THE DROVES
SOLAR FARM

The Droves Solar Farm

Appendix 10.3: Construction and Noise Modelling

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Date: November 2025
PINS reference: EN0110013
Document reference: APP/6.4 (Original)
APFP Regulation Reg 5(2)(a)
Planning Act 2008
Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

6.4 ES Appendix 10.3 Construction and Noise Modelling

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1. Construction Noise and Vibration

1.1 Construction Noise

The construction assessment has been based on a number of assumptions for construction activity, which have been outlined in ES Chapter 10: Noise and Vibration [APP/6.2]. The construction noise impact assessment considers the construction activity typical for the type and scale of the Scheme, based on British Standard (BS) 5228-1 *'Code of Practice for Noise and Vibration Control on Construction and Open Sites Part 1: Noise'* (British Standards Institution (BSI), 2014) tables of various construction activities and experience of similar developments. Table 10.3.1 below shows the assumed construction stages that would take place on the Site and the associated overall Sound Power Levels during these stages. These Sound Power Levels are based on likely worst-case assumptions including: the typical emission levels, number of plant items in operation, and the percentage of time the relevant plant will be in use during a 11-hour period (07:00 to 18:00 weekday working hours (as outlined in ES Chapter 5: Scheme Description [APP/6.1]). Reference data for the emission levels of typical construction plant set out in BS 5228-1 (BSI, 2014) was used were possible, supplemented with inhouse available manufacturer's data where necessary. It is conservatively assumed that there are no screening effects, and that the ground cover is characterised as 50% hard / 50% soft for all construction assessment results.

Based on professional judgement, receptors more than 500 m are unlikely to experience significant noise levels from the typical construction activities involved in the development, as such 12 West Acre Road and Silver Drift NSRS (shown in Figure 10.2.1 in ES Appendix 10.2: Noise Survey [APP/6.4]) have been excluded from detailed assessments.

Table 10.3.1 shows predicted Sound Pressure Levels at the receptors calculated from the overall assumed Sound Power Level for the activity. The activities are split between the Solar PV Site and BESS works and the substations (with Grid Infrastructure) works, which are at different distances to each receptor based on ES Figure 5.1: Concept Masterplan [APP/6.3] showing the chosen or candidate areas for Customer Substation and National Grid Substation with Grid infrastructure, and Battery Electrical Storage System (BESS) and Solar PV Site. The assessment assumes that access road works and PV panel piling can occur at any closest point within the boundary as worst-case, whereas the site compound and works related to National Grid Substation and Customer Substation and BESS are situated within their designated areas as set out in ES Figure 5.1: Concept Masterplan [APP/6.3].

Table 10.3.1 Construction plant and equipment assumptions (based on BS 5228-1 guidance)

Construction Activity	Equipment/Plant	Assumed Overall Sound Power L_{wA} (dB)	Receptor	Minimum Distance to Activity (m)	Sound Level at Receptor L_{Aeq} (dB)
Solar PV & BESS Works					
Access Road (New / Upgrade)	Excavator / Tamper / Wheeled Backhoe Loader / Dumper / Vibratory Roller / Delivery Lorry / Asphalt Paver	108	Glebe Cottages	220	52
			South Acre Hall	280	49
			Finger Hill Cabin	142	56
			Keepers Cottage	70	63
			The Off Barn	650	41
			Hall Farm	500	44
			The Splashes	13	78
Site Compound	Excavator / Dozer / Wheeled Backhoe Loader / Vibratory	112	Glebe Cottages	220	55
			South Acre Hall	280	53
			Finger Hill Cabin	142	59

Construction Activity	Equipment/Plant	Assumed Overall Sound Power L_{wA} (dB)	Receptor	Minimum Distance to Activity (m)	Sound Level at Receptor L_{Aeq} (dB)
	Roller / Dump Truck / Delivery Lorry / Mobile Tele-crane		Keepers Cottage	85	64
			The Off Barn	710	44
			Hall Farm	500	47
			The Splashes	530	47
Earthworks (BESS)	Excavator / Dozer / Wheeled Backhoe Loader / Dump Truck	111	Glebe Cottages	400	48
			South Acre Hall	460	47
			Finger Hill Cabin	500	46
			Keepers Cottage	1250	37
			The Off Barn	710	42
			Hall Farm	3100	28
			The Splashes	1960	33
M&E Installation Works (BESS)	Delivery Lorry / Mobile Tele-crane / Generator / Towing Tractor / Compressor / Tools / Hammering	108	Glebe Cottages	400	45
			South Acre Hall	460	44
			Finger Hill Cabin	500	43
			Keepers Cottage	1250	34
			The Off Barn	710	40
			Hall Farm	3100	25
			The Splashes	1960	30
Piling (Solar PV)	Tubular Steel Piling (Hydraulic Jacking 240mm) / Mobile Tele-crane / Wheeled Backhoe Loader	117	Glebe Cottages	260	58
			South Acre Hall	280	57
			Finger Hill Cabin	150	63
			Keepers Cottage	85	69
			The Off Barn	710	48
			Hall Farm	490	52
			The Splashes	530	51
Customer Substation, National Grid Substation Works					
Enabling Works (Earthworks & Piling)	Excavator / Wheeled Backhoe Loader / Dump Truck / Delivery Lorry / Vibratory Roller / Tubular Steel Piling	120	Glebe Cottages	400	57
			South Acre Hall	460	56
			Finger Hill Cabin	500	55
			Keepers Cottage	1250	46
			The Off Barn	710	52
			Hall Farm	3100	37

Construction Activity	Equipment/Plant	Assumed Overall Sound Power L_{wA} (dB)	Receptor	Minimum Distance to Activity (m)	Sound Level at Receptor L_{Aeq} (dB)
			The Splashes	1960	42
Civil Works & Concrete Pour	Concrete Truck / Generator / Compressor / Power Tools / Delivery Lorry	112	Glebe Cottages	400	50
			South Acre Hall	460	48
			Finger Hill Cabin	500	47
			Keepers Cottage	1250	39
			The Off Barn	710	44
			Hall Farm	3100	30
			The Splashes	1960	34
M&E Installation Works	Delivery Lorry / Mobile Tele-crane / Generator / Towing Tractor / Compressor / Tools / Hammering	110	Glebe Cottages	400	47
			South Acre Hall	460	46
			Finger Hill Cabin	500	45
			Keepers Cottage	1250	36
			The Off Barn	710	42
			Hall Farm	3100	28
			The Splashes	1960	32
Grid Connection Infrastructure Works					
Temporary Works – Existing Gird Pylons	Compressor / Power tools / Generator / Wheeled Backhoe Loader / Lorry/ Mobile tele crane	110	Glebe Cottages	220	53
			South Acre Hall	150	57
			Finger Hill Cabin	75	63
			Keepers Cottage	1220	36
			The Off Barn	410	47
			Hall Farm	2800	28
			The Splashes	2200	31
New Grid Infrastructure Construction	Concrete truck / Tractor & cable drum trailer / Compressor / Power tools / Delivery lorry / Tracked excavator / Mobile tele crane / Hammering	112	Glebe Cottages	285	53
			South Acre Hall	400	50
			Finger Hill Cabin	540	47
			Keepers Cottage	1340	38
			The Off Barn	480	48
			Hall Farm	3450	29
			The Splashes	2200	33

Table 10.3.1 shows all predicted levels of noise from all activities to be below 65 dB L_{Aeq}, except for piling works for the solar PV arrays which result in noise levels above 65 dB L_{Aeq} (at 69 dB L_{Aeq}) at Keepers Cottage only and road upgrade works in proximity to The Splashes with noise levels of 78 dB L_{Aeq}. Therefore, all receptor for all activities except for these receptors are associated with 'low' to 'negligible' magnitude of impact based on the criteria presented in Table 10.5 of ES Chapter 10: Noise and Vibration [APP/6.2]. Keepers Cottage during construction piling works can experience levels above 65 dB L_{Aeq} and is associated with a 'medium' magnitude of impact.

The Splashes are a cluster of residential receptors located in proximity to the A47 slip road which will be upgraded as part of the Scheme. Although the predicted worst-case noise levels could be associated with a 'high' impact based on the criteria in Table 10.5 of ES Chapter 10: Noise and Vibration [APP/6.2], the road upgrade works are expected to be very short in duration at the nearest point to each receptor, in practice they are unlikely to generate noise levels up to 78 dB L_{Aeq} and with prior notice residents are generally tolerant of road work noise of short duration, therefore, the magnitude of impact is considered to be 'low' based on professional judgement.

The likely construction noise levels estimated at different distances from the Horizontal Directional Drilling (HDD) and cable trenching works has been undertaken in accordance with BS 5228-1 which provides methods for undertaking such predictions. The possible locations of cable trenching and HDD works are unknown at this stage; it is assumed at this stage that they can take place anywhere within the designated zone in main site boundary as worst-case. HDD works are not expected at areas of temporary Grid Infrastructure works (which will mainly consist of removal/rerouting of pylons), or the road upgrade works at the southern area near The Splashes. HDD may also occur during the night-time for less than 1-week duration, as such, Table 10.3.2 presents the activity, the equipment, overall sound Power Levels, and resulting Sound Pressure Levels at incremental distances to show extent of effects and number of receptors affected.

Table 10.3.2 Predicted L_{Aeq} noise levels (dB) based at different distances for each of the working stages

Activity	Equipment/Plant	Assumed Overall Sound Power L_{wA} (dB)	Distances (m)	Sound Level at distance L_{Aeq} (dB)	No. of Receptors Affected
HDD Works	HDD power unit and drill / HDD generator / Bentonite pump / Bentonite mixer / Generator for Site Offices	115	25	79	1
			50	72	1
			100	65	1
			200	59	2
			250	57	2
			300	55	4
			400	52	5
Cable Trenching & Backfilling	Excavator / dumper / Cable drum trailer / wacker plate	107	25	71	1
			50	64	1
			100	58	1
			150	54	2
			200	51	2
			300	47	4
			400	44	5

As can be seen in Table 10.3.3, for determination of night-time impacts based on the criteria in Table 10.5 of ES Chapter 10: Noise and Vibration [APP/6.2], HDD activity predicted noise levels are below 55 dB(A) at a distance greater than 300 m. 'Medium' or 'high' magnitude of impacts are expected for a level above 55 dB(A) only, as such, only receptors within this distance are expected to have 'medium' or 'high' magnitude of impact. Four receptors are within the distance of 300 m from site boundary: Keepers' Cottage, Finger Hill Cabin, South Acre Hall, and Glebe Cottages. As such, these four receptors can potentially have 'medium' to 'high' magnitude of impact for HDD activities during the night.

With regards to daytime works, only one receptor (Keepers Cottage) is within 50 m distance of the site boundary for cable trenching works and within 100 m for HDD works, based on the 65 dB(A) criterion in Table 10.5 of ES Chapter 10: Noise & Vibration [APP/6.2], as such, only this receptor can potentially have 'medium' to 'high' magnitude of impact from HDD and cable trenching activities during the day. It should, however, be noted that these distances are from the closest point of the site boundary to the respective receptor, in practice, HDD and cable trenching locations can be further away within the site perimeter itself which can result in 'low' to 'negligible' magnitude of impacts at all receptors.

Public Right of Way (Construction Noise)

The Scheme includes several Public Right of Way (PRoW). ES Chapter 5: Scheme Description [APP/6.1] outlines a minimum separation distance of 15 m from construction activity to the PRoW, as the exact location of construction activity is unknown at this stage, it is assumed that construction activity can take place anywhere and as close to 15 m from PRoW. Predicted levels, based on a worst-case separation distance of 15 m, range from 77 dB L_{Aeq} to 88 dB L_{Aeq} from the 108 dB L_{WA} to 120 dB L_{WA} of the construction activities within the Site, however, noise levels would decrease as PRoW users move away from the construction activity.

The construction magnitude of impact criteria presented in Table 10.5 of ES Chapter 10: Noise and Vibration [APP/6.2] is applicable over a working day period and PRoW use is transient which will reduce exposure.

1.2 Construction vibration

Vibration predictions have been undertaken using reference information from BS 5228-2 *'Code of Practice for Noise and Vibration Control on Construction and Open Sites Part 2: Vibration*' (BSI, 2014) for vibratory plant at varying distances, based on worst-case assumptions likely to over-estimate actual vibration levels in practice. Although HDD plant may also generate vibration locally, given this work is relatively distant from the nearest sensitive receptors, it does not require further consideration.

For vibratory ground compaction, predictions were made assuming a 0.8 mm drum vibration amplitude and a 1.5 m drum width, both for steady state and at start-up/run-down. For the percussive piling, predictions are based on piles at refusal with an 85 kJ (Kilojoules) hammer energy as a worst case. HDD work is typically considered to produce similar vibration levels as vibratory piling be Table 10.3.3 sets out the predicted Peak Particle Velocity (PPV) in mm/s for different separation distances.

Table 10.3.3 Predicted worst-case vibration levels (PPV, mm/s) for key activities

Distance (m)	Vibratory compaction, steady state, mm/s	Vibratory compaction, start-up/run-down, mm/s	Percussive piling, mm/s	Vibratory Piling / HDD drilling, steady state, mm/s	Vibratory Piling / HDD drilling, start-up/run-down, mm/s
25	0.8	1.1	0.7	0.7	1.3
30	0.6	0.9	0.6	0.5	1.0
50	0.3	0.5	0.3	0.3	0.5
100	0.1	0.2	0.1	0.1	0.2

Table 10.3.3 shows predicted vibration levels to reduce below 1 mm/s for all activities at 50 m distances, only one receptor (Keepers Cottage) is within 50 m distance of site boundary and as such can potentially have 'medium' magnitude of impact based on the criteria presented in Table 10.5 of ES Chapter 10: Noise and Vibration [APP/6.2].

For PRoW receptors, ground compaction within 15 m (worst-case distance) could lead to higher vibration levels marginally above 1 mm/s, corresponding to a medium impact magnitude.

1.3 Construction Traffic Noise

Construction traffic movements on existing local surrounding roads also represent a potential source of noise impacts to surrounding properties. Table 10.3.4 shows the future (2031) traffic flow with and without Development Construction Traffic and the predicted maximum change in traffic noise, in accordance with CRTN method, associated with the changes in traffic flows. Baseline levels on other roads are below 1000 daily movements which is below the threshold at which CRTN calculations can be reliably undertaken. Table 10.3.5 presents the predicted noise levels, in accordance with BS 5228-1 method, at receptors from the number of passing HGVs over a working day.

Table 10.3.4 - Projected traffic flows and CRTN predicted increase in daily average traffic noise levels

Road	Without Development (2031 Baseline)		With Development Construction Traffic (2031)		Maximum Change in Traffic Noise Leve, dB
	Annual Average Daily Traffic Flow	% Heavy Goods Vehicles	Annual Average Daily Traffic Flow	%Heavy Goods Vehicles	
A1065 South	8394	4	8853	5	0.4
A1065 MID	8269	5	8651	5	0.2
A1065 North	7535	6	7694	6	0.1

Table 10.3.5 – BS5228-1 predicted noise levels at receptor boundary from passing HGVs in a working day ($L_{Aeq,T}$)

Road	HGVs per working day	Predicted $L_{Aeq,T}$ at Receptor Boundary dB(A)
South Acre Road North	11	51
South Acre Road South	7	49
West Acre Road	16	53
Narford Lane	15	52
River Road South	12	-
River Road North	2	-

Table 10.3.4 indicates a maximum potential increase of traffic noise no more than 0.4 dB on A1065 South, this corresponds to 'negligible' magnitude of impact based on criteria in Table 10.5 of ES Chapter 10: Noise and Vibration [APP/6.4]

In addition to traffic noise on the roads of Table 10.3.4, roads carrying lower baseline traffic levels below 1000 vehicles per day are considered in Table 10.3.5. The impact from the construction traffic, specifically HGV traffic, passing to and from the site is considered for nearest receptors on the respective roads assuming a worst-case receptor boundary to road distance of 5 m, with the exception of River Road North & South, which cuts across the Site from Narford Road to West Acre Road and does not contain any receptors along the road. Based on the prediction method in BS 5228-1, with a Sound Power Level of 108 dB(A) for a typical HGV passing, the worst-case predicted level at the closest receptors is 53 dB L_{Aeq} at West Acre Road.

This worst-case predicted levels represent a 'negligible' magnitude of impact at all receptors based on criteria in Table 10.5 of ES Chapter 10: Noise and Vibration [APP/6.2].

2. Operational Noise

Prediction of sound propagation at representative noise sensitive receptors, closest to the site boundary, has been undertaken in accordance with ISO 9613-2 'Acoustics – attenuation of sound during propagation outdoors – Part 2: General method of Calculation (International Organisation for Standardisation (ISO), 2024). This was implemented in the CadnaA®[1] prediction software. Propagation over soft ground was assumed, typical of cultivated land in rural conditions, with receptor locations modelled at a height of 4 m to represent a first-floor window. Please note that the model did not consider any screening from the solar PV panels themselves which were not included in the noise model as solid elements, therefore representing a precautionary assumption.

2.1 Noise sources assumed

The exact design and specifications of the installations and equipment will be the result of a future tendering process and therefore representative equipment has been assumed for this noise assessment, based on manufacturer equipment specifications and available data. The assumed noise emission levels are set out below in Table 10.3.6. Spectral data (where relevant) was based on manufacturer data when available or from experience of representative units and was scaled to achieve the Sound Power Levels of the respective equipment.

Table 10.3.6 - Electrical/mechanical plant in the Scheme – Assumed Sound Power Levels in dB(A)

Noise Source [Quantity]	Sound Power Levels, dB, L_{WA}	Octave Band Centre Frequency (Hz), A-weighted							
		63	125	250	500	1000	2000	4000	8000
CS–400kV SGT Transformer [4]	93	66	84	90	84	84	80	75	76
BESS-PCS Inverters [148]	92	42	61	77	82	86	87	87	82
Solar-Conversion Units [145]	91	38	58	74	79	83	84	89	79
BESS-MV Transformers [74]	80	53	71	77	71	71	67	62	63
BESS-Battery Containers [430]	75	50	59	67	67	68	68	68	65

Table 10.3.6 shows the quantity of each respective plant assumed in the assessment based on the project capacity. The proposed National Grid Substation will not contain any noise emitting plant and will consist of only grid connection infrastructure, and all transformers (4x) will be in the Customer Substation. The Conversion Unit in the solar PV array fields included an inverter and transformer unit, however, as the inverter was the clearly dominant noise source, i.e., more than 10 dB higher than transformers, only these were included in the noise model.

The Sound Power Level of a typical 150 MVA Super Grid Transformer (400/33 kV SGT) is 92 dB(A) from the main unit at 50% load and 84 dB(A) from the cooling system, therefore, the combined level of 93 dB L_{WA} has been used in the model. Typically, under normal operating conditions, SGTs are less than 50% loaded, under maintenance conditions, SGTs may be 50% loaded and where there is a single SGT under fault conditions it may reach an operating load above 50%. While maintenance conditions may occur regularly, faulty operating

1 DataKustik GmbH, Computer Aided Noise Abatement (CadnaA®) software package, (Link https://www.datakustik.com/products/cadnaa/cadnaa/)

conditions are unlikely as four SGTs are proposed in the Scheme, it is therefore considered that the sound power level of 93 dB(A) used for the assessment is a conservative value.

The Solar PV Arrays only operate during daylight and are not expected to operate at night (it can however operate between 05:00 to 07:00 in summer time), whereas the BESS machinery is likely to operate at reduced capacity during the night-time due to the reduced load and cooling requirements, however, all plant has been modelled at 100% operating conditions for day and night periods which presents a highly conservative assessment.

As outlined in ES Figure 5.1: Concept Masterplan [APP/6.3], Fields 27 will accommodate the National Grid Substation and Customer Substations and Fields 27 and 24 will accommodate the BESS. The model showed BESS to be the main noise source from the Scheme therefore, BESS was modelled at both Field 27 and 24. In order to minimise loss of solar PV area, the BESS is proposed to be located around the NSG and CS compound in field 27, roughly 5 ha in area. The BESS is expected to be no more than 10 ha as such the spill-over area of 5 ha of BESS has been modelled to the northern area of Field 24. The exact layout of the equipment within the BESS is not known as such the BESS has been modelled as an area source where the total Sound Power Level of the area source is the logarithmic sum of all the noise emitting sources i.e. PCS Invertors, MV Transformers, and Containers, within the area (split between the two fields).

The solar panels may use Fixed Arrays or Single Axis Tracking (SAT) technology with typically one motor operating for every 100 m of solar array. Fixed arrays do not produce any noise and manufacturer data for a typical SAT engine suggests a sound power of 50 dB(A) for such units. These would only typically run for a few seconds every few minutes and their noise emission levels are very low, with predicted levels of 11 dB at 50 m distance. Therefore, noise contribution from the SAT motors is considered negligible and were not included in the model and assessment.

2.2 Prediction results.

Table 10.3.7 presents the predicted operational noise levels from the model with separate results provided for the contribution of the plant in the BESS area and other plant modelled across the Site. The model and all predictions in this assessment incorporate the embedded mitigations outlined in ES Chapter 10: Noise & Vibration [APP/6.2]. The resulting BS 4142 assessment is set out for day- and night-time periods in Table 10.3.8.

Table 10.3.7 - Predicted operational noise levels (L_{Aeq}, dB) and respective noise contributions from each element of the Scheme– prior to any additional mitigation.

Receptors	Predicted Sound Levels, dB L_{Aeq}			
	All Plant	Customer Substation Only	Solar Conversion Units Only	BESS Storage Only
The Off Barn	32	22	20	32
Glebe Cottages	28	18	18	27
South Acre Hall	26	16	16	25
Finger Hill Cabin	29	17	24	27
Keepers Cottage	37	16	36	28
West Acre Rd / Hall Farm	19	-	19	-
The Splashes	19	-	19	-

'-'indicates the predicted level is below 0.

Table 10.3.7 shows noise contribution levels from respective Project elements, the loudest element in the Scheme is the BESS for all receptors, except for Keepers Cottage which is in proximity to Solar Conversion Units and therefore, has a dominant noise contribution of 36 dB(A) from the nearest units. Solar Conversion

units have low noise contribution at the rest of the NSRs in comparison. The Customer Substation has low contribution at all receptors.

2.3 BS 4142 Assessment

BS 4142 states that corrections should be applied to account for certain acoustic characteristics evident at the receptors which can increase the level of noise impact perceived by the receptors of the dwelling. The four acoustic features to be considered in the application of rating corrections are:

- Impulsivity: A correction of up to +9 dB can be applied for sound that is highly impulsive, considering both the rapidity and overall change in sound level. Subjectively this can be a penalty of +3 dB for impulsivity that's just perceptible, +6 dB for clearly perceptible and +9 dB for highly perceptible.
- Tonality: Sound ranging from non-tonal to prominently tonal can have a correction of up to +6 dB. Subjectively this can a +2 dB penalty for just perceptible tone, +4 dB for clearly perceptible, and +6 dB for highly perceptible.
- Intermittency: Sound that has identifiable on/off conditions and is readily distinctive against the residual acoustic environment a +3 dB penalty can be applied.
- Distinctiveness: Where the specific sound characteristics are neither tonal or impulsive but readily distinctive against the residual acoustic environment, a penalty of +3 dB can be applied (where no tonal or impulsive penalty have been applied).

Electrical units such as the transformers can produce a "humming" or tonal sound attributed to magnetostriction, however, this is dependent on the overall absolute noise level at the receptor, for example, where the overall predicted noise levels from the transformers is less than 20 dB(A) then the noise, and any 'tone' therein, is unlikely to be audible. A conservative penalty of +2 dB has been added to the predicted levels at receptors when determining the Rating Levels (L_{Ar}): this corresponds according to BS 4142 to tonal noise that is predicted to be slightly perceptible, when distance, topography and masking from other noise sources is taken into consideration.

The equipment will run continuously and will not have identifiable on/off conditions or be impulsive in nature, as such no penalty for impulsivity or intermittency are applicable. Furthermore, as a tonal penalty has been applied so no additional penalty for distinctiveness is applicable, therefore, a Rating Level penalty of 2 dB is used.

The representative (typical lowest) background noise levels, as detailed in ES Appendix 10.2: Noise Survey [APP/6.4] in Table 10.2.7, have been used in the BS 4142 assessment. The criterion in Table 10.6 of ES Chapter 10: Noise and Vibration [APP/6.2] is used to determine the magnitude of impact for both day and night-time periods, based on their Rating Level and exceedance to representative background levels.

Table 10.3.8 - Derived background, predicted rated noise levels (dB) and BS 4142 assessment at key receptors – prior to mitigation.

Property	Typical background, dB (L_{A90})		Predicted Rating Level, dB (L_{Ar})	Difference with background, dB		Difference to 35 dB(A) absolute criterion, dB	Magnitude of Impact
	Day	Night		Day	Night		
The Off Barn	32	28	34	2	6	-1	Low
Glebe Cottages	30	24	30	0	6	-5	Low
South Acre Hall	30	24	28	-2	4	-7	Low
Finger Hill Cabin	30	24	31	1	7	-4	Low
Keepers Cottage	32	28	39	7	11	4	Medium
West Acre Rd / Hall Farm	32	28	21	-11	-7	-14	Negligible
The Splashes	53	28	21	-32	-7	-14	Negligible

As can be seen in table above, with the exception of Keepers Cottage, where impact is 'medium', all other receptors have an impact of 'low' to 'negligible' magnitude.

2.3.1 Embedded and Additional Mitigation

The noise model of the Scheme includes the embedded measures stated in Section 10.7 of ES Chapter 10: Noise and Vibration [APP/6.2], including;

- Acoustic Barrier along western perimeter of Field 27 and partially along Field 24 adjacent to the BESS;
- Minimum separation distance of 250 m between Solar CUs and NSRs; and
- Minimum separation distance of 15 m of any plant to PRoW.

The results in Table 10.3.8 include these embedded measures which result in a medium impact with an exceedance of 4 dB at Keepers Cottage NSR only. It can be seen from Table 10.3.7 that the main noise contributor at this NSR is the Solar CU, namely, the CUs located in proximity around Keepers Cottage. As such a mitigation engineering exercise was undertaken to determine most effective additional mitigation measures to achieve compliance at this NSR.

It was found that a reduction of 8 dB in the noise emission levels of the Solar CUs (i.e., from 91 dB(A) to 83 dB(A)) within 500 m of Keepers Cottage provided sufficient attenuation to reduce predicted levels to 33 dB(A) at the NSR. This reduction can be achieved by one or a combination of; selection of a quieter model, acoustic barriers, enclosures, or silencer kits etc. applied to all CUs within 500 m of Keepers Cottage. Accounting for the 2 dB rating penalty results in 35 dB(A) predicted rating level at Keepers Cottage which is compliant with the absolute criterion and 'low' in magnitude of impact.

Predicted levels after incorporation of the embedded and additional mitigations above are illustrated in Figure 10.3.1.

2.4 Low Frequency Assessment

An assessment has been undertaken for low frequency noise in accordance with the criteria outlined in the research paper '*Procedure for the assessment of low frequency noise complaints'* by University of Salford and DEFRA in 2005, following consultation with Breckland Council. Table 10.3.9 presents the 1/3 octave limits for low frequency noise as stated in Section 4.1: 'The criterion curve' of the research paper, based on the most stringent noise limit for night-time periods. The criterion is based on un-weighted level for each third octave frequency band and ranges from 10 to 160 Hz.

Table 10.3.9 –Criterion for Low Frequency Noise – DEFRA/University of Salford – internal noise levels

Frequency, Hz	10	12.5	16	20	25	31.5	40	50	**63**	80	100	**125**	160
dB, L_{eq}	92	87	83	74	64	56	49	43	**42**	40	38	**36**	34

Third Octave data was not available for the equipment and could not be procured, as such, assessment of operational octave band levels have been predicted at each receptor for comparison. As a conservative approach, the Octave predicted levels are compared to the Third Octave centre frequency bands highlighted in bold in Table 10.3.10, because where the predicted centre octave band level (which is the sum of the adjacent third octave levels) is below the third octave centre frequency criteria (bold) in Table 10.3.9, then the third octave level will also be below the criteria.

Table 10.3.10 below presents the predicted octave band noise levels at each receptor from all operational plant running simultaneously and at 100% capacity. For completeness the full spectrum is provided at each receptor however, transformer and low frequency noise is generally expected to be dominant at around 100 Hz and therefore the predicted levels are compared against the criteria of 63 Hz and 120.

Table 10.3.10: Predicted Octave Band Noise Levels at NSRs – prior to additional mitigation.

Receptor	Octave Band Centre Frequency (Hz), Un-weighted Predicted Level, dB							
	63	125	250	500	1000	2000	4000	8000
The Off Barn	31	29	31	30	30	21	-9	-80
Glebe Cottages	21	27	29	26	25	16	-6	-77
South Acre Hall	19	26	27	24	23	13	-12	-80
Finger Hill Cabin	20	27	28	26	26	19	5	-59
Keepers Cottage	24	26	29	29	32	31	28	-5
West Acre Rd / Hall Farm	5	7	14	14	17	12	-2	-72
The Splashes	11	6	13	12	17	12	-4	-77

Table 10.3.10 shows the highest predicted at 63 Hz is 31 dB at The Off Barn receptor (closest to CS) which is 11 dB below the respective criterion, and at 125 Hz the highest predicted level is 29 dB at 'The Off Barn' receptor which is 7 dB below respective criterion. Furthermore, the criteria apply to internal noise levels and therefore a further allowance for the reduction of the building envelope would apply, which is neglected in this analysis. Therefore, the criterion is clearly unlikely to be exceeded even in the absence of mitigation.

2.5 Operational Traffic Noise

Maintenance during the operational phase will include ad-hoc replacements of defective PV panels due to routine wear and tear or damages, which will be carried out on a small scale typically using light service vehicles (e.g., 4x4 or panel vans), HGVs will only be used where necessary, therefore, given the low volume of vehicles, negligible increase in HGV movements is expected in the maintenance of the Scheme and is not expected to give rise to significant effects. Programmed replacements and upgrades of PV panels or BESS components will be phased and will be managed through the detailed Operational Traffic Management Plan (OTMP) as outlined in ES Chapter 10: Transport and Access [APP/6.2], however, detailed vehicle movements are not known at this stage. Construction HGV traffic noise assessment was based on 16 HGV movements per day at most as shown in Table 10.3.4, which results in negligible effects, therefore , on this basis the magnitude of impact of fewer HGV movements expected for operational replacement and maintenance activities is considered negligible and not considered further in this assessment.

2.6 Public Right of Way (Operational Noise)

Public Right of Way are located directly adjacent to the assumed BESS, Customer Substation, and National Grid Substation zones, as stated previously, a buffer distance of 15 m is set for all PRoW at all fields, and furthermore, a separation of 50 m from PRoW to the western perimeter of BESS, Customer Substation, and National Grid Substation in Field 27 and Field 24 is expected due to the buffering area required for the bund and earth fill adjacent the PRoW. The assessment, therefore, accounts for these buffers when predicting noise levels at PRoW. Predicted levels for the PRoW identified are illustrated in Figure 10.3.1.

It can be seen in Figure 10.3.1 that no PRoW will be exposed to worst-case noise levels above 55 dB(A) along the western boundary of the designated BESS zone in Field 27 and Field 24. Furthermore, Sound Pressure Level (SPL) from the Solar CU (91 dB L_{WA}) when considering the dimensions of the noise radiating unit (15 m x 5 m x 3.5 m), is calculated to be 54.4 dB(A) at a 15 m distance. As such, with the embedded mitigation of a 15 m buffer applied for PRoW, the predicted noise levels at any point along the PRoW are at or below the

absolute level criterion of 55 dB(A) and is therefore considered to be of 'medium or low' magnitude of impact. Although there are several Solar CUs in the fields along PRoW, they are separated sufficiently apart to avoid an increase in combined noise levels at any single point along in the PRoW.

Figure 10.3.1 – Predicted operational noise levels – with additional and embedded mitigation.

THE DROVES

SOLAR FARM