Noise and Vibration Impact Assessment

Bennett Street, Manchester

Reference: 50-636-R1-4

Date: July 2022

NOISE AND VIBRATION IMPACT ASSESSMENT

Bennett Street
Manchester

Prepared for:

Kellen Homes

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E3P

Taylor Road
Trafford Park
Urmston
Manchester
M41 7JQ

+ 44 (0) 161 707 9612
https://e3p.co.uk

Registered in England
CRN: 807255262

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PREPARED BY	L Faulkner	L Faulkner	L Faulkner
QUALIFICATIONS	BSc (Hons), PGDip, MIOA	BSc (Hons), PGDip, MIOA	BSc (Hons), PGDip, MIOA
POSITION	Associate Director	Associate Director	Associate Director
CHECKED BY	S Boughton	S Boughton	S Boughton
QUALIFICATIONS	BEng (Hons), AMIOA	BEng (Hons), AMIOA	BEng (Hons), AMIOA
POSITION	Consultant	Consultant	Consultant
AUTHORISED BY	L Faulkner	L Faulkner	L Faulkner
QUALIFICATIONS	BSc (Hons), PGDip, MIOA	BSc (Hons), PGDip, MIOA	BSc (Hons), PGDip, MIOA
POSITION	Associate Director	Associate Director	Associate Director

EXECUTIVE SUMMARY

BACKGROUND

Site Address	Bennett Street, Manchester M12 5NL
National Grid Reference	E 386194 N 397049
Proposed Development	Planning application for 272 residential units with community centre, associated access and landscaping.
Report Objectives	The objectives of this report are to: - Identify, measure and assess the potential impact of any existing noise and vibration sources in the immediate vicinity of the Site upon proposed residential development. The report follows current and relevant British Standards in order to provide a robust assessment.

ASSESSMENT

Surveys Completed	E3P has undertaken two unattended rail traffic sound surveys in order to capture sound from the railway lines to the west and to the north. Furthermore, a vibration survey has been conducted concurrently with the sound survey at the western boundary of the site where rail traffic is more dominant. An attended road traffic sound survey has been conducted for Bennett Street in accordance with the shortened measurement procedure given in Calculation of Road Traffic Noise.
Assessments	A 3D noise model has been constructed to assess potential rail and road traffic sound impact across the site, within rear garden areas and incident upon proposed facades. External and internal noise levels are assessed in accordance with the criteria given in BS 8233:2014+A1:2019. Rail vibration was found to result in a less than low probability for adverse comment.
Mitigation Requirements	It was found that acoustic barriers are required for certain garden areas due to the impact of sound from rail and/or road traffic in order to achieve levels as close as possible to 55 dB. Considering the height of the railway line above the site, a compromise between unduly high barriers and slightly elevated noise levels has been made. Furthermore, whole dwelling ventilation is required for plots in order to provide background ventilation. The client will install a System 2 PIV to all plots which satisfies the requirements of this report.

CONCLUSIONS

The assessment has found that, with mitigation measures in place, no adverse impact is predicted at the proposed receptors during daytime and night-time periods.

As such, noise need not be a determining factor in the granting of planning permission.

TABLE OF CONTENTS

EXECUTIVE SUMMARY 2
Background 2
Assessment 2
Conclusions 2

1. INTRODUCTION 4
1.1. Background 4
1.2. Proposed Development 4
1.3. Limitations 4

2. ASSESSMENT METHODOLOGY 5
2.1. National Planning Policy Framework 5
2.2. National Planning Practice Guidance 5
2.3. Manchester City Council (2022) Planning & Noise. Technical Guidance 7
2.3.1. Residential Developments 8
2.4. British Standard BS 8233:2014+A1:2019 – Guidance on Sound Insulation and Noise Reduction for Buildings 8
2.4.1. Noise Criteria Limits 8
2.4.2. Ventilation Requirements 9
2.5. World Health Organisation (WHO) – Guidelines for Community Noise 10
2.6. Institute of Acoustics and Association of Noise Consultants (2020) Acoustics Ventilation and Overheating: Residential Design Guide 10
2.7. British Standard BS6472-1: 2008: Guide to evaluation of Human Exposure to Vibration in Buildings 13

3. SURVEY RESULTS 14
3.1. Rail Traffic Sound Measurement - Viaduct 14
3.2. Rail Traffic Sound Measurement - Northern 15
3.3. Road Traffic Sound Measurement – Bennett Street 16
3.4. Rail Vibration Survey 18

4. NOISE IMPACT ASSESSMENT 19
4.1. External Amenity Area Noise Level Assessment 19
4.2. Internal Noise Level Assessment 20
4.2.1. Ventilation Condition 20
4.2.2. Overheating Condition 21

5. MITIGATION 22
5.1. External Amenity Areas 22
5.2. Façade Insulation 22

6. CONCLUSION AND RECOMMENDATIONS 24

APPENDIX I GLOSSARY OF ACOUSTIC TERMINOLOGY 25

APPENDIX II MEASURED SOUND PRESSURE LEVELS 28

APPENDIX III FIGURES 31

1. INTRODUCTION

1.1. BACKGROUND

E3P were commissioned by Kellen Homes to undertake a Noise and Vibration Impact Assessment to accompany a Planning Application for a residential development at Bennett Street in Manchester, to be referred to hereafter as '*the Site*'.

This assessment looks to determine the key existing noise and vibration sources and assess their impact upon proposed receptors and to specify mitigation measures, where required.

1.2. PROPOSED DEVELOPMENT

Kellen Homes intends to the develop the site for 272 residential units with associated open space, landscaping and access.

The key sources of existing sound impacting upon the Site is rail traffic associated with the elevated viaduct along the south western boundary and, to a lesser extent, the lines along the northern boundary. Furthermore, there is potential for rail vibration to be perceptible along the boundary with the line. There is also potential for elevated noise levels for plots along Bennett Street due to road traffic sound.

This assessment has been undertaken in accordance with the following supplied drawings:

- Site Layout (Drawing Number KH006 A-100) dated 18th February 2022.

1.3. LIMITATIONS

Where a noise or vibration survey is required to inform an assessment, E3P will endeavour to ensure that all noise and vibration measurements taken are robust, representative and reliable in order to inform an accurate assessment.

Where mitigation measures are specified in this report, it should be noted that these measures are relative to a specific sound or vibration source, both in terms of the measured sound pressure and vibration level and the character of the sound source. Where either the sound pressure level or the character of the sound varies following completion of the sound survey, E3P cannot be held responsible for any subsequent variations in the proposed mitigation performance.

2. ASSESSMENT METHODOLOGY

2.1. NATIONAL PLANNING POLICY FRAMEWORK

To prevent unacceptable risks from pollution, planning policies and decisions should ensure that new development is appropriate for its location. The effects (including cumulative effects) of pollution on health, the natural environment or general amenity, and the potential sensitivity of the area or proposed development to adverse effects from pollution, should be considered.

The national planning policy framework states that planning policies and decisions should aim to:

- Avoid noise from giving rise to significant adverse impacts on health and quality of life as a result of new development.
- Mitigate and reduce to a minimum, other adverse impacts on health and quality of life arising from noise from new development, including through the use of conditions.
- Recognise that development will often create some noise and existing businesses wanting to develop in continuance of their business should not have unreasonable restrictions put on them because of changes in nearby land uses since they were established.
- Identify and protect areas of tranquillity which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason.

2.2. 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-making should take account of the acoustic environment and in doing so consider:

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

In line with the explanatory note of the NPSE, this would include identifying whether the overall effect of the noise exposure (including the impact during the construction phase, where 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 2.1 summarises the noise exposure hierarchy, based on the likely average response.

TABLE 2.1 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			
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, or having to close windows for some of the time because of the noise where there is no alternative ventilation. 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, having to keep windows closed most of the time because of the noise where there is no alternative ventilation. 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 (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 situation. These factors include the following:

- 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. 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 can be important.
- The spectral content of the noise and the general character of the noise. The local topology and topography should also be considered 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 considered 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.
- If external amenity spaces are an intrinsic part of the overall design, then the acoustic environment of those spaces should be considered so that they can be enjoyed as intended.

2.3. MANCHESTER CITY COUNCIL (2022) PLANNING & NOISE. TECHNICAL GUIDANCE

In the context of government policy, the Council require that developments aim for:

1. A noise level between the **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) and the **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). Conditions may be attached.

If point 1 cannot be achieved, then:

2. If the assessment results in a level between the **Lowest Observed Adverse Effect Level** and the **Significant Observed Adverse Effect Level** (this is the level of noise exposure above which significant adverse effects on health and quality of life occur), mitigation will be necessary to reduce the level and thus conditions will be attached.

If points 1 & 2 cannot be achieved, then:

3. If the assessment results in a **Significant Observed Adverse Effect Level** after mitigation, the application will be recommended for refusal.

2.3.1. RESIDENTIAL DEVELOPMENTS

The Council has adopted the following noise limits for residential properties:

- Bedrooms (night time - 23.00 - 07.00) 30 dB L_{Aeq} (individual noise events should not normally exceed 45 dB $L_{Amax,F}$ by more than 10 times)
- Living Rooms (daytime - 07.00 - 23.00) 35 dB L_{Aeq}
- Gardens and terraces (daytime) 55 dB L_{Aeq}

These criteria have been adopted for the following reasons:

- BS 8233: 2014 recognises these levels as a good standard for resting/sleeping conditions.
- The WHO document 'Guidelines for Community Noise' recommends an internal L_{Aeq} of 30dB for optimal sleep conditions (and no more than 35dB for internal rooms during daytime).
- The performance of acoustic insulation schemes can often be below that specified, according to the quality of installation, materials, noise spectrum and deterioration / wear and tear of building elements. A high design specification introduces a 'safety margin' should building elements not perform as well as expected ('on-site' performance).
- Performance specification for glazing does not usually take into account the detrimental effect of vents on the sound insulation. Even 'acoustic' vents will reduce the performance of the facade insulation, as they will inherently contain a free open area for air exchange.
- There is a general increase in urban noise levels, which can in the future be reasonably accommodated by these standards.
- The standards support the Local Authority corporate objective to prevent ill-health and improve local peoples' health and well being.

2.4. BRITISH STANDARD BS 8233:2014+A1:2019 – GUIDANCE ON SOUND INSULATION AND NOISE REDUCTION FOR BUILDINGS

2.4.1. NOISE CRITERIA LIMITS

The scope of this standard is the provision of recommendations for the control of noise in and around buildings including residential dwellings. 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 residential dwellings, as shown in Table 2.2.

TABLE 2.2 BS 8233:2014 RECOMMENDED INTERNAL NOISE LEVELS

CRITERION	TYPICAL SITUATION	DESIGN CRITERION, $L_{Aeq,T}$ (dB)
Suitable Resting and Sleeping Conditions	Living Room	35
	Bedroom	30

BS 8233 goes on to recommend noise levels for gardens:

> *It is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$, with an upper guideline value of 55 dB $L_{Aeq,T}$ 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.*

BS 8233 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.*

2.4.2. VENTILATION REQUIREMENTS

Where a partially open window cannot be relied upon to provide an adequate level of façade sound insulation performance, it is necessary to consider alternative ventilation for habitable rooms. Section 8.4.5.4 within BS 8233 states:

> *The Building Regulations' supporting documents on ventilation [48, 49, 50] recommend that habitable rooms in dwellings have background ventilation. Where openable windows cannot be relied upon for this ventilation, trickle ventilators can be used and sound attenuating types are available. However, windows may remain openable for rapid or purge ventilation, or at the occupant's choice.*
>
> *Alternatively, acoustic ventilation units (see 7.7.2 below) are available for insertion in external walls. These can provide sound reduction comparable with double glazed windows. However, ducted systems with intakes on the quiet side of the building might be required in very noisy situations, or where appearance rules out through-the-wall fans.*

Section 7.7.2 states:

> *NOTE 5 If relying on closed windows to meet the guide values, there needs to be an appropriate alternative ventilation that does not compromise the façade insulation or the resulting noise level.*

2.5. WORLD HEALTH ORGANISATION (WHO) – GUIDELINES FOR COMMUNITY NOISE

The WHO gives guidance on desirable levels of environmental noise. The levels presented in the WHO Community Guidelines are those at which adverse effects become measurable. The 1980 WHO document suggested that *"general daytime outdoor noise levels of less than 55 dB(A) $L_{eq,16hr}$ are desirable to prevent any significant community annoyance."* This level is an external free-field noise level. The 1980 document also stated in relation to internal levels, *"that night-time noise levels of 35 dB(A) $L_{eq,8hr}$ or less will not interfere with the restorative process of sleep"*.

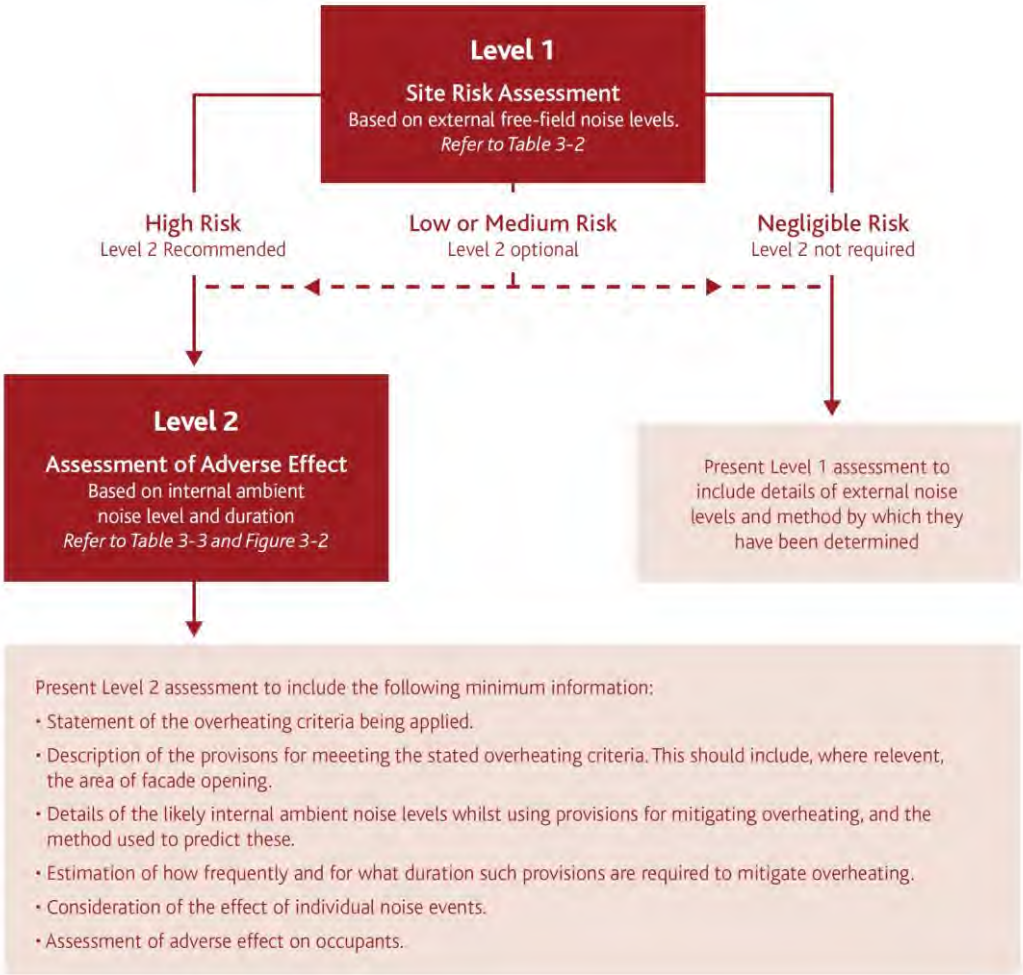
A report was submitted to the WHO in 1995 for consideration as a revision to the 1980 document and revised community guidelines were issued in 2000. In the 2000 guidelines, it is considered that the sleep disturbance criteria should be taken as an internal noise level of 30 dB $L_{Aeq,8\ hr}$ or an external level of 45 dB $L_{Aeq,8\ hr}$. It also recommends that internal L_{Amax} levels of 45 dB and external L_{Amax} levels of 60 dB should be limited where possible.

2.6. INSTITUTE OF ACOUSTICS AND ASSOCIATION OF NOISE CONSULTANTS (2020) ACOUSTICS VENTILATION AND OVERHEATING: RESIDENTIAL DESIGN GUIDE

The Acoustics Ventilation and Overheating (AVO) Residential Design Guide provides an approach as to how the competing aspects of thermal and acoustic comfort can be managed. The AVO Guide aims to assist designers to adopt an integrated approach to the acoustic design within the context of the ventilation and thermal comfort requirements.

The AVO Guide provides a method for assessing the impact of opening windows and providing whole house ventilation due to the impact of noise via a two-level noise assessment procedure, as below:

DIAGRAM 2.1 TWO LEVEL NOISE ASSESSMENT PROCEDURE – OVERHEATING CONDITION



A level 1 risk assessment is based on external free-field noise levels with the assumption of a partially opened window in use for mitigation of overheating. A level 1 assessment is appropriate for scenarios where the risk to a development is deemed 'Negligible'. 'Low' and 'Medium' risk sites only require a level 2 assessment on an optional basis in order to give further confidence in the suitability of internal noise conditions. The noise levels suggested in Table 2.4 and 2.5 assume a steady road traffic noise source but can be adapted for other transport sources.

TABLE 2.4 GUIDANCE FOR LEVEL 1 SITE RISK ASSESSMENT OF NOISE FROM TRANSPORT NOISE SOURCES RELATING TO OVERHEATING CONDITION

RISK CATEGORY FOR LEVEL 1 ASSESSMENT - EXTERNAL		RISK LEVEL	POTENTIAL EFFECT WITHOUT MITIGATION	RECOMMENDATION FOR LEVEL 2 ASSESSMENT
$L_{Aeq,T}$ during 07:00 - 23:00	$L_{Aeq,8hr}$ during 23:00 - 07:00			
≥65dB	≥55dB	**High**	Increasing risk of adverse effect	Recommended
>55 dB and <63 dB	>45 and <55 dB	**Medium**		Optional
>50dB and <55 dB		**Low**		
≤50 dB	≤45 dB	**Negligible**	Use of opening window as means of mitigating overheating is not likely to result in adverse effect	Not Required

A level 2 assessment will be carried out when the risk of adverse effect is 'High' or it is deemed appropriate for a 'low' or 'medium' risk site. An increase in internal ambient noise level can cause a change in human behaviour. At high levels this creates situations where occupants can no longer open windows for ventilation due to high external noise levels. A level 2 assessment identifies these situations and allows for appropriate alternative ventilation systems to be recommended.

TABLE 2.5 GUIDANCE FOR LEVEL 2 ASSESSMENT OF NOISE FROM TRANSPORT NOISE SOURCES RELATING TO OVERHEATING CONDITION

INTERNAL AMBIENT NOISE LEVEL AT FAÇADE LOCATIONS			EXAMPLE OF OUTCOMES
$L_{Aeq,T}$ during 07:00 - 23:00	$L_{Aeq,8hr}$ during 23:00 - 07:00	Individual noise events during 23:00 - 07:00	
>50 dB	>42 dB	Normally exceeds 65 dB $L_{AF,max}$	Noise causes a material change in behaviour e.g. having to keep windows closed most of the time
Increasing noise levels			Increasing the likelihood of impact on reliable speech communication during the day or sleep disturbance at night
≤35 dB	≤30 dB	Do not normally exceeds $L_{AF,max}$ 45 dB more than 10 times a night	Noise can be heard but does not cause any change in behaviour

2.7. BRITISH STANDARD BS6472-1: 2008: GUIDE TO EVALUATION OF HUMAN EXPOSURE TO VIBRATION IN BUILDINGS

With respect to human exposure to building vibration, BS6472 provides guideline values of the Vibration Dose Value (VDV) above which various degrees of adverse comment may be expected from the occupants of residential buildings. The VDV is defined mathematically as the fourth root of the time integral of the fourth power of the vibration acceleration, after it has been frequency weighted. The guideline values recommended by BS6472 are shown in Table 2.6 below.

TABLE 2.6 BS 6472 GUIDELINE VALUES

PLACE	LOW PROBABILITY OF ADVERSE COMMENT	ADVERSE COMMENT POSSIBLE	ADVERSE COMMENT PROBABLE
Residential Buildings (16-hour day)	0.2-0.4	0.4-0.8	0.8-1.6
Residential Buildings (8-hour night)	0.1-0.2	0.2-0.4	0.4-0.8

Where the vibration is intermittent rather than continuous in nature, BS6472 defines procedures for calculating the estimated Vibration Dose Value (eVDV), based on the number and duration of vibration events and the recorded value of the root mean square frequency weighted vibration acceleration. The frequency weighting takes into account the response of the human body to vibrations of different frequency and whether the person is lying down or standing. The eVDV can then be taken as the VDV for use in the assessment of human exposure to vibration in buildings.

The above guidance relates to vibration measured at the point of entry into the human body, which is usually taken to mean the ground surface or at a point mid-span of an upper storey floor, rather than the point of entry into the building (a foundation element).

3. SURVEY RESULTS

The measurement position is detailed in Figure 1 of Appendix III.

3.1. RAIL TRAFFIC SOUND MEASUREMENT - VIADUCT

E3P has conducted a Rail Traffic Noise Survey to measure the level of noise generated by locomotives along the main railway line along the viaduct during a typical daytime and night-time period. The survey was carried out over the following time periods in accordance with Calculation of Rail Noise (CRN):

- 14:43 Monday 27th June to 15:30 Tuesday 28th June 2022.

The main purpose of the position was to calibrate the noise model, along with NMP2, alongside information provided on the DEFRA Noise Mapping website. The following noise measurement position was chosen for the Rail Traffic Noise Survey:

- Noise Measurement Position 1 (NMP1): Located approximately 4 m from the viaduct wall along the western boundary of the Site. The microphone was located at a height of 1.5 m above ground level and in free-field conditions. The sound climate was dominated by occasional rail traffic and distant road traffic.

A summary of the measured sound pressure levels from the Rail Traffic Noise Survey are presented in Table 3.1.

TABLE 3.1 SUMMARY OF MEASURED NOISE LEVELS FOR NMP1 – RAILWAY LINE

MEASUREMENT START TIME	MEASURED SOUND PRESSURE LEVELS (dB)	
	$L_{Aeq,T}$	10th Highest $L_{Amax,fast}$
15:00	52.2	N/A
16:00	52.9	
17:00	53.9	
18:00	53.1	
19:00	54.5	
20:00	53.0	
21:00	52.5	
22:00	53.2	
23:00	54.3	75.6
00:00	52.7	
01:00	51.3	
02:00	43.8	
03:00	52.6	
04:00	48.3	
05:00	54.9	

MEASUREMENT START TIME	MEASURED SOUND PRESSURE LEVELS (dB)	
	$L_{Aeq,T}$	10th Highest $L_{Amax,fast}$
06:00	53.2	
07:00	62.7	N/A
08:00	54.2	
09:00	55.0	
10:00	54.4	
11:00	54.6	
12:00	54.5	
13:00	55.2	
14:00	55.3	
Average Daytime $L_{Aeq,16\ hour}$		**54**
Average Night-time $L_{Aeq,8\ hour}$		**51**

3.2. RAIL TRAFFIC SOUND MEASUREMENT - NORTHERN

E3P has conducted a Rail Traffic Noise Survey to measure the level of noise generated by locomotives along the main railway line along the viaduct and to capture movements to the north during a typical daytime and night-time period. The survey was carried out over the following time periods in accordance with CRN:

- 14:30 Monday 27th June to 14:30 Tuesday 28th June 2022.

The main purpose of the position was to calibrate the noise model, along with NMP1, alongside information provided on the DEFRA Noise Mapping website. The following noise measurement position was chosen for the Rail Traffic Noise Survey:

- Noise Measurement Position 2 (NMP2): Located on the northern boundary approximately 68 m from the viaduct wall along the western boundary of the Site. The microphone was located at a height of 1.5 m above ground level and in free-field conditions. The sound climate was dominated by occasional rail traffic.

A summary of the measured sound pressure levels from the Rail Traffic Noise Survey are presented in Table 3.2.

TABLE 3.2 SUMMARY OF MEASURED NOISE LEVELS FOR NMP2 – NORTH

MEASUREMENT START TIME	MEASURED SOUND PRESSURE LEVELS (dB)	
	$L_{Aeq,T}$	10th Highest $L_{Amax,fast}$
15:00	54.1	N/A
16:00	54.9	
17:00	55.6	
18:00	54.7	
19:00	54.7	
20:00	55.1	
21:00	53.7	
22:00	53.8	
23:00	53.5	71.8
00:00	52.4	
01:00	50.9	
02:00	45.0	
03:00	54.8	
04:00	50.3	
05:00	54.8	
06:00	53.6	
07:00	56.6	N/A
08:00	55.4	
09:00	56.8	
10:00	57.1	
11:00	56.5	
12:00	57.3	
13:00	57.5	
14:00	57.4	
Average Daytime $L_{Aeq,16\ hour}$		**56**
Average Night-time $L_{Aeq,8\ hour}$		**52**

3.3. ROAD TRAFFIC SOUND MEASUREMENT – BENNETT STREET

E3P has conducted an attended road traffic sound measurement in accordance with the shortened measurement procedure given in Calculation of Road Traffic Noise (CRTN). The survey was carried out over the following periods:

- 10:30 - 13:30 Thursday 23rd June 2022.

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

- Noise Measurement Position 3 (NMP3): Located on the edge of the public park to the east of the site, between Gregory Street and Kniveton Road. Due to ongoing site works within the development site, a position adjacent to the development site was not possible at the time. Traffic conditions were noted to be similar as those at the site. The microphone of the sound level meter was approximately 9 m from the nearest kerbstone. The microphone was located at a height of 1.5 m above ground level and in free-field conditions.

A summary of the measured sound pressure levels from the Road Traffic Noise Survey is presented in Table 3.3.

TABLE 3.3 SUMMARY OF MEASURED NOISE LEVELS FOR NMP1 – BENNETT STREET

MEASUREMENT START	MEASURED SOUND PRESSURE LEVELS (dB)			
	$L_{Aeq,1hr}$	10th Highest $L_{Amax,fast}$	$L_{A10,1hr}$	$L_{A90,1hr}$
10:30	59.8	75.0	61.6	45.8
11:30	58.7		61.8	47.7
12:30	57.0		59.8	45.8
Derived daytime noise level, $L_{Aeq,16hr}$				**58**
Derived night-time noise level, $L_{Aeq,8hr}$				**50**

During the survey, conditions remained dry and wind speeds rarely exceeded 5 m/s. The equipment outlined in Table 3.4 was used for the noise survey.

TABLE 3.4 NOISE MEASUREMENT EQUIPMENT AND CALIBRATION DATES

MEASUREMENT POSITION	EQUIPMENT DESCRIPTION	MANUFACTURER & TYPE NUMBER	SERIAL NUMBER	LAST CALIBRATION DATE
NMP2 and NMP3	Sound Level Meter	01dB Fusion	12039	21st June 2021
	Pre-amplifier	01dB Pre22	1805124	
	Microphone	GRAS 40CE	330832	
	Calibrator	01dB Cal31	87281	3rd February 2022
NMP1	Sound and Vibration Level Meter	Svantek MK255 & SV12L	106978	14th July 2021
	Pre-amplifier			
	Microphone	MK255	20699	

The sound level meters were field calibrated on site using the above-mentioned calibrator prior to and after noise measurements were taken. No significant drift was witnessed as noted above. Calibration certificates are available upon request.

3.4. RAIL VIBRATION SURVEY

E3P has conducted attended vibration measurements of train pass-bys during a typical weekday period. The survey was carried out at the same time as NMP1.

The following vibration measurement position was chosen for the Rail Pass-by Survey:

- Vibration Measurement Position 1 (VMP1): Located on the western boundary approximately 4 m from the viaduct in a position representative of the closest proposed garden edge. The geophone of the meter was secured into the ground using the supplied spikes and levelled with the attached spirit level.

An attended measurement was undertaken so that the hourly dose value could be calculated. The overall VDV in each axis is presented in Table 3.5.

TABLE 3.5 RAIL VIBRATION VDV

MEASUREMENT PERIOD	TRANSVERSE VDV ($m/s^{-1.75}$)	LONGITUDINAL VDV ($m/s^{-1.75}$)	VERTICAL VDV ($m/s^{-1.75}$)
27/06/2022 15:00-23:00	0.002	0.002	0.027
27/06/2022 23:00-07:00	0.001	0.002	0.016
27/06/2022 07:00-15:00	0.002	0.002	0.029

The vibration dose values that are shown above, even the maximum levels, are considered to be very low and fall well below the threshold values for low probability of adverse impact.

As such, further consideration of railway vibration is not considered to be required.

The following equipment was used for the vibration survey.

TABLE 3.6 VIBRATION MEASUREMENT EQUIPMENT AND CALIBRATION DATES

MEASUREMENT POSITION	EQUIPMENT DESCRIPTION	MANUFACTURER & TYPE NUMBER	SERIAL NUMBER	LAST CALIBRATION DATE
VMP1	Sound and Vibration Level Meter	Svantek MK255 & SV12L	106978	14th July 2021

4. NOISE IMPACT ASSESSMENT

For the purposes of this assessment, E3P has used noise modelling software, CadnaA 2022 MR1, to determine the impact of noise from rail and road traffic sound.

The following inputs have been included in the model:

- Site Layout dated 18th February 2022.
- The railway lines along the viaduct and lines to the north have been inputted into the noise model and calibrated using the data from NMP1 and NMP2 and data given for daytime and night-time noise levels from DEFRA Noise Mapping. The DEFRA Maps are modelled at 4 m using 10 m x 10 m grids. As such, this model was run first and then refined using NMP1 and NMP2 data which returned higher noise levels than given in the DEFRA data. As such, the model is considered worst case.
- Site elevations have been taken as existing by way of a 2 m grid Digital Terrain Model (DTM) which contains public sector information licensed under the Open Government Licence v3.0.
- A reflection order of 2 has been used in all calculations.
- Average ground absorption is set at 0.5; and
- Noise levels generated using ISO 9613-1 and ISO 9613-2 "*Acoustics – Attenuation of sound during propagation outdoors*" as incorporated into CadnaA software.

4.1. EXTERNAL AMENITY AREA NOISE LEVEL ASSESSMENT

The noise model has been used to predict noise levels in external amenity areas which are to be used for relaxation. The predicted levels range from 42 dB and up to 61 dB in the worst affected areas.

As such, it is predicted that the No Observed Adverse Effect Level (NOAEL) is achieved in amenity space with noise levels of below 55 dB without mitigation measures in place, with the following commentary:

> *"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."*

Accordingly, no action is required for these gardens.

However, some garden areas close to the viaduct or those side on to Bennett Street will experience an exceedance of this criterion and, as such, will require mitigation measures. This is discussed in Section 5.1.

4.2. INTERNAL NOISE LEVEL ASSESSMENT

With regards internal noise levels, E3P has assumed a standard glazing specification of 4 mm glass/20 mm air space/4 mm glass affords sound insulation performance in the order of 31 dB however this is for a pink noise spectrum. The same unit, weighted for road traffic noise using the '+$C_{t,r}$' correction and rail traffic noise using the '+C_t' correction, has a sound insulation performance value of approximately 25 dB and 30 dB respectively and so these values has been used to calculate internal noise levels. The recently published AVO has found that a common reduction for an open window is 13 dB based on research undertaken. As such, a figure of 13 dB is applied here.

The model has been used to predict façade noise levels at all floor levels. In order to determine any requirements for mitigation, E3P has added the reduction provided by the glazing (25 dB for road and 30 dB for rail) to the relevant criterion for day (35 dB) and for night (30 dB). As such, any facades subject to noise levels higher than 60 dB during the day and/or 55 dB during the night along the road or 65 dB during the day and/or 60 dB during the night due to rail traffic will require higher specification glazing.

The highest predicted day and night façade levels here are 62 dB and 56 dB for road traffic and 68 dB and 65 dB for rail traffic respectively. As such, higher specification glazing is required for certain plots.

The maximum noise level likely to be experienced at plots along the road is noted to be 81 dB. When considering glazing provides attenuation of 31 dB for non-specific sound, the internal noise levels are likely to be approximately 49 dB, some 4 dB above the criterion. As such, this exceedance will be considered when specifying glazing.

The maximum noise level likely to be experienced at plots due to rail traffic is noted to be 76 dB. When considering glazing provides attenuation of 31 dB for non-specific sound, the internal noise levels are likely to be approximately 45 dB.

With regards opening windows, there is a requirement to consider the need to open windows for ventilation and the mitigation of overheating. At this stage, the assessment assumes that ventilation would be provided by way of extract fans in kitchens and bathrooms and openable windows.

4.2.1. VENTILATION CONDITION

When considering a partially open window for ventilation purposes, E3P has assessed whether the BS 8233:2014 internal criterion can be achieved with windows open for ventilation. Here ventilation is defined as:

> *To provide fresh air to the building and to dilute and disperse residual water vapour not dealt with by extract ventilation as well as removing other pollutants which are released throughout the building.*

Thermal comfort and overheating are considered in Section 4.2.2. Purge ventilation is provided by an open window regardless of the ventilation strategy.

As such, a comparison of predicted internal noise levels, with windows open, with the BS 8233:2014 criterion is required. This results in an allowable external noise level of 48 dB during the day and 43 dB during the night in order to achieve the internal criteria with windows open.

As can be seen from the Figures, most facades will experience an exceedance of both criteria and, as such, most plots will require a whole dwelling ventilation system as, when windows are opened for ventilation, the internal ambient noise levels are not considered acceptable and exceed the required criterion. Section 5.0 discusses the requirements and provides necessary advice.

The exact system will also be dependent on the outcome of the overheating condition below.

4.2.2. OVERHEATING CONDITION

E3P has undertaken a level 1 assessment in accordance with the AVO Guide and adopted the noise levels outlined for negligible and low risk. Any plots that pass this test will not require whole house ventilation to control the overheating as external noise levels would be sufficiently low enough that an open window can provide the overheating mitigation without compromising internal noise levels. As such, the allowable façade noise levels are 55 dB during the day and 50 dB during the night. Any facades experiencing higher noise levels than these may be subject to an optional level 2 assessment.

As shown in the Figures, plots central and on the eastern edge of the site fall below this test criteria and, as such, a Level 2 Assessment is not required, and the opening of windows is considered acceptable in order to mitigate overheating.

As such, a means of providing ventilation only will be required for the affected plots which a system 1 whole dwelling ventilation system would provide. This would typically entail extract fans to wet rooms and background ventilators installed in habitable rooms.

In order to achieve the required internal ambient noise levels, any background ventilators, where required, must achieve at least 30 dB $D_{n,e,w}$ + C_t and/or 25 dB $D_{n,e,w}$ + $C_{t,r}$ in the open position, depending on the noise source. This level of reduction is likely to be achieved by a standard background ventilator. The number of background ventilators per room will be dependent on the requirements given in Building Regulations Part F.

However, as can be seen from the Figures, all plots along the south eastern, south western and northern boundaries will experience an exceedance of these noise levels and so a Level 2 assessment has been undertaken for these facades.

An overheating assessment of the site has been undertaken as per the method provided by Good Homes Alliance. The assessment determined a medium risk of overheating. Secondly, it is important to consider the predicted internal noise levels with windows open. The anticipated internal levels with a partially open window (13 dB attenuation) to control overheating would be 55 dB during the day and 52 dB at night for the worst affected dwellings, with overheating design case L_{AFmax} levels up to 63 dB.

Considering these levels on the AVO diagrams, these levels are above the “SOAEL” level, and above a level at which noise causes a material change in behaviour. Furthermore, given the medium risk of overheating and that quieter facades are not available for the worst affected plots to open windows to mitigate overheating, mechanical ventilation is required for certain dwellings. As plot numbers are not available, the requirements are detailed on a plan at the rear of the report.

5. MITIGATION

5.1. EXTERNAL AMENITY AREAS

Section 4.2 determined that the sound level in some external amenity areas would exceed the 55 dB criterion. As such, the noise model has been used to predict noise levels in the affected amenity areas with acoustic barriers in place.

Due to the height of the viaduct above the site, barriers for exposed gardens in the western area are only partially effective with very little reduction compared to the height of barrier needed. Indeed, in order to achieve levels of 55 dB and below, barriers along this boundary would need to be at least 5 m in height. However, BS 8233 provides the following advice:

> *It is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$, with an upper guideline value of 55 dB $L_{Aeq,T}$ 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.*

BS 8233 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.*

As such, E3P have assumed a maximum barrier height of 2.1 m. The resultant noise model is shown in Figure 4. As can be seen, noise levels range between 55 and 57 dB in the gardens of the worst affected plots. This level is considered acceptable and the lowest practicable noise levels with a compromise between slightly elevated noise levels and unduly high barriers.

The barriers proposed can be of wooden fence or brick wall construction but must be sealed at the base, be free from holes and have a minimum mass of 10 kg/m^2.

5.2. FAÇADE INSULATION

The previous section determined that standard thermal double glazing will be sufficient for most plots. However, certain plots close to Bennett Street and the viaduct will require higher specification glazing.

The following specifications are required and their locations, based on plot-by-plot, are shown on Figure 5:

<u>Road Traffic</u>

- 35 dB R_w - example specification of 10 mm glass / 6 to 20 mm air space / 4 mm glass.
- 27 dB $R_w + C_{t,r}$ – example specification of 6 mm glass / 6 to 20 mm air space / 6 mm glass.

Rail Traffic

- 31 dB $R_w + C_t$ – example specification of 10 mm glass / 6 to 20 mm air space / 4 mm glass.
- 32 dB $R_w + C_t$ – example specification of 10 mm glass / 6 to 20 mm air space / 4 mm glass.
- 33 dB $R_w + C_t$ – example specification of 10 mm glass / 6 to 20 mm air space / 4 mm glass.
- 34 dB $R_w + C_t$ – example specification of 10 mm glass / 6 to 20 mm air space / 6 mm glass.
- 35 dB $R_w + C_t$ – example specification of 6 mm glass / 6 to 20 mm air space / 6.8 mm laminated glass.

Furthermore, when windows are opened for ventilation purposes, internal noise levels are exceeded and, as such, a whole dwelling ventilation system is required for all plots with mechanical ventilation required for plots closest to Bennett Street and the Viaduct.

System 1 consists of background ('trickle') ventilators open in living rooms and bedrooms to provide whole dwelling ventilation paired with extract fans in wet rooms. This will be sufficient for all other plots that are not highlighted on Figure 5 for a mechanical system.

However, it is understood that Kellen Homes will be installing the Vent Axia Positive Input Ventilation System, classed as System 2. Upon review of the information, and assuming the PoziDry Pro will be installed, this system provides control on thermal comfort with fully adjustable air velocity and temperate for the residents. This satisfies both of the above requirements for system 1 and mechanical assistance.

The proposed system is also of a low noise design and as such would not result in audible sound from the unit, which is hung in the roof space to limit any vibration induced sound.

In order to achieve the required internal ambient noise levels, where background ventilators form part of the system, the reduction provided by the vent in the open position should, at least, match the attenuation provided by the glazing unit.

The number of background ventilators per room will be dependent on the requirements given in Building Regulations Part F.

6. CONCLUSION AND RECOMMENDATIONS

E3P were commissioned by Kellen Homes in order to undertake a Noise and Vibration Impact Assessment for a proposed residential development on land off Bennett Street in Manchester.

Unattended monitoring has been conducted to quantify levels of rail traffic sound across the site as well as a dedicated rail traffic vibration survey. Furthermore, an attended road traffic sound measurement has been conducted.

A 3D noise model has been constructed to assess potential road and rail sound upon the proposed receptors in accordance with the criterion, for day and night, given in BS 8233:2014+A1:2019.

The assessment determined that higher specification glazing and mechanical ventilation is required for certain plots. Standard thermal double glazing would be sufficient for most plots along with System 1 ventilation.

Acoustic barriers are required at heights of 2.1 m in order to control rail and road traffic sound to achieve the lowest practicable noise levels, below 57 dB, in the affected gardens.

Rail vibration was found to be sufficiently low to be of low probability for adverse comment.

With mitigation measures in place, this assessment has shown that no adverse impact is predicted day or night at the proposed receptors due to existing sound sources.

As such, noise need not be a material consideration in the granting of planning permission as long as the recommendations of this report are followed and included within the design stage.

END OF REPORT

APPENDIX I
GLOSSARY OF ACOUSTIC TERMINOLOGY

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	LOCATION/EXAMPLE
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 a factory
100–110	Burglar alarm at 1 m 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 (2E-05 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 L_{eq} noise level but will still affect the noise environment. Unless described otherwise, it is measured using the "fast" sound level meter response.
L_{10} and 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 L_n 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 to describe traffic noise.
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 125-millisecond time constant.
Slow	A time weighting used in the root-mean-square section of a sound level meter with a 1000-millisecond time constant.

APPENDIX II
MEASURED SOUND PRESSURE LEVELS

TABLE A.1 HOURLY MEASURED SOUND PRESSURE LEVELS – NMP1

PERIOD START	AMBIENT SOUND LEVEL, $L_{Aeq,1hr}$ (dB)	MAXIMUM MEASURED SOUND LEVEL, $L_{Amax,fast}$ (dB)	BACKGROUND SOUND LEVEL, $L_{A90,1hr}$ (dB)
27/06/2022 15:28	52.2	76.1	40.5
27/06/2022 16:28	52.9	76.2	40.6
27/06/2022 17:28	53.9	74.8	40.6
27/06/2022 18:28	53.1	75.3	39.0
27/06/2022 19:28	54.5	73.6	36.4
27/06/2022 20:28	53.0	73.4	38.0
27/06/2022 21:28	52.5	73.7	36.2
27/06/2022 22:28	53.2	74.1	35.9
27/06/2022 23:28	54.3	75.0	37.4
28/06/2022 00:28	52.7	72.6	37.8
28/06/2022 01:28	51.3	74.7	38.2
28/06/2022 02:28	43.8	65.7	35.6
28/06/2022 03:28	52.6	81.5	35.2
28/06/2022 04:28	48.3	70.8	39.1
28/06/2022 05:28	54.9	77.2	41.9
28/06/2022 06:28	53.2	75.8	45.4
28/06/2022 07:28	62.7	91.9	45.2
28/06/2022 08:28	54.2	75.7	44.0
28/06/2022 09:28	55.0	75.0	43.5
28/06/2022 10:28	54.4	73.7	44.4
28/06/2022 11:28	54.6	80.3	44.5
28/06/2022 12:28	54.5	80.4	46.6
28/06/2022 13:28	55.2	78.8	45.8
28/06/2022 14:28	55.3	77.5	46.4

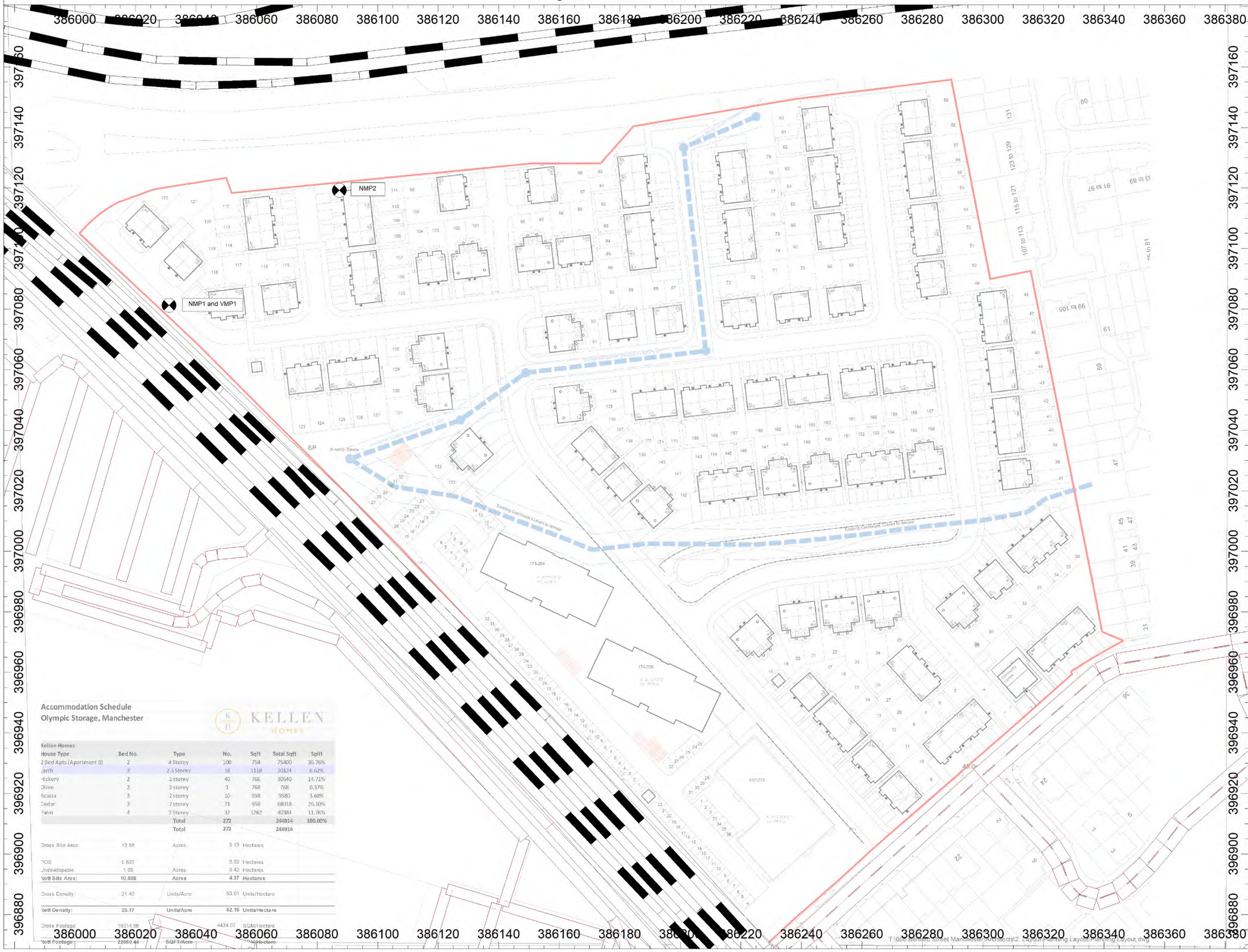
TABLE A.2 HOURLY MEASURED SOUND PRESSURE LEVELS – NMP2

PERIOD START	AMBIENT SOUND LEVEL, $L_{Aeq,1hr}$ (dB)	MAXIMUM MEASURED SOUND LEVEL, $L_{Amax,fast}$ (dB)	BACKGROUND SOUND LEVEL, $L_{A90,1hr}$ (dB)
27/06/2022 14:28	54.1	73.0	42.4
27/06/2022 15:28	54.9	73.9	43.3
27/06/2022 16:28	55.6	75.5	43.5
27/06/2022 17:28	54.7	72.2	42.5
27/06/2022 18:28	54.7	71.6	40.0

PERIOD START	AMBIENT SOUND LEVEL, $L_{Aeq,1hr}$ (dB)	MAXIMUM MEASURED SOUND LEVEL, $L_{Amax,fast}$ (dB)	BACKGROUND SOUND LEVEL, $L_{A90,1hr}$ (dB)
27/06/2022 19:28	55.1	73.9	43.3
27/06/2022 20:28	53.7	71.8	41.2
27/06/2022 21:28	53.8	72.7	41.1
27/06/2022 22:28	53.5	75.1	40.4
27/06/2022 23:28	52.4	71.1	39.5
28/06/2022 00:28	50.9	70.1	39.6
28/06/2022 01:28	45.0	68.1	38.2
28/06/2022 02:28	54.8	77.4	37.8
28/06/2022 03:28	50.3	72.9	40.8
28/06/2022 04:28	54.8	73.6	42.6
28/06/2022 05:28	53.6	70.2	46.1
28/06/2022 06:28	56.6	73.2	47.3
28/06/2022 07:28	55.4	71.8	46.6
28/06/2022 08:28	56.8	75.3	47.1
28/06/2022 09:28	57.1	81.1	48.2
28/06/2022 10:28	56.5	80.8	47.2
28/06/2022 11:28	57.3	75.0	49.6
28/06/2022 12:28	57.5	75.7	48.6
28/06/2022 13:28	57.4	74.2	49.0

APPENDIX III
FIGURES

Figure 1 - Noise and Vibration Measurement Positions



Accommodation Schedule
Olympic Storage, Manchester

KELLEN HOMES

Kellen Homes House Type	Bed No.	Type	No.	Sqft	Total Sqft	Split
2 Bed Apts (Apartment 3)	2	4 Storey	100	754	75400	36.76%
Larch	3	2.5 Storey	18	1118	20124	6.62%
Hickory	2	2 storey	40	766	30640	14.71%
Olive	2	2 storey	1	768	768	0.37%
Acacia	3	2 storey	10	958	9580	3.68%
Cedar	3	2 storey	71	958	68018	26.10%
Palm	4	3 Storey	32	1262	40384	11.76%
		Total	272		244914	100.00%
		Total	272		244914	

Gross Site Area:	12.88	Acres	5.13	Hectares
POS	0.822		0.33	Hectares
Undevelopable	1.05	Acres	0.42	Hectares
Nett Site Area:	**10.808**	**Acres**	**4.37**	**Hectares**
Gross Density:	21.45	Units/Acre	53.01	Units/Hectare
Nett Density:	**25.17**	**Units/Acre**	**62.19**	**Units/Hectare**
Gross Footage	19014.98		4434.07	SQM/Hectare
Nett Footage:	22660.44	SQFT/Acre		SQM/Hectare

Project:
Bennett Street, Manchester

Project-No:
50-636

Client:
Kellen Homes

N

e3p

Project Engineer: L Faulkner
Date: 14/07/2022

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Figure 2 - Daytime Grid Noise Map - Calculation at 1.5 m above ground level

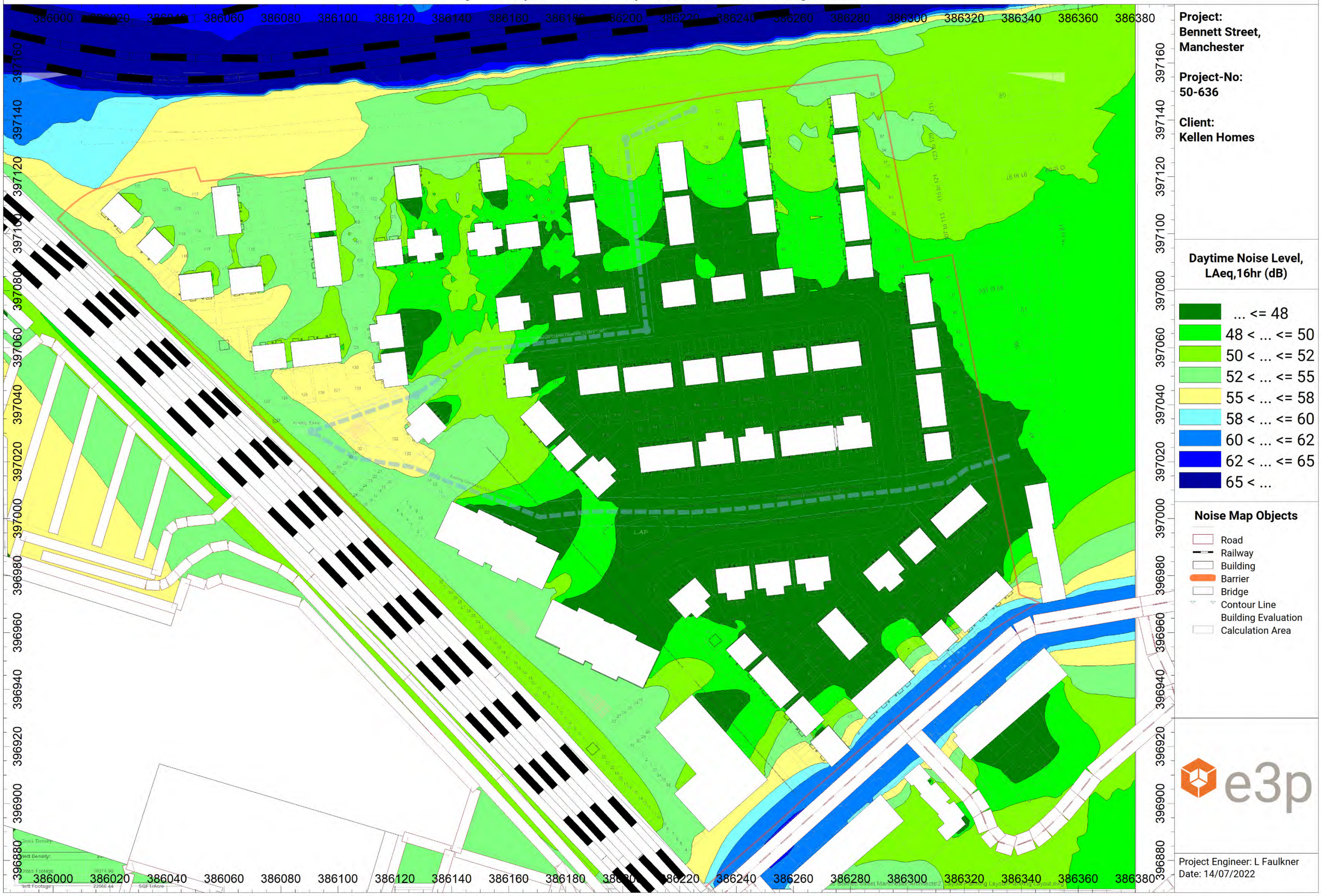


Figure 3 - Night-time Grid Noise Map - Calculation at 4 m above ground level

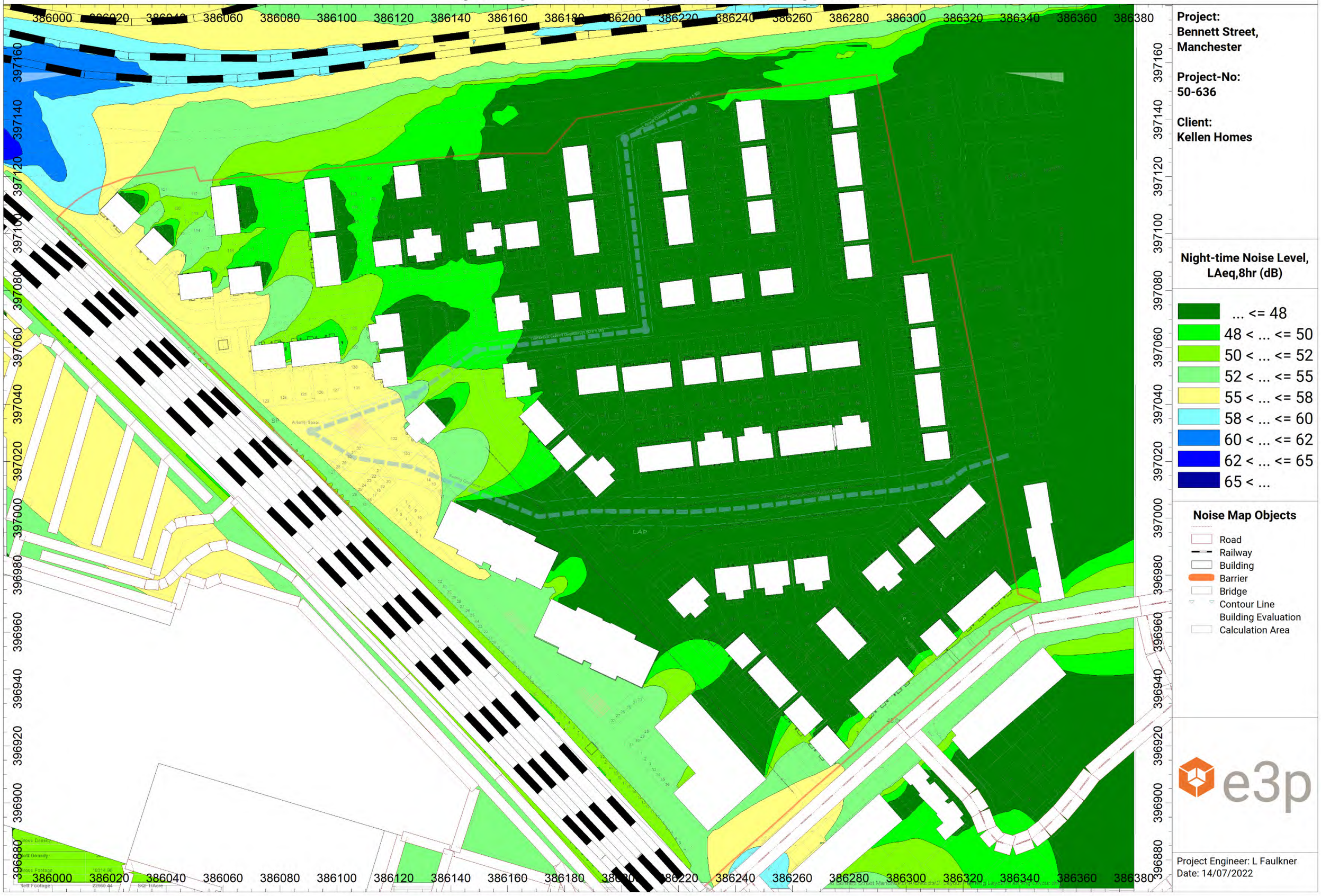
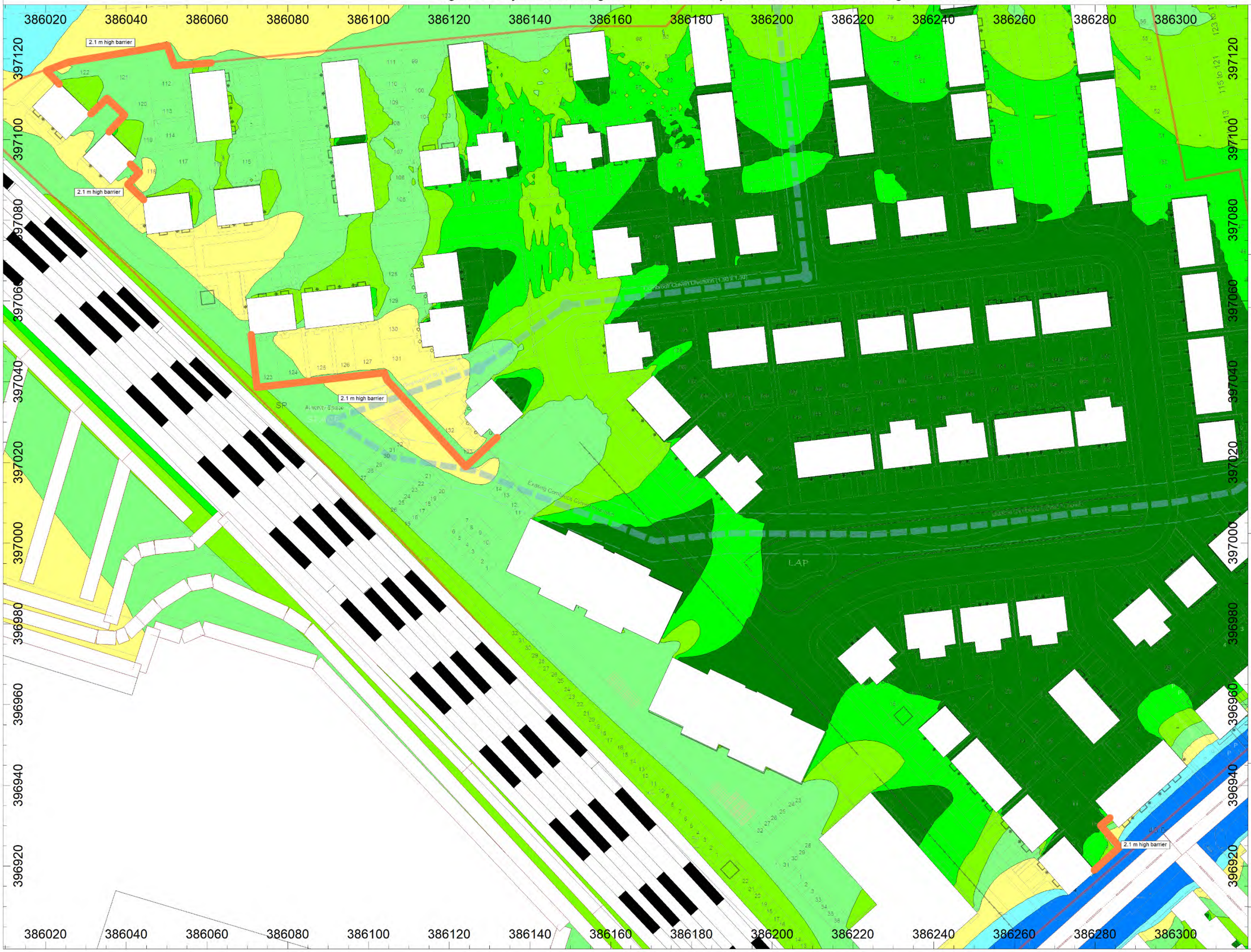


Figure 4 - Daytime with Mitigation Grid Noise Map - Calculation at 1.5 m above ground level



Project:
Bennett Street, Manchester

Project-No:
50-636

Client:
Kellen Homes

Daytime Noise Level, LAeq,16hr (dB)

- ... <= 48
- 48 < ... <= 50
- 50 < ... <= 52
- 52 < ... <= 55
- 55 < ... <= 58
- 58 < ... <= 60
- 60 < ... <= 62
- 62 < ... <= 65
- 65 < ...

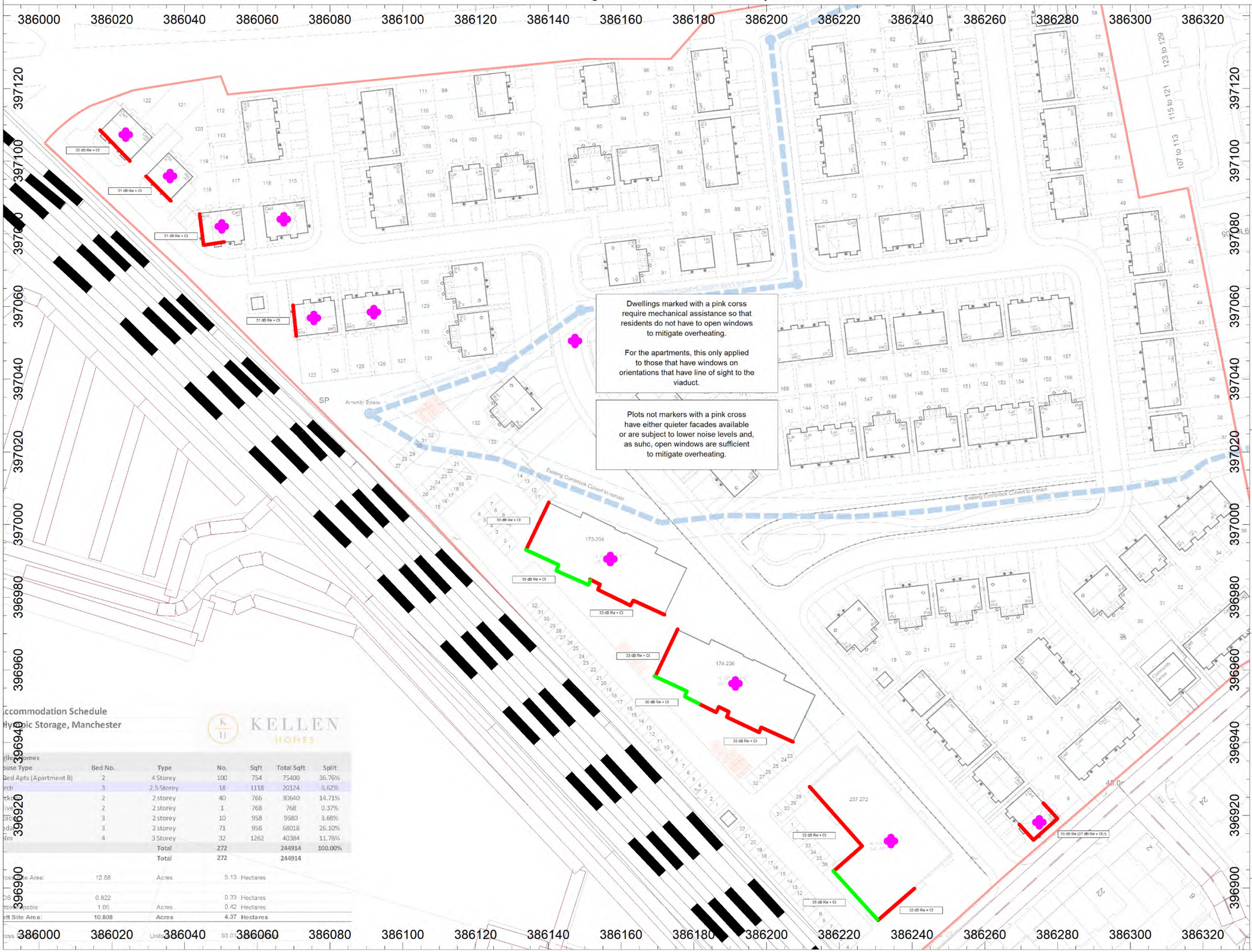
Noise Map Objects

- Road
- Railway
- Building
- Barrier
- Bridge
- Contour Line
- Building Evaluation
- Calculation Area

e3p

Project Engineer: L Faulkner
Date: 14/07/2022

Figure 5 - Facade Insulation Requirements



ccommodation Schedule
Hy pic Storage, Manchester

KELLEN HOMES

ellen Homes						
ouse Type	Bed No.	Type	No.	Sqft	Total Sqft	Split
Bed Apts (Apartment B)	2	4 Storey	100	754	75400	36.76%
rch	3	2.5 Storey	18	1118	20124	6.62%
ckoo	2	2 storey	40	766	30640	14.71%
ive	2	2 storey	1	768	768	0.37%
cac	3	2 storey	10	958	9580	3.68%
eda	3	2 storey	71	958	68018	26.10%
lm	4	3 Storey	32	1262	40384	11.76%
		Total	272		244914	100.00%
		Total	272		244914	

ross Site Area:	12.68	Acres	5.13	Hectares
OS	0.822		0.33	Hectares
ndevelopable	1.05	Acres	0.42	Hectares
ett Site Area:	10.808	Acres	4.37	Hectares
ross		Units	53.01	

Project:
Bennett Street, Manchester

Project-No:
50-636

Client:
Kellen Homes

N

e3p

Project Engineer: L Faulkner
Date: 14/07/2022