

Hickie & Hickie Ltd

UNITS 3 & 4 WESLEY GATE, READING

Noise assessment for proposed extension

Report No. 17-0090-0 R02



Hickie & Hickie Ltd

UNIT 3 & 4 WESLEY GATE, READING

Noise assessment for proposed extension

Report No.: 17-0090-0 R02

Date: 29 September 2017

Prepared by:

C Heal MEng(Hons) MIOA



Checked by:

C Matheson MEng(Hons) MIOA



Managing Director: Peter Rogers BSc(Hons) MSc CEng FIOA

5 Charlecote Mews, Staple Gardens, Winchester, Hampshire. SO23 8SR
T +44 (0)1962 858800 E sa@sustainableacoustics.co.uk W www.sustainableacoustics.co.uk
Registered in England • Company No 08149221 • VAT Regist No 100557305



INVESTORS
IN PEOPLE





CONTENTS

1	INTRODUCTION	5
1.1	Context.....	5
2	POLICY AND GUIDANCE ON NOISE.....	6
3	LOCAL POLICY	6
4	INITIAL SITE RISK ASSESSMENT	7
5	ACOUSTIC DESIGN STATEMENT	8
5.1	Noise assessment.....	8
5.2	Internal noise levels	9
5.3	External amenity area noise	10
5.4	Mitigation.....	10
6	SUMMARY AND RECOMMENDATION TO THE DECISION MAKER	11
	APPENDIX 1 POLICY AND GUIDANCE ON NOISE	I
	APPENDIX 2 NOISE SURVEY	VI
	APPENDIX 3 ACOUSTIC TERMINOLOGY	X



TABLES

Table 1: Noise levels at 3 rd floor development (free-field).....	7
Table 2: Approximate internal noise levels with natural ventilation via open windows	9
Table 3: Summary of measured noise levels (free-field).....	IX
Table 4: Noise levels at 3 rd floor development (free-field)	IX

FIGURES

Figure 1: Site location	5
Figure 2: Proposed third floor plan	6
Figure 3: Noise model of vertical section through road and balconies.....	8
Figure 4: Façade noise level measured at the front in 15 minute periods.....	VIII
Figure 5: Façade noise level measured at the rear in 15 minute periods	VIII

1 INTRODUCTION

It is proposed to develop a roof extension at the third floor of Units 3-4 Wesley Gate, Queen's Road, Reading, to provide additional residential accommodation, to compliment the redevelopment of the existing office space to residential on the ground, first and second floors approved under Permitted Development rights (application no. 170314).

This report provides an assessment of the impact of noise on the proposed extension and recommendations to mitigate adverse effects due to noise. Note this report does not assess the permitted development.

1.1 Context

The development site is located on Queens Road in central Reading area as shown below. The principle noise sources affecting the site are road traffic on Queens Road and occasional vehicle movements at the rear.



Figure 1: Site location

The floor plan for the proposed roof extension is shown below:

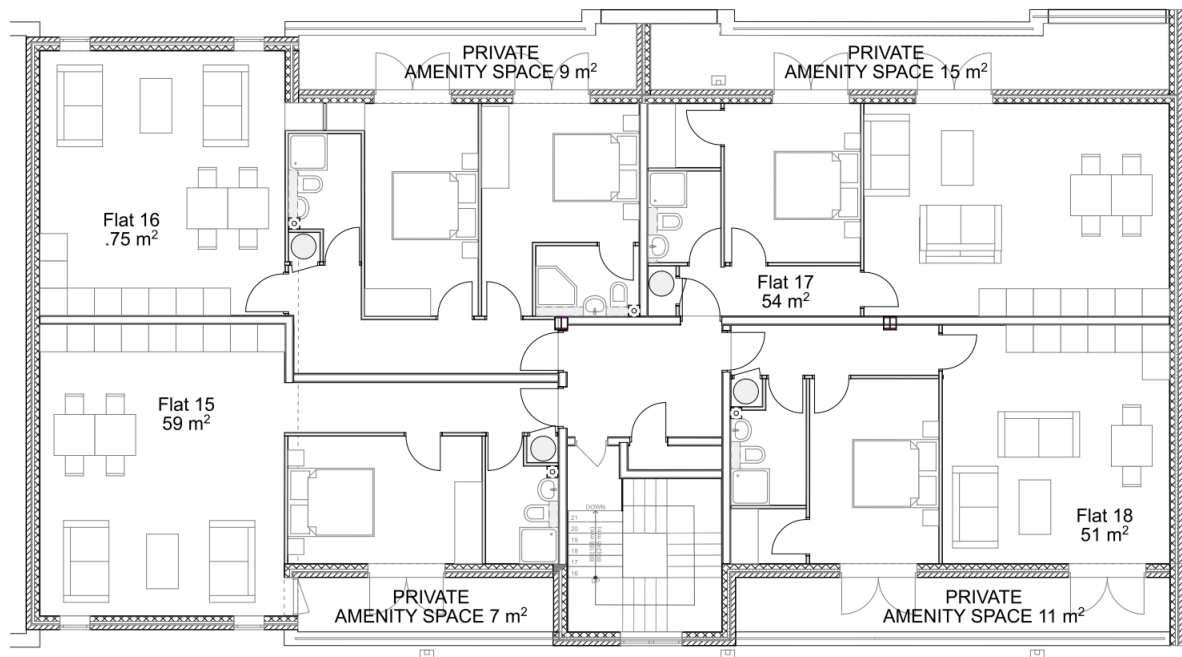


Figure 2: Proposed third floor plan

2 POLICY AND GUIDANCE ON NOISE

National planning policy is provided in the National Planning Policy Framework (NPPF), which supports a presumption in favour of development, unless the adverse impacts of that development would outweigh the benefits when assessed against the policies in the Framework, taken as a whole. Policy on noise implications is to *avoid* significant adverse impacts, *mitigate* and reduce other adverse impacts and to *recognise* the need for development. This is further qualified in the Noise Policy Statement for England (NPSE).

Professional Practice Guidance on Planning & Noise (ProPG) provides recognised advice and an appropriate assessment process for new residential development, which is followed in this report.

Design criteria for internal and external noise levels, based on the recommendations of the World Health Organisation are provided in the British Standard BS 8233: 2014. ProPG provides expands on these criteria.

Further information on the national policy and guidance is provided in Appendix 1 of this report.

3 LOCAL POLICY

Relevant local policy is provided in the Reading Borough Local Development Framework, Adopted January 2008 with alterations adopted January 2015. General policy on noise for new development is provided in Policy CS34:



Policy CS34: Pollution and Water

...

Proposals for development that are sensitive to the effects of air, noise or light pollution will only be permitted in areas where they will not be subject to high levels of such pollution, unless adequate mitigation measures are provided to minimise the impact of such pollution.

The Sites and Detailed Policies Document (SDPD) Adopted October 2012, with alterations adopted January 2015, has the following policies on noise:

DM4: SAFEGUARDING AMENITY

Development will not cause a significant detrimental impact to the living environment of existing or new residential properties, in terms of:

...

Noise and disturbance;

Similar policies are proposed in the Draft Reading Borough Local Plan, May 2017 (e.g. EN16: POLLUTION AND WATER RESOURCES). It is also noted that in the Central Reading area at paragraph 5.3.25 of the draft local plan that:

In some cases, in order for the internal noise levels to be reasonable and not adversely affect health it would be necessary to provide a system of ventilation that entirely removes the necessity to open windows, even in very hot weather. Similarly, in terms of air quality, mitigation of impacts on residential development may be required, including means of ventilation that remove the need to open windows, and draw in the lowest levels of pollution possible, for instance from roof sources. This should be secured through the design of the proposal, and planning condition if necessary.

4 INITIAL SITE RISK ASSESSMENT

Following analysis of the survey results as detailed in Appendix 2, the free-field noise levels at the development on the third floor are as shown in the table below:

Period	L _{Aeq}	L _{Amax}
Front 3rd floor		
16hr Daytime	68	
8hr Night-time	61	75
Rear 3rd floor		
16 hr Daytime	52	
8hr Night-time	44	53

Table 1: Noise levels at 3rd floor development (free-field)

The Stage 1: Initial Site Risk Assessment following the advice ProPG (see Appendix 1) for the site is a Medium to High risk at the front façade and a Negligible risk at the rear façade. The advice for Medium and High risk sites is that development may be refused unless good acoustic design process is demonstrated in an Acoustic Design Statement, which confirms how the adverse impacts of noise will be mitigated and minimised, and that significant adverse noise impact will be avoided.

5 ACOUSTIC DESIGN STATEMENT

5.1 Noise assessment

The layout is designed with the majority of the rooms set back behind a parapet wall, which will significantly reduce noise levels incident on these façades. The window area to the two living rooms, (which are not set-back) is relatively low, which will reduce noise break-in to these rooms as windows and ventilation openings are typically the weakest elements of sound insulation to the building envelope.

The reduction in noise due to screening from the balcony walls has been calculated from octave band source data for the road traffic noise using Maekawa barrier theory and also using an IMMI noise modelling software. The IMMI noise model implements the methodology in ISO 9613 and assuming line sources with finite length for the road and reflective surfaces. The results of the noise modelling are shown below:

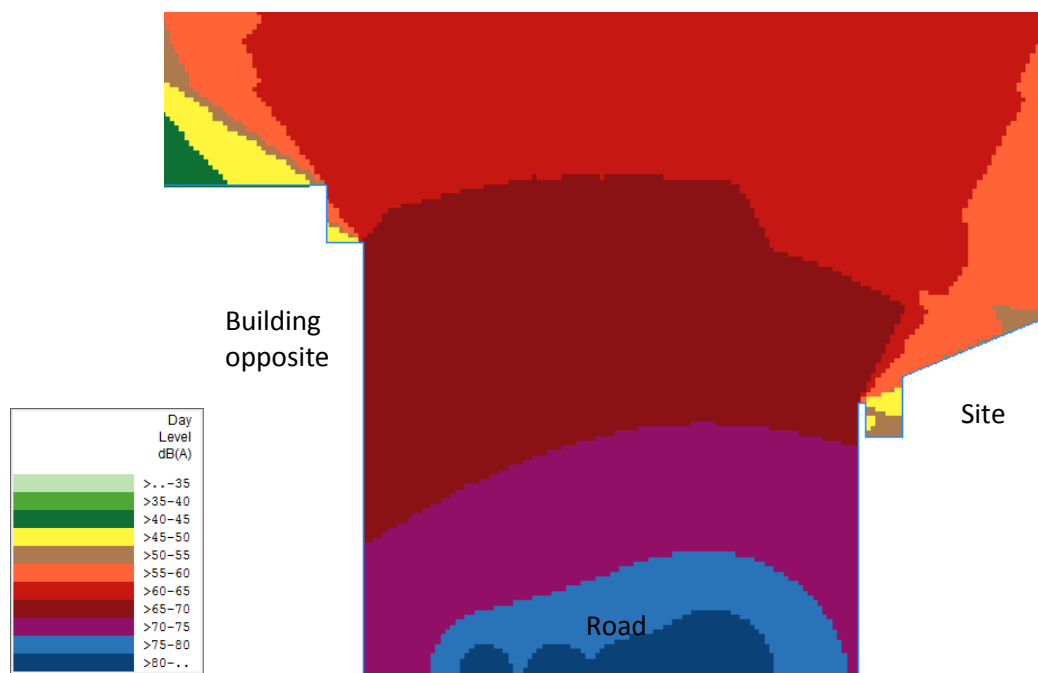


Figure 3: Noise model of vertical section through road and balconies

The calculated noise level at the set-back façade at the front is approximately 52 dB L_{Aeq} during the day and approximately 45 dB L_{Aeq} at night with typical maximum levels up to 61 dB L_{Amax} (at a receiver



height of 2m above floor level). The calculated noise levels for a person on the balconies will generally be in the range up to 55 dB L_{Aeq} , depending on whether in a seated or standing position.

At the rear the effect of screening due to the balcony wall will be similar to the front (approximately 15 dBA depending on frequency spectrum and receiver height); although the path length difference is marginally lower as sources are further from the barrier, there is minimal reflected component from a nearby façade.

5.2 Internal noise levels

Assuming a partially open window (or door) for ventilation, approximate internal noise levels in rooms can be determined by assuming 15 dB attenuation (see BS 8233: 2014 Annex G). A similar level difference can be assumed for a door, as a smaller opening is required to achieve the same area; note however this does assume the door can be prevented from swinging open wider during windy conditions. The table below shows the approximate internal noise levels with natural ventilation via windows or doors and the relevant internal noise level criterion from BS 8233 and ProPG for comparison:

Room	Approximate Internal level with natural ventilation	Criterion
Rear living room without balcony	37 dB $L_{Aeq, 16 \text{ hour}}$	35 dB $L_{Aeq, 16 \text{ hour}}$
Rear living room with balcony	22 dB $L_{Aeq, 16 \text{ hour}}$	35 dB $L_{Aeq, 16 \text{ hour}}$
Rear bedrooms (with balcony)	14 dB $L_{Aeq, 8 \text{ hour}}$ 23 dB L_{Amax}	30 dB $L_{Aeq, 8 \text{ hour}}$ 45 dB L_{Amax}
Front living room without balcony	53 dB $L_{Aeq, 16 \text{ hour}}$	35 dB $L_{Aeq, 16 \text{ hour}}$
Front living room with balcony	37 dB $L_{Aeq, 16 \text{ hour}}$	35 dB $L_{Aeq, 16 \text{ hour}}$
Front bedrooms (with balcony)	30 dB $L_{Aeq, 8 \text{ hour}}$ 46 dB L_{Amax}	30 dB $L_{Aeq, 8 \text{ hour}}$ 45 dB L_{Amax}

Table 2: Approximate internal noise levels with natural ventilation via open windows

It can be seen that at the front, unacceptable noise levels would occur in the living room without a balcony. At the rear living room without a balcony and the front rooms with a balcony, noise levels are equal to or marginally above the recommended criteria. At the rear rooms with a balcony internal noise levels are well within the recommended criteria.

Further mitigation of noise is therefore necessary to F16 living room and recommended for other rooms to reduce the marginal risk of noise disturbance to occupants.

It is unlikely to be possible to further increase the length of the balconies to the living rooms that are not set back without impacting on the quality and space available for accommodation. It, however, may be possible to increase the height of screening to the balconies to further reduce noise levels and provide alternative ventilation as an option to residents so that internal noise levels can be minimised. This is discussed further in the mitigation section at 5.4.



5.3 External amenity area noise

The setback provides a private external amenity space for each dwelling. The parapet wall provides screening of the road traffic noise sources below. Noise levels on the front space will be up to approximately 55 dB $L_{Aeq, 16hr}$ in a standing position and predicted to be up to approximately 50 dB $L_{Aeq, 16hr}$ in a seated position. At the rear space, daytime noise levels will be up to approximately 40 dB $L_{Aeq, 16hr}$. These noise levels are within the recommended criterion of 50-55 dB L_{Aeq} in BS 8233: 2014, therefore providing a usable amenity space.

It is noted that there is limited scope for quiet external amenity in the central Reading area generally and the development proposal allows for a useable external space. The nearest amenity park is at Forbury Gardens approximately 8 minutes' walk away, however, this may not have lower noise levels. The River Thames walk is within approximately 20 minutes' walk of the site, which is further from transportation noise sources.

5.4 Mitigation

Internal noise levels will exceed the recommended criterion in Flat 16, living room and may marginally exceed the recommended criteria in other rooms with natural ventilation partially open windows or doors. Two mitigation options are recommended:

1. Increase height of parapet wall to front amenity spaces (e.g. glass screen)
2. Provide an alternative ventilation option for Flats 16 and 17 (e.g. Part F system 3 or 4)

Option 1: Increase height of screen

Internal noise levels in the rooms set-back behind the amenity spaces could be reduced by increasing the height of the barrier provided by the parapet wall. It is calculated that an increase by approximately 400mm (roughly at head height of a person standing in the external space), would reduce noise levels by 2 dB. The calculations indicate that this would allow all rooms set-back to meet the internal noise criteria with natural ventilation.

This would also reduce noise levels in the external amenity space, making it more desirable for use.

Option 2: Alternative ventilation

Flat 16, living room

Standard trickle vents would not provide sufficient sound insulation for Flat 16 living room and are in any case unlikely to provide sufficient open area. Up to 3 acoustic frame vents (which typically have an area of 5000mm² each) with a D_{new} of 39 dB or acoustic through wall vents (typically up to 10000mm² each) with a D_{new} of 39 dB would provide sufficient attenuation.

If through wall vents are located to the side into the private amenity space (i.e. tucked behind the parapet wall), the noise reduction requirement reduces significantly, however, it is still recommended that ventilators with an acoustic rating are used, as standard through wall vents may not provide sufficient attenuation.



Other rooms

For the all other rooms, any sensible combination of standard trickle vents or acoustically rated through wall vents will provide sufficient noise attenuation. Note however that trickle vents alone are unlikely to provide sufficient area for background ventilation (System 1) and either continuous extract (System 3) or mechanical supply and extract (system 4) are likely to be required.

The ventilation system will need to be selected in combination with parts F and L of the Building Regulations. The mechanical system design will need to achieve internal background noise levels of NR 30 or less in daytime habitable rooms and NR 25 or less in bedrooms. Boost functions can be noisier as long as they are under the occupiers control, otherwise, it is recommended that the boost function should be no more than +5 dB above the background mode.

It is noted that the exposed side of the development (front) is north facing and therefore overheating, requiring more frequent use of purge ventilation, is considerably less likely to be of concern.

Glazing sound insulation requirements

The calculations assume standard thermal double glazing with a sound reduction index of approximately R_w 32 dB (e.g. 6mm float/12 mm void/6mm float). Standard double glazing to the windows and doors will provide sufficient noise reduction when closed, provided they have correctly fitted and functioning seals.

6 SUMMARY AND RECOMMENDATION

The set-back and provision of external private amenity space reduces noise levels from being a high risk of adverse impact to a low risk and avoid significant adverse impact to health and quality of life from occurring. With the inclusion of the recommended mitigation options, it will allow the design to meet the recommended criteria in ProPG and BS 8233:2014. The recommended mitigation options are to do either or both of the following:

- Marginally increase the height of the screen to the parapet wall to front amenity spaces
- Provide an alternative ventilation option for Flats 16 and 17

The development will therefore comply with the requirements of local and national policy to mitigate and minimise adverse impacts of noise. As such with the inclusion of the recommended mitigation, noise need not be a material factor in granting of planning permission and there should be no need for additional conditions to be attached to any planning permission, other than to ensure the above recommendations are implemented.



APPENDIX 1 Policy and Guidance on Noise



A1.1 National Planning Policy Framework

Current planning policy is based on the National Planning Policy Framework (NPPF), published in March 2012, which supports a presumption in favour of development, unless the adverse impacts of that development would outweigh the benefits when assessed against the policies in the Framework, taken as a whole.

The noise implications of development are recognised at paragraph 123, where it is stated that planning policies and decisions should aim to

- *avoid noise from giving rise to significant adverse impacts on health and quality of life as a result of new development;*
- *mitigate and reduce to a minimum other adverse impacts on health and quality of life arising from noise from new development, including through the use of conditions;*
- *recognise that development will often create some noise and existing businesses wanting to develop in continuance of their business should not have unreasonable restrictions put on them because of changes in nearby land uses since they were established.*

A1.2 Noise Policy Statement for England

Paragraph 123 of the NPPF also refers to advice on adverse effects of noise given in the Noise Policy Statement for England¹ (NPSE). This document sets out a policy vision 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”.

To achieve this vision the Statement sets the following three aims:

- *avoid significant adverse impacts on health and quality of life*
- *mitigate and minimise adverse impacts on health and quality of life; and*
- *where possible, contribute to the improvement of health and quality of life.*

A1.3 ProPG

Professional Practice Guidance on Planning & Noise: New Residential Development, published May 2017 by a Working Group of the Institute of Acoustics, Association of Noise Consultants and Chartered Institute of Environmental Health to provide guidance on the approach to the management of noise within the planning system in England. Whilst it is not an official government code of practice, it is endorsed by the appropriate professional bodies and reflects the NPSE, NPPF and Planning Practice Guidance. It is restricted primarily to the consideration of new residential development that will be exposed to transportation noise sources.

¹ Department for Environment, Food and Rural Affairs, *Noise Policy Statement for England*, London, 2010



ProPG advocates consideration of noise at an early stage and good acoustic design to produce sustainable development. It uses a two stage approach; an initial risk assessment and, where there is more than a negligible risk of adverse noise effects, an Acoustic Design Statement (ADS) should be produced with considers four key elements:

1. Good Acoustic Design Process
2. Observe internal Noise Level Guidelines
3. External Amenity Area Noise Assessment
4. Other Relevant Issues

Design target noise levels are based on BS 8233: 2014 with additional guidance on individual noise events at night, how windows and ventilation should be assessed and how the assessment should be considered where target noise levels may be difficult to achieve. Guidance is also given on how provision or access to quiet external amenity should be assessed.

The principle 'Other Relevant Issues' to be considered a ProPG Stage 2: Element 4 are:

- 4(i) Compliance with relevant national and local policy
- 4(ii) Magnitude and extent of compliance with ProPG
- 4(iii) Likely occupants of the development
- 4(iv) Acoustic design vs unintended adverse consequences
- 4(v) Acoustic design vs wider planning objectives

The outcome of the assessment will result in one of four recommendations to the decision maker:

- A. Planning consent may be granted without any need for noise conditions;
- B. Planning consent may be granted subject to the inclusion of suitable noise conditions;
- C. Planning consent should be refused on noise grounds in order to avoid significant adverse effects ("avoid"); or
- D. Planning consent should be refused on noise grounds in order to prevent unacceptable adverse effects ("prevent").

The criteria for the ProPG Stage 1: Initial Site Risk Assessment are reproduced below:

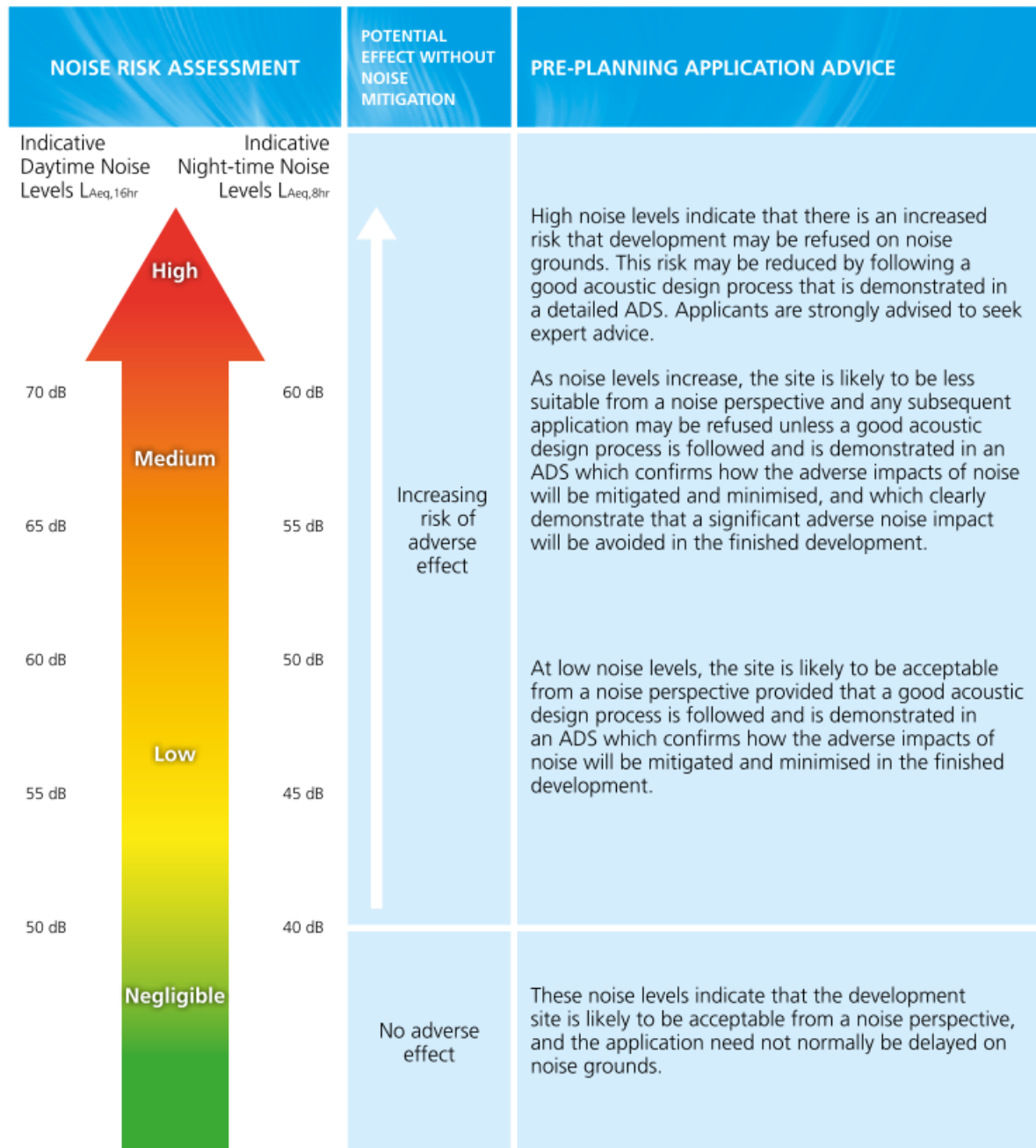


Figure 1 Notes:

- Indicative noise levels should be assessed without inclusion of the acoustic effect of any scheme specific noise mitigation measures.
- Indicative noise levels are the combined free-field noise level from all sources of transport noise and may also include industrial/commercial noise where this is present but is "not dominant".
- $L_{Aeq,16hr}$ is for daytime 0700 – 2300, $L_{Aeq,8hr}$ is for night-time 2300 – 0700.
- An indication that there may be more than 10 noise events at night (2300 – 0700) with $L_{Amax,f} > 60$ dB means the site should not be regarded as negligible risk.

Figure 1. Stage 1– Initial Site Noise Risk Assessment

Note also that Appendix A para A.19: "A site should be regarded as high risk where the $L_{Amax,f}$ exceeds or is likely to exceed 80 dB more than 20 times per night."



A1.4 BS 8233: 2014

The British Standard BS 8233: 2014, *Guidance on Sound insulation and noise reduction for buildings* provides additional guidance on noise levels from sources without specific character in the built environment, based on the recommendations of the World Health Organisation. The criteria desirable levels of steady state, “anonymous” noise in unoccupied spaces within dwellings, from sources such as road traffic, mechanical services and other continuously running plant, are tabulated below:

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

The standard also recommends that for traditional external amenity areas, such as gardens, it is desirable that external noise levels do not exceed 50 dB $L_{Aeq, T}$, and that 55 dB $L_{Aeq, T}$ would be acceptable in noisier environments. However, it is recognised that these values may not be achievable in all areas where development is desirable, and in such locations, development should be designed to achieve the lowest practicable levels.

BS 8233 states that regular individual noise events can cause sleep disturbance and that a guideline value in terms of SEL or $L_{Amax, F}$ may be set depending on the character and number of events. *ProPG adds to these criteria with the advice that good acoustic design should aim limit individual events to not more than 45 dB $L_{Amax, F}$ more than 10 times per night (inside bedrooms).*

Where development is considered necessary or desirable, despite external noise level above WHO guidelines, it is noted in BS 8233 that the above target levels may be relaxed by up to 5 dB. *ProPG expands on this stating that the more often internal noise levels exceed the target by more than 5 dB, the more likely they are to be regarded as unreasonable and it should be demonstrated how these will be kept to a minimum. Where internal target levels are exceeded by more than 10 dB they are highly likely to be regarded as unacceptable and should be prevented.*



APPENDIX 2 Noise Survey



A2.1 Methodology

A logging sound level meter was installed at both the front and the rear of the site between 31st August and 4th September 2017. At the front the microphone was placed at 1st floor level at 1m from the façade on an existing balcony. At the rear the microphone was placed on a boom approximately 1m from the façade at the second floor level. Both microphones were fitted with outdoor windshields. Noise level parameters were measured in 15 periods.

The weather during this period was calm with wind speeds of less than 1m/s from a south westerly direction, rising slightly on the afternoon of 3rd. Temperatures were up to 20 C during the day and falling to approximately 10 C at night. There was a period of heavy rain on the afternoon of 3rd and into the early morning of the 4th.

A2.2 Instrumentation

The equipment used during the survey is shown below. Prior to and on completion of the survey, the calibration of the sound level meter and microphone was checked using the field calibrator and no significant change in the calibration level occurred.

Equipment	Type	Serial Number	Calibration	
			Date	Certificate no
Front				
Rion Class 1 sound level meter	NA-28	00170246	06/04/17	U18435
Preamplifier	NH-23	60254	06/04/17	U18435
Microphone	UC-59	00299	06/04/17	18433
Rion Calibrator	NC-74	34773049	06/04/17	U18434
Rear				
Larson Davis Class 1 Sound Level Meter	824	1344	13/06/16	28811
Preamplifier	PRM 902	3159	13/06/16	28811
Microphone	2541	5099	13/06/16	28811
Larson Davis sound calibrator	CAL 200	2206	09/06/16	28814U

A2.3 Analysis of measured noise levels

The measured noise levels are shown in Figures A1.1 and A1.2 below. Note that as they are measured at 1m from the façade they include a reflected component from the façade and incident/free-field levels are up to 3 dB lower.

The period of rain from the afternoon of 3rd to early morning of the 4th appears to have affected the measurements at the rear and it is assumed that there may be, for example, a blocked gutter overflowing and water splashing on or near the microphone. The data measured the start of the period of rain onwards has, therefore, been ignored.

There were demolition works being undertaken inside the building at the second floor level to remove partitions, ceilings and during the day on 31st August finishing at around 3:30pm. These may have marginally affected the measured noise levels at the rear monitoring position and this period has therefore been excluded from the analysis.

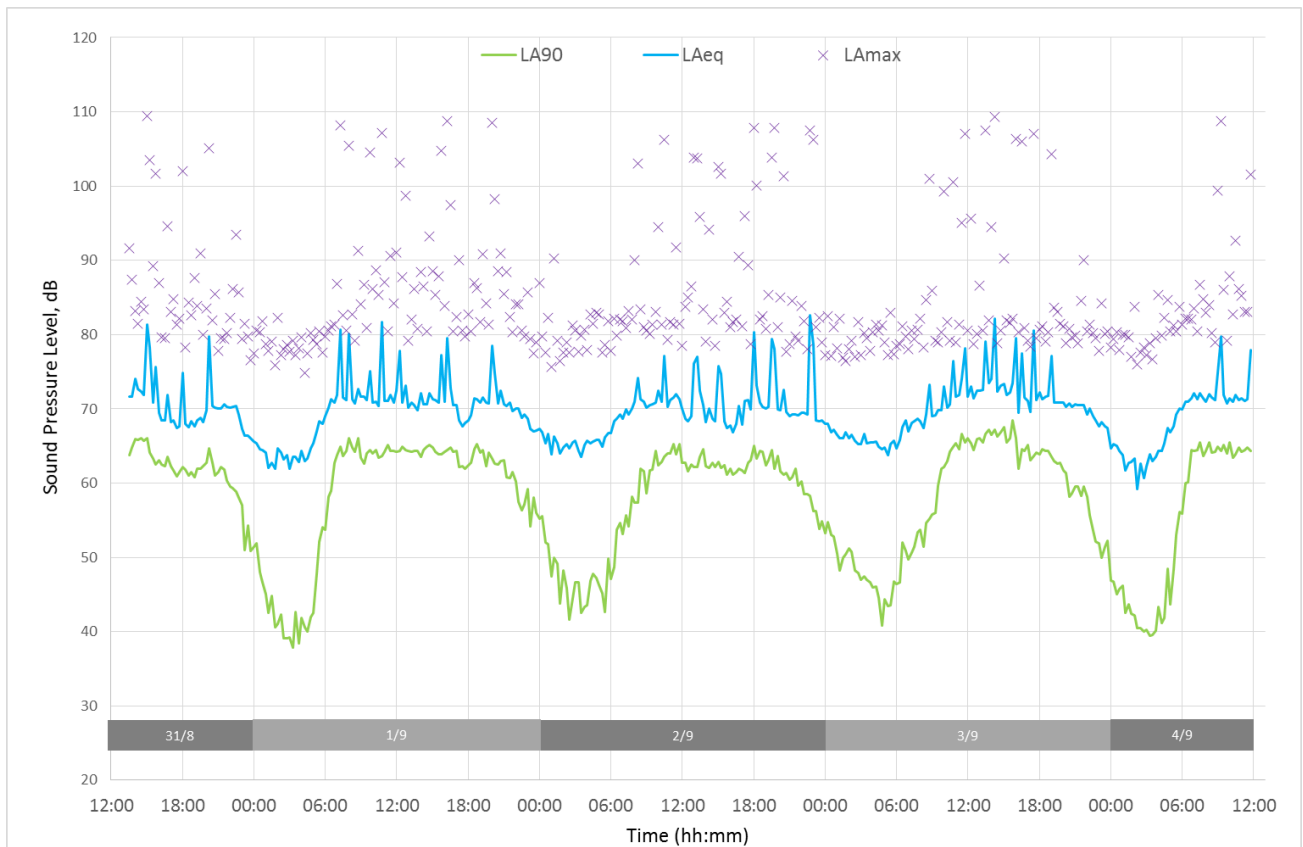


Figure 4: Façade noise level measured at the front in 15 minute periods

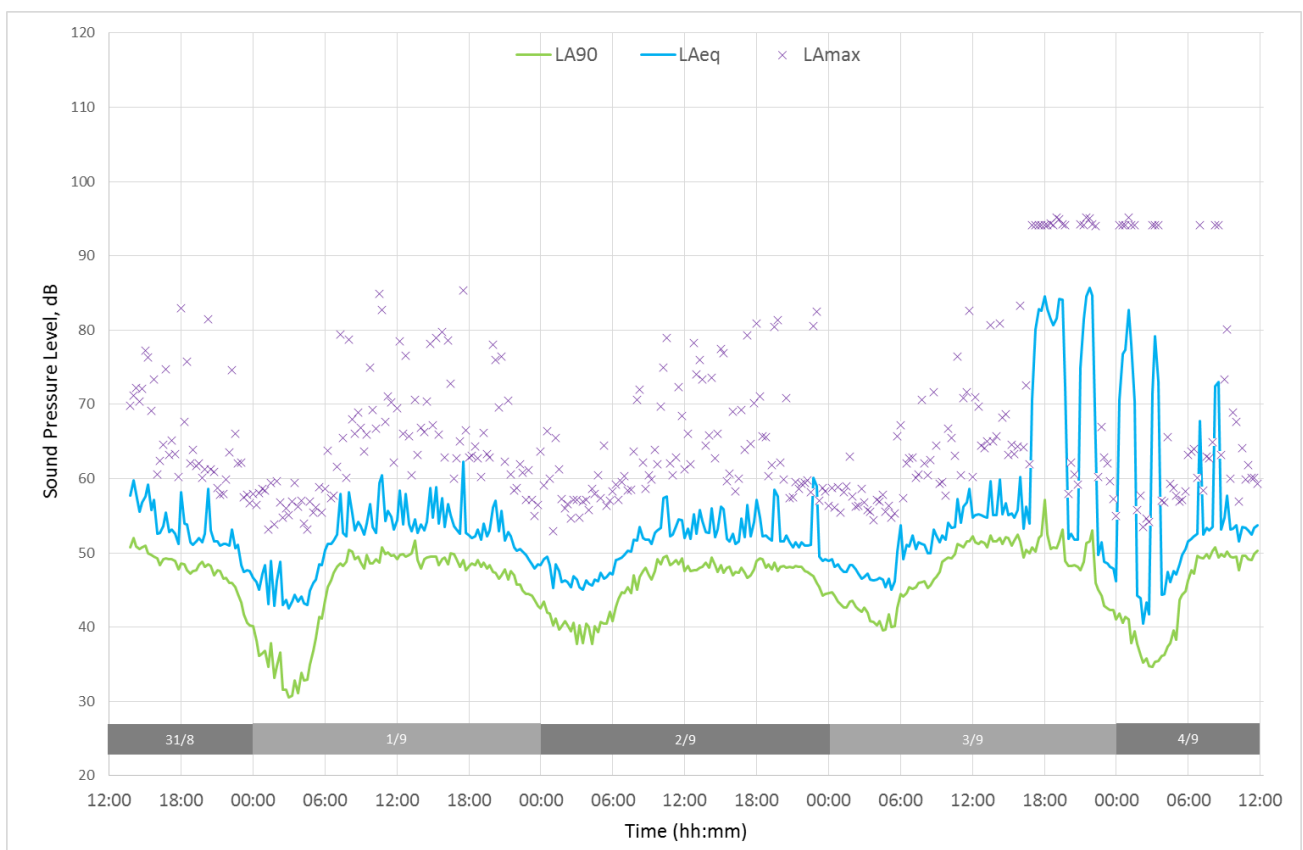


Figure 5: Façade noise level measured at the rear in 15 minute periods



A summary of the measured noise levels for the overall 16 hour daytime (0700-2300) and 8 hour night-time (0230-0700) periods is shown in the table below. Note these have been corrected to free-field/incident levels by subtracting 2.5 dB.

Period	L_{Aeq} Range (15min)	Period	L_{A90} Range (15min)	$L_{Amax, fast}$ Range (15min)
Front 1st floor				
16hr Daytime	64-80	71	47-66	75-107
8hr Night-time	57-76	64	35-62	72-104
Rear 2nd floor				
16hr Daytime	47-60	52	42-50	55-83
8hr Night-time	40-57	44	28-45	50-80

Table 3: Summary of measured noise levels (free-field)

The maximum noise levels measured due to individual short term events cover a large range. Maximum noise levels are most relevant at night, where there is potential for sleep disturbance. At the front measurement position near to the road, the average of the free-field maximum levels measured during each 15 minute period was 78 dB L_{Amax} , and the maximum level exceeded for highest 10 periods was also 78 dB L_{Amax} (as there are 32 x 15 minute periods at night is equivalent to the 70th percentile). At the rear façade the average of the maximum levels measured at night was 56 dB L_{Amax} , and the level exceeded for the highest 10 periods was also 56 dB L_{Amax} .

The measurement position at the front is closer to the road than the proposed development at the third floor level. Overall L_{Aeq} noise levels from road traffic will be approximately 3 dB lower² at the third floor (not including any screening or set-back from the façade line). Maximum noise level from individual events could be up to 5 dB lower³ at the third floor level, but for the purposes of this assessment a more conservative estimate of 3 dB lower at the third floor level is assumed. At the rear façade the noise levels at the third floor level will be similar to those measured at the second floor level⁴. The free-field noise level at the proposed development on the third floor level for the purposes of assessment are, therefore, shown in the table below:

Period	L_{Aeq}	L_{Amax}
Front 3rd floor		
16hr Daytime	68	
8hr Night-time	61	75
Rear 3rd floor		
16 hr Daytime	52	
8hr Night-time	44	53

Table 4: Noise levels at 3rd floor development (free-field)

² Assumes attenuation from a line source with finite length.

³ Assumes attenuation from a point source in the nearest lane close to the site.

⁴ Noise levels are less likely to originate from sources near to the measurement position.



APPENDIX 3 Acoustic Terminology



Environmental Noise

Environmental noise is normally described in terms of the single figure A-weighted sound pressure level, in decibels (dB). The A-weighting corresponds to the frequency sensitivity of the ear and, therefore, provides an approximation to the subjective response to sound at different frequencies. When a sound level is expressed in this way, the units can be denoted dB(A).

When sound is time varying, it is convenient to express the sound level using an indicator, or descriptor that takes account of this variation. Two types of indicator are in common use, the equivalent continuous sound level and the statistical indicators.

Equivalent continuous sound level

$L_{Aeq, T}$: This indicator provides the overall noise exposure to time varying sound and is the energy average of the sound over a specified time period. It is the notional steady level that would, over a given period of time, deliver the same sound energy as the actual fluctuating sound over the same period. It is denoted $L_{eq, T}$, or, if A-weighted, $L_{Aeq, T}$, where T is the time period of interest.

Statistical indicators

The statistical indicators are also single figure descriptors, but provide additional information on the temporal variation of the noise level with time. The indicators are expressed as the sound level exceeded for a specified percentage of the time period of interest and the most commonly used are described below:

$L_{A90, T}$: the A-weighted noise level exceeded for 90% of the time period T. This indicator is representative of the noise level occurring in the absence of short-term events and is used in the UK to represent the background noise level.

$L_{A10, T}$: the A-weighted noise level exceeded for 10% of the time period T. This indicator is used in the UK to define traffic noise, although in PPG 24 the $L_{Aeq, T}$ is used. For freely flowing continuous traffic, the $L_{Aeq, T}$ is approximately 3 dB lower than the $L_{A10, T}$.

$L_{A1, T}$: the A-weighted noise level exceeded for 1% of the time period T. This indicator is representative of any short-term peaks that occur in the time period.

$L_{Amax, T}$: the maximum A-weighted noise level that occurred during the time period T. It usually includes an additional subscript, slow (s) or fast (f), ie $L_{Amax, slow, T}$ or $L_{Amax, fast, T}$ which denotes the response time used in the analysis algorithm. The fast response tracks the maximum level of a rapidly changing sound more accurately than the slow response and the value is generally higher for impulsive or transient sounds.

$L_{Amin, T}$: the minimum A-weighted sound level occurring in the time period T, expressed in a similar way to the $L_{Amax, T}$.



Sound Insulation

When specifying the level of sound insulation required for a given building element the following descriptors may be used:

- R_w : the 'weighted sound reduction index'. This represents the level of sound reduction measured in a laboratory for a given building element. The w denotes 'weighting' and takes account of the deviations in sound reduction at a range of frequency bands when compared with a reference curve to determine the single figure value. Note this does not represent the in-situ performance of an installed element. Manufacturers should quote the R_w performance for their products.
- D_{new} : This is a way to represent the sound insulation provided by a small building element, such as a ventilation opening. The 'D' denotes the sound level difference measured across the installed element 'e' and is normalised 'n' to take account of the receiving room properties in which it was measured, and weighted 'w' by comparing the level difference across a range of frequency bands and comparing with a standard reference curve to provide a single figure value. Manufacturers of small building elements such as ventilation openings should state the D_{new} performance of their products.