LAHC Projects - Warwick Farm

Acoustics Report

Development Application

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Revision

Revision	Date	Comment	Prepared By	Approved By
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1. Introduction

As part of the Development Application (DA) documentation process, Wood & Grieve Engineers Now part of Stantec has been engaged by Taylor Construction Group Pty Ltd to provide an acoustic assessment for the proposed residential development, located at 11-13 Mannix Parade, Warwick Farm, NSW 2170.

This assessment discusses the likely noise impact of the proposed development upon the potentially nearest most-affected residential receivers and institutional receiver. Furthermore, there is potential for external noise intruding into the proposed development.

This assessment has been prepared considering the following documents:

- Liverpool Development Control Plan 2008.
- NSW Environment Protection Authority (EPA) Noise Policy for Industry, 2017 (NPI 2017).
- Department of Planning (DoP) – Development near Rail Corridors and Busy Roads – Interim Guideline;
- NSW Road Noise Policy, 2011 (RNP 2011).
- AS/NZS 2107:2016: “Acoustics – Recommended design sound levels and reverberation times for building interiors”.
- NSW Environment Protection Authority (EPA) Interim Construction Noise Guideline (ICNG July 2009).
- Bureau of Meteorology, Daily rainfall report.
- Assessing Vibration – A Technical Guideline (NSW AV-TG), issued February 2006 by the Department of Environment and Conservation NSW, now part of the NSW EPA.
- British Standard BS5228: Part 1:1997 “Noise and Vibration Control on Construction and Open Sites.”.
- British Standard BS7358:1993 “Evaluation and Measurement for Vibration in Buildings” – Part 2: “Guide to Damage Levels from Ground borne Vibration”.
- German Standard DIN4150-Part 3 “Structural vibration in buildings – Effects on structures.

This report provides:

- Indicative recommendations for noise mitigation measures for the proposed development in order to meet the relevant criteria.

The work documented in this report was carried out in accordance with the Wood & Grieve Engineers Quality Assurance system, which is based on Australian Standard / NZS ISO 9001.

This report is based on our understanding of the proposed project, application of the relevant state guidelines and professional experience within the acoustic field. Therefore, this report shall not be relied upon as providing any warranties or guarantees.

2. Background

2.1 Information Sources

The following documentation has been used for the preparation of this report:

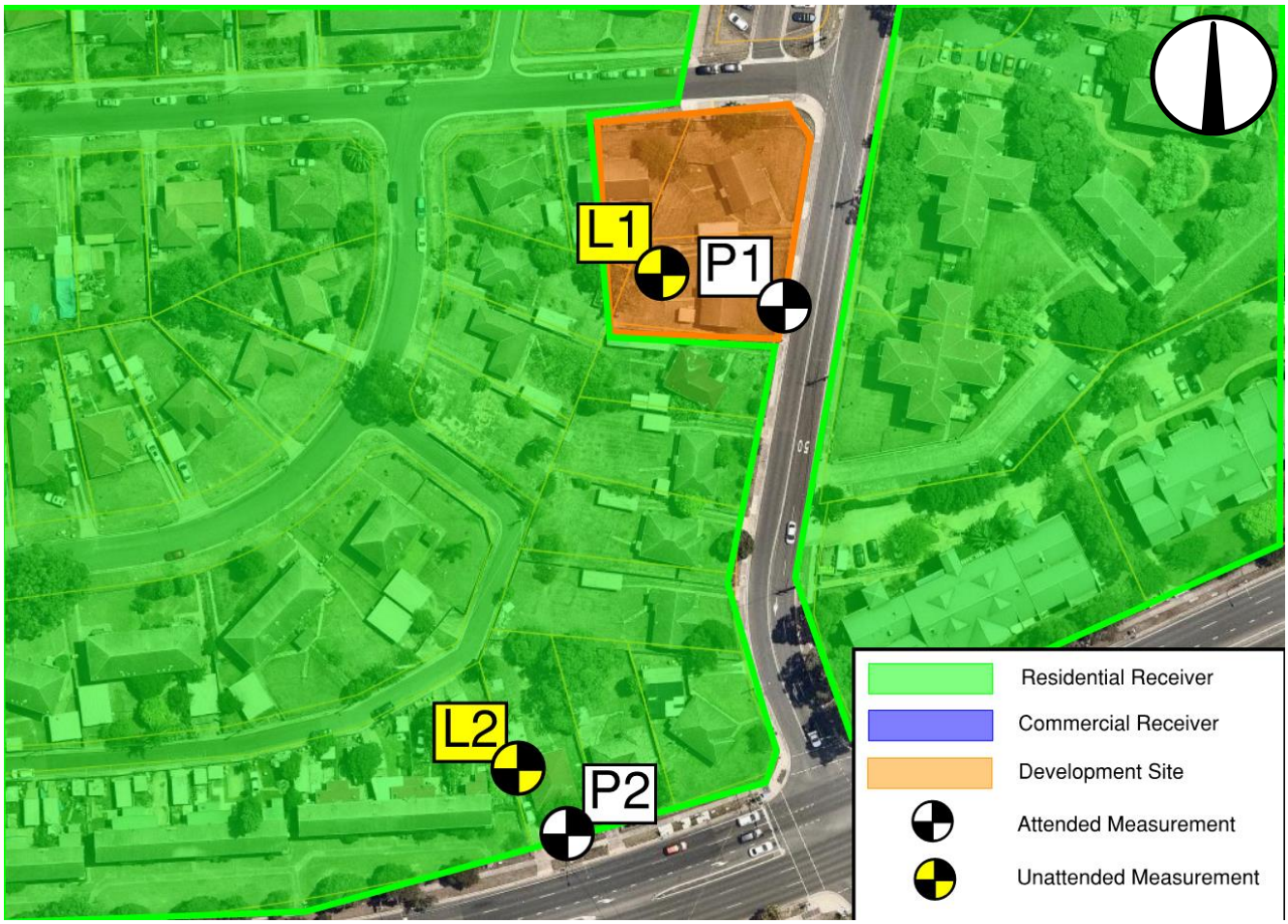
- Site drawings presenting the location of the proposed residential development in relation to the nearest receivers.
- Noise data collected on site through the use of a noise logger and a handheld spectrum analyser.
- Development Application (DA) architectural drawings issued by TURNER dated 31st July 2020.
- Traffic impact assessment issued by ptc. dated 17th August 2020.

3. Project Overview

3.1 Site Description

The proposed residential development is located at 11-13 Mannix Parade, Warwick Farm, NSW 2170. The development is bound by residential units on all sides, and it is aligned with Mc Girr Parade to the North and Mannix Parade to the East. The nearest potentially affected noise receivers are shown in Figure 1. The development also sits North to the Hume Highway.

Figure 1: Aerial Photo of the Area Showing an Overview of the Site and Measurement Locations



Source: nearmap.com

3.1.1 Acoustic Considerations

The acoustic considerations relating to the proposed development are as follows:

- Noise from vehicle movements on Mc Girr Parade, Mannix Parade and Hume Highway intruding into the proposed development's habitable spaces
- Noise emissions from mechanical plant servicing the proposed development to the surrounding noise sensitive receivers
- Increased traffic noise generated by the proposed development affecting the surrounding residential receivers

4. Noise Survey

4.1 Instrumentation

The equipment used for the noise survey was the following:

- Hand-held sound spectrum analyser Brüel & Kjær Type 2250, S/N 2709742
- Brüel & Kjær Sound Calibrator, S/N 2709826
- Brüel & Kjær Noise Logger; S/N 3011814
- Casella Noise Logger; S/N 1488204
- NTi XL2 Sound Level Meter, S/N A2A-11555-E0

All equipment was calibrated before and after the measurements and no significant drift was found. All equipment carries current traceable calibration certificates that can be provided upon request.

4.2 Attended Noise Survey Results

Attended noise measurements of 15-minute duration were conducted on site to characterise the acoustic environment for noise intruding into the development and to determine any noise impacts on the surrounding receivers. A summary of the attended noise measurements taken at the proposed residential development site are shown in Table 1.

Table 1: Summary of results for attended noise surveys

Measurement Location	Measurement Time	L_{Aeq} dB(A)	L_{A90} dB(A)	L_{Amax} dB(A)	Comments
P1	9:00 am	61	47	84	Traffic movement on Hume Highway and Mannix Parade
P2	8:15 am	74	62	76	Traffic movement on Hume Highway

4.3 Unattended Noise Survey Results

4.3.1 Background and Ambient Noise Monitoring

Noise monitors were placed at positions L1 and L2 (shown in Figure 1) to measure the background and ambient noise that is representative of the surrounding noise-sensitive receivers. The noise loggers were installed from the 20th March 2020 to the 27th March 2020. The results for the unattended background noise surveys are shown in Table 2 below (for the day, evening and night periods). Note that any rain affected data during the period of logging has been excluded from the calculations.

Table 2: Summary of results for background and ambient noise surveys

Location	Equivalent Continuous Noise Level $L_{Aeq,period}$ - dB(A)			Background Noise Level RBL - dB(A)		
	Day	Evening	Night	Day	Evening	Night
L1	54	58	52	46	46	41
L2	63	62	60	47	49	39

Figure 2: Unattended noise monitoring data – L1

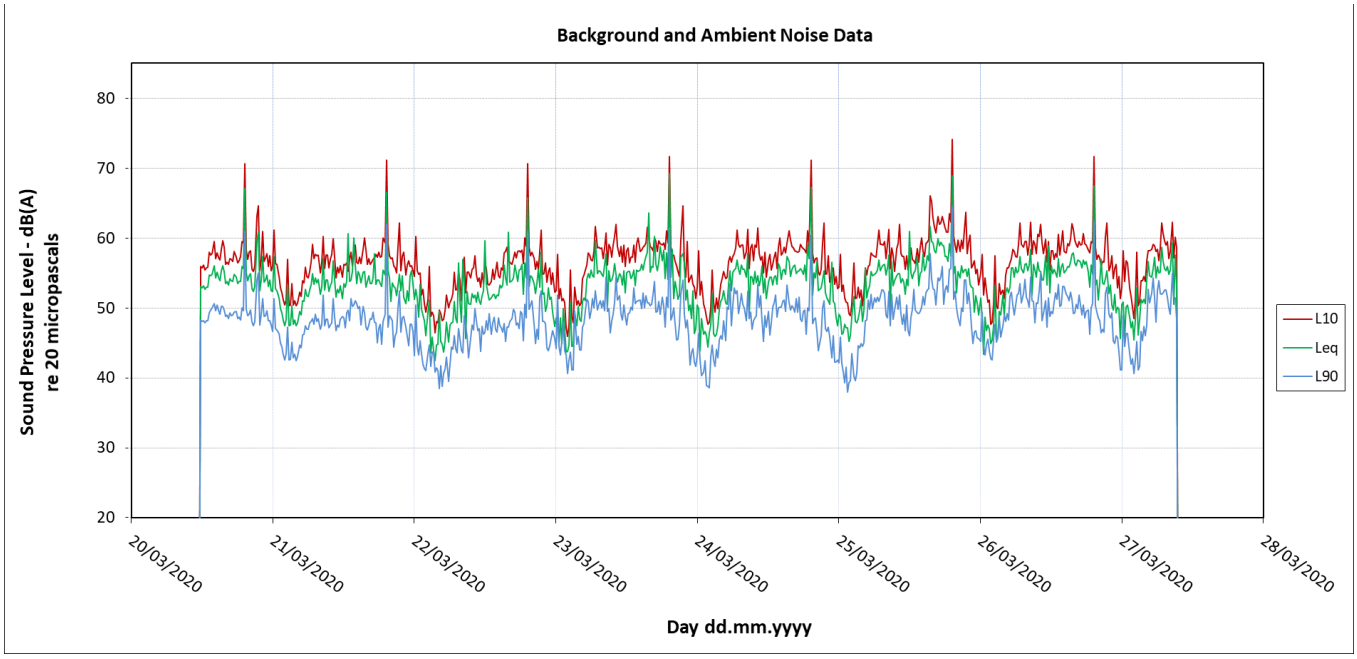
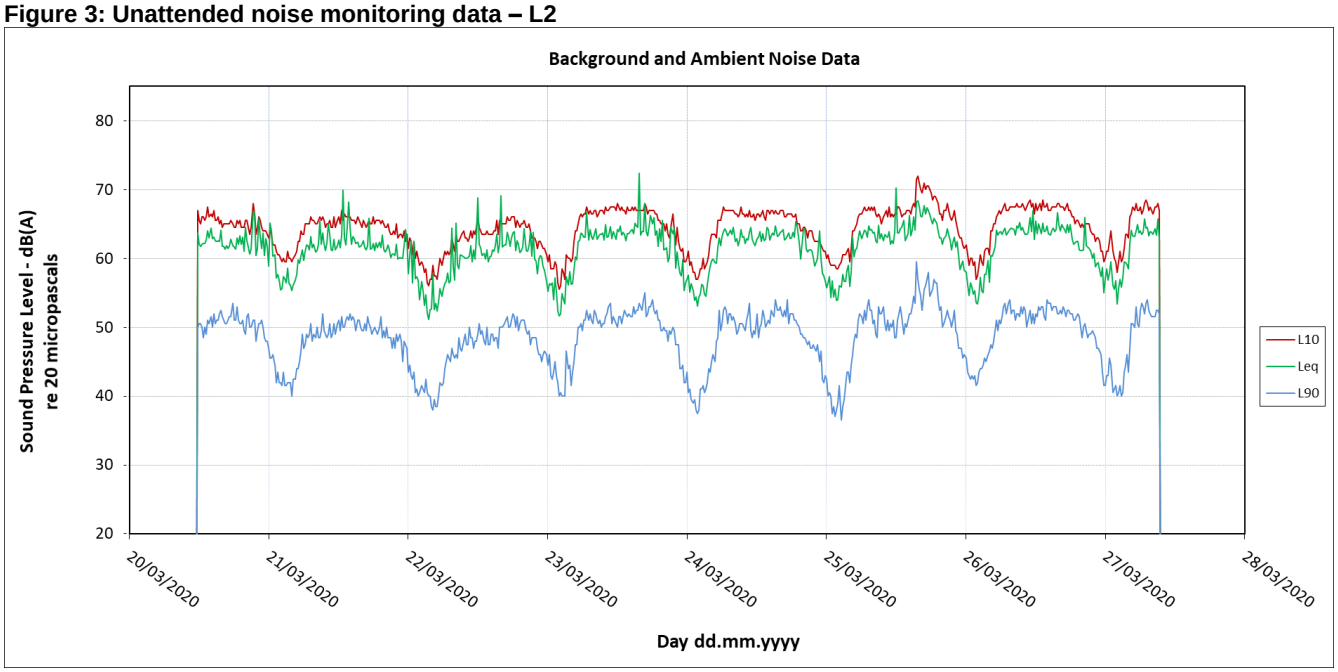


Figure 3: Unattended noise monitoring data – L2



4.3.2 Traffic Noise Monitoring

Noise monitors were placed at positions L2 (shown in Figure 1) to measure the noise generated by vehicle movements on Mannix Parade during the 15 hour and 9 hour periods established in the Department of Planning's Development near Rail Corridors and Busy Roads – Interim Guideline. Noise monitor L2 was installed from the 20th March 2020 to the 27th March 2020. The results for the unattended traffic noise surveys are shown in Table 3 below (for the day and night periods). These measurements were taken in absence of any industrial noise sources.

Note that any rain affected data during the period of logging has been excluded from the calculations.

Table 3: Summary of results for traffic noise surveys

Location	Equivalent Continuous Noise Level $L_{Aeq,period}$ - dB(A)		Noisiest 1 Hour $L_{Aeq,1hour}$ - dB(A)	
	Day (15hr)	Night (9hr)	Day	Night
L1	63	62	68	63

5. Noise and Vibration Criteria

5.1 Internal Noise Level Criteria

5.1.1 AS/NZS 2107:2016

Australian Standard AS/NZS 2107:2016 – *'Acoustics- Recommended design sound levels and reverberation times for building interiors'* specifies target noise levels for internal spaces to the development. Traffic noise intrusion AS 3671 refers to internal noise compliance with AS/NZS2107:2016. Refer to Table 4 for the values corresponding to residential spaces near minor roads.

Table 4: Recommended noise levels according to AS/NZS 2107:2016

Houses and apartments in suburban areas or near minor roads	Recommended Design Sound Level, $L_{Aeq,t}$, dB(A)	
	Satisfactory	Maximum
Sleeping areas	30	35
Living areas	30	40
Work Areas	35	40
Common Areas (lift lobby, foyer)	45	50

5.1.2 Development near Rail Corridors & Busy Roads – Interim Guideline

The DoP's Development near Rail Corridors and Busy Roads – Interim Guideline governs the required maximum internal noise levels averaged over certain periods within bedrooms and living areas of apartments in the development. The guideline details the application of clause 102 of the State Environmental Planning Policy (SEPP) Infrastructure which states the following for residential developments:

> *"If the development is for the purposes of residential accommodation, the consent authority must not grant consent to the development unless it is satisfied that appropriate measures will be taken to ensure that the following LAeq levels are not exceeded:*
>
> *(a) In any bedroom in the residential accommodation – 35 dB(A) at any time between 10.00 pm and 7.00 am,*
>
> *(b) Anywhere else in the residential accommodation (other than a garage, kitchen, bathroom or hallway) – 40 dB(A) at any time."*

The DoP's Development near Rail Corridors and Busy Roads – Interim Guideline also states the following in regard to an open windows assessment:

> *"If internal noise levels with windows or doors open exceed the criteria by more than 10dBA, the design of the ventilation for these rooms should be such that occupants can leave windows closed, if they so desire, and also to meet the ventilation requirements of the Building Code of Australia."*

The ventilation requirements referred to in the requirements are in-line with the requirements established in the ADG Objective 4B-1 and AS1668.2.

Table 5 provides a summary of the criteria established in the DoP's Interim Guideline below.

Table 5: Summary of DoP's Interim Guideline criteria for residential developments adjacent to rail corridors

Type of habitable space	Applicable Time Period	Assessment Noise Metric	Windows/Doors Closed Criteria – dB(A)	Windows/Doors Open Criteria – dB(A)
Sleeping areas (bedrooms)	10:00pm – 7:00am	$L_{Aeq,9h(night)}$	35	45
Living rooms	At any time	$L_{Aeq,15h(day)}$	40	50

5.2 External Noise Emissions

5.2.1 Liverpool Council DCP

The Liverpool council DCP 2008, Part 3.6 states the following with regards to external noise emissions from the proposed development to noise-sensitive receivers:

> *"The proposed buildings must comply with the Environment Protection Authority criteria and the current relevant Australian Standards for noise and vibration and quality assurance."*

5.2.2 NSW EPA Noise Policy for Industry (NPI)

The NPI sets out noise criteria to control the noise emission from industrial noise sources from activities listed in Schedule 1 of the POEO Act and regulated by the EPA. The external noise due to mechanical services from the proposed development is also addressed following the guideline in the NSW EPA's NPI.

The calculation is based on the results of the ambient and background noise unattended monitoring, addressing two components:

- Controlling intrusive noise into nearby residences (Intrusiveness Criteria)
- Maintaining noise level amenity for particular land uses (Amenity Criteria)

Once both criteria are established the most stringent for each considered assessment period (day, evening, night) is adopted as the project-specific noise level (PSNL).

Intrusiveness Criteria

The NSW EPA NPI states the following:

> *"The intrusiveness of an industrial noise source may generally be considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (represented by the L_{Aeq} descriptor), measured over a 15-minute period, does not exceed the background noise level measured in the absence of the source by more than 5 dB(A)."*

The intrusiveness criterion can be summarised as follows:

$L_{Aeq,\ 15\ minute} \leq$ RBL background noise level + 5 dB(A)

The intrusiveness criterion for the closest residential receivers is presented in Table 6 below. Note the values from L1 and L2 have been used in this assessment as they are the most relevant to define the background and ambient noise level of the residential receivers.

Table 6: EPA NPI Intrusiveness Criteria

Period	Noise Descriptor – dB(A)	Noise Criteria – All residential receivers $L_{Aeq,15mins}$
Residential Receiver		
Daytime 7am – 6pm	$L_{Aeq,15min} \leq$ RBL + 5	51
Evening 6pm – 10pm	$L_{Aeq,15min} \leq$ RBL + 5	51
Night 10pm – 7am	$L_{Aeq,15min} \leq$ RBL + 5	46

Amenity Criteria

The NSW NPfI states the following:

> *"To limit continuing increases in noise levels from application of the intrusiveness level alone, the ambient noise level within an area from all industrial noise sources combined should remain below the recommended amenity noise levels specified in Table 2.2 where feasible and reasonable. The recommended amenity noise levels will protect against noise impacts such as speech interference, community annoyance and some sleep disturbance. The recommended amenity noise levels have been selected on the basis of studies that relate industrial noise to annoyance in communities" (Miedema and Voss, 2004).*

To ensure that industrial noise levels (existing plus new) remain within the recommended amenity noise levels for an area, a project amenity noise level applies for each new source of industrial noise as follows:

> *"Project amenity noise level for industrial developments = recommended amenity noise level (Table 2.2) minus 5 dB(A)"*

The applicable parts of Table 2.2: Amenity noise levels which are relevant to the project are reproduced below:

Table 7: NSW NPI Table 2.2 amenity criteria for external noise levels

Type of Receiver	Noise Amenity Area	Time of Day	L_{Aeq} , dB(A) Project amenity noise level	Adjusted Acceptable Levels $L_{Aeq,15mins}$
Residential Receiver	Suburban*	Day	50	50
	Urban*	Evening	40	48
	Urban*	Night	35	42
Commercial Receiver	All	When in use	65	-

*Suburban area as defined in EPA NSW NPI Table 2.3

Sleep Disturbance

The NPI establishes sleep disturbance criteria for residential receivers in close proximity to industrial noise sources during the night-time period, such as vehicle movements and car door slams on private roads. The criteria for protecting the amenity of surrounding residential receivers in regard to sleep disturbance is:

- $L_{Aeq,15min}$ 40 dB(A) or prevailing RBL plus 5dB, whichever is greater, and/or
- L_{AFmax} 52 dB(A) or prevailing RBL plus 15dB, whichever is greater

Table 8 summarises the sleep disturbance criteria for the proposed development.

Table 8: Sleep Disturbance Criteria

Period	Sleep Disturbance Criteria

	L_{AFmax} – dB(A)	$L_{Aeq,15min}$ – dB(A)
Residential Receiver		
Night (10:00pm to 7:00am)	56	46

5.2.3 Project Noise Trigger Levels

In summary, there are two criteria specific to this project. The overall criteria from all industrial plant noise sources were established using the lowest values from the NPI noise levels mentioned above. These levels are shown in Table 9 below.

Table 9: Project noise trigger levels for industrial noise emissions

Period	Descriptor	Project Specific Noise Emission Levels dB(A)
Residential Receiver – R1		
Day (7:00am to 6:00pm)	$L_{Aeq,15min}$	51
Evening (6:00pm to 10:00pm)	$L_{Aeq,15min}$	51
Night (10:00pm to 7:00am)	$L_{Aeq,15min}$	45
	L_{AFmax}	56

5.3 Traffic Noise Generation Criteria

The L_{Aeq} noise level or the "equivalent continuous noise level" correlates best with the human perception of annoyance associated with traffic noise. Road traffic noise impact is assessed in accordance with the NSW Road Noise Policy (RNP, Office of Environment and Heritage 2011). The criterion (Table 3 – Road Traffic Noise Assessment Criteria for Residential Land Uses) divides land use developments into different categories and lists the respective criteria for each case. The category that is relevant to the proposed use of the site is shown in Table 10.

Table 10: NSW Road Noise Policy – Traffic Noise Assessment Criteria

Road Category	Type of project/land use	Assessment Criteria – dB(A) (external)	
		Day (7am – 10pm)	Night (10pm – 7am)
Freeway/ arterial/ sub-arterial roads	4. Existing residences affected by noise from new freeway/arterial/sub-arterial road corridors	$L_{Aeq,\ (1\ hour)}$ 55	$L_{Aeq,\ (1\ hour)}$ 55
	5. Existing residences affected by noise from redevelopment of existing freeway/arterial/sub-arterial road corridors	$L_{Aeq,\ (1\ hour)}$ 60	$L_{Aeq,\ (1\ hour)}$ 55
	6. Existing residences affected by additional traffic on existing freeway/arterial/sub-arterial road corridors generated by land use developments		
Local roads	Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq,1\ hour}$ 55	$L_{Aeq,1\ hour}$ 50

In the event that the traffic noise at the site is already in excess of the criteria noted above, the NSW RNP states that the primary objective is to reduce the existing level through feasible and reasonable measures to meet the criteria above.

If this is not achievable, *Section 3.4.1 Process for applying the criteria – Step 4* states that for existing residences affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise should be limited to 2 dB above that of the corresponding 'no build option'. The inherent quality of noise from vehicles on public roads arriving to and departing from the site would be indistinguishable from other traffic noise on public roads.

5.4 Construction Noise Criteria

Noise criteria for construction sites are established in accordance with the Interim Construction Noise Guideline (ICNG July 2009) by the NSW Environment Protection Authority (EPA). It is important to note that the recommended criteria are for planning purposes only. Numerous other factors need to be considered when assessing potential noise impacts from construction works.

However, in undertaking the assessment of potential noise intrusion associated with the proposed construction activities, Chapter 4 of the NSW EPA ICNG (July 2009) were specifically referenced. The limits presented in Table 11 apply.

Table 11: NSW EPA ICNG Construction Noise Criteria

Time of Day	Management Level $L_{Aeq,15min}$ *	How to Apply
Recommended Standard Hours: Mon – Fri (7am – 6pm) Sat (8am – 1pm) No work on Sunday & Public Holidays	Noise Affected RBL + 10dB(A)	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq,15min}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residences of the nature of works to be carried out, the expected noise levels and duration as well as contact details.
	Highly Noise Affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur in, taking into account: • Times identified by the community when they are less sensitive to noise (such as before and after school, for works near schools, or mid-morning or mid-afternoon for works near residences) • If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside Recommended Standard Hours	Noise Affected RBL + 5dB(A)	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see section 7.2.2.

Note: Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Source: Chapter 4 (Table 2 Sec 4.1.1) of NSW DECCW ICNG.

5.5 Construction Vibration Criteria

The EPA has developed a document, “Assessing vibration: A technical Guideline” in February 2006 to assist in preventing people from excessive vibration levels within buildings. The guideline does not however address vibration induced damage to structures or structure-borne noise effects.

Vibration and its associated effects are usually classified as continuous, impulsive or intermittent.

5.5.1 Human Comfort – Continuous and Impulsive Vibration Criteria

Structural vibration in buildings can be detected by occupants and can affect them in many ways including reducing their quality of life and also their working efficiency. Complaint levels from occupants of buildings subject to vibration depend upon their use of the building and the time of the day.

Maximum allowable magnitudes of building vibration with respect to human response are shown in Table 12. It should be noted that the human comfort for vibration are more stringent than the building damage criteria.

Table 12: RMS values for continuous and impulsive vibration acceleration (m/s2) 1-80Hz

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous vibration					
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and place of worship	Day or night-time	0.020	0.014	0.040	0.028
Impulsive vibration					
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and place of worship	Day or night-time	0.64	0.46	1.28	0.92

5.5.2 Human Comfort – Intermittent Vibration Criteria

Disturbance caused by vibration will depend on its duration and its magnitude. This methodology of assessing intermittent vibration levels involves the calculation of a parameter called the Vibration Dose Value (VDV) which is used to evaluate the cumulative effects of intermittent vibration. Various studies support the fact that VDV assessment methods are far more accurate in assessing the level of disturbance than methods which is only based on the vibration magnitude.

Table 13: Acceptable Vibration Dose Values for Intermittent Vibration (m/s1.75)

Location	Daytime (7:00am to 10:00pm)		Night-time (10:00pm to 7:00am)	
	Preferred value	Maximum value	Preferred value	Maximum value
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and place of worship	0.40	0.80	0.40	0.80

5.5.3 Structural Damage – Vibration Criteria

Ground vibration criteria are defined in terms of levels of vibration emission from the construction activities which will avoid the risk of damaging surrounding buildings or structures. It should be noted that human comfort criteria are normally expressed in terms of acceleration whereas structural damage criteria are normally expressed in terms of velocity.

Most commonly specified structural vibration levels are defined to minimize the risk of cosmetic surface cracks and are set below the levels that have the potential to cause damage to the main structure. Structural damage criteria are presented in German Standard DIN4150-Part 3 “Structural vibration in buildings – Effects on structures” and British Standard BS7385-Part 2: 1993 “Evaluation and Measurement for Vibration in Buildings”. Table 14 indicates the vibration limits presented in DIN4150-Part 3 to ensure structural damage doesn’t occur.

Table 14: Guideline value of vibration velocity, vi, for evaluating the effects of short-term vibration

Line	Type of Structure	Vibration velocity, vi, in mm/s			
		Foundation			Plane of floor of uppermost full storey
		At a frequency of			
		Less than 10Hz	10 to 50Hz	50 to 100*Hz	All Frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that, because of their particular sensitivity to vibration, do not correspond to those listed in lines 1 and 2 and are of great intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8
*For frequencies above 100Hz, at least the values specified in this column shall be applied					

Table 15 presents guide values for building vibration, based on the lowest vibration levels above which cosmetic damage has been demonstrated as per BS7385-Part 2:1993.

Table 15: Transient vibration guide values for cosmetic damage

Type of Building	Peak Particle Velocity in frequency range of predominant pulse (PPV)	
Residential or light commercial type buildings	4 Hz to 15 Hz	15 Hz and above
	15mm/s at 4Hz increasing to 20mm/s at 15Hz	20mm/s at 15Hz increasing to 50mm/s at 40Hz and above

5.5.4 Construction Vibration Objectives

Table 16 indicates the construction vibration criteria applicable to the residential properties located adjacent to the development site.

Table 16: Construction vibration criteria summary

Location	Period	Human Comfort Vibration Objectives			Building damage Objectives – Velocity (mm/s)
		Continuous mm/s^2 (RMS)		Intermittent $mm/s^{1.75}$ (VDV)	
		z-axis	x- and y-axis		
Residential	Day time	10 - 20	7 - 14	0.20 - 0.40	5
	Night-time	7 - 14	5 - 10	0.13 - 0.26	5

6. Noise Impact Assessment

The following sections detail the acoustic requirements for the proposed building facade glazing, and the noise impact assessment from external noise emissions to surrounding noise-sensitive receivers.

6.1 External Facade Assessment

In order to provide acoustic amenity to occupants for the future residential units and comply with the project specific internal noise levels, the acoustic performance of the building façades was assessed.

The general limiting factor of the performance of a building façade in term of noise attenuation is the glazing. In the case of this particular proposed development, the roads adjacent to the property will place the greatest acoustic demand on the facade. Refer to Appendix B for noise modelling results.

6.1.1 Glazing Recommendations

In order to achieve the recommended internal noise levels criterion as summarised in Table 4, the minimum recommended glazing systems for the façades of the proposed development are presented in Table 17 and the corresponding locations of the glazing systems are provided in Appendix D.

This assessment is based on the worst-case scenario of external noise obtained from the attended and unattended noise measurements surrounding the sites towards the most affected residential units. The glazing systems presented below should be considered as the minimum requirements to achieve appropriate acoustic performance. Greater glazing systems may be required for structural loading, wind loading, ESD, etc. Note that there was assumed to be no attenuation through external façade elements such as unsealed balustrades or landscaping elements.

Table 17: Recommended glazing thicknesses to meet acoustic performance

Proposed Glazing System	Equivalent DGU	Required Acoustic Rating of Glazing Assembly (min. Rw)
6.38mm laminated Single Glazed Glass System	6mm / 12mm / 6mm	32
8.38mm laminated Single Glazed Glass System	6mm / 12mm / 6mm	34
10.38mm laminated Single Glazed Glass System	6.38mm / 12mm / 6mm	36
12.38mm laminated Single Glazed Glass System	12.38mm / 12mm / 6mm	37

Note: Refer to Appendix D for designations of glazing arrangements on plan.

For the purpose of this assessment we have considered single laminated glass wherever possible. The glazing system proposed above has been provided for Development Application purposes only. The acoustic performance of the glazing facade should be reviewed as the combined noise from external sources and mechanical services could result in internal noise level exceeding the recommended design sound level during the detailed design stage of the project.

6.1.2 Open Windows Assessment

An open windows assessment has been conducted in order to assess whether the habitable spaces can meet the internal noise level requirements stipulated within the DoP's Interim Guideline with windows open for ventilation (open in accordance with the natural ventilation requirements of the NCC).

If there is an exceedance of the internal noise level criteria with the windows open, an alternative means of ventilation is required in accordance with the requirements of the National Construction Code 2016 Amendment 1 (i.e. an alternative ventilation system complying with AS 1668.2 and AS/NZS 3666.1).

The results of the alternative means of ventilation assessment are provided in Appendix C. Where the façade is highlighted in:

- Red – At this location, a bedroom or living room within a residential apartment space will require an alternative means of ventilation (mechanical ventilation)
- Green – At this location, spaces within a residential apartment will not require an alternative means of ventilation, and each space will be able to rely on opening their windows to achieve the ventilation requirements.

Mark-ups have been provided in Appendix C from Figure 12 to Figure 15, showing the habitable spaces within each apartment that will require alternative means of ventilation.

6.2 Mechanical Noise Emissions

The following noise sources are associated with the site operation, and details about expected noise levels from these sources are given in the ensuing sub-sections. Noise sources from general operations of the site typically include mechanical services noise from air-conditioning equipment and exhaust fans etc. servicing the units. These noise sources have been used to predict in the worst-case scenario the noise impact of the proposed development at the boundary of the nearest sensitive receivers.

The main mechanical sources associated with the development will include:

- Condenser units (Location TBC)
- Carpark exhaust (Located on 6th Floor South-West Terrace)

In order to assess the worst-case scenario, it was assumed that the air conditioning units and exhausts and supply fans are running at any time throughout a 24hr period. With all, the night-time is the most stringent period for the noise generated by the operation of mechanical plant and as such this criterion was used as the noise target at the boundary of the nearest sensitive receivers for the project.

6.2.1 Proposed Maximum Noise Levels

Table 18 presents the proposed maximum sound power levels for individual mechanical units to achieve the noise criteria shown at the nearest sensitive receiver of the site. Typical mechanical plant spectra have been implemented in the calculations and will need to be amended once specific units have been selected later in the design stage.

Table 18: Proposed acoustic power for individual mechanical units

Item	SWL re 10^{-12} W, dB(A)								
	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	Overall dB(A)
Balcony Condenser Unit	61	63	61	54	47	46	39	39	56.6
Carpark exhaust fan	91	88	89	90	89	89	84	77	95

6.2.2 General Noise Mitigation Measures

Mitigation measures for the mechanical plant should be considered during the Design Development stage so as to comply with the outlined criteria at the nearest sensitive receivers. These amelioration measures could include but not limited to the following:

- Positioning mechanical plant away from nearby receivers
- Acoustic attenuators fitted to duct work
- Screening around mechanical plant
- Acoustic insulation within duct work

Note that this is a preliminary solution as the design is yet to be finalized. A detailed acoustic assessment will be conducted during the design stage as more information becomes available regarding performance data of specific mechanical equipment or any further mechanical design information. Acoustic treatment will be proposed to ensure compliance with the project noise trigger levels established in Section 5.2.3.

6.3 Road Traffic Noise Generation

For the road traffic noise assessment, traffic numbers and generated vehicles was based on the information provided in the traffic impact statement. This data has been used to calculate the expected noise increase due to traffic associated with the development onto residences on Mannix Parade and Hume Highway.

This data has been used to calculate the expected noise increase due to traffic associated with the development. The relevant information regarding peak hour vehicle movements on the lane adjacent to the proposed development has been summarized in Table 19.

Table 19: Existing and predicted traffic flow volumes (peak hour)

Time	Existing Lane	
	Existing	Existing + Increased
Mannix Road (AM Peak)	243	252
Mannix Road (PM Peak)	256	259
Hume Highway (AM Peak)	6672	6675
Hume Highway (PM Peak)	6598	6605

A computer model was used to predict the traffic noise increase arising from the proposed development. The software algorithm is based on the “Calculation of Road Traffic Noise (CoRTN) model” of the UK Department of Transport. This model describes noise emitted by a constant traffic flow. The model uses standard curves to approximate vehicle noise levels. It also assumes the traffic can be broken down into two broad categories; cars and heavy vehicles. The source sound levels used in this project to model traffic noise levels are contained within the calculation algorithms of the noise model. Furthermore, the model was verified and calibrated using the short-term noise monitoring results obtained for this project.

The values presented in Table 20 below compare the existing noise levels estimated by the model with the estimated noise levels expected from an increase in vehicle movements associated with the proposed development.

Table 20: Predicted increase in traffic noise levels (peak hour)

Location	Existing Noise Levels $L_{Aeq-1hour}$, dB(A)	Predicted Noise Levels $L_{Aeq-1hour}$, dB(A)	Criteria $L_{Aeq-1hour}$, dB(A)	Complies?
Mannix Road (AM Peak)	61	61.2	55	Yes
Mannix Road (PM Peak)	55	55.1	50	Yes
Hume Highway (AM Peak)	68	68	60	Yes
Hume Highway (PM Peak)	63	63	55	Yes

As shown in Table 20, the existing scenario is above the criteria. Based on the predicted noise levels during the peak hours, the noise increase on Mannix Parade and Hume Highway shall fall under the assessment criteria mentioned in *Section 3.4.1 Process for applying the criteria – Step 4* of NSW RNP, and is expected to comply with the requirements of the NSW Road Noise Policy.

7. Conclusion

An acoustic assessment for the proposed residential development located at 11-13 Mannix Parade, Warwick Farm, NSW 2170 has been conducted. This document forms part of the documentation package to be submitted to local authorities as part of the Development Application process.

This report has provided criteria, in-principle treatment and design requirements which aim to achieve the statutory criteria discussed in Section 5. In terms of noise criteria, we have provided the following:

- Noise criteria for internal noise levels according to AS/NZS 2107:2016, provided in Section 5.1.
- Noise criteria for emissions from the development to receivers in accordance with the NPI and provided in Section 5.2
- Construction noise and vibration criteria provided in Sections 5.4 and 5.5.

Acoustic performance requirements for the façade elements have been provided to achieve internal noise levels in accordance with the requirements of AS/NZS2107:2016. These requirements are based on the noise monitoring conducted on the site installed from 20th March to the 27th March 2020. The preliminary glazing performance requirements are presented in Section 6.1.

The maximum sound power levels for the mechanical services presented in this report for the day, evening and night time are based off the project noise trigger noise levels established in Section 5.2.3. Should the plant sound power levels exceed the levels presented in this report additional noise mitigation measures will be required. These measures will be developed and implemented during the design stages of the project.

Even though no assessment can be considered as being thorough enough to preclude all potential environmental impacts, having given regard to the above listed conclusions, it is the finding of this assessment that the development application should not be refused on the grounds of excessive noise generation, as it can comply with all applicable standards and regulations.

The information presented in this report shall be reviewed if any modifications to the features of the development specified in this report occur, including and not restricted to selection of air-conditioning units, layout of equipment, modifications to the building and introduction of any additional noise sources.

Appendix A Glossary of Acoustic Terms

NOISE	
Acceptable Noise Level:	The acceptable LAeq noise level from industrial sources, recommended by the EPA (Table 2.1, INP). Note that this noise level refers to all industrial sources at the receiver location, and not only noise due to a specific project under consideration.
Adverse Weather:	Weather conditions that affect noise (wind and temperature inversions) that occur at a particular site for a significant period of time. The previous conditions are for wind occurring more than 30% of the time in any assessment period in any season and/or for temperature inversions occurring more than 30% of the nights in winter).
Acoustic Barrier:	Solid walls or partitions, solid fences, earth mounds, earth berms, buildings, etc. used to reduce noise.
Ambient Noise:	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment Period:	The period in a day over which assessments are made.
Assessment Location	The position at which noise measurements are undertaken or estimated.
Background Noise:	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level.
Decibel [dB]:	The units of sound pressure level.
dB(A):	A-weighted decibels. Noise measured using the A filter.
Extraneous Noise:	Noise resulting from activities that are not typical of the area. Atypical activities include construction, and traffic generated by holidays period and by special events such as concert or sporting events. Normal daily traffic is not considered to be extraneous.
Free Field:	An environment in which there are no acoustic reflective surfaces. Free field noise measurements are carried out outdoors at least 3.5m from any acoustic reflecting structures other than the ground
Frequency:	Frequency is synonymous to pitch. Frequency or pitch can be measured on a scale in units of Hertz (Hz).
Impulsive Noise:	Noise having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent Noise:	Level that drops to the background noise level several times during the period of observation.
LAmax	The maximum A-weighted sound pressure level measured over a period.
LAmin	The minimum A-weighted sound pressure level measured over a period.
LA1	The A-weighted sound pressure level that is exceeded for 1% of the time for which the sound is measured.
LA10	The A-weighted sound pressure level that is exceeded for 10% of the time for which the sound is measured.
LA90	The A-weighted level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
LAeq	The A-weighted “equivalent noise level” is the summation of noise events and integrated over a selected period of time.

LAeqT	The constant A-weighted sound which has the same energy as the fluctuating sound of the traffic, averaged over time T.
Reflection:	Sound wave changed in direction of propagation due to a solid object met on its path.
R-w:	The Sound Insulation Rating R-w is a measure of the noise reduction performance of the partition.
SEL:	Sound Exposure Level is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound Absorption:	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound Level Meter:	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound Pressure Level:	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound Power Level:	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise:	Containing a prominent frequency and characterised by a definite pitch.

Appendix B Façade Noise Map Assessment

Figure 4: North Facade noise Map - Living units other than Bedroom.

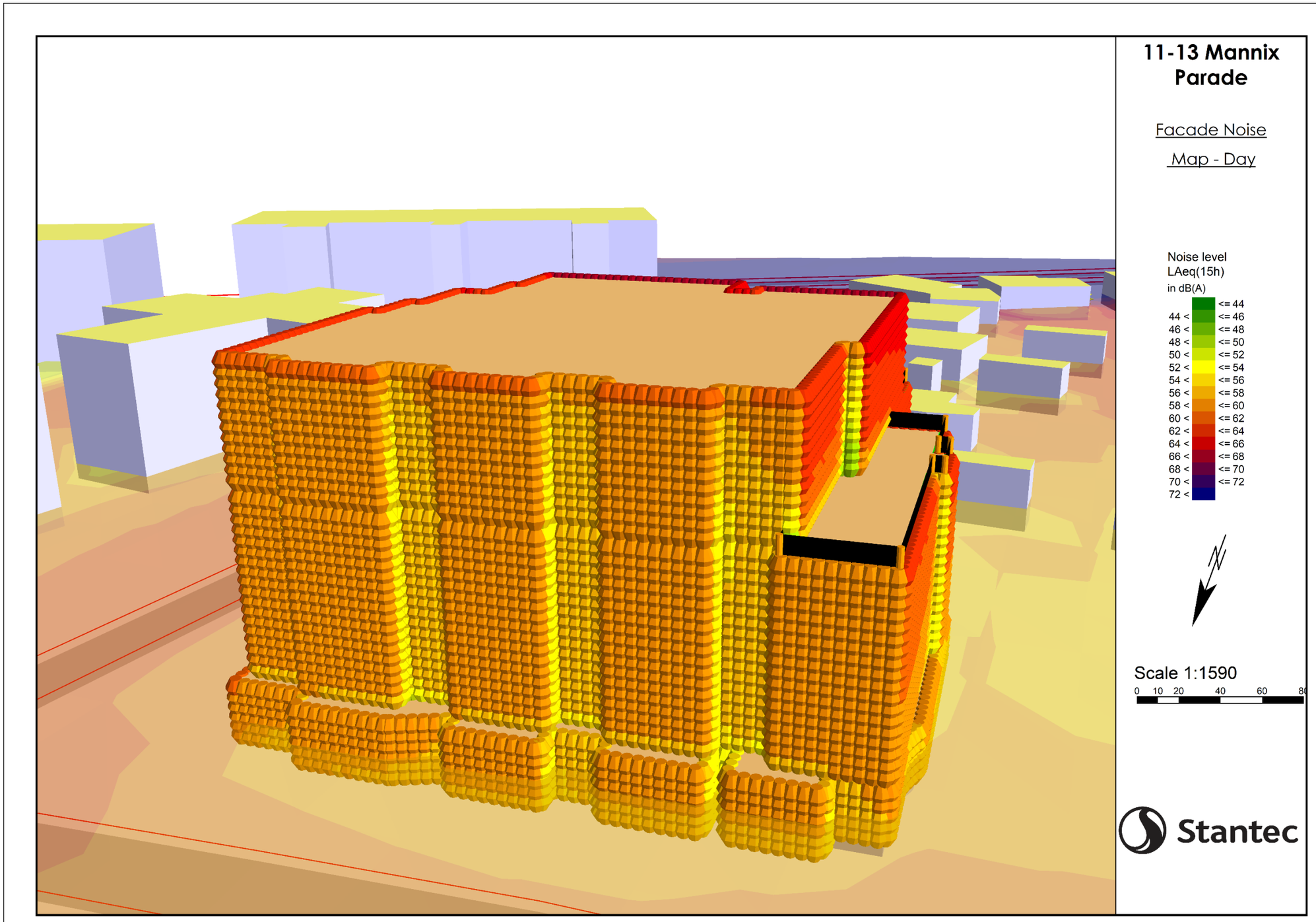


Figure 5: West Facade noise Map - Living units other than Bedroom.

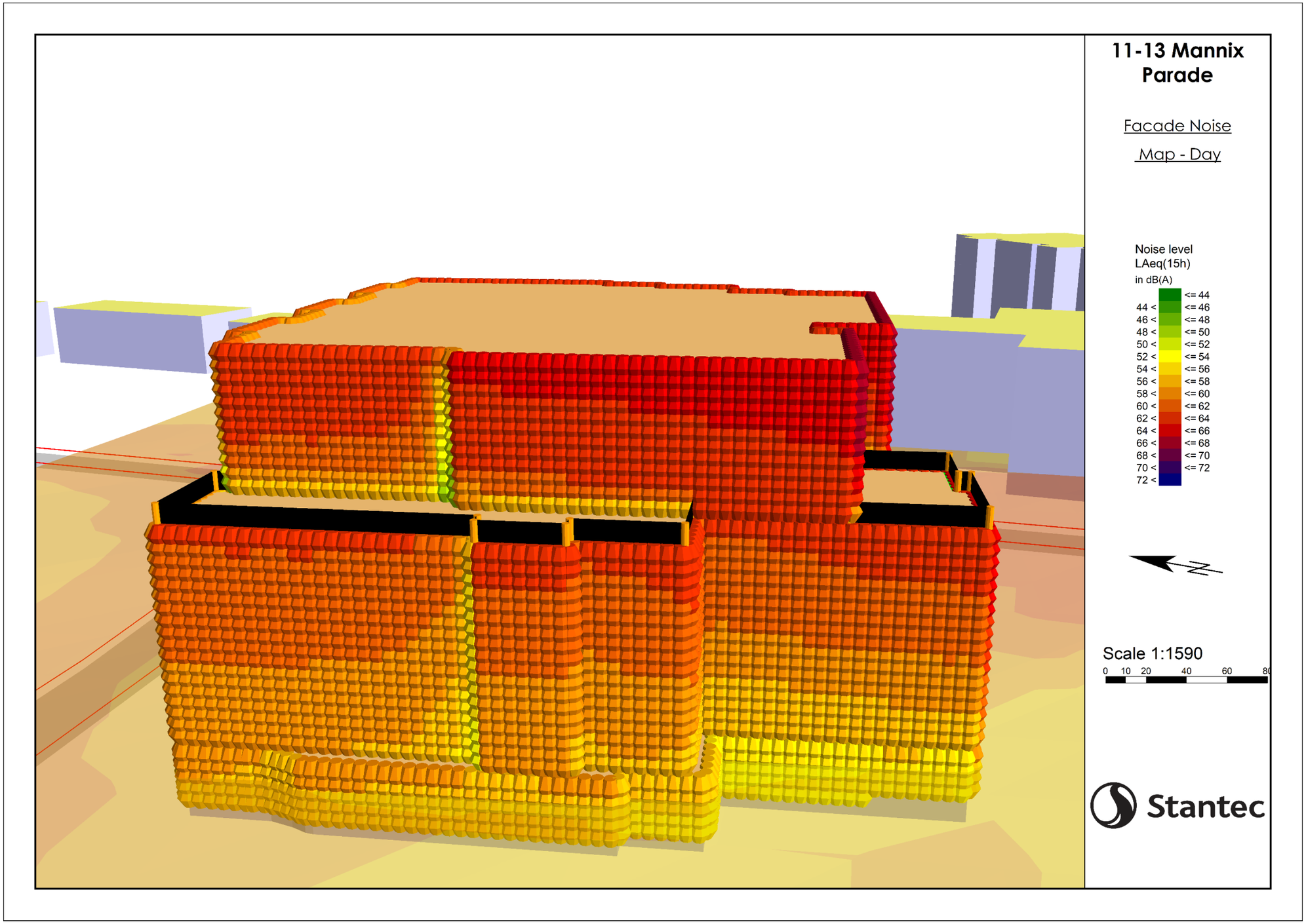


Figure 6: South Facade noise Map - Living units other than Bedroom.

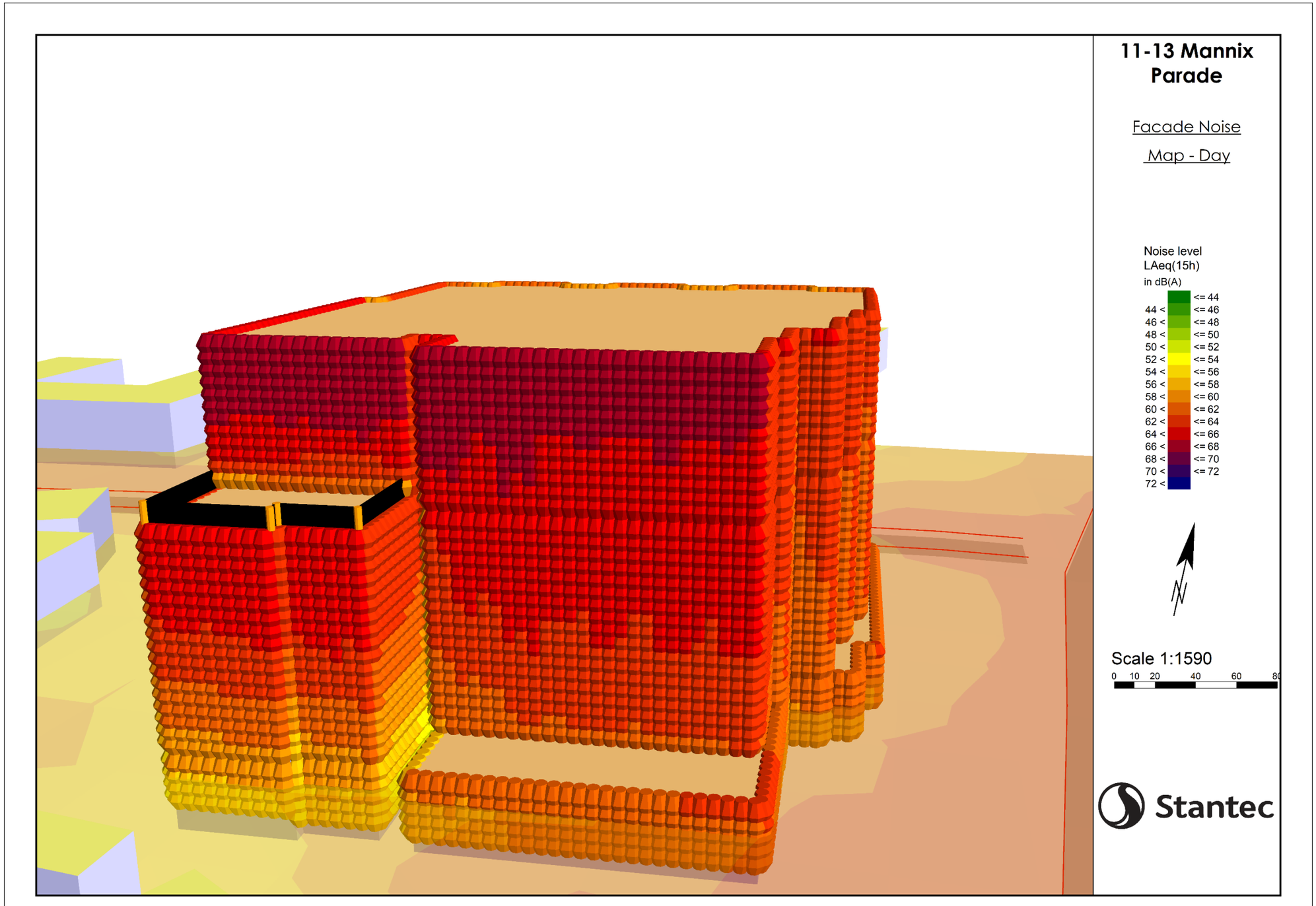


Figure 7: East Facade noise Map - Living units other than Bedroom.

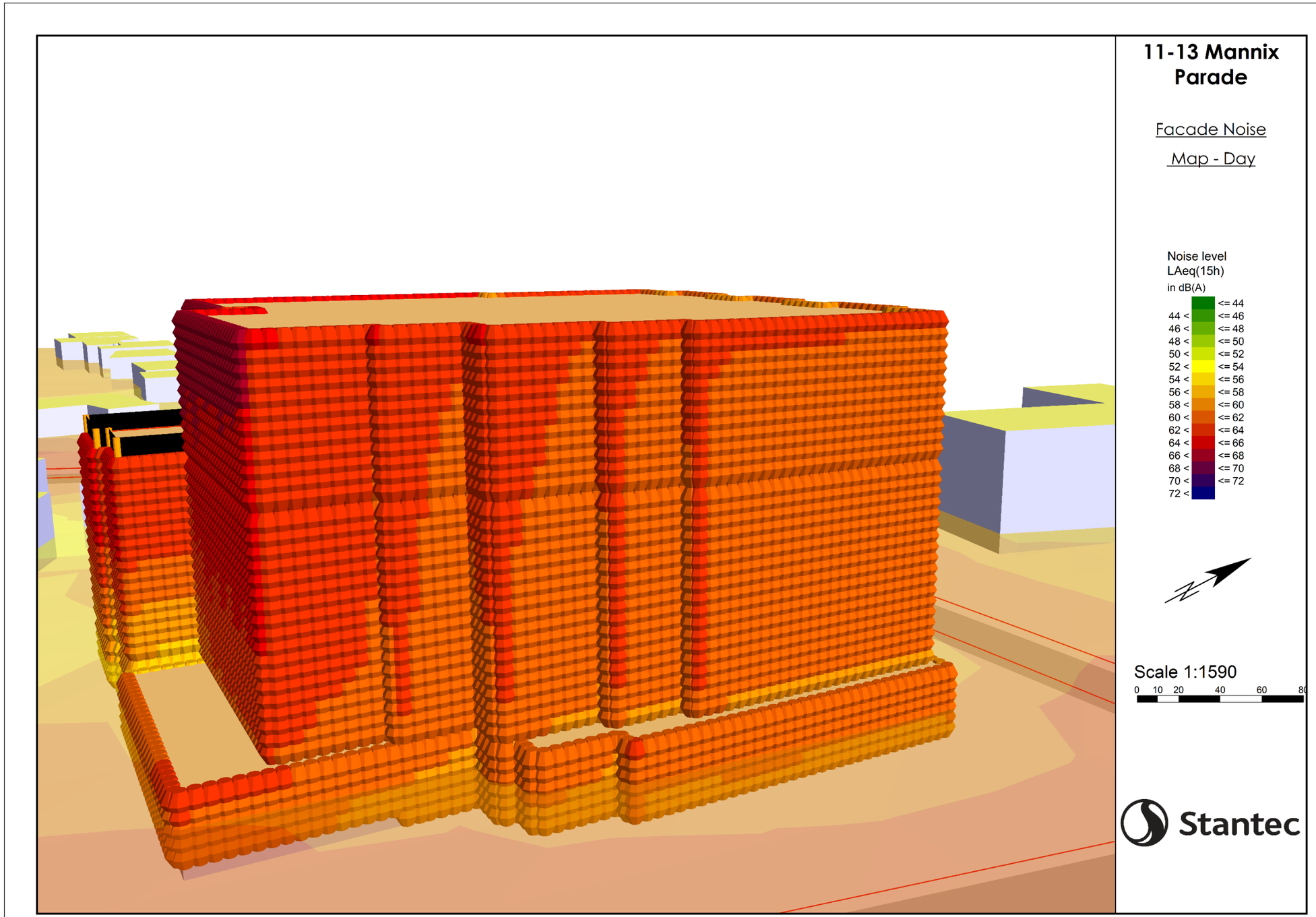


Figure 8: North Facade noise Map - Bedroom.

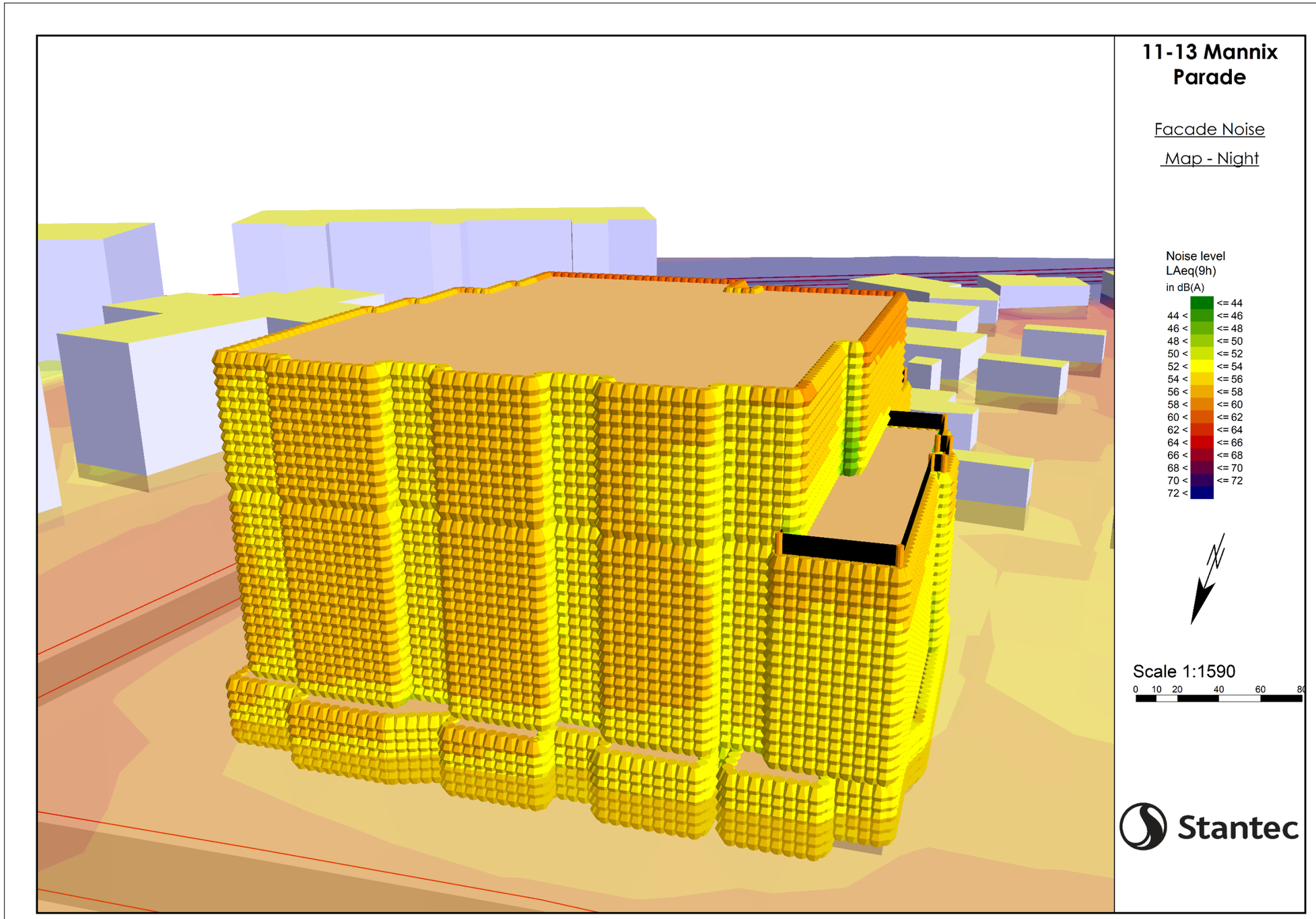


Figure 9: West Facade noise Map - Bedroom.

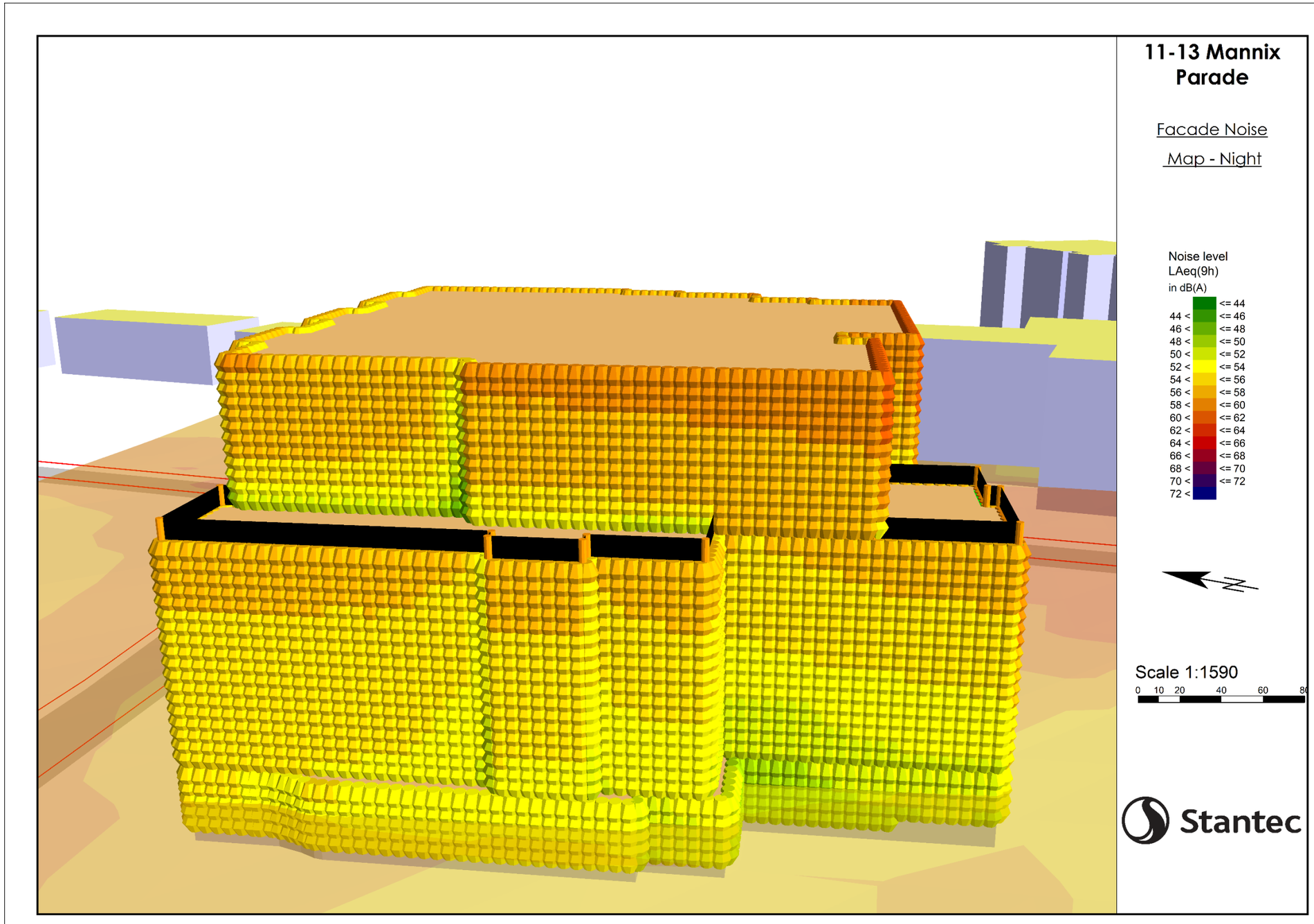


Figure 10: South Facade noise Map - Bedroom.

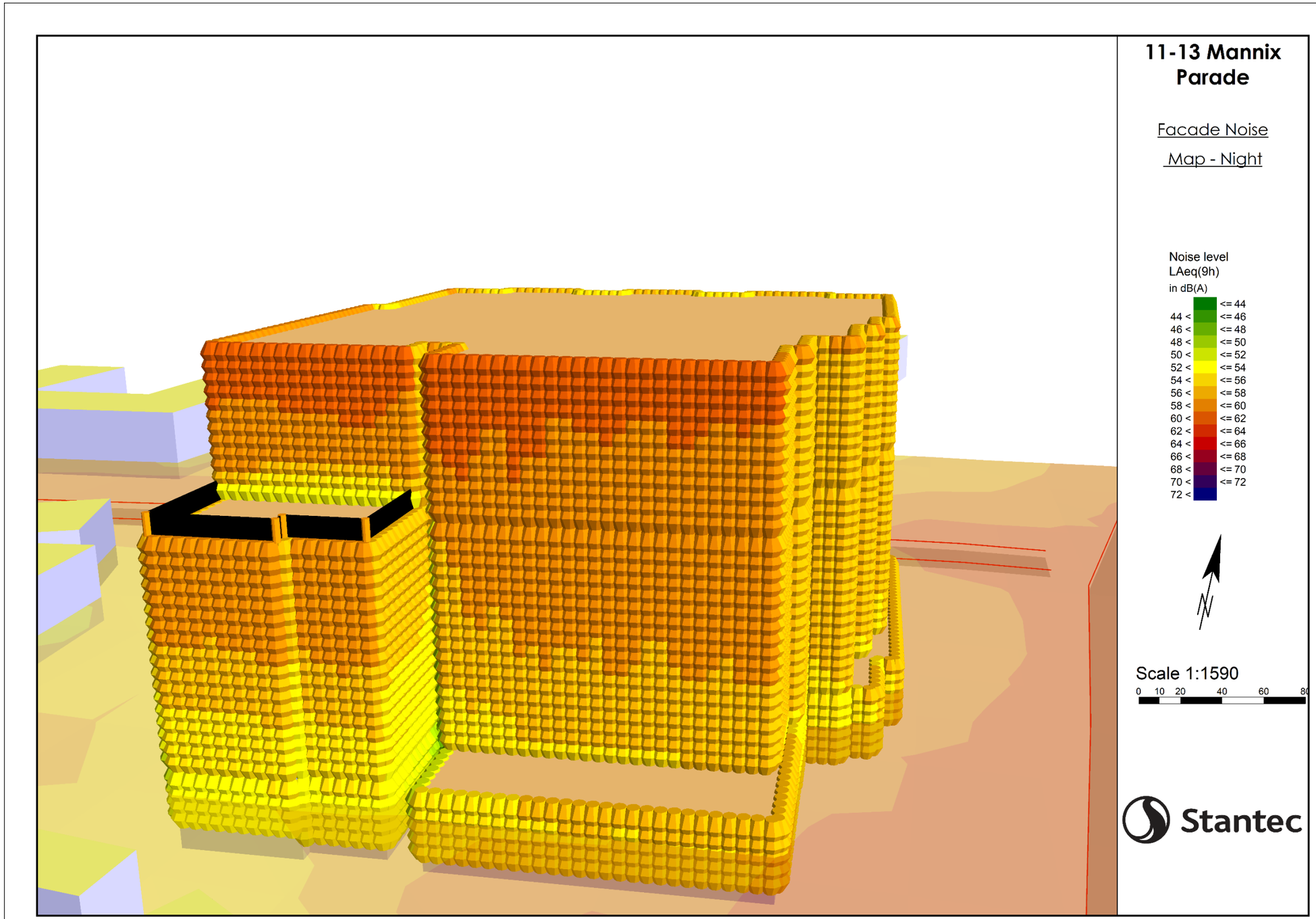
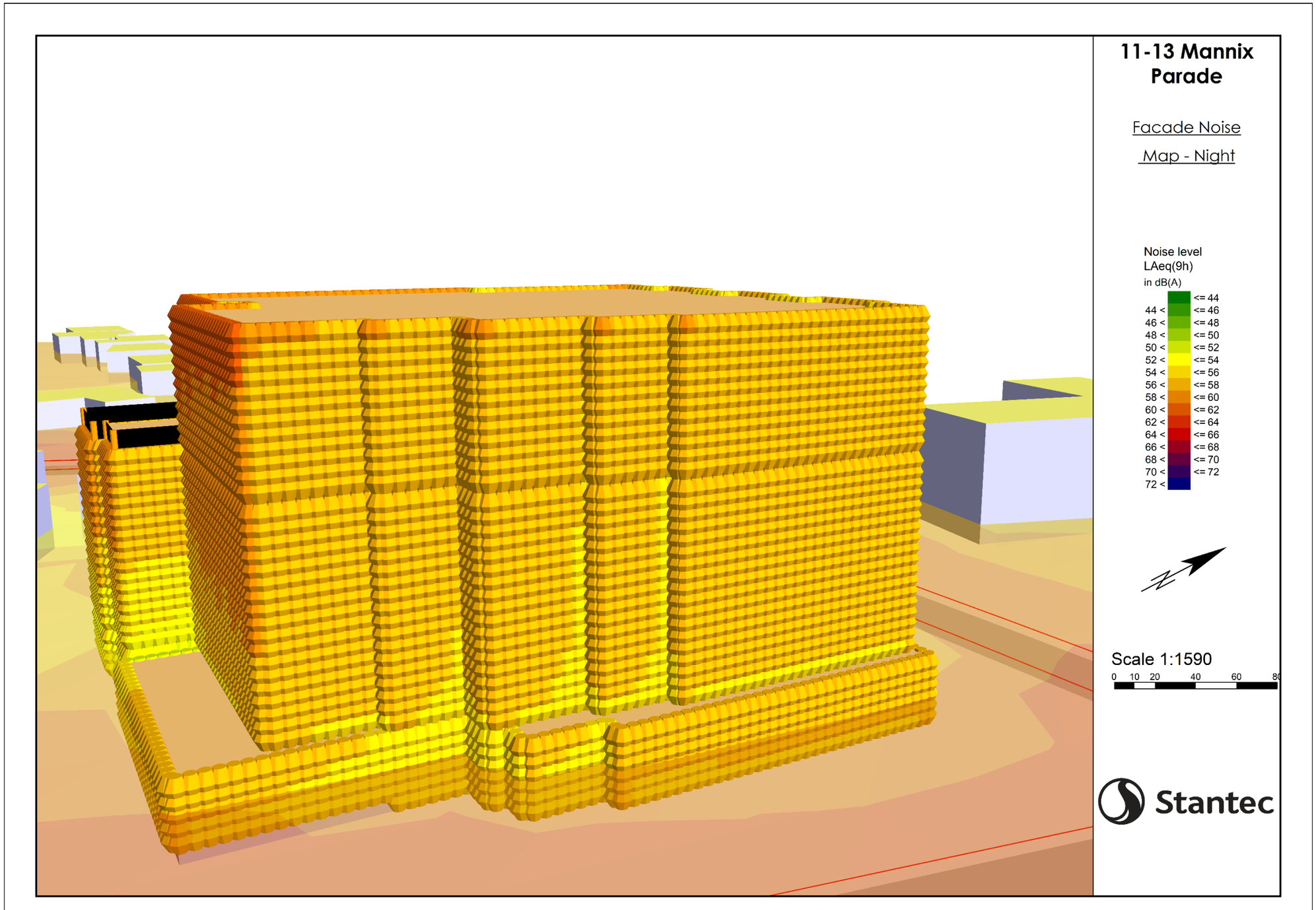


Figure 11: East Facade noise Map - Bedroom.



Appendix C Alternate Ventilation Assessment

Figure 12: North-East Requirement for alternate ventilation - Living units other than Bedroom.

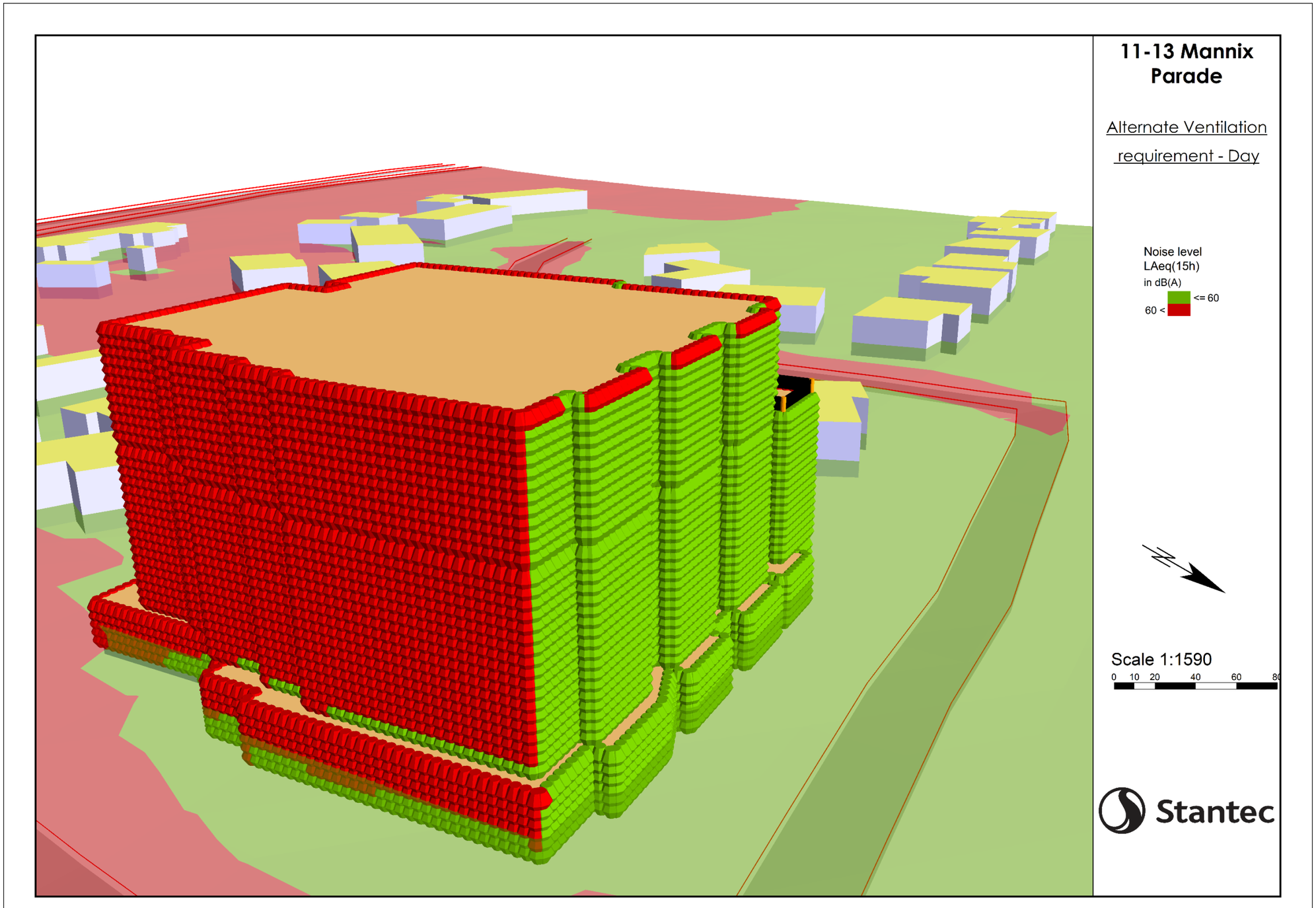


Figure 13: South-West Requirement for alternate ventilation - Living units other than Bedroom.

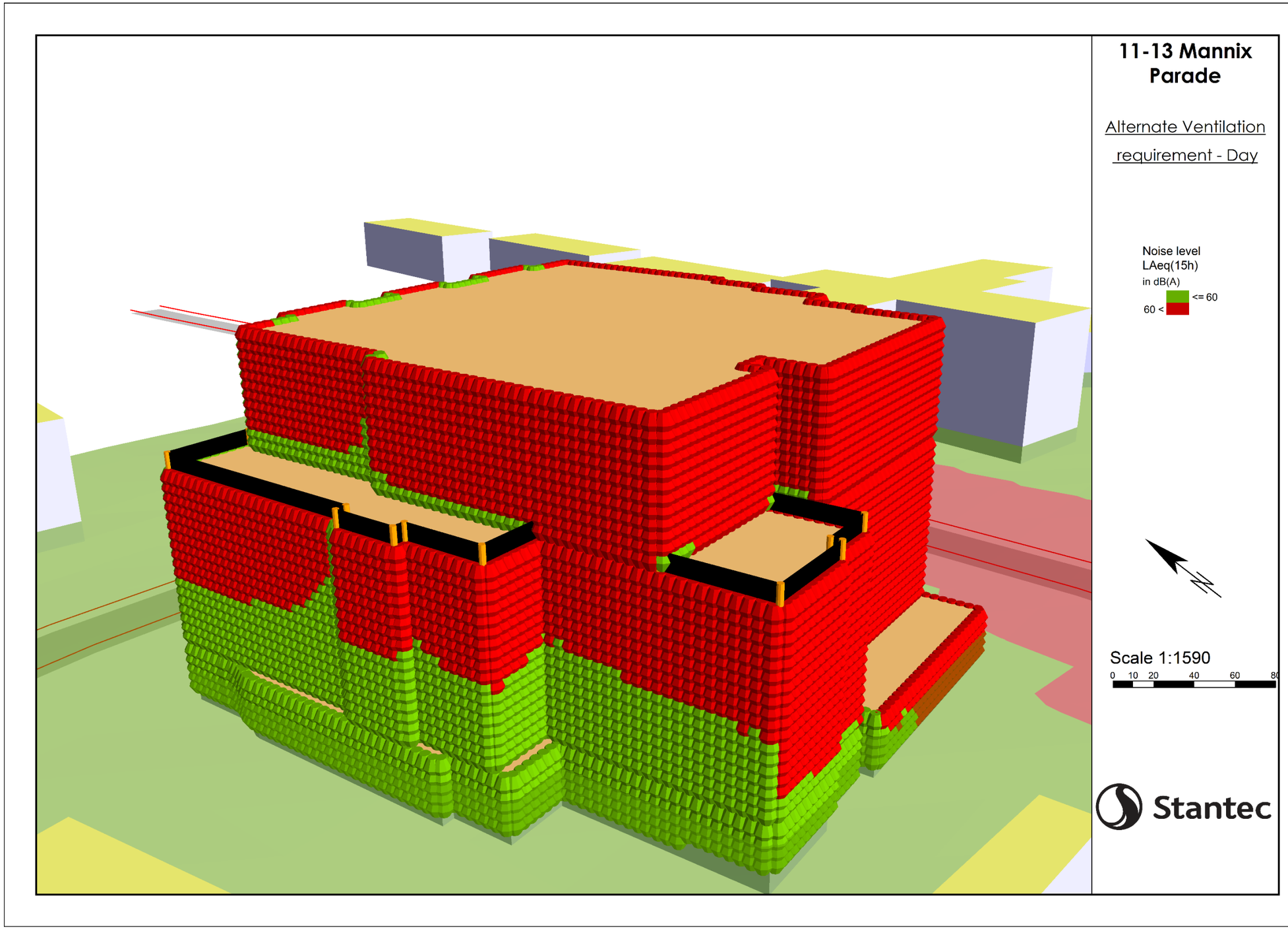


Figure 14: North-East Requirement for alternate ventilation - Bedroom.

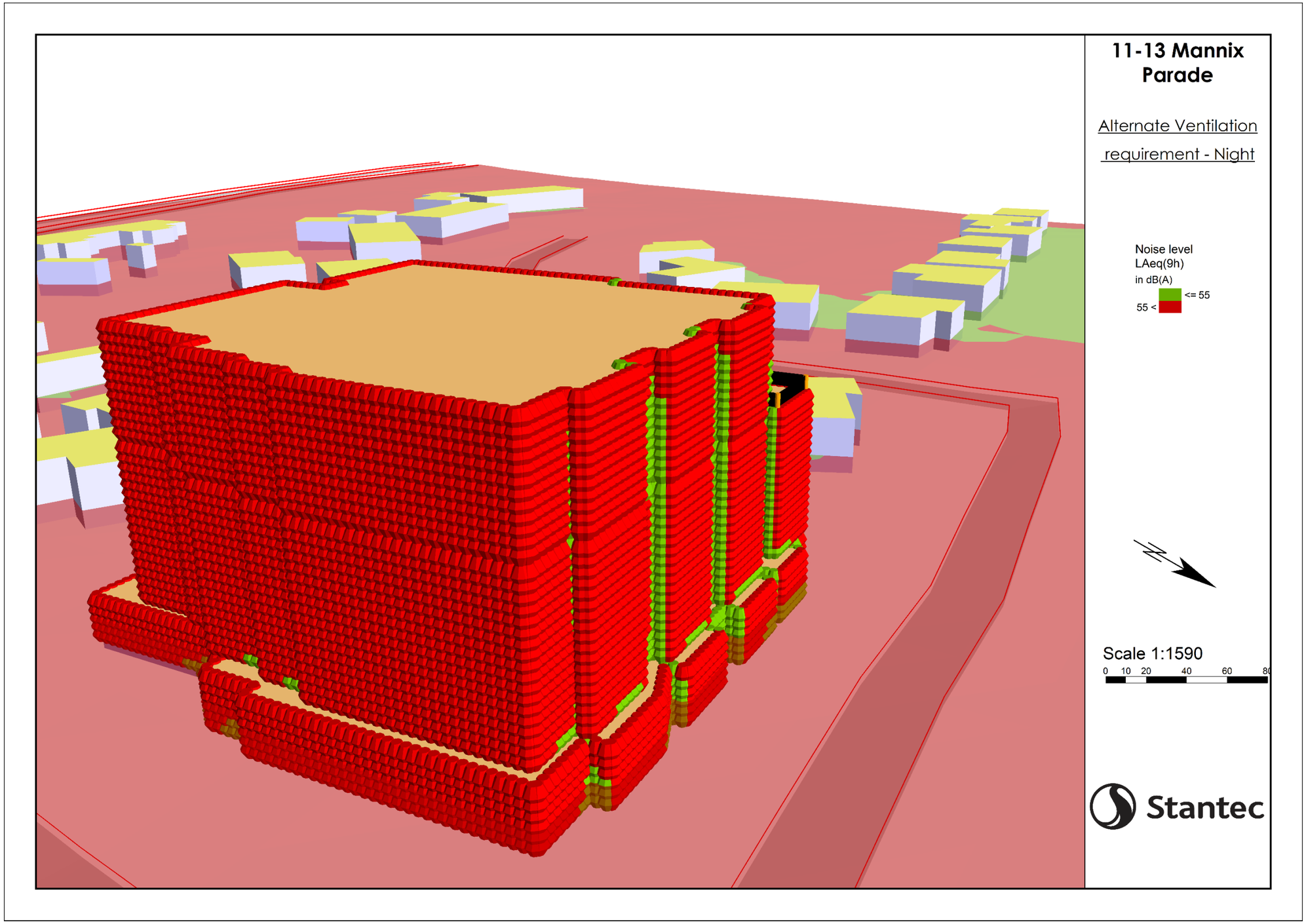
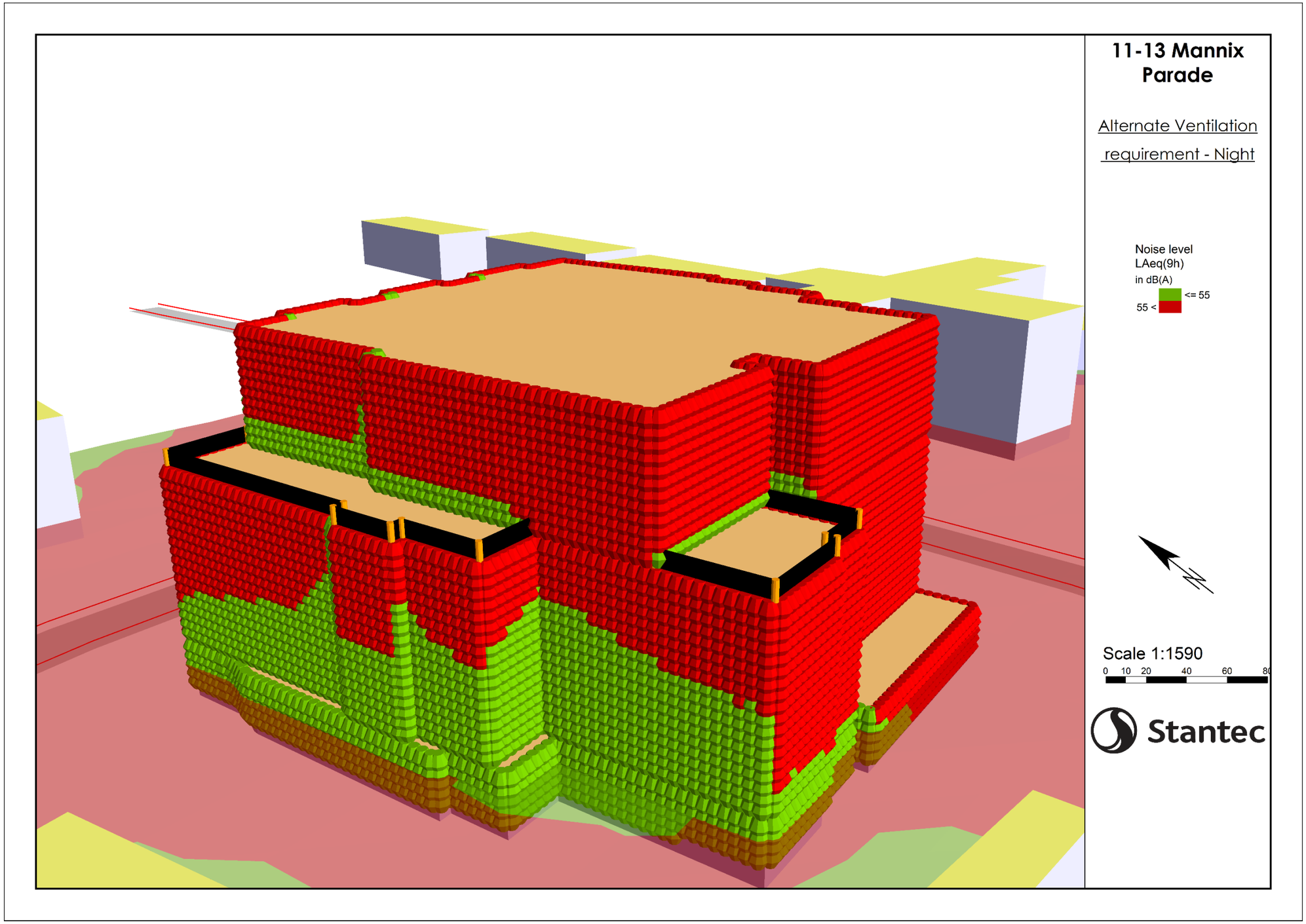


Figure 15: South-West Requirement for alternate ventilation - Bedroom.



Appendix D Preliminary Glazing Mark-Up

Figure 16: Ground Floor Glazing Mark-Up

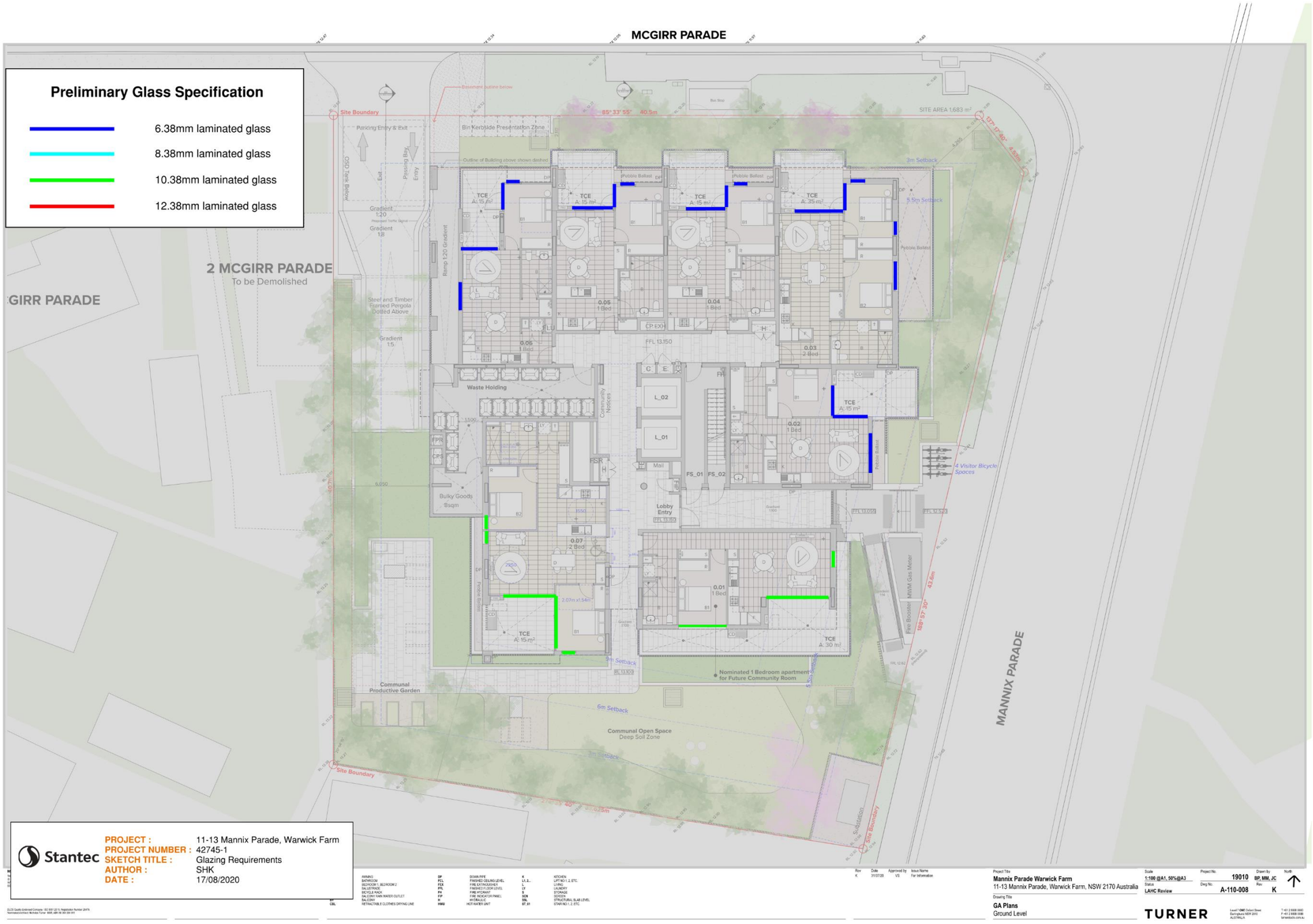


Figure 17: First Floor – Third Floor Glazing Mark-Up

Figure 18: Fourth Floor Glazing Mark-Up

Figure 19: Fifth Floor Glazing Mark-Up

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community in mind

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