Taylor Wimpey UK Ltd

Land at Canon Pyon Road, Hereford

Noise Impact Assessment

297618-01(01)

AUGUST 2019

QUALITY ASSURANCE

Client:	Taylor Wimpey UK Ltd
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Document history

Rev.	Purpose Description	Author	Reviewer	Date
--	Report for internal review	IMG	DP	21/08/2019
00	Draft report issued	IMG	DP	23/08/2019
01	Final report as per comments from Taylor Wimpey and Asbri Planning	IMG	DP	27/08/2019

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1 INTRODUCTION

1.1 Instruction

RSK Environment Ltd has been instructed by Taylor Wimpey UK Ltd. to undertake a noise assessment of a proposed residential development at Canon Pyon Road, Hereford.

An outline planning application (**Ref. P191770/O**) for the proposed development was submitted in May 2019. This report has been prepared as a supplementary report to the outline planning application.

The applicant is seeking outline planning permission for residential development. The site comprises approximately 3.7 hectares of land that are currently in agricultural use.

1.2 Site Location and Description

The development site is located off Canon Pyon Road, Hereford. The site is centred on National Grid Reference 349111E, 242550N and covers an approximate area of 3.7 hectares. The proposed development site is located on the northern edge of Hereford and comprises agriculture land. The surroundings of the proposed development site are as follows:

- Northern boundary – Agricultural land, with some construction works being undertaken at the time of the baseline noise survey by Dwr Cymru Welsh Water (DCWW) at another plot located further north;
- Eastern boundary – Agricultural land;
- Southern boundary – Residential properties adjacent to Roman Road; and
- Western boundary – Canon Pyon Road and a number of residential dwellings adjacent to that road.

It should be noted that the southern boundary of the site is currently being used by DCWW as a site compound for the overnight staying of various items of plant (it is understood that these consist of an excavator and a dozer), with the eastern site boundary being also used as haul route.

The site location plan is presented in Figure 1.1 overleaf.

1.3 Proposed Development

The proposed development comprises residential development with associated internal access roads, garages, vehicle parking bays, and hard/soft landscaping. The proposed dwellings consist of detached, semi-detached and terraced properties. Access to the site will be via Canon Pyon Road to west.

The proposed development plan is presented in Figure 1.2 overleaf. It should be noted that a number for each proposed residential building have been included in Figure 1.2; these references have been prepared by RSK and will be used in order to assess internal noise levels for the proposed buildings as described in Section 5. Please note that since this is an outline planning application, the noise model results are based on indicative locations of development blocks as per the Illustrative Masterplan; future reserved matters schemes will determine the exact number, size and location of dwellings.

Figure 1.1 Site Location Plan

Figure 1.2 Proposed Development Plan [1]

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[1] '*Illustrative Masterplan'* (Ref. '*CSA/3339/115*'). The ref. numbers for the residential buildings have been added by RSK and are used in Section 5 to assess internal noise; each building include at least one residential unit.

1.4 Initial Appraisal

Considering the absence of any sources of ground borne vibration within 100 metres of the proposed development, for example below ground railway lines, adverse ground borne noise or vibration impacts are considered unlikely.

It is understood that the proposed development is entirely made up of permanent residential dwellings and associated amenity spaces and there is no commercial or industrial activity that could create noise or vibration that has the potential to affect existing dwellings or facilities.

The type of construction works, from experience, is not considered to be significant or excessively noisy and therefore a quantitative noise assessment is excluded from this assessment. Construction activities will be restricted to daytime hours (Monday – Saturday) and will be temporary in nature therefore the potential for impact will be negligible.

The remainder of this report therefore deals with the identification of likely adverse and significantly adverse effects on the proposed development caused by existing sources of airborne noise and puts forward design proposals to address them consistent with the requirements of noise and planning policy. This would include noise from transport infrastructure and any commercial or industrial operations, but not works of a temporary nature. Based on a brief review of aerial imagery and maps this is likely to be principally Canon Pyon Road to the west supported by the detailed descriptions set out in Section 3.

A glossary of acoustic terminology relevant to the assessment is included within Appendix 1.

2 REGULATORY FRAMEWORK

2.1 Noise and Planning Policy

Since its publication by the Department for Environment, Food and Rural Affairs (DEFRA) in 2010, the '*Noise Policy Statement for England'* (NPSE) (**Ref. 01**) has been the overarching Central Government noise policy that has been available to inform the consideration of noise in relation to the consenting of everything from small scale residential development to national infrastructure. The '*National Policy Planning Framework'* (NPPF) (**Ref. 02**), as updated by the Ministry of Housing, Communities and Local Government in 2019, has noise aims that are consistent with NPSE. The noise policy aims as stated in NPSE are:

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;

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.

In order to help translate these aims into practical guidance the NPSE uses the same terminology as used by the World Health Organisation (WHO), for example in the '*Night Noise Guidelines for Europe'*, 2009 (NNG) (**Ref. 03**) by referring to the Lowest Observed Adverse Effect Level (LOAEL) which is defined as the level above which adverse effects on health and quality of life can be detected. The NPSE extends this concept to define the level above which significant adverse effects on health and quality of life can be detected, hence the Significant Observed Adverse Effect Level (SOAEL).

The NPSE notes '*It is not possible to have a single objective noise-based measure that defines SOAEL that is applicable to all sources of noise in all situations. Consequently, the SOAEL is likely to be different for different noise sources, for different receptors and at different times'*. The second aim of the NPSE refers to the situation where the impact lies somewhere between LOAEL and SOAEL. It requires that all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life while also taking into account the guiding principles of sustainable development. This does not mean that such adverse effects cannot occur.

Not having specific SOAEL values in the NPSE means that relevant standards and guidance are used to propose values for the LOAEL and SOAEL thresholds for a particular situation or development.

2.2 Professional Planning Guidance on Planning and Noise (ProPG Planning and Noise): 2017

The ProPG: Planning and Noise guidance document (**Ref. 04**) was published by the Association of Noise Consultants (ANC), the Institute of Acoustics (IoA) and the Chartered Institute of Environmental Health (CIEH) in May 2017.

The main objectives of this document are to provide technical guidance regarding the management of noise affecting new residential developments in England. The document provides advice on good acoustic design and '*aims to protect people from the harmful effects of noise*'.

This document emphasises the necessity of considering acoustics at the early stages of the design process. That will identify a number of opportunities for better acoustics during the early stages of the design and therefore to minimise reliance on mitigation measures later on in the process. The document also encourages undertaking early consultation with the Local Planning Authority in order to get appropriate feedback on the proposed acoustic methodology.

The ProPG approach includes two stages, consisting '*Stage 1'* of an initial noise-risk assessment for the development, and '*Stage 2'* of a systematic consideration of four key elements (i.e. Good Acoustic Design Process, Internal Noise Level Guidelines, External Amenity Area Noise Assessment and Assessment of Other Relevant Issues).

2.3 BS 8233: 2014 'Guidance on sound insulation and noise reduction for buildings'

Internal Noise Criteria

British Standard (BS) 8233 (**Ref. 05**) establishes internal ambient noise levels for dwellings based upon occupancy patterns and derived from World Health Organisation (WHO) guidelines for community noise (1999) (**Ref. 06**). These are summarised in Table 2.1.

Table 2.1 Summary of internal noise levels

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living room	35 dB $L_{Aeq,16h}$	---
Dining	Dining room/area	40 dB $L_{Aeq,16h}$	---
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16h}$	30 dB $L_{Aeq,8h}$

It should be noted that the internal target levels as shown in Table 2.1 can be relaxed by 5 dB where the proposed development is considered '*necessary or desirable'* and reasonable internal conditions would still be achieved, as per noted in Paragraph 7.7.2 of BS 8233.

External Noise Criteria

BS8233 also provides design criteria for external noise and Section 7.7.3.2 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 the 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."

2.4 Design Manual for Roads and Bridges, 2011

The Design Manual for Roads and Bridges (DMRB) HD213/11, Volume 11, Section 3, Part 7 (**Ref. 07**), provides advice on the assessment of noise and vibration impacts due to road traffic.

Two sets of criteria are presented for assessing the impact of traffic noise changes, one for the short term and another for the long term, which takes into account the difference in the human perception of short- and long-term environmental noise changes. In the short term a change in road traffic noise of 1 dB $L_{A10,\ 18hour}$ is the smallest that is considered perceptible whilst in the longer term a 3 dB $L_{A10,\ 18hour}$ change is considered just perceptible. A change in road traffic flow of 25% is generally predicted to give rise to a change in noise of approximately 1 dB(A).

The criteria from DMRB for short- and long-term effects are presented in Table 2.2.

Table 2.2 DMRB Criteria for determining magnitude of impact

Short Term		Long Term	
Change in Noise Level (dB $L_{A10,18h}$)	Magnitude of Impact	Change in Noise Level (dB $L_{A10,18h}$)	Magnitude of Impact
0	No Change	0	No Change
0.1 – 0.9	Negligible	0.1 – 2.9	Negligible
1.0 – 2.9	Minor	3.0 – 4.9	Minor
3.0 – 4.9	Moderate	5.0 – 9.9	Moderate
5.0 +	Major	10.0 +	Major

The DMRB short-term criteria have been used in the assessment to determine the noise impact associated with operational phase traffic.

2.5 Stakeholder Engagement

The Environmental Health services at HC submitted an opinion response to the Development Management (Planning and Transportation) department at HC on 30 May 2019 with regards to the noise effects associated with the proposal, as shown below:

‘(…) *The applicant is requested to provide a Phase 1 noise risk assessment for road traffic noise in accordance with the ProPG guidance.*

Should the noise risk be found to be negligible then our department would have no objections to this proposal. However, if the noise risk is more than negligible then the applicant will be requested to supply an Acoustic Design Statement at the Reserved Matters stage in accordance with the ProPG guidance. This is to ensure that the desirable BS8233 internal and external noise standards can be met as far as possible. Effectively there is only a small section of this site which is likely to be impacted directly by road traffic noise from the Canon Pyon Road so we would request that in particular the design of the closest properties takes into account physical mitigation against road traffic noise e.g. by placing as many bedrooms on the non-road side of the development as possible.’

Further to the above, RSK consulted with the Environmental Health department in June 2019 regarding the proposed noise monitoring strategy and assessment methodology. It was confirmed that the proposed methodology was appropriate for the purpose of this assessment.

3 BASELINE SURVEY AND RESULTS

3.1 Guidance Methodology

The three-part standard BS 7445 '*Description and measurement of environmental noise. Guide to quantities and procedures*' (**Ref. 08**) provide the framework within which environmental noise should be quantified. Part 1 (2003) provides a guide to quantities and procedures and Part 2 (1991) provides a guide to the acquisition of data pertinent to land use. Part 3 (1991) provides a guide to the application of noise limits.

BS 7445 also refers to a further standard, BS EN 61672 (**Ref. 09**), which prescribes the equipment necessary for such measurements. Whilst BS 7445 does not prescribe the meteorological conditions under which noise measurements should or should not be taken, it does (part 2, paragraph 5.4.3.3) recommend that in order:

> *"…to facilitate the comparison of results (measurements of noise from different sources), it may be necessary to carry out measurements under selected meteorological conditions which are reproducible and correspond to quite stable propagation conditions."*

These conditions include:

- Wind speed not exceeding 5 ms^{-1} (measured at a height of 3 to 11 m above ground);
- Downwind +/- 45 degrees of the line to the centre of the dominant source;
- No strong temperature inversions near the ground; and
- No heavy precipitation.

3.2 Survey Measurement Details

A baseline noise survey was undertaken between Thursday 27 June and Wednesday 3 July 2019. Two unattended measurements (UL01 and UL02) were undertaken over a representative midweek and weekend period at representative positions within the development site. Attended measurements at one location (AL01) were also undertaken to gather information about the principal noise sources to inform the modelling, assessment and the environmental acoustic design. Discussions were sought with the Client prior to installation to agree the most appropriate locations, taking into account the confines of the site.

A description of the measurement positions and rationale is provided in Table 3.1. The location of the noise measurement positions is shown graphically in Figure 3.1 overleaf.

Table 3.1 Measurement Location Details

No.	Type [1]	Location	Rationale
UL01	U	South-west boundary	To measure noise levels along the south-west of the site and to obtain vehicle noise along Canon Pyon Road
UL02	U	North-east boundary	To measure noise levels in proximity to the existing dwellings adjoining the site
AL01	A	North boundary	To measure noise levels at the nearest areas to the construction works being undertaken to the north of the site

(1) Unattended denoted U Attended denoted A

Figure 3.1 Noise Survey Locations (scale assumes the map is printed at full A4-page)

3.3 Survey Equipment

The noise survey was undertaken using the following equipment:

Table 3.2 Measurement Equipment

Equipment	Type	Serial number	Calibration date
Class 1 Sound Level Meters	RION NL-52	00453835	18/03/2019
	RION NL-52	01043376	18/04/2019
Acoustic Calibrator	RION NC-74	35270127	26/04/2019

All noise measurements were undertaken in free field conditions with the microphone positioned away from any significant reflecting surfaces and at 1.5 m above the ground height to the requirements of BS7445-1:2003 '*Description and measurement of environmental noise. Guide to quantities and procedures*'.

The calibration of each sound level meter was checked before and after the measurements, using the acoustic calibrator at 94 dB at 1 kHz; no calibration drift above 0.2 dB was noted.

The sound level meters used conform to the requirements of BS EN 61672-1: 2013 '*Electroacoustics. Sound level meter, Specifications'*. The calibrator used conforms to the requirements of BS EN IEC 60942: 2018 *'Electroacoustics, Sound calibrators'* (**Ref. 10**). The equipment used has a calibration history that is traceable to a certified calibration institution. Sound level meters are required for calibration every 2 years, with acoustic calibrators requiring calibration annually. Calibration certificates are available upon request.

3.5 Overall Noise Environment Description

The noise environment at all measurement locations was affected by constant noise from Canon Pyon Road. However, during the survey, it became apparent that some noise sources other than road traffic (e.g. construction noise from the DCWW site and associated auxiliary zones) could affect the baseline noise measurements; therefore and in order to investigate the nature of the noise sources affecting the unattended measurements in proximity to Canon Pyon Road, audio recordings for all the events exceeding a 60 dB $L_{Aeq,\ 1s}$ trigger level were undertaken during the noise measurements for UL01.

A number of observations on noise sources affecting each survey location have been included at the end of each set of results tables, so these can be seen in context and related to the measured levels.

3.6 Meteorological Conditions

Weather conditions during the attended noise measurement were noted to be dry and calm, with temperatures of 11-14 °C. Average wind speeds during the attended noise measurement were below 2 ms^{-1}.

Available weather records for a weather station located in Frome (weather station ID. '*IENGLAND624*') were obtained through Wunderground[2].

[2] www.wunderground.com

The analysis of the data shows that the weather conditions during the unattended noise measurements were generally suitable for noise monitoring, with dry and calm weather conditions being recorded.

The available weather data have been summarised in Table 3.3.

Table 3.3 Weather conditions during the unattended noise measurements (weather station ref. '*IENGLAND624*').

Date	Temperature (°C)	Precipitation (mm)	Average wind speed (ms^{-1})	Prevailing wind direction
Thursday 27/06/2019	10 to 16	0	1.4	ENE
Friday 28/06/2019	11 to 27	0	0.8	E
Saturday 29/06/2019	14 to 31	0	0.6	SSW
Sunday 30/06/2019	13 to 21	0	1.7	W
Monday 01/07/2019	11 to 21	0	0.8	W
Tuesday 02/07/2019	7 to 21	0	0.2	N
Wednesday 03/07/2019	9 to 10	0	0.3	ENE

3.9 Results

Measured noise levels at unattended survey locations UL01 and UL02 are summarised in Table 3.5 and for attended location AL01 in Table 3.4 below. All the values reported are considered to represent free-field conditions and survey location details are shown in Appendix 2. A detailed time history for locations UL01 and UL2 is presented in Appendix 3.

Table 3.4 Noise monitoring results - Unattended noise monitoring

NML Id	Date	Time period	Measured noise levels [1]			
			$L_{Aeq, T}$ dB	$L_{AFmax, 15min}$ dB (min - max)	$L_{A90, T}$ dB	$L_{A10, T}$ dB
UL01	Thursday 27/06/2019	11:00-23:00 [2]	56	68-90	44	61
		23:00-07:00	51	66-76	35	47
	Friday 28/06/2019	07:00-23:00	57	66-85	45	61
		23:00-07:00	47	44-72	33	44
	Saturday 29/06/2019	07:00-23:00 [3]	55	66-92	40	59
		23:00-07:00	48	60-75	34	48
	Sunday 30/06/2019	07:00-23:00	55	66-82	42	57
		23:00-07:00	51	38-77	33	47
	Monday 01/07/2019	07:00-23:00	57	67-84	42	60
		23:00-07:00	52	45-88	28	47
	Tuesday 02/07/2019	07:00-23:00	56	68-82	39	60
	Wednesday 03/07/2019	23:00-07:00	51	45-85	28	44

	Average [2]	**Daytime**	**56**	**66-92**	**42**	**60**
		Night-time	**51**	**38-88**	**32**	**46**
UL02	Thursday 27/06/2019	11:30-23:00	48	48-77	43	49
	Thursday 27/06/2019 / Friday 28/06/2019	23:00-07:00	43	45-76	35	43
	Friday 28/06/2019	07:00-23:00	48	48-78	42	48
	Friday 28/06/2019 / Saturday 29/06/2019	23:00-07:00	40	42-75	33	39
	Saturday 29/06/2019	07:00-23:00	44	51-74	36	45
	Saturday 29/06/2019 / Sunday 30/06/2019	23:00-07:00	42	45-71	31	41
	Sunday 30/06/2019	07:00-23:00	43	48-71	37	45
	Sunday 30/06/2019 / Monday 01/07/2019	23:00-07:00	39	47-71	29	39
	Monday 01/07/2019	07:00-23:00	48	50-75	39	48
	Monday 01/07/2019 / Tuesday 02/07/2019	23:00-07:00	40	41-68	26	39
	Tuesday 02/07/2019	07:00-23:00	51	50-80	40	50
	Tuesday 02/07/2019 / Wednesday 03/07/2019	23:00-07:00	43	41-76	27	39
	Average [4]	**Daytime**	**48**	**48-80**	**40**	**48**
		Night-time	**41**	**41-76**	**30**	**40**

(1) $L_{Aeq,\ T}$ values are the logarithmic average of $L_{Aeq,\ 15min}$ samples, and the $L_{A10,\ T}$ and $L_{A90,\ T}$ are the arithmetic average of $L_{A10,\ 15min}$ and $L_{A90,\ 15min}$ samples.

(2) Noise measurements between 13:32 and 15:02 have been discounted from this analysis, as these were affected by prominent construction noise.

(3) Noise measurements between 08:47 and 09:17 have been discounted from this analysis, as these were affected by prominent construction noise.

(4) Arithmetic average of derived daytime 16 hr and night-time 8 hr values

The noise environment observed during the installation and retrieval of the unattended sound level meter at UL01 was dominated by continuous road traffic noise from Canon Pyon Road. Other less prominent noise sources included bird calls.

After analysing the audio files recorded during the noise survey, it results clear that some construction activities had a significant effect on the measurements, and therefore noise measurements undertaken between 13:32 and 15:02 on 27/06/2019 and between 08:47 and 09:17 on 29/06/2019 have been discounted from the data analysis. Noise measurements for all the remaining periods are considered not to be significantly affected by construction noise.

As shown in Table 3.5, a number of relatively elevated $L_{AFmax,\ 15min}$ values were recorded at UL01. After analysing the time-distribution of these events and the audio files recorded during the survey, it was noted that the majority of these events are related to vehicle movements at Canon Pyon Road, with some influence from bird calls, especially during early morning periods (dawn chorus).

The noise environment observed during the installation and retrieval of the sound level meter at UL02 was also dominated by road traffic noise, with some influence of nearby construction activities.

It should be noted that averaged $L_{A10,\ T}$ values at UL01 and UL02 for night-time periods are below the averaged $L_{Aeq,\ T}$ values for the same periods. This would be as result of the influence of short-term and intermittent high-energy acoustic events in close proximity to the microphone (e.g. bird calls), as previously mentioned.

A summary of the attended noise measurement results is shown in Table 3.5 below.

Table 3.5 Noise survey results - Attended noise survey location AL01

Date	Start Time	Duration	$L_{Aeq, T}$ dB	$L_{Amax, T}$ dB	$L_{A90, T}$ dB	$L_{A10, T}$ dB
Thu. 27/06//2019	09:28-09:43	15 min	45	63	42	47
	09:43-09:58	15 min	49	71	40	47
	09:58-10:13	15 min	44	62	41	46
	10:13-10:28	15 min	43	56	40	45
	Average / L_{Amax} Range		**46**	**56-71**	**41**	**46**

Attended noise measurements were used to further investigate the noise environment at the closest areas to the rear of the existing dwellings adjacent to the site. Noise sources during the attended noise measurements were road traffic, bird calls and distant construction noise.

4 ACOUSTIC MODELLING

4.1 Guidance on Methodology

As the existing noise environment is dominated by road traffic noise the Calculation of Road Traffic Noise (CRTN) (**Ref. 11**) method has been applied to develop the acoustic model.

4.1.1 Modelling parameters

A computer noise model of the site has been constructed using SoundPLAN (v8.1 airborne noise prediction software. The model has been set up with the following parameters.

Table 4.1 Modelling parameters

Item	Setting
Ground Absorption	Hard, acoustically reflective ground (0.2 coefficient) – roads, pavements and hard standing areas Acoustically soft (assumed 0.8 coefficient) – grass or vegetated areas.
Meteorological Conditions (ISO 9613 calculations only)	10 degrees Celsius; 70% humidity; and Wind from source to receiver.
Receptor Height	New residential dwellings: - Ground Floor 1.5 m above ground; and - First Floor 4.0 m above ground.
Source Modelling	External noise sources, such as road traffic have been treated as line sources. Main algorithms used for road traffic noise is CRTN). CRTN describes the procedures for calculating noise from road traffic; the memorandum uses traffic flows, % HGV's and road speed, amongst other parameters to calculate the noise level in terms of the $L_{A10, 18hr}$ or $L_{A10, 1hr}$.
Terrain	LIDAR 2 m-resolution elevation lines (DTM).
Barriers	The existing dwellings bounding the site to the west have been included within the noise model. These buildings are located between the site and Canon Pyon Road and therefore provided some noise attenuation to the proposed dwellings. The proposed new buildings as per the 'Illustrative Masterplan' (drawing Ref. 'CSA/3339/115') have been incorporated into the noise model. It has been assumed that all the dwellings are 2-storey buildings, where the garage blocks are single-storey buildings.

4.1.2 Uncertainty

With regard to the model uncertainty, this would include reliability of input data, assumption of meteorological conditions (as shown in Table 3.4) and uncertainty inherent with the CRTN calculation method.

Uncertainty has been minimised by basing the validation of the model on baseline measurements undertaken over various days sufficient to obtain a robust dataset. Noise measurements are representative of the worst-case noise sensitive receptors for the existing noise sources, and measurements were undertaken under free-field conditions.

4.1.3 Road Traffic

A quantitative assessment of road traffic noise has been undertaken to derive the impact of changes in traffic flows caused by the proposed development. The assessment accounts for the change in noise levels for the roads in the vicinity of the site. The road traffic noise levels have been calculated in accordance with the methodology set out in CRTN.

Road traffic data has been provided by Asbri Transport. The assessment considers a short-term change in traffic numbers in the development opening year (2022), with ('*Do Minimum Opening Year*') and without ('*Do Something Opening Year*') the proposed development. It should be noted that road traffic data for 2022 (for both scenarios i.e. with and without the proposed development) includes committed traffic data from other proposed developments in the area.

A summary of this data is presented below in Table 4.2. It should be noted that no average traffic speeds are available for these roads, and therefore the speed limit for each road has been used to derive the traffic speed in accordance with the road classification included in page 6 of the CRTN memorandum.

Table 4.2 Traffic data (18hr Annual Average Weekly Traffic, AAWT).

Road Name	Speed (km/h)	2019, Baseline		2022, Baseline and Committed		2022, inc. development	
		Total vehicles	% HGV	Total vehicles	% HGV	Total vehicles	% HGV
Canon Pyon Road	64	6295	2	6503	2	6886	2
Roman Road	64	10073	3	10405	3	10620	3
Three Elms Road	64	7164	1	7400	1	7528	1
A4103	64	8549	3	8832	3	8872	3

4.2 Noise Model Validation

The noise model predictions for the present year have been compared with the noise monitoring results at location UL01, which is located in proximity to the main noise source affecting the site (road traffic at Canon Pyon Road).

Differences between measured and predicted noise levels are presented in Table 4.3 below.

Table 4.3 Comparison between measured and predicted noise levels

Receptor ID	Time period	Daytime periods		
		Measured level [1] $L_{Aeq,T}$ dB	Predicted level [1] $L_{Aeq,T}$ dB	Difference predicted - measured, dB
UL01	Daytime	55 to 57	58	1 to 3
	Night time	47 to 52	51	-1 to 4

(1) Receptor height: 1.5 m above ground level.

The model was validated using assumed road emission levels against the measured noise levels obtained during the baseline survey.

The range in predicted/measured levels is between -1 and 4 dB $L_{Aeq,T}$. An uncertainty of this amount is expected (particularly at night) given the variance in traffic conditions (surface condition, vehicle numbers, speed etc.) weather conditions, local influences and seasonal fluctuations which play a role with noise measurement and modelling. The model was calibrated assuming road traffic noise as the main contributor to ambient noise levels; this is consistent with observations undertaken during the attended site visits.

Overall it is considered the predicted levels provide a good representation of the likely noise environment across the site.

5 ASSESSMENT AND DESIGN

5.1 Road Traffic Noise Assessment

The assessment of potential noise impacts as a result of operational phase traffic flows has been undertaken based on the criteria for noise impacts in both the short term and the long term as set out in DMRB HD 213/11.

Short-term Assessment

Based on the traffic data contained within Table 4.2, the basic noise levels at 10 m have been calculated in accordance with CRTN; from this, the change in road traffic noise levels has been determined (by comparing noise levels for the '*Do Something Opening Year*' or DSOY scenario with calculated noise levels for the '*Do Minimum Opening Year'* or DMOY scenario; DMOY includes baseline and committed traffic flows, while DSOY includes baseline, committed and development flows), as presented in Table 5.1 below.

Table 5.1 Comparison of basic road traffic noise levels. Short-term assessment

Road link	Basic Road Traffic Noise Levels dB $L_{A10,18hr}$ at 10 m		Difference 'DSOY' - 'DMOY'
	'DMOY'	'DSOY'	
Canon Pyon Road	65	65	0
Roman Road	67	67	0
Three Elms Road	66	66	0
A4103	66	66	0

The change in road traffic noise levels presented in Table 5.1 show that the increases in road traffic noise levels between the 'DMOY' to 'DSOY' scenarios for the proposal are below 1 dB $L_{A10,18hr}$ for the considered roads. Based on the short-term assessment criteria presented in Table 2.2, the change in traffic flow will give rise to no-change or negligible noise impacts for the considered roads.

5.2 Site Suitability Assessment

5.2.1 Indoor Living Area

Internal Ambient Noise

The guidance document, BS 8223:2014 states that indoor noise levels within bedrooms should not exceed 30 dB $L_{Aeq, 8hr}$ during the night-time and 35 dB $L_{Aeq, 16hr}$ within bedrooms and living rooms for the daytime. It is considered that these levels are the lowest observed adverse effect levels (LOAEL) in line with Defra's Noise Policy Statement for England (NPSE).

Predicted noise levels for daytime and night-time have been calculated for the proposed development area and based on the indicative locations of the development blocks as per the Illustrative Masterplan, considering road traffic noise. Table 5.2 includes the maximum predicted façade noise levels for each building and the level of attenuation recommended to comply with BS 8233 criteria. Maximum calculated noise levels for each scenario are highlighted in bold.

Table 5.2 BS8233 Assessment. Scenarios 01 (road traffic noise) and 02 (road traffic and sport activities)

Building/ Plot ID [1]	Period	BS8233 Internal Ambient Noise Requirements, dB	Predicted Maximum Noise Level/ $L_{Aeq, T}$ dB	Attenuation Design Target for Building Envelope, dB [3]
01	Daytime	35 (living room/ bedroom)	50	15
	Night time	30 (bedroom)	42	12
02	Daytime	35 (living room/ bedroom)	46	11
	Night time	30 (bedroom)	39	9
03	Daytime	35 (living room/ bedroom)	46	11
	Night time	30 (bedroom)	39	9
04	Daytime	35 (living room/ bedroom)	44	9
	Night time	30 (bedroom)	37	7
05	Daytime	35 (living room/ bedroom)	44	9
	Night time	30 (bedroom)	37	7
06	Daytime	35 (living room/ bedroom)	43	8
	Night time	30 (bedroom)	36	6
07	Daytime	35 (living room/ bedroom)	42	7
	Night time	30 (bedroom)	35	5
08	Daytime	35 (living room/ bedroom)	47	12
	Night time	30 (bedroom)	40	10
09	Daytime	35 (living room/ bedroom)	44	9
	Night time	30 (bedroom)	37	7
10	Daytime	35 (living room/ bedroom)	41	6
	Night time	30 (bedroom)	34	4
11	Daytime	35 (living room/ bedroom)	41	6
	Night time	30 (bedroom)	34	4
12	Daytime	35 (living room/ bedroom)	49	14
	Night time	30 (bedroom)	41	11
13	Daytime	35 (living room/ bedroom)	44	9
	Night time	30 (bedroom)	37	7

Building/ Plot ID [1]	Period	BS8233 Internal Ambient Noise Requirements, dB	Predicted Maximum Noise Level/ $L_{Aeq,T}$ dB	Attenuation Design Target for Building Envelope, dB [3]
14	Daytime	35 (living room/ bedroom)	43	8
	Night time	30 (bedroom)	36	6
15	Daytime	35 (living room/ bedroom)	42	7
	Night time	30 (bedroom)	35	5
16	Daytime	35 (living room/ bedroom)	41	6
	Night time	30 (bedroom)	34	4
17	Daytime	35 (living room/ bedroom)	49	14
	Night time	30 (bedroom)	41	11
18	Daytime	35 (living room/ bedroom)	42	7
	Night time	30 (bedroom)	36	6
19	Daytime	35 (living room/ bedroom)	41	6
	Night time	30 (bedroom)	34	4
20	Daytime	35 (living room/ bedroom)	44	9
	Night time	30 (bedroom)	37	7
21	Daytime	35 (living room/ bedroom)	47	12
	Night time	30 (bedroom)	40	10
22	Daytime	35 (living room/ bedroom)	42	7
	Night time	30 (bedroom)	35	5
23	Daytime	35 (living room/ bedroom)	41	6
	Night time	30 (bedroom)	34	4
24	Daytime	35 (living room/ bedroom)	47	12
	Night time	30 (bedroom)	40	10
25	Daytime	35 (living room/ bedroom)	43	8
	Night time	30 (bedroom)	36	6
26	Daytime	35 (living room/ bedroom)	41	6
	Night time	30 (bedroom)	34	4
27	Daytime	35 (living room/ bedroom)	41	6

Building/ Plot ID [1]	Period	BS8233 Internal Ambient Noise Requirements, dB	Predicted Maximum Noise Level/ $L_{Aeq, T}$ dB	Attenuation Design Target for Building Envelope, dB [3]
	Night time	30 (bedroom)	34	4
28	Daytime	35 (living room/ bedroom)	48	13
	Night time	30 (bedroom)	41	11
29	Daytime	35 (living room/ bedroom)	49	14
	Night time	30 (bedroom)	41	11
30	Daytime	35 (living room/ bedroom)	49	14
	Night time	30 (bedroom)	41	11
31	Daytime	35 (living room/ bedroom)	43	8
	Night time	30 (bedroom)	36	6
32	Daytime	35 (living room/ bedroom)	42	7
	Night time	30 (bedroom)	35	5
33	Daytime	35 (living room/ bedroom)	42	7
	Night time	30 (bedroom)	35	5
34	Daytime	35 (living room/ bedroom)	42	7
	Night time	30 (bedroom)	35	5
35	Daytime	35 (living room/ bedroom)	48	13
	Night time	30 (bedroom)	41	11
36	Daytime	35 (living room/ bedroom)	45	10
	Night time	30 (bedroom)	38	8
37	Daytime	35 (living room/ bedroom)	45	10
	Night time	30 (bedroom)	38	8
38	Daytime	35 (living room/ bedroom)	44	9
	Night time	30 (bedroom)	37	7
39	Daytime	35 (living room/ bedroom)	44	9
	Night time	30 (bedroom)	37	7
40	Daytime	35 (living room/ bedroom)	44	9
	Night time	30 (bedroom)	37	7

Building/ Plot ID [1]	Period	BS8233 Internal Ambient Noise Requirements, dB	Predicted Maximum Noise Level/ $L_{Aeq,T}$ dB	Attenuation Design Target for Building Envelope, dB [3]
41	Daytime	35 (living room/ bedroom)	49	14
	Night time	30 (bedroom)	42	12
42	Daytime	35 (living room/ bedroom)	44	9
	Night time	30 (bedroom)	37	7
43	Daytime	35 (living room/ bedroom)	47	12
	Night time	30 (bedroom)	40	10
44	Daytime	35 (living room/ bedroom)	45	10
	Night time	30 (bedroom)	38	8
45	Daytime	35 (living room/ bedroom)	44	9
	Night time	30 (bedroom)	37	7
46	Daytime	35 (living room/ bedroom)	49	14
	Night time	30 (bedroom)	42	12
47	Daytime	35 (living room/ bedroom)	50	15
	Night time	30 (bedroom)	42	12
48	Daytime	35 (living room/ bedroom)	45	10
	Night time	30 (bedroom)	38	8
49	Daytime	35 (living room/ bedroom)	45	10
	Night time	30 (bedroom)	38	8
50	Daytime	35 (living room/ bedroom)	63	28
	Night time	30 (bedroom)	55	25
51	Daytime	35 (living room/ bedroom)	58	23
	Night time	30 (bedroom)	51	21
52	Daytime	35 (living room/ bedroom)	57	22
	Night time	30 (bedroom)	49	19
53	Daytime	35 (living room/ bedroom)	55	20
	Night time	30 (bedroom)	48	18
54	Daytime	35 (living room/ bedroom)	52	17

Building/ Plot ID [1]	Period	BS8233 Internal Ambient Noise Requirements, dB	Predicted Maximum Noise Level/ $L_{Aeq, T}$ dB	Attenuation Design Target for Building Envelope, dB [3]
	Night time	30 (bedroom)	45	15
55	Daytime	35 (living room/ bedroom)	54	19
	Night time	30 (bedroom)	46	16
56	Daytime	35 (living room/ bedroom)	52	17
	Night time	30 (bedroom)	44	14
57	Daytime	35 (living room/ bedroom)	51	16
	Night time	30 (bedroom)	44	14
58	Daytime	35 (living room/ bedroom)	50	15
	Night time	30 (bedroom)	43	13

(1) As shown in Figure 1.2.

(2) Free-field noise levels.

(3) Simple level difference (i.e. D_w) rather than sound reduction index.

Modelled daytime noise levels ($L_{Aeq, 16hr}$) range between 41 and 63 dB, with the highest levels corresponding to the closest sensitive receptor to the main road affecting the site (i.e. Canon Pyon Road).

Modelled night-time noise levels ($L_{Aeq, 8hr}$) range between 34 and 55 dB, with the highest levels corresponding to the closest sensitive receptor to Canon Pyon Road.

The attenuation required by the building envelope of the proposed residential units in order to meet the BS8233 internal ambient noise requirements during both periods will range between 4 and 28 dB for the considered receptors.

Internal Maximum Noise Events – WHO

Measured noise levels at the monitoring position located in proximity to Canon Pyon Road (UL01) have been analysed in order to determine the value of the 10th highest individual night maximum (L_{Fmax}) events in accordance with WHO guidelines. One-second samples measured between 23:00-07:00 have been analysed to obtain a true maximum noise level, in order to identify independent noisy events occurring at least 30 seconds apart (this is the assumed period to avoid consideration of various peaks from a same event/action).

The results of this analysis have been included in Table 5.3.

Table 5.3 Maximum Measured Noise Levels

Noise Monitoring Location ID	10th Highest individual night maximum event/ L_{Fmax} dB [1]
UL01	71

(1) Where the noise measurements include a number of nights, the 10th highest individual maximum event for all the considered nights has been considered within the assessment.

The above data has been used in order to calibrate a noise model for the site, assuming that the maximum levels are the result of vehicle movements along the nearby roads.

Table 5.4 summarises the L_{Fmax} noise predictions at heights considered representative of the bedrooms for the proposed residential dwellings (as per the indicative locations of the development blocks shown in the Illustrative Masterplan).

Table 5.4 WHO Assessment (Maximum Noise Level – Night)

Building/ Plot ID [1]	Predicted Maximum Noise Level, L_{Fmax} dB [2]	WHO Internal Criteria, L_{Fmax} dB	Attenuation Required by Building Envelope, dB [3]	Attenuation requirement higher than BS8233:2014
01	48	45	0	No
02	47	45	0	No
03	47	45	0	No
04	47	45	0	No
05	46	45	0	No
06	47	45	0	No
07	47	45	0	No
08	47	45	0	No
09	48	45	0	No
10	48	45	0	No
11	47	45	0	No
12	49	45	1	No
13	48	45	0	No
14	49	45	1	No
15	49	45	1	No

Building/ Plot ID [1]	Predicted Maximum Noise Level, L_{Fmax} dB [2]	WHO Internal Criteria, L_{Fmax} dB	Attenuation Required by Building Envelope, dB [3]	Attenuation requirement higher than BS8233:2014
16	48	45	0	No
17	53	45	5	No
18	49	45	1	No
19	49	45	1	No
20	52	45	4	No
21	56	45	8	No
22	50	45	2	No
23	49	45	1	No
24	59	45	11	No
25	52	45	4	No
26	51	45	3	No
27	50	45	2	No
28	60	45	12	No
29	60	45	12	No
30	60	45	12	No
31	53	45	5	No
32	50	45	2	No
33	51	45	3	No
34	50	45	2	No
35	60	45	12	No
36	56	45	8	No
37	55	45	7	No
38	52	45	4	No
39	52	45	4	No
40	51	45	3	No
41	62	45	14	No
42	54	45	6	No
43	59	45	11	No
44	57	45	9	No
45	55	45	7	No
46	62	45	14	No
47	62	45	14	No
48	56	45	8	No
49	57	45	9	No
50	78	45	30	Yes
51	73	45	25	Yes
52	71	45	23	Yes
53	69	45	21	Yes
54	65	45	17	No
55	68	45	20	Yes
56	63	45	15	No
57	62	45	14	No
58	61	45	13	No

(1) As shown in Figure 1.2.

(2) Free-field noise levels.

(3) Simple level-difference rather than sound reduction index.

Modelled maximum noise levels (L_{Fmax}) for night time periods range between 43 and 75 dB, with the highest levels corresponding to the closest sensitive receptor to the main road affecting the site (i.e. Canon Pyon Road). The attenuation required by the building envelope of the proposed residential units in order to meet the WHO criteria will range between 0 and 30 dB for the considered receptors.

It should be noted that the noise model results are based on the indicative locations of the development blocks as per he Illustrative Masterplan. A revised version of this report will be prepared once the exact number, size and location of the proposed dwellings is known and will accompany future reserved matters applications. Assuming that baseline conditions remain unaltered, it is likely that the revision of the masterplan will not result in substantial changes to the outputs of the noise model.

5.2.2 Discussion of the results

The facades of the proposed sensitive receptors facing Canon Pyon Road would be subjected to the highest noise levels throughout the development site, both $L_{Aeq, T}$ and L_{Fmax}.

BS8233 states that '*The Building Regulations' supporting documents on ventilation… recommend that habitable rooms in dwellings have background ventilation. Where openable windows cannot be relied upon for this ventilation, trickle ventilators can be used and sound attenuating types are available. However, windows may remain openable for rapid or purge ventilation, or at the occupant's choice*.'

The noise reduction through a partially open window is considered to be approximately 10 dB and 15 dB, as per *'NANR116 Open/ Closed Window Research'* published by Napier University in 2007 (**Ref. 12**). Therefore, in areas below 50 dB(A) during the day and 45 dB(A) at night, it is likely that open windows for ventilation without any additional mitigation (in the form of trickle-vent/hit and miss vents) will be considered appropriate. In a similar way for maximum noise events in areas with regular L_{Fmax} events lower than 60 dB(A) open windows for ventilation without any additional mitigation (in the form of trickle-vent/hit and miss vents) is likely to be considered appropriate

The level of attenuation necessary for the indoor living areas at the closest proposed residential buildings to Canon Pyon Road (i.e. ref 50 and 51, as shown in Figure 1.2) is likely to be achieved using high specification performance thermal double-glazing products supported by trickle vents (with a minimum sound transmission loss of 30 dB) for background ventilation and allowing occupants to open windows for rapid purge ventilation whilst complying with the BS 8233 internal ambient guidance for both day and night time periods. The building fabric should be constructed to ensure that a 30-dB reduction is achieved, taking into account room dimensions and room surface finishes. Care should be taken while choosing fixing methods for glazing and other building elements to ensure that the required attenuation is achieved and not compromised through workmanship.

The proposed properties at a greater distance from Canon Pyon Road are recommended a lower level of attenuation to reduce internal noise levels, as compared with the receptors closest to Canon Pyon Road. Although a low specification thermal double glazed with suitable trickle vent is envisaged for the properties further away from Canon Pyon Road the SRI (Sound Reduction Index) and transmission loss will be determined at detailed mitigation design stage.

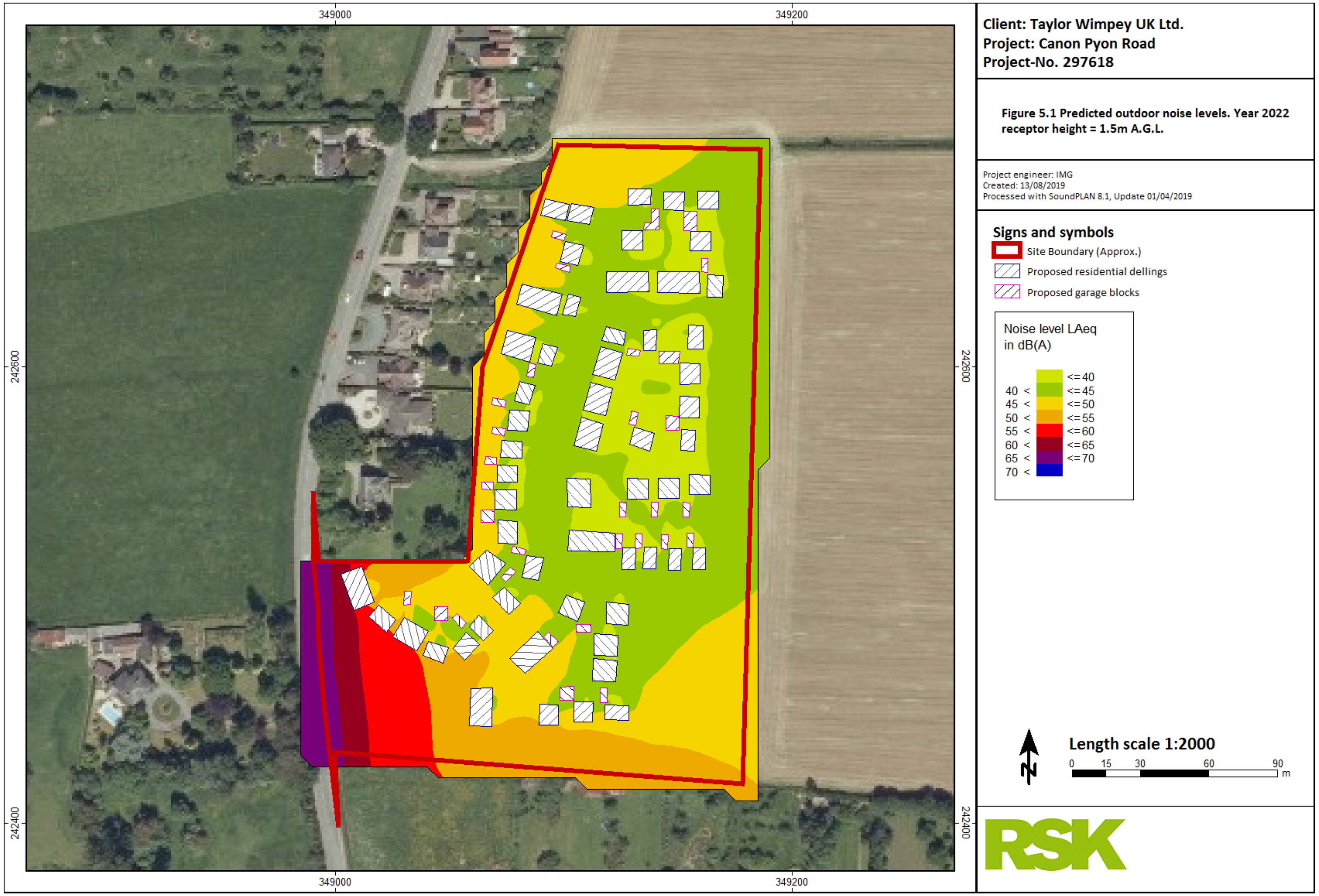
Traffic data for internal movements within the development site are not currently available. Taking into account the size of the site, it is unlikely that internal traffic movements would influence the façade treatment for the elevations facing onto the internal road and therefore have a relevant effect on the noise environment for the proposed development.

5.2.3 Outdoor living area

The proposed development will include provision for outdoor living areas.

Predicted noise levels if the indicative locations of the proposed buildings as included within the Illustrative Masterplan are considered, are likely to be below the 50 dB(A) lower criteria included within BS 8233:2014 for the majority of the site, with only the nearest garden areas to Canon Pyon Road (gardens located to the rear of building number 50, as per the number references included in Figure 1.2) being above these levels but always meeting the 55 dB(A) upper criteria. This is shown graphically at Figure 5.1 overleaf.

Figure 5.1 Daytime L_{Aeq} noise levels (dBA) including the proposed development. Receptor height = 1.5 m (i.e. Ground Floor) (scale assumes the map is printed at full A4-page)



5.2.4 Noise Risk Assessment. ProPG (2017)

According to the noise risk categories included in ProPG Planning and Noise, the proposed development would present '*Negligible'* to '*Low'* noise risks, corresponding the latest exclusively to the closest properties to Canon Pyon Road. Therefore, as described within ProPG, the development site is likely to be acceptable from a noise perspective.

It should be noted that the site layout has been designed so the garden areas are located away from Canon Pyon Road, benefitting from the acoustic screening afforded by intervening buildings. A good acoustic design process has been followed for the areas exposed to higher noise levels (i.e. nearest areas to Canon Pyon Road), which would be in line with the recommendations included in ProPG Planning and Noise.

6 CONCLUSIONS

A noise impact assessment has been undertaken for the proposed residential development at Canon Pyon Road, Hereford. This assessment includes noise monitoring at four locations across the proposed development and the closest noise sources to the site; this report also includes predicted noise levels across the site along with recommended mitigation measures derived from the computational noise model.

The results discussed are based on noise monitoring levels and computer noise modelling predictions which have been developed from road traffic predictions for the local road network.

An operational traffic noise assessment has been undertaken for the closest existing receptors to the proposed development to assess the site suitability for the proposed development, considering road traffic flows for the opening year (2020) with and without the proposed development (short-term assessment); this assessment predicts no change in road traffic noise levels.

Predicted noise levels during the operation of the proposed development if road traffic data for the future assessment year is considered at potential residential locations are of a magnitude where a standard double-glazed system providing attenuation of 28 dB(A) would be suitable at all areas of the proposed development. Where the external noise level stipulates whole dwelling ventilation cannot be provided via openable windows, a suitable internal acoustic environment should be achievable through installation of mid-range acoustic trickle ventilators. Initial recommendations for the acoustic performance have been provided, however, the final specifications will be subject to the detailed design carried out at a subsequent stage.

Good acoustics design has been incorporated to the design process, in order to minimise noise levels at the closest properties to Canon Pyon Road. According to the noise risk categories included in ProPG Planning and Noise (2017), the proposed development would present '*Negligible*' to '*Low*' noise risks, corresponding the latest exclusively to the closest properties to Canon Pyon Road. Therefore, as described within ProPG, the development site is likely to be acceptable from a noise perspective.

The predicted noise levels at the proposed garden areas would likely meet the BS 8233: 2014 noise guidelines for outdoor living areas throughout the majority of the site. The closest properties to Canon Pyon Road will be the most exposed units to road traffic noise. However, good acoustic design parameters have been adopted during the design of the proposed development in order to minimise noise levels at these garden areas; gardens are proposed to be located away from Canon Pyon Road and will be screened by the intervening building in front.

It should be noted that this noise report accompanies an outline planning application for the proposed residential development, and the results are based on indicative locations of development blocks as per the Illustrative Masterplan. The noise assessment will be updated once the fixed number, size and location of dwellings is known and will accompany future reserved matters applications. Assuming that baseline conditions remain unaltered, it is likely that any proposed change will not result in substantial changes to the results of this assessment.

In summary, existing noise levels across the site are predicted to be of a magnitude suitable for proposed residential development, assuming appropriate and compliant mitigation measures are included through design. The proposed development site is therefore considered to be suitable for the intended development.

7 REFERENCES

- **Ref. 01** - Noise Policy Statement for England (NPSE). DEFRA, 2010.
- **Ref. 02** - National Planning Policy Framework. Department for Communities and Local Government. February 2019.
- **Ref. 03** - Night Noise Guidelines for Europe. World Health Organisation, 2009.
- **Ref. 04** - Professional Practice Guidance on Planning & Noise (ProPG: Planning & Noise). Acoustics & Noise Consultants (ANC), Institute of Acoustics (IoA) and Character Institute of Environmental Health (CIEH). November 2017.
- **Ref. 05** - British Standard 8233: 2014, Sound insulation and noise reduction in buildings – code of practice. British Standards Institution, 2014.
- **Ref. 06** - Guidelines for community noise. World Health Organisation, 1999.
- **Ref. 07** - Design Manual for Roads and Bridges. HD 213/11 Volume 11, Section 3, Part 7 Revision 1. Noise and Vibration Highways Agency, 2011.
- **Ref. 08** - British Standard 7445-1:2003, Description and measurement of environmental noise. Parts 1 to 3: Guide to quantities and procedures. British Standards Institution, 1991 to 2003.
- **Ref. 09** - British Standard EN 61672-1:2013, Electroacoustics. Sound level meters. Specifications. British Standards Institution, 1991 to 2013.
- **Ref. 10** - British Standard EN IEC 60942:2018, Electroacoustics. Sound calibrators.
- **Ref. 11** - Calculation of Road Traffic Noise. Department of Transport, Welsh Office HMSO, 1988.
- **Ref. 12** - NANR116 Open/ Closed Window Research. The Napier University/ DEFRA, 2007.

APPENDIX 1: ACOUSTICS GLOSSARY

L_p - Sound Pressure Level

The basic unit of sound measurement is the sound pressure level, which is measured on a logarithmic scale and expressed in decibels (dB). The logarithmic scale makes it easier to manage the large range of audible sound pressures, and also more closely represents the way the human ear responds to differences in sound pressure:

$L_p = 20 \log_{10} (p/p_0)$

where p = RMS (root mean square) sound pressure; and

p_0 = reference sound pressure 2×10^{-5} Pa.

Frequency Weighting Networks

Frequency weighting networks, which are generally built into sound level meters, attenuate the signal at some frequencies and amplify it at others. The A-weighting network approximately corresponds to human frequency response to sound. Sound levels measured with the A-weighting network are expressed in dBA. Other weighting networks also exist, such as C-weighting which is nearly linear (i.e. un-weighted) and other more specialised weighting networks. Variables such as L_p and L_{eq} that can be measured using such weightings are expressed as L_{pA} / L_{pC}, L_{Aeq} / L_{Ceq} etc.

Time Weighting

Sound level meters use various averaging times for the measurement of root mean square (RMS) sound pressure level. The most commonly used are fast (0.125 s averaging time), slow (1 s averaging time) and impulse (0.035 s averaging time). Variables that are measures with time weightings are expressed as L_{AFmax} etc.

RMS for a set of values is the square root of the arithmetic mean of the squares of the values and is broadly used in acoustics because it can be related to the average intensity and the loudness of the sound.

L_{Aeq} – Equivalent Continuous Sound Pressure Level

Sound levels tend to fluctuate, and as such an ‘instantaneous’ measurement like sound pressure level cannot fully describe many real-world situations. A summation can be made of the measured sound energy over a certain period, and a notional steady level can be calculated which would contain the same total energy as the fluctuating sound. This notional level is termed the equivalent continuous sound level L_{eq}. L_{eq} can be determined over any time period, which is indicated as $L_{eq,T}$ where T is the time period (e.g. $L_{eq,24h}$).

In mathematical terms, for n discrete sound level measurements, Leq is given by:

$L_{eq,T} = 10 \log 10 (t_1 \times 10^{L1/10} + t_2 \times 10^{L2/10} + \ldots t_n \times 10^{Ln/10})/T$

where t_1 = time at level L_1 dB;

t_2 = time at level L_2 dB etc.

and T = total time

L_{max} - Maximum Sound Pressure Level or Maximum Noise Level

This is the maximum RMS sound pressure level occurring within a specified period. The time weighting is usually specified, such as in L_{Fmax}.

L_N - Percentile or Statistical Levels

Sometimes it is useful to calculate the level which is exceeded for a certain per-cent of a total period. Background noise is often defined as the A-weighted sound pressure level exceeded for 90% of the specified period T, expressed $L_{90,T}$. Road traffic noise is often characterised in terms of $L_{A10,18hr}$.

R – Sound Reduction Index

The sound reduction index is a weighted sound reduction index in decibels which uses the specific transmission coefficient for a partition or single component to produce an accurate and repeatable measurement of the sound reduction performance for the partition or component.

R_W – Weighted Sound Reduction Index

This index described the airborne insulation features of a building element. This value in dB is measured in laboratory over a frequency range 100 to 3150 Hz.

APPENDIX 2: PHOTOGRAPHS

Figure A2.1 Unattended monitoring position UL01

Figure A2.2 Unattended monitoring position UL02

Figure A2.3 Attended monitoring position AL01

Figure A2.4 Attended monitoring position AL02

APPENDIX 3: NOISE SURVEY DATA

Figure A3.1 UL01 Noise Survey Results

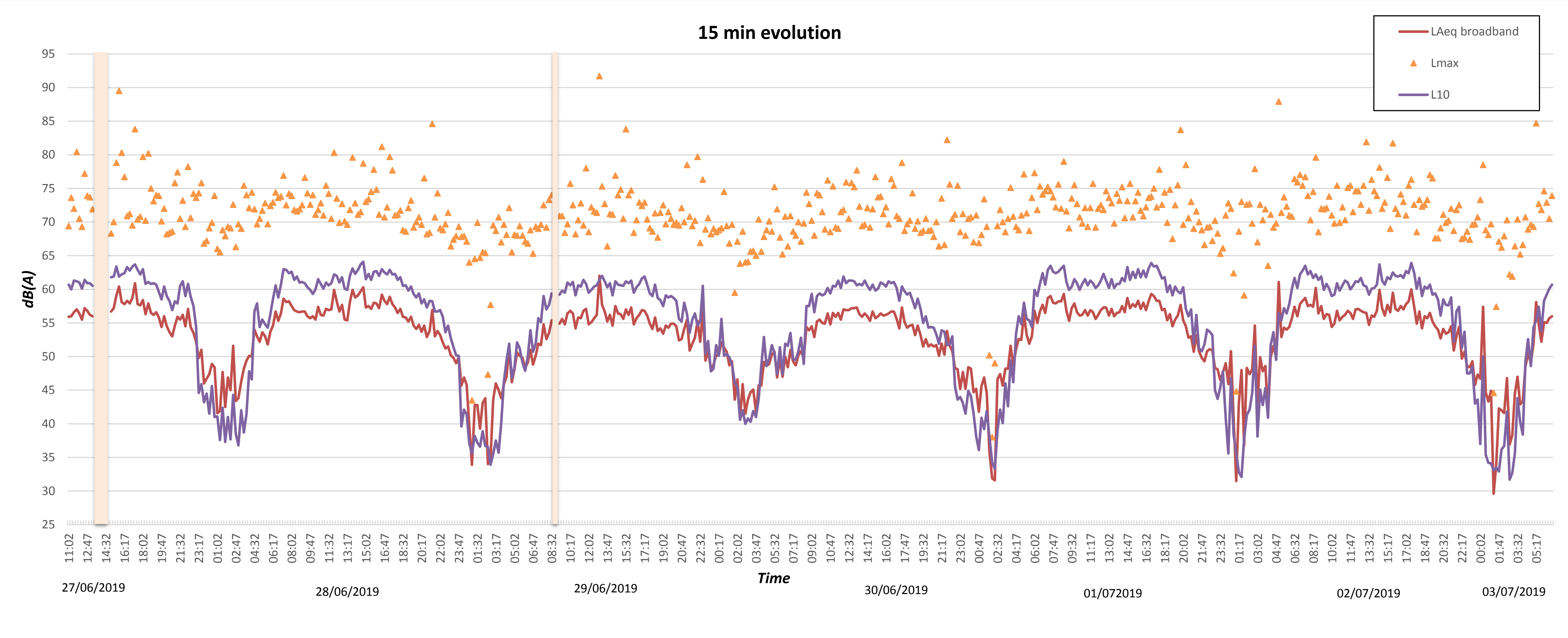


Figure A3.2 UL02 Noise Monitoring Results