TECHNICAL APPENDIX 11.1

Noise Monitor In-Situ

NML 1 – H7

NML 2 – H37

NML 3A

NML 5 – H103

NML 7 – Quarry

NML 8 – H108

NML 9 – H19

NML 831 – H14

Noise Monitoring Locations and the Proposed Development

TECHNICAL APPENDIX 11.2

Wind Speed Calculations for Hub Height

A GOOD PRACTICE GUIDE TO THE APPLICATION OF ETSU-R-97 FOR THE ASSESSMENT AND RATING OF WIND TURBINE NOISE

Institute of Acoustics

4.5 Wind Shear Corrections

4.5.1 Basing the predictions on sound power data tested in accordance with the IEC 61400-11 standard (or equivalent) should mean that the wind reference used corresponds to hub height wind speeds, standardised to 10 m height using a fixed correction (see **Annex A**). These predictions can then be compared to background levels and/or associated noise limits derived using an equivalent wind speed reference, which will have wind shear taken into account directly.

4.5.2 When this is not the case, for example when considering background data measured against direct wind speed measurements at 10 m height, it is necessary to apply corrections to account for this. Any such corrections should be clearly outlined and detailed in any noise assessment so that they can be reviewed by any assessor. The assessment should be made using the most detailed information available.

4.5.3 Examples of methods which can be used to correct predictions to account for wind shear effects, when only using a 10 m mast, are included in **Supplementary Guidance Note 4** (wind shear). This note presents methods to calculate corrections on the basis of long-term data measured at different heights, but as such data may not be available for a specific site, typical shear values are also presented. Alternatively, similarly derived corrections representing typical (average) shear values can be applied to the wind speed reference used for the derived typical background noise levels.

4.5.4 The following simplified method is proposed for ease of use: applying a fixed correction by subtracting the following factors from the wind speed reference used in the turbine predictions: 1 m/s for turbine hub heights of up to 30 m, 2 m/s for hub heights of up to 60 m and 3 m/s for hub heights of more than 60 m. Such a generic approach would be suitable in the context of a study made using a 10 m mast to limit costs, in the absence of site-specific data.

4.5.5 If it can be demonstrated that the predicted levels are below the applicable lower fixed limits regardless of wind speed, it can be seen that wind shear would not have an effect on the assessment and this may form the basis of a suitable planning condition.

TECHNICAL APPENDIX 11.3

Background Noise Levels, background plus 5 trendline with the predicted noise levels against a noise limit of 45 dB(A) at each receptor

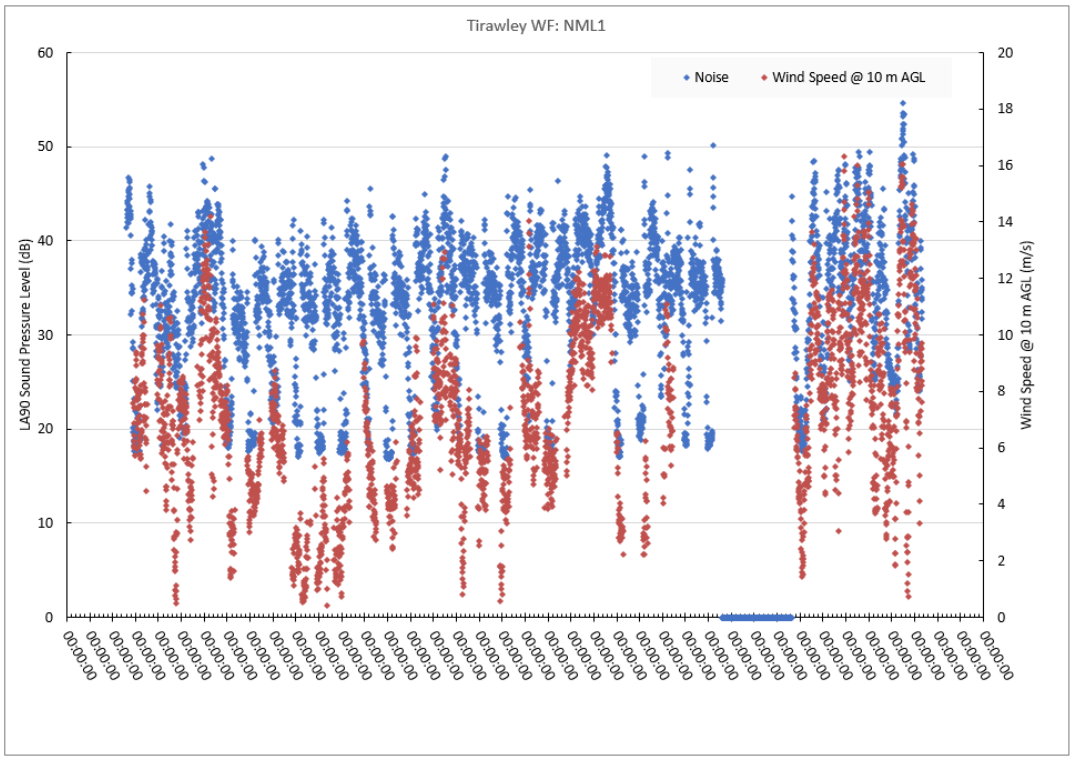


Chart 11.1: NML 1 – H7, comparing the background noise level and wind speed over the measurement period

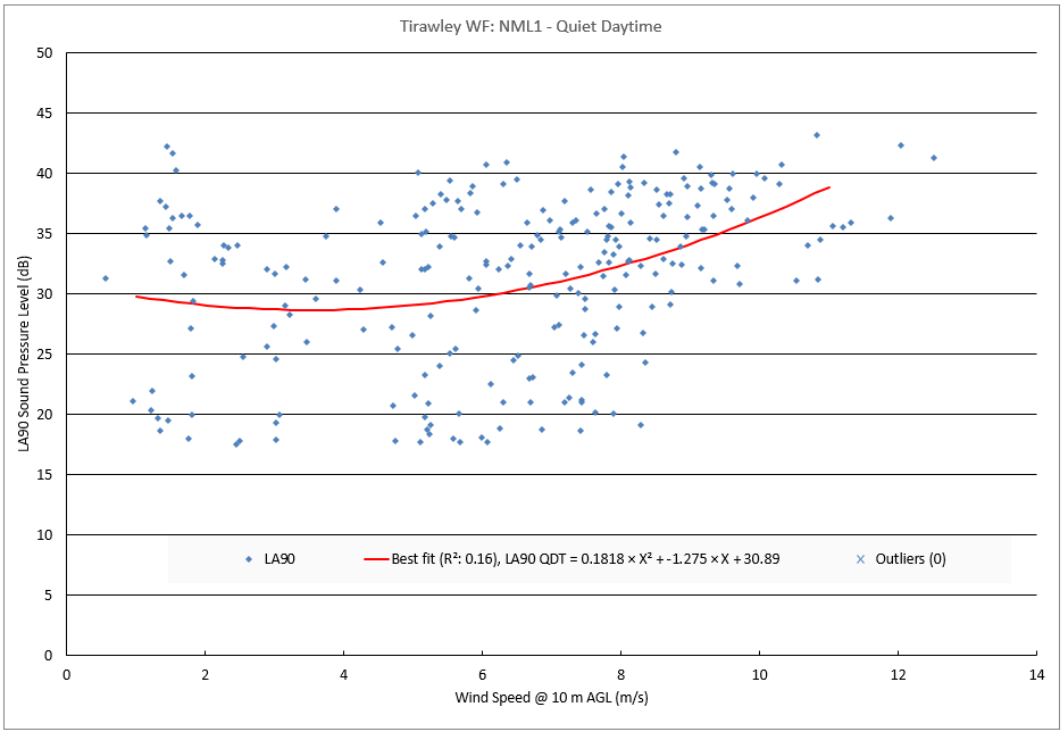


Chart 11.2: NML 1 – H7 for quiet daytime, background noise level, predicted level and assessment limit

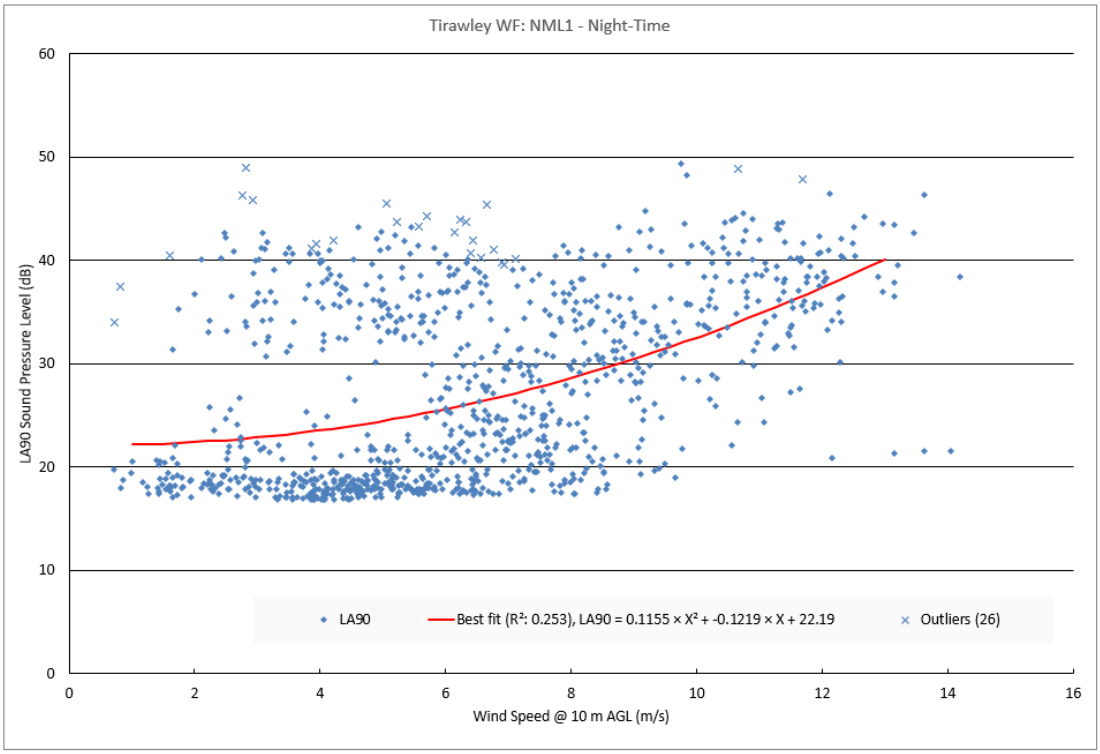


Chart 11.3: NML 1 – H7 for night-time, background noise level, predicted level and assessment limit

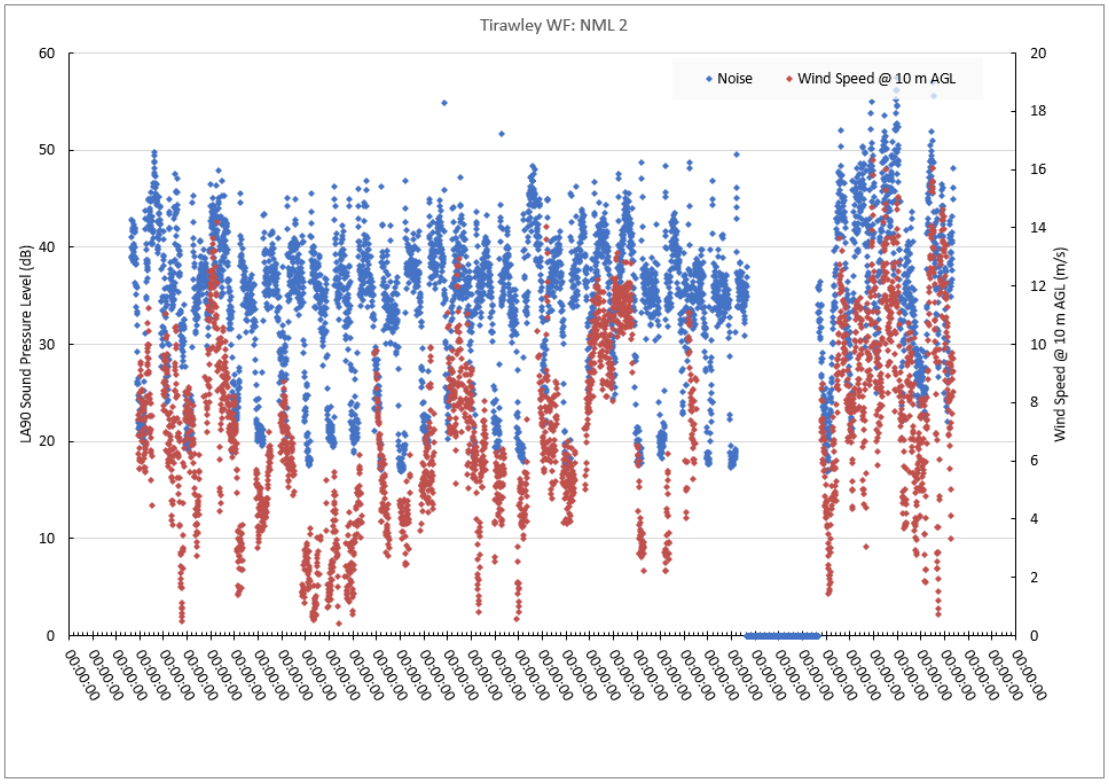


Chart 11.4: NML 2 - H37 comparing the background noise level and wind speed over the measurement period

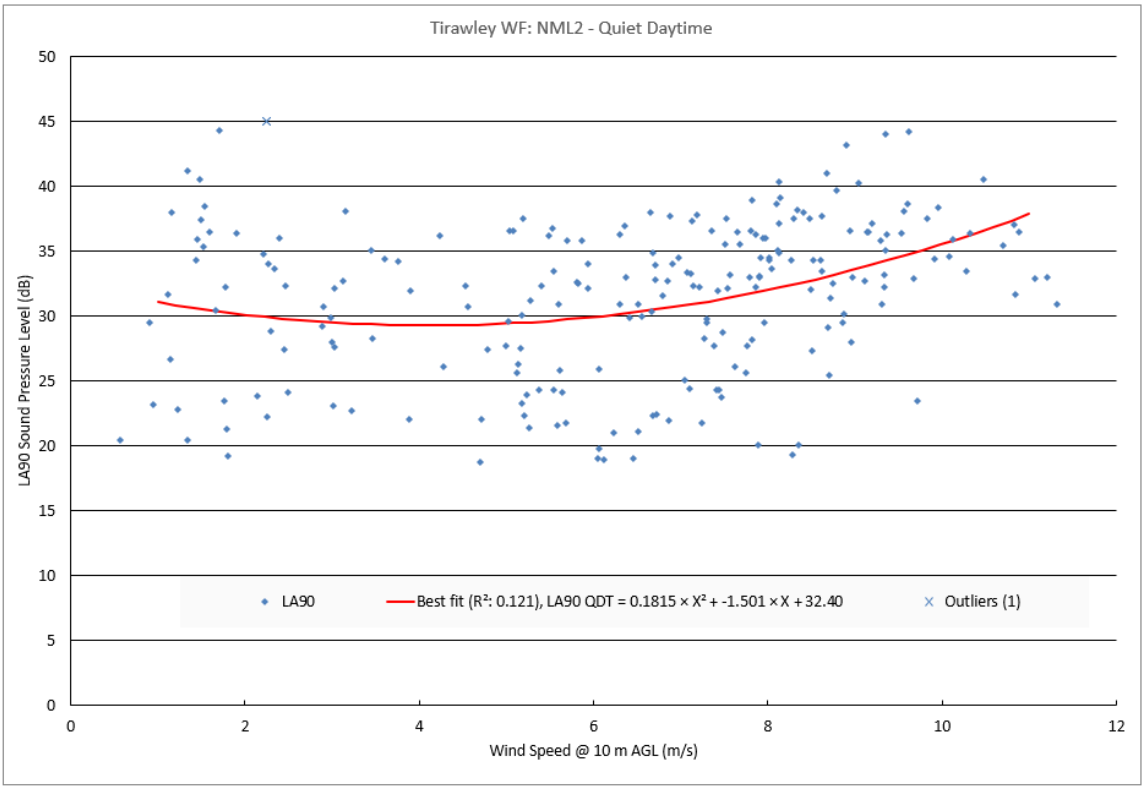


Chart 11.5: NML 2 - H37 for quiet daytime, background noise level, predicted level and assessment limit

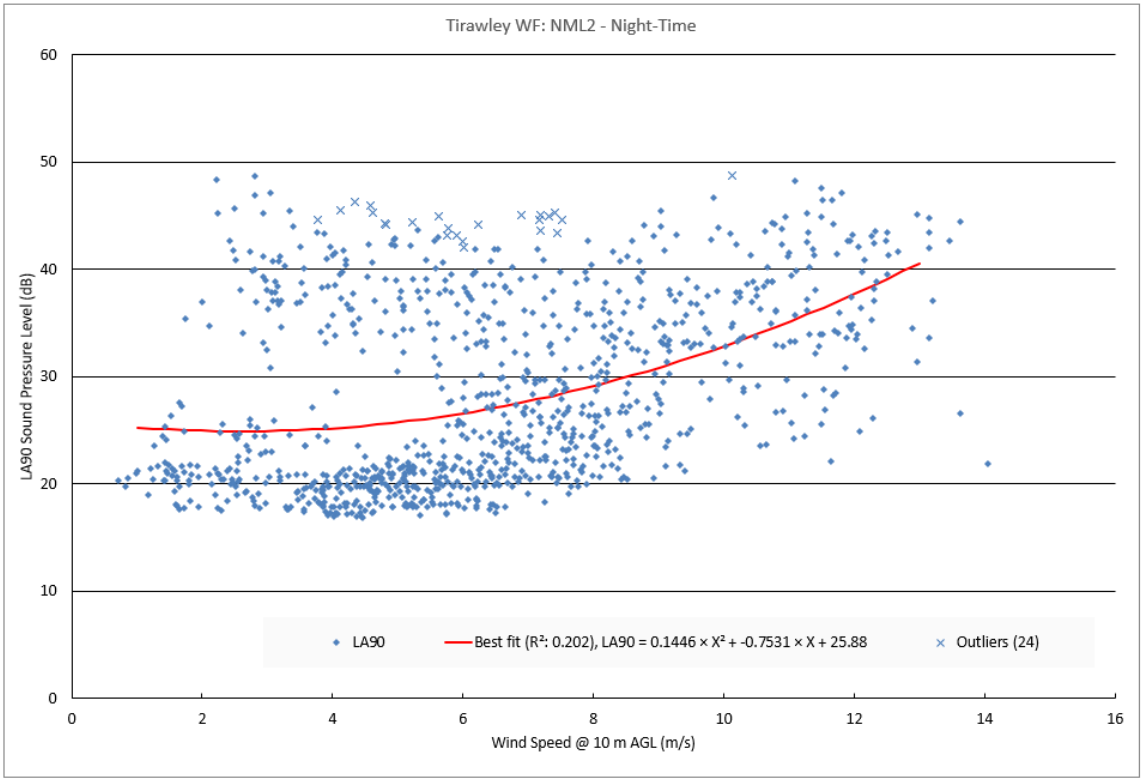


Chart 11.6: NML 2 - H37 for night-time, background noise level, predicted level and assessment limit

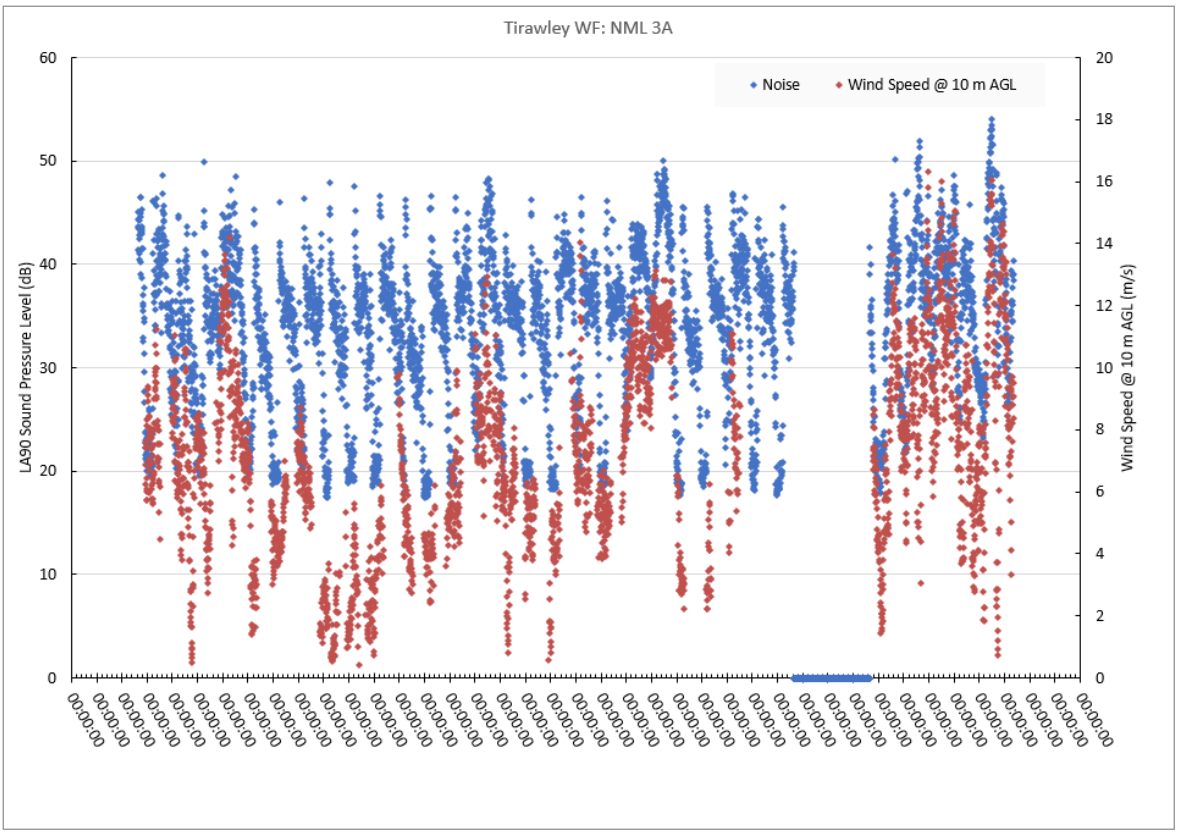


Chart 11.7: NML 3A comparing the background noise level and wind speed over the measurement period

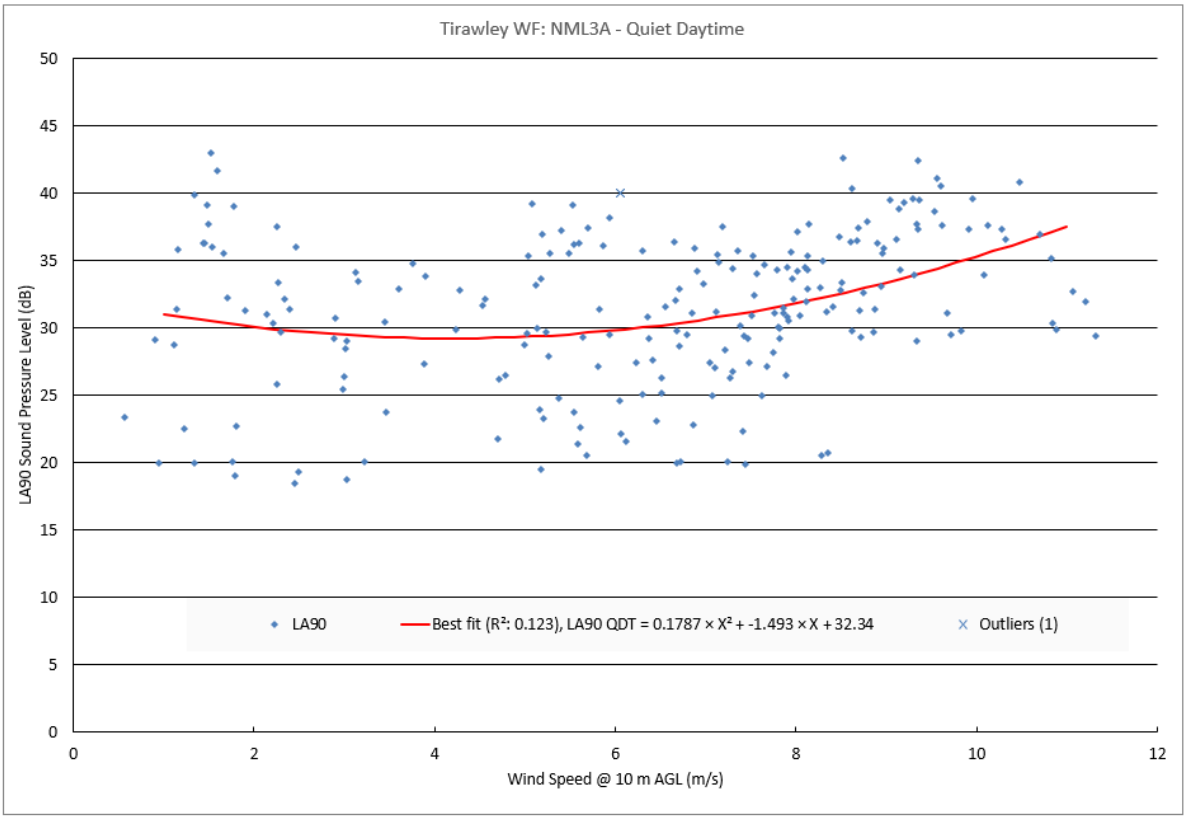


Chart 11.8: NML 3A for quiet daytime, background noise level, predicted level and assessment limit

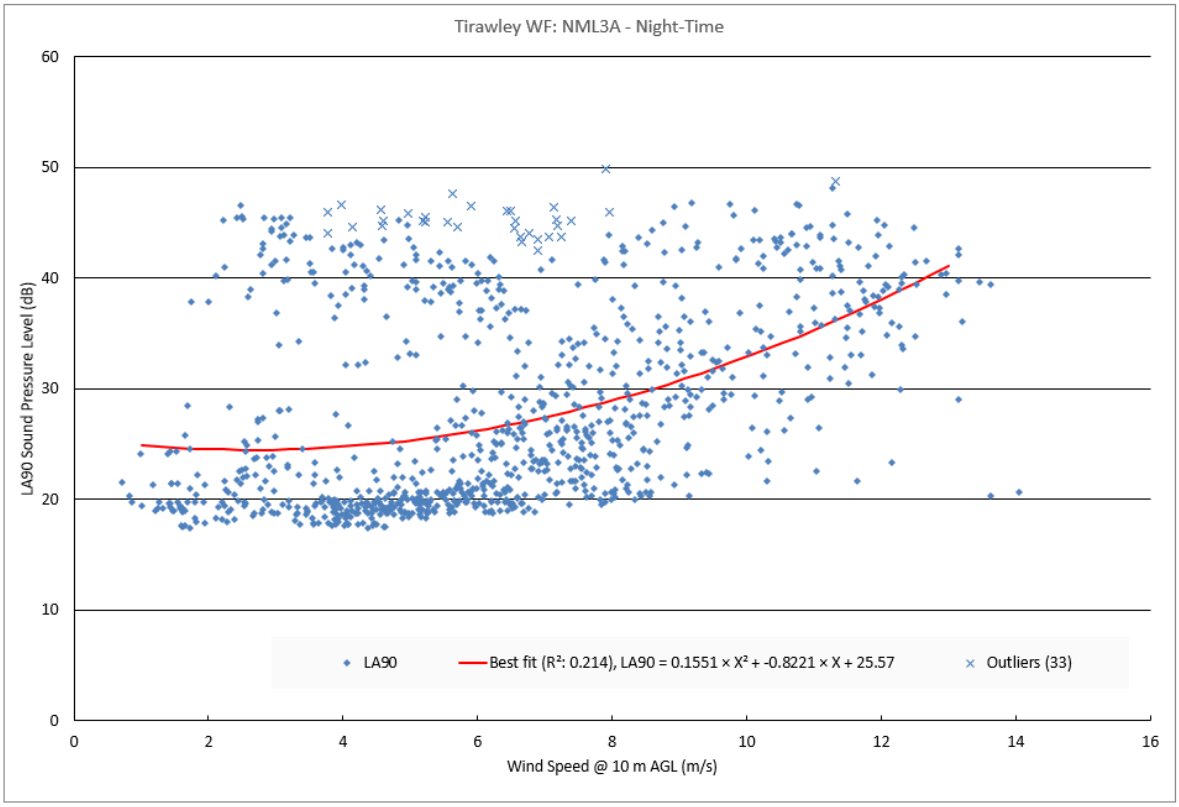


Chart 11.9: NML 3A for night-time, background noise level, predicted level and assessment limit

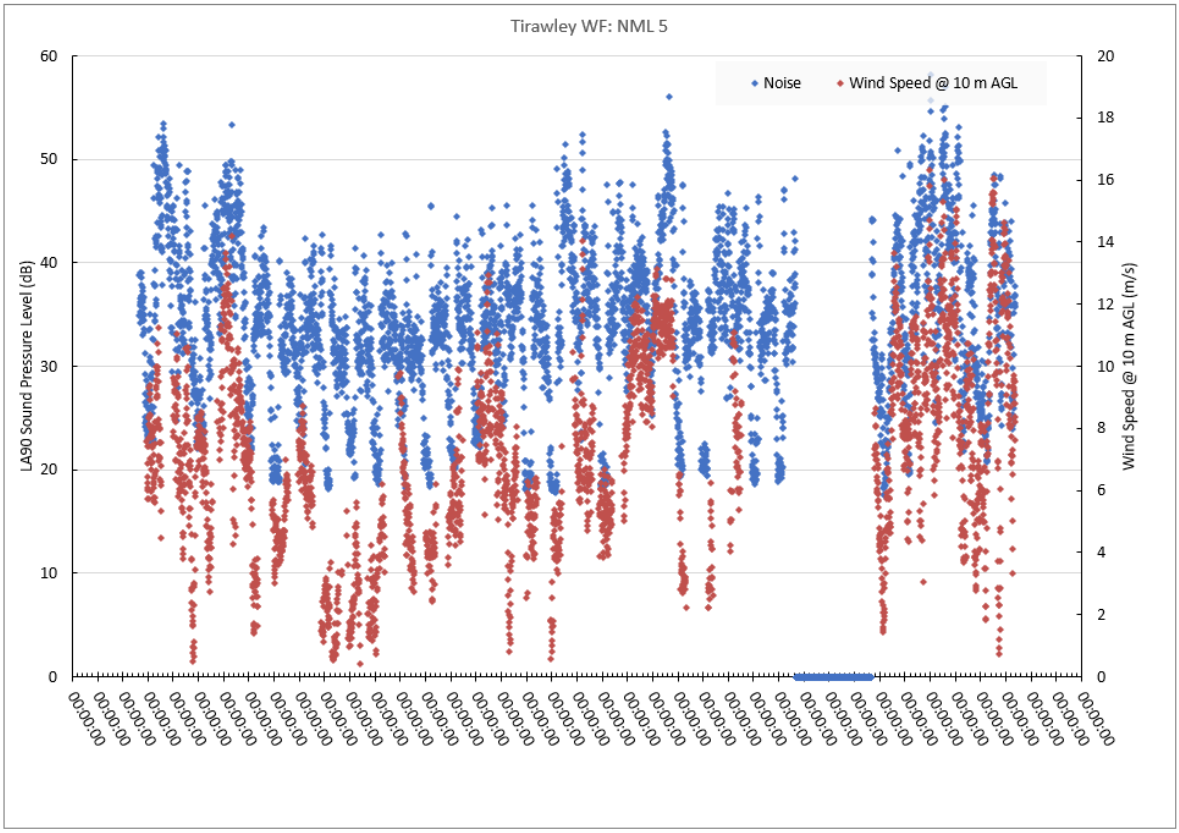


Chart 11.10: NML 5 – H103 comparing the background noise level and wind speed over the measurement period

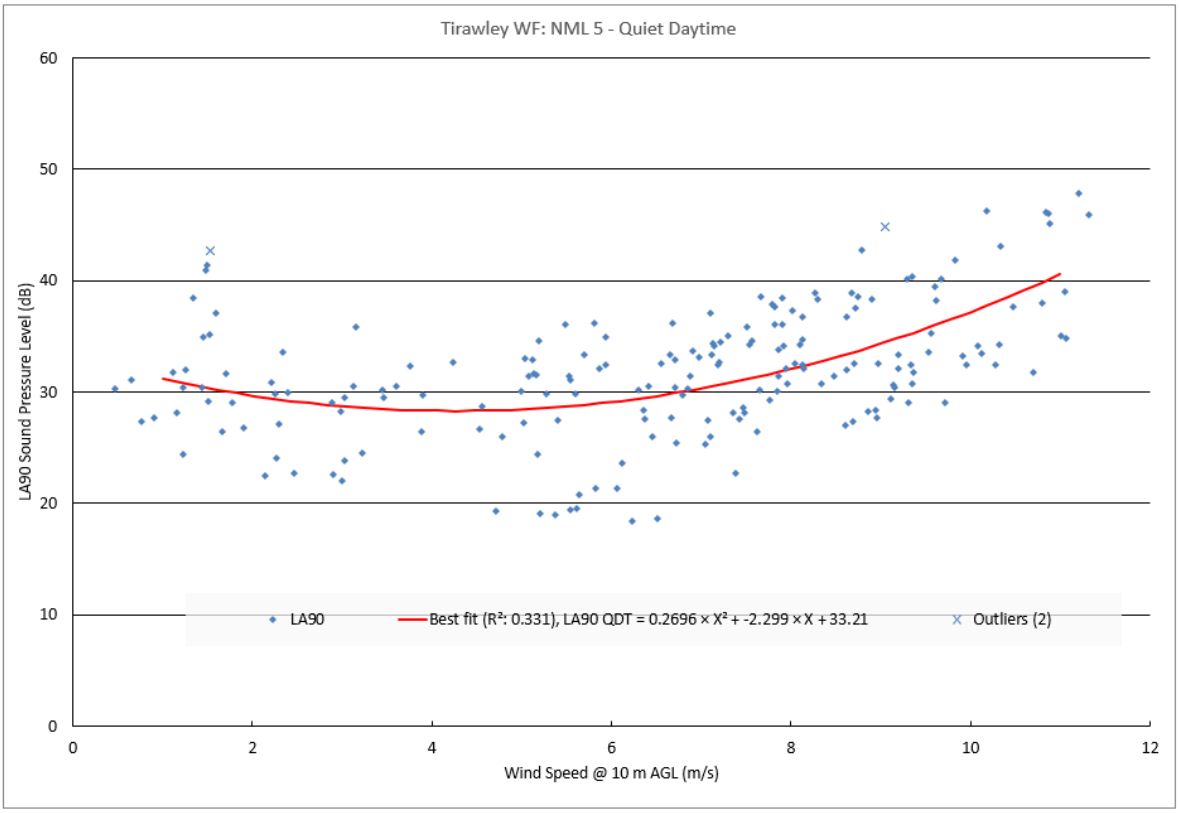


Chart 11.11: NML 5 – H103 for quiet daytime, background noise level, predicted level and assessment limit

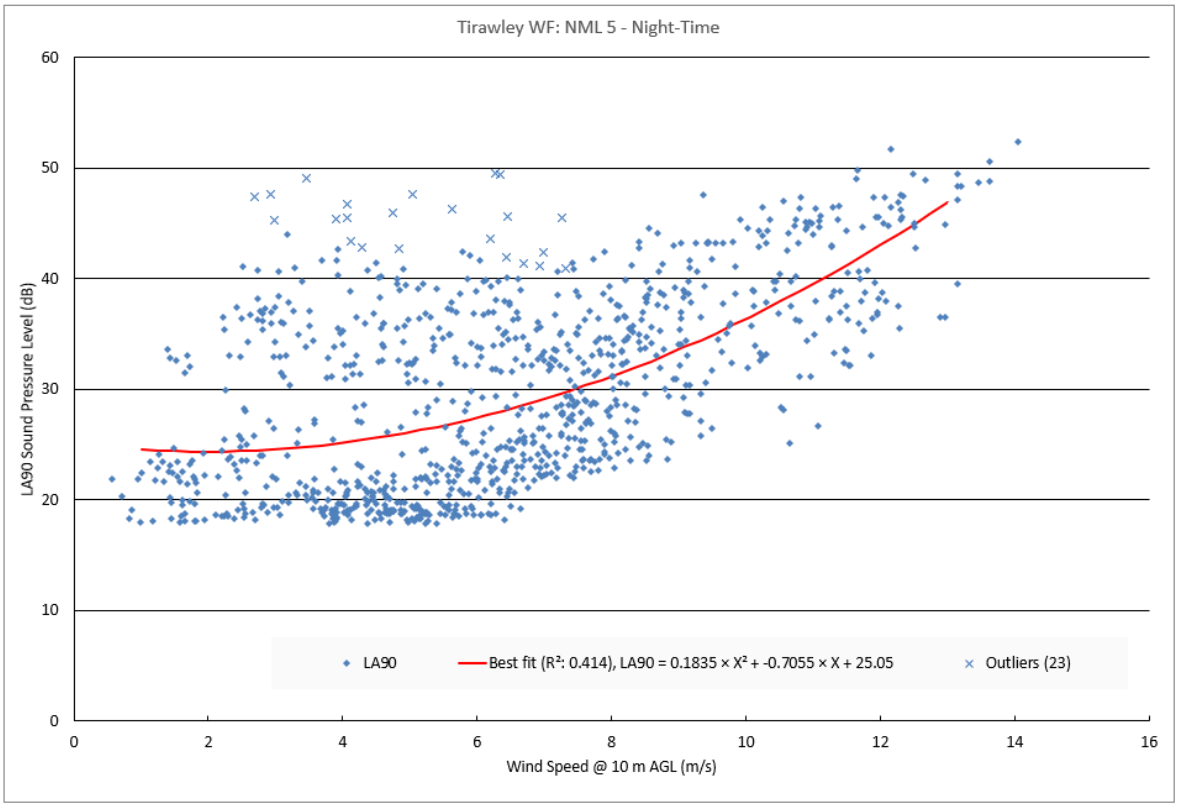


Chart 11.12: NML 5 – H103 for night-time, background noise level, predicted level and assessment limit

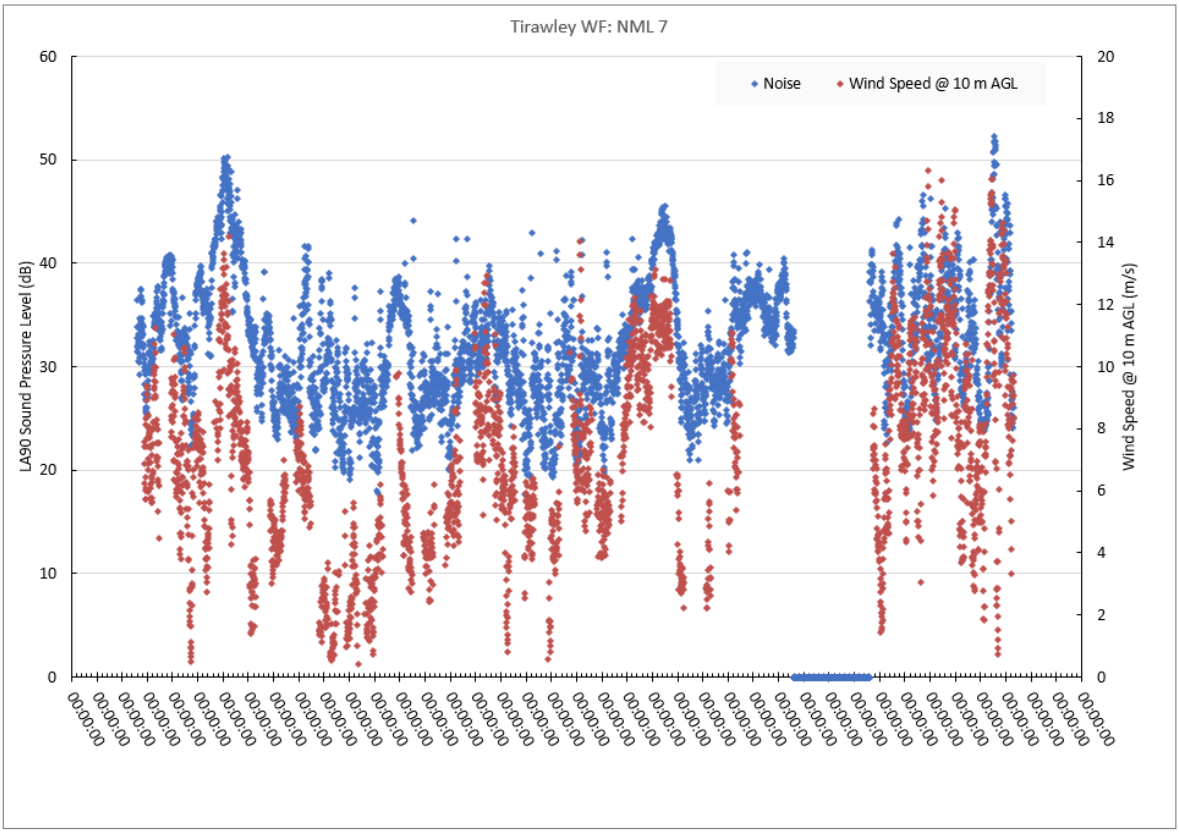


Chart 11.13: NML 7 - Quarry comparing the background noise level and wind speed over the measurement period

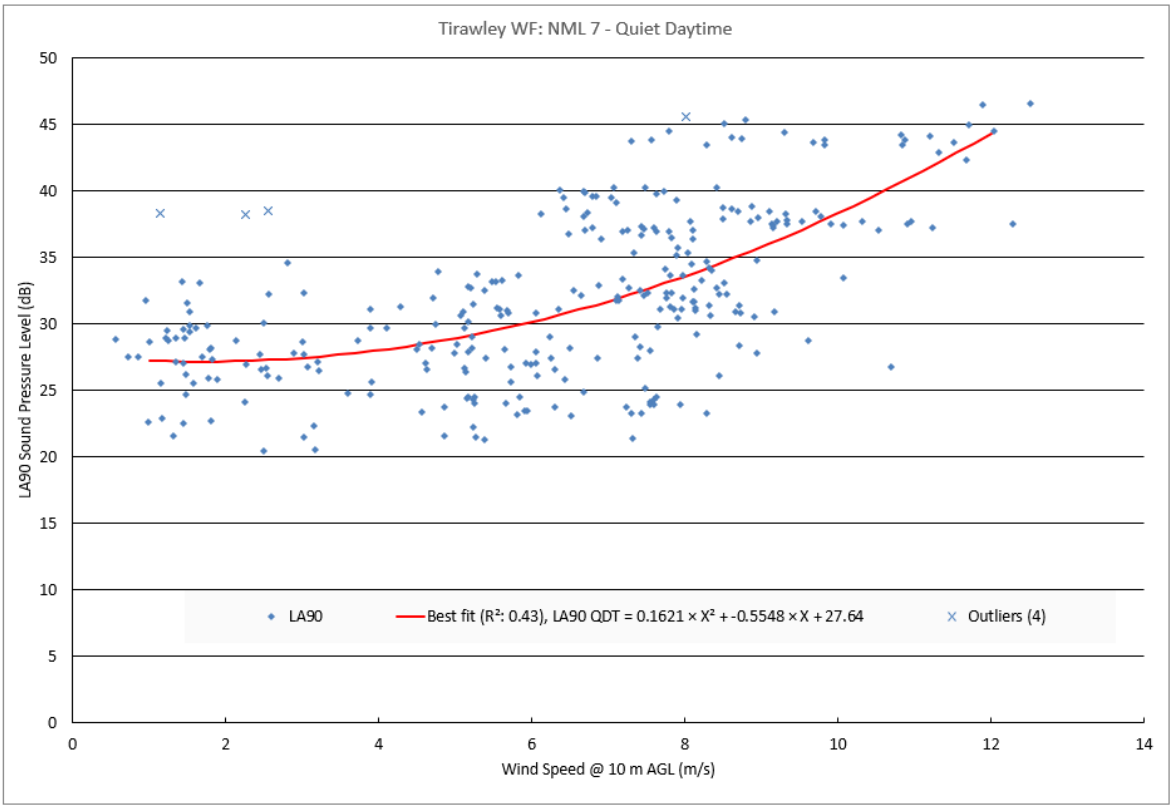


Chart 11.14: NML 7 - Quarry for quiet daytime, background noise level, predicted level and assessment limit

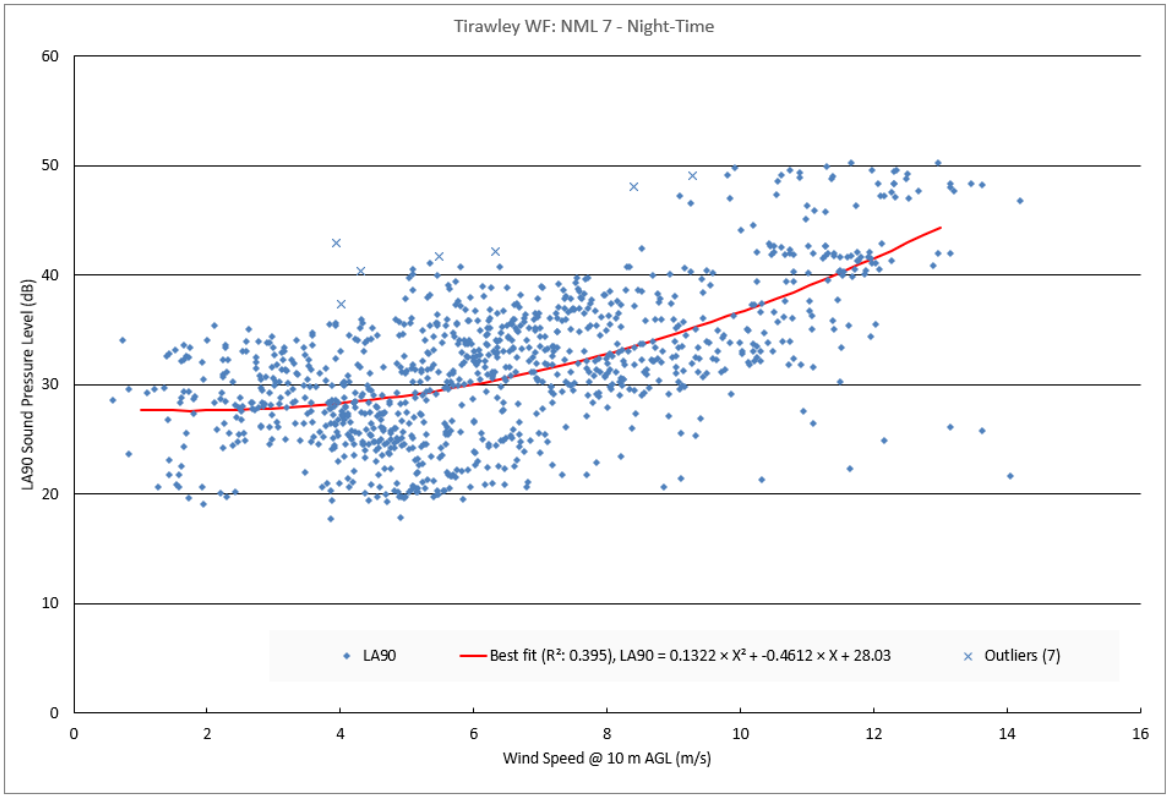


Chart 11.15: NML 7 - Quarry for night-time, background noise level, predicted level and assessment limit

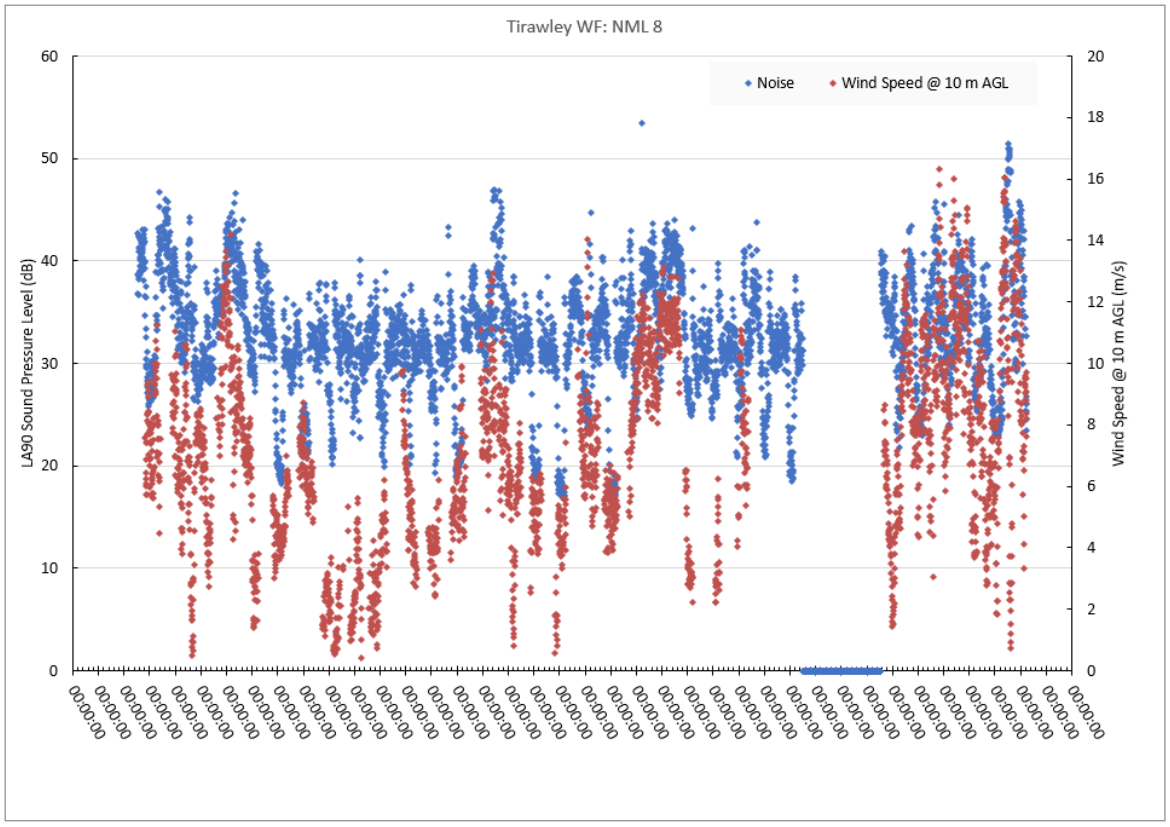


Chart 11.16: NML 8 - H108 comparing the background noise level and wind speed over the measurement period

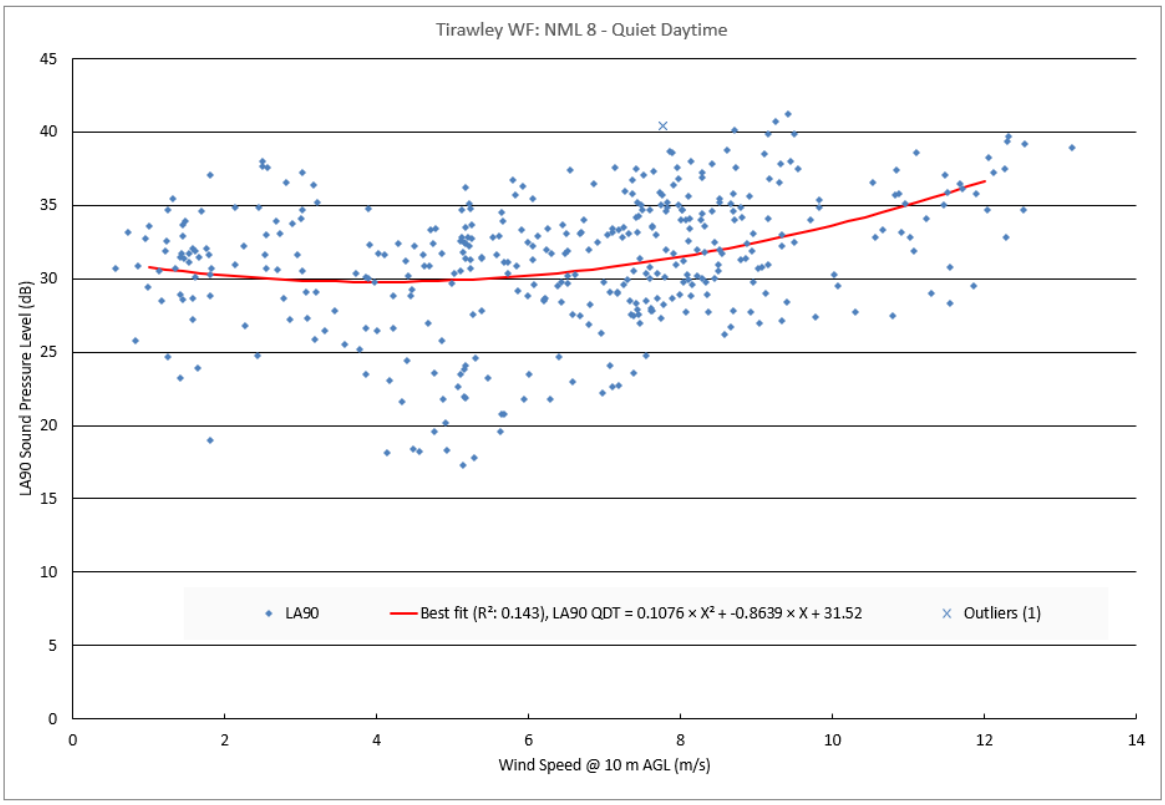


Chart 11.17: NML 8 - H108 for quiet daytime, background noise level, predicted level and assessment limit

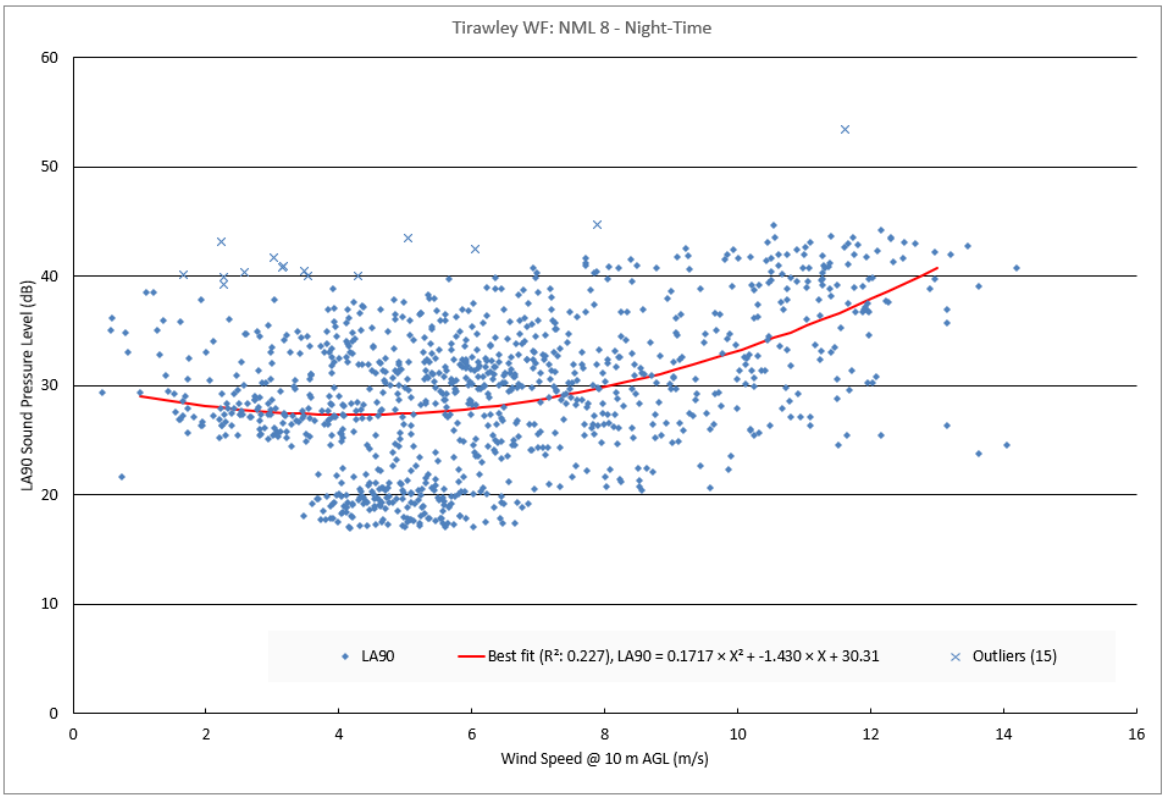


Chart 11.18: NML 8 - H108 for night-time, background noise level, predicted level and assessment limit

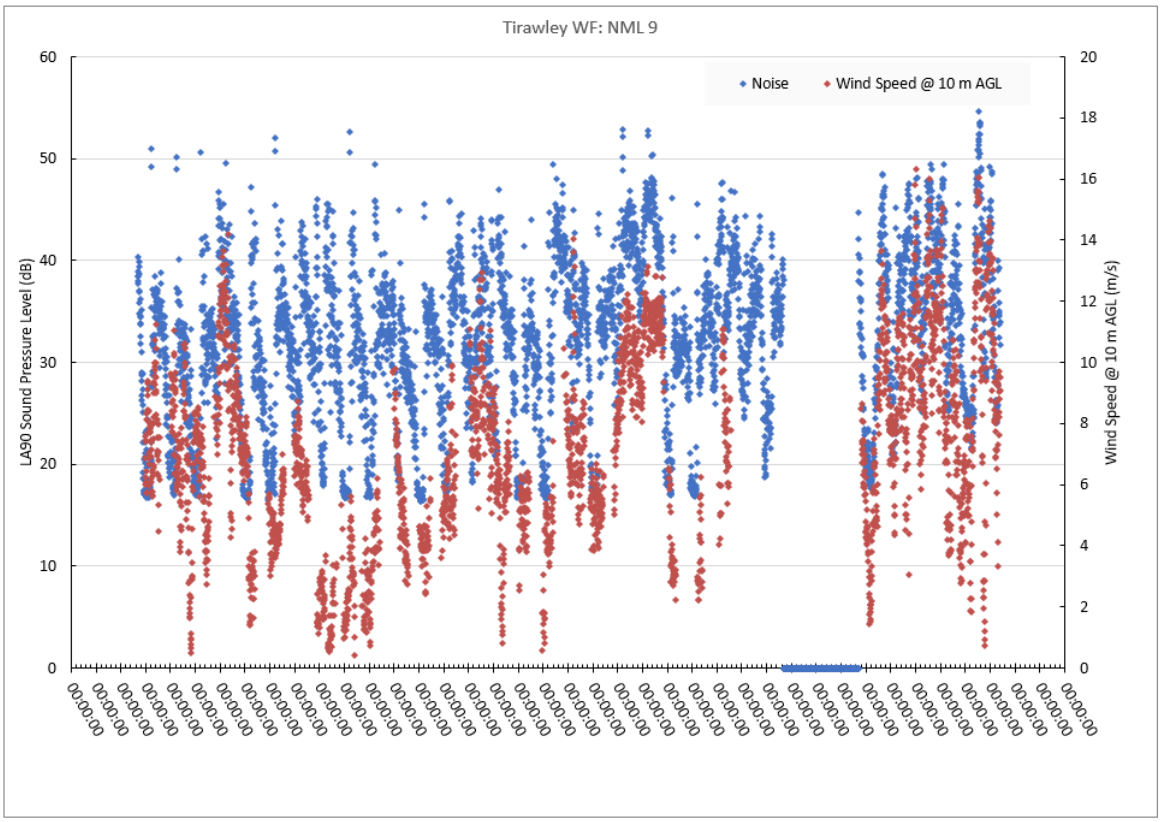


Chart 11.19: NML 9 - H19 comparing the background noise level and wind speed over the measurement period

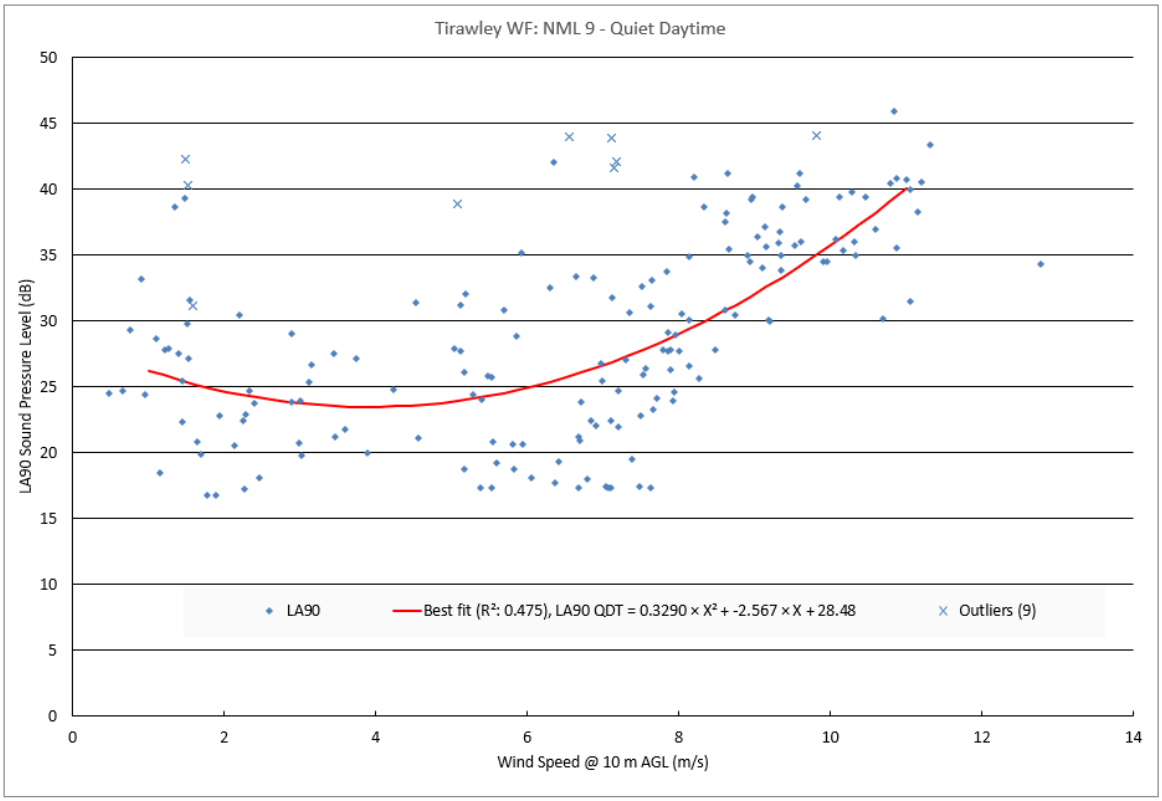


Chart 11.20: NML 9 - H19 for quiet daytime, background noise level, predicted level and assessment limit

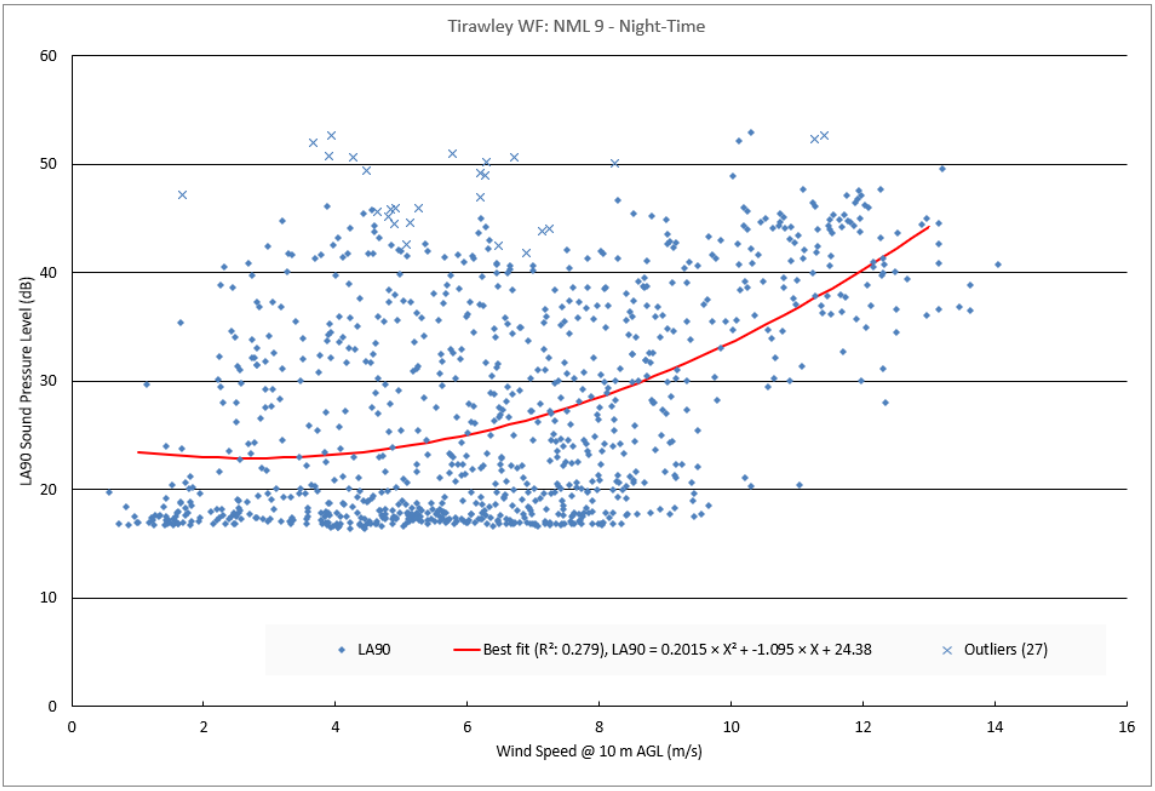


Chart 11.21: NML 9 - H19 for night-time, background noise level, predicted level and assessment limit

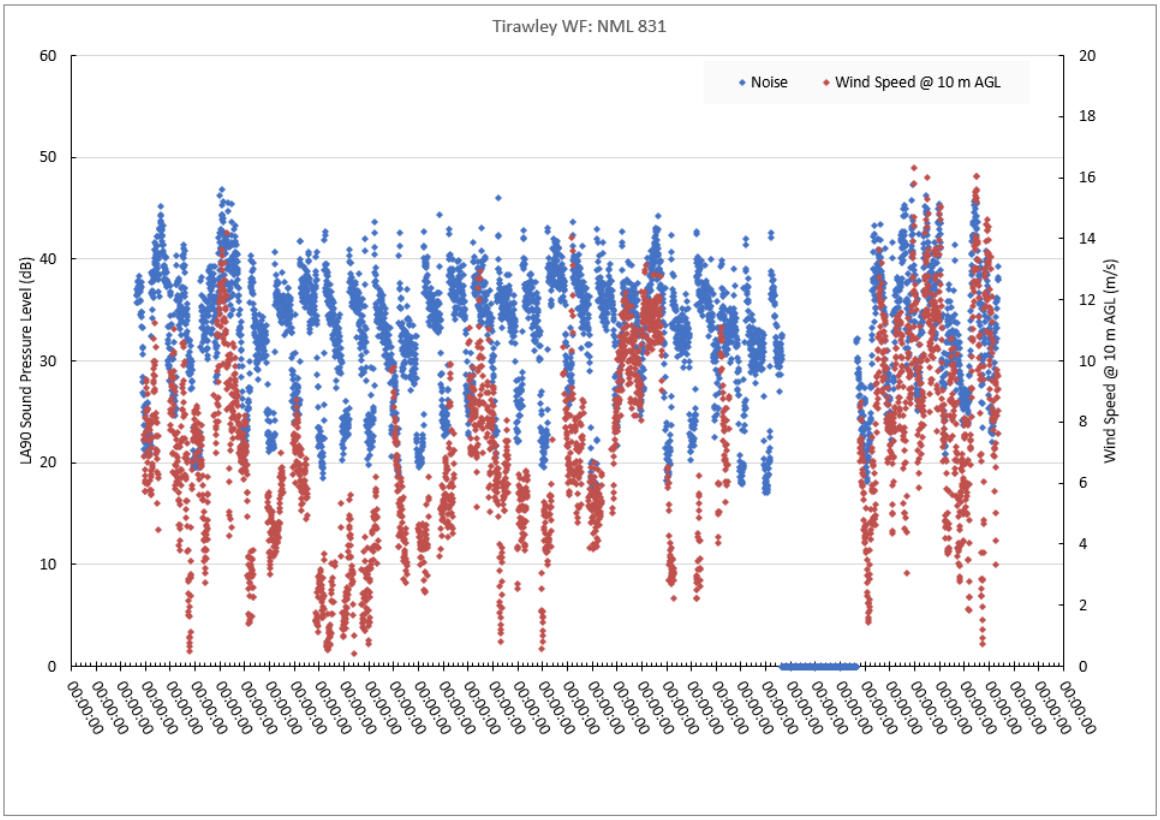


Chart 11.22: NML 831 - H14 comparing the background noise level and wind speed over the measurement period

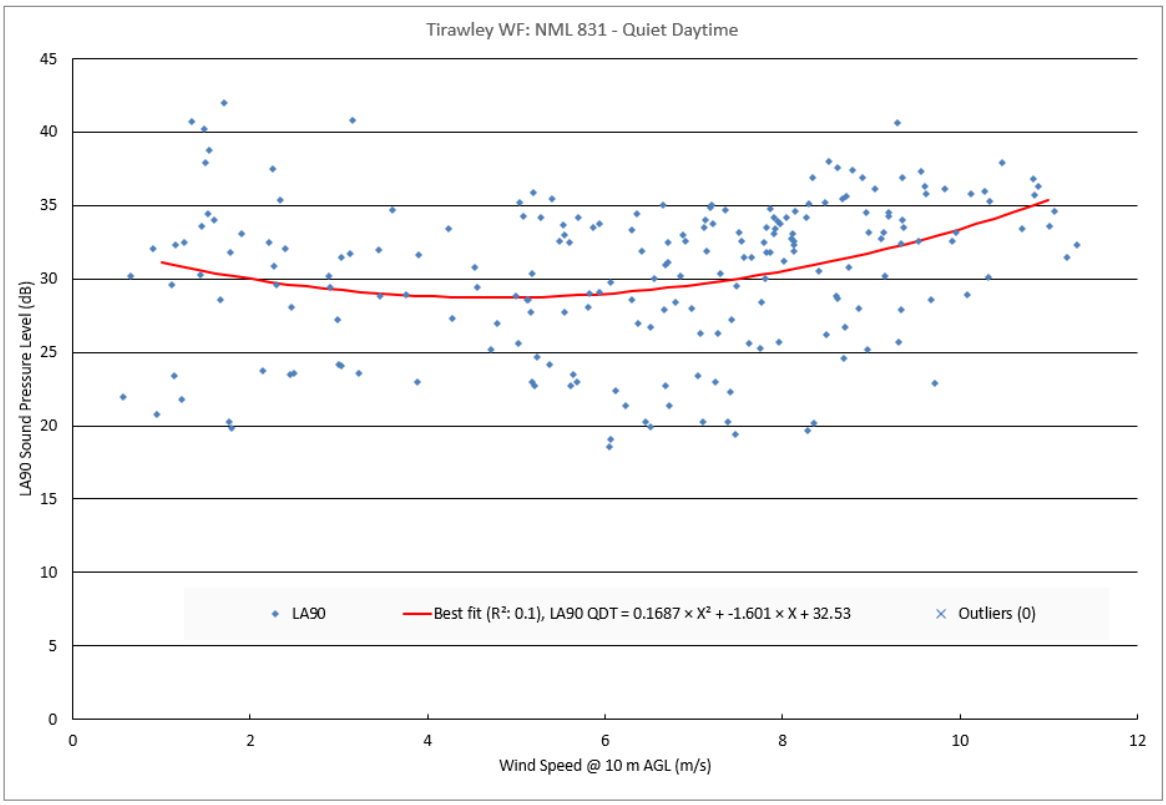


Chart 11.23: NML 831 - H14 for quiet daytime, background noise level, predicted level and assessment limit

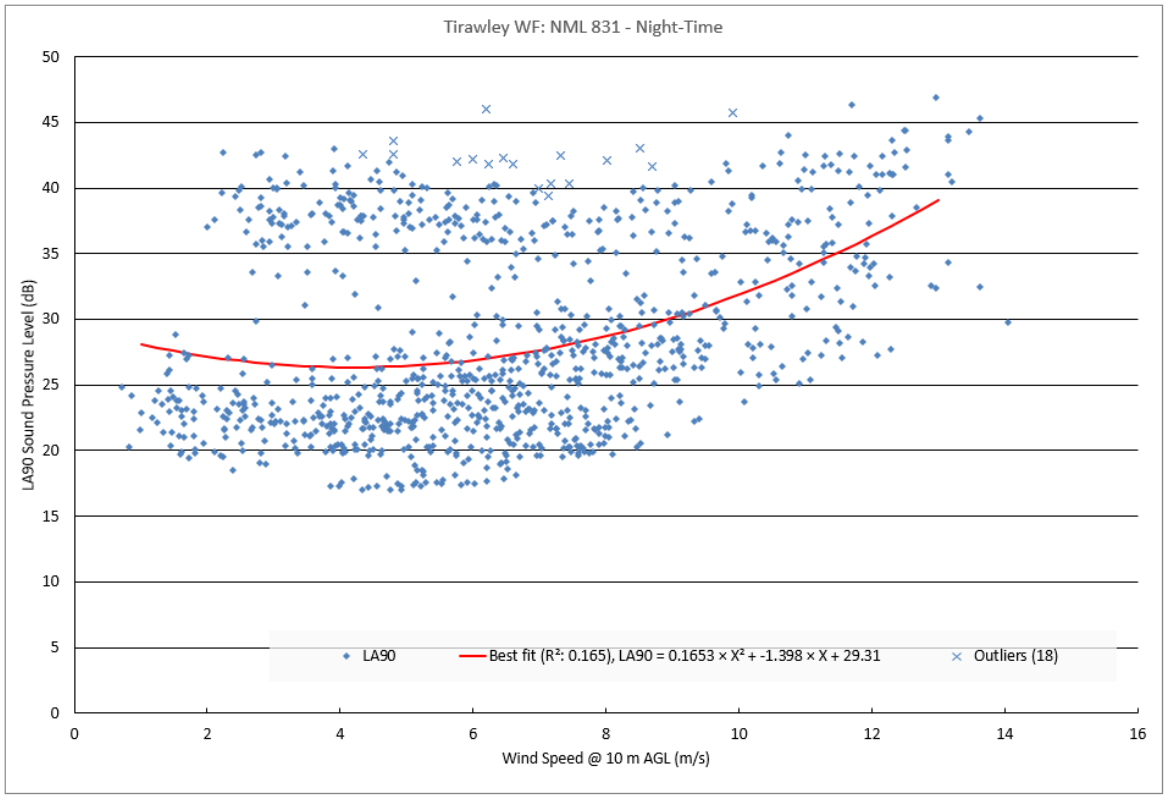
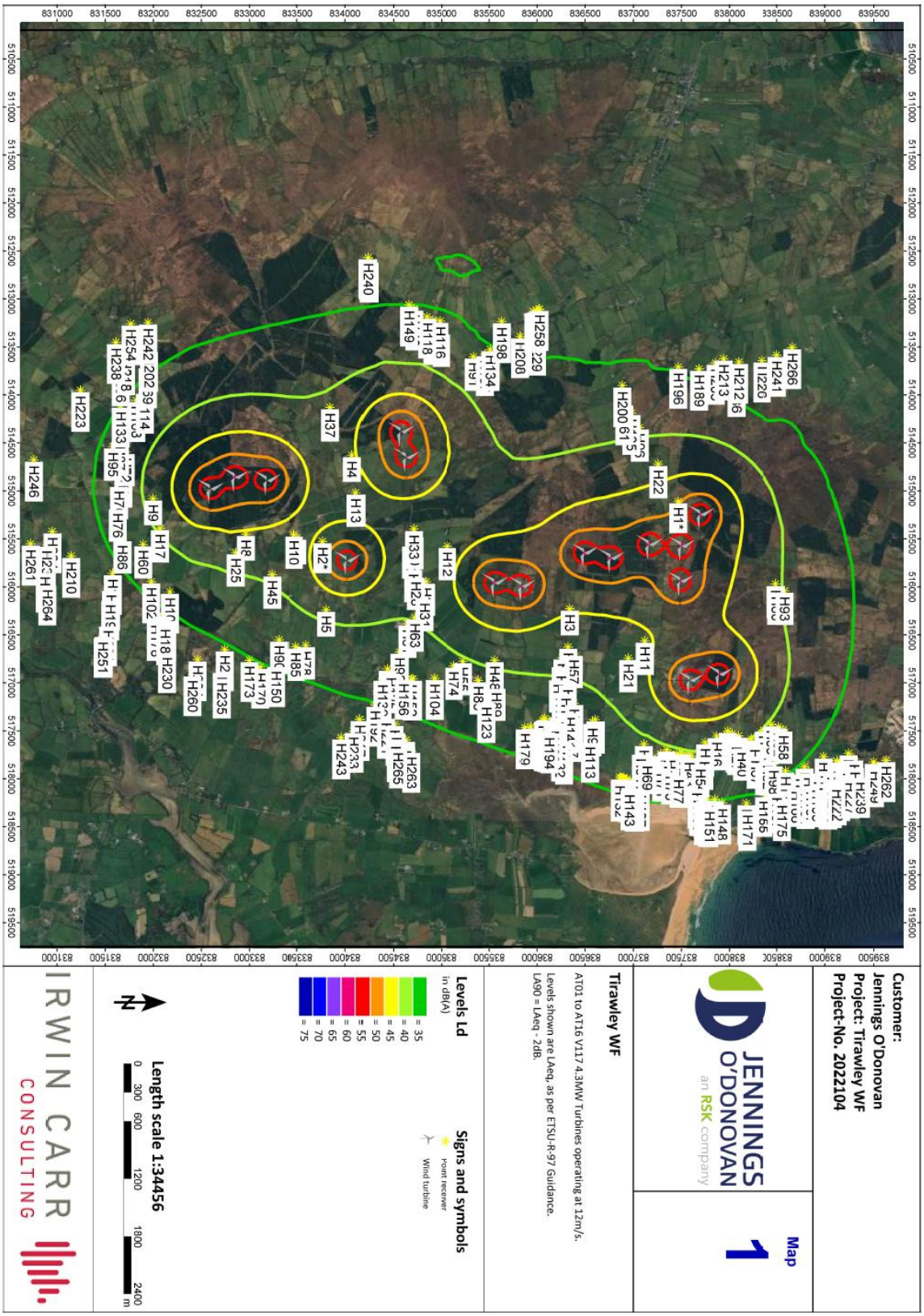
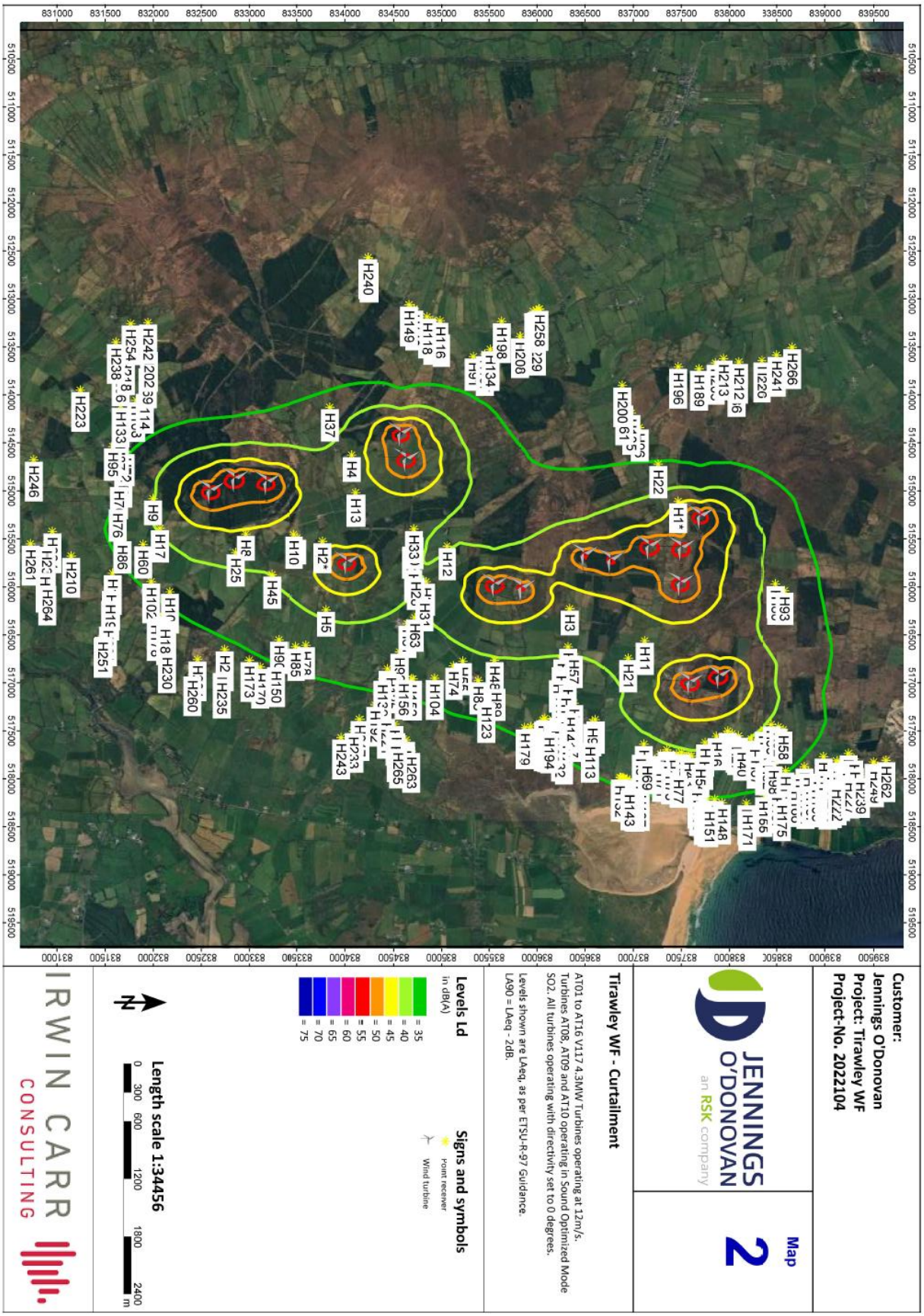


Chart 10.24: NML 831 - H14 for night-time, background noise level, predicted level and assessment limit

TECHNICAL APPENDIX 11.4

SoundPLAN Noise Outputs




Customer:
Jennings O'Donovan
Project: Tirawley WF
Project-No. 2022104
JENNINGS O'DONOVAN
an RSK company
Map 2
Tirawley WF - Curtailment
AT01 to AT16 V117 4.3MW Turbines operating at 12m/s.
Turbines AT08, AT09 and AT10 operating in Sound Optimized Mode SO2. All turbines operating with directivity set to 0 degrees.
Levels shown are LAeq, as per ETSU-R-97 Guidance.
LA90 = LAeq - 2dB.
Levels Ld
in dB(A)
= 35
= 40
= 45
= 50
= 55
= 60
= 65
= 70
= 75
Signs and symbols
Point receiver
Wind turbine
N
Length scale 1:34456
0 300 600 1200 1800 2400 m
IRWIN CARR CONSULTING

TECHNICAL APPENDIX 11.5

Calibration Certificates of Noise Instruments

MTS Calibration Ltd,
The Grange Business Centre,
Belasis Avenue,
Billingham TS23 1LG,
England
Telephone: 01642 876 410

0607

CERTIFICATE OF CALIBRATION

Page 1 of 1

Approved Signatory:

Tony Sherris

Issued by: MTS Calibration Ltd
Performed by Tony Sherris
Date of Issue: 02 March 2023 **Certificate Number:** 38152U

Sound Calibrator

Client: Environmental Measurements
Unit 12, Tallaght Business Centre
Whitestown Business Park
Co.Dublin 24, Ireland

On behalf of: Brendan Oreilly

The Device calibrated was:

Larson Davis **Model CAL200** **Serial Number 18140**

The measurements were performed at Elvington Close, Billingham, TS23 3YS and the measured values were as follows:

Output Level 1:	93.98	dB re 20µPa	± 0.15 dB (k= 2)
Fundamental Frequency 1:	1000.07	Hz	± 0.11 Hz (k= 2)
Total Harmonic Distortion 1:	0.37	%	± 0.01 % (k= 2)
Output Level 2:	114.01	dB re 20µPa	± 0.15 dB (k= 2)
Fundamental Frequency 2:	1000.07	Hz	± 0.11 Hz (k= 2)
Total Harmonic Distortion 2:	0.51	%	± 0.01 % (k= 2)

This measurement is valid only for the above device configured for calibration of a WS-2 microphone under the stated environmental conditions. For deviation of prevailing conditions, the manufacturer's literature for the calibrator should be referred to.

Date of Measurements: 02 March 2023 *Date of Receipt:* 23 February 2023

Method of calibration

A Reference Calibrator was used to establish the sensitivity of the measurement chain. The same measurement chain is then used to determine the output level of the Object Calibrator by the difference between its output and that of the nominated Reference Calibrator. Four independent measurements of the third-octave band sound pressure levels produced by the Reference Calibrators and the Object Calibrator are averaged to minimise uncertainties of the calibration. The measurement chain consists of a calibrated, Reference Microphone, Reference Preamplifier and Reference Analyser.

As well as providing a traceable measurement of the sound pressure level in the cavity of the Object Calibrator, the Calibrator's frequency and total harmonic distortion are also measured. Frequency is determined from the average of four independent measurements using a multimeter. The total harmonic distortion is measured from the average of three independent measurements by third octave analysis, subtracting the level of the fundamental frequency from the sum of the combined harmonics in the frequency band to 20kHz. The complete procedure is detailed in the MTS Calibration Ltd work procedure WP01.

The sound pressure level generated by the calibrator in its WS2 configuration was measured by reference to the reference Sound Calibrator as shown in the Test Equipment section below.

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k (individually calculated as above), providing a coverage probability of approximately 95%. The uncertainty evaluation has been calculated in accordance with the current version of UKAS publication M3003. The uncertainty quoted for the Distortion Measurement is the Distortion Percentage as measured, multiplied by our Uncertainty as calculated for the individual measurement or our CMC, whichever is the larger.

Measurement Conditions:

Temperature	23	°C	± 1 °C
Atmospheric Pressure	1027	mBar	± 2 mBar
Relative Humidity	35	%	± 5 %

Test Equipment used during this calibration:

Equipment	Manufacturer	Model	Serial No.	Traceability Ref.	Calibration Due
Reference Calibrator	Brüel & Kjær	4231	2326247	TE 129	Nov-23
Multimeter	HP	34401A	36146A63804	TE 105	Oct-23
Microphone	B&K	4133	810486	TE 155	Aug-23
Real-Time Analyser (set 1)	Larson Davis	2900	0492	TE 108	Jul-23

End of Certificate

MTS Calibration Ltd,
The Grange Business Centre,
Belasis Avenue,
Billingham TS23 1LG,
England
Telephone: 01642 876 410

CERTIFICATE OF CALIBRATION

Approved Signatory:

Tony Sherris

Issued by: MTS Calibration Ltd

Date of Issue: 02 August 2023 **Certificate Number:** 38648

Sound Level Meter

Sound Level Meter Periodic Tests to EN 61672-3: 2013 Class 1

Client: Brendan Oreilly

Instrument Make: Larson Davis
Instrument Model: LxT1L
Serial Number: 0005660

1

Associated Equipment	Make	Model	Serial number
Preamplifier	Larson Davis	PRMLxT1L	055684
Microphone	PCB	377B02	305875
Calibrator	Larson Davis	CAL200	9175
Calibrator supplied by	MTS for this calibration		

The measurements were performed at The Grange Business Centre, Belasis Avenue, TS23 1LD. The results only apply to the items tested.

Periodic tests were performed in accordance with procedures from IEC 61672-3:2013 Class 1

Test results summary, detailed results are shown on subsequent pages.

Tests performed	Section	Results of test	Page	Comments
Calibration Certificate	22		1	
Additional information			2	
Indication with Calibrator Supplied	10	No Limit	3	
Self-Generated Noise	11	No Limit	3	
Frequency and Time-weightings at 1kHz	14	Complies	3	
Long term stability	15	Complies	3	
High stability	21	Complies	3	
Acoustic Tests	12	Complies	4	
Frequency Weighting A	13	Complies	5	
Frequency Weighting C	13	Complies	6	
Frequency Weighting Z	13	Complies	7	
Level Linearity	16	Complies	8	
Level Linearity Range Control	17		n/a	SLM only has one range
Tone-burst Response	18	Complies	9	
Peak C sound level	19	Complies	10	
Overload indication	20	Complies	11	

The instrument was within the above specification as received - no modifications were made

The sound level meter submitted for testing has successfully completed the periodic tests of IEC 61672-3: 2013 for the environmental conditions under which the tests were performed. As evidence was publicly available, from an independent testing organisation responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2: 2013, to demonstrate that the model of sound level meter fully conformed to the Class 1 specifications in IEC 61672-1: 2013, the sound level meter submitted for testing conforms to the Class 1 specifications of IEC 61672-1: 2013

Additional tests performed	Reference	
Microphone full frequency response	38650	See additional certificate
Filter calibration, third octave or octave	38648F	See additional certificate

MTS Calibration Ltd,
The Grange Business Centre,
Belasis Avenue,
Billingham TS23 1LG,
England
Telephone: 01642 876 410

CERTIFICATE OF CALIBRATION

Approved Signatory:

Tony Sherris

Issued by: MTS Calibration Ltd

Date of Issue: 07 March 2022 **Certificate Number:** 38175

Sound Level Meter

Sound Level Meter Periodic Tests to EN 61672-3: 2013 Class 1

Client: Brendan Oreilly

Instrument Make: Larson Davis
Instrument Model: LxT1L
Serial Number: 0005058

2

Associated Equipment	Make	Model	Serial number
Preamplifier	PCB	PRMLxT1L	036054
Microphone	PCB	377B02	153775
Calibrator	Larson Davis	CAL200	9175
Calibrator supplied by	MTS for this calibration		

The measurements were performed at The Grange Business Centre, Belasis Avenue, TS23 1LD. The results only apply to the items tested.

Periodic tests were performed in accordance with procedures from IEC 61672-3:2013 Class 1

Test results summary, detailed results are shown on subsequent pages.

Tests performed	Section	Results of test	Page	Comments
Calibration Certificate	22		1	
Additional information			2	
Indication with Calibrator Supplied	10	No Limit	3	
Self-Generated Noise	11	No Limit	3	
Frequency and Time-weightings at 1kHz	14	Complies	3	
Long term stability	15	Complies	3	
High stability	21	Complies	3	
Acoustic Tests	12	Complies	4	
Frequency Weighting A	13	Complies	5	
Frequency Weighting C	13	Complies	6	
Frequency Weighting Z	13	Complies	7	
Level Linearity	16	Complies	8	
Level Linearity Range Control	17		n/a	SLM only has one range
Tone-burst Response	18	Complies	9	
Peak C sound level	19	Complies	10	
Overload indication	20	Complies	11	

The instrument was within the above specification as received - no modifications were made

The sound level meter submitted for testing has successfully completed the periodic tests of IEC 61672-3: 2013 for the environmental conditions under which the tests were performed. As evidence was publicly available, from an independent testing organisation responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2: 2013, to demonstrate that the model of sound level meter fully conformed to the Class 1 specifications in IEC 61672-1: 2013, the sound level meter submitted for testing conforms to the Class 1 specifications of IEC 61672-1: 2013

Additional tests performed	Reference	
Microphone full frequency response	38177	See additional certificate
Filter calibration, third octave or octave	38175F	See additional certificate

MTS Calibration Ltd,
The Grange Business Centre,
Belasis Avenue,
Billingham TS23 1LG,
England
Telephone: 01642 876 410

CERTIFICATE OF CALIBRATION

Approved Signatory:

Tony Sherris

Issued by: MTS Calibration Ltd

Date of Issue: 05 August 2022 **Certificate Number:** 37266

Sound Level Meter

Sound Level Meter Periodic Tests to EN 61672-3: 2013 Class 1

Client: Environmental Measurements
Unit 12, Tallaght Business Centre
Whitestown Business Park
Co.Dublin 24, Ireland

4

Instrument Make: Larson Davis
Instrument Model: LxT1L
Serial Number: 0005990

Associated Equipment	Make	Model	Serial number
Preamplifier	Larson Davis	PRMLxT1L	055804
Microphone	PCB	377B02	316349
Calibrator	Brüel & Kjær	4231	3014620
Calibrator supplied by	MTS for this calibration		

The measurements were performed at Elvington Close, Billingham, TS23 3YS. The results only apply to the items tested.

Periodic tests were performed in accordance with procedures from IEC 61672-3:2013 Class 1

Test results summary, detailed results are shown on subsequent pages.

Tests performed	Section	Results of test	Page	Comments
Calibration Certificate	22		1	
Additional information			2	
Indication with Calibrator Supplied	10	No Limit	3	
Self-Generated Noise	11	No Limit	3	
Frequency and Time-weightings at 1kHz	14	Complies	3	
Long term stability	15	Complies	3	
High stability	21	Complies	3	
Acoustic Tests	12	Complies	4	
Frequency Weighting A	13	Complies	5	
Frequency Weighting C	13	Complies	6	
Frequency Weighting Z	13	Complies	7	
Level Linearity	16	Complies	8	
Level Linearity Range Control	17		n/a	SLM only has one range
Tone-burst Response	18	Complies	9	
Peak C sound level	19	Complies	10	
Overload indication	20	Complies	11	

The instrument was within the above specification as received - no modifications were made

The sound level meter submitted for testing has successfully completed the periodic tests of IEC 61672-3: 2013 for the environmental conditions under which the tests were performed. As evidence was publicly available, from an independent testing organisation responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2: 2013, to demonstrate that the model of sound level meter fully conformed to the Class 1 specifications in IEC 61672-1: 2013, the sound level meter submitted for testing conforms to the Class 1 specifications of IEC 61672-1: 2013

Additional tests performed	Reference	
Microphone full frequency response	37268	See additional certificate
Filter calibration, third octave or octave	37266F	See additional certificate

MTS Calibration Ltd,
The Grange Business Centre,
Belasis Avenue,
Billingham TS23 1LG,
England
Telephone: 01642 876 410

CERTIFICATE OF CALIBRATION

Approved Signatory:

Tony Sherris

Issued by: MTS Calibration Ltd

Date of Issue: 08 March 2023 **Certificate Number:** 38149

Sound Level Meter

Sound Level Meter Periodic Tests to EN 61672-3: 2013 Class 1

Client: Brendan Oreilly

Instrument Make: Larson Davis
Instrument Model: LxT1L
Serial Number: 0005992

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Associated Equipment	Make	Model	Serial number
Preamplifier	PCB	PRMLxT1L	028029
Microphone	PCB	377B02	147913
Calibrator	Larson Davis	CAL200	18140
Calibrator supplied by	the Client, with the SLM		

The measurements were performed at The Grange Business Centre, Belasis Avenue, TS23 1LD. The results only apply to the items tested.

Periodic tests were performed in accordance with procedures from IEC 61672-3:2013 Class 1

Test results summary, detailed results are shown on subsequent pages.

Tests performed	Section	Results of test	Page	Comments
Calibration Certificate	22		1	
Additional information			2	
Indication with Calibrator Supplied	10	No Limit	3	
Self-Generated Noise	11	No Limit	3	
Frequency and Time-weightings at 1kHz	14	Complies	3	
Long term stability	15	Complies	3	
High stability	21	Complies	3	
Acoustic Tests	12	Complies	4	
Frequency Weighting A	13	Complies	5	
Frequency Weighting C	13	Complies	6	
Frequency Weighting Z	13	Complies	7	
Level Linearity	16	Complies	8	
Level Linearity Range Control	17		n/a	SLM only has one range
Tone-burst Response	18	Complies	9	
Peak C sound level	19	Complies	10	
Overload indication	20	Complies	11	

The instrument was within the above specification as received - no modifications were made

The sound level meter submitted for testing has successfully completed the periodic tests of IEC 61672-3: 2013 for the environmental conditions under which the tests were performed. As evidence was publicly available, from an independent testing organisation responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2: 2013, to demonstrate that the model of sound level meter fully conformed to the Class 1 specifications in IEC 61672-1: 2013, the sound level meter submitted for testing conforms to the Class 1 specifications of IEC 61672-1: 2013

Additional tests performed	Reference	
Microphone full frequency response	38151	See additional certificate
Filter calibration, third octave or octave	38149F	See additional certificate
Calibrator calibration	38152U	See additional UKAS certificate

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CERTIFICATE OF CALIBRATION

Approved Signatory:

Tony Sherris

Issued by: MTS Calibration Ltd

Date of Issue: 05 August 2022 **Certificate Number:** 37269

Sound Level Meter

Sound Level Meter Periodic Tests to EN 61672-3: 2013 Class 1

Client: Environmental Measurements for Brendan O'Reilly
Unit 12, Tallaght Business Centre
Whitestown Business Park
Co.Dublin 24, Ireland

Instrument Make: Larson Davis
Instrument Model: LxT1L
Serial Number: 0005046

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Associated Equipment	Make	Model	Serial number
Preamplifier	Larson Davis	PRMLxT1L	042734
Microphone	PCB	377B02	172753
Calibrator	Brüel & Kjær	4231	2343058
Calibrator supplied by	MTS for this calibration		

The measurements were performed at Elvington Close, Billingham, TS23 3YS. The results only apply to the items tested.

Periodic tests were performed in accordance with procedures from IEC 61672-3:2013 Class 1

Test results summary, detailed results are shown on subsequent pages.

Tests performed	Section	Results of test	Page	Comments
Calibration Certificate	22		1	
Additional information			2	
Indication with Calibrator Supplied	10	No Limit	3	
Self-Generated Noise	11	No Limit	3	
Frequency and Time-weightings at 1kHz	14	Complies	3	
Long term stability	15	Complies	3	
High stability	21	Complies	3	
Acoustic Tests	12	Complies	4	
Frequency Weighting A	13	Complies	5	
Frequency Weighting C	13	Complies	6	
Frequency Weighting Z	13	Complies	7	
Level Linearity	16	Complies	8	
Level Linearity Range Control	17		n/a	SLM only has one range
Tone-burst Response	18	Complies	9	
Peak C sound level	19	Complies	10	
Overload indication	20	Complies	11	

The instrument was within the above specification as received - no modifications were made

The sound level meter submitted for testing has successfully completed the periodic tests of IEC 61672-3: 2013 for the environmental conditions under which the tests were performed. As evidence was publicly available, from an independent testing organisation responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2: 2013, to demonstrate that the model of sound level meter fully conformed to the Class 1 specifications in IEC 61672-1: 2013, the sound level meter submitted for testing conforms to the Class 1 specifications of IEC 61672-1: 2013

Additional tests performed	Reference	
Microphone full frequency response	37271	See additional certificate
Filter calibration, third octave or octave	37269F	See additional certificate

Calibration Certificate

Certificate Number 2021014389
Customer:
Environmental Measurement
Unit 12 Tallaght Business Centre
Whitestown Business Park
Dublin, 24, Ireland

Model Number	LxT SE		***Procedure Number***	D0001.8378	
Serial Number	0006871		***Technician***	Ron Harris	
Test Results	**Pass**		***Calibration Date***	10 Nov 2021	
Initial Condition	As Manufactured		***Calibration Due***		
Description	Sound Expert LxT Class 1 Sound Level Meter Firmware Revision: 2.404		***Temperature***	23.46 °C	± 0.25 °C
			Humidity	51.9 %RH	± 2.0 %RH
			Static Pressure	86.64 kPa	± 0.13 kPa

Evaluation Method Tested electrically using Larson Davis PRMLxT1L S/N 070117 and a 12.0 pF capacitor to simulate microphone capacitance. Data reported in dB re 20 µPa assuming a microphone sensitivity of 23.6 mV/Pa.

Compliance Standards Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8384:

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61252:2002	ANSI S1.25 (R2007)
IEC 61672:2013 Class 1	ANSI S1.43 (R2007) Type 1
IEC 61260:2001 Class 1	ANSI S1.11 (R2009) Class 1

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2017. **Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.**

The quality system is registered to ISO 9001:2015.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

Correction data from Larson Davis LxT Manual for SoundTrack LxT & SoundExpert Lxt, I770.01 Rev O Supporting Firmware Version 4.0.5, 2019-09-10

Calibration Check Frequency: 1000 Hz; Reference Sound Pressure Level: 114 dB re 20 µPa

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Provo, UT 84601, United States
716-684-0001

ilac-MRA ACCREDITED Cert. #2822.01

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D0001.8407 Rev F

Calibration Certificate

Certificate Number 2021014391
Customer:
Environmental Measurement
Unit 12 Tallaght Business Centre
Whitestown Business Park
Dublin, 24, Ireland

Model Number	LxT SE	***Procedure Number***	D0001.8378		
Serial Number	0006869	***Technician***	Ron Harris		
Test Results	**Pass**	***Calibration Date***	10 Nov 2021		
Initial Condition	As Manufactured	***Calibration Due***			
		Temperature	23,41	°C	± 0,25 °C
Description	Sound Expert LxT Class 1 Sound Level Meter Firmware Revision: 2,404	***Humidity***	53,2	%RH	± 2,0 %RH
		Static Pressure	86.63	kPa	± 0.13 kPa

Evaluation Method Tested electrically using Larson Davis PRMLxT1L S/N 070113 and a 12,0 pF capacitor to simulate microphone capacitance. Data reported in dB re 20 µPa assuming a microphone sensitivity of 23.6 mV/Pa.

Compliance Standards Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001,8384:

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61252:2002	ANSI S1,25 (R2007)
IEC 61672:2013 Class 1	ANSI S1.43 (R2007) Type 1
IEC 61260:2001 Class 1	ANSI S1.11 (R2009) Class 1

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2017. **Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.**

The quality system is registered to ISO 9001:2015.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

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Correction data from Larson Davis LxT Manual for SoundTrack LxT & SoundExpert Lxt, I770.01 Rev O Supporting Firmware Version 4.0.5, 2019-09-10

Calibration Check Frequency: 1000 Hz; Reference Sound Pressure Level: 114 dB re 20 µPa

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Calibration Certificate

Certificate Number 2021014392
Customer:
Environmental Measurement
Unit 12 Tallaght Business Centre
Whitestown Business Park
Dublin, 24, Ireland

Model Number	LxT SE	***Procedure Number***	D0001.8378		
Serial Number	0006870	***Technician***	Ron Harris		
Test Results	**Pass**	***Calibration Date***	10 Nov 2021		
Initial Condition	As Manufactured	***Calibration Due***			
		Temperature	23,5	°C	± 0,25 °C
Description	Sound Expert LxT Class 1 Sound Level Meter Firmware Revision: 2,404	***Humidity***	53	%RH	± 2.0 %RH
		Static Pressure	86.69	kPa	± 0.13 kPa

Evaluation Method Tested electrically using Larson Davis PRMLxT1L S/N 070116 and a 12.0 pF capacitor to simulate microphone capacitance. Data reported in dB re 20 µPa assuming a microphone sensitivity of 23.6 mV/Pa.

Compliance Standards Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8384:

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61252:2002	ANSI S1.25 (R2007)
IEC 61672:2013 Class 1	ANSI S1.43 (R2007) Type 1
IEC 61260:2001 Class 1	ANSI S1.11 (R2009) Class 1

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2017. **Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.**

The quality system is registered to ISO 9001:2015.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

Correction data from Larson Davis LxT Manual for SoundTrack LxT & SoundExpert Lxt, I770.01 Rev O Supporting Firmware Version 4.0.5, 2019-09-10

Calibration Check Frequency: 1000 Hz; Reference Sound Pressure Level: 114 dB re 20 µPa

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TECHNICAL APPENDIX 11.6

Candidate Turbine Manufacturer's Performance Specification

4.3 Sound Curves, Power Optimized Mode PO2/PO2-0S; HWO Disabled

Sound Power Level at Hub Height		
Conditions for Sound Power Level:	Measurement standard IEC 61400-11 ed. 3 Maximum turbulence at hub height: 30% Inflow angle (vertical): 0 ±2° Air density: 1.225 kg/m³	
Wind speed at hub height [m/s]	Sound Power Level at Hub Height [dBA] Mode PO2 (Blades with serrated trailing edge)	Sound Power Level at Hub Height [dBA] Mode PO2-0S (Blades without serrated trailing edge)
3	91.7	93.7
4	92.2	94.6
5	94	97.1
6	97	100.2
7	100	103.1
8	102.8	105.6
9	105.1	107.7
10	106	108.5
11	106	108.5
12	106	108.5
13	106	108.5
14	106	108.5
15	106	108.5
16	106	108.5
17	106	108.5
18	106	108.5
19	106	108.5
20	106	108.5
21	106	108.5
22	106	108.5
23	106	108.5
24	106	108.5
25	106	108.5
26	106	108.5
27	106	108.5

Table 4-3: Sound curves, Mode PO2/PO2-0S (High Wind Operation Disabled)

Candidate Turbine Manufacturer's Performance Specifications during Curtailment Strategy

10.3 Sound Curves, Sound Optimized Mode SO1

Sound Power Level at Hub Height	
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 3** **Maximum turbulence at hub height: 30%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m^3**
Wind speed at hub height [m/s]	**Sound Power Level at Hub Height [dBA]** **Sound Optimized Mode SO1 (Blades with serrated trailing edge)**
3	92.2
4	92.8
5	94.0
6	97.0
7	100.0
8	102.7
9	104.2
10	105.0
11	105.0
12	105.0
13	105.0
14	105.0
15	105.0
16	105.0
17	105.0
18	105.0
19	105.0
20	105.0

Table 10-3: Sound curves, Sound Optimized Mode SO1

12.3 Sound Curves, Sound Optimized Mode SO2

Sound Power Level at Hub Height	
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 3** **Maximum turbulence at hub height: 30%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m³**
Wind speed at hub height [m/s]	**Sound Power Level at Hub Height [dBA]** **Sound Optimized Mode SO2 (Blades with serrated trailing edge)**
3	92.2
4	92.8
5	94.0
6	97.0
7	99.9
8	101.6
9	102.3
10	102.3
11	102.4
12	102.7
13	103.0
14	103.0
15	103.0
16	103.0
17	103.0
18	103.0
19	103.0
20	103.0

Table 12-3: Sound curves, Sound Optimized Mode SO2