



NOISE IMPACT ASSESSMENT SIPSON ROAD, WEST DRAYTON

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EXECUTIVE SUMMARY

Noise Surveys

A series of Noise Surveys have been completed, and a 3D Noise Model built, in order to quantify the impacts of road traffic noise and aircraft noise upon the proposed hotel development.

Noise Impact Assessment

The Noise Impact Assessment has identified that the key noise sources impacting upon the development are the M4 motorway to the west, Sipson Road to the North and aircraft using Heathrow airport to the south. Accordingly appropriate mitigation has been specified in order to reduce these impacts for both external and internal habitable areas.

Recommended Noise Mitigation Measures

This Noise Impact Assessment has recommended alternative ventilation for all habitable rooms as an alternative to opening windows. Higher than standard specification glazing is also recommended to meet BS8233:2014 internal noise criteria.

Subject to the incorporation of the identified mitigation measures, it is considered that in principle, the Site is suitable for the promotion of residential development.





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1. INTRODUCTION

1.1 Background

Resource and Environmental Consultants (REC) Limited have been commissioned by GA&A Design Ltd to undertake a Noise Impact Assessment for a proposed hotel development on land located off Sipson Road, West Drayton, adjacent to the existing Radisson Park Inn and Heathrow airport. This will subsequently be referred to as '*the Site*'.

This assessment has been undertaken to identify key noise sources in the vicinity of the Site which may have the potential to impact upon the proposed noise-sensitive hotel development.

All acronyms used within this report are defined in the Glossary presented in Appendix II.

1.2 Site Location & Proposed Development

The Site comprises a parcel of hard standing containing a disused social club. To the north lies Sipson Road while other aspects face onto parking areas and buildings of the Radisson Park Inn Hotel. Past this, further to the west, the M4 runs north-south in a cutting. The site is 650m north of the north runway of Heathrow airport.

The key noise sources impacting upon the Site are road traffic using the M4 to the west and Sipson Rd to the North, and aircraft using Heathrow airport to the south.

This assessment has been undertaken with due regard to the planning drawings shown on the drawings provided by GA&A Design on 17th November 2016, an example of which is shown in Appendix III.

1.3 Limitations

The limitations of this report are presented in Appendix I.

1.4 Confidentiality

REC has prepared this report solely for the use of the Client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed. Should any third party wish to use or rely upon the contents of the report, written approval must be sought from REC; a charge may be levied against such approval.





2. ASSESSMENT CRITERIA

2.1 National Planning Practice Guidance

Noise needs to be considered when new developments may create additional noise and when new developments would be sensitive to the prevailing acoustic environment. When preparing local or neighbourhood plans, or taking decisions about new development, there may also be opportunities to consider improvements to the acoustic environment.

Local planning authorities' plan-making and decision taking should take account of the acoustic environment and in doing so consider:

- ▶ Whether or not a significant adverse effect is occurring or likely to occur;
- ▶ Whether or not an adverse effect is occurring or likely to occur; and
- ▶ Whether or not a good standard of amenity can be achieved.

In line with the Explanatory Note of the Noise Policy Statement for England, this would include identifying whether the overall effect of the noise exposure (including the impact during the construction phase wherever applicable) is, or would be, above or below the significant observed adverse effect level and the lowest observed adverse effect level for the given situation.

The Observed Effect Levels are as follows:

- ▶ Significant observed adverse effect level: This is the level of noise exposure above which significant adverse effects on health and quality of life occur.
- ▶ Lowest observed adverse effect level: this is the level of noise exposure above which adverse effects on health and quality of life can be detected.
- ▶ No observed effect level: this is the level of noise exposure below which no effect at all on health or quality of life can be detected.

Table 1 summarises the noise exposure hierarchy, based on the likely average response.

Table 1 Noise Exposure Hierarchy

Perception	Examples of Outcomes	Increasing Effect Level	Action
Not Noticeable	No Effect	No Observed Effect	No specific measures required
Noticeable and not intrusive	Noise can be heard but does not cause any change in behaviour or attitude. 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	





Perception	Examples of Outcomes	Increasing Effect Level	Action
Noticeable and intrusive	Noise can be heard and causes small changes in behaviour and/or attitude, 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 perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
		Significant Observed Adverse Effect Level	
Noticeable and disruptive	The noise causes a material change in behaviour and/or attitude, 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 Effect	Avoid
Noticeable and very disruptive	Extensive and regular changes in behaviour and/or an inability to mitigate effect of noise leading to psychological stress or physiological effects, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory	Unacceptable Adverse Effect	Prevent

The subjective nature of noise means that there is not a simple relationship between noise levels and the impact on those affected. This will depend on how various factors combine in any particular situation.

These factors include:

- ▶ The source and absolute level of the noise together with the time of day it occurs. Some types and level of noise will cause a greater adverse effect at night than if they occurred during the day – this is because people tend to be more sensitive to noise at night as they are trying to sleep. The adverse effect can also be greater simply because there is less background noise at night;
- ▶ For non-continuous sources of noise, the number of noise events, and the frequency and pattern of occurrence of the noise;
- ▶ The spectral content of the noise and the general character of the noise. The local topology and topography should also be taken into account along with the existing and, where appropriate, the planned character of the area.

More specific factors to consider when relevant:

- ▶ where applicable, the cumulative impacts of more than one source should be taken into account along with the extent to which the source of noise is intermittent and of limited duration;
- ▶ consideration should also be given to whether adverse internal effects can be completely removed by closing windows and, in the case of new residential development, if the proposed mitigation relies on windows being kept closed most of the time. In both cases a suitable alternative means of ventilation is likely to be necessary. Further information on ventilation can be found in the Building Regulations.





- ▶ If external amenity spaces are an intrinsic part of the overall design, the acoustic environment of those spaces should be considered so that they can be enjoyed as intended.

2.2 Local Authority Guidance and Criteria – London Borough of Hillingdon Environmental Health Department

REC has contacted Muhammad Islam of London Borough of Hillingdon (LBH) Environmental Health Department on the 20th December 2016 in order to agree the methodology for the noise survey and the appropriate noise criteria for this assessment. The following were agreed, in accordance with BS8233: 2014:

- ▶ The maximum permissible average noise level in living rooms shall not exceed 35dB $L_{Aeq,16hr}$;
- ▶ The maximum permissible average noise level in bedrooms shall not exceed 30dB $L_{Aeq,8hr}$; and
- ▶ The maximum permissible instantaneous noise level in bedrooms shall not exceed 45dB $L_{Amax,fast}$.

Noise surveys were initially proposed to assess the M4, A4 and noise from aircraft using the nearby Heathrow airport. Following a site visit by REC and discussion with Muhammad Islam it was agreed that the A4 noise survey could be scoped out from the assessment due to the relative insignificance of the road as a noise source.

With regard to the BS4142:2014 assessment:

- ▶ REC suggested that the Rating Level of any commercial sound, $L_{A,r}$, shall not exceed the existing typical Background Sound Level, L_{A90} ($L_{A,r} = L_{A90}$); however
- ▶ LBH requested that a criterion of $L_{A,r} = L_{A90} - 5\text{dBA}$ be used instead, lower than suggested by the guidance.

2.3 Calculation of Road Traffic Noise 1988

The Calculation of Road Traffic Noise (CRTN) memorandum, produced by the Department of Transport for the Welsh Office, describes the procedures for calculating noise from road traffic. Section III of this memorandum details the shortened measurement procedure whereby measurements of the L_{10} parameter are made over any three consecutive hours between 10:00 and 17:00. From the arithmetic average of the three 1-hour values, the $L_{10,18hr}$ noise levels is derived before derivation of the $L_{Aeq,16hr}$ value.

2.4 Transport Research Laboratory – Converting the UK Traffic Noise Index $L_{A10,18hr}$ to EU Noise Indices for Noise Mapping

This document provides a method for converting the $L_{A10,18hr}$ level to the L_{night} level using the following formula, applicable to non-motorway roads;

$$L_{night} = 0.90 \times L_{A10,18hr} - 3.77\text{dB}$$

2.5 British Standard BS8233: 2014: Guidance on Sound Insulation and Noise Reduction for Buildings

The scope of this standard is the provision of recommendations for the control of noise in and around buildings. It suggests appropriate criteria and limits for different situations, which are primarily intended to guide the design of new buildings or refurbished buildings undergoing a change





of use, rather than to assess the effect of changes in the external noise climate.

The standard suggests suitable internal noise levels within different types of buildings, including dwellings, as shown in Table 2:

Table 2: BS8233 Recommended Internal Noise Levels

Criterion	Typical Situation	Design $L_{Aeq,T}$ (dB)
Suitable resting / sleeping conditions	Living Room	35
	Bedroom	30
For a reasonable standard in bedrooms at night, individual noise events (measured with fast time weighting) should not normally exceed 45dB L_{Amax}		

BS8233 goes on to recommend noise levels for gardens. According to BS8233;

“It is desirable that the external noise level does not exceed 50dB $L_{Aeq,T}$ with an upper guideline value of 55dB $L_{Aeq,T}$ which would be acceptable in noisier environments. However, it is also recognised that these guideline values are not achievable in all circumstances where development might be desirable. In higher noise areas, such as city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise levels and other factors might be warranted”.

BS8233 goes on to say:

“In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited”.

2.6 World Health Organisation's (WHO) 'Guidelines for Community Noise'

The WHO 'Guidelines for Community Noise' offers advice with regard to setting noise criteria applicable to sleep disturbance. Section 4.2.3 specifies:

‘If the noise is not continuous, L_{Amax} or SEL are used to indicate the probability of noise-induced awakenings. Effects have been observed at individual L_{Amax} exposures of 45 dB or less. Consequently, it is important to limit the number of noise events with a L_{Amax} exceeding 45 dB.’

The guidelines go on to state:

‘At night, sound pressure levels at the outside façades of the living spaces should not exceed 45 dB L_{Aeq} and 60 dB L_{Amax} so that people may sleep with bedroom windows open. These values have been obtained by assuming that the noise reduction from outside to inside with the window partly open is 15 dB.’

The sound insulation performance value of 15dB for a façade containing a partially open window accords with the guidance offered in BS8233:2014.

The guidelines reference a study by Vallet & Vernet, 1991, which concluded that:





'For a good sleep, it is believed that indoor sound pressure levels should not exceed approximately 45 dB $L_{AF,max}$ more than 10-15 times per night.'

Accordingly this assessment has utilised the 10th highest measured maximum noise level from the night-time period and allows for an assessment of a typical maximum noise level in determining façade sound insulation performance.

2.7 BS4142: 2014 'Methods for rating and assessing industrial and commercial sound'

This standard describes methods for rating and assessing sound of an industrial or commercial nature which includes:

- ▶ Sound from industrial and manufacturing processes;
- ▶ Sound from fixed installations which comprise mechanical and electrical plant and equipment;
- ▶ Sound from the loading and unloading of goods and materials at industrial and / or commercial premises; and,
- ▶ Sound from mobile plant and vehicles that is an intrinsic part of the overall sound emanating from processes or premises, such as that from forklift trucks, or that from train or ship movements on or around an industrial or commercial Site.

The procedure detailed in the standard compares the measured or predicted noise level 'the specific noise level' from any of the above detailed noise sources with the background sound level at a residential dwelling. The measured background sound level at a receptor should be reliable and should not necessarily ascertain a lowest measured background sound level, but rather to quantify what is typical.'

The specific noise level also acknowledges the following reference time intervals depending upon whether the noise source operates during daytime or night-time periods:

- ▶ Daytime (07:00 – 23:00): 1 hr; and,
- ▶ Night-time (23:00 – 07:00): 15 minutes.

There are a number of 'penalties' which can be attributed to the specific sound level depending upon the 'acoustic features' of the sound level under investigation as follows. These penalties vary in their weighting depending upon the severity of the acoustic feature, as follows:

Tonality

- ▶ +2dB: where the tonality is just perceptible;
- ▶ +4dB: where the tonality is clearly perceptible; and,
- ▶ +6dB: where the tonality is highly perceptible.

Impulsivity

- ▶ +3dB: where the impulsivity is just perceptible;
- ▶ +6dB: where the impulsivity is clearly perceptible; and,
- ▶ +9dB: where the impulsivity is highly perceptible.

Intermittency

- ▶ +3dB: where the intermittency is readily distinctive against the acoustic environment.





In addition to the above acoustic features, there is a penalty for 'other sound characteristics' of +3dB where a sound exhibits characteristics that are neither tonal nor impulsive, though are readily distinctive against the acoustic environment.

BS4142 goes on to state that the rating level is equal to the specific sound level if there are no such features present or expected to be present.

Assessment of the rating level relative to the background noise level can yield the following commentary:

- ▶ Typically the greater this difference (between the rating level and the background sound level), the greater the magnitude of impact;
- ▶ A difference of around +10dB or more is likely to be an indication of a significant adverse impact, depending on the context;
- ▶ A difference of around +5dB is likely to be an indication of an adverse impact, depending on the context; and,
- ▶ The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact.

With the above in mind, it is common that a Local Planning Authority will specify their own criteria for the rating level relative to the background sound level and, where this is the case, this criteria usually takes precedence over a simple comparison of the rating level against the background sound level.





3. NOISE SURVEY

After consultation with Muhammad Islam of LBH, NMP1 (for the A4) was removed from the assessment due to being insignificant, and Sipson Road (NMP4) but the numbering system of the original proposal is preserved here for clarity.

3.1 Road Traffic Noise Survey – M4

REC has conducted a Road Traffic Noise Survey in order to measure the level of noise generated by vehicles using the M4 to the west of the site. The survey was carried out over the following period:

- ▶ Thursday 22nd at 13:00 to Friday 23rd December 2016 at 13:00.

The following noise measurement position was chosen for the Road Traffic Noise Survey:

- ▶ Noise Measurement Position 2 (NMP2): Located on the boundary of the Park Inn Radisson hotel car park with the M4 motorway embankment, at 34m from the road centre. The microphone was located 1.5m above ground level and in free-field conditions. Noise at this location was dominated by vehicle noise from the M4 with no other sources significant.

A summary of the measured sound pressure levels from the Road Traffic Noise Survey is presented in Table 3.

Table 3: Summary of Measured Noise Levels for NMP2

Measurement Position	Period	Measured Sound Pressure Level, free-field (dB)	
		L _{Aeq,T}	L _{Amax,fast} ¹
NMP2	Daytime (0700-2300)	74.5	-
	Night-time (2300 – 0700)	70.4	77.6
¹ 10 th highest L _{Amax,fast} from overnight period			

The following equipment was used for the Noise Survey.

Table 4: Noise Measurement Equipment

Measurement Position	Equipment Description	Manufacturer & Type No.	Serial No.	Calibration Due Date
NMP2	Sound Level Meter	01dB-Metravib Black Solo	65882	10 th February 2018
	Pre-amplifier	01dB-Metravib PRE 21 S	16614	
	Microphone	01dB Metravib MCE212	175374	
	Calibrator	01dB-Metravib CAL-21	35134328	10 th February 2017
Calibration Level at Start of Survey	93.9dB	Calibration Level at End of Survey	93.9dB	Drift: 0dB



The sound level meter was field-calibrated on Site prior to and after noise measurements were taken. No significant drift was witnessed. Calibration certificates are available upon request.

3.2 Background Sound Survey

REC has conducted two full 24 hour Background Sound Surveys over both a weekday and weekend period. These are suitable for establishing the existing background sound levels in the absence of any commercial sound. The surveys were carried out over the following periods:

- ▶ 14:00 Wednesday 14th to 14:00 Thursday 15th December 2016.
- ▶ 23:00 Saturday 7th to 23:00 Sunday 8th January 2017.

The following noise measurement position was chosen for the Background Sound Surveys:

- ▶ Noise Measurement Position 3 (NMP3): Located to the immediate west of the existing building in the southern part of the site. The NMP was therefore not subject to any particular sound source. The microphone of the sound level meter was located at a height of 1.5m above ground level and in free-field conditions. Sound sources at this location consisted of distant road traffic, occasional birdcalls and aircraft.

A summary of the range of measured sound pressure levels from the Background Sound Survey is presented in Table 5. A full hourly breakdown of the measurements is presented in Table A1 in Appendix IV.

Equipment used was as per Table 4 above.

Table 5: Summary of Measured Background Sound Levels

Time/date	Median Measured Sound Pressure Level, free-field. Assessment period 15mins night, 1 hour day. (dB)		Overall day/night level for time/date $L_{Aeq,T}$ (dB)	10 th highest $L_{Amax,f}$ from period (dB)
	$L_{Aeq,T}$	$L_{A90,T}$		
Wed 14 th & Thur 15 th Dec, Day	60.6	52.2	60.1	-
Wed 14 th to Thur 15 th Dec, Night	53.5	48.0	55.5	73.2
Sun 8 th Jan, Day	58.1	49.8	57.8	-
Sat 7 th –to Sun 8 th Jan, Night	51.4	45.6	53.1	70.0

Table 6 details the meteorological conditions at the start and end of the background sound survey.





Table 6: Record of Meteorological Conditions at Start and End of Surveys

Survey	Wind Speed (m/s)	Wind Direction	Precipitation Occurred?	Fog or Mist Evident?	Was the Ground Wet, Frozen or Snow Covered?	Temperature (°C)	Cloud Cover (%)
Weekday	2	NE	No	No	No	-	60
	4	SSW	No	No	No	-	100
Weekend	0	SW	No	No	No	-	100
	5	SW	No	No	Slightly damp	-	100

3.3 Road Traffic Noise Survey – Sipson Rd

REC has conducted a Road Traffic Noise Survey in order to measure the level of noise generated by vehicles using Sipson Rd to the north-east of the site. The survey was carried out over the following period:

- ▶ Wednesday 14th December 2016 from 11:12 to 14:12.

The following noise measurement position was chosen for the Road Traffic Noise Survey:

- ▶ Noise Measurement Position 4 (NMP4): Located on the northern site boundary, at 9m from the road centre. The microphone was located 1.5m above ground level and in free-field conditions. Noise at this location was dominated by vehicle noise from the Sipson Rd (including HGVs attending the nearby quarry).

A summary of the measured sound pressure levels from the Road Traffic Noise Survey is presented in Table 7.

Table 7: Summary of Measured Noise Levels for NMP4

Measurement Position	Period start	Measured Sound Pressure Level, free-field (dB)		
		L _{Aeq,T}	L _{Amax,fast} ¹	L _{A10,T}
NMP4	11:12	71.5	88.4	75.4
	12:12	72.0		76.4
	13:12	72.2		76.4

¹ 10th highest L_{Amax,fast} from overnight period

The equipment used for the Noise Survey was as per Table 5 above. The sound level meter was field-calibrated on Site prior to and after noise measurements were taken. No significant drift was witnessed. Calibration certificates are available upon request.



3.4 Heathrow Noise Action Plan Contours

Noise levels due to aircraft using Heathrow airport have been taken from the maps included in the 2014 document Heathrow Noise Action Plan Contours. In all three cases the site location was very close to one of the 10dB separated contours. The following levels have therefore been used:

Table 8: Aircraft noise levels at development

Position	Document Parameter	Period included	Level (dBA)
All NMPs and planned development	L _{day}	0700 – 1900	60
	L _{eve}	1900 – 2300	60
	L _{night}	2300 – 0700	50

Note that the daytime noise level used in this assessment includes both the 'daytime' and 'evening' periods in the Heathrow document. However as these values are the same, an overall daytime noise level of 60 dBA is clearly applicable.





4.0 NOISE IMPACT ASSESSMENT

4.1 Noise model & Methodology

In order to accurately assess road traffic noise across the Site, a 3D Noise Model has been constructed using the modelling software CadnaA. Outputs from the model have been used to modify the initial masterplan so as to satisfy criteria for exterior amenity noise levels, and to provide improved interior amenity levels by way of building. These have been achieved by modification of building heights, locations and orientations.

The following assumptions, inputs and considerations have been included in the model:

- ▶ Planning Layout and plans as retrieved from Dropbox on 17th November 2016;
- ▶ Site elevations have been taken as existing;
- ▶ Topographical data at 5m horizontal and 0.60m vertical resolution has been used;
- ▶ Existing buildings that provide shielding from any of the noise sources have been included in the model;
- ▶ Where survey data covered multiple days, worst case have been used;
- ▶ A reflection order of 2 has been used in all calculations, except for the proposed development where no reflections have been used in order to show free-field levels without façade effects for ease of interpretation;
- ▶ Dwellings heights are as supplied by GA&A Design Ltd;
- ▶ Heathrow aircraft noise has been modelled as arising from a line source 40m above the northern runway;
- ▶ Noise levels generated using ISO 9613-1 and ISO 9613-2 "*Acoustics – Attenuation of sound during propagation outdoors*" as incorporated into the CadnaA software; and
- ▶ $L_{A_{Max}}$ noise modelled as point sources calibrated to the 10th highest $L_{A_{Max,f}}$ event at representative location (ie on road/flight path), for the worst case survey period.

In order to calculate daytime and night-time noise levels from the 3 hour CRTN values, the following transformations have been used:

1. Calculation of the $L_{A_{10,18hr}}$ noise level:

$$L_{10,18hr} = 1/3 \times \sum L_{10,3hr} - 1 \text{ dB}$$

2. Calculation of the $L_{A_{eq,16hr}}$ noise level:

$$L_{eq,16hr} = L_{10,18hr} - 2 \text{ dB}$$

3. Calculation of the night-time $L_{A_{eq,8hr}}$ noise level:

$$L_{night} (L_{eq,8hr}) = 0.90 \times L_{10,18hr} - 3.77 \text{ dB}$$

Façade and internal levels have been considered for representative locations around the development and are listed by the facing-orientation of the façade, for example W for West facing. Where two locations are included for a façade these are listed as, for example, W(N) and W(S) for North and South respectively.





4.2 Internal Noise Impact for Proposed Development

In order to accurately determine the noise level within habitable rooms, the external noise levels immediately outside the façades, but not including reflections from the façades themselves, have been derived in the noise model. These levels are tabulated in Appendix IV and are shown graphically on the Figures. All buildings give rise to reflections in the model aside from the hotel itself thus meaning the levels shown in the vicinity of the proposed hotel are free-field as tabulated. Appendix III contains figures showing daytime and night time façade levels for representative floors.

In addition to the average noise levels, an assessment of the maximum instantaneous noise level during the night-time period is required. As such events propagate as point sources from arbitrary points along the source route (road/flightpath), a strict evaluation of all possible propagation paths and resultant levels is not feasible. For the purposes of this assessment point sound sources calibrated to each of the 10th highest $L_{Amax,fast}$ measured have been included in the model at the closest points for both Sipson Rd and the flightpath. The M4 is too distant for L_{Amax} events to be significant. Façade and internal levels have been derived and are tabulated in Appendix IV.

It is notable that noise levels due to aircraft using the airport to the south is broadly comparable to the noise levels due to Sipson Rd to the North, and therefore the North and South facades are subject to broadly similar noise levels.

With regard to internal noise levels, BS8233:2014 suggests that a standard double glazing unit with configuration 6mm glass/12mm air space/6mm glass affords sound insulation performance of the order of 33dB; this however this is for a pink noise spectrum. The same unit, weighted for road traffic noise using the '+C_{tr}' correction, has a sound insulation performance of approximately 30dB and so this value has been used to calculate internal noise levels. BS8233:2014 also goes on to recommend that a partially open window provides approximately 15dB attenuation, and this value is also used here.

Tables A1 to A3 detail the calculated façade and internal noise levels compared to the relevant criteria for Daytime L_{Aeq} , Night-time L_{Aeq} and Night-time $L_{Amax,f}$. Any exceedances above the required criteria calculated with windows open and windows closed are highlighted in **bold red**.

Results for interior amenity noise levels can be summarised as follows:

- ▶ The positive values in the final columns of each table show that all criteria are exceeded for all facades considered with windows open. Therefore alternative ventilation to provide adequate airflow without opening windows is required for all rooms, and this is covered in Section 5.
- ▶ A majority of facades do not meet one of the three noise level criteria with windows closed, requiring mitigation. Data for these facades is tabulated with example glazing specifications given in Section 5.

Without mitigation in place and/or windows open for background ventilation, the LOAEL is achieved which would be noticeable and disruptive resulting in the following:

“Noise can be heard and causes small changes in behaviour and/or attitude, 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 perceived change in the quality of life..”

4.3 Commercial Sound Assessment

There is the potential for fixed plant items associated with the development to impact upon existing noise sensitive receptors.

At the time of producing this report the precise details of mechanical and electrical plant were unknown and so it is appropriate to set plant noise emission limits which are based upon the measured background sound level, criteria agreed with the LPA and criteria specified in BS4142:2014.

The table below calculates the plant noise emission limits for the daytime and night-time periods based on $L_{A,r} = L_{A90}$, the most stringent criterion in BS4142:2014. This is therefore considered robust. The median background sound levels from the survey period have been adopted, in line with the ‘typical’ noise levels required by BS 4142:2014.

Table 9: Calculation of Plant Noise Emission Limits for the Daytime and Night-time Periods

Period	Day / Night	Median Measured Background Sound Level $L_{A90,1 \text{ hour}}$ (dB)	Adopted Criterion (dB)	Calculated Plant Noise Emission Limit $L_{A,r}$ (dB)
Weekday	Daytime (07:00 – 23:00)	52.2	$L_{A,r} = L_{A90,t} - 5$	47.2
	Night-time (23:00 – 07:00)	48.0		43.0
Weekend	Daytime (07:00 – 23:00)	49.8	$L_{A,r} = L_{A90,t} - 5$	44.8
	Night-time (23:00 – 07:00)	45.6		42.6

Table 9 indicates the plant noise emission limits which are applicable for the closest noise sensitive receptors for the daytime and night-time periods.

It should be noted that the emission limit is a rating level which can include for a range of penalties or ‘acoustic feature corrections’ as detailed in BS4142:2014 and as such the actual measured or calculated sound pressure level outside the closest residential window could be up to 18dB lower than the values presented here.

It is recommended that at the final design stage, a noise consultant is appointed in order to perform the necessary noise break-out calculations when plant types and specifications are known in order to ensure the above rating levels are not exceeded.





5. MITIGATION

5.1 Internal Amenity Areas

Section 4 indicated that for all facades, the opening of windows will cause an exceedance of both daytime and night-time noise levels. Therefore it is necessary to consider an alternative ventilation scheme which does not require the opening of windows to provide fresh air flow. It is likely that the design of the hotel includes for such a facility, however at minimum it is recommended that a through-frame window mounted trickle ventilator is incorporated into the glazing unit of habitable rooms so that fresh air can enter the room without having to open windows.

The trickle ventilator should be combined with a system that can provide fresh air flow into habitable rooms without the need for opening a window, for example a Passive Extract Ventilation (PEV) system which extracts air from the habitable rooms.

Section 4 also finds that for a subset of facades standard double glazing, providing an attenuation of 30 dBA $R_W + C_{t,r}$, will not suffice. Therefore the table below lists an example specification for glazing in these cases. Note that these are merely examples and numerous other specifications exist to provide such attenuations.

Table 10: Noise criterion exceedances and glazing specifications

Storey	Façade facing	Daytime exceedance L_{Aeq} (dB)	Night-time exceedance L_{Aeq} (dB)	Night-time exceedance $L_{Amax,f}$ (dB)	Largest exceedance (dB)	Glazing attenuation required (dB)	Example specification
4th floor	W(N)	+0.2	-2.2	+0	0.2	31	4 (6) 10
5th floor	W(N)	+0.3	-1.8	+2.5	2.5	33	10 (12) 12
6th floor	W(N)	+0.5	-1.2	+3.3	3.3	34	12 (16) 6
5th floor	W(S)	-1.3	-3.0	+2.3	2.3	33	10 (12) 12
6th floor	W(S)	-1.1	-2.5	+3.4	3.4	34	12 (16) 6
5th floor	S	+0.2	-2.7	+1.8	1.8	32	10 (16) 6
6th floor	S	+0.8	-2.1	+3.5	3.5	34	12 (16) 6
Ground floor	E(S)	+3.5	-0.4	-4.5	3.5	34	12 (16) 6
1st floor	E(S)	+3.5	-0.5	-4.5	3.5	34	12 (16) 6
2nd floor	E(S)	+3.6	-0.3	-4.5	3.6	34	12 (16) 6
3rd floor	E(S)	+3.6	-0.2	-4.6	3.6	34	12 (16) 6
4th floor	E(S)	+3.7	-0.2	-3.5	3.7	34	12 (16) 6
5th floor	E(S)	+3.9	+0	+0.6	3.9	34	12 (16) 6
6th floor	E(S)	+4	+0.1	+3.3	4.0	34	6 (16) 8.8



Ground floor	E(N)	+5.3	+1.2	-3.3	5.3	36	10 (16) 8.8
1st floor	E(N)	+5.7	+1.5	-3.2	5.7	36	10 (16) 8.8
2nd floor	E(N)	+5.5	+1.4	-3.3	5.5	36	10 (16) 8.8
3rd floor	E(N)	+5.4	+1.3	-3.4	5.4	36	10 (16) 8.8
4th floor	E(N)	+5.3	+1.2	-3.1	5.3	36	10 (16) 8.8
5th floor	E(N)	+5.3	+1.2	+0.7	5.3	36	10 (16) 8.8
6th floor	E(N)	+5.2	+1.1	+3.1	5.2	36	10 (16) 8.8
Ground floor	N(E)	+5.3	+1.7	-1.4	5.3	36	10 (16) 8.8
1st floor	N(E)	+5.8	+2	-1.4	5.8	36	10 (16) 8.8
2nd floor	N(E)	+6.4	+2.5	-1.4	6.4	37	8 (16) 10.8
3rd floor	N(E)	+6.3	+2.5	-1.5	6.3	37	8 (16) 10.8
4th floor	N(E)	+5.9	+2.2	-1.6	5.9	36	10 (16) 8.8
5th floor	N(E)	+5.5	+1.9	-1.7	5.5	36	10 (16) 8.8
6th floor	N(E)	+3.1	+1.1	-4.3	3.1	34	12 (16) 6
Ground floor	N(W)	+4.2	+0.9	-0.7	4.2	35	6 (16) 8.8
1st floor	N(W)	+5.7	+1.9	-0.7	5.7	36	10 (16) 8.8
2nd floor	N(W)	+5.5	+1.9	-0.7	5.5	36	10 (16) 8.8
3rd floor	N(W)	+6.2	+2.5	-0.8	6.2	37	8 (16) 10.8
4th floor	N(W)	+5.8	+2.2	-1.0	5.8	36	10 (16) 8.8
5th floor	N(W)	+5.4	+1.8	-1.1	5.4	36	10 (16) 8.8
6th floor	N(W)	+2.9	+1.7	-3.8	2.9	33	10 (12) 12





6.0 CONCLUSION

REC Limited has been commissioned by GA&A Design to undertake a Noise Impact Assessment for a proposed hotel development on land at Sipson Rd, West Drayton.

This assessment has been undertaken to identify key noise sources in the vicinity of the Site which may have the potential to impact upon the proposed noise-sensitive development.

The Noise Impact Assessment has identified that the key noise sources impacting upon the development are road traffic using Sipson Rd and the M4, and aircraft using the nearby Heathrow airport.

This Noise Impact Assessment has recommended alternative ventilation for all habitable rooms as an alternative to opening windows, as well as higher specification glazing for certain facades.

Subject to the incorporation of the identified mitigation measures, it is considered that in principle, the Site is suitable for the proposed development.







1. This report and its findings should be considered in relation to the terms of reference and objectives agreed between REC Limited and the Client as indicated in Section 1.2.
2. The executive summary, conclusions and recommendations sections of the report provide an overview and guidance only and should not be specifically relied upon without considering the context of the report in full.
3. REC cannot be held responsible for any use of the report or its contents for any purpose other than that for which it was prepared. The copyright in this report and other plans and documents prepared by REC is owned by them and no such plans or documents may be reproduced, published or adapted without written consent. Complete copies of this may, however, be made and distributed by the client as is expected in dealing with matters related to its commission. Should the client pass copies of the report to other parties for information, the whole report should be copied, but no professional liability or warranties shall be extended to other parties by REC in this connection without their explicit written agreement there to by REC.







Noise

Noise is defined as unwanted sound. Human ears are able to respond to sound in the frequency range 20 Hz (deep bass) to 20,000 Hz (high treble) and over the audible range of 0 dB (the threshold of perception) to 140 dB (the threshold of pain). The ear does not respond equally to different frequencies of the same magnitude, but is more responsive to mid-frequencies than to lower or higher frequencies. To quantify noise in a manner that approximates the response of the human ear, a weighting mechanism is used. This reduces the importance of lower and higher frequencies, in a similar manner to the human ear.

Furthermore, the perception of noise may be determined by a number of other factors, which may not necessarily be acoustic. In general, the impact of noise depends upon its level, the margin by which it exceeds the background level, its character and its variation over a given period of time. In some cases, the time of day and other acoustic features such as tonality or impulsiveness may be important, as may the disposition of the affected individual. Any assessment of noise should give due consideration to all of these factors when assessing the significance of a noise source.

The most widely used weighting mechanism that best corresponds to the response of the human ear is the 'A'-weighting scale. This is widely used for environmental noise measurement, and the levels are denoted as dB(A) or L_{Aeq} , L_{A90} etc., according to the parameter being measured.

The decibel scale is logarithmic rather than linear, and hence a 3 dB increase in sound level represents a doubling of the sound energy present. Judgement of sound is subjective, but as a general guide a 10 dB(A) increase can be taken to represent a doubling of loudness, whilst an increase in the order of 3 dB(A) is generally regarded as the minimum difference needed to perceive a change under normal listening conditions.

An indication of the range of sound levels commonly found in the environment is given in the following table.

Table A1: Typical Sound Pressure Levels

Sound Pressure Level dB(A)	Location
0	Threshold of hearing
20 - 30	Quiet bedroom at night
30 - 40	Living room during the day
40 - 50	Typical office
50 - 60	Inside a car
60 - 70	Typical high street
70 - 90	Inside factory
100 - 110	Burglar alarm at 1m away
110 - 130	Jet aircraft on take off
140	Threshold of pain





Acoustic Terminology

Table A2: Terminology

Descriptor	Explanation
dB (decibel)	The scale on which sound pressure level is expressed. It is defined as 20 times the logarithm of the ratio between the root-mean-square pressure of the sound field and a reference pressure (2x10 ⁻⁵ Pa).
dB(A)	A-weighted decibel. This is a measure of the overall level of sound across the audible spectrum with a frequency weighting (i.e. 'A' weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies.
L _{Aeq, T}	L _{Aeq} is defined as the notional steady sound level which, over a stated period of time (T), would contain the same amount of acoustical energy as the A - weighted fluctuating sound measured over that period.
L _{Amax}	L _{Amax} is the maximum A - weighted sound pressure level recorded over the period stated. L _{Amax} is sometimes used in assessing environmental noise where occasional loud noises occur, which may have little effect on the overall Leq noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
L ₁₀ & L ₉₀	If a non-steady noise is to be described it is necessary to know both its level and the degree of fluctuation. The Ln indices are used for this purpose, and the term refers to the level exceeded for n% of the time. Hence L ₁₀ is the level exceeded for 10% of the time and as such can be regarded as the 'average maximum level'. Similarly, L ₉₀ is the 'average minimum level' and is often used to describe the background noise. It is common practice to use the L ₁₀ index
Free-field Level	A sound field determined at a point away from reflective surfaces other than the ground with no significant contributions due to sound from other reflective surfaces. Generally as measured outside and away from buildings.
Fast	A time weighting used in the root mean square section of a sound level meter with a 125millisecond time constant.
Slow	A time weighting used in the root mean square section of a sound level meter with a 1000millisecond time constant.







Proposed layout.

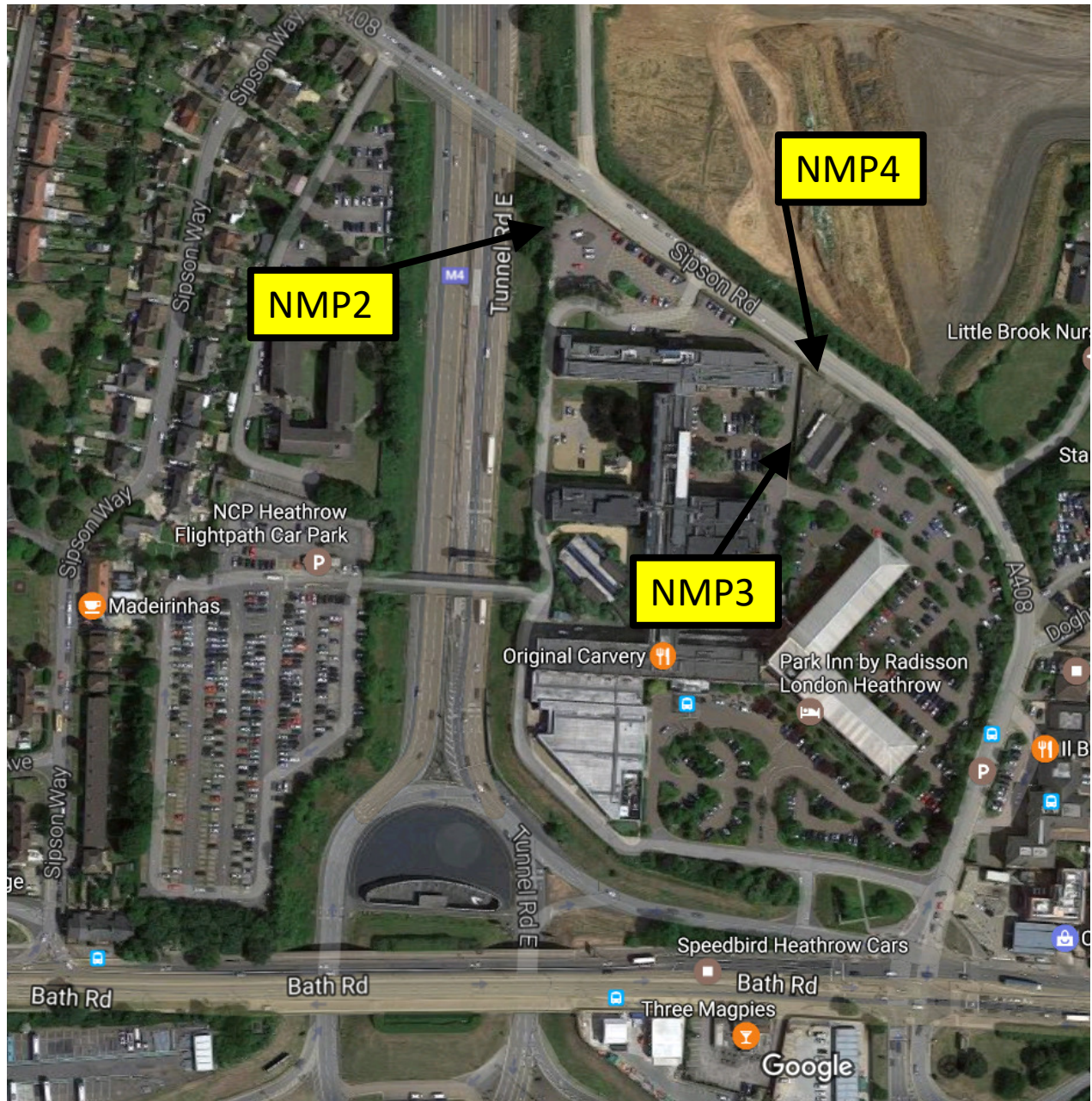


1 Proposed Typical Floor Plan 2nd - 5th
1 : 100





Survey locations.



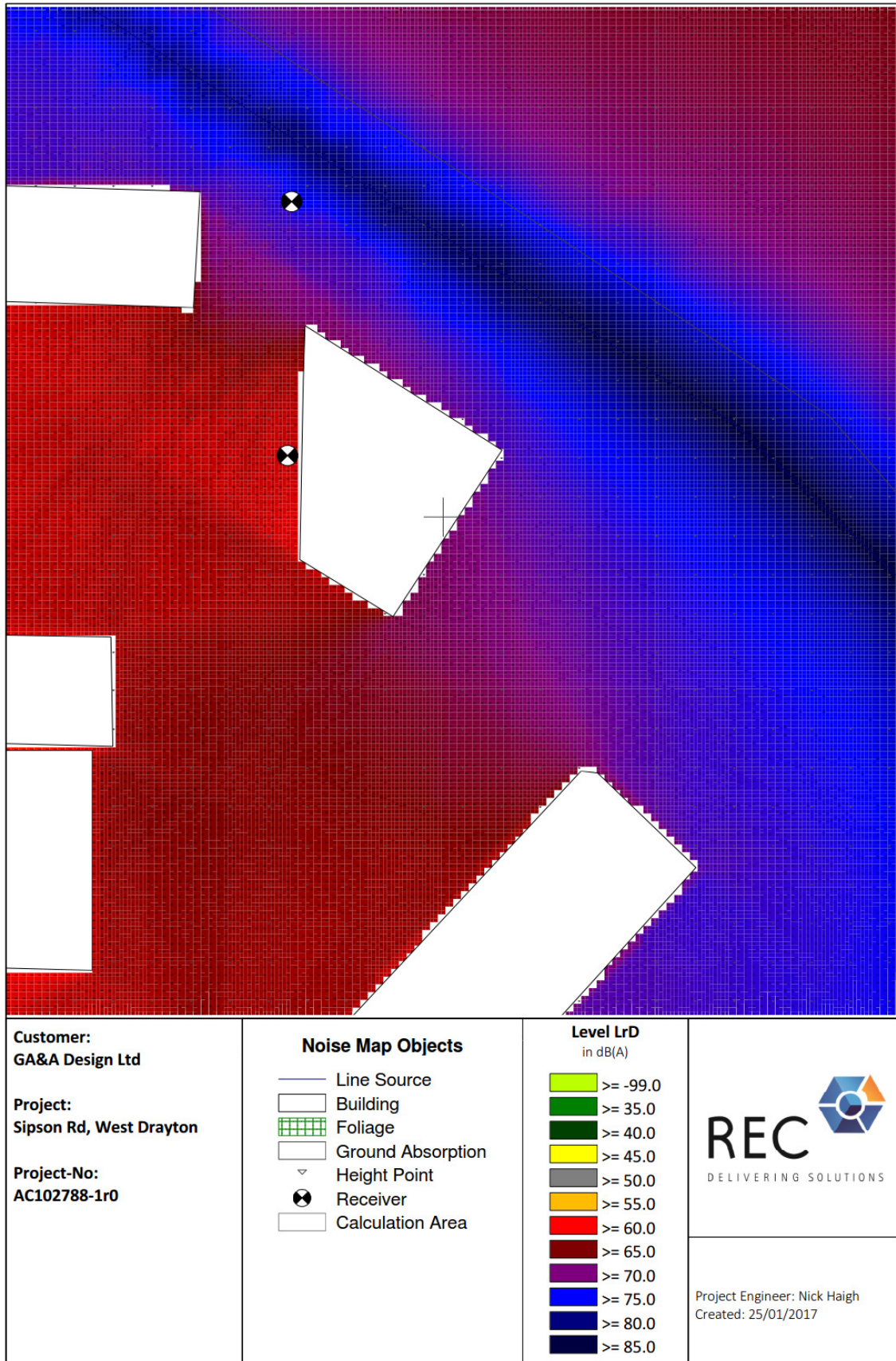


Area shown in following Noise Maps



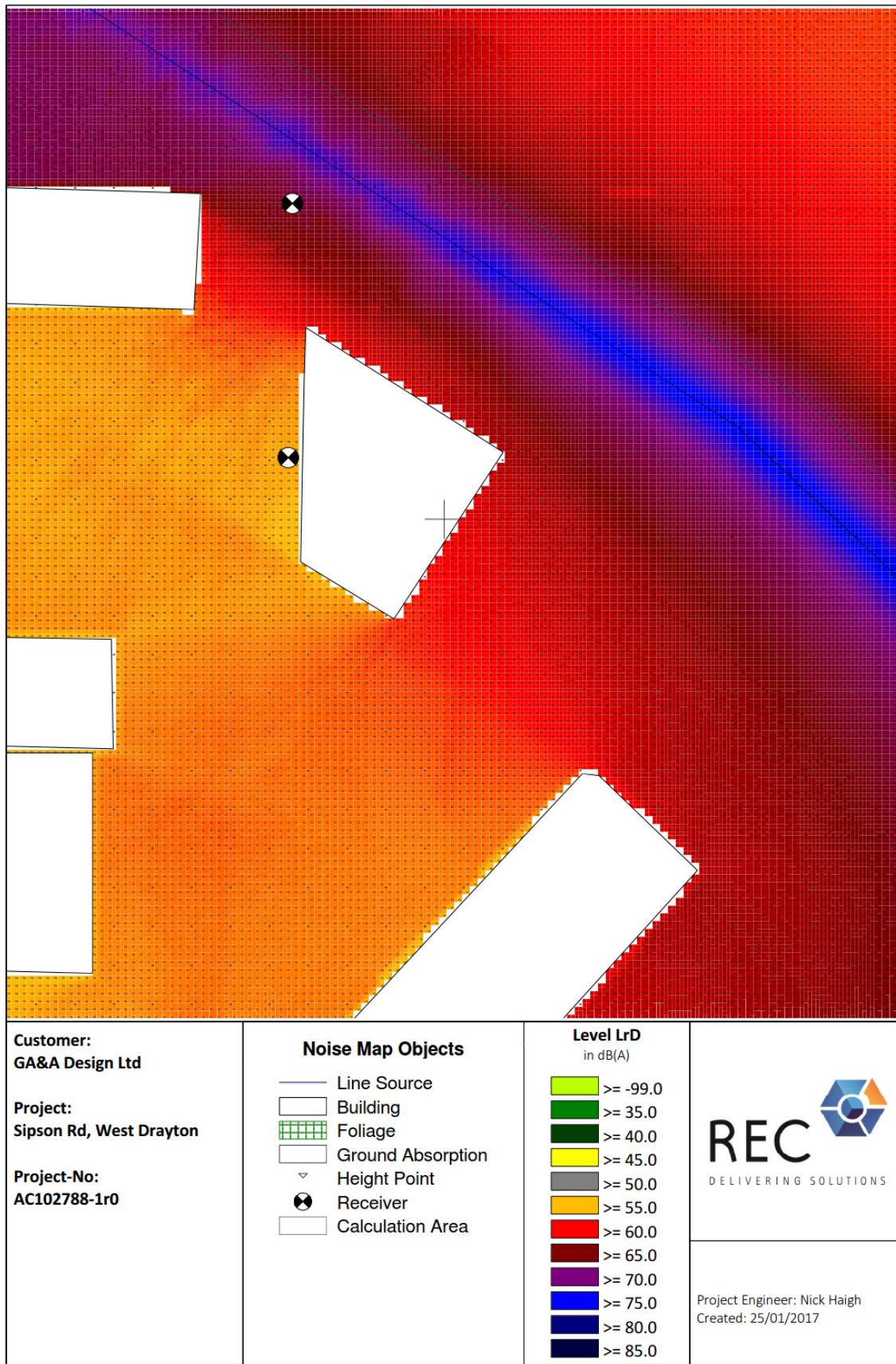


Calculated Noise Map; Groundfloor (Level 0) Day.



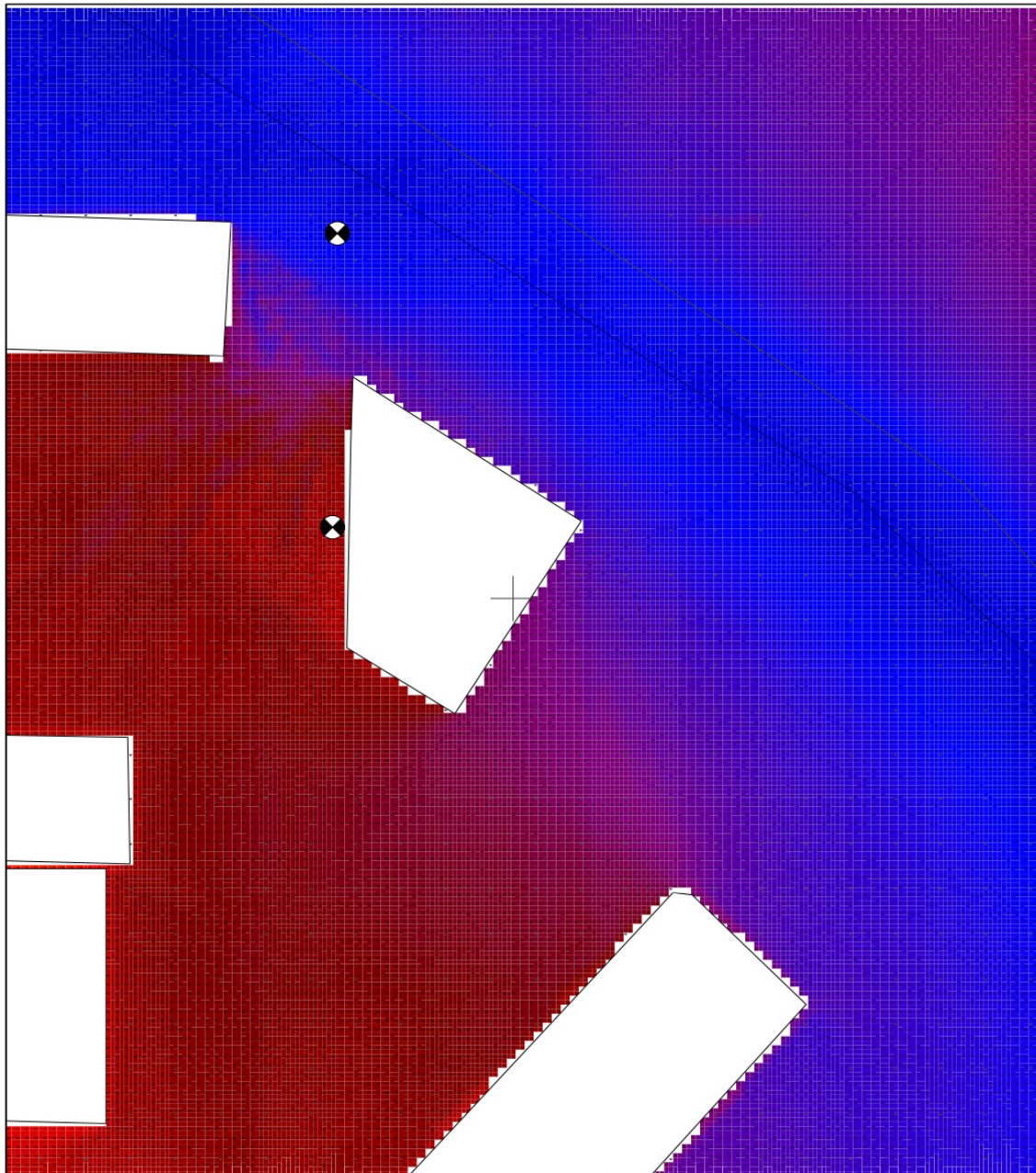


Calculated Noise Map; Groundfloor (Level 0) Night.





Calculated Noise Map; 3rd floor (Level 3) Day.

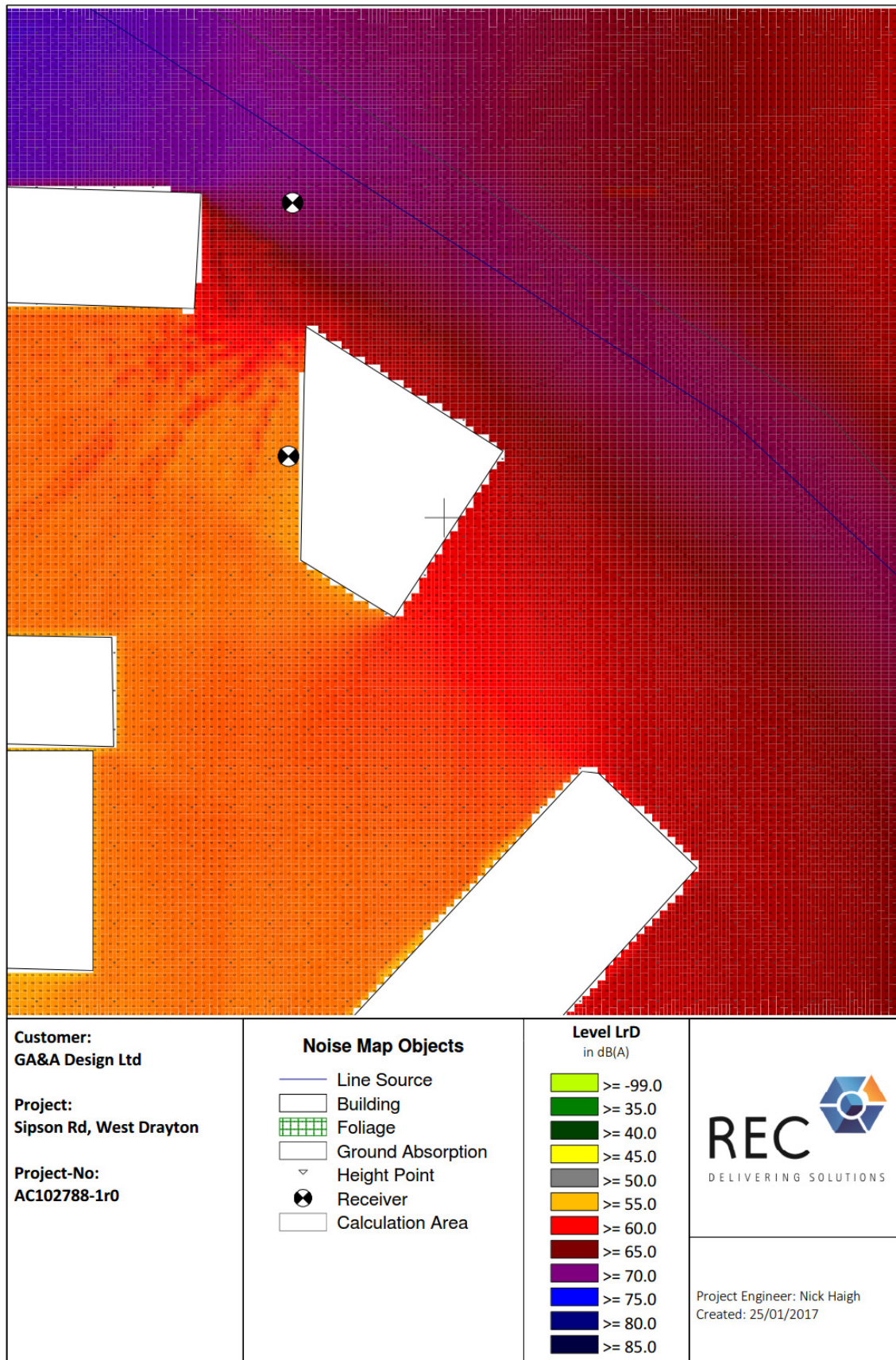


Customer: GA&A Design Ltd Project: Sipson Rd, West Drayton Project-No: AC102788-1r0	Noise Map Objects  Line Source  Building  Foliage  Ground Absorption  Height Point  Receiver  Calculation Area	Level LrD in dB(A)  ≥ -99.0  ≥ 35.0  ≥ 40.0  ≥ 45.0  ≥ 50.0  ≥ 55.0  ≥ 60.0  ≥ 65.0  ≥ 70.0  ≥ 75.0  ≥ 80.0  ≥ 85.0	 REC DELIVERING SOLUTIONS Project Engineer: Nick Haigh Created: 25/01/2017
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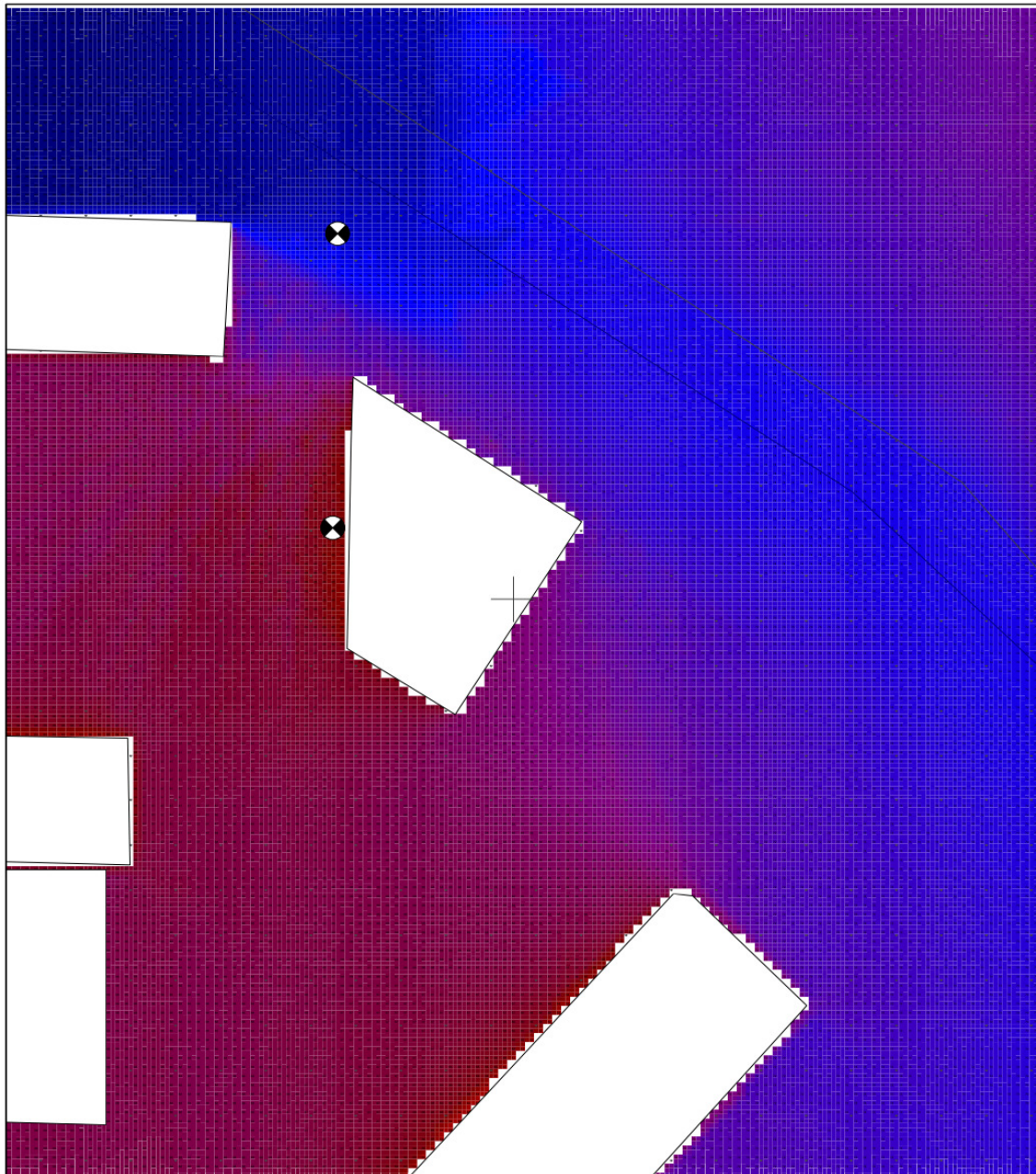


Calculated Noise Map; 3rd floor (Level 3) Night.





Calculated Noise Map; 5th floor (Level 5) Day.

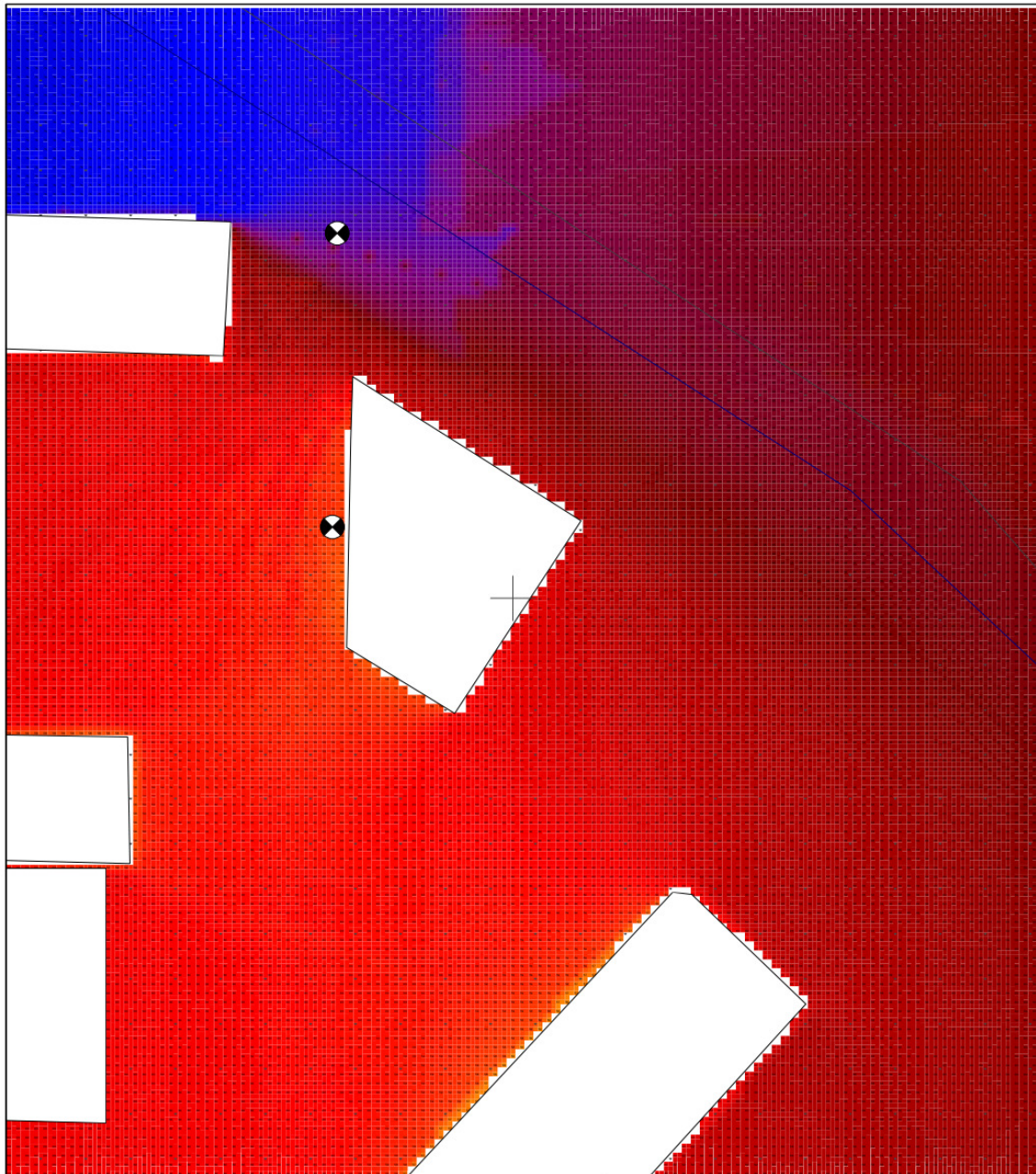


Customer: GA&A Design Ltd Project: Sipson Rd, West Drayton Project-No: AC102788-1r0	Noise Map Objects - Line Source - Building - Foliage - Ground Absorption - Height Point - Receiver - Calculation Area	Level LrD in dB(A) >= -99.0 >= 35.0 >= 40.0 >= 45.0 >= 50.0 >= 55.0 >= 60.0 >= 65.0 >= 70.0 >= 75.0 >= 80.0 >= 85.0	REC  DELIVERING SOLUTIONS Project Engineer: Nick Haigh Created: 25/01/2017
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Calculated Noise Map; 5th floor (Level 5) Night.



Customer: GA&A Design Ltd Project: Sipson Rd, West Drayton Project-No: AC102788-1r0	Noise Map Objects - Line Source - Building - Foliage - Ground Absorption - Height Point - Receiver - Calculation Area	Level LrD in dB(A) >= -99.0 >= 35.0 >= 40.0 >= 45.0 >= 50.0 >= 55.0 >= 60.0 >= 65.0 >= 70.0 >= 75.0 >= 80.0 >= 85.0	REC  DELIVERING SOLUTIONS Project Engineer: Nick Haigh Created: 25/01/2017
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APPENDIX IV FAÇADE NOISE LEVELS





Table A1: Calculated Daytime Internal Noise Levels compared to criterion of 35 dBA.

Floor	Façade Orientation	Calculated Free-field Façade Noise Level, $L_{Aeq,16hr}$ (dB)	Calculated Internal Noise Level with Windows Closed (dB)	Difference with BS8233:2014 Internal Criterion, $L_{Aeq,16hr}$ (dB)	Calculated Internal Noise Level with Windows Open (dB)	Difference with BS8233:2014 Internal Criterion, $L_{Aeq,16hr}$ (dB)
Ground floor	W(N)	62.4	32.4	-2.6	47.4	+12.4
1st floor	W(N)	62.6	32.6	-2.4	47.6	+12.6
2nd floor	W(N)	63.2	33.2	-1.8	48.2	+13.2
3rd floor	W(N)	63.8	33.8	-1.2	48.8	+13.8
4th floor	W(N)	65.2	35.2	+0.2	50.2	+15.2
5th floor	W(N)	65.3	35.3	+0.3	50.3	+15.3
6th floor	W(N)	65.5	35.5	+0.5	50.5	+15.5
Ground floor	W(S)	61.1	31.1	-3.9	46.1	+11.1
1st floor	W(S)	61.3	31.3	-3.7	46.3	+11.3
2nd floor	W(S)	61.9	31.9	-3.1	46.9	+11.9
3rd floor	W(S)	62.8	32.8	-2.2	47.8	+12.8
4th floor	W(S)	63.6	33.6	-1.4	48.6	+13.6
5th floor	W(S)	63.7	33.7	-1.3	48.7	+13.7
6th floor	W(S)	63.9	33.9	-1.1	48.9	+13.9
Ground floor	S	62.3	32.3	-2.7	47.3	+12.3
1st floor	S	62.1	32.1	-2.9	47.1	+12.1
2nd floor	S	62.6	32.6	-2.4	47.6	+12.6
3rd floor	S	63.3	33.3	-1.7	48.3	+13.3
4th floor	S	64.5	34.5	-0.5	49.5	+14.5
5th floor	S	65.2	35.2	+0.2	50.2	+15.2
6th floor	S	65.8	35.8	+0.8	50.8	+15.8
Ground floor	E(S)	68.5	38.5	+3.5	53.5	+18.5
1st floor	E(S)	68.5	38.5	+3.5	53.5	+18.5
2nd floor	E(S)	68.6	38.6	+3.6	53.6	+18.6
3rd floor	E(S)	68.6	38.6	+3.6	53.6	+18.6
4th floor	E(S)	68.7	38.7	+3.7	53.7	+18.7
5th floor	E(S)	68.9	38.9	+3.9	53.9	+18.9
6th floor	E(S)	69	39.0	+4	54.0	+19
Ground floor	E(N)	70.3	40.3	+5.3	55.3	+20.3





Floor	Façade Orientation	Calculated Free-field Façade Noise Level, $L_{Aeq,16hr}$ (dB)	Calculated Internal Noise Level with Windows Closed (dB)	Difference with BS8233:2014 Internal Criterion, $L_{Aeq,16hr}$ (dB)	Calculated Internal Noise Level with Windows Open (dB)	Difference with BS8233:2014 Internal Criterion, $L_{Aeq,16hr}$ (dB)
1st floor	E(N)	70.7	40.7	+5.7	55.7	+20.7
2nd floor	E(N)	70.5	40.5	+5.5	55.5	+20.5
3rd floor	E(N)	70.4	40.4	+5.4	55.4	+20.4
4th floor	E(N)	70.3	40.3	+5.3	55.3	+20.3
5th floor	E(N)	70.3	40.3	+5.3	55.3	+20.3
6th floor	E(N)	70.2	40.2	+5.2	55.2	+20.2
Ground floor	N(E)	70.3	40.3	+5.3	55.3	+20.3
1st floor	N(E)	70.8	40.8	+5.8	55.8	+20.8
2nd floor	N(E)	71.4	41.4	+6.4	56.4	+21.4
3rd floor	N(E)	71.3	41.3	+6.3	56.3	+21.3
4th floor	N(E)	70.9	40.9	+5.9	55.9	+20.9
5th floor	N(E)	70.5	40.5	+5.5	55.5	+20.5
6th floor	N(E)	68.1	38.1	+3.1	53.1	+18.1
Ground floor	N(W)	69.2	39.2	+4.2	54.2	+19.2
1st floor	N(W)	70.7	40.7	+5.7	55.7	+20.7
2nd floor	N(W)	70.5	40.5	+5.5	55.5	+20.5
3rd floor	N(W)	71.2	41.2	+6.2	56.2	+21.2
4th floor	N(W)	70.8	40.8	+5.8	55.8	+20.8
5th floor	N(W)	70.4	40.4	+5.4	55.4	+20.4
6th floor	N(W)	67.9	37.9	+2.9	52.9	+17.9





Table A2 Calculated Night-time Internal Noise Levels compared to criterion of 30 dBA

Floor	Façade Orientation	Calculated Free-field Façade Noise Level, $L_{Aeq,16hr}$ (dB)	Calculated Internal Noise Level with Windows Closed (dB)	Difference with WHO Internal Criterion, $L_{Amax,f}$ (dB)	Calculated Internal Noise Level with Windows Open (dB)	Difference with WHO Internal Criterion, $L_{Amax,f}$ (dB)
Ground floor	W(N)	55.8	25.8	-4.2	40.8	+10.8
1st floor	W(N)	55.7	25.7	-4.3	40.7	+10.7
2nd floor	W(N)	56.3	26.3	-3.7	41.3	+11.3
3rd floor	W(N)	56.7	26.7	-3.3	41.7	+11.7
4th floor	W(N)	57.8	27.8	-2.2	42.8	+12.8
5th floor	W(N)	58.2	28.2	-1.8	43.2	+13.2
6th floor	W(N)	58.8	28.8	-1.2	43.8	+13.8
Ground floor	W(S)	54.8	24.8	-5.2	39.8	+9.8
1st floor	W(S)	54.7	24.7	-5.3	39.7	+9.7
2nd floor	W(S)	55.3	25.3	-4.7	40.3	+10.3
3rd floor	W(S)	55.9	25.9	-4.1	40.9	+10.9
4th floor	W(S)	56.6	26.6	-3.4	41.6	+11.6
5th floor	W(S)	57	27.0	-3.0	42.0	+12
6th floor	W(S)	57.5	27.5	-2.5	42.5	+12.5
Ground floor	S	54.9	24.9	-5.1	39.9	+9.9
1st floor	S	54.5	24.5	-5.5	39.5	+9.5
2nd floor	S	55.1	25.1	-4.9	40.1	+10.1
3rd floor	S	55.6	25.6	-4.4	40.6	+10.6
4th floor	S	56.5	26.5	-3.5	41.5	+11.5
5th floor	S	57.3	27.3	-2.7	42.3	+12.3
6th floor	S	57.9	27.9	-2.1	42.9	+12.9
Ground floor	E(S)	59.6	29.6	-0.4	44.6	+14.6
1st floor	E(S)	59.5	29.5	-0.5	44.5	+14.5
2nd floor	E(S)	59.7	29.7	-0.3	44.7	+14.7
3rd floor	E(S)	59.8	29.8	-0.2	44.8	+14.8
4th floor	E(S)	59.8	29.8	-0.2	44.8	+14.8
5th floor	E(S)	60	30.0	+0	45.0	+15
6th floor	E(S)	60.1	30.1	+0.1	45.1	+15.1
Ground floor	E(N)	61.2	31.2	+1.2	46.2	+16.2





Floor	Façade Orientation	Calculated Free-field Façade Noise Level, $L_{Aeq,16hr}$ (dB)	Calculated Internal Noise Level with Windows Closed (dB)	Difference with WHO Internal Criterion, $L_{Amax,f}$ (dB)	Calculated Internal Noise Level with Windows Open (dB)	Difference with WHO Internal Criterion, $L_{Amax,f}$ (dB)
1st floor	E(N)	61.5	31.5	+1.5	46.5	+16.5
2nd floor	E(N)	61.4	31.4	+1.4	46.4	+16.4
3rd floor	E(N)	61.3	31.3	+1.3	46.3	+16.3
4th floor	E(N)	61.2	31.2	+1.2	46.2	+16.2
5th floor	E(N)	61.2	31.2	+1.2	46.2	+16.2
6th floor	E(N)	61.1	31.1	+1.1	46.1	+16.1
Ground floor	N(E)	61.7	31.7	+1.7	46.7	+16.7
1st floor	N(E)	62	32.0	+2	47.0	+17
2nd floor	N(E)	62.5	32.5	+2.5	47.5	+17.5
3rd floor	N(E)	62.5	32.5	+2.5	47.5	+17.5
4th floor	N(E)	62.2	32.2	+2.2	47.2	+17.2
5th floor	N(E)	61.9	31.9	+1.9	46.9	+16.9
6th floor	N(E)	61.1	31.1	+1.1	46.1	+16.1
Ground floor	N(W)	60.9	30.9	+0.9	45.9	+15.9
1st floor	N(W)	61.9	31.9	+1.9	46.9	+16.9
2nd floor	N(W)	61.9	31.9	+1.9	46.9	+16.9
3rd floor	N(W)	62.5	32.5	+2.5	47.5	+17.5
4th floor	N(W)	62.2	32.2	+2.2	47.2	+17.2
5th floor	N(W)	61.8	31.8	+1.8	46.8	+16.8
6th floor	N(W)	61.7	31.7	+1.7	46.7	+16.7





Table A3 Calculated Night-time Maximum Internal Noise Levels compared to criterion of 45 dBA

Floor	Façade Orientation	Calculated Free-field Façade Noise Level, $L_{Aeq,16hr}$ (dB)	Calculated Internal Noise Level with Windows Closed (dB)	Difference with BS8233:2014 Internal Criterion, $L_{Aeq,8hr}$ (dB)	Calculated Internal Noise Level with Windows Open (dB)	Difference with BS8233:2014 Internal Criterion, $L_{Aeq,8hr}$ (dB)
Ground floor	W(N)	71.8	41.8	-3.2	56.8	+11.8
1st floor	W(N)	71.8	41.8	-3.2	56.8	+11.8
2nd floor	W(N)	71.7	41.7	-3.3	56.7	+11.7
3rd floor	W(N)	72.1	42.1	-2.9	57.1	+12.1
4th floor	W(N)	75.0	45.0	+0	60.0	+15
5th floor	W(N)	77.5	47.5	+2.5	62.5	+17.5
6th floor	W(N)	78.3	48.3	+3.3	63.3	+18.3
Ground floor	W(S)	69.9	39.9	-5.1	54.9	+9.9
1st floor	W(S)	69.9	39.9	-5.1	54.9	+9.9
2nd floor	W(S)	69.9	39.9	-5.1	54.9	+9.9
3rd floor	W(S)	71.2	41.2	-3.8	56.2	+11.2
4th floor	W(S)	74.3	44.3	-0.7	59.3	+14.3
5th floor	W(S)	77.3	47.3	+2.3	62.3	+17.3
6th floor	W(S)	78.4	48.4	+3.4	63.4	+18.4
Ground floor	S	65.3	35.3	-9.7	50.3	+5.3
1st floor	S	66.5	36.5	-8.5	51.5	+6.5
2nd floor	S	68.0	38.0	-7.0	53.0	+8
3rd floor	S	70.4	40.4	-4.6	55.4	+10.4
4th floor	S	73.4	43.4	-1.6	58.4	+13.4
5th floor	S	76.8	46.8	+1.8	61.8	+16.8
6th floor	S	78.5	48.5	+3.5	63.5	+18.5
Ground floor	E(S)	70.5	40.5	-4.5	55.5	+10.5
1st floor	E(S)	70.5	40.5	-4.5	55.5	+10.5
2nd floor	E(S)	70.5	40.5	-4.5	55.5	+10.5
3rd floor	E(S)	70.4	40.4	-4.6	55.4	+10.4
4th floor	E(S)	71.5	41.5	-3.5	56.5	+11.5
5th floor	E(S)	75.6	45.6	+0.6	60.6	+15.6
6th floor	E(S)	78.3	48.3	+3.3	63.3	+18.3
Ground floor	E(N)	71.7	41.7	-3.3	56.7	+11.7





Floor	Façade Orientation	Calculated Free-field Façade Noise Level, $L_{Aeq,16hr}$ (dB)	Calculated Internal Noise Level with Windows Closed (dB)	Difference with BS8233:2014 Internal Criterion, $L_{Aeq,8hr}$ (dB)	Calculated Internal Noise Level with Windows Open (dB)	Difference with BS8233:2014 Internal Criterion, $L_{Aeq,8hr}$ (dB)
1st floor	E(N)	71.8	41.8	-3.2	56.8	+11.8
2nd floor	E(N)	71.7	41.7	-3.3	56.7	+11.7
3rd floor	E(N)	71.6	41.6	-3.4	56.6	+11.6
4th floor	E(N)	71.9	41.9	-3.1	56.9	+11.9
5th floor	E(N)	75.7	45.7	+0.7	60.7	+15.7
6th floor	E(N)	78.1	48.1	+3.1	63.1	+18.1
Ground floor	N(E)	73.6	43.6	-1.4	58.6	+13.6
1st floor	N(E)	73.6	43.6	-1.4	58.6	+13.6
2nd floor	N(E)	73.6	43.6	-1.4	58.6	+13.6
3rd floor	N(E)	73.5	43.5	-1.5	58.5	+13.5
4th floor	N(E)	73.4	43.4	-1.6	58.4	+13.4
5th floor	N(E)	73.3	43.3	-1.7	58.3	+13.3
6th floor	N(E)	70.7	40.7	-4.3	55.7	+10.7
Ground floor	N(W)	74.3	44.3	-0.7	59.3	+14.3
1st floor	N(W)	74.3	44.3	-0.7	59.3	+14.3
2nd floor	N(W)	74.3	44.3	-0.7	59.3	+14.3
3rd floor	N(W)	74.2	44.2	-0.8	59.2	+14.2
4th floor	N(W)	74.0	44.0	-1.0	59.0	+14
5th floor	N(W)	73.9	43.9	-1.1	58.9	+13.9
6th floor	N(W)	71.2	41.2	-3.8	56.2	+11.2

