PADNALL LAKE PHASES 3 & 4

House Type Comparison

Mae Architects

MACH GROUP

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FOREWORD

At MACH we believe in enhancing wellbeing and user experience within the built environment, through efficient **low energy design** solutions and exceptional engineering.

Our university led R&D allows us to **think differently** and to drive **creative solutions** through the technologies and tools we have developed in house. In doing so this has grown our services and our understanding of buildings and their capabilities, improving not only the way we work, but also how we **communicate and collaborate**.

Our services include acoustics and building physics such as thermal, ventilation and overheating assessments, which allows us to provide a **truly holistic design service**.

This ensures the schemes we support meet the end user's needs, **maximise efficiency** and minimise the impact upon our environment.

We are **passionate** individuals who come together to deliver outstanding consultancy, because we **love** what we do. Our ambition and passion drive's us to go further, to think differently and to overcome the challenges we encounter, resulting in stunning, **low carbon buildings**.

MACH'S SERVICES

Acoustics

- Internal Building Design
- Environmental Noise
- Façade Design
- Natural Ventilation Solutions
- Acoustics in BIM
- Sound Insulation Testing

Building Physics & Sustainability

- Thermal Modelling
- Ventilation and Overheating Assessments
- Internal Daylight Analysis
- Daylight & Sunlight Impact Assessments
- Energy Statements
- Part L / SAP and SBEM Calculations

MACH GROUP

1.0 INTRODUCTION

This report provides an initial review of the energy efficiency and quality of daylight, acoustics, and ventilation within the proposed Padnall Lake Phases 3 & 4 development, covering both the proposed terrace houses.

1.1 MACH's Design Philosophy

At MACH we believe in enhancing wellbeing and user experience within the built environment through efficient low energy design solutions and exceptional engineering. With acoustics and building physics engineers, our design philosophy is to provide a balanced approach to façade design which benefit multiple factors affecting indoor wellbeing rather than just a singular one.

The figure opposite illustrates the interrelation of acoustics, daylight, ventilation and overheating and is a visual summary of all the balancing act of all the different aspects MACH considers when approaching façade design.

1.2 Alternative Strategies to the Outline Planning Design

From attending meetings with the design team for Phases 1 & 2, MACH understand that due to high external noise levels, the design of Phases 1 & 2 restricts natural ventilation on the south façade, which would lead to a reliance on mechanical ventilation.

Guidance from the Greater London Authority (GLA) recommends that reliance on mechanical ventilation for summertime cooling should be avoided where possible, and as such MACH have been investigating methods of introducing natural ventilation to the south façade, whilst achieving suitable internal noise levels.

This could be achieved through passive screening measures as well as attenuated ventilation openings; however, fitting these attenuators can be challenging due to the length and bulk of the units required. Therefore, MACH have been exploring options of how to integrate lower noise levels within the design without impacting internal floor areas and minimizing any architectural impact.

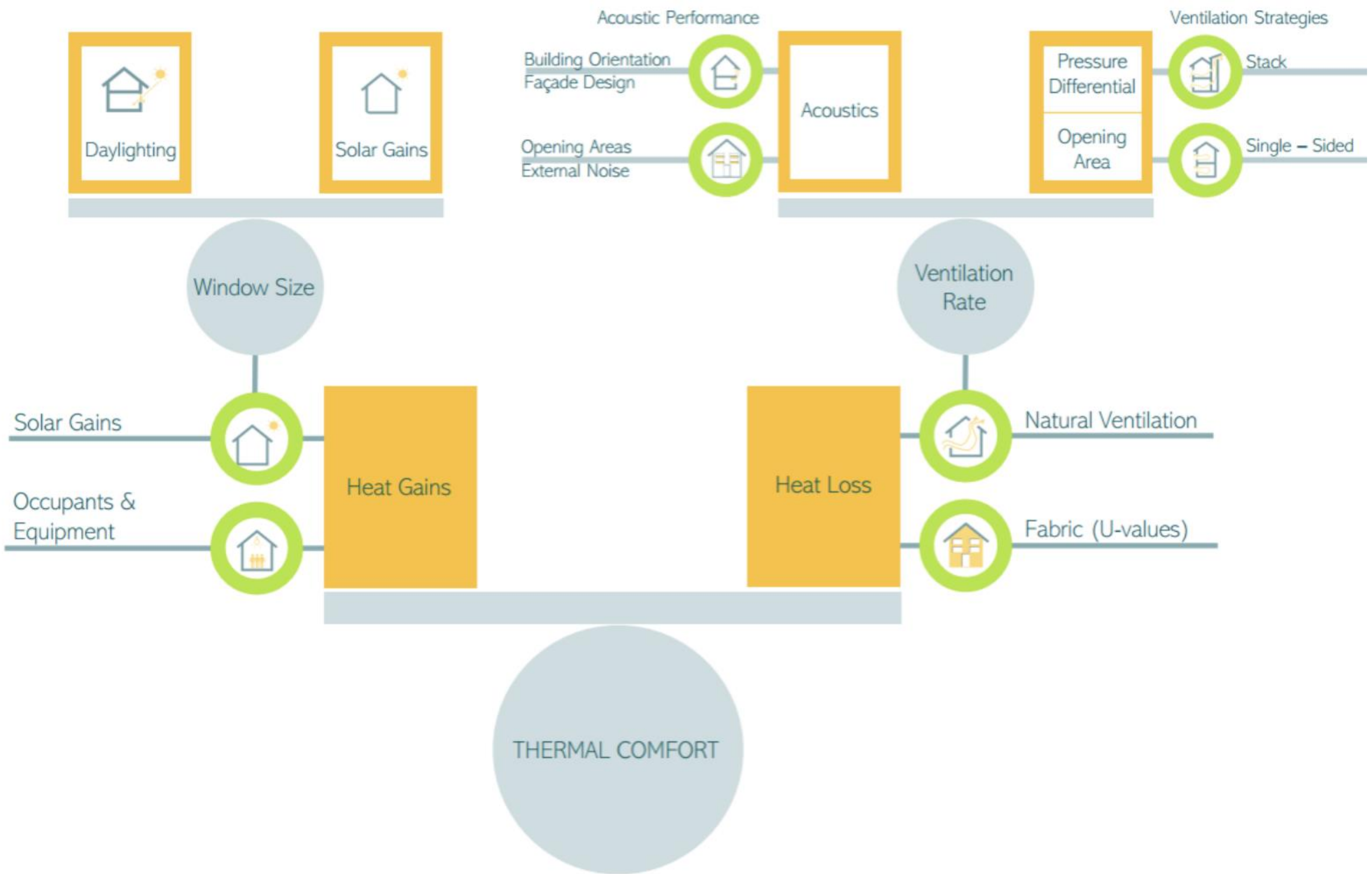


Figure 1.1 Balancing thermal comfort with acoustics, daylight, and energy use.

2.0 METHODOLOGY

MACH have reviewed the new design proposals to assess the following elements of internal occupant comfort and sustainable design:

2.1 Energy Use & Carbon Emissions

To establish the impact of different form factors of the terraced housing, MACH have conducted SAP calculations to determine and compare the fabric efficiency of the proposed and outline design, and how this affects overall carbon emissions.

SAP calculations were carried out using Part L SAP methodology, in which all thermal elements and building inputs were assumed to be the same, with the exception building geometry and length of thermal bridging.

This assessment allows an initial review of how the form factor and efficiency of floor area can be used to minimize carbon emissions.

2.2 Internal Daylight

An initial internal daylight assessment has been carried out to determine the quality of daylight within the proposed living areas, kitchens, and bedrooms. The assessment has been carried out as per typical guidance within the Building Research Establishment (BRE) Guide '*Site Layout Planning for Sunlight and Daylight: A Guide to Good Practice (2011)*' and the British Standard '*BS 8206-2:2008 Lighting for buildings –Part 2: Code of practice for daylighting*'.

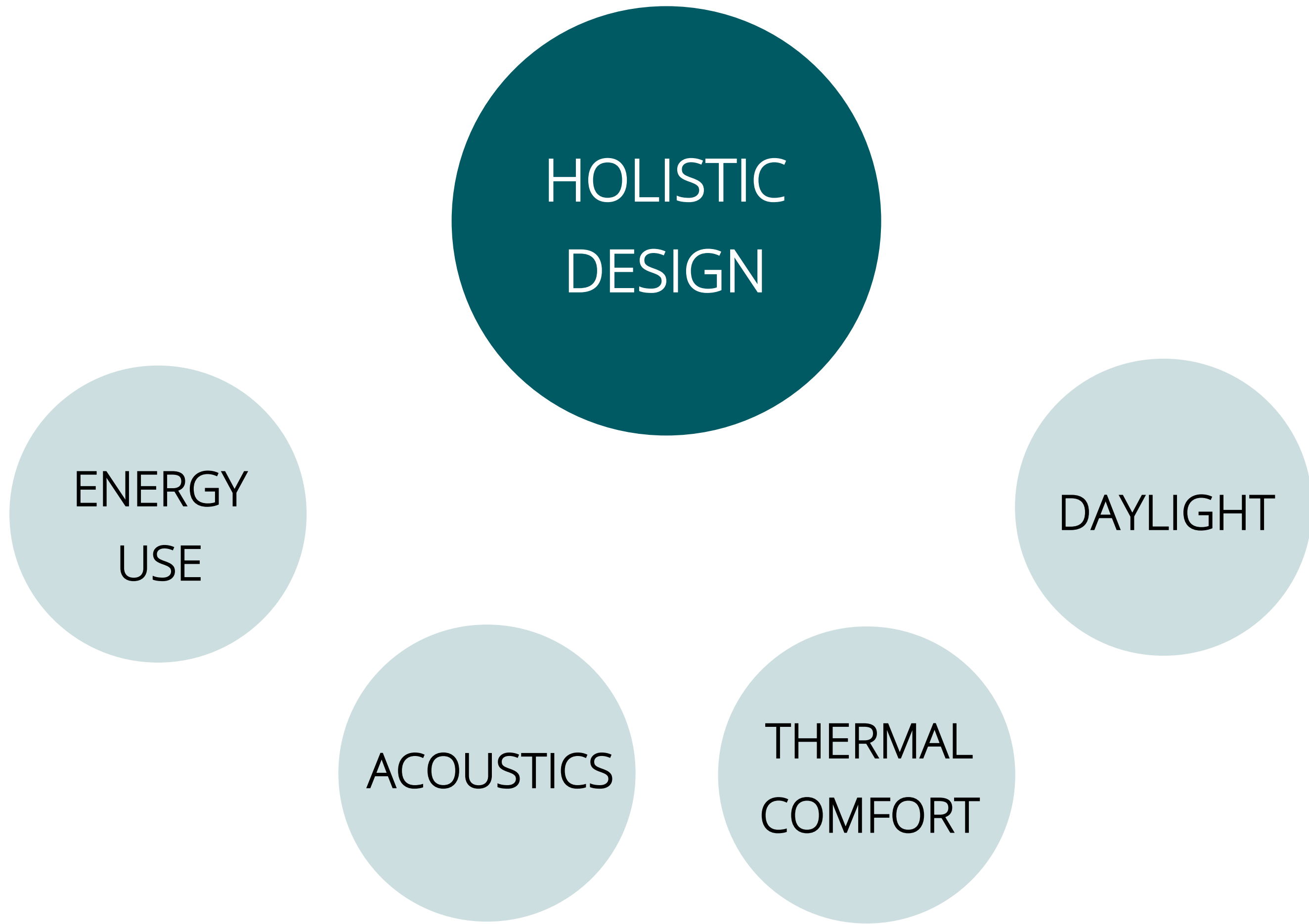
The external daylight and sunlight impact assessment of the scheme is assessed in a separate report by MACH.

2.3 Ventilation and Acoustics

Due to the high noise levels on site, there will be restrictions on how natural ventilation can be used on the scheme without impacting on the internal acoustic quality of the proposed dwellings. The result of this could lead to a reliance on mechanical ventilation, which increases overall energy use.

MACH have explored alternative strategies in reducing noise levels at the façade, as well as reducing the overall ventilation area required to cool the dwellings in the summer months.

MACH have reviewed the acoustic performance in more detail within a separate report. Please refer to this report for more detailed information.

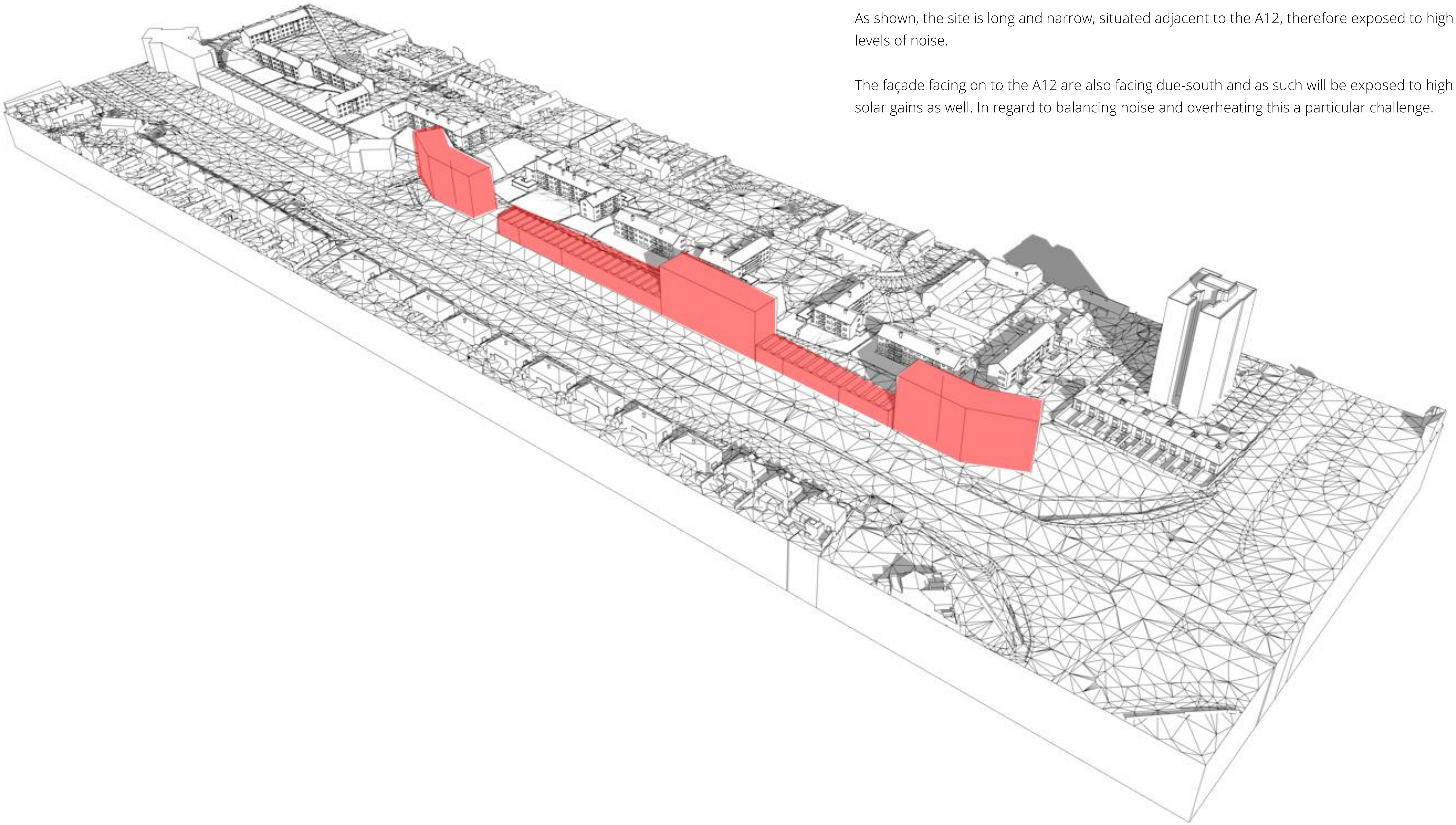


3.0 THE INITIAL DESIGN

The red buildings outline the original design of the scheme, which include 3 blocks of flats situated at each end and one in the middle, as well as townhouses located in between the blocks.

As shown, the site is long and narrow, situated adjacent to the A12, therefore exposed to high levels of noise.

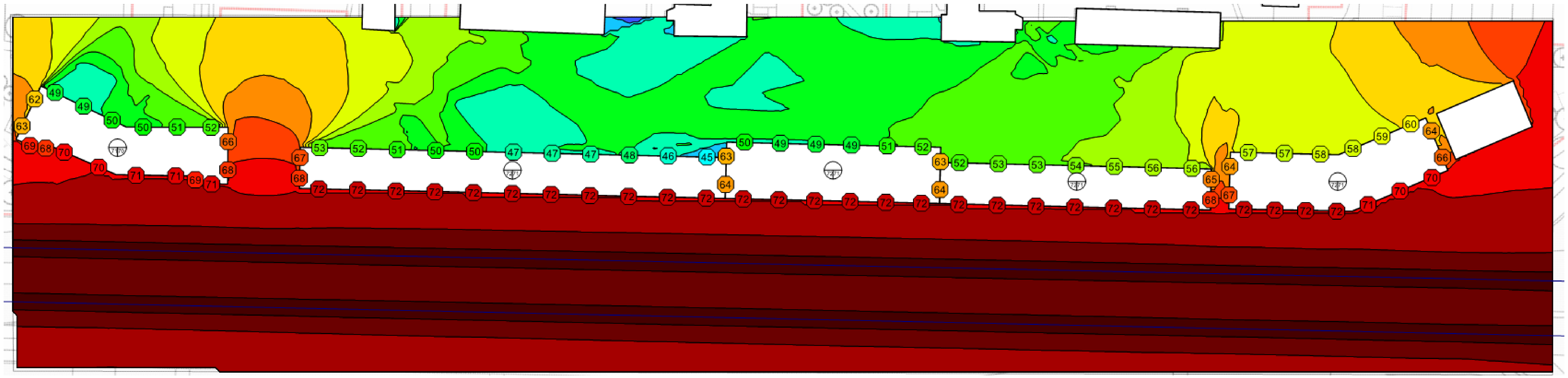
The façade facing on to the A12 are also facing due-south and as such will be exposed to high solar gains as well. In regard to balancing noise and overheating this a particular challenge.



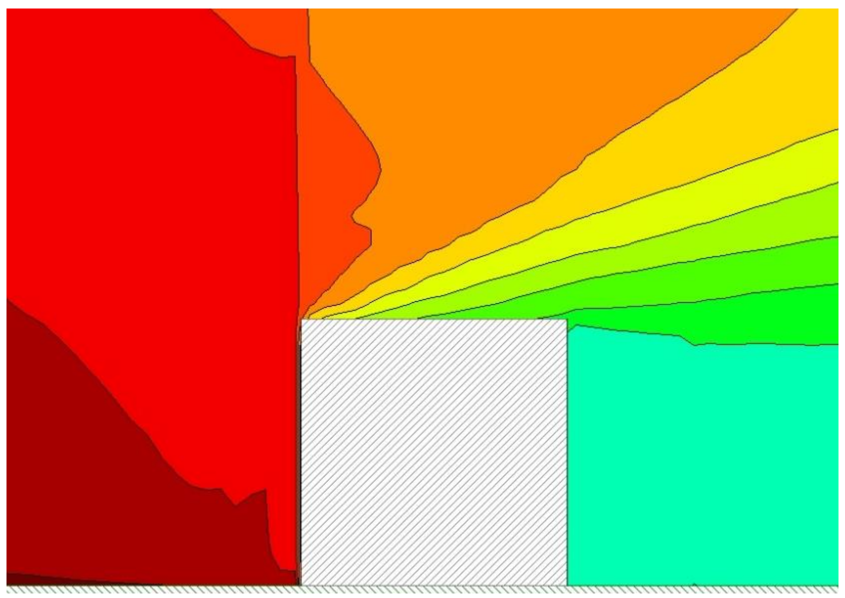
3.1 Site Constraints – Noise

The noise map below shows the range of noise levels across the site with the original design proposals. The southern facades are exposed to very high levels of noise, however the northern elevations and outdoor space benefit from screening and offer opportunity for good quality outdoor amenity and natural ventilation with openable windows.

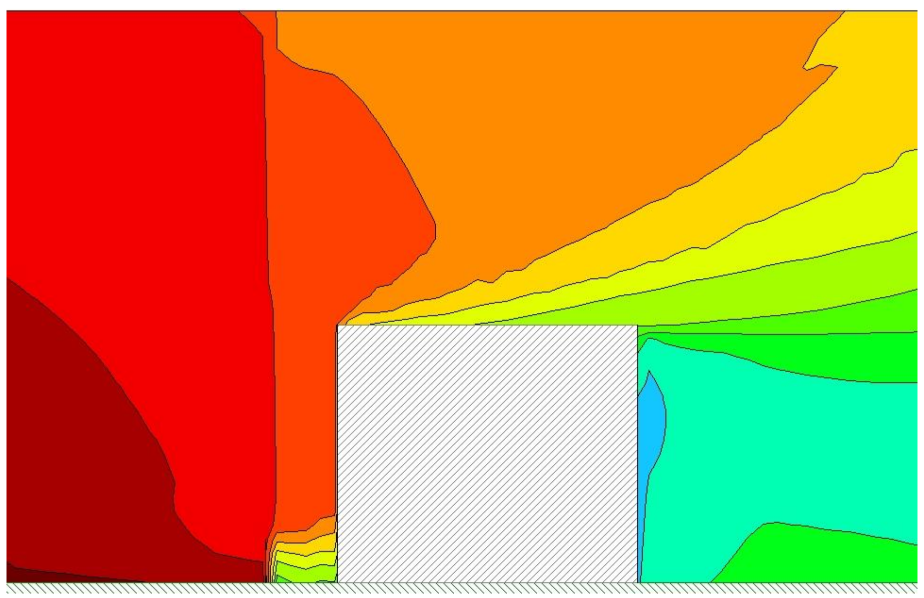
As part of MACH's involvement, noise mapping was carried out to investigate how acoustic fences or screening with building masses could be used to create quieter spaces.



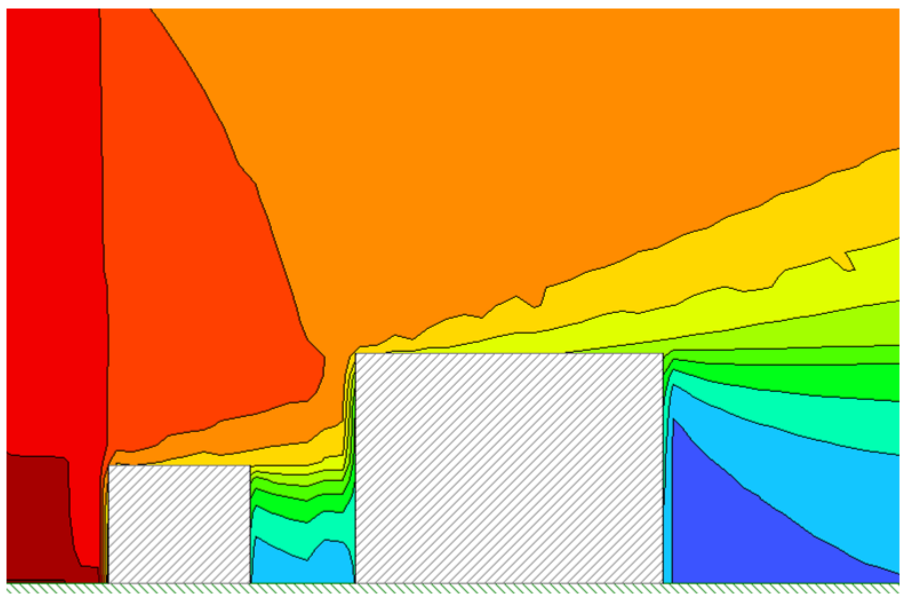
SITE PLAN WITH NOISE MAPPING



SECTION - NO GARDEN FENCE



SECTION -WITH GARDEN FENCE



SECTION -WITH COURTYARD

3.2 Previous House Type

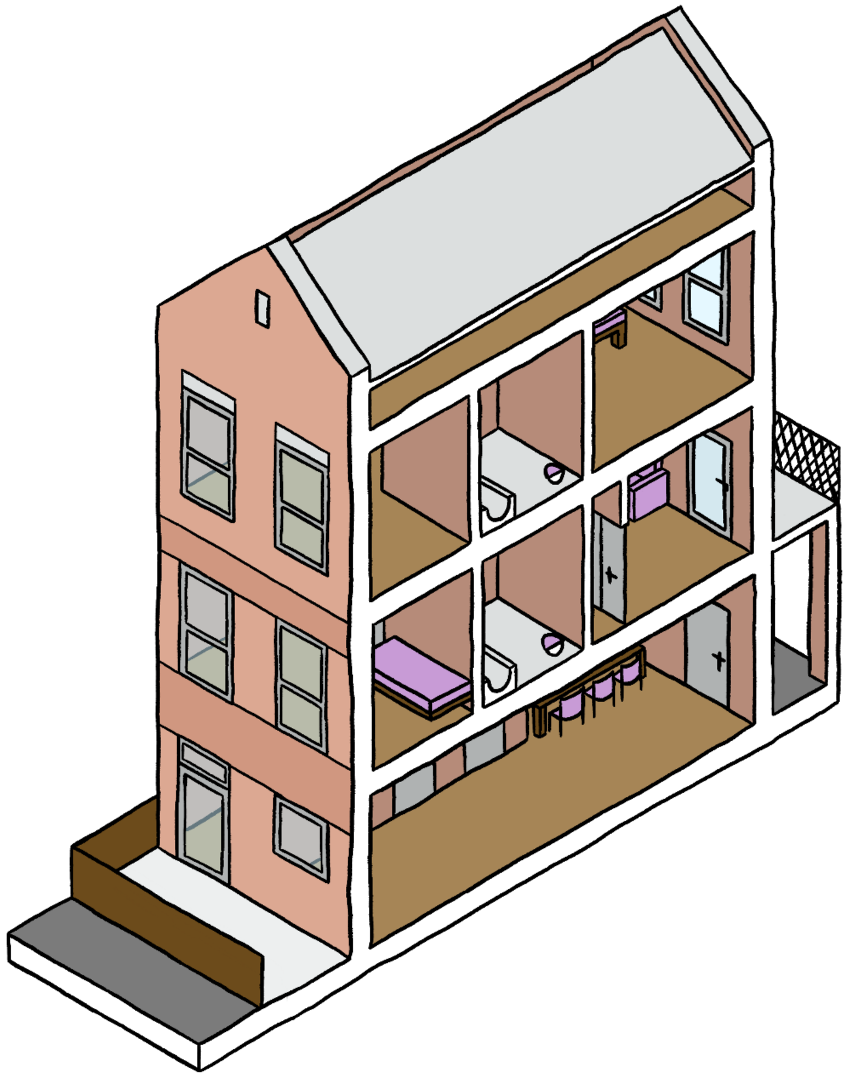
The previous house type, as illustrated below, can be summarised as follows;

- 3 bedroom 3 storey townhouse
- Exposure to high noise levels, with poor outdoor amenity facing on to the A12.
- An overheating mitigation strategy that relies on oversized MVHR units with openable windows. This creates excess carbon emissions and poor internal noise levels.
- Good daylight levels on the upper floors but limited daylight on ground floor
- Good form factor that reduces heating requirements, but large amounts of circulation area.

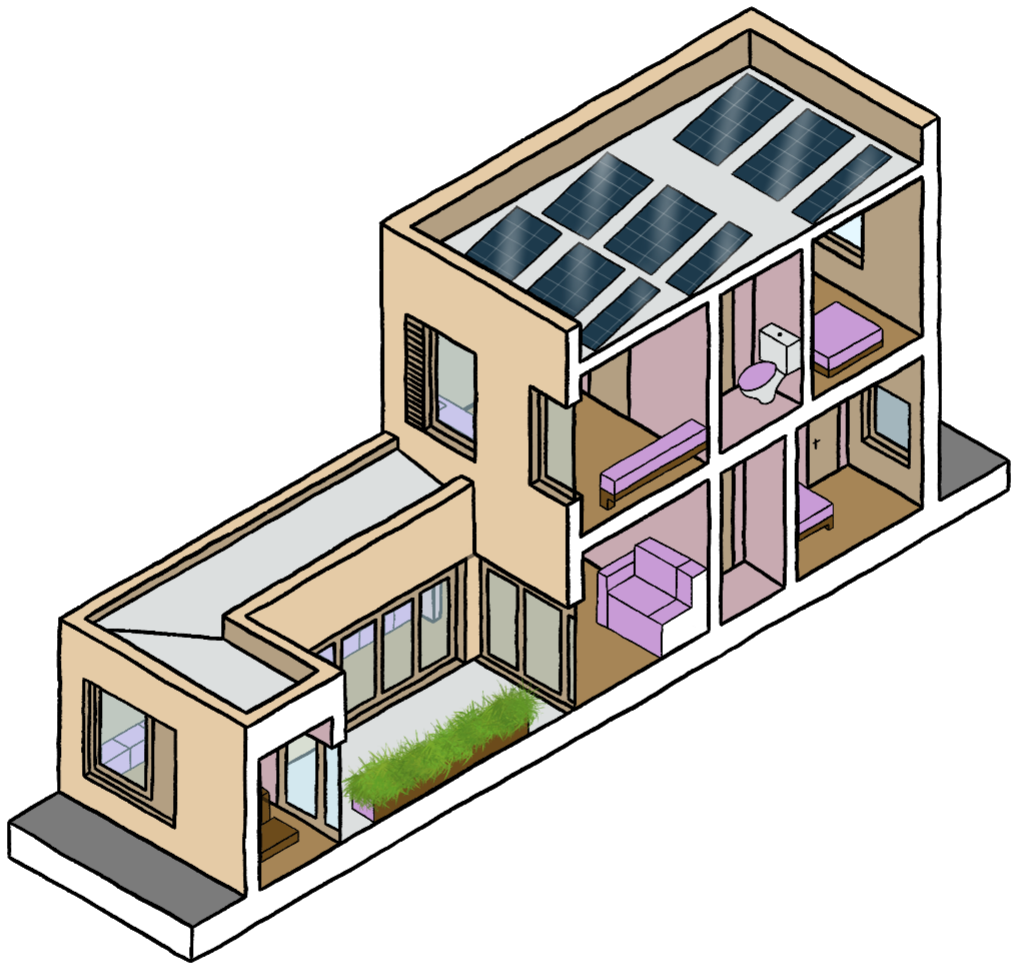
3.3 Proposed House Type

The redesigned house type, also illustrated below, can be summarised as follows;

- 3 bedroom 2 storey townhouse
- Enclosed outdoor amenity that is screened from the A12
- An overheating mitigation strategy that uses acoustic screening and attenuated ventilators, thereby reducing carbon emissions.
- Good daylight levels throughout the ground and first floor.
- An increased form factor but highly efficient use of floor area. With flat south-facing roofs for PV panels.



ORIGINAL TOWNHOUSE DESIGN



REVISED COURTYARD DESIGN

3.4 Courtyard Design

The image opposite (from Mae Architects) illustrates how the courtyard house has been optimised to meet the challenges provided by the site.

The courtyard provides a quiet outdoor area that is screened from the adjacent road, that allows for improved air quality and opportunity for natural ventilation.

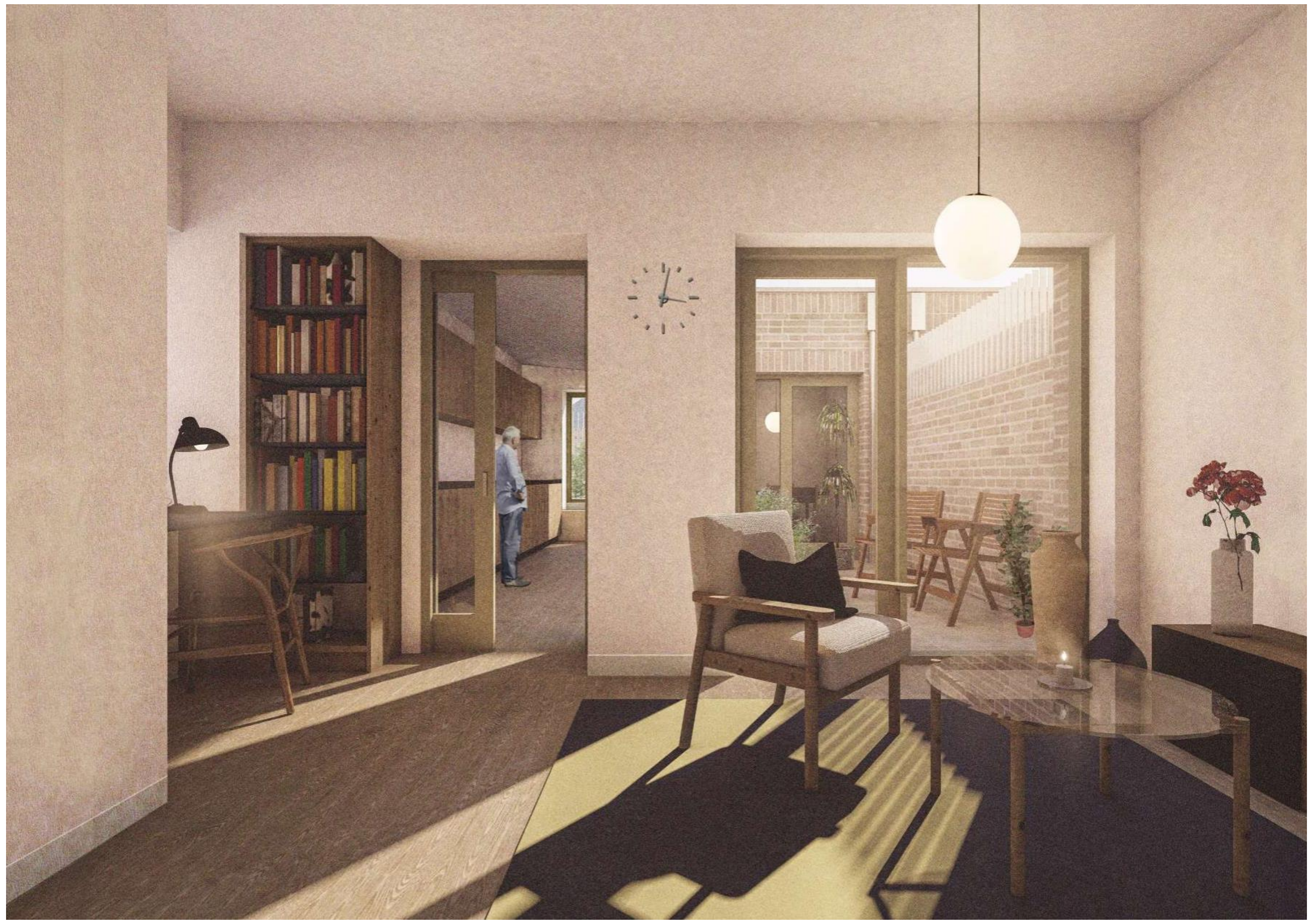
The internal layout has been optimised to minimise circulation space, where the kitchen, dining and living area surrounds the central courtyard.

The majority of bedrooms are located to the north so that noise exposure is minimised and to sleep disturbance is avoided.

Adequate glazing is provided to ensure that spaces are sufficiently daylit, making use of the shorter room depths that allow for better distribution of daylight and sunlight.

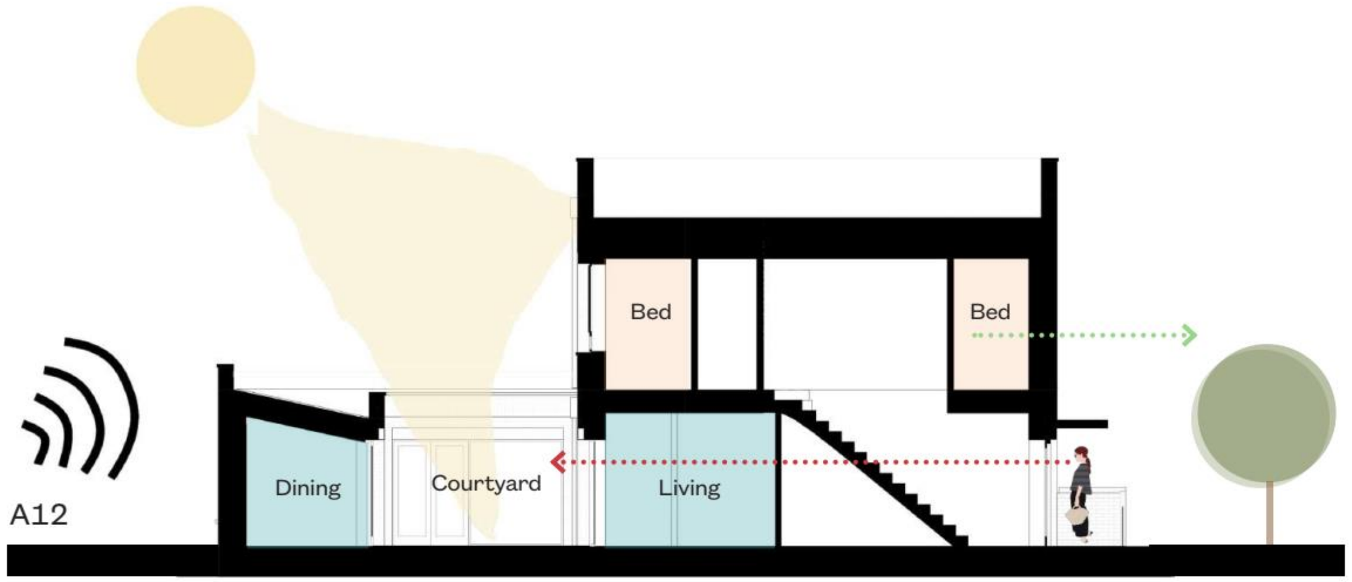
Image credit: Mae Architects

Courtyard House - Sectional View



GROUND FLOOR VISUALISATION- CREDIT: MAE ARCHITECTS

COURTYARD VISUALISATION- CREDIT: MAE ARCHITECTS



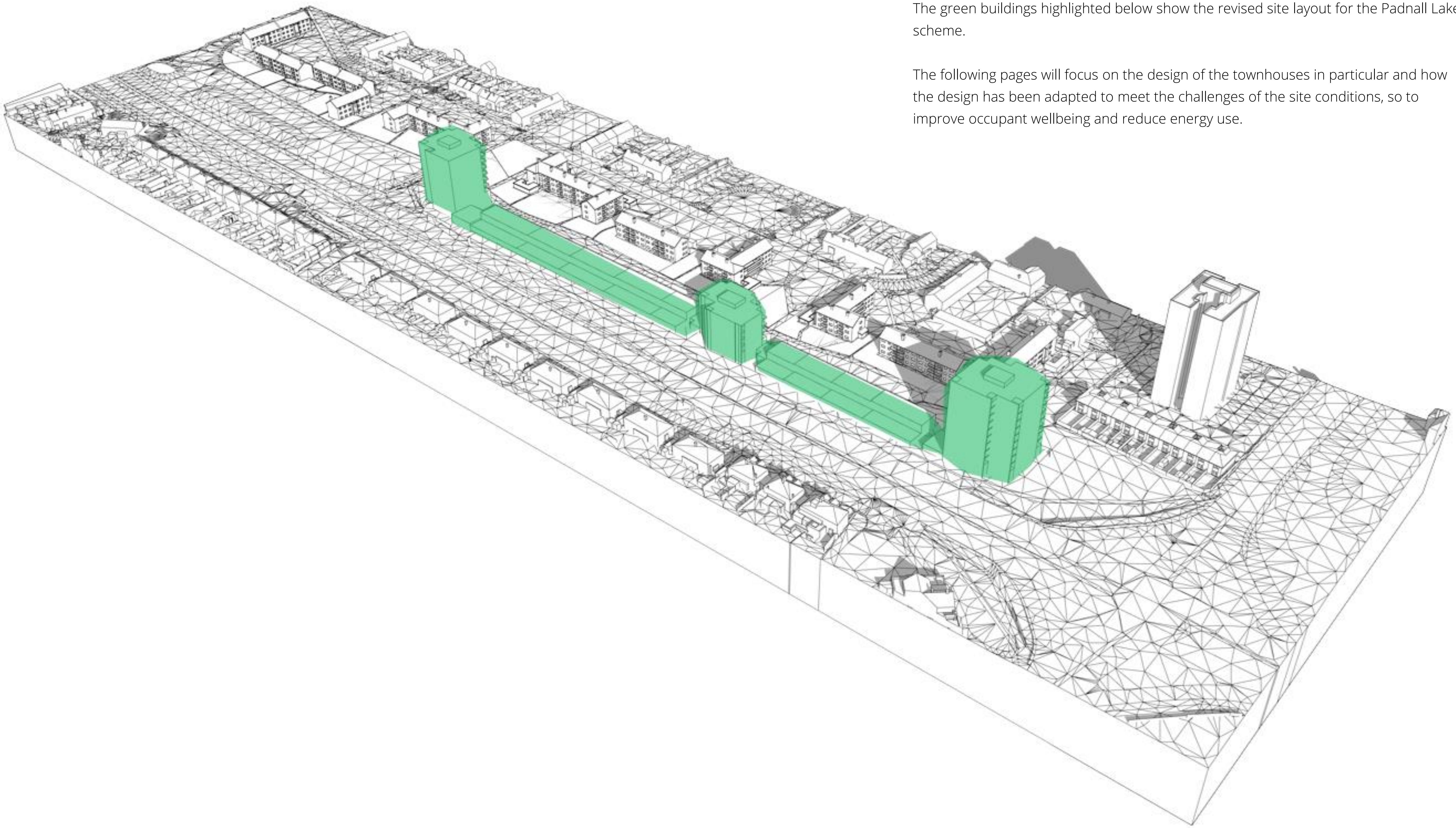
PROPOSED TOWNHOUSE SECTION- CREDIT: MAE ARCHITECTS

COURTYARD REFERENCES- CREDIT: MAE ARCHITECTS

3.5 Updated Site Layout

The green buildings highlighted below show the revised site layout for the Padnall Lake scheme.

The following pages will focus on the design of the townhouses in particular and how the design has been adapted to meet the challenges of the site conditions, so to improve occupant wellbeing and reduce energy use.



3.6 Thermal Modelling

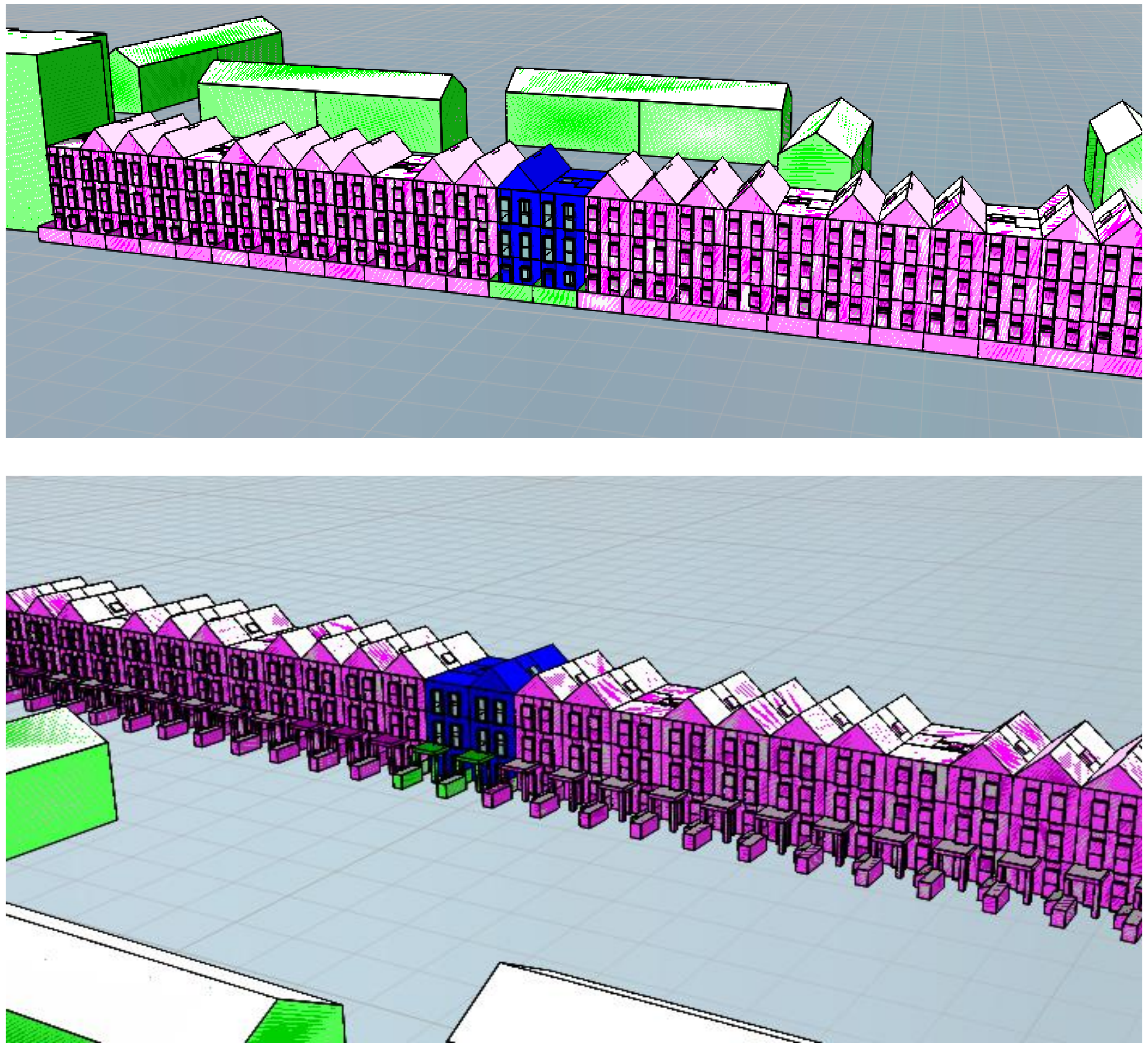
To support the design process and allow the team to make informed decisions, MACH provided numerous iterations of thermal modelling during the design of the courtyard townhouse option.

For fair comparison, thermal modelling was also carried out for the original townhouse option too, so to determine if the design changes resulted in significant improvement to occupant comfort.

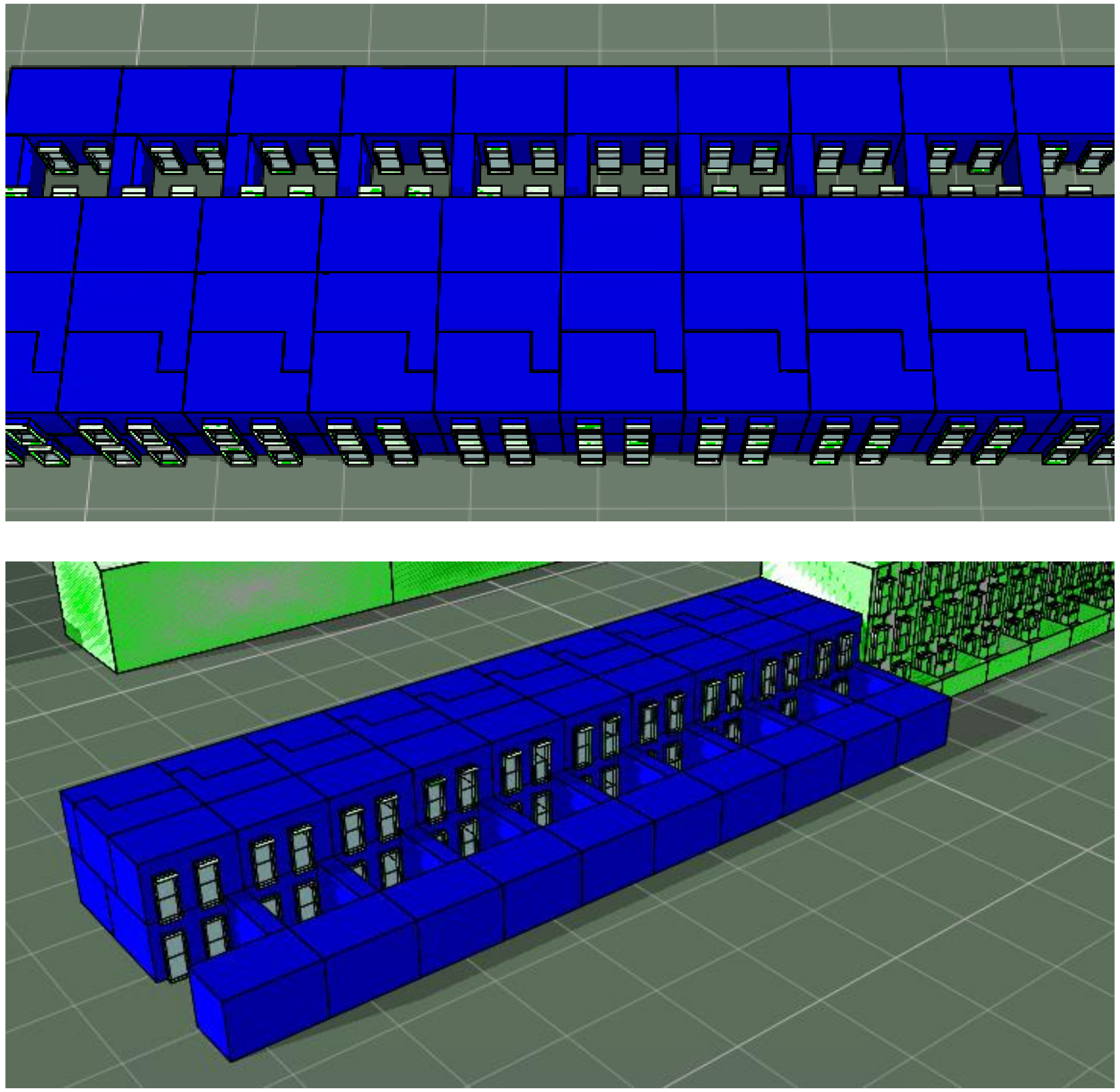
Thermal modelling was used for both daylight and overheating analysis. The figures below provide screenshots of the thermal model constructed by MACH.

MACH carried out Part O overheating analysis to explore alternative cooling and ventilation options for the scheme, so to determine if natural ventilation can be adopted without impacting upon acoustic comfort.

Furthermore, daylight modelling was carried out across all occupied room types for the previous and revised townhouse design. The results are shown in the following pages.



THERMAL MODEL - ORIGINAL DESIGN



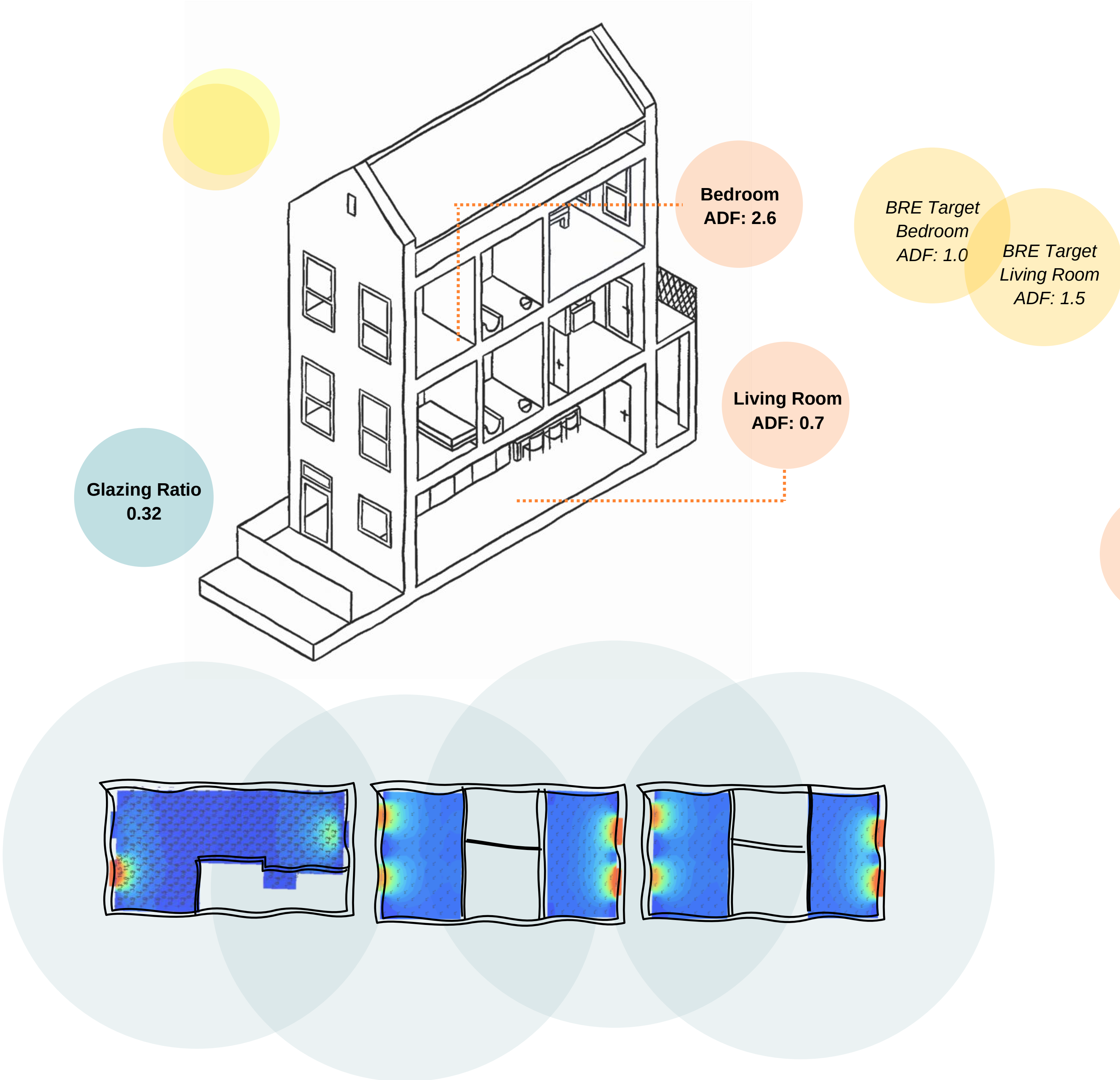
THERMAL MODEL - REVISED DESIGN

4.0 HOUSE TYPE COMPARISON – DAYLIGHT

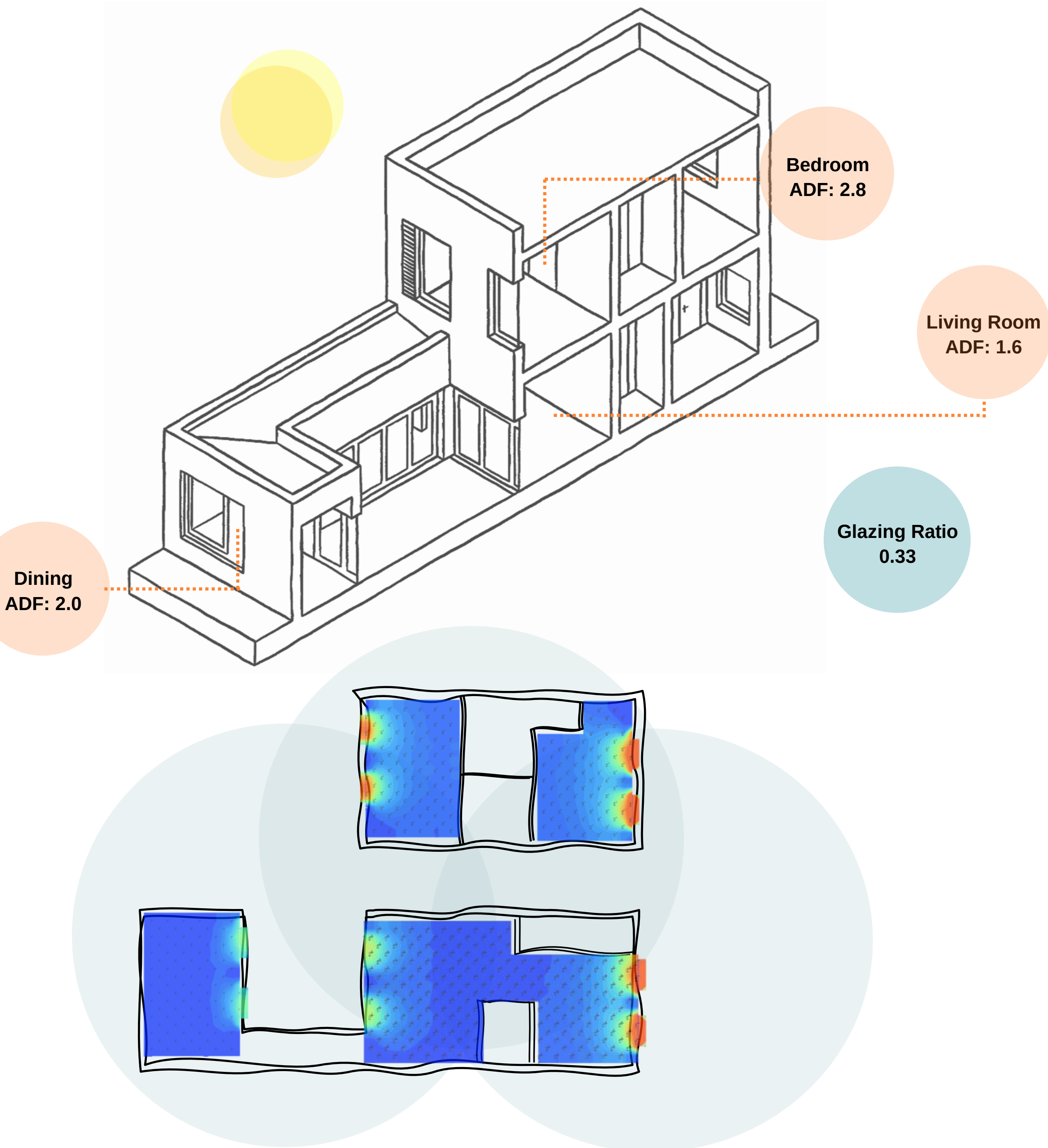
The images below provide a summary of the daylight modelling.

It is found that the deep floorplan of the outline planning option results in low levels of daylight within the ground floor layout; however, the upper floor bedrooms achieved very good levels of daylight.

The proposed housing option is shown to provide better levels of daylight within the downstairs living and kitchen area due to the shallow floor plan. The upper bedrooms achieve a similar level of daylight to the outline planning option. Additional glazing to the kitchen was provided to the south façade to ensure adequate light levels.



INTERNAL DAYLIGHT PLOTS – ORIGINAL DESIGN



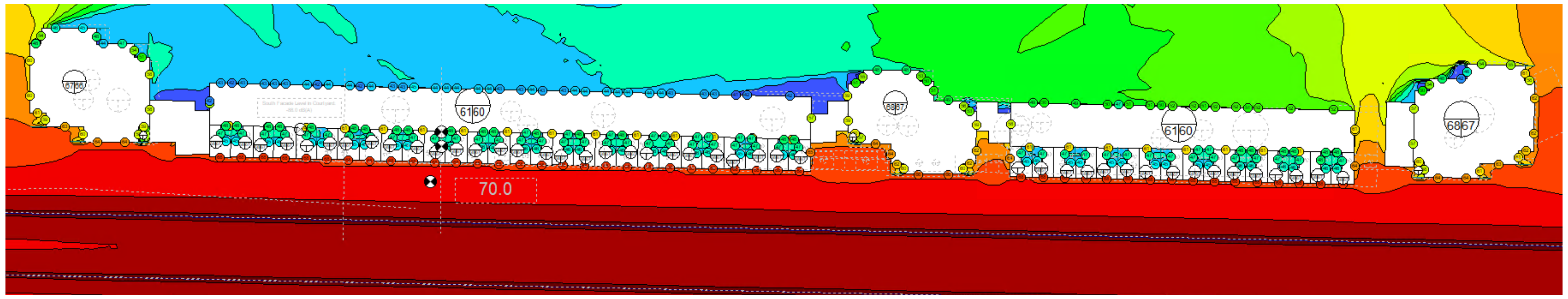
INTERNAL DAYLIGHT PLOTS – REVISED DESIGN

4.1 External Noise Levels

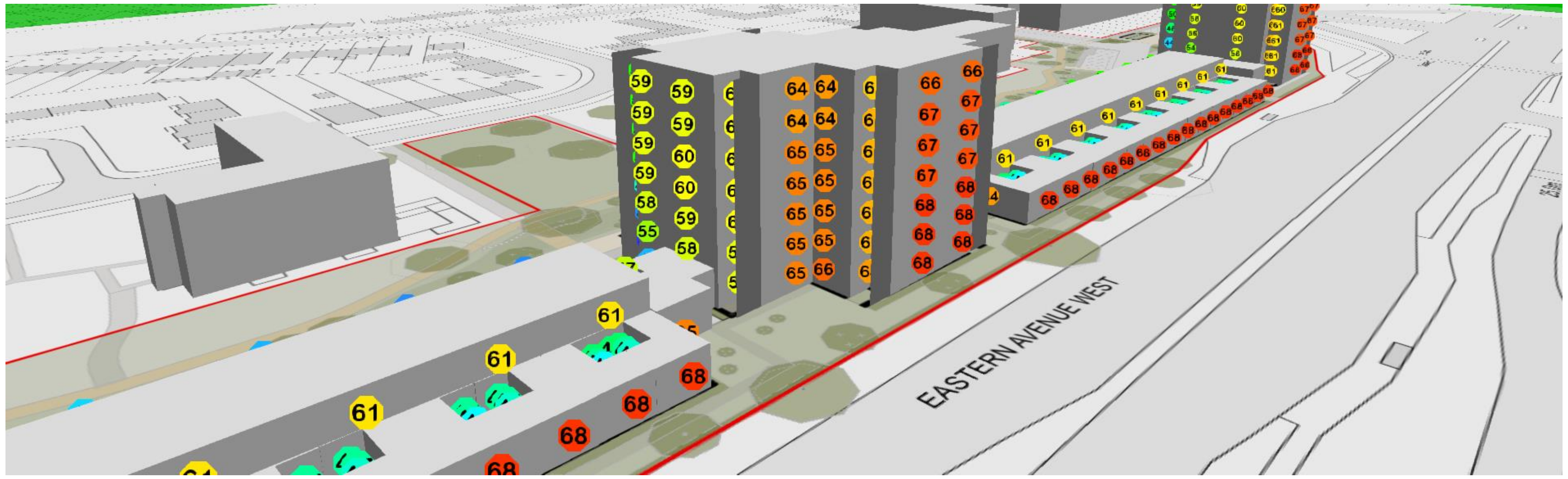
Detailed noise mapping was carried out of the proposed design changes, so to understand how best to inform the ventilation strategy.

The section opposite shows an earlier noise map section of the courtyard design, such to understand the screening benefits provided from the building massing.

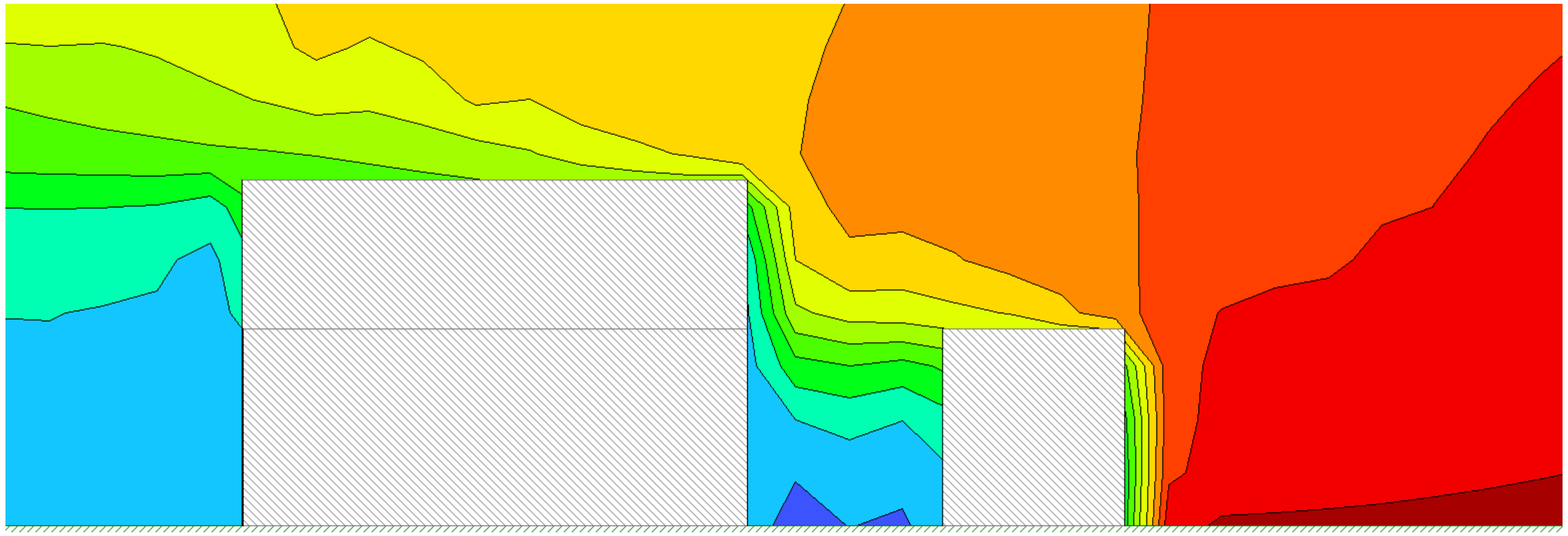
Further on in the design process, a pitched roof was introduced to the kitchen to provide even further acoustic screening to the rest of the building and adjacent courtyard.



REVISED DESIGN LAYOUT – NIGHT TIME NOISE LEVELS



3D NOISE MAPPING OUTPUTS



SECTION VIEW OF REVISED HOUSE NOISE MAP

4.2 External noise levels

The image below outlines that noise levels facing on to the A12 will experience noise levels of up to 72dBL$_{Aeq}$ during the day, which will severely limit opportunities for ventilation via natural ventilation.

The image opposite demonstrates that by adding the courtyard to the design, the main building façade is moved away from the noise source, with additional acoustic screening provided by the building massing.

The quality of the external amenity area to each property is shown to increase dramatically with the introduction of the courtyard. The courtyard area will achieve noise levels of <55dBL$_{Aeq}$, compared to the 72dBdBL$_{Aeq}$ from the outline planning design.

As a result, this brings the amenity quality inline with WHO guidelines for good quality design.

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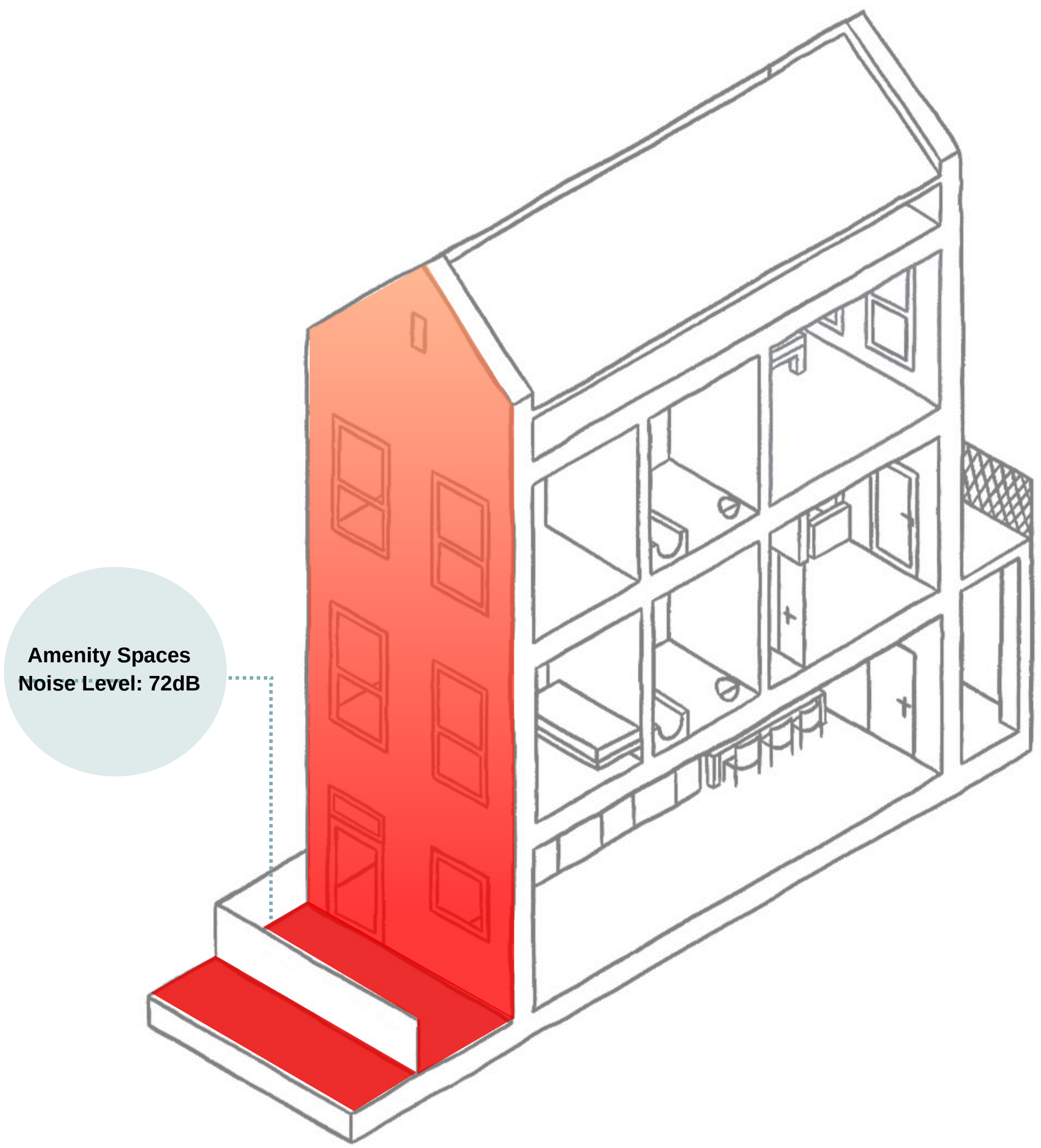
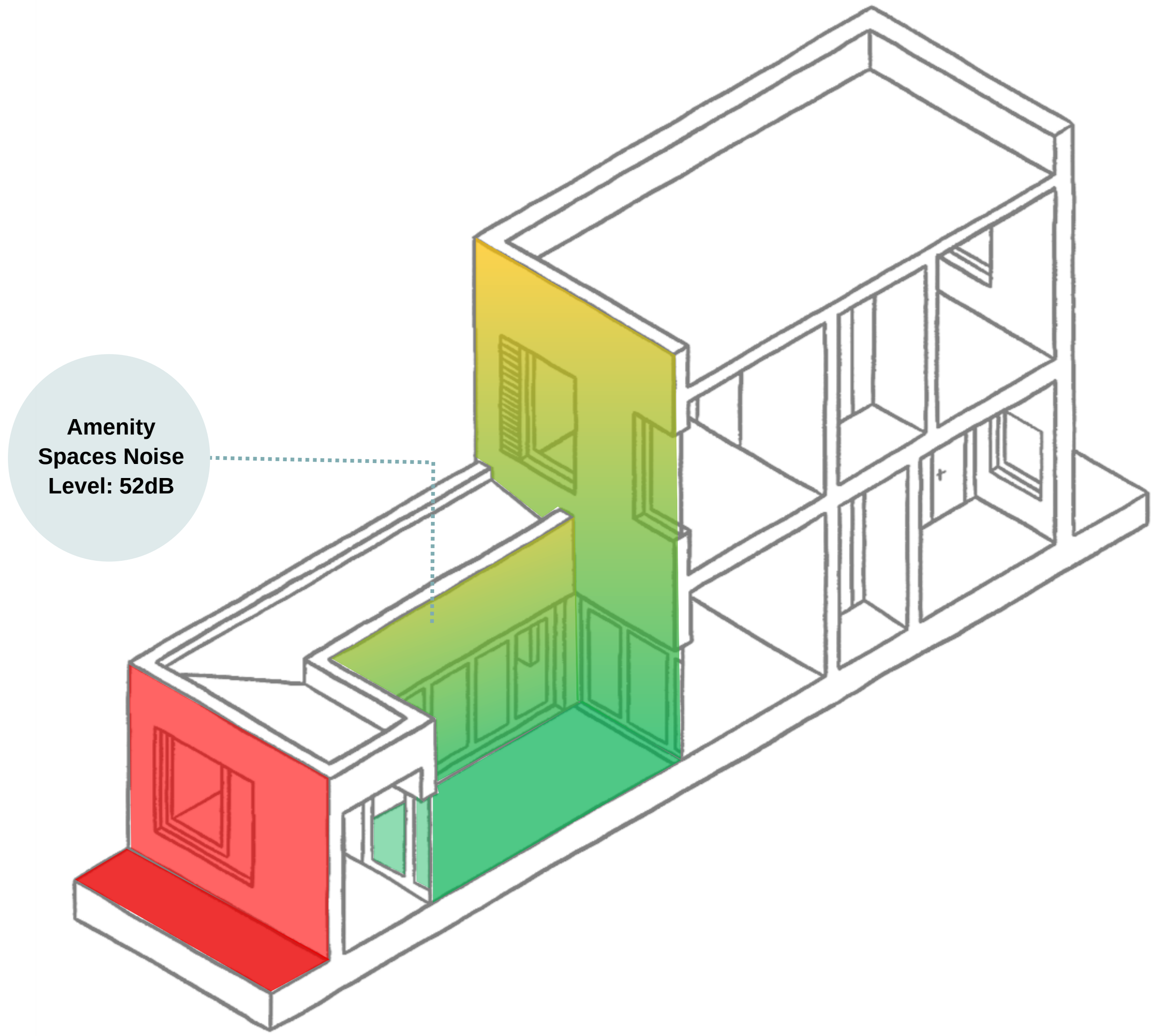


EXTERNAL NOISE – ORIGNAL TOWNHOUSE



EXTERNAL NOISE – REVISED TOWNHOUSE

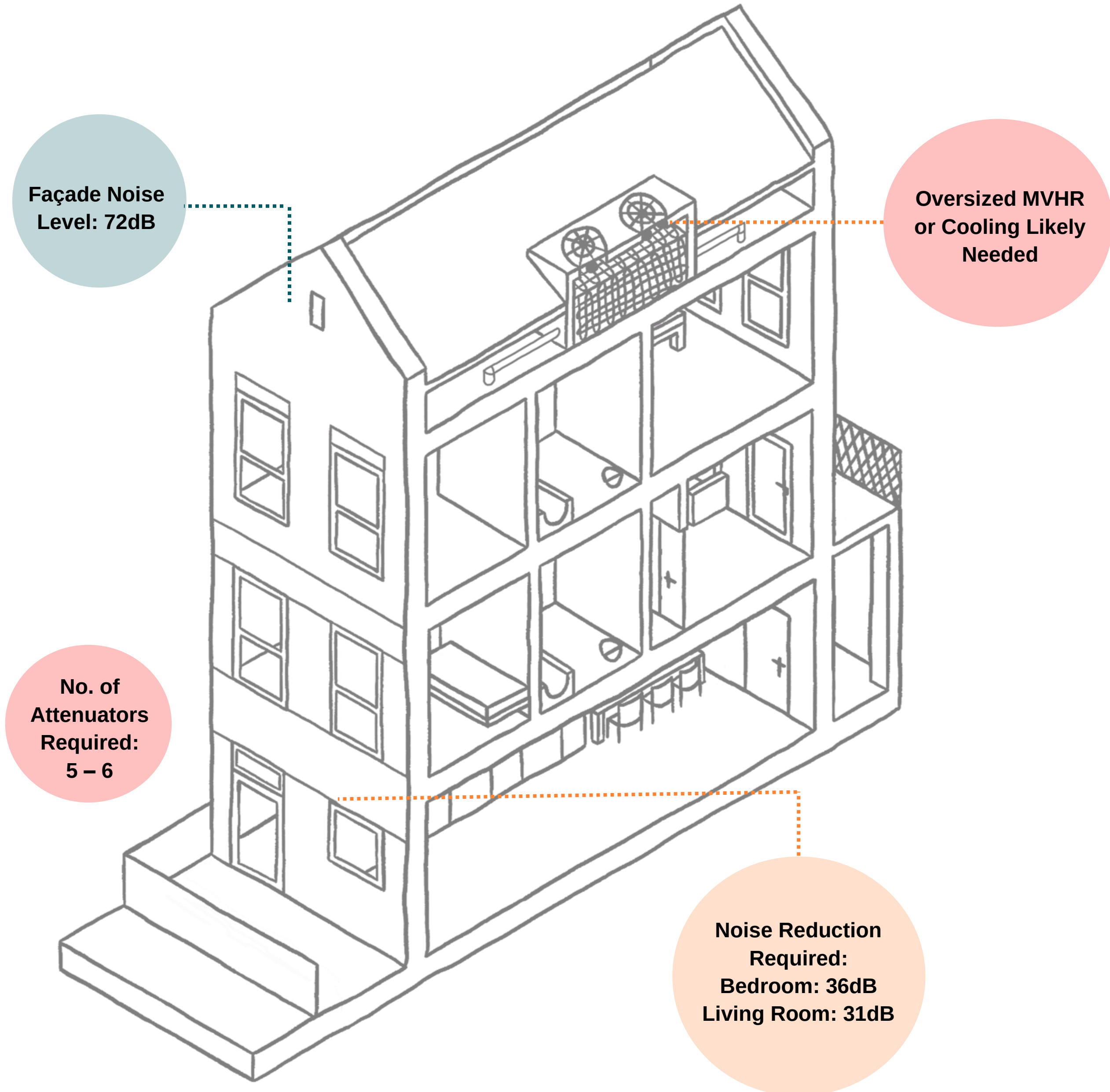
5.0 HOUSE TYPE COMPARISON – VENTILATION & ACOUSTICS

The images below illustrate the different ventilation design principles between the two housing options. The revised design is a switch to a more passive-cooling orientated design, with an aim for occupant wellbeing and reduced carbon emissions.

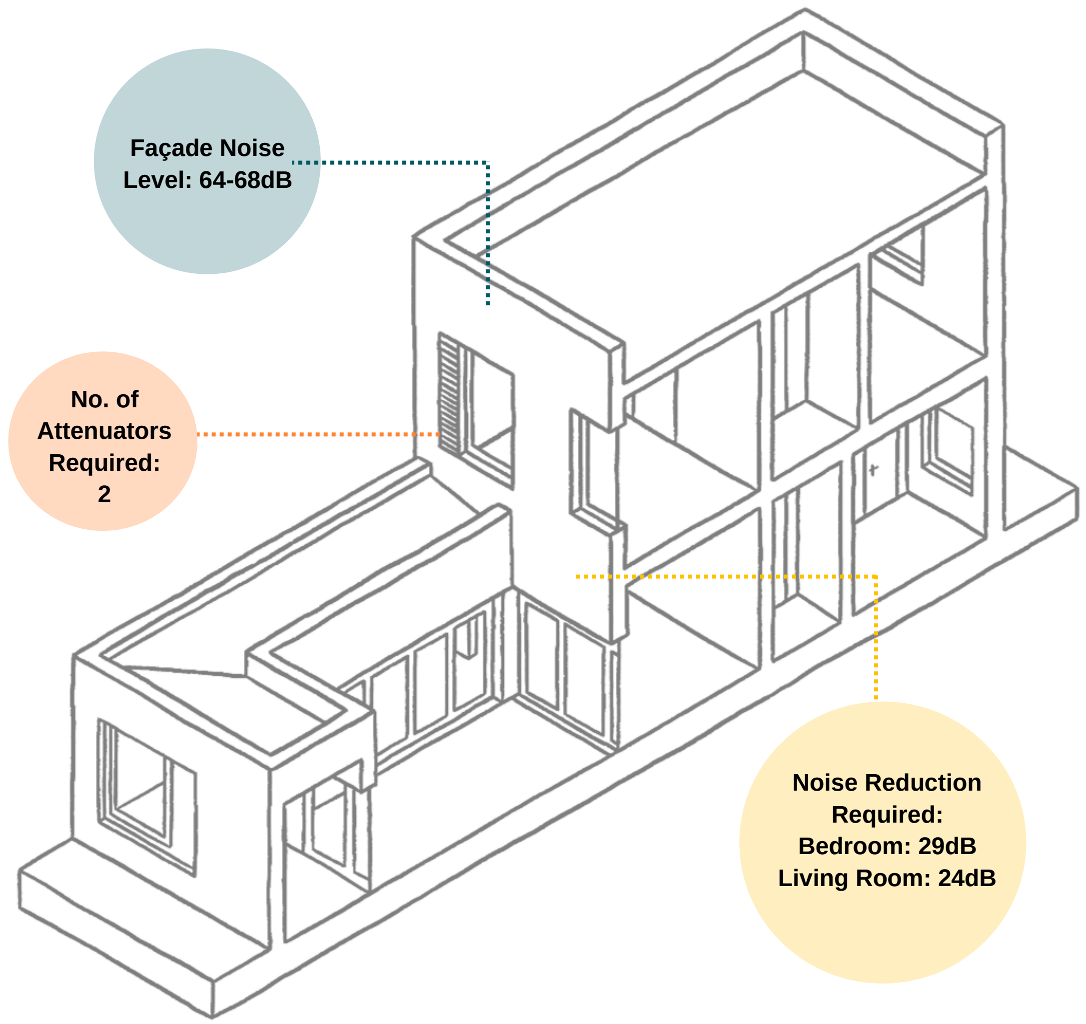
To meet Part O overheating and noise criteria, the original townhouse would either need a large number of acoustic attenuators to the façade, which would be cumbersome and difficult to incorporate within the façade, or use oversized MVHR or mechanical cooling to provide sufficient cooling without needing to open windows.

For the revised design, the proposed layout means that only one room (the first bedroom) needs to have a ventilator opening on to the road, this will drastically reduce the number of acoustic attenuators needed on the façade. Furthermore, the screening from the building massing ensures that the attenuator has a reduced sound reduction, which means the attenuator can be slimmer and more easily adopted in the façade design.

Rooms adjacent to the courtyard will experience significantly lower noise levels and will be able to naturally ventilate via openable windows.



VENTILATION DESIGN – ORIGINAL TOWNHOUSE



VENTILATION DESIGN – REVISED TOWNHOUSE

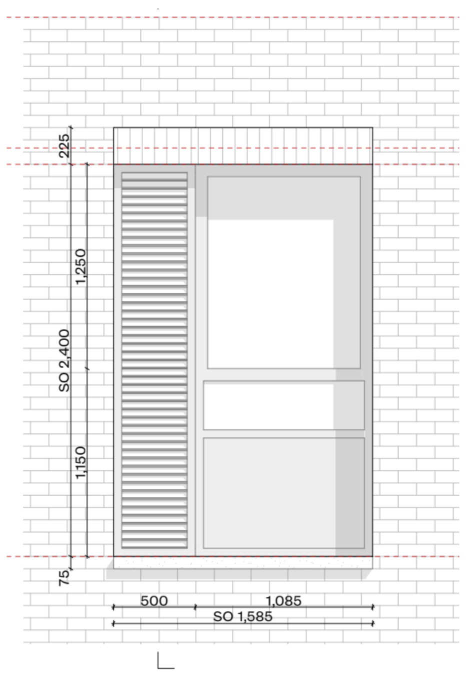
5.1 ATTENUATOR DESIGN

The images across show how the attenuated ventilators can be adopted within the façade with minimal visual impact.

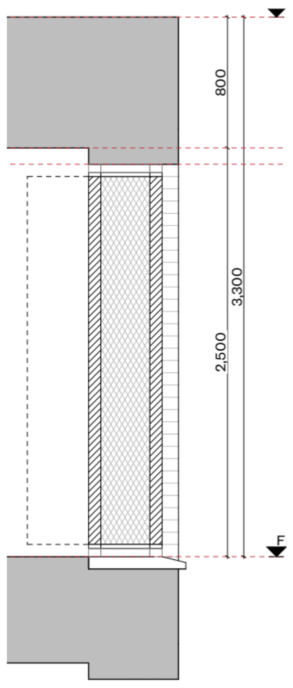
Through careful design and various iterations of design optimisation, MACH were able to advise on an attenuation design that fits within the depth of the external wall, thereby reducing any impact on room layout.

Furthermore, the attenuator design can be incorporated within the window framing system. This brings a range of benefits to the design, largely reducing thermal bridging and maintaining a constant airtight and thermal line across the façade.

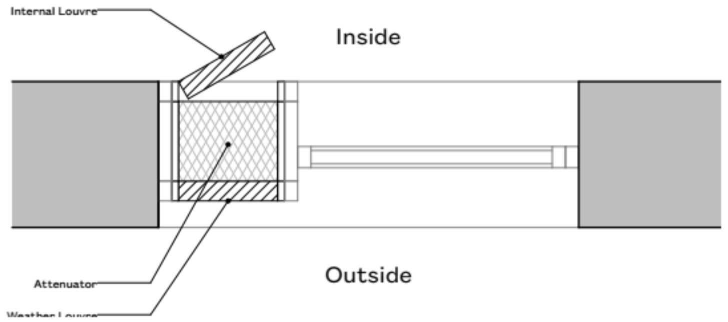
Image credit: Mae Architects



Detail Elevation - Window incorporating attenuator



Typical Section



Detail Plan

6.0 HOUSE TYPE COMPARISON – CARBON EMISSIONS

The images below outline the calculated fabric efficiency and overall energy use using Part L methodology. The building fabric values and building services efficiencies are the same for the assessment of each house type, and as such the assessment is a comparison between the fabric efficiency due to floor area and form factor.

It is shown that regarding overall emissions per m2 of floor plan ($kgCO_2/m^2$), the outline planning house type is the most efficient, however, through the reduction of additional circulation spaces, the proposed design option benefits from a much more efficient use of floor area, which reduces the overall yearly emissions.

Furthermore, the change to a flat roof allows for the roof area to be used more effective for PV panels, as they can be directed due-South to get the most efficiency from the units.

As such the overall emissions per dwelling have shown to be reduced from the original design, resulting in less carbon emissions across the development. Note that the predicted emissions are not representative of the intended overall efficiency and total carbon emissions but are to be used for comparison between the house types only.

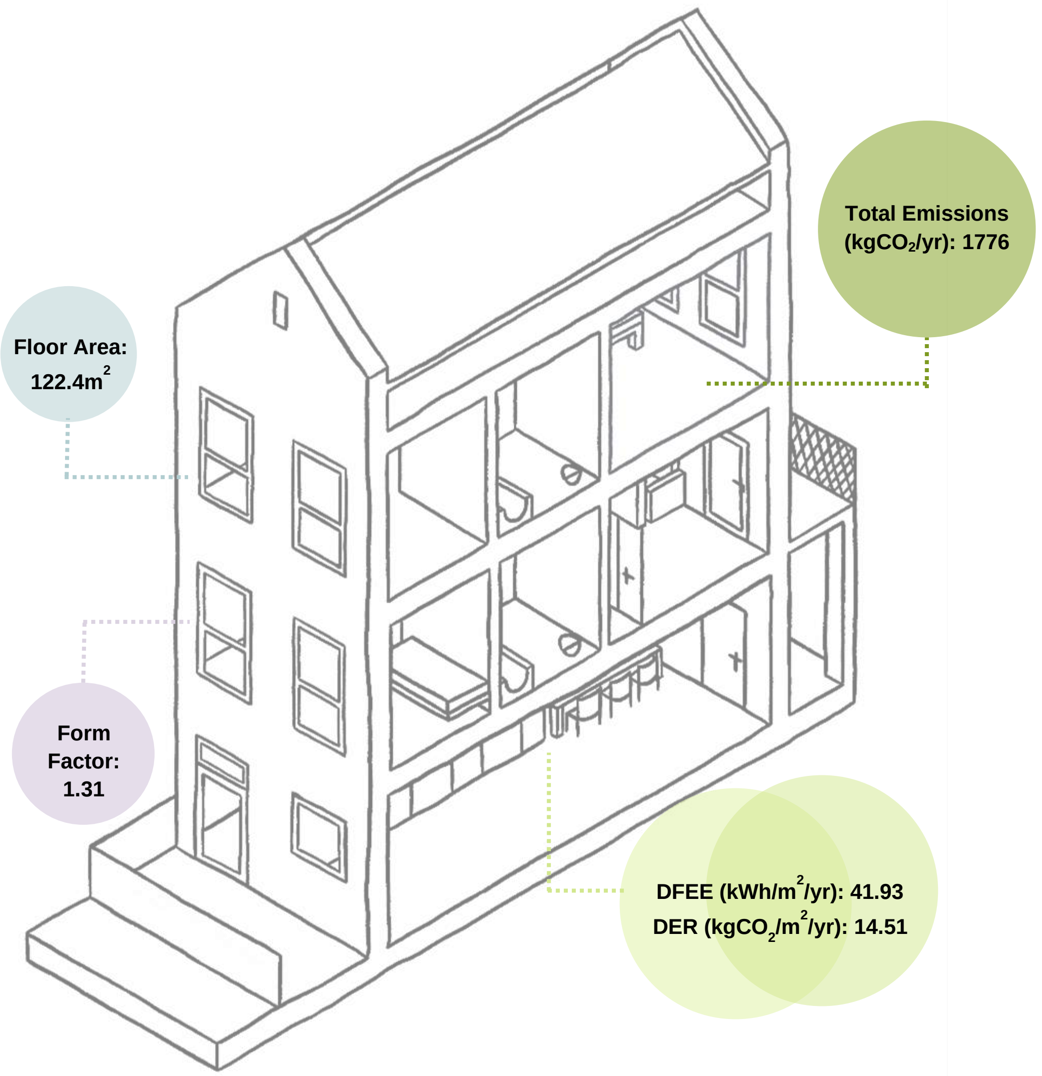


Figure 6.1: Fabric efficiencies and carbon emissions of outline planning option

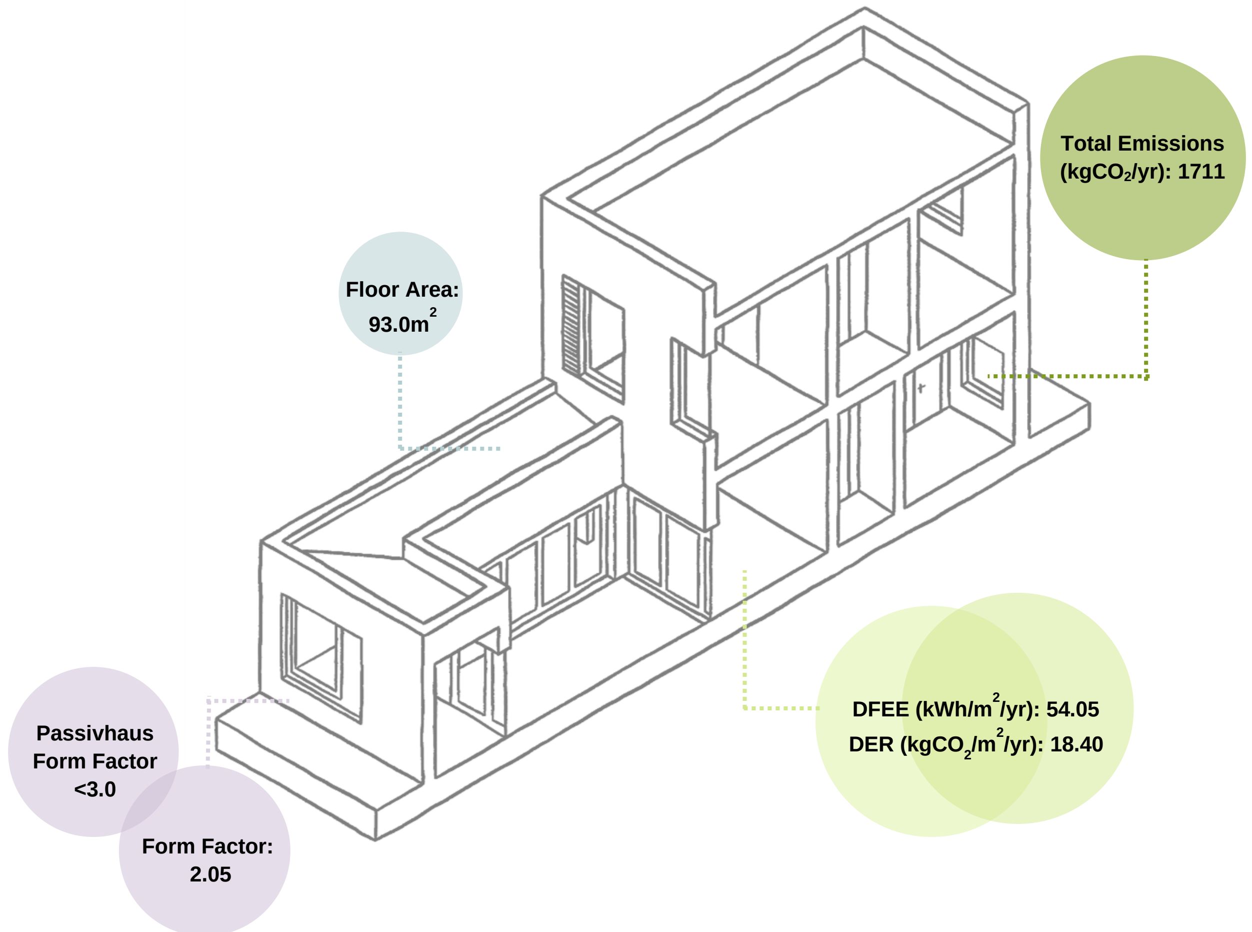


Figure 6.2: Fabric efficiencies and carbon emissions of proposed housing option

7.0 SUMMARY

The table below provides a summary of the acoustic, ventilation and sustainability impacts/benefits of the outline planning and proposed house type. As shown, the proposed housing option shows potential benefits for all elements of the design assessed.

As a result the proposed redesign will have improvements on the internal environmental quality of the spaces, as well as reduced energy use.

Design Element	Performance Values	Detail	Outline Planning Option	Proposed Option
Energy	DFEE (kWh/m^2/yr)	-	41.93	54.05
	DER (kgCO$_2$/m^2/yr)	-	14.5	18.4
	Total Emissions (kgCO$_2$/yr)	-	1776	1711
Daylight	Average Daylight Factor (ADF %)	Living Room	0.7	1.6
		Bedroom	2.6	0.7 (ground) 2.8 (1st floor)
Ventilation & Acoustics	Rooms requiring attenuation*	Living Room	1	0 - 1
		Bedroom	2	1 - 2
	Noise Level at Façade (Daytime)	Living Room	Up to 72dB	Up to 64dB
		Bedroom	Up to 72dB	Up to 68dB
	External Amenity (Daytime)	Garden	>70dB	<55dB