Assessment of Acoustic Impact for the Proposed Kingston Solar Farm

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Revision History

Issue	Date	Author	Nature & Location of Change
01	30 Nov 2021	Andrew Birchby	First created
02	6 Dec 2021	Andrew Birchby	Updated Appendix B

CONTENTS

1.0 INTRODUCTION & SCOPE

This report contains an assessment of the acoustic impact of the proposed Kingston solar farm. Two Members of the Institute of Acoustics have been involved in its production. Details of their experience and qualifications can be found in Appendix A.

The scope includes determining the baseline and predicting sound levels due to the proposed development in order to assess the level of impact in accordance with relevant planning guidance.

2.0 PLANNING GUIDANCE

2.1 National Planning Policy Framework

Within England, the treatment of noise is defined in the planning context by the National Planning Policy Framework (NPPF)[1] which details the Government's planning policies and how these are expected to be applied. The NPPF provides advice on the role of the planning system in helping to prevent and limit the adverse effects of noise, stating that planning policies and decisions should aim to avoid noise giving rise to significant adverse impacts, whilst at the same time mitigating and reducing to a minimum other adverse impacts on health and quality of life. At this point the NPPF refers to the Noise Policy Statement for England (NPSE)[2] which provides guidance on the categorisation of impact levels.

2.2 Noise Policy Statement for England

The Noise Policy Statement for England (NPSE) sets out the long-term vision of Government noise policy: to promote good health and quality of life through effective noise management within the context of sustainable development. In order to weigh noise impacts against the economic and social benefits of the activity under consideration, NPSE defines three categories of effect level:

- No Observed Effect Level (NOEL): noise levels below this have no detectable effect on health and quality of life;
- Lowest Observed Adverse Effect Level (LOAEL): the level above which adverse effects on health and quality of life can be detected; and
- Significant Observed Adverse Effect Level (SOAEL): the level above which effects on health and quality of life become significant.

2.3 National Planning Practice Guidance

National Planning Practice Guidance (NPPG)[3] puts the effect levels defined by NPSE into greater context by explaining how such noise levels might be perceived, providing examples of outcomes based on likely average response, and advising on appropriate actions. These are reproduced in Table 1 below.

[1] "National Planning Policy Framework", Department for Communities and Local Government, March 2012
[2] "Noise Policy Statement for England (NPSE)", Department for Environment, Food and Rural Affairs, March 2010
[3] "National Planning Practice Guidance", Department for Communities and Local Government, March 2014

Table 1 - Noise Exposure Hierarchy

Perception	Examples of Outcomes	Increasing Effect Level	Action
Not noticeable	No Effect	No Observed Effect	No specific measures required
No Observed Effect Level (NOEL)			
Noticeable and not intrusive	Noise can be heard, but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.	No Observed Adverse Effect	No specific measures required
Lowest Observed Adverse Effect Level (LOAEL)			
Noticeable and intrusive	Noise can be heard and causes small changes in behaviour and/or attitude, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
Significant Observed Adverse Effect Level (SOAEL)			
Noticeable and disruptive	The noise causes a material change in behaviour and/or attitude, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid
Noticeable and very disruptive	Extensive and regular changes in behaviour and/or an inability to mitigate effect of noise leading to psychological stress or physiological effects, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory	Unacceptable Adverse Effect	Prevent

2.4 National Policy Statements

In addition to the aforementioned guidance which is applicable to all forms of environmental noise, specific guidance relating to nationally significant energy infrastructure has been published by the Department of Energy and Climate Change (DECC). Whilst the proposed development is not of a scale that would be deemed nationally significant, the relevant National Policy Statements are informative in that they suggest an assessment methodology that would be considered appropriate for the type of development being proposed.

The Overarching National Policy Statement for Energy (EN-1)[4] outlines the need for new electricity capacity from renewable sources as the country transitions to a low carbon electricity

[4] "Overarching National Policy Statement for Energy (EN-1)", Department of Energy and Climate Change, July 2011

system. However, referring back to the NPSE, EN-1 recognises the potential for energy infrastructure to impact on health and quality of life if it results in excessive noise. It goes on to say that where noise impacts are likely to arise, they should be assessed according to the principles of the relevant British Standards.

Of the examples provided, BS 4142[5] and BS 8233[6] relate to operational sound. BS 4142 describes methods for rating and assessing sound of an industrial or commercial nature. Outdoor sound levels are used to assess the likely effects on people who might be inside or outside a residential property. BS 8233 provides guidance on the control of noise for new buildings or those undergoing refurbishment. It does not provide guidance on assessing the effect of changes in external noise levels on occupants of existing buildings.

The National Policy Statement for Electricity Networks Infrastructure (EN-5)[7], relevant to the transmission and distribution parts of the electricity network along with any associated infrastructure, such as substations and converter stations, again points to the appropriateness of BS 4142 in assessing the acoustic impact of such projects. The inverters and transformers deployed as part of the proposed project are examples of infrastructure of this kind.

3.0 METHODOLOGY

3.1 Overview

An assessment in accordance with BS 4142: 2014 has been undertaken in order to determine the acoustic impact of the proposed development. This approach is consistent with the guidance provided in the National Policy Statements published by DECC for this type of development. BS 4142 lends itself well to an assessment in accordance with NPPF, NPSE and NPPG as it allows the level of impact to be ascertained.

3.2 Baseline Conditions

In order to complete a BS 4142 assessment of the proposal, the background sound level at the times when the new sound source is intended to be operational should be measured. The background sound level is defined as the A-weighted sound pressure level that is exceeded for 90 % of the measurement time interval, or $L_{A90,\,T}$.

Measurements should be made at a location that is representative of the assessment locations, the time interval should be sufficient to obtain a representative value, and the duration should be long enough to reflect the range of background sound levels over the period of interest.

Precautions should be taken to minimise the influence on the results from sources of interference. Weather conditions that may affect the measurements should be recorded and an effective wind shield used to minimise turbulence at the microphone.

A statistical analysis, following the example given by BS 4142, should be used to determine an appropriate background sound level for the analysis from the range of results obtained.

[5] "Methods for rating and assessing industrial and commercial sound", BS 4142: 2014+A1: 2019, The British Standards Institution 2014 (Amended 2019)
[6] "Guidance on sound insulation and noise reduction for buildings", BS 8233: 2014, The British Standards Institution 2014
[7] "National Policy Statement for Electricity Networks Infrastructure (EN-5)", Department of Energy and Climate Change, July 2011

3.3 Propagation

The ISO 9613-2[8] propagation model shall be used to predict the specific sound levels due to the proposed development at nearby residential properties. The propagation model takes account of sound attenuation due to geometric spreading and atmospheric absorption. The assumed temperature and relative humidity are 10 ˚C and 70 % respectively.

Ground effects are also taken into account by the propagation model, with a ground factor of 0.5 adopted to reflect a mix of hard and porous ground between the site and the assessment locations. A 4 m receiver height shall be used. The effect of surface features such as buildings and trees shall not be included in the model although the effect of the solar panels is considered. There is a level of conservatism built into the model as a result of the adoption of these settings.

ISO 9613-2 is a downwind propagation model. Where conditions less favourable to sound propagation occur, such as when the assessment locations are crosswind or upwind of the proposed development, the sound levels would be expected to be less and the downwind predictions presented here would be regarded as conservative.

3.4 Assessment

Once the specific sound levels due to the proposed new sound source have been predicted the rating sound level can be calculated, it is this which is compared to the existing background sound level to determine the level of impact. The rating level is obtained by adding any penalties due to character that may be applicable to the predicted specific sound level.

Table 2 details how the difference between the rating sound level and background sound level is used to come to a judgement about the level of impact under BS 4142, although is noted that any assessment is context specific. These criteria relate well with the categories defined by NPSE: with the background sound level representing the NOEL, 5 dB above background representing the LOAEL and 10 dB above background the SOAEL.

Table 2 - BS 4142 Assessment Criteria

Rating Level	BS 4142 Assessment
Below background	Indicates low impact
5 dB above background	Indicates adverse impact
10 dB above background	Indicates significant adverse impact

Depending upon the diurnal variation in the background sound level, and the times when the proposed new sound source is scheduled to operate, it may be appropriate to undertake separate assessments for certain times of day e.g. day, evening and night.

4.0 BASELINE DATA

Baseline noise levels were determined in a survey undertaken by Hoare Lea Acoustics between Thursday 22nd April and Friday 23rd April 2021. Full details of the survey including the methodology, results, equipment used, photos and charts are provided in Hoare Lea's report (Appendix B)[9].

The measured background sound levels during day and night-time periods are shown in Table 3. The two survey positions, L1 and L2, are shown in red on the map in Figure 1 (Appendix C). Based on proximity the data recorded at survey location L1 is assumed to be representative of

[8] "Acoustics - Attenuation of Sound During Propagation Outdoors, Part 2: General Method of Calculation", International Organisation for Standardisation 1996
[9] RES Kingston Solar Farm, Gotham, Nottinghamshire. Noise survey report revision 3. Hoare Lea, 6 December 2021

houses H3, H7, H9 and H12-H14. Data from survey location L2 is assumed to represent houses H1, H2, H4-H6, H8, H10, H11 and H15-H17.

Table 3 - Baseline Data

House ID	X, m	Y, m	Day Background, dB L_{A90}	Night Background, dB L_{A90}	Day Residual, dB L_{Aeq}	Night Residual, dB L_{Aeq}
H1	452956	329025	32	28	38	33
H2	451951	328938	32	28	38	33
H3	454205	327170	28	25	38	31
H4	452641	329376	32	28	38	33
H5	451952	328938	32	28	38	33
H6	452734	328385	32	28	38	33
H7	453851	327926	28	25	38	31
H8	452711	329511	32	28	38	33
H9	453948	327684	28	25	38	31
H10	451952	328937	32	28	38	33
H11	452723	329479	32	28	38	33
H12	454218	327198	28	25	38	31
H13	454225	327165	28	25	38	31
H14	454760	327747	28	25	38	31
H15	452734	329530	32	28	38	33
H16	452759	329517	32	28	38	33
H17	451951	328938	32	28	38	33

5.0 ASSESSMENT

The main sources of sound within the proposed development are the 20 inverters and transformers located at the solar inverter substations along with the grid transformer at the grid substation. The inverters are assumed to be operating during daytime periods only when the solar farm is generating power. The transformers are assumed to be operating at all times.

Acoustic emission data for the proposed equipment is detailed in Table 4. The data corresponds to the maximum acoustic emission for each device as advised by the manufacturer. Predictions based on this data therefore represent the worst case and the noise levels would be expected to be less when the site isn't operating at maximum capacity.

Table 4 - Acoustic Emission Data

Equipment	Sound Pressure Level at 1m, dB L_{Aeq}
Solar substation (inverter plus transformer)	79
Solar transformer alone	71
Grid transformer	82

The sound emitted by the inverter cooling fans and transformers can have distinctive character. Under the subjective method described in BS 4142, a correction of 2 dB has been applied in the event that tones are just perceptible at the assessment locations.

Predicted specific sound levels and the resulting rating level at nearby properties are detailed in Table 5 for daytime periods and Table 6 for night-time periods. The rating level is then compared to the background sound levels of Table 3 to assess the impact at each location. An illustrative sound footprint for the proposed development showing the predicted specific sound level during daytime periods is provided in Figure 1 (Appendix C). An illustrative sound footprint for night-time periods is shown in Figure 2.

Table 5 – BS 4142 Assessment Results - Day

House ID	Specific Level, dB L_{Aeq}	Rating Level, dB L_{Aeq}	Rating vs Background, dB	Potential Impact
H1	30	32	0	Low/Minor
H2	17	19	-13	Low
H3	25	27	-1	Low
H4	34	36	4	Minor
H5	17	19	-13	Low
H6	23	25	-7	Low
H7	31	33	5	Minor/Adverse
H8	21	23	-9	Low
H9	31	33	5	Minor/Adverse
H10	17	19	-13	Low
H11	22	24	-8	Low
H12	25	27	-1	Low
H13	24	26	-2	Low
H14	19	21	-7	Low
H15	21	23	-9	Low
H16	21	23	-9	Low
H17	17	19	-13	Low

Table 6 – BS 4142 Assessment Results - Night

House ID	Specific Level, dB L_{Aeq}	Rating Level, dB L_{Aeq}	Rating vs Background, dB	Potential Impact
H1	26	28	0	Low/Minor
H2	13	15	-13	Low
H3	19	21	-4	Low
H4	30	32	4	Minor
H5	13	15	-13	Low
H6	18	20	-8	Low
H7	24	26	1	Minor
H8	19	21	-7	Low
H9	24	26	1	Minor
H10	13	15	-13	Low
H11	20	22	-6	Low
H12	19	21	-4	Low
H13	18	20	-5	Low
H14	14	16	-9	Low
H15	19	21	-7	Low
H16	19	21	-7	Low
H17	13	15	-13	Low

Whilst rating levels at the threshold for when adverse impacts may start to occur are predicted at two properties during daytime periods, BS 4142 states that absolute levels might be more relevant than the margin above background in circumstances where the background sound levels are low, as is the case at this site. The Environmental Health Department at Rushcliffe Borough Council has been consulted and agreed that an assessment based on absolute levels is more appropriate given the low background levels. The Community Noise Guidelines produced by the World Health Organisation (WHO) along with BS 8233: 2014 were agreed as being appropriate for use.

The WHO Guidelines for Community Noise[10] recommend sound levels intended to minimise health impacts in specific environments. At dwellings the Guidelines for Community Noise recommend that outside sound levels should not exceed 45 dB L_{Aeq} so that people may sleep

[10] "Guidelines for Community Noise", World Health Organisation, March 1999

with the windows open and not be disturbed. During the daytime the sound level should not exceed 50 dB L_{Aeq} to protect the majority of people from being moderately annoyed.

The predicted specific sound levels due to the proposed development during daytime periods from Table 5 are added to the residual sound levels measured during the day from Table 3 to determine the total ambient sound level during daytime periods at each house. The daytime ambient sound level is compared to the WHO target value for daytime periods in Table 7. The limit is met by a minimum margin of 11 dB(A).

Table 7 - WHO Assessment Results - Day

House ID	Ambient Sound Level, dB L_{Aeq}	Limit, dB L_{Aeq}	Margin, dB
H1	39	50	-11
H2	38	50	-12
H3	38	50	-12
H4	39	50	-11
H5	38	50	-12
H6	38	50	-12
H7	39	50	-11
H8	38	50	-12
H9	39	50	-11
H10	38	50	-12
H11	38	50	-12
H12	38	50	-12
H13	38	50	-12
H14	38	50	-12
H15	38	50	-12
H16	38	50	-12
H17	38	50	-12

The predicted specific sound levels due to the proposed development at night from Table 6 are added to the residual sound levels measured during the night from Table 3 to determine the total ambient sound level at each house for night-time periods. The ambient sound level during the night is compared to the WHO target value for night-time periods in Table 8. The limit is met by a minimum margin of 10 dB(A).

Table 8 - WHO Assessment Results - Night

House ID	Ambient Sound Level, dB L_{Aeq}	Limit, dB L_{Aeq}	Margin, dB
H1	34	45	-11
H2	33	45	-12
H3	31	45	-14
H4	35	45	-10
H5	33	45	-12
H6	33	45	-12
H7	32	45	-13
H8	33	45	-12
H9	32	45	-13
H10	33	45	-12
H11	33	45	-12
H12	31	45	-14
H13	31	45	-14
H14	31	45	-14
H15	33	45	-12
H16	33	45	-12
H17	33	45	-12

BS 8233 provides indoor ambient noise levels for dwellings for different activities, locations and times of day and states that it is desirable that these guideline values are not exceeded. The most conservative values specified are those conducive to sleeping or daytime resting in a bedroom where the internal noise level should not exceed 30 dB $L_{Aeq,\ 8\ hour}$ at night and 35 dB $L_{Aeq,\ 16\ hour}$ during the day. If a 15 dB reduction is assumed for attenuation through an open window then these limits are consistent with the outdoor limits specified by the WHO Community Noise Guidelines such that they are met by the same margins as shown in Tables 9 (day) and 10 (night).

Table 9 - BS 8233 Assessment Results - Day

House ID	Indoor Sound Level, dB L_{Aeq}	Limit, dB L_{Aeq}	Margin, dB
H1	24	35	-11
H2	23	35	-12
H3	23	35	-12
H4	24	35	-11
H5	23	35	-12
H6	23	35	-12
H7	24	35	-11
H8	23	35	-12
H9	24	35	-11
H10	23	35	-12
H11	23	35	-12
H12	23	35	-12
H13	23	35	-12
H14	23	35	-12
H15	23	35	-12
H16	23	35	-12
H17	23	35	-12

Table 10 - BS 8233 Assessment Results - Night

House ID	Indoor Sound Level, dB L_{Aeq}	Limit, dB L_{Aeq}	Margin, dB
H1	19	30	-11
H2	18	30	-12
H3	16	30	-14
H4	20	30	-10
H5	18	30	-12
H6	18	30	-12
H7	17	30	-13
H8	18	30	-12
H9	17	30	-13
H10	18	30	-12
H11	18	30	-12
H12	16	30	-14
H13	16	30	-14
H14	16	30	-14
H15	18	30	-12
H16	18	30	-12
H17	18	30	-12

A level of conservatism has been built into the assessment to compensate for the potential impact of uncertainty. The predicted specific sound levels presented in this assessment, and the sound footprints shown in Figures 1 and 2, reflect this. The amenity of nearby residents can be protected by the imposition of a planning condition relating to sound. A suggested appropriate form of wording for such a condition is provided in Appendix D.

6.0 CONCLUSIONS

An assessment of the acoustic impact of the proposed Kingston solar farm has been undertaken in accordance with BS 4142: 2014. Whilst the margin by which the rating level exceeds the background is at the threshold for when adverse impacts may start to occur, such an assessment is considered overly conservative in the context of the low background sound levels at this site. BS 4142 states that assessments against absolute limits might be more appropriate in this situation. An assessment against absolute limits, in line with WHO guidance and BS 8233 as agreed with the Rushcliffe Borough Council Environmental Health Department, demonstrates that such limits are met at all of the properties considered in the assessment.

APPENDIX A – EXPERIENCE AND QUALIFICATIONS

Author:

Name	Andrew Birchby
Experience	Acoustic Specialist, Renewable Energy Systems, 2017-Present Senior Acoustic Analyst, Renewable Energy Systems, 2014-2016 Acoustic Analyst, Renewable Energy Systems, 2012-2014 Technical Analyst, Renewable Energy Systems, 2006-2012
Qualifications	MIOA, Member of the Institute of Acoustics MSc Environmental Governance, Manchester University IOA Postgraduate Diploma in Acoustics and Noise Control MEng Systems Engineering, Loughborough University

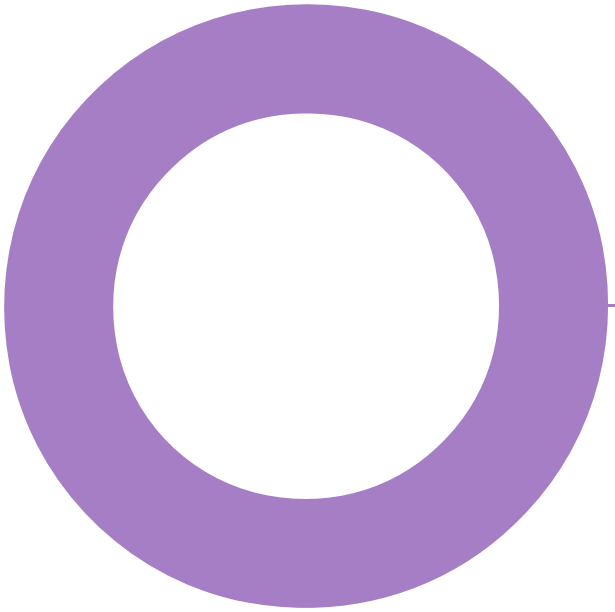
Checker/Approver:

Name	Dr Jeremy Bass
Experience	Head of Specialist Services/Senior Technical Manager, Renewable Energy Systems, 2000-Present Technical Analyst/Senior Technical Analyst, Renewable Energy Systems, 1990-2000 Foreign Exchange Researcher, Mechanical Engineering Laboratory, Tsukuba, Japan, 1989-1990 Research Associate, Energy Research Unit, Rutherford Appleton Laboratory, 1986-1989
Qualifications	MIOA, Member of the Institute of Acoustics MInstP, Member of the Institute of Physics PhD, The Potential of Combined Heat & Power, Wind Power & Load Management for Cost Reduction in Small Electricity Supply Systems, Department of Applied Physics, University of Strathclyde BSc Physics, University of Durham

APPENDIX B – BASELINE NOISE ASSESSMENT REPORT

RES Kingston Solar Farm. Gotham, Nottinghamshire.
Noise survey report.

ACOUSTICS
NOISE SURVEY REPORT
HOARE LEA
REVISION 3 – 06 DECEMBER 2021



Audit sheet.

Rev.	Date	Description of change / purpose of issue	Prepared	Reviewed	Authorised
1	30/04/2021	First version	RN	MMC	MMC
2	29/11/2021	Updated Figure 1	RN		
3	06/12/2021	Updated Figure 2	RN		

Project number: 1012302
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Contents.

1. Introduction.

Hoare Lea LLP have been appointed to undertake a background noise survey in relation to the proposed Kingston Solar Farm on land near Gotham, Nottinghamshire.

This report sets out the existing noise climate and summarises the background survey undertaken.

The methodology within BS 4142:2014 has been considered in the survey, to assist with determining prevailing background noise levels at the closest noise-sensitive receptors.

2. Site Context

The existing site was observed to be rural in nature, consisting primarily of empty fields and forest areas, with some localised commercial uses. Figure 1 below illustrates the outline of the proposed development overlaid onto the existing rural site area.

Figure 1: Site context showing the outline of the proposed development site.

3. Relevant guidance.

3.1 British Standard 4142:2014+A1:2019 Methods for rating and assessing industrial and commercial sound.

Current Government advice to Local Planning Authorities in both England and Wales makes reference to BS 4142 as being the appropriate guidance for assessing commercial operations and fixed building services plant noise. The British Standard provides an objective method for rating the significance of impact from industrial and commercial operations. It describes a means of determining sound levels from fixed plant installations and determining the background sound levels that prevail on a site.

The assessment of the impacts is based on the subtraction of the pre-existing background sound level ($L_{A90,T}$) from the rating level ($L_{Ar,Tr}$).

The standard does not give a definitive method for determining the background sound level but instead, as a commentary, states that *"the objective is not simply to ascertain a lowest measured background sound level, but rather to quantify what is typical during particular time periods"*.

Clause 8.1.4, which discusses the monitoring duration, states *"there is no "single" background sound level as this is a fluctuating parameter. However, the background sound level used for the assessment should be representative of the period being assessed."* As a note to this clause the following commentary is given on obtaining a representative backgrounds sound level:

"To obtain a representative background sound level a series of either sequential or disaggregated measurements ought to be carried out for the period(s) of interest, possibly on more than one occasion. A representative level ought to account for the range of background sound levels and ought not automatically to be assumed to be either the minimum or modal value."

The rating level is defined objectively as the specific source noise level in question (either measured or predicted) with graduated corrections for tonality (up to +6 dB), impulsivity (up to +9 dB), intermittency (+3 dB) and other sound characteristics (+3 dB) which may be determined either subjectively or objectively, if necessary.

The background sound level is subtracted from the rating level and the difference used to assess the impact of the specific noise source:

- A difference of around +10 dB is likely to be an indication of a significant adverse impact, depending on context;
- A difference of around +5 dB is likely to be an indication of an adverse impact, depending on context; and
- A difference of +0 dB or less is an indication of the specific sound source having a low impact, depending on the context.

This method is only applicable for external noise levels. The scope of the method for assessing industrial and commercial sound is clearly defined in Section 1 of the Standard; music, entertainment and people are included in the list of noise sources not intended to be assessed by the method.

4. Acoustic survey.

A series of acoustic survey measurements have been undertaken at the site to quantify the existing background noise climate in the area. Locations of the acoustic survey measurements and the resultant noise levels are shown in Figure 2. The weather during the site visits was overall clear with a slight breeze at all measurement positions.

4.1 Methodology.

The acoustic survey included four attended and two unattended measurements, at locations spatially distributed across the site area, representative of nearby noise sensitive residential receptors. The unattended measurements were undertaken from Thursday 22nd April to Friday 23rd April 2021. The attended survey measurements were undertaken during the day on Friday 23rd April 2021 to supplement the longer-term data acquired.

Measurements were made under free-field conditions, and weather conditions were generally suitable for the purpose of the measurements with fairly calm and dry conditions for the duration of the survey.

Note that this survey was undertaken whilst some restrictions related to the COVID-19 pandemic were still in place in England. However, due to the largely remote nature of the site area, where background noise levels are likely to remain relatively quiet, it was still deemed reasonably representative of noise levels in the area, although traffic noise levels could possibly lower than usual. The likelihood is that, if the measured levels represent a departure from long-term conditions at the site, they will tend to be lower which represents a conservative assumption.

The local noise climate was observed to consist of distant road traffic noise from the M1 motorway and A6 to the south west, as well as natural sources like bird noise and occasional vehicle pass-by on local roads. However overall, the levels of noise observed were consistent with the rural nature of the site. Although construction activity was ongoing at an area near the forest between locations A2 and A3 on Figure 2 below, this was not clearly discernible at these measurement positions and is therefore not considered to have influenced the measurements.

All survey equipment was field calibrated at the start and end of each set of measurements with no discernible drift in level observed. The measurement instrumentation used is listed in Appendix A attached.

4.2 Results.

Time history plots of the unattended measurements taken at L1 and L2 can be found in Appendix B attached. The weather conditions throughout the measurement period were dry and suitable for environmental noise measurements.

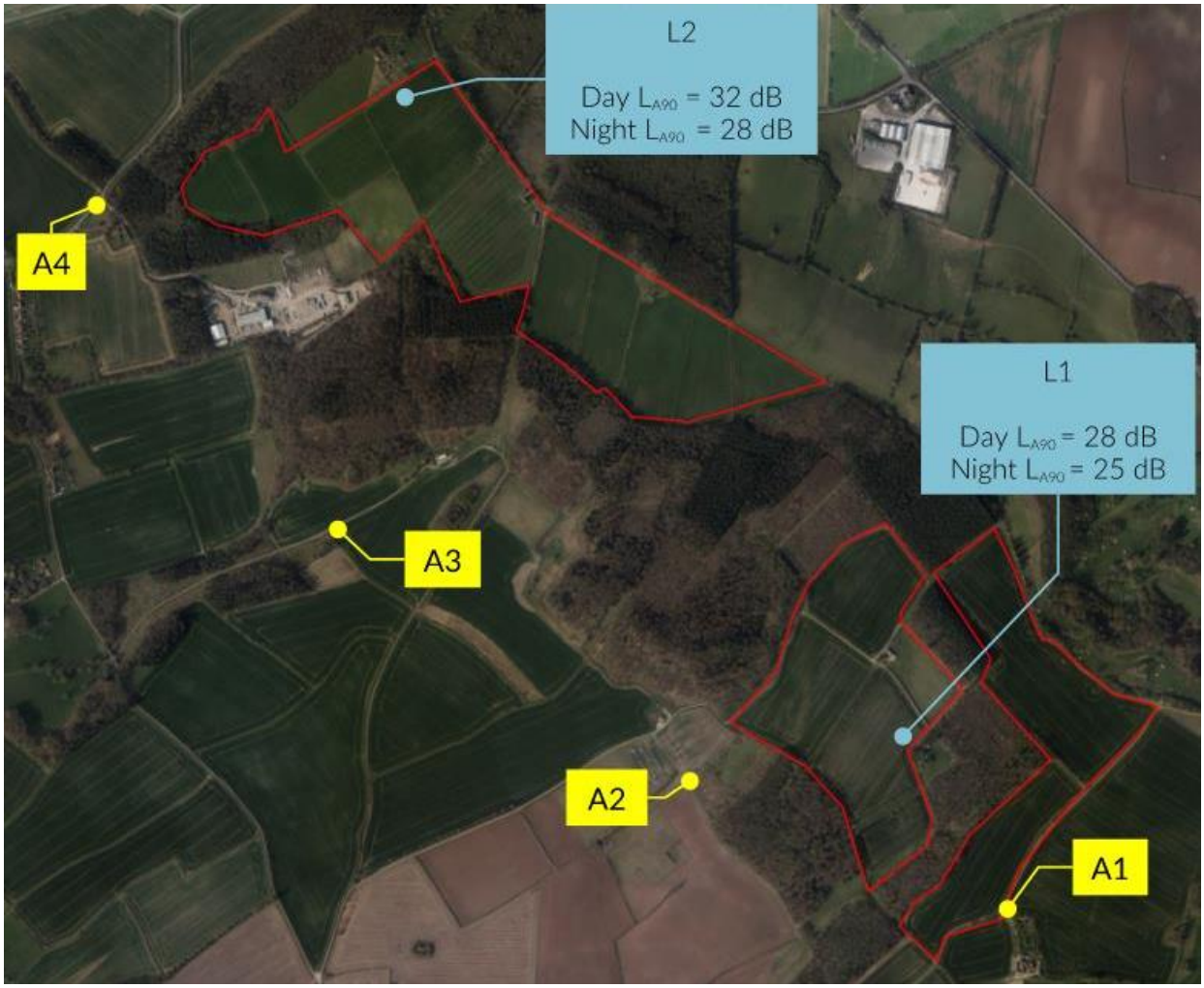


Figure 2: Acoustic survey locations, resultant representative background sound levels at each unattended measurement position (L1 & L2) and attended measurement positions (A1, A2, A3 & A4).

4.3 Background sound levels.

In line with the requirements of BS 4142, in order to "*quantify what is typical during particular time periods*", a statistical analysis of the measured background sound levels has been undertaken. The periods of interest have been taken as day-time (07:00 to 23:00) and night-time (23:00 to 07:00).

Assessment durations of 15-minutes are used for both day and night-time periods. A single $L_{A90,1h}$ measurement would always be higher than the lowest of the four 15-minute duration background sound levels it comprises. Therefore, this represents a conservative case.

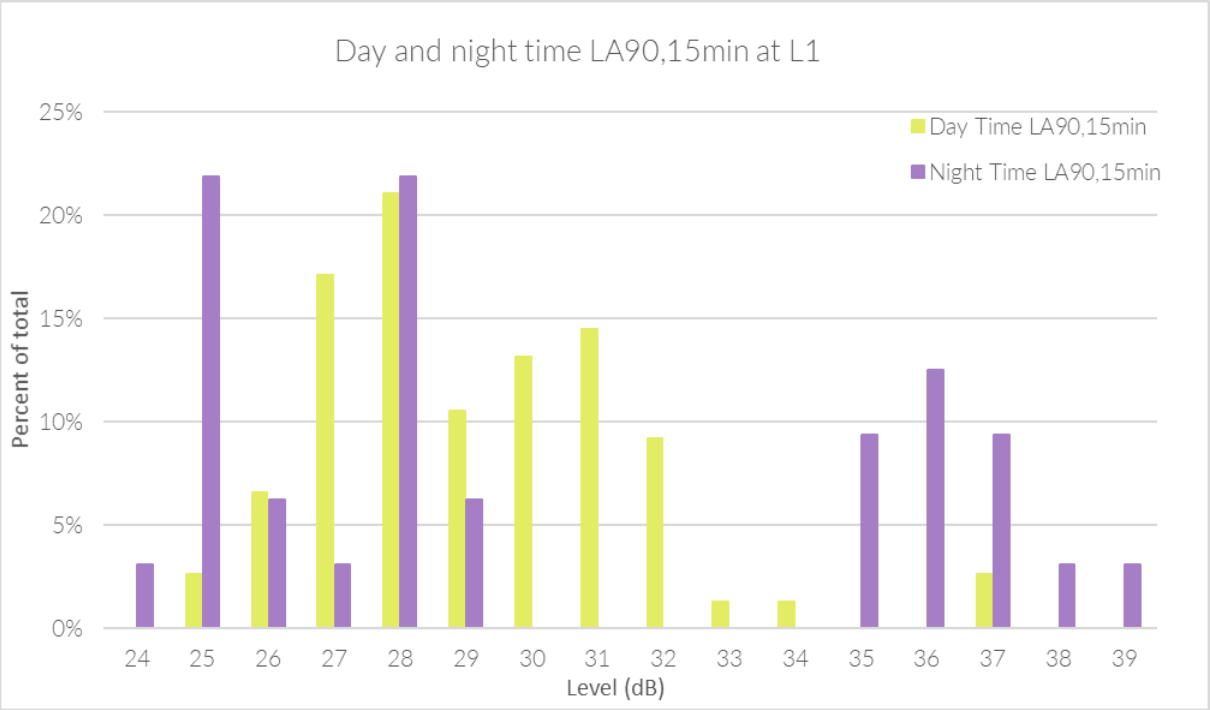


Figure 3: Statistical analysis of measured background noise levels at L1 near Gotham (Unattended Position).

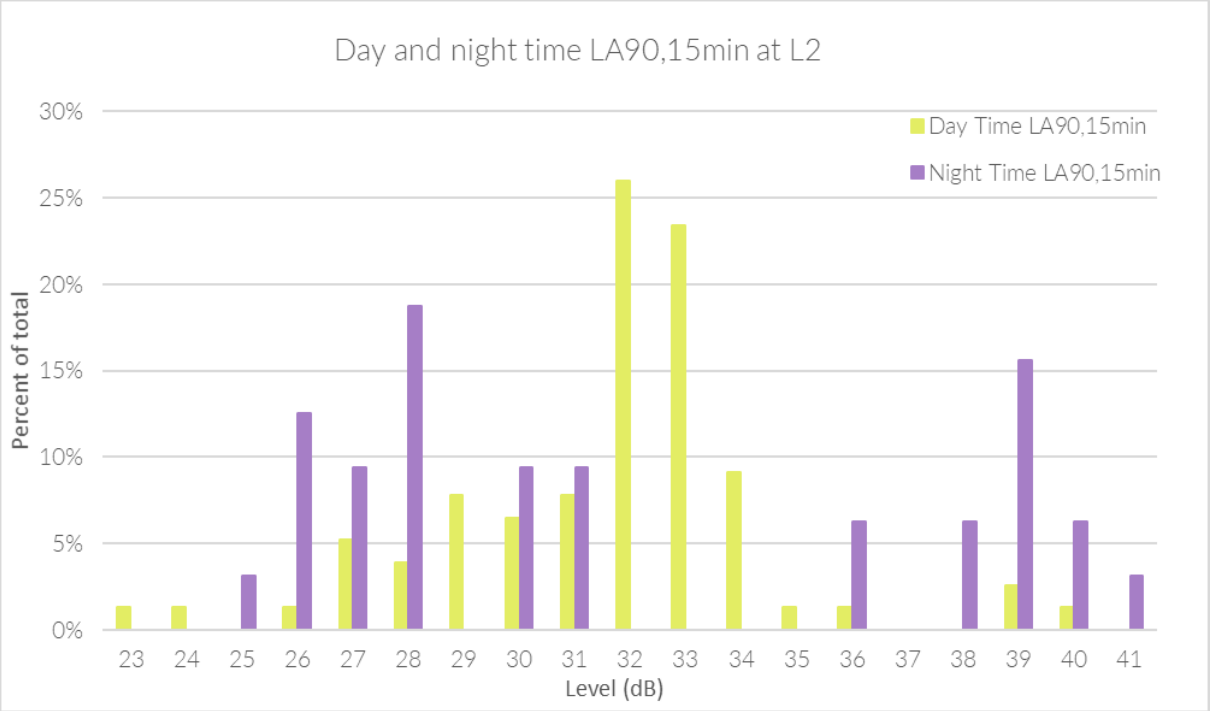


Figure 4: Statistical analysis of measured background noise levels at L2 near Gotham (Unattended Position).

Using the above statistical analysis charts together with the time history charts included in Appendix B, given the context of the site, representative (typical lowest) background sound levels have been determined to represent each of the periods of interest. The results are set out in Figure 2 above and Table 1 below for the unattended measurement positions, L1 and L2.

Monitoring Location	$L_{A90,T}$ background noise level (dB) measurement period (T) result	
	Day	Night
L1	28	25
L2	32	28

Table 1 - Representative L_{A90} background noise levels at unattended measurement locations

4.4 Attended measurements.

Attended noise measurements were carried out at four positions, over several 5-minute periods per position on 23rd April 2021 during day-time hours. The attended monitoring locations were selected to be representative of noise-sensitive residential properties neighbouring the site of the proposed Solar Farm. Monitoring results are set out in Table 2.

Attended measurement position ID	Measurement period start time	Measured $L_{Aeq,5min}$ (dB)	Measured $L_{A90,5min}$ (dB)
A1	23/04/2021 12:15	39.4	28.2
	23/04/2021 12:20	42.7	27.9
	23/04/2021 12:25	37.4	27.6
A2	23/04/2021 12:45	36.8	31.0
	24/04/2021 12:50	33.4	29.1
	25/04/2021 12:55	37.2	31.1
A3	25/04/2021 13:15	28.9	27.0
	25/04/2021 13:20	29.7	27.9
	25/04/2021 13:25	29.9	27.0
A4	25/04/2021 13:45	60.8	37.1
	25/04/2021 13:50	59.2	31.2
	25/04/2021 13:55	65.5	34.5

Table 2: Attended survey results.

Comparison of the results of Table 2 with levels measured at the fixed positions (L1 and L2) shows that similar levels were measured at location L1 (south of the site) in most cases. This indicates that the background daytime noise levels remain relatively uniform across the site. This was supported by on-site observations of the noise climate, whilst undertaking measurements at each position, as being largely influenced by distant traffic noise to the south-west.

The exception was position A4 to the north-west which was influenced by local traffic on Kegworth Road. For this location and nearby noise-sensitive locations, the background levels at measurement location L2 appear to be more representative.

5. Summary and conclusion.

Hoare Lea LLP have been appointed to undertake a noise survey in relation to the proposed development of a solar farm on land near Gotham, Nottinghamshire, in line with the methodology of BS 4142:2014.

Typical lowest background noise levels at each of the unattended measurement positions were determined for the day, evening and night-time periods. Measured noise levels were considered likely to be representative if marginally lower than usual due to ongoing restrictions associated with the Covid19 pandemic.

The results of supplementary attended noise measurements, undertaken nearby noise sensitive residential receptors, showed that this was representative of typical background noise environment at other neighbouring properties.

Appendix A: Acoustic survey equipment & Photos.

Equipment	Type	Serial Number	Last Calibrated
Sound Level Meter	Rion NL-52	00632045	23/12/2019
Pre-amplifier	Rion NH-25	32073	23/12/2019
Microphone	Rion UC-59	05212	23/12/2019

Table B1 - Sound level meter L1

Equipment	Type	Serial Number	Last Calibrated
Sound Level Meter	Rion NL-52	00331819	23/12/2019
Pre-amplifier	Rion NH-25	21770	23/12/2019
Microphone	Rion UC-59	10813	23/12/2019

Table B2 - Sound level meter L2

Equipment	Type	Serial Number	Last Calibrated
Sound Level Meter	Rion NL-31	00910437	18/10/2017
Pre-amplifier	Rion NH-21	07193	18/10/2017
Microphone	Rion UC-53A	309256	18/10/2017

Table B3 - Sound level meter 3 - attended survey

A field calibration was carried out at the start and end of the measurements, using:

Equipment	Type	Serial Number	Last Calibrated
Calibrator	Rion NC-74	34551669	27/04/2017

Table B4 - Calibrator

Figure B 1- Measurement Position L1 (1 of 2) - unattended

Figure B 2- Measurement Position L1 (2 of 2) - unattended

Figure B 3- Measurement Position L2 (1 of 2) - unattended

Figure B 4- Measurement Position L2 (1 of 2) - unattended

Figure B 5- attended measurement position A1

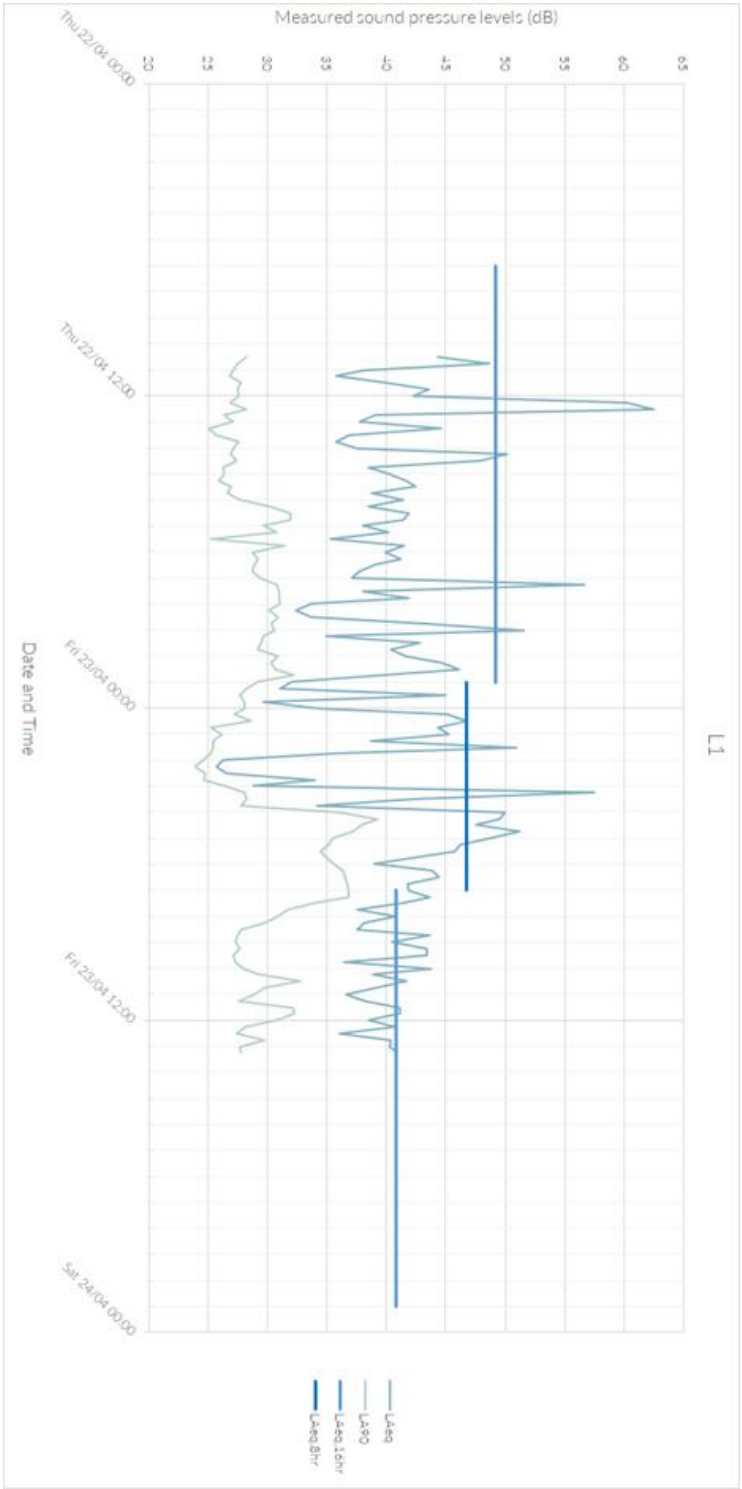
Figure B 6- attended measurement position A2

Figure B 7- attended measurement position A3

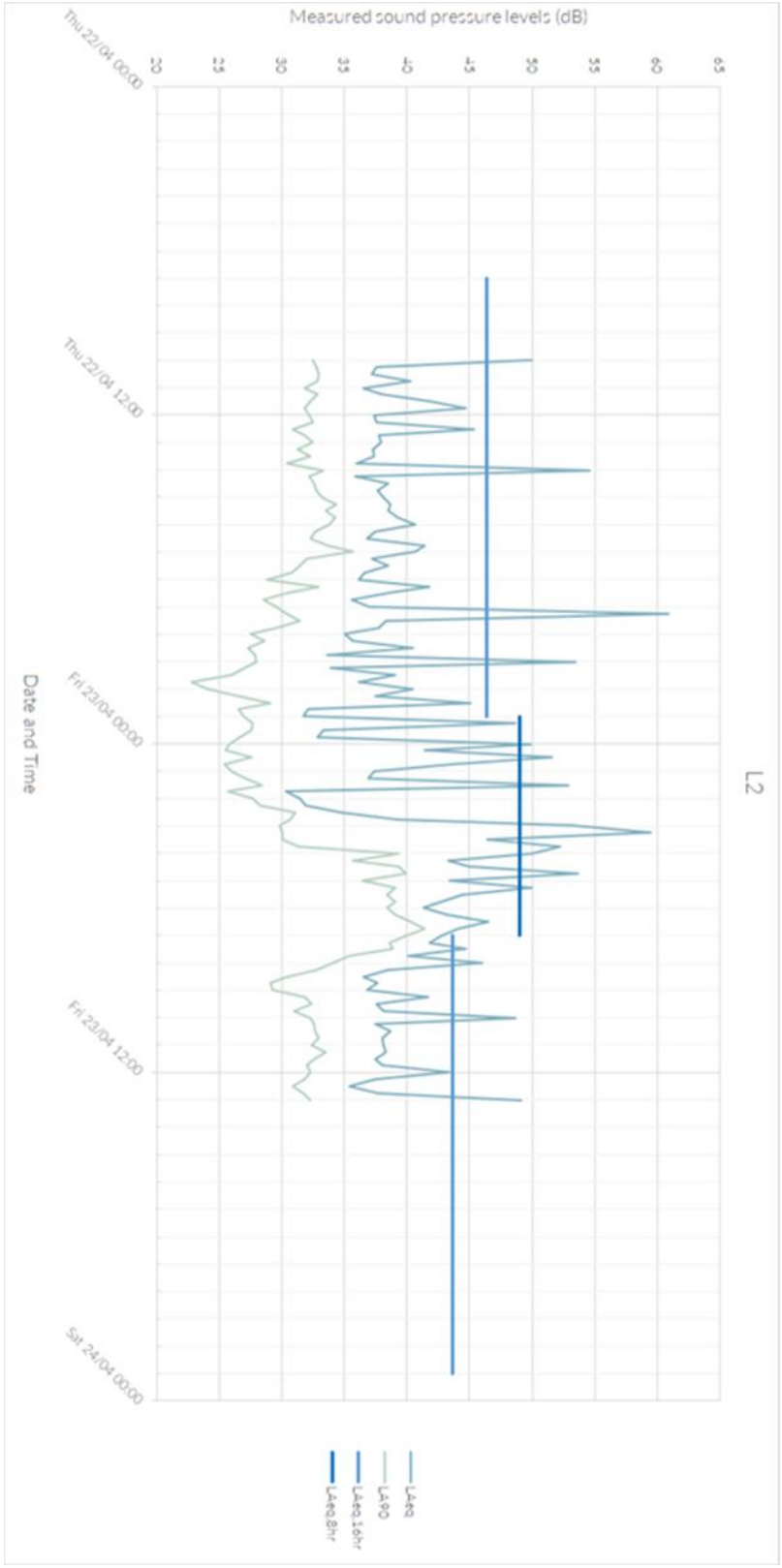
Figure B 8- attended measurement position A4

Appendix B: Time history chart.

B.1 Unattended measurement position L1



B.2 Unattended measurement position L2



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APPENDIX C – FIGURES

Figure 1 – Predicted Specific Sound Footprint - Day

The L_{Aeq} descriptor has been used
Grid intervals at 1km
Red receiver icons indicate survey locations

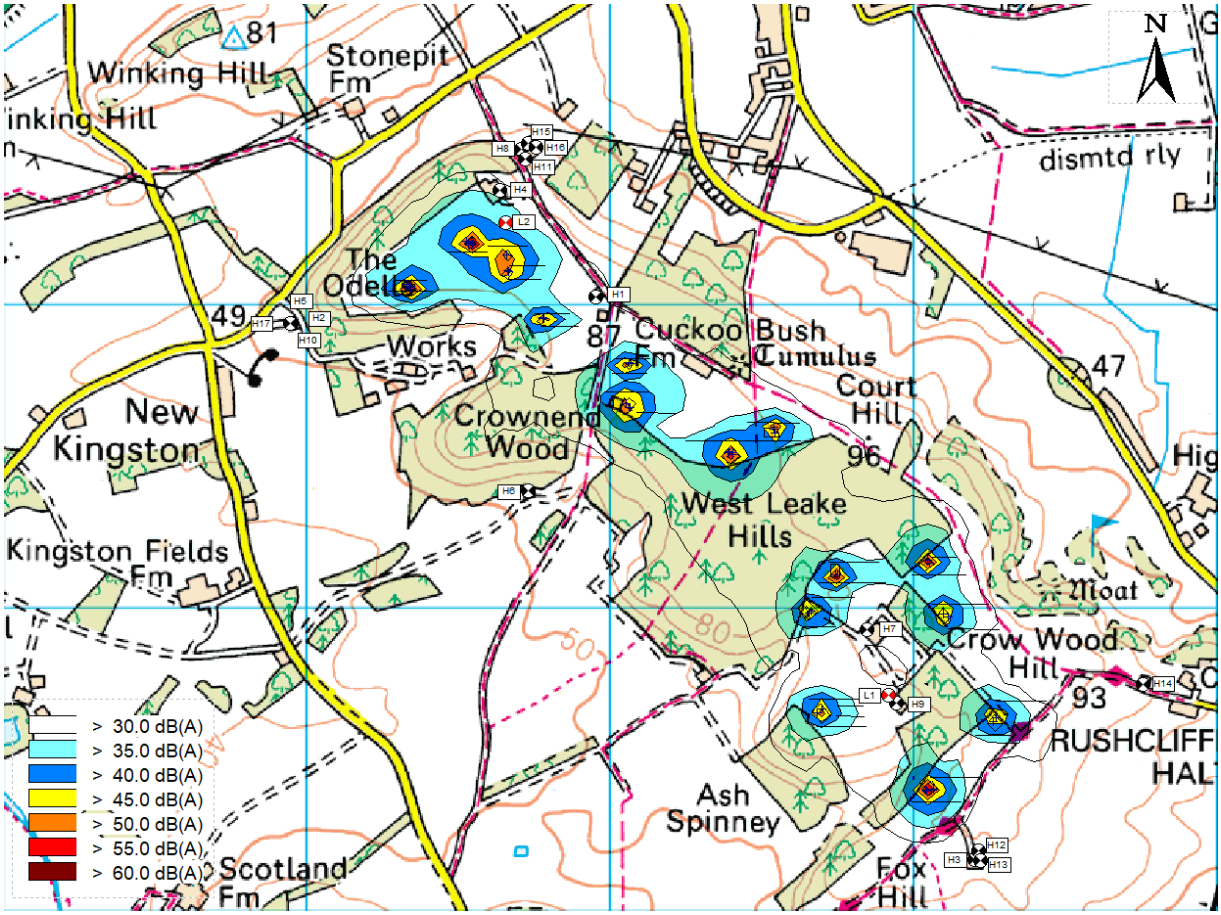
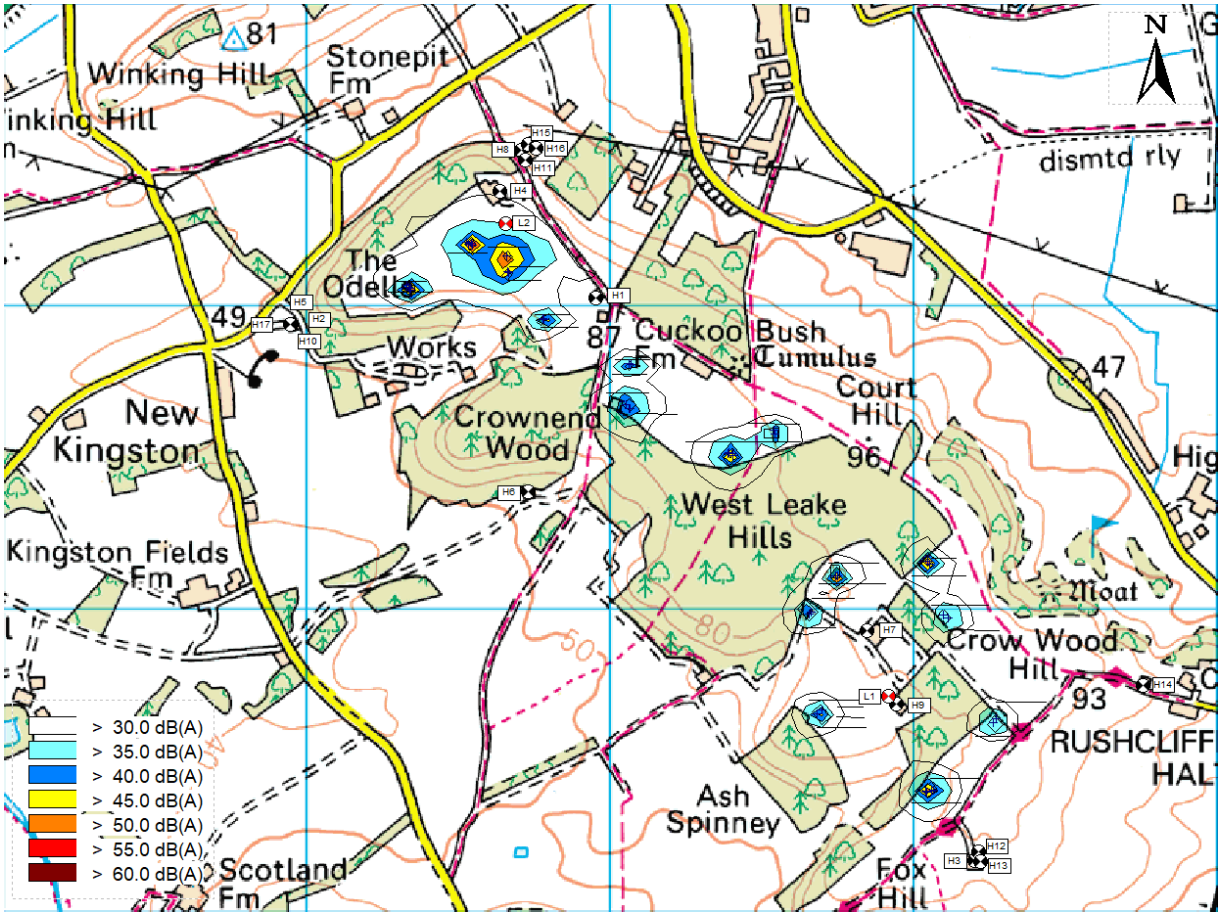


Figure 2 - Predicted Specific Sound Footprint - Night

The L_{Aeq} descriptor has been used

Grid intervals at 1km

Red receiver icons indicate survey locations



APPENDIX D – SUGGESTED PLANNING CONDITION WORDING

The facility shall be designed and operated to ensure that the sound level shall not exceed 50 dB L_{Aeq} during the day and 45 dB L_{Aeq} at night outside the nearest residential properties (as identified in RES report 04533-2749583-02).