
Hyde Road, Manchester

Acoustic Design Strategy Report – Stage 2

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1 Introduction

This report outlines the acoustic design strategy for the proposed Hyde Road School development and includes the following:

- Proposed acoustic design criteria;
- Summary of environmental noise surveys & noise prediction modelling undertaken;
- Stage 2 acoustic design strategy, including ventilation strategy, airborne sound insulation, impact sound insulation, control of reverberation and the control of noise from building services;
- Outline measures to protect the amenity of nearby noise sensitive receptors.

2 Design Guidance

The proposed acoustic requirements are provided on the basis of the project Brief documents, relevant British Standards, Codes of Practices & best practice professional guidance publications, and Local Authority requirements. The most relevant guidance referenced when developing the criteria is Building Bulletin 93.

2.1 Building Bulletin 93 ‘Acoustic Design of Schools’, 2015 (BB93)

Acoustic conditions in educational buildings are controlled by Part E of the Building Regulations, Schools Premises Regulations and the Independent School Standards. Premises are also subject to the Equality Act.

Requirement E4 of the Building Regulations applies to teaching and learning spaces and states *‘each room or other space in a school building shall be designed and constructed in such a way that it has the acoustic conditions and the insulation against disturbance by noise appropriate to its use.’*.

The normal way of satisfying Requirement E4 of the Building Regulations, School Premises Regulations and Independent School Standards is to meet the values for sound insulation, reverberation time and internal ambient noise level given in BB93 ‘Acoustic Design of Schools: Performance Standards’.

2.2 Other relevant guidance

Other relevant guidance documents referenced when developing the acoustic criteria include:

- British Standard 4142: 2014 (BS 4142) ‘Method for rating and assessing industrial and commercial sound’.
- Manchester City Council ‘Planning & Noise Technical Guidance’, 2015
- Sports England Artificial Grass Pitch (AGP) Acoustics - Planning Implications 2015

2.2.1 BREEAM New Construction

It is understood that BREEAM very good is targeted for the scheme; the following acoustic related credits are available:

Hea 05 – 3 credits available relating to sound insulation, reverberation time, and internal ambient noise levels.

Pol 05 – 1 credit available relating to control of external plant noise emissions

The criteria outlined in this report address the available credits; at this stage it is recommended that a total of 3 credits are targeted (2 Hea / 1 Pol).

3 Proposed Criteria

The acoustic design criteria are proposed on the basis of the BB93 performance requirements. In accordance with BB93, where criteria are specified for ancillary spaces (i.e. non-teaching/learning) these are provided for guidance only.

3.1 Internal Ambient Noise Levels (IANL)

The IANL criteria are proposed in accordance with BB93 guidance.

The IANL includes noise contributions from:

- External sources outside the building premises (including, but not limited to, noise from road, rail and air traffic, industrial and commercial premises).
- Building services (e.g. ventilation systems, plant, drainage).
- Actuator and damper noise.

The IANL excludes contributions from:

- Activity noise within the building premises (e.g. noise from staff, students and equipment within the building).
- Rain noise - however lightweight roofs and any roof glazing should be designed to provide suitable control of rain noise reverberant sound pressure level in a space.
- Emergency plant such as electrical generators.

A summary of the proposed IANL criteria is provided in the table below for the main room types within the scheme.

Table 1: BB93 Internal ambient noise level criteria

Room Type	IANL upper limit, dB L _{Aeq,T}
General Classrooms	35
Offices, Staff workrooms, Meeting/Conference room, Interview room	40
Student Support	30
Intervention spaces	35
Kitchen	50
Science Labs, Res Materials, Food Tech, Product Design, Art, ICT, Library, resource/breakout areas	40
Main Hall, Drama	35
Sports Hall, Activity Studio	40
Music: Recording, practice, classroom	35
Circulation spaces, corridors, stairwells	45
Toilets	50
Changing Rooms	50

Room Type	IANL upper limit, dB L _{Aeq,T}
Dining Room	45

3.1.1 Building services and indoor ambient noise levels

The IANL criteria in teaching and learning spaces should be achieved when the ventilation systems are operating in their normal condition; when providing intermittent boost ventilation; and when operating to control summertime overheating (as defined in BB93). A ventilation strategy may use one type of system for normal operation, and different types of system for intermittent boost and summertime overheating. The tolerances on the IANL limits applicable to the project are defined in Table 2 of BB93 for different types of ventilation system under different operating conditions (refer Appendix II).

For example, for typical teaching spaces under ‘normal operation’ a +5dB relaxation to the IANL is allowed where natural ventilation is provided. Where hybrid/mixed mode ventilation is provided a +5dB relaxation is allowed to the overall IANL, although no relaxation is allowed to the mechanical noise component.

3.2 Rain Noise

Rain impact noise should not result in undue disturbance in internal spaces. Indoor ambient noise levels during ‘heavy’ rainfall (as defined in BS EN ISO 140-18) should not exceed the stated IANL criteria by more than 25 dB(A).

3.3 Airborne Sound Insulation

The sound insulation is assessed in terms of standardised level difference D_{nT} in accordance with BS EN ISO 16283-1 and the results are weighted and expressed as a single-number quantity, D_{nT,w} in accordance with BS EN ISO 717-1. For the purposes of the assessment, the reference reverberation time T may be either:

- the upper limit for the mid-frequency reverberation time, T_{mf,max} for the receiving room type (see Table 6) applied to all one-third octave bands from 100 Hz to 3.15 kHz;

Or, for commissioning measurements:

- the measured reverberation time in each one third octave band, provided that the mid-frequency reverberation time, T_{mf}, complies with the requirements in Table 6 and is representative of the reverberation times expected when the room is finished and unfurnished.

Table 3 presents the proposed minimum standards for airborne sound insulation required between rooms. These values are defined by the activity noise in the source room and the noise tolerance in the receiving room as given in Table 2. The design assessment of D_{nT,w} between two rooms should be carried out in both directions.

Table 2: Proposed room classification for sound insulation requirements

Room Type	Noise Generation (Source Room)	Noise Tolerance (Receiving Room)
General Classrooms	Average	Medium
Music Classroom & Practice & Recording	Very High	Low
Offices, Staff workrooms, Meeting/Conference rooms, Interview room	Low	Medium
Student Support	Average	Medium
Intervention spaces	High	Low
Kitchen	High	High
Science Labs, Res Materials, Food Tech, Product Design, Art, ICT, Library, resource/breakout areas	Average	Medium
Resistant Materials	High	High
Main Hall, Drama	High	Low
Sports Hall, Activity Studio	High	Medium
Dedicated unoccupied circulation spaces	Average	Medium
Corridors, stairwells	Average	High
Toilets, Changing Rooms	Average	High
Dining Room	High	High

Table 3: BB93 performance standards for airborne sound insulation between spaces

Minimum D _{nT,w} (dB)		Activity noise in source room			
		Low	Average	High	Very High
Noise tolerance in receiving room	High	N/A	35	45	50
	Medium	40	45	50	55
	Low	45	50	55	55

The following additional airborne sound insulation criteria clarifications should be noted:

The airborne sound insulation criteria proposed in the tables above does not apply where a noise sensitive room is linked with another occupied room via an interconnecting door for operational or safety purposes. Where this occurs, a doorset should be used with a rating of at least R_w 35 dB. The surrounding wall (including any glazing) should have a composite sound insulation rating of at least R_w 45 dB.

The airborne sound insulation criteria proposed in the tables above does not apply where a moveable wall is present between adjacent spaces. Where a moveable wall is present between a teaching or learning space and an adjacent space, the D_{nT,w} between the spaces should be at least 40 dB.

BB93 Sound insulation requirements for meeting rooms only achieve a basic level of acoustic privacy as defined in BS8233.

It should also be noted that with reference to music room performance standards BB93 states ‘*the levels of sound insulation between some music rooms may not be sufficient for particularly noisy activities and timetabling/management will need to be considered... if timetabling/management or isolation is not possible the levels of sound insulation should be increased*’

3.3.1 Airborne sound insulation between dedicated circulation spaces and adjacent rooms

The objective is to attenuate airborne sound transmitted between dedicated circulation spaces and other spaces used by students, for the purpose of minimising disturbance to teaching and learning spaces. This applies where the separating construction contains doors and/or glazed elements.

The following table presents the proposed minimum permissible airborne sound insulation for a separating corridor wall that contains doors and/or glazed elements.

Table 4: BB93 performance standards for airborne sound insulation between dedicated circulation spaces and adjacent spaces separated by a wall containing a door and/or glazing

Type of space	Minimum R_w dB		Minimum $D_{n,e,w}$ - 10LgN dB for transfer grilles, where N is the number of grilles
	Composite R_w of wall and glazing with no ventilator	Doorset	
Music Class, Practice & recording; Main Hall, Drama, Student support	45	35	37
All other rooms used for teaching or learning	40	30	32

3.4 Impact Sound Insulation of floors

The objective is to control impact sound (e.g. from footsteps and movement of furniture) transmitted into spaces via the floor above.

It is proposed to base the impact sound insulation criteria on BB93 2015 requirements.

Table 5 presents the proposed impact sound insulation performance criteria. Values in the table are the maximum permissible weighted standardised impact sound pressure level $L'_{nT,w}$ dB. This is measured in accordance with BS EN ISO 140-7 and rated in accordance with BS EN ISO 717-2.

For the purposes of the assessment the reference reverberation time T may be either:

- the upper limit for the mid-frequency reverberation time, $T_{mf,max}$ for the receiving room type (see Table 6) applied to all one-third octave bands from 100 Hz to 3.15 kHz;

or, for commissioning measurements:

- the measured reverberation time in each third octave band, provided that the mid-frequency reverberation time, T_{mf} , complies with the requirements in Table 6 and is representative of the reverberation times expected when the room is finished and unfurnished.

The impact sound insulation performance requirements do not apply where the upper room is normally unoccupied (e.g. store rooms and plant rooms).

Table 5: BB93 performance standards for impact sound insulation of floors

Type of room (receiving room)	Maximum impact sound pressure level $L'_{nT,w}$
General Classrooms	60
Music Classroom, Recording & Practice rooms	55
Offices, Staff workrooms	65
Meeting/Conference room, Interview room	60
Student support	55
Intervention spaces	60
Kitchen, Changing, Toilets	65
Science Labs, Res Materials, Food Tech, Product Design, Art, ICT, Library, resource/breakout areas	60
Main Hall, Drama, Activity studio	60
Dining Room	65

3.5 Room Acoustics

The objective is to provide suitable reverberation times (RTs) for:

- Clear communication of speech between teacher and student;
- Clear communication between students.

The proposed reverberation time criteria is presented in the following table. The reverberation time is quoted in terms of the mid-frequency reverberation time, T_{mf} which is the arithmetic average of the reverberation times in the 500 Hz, 1 kHz and 2 kHz octave bands, or the arithmetic average of the reverberation times in the one-third octave bands from 400 Hz to 2.5 kHz. These values are for rooms that are finished, furnished for normal use, but unoccupied.

Table 6: BB93 performance standards for reverberation time

Type of room (receiving room)	T_{mf} seconds
General Classrooms	≤ 0.8

Type of room (receiving room)	T_{mf} seconds
Music Classroom	≤ 1.0
Music Practice rooms <30m ³	≤ 0.6
Recording	≤ 0.5
Offices, Staff workrooms	≤ 1.0
Meeting/Conference room, Interview room	≤ 0.8
Student Support	$\leq 0.4^1$
Intervention	≤ 0.6
Kitchen	≤ 1.5
Science Labs, Food, Art, ICT, Resistant Materials	≤ 0.8
Library	≤ 1.0
Resource/breakout areas (including within circulation)	≤ 1.2
Main Hall	$0.8 - 1.2^2$
Drama	≤ 1.0
Sports Hall	$\leq 2.0^3$
Activity Studio	$\leq 1.5^3$
Corridors, circulation, stairwells	ADE: refer Section 3.5.2
Toilets, Changing Rooms	≤ 1.5
Dining Room	≤ 1.0

¹ For this room type, $T < 0.4$ averaged from 125Hz – 4kHz octave band centre frequencies and $T < 0.6s$ in every octave band in this range.

² Reverberation time should be within the indicated range, including the values given.

³ Refer Section 3.5.1

3.5.1 Sports Hall & Activity Studio

In accordance with BB93, compliance with the reverberation time criteria for the Sports Hall and Activity studio can be demonstrated by execution of a design in accordance with the ‘Acoustics of Schools: a Design Guide’.

3.5.2 Sound absorption in enclosed corridors and stairwells which provide direct access to teaching and study spaces

The objective is to absorb sound in corridors and stairwells so that it does not interfere with teaching and study activities in adjacent rooms. This requirement applies to any corridor and stairwell which provides direct access to teaching and study spaces. The amount of absorption required should be calculated according to Approved Document E, Section 7. This describes two calculation methods, A and B, for controlling reverberation in the common internal parts of domestic buildings. Either of these methods can be used to determine the amount of absorption in corridors and stairwells. Note this criteria does not apply to ‘occupied’ circulation spaces proposed to include break-out/resource areas.

3.6 External Noise Emission Criteria

Based on recent project experience for similar high school schemes which have been granted planning permission by Manchester City Council (MCC) Local Planning

Authority (LPA), suitable noise level criteria and assessment methodology for the proposed are outlined below.

3.6.1 Plant noise limits at nearest existing noise sensitive receptors

Manchester City Council's 'Planning & Noise – Technical Guidance (December 2015)' document, states that the following criteria be met in relation to noise and vibration from fixed plant / equipment:

*'Any noise assessment needs to consider not only the overall level of noise emitted but also its particular characteristics. The noise assessment should be based on BS 4142: 2014 and any application for fixed plant, equipment or machinery must demonstrate that:
Externally mounted ancillary plant, equipment and servicing shall be selected and/or acoustically treated in accordance with a scheme designed so as to achieve a rating level of 5dB (L_{Aeq}) below the typical background (L_{A90}) level at the nearest noise sensitive location.'*

It is worth noting that the above criteria corresponds with BREEAM Pol 05 (NC 2018) requirements.

3.6.2 Plant noise limits at the facades of the proposed development building

When determining attenuation requirements in relation to external noise limits for fixed plant, it should be noted that plant must also be selected and/or designed to ensure that the external noise emissions generated at the facades/roof of the proposed development will not cause the proposed internal noise level criteria to be exceeded.

3.6.3 Sports pitch noise limits at nearest existing noise sensitive receptors

Criteria for noise egress from the proposed football pitches and multi-use games areas has been based on Sports England guidance as detailed below.

In the guidance document '*Sports England Artificial Grass Pitch (AGP) Acoustics - Planning Implications 2015*', Sports England discuss the analysis of sports noise from a typical artificial grass pitch (AGP) so not to disturb nearby existing residents.

The guidance does not state any definitive criteria but instead cites the World Health Organisation (WHO) '*Guidelines for Community Noise*' (1999) which states:

"...the noise level outside a residential property during the daytime about 1 metre from façades of living spaces should not exceed 50 dB L_{Aeq}."

The Sports England guidance goes on to state an alternative assessment methodology may be appropriate in some circumstances, such as when existing noise levels in the area are high. For example, it suggests that in some circumstances it would be appropriate to conclude that an increase in the ambient noise climate

(L_{Aeq, 1 hour}) of less than 3 decibels would result in a "slight impact", and that this assessment conclusion *"generally conforms with the withdrawn Planning Policy Guidance Document 24 statement that a change of 3 dB(A) is the minimum perceptible under normal conditions."*

The guidance goes on to state that:

"Where noise from the new source (the AGP) does not exceed the existing noise climate the increase in noise will be no more than 3 decibels. This is the minimum that can normally be perceived. The noise levels are both to be measured using the L_{Aeq} parameter over the same time period, T."

The following criteria has been proposed for the sports pitches based on the above AGP guidance:

- Where the measured pre-development ambient noise level (dB L_{Aeq,T}) at the nearest noise sensitive receptor is below 50 dB, the noise level resulting from noise from the proposed sports pitches (dB L_{Aeq, 1 hour}) should not exceed a level of 50dB at the receptor, as per WHO guidelines.
- Where the measured pre-development ambient noise level (dB L_{Aeq, 1 hour}) at the nearest noise sensitive receptor is greater than 50 dB, the noise level resulting from noise from the proposed sports pitches (dB L_{Aeq, 1 hour}) should not exceed the measured pre-development ambient noise level at the receptor.

3.7 Room assignment clarifications

- The Student Support space at ground floor has been assigned the BB93 'Teaching space intended specifically for students with special hearing and communication needs', i.e. to provide acoustic conditions suitable for a SEN teaching space.
- Music recording space at ground floor has been assigned the BB93 'Control room - for recording' classification, rather than the 'recording studio' classification.
- Intervention spaces have been assigned the BB93 'SEN calming' classification.

4 Environmental Noise Survey

An environmental noise survey has been undertaken on the 3rd November 2020 at various positions on and in the vicinity of the proposed site.

The data obtained has been used in order to assist in the following:

- Establishing the baseline pre-development noise climate at the site;
- Informing a 3D acoustic noise model of the site for the purposes of assessment of the required sound insulation of the building fabric, including glazing and ventilation; and
- Establishing noise limit criteria for external noise emissions associated with the project from noise associated with the use of the outdoor MUGA pitches as well as noise associated with external plant equipment associated with the development.

4.1 Survey Methodology

A series of manned short-term measurements were undertaken during ‘worst-case’ daytime and night-time periods. The approximate site boundary & measurement positions are presented in Figure 1 and were selected in order to:

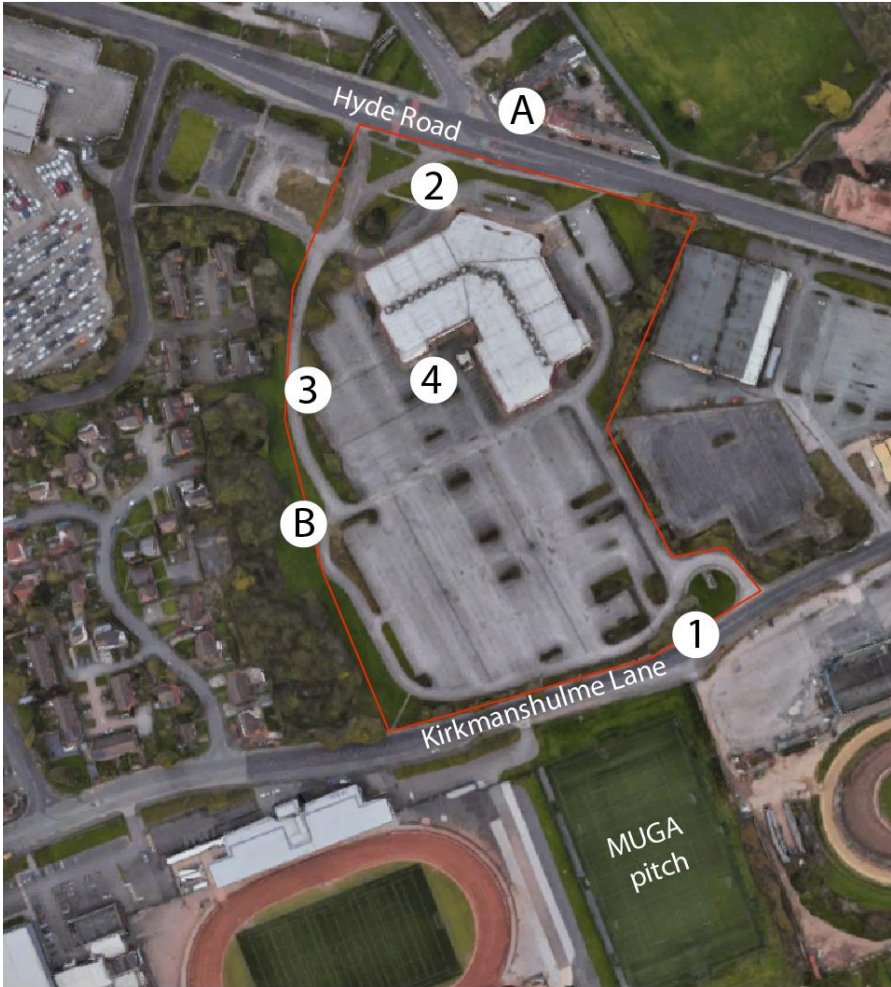
- Measure worst-case, i.e. noisiest, daytime (0800 – 1000 hours) noise levels in order to inform a 3D noise model of the site used to establish the required sound insulation of the building fabric, including glazing and ventilation (Positions 1 – 4);
- Provide data representative of the worst-case, i.e. quietest, daytime (1000 – 1100 hours) noise levels at the nearest or most exposed residential noise sensitive receptors for the purposes of informing external noise emission limits to maintain residential amenity (Positions A – B).

Weather conditions during the survey were dry with low wind speeds varying below 2m/s in a westerly direction, temperatures varying around 6°C and cloud cover of approximately 70%.

The instrumentation used for measurements consisted of 1no. B&K 2260 sound level meter which was calibrated prior to commencing and upon completion of the survey, with no significant drift in sensitivity observed.

At each position octave band and A-weighted fast response levels were recorded for a comprehensive suite of noise level metrics. All readings were taken at a height of 1.5m above local ground level in free-field conditions. Measurements were carried out by Gavin Stevenson MIOA.

Figure 1: Approximate survey measurement positions (red line shows approximate site boundary)



4.1.1 On-Site Noise Climate

The ambient noise climate at the site is dominated by road traffic noise primarily from vehicles travelling on Hyde Road and Kirkmanshulme Lane.

The background noise climate at the site is dominated by distant road traffic noise, primarily from the south-west of the site.

Other noise sources contributing to the ambient noise climate on site included noise from people in the local area, as well as low level noise from the MUGA pitches located to the south of the proposed development site.

It is noted that the speedway stadium to the south of the proposed site does not have the necessary permissions to operate for speedway during typical school opening hours (weekdays); other associated mixed-use external games/sports areas are not expected to cause an increase to the surveyed levels at the proposed development site based on a review of the submitted noise reports associated with the speedway complex’s prior planning application.

4.1.2 Results

A summary of the measured results are presented in Table 7 table below.

Table 7: Summary of noise measurement results

Measurement Position	Start Time (hh:mm)	Duration (mm:ss)	L _{Aeq,5mins} Range (dB)	L _{AFmax,5mins} Range (dB)	L _{A90,5mins} Range (dB)
1	08:00	10:00	62 - 63	74 - 76	49
1	09:00	10:00	64 - 65	77 - 80	50
2	08:15	10:00	67	76	55 - 56
2	09:15	10:00	66 - 67	75	57
3	08:28	10:00	51 - 52	64 - 66	49
3	09:27	10:00	51	60 - 67	49
4	08:40	10:00	52 - 54	56 - 62	51 - 52
4	09:40	10:00	53 - 54	59 - 60	51 - 52
A	10:05	15:00	70 - 71	81 - 83	57 - 58
B	10:24	15:00	48 - 49	55 - 59	47

5 Site Analysis

5.1 Noise Prediction Modelling

5.1.1 Predicted façade noise levels

3D noise prediction models have been created to establish predicted façade noise levels for the worst-case daytime periods.

A baseline model has been developed to enable validation of the model to the environmental noise survey data collected, accounting for the main sources of noise on-site (i.e. road traffic noise). A further model has then been developed, based on the current proposed layout for the site to predict the levels incident upon the façades of the development.

The following figures present the predicted noise contours across the proposed site at 1.5m AGL caused by dominant traffic noise sources. Noise levels at the façades of the proposed buildings are predicted to range between 50 – 64 dBA.

Figure 2: Noise modelling screen shot presenting indicative dBA noise contour at 1.5m AGL

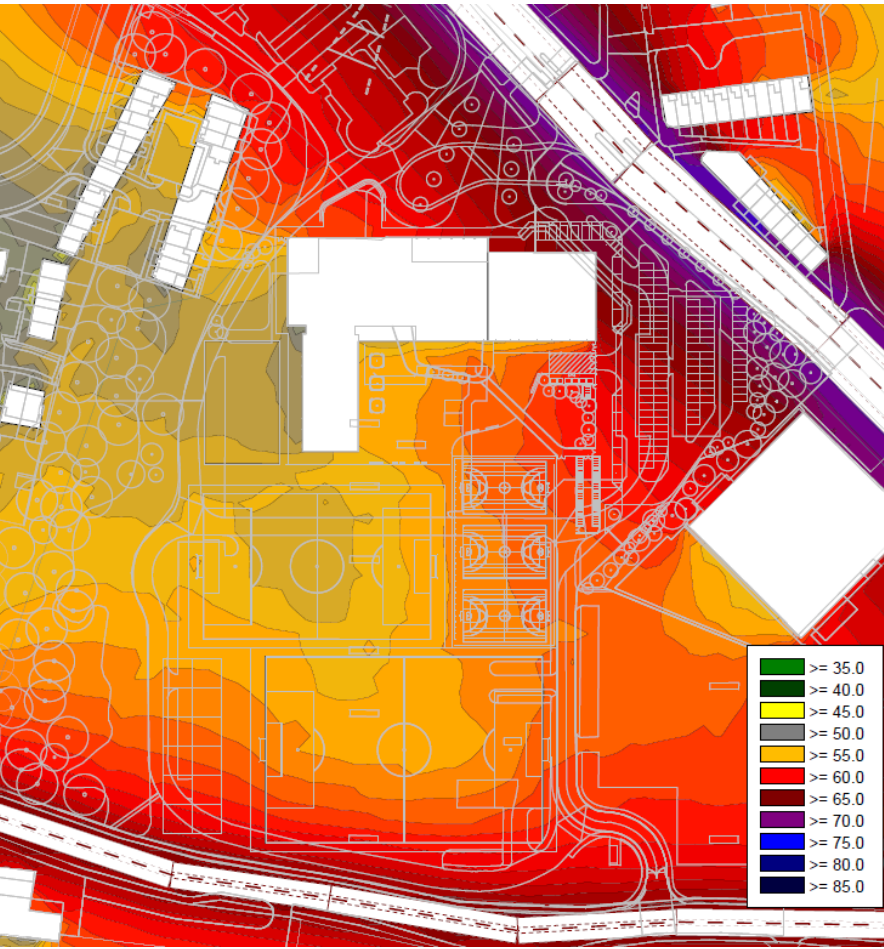
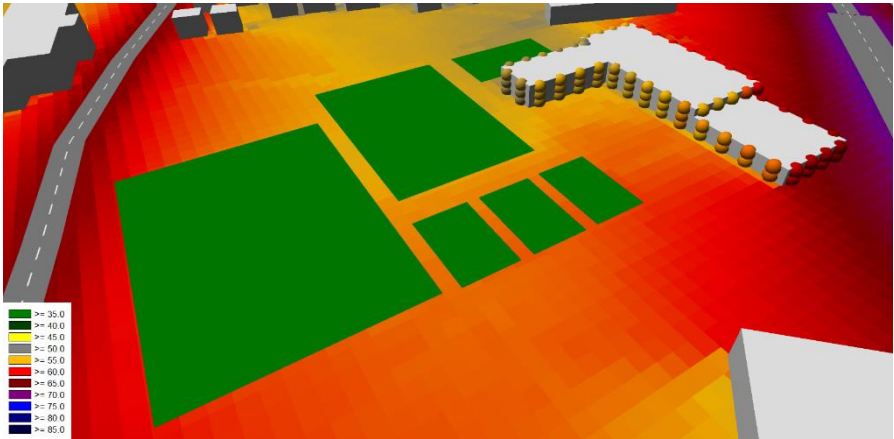


Figure 3: Indicative noise modelling 3D view screen shot.



The results of the noise survey and modelling exercise have been used to assess the required sound insulation of the building fabric, including glazing and ventilation.

Using environmental noise survey data from on-site measurements and results of environmental noise modelling, the proposed building envelope strategy for the new buildings associated with the proposed development can be assessed against criteria detailed in Section 3.

Based on the measured noise levels for worst-case, i.e. noisiest, daytime break-in noise at the locations of the proposed building façades, conventional external window, wall and roof build-ups and ventilation strategies will enable compliance with the criteria detailed in Section 3; further detail is provided in Section 6.

5.1.2 Acoustic modelling of sports pitch noise break-out

A 3D noise prediction model of the site has been created within CadnaA acoustic modelling software in order to determine predicted noise levels at the nearest or most exposed noise sensitive receptors due to noise generated from the proposed new sports pitches in line with guidance detailed in Sports England Artificial Grass Pitch (AGP) Acoustics - Planning Implications 2015.

A baseline model has been developed to enable calibration of the football pitch noise within the model to the following noise levels stated within Sports England guidance as representative of a typical AGP:

- “A typical free-field noise level of 58 dB $L_{Aeq}(1\text{ hour})$ at a distance of 10 metres (m) from the sideline halfway marking”
- “When a site is in an open location, noise levels of 50 dB $L_{Aeq}(1\text{ hour})$ can be achieved at a distance of 40 m [from the sideline halfway marking] at 1.5 m above the ground”

Sports England guidance expresses that the dominant noise sources from typical AGP sports sessions, including football and hockey, are shouting voices. These noise sources are most accurately modelled as point sources.

The following assumptions were made for a typical sports session (football) in order to calibrate the model:

- The “on-time” of each player shouting will be a maximum of approximately 10% of the match duration.
- The majority of shouting activity occurs within the centre third of the pitch and from the goalkeepers.
- Typically, a football match on the larger pitches has 2 coaching staff shouting from the side-lines with a maximum “on-time” of 25% of the match duration.

The baseline model which adopted the above assumptions was found to calibrate well with the Sport England stated representative sports pitch noise levels.

Following the baseline calibration model, a further model has been developed based on the proposed external layouts for the scheme, and the assumptions outlined were applied to each of the sports pitch zones to provide a realistic worst case assessment of each zone being used simultaneously.

In the first instance, the preliminary modelling undertaken at this stage has assumed that all pitches are in use concurrently with the intention of allowing unrestricted use for the school.

Figure 4 presents an indicative contour plot from the CadnaA modelling of the site, which indicates the predicted noise levels at the façades of the nearest noise sensitive receptors due to sports pitch noise only, when all pitches are in use at the same time.

Based on the modelling exercise undertaken, the noise levels presented in Table 8 are predicted due to noise egress from the proposed football pitches, when all pitches are in use at the same time, at the nearest/most exposed noise sensitive receptors:

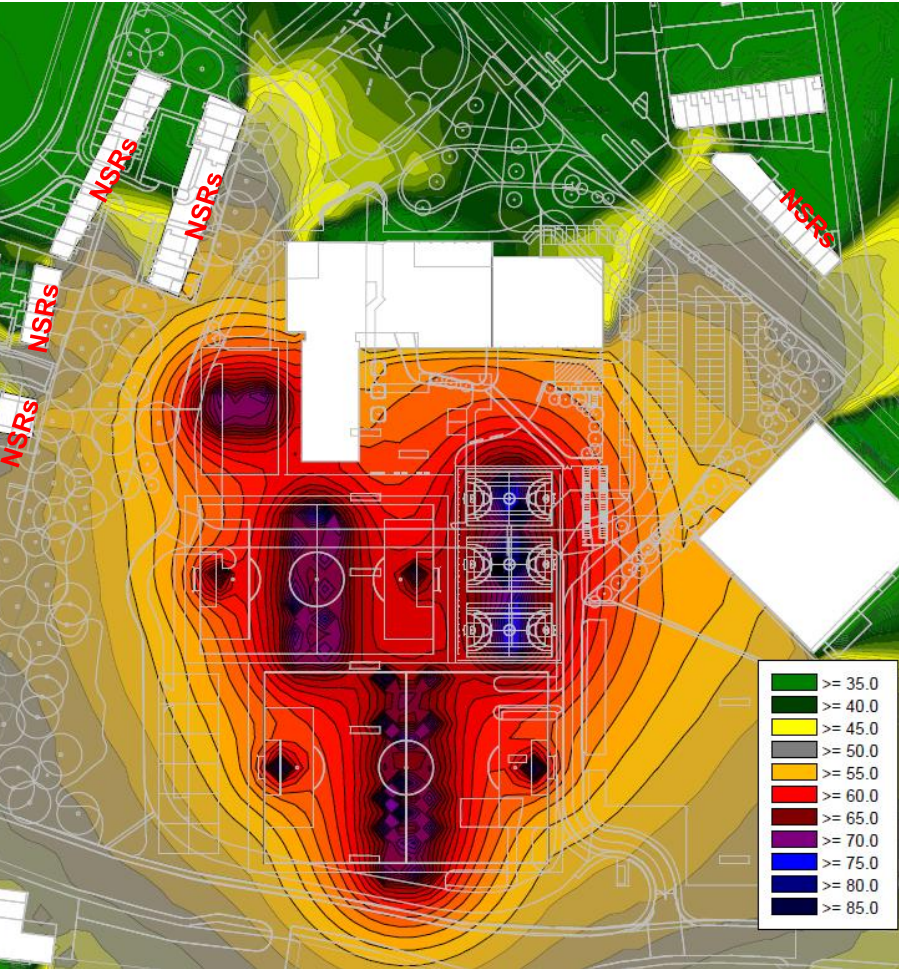
Table 8: Noise levels at nearest noise sensitive receptors (NSR) due to noise egress from the proposed sports pitches, when all pitches are in use at the same time

Noise sensitive receptor (NSR) location	Proposed noise level criteria at façade of NSR (dBA $L_{Aeq,1hour}$) due to noise egress from the proposed sports pitches	CadnaA predicted noise level at façade of NSR (dBA $L_{Aeq,1hour}$) due to noise egress from the proposed sports pitches
Residential properties off Hyde Road to the north-east of the proposed site	≤ 71	50
Residential properties to the west of the proposed site	≤ 50	52

As can be seen from the results in Table 8, noise levels at the façades of the nearest noise sensitive receptors due to noise egress from the proposed sports pitches achieve the proposed noise level criteria for the residential NSR to the north-east of

the site, but do not achieve the criteria for those residential NSR to the west of the proposed site, when assuming all pitches are in concurrent use.

Figure 4: CadnaA modelling screen shot presenting indicative noise contour grid at 1.5m AGL for sports pitch noise only, when all pitches are in use at the same time. Levels quoted in key are L_{Aeq} (dB)



5.1.2.1 Preliminary mitigation recommendations

At this stage, in order to meet the LPA's accepted criteria relating to sports pitch noise breakout based on the current modelled scenario, the following strategy is recommended for consideration by the design team and stakeholders:

- Acoustic screening: providing effective acoustic screening in the form of a suitably specified noise barrier (e.g. close-board timber fencing, or proprietary noise barrier) which breaks line of sight between the nearest sports pitch (north west) and the nearby residential dwellings. Indicative modelling suggests that a noise barrier of approximately 2.7m height above local ground level, close to the boundary of the north west sports pitch would sufficiently reduce sports pitch noise at the nearest noise sensitive receptors.
- It is worth noting that a development site boundary treatment would be expected to require prohibitive height to provide effective acoustic screening to upper floor windows of the nearby residences.

As an alternative to providing a physical barrier, a revised modelling approach could be implemented to reflect an operational management plan, i.e. a reduction in the number of external sports pitches which are proposed for concurrent use could potentially allow the LPA criteria to be achieved; this would require engagement and agreement with the proposed users/stakeholders.

6 Building Envelope

Noise break-in calculations have been undertaken to determine minimum performance values for building envelope elements on the basis of the measured and predicted noise levels established through the noise survey and modelling exercise.

6.1 Ventilation strategy

Where a natural ventilation strategy is adopted, it is typically the façade openings which are the weakest sound insulating element in the building envelope.

On the basis of the predicted noise levels incident upon the façades of the development, meeting normal ventilation requirements to teaching spaces via opening windows is not feasible from a noise perspective.

The proposed ventilation strategy has been developed by the engineers, and is understood to consist of:

- Generally, perimeter hybrid mixed mode systems of natural/forced ventilation to teaching spaces where possible.
- Elsewhere, mechanical ventilation in the form of centralised mechanical ventilation, and dedicated extract ventilation will be provided.

During Stage 2 a preliminary appraisal has been undertaken of the initial ventilation strategy proposals; in summary:

- Typical classroom hybrid/NVHR system to meet the defined 'normal' operation requirements is expected to be suitable where proposed across the scheme - assuming a basic level of attenuation from outside to inside provided by the units ($D_{n,e,w}$ 37 dB)
- Natural ventilation via openable windows for summertime cooling as defined in BB93, i.e. limited to hottest 200hrs, will be capable of achieving the BB93 internal noise limits.
- Outside of the hottest 200hrs, natural ventilation by means of openable windows would not allow the relevant internal noise limits to be achieved in classrooms, and an alternative strategy should be implemented.
- It is worth noting that the hybrid NVHR units also need to meet the BB93 mechanical noise limits internally. This is straight forward for typical duties, but has the potential to present issues if much higher duties are needed while still being defined as 'normal operation', e.g. for cooling outside the 200hrs. This will be effectively mitigated with appropriate equipment selections or attenuation measures as the design progresses.
- Where mechanically ventilated, internal ambient noise level criteria will be achieved through the design and selection of M&E equipment and systems serving the spaces.

6.2 External façade

On the basis of the preliminary break-in calculations undertaken during Stage 2 it is recommended that the external windows should provide a minimum airborne sound insulation performance of R_{w+ctr} 27 dB & R_w 31 dB.

It should be noted that the above performance requirement relates to the overall window assembly (i.e. glazing and framework). This level of performance can be achieved with typical thermal double glazed window units.

At this stage it is recommended that the external wall cladding system should provide a minimum airborne sound insulation performance of R_{w+ctr} 35 dB & R_w 45 dB.

Based on the strip sections provided by the architects, the proposed external wall build-ups incorporate either a brick outer skin or a lightweight cladding panel system, cavity with insulation (lightweight systems: PIR type; brick system: mineral wool), sheathing board, uninsulated SFS zone, and double layer plasterboard internal lining.

These build-ups are expected to be capable of providing a suitable level of airborne sound insulation performance.

The above specifications should be refined as the design progresses on the basis of the finalised glazing/solid wall extents, external wall build-ups, and ventilation proposals.

6.2.1 Flanking sound insulation implications

Where partitions between noise sensitive adjacencies return to external walls, it should be noted that the cladding system should be suitably detailed to minimise flanking between spaces (refer Section 8)

The internal plasterboard lining should be built from slab to soffit and discontinued at junctions with internal walls. In addition, the external wall cavities at the junction with the separating walls and floors should be sealed, e.g. using a proprietary mineral fibre cavity stop with a minimum density of 100 kg/m³.

In some areas an enhanced internal lining is anticipated to be required to suitably control flanking paths to allow BB93 sound insulation criteria to be achieved.

At this stage it is recommended that an allowance is made for an additional minimum of 25mm mineral wool insulation (density range 10 -45 kg/m³) to the proposed build-up, within the SFS/internal plasterboard lining cavity to music & SEN teaching spaces.

6.3 External Roof

At this stage it is recommended that the proposed lightweight roof system should provide a minimum airborne sound insulation performance of R_{w+ctr} 32 dB & R_w 35 dB to meet typical BB93 internal noise requirements.

It is understood that a lightweight roof system is proposed incorporating a structural profiled metal deck; this level of performance can typically be achieved where sufficient mineral wool insulation is incorporated into the build-up. Should PIR type insulation be proposed it may be necessary to include an acoustic mass barrier layer into the build-up to meet the relevant airborne and rain noise insulation performance requirements.

To the sports hall it is recommended that an allowance is made for a perforated roof deck with mineral fibre profile inserts to achieve a minimum Class C acoustic absorption performance (e.g. perforated D100 profile with mineral fibre inserts, refer Section 9.3.1.1)

6.3.1 Rain impact noise insulation requirements

It is recommended that to control rain impact noise within BB93 limits, the proposed lightweight roofing should provide the following performance:

- General Classrooms $\leq L_{IA}$ 52 dB,
- Science Labs $\leq L_{IA}$ 57 dB
- Offices $\leq L_{IA}$ 56 dB,
- Sports Hall $\leq L_{IA}$ 58 dB,

6.3.2 Flanking sound insulation implications

At upper level classrooms where extents of the soffit are proposed to be exposed where accommodating NVHR units / daylighting requirements, it may be necessary to enhance the flanking performance of the roof construction; this would be anticipated to take the form of a sound insulating plasterboard lining to the underside of the roof build-up, discontinuous between rooms, with mineral wool insulation in the cavity. Where suspended ceilings are present with no open transfer grilles, flanking sound insulation can be provided through a suitable specification of ceiling tile. These requirements should be developed in the subsequent design stages.

7 Internal Sound Insulation

7.1 Internal Walls

The preliminary minimum airborne sound insulation performance requirements for the internal partitions within the scheme in order to meet the BB93 in-situ $D_{nT,w}$ performance standards have been provided to the design team and are presented in Figure 5 and Figure 6. Calculations have been undertaken on the basis of the geometries & dimensions outlined in the architects frozen Stage 2 plans issued 03/12/2020.

For ease of comparison with manufacturer’s data, the separation requirements for separating walls have been marked up in terms of the required R_w performance. Example wall build-ups to achieve various R_w acoustic ratings are included in Table 9.

For drywall partitions, the drywall supplier will be responsible for confirming the build-up requirements necessary to achieve the R_w ratings specified.

It is recommended that R_w 45 dB rated walls should include at least 25 mm mineral wool insulation (density range 10 to 45 kg/m³).

Some walls on the mark-ups are marked with ‘Block’. This indicates where the wall is recommended to be a masonry build-up, rather than a drywall partition, to provide enhanced low frequency sound insulation. Should drywall partitions be used, ratings to these walls may need to increase.

At this stage plant room wall ratings are provided on the basis of an assumed typical reverberant noise level within plant rooms of 75dBA.

Table 9: Example partition constructions

Minimum R_w dB	Example drywall constructions
R_w 40 dB	15mm SoundBloc (or equivalent) on each side of 70 mm metal studs at 600 mm centres.
R_w 45 dB	12.5mm SoundBloc (or equivalent) on each side of 70 mm metal studs at 600 mm centres; 25 mm Isowool APR 1200 insulation in the cavity.
R_w 50 dB	2 x 12.5mm SoundBloc (or equivalent) on each side of 70 mm metal studs at 600 mm centres; 25 mm Isowool APR 1200 insulation in the cavity.
R_w 55 dB	2 x15mm SoundBloc (or equivalent) on each side of 70 mm metal studs at 600mm centres. 50mm Isowool APR1200 in the cavity.
R_w 60 dB	2 x 12.5mm SoundBloc (or equivalent) and 2mm plaster skim on each side of 92 mm Acoustuds at 600mm centres. 100mm Isover modular roll in the cavity.
R_w 63 dB	19mm Gyproc Plank and 12.5mm SoundBloc (or equivalent) on each side of 70 mm metal studs at 600mm centres with a Gypframe RB1 Resilient Bar. 50mm Isowool APR1200 in the cavity.

7.1.1 Internal glazed screens

Internal glazed screens should be rated to allow the BB93 sound insulation requirements to be achieved.

At this stage we recommend an allowance is made for proposed internal glazed screens to achieve an airborne sound insulation performance equivalent to the partition requirements outlined in the sample sound insulation mark-ups.

It is worth noting that the acoustic performance of glazed partitions can be limited due to the nature of the system, i.e. structural connections, loading requirements, small cavity depths. Conventional glazed partitions cannot typically achieve R_w ratings above 50 dB. Bespoke glazed partitions incorporating twin frames and thick acoustic laminated panes will likely be required for higher R_w ratings. R_w performance requirements apply to the complete glazing assembly i.e. including frame, seals etc. Laboratory test certification should be provided for the final selected glazing assemblies in subsequent design stages.

In subsequent design stages these requirements can be refined; ratings will depend upon the constituent areas and acoustic performance of the proposed separating wall construction.

7.1.2 Movable partitions

A moveable wall is proposed between the Main Hall and the Activity Studio. Where there is a moveable partition between teaching areas, BB93 states that the on-site airborne sound insulation performance between the spaces should be at least $D_{nT,w}$ 40 dB.

It should be noted that this level of performance is not typically capable of allowing undisturbed simultaneous noisy and noise sensitive activities in the adjacent spaces, and operational management will be required to mitigate this.

We recommend that R_w 55 dB rated moveable walls be provided between the adjacencies detailed above. It should be noted that this rating is for the complete assembly (i.e. all components, not just the wall panel).

We recommend that the moveable wall supplier provide field test data to confirm that the moveable partitions proposed are capable of achieving an on-site figure of R'_w 40 dB.

Any fixed partition areas bordering the moveable partition (e.g. partition bulkheads) should also be rated at R_w 55 dB.

7.2 Internal Doors

Acoustic performance requirements for internal doors have been presented in the sample sound insulation mark-ups. In accordance with BB93 requirements, generally, R_w 30 dB doors are proposed between typical teaching spaces and circulation areas; R_w 35 dB doorsets are proposed to areas of increased activity noise or increased sensitivity to noise (e.g. music, SEN spaces respectively), and interconnected typically occupied spaces.

To achieve these acoustic performance ratings, doorsets will require either insulated metal doors, solid core timber doors or double glazed glass doors. All door assemblies will require full perimeter seals, including threshold, and no ventilation grilles

7.2.1 Typical interconnected spaces

Where spaces are required to be interconnected for operational or health and safety reasons, walls and doors between interconnected spaces have been rated in line with BB93 guidance. BB93 notes that the level of acoustic separation is limited where spaces are interconnected, and may require management depending on the noise generation and sensitivities of the activities within (e.g. L00 Main Hall, Activity Studio, Drama, Classroom, Music room & the circulation break-out space).

7.2.2 Music spaces

At this stage the practice/recording spaces are proposed to be interconnected with the music classroom, and so the sound insulation performance achievable between these spaces is limited by the presence of the doorsets.

While the sound insulation requirements stated on the mark-ups are in accordance with the BB93 requirements for interconnected spaces, this will offer only limited acoustic separation. For example, if these spaces were not interconnected, the separating partitions would be rated R_w 62 dB to achieve the BB93 criteria for fixed partitions.

An improved level of separation could be achieved with lobbied doorsets, or by removing interconnecting doorsets between the music classroom and practice spaces and providing alternative access.

As proposed, the overall level of acoustic separation would not be expected to allow simultaneous undisturbed use of the adjacent spaces – this should be communicated to and agreed with stakeholders.

7.2.3 Internal plant room and riser doors

Plant room and riser doors may also need to be acoustically rated depending on expected plant noise levels and the sensitivity of the adjacent area local to the door. Suitable ratings for the scheme will be defined in the subsequent design stages, in the form of scheme-wide sound insulation mark-ups.

7.3 Separating Floors

Preliminary calculations have been undertaken during stage 2 to establish the separation requirements to achieve the BB93 on-site airborne and impact sound insulation performance requirements.

7.3.1 Airborne sound insulation

Generally, a vertical airborne sound insulation performance of R_w 50 dB is expected to be meet BB93 requirements for typical classroom adjacencies;

For adjacencies with increased noise generation / noise tolerance, a vertical airborne sound insulation performance of R_w 55 dB is expected to meet BB93 requirements;

It is understood that the preliminary structural proposal consists of a 140mm trapezoidal composite deck (140mm Comflor 60, or equivalent mass), this construction is expected to be capable of meeting the typical vertical adjacency requirements.

Where an increased airborne performance is required (refer Table 10), an acoustic uplift in performance would be required. This could be achieved by:

- Increasing the thickness of the composite deck to 150mm (comflor 60, or equivalent mass), with a basic mineral fibre suspended ceiling featuring no open air transfer grilles beneath.
- OR
- In addition to the preliminary 140mm composite deck proposed, incorporating a suitable suspended ceiling specification – at this stage it is anticipated this would take the form of:
 - Suspended ceiling featuring no open air transfer grilles, and offering a minimum sound insulation performance of D_{nfw} 43 dB (in addition to the acoustic absorption requirements outlined in

Section 9) – this level of performance could be achieved with an Ecophon Combison Duo A ceiling tile.

Table 10: Spaces potentially requiring increased ceiling specification (refer 7.3.1)

Room / space
L0 Food Tech
L0 Music Classroom, Practice & Recording
L0 Student Support
L0 Kitchen
L0 Resistant Materials
L0 Main Hall,
L0 Activity Studio
L0 Drama
L0 Changing Rooms
L0 Dining Room
L1 Intervention

7.3.2 Impact sound insulation

Across the scheme, to achieve impact sound insulation requirements, suitably specified carpet floor finishes or hard floor finishes incorporating impact resilient layers will be required to occupied areas above teaching and learning spaces; in areas of increased sensitivity, a strategy implementing a suitable ceiling specification or plasterboard underlining may also be required in addition to the above. These requirements will be developed based on an appraisal of the preferred separating structural slab construction/strategy in the subsequent design stage.

Figure 5: Sample horizontal sound insulation mark-ups – Level 00

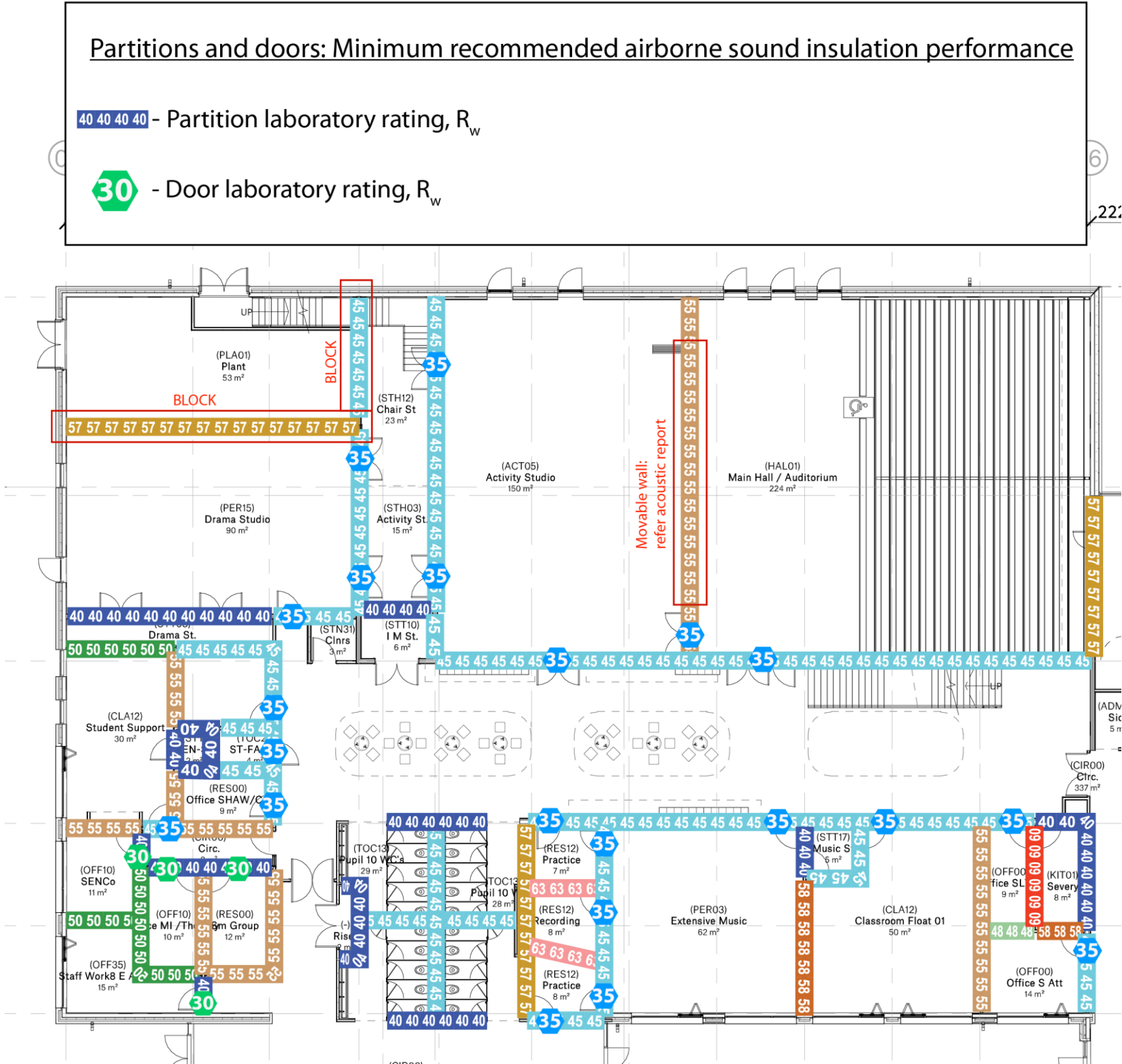
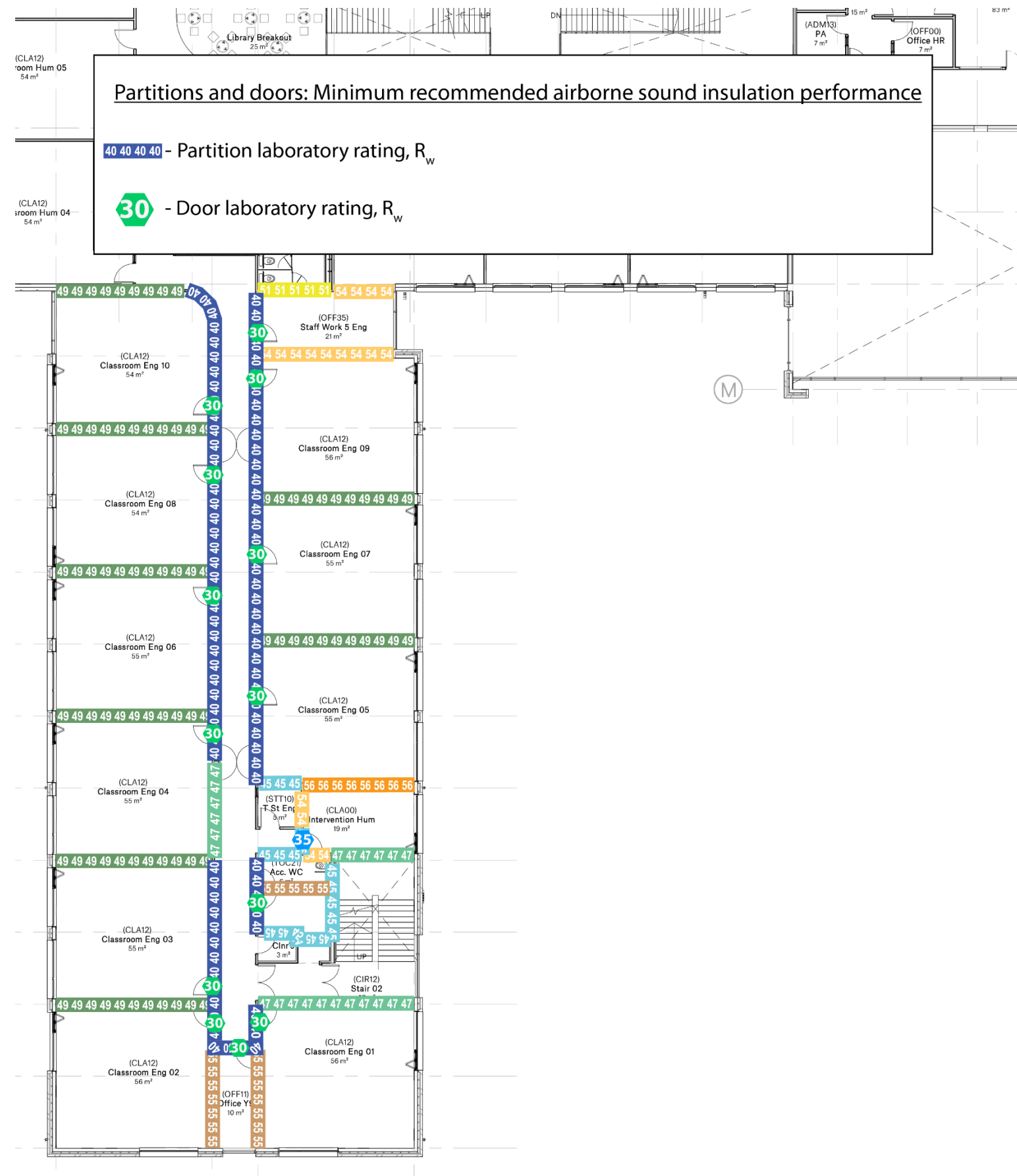


Figure 6: Sample horizontal sound insulation mark-ups – Level 01



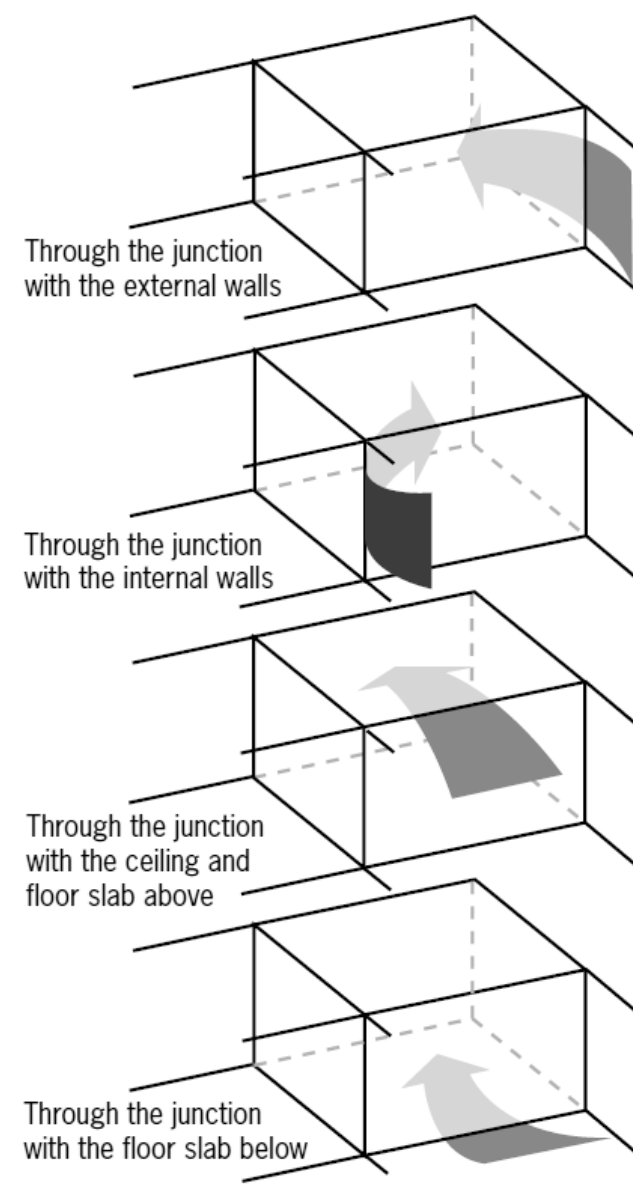
8 Junction Detailing

In order to control flanking noise transmission between noise sensitive spaces, careful detailing at junctions is necessary.

Partitions should be constructed full height from structural base slab to structural soffit and should be well sealed at these junctions using flexible acoustic sealant.

All penetrations and junctions will need to be carefully detailed to ensure that the acoustic performance of the walls and floors are not degraded or bypassed. Figure 7 provides an illustration of the main flanking paths.

Figure 7: Main flanking paths (from BB93)



8.1 Acoustic Detailing Principles

We recommend that the following junction detailing principles are implemented. It should be noted that these are general principles only and will need to be developed and adapted for specific locations in the subsequent design stages.

- All partitions should be built full height from structural floor slab to structural floor slab.
- Building envelope elements which run common between adjacent internal spaces must be designed to ensure that the flanking sound insulation performance of the building element does not degrade the sound insulation performance requirement between adjacent spaces.
- All corridor partitions should be discontinued at junctions with separating walls. At junctions between separating masonry walls and internal flanking partitions, the separating wall should be carried through the flanking wall to discontinue the flanking wall across the junction;
- For separating drywall partitions rated $\geq R_w$ 45 dB, the internal lining of drywall corridor partitions should be discontinued at junctions with separating walls and a cavity stop or mineral wool packing should be installed to close any cavity formed at the partition junction.
- The principles above should be applied at the internal lining of the external wall construction, i.e. internal lining discontinued either side of the separating partition with the separating construction carried through, and any cavity formed in the junction closed with mineral wool packing or a cavity stop.
- Where separating walls meet the underside of the soffit or roof, an acoustic deflection head detail will be required to minimise flanking sound. A timber (or other board material) head stop equivalent to the channel width should be used to form a stop at the head of the partition. Steel angles (or equivalent) should be used to close the joint for partition ratings $>R_w$ 45dB. At junctions with profiled soffit/roof decks, a strategy incorporating either a plasterboard collar & mineral fibre packing, or suitable firestop block and mastic facing will be required to seal the profiles.
- All building service penetrations and common services between rooms must be adequately treated so that flanking sound transmission between services does not degrade the sound insulation performance between adjacent spaces. To maintain the necessary sound insulation performance, services penetrations through rated partitions should be effectively sealed by packing any holes tightly with mineral wool and sealing with flexible sealant. Where larger holes are present a plasterboard/metal blanking panel will be required around the penetrations.

8.2 Service Penetrations

Where possible, it is recommended to avoid service penetrations through acoustically rated separating partitions between sensitive spaces. To maintain the necessary sound insulation performance, all services penetrations through rated partitions should be effectively sealed by packing any holes tightly with mineral wool and sealing with flexible sealant. Where larger holes ($>12\text{mm}$) are present a plasterboard blanking panel / metal collar will be required around the penetrations. Figure 8 and Figure 9 present the recommended detailing principles for service penetrations. Subject to the specific scenario, in some cases ablative coated mineral fibre batts arrangements can be used to detail service penetrations, typically this

would be within lower rated partitions (e.g. corridor walls featuring doorsets), or small penetration areas.

Figure 8: Recommended acoustic detailing principles for duct or pipe penetration through a single leaf drywall partition (the same principles apply to masonry walls however the collar linings should be of sufficient build-up to achieve the R_w performance ratings stated in the sound insulation performance mark-ups and the opening in the wall should be restricted to the size required to allow a practical installation of the building service element)

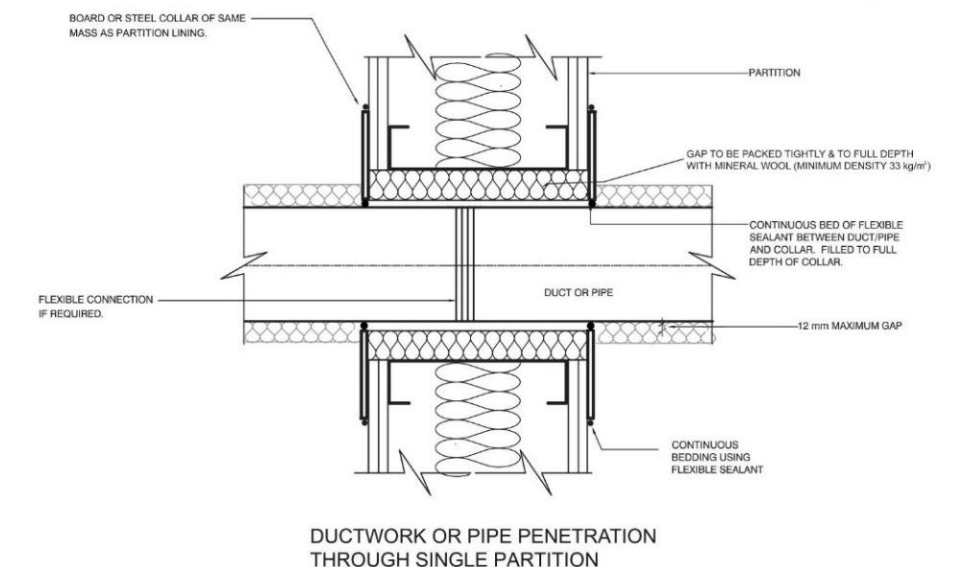
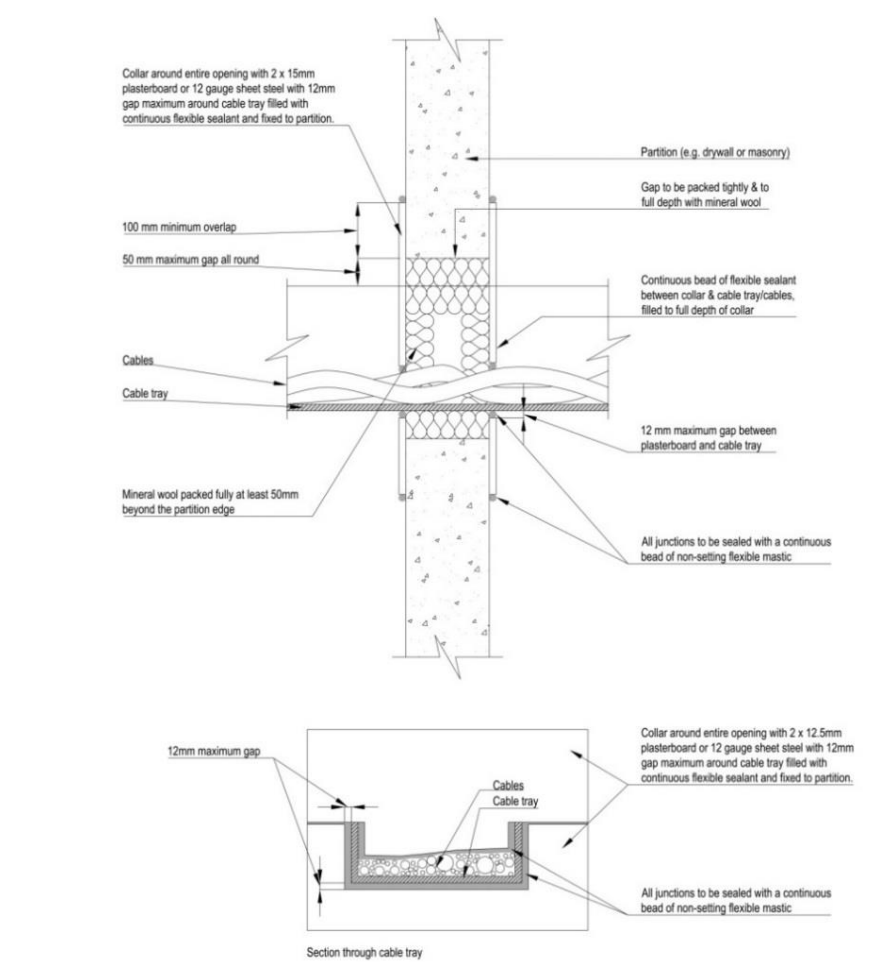


Figure 9: Recommended acoustic detailing principles for cable tray penetration through a single leaf wall

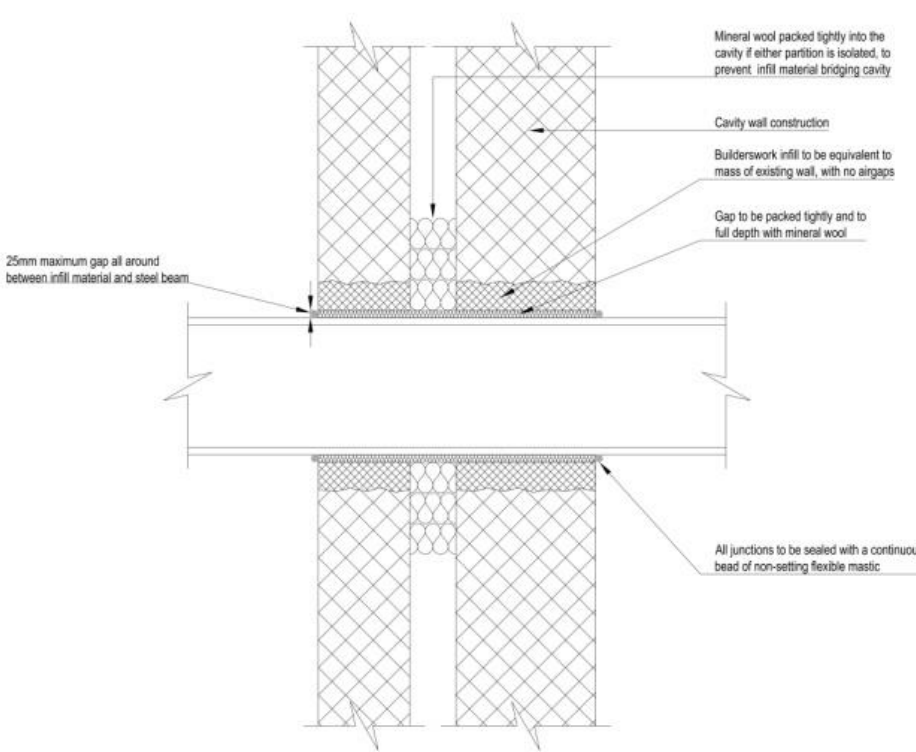


Cable Tray Penetration Through Single Leaf Wall
Acoustic Principles Only
Not To Scale

8.3 Steelwork Penetrations

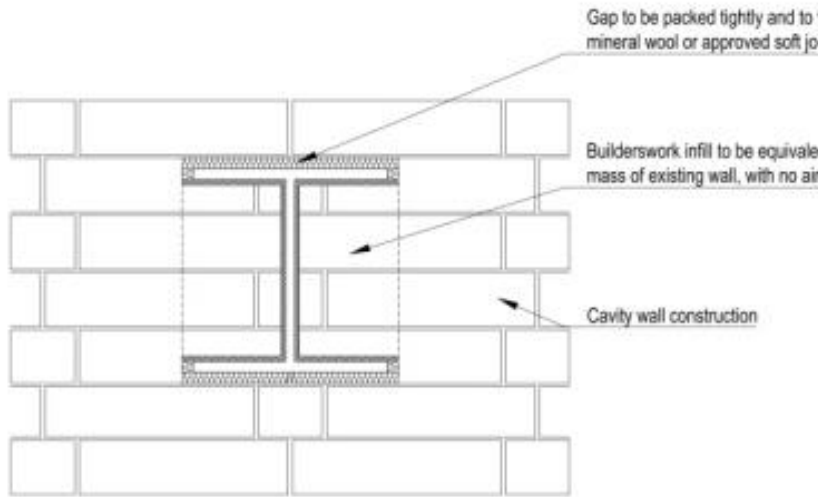
Figure 10 presents our recommended detailing principles for sealing steelwork penetrations.

Figure 10: Recommended acoustic detailing principles for steelwork penetration, principles apply to dry-wall partition



Steel Beam Penetration Through Double Leaf Wall

Acoustic Principles Only
Not To Scale



8.3.1 Steelwork enclosures

8.3.1.1 Beam enclosures

Where steel beams are located parallel above partitions, the enclosure strategy should offer an equivalent performance to that of the separating partition; in the first instance we recommend that the partition linings are carried around the steel beam to the soffit underside.

8.3.1.2 Column enclosures

The following section outlines a preliminary column boxing strategy, which should be refined as the design progresses. Indicative detailing principles are demonstrated in the example British Gypsum details below:

Figure 11: Indicative column boxing, principle anticipated to be suitable for separating partitions rated $R_w < 50$ dB

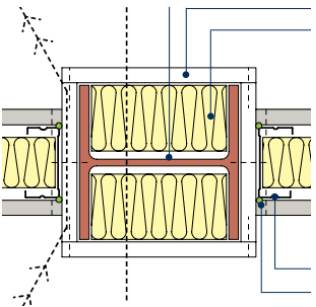


Figure 12: Indicative column boxing, principle anticipated to be suitable for separating partitions rated $R_w < 55$ dB

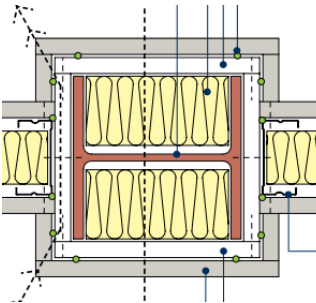
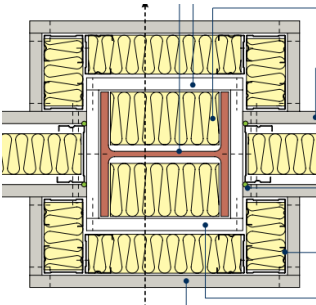


Figure 13: Indicative column boxing, principle anticipated to be suitable for separating partitions rated $R_w < 60$ dB



9 Room Acoustics

It is essential to suitably control reverberation within teaching and learning spaces to facilitate a good acoustic environment for critical listening activities.

Preliminary reverberation time calculations have been undertaken for a representative sample of spaces, to provide recommendations such to allow the BB93 performance criteria to be achieved.

These preliminary absorption requirements should be reviewed in the subsequent design stages and revised to reflect changes in architectural geometries, room finishes etc.

9.1 Acoustic absorber performance requirements

Typically acoustic absorption is specified in terms of absorbency class (Class A, B, C etc.). However as BB93 requirements predominantly relate to mid-frequency reverberation time (T_{mf}), consequently, absorber performance requirements to achieve BB93 T_{mf} criteria are specified in terms of the arithmetic average practical absorption coefficient across the 500Hz -2kHz frequency bands (α_{tmf}).

Table 11: Absorption performance requirements

Equivalent mid-frequency absorption class	Octave band centre frequencies (Hz)		
	500	1k	2k
'Class A'	0.90	0.90	0.90

9.2 Typical enclosed spaces

Table 11 presents indicative acoustic finish coverage area requirements for a sample of the typical enclosed spaces within the scheme.

Room types and dimensions have been referenced from the frozen Stage 2 plans and sections issued by the architects on 03/12/2020.

The area coverage requirements are presented in the form of a percentage of the floor area, and assumes absorption will be provided at heights no greater than 3m AFFL (i.e. underside of ceiling / top of wall panels ≤3m AFFL).

Table 12: Typical enclosed spaces absorption requirements

Room type	Limit, T_{mf} , s	Assumed floor area	Assumed floor finish	'Class A' absorption as % floor area
Classroom	0.8	56	soft (carpet)	49%
Science Lab	0.8	83	Hard (vinyl/wood)	62%
Music Classroom	1	62	soft (carpet)	34%
Music Practice rooms ⁽¹⁾	0.6	8	soft (carpet)	64%
Recording ⁽¹⁾	0.5	8	soft (carpet)	84%

Room type	Limit, T_{mf} , s	Assumed floor area	Assumed floor finish	'Class A' absorption as % floor area
Offices, Staff workrooms	1	21	soft (carpet)	30%
Meeting/Conference room, Interview room	0.8	20	soft (carpet)	44%
Student Support ⁽¹⁾	0.4	30	soft (carpet)	130%
Intervention ⁽¹⁾	0.6	19	soft (carpet)	68%
Kitchen	1.5	100	Hard (vinyl/wood)	27%
Food, Art, ICT, Resistant Materials	0.8	104	Hard (vinyl/wood)	62%
Library	1	83	soft (carpet)	35%
Resource/breakout areas (including within circulation)	1.2	214	Hard (vinyl/wood)	38%
Main Hall	1.2	224	Hard (vinyl/wood)	82%
Drama	1	90	Hard (vinyl/wood)	98%
Sports Hall	2	594	Hard (vinyl/wood)	55%
Activity Studio	1.5	150	Hard (vinyl/wood)	65%
Toilet	1.5	24	Hard (vinyl/wood)	20%
Changing rooms	1.5	67	Hard (vinyl/wood)	27%
Dining room	1.5	436	Hard (vinyl/wood)	51%

Notes: (1) in these spaces with more onerous reverberation time criteria, it is recommended that absorption is distributed across **ceiling and walls**; in the absence of wall absorption, the BB93 criteria may not be achievable.

9.3 Large Volume Spaces

In large volume / double height spaces and spaces with acoustically complex geometries, wall absorption will also be required to satisfy BB93 requirements.

Based on preliminary calculations, indicative acoustic finish coverage area requirements are outlined in Table 13.

The absorption extents stated assume that absorption will be evenly distributed throughout the space (soffit/ceiling & walls) and wall absorption provided to a minimum of 2 non-parallel walls at heights no greater than 3m AFFL.

Table 13: Indicative large volume / double height spaces absorption requirements

Room type	Limit, T_{mf} , s	Assumed floor area	Assumed floor finish	Evenly distributed 'Class A' absorption as % floor area
Resource/breakout area within circulation	1.2	214	Hard (vinyl/wood)	40%
Main Hall	1.2	224	Hard (vinyl/wood)	82%
Drama	1	90	Hard (vinyl/wood)	98%
Dining room	1.5	436	Hard (vinyl/wood)	51%

It is recommended that 3D acoustic modelling is undertaken in the subsequent design stages in order to refine the acoustic absorption strategies in these areas.

9.3.1 Sports Hall & Activity Studio

In the Sports Hall and Activity Studio, it is proposed at this stage to implement an absorption strategy in line with the BB93 Design Guide:

Figure 14: BB93 Example 'Acoustics of Schools: Design Guide' activity/sports hall absorption strategy

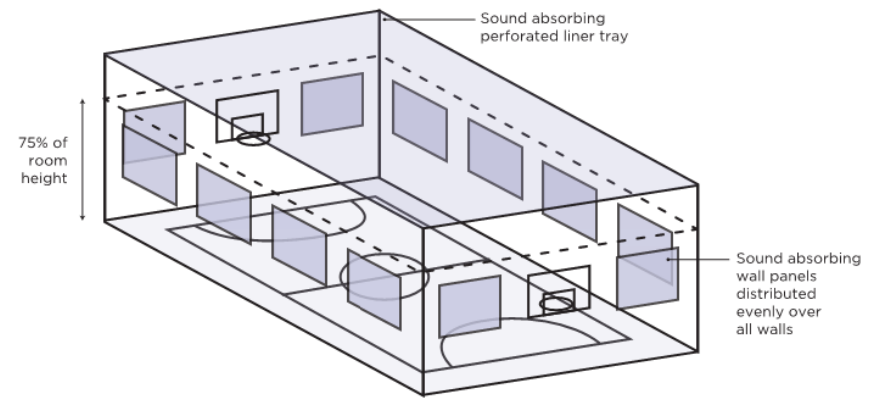


Figure A4.1 Example of sound absorbing finishes and even distribution of sound absorbing wall panels below 75 % of room height

9.3.1.1 Sports Hall

The following preliminary absorption strategy is recommended to meet the BB93 design guide requirements:

- Acoustic absorption provided to a minimum of 450m² of the soffit, offering ≥0.6 α_{tmf} performance. This level of performance can be achieved with various absorbent ceiling systems or perforated profiled deck types with mineral wool inserts (e.g. D100 with profile inserts).
- Absorbent wall panels/system, at no greater than 75% height AFFL – It is recommended that the absorbent wall panels should provide ≥0.9 α_{tmf} performance, cover a minimum of 125m² in the Sports Hall, and be distributed evenly across at least two non-parallel walls. This level of performance could be achieved with various acoustic wall panels/systems (e.g. Ecophon Akusto Wall C wall panel).

9.3.1.2 Activity Studio

The following preliminary absorption strategy is recommended to meet the BB93 design guide requirements:

- Acoustic absorption provided to a minimum of 135m² of the soffit offering ≥0.9 α_{tmf} performance. This level of performance can be achieved with various typical absorbent suspended ceiling systems.

- Absorbent wall panels/system distributed at no greater than 75% height – It is recommended that the absorbent wall panels should provide $\geq 0.9 \alpha_{\text{mf}}$ performance, cover a minimum of 35m² in the Activity Studio, and be distributed evenly across at least two non-parallel walls. For example, this level of performance could be achieved with an Ecophon Akusto Wall C wall panel.

9.4 Dedicated circulation spaces providing direct access to teaching and learning areas

In corridors/circulation areas providing direct access to teaching and learning spaces, suspended ceiling it is recommended that a minimum of Class C acoustic ceiling tiles should be provided to the full ceiling area to meet the BB93/ADE criteria.

10 Building Services

10.1 Internal building services noise

Building service items and associated attenuation measures should be selected to ensure compliance with the BB93 IANL criteria.

The table below presents recommended building services noise upper limits to allow the BB93 IANL criteria to be achieved when considering the cumulative noise level of building services noise and other external noise sources (e.g. road traffic), and the BB93 mechanical services noise limits.

The upper limits are presented in terms of $L_{Aeq,T}$ dB and NR levels; both criteria should be complied with when operating at duties to satisfy the BB93 defined ‘normal’ operation. The limits provided are cumulative and any selection should take account of the total number of noise sources within the space (e.g. inlet, outlet, case, number of units, etc.); these limits should be refined in the subsequent design stages as the external envelope build-ups and associated performance are developed.

Table 14: Preliminary room-side building services noise limits

Room Type	Recommended building services noise limits to achieve the IANL criteria, $L_{Aeq, 30mins}$ dB	Recommended building services NR limits to achieve the IANL criteria
General Classrooms	35	29
Offices, Staff workrooms, Meeting/Conference room, Interview room	40	34
Student Support	30	24
Intervention spaces	35	29
Kitchen	50	44
Science Labs, Res Materials, Food Tech, Product Design, Art, ICT, Library, resource/breakout areas	40	34
Main Hall, Drama	35	29
Sports Hall, Activity Studio	40	34
Music: Recording, practice, classroom	35	29
Circulation spaces, corridors, stairwells	45	39
Toilets	50	44
Changing Rooms	50	44
Dining Room	45	39

10.2 Equipment noise levels

General comments on equipment selections with regard to noise levels are provided below:

- Primary attenuators should be incorporated into ductwork near to plant. This helps to reduce airborne noise transmission to the building to an acceptable level.
- In-room units located within occupied spaces will need to be carefully selected to ensure internal noise requirements are achieved. As well as in-line attenuation, it is important to recognise that the units may also need acoustic cladding / boxing in order to control the level of break-out noise from the unit casing. The requirement for this will be dependent on final unit selections.

It should be noted that the internal building services noise limits provided in are cumulative room-side limits, i.e. accounting for all sources of building services noise in the space (case radiated/breakout noise, and down-duct inlet & outlet noise).

10.3 External plant noise emission limits

10.3.1 Plant noise limits at nearest noise sensitive receptors

External plant noise emissions associated with the development should be suitably controlled in order to maintain residential amenity at nearby noise sensitive receptors.

It is assumed that the plant associated with the scheme will only be operational during the typical hours of operation (i.e. daytime), therefore only daytime (0700 – 2300 hours) BS4142 rating noise limits have been proposed below. If the proposed development plant were to be operational during the defined BS4142 night-time period (2300 – 0700 hours), the criteria would need to be revised.

On this basis, the following cumulative noise limits are proposed for fixed items of plant associated with the development, in line with the Local Authority’s understood criteria.

Table 15: Preliminary external plant noise emission limits

Noise sensitive receptor	Measured representative Background level, $L_{AF90,T}$ (dB)	Cumulative Plant Noise Rating Level Limit at façade of NSR property, $L_{Afi,Tr}$ (dB)
Residential dwellings to the north-east of the proposed development site off Hyde Road	57	52
Residential dwellings to the west of the proposed development site off Ellen Wilkinson Crescent and Bracewell Close	47	42

It should be noted that the plant noise limits provided are for the cumulative BS 4142 rating level of all items of plant, and allowance should be made for the number and character of the noise sources. Plant noise should also be controlled sufficiently to ensure that the indoor ambient noise level design criteria for the proposed development are not exceeded.

10.4 Ductwork regenerated noise

Regenerated duct-borne noise is caused by the interaction of airflow with ductwork elements. The air speed within each system zone must be selected to limit regenerated noise levels. General comments on ductwork regenerated noise are provided below:

- The following table presents typical recommended velocities related to indoor ambient noise level criteria.

Table 16: Maximum recommended duct velocities

Room indoor ambient noise level criteria	In-duct max. air velocity (m/s)		
	Main	Branch	Final run-outs
≥31 dBA / NR 25	5	4.5	2.5
≥36 dBA / NR 30	6.5	5.5	3.25
≥41 dBA / NR 35	7.5	6.0	4.0
≥46 dBA / NR 40	9.0	7.0	5.0

- Dampers and other variable air devices such as VAV units can generate significant regenerated noise and may require acoustic lining or cladding to achieve building service noise criteria.
- Dampers near to supply termination elements should be set as near to the fully open condition as possible. In any case it should be ensured that the maximum permissible noise levels for each space are satisfied.
- Dampers should be installed at a suitable distance from other ductwork components and ductwork terminations including grilles and diffusers to prevent turbulent airflow and minimise regenerated noise.
- Ductwork layouts should incorporate the following (but not limited to) design principles to minimise regenerated noise and laminar airflow within the system:
 - Gradual bends.
 - Gradual changes in cross sectional area / long transition pieces.
 - Rectangular ductwork with a low aspect ratio.

Provide a minimum straight line of duct length equal to the height or width of the duct (whichever is greater) before and after duct bends, transitions, VAV units, attenuators including splitters/pods and any other duct elements which provide an equivalent or greater disruption to airflow.

10.5 Crosstalk noise transmission

Crosstalk noise transmission can occur between two spaces which are served by branches on a common duct system.

Sufficient crosstalk attenuation and associated acoustic lagging should be provided in order to achieve the internal sound insulation requirements between adjacent spaces and building service noise requirements.

Ductwork will be acoustically lagged where necessary to limit flanking sound transmission to allow the sound insulation performance requirements to be achieved.

Generally, crosstalk attenuators and acoustic lagging of ducts will be required in the following rooms:

- Enclosed rooms classified as ‘medium’ and ‘low’ noise tolerance in BB93 (ref Table 2).
- Enclosed rooms classified as ‘high’ activity noise in BB93 (ref Table 2).
- Plant rooms containing high noise generating equipment.

Acoustic lagging and crosstalk requirements should be reviewed as the design progresses.

10.6 Common plenums

Ventilation plenums should be provided on a per room basis and should not run common between adjacent acoustically sensitive spaces.

10.7 Pipework

Where necessary, pipework will be suitably clad or lagged to prevent excessive pipe noise break-out and flanking sound transmission through pipes.

Where possible, rainwater, soil and waste pipes will be enclosed within service risers and not run across occupied rooms. Where this cannot be avoided, the pipework will be boxed in or acoustically lagged; boxing and lagging requirements will dependant on the room type and the pipework layout.

Should pressurised pipework layouts include large scale runs between occupied spaces, these runs may need to be acoustically lagged, particularly where partitions are specified with sound insulation ratings of >R_w 45 dB.

10.8 Vibration isolation

All vibration generating plant and machinery should be mounted on a heavy framework or floor slab and be supported by suitable anti-vibration mounts or resilient pads to prevent vibration energy transfer to the structure. If package units have integral isolation, direct mounting on housekeeping bases may be acceptable.

Flexible connections should be employed between isolated plant and non-isolated components and building elements. These connections should allow unrestricted movement of the plant item and should not make up for misalignment.

11 Summary

Acoustic design performance standards have been detailed for the various room types included within the proposed Hyde Road School development in accordance with BB93 and other relevant guidance documents.

A summary of the environmental noise survey and noise prediction modelling has been provided.

A preliminary assessment of the external sports pitches indicates that the LPA criteria may be exceeded; indicative mitigation measures have been discussed for consideration.

Preliminary recommendations with regard to the acoustic performance of building envelope elements have been provided.

Preliminary partition and door sound insulation ratings have been provided for a sample of spaces.

Preliminary recommendations relating to the airborne and impact sound insulation of separating floors has been provided.

Initial general acoustic detailing principles to maintain sound separation standards between typical adjacent spaces have been provided.

Preliminary acoustic absorptive finish recommendations for the main room types across the scheme has been provided.

Preliminary internal and external building services noise limits have been provided to allow the relevant design criteria to be achieved.

Appendix I – Glossary of Acoustic Terms

Acoustic Absorption

Acoustic absorption refers to the process by which energy is removed from the sound field. Most materials will absorb a proportion of sound, i.e. convert acoustic energy into heat. It is measurable and is defined for any particular material or surface by a coefficient α between 0 (totally reflective) and 1 (totally absorbent) at each frequency. Acoustic absorption is defined as the product of the surface area of the absorbing material (S), and its absorption coefficient (α).

A-Weighting

Normal hearing covers the frequency range from about 20Hz to 20kHz but sensitivity is greatest between about 500Hz and 8kHz. The "A-Weighting" is an electronic filters network incorporated in sound level meters which approximately corresponds to the frequency response of the ear. The unit of measurement of A-weighted sound level is dBA.

Decibel, dB

This is the unit to measure sound. The human ear has an approximately logarithmic response to acoustic pressure over a very large dynamic range (typically 20 micro-Pascals to 100 Pascals). We therefore use a logarithmic scale to describe sound pressure level, intensities and sound power levels. Subjectively, an increase of 10 dB corresponds to a doubling in the perceived loudness of sound.

Equivalent Continuous Sound Level L_{eq} or L_{Aeq}

The continuous equivalent sound level, L_{Aeq} is a notional sound level. It is the sound level, which, if maintained for a given length of time, would produce the same acoustic energy as a fluctuating noise over the same time period. (The above formula is implemented electronically in all good sound level meters and it is customary to measure rather than calculate the equivalent continuous sound level.) L_{Aeq} is widely used to measure any environmental noise which varies considerably with time.

Flanking Transmission

Sound transmitted between rooms via flanking elements instead of directly through separating elements or along any path other than the direct path.

Mid-Frequency Reverberation Time, T_{mf}

The arithmetic average of reverberation times in the 500Hz, 1kHz and 2kHz octave bands.

Octave and Third Octave Bands

The human ear is sensitive to sound over a range of approximately 20Hz to 20kHz, and is generally more sensitive to medium and high frequencies than to low frequencies. In order to define the frequency content of a noise, the spectrum is divided into frequency bands, and the sound pressure level is measured in each band. The most commonly used frequency bands are octave bands, in which the mid frequency of each band is twice that of the band below it. (For instance the octave bands above and below the 500Hz octave band are 1kHz and 250Hz respectively). For finer analysis, each octave band may be split into three one-third octave bands or in some cases, fine frequency bands.

Reverberation Time, RT

The RT is defined as the time taken for an impulsive sound to die away to one thousandth of its original sound pressure level - that is, to decrease by 60dB. The sound waves are reflected many times from each surface in the room, and are partly reduced at each reflection, the amount of reduction depending on the acoustic absorption of the surface. Acoustic absorption is measurable and is defined by a coefficient between 0 (totally reflective) and 1 (totally absorbent) at each frequency. Although an anomaly in the standard laboratory test procedure can lead to absorption coefficients higher than 1, this is not achievable in real installations.

Statistical Level L_{90} or L_{A90}

Sound pressure level that is exceed for 90% of the measurement time. Consequently it is indicative of the general background noise level in the absence of any higher level short duration events that occur during the period.

Weighted element normalized level difference $D_{n,e,w}$

The single number quantity for difference in the space and time averaged sound pressure level produced in two rooms by a source in one, where sound transmission is only due to a small building element (e.g. transfer air devices, electrical cable ducts, transit sealing systems). The $D_{n,e,w}$ relates to the value, in decibels, of the reference curve at 500Hz after shifting it in accordance with the method specified in ISO 717-1.

Weighted Sound Reduction Index, R_w

This is a weighted single figure descriptor of the sound insulation performance of a partition measured under laboratory conditions. The sound reduction index in each of the one-third octave bands from 100Hz to 3150Hz is compared with a standard set of curves. The value of R_w for a given partition is obtained from the standard curve which when compared with the measured SRI values produces an adverse deviation as close to -32dB as possible. Only the SRI values which fall below a particular standard curve are considered in the sum. Positive deviations from the standard curve are not taken into account.

Weighted Standardised Level Difference, $D_{nT,w}$

The single number quantity for airborne sound insulation rating, relating to the value, in decibels, of the reference curve at 500Hz after shifting it in accordance with the method specified in ISO 717-1: 1997.

Weighted Standardised Impact Sound Pressure Level, $L'_{nT,w}$

Weighted standardised level, a single figure generated by comparing the L'_{nT} with the reference curve at 500 Hz after shifting it in accordance with the method specified in BS EN ISO 717-2: 1997. The reference curve is shifted in 1 dB steps until the sum of adverse deviation of the test curve, compared to the reference curve, is as large as possible, but no more than 32.0 dB. The value of the shifted reference curve at 500 Hz is taken as the $L'_{nT,w}$. N.B. As $L'_{nT,w}$ for impact transmission represents an absolute level, a lower figure constitutes better performance.

Appendix II – Summary of BB93 February 2015 ventilation condition, system type and associated IANL tolerance

Table 17: Summary of ventilation condition, system type and associated IANL tolerance (reproduced from BB93, Table 2)

Condition	Ventilation system	Noise level limit
Normal - ventilation for normal teaching and learning activities	Mechanical ¹	Table 1 value
	Natural ²	Table 1 value + 5 dB ⁴
	Hybrid ²	Mechanical system noise: Table 1 value Total noise level: Table 1 value + 5 dB
Summertime ⁵ - ventilation under local control of teacher to prevent overheating – allowable during the hottest 200 hrs of the year	Mechanical	Table 1 value + 5 dB ⁴
	Natural or Hybrid	≤55 dB
Intermittent boost ⁶ – 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	Table 1 value + 5 dB ⁴
	Natural	≤55 dB
Process – extract ³ can be automatic ventilation for safety and/or under local control of teacher	Mechanical and/or natural	See IoA/ANC guide for operational noise levels

¹ The normal condition for a ventilation system with purely mechanical air supply is defined as when the system is operating to limit the daily average carbon dioxide concentration to no more than 1,000ppm with the maximum concentration not exceeding 1,500ppm for more than 20 consecutive minutes on any day during normal school operating hours. This would normally equate to a minimum ventilation rate of approximately 8l/s per person. Mechanical ventilation in this context refers to systems (or parts of systems) that use mechanical fans to mix or drive the air including those in mechanical, hybrid, mixed mode and natural ventilation systems and in fan convector heaters.

² The normal condition for a ventilation system in natural or hybrid mode is defined as when the system is operating to limit the daily average carbon dioxide concentration to no more than 1,500ppm with the maximum concentration not exceeding 2,000ppm for more than 20 consecutive minutes on any day. This would normally equate to a minimum ventilation rate of approximately 5l/s per person. For hybrid systems, the mechanical noise excluding external noise break in, should meet the IANL figure in Table 1.

The mid-season design condition can be used in simple ventilation calculations and is defined as an outside temperature of 11 °C and an internal air temperature of 20 °C with no external wind effect.

Where there is a hybrid system, any mechanical system components should meet the IANL limits from Table 1. The total noise level including external noise ingress may exceed the IANL limit from Table 1 by up to 5 dB.

³ Process extract includes the operational noise from local exhaust ventilation systems and boost ventilation under the local control of the teacher as required for fume and dust extract in

design and technology, odour and steam from cookers in food technology, fume cupboard extract and similar process extract systems. See guidance on specification and measurement of operational noise levels in 'Acoustics of Schools: a design guide'

⁴ The +5 dB does not apply to teaching and learning spaces where the Table 1 IANL is greater than or equal to 45 dB.

⁵ Natural, mechanical or hybrid ventilation systems may be used to improve thermal comfort in summer at the expense of higher IANL. The normal ventilation IANL can be exceeded during the hottest 200 hours in peak summertime conditions and the design should show that IANLs, defined in the table above can be met under these conditions as well as under normal operation. The ventilation must be under the local control of the teacher so that the noise level can be reduced to normal levels when needed. This does not apply to classrooms intended specifically for students with special hearing and communication needs, or to speech therapy rooms.

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.

⁶ The noise level from locally controlled intermittent boost mechanical ventilation may exceed the IANL by up to 5 dB.