Technical Appendix 10.1: Construction Noise Report

tnei

A specialist energy consultancy

Technical Appendix 10.1

Construction Noise Report

Revised Larbrax Wind Farm

Orsted

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Executive Summary

TNEI Services Limited (TNEI) was commissioned by Land Use Consultants (LUC) on behalf of Orsted (the Applicant) to undertake predictions of noise levels associated with the construction of the proposed Revised Larbrax Wind Farm (the Proposed Development). The noise predictions were used to assess the potential impact of noise attributable to the construction of the Proposed Development on the occupiers of nearby noise sensitive receptors.

A noise impact assessment has been undertaken using guidance contained in BS 5228-Part 1: 2009+A1:2014 *'Noise and vibration control on construction and open sites- Noise'* and the calculation methodology in ISO 9613:1996 *'Acoustics - Attenuation of sound during propagation outdoors'*, together with noise data for appropriate construction plant.

Five residential receptors neighbouring the Proposed Development were identified as the properties located closest to the proposed construction activity areas. Predictions have been made assuming that all plant is operating continually to provide a worst-case scenario. In addition, the noise model assumes that noise sources will be located within the most likely activity areas closest to the receptors, whereas in reality plant will move around the site and only a proportion of the plant may be operating at any one time. As such, the predictions are inherently conservative. The predicted noise levels will remain below the most stringent of the noise threshold levels detailed in the BS 5228 standard.

Off-site construction vehicles will amount to a small increase of HGV movements per hour over the course of a typical 12-hour shift, and as such; the small temporary increase in traffic will not have a significant noise impact at receptors found along local roads.

Accordingly, the assessment concludes that there will be no significant construction noise impacts.

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1 Introduction

1.1 Brief

1.1.1 TNEI was commissioned by Land Use Consultants (LUC) on behalf of Orsted (the Applicant) to undertake a construction noise assessment for the proposed Revised Larbrax Wind Farm (hereinafter referred to as the Proposed Development). The following steps summarise the noise assessment process:

- Establish typical ambient noise levels at sensitive receptors closest to the anticipated construction activities and derive appropriate noise threshold levels in accordance with BS 5228-1:2009 +A1:2014 [(1)];
- Undertake predictions of activity noise from different construction phases that will be incident at the nearest sensitive receptors;
- Compare the predicted noise levels with the derived threshold values; and,
- Identify any requirements for mitigation measures, if needed.

1.2 Nomenclature

1.2.1 The following terms and definitions are used throughout this report;

- **Emission** refers to the sound level emitted from a sound source, expressed as either a sound power level or a sound pressure level;
- **Immission** refers to the sound pressure level received at a specific location from a noise source(s);
- **SWL** indicates the sound power level in decibels (dB);
- **SPL** indicates the sound pressure level in decibels (dB);
- **NSR** (Noise Sensitive Receptor) are identified receptors that are sensitive to noise;
- **NML** (Noise Monitoring Location) refers to any location where baseline or specific noise levels have been measured; and
- **CNAL** (Construction Noise Assessment Location) refers to any location where the construction noise immission levels are calculated and assessed.

1.2.2 Unless otherwise stated, all noise levels refer to free field levels i.e. noise levels without influence from any nearby reflective surfaces.

1.3 Site Description

1.3.1 The site is located within a relatively remote area in the north-west of the North Rhins Peninsula, approximately 9 km west of Stranraer, Dumfries and Galloway, and has an approximate OS Grid Reference centre point of 19712, 56185.

1.3.2 Properties within the surrounding area are mainly single rural dwellings, farmhouses and holiday cottages which are scattered throughout the area. The closest properties to the Site include Greenburn and Meikle Galdenoch (north-east), Larbrax Lodge (east), and Larbrax Cottages and Meikle Larbrax (south). Within the wider area there are a number of small rural settlements including Portpatrick, approximately 8 km to the south and Leswalt, 5.5 km to the east.

1.3.3 The Proposed Development comprises four wind turbines with a maximum blade tip of 149.9 m. The proposed layout is shown on Figure A1.1 in Annex 1.

1.3.4 Construction of the Proposed Development would require laying of tracks across the site, establishing a construction compound, operation of a borrow pit within the Proposed Development Site, excavation of turbine foundations, concrete batching and pouring, construction of turbine bases, installation of turbines, installation of a substation / battery storage compound and other infrastructure. Full details can be found in EIA Report Chapter 4: Development Description.

1.3.5 Construction is anticipated to last for 12 months and the indicative construction timetable is shown as

1.3.6 Table 1-1.

Table 1-1: Indicative Construction Timetable

Task	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
Mobilisation & Enabling Works (including working borrow pit, construction of new site junction, construction compound and tree/scrub removal)												
Access Tracks												
Wind Turbine Foundations												
Crane Hardstandings												
Cabling and Electrical Works												
Substation, control building and BESS												
Wind Turbine Erection & Mast												
Commissioning and Restoration												

1.3.7 TNEI has undertaken noise propagation modelling for 12 scenarios (one scenario for each month). Although no specific construction activities are proposed to occur during the night-time, an additional scenario has been assessed to consider any potential noise from the operation of generators and or plant that may be required to be left on over-night, for example, to provide lighting on site.

2 Noise Guidance and Planning Policy

2.1 Overview of Noise Guidance and Standards

2.1.1 In assessing the potential noise impacts from the construction of the Proposed Development, the following guidance and policy documents have been considered:

- The Environmental Noise (Scotland) Regulations [(2)];
- Planning and Advice Note (PAN) 1/2011 *'Planning and Noise'* [(3)];
- Technical Advice Note (TAN) *'Assessment of Noise'* [(4);] and
- BS 5228:2009+A1:2014 *'Code of practice for noise and vibration control on construction and open sites. Noise*'.

2.1.2 BS 5228:2009 provides useful guidance on practical noise control. Part 1 provides recommendations for basic methods of noise control including sections on community relations, training, occupational noise effects, neighbourhood nuisance and project supervision. The annexes provide information on noise sources, noise calculation procedures, mitigation measures and their effectiveness.

2.1.3 Part 1 also contains sound power level data for a variety of construction plant. This data was obtained from field measurements of actual plant operating on construction and open sites in the United Kingdom and is therefore appropriate to use as source level data for construction noise predictions.

2.1.4 The 2009 version of BS 5228 was subject to an additional update in 2014. Accordingly, the construction noise assessment in this chapter has been undertaken in accordance with BS 5228 1:2009+A1:2014 'Code of practice for noise and vibration control on construction and open sites. Noise', (BSI, 2009), hereinafter referred to as BS 5228.

2.1.5 For noise relating to the operation of harvester, forwarder and skidder units, source data was taken from the Forestry Commission Noise Hazards in Forestry Operations and Selection of Personal Protective Equipment. Edinburgh: The Crown, 20037.

2.1.6 The overarching legislation in relation to terrestrial environmental noise is the '*Environmental Noise Directive'* (The European Parliament and the Council of the European Union, 2002) (END). The END aims to limit people's exposure to environmental noise but does not prescribe noise limits. Instead, it requires each member state to provide data on noise exposure, and to develop action plans to prevent or reduce noise exposure, and to preserve existing quiet areas. In Scotland the END is transposed and implemented within *'The Environmental Noise (Scotland) Regulations'* (Scottish Statutory Instruments, 2006). No changes have been made to The Environmental Noise (Scotland) Regulations' since the UK left the European Union (EU).

2.2 National Planning Guidance

2.2.1 At the national level the relevant policy documents are: Planning Advice Note (PAN) 1/2011 – *'Planning and Noise*,' and the associated *Technical Advice Note (TAN) – 'Assessment of Noise'*.

2.2.2 PAN 1/2011 provides little guidance in respect of construction noise, other than recommending that the use of planning conditions is not the preferred method for controlling temporary construction noise. Specifically, the document states:

"32. While planning conditions can be used to limit noise from temporary construction sites, it is most effectively controlled through the Control of Pollution Act 1974 (COPA74) and the Pollution and Prevention Control Act 1999 for relevant installations. Notice can be served in advance of works and site conditions set to control activities."

2.2.3 BS 5228:1997 '*Noise and vibration control on construction and open sites. Code of practice for basic information and procedures for noise and vibration control*' parts 1 to 5 (BSI, 1997) is the approved Code of Practice under COPA74 (5), however, it is the 2009 version of the Standard which should be used for Environmental Impact Assessments (EIA) and planning applications. In this regards the TAN states:

"However, under Environmental Impact Assessments and for planning purposes i.e. not in regard to the Control of Pollution Act 1974, the 2009 version of BS 5228 is applicable. The 2009 version of the standard consists of Parts 1 and 2 for noise and vibration respectively."

3 Potential Impacts

3.1 Construction Noise Sources

3.1.1 Noise levels from construction activities will vary continually over time as activities and plant start and stop and move around the site. In order to assess the potential impacts of construction noise, a worst-case scenario is considered where all construction plant and activities are assumed to be working continually and in locations closest to the nearest NSRs.

3.2 Construction Phases

3.2.1 The core hours for construction activity will likely be between the hours of 07:00 to 19:00 Monday to Friday and 07:00 to 13:00 Saturday, however, the assessment also considered construction works outside of these hours.

3.2.2 'Good practice measures' for construction noise will be included as standard practice to minimise environmental effects. This includes the implementation of a Construction Environmental Management Plan (CEMP).

3.2.3 Although an indicative timetable of construction works has been provided for the purposes of the EIA, no specific construction schedule has been determined. EIA Chapter 4: Development Description does, however, provide descriptions of some of the likely construction activities that will be undertaken and the type of plant that will be involved.

3.2.4 To consider the variation in noise levels that will occur throughout the construction period, a series of construction scenarios have been modelled. The scenarios are based on the tasks detailed in the indicative timetable (see

3.2.5 Table 1-1), and TNEI's knowledge and experience of other similar sites and construction schedules.

3.2.6 Each scenario has been assessed against a set of threshold levels in order to determine the likely temporary noise impacts.

3.2.7 The assessment does not consider the noise impacts associated with decommissioning, as the plant and activities used for this phase are assumed to be similar in nature (and noise output) to those already considered in the modelled construction scenarios. Accordingly, if noise levels during the construction phases are acceptable, they should also be acceptable during decommissioning.

3.3 Off-site construction vehicles

3.3.1 It is very unlikely that temporary increase in traffic flows due to construction vehicles will have an impact on receptors found further from the site along the local road network. The Transport Assessment for this Proposed Development (Technical Appendix 11.1) indicates that that highest HGV traffic movements increase will occur on the B738 and concluded :

"To put the increase into perspective, the B738 will see an additional 38 HGV movements per day or three HGV movements per hour over the course of a typical 12-hour shift. This is not considered significant in terms of overall traffic flows."

3.3.2 As such, this small temporary increase in traffic will not have a significant noise impact at receptors found along local roads and no further assessment is required.

4 Methodology

4.1 Methodology for the Prediction of Noise

4.1.1 In order to predict the noise immission levels attributable to the construction of the Proposed Development, noise propagation models are produced using the propriety noise modelling software CadnaA. Within the software, complex models can be used to simulate the propagation of noise according to a range of international calculation standards.

4.1.2 For each CNAL, the $L_{Aeq(t)}$ levels have been predicted in accordance with ISO 9613-2:1996 *'Acoustics - Attenuation of sound during propagation outdoors: Engineering method for the prediction of sound pressure levels outdoors'*. [6]

4.1.3 The ISO 9613 propagation model was chosen in preference to the calculation method presented in BS 5228, primarily because of some of the significant distances from source to receptor evident on this site. Specifically, BS 5228 notes in F 2.2.2.2, that at distances over 300 m noise predictions using the BS 5228 methodology should be treated with caution, especially where a soft ground correction factor has been applied because of the increasing importance of meteorological effects; whereas ISO 9613-2 provides equations that have been validated up to 1,000 m.

4.1.4 The ISO 9613 model can take account of the following factors that influence sound propagation outdoors:

- geometric divergence;
- air absorption;
- reflecting obstacles;
- screening; and
- ground reflections.

4.1.5 The model uses the octave band sound power output of the proposed plant as its acoustic input data, and calculates on an octave band basis, attenuation due to geometric spreading, atmospheric absorption and ground effects.

4.1.6 For the purposes of this assessment, all noise level predictions have been undertaken using a receiver height of 1.5 m above local ground level. Soft ground (G=1) attenuation has been assumed at all locations, except for areas of hardstanding such as the turbine foundations and the construction compound. Air absorption based on a temperature of 10 °C and 70 % relative humidity has been assumed.

4.2 Limitations of the Noise Model

4.2.1 The noise propagation models are intended to give a good approximation of the specific noise level and the contribution of each individual source. However, it is expected that actual levels are unlikely to be matched exactly with modelled values and the following limitations in the model should be considered:

- In accordance with ISO 9613-2, all assessment locations are modelled as downwind of all noise sources and propagation calculations are based on a moderate ground-based temperature inversion, such as commonly occurs at night;

- The predicted barrier attenuation provided by local topography, embankments, walls, buildings and other structures in the intervening ground between source and receiver can only be approximated and not all barrier attenuation will have been accounted for;
- Unless specifically stated, the models assume all fixed noise sources are operating continuously and simultaneously, estimating a worst-case source noise level; and
- All mobile plant (excavators, dozers, rollers etc) have been modelled as line sources along their anticipated movement paths and the sound power level of the source is effectively averaged out across the length of the entire line. This will give an approximation of the overall noise levels from mobile plant at receptor locations; however, in reality noise levels will fluctuate as construction plant and activities move around in their activity areas.

4.3 Assessing Construction Noise Effects

4.3.1 Annex E, part E.3.2 of BS 5228 provides example criteria for assessing the significance of construction noise effects and acceptable limits for construction noise.

4.3.2 Table E.1 of BS 5228 (represented here Table 4-1) contains an example of the significance criteria that can be used to assess construction activities.

Table 4-1: Example of Threshold of Potential Significant Effect at Dwellings ($dB_{(A)}$)

Assessment Category and Threshold Value Period	Threshold Value $L_{Aeq,T}$ dB		
	Category $A_{(A)}$	Category $B_{(B)}$	Category $C_{(C)}$
Night-Time (23:00 – 07:00)	45	50	55
Evenings and Weekends$_{(D)}$	55	60	65
Daytime (07:00 – 19:00) and Saturdays (07:00 to 13:00)	65	70	75

(A) Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are less than these values;

(B) Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are the same as category A values;

(C) Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are higher than category A values;

(D) 19:00-23:00 weekdays, 13:00-23:00 Saturdays and 07:00 – 23:00 Sundays.

4.3.3 The values can be considered thresholds for the construction noise levels (quantified using the L_{Aeq} noise metric). The values in each category are to be used where the existing noise level at each location, rounded to the nearest 5 dB, is below the level given for a particular time of day. BS 5228 provides the following advice regarding the threshold levels:

"Note: 1 A potential significant effect is indicated if the LAeq,T noise level arising from the site exceeds the threshold level for the category appropriate to the ambient noise level.

Note 2: If the ambient noise level exceeds the Category C threshold values given in the table (i.e. the ambient noise level is higher than the above values), then a potential significant effect is indicated if the total LAeq,T noise level for the period increases by more than 3dB due to site noise.

Note 3: Applied to residential receptors only."

4.3.4 Therefore, the assessment of construction noise reflects a specific noise threshold for the locality (set relative to the existing ambient noise levels) and for various time periods.

4.4 Study Area

4.4.1 Noise Sensitive Receptors (NSRs) are people in residential properties (can also be in schools, hospitals) and, therefore, may require protection from nearby noise sources. The Study Area for the noise assessment has been defined through the identification of the NSRs around the Proposed Development and all are residential properties.

4.4.2 To assess the closest NSRs in detail, the five nearest NSRs in any direction were selected and labelled as Construction Noise Assessment Locations (CNALs). The CNALs are defined using the closest NSRs to the Proposed Development on the assumption that if noise levels are within acceptable levels at the closest receptors, then it is reasonable to assume they will also be acceptable at more distant locations.

4.4.3 Table 4-2 details the CNALs considered within the Construction Noise Assessment. Figure A1.1 in Annex 1 also details the CNALs.

Table 4-2: Construction Noise Assessment Locations

CNAL ID	Coordinates	
	Eastings	Northings
CNAL1 - Meikle Labrax	197605	560443
CNAL2- Meikle Labrax Cottages	197773	560984
CNAL3 - Labrax Lodge	198211	561552
CNAL4 - Glenvallagh Cottage	198177	562887
CNAL5 - Greenburn	197342	563086

4.5 Baseline Noise Levels and Category Criteria

4.5.1 TNEI carried out a noise survey in the area as part of the Operational Wind Farm Noise Assessment for the Proposed Development.

4.5.2 At all locations the measured ambient noise levels are relatively low when considering calm wind conditions as requested by BS 5228. The ambient noise levels at low wind speeds (< 5m/s) at 4 locations in the area were below the category A values. As such the assessment

criteria for this project has been against the category A threshold values (see Table 4-1), which are the most stringent.

4.5.3 It should be noted that exceedance of the criteria does not in itself indicate a significant effect, rather, the standard states *'If the site noise level exceeds the appropriate category value, then a potential significant effect is indicated. The assessor then needs to consider other project-specific factors, such as the number of receptors affected and the duration and character of the impact, to determine if there is a significant effect'*.

5 Noise Impact Assessment

5.1 Modelling of Individual Sound Sources

5.1.1 Noise immission levels will vary throughout the construction period as construction activities, plant and locations vary. For much of the working day the noise associated with construction activities will be less than predicted, as the assessment assumes all equipment is continually operating at full power and in locations closest to the NSRs, whereas in practice, equipment load and precise location may vary throughout the day. This approach has been adopted to represent a worst-case assessment.

5.1.2 At this stage a detailed plant list is not available, therefore, a generic plant list based upon experience of similar projects has been used. All modelled noise sources and associated SWL & SPL data is included in Annex 2: Noise Model Data. Source noise level data is taken from Annex C of BS 5228, which provides octave band SPL levels for a wide variety of construction plant and activities suitable for the estimation of noise immission levels.

5.1.3 Construction noise sources for any given activity will generally comprise a mix of both moving and static sources. Mobile sources include mobile construction plant and Heavy Goods Vehicles (HGVs), while static construction plant could include generators, lighting rigs and pumps. Static equipment is usually located at a fixed location for an extended period of time.

5.1.4 For both mobile and static plant, activity noise levels will be transient in nature due to changes in location, on/off periods, and fluctuations of load on any individual machine.

5.1.5 All static items of plant and activities have been modelled as single point sources. All mobile plant (excavators, dozers, dumpers etc) have been modelled as line sources along their anticipated movement paths or as a stationary point source located at the closest point of its anticipated work area to any given CNAL.

5.2 Modelling of Construction Activities.

5.2.1 The assessment considers a number of construction scenarios based on the key construction activities detailed in EIA Report Chapter 4: Development Description, and the indicative construction timetable (

5.2.2 Table 1-1 of this report).

5.2.3 Noise propagation modelling has been undertaken considering the key activities that are likely to occur throughout the construction period. Details of the items of plant assumed to be operating in each modelled scenario, their location as well as noise data for each modelled noise source, are included in Annex 2: Noise Model Data.

5.2.4 A summary of the modelled scenarios is presented in Table 5-1.

Table 5-1: Summary of Modelled Construction Scenarios

Scenario	Construction Activities	Description
01-12	Operation of Construction Compound	Diesel generators for power and lighting are operating in the construction compound
01	Vegetation/scrub removal	Vegetation/scrub removal around the site entrance
	Temp Construction Compound	Construction of the temporary construction compound begins
	Borrow Pit	works begin in/at the borrow pit
02	Vegetation/scrub removal	Vegetation/scrub removal around the site entrance
	Temp Construction Compound	The temporary construction compound is completed
	Borrow Pit	Works on the borrow pit continue
	Access Junction	Improvements to the junction off of the B738 road begin.
03	Borrow Pit	Works are completed on the borrow pit
	Access Junction	Upgrades to the B738 junction are completed
	Access Tracks	The access track to Turbine 1 location is built
04	Access Tracks	Access tracks to turbines 2 and 3 are built
05	Concrete Batching	Concrete batching in the construction compound
	Foundations	Turbine 1 foundations are dug and poured
	Access Tracks	Access tracks to turbine 4 are built
06	Concrete Batching	Concrete batching in the construction compound
	Foundations	Foundations for turbines 2 and 3 are dug and poured
	Hardstands	The hardstand for turbine 1 is built
07	Concrete Batching	Concrete batching in the construction compound
	Foundations	Foundations for turbine 4 are dug and poured
	Hardstands	Hardstands for turbines 2 and 3 are built
	Cable trenching	Cabling from turbine 1 to the substation is carried out
08	Concrete Batching	Concrete batching in the construction compound
	Hardstands	Construction of hardstand for turbine 4
	Foundations	Construction of foundations for substation
	Cable trenching	Cabling from turbines 2, 3 and 4 to substation
09	Concrete Batching	Concrete batching in the construction compound
	Hardstands	Concrete pour of hardstand for substation
10	Substation	Craning in of electrical infrastructure for substation
	Turbine erection	Erection of turbines 1 and 2
11	Turbine Erection	Erection of turbines 3 and 4
	Backfilling	Backfilling and earthworks at various locations across the eastern side of the site
12	Backfilling	Backfilling and earthworks at various locations across the western side of the site
13-Night	Lights, Power	Night lighting generator, power generator

5.3 Calculated Noise Immission Levels

5.3.1 Table 5- presents the calculated noise immission levels at each CNAL for all modelled scenarios.

Table 5-2: Predicted Construction Noise immission Levels, dB $L_{Aeq(t)}$

Receptor ID	Scenario												
	1	2	3	4	5	6	7	8	9	10	11	12	13-Night
CNAL1 - Meikle Labrax	34	34	33	27	34	32	31	28	23	23	25	21	9
CNAL2- Meikle Labrax Cottages	36	37	36	30	33	32	32	31	25	25	28	23	12
CNAL3 - Labrax Lodge	37	44	43	30	36	36	34	32	29	26	32	23	14
CNAL4 - Glenvallagh Cottage	35	38	37	29	34	35	34	32	30	24	31	25	18
CNAL5 - Greenburn	39	40	40	32	34	37	37	35	30	29	31	27	13

5.3.2 For all CNALs the predicted noise levels for all modelled scenarios are well below the daytime threshold value of 65 dBA and the evening and weekend threshold of 55 dBA. Similarly, the predicted night-time scenario (S13) noise levels are well below the night-time threshold value of 45 dBA.

5.3.3 No significant effects resulting from construction noise are predicted. Nevertheless, a range of good practice measures would be detailed in a Construction Environmental Management Plan (CEMP) and employed to minimise noise impacts.

5.3.4 Good site practices would be implemented to minimise the likely effects to a minimum. Section 8 of BS 5228 recommends a number of simple control measures as summarised below that would be employed onsite:

- Keep local residents informed of the proposed working schedule, where appropriate, including the times and duration of any abnormally noisy activity that may cause concern;
- Ensure that any extraordinary site work continuing throughout 24 hours of a day (for example, crane operations lifting components onto the tower) would be programmed, when appropriate, so that haulage vehicles would not arrive at or leave the site between 19:00 and 07:00, with the exception of abnormal loads that would be scheduled to avoid significant traffic flows;

- Ensure all vehicles and mechanical plant would be fitted with effective exhaust silencers and be subject to programmed maintenance;
- Select inherently quiet plant where appropriate - all major compressors would be 'sound reduced' models fitted with properly lined and sealed acoustic covers, which would be kept closed whenever the machines are in use;
- Ensure all ancillary pneumatic percussive tools would be fitted with mufflers or silencers of the type recommended by the manufacturers;
- Instruct that machines would be shut down between work periods or throttled down to a minimum;
- Regularly maintain all equipment used on site, including maintenance related to noise emissions;
- Vehicles would be loaded carefully to ensure minimal drop heights so as to minimise noise during this operation; and
- Ensure all ancillary plant such as generators and pumps would be positioned so as to cause minimum noise disturbance and if necessary, temporary acoustic screens or enclosures should be provided.

6 Summary

6.1.1 The noise impact assessment has considered the existing noise environment at local NSRs in order to determine appropriate noise threshold levels for construction activities.

6.1.2 Noise propagation modelling has been undertaken in accordance with ISO 9613-2:1996 and the anticipated noise immission levels presented for scenarios likely to occur throughout the construction period of the Proposed Development. The modelled scenarios consider the 'noisiest' activities that are likely to occur during the construction period, and the modelling assumes that the construction activities are occurring at locations within the development site that are closest to the NSRs.

6.1.3 The predicted levels are below the Category A Threshold Levels as detailed within BS 5228:2009. Accordingly, construction noise impacts are below the indicator for a potential significant effect.

6.1.4 No regular construction activities are currently proposed outside the BS 5228 defined daytime periods, however, it is noted that the predicted noise levels are also below the BS 5228 threshold levels for evenings, weekends and night-time.

6.1.5 The assessment concludes that construction noise levels will remain below the threshold for a potential significant effect to occur. Good practice measures for construction noise will be included as standard practice to minimise environmental effects. This includes the implementation of a Construction Environmental Management Plan (CEMP).

7 References

1. **British Standards Institute.** *Code of practice for noise and vibration control on construction and open sites. Noise.* UK : BSI, 2014. BS 5228-1:2009+A1:2014 .

2. **Scottish Statutory Instruments.** *2006 No. 465 Environmental Protection. The Environmental Noise (Scotland) Regulations.* Scotland : The Crown, 2006.

3. **The Scottish Government.** *PAN 1/2011 Planning and Noise.* Scotland : The Crown, 2011.

4. —. *Technical Advice Note (TAN).*

5. **HM Government.** *Control of Pollution Act 1974 Chapter 40.* London : Her Majesty's Stationery Office, 1974.

6. **(ISO), International Organisation for Standardisation.** *Acoustics – Attenuation of Sound During Propagation Outdoors: Part 2 – Attenuation of sound during propagation outdoors.* Geneva : ISO, 1996. ISO 9613-2:1996.

7. **Forestry Commission.** *Noise Hazards in Forestry Operations and Selection of Personal Protective Equipment.* Edinburgh : The Crown, 2003.

Annex 1 – Figure

LEGEND

- Construction Noise Assessment Locations (CNALs)
- Larbrax Wind Turbines
- Tree/scrub removal
- Proposed new track/access junction
- Track to be upgraded
- Hardstanding temporary
- Hardstanding permanent
- Temporary construction compound
- Temporary borrow pit
- Substation/battery storage

Rev.	Date	Amendment Details	Drawn	Approved
0	23/10/2024	FOR INFORMATION	WC	MC

tnei

Client: Ørsted

Drawing Status: FOR PLANNING

Project Title: REVISED LARBRAX WIND FARM

Drawing Title: FIGURE A1.1 - CONSTRUCTION NOISE STUDY AREA

Scale:	Original Size:	Spatial Reference:
1:12,500	A3	British National Grid

Drawing Number: 15893-012

Annex 2 – Noise Model Data

Scenario	Construction activity	Specific Machinery/Activity	Source
1 - 12	Operation of diesel generators in construction compound for power and lighting	Diesel generator (C4.86), Diesel generator (C4.76)	BS 5228-1:2009+A1:2014: Annex C
1	Tree felling around site entrance	Forwarder, Harvester, Skidder	Forestry Commission
1	Construction of Temp Construction Compound	Tracked Excavator, Dozer, Dumper	BS 5228-1:2009+A1:2014: Annex C
1	Working Borrow Pit	Tracked Excavator, Breaker mounted on excavator	BS 5228-1:2009+A1:2014: Annex C
2	Tree felling around site entrance	Forwarder, Harvester, Skidder	Forestry Commission
2	Construction of Temp Construction Compound	Tracked Excavator, Dozer, Dumper	BS 5228-1:2009+A1:2014: Annex C
2	Working Borrow Pit	Tracked Excavator, Breaker mounted on excavator	BS 5228-1:2009+A1:2014: Annex C
2	B738 access junction	Tracked Excavator, Dozer, Dumper	BS 5228-1:2009+A1:2014: Annex C
3	Working Borrow Pit	Tracked Excavator, Breaker mounted on excavator	BS 5228-1:2009+A1:2014: Annex C
3	B738 access junction	Tracked Excavator, Dozer, Dumper	BS 5228-1:2009+A1:2014: Annex C
3	Access tracks to Turbine 1	Tracked Excavator, Dozer, Dumper	BS 5228-1:2009+A1:2014: Annex C
4	Access tracks to Turbine 2	Tracked Excavator, Dozer, Dumper	BS 5228-1:2009+A1:2014: Annex C
4	Access tracks to Turbine 3	Tracked Excavator, Dozer, Dumper	BS 5228-1:2009+A1:2014: Annex C
5	Construction of foundations at Turbine 1	Tracked Excavator, Hydraulic hammer rig, Vibratory roller	BS 5228-1:2009+A1:2014: Annex C
5	Concrete pour & Vibration of Pour at Turbine 1	Concrete pump + cement mixer truck (discharging), Poker vibrator	BS 5228-1:2009+A1:2014: Annex C

5	Access tracks to Turbine 3	Tracked Excavator, Dozer, Dumper	BS 5228-1:2009+A1:2014: Annex C
5	Concrete batching in the construction compound	Tracked Excavator, Concrete Mixer Truck, Water pump (diesel)	BS 5228-1:2009+A1:2014: Annex C
6	Construction of foundations at Turbine 2	Tracked Excavator, Hydraulic hammer rig, Vibratory roller	BS 5228-1:2009+A1:2014: Annex C
6	Construction of foundations at Turbine 3	Tracked Excavator, Hydraulic hammer rig, Vibratory roller	BS 5228-1:2009+A1:2014: Annex C
6	Concrete pour & Vibration of Pour at Turbine 2	Concrete pump + cement mixer truck (discharging), Poker vibrator	BS 5228-1:2009+A1:2014: Annex C
6	Concrete pour & Vibration of Pour at Turbine 3	Concrete pump + cement mixer truck (discharging), Poker vibrator	BS 5228-1:2009+A1:2014: Annex C
6	Construction of Hardstand at Turbine 1	Tracked Excavator, Dozer, Dumper, Vibratory roller, Concrete pump + cement mixer truck (discharging)	BS 5228-1:2009+A1:2014: Annex C
6	Concrete batching in the construction compound	Tracked Excavator, Concrete Mixer Truck, Water pump (diesel)	BS 5228-1:2009+A1:2014: Annex C
7	Construction of foundations at Turbine 4	Tracked, Excavator, Hydraulic hammer rig, Vibratory roller	BS 5228-1:2009+A1:2014: Annex C
7	Concrete pour & Vibration of Pour at Turbine 4	Concrete pump + cement mixer truck, (discharging), Poker vibrator	BS 5228-1:2009+A1:2014: Annex C
7	Construction of Hardstand at Turbine 2	Tracked Excavator, Dozer, Dumper, Vibratory roller, Concrete pump + cement mixer truck (discharging)	BS 5228-1:2009+A1:2014: Annex C
7	Construction of Hardstand at Turbine 3	Tracked Excavator, Dozer, Dumper, Vibratory roller, Concrete pump + cement mixer truck (discharging)	BS 5228-1:2009+A1:2014: Annex C
7	Cabling from Turbine 1 to substation	Tracked excavator	BS 5228-1:2009+A1:2014: Annex C
7	Concrete batching in the construction compound	Tracked Excavator, Concrete Mixer Truck, Water pump (diesel)	BS 5228-1:2009+A1:2014: Annex C
8	Construction of Hardstand at Turbine 4	Tracked Excavator, Dozer, Dumper, Vibratory roller, Concrete pump + cement mixer truck (discharging)	BS 5228-1:2009+A1:2014: Annex C

8	Levelling for Hardstand at Substation	Tracked Excavator, Dozer	BS 5228-1:2009+A1:2014: Annex C
8	Cabling from Turbine 2 to substation	Tracked excavator	BS 5228-1:2009+A1:2014: Annex C
8	Cabling from Turbine 3 to substation	Tracked excavator	BS 5228-1:2009+A1:2014: Annex C
8	Cabling from Turbine 4 to substation	Tracked excavator	BS 5228-1:2009+A1:2014: Annex C
8	Concrete batching in the construction compound	Tracked Excavator, Concrete Mixer Truck, Water pump (diesel)	BS 5228-1:2009+A1:2014: Annex C
9	Concrete pour & Vibration for Hardstand at Substation	Vibratory roller, Concrete pump + cement mixer truck (discharging)	BS 5228-1:2009+A1:2014: Annex C
9	Concrete batching in the construction compound	Tracked Excavator, Concrete Mixer Truck, Water pump (diesel)	BS 5228-1:2009+A1:2014: Annex C
10	Craning electrical infrastructure in	Tracked Excavator, Wheeled mobile crane	BS 5228-1:2009+A1:2014: Annex C
10	Erection of T1	Mobile telescopic crane, Wheeled mobile crane	BS 5228-1:2009+A1:2014: Annex C
10	Erection of T2	Mobile telescopic crane, Wheeled mobile crane	BS 5228-1:2009+A1:2014: Annex C
11	Erection of T3	Mobile telescopic crane, Wheeled mobile crane	BS 5228-1:2009+A1:2014: Annex C
11	Erection of T4	Mobile telescopic crane, Wheeled mobile crane	BS 5228-1:2009+A1:2014: Annex C
11	Earthworks at various locations across the eastern side of the site	Tracked Excavator, Dozer, Dumper	BS 5228-1:2009+A1:2014: Annex C
12	Earthworks at various locations across the western side of the site	Tracked Excavator, Dozer, Dumper	BS 5228-1:2009+A1:2014: Annex C
13 - Night	Lighting Generator	Diesel generator (C4.86)	BS 5228-1:2009+A1:2014: Annex C
13 - Night	Power Generator for Cabins/ Construction Compound	Diesel generator (C4.76)	BS 5228-1:2009+A1:2014: Annex C

Sound Power Levels

Name	Octave Spectrum (dB)											Source
	31.5	63	125	250	500	1000	2000	4000	8000	A	lin	
Breaker mounted on excavator (C1.9)	28.0	116.0	116.0	114.0	117.0	111.0	111.0	108.0	104.0	118.3	122.7	BS 5228-1:2009+A1:2014: Annex C
Dozer (C2.10)	28.0	117.0	118.0	109.0	101.0	102.0	98.0	96.0	92.0	108.0	121.0	BS 5228-1:2009+A1:2014: Annex C
Tracked Excavator (C2.14)	28.0	113.0	106.0	105.0	105.0	101.0	99.0	96.0	91.0	107.0	115.1	BS 5228-1:2009+A1:2014: Annex C
Vibratory roller (C2.39)	28.0	116.0	111.0	97.0	96.0	95.0	93.0	90.0	87.0	101.5	117.3	BS 5228-1:2009+A1:2014: Annex C
Hydraulic hammer rig (C3.1)	28.0	110.0	110.0	110.0	117.0	111.0	106.0	103.0	98.0	116.7	120.0	BS 5228-1:2009+A1:2014: Annex C
Dumper (C4.9)	28.0	110.0	110.0	106.0	105.0	97.0	95.0	89.0	81.0	105.2	114.5	BS 5228-1:2009+A1:2014: Annex C
Concrete Mixer Truck (C4.20)	28.0	111.0	102.0	94.0	97.0	98.0	106.0	88.0	83.0	108.0	112.9	BS 5228-1:2009+A1:2014: Annex C
Concrete pump + cement mixer truck (discharging) (C4.24)	28.0	97.0	92.0	92.0	94.0	91.0	87.0	81.0	75.0	95.5	101.0	BS 5228-1:2009+A1:2014: Annex C

Poker vibrator (C4.33)	28.0	110.0	108.0	108.0	101.0	97.0	100.0	98.0	93.0	106.4	114.2	BS 5228-1:2009+A1:2014: Annex C
Mobile telescopic crane (C4.41)	28.0	101.0	99.0	96.0	98.0	94.0	91.0	82.0	77.0	99.1	105.4	BS 5228-1:2009+A1:2014: Annex C
Wheeled mobile crane (C4.43)	28.0	108.0	104.0	99.0	91.0	92.0	91.0	84.0	78.0	97.8	110.0	BS 5228-1:2009+A1:2014: Annex C
Tracked excavator (C4.63)	28.0	105.0	114.0	103.0	103.0	99.0	97.0	92.0	83.0	105.5	115.3	BS 5228-1:2009+A1:2014: Annex C
Diesel generator (C4.76)	28.0	108.0	102.0	85.0	82.0	81.0	76.0	73.0	65.0	89.4	109.0	BS 5228-1:2009+A1:2014: Annex C
Diesel generator (C4.86)	28.0	106.0	99.0	94.0	90.0	87.0	83.0	84.0	77.0	93.5	107.2	BS 5228-1:2009+A1:2014: Annex C
Water pump (diesel) (C4.88)	28.0	98.0	93.0	94.0	92.0	92.0	91.0	84.0	74.0	96.7	101.9	BS 5228-1:2009+A1:2014: Annex C
Harvester					93.4					93.4	96.6	Forestry Commission
Forwarder					87.7					87.7	90.9	Forestry Commission
Skidder					93.4					93.4	96.6	Forestry Commission

Technical Appendix 10.2: Wind Farm Operational Noise Report

tnei

A specialist energy consultancy

Technical Appendix 10.2

Wind Farm Operational Noise Report

Revised Larbrax Wind Farm

Orsted

15893-005-R0
25 October 2024

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Ørsted

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Executive Summary

TNEI Services was commissioned by Land Use Consultants (LUC) on behalf of Orsted ('the Applicant') to undertake an assessment of the potential impact of operational noise from the proposed Revised Larbrax Wind Farm (hereinafter referred to as 'the Proposed Development'), on the nearest noise sensitive receptors.

The Scottish Government's web based renewables advice on 'Onshore Wind Turbines' states: *'The Report, "The Assessment and Rating of Noise from Wind Farms" (Final Report, Sept 1996, DTI), (ETSU-R-97), describes a framework for the measurement of wind farm noise, which should be followed by applicants and consultees, and used by planning authorities to assess and rate noise from wind energy developments, until such time as an update is available. This gives indicative noise levels thought to offer a reasonable degree of protection to wind farm neighbours, without placing unreasonable burdens on wind farm developers, and suggests appropriate noise conditions.'* The advice document then goes on to state: *'The Institute of Acoustics (IOA) has since published Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise [IOA GPG]. The document provides significant support on technical issues to all users of the ETSU-R-97 method for rating and assessing wind turbine noise, and should be used by all IOA members and those undertaking assessments to ETSU-R-97. The Scottish Government accepts that the guide represents current industry good practice.'* The guidance contained within ETSU-R-97 and current good practice has been used to assess the potential operational noise impact of the Proposed Development.

The operational noise assessment has been undertaken in three stages:

1) establish the Total ETSU-R-97 Noise Limits for each Noise Assessment Location (NAL) using the measured background noise levels to derive new limits;

2) undertake noise modelling to determine whether noise predictions from the Proposed Development on its own are within 10 dB of the noise predictions from other wind turbines within the area for each NAL. Where turbine predictions are within 10 dB then a cumulative noise assessment has been undertaken for that NAL (and where not the NAL has been scoped out); and

3) derive the SSNLs for the Proposed Development (through apportioning the Total ETSU-R-97 Noise Limits with other turbines which are within 10 dB of the noise predictions (at each applicable NAL) and compare the noise predictions from the Proposed Development on its own against the SSNLs.

There are a number of small to medium sized wind turbines in proximity to the Proposed Development which have been considered when assessing potential cumulative wind turbine noise impact. It has been assumed that, should the Proposed Development gain consent, the three operational turbines at Meikle Galdenoch and the two operational turbines at Meikle Larbrax will be decommissioned. This assumption is consistent with the original noise assessment undertaken as part of the existing 2020 consent for Larbrax Wind Farm. Therefore, these two sets of turbines have not been considered within the cumulative noise assessment.

The nearby wind turbines included in the cumulative assessment are Knocknain (DW54 900 kW, 1 of), High Mark (WES 80 kW, 2 of), High Auchneel (WES 80 kW, 1 of), Auchnotteroch (WES 80 kW, 1 of), and Glaik Hill (WES 250kW, 1 of).

For the Consented Larbrax Wind Farm, a background noise survey was undertaken by AECOM in 2013 to inform the Noise ES Chapter dated 2015. A new comprehensive background noise survey has been undertaken by TNEI, between November 2021 and January 2022, at four Noise Monitoring Locations (NMLs) surrounding the Site. The TNEI noise survey is the most recent and robust noise survey

available, is in accordance with good practice for wind farm noise assessments and has been used in this assessment to represent existing background noise levels.

A total of sixteen noise sensitive receptors were chosen as Noise Assessment Locations (NALs) and after an initial review twelve were selected for a detailed cumulative noise assessment. The NALs were chosen to represent the noise sensitive receptors located closest to the Proposed Development in any direction, and some further receptors near other wind turbines.

Based on the guidance in ETSU-R-97 and to reflect the presence of existing wind turbines in the area, the daytime Total ETSU-R-97 Noise Limit was set at 40 dB(A) or background plus 5 dB whichever is the greater. The night-time Total ETSU-R-97 Noise Limit has been set at 43 dB(A) or background plus 5 dB whichever is the greater. The Site Specific daytime limit for noise associated with the Proposed Development has been set such that it never exceeds 35 dB(A) or background plus 5 dB, whichever is the greater. This represents the lower end of the daytime limits that can be applied under ETSU-R-97. The night-time Site Specific Noise Limits have been set at 43 dB(A) or background plus 5 dB whichever is the greater.

The exception to the setting of both the daytime and night-time fixed minimum noise limits occur where a property occupier has a Financial Involvement (FI) in a wind farm development where the fixed minimum limit can be increased to 45 dB(A) for both daytime and night-time periods. For the purposes of this assessment, it has been assumed that there is one property FI with the Proposed Development, two properties FI with the operational Knocknain turbine, one property FI with the operational High Mark turbine, and one property FI with the Auchnotteroch turbine..

Predictions of wind turbine noise for the Proposed Development were made, based upon the sound power level data for a candidate wind turbine, the Nordex N133 4.8 MW with Serrated Blades and a hub height of 83.4 m. This wind turbine model was chosen as it is considered representative of the type of turbine that could be installed at the site. Whatever the final turbine choice is, the Proposed Development would have to meet the noise limits determined and contained within any condition applied as part of consent. For the other nearby wind farm schemes considered, predictions were undertaken using sound power level data for the installed turbines or the candidate presented in their respective planning applications. The model of turbine was either identified through an online search, or through the use of the Council's Planning Application Portal.

Modelling was undertaken using the ISO 9613 *'Acoustics – Attenuation of sound during propagation outdoors Part 2: General method of calculation'* noise prediction model which accords with current good practice and is considered to provide a realistic impact assessment.

A cumulative assessment was undertaken at the NALs where predictions from the Proposed Development were found to be within 10 dB of the noise predictions from all other schemes. The likely cumulative assessment was required at twelve NALs. This shows that the Proposed Development with the candidate turbine operating in full mode, and operating concurrently with other nearby wind farms in the area can meet the Total ETSU-R-97 Noise Limits at all NALs.

Site Specific Noise Limits have also been derived based on an apportionment of the Total ETSU-R-97 Noise Limits, to suggest potential limit values that could be used to condition the operation of the Proposed Development on its own. The apportionment was undertaken in accordance with current good practice.

Predicted noise levels from the Proposed Development with a candidate wind turbine operating in full mode are below the Site Specific Noise Limits at the NALs. The assessment demonstrates that the candidate turbine and proposed layout assessed would meet all relevant guidance for wind farm noise.

There are a number of wind turbine makes and models that may be suitable for the Proposed Development. Should the Proposed Development receive planning permission, the final choice of turbine would be subject to a competitive tendering process. As such, predictions of wind turbine noise are for information only. The final choice of turbine would, however, have to meet the Site Specific Noise limits determined and contained within any condition imposed. The use of Site Specific Noise Limits would ensure that the Proposed Development could operate concurrently with the other nearby wind turbines in the area. Likewise, any future wind turbine applications would need to demonstrate that they can operate cumulatively within the Total ETSU-R-97 Noise Limits with the Proposed Development in place.

Should consent be granted for the Proposed Development it would be appropriate to include a set of noise related planning conditions, which detail the noise limits applicable to the Proposed Development.

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Annex 6 – Summary of Wind Turbine Noise Source Data

1 Introduction

1.1 Brief

1.1.1 TNEI was commissioned by Land Use Consultants (LUC) on behalf of Orsted ('the Applicant') to undertake an operational noise assessment for the proposed Revised Larbrax Wind Farm (hereinafter referred to as 'the Proposed Development'). The following steps summarise the noise assessment process:

- Identify the nearby noise sensitive receptors;
- Measure the background noise levels at a sample of noise sensitive receptors;
- Determine the Total ETSU-R-97 Noise Limits applicable to all wind farms in the area, based on a background noise levels and fixed minimum limits;
- Undertake cumulative noise predictions, where required, to take account of other proposed, consented or operational schemes near to the Proposed Development;
- Compare the predicted cumulative noise levels against the Total ETSU-R-97 Noise Limits;
- Derive Site Specific Noise Limits for the Proposed Development, suitable for inclusion in noise related planning conditions should consent be granted for the Proposed Development;
- Compare the predicted noise levels from the Proposed Development operating on its own against the Site Specific Noise Limits;
- Assess the impact of noise from the Proposed Development with reference to existing Government Guidance and the recommendations of the Department of Trade and Industry Noise Working Group on Noise from Wind Turbines, which are contained within the Department of Trade and Industry Noise Working Group on Noise from Wind Turbines which are contained within ETSU-R-97 *'The Assessment and Rating of Noise from Wind Farms'* (1) and *'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise'* (2) (IOA GPG) which represents current good practice.

1.2 Background

1.2.1 The site is located within a relatively remote area in the north-west of the North Rhins Peninsula, approximately 9 km west of Stranraer, Dumfries and Galloway, and has an approximate OS Grid Refer centre point of E 197120, N 561850.

1.2.2 Properties within the surrounding area are mainly single rural dwellings, farmhouses and holiday cottages which are scattered throughout the area. The closest properties to the Site include Greenburn and Meikle Galdenoch (north-east), Larbrax Lodge (east), and Larbrax Cottages and Meikle Larbrax (south). Within the wider area there are a number of small rural settlements including Portpatrick, approximately 8 km to the south and Leswalt, 5.5 km to the east.

1.2.3 The Proposed Development comprises four wind turbines with a maximum blade tip height of 149.9 m. The proposed layout is shown on Figure A1.1 in Annex 1.

1.2.4 In the absence of a confirmed turbine model, this noise assessment models a candidate turbine, the Nordex N133 4.8 MW, with Serrated Blades and a hub height of 83.4 m. This turbine has been selected as it is representative of the turbine type which could be installed at the site within the maximum blade tip height parameter.

1.2.5 The noise assessment has considered schemes which are operational, consented and proposed (planning application submitted). The schemes found to be relevant and therefore considered in this assessment are small to medium sized wind turbines, of which most are currently operational. They are summarised in Table 1.1 and are also shown in Figure A1.1.

Table 1.1 Cumulative Wind Farm/ Turbine Development

Wind Farm/ Wind Turbine	Number of Turbines	Status and Bearing	Modelled Turbine
Knocknain	1	Consented (to replace an existing operational Enercon E33 turbine), to the north.	EWT DW54 900 kW
High Mark	2	Operational, to the north.	WES 80 kW
High Auchneel	1	Operational, to the north.	WES 80 kW
Auchnotteroch	1	Operational, to the southeast.	WES 80 kW
Glaik Hill	1	Operational, to the southeast.	WES LW30 250 kW

1.2.6 It has been assumed that, should the Proposed Development gain planning permission, the three operational turbines at Meikle Galdenoch and the two operational turbines at Meikle Larbrax will be decommissioned. This assumption is consistent with the original noise assessment undertaken as part of the existing planning permission for Larbrax Wind Farm. Therefore, these two sets of turbines have not been considered within the cumulative noise assessment.

1.2.7 For the purposes of assessing the above schemes in conjunction with the Proposed Development, the following terms have been referred to throughout the assessment:

- Total ETSU-R-97 Noise Limits; defined as being the limit that should not be exceeded from the cumulative operation of all wind farm developments, including the Proposed Development; and
- Site Specific Noise Limits; defined as being the limit that is specific to the Proposed Development only, and derived through the apportionment (where required), of the Total ETSU-R-97 Noise Limits in accordance with current good practice.

1.2.8 Note that in this report, the term ‘noise emission’ relates to the sound power level actually radiated from each wind turbine, whereas the term ‘noise immission’ relates to the sound pressure level (the received noise) at any receptor location due to the operation of the wind turbines. All references to dB are referring to A weighted noise levels (dB(A)) unless otherwise stated. A full glossary of terms is provided in Section 8.

2 Noise Planning Policy and Guidance

2.1 Overview of Noise Planning Policy and Guidance

2.1.1 In assessing the potential noise impacts of the Proposed Development, the following guidance and policy documents have been considered:

- National Planning Policy (3);
- Local Planning Policy;
- Web Based Renewables Advice: *'Onshore Wind Turbines'* (4);
- Planning Advice Note PAN 1/2011: *'Planning and Noise'* (5);
- ETSU-R-97 *'The Assessment and Rating of Noise from Wind Farms'*; and
- Institute of Acoustics *'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise'* (IOA GPG) May 2013.

2.2 National Planning Policy

2.2.1 As the Proposed Development has capacity to generate under 50 MW, the Proposed Development requires planning permission at local level from the Local Planning Authority, in this case Dumfries and Galloway Council (DGC).

National Planning Framework 4 (NPPF4)

2.2.2 As of February 2023, National Planning Framework 4 ('NPF4') now forms part of the statutory Development Plan alongside the relevant Local Development Plan and any related Supplementary Guidance for Dumfries and Galloway. Such plans will often contain policies tailored specifically to control certain kinds of development and such policies carry more weight in the decision making process.

2.2.3 National Planning Framework 4 ('NPF4') was adopted on 13 February 2023 and supersedes National Planning Framework 3 and Scottish Planning Policy. Policy 11 – Energy states that renewable energy projects must be able to demonstrate how any noise impacts on communities have been addressed through the project's design and any associated mitigation. Policy 23 – Health and Safety outlines how 'development proposals that are likely to raise unacceptable noise issues will not be supported' and states that 'a Noise Impact Assessment may be required where the nature of the proposal or its location suggests that significant effects are likely.'

2.2.4 The Scottish Government's online Onshore Wind: Policy Statement 2022 (published on 21 December 2022) (6) states (in Section 3.7) that: 'The Assessment and Rating of Noise from Wind Farms' (Final Report, Sept 1996, DTI), (ETSU-R-97) provides the framework for the measurement of wind turbine noise, and all applicants are required to follow the framework and use it to assess and rate noise from wind energy developments.'

Web Based Planning Advice – Onshore Wind Turbines

2.2.5 The 'Onshore Wind Turbines' web-based document also describes the types of noise (mechanical and aerodynamic) that wind turbines generate. Mechanical noise is generated

by the gearbox and generator and other parts of the drive train, which can be radiated as noise through the nacelle, gear box, tower and supporting structures, together with the aerodynamic noise generated by the action of the blades rotating through the air. The document states '*there has been significant reduction in the mechanical noise generated by wind turbines through improved turbine* design' and goes on to note:

'The Report, "The Assessment and Rating of Noise from Wind Farms" (Final Report, Sept 1996, DTI), (ETSU-R-97), describes a framework for the measurement of wind farm noise, which should be followed by applicants and consultees, and used by planning authorities to assess and rate noise from wind energy developments, until such time as an update is available. This gives indicative noise levels thought to offer a reasonable degree of protection to wind farm neighbours, without placing unreasonable burdens on wind farm developers, and suggests appropriate noise conditions.'

2.2.6 The web-based document then refers to the IOA GPG as a source, which provides:

'significant support on technical issues to all users of the ETSU-R-97 method for rating and assessing wind turbine noise, and should be used by all IOA members and those undertaking assessments to ETSU-R-97. The Scottish Government accepts that the guide represents current industry good practice.'

2.2.7 The document also refers to the role of PAN1/2011 'Planning and Noise' to:

'provide advice on the role of the planning system in helping to prevent and limit the adverse effects of noise. The associated Technical Advice Note provides guidance which may assist in the technical evaluation of noise assessment.'

2.2.8 Examination of the Technical Advice Note (7) confirms that it provides advice on wind farms by referring to ETSU-R-97 and relevant parameters for modelling identified in the Institute of Acoustics Bulletin March 2009, on page 37. This has been superseded by the introduction of the IOA GPG in May 2013.

Planning Advice Note PAN 1/2011: Planning and Noise

2.2.9 PAN 1/2011 provides advice on the role of the planning system in helping to prevent and limit the adverse effects of noise. Paragraph 29 contains some specific information on noise from wind farms and states the following:

'There are two sources of noise from wind turbines - the mechanical noise from the turbines and the aerodynamic noise from the blades. Mechanical noise is related to engineering design. Aerodynamic noise varies with rotor design and wind speed, and is generally greatest at low speeds. Good acoustical design and siting of turbines is essential to minimise the potential to generate noise. Web based planning advice on renewable technologies for Onshore wind turbines provides advice on 'The Assessment and Rating of Noise from Wind Farms' (ETSU-R-97) published by the former Department of Trade and Industry [DTI] and the findings of the Salford University report into Aerodynamic Modulation of Wind Turbine Noise.'

2.3 Local Policy

Dumfries and Galloway Local Development Plan 2

2.3.1 The adopted Development Plan for the area comprises the Dumfries and Galloway Local Development Plan 2 (LDP2) which was adopted in October 2019. The Local Plan sets out detailed policies and specific proposals for the development and use of land within Dumfries and Galloway. Where policies in NPF4 contradict those in LDP2 and its associated Supplementary Guidance then NPF4, as the most recent plan, will take precedence.

2.3.2 Policy IN1: Renewable Energy, covers the principal policy guidance in relation to renewable energy. It states:

'The Council will support development proposals for all renewable energy generation and/or storage which are located, sited and designed appropriately. The acceptability of any proposed development will be assessed against the following considerations: …….noise. To enable this assessment sufficient detail should be submitted, to include the following as relevant to the scale and nature of the proposal…… environmental and other impacts associated with the construction and operational phases of the development including details of any visual impact, noise and odour issues.'

2.3.3 Policy IN2: Wind Energy, provides the principal policy guidance in relation to wind energy developments. It states that:

'The Council will support wind energy proposals that are located, sited and designed appropriately. The acceptability of any proposed wind energy development will be assessed against …… The extent of any detrimental impact on communities, individual dwellings, residents and local amenity, including assessment of the impacts of noise, shadow flicker, visual dominance and the potential for associated mitigation.'

Dumfries and Galloway LDP 2 Supplementary Guidance – Wind Energy Development: Development Management Considerations

2.3.4 The policy detailed above is supported by more detailed guidance contained within Supplementary Guidance - Wind Energy Development: Development Management Considerations. The guidance was adopted in February 2020 and is a material consideration as it forms part of the development plan and is afforded the same weight as the LDP.

2.3.5 In relation to noise paragraph E11 states:

'for all large and medium turbines a full site-specific noise impact assessment, following ETSU-R-97 and Institute of Acoustics methodology (or subsequent accepted national guidelines), which includes cumulative impact would be required for all appropriate noise sensitive properties as agreed with Environmental Standards.'

2.4 ETSU-R-97 The Assessment and Rating of Noise from Wind Farms

2.4.1 As wind farms started to be developed in the UK in the early 1990's, it became apparent that existing noise standards did not fully address the issues associated with the unique characteristics of wind farm developments and there was a need for an agreed methodology for defining acceptable noise limits for wind farm developments. This methodology was

developed for the former Department of Trade and Industry (DTI) by the Working Group on Noise from Wind Turbines (WGNWT).

2.4.2 The WGNWT comprised a number of interested parties including, amongst others, Environmental Health Officers, wind farm operators, independent acoustic consultants and legal experts who:

'…between them have a breadth and depth of experience in assessing and controlling the environmental impact of noise from wind farms.'

2.4.3 In this way it represented the views of all the stakeholders that are involved in the assessment of noise impacts of wind farm developments. The recommendations of the WGNWT are presented in the DTI Report – ETSU-R-97 *'The Assessment and Rating of Noise from Wind Farms (1996).'*

2.4.4 The basic aim of the WGNWT in arriving at the recommendations was the intention to provide:

'Indicative noise levels thought to offer a reasonable degree of protection to wind farm neighbours, without placing unreasonable restrictions on wind farm development or adding to the costs and administrative burdens on wind farm developers or local authorities.'

2.4.5 ETSU-R-97 makes it clear from the outset that any noise restrictions placed on a wind farm must balance the environmental impact of the wind farm against the national and global benefits that would arise through the development of renewable energy sources:

'The planning system must therefore seek to control the environmental impacts from a wind farm whilst at the same time recognising the national and global benefits that would arise through the development of renewable energy sources and not be so severe that wind farm development is unduly stifled.'

2.4.6 Where noise at the nearest noise sensitive receptors is limited to an $L_{A90,10min}$ of 35 dB(A) up to wind speeds of 10 ms^{-1} at a height of 10 m, then it does not need to be considered in the noise assessment, as protection of the amenity of these properties can be controlled through a simplified noise limit. In this regard ETSU-R-97 states that:

'For single turbines or wind farms with very large separation distances between the turbines and the nearest properties, a simplified noise condition may be suitable. If the noise is limited to an $L_{A90,10min}$ of 35 dB(A) up to wind speeds of 10 m/s at 10 m height, then this condition alone would offer sufficient protection of amenity, and background noise surveys would be unnecessary.'

2.4.7 The ETSU-R-97 assessment procedure specifies that where wind turbine noise is expected to be above the simplified limit of 35 dB L_{A90} noise limits should be set relative to existing background noise levels at the nearest receptors. These limits should reflect the variation in both turbine source noise and background noise with wind speed. Absolute lower limits, different for daytime and night-time, are applied where low levels of background noise are measured. The wind speed range that should be considered ranges between the cut-in wind speed for the turbines (usually about 2 to 3 ms^{-1}) and up to 12 ms^{-1}, where all wind speeds are referenced to a 10 metre measurement height.

2.4.8 Separate noise limits apply for daytime and for night-time. Daytime limits are chosen to protect a property's external amenity, and night-time limits are chosen to prevent sleep disturbance indoors, with windows open.

2.4.9 The daytime noise limit is derived from background noise data measured during so-called 'quiet periods of the day', which comprise weekday evenings (18:00 to 23:00), Saturday afternoons and evenings (13:00 to 23:00) and all day and evening on Sundays (07:00 to 23:00). Multiple samples of 10 minute background noise levels using the $L_{A90,10min}$ measurement index are logged continuously over a range of wind speed conditions. These measured noise levels are then plotted against concurrent wind speed data and a 'best fit' curve is fitted to the data to establish the background noise level as a function of wind speed. The ETSU–R-97 daytime noise limit, sometimes referred to as a 'criterion curve', is then set at a level 5 dB(A) above the best fit curve over the desired wind speed range; subject to an appropriate daytime fixed minimum limit:

'For wind speeds where the best fit curve to the background noise data lies below a level of 30 - 35 dB(A) the criterion curve is set at a fixed level in the range 35 - 40 dB(A). The precise choice of criterion curve level within the range 35 - 40 dB(A) depends on a number of factors: the number of noise affected properties, the likely duration, the level of exposure and the potential impact on the power output of the wind farm. The quiet daytime limits have been set in ETSU-R-97 on the basis of protecting the amenity of residents whilst outside their dwellings in garden areas.'

2.4.10 The night-time noise limit is derived from background noise data measured during the night-time periods (23:00 to 07:00), with no differentiation being made between weekdays and weekends. The 10 minute L_{A90} noise levels measured over the night time periods are plotted against concurrent wind speed data and a 'best fit' correlation is established. The night-time noise limit is also based on a level 5 dB(A) above the best fit curve over the 0 - 12 ms^{-1} wind speed range, with a fixed minimum limit of 43 dB L_{A90}.

2.4.11 The exception to the setting of both the daytime and night-time fixed minimum limits occurs where a property occupier has a financial involvement in the wind farm development. Paragraph 24 of ETSU-R-97 states:

'The Noise Working Group recommends that both day and night time lower fixed limits can be increased to 45 dB(A) and that consideration should be given to increasing the permissible margin above background where the occupier of the property has some financial involvement in the wind farm.'

2.4.12 ETSU-R-97 provides a robust basis for determining the noise limits for wind turbine(s) and since its introduction has become the accepted standard for such developments across the UK.

2.5 Current Good Practice

A Good Practice Guide on the Application of ETSU-R-97

2.5.1 In May 2013, the Institute of Acoustics issued *'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise'* (IOA GPG). The document provides guidance on background data collection, data analysis and limit derivation, noise predictions, cumulative issues, reporting requirements and other matters such as noise related planning conditions.

2.5.2 The Authors of the IOA GPG sets out the scope of the document in Section 1.2:

'This guide presents current good practice in the application of the ETSU-R-97 assessment methodology for all wind turbine developments above 50 kW, reflecting the original principles within ETSU-R-97, and the results of research carried out and experience gained since ETSU-R-97 was published. The noise limits in ETSU-R-97 have not been examined as these are a matter for Government.'

2.5.3 The guidance document was endorsed, on behalf of Scottish Government by the Cabinet Secretary for Finance, Employment and Sustainable Growth, Mr John Swinney MSP (8).The recommendations included in the IOA GPG have been considered and applied throughout this noise assessment for the Proposed Development.

2.5.4 The IOA GPG refers to six Supplementary Guidance Notes and where applicable these have also been considered in this report.

2.5.5 The guidance contained within ETSU-R-97 and the IOA GPG has therefore been used to assess and rate the operational noise emissions from the Proposed Development.

2.6 WSP BEIS Report

2.6.1 In February 2023, WSP published *'A review of noise guidance for onshore wind turbines'* (9)('WSP BEIS report'). The report, which was subsequently re-issued as version 4 in May 2023, was commissioned by (the former) UK Government Department for Business, Energy & Industrial Strategy (BEIS). The primary aim of the review was to make a recommendation on whether, in view of government policies on noise and Net Zero, and available evidence, the existing guidance requires updating.

2.6.2 The WSP BEIS report concluded that:

'the guidance would benefit from further review and updating of the aspects identified. This could be supported by currently available evidence, which is summarised in this report. However, the study has also highlighted gaps in the state of knowledge, which should be addressed by further research, to support any updates to the guidance.'

2.6.3 A series of recommendations are made regarding further research whilst some additional suggestions are included regarding the development of new or updated guidance. The following recommendation is included on page 26 of the WSP BEIS report:

'the separation of the 'policy position' (addressing the balance between controlling noise impact and enabling renewable energy development), 'technical guidance' (application of the assessment approach), and 'technical justification' (the supporting evidence) into discrete, linked documents'

2.6.4 The WSP BEIS report notes at the outset that *'Any views expressed within it do not necessarily represent the views of the UK government or the governments of any of the devolved administrations'.* The report does state on page 25 that:

'Consideration should be given to including a clear position statement in guidance confirming the intended policy balance between protection from noise impact, and enabling of

renewable energy development (to achieve Net Zero), linked with the wider policies that underpin the government approach to noise management.'

2.6.5 The UK Government Department for Energy Security and Net Zero (DESNZ) has recently issued a tender seeking support to update ETSU-R-97. At the present time there are no set timescales for such an update to be published or adopted.

2.6.6 In relation to the guidance that should be used to assess the Proposed Development, the Scottish Government Guidance is clear; the Onshore Wind Policy Statement 2022 states:

'3.7.1. 'The Assessment and Rating of Noise from Wind Farms' (Final Report, Sept 1996, DTI), (ETSU-R-97) provides the framework for the measurement of wind turbine noise, and all applicants are required to follow the framework and use it to assess and rate noise from wind energy developments.'

'3.7.4. Until such time as new guidance is produced, ETSU-R-97 should continue to be followed by applicants and used to assess and rate noise from wind energy developments.'

2.6.7 The guidance contained within ETSU-R-97 and the IOA GPG has therefore been used to assess and rate the operational noise emissions from the Proposed Development.

3 Potential Impacts

3.1 Operational Noise Sources

3.1.1 Wind turbines may emit two types of noise. Firstly, aerodynamic noise is a more natural sounding 'broad band' noise, albeit with a characteristic modulation, or 'swish', which is produced by the movement of the rotating blades through the air. Secondly, mechanical noise may emanate from components within the nacelle of a wind turbine. Potential sources of mechanical noise include gearboxes or generators.

3.1.2 Aerodynamic noise is usually perceived when the wind speeds are fairly low although at very low wind speeds the blades do not rotate, or rotate very slowly, and so negligible aerodynamic noise is generated. In higher winds aerodynamic noise may be masked by the normal sound of wind blowing through the trees and around buildings. The level of this natural 'masking' noise relative to the level of wind turbine noise is one of the several factors that determine the subjective audibility of the wind turbines (10).

3.2 Amplitude Modulation

3.2.1 In the context of wind turbine noise amplitude modulation describes a variation in noise level over time; for example, observers may describe a 'whoosh whoosh' sound, which can be heard close to a wind turbine as the blades sweep past. Amplitude Modulation of aerodynamic noise is an inherent characteristic of wind turbine noise and was noted in ETSU-R-97, on page 68:

'The modulation or rhythmic swish emitted by wind turbines has been considered by some to have a characteristic that is irregular enough to attract attention. The level and depth of modulation of the blade noise is, to a degree, turbine-dependent and is dependent upon the position of the observer. Some wind turbines emit a greater level of modulation of the blade noise than others. Therefore, although some wind turbines might be considered to have a character that may attract one's attention, others have noise characteristics which are considerably less intrusive and unlikely to attract one's attention and be subject to any penalty.

This modulation of blade noise may result in a variation of the overall A-weighted noise level by as much as 3dBA (peak to trough) when measured close to a wind turbine. As distance from the wind turbine [or] wind farm increases, this depth of modulation would be expected to decrease as atmospheric absorption attenuates the high frequency energy radiated by the blade.'

3.2.2 In recent times the Acoustics community has sought to make a distinction between the AM discussed within ETSU-R-97, which is expected at most wind farms and as such may be considered as 'Normal Amplitude Modulation' (NAM), compared to the unusual AM that has sometimes been heard at some wind farms, hereinafter referred to as 'Other Amplitude Modulation' (OAM). The term OAM is used to describe an unusual feature of aerodynamic noise from wind turbines, where a greater than normal degree of regular fluctuation in sound level occurs at blade passing frequency, typically once per second. In some appeal decisions it may also be referred to as 'Excess Amplitude Modulation' (EAM). It should be noted that the noise assessment and rating procedure detailed in ETSU-R-97 fully takes into

account the presence of the intrinsic level of NAM when setting acceptable noise limits for wind farms.

3.2.3 On 16 December 2013, RenewableUK (RUK) released six technical papers (11) on AM, which reflected the outcomes of research commissioned over the previous three years, together with a template planning condition. Whilst this research undoubtedly improved understanding of Other Amplitude Modulation (OAM) and its effects, it should be noted that at the time of writing it has not been endorsed by any relevant body such as the Institute of Acoustics (IOA).

3.2.4 On 22 January 2014, the IOA released a statement regarding the RUK research and the proposed planning condition to deal with the issue of amplitude modulation from a wind turbine and stated:

'This research is a significant step forward in understanding what causes amplitude modulation from a wind turbine, and how people react to it. The proposed planning condition, though, needs a period of testing and validation before it can be considered to be good practice. The IOA understands that RenewableUK will shortly be making the analysis tool publicly available on their website so that all interested parties can test the proposed condition, and the IOA will review the results later in the year. Until that time, the IOA cautions the use of the proposed planning condition.'

3.2.5 Research regarding amplitude modulation continued. In April 2015, the IOA issued a discussion document entitled *'Methods for Rating Amplitude Modulation in Wind Turbine Noise'*. The document presented three methods that can be used to quantify the level of AM at a given measurement location. After extensive consultation a preferred method of measuring OAM, which provides a framework for practitioners to measure and rate AM, was recommended by the IOA.

3.2.6 On 3 August 2015, the Department for Energy and Climate Change (DECC), now the Department for Business, Energy and Industrial Strategy (BEIS), commissioned independent consultants WSP Parsons Brinkerhoff to carry out a literature review on OAM (which they refer to simply as AM). The stated aims were as follows:

- *To review the available evidence on Amplitude Modulation (AM) in relation to wind turbines, including but not limited to the research commissioned and published by RenewableUK in December 2013;*
- *To work closely with the Institute of Acoustics' AM working group, who are expected to recommend a preferred metric and methodology for quantifying and assessing the level of AM in a sample of wind turbine noise data;*
- *To review the robustness of relevant dose response relationships, including the one developed by the University of Salford as part of the RenewableUK study, on which the correction (or penalty) for amplitude modulation proposed as part of its template planning condition is based;*
- *To consider how, in a policy context, the level(s) of AM in a sample of noise data should be interpreted, in particular determining at what point it causes a significant adverse impact;*
- *To recommend how excessive AM might be controlled through the use of an appropriate planning condition; and*

- *To consider the engineering/cost trade-offs of possible mitigation measures.*

3.2.7 Their report, which was released in October 2016, concluded that there is sufficient robust evidence that excessive AM leads to increased annoyance from wind turbine noise and recommended that excessive AM is controlled through a suitably worded planning condition, which will control it during periods of complaint. Those periods should be identified by measurement using the metric proposed by the work undertaken by the IOA, and enforcement action would rely upon professional judgement by Local Authority Environmental Health Officers based on the duration and frequency of occurrence.

3.2.8 It is not clear within the body of the report which evidence the authors relied upon to arrive at their conclusions, although the Executive Summary states (page 4);

"It is noted that none of the Category 1 or 2 papers have been designed to answer the main aim of the current review in its entirety. The Category 1 studies have limited representativeness due to sample constraints and the artificiality of laboratory environments, whereas the Category 2 studies generally do not directly address the issue of AM WTN exposure-response. A meta - analysis of the identified studies was not possible due to the incompatibility of the various methodologies employed. Notwithstanding the limitations in the evidence, it was agreed with DECC that the factors to be included in a planning condition should be recommended based on the available evidence, and supplemented with professional experience".

3.2.9 The report (12) states that any planning condition must accord with existing planning guidance, and should be subject to legal advice on a case by case basis. Existing guidance would include compliance with the six tests of a planning condition embodied in Circular 4/98. The report's authors did not dictate a particular condition to be used but did suggest that any condition should include the following elements (p5):

- *"The AM condition should cover periods of complaints (due to unacceptable AM);*
- *The IoA-recommended metric should be used to quantify AM (being the most robust available objective metric);*
- *Analysis should be made using individual 10-minute periods, applying the appropriate decibel 'penalty' to each period, with subsequent analysis;*
- *The AM decibel penalty should be additional to any decibel penalty for tonality; and*
- *An additional decibel penalty is proposed during the night time period to account for the current difference between the night and day limits on many sites to ensure the control method works during the most sensitive period of the day."*

3.2.10 AM was considered in the WSP BEIS report. The report notes that the IOA Method provides a suitable approach to measure and quantify AM (whilst noting that work is ongoing to refine the approach) but also highlights that further work is required to develop a robust mechanism for controlling AM that could be incorporated into a planning condition. In relation to the potential adoption of a penalty scheme to control AM the WSP BEIS report notes on page 208 that:

'In practice, the details of applying such a penalty scheme are complicated by the complexities of wind turbine sound measurements. These often involve a considerable amount of data filtering and data aggregation to address the practical difficulties of measuring a highly variable source, which is often also at a level that is relatively low

compared with other, fluctuating residual sounds present in the acoustic environment. Such details will need to be carefully considered in further study, and the example planning condition proposed by a group of IOA members in 2017 [505] should be considered as a starting point.'

3.2.11 Until such a 'further study' is completed, and additional guidance is published, the approach set out in the IOA GPG remains valid, the document states (paragraph 7.2.10):

'7.2.1 The evidence in relation to "Excess" or "Other" Amplitude Modulation (AM) is still developing. At the time of writing, current practice is not to assign a planning condition to deal with AM.'

4 Methodology

4.1 Assessing Operational Noise Impact

4.1.1 To undertake an assessment of the operational noise impact in accordance with the requirements of ETSU-R-97 and the IOA GPG, the following steps have been followed:

- Specify the location of the wind turbines for the Proposed Development and nearby relevant wind turbines / farms;
- Measure noise levels in the area in the absence of wind turbine noise, to establish representative background noise levels across a range of wind speeds;
- Identify the locations of all nearby noise sensitive receptors and select a sample of relevant Noise Assessment Locations (NAL). For each NAL, identify the most representative measured background noise dataset;
- Establish for each NAL the Total ETSU-R-97 Noise Limits, relative to background noise levels or fixed minimums;
- Specify the likely noise emission characteristics of the wind turbines for the Proposed Development and all nearby cumulative wind turbines;
- Calculate the likely noise immission levels due to the cumulative operation of all relevant wind turbines and compare it to the Total ETSU-R-97 Noise Limits;
- Determine the Site Specific Noise Limits which take account of the noise limit already allocated to/ could theoretically be used by other schemes in the area; and
- Calculate the likely noise immission levels due to the operation of the Proposed Development on its own and compare it to the Proposed Development's Site Specific Noise Limits.

4.1.2 In order to consider the steps outlined above the assessment has been split into three separate stages:

- Stage 1 - establish the Total ETSU-R-97 Noise Limits for each Noise Assessment Location (NAL) using the measured background noise levels to derive new limits;

- Stage 2 - undertake noise modelling to determine whether noise predictions from the Proposed Development on its own are within 10 dB of the noise predictions from other wind turbines within the area for each NAL. Where turbine predictions are within 10 dB then a cumulative noise assessment has been undertaken for that NAL (and where not the NAL has been scoped out); and

- Stage 3 - derive the SSNLs for the Proposed Development (through apportioning the Total ETSU-R-97 Noise Limits with other turbines which are within 10 dB of the noise predictions (at each applicable NAL) and compare the noise predictions from the Proposed Development on its own against the SSNLs.

4.2 Consultation

Environmental Health Scoping Response (dated April 2024)

4.2.1 An EIA Scoping Report was submitted to DGC in September 2023 (ref. 23/2032/SCO). Within the Scoping Report was the suggested approach to the noise assessment.

4.2.2 The Environmental Health Department at DGC responded to the Scoping Report in a letter dated 20th April 2024, categorised as 'Consultation response'. Within the letter were comments on operational noise, stating:

'In relation to the above application, I have no objections in principle however, until a site-specific impact assessment has been carried out with regard to noise, potential for impact on private water supplies etc we would be unable to comment fully as to the expected impacts.'

4.2.3 Overall, the methodology from ETSU-R-97 and the IOA GPG is understood to be the relevant guidelines and therefore the operational noise assessment adheres to this methodology, as outlined in the Scoping Report.

4.3 Setting the Total ETSU-R-97 Noise Limits (Stage 1)

Background Noise Levels and Wind Shear

4.3.1 Wind shear can be defined as *'the change in the relationship between wind speed at different heights'.* Due to wind shear, wind speeds recorded on one meteorological mast at different heights are usually different, generally the higher the anemometer the higher the wind speed recorded. For example, if a wind speed of 4 ms^{-1} is recorded at 80 m height, 3.5 ms^{-1} may be recorded at 40 m and 2.5 ms^{-1} may be recorded at 10 m.

4.3.2 Hub height wind speed is the key wind speed for a wind farm noise assessment, as it is the wind speed at hub height which will determine the noise emitted by the wind turbines and informs the turbine control system. Ideally, both wind turbine noise predictions and background noise level measurements should refer to hub height wind speed (or a representation thereof), ensuring that there is no discrepancy between the wind speed at which the noise is emitted and the wind speed at which the corresponding background noise is measured.

4.3.3 The IOA GPG states that one of three methods (A, B or C) to account for wind shear may be adopted. For this assessment the 'Method A' of Section 2.6.3 of the IOA GPG was used to fully take account of wind shear. The details are described in the Section 5 'Baseline'.

Noise Impact Criteria in ETSU-R-97

4.3.4 ETSU-R-97 recommends noise limits should be set at 5 dB(A) above existing background noise levels, or a fixed minimum limit of 35-40 dB during the daytime and 43 dB during the night-time periods where background noise levels are low, and that these limits should reflect the variation in background noise with wind speed. Different limits apply to those properties that have a financial interest in the wind energy development (45 dB or background plus 5 dB (whichever is the greater) for both daytime and night-time).

4.3.5 The choice of quiet daytime fixed minimum limits should be considered in light of the guidance contained within ETSU-R-97 and the IOA GPG. Noise limits established at properties in accordance with ETSU-R-97 shall be applicable to all existing/ proposed (in planning) wind farms in the area and will henceforth be referred to as the 'Total ETSU-R-97 Noise Limits'. For this assessment a daytime fixed minimum limit of 40 dB or background plus 5 dB, whichever is greater. The night-time noise limits have been based on 43 dB or background plus 5 dB, whichever is greater.

4.3.6 The acceptable limits for wind turbine operational noise are clearly defined for all time periods by the application of the ETSU-R-97 methodology. Consequently, the test applied to operational noise is whether or not the predicted wind turbine noise levels at nearby noise sensitive properties lie below the ETSU-R-97 noise limits. Depending on the levels of background noise, the satisfaction of the ETSU-R-97 derived limits can lead to a situation whereby, at some locations under some wind conditions and for a certain proportion of the time, the wind turbine noise would be audible.

4.4 Assessment of likely effects and the requirement for a cumulative assessment (Stage 2)

4.4.1 The IOA GPG (2013) includes a detailed section on cumulative noise and provides guidance on where a cumulative assessment is required. Section 5.1.4 and 5.1.5 of the GPG state:

'During scoping of a new wind farm development consideration should be given to cumulative noise impacts from any other wind farms in the locality. If the proposed wind farm produces noise levels within 10 dB of any existing wind farm/s at the same receptor location, then a cumulative noise impact assessment is necessary.

Equally, in such cases where noise from the proposed wind farm is predicted to be 10 dB greater than that from the existing wind farm (but compliant with ETSU-R-97 in its own right), then a cumulative noise impact assessment would not be necessary.'

4.4.2 An assessment was undertaken at a selection of noise sensitive receptors proximate to the Proposed Development and other nearby wind farm developments to determine whether the wind turbine noise immission from the Proposed Development were within 10 dB of the wind turbine noise immission from the other schemes. Where predictions were found to be within 10 dB of each other, then a cumulative noise assessment was undertaken to determine the likely impacts of the Proposed Development, however, if wind turbine immission were greater than 10 dB apart then a cumulative noise assessment was not required.

Noise Prediction / Propagation Model

4.4.3 The ISO 9613-2: 1996 *'Acoustics – Attenuation of sound during propagation outdoors Part 2: General method of calculation'* (13) model algorithm provides a robust prediction method for calculating the noise immission levels at the nearest receptors.

4.4.4 The use of ISO 9613-2 is discussed in the IOA GPG which states, in Section 4.1.4:

'ISO 9613-2 standard in particular, which is widely used in the UK, can be applied to obtain realistic predictions of noise from on-shore wind turbines during worst case propagation conditions (i.e. sound speed gradients due to downwind conditions or temperature

inversions), but only provided that the appropriate choice of input parameters and correction factors are made.'

4.4.5 There is currently no standard approach to specifying error bands on noise predictions. Table 5 of ISO 9613-2 suggests, at best, an estimated of accuracy of ± 3 dB(A). The work undertaken as part of the EC research study concluded that the ISO 9613-2 algorithm reliably predicted noise levels that would generally occur under downwind propagation conditions. The error bands referenced in the ISO standard itself relate to the general application of the standard. Additional, wind farm specific studies, have also been undertaken to validate the use of the standard to predict wind farm noise and these are referenced in Section 4 of the IOA GPG which goes on to conclude that: *'The outcome of this research has demonstrated that the ISO 9613-2 standard in particular, which is widely used in the UK, can be applied to obtain realistic predictions of noise from on-shore wind turbines during worst case propagation conditions (i.e. sound speed gradients due to downwind conditions or temperature inversions), but only provided that the appropriate choice of input parameters and correction factors are made.'* TNEIs experience of undertaking compliance monitoring for operational wind farms indicates that the predictions undertaken using the guidance in the IOA GPG show a good correlation with measured levels.

4.4.6 The ISO 9613-2 model can take account of the following factors that influence sound propagation outdoors:

- Geometric divergence;
- Atmospheric absorption;
- Reflecting obstacles;
- Screening;
- Vegetation; and
- Ground attenuation.

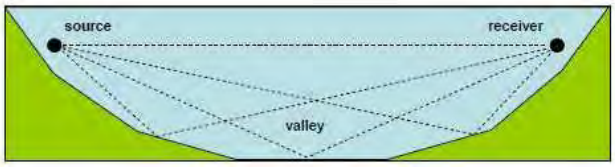
4.4.7 The model uses as its acoustic input data the octave band sound power output of the turbine and calculates, on an octave band basis, attenuation due to the factors above, as appropriate.

4.4.8 The IOA GPG quotes a comparative study undertaken in Australia that indicated ISO 9613-2 can, in some conditions, under-predict ground attenuation effects and the potential for additional reflection paths 'across a valley', whilst slightly over-predicting on flat terrain. It should be noted, however, that the wind farm layouts studied were untypical for the UK, with rows of turbines spreading over 10 km on an elevated ridge. It also should be noted that no correction for background contribution was undertaken and the monitoring locations were located as far as 1.7 km from the nearest turbine, where turbine noise may be at similar levels to background noise and therefore difficult to differentiate. For the study's modelling work topographic height data was included as an input, which is consistent with ISO 9613-2 methodology generally, but not with the requirements of the IOA GPG.

4.4.9 The model used in this assessment does not model barrier attenuation using the method in ISO 9613-2, but instead uses the guidance in the IOA GPG to consider whether any topographical corrections are required as set out below in Sections 4.4.10 to 4.4.13. Any differences in ground height (AOD) between the receptors and the turbines are considered when calculating the propagation distance between each source and receiver.

4.4.10 The IOA GPG states that a *'further correction of +3 dB should be added to the calculated overall A-weighted level for propagation 'across a valley', i.e. a concave ground profile or where the ground falls away significantly between a turbine and the receiver location.'* The potential reflection paths are illustrated in Schematic 4.1 below.

Schematic 4.1: Multiple reflection paths for sound propagation across concave ground



Source: IOA GPG, page 21, Figure 5

4.4.11 A formula from the JOULE Project JOR3-CT95-0051 dated 1998 is suggested for determining whether a correction is required.

$$h_m \geq 1.5 \times (abs\ (h_s - h_r) / 2)$$

where h_m is the mean height above the ground of the direct line of sight from the receiver to the source (as defined in ISO 9613-2, Figure 3), and h_s and h_r are the heights above local ground level of the source and receiver respectively).

4.4.12 The calculation of h_m requires consideration of the digital terrain model and needs to be performed for each path between every turbine and every receiver. Interpretation of the results of the calculation above and the subsequent inclusion of a concave ground profile correction requires careful consideration with any topographical variation considered in the context of a site.

4.4.13 The IOA GPG also discusses the potential for topographical screening effects of the terrain surrounding a wind farm and the nearby noise sensitive receptors. Although barrier screening effects in ISO 9613-2 can make corrections of up to 15 dB, the IOA GPG states that where there is no line of sight between the highest point on the rotor and the receiver location a reduction of no more than 2 dB may be applied.

4.4.14 The modelling parameters used in this assessment are detailed in Section 6.2.1 below.

4.5 Setting the Site Specific Noise Limits (Stage 3)

4.5.1 Summary Box 21 of the IOA GPG states:

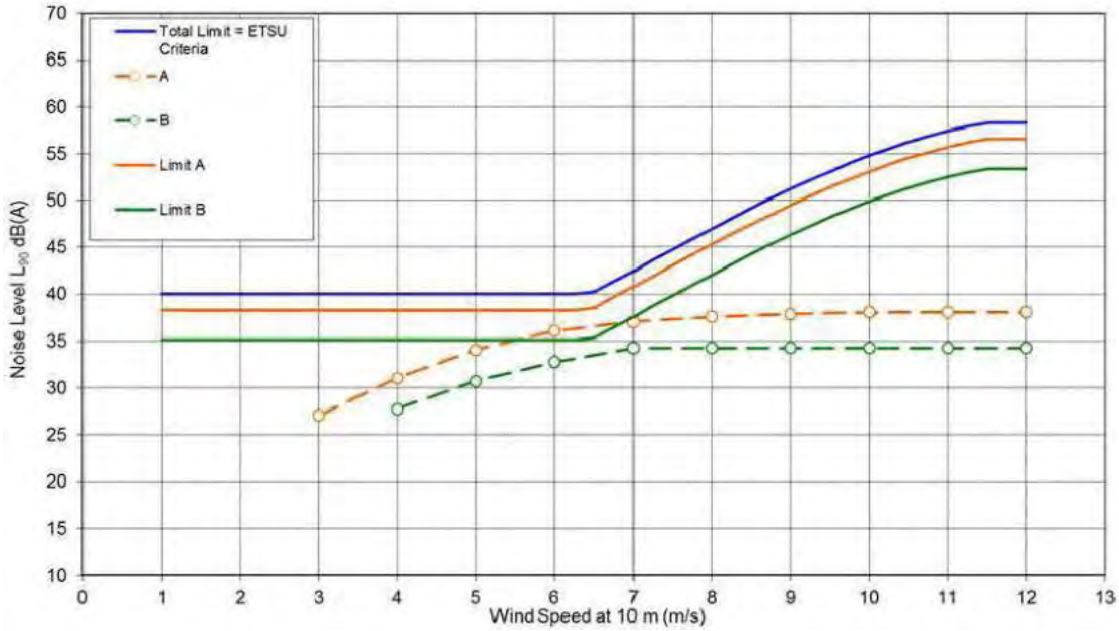
'Whenever a cumulative situation is encountered, the noise limits for an individual wind farm should be determined in such a way that no cumulative excess of the total ETSU-R-97 noise limit would occur.'

4.5.2 In order to determine site specific noise limits at receptors in proximity to the Proposed Development, where required an apportionment of the Total ETSU-R-97 noise limits has been undertaken. The limit apportionment has considered the noise limit already allocated to other wind farms in the area.

4.5.3 This approach is demonstrated in Graph 4.1 below. In this example the total limit (shown in blue) is shared between wind farm A and wind farm B. The two noise limits for a given

receptor (the solid orange and green lines) when added together equate to the Total ETSU-R-97 Noise limit, and the predicted levels for each wind farm (the dashed lines) meet the specific limits established for the individual wind farms.

Graph 4.1: Limit Apportionment Example



4.5.4 The limit derivation can also be undertaken with consideration to the amount of headroom between another schemes(s) predictions and the Total Noise Limit. With regard to this Section 5.4.11 of the IOA GPG states:

'In cases where there is significant headroom (e.g. 5 to 10 dB) between the predicted noise levels from the existing wind farm and the Total Noise Limits, where there would be no realistic prospect of the existing wind farm producing noise levels up to the Total Noise Limits, agreement could be sought with the LPA as to a suitable predicted noise level (including an appropriate margin to cover factors such as potential increases in noise) from the existing wind farm to be used to inform the available headroom for the cumulative assessment without the need for negotiation or cumulative conditioning. This may be the case particularly at low wind speeds.'

4.5.5 Information on the approach to apportionment for Site Specific Noise Limits is made on a receptor by receptor basis and specific detail of the chosen approach for each receptor is provided in Section 6.6 below.

5 Baseline

5.1 Identification of Potential Noise Receptors

5.1.1 For the Consented Larbrax Wind Farm, a background noise survey was undertaken by AECOM in 2013 to inform the Noise ES Chapter dated 2015. A new comprehensive background noise survey has been undertaken by TNEI, between November 2021 and January 2022, at four Noise Monitoring Locations (NMLs) surrounding the Site. The TNEI noise survey is the most recent and robust noise survey available, is in accordance with good practice for wind farm noise assessments and has been used in this assessment to represent existing background noise levels (and to set limits relative to it).

5.1.2 As such, the properties identified for noise monitoring were selected to be comparable to those in the previous survey and are detailed below. Where possible, final on-site locations were selected to have minimal influence from other noise sources such as local watercourses, operational wind turbines and vegetation.

5.2 Background Noise Survey

5.2.1 Background noise monitoring was undertaken for the purposes of setting the Total ETSU-R-97 Noise Limits. Data was recorded over the period 9th November 2021 to the 12th January 2022 at four locations.

5.2.2 Details of the exact monitoring periods, the rationale behind the exact kit location and the dominant noise sources observed at each of the Noise Monitoring Location (NML) are detailed in the Field Data Sheets (FDS) included in Annex 2. One of the dominant noise sources in the area was observed to be wind induced noise (i.e. wind reflecting in trees and buildings) and the sound of the sea on the coastline.

5.2.3 At NML1 and NML3, due to the close proximity of the three operational 15 kW turbines at Meikle Galdenoch (near NML1) and the close proximity of the two 15 kW turbines at Meikle Larbrax (near NML3) the onsite observations indicated that these were audible and therefore would be contributing to measured noise levels. As measured background noise levels should be in the absence of wind turbine noise, an analysis was done to subtract the predictions from the nearby operational wind turbines from the measured background noise data. More details of the analysis to remove potential existing wind turbine noise are presented below.

5.2.4 At NML2 a diesel generator was in operation at the property for a large proportion of the survey and therefore a significant number of datapoints have been manually excluded for NML2.

5.2.5 The NML is the position that the sound level meter was sited at each property, as shown on Figure A1.1 (Annex 1) and summarised in Table 5.1 below.

Table 5.1 Noise Monitoring Locations

NML/ Receptor Name	Easting	Northing
NML1 - Greenburn	197351	563069

NML/ Receptor Name	Easting	Northing
NML2 – Larbrax Lodge	198219	561600
NML3 – Larbrax Cottages	197866	560928
NML4 – Cairnhapple House	198237	562791

5.3 Noise Monitoring Equipment

5.3.1 Section 2.4 of the IOA GPG includes information on the type and specification of noise monitoring equipment which should be used for background noise surveys and states:

'Noise measurement equipment and calibrators used on site should comply with Class 1/Type 1 of the relevant standard(s). Enhanced microphone windscreens should be used. Standard windshields of a diameter of less than 100 mm cannot be relied upon to provide sufficient reduction of wind noise in most circumstances.'

5.3.2 The noise monitoring equipment used for the background noise survey meets with the requirements of the IOA GPG. Details of the noise monitoring equipment used, the calibration drift recorded and photographs at each NML are detailed in the FDS included in Annex 3. The IOA GPG states that for calibration drift greater than 1 dB the measurements should be discarded. The maximum calibration drift recorded during the noise survey was 0.2 dB as detailed in the FDS (included in Annex 3), therefore all recorded data is valid.

5.3.3 Copies of the calibration/conformance certificates for the sound level meters and sound level calibrator used for the noise survey are included in Annex 3. All sound level meters conform to Class 1/ Type 1.

5.3.4 The microphones were all mounted between 1.2 m and 1.5 m above local ground level, situated between 3.5 m and 20 m from the dwelling and were located *'in an area frequently used for rest and relaxation'* (Section 2.5.1 of IOA GPG), where appropriate, away from obvious local sources of noise such as boiler flues, fans and running water. The sound level meters were situated as far away from hard reflective surfaces such as fences and walls as practicable.

5.3.5 All measurement systems were set to log the L_{A90} and L_{Aeq} noise levels over the required ten minute intervals continuously over the deployment period.

5.4 Meteorological Data

5.4.1 ETSU-R-97 states on Page 84 that:

'background noise measurements should be correlated with wind speed measurements performed at the proposed site, such that the actual operating noise levels from the turbines may be compared with the noise levels that would otherwise be experienced at a dwelling.'

5.4.2 The preferred methodologies for measuring or calculating wind shear are detailed in Section 4.3.3.

5.4.3 For the Proposed Development, concurrent wind speed/direction data was recorded at various heights between 10 m and 149 m during the noise survey using a LIDAR unit which was located within the site. The meteorological data was collected, processed, and provided by the Applicant.

5.4.4 In accordance with the IOA GPG, methodology A, has been adopted for this assessment which involved using data collected at 91 m and 82 m by the LIDAR unit to calculate the hub height (84 m) wind speeds which, in turn, was standardised to a height of 10 m above ground. As such the background and limits in this report are valid for any potential hub height up to 84 m.

5.4.5 Wind speed and direction data were collected over the same time-scale and averaged over the same ten minute periods as the noise data to provide the analysis of the measured background noise as a function of wind speed and direction.

5.4.6 A Tipping bucket rain gauge was installed for the duration of the noise survey to record periods of rainfall, time synchronised to the sound measurements. Rain data was collected by TNEI. As per the recommendations in Section 3.1.9 of the IOA GPG, the rain data were analysed by TNEI and the 10 minute periods which contain the registered rainfall events and the preceding 10 minute period have been excluded. All excluded rainfall periods are shown on Figures A1.2a-A1.2d (Annex 1) as blue squares.

Influence of Existing Turbines on Background Measurements

5.4.7 Through onsite observations it was determined that the measured background noise levels at NMLs 1 and 3 were influence by the operational turbines of Meikle Galdenoch and Meikle Larbrax, respectively. ETSU-R-97 states that background noise levels should be determined such that they are not influenced by existing turbine noise. The IOA GPG details that, in situations where measurement locations are potentially influenced by existing turbine noise, the following approaches can be adopted:

1. The existing wind turbines can be switched off (assuming the applicant has control of those turbines and noting that there would be associated cost implications);
2. The contribution of the wind turbines can be accounted for by filtering the measured data by direction (only including background data when a receptor is upwind of the wind turbines) or by subtracting predicted turbine noise from the measured levels;
3. Limits can be set using 'proxy' datasets measured at location(s) outside of the influence of the wind turbines; or
4. Limits can be set using data collected as part of previous background noise assessments undertaken before the wind turbines were operational, providing the equipment and both noise and meteorological data obtained are appropriate.

5.4.8 Therefore, measured data from these NMLs was analysed in accordance with Section 5.2.3 of the IOA GPG (approach 2 as detailed in Section 5.4.7 above) to remove the potential turbine noise from measured data. Specifically, the subtractive approach was adopted. No directional filtering was undertaken to remove any influence from the operational turbines as the downwind conditions at NMLs 1 and 3 coincided with the downwind conditions from the dominant noise source in the area – the sound of the sea crashing on the coastline.

5.4.9 Using the subtractive approach, measured background noise data from NMLs 1 and 3 was reduced by subtracting the predicted wind turbine noise levels from Meikle Galdenoch and Meikle Larbrax, respectively. It was assumed that both sets of turbines were Proven P35-2 15 kW turbines, with a hub height of 15 m and a maximum sound power level of 104.3 dB. Wind direction and directivity attenuation was considered within the predictions. Where predicted noise levels were equal to, or greater than, the measured background noise levels for any given 10 minute period, it was not possible to undertake the subtractive correction. For these instances, the measured background noise levels have been reduced by 10 dB. This is considered a cautious approach. All adjustments have been implemented in the measurement points shown in the Figures A1.2a and A1.2c (Annex 1).

5.5 Directional Filtering of Background Noise

5.5.1 In Section 3.1.22 of the IOA GPG the need to directionally filter background noise data is discussed. Where a receiver is located upwind of a dominant local noise source (i.e. road, industry) whilst also being systematically downwind of the Proposed Development then it may be necessary to filter background noise data, particularly when this corresponds to the prevailing wind direction.

5.5.2 For this site, the NMLs were sited such that the downwind conditions from the local dominant noise source (the coast) coincide with the downwind conditions of the Proposed Development. Therefore, no directional filtering has been undertaken.

5.6 Analysis of Measured Data

5.6.1 Analysis of the measured data has been undertaken in accordance with the recommendations in ETSU-R-97 and the IOA GPG.

5.6.2 Meteorological data was screened upon receipt by TNEI and where rainfall occurred, the noise and wind speed data has been excluded from the assessment as detailed in Section 5.4 above.

5.6.3 Time series graphs are provided in Annex 4, which show the variation in measured wind speed/direction and noise level (or corrected noise level in the case of NMLs 1 and 3) over the monitoring period. These graphs also show where data was excluded, either due to rainfall, birdsong or manual exclusions due to atypical data.

5.7 Prevailing Background Noise Level

5.7.1 Tabel 5.2 and Table 5.3 summarise the prevailing background noise levels measured during the noise monitoring period, after filtering of the individual datasets as discussed above.

Table 5.2 Summary of Prevailing Background Noise Levels during Quiet Daytime Periods (dB(A))

NML	Prevailing Background Noise Level $L_{A90,10\ min}$											
	1	2	3	4	5	6	7	8	9	10	11	12
NML1 - Greenburn	24.9*	24.9	25.5	26.8	28.7	31.1	33.9	36.9	40.2	43.5	46.8	50.0
NML2 – Larbrax Lodge	24.7*	24.7*	24.7*	24.7	26.8	29.2	31.7	34.3	36.9	39.5	42.0	42.0*
NML3 – Larbrax Cottages	28.2	28.2	28.4	28.9	29.7	30.7	32.1	33.7	35.6	37.8	40.3	43.0
NML4 – Cairnhapple House	22.2	22.2	22.7	24.2	26.4	29.2	32.2	35.5	38.6	41.6	44.1	46.0

* Flatlined where derived minimum occurs at lower wind speeds and derived maximum occurs at higher wind speeds.

Table 5.3 Summary of Prevailing Background Noise Levels during Night time Periods (dB(A))

NML	Prevailing Background Noise Level $L_{A90,10\ min}$											
	1	2	3	4	5	6	7	8	9	10	11	12
NML1 - Greenburn	25.1*	25.1*	25.1	27.0	29.3	31.9	34.7	37.5	40.4	43.2	45.9	48.4
NML2 – Larbrax Lodge	20.6	20.6	23.4	26.6	30.0	33.3	36.2	38.5	39.9	40.2	40.2	40.2*
NML3 – Larbrax Cottages	26.7	26.7	27.8	29.1	30.5	32.0	33.6	35.2	36.7	38.1	39.4	40.5
NML4 – Cairnhapple House	20.4	20.4	21.8	23.8	26.3	29.2	32.3	35.5	38.6	41.6	44.2	46.5

* Flatlined where derived minimum occurs at lower wind speeds and derived maximum occurs at higher wind speeds.

5.7.2 A series of graphs are presented for each of the NMLs to illustrate the data collected, these are included as Figures A1.2a - A1.2d (Annex 1). There is a set of graphs for each of the NMLs, which show the range of wind speeds and directions recorded during the survey by the LIDAR, the 10 minute average wind speeds plotted against the recorded $L_{A90,\ 10min}$ noise levels, and a calculated 'best fit' polynomial regression line for the quiet daytime and night time periods. Each Figure also includes a Table with the number of recorded data points per integer wind speed bin and the prevailing measured background noise levels.

5.7.3 The prevailing measured background noise levels have been calculated using a best fit polynomial regression line of no more than a fourth order through the measured $L_{A90,\ 10min}$ noise data, as required by ETSU-R-97 and the IOA GPG.

5.7.4 In line with the recommendations included in Section 3.1.21 of the IOA GPG, where relevant, the polynomial background curve for the low-speed conditions has been flatlined at the lower wind speeds where the derived minimum occurs. This is presented on the figures; the final regression analysis curve is shown as a continuous black line and the original polynomial line of best fit through the data is shown as a dashed black line.

5.7.5 Section 2.9.5 of the IOA GPG recommends that no fewer than 200 valid data points should be recorded in each of the quiet daytime and night time periods, with no fewer than 5 valid data points in any 1 ms^{-1} wind speed bin. Where the background noise data has been filtered by wind direction the IOA GPG (Section 2.9.6) recommends that 100 data points and 3 per wind speed bin may be appropriate. Where the minimum number of data points in a wind speed bin was not achieved, data in that bin has been manually excluded from the assessment.

5.7.6 ETSU-R-97 states (Page 101) that data may not be extrapolated beyond the measured range of wind speeds. It is however reasonable to assume that background noise levels will not decrease at higher wind speeds. As such, in the interest of protecting residential amenity, the noise levels for higher wind speeds where data has not been collected have been set equal to those derived for lower wind speeds as set out below (as per Section 3.1.20 of the IOA GPG).

5.7.7 A summary of the analysis applied to the individual datasets as recommended by the IOA GPG is included in Table 5.4 below.

Table 5.4 Analysis of Measured Datasets

NML	Quiet Daytime	Night Time
NML1 - Greenburn	Flatlined below 2 ms^{-1} (minimum recorded).	Flatlined below 3 ms^{-1} (minimum recorded).
NML2 – Larbrax Lodge	Flatlined below 4 ms^{-1} (minimum recorded) and for 12 ms^{-1}.	Flatlined for 12 ms^{-1}.
NML3 – Larbrax Cottages	No specific adjustments to trendline required, sufficient data at all wind speeds.	
NML4 – Cairnhapple House	No specific adjustments to trendline required, sufficient data at all wind speeds.	

5.7.8 The number of data points measured in each wind speed bin for each receptor, once exclusions were applied, are summarised in Figures A1.2a - A1.2d (Annex 1). The Figures also show the final prevailing background noise levels which have been determined following the analysis detailed above.

6 Noise Assessment Results

6.1 Noise Assessment Locations

6.1.1 Noise Assessment Locations (NAL) refer to the position where a detailed assessment was undertaken, denoted by the blue house symbol on Figure A1.1 (Annex 1). A total of sixteen noise sensitive receptors were chosen as NALs. The NALs chosen were the closest receptors to the Proposed Development in any direction. Predictions of wind turbine noise have been made at each of the NALs detailed in Table 6.1, where coordinates are intended to be the closest edge of the amenity area (usually the garden) to the wind turbines.

6.1.2 This approach ensures that the report models the worst case (highest) noise immission level expected at each group of noise sensitive receptors, as, generally speaking, sound levels decrease due to the attenuating factors described in Section 6.3 and thus the closer to a noise source, the higher the noise level.

Table 6.1 Noise Assessment Locations

Noise Assessment Location (NAL)	Easting (m)	Northing (m)	Elevation (m AOD)	Approximate Distance to Nearest Revised Larbrax Turbine* (m)	Background Noise Data used
NAL1 - Meikle Larbrax	197605	560443	48	1165 (T1)	NML3
NAL2 - Larbrax Cottages	197773	560984	59	916 (T1)	NML3
NAL3 - Larbrax Lodge	198211	561552	71	1253 (T1)	NML2
NAL4 - Glenvallagh Cottage	198177	562887	70	1766 (T2)	NML4
NAL5 - Greenburn	197342	563086	70	1187 (T4)	NML1
NAL6 - Meikle Galdenoch	197360	563228	70	1258 (T4)	NML1
NAL7 - Drumwhistley	197279	563335	70	1237 (T4)	NML1
NAL8 - Galdenoch Mill Cottage	197336	563472	64	1360 (T4)	NML1
NAL9 - Little Galdenoch Farm	197835	563477	77	1794 (T4)	NML1
NAL10 - Knocknain Cottages	197382	563807	63	1609 (T4)	NML1
NAL11 - The Potting Shed (FI with Knocknain turbine)	197414	564246	62	1959 (T4)	NML1
NAL12 – Knocknain Farm (FI with Knocknain turbine)	197445	564255	64	1985 (T4)	NML1

Noise Assessment Location (NAL)	Easting (m)	Northing (m)	Elevation (m AOD)	Approximate Distance to Nearest Revised Larbrax Turbine* (m)	Background Noise Data used
NAL13 - High Mark Farm (FI with High Mark turbine)	196651	564434	69	1794 (T4)	NML1
NAL14 - High Mark Cottages	196904	564585	67	2012 (T4)	NML1
NAL15 - Auchnotteroch (FI with Auchnotteroch turbine)	199461	560558	100	2639 (T1)	NML3
NAL16 - Pinewood	198931	559540	90	2717 (T1)	NML3

** Please note the distances to nearest turbines quoted above may differ from those reported elsewhere. Distances for the noise assessment are taken from the nearest turbine to the closest edge of the amenity area (usually the garden).*

6.2 Noise Emission Characteristics of the Wind Turbines

6.2.1 There are a range of wind turbine models which may be suitable for installation at the Proposed Development. This assessment considers the Nordex N133 4.8 MW with Serrated Blades and a hub height of 83.4 m, the coordinates of which are provided in Annex 5. The wind turbines considered for the other nearby wind farms considered are also detailed in Annex 5 and all wind turbines are shown on Figure A1.1 in Annex 1.

6.2.2 Details of the sound power level, octave data and measurement uncertainty used for all the turbines considered in this assessment are included in Annex 6. Due to the differences in the way in which levels are provided by the different manufacturers, TNEI has accounted for uncertainty using the guidance contained within Section 4.2 of the IOA GPG.

6.2.3 Manufacturer data is usually supplied based on a specific hub height whilst values are presented as standardised to 10 m height. The noise model used in this assessment alters turbine noise data to account for different hub heights, where applicable. The hub heights considered for all wind turbines are detailed in Annex 5.

6.3 Noise Propagation Parameters

6.3.1 As detailed in Section 4.4 above, the full version of the ISO 9613-2 model has been used to calculate the noise immission levels at the nearest receptors.

6.3.2 For the purposes of the present assessment, all noise level predictions have been undertaken using a receiver height of 4.0 m above local ground level, mixed ground (G=0.5) and air absorption co-efficients based on a temperature of 10 °C and 70 % relative humidity to provide a realistic impact assessment. The modelling parameters reflect current good practice as detailed within the IOA GPG.

6.3.3 The wind turbine noise immission levels are based on the $L_{A90,10\ minute}$ noise indicator in accordance with the recommendations in ETSU-R-97, which were obtained by subtracting 2 dB(A) from the turbine sound power level data (L_{Aeq} indicator).

6.3.4 A topographical assessment has been undertaken between each noise sensitive receptor and wind turbine location to determine whether any concave ground profiles exist between the source and receiver (noise sensitive receptor). Analysis undertaken using a combination of CadnaA (14) and an Excel model found that if the formula in the IOA GPG is applied directly a +3 dB correction is required for some turbines at a number of receptors as summarised in Annex 5.

6.3.5 In addition, an assessment has been undertaken to determine whether any topographical screening effects of the terrain occur where there is no direct line of sight between the highest point on the turbine rotor and the receiver location. Upon analysis of each noise sensitive receptor it was found that a barrier correction of -2 dB could be applied for some turbines at a number of receptors as detailed in Annex 5. In reality, there is significant screening at some of the locations so more attenuation may occur in practice, the use of a -2 dB value is therefore considered to be conservative as it results in the highest predicted levels. All corrections have been applied in all of the Tables and Graphs in this report.

6.3.6 The noise predictions have taken into account directivity effects in line with good practice. The directivity of wind turbines has been recognised for some time. Building on earlier work by NASA, in 1988 Wyle Laboratories studied sound propagation using an omnidirectional loudspeaker source elevated 80 ft above ground, in upwind, downwind and cross wind situations, and in both flat and hilly terrain, then compared those measurements to measured data from actual wind turbines. Their study quantified directivity factors for a limited frequency range, but was unable to conclusively demonstrate the anticipated directivity effects on real wind turbines. It also highlighted, but was unable to explain, measured differences observed between flat and hilly terrain.

6.3.7 Hubbard (1990) (IOA GPG Section 4.4.3) described a number of factors believed to influence propagation and directivity, notably refraction caused by vertical wind and temperature gradients. In the downwind direction the wind gradient causes the sound rays to bend toward the ground, whereas in the upwind direction the rays curve upward away from the ground. Upwind of the turbine this results in a region of increased attenuation termed the ‘shadow zone’. The excess attenuation is frequency dependent, with lowest frequencies least attenuated. Relating this to the earlier NASA studies, Hubbard noted that the distance from the source to the edge of the shadow zone is related to the wind speed gradient and the elevation of the source, which for a typical turbine source was calculated to be approximately 5 times the source height.

6.3.8 This observation was adopted in the IOA GPG, which states (Section 4.4.2) ‘Such reductions (due to “shadow zone” refraction effects) will in practice only progressively come into play at distances of between 5 and 10 turbine tip heights’, while Section 4.4.3 provides graphical examples of increasing broadband directivity with increasing tip height scaling in both flat and hilly terrain, without qualifying either of those designations.

6.3.9 The IOA GPG recommends (Section 4.4.1) that directivity attenuation factors adopted in any assessment should be clearly stated. The TNEI noise model can consider the effect of directivity, and in line with current good practice the attenuation values used are in detailed in Table 6.2. These are based upon the examples given in the IOA GPG (Section 4.4.2), using interpolation where required, and adopting a single attenuation value for receptors located more than 5 tip heights from a turbine.

Table 6.2 Wind Directivity Attenuation Factors used in Modelling

Direction (º)	0	15	30	45	60	75	90	105	120	135	150	165
Attenuation dB(A))	-10	-9.9	-9.3	-8.3	-6.7	-4.6	-2	0	0	0	0	0
Direction (º)	180	195	210	225	240	255	270	285	300	315	330	345
Attenuation (dB(A))	0	0	0	0	0	0	-2	-4.6	-6.7	-8.3	-9.3	-9.9

6.4 Total ETSU-R-97 Noise Limits (Stage 1)

6.4.1 The Total ETSU-R-97 Noise Limits for each of the NALs selected for the cumulative assessment (further detail of which is presented in Section 6.5) are detailed in Table 6.3 below.

Table 6.3 Total ETSU-R-97 Noise Limits Quiet Daytime

Location	Wind Speed (ms^{-1}) as standardised to 10m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Meikle Larbrax	40	40	40	40	40	40	40	40	40.6	42.8	45.3	48
NAL2 - Larbrax Cottages	40	40	40	40	40	40	40	40	40.6	42.8	45.3	48
NAL3 - Larbrax Lodge	40	40	40	40	40	40	40	40	41.9	44.5	47	47
NAL4 - Glenvallagh Cottage	40	40	40	40	40	40	40	40.5	43.6	46.6	49.1	51
NAL5 - Greenburn	40	40	40	40	40	40	40	41.9	45.2	48.5	51.8	55
NAL6 - Meikle Galdenoch	40	40	40	40	40	40	40	41.9	45.2	48.5	51.8	55
NAL7 - Drumwhistley (FI with Proposed Development)	45	45	45	45	45	45	45	45	45.2	48.5	51.8	55
NAL8 - Galdenoch Mill Cottage	40	40	40	40	40	40	40	41.9	45.2	48.5	51.8	55
NAL9 - Little Galdenoch Farm	40	40	40	40	40	40	40	41.9	45.2	48.5	51.8	55
NAL10 - Knocknain Cottages	40	40	40	40	40	40	40	41.9	45.2	48.5	51.8	55
NAL11 - The Potting Shed (FI with Knocknain)	45	45	45	45	45	45	45	45	45.2	48.5	51.8	55
NAL12 - Knocknain (FI with Knocknain)	45	45	45	45	45	45	45	45	45.2	48.5	51.8	55

Table 6.4 Total ETSU-R-97 Noise Limits Night-time

Location	Wind Speed (ms^{-1}) as standardised to 10m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Meikle Larbrax	43	43	43	43	43	43	43	43	43	43.1	44.4	45.5
NAL2 - Larbrax Cottages	43	43	43	43	43	43	43	43	43	43.1	44.4	45.5
NAL3 - Larbrax Lodge	43	43	43	43	43	43	43	43.5	44.9	45.2	45.2	45.2
NAL4 - Glenvallagh Cottage	43	43	43	43	43	43	43	43	43.6	46.6	49.2	51.5
NAL5 - Greenburn	43	43	43	43	43	43	43	43	45.4	48.2	50.9	53.4
NAL6 - Meikle Galdenoch	43	43	43	43	43	43	43	43	45.4	48.2	50.9	53.4
NAL7 - Drumwhistley (FI with Proposed Development)	45	45	45	45	45	45	45	45	45.4	48.2	50.9	53.4
NAL8 - Galdenoch Mill Cottage	43	43	43	43	43	43	43	43	45.4	48.2	50.9	53.4
NAL9 - Little Galdenoch Farm	43	43	43	43	43	43	43	43	45.4	48.2	50.9	53.4
NAL10 - Knocknain Cottages	43	43	43	43	43	43	43	43	45.4	48.2	50.9	53.4
NAL11 - The Potting Shed (FI with Knocknain)	45	45	45	45	45	45	45	45	45.4	48.2	50.9	53.4
NAL12 - Knocknain (FI with Knocknain)	45	45	45	45	45	45	45	45	45.4	48.2	50.9	53.4

6.5 Predicting the requirement for a cumulative assessment and the likely effects (Stage 2)

6.5.1 A comparison has been undertaken of the predicted wind turbine noise immission levels from the Proposed Development against the predictions of all other schemes at all of the NALs in order to calculate whether predictions are within 10 dB of each other. All turbines have been assumed to be operating in full unconstrained mode. Annex 5 shows these predictions and comparison in tabular form.

6.5.2 Table 6.5Table 6.5 below summarises the results and whether a cumulative noise assessment is required.

Table 6.5 Cumulative Assessment Requirement

Noise Assessment Location (NAL)	Are predicted wind turbine noise levels within 10 dB?	Is a cumulative assessment required?
NAL1 - Meikle Larbrax	YES	YES
NAL2 - Larbrax Cottages	YES	YES

Noise Assessment Location (NAL)	Are predicted wind turbine noise levels within 10 dB?	Is a cumulative assessment required?
NAL3 - Larbrax Lodge	YES	YES
NAL4 - Glenvallagh Cottage	YES	YES
NAL5 - Greenburn	YES	YES
NAL6 - Meikle Galdenoch	YES	YES
NAL7 - Drumwhistley	YES	YES
NAL8 - Galdenoch Mill Cottage	YES	YES
NAL9 - Little Galdenoch Farm	YES	YES
NAL10 - Knocknain Cottages	YES	YES
NAL11 - The Potting Shed (FI with Knocknain turbine)	YES	YES
NAL12 - Knocknain (FI with Knocknain turbine)	YES	YES
NAL13 - High Mark Farm (FI with High Mark turbine)	NO	NO
NAL14 - High Mark Cottages	NO	NO
NAL15 - Auchnotteroch (FI with Auchnotteroch turbine)	NO	NO
NAL16 - Pinewood	NO	NO

6.5.3 As summarised in

6.5.4 Table 6.5 above and as detailed in Annex 5, a cumulative noise assessment is required at NALs 1 – 12, and as such these twelve NALs were selected for a detailed cumulative noise assessment. At NALs 13-16 (receptors far from the Proposed Development only selected for tests in Annex 5), the predictions for the Proposed Development are very low and significantly below noise from existing turbines near these receptors, so no further assessment than that in Annex 5 is required.

6.5.5 A likely cumulative noise assessment was undertaken. Figures A1.3a-l (Annex 1) show predictions from the Proposed Development and cumulative (including Proposed Development) against the Total ETSU-R-97 Noise Limits for NALs 1-12. The individual contributions of the cumulative schemes are also shown.

6.5.6 Table 6.6 and Table 6.7 summarise the results of the likely cumulative noise assessment and show that the predicted cumulative wind turbine noise immission levels meet the Total ETSU-R-97 Noise limits under all conditions at all NALs.

6.5.7 The predicted 'likely' cumulative levels are the actual levels expected at an NAL and include the addition of an appropriate level of uncertainty to the turbine source data as per Section 4.2 of the IOA GPG. The uncertainty level added by TNEI when interpreting manufacturer data is generally +2 dB but this can vary depending on the turbine manufacturer data available for each turbine.

Table 6.6 ETSU-R-97 Compliance Table – Likely Cumulative Noise - Daytime

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Meikle Larbrax	Total Noise Limit: ETSU-R-97 L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.6	42.8	45.3	48.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	-	27.8	31.5	32.1	32.2	32.4	32.5	32.6	32.7
	Exceedance Level	-	-	-	-	-12.2	-8.5	-7.9	-7.8	-8.2	-10.3	-12.7	-15.3
NAL2 - Larbrax Cottages	Total Noise Limit: ETSU-R-97 L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.6	42.8	45.3	48.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	-	29.9	33.9	34.5	34.5	34.6	34.6	34.6	34.7
	Exceedance Level	-	-	-	-	-10.1	-6.1	-5.5	-5.5	-6.0	-8.2	-10.7	-13.3
NAL3 - Larbrax Lodge	Total Noise Limit: ETSU-R-97 L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	41.9	44.5	47.0	47.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	-	27.7	31.7	32.3	32.3	32.4	32.5	32.5	32.5
	Exceedance Level	-	-	-	-	-12.3	-8.3	-7.7	-7.7	-9.5	-12.0	-14.5	-14.5
NAL4 - Glenvallagh Cottage	Total Noise Limit: ETSU-R-97 L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.5	43.6	46.6	49.1	51.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	-	26.7	30.2	30.9	31.1	31.5	31.7	31.8	31.8
	Exceedance Level	-	-	-	-	-13.3	-9.8	-9.1	-9.4	-12.1	-14.9	-17.3	-19.2
NAL5 - Greenburn	Total Noise Limit: ETSU-R-97 L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	41.9	45.2	48.5	51.8	55.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	-	30.8	34.2	34.8	35.1	35.6	35.8	35.9	36.0
	Exceedance Level	-	-	-	-	-9.2	-5.8	-5.2	-6.8	-9.6	-12.7	-15.9	-19.0

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL6 - Meikle Galdenoch	Total Noise Limit: ETSU-R-97 L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	41.9	45.2	48.5	51.8	55.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	-	30.6	33.7	34.5	34.9	35.5	35.8	35.9	36.0
	Exceedance Level	-	-	-	-	-9.4	-6.3	-5.5	-7.0	-9.7	-12.7	-15.9	-19.0
NAL7 - Drumwhistley (FI with Proposed Development)	Total Noise Limit: ETSU-R-97 L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.2	48.5	51.8	55.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	-	31.1	34.0	34.8	35.4	36.2	36.5	36.6	36.7
	Exceedance Level	-	-	-	-	-13.9	-11	-10.2	-9.6	-9.0	-12.0	-15.2	-18.3
NAL8 - Galdenoch Mill Cottage	Total Noise Limit: ETSU-R-97 L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	41.9	45.2	48.5	51.8	55.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	-	30.4	33.4	34.3	35.2	36.1	36.5	36.6	36.6
	Exceedance Level	-	-	-	-	-9.6	-6.6	-5.7	-6.7	-9.1	-12.0	-15.2	-18.4
NAL9 - Little Galdenoch Farm	Total Noise Limit: ETSU-R-97 L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	41.9	45.2	48.5	51.8	55.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	-	28.6	31.3	32.0	32.6	33.4	33.8	34.0	34.1
	Exceedance Level	-	-	-	-	-11.4	-8.7	-8.0	-9.3	-11.8	-14.7	-17.8	-20.9
NAL10 - Knocknain Cottages	Total Noise Limit: ETSU-R-97 L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	41.9	45.2	48.5	51.8	55.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	-	32.7	35.1	36.4	37.6	38.9	39.5	39.5	39.5
	Exceedance Level	-	-	-	-	-7.3	-4.9	-3.6	-4.3	-6.3	-9.0	-12.3	-15.5

NAL11 - The Potting Shed (FI with Knocknain)	Total Noise Limit: ETSU-R-97 L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.2	48.5	51.8	55.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	-	34.0	35.4	36.4	37.6	39.1	39.7	39.9	40.1
	Exceedance Level	-	-	-	-	-11	-9.6	-8.6	-7.4	-6.1	-8.8	-11.9	-14.9
NAL12 - Knocknain (FI with Knocknain)	Total Noise Limit: ETSU-R-97 L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.2	48.5	51.8	55.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	-	33.7	35.1	36.1	37.2	38.6	39.3	39.5	39.6
	Exceedance Level	-	-	-	-	-11.3	-9.9	-8.9	-7.8	-6.6	-9.2	-12.3	-15.4

Note: For the cumulative noise predictions, the noise model considers the range of noise data available for each turbine type modelled. For some turbines noise data was not available for lower wind speeds therefore no cumulative predictions are included for some low wind speeds.

Table 6.7 ETSU-R-97 Compliance Table – Likely Cumulative Noise – Night-time

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Meikle Larbrax	Total Noise Limit: ETSU-R-97 L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.1	44.4	45.5
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	-	27.8	31.5	32.1	32.2	32.4	32.5	32.6	32.7
	Exceedance Level	-	-	-	-	-15.2	-11.5	-10.9	-10.8	-10.6	-10.6	-11.8	-12.8
NAL2 - Larbrax Cottages	Total Noise Limit: ETSU-R-97 L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.1	44.4	45.5
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	-	29.9	33.9	34.5	34.5	34.6	34.6	34.6	34.7
	Exceedance Level	-	-	-	-	-13.1	-9.1	-8.5	-8.5	-8.4	-8.5	-9.8	-10.8
NAL3 - Larbrax Lodge	Total Noise Limit: ETSU-R-97 L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.5	44.9	45.2	45.2	45.2
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	-	27.7	31.7	32.3	32.3	32.4	32.5	32.5	32.5
	Exceedance Level	-	-	-	-	-15.3	-11.3	-10.7	-11.2	-12.5	-12.7	-12.7	-12.7
NAL4 - Glenvallagh Cottage	Total Noise Limit: ETSU-R-97 L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.6	46.6	49.2	51.5
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	-	26.7	30.2	30.9	31.1	31.5	31.7	31.8	31.8
	Exceedance Level	-	-	-	-	-16.3	-12.8	-12.1	-11.9	-12.1	-14.9	-17.4	-19.7

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL5 - Greenburn	Total Noise Limit: ETSU-R-97 L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.4	48.2	50.9	53.4
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	-	30.8	34.2	34.8	35.1	35.6	35.8	35.9	36.0
	Exceedance Level	-	-	-	-	-12.2	-8.8	-8.2	-7.9	-9.8	-12.4	-15.0	-17.4
NAL6 - Meikle Galdenoch	Total Noise Limit: ETSU-R-97 L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.4	48.2	50.9	53.4
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	-	30.6	33.7	34.5	34.9	35.5	35.8	35.9	36.0
	Exceedance Level	-	-	-	-	-12.4	-9.3	-8.5	-8.1	-9.9	-12.4	-15.0	-17.4
NAL7 - Drumwhistley (FI with Proposed Development)	Total Noise Limit: ETSU-R-97 LA90	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.4	48.2	50.9	53.4
	Predicted Cumulative Wind Turbine Noise LA90	-	-	-	-	31.1	34	34.8	35.4	36.2	36.5	36.6	36.7
	Exceedance Level	-	-	-	-	-13.9	-11	-10.2	-9.6	-9.2	-11.7	-14.3	-16.7
NAL8 - Galdenoch Mill Cottage	Total Noise Limit: ETSU-R-97 L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.4	48.2	50.9	53.4
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	-	30.4	33.4	34.3	35.2	36.1	36.5	36.6	36.6
	Exceedance Level	-	-	-	-	-12.6	-9.6	-8.7	-7.8	-9.3	-11.7	-14.3	-16.8

NAL9 - Little Galdenoch Farm	Total Noise Limit: ETSU-R-97 L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.4	48.2	50.9	53.4
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	-	28.6	31.3	32.0	32.6	33.4	33.8	34.0	34.1
	Exceedance Level	-	-	-	-	-14.4	-11.7	-11	-10.4	-12	-14.4	-16.9	-19.3
NAL10 - Knocknain Cottages	Total Noise Limit: ETSU-R-97 L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.4	48.2	50.9	53.4
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	-	32.7	35.1	36.4	37.6	38.9	39.5	39.5	39.5
	Exceedance Level	-	-	-	-	-10.3	-7.9	-6.6	-5.4	-6.5	-8.7	-11.4	-13.9
NAL11 - The Potting Shed (FI with Knocknain)	Total Noise Limit: ETSU-R-97 L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.4	48.2	50.9	53.4
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	-	34.0	35.4	36.4	37.6	39.1	39.7	39.9	40.1
	Exceedance Level	-	-	-	-	-11.0	-9.6	-8.6	-7.4	-6.3	-8.5	-11.0	-13.3
NAL12 - Knocknain (FI with Knocknain)	Total Noise Limit: ETSU-R-97 L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.4	48.2	50.9	53.4
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	-	33.7	35.1	36.1	37.2	38.6	39.3	39.5	39.6
	Exceedance Level	-	-	-	-	-11.3	-9.9	-8.9	-7.8	-6.8	-8.9	-11.4	-13.8

6.6 Derivation of Site Specific Noise Limits (Stage 3)

6.6.1 In order to protect residential amenity, the IOA GPG (2013) recommendations are that cumulatively, all schemes operate within the Total ETSU-R-97 Noise Limits. This can be found in summary box SB21 of the IOA GPG (2013) which states:

'Whenever a cumulative situation is encountered, the noise limits for an individual wind farm should be determined in such a way that no cumulative excess of the total ETSU-R-97 noise limit would occur.'

6.6.2 The stage 2 has demonstrated that there would be no cumulative excess of the total ETSU-R-97 noise limit. This stage 3 is a further step to consider the fact nearby wind farms may have the right to operate at higher levels than 'likely' predictions and also to consider potential noise conditions applicable to the Proposed Development on its own.

6.6.3 Site Specific Noise Limits have been calculated as an apportionment of the Total ETSU-R-97 noise limits. The modelling done for any apportionment assumes that all nearby wind turbines considered are operating and with wind blowing from behind the existing turbines towards the receptors (downwind), which can lead to an assumed situation were at the same time a NAL will be in upwind conditions from the proposed development. Because the SSNL are intended to be tested in downwind (not upwind), these are very much worst-case assumptions when setting the SSNLs.

6.6.4 The apportionment options provided in the IOA GPG were considered to determine the most appropriate option for each NAL, as detailed in Table 6.8.

Table 6.8 Limit Derivation Strategy

NAL	Limit Derivation Strategy
NALs 1 – 7, 9	The likely predictions level from other schemes were found to be more than 10 dB below the Total ETSU-R-97 Noise Limits and as such the entire noise limits has been allocated to the Proposed Development.
NALs 8, 10	At some wind speeds the likely predictions level from the nearby wind turbines were found to be within 5 - 10 dB of the TNL. As such, a 2 dB cautious buffer has been added to the nearby turbines noise predictions (to assume they could have the right to be louder) and the resulting 'cautious' predictions of cumulative wind turbine noise have then been logarithmically subtracted from the Total ETSU-R-97 Noise Limit to determine the 'residual noise limit'. An additional rule was also added during the daytime for low wind speeds to assume a fixed minimum of 35dB. As a summary, the resulting Site Specific Noise Limits were determined as follows: • The night-time limit was set to the residual noise limit. • The daytime noise limit was determined by taking the lowest of either: o The residual noise limit; or o Background noise plus 5 dB or the daytime fixed minimum limit of 35 dB (whichever is greater).
NALs 11-12	Likely predictions for the Proposed Development are low at these NALs and therefore the Proposed Development does not require a share of the Total ETSU-

NAL	Limit Derivation Strategy
	R-97 Noise Limit. Therefore, the Site Specific Noise Limits have been set at 10 dB below the Total ETSU-R-97 Noise Limits. This occurs during both the daytime and nighttime.

6.6.5 A series of graphs to show the predicted wind turbine noise from the Proposed Development compared to the Site Specific Noise Limits are included as Figures A1.4a - A1.4l (Annex 1). These graphs are for NAL 1 – NAL12 and show the Total ETSU-R-97 Noise Limit (solid red line), the Site Specific Noise Limit (dashed red line with triangles) and the predicted wind turbine noise from the Proposed Development in full mode for the candidate turbine (solid blue line).

6.6.6 Table 6.9 and Table 6.10 show the daytime and night-time Site Specific Noise Limits, noise predictions for the Proposed Development and the exceedance level. A negative exceedance demonstrates compliance with the Site Specific Noise Limits.

6.6.7 The Tables show that the predicted wind turbine noise immission levels meet the Site Specific Noise Limits under all conditions and at all locations for both daytime and night-time periods. The candidate turbine was chosen as it is considered to be representative of the type of turbine that could be installed at the site. There are a number of wind turbine makes and models that may be suitable for the Proposed Development, should the proposal receive planning permission the final choice of turbine would be subject to a competitive tendering process. The final choice of turbine would have to meet the noise limits.

Table 6.9 Site Specific Noise Limits Compliance Table – Daytime

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Meikle Larbrax	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.0	35.7	37.1	38.7	40.4	42.7	45.2	47.9
	Predicted Proposed Development Noise L_{A90}	-	-	20.3	21.5	27.0	31.2	31.7	31.7	31.7	31.7	31.7	31.7
	Exceedance Level	-	-	-14.7	-13.5	-8.0	-4.5	-5.4	-7.0	-8.7	-11.0	-13.5	-16.2
NAL2 - Larbrax Cottages	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.0	35.7	37.1	38.7	40.4	42.7	45.2	47.9
	Predicted Proposed Development Noise L_{A90}	-	-	22.9	24.1	29.6	33.8	34.4	34.4	34.4	34.4	34.4	34.4
	Exceedance Level	-	-	-12.1	-10.9	-5.4	-1.9	-2.7	-4.3	-6.0	-8.3	-10.8	-13.5
NAL3 - Larbrax Lodge	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.0	35.0	36.7	39.3	41.8	44.5	47.0	47.0
	Predicted Proposed Development Noise L_{A90}	-	-	20.7	21.9	27.4	31.6	32.1	32.1	32.1	32.1	32.1	32.1
	Exceedance Level	-	-	-14.3	-13.1	-7.6	-3.4	-4.6	-7.2	-9.7	-12.4	-14.9	-14.9
NAL4 - Glenvallagh Cottage	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.0	35.0	37.2	40.3	43.5	46.5	49.1	51.0
	Predicted Proposed Development Noise L_{A90}	-	-	18.6	19.8	25.3	29.5	30.1	30.1	30.1	30.1	30.1	30.1
	Exceedance Level	-	-	-16.4	-15.2	-9.7	-5.5	-7.1	-10.2	-13.4	-16.4	-19.0	-20.9
NAL5 - Greenburn	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.0	36.1	38.9	41.5	44.9	48.4	51.7	55.0
	Predicted Proposed Development Noise L_{A90}	-	-	22.4	23.6	29.1	33.3	33.9	33.9	33.9	33.9	33.9	33.9
	Exceedance Level	-	-	-12.6	-11.4	-5.9	-2.8	-5.0	-7.6	-11.0	-14.5	-17.8	-21.1
NAL6 - Meikle Galdenoch	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.0	36.1	38.9	41.4	44.9	48.3	51.7	55.0
	Predicted Proposed Development Noise L_{A90}	-	-	21.5	22.7	28.2	32.4	33.0	33.0	33.0	33.0	33.0	33.0
	Exceedance Level	-	-	-13.5	-12.3	-6.8	-3.7	-5.9	-8.4	-11.9	-15.3	-18.7	-22.0

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL7 - Drumwhistley (FI with Proposed Development)	Site Specific Noise Limit L_{A90}	45.0	45.0	45.0	45.0	44.9	44.8	44.7	44.6	44.7	48.2	51.7	54.9
	Predicted Wind Turbine Noise L_{A90}	-	-	21.4	22.6	28.1	32.3	32.9	32.9	32.9	32.9	32.9	32.9
	Exceedance Level	-	-	-23.6	-22.4	-16.8	-12.5	-11.8	-11.7	-11.8	-15.3	-18.8	-22.0
NAL8 - Galdenoch Mill Cottage	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.0	36.1	38.9	41.0	44.6	48.2	51.7	54.9
	Predicted Proposed Development Noise L_{A90}	-	-	20.0	21.2	26.7	30.9	31.5	31.5	31.5	31.5	31.5	31.5
	Exceedance Level	-	-	-15.0	-13.8	-8.3	-5.2	-7.4	-9.5	-13.1	-16.7	-20.2	-23.4
NAL9 - Little Galdenoch Farm	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.0	36.1	38.9	41.5	44.9	48.4	51.7	55.0
	Predicted Proposed Development Noise L_{A90}	-	-	18.1	19.4	24.9	29.0	29.6	29.6	29.6	29.6	29.6	29.6
	Exceedance Level	-	-	-16.9	-15.6	-10.1	-7.1	-9.3	-11.9	-15.3	-18.8	-22.1	-25.4
NAL10 - Knocknain Cottages	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.0	36.1	36.7	38.9	43.5	47.6	51.4	54.8
	Predicted Proposed Development Noise L_{A90}	-	-	18.4	19.6	25.1	29.3	29.9	29.9	29.9	29.9	29.9	29.9
	Exceedance Level	-	-	-16.6	-15.4	-9.9	-6.8	-6.8	-9.0	-13.6	-17.7	-21.5	-24.9
NAL11 - The Potting Shed (FI with Knocknain)	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.2	38.5	41.8	45.0
	Predicted Proposed Development Noise L_{A90}	-	-	14.2	15.4	20.9	25.1	25.7	25.7	25.7	25.7	25.7	25.7
	Exceedance Level	-	-	-20.8	-19.6	-14.1	-9.9	-9.3	-9.3	-9.5	-12.8	-16.1	-19.3
NAL12 - Knocknain (FI with Knocknain)	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.2	38.5	41.8	45.0
	Predicted Proposed Development Noise L_{A90}	-	-	15.7	16.9	22.4	26.6	27.2	27.2	27.2	27.2	27.2	27.2
	Exceedance Level	-	-	-19.3	-18.1	-12.6	-8.4	-7.8	-7.8	-8.0	-11.3	-14.6	-17.8

Table 6.10 Site Specific Noise Limits Compliance Table – Night-time

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Meikle Larbrax	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	42.9	42.9	42.9	43.0	44.3	45.4
	Predicted Proposed Development Noise L_{A90}	-	-	20.3	21.5	27.0	31.2	31.7	31.7	31.7	31.7	31.7	31.7
	Exceedance Level	-	-	-22.7	-21.5	-16.0	-11.8	-11.2	-11.2	-11.2	-11.3	-12.6	-13.7
NAL2 - Larbrax Cottages	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	42.9	42.9	42.9	43.0	44.3	45.4
	Predicted Proposed Development Noise L_{A90}	-	-	22.9	24.1	29.6	33.8	34.4	34.4	34.4	34.4	34.4	34.4
	Exceedance Level	-	-	-20.1	-18.9	-13.4	-9.2	-8.5	-8.5	-8.5	-8.6	-9.9	-11.0
NAL3 - Larbrax Lodge	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.5	44.9	45.2	45.2	45.2
	Predicted Proposed Development Noise L_{A90}	-	-	20.7	21.9	27.4	31.6	32.1	32.1	32.1	32.1	32.1	32.1
	Exceedance Level	-	-	-22.3	-21.1	-15.6	-11.4	-10.9	-11.4	-12.8	-13.1	-13.1	-13.1
NAL4 - Glenvallagh Cottage	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	42.9	42.9	42.9	43.5	46.5	49.2	51.5
	Predicted Proposed Development Noise L_{A90}	-	-	18.6	19.8	25.3	29.5	30.1	30.1	30.1	30.1	30.1	30.1
	Exceedance Level	-	-	-24.4	-23.2	-17.7	-13.4	-12.8	-12.8	-13.4	-16.4	-19.1	-21.4
NAL5 - Greenburn	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	42.9	42.8	42.8	42.7	45.1	48.1	50.8	53.3
	Predicted Proposed Development Noise L_{A90}	-	-	22.4	23.6	29.1	33.3	33.9	33.9	33.9	33.9	33.9	33.9
	Exceedance Level	-	-	-20.6	-19.4	-13.8	-9.5	-8.9	-8.8	-11.2	-14.2	-16.9	-19.4
NAL6 - Meikle Galdenoch	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	42.8	42.8	42.7	42.6	45.1	48.0	50.8	53.3
	Predicted Proposed Development Noise L_{A90}	-	-	21.5	22.7	28.2	32.4	33.0	33.0	33.0	33.0	33.0	33.0
	Exceedance Level	-	-	-21.5	-20.3	-14.6	-10.4	-9.7	-9.6	-12.1	-15.0	-17.8	-20.3

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL7 - Drumwhistley (FI with Proposed Development)	Site Specific Noise Limit L_{A90}	45.0	45.0	45.0	45.0	44.9	44.8	44.7	44.6	44.9	47.9	50.7	53.3
	Predicted Wind Turbine Noise L_{A90}	-	-	21.4	22.6	28.1	32.3	32.9	32.9	32.9	32.9	32.9	32.9
	Exceedance Level	-	-	-23.6	-22.4	-16.8	-12.5	-11.8	-11.7	-12.0	-15.0	-17.8	-20.4
NAL8 - Galdenoch Mill Cottage	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	42.8	42.6	42.5	42.3	44.8	47.9	50.7	53.3
	Predicted Proposed Development Noise L_{A90}	-	-	20.0	21.2	26.7	30.9	31.5	31.5	31.5	31.5	31.5	31.5
	Exceedance Level	-	-	-23.0	-21.8	-16.1	-11.7	-11.0	-10.8	-13.3	-16.4	-19.2	-21.8
NAL9 - Little Galdenoch Farm	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	42.9	42.8	42.8	42.7	45.1	48.0	50.8	53.3
	Predicted Proposed Development Noise L_{A90}	-	-	18.1	19.4	24.9	29.0	29.6	29.6	29.6	29.6	29.6	29.6
	Exceedance Level	-	-	-24.9	-23.6	-18.0	-13.8	-13.2	-13.1	-15.5	-18.4	-21.2	-23.7
NAL10 - Knocknain Cottages	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	42.4	42.1	41.6	40.9	43.7	47.3	50.4	53.1
	Predicted Proposed Development Noise L_{A90}	-	-	18.4	19.6	25.1	29.3	29.9	29.9	29.9	29.9	29.9	29.9
	Exceedance Level	-	-	-24.6	-23.4	-17.3	-12.8	-11.7	-11.0	-13.8	-17.4	-20.5	-23.2
NAL11 - The Potting Shed (FI with Knocknain)	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.4	38.2	40.9	43.4
	Predicted Proposed Development Noise L_{A90}	-	-	14.2	15.4	20.9	25.1	25.7	25.7	25.7	25.7	25.7	25.7
	Exceedance Level	-	-	-20.8	-19.6	-14.1	-9.9	-9.3	-9.3	-9.7	-12.5	-15.2	-17.7
NAL12 - Knocknain (FI with Knocknain)	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.4	38.2	40.9	43.4
	Predicted Proposed Development Noise L_{A90}	-	-	15.7	16.9	22.4	26.6	27.2	27.2	27.2	27.2	27.2	27.2
	Exceedance Level	-	-	-19.3	-18.1	-12.6	-8.4	-7.8	-7.8	-8.2	-11.0	-13.7	-16.2

6.7 Choice of Daytime Fixed Minimum Noise Limit (35 – 40 dB)

6.7.1 Having due regard to the guidance in ETSU-R-97 and considering the cumulative impacts of the Proposed Development operating in conjunction with other consented or operational schemes a cumulative daytime Total fixed minimum limit of 40 dB has been adopted.

6.7.2 The choice of daytime fixed minimum limit depends on three factors which are discussed on page 65 of ETSU-R-97 and in Section 3.2.4 of the IOA GPG. The IOA GPG notes that:

'It can be argued that assessing these factors do not represent an acoustic consideration but ultimately a planning consideration, and therefore are difficult for noise consultants to fully determine.'

6.7.3 Detailed commentary for each of the three factors when considering this Proposed Development are included within Table 6.11 below to provide a potential rationale for planning decision makers.

Table 6.11 Consideration of Guidance provided on Choice of Fixed Minimum Limit for the Total Noise Limits

Factor	Guidance in ETSU-R-97	Guidance in IOA GPG	Commentary for the Proposed Development
1) The number of noise affected properties	*"The planning process is trying to balance the benefits arising out of the development of renewable energy sources against the local environmental impact. The more dwellings that are in the vicinity of a wind farm the tighter the limits should be as the total environmental impact will be greater. Conversely if only a few dwellings are affected, then the environmental impact is less and noise limits towards the upper end of the range may be appropriate. Developers still have to consider the interests of individuals as protected under the Environmental Protection Act 1990."*	*"The number of neighbouring properties will depend on the nature of the area, (rural, semi-rural, urban) and is sometimes considered in relation to the size of the scheme and study area. The predicted 35 dB LA90 contour (at maximum noise output up to 12 m/s) can provide a guide to the dwellings to be considered in this respect."*	The Site itself is located in a rural area with a relatively low number of dwellings which surround the site. Although the Total ETSU-R-97 Noise Limit are suggested to be based on a Fixed Minimum Limit (FML) of 40 dB, it is worth noting that predicted cumulative noise levels for day time would actually be below the limits set if using a lower fixed minimum of 35 dB at 11 of the 12 NALs considered in the cumulative assessment. Consideration of this test suggests that a Total ETSU-R-97 Noise Limit towards the upper end of the range permitted in ETSU-R-97 would be appropriate due to the very low number of affected properties.
2) The effect of using tighter limits on the potential power output of the wind farm:	*"Similar arguments can be made when considering the effect of noise limits on uptake of wind energy. A single wind turbine causing noise levels of 40dB(A) at several nearby residences would have less planning merit (noise considerations only) than 30 wind turbines also causing the same amount of noise at several nearby residences."*	*"This is in practice mainly based on the relative generating capacity of the development, as larger schemes have relatively more planning merit (for noise) according to the description in ETSU-R-97. In cases when the amenity fixed limit has little or no impact on the generating capacity (i.e. noise is not a significant design constraint) then a reduced limit may be applied."*	The Proposed Development, if approved, would generate a significant amount of renewable energy with the rated capacity of the development estimated at up to 19.2 MW of electricity generated by the wind turbines. If the Total ETSU-R-97 Noise Limit was derived based on a lower fixed minimum of 35 dB, it would result in the derivation of a lower Site Specific Noise Limit at NAL10, which may cause exceedances of circa 3 dB at 6 m/s during the daytime. This is due to the influence of the single, smaller, turbine at Knocknain, which is another

Factor	Guidance in ETSU-R-97	Guidance in IOA GPG	Commentary for the Proposed Development
			renewable electricity generating development. Consideration of this test suggests that a Total Noise Limit towards the upper of the range permitted in ETSU-R-97 would be appropriate as otherwise this could potentially result in unnecessary loss of renewable energy.
3) The duration of exposure of these properties.	*"The proportion of the time at which background noise levels are low and how low the background noise level gets are both recognised as factors which could affect the setting of an appropriate lower limit. For example, a property which experienced background noise levels below 30dB(A) for a substantial proportion of the time in which the turbines would be operating could be expected to receive tighter noise limits than a property at which the background noise levels soon increased to levels above 35dB(A). This approach is difficult to formulate precisely and a degree of judgement should be exercised."*	*"This last test is more difficult to formulate. But ETSU-R-97 notes that the likely excess of turbine noise relative to background noise levels should be a relevant consideration. In rural areas, this will often be determined by the sheltering of the property relative to the wind farm site. Account can also be taken of the effects of wind directions (including prevailing ones at the site) and likely directional effects. For cumulative developments, in some cases the effective duration of exposure may increase because of cumulative effects."*	Background noise levels vary across the NMLs but in general the daytime noise levels are relatively low and are broadly consistent with levels measured at rural locations in the UK. As noted above, for the vast majority of locations the level of exposure is low when considering the likely cumulative predictions. At NAL10, downwind predictions indicate that wind turbine noise from the Proposed Development will be less than the background noise levels at all windspeeds during the daytime. Therefore, the duration and level of exposure from the Proposed Development can be considered low, with the length and duration of exposure of cumulative wind turbine noise being largely driven by the single turbine at Knocknain. Consideration of this test suggests a Total ETSU-R-97 Noise Limit towards the upper end of the range permitted in ETSU-R-97 would be appropriate.

6.8 Micrositing

6.8.1 A 100 m micrositing distance is proposed. It should be noted that the need to include a concave ground profile correction and/or barrier correction may change depending on the final location of the turbines (following micrositing) and the final turbine hub height. Nevertheless, turbine noise levels will have to meet the noise limits established in this report regardless of any increases and decreases in noise propagation caused by topography. Should consent be granted, the need to apply a concave ground profile/ barrier correction will need to be considered by the Applicant prior to the final selection of a turbine model for the site.

7 Summary and Conclusions

7.1.1 This report has assessed the potential impact of operational noise from the Proposed Development on the nearby noise sensitive residential receptors. The guidance contained within ETSU-R-97 and current good practice (IOA GPG) has been used to assess the potential noise impact of the Proposed Development.

7.1.2 Background noise monitoring was undertaken by TNEI at four locations neighbouring the Proposed Development. The measured data from these NMLs was analysed in accordance with Section 5.2.3 (approach 2) of the IOA GPG to remove the any potential turbine noise from the measured data at NMLs 1 and 3. A total of sixteen noise sensitive receptors were chosen as Noise Assessment Locations (NALs) and after an initial review twelve were selected for a detailed cumulative noise assessment. The assessment locations were chosen to represent the noise sensitive receptors located closest to the Proposed Development and other nearby wind farms.

7.1.3 Wind speed data was collected within the wind farm site. The data collected at 91 m and 82 m was used to calculate the hub height wind speed which, in turn, was standardised to a height of 10 m above ground. As such the background and limits in this report are valid for any potential hub height up to 84 m.

7.1.4 A Total ETSU-R-97 Noise Limit of 40 dB(A) daytime or background plus 5dB (whichever is the greater) and 43 dB(A) night-time or background plus 5dB (whichever is the greater) was used in this assessment. The only exception being where the occupiers of a property are financially involved with the Proposed Development or another scheme and for those NALs a fixed minimum limit of 45 dB was used for the daytime and night-time periods. For the purposes of this assessment, it has been assumed that there is one property FI with the Proposed Development, two properties FI with the operational Knocknain turbine, one property FI with the operational High Mark turbine, and one property FI with the Auchnotteroch turbine.

7.1.5 There are a number of small wind turbines in proximity to the Proposed Development found to be relevant for considering potential cumulative operational wind turbine noise. It has been assumed that, should the Proposed Development gain consent, the three operational turbines at Meikle Galdenoch and the two operational turbines at Meikle Larbrax will be decommissioned. This assumption is consistent with the original noise assessment undertaken for the Consented Larbrax Wind Farm and these two sets of turbines have not been considered within the cumulative noise assessment.

7.1.6 A cumulative assessment was undertaken where predicted levels from Proposed Development were found to be within 10 dB of the predicted cumulative levels from other wind farm in the area. The results show that the predicted cumulative wind farm noise immission levels meet the Total ETSU-R-97 Noise Limits at all locations.

7.1.7 An apportionment of the Total ETSU-R-97 Noise Limits was undertaken to calculate 'Site Specific Noise Limits' for the Proposed Development at the NALs. This step is necessary to consider potential conditioning of the Proposed Development operating on its own and to also assume that some of the nearby wind farms could in practice be allowed to operate at higher levels than typical 'likely' noise predictions assumed in the cumulative assessment. The results show that the predicted wind turbine noise immission levels for the Proposed

Development meet the Site Specific Noise Limits under all conditions and at all locations for both daytime and night-time periods.

7.1.8 The candidate turbine was chosen as it is considered to be representative of the type of turbine that could be installed at the site. There are a number of wind turbine makes and models that may be suitable for the Proposed Development. Should the proposal receive planning permission, the final choice of turbine would be subject to a competitive tendering process. The final choice of turbine would have to meet the noise limits determined and contained within any condition imposed.

8 Glossary of Terms

AOD: Above Ordnance Datum is the height above sea level.

Amplitude Modulation: a variation in noise level over time; for example observers may describe a 'whoosh whoosh' sound, which can be heard close to a wind turbine as the blades sweep past.

Attenuation: the reduction in level of a sound between the source and a receiver due to any combination of effects including: distance, atmospheric absorption, acoustic screening, the presence of a building façade, etc.

Background Noise: the noise level rarely fallen below in any given location over any given time period, often classed according to daytime, evening or night-time periods. The L_{A90} indices (see below) is often used to represent the background noise level.

Bin: subset or group into which data can be sorted; in the case of wind speeds, bins are often centred on integer wind speeds with a width of 1 m/s. For example the 4 m/s bin would include all data with wind speeds of 3.5 to 4.5 m/s.

Dawn Chorus: noise due to birds which can occur at sunrise.

Broadband Noise: noise with components over a wide range of frequencies.

Decibel (dB): the ratio between the quietest audible sound and the loudest tolerable sound is a million to one in terms of the change in sound pressure. A logarithmic scale is used in noise level measurements because of this wide range. The scale used is the decibel (dB) scale which extends from 0 to 140 decibels (dB) corresponding to the intensity of the sound level.

dB(A): the ear has the ability to recognise a particular sound depending on its pitch or frequency. Microphones cannot differentiate noise in the same way as the ear, and to counter this weakness the noise measuring instrument applies a correction to correspond more closely to the frequency response of the human ear. The correction factor is called 'A Weighting' and the resulting measurements are written as dB(A). The dB(A) is internationally accepted and has been found to correspond well with people's subjective reaction to noise. Some typical subjective changes in noise levels are:

- a change of 3 dB(A) is just perceptible;
- a change of 5 dB(A) is clearly perceptible;
- a change of 10 dB(A) is twice (or half) as loud.

Directivity: the property of a sound source that causes more sound to be radiated in one direction than another.

Frequency: the pitch of a sound in Hz or kHz. See Hertz.

Ground Effects: the modification of sound at a receiver location due to the interaction of the sound wave with the ground along its propagation path from source to receiver. Described using the term 'G', and ranges between 0 (hard), 0.5 (mixed) and 1 (soft).

Hertz (Hz): sound frequency refers to how quickly the air vibrates, or how close the sound waves are to each other (in cycles per second, or Hertz (Hz)).

L_w: is the sound power level. It is a measure of the total noise energy radiated by a source of noise, and is used to calculate noise levels at a distant location. The L_{WA} is the A-weighted sound power level.

L_{eq}: is the equivalent continuous sound level, and is the sound level of a steady sound with the same energy as a fluctuating sound over the same period. It is possible to consider this level as the ambient noise encompassing all noise at a given time. The $LA_{eq,T}$ is the A-weighted equivalent continuous sound level over a given time period (T).

L_{90}: index represents the noise level exceeded for 90 percent of the measurement period and is used to indicate quieter times during the measurement period. It is often used to measure the background noise level. The $L_{A90,10min}$ is the A-weighted background noise level over a ten minute measurement sample.

Noise emission: the noise energy emitted by a source (e.g. a wind turbine).

Noise immission: the sound pressure level detected at a given location (e.g. the nearest dwelling).

Night-time Hours: ETSU-R-97 defines the night-time hours as 23.00 to 07.00 every day.

Quiet Daytime Hours: ETSU-R-97 defines the amenity hours as 18.00 to 23.00 Monday to Friday, 13.00 to 23.00 on Saturdays and 07.00 to 23.00 on Sundays.

Sound Level Meter: an instrument for measuring sound pressure level.

Sound Power Level: the total sound power radiated by a source, in decibels.

Sound Pressure Level: a measure of the sound pressure at a point, in decibels**.**

Standardised Wind Speed: a wind speed measured at a height different than 10 m (generally measured at the turbine hub height) which is expressed to a reference height of 10 m using a roughness length of 0.05 for standardisation purpose (in accordance with the IEC 61400-11 standard).

Tonal Noise: noise which covers a very restricted range of frequencies (e.g. a range of ≤20 Hz). This noise can be more annoying than broadband noise.

Wind Shear: the increase of wind speed with height above the ground.

9 References

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Annex 1 – Figures

N

NAL13 High Mark Farm
NAL14 High Mark Cottage
NAL11 Potting Shed
NAL12 Knocknain Farm
NAL10 Knocknain Cottages
NAL9 Little Galdenoch
NAL8 Galdenoch Mill Cottage
NAL6 Meikle Galdenoch
NAL7 Drumwhistley
NAL5 Greenburn
NML01 - Greenburn
NAL4 Glenvallagh Cottage
NML04 - Cairnhapple House
T4
T3
T2
T1
NML02 - Larbrax Lodge
NAL3 Larbrax Lodge
NAL2 Larbrax Cottages
NML03 - Larbrax Cottages
NAL1 Meikle Labrax
NAL15 Auchnotteroch
NAL16 Pinewood

Garchrie Moss
Galdenoch Moor
Larbrax Moor
Glenstockdale
Lochnaw Loch

0 0.5 1 Kilometre

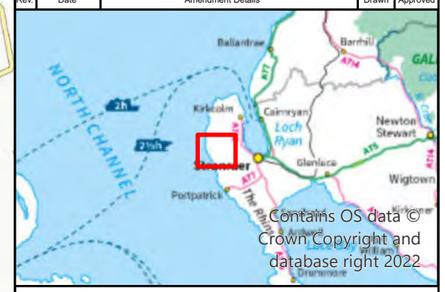
LEGEND

- Noise Assessment Locations (NALs)
- Noise Monitoring Locations (NMLs) - TNEI 2022

Wind Turbines / Farms

- Auchnotteroch
- Glaik Hill
- High Auchneel
- High Mark
- Knocknain
- Proposed Development / Revised Larbrax

Rev.	Date	Amendment Details	Drawn	Approved
2	25/10/2024	FINAL ISSUE	AD	MC
1	03/09/2024	CLIENT COMMENTS	AD	MC
0	07/08/2024	FIRST DRAFT	JCM	MC



tnei

Client: Ørsted

Drawing Status: FOR INFORMATION

Project Title: REVISED LARBRAX WIND FARM

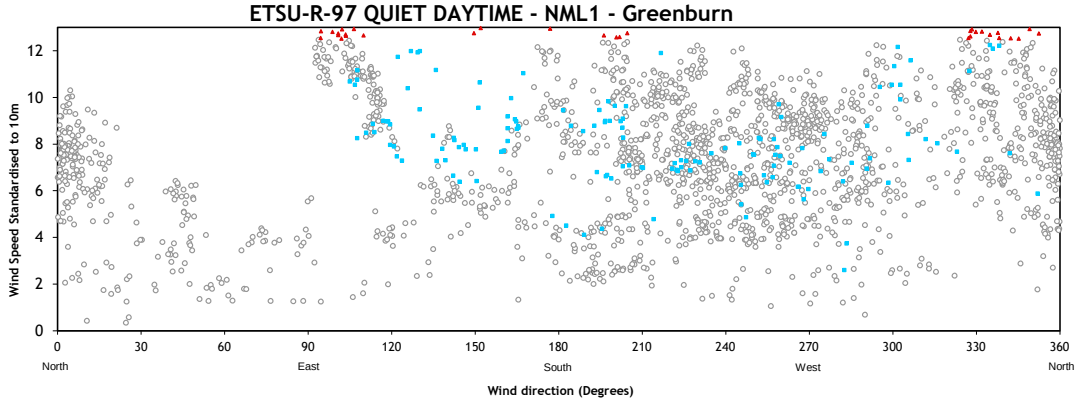
Drawing Title: FIGURE A1.1 - WIND TURBINE NOISE ASSESSMENT LOCATIONS

Scale:	Original Size:	Spatial Reference:
1:22,500	A3	British National Grid

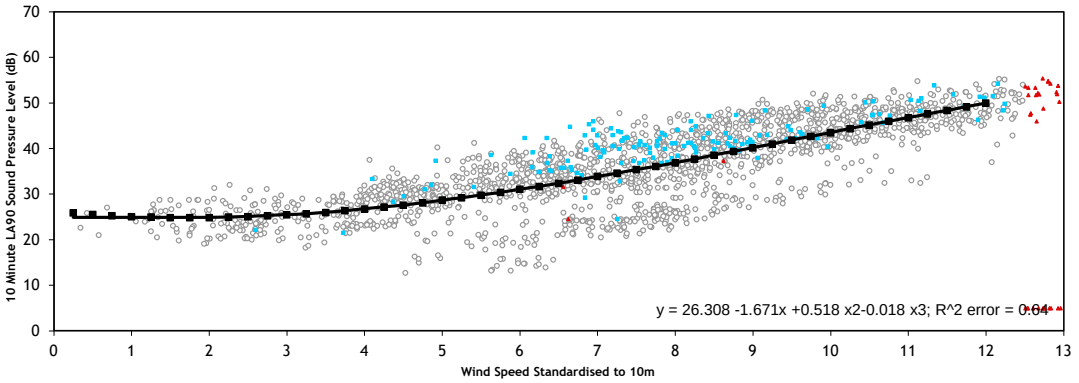
Drawing Number: 15893-011

ETSU-R-97 QUIET DAYTIME - NML1 - Greenburn

Wind Conditions Quiet Daytime



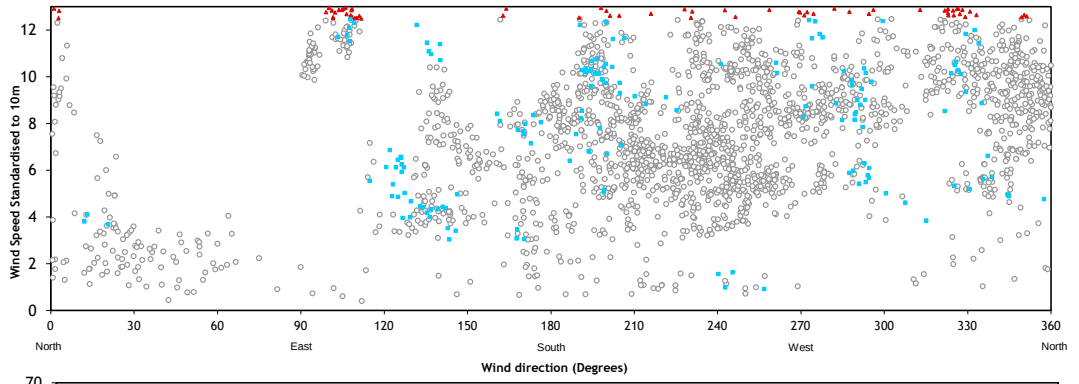
Regression Analysis Quiet Daytime



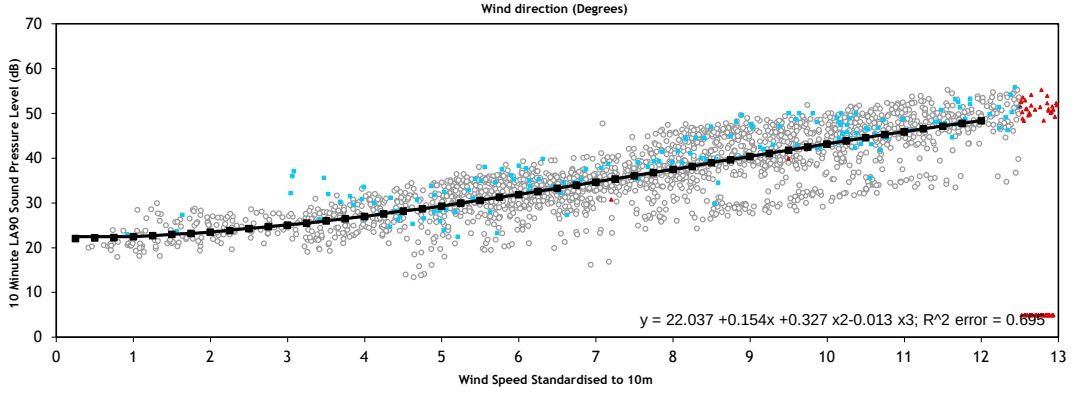
Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	59	68	151	146	222	234	286	229	218	156	83	1852
Prevailing Background	24.9	25.5	26.8	28.7	31.1	33.9	36.9	40.2	43.5	46.8	50	

ETSU-R-97 NIGHT-TIME - NML1 - Greenburn

Wind Conditions Night-Time



Regression Analysis Night-Time



Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	60	71	128	185	272	257	274	276	245	188	118	2074
Prevailing Background	23.5	25.1	27	29.3	31.9	34.7	37.5	40.4	43.2	45.9	48.4	

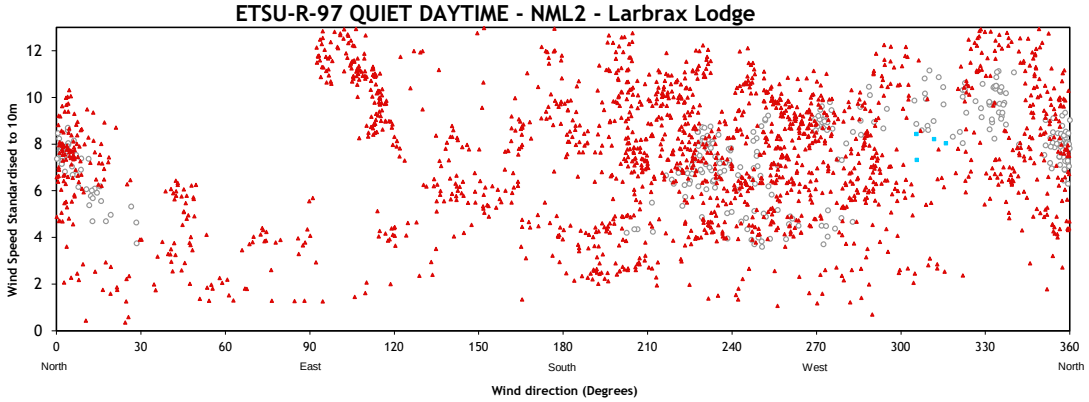
Legend:

- L_{A90} 10 Minute Measurement Point
- Line of best fit
- Line of best fit flat lined where appropriate(Prevailing Background)
- Excluded Data-Manual exclusion
- Excluded Data-Rain
- Excluded Data-Filtered Wind Direction

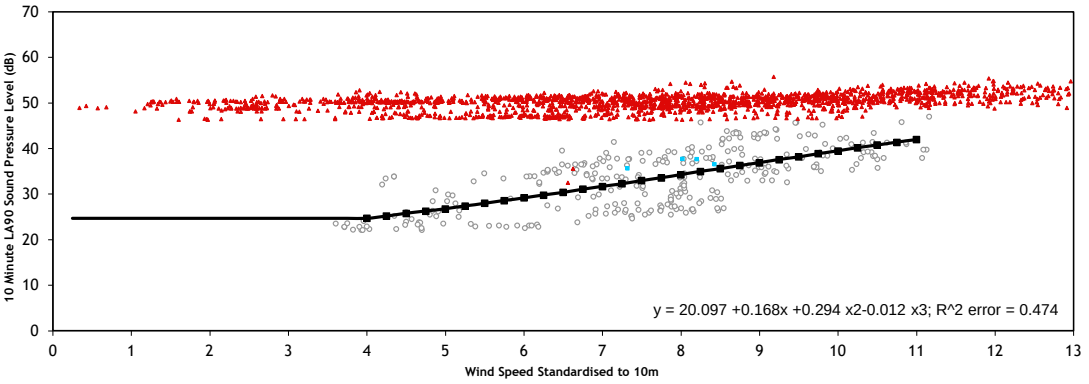
Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Wind Conditions&Regression Analysis NML1 - Greenburn
Figure Number	1.2a
Drawn	AD
Checked	MC
Date	19/08/2024
Document Reference	15893-Models

ETSU-R-97 QUIET DAYTIME - NML2 - Larbrax Lodge

Wind Conditions Quiet Daytime



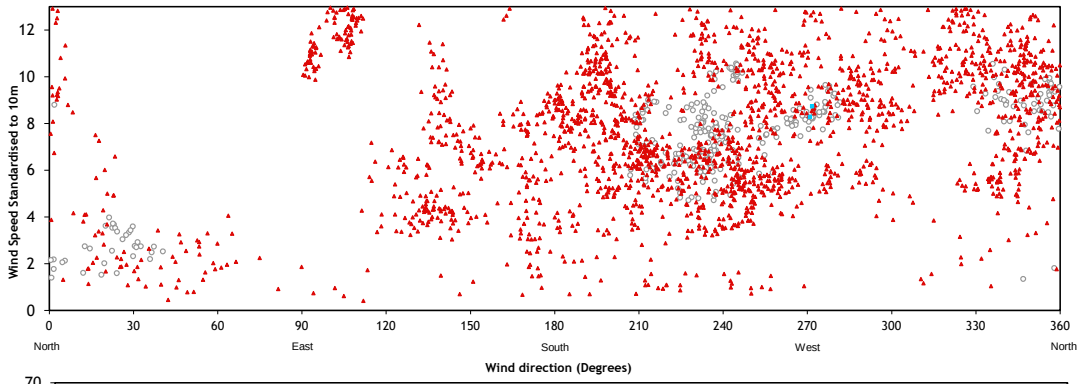
Regression Analysis Quiet Daytime



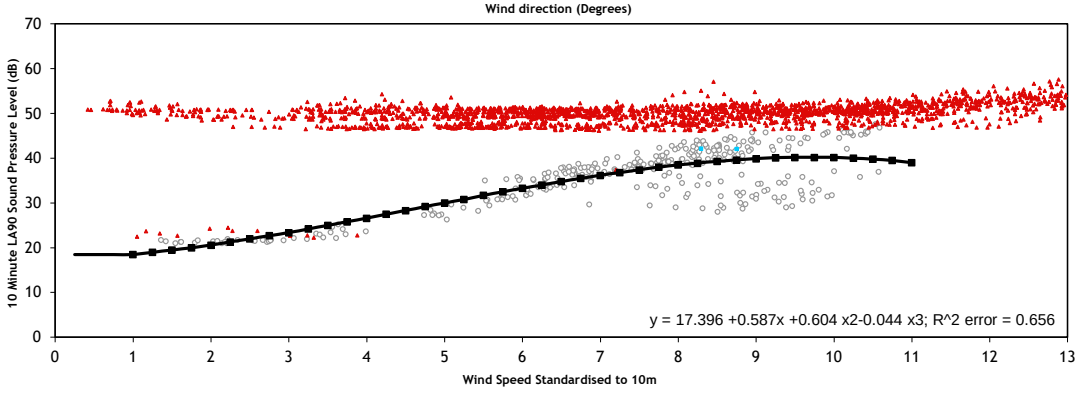
Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	0	0	20	23	27	55	73	55	31	10	0	294
Prevailing Background	24.7	24.7	24.7	26.8	29.2	31.7	34.3	36.9	39.5	42	-	

ETSU-R-97 NIGHT-TIME - NML2 - Larbrax Lodge

Wind Conditions Night-Time



Regression Analysis Night-Time



Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	13	14	7	11	40	50	82	64	30	3	0	314
Prevailing Background	20.6	23.4	26.6	30	33.3	36.2	38.5	39.9	40.2	39	-	

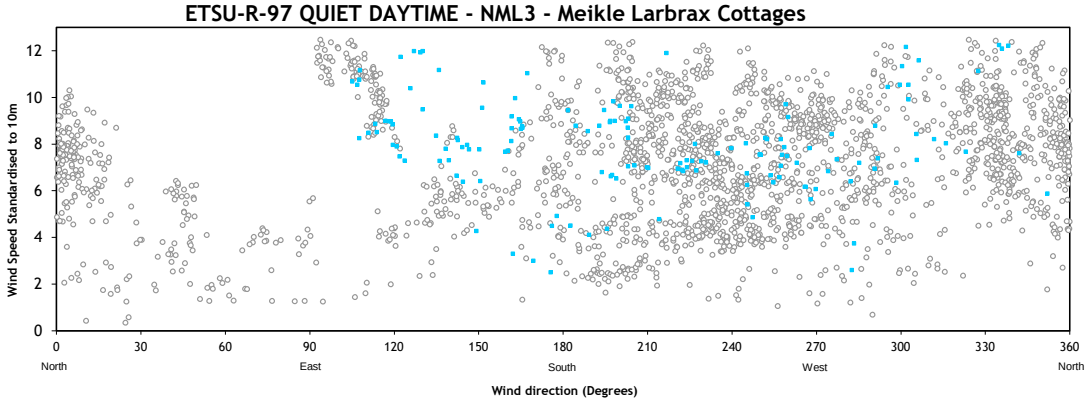
Legend:

- L_{A90} 10 Minute Measurement Point
- Line of best fit
- Line of best fit flat lined where appropriate(Prevailing Background)
- Excluded Data-Manual exclusion (Diesel Generator mostly)
- Excluded Data-Rain
- Excluded Data-Filtered Wind Direction

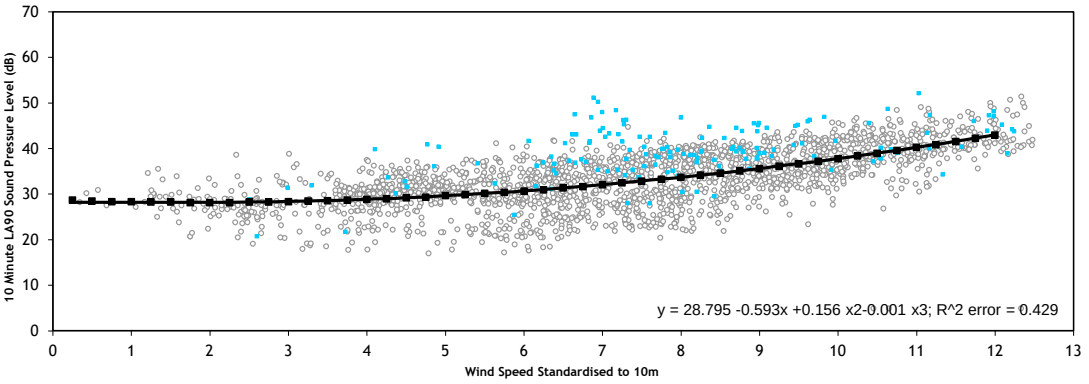
Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Wind Conditions&Regression Analysis NML2 - Larbrax Lodge
Figure Number	1.2b
Drawn	AD
Checked	MC
Date	19/08/2024
Document Reference	15893-Models

ETSU-R-97 QUIET DAYTIME - NML3 - Meikle Larbrax Cottages

Wind Conditions Quiet Daytime



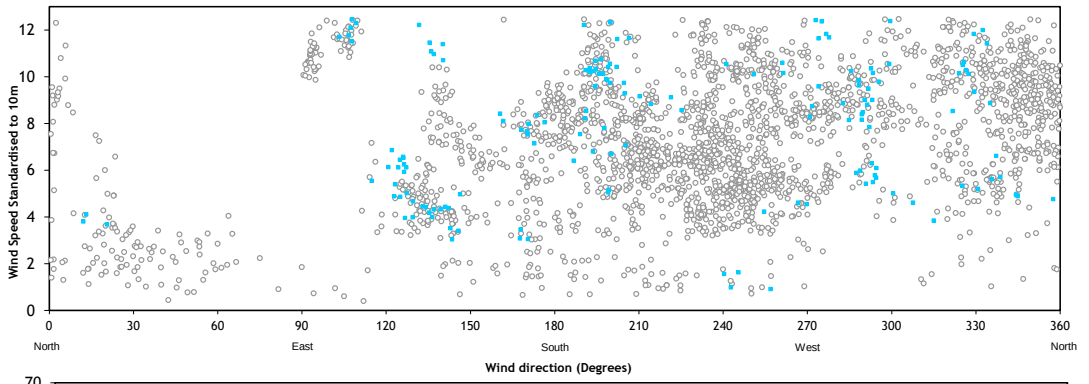
Regression Analysis Quiet Daytime



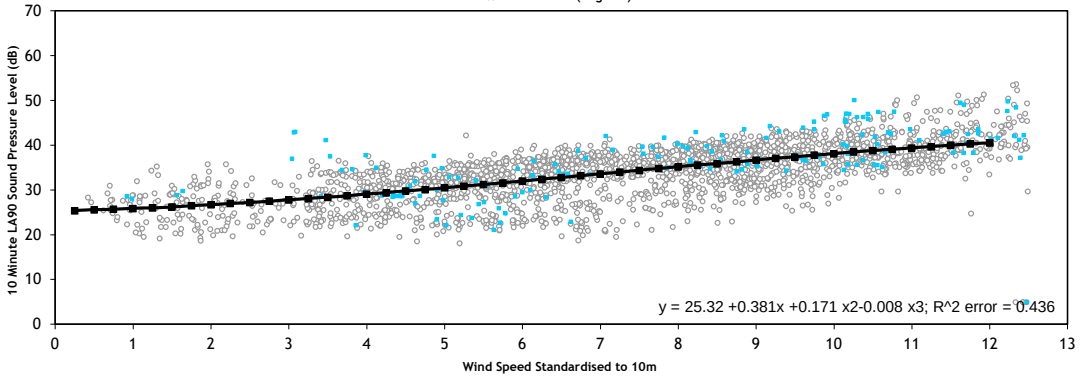
Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	67	77	213	208	271	281	326	284	245	158	83	2213
Prevailing Background	28.2	28.4	28.9	29.7	30.7	32.1	33.7	35.6	37.8	40.3	43	

ETSU-R-97 NIGHT-TIME - NML3 - Meikle Larbrax Cottages

Wind Conditions Night-Time



Regression Analysis Night-Time



Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	81	84	178	274	320	300	315	321	258	196	122	2449
Prevailing Background	26.7	27.8	29.1	30.5	32	33.6	35.2	36.7	38.1	39.4	40.5	

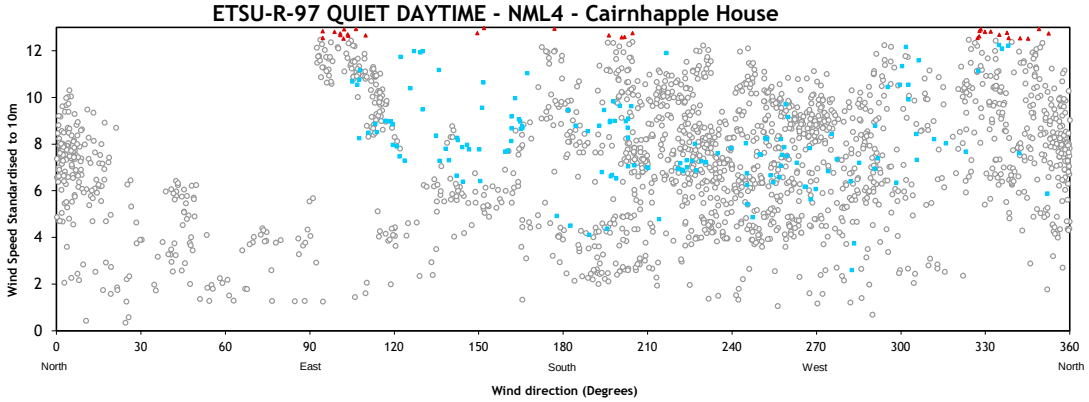
Legend:

- L_{A90} 10 Minute Measurement Point
- Line of best fit
- Line of best fit flat lined where appropriate(Prevailing Background)
- Excluded Data-Manual exclusion
- Excluded Data-Rain
- Excluded Data-Filtered Wind Direction

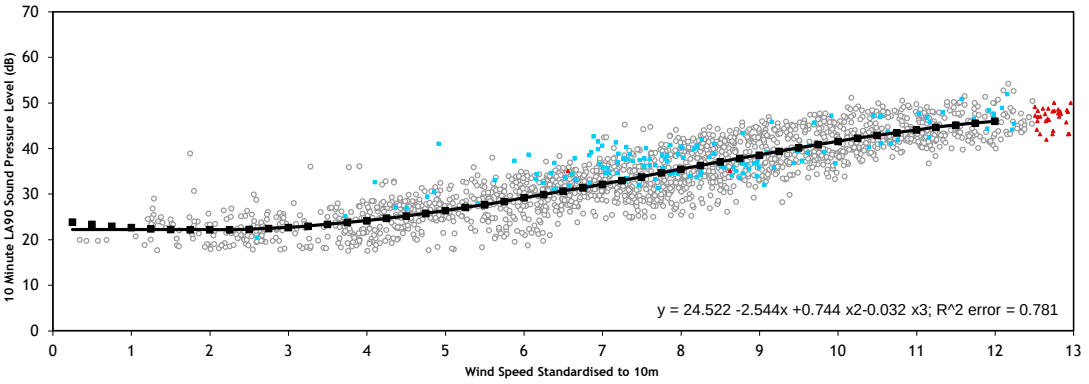
Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Wind Conditions&Regression Analysis NML3 - Meikle Larbrax Cottages
Figure Number	1.2c
Drawn	AD
Checked	MC
Date	19/08/2024
Document Reference	15421 - Models

ETSU-R-97 QUIET DAYTIME - NML4 - Cairnhapple House

Wind Conditions Quiet Daytime



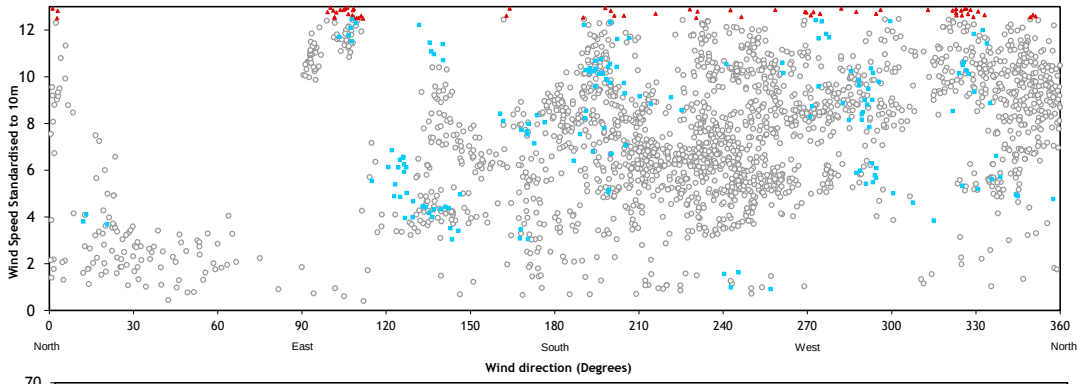
Regression Analysis Quiet Daytime



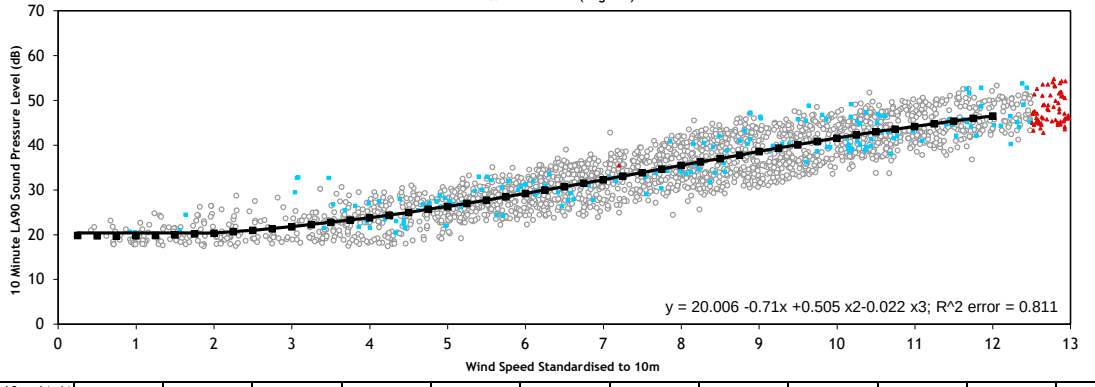
Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	59	68	151	146	222	234	286	229	218	156	83	1852
Prevailing Background	22.2	22.7	24.2	26.4	29.2	32.2	35.5	38.6	41.6	44.1	46	

ETSU-R-97 NIGHT-TIME - NML4 - Cairnhapple House

Wind Conditions Night-Time



Regression Analysis Night-Time



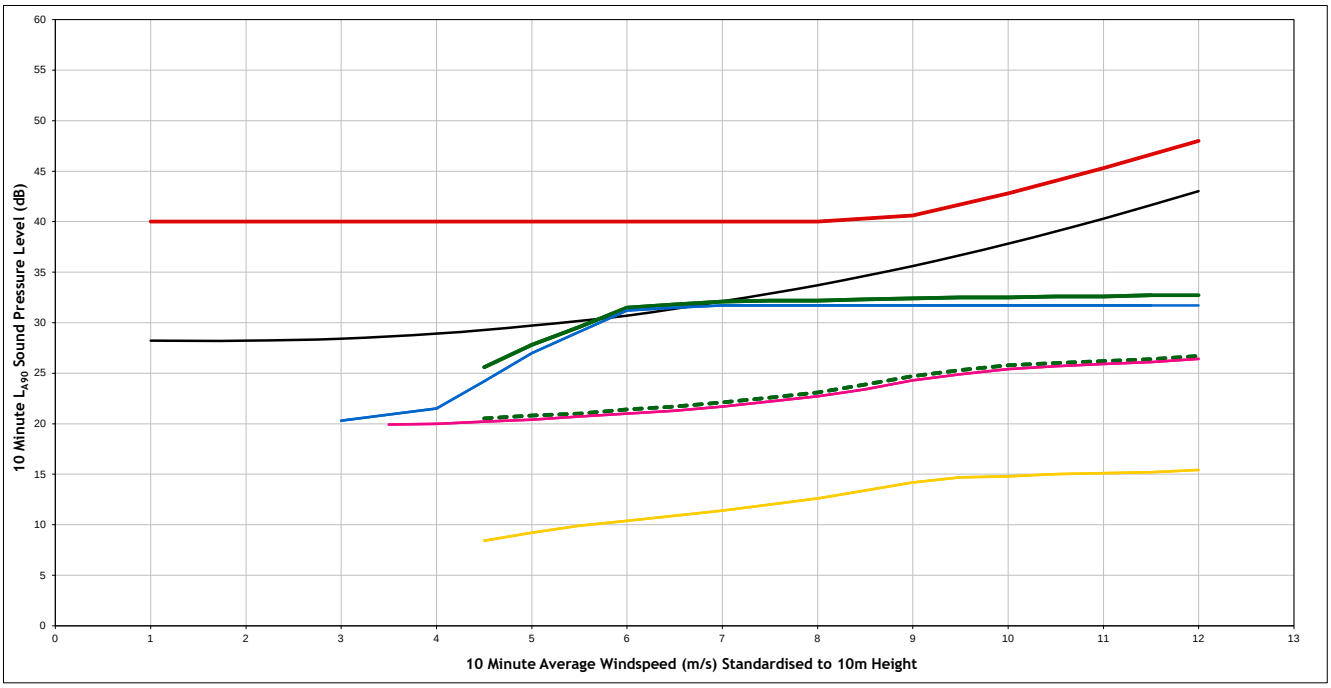
Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	60	71	128	185	272	257	274	276	245	188	118	2074
Prevailing Background	20.4	21.8	23.8	26.3	29.2	32.3	35.5	38.6	41.6	44.2	46.5	

Legend:

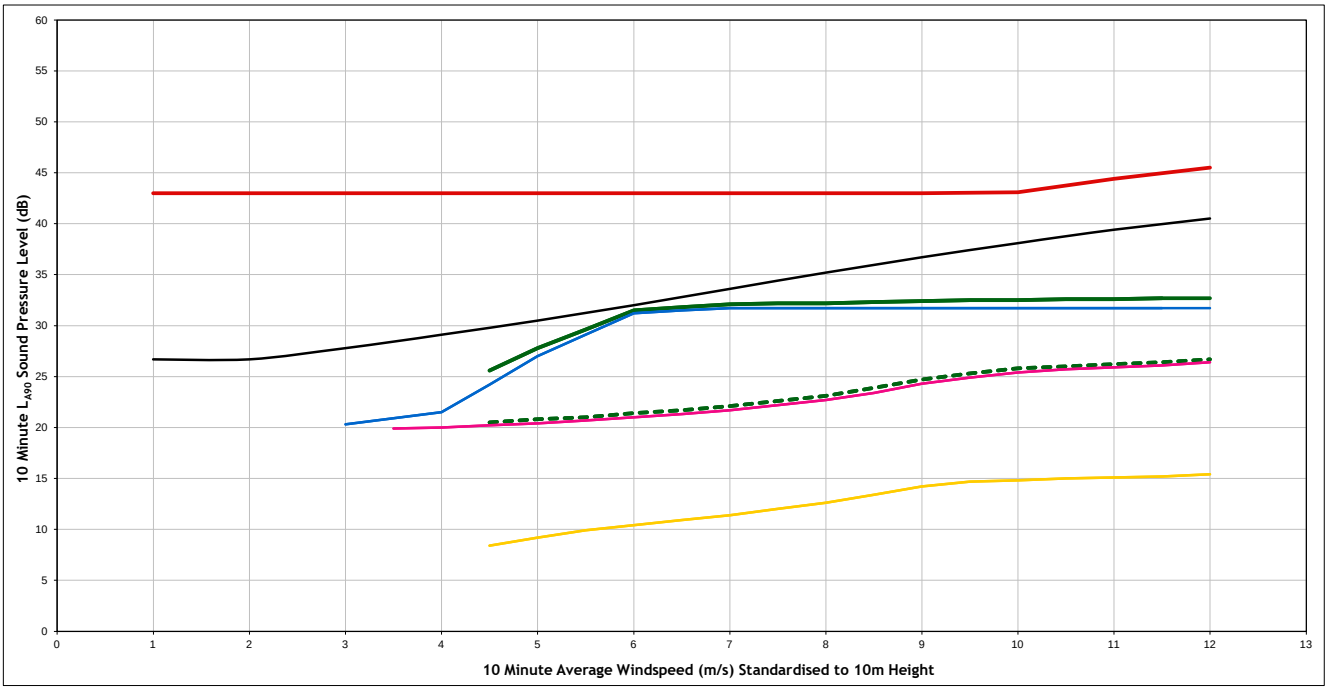
- L_{A90} 10 Minute Measurement Point
- Line of best fit
- Line of best fit flat lined where appropriate(Prevailing Background)
- Excluded Data-Manual exclusion
- Excluded Data-Rain
- Excluded Data-Filtered Wind Direction

Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Wind Conditions&Regression Analysis NML4 - Cairnhapple House
Figure Number	1.2d
Drawn	AD
Checked	MC
Date	19/08/2024
Document Reference	15893 - Models

Daytime - Meikle Labrax (NAL1)



Night Time - Meikle Labrax (NAL1)

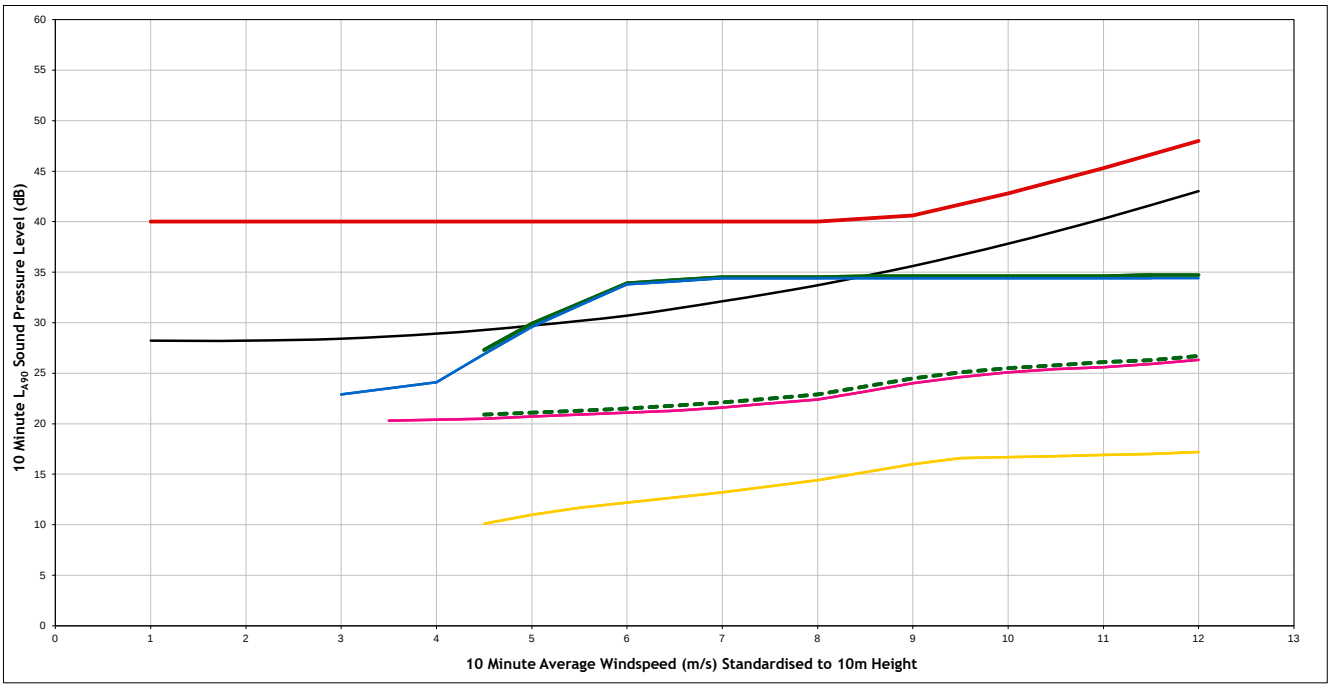


Legend:

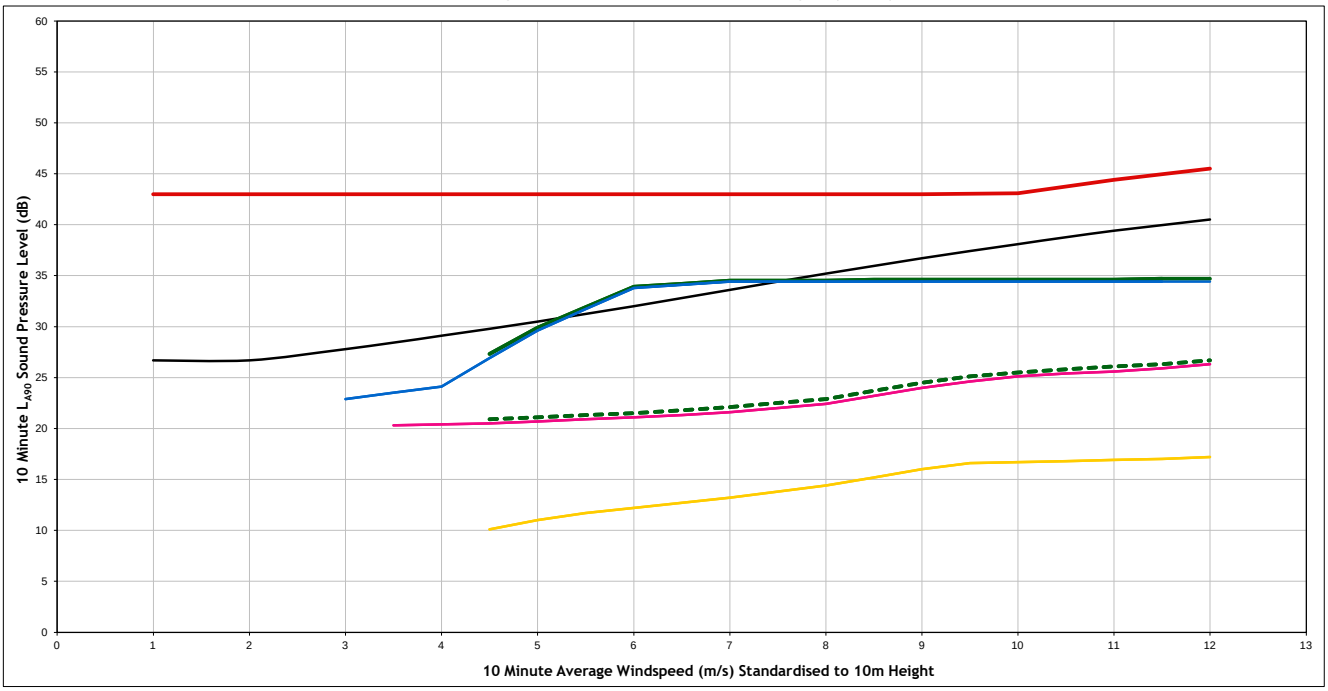
- Background Noise Trendline
- Total ETSU-R-97-Limit
- Cumulative (including the Proposed Development)
- Cumulative (excluding the Proposed Development)
- Proposed Development (4 x Nordex N133 4.8 MW)
- Wind Turbines to the North (Knocknain 1 x DW54 + High Mark 2 x WES 80 + High Auchneel 1 x WES 80)
- Wind Turbines to the South East (Auchnotteroch 1 x WES 80 + Glaik Hill 1 x WES 250)

Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Noise Assessment Likely cumulative Meikle Labrax (NAL1)
Figure Number	Figure A1.3a
Scale	NTS
Drawn	AD
Checked	MC
Date	24/10/2024
Document Reference	15893-Models

Daytime - Meikle Labrax Cottages (NAL2)



Night Time - Meikle Labrax Cottages (NAL2)

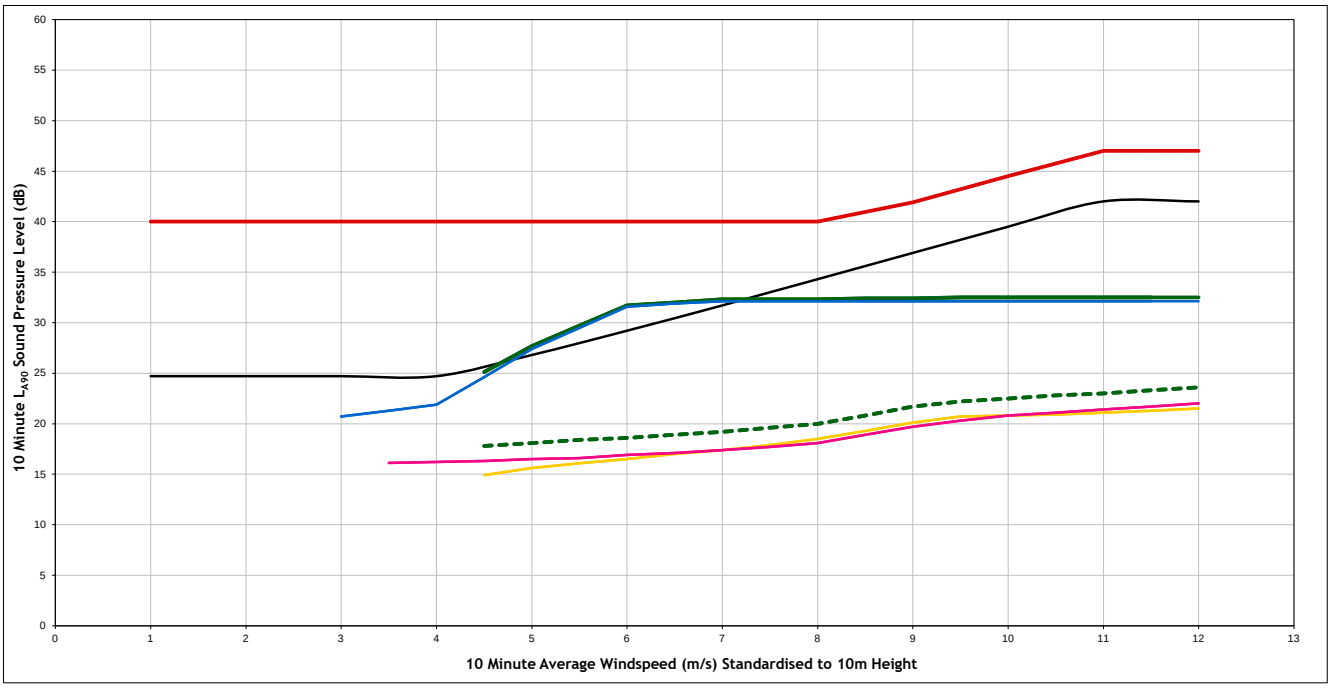


Legend:

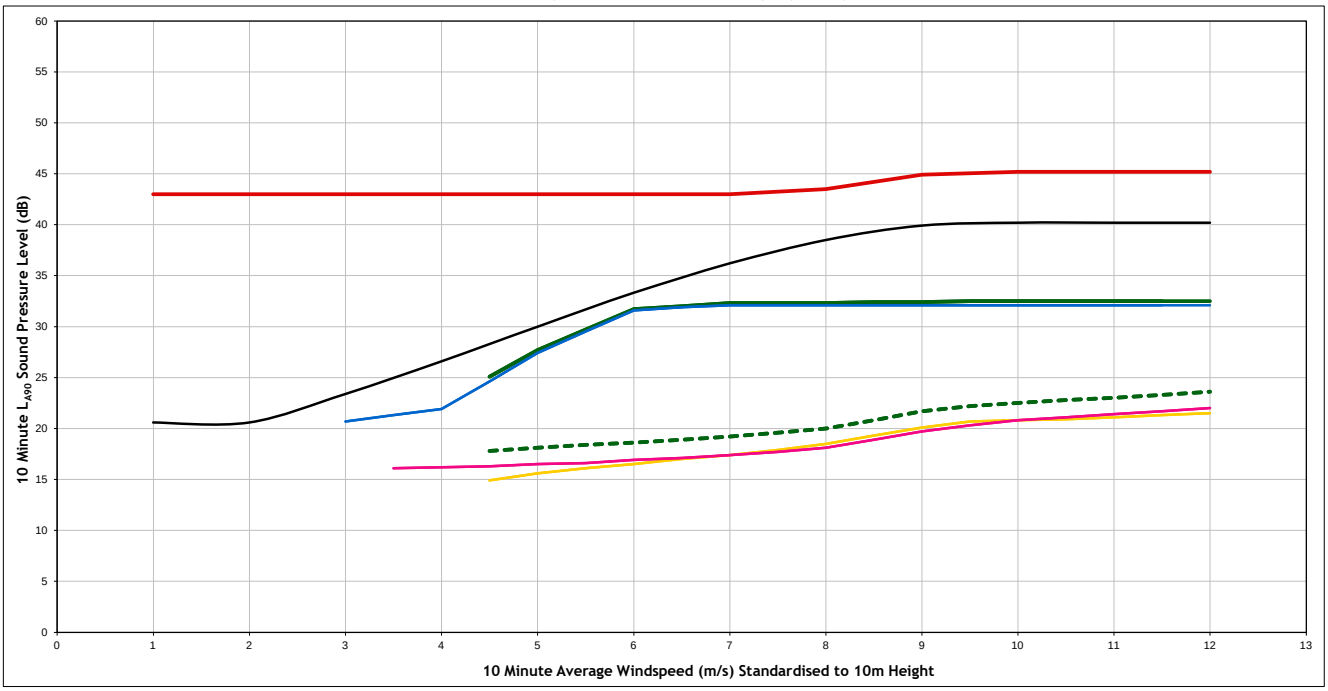
- Background Noise Trendline
- Total ETSU-R-97-Limit
- Cumulative (including the Proposed Development)
- Cumulative (excluding the Proposed Development)
- Proposed Development (4 x Nordex N133 4.8 MW)
- Wind Turbines to the North (Knocknain 1 x DW54 + High Mark 2 x WES 80 + High Auchneel 1 x WES 80)
- Wind Turbines to the South East (Auchnotteroch 1 x WES 80 + Glaik Hill 1 x WES 250)

Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Noise Assessment Likely cumulative Meikle Labrax Cottages (NAL2)
Figure Number	Figure A1.3b
Scale	NTS
Drawn	AD
Checked	MC
Date	24/10/2024
Document Reference	15893-Models

Daytime - Labrax Lodge (NAL3)



Night Time - Labrax Lodge (NAL3)

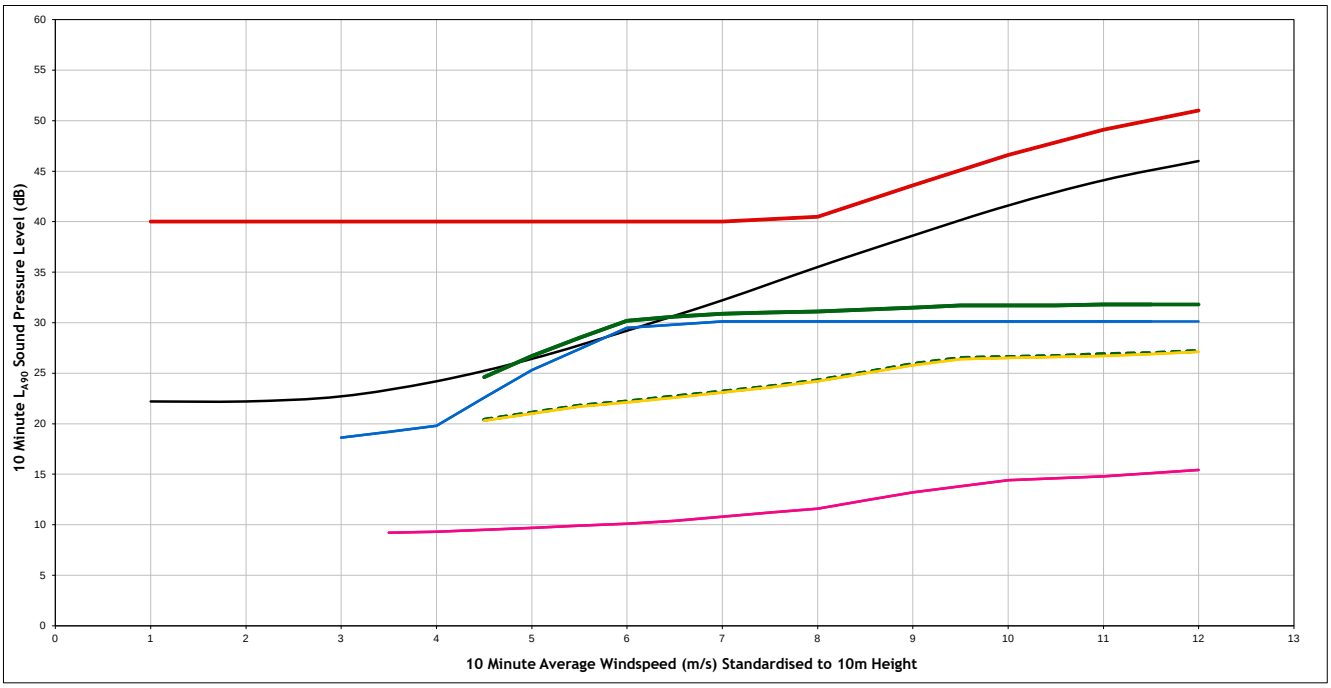


Legend:

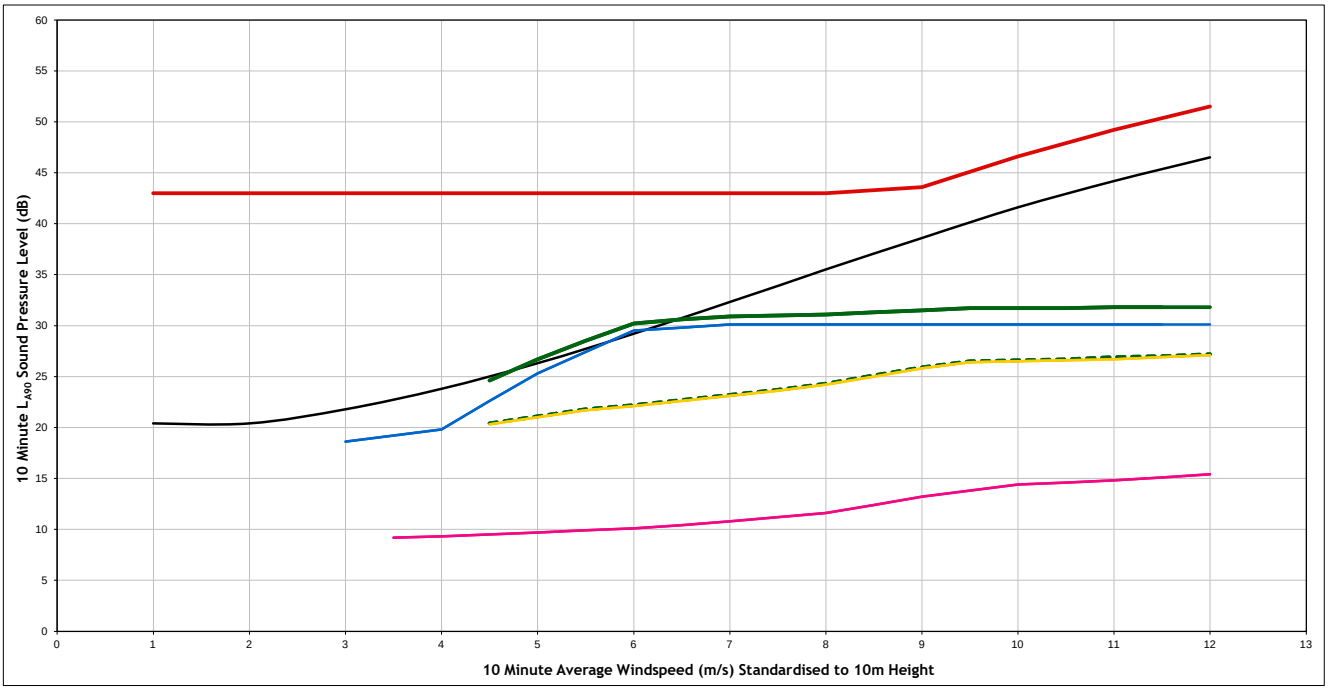
- Background Noise Trendline
- Total ETSU-R-97-Limit
- Cumulative (including the Proposed Development)
- Cumulative (excluding the Proposed Development)
- Proposed Development (4 x Nordex N133 4.8 MW)
- Wind Turbines to the North (Knocknain 1 x DW54 + High Mark 2 x WES 80 + High Auchneel 1 x WES 80)
- Wind Turbines to the South East (Auchnotteroch 1 x WES 80 + Glaik Hill 1 x WES 250)

Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Noise Assessment Likely cumulative Labrax Lodge (NAL3)
Figure Number	Figure A1.3c
Scale	NTS
Drawn	AD
Checked	MC
Date	24/10/2024
Document Reference	15893-Models

Daytime - Glenvallagh Cottage (NAL4)



Night Time - Glenvallagh Cottage (NAL4)

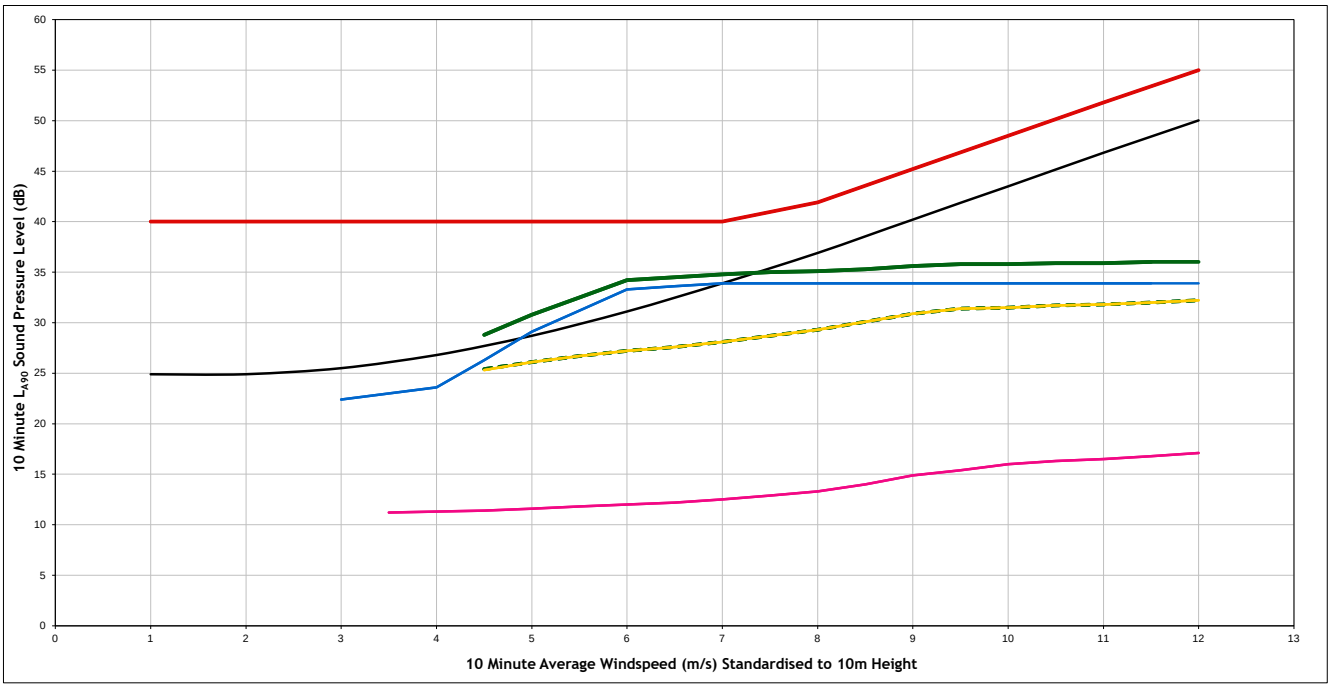


Legend:

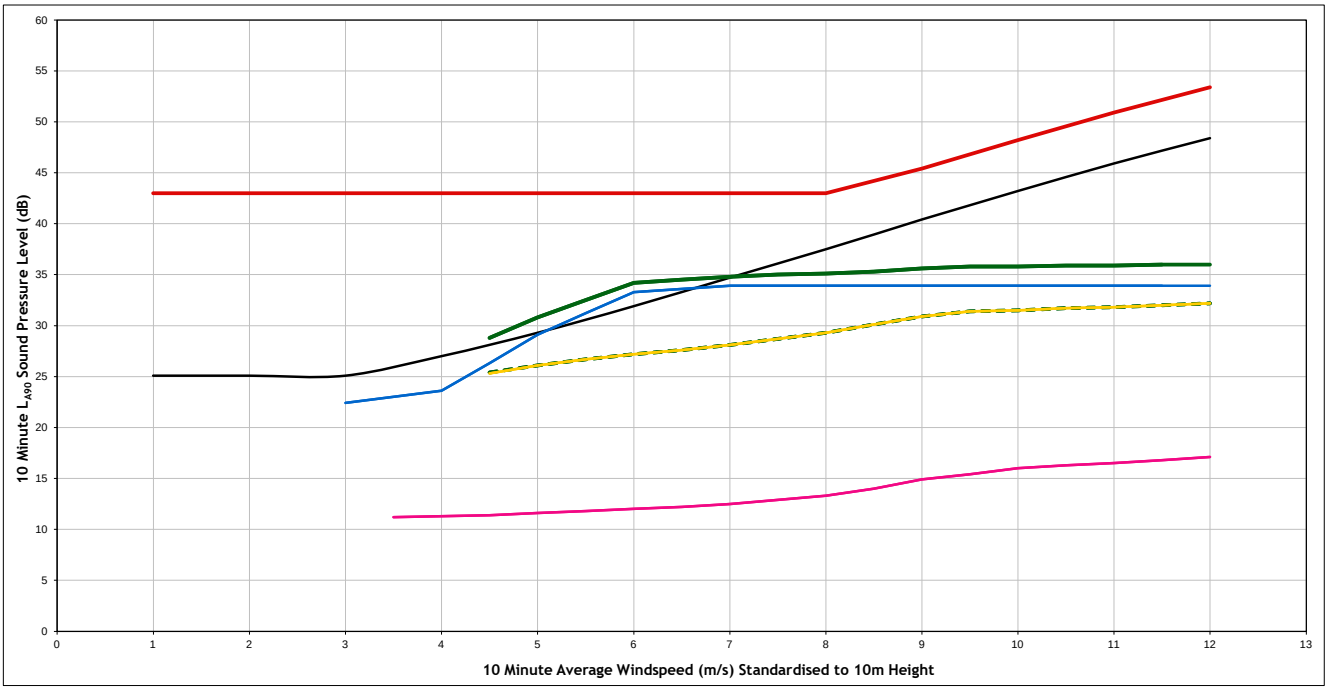
- Background Noise Trendline
- Total ETSU-R-97-Limit
- Cumulative (including the Proposed Development)
- Cumulative (excluding the Proposed Development)
- Proposed Development (4 x Nordex N133 4.8 MW)
- Wind Turbines to the North (Knocknain 1 x DW54 + High Mark 2 x WES 80 + High Auchneel 1 x WES 80)
- Wind Turbines to the South East (Auchnotteroch 1 x WES 80 + Glaik Hill 1 x WES 250)

Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Noise Assessment Likely cumulative Glenvallagh Cottage (NAL4)
Figure Number	Figure A1.3d
Scale	NTS
Drawn	AD
Checked	MC
Date	24/10/2024
Document Reference	15893-Models

Daytime - Greenburn (NAL5)



Night Time - Greenburn (NAL5)

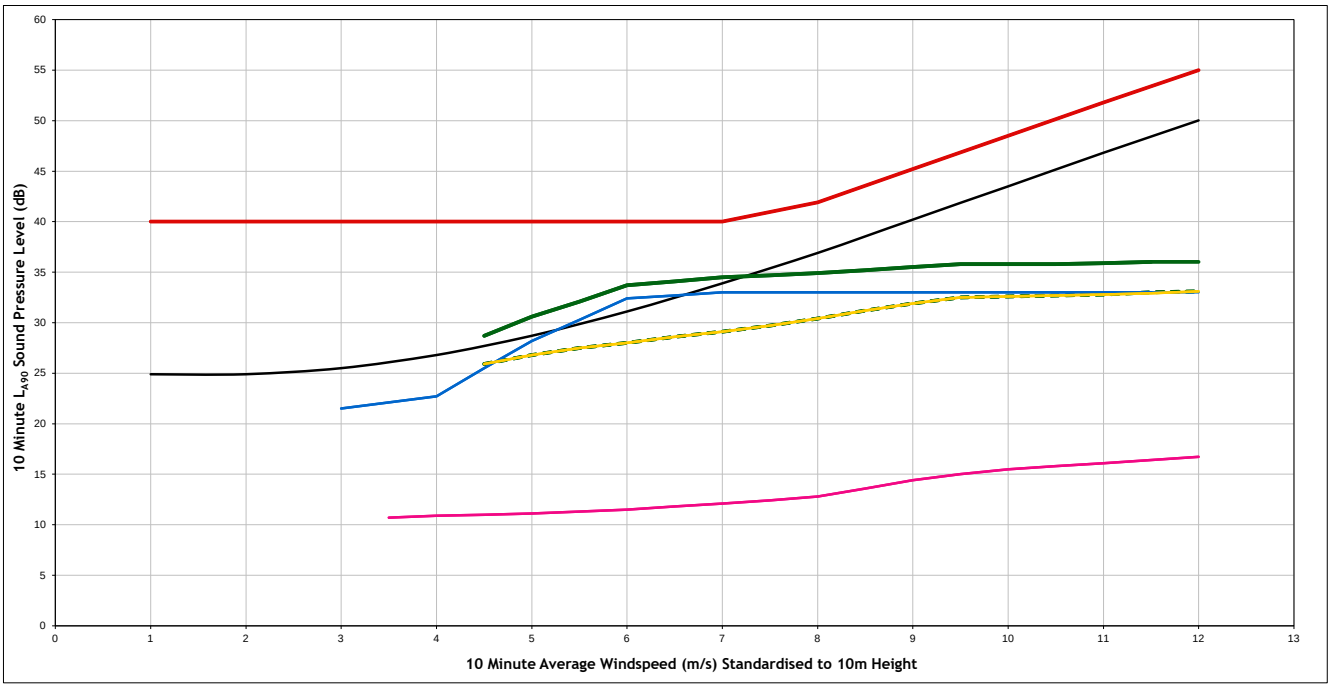


Legend:

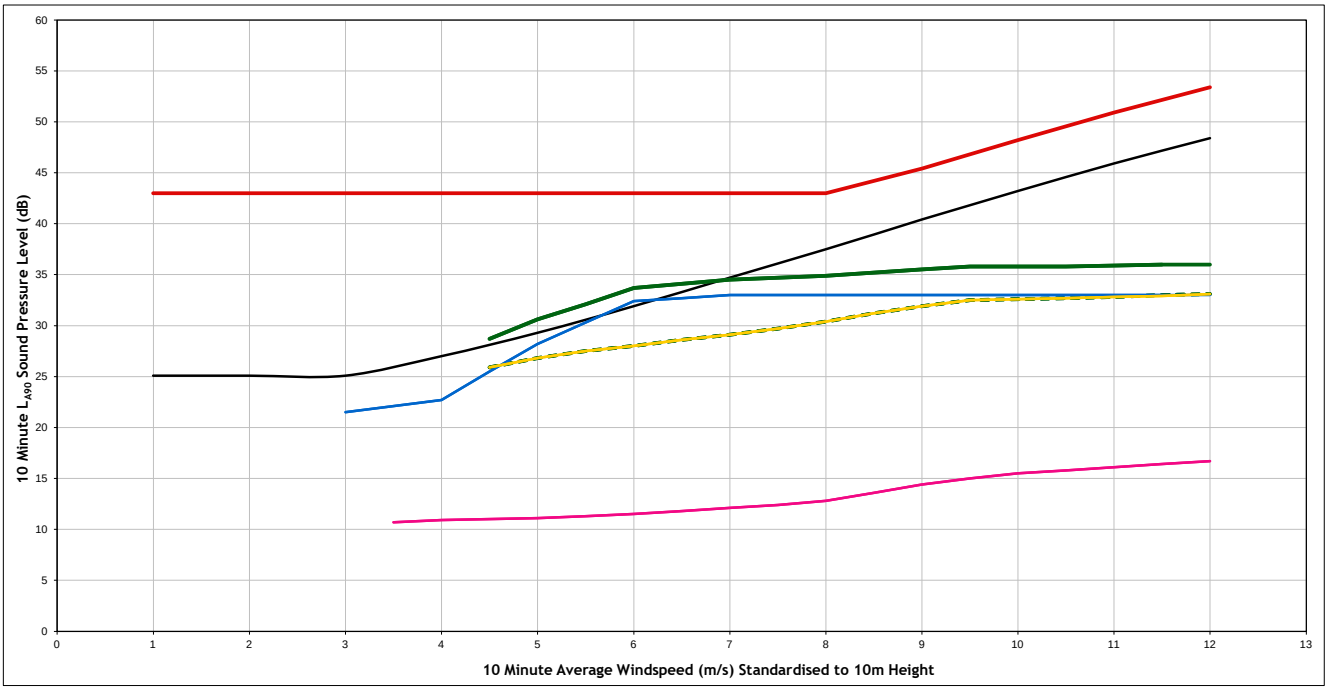
- Background Noise Trendline
- Total ETSU-R-97-Limit
- Cumulative (including the Proposed Development)
- Cumulative (excluding the Proposed Development)
- Proposed Development (4 x Nordex N133 4.8 MW)
- Wind Turbines to the North (Knocknain 1 x DW54 + High Mark 2 x WES 80 + High Auchneel 1 x WES 80)
- Wind Turbines to the South East (Auchnotteroch 1 x WES 80 + Glaik Hill 1 x WES 250)

Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Noise Assessment Likely cumulative Greenburn (NAL5)
Figure Number	Figure A1.3e
Scale	NTS
Drawn	AD
Checked	MC
Date	24/10/2024
Document Reference	15893-Models

Daytime - Meikle Galdenoch (NAL6)



Night Time - Meikle Galdenoch (NAL6)

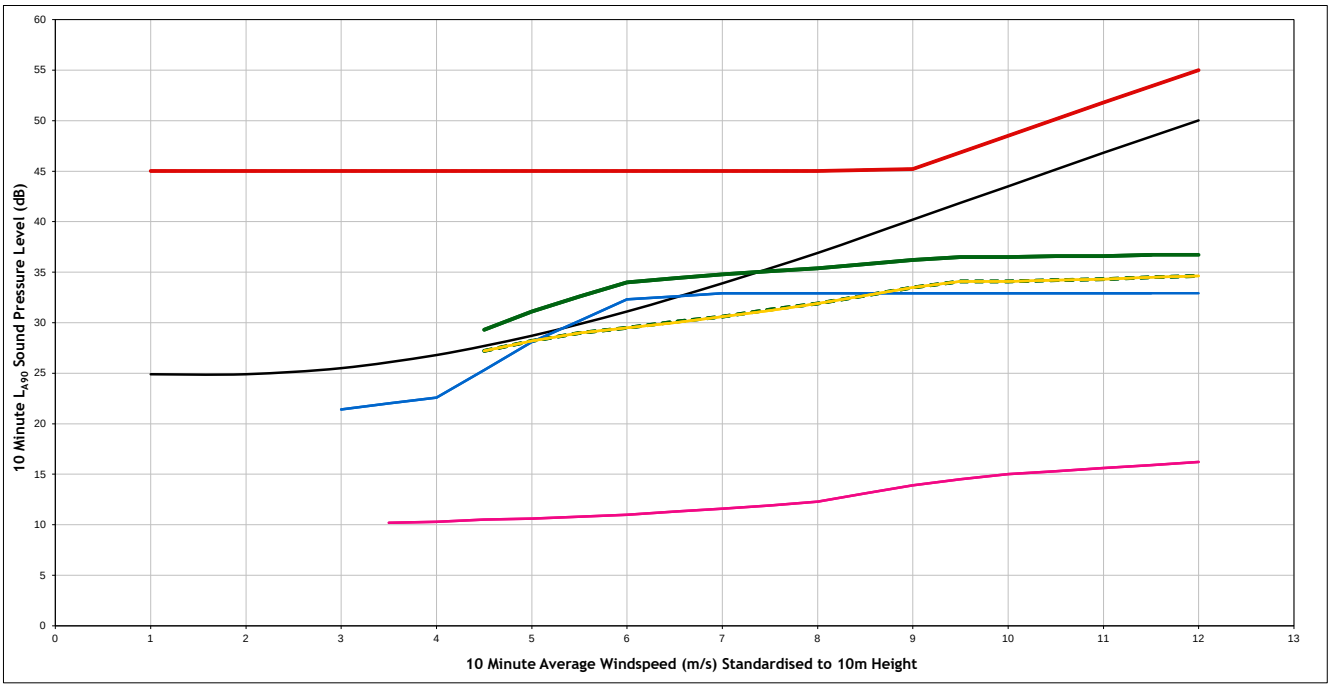


Legend:

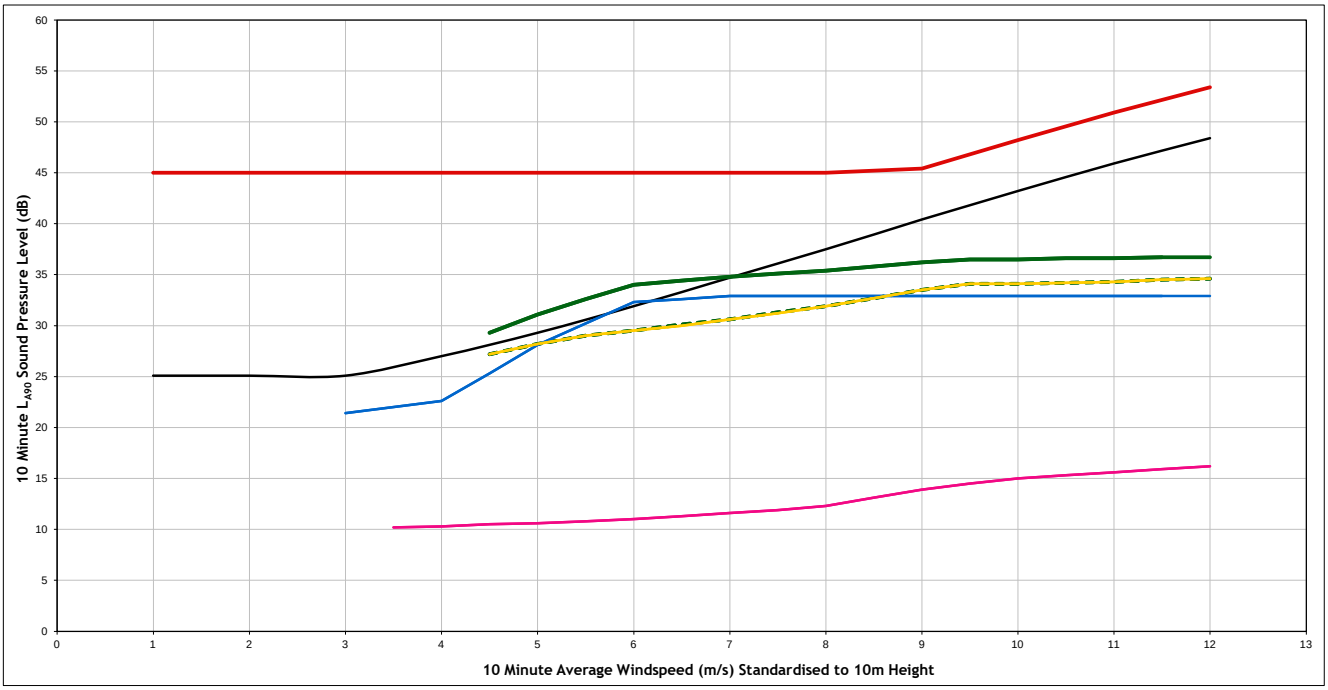
- Background Noise Trendline
- Total ETSU-R-97-Limit
- Cumulative (including the Proposed Development)
- Cumulative (excluding the Proposed Development)
- Proposed Development (4 x Nordex N133 4.8 MW)
- Wind Turbines to the North (Knocknain 1 x DW54 + High Mark 2 x WES 80 + High Auchneel 1 x WES 80)
- Wind Turbines to the South East (Auchnotteroch 1 x WES 80 + Glaik Hill 1 x WES 250)

Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Noise Assessment Likely cumulative Meikle Galdenoch (NAL6)
Figure Number	Figure A1.3f
Scale	NTS
Drawn	AD
Checked	MC
Date	24/10/2024
Document Reference	15893-Models

Daytime - Drumwhistley (FI with Larbrax) (NAL7)



Night Time - Drumwhistley (FI with Larbrax) (NAL7)

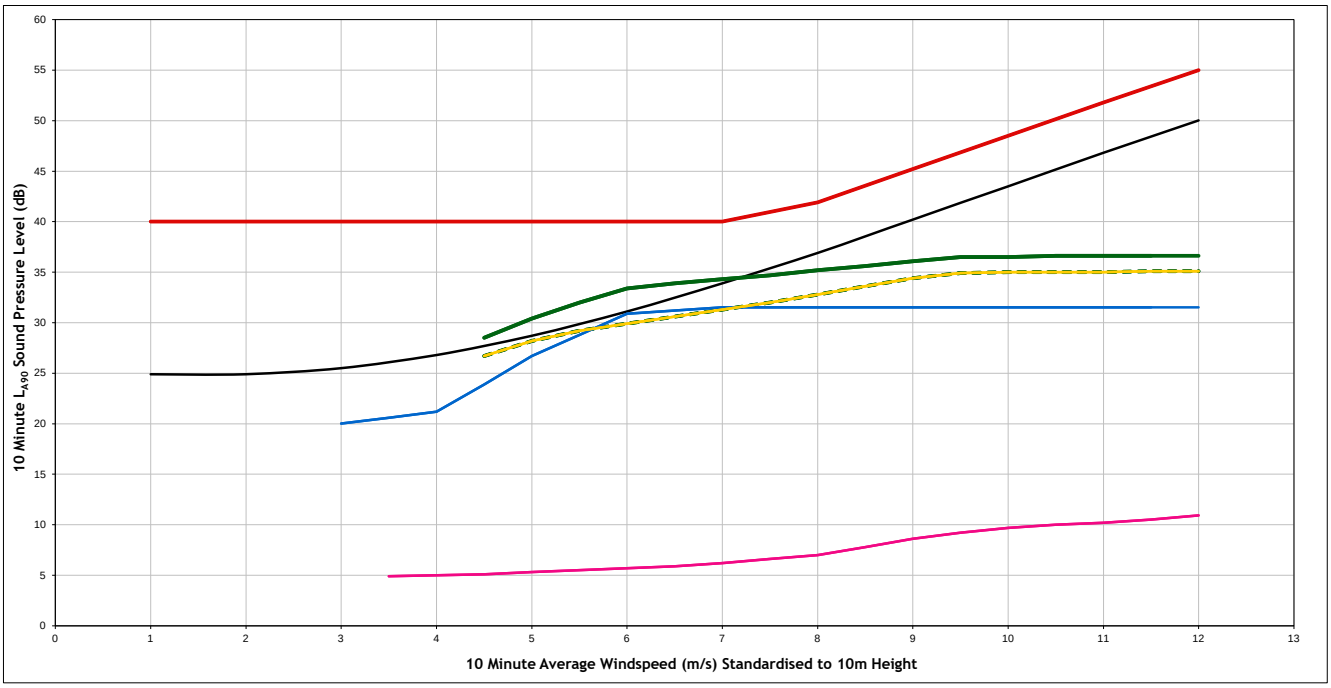


Legend:

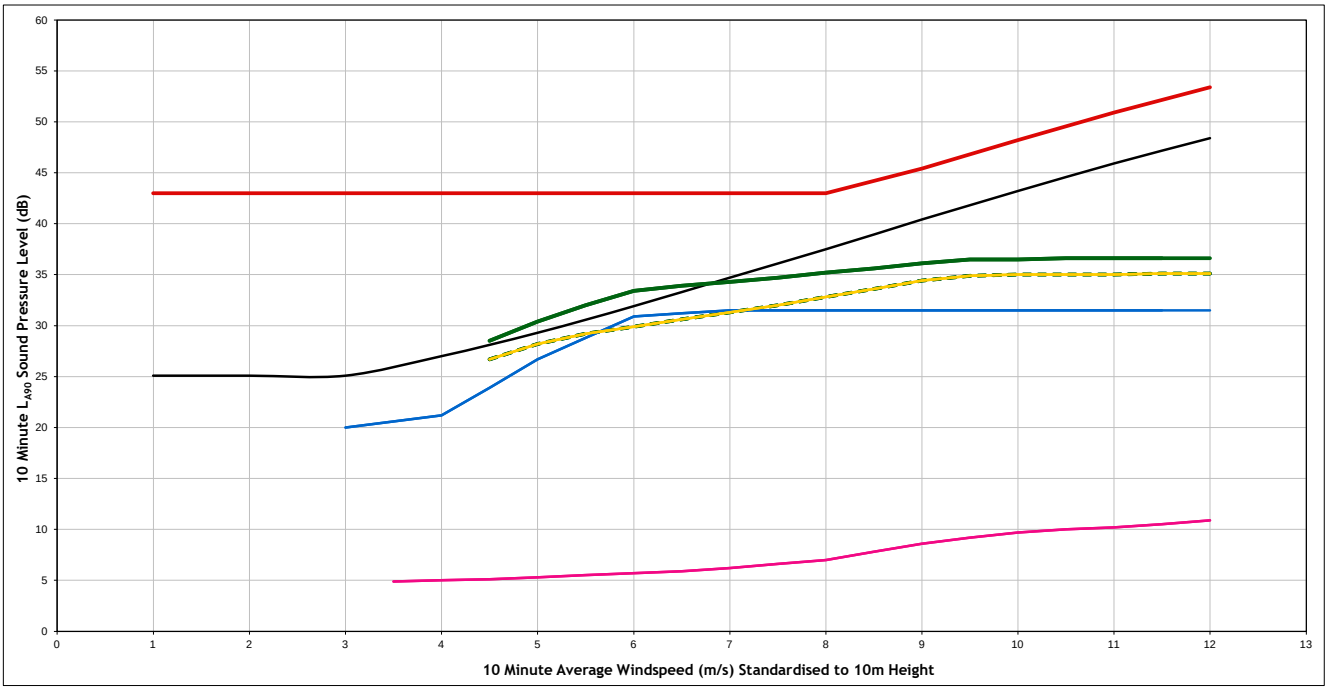
- Background Noise Trendline
- Total ETSU-R-97-Limit
- Cumulative (including the Proposed Development)
- Cumulative (excluding the Proposed Development)
- Proposed Development (4 x Nordex N133 4.8 MW)
- Wind Turbines to the North (Knocknain 1 x DW54 + High Mark 2 x WES 80 + High Auchneel 1 x WES 80)
- Wind Turbines to the South East (Auchnotteroch 1 x WES 80 + Glaik Hill 1 x WES 250)

Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Noise Assessment Likely cumulative Drumwhistley (FI with Larbrax) (NAL7)
Figure Number	Figure A1.3g
Scale	NTS
Drawn	AD
Checked	MC
Date	24/10/2024
Document Reference	15893-Models

Daytime - Galdenoch Mill Cottage (NAL8)



Night Time - Galdenoch Mill Cottage (NAL8)

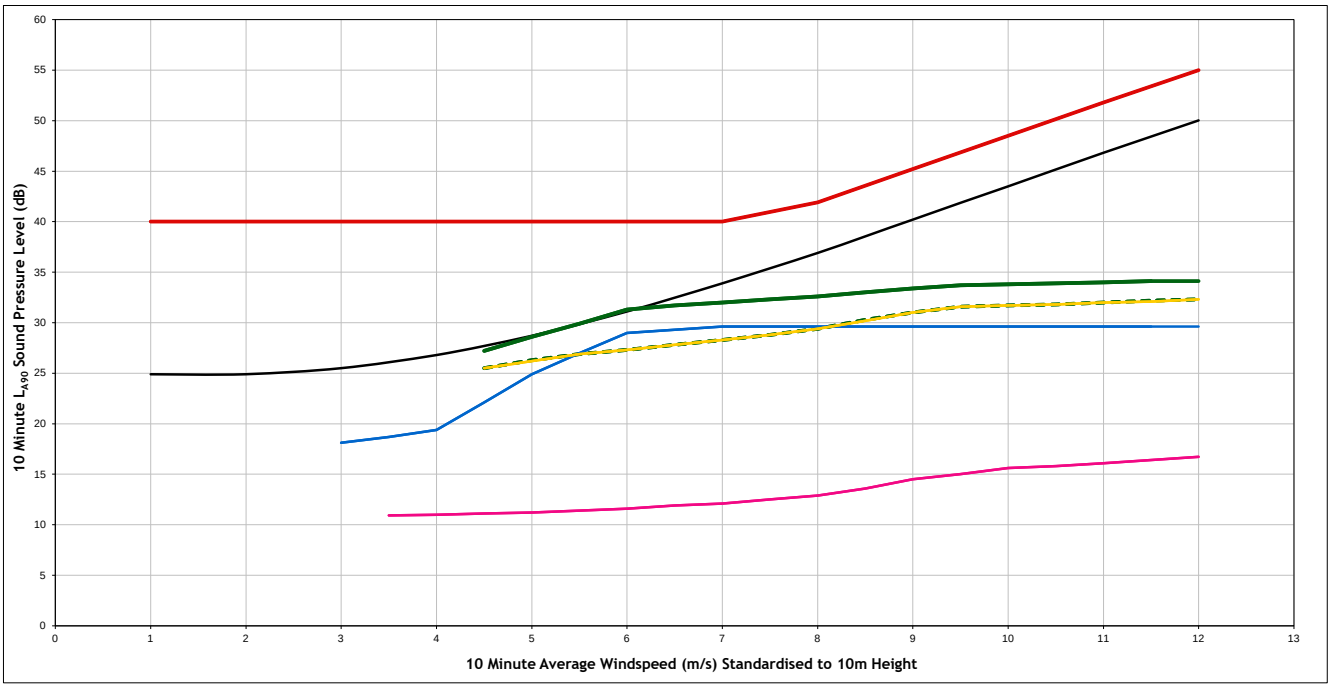


Legend:

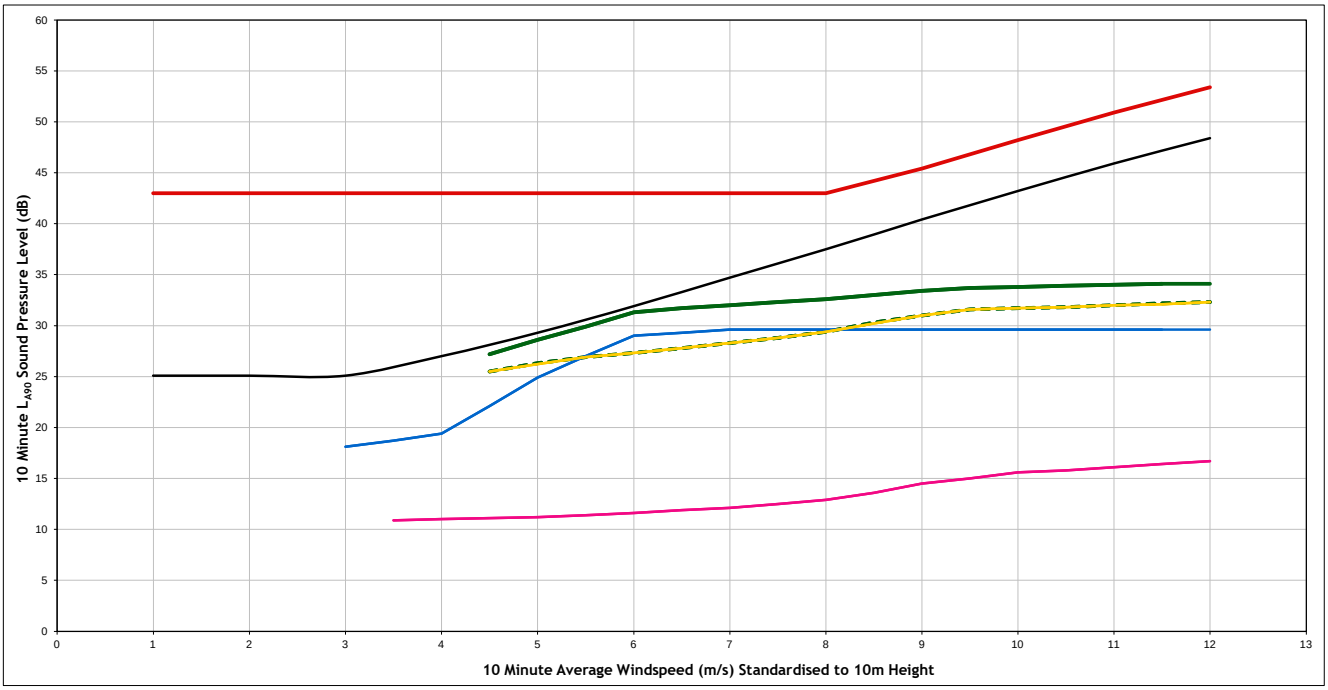
- Background Noise Trendline
- Total ETSU-R-97-Limit
- Cumulative (including the Proposed Development)
- Cumulative (excluding the Proposed Development)
- Proposed Development (4 x Nordex N133 4.8 MW)
- Wind Turbines to the North (Knocknain 1 x DW54 + High Mark 2 x WES 80 + High Auchneel 1 x WES 80)
- Wind Turbines to the South East (Auchnotteroch 1 x WES 80 + Glaik Hill 1 x WES 250)

Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Noise Assessment Likely cumulative Galdenoch Mill Cottage (NAL8)
Figure Number	Figure A1.3h
Scale	NTS
Drawn	AD
Checked	MC
Date	24/10/2024
Document Reference	15893-Models

Daytime - Little Galdenoch Farm (NAL9)



Night Time - Little Galdenoch Farm (NAL9)

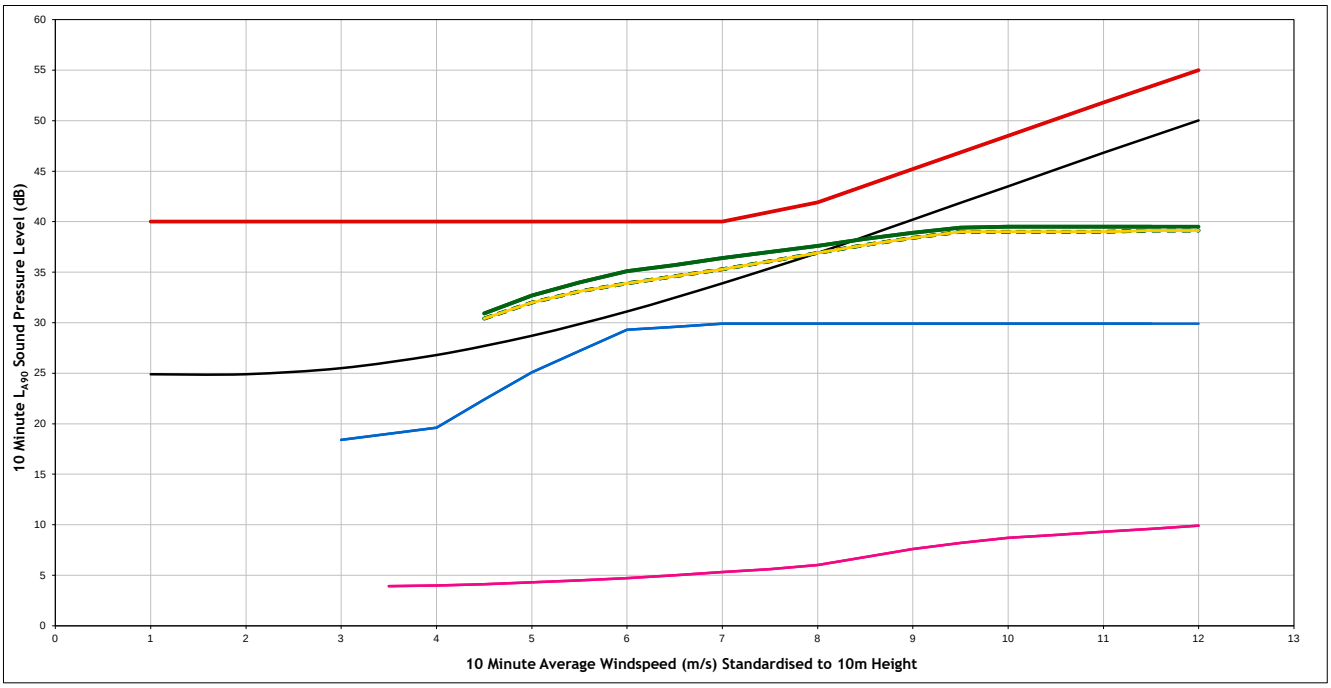


Legend:

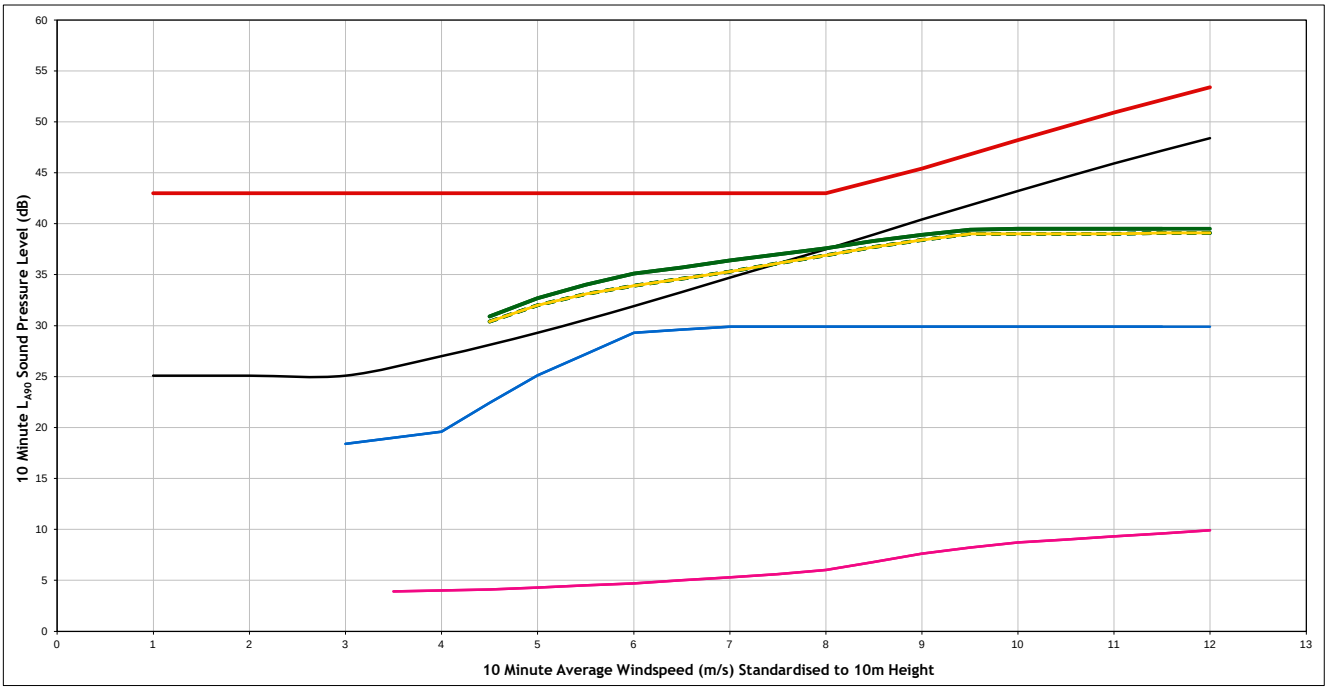
- Background Noise Trendline
- Total ETSU-R-97-Limit
- Cumulative (including the Proposed Development)
- Cumulative (excluding the Proposed Development)
- Proposed Development (4 x Nordex N133 4.8 MW)
- Wind Turbines to the North (Knocknain 1 x DW54 + High Mark 2 x WES 80 + High Auchneel 1 x WES 80)
- Wind Turbines to the South East (Auchnotteroch 1 x WES 80 + Glaik Hill 1 x WES 250)

Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Noise Assessment Likely cumulative Little Galdenoch Farm (NAL9)
Figure Number	Figure A1.3i
Scale	NTS
Drawn	AD
Checked	MC
Date	24/10/2024
Document Reference	15893-Models

Daytime - Knocknain Cottages (NAL10)



Night Time - Knocknain Cottages (NAL10)

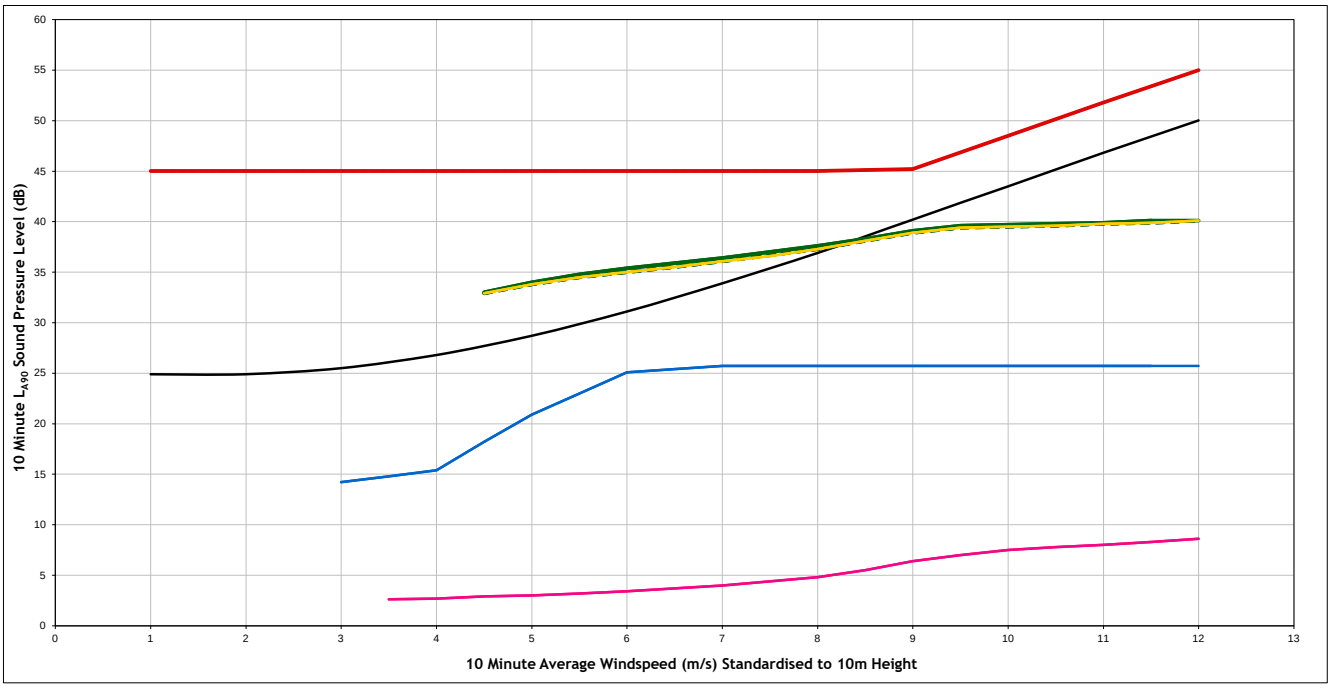


Legend:

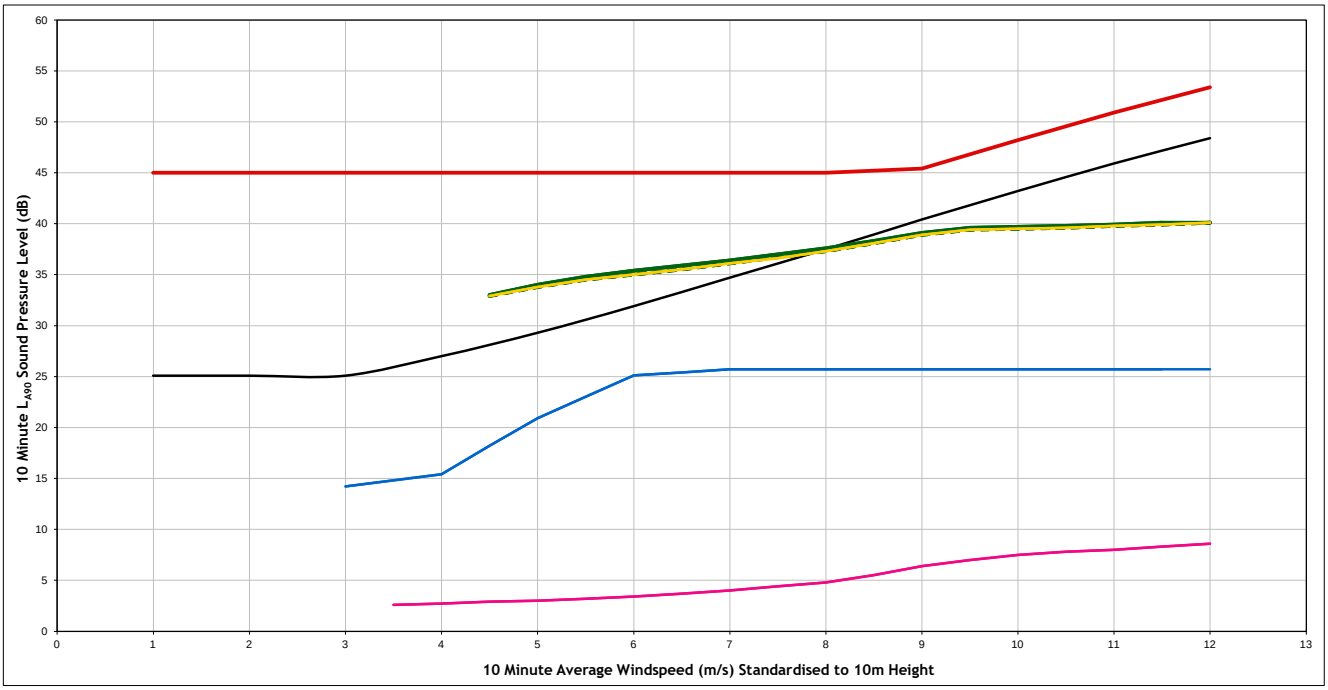
- Background Noise Trendline
- Total ETSU-R-97-Limit
- Cumulative (including the Proposed Development)
- Cumulative (excluding the Proposed Development)
- Proposed Development (4 x Nordex N133 4.8 MW)
- Wind Turbines to the North (Knocknain 1 x DW54 + High Mark 2 x WES 80 + High Auchneel 1 x WES 80)
- Wind Turbines to the South East (Auchnotteroch 1 x WES 80 + Glaik Hill 1 x WES 250)

Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Noise Assessment Likely cumulative Knocknain Cottages (NAL10)
Figure Number	Figure A1.3j
Scale	NTS
Drawn	AD
Checked	MC
Date	24/10/2024
Document Reference	15893-Models

Daytime - The Potting Shed (Fl with Knocknain) (NAL11)



Night Time - The Potting Shed (Fl with Knocknain) (NAL11)

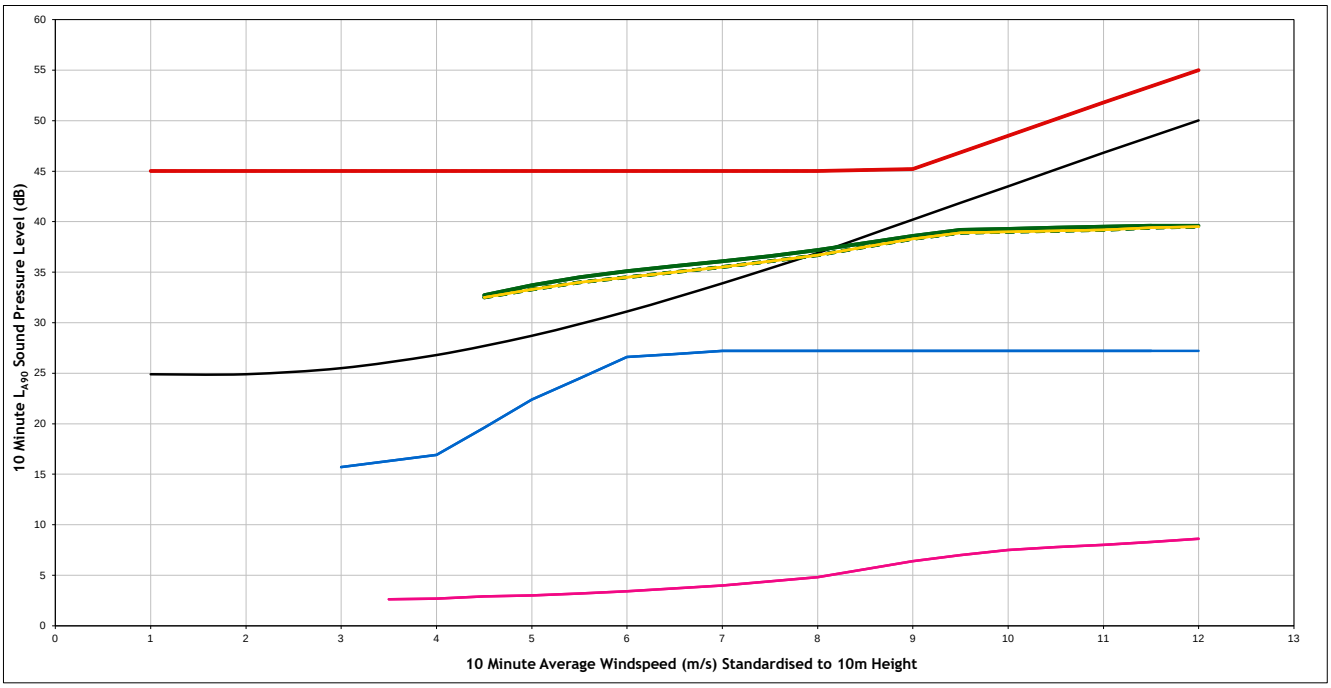


Legend:

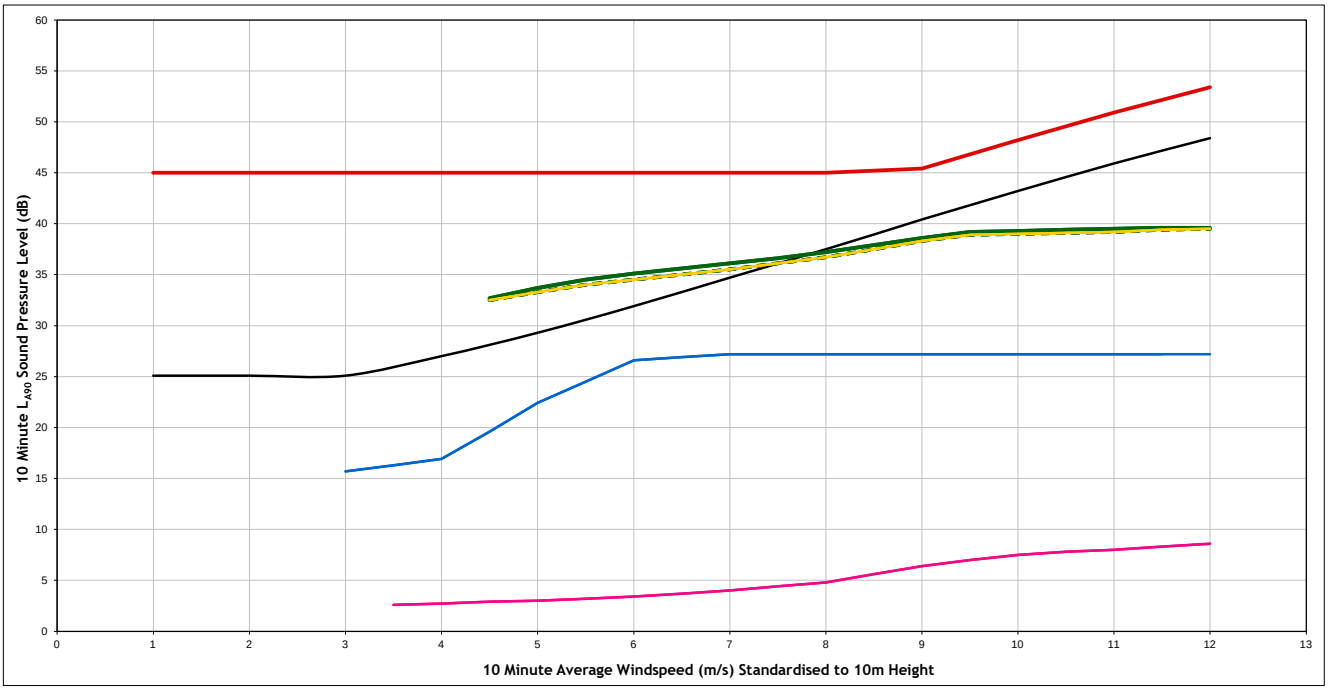
- Background Noise Trendline
- Total ETSU-R-97-Limit
- Cumulative (including the Proposed Development)
- Cumulative (excluding the Proposed Development)
- Proposed Development (4 x Nordex N133 4.8 MW)
- Wind Turbines to the North (Knocknain 1 x DW54 + High Mark 2 x WES 80 + High Auchneel 1 x WES 80)
- Wind Turbines to the South East (Auchnotteroch 1 x WES 80 + Glaik Hill 1 x WES 250)

Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Noise Assessment Likely cumulative The Potting Shed (Fl with Knocknain) (NAL11)
Figure Number	Figure A1.3k
Scale	NTS
Drawn	AD
Checked	MC
Date	24/10/2024
Document Reference	15893-Models

Daytime - Knocknain (FI with Knocknain) (NAL12)



Night Time - Knocknain (FI with Knocknain) (NAL12)

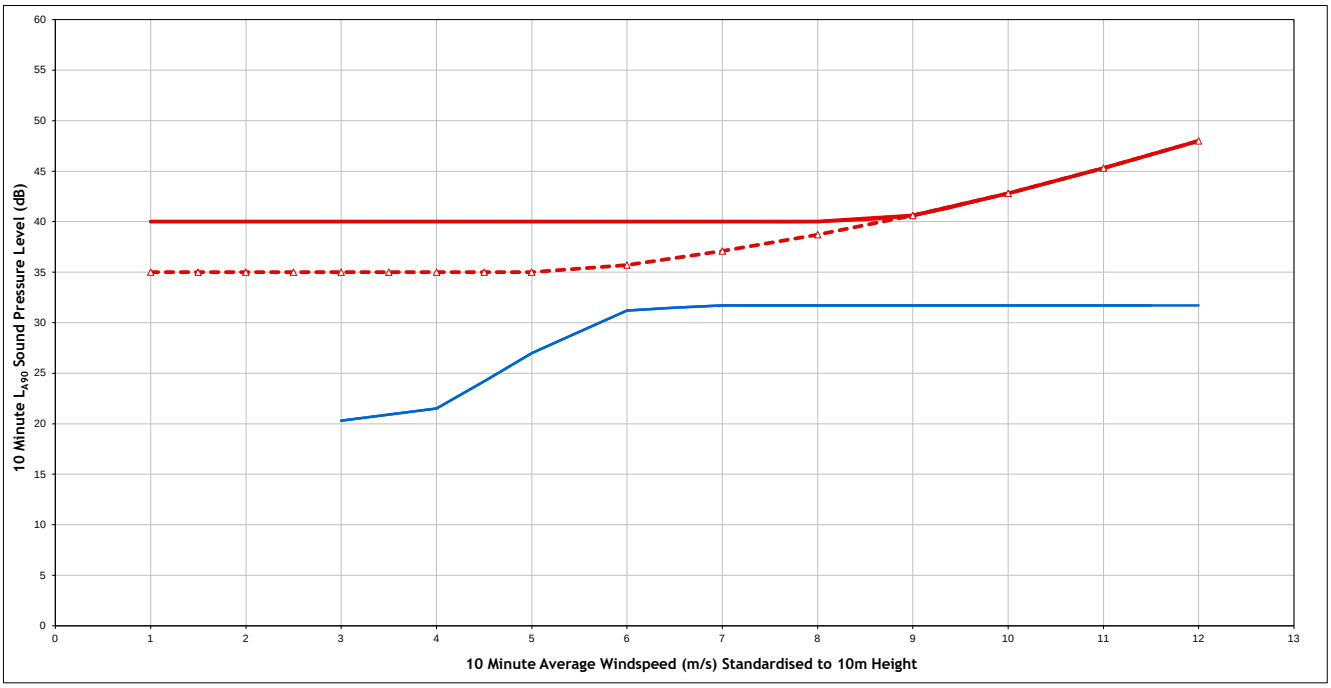


Legend:

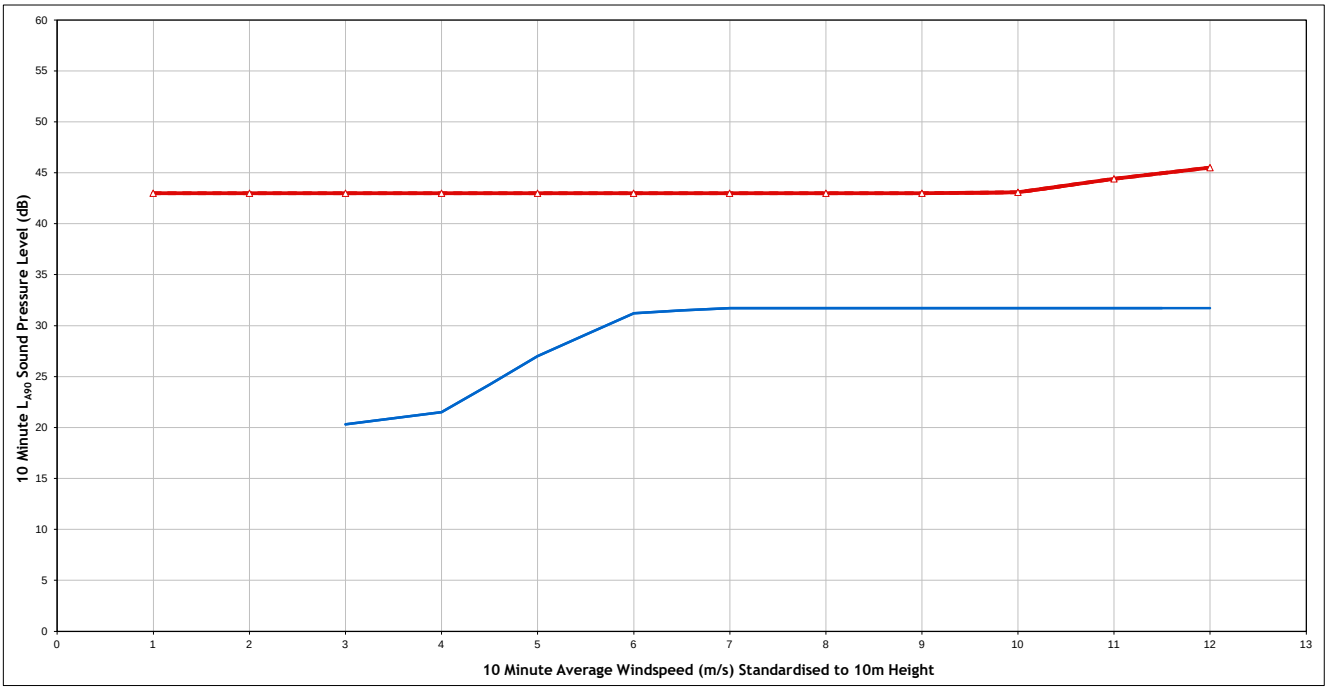
- Background Noise Trendline
- Total ETSU-R-97-Limit
- Cumulative (including the Proposed Development)
- Cumulative (excluding the Proposed Development)
- Proposed Development (4 x Nordex N133 4.8 MW)
- Wind Turbines to the North (Knocknain 1 x DW54 + High Mark 2 x WES 80 + High Auchneel 1 x WES 80)
- Wind Turbines to the South East (Auchnotteroch 1 x WES 80 + Glaik Hill 1 x WES 250)

Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Noise Assessment Likely cumulative Knocknain (FI with Knocknain) (NAL12)
Figure Number	Figure A1.3l
Scale	NTS
Drawn	AD
Checked	MC
Date	24/10/2024
Document Reference	15893-Models

Daytime - Meikle Labrax (NAL1)



Night Time - Meikle Labrax (NAL1)

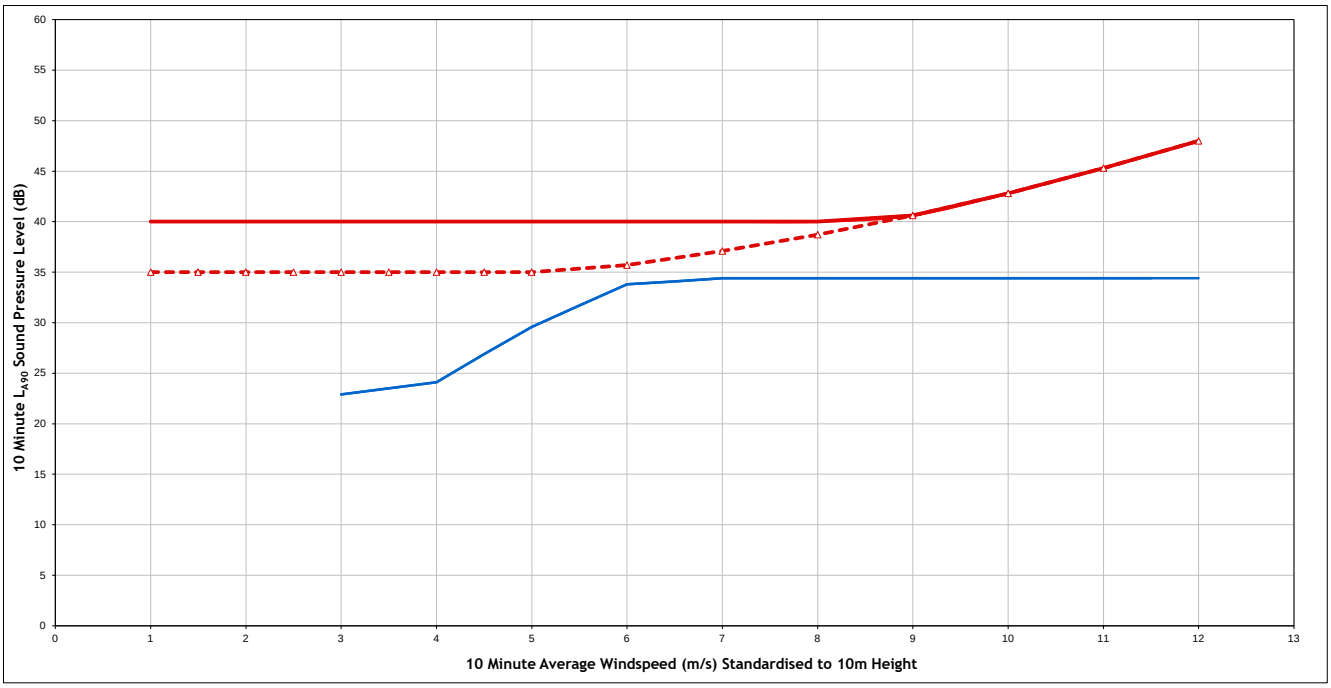


Legend:

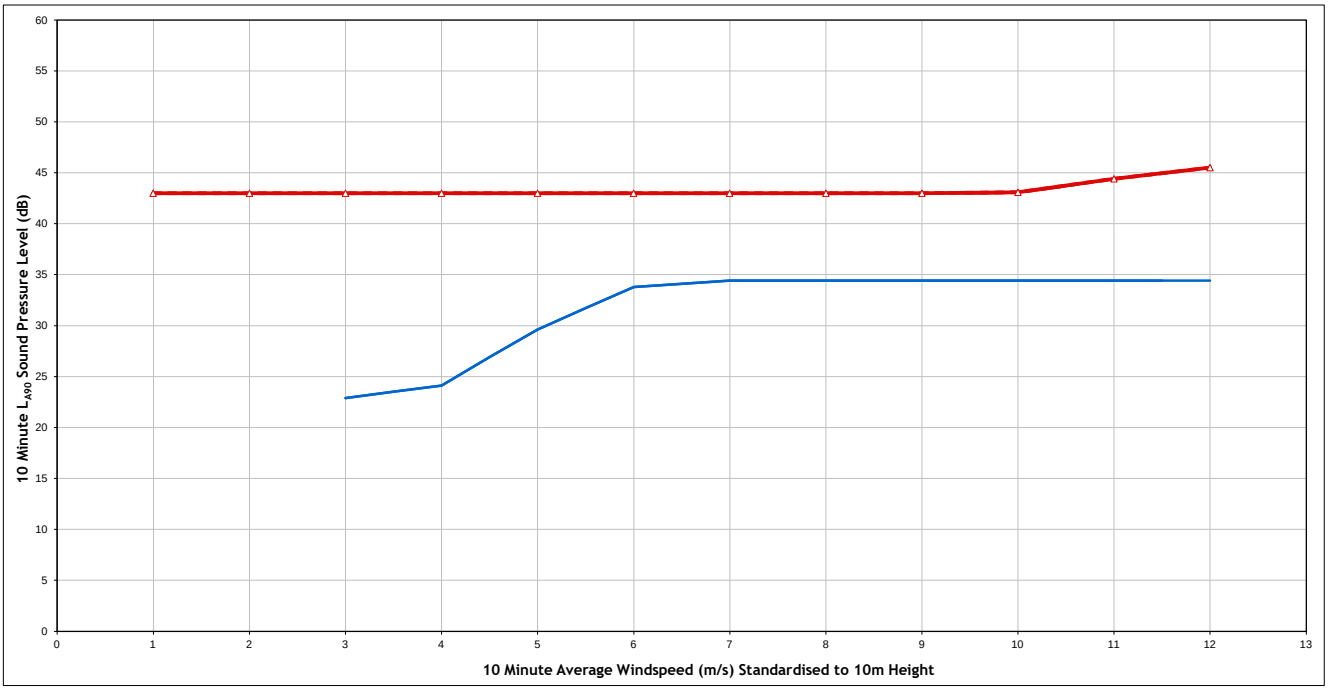
- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development (4 x Nordex N133 4.8 MW)

Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Noise Assessment against SSNL Meikle Labrax (NAL1)
Figure Number	Figure A1.4a
Scale	NTS
Drawn	AD
Checked	MC
Date	24/10/2024
Document Reference	15893-Models

Daytime - Meikle Labrax Cottages (NAL2)



Night Time - Meikle Labrax Cottages (NAL2)

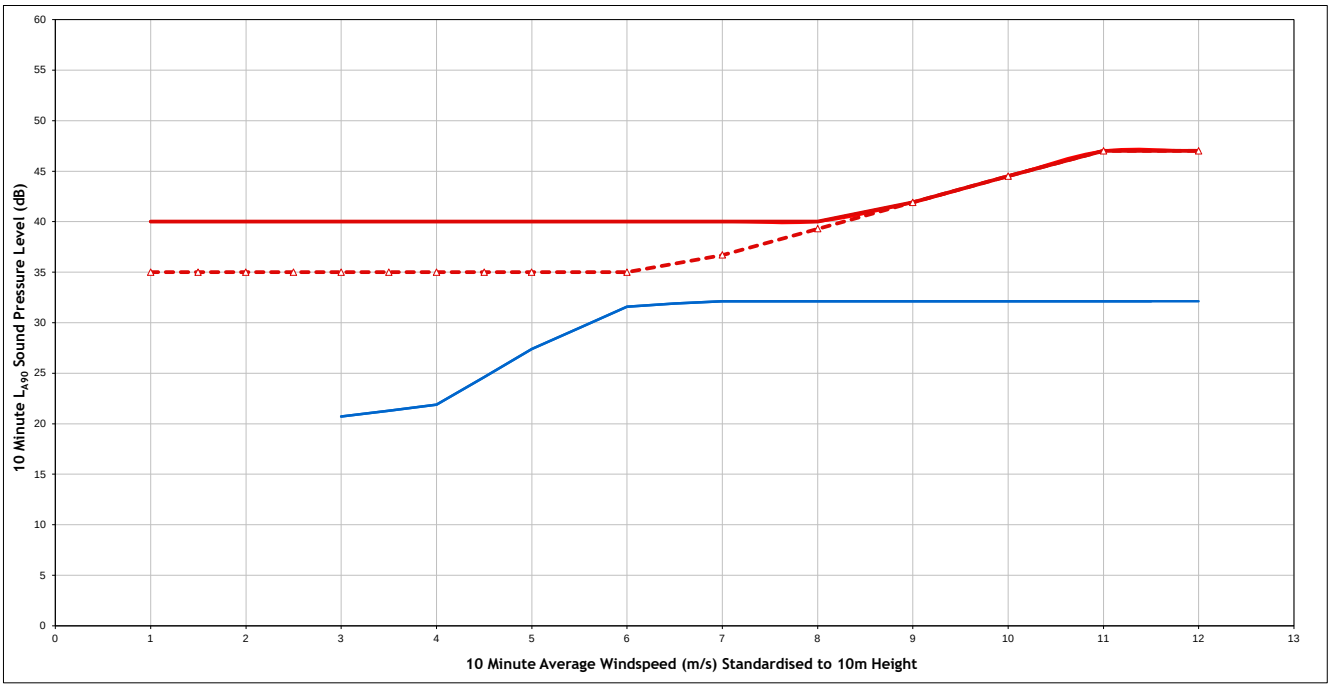


Legend:

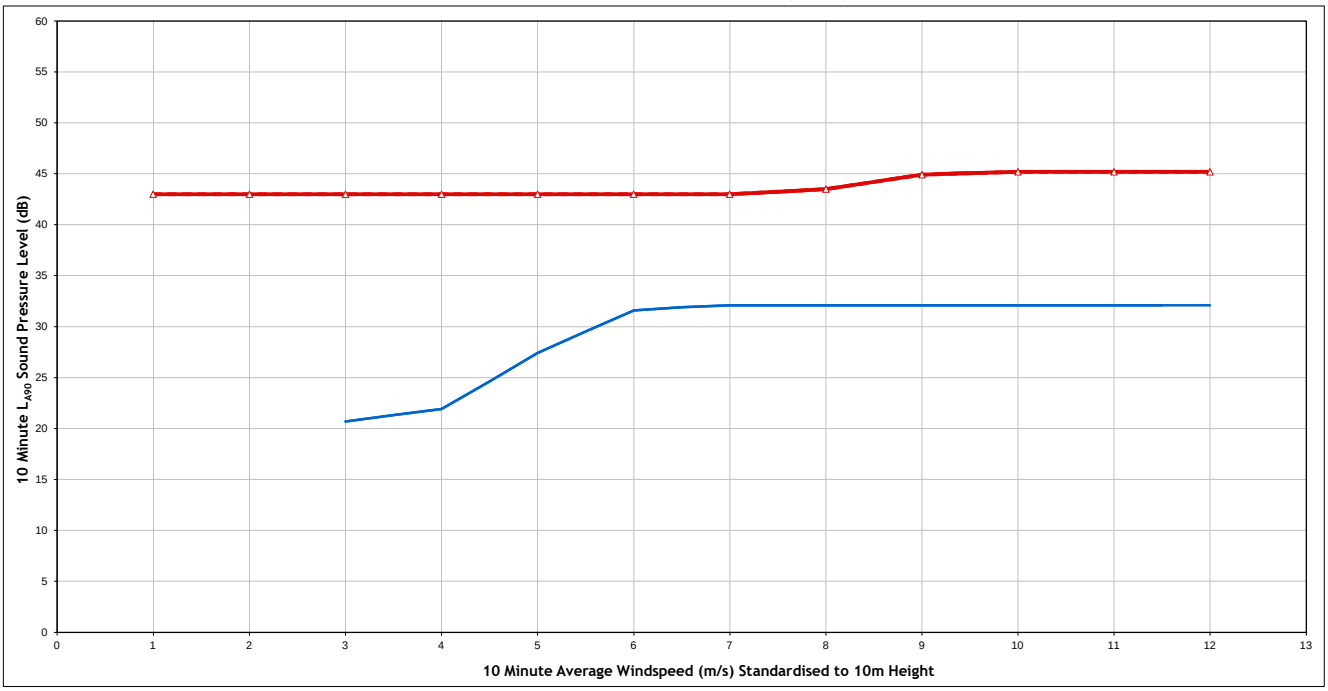
- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development (4 x Nordex N133 4.8 MW)

Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Noise Assessment against SSNL Meikle Labrax Cottages (NAL2)
Figure Number	Figure A1.4b
Scale	NTS
Drawn	AD
Checked	MC
Date	24/10/2024
Document Reference	15893-Models

Daytime - Labrax Lodge (NAL3)



Night Time - Labrax Lodge (NAL3)

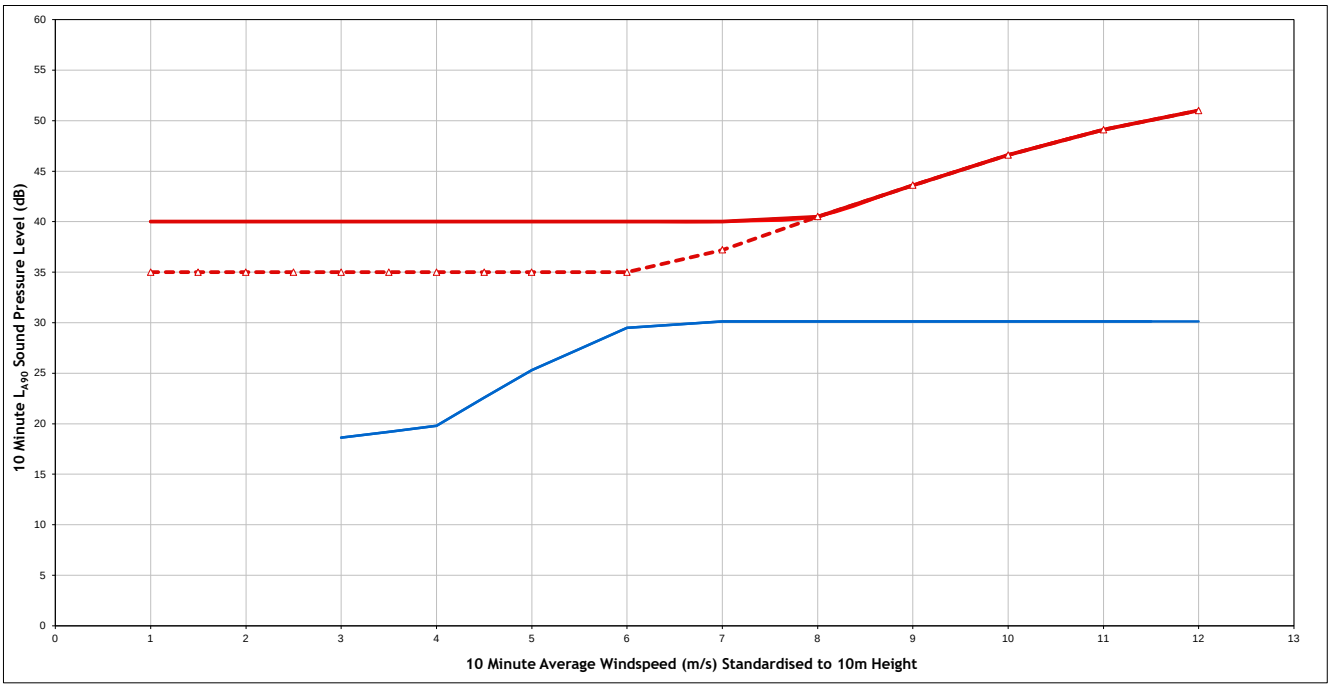


Legend:

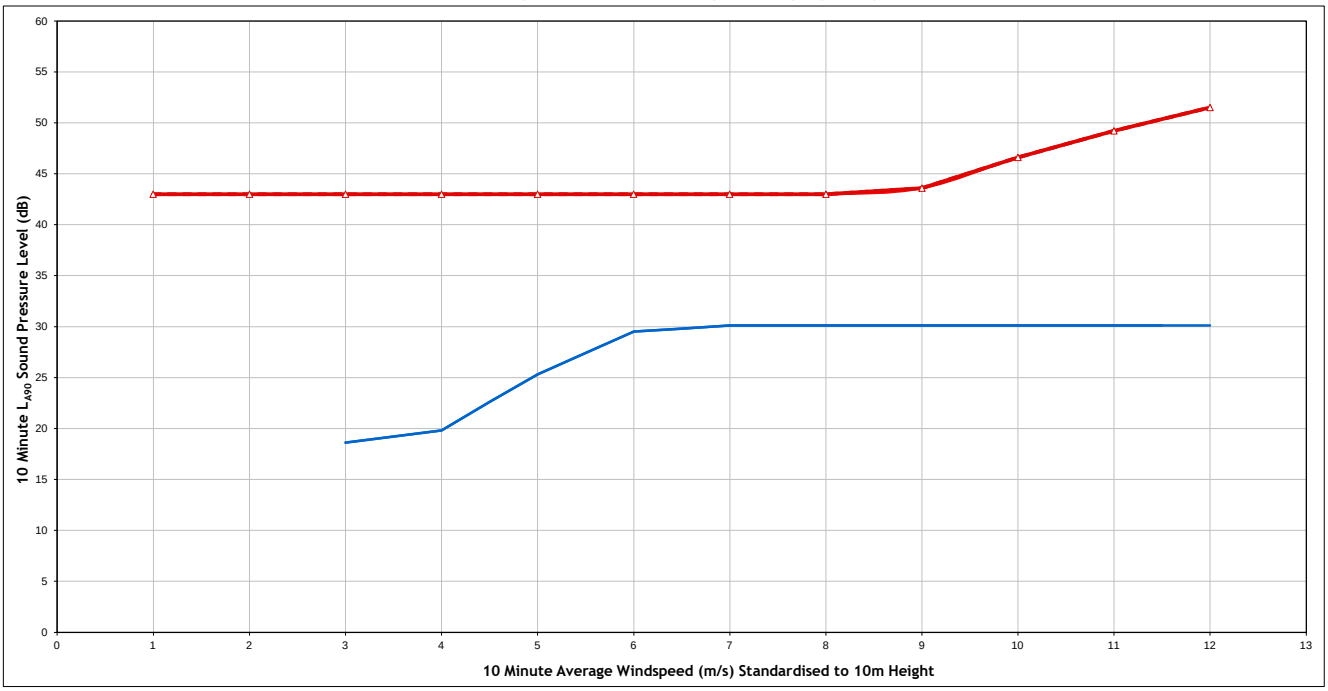
- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development (4 x Nordex N133 4.8 MW)

Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Noise Assessment against SSNL Labrax Lodge (NAL3)
Figure Number	Figure A1.4c
Scale	NTS
Drawn	AD
Checked	MC
Date	24/10/2024
Document Reference	15893-Models

Daytime - Glenvallagh Cottage (NAL4)



Night Time - Glenvallagh Cottage (NAL4)

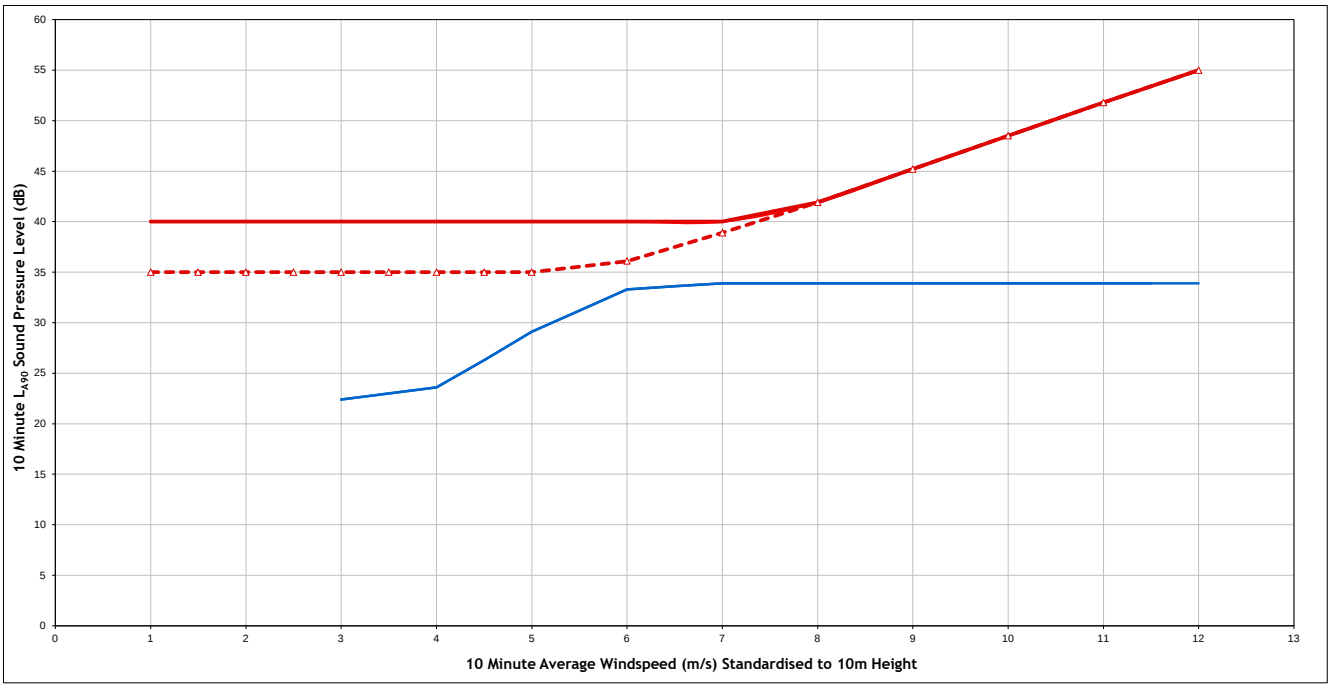


Legend:

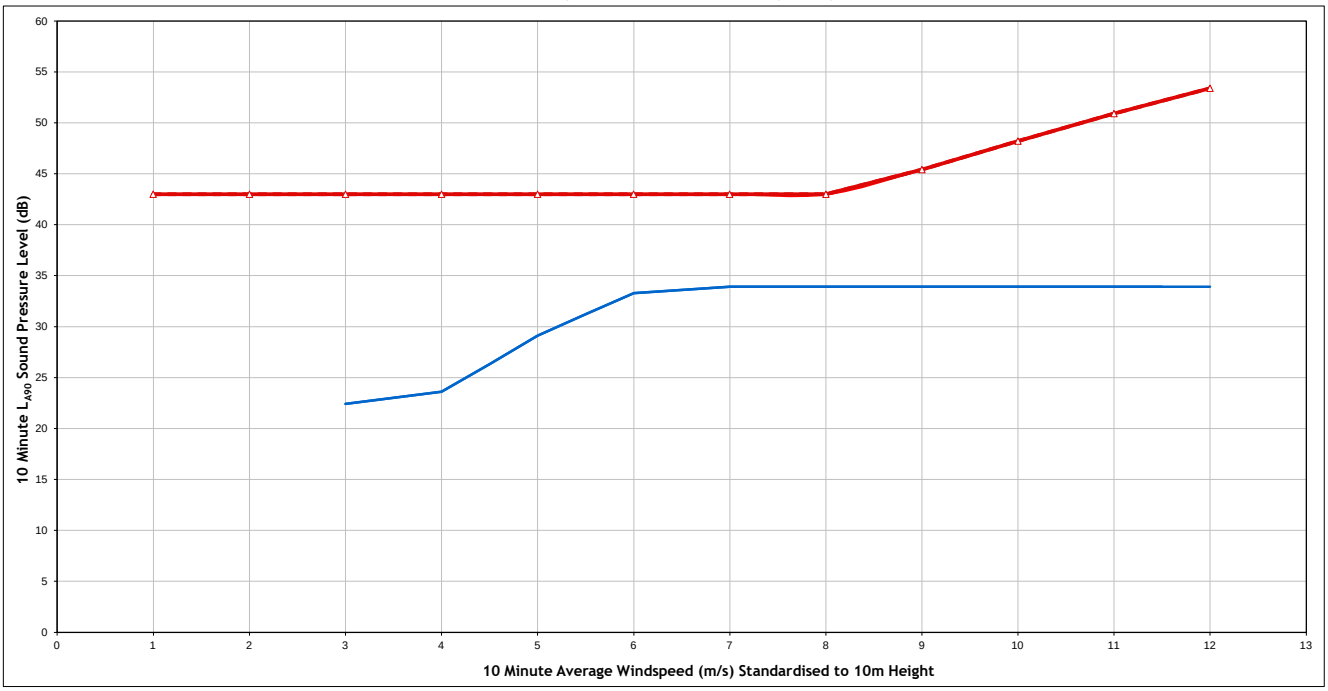
- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development (4 x Nordex N133 4.8 MW)

Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Noise Assessment against SSNL Glenvallagh Cottage (NAL4)
Figure Number	Figure A1.4d
Scale	NTS
Drawn	AD
Checked	MC
Date	24/10/2024
Document Reference	15893-Models

Daytime - Greenburn (NAL5)



Night Time - Greenburn (NAL5)

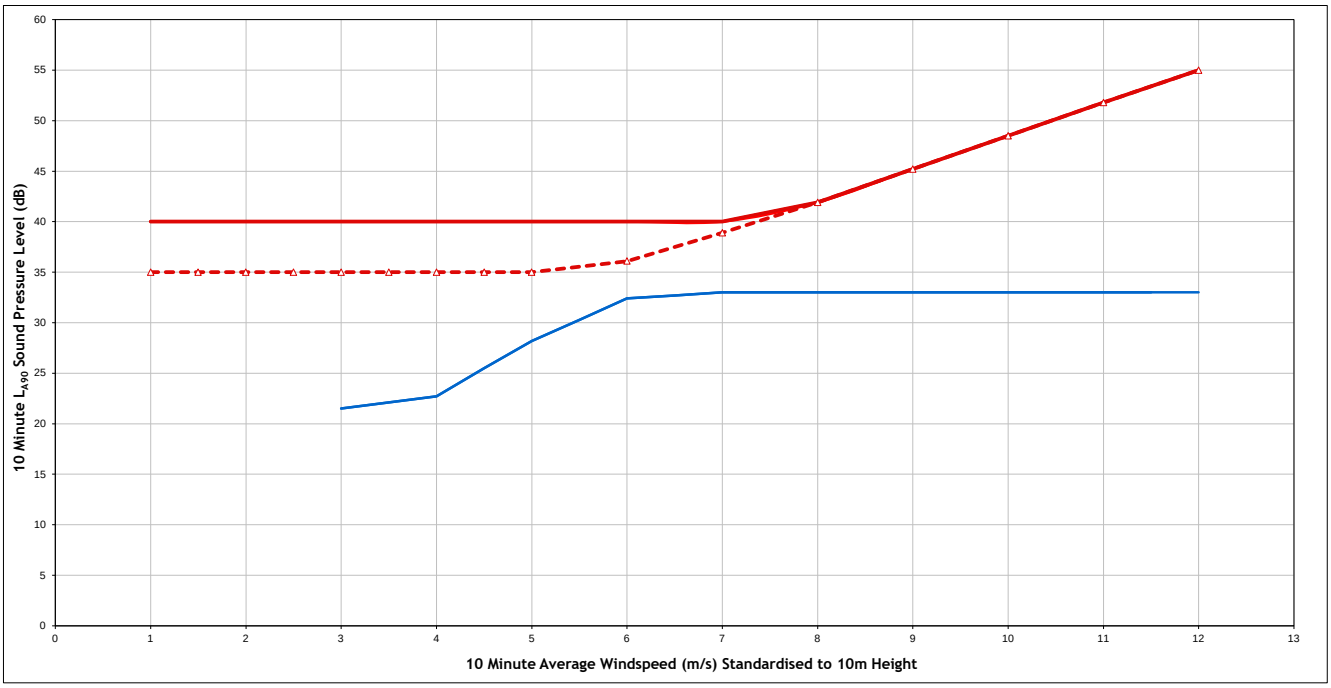


Legend:

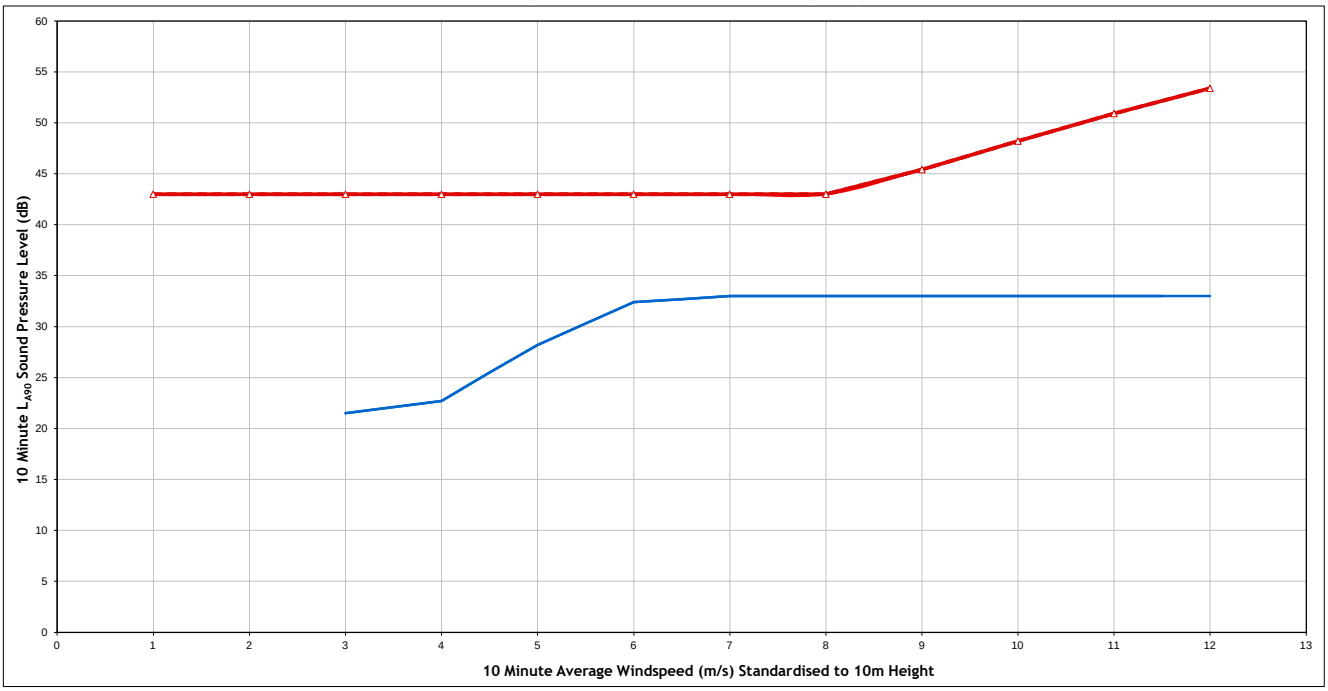
- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development (4 x Nordex N133 4.8 MW)

Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Noise Assessment against SSNL Greenburn (NAL5)
Figure Number	Figure A1.4e
Scale	NTS
Drawn	AD
Checked	MC
Date	24/10/2024
Document Reference	15893-Models

Daytime - Meikle Galdenoch (NAL6)



Night Time - Meikle Galdenoch (NAL6)

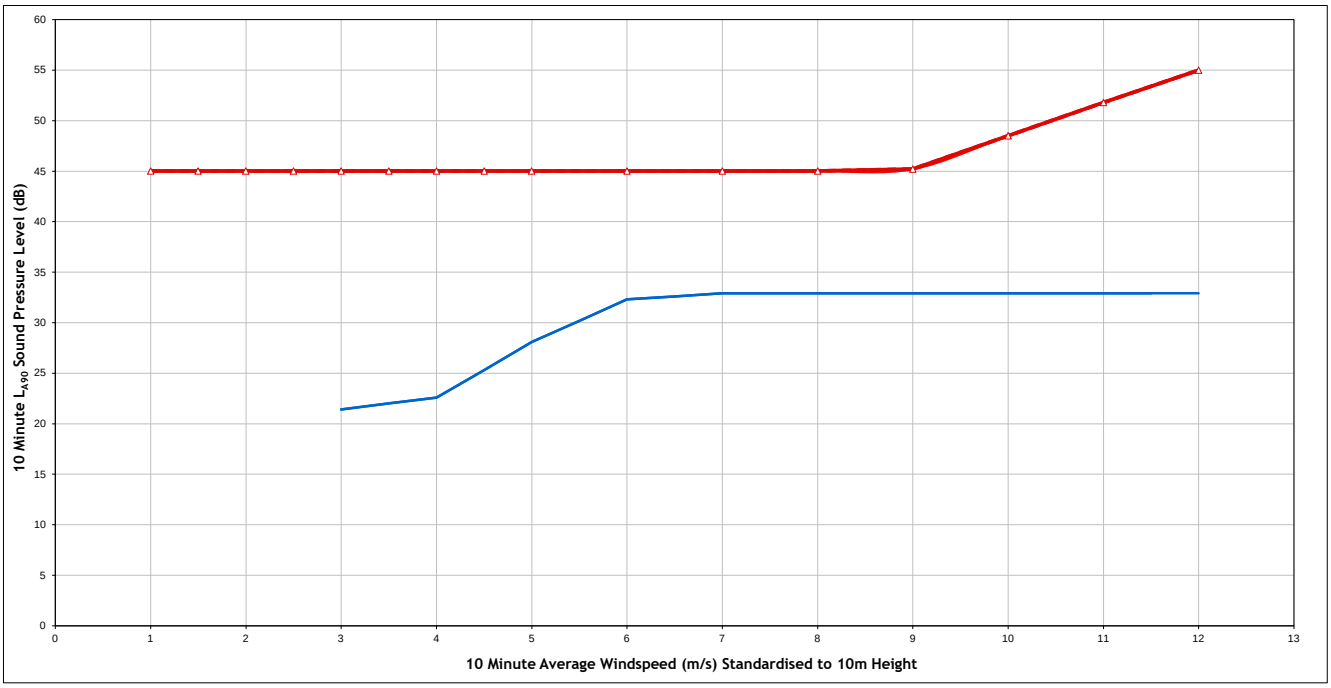


Legend:

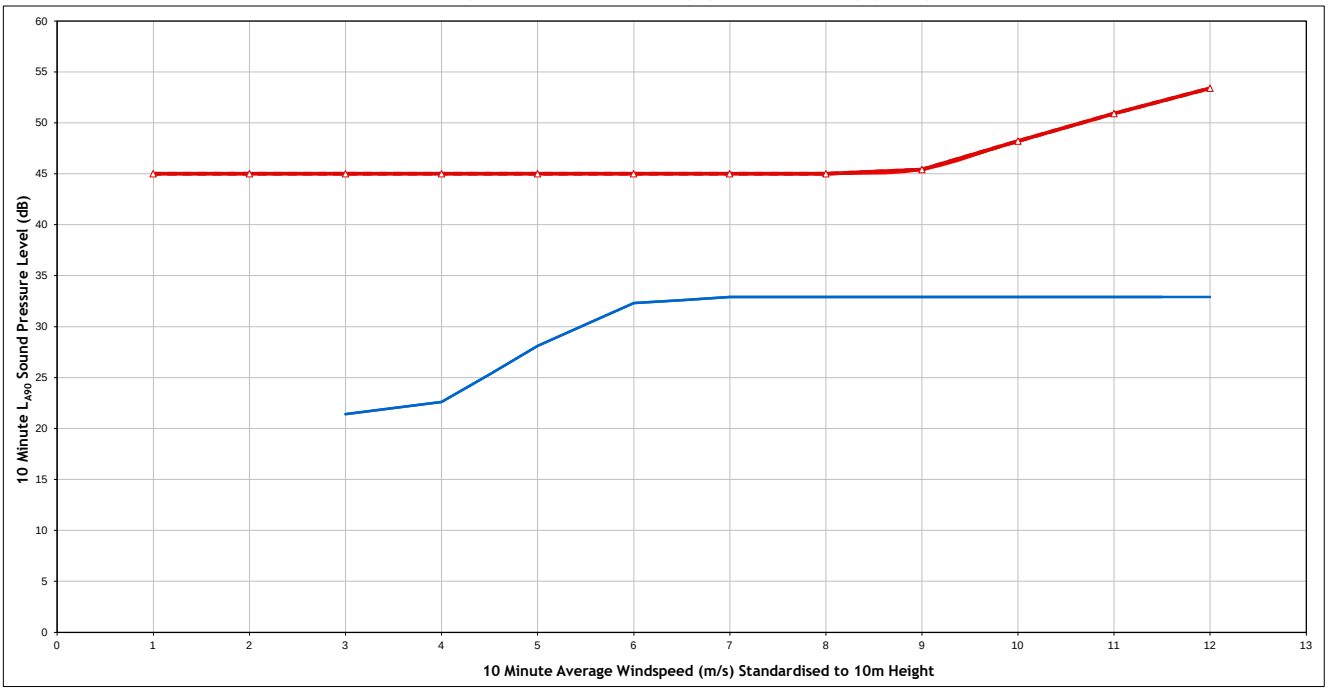
- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development (4 x Nordex N133 4.8 MW)

Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Noise Assessment against SSNL Meikle Galdenoch (NAL6)
Figure Number	Figure A1.4f
Scale	NTS
Drawn	AD
Checked	MC
Date	24/10/2024
Document Reference	15893-Models

Daytime - Drumwhistley (FI with Larbrax) (NAL7)



Night Time - Drumwhistley (FI with Larbrax) (NAL7)

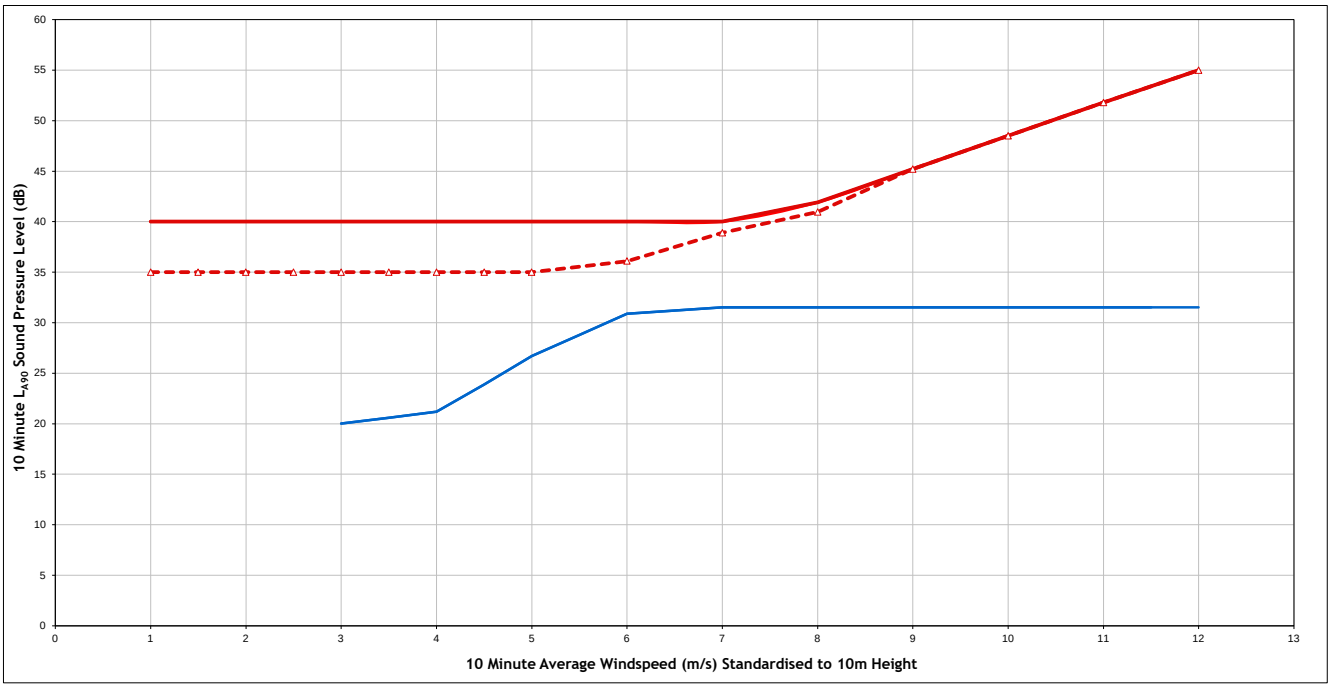


Legend:

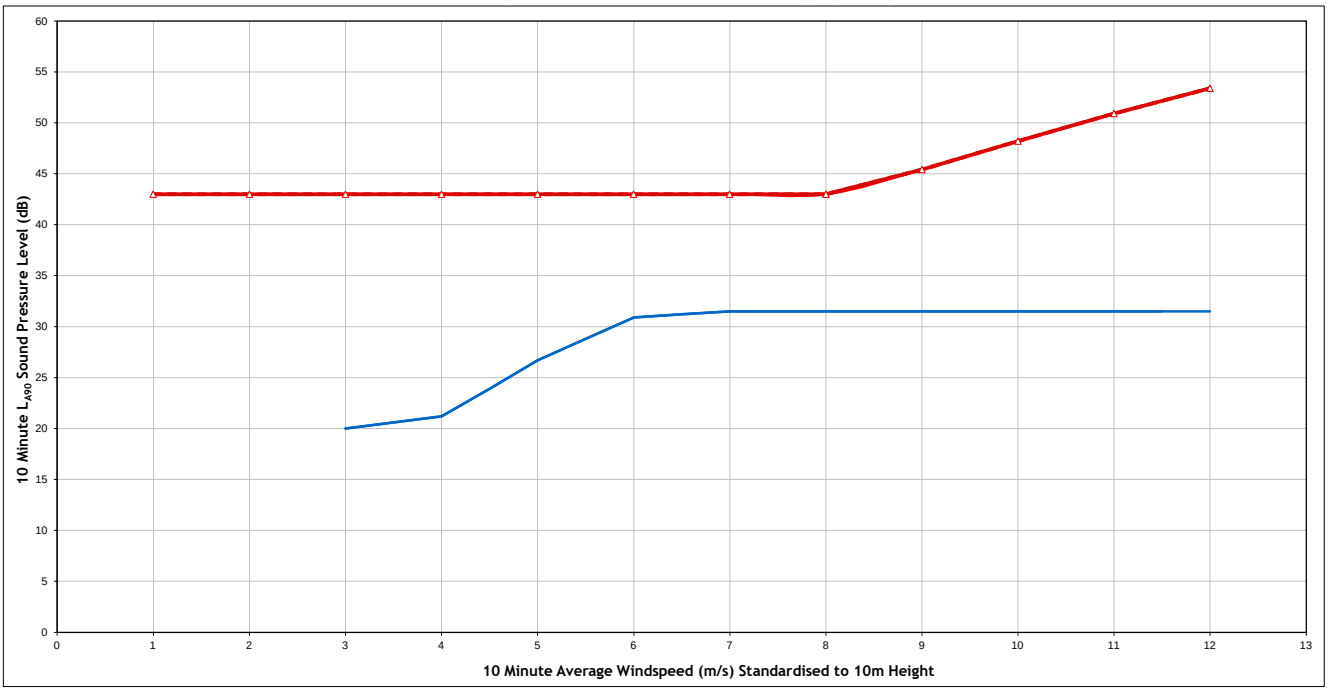
- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development (4 x Nordex N133 4.8 MW)

Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Noise Assessment against SSNL Drumwhistley (FI with Larbrax) (NAL7)
Figure Number	Figure A1.4g
Scale	NTS
Drawn	AD
Checked	MC
Date	24/10/2024
Document Reference	15893-Models

Daytime - Galdenoch Mill Cottage (NAL8)



Night Time - Galdenoch Mill Cottage (NAL8)

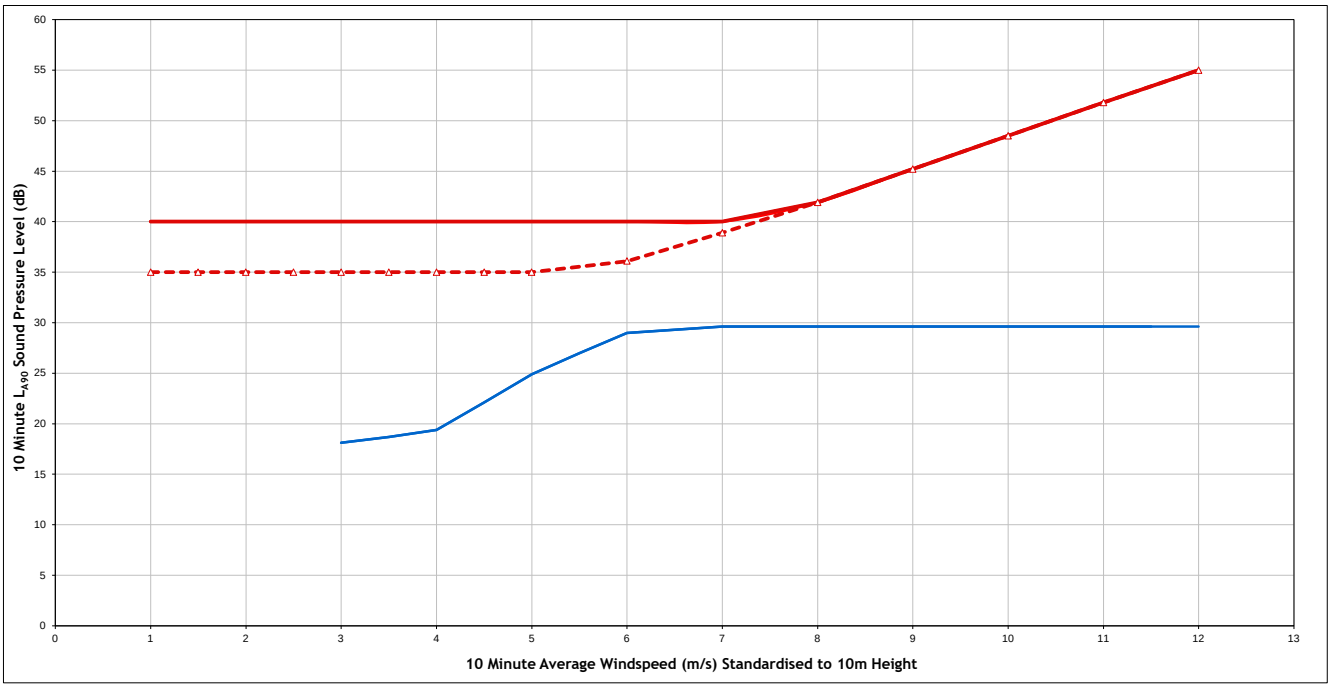


Legend:

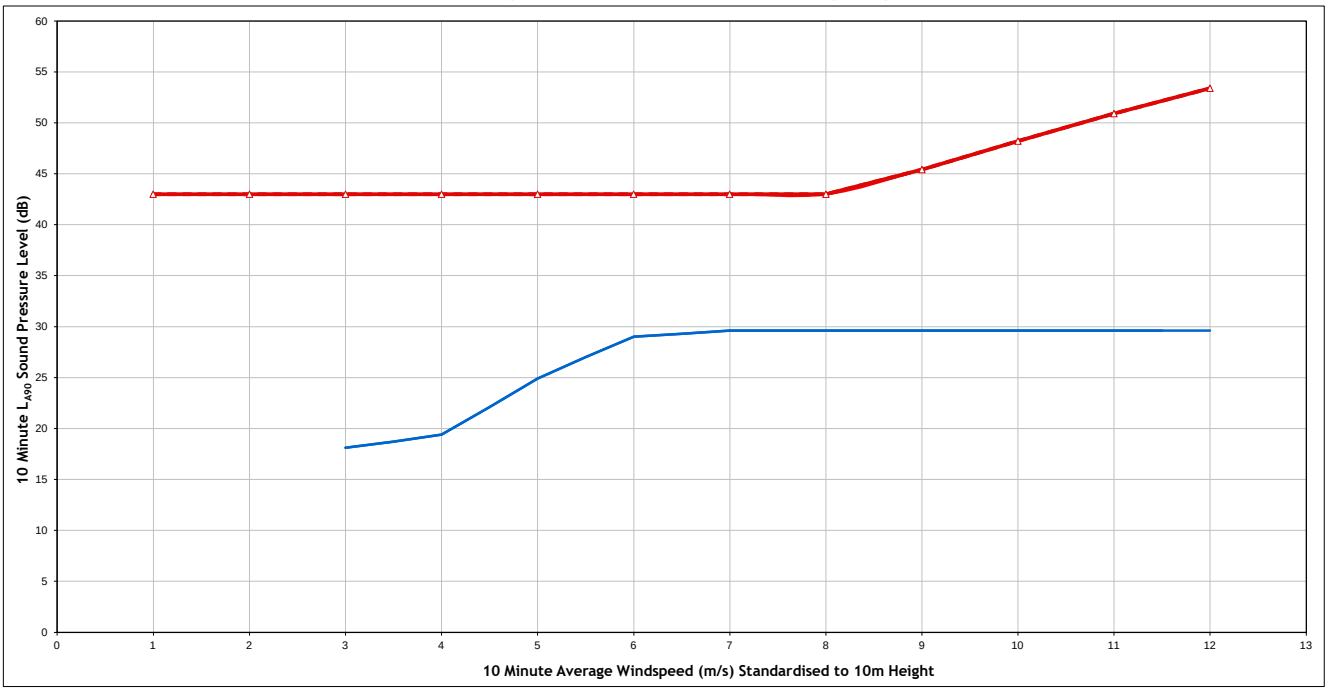
- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development (4 x Nordex N133 4.8 MW)

Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Noise Assessment against SSNL Galdenoch Mill Cottage (NAL8)
Figure Number	Figure A1.4h
Scale	NTS
Drawn	AD
Checked	MC
Date	24/10/2024
Document Reference	15893-Models

Daytime - Little Galdenoch Farm (NAL9)



Night Time - Little Galdenoch Farm (NAL9)

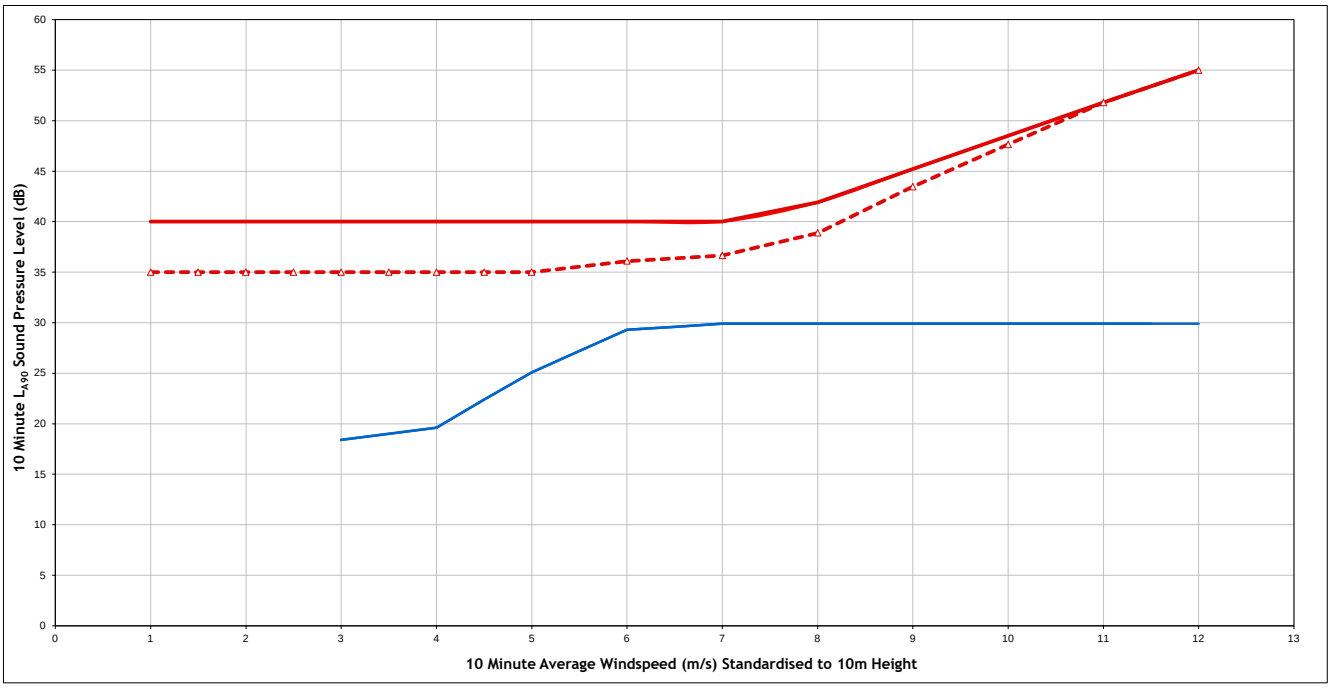


Legend:

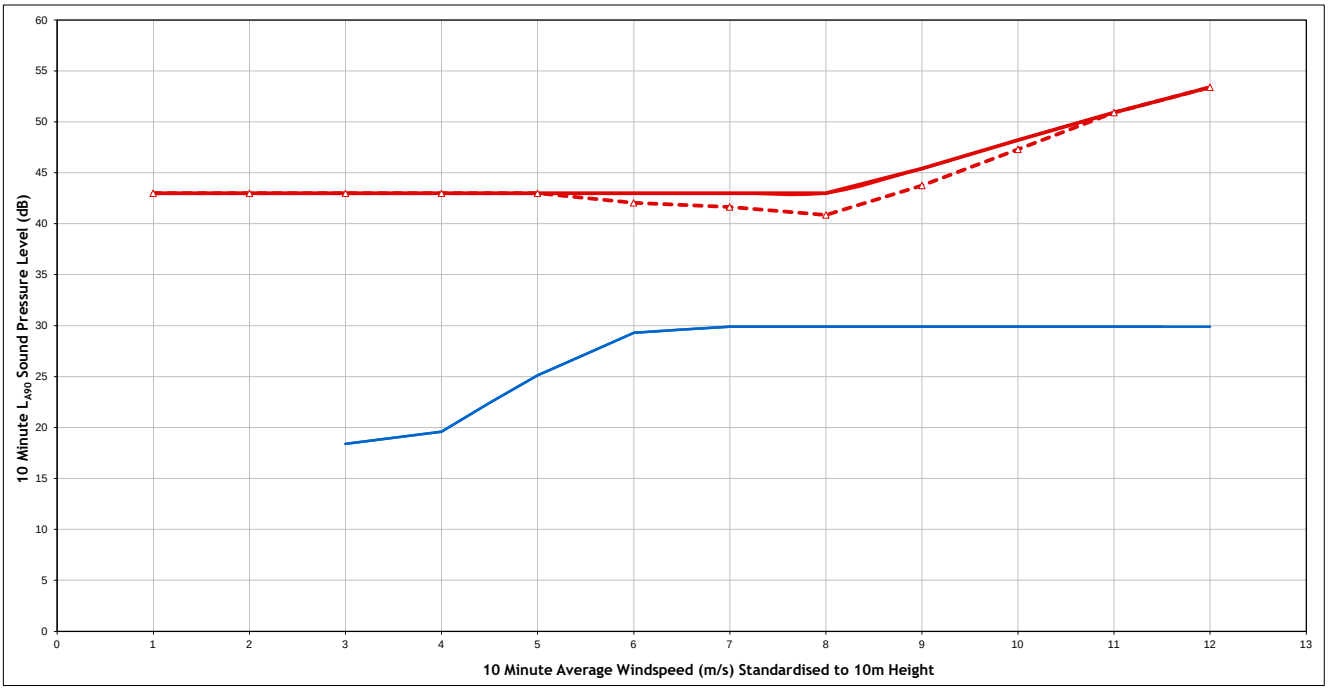
- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development (4 x Nordex N133 4.8 MW)

Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Noise Assessment against SSNL Little Galdenoch Farm (NAL9)
Figure Number	Figure A1.4i
Scale	NTS
Drawn	AD
Checked	MC
Date	24/10/2024
Document Reference	15893-Models

Daytime - Knocknain Cottages (NAL10)



Night Time - Knocknain Cottages (NAL10)

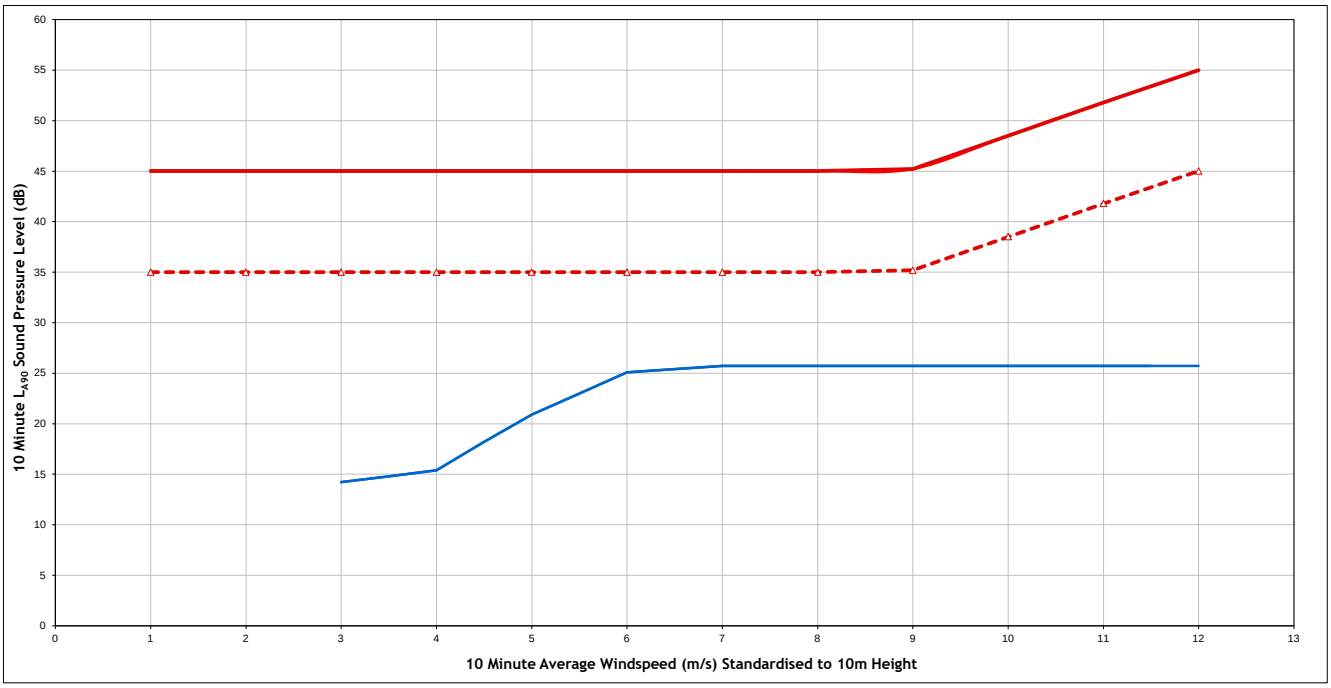


Legend:

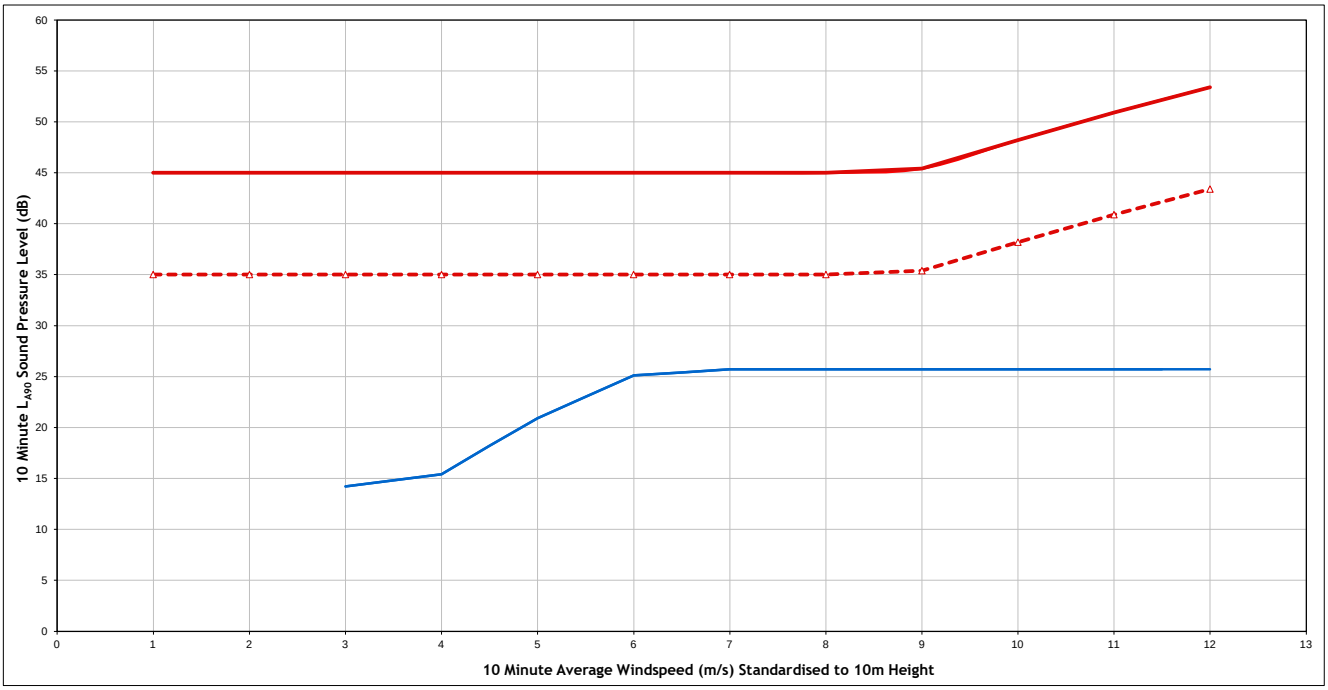
- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development (4 x Nordex N133 4.8 MW)

Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Noise Assessment against SSNL Knocknain Cottages (NAL10)
Figure Number	Figure A1.4j
Scale	NTS
Drawn	AD
Checked	MC
Date	24/10/2024
Document Reference	15893-Models

Daytime - The Potting Shed (Fl with Knocknain) (NAL11)



Night Time - The Potting Shed (Fl with Knocknain) (NAL11)

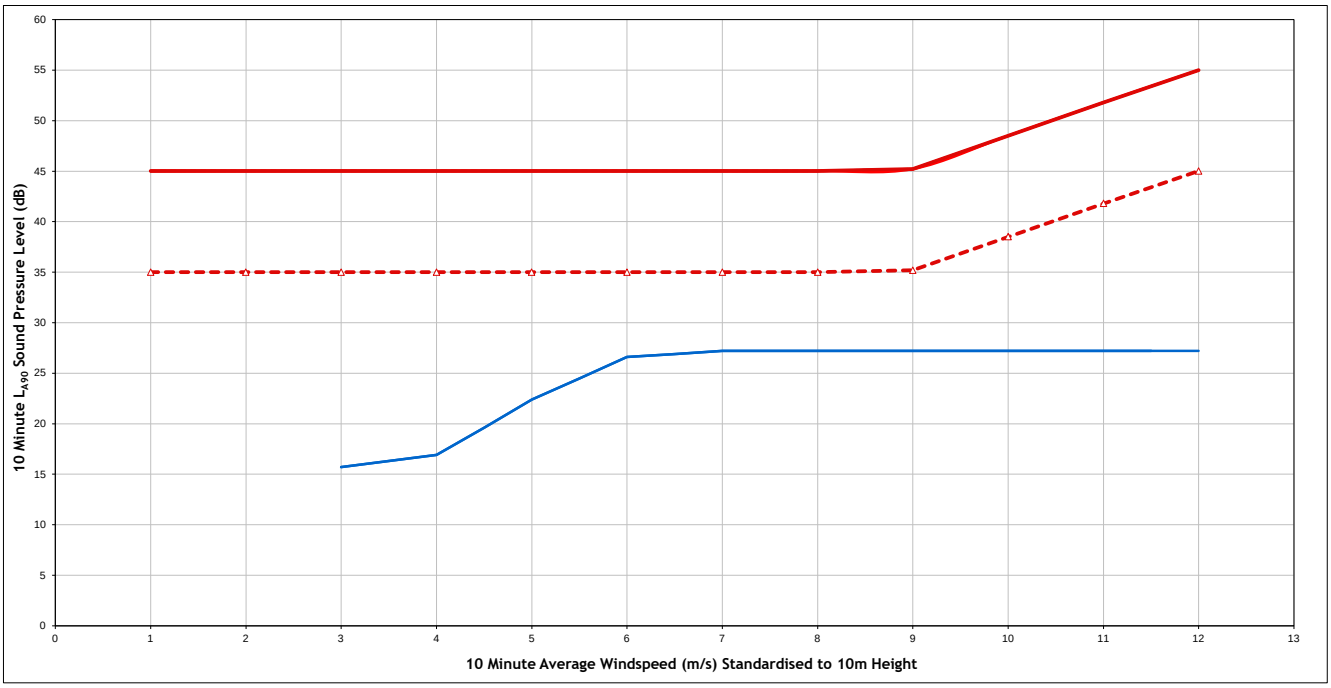


Legend:

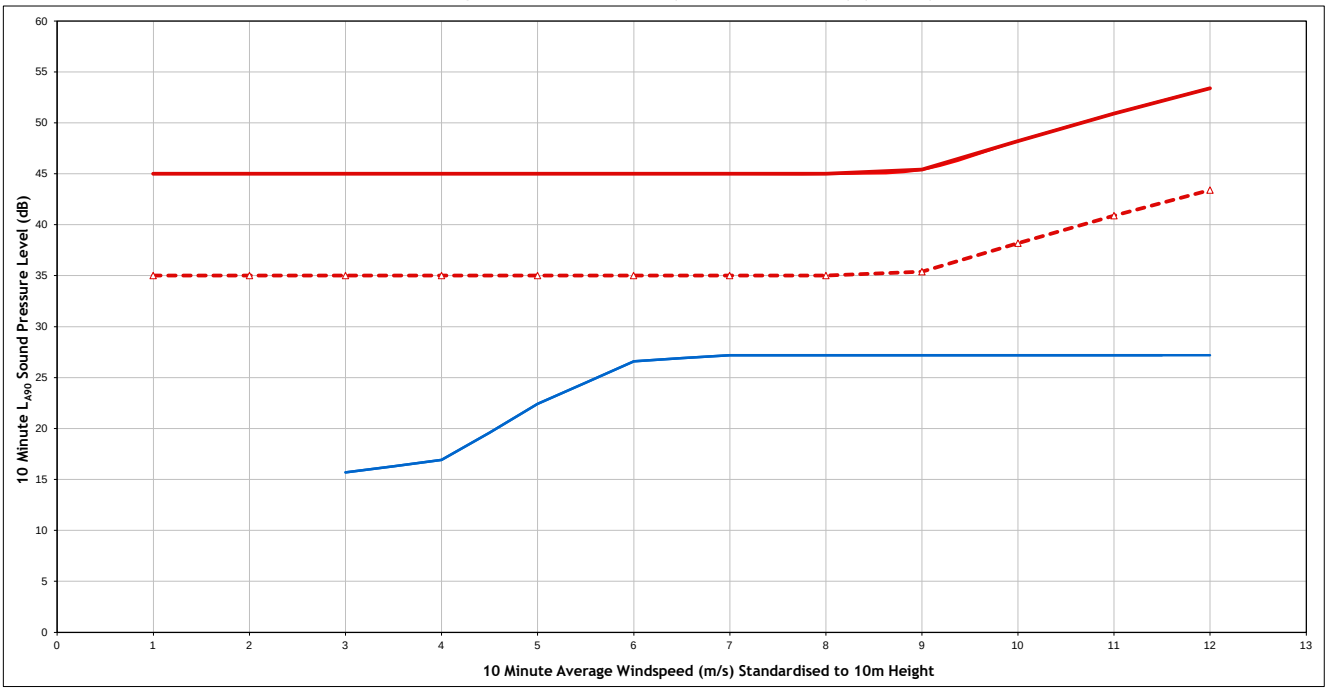
- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development (4 x Nordex N133 4.8 MW)

Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Noise Assessment against SSNL The Potting Shed (Fl with Knocknain) (NAL11)
Figure Number	Figure A1.4k
Scale	NTS
Drawn	AD
Checked	MC
Date	24/10/2024
Document Reference	15893-Models

Daytime - Knocknain (FI with Knocknain) (NAL12)



Night Time - Knocknain (FI with Knocknain) (NAL12)



Legend:

- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development (4 x Nordex N133 4.8 MW)

Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Noise Assessment against SSNL Knocknain (FI with Knocknain) (NAL12)
Figure Number	Figure A1.4l
Scale	NTS
Drawn	AD
Checked	MC
Date	24/10/2024
Document Reference	15893-Models

Annex 2 – Noise Survey Field Data Sheets

Noise Monitoring Field Data Sheet

MONITORING LOCATION

Location Name	NML 01 – Greenburn Cottage
Description	Representative of receptors to the North of the proposed development
Comments	Measurements were undertaken by TNEI to establish the baseline noise levels for a wind farm noise assessment. The noise meter was located in a free field position, greater than 3.5 m from any hard reflecting surface excluding the ground.
Approximate National Grid Reference	197351, 563069
Survey Period	09/11/2021 – 12/01/2022
Noise sources noted during installation, maintenance and removal	The predominant sounds heard during site visits were Sea noise and vegetation noise as well as noise from the nearby small 15kW wind turbines. Other noise heard included birdsong, occasional cow noise.

NOISE MONITORING EQUIPMENT DETAILS

Survey	Kit Number	Model	Serial Number	Last Calibrated/ Conformance Checked
Sound Level Meter	SLM 023	Rion NL-32	00703297	17/09/2020
Pre Amplifier	SLM 023	Rion NH-21	33388	17/09/2020
Microphone	SLM 023	Rion UC-53A	317049	17/09/2020
Calibrator	Cal02	Rion NC-74	34973250	15/01/2021
Calibrator	Cal08	Rion NC-75	35002724	04/02/2021

DATA

File Name	Start Time	End Time	Cal. at Start	Cal. at End	Drift	Observations
0101	14:10 GMT 09/11/2021	12:11 GMT 10/12/2021	94.0	94.0	0.0	9/11/2021: The nearby small 15kW wind turbines at Meikle Galdenoch were audible. Birdsong and nearby cows were also noticeable. The general background noise levels were elevated at this location due to Sea noise from the nearby coastline. The stream which ran adjacent to the property was not audible at the time of installation. The weather was calm, with no rain and 2 Oktas of cloud coverage. It was approximately 12 degrees Celsius.
0102	12:20 GMT 10/12/2021	12:20 GMT 12/01/2022	94.0	93.9	0.1	10/12/2021: The nearby small 15kW wind turbines at Meikle Galdenoch were faintly audible. The Sea noise was noticeable. The nearby cows and vegetation noise in the wind was also noticeable. The nearby stream was not audible. 12/01/2022: The nearby small 15kW wind turbines at Meikle Galdenoch were faintly audible and the nearby stream was not audible.

PHOTOGRAPHS

North 	**South** 
East 	**West** 

Noise Monitoring Field Data Sheet

MONITORING LOCATION

Location Name	NML 02 – Larbrax Lodge
Description	Representative of receptors to the East of the proposed development
Comments	Measurements were undertaken by TNEI to establish the baseline noise levels for a wind farm noise assessment. The noise meter was located in a free field position, greater than 3.5 m from any hard reflecting surface except the ground.
Approximate National Grid Reference	198219, 561600
Survey Period	09/11/2021 – 12/01/2022
Noise sources noted during installation, maintenance and removal	A generator was in operation for large portions of the survey, hence a large proportion of data was judged not representative and removed. Other noise heard during site visits included sea noise, vegetation noise in the wind, dogs barking and birdsong.

NOISE MONITORING EQUIPMENT DETAILS

Survey	Kit Number	Model	Serial Number	Last Calibrated/ Conformance Checked
Sound Level Meter	SLM 045 SLM 026	Rion NL-52 Rion NL-32	00386758 00703295	10/09/2020 21/06/2021
Pre Amplifier	SLM 045 SLM 026	Rion NH-25 Rion NH-21	76908 33386	10/09/2020 21/06/2021
Microphone	SLM 045 SLM 026	Rion UC-59 Rion UC53A	12755 317047	10/09/2020 21/06/2021
Calibrator	Cal02	Rion NC-74	34973250	15/01/2021
Calibrator	Cal08	Rion NC-75	35002724	04/02/2021

DATA

File Name	Start Time	End Time	Cal. at Start	Cal. at End	Drift	Observations
0201	14:50 GMT 09/11/2021	12:39 GMT 22/11/2021	94.0	93.7	0.3	09/11/2021: Wind in trees and the sounds of waves crashing along the coastline (sea noise) could be heard. Other noise heard included dogs barking, birdsong.
0202	12:20 GMT 22/12/2021	12:20 GMT 10/12/2021	94.0	93.9	0.1	22/12/2021: SLM 045 was swapped out to SLM 026 during this visit. Faint sounds of water trickling in the nearby pond, dogs barking, vegetation rustle and birdsong were heard.
0203	10:50 GMT 10/12/2021	11:20 GMT 12/02/2022	94.0	93.9	0.1	10/12/2021: During this visit it was noted that there was a generator running outside the property, this was prominently audible. Wind in the vegetation and dogs barking could also be heard. 12/02/2022: The generator was not operating during this visit. The faint sounds of running water and vegetation rustle could also be heard.

PHOTOGRAPHS

North 	**South** 
East 	**West** 

Noise Monitoring Field Data Sheet

MONITORING LOCATION

Location Name	NML 03 – Meikle Larbrax Cottages
Description	Representative of receptors to the Southeast of the proposed development
Comments	Measurements were undertaken by TNEI to establish the baseline noise levels for a wind farm noise assessment. The noise meter was located in a free field position, greater than 3.5 m from any hard reflecting surface excluding the ground.
Approximate National Grid Reference	197866, 560928
Survey Period	09/11/2021 – 12/01/2022
Noise sources noted during installation, maintenance and removal	The predominant sounds heard during site visits were Sea noise and vegetation noise as well as noise from the nearby small 15kW wind turbines. Other noise heard included birdsong and the stream running through the garden.

NOISE MONITORING EQUIPMENT DETAILS

Survey	Kit Number	Model	Serial Number	Last Calibrated/ Conformance Checked
Sound Level Meter	SLM 022	Rion NL-32	00703291	17/09/2020
Pre Amplifier	SLM 022	Rion NH-21	33382	17/09/2020
Microphone	SLM 022	Rion UC-53A	317043	17/09/2020
Calibrator	Cal02	Rion NC-74	34973250	15/01/2021
Calibrator	Cal08	Rion NC-75	35002724	04/02/2021

NOISE MONITORING EQUIPMENT SETTINGS

	Network (A,B,Z)	Index and Time	Time Weighting (Slow, Fast)	Range (dB)	Audio
Parameters Recorded	A	$L_{A9010min}$, $L_{Aeq10min}$	Fast	20-110	No

DATA

File Name	Start Time	End Time	Cal. at Start	Cal. at End	Drift	Observations
0301	15:50 GMT 09/11/2021	11:22 GMT 10/12/2021	94.0	93.9	0.1	09/11/2021: It was noted that a stream ran though the garden so the kit was sited as far away from the stream as practicable where it was only faintly audible. The two small 15kW wind turbines located at Meikle Larbrax were audible and so was Sea noise and vegetation noise and birdsongs.
0302	11:40 GMT 10/12/2021	11:40 GMT 12/01/2022	94.0	93.9	0.1	10/12/2021: During this visit the stream was faintly audible, along with the rustle of foliage and roosters crowing. The nearby small turbines were not audible. 12/01/2022:

						During this visit the nearby small turbines were clearly audible. Birdsong, sea noise and vegetation rustle could also be heard

PHOTOGRAPHS

North 	**South** 
East 	**West** 

Noise Monitoring Field Data Sheet

MONITORING LOCATION

Location Name	NML 04 – Cairnhapple House
Description	Representative of receptors to the North-East of the proposed development
Comments	Measurements were undertaken by TNEI to establish the baseline noise levels for a wind farm noise assessment. The noise meter was located in a free field position, greater than 3.5 m from any hard reflecting surface excluding the ground.
Approximate National Grid Reference	198237, 562791
Survey Period	09/11/2021 – 12/01/2022
Noise sources noted during installation, Maintenance and removal	The predominant sounds heard during site visits included the occasional passing of cars, residential activity, birdsong and vegetation rustle in the wind.

NOISE MONITORING EQUIPMENT DETAILS

Survey	Kit Number	Model	Serial Number	Last Calibrated/ Conformance Checked
Sound Level Meter	SLM 046	Rion NL-52	00386759	10/09/2020
Pre Amplifier	SLM 046	Rion NH-25	76909	10/09/2020
Microphone	SLM 046	Rion UC-59	12756	10/09/2020
Calibrator	Cal02	Rion NC-74	34973250	15/01/2021
Calibrator	Cal08	Rion NC-75	35002724	04/02/2021

NOISE MONITORING EQUIPMENT SETTINGS

	Network (A,B,Z)	Index and Time	Time Weighting (Slow, Fast)	Range (dB)	Audio
Parameters Recorded	A	$L_{A9010min}$, $L_{Aeq10min}$	Fast	20-110	No

DATA

File Name	Start Time	End Time	Cal. at Start	Cal. at End	Drift	Observations
0401	12:50 GMT 09/11/2021	10:02 GMT 10/12/2021	94.0	94.2	0.2	09/11/2021: Birdsong, vegetation rustle, distant road noise and occasional gunshot in the distance were audible. The weather was calm and sunny, with 2 Oktas of cloud coverage at a temperature of 12 degrees Celsius.
0402	10:20 GMT 10/12/2021	11:50 GMT 12/01/2022	94.0	94.0	0.0	10/12/2021: The sounds of birdsong, vegetation rustle, distant road noise were audible. 12/01/2022: During this visit, the sounds of birdsong and vegetation rustle were audible.

PHOTOGRAPHS

North 	**South** 
East 	**West** 

Annex 3 – Calibration Certificates

TNEI Calibrator 2

CERTIFICATE OF CALIBRATION

0653

Date of Issue: 15 January 2021

Certificate Number: UCRT21/1081

Calibrated at & Certificate issued by:
ANV Measurement Systems
Beaufort Court
17 Roebuck Way
Milton Keynes MK5 8HL
Telephone 01908 642846 Fax 01908 642814
E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Approved Signatory [redacted]

K. Mistry

Customer	TNEI Services Ltd 7th Floor West One Forth Banks Newcastle Upon Tyne NE1 3PA
Order No.	5001
Test Procedure	Procedure TP 1 Calibration of Sound Calibrators
Description	Acoustic Calibrator

Identification	*Manufacturer*	*Instrument*	*Model*	*Serial No.*
	Rion	Calibrator	NC-74	34973250

The calibrator has been tested as specified in Annex B of IEC 60942:2003. As public evidence was available from a testing organisation (PTB) responsible for approving the results of pattern evaluation tests, to demonstrate that the model of sound calibrator fully conformed to the requirements for pattern evaluation described in Annex A of IEC 60942:2003, the sound calibrator tested is considered to conform to all the class 1 requirements of IEC 60942:2003.

ANV Job No.	UKAS21/01038	
Date Received	14 January 2021	
Date Calibrated	15 January 2021	
Previous Certificate	*Dated*	09 March 2020
	Certificate No.	UCRT20/1289
	Laboratory	0653

TNEI Calibrator 8

MEASUREMENT SYSTEMS

CERTIFICATE OF CALIBRATION

0653

Date of Issue: 04 February 2021

Certificate Number: UCRT21/1160

Calibrated at & Certificate issued by:
ANV Measurement Systems
Beaufort Court
17 Roebuck Way
Milton Keynes MK5 8HL
Telephone 01908 642846 Fax 01908 642814
E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Approved Signatory [redacted]

K. Mistry

Customer	TNEI 7th Floor West One Forth Banks Newcastle Upon Tyne NE1 3PA
Order No.	1674
Test Procedure	Procedure TP 1 Calibration of Sound Calibrators
Description	Acoustic Calibrator

Identification	*Manufacturer*	*Instrument*	*Model*	*Serial No.*
	Rion	Calibrator	NC-75	35002724

The calibrator has been tested as specified in Annex B of IEC 60942:2003. As public evidence was available from a testing organisation (PTB) responsible for approving the results of pattern evaluation tests, to demonstrate that the model of sound calibrator fully conformed to the requirements for pattern evaluation described in Annex A of IEC 60942:2003, the sound calibrator tested is considered to conform to all the class 1 requirements of IEC 60942:2003.

ANV Job No.	UKAS21/02081
Date Received	03 February 2021
Date Calibrated	04 February 2021
Previous Certificate	*Dated* Initial Calibration *Certificate No.* *Laboratory*

NSAI

National Metrology Laboratory

Certificate of Calibration

Issued to	TNEI Group Floor 7 West One Forth Banks Newcastle Upon Tyne England
Attention of	Ewan Watson

Certificate Number	**212418**
Item Calibrated	Rion NL-32 Sound Level Meter, complete with Rion UC53A Microphone
Serial Numbers	00703295 (Sound Level Meter) and 317047 (Microphone)
ID Number	SLM026
Order Number	1691
Date Received	21 Jun 2021
NML Procedure Number	AP-NM-09
Method	The above sound level meter was allowed to stabilise for a suitable period in laboratory conditions. It was then calibrated by carrying out the verification tests detailed in IEC 61672-3 (2006), *Periodic tests, specification for the verification of sound level meters*. This standard specifies a procedure for the periodic verification of conformance of a sound level meter or integrating-averaging meter to IEC 61672-1 (2003).
Calibration Standards	Norsonic 1504A Calibration System incorporating: SR DS360 Signal Generator, No. 0735 [Cal Due Date: 10 Jun 2022] Agilent 34401A Digital Multimeter, No. 0736 [Cal Due Date: 10 Jun 2022] B&K 4134 Measuring Microphone, No. 0743 [Cal Due Date: 27 May 2022] B&K 4228 Pistonphone, No. 0741 [Cal Due Date: 26 May 2022] B&K 4226 Acoustical Calibrator, No. 0150 [Cal Due Date: 02 Sep 2021]

Calibrated by	[redacted] David Fleming	**Approved by**	[redacted] Paul Hetherington
Date of Calibration	23 Jun 2021	**Date of Issue**	23 Jun 2021

CIPM MRA

This certificate is consistent with Calibration and Measurement Capabilities (CMC's) that are included in Appendix C of the Mutual Recognition Arrangement (MRA) drawn up by the International Committee for Weights and Measures. Under the MRA, all participating institutes recognize the validity of each other's calibration certificates and measurement reports for quantities, ranges and measurement uncertainties specified in Appendix C (for details see www.bipm.org)

TNEI SLM 23

CERTIFICATE OF CALIBRATION

Date of Issue: 17 September 2020 **Certificate Number: TCRT20/1545**

Issued by:
ANV Measurement Systems
Beaufort Court
17 Roebuck Way
Milton Keynes MK5 8HL
Telephone 01908 642846 Fax 01908 642814
E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Approved Signatory

[redacted]

K. Mistry

Customer	TNEI Services Ltd 7th Floor West One Forth Banks Newcastle upon Tyne NE1 3PA
Order No.	5001
Description	Sound Level Meter / Pre-amp / Microphone / Associated Calibrator

Identification

Manufacturer	*Instrument*	*Type*	*Serial No. / Version*
Rion	Sound Level Meter	NL-32	00703297
Rion	Firmware		1.400
Rion	Pre Amplifier	NH-21	33388
Rion	Microphone	UC-53A	317049
Rion	Calibrator	NC-74	34536109
	Calibrator adaptor type if applicable		NC-74-002

Performance Class 1

Test Procedure TP 2.SLM 61672-3 TPS-49

Procedures from IEC 61672-3:2006 were used to perform the periodic test.

Type Approved to IEC 61672-1:2002 No Approval Number

If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2003

Date Received 16 September 2020 ANV Job No. TRAC20/09312

Date Calibrated 17 September 2020

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed. However, no general statement or conclusion can be made about conformance of the sound level meter to the full requirements of IEC 61672-1:2002 because evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002 and because the periodic tests of IEC 61672-3:2006 cover only a limited subset of the specifications in IEC 61672-1:2002.

Previous Certificate	*Dated*	*Certificate No.*	*Laboratory*
	12 April 2019	TCRT19/1298	ANV Measurement Systems

TNEI SLM 45

MEASUREMENT SYSTEMS

CERTIFICATE OF CALIBRATION

Date of Issue: 10 September 2020

Certificate Number: TCRT20/1518

Issued by:
ANV Measurement Systems
Beaufort Court
17 Roebuck Way
Milton Keynes MK5 8HL
Telephone 01908 642846 Fax 01908 642814
E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Approved Signatory

K. Mistry [redacted]

Customer	TNEI Services Ltd 7th Floor West One Forth Banks Newcastle upon Tyne NE1 3PA
Order No.	5001
Description	Sound Level Meter / Pre-amp / Microphone / Associated Calibrator

Identification

Manufacturer	*Instrument*	*Type*	*Serial No. / Version*
Rion	Sound Level Meter	NL-52	00386758
Rion	Firmware		2.0
Rion	Pre Amplifier	NH-25	76908
Rion	Microphone	UC-59	12755
Rion	Calibrator	NC-74	34536109
	Calibrator adaptor type if applicable		NC-74-002

Performance Class 1

Test Procedure TP 2.SLM 61672-3 TPS-49

Procedures from IEC 61672-3:2006 were used to perform the periodic tests.

Type Approved to IEC 61672-1:2002 YES Approval Number 21.21 / 13.02

If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2003

Date Received 09 September 2020 ANV Job No. TRAC20/09299

Date Calibrated 10 September 2020

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent testing organisation responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2:2003, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002, the sound level meter submitted for testing conforms to the class 1 requirements of IEC 61672-1:2002.

Previous Certificate	*Dated*	*Certificate No.*	*Laboratory*
	03 June 2019	TCRT19/1436	ANV Measurement Systems

TNEI SLM 22

CERTIFICATE OF CALIBRATION

Date of Issue: 17 September 2020 **Certificate Number: TCRT20/1547**

Issued by:
ANV Measurement Systems
Beaufort Court
17 Roebuck Way
Milton Keynes MK5 8HL
Telephone 01908 642846 Fax 01908 642814
E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Approved Signatory

[redacted]

K. Mistry

Customer	TNEI Services Ltd 7th Floor West One Forth Banks Newcastle upon Tyne NE1 3PA
Order No.	5001
Description	Sound Level Meter / Pre-amp / Microphone / Associated Calibrator

Identification

Manufacturer	*Instrument*	*Type*	*Serial No. / Version*
Rion	Sound Level Meter	NL-32	00703291
Rion	Firmware		1.400
Rion	Pre Amplifier	NH-21	33382
Rion	Microphone	UC-53A	317043
Rion	Calibrator	NC-74	34536109
	Calibrator adaptor type if applicable		NC-74-002

Performance Class 1

Test Procedure TP 2.SLM 61672-3 TPS-49

Procedures from IEC 61672-3:2006 were used to perform the periodic test.

Type Approved to IEC 61672-1:2002 No Approval Number

If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2003

Date Received 16 September 2020 ANV Job No. TRAC20/09312

Date Calibrated 17 September 2020

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed. However, no general statement or conclusion can be made about conformance of the sound level meter to the full requirements of IEC 61672-1:2002 because evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002 and because the periodic tests of IEC 61672-3:2006 cover only a limited subset of the specifications in IEC 61672-1:2002.

Previous Certificate	*Dated*	*Certificate No.*	*Laboratory*
	15 April 2019	TCRT19/1307	ANV Measurement Systems

TNEI SLM 46

CERTIFICATE OF CALIBRATION

Date of Issue: 10 September 2020 **Certificate Number: TCRT20/1516**

Issued by:
ANV Measurement Systems
Beaufort Court
17 Roebuck Way
Milton Keynes MK5 8HL
Telephone 01908 642846 Fax 01908 642814
E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Approved Signatory [redacted]

K. Mistry

Customer	TNEI Services Ltd 7th Floor West One Forth Banks Newcastle upon Tyne NE1 3PA
Order No.	5001
Description	Sound Level Meter / Pre-amp / Microphone / Associated Calibrator

Identification

Manufacturer	*Instrument*	*Type*	*Serial No. / Version*
Rion	Sound Level Meter	NL-52	00386759
Rion	Firmware		2.0
Rion	Pre Amplifier	NH-25	76909
Rion	Microphone	UC-59	12756
Rion	Calibrator	NC-74	34536109
	Calibrator adaptor type if applicable		NC-74-002

Performance Class 1

Test Procedure TP 2.SLM 61672-3 TPS-49

Procedures from IEC 61672-3:2006 were used to perform the periodic tests.

Type Approved to IEC 61672-1:2002 YES Approval Number 21.21 / 13.02

If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2003

Date Received 09 September 2020 ANV Job No. TRAC20/09299

Date Calibrated 10 September 2020

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent testing organisation responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2:2003, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002, the sound level meter submitted for testing conforms to the class 1 requirements of IEC 61672-1:2002.

Previous Certificate	*Dated*	*Certificate No.*	*Laboratory*
	03 June 2019	TCRT19/1439	ANV Measurement Systems

TNEI SLM 36

MEASUREMENT SYSTEMS

CERTIFICATE OF CALIBRATION

Date of Issue: 17 September 2020

Certificate Number: TCRT20/1546

Issued by:
ANV Measurement Systems
Beaufort Court
17 Roebuck Way
Milton Keynes MK5 8HL
Telephone 01908 642846 Fax 01908 642814
E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Approved Signatory

[redacted]

K. Mistry

Customer	TNEI Services Ltd 7th Floor West One Forth Banks Newcastle upon Tyne NE1 3PA
Order No.	5001
Description	Sound Level Meter / Pre-amp / Microphone / Associated Calibrator

Identification	*Manufacturer*	*Instrument*	*Type*	*Serial No. / Version*
	Rion	Sound Level Meter	NL-52	01165338
	Rion	Firmware		2.0
	Rion	Pre Amplifier	NH-25	65565
	Rion	Microphone	UC-59	10557
	Rion	Calibrator	NC-74	34536109
		Calibrator adaptor type if applicable		NC-74-002

Performance Class	1
Test Procedure	TP 2.SLM 61672-3 TPS-49

Procedures from IEC 61672-3:2006 were used to perform the periodic tests.

Type Approved to IEC 61672-1:2002 YES Approval Number 21.21 / 13.02

If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2003

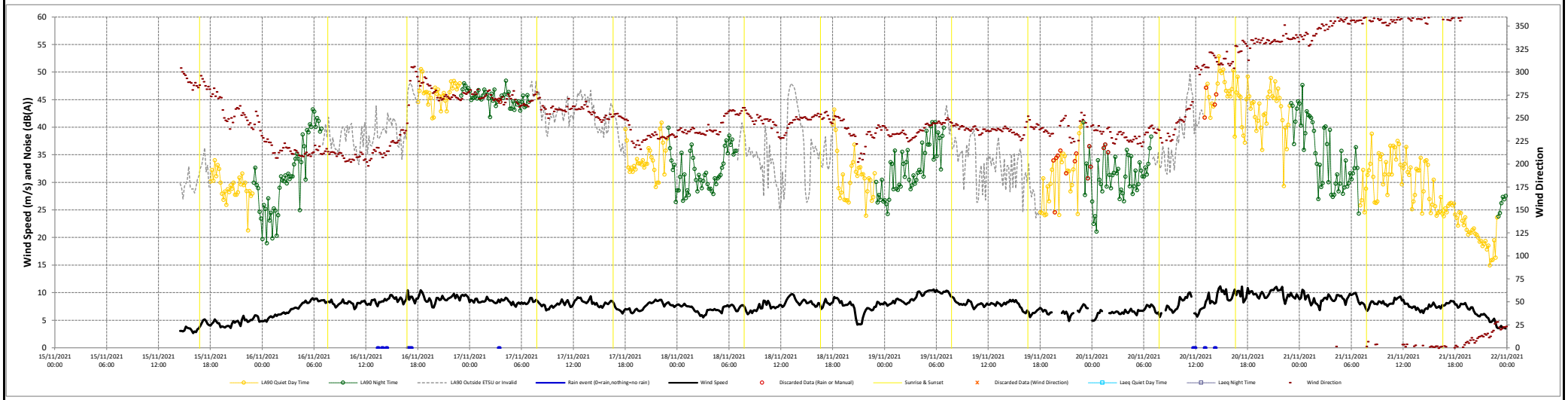
Date Received	16 September 2020	ANV Job No.	TRAC20/09312
Date Calibrated	17 September 2020		

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent testing organisation responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2:2003, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002, the sound level meter submitted for testing conforms to the class 1 requirements of IEC 61672-1:2002.

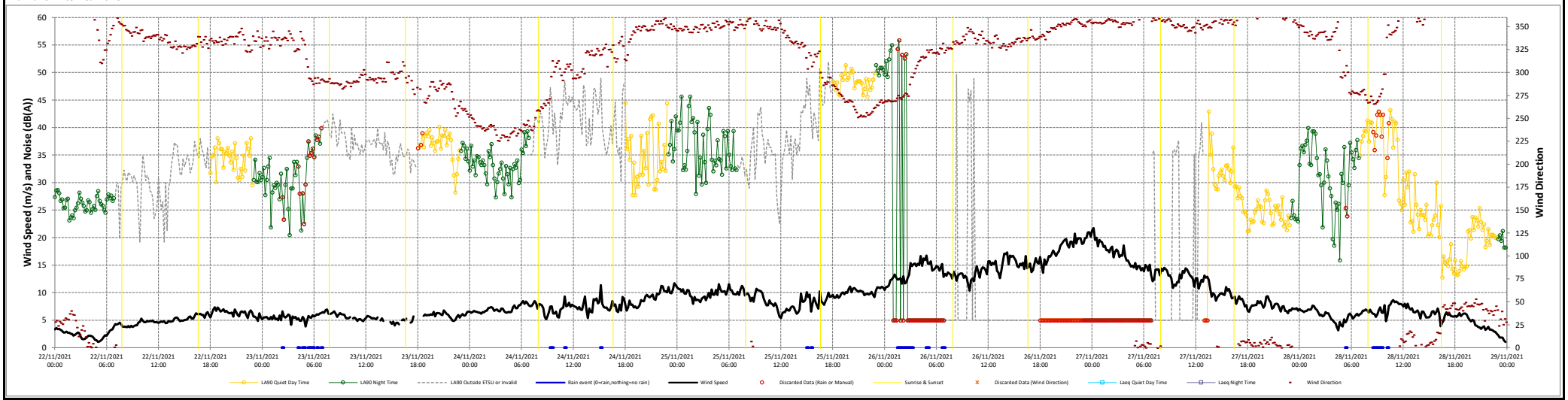
Previous Certificate	*Dated*	*Certificate No.*	*Laboratory*
	12 April 2019	TCRT19/1293	ANV Measurement Systems

Annex 4 – Time Series

15/11/2021 to 22/11/2021

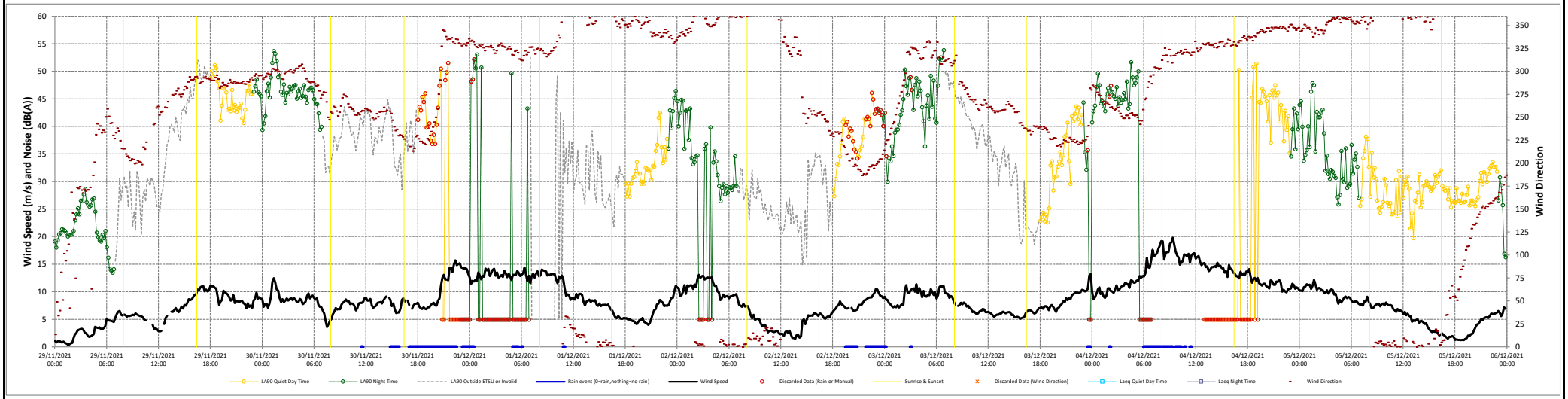


22/11/2021 to 29/11/2021

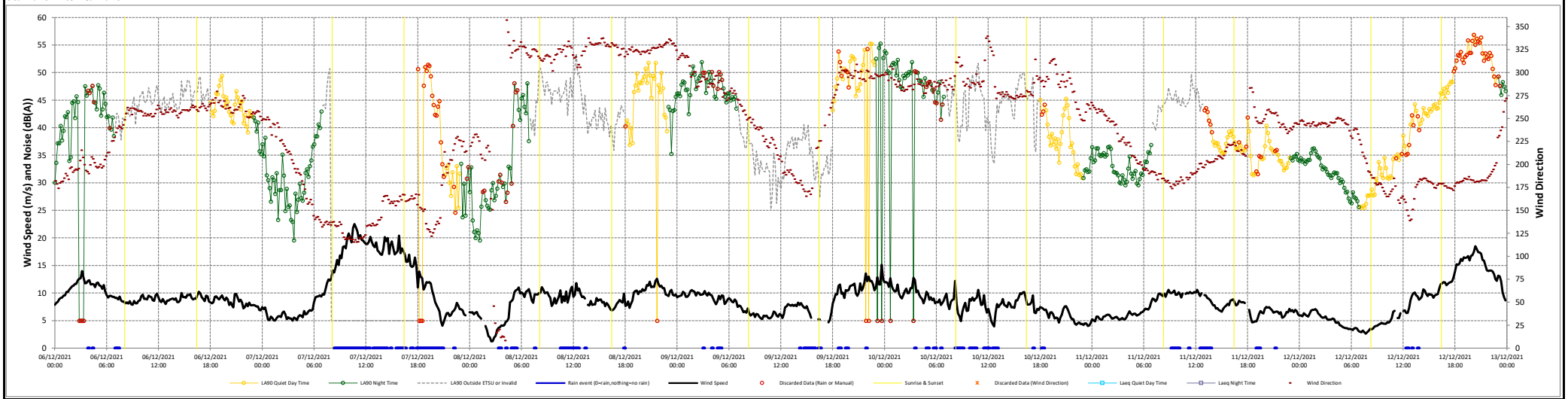


Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Time Serie for NML1 - Greenburn Page 1 of 5
Date	19/08/2024

29/11/2021 to 06/12/2021

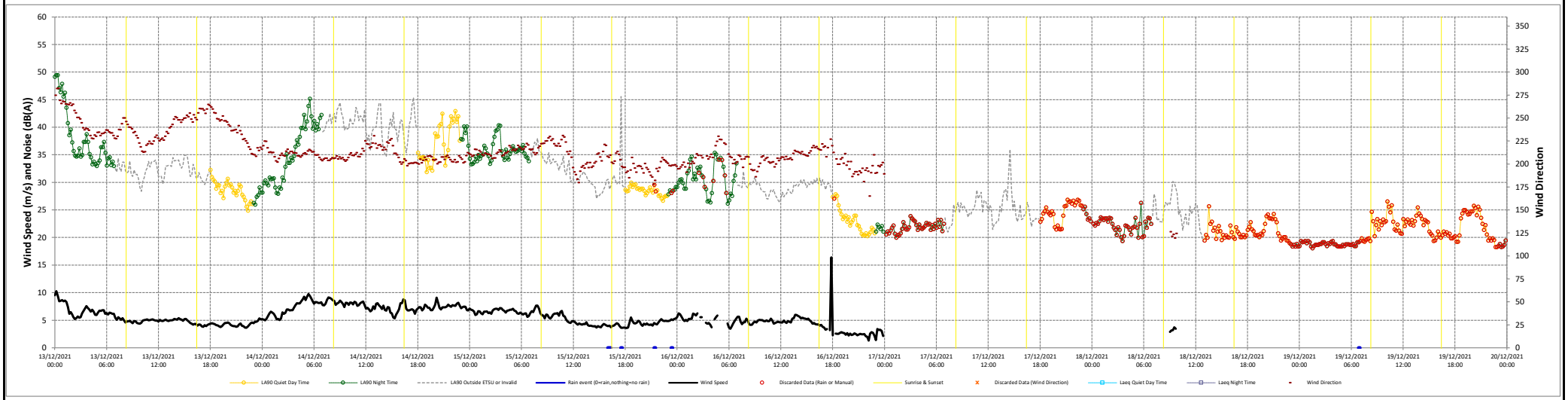


06/12/2021 to 13/12/2021

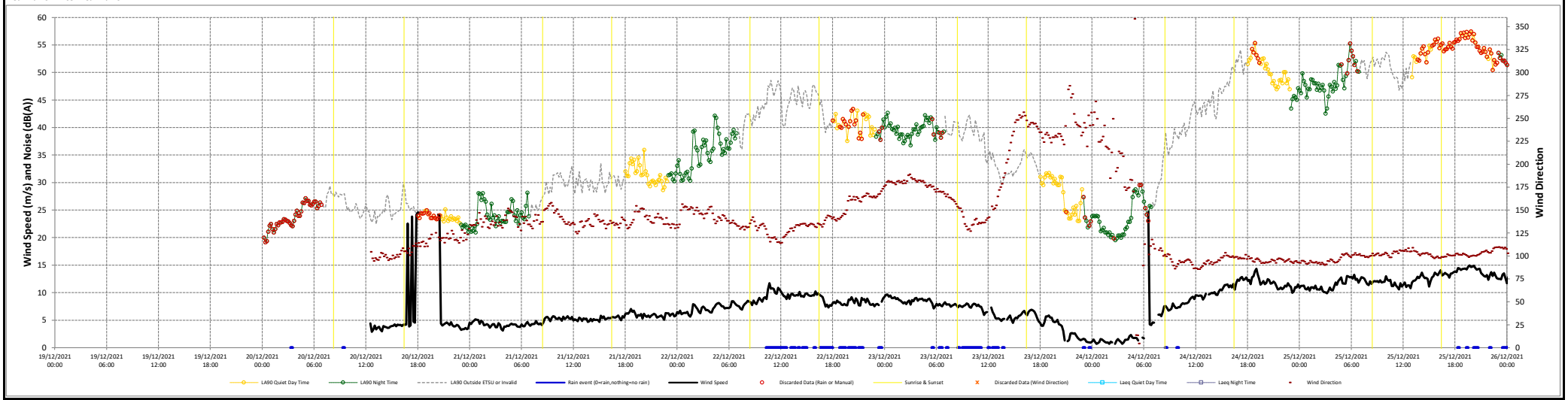


Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Time Serie for NML1 - Greenburn Page 2 of 5
Date	19/08/2024

13/12/2021 to 20/12/2021

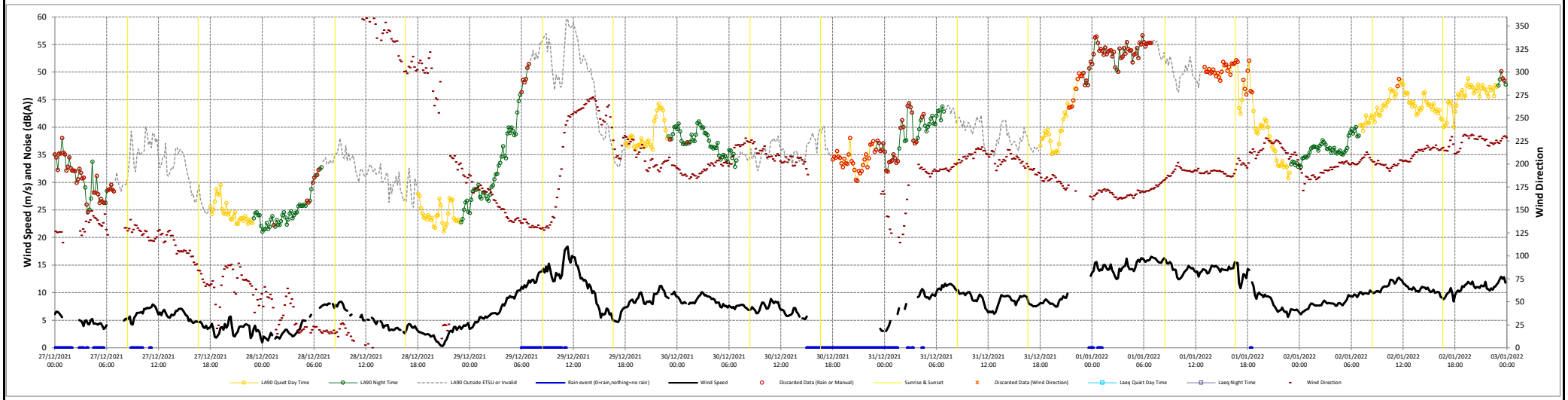


19/12/2021 to 26/12/2021

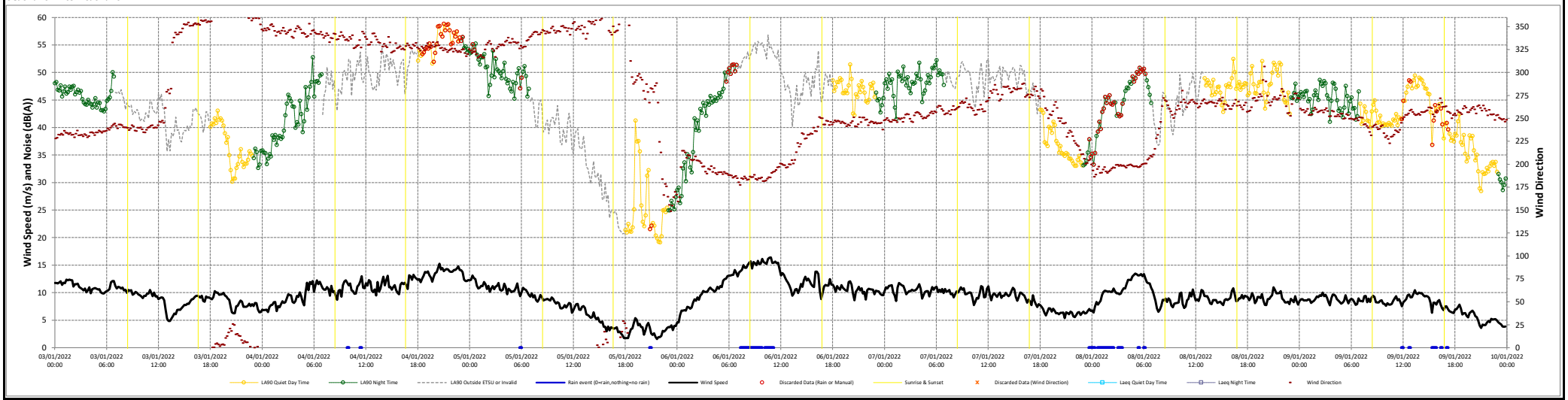


Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Time Serie for NML1 - Greenburn Page 3 of 5
Date	19/08/2024

27/12/2021 to 03/01/2022

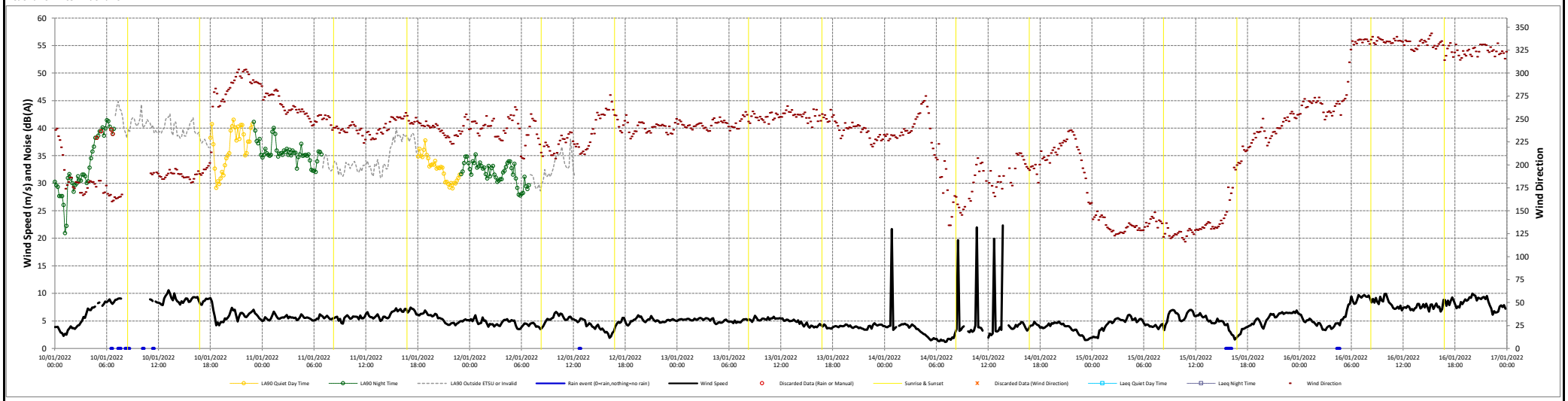


03/01/2022 to 10/01/2022

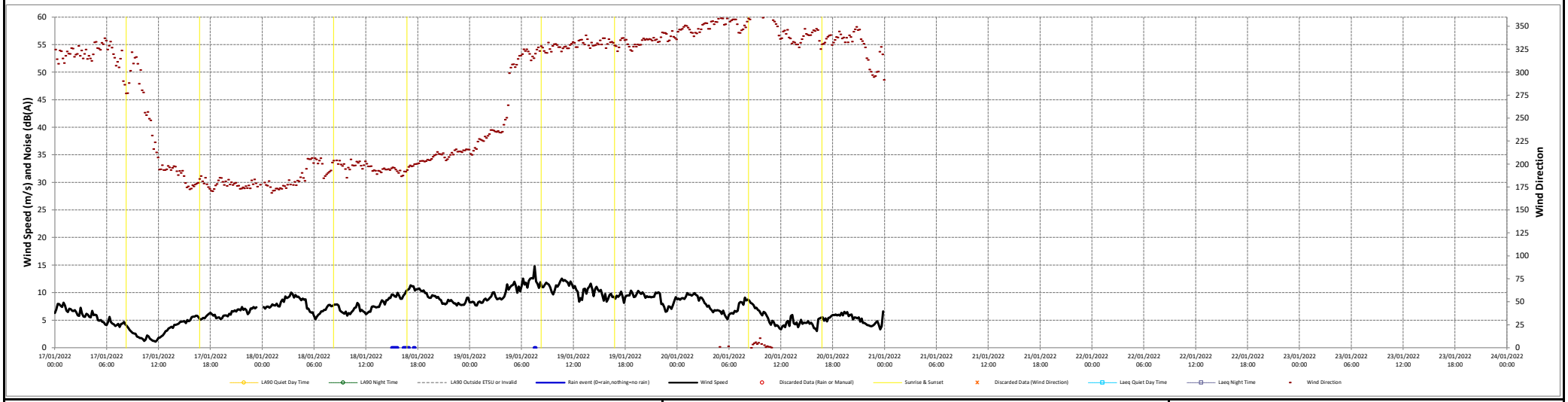


Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Time Serie for NML1 - Greenburn Page 4 of 5
Date	19/08/2024

10/01/2022 to 17/01/2022

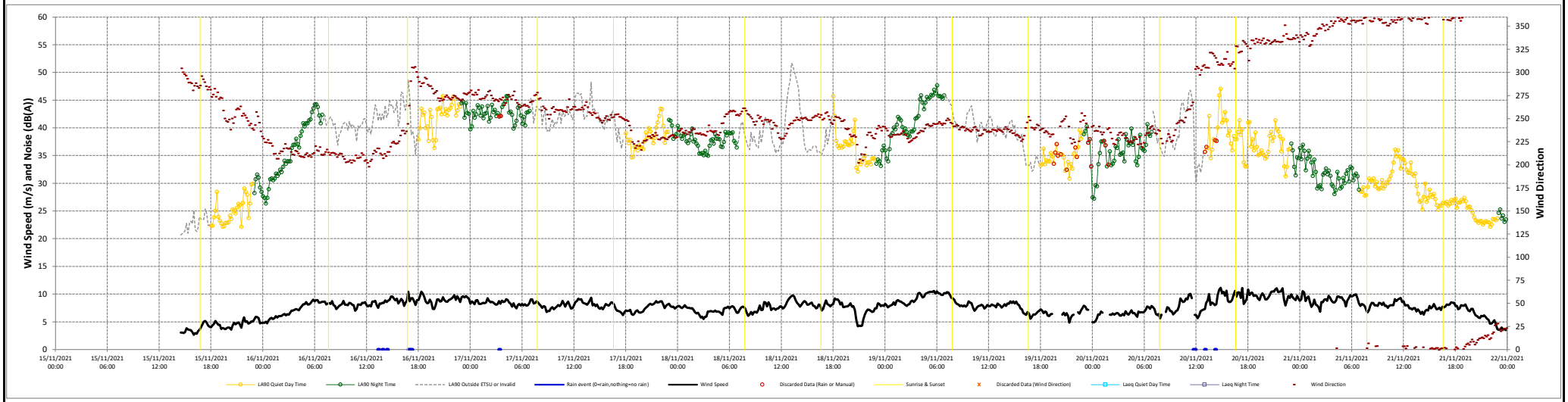


17/01/2022 to 24/01/2022

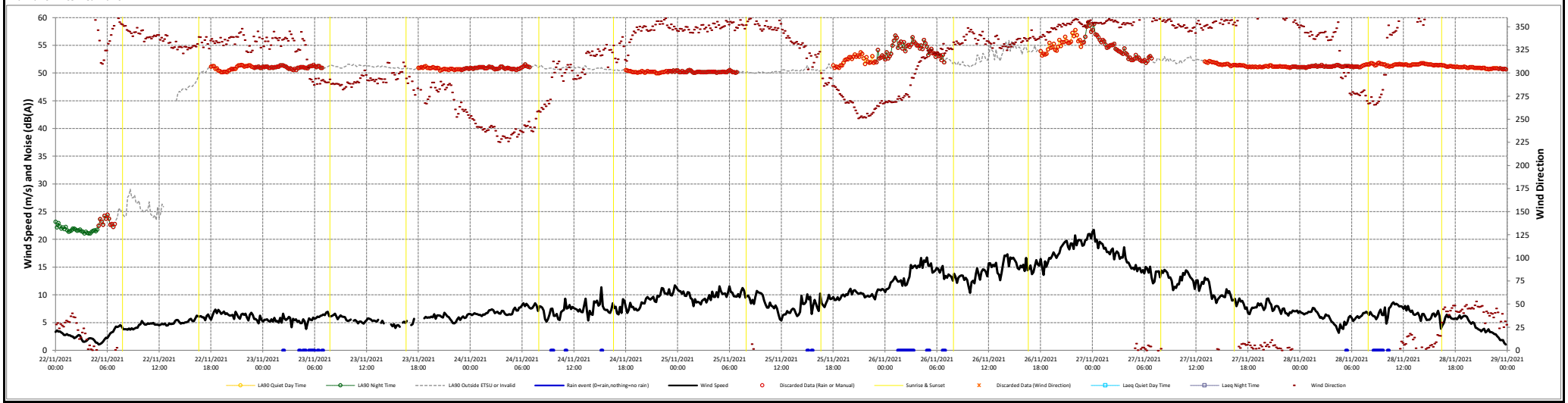


Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Time Serie for NML1 - Greenburn Page 5 of 5
Date	19/08/2024

15/11/2021 to 22/11/2021

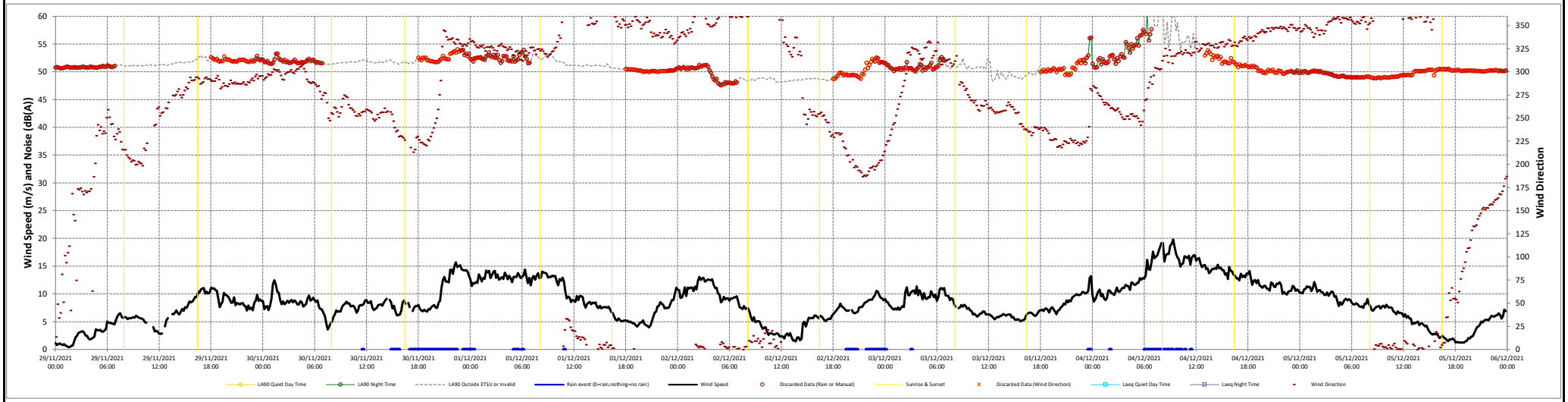


22/11/2021 to 29/11/2021

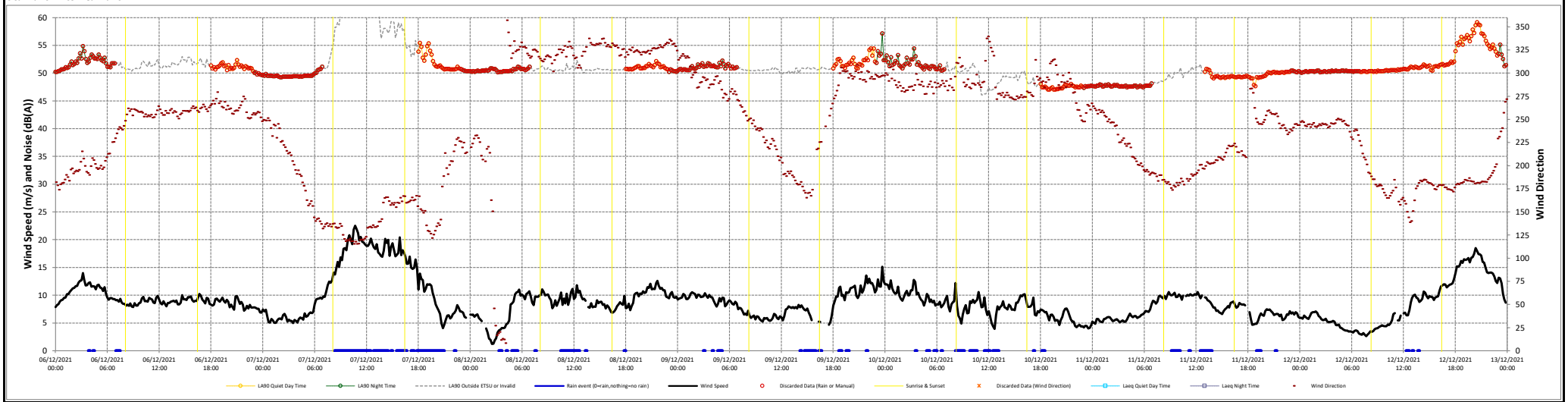


Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Time Serie for NML2 - Larbrax Lodge Page 1 of 5
Date	19/08/2024

29/11/2021 to 06/12/2021

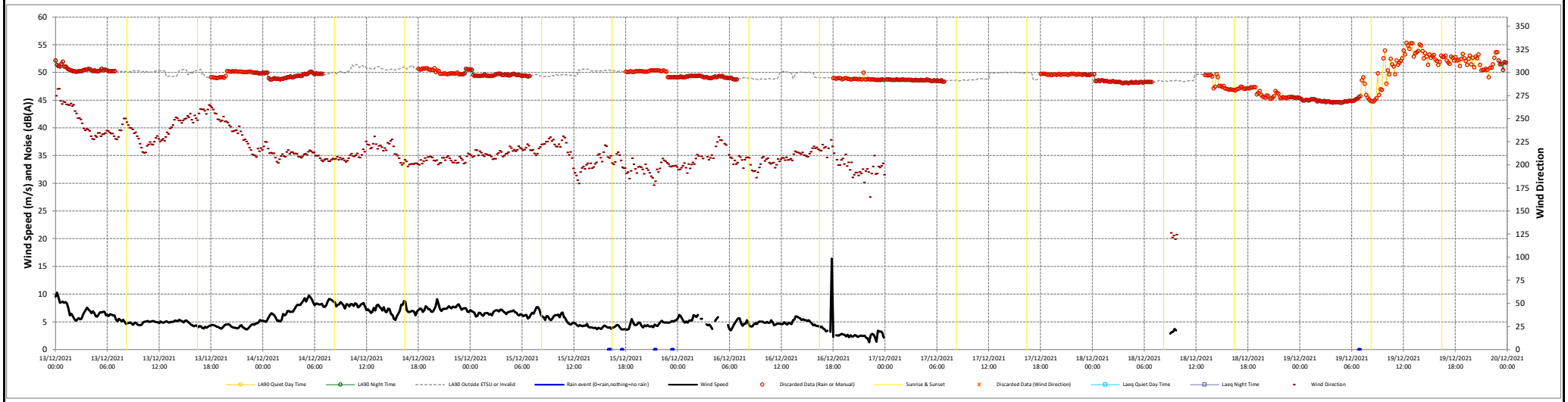


06/12/2021 to 13/12/2021

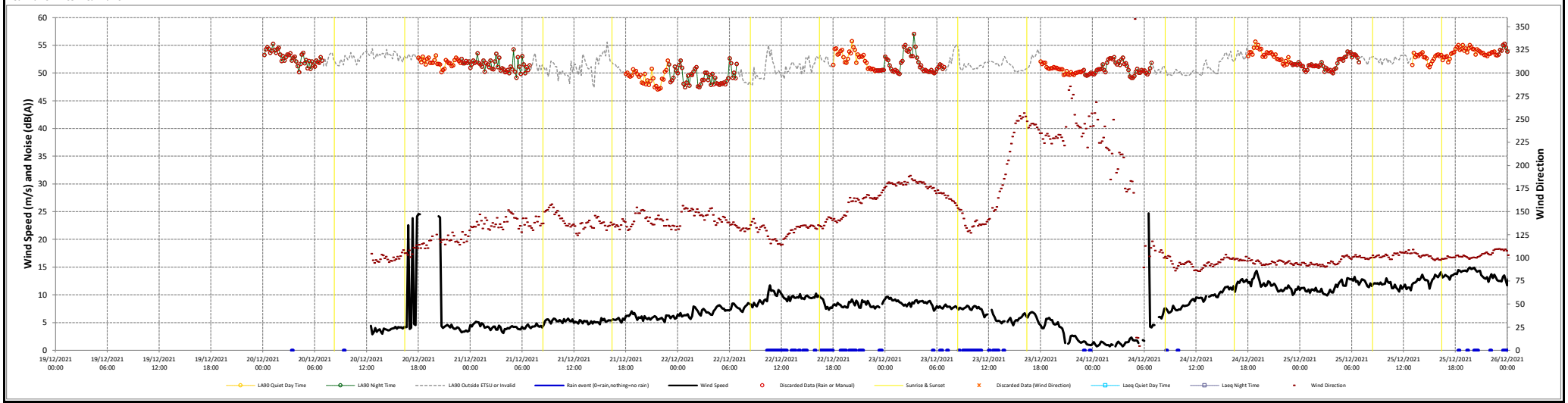


Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Time Serie for NML2 - Larbrax Lodge Page 2 of 5
Date	19/08/2024

13/12/2021 to 20/12/2021

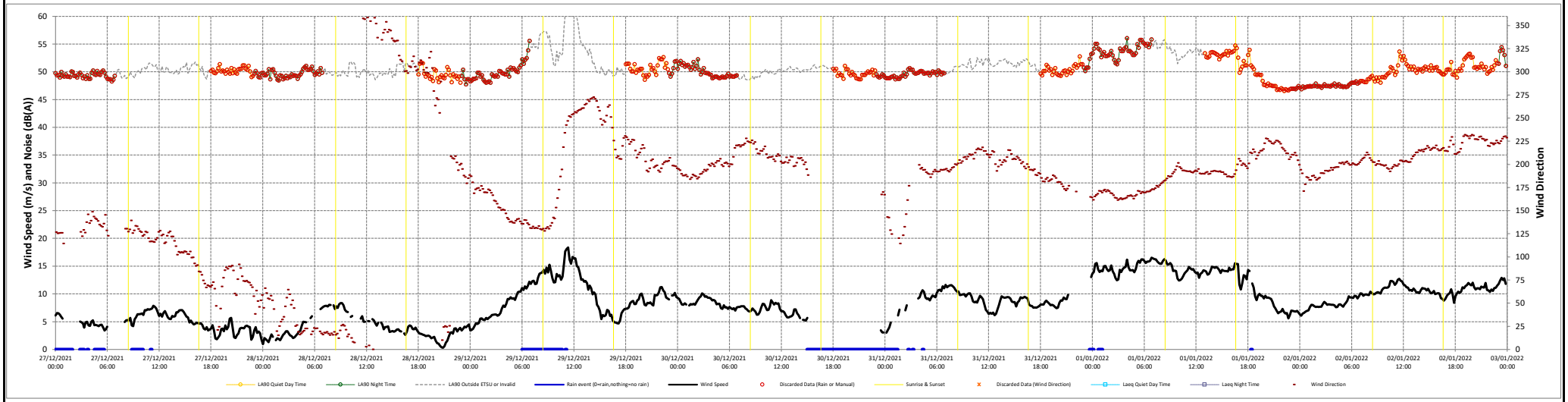


19/12/2021 to 26/12/2021

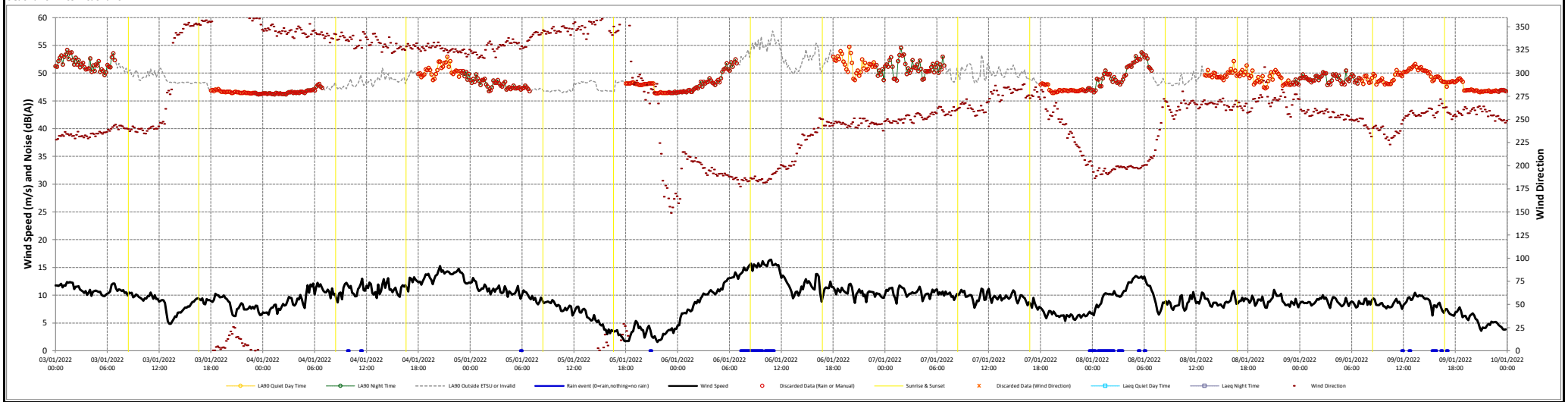


Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Time Serie for NML2 - Larbrax Lodge Page 3 of 5
Date	19/08/2024

27/12/2021 to 03/01/2022

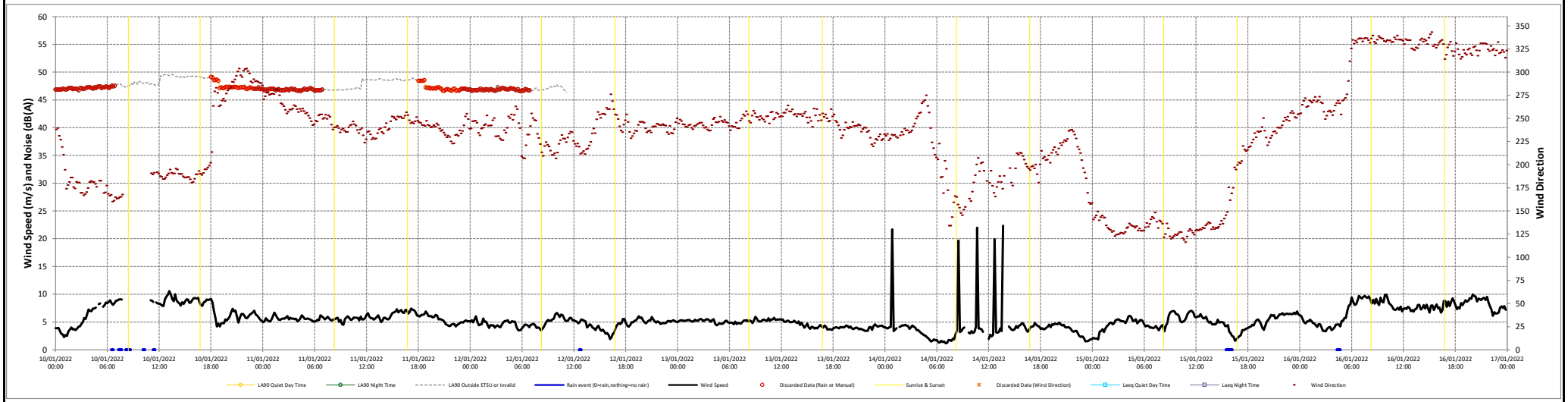


03/01/2022 to 10/01/2022

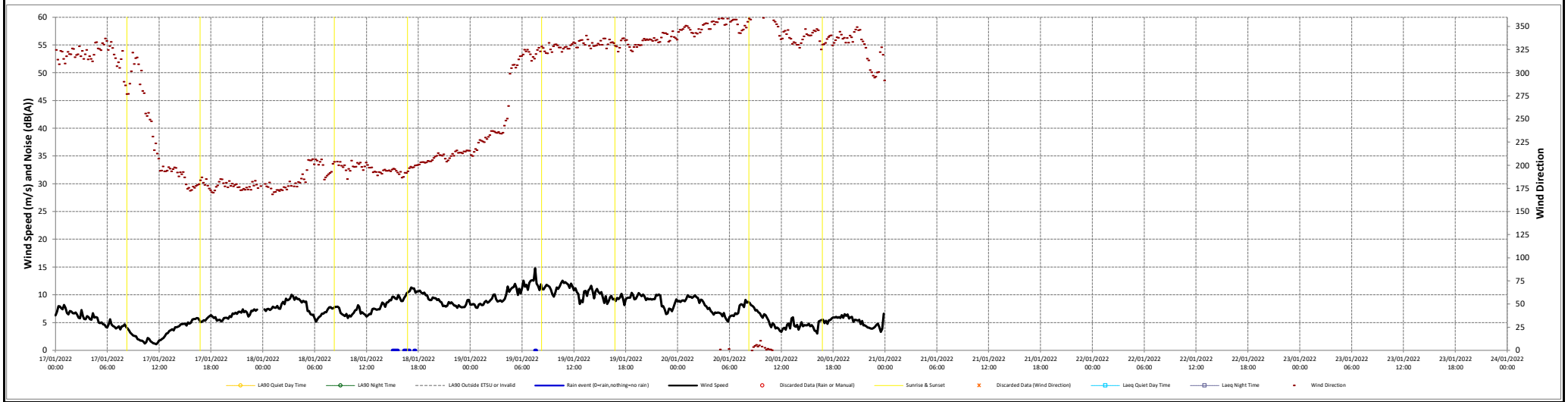


Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Time Serie for NML2 - Larbrax Lodge Page 4 of 5
Date	19/08/2024

10/01/2022 to 17/01/2022

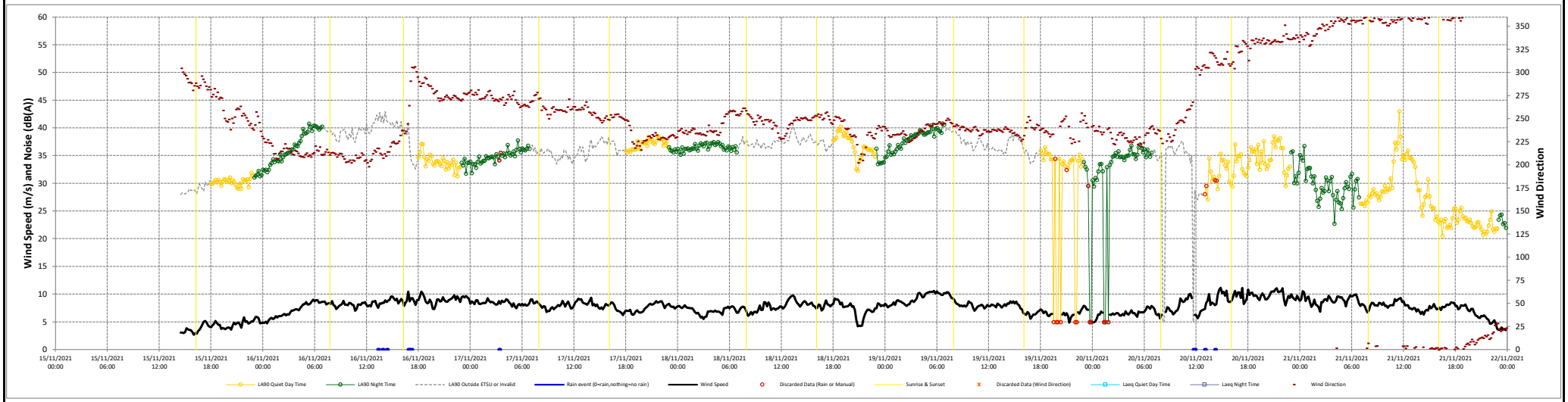


17/01/2022 to 24/01/2022

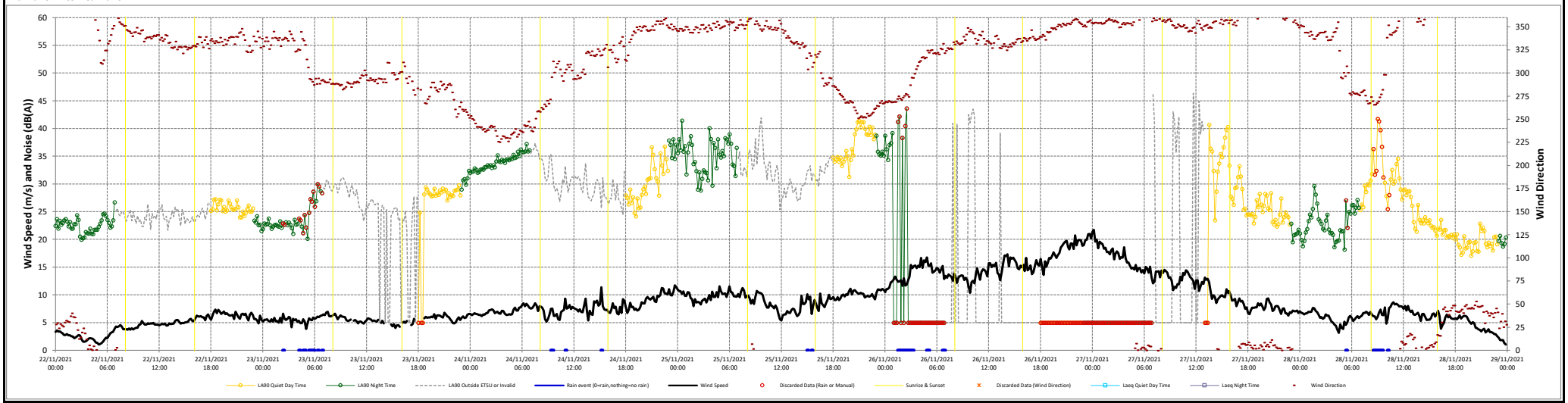


Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Time Serie for NML2 - Larbrax Lodge Page 5 of 5
Date	19/08/2024

15/11/2021 to 22/11/2021

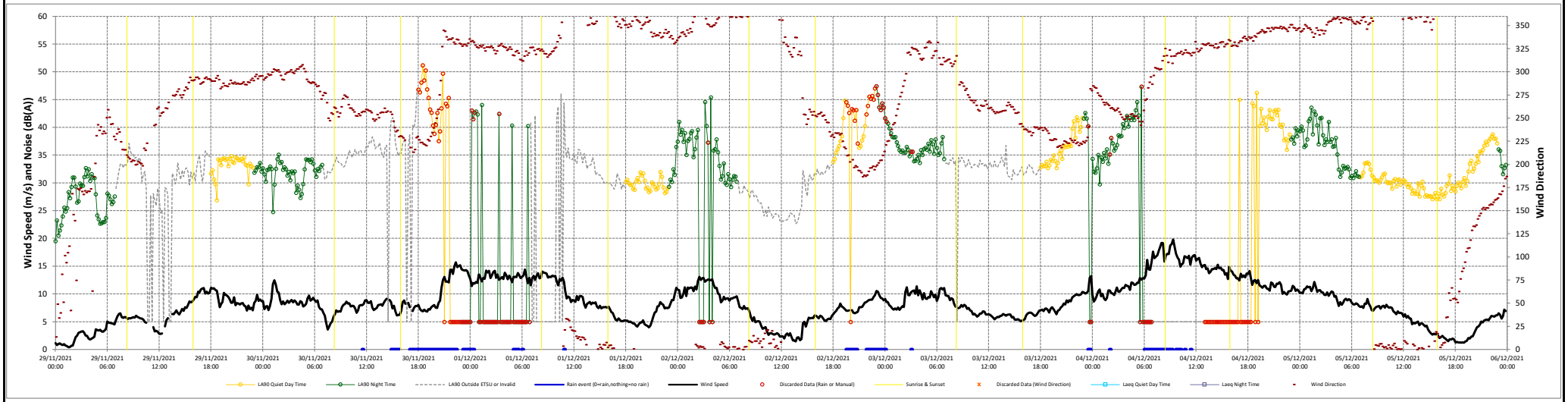


22/11/2021 to 29/11/2021

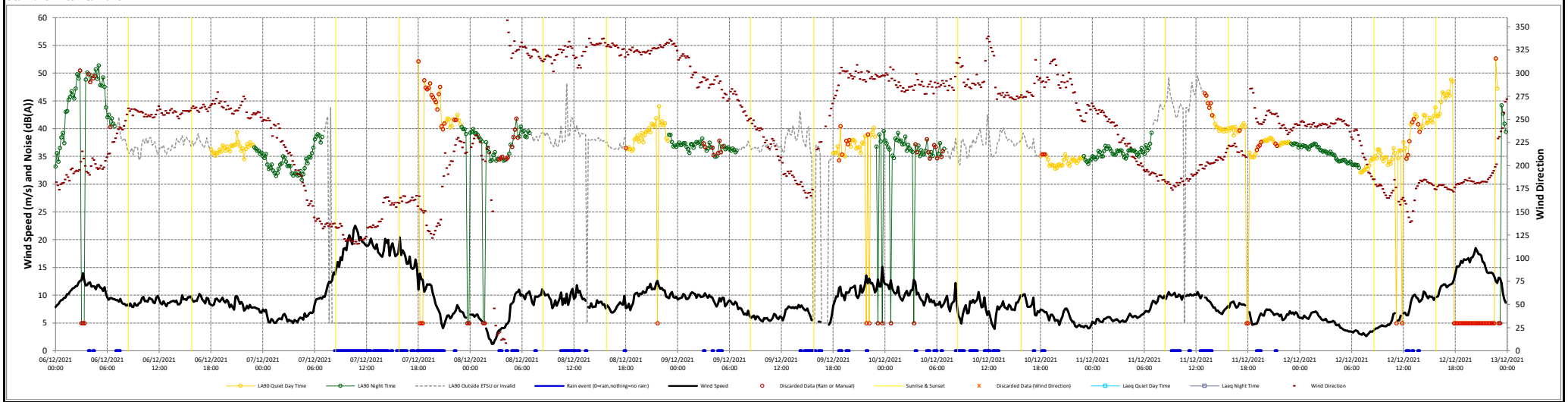


Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Time Serie for NML3 - Meikle Larbrax Cottages Page 1 of 5
Date	19/08/2024

29/11/2021 to 06/12/2021

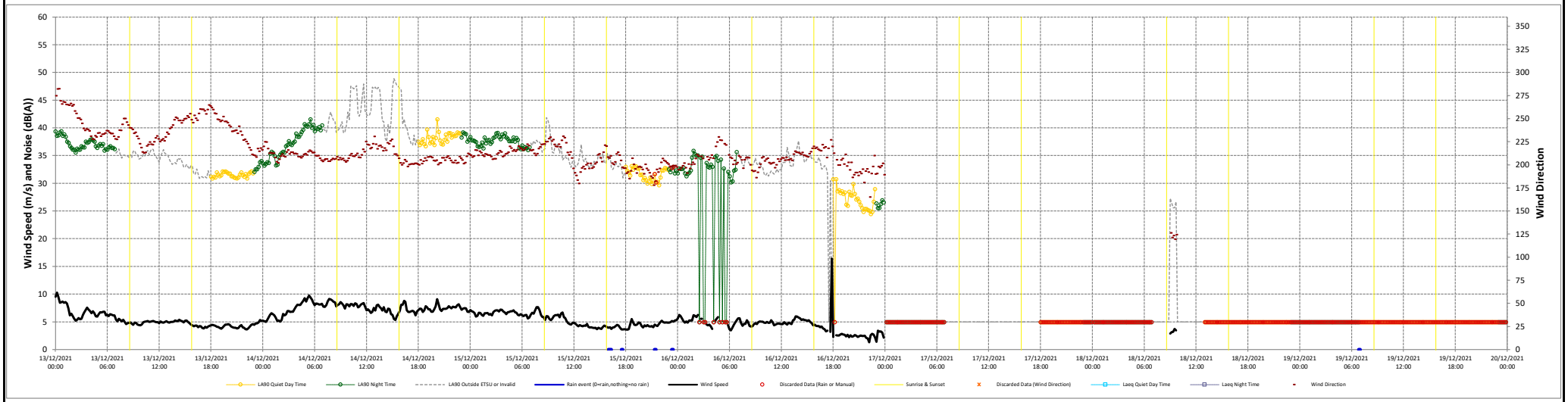


06/12/2021 to 13/12/2021

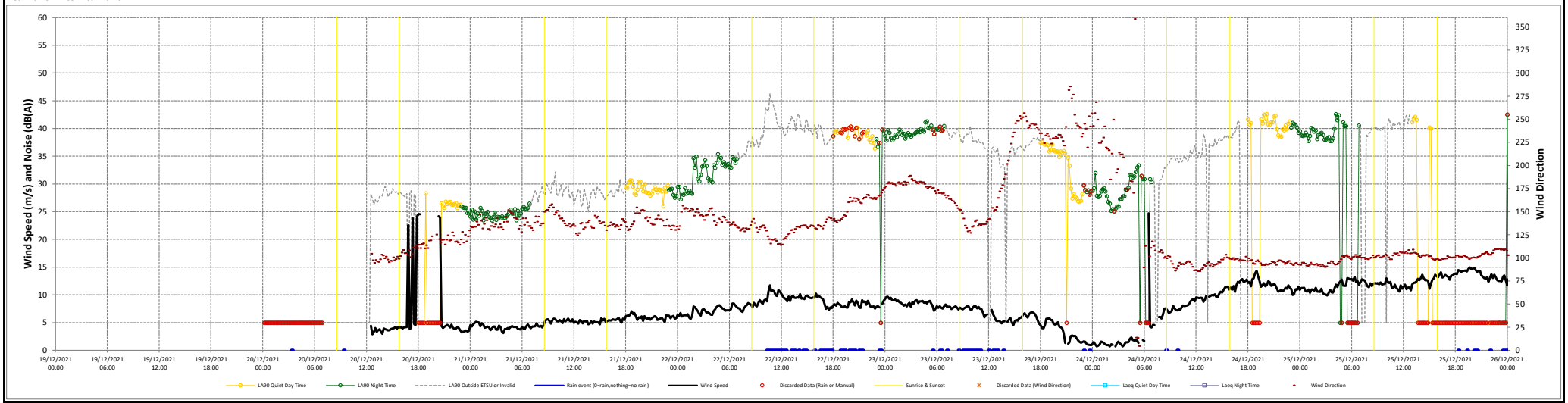


Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Time Serie for NML3 - Meikle Larbrax Cottages Page 2 of 5
Date	19/08/2024

13/12/2021 to 20/12/2021

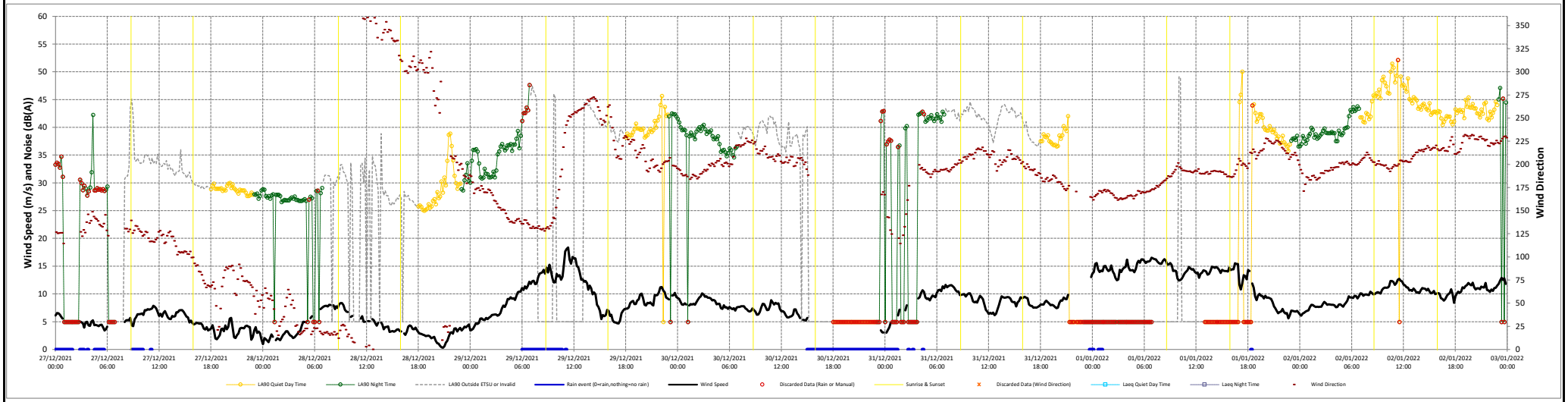


19/12/2021 to 26/12/2021

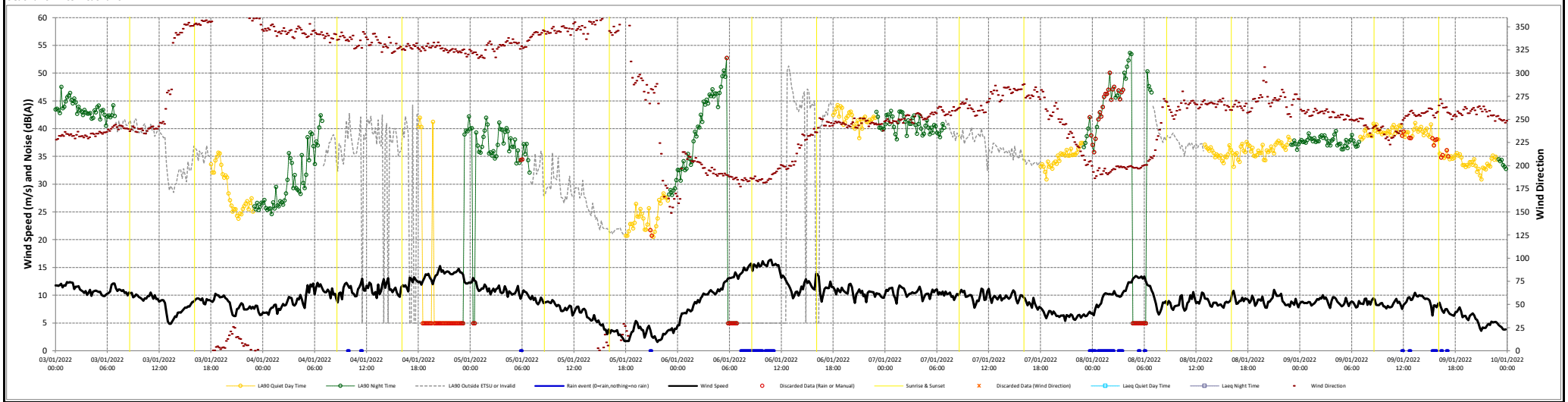


Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Time Serie for NML3 - Meikle Larbrax Cottages Page 3 of 5
Date	19/08/2024

27/12/2021 to 03/01/2022

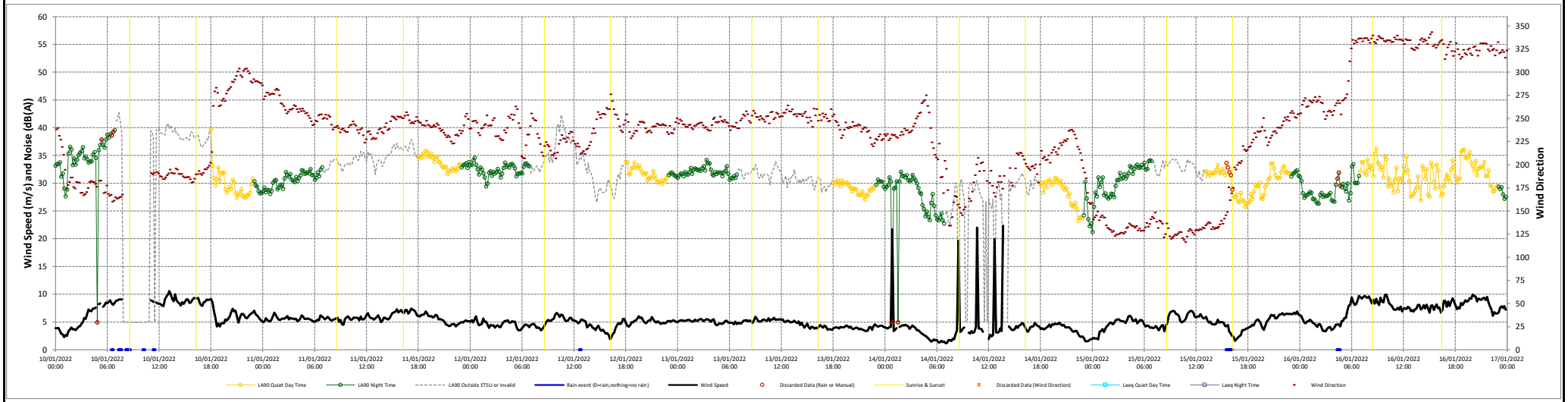


03/01/2022 to 10/01/2022

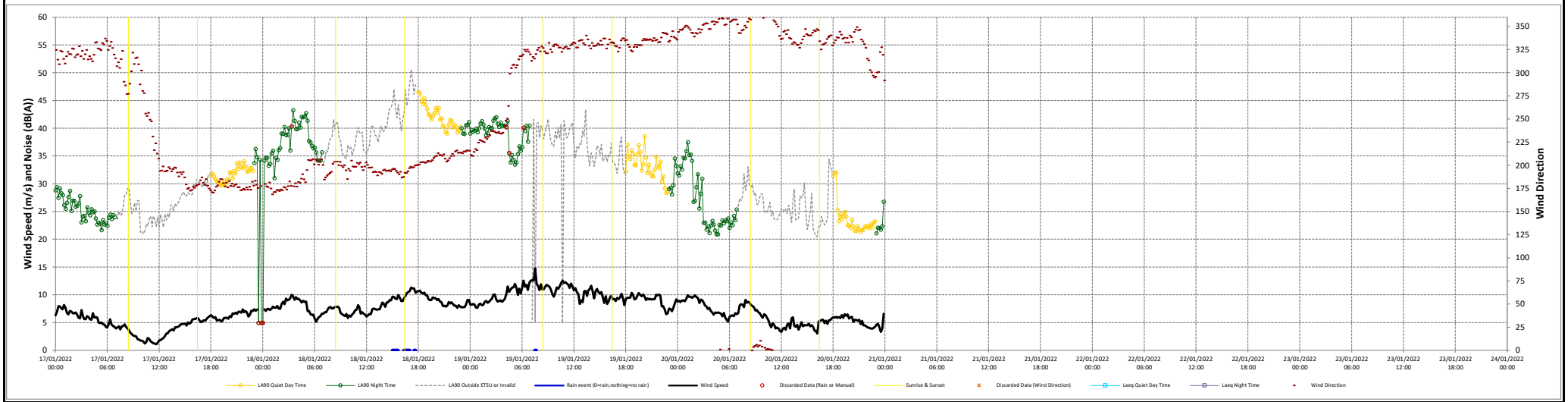


Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Time Serie for NML3 - Meikle Larbrax Cottages Page 4 of 5
Date	19/08/2024

10/01/2022 to 17/01/2022

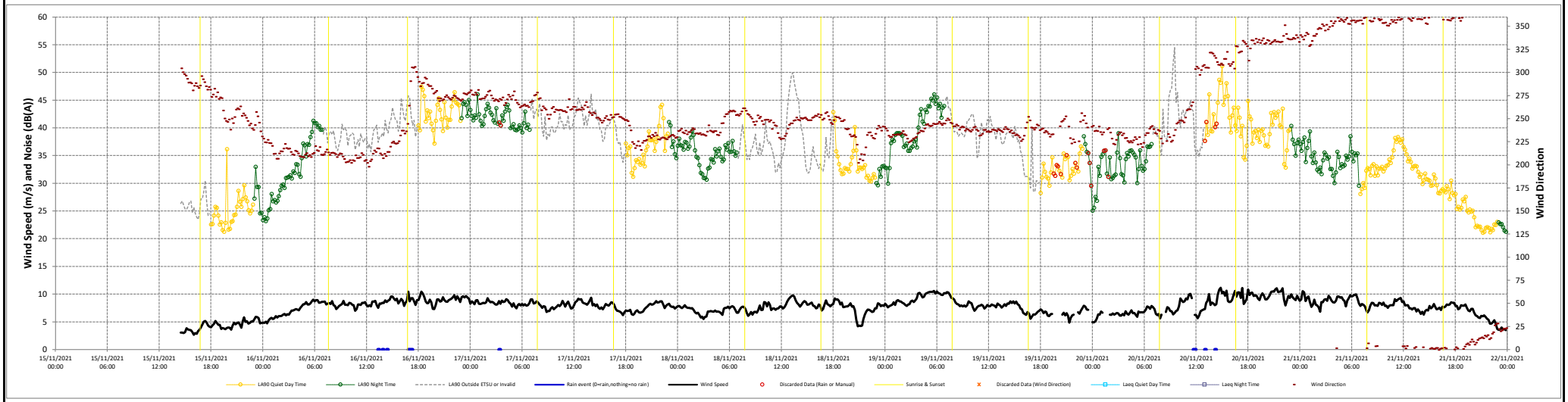


17/01/2022 to 24/01/2022

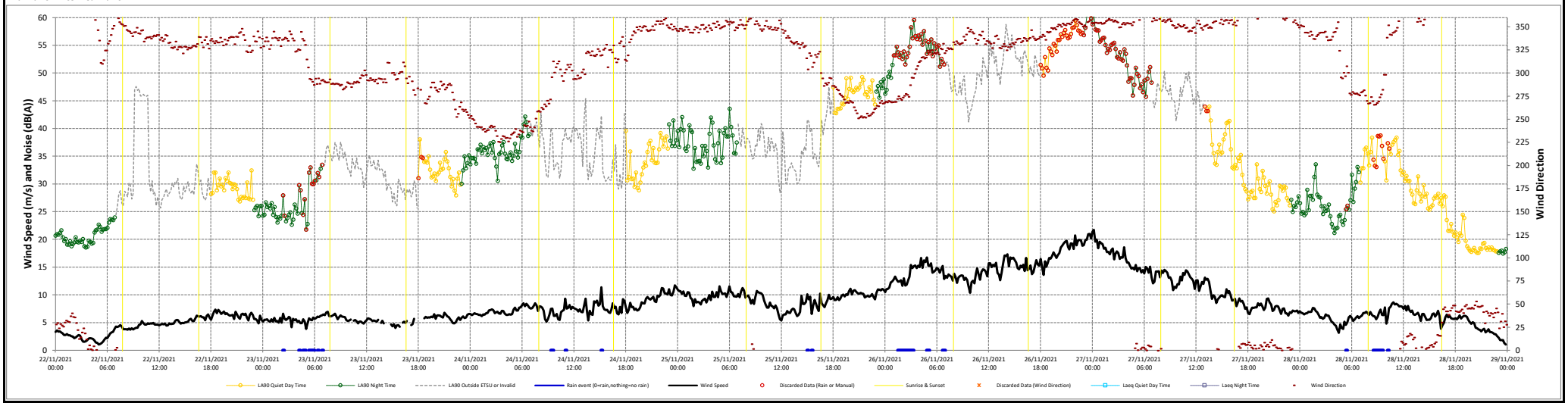


Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Time Serie for NML3 - Meikle Larbrax Cottages Page 5 of 5
Date	19/08/2024

15/11/2021 to 22/11/2021

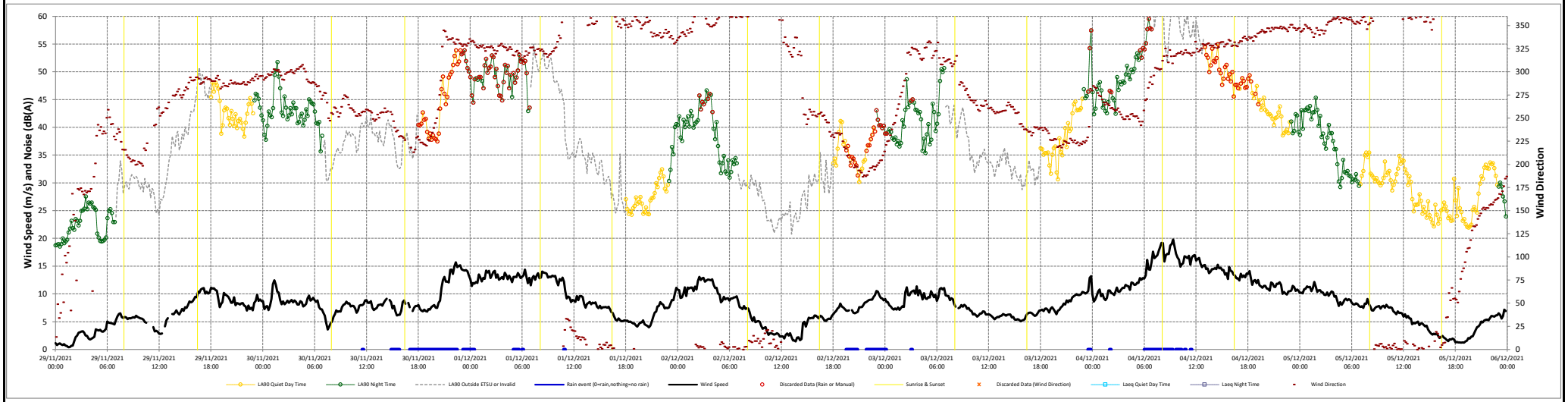


22/11/2021 to 29/11/2021

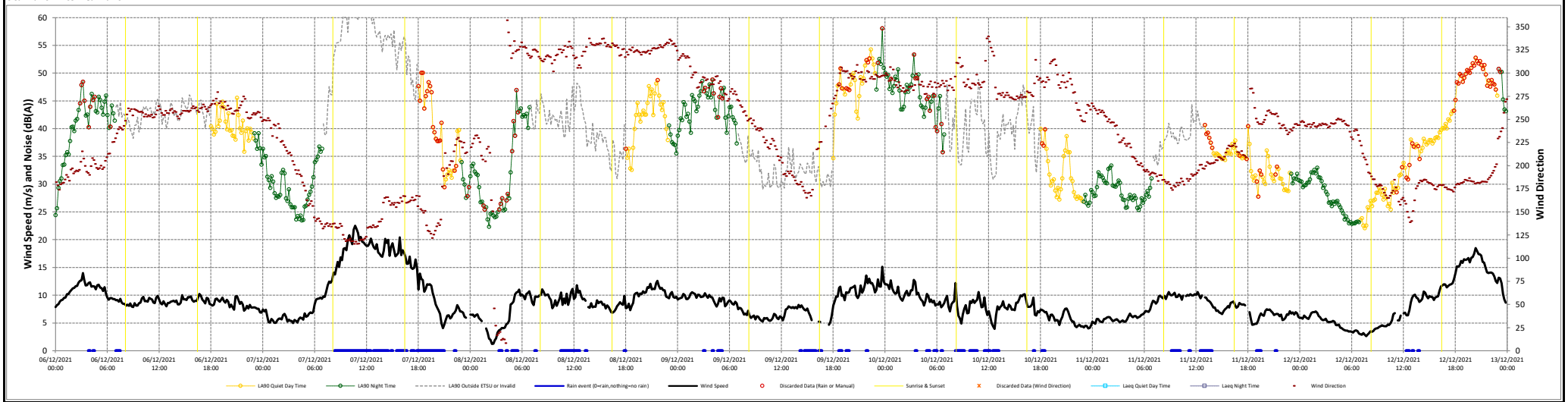


Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Time Serie for NML4 - Cairnhapple House Page 1 of 5
Date	19/08/2024

29/11/2021 to 06/12/2021

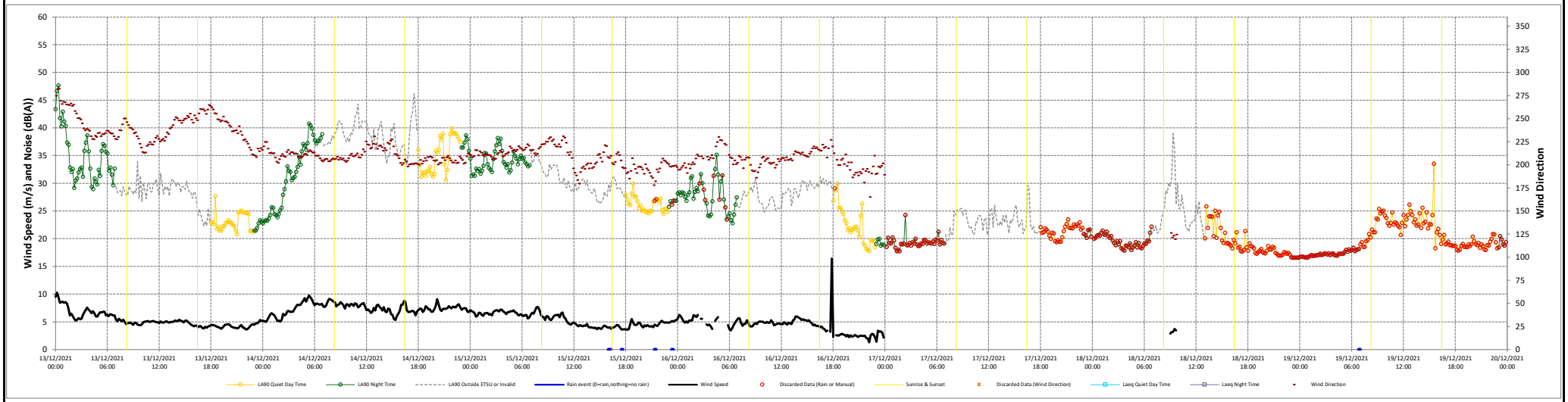


06/12/2021 to 13/12/2021

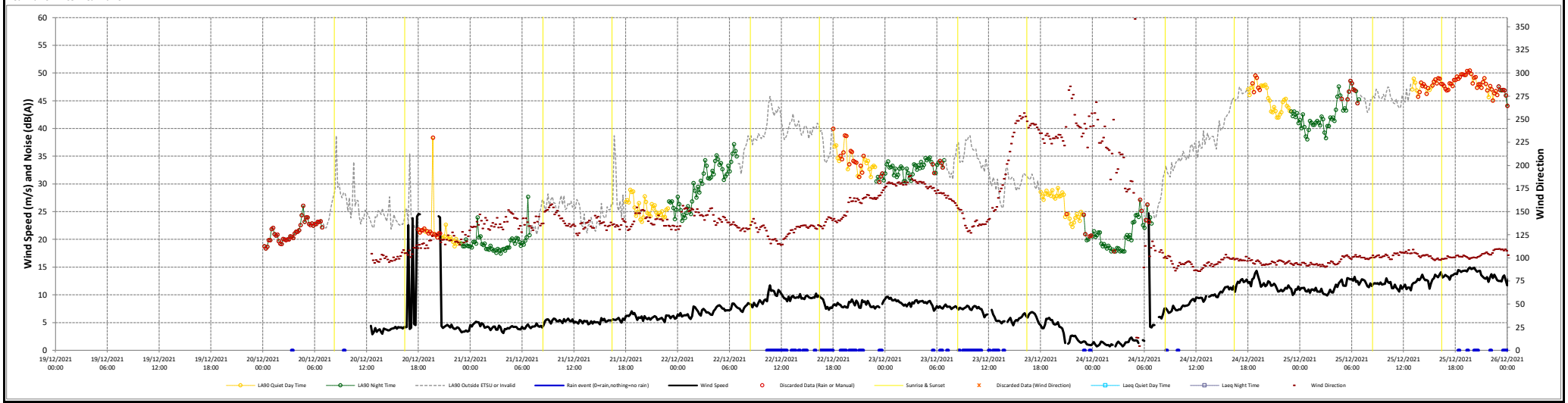


Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Time Serie for NML4 - Cairnhapple House Page 2 of 5
Date	19/08/2024

13/12/2021 to 20/12/2021

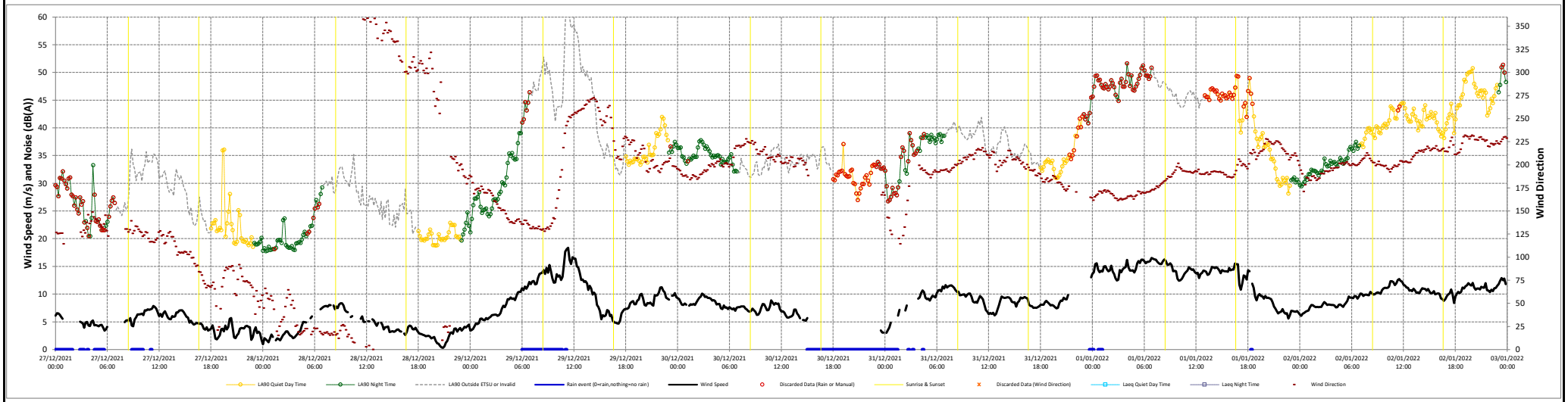


19/12/2021 to 26/12/2021



Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Time Serie for NML4 - Cairnhapple House Page 3 of 5
Date	19/08/2024

27/12/2021 to 03/01/2022



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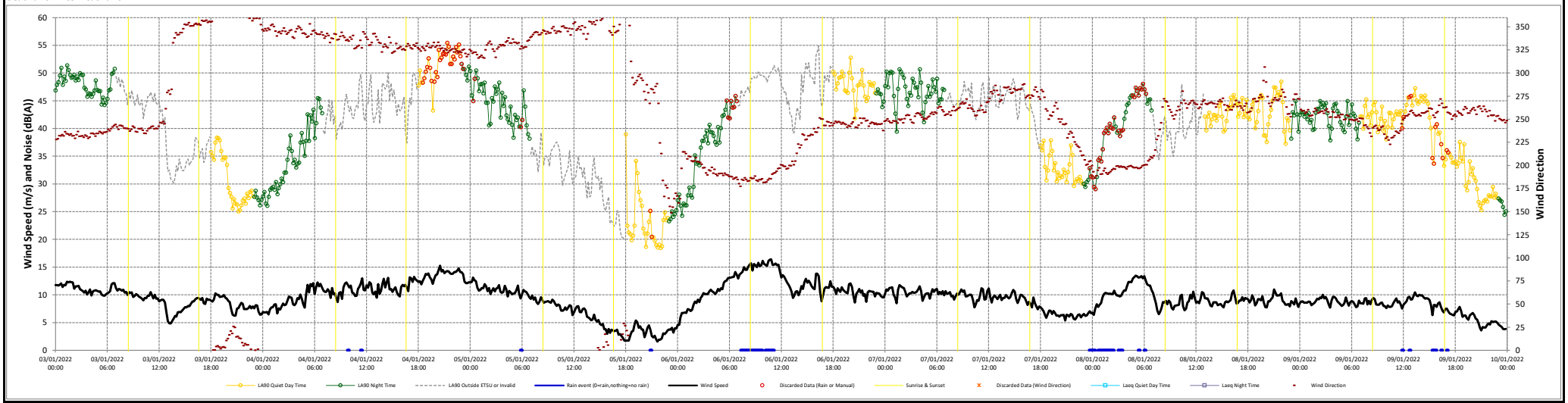
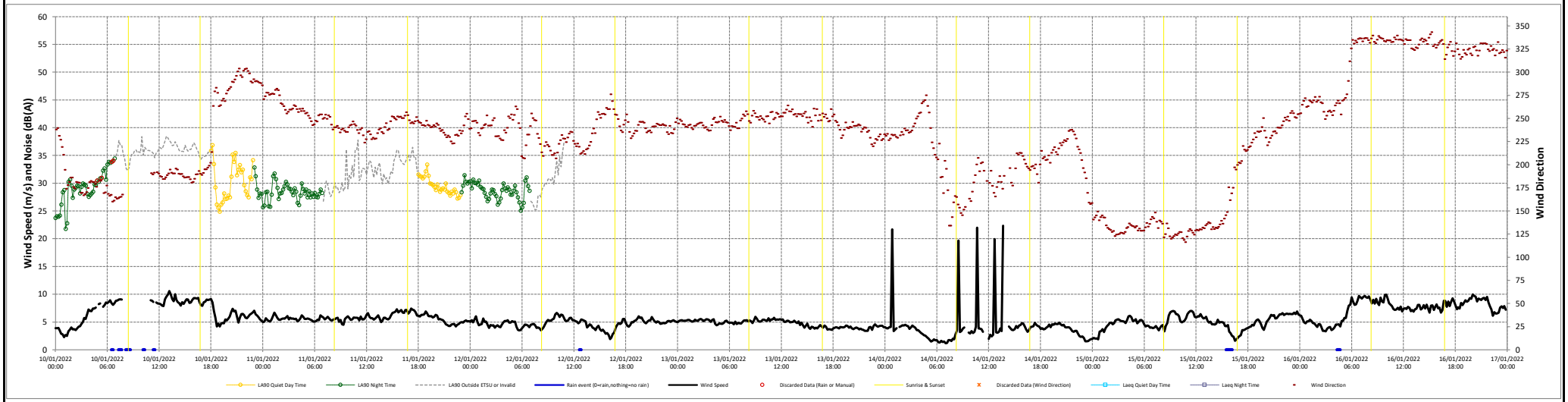
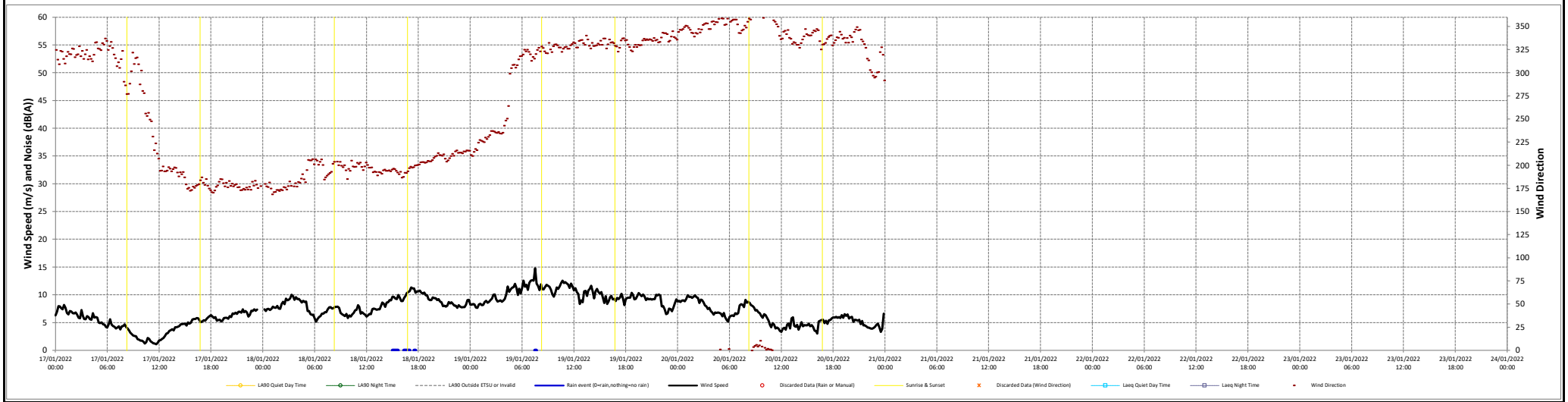


Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Time Serie for NML4 - Cairnhapple House Page 4 of 5
Date	19/08/2024

10/01/2022 to 17/01/2022



17/01/2022 to 24/01/2022



Project	Revised Larbrax Wind Farm
Client	Orsted
Title	Time Serie for NML4 - Cairnhapple House Page 5 of 5
Date	19/08/2024

Annex 5 – Topographical Corrections/ Turbine Coordinates

Noise Predictions to test if a Cumulative Noise Assessment is required

P1 : Predictions of the Proposed Development only (4 x N133)

Wind Speed (m/s)	1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Meikle Labrax	-	-	20.3	21.5	27	31.2	31.7	31.7	31.7	31.7	31.7	31.7
NAL2 - Meikle Labrax Cottages	-	-	22.9	24.1	29.6	33.8	34.4	34.4	34.4	34.4	34.4	34.4
NAL3 - Labrax Lodge	-	-	20.7	21.9	27.4	31.6	32.1	32.1	32.1	32.1	32.1	32.1
NAL4 - Glenvallagh Cottage	-	-	18.6	19.8	25.3	29.5	30.1	30.1	30.1	30.1	30.1	30.1
NAL5 - Greenburn	-	-	22.4	23.6	29.1	33.3	33.9	33.9	33.9	33.9	33.9	33.9
NAL6 - Meikle Galdenoch	-	-	21.5	22.7	28.2	32.4	33	33	33	33	33	33
NAL7 - Drumwhistley (FI with Larbrax)	-	-	21.4	22.6	28.1	32.3	32.9	32.9	32.9	32.9	32.9	32.9
NAL8 - Galdenoch Mill Cottage	-	-	20	21.2	26.7	30.9	31.5	31.5	31.5	31.5	31.5	31.5
NAL9 - Little Galdenoch Farm	-	-	18.1	19.4	24.9	29	29.6	29.6	29.6	29.6	29.6	29.6
NAL10 - Knocknain Cottages	-	-	18.4	19.6	25.1	29.3	29.9	29.9	29.9	29.9	29.9	29.9
NAL11 - The Potting Shed (FI with Knocknain)	-	-	14.2	15.4	20.9	25.1	25.7	25.7	25.7	25.7	25.7	25.7
NAL12 - Knocknain (FI with Knocknain)	-	-	15.7	16.9	22.4	26.6	27.2	27.2	27.2	27.2	27.2	27.2
NAL13 - High Mark Farm (FI with High Mark)	-	-	16.6	17.8	23.3	27.5	28.1	28.1	28.1	28.1	28.1	28.1
NAL14 - High Mark Cottages	-	-	15.5	16.7	22.2	26.4	27	27	27	27	27	27
NAL15 - Auchnotteroch (FI with Auchnotteroch)	-	-	12.7	13.9	19.4	23.6	24.2	24.2	24.2	24.2	24.2	24.2
NAL16 - Pinewood	-	-	12.2	13.4	18.9	23.1	23.7	23.7	23.7	23.7	23.7	23.7

P2 : Predictions of 3rd party schemes (cumulative excluding the Proposed Development):

Wind Speed (m/s)	1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Meikle Labrax	-	-	-	-	20.8	21.4	22.1	23.1	24.7	25.8	26.2	26.7
NAL2 - Meikle Labrax Cottages	-	-	-	-	21.1	21.5	22.1	22.9	24.5	25.5	26.1	26.7
NAL3 - Labrax Lodge	-	-	-	-	18.1	18.6	19.2	20	21.7	22.5	23	23.6
NAL4 - Glenvallagh Cottage	-	-	-	-	21.1	22.2	23.2	24.3	25.9	26.6	26.9	27.2
NAL5 - Greenburn	-	-	-	-	26.1	27.2	28.1	29.3	30.9	31.5	31.8	32.2
NAL6 - Meikle Galdenoch	-	-	-	-	26.8	28	29.1	30.4	31.9	32.6	32.8	33.1
NAL7 - Drumwhistley (FI with Larbrax)	-	-	-	-	28.2	29.5	30.6	31.9	33.5	34.1	34.3	34.6
NAL8 - Galdenoch Mill Cottage	-	-	-	-	28.2	29.9	31.3	32.8	34.4	35	35	35.1
NAL9 - Little Galdenoch Farm	-	-	-	-	26.3	27.3	28.3	29.4	31	31.7	32	32.3
NAL10 - Knocknain Cottages	-	-	-	-	32	33.9	35.3	36.9	38.4	39	39	39.1
NAL11 - The Potting Shed (FI with Knocknain)	-	-	-	-	33.8	35	36.1	37.3	38.9	39.5	39.8	40.1
NAL12 - Knocknain (FI with Knocknain)	-	-	-	-	33.3	34.5	35.5	36.7	38.3	39	39.2	39.5
NAL13 - High Mark Farm (FI with High Mark)	-	-	-	-	41.9	42	42.2	42.5	44.2	45	45.8	46.7
NAL14 - High Mark Cottages	-	-	-	-	35.2	36.5	37.2	38.3	39.9	40.6	40.9	41.2
NAL15 - Auchnotteroch (FI with Auchnotteroch)	-	-	-	-	47	47	47	47.1	48.9	49.8	50.7	51.6
NAL16 - Pinewood	-	-	-	-	34.2	35.8	37.5	39.2	40.6	42	42.1	42.2

Difference P1 - P2 (values > +10 dB or < -10 dB indicate a cumulative noise assessment is not required - highlighted in red)

Wind Speed (m/s)	1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Meikle Labrax	-	-	-	-	6.2	9.8	9.6	8.6	7	5.9	5.5	5
NAL2 - Meikle Labrax Cottages	-	-	-	-	8.5	12.3	12.3	11.5	9.9	8.9	8.3	7.7
NAL3 - Labrax Lodge	-	-	-	-	9.3	13	12.9	12.1	10.4	9.6	9.1	8.5
NAL4 - Glenvallagh Cottage	-	-	-	-	4.2	7.3	6.9	5.8	4.2	3.5	3.2	2.9
NAL5 - Greenburn	-	-	-	-	3	6.1	5.8	4.6	3	2.4	2.1	1.7
NAL6 - Meikle Galdenoch	-	-	-	-	1.4	4.4	3.9	2.6	1.1	0.4	0.2	-0.1
NAL7 - Drumwhistley (FI with Larbrax)	-	-	-	-	-0.1	2.8	2.3	1	-0.6	-1.2	-1.4	-1.7
NAL8 - Galdenoch Mill Cottage	-	-	-	-	-1.5	1	0.2	-1.3	-2.9	-3.5	-3.5	-3.6
NAL9 - Little Galdenoch Farm	-	-	-	-	-1.4	1.7	1.3	0.2	-1.4	-2.1	-2.4	-2.7
NAL10 - Knocknain Cottages	-	-	-	-	-6.9	-4.6	-5.4	-7	-8.5	-9.1	-9.1	-9.2
NAL11 - The Potting Shed (FI with Knocknain)	-	-	-	-	-12.9	-9.9	-10.4	-11.6	-13.2	-13.8	-14.1	-14.4
NAL12 - Knocknain (FI with Knocknain)	-	-	-	-	-10.9	-7.9	-8.3	-9.5	-11.1	-11.8	-12	-12.3
NAL13 - High Mark Farm (FI with High Mark)	-	-	-	-	-18.6	-14.5	-14.1	-14.4	-16.1	-16.9	-17.7	-18.6
NAL14 - High Mark Cottages	-	-	-	-	-13	-10.1	-10.2	-11.3	-12.9	-13.6	-13.9	-14.2
NAL15 - Auchnotteroch (FI with Auchnotteroch)	-	-	-	-	-27.6	-23.4	-22.8	-22.9	-24.7	-25.6	-26.5	-27.4
NAL16 - Pinewood	-	-	-	-	-15.3	-12.7	-13.8	-15.5	-16.9	-18.3	-18.4	-18.5

Topographical (concave ground/ barrier) Adjustment Table and coordinates

Notes/Comments

Requirement to include a concave ground profile correction of +3dB has been calculated in accordance with section 4.3.9 of the IOA GPG (July 2011)

A barrier correction of -2dB is included where the landform completely obscures a turbine at the noise assessment location

Where analysis indicates that both are required the barrier correction take precedence and a correction of -2dB is applied

Wind Farm	Hub	ID	Noise Senstive Receptor																X	Y	Turbine Considered
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16			
Knocknain	37	1	-2	-2	0	0	0	0	0	0	0	0	0	0	0	3	0	-2	197024	564035	EWT DW54 900kW
High Mark-WT1	18	2	-2	-2	3	3	3	3	3	-2	3	-2	3	3	3	0	-2	-2	196364	564490	WES-WES80
High Mark-WT2	18	3	-2	-2	3	3	3	3	3	-2	3	-2	3	3	3	0	-2	-2	196376	564517	WES-WES80
High Auchneel	18	4	-2	-2	-2	-2	3	-2	-2	-2	3	-2	3	3	3	3	-2	-2	197097	565055	WES-WES80
Auchnotteroch	18	5	3	3	-2	-2	3	3	3	-2	3	-2	-2	-2	3	-2	3	3	199349	560505	WES-WES80
Glaik Hill	30	6	3	3	0	0	3	3	3	-2	3	-2	-2	-2	3	-2	3	3	199245	559400	WES LW30-250 250KW
Larbrax-WT1	83.4	7	0	0	0	0	0	0	0	0	0	0	-2	0	0	0	0	0	196965	561416	Nordex N133 4.8MW Mode 0
Larbrax-WT2	83.4	8	0	0	0	0	0	0	0	0	0	0	-2	0	0	0	0	0	196748	561849	Nordex N133 4.8MW Mode 0
Larbrax-WT3	83.4	9	-2	0	0	0	0	0	0	-2	0	0	-2	-2	0	0	0	0	196251	562184	Nordex N133 4.8MW Mode 0
Larbrax-WT4	83.4	10	-2	0	0	0	0	0	0	0	0	0	-2	0	0	0	0	0	196222	562692	Nordex N133 4.8MW Mode 0

Annex 6 – Summary of Wind Turbine Noise Source Data

Wind Turbine Noise Data assumptions

Table A6.1: Sound Power Level Data

Wind Farm	Wind Turbine	Hub height of source data (Modelled hub heights are presented in Annex 5)	Uncertainty added	Reference Wind Speed (ms^{-1}) Standardised to 10 m Height									
				3	4	5	6	7	8	9	10	11	12
Proposed Development/Revised Larbrax	Nordex N133, 4.8 MW with Serrated Blades	83	2 dB	95.0	96.2	101.7	105.9	106.5	106.5	106.5	106.5	106.5	106.5
High Mark & High Auchneel & Auchnotteroch	WES18 80 kW	18.9	Up to 2.3 dB (test report)	98.3	98.3	98.3	98.3	98.3	98.4	100.3	101.1	102.0	103.0
Glaik Hill	WES30 250 kW	31	Up to 1.5 dB (test report)	91.0	92.8	94.6	96.4	98.2	100.0	101.4	102.8	102.8	102.8
Knocknain	EWT DW54 900 kW	50	2 dB	-	94.0	97.9	99.6	101.2	103.0	104.5	104.5	104.5	104.5

Table A6.2: Octave Band Data

Wind Farm	Wind Turbine	Reference Wind Speed (m/s)	Octave Band (Hz)								
			63	125	250	500	1000	2000	4000	8000	Overall
Proposed Development/Revised Larbrax	Nordex N133, 4.8 MW with Serrated Blades	10	88.2	95.2	99.0	99.9	100.4	99.1	94.8	85.6	106.5
High Mark & High Auchneel & Auchnotteroch	WES18 80 kW	10	78.7	86.5	87.9	92.3	96.9	96.4	88.9	80.2	101.1
Glaik Hill	WES30 250 kW	7	77.0	81.2	85.7	91.7	94.9	90.6	85.5	76.1	98.2
Knocknain	EWT DW54 900 kW	6	79.4	86.8	92.8	94.7	93.7	89.9	85.2	77.6	99.6