

Acoustic Associates Sussex Ltd

Planning Application Noise Assessment

Site: Lidsey Road, Westergate, Chichester PO20 3SU.
Client: Tim Johnson

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Issue 2



Acoustic Associates

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Issue 1	12/07/2018	Original Issue
Issue 2	02/04/2020	Revised Plans

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1 Introduction

Acoustic Associates have been appointed to undertake an acoustic assessment to support the introduction of housing onto a greenfield site adjacent to the A29.

Standards and guidance referenced for this assessment include:

- World Health Organisation (WHO) - Guidelines for Community Noise 1999
- BS8233 (Sound insulation and noise reduction for buildings) 2014
- ISO9613 (Attenuation of sound during propagation outdoors) 1996
- National Planning Policy Framework (NPPF) 2019
- ProPG Planning Guidance, June 2017

To fully identify the soundscape at the application site, three sound level meters were deployed from 22nd to 27th June 2018. The sound level meters were specifically placed at strategic locations where building facades would be located to prevent any further calculations being necessary. Once the daytime and night time noise levels had been identified at the top, middle and bottom of the site, an IMMI noise prediction model was created and calibrated to determine how sound is likely to propagate across the application site. By annotating the proposed residential properties and receiver points such as windows and gardens, noise levels have been predicted.

The sound sources around the site were also considered to determine appropriate internal noise levels for future residents. Where continuous and anonymous noise is the dominant source, such as road traffic on the A29, criteria has been applied from Table 4 of BS8233:2014. Similarly, good practice has dictated the application of ProPG 2017 where airborne transportation noise is the dominant noise source. However, where noisier events have occurred, such as the Lees Yard commercial/Industrial yard to the South, the noise model has been calibrated against the worst daytime and night time hour to provide a robust and worst-case assessment.

The report concludes that whilst standard thermal double glazing will be sufficient to protect future occupiers inside housing with windows closed. However, in the majority of cases, by opening windows, this is likely to cause raised internal noise levels that exceed the requirements of BS8233:2014. To overcome this, acoustic ventilators are proposed to provide the level of background ventilation required. The degree of protection required differs depending on where the properties are located on the application site.

The report has followed the principles of good acoustic design, as required by ProPG2017 and should the mitigation measures discussed in section 9 be implemented, there is no reason why the planning application should be refused on noise grounds.

2 Context, Noise Criteria & Noise Assessment Methodology

2.1 Context

The planning application seeks the introduction of residential housing on a paddock plot. The site is currently a vacant field with hedge borders to the North, East, South and West. The existing site is seen in Figure 1 below. The A29 runs North to South on the Western site boundary.



Figure 1. Current Site layout, orientated North

Figure 2 below shows the proposed housing layout within the application site.

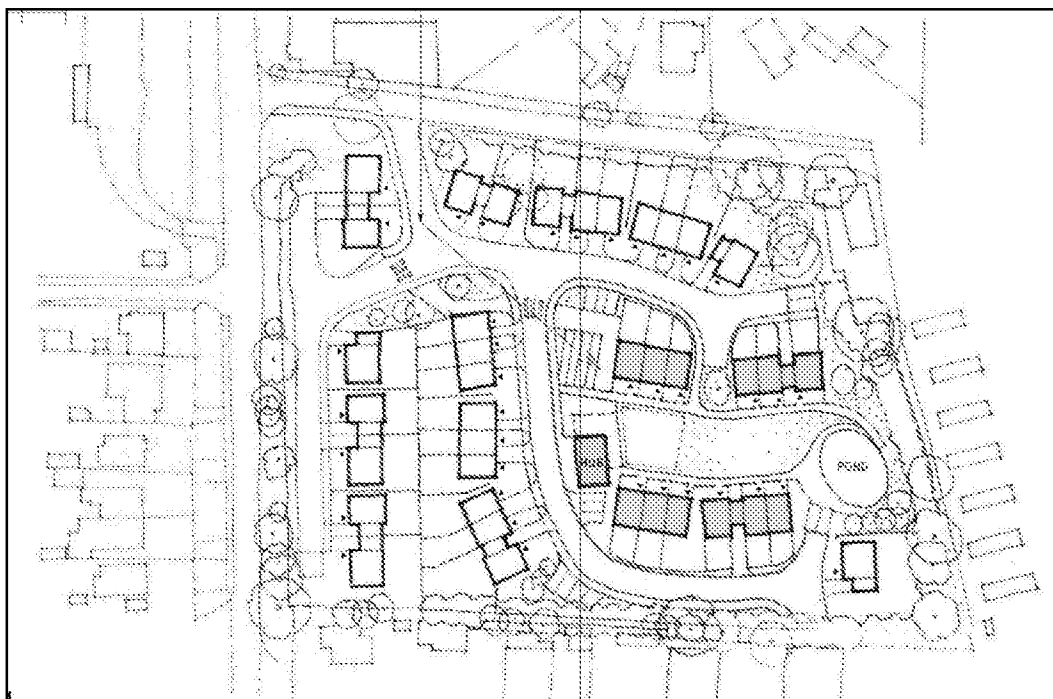


Figure 2. Proposed site layout, Orientated North

2.2 Location

The site is square in shape and has the A29 located on the Western border and an access road to Willows Caravan Park to the North. Static caravans are located on the Eastern boundary and “Lees Yard” commercial/industrial estate is located on the Southern boundary.

A rail crossing is located approximately 255m North of the location.

2.3 Soundscape

The sounds heard whilst on site were road traffic noise from the A29. This is a 30mph speed limit and vehicles are likely to be either continuously flowing traffic or when interrupted by the train crossing, deceleration or acceleration away from the static rail crossing.

Sounds were also noted from D&R Structures, steel fabricators, located at Unit 7 at the Southern Industrial Estate. These included a reverse bleeper from a fork lift truck, metal “shrieking” as it was being moved and what sounded like angle grinding and/or cutting of metal. Such sounds associated with the metal work were heard both on installing and decommissioning the survey instrumentation. The noise from such operations and banging of metal formwork has the potential to attract a listener’s attention.

Birdsong was also heard on site.

2.4 National Planning Policy Framework 2019

The National Planning Policy Framework (Feb 2019) defines the Government’s planning policies for England and how these are expected to be applied. It sets out the Government’s requirements for the planning system only to the extent that it is relevant, proportionate and necessary to do so.

The following paragraphs are relevant within NPPF Section 15 (Conserving and enhancing the natural environment) states the following:

Paragraph 170(e) - preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans; and

Paragraph 180-Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:

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

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

Paragraph 182 - 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.

2.5 ProPG Planning Guidance, June 2017

Recent planning guidance released in 2017 relates to new residential development and airborne transportation noise, which includes exposure to railway and aviation noise. Whilst ProPG, 2017 generally mirrors the requirements of BS8233:2014 and the World Health Organisation Guidelines, 1999, it goes further in setting a limit for inside bedrooms for L_{Amax} events and specifically, no more than 10 L_{Amax} events per night time period above 45dB(A).

ProPG, 2017 advocates that it is not necessarily about satisfying internal target criteria, but additionally that there should be a demonstration of good acoustic design. The principles of ProPG, 2017 have been followed and are detailed in the report.

2.6 Noise Policy Statement for England (NPSE, 2010)

2.6.1 NPSE Mission Statement

The document "Noise Policy Statement for England" sets out the following vision for on- going noise policy:

"Promote good health and quality of life through the effective management of noise within the context of Government policy on sustainable development."

This vision should be achieved through the following Noise Policy Aims:

"Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development: 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".

2.6.2 NPSE Noise "Effect Levels"

To achieve these objectives the Noise Policy Statement sets out three noise levels to be defined by the assessor:

- 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.

The Noise Policy Statement considers that noise levels above the SOAEL would be seen to have, by definition, significant adverse effects and would be considered unacceptable.

Where the assessed noise levels fall between the LOAEL and the SOAEL noise levels, the Policy Statement requires that:

"all reasonable steps should be taken to mitigate and minimize adverse effects on health and quality of life while also taking into account the guiding principles of sustainable development... .. This does not mean that such adverse effects cannot occur."

Where noise levels are below the LOAEL it is considered there will be no adverse effect. Once noise levels are below the NOEL there will be no observable change.

2.6.3 Guidance Documents

For guidance as to a numerical definition of LOAEL, while this is not provided specifically, it is helpful to refer to the following Standards.

- BS8233: 2014: Guidance on Sound insulation and noise reduction for buildings
- World Health Organization (WHO) - Guidelines for Community Noise 1999
- BS4142: 2014: Method for rating and assessing industrial and commercial sound

2.7 WHO Internal Noise Criteria

The target internal levels are based on guidelines laid out by the World Health Organisation (WHO) and are as follows:

Room Type	Target Maximum Internal Level - L_{Aeq} dB(A)
Living rooms	35 (Daytime only)
Bedrooms	30 (Night)
Room Type	Maximum Internal Level – L_{Amax} dB(A)
Bedrooms	45 (not more than 10-15 times per Night)

Table 1. WHO(1999) Internal Sound Levels to be Achieved

The target maximum internal noise level for a bedroom during the night time corresponds to the threshold of sleep disturbance. WHO state that the noise level outside a bedroom window would be less than 45dB(A) this assumes that an open window provides 15dB attenuation.

2.8 WHO External Noise Criteria (World Health Organisation, 1999)

With regard to outdoor amenity areas WHO states the following:

To protect the majority of people from being seriously annoyed during the daytime, the outdoor sound level from steady, continuous noise should not exceed 55dB(A) on balconies, terraces and in outdoor living areas.

To protect the majority of people from being moderately annoyed during the daytime, the outdoor sound level from steady, continuous noise should not exceed 50dB(A) on balconies, terraces and in outdoor living areas.

2.9 BS8233:2014 Noise Criteria

Table 4 of BS8233:2014 provides the following guideline values:

Activity	Location	Time period of day	
		07:00-23:00	23:00-07:00
Resting	Living Rooms	35dB L _{Aeq,16hour}	-
Dining	Dining Room/Area	40dB L _{Aeq,16hour}	-
Sleeping (daytime resting)	Bedroom	35dB L _{Aeq,16hour}	30dB L _{Aeq,8hour}

Table 2: BS8233:2014 Criteria

3 Environmental Sound Survey

3.1 Methodology

A noise survey was carried out from 22nd June 2018 to 27th June 2018 capturing a weekend to ensure any variability in the soundscape was understood.

Three sound level meters were selected to identify the sound levels incident on the site boundaries and were located at the positions of where new residential housing is currently proposed. All three meters were set to fast and A weighting filters and were calibrated to 94dB(A) whilst setting up and decommissioning the survey equipment. No drift was noted

All three meters were set up in free field locations.

Survey(s) carried out by	Scott Castle BSc (Hons) Env Health, MCIEH CEnvH PGDip Acoustics AMIOA,
Location Reference	1
Equipment Used	Castle Mirus - Type 1 Sound Level Meter
Equipment Used	Castle Group Acoustic Calibrator – GA602-Serial.031042
Location of Microphone	10m From Northern Boundary – SU93897/04043
Duration of Survey	Start 14:55 22/06/2018 / Stop 15:15 27/06/2018
Height	1.5m above ground level

Survey(s) carried out by	Scott Castle BSc (Hons) Env Health, MCIEH CEnvH PGDip Acoustics AMIOA,
Location Reference	2
Equipment Used	Castle Mirus - Type 1 Sound Level Meter (Audio Capture)
Equipment Used	Castle Group Acoustic Calibrator – GA602-Serial.031042
Location of Microphone	8.5m from Western Boundary – SU 93826/04010
Duration of Survey	Start 15:20 22/06/2018 / Stop 15:50 27/06/2018
Height	1.5m above ground level

Survey(s) carried out by	Scott Castle BSc (Hons) Env Health, MCIEH CEnvH PGDip Acoustics AMIOA,
Location Reference	3
Equipment Used	Norsonic 118 – Type 1 Sound Level Meter
Equipment Used	Castle Group Acoustic Calibrator – GA602-Serial.031042
Location of Microphone	10m North from Southern Boundary – SU 93895/03961
Duration of Survey	Start 14:30 22/06/2018 / Stop 15:00 27/06/2018
Height	1.5m above ground level

The rationale for the placement of the meters was as follows:

- Castle (Position 1). The meter was located to identify the impact of road traffic in and out of the caravan site which was seen to be very regular. The Northern approach road to the caravan site is a 10mph road with regularly spaced speedhumps. The meter was also located at the position of a proposed residential façade to avoid any additional calculations. The Castle Mirus was set to record to 5-minute data intervals
- Castle Audio Capture (Position 2) – To capture passing road traffic noise from the North and South carriageways. Audio Capture was set at 68dB as a trigger to identify any particularly loud events. The Castle Mirus was set to record to 5-minute data intervals.
- Norsonic (Position 3) - The meter was located to identify the sound from the industrial estate located to the South as the meter was equipped with 1/3 octave bands enabled. Again, the specific location was chosen to represent a proposed building façade. The Norsonic 118 was set to record to 15-minute data intervals, with 5-minute reference periods, should further detailed analysis be necessary.

All meters were located in free field positions and are seen in Figures 3 and 4 below.

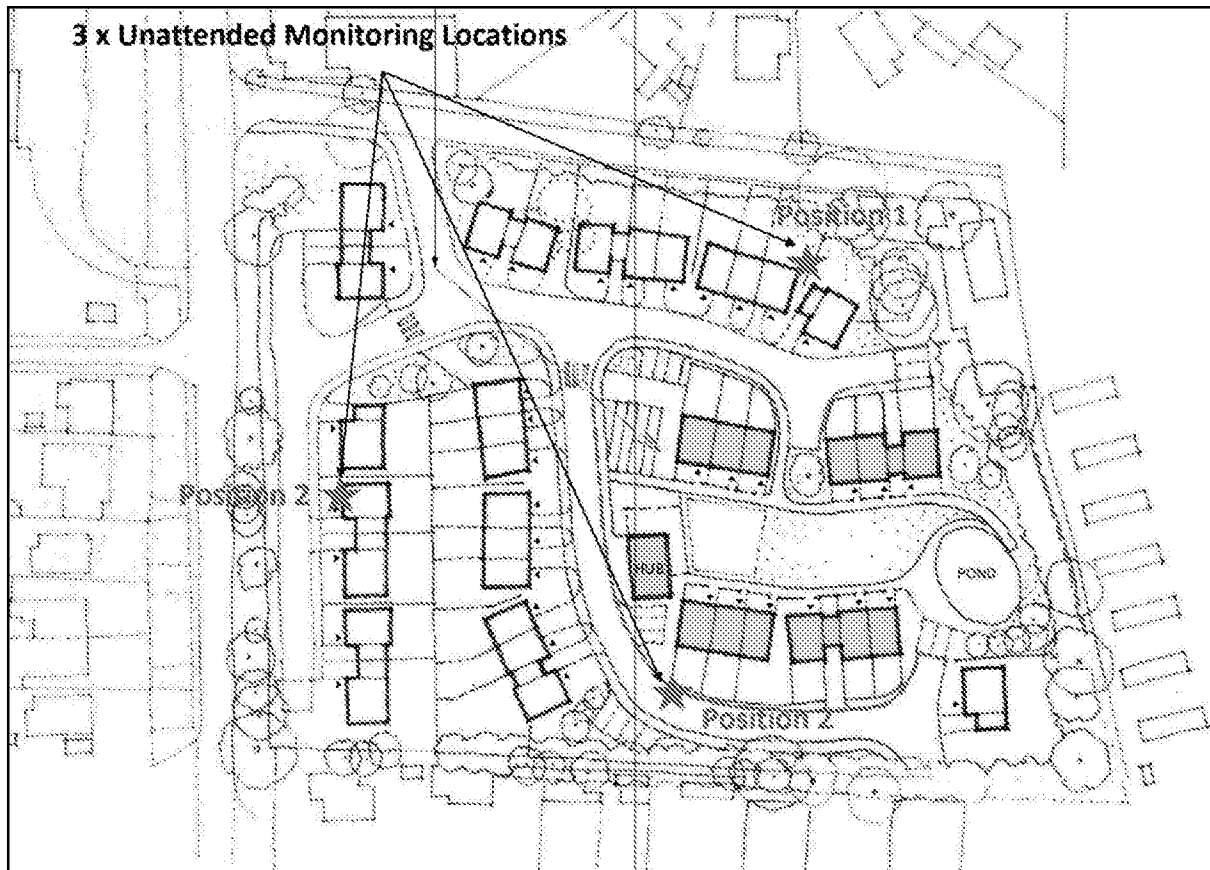


Figure 3. Proposed site layout annotated with 3 survey positions

Figure 4 below shows photographs of the unattended survey positions, all of which are freefield.

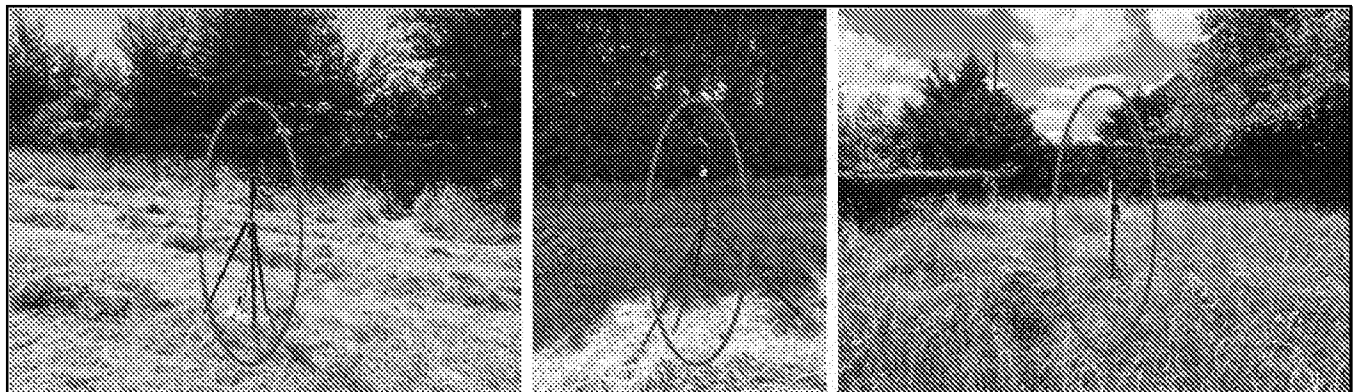


Figure 4. Unattended survey locations (2, 3, 1)

3.2 Weather Conditions

The weather conditions for the survey period were and warm dry, with nil precipitation and ideal for environmental noise monitoring. Windspeeds were generally under 5m/s.

4 Methodology and Assessment Standards

4.1 Proposed Noise Model

Three sound level meters were deliberately deployed on the site at the three strategic locations discussed above. These were placed to collect data which will inform the construction of a noise model within specialist noise modelling software (IMMI).

The noise model, once calibrated will then show the predicted façade levels for the proposed new buildings and what, if any, mitigation measures are then needed to protect the future residential occupiers.

4.2 Applicable Assessment Standards

Airborne transportation noise is governed by ProPG (2017) and will be applicable for the Western and Northern boundaries of the application site.

BS8233:2014 provides criteria for internal noise levels for new buildings where there is continuous and anonymous noise sources such as road traffic noise. This is discussed above in section 2.9. A more stringent and lower internal criterion is considered appropriate for the AO1 apartment blocks and/or DO3 properties located in close proximity to Lee's Yard commercial/industrial estate.

Whilst BS4142:2014 describes and allows impact to be quantified of new commercial activities, section 8.5 goes on to describe that where new residents are introduced, the sound in question forms a part of the soundscape and care needs to be taken to ensure that the soundscape has been fully qualified. BS4142:2014 also goes on to state that one may consider the use of other more applicable metrics or standards.

Additionally, the NPPF sections 109 and 123 list the importance of protecting future residents from noise and importantly, protecting existing businesses from unreasonable burdens created by the introduction of new residential receptors. This is further argued in the "*Agent of Change Principle*" and why it is necessary to be fully aware of the soundscape and its implications for residential use.

Given the above principles, a more stringent criteria is necessary to be applied for the proposed residential properties at the Southern boundary due to the commercial uses and to ensure that such uses are not prejudiced by developing the site.

5 Results of the Unattended Sound Survey

5.1 Unattended Data

Due to the freefield nature of the survey locations, no additional corrections are necessary at this stage.

5.1.1 Location 1

Logarithmically Averaged Day and Night time Periods			
L_{Aeq}, 16 hour- 07:00-23:00		L_{Aeq}, 8 hour 23:00-07:00	
Day 1	48.2	Night 1	43.2
Day 2	45.6	Night 2	41.5
Day 3	49.4	Night 3	42.1
Day 4	46.8	Night 4	42.9
Day 5	45.7	Night 5	40.9
Arithmetic Average	47.1		42.1

Table 3. Northern Survey Location

5.1.2 Location 2

Logarithmically Averaged Day and Night time Periods			
L_{Aeq}, 16 hour- 07:00-23:00		L_{Aeq}, 8 hour 23:00-07:00	
Day 1	58.7	Night 1	53.1
Day 2	58.1	Night 2	52.9
Day 3	62.7	Night 3	53.5
Day 4	58.8	Night 4	54.0
Day 5	56.4	Night 5	53.6
Arithmetic Average	58.9		53.4

Table 4 . Middle Survey Location

5.1.3 Location 3

Logarithmically Averaged Day and Night time Periods			
L_{Aeq}, 16 hour- 07:00-23:00		L_{Aeq}, 8 hour 23:00-07:00	
Day 1	52.1	Night 1	44.4
Day 2	48.3	Night 2	45.0
Day 3	46.3	Night 3	45.7
Day 4	54.9	Night 4	45.9
Day 5	49.4	Night 5	45.5
Arithmetic Average	50.2	Arithmetic Average	45.3

Table 5. Southern Survey Location

5.2 Grass Cutting

It was noted during the visit to collect the survey equipment that the grass had been cut and collected. The client and the subcontractor, confirmed that this had been done on Monday the 25th June from approximately 11am to 17:00 hours. Despite the relatively large size of the site, the baling activities, are apparent on all three meters and are evident in each of the survey datasets.

The hours on the day in question have been removed from each of the datasets ensuring that the data collection is in fact representative and robust. The data in table 6 below is therefore corrected to exclude the grass cutting.

5.3 Summary of Noise Data

Having removed the 6 hours of bailing activities from the site data from Monday 25th June 2018, the following is the arithmetic daytime values for the 5-day survey period. The rounded figures are shown in brackets. The night time values would not have been impacted and remain unchanged.

Location	Daytime $L_{Aeq, 16 \text{ Hour}}$	Night time $L_{Aeq, 8 \text{ hour}}$
1	46.6 (47dB(A))	42.1 (42 dB(A))
2	58.6 (59 dB(A))	53.4 (53 dB(A))
3	49.4 (49 dB(A))	45.3 (45 dB(A))

Table 6. Revised Noise Data

5.3.1 Review of Data for Night Time

There are two main drivers which relate to internal noise levels for restful sleep inside a bedroom at night. These are the measured 8-hour L_{Aeq} of 30dB(A) as stated by Table 4 of BS8233:2014 and additionally, the more recent publication of ProPG (2017) which requires no more than 10 occurrences per night above 45 dB L_{Amax} measured inside the bedroom.

Time history graphs are shown for the three locations which identify L_{Aeq} , L_{A90} and L_{Amax} for the 8-hour night time period of 23:00-07:00 hours.

Based on an open window providing a loss of 15dB from outside sound pressure levels to inside sound pressure levels, the following tables may be identified to determine if windows are capable of being opened in a residential bedroom.

Location 1

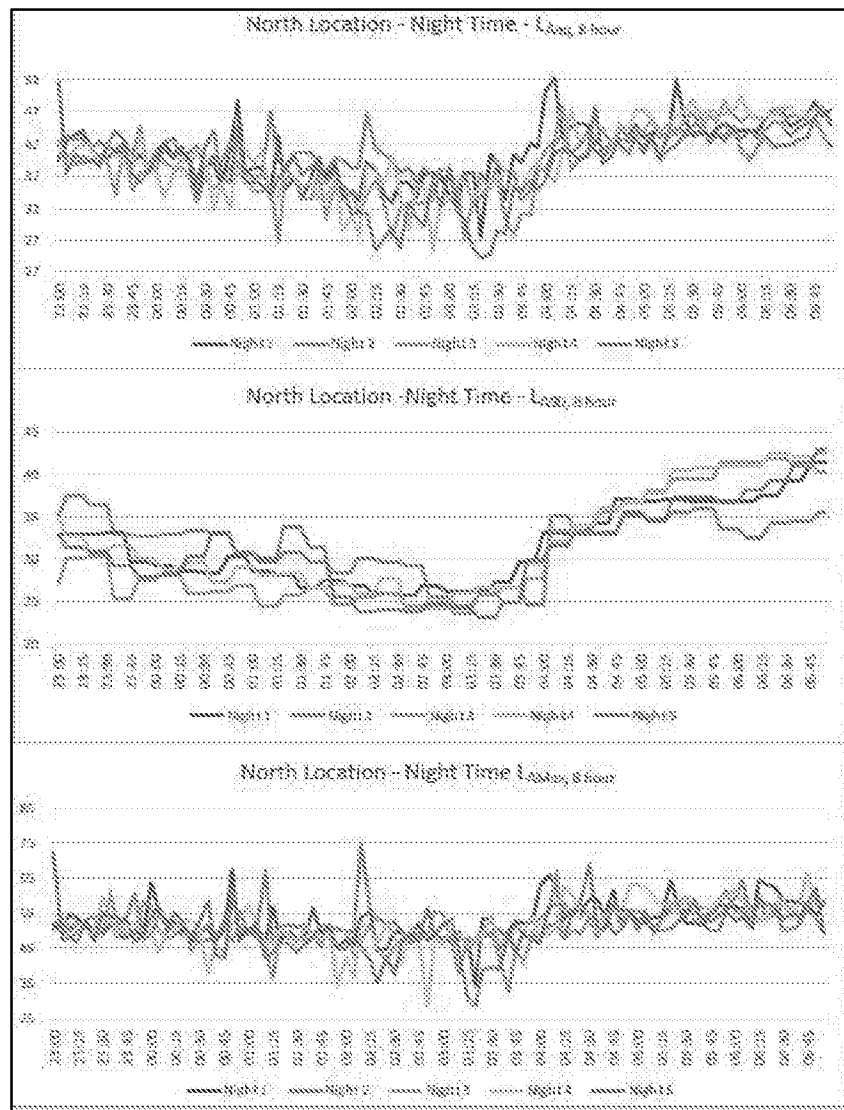


Figure 5. Northern Survey Location data showing L_{Aeq} , L_{A90} and L_{Amax} data

No. of Occurrences of L_{Amax} between 23:00-07:00 hours above 45dB L_{Amax} (SRI 15)				
Night 1	Night 2	Night 3	Night 4	Night 5
10	4	3	6	3

Table 7. Number of occurrences of L_{Amax} above 45dB(A) inside the bedroom at night with a window open

On the basis of the information above in Table 7, it is apparent that properties with bedrooms facing onto the northern access road, may have their bedroom windows open during the night time period, without any adverse result in terms of L_{Amax} awakenings. The worst-case night time 8 hour L_{Aeq} , was measured as 43dB(A), so an open window with a 15dB reduction provides a permissible 28dB(A) in the bedroom environment and meets BS8233:2014.

Given the variation and spread of housing, the noise modelling software will be used to predict the façade locations, as not all properties are located at the survey positions.

Location 2

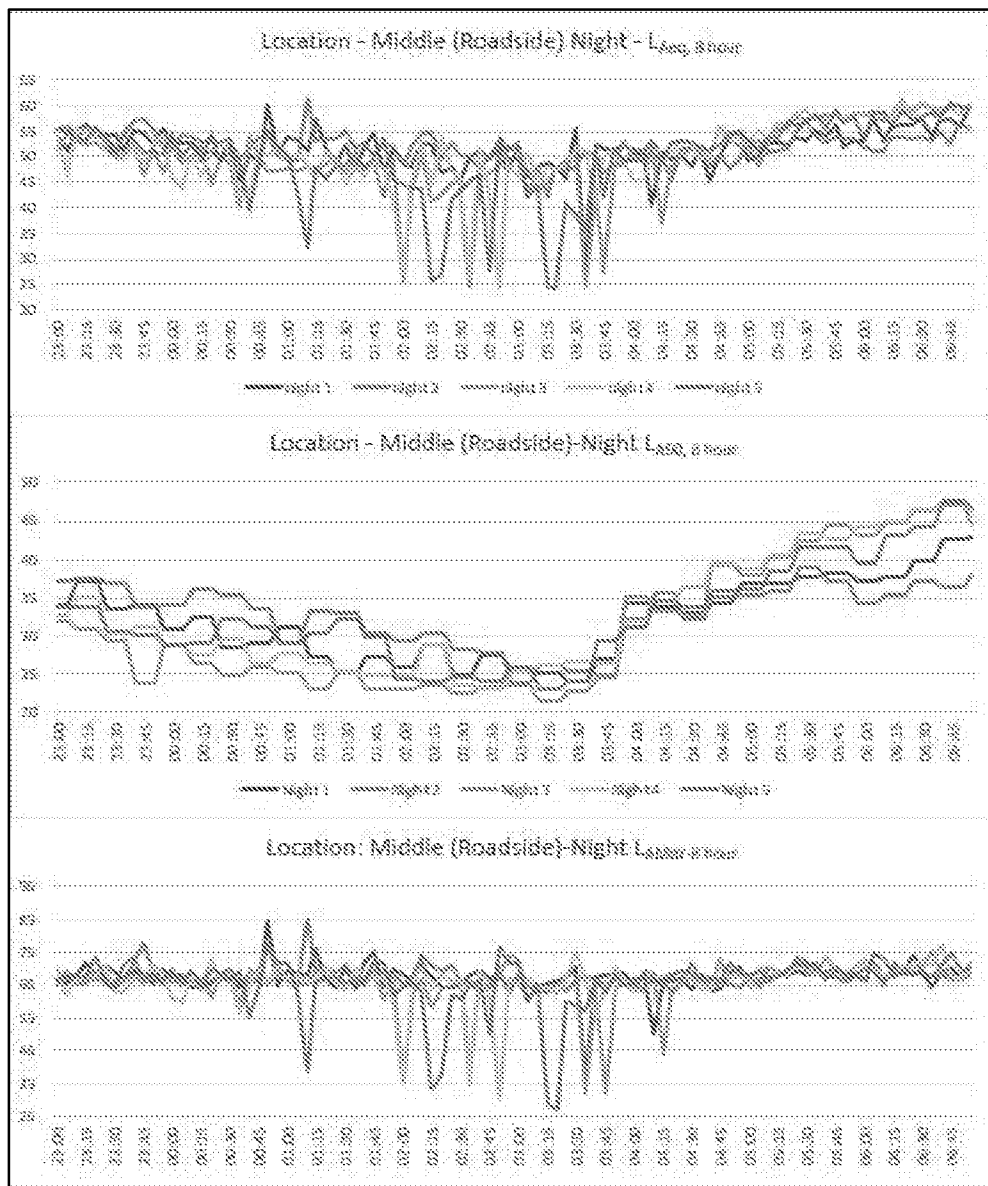


Figure 6. Middle Survey location showing L_{Aeq} , L_{A90} and L_{Amax} data

No. of Occurrences of L_{Amax} between 23:00-07:00 hours above 45dB L_{Amax} (SRI 15)				
Night 1	Night 2	Night 3	Night 4	Night 5
94	96	89	89	85

Table 8. Number of occurrences of L_{Amax} above 45dB(A) inside the bedroom at night with a window open

Table 8 above suggests that for bedrooms facing the roadside at the survey measurement position, if these were to be open windows for ventilation at night, the night time criterion for internal sound levels would be exceeded. Similarly, the worst-case night recorded was measured at the survey location as being 54 dB L_{Aeq} , 8 hour. With an open window, this is likely to be 39dB in the bedroom and exceeds the requirements of Table 4, BS8233:2014.

Given the variation and spread of housing, the noise modelling software will be used to predict the façade locations, as not all properties are located at the survey positions.

Location 3

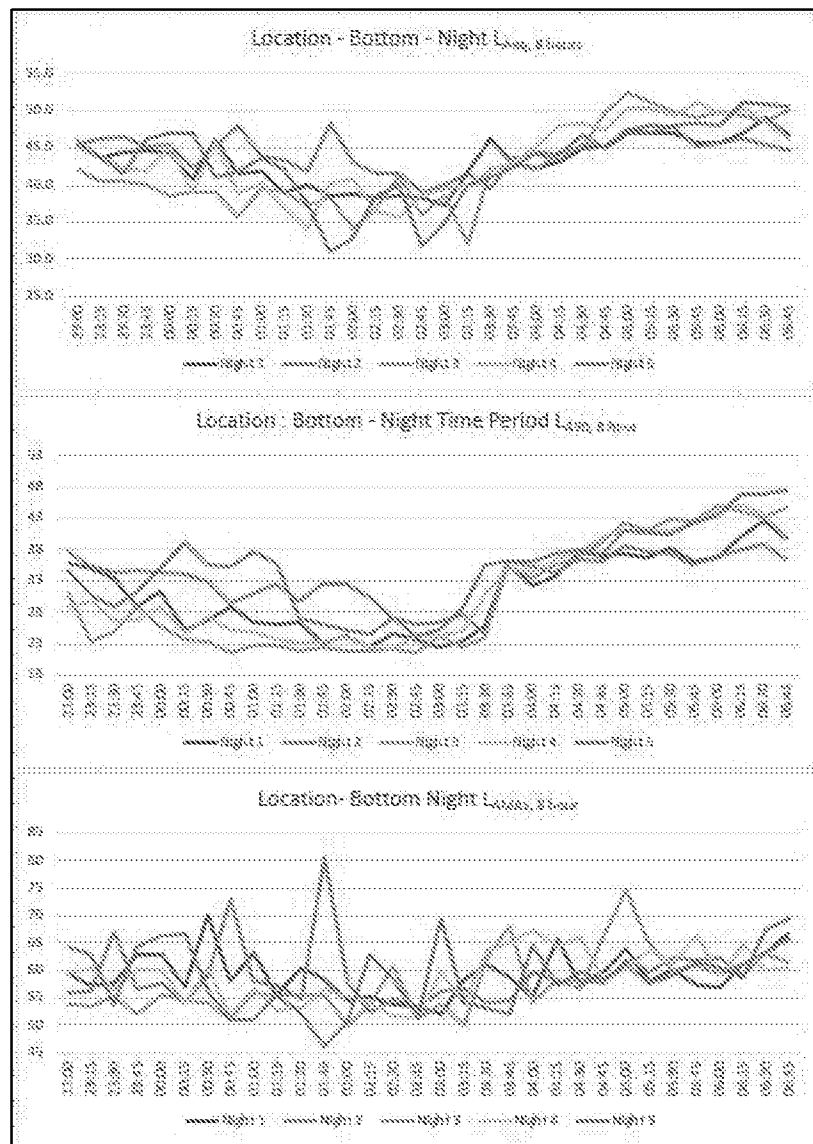


Figure 7. Southern Survey Position showing L_{Aeq} , L_{A90} and L_{Amax} data

The Norsonic data suggests that 45 dB L_{Amax} measured internally is exceeded 32 times a night based on an open window.

The worst case recorded night time measurement is 46dB $L_{Aeq, 8 \text{ hour}}$. With an open window this would provide 31dB, an exceedance of the requirements of Table 4 of BS8233:2014. Similarly, the number of exceedances per night of 45dB L_{Amax} would prevent a window being opened at the survey position for ventilation.

Given the variation and spread of housing, the noise modelling software will be used to predict the façade locations, as not all properties are located at the survey positions.

6 Noise Modelling Software

The IMMI (Wolfel, 2015) noise modelling software is useful as it applies and faithfully replicates the methodology in ISO 9613 for sound propagation. Given the noise sources which surround the site, the relevant noise sources may be replicated using three line sources and additionally, the industrial estate to the south replicated as an area noise source.

The noisiest unit is potentially Unit 7 (D&R Structures steel fabricators) which can be replicated using the building as an area noise source with an opening applied to account for their Western door opening.

The noise model is constructed by taking a proposed site plan and annotating the roads as well as the proposed residential properties, the industrial estate buildings and any other fence-lines and vegetation elements to replicate as accurately as possible the site conditions. The survey positions are then carefully added as receiving points within the model on the relevant facades and the correct heights.

The noise model is then calibrated by adjusting the noise sources until such time that the survey positions are matched with the unattended data for both the daytime and night-time sound pressure levels.

The noise model has been calibrated to the worst case $L_{Aeq, 16 \text{ hour}}$ for daytime and night time for positions 1 and 2 and for position 3, calibrated to the worst case hour. This allows a robust and conservative assessment.

6.1 Assumptions made and entered into the Noise Model

Whilst a 1.8m timber palisade fence is evident on the southern boundary of the site, the fence-line has not been included in the initial modelling to account for the existing situation.

Vegetation has not been added to either of the site boundaries (North, West and Southern boundaries), therefore presenting a worst-case assessment.

To ensure that the model is accurate as possible, the grid axis for the noise contour predictions has been set to 0.5 metre with a 3dB contour change to show visually, how the site is impacted by sound and how sound sources propagate.

Each property had had receptor positions plotted representative of windows at 1.5m (ground floor) and 4.0m (First floor) respectively.

The noise modelling software has only been used with the revised dataset for calibration (I.E. data adjusted to remove grass cutting extraneous noise).

Visits to the commercial yard/industrial estate indicate numerous noise sources including those such as mobile plant such as fork lift trucks, deliveries to site of steel and plastics, vehicles and building materials. However, given the dominant noise source of D&R Structures, the site has been modelled as an area noise source and adjusted until such time that the Southern survey results are matched for both daytime and night time periods.

To ensure an assessment of gardens or external amenity areas, receptor positions have been added to the rear garden areas, and these are without the individual privacy fences that properties might expect, again, presenting a worst-case assessment. Garden reception positions have been entered as freefield and at 1.5m in height.

6.2 Noise Modelling Results

The results of the IMMI (Wolfel) Noise modelling software can be seen in Figures 8-10 below and include 3D and 2D Modelling. The actual predicted noise levels can be seen in Appendix A which has been broken down into property locations.

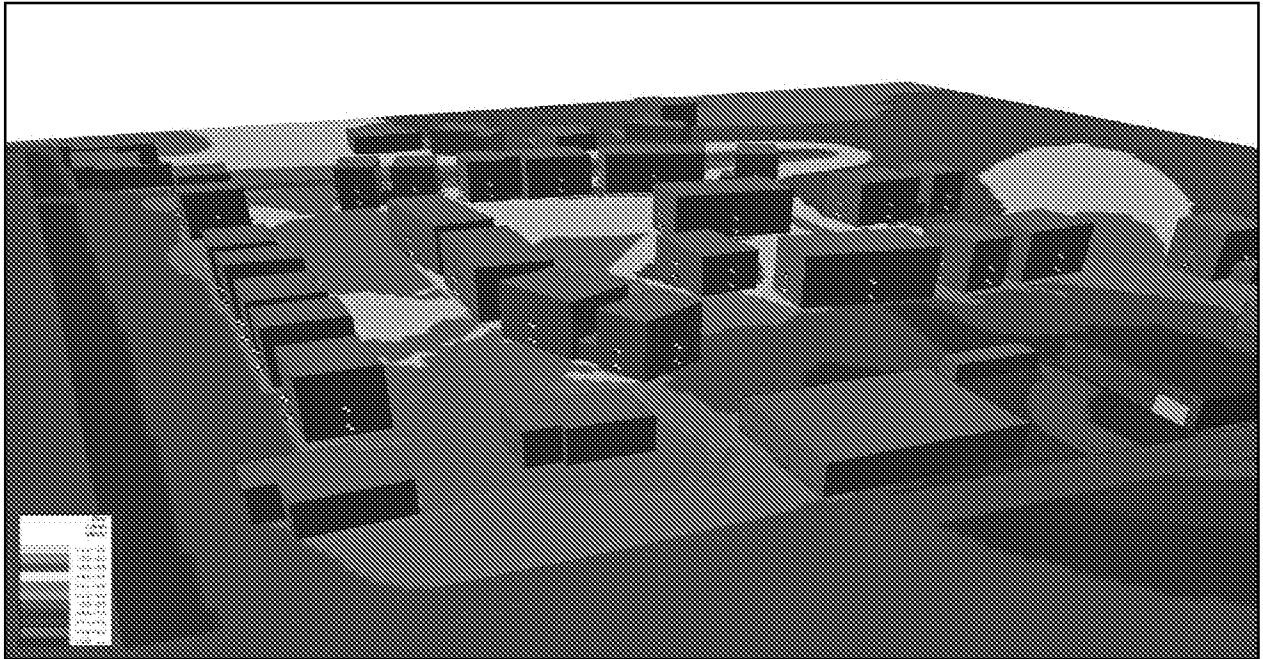


Figure 8. 3D IMMI Noise Modelling - Looking North

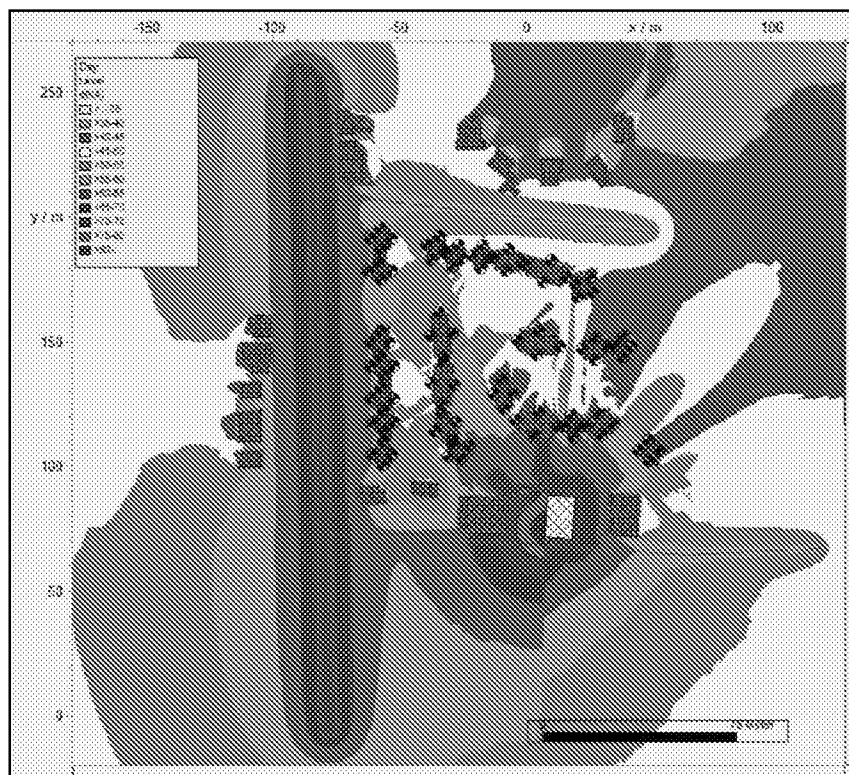




Figure 10. 2D IMMI Night-time Noise Contours

Whilst there is a 1.8 metre palisade fence on the Site's Southern boundary with Lee's Yard, it is unlikely to be providing any acoustic protection as there are large transparent areas where sound energy will be able to travel through. The impact of D&R Structures is apparent for the daytime and travels North into and across the application site.

6.3 Noise Model Outcomes

From the noise modelling process, it is apparent that the A29 is having an impact on the Western most properties and similarly, the commercial/industrial estate located to the South is also having an impact for the lower tranche of properties. Specifically, it is the metalworks within Lee's Yard which was added into the site, which is propagating North across the site.

Without any mitigation measures applied to the model and a simplistic subtraction of internal BS8233:2014 criteria from the free field external predicted sound pressure levels, it is apparent that the highest Sound Reduction Index (SRI) required is 27.7 dB for the daytime period. Such levels relate to the proximity of Units R and Y to the established metal working site. The highest night time sound reduction index, again based on a simplistic subtraction of internal criterion from external sound levels is 26.4dB from the South facing first floor level of Property A, suggesting the A29 as the dominant sound source during the daytime period (07:00-23:00 hours).

In line with ProPG2017 and the driving principles of good acoustic design, receptor positions were placed at ground floor (1.5m) and first floor levels (4m) to record all of the façade predictions in order that future design may consider habitable spaces such as bedrooms on the quieter/less impacted facades.

It was necessary to name each of the buildings, in order that the predicted freefield levels from the noise modelling software can be related to the proposed properties in question. The noise modelling predictions are included in Appendix A for further reference.



Figure 11. Proposed Residential Naming System, Orientated North

The principle factor derived from the predictions in Appendix A is that the internal sound levels required in BS8233:2014 are met in all circumstances with the windows closed. However, when windows are opened, in the majority of cases, the internal soundscape is above the requirements of BS8233:2014. The windows assessed against were standard thermal double glazed units with a 4/12/4 configuration providing a R_w of 33dB when installed into a masonry façade.

With windows required to be closed, there will be a requirement to provide background ventilation into the properties.

6.4 Assessment of External Amenity Areas

When considering external amenity areas or gardens, as per section 2.8 above, the $L_{Aeq, 16 \text{ hour}}$ noise level should not exceed 50dB(A) to protect the majority of people from being moderately annoyed. It should be remembered that the 50dB(A) would be assessed over a 16-hour day.

Garden areas were entered into the noise model as receiver points at 1.5 metres in height and at the principal areas of concern. It is noted that the garden reception points were added without any external garden fences. The addition of likely 1.8m privacy fences would reduce sound levels further still within the compartmentalised garden areas.

The predicted freefield noise levels are seen below in Figure 12. Gardens 10 and 11 experience significantly higher sound levels and on further investigation within the software are as a result of the close proximity to the metal working premises. As stated above, these garden levels would reduce further still with the erection of rear garden fencing which separates the properties from the access road. The cells shaded red indicate where the sound levels exceed 55dB $L_{Aeq, 16 \text{ hour}}$.

However, as stated, the model has been deliberately set to a worst-case hour for the commercial metalworks site to the South and do not include any boundary fencing/privacy fencing which are likely to reduce sound levels further still.

Location	Predicted Sound Level, $L_{Aeq,16\text{ hour}}$
Garden 1	53.8
Garden 2	50.4
Garden 3	48.5
Garden 4	48.6
Garden 5	50.4
Garden 6	55.5
Garden 7	52.1
Garden 8	49.5
Garden 9	52.2
Garden 10	63.7
Garden 11	60.4

Figure 12. External Amenity Areas- $L_{Aeq,16\text{ hour}}$

6.5 Revised Noise Criterion for Properties close to Lee's Yard

BS8233:2014 provides criterion for internal noise levels which considers continuous and anonymous noise sources, such as road traffic noise. It is noted that the commercial/industrial area to the South will generate "other" types of noise which may be more noticeable to a listener.

There are two approaches which may be applied and it is not appropriate to apply both as this would cause an over complication. Either the internal criteria for living areas and bedrooms inside the residential properties may be reduced and the predicted noise levels assessed against the revised criteria, or alternatively, a worst-case hour may be examined and the predicted noise levels assessed.

As discussed above, the worst-case hour from location 3 survey position has been used to calibrate the noise model. The worst-case hours are shown in 6.6 below.

6.6 Assessment of Worst-Case hours for daytime and night time periods at Location 3.

The daytime hours are shown below.

Hours	Day 1	Day 2	Day 3	Day 4	Day 5
07:00-08:00	51	48	46	50	48
08:00-09:00	53	49	46	58	49
09:00-10:00	51	48	46	48	47
10:00-11:00	52	48	48	51	48
11:00-12:00	54	50	47	52	52
12:00-13:00	52	48	47	57	48
13:00-14:00	49	49	46	54	50
14:00-15:00	49	49	48	57	50
15:00-16:00	50	49	46	62	54
16:00-17:00	60	48	46	59	51
17:00-18:00	50	48	46	53	50
18:00-19:00	51	48	46	47	47
19:00-20:00	48	48	47	44	45
20:00-21:00	46	47	46	47	46
21:00-22:00	47	47	45	45	46
22:00-23:00	46	46	43	44	47

Table 9. Assessment of Daytime Hours

Whilst 62 dB $L_{Aeq, 1 \text{ hour}}$ is noted to be the highest, this was as a result of the baling/grass cutting activities occurring. 60dB $L_{Aeq, 1 \text{ hour}}$ is therefore considered to be the worst case daytime hour.

The night time hours are shown below

Time	Night 1	Night 2	Night 3	Night 4	Night 5
23:00-00:00	45	46	41	43	45
00:00-01:00	44	46	38	43	45
01:00-02:00	40	45	39	39	41
02:00-03:00	38	41	38	38	37
03:00-04:00	43	41	40	41	40
04:00-05:00	44	45	46	47	45
05:00-06:00	47	47	51	50	48
06:00-07:00	47	46	49	49	50

Table 10. Assessment of Night Time hours

From Table 10, 51dB $L_{Aeq, 1 \text{ hour}}$ is noted to be the worst-case hour for the night time period.

7 Pro-PG(2017) Assessment

Pro-PG (2017) requires that an initial risk assessment is produced to inform decision makers of the soundscape and what level of risk this presents for the development. The results of the risk assessment are seen in Figure 13 below indicating a low risk. The risk assessment has used the highest of the three locations data to inform a simple assessment.

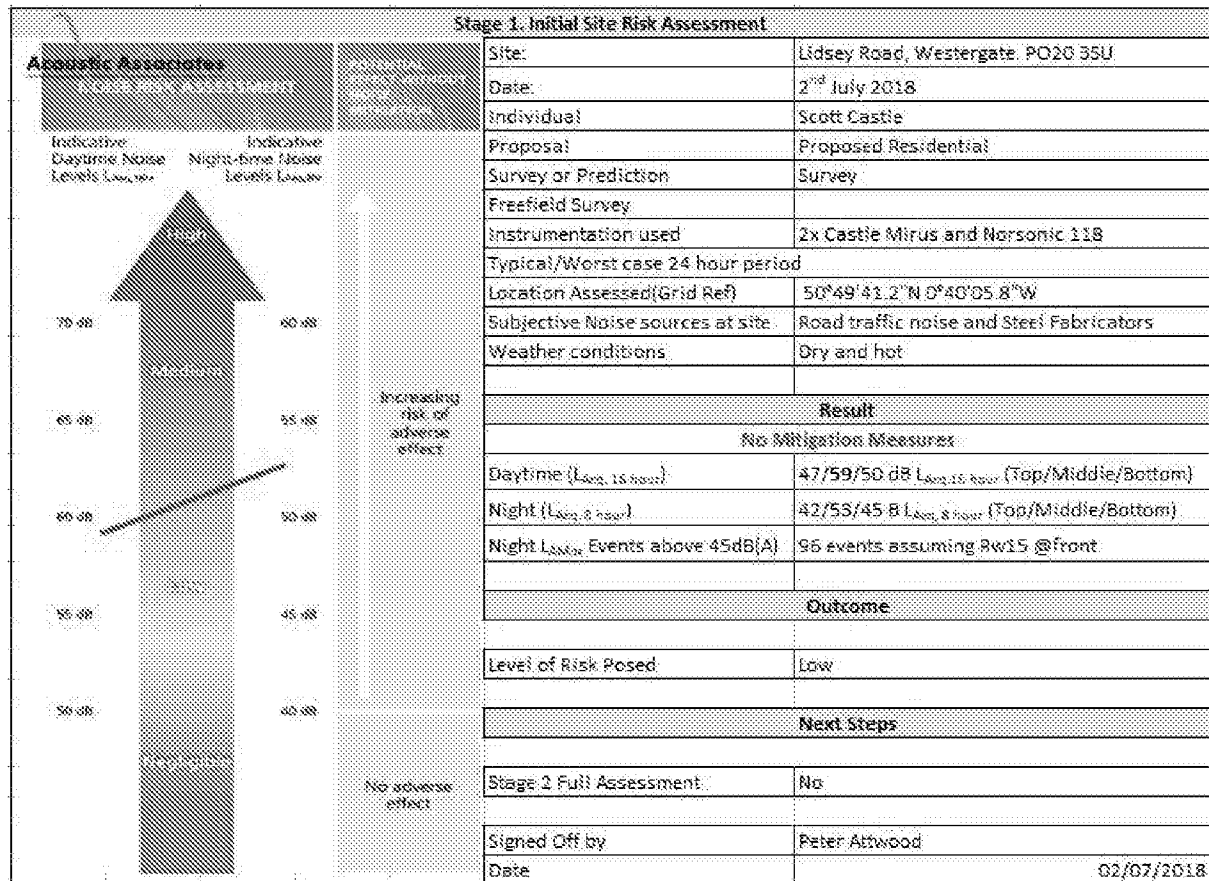


Figure 13. Initial Site Risk Assessment- ProPG2017

The principles of ProPG (2017) have been applied in terms of ensuring that any mitigation measures ensure that the internal L_{Amax} values do not exceed 45dB L_{Amax} more than 10 times a night.

8 Discussion

It is relevant to note that the noise model, used to predict sound levels to demonstrate a worst-case scenario, has been calibrated using the worst $L_{Aeq, 16\text{ hour}}$ and $L_{Aeq, 8\text{ hour}}$ averages for positions 1 and 2 (North and Middle) and used the single worst-case hour (60dB(A)) for position 3 for both daytime and night time periods. As seen in 6.6 above 60dB $L_{Aeq, 1\text{ hour}}$ occurs only once in the recorded 5-day dataset.

With regards to the noise modelling process, it is apparent that the existing timber palisade fence which demarks the southern boundary between the site and Lees Yard is not likely to be providing any acoustic protection. This is due to the gaps in the fence allowing the sound energy through. The model was therefore run without any fence-line and the sound generated within Lees Yard was seen to propagate freely across the application site.

The model was therefore re-run with a 2m acoustic fence to replace the existing timber palisade fence and the predicted noise levels compared against BS8233:2014 criteria, with marginal improvement to the rear areas, however, as noted, the introduction of boundary/privacy fencing is likely to be instrumental in further reducing the sound pressure levels still (especially where line of sight is broken).

The A29 was seen to impact those properties located to the Western edge of the proposed application site, whereas as anticipated, the noise generated from Lees Yard is seen to impact the closest properties on the southern element of the scheme.

Whilst it was referenced that in all cases, with windows closed, the internal sound levels were achieved, windows may still be opened during the daytime and night time periods for those properties located in the North East corner of the proposed scheme, away from the A29 and away from Lee's Yard.

The benefit of using the noise modelling software to produce predictions for each residential façade, is that further detailed planning may benefit from more sensitive uses such as bedrooms being placed on the quieter facades. This is consistent with good acoustic design as advocated in ProPG2017.

The initial site risk assessment, as required by ProPG2017, also indicates that the risk associated with developing at the site is Low.

9 Mitigation Measures

The mitigation measures being recommended will ensure that both daytime and night time criteria from BS8233:2014 are met for the proposed properties.

As discussed above, restful sleep in a bedroom depends not only internal L_{Aeq} noise levels being achieved throughout the 8-hour night time period, but also in restricting the number of L_{AMax} events which are likely to occur inside the bedroom above 45 dB L_{AMax} , as these have the potential to impact sleep.

9.1 Glazing

The calculations been carried out on the basis of a standard thermal double-glazed window of 4/12/4 providing an acoustic loss from outside to inside of 33 dB or 33 R_w , when set in a masonry façade. An open window is estimated to provide a 15 dB loss or 15 R_w . This approach is commensurate with that of Annex G.1 of BS8233:2014.

Standard thermal double glazing will be satisfactory for the site, but when it comes to opening windows, selected properties in close proximity to both the A29 and the industrial estate will receive noise levels inside either living areas or bedrooms which exceed the requirements of Table 4 of BS8233:2014.

There will therefore be a requirement to ensure that both living areas and bedrooms are capable of being sufficiently ventilated in line with Building Regulations Approved Document F.

9.2 Ventilation

There are a number of ways of ventilating and providing fresh air into a property. When considering ventilation, there must be sufficient air changes but also compliance with the building regulations (Approved Document F).

The options are as follows:

System 1 - Background ventilation using trickle vents

System 2 - Passive stack ventilation

System 3 - Continuous mechanical extraction ventilation (MEV)

System 4 - Mechanical Ventilation and Heat Recovery (MVHR)

Whilst residents retain the freedom to open their windows, by doing so, the internal noise levels are likely to be exceeded. However, for purge ventilation, it is important to note that noise levels are not applicable. Purge ventilation is the process of allowing rapid turnover of air changes when for example one wishes to remove cooking odours or paint fumes from inside the property.

Not all properties require ventilation, as some are capable of having open windows and this is largely dependent on the location of the proposed residential property. Note the comments above regarding those properties set in the North East corner of the proposed development.

There will be a requirement to provide background ventilation and cooling for properties where windows need to be kept closed to maintain internal noise levels. Systems 1 and 3 may normally be applied to provide such ventilation, but these will require acoustically treated ventilation systems.

With closed windows, an acoustically treated through the wall ventilator or trickle ventilator will provide sufficient air flow and air changes to the impacted bedrooms or living areas. It is strongly recommended that an M&E consultant be contacted to ensure the selection of appropriate ventilation.

As stated above, applying the principle of good acoustic design, will allow future refinement of the development to consider where exactly certain rooms are placed, based on their exposure to the site soundscape.

Ventilation associated with the windows on the Western properties directly overlooking the A29 shall have a $D_{n,e,w}$ of no less than 23dB. Similarly, ventilation associated with windows on properties to the South, which are likely to have line of sight to the Lee's Yard Industrial Estate area will be required to have a $D_{n,e,w}$ of 29dB.

9.3 External Amenity Areas

As stated above, there are three properties with gardens (which were examined in the worst case areas) which are likely to exceed 55 dB $L_{Aeq,16\text{ hour}}$. A 2.5 metre fence-line applied to the Western and Southern aspects properties, R, S and T will reduce noise levels and increase privacy to the rear garden areas.

9.4 Acoustic Fence

As stated above (section 8), a 2-metre acoustic fence will be required on the southern boundary to reduce the noise levels arising from the Lee's yard commercial/industrial estate. This should run the length of the site and may be placed in close proximity to the existing timber fence-line to ensure that the green vegetation remains in place. The fence should be an acoustic fence to provide a sufficient barrier, as opposed to a close boarded fence.

The acoustic fence should be constructed from butt jointed timbers (minimum of 20mm thick). 12-20mm cover strips should also be fitted over the whole of the butt joint as shown below:

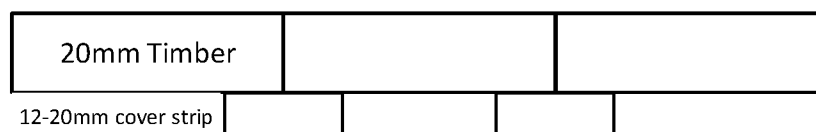


Figure 14. Using batons to cover the fencing joins on an acoustic fence

10 Uncertainty

In line with professional guidance, steps have been taken to reduce and report uncertainty in the report writing and data collection process.

To ensure robust data capture, three sound level meters were used for the site and placed at locations representative of proposed residential dwellings.

The sound level meters used were calibrated before and after the survey in situ, without any drift having occurred, to ensure that the information and data being obtained was representative and that the sound level meters were operating correctly.

Weather conditions were also considered to be ideal for environmental monitoring.

With any calculations made, including the determination of background sound levels, there has not been any additional rounding of numbers to prevent double handling, this has only occurred once at the final part of the sum and is presented to the reader with an easy to understand reference level or single figure.

Site distances were measured using a laser measurer and were repeated to ensure that these were representative data.

To account for the fact that the internal noise standards contained within BS8233:2014 (Table 4), relate to continuous and anonymous noise sources, the internal target criteria for properties in close proximity to the Southern commercial/industrial estate have been lowered to ensure appropriate levels internally.

With regards to data analysis, only complete days from the dataset have been used and where it was identified grass cutting and baling on the application site, the data for the 6 hours has been removed from each of the three datasets.

To check the noise modelling process, it is known that the middle survey position was measured at 8.5 metres from the internal hedge-line. Using a 10log attenuation for a line source to estimate the noise level to the nearest property at DO2, this is estimated to be 29m. Using inverse square law $L1-L2 = 10\log(29/8) = 5\text{dB(A)}$ reduction. Subtracting 5dB(A) from the arithmetic average noise level of 59 provides 54dB, whereas the ground floor sliding glazed windows of DO2(1) were predicted by IMMI to be 53dB, 1dB different. It is therefore felt that the model is working as intended.

11 Conclusion

To fully identify the soundscape at the application site, three sound level meters were deployed from 22nd to 27th June 2018. The sound level meters were specifically placed at strategic locations where building facades would be located to prevent any further calculations being necessary. Once the daytime and night time noise levels had been identified at the top, middle and bottom of the site, an IMMI noise prediction model was created and calibrated to determine how sound is likely to propagate across the application site. By annotating the proposed residential properties and receiver points such as windows and gardens, noise levels have been predicted.

The sound sources around the site were also considered to determine appropriate internal noise levels for future residents. Where continuous and anonymous noise is the dominant source, such as road traffic on the A29, criteria has been applied from Table 4 of BS8233:2014. Similarly, good practice has dictated the application of ProPG 2017 where airborne transportation noise is the dominant noise source. However, where noisier events have occurred, such as the Lees Yard commercial/Industrial yard to the South, the noise model has been calibrated against the worst daytime and night time hour to provide a robust and worst-case assessment.

The report concludes that whilst standard thermal double glazing will be sufficient to protect future occupiers inside housing with windows closed. However, in the majority of cases, by opening windows, this is likely to cause raised internal noise levels that exceed the requirements of BS8233:2014. To overcome this, acoustic ventilators are proposed to provide the level of background ventilation required. The degree of protection required differs depending on where the properties are located on the application site.

The report has followed the principles of good acoustic design, as required by ProPG2017 and should the mitigation measures discussed in section 9 be implemented, there is no reason why the planning application should be refused on noise grounds.

12 Appendix A

Please note that the shaded red cells represent where the internal daytime/night time sound level criteria (BS8233:2014) has been exceeded. The two shaded yellow cells represent the maximum values predicted.

Location	Predicted Daytime	Predicted Night Time	Daytime		Night Time		SRI	
			Window Open	Window Closed	Window Open	Window Closed	Day	Night
A 1 GF Sout	55.1	54.3	43.1	25.1	42.3	24.3	20.1	24.3
A 1 UF1Sout	57.6	56.4	45.6	27.6	44.4	26.4	22.6	26.4
A 2 GF East	51.6	52.1	39.6	21.6	40.1	22.1	16.6	22.1
A 2 UF1East	53.2	54.0	41.2	23.2	42.0	24.0	18.2	24.0
A 3 UF1Nort	57.5	51.3	45.5	27.5	39.3	21.3	22.5	21.3
A 4 GF West	58.9	52.9	46.9	28.9	40.9	22.9	23.9	22.9
A 4 UF1West	61.1	55.0	49.1	31.1	43.0	25.0	26.1	25.0
B 1 GF Nort	53.7	47.0	41.7	23.7	35.0	17.0	18.7	17.0
B 1 UF1Nort	56.1	49.3	44.1	26.1	37.3	19.3	21.1	19.3
B 2 GF East	49.6	48.8	37.6	19.6	36.8	18.8	14.6	18.8
B 2 UF1East	51.0	50.0	39.0	21.0	38.0	20.0	16.0	20.0
B 3 UF1Sout	58.2	51.5	46.2	28.2	39.5	21.5	23.2	21.5
B 4 GF West	59.1	52.9	47.1	29.1	40.9	22.9	24.1	22.9
B 4 UF1West	61.2	54.9	49.2	31.2	42.9	24.9	26.2	24.9
C 1 GF Sout	53.6	47.4	41.6	23.6	35.4	17.4	18.6	17.4
C 1 UF1Sout	56.0	49.5	44.0	26.0	37.5	19.5	21.0	19.5
C 2 GF East	46.8	46.1	34.8	16.8	34.1	16.1	11.8	16.1
C 2 UF1East	47.9	47.1	35.9	17.9	35.1	17.1	12.9	17.1
C 3 UF1Nort	57.4	50.6	45.4	27.4	38.6	20.6	22.4	20.6
C 4 GF West	59.0	52.7	47.0	29.0	40.7	22.7	24.0	22.7
C 4 UF1West	61.1	54.6	49.1	31.1	42.6	24.6	26.1	24.6
D 1 GF Nort	54.0	47.1	42.0	24.0	35.1	17.1	19.0	17.1
D 1 UF1Nort	56.3	49.4	44.3	26.3	37.4	19.4	21.3	19.4
D 2 GF East	47.4	45.0	35.4	17.4	33.0	15.0	12.4	15.0
D 2 UF1East	48.7	46.0	36.7	18.7	34.0	16.0	13.7	16.0
D 3 UF1Sout	57.4	50.5	45.4	27.4	38.5	20.5	22.4	20.5
D 4 GF West	59.0	52.4	47.0	29.0	40.4	22.4	24.0	22.4
D 4 UF1West	61.1	54.4	49.1	31.1	42.4	24.4	26.1	24.4
E 1 UF1Nort	57.4	50.6	45.4	27.4	38.6	20.6	22.4	20.6
E 2 GF East	46.3	42.9	34.3	16.3	30.9	12.9	11.3	12.9
E 2 UF1East	48.1	44.1	36.1	18.1	32.1	14.1	13.1	14.1
E 3 GF Sout	54.6	47.7	42.6	24.6	35.7	17.7	19.6	17.7
E 3 UF1Sout	56.9	50.0	44.9	26.9	38.0	20.0	21.9	20.0
E 4 GF West	59.0	52.3	47.0	29.0	40.3	22.3	24.0	22.3
E 4 UF1West	61.1	54.3	49.1	31.1	42.3	24.3	26.1	24.3
F 1 GF Sout	55.3	48.7	43.3	25.3	36.7	18.7	20.3	18.7
F 1 UF1Sout	57.2	50.5	45.2	27.2	38.5	20.5	22.2	20.5
F 2 GF West	58.7	51.9	46.7	28.7	39.9	21.9	23.7	21.9
F 2 UF1West	60.8	54.0	48.8	30.8	42.0	24.0	25.8	24.0
F 3 UF1Nort	56.4	49.5	44.4	26.4	37.5	19.5	21.4	19.5
F 4 GF East	44.5	42.0	32.5	14.5	30.0	12.0	9.5	12.0
F 4 UF1East	46.2	43.0	34.2	16.2	31.0	13.0	11.2	13.0
G 1 GF Nort	54.5	47.9	42.5	24.5	35.9	17.9	19.5	17.9
G 1 UF1Nort	56.3	49.7	44.3	26.3	37.7	19.7	21.3	19.7
G 2 GF East	46.6	42.9	34.6	16.6	30.9	12.9	11.6	12.9
G 2 UF1East	48.0	43.8	36.0	18.0	31.8	13.8	13.0	13.8
G 3 UF1Sout	55.1	48.3	43.1	25.1	36.3	18.3	20.1	18.3
G 4 GF West	58.2	51.4	46.2	28.2	39.4	21.4	23.2	21.4
G 4 UF1West	60.3	53.4	48.3	30.3	41.4	23.4	25.3	23.4

H	1 GF West	50.0	43.9	38.0	20.0	31.9	13.9	15.0	13.9
H	1 UF1West	51.6	45.4	39.6	21.6	33.4	15.4	16.6	15.4
H	2 GF Nort	49.3	43.6	37.3	19.3	31.6	13.6	14.3	13.6
H	2 UF1Nort	50.2	44.4	38.2	20.2	32.4	14.4	15.2	14.4
H	3 UF1East	46.6	41.7	34.6	16.6	29.7	11.7	11.6	11.7
H	4 GF Sout	51.9	44.6	38.8	21.9	32.6	14.6	16.9	14.6
H	4 UF1Sout	53.2	45.8	41.2	23.2	33.8	15.8	18.2	15.8
I	1 GF Nort	47.2	41.7	35.2	17.2	29.7	11.7	12.2	11.7
I	1 UF1Nort	48.4	42.8	36.4	18.4	30.8	12.8	13.4	12.8
I	2 GF East	46.2	41.2	34.2	16.2	29.2	11.2	11.2	11.2
I	2 UF1East	47.7	42.2	35.7	17.7	30.2	12.2	12.7	12.2
I	3 GF Sout	48.6	43.0	36.6	18.6	31.0	13.0	13.6	13.0
I	3 UF1Sout	50.0	44.0	38.0	20.0	32.0	14.0	15.0	14.0
I	4 UF1West	47.8	41.9	35.8	17.8	29.9	11.9	12.8	11.9
J	1 GF Nort	47.7	42.1	35.7	17.7	30.1	12.1	12.7	12.1
J	1 UF1Nort	48.6	43.1	36.6	18.6	31.1	13.1	13.6	13.1
J	2 UF1East	34.5	30.1	22.5	4.5	18.1	0.1	-0.5	0.1
J	3 GF Sout	46.5	41.2	34.5	16.5	29.2	11.2	11.5	11.2
J	3 UF1Sout	47.5	42.1	35.5	17.5	30.1	12.1	12.5	12.1
J	4 GF West	44.2	39.8	32.2	14.2	27.8	9.8	9.2	9.8
J	4 UF1West	45.8	40.9	33.8	15.8	28.9	10.9	10.8	10.9
K	1 UF1West	34.6	30.1	22.6	4.6	18.1	0.1	-0.4	0.1
K	2 GF Sout	45.0	40.8	33.0	15.0	28.8	10.8	10.0	10.8
K	2 UF1Sout	45.9	41.7	33.9	15.9	29.7	11.7	10.9	11.7
K	3 GF East	42.4	38.2	30.4	12.4	26.2	8.2	7.4	8.2
K	3 UF1East	44.3	39.6	32.3	14.3	27.6	9.6	9.3	9.6
K	4 GF Nort	47.1	41.7	35.1	17.1	29.7	11.7	12.1	11.7
K	4 UF1Nort	48.1	42.7	36.1	18.1	30.7	12.7	13.1	12.7
M	1 GF Nort	44.9	39.8	32.9	14.9	27.8	9.8	9.9	9.8
M	1 UF1Nort	46.4	41.2	34.4	16.4	29.2	11.2	11.4	11.2
M	2 GF East	44.9	39.5	32.9	14.9	27.5	9.5	9.9	9.5
M	2 UF1East	46.3	40.9	34.3	16.3	28.9	10.9	11.3	10.9
M	3 GF S/W	44.0	39.8	32.0	14.0	27.8	9.8	9.0	9.8
M	3 UF1S/W	45.0	40.7	33.0	15.0	28.7	10.7	10.0	10.7
M	4 GF West	42.2	39.0	30.2	12.2	27.0	9.0	7.2	9.0
M	4 UF1West	43.9	40.4	31.9	13.9	28.4	10.4	8.9	10.4
N	1 UF1N/W	43.6	38.0	31.6	13.6	26.0	8.0	8.6	8.0
N	2 GF N/E	42.3	38.7	30.3	12.3	26.7	8.7	7.3	8.7
N	2 UF1N/E	44.2	40.2	32.2	14.2	28.2	10.2	9.2	10.2
N	3 GF S/E	43.2	41.2	31.2	13.2	29.2	11.2	8.2	11.2
N	3 UF1S/E	44.1	42.2	32.1	14.1	30.2	12.2	9.1	12.2
N	4 GF S/W	48.8	41.3	36.8	18.8	29.3	11.3	13.8	11.3
N	4 UF1S/W	49.4	42.4	37.4	19.4	30.4	12.4	14.4	12.4
O	1 GF Nort	40.9	36.8	28.9	10.9	24.8	6.8	5.9	6.8
O	1 UF1Nort	41.7	37.4	29.7	11.7	25.4	7.4	6.7	7.4
O	2 GF East	38.1	46.7	26.1	8.1	34.7	16.7	3.1	16.7
O	2 UF1East	38.5	47.3	26.5	8.5	35.3	17.3	3.5	17.3
O	3 GF Sout	42.0	47.1	30.0	12.0	35.1	17.1	7.0	17.1
O	3 UF1Sout	43.1	47.7	31.1	13.1	35.7	17.7	8.1	17.7
O	4 UF1West	42.0	43.7	30.0	12.0	31.7	13.7	7.0	13.7

P	1	GF Nort	41.1	36.1	29.1	11.1	24.1	6.1	6.1	6.1
P	1	UF1Nort	41.7	36.7	29.7	11.7	24.7	6.7	6.7	6.7
P	2	UF1East	39.6	45.3	27.6	9.6	33.3	15.3	4.6	15.3
P	3	GF Sout	45.2	45.9	33.2	15.2	33.9	15.9	10.2	15.9
P	3	UF1Sout	47.0	46.6	35.0	17.0	34.6	16.6	12.0	16.6
P	4	GF West	46.1	42.8	34.1	16.1	30.8	12.8	11.1	12.8
P	4	UF1West	47.0	44.1	35.0	17.0	32.1	14.1	12.0	14.1
Q	1	GF West	46.8	40.8	34.8	16.8	28.8	10.8	11.8	10.8
Q	1	UF1West	47.2	41.7	35.2	17.2	29.7	11.7	12.2	11.7
Q	2	GF Sout	44.3	41.6	32.3	14.3	29.6	11.6	9.3	11.6
Q	2	UF1Sout	45.7	42.6	33.7	15.7	30.6	12.6	10.7	12.6
Q	3	GF East	47.3	42.5	35.3	17.3	30.5	12.5	12.3	12.5
Q	3	UF1East	48.0	43.1	36.0	18.0	31.1	13.1	13.0	13.1
Q	4	GF Nort	43.1	37.3	31.1	13.1	25.3	7.3	8.1	7.3
Q	4	UF1Nort	43.8	38.0	31.8	13.8	26.0	8.0	8.8	8.0
R	1	GF Nort	46.3	39.9	34.3	16.3	27.9	9.9	11.3	9.9
R	1	UF1Nort	46.9	40.4	34.9	16.9	28.4	10.4	11.9	10.4
R	2	GF East	58.5	49.0	46.5	28.5	37.0	19.0	23.5	19.0
R	2	UF1East	59.7	50.2	47.7	29.7	38.2	20.2	24.7	20.2
R	3	GF Sout	61.7	49.9	49.7	31.7	37.9	19.9	26.7	19.9
R	3	UF1Sout	62.7	51.8	50.7	32.7	38.8	21.8	27.7	21.8
R	4	GF West	47.0	48.0	35.0	17.0	36.0	18.0	12.0	18.0
R	4	UF1West	49.1	49.0	37.1	19.1	37.0	19.0	14.1	19.0
S	1	GF Nort	44.0	43.4	32.0	14.0	31.4	13.4	9.0	13.4
S	1	UF1Nort	44.7	42.8	32.7	14.7	30.8	12.8	9.7	12.8
S	2	UF1East	50.8	49.8	38.8	20.8	37.8	19.8	15.8	19.8
S	3	GF Sout	58.4	51.9	46.4	28.4	39.9	21.9	23.4	21.9
S	3	UF1Sout	59.2	53.2	47.2	29.2	41.2	23.2	24.2	23.2
S	4	GF West	57.7	48.4	45.7	27.7	36.4	18.4	22.7	18.4
S	4	UF1West	58.8	50.0	46.8	28.8	38.0	20.0	23.8	20.0
T	1	GF Nort	44.6	41.6	32.6	14.6	29.6	11.6	9.6	11.6
T	1	UF1Nort	45.4	42.1	33.4	15.4	30.1	12.1	10.4	12.1
T	2	GF East	51.9	48.3	39.9	21.9	36.3	18.3	16.9	18.3
T	2	UF1East	52.7	49.3	40.7	22.7	37.3	19.3	17.7	19.3
T	3	GF Sout	57.6	52.3	45.6	27.6	40.3	22.3	22.6	22.3
T	3	UF1Sout	58.7	53.3	46.7	28.7	41.3	23.3	23.7	23.3
T	4	UF1West	58.1	50.7	46.1	28.1	38.7	20.7	23.1	20.7
U	1	GF Nort	43.6	40.5	31.6	13.6	28.5	10.5	8.6	10.5
U	1	UF1Nort	44.5	41.2	32.5	14.5	29.2	11.2	9.5	11.2
U	2	GF East	41.2	53.1	29.2	11.2	41.1	23.1	6.2	23.1
U	2	UF1East	41.9	54.4	29.9	11.9	42.4	24.4	6.9	24.4
U	3	UF1Sout	56.2	55.7	44.2	26.2	43.7	25.7	21.2	25.7
U	4	GF West	55.6	48.3	43.6	25.6	36.3	18.3	20.6	18.3
U	4	UF1West	56.9	49.7	44.9	26.9	37.7	19.7	21.9	19.7
V	1	GF East	52.5	42.1	40.5	22.5	30.1	12.1	17.5	12.1
V	1	UF1East	53.3	42.9	41.3	23.3	30.9	12.9	18.3	12.9
V	2	GF Nort	49.8	43.2	37.8	19.8	31.2	13.2	14.8	13.2
V	2	UF1Nort	51.0	44.4	39.0	21.0	32.4	14.4	16.0	14.4
V	3	GF West	50.1	45.6	38.1	20.1	33.6	15.6	15.1	15.6
V	3	UF1West	51.5	46.6	39.5	21.5	34.6	16.6	16.5	16.6
V	4	GF Sout	46.5	40.5	34.5	16.5	28.5	10.5	11.5	10.5
V	4	UF1Sout	47.8	41.6	35.8	17.8	29.6	11.6	12.8	11.6
W	1	GF Nort	45.6	39.6	33.6	15.6	27.6	9.6	10.6	9.6
W	1	UF1Nort	46.9	40.6	34.9	16.9	28.6	10.6	11.9	10.6
W	2	GF East	55.8	43.8	43.8	25.8	31.8	13.8	20.8	13.8
W	2	UF1East	56.8	44.6	44.8	26.8	32.6	14.6	21.8	14.6
W	3	GF Sout	49.0	43.7	37.0	19.0	31.7	13.7	14.0	13.7
W	3	UF1Sout	50.2	44.7	38.2	20.2	32.7	14.7	15.2	14.7
W	4	GF West	48.7	46.0	36.7	18.7	34.0	16.0	13.7	16.0
W	4	UF1West	50.2	47.2	38.2	20.2	35.2	17.2	15.2	17.2

X	1 GF N/W	55.8	45.4	43.8	25.8	33.4	15.4	20.8	15.4
X	1 UF1N/W	56.7	46.2	44.7	26.7	34.2	16.2	21.7	16.2
X	2 GF N/E	58.4	45.8	46.4	28.4	33.8	15.8	23.4	15.8
X	2 UF1N/E	59.3	46.7	47.3	29.3	34.7	16.7	24.3	16.7
X	3 GF S/E	42.1	38.6	30.1	12.1	26.6	8.6	7.1	8.6
X	3 UF1S/E	50.1	46.0	38.1	20.1	34.0	16.0	15.1	16.0
X	4 GF West	50.9	49.4	38.9	20.9	37.4	19.4	15.9	19.4
X	4 UF1West	52.4	50.8	40.4	22.4	38.8	20.8	17.4	20.8
Y	1 GF N/W	43.9	40.0	31.9	13.9	28.0	10.0	8.9	10.0
Y	1 UF1N/W	50.4	45.1	38.4	20.4	33.1	15.1	15.4	15.1
Y	2 GF N/E	60.6	46.5	48.5	30.6	34.5	16.5	25.6	16.5
Y	2 UF1N/E	61.7	47.8	49.7	31.7	35.8	17.8	26.7	17.8
Y	3 GF S/E	60.9	52.6	48.9	30.9	40.5	22.6	25.9	22.6
Y	3 UF1S/E	62.2	54.4	50.2	32.2	42.4	24.4	27.2	24.4
Y	4 GF S/W	48.0	51.1	36.0	18.0	39.1	21.1	13.0	21.1
Y	4 UF1S/W	49.9	53.0	37.9	19.9	41.0	23.0	14.9	23.0
Hub	1 GF Nort	42.2	37.6	30.2	12.2	25.6	7.6	7.2	7.6
Hub	1 UF1Nort	43.3	38.5	31.3	13.3	26.5	8.5	8.3	8.5
Hub	2 GF East	44.7	45.0	32.7	14.7	33.0	15.0	9.7	15.0
Hub	2 UF1East	46.4	45.9	34.4	16.4	33.9	15.9	11.4	15.9
Hub	3 GF Sout	56.7	48.3	44.7	26.7	36.3	18.3	21.7	18.3
Hub	3 UF1Sout	58.1	49.6	46.1	28.1	37.5	19.6	23.1	19.6
Hub	4 GF West	44.5	44.3	32.5	14.5	32.3	14.3	9.5	14.3
Hub	4 UF1West	46.7	45.3	34.7	16.7	33.3	15.3	11.7	15.3