Redrow Homes Limited

BLOWERS WOOD

Noise Assessment

70094117
FEBRUARY 2023

PUBLIC

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TYPE OF DOCUMENT (VERSION) PUBLIC

PROJECT NO. 70094117

OUR REF. NO. 70094117

DATE: FEBRUARY 2023

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QUALITY CONTROL

Issue/revision	First issue	Revision 1	Revision 2	Revision 3
Remarks	Draft for client review	Final – no changes	Changed report status to 'public'	
Date	20/01/2023	30/01/2023	27/02/2023	
Prepared by	Toby Lewis	Toby Lewis	Toby Lewis	
Signature			Lewis, Toby (UKTWL001) Digitally signed by Lewis, Toby (UKTWL001) DN: cn=Lewis, Toby (UKTWL001), ou=Active, email=Toby.Lewis@wsp.com Reason: I am the author of this document Date: 2023.02.27 09:17:14	
Checked by	Steve Fisher	Steve Fisher	Steve Fisher	
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Authorised by	Toby Lewis	Toby Lewis	Toby Lewis	
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Project number	70094117	70094117	70094117	
Report number	70094117	70094117	70094117	
File reference	70094117	70094117	70094117	

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1 INTRODUCTION

1.1 INSTRUCTION

1.1.1. WSP has been instructed by Redrow Homes Limited to undertake a noise assessment to accompany a planning application for a residential development at land at Blowers Wood, Gillingham, Kent.

1.2 SITE LOCATION

1.2.1. The development site is located within the administrative boundary of Medway District Council (MDC). To the east it is bounded by the A278 Hoath Way which is elevated relative to the development site. Maidstone Road is immediately to the south-east of the development site, beyond which is the grade separated junction serving the M2 and the A278. Woodland and agricultural land lie to the south-west, beyond which is the M2 motorway. A belt of woodland, beyond which is a residential area of Gillingham, is to the north-west.

1.2.2. The development site and its surrounds are shown in Figure 1-1 below, with the approximate site boundary shown in red.

Figure 1-1 – The Development Site

1.3 THE DEVELOPMENT PROPOSAL

1.3.1. The proposed development will entail 88 units, comprising houses and apartments. Early iterations of the proposed layout have been subject to three dimensional noise modelling to ensure that the final design is effective in protecting future residents from noise. The final layout is shown in Figure 1-2 below.

Figure 1-2 – Proposed Site Layout

1.3.2. This report is necessarily technical in nature and a glossary of acoustics terminology is provided at **Appendix A** for the convenience of the reader.

2 PLANNING POLICIES AND GUIDANCE

2.1 OVERVIEW

2.1.1. This section considers relevant national and local planning policies that are relevant to noise in the context of the application.

2.2 NATIONAL PLANNING POLICY

NATIONAL PLANNING POLICY FRAMEWORK (NPPF)

2.2.1. The original NPPF was published by central government in 2012 with the latest revision published in July 2021. It replaces previous noise policy contained in Planning Policy Guidance Note 24. It does not replace the Noise Policy Statement for England 2010 to which it refers.

2.2.2. The NPPF is a concise document that provides its position on noise primarily in paragraph 185 which is reproduced below:

> *'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.*
>
> *Footnote 65 See Explanatory Note to the Noise Policy Statement for England (Department for Environment, Food & Rural Affairs, 2010)'*

2.2.3. Paragraph 187 of the NPPF provides additional policy information applicable where new development is proposed close to existing commercial noise sources and is reproduced below.

> *'Planning policies and decisions should ensure that new development can be integrated effectively with existing businesses and community facilities (such as places of worship, pubs, music venues and sports clubs). Existing businesses and facilities should not have unreasonable restrictions placed on them as a result of development permitted after they were established. Where the operation of an existing business or community facility could have a significant adverse effect on new development (including changes of use) in its vicinity, the applicant (or 'agent of change') should be required to provide suitable mitigation before the development has been completed.'*

THE NOISE POLICY STATEMENT FOR ENGLAND (NPSE)

2.2.4. This provides more detail than the NPPF setting out the long-term vision of Government noise policy and applying to all forms of noise excluding occupational noise. The NPSE repeatedly refers to the management and control of noise within the context of Government Policy on sustainable development.

2.2.5. The NPSE also stresses that noise should not be considered in isolation from other related factors. At paragraph 2.7 for example it states:

'*…the application of the NPSE should enable noise to be considered alongside other relevant issues and not to be considered in isolation. In the past, the wider benefits of a particular policy, development or other activity may not have been given adequate weight when assessing the noise implications.*'

2.2.6. The NPSE introduces and describes three categories, or levels, describing the presence or absence of noise effects but does not quantify those categories, stating that the corresponding objective levels are likely to be different for different noise sources, receptors and times of the day or night. These categories are:

- NOEL – No Observed Effect Level – This is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise
- LOAEL – Lowest Observed Adverse Effect Level – This is the level above which adverse effects on health and quality of life can be detected
- SOAEL – Significant Observed Adverse Effect Level – This is the level above which significant adverse effects on health and quality of life occur.

2.2.7. The NPSE recognised that, at the time of publication, further research was needed into how these categories might be quantified for different scenarios. There is still no robust, universally accepted method of deriving suitable values and a variety of approaches are adopted in different circumstances. The subjective guidance provided in the government's web-based Planning Practice Guidance (PPG) for noise can be of assistance in deriving suitable values (see section 2.4 below).

2.2.8. The three aims of the NPSE are in alignment with the categories described in paragraph 2.2.6 above. These aims are:

1. *Avoid significant adverse impacts on health and quality of life from environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.*
2. *Mitigate and minimise adverse impacts on health and quality of life from environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.*
3. *Where possible, contribute to the improvement of health and quality of life through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.*

2.2.9. Although no absolute noise levels have been aligned with LOAEL and SOAEL, Highways England has adopted sound levels which are generally aligned with the following L_{Aeq} free-field values for road traffic noise:

LOAEL	Day 50 dB $L_{Aeq,16h}$	Night 40 dB $L_{Aeq,8h}$
SOAEL	Day 63 dB $L_{Aeq,16h}$	Night 55 dB $L_{Aeq,8h}$

2.3 LOCAL POLICY

2.3.1. The Medway Local Plan (to 2040) is currently in development and pre-adoption.

2.3.2. The current adopted policies are set out in the Medway Local Plan 2003. Policy BNE2: *Amenity Protection* is relevant to the development and states:

All development should secure the amenities of its future occupants, and protect those amenities enjoyed by nearby and adjacent properties. The design of development, should have regard to:

(i) privacy, daylight, and sunlight; and

(ii) noise, vibration, light, heat, smell and airborne emissions consisting of fumes, smoke, soot, ash, dust and grit; and

(iii) activity levels and traffic generation.

2.3.3. Policy BNE3: *Noise standards* is also relevant. That states:

In considering the impact of noise from transport related sources on new residential development, the noise exposure categories (NECs) set out below will be applied as follows:

(i) where noise levels are within category A, noise need not be considered as a determining factor;

(ii) where noise levels fall within category B, the applicant should demonstrate that adequate mitigation measures are included in the proposal to reduce noise to a satisfactory level or, where appropriate, conditions will be imposed to ensure such mitigation measures;

(iii) where noise levels fall within category C, the development will not be permitted unless either (a) the site is allocated for residential development or (b) there are no alternative quieter sites available. In both cases, a substantial level of protection against noise must be provided;

(iv) where noise levels are within category D, planning permission will be refused.

Noise levels[1] *corresponding to the noise exposure categories for new dwellings* $L_{Aeq,T}$ *dB*

Noise Source	*Noise Exposure Category (NEC)*			
	A	*B*	*C*	*D*
Road Traffic				
0700-2300	*<55*	*55-63*	*63-72 >*	*72*
2300-0700[2]	*<45*	*45-57*	*57-66*	*>66*
Rail Traffic				
0700-2300	*<55*	*55-66*	*66-74*	*>74*
2300-0700[2]	*<45*	*45-59*	*59-66*	*>66*
Air Traffic				
0700-2300	*<57*	*57-66*	*66-72*	*>72*
2300-0700[3]	*<48*	*48-57*	*57-66*	*>66*
Mixed Sources[4]				

0700-2300	*<55*	*55-63*	*63-72*	*>72*
2300-0700(2)	*<45*	*45-57*	*57-66*	*>66*

These thresholds may be increased or decreased by up to 3 dB(A) where it can be justified.

(1) Noise levels: the free field noise level(s) (L_{AeqqT}) [sic] *used when deciding the NEC of a site should be representative of typical conditions.*

(2) Night-time noise levels (2300-0700 hours): sites where the free field individual noise events regularly exceed 80dB L_{Amax} (S time weighting) several times in any hour, should be treated as being in NEC C regardless of the $L_{Aeq,8H}$ (except where the $L_{Aeq,8H}$ already puts the site in NEC D).

(3) Aircraft noise: daytime values accord with the contour values adopted by the Department of the Environment, Transport and the Regions which relate to levels measured 1.2m above open ground. For the same amount of noise energy, contour values can be up to 2 dB(A) higher than those of other sources because of ground reflection effects.

(4) Mixed sources: this refers to any combination of road, rail and industrial noise sources. The 'mixed source' values are based on the lowest numerical values of the single source limits in the table. The 'mixed source' NECs should only be used where no individual noise source is dominant.

Residential development should be designed to minimise noise levels within gardens and/or amenity areas provided by that development, with the aim of having these areas experience a general daytime (07.00 to 23.00 hours) noise level of at most 55 $L_{Aeq,T}$ dB.

Noise sensitive development (including offices, hospitals, schools and, in respect of noise emanating from non-transport related sources, housing) should be designed to minimise the impact of existing noise sources and the applicant will be required to demonstrate that the proposed development will not be exposed to unacceptable levels of noise relative to the proposed use.

Noise-generating development should be located and designed so as not to have a significant adverse noise impact on any nearby noise sensitive uses (including offices, hospitals, schools and, in respect of noise emanating from non-transport related sources, housing).

2.4 GUIDANCE AND STANDARDS

PLANNING PRACTICE GUIDANCE (PPG)

2.4.1. The Government launched the PPG web-based resource in March 2014 and refreshed it in July 2019. The section on noise provides tabulated descriptions of example outcomes of the categories introduced in the NPSE based on the likely average response. It also adds a fourth category termed Unacceptable Adverse Effect (UAE). The tabulated descriptions are summarised in Table 2-1 below.

Table 2-1 – Outcome Descriptors for Noise Effect Levels

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

2.4.2. The PPG recognises that there is not a simple relationship between measured or predicted noise levels and the resultant impact and that this will depend on how various factors combine. The factors thought to be most relevant in this assessment are:

- The source and absolute level of the noise together with the time of day it occurs
- For non-continuous sources of noise, the number of noise events and the frequency and pattern of occurrence of the noise
- The spectral content and general character of the noise i.e. tonal or with other particular features
- The local topology and topography
- The existing or, where appropriate, planned character of the area

BRITISH STANDARD (BS) 8233:2014 GUIDANCE ON SOUND INSULATION AND NOISE REDUCTION FOR BUILDINGS

2.4.3. This Standard provides guidance for the control of noise in and around buildings. The guidance provided within the document is applicable to the design of new buildings.

2.4.4. The guidance provided includes appropriate internal and external noise level criteria, which are applicable to dwellings exposed to steady external noise sources. It is stated that it is desirable for internal ambient noise levels not to exceed the criteria set out in Table 4 of the Standard, which are reproduced in Table 2-2 below, although Note 7 to the table states that reasonable internal conditions can still be achieved with the tabulated values relaxed by up to 5 dB.

2.4.5. Note 4 to Table 4 advises that regular noise events (for example, scheduled aircraft) can cause sleep disturbance and that a *'guideline value may be set in terms of SEL or $L_{Amax,F}$, depending on the character and number of events per night'*.

Table 2-2 – Summary of Internal Ambient Noise Level Criteria for Habitable Rooms from BS 8233:2014

Activity	Location	Period	
		07:00 to 23:00 hours	23:00 to 07:00 hours
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 $L_{Aeq,8h}$

2.4.6. With respect to external amenity space such as gardens and patios, it is stated that it is desirable that the noise level does not exceed 50 dB $L_{Aeq,16h}$, with an upper guideline value of 55 dB $L_{Aeq,16h}$, being acceptable in noisier environments.

2.4.7. The Standard also states at paragraph 7.7.3.2 '*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'*.

PROFESSIONAL PRACTICE GUIDANCE – PLANNING AND NOISE

2.4.8. The ProPG was published by the Chartered Institute of Environmental Health (CIEH), the Institute of Acoustics (IoA) and the Association of Noise Consultants (ANC) in June 2017. This guidance is non-statutory and is primarily aimed at the assessment of proposed residential development *'exposed predominantly to noise from existing transport sources'*.

2.4.9. A two-stage approach is advocated.

Stage 1 – an initial noise risk assessment of the proposed development site

Stage 2 – a systematic consideration of four key elements:

- Element 1 – demonstrating good acoustic design
- Element 2 – observing internal noise level guidelines
- Element 3 – undertaking an external amenity area noise assessment
- Element 4 – consideration of other relevant issues.

2.4.10. This approach is underpinned by an Acoustic Design Statement (ADS), the level of detail of which should be commensurate with the risk assessment for the development site.

2.4.11. With reference to the night time period, the ProPG suggests that sites where there are more than ten incidents of external L_{Amax} levels greater than 60 dB should not be risk assessed as negligible.

2.5 PRE-APPLICATION ADVICE

2.5.1. MDC provided the applicant with pre-application advice with reference to the development site in June 2022 (MDC reference PRE/22/0772). It included the following three comments with relevance to the noise assessment.

1) *Northeast boundary (AS78) - When taking into account that this is one of the more important tree lined gateways into Medway, a wider tree buffer would be required to mitigate the visual impact of the development and potentially offset any noise concerns.*

2) *A significantly increased buffer is advised to the north-east boundary to mitigate noise/ visual concerns.*

3) *The site is adjacent to the M2 and Hoath Way where levels of road traffic noise are likely to be elevated. Therefore, an acoustic assessment will be required with any planning application. Similarly, and due to the size of the development an air quality assessment will also be required. The scope and methodology to be employed should be agreed up front with the Environmental Protection Team and contact details can be provided upon request.*

2.5.2. Points 1 and 2 relate to a potential increase in the size of the buffer between the adjacent roads and the closest dwellings proposed in an earlier iteration of the layout, although it is thought that the primary reason that MDC raised this was with respect to visual screening rather than acoustics. In fact, an increased set back would yield only marginal returns in terms of reductions in noise levels at the closest facades and would undermine the acoustic barrier function served by the first row of units in protecting the gardens and remainder of the development site behind them. The relatively high noise contribution from the M2, compared to that of the much closer local roads, would also limit or negate any potential acoustic benefit from increasing the buffer.

3 NOISE ASSESSMENT APPROACH

3.1.1. A noise survey was undertaken at the development site to quantify road traffic noise levels, predominantly from the two road links adjacent to the site. These measurements provided source data applicable to these roads.

3.1.2. Noise contributions from road traffic on three road links have been predicted using a three dimensional digital noise model of the development site and its surrounds. These are:

1) The A278 to the east;
2) Maidstone Road to the south; and
3) The M2 and its east bound slip roads.

3.1.3. Noise from the M2 and its slip roads was modelled using publicly available traffic flow data sourced from National Highways. The source levels for the two local roads were then derived based on the survey data and the quantified underlying contribution from the more distant M2.

3.1.4. The noise model allows noise levels to be predicted across the development site rather than at discrete monitoring locations. Once a model has been verified against monitoring data it can be used to test potential development layouts, so that building positioning and orientations can be optimised. The initial development plans were revised and refined, based on early modelling runs, to minimise noise exposure and to maximise the protection of external amenity areas through design.

3.1.5. The final noise model runs, based on the final development scheme, show the predicted noise levels across the developed site and are presented in this report.

3.1.6. Air source heat pumps (ASHPs) will be provided for many of the homes within the proposed development and the potential for the noise from these to cause impacts within the development has been considered with reference to the worst-case absolute and relative sound levels that would result from their operation.

4 NOISE SURVEY

4.1.1. The site visits were made on Thursday 03 March 2022, when the noise monitoring equipment was installed, and Thursday 10 March 2022 when the equipment was removed.

4.1.2. Two monitoring locations were adopted, designed to measure worst case road traffic noise exposure close to the most southerly and northerly corners of the site.

4.1.3. Monitoring Location 1 (ML1) was located in the south corner of the development site. The system was around 8 m from the south-west boundary and 10 m from the south-east boundary of the field. This placed it around 21 m from the kerb of Maidstone Road. The position of ML1 is shown in the aerial photograph presented at Figure 4-1 and in the photograph at Figure 4-2.

4.1.4. The assembled system was subjected to a field calibration check prior to commencing the monitoring run at 11:55. The microphone and pre-amplifier were tripod mounted, connected to the sound level meter via a cable, at a height of around 1.5 m above ground level. Vehicles passing on Maidstone Road were the dominant noise sources for discrete periods but, in their absence, road traffic noise from the M2 was dominant.

4.1.5. Monitoring Location 2 (ML2) was located towards the north corner of the development site, around 20 m back from the north-east boundary of the field and 10 m back from the north-east boundary. This placed it around 25 m back from the kerb of Hoath Way (which was elevated compared to the monitoring location). The position of ML2 is shown in the aerial photograph presented at Figure 4-1 and in the photograph at Figure 4-3.

4.1.6. The assembled monitoring system at ML2 was subjected to a field calibration check and monitoring commenced at 11:40. The microphone and pre-amplifier were tripod mounted at a height of around 1.5 m above local ground level. Road traffic from Hoath Way was the dominant noise contribution at this location.

4.1.7. On the return visit on the 10 March 2022 the instrument at ML1 was found as left and operating normally. The system was subject to a calibration drift check on-site and no significant drift was found to have taken place. The measurement was terminated 10:06.

4.1.8. The instrument at ML2 was also found as left and operating normally. The system was subject to a calibration drift check on-site and no significant drift was found to have taken place. The measurement was terminated 09:56. Both systems were retrieved for analysis.

4.1.9. The monitoring data were downloaded and stored on secure network drives prior to analysis being undertaken in proprietary software and in MS Excel with the original data retained unaltered. The monitoring results are presented in the next section.

4.1.10. The details of the instruments used in the survey are presented in **Appendix B**.

Figure 4-1 – Monitoring Locations

Figure 4-2 – Monitoring Location 1

Figure 4-3 – Monitoring Location 2

5 MONITORING RESULTS

5.1.1. Meteorological data were sourced from the MET office observation station at Shoeburyness in Essex, which is around 25 km to the north-east. There was some precipitation during the evening of Friday 4 March through into the morning of Saturday 5 March. Also, very briefly, in the early hours of the morning of Monday 7 March.

5.1.2. There were also some periods of higher than ideal wind speeds during the survey, when wind speeds were between 5 and 10 m/s. Sound level data logged during rainfall or when average wind speeds exceeded 5 m/s were discarded from the data set prior to deriving the representative values which were used to verify the noise model output.

5.1.3. The raw hourly ambient ($L_{Aeq,1h}$) sound level data logged at ML1 and ML2 are plotted in the graph presented at **Appendix C** with the hourly average wind speeds, with periods of rainfall indicated. The periods for which sound level data have been excluded from analysis are also marked. Fortunately, there were sufficient data points retained during weekday day and night periods to yield reliable data for the purposes of the predictions and the assessment.

5.1.4. The sound levels logged show a typical diurnal pattern that one might expect for the location. The summary data, including those raw data derived before the weather exclusions were applied, and those retained afterwards, are presented in Table 5-1 for the daytime periods and Table 5-2 for the night time.

Table 5-1 – Average Noise Levels During the Day (07:00 – 23:00), dB $L_{Aeq,16h}$

	ML1		ML2	
	Raw Data	Exclusions	Raw Data	Exclusions
Thursday 03 March 2022	58.0[1]	58.0[1]	62.0[1]	62.0[1]
Friday 04 March 2022	58.3	58.3	61.5	61.5
Saturday 05 March 2022	59.5	59.2	61.8	61.6
Sunday 06 March 2022	59.1	-	60.3	-
Monday 07 March 2022	59.8	59.8	62.5	62.5
Tuesday 08 March 2022	59.3	59.6	62.7	62.4
Wednesday 09 March 2022	60.4	60.0	62.7	62.2
Thursday 10 March 2022	61.4[2]	61.4[2]	64.4[2]	64.4[2]

Notes to Table 5-1

1. Incomplete measurements (commenced at 12:00 and 11:00 for MLs 1 and 2 respectively)
2. Incomplete measurements (terminated at 11:00 and 10:00 for MLs 1 and 2 respectively)

Table 5-2 – Average Noise Levels During the Night (23:00 – 07:00), dB $L_{Aeq,8h}$

	ML1		ML2	
	Raw Data	Exclusions	Raw Data	Exclusions
Thursday 03 March 2022	54.7	54.7	56.5	56.5
Friday 04 March 2022	52.2	-	54.4	-
Saturday 05 March 2022	52.4	-	53.2	-
Sunday 06 March 2022	56.4	58.2	54.7	56.0
Monday 07 March 2022	53.5	-	56.7	-
Tuesday 08 March 2022	56.6	56.6	57.4	57.4
Wednesday 09 March 2022	56.6	56.6	56.2	56.2

5.1.5. It is evident from the tables that, with the exception of Sunday 06 March, the weather effects were minimal during the daytime periods. During the night times, when far more data were excluded, there was insufficient data retained to derive any values for three of the periods. For some of the other periods, the values derived following the data exclusions, are higher than the corresponding raw values, which may seem counter intuitive. The reason for this is the disproportionate removal of data from the middle of the affected night time periods and the resulting increase in the influence of the early rush hour. For this reason, the use of those higher values underpins a precautionary assessment, where night time levels are taken to be slightly higher than might otherwise have been the case.

5.1.6. Based on the retained data set out in the tables above, the daytime and night time average levels adopted for the two monitoring locations in this assessment are as follows:

ML1	Daytime	59.1 dB	Night time	56.7 dB
ML2	Daytime	62.0 dB	Night time	56.6 dB

5.1.7. For road traffic noise the night time maximum noise levels (L_{AFmax}) are also relevant although these cannot be meaningfully averaged in the same way as the data presented in Figures 5-1 and 5-2, nor are they so readily assessed in noise models.

5.1.8. The approach for night time maxima is to consider the number of significant night time noise events (noisy vehicles) and the magnitude of the resulting maximum noise levels, at those residential facades proposed closest to Hoath Way and Maidstone Road. This is based on the ninetieth percentile of the maximum noise levels (referred to as the 'typical' night time maximum) logged for each five minutes of the night time period (which roughly equates to the noisiest ten events so is comparable with the threshold in the ProPG). The typical night time maximum levels based on the raw data (i.e. without exclusions) are presented in Table 5-3.

Table 5-3 – Maximum Noise Levels During the Night (23:00 – 07:00), dB L_{Amax}

	ML1	ML2
Thursday 03 March 2022	65	67
Friday 04 March 2022	64	67
Saturday 05 March 2022	62	67
Sunday 06 March 2022	63	67
Monday 07 March 2022	63	67
Tuesday 08 March 2022	67	66
Wednesday 09 March 2022	66	68

5.1.9. The ninetieth percentile of the five minute logged L_{Amax} levels from all of the weekday night time periods (excluding Friday and Monday due to potential weather effects) are as follows set out below.

ML1 66 dB

ML2 67 dB

5.1.10. These sound levels were derived at measurement locations so need to be distance corrected for the build line of the first row of units. The measurement distances from the centre line of the closest lane in each case was 23 m for ML1 and 27 m for ML2.

5.1.11. The build line for the closest proposed units is 27 m, for unit 76 with respect to Maidstone Road (ML1) and 33 m for the apartment block in the north corner of the site with respect to Hoath Way (ML2). The maisonettes (units 21-22) are closer to Maidstone Road but present a relatively inert elevation towards the road which features small bathroom windows only with no windows to habitable rooms.

5.1.12. Based on these distances the following typical maximum noise levels are predicted at the build line.

Maidstone Road	65 dB
Hoath Way	65 dB

6 NOISE MODELLING

6.1.1. The noise model was created in the CadnaA® noise modelling package using detailed topography sourced from https://environment.data.gov.uk/ for the surrounding area and data provided by the developer for the site itself. The ground types adopted in the model were based on observations from site visits and aerial photography.

6.1.2. The noise from the M2 and its east bound slip roads was modelled by creating a road source to which traffic flow data sourced from National Highways was apportioned. The CRTN[1] algorithms were used to predict L_{A10} values, which were adjusted to $L_{Aeq,16h}$ and $L_{Aeq,8h}$ levels, within the model, based on the TRL adjustment factors[2]. These values were plotted across the development site and its surrounds.

6.1.3. Traffic flow data were unavailable for Maidstone Road and Hoath Road, so these road sources were created in the model and sound levels assigned to them based on the survey data.

6.1.4. The noise model was first run based on the current, open, site conditions to ensure that the outputs verified well with the monitoring data. This verification study yielded the results presented in Table 6-1 which are indicative of a well performing noise model. The only variation in excess of 1 dB was an over prediction which suggests that the model is slightly precautionary.

Table 6-1 – Comparison of Survey Data and Model Predictions, dB $L_{Aeq,T}$

	Daytime			Night time		
	Measured	Predicted	Difference	Measured	Predicted	Difference
ML1	59.6	60	0.4	56.7	56.3	0.4
ML2	62.5	62.4	0.1	56.6	58.4	1.8

6.1.5. Once the model was performing as shown in Table 6-1 the early iterations of the development layout were introduced, and several model runs were undertaken to evaluate their acoustic performance. The results of these model runs were used to inform masterplan revisions which included presenting a relatively unbroken frontage towards Hoath Way and screening gardens, which would otherwise have been exposed to noise from the local roads. Where it was not practicable to screen gardens using houses, some 2 m high acoustic fencing is proposed.

6.1.6. A 3-d screenshot of the model, taken from the south-east is presented at Figure 6-1. The daytime and night time noise level plots with the development in place are shown in the model plots in Figures 6-2 and 6-3 with the position of the proposed 2 m high fencing shown in yellow.

[1] Calculation of Road traffic Noise. Department of Transport Welsh Office 1988.
[2] Converting the UK traffic noise index $L_{A10,18h}$ to EH noise indices for noise mapping. TRL 2002.

Figure 6-1 – 3-d Screenshot of the Noise Model from the South-east

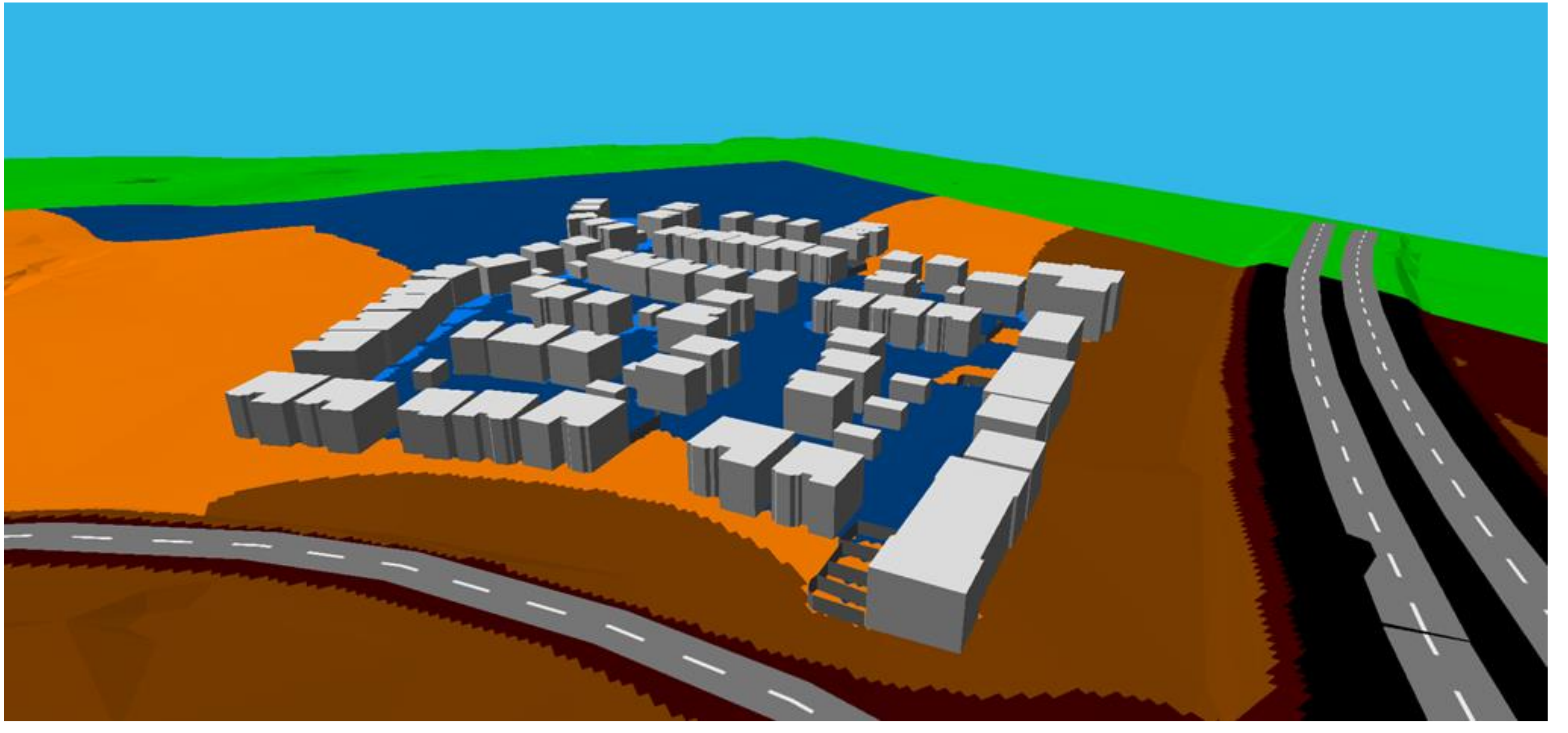
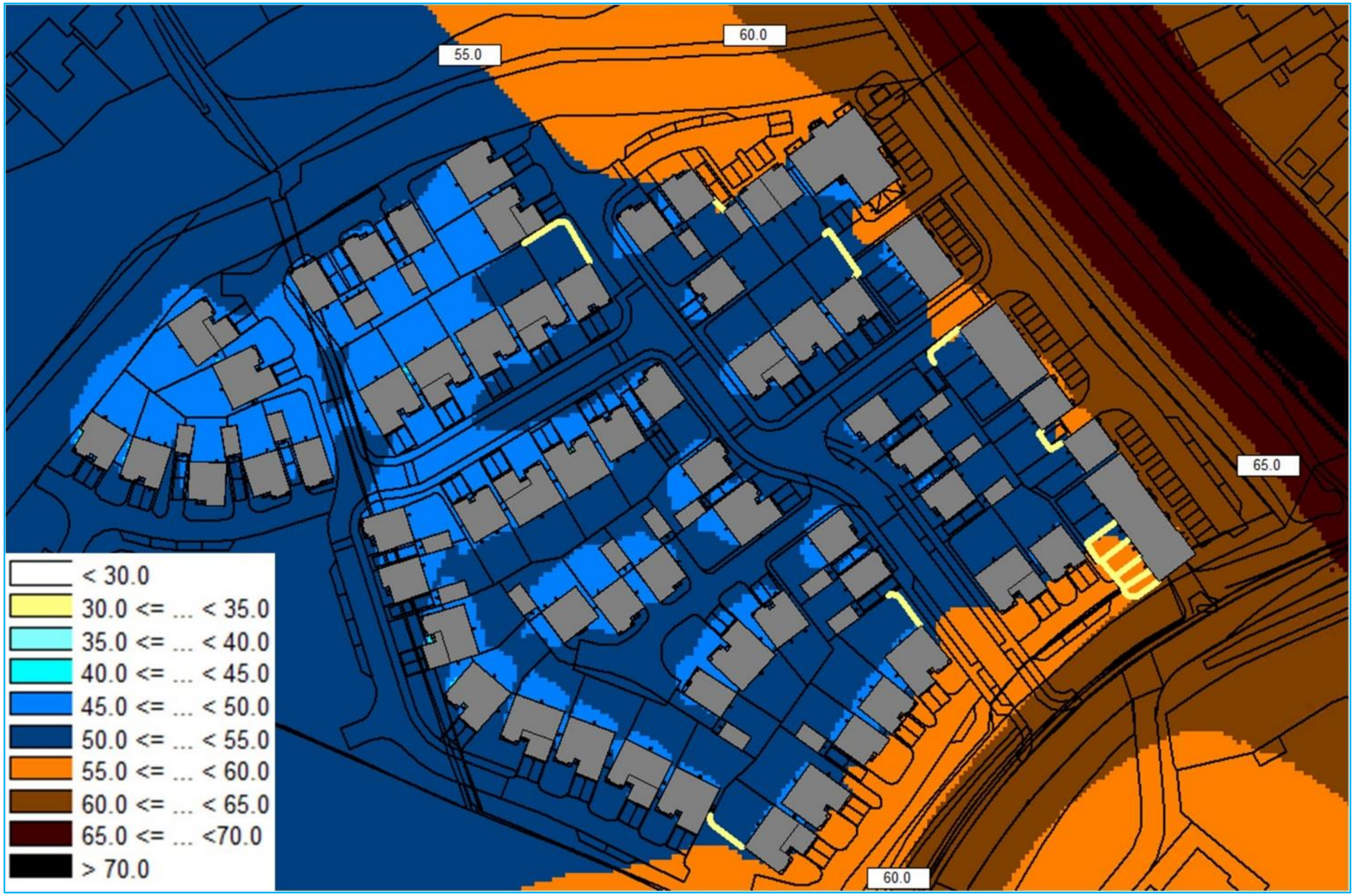


Figure 6-2 – Model Output Plot Daytime dB $L_{Aeq,16h}$ at 1.5 m Above Ground Level

Figure 6-3 – Model Output Plot Night time dB $L_{Aeq,8h}$ at 4.5 m Above Ground Level



DAYTIME

6.1.7. As can be seen from the model plot at Figure 6-2 the vast majority of the gardens proposed in the development would be exposed to sound levels below the BS 8233 55 dB $L_{Aeq,16h}$ threshold and many to levels below 50 dB $L_{Aeq,16h}$. Levels in excess of 55 dB $L_{Aeq,16h}$ are only predicted in parts of four gardens (units 19–22 inclusive) and those exceedances are no greater than 2 dB. Given these levels are only just within Noise Exposure Category (NEC) B based on the MDC local policy (see paragraph 2.3.3), and the advice in BS 8233 (see paragraph 2.4.7) the sound levels predicted in garden areas are considered acceptable within the context of the development.

6.1.8. The highest daytime sound levels, predicted at the most exposed facades, are 63 dB $L_{Aeq,16h}$. These are the north-east facing facades in the south-east corner of the site (Units 20-22). All of the exposed facades on the north-east edge of the development site (Units 6-36) are predicted to be subjected to levels above 60 dB $L_{Aeq,16h}$ during the day. Those units orientated towards Maidstone Road, to the south-east, are less exposed with façade levels below 60 dB $L_{Aeq,16h}$ predicted.

6.1.9. Whilst some other units on the exposed south-west and north edges of the development site are also predicted to be exposed to sound levels of around 55 dB $L_{Aeq,16h}$, all of the other proposed units will benefit from a combination of screening and/or distance attenuation so that façade noise exposure is less and is within NEC A during the day.

6.1.10. Based on the predicted levels, outside to inside reductions of 28 dB would be necessary on the most exposed elevations on the north-east edge of the site, and reductions of around 25 dB for those on the south-east side. These levels of attenuation could be achieved by good quality thermal double glazing when it is closed. With windows open, however, the attenuation would be reduced to around 15 dB.

6.1.11. On that basis there would be reliance on closed windows to achieve the daytime internal criterion on facades exposed to the 50 dB contour or higher (dark blue, orange and brown contours) in Figure 6-2, so at least one façade for the majority of the proposed units. Under these circumstances a suitable means of alternative ventilation, other than opening windows, would be necessary for affected habitable rooms.

NIGHT TIME

6.1.12. During the night time, the average sound levels predicted at the first floor windows proposed closest to, and facing, Hoath Way to the north-east are generally around 60 dB $L_{Aeq,8h}$ with those most exposed units, in the south-east corner of the site (units 20-22), around 62 dB $L_{Aeq,8h}$. On the south-east side of the site, facing Maidstone Road, the levels at the exposed facades are predicted to be around 57 dB $L_{Aeq,8h}$. Based on these levels, outside to inside reductions of up to 32 dB would be necessary to achieve the internal criterion for the most exposed bedrooms. For units not adjacent to Hoath Way, the highest corresponding reduction required would be 27 dB.

6.1.13. The façade mitigation requirements dictated by the average night time sound levels are higher than those required to achieve the daytime internal criteria so, under those circumstances, it is the night time levels that will comprise the design constraint.

6.1.14. The typical L_{Amax} sound levels are also relevant during the night time and these were quantified as 65 dB L_{Amax} for the most exposed elevations on both the north-east and south-east sides of the site (see paragraph 5.1.12).

6.1.15. Given that the maximum night time sound levels identified are less than 10 dB higher than the corresponding average levels ($L_{Aeq,8h}$) the maximum sound levels are less constraining (as the differential in the respective design criteria is 10 dB). For that reason, it is the night time average sound levels, which are plotted in Figure 6-3, that are used as a basis for façade mitigation recommendations.

VENTILATION AND OVERHEATING

6.1.16. The AVO[3] and ADO[4] both deal with the dynamic between the need to keep windows closed to achieve internal acoustic design criteria and its potential conflict with the creation of overheating conditions.

6.1.17. The ADO suggests that windows are likely to be closed during sleeping hours if noise within bedrooms exceeds 40 dB $L_{Aeq,8h}$ or 55 dB L_{AFmax} more than ten times per night. The assumed outside-to-inside sound reduction afforded by an open window is considered to be between 13 dB (the AVO[4]) and 15 dB (BS 8233:2014). Either way, the internal noise levels anticipated inside the most exposed habitable rooms are predicted to be below the ADO threshold for maximum levels but above that for average levels so overheating may need to be considered in conjunction with building regulations, if not before, if the cooling options provided by the ASHPs (which are considered in section 7 below) are considered insufficient.

6.1.18. On that basis there would be some additional reliance on closed windows to achieve the internal criteria for all habitable room windows, a suitable means of increasing ventilation without opening windows would be necessary for affected habitable rooms.

[3] Acoustics Ventilation and Overheating Residential Design Guide. Association of Noise Consultants 2020
[4] The Building Regulations 2010. Approved Document O: Overheating 2021 Edition.

7 AIR SOURCE HEAT PUMPS

7.1 PROPOSED UNITS

7.1.1. It is proposed that most of the individual units will be served by air source heat pumps (ASHPs) to meet hot water and heating needs. The exceptions will be the maisonettes (units 6-11, 16-17 and 21-22) and apartments (units 28-36) which will have electric heating.

7.1.2. The ASHPs used will be from the Vaillant aeroThERM range with the unit ratings as shown in Table 7-1.

Table 7-1 – ASHP Ratings by House Type and Plot Number

ASHP Rating	ASHP Sound Power Level dB	House Types	Plot Numbers
3 kW	54	Dart, Hexham	12-15, 18-20, 24-27.
5 kW	54	Letchworth, Stratford, Oxford, Overton, Cambridge, Leamington	2-5, 23, 37-41, 46-48, 53, 56-62, 65-67, 76-77, 79-81, 83, 85-86, 88.
7 kW	55	Harrogate, Henley, Hampstead	1, 42-45, 49-52, 54-55, 63-64, 68-75, 78, 82, 84, 87.

7.2 APPLICABLE CRITERIA

7.2.1. With respect to sound levels at the dwellings that the ASHPs serve (as opposed to neighbouring properties), there are no applicable standards other than those general internal acoustic criteria set out in BS 8233 as reproduced in Table 2-2 above. The most stringent of those would correlate with steady external plant noise levels of 50 dB $L_{Aeq,T}$ during the day and 45 dB $L_{Aeq,T}$ during the night adjacent to the window of a living room or bedroom so that internal criteria would not be exceeded under open window conditions.

7.2.2. There are also no definitive noise level standards applicable to ASHPs in the context of neighbouring units proposed as part of a wider residential development. The following criteria, which are applicable to external sound levels at *existing* neighbouring noise sensitive properties, are potentially relevant:

1) A Micro certification scheme (MCS) permitted development[5] sound level of up to 42 dB $L_{Aeq,T}$ at a residential window (which is predicated on an assumed background sound level of 40 dB and equates to a contribution from the actual ASHP of 38 dB $L_{Aeq,T}$).

2) The BS 4142[6] approach of adopting a rating level relative to the background sound level – currently advocated by the relevant professional bodies[7]. The CIEH/IoA Professional Advice

[5] Heat pump Installation. MIS 3005-1. MCS Service Company Ltd 2022.
[6] BS4142:2014 Methods for rating and assessing industrial and commercial sound.
[7] Heat Pumps Professional Advice Note. Chartered Institute of Environmental Health and Institute of Acoustics 2022.

Note recommends maximum rating levels of 35 dB $L_{Aeq,T}$ at sensitive facades and up to 40 dB $L_{Aeq,T}$ where local contextual factors justify a relaxation.

7.2.3. In the context of a new multi-unit residential development, however, these levels may be overly stringent as the ASHPs will not be new sources introduced in proximity to existing residents. Furthermore, the development site is subject to distant road traffic noise from the use of the M2 which will provide masking to any steady plant noise.

7.3 ASSESSMENT OF NOISE LEVELS

7.3.1. It is anticipated that heat pumps will be positioned a minimum of 50 cm from the building façades and a further 1 m horizontal distance from any window to a habitable room. On that basis, worst case sound levels predicted outside the closest windows, based on the data presented in Table 7-1, would be 45 dB $L_{Aeq,T}$ at ground floor level and 36 dB $L_{Aeq,T}$ at first floor level. Given that no ground floor bedrooms would be affected (as the maisonettes and apartments will have electric heating) the BS 8233 criteria would be complied with by a reasonable margin (5 dB during the day and 9 dB during the night) even under open window conditions.

7.3.2. For the semi-detached or terraced Dart and Hexham house types, there is a potential for a very small cumulative effect from two or even three ASHPs. The worst-case sound levels predicted in these circumstances are 45 dB $L_{Aeq,T}$ at ground floor level and 37 dB $L_{Aeq,T}$ at the first floor so, again, comfortably compliant with the BS 8233 criteria.

7.3.3. With respect to noise from any ASHP affecting a neighbouring property within the development, it is anticipated that the minimum separation distance (between ASHP and habitable room window) would be around 2.5 m. On that basis and with an unobstructed view, the noisiest units would result in sound levels of around 39 dB $L_{Aeq,T}$ at ground level and 33 dB $L_{Aeq,T}$ at first floor level. In reality, it is unlikely that there would be an unobstructed view, from ground floor level in-particular, as garden fencing erected between the units it likely to provide some screening. These predictions are therefore considered to be very much worst-case.

7.3.4. The relative assessment approach adopted in BS 4142 is dependent on the quantification of the representative background sound level at the assessment locations. Understanding the background sound level is also important in considering the level of masking noise likely to be present and as a contextual factor.

7.3.5. The noise model plots presented at Figures 6-2 and 6-3 show the average road traffic generated sound levels ($L_{Aeq,T}$) across the developed site but, whilst the background sound level is likely to be similar (if somewhat lower) there is no widely recognised conversion factor to derive it. For that reason, WSP has undertaken a study to assess the relationship between average sound levels ($L_{Aeq,T}$) and background sound levels ($L_{A90,T}$) at similar sites where road traffic noise from a motorway or dual carriage way, at a similar distance, is the dominant sound source.

7.3.6. The study considered the differences between the L_{Aeq} and L_{A90} levels measured at eight open development sites. All of the sites were between 80 m and 510 m from a motorway or dual carriageway (the Blowers Wood development site is around 200 m from the M2) with minimal screening between source and receptor. In each case, road traffic was considered to be the dominant noise source at the measurement location. All of the surveys were undertaken between

2017 and 2022. In each case the differential between the L_{Aeq} and L_{A90} was derived during upwind and down wind conditions during the daytime (07:00-23:00) and night time (23:00-07:00) periods.

7.3.7. The results of the study are summarised in Table 7-2.

Table 7-2 – Differential between L_{Aeq} and L_{A90} at Study Sites, dB

	Down Wind (from Road to site)		Upwind (from Site to Road)	
Test Site	**Daytime**	**Night time**	**Daytime**	**Night time**
North Barton Road	3.2	5.7	2.5	5.2
Luton Road	2.6	3.7	NA	NA
Gosden Hill	2.9	4.8	NA	NA
Gosden Hill 2	2.5	4.2	NA	NA
Milford	2.8	5.1	2.7	3.4
Sutton Land Development	3.1	3.0	3.6	4.4
Windmill Golf	3.2	5.6	3.1	8.9
Average	**2.8**	**4.6**	**3.0**	**5.5**

7.3.8. Based on the average data derived from the study, the L_{A90} sound level is around 3 dB lower than the L_{Aeq} level during the daytime and around 5 dB during the night-time. The difference between the two is to be expected as the dominance of the road traffic noise is likely to be higher during the day and so extraneous sources result in less variation.

7.3.9. There is a slight variation (0.9 dB) in the differential during the night time under upwind and down wind conditions. The reason for this is also likely to be the relative dominance of the road traffic noise being stronger under downwind conditions, resulting in less influence from extraneous sources.

7.3.10. The lowest L_{Aeq} levels predicted at the development site, in relatively sheltered rear gardens in the north-west part of the site, are 47 dB $L_{Aeq,16h}$ during the day and night time periods. If the average differentials from the study are applied to those data the lowest background sound levels at proposed residential facades within the application site will be around 44 dB during the day and 42 dB during the night time.

7.3.11. The background sound levels are therefore likely to be higher than those assumed in the MCS (see paragraph 7.2.2) and would provide some degree of masking to ASHP noise during both the daytime and night time periods.

7.3.12. Based on the BS 4142 approach – the worst-case rating levels arising from ASHPs not associated with the receptor property (ground floor with no screening assumed) would be around 3 dB below the night time background sound level. That would be indicative of a low (or no) impact.

7.3.13. Given that noise from the ASHPs would comply with the two absolute criteria and the relative BS 4142 based approach, it is thought that there would be no adverse impact from the noise of the ASHPs within the development.

8 MITIGATION RECOMMENDATIONS

8.1.1. The primary means of mitigation employed at the development site is the layout which has been developed and refined via a good acoustic design process. This has ensured that the majority of units and external amenity spaces benefit from a high level of screening to minimise noise exposure.

8.1.2. Precautionary detailed break-in calculations have been undertaken for the proposed units that are most exposed to road traffic noise. The proxy unit adopted for the most exposed elevations on the north-east side of the site was the bedroom of the first floor maisonette of unit 22/23 (the east corner of the site). This was chosen as it is one of the most exposed units and the bedroom has two windows facing Hoath Way and so comprises worst case exposure for habitable rooms.

8.1.3. The minimum performance specifications identified as necessary to achieve compliance with all of the internal criteria for the exposed elevation of the first row of units on the north-east side of the site are as follows:

- Minimum glazing acoustic performance 29 dB R_w+C_{tr}
- Minimum vent acoustic performance 35 dB $D_{,new}$

8.1.4. The configuration tested in the break-in calculations was a 6mm / 12mm / 6mm (pane / cavity /pane) unit with two in-frame acoustic trickle vents. However, most ‘standard’ thermal double glazed units would meet the stated glazing performance on the proviso that non-acoustic in-frame trickle vents were avoided. There are numerous in-frame acoustic trickle vents available that would meet the minimum vent performance specified above.

8.1.5. Break-in calculations were also tested for the first row of houses on the south-west side of the site. Bedroom 1 of unit 7 (Henley house type) was used as a worst-case proxy due to the large area of glazing on its bay window compared to the room size.

8.1.6. The minimum performance specifications identified as necessary to achieve compliance with all of the internal criteria for the exposed elevation of the first row of units on the south-east side of the site are as follows:

- Minimum glazing acoustic performance 29 dB R_w+C_{tr}
- Minimum vent acoustic performance 32 dB $D_{,new}$

8.1.7. The configuration tested in the break-in calculations was a 6mm / 12mm / 6mm (pane / cavity /pane) unit with two standard in-frame hit and miss trickle vents. Most standard double glazing with standard vents would achieve these criteria.

8.1.8. For all dwellings further back from the north-east and south-east sides of the site, standard double glazing and trickle vents would be adequate to achieve the internal criteria when the windows are closed.

8.1.9. As it is predicted that the internal night time criteria would be exceeded in habitable rooms across the development site when windows are open (albeit by a small margin in many cases) it would be appropriate for an alternative means of ventilation to be provided to allow noise sensitive residents to keep windows closed.

8.1.10. It is recommended that intermittent extraction ventilation units are provided for all habitable rooms to allow noise sensitive residents to increase ventilation rates without compromising the acoustic mitigation.

8.1.11. The recommended façade noise mitigation measures are summarised in Table 8-1.

Table 8-1 – Noise Mitigation Recommendations

Mitigation	Plot numbers	Elevation
Minimum glazing performance 29 dB R_w+C_{tr} Minimum vent acoustic performance 35 dB $D_{,new}$ Intermittent extract ventilation for habitable rooms	6-22	North-east
	23	North-east
	24-36	North-east
Minimum glazing performance 29 dB R_w+C_{tr} Intermittent extract ventilation for habitable rooms	1-2	South-east
	74-78	South-east
Intermittent extract ventilation for habitable rooms	All	All

8.1.12. The locations where 2 m high acoustic barriers are recommended to minimise external sound levels in gardens are shown in yellow in Figures 6-2 and 6-3. For the avoidance of doubt, these are recommended for units 6/7, 13/14, 19-23, 39, 53, 74 and 78.

9 CONCLUSIONS

9.1.1. The proposed development has been informed and refined via a process of good acoustic design to ensure that the layout and building positioning and orientation are optimised to minimise noise exposure for future residents.

9.1.2. Acceptable noise criteria have been achieved in external amenity spaces with the vast majority of garden spaces predicted to be exposed to sound levels below 55 dB $L_{Aeq,16h}$.

9.1.3. Façade mitigation will be necessary on the exposed façade of the first row of units opposite Hoath Way and Maidstone Road but standard glazing and vents will be adequate on the remainder of the development.

9.1.4. The most stringent internal criteria will not be met with windows open, so intermittent extract ventilation is recommended for habitable rooms to allow noise sensitive residents to increase ventilation without opening windows.

9.1.5. A detailed overheating assessment has not been undertaken but the majority of units will be served by ASHPs which are understood to have active and passive cooling functionality.

9.1.6. The noise levels generated by the operation of the proposed ASHPs has been assessed and it is concluded that any associated impacts will be acceptable at this site.

Appendix A

ACOUSTIC GLOSSARY

ACOUSTIC GLOSSARY

- Acoustic environment: Sound from all sound sources as modified by the environment. Can be actual or simulated, outdoor or indoor, as experienced or in memory. Modifications by the environment includes: effects on sound propagation, resulting, for example, from meteorological conditions; absorption; diffraction; reverberation; and reflection.
- Airborne sound: Sound that reaches the point of interest by propagation through air.
- Ambient sound: Totally encompassing sound in a given situation at a given time, usually composed of sound from many sources near and far.
- A-weighting, dB(A): The unit of sound level, weighted according to the A-scale, which takes into account the increased sensitivity of the human ear at some frequencies.
- Background sound: Underlying level of sound over a period, T, which might in part be an indication of relative quietness at a given location.
- Broadband sound/ noise: Sound whose energy is distributed over a wide section of the audible range.
- Calibration: The measurement system/ chain should be periodically calibrated, within a laboratory, against traceable calibration instrumentation, to either National Standards or as UKAS-Accredited, as required. The calibration of the system should also be checked in the field using a portable calibrator before and after each short term measurements, and periodically for longer term monitoring.
- Class 1: The Class of a sound level meter describes its accuracy as defined by the relevant international standards – Class 1 is more accurate than Class 2. The older standard IEC 60651 referred to the grade as "Type", whereas the new standard IEC 61672 refers to it as the "Class". The most accurate meters used in the field (as opposed to a laboratory) are Class 1. Class 2 meters can be used in some instances; however WSP use Class 1 (or Type 1) meters by default, as required by BS 4142:2014, for example.
- Context: The circumstances that form the setting for an event, statement, or idea, and in terms of which it can be fully understood. When considering context, pertinent factors include: the absolute level of sound; the character and level of the residual sound compared to the character and level of the specific sound; evidence on human response to the sound; and the sensitivity of the receptor and whether dwellings or other premises used for residential purposes will already incorporate design measures that secure good internal and/or outdoor acoustic conditions.
- Decibel (dB): A scale for comparing the ratios of two quantities, including sound pressure and sound power. The difference in level between two sounds (s1 and s2) is given by 20 $\log_{10}$ (s1/s2). The decibel can also be used to measure absolute quantities by specifying a reference value that fixes one point on the scale. For sound pressure, the reference value is 20 Pa.
- Dwelling: A building used for living purposes. A mobile home used for permanent living should be included in an assessment. If calculations are being conducted for compensation purposes, then some mobile homes are dealt with under the Highways Noise Payments and Moveable Homes Regulations.
- Façade/ façade level: At a distance of 1 m in front of a large sound reflecting object such as a building façade. According to BS 8233:2014, “Façade level measurements of L_{pA} are typically 1

dB to 2 dB higher than corresponding free-field measurements because of the reflection from the façade." The Calculation of Road Traffic Noise (1988) uses 2.5 dB, whilst BS 5228-1:2009+A1:2014 recommends 3 dB. Owing to the latter examples, together with other historical documents, it is more usual to apply 3 dB.

- Fast time-weighting (F): Averaging time used in sound level meters. Defined in BS EN 61672-2:2013 Electroacoustics. Sound level meters. Pattern evaluation tests.
- Free-field/ free-field Level: Far from the presence of sound reflecting objects (except the ground), usually taken to mean at least 3.5 m away.
- Hertz (Hz): The unit of Frequency or Pitch of a sound. One hertz equals one cycle per second. 1 kHz = 1000 Hz, 2 kHz = 2000 Hz, etc.
- $L_{AF90,T}$: The A-weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of a given time interval, T, measured using time fast time-weighting (F). Generally used to describe the 'background' sound conditions.
- L_{AFmax}: The maximum A-weighted sound pressure level during a given time period. L_{max} is sometimes used for the assessment of occasional loud sounds, which may have little effect on the overall L_{eq} noise level, but could still affect the sound environment. Unless described otherwise, it is measured using the fast time-weighting (F).
- $L_{eq,T}$: A sound level index called the equivalent continuous sound level over the time period T. This is the level of a notional steady sound that would contain the same amount of sound energy as the actual, possibly fluctuating, sound that was recorded. Where the value is A-weighted, is will be presented '$L_{Aeq,T}$' or 'dBA $L_{eq,T}$', otherwise is should be an un-weighted (or linear) value.
- Line source: A sound source composed of many point sources in a defined line, such as a train, flow of traffic on a motorway, or constant aircraft take-offs and landings. Sound levels measured from line sources decrease at a rate of 3 dB per doubling of distance.
- L_p: See Sound Pressure Level.
- L_W: See Sound Power Level.
- Noise-sensitive receptor (NSR): A term from BS 5228-1:2009+A1:2014, representing any occupied premises outside a construction site used as a dwelling (including gardens), place of worship, educational establishment, hospital or similar institution, or any other property likely to be adversely affected by an increase in sound level.
- Octave/ octave band: Band of frequencies in which the upper limit of the band is twice the frequency of the lower limit. For example, the 1000 Hz (1 kHz) octave band contains noise energy at all frequencies from 707 to 1414 Hz.
- Percentile level: The sound pressure level exceeded for N% of a specified time interval, see $L_{AF90,T}$ etc.
- Point source: A sound source whose dimensions are small compared to the propagation distances involved. Due to the Inverse Square Law, the sound level pressure level decreases by 6 dB every time the distance between the measurement point and the source is doubled.
- R: See Sound Reduction Index.

- Rating level, $L_{Ar,Tr}$: The equivalent continuous A-weighted sound pressure level ($L_{Aeq,T}$, see also Specific Sound Level) of the sound, plus any adjustment for the characteristic features of the sound.
- Reference time interval, Tr: Specified interval over which the specific sound level is determined. This is 1 h during the day from 07:00 h to 23:00 h and 15 min at night from 23:00 h to 07:00 h.
- Residual sound: ambient sound remaining at the assessment location when the specific sound source is suppressed (or absent) to such a degree that it does not contribute to the ambient sound.
- Residual sound level, $L_r = L_{Aeq,T}$: Equivalent continuous A-weighted sound pressure level of the residual sound at the assessment location over a given time interval, T.
- Sound level metrics, indices or parameters: Sound levels usually fluctuate over time, so it is often necessary to consider an average or statistical sound level. This can be done in several ways, so a number of different metrics have been defined, according to how the averaging or statistics are carried out.
- Sound power level, L_W: Sound power measured on a decibel scale, relative to a reference value of 10^{-12} W.
- Sound power: The sound energy radiated per unit time by a sound source. Measured in Watts (W).
- Sound pressure level (sound level), L_p: The sound level is the sound pressure relative to a standard reference pressure of 20 Pa ($20x10^{-6}$ Pascals) on a decibel scale.
- Sound pressure: Sound, or sound pressure, is a fluctuation in air pressure over the static ambient pressure.
- Specific sound source: Sound source being assessed.
- Type 1: See Class 1 above.

Appendix B

INSTRUMENT DETAILS

Table B-1 – Monitoring Equipment

Location	Name	Description	Manufacturer and type no.	Serial no.
ML1	Solo 18	Sound Level Meter	01dB-METRAVIB Black Solo 'Datalogging Integrating Sound Level Meter'	65804
		Pre-amplifier	01dB-Metravib PRE 21 S	16471
		Microphone	GRAS 40AE Microphone	181885
		Calibrator	01dB-STELL Cal 21 Sound Calibrator	35113823
ML2	Duo 3	Sound Level Meter	01dB-Stell Duo 'Datalogging Integrating Sound Level Meter'	10617
		Pre-amplifier	01dB-Stell PRE 22 Preamplifier	10324
		Microphone	G.R.A.S Type 40CD Condenser Microphone	162071
		Calibrator	01dB-STELL Cal 21 Sound Calibrator	34924010

Appendix C

TIME HISTORY GRAPHS

Figure C-1 – Weather Conditions

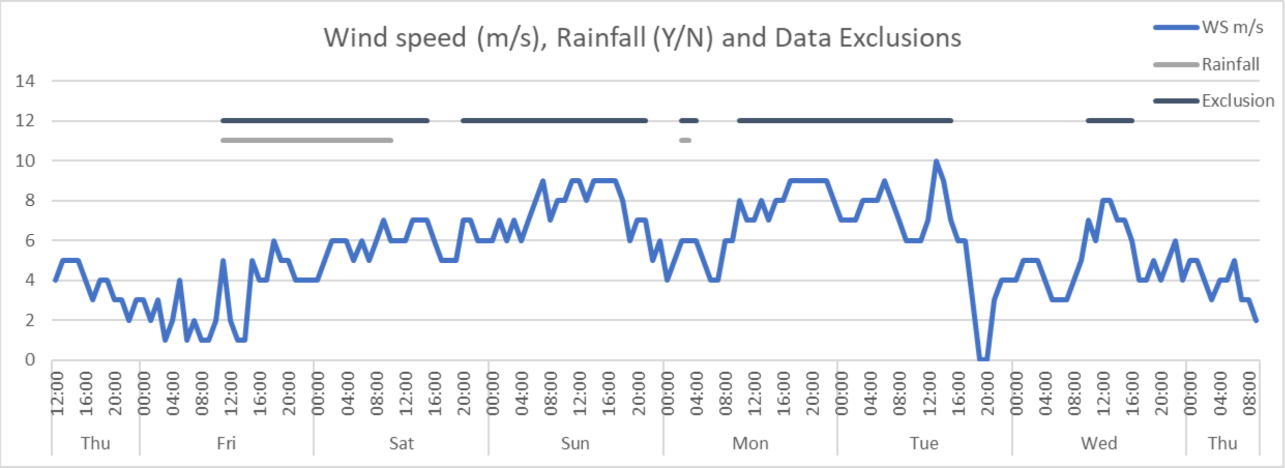


Figure C-2 – Sound Levels ML1

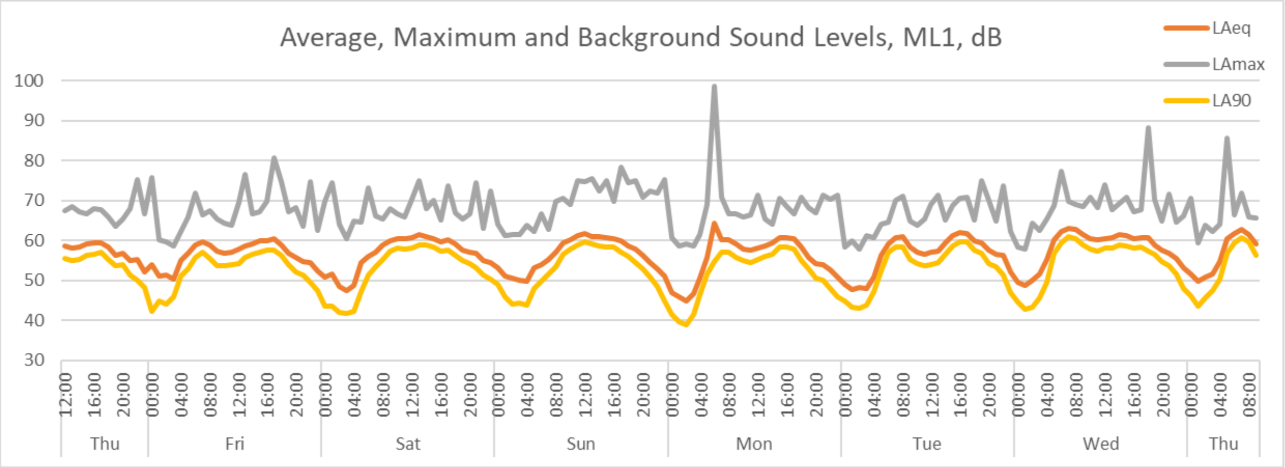
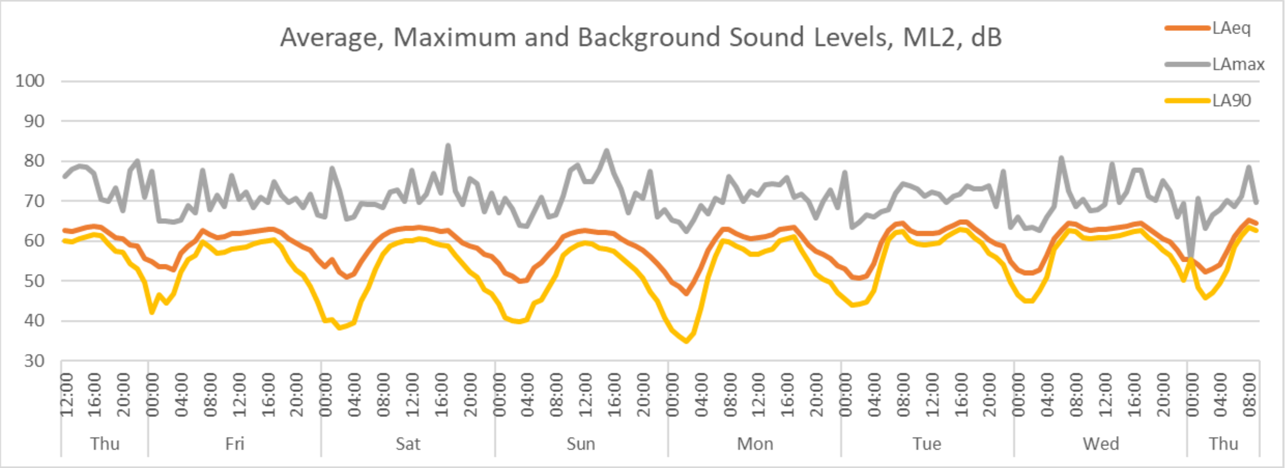


Figure C-3 – Sound Levels ML2



Appendix D

LIMITATIONS

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This report has been prepared for the titled project or named part thereof and should not be used in whole or part and relied upon for any other project without the written authorisation of WSP UK Limited. WSP UK Limited accepts no responsibility or liability for the consequences of this document if it is used for a purpose other than that for which it was commissioned.

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The findings and opinions expressed are relevant to the dates of the site works and should not be relied upon to represent conditions at substantially later dates. Opinions included therein are based on information gathered during the study and from our experience. If additional information becomes available which may affect our comments, conclusions or recommendations WSP UK Limited reserve the right to review the information, reassess any new potential concerns and modify our opinions accordingly.

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