Benwick Primary School, Cambridgeshire

Acoustic Design Strategy

BPS-APX-ZZ-ZZ-RP-J-0003

18th October 2023

Revision P02

ANC ACOUSTICS & NOISE CONSULTANTS

Institute of Acoustics sponsoring organisation

Benwick Primary School, Cambridgeshire

Acoustic Design Strategy

BPS-APX-ZZ-ZZ-RP-J-0003

Revision	Description	Issued by	Date
P01	First issue	ABW	17th October 2023
P02	Second issue	ABW	18th October 2023

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1 Summary

1.1 This report details the performance standards of Building Bulletin 93 and outlines the manner in which the performance standards may be achieved.

1.2 The Building Regulations Approved Document E refers to the acoustic performance standards of Building Bulletin 93 to comply with Requirement E4 of The Building Regulations for all new build elements.

1.3 Building Bulletin 93 also provides guidance in support of the School Premises Regulations and the Independent School Standards.

1.4 The project is targeting BREEAM 'Very Good' standard and three credits are available under the Hea 05 credit for the internal acoustic performance by meeting BB 93 performance standards.

1.5 The acoustic performance parameters of ambient noise, sound insulation between spaces, reverberation time and absorption in circulation areas are covered.

1.6 Partition acoustic performance, potential construction types, detailing, and absorption are discussed and outlined.

1.7 A summary of the adopted acoustic performance standards and requirements for each space are shown in Appendix A.

1.8 Partition and door sound reduction rating requirements to achieve BB 93 performance standards are indicated on the drawing mark-ups in Appendix H.

1.9 Measured representative background noise levels have been determined and mechanical plant noise emission limits are provided.

1.10 Based on a review of the current stage of the scheme, and the adopted BB 93 criteria identified, BB 93 performance and BREEAM Hea 05 design requirements are met.

1.11 Where required, such as for BREEAM Hea 05 credits, acoustic testing shall be carried out to demonstrate compliance with BB 93 performance standards.

2 Introduction

2.1 Apex Acoustics has been commissioned to provide acoustic consultancy for the Benwick Primary School development, High Street, Benwick, Cambridgeshire, PE15 0XA.

2.2 The school currently has four general teaching classrooms: two located within the main building and two within a temporary mobile building (identified in green in Figure 1, Appendix C). It is proposed to replace the temporary classrooms with a permanent provision. Pupil numbers are forecast to remain the same.

2.3 Building Bulletin 93 (BB 93) Acoustic design of schools: performance standards, Reference 2, sets out the minimum performance standards for the acoustics in school buildings.

2.4 Acoustics of Schools: a design guide, Reference 3, provides supporting guidance and recommendations for satisfying the performance standards of BB 93.

2.5 The Building Regulations Approved Document E (AD-E), Reference 4, refers to the acoustic performance standards of BB 93 to comply with Requirement E4 of The Building Regulations for all new build elements.

2.6 BB 93 also provides guidance in support of the School Premises Regulations (SPR), Reference 5, and the Independent School Standards (ISS), Reference 6.

2.7 This report addresses the following acoustic performance parameters in turn:

- Indoor ambient noise levels (IANL)
- Control of rain noise
- Sound insulation of walls
- Reverberation times and absorption
- Mechanical plant noise

3 Acoustic Requirements

3.1 Acoustic requirements are based on the Cambridge City Council Education Capital Project Brief, Reference 1.

3.2 **Regulatory requirements**

3.3 The following Regulatory requirements apply to new school buildings:

- Requirement E4 of the Building Regulations, Reference 4
- Schools Premises Regulations, Reference 5
- Independent Schools Standards, where relevant, Reference 6

3.4 The normal way of satisfying Requirement E4 of the Building Regulations, The Schools Premises Regulations and the Independent Schools Standards where relevant is to meet the appropriate performance standards as outlined in Section 1 of Building Bulletin 93 (BB 93), Reference 2. The additional guidance of Acoustics of Schools: a design guide, Reference 3, should also be considered.

3.5 **DfE requirements**

3.6 The Department for Education (DfE) refers to the acoustic performance standards of BB 93 for compliance with the School Output Specification Generic Brief and associated Annexes, Reference 7.

3.7 **Refurbishment**

3.8 With respect to the refurbishment and conversion of existing spaces, BB 93 states that, *"refurbished elements should meet, as far as reasonably practicable, the acoustic performance given in these guidelines"*.

3.9 BB 93 sets out performance standards for refurbished spaces that are generally less onerous than for new build spaces.

3.10 **BREEAM**

3.11 It is understood that the project is targeting BREEAM 'Very Good' standard. Up to three credits are available under the Hea 05 credit for the internal acoustic performance of educational facilities by meeting the performance standards in BB 93. Credit requirements are set out in Table 1.

3.12 A programme of pre-completion testing is required to demonstrate compliance – see Section 10.

3.13 It is understood from the project BREEAM Assessor that the development is to be assessed as a 'Simple Building', hence the Pol 05 noise pollution credit is not applicable

Credit	Criteria
First credit – Sound insulation	Achieve the performance standards set out in Section 1 of BB 93 relating to airborne sound insulation between spaces.
Second credit – Indoor ambient noise levels	Achieve the indoor ambient noise level standards set out within Section 1 of BB 93 for all room types.
Third credit – Room acoustics	Teaching and study spaces achieve the requirements relating to reverberation time for teaching and study spaces set out within Section 1 of BB93. Corridor and stairwells, for those that give direct access to teaching and study spaces, achieve the performance requirements relating to sound absorption.

Table 1: BREEAM Hea 05 credit requirements

3.14 **Planning application**

3.15 The need for due regard to suitable noise control of external noise emissions is not directly covered by Building Regulations, School Premises Regulations or BB 93, and is more typically a planning and environmental health consideration.

3.16 Planning considerations for new buildings subject to a planning application shall typically need to include a consideration of the noise emission impact from the operational site. Typical guidance for assessing the noise impact is outlined below.

3.17 BS 4142, Reference 8, details methods for assessing industrial and commercial sounds, and is typically used for assessing impacts from building services plant. The method estimates the impact significance by comparing the Rated noise against the background sound levels, as summarised below:

a) Typically, the greater this difference, the greater the magnitude of the impact.
b) A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.
c) A difference of around + 5 dB is likely to be an indication of an adverse impact, depending on the context.
d) The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound sources having a low impact, depending on the context.

3.18 Considering the baseline noise conditions, noise limits for the proposed plant can be identified at the nearest noise-sensitive receptors (NSR).

4 Indoor ambient noise levels

4.1 This performance parameter identifies upper limits for the combination of external noise sources (not related to school activities) and building services noise.

4.2 The upper indoor ambient noise level (IANL) limits described in BB 93 are shown in Appendix A.

4.3 It is understood that the proposed building is to have a hybrid ventilation strategy; building services should satisfy the IANL limits in Appendix A.

4.4 **IANL tolerances**

4.5 Various IANL tolerances are defined in BB 93 depending on the ventilation system and the operating condition, these tolerances are summarised in Table 2.

Condition	Ventilation system	Noise level limit
Normal - ventilation for normal teaching and learning activities	Mechanical	BB 93 Table 1 value
	Natural	BB 93 Table 1 value + 5 dB
	Hybrid	Mechanical system noise: BB 93 Table 1 value
		Total noise level: BB 93 Table 1 value + 5 dB
Summertime - ventilation under local control of teacher to prevent overheating – allowable during the hottest 200 hours of the year	Mechanical	BB 93 Table 1 value + 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	BB 93 Table 1 value + 5 dB
	Natural	≤ 55 dB

Table 2: Summary of ventilation conditions and internal ambient noise level tolerances

4.6 The definitions given in BB 93 for ventilation conditions are detailed in Appendix B.

4.7 The tolerances for natural ventilation for the ventilation conditions described above are shown in Table 3.

BB 93 room type	IANL Limit - natural ventilation, 'normal' conditions, $L_{Aeq,30min}$		IANL Limit - natural ventilation during 'Summertime' condition, $L_{Aeq,30min}$	IANL Limit - natural ventilation during 'boost' condition, $L_{Aeq,30min}$
	New build	Refurbishment		
Classrooms	40 dB	n/a	55 dB	55 dB

Table 3: BB93 IANL limits for teaching and learning spaces (lowest IANLs), when utilising natural ventilation

4.8 **Façade sound insulation**

4.9 BB93 states that:

"Where external ambient free field noise levels at the façade expressed as the $L_{Aeq,30min}$, do not exceed the IANL figures given in Table 1 by more than 16 dB for single sided ventilated spaces and 20 dB for cross ventilated or roof ventilated spaces, the criteria for natural ventilation can usually be achieved. However, the ventilation strategy still requires appropriate design of façade openings, height difference between low and high levels openings, corridor transfer vents/stacks, etc, to limit the required façade open areas appropriately".

4.10 When considering the highest measured daytime $L_{Aeq,T}$ noise level and the level differences presented above, the internal levels in teaching spaces would be no greater than:

- Single side ventilated ≈ 29 dB $L_{Aeq,30min}$
- Cross-ventilated ≈ 25 dB $L_{Aeq,30min}$

4.11 Therefore, based on Apex noise survey, to meet BB 93 criteria for indoor ambient noise levels, open windows are feasible to all rooms of the school under normal, summertime and intermittent boost ventilation conditions.

4.12 **Glazing**

4.13 Considering the BB 93 indoor ambient noise levels are expected to be achieved with windows open, there are no constraints on glazing acoustic performance and double-glazed units provided for thermal purposes will be suitable. glazing. Notwithstanding, glazing with nominal rating of 30 dB R_w is suitable to control the break-in of external airborne noise.

4.14 The proposed glazing is 4 mm toughened outer pane, assumed minimum 16 mm argon filled cavity and 6.8 mm laminated inner pane, is rated > 30 dB R_w and is suitable.

4.15 **External Walls**

4.16 External walls with nominal rating 40 dB R_w are suitable to control the break-in of external airborne noise.

4.17 Outline proposed external wall build-ups are as follows: rain screen cladding, nominal 140 mm rigid insulation and 9 mm OSB, SHS or timber frame and 15 mm impact resistant dry lining board on battens.

4.18 Typical construction types required to meet thermal, structural and other requirements when detailed and installed to a good standard shall be suitable to meet the nominal acoustic rating.

4.19 **Roof**

4.20 A roof with nominal rating 30 dB R_w is suitable to control the break-in of external airborne noise. The proposed roof construction (described below), in conjunction with suspended ceiling below, is assessed to be rated ≥ 30 dB R_w and, therefore, meets airborne sound insulation requirements.

4.21 Building Regulation submissions should show that lightweight roofs and roof glazing provide a suitable control of rain noise reverberant sound pressure level in a space when calculated for heavy rain noise excitation, as defined in BS EN ISO 140-18, Reference 9.

4.22 BB 93 requires that noise from heavy rainfall should result in an IANL no greater than 25 dB above the indoor ambient noise level limits set out in Appendix A.

4.23 Preliminary proposals for the roof are as follows:

- Mid weathered zinc grey standing seam roof sheeting
- *Anti-drumming membrane (see paragraph 4.25)*
- 'full fill insulation between joists' – *insulation type TBC (see paragraph 4.24)*
- 22 mm OSB
- Joists
- 2 no. layers 12.5 mm Fireline plasterboard *on resilient bars (see paragraph 4.25)*
- Suspended ceiling below

4.24 Mineral wool type insulation performs better acoustically than rigid insulation and, therefore, is recommended from an acoustic point of view.

4.25 Dependent on the insulation type used, inclusion of both an anti-drumming membrane and resilient bars is unlikely to be necessary to meet BB 93 rain noise requirements. Subject to provision of suitable rain noise test data, this shall be reviewed as the design is developed.

4.26 A double glazed rooflight is proposed to the P03 Cloaks space. Double glazed rooflights mitigate rain noise drumming to a degree that meets BB 93 rain noise requirements.

4.27 It should be understood that rain noise will still be audible within spaces.

5 Sound insulation of walls

5.1 The calculated partition sound insulation requirements are indicated on the colour drawing mark-up in Appendix H, based on the activity and tolerance categories set out in Appendix A.

5.2 Architect's Acoustic Strategy drawings are included in Appendix G; acoustic rating match the Apex mark-up in Appendix H.

5.3 A review of the architect's proposed wall types against the acoustic ratings shown on the mark-ups is shown in Table 4.

Partition Type	Description	40 dB R_w	45 dB R_w	51 dB R_w	Comments
Type A	70 mm studs, 15 mm DuraLine and 12.5 mm WallBoard linings on either side, with 50 mm insulation wool	✓	✓	✓	Estimated performance ≥ 51 dB R_w. Scope to reduce to single linings and omit insulation wool if this partition is intended to be used where a lesser rating is required.
Type B	70 mm studs, 15 mm DuraLine and 12.5 mm WallBoard linings on either side	✓	✓		Estimated performance ≈ 48 dB R_w. Partition construction is suitable.
Type C	70 mm studs @ 400 mm centres where tiled, MR 15 mm DuraLine and 12.5 mm WallBoard linings on either side	✓	✓		Estimated performance ≈ 48 dB R_w. Partition construction is suitable.
Type D	70 mm studs, 15 mm DuraLine and 15 mm SoundBloc linings on either side, with 50 mm insulation wool	✓	✓	✓	Estimated performance ≥ 51 dB R_w. Partition construction is suitable.

Table 4: Wall type review

5.4 All walls with a sound insulation rating should be constructed from the structural floor base to the structural soffit.

5.5 Where there are small gaps between the top of partitions and soffit, these may be treated as described in Appendix D.

5.6 It is noted that the table of potential partition specifications addresses the acoustic performance only. Other performance parameters such as durability, fire, and structure are not addressed.

5.7 **Exceptions: BB 93 Section 1.2.3**

5.8 In cases where operational or safety purposes require rooms to be linked, Exception B of Section 1.2.3 of the BB 93 performance standards allows an exception to the sound insulation requirements.

5.9 Interconnecting doorsets are required to have a minimum performance of 35 dB R_w with the separating wall (including any glazing) having a composite performance of at least 45 dB R_w.

5.10 The P03 Cloaks space provides access to Classrooms P01 and P02. It is recommended that the ratings for interconnecting doorsets be used, i.e. doorsets with minimum performance of 35 dB R_w.

5.11 A standard 54 mm solid core door, such as a typical FD60, when fitted with compression or wipe seals, may achieve a rating of ≥ 35 dB R_w.

5.12 Potential doorset options are shown in Table 5. Test data should be provided by the manufacturer for the selected unit.

5.13 To achieve a rating of ≥ 35 dB R_w for a door set in practice, a threshold seal is required.

R_w / dB	Potential door options
30	A standard 44 mm solid core door such as a typical FD 30, when fitted with appropriate seals. See www.acousticselector.com for appropriate seals. 6 mm glass has a performance of 32 dB R_w, therefore a vision panel may not be detrimental to the performance required.
35	A standard 54 mm solid core door such as a typical FD 60, when fitted with appropriate seals. See www.acousticselector.com for appropriate seals. 10 mm glass has a performance of 36 dB R_w, therefore a vision panel may not be detrimental to the performance required

Table 5: Door options

6 Detailing, flanking noise, and services penetrations

6.1 **Detailing for plasterboard walls**

6.2 If recessed, sockets should ideally not be back-to-back, but staggered by at least 450 mm, and may be treated with equivalent plasterboard linings behind to the partition penetrated, prefabricated socket boxes or intumescent lining pads. Potential suppliers are listed in Appendix E.

6.3 A plasterboard lining to an external wall or internal plasterboard partitions should not be continuous past a separating partition rated at ≥ 50 dB R_w.

6.4 **Detailing for masonry walls (if applicable)**

6.5 A blockwork leaf of 100 mm should not be continuous past a separating wall; the separating masonry wall should be toothed or tied into the flanking element. As above.

6.6 Appropriate sealing at the soffit is also required to control flanking noise.

6.7 **Services penetrations**

6.8 All penetrations through separating partitions must be fully sealed where the partition has a separating function between rooms. In practice this is the aspect that most often and significantly degrades the sound insulation performance on site.

6.9 It is generally easier to route services along the corridors and break through the corridor wall than it is to seal penetrations through separating walls between classrooms.

6.10 The level of detailed required for services penetrations through walls of various rating categories is described in Appendix D.

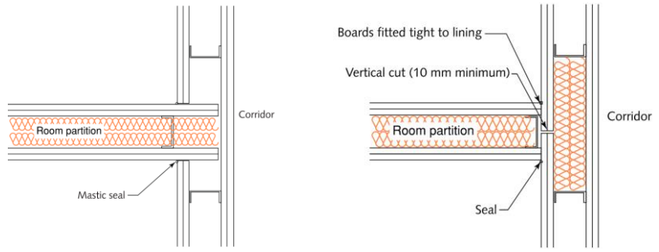
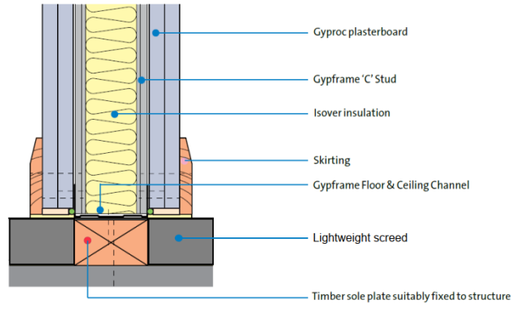
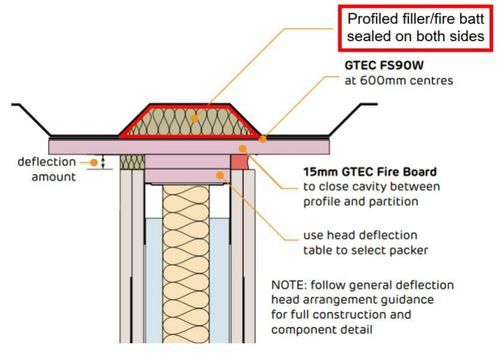
Flanking element	Examples of 'acoustic' detailing for sound insulation
Partition junction detailing	• A plasterboard lining to an external wall or internal plasterboard partitions should not be continuous past an acoustically rated partition e.g.  • If the junction is formed with a break in the flanking wall lining (i.e. indicative detail on the right above) for partitions rated ≥ 51 dB R_w insulation wool is required in the junction zone to mitigate flanking sound transmission around the partition via the flanking wall or external wall cavity.
Floor / ceiling junction	• Where applicable, lightweight screeds, floating floors, raised access floors and ceiling linings should not be continuous past a partition rated ≥ 51 dB R_w, and should be independent each side of the partition. For lightweight screeds, this may be achieved with a timber sole plate as indicated below.  • Partitions must be appropriately sealed to the underside of the structural soffit. Profiled fillers/fire batt, sealed on both sides may be used to seal gaps created by a metal deck (if applicable), to mitigate sound transmission over partitions. 

Table 6: Flanking noise control detailing

7 Control of Reverberation

7.1 **Teaching and Study Spaces**

7.2 BB 93 quotes maximum mid-frequency reverberation times, T_{mf}, in unoccupied but furnished spaces.

7.3 The control of reverberant sound is considered the most important aspect of enabling good speech intelligibility. It is noted that lower reverberation times than the upper limits described in BB 93 are advantageous for both teachers and students, by increasing speech intelligibility and reducing ambient noise levels.

7.4 The approach for the control of reverberation is to use Class A ($\alpha \geq 0.9$ according to BS EN ISO 11654, Reference 10) ceilings to classrooms P01 and P02, and Cloaks P03 (see paragraph 7.8).

7.5 Absorption Classes are described according to ISO 11654, Reference 10; this absorption classification system is based on a reference curve for octave bands between 250 Hz and 4 kHz, although the BB 93 standards assessment is based on the 500 Hz, 1 kHz and 2 kHz octave bands only. Therefore there may be some discrepancy between the absorption Classes proposed and the performance of any particular products, and the Classes are offered as guidance only; the performance of all particular products should be checked before compliance with the requirements of BB 93 can be confirmed. Suitable products are listed in Appendix E.

7.6 **Circulation spaces**

7.7 There are two methods for calculating the absorption in circulation areas described as Method A and Method B. Method A of AD-E indicates that an absorber of minimum Class C, should be used to an area equal to the floor area of corridors and circulation areas. An alternative method of assessment is Method B of AD-E; this is based on the volume of the circulation space and describes absorption areas to be provided based on the volume. Method B assessment enables the absorption to be provided with a mixture of different materials and absorption Classes, if preferred.

7.8 The P03 Cloaks space may be considered as a circulation space as it provides access to the classrooms. A portion of the ceiling is taken up by the rooflight and plasterboard bulkhead. Class A ceiling tiles may be used to provide an area of absorption equivalent to a full cover Class C ceiling, thereby meeting requirements.

8 Mechanical plant noise

8.1 **Internal building services noise for BB 93 indoor ambient noise level limits**

8.2 Internal building services will need to be designed with consideration to the relevant BB 93 IANL criteria. Recommended internal M&E noise level limits in terms of Noise Rating curves, NR, are set out in Table 7.

Space	Recommended M&E noise limit
New classroom building	
Classrooms	≤ NR 29
Cloaks	≤ NR 39
WCs	≤ NR 39
Refurbished spaces	
Medical room	≤ NR 39
WCs	≤ NR 49

Table 7: Internal M&E noise limits

8.3 **External fixed building services installations noise impact**

8.4 New sources of fixed building service plant associated with the development include an air source heat pump (ASHP), hybrid ventilation units to classrooms (HVU), heat recovery unit (HRU) serving the WCs and Cloaks and WC extract fans.

8.5 It is common for Local Planning Authorities to identify that the impact from building services noise sources on nearby noise sensitive receptors, including dwellings, should be considered and assessed, so as to reduce the potential for a significant adverse impact.

8.6 BS 4142 indicates a “low” impact may be achieved, when the plant noise as Rated according to BS 4142 does not exceed the existing background noise level. Therefore, based on the baseline survey the potential limit for new building services plant at 1 metre outside noise-sensitive windows of the nearest identified NSR is indicated in Table 8, assuming plant may operate during the daytime and night-time.

Location	BS 4142 Rated noise level limit, dB $L_{Ar,Tr}$	
	Daytime (07:00-23:00)	Night-time (23:00-07:00)
A & B – residential premises to the west and north	≤ 38	≤ 26
C – Flutterbies Childcare Centre	≤ 38	-

Table 8: Noise limits for building services plant at identified NSR

8.7 The background noise levels during the day and night-time are very low. This will require careful design of M&E including, for example, locating all M&E sources of noise away from residential façades, and preferably screened by the massing of the school buildings.

8.8 Proposed plant noise limits apply to the cumulative rated noise level of all new items of plant.

8.9 With consideration to the amenity of gardens to residential premises, BS 8233 (Reference 11) states that noise levels in external amenity spaces should not exceed 50 dB $L_{Aeq,T}$. By achieving limits at NSR façades, garden amenity limits shall be met.

9 Alternative performance standards

9.1 Section 0.5 of BB 93 indicates that alternative performance standards (APS) may be adopted for new builds where the standards of BB 93 are not appropriate and should not normally be of a lower standard than those shown for refurbishment.

9.2 BB 93 Section 0.5 indicates than any APS must be justified by a suitably qualified acoustician and the school client body on the grounds of educational, environmental or health and safety needs. The contractor, with the assistance of the project acoustician, should make the building control body and the client aware of the practical implications with respect to the operation of the space.

9.3 At this time, no APS are required and BB 93 performance standards shall be met throughout.

10 Schedule of acoustic performance testing

10.1 BB 93 indicates that testing should be carried out according to the Association of Noise Consultants Good Practice Guide for the Acoustic Testing of Schools, Reference 12. Testing is required to demonstrate compliance with BREEAM Hea 05 post-construction evidence requirements.

10.2 BB 93 recommends testing of sound insulation, ambient noise and reverberation time, carried out at a rate of one in four new build teaching and study rooms; the following schedule is proposed based on up to 2 relevant teaching / study spaces:

Test type	No. tests proposed
Wall airborne sound insulation	up to 1*
Ambient noise level	1
Reverberation time	1
* Due to the presence of doors in the partitions between classrooms and the group room, there is little scope for testing of walls.	

Table 9: Proposed schedule of in-situ acoustic performance testing for BB 93

11 Conclusion

11.1 Based on the assumptions and calculations detailed in this report, appropriate construction features have been identified that are capable of achieving the acoustic performance standards of BB 93.

11.2 By meeting the acoustic performance standards of BB 93, BREEAM Hea 05 credit requirements shall also be met. Acoustic testing is required at pre-completion stage to demonstrate compliance.

12 References

1 Cambridge City Council Education Capital Project Brief, document reference: 23-01-30 Project brief - Benwick MS2 - 7 v5

2 Building Bulletin 93: Acoustic design of schools - performance standards, DfE & EFA, February 2015.

3 Acoustics of Schools: a design guide, IOA & ANC, November 2015.

4 Approved Document E, Resistance to the Passage of Sound, The Building Regulations 2000, 2003 Edition, as amended June 2004.

5 The School Premises (England) Regulations 2012, Statutory Instruments, No. 1943.

6 The Education (Independent School Standards) (England) Regulations 2010, 2013, Statutory Instruments, No. 1997.

7 Department for Education, Employers Requirements Part B, School Output Specification Generic Design Brief, May 2022, and Annex 1A-3 November 2021-May 2022

8 BS 4142:2014: A1+2019, Method for rating and assessing industrial and commercial sound

9 BS EN ISO 140-18, 2006: Acoustics – Measurement of sound insulation in buildings and of building elements. Part 18 – Laboratory measurement of sound generated by rainfall on building elements.

10 BS EN ISO 11654: 1997 Acoustics – Sound Absorbers for use in Buildings – Rating of Sound Absorption

11 BS 8233:2014 Guidance on sound insulation and noise reduction for buildings

12 Association of Noise Consultants, Good Practice Guide - Acoustic Testing of Schools, Version 2, November 2015

Appendix A Adopted acoustic performance standards

Room Name	BB 93 room description	Indoor ambient noise upper limit / dB $L_{Aeq,30min}$	Activity noise (source room)	Noise tolerance (receive room)	T_{mf} limit (seconds)
New classroom building					
P01 Classroom	Primary School Classroom	35	Average	Medium	≤ 0.6
P02 Classroom					
P03 Cloaks	Coats and locker area	45	Average	High	≤ 1.5
P04 WCs	Toilet	50	Average	High	≤ 2.0
P05 Staff/Acc WC					
P06 Cleaners	Store	n/a	n/a	n/a	n/a
P07 Hub	Server Room	n/a	Low	High	n/a
P08 Plant	Plant Room	n/a	Low	High	n/a
Refurbished spaces					
EB.04 Medical room	*Medical room**	*45*	*Low*	*Medium*	*≤ 1.2*
EB.03 Staff WC	*Toilet**	*55*	*Average*	*High*	*≤ 2.0*
EB.07 Unisex WC					

Notes:

** – Performance standards for refurbished spaces are provided for guidance as only refurbished elements to these spaces need to meet BB 93 requirements.*

Table 10: Acoustic performance standards

Appendix B Ventilation conditions and systems

B.1 For mechanical ventilation systems BB 93 states:

"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 1,000 ppm 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."

B.2 For natural and hybrid ventilation systems BB 93 states:

"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 1,500 ppm 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 5 l/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 external ambient free field noise levels at the facade expressed as the $L_{Aeq,30mins}$, do not exceed the IANL figures given in Table 1 by more than 16 dB for single sided ventilated spaces and 20 dB for cross ventilated or roof ventilated spaces, the criteria for natural ventilation can usually be achieved. However, the ventilation strategy still requires appropriate design of façade openings, height differences between low and high level openings, corridor transfer vents/stacks, etc, to limit the required façade open areas appropriately."

Appendix C Apex Noise Survey

C.1 Measurements of the existing noise environment were made from Tuesday 23rd to Wednesday 24th August 2022 at one representative position, 'MP', shown in Figure 1. The noise survey location is considered representative to inform the noise climate at both proposed new school buildings and nearby dwellings.

Figure 1: Site, existing/proposed classrooms (green) noise survey measurement position (orange) and identified NSR (red)

C.2 The microphone was located at approximately 1.5 m above ground level, fixed to a tripod, away from other reflecting surfaces, such that the measurements are considered to be free-field.

C.3 Data was recorded in single octave band frequencies and at one-second intervals throughout the measurement period.

C.4 The equipment used is listed in Table 11.

Equipment	Model	Serial no.
Sound Level Meter	NTi XL2	A2A-11062-E0
Calibrator	Larson Davis CAL 200	13403

Table 11: Equipment used

C.5 Both meter and calibrator have current calibration certificates traceable to national standards. The sound level meter has been calibrated within the last two years and calibrator has been calibrated within the last year in accordance with the guidance of BS 4142; calibration certificates are available on request.

C.6 The equipment was field calibrated before and after the measurements with no significant drift in sensitivity noted.

C.7 Weather conditions were dry during measurements with wind speeds below 5 m/s. No rain occurred and cloud coverage was around 80-100 %. Temperatures varied between 20-29 °C.

C.8 The measurements were carried out during school holidays and were not affected by existing school activities.

C.9 The ambient noise environment was dominated by birdsong, occasional aircraft flying overhead, distant road traffic noise and occasional vehicles on local roads.

C.10 Noise sensitive receptors and noise sources

C.11 Identified noise-sensitive receptors (NSRs) adjacent to the development include:

- NSR A - the nearest residential premises on Old W Estate to the west of the site;
- NSR B - residential premises to the north of the site;
- NSR C - Flutterbies Childcare Centre.

C.12 The identified NSRs are indicated in Figure 1.

C.13 The measurements were carried out during school holidays and were not affected by existing school activities.

C.14 The ambient noise environment was dominated by road traffic noise, primarily from vehicles on High Street, and birdsong.

C.15 Results

C.16 A summary of the results is shown in Table 12. A time history of measured levels is shown in Figure 2.

Period	Start date // Time hh:mm	Duration hh:mm	dB $L_{Aeq,T}$	dB $L_{A90,T}$	$L_{A01,T}$
Day	23/08/22 // 13:00	10:00	53	26	65
Night	23-24/08/22 // 23:00	08:00	47	24	62
Day	24/08/22 // 07:00	07:00	56	39	66

Table 12: Summary of measured noise levels

C.17 The time history of the measured levels is shown below.

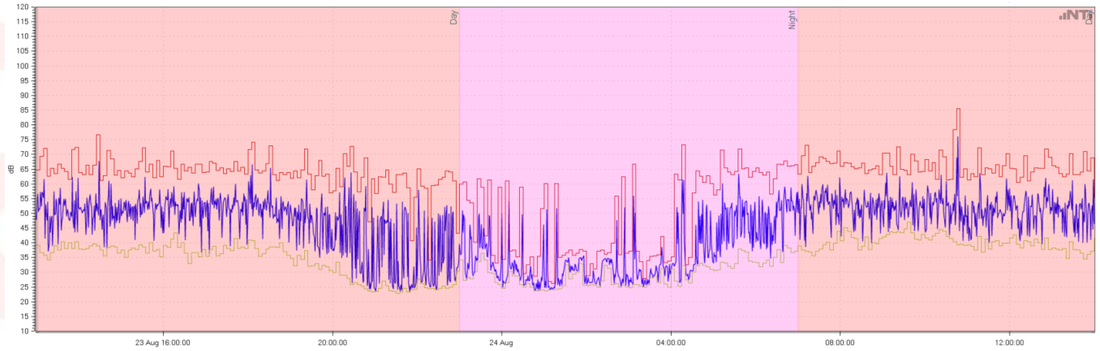


Figure 2: Time history of measured $L_{Aeq,5min}$ (blue), $L_{A01,5min}$ (red) and $L_{A90,5min}$ (green) levels at MP

C.18 Analysis has been undertaken as per BS 4142 guidance for the long term measurements locations to determine representative daytime and night-time background noise levels, with results summarised in Table 13, and histograms in Figure 3 and Figure 4. The selected representative background noise level is identified in **red**.

Daytime (07:00-23:00) background noise dB $L_{A90,T}$	Night-time (23:00-07:00) background noise dB $L_{A90,T}$
38	26

Table 13: Background noise levels, with guidance of BS 4142

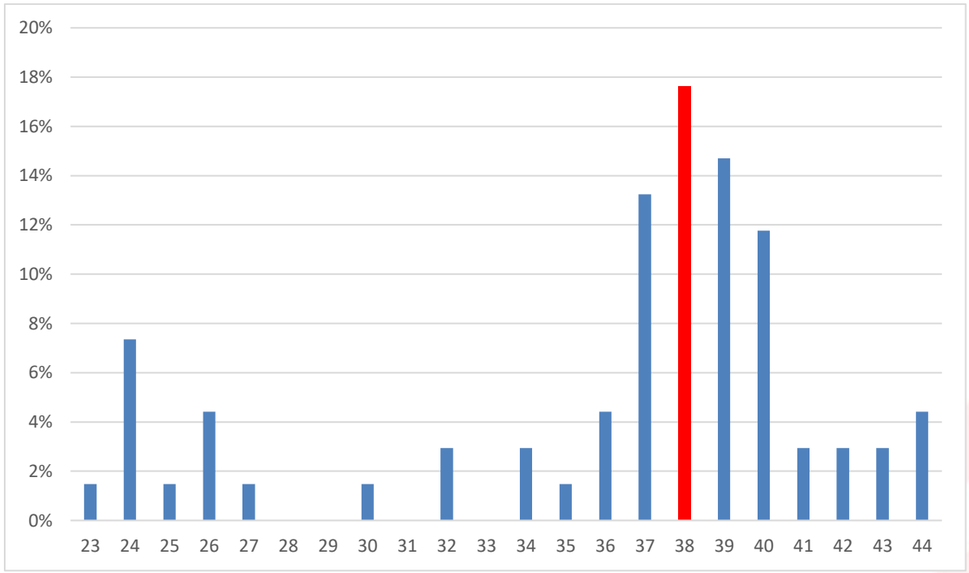


Figure 3: Analysis of daytime (07:00-23:00) background levels, $L_{A90,15min}$

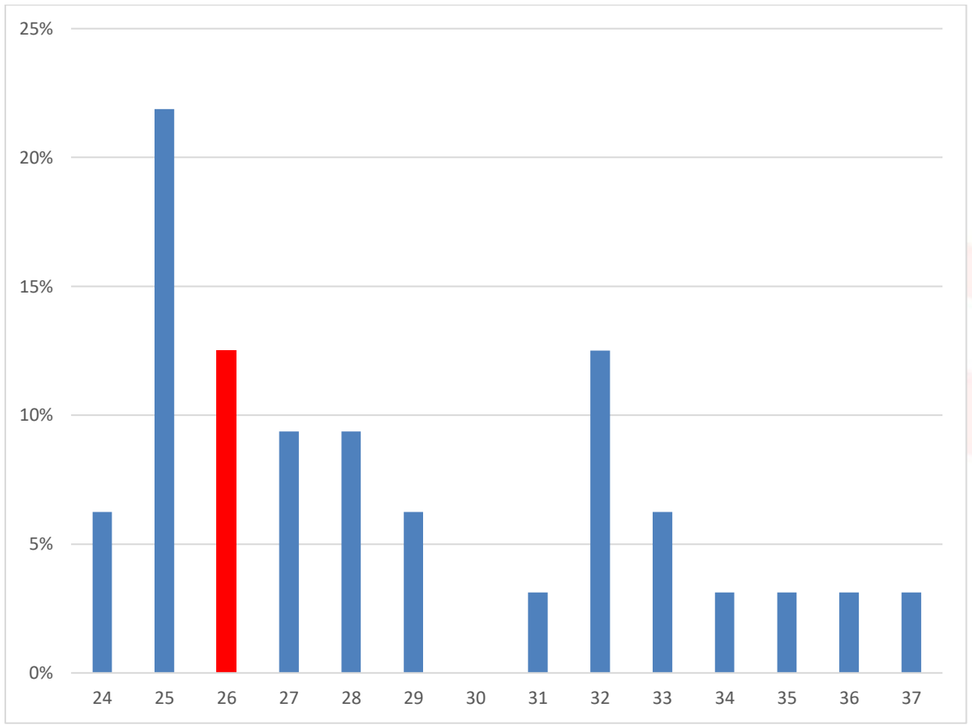


Figure 4: Analysis of night-time (23:00-07:00) background levels, $L_{A90,15min}$

Appendix D Services penetrations

D.1 It is generally easier to route services along the corridors and break through the corridor wall than it is to seal penetrations through separating walls between classrooms.

D.2 Sealing services penetrations is proposed as in Table 14 below.

Partition rating / R_w dB	Services penetrations sealing - above suspended ceiling level
≤ 40	A single layer of ablative coated batt (such as Hilti CP 670) should be cut and friction fitted around service penetrations. The batt should be sealed with acoustic mastic. All joints, cracks and gaps less than 20 mm may be sealed with acoustic mastic only. The total area of ablative batt should be kept to a minimum, where large areas need to be sealed the advice for partitions rated ≥ R_w 51 should be taken.
41 – 49	Two layers of ablative coated batt (such as Hilti CP 670) should be cut and friction fitted around service penetrations, and sealed as above. All joints, cracks and gaps less than 20 mm may be sealed with acoustic mastic only. The total area of ablative batt should be kept to a minimum, where large areas need to be sealed the advice for partitions rated ≥ R_w 51 should be taken.
≥ 50	All voids around the service penetration should be packed with quilt and the penetrations should have two layers of plasterboard equivalent to the wall linings or 2 x 12.5 mm SoundBloc, scribed around the services to within no more than 20 mm and sealed all around with acoustic mastic, overlapping the plasterboard partition by at least 50 mm if surface mounted.

Table 14: Service penetration detailing

Appendix E Suppliers of proprietary acoustic products

E.1 Inclusion or otherwise in the list below does not imply endorsement of any particular product or material.

E.2 Acoustic doorsets

E.3 Leaderflush Shapland, www.lsgroupltd.co.uk

E.4 Soundsorba, www.soundsorba.com

E.5 www.amadeus-acousticsolutions.co.uk

E.6 Absorbent ceiling tiles:

E.7 Ecophon Gedina E or Advantage, www.ecophon.co.uk

E.8 Rockfon Blanka (performance varies but all except edge type B are Class A), www.rockfon.co.uk

E.9 Zentia (formerly Armstrong) Perla OP (Class A), www.armstrong.co.uk

E.10 Absorbent wall panels

E.11 Wallsorba, from www.soundsorba.com

E.12 Ecophon wall panels, www.ecophon.co.uk

E.13 Vertiface composition, Superphon wall panels from www.cmsacoustics.co.uk

E.14 Rockfon Boxer, wall mounted, www.rockfon.co.uk

E.15 Various wall panels from J C Wilkins, www.acoustic-supplies.com

E.16 Acoustic socket back box liners

E.17 Acoustic and intumescent Putty Pads, such CP 617 from www.hilti.co.uk

E.18 Intumescent putty pads from Envirograf:, www.envirograf.com

E.19 SRS Acoustic Socket Box, www.soundreduction.co.uk/1.html

E.20 High density mineral wool batts

E.21 Hilti CP 670, from www.hilti.co.uk

E.22 Fire Barrier from Firestem, www.firestem.co.uk

Appendix F Glossary of terms

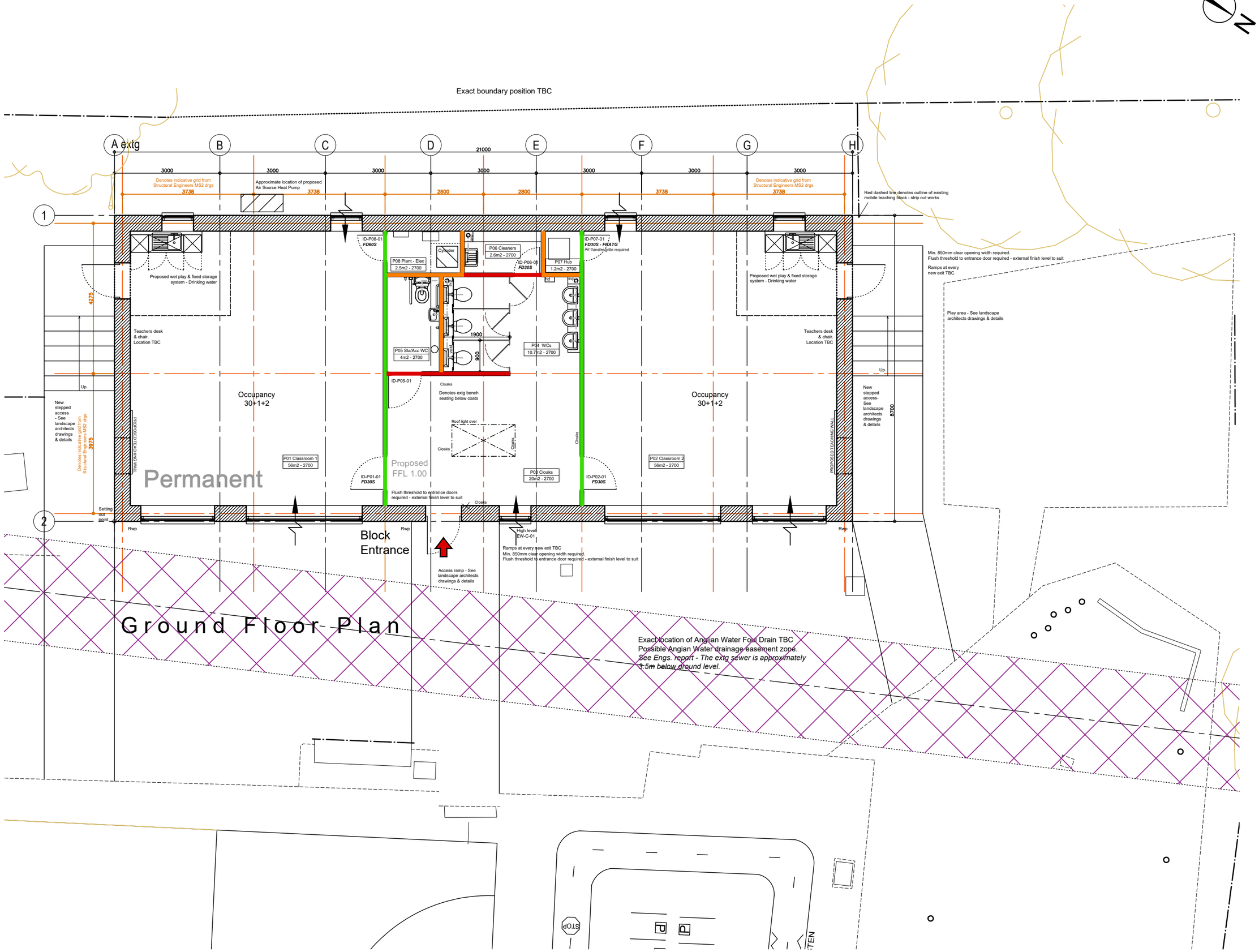
Term	Meaning	See
Absorption coefficient	A quantity characterizing the effectiveness of a sound absorbing surface. The proportion of sound energy absorbed is given as a number between zero (for a fully reflective surface) and one (for a fully absorptive surface). Note that sound absorption coefficients determined from laboratory measurements may have values slightly larger than one. See BS EN 20354:1993.	ISO 11654
Airborne sound insulation	Sound insulation that reduces transmission of airborne sound between buildings or parts of buildings.	BB 93, AD-E
Direct transmission	The process in which sound that is incident on one side of a building element is radiated by the other side.	BB 93, AD-E
D_{nT}	The difference in sound level between a pair of rooms, in a stated frequency band, corrected for the reverberation time. See BS EN ISO 140-4:1998.	ISO 140-4
$D_{nT,w}$	A single-number quantity which characterizes the airborne sound insulation between rooms. See BS EN ISO 71 7-1:1997.	ISO 717-1
$D_{nT(Tmf,max),w}$	The level difference as above, based on the maximum allowable reverberation time in the receiving room	BB 93
Flanking element	Any building element that contributes to sound transmission between rooms in a building that is not a separating floor or separating wall.	BB 93, AD-E
Flanking transmission	Sound transmitted between rooms via flanking elements instead of directly through separating elements or along any path other than the direct path.	BB 93, AD-E
$L_{Aeq,T}$	The value of the A-weighted sound pressure level in decibels (dB) of a continuous, steady sound that within a specified time interval, T, has the same mean squared sound pressure as the sound under consideration that varies with time.	BB 93
R_w	A single-number quantity which characterizes the airborne sound insulation of a material or building element in the laboratory. See BS EN ISO 71 7-1:1997.	ISO 717-1
Sound reduction index, R_w	A quantity, measured in a laboratory, which characterizes the sound insulating properties of a material or building element in a stated frequency band. See BS EN ISO 140-3:1995.	ISO 140-3
T_{mf}	Mid-frequency reverberation time, defined as the arithmetic mean of the reverberation times in the 500 Hz, 1 kHz, and 2 kHz octave bands.	BB 93
$T_{mf,\,max}$	Maximum allowable mid-frequency reverberation time	BB 93

F.1 For a complete glossary of terms, see www.apexacoustics.co.uk

Appendix G Architect's Acoustic Strategy Drawings

G.1 The following pages contain architect's Acoustic Strategy drawings for reference.

G.2 Acoustic Strategy drawings are aligned with Apex specification.



This drawing is not to be scaled. The architect is to be informed of any errors before work proceeds. The general contractor is responsible for checking all dimensions

Notes

These drawings are for illustrative purpose only. They are created from a combination of historic record drawings and survey data. The accuracy of the information contained within cannot be guaranteed and should not be relied upon.

Refer to Landscape architects drawing for external works

See M&E drawings for details of relevant works

DRAWING LEGEND

- Existing walls
- Denotes strip out works
- Denotes new build
- Exact location of Anglian Water Foul Drain TBC, Possible Angian Water drainage easement zone
- ***Warning Hazzard Follow safety instructions.***

ACOUSTIC DRAWING LEGEND

- Rw 51 dB partition
- Rw 45 dB partition
- Rw 40 dB partition

Rev	Date + notes	Drwn	Chkd
P1	2023.09.20 First issue	JC	KM

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cambridge@rhpartnership.co.uk

Project
Benwick Community Primary School
2 classrooms, toilets & cloaks in the same location as the existing mobile

Drawing
Proposed Acoustic Strategy - Permanent

Project	originator	volume	level	type	role	number	revision
BPS-RHP-TB-ZZ-DR-A-2405							P1

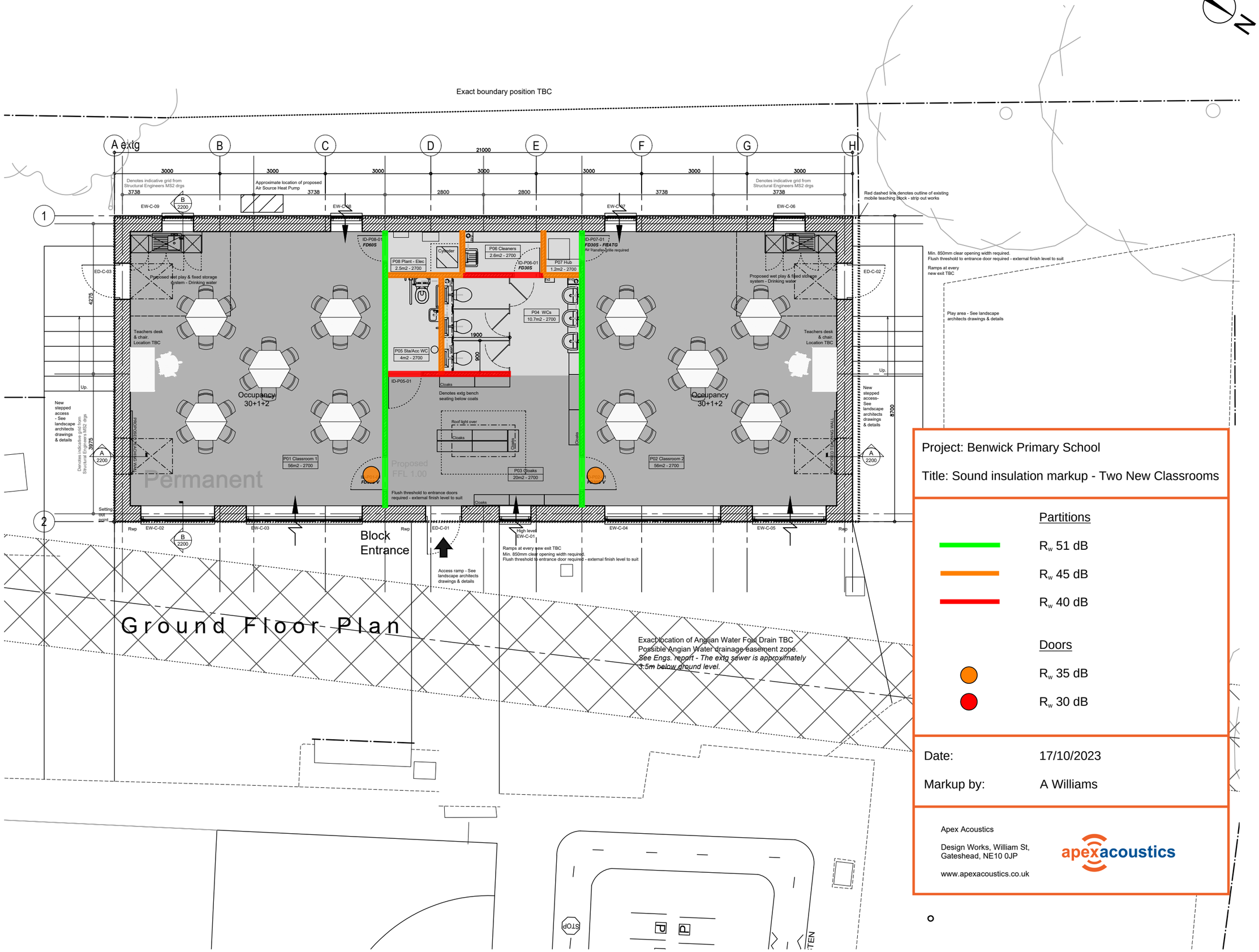
Scale(s) @ A1	RHP Project	Drwn	Chkd
1:50	P01207	JC	KM

Status: MS3
Suitability: S0

File location: H:\Projects\P1200-P1249\P1207 Benwick Primary School\BIM\01-WIP\Shwd_Files\2000-2999 GAs\2400-2499 Acoustic Strategy\BPS-RHP-TB-ZZ-DR-A-2405-P1 # MS3 Proposed Acoustic Strategy.dwg Last Plotted: 21/9/2023 8:10AM

Appendix H Drawing mark-ups for sound insulation

H.1 The following pages contain the sound insulation and absorption proposals to satisfy BB 93 performance standards.



This drawing is not to be scaled. The architect is to be informed of any errors before work proceeds. The general contractor is responsible for checking all dimensions

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Drawings based on topographical survey & CCC 7 bay modular classroom building number 674 plan

- Basic Teaching
- Large Spaces
- Learning Resource Areas
- Staff & Administration Areas
- Storage
- Supplementary Areas
- Non-Net Areas

Project: Benwick Primary School

Title: Sound insulation markup - Two New Classrooms

Partitions

- R_w 51 dB
- R_w 45 dB
- R_w 40 dB

Doors

- R_w 35 dB
- R_w 30 dB

Date: 17/10/2023

Markup by: A Williams

Apex Acoustics

Design Works, William St, Gateshead, NE10 0JP

www.apexacoustics.co.uk

Rev	Date + notes	Drwn	Chkd
P5	26.09.2023 Cross references to section lines added, drg 2200.	JC	KM
P4	20.09.2023 Issued for MS3	JC	KM
P3	10.08.2023 Issued for MS2	JC	KM
P2	03.08.2023 Locations of ASHP & associated cylinder added following review at DTM. Plant room size increased to suit cylinder requirements and WC zone reduced to suit.	JC	KM
P1	26.07.2023 First Issue	JC	KM

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Project

Benwick Community Primary School
2 classrooms, toilets & cloaks in the same location as the existing mobile

Drawing

Proposed plan - Permanent

Project	originator	volume	level	type	role	number	revision
BPS-RHP-TB-ZZ-DR-A-2005							P5

Scale(s) @ A1	RHP Project	Drwn	Chkd
1:50	P01207	JC	KM

Status: MS3

Suitability: S0