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Technical Report:

Environmental Noise Assessment for proposed dwellings at Old Cottage, Start Hill, Takeley CM22 7TG

Project Ref: 10699

Environmental Noise Assessment

Date of Issue:	11th July 2023
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1. Executive Summary

1.1. The acoustic environment at Old Cottage, Start Hill, Takely CM22 7TG, was dominated by air traffic, taking off in the (predominant) south-west direction, from Stansted Airport with a continuous drone of road traffic during times of no overhead flying.

1.2. dB Consultation Limited (dBC) were commissioned to provide an environmental noise assessment to accompany the original planning application for the site.

1.3. The ambient sound levels were measured at representative locations, P1 and P2, of the new dwellings between Thursday 9th September and Wednesday 15th September 2021.

1.4. At P1, the highest daytime 07:00 – 23:00 sound level was $L_{Aeq,16hr}$ 66dB and the night-time 23:00 – 07:00 was $L_{Aeq,8hr}$ 62dB during SW air traffic take off. At P2, the highest daytime 07:00 – 23:00 sound level was $L_{Aeq,16hr}$ 66dB and the night-time 23:00 – 07:00 was $L_{Aeq,8hr}$ 61dB during SW air traffic take off. These levels were the same or slightly below the summer 2019 published noise contours at this distance from the airport of 66dB(A) day contour and 63dB(A) night contour. This difference is likely due to reduced out of season timetable and the reduction in flight numbers caused by the COVID-19 global pandemic.

1.5. There is a new noise contour document issued in May 2022, there was no change to the contours as assessed for the original report.

1.6. Using guidance outlined in ProPG Planning and Noise guidance, the measured noise levels place the development into a medium to high risk category meaning the development requires good acoustic design to sufficiently mitigate the potential effects of noise and allow residents comfortable living conditions with regards to external noise.

1.7. To meet the BS 8233:2014 acoustic criteria for indoor noise levels high specification glazing R_w44dB should be installed in the living/dining rooms and R_w46dB in the bedrooms. Glazing, external façade and roof/ceiling specifications are given in Table 1 page 4 of section 2. Recommendations.

1.8. ProPG Planning and Noise document states that '*In most circumstances in noise sensitive rooms at night (e.g. bedrooms) good acoustic design can be used so that individual noise events do not normally exceed 45dB $L_{Amax,F}$ more than 10 times a night*'. Night-time maximum noise levels can be significantly reduced by the recommended high specification glazing installed in the bedrooms, ensuring maximum noise levels meet or will be marginally above the recommended 45dB L_{Amax} level internal night-time level.

1.9. The garden area is likely to be affected by daytime noise above the BS 8233 guideline level. This is only a guideline level and overhead aircraft flying noise cannot be practically mitigated. It is our considered opinion that the provision of a garden area outweighs higher than recommended noise levels.

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1.10. dBC has demonstrated that with high specification glazing, whole house ventilation, standard external façade sound insulation residents should not be adversely affected by sound during both the day and night.

1.11. This scheme of sound insulation demonstrates a compliance with both the Local Plan Policy ENV10 and the NPPF paragraph 185 '*avoid noise giving rise to significant adverse impacts on health and the quality of life*'.

1.12. It should be noted that other residential development e.g. UTT/19/0160/FUL and UTT/19/0445/FUL for single dwellings have been approved by the Local Planning Authority subject to conditions requiring a scheme of noise insulation that are affected by similar levels of external noise as this site.

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2. Recommendations

2.1. These were the recommendations for the original planning application. These recommendations have not changed and remain valid for the new application.

2.2. The glazing, external façade and roof/ceiling specifications that should be installed at the development are shown in Table 1. These specifications are the minimum suggested specifications. Any other glazing can be used if the specification used is equivalent.

Element	R_w	Sound Reduction Index, *R* 1/1 octave band centre frequency between 31.5Hz and 8kHz								
		31.5	63	125	250	500	1k	2k	4k	8k
Brick/Block Cavity	50	24	28	34	41	45	54	58	58	58
Roof and enhanced ceiling	48	20	26	32	38	44	50	56	62	62
10mm glass/16mmArgon/8.8mm Pilkington Optiphon Living & Dining Room/Kitchen	44	18	23	28	31	42	45	50	58	58
10mm glass/16mmArgon/16.8mm Pilkington Optiphon Bedrooms	46	18	23	28	36	43	47	49	58	58

Table 1: Sound Reduction Indices, *R*.

2.3. Please note: Glazing with higher sound insulation properties may be possible to install e.g. triple glazing and secondary glazing systems but these would need to be coupled with enhanced external façade sound insulation and the cost/benefit may be minimal.

2.4. The first-floor ceilings of all the dwellings should be enhanced whereby the usual directly fixed 1 layer of 12.5mm plasterboard should be replaced with 2 layers of 15mm 'Soundbloc' plasterboard fixed to the ceiling joists on resilient bars. The roof should be finished with regular glazed clay tiles.

2.5. It is recommended that the walls are a brick/block cavity construction or similar double leaf construction.

2.6. Prior to any construction taking place the materials used for the glazing, external façade and ceilings should be checked by an acoustic consultant. Internal layout of the dwellings was not available to dBC therefore glazing specifications should be checked by an acoustic consultant if there is a variation in room dimensions different to those specified in Section 7.

2.7. The dwelling should have a whole house ventilation system installed which would negate the need for trickle or passive in wall ventilators, which are not advised.

2.8. All windows should remain openable.

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3. Introduction

3.1. The original planning application UTT/21/3339/FUL for this site was approved in Jun 2022, Spartan Group Holdings Limited will submit a new planning application that will raise the number of dwellings from seven to nine, at this location, within the existing garden of Old Cottage, Start Hill, Takeley, CM22 7TG. The fundamental change is plot number, it is within the same site boundary.

3.2. The site is located adjacent to the B1256 and relatively close to the M11 and Stansted Airport. These sources may have a negative impact in terms of noise upon potential new residents.

3.3. An environmental noise assessment, document number **dBC/Old Cottage/10297/SR/001,** accompanied the original application which gained approval.

3.4. The original report was written by Samantha Riley of dB Consultation Limited (dBC), a practicing acoustician for over 24 years, Full Member of the Institute of Acoustics (MIOA) and experienced in noise assessment in many industrial and commercial sectors.

3.5. The original report was reviewed by Mick Lane, Acoustic Director at dB Consultation Limited, a practicing acoustician for over 18 years, Full Member of the Institute of Acoustics (MIOA) and experienced in noise assessment in many industrial and commercial sectors.

3.6. The revisions to the original environmental noise assessment have been made by Mick Lane.

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4. Standards / References / Assessment Criteria

Noise Policy Statement for England (NPSE) March 2010

4.1. The NPSE sets out the long-term vision of the Government's policy on noise, which in essence is to promote good health and a good quality of life through the effective management of noise within the context of Government Policy on sustainable development.

4.2. The NPSE outlines three aims for effective management and control of environmental, neighbourhood and neighbour noise:

- *Avoid significant adverse impacts on health and quality of life;*
- *Mitigate and minimize adverse impacts on health and quality of life; and*
- *Where possible, contribute to the improvement of health & quality of life.*

4.3. In its aims, the NPSE uses key phrases "significant adverse" and "adverse" and these are related to the following terms which are currently being applied to noise impacts.;

- *NOEL – No Observed Effect Level – this is the level below which no effect can be detected or measured,*
- *LOAEL – Lowest Observed Adverse Effect Level – which is the level above which adverse effects on health and quality of life can be detected; and*
- *SOAEL – Significant Observed Adverse Effect Level – which is the level above which significant adverse effects on health and quality of life occur.*

4.4. The NPSE notes that it is not possible to have a single objective noise-based measure that defines SOAEL that would be applicable in all situations, consequently the NOEL, LOAEL and SOAEL are likely to change for the location, noise type and times. It is the acoustician who should identify relevant SOAEL levels taking into account the noise source exposures and receptors.

Pro PPG Planning And Noise May 2017

4.5. Note 3 Page 13 states *'In most circumstances in noise sensitive rooms at night (e.g. bedrooms) good acoustic design can be used so that individual noise events do not normally exceed 45dB LAmax,F more than 10 times a night'.*

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National Planning Policy Framework July 2021

4.6. Paragraph 185 relates planning and noise in this document.

185. Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:

a) mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life[65];

b) identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason; and

c) limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation.

Uttlesford Local Plan January 2005

4.7. Uttlesford District Council adopted the Local Plan in January 2005, Policy ENV10 relevant to this application.

5.21. National guidance on Planning and Noise indicates the appropriate response to the level of noise by source. This includes road, rail and mixed sources as well as air noise.

Policy ENV10 - Noise Sensitive Development and Disturbance from Aircraft

Housing and other noise sensitive development will not be permitted if the occupants would experience significant noise disturbance. This will be assessed by using the appropriate noise contour for the type of development and will take into account mitigation by design and sound proofing features

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ERCD Report 2003

Noise Exposure Contours for Stansted Airport 2019

4.8. The day and night-time noise contours surrounding Stansted Airport were published by the Civil Aviation Authority, Aviation House, Gatwick Airport South, West Sussex, RH6 0YR.

4.9. Fig. 1. shows part of the Stansted 2019 summer day actual model split (75%SW/25%NE) L_{eq} contours with the development site marked.

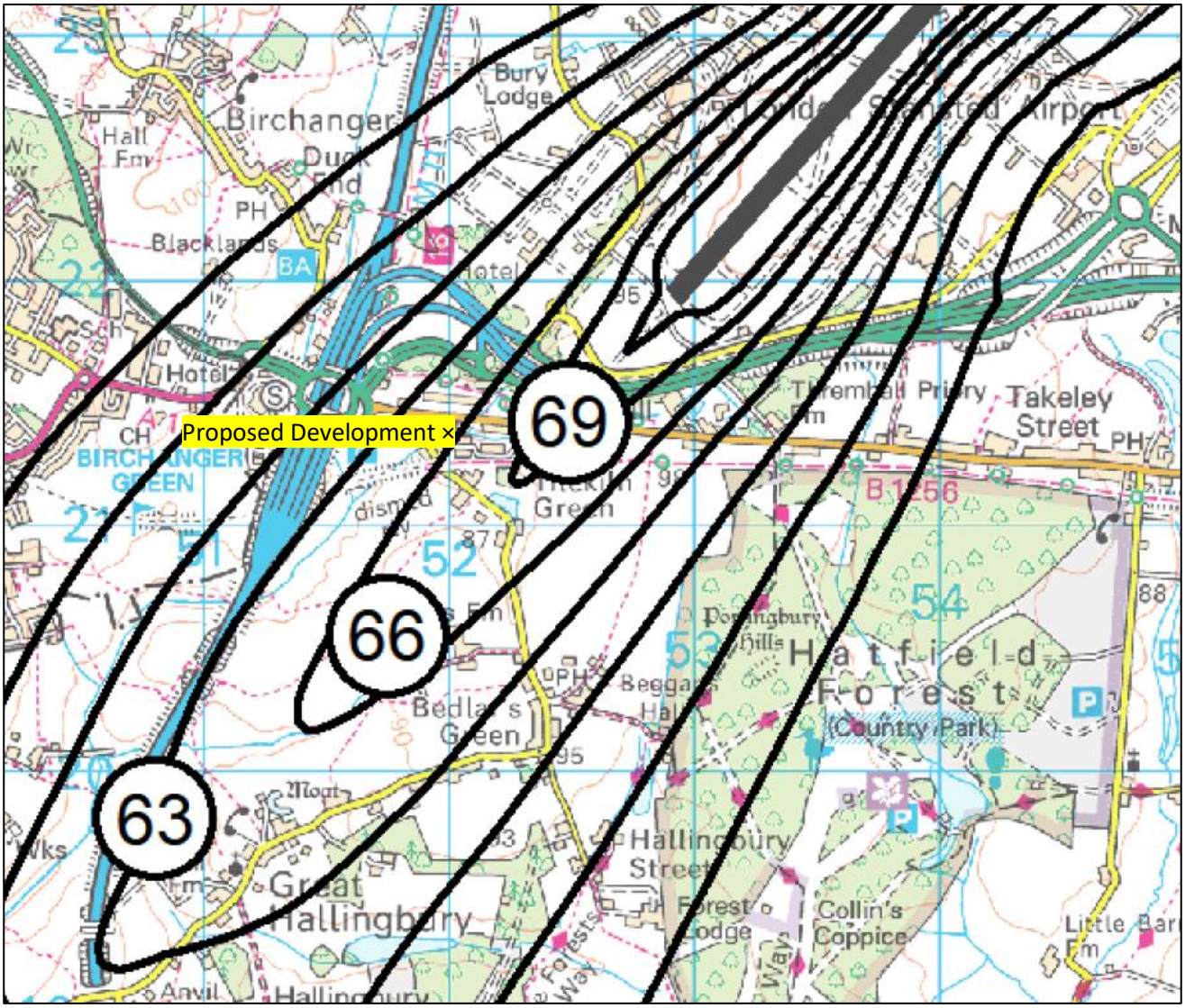

Fig. 1: Stansted summer daytime noise contours 2019.

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4.10. Fig. 2. shows part of the Stansted 2019 summer night actual model split (75%SW/25%NE) L_{eq} contours with the development site marked.

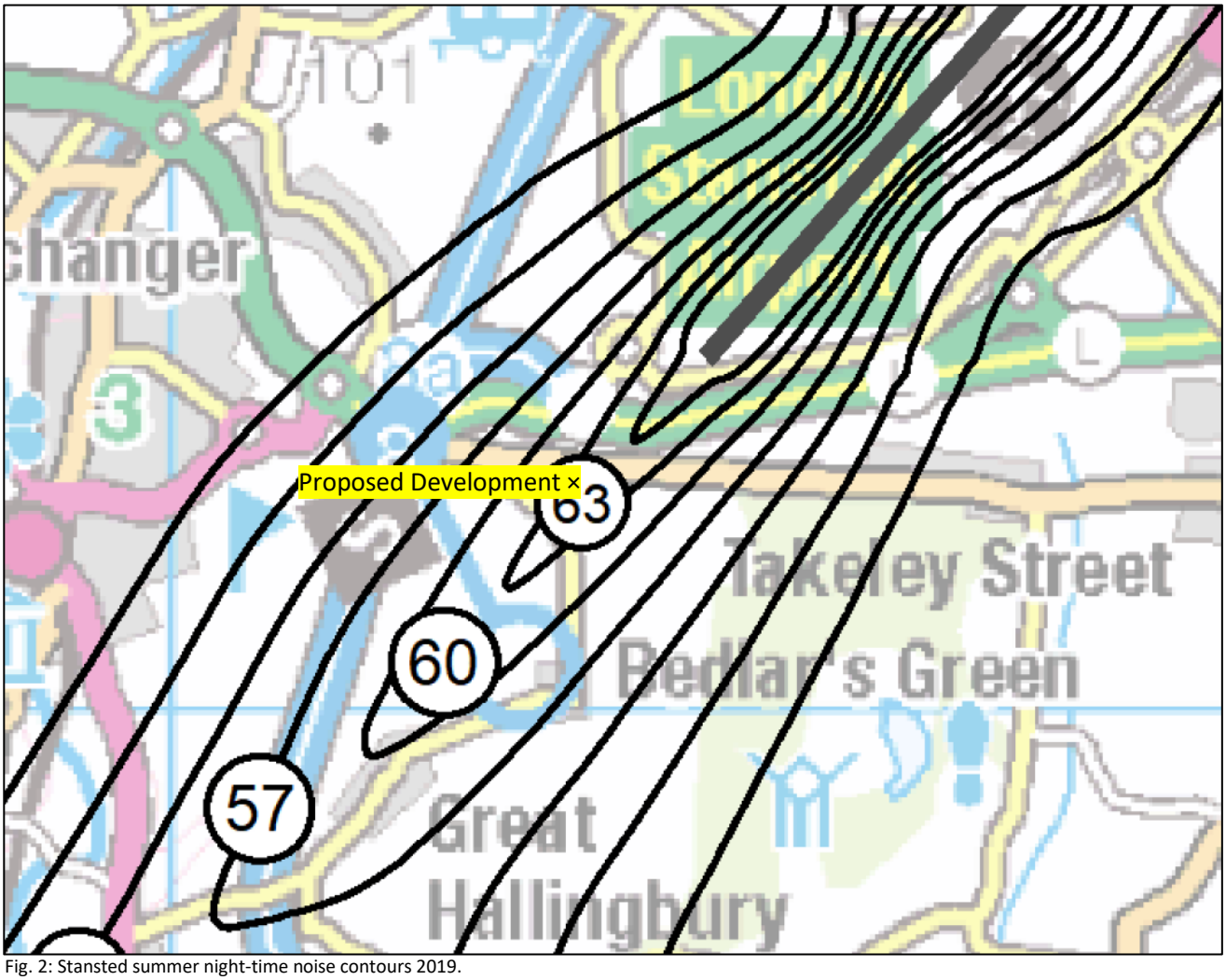

Fig. 2: Stansted summer night-time noise contours 2019.

4.11. The relevant noise contour for the development was 66dB $L_{Aeq,16hr}$ (day) and 63dB $L_{Aeq,8hr}$ (night).

4.12. An updated Noise Contour report was published in May 2022, after this report was published. There is no change to the noise contours at this proposed development.

BS 8233:2014 Sound Insulation and Noise Reduction for Buildings

4.13. This standard uses the results of research and experience to provide information on the design of buildings to result in suitable internal acoustic environments appropriate for their functions. It includes controlling the noise from outside the building, noise from plant and services within it and room acoustics for non-critical situations.

4.14. The main changes in this latest version of BS 8233 were made to include revisions to Building Regulations Approved Doc E, the publication of the National Planning Policy Framework in 2012 removal of documents such as PPG24, and most importantly a reappraisal of the targets for various classes of living spaces following various research findings.

4.15. Section 5.2 states that 'when planning permission is sought for a new building or a change of use to an existing building, the local authority may grant permission, with or without conditions regarding noise levels so that local or national policies are met'.

4.16. Paragraph 6.3.2 states: 'It should be noted that for a jet aircraft the frequency content of noise when landing is generally different from that when departing. Typically, landing jet aircraft produce relatively higher levels of high frequency noise and departing jet aircraft produce relatively higher levels of low frequency noise'. This report will consider taking off noise as a worst-case scenario.

4.17. Section 7.7.2 provides a desirable level for the internal ambient noise levels for dwellings which have been included in the table below.

Activity	Location	Time Period	
		07:00 to 23:00	23:00 to 07:00
Resting	Living Room	35dB $L_{Aeq,16h}$	-
Dining	Dining Room/Area	40dB $L_{Aeq,16h}$	-
Sleeping	Bedroom	35dB $L_{Aeq,16h}$	30dB $L_{Aeq,8h}$

Table 2: Excerpt of BS8233:2014 Table 4 – Indoor Ambient Noise Levels for Dwellings.

4.18. Note 5 of this section states that 'If relying on closed windows to meet the guide values, there needs to be an appropriate alternative ventilation that does not compromise the façade insulation or the resulting noise level". If applicable, any room should have adequate ventilation (e.g. trickle ventilators should be open) during assessment'.

4.19. Section 7.7.3.2 refers to the design criteria for external areas such as gardens and patios. For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50dB LAeq,T with an upper guideline value of 55dB LAeq,T which would be acceptable in noisier environments.

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5 Site Description

5.1. The site is adjacent to the B1256. The acoustic environment on site was dominated by air traffic **during SW take off** from Stansted Airport with significant influence from road traffic. The site is marked in red and distances to significant noise sources (yellow) are marked on Fig. 3 below.

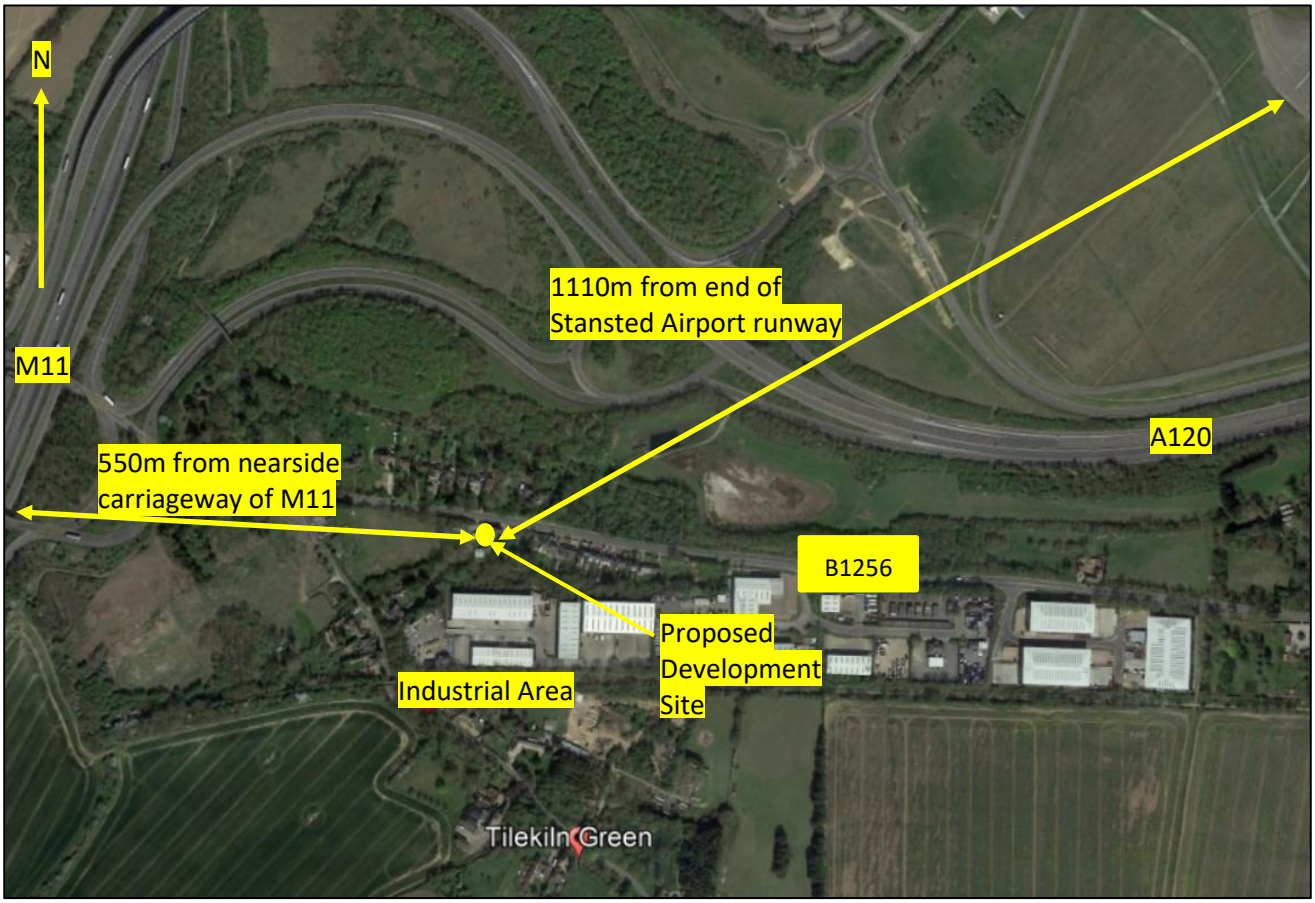

Fig. 3: Site Location

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5.2. Fig. 4 shows the proposed 9 dwelling development. Monitoring Locations, P1 and P2 are marked.

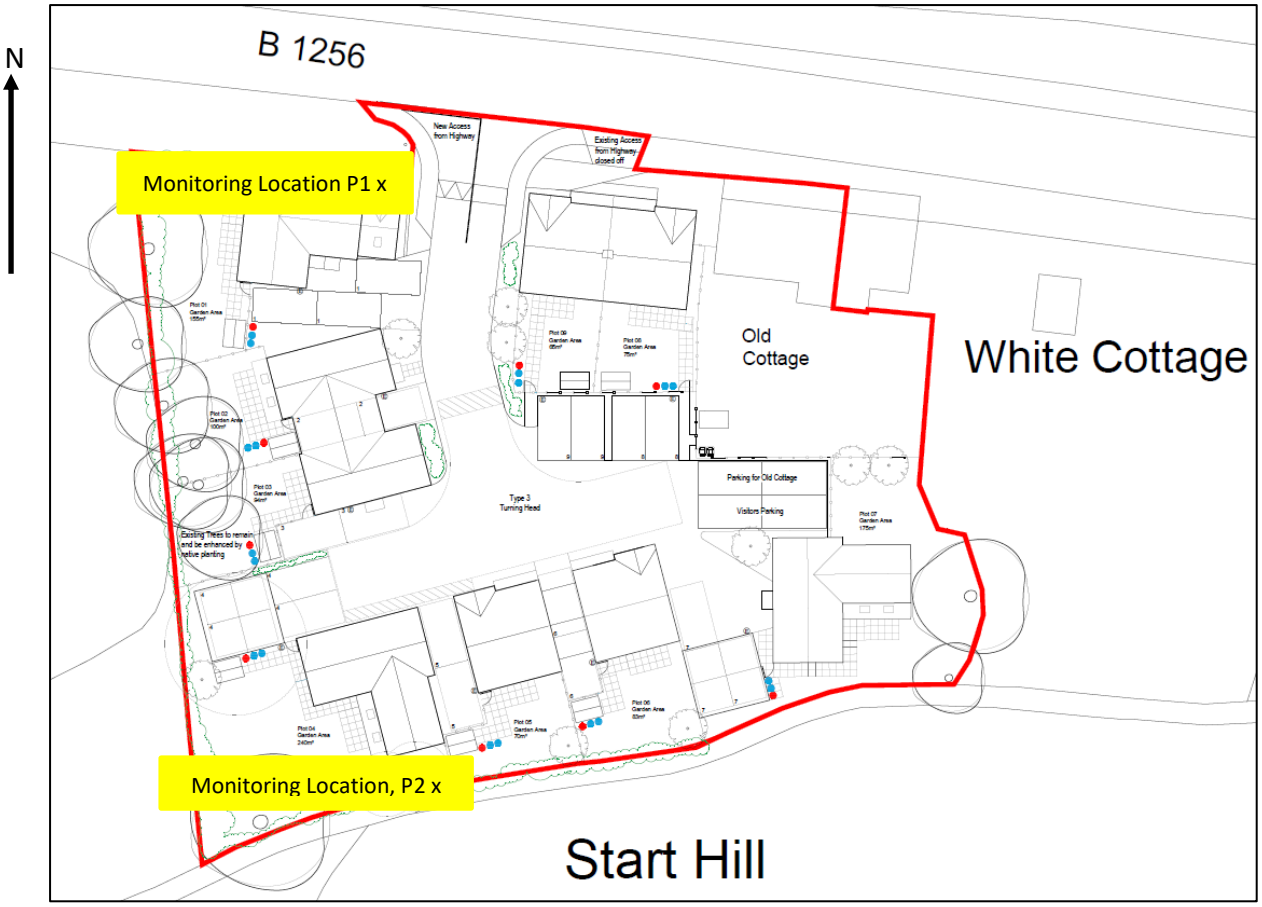

Fig. 4: Proposed Residential Development (red outline).

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6. Ambient Sound Levels

6.1. **Stansted Airport has published summertime noise contours surrounding the airport. At this location, the daytime contour was 66dB(A) and the night-time contour was 63dB(A). There is no change from previous studies for the summer (worst-case scenario) contours for this site.**

6.2. dBC measured the ambient sound levels at two locations at the proposed development between 9th September and 15th September 2021. The monitoring was undertaken to confirm the noise contour levels, consider road noise from the B1256 and provide an octave band spectrum for use later in this assessment.

6.3. The monitoring locations are shown in Table 3 below.

Location	Photo	Noise Sources
P1 1.5m above the ground, on the north boundary of the site adjacent to the B1256.		Aircraft, road traffic and bird song
P2 1.5m above the ground, on the south boundary of the site.		Aircraft, road traffic and bird song

Table 3: P1 & P2 Monitoring Locations.

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6.4. The measurements were taken at P1 using NOR 140 sound level meter serial number 1404899 using a Campbell Associates outdoor microphone system serial number GRA-41AL#07 serial number 42111 and at P2 NOR 140 sound level meter serial number 1406178 using a Campbell Associates outdoor microphone system serial number GRA-41AL#06 serial number 44949 which have been calibrated at a UKAS accredited laboratory within the last two years – calibration certificates are available upon request The sound level meter was field calibrated with a Norsonic 1251 acoustic calibrator serial number 34682 to 114dB. The field calibrations were within the accepted tolerance of 0.5dB for environmental sound measurements. From 06.00 on 13 September onwards the SLM failed to log recordings at P1, sufficient data had been collected.

6.5. The sound level meter was set up to measure in 1hr periods. The parameters measured were $L_{Aeq,1hr}$ and $L_{eq,1hr}$ for 1/1 octave band centre frequencies between 31.5Hz and 8kHz.

6.6. The weather during the monitoring period has been summarised in Table 4.

Date	Time	Weather	Temperature °C	Wind Speed ms^{-1}	Wind Direction
9th September	Day 07:00 – 23:00	Overcast, light showers	17-22	2.5- 3.1	SW
9th/10th Sept	Night 23:00 – 07:00	Light cloud	16-17	1.4-1.7	S
10th September	Day 07:00 – 23:00	Light showers	16-21	1.4-2.2	NES/SW
10th/11th Sept	Night 23:00 – 07:00	Light cloud	15-16	1.9	W/SW
11th September	Day 07:00 – 23:00	Light cloud, dry	15-21	1.9-2.5	W
11th/12th Sept	Night 23:00 – 07:00	Light cloud	13-16	1.4	W/WNW
12th September	Day 07:00 – 23:00	Light cloud, dry	14-19	1.4-1.7	W/WNW
12th/13th Sept	Night 23:00 – 07:00	Light cloud	12-14	1.4	N/NE
13th September	Day 07:00 – 23:00	Cloudy, gentle breeze	13-19	1.5-1.7	N/ENE
13th/14th Sept	Night 23:00 – 07:00	Light cloud	13-14	1.1-1.4	ENE
14th September	Day 07:00 – 23:00	Heavy showers, cloudy	13-19	1.4-2.5	NE
14th/15th Sept	Night 23:00 – 07:00	Cloudy, gentle breeze	13-15	1.9-2.2	NE/ENE
15th Sept	Day 07:00 – 23:00	Overcast, showers	13-19	2.2-2.8	NE

Table 4: Weather.

6.7. The daytime $L_{Aeq,16hr}$ and night-time $L_{Aeq,8hr}$ ambient levels measured at P1 and P2 are shown below.

Measurement Location	Date	Daytime 07:00 – 23:00 $L_{Aeq,16hr}$ in dB	Date	Night-time 23:00 – 07:00 $L_{Aeq,8hr}$ in dB
P1	9th September	65	9th/10th September	61
	10th September	66	10th/11th September	62
	11th September	65	11th/12th September	60
	12th September	62	12th/13th September	55*
	13th September	No data	13th/14th September	No data
	14th September	No data	14th/15th September	No data
	15th September	No data		

Table 5: P1 Ambient Sound Levels in dB.*7-hour time period, meter stopped saving.

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Measurement Location	Date	Daytime 07:00 – 23:00 $L_{Aeq,16hr}$ in dB	Date	Night-time 23:00 – 07:00 $L_{Aeq,8hr}$ in dB
P2	9th September	65*	9th/10th September	61
	10th September	66	10th/11th September	61
	11th September	65	11th/12th September	59
	12th September	60	12th/13th September	54
	13th September	56	13th/14th September	54
	14th September	57	14th/15th September	53
	15th September	56**		

Table 6: P2 Ambient Sound Levels in dB.

*15-hour time period, **8-hour time period.

6.8. The daytime and night-time (13th to 15th September) noise level differences were likely to be due to take off direction from Stansted where the higher levels corresponded to the predominant SW direction.

6.9. Only on the 10th September, were the daytime ambient noise levels 66dB(A) at P1 and P2, the remainder of the readings were below the published noise contour level for this site. This difference is likely due to the reduction in flight numbers caused by the COVID-19 global pandemic. The same can be said for the night-time levels.

6.10. During lower flight numbers road traffic noise will have a greater affect upon levels affecting the site.

6.11. During set up and removal of the sound monitoring equipment, the noise levels affecting site were clearly dominated by air and road traffic, no specific noise from HGV movements or plant was evident from the industrial site to the south.

6.12. **dBC will use the published contour noise levels for the assessment, 66dB(A) during the day and 63dB(A) at night which should provide sufficient protection from the industrial site in this case.**

6.13. Table 7 shows representative the 1/1 octave band data for the day and night-time measurements at P1 and P2.

Location		dBA	1/1 octave band centre frequencies in Hz								
			31.5	63	125	250	500	1.0k	2.0k	4.0k	8.0k
P1	Day	66	67	66	67	65	63	61	58	53	46
	Night	62	62	61	63	61	59	56	54	48	39
P2	Day	66	71	68	68	66	64	60	57	52	44
	Night	61	61	61	63	62	59	56	53	47	37

Table 7: Octave Band Data in dB.

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7. *BS 8233 Assessment*

7.1. dBC has assumed a two-storey, standard double leaf construction of minimum weighted sound reduction index, R_W50dB.

7.2. In the proposed houses, the **first-floor ceiling** should be enhanced compared to the usual directly fixed 1 layer of 12.5mm plasterboard. The ceilings (in their entirety) should be finished with 2 layers of 15mm 'Soundbloc' plasterboard fixed to the ceiling joists on resilient bars.

7.3. Internal layouts for the proposed dwellings were not available to dBC at the time of this assessment therefore standard room and window sizes have been assumed. The indoor ambient noise level within the living room and bedroom has been determined by calculation using the following room dimensions and the sound reduction indices (*R*) of the building products in Table 8.

Living Room size 8mL x 4mW x 2.4mH windows 6m^2

Bedroom size 4mL x 4mW x 2.4mH windows 5m^2

Element	R_w	Sound Reduction Index, *R* 1/1 octave band centre frequency between 31.5Hz and 8kHz								
		31.5	63	125	250	500	1k	2k	4k	8k
Brick/Block Cavity	50	24	28	34	41	45	54	58	58	58
Roof and enhanced ceiling	48	20	26	32	38	44	50	56	62	62
10mm glass/16mmArgon/8.8mm Pilkington Optiphon Living & Dining Room/Kitchen	44	18	23	28	31	42	45	50	58	58
10mm glass/20mmArgon/8.8mm Pilkington Optiphon Bedrooms	46	18	23	28	36	43	47	49	58	58

Table 8: Sound Reduction Indices, *R*.

7.4. All the remaining glazing, bathrooms and utility room can be standard double glazing.

7.5. Background ventilation for this dwelling should be provided by a whole house ventilation system and not passive in wall or trickle ventilators. Passive ventilators provide a hole in the external façade or window frame that compromises the external façade sound insulation.

7.6. Background ventilation should not be confused with opening windows for rapid ventilation or to prevent overheating. The glazing should remain fully openable and it should always be the occupant's decision to open a window or not. It is usually understood that when living in a location affected by moderately high noise levels there is likely to be a compromise of higher internal noise levels if the windows are opened.

7.7. dBC has advised ventilation options to ensure internal noise level criteria is met without compromise of the external façade sound insulation. A full ventilation scheme will be advised by others to ensure the dwellings have sufficient ventilation to meet Building Regulations.

7.8. Using the published Stansted Airport noise contour levels at this location and spectral data from Table 6 the calculated indoor ambient noise levels within the living rooms and bedrooms with the appropriate assessment criteria, is shown in Table 9.

Living Room		Bedroom	
$L_{Aeq,16hr}$	Criteria	$L_{Aeq,8hr}$	Criteria
32	35	29	30

Table 9: Indoor Ambient Noise Levels in dB.

7.9. The internal ambient noise levels meet the performance criteria for living room resting and bedroom sleeping as stated in BS 8233:2014.

Maximum Noise Levels

7.10. Stansted Airport Limited (STAL) are likely to be a planning consultee for this application and usually require a night-time maximum noise level assessment.

7.11. For this assessment the night-time maximum noise levels, L_{Amax} during SW flying operations measured across site were between L_{Amax} 74 and 86dB.

7.12. ProPG Planning and Noise document states that '*In most circumstances in noise sensitive rooms at night (e.g. bedrooms) good acoustic design can be used so that individual noise events do not normally exceed 45dB $L_{Amax,F}$ more than 10 times a night*'.

7.13. The sound insulation of the proposed dwelling should reduce maximum noise levels to as low as possible during this period.

7.14. dBC has assessed the maximum noise levels in the bedrooms across site during the night-time period and the internal maximum noise levels would range from 40dB(A) to 54dB(A). Some maximum noise levels meet the criteria, and some are above the criteria. Deviation above the criteria was due to the spectral breakdown of the maximum noise levels.

External Amenity Areas

7.15. During SW directional flying operations (75% of the time) and 'normal' flight numbers, the site is within a daytime 66dB(A) contour that will affect all external amenity space. For privacy, the gardens should be enclosed with a 2m high close boarded fence, minimum surface mass of 10kg/m^2. The fences would help screen road traffic noise in the absence of flying to levels below the upper guidance value of 55dB(A). However, the gardens cannot be screened from overhead air traffic, therefore, the ambient noise levels in the garden are likely to be above the upper guideline value. Despite this, it is our considered opinion that the provision of external amenity areas is essential to this development and the benefit to future residents of a garden outweigh the fact that they may be subject to moderately high noise levels.

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7.16. Please note the site is an existing garden that is already subject to noise level measured in this report.

7.17. It should be noted that other residential development e.g. UTT/19/0160/FUL and UTT/19/0445/FUL for single dwellings have been approved by the Local Planning Authority subject to conditions requiring a scheme of noise insulation that are affected by similar levels of external noise as this site.

7.18. Furthermore, it would be reasonable to assume that future residents of this house should understand the source and level of environmental noise affecting site prior to occupation.

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8. *Conclusions*

8.1. These were the original report conclusions which remain valid for this application.

8.2. The site is affected by relatively high noise levels dominated by aircraft taking off from Stansted Airport in the SW flying direction. Despite this, permission for residential developments has been granted on a plot adjacent to the site affected by similar noise levels as this site.

8.3. The published 2019 summer noise contour for this location was 66dB(A) during the day and 63dB(A) at night. Document Ref. **ERCD Report 2003**. These contours have not changed for the 2021 report.

8.4. dBC confirmed the noise contour levels and obtained aircraft spectral data, during SW flying operations, for use in the BS 8233 assessment.

8.5. The report demonstrated that using high specification glazing R_w44dB and R_w46dB as detailed in Table 6, page 16, internal noise levels in the proposed living rooms and bedrooms would be below the BS 8233 criteria as detailed in Table 2, page 11.

8.6. To ensure the internal noise levels are met, the minimum weighted sound reduction index must be R_w50dB for the external walls and R_w48dB for the roof/ceiling.

8.7. Night-time maximum noise levels affecting site can be reasonably reduced by the high specification glazing to levels within the bedrooms that may meet or occasionally be above the recommended 45dB L_{Amax} level.

8.8. Glazing with higher sound insulation properties may be possible to install e.g. triple glazing and secondary glazing systems but these would need to be coupled with enhanced external façade sound insulation and the cost/benefit may be minimal.

8.9. The dwellings would benefit from whole house ventilation which would provide background ventilation without the need for trickle or passive in wall ventilators which are not advised.

8.10. All windows should remain openable.

8.11. The garden area is likely to be affected, during SW flying operations, by daytime noise above the BS 8233 guideline level. This is only a guideline level and aircraft noise cannot be practically mitigated. It is our considered opinion that the provision of a garden area outweighs higher than guidance noise levels. Please note the garden is an existing garden subject to the noise levels assessed in this report.

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8.12. BS 8233 states "For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50 dB $L_{Aeq,\ T}$ with an upper guideline value of 55 dB $L_{Aeq,\ T}$ which would be acceptable in noisier environments. However, it is also recognized that these guideline values are not achievable in all circumstances where development might be desirable. In higher noise areas, such as city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise levels and other factors, such as convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited."

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9. *Glossary of Acoustic Terminology.*

dB(A)

The human ear is less sensitive to low (below 125Hz) and high (above 16kHz) frequency sounds. A sound level meter can be used to duplicate the ear's variable sensitivity to sound across a spectrum of frequencies. This is achieved by building a filter into the instrument with a similar frequency response to that of the average ear. This is called an "A-weighting filter". Measurements of sound made with this filter are called A-weighted sound level measurements and the unit is dB(A).

$L_{eq,T}$

The sound from noise sources often fluctuates widely during a given period of time. An average value can be measured, the equivalent sound pressure level Leq. The Leq is the equivalent sound level which would deliver the same sound energy as the actual fluctuating sound measured in the same time period (T).

$L_{10,T}$

This is the minimum level exceeded for not more than 10% of the time period (T). This parameter is often used as a "not to exceed" criterion for noise.

$L_{90,T}$

This is the minimum level exceeded for not more than 90% of the time period (T). This parameter is often used as a descriptor of "background noise" for environmental impact studies.

L_{fmax}

This is the maximum sound pressure level that has been measured over a period using a fast time constant.

Octave Bands

In order to completely determine the composition of a sound it is necessary to determine the sound level at each frequency individually. Usually, values are stated in octave bands. The audible frequency region is divided into 10 such octave bands whose centre frequencies are defined in accordance with international standards.

Addition of noise from several sources

Noise from different sound sources combine, on a logarithmic scale, to produce a sound level higher than that from any individual source. Two equally intense sound sources operating together produce a sound level which is 3dB higher than one alone and 3 identical sources produce a 5dB higher sound level.

Attenuation by distance

Sound which propagates from a point source in free air attenuates by 6dB for each doubling of distance from the noise source. Sound energy from line sources (e.g. stream of cars) drops off by 3dB for each doubling of distance.

Subjective impression of noise

Sound intensity is not perceived directly at the ear; rather it is transferred by the complex hearing mechanism to the brain where acoustic sensations can be interpreted as loudness. This makes hearing perception highly individualised. Sensitivity to noise also depends on frequency content, time of occurrence, duration of sound and psychological factors such as emotion and expectations. The following table is a reasonable guide to help explain increases or decreases in sound levels for many acoustic scenarios.

Change in sound level (dB)	Change in perceived loudness
1	Imperceptible
3	Just barely perceptible
6	Clearly noticeable
10	About twice as loud
20	About 4 times as loud

Barriers

Outdoor barriers can be used to reduce environmental noises, such as traffic noise. The effectiveness of barriers is dependent on factors such as its distance from the noise source and the receiver, its height and its construction.

Reverberation control

When sound falls on the surfaces of a room, part of its energy is absorbed, and part is reflected back into the room. The amount of reflected sound defines the reverberation of a room, a characteristic that is critical for spaces of different uses as it can affect the quality of audio signals such as speech or music. Excess reverberation in a room can be controlled by the effective use of sound-absorbing treatment on the surfaces, such as fibrous ceiling boards, curtains and carpets.