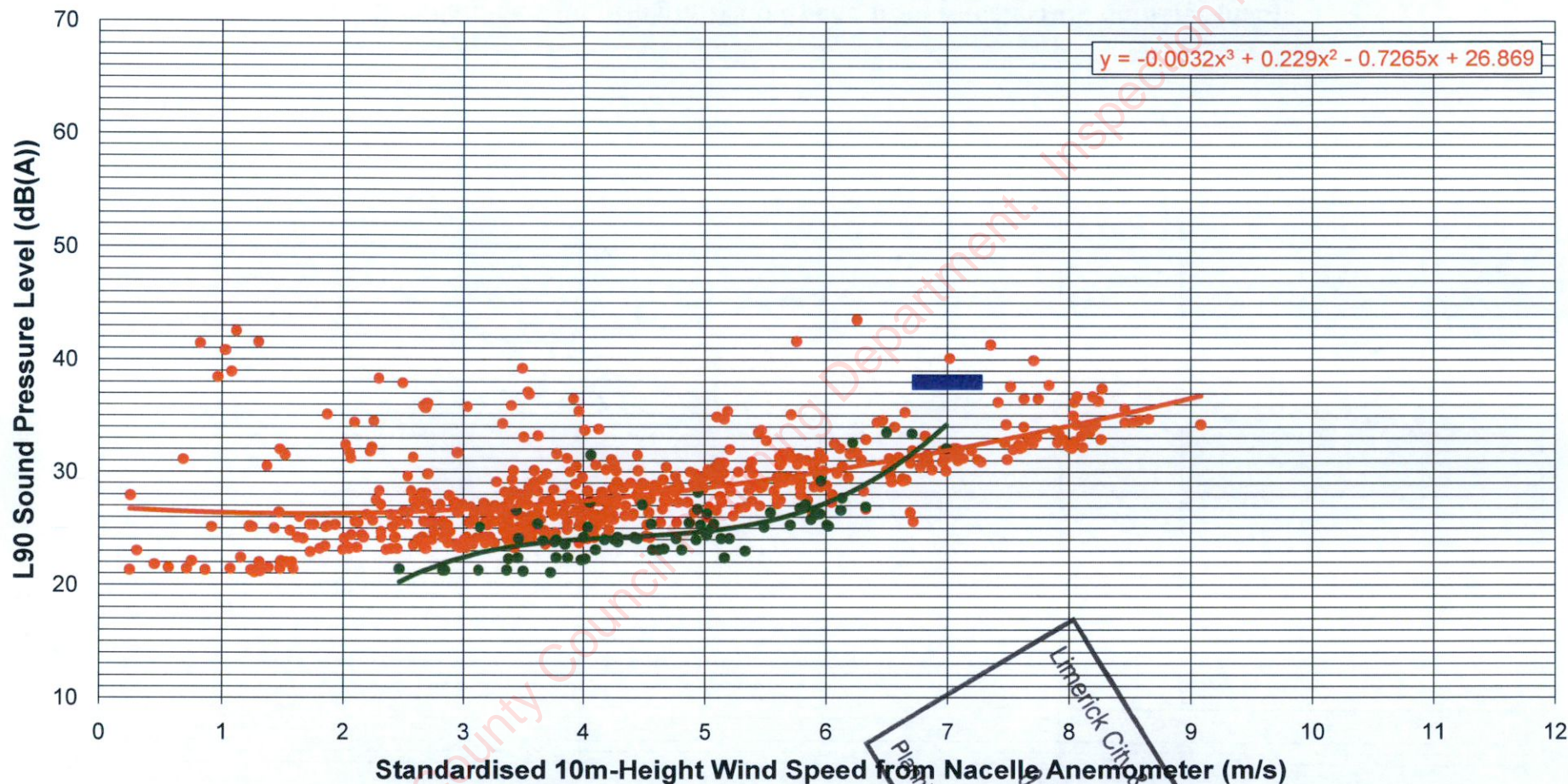
**Knockastanna W/F Noise Compliance Assessment  
House B - Measured Noise Levels vs Wind Speed  
(Night Hours 2300-0700)**



- |  |   |
|--|---|
| ● Turbines Shut Down Levels                | ● Measured Downwind Noise Level             |
| — Critical Wind Speed Noise Limit          | — Trendline Through Measured Shut Down Data |
| — Trendline Through Measured Downwind Data |   |



# Knockastanna W/F Noise Compliance Assessment House E - Measured Noise Levels vs Wind Speed (Night Hours 2300-0500)

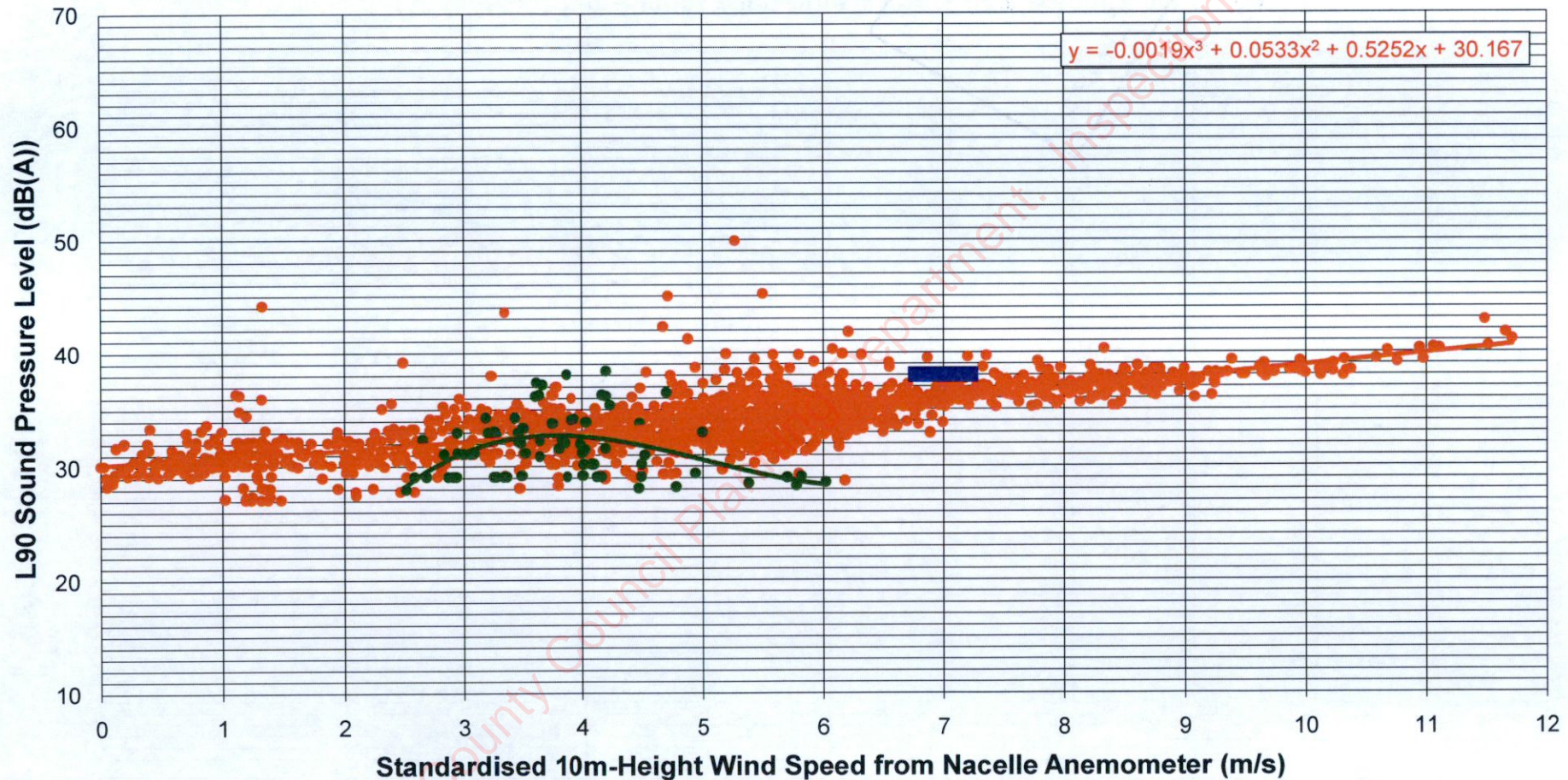


- Measured Downwind Noise Level
- Critical Wind Speed Noise Limit
- Trendline Through Measured Shut Down Data
- Turbines Shut Down Levels
- Trendline Through Measured Downwind Data

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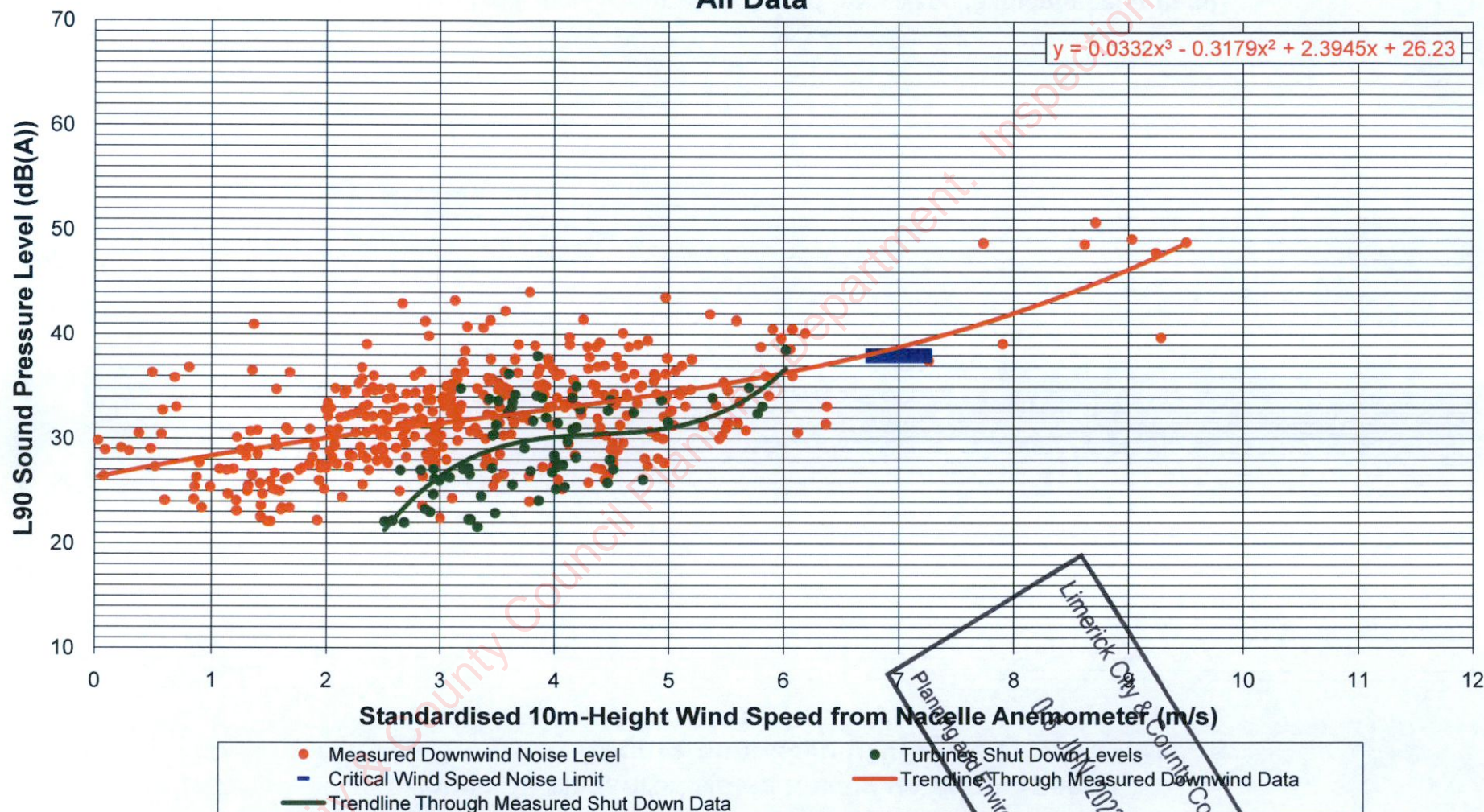
**Knockastanna W/F Noise Compliance Assessment  
House H - Measured Noise Levels vs Wind Speed  
(Night Hours 2300-0700)**



- Measured Downwind Noise Level
- Critical Wind Speed Noise Limit
- Trendline Through Measured Shut Down Data
- Turbines Shut Down Levels
- Trendline Through Measured Downwind Data



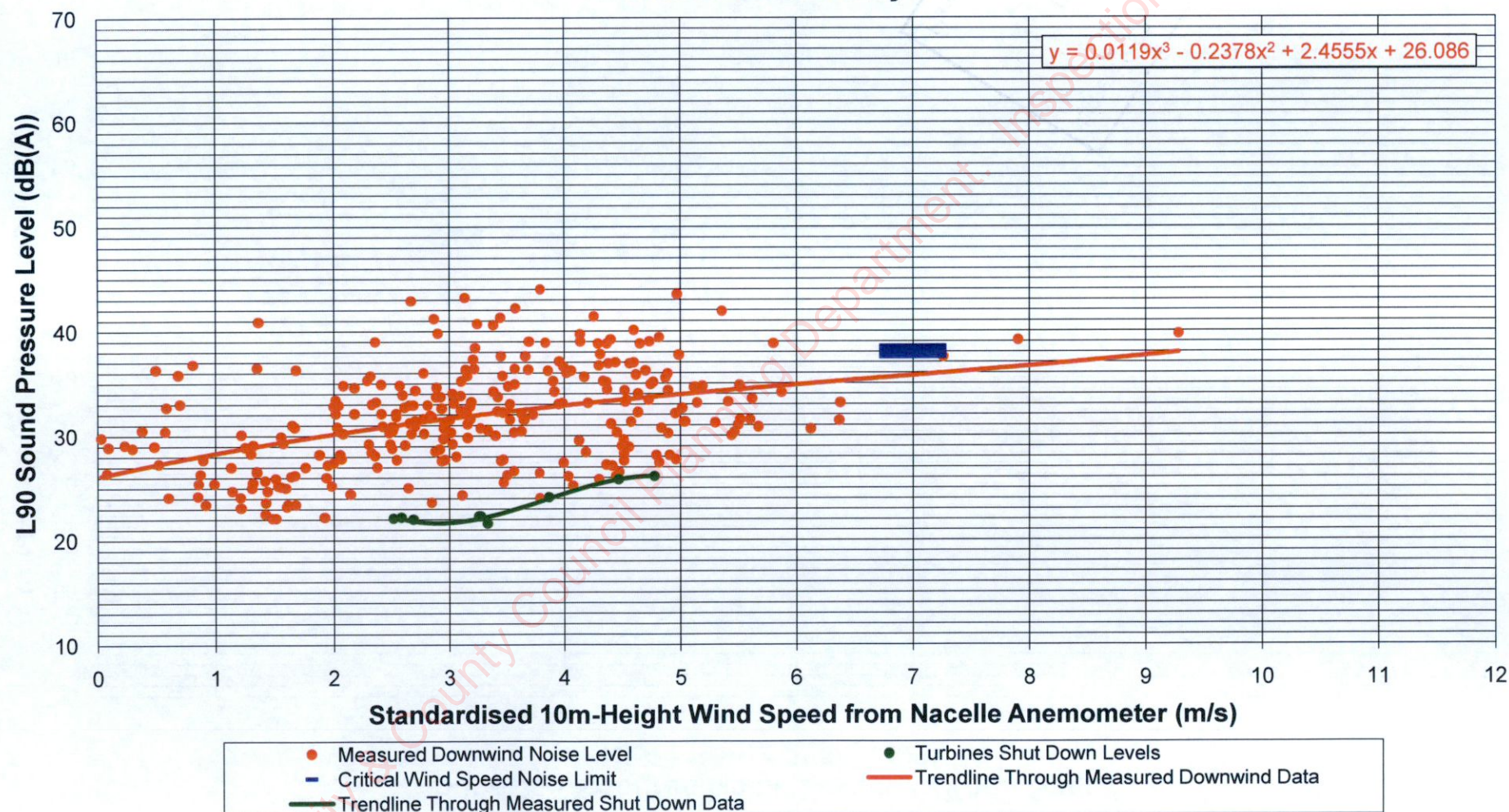
# Knockastanna W/F Noise Compliance Assessment House J - Measured Noise Levels vs Wind Speed (Night Hours 2300-0700) All Data



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04 July 2022

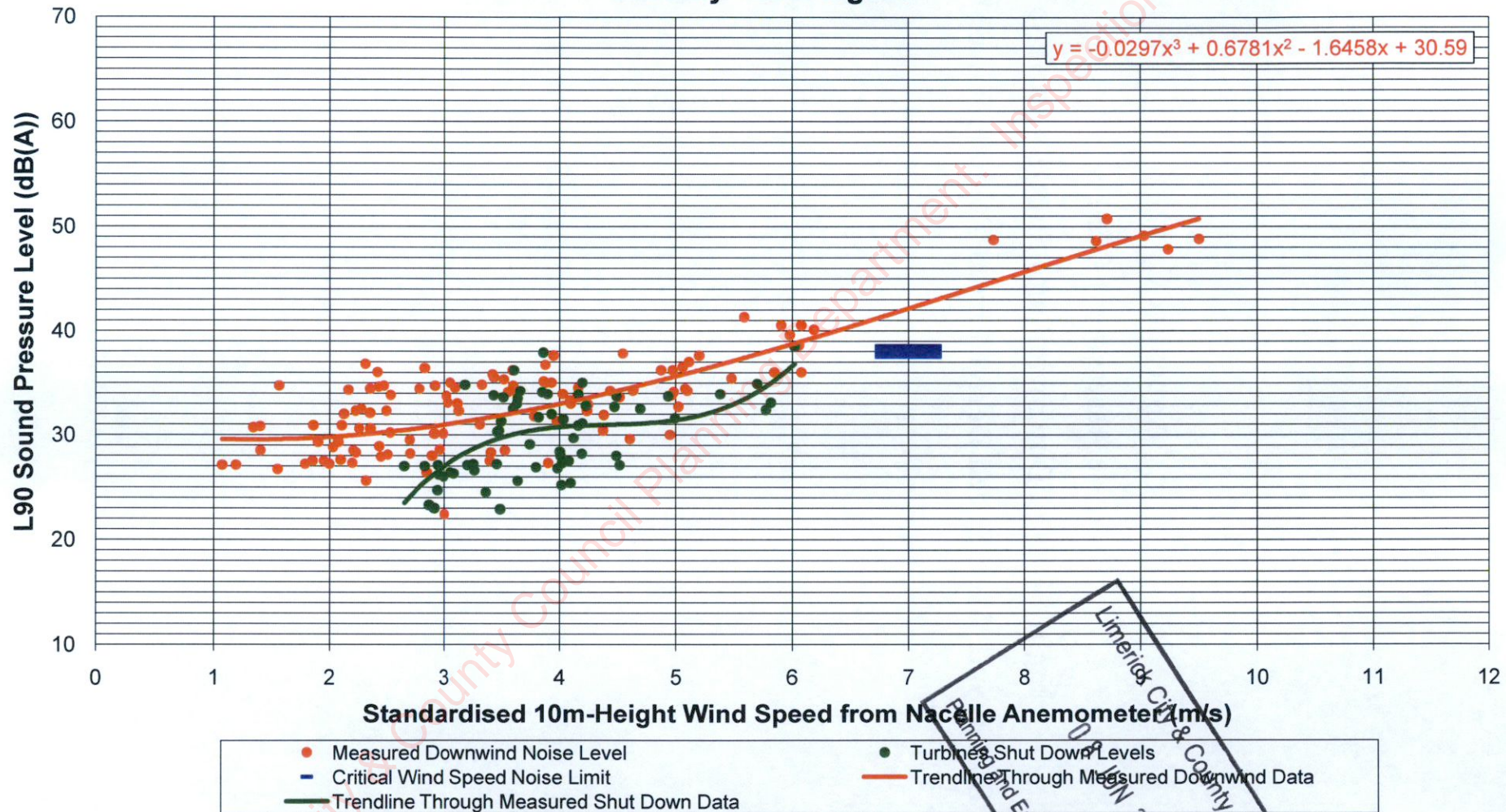


**Knockastanna W/F Noise Compliance Assessment  
House J - Measured Noise Levels vs Wind Speed  
(Night Hours 2300-0700)  
11th June - 3rd July**





**Knockastanna W/F Noise Compliance Assessment  
House J - Measured Noise Levels vs Wind Speed  
(Night Hours 2300-0700)  
3rd July - 5th August**



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2022



## **Appendix C**

### **Noise Assessment Charts**

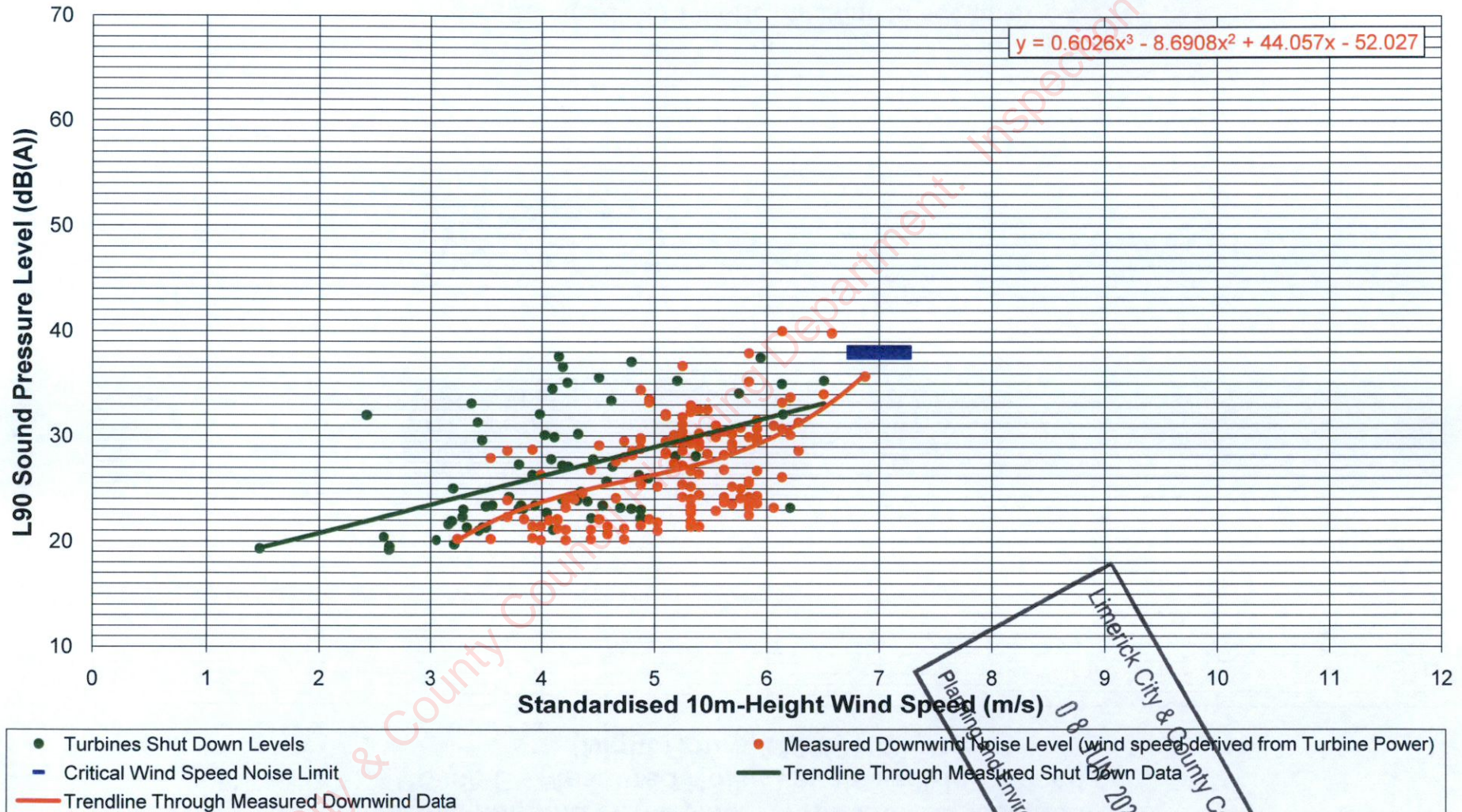
#### **Night Filtered Downwind and Shut-Down Data**

#### **Downwind Wind Speed Derived from Turbine Power Output**

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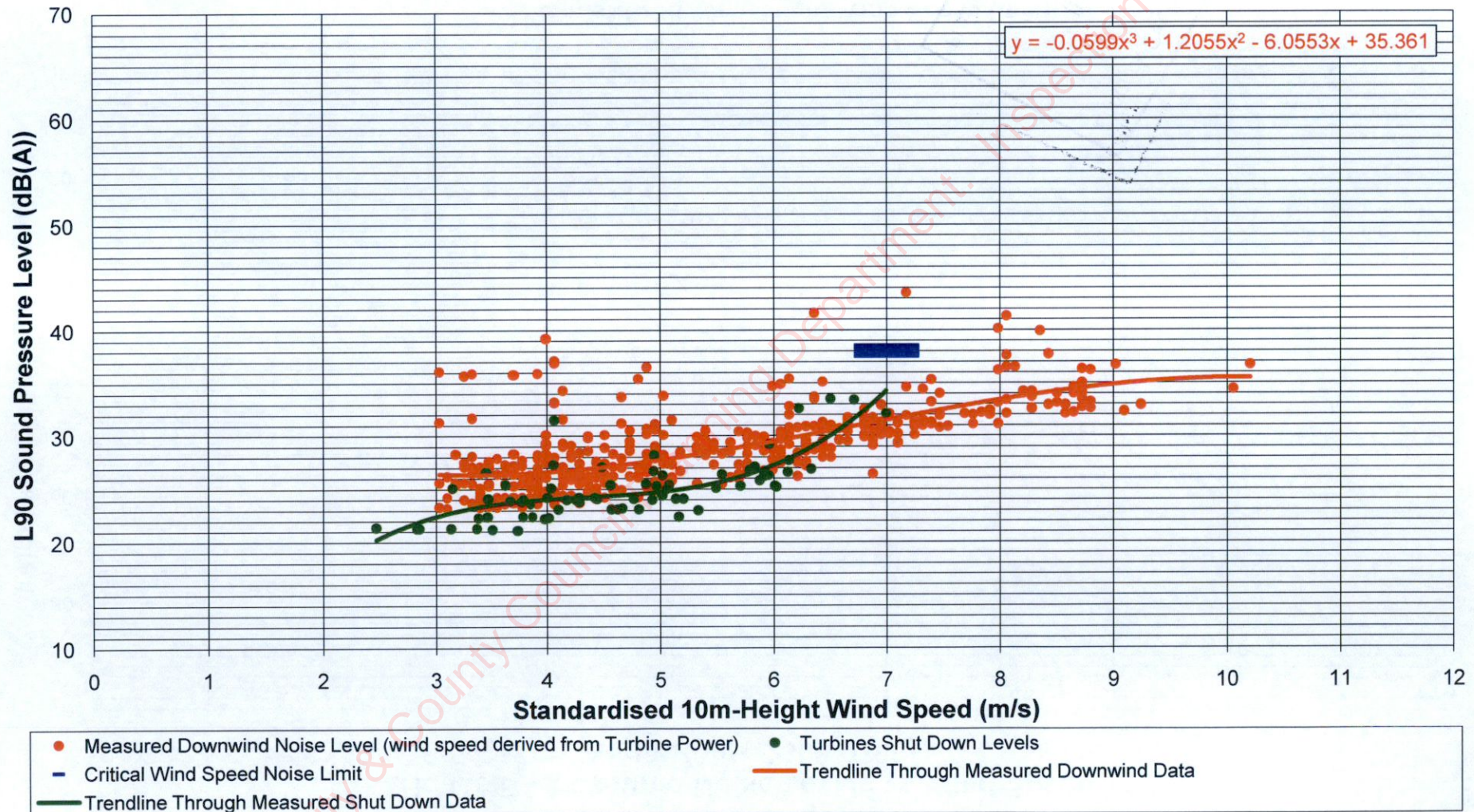
# Knockastanna W/F Noise Compliance Assessment House B - Measured Noise Levels vs Wind Speed (Night Hours 2300-0700)



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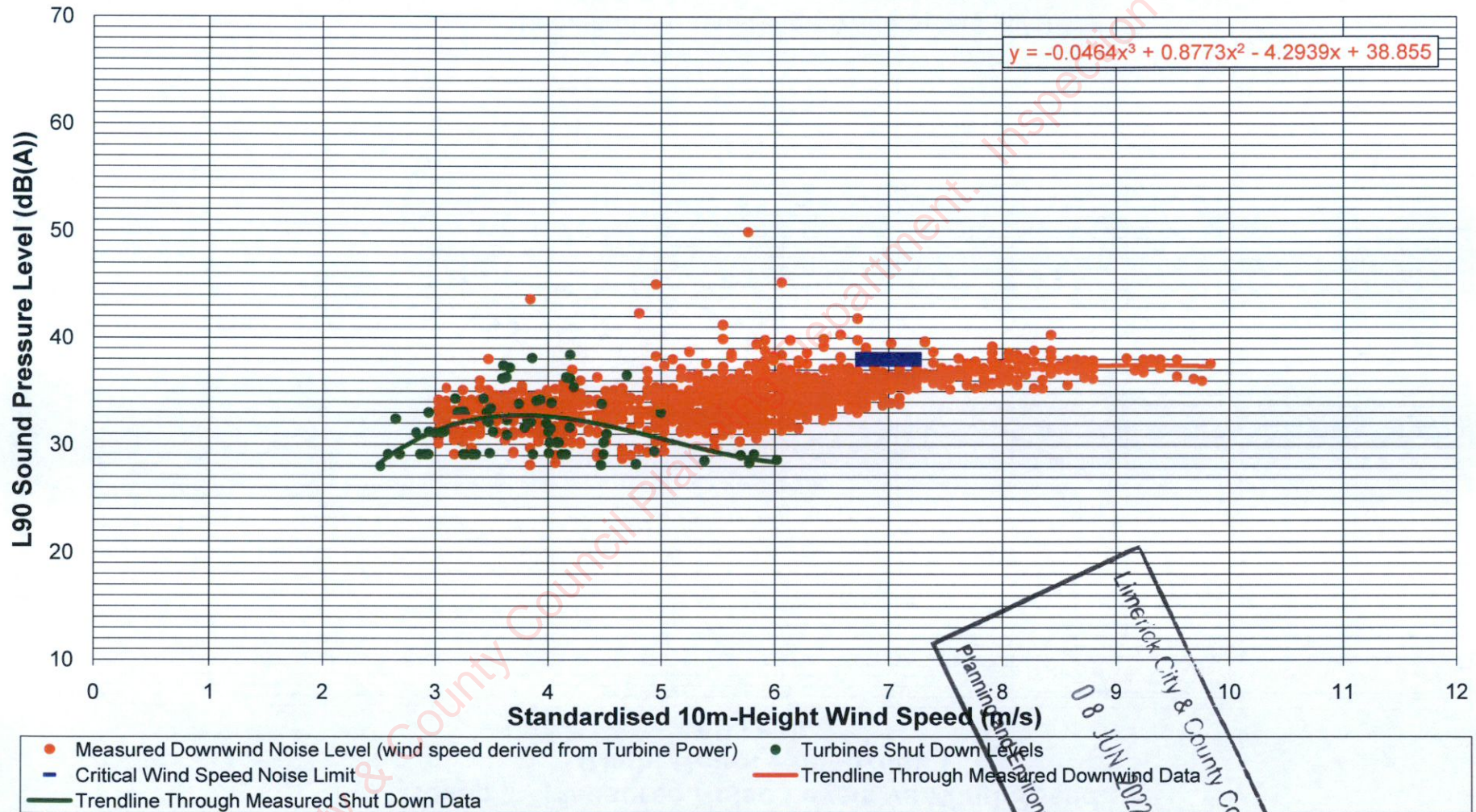


# Knockastanna W/F Noise Compliance Assessment House E - Measured Noise Levels vs Wind Speed (Night Hours 2300-0500)





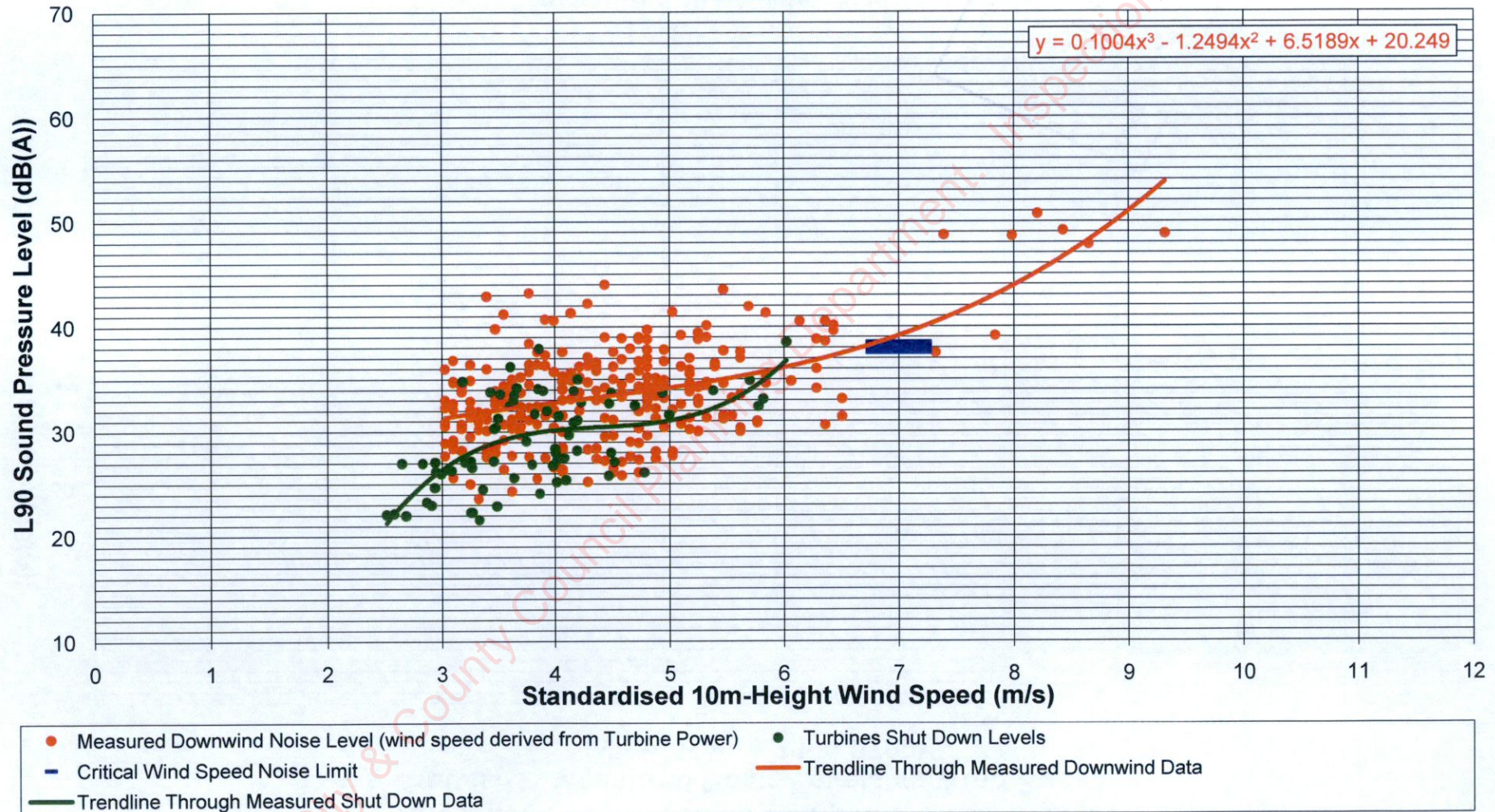
# Knockastanna W/F Noise Compliance Assessment House H - Measured Noise Levels vs Wind Speed (Night Hours 2300-0700)



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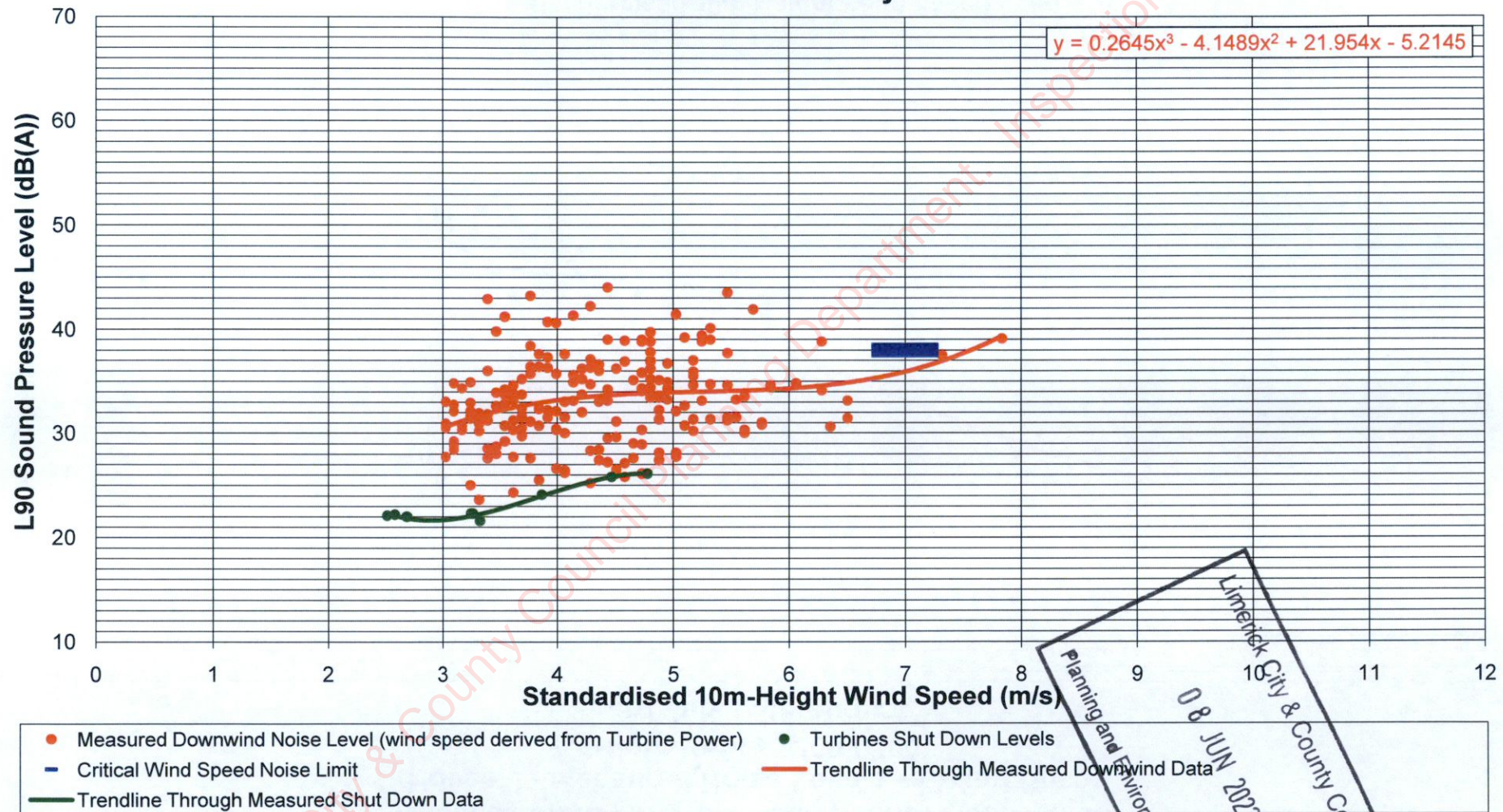


**Knockastanna W/F Noise Compliance Assessment**  
**House J - Measured Noise Levels vs Wind Speed**  
**(Night Hours 2300-0700)**  
**All Data**





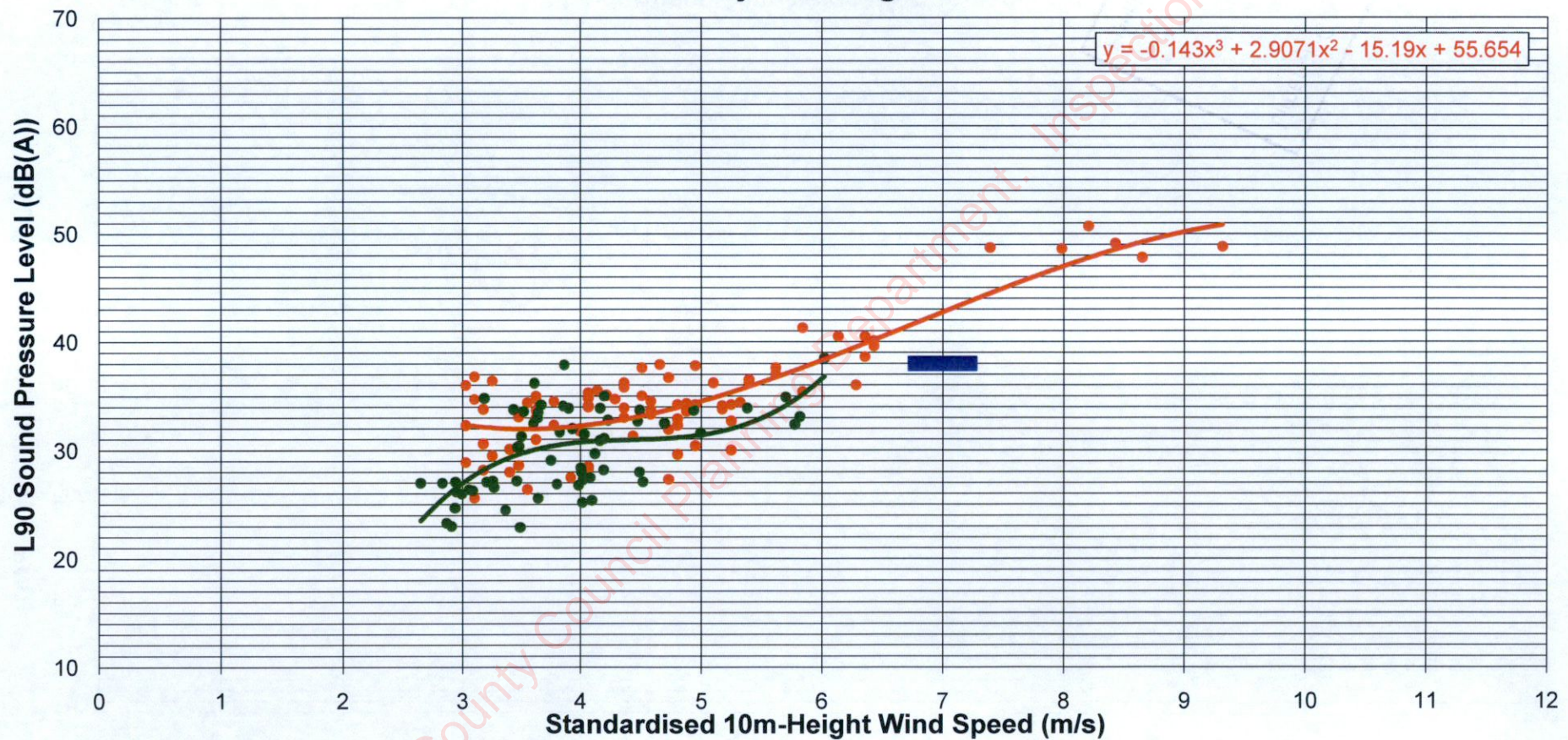
**Knockastanna W/F Noise Compliance Assessment  
House J - Measured Noise Levels vs Wind Speed  
(Night Hours 2300-0700)  
11th June - 3rd July**



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**Knockastanna W/F Noise Compliance Assessment  
House J - Measured Noise Levels vs Wind Speed  
(Night Hours 2300-0700)  
3rd July - 5th August**



- |   |  |
|---|--|
| ● Measured Downwind Noise Level (wind speed derived from Turbine Power) | ● Turbines Shut Down Levels                |
| — Critical Wind Speed Noise Limit                                       | — Trendline Through Measured Downwind Data |
| — Trendline Through Measured Shut Down Data                             |  |