



**Environmental Noise Assessment For A
Proposed Residential Development On Land To
The Rear Of 35 Fleet Road, Holbeach**

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SUMMARY

An environmental noise assessment has been carried out for a proposed residential development on land to the rear of 35 Fleet Road, Holbeach, on behalf of Gemmix Ltd. The assessment was carried out in accordance with the ProPG Planning and Noise Guidance, the National Planning Policy Framework (NPPF) and other relevant noise standards and guidance.

It includes attended noise monitoring, predictive noise modelling, assessment of the results and consideration of noise mitigation measures.

The NPPF assessment carried out shows that, the noise impact on the worst affected dwellings is at the “Lowest Observed Adverse Effect Level”. Should the mitigation measures recommended within this report be adopted, then an acceptable noise situation should occur for future occupants of the residential premises.

The ProPG initial noise risk assessment for the site shows that noise emissions across the proposed site are likely to be indicative of a “Negligible – Low Risk” during the daytime and a “Low - Medium Risk” during the night-time period. Implementation of a good acoustic design process have therefore been considered to demonstrate that an acceptable noise situation can occur for the future residents of the proposed residential premises.

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1 OBJECTIVES

- 1.1** To carry out an environmental noise assessment for a proposed residential development on land to the rear of 35 Fleet Road, Holbeach, (see Figures 1 & 2), in accordance with the ProPG Planning and Noise Guidance (ProPG – Reference 7), the National Planning Policy Framework (NPPF – Reference 1), the Noise Policy Statement for England (NPSE – Reference 2), the National Policy Planning Guidance (NPPG - Reference 3), British Standard (BS) 4142 (Reference 10), the World Health Organisation Guidance (WHO – Reference 5) and British Standard (BS) 8233 (Reference 6).
- 1.2** To recommend solutions to any problems identified by the assessment.

2 CONCLUSIONS

- 2.1** Using terminology from the ProPG, noise levels across the site are likely to be indicative of a “Negligible – Low Risk” during the daytime and a “Low - Medium” risk during the night-time period. A good acoustic design process and noise mitigation measures to protect the future residents from potential industrial noise emissions are therefore recommended.
- 2.2** The assessment in accordance with BS 4142 shows that based on what is assumed to be “typical” noise emissions from the adjacent industrial estate (based upon site activity that was witnessed during the attended noise monitoring), industrial noise emissions are likely to be at a level where an observed adverse impact could occur during the daytime period. As no noticeable industrial site activity was witnessed during the attended night-time site visit between 04:33 - 07:00 hours, the “typical” night-time assessment shows that the site would be subjected to “no impact” in accordance with BS 4142.
- 2.3** Acceptable noise levels below the threshold for “serious annoyance, daytime and evening” given in the WHO guidelines and also meeting the ProPG guidance can be achieved within all outdoor amenity areas to the proposed dwellings provided recommendations within this report are implemented.
- 2.4** Acceptable noise levels below the threshold for “speech intelligibility and moderate annoyance, daytime and evening” given in the WHO guidelines and also meeting the ProPG guidance can be achieved inside living rooms provided recommendations within this report are implemented.
- 2.5** Acceptable noise levels below the threshold for “sleep disturbance, night-time” given in the WHO guidelines and also meeting the ProPG guidance can be achieved inside bedrooms provided recommendations within this report are implemented.
- 2.6** Using the noise impact criteria from the NPSE and the NPPG, the assessment carried out shows that with the proposed mitigation measures installed, the noise impact on the proposed residential development is likely to be at the “Lowest Observed Adverse Effect Level”, this is deemed to be an acceptable noise situation.

*** see Appendix 1 for a Glossary of Terms**

3 **RECOMMENDATIONS**

- 3.1** This report should be used in support of the Planning Application for the proposed residential development on land to the rear of 35 Fleet Road, Holbeach.
- 3.2** The predicted noise levels assume that a 2m high acoustic barrier (e.g: close boarded fencing) will be installed between the proposed site and the adjacent Industrial site to the West. It is recommended that fencing of this nature is installed and should have a mass per unit area of $\geq 10 \text{ kg/m}^2$ (see Figure 8). The footprint of the proposed barrier is indicated in Figure 2.
- 3.3** The following noise mitigation measures are required for the proposed dwellings:
- Double glazing fitted with compression seals should be built into all living rooms and bedrooms. Glazing specifications are given below for ground floor windows (representative of living rooms) and first floor windows (representative of bedrooms) which should achieve satisfactory internal noise levels.

Location	Minimum R dB at frequency (Hz) for glazing				
	125	250	500	1000	2000
All Bedrooms and Living Rooms	24	20	25	35	38

This is likely to be achieved using a minimum specification of 4/12/4 double glazing with compression seals. An example of a product achieving this specification is the Pilkington Insulight 4/12/4 double glazing or equivalent.

- Internal noise levels within the proposed plots have the potential to be excessive when assessed under what is assumed to be “worst case” Industrial site activity if living room and bedroom windows are opened. Alternative ventilation must therefore be installed. Any ventilation attached to the walls should achieve the following sound insulation values when in the open position.

Location	Minimum D _{ne} dB at frequency (Hz) for Ventilation				
	125	250	500	1000	2000
All Bedrooms and Living Rooms	30	33	38	37	36

The specification detailed above is likely to be achieved using acoustic trickle vents. Acoustic Associates can provide further advice on acceptability once make and model details of the proposed vents are chosen.

- If rooms are mechanically ventilated then the system chosen must comply with the Approved Document F (Reference 4). Alternatively, a ‘whole house’ ventilation system could be used.
- Internal room layouts to dwellings should ideally be orientated so that living rooms and as many bedrooms as possible are located on the eastern façade of the proposed plots and

that kitchens, hallways, landings, stairwells and bathrooms etc are facing towards the industrial estate.

4 BACKGROUND

Gemmix Ltd have applied for planning permission for the proposed residential development on land to the rear of 35 Fleet Road, Holbeach. Fleet Road is immediately to the South of the site, whilst the A17 is approximately 430m to the North. An Industrial estate is located to the immediate West of the proposed site with the yard area serving the JML Henderson Ltd industrial unit located on the western site boundary. Acoustic Associates (Peterborough) were asked to undertake an environmental noise assessment of the proposed development and this report documents the results of that assessment. The location of the site is shown in Figure 1 and the proposed plot layout is shown in Figure 2.

5 POLICY, GUIDANCE AND STANDARDS

5.1 National Policy Planning Framework

The National Policy Planning Framework (Reference 1) states the following with respect to noise (para 123).

“Planning policies and decisions should aim to:

avoid noise from giving rise to significant adverse impacts (27) on health and quality of life as a result of new development;

mitigate and reduce to a minimum other adverse impacts (27) on health and quality of life arising from noise from new development, including through the use of conditions;

recognise that development will often create some noise and existing businesses wanting to develop in continuance of their business should not have unreasonable restrictions put on them because of changes in nearby land uses since they were established and

identify and protect areas of tranquility which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason.”

The footnote 27 in the first two bullet points refers to the Noise Policy Statement for England (NPSE – Reference 2) in order to explain what it means by “adverse impact”.

5.2 Noise Policy Statement for England and National Policy Planning Guidance

The NPSE has stated that the impact of noise be classified according to an “effect level” (shown in column 3 below). The National Policy Planning Guidance (NPPG - Reference 3) has clarified

what this effect level below means in terms of its perception by people at receptors and what action should be taken (columns 1 and 4 in Table 1 below).

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			
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 Adverse 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

Table 1 - National Policy Planning Guidance noise exposure hierarchy

5.3 World Health Organisation Guidance

5.3.1 The World Health Organisation (WHO) has published guidelines for community noise, as shown in Table 2 (Reference 5). This WHO document gives guidance for the levels of noise both inside and outside of dwellings.

Specific Environment	Critical Health Effect(s)	L _{Aeq} (dB)	Time Base (hours)	L _{Amax, fast} (dB)
Outdoor living area	Serious annoyance, daytime and evening	55	16	-
	Moderate annoyance, daytime and evening	50	16	-
Dwelling, indoors	Speech intelligibility and moderate annoyance, daytime and evening	35	16	-
Inside bedrooms	Sleep disturbance, night-time	30	8	45
Outside bedrooms	Sleep disturbance, window open (outdoor values)	45	8	60

Note: The 'daytime' and 'night-time' periods are generally referred to as 0700 to 2300 and 2300 to 0700 hours respectively.

Table 2 - World Health Organisation Noise Guidance Levels

5.3.2 For impulsive noise, such as that associated with rail movements, WHO states *"For a good sleep, it is believed that indoor sound pressure levels should not exceed approximately 45 dB L_{Amax} more than 10–15 times per night"*.

5.4 British Standard (BS) 8233:2014

BS 8233:2014 (Reference 6) also gives guidance on indoor ambient noise levels, as shown in Table 3.

Activity	Location	Noise criteria	
		07:00 to 23:00	23:00 to 07:00
Resting	Living room	35 dB L _{Aeq,16hour}	-
Dining	Dining room/area	40 dB L _{Aeq,16hour}	-
Sleeping	Bedroom	35 dB L _{Aeq,16hour}	30 dB L _{Aeq,8hour}

Table 3 - BS 8233: 2014 guidance indoor ambient noise levels for dwellings.

5.5 British Standard BS 4142:2014

5.5.1 BS 4142 (Reference 10) is a standard which describes a method for assessing whether the 'specific noise' from an industrial source is likely to give rise to complaints from residents of the adjacent dwellings. The 'specific noise' levels are determined outside dwellings. The specific noise level is determined for reference time periods of 1-hour for the daytime (7am to 11pm) and 15 minutes for the night time. Tonal or impulsive characteristics of a noise are likely to increase the scope for complaints and this is taken into account by adding a value to the specific noise source level to obtain the 'rating level'. The value may be between 0 and 15 dB depending on objective and subjective measures detailed in the standard. The following table

details the values added for the subjective method (which is the method used in this assessment).

Characteristics of noise	Noise at receptor	Value to add to specific noise level for rating level
Noise has tonal characteristics	Just perceptible	+2 dB
	Clearly perceptible	+4 dB
	Highly perceptible	+6 dB
Noise has impulsive characteristics	Just perceptible	+3 dB
	Clearly perceptible	+6 dB
	Highly perceptible	+9 dB
Other - characteristics that are neither tonal nor impulsive but are readily distinctive against the residual acoustic environment,	-	+ 3 dB
Intermittency	If intermittency is readily distinctive in the residual acoustic environment	+3 dB

Table 4 – BS 4142 – Corrections to noise to calculate rating level – subjective method

5.5.2 BS 4142 requires that the rating Level of a noise is compared with the existing background noise ($LA_{90,T}$). Guidance given in the standard states the following regarding the difference between the rating Level and the background noise.

A difference of 0 dB is indicative of a “*minor impact*”;

A difference of +5 dB is indicative of an “*adverse impact*”;

A difference of +10 dB is indicative of a “*significant adverse impact*”.

5.6 ProPG: Planning and Noise (Reference 7)

This document was produced by noise professionals to offer them guidance on noise management within the planning system in England. It recommends a 2-stage approach to managing for noise:

5.6.1 ProPG: Stage 1 – Initial Site Noise Risk Assessment

5.6.1.1 The aim of this stage is to provide an indication of the likely risk of adverse effects due to noise from developing a site. Using measurement and/or prediction, indicative future noise levels on a site are estimated.

5.6.1.2 The following excerpt shows the potential effect associated with likely site noise levels for daytime and night-time.

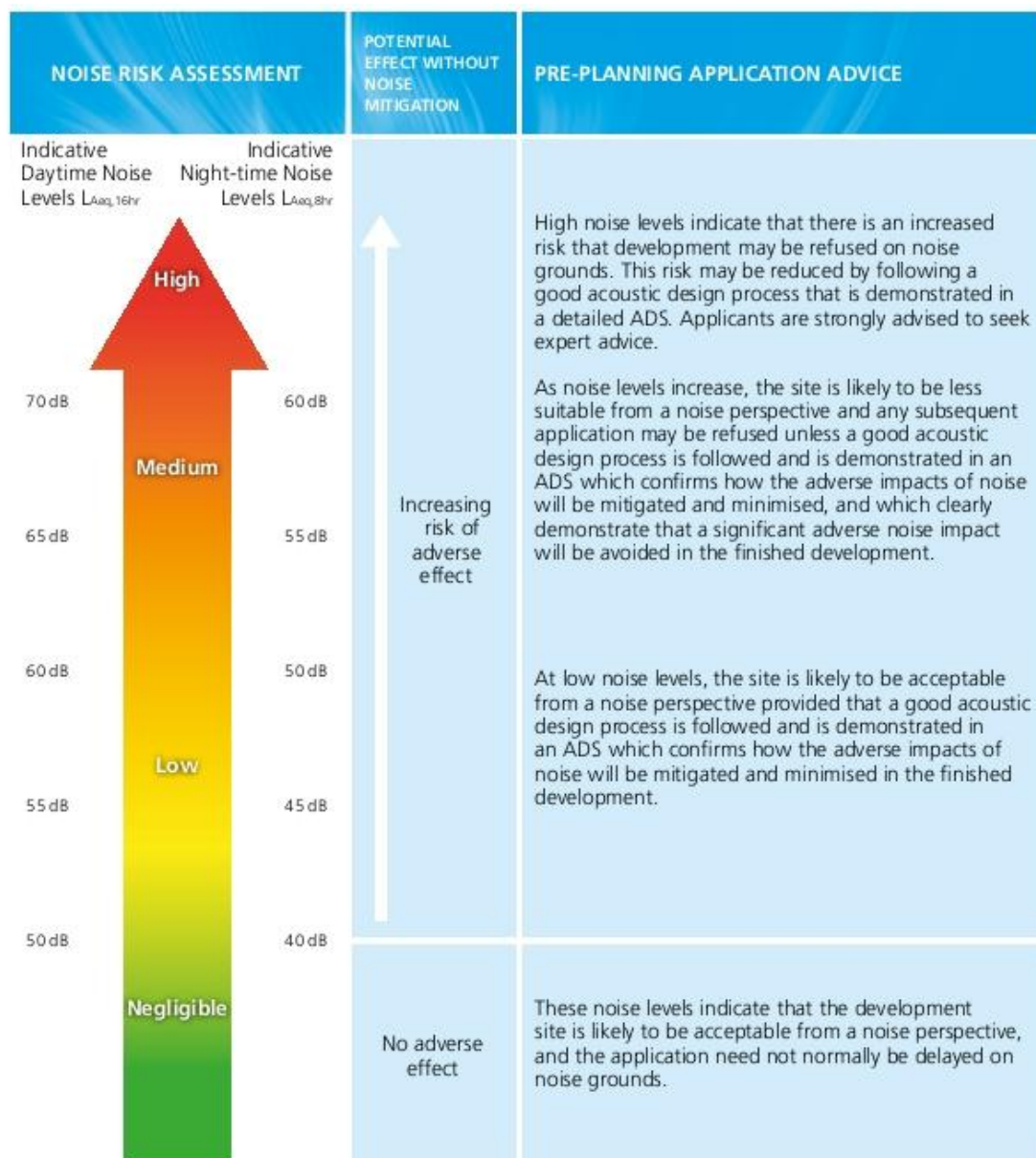


Figure 1 Notes:

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

Figure 1. Stage 1– Initial Site Noise Risk Assessment

5.6.1.3 It must be noted that the initial assessment of noise risk is not the basis for the eventual recommendation of approval. Its aim is to give an early assessment of site suitability for residential development and the extent of the acoustic issues to be faced. The higher the risk the more important it is that good acoustic design is followed for the development.

5.6.2 ProPG: Stage 2 – Full Assessment

There are 4 stages to a full assessment and these are briefly described below.

5.6.2.1 Element 1 - Good Acoustic Design Process

Provide an integrated solution whereby development avoids “unreasonable” and prevents “unacceptable” acoustic conditions. In particular the following should be considered: -

Check the feasibility of relocating or reducing noise levels from relevant sources.

Consider options for planning the site or building layout.

Consider the orientation of proposed building(s).

Select construction types and methods for meeting building performance requirements.

Examine the effects of noise control measures on ventilation, fire regulation, health and safety, cost, CDM (construction, design and management) etc.

Assess the viability of alternative solutions.

Assess external amenity area noise.

5.6.2.2 Element 2 – Internal noise level Guidelines

Seek to achieve recommended noise levels inside noise sensitive rooms in new residential development. The following excerpt from the document shows the recommended internal noise levels that should ideally be achieved.

Activity	Location	Noise criteria	
		07:00 to 23:00	23:00 to 07:00
Resting	Living room	35 dB L _{Aeq,16hour}	-
Dining	Dining room / area	40 dB L _{Aeq,16hour}	-
Sleeping	Bedroom	35 dB L _{Aeq,16hour}	30 dB L _{Aeq,8hour} 145 dB L _{Amax,F}

¹ In most circumstances this should not exceed 10-15 times per night.

Table 5– ProPG Internal Noise Level Guidelines

5.6.2.3 Element 3 – External Amenity Area Noise Assessment

The acoustic environment of external amenity areas that are an intrinsic part of the overall design assessment should always be assessed and noise levels should ideally not be above the range 50-55 dB L_{Aeq,16hours}. However the following follow-up advice should be noted

“In higher noise areas, such as city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited.”

5.6.2.4 Element 4 – Assessment of Other Relevant Issues

At this stage the following should be addressed:

- compliance with relevant national and local policy
- magnitude and extent of compliance with ProPG
- likely occupants of the development
- acoustic design v unintended adverse consequences
- acoustic design v wider planning objectives

5.7 Criteria for this assessment

ProPG Stage 1 guidance has been used to carry out an initial noise risk assessment. The assessment then uses ProPG Stage 2 guidance to carry out a systematic approach taking account of the four key elements given in the guidance. ProPG, BS 8233 and WHO Guidance is used to assess noise inside dwellings and within outdoor amenity areas. The impact of Industrial noise is also assessed in accordance with BS 4142. The overall noise impact with mitigation measures in place is classified according to criteria given in the NPSE and NPPG.

6 NOISE ASSESSMENT

6.1 Ambient and Background Noise

Attended noise monitoring was carried out at Monitoring Locations A – F (see Figure 1). The Monitoring exercise took place between 04:33 – 11:14 hours on Thursday 17th October 2019. The noise monitoring locations used were in free-field conditions at a height of approximately 1.2 metres above ground level. The weather conditions during the monitoring period were dry, mostly clear skies, approximately 3 - 11°C, with a very light southerly wind (speeds of 0 – 1.5m/s). Appendix 2 gives details of the noise instrumentation used.

6.2 Specific Noise Sources

The proposed plots will be exposed to a combination of road traffic noise from Fleet Road to the South and the A17 to the North during both the daytime and night-time periods. Noise levels associated with Fleet Road have been quantified using the measurements taken at Monitoring Location A, whilst measurements at Monitoring Location A and levels measured previously by Acoustic Associates have been used to quantify noise emissions from the A17. Specific noise measurements were also taken associated with the noisiest operations witnessed on the industrial estate to the West of the proposed site. The industrial estate hosts a large number of industrial and commercial units and it is understood that the unit closest to the site JML Henderson Ltd operates from as early as 05:00 hours daily. It is understood that JML

Henderson Ltd are a product distributor and also carry out fabrication tasks on site. During my site visit, no site activity on the industrial estate, with the exception of a few cars arriving at some of the premises (from approximately 06:35 hours) occurred during the 2.5 hour night-time monitoring period.

The first activity witnessed on the JML Henderson Ltd site from this premises was at approximately 07:17 hours when a pickup pulled into the far side of the site and parked up. The roller shutter doors on the site were open from 07:20 and were kept open for the duration of the site visit. Regular intermittent noise (manual movement of material etc) were regularly audible from the JML site, although these had very little influence on the measured ambient noise levels which were dominated by noise contributions from the road networks surrounding the site and occasionally from aircraft flying overhead.

Periods where noise emissions from the JML Henderson Ltd site were significant, were in the 5 minute period between 09:13 – 09:18 hours where a shopping trolley was dragged across the yard area and also between 10:28 – 10:38 when a HGV entered the JML site, turned around close to the site boundary and pulled up to the roller shutter doors. The HGV was then unloaded using a Toyota Tonero 25 FLT for a few minutes, and the HGV then left the site. This site activity was captured at Monitoring Locations A and D. When collecting my monitoring equipment at the end of my site visit just after 11am a person on the JML Henderson Ltd site saw me and my monitoring equipment and immediately stopped what they were doing and started operating a FLT continuously within the yard area. I took a 5 minute reading associated with this activity at Monitoring Location A, which included movement of the fork lift truck, banging of materials and shouting from the FLT operator to other people on the JML Henderson Ltd site. I have not used this reading within my predictions, as I suspect the activity was a simulation, rather than being representative of realistic operations and have therefore used measurements associated with the unloading of a HGV in my predictions. It should however be noted that the 5 minute sample of these simulated actions were only 1 dB(A) higher than the levels used for my predictions, so the decision not to use it does not affect the reports conclusions or recommendations.

For a period between approximately 07:50 – 09:15 distant noise from J.T Ward Joinery was also audible on the proposed site during breaks in road traffic. Further investigation showed that the dominant contributors were from an extraction system located outside the northern façade of this premises. A small contribution was also noted from an open roller shutter door on the southern façade of this premises. Short term specific noise measurements of these noise sources were taken at Monitoring Locations F and E respectively.

6.3 Computer noise model of the site and surrounding area

A computer noise model of the site and surrounding area was generated using Wolfel IMMI Computer Noise Modelling Software (Reference 8) which uses the methods given in ISO 9613 – 2 (Reference 9) to calculate noise levels across the site. The model was calibrated using the

noise measurements taken on site. Calculations have been carried out for the daytime and night-time periods and are based upon two scenarios:

Scenario 1: Assumed “Typical” site operations (based on what was witnessed during my monitoring exercise), including:

Road traffic (daytime and night-time), 10 minutes of HGV activity and FLT movements on the JML Henderson Ltd site each hour and continuous extractor noise and continuous noise emissions from the open roller shutter door on the J.T Ward Joinery site during the daytime period. No Industrial site activity during the night-time.

Scenario 2: Assumed “Worst Case” site operations, including:

Road traffic (daytime and night-time), Continuous HGV activity and FLT movements on the JML Henderson Ltd site during the daytime and night-time and extractor noise and continuous noise emissions from the open roller shutter door on the J.T Ward Joinery site during the daytime period only.

These scenarios are referred to further in the results section of this report.

7 RESULTS

7.1 Measured noise levels

The results from the attended ambient and background noise monitoring at Monitoring Locations A – F are shown below in Tables 6 - 11. The tables show the 'energy average' noise levels ($L_{Aeq,T}$), maximum sound pressure levels ($L_{Amax,T}$) and background noise levels ($L_{A90,T}$).

Date	Time (Hours)	Ambient Noise Level ($L_{Aeq,T}$) dB(A)	Background Noise Level ($L_{A90,T}$) dB(A)	Maximum Noise Level ($L_{Amax,T}$) dB(A)	Comments
17/10/2019	04:33 – 04:38	43.5	30.8	54.4	Noise emissions dominated by road traffic noise on Fleet Road and distant traffic on A17.
	04:38 – 04:43	45.2	31.8	56.2	
	04:43 – 04:48	47.1	33.0	57.1	
	04:48 – 04:53	46.3	32.7	55.5	
	04:53 – 04:58	45.1	33.1	56.4	
	04:58 – 05:03	46.6	35.2	56.6	
	05:03 – 05:08	46.5	38.2	56.5	
	05:08 – 05:13	44.6	36.3	54.1	
	05:13 – 05:18	46.8	37.8	56.5	
	05:18 – 05:23	41.7	36.6	52.0	
	05:23 – 05:28	42.6	36.4	55.0	
	05:28 – 05:33	43.8	39.9	54.6	
	05:33 – 05:38	45.6	40.9	54.4	
	05:38 – 05:43	42.8	39.2	53.9	
	05:43 – 05:48	46.2	42.7	56.0	
	05:48 – 05:53	44.9	39.8	54.1	
	05:53 – 05:58	44.0	39.4	51.7	
	05:58 – 06:03	47.0	41.3	53.5	
	06:03 – 06:08	47.4	41.4	57.9	
	06:08 – 06:13	48.7	44.5	59.0	
	06:13 – 06:18	48.9	44.5	56.8	
	06:18 – 06:23	49.8	46.4	56.5	
	06:23 – 06:28	48.3	42.8	57.0	
	06:28 – 06:33	46.6	42.5	53.5	
	06:33 – 06:38	49.1	45.9	59.0	
	06:38 – 06:43	49.7	45.1	58.2	
	06:43 – 06:48	49.1	44.7	57.1	
	06:48 – 06:53	50.0	46.4	58.1	
	06:53 – 06:58	50.3	47.1	58.4	
	06:58 – 07:03	49.7	45.2	60.1	
	07:03 – 07:08	48.2	45.1	63.1	
	07:08 – 07:13	48.4	46.0	61.6	
	07:13 – 07:18	48.6	46.1	57.4	
	07:18 – 07:23	47.4	44.5	58.2	
	07:23 – 07:28	48.4	44.6	71.8	
	07:28 – 07:33	48.8	45.4	61.9	
	07:33 – 07:38	48.0	45.4	59.9	
	07:38 – 07:43	48.0	45.8	56.5	
	07:43 – 07:48	49.1	45.9	61.9	

Table 6 – Measured noise levels at Monitoring Location A

Date	Time (Hours)	Ambient Noise Level ($L_{Aeq,T}$) dB(A)	Background Noise Level ($L_{A90,T}$) dB(A)	Maximum Noise Level ($L_{Amax,T}$) dB(A)	Comments
17/10/2019	07:48 – 07:53	49.1	46.6	67.4	Noise emissions dominated by road traffic noise on Fleet Road and distant traffic on the A17. Some occasional aircraft noise contribution. Occasional intermittent banging clattering on the JML Henderson Ltd site due to manual handling of materials. Extractor on J.T Ward Joinery site also faintly audible during breaks in road traffic.
	07:53 – 07:58	50.0	47.1	58.6	
	07:58 – 08:03	49.0	46.3	62.3	
	08:03 – 08:08	49.2	46.3	57.8	
	08:08 – 08:13	49.4	46.5	65.7	
	08:13 – 08:18	48.2	45.5	63.1	
	08:18 – 08:23	49.8	45.5	72.7	
	08:23 – 08:28	54.3	46.3	74.4	
	08:28 – 08:33	50.5	46.0	61.5	
	08:33 – 08:38	48.9	45.3	55.1	
	08:38 – 08:43	48.6	45.4	62.4	
	08:43 – 08:48	48.1	44.6	58.2	
	08:48 – 08:53	47.0	44.5	53.1	
	08:53 – 08:58	48.4	45.1	59.4	
	08:58 – 09:03	48.0	43.7	59.2	
	09:03 – 09:08	46.2	43.4	53.4	
	09:08 – 09:13	47.6	44.0	62.4	
	09:13 – 09:18	53.9	43.1	69.7	Shopping trolley used to move materials on the JML Henderson Ltd site.
	09:18 – 09:23	47.0	41.0	60.8	Noise emissions dominated by road traffic noise on Fleet Road and distant traffic on the A17. Some occasional aircraft noise contribution. Occasional intermittent banging clattering on the JML Henderson Ltd site due to manual handling of materials.
	09:23 – 09:28	45.3	40.7	56.4	
	09:28 – 09:33	45.2	41.1	54.5	
	09:33 – 09:38	46.6	42.2	55.5	
	09:38 – 09:43	46.7	42.4	57.4	
	09:43 – 09:48	46.8	41.8	57.0	
	09:48 – 09:53	46.6	41.3	56.8	
	09:53 – 09:58	47.3	42.0	62.7	
	09:58 – 10:03	44.6	41.2	57.0	
	10:03 – 10:08	46.0	41.8	65.2	
	10:08 – 10:13	47.1	41.3	58.9	
	10:13 – 10:18	45.9	38.5	66.4	
	10:18 – 10:23	46.0	39.9	57.5	HGV movements on and off the JML Henderson Ltd site. FLT used to unload the HGV.
	10:23 – 10:28	44.1	37.4	55.3	
	10:28 – 10:33	50.7	42.0	66.0	Noise emissions dominated by road traffic noise on Fleet Road and distant traffic on the A17. Some occasional aircraft noise contribution. Occasional intermittent banging clattering on the JML Henderson Ltd site due to manual handling of materials.
	10:33 – 10:38	51.7	40.2	65.3	
	10:38 – 10:43	45.4	37.0	65.4	
	10:43 – 10:48	47.8	40.7	60.2	
	10:48 – 10:53	49.8	39.3	65.8	
	10:53 – 10:58	45.1	38.6	56.0	FLT used constantly on the JML Henderson Ltd site for this 5 minute period, immediately after the operator became aware of my presence on site.
	10:58 – 11:03	44.5	37.7	54.0	
	11:09 – 11:14	52.7	42.0	75.1	

Table 6 – Measured noise levels at Monitoring Location A (continued)

Date	Time (Hours)	Ambient Noise Level ($L_{Aeq,T}$) dB(A)	Background Noise Level ($L_{A90,T}$) dB(A)	Maximum Noise Level ($L_{Amax,T}$) dB(A)	Comments
17/10/2019	05:03 – 05:08	44.8	35.8	60.9	Noise emissions dominated by road traffic noise on Fleet Road and distant traffic on A17.
	05:08 – 05:13	43.6	33.5	60.6	
	05:13 – 05:18	44.9	36.2	62.0	
	05:18 – 05:23	41.3	35.4	58.6	
	05:23 – 05:28	47.2	34.2	65.8	
	05:28 – 05:33	46.5	38.7	66.3	
	05:33 – 05:38	50.2	39.3	65.7	
	05:38 – 05:43	45.2	38.0	64.7	
	05:43 – 05:48	49.4	41.2	70.9	
	05:48 – 05:53	46.0	37.3	61.9	
	05:53 – 05:58	45.0	36.7	61.7	
	05:58 – 06:03	47.5	39.6	63.5	
	06:03 – 06:08	48.5	38.9	69.1	
	06:08 – 06:13	48.1	42.0	63.8	
	06:13 – 06:18	49.5	42.0	65.9	
	06:18 – 06:23	49.9	44.2	63.2	
	06:23 – 06:28	51.1	42.6	64.6	
	06:28 – 06:33	48.6	41.9	64.3	
	06:33 – 06:38	50.1	44.1	64.7	
	06:38 – 06:43	49.3	43.0	65.7	
	06:43 – 06:48	48.5	42.0	64.1	
	06:48 – 06:53	51.3	44.0	70.4	
	06:53 – 06:58	50.8	44.1	64.7	
	06:58 – 07:03	51.6	44.2	64.6	
	07:03 – 07:08	51.2	41.5	64.9	
	07:08 – 07:13	50.8	44.4	65.4	
	07:13 – 07:18	51.5	44.6	65.4	
	07:18 – 07:23	51.1	44.2	64.5	
	07:23 – 07:28	50.9	44.1	66.1	
	07:28 – 07:33	51.3	44.8	64.9	
	07:33 – 07:38	50.7	44.3	64.7	
	07:38 – 07:43	53.3	45.6	70.1	
	07:43 – 07:48	54.9	46.7	70.1	

Table 7 – Measured noise levels at Monitoring Location B

Date	Time (Hours)	Ambient Noise Level ($L_{Aeq,T}$) dB(A)	Background Noise Level ($L_{A90,T}$) dB(A)	Maximum Noise Level ($L_{Amax,T}$) dB(A)	Comments
17/10/2019	08:08 – 08:13	49.5	48.1	54.9	Noise emissions dominated by road traffic noise on Fleet Road and distant traffic on the A17. Some occasional aircraft noise contribution. Occasional intermittent banging clattering on the JML Henderson Ltd site due to manual handling of materials. Extractor on J.T Ward Joinery site was audible during breaks in road traffic between approximately 07:50 – 09:15 hours.
	08:13 – 08:18	49.5	47.6	69.6	
	08:18 – 08:23	50.2	48.0	71.1	
	08:23 – 08:28	49.6	48.0	55.8	
	08:28 – 08:33	49.7	48.0	60.2	
	08:33 – 08:38	51.5	47.2	70.4	
	08:38 – 08:43	49.6	47.1	65.2	
	08:43 – 08:48	48.3	46.3	57.2	
	08:48 – 08:53	47.8	46.2	56.7	
	08:53 – 08:58	48.3	46.4	56.8	
	08:58 – 09:03	47.5	45.3	53.9	
	09:03 – 09:08	46.9	45.1	54.6	
	09:08 – 09:13	47.5	45.3	58.3	
	09:13 – 09:18	46.6	44.7	55.1	
	09:18 – 09:23	46.9	43.6	58.5	
	09:23 – 09:28	45.8	43.4	58.2	
	09:28 – 09:33	44.6	41.8	52.8	
	09:33 – 09:38	45.8	43.1	54.5	

Table 8 – Measured noise levels at Monitoring Location C

Date	Time (Hours)	Ambient Noise Level ($L_{Aeq,T}$) dB(A)	Background Noise Level ($L_{A90,T}$) dB(A)	Maximum Noise Level ($L_{Amax,T}$) dB(A)	Comments
17/10/2019	09:43 – 09:48	47.5	40.9	57.8	Noise emissions dominated by road traffic noise on Fleet Road and distant traffic on the A17. Some occasional aircraft noise contribution. Occasional intermittent banging clattering on the JML Henderson Ltd site due to manual handling of materials.
	09:48 – 09:53	46.7	40.3	59.8	
	09:53 – 09:58	48.3	41.8	64.9	
	09:58 – 10:03	45.1	40.7	60.0	
	10:03 – 10:08	45.4	41.5	56.1	
	10:08 – 10:13	48.1	40.8	61.1	
	10:13 – 10:18	45.3	37.6	59.7	
	10:18 – 10:23	46.8	38.8	59.7	
	10:23 – 10:28	44.4	36.6	61.4	HGV movements on and off the JML Henderson Ltd site. FLT used to unload the HGV.
	10:28 – 10:33	52.7	40.8	68.3	
	10:33 – 10:38	53.0	39.5	66.4	Noise emissions dominated by road traffic noise on Fleet Road and distant traffic on the A17. Some occasional aircraft noise contribution. Occasional intermittent banging clattering on the JML Henderson Ltd site due to manual handling of materials.
	10:38 – 10:43	46.3	35.8	67.4	
	10:43 – 10:48	47.9	39.6	60.8	
	10:48 – 10:53	49.9	39.1	67.0	
	10:53 – 10:58	45.7	37.7	59.4	
	10:58 – 11:03	46.2	36.6	61.4	
	11:03 – 11:08	45.4	36.4	63.0	

Table 9 – Measured noise levels at Monitoring Location D

Date	Time (Hours)	Ambient Noise Level ($L_{Aeq,T}$) dB(A)	Background Noise Level ($L_{A90,T}$) dB(A)	Maximum Noise Level ($L_{Amax,T}$) dB(A)	Comments
17/10/2019	08:17 – 08:18	50.0	48.8	54.5	Noise emissions dominated by noise emissions from inside the J.T Ward Joinery premises.
	08:46 – 08:47	52.6	50.9	56.7	

Table 10 – Measured noise levels at Monitoring Location E

Date	Time (Hours)	Ambient Noise Level ($L_{Aeq,T}$) dB(A)	Background Noise Level ($L_{A90,T}$) dB(A)	Maximum Noise Level ($L_{Amax,T}$) dB(A)	Comments
17/10/2019	08:19 – 08:20	62.7	61.5	64.7	Noise emissions dominated by noise emissions from the extraction system serving the J.T Ward Joinery premises.
	08:47 – 08:48	62.1	61.1	68.9	

Table 11 – Measured noise levels at Monitoring Location F

7.2 ProPG Stage 1 – Initial noise risk assessment

The measured noise data was input into a computer model of the site (see Figure 3). The predicted output from this software model is shown as noise contours across the proposed development site for Scenario 1, the assumed “typical” site operations (see Figures 4 and 5) and also Scenario 2, the assumed “worst case” site operations (see Figures 6 and 7). The noise contour maps have all been colour coded in accordance with the indicative daytime and night-time noise level colour coding scheme given in excerpt 1 of the Pro-PG Stage 1 assessment criteria. Based upon the “worst case” noise scenario, it is shown in Figures 6 and 7 that the proposed site is likely to be indicative of a “Low - Negligible Risk” during the daytime and a “Low – Medium Risk” during the night-time period.

Based upon the above, in order for a planning application to be successful it is important that good acoustic design is considered.

7.3 British Standard (BS) 4142 Assessment

During the daytime monitoring period noise emissions associated with the neighbouring Industrial estate (JML Henderson Ltd and J.T Ward Joinery) were present and were included within the noise model predictions. The presence of these industrial noise contributions have been assessed in accordance with BS 4142. The daytime Assessment Location is within the outdoor amenity area of the worst affected plot (Plot 1 – See Figure 2). The results of the daytime BS 4142 assessment are shown below in Table 12.

Daytime BS 4142 Assessment		Comments
Predicted specific sound level within the worst affected outdoor amenity area (Plot 1 - 1.5m above the ground), based on Scenario 1 – assumed “typical” site operations	$L_{Aeq,T} = 41\text{dB(A)}$	Predicted sound level calculated using the computer noise model. Industrial Noise sources associated with JML Henderson Ltd and J.T Ward Joinery only (excluding road traffic noise).
Background sound level	$L_{A90,T} = 45\text{ dB(A)}$	The “modal” background sound level measured during the daytime period at Monitoring Location A.
Assessment made during the daytime, so the reference time interval is 1 hour	-	HGV deliveries on the JML Henderson Ltd site, including entering / exiting the site and being unloaded using a FLT have been assumed to take place for 10 minutes in any 1 hour daytime reference period. Extraction system noise and open roller shutter noise emissions from the J. T Ward Joinery site have been assumed to take place continuously throughout the entire 1 hour reference period.
Acoustic feature correction	+10 dB	The tonality of noise emission from the industrial noise sources, particularly those on the JML Henderson Ltd site could potentially be “clearly perceptible” within the worst affected gardens (+4dB correction) They could also generate impulsive noise emissions that are “clearly perceptible” within the worst affected gardens, therefore a +6dB correction has been applied for impulsivity.
Rating Level	$(41 + 10) = 51\text{ dB}$	Acoustic feature correction added to the specific sound level.
Excess of rating level over the background sound level	$51 - 45 = +6\text{ dB}$	The predicted “rating level” ($L_{A,r,T,r}$) is 6 dB(A) above the background sound level, which is likely to result in a level where an “observed adverse impact” could occur for the residents of the worst affected proposed plots. Noise mitigation measures are therefore considered to ensure that noise levels within living rooms during the daytime achieve acceptable levels.
Assessment when taking account of context	-	The predicted noise levels within living rooms and within outdoor amenity areas (with the proposed mitigation measures installed) achieve the ProPG and WHO guidance levels and therefore taking this into account an acceptable noise situation is deemed to occur for the future residents of the proposed residential premises.
Uncertainty of the assessment	-	If calculations were to be based on Scenario 2 – assumed “worst case” industrial noise emissions then the excess of the Rating Level over Background noise level would increase by a further 8 dB, which would be deemed to have a “significant adverse impact”. From what was witnessed on site, this is unlikely to represent what typically occurs, however to ensure that the survey covers a “worst case” noise scenario, the reports recommendations for minimum specifications of glazing and ventilation for the proposed plots will be designed to achieve acceptable noise levels, even under “worst case” assumptions.

Table 12 – BS 4142 Daytime Assessment

During the night-time monitoring period no noticeable or significant noise emissions associated with the industrial site were witnessed between 04:33 – 07:00 hours. Based on what was witnessed it is reasonable to assume that on the morning of the site visit the BS 4142 Assessment would conclude that “no impact” is likely to occur during the night-time period. It is also understood that the Industrial units are not restricted in terms of their operational hours and it would not be unreasonable to assume that site activity on the sites could potentially occur during the night-time period. If activity similar to the assumed daytime worst case operations on the JML Henderson Ltd site, were to take place during the night-time period, then it is highly likely that this would result in a “significant adverse impact” in accordance with BS 4142. It is therefore important to ensure that the proposed dwellings are adequately designed to achieve acceptable noise levels within bedrooms, even under circumstances where the JML Henderson Ltd site is used during the night-time period. This has been addressed in Section 7.3.

7.3 ProPG Stage 2 – Full assessment of the four key elements

7.3.1 Element 1 – Good acoustic design process

The following measures should be considered to protect residential amenity inside and outside dwellings:

Orientation of buildings and outdoor amenity areas

It is best practice to locate the proposed buildings between the industrial noise sources and the outdoor amenity areas serving the dwellings. In this case the layout of the plots had already been determined prior to Acoustic Associates involvement in the process, therefore we have not been able to influence this aspect of the design. However the client has identified the need to protect the outdoor amenity areas from industrial noise emissions and has proposed a 2 metre high acoustic barrier on the western boundary of the site (see Figure 2). This barrier has been included in the noise model predictions and its impact is shown in Section 7.3.3.

Orientation of rooms within buildings

Internal room layouts to dwellings should ideally be orientated so that living rooms and as many bedrooms as possible are located on the eastern façade of the proposed plots and that kitchens, hallways, landings, stairwells and bathrooms etc are facing towards the industrial estate. If this is not possible, then the layout should where possible have at least one window of habitable rooms that can be opened on a façade facing away from the industrial site, to potentially allow for the option of natural ventilation. It is understood that the internal room layout has not yet been determined so this advice should be considered when determining this element of the design.

7.3.2 Element 2 – Internal noise level guidelines

Based on the proposed plot layout, external noise levels have been predicted at 1m away from the worst affected plot façade (Plot 1) at heights of 1.5 metres (daytime) and 4.5 metres (night-time) and are representative of locations outside of where living room and bedroom windows could potentially be located. Table 13 summarises these predictions. Also included in the table are predicted internal noise levels allowing for a 15 dB(A) reduction for partially open windows. These predictions are based on Scenario 2 – assumed “worst case” site operations.

Assessment Location	Predicted Noise Level Outside the Façade dB(A)		Predicted Internal Noise Level with partially open windows dB(A)		Compliance with ProPG / WHO / BS 8233 Guidance
	L _{Aeq,16hour} Daytime	L _{Aeq,8hour} Night time	L _{Aeq,16hour} Daytime	L _{Aeq,8hour} Night time	
Plots 1 Façade	51	54	36	39	NO

Table 13 – Internal noise level predictions with partially opened windows

Ventilation and glazing

Site layouts should be designed so that the internal target ambient noise levels can be achieved with open windows in as many properties / façades as possible to demonstrate good acoustic design. Where it is not possible to achieve reasonable internal noise levels with open windows (i.e. on the worst affected façade of Plot 1), then alternative means for suitably ventilating properties will be required.

The WHO gives guidance on indoor noise levels above which critical health effects occur: 35 dB(A) – speech intelligibility disturbance and 30 dB(A) – sleep disturbance. BS 8233 also implies that an internal night-time level of <30 dB(A) is suitable for bedrooms and an internal daytime level of <35 dB(A) is suitable for living rooms and bedrooms.

Noise can enter a building through many paths, e.g: windows, walls, roof, etc. However, in most cases windows and vents provide the main path and it is important to ensure that their insulation is specified correctly. Table 14 shows the predicted internal noise levels within the living room and bedrooms of the worst affected residential premises (Plot 1) during Scenario 2 – assumed “worst case” site operations. The predicted internal noise levels are based upon the assumption that all windows fitted will be double glazed units meeting the minimum specification discussed in Section 3.2 and will be kept closed, therefore alternative ventilation arrangements will be required. Glazed areas of 2m² have been assumed for each room assessed. For the purposes of this assessment two acoustic trickle vents have been assumed to provide ventilation to each living room and bedroom (any vents installed will need to achieve the minimum D_{new} values specified in Section 3.2 when in the open position). Living room volumes have been assumed to be 38.4m³, whilst bedroom volumes are assumed to be 28.8m³. Internal reverberation times of 0.5 seconds have been assumed.

Assessment Location	Predicted Noise Level Outside the Façade dB(A)		Predicted Internal Noise Level dB(A)		Compliance with ProPG / WHO / BS 8233 Guidance
	L _{Aeq,16hour} Daytime	L _{Aeq,8hour} Night time	L _{Aeq,16hour} Daytime	L _{Aeq,8hour} Night time	
Plot 1 Façade	51	54	22	29	YES

Table 14 – Predicted worst case Internal noise levels (with proposed glazing / ventilation Installed and windows closed)

It can be seen that with windows on the worst affected façade closed and ventilation (meeting the minimum specification in Section 3.2) installed and open, the proposed development should meet the ProPG, WHO and BS 8233 internal noise criteria within all plots. Any ventilation system installed must comply with the Approved Document F (Reference 4). This is deemed to be an acceptable noise situation.

7.3.3 Element 3 – External amenity area noise assessment

Protection of outdoor amenity areas

The proposed outdoor amenity areas of the proposed plots have been designed with a 2 metres high acoustic barrier on the Western site boundary. Based on the proposed plot layout, noise levels within outdoor amenity areas have been predicted at a height of 1.5 metres above ground and 3.5 metres from the building façade, giving predicted ($L_{Aeq,T}$) outdoor amenity area noise levels in the worst affected plot (Plot 1) of 48 dB(A) under assumed “typical” site operations. This is regarded as being below the threshold for “*moderate annoyance, daytime and evening*”, in accordance with the WHO Guidelines. Even during the assumed “worst case” daytime operations, this level only increases to 51 dB(A) which is below the threshold for “*serious annoyance, daytime and evening*”. This is deemed to be an acceptable noise situation.

7.3.4 Element 4 – Assessment of Other Relevant Issues

Using the noise impact criteria from the Noise Policy Statement for England (NPSE) and the NPPG the assessment carried out shows that, the noise impact on the proposed residential dwellings is likely to be at a level where the “Lowest Observed Adverse Effect” could occur.

There are no other relevant issues likely to affect this assessment as detailed in Element 4 of the ProPG Stage 2 Assessment.

7.4 ProPG Stage 2 – Recommendation to the decision maker

It is recommended that the mitigation measures proposed within the recommendations section of this report are implemented as part of the development and the recommendation to the decision maker is that Planning Permission should be awarded, subject to these conditions.

8 UNCERTAINTIES

The main uncertainties relating to assessments of this type relate to:

- Measured noise levels used
- Sources of noise that have been assumed
- Predictive computer modelling

Uncertainties relating to the daytime and night-time measured noise levels associated with road traffic are minimal due to the regular flow of traffic on both roads.

There are some uncertainties relating to noise levels assumed for the Industrial estate as it is not unreasonable to assume that noise emissions will differ from a day to day basis. However, as a worst case noise scenario, with regard to industrial / commercial noise emissions has been assumed for the nearest site (JML Henderson Ltd), the predictions are likely to be an overestimate of noise levels during the majority of the daytime and night-time periods.

The suggested control measures have been specified to result in acceptable internal noise levels, even under assumed “worst case” site operations.

The uncertainties relating to the use of predictive modelling are understood to be ± 3 dB(A).

These uncertainties are unlikely to affect the conclusions of this report.

REFERENCES

1. *National Policy Planning Framework*; DCLG, 2012.
2. *Noise Policy Statement for England*; DEFRA, 2010.
3. *National Policy Planning Guidance, 2014, DEFRA*.
4. *Document F Ventilation Regulations*; thenbs, 2010.
5. *World Health Organisation Guidance, Guidelines for Community Noise*; WHO, 1999.
6. *British Standard BS 8233, Guidance on sound insulation and noise reduction for buildings*; BSI, 2014.
7. *Professional Practice Guidance on Planning & Noise: New Residential Development*; ProPG, 2017.
8. *Wolfel IMMI Computer Noise Modelling Software*.
9. *ISO 9613-2 Acoustics of sound during propagation outdoors, Part 2: General method of calculation*; ISO, 1996.
10. *British Standard BS 4142:2014, Methods of rating and assessing industrial and commercial sound*; BSI, 2014.

Appendix 1 – Glossary of terms

Sound Pressure	The variation of ambient pressure that is detected by the ear as sound.
Noise	Unwanted sound
decibel (dB)	Ten times the logarithm of the square of the ratio of the Sound Pressure to a reference pressure (20 micro-Pascal's).
Sound Pressure Level (L_p)	The decibel version of the Sound Pressure.
A-Weighting	A frequency weighting which simulates the response of the ear. An A-Weighted Sound Pressure Level is denoted by L _{pA} and has units of dB(A)
L_{Aeq,T}	The value of the A-weighted sound pressure level, in decibels [dB(A)], of a continuous steady sound that within a specified time interval (T), for example 16 hours, has the same mean-square sound pressure as a sound that varies with time. Therefore, the average over a 16 hour period would be denoted as L _{Aeq,16h}
L_{Amax,T}	The maximum A-Weighted sound pressure level that was encountered during the measurement period.
L_{A90,T}	The A-Weighted sound pressure level that is exceeded for 90% of the time (T). This is usually used a measure of background noise.
Free Field	Where noise can propagate freely without any reflections from buildings etc.
Octave Band	A band of frequencies the upper limit of which is twice the lower limit. They are known by their centre frequency, e.g., 63, 125, 250, 500, 1000, 2000
NPSE Criteria	
NOEL	No Observed Effect Level
LOAEL	Lowest Observed Adverse Effect Level
SOAEL	Significant Observed Adverse Effect Level

BS 4142 Terms

T_r	The reference time interval over which an equivalent continuous A-weighted sound pressure is determined. Day time = 1 hour Night-time = 15 minutes
T_m	The measurement time interval over which measurements are taken.
Ambient Noise	Total sound in a given situation at a given time.
Residual Noise	The ambient noise remaining at a given position in a given situation when the specific noise is suppressed to a degree such that it does not contribute to the ambient noise.
Specific Noise Level Rating Level L_{Ar,T_r}	The dB L_{Aeq,T_r} of the noise sources being assessed at a site. The specific noise level plus any correction (+5 dB) for the character of the noise, known as the Rating Level.
Assessment Level	Difference between Rating Level ($L_{Ar,T}$) and Background Noise ($L_{A90,T}$)
Sound Power Level (L_{WA})	The noise level from the source in terms of sound power, in dB(A).

Appendix 2 – Noise instrumentation

Type	Manufacturer	Description	Serial Number	Last Calibration Date	Calibration Certificate No.
Svan 945A	Svantek	Sound level meter	9485	01/05/2019	187795
GA 607	Castle	Sound level calibrator	032942	01/05/2019	187794
Svan 949	Svantek	Sound level meter	8101	10/01/2019	183869
4230	Bruel & Kjaer	Sound level calibrator	781674	10/01/2019	183870
Svan 957	Svantek	Sound level meter	23893	25/10/2017	171631

The calibration of the instrumentation was checked at the start and end of the tests and there was no significant drift.

Figure 1 - Location Plan

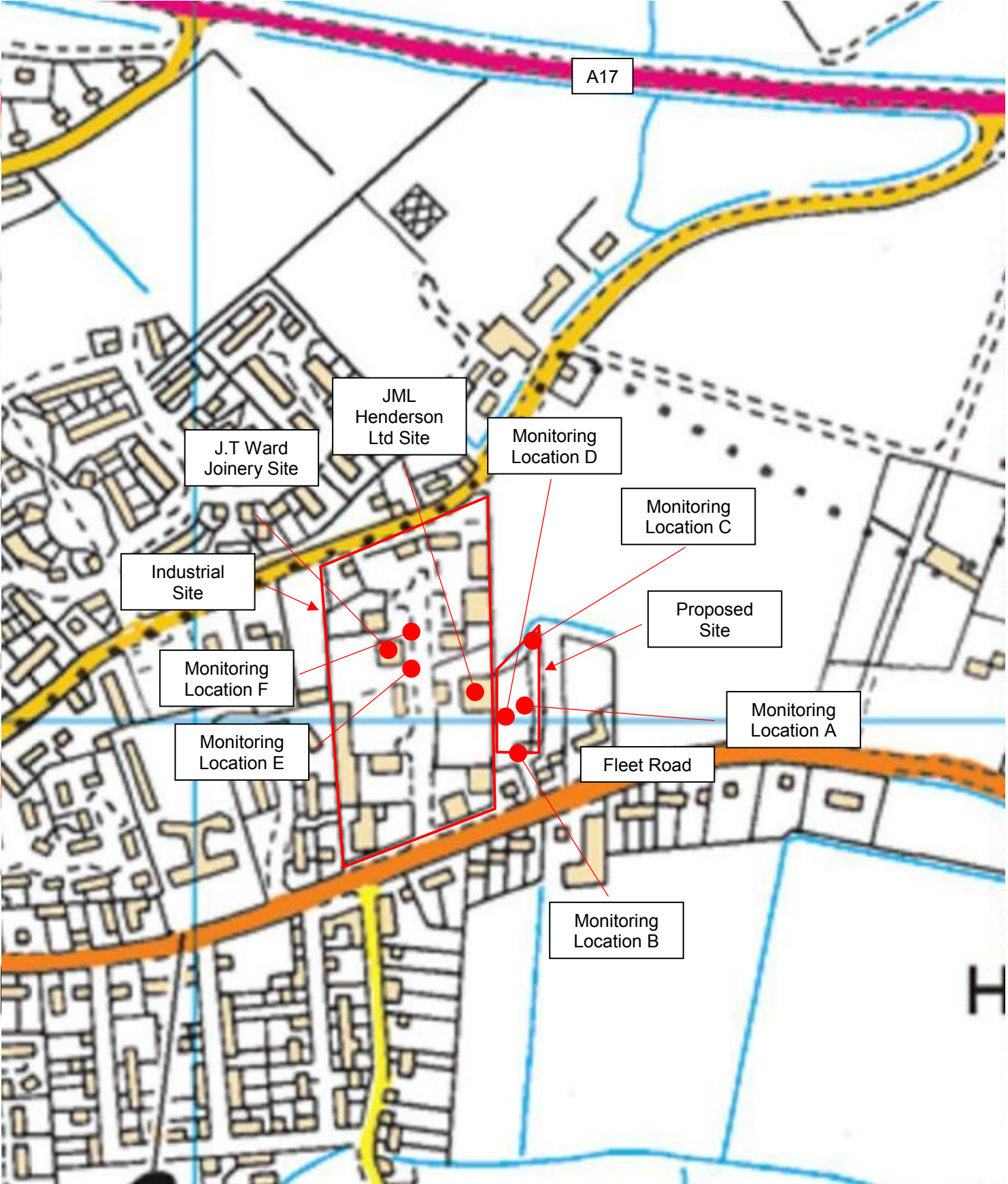


Figure 3 – Computer Noise Model Of The Site

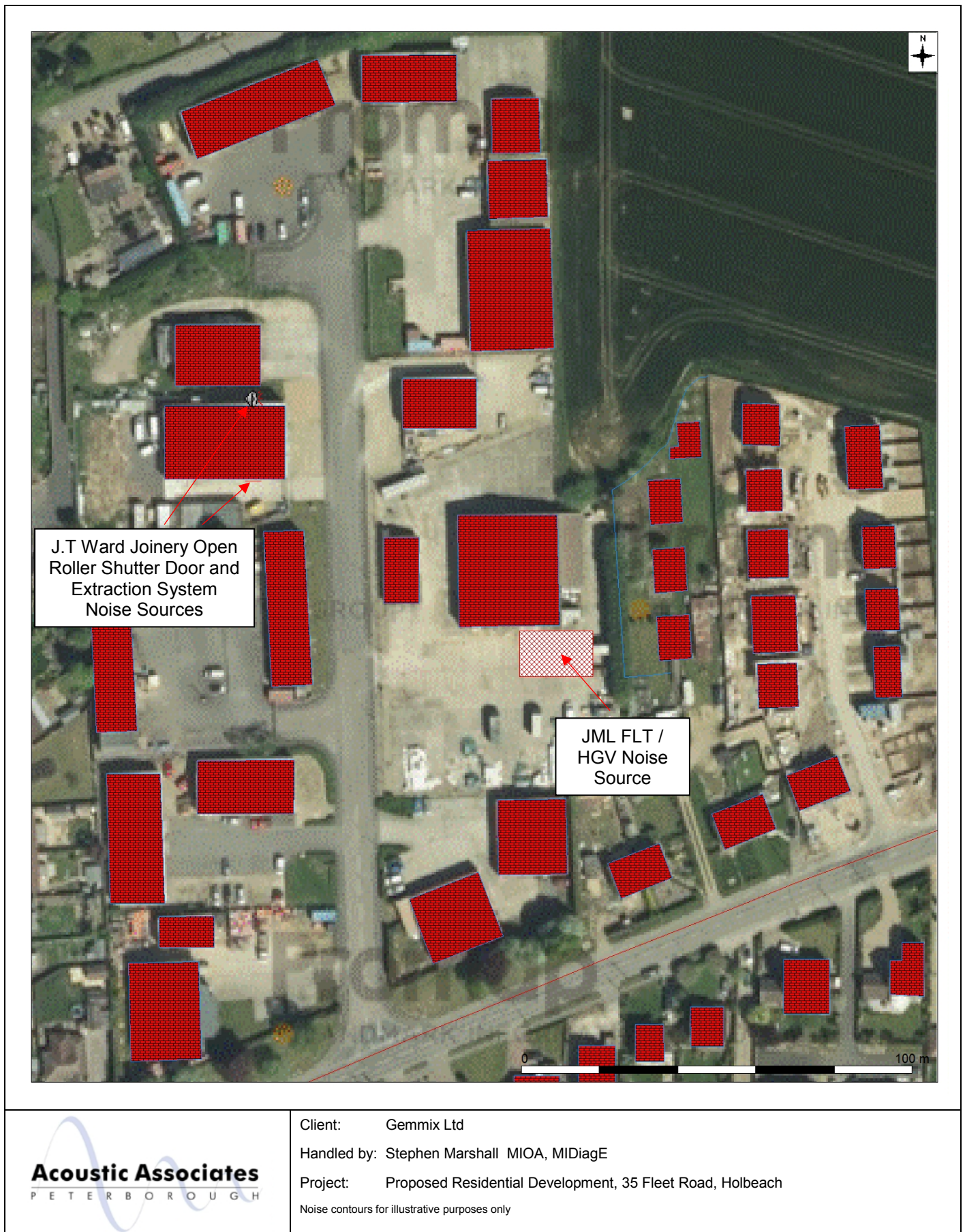


Figure 4 – Daytime noise contours at 1.5 metres above ground (Assumed Typical Operations)

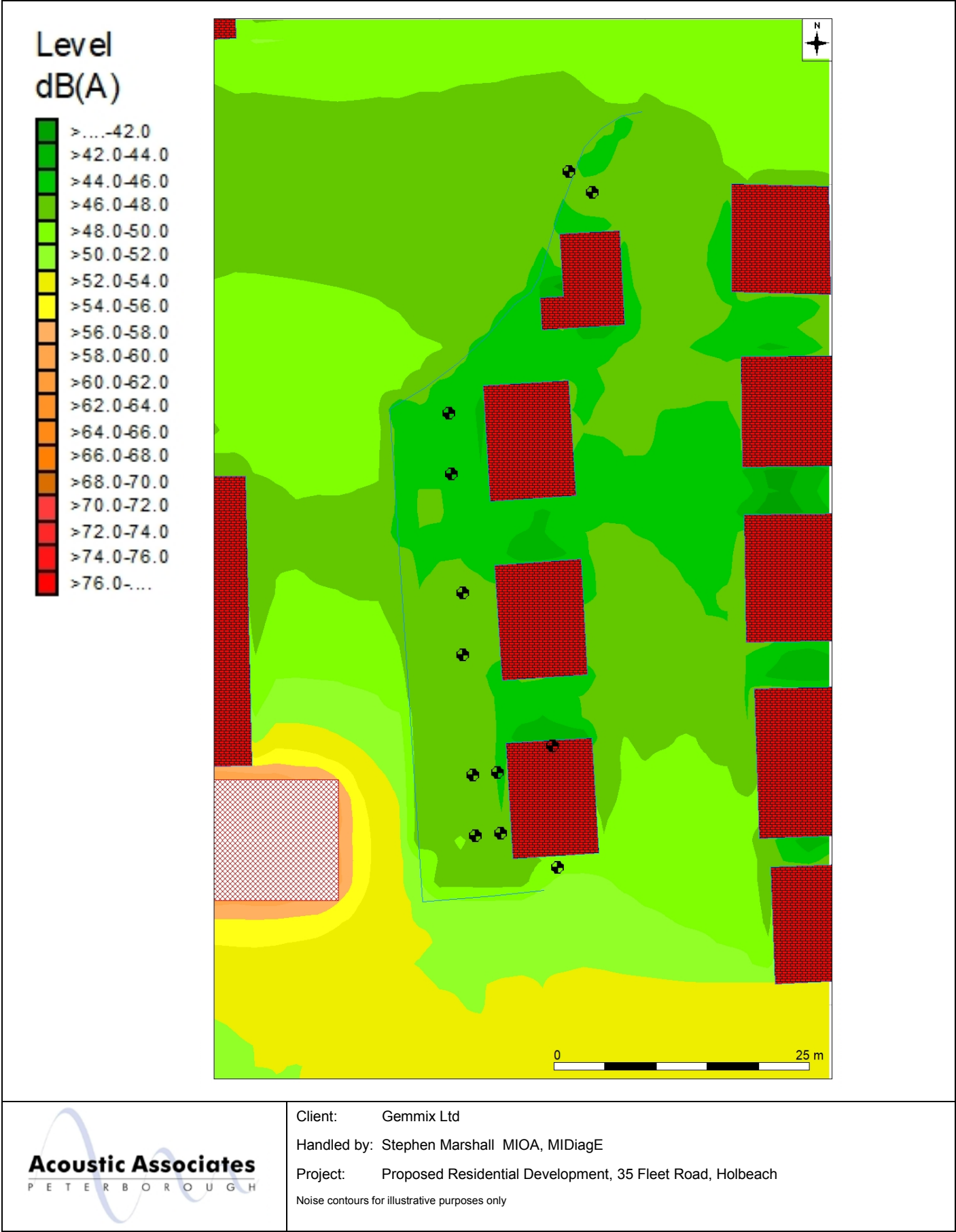


Figure 5 – Night-time noise contours 4.5 metres above ground (Assumed Typical Operations)

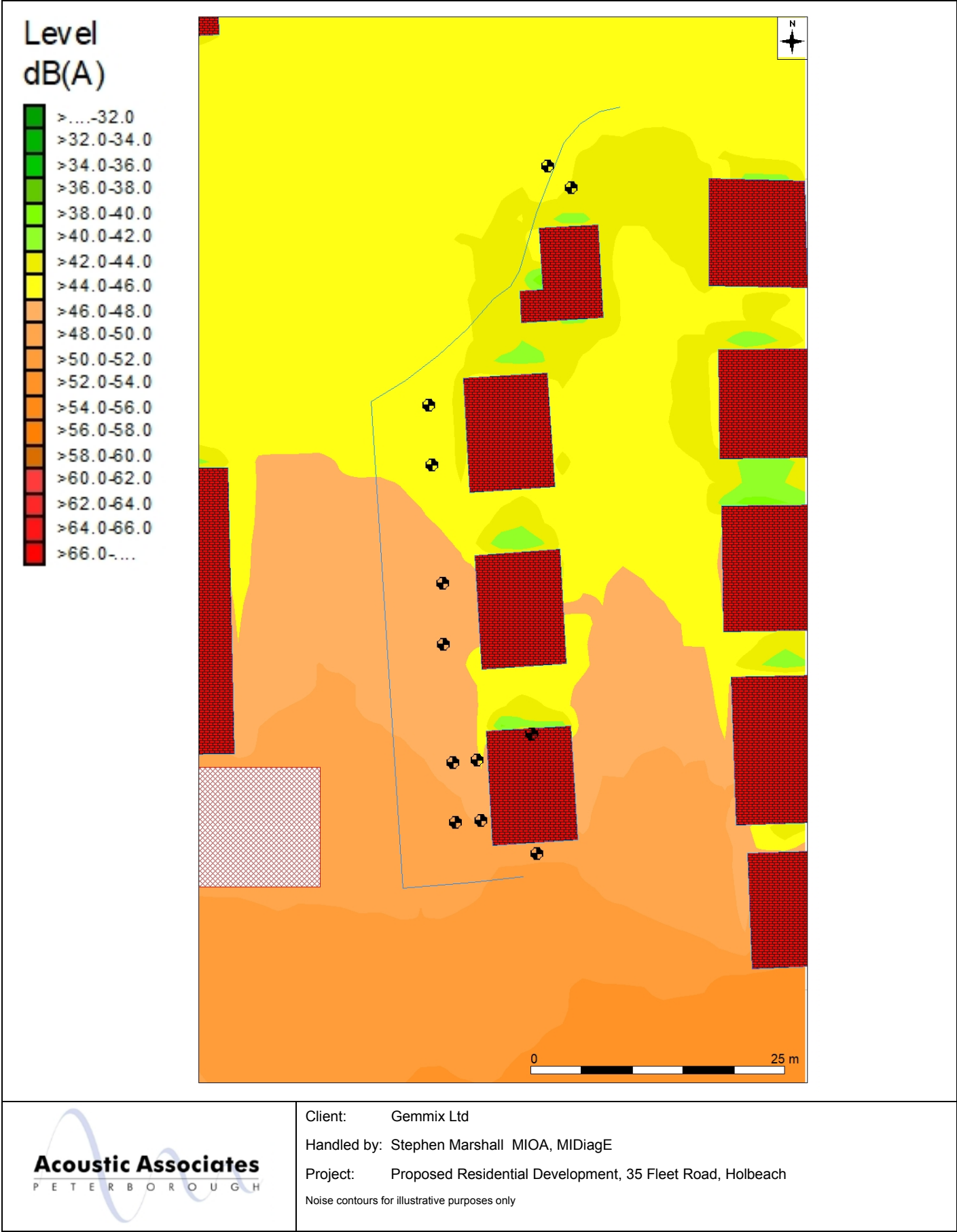


Figure 6 – Daytime noise contours 1.5 metres above ground (Assumed Worst Case Operations)

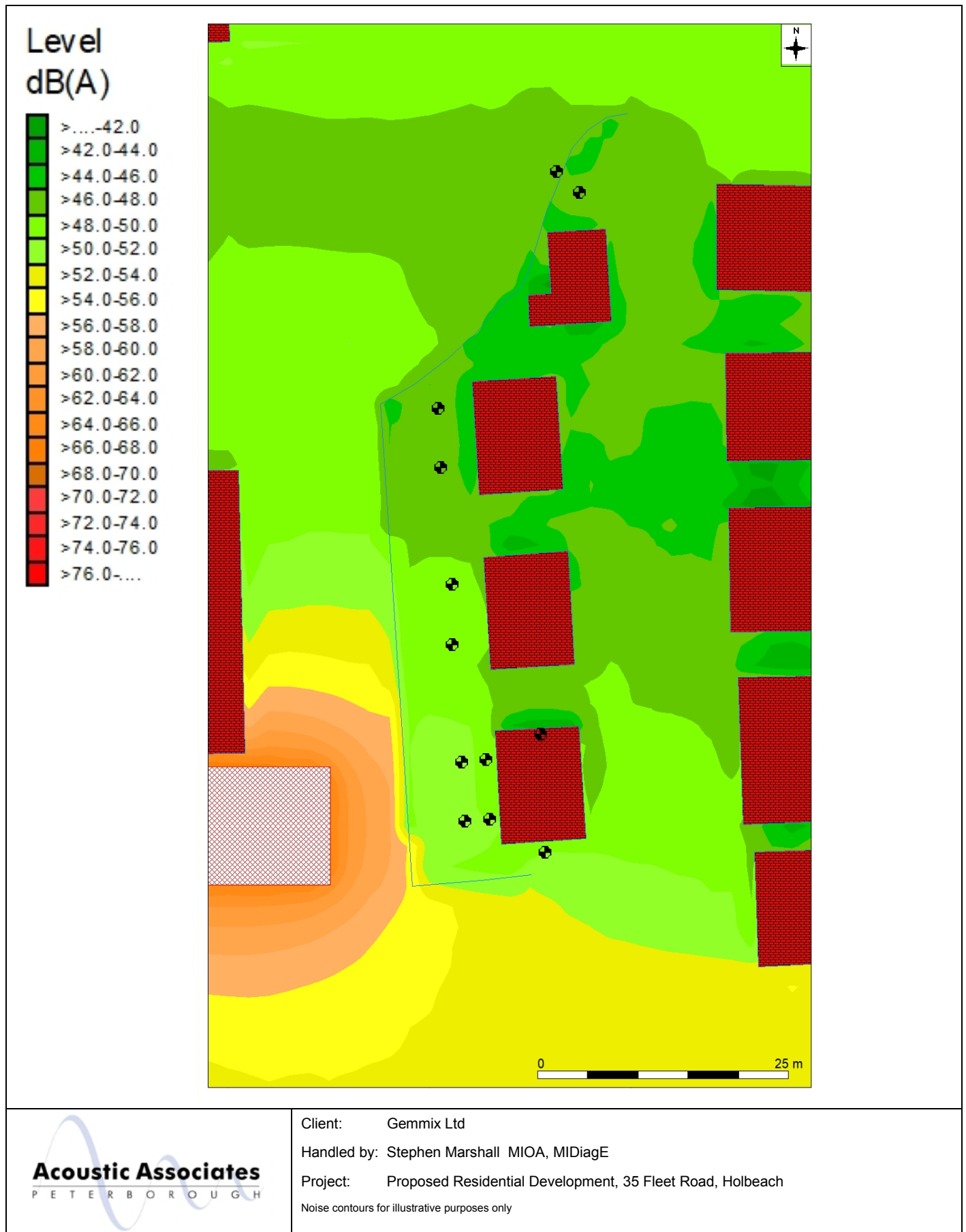


Figure 7 - Night-time noise contours 4.5 metres above ground (Worst Case Operations)

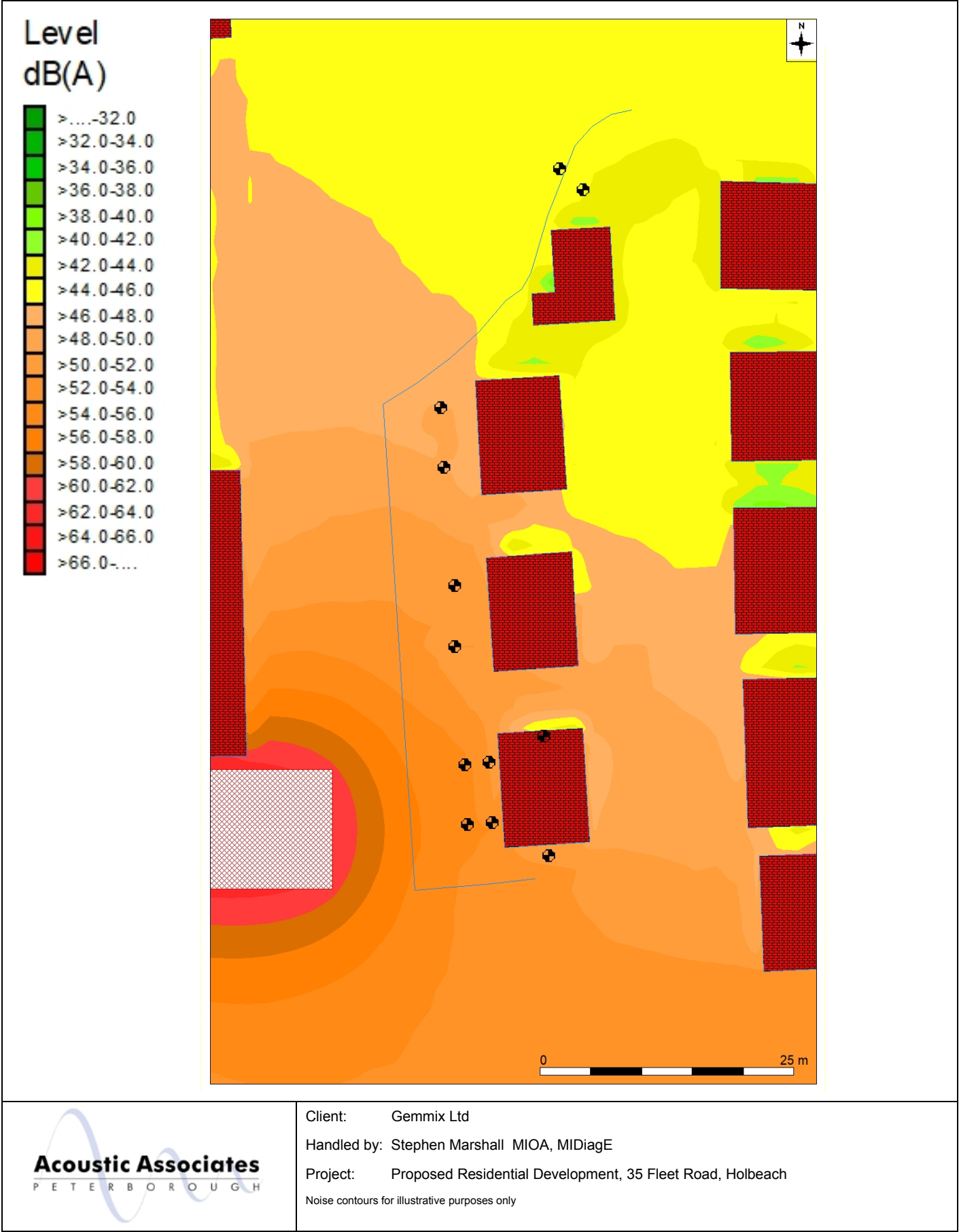
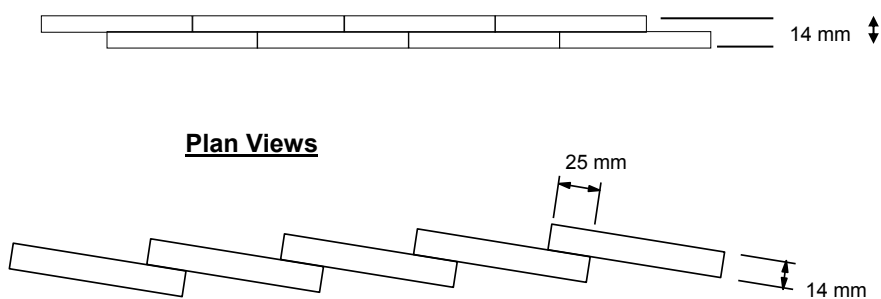


Figure 8 – Acoustic Barrier Guidance

Any material can be used to construct the acoustic barriers, with a minimum surface density of 10 kg/m². This will give noise attenuation up to 20 dB.

It is advised that the minimum thickness of a wooden fence is at least 14mm and is overlapped as shown below.

Suitable Wooden Fence Configurations:



Note: All gaps should be sealed, including the area between the ground and bottom of the fence.