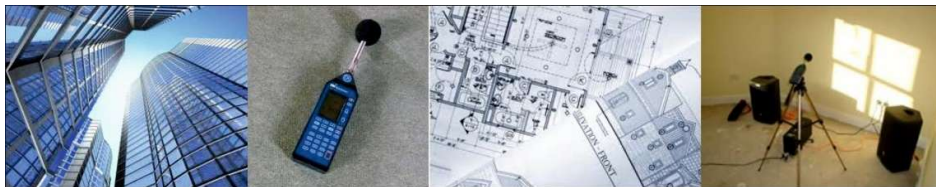


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MILTON PLACE GRAVESEND KENT DA12 2BL

ENVIRONMENTAL NOISE ASSESSMENT

v.3

Client:

GRAVESHAM COMMUNITY INVESTMENT PARTNERSHIP LLP

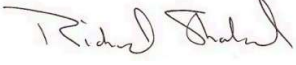
c/o The Powder House
Gunpowder Mill
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20th February 2025

Ref: M5600

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Project Reference	M5600
Issue No.	
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Date	20th February 2025

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1. SUMMARY

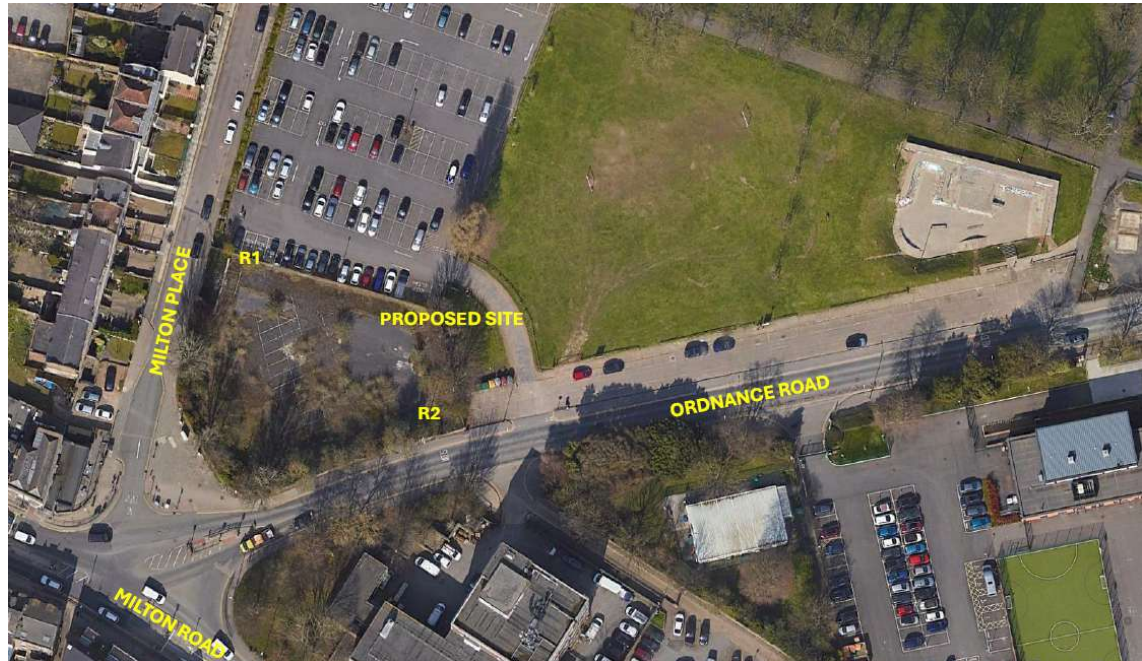
- 1.1 An assessment of environmental noise has been undertaken at a proposed residential development at Milton Place, Gravesend, Kent, DA12 2BL.
- 1.2 The objective of the exercise is to demonstrate that the land is suitable for residential development and how, in principle, an acceptable level of acoustic amenity may be provided.
- 1.3 The existing ambient noise climate affecting the site has been established (Section 3), and the survey has confirmed a typical variation in daytime and night-time levels.
- 1.4 Section 4 provides a description of the relevant national planning policies and defines the criteria which would commonly be applied to projects of this nature.
- 1.5 Means of attenuating the external noise levels have been submitted (Section 5), in the form of a specification for the façade glazing (Tables 5.2 & 5.3).
- 1.6 Section 5 also provides an assessment of noise in external amenity areas. This conclude that all bar one property will experience levels below the threshold values described in the WHO guidance. For the single plot above the numerical target, the Section discusses the practical implications.
- 1.7 Consideration has then been given to the acoustic impact of an open window strategy to address ventilation issues. It has been shown that the predicted external noise levels are below the limits given ADO Overheating for houses 1 – 4 & 12 – 15. These properties may adopt an open window strategy for addressing any overheating issues (see Table 6.3).
- 1.8 Where the predicted noise levels exceed the limits in ADO, properties will be ventilated by means of centralised MEV fans with acoustic trickle vents, designed to counter any overheating issues. Windows will, of course, remain openable.
- 1.9 Overall, it is concluded that, with the recommended measures in place, occupants of new properties can be provided with an acceptable acoustic environment using very practicable methods of construction.

2. INTRODUCTION

- 2.1 An assessment of environmental noise has been undertaken at Milton Place, Kent, DA12 2BL, on behalf of Gravesham Community Investment Partnership LLP.
- 2.2 The site is situated east of Milton Place and north of Ordnance Road. The immediate locality would be described as a mixed residential and commercial area (Figure 1 – Site Location).
- 2.3 The objective of this exercise is to demonstrate the means by which occupiers of dwellings on the site may be guaranteed an acceptable level acoustic amenity. This will be achieved through the consideration of an indicative site layout (Figures 2 to 5 – Proposed GF to 3F Layouts).
- 2.4 It is recognised that the proposed development may be subject to high levels of noise, predominantly from road traffic passing by on the Milton Road, Milton Place and Ordnance Road (the latter being a main route to the local industrial and dock area).
- 2.5 Formally, the objectives of the current exercise may be summarised as follows:
- (i) To determine the existing ambient noise climate in the vicinity of the development site.
 - (ii) To assess likely noise levels at the facades of any new buildings, and to specify a suitable façade construction to ensure acceptable conditions.
 - (iii) To consider the strategy for mitigating overheating issues in the properties, whilst sustaining the acoustic integrity of the façades.
 - (iv) To consider external noise levels and advise on any requirements for site screening.
- 2.6 This report details the investigations carried out in respect of each of these objectives and summarises the conclusions which have been reached.

3. SURVEY OF CURRENT NOISE & VIBRATION LEVELS

- 3.1 The first step in the assessment of potential impact is to measure and describe the existing ambient noise levels affecting the site.
- 3.2 A noise survey was undertaken from Monday 9th to Wednesday 11th December 2024.
- 3.3 Two Rion NL-52 Type 1 sound level meters were set up at locations as shown below.



- 3.4 The microphones of the meters were attached to extendable light stands and set up at the following heights, in a free field position,
- R1 – 3m
 - R2 – 2.5m
- 3.5 The equipment was calibrated before and after the survey and showed no significant variance.
- 3.6 The equipment was configured to measure 5minute samples of the following acoustic parameters:

L_{Aeq} The A-weighted equivalent continuous sound pressure level which, over the sample period, contains the same acoustic energy as the time-varying signal being recorded.

L_{Amax} The A-weighted maximum sound pressure level recorded during each sample period (as measured on fast response).

L_{A90} A statistical parameter representing the A-Weighted noise level exceeded for 90% of each sample period. This is commonly used to describe the underlying background noise levels.

3.7 Weather conditions throughout the survey period are summarized in Table 3.1.

Date	Average Temperature (°C)	Rainfall (mm)	Average Wind Speed m/sec	Wind Direction
Monday 09/12	6	4.8	5.5 – 7.9	N
Tuesday 10/12	5	7.4	3.4 – 5.4	NE
Wednesday 11/12	4	0.0	5.5 – 7.9	NE

Table 3.1 – Summary of Weather Conditions

3.8 Figures 6 & 7 show the variation in noise levels during the survey period at each location, and Table 3.2 confirms the measured levels during each of the standard daytime and night-time periods.

R1 – Milton Place				
Period		Day Time L _{Aeq} , 07.00 – 23.00	Night-Time L _{Aeq} , 23.00 – 07.00	Typical L _{Amax} , fast Night
Monday 09/12	dB(A)	56.8*	52.8	69
Tuesday 10/12	dB(A)	57.3	52.7	74
Wednesday 11/12	dB(A)	57.9*		
R2 – Ordnance Road				
Monday 09/12	dB(A)	67.6*	64.2	87
Tuesday 10/12	dB(A)	68.4	63.9	90
Wednesday 11/12	dB(A)	69.3*		
*Part measurements				

Table 3.2 – Summary of Measured Noise Levels

3.9 The L_{Amax} levels shown in the tables are the peak values based on the 90th percentile and may exclude exceptional 'one-off' events during the night.

3.10 Ian Sharland Limited has taken the source data acquired and developed a computer model of the site using the DGMR iNoise software. The calculations are based on the ISO 9613 and CNOSSOS-EU methods and the recommendations of the quality standard ISO.

3.11 The topography of the site has been created, and then the principal sources of noise have been added, calibrated in strength to the survey results. These include road traffic running along Ordnance Road and Milton Place.

- 3.12 The various buildings have then been added to the model, and at this stage they have all been designed as 2/2½ storey houses and a 4-storey apartment block.
- 3.13 The software has then been used to create a schedule of predictions at each façade of each building, for daytime and night-time periods.
- 3.14 Figures 8 – 15 provide the relevant daytime and night-time noise maps across the site (ground to 3rd floor).
- 3.15 Appendix 1 provides a table of the predicted daytime, night-time $L_{Aeq,8hrs}$ and L_{Amax} façade noise levels for each building.
- 3.16 Section 5 of this report will discuss these noise levels, in respect of their suitability for residential building.

4. ASSESSMENT OF NOISE LEVELS

4.1 National Planning Policy Framework (December 2024)

- 4.1.1 The National Planning Policy Framework (NPPF) sets out the Government's planning policies for England and how these should be applied. It provides a framework within which locally prepared plans for housing and other development can be produced.
- 4.1.2 Planning law requires that applications for planning permission be determined in accordance with the development plan unless material considerations indicate otherwise. The National Planning Policy Framework must be considered in preparing the development plan and is a material consideration in planning decisions. Planning policies and decisions must also reflect relevant international obligations and statutory requirements.
- 4.1.3 The purpose of the planning system is to contribute to the achievement of sustainable development. At a very high level, the objective of sustainable development can be summarised as meeting the needs of the present without compromising the ability of future generations to meet their own needs.
- 4.1.4 Paragraphs 187, 198 & 200 of the NPPF states:

187. *Planning policies and decisions should contribute to and enhance the natural and local environment by:*

- (a) *protecting and enhancing valued landscapes, sites of biodiversity or geological value and soils (in a manner commensurate with their statutory status or identified quality in the development plan).*
- (b) *recognising the intrinsic character and beauty of the countryside, and the wider benefits from natural capital and ecosystem services – including the economic and other benefits of the best and most versatile agricultural land, and of trees and woodland.*
- (c) *maintaining the character of the undeveloped coast, while improving public access to it where appropriate.*
- (d) *minimising impacts on and providing net gains for biodiversity, including by establishing coherent ecological networks that are more resilient to current and future pressures and incorporating features which support priority or threatened species such as swifts, bats and hedgehogs.*
- (e) *preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans; and*
- (f) *remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate.*

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

- a) *mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life*
- b) *identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason; and*
- c) *limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation.*

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

4.2 National Policy Statement for England (March 2010)

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

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

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

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

- *avoid significant adverse impacts on health and quality of life.*
- *mitigate and minimise adverse impacts on health and quality of life.*
- *and where possible, contribute to the improvement of health and quality of life".*

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

- **NOEL** - No Observed Effect Level
This is the level below which no effect can be detected. In simple terms, below this level there is no detectable effect on health and quality of life due to the noise.
- **LOAEL** - Lowest Observed Adverse Effect Level
This is the level above which adverse effects on health and quality of life can be detected. Where levels lie between the LOAEL and SOAEL, the Statement requires that all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life while also taking into account the guiding principles of sustainable development, as set out in the NPPF.
- **SOAEL** - Significant Observed Adverse Effect Level
This is the level above which significant adverse effects on health and quality of life occur. It notes, however, that “it is not possible to have a single objective noise-based measure that describes SOAEL that is applicable to all sources of noise in all situations. Consequently, the SOAEL is likely to be different for different noise sources, for different receptors and at different times”.

4.2.4 Paragraph 2.7 states that “... the application of the NPSE should enable noise to be considered alongside other relevant issues and not to be considered in isolation. In the past, the wider benefits of a policy, development or other activity may not have been given adequate weight when assessing the noise implications”.

4.2.5 This provides clear guidance that noise must not be considered in isolation but as part of the overall scheme, taking into account the overall sustainability and associated impacts of the proposed development; there is no benefit in reducing noise to an excessively low level if this creates or increases some other adverse impact. Similarly, it may be appropriate in some cases for noise to have an adverse impact if this is outweighed by the reduction or removal of some other adverse impact that is of greater significance to the development.

4.2.6 The Noise Policy Statement considers that noise levels above the SOAEL would be seen to have, by definition, significant adverse effects and would be considered unacceptable. Where the assessed noise levels fall between the LOAEL and the SOAEL noise levels, the Policy Statement requires that:

“all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life while also considering the guiding principles of sustainable development.... This does not mean that such adverse effects cannot occur.”

4.2.7 Where noise levels are below the LOAEL it is considered there will be no adverse effect. Once noise levels are below the NOEL there will be no observable change. An indication of the numerical definition of LOAEL may be derived from the following guidance.

4.3 Planning Practice Guide 'Noise' (July 2019)

- 4.3.1 The Ministry of Housing Communities and Local Government provided further guidance to support the NPPF. The section, Noise, published in July 2019, provides the following advice:

When is noise relevant to planning?

Noise needs to be considered when development may create additional noise, or would be sensitive to the prevailing acoustic environment (including any anticipated changes to that environment from activities that are permitted but not yet commenced). When preparing plans, or taking decisions about new development, there may also be opportunities to make improvements to the acoustic environment. Good acoustic design needs to be considered early in the planning process to ensure that the most appropriate and cost-effective solutions are identified from the outset.

What are the observed effect levels?

- *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.*

Although the word 'level' is used here, this does not mean that the effects can only be defined in terms of a single value of noise exposure. In some circumstances adverse effects are defined in terms of a combination of more than one factor such as noise exposure, the number of occurrences of the noise in a given time period, the duration of the noise and the time of day the noise occurs.

How can it be established whether noise is likely to be a concern?

At the lowest extreme, when noise is not perceived to be present, there is by definition no effect. As the noise exposure increases, it will cross the 'no observed effect' level. However, the noise has no adverse effect so long as the exposure does not cause any change in behaviour, attitude or other physiological responses of those affected by it. The noise may slightly affect the acoustic character of an area but not to the extent there is a change in quality of life. If the noise exposure is at this level no specific measures are required to manage the acoustic environment.

As the exposure increases further, it crosses the 'lowest observed adverse effect' level boundary above which the noise starts to cause small changes in behaviour and attitude, for example, having to turn up the volume on the television or needing to speak more loudly to be heard. The noise therefore starts to have an adverse effect and consideration needs to be given to mitigating and minimising those effects (taking account of the economic and social benefits being derived from the activity causing the noise).

Increasing noise exposure will at some point cause the 'significant observed adverse effect' level boundary to be crossed. Above this level the noise causes a material change

in behaviour such as keeping windows closed for most of the time or avoiding certain activities during periods when the noise is present. If the exposure is predicted to be above this level the planning process should be used to avoid this effect occurring, for example through the choice of sites at the plan-making stage, or by use of appropriate mitigation such as by altering the design and layout. While such decisions must be made taking account of the economic and social benefit of the activity causing or affected by the noise, it is undesirable for such exposure to be caused.

At the highest extreme, noise exposure would cause extensive and sustained adverse changes in behaviour and /or health without an ability to mitigate the effect of the noise. The impacts on health and quality of life are such that regardless of the benefits of the activity causing the noise, this situation should be avoided.

- 4.3.2 The table below summarises the noise exposure hierarchy, based on the likely average response:

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

Table 4.1 – Noise Exposure Hierarchy

4.3.3 The guidance further advises:

What factors influence whether noise could be a concern?

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

These factors include:

- the source and absolute level of the noise together with the time of day it occurs. Some types and level of noise will cause a greater adverse effect at night than if

they occurred during the day – this is because people tend to be more sensitive to noise at night as they are trying to sleep. The adverse effect can also be greater simply because there is less background noise at night.

- for a new noise making source, how the noise from it relates to the existing sound environment.
- for non-continuous sources of noise, the number of noise events, and the frequency and pattern of occurrence of the noise.
- the spectral content of the noise (i.e. whether or not the noise contains particular high or low frequency content) and the general character of the noise (i.e. whether or not the noise contains particular tonal characteristics or other particular features), and
- the local arrangement of buildings, surfaces and green infrastructure, and the extent to which it reflects or absorbs noise.

More specific factors to consider when relevant include:

- the cumulative impacts of more than one source of noise.
- whether any 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 (and the effect this may have on living conditions). In both cases a suitable alternative means of ventilation is likely to be necessary. Further information on ventilation can be found in the Building Regulations;
- In cases where existing noise sensitive locations already experience high noise levels, a development that is expected to cause even a small increase in the overall noise level may result in a significant adverse effect occurring even though little to no change in behaviour would be likely to occur.
- Noise Action Plans (where these exist), and, in particular the Important Areas identified through the process associated with the Environmental Noise Directive and corresponding regulations should be taken into account. Defra's website has information on Noise Action Plans and Important Areas. Local authority environmental health departments will also be able to provide information about Important Areas.
- the effect of noise on wildlife. Noise can adversely affect wildlife and ecosystems. Particular consideration needs to be given to the potential effects of noisy development on international, national and locally designated sites of importance for biodiversity.
- where external amenity spaces are an intrinsic part of the overall design, the acoustic environment of those spaces should be considered so that they can be enjoyed as intended.
- some commercial developments including restaurants, hot food takeaways, night clubs and public houses can have particular impacts, not least because activities are often at their peak in the evening and late at night. Local planning authorities will wish to bear in mind not only the noise that is generated within the premises but also the noise that may be made by customers in the vicinity.

When proposed developments could include activities that would be covered by the licensing regime, local planning authorities will need to consider whether the potential for adverse noise impacts will be addressed through licensing controls (including licence conditions). Local planning authorities should not however presume that licence conditions will provide for noise management in all instances and should liaise with the licensing authority.

Are there further considerations relating to mitigating the impact of noise on residential developments?

Noise impacts may be partially offset if residents have access to one or more of:

- a relatively quiet facade (containing windows to habitable rooms) as part of their dwelling.
- a relatively quiet external amenity space for their sole use, (e.g. a garden or balcony). Although the existence of a garden or balcony is generally desirable, the intended benefits will be reduced if this area is exposed to noise levels that result in significant adverse effects.
- a relatively quiet, protected, nearby external amenity space for sole use by a limited group of residents as part of the amenity of their dwellings; and/or
- a relatively quiet, protected, external publically accessible amenity space (e.g. a public park or a local green space designated because of its tranquillity) that is nearby (e.g. within a 5-minute walking distance).

4.3.4 The noise impact on residential developments may be partially off-set if the residents of those dwellings have access to:

- *a relatively quiet facade (containing windows to habitable rooms) as part of their dwelling, and/or;*
- *a relatively quiet external amenity space for their sole use, (e.g. a garden or balcony). Although the existence of a garden or balcony is generally desirable, the intended benefits will be reduced with increasing noise exposure and could be such that significant adverse effects occur, and/or;*
- *a relatively quiet, protected, nearby external amenity space for sole use by a limited group of residents as part of the amenity of their dwellings, and/or;*
- *a relatively quiet, protected, external publically accessible amenity space (e.g. a public park or a local green space designated because of its tranquillity) that is nearby (e.g. within a 5 minute walking distance).*

4.4 BS8233:2014 Guidance on Sound Insulation and Noise Reduction for Buildings

- 4.4.1 There is much guidance on the levels of intrusive noise which would be considered acceptable within residential accommodation such as this. Typical advice is found in British Standard 8233:2014 "Guidance on Sound Insulation and Noise Reduction for buildings". Following similar guidance in the 1999 World Health Organisation report "Guidelines for Community Noise", the Standard sets out the following limits for indoor ambient noise levels within living rooms and bedrooms of residential accommodation. This suggests:

Activity	Location	0700 - 2300	2300 - 0700
Resting	Living Room	35 dB(A) LAeq, 16 hr	-
Dining	Dining room/Area	40 dB(A) LAeq, 16 hr	-
Sleeping	Bedroom	35 dB(A) LAeq, 16 hr	30 dB(A) LAeq, 8 hr

Table 4.2 - BS8233 Indoor Guideline Values

- 4.4.2 It is usually considered that an open window will provide a reduction of some 10-15 dB(A)¹. Therefore the 'good' internal standards quoted above would broadly equate to the following targets immediately outside the buildings:

Activity	Location	0700 - 2300	2300 - 0700
Resting	Living Room	48 dB(A) LAeq, 16 hr	-
Dining	Dining room/Area	53 dB(A) LAeq, 16 hr	-
Sleeping	Bedroom	48 dB(A) LAeq, 16 hr	43 dB(A) LAeq, 8 hr

Table 4.3 - BS8233 Derived Facade Guideline Values

- 4.4.3 BS8233 recognises that, where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal target levels may be relaxed by up to 5 dB, and reasonable conditions will be achieved².
- 4.4.4 It should be noted that the levels quoted in BS8233 are intended to reflect the acceptability of steady, continuous noise. Sources of intermittent and tonal noise may generate greater annoyance for a similar overall magnitude. Whilst BS8233 does not explicitly state a correction for those circumstances, it may be appropriate to consider that the Good and Reasonable standards would be achieved with levels which are perhaps 5 dB lower than stated in the table above.
- 4.4.5 It is also noted that BS8233 was written from a view of designing new buildings to protect occupants from existing noise sources. This does necessarily infer, however, that the acceptability of an occupant to an absolute level noise within a building will be different if the introduction of the noise source post-dates the construction of the building.

¹ Reference PPG24 Planning & Noise, which adopted a mid-range value of 13 dB(A)

² Note, the relaxation specified in BS8233 must be read in conjunction with parallel guidance set out in Approved Document O.

4.5 World Health Organisation Guidelines

- 4.5.1 Further advice is provided in the 1999 WHO report "Guidelines for Community Noise".
- 4.5.2 This indicates that the steady noise level in external amenity areas, such as gardens or outdoor living areas should not exceed 55 dB(A) $L_{Aeq, t}$, and should preferably be designed below 50 dB(A) $L_{Aeq, t}$.
- 4.5.3 The document also provides guidance on the impact of peak noise levels on sleeping conditions. This suggests that levels above 45 dB(A) L_{Amax} inside a bedroom would be disturbing to sleep. With windows open, this would equate to a level of approximately 58 dB(A) L_{Amax} externally.

4.6 Approved Document F Ventilation

- 4.6.1 Approved Document F (2021 edition, Volume 1 & 2) of the Building Regulations 2010 sets out the requirements for ventilation in dwellings. ADF describes three types of ventilation, summarised in the table below:

Type of Ventilation	Definition in ADF	Location/reason for ventilation	Required
Whole Dwelling Ventilation ³	Whole building ventilation (general ventilation is normally continuous ventilation of rooms or spaces at a relatively low rate to dilute and remove pollutants and water vapour not removed by operation of extract ventilation, purge ventilation or infiltration, as well as supplying outdoor air into the building. For an individual dwelling this is referred to as 'whole dwelling ventilation'.	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	Continuously
Extract Ventilation	Extract ventilation is the removal of air directly from a space or spaces to the outside. Extract ventilation may be provided by natural means, e.g., by passive stack ventilation) or by mechanical means (e.g., by an extract fan or central system)	From rooms where most water vapour and/or pollutants are released, e.g., due to activities such as cooking or bathing. This is to minimise their spread to the rest of the building	Continuously or intermittently
Purge Ventilation	Purge ventilation is manually controlled ventilation of rooms or spaces at a relatively high rate to rapidly dilute pollution and/or water vapour. Purge ventilation may be provided by natural means (e.g., an openable window) or by a mechanical means (e.g., a fan)	Throughout the building to aid the removal of high concentrations of pollutants and water vapour released from occasional activities such as painting and decorating or accidental released such as smoke from burnt food or spillage of water	Occasionally

Table 4.4 – ADF Types of Ventilation

4.6.2 It is important to differentiate between the need to provide 'purge ventilation' as required occasionally under ADF, against the provision of ventilation to help control overheating, which is now covered by Approved Document O Overheating. ADF states:

This document <ADF> sets minimum standards for purge ventilation for rapidly diluting indoor air pollutants and extracting water vapour where necessary in habitable rooms in dwellings. For domestic-type buildings, Part O may require a higher standard than the guidance given in this document for purge ventilation to remove excess heat. In this case, the higher of the two standards should be followed.

4.6.3 There are various types of ventilation described in ADF, including:

³ Not to be confused with 'background ventilation'. ADF defines the term 'background ventilator' as a trickle vent.

Ventilation System	Provision with ADF System / Purpose		
	Whole Dwelling Ventilation	Extract Ventilation	Purge Ventilation
Background ventilation and intermittent extract fans	Background ventilators (trickle vents)	Intermittent extract fans	Typically provided by opening windows
Continuous mechanical extract (MEV)	Continuous mechanical extract – minimum low rate. Trickle vents to provide inlet air	Continuous mechanical extract – minimum high rates. Trickle vents to provide inlet air	Typically provided by opening windows
Continuous mechanical supply and extract with heat recovery (MVHR)	Continuous mechanical supply and extract – minimum low rate	Continuous mechanical supply and extract – minimum high rate	Typically provided by opening windows

Table 4.5 – ADF Template Systems

- 4.6.4 With regard to the provision of purge ventilation within habitable rooms, the approved document notes that there may be practical difficulties in achieving this (e.g., if unable to open a window due to excessive noise from outside).
- 4.6.5 Whilst ADF does give advisory residential noise limits during normal conditions (not boost)⁴, it does not itself confirm limits for noise during purge ventilation.

4.7 Approved Document O – Overheating

- 4.7.1 Approved Document O Overheating describes the means by which designers can protect the health and welfare of occupants of the building by reducing the occurrence of high indoor temperatures.
- 4.7.2 The scope of the Document applies to residential dwellings and institutions, and includes the following building types:

⁴ In line with BS8233 guidance.

Title	Purpose for which the building is intended to be used
Residential (dwellings)	Dwellings, which includes both dwellinghouses and flats.
Residential (institutional)	Home, school or other similar establishment, where people sleep on the premises. The building may be living accommodation for the care or maintenance of any of the following. a. Older and disabled people, due to illness or other physical or mental condition. b. People under the age of 5 years.
Residential (other)	Residential college, hall of residence and other student accommodation, and living accommodation for children aged 5 years and older.

Table 4.6 – ADO Scope

4.7.3 In respect of the acoustic implications, the Document considers the acceptable limits for noise within bedrooms at night. This applies when the method of overheating control is active – whether that be an open window, passive vent or mechanical system. The noise limits are summarised below:

- a. 40dB $L_{Aeq,t}$ averaged over 8 hours (between 11pm and 7am).**
- b. 55dB $L_{Amax,f}$ more than 10 times a night (between 11pm and 7am).**

4.7.4 Should an analysis of the external noise levels (for open windows/vents) indicate that these values will be exceeded, an alternative strategy should be adopted.

4.8 IOA/ANC Acoustics Ventilation and Overheating – Residential Design Guide

4.8.1 The Institute of Acoustic and Association of Noise Consultants have published the 'Acoustics Ventilation and Overheating – Residential Design Guide' (January 2020) to promote best practice in the design of residential buildings to control overheating in areas of high ambient noise.

4.4.2 When providing design targets inside the dwellings, the AVOG document advises that the internal noise standard of BS8233:2014 (as copied here in Table 4.2) should be achieved when providing adequate ventilation as defined in ADF. However, the document continues to propose that it is considered reasonable to allow higher levels of internal ambient noise from transport sources when higher rates of ventilation are required in relation to the overheating condition.

4.8.3 This proposition is based on the fact that overheating will occur for only part of the time, during which there will be a trade-off between acoustic and thermal conditions, given that

residents would have some control over their environment (a principle well established in the field of thermal comfort).

- 4.8.4 The guide indicates that the sound level difference across a façade, with standard opening windows, would be 13 dB(A), but that this figure may be greater if windows are shielded by balconies.
- 4.8.5 BS8233:2014 states that, if internal noise levels are no more than 5 dB greater than the levels shown here in Table 4.2, this would be a 'reasonable' standard. Therefore, if external noise levels do not exceed the following values when windows are open, conditions should be considered wholly acceptable, and therefore the threshold between No and Low Observed Adverse Effect Levels:

Location	0700 - 2300	2300 - 0700
Living Room	53 dB(A) LAeq, 16 hr	-
Bedrooms	53 dB(A) LAeq, 16 hr	48 dB(A) LAeq, 8 hr

Table 4.5 – Proposed LOAEL Façade Noise Levels with Windows Open

- 4.8.6 To consider the upper limit, beyond which internal conditions should not be deemed acceptable, reference is made to issue of speech interference. With reference to the numerical values in BS8233 (see Table 4.5 above), the AVOG document adopts an internal daytime limit of 50 dB(A), which would then equate to an external limit of 63 dB(A) when windows are open.
- 4.8.7 At night, reference is made to the WHO Night Noise Guidelines, which developed the original WHO Guidelines for Community Noise report. This states that if external noise levels exceed 55 dB(A) L_{Aeq} , 'adverse health effects occur frequency and a sizeable proportion of the population is highly annoyed and sleep disturbed'.
- 4.8.8 The table below therefore may be taken to represent the threshold for SOAEL:

Location	0700 - 2300	2300 - 0700
Living Room	63 dB(A) LAeq, 16 hr	-
Bedrooms	63 dB(A) LAeq, 16 hr	55 dB(A) LAeq, 8 hr

Table 4.7 – Proposed SOAEL Threshold Façade Noise Levels with Windows Open

5. RECOMMENDATIONS FOR NOISE ATTENUATION MEASURES

INTERNAL NOISE LEVELS

- 5.1 Section 4.4.1 of this report has provided guidance for internal noise levels within residential rooms as stated within BS8233.
- 5.2 It is therefore recommended that all residential dwellings be designed to achieve the following levels:
- Living Rooms: ≤ 35 dB(A) L_{Aeq} , 07.00 – 23.00
Bedrooms: ≤ 30 dB(A) L_{Aeq} , 23.00 – 07.00, and also
 ≤ 45 dB(A) L_{Amax} , 23.00 – 07.00
- 5.3 Appendix 1 confirms the predicted external façade noise levels dB(A) across the site and overall performance targets required through each façade of the buildings. These figures are based initially on the targets of Para 5.2, the measured noise levels given in Para 3.8 and have been predicted using INoise V2024 noise mapping software. Noise levels have been adjusted, allowing for the difference in distance between the measurement location and facades of the buildings. Figures 5 - 15 provide noise maps for the daytime L_{Aeq} and night-time L_{Aeq} noise levels.
- 5.4 The external façade construction has not been confirmed but a likely construction would be,
- Brick outer skin,
 - Notional 100mm partially insulated cavity,
 - Inner leaf of timber frame or masonry.
- 5.5 Table 5.1 confirms the minimum glazing requirement for different predicted façade noise levels, based on the facade construction stated in Para 5.4, and the objective performance associated with each glazing type. Appendix 2 provides detailed calculations for each of the glazing types:

	Minimum Sound Reduction, dB, at Octave Band Centre Frequency (Hz)							Overall Rating & Possible Configuration
	63	125	250	500	1K	2K	4K	
Bedrooms subject to levels between 89 - 92 dB(A) $L_{Amax,fast}$	33	38	44	48	53	54	61	43 dB Rw + Ctr 10.8A / 24 / 14.8A
Bedrooms subject to levels between 85 - 88 dB(A) $L_{Amax,fast}$	33	33	37	42	42	49	55	42 dB Rw + Ctr 12 / 20 / 8.8A
Bedrooms subject to levels between 80 - 84 dB(A) $L_{Amax,fast}$	35	27	33	41	47	43	54	37 dB Rw + Ctr 8 / 20 / 12.8A
Bedrooms subject to levels between 72 - 79 dB(A) $L_{Amax,fast}$	33	30	25	34	45	44	52	35 dB Rw + Ctr 6 / 12 / 8.4A
Bedrooms subject to levels up to 71 dB(A) $L_{Amax,fast}$	21	21	18	26	37	42	33	27 dB Rw + Ctr 4 / 16 / 4

(Continued overleaf)

	Minimum Sound Reduction, dB, at Octave Band Centre Frequency (Hz)							Overall Rating & Possible Configuration
	63	125	250	500	1K	2K	4K	
Living Rooms subject to levels between 68 - 71 dB(A) L_{Aeq}	33	30	25	34	45	44	52	35 dB Rw + Ctr 6 / 12 / 8.4A
Living Rooms subject to levels between 64 - 67 dB(A) L_{Aeq}	30	26	21	28	41	38	37	29 dB Rw + Ctr 6 / 12 / 4
Living Rooms subject to levels up to 63 dB(A) L_{Aeq}	21	21	18	26	37	42	33	27 dB Rw + Ctr 4 / 16 / 4

Table 5.1 – Possible Glazing Configurations

5.6 Tables 5.2 & 5.3 then confirm the application of these difference glazing specifications to each dwelling:

PLOT	LIVING ROOMS	BEDROOMS	PLOT	LIVING ROOMS	BEDROOMS
F001	27	27	F207 - F208	35	43
F002	29	42	F209	35	42
F003 - F006	35	43	F210	27	37
F007	27	37	F211 - F214	27	35
F008 - F011	27	35	F215 - F217	27	27
F012 - 013	27	27	F216	27	27
F101 - F103	27	27	F301 - F303	27	27
F104	35	42	F304 - F308	35	42
F105 - F108	35	43	F309	29	37
F109	35	42	F310	27	37
F110	27	37	F311 - F313	27	35
F111	27	35	F314	27	27
F112 - F114	27	35			
F115 - F117	27	27			
F201 - F203	27	27			
F204	35	42			
F205	35	43			
F206	35	42			

Table 5.2 – Overall Glazing Performance, dB Rw + Ctr, for Flats

PLOT	LIVING ROOMS				BEDROOMS			
	NORTH	SOUTH	EAST	WEST	NORTH	SOUTH	EAST	WEST
H01	27	27	N/A	N/A	27	35	N/A	35
H02	27	27	N/A	N/A	27	35	N/A	N/A
H03	27	27	N/A	N/A	27	35	N/A	N/A
H04	27	27	N/A	N/A	27	35	N/A	N/A
H05	N/A	N/A	27	27	N/A	N/A	35	27
H06	N/A	N/A	27	27	N/A	N/A	35	27
H07	N/A	N/A	27	27	N/A	N/A	35	35
H08	N/A	N/A	27	27	N/A	N/A	35	35
H09	N/A	N/A	27	27	N/A	N/A	37	37
H10	N/A	N/A	29	27	N/A	N/A	37	37
H11	27	35	N/A	N/A	27	42	N/A	N/A
H12	27	35	N/A	N/A	27	42	N/A	N/A
H13	27	35	N/A	N/A	27	42	N/A	N/A
H14	27	35	N/A	N/A	27	42	N/A	N/A
H15	27	35	N/A	N/A	27	42	N/A	N/A

Table 5.3 – Overall Glazing Performance, dB $R_w + C_{tr}$, for Houses

- 5.7 If trickle ventilators (or equivalent forms of a passive ventilation grills) are to be adopted, they should be selected to provide a sound insulation performance, $D_{n,e,w}$, at least 8 dB higher than the glazing performance, $R_w + C_{tr}$ (in order to ensure acceptable internal levels) This performance relates to the grill in the Open position.

EXTERNAL AMENITY SPACE

- 5.8 The World Health Organisation offers guidance that, to protect the majority of people from being seriously annoyed during the daytime, the sound pressure level on balconies, terraces and outdoor living areas should not exceed 55 dB L_{Aeq} for a steady, continuous noise.
- 5.9 The predicted noise levels within all amenity areas ranges are shown in Table 5.4, and it can be seen that all would meet the WHO criteria, apart from Plot 10 of the houses.

PLOT	PREDICTED NOISE LEVEL, L_{Aeq} , 16hrs dB(A)	PLOT	PREDICTED NOISE LEVEL, dB(A)
H-01	50	H-09	55
H-02	46	H-10	58
H-03	46	H-11	50
H-04	48	H-12	47
H-05	49	H-13	46
H-06	49	H-14	46
H-07	49	H-15	48
H-08	52	Roof Terrace	50

Table 5.4 – Predicted Amenity Noise Levels

- 5.10 It should be noted that these predictions are based on the gardens of the houses being fully enclosed with 1.8m high close boarded timber fences.
- 5.11 In respect of Plot H-10, the predicted noise level would be described as being just noticeably louder than the threshold value of 55 dB(A). The means of reducing noise levels towards the target value (particularly on the terrace area) would in theory be to raise the height of the fence to the south boundary (to 2.5m or preferably 3m). However, this would need to be approved by the LPA, balancing other non-acoustic implications.
- 5.12 Furthermore, British Standard 8233:2014 does clarify the importance of external space, even if conditions are louder than ‘ideal’:

7.7.3.2 Design criteria for external noise

For traditional external areas that are used for amenity space, such as gardens and patios, 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 recognized 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, 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.

- 5.13 Therefore, it would be concluded that, if the landscaping scheme and other constraints are deemed of greater importance, the proposed scheme can be deemed to be acceptable if a very limited area of the project experiences external noise levels above the 55 dB(A) guideline.

6. ASSESSMENT OF OVERHEATING MITIGATION

- 6.1 The preferred means of countering overheating issues is usually to rely on open windows to provide the necessary ventilation.
- 6.2 Open windows do have an adverse impact on the acoustic integrity of the building construction, however, and ADO has therefore confirmed the maximum acceptable internal noise levels when windows are opened for this specific purpose.
- 6.3 To repeat Para.4.7.3 above, the acceptable levels are:
- a. 40dB $L_{Aeq,t}$, averaged over 8 hours (between 11pm and 7am).
 - b. 55dB $L_{Amax,f}$ more than 10 times a night (between 11pm and 7am).
- 6.4 A review of the 8-hour average noise levels and the typical peak noise levels affecting the site confirms that the former represents the more onerous criteria.
- 6.5 The question is then how the internal target of 55dB $L_{Amax,f}$ equates to an external 'façade noise level', when the windows are open for the purposes of overheating.
- 6.6 At this point, it is necessary to explain the difference between free-field and façade noise levels. The former represents the sound level which would be recorded at a particular position, with no buildings (or other reflecting surfaces) nearby. The latter represents the sound level which would be recorded directly in front of a building. As such, it will include acoustic energy which passes the microphone and is then reflected back off the building, past the microphone again. The correction between two equivalent measurements is normally taken to be 3 dB (the façade value being the louder).
- 6.7 It is then necessary to consider the likely acoustic loss through the open window. Approved Document O provides a simplified estimate of 9 dB. This relates to properties in a 'medium risk' area for overheating, as would be the case here. The loss is based on windows being set to an open area which is 4% of the floor area of the bedroom.
- 6.8 It is noted that this loss relates to the difference between the free-field noise level at the location and the resulting internal noise level. The difference between the façade noise level and resulting internal noise level would be some 7 dB.
- 6.9 This value is lower than the guidance provided in PPG24 'Planning and Noise', which advised that a partially open window would provide a reduction between 10 and 15 dB(A).
- 6.10 The value quoted in Approved Document O is offered in a conservative manner, to allow for a safe, simplified assessment of conditions. The Document does allow for a more detailed assessment of acoustic loss.

- 6.11 In the first instance, reference is made here to the work by Napier University, and their much-referenced report on the acoustic performance of windows, NANR116: 'Open/Closed Window Research - Sound Insulation Through Ventilated Domestic Windows', April 2007
- 6.12 To counter overheating, the windows require an open area of at least 4% of the floor area. A review of the floor plans indicates that bedrooms have floor areas approximately 14m². This indicates that the open area of the windows would need to be 0.56m².
- 6.13 Assuming a side hung casement window, the Napier Report would indicate that the acoustic loss from outside (façade level) to inside would be 12 – 15 dB(A), for the openings here.
- 6.14 The final approach is to consider a 'first-principles' calculation of the loss through the window. This would reflect the open area, the sound reduction of the opening (zero) and the acoustic absorption of the room into which the sound is travelling.
- 6.15 Table 6.1 provides this calculation and indicates an acoustic loss from outside (façade level) to inside of 13 dB(A).

Frequency	Hz	63	125	250	500	1000	2000	4000	8000	dB(A)
Reference facade SPL, outside	dB	105	102	98	96	96	93	87	82	100
SRI open Window	dB	0	0	0	0	0	0	0	0	
Reflection Loss, 0.56m ²	dB	-4	-2	0	0	0	0	0	0	
Area correction, 0.56m ²	dB	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5	
Absorption in room	m ²	11.27	11.27	11.27	11.27	11.27	11.27	11.27	11.27	
Absorption Loss	dB	-10.5	-10.5	-10.5	-10.5	-10.5	-10.5	-10.5	-10.5	
Net SPL	dB	88	87	85	83	83	80	74	69	87
Difference	dB	17	15	13	13	13	13	13	13	

Table 6.1 – Calculation of loss through an open window

- 6.16 The table below summarises the various results:

Source	Difference between façade sound level (road traffic) and resulting internal noise level
ADO Simplified	9 dB(A)
PPG24	10 – 15 dB(A)
Napier University NANR116 Study	12 – 15 dB(A)
First Principles Calculation	13 dB(A)

Table 6.2 – Acoustic Loss for Traffic Noise through 0.56m² opening.

- 6.17 It is therefore concluded that a reduction of 13 dB(A) would be a reasonable, safe prediction of the acoustic loss across this development, and the criteria of ADO would therefore equate to external facade noise limits of,

Bedrooms – 53 dB LAeq,2300 - 0700

Bedrooms – 68 dB LAFmax, 2300 - 0700

- 6.18 Appendix 3 confirms the predicted internal noise level with a suitably open window and confirms whether or not the situation would be considered compliant with the limits of ADO.
- 6.19 The facades highlighted in 'yellow' below show the areas of the development where open windows are **NOT** a suitable solution and where an alternative approach is appropriate.

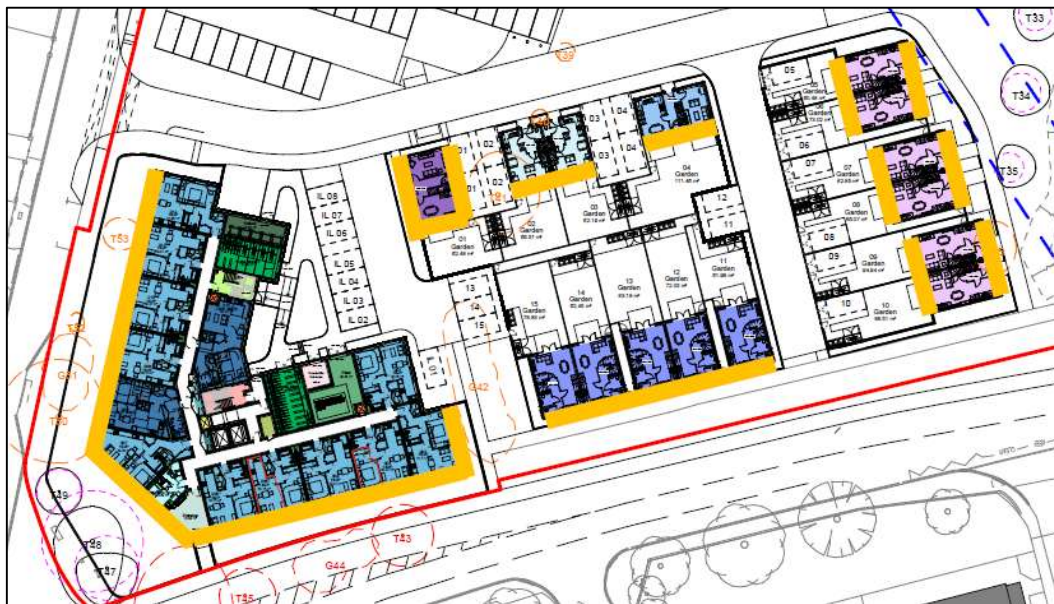


Figure 6.1 – Bedrooms where Open Window Overheating Strategy is NOT Suitable

- 6.20 To provide a compliant solution, the following ventilation strategy is proposed here.
- 6.21 For the houses, a centralised MEV system will be installed on each floor of the property, with fresh air supplied through acoustic trickle vents (ref. para. 5.7).
- 6.22 For the apartments, each property will be provided with a centralised MEF system, with fresh air supplied through acoustic trickle vents (ref. para. 5.7).
- 6.23 The Mechanical Consultant has confirmed that the provision of the MEV systems will adequately address overheating issues within the properties.
- 6.24 Regardless of this provision, it is confirmed that all windows across the development would be designed to be openable.

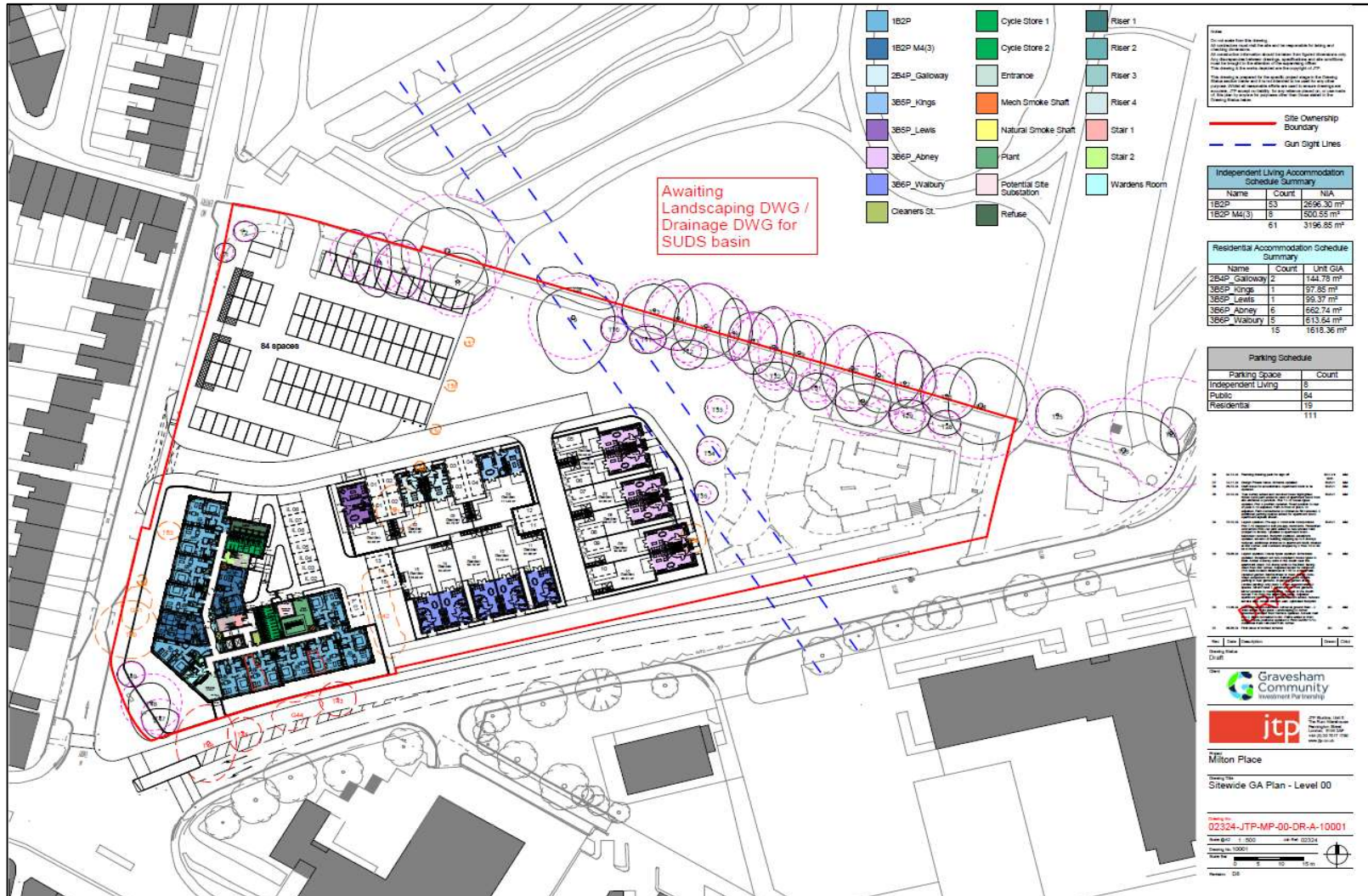
7. CONCLUSION

- 7.1 The foregoing assessment has looked at the levels of ambient noise within the vicinity of a proposed new residential development at land south of Milton Place, Gravesend, Kent, DA12 2BL, on behalf of Gravesham Community Investment Partnership LLP.
- 7.2 It has been concluded that, by specifying appropriate glazing and facade construction along with acoustically treated means of ventilation, it will be possible to ensure that an acceptable internal environment can be provided within new dwellings.
- 7.3 It has been shown that noise levels within the vast majority amenity areas can meet the WHO's guidance of 55 dB L_{Aeq} . For the one area of exceedance, reference is made to the British Standard guidance which clarifies that such conditions should not be necessarily prohibited.

FIGURE 1 – SITE LOCATION



FIGURE 2 – PROPOSED GF PLAN



33



FIGURE 4 – PROPOSED 2F PLAN

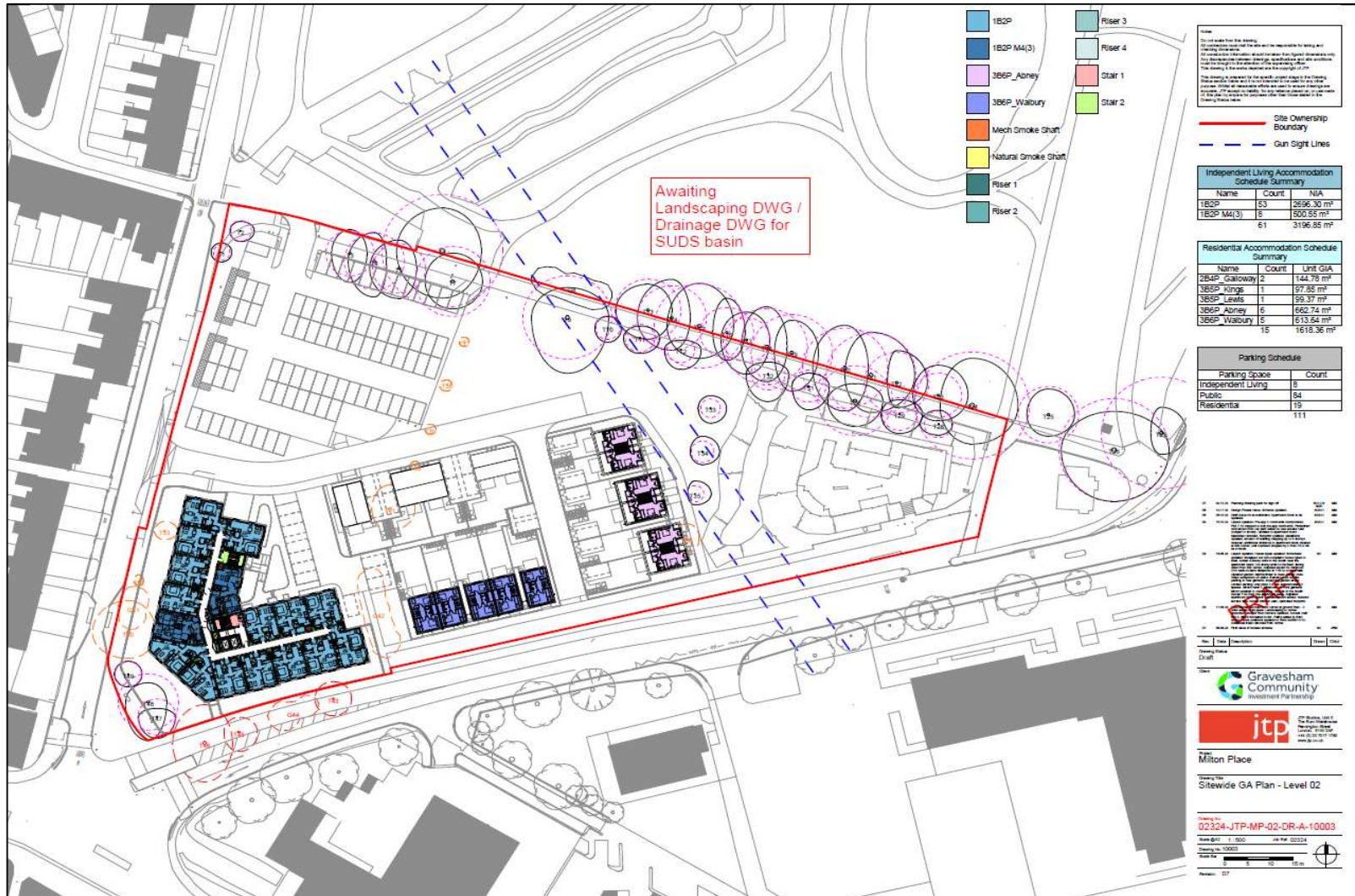


FIGURE 5 – PROPOSED 3F PLAN

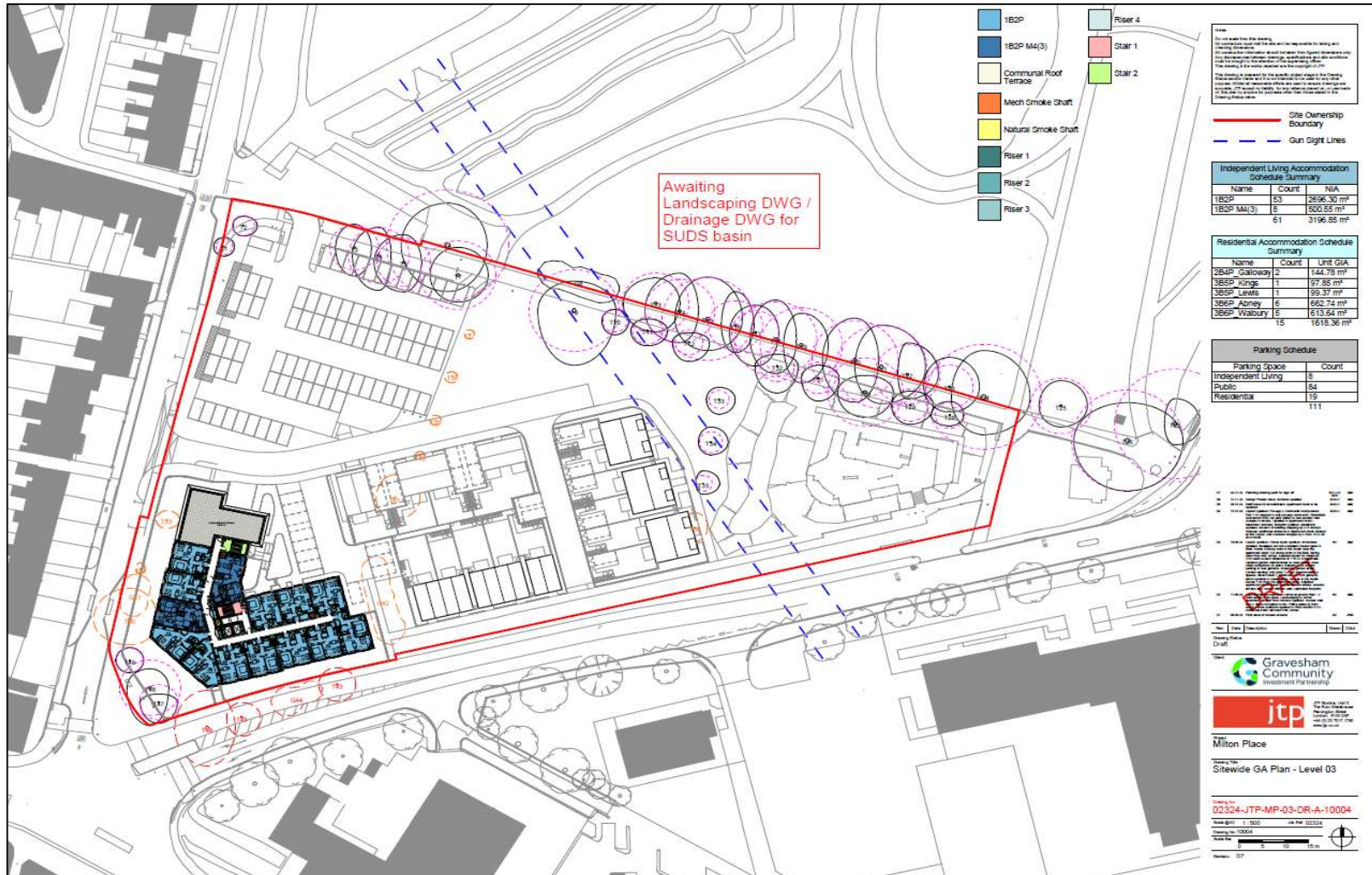


FIGURE 6 – VARIATION OF MEASURED NOISE LEVELS – R1

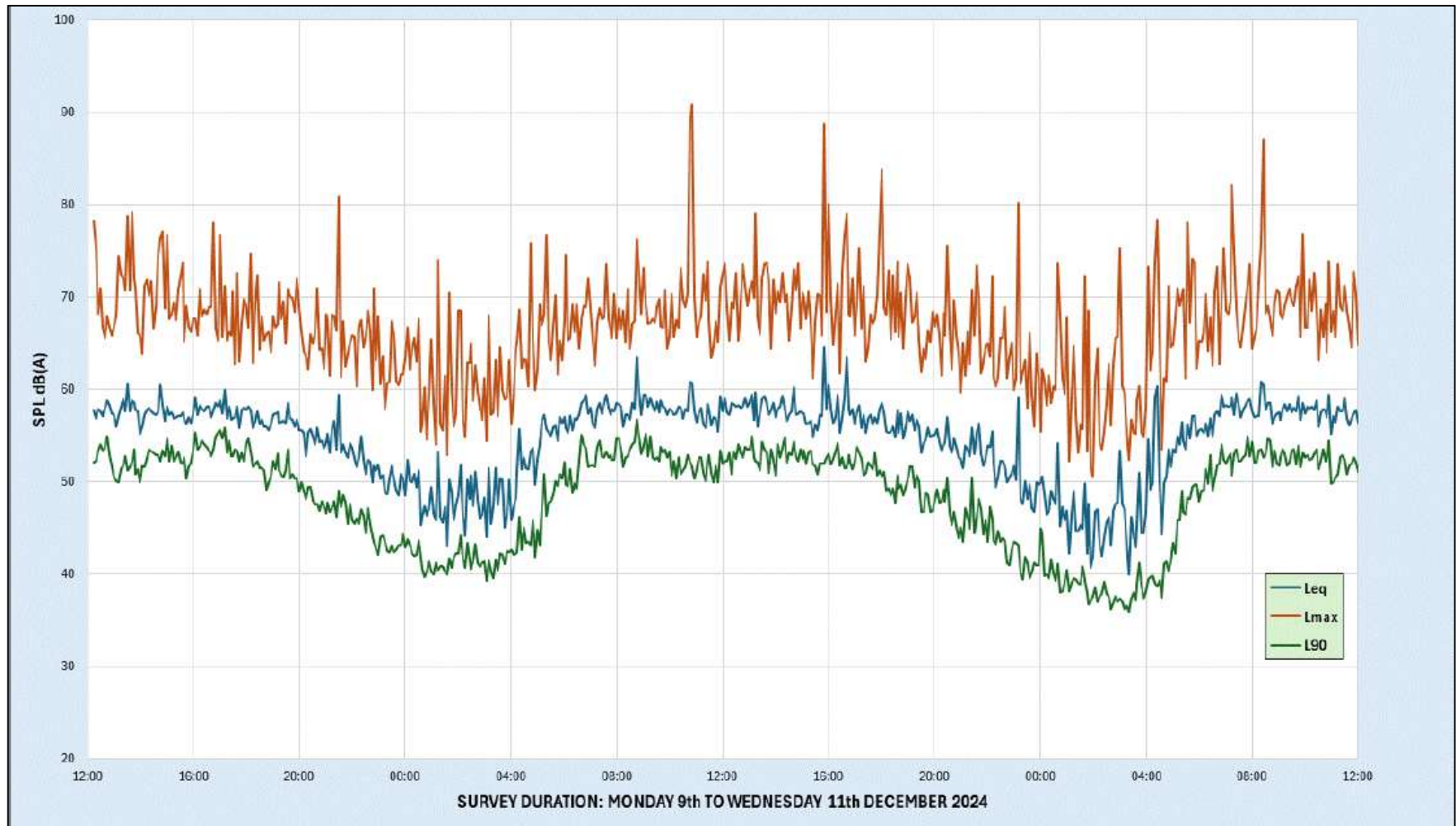


FIGURE 7 – VARIATION OF MEASURED NOISE LEVELS – R2

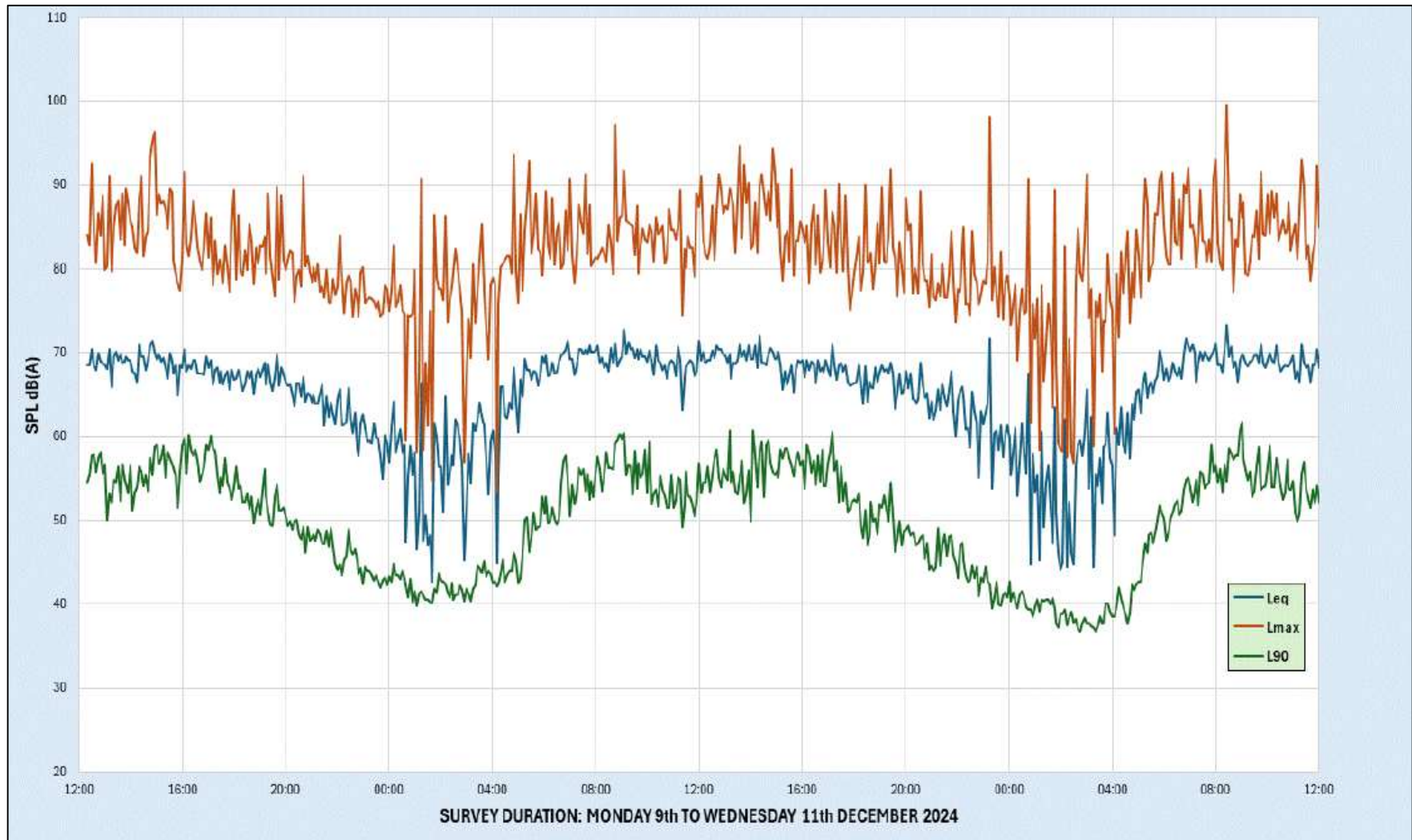


FIGURE 8 – DAYTIME L_{Aeq} GF NOISE MAP

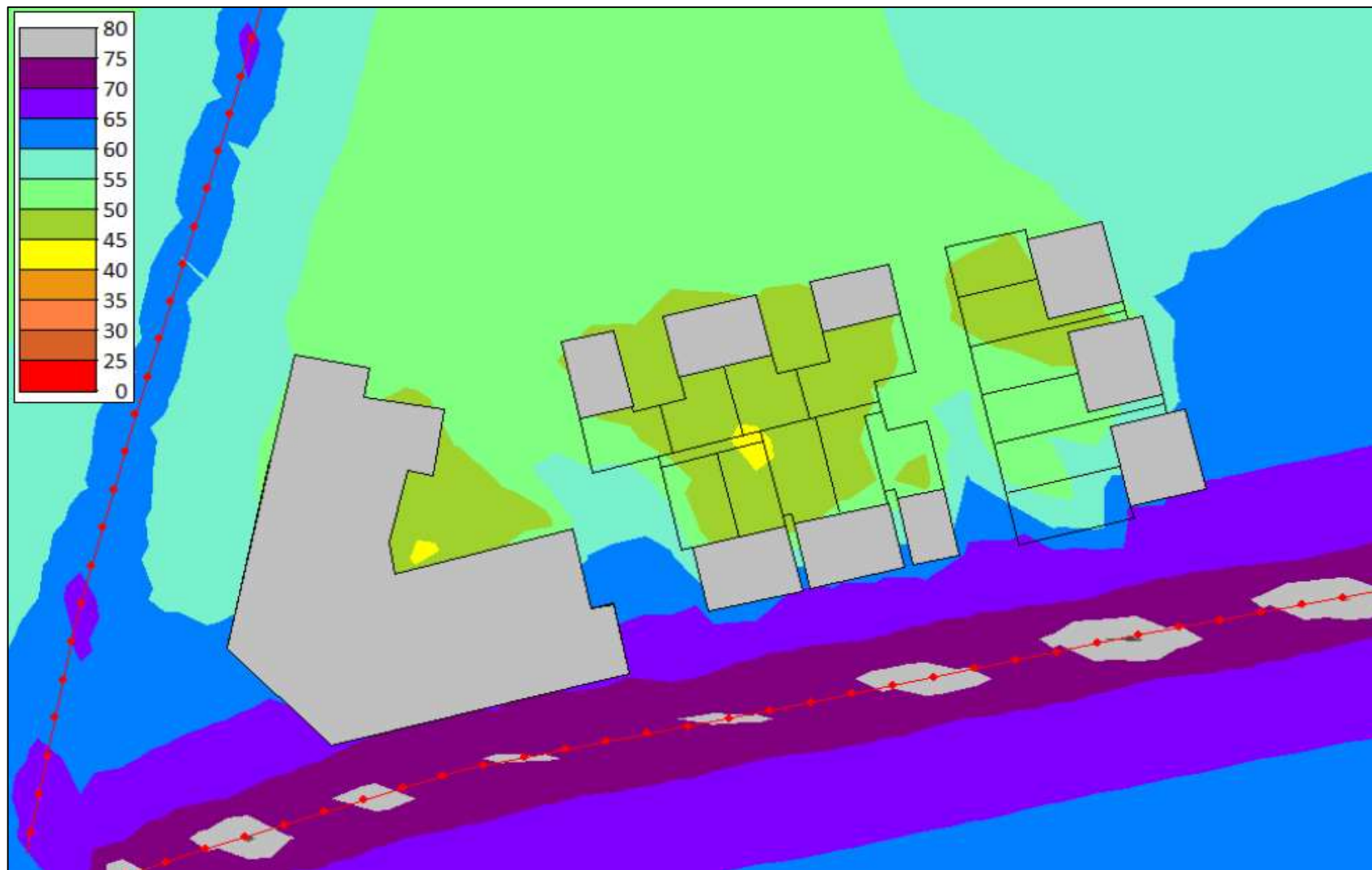


FIGURE 9 – DAYTIME L_{Aeq} 1F NOISE MAP

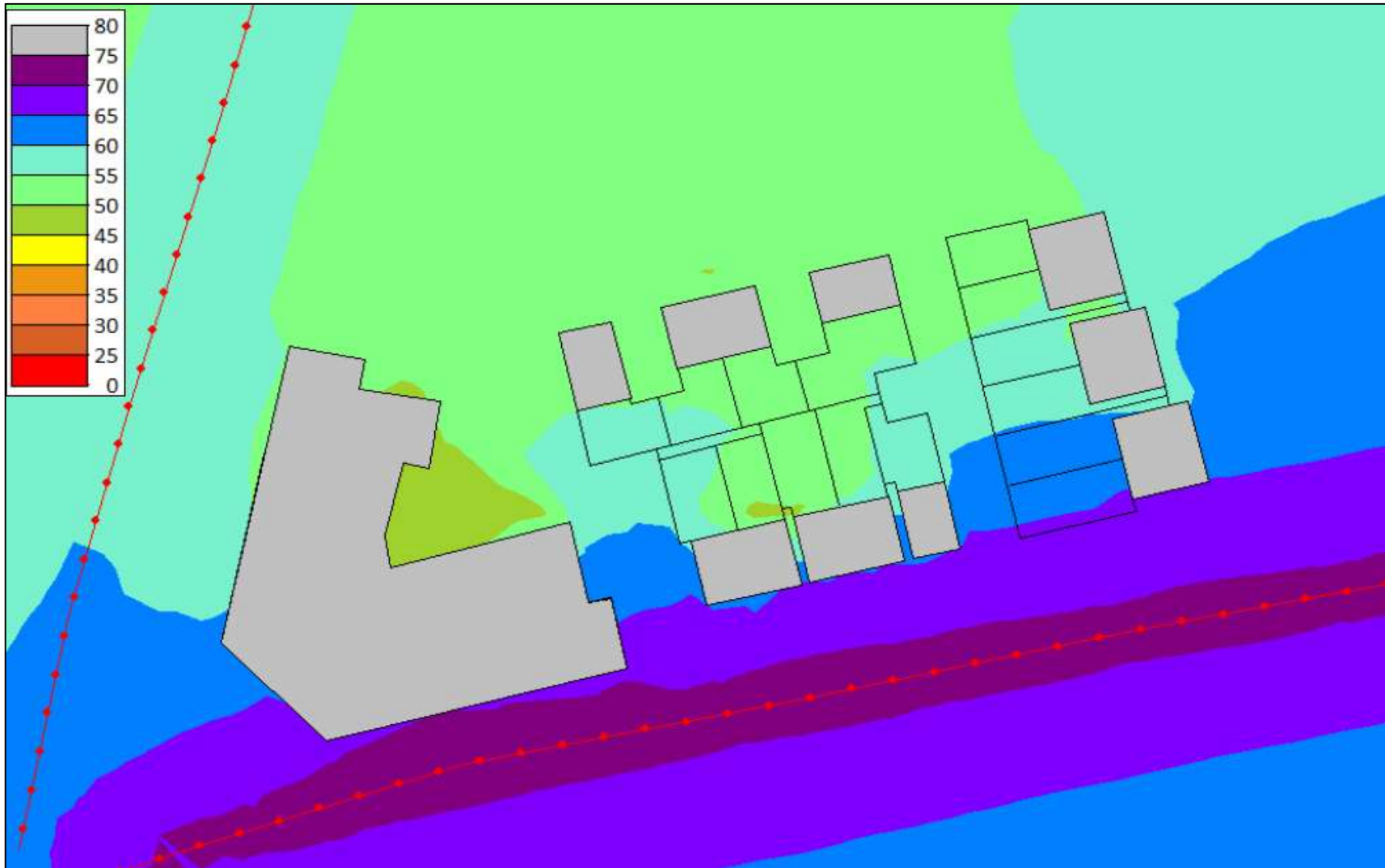


FIGURE 10 – DAYTIME L_{Aeq} 2F NOISE MAP

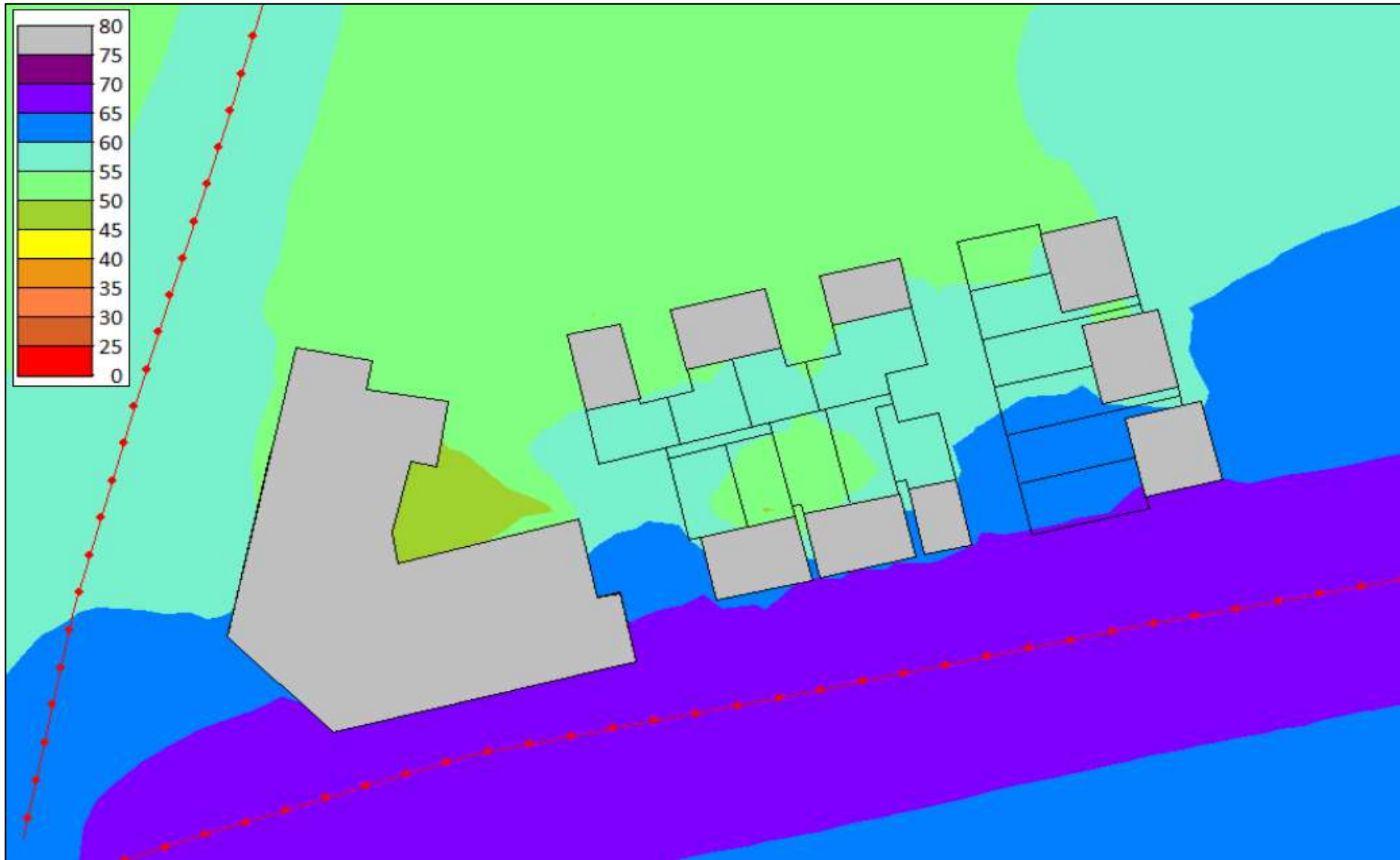


FIGURE 11 – DAYTIME L_{Aeq} 3F NOISE MAP

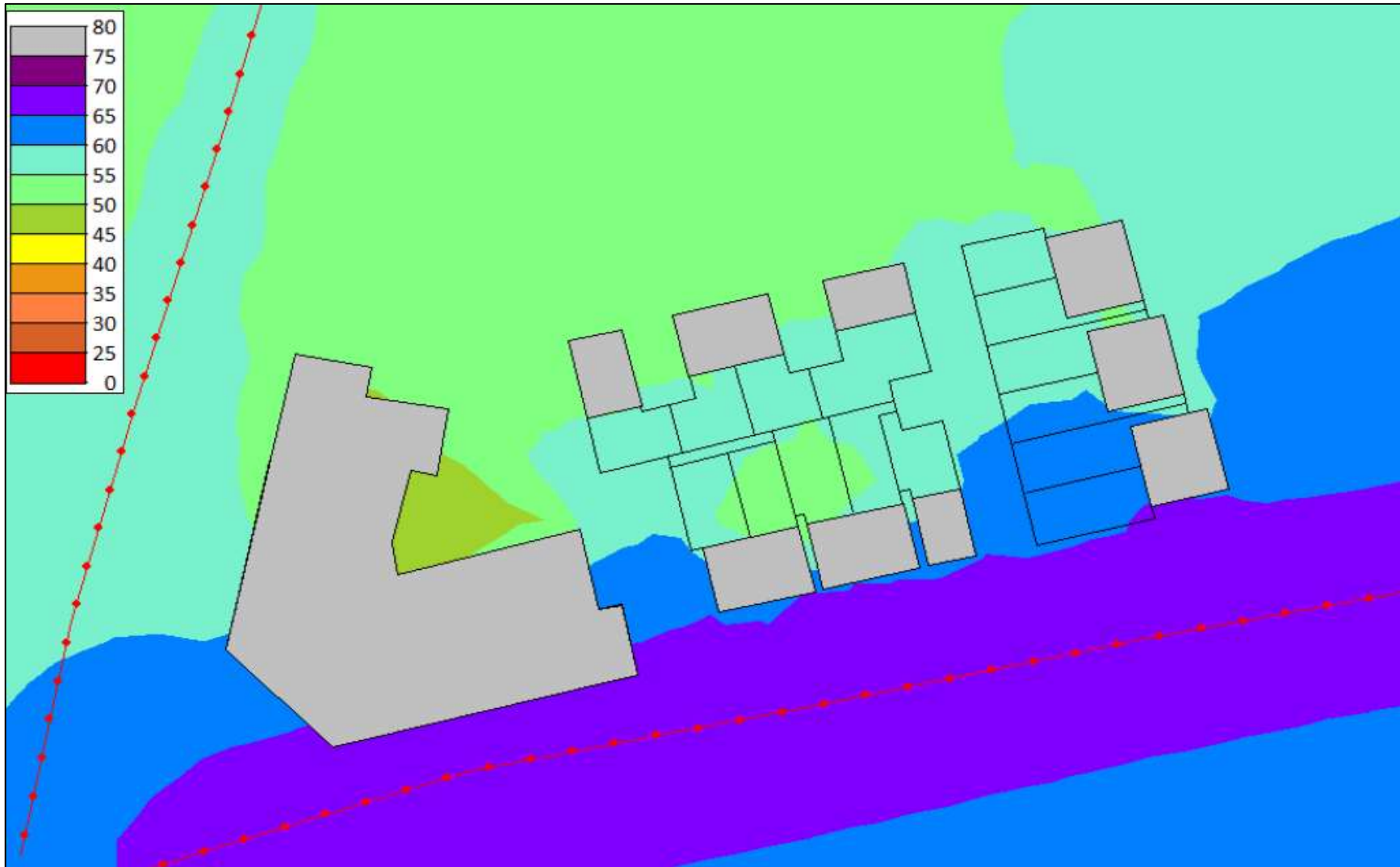


FIGURE 12 – NIGHT-TIME L_{Aeq} GF NOISE MAP

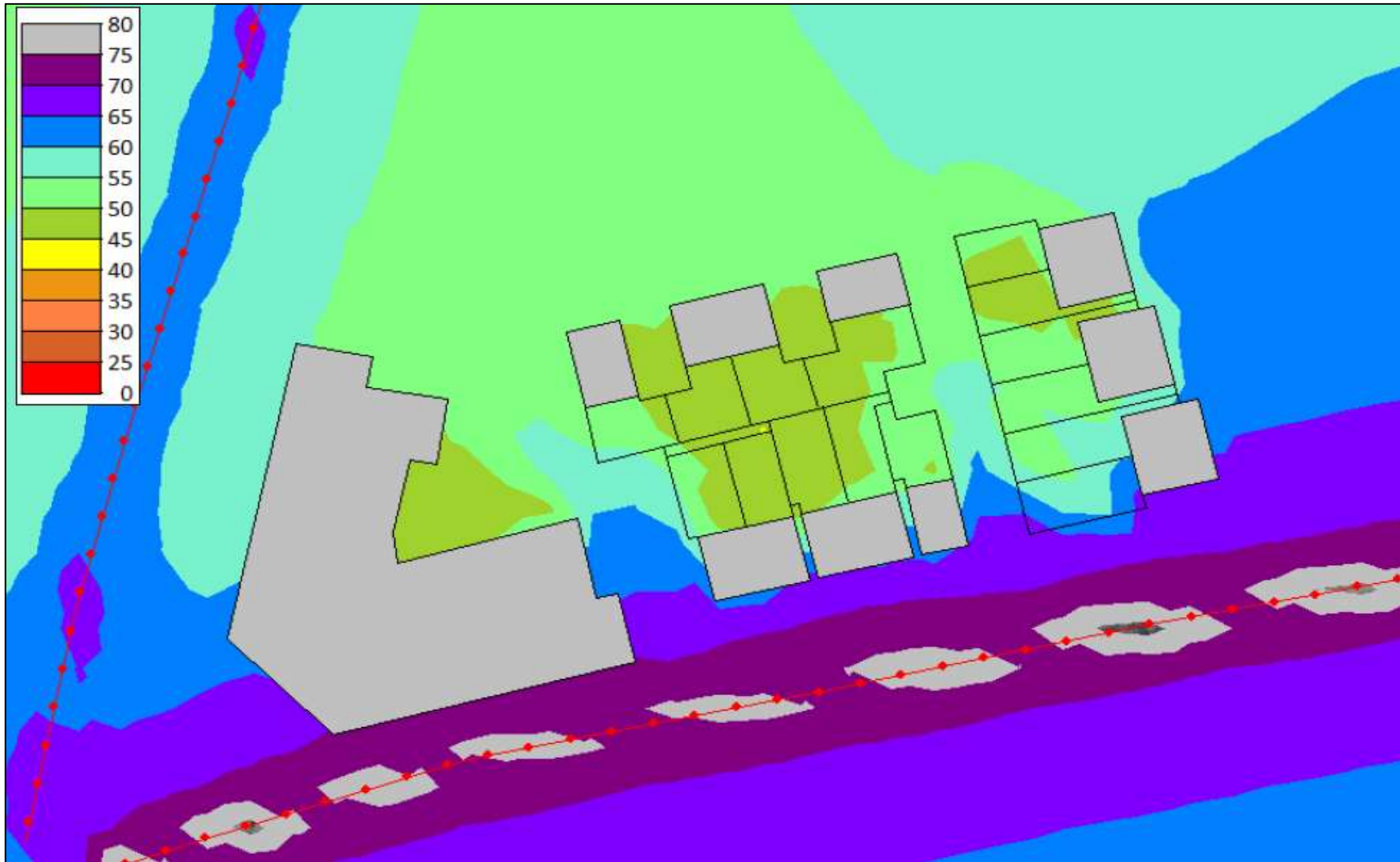


FIGURE 13 – NIGHT-TIME L_{Aeq} 1F NOISE MAP

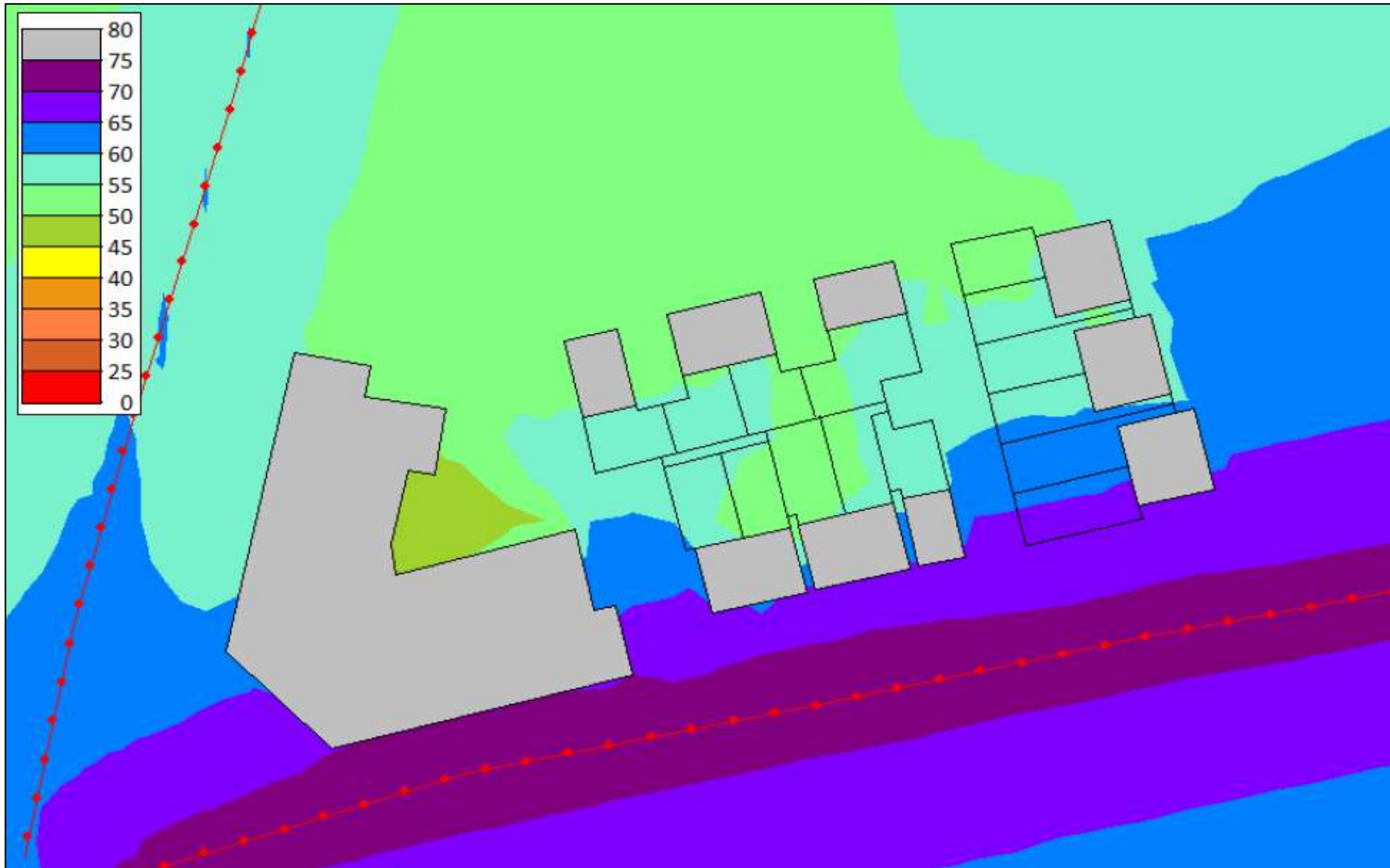


FIGURE 14 – NIGHT-TIME L_{Aeq} 2F NOISE MAP

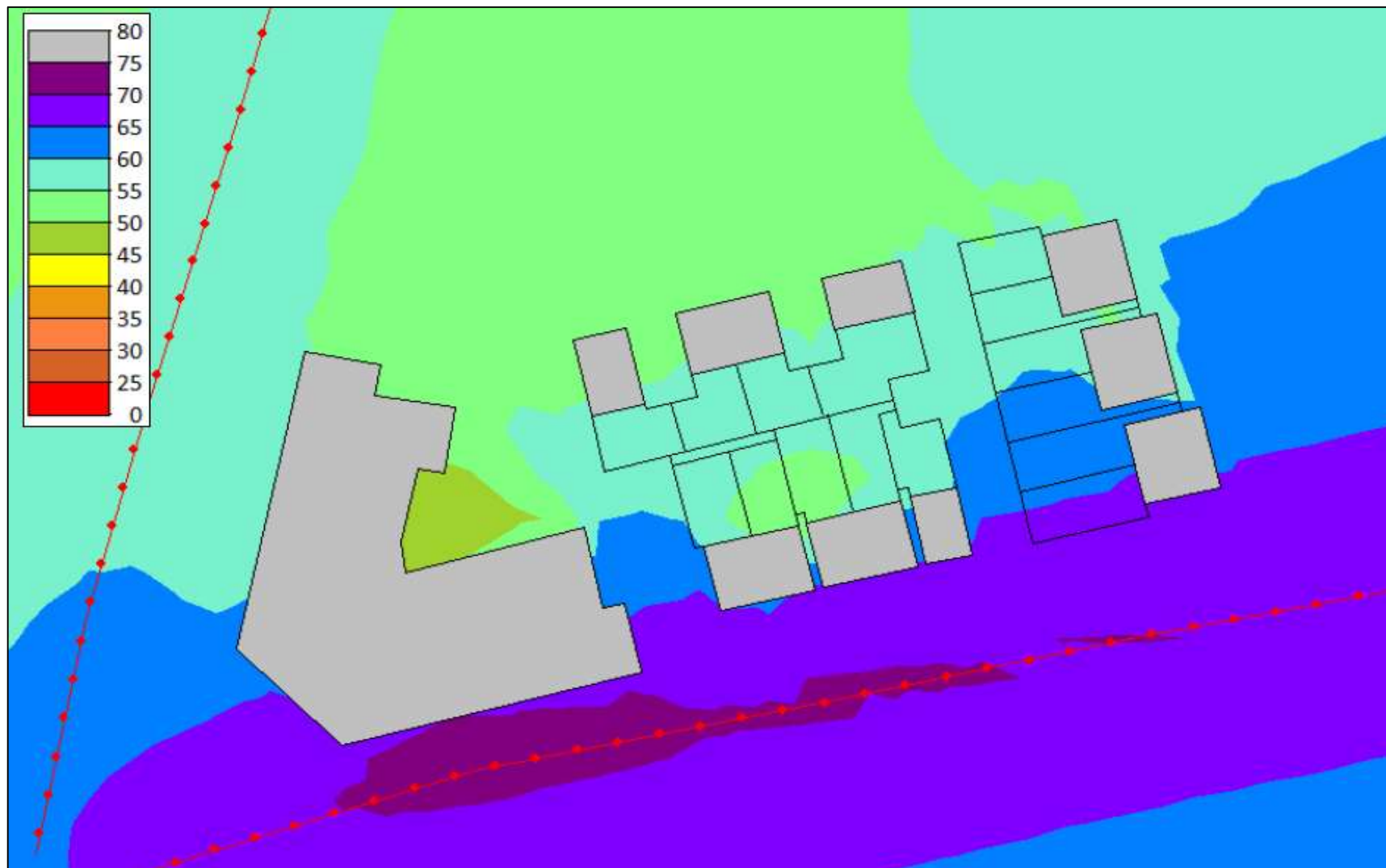
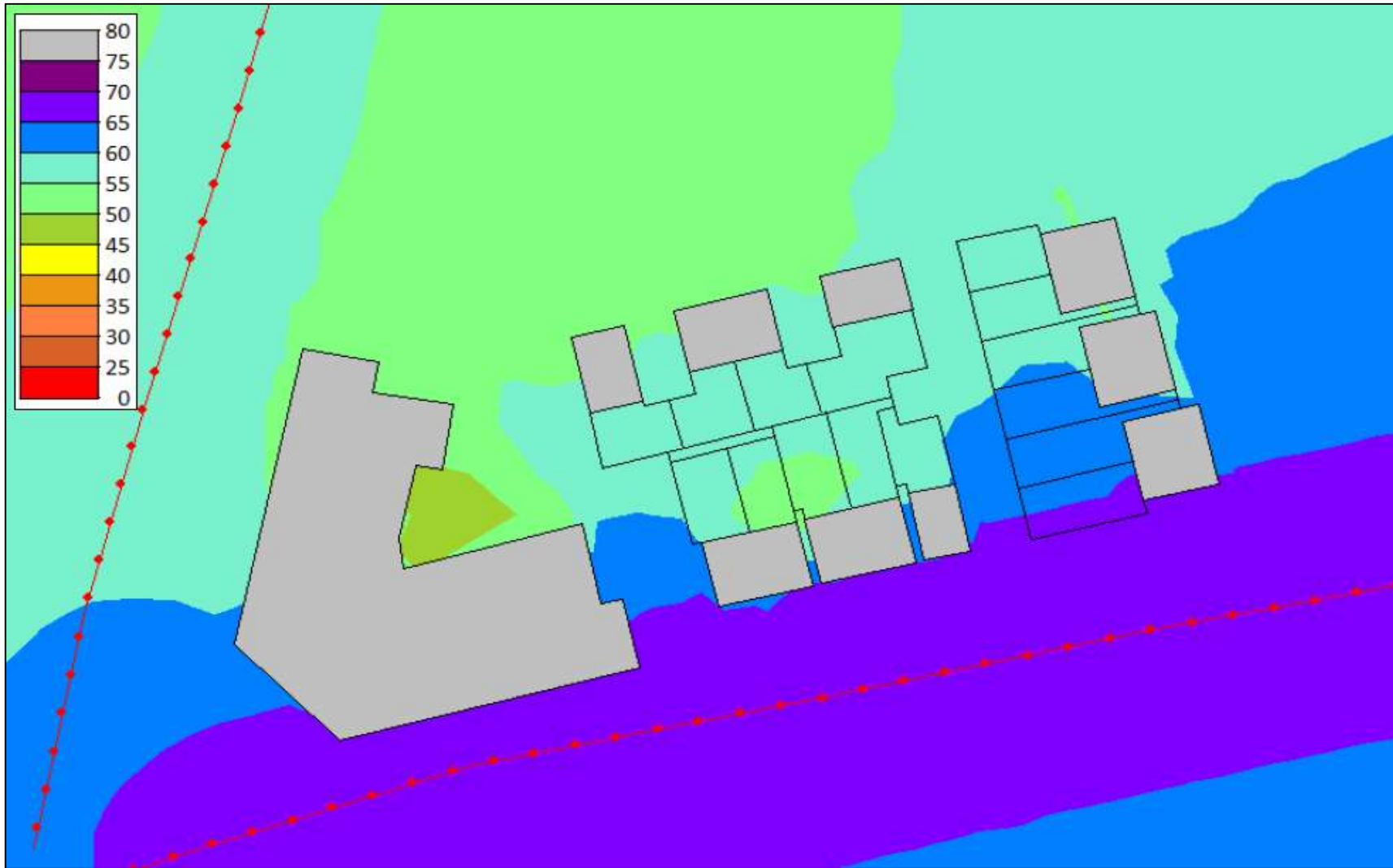


FIGURE 15 – NIGHT-TIME L_{Aeq} 3F NOISE MAP



APPENDIX 1 – PREDICTED FAÇADE NOISE LEVELS

FLATS			
Plot	Daytime L _{Aeq}	Night-time L _{Aeq}	Night-time L _{Amax}
F001	60	42	60
F002	67	67	87
F003	71	67	92
F004	71	67	90
F005	71	67	91
F006	71	67	91
F007	63	60	84
F008	57	53	76
F009	56	52	75
F010	55	52	74
F011	55	51	73
F012	55	49	69
F013	46	41	58
F101	46	42	57
F102	47	42	58
F103	60	44	60
F104	70	61	86
F105	71	67	91
F106	71	67	89
F107	71	67	90
F108	70	67	90
F109	70	62	86
F110	63	60	84
F111	57	53	76
F112	56	52	75
F113	55	51	74
F114	55	51	73
F115	55	49	69
F116	52	44	65
F117	47	42	57
F201	47	43	57
F202	47	43	58
F203	60	44	60
F204	69	61	86
F205	70	66	89
F206	70	66	88
F207	70	66	89
F208	69	66	89
F209	69	61	85

FLATS			
Plot	Daytime LAeq	Night-time LAeq	Night-time LAmax
F210	63	60	84
F211	57	53	76
F212	56	51	75
F213	55	51	74
F214	55	51	73
F215	55	48	68
F216	52	45	66
F217	48	43	57
F301	48	44	57
F302	48	44	58
F303	60	45	61
F304	69	60	85
F305	69	65	87
F306	68	64	86
F307	68	64	87
F308	68	64	86
F309	67	60	83
F310	62	59	82
F311	57	52	76
F312	56	51	75
F313	55	51	74
F314	48	44	57

HOUSES					
Plot	Daytime LAeq	Night-time LAeq		Night-time LAmax	
		1F	2F	1F	2F
H01	50	46 - 52		63 - 78	
H02	48	46 / 50		61 / 76	
H03	48	46 / 50		60 / 71	
H04	51	46 - 51		61 / 76	
H05	60	49 / 55	55	71 / 75	75
H06	59	50 / 55	55	71 / 75	75
H07	61	52 / 56	56	75 / 78	78
H08	61	53 / 57	57	76 / 77	77
H09	63	58 / 59	59	80 / 81	81
H10	65	60	60	83	83
H11	68	50 / 64	51 / 63	68 / 87	71 / 86
H12	68	45 / 64	46 / 64	65 / 88	65 / 87
H13	68	45 / 64	46 / 64	64 / 88	64 / 86
H14	68	45 / 64	46 / 64	63 / 88	64 / 87
H15	68	45 / 64	46 / 64	65 / 88	65 / 87

APPENDIX 2 – OUTSIDE TO INSIDE CALCULATIONS

FLATS: 89 - 92 dB(A)										
Frequency	Hz	63	125	250	500	1000	2000	4000	8000	dB(A)
External Noise Level LAmax	dB	91	88	95	88	87	82	77	71	92
Glazing Specified: 10.8A / 24 / 14.8A	dB	33	38	44	48	53	54	61	60	
Area of Window	dB	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	
Area Correction	dB	4	4	4	4	4	4	4	4	
Likely RT in Room	sec	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
Room Volume	m3	32	32	32	32	32	32	32	32	
Absorption		10	10	10	10	10	10	10	10	
Absorption Correction	dB	10	10	10	10	10	10	10	10	
Net SPL Inside	dB	52	43	44	33	27	21	10	4	38
External Wall	dB	43	45	45	49	57	65	70	70	
Area of Wall	dB	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	
Area Correction	dB	6	6	6	6	6	6	6	6	
Likely RT in Room	sec	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
Room Volume	m3	32	32	32	32	32	32	32	32	
Absorption		10	10	10	10	10	10	10	10	
Absorption Correction	dB	10	10	10	10	10	10	10	10	
Net SPL Inside	dB	45	39	46	35	26	13	4	-3	39
Combined Level from elements	dB	52	45	48	37	30	22	11	5	41
Tolerance on Calculation	dB	3	3	3	3	3	3	3	3	
Predicted Internal Noise Level	dB	55	48	51	40	33	25	14	8	44

FLATS: 85 - 88 dB(A)										
Frequency	Hz	63	125	250	500	1000	2000	4000	8000	dB(A)
External Noise Level LAmax	dB	88	84	91	84	83	78	73	66	88
Glazing Specified: 12 / 20 / 8.8A	dB	33	33	37	42	42	49	55	46	
Area of Window	dB	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	
Area Correction	dB	4	4	4	4	4	4	4	4	
Likely RT in Room	sec	0.5	0.5	0.5	0.48	0.47	0.58	0.62	0.5	
Room Volume	m3	32	32	32	32	32	32	32	32	
Absorption		10	10	10	11	11	9	8	10	
Absorption Correction	dB	10	10	10	10	10	9	9	10	
Net SPL Inside	dB	48	44	47	35	34	23	12	13	41
External Wall	dB	43	45	45	49	57	65	70	70	
Area of Wall	dB	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	
Area Correction	dB	6	6	6	6	6	6	6	6	
Likely RT in Room	sec	0.5	0.5	0.5	0.48	0.47	0.58	0.62	0.5	
Room Volume	m3	32	32	32	32	32	32	32	32	
Absorption		10	10	10	11	11	9	8	10	
Absorption Correction	dB	10	10	10	10	10	9	9	10	
Net SPL Inside	dB	41	35	42	31	22	10	0	-8	35
Combined Level from elements	dB	49	45	49	37	34	23	13	13	42
Tolerance on Calculation	dB	3	3	3	3	3	3	3	3	
Predicted Internal Noise Level	dB	52	48	52	40	37	26	16	16	45

FLATS: 80 - 84 dB(A)										
Frequency	Hz	63	125	250	500	1000	2000	4000	8000	dB(A)
External Noise Level LAmax	dB	84	80	87	80	79	74	69	62	84
Glazing Specified: 8 / 20 / 12.8A	dB	35	27	33	41	47	43	54	54	
Area of Window	dB	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	
Area Correction	dB	4	4	4	4	4	4	4	4	
Likely RT in Room	sec	0.5	0.5	0.5	0.48	0.47	0.58	0.62	0.5	
Room Volume	m3	32	32	32	32	32	32	32	32	
Absorption		10	10	10	11	11	9	8	10	
Absorption Correction	dB	10	10	10	10	10	9	9	10	
Net SPL Inside	dB	42	46	47	32	25	25	9	1	40
External Wall	dB	43	45	45	49	57	65	70	70	
Area of Wall	dB	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	
Area Correction	dB	6	6	6	6	6	6	6	6	
Likely RT in Room	sec	0.5	0.5	0.5	0.48	0.47	0.58	0.62	0.5	
Room Volume	m3	32	32	32	32	32	32	32	32	
Absorption		10	10	10	11	11	9	8	10	
Absorption Correction	dB	10	10	10	10	10	9	9	10	
Net SPL Inside	dB	37	31	38	27	18	6	-4	-12	31
Combined Level from elements	dB	44	47	48	33	26	25	10	2	40
Tolerance on Calculation	dB	3	3	3	3	3	3	3	3	
Predicted Internal Noise Level	dB	47	50	51	36	29	28	13	5	43

FLATS: 72 - 79 dB(A)										
Frequency	Hz	63	125	250	500	1000	2000	4000	8000	dB(A)
External Noise Level LAmax	dB	79	75	82	75	74	69	64	57	79
Glazing Specified: 6 / 12 / 8.4A	dB	33	30	25	34	45	44	52	46	
Area of Window	dB	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	
Area Correction	dB	4	4	4	4	4	4	4	4	
Likely RT in Room	sec	0.5	0.5	0.5	0.48	0.47	0.58	0.62	0.5	
Room Volume	m3	32	32	32	32	32	32	32	32	
Absorption		10	10	10	11	11	9	8	10	
Absorption Correction	dB	10	10	10	10	10	9	9	10	
Net SPL Inside	dB	39	38	51	34	22	19	6	4	42
External Wall	dB	43	45	45	49	57	65	70	70	
Area of Wall	dB	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	
Area Correction	dB	6	6	6	6	6	6	6	6	
Likely RT in Room	sec	0.5	0.5	0.5	0.48	0.47	0.58	0.62	0.5	
Room Volume	m3	32	32	32	32	32	32	32	32	
Absorption		10	10	10	11	11	9	8	10	
Absorption Correction	dB	10	10	10	10	10	9	9	10	
Net SPL Inside	dB	32	26	33	22	13	1	-9	-17	26
Combined Level from elements	dB	40	39	51	35	23	19	6	4	42
Tolerance on Calculation	dB	3	3	3	3	3	3	3	3	
Predicted Internal Noise Level	dB	43	42	54	38	26	22	9	7	45

FLATS: UP TO 71 dB(A)										
Frequency	Hz	63	125	250	500	1000	2000	4000	8000	dB(A)
External Noise Level LAmax	dB	71	67	74	67	66	61	56	49	71
Glazing Specified: 4 / 16 / 4	dB	21	21	18	26	37	42	33	46	
Area of Window	dB	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	
Area Correction	dB	4	4	4	4	4	4	4	4	
Likely RT in Room	sec	0.5	0.5	0.5	0.48	0.47	0.58	0.62	0.5	
Room Volume	m3	32	32	32	32	32	32	32	32	
Absorption		10	10	10	11	11	9	8	10	
Absorption Correction	dB	10	10	10	10	10	9	9	10	
Net SPL Inside	dB	43	39	49	34	22	13	17	-4	41
External Wall	dB	43	45	45	49	57	65	70	70	
Area of Wall	dB	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	
Area Correction	dB	6	6	6	6	6	6	6	6	
Likely RT in Room	sec	0.5	0.5	0.5	0.48	0.47	0.58	0.62	0.5	
Room Volume	m3	32	32	32	32	32	32	32	32	
Absorption		10	10	10	11	11	9	8	10	
Absorption Correction	dB	10	10	10	10	10	9	9	10	
Net SPL Inside	dB	24	18	25	14	5	-7	-17	-25	18
Combined Level from elements	dB	43	39	49	34	22	13	17	-4	41
Tolerance on Calculation	dB	3	3	3	3	3	3	3	3	
Predicted Internal Noise Level	dB	46	42	52	37	25	16	20	-1	44

LIVING ROOMS: 68 - 71 dB(A)										
Frequency	Hz	63	125	250	500	1000	2000	4000	8000	dB(A)
External Noise Level LAeq	dB	75	68	67	65	68	65	59	54	71
Glazing Specified: 6 / 12 / 8.4A	dB	33	30	25	34	45	44	52	46	
Area of Window	dB	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	
Area Correction	dB	6	6	6	6	6	6	6	6	
Likely RT in Room	sec	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	
Room Volume	m3	51	51	51	51	51	51	51	51	
Absorption		14	14	14	14	14	14	14	14	
Absorption Correction	dB	11	11	11	11	11	11	11	11	
Net SPL Inside	dB	37	33	38	26	18	16	2	3	30
External Wall	dB	43	45	45	49	57	65	70	70	
Area of Wall	dB	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	
Area Correction	dB	7	7	7	7	7	7	7	7	
Likely RT in Room	sec	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	
Room Volume	m3	51	51	51	51	51	51	51	51	
Absorption		14	14	14	14	14	14	14	14	
Absorption Correction	dB	11	11	11	11	11	11	11	11	
Net SPL Inside	dB	27	18	17	11	6	-5	-16	-21	13
Combined Level from elements	dB	38	33	38	26	18	16	2	3	31
Tolerance on Calculation	dB	3	3	3	3	3	3	3	3	
Predicted Internal Noise Level	dB	41	36	41	29	21	19	5	6	34

LIVING ROOMS: 64 - 67 dB(A)										
Frequency	Hz	63	125	250	500	1000	2000	4000	8000	dB(A)
External Noise Level LAeq	dB	71	64	63	61	64	61	55	50	67
Glazing Specified: 6 / 12 / 4	dB	30	26	21	28	41	38	37	46	
Area of Window	dB	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	
Area Correction	dB	6	6	6	6	6	6	6	6	
Likely RT in Room	sec	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	
Room Volume	m3	51	51	51	51	51	51	51	51	
Absorption		14	14	14	14	14	14	14	14	
Absorption Correction	dB	11	11	11	11	11	11	11	11	
Net SPL Inside	dB	36	33	37	28	18	18	13	-1	31
External Wall	dB	43	45	45	49	57	65	70	70	
Area of Wall	dB	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	
Area Correction	dB	7	7	7	7	7	7	7	7	
Likely RT in Room	sec	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	
Room Volume	m3	51	51	51	51	51	51	51	51	
Absorption		14	14	14	14	14	14	14	14	
Absorption Correction	dB	11	11	11	11	11	11	11	11	
Net SPL Inside	dB	23	14	13	7	2	-9	-20	-25	9
Combined Level from elements	dB	36	33	37	28	18	18	13	-1	31
Tolerance on Calculation	dB	3	3	3	3	3	3	3	3	
Predicted Internal Noise Level	dB	39	36	40	31	21	21	16	2	34

LIVING ROOMS: UP TO 63 dB(A)										
Frequency	Hz	63	125	250	500	1000	2000	4000	8000	dB(A)
External Noise Level LAeq	dB	67	60	59	57	60	57	51	46	63
Glazing Specified: 4 / 16 / 4	dB	21	21	18	26	37	42	33	46	
Area of Window	dB	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	
Area Correction	dB	6	6	6	6	6	6	6	6	
Likely RT in Room	sec	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	
Room Volume	m3	51	51	51	51	51	51	51	51	
Absorption		14	14	14	14	14	14	14	14	
Absorption Correction	dB	11	11	11	11	11	11	11	11	
Net SPL Inside	dB	41	34	36	26	18	10	13	-5	30
External Wall	dB	43	45	45	49	57	65	70	70	
Area of Wall	dB	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	
Area Correction	dB	7	7	7	7	7	7	7	7	
Likely RT in Room	sec	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	
Room Volume	m3	51	51	51	51	51	51	51	51	
Absorption		14	14	14	14	14	14	14	14	
Absorption Correction	dB	11	11	11	11	11	11	11	11	
Net SPL Inside	dB	19	10	9	3	-2	-13	-24	-29	5
Combined Level from elements	dB	41	34	36	26	18	10	13	-5	30
Tolerance on Calculation	dB	3	3	3	3	3	3	3	3	
Predicted Internal Noise Level	dB	44	37	39	29	21	13	16	-2	33

APPENDIX 3 – ASSESSMENT OF ADO COMPLIANCE FOR BEDROOMS (L_{Amax})

FLATS					
Plot	Internal Level with Open Windows Night L _{Amax}	Overheating Strategy	Plot	Internal Level with Open Windows Night L _{Amax}	Overheating Strategy
F001	47	Open Windows	F202	45	Open Windows
F002	74	Mechanical Ventilation	F203	47	Open Windows
F003	79	Mechanical Ventilation	F204	73	Mechanical Ventilation
F004	77	Mechanical Ventilation	F205	76	Mechanical Ventilation
F005	78	Mechanical Ventilation	F206	75	Mechanical Ventilation
F006	78	Mechanical Ventilation	F207	76	Mechanical Ventilation
F007	71	Mechanical Ventilation	F208	76	Mechanical Ventilation
F008	63	Mechanical Ventilation	F209	72	Mechanical Ventilation
F009	62	Mechanical Ventilation	F210	71	Mechanical Ventilation
F010	61	Mechanical Ventilation	F211	63	Mechanical Ventilation
F011	60	Mechanical Ventilation	F212	62	Mechanical Ventilation
F012	56	Mechanical Ventilation	F213	61	Mechanical Ventilation
F013	45	Open Windows	F214	60	Mechanical Ventilation
F101	44	Open Windows	F215	55	Mechanical Ventilation
F102	45	Open Windows	F216	53	Open Windows
F103	47	Open Windows	F217	44	Open Windows
F104	73	Mechanical Ventilation	F301	44	Open Windows
F105	78	Mechanical Ventilation	F302	45	Open Windows
F106	76	Mechanical Ventilation	F303	48	Open Windows
F107	77	Mechanical Ventilation	F304	72	Mechanical Ventilation
F108	77	Mechanical Ventilation	F305	74	Mechanical Ventilation
F109	73	Mechanical Ventilation	F306	73	Mechanical Ventilation
F110	71	Mechanical Ventilation	F307	74	Mechanical Ventilation
F111	63	Mechanical Ventilation	F308	73	Mechanical Ventilation
F112	62	Mechanical Ventilation	F309	70	Mechanical Ventilation
F113	61	Mechanical Ventilation	F310	69	Mechanical Ventilation
F114	60	Mechanical Ventilation	F311	63	Mechanical Ventilation
F115	56	Mechanical Ventilation	F312	62	Mechanical Ventilation
F116	52	Open Windows	F313	61	Mechanical Ventilation
F117	44	Open Windows	F314	44	Open Windows
F201	44	Open Windows			

HOUSES			
Plot	Facade	Internal Level with Open Windows Night L_{max}	Overheating Strategy
1 st Floor			
H01	North	50	Open windows
H01	South	65	Mechanical Ventilation
H01	West	63	Mechanical Ventilation
H02	North	48	Open windows
H02	South	63	Mechanical Ventilation
H03	North	47	Open windows
H03	South	58	Mechanical Ventilation
H04	North	48	Open windows
H04	South	63	Mechanical Ventilation
H05	East	62	Mechanical Ventilation
H05	West	58	Mechanical Ventilation
H06	East	62	Mechanical Ventilation
H06	West	58	Mechanical Ventilation
H07	East	65	Mechanical Ventilation
H07	West	62	Mechanical Ventilation
H08	East	64	Mechanical Ventilation
H08	West	63	Mechanical Ventilation
H09	East	68	Mechanical Ventilation
H09	West	67	Mechanical Ventilation
H10	East	70	Mechanical Ventilation
H10	West	70	Mechanical Ventilation
H11	North	55	Open windows
H11	South	74	Mechanical Ventilation
H12	North	52	Open windows
H12	South	75	Mechanical Ventilation
H13	North	51	Open windows
H13	South	75	Mechanical Ventilation
H14	North	50	Open windows
H14	South	75	Mechanical Ventilation
H15	North	52	Open windows
H15	South	75	Mechanical Ventilation

HOUSES			
Plot	Facade	Internal Level with Open Windows Night L_{Amax}	Overheating Strategy
2 nd Floor			
H05	East	62	Mechanical Ventilation
H06	East	62	Mechanical Ventilation
H07	East	65	Mechanical Ventilation
H08	East	64	Mechanical Ventilation
H09	East	68	Mechanical Ventilation
H10	East	70	Mechanical Ventilation
H11	North	58	Mechanical Ventilation
H11	South	73	Mechanical Ventilation
H12	North	52	Open windows
H12	South	74	Mechanical Ventilation
H13	North	51	Open windows
H13	South	73	Mechanical Ventilation
H14	North	51	Open windows
H14	South	74	Mechanical Ventilation
H15	North	52	Open windows
H15	South	74	Mechanical Ventilation

APPENDIX 4 - TERMINOLOGY RELATING TO NOISE

Sound Pressure	Sound, or sound pressure, is a fluctuation in air pressure over the static ambient pressure.
Sound Pressure Level	The sound level is the sound pressure relative to a standard reference pressure of 20µPa (20x10 ⁻⁶ Pascals) on a decibel scale.
Decibel (dB)	A scale for comparing the ratios of two quantities, including sound pressure and sound power. The difference in level between two sounds s_1 and s_2 is given by $20 \log_{10} (s_1 / s_2)$. The decibel can also be used to measure absolute quantities by specifying a reference value that fixes one point on the scale. For sound pressure, the reference value is 20µPa.
A-weighting, dB(A)	The unit of sound level, weighted according to the A scale, which takes into account the increased sensitivity of the human ear at some frequencies.
Noise Level Indices	Noise levels usually fluctuate over time, so it is often necessary to consider an average or statistical noise level. This can be done in several ways, so a number of different noise indices have been defined, according to how the averaging or statistics are carried out.
Leq,T	A noise level index called the equivalent continuous noise level over the time period T. This is the level of a notional steady sound that would contain the same amount of sound energy as the actual, possibly fluctuating, sound that was recorded.
Lmax,T	A noise level index defined as the maximum noise level during the period T. Lmax is sometimes used for the assessment of occasional loud noises, which may have little effect on the overall Leq noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
L90,T	A noise level index. The noise level exceeded for 90% of the time over the period T. L90 can be considered to be the "average minimum" noise level and is often used to describe the background noise.
Free-Field	Far from the presence of sound reflecting objects (except the ground), usually taken to mean at least 3.5m.
Façade Noise Level	At a distance of 1m in front of a large sound reflecting object such as a façade.
Fast/Slow Time Weighting	Averaging times used in sound level meters.
Octave Band	Range of frequencies whose upper limit is twice the lower limit.
DnT,w	The single number quantity that characterises airborne sound insulation between rooms over a range of frequencies.
Rw	Single number quantity that characterises the airborne sound insulating properties of a material or building element over a range of frequencies.