



THINKING **DIFFERENTLY**

BLESSED CARLO ACUTIS CATHOLIC SCHOOL

Environmental Noise Assessment

Willmott Dixon



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Environmental Noise Assessment

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1.0 INTRODUCTION

The aim of this report to provide the design team with an early understand of the acoustic implication for Blessed Carlo Acutis Catholic School.

At this stage BB93 has been used as the performance standards.

1.1 Project Summary

1.1.1 Indoor Ambient Noise Levels

Indoor ambient noise within cellular spaces, is external noise and noise from services breaking through the façades. At the point of writing this document, the ventilation strategy has not been fully established, however based upon current drawings, MACH has produced a basic, very early, acoustic model, this has shown that the site is relatively quiet except façades directly facing Galon Uchaf Road and Gwaunfarren Road. The topographical survey data has been included within the model produces to date.

1.1.2 Sound Insulation

Sound Insulation will be developed at a later stage in this project.

1.1.3 Reverberation Treatments

Reverberation treatments will be developed at a later stage in this project.

1.2 Tabulated Overview

	Project Summary	
Project Name	Blessed Carlo Acutis Catholic School	
Client	Willmott Dixon	
Construction Type	Unknown	
		Section
Build Type	New Build - Education Building (Primary + Secondary School)	-
Number of Floors	4 Storeys	-
Background Ventilation		
Ventilation Type	Mixed mode	-
Outdoor Amenities	Noise levels are generally <55dB across the site and therefore no noise mitigation measures will be required for sports activities. Noise maps have been provided which will enable a selection of an outdoor teaching space in this area.	-
Determination of Façade Noise Levels	Mapping Noise Levels	-
Façade Noise Levels	Openable windows be used for the majority of teaching spaces on facades with noise levels< 53 dB. Care will be required for the facades facing the Galon Uchaf road and Gwaunfarren Road.	-

2.0 INDOOR AMBIENT NOISE LIMITS – PERFORMANCE REQUIREMENTS

Indoor ambient noise levels are function of the ventilation type used, in terms of the specification required internal noise levels, the specified façade reduction and any services noise.

- BB93 provides dispensation for indoor ambient noise levels, for ventilation types which reduced the buildings carbon footprint.
- If mechanical ventilation is used Indoor ambient noise levels will be the sum of facade noise break in with services noise.

Table 2.1 below shows a summary of the internal ambient noise limit is affected by various conditions for a chosen ventilation system. The sections following expand on the respective relaxations.

Condition	Ventilation System	New Internal Ambient Noise Limit
Normal - ventilation for normal teaching and learning activities	Mechanical	IANL*
	Natural	IANL* + 5 dB
	Hybrid	Mechanical system noise: IANL*
		Total noise level: IANL* + 5 dB
Summertime - ventilation under local control of teacher to prevent overheating - allowable during the hottest 200 hrs of the year	Mechanical	IANL* + 5 dB
	Natural or Hybrid	≤55 dB
Intermittent boost - ventilation under local control of teacher for dilution of fumes during practical activities as in practical spaces for science, art, food technology and design and technology	Mechanical	IANL* + 5 dB
	Natural or Hybrid	≤55 dB
Process - extract can be automatic ventilation for safety and/or under local control of teacher	Mechanical and/or natural	See IoA/ANC guide 'Acoustics of Schools: a design guide' for operational noise levels

Table 2.1: summary of ventilation condition, system type and associated IANL tolerance

* Noise level limits are determined by the room classification. These will be provided once a room schedule has been developed.

2.1 Natural Ventilation

Natural ventilation allows indoor ambient noise limits to be relaxed by +5 dB $L_{Aeq,30min}$. This does not apply to spaces with an indoor ambient noise limit of 45 dB $L_{Aeq,30min}$ or higher.

BB93 permits a relaxation during the hottest 200 hrs summertime, where noise limits can be increased up to 55 dBA. This limit also applies to locally controlled hybrid ventilation systems when intermittent boost is required for certain practical activities.

See section 2.4 for the BB93 definition of summertime.

This condition does not apply to classrooms intended specifically for students with special hearing and communication needs, or to speech therapy rooms.

2.2 Hybrid Ventilation System

Hybrid ventilation strategy allows the total indoor ambient noise limits to be relaxed by +5 dB $L_{Aeq,30min}$. This does not apply to spaces with an indoor ambient noise limit of 45 dB $L_{Aeq,30min}$ or higher.

Summertime relaxation (see section 2.4) does not apply to classrooms specifically for students with special hearing and communication needs, or to speech therapy rooms.

2.3 Mechanical Ventilation System

Indoor ambient noise levels for mechanically ventilated spaces are required to meet the levels for its BB93 room classification. These will be provided once a room schedule has been developed.

If a room is mechanically ventilated or cooled, the plant should be assumed to be running at its normal operating duty.

For spaces adjacent to the façade, internal ambient noise levels will be a function of the sum of services noise and façade noise break in. As such it is essential to ensure that both these components are designed below, BB93 target such that the sum of service noise and façade noise break in are below BB93 require levels.

2.4 Summertime - Hottest 200 hrs: Definition

BB93 defined Summertime as “Summertime - ventilation under local control of teacher to prevent overheating – allowable during the hottest 200 hrs of the year.” The hottest 200 hrs is defined as:

“The peak summertime condition is defined as the 200 hottest hours that occur using the design summer year (DSY) weather file during normal daily school operating hours including the summer holiday period. Thermal modelling and assessment of acoustic performance should be carried out as if the school were occupied through the summer holiday period. This corresponds to a much lower number of hours during normal term time (equivalent to typically 40 teaching hours in a school year) as most of the hottest hours occur during the holiday period.”

For the summertime 200 hours to apply, the ventilation strategy must be under the local control of the teacher so that the noise level can be reduced to normal levels when needed.

At this stage MACH would like to stress that an indoor ambient noise level of 55 dBA will impact upon teaching. We would therefore advise that if this condition is being sort, the teachers using this development are informed of the impact of such high noise levels.

2.5 L1 Noise Level

BB93 also sets a maximum “L1” noise level of 60 dB $L_{A1,30min}$ in teaching spaces. This only requires assessment where the indoor ambient noise level target is 45dB $L_{Aeq,30min}$ or greater.

The L1 noise level is the measured noise value just exceeded for 1% of the time, it is representative of the loudest noise experienced in the space.

2.6 Outdoor Amenity

With respect to outdoor play and learning areas, “Acoustics of Schools: a design guide” states the following. It is worth noting that these requirements are not provided in BB93.

“2.2 Recommendations for external noise levels outside school buildings

Although Requirement E4 does not apply to external noise, the following recommendations are considered good practice for providing suitable acoustic conditions outside school buildings.

For new schools, 60 dB $L_{Aeq,30min}$ should be regarded as an upper limit for external noise at the boundary of external areas used for formal and informal outdoor teaching and recreation.

It may be possible to meet the specified indoor ambient noise levels on sites where external noise levels are as high as 70 dB $L_{Aeq,30min}$ but this will require considerable building envelope sound insulation, or screening.

Playgrounds, outdoor recreation areas and playing fields are generally considered to be of relatively low sensitivity to noise. Indeed, playing fields may be used as buffer zones to separate school buildings from busy roads where necessary. However, where used for teaching, for example sports lessons, outdoor ambient noise levels have a significant impact on communication in an environment which is already acoustically less favourable than most classrooms. Noise levels in unoccupied playgrounds, playing fields and other outdoor areas should not exceed 55 dB $L_{Aeq,30min}$ and there should be at least one area suitable for outdoor teaching activities where noise levels are below 50 dB $L_{Aeq,30min}$. If this is not possible, due to a lack of suitably quiet sites, acoustic screening should be used to reduce noise levels in these areas as much as practicable, and an assessment of noise levels and options for reducing these should be carried out. Noise levels can be reduced by up to 10 dBA at positions near an acoustic screen.”

Area	Noise Level
	(dB $L_{Aeq,30min}$)
Unoccupied playgrounds, playing fields and other outdoor areas	≤ 55
Outdoor teaching activities (1)	≤ 50
(1) Should be at least one area suitable for this.	

Table 2.2: Outdoor amenity noise levels

Please see noise maps in Section 0 for the available locations around the school site for external teaching in line with the requirements above.

2.7 Rain Noise

The criteria stated in the table below is required to be demonstrated through laboratory tests and/or calculation, and includes any glazing, or lightweight structure.

Rain Type (as defined by BS EN ISO 140-18)	Rain Noise Limit (dB $L_{Aeq,30min}$)
Heavy Rainfall	≤ Indoor Ambient Noise Limit + 25 dB

Table 2.3: Rain Noise Limits

2.8 Performance Requirements

At this stage, a room schedule and the ventilation strategy for rooms have not been developed. MACH will therefore provide a full performance requirement specification for all spaces as the project develops.

The information over leaf should therefore be used as a guidance summary.

	Mechanical Ventilation		Natural Ventilation		Hybrid Ventilation		
	Normal Ventilation	Summertime or Intermittent Boost Ventilation	Normal Ventilation	Summertime or Intermittent Boost Ventilation	Normal Ventilation	Summertime Boost or Intermittent Ventilation	
New Build Development							
BB93 Classification		Limited to ≈40 Teaching Hours in a School Year		Limited to ≈40 Teaching Hours in a School Year	Mechanical	Total	Limited to ≈40 Teaching Hours in a School Year
Nursery School Room	35	40	40	55	35	40	55
Primary School: Classroom, Class Base, General Teaching Area, Small Group Room	35	40	40	55	35	40	55
Secondary School: Classroom, General Teaching, Seminar Room, Tutorial Ro., Language Lab	35	40	40	55	35	40	55
Open-Plan Teaching Area	40	45	45	55	40	45	55
Open-Plan Resource Area	40	45	45	55	40	45	55
Primary Music Room	35	40	40	55	35	40	55
Secondary Music Classroom	35	40	40	55	35	40	55
Small Practice/Group Room (Music) (<30m2)	35	40	40	55	35	40	55
Large Practice/Group Room (Music) (>30m2)	35	40	40	55	35	40	55
Ensemble Room (Music)	30	35	35	55	30	35	55
Performance/Recital Room (Music)	35	40	40	55	35	40	55
Recording Studio	30	35	35	55	30	35	55
Control Room - For Recording	35	40	40	55	35	40	55
Control Room - Not For Recording	35	40	40	55	35	40	55
Lecture Room (Small - Fewer Than 50 People)	35	40	40	55	35	40	55
Lecture Room (Large - More Than 50 People)	35	40	40	55	35	40	55
Teaching space intended specifically for pupils with special hearing & communication needs	30	35	35	55	30	35	55
SEN Calming Room	35	40	40	55	35	40	55
Study Room (Individual Study, Withdrawal, Remedial Work, Teacher Preparation)	40	45	45	55	40	45	55
Libraries: Quiet Study Areas	40	45	45	55	40	45	55
Libraries: Resource Areas	40	45	45	55	40	45	55
Science Laboratory	40	45	45	55	40	45	55
Drama Studio	35	40	40	55	35	40	55
Resistant Materials, CAD/CAM Areas	40	45	45	55	40	45	55
Electronics/Control, Textiles, Food, Graphics, Design/Resource Area, ICT Room, Art	40	45	45	55	40	45	55
Assembly & Multi-Purpose Hall (Drama, PE, Audio/Visual Presentations, Occasional Music)	35	40	40	55	35	40	55
Atrium, Circulation Space not intended for teaching and learning	45	45	45	55	45	50	55
Sports Hall	40	45	45	55	40	45	55
Dance Studio	40	45	45	55	40	45	55
Gymnasium/Activity Studio	40	45	45	55	40	45	55
Swimming Pool	50	50	50	55	50	55	55
Meeting Room, Interviewing/Counselling Room, Video Conference Room	40	45	45	55	40	45	55
Dining Room	45	45	45	55	45	50	55
#Kitchen	50	-	-	-	50	-	-
#Office, Medical Room, Staff Room	40	-	-	-	40	-	-
##Corridor, Stairwell, Coats and Locker Area	45	-	-	-	45	-	-
###Changing Area	50	-	-	-	50	-	-
###Toilet	50	-	-	-	50	-	-

Table 2.4: Indoor Ambient Noise Levels Required for Each Ventilation Strategy

3.0 INDOOR AMBIENT NOISE LIMITS – DEMONSTRATION OF COMPLIANCE

3.1 Noise Climate

Appendix A provides full details of the environmental noise survey conducted for the site. The table below presents measured noise level data averaged into 30 minute time periods as required by BB93 to calculate indoor ambient noise levels against the limits set.

3.1.1 Summary of $L_{Aeq,30mins}$ Noise Levels

Based on the results of the environmental noise survey as outlined within A.1 of this report, the $L_{Aeq, 30mins}$ noise levels representative of the local noise climate has been produced by means of logarithmically averaging the fixed measurement data to fit this time period as shown in Table 3.1.

Location	Date	Start	End	Duration	$L_{Aeq,30min}$ (dB)
Fixed Measurement Location 1	07/07/2022	11:30	12:00	00:30:00	58
		12:00	12:30	00:30:00	57
		12:30	13:00	00:30:00	56
		13:00	13:30	00:30:00	58
		13:30	14:00	00:30:00	57
		14:00	14:30	00:30:00	57
		14:30	15:00	00:30:00	57
		15:00	15:30	00:30:00	59
		15:30	16:00	00:30:00	58
		16:00	16:30	00:30:00	59
		16:30	17:00	00:30:00	58
	08/07/2022	09:00	09:30	00:30:00	57
		09:30	10:00	00:20:00	58
		10:00	10:30	00:30:00	58
		10:30	11:00	00:30:00	58
		11:00	11:30	00:30:00	58
		11:30	12:00	00:30:00	57
		12:00	12:30	00:30:00	57
		12:30	13:00	00:30:00	57
		13:00	13:30	00:30:00	62
		13:30	14:00	00:30:00	57

Table 3.1: $L_{Aeq, 30mins}$

As shown in Table 3.1, 62 dB $L_{Aeq, 30mins}$ is the highest measured $L_{Aeq, 30mins}$ noise level at the fixed measurement position.

3.2 Façade Noise Exposure Levels - Noise Mapping

The measured noise level data has been used to calibrate a detailed model in CadnaA noise prediction software, such to more accurately understand and assess the propagation of noise across the site.

CadnaA is an industry standard noise propagation software. The software calculates how sound travels over distance. The models take into account reflections off hard surfaces, ground absorption, geometrical spreading. The calculations are performed in accordance with ISO 9613: Attenuation of sound during propagation outdoors. The results are presented below.

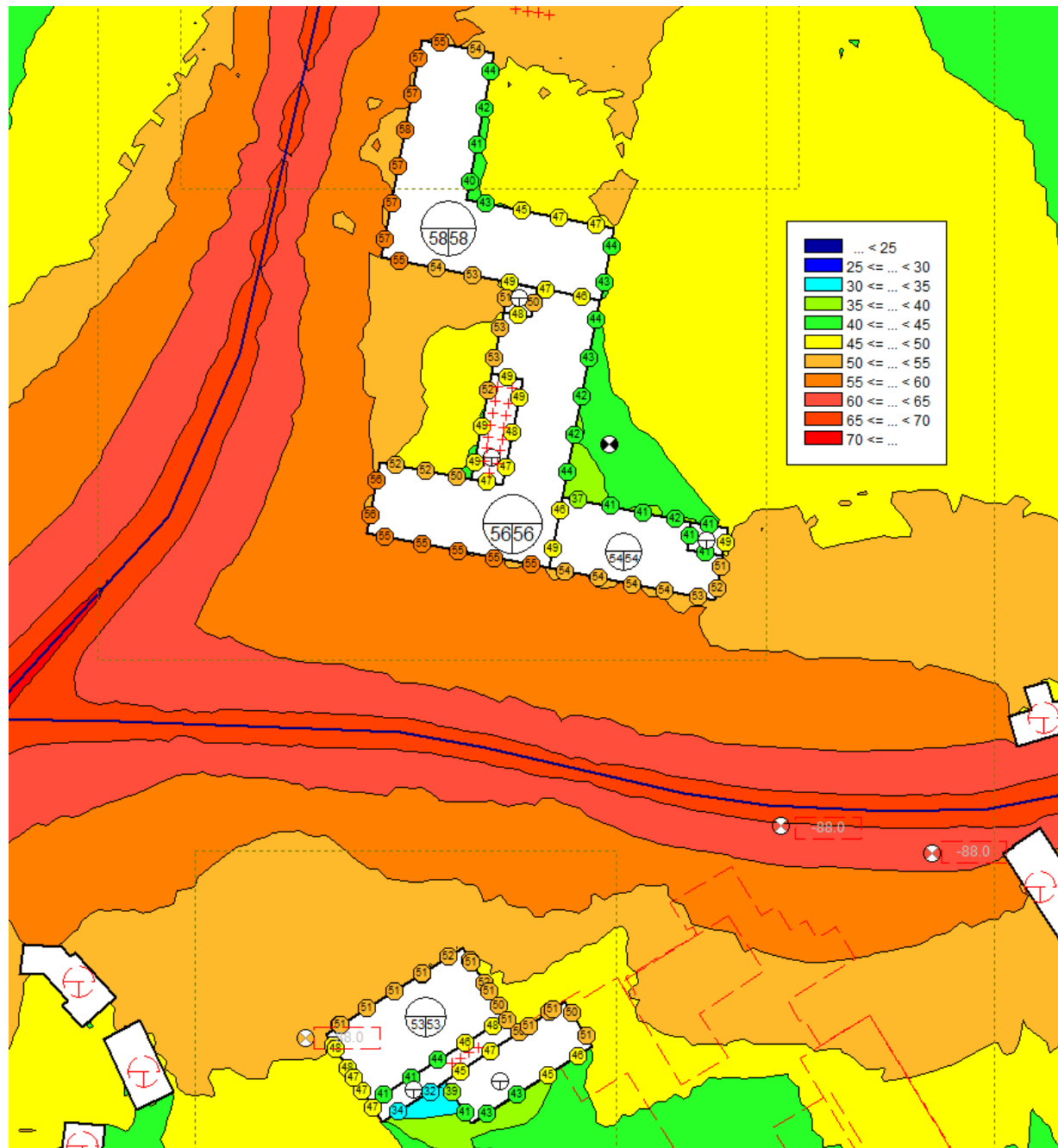


Figure 3.1: Predicted Noise Level - Site Map

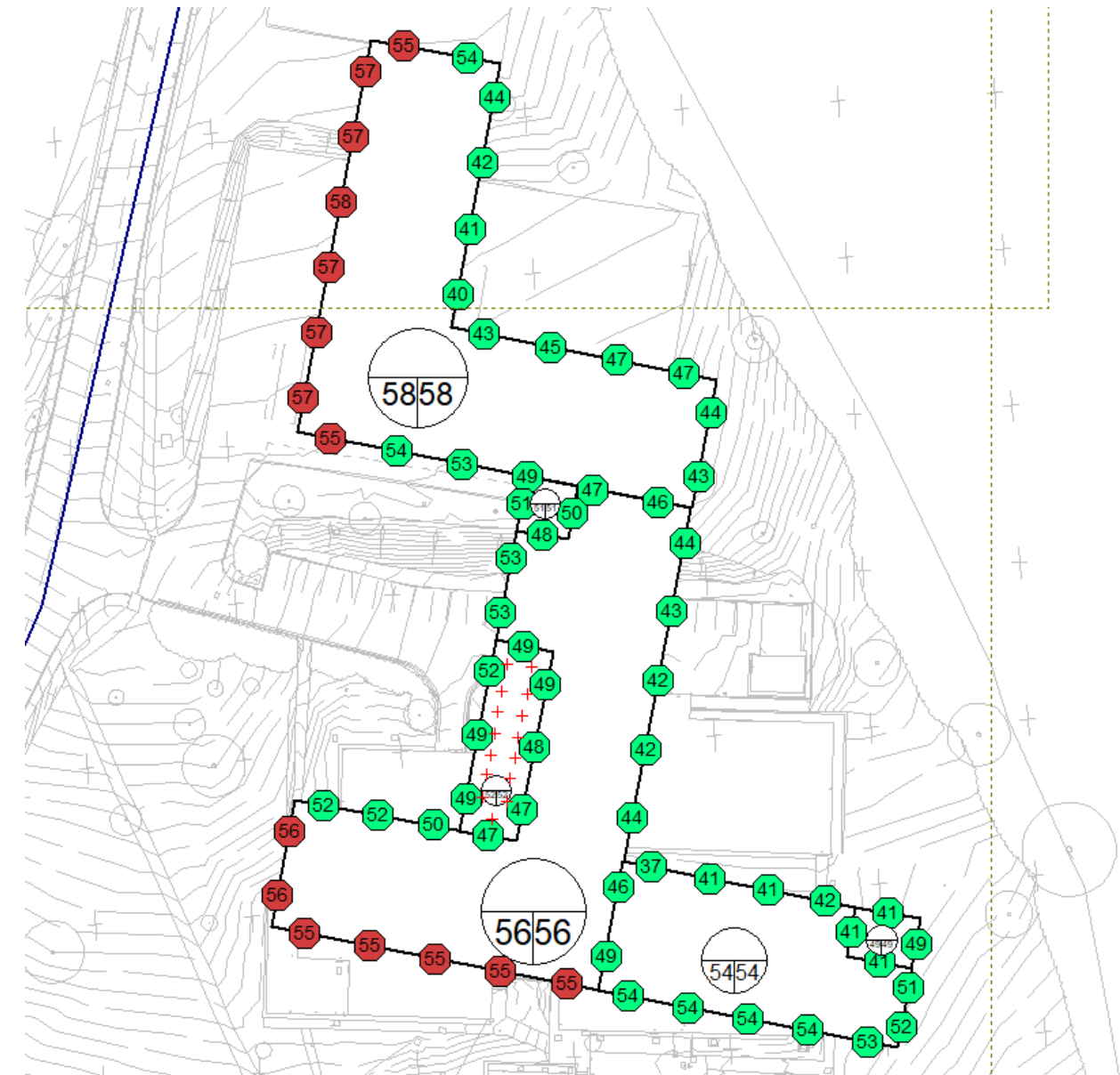


Figure 3.2: Predicted Noise Level - School Block

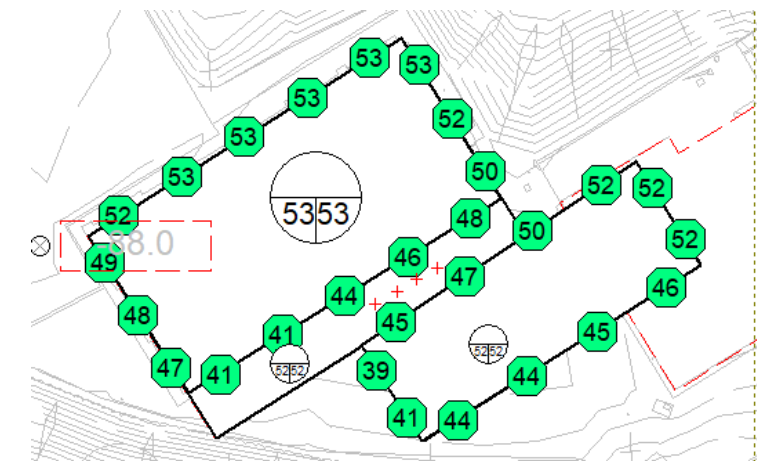


Figure 3.3: Predicted Noise Level - Sports Hall

3.3 Natural Ventilation – Façade Sound Reduction – Noise Levels < 53 dB

3.3.1 Spaces not for Students with Hearing and Communication Difficulties

The most onerous internal ambient noise level target provided by BB93 for non-SEN spaces is ≤ 35 dB $L_{Aeq,30min}$. With the additional natural ventilation relaxation of +5dB, that means the most onerous indoor ambient noise level requirement for non-SEN spaces is 40 dB $L_{Aeq,30min}$.

An open window typically provides between 10 to 15 dBA of sound attenuation. MACH Acoustics typically take 13 dBA as the sound attenuation provided by an open window ventilation strategy. Subtracting this figure from the predicted façade noise level gives a predicted internal noise level.

Noise Level on Façade (dB $L_{Aeq,30min}$)	Typical Open Window Attenuation (dB)	Predicted Indoor Ambient Noise Level (dB $L_{Aeq,30min}$)
53	- 13	40

Table 3.2: Natural Ventilation Feasibility In Standard Teaching Spaces

The spaces on the facades with noise level less than 53 dB can be naturally ventilated through simple openable windows.

3.3.2 Spaces for Students with Hearing and Communication Difficulties, Recording Rooms & Ensemble Rooms

The internal ambient noise level target provided by BB93 for the spaces listed above is ≤ 30 dB $L_{Aeq,30min}$ for daytime. With the additional natural ventilation relaxation of +5dB, that means the most onerous indoor ambient noise level requirement for SEN spaces is 35 dB $L_{Aeq,30min}$.

Based on the drawings BCA-ATK-V1-ZZ-DR-A-041001-P1, BCA-ATK-V1-ZZ-DR-A-041002-P1 and BCA-ATK-V2-ZZ-DR-A-041003-P1, the only spaces listed above are the ALN space on Level 01 which is not exposed to any façade, and ALNCo & ALN res on level 03 where the highest predicted façade noise level is 47 dB.

Noise Level on Façade (dB $L_{Aeq,T}$)	Typical Open Window Attenuation (dB)	Predicted Indoor Ambient Noise Level (dB $L_{Aeq,30min}$)
47	- 13	34

Table 3.3: Natural Ventilation Feasibility In SEN Spaces, Recording Studios & Ensemble Rooms

Therefore, the spaces for students with hearing and communication difficulties can be naturally ventilated through simple openable windows based on their currently proposed locations facing away from the roads.

3.4 Façade Elements

Due to the difference between the external and internal levels relatively low, the table below provides a nominal specification which is seen to be achieved by almost all construction types. Therefore, if required, this specification could be added to the NBS specification.

Element	Sound Reduction Indices, dB (Octave Band Centre Frequency, Hz)						Weighted, dB	
	125	250	500	1000	2000	4000		
Façade Types 1								
Solid Wall	38	37	36	44	49	50	43	R _w
Solid Roof	19	26	36	47	55	47	38	R _w
Glazing	24	20	25	34	37	37	31	R _w

Table 3.4: Minimum sound reduction indices (SRI) for façade elements

3.5 Natural Ventilation - Façade Sound Reduction - Noise Levels > 53 dB

At this stage, it is seen that some spaces facing the Galon Uchaf road and Gwaunfarren road will exceed external noise levels of 53 dB $L_{Aeq,30min}$, MACH is happy to develop ideas as to how to naturally ventilate these spaces.

The following section covers general concepts on the interaction between acoustics and ventilation and how to maximise the effectiveness of ventilation strategies from an acoustic perspective.

4.0 ACOUSTICS AND VENTILATION

4.1 Introduction

A building's ventilation and acoustic strategy are intrinsically linked:

- Vents in façades introduce external noise break-in affecting internal noise levels
- Openings in walls for cross vent can compromise sound insulation and thus privacy internally.
- Ducts used for heat recovery can also have significant negative impact upon privacy between spaces.

This section therefore discusses the acoustics and ventilation strategies, importantly MACH aims to enhance the ventilation strategies, improving the building performance and reducing the cost of ductwork and attenuators.

4.2 Ventilation Types

4.2.1 Summertime Ventilation

Summertime ventilation is driven by cooling requirements; thus, ventilation rates are typically at their highest. Large openings in the façades, possibly cross ventilation or a ducted extract system can be employed. All these elements bring acoustic challenges, however they can all be overcome.

4.2.2 Wintertime Ventilation

Winter ventilation rates are considerably lower than those used for summertime cooling. It is therefore often the case that if the system works with summertime ventilation rates, then it will also work during the less demanding winter time. Hence, the design advice in these sections focuses on summertime cooling.

Heat recovery is an important aspect during wintertime, therefore a method of recirculating the air around the building is important if a central system is used. Again, acoustics plays a role here in that a ducted system is often needed. This needs to be sized to reduced pressure losses, however, large ducts interconnecting spaces, can allow the passage of sound between spaces throughout the building. Thus, care is needed with respect to the acoustic design of such a system, **it is highly likely that cross talk attenuators will be needed where ducts pass through acoustically rated walls.**

To avoid the use of extract ducts, MACH therefore recommends a cross vent type system, that can also be used to enhance cooling in the summertime, see section 4.4 below.

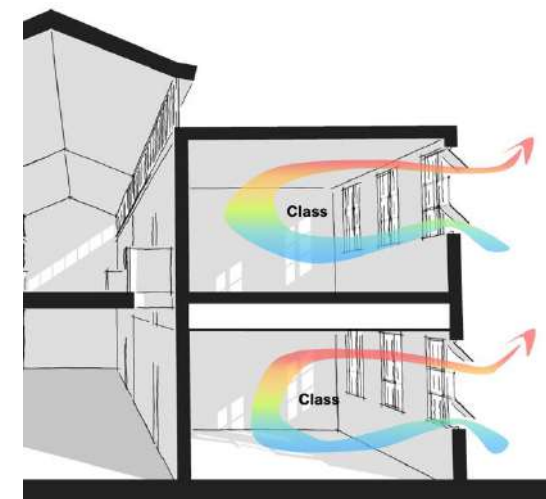
4.2.3 Purge Ventilation

Purge ventilation is used to remove pollutants and/or water vapour using higher rates of ventilation. Since purge ventilation an exceptional form of ventilation (i.e., outside of the day to day ventilation strategy), hence, no acoustic criteria apply to this type of ventilation. Consequently, this type of ventilation is not covered below.

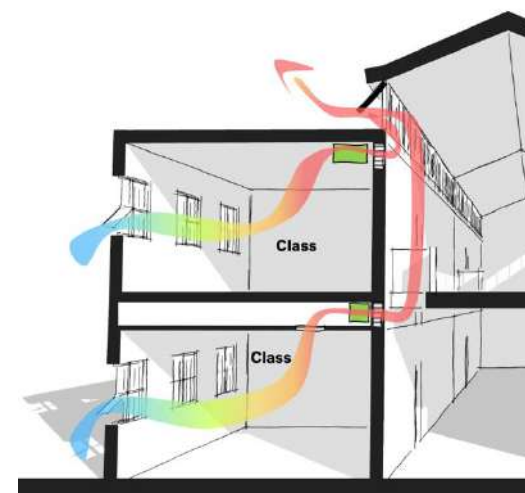
4.3 Summertime - Single Side Ventilation

- A basic form of ventilation
- Low levels of stack effect and thus a low driving force is available to move air.
- A low driving force results in large openings in the façade raising noise break-in challenges even on quiet sites.

Recommended maximum external noise levels of ≈ 52 dBA, with a maximum open area of 1m^2 per classroom.



4.4 Summertime - Cross Ventilation



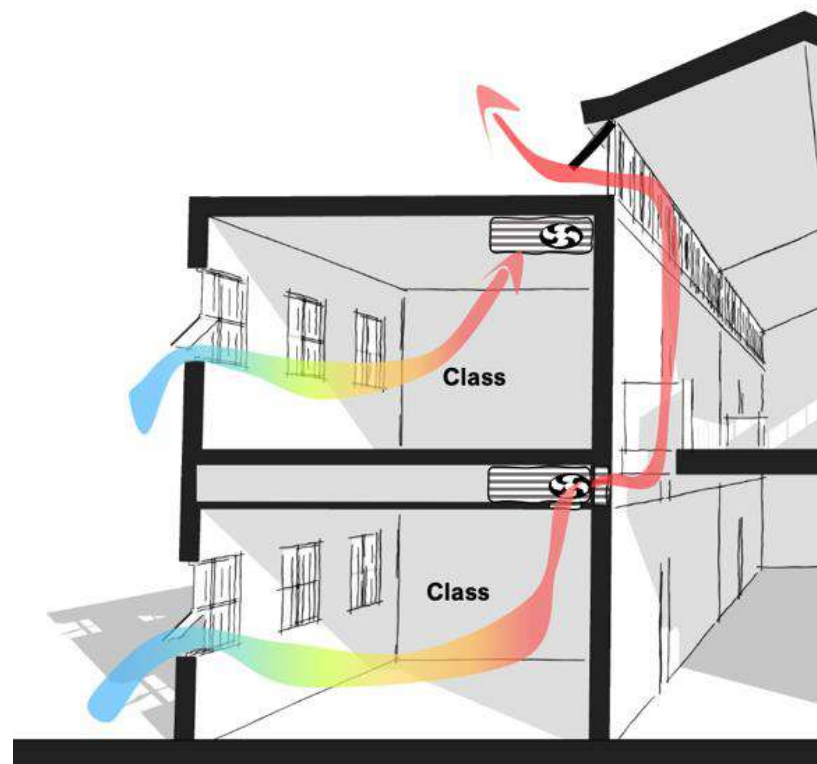
- Cross ventilation takes greater advantage of the stack effect, meaning that air-buoyancy drives the air through the building.
- The increased air force, results in smaller openings required in the façade, and thus less noise ingress.
- Hence, cross vent can be used as a form of noise control on moderately noisy sites.

Recommended maximum external noise levels of ≈ 55 dBA, with a maximum open area of 0.5m^2 per classroom.

Cross-vent can conflict with requirements for acoustic privacy. See Section 4.9 below on crosstalk attenuators.

As illustrated above, the size of the crosstalk attenuators used within cross ventilation can be made smaller if placed above an acoustics ceiling. This is because the acoustic ceiling can be made to act as an acoustic plenum, providing additional acoustic attenuation.

4.5 Summertime – Mechanical Boost Ventilation Local Units



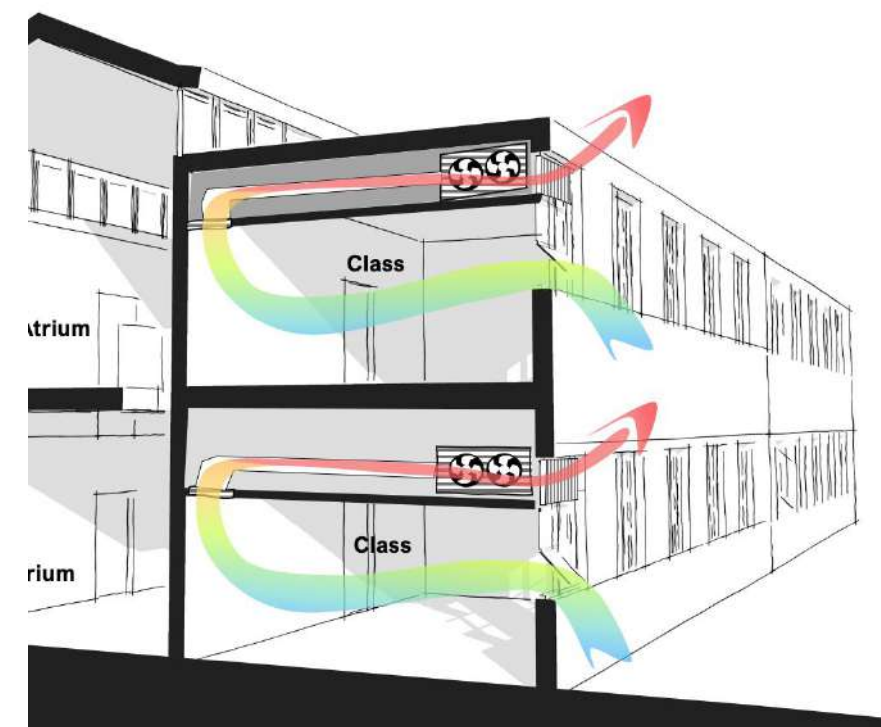
- Boost Ventilation works by mechanically extracting air from teaching spaces.
- The core acoustic advantage of mechanical boost ventilation being that openings in the façade are reduced further, due to the extra driving force.
- With smaller façade openings, noise ingress can be reduced, thus this type of ventilation is suited to noisier sites, while still offering a low energy solution.

Recommended maximum external noise levels of ≈ 58 dBA, with a maximum open area of 0.25m^2 per classroom.

4.6 NVHR Air Flow Strategies

NVHR units are typically small units, mounted at high levels directly to the building façade. NVHR units are used to provide wintertime ventilation, where they incorporate a level of heat recovery. In the summertime, NVHR units can also be used in combination with openable windows to provide ventilation for cooling.

The fan boost means that additional negative pressure can be provided to the room, meaning that façade opening sizes can be reduced, thus increasing the façade sound resistance, and allowing for increased external noise levels whilst still meeting indoor ambient noise limits.



4.7 Mechanical Boost Ventilation Central Units – Summertime Ventilation

The system below shows assisted mechanical extract ventilation to the central circulation space between teaching zones. In this instance, cross vent attenuators are needed since air is drawn out of the classrooms via the central circulation space.

Again, the advantage of this system is reduced façade vent opening sizes, and the subsequent additional acoustic attenuation associated with a smaller opening. Therefore, openable windows can still be used on site with external noise levels in the order of ≈ 58 dBA, where façade opening are less than 0.25m^2 .



4.8 Wintertime Ventilation - MVHR (Mechanical Ventilation with Heat Recovery)

Heating air consumes energy and therefore simply exhausting the heated air from a building includes a lot of wasted energy. The heat recovery process therefore aims to extract as much of this energy as possible for exhausting the stale air.

How this process impacts the acoustic performance of a building needs careful consideration where the acoustic requirements of heat recovery systems are outlined below.

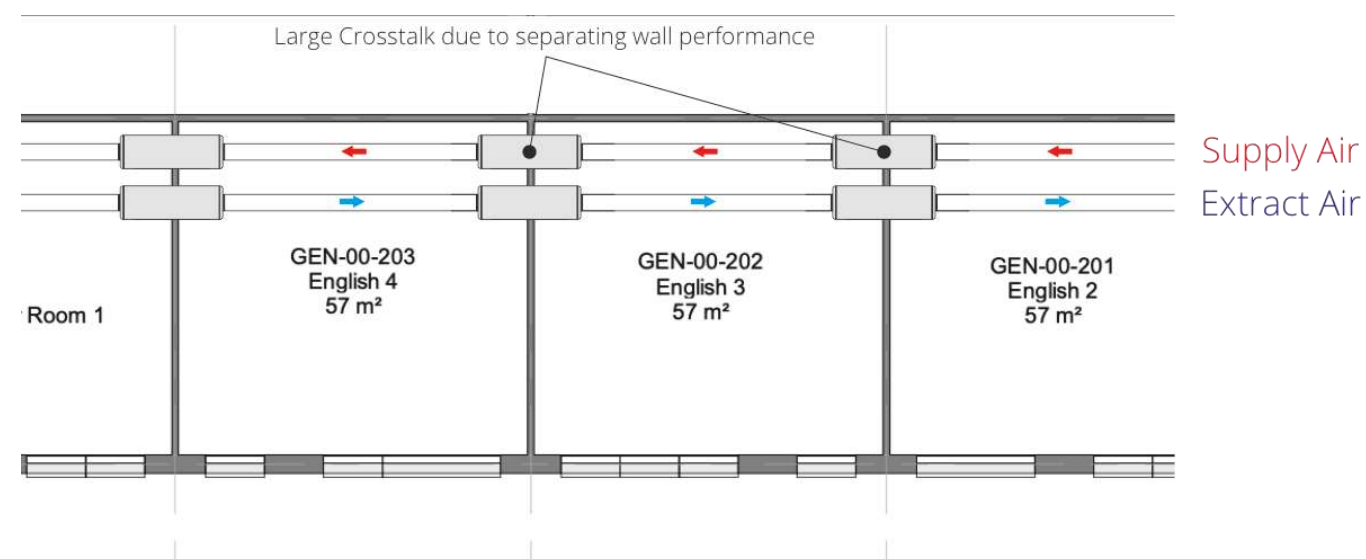
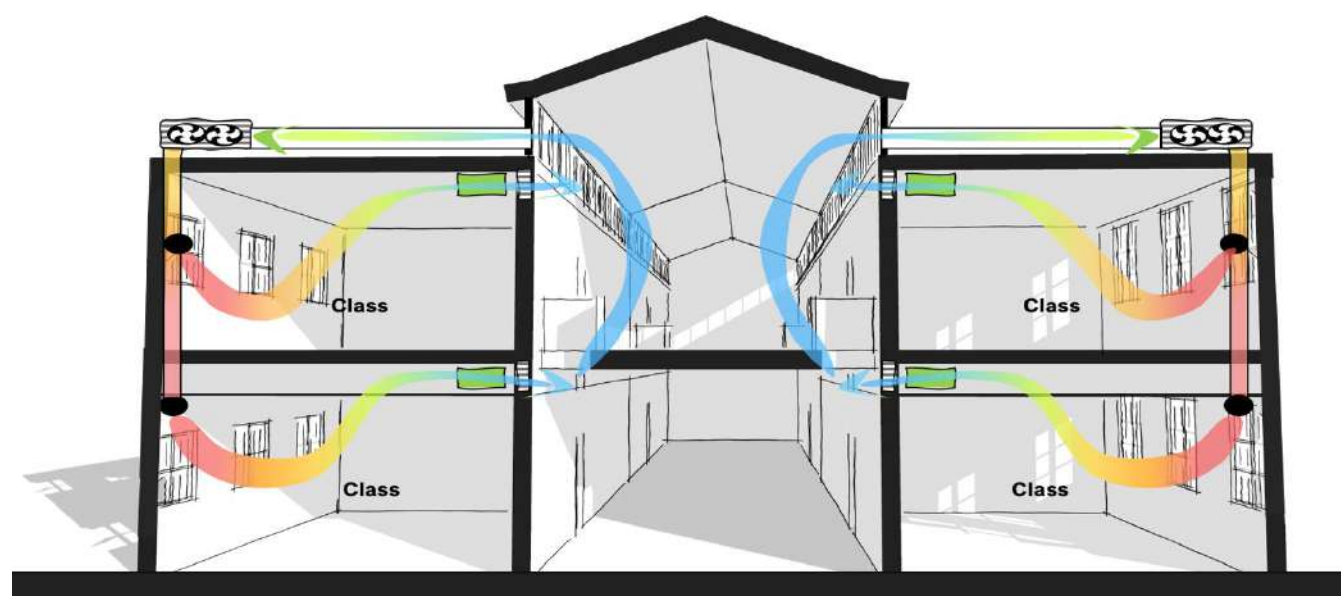


Figure 4.1 Cross Talk Ventilation Supply and Extract Across Separating Partitions

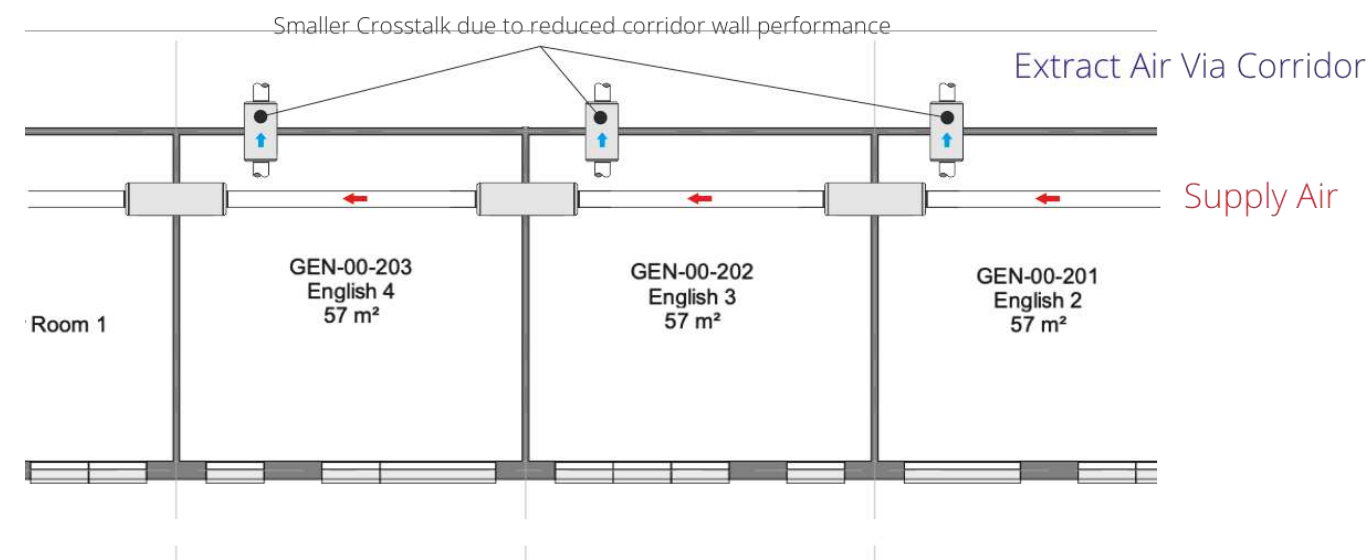


Figure 4.2 Cross Talk Ventilation Extract via Corridor, Supply via Separating Partitions

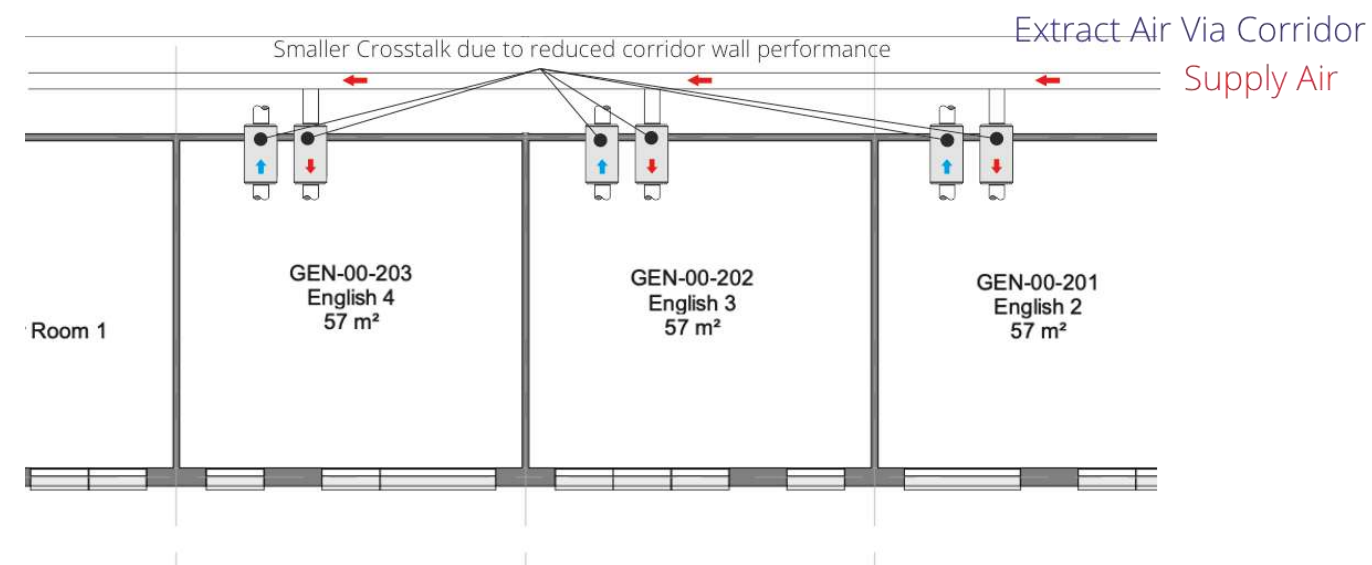


Figure 4.3 Cross Talk Ventilation Supply and Extract Through Corridor Walls

4.9 Cross Ventilators

Natural ventilation works best when undertaken in combination with cross ventilation, this not only improves the airflow through a space, but also reduces the size of the openings required within the façade. As such, improved ventilation is provided with reduced levels of noise ingress.

Another advantage of using cross ventilators in corridor walls is that an air path from teaching spaces via the circulation provides an opportunity for a centralised heat recovery unit.

The drawback of cross ventilation is that a new sound path is introduced, where sound can pass from a corridor space into a sensitive area. As such, a cross talk attenuator is required such to prevent the passage of sound whilst still maintaining the airflow into the corridor spaces.

Two type of cross vent attenuators are therefore provided, where both systems offer a cost effective and easy installation to meet the acoustic and ventilation requirements of some of the system proposed above.

4.9.1 Passivent SoundScoop

The Passivent SoundScoops are a range of air transfer ventilation units which combine exceptional acoustic attenuation with very low airflow resistance. The range comprises the passive SoundScoop and the SoundScoop iAT with *intelligent* airflow technology.

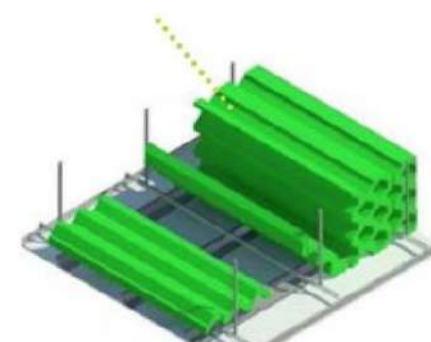


Figure 4.4 Passivent SoundScoop – Cross vent unit for summer and winter time ventilation

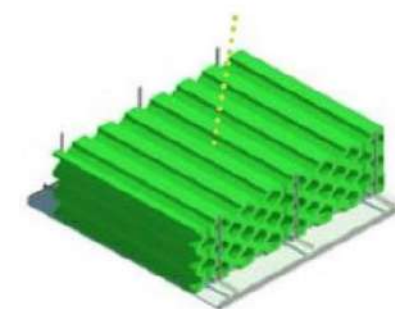
4.9.2 Honeycomb Attenuator

The Honeycomb Attenuator was designed to form a unison between natural ventilation, heat recovery and acoustics, without having to design your building around large bulkheads accommodating big, heavy attenuators.

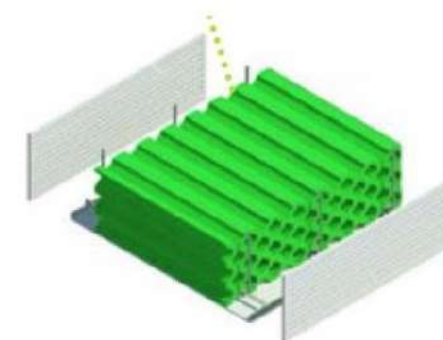
A key advantage of the Honeycomb Attenuator is the ease and simplicity of its installation, where the Honeycomb Attenuator is installed into an MF bulkhead. As shown in the images below, the metal frames of the bulkhead are installed in a conventional manner. Once the metal frame has been constructed, the tessellating foam is arranged into honeycomb pairs by alternating the orientation of adjacent layers, which is then simply placed into the metal frame arrangement. The malleable foam design can be cut on site to fit around building services. Once complete, the MF bulkhead is simply clad with louvres to allow for airflow between teaching spaces and circulation spaces.



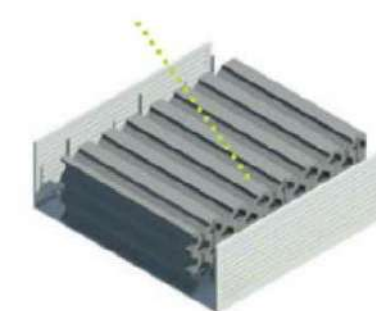
The tessellating foam is horizontally arranged in the bulkhead, forming the honeycomb formation.



Once the honeycomb attenuator is in place, architectural grills are installed. It is important that the bulkhead is well finished, with no voids.



The assembled honeycomb attenuator bulkhead.



The finished bulkhead on the MF5 Tracking System.

Figure 4.5 Honeycomb Attenuator – Installation Process

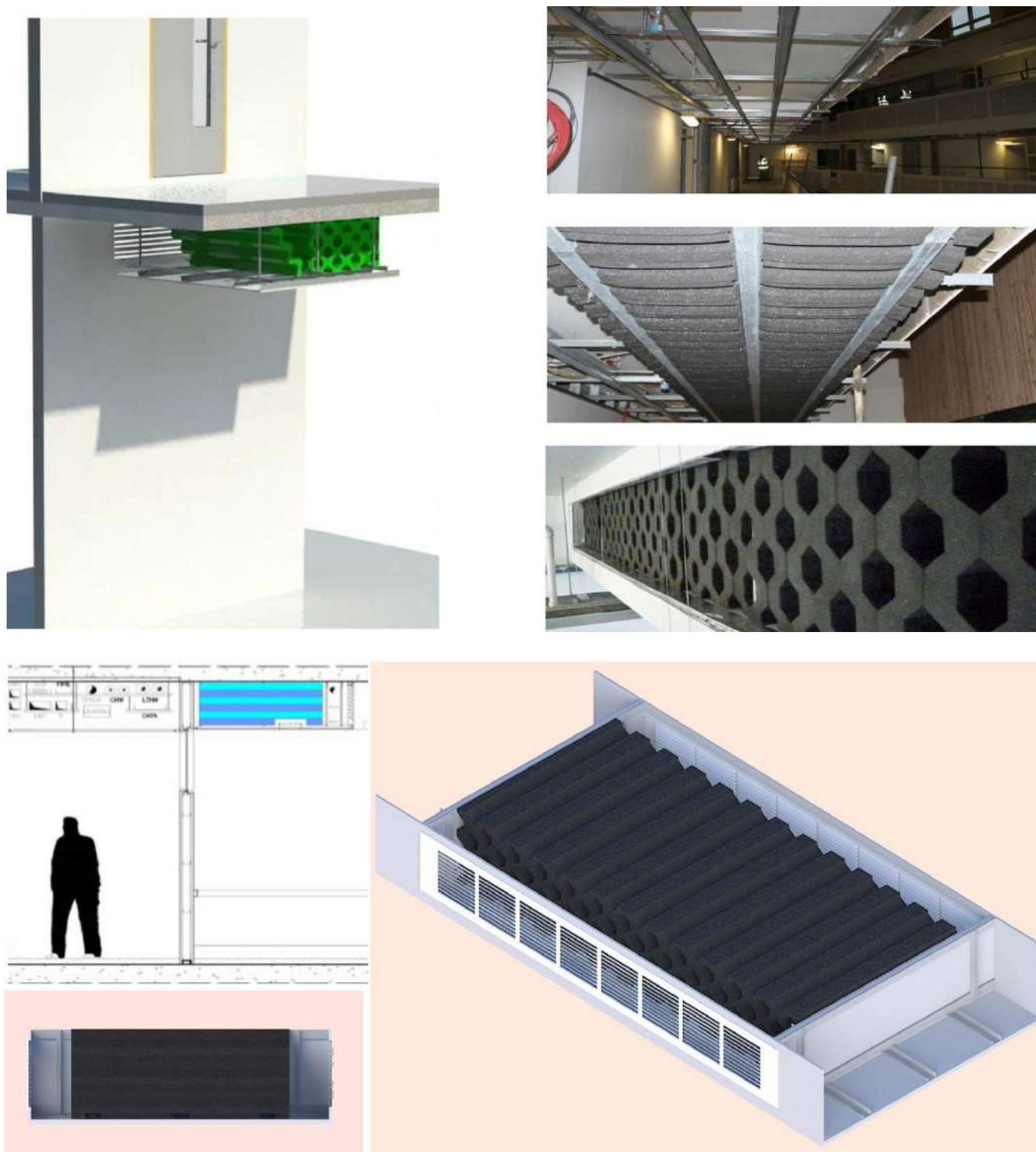


Figure 4.6 Honeycomb Attenuator - Installation Examples

5.0 PLANT NOISE BREAK-OUT

5.1 Criteria

BS 4142:2014 “Methods for rating and assessing industrial and commercial sound” describes a method of determining the level of noise of an industrial nature, together with the procedures for assessing whether the noise in question is likely to give rise to complaints from persons living in the vicinity. As such, an assessment to BS 4142 is typically called for within planning conditions.

The likelihood of complaints in response to a noise depends on various factors. BS 4142 assesses the likelihood of complaints by considering the margin by which the noise in question exceeds the background noise level.

5.2 Design Target

It is currently unknown whether the local authority has specific plant noise limits; therefore, the plant noise rating level limits at the nearest noise sensitive receptor will be set at a later date in accordance with any planning conditions set for this development by the local authority.

This will be assessed against the existing background noise levels, L_{A90} . For the purposes of assessment, MACH Acoustics has used the typical daytime and night-time background noise level based on the L_{A90} histogram data in Appendix B.

Position	Time Period	Assessed Background Noise Level (dB L_{A90})
Fixed	Daytime (07:00 - 23:00)	42
	Night-Time (23:00 - 07:00)	28

Table 5.1: L_{A90} Background Noise Levels for Plant Noise Break-out Assessment

6.0 MUGA NOISE BREAKOUT

6.1 ASSESSMENT METHODOLOGY AND CRITERIA

6.1.1 Planning Policy Wales

Planning Policy Wales (PPW) Edition 10 introduced in December 2018 has the primary objective of ensuring that the planning system contributes towards the delivery of sustainable development and improves the social, economic, environmental and cultural well-being of Wales, as required by the Planning (Wales) Act 2015, the Well-being of Future Generations (Wales) Act 2015 and other key legislation.

PPW is supplemented with a number of Technical Advice Notes (TAN), where TAN 11 covers noise.

6.1.2 Technical Advice Note (TAN) 11: Noise

For noise from recreational and sporting activities, TAN 11 states the following:

“For these activities the local planning authority will have to take account of how frequently the noise will be generated and how disturbing it will be, and balance the enjoyment of the participants against nuisance to other people. Partially open buildings such as stadia may not be in frequent use. Depending on local circumstances and public opinion, local planning authorities may consider it reasonable to permit higher noise emission levels than they would from industrial development, subject to a limit on the hours of use, and the control of noise emissions (including public address systems) during unsocial hours.

A number of sports activities are the subject of Codes of Practice. Some noise generating activities enjoy permitted development rights granted by Part 4 of Schedule 2 to the Town and County Planning (General Permitted Development) Order 1995, and so may not require specific planning permission provided that they occur on a temporary basis. However, this permission may be withdrawn by making a direction under Article 4 of the Order.”

No additional guidance is provided in terms of how to assess the noise impact of recreational and sporting activities, therefore MACH has applied guidance provided within National Planning Policy Guidance – Noise for England as this has been used previously in similar assessments and is considered to be a robust assessment methodology.

6.1.3 National Planning Policy Framework (NPPF)

The National Planning Policy Framework (NPPF) was first introduced in 2012 and has been updated with the latest publication in July 2018. The NPPF provides a framework within which local people and their council can produce their own distinctive local and neighbourhood plans, which reflect the needs and priorities of their communities. There are no significant changes to noise in this latest revision where Paragraph 180 of the NPPF states the following;

“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:

- 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 life⁶⁰
- Identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason;”

[60] See Explanatory Note to the *Noise Policy Statement for England* (Department for Environment, Food & Rural Affairs, 2010)

6.1.4 Noise Policy Statement for England

The aim of the Noise Policy Statement for England (NPSE) is to provide clarity regarding current policies and practices to enable noise management decisions to be made within the wider context, at the most appropriate level, in a cost-effective manner and in a timely fashion. The NPSE applies to all forms of noise including environmental noise, neighbour noise and neighbourhood noise.

Noise Policy Vision: Promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development.

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

Observed Effect Level: In order to fit an objective assessment of “significant adverse” and “adverse” impacts, the NPSE introduced the concept of categorising the impact from noise pollution into different observed effect level categories. This has been expanded further within the more recent document “National Planning Policy Guidance – Noise”.

6.1.5 National Planning Policy Guidance - Noise

Guidance on the interpretation of the policy aims contained within the NPPF is contained within National Planning Policy Guidance (NPPG). The NPPG introduces the concept of a noise exposure hierarchy based on likely average response. The current guidance contained in the NPPG is summarised in the table below. This advice has not changed since the introduction of the 2018 version of the NPPF.

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

Table 6.1: Noise Exposure Hierarchy

6.1.6 Summary of National Guidance

The first two aims of the NPSE and the table from NPPG-Noise (Table 6.1) require that no significant adverse impact should occur and that, where a noise level which falls between a level which represents the lowest observable adverse effect and a level which represents a significant observed adverse effect, then according to the explanatory notes in the statement:

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

Therefore, taking an overview of national policy it is clear that when considering the impact of noise, one must consider the significance of any impact. The presence of an adverse impact in itself is not sufficient to refuse permission.

6.2 Guideline Noise Values

There are a number of guidance documents that contain recommended guideline noise values. These are discussed below.

6.2.1 World Health Organisation: Guidelines on Community Noise (1999)

The World Health Organisation (WHO) document ‘*Guidelines for Community Noise*’, sets out guidance as to noise levels at which there will be an unacceptable impact on the local community. This guidance considers many different types of noise sources. In paragraph 4.3.1 the impact of noise on dwellings is considered.

The WHO guidelines state that to protect the majority of people from being seriously annoyed during the daytime (0700 – 2300), the sound pressure level on balconies, terraces and outdoor living areas should not exceed 55 dB $L_{Aeq,16hour}$ for a steady, continuous noise. To protect the majority of people from being moderately annoyed during the daytime, the outdoor sound pressure level should not exceed 50 dB $L_{Aeq,16hour}$.

6.2.2 World Health Organisation: Environmental Noise Guidelines for the European Region (ENGER) (2018)

This document generally supersedes the 1999 document, although it states that noise level guidance not included within should refer back to the 1999 document. Considering the ENGER document considers noise types of road, rail, aircraft, wind turbines and music. The WHO ENGER is not considered in this assessment.

6.2.3 BS 8233: 2014 Guidance on Sound Insulation and Noise Reduction for Buildings

BS8233:2014 ‘*Guidance on sound insulation and noise reduction for buildings*’, provides guidance for acceptable internal noise levels within and external to residential dwellings. Table 4 within BS8233:2014 states that to achieve desirable living conditions, background noise levels should be 35 dB $L_{Aeq,16hour}$ or less within Living rooms, and 40 dB $L_{Aeq,16hour}$ within dining rooms during the day (07:00 to 23:00). Where Table 4 Note 7, also states where noise levels are 5dB higher, reasonable living conditions can still be achieved.

A partially open window typically provides 15 dB of attenuation therefore applying this to the indoor targets provides us with an external noise levels at the façade;

BS8233:2014 - Desirable internal conditions: Façade noise levels <50dB $L_{Aeq,16hour}$

BS8233:2014 - Reasonable internal conditions: Façade noise levels <55dB $L_{Aeq,16hour}$

6.2.4 Sport England – AGP (2015)

The document “Sport England Design Guidance Note - Artificial Grass Pitches (AGP’s) - Planning Applications - New Guidance 2015”, seeks to provide guidance on assessment methodology and limits that might be set for proposals adjacent to sensitive residential areas. However, this document is not endorsed by either the Institute of Acoustics (I.O.A.) or the Association of Noise Consultants (ANC) and are the opinions of the few select authors of the document. It is not a peer reviewed document. As such there are some elements within this guidance which Mach Acoustics disagrees with, but none the less is a good foundation to begin such an assessment.

6.2.4.1 Sport England Criteria

Sport England suggest that the absolute objective noise level of 50dB $L_{Aeq,1hour}$ is a recommended criterion which is taken from WHO guideline values.

However, the Sports England document also highlights this WHO criteria having been reviewed by the National Physical Laboratory (Ref: CMAM16) which states;

“Exceedance of the WHO guideline values does not necessarily imply significant noise impact and indeed, it may be that significant impacts do not occur until much high levels of noise exposure are reached”

Sports England concludes the above with stating;

“therefore it is not necessarily the case that where these levels are exceeding, the noise will adversely affect nearby residential properties.”

6.2.4.2 MACH Comments on Sport England Criteria

MACH disagrees with the absolute value of 50dB $L_{Aeq,1hour}$, particularly with the time base of 1 hour. WHO is based upon substantial research and advises that where the receptors are residential dwellings the assessed time base of a 16hour daytime period is used (07:00 to 23:00). Using the time base of 16 hours allows for objective methods of time limiting mitigation to be used, otherwise assessing the reduced impact of limiting operation time of a facility would not be possible.

Furthermore, in Section 6.2.5 of this report it is argued that the Low Observable Adverse Effect Level begins somewhere between 50dBA and 55dBA, 16hour. Where there is no clear evidence to suggest it’s 50dB $L_{Aeq,1hour}$. It is therefore considered that the criteria suggested in the Sport England document is very conservative and perhaps incorrect.

6.2.5 Summary of Guideline Values of Absolute Noise Levels

Based upon the core guidance documents above it can be determined there is no clear single value at which LOEAL begins, where it is believed to be somewhere between 50 and 55dB $L_{Aeq,16hour}$. However, to avoid any doubt a value of 50dB $L_{Aeq,16hour}$ is used as a robust approach.

There is no to little guidance to establish at what noise level SOEAL begins for a noise source such as a MUGA. However, reference to the value of 65dB $L_{Aeq,16hour}$ is given within the “HS2 Phase 1 Environmental Statement” which is referred to within the “Institute of Environmental Management & Assessment – Guidelines for Environmental Noise Impact Assessment”. However, one must be careful to use this value since it has been determined in relation to rail noise which we are not dealing with. However, at this time it is the only value MACH are aware of which aims to place an objective noise level on SOEAL.

Receptor Location	Level of Adverse Effect	Sound Pressure level, Daytime (07:00 to 23:00), $L_{Aeq,16hour}$
<u>Residential</u> – Outdoor amenity & 1 meter from Facade	Low Observable Adverse Effect Level (LOAEL)	50 – 55 dB
<u>Residential</u> – Outdoor amenity & 1 meter from Facade	Significant Observable Adverse Effect Level (SOAEL)	65 dB

Table 6.2: Low Observable Adverse Effect Level & Significant Observable Adverse Effect Level Noise Criteria

6.2.6 Assessment Criteria based upon Change in Noise Level

As an additional assessment criterion, Sport England suggest that reviewing the change in noise level due to a new development may be considered where appropriate.

The following table shows the response to changes in noise (known as a semantic scale); this table was included in a draft publication;

“Institute of Acoustics / Institute of Environmental Management & Assessment - Working Party Consultation – Draft (2002)”.

However, this document is superseded by “Institute of Environmental Management & Assessment – Guidelines for Environmental Noise Impact Assessment” (IEMA). The Institute of Acoustics (I.O.A.) is no longer involved with this publication and the table below has been removed as supporting guidance. Instead a very similar table is presented within IEMA - Table 7-14. However, it very clearly warns that it is part of an example from a the “HS2 Phase 1 Environmental Statement”. This type of table is very commonly used within travel infrastructure projects and similarities are found in the Design Manual for Roads & Bridges. It is therefore clear that such an assessment is established for travel infrastructure, however it’s suitability for other noise sources such as a MUGA is unknown, therefore must be used with care.

Change in Equivalent Noise Level, dBA	Subjective Impression	Impact Description
0	No Change	No Impact
0.1 – 3	Imperceptible	Slight
3.1 – 5	Perceptible change in loudness	Slight / Moderate Impact
5.1 – 10	Up to doubling in loudness	Moderate / Substantial Impact
> 10	More than doubling in loudness	Severe Impact

Table 6.3: Categorising the Significance of the Basic Noise Change

6.3 Noise Modelling

The software used was “CadnaA” noise prediction software, the leading software for calculation, presentation, assessment, and prediction of environmental noise.

Noise modelling has allowed for the assessment of noise from the MUGA.

6.3.1 Sport England Calibration of Model

The SE document determines the typical noise generated by an Artificial Grass Pitch (AGP) by having conducted measurements of 9 varying sports sessions on different pitches. Sports included, football, rugby, hockey, ranging from 12 to 50 players on the pitch. The measurements identify that typical noise generated by such a pitch is 58 dBL_{Aeq,1hour} at 10 metres from the centre of the side line.

Our calculation models were calibrated to 58 dBL_{Aeq,1hour} at 10 metres from the centre of the side line.



Figure 6.1: CadnaA noise mapping

6.3.2 Source Noise Levels

Source Noise Levels have been set based on advice in Sports England's guide 'Artificial Grass Pitch (AGP) Acoustics – Planning Implications.' The area sources within the modelling have therefore been calibrated to these noise levels.

The noise generated by the MUGA has been calibrated to 58 dB at 10 metres away from the side-line.

Noise Source	Noise Level	Source	Calibration Ground Type	Impact Assessment Ground Type
Existing Rugby Pitch	58 dB(A) at 10m	Sport England	Soft	Soft
MUGAs	58 dB(A) at 10m	Sport England	Soft	Hard
2 x 3G Pitches	58 dB(A) at 10m	Sport England	Soft	Hard

Table 6.4: Representative noise levels

6.4 Nearest Noise Sensitive Receivers

Locations that are considered to be noise sensitive receivers which will be assessed within this exercise are listed below.

Noise Source	Nearest Sensitive Receivers	Reference
Existing Rugby Pitch	Residential dwellings on Galon Uchaf Rd	1
MUGAs	3 – 9 Gwaunfarren Grove	2
2 x 3G Pitches to be flood lit	1-6 Seward Street	3
	1 Cyres St	4
	29 & 30 Bishops Grove	5
	10-16 Tygwyn St	6

Table 6.5: Nearest noise sensitive receivers



Figure 6.2: Assessed MUGAs (Red) and Nearest Sensitive Receivers (Blue)

6.5 Predicted Noise Levels

6.5.1 Base Model – No Mitigation – 16 Hour Assessment

Figure 6.3 shows the predicted noise contribution from the MUGAs when active having used the 58dB $L_{Aeq,1hour}$ at 10 metre calibration value in Sport England.



Figure 6.3: Predicted max noise levels around the MUGAs

6.6 Correction for Hours of Operation

The MUGA and 3G pitches will be used by the school in addition to community use, where the assumed operation times of these uses are presented below. The rugby pitch is understood to only be used by the school so has been assessed with reduced operational hours

Noise Source	Operational Hours	Duration
Existing Rugby Pitch	09:00 to 17:00	8 hours
MUGAs	07:00 to 21:00	14 hours
2 x 3G Pitches to be flood lit	07:00 to 21:00	14 hours

Table 6.6: Operational Hours

The table below presents 5 main residential receiver locations where the predicted noise contribution for the MUGA and tennis court from Figure 6.3 are presented. In addition, a correction for the reduction of noise level due to the 8 and 12 hours of operation within a 16 hour day period is applied to identify what the noise contribution from the MUGA and Tennis courts will be in a full 16 hour day period (07:00 to 23:00).

The correction applied is presented in the calculation below.

$$\text{Correction} = 10\log\left(\frac{8\text{hours}}{16\text{hours}}\right) = -3.0\text{dB}$$

$$\text{Correction} = 10\log\left(\frac{12\text{hours}}{16\text{hours}}\right) = -1.2\text{dB}$$

Noise Contribution from MUGA & Tennis Court, $L_{Aeq,1hour}$, calculating to equivalent 16hour period						
	Residential dwellings on Galon Uchaf Rd	7&8 Gwaunfarren Grove	1-6 Seward Street	1 Cyres St	10-16 Tygwyn St	29 & 30 Bishops Grove
MUGA & Pitches $L_{Aeq,12hours}$	54 dB	59	54	54	54	55
Correction for 16hour day	-3.0 dB	-3.0 dB	-1.2 dB	-1.2 dB	-1.2 dB	-1.2 dB
Total $L_{Aeq,16hour}$	51.0 dB	56.0 dB	52.8 dB	52.8 dB	52.8 dB	53.8 dB

Table 6.7: MUGA and Tennis Court noise contribution over a 16hour period

6.7 Assessment

The table below presents the assessment at the 3 NSR locations.

Location	MUGA Noise Contribution dB L _{Aeq,16hour}	Existing Ambient noise level (dBA)	Predicted Ambient Noise Level L _{Aeq,16hour}	Absolute Objective Assessment
Residential dwellings on Galon Uchaf Rd	51	52	55	Low Observable Adverse Effect
7&8 Gwaunfarren Grove	56	52	57	Slightly Above Low Observable Adverse Effect
1-6 Seward Street	53	49	54	Low Observable Adverse Effect
1 Cyres St	53	44	54	Low Observable Adverse Effect
10-16 Tygwyn St	53	42	53	Low Observable Adverse Effect
29 &30 Bishops Grove	54	40	54	Low Observable Adverse Effect

Table 6.8: Summary of combined predicted ambient noise levels

As the table shows, the predicted ambient noise levels range from 53 to 57 dB at the worst affected noise sensitive receivers assessed with only 1 receiver predicted to be above 55 dB when the pitches are in use,

This indicates that whilst some receivers are likely to be subject to a noticeable increase in noise levels, the absolute noise levels are not likely to be significant.

However, the presence of an adverse impact in itself is not sufficient to refuse permission and the wider benefit to the local community should be considered, as highlighted in the NPSE, discussed in Section 6.1.4 of this report.

6.8 Good Design

In order promote good design, the Sport England provides the following guidance which should be followed:

- Where included, acoustic barriers should be built outside the perimeter fence, so they are protected from being hit by balls and generating impact sounds.
- Weldmesh fencing is commonly used to enclose the AGP and the panels should be securely clamped with resilient fixings to avoid vibrations.
- Sheet metal advertising signs can make a clattering noise when hit by a hockey ball and these should be avoided in proximity to the playing surface or replaced by soft vinyl signs.
- Lightweight ‘substitutes’ shelters also have the potential to clatter when hit by hockey balls and should be located within recesses to reduce the risk of impact.
- People tend to congregate around the entrance to the AGP and as such, it is advisable that the entrance and access route should be located away from nearby housing where possible.
- Some users may act in an unreasonable manner resulting in higher noise levels and a management/monitoring plan could be developed to effectively respond to specific incidents.
- Similarly, the restriction of use to authorised groups could be appropriate in many situations.

APPENDIX A - ENVIRONMENTAL NOISE SURVEY

To establish the existing environmental noise levels on site, a noise survey was conducted between 11:35 on the 07/07/2022 and 14:15 on the 08/07/2022.

This site assessment was undertaken by Jason Bradshaw of MACH Group.

A.1 Site Description

The proposed development is located at the existing site of Bishop Hedley Catholic High School, in a dense residential area of Merthyr Tydfil. Traffic from the surrounding roads are the main contributors to the noise climate on site.

A.1.1 Subjective Noise Climate (On-site)

Noise Type	Noise Characteristics	Sources
Dominant	A primary contributor of noise levels on the site.	Road traffic from Galon Uchaf Rd & Gwaunfarren Rd.
Other Noise Contributions	Contributors to the remainder of the noise climate on site.	Residential areas

Table A.1 - Subjective Summary of the Noise Sources

A.1.2 Non-Representative Noise Sources

During the survey, no noise events occurred which would be deemed as atypical of the site location.

A.2 All Measurement Locations

To help with the understanding of the site and measurement locations all the measurement positions are presented on the map. Photos of the locations in situ are in the following sections.

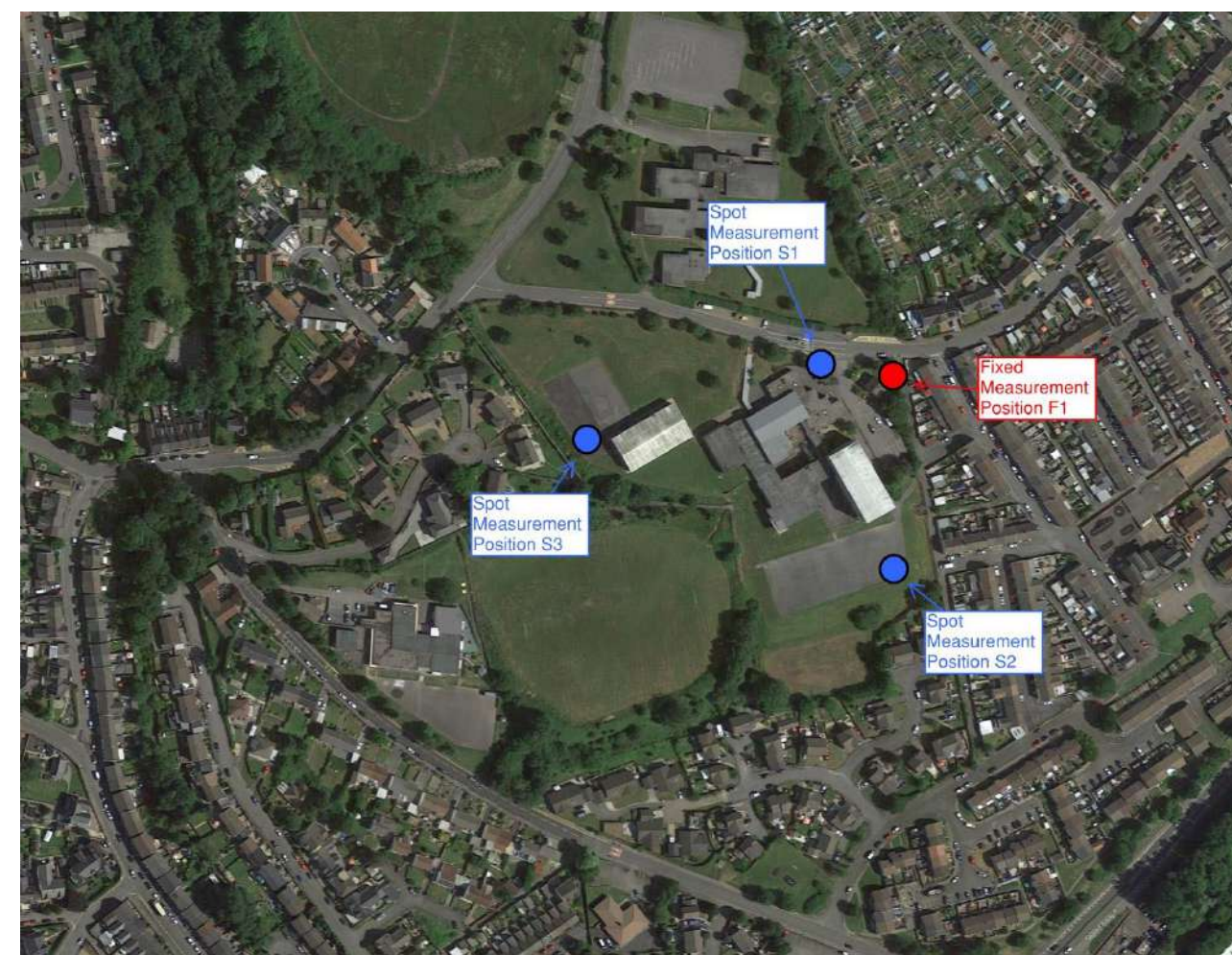


Figure A.1 - All Measurement Locations on a Map

A.3 Fixed Measurement

A fixed microphone position was used to record noise levels between 11:35 on the 07/07/2022 and 14:15 on the 08/07/2022, where the fixed long-term meter was set to measure consecutive 'A' weighted 5-minute time samples. Measurements have been taken in free field conditions.

To help with the understanding of the site and the measurement locations, the figures below present the location of the microphone position(s) in situ. The results of the environmental noise survey are provided within section A.3.2.

A.3.1 Fixed measurement Location – F1



Figure A.2 - Fixed Measurement location in situ

A.3.2 Fixed Measurement Results

The following graph presents the noise levels recorded over the measurement period at the fixed location (F1).

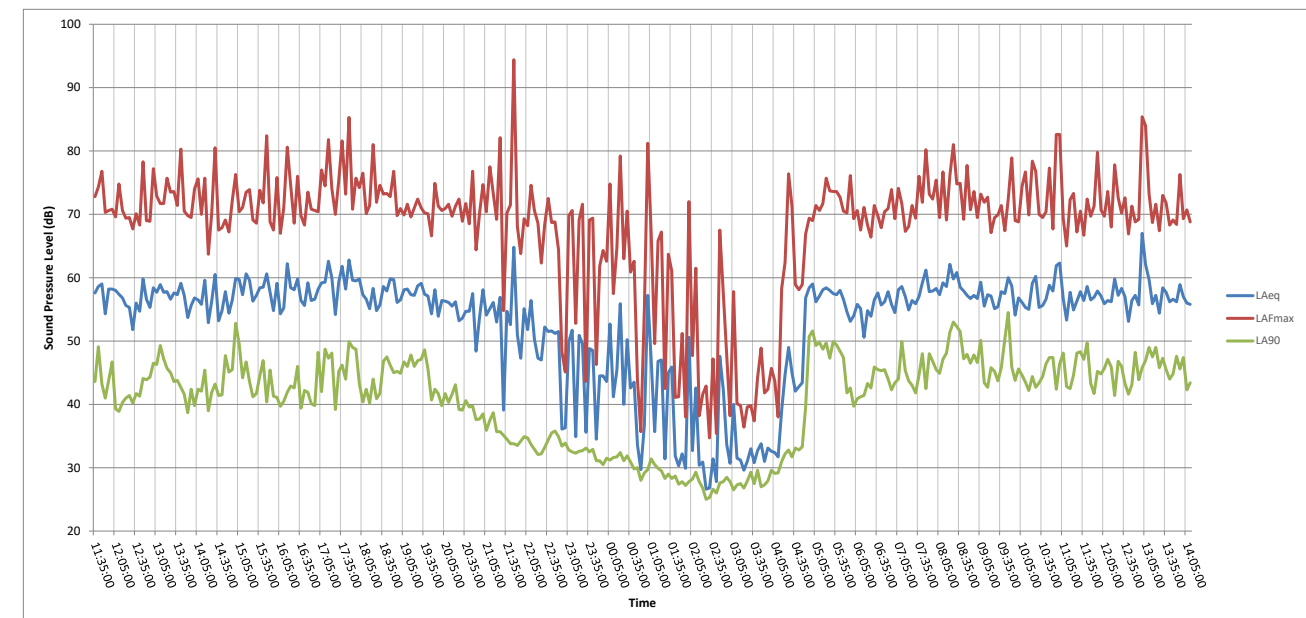


Figure A.3 - Sound Pressure Level at fixed location, F1

A.4 Spot Measurements

Spot measurements help quantify existing noise levels at different points around the site. The figures below present the location of the microphone position(s) in situ. The results of the measured levels at these location(s) are also presented in section A.5.

A.4.1 Spot Measurement - S1

This spot measurement was taken between 09:25 – 09:40 on 07/07/2022 and 08:40 – 09:00 on 08/07/2022 in free field conditions.



Figure A.4- Spot Measurement S1 in situ

A.4.2 Spot Measurement – S2

This spot measurement was taken between 09:20 – 09:30 and 14:35 – 14:45 on 08/07/2022 in free field conditions.



Figure A.5 - Spot Measurement S2 in situ

A.4.3 Spot Measurement – S3

This spot measurement was taken between 09:35 – 09:45 and 13:50 – 14:00 on 08/07/2022 in free field conditions.



Figure A.6 - Spot Measurement S3 in situ

A.5 All Spot Measurement Results

The L_{Aeq} , L_{AFmax} , and L_{A90} levels measured from all spot measurements are shown in Table A.2 below.

Spot	Date	Start	End	Duration	$L_{Aeq, T}$ (dB)	L_{AFmax}	L_{A90}
S1 (1)	07/07/2022	09:25	09:40	15 mins	61.5	84.5	46.3
S1 (2)	08/07/2022	08:40	09:00	20 mins	60.1	74.7	42.4
S2 (1)	08/07/2022	09:20	09:30	10 mins	42.8	57.5	38.1
S2 (2)	08/07/2022	14:35	14:45	10 mins	44.8	58.4	41.0
S3 (1)	08/07/2022	09:35	09:45	10 mins	50.2	69.7	40.7
S3 (2)	08/07/2022	13:50	14:00	10 mins	51.7	66.8	46.0

Table A.2 - Spot Measurement Results Table

A.6 Measurement Equipment

Item	Serial No.	Last Calibration	Certificate No.	Calibration Due
NTI Precision Sound Analyser XL2 TA	A2A-08695-E0	Dec-21	167866	Dec-23
NTI Pre-amplifier MA220	7182	Dec-21	167866	Dec-23
NTI Microphone Capsule MC230	9173	Dec-21	167862	Dec-23
NTI Precision Sound Analyser XL2 TA	A2A-15207-E0	Nov-20	149145	Nov-22
NTI Pre-amplifier MA220	7856	Nov-20	149145	Nov-22
NTI Microphone Capsule MC230A	A16182	Nov-20	149115	Nov-22
Svantek Acoustic Calibrator SV31	32527	Dec-21	167864	Dec-22

Table A.3 - Measurement Equipment

A.7 Meteorological Conditions

Data Taken from: <https://www.timeanddate.com/weather/>

Date	Time (hh:mm)	Temperature (High / Low) (°C)	Humidity (%)	Pressure (hPa)	Wind Speed (m/s)	Wind Direction	Conditions
07/07/2022	06:00	20/15	75	1030	3.6	N	Overcast
	12:00	21/19	70	1032	4.2	WSW	Mild
	18:00	20/16	86	1032	4.2	W	Cool
08/07/2022	00:00	17/14	88	1033	1.7	NNE	Cool
	06:00	22/16	74	1034	2.8	WNW	Mild

Table A.4 - Meteorological Conditions

APPENDIX B - LA90 HISTOGRAM

