SYNTEGRA CONSULTING

Collis Primary School, Teddington

Acoustic Assessment

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1. Executive Summary

An assessment has been carried out for the **Collis Primary School, Teddington** in order to demonstrate compliance with the criteria and design advice provided within BB93. The scheme involves the construction of a new build two storey primary school containing twelve classrooms (Reception and Years 1 and 2), a nursery, an art/DT room, a dining hall, a kitchen and various offices and ancillary spaces.

The assessment has identified:

- Internal Ambient Noise Levels.
    - **The proposed external wall construction should readily achieve the requirements of BB93, even with open windows.**
    - **Maximum noise levels from mechanical ventilation systems have been provided if this ventilation strategy is to be utilised.**
    - **Where ductwork connects two rooms, cross-talk attenuators should be considered to assist with speech privacy.**
    - **The roof construction has been assessed and it has been identified that it will sufficiently mitigate rain noise.**
- Internal Sound Insulation
    - The sound insulation requirements of all of the different rooms has been assessed and two different wall constructions have been specified in order to achieve those requirements.
    - **The wall constructions are detailed in Table 5.2 and a marked-up plan showing which walls would require each type of wall construction is provided in Appendix 3**.
    - **The sound insulation of the proposed floor has been assessed and it has been identified that the airborne and impact sound insulation criteria should be readily achieved.**
- Reverberation
    - **The Art/DT Classroom (Room 22) and the Dining Hall (Room 10), which will both have a vinyl floor finish, should have ceiling tiles rated to be a Class C absorber or better.**
    - **All other rooms should have ceiling tiles rated to be a Class D absorber or better.**

It is important to note that, as with any construction project, the ability to meet the specification will rely upon the quality of the built structure. As such the works should be carried out to a high standard of workmanship to ensure that any sound insulation measures are not breached, for example by installing a rigid connection across an isolated connection (such as resilient bars or a resilient matt). Additionally, any joints between different walls and the party wall and the ceiling/floor should be carefully filled with acoustic mastic.

2. Introduction

This report has been prepared to assess the acoustic conditions of the proposed construction for the **Collis Primary School, Teddington**. The scheme involves the construction of a new build two storey primary school containing twelve classrooms (Reception and Years 1 and 2), a nursery, an art/DT room, a dining hall, a kitchen and various ancillary spaces.

The report assesses the current design proposals and determines the level of compliance with the identified criteria.

The site location is provided as **Figure 2.1** below.

Figure 2.1: Site Location

The proposed internal layout plans for the new school have been provided by Extraspace Solutions and produced by AHR Architects Ltd. The proposed internal layout plans (drawing numbers PL-CPS-AHR-00-00-DR-A-20-001 and PL-CPS-AHR-00-01-DR-A-20-001 dated 13th August 2019) are reproduced as **Figure 2.2** (ground floor) and **Figure 2.3** (first floor) below.

Figure 2.2: Proposed Ground Floor Internal Layout Plans

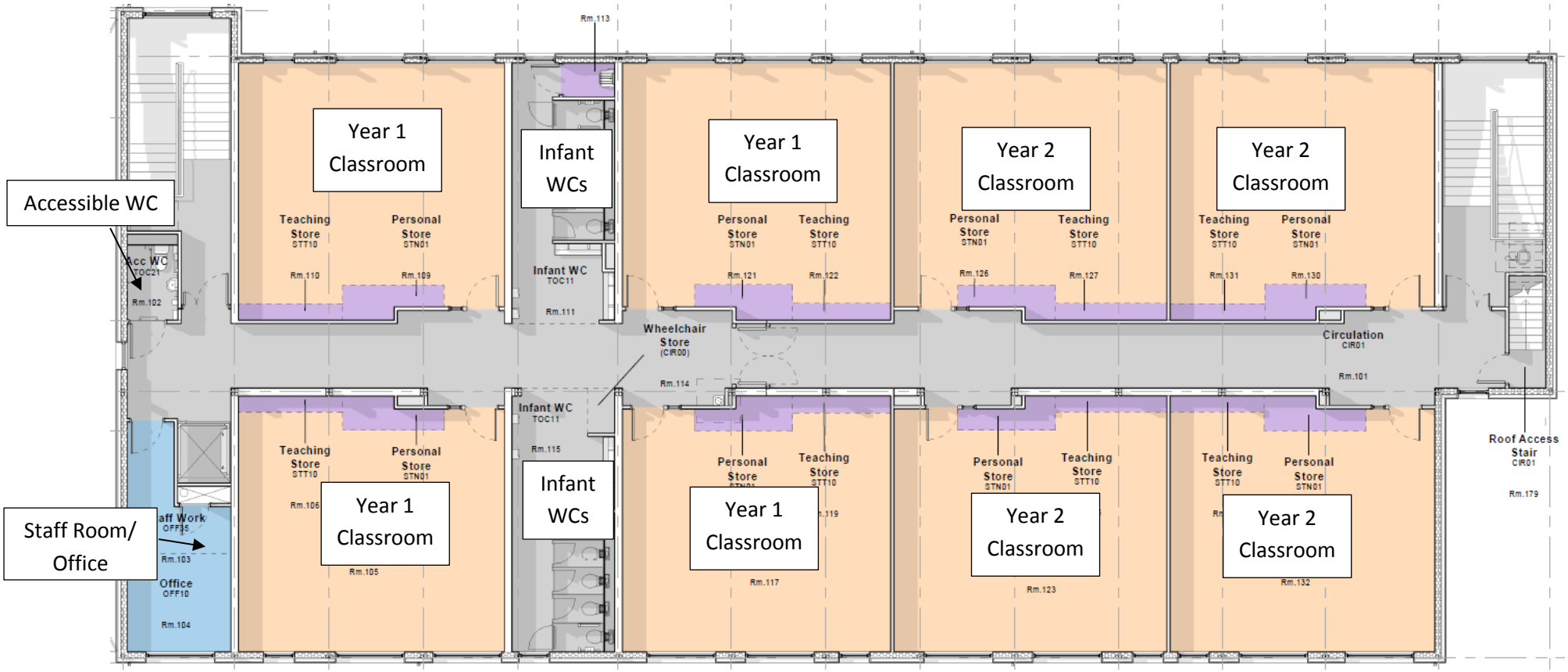


Figure 2.3: Proposed First Floor Internal Layout Plans

3. Guidance Documents

3.1. Building Bulletin 93 – Acoustic Design of Schools: Performance Standards

Building Bulletin 93 – Acoustic Design of Schools: Performance Standards (BB93) was published in 2014 and sets out minimum performance standards for the acoustics of school buildings. The document describes the normal means of demonstrating compliance with the Building Regulations. It also provides guidance in support of the School Premises Regulations (2012) and the Independent School Standards (2013). The document supersedes Section 1 of the previous version of BB93 which was published in 2003.

3.1.1. Indoor Ambient Noise Levels

Table 1 in Section 1 of the document specifies an upper limit for indoor ambient noise levels in specified spaces. Those most relevant to primary schools are reproduced in **Table 3.1** below.

Type of Room	Upper limit for the indoor ambient noise level $L_{Aeq,30min}$ (dB)
	New Build
Primary school: classroom, class base, general teaching area, small group room	35
Open plan: teaching area, resource/breakout area	40
Primary music room	35
SEN calming room	35
Library	40
Assembly halls, multi-purpose halls (drama, PE, audio/visual presentations, assembly, occasional music)	35
Atrium, circulation space not intended for teaching or learning	45
Meeting room, interviewing/counselling room, video conference room	40
Dining rooms	45
Administration and Ancillary spaces	
Kitchens	50
Offices, medical room, staff rooms	40
Corridors, stairwells, coats and locker areas	45
Changing areas	50
Toilets	50

Table 3.1: Upper Limit for the Indoor Ambient Noise Level $L_{Aeq,30min}$

3.1.2. Ventilation Noise

It is stated within BB93:

'Noise from building services under normal conditions should meet the limits for indoor ambient noise levels (IANL) given in table 1 [**Table 3.1** of this report].

The design should show that IANLs can be achieved when the ventilation systems are operating in their normal condition; when providing intermittent boost ventilation; and when operating to control summertime overheating. 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 in Table 1 for different types of ventilation system under different operating conditions are summarised in Table 2 below.'

The most relevant parts of Table 2 of Section 1 of BB93 is reproduced in **Table 3.2**.

Condition	Ventilation System	Noise Level Limit
Normal – ventilation for normal teaching and learning activities	Mechanical	**Table 3.1** value
	Natural	**Table 3.1** value + 5 dB
	Hybrid	Mechanical system noise: **Table 3.1** value
		Total system noise: **Table 3.1** value + 5 dB
Summertime – ventilation under local control of teacher to prevent overheating – allowable during the hottest 200 hours of the year	Mechanical	**Table 3.1** 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	**Table 3.1** value + 5 dB
	Natural or Hybrid	≤ 55 dB

Table 3.2: Summary of Ventilation Conditions, System Type and Associated Indoor Ambient Noise Level Tolerance

3.1.3. **Rain Noise**

In respect of noise from heavy rain falling on roofs of schools, it is important to consider how much insulation is included within the roof structure in order to ensure that noise levels are not too high. BB93 states:

"The IANL [indoor ambient noise level] *excludes noise contributions from… rain noise - however, Building Regulation submissions should demonstrate that lightweight roofs and roof glazing have been designed to provide suitable control of rain noise reverberant sound pressure level in a space (calculated using laboratory test data with 'heavy' rain noise excitation as defined in BS EN ISO 140-18). Levels during heavy rain should not be more than 25 dB above the appropriate indoor ambient noise level given in table 1 (for refurbishments, this applies only to new roofing elements and not to repairs to existing roofs)."*

The document *"Acoustics of Schools – A Design Guide"* (published November 2015) provides supporting information and states:

"The impact noise from rain falling on the roof can substantially increase the indoor noise level; in some cases, the noise level inside a school due to rain can be as high as 70 dBA. Although rain noise is excluded from the definition of indoor ambient noise in Section 1.1.1 of Building Bulletin 93, it is a potentially significant noise source which must be considered at an early stage in the roof design to minimise disturbance inside the school.

Excessive noise from rain on the roof can occur in spaces such as sports halls and assembly halls where the roof has a large surface area and is constructed from profiled metal cladding with no sealed roof void to attenuate the noise before it radiates into the space below. Suitable treatments that can be used in combination to provide sufficient resistance to impact sound from rain on the roof are:

- *damping of the profiled metal cladding (e.g. using commercial damping materials)*
- *use of dense mineral wool insulation in the roof build-up*
- *independent ceilings below the lightweight roof.*

Profiled metal cladding used without mineral wool insulation or without an independent ceiling is unlikely to provide sufficient resistance to impact sound from rain on the roof. Reference can be made to manufacturers' data to assess the effect of 'Heavy' rain noise (measured in accordance with BS EN ISO 140-18) for a range of lightweight roof constructions."

3.1.4. **Airborne Sound Insulation**

Table 1 in Section 1 of the document specifies the typical activity noise level and noise tolerance of specified spaces. Those most relevant to primary schools are reproduced in **Table 3.3** below.

Type of Room	Room classification for the purpose of airborne sound insulation	
	Activity Noise (Source Room)	**Noise Tolerance (Receiving Room)**
Nursery School Rooms Primary school: classroom, class base, general teaching area, small group room	Average	Medium
Open plan: teaching area, resource/breakout area	Average	Medium
Primary music room	High	Medium
SEN calming room	High	Low
Library – Quiet study area Resource area	Low Average	Medium Medium
Assembly halls, multi-purpose halls (drama, PE, audio/visual presentations, assembly, occasional music)	High	Low
Atrium, circulation space not intended for teaching or learning	Average	Medium
Meeting room, interviewing/counselling room, video conference room	Low	Medium
Dining rooms	High	High
Administration and Ancillary spaces Kitchens Offices, medical room, staff rooms Corridors, stairwells, coats and locker areas Changing areas Toilets	 High Low Average High Average	 High Medium High High High

Table 3.3: Room Classification for the Purpose of Airborne Sound Insulation

Utilising the room classifications obtained from **Table 3.3**, the level of airborne sound insulation ($D_{nT,w}$) can be obtained utilising Tables 3a and 3b from BB93, which are reproduced in **Table 3.4**.

Minimum $D_{nT,w}$ (dB)			Activity noise in source room			
			Low	Average	High	Very High
New build performance standards	Noise tolerance in receiving room	High	N/A	35	45	50
		Medium	40	45	50	55
		Low	45	50	55	55

Table 3.4: Performance Standards for Airborne Sound Insulation Between Spaces

Additionally, performance standards for airborne sound insulation between circulation spaces and other spaces used by students are provided in Tables 4a and 4b of Section 1 of the document and those standards most relevant to primary schools are reproduced in **Table 3.5**.

Type of Room	Minimum R_w dB		
	Composite R_w of wall and glazing (no ventilator)	Composite R_w of wall and glazing (with ventilator)	Doorset
	New Build	New Build	
Teaching space intended specifically for use by students with special hearing or communication needs	45	38	35
All other rooms used for teaching or learning	40	33	30

Table 3.5: Performance Standards for Airborne Sound Insulation Between Circulation Spaces and Other Spaces Used by Students

3.1.5. **Impact Sound Insulation**

Table 5 in Section 1 of the document specifies the maximum impact sound insulation ($L'_{nT,w}$) for receiving rooms of different types and uses. Those most relevant to primary schools are reproduced in **Table 3.6** below.

Type of Room (receiving room)	Maximum impact sound pressure level ($L'_{nT,w}$) dB
	New Build
Teaching space intended specifically for students with special hearing and communication needs	55
All other teaching areas SEN calming room Library Assembly halls, multi-purpose halls (drama, PE, audio/visual presentations, assembly, occasional music) Meeting room, interviewing/counselling room, video conference room Administration and Ancillary spaces	60
Dining rooms	65

Table 3.6: Performance Standards for Impact Sound Insulation of Floors

3.1.6. **Reverberation Times**

The reverberation time of spaces within schools is important as it affects speech intelligibility. If the reverberation time is too long, then background noise levels can build up quickly within rooms and it

can be difficult for students to hear what the teacher is saying. Similarly, if the reverberation time is too short, then sound can be absorbed too quickly and students further away from the teacher can struggle to hear what the teacher is saying. Table 6 in Section 1 of the document specifies the maximum mid-frequency reverberation time for different rooms. Those most relevant to primary schools are reproduced in **Table 3.7** below.

Type of Room (receiving room)	Maximum Mid-Frequency Reverberation Time (T_{mf}) (seconds)
	New Build
Primary school: classroom, class base, general teaching area, small group room	≤ 0.6
Open plan: teaching area resource/breakout area	≤ 0.5 ≤ 1.2
Primary music room	≤ 1.0
SEN calming room	≤ 0.6
Library	≤ 1.0
Assembly halls, multi-purpose halls (drama, PE, audio/visual presentations, assembly, occasional music)	0.8 – 1.2
Atrium, circulation space not intended for teaching or learning	≤ 1.5
Meeting room, interviewing/counselling room, video conference room	≤ 0.8
Dining rooms	≤ 1.0
Administration and Ancillary spaces Kitchens Offices, medical room, staff rooms Corridors, stairwells, coats and locker areas Changing areas Toilets	 ≤ 1.5 ≤ 1.0 * ≤ 1.5 ≤ 1.5

Table 3.7: Performance Standards for Reverberation Time

Notes: * For corridors, an area equal to or greater than the floor area should be covered with a Class C absorber or better. The simplest way to do this is to cover the ceiling area with the additional absorption, although this is obviously not possible if the ceiling soffit is required to be exposed for cooling purposes.

* For stairwells, an area equal to or greater than the total combined area of the stair treads, intermediate landings, upper landings and the ceiling area of the top floor should be covered with a Class D absorber. Alternatively, 50% of the total combined area can be covered with a Class C absorber or better.

3.2. Acoustics of Schools – A Design Guide

The document Acoustics of Schools – A Design Guide was published in November 2015 and provides supporting guidance and recommendations on the acoustic design of new and refurbished schools. The document supersedes Sections 2 to 7 of the previous version of BB93 published in 2003 and supports the acoustic performance standards provided in the current version of BB93, published in 2015.

4. Internal Ambient Noise Levels

4.1. Baseline Noise Levels

The ambient noise levels at the site have previously been obtained by measurement by Mott Macdonald on the 20th and 21st September 2016 and have been previously reported in their report *'Collis Primary School – Acoustic Feasibility Assessment'* dated October 2016 with reference 374941 | 1 | A | 26 October 2016.

A summary of the results of the baseline noise survey are displayed in **Table 4.1**

Measurement Position	Maximum $L_{Aeq,30min}$ (dB)
LT1	56.7
ST1	58.6
ST2	55.4
ST3	57.8
ST4	49.2
ST5	50.1

Table 4.1: Summary of Measured Noise Levels

4.2. Internal Ambient Noise Level Criteria

The internal ambient noise level criteria for the project have been determined utilising the internal layout plans along with the advice contained within BB93, as summarised in **Section 3.1.1**. The internal ambient noise level criteria adopted for this scheme for example rooms are presented in **Table 4.2**. The example rooms have been chosen in order to assess each type of room and scenario. It can therefore be safely assumed that if the identified criteria is achieved from the example rooms, the remainder of the rooms within the school will achieve the internal ambient noise level criteria.

Room Reference	Room Use	Upper limit for the indoor ambient noise level $L_{Aeq,30min}$ (dB) (windows closed)	Upper limit for the indoor ambient noise level $L_{Aeq,30min}$ (dB) (windows open)
10	Dining Hall	45	50
92	Kitchen	50	55
99	Nursery	35	40
22	Art/DT Room	35	40
28	Reception Classroom 3	35	40
103/104	Staff Work Room	40	45
108	Year 1 Classroom	35	40
132	Year 2 Classroom	35	40

Table 4.2: Internal Ambient Noise Level Criteria

4.3. Building Envelope Assessment

The proposed external wall and roof construction has been provided by Extraspace Solutions in their drawing number 2027-ESS-XX-ZZ-DR-W-200-P2 dated November 2017 and is summarised as follows:

- External wall construction
    - Render cladding on battens or Corium Tiling on a Horizontal Rail System

  - Breather membrane to external face of plywood
  - 11mm OSB board
  - Steel posts
  - 140mm rigid insulation
  - 147mm timber stud frame
  - Vapour control layer
  - 15mm *Siniat Megadeco* plasterboard
- Roof construction
  - 80mm thick *Kingspan KS1000RW* Roof Panel
  - 130mm roof joists
  - 130mm insulation between joists
  - 12.5mm *fireline* board
  - Suspended ceiling (Syntegra have assumed a light steel grid with standard ceiling tiles for the purposes of the building envelope assessment)

The sound reduction properties of the external wall, roof and dormer wall constructions have been determined utilising the INSUL software programme which implements a number of papers and standards including BS EN 12354-3:2000 *"Building acoustics – Estimation of acoustic performance of buildings from the performance of elements – Part 3: Airborne sound insulation against outdoor sound"*.

The sound insulation of the wall structure has been predicted to be 55 dB R_w.

The sound insulation of the roof structure has been predicted to be 47 dB R_w.

Additionally, Syntegra have made the following assumptions in respect of glazing and ventilation systems:

- Window (if closed for ventilation purposes) – expected sound insulation from standard double glazing is 28 dB R_w
- Ventilation could be provided by either open windows or through wall vents (or equivalent)
  - For open windows, Syntegra have assumed a total façade sound reduction of 15 dB[1].
  - For a through wall ventilator, Syntegra have assumed a 100mm through-wall vent with expected $D_{n,e,w}$ of approximately 32 dB for calculation purposes.

The composite sound insulation properties of the proposed building envelope (assuming a through wall ventilator) for each room have been calculated utilising standard acoustic formula. A second assessment has been carried out assuming open windows for ventilation for which a total façade sound reduction of 15 dB has been assumed.

[1] A sound reduction of 10 dB – 15 dB from an open window is widely accepted and has been referenced in many documents, including PPG24 (now revoked) and most recently in the document "ProPG: Planning and Noise – Professional Practice Guidance on Planning & Noise – New Residential Development" published in May 2017 and produced by the ANC, IOA and CIEH.

4.4. Compliance with Criteria

A detailed façade break-in assessment has been carried out based on the site layout plans and the construction assumptions detailed above in order to determine the expected internal ambient noise level within each of the identified rooms. The predicted internal ambient noise levels have been compared against the identified criteria and this assessment is summarised in **Table 4.3**. It should be noted that the calculations using the composite SRI have been completed in octave bands and are presented as single figures for ease of reporting. Example calculation sheets have been provided in **Appendix 2**.

Room Reference	Room Use	Windows Closed (Calculated Composite SRI)		Windows Open (15 dB Reduction)	
		Predicted Internal $L_{Aeq,30min}$ (dB)	Achievement of Identified Criteria (ref. Table 4.2)	Predicted Internal $L_{Aeq,30min}$ (dB)	Achievement of Identified Criteria (ref. Table 4.2)
10	Dining Hall	17	✓	34	✓
92	Kitchen	16	✓	34	✓
99	Nursery	18	✓	34	✓
22	Art/DT Room	17	✓	34	✓
28	Reception Classroom 3	18	✓	34	✓
103/104	Staff Work Room	22	✓	34	✓
108	Year 1 Classroom	18	✓	34	✓
132	Year 2 Classroom	18	✓	34	✓

Table 4.3: Internal Ambient Noise Level Assessment

It can be identified from Table 4.3 that the proposed construction should readily achieve the requirements of BB93 regardless of ventilation strategy.

4.5. Mechanical Ventilation

If mechanical ventilation is to be utilised, the total indoor ambient noise level must not exceed the criteria identified in **Table 4.2** for windows closed. This includes contributions from both the external noise break in and the mechanical noise. The maximum noise level from mechanical systems for each room is provided in **Table 4.4**.

In addition to ensuring maximum noise levels do not exceed the levels identified in **Table 4.4**, it is important to consider cross-talk where rooms are connected by ductwork and appropriate attenuators should be installed where this is identified as a concern. Cross-talk attenuators assist in protecting speech privacy, which can be undermined through ductwork where adjacent rooms are connected.

Room Reference	Room Use	Upper limit for the indoor ambient noise level $L_{Aeq,30min}$ (dB) (windows closed)	Predicted Internal $L_{Aeq,30min}$ (dB) from noise break-in through closed windows	Permitted noise level from mechanical ventilation system L_{Aeq} (dB)
48/49	Staff Rooms	40	19	40
141	Large Group Room	35	19	35
139	Accessible WC	50	n/a	50
9	Circulation Space	45	n/a	45
10	Dining Hall	45	17	45
92	Kitchen	50	16	50
99	Nursery	35	18	35
178	Nursery WC	50	n/a	50
135	Small Group Room	35	n/a	35
126	Nursery Office	40	19	40
21	Other Pupil WC	50	n/a	50
62	Reception Classroom 3	35	18	35
63	Reception WC	50	n/a	50
68	Reception WC	50	n/a	50
67	Reception Classroom 4	35	18	35
65	Small Group Room	35	19	35
61	Library	40	19	40
22	Art/DT Room	35	19	35
58	Reception Classroom 2	35	18	35
56	Reception WC	50	n/a	50
54	Reception WC	50	n/a	50
55	Reception Classroom 1	35	18	35
16	Hygiene	50	n/a	50
5	Reprographics	40	n/a	40
-	Stairwells	45	n/a	45
102	Accessible WC	50	n/a	50
103/104	Staff Work Room	40	22	40
104	Office	40	22	40
105	Year 1 Classroom	35	18	35
108	Year 1 Classroom	35	18	35
111	Infant WC	50	n/a	50
115	Infant WC	50	n/a	50
117	Year 1 Classroom	35	18	35
120	Year 1 Classroom	35	18	35
123	Year 2 Classroom	35	18	35
128	Year 2 Classroom	35	18	35
129	Year 2 Classroom	35	18	35
132	Year 2 Classroom	35	18	35

Table 4.4: Mechanical Ventilation Maximum Noise Levels

4.6. **Rain Noise**

An assessment of the likely rain noise within rooms has been carried out using the methodologies set out in BRE Information Paper *"Rain noise from glazed and lightweight roofing"* (Reference: IP 2/06 dated January 2006) and the construction assumptions detailed above in order to determine the expected internal rain noise level within each of the identified rooms. The predicted internal rain noise levels during periods of heavy rain have been compared against the identified criteria and this assessment is summarised in **Table 4.5**.

Room Reference	Room Use	Predicted Internal $L_{Aeq,30min}$ (dB)	Upper limit for Rainfall Noise $L_{Aeq,30min}$ (dB)	Achievement of Identified Criteria
99	Nursery	45	60	✓
10	Dining Hall	48	70	✓
120	Year 1 Classroom	45	60	✓

Table 4.5: Internal Rain Noise Level Assessment

It can be identified from **Table 4.5** that the proposed construction should readily achieve the requirements of BB93 for rain noise.

5. Walls – Internal Sound Insulation

5.1. Airborne Sound Insulation Criteria

The airborne sound insulation criteria for the project have been determined utilising the internal layout plans along with the advice contained within BB93, as summarised in **Section 3.1.4**. The airborne sound insulation criteria in terms of $D_{nT,w}$ (on-site sound insulation value) have been determined from BB93 and the subsequent R_w (laboratory sound insulation value) has been determined from standard acoustic formulae. The internal sound insulation criteria adopted for this assessment are presented in **Table 5.1**.

The calculated required R_w sound insulation values have been utilised to specify two different wall constructions for a low and medium sound insulation requirement respectively. The wall type required is noted in **Table 5.1** and a full description of the wall type is provided in **Table 5.2**. A site layout plan has been marked-up to show the required wall types and this is presented in **Appendix 3**.

Source Room		Receiver Room		Activity Noise (Source Room)	Noise Tolerance (Receiving Room)	Minimum $D_{nT,w}$ (dB)	Calculated Minimum R_w (dB) Required	Wall Type Recommended
Room Reference	Room Use	Room Reference	Room Use					
180	Plant	10	Dining	Average	High	35	36	1 – Low Sound Insulation – 50 dB R_w wall
-	Stairwell	10	Dining Hall	Average	High	35	36	
56	Reception WC	139	Accessible WC	Average	High	35	45	
115	Infant WC	105	Year 1 Classroom	Average	Medium	45	46	
123	Year 2 Classroom	132	Year 2 Classroom	Average	Medium	45	46	
54	Reception WC	55	Reception 1	Average	Medium	45	47	
55	Reception 1	58	Reception 2	Average	Medium	45	47	
9	Corridor	55	Reception 1	Average	Medium	45	47	
-	Stairwell	108	Year 1 Classroom	Average	Medium	45	47	
92	Kitchen	10	Dining	High	High	45	48	
21	Other Pupil WC	22	Art/DT	Average	Medium	45	49	
10	Dining	99	Nursery	High	Medium	50	50	
178	Nursery WC	135	Small Group	Average	Medium	45	50	

Source Room		Receiver Room		Activity Noise (Source Room)	Noise Tolerance (Receiving Room)	Minimum $D_{nT,w}$ (dB)	Calculated Minimum R_w (dB) Required	Wall Type Recommended
Room Reference	Room Use	Room Reference	Room Use					
180	Plant	48/49	Staff Rooms	Average	Medium	45	50	
141	Large Group Room	48/49	Staff Rooms	Average	Medium	45	50	
22	Art/DT	61	Library	Average	Medium	45	50	
54	Reception WC	61	Library	Average	Medium	45	50	
68	Reception WC	65	Small Group Room	Average	Medium	45	50	
67	Reception 4	65	Small Group Room	Average	Medium	45	50	
105	Year 1 Classroom	103/104	Staff Work Room	Average	Medium	45	50	
99	Nursery	136	Office	Average	Medium	45	53	2 – Medium Sound Insulation – 56 dB R_w wall
99	Nursery	135	Small Group	Average	Medium	45	53	
92	Kitchen	136	Office	High	Medium	50	56	
92	Kitchen	135	Small Group	High	Medium	50	56	

Table 5.1: Walls – Airborne Sound Insulation

5.2. Sound Insulation Properties of Walls

Syntegra have specified three wall types to meet the sound insulation requirements, as identified in **Table 5.1** above, and these are presented in **Table 5.2**. Different constructions with the same R_w value for each wall type could be utilised.

The sound insulation properties of the proposed walls have been determined utilising the INSUL software programme.

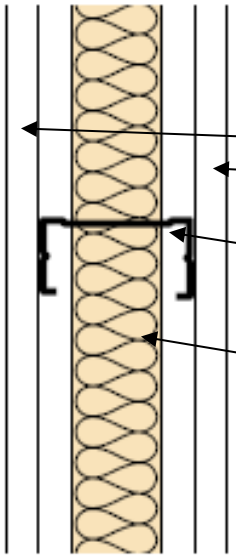
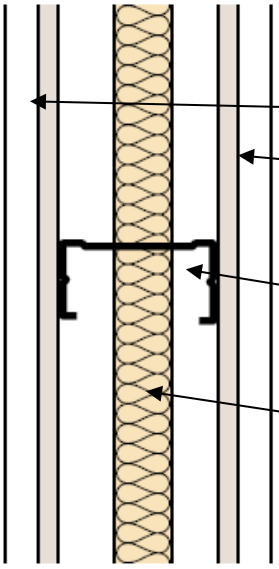
Partition Reference	Plan of Partition	Description of Partition	R_w (dB)
1 – Low Sound Insulation Wall		• 1x15mm *Siniat Megadeco* board each side. • 70mm steel studs at 600mm centres. • 50mm mineral wool (16 kg/m^3) between studs.	50
2 – Medium Sound Insulation Wall		• 1x15mm *Siniat Megadeco* board and 1x9.5mm *GTEC Standard Board* each side. • 70mm steel studs at 600mm centres. • 25mm mineral wool (16 kg/m^3) between studs.	56

Table 5.2: Sound Insulation Properties – Walls

5.2.1. Doors

All doors should be selected to achieve a sound insulation of at least 30 dB R_w.

5.3. **Workmanship**

It is important to note that, as with any construction project, the ability to meet the specification will rely upon the quality of the built structure. As such the works should be carried out to a high standard of workmanship to ensure that any sound insulation measures are not breached, for example by installing a rigid connection across an isolated connection (such as resilient bars). Additionally, any joints between different walls and the party wall and the ceiling/floor should be carefully filled with acoustic mastic.

6. Floors – Internal Sound Insulation

6.1. Sound Insulation Criteria

The airborne sound insulation criteria for the project have been determined utilising the internal layout plans along with the advice contained within BB93, as summarised in **Section 3.1.5**. The internal sound insulation criteria adopted for this assessment are presented in **Table 6.1**.

Source Room		Receiver Room		Activity Noise (Source Room)	Noise Tolerance (Receiving Room)	Minimum $D_{nT,w}$ (dB)	Maximum $L'_{nT,w}$ (dB)
Room Reference	Room Use	Room Reference	Room Use				
108	Year 1 Classroom	22	Art/DT Room	Average	Medium	45	60
132	Year 2 Classroom	67	Reception 4	Average	Medium	45	60
105	Year 1 Classroom	48/49	Staff Work Room	Average	Medium	45	60

Table 6.1: Floors – Sound Insulation Criteria

6.2. Sound Insulation Assessment of Floors

The proposed internal floor constructions have been provided by Extraspace Solutions and is summarised as follows:

- Internal floor construction
  - Carpet or vinyl floor finish
  - 18mm plywood
  - 2 x 180mm steel floor joists resting on 250mm floor beams. Gaps between 180mm floor joists filled with mineral wool type sound insulation
  - 1 x 15mm *Siniat Megadeco* plasterboard and 1 x 12.5mm *Siniat Megadeco* plasterboard
  - Nominal 500mm suspended ceiling (Syntegra have assumed a light steel grid with standard ceiling tiles for the purposes of the sound insulation assessment)

The sound reduction properties of the internal floor construction have been determined from on-site measurements on the same floor construction on a previous Extraspace site. **The airborne sound insulation of the floor structure has been determined to be 64 dB R_w and the impact sound insulation has been determined to be 47 dB $L_{n,w}$.**

6.3. Compliance with Criteria

The predicted sound insulation values have been calculated using standard acoustic formulae for the identified rooms across the proposed school and these are presented in **Table 6.2**. The predicted sound insulation values are also compared against the identified sound insulation assessment criteria.

Source Room		Receiver Room		Predicted $D_{nT,w}$ (dB)	Achievement of Identified Criteria (ref. Table 6.1)	Predicted $L'_{nT,w}$ (dB)	Achievement of Identified Criteria (ref. Table 6.1)
Room Reference	Room Use	Room Reference	Room Use				
108	Year 1 Classroom	22	Art/DT Room	58	✓	48	✓
132	Year 2 Classroom	67	Reception 4	58	✓	46	✓
105	Year 1 Classroom	48/49	Staff Work Room	58	✓	49	✓

Table 6.2: Floors – Sound Insulation Assessment

It can be identified from **Table 6.2** that the proposed constructions should readily achieve the requirements of BB93 in respect of airborne and impact sound insulation.

7. Reverberation Time Assessment

7.1. Reverberation Time Criteria

The reverberation time criteria for the project have been determined utilising the internal layout plans along with the advice contained within BB93, as summarised in **Section 3.1.6**. The reverberation time criteria adopted for this scheme for example rooms are presented in **Table 7.1**. The example rooms have been chosen in order to assess each type of room and internal finishes. It can therefore be safely assumed that if the identified criteria are achieved from the example rooms, the remainder of the rooms within the school will achieve the reverberation time criteria.

Room Reference	Room Use	Maximum Mid-Frequency Reverberation Time (T_{mf}) (seconds)
10	Dining Hall	≤ 1.0
92	Kitchen	≤ 1.5
99	Nursery	≤ 0.6
22	Art/DT Classroom	≤ 0.8
55	Reception Classroom 1	≤ 0.6
103/104	Staff Work Room and Office	≤ 0.6
120	Year 1 Classroom	≤ 0.6
132	Year 2 Classroom	≤ 0.6

Table 7.1: Reverberation Time Criteria

7.2. Reverberation Time Assessment and Compliance with Criteria

The proposed room finishes, and internal layouts have been provided by Extraspace Solutions. The following assumptions have been made in respect of the suspended ceiling:

- **The Art/DT Classroom (Room 22) and the Dining Hall (Room 10), which will both have a vinyl floor finish, should have ceiling tiles rated to be a Class C absorber or better.**
- **All other rooms should have ceiling tiles rated to be a Class D absorber or better.**

The reverberation time within each room has been calculated using standard acoustic formulae. The predicted reverberation times have been compared against the identified criteria and this assessment is summarised in **Table 7.2**. It should be noted that the calculations of reverberation time have been completed in octave bands and are presented as single figures for ease of reporting. Example calculation sheets have been provided in **Appendix 4**.

Room Reference	Room Use	Maximum Mid-Frequency Reverberation Time (T_{mf}) (seconds)	Predicted T_{mf} (s)	Achievement of Identified Criteria (ref. Table 6.1)
10	Dining Hall	≤ 1.0	0.6	✓
92	Kitchen	≤ 1.5	1.1	✓
99	Nursery	≤ 0.6	0.6	✓
22	Art/DT Classroom	≤ 0.8	0.6	✓
55	Reception Classroom 1	≤ 0.6	0.6	✓
103/104	Staff Work Room and Office	≤ 0.6	0.6	✓
120	Year 1 Classroom	≤ 0.6	0.6	✓
132	Year 2 Classroom	≤ 0.6	0.6	✓

Table 7.2: Reverberation Time Assessment

It can be identified from Table 7.2 that the proposed room finishes should achieve the requirements of BB93, subject to the installation of appropriate Class absorption ceiling tiles.

Corridors within the proposed school should have an appropriate amount of sound insulation, the current advice to providing this is taken from the Building Regulations Approved Document E. An area equal to or greater than the floor area should be covered with a Class C absorber or better. The simplest way to do this is to cover the ceiling area with the additional absorption.

8. Conclusion

An assessment has been carried out for the **Collis Primary School, Teddington** in order to demonstrate compliance with the criteria and design advice provided within BB93.

The assessment has identified:

- Internal Ambient Noise Levels.
    - **The proposed external wall construction should readily achieve the requirements of BB93, even with open windows.**
    - **Maximum noise levels from mechanical ventilation systems have been provided if this ventilation strategy is to be utilised.**
    - **Where ductwork connects two rooms, cross-talk attenuators should be considered to assist with speech privacy.**
    - **The roof construction has been assessed and it has been identified that it will sufficiently mitigate rain noise.**
- Internal Sound Insulation
    - The sound insulation requirements of all of the different rooms has been assessed and two different wall constructions have been specified in order to achieve those requirements.
    - **The wall constructions are detailed in Table 5.2 and a marked-up plan showing which walls would require each type of wall construction is provided in Appendix 3**.
    - **The sound insulation of the proposed floor has been assessed and it has been identified that the airborne and impact sound insulation criteria should be readily achieved.**
- Reverberation
    - **The Art/DT Classroom (Room 22) and the Dining Hall (Room 10), which will both have a vinyl floor finish, should have ceiling tiles rated to be a Class C absorber or better.**
    - **All other rooms should have ceiling tiles rated to be a Class D absorber or better.**

It is important to note that, as with any construction project, the ability to meet the specification will rely upon the quality of the built structure. As such the works should be carried out to a high standard of workmanship to ensure that any sound insulation measures are not breached, for example by installing a rigid connection across an isolated connection (such as resilient bars or a resilient matt). Additionally, any joints between different walls and the party wall and the ceiling/floor should be carefully filled with acoustic mastic.

9. Appendix 1: Glossary of Acoustic Terminology

Term	Description
'A'-Weighting	This is the main way of adjusting measured sound pressure levels to take into account human hearing, and our uneven frequency response.
Decibel (dB)	This is a tenth (deci) of a bel. The decibel can be a measure of the magnitude of sound, changes in sound level and a measure of sound insulation. Decibels are not an absolute unit of measurement but are an expression of ratio between two quantities expressed in logarithmic form.
Frequency	Frequency is related to sound pitch; frequency equals the ratio between velocity of sound and wavelength.
$L_{Aeq,T}$	The equivalent steady sound level in dB containing the same acoustic energy as the actual fluctuating sound level over the given period, T. T may be as short as 1 second when used to describe a single event, or as long as 24 hours when used to describe the noise climate at a specified location. $L_{Aeq,T}$ can be measured directly with an integrating sound level meter.
L_{Amax}	The 'A'-weighted maximum sound pressure level measured over a measurement period.
R_w	Weighted sound reduction index, a single number quantity for the airborne sound insulation in buildings and of building elements such as wall, doors and windows. The quantity is intended for rating the airborne sound insulation and for simplifying the formulation of acoustical requirements in building codes, when measured in the presence of flanking sound transmission, denoted R_w.
D	Arithmetic difference of the SPL between two spaces, for example room (a) and room (b)
$D_{nT,w}$	Weighted value of D, standardised to a constant reverberation time.
L	Average SPL measured in the receiver room when the floor under test is subject to a standardised impact sound source.
$L'_{nT,W}$	Weighted value of L, standardised to a constant reverberation time.

10. Appendix 2: Example Calculation Sheets for External Building Fabric Assessment

17-3872 Collis Primary School

Room 99 - Nursery - North-West Façade

Building Fabric Analysis - BS 8233:2014 Detailed Calculation Method

Room details:

	Meters (m)
Length	5.2
Width	13
Height	2.7

	m²
Total Façade and Ceiling Area	102.7
Total Surface Area	233.48

	m²
Area of window	10.2
Area of ceiling	67.6
Area of wall	24.9

Measured External Free-Field Noise Levels (dB)

	Frequency (octave bands) 63	125	250	500	1000	2000	4000	8000	dBA
Daytime L_{eq}	29.6	36.7	41.0	44.0	43.6	43.9	40.7		**49**
Night-time L_{eq}									**0**
Night-time L_{max}									**0**

Average Absorption Coefficients for the Room

	Frequency (octave bands) 63	125	250	500	1000	2000	4000	8000
Room type: ces with hard suspended ceiling <40 (Drop down menu)	0.08	0.1	0.1	0.15	0.2	0.2	0.25	0.25
Absorption Area of Room (m^2)	18.68	23.35	23.35	35.02	46.70	46.70	58.37	58.37

R_w for each Facade Element

		Frequency (octave bands) 63	125	250	500	1000	2000	4000	8000
Vent	Thru-wall vent (100mm dia) (Drop down menu)	35	42	38	32	33	39	39	0
Window	4/16/4 double glazing (Drop down menu)	20	24	20	25	34	37	37	0
Wall	Collis Primary School Proposed Wall (Drop down menu)	19	28	47	53	58	58	65	0
Ceiling	Collis Primary School Proposed Roof (Drop down menu)	12	22	36	48	53	54	57	0

Predicted Internal Noise Levels (dB)

	Frequency (octave bands) 63	125	250	500	1000	2000	4000	8000	dBA
Daytime L_{eq}	27	23	21	18	10	6	1	0	**18**
Night-time L_{eq}									**0**
Night-time L_{max}									**0**

17-3872 Collis Primary School

Room 62 - Reception Classroom 3 - South-West Façade

Building Fabric Analysis - BS 8233:2014 Detailed Calculation Method

Room details:

	Meters (m)
Length	7.4
Width	8.3
Height	2.7

	m²
Total Façade and Ceiling Area	83.83
Total Surface Area	207.62

	m²
Area of window	7.5
Area of ceiling	61.42
Area of wall	14.91

Measured External Free-Field Noise Levels (dB)

	Frequency (octave bands)								dBA
	63	125	250	500	1000	2000	4000	8000	
Daytime L_{eq}	29.6	36.7	41.0	44.0	43.6	43.9	40.7		49
Night-time L_{eq}									0
Night-time L_{max}									0

Average Absorption Coefficients for the Room

	Frequency (octave bands)							
	63	125	250	500	1000	2000	4000	8000
Room type: ces with hard suspended ceiling <40 (Drop down menu)	0.08	0.1	0.1	0.15	0.2	0.2	0.25	0.25
Absorption Area of Room (m^2)	16.61	20.76	20.76	31.14	41.52	41.52	51.91	51.91

R_w for each Facade Element

		Frequency (octave bands)							
		63	125	250	500	1000	2000	4000	8000
Vent	Thru-wall vent (100mm dia) (Drop down menu)	35	42	38	32	33	39	39	0
Window	4/16/4 double glazing (Drop down menu)	20	24	20	25	34	37	37	0
Wall	Collis Primary School Proposed Wall (Drop down menu)	19	28	47	53	58	58	65	0
Ceiling	Collis Primary School Proposed Roof (Drop down menu)	12	22	36	48	53	54	57	0

Predicted Internal Noise Levels (dB)

	Frequency (octave bands)								dBA
	63	125	250	500	1000	2000	4000	8000	
Daytime L_{eq}	27	23	20	17	10	6	1	0	18
Night-time L_{eq}									0
Night-time L_{max}									0

17-3872 Collis Primary School

Room 58 - Reception Classroom 2 - North-East Façade

Building Fabric Analysis - BS 8233:2014 Detailed Calculation Method

Room details:

	Meters (m)
Length	7.4
Width	8.4
Height	2.7

	m²
Total Façade and Ceiling Area	84.84
Total Surface Area	209.64

	m²
Area of window	7.5
Area of ceiling	62.16
Area of wall	15.18

Measured External Free-Field Noise Levels (dB)

	Frequency (octave bands)								dBA
	63	125	250	500	1000	2000	4000	8000	
Daytime L_{eq}	29.6	36.7	41.0	44.0	43.6	43.9	40.7		**49**
Night-time L_{eq}									**0**
Night-time L_{max}									**0**

Average Absorption Coefficients for the Room

	Frequency (octave bands)							
	63	125	250	500	1000	2000	4000	8000
Room type: ces with hard suspended ceiling <40 (Drop down menu)	0.08	0.1	0.1	0.15	0.2	0.2	0.25	0.25
Absorption Area of Room (m^2)	16.77	20.96	20.96	31.45	41.93	41.93	52.41	52.41

R_w for each Facade Element

		Frequency (octave bands)							
		63	125	250	500	1000	2000	4000	8000
Vent	Thru-wall vent (100mm dia) (Drop down menu)	35	42	38	32	33	39	39	0
Window	4/16/4 double glazing (Drop down menu)	20	24	20	25	34	37	37	0
Wall	Collis Primary School Proposed Wall (Drop down menu)	19	28	47	53	58	58	65	0
Ceiling	Collis Primary School Proposed Roof (Drop down menu)	12	22	36	48	53	54	57	0

Predicted Internal Noise Levels (dB)

	Frequency (octave bands)								dBA
	63	125	250	500	1000	2000	4000	8000	
Daytime L_{eq}	27	23	20	17	10	5	1	0	**18**
Night-time L_{eq}									**0**
Night-time L_{max}									**0**

17-3872 Collis Primary School

Room 120 - Year 1 Classroom - North-East Façade

Building Fabric Analysis - BS 8233:2014 Detailed Calculation Method

Room details:

	Meters (m)
Length	7.4
Width	7.8
Height	2.7

	m²
Total Façade and Ceiling Area	78.78
Total Surface Area	197.52

	m²
Area of window	7.7
Area of ceiling	57.72
Area of wall	13.36

Measured External Free-Field Noise Levels (dB)

	Frequency (octave bands) 63	125	250	500	1000	2000	4000	8000	dBA
Daytime L_{eq}	29.6	36.7	41.0	44.0	43.6	43.9	40.7		**49**
Night-time L_{eq}									**0**
Night-time L_{max}									**0**

Average Absorption Coefficients for the Room

	Frequency (octave bands) 63	125	250	500	1000	2000	4000	8000
Room type: ces with hard suspended ceiling <40 (Drop down menu)	0.08	0.1	0.1	0.15	0.2	0.2	0.25	0.25
Absorption Area of Room (m^2)	15.80	19.75	19.75	29.63	39.50	39.50	49.38	49.38

R_w for each Facade Element

		Frequency (octave bands) 63	125	250	500	1000	2000	4000	8000
Vent	Thru-wall vent (100mm dia) (Drop down menu)	35	42	38	32	33	39	39	0
Window	4/16/4 double glazing (Drop down menu)	20	24	20	25	34	37	37	0
Wall	Collis Primary School Proposed Wall (Drop down menu)	19	28	47	53	58	58	65	0
Ceiling	Collis Primary School Proposed Roof (Drop down menu)	12	22	36	48	53	54	57	0

Predicted Internal Noise Levels (dB)

	Frequency (octave bands) 63	125	250	500	1000	2000	4000	8000	dBA
Daytime L_{eq}	27	23	21	17	10	6	1	0	**18**
Night-time L_{eq}									**0**
Night-time L_{max}									**0**

17-3872 Collis Primary School

Room 123 - Year 2 Classroom - South-West Façade

Building Fabric Analysis - BS 8233:2014 Detailed Calculation Method

Room details:

	Meters (m)
Length	7.4
Width	7.8
Height	2.7

	m²
Total Façade and Ceiling Area	78.78
Total Surface Area	197.52

	m²
Area of window	7.7
Area of ceiling	57.72
Area of wall	13.36

Measured External Free-Field Noise Levels (dB)

	Frequency (octave bands) 63	125	250	500	1000	2000	4000	8000	dBA
Daytime L_{eq}	29.6	36.7	41.0	44.0	43.6	43.9	40.7		49
Night-time L_{eq}									0
Night-time L_{max}									0

Average Absorption Coefficients for the Room

	Frequency (octave bands) 63	125	250	500	1000	2000	4000	8000
Room type: ces with hard suspended ceiling <40 (Drop down menu)	0.08	0.1	0.1	0.15	0.2	0.2	0.25	0.25
Absorption Area of Room (m^2)	15.80	19.75	19.75	29.63	39.50	39.50	49.38	49.38

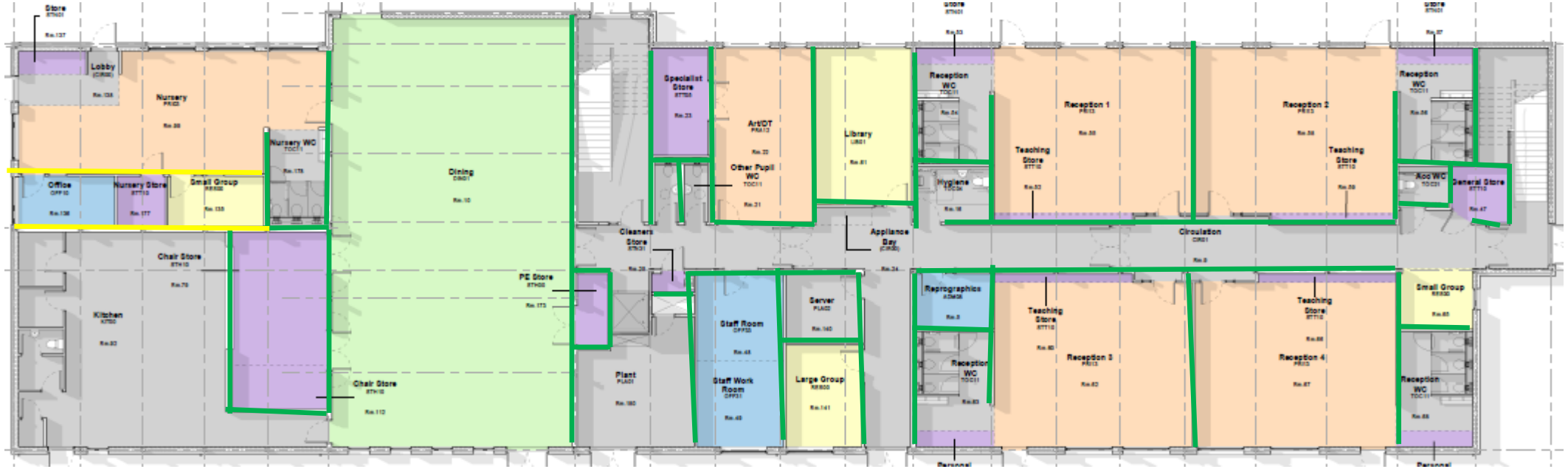
R_w for each Facade Element

		Frequency (octave bands) 63	125	250	500	1000	2000	4000	8000
Vent	Thru-wall vent (100mm dia) (Drop down menu)	35	42	38	32	33	39	39	0
Window	4/16/4 double glazing (Drop down menu)	20	24	20	25	34	37	37	0
Wall	Collis Primary School Proposed Wall (Drop down menu)	19	28	47	53	58	58	65	0
Ceiling	Collis Primary School Proposed Roof (Drop down menu)	12	22	36	48	53	54	57	0

Predicted Internal Noise Levels (dB)

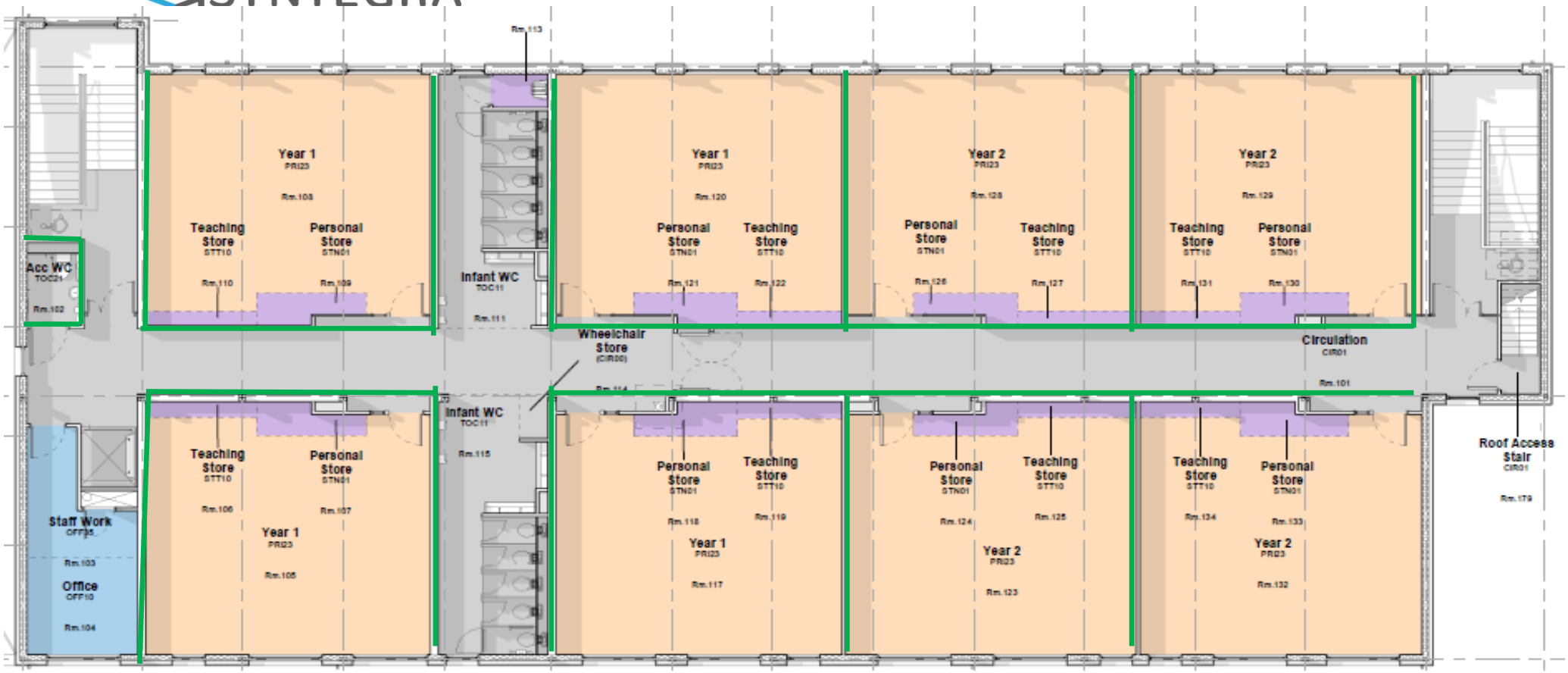
	Frequency (octave bands) 63	125	250	500	1000	2000	4000	8000	dBA
Daytime L_{eq}	27	23	21	17	10	6	1	0	18
Night-time L_{eq}									0
Night-time L_{max}									0

11. Appendix 3: Internal Sound Insulation Requirements for Walls (R_w)



Ground Floor

Key	
	1 – Low Sound Insulation Wall (50 dB R_w)
	2 – Medium Sound Insulation Wall (56 dB R_w)



First Floor

Key	
	1 – Low Sound Insulation Wall (50 dB R_w)
	2 – Medium Sound Insulation Wall (56 dB R_w)

12. Appendix 4: Example Calculation Sheets for Reverberation Time

Reverberation Time Calculator (Sabine)

Project Number	17-3872
Project	Collis Primary School
Room	10 - Hall

Rt = 0.161 * V / A

Room Dimensions	
L (m)	10
W (m)	18.2
H (m)	2.7
Volume (m3)	491.4

Element	Material - Select from drop-down list	Absorption Coefficient (α) by Frequency (Hz)								Area of Element (m^2)
		63	125	250	500	1000	2000	4000	8000	
Wall 1	Plasterboard on frame, 100mm cavity with mineral wool	0	0.3	0.12	0.08	0.06	0.06	0.05	0	118.48
Wall 2		0	0	0	0	0	0	0	0	
Wall 3		0	0	0	0	0	0	0	0	
Wall 4		0	0	0	0	0	0	0	0	
Windows	Double glazing, 2-3mm glass, 10mm air gap	0	0.15	0.05	0.03	0.03	0.02	0.02	0	14.6
Doors	Door (wood)	0	0.14	0.1	0.08	0.08	0.08	0.08	0	19.2
Floor	Linoleum or vinyl stuck to concrete	0	0.02	0.02	0.03	0.04	0.04	0.05	0	182
Ceiling	CLASS C ABSORBER	0	0.4	0.4	0.6	0.6	0.6	0.5	0	182
Other 1		0	0	0	0	0	0	0	0	
Other 2		0	0	0	0	0	0	0	0	
Other 3		0	0	0	0	0	0	0	0	
Other 4		0	0	0	0	0	0	0	0	
Overall Absortion Area (m^2)		0	116.862	93.3076	126.1124	125.5628	125.4168	107.852	0	
Reverberation Time (s)		#DIV/0!	0.7	0.8	0.6	0.6	0.6	0.7	#DIV/0!	
Mid Frequency Reverberation Time (T_{mf}) (500Hz - 2kHz)					**0.6**					

Reverberation Time Calculator (Sabine)

Project Number	17-3872
Project	Collis Primary School
Room	99 - Nursery

Rt = 0.161 * V / A

Room Dimensions

L (m)	5.2
W (m)	13
H (m)	2.7
Volume (m3)	182.52

Element	Material - Select from drop-down list	Absorption Coefficient (α) by Frequency (Hz)								Area of Element (m^2)
		63	125	250	500	1000	2000	4000	8000	
Wall 1	Plasterboard on frame, 100mm cavity with mineral wool	0	0.3	0.12	0.08	0.06	0.06	0.05	0	78.48
Wall 2		0	0	0	0	0	0	0	0	
Wall 3		0	0	0	0	0	0	0	0	
Wall 4		0	0	0	0	0	0	0	0	
Windows	Double glazing, 2-3mm glass, 10mm air gap	0	0.15	0.05	0.03	0.03	0.02	0.02	0	10.2
Doors	Door (wood)	0	0.14	0.1	0.08	0.08	0.08	0.08	0	9.6
Floor	Carpet, thin, over thin felt on concrete	0	0.1	0.15	0.25	0.3	0.3	0.3	0	67.6
Ceiling	CLASS D ABSORBER	0	0.1	0.1	0.3	0.3	0.3	0.2	0	67.6
Other 1		0	0	0	0	0	0	0	0	
Other 2		0	0	0	0	0	0	0	0	
Other 3		0	0	0	0	0	0	0	0	
Other 4		0	0	0	0	0	0	0	0	
Overall Absortion Area (m^2)		0	39.938	27.7876	44.5324	46.3428	46.2408	38.696	0	
Reverberation Time (s)		#DIV/0!	0.7	1.1	0.7	0.6	0.6	0.8	#DIV/0!	
Mid Frequency Reverberation Time (T_{mf}) (500Hz - 2kHz)					**0.6**					

Reverberation Time Calculator (Sabine)

Project Number	17-3872
Project	Collis Primary School
Room	120 - Year 1

Rt = 0.161 * V / A

Room Dimensions	
L (m)	7.8
W (m)	7.4
H (m)	2.7
Volume (m3)	155.844

Element	Material - Select from drop-down list	Absorption Coefficient (α) by Frequency (Hz)								Area of Element (m^2)
		63	125	250	500	1000	2000	4000	8000	
Wall 1	Plasterboard on frame, 100mm cavity with mineral wool	0	0.3	0.12	0.08	0.06	0.06	0.05	0	69.58
Wall 2		0	0	0	0	0	0	0	0	
Wall 3		0	0	0	0	0	0	0	0	
Wall 4		0	0	0	0	0	0	0	0	
Windows	Double glazing, 2-3mm glass, 10mm air gap	0	0.15	0.05	0.03	0.03	0.02	0.02	0	7.7
Doors	Door (wood)	0	0.14	0.1	0.08	0.08	0.08	0.08	0	4.8
Floor	Carpet, thin, over thin felt on concrete	0	0.1	0.15	0.25	0.3	0.3	0.3	0	57.72
Ceiling	CLASS D ABSORBER	0	0.1	0.1	0.3	0.3	0.3	0.2	0	57.72
Other 1		0	0	0	0	0	0	0	0	
Other 2		0	0	0	0	0	0	0	0	
Other 3		0	0	0	0	0	0	0	0	
Other 4		0	0	0	0	0	0	0	0	
Overall Absortion Area (m^2)		0	34.245	23.6446	37.9274	39.4218	39.3448	32.877	0	
Reverberation Time (s)		#DIV/0!	0.7	1.1	0.7	0.6	0.6	0.8	#DIV/0!	
Mid Frequency Reverberation Time (T_{mf}) (500Hz - 2kHz)					**0.6**					