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City of London Golden Lane Estate

Crescent House Facade Noise Assessment

City of London Corporation

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Quality information

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1. Introduction

AECOM have been appointed by the City of London Corporation (CoL) to provide acoustic design advice for the refurbishment of the apartment windows in the Golden Lane Estate, Barbican London. We understand that the possibilities of improving the condition and performance of apartment windows in the Golden Lane Estate is being examined, bearing in mind its Grade II listing for the estate (Grade II* for the Crescent House). The project is separated into 5 phases to cover Crescent House, Cullum Welch, the Maisonettes, Stanley Cohen and Great Arthur House.

It is our understanding that residents of Crescent House, particularly those whose flats face Goswell Road, are exposed to high levels of noise within their flats. As part of the study, investigations are required on the existing acoustic environment around the site and façade upgrade recommendations to achieve a reduction in internal ambient noise levels. We understand that it has yet to be decided whether façade elements are to be refurbished (e.g. keep timber frames and replace the glazing) or whether façade elements are to be completely replaced; it is however understood that the use of a secondary glazed element is not feasible and therefore not proposed.

This report presents the acoustic design criteria in relation to noise intrusion within flats, the results of the noise monitoring on site and the proposed design strategy and specifications to achieve this.

A glossary of acoustic terminology used within this report is included in Appendix A.

2. Noise Guidance and Assessment Criteria

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

The standard provides guidance on internal noise levels for various uses including dwellings and commercial properties. Guidance on desirable noise levels inside dwellings, in terms of day and night-time $L_{Aeq,T}$, are provided in Table 4 of the BS 8233:2014[1].

Table 2-1 below reproduces the desirable upper limits for internal noise levels within dwellings.

Table 2-1. Indoor ambient noise levels in dwellings (BS8233:2014)

Location	Activity	Period		Criteria
Residential living room	Resting	Daytime	07:00-23:00	35 dB $L_{Aeq,16h}$
	Dining room/area			40 dB $L_{Aeq,16h}$
Residential bedroom	Resting	Daytime	07:00-23:00	35 dB $L_{Aeq,16h}$
	Sleeping	Night-time	23:00-07:00	30 dB $L_{Aeq,8h}$

Regular individual noise events at night have the potential to disturb the sleep of inhabitants in dwellings. BS 8233 states that:

> *"A guideline value may be set in terms of SEL or L_{AFmax}, depending on the character and number of events per night".*

2.2 Professional Practice Guidance: Planning and Noise, 2017

Professional Practice Guidance: Planning and Noise (ProPG)[2] has been produced by the Institute of Acoustics (IoA), the Association of Noise Consultants (ANC) and the Chartered Institute of Environmental Health (CIEH) to

[1] British Standard 8233:2014 Guidance on sound insulation and noise reduction for buildings, BSI, 2014
[2] Association of Noise Consultants/ Institute of Acoustic/ Chartered Institute of Environmental Health (2017); Professional Planning Guidance: Planning and Noise.

provide practitioners with guidance on a recommended approach to the management of noise within the planning system in England. ProPG provides planning guidance for the consideration of new residential developments that will be exposed predominantly to airborne noise from transport sources.

The indoor ambient noise levels recommended by ProPG are identical to those within BS 8233:2014. In addition, with regards to sleep quality and well-being, a noise level of 45 dB L_{Amax} inside bedrooms has been identified as a threshold value above which sleep effects due to individual events become observable. In most circumstances, good acoustic design should be used so that individual noise events do not normally exceed this threshold value more than 10 times a night.

ProPG allows some flexibility with reference to the BS 8233:2014 internal $L_{Aeq,T}$ noise criteria and individual noise events (L_{Amax}) for areas, stating that they can be relaxed by up to 5 dB and still achieve reasonable internal conditions where development is considered necessary or desirable.

2.3 Summary of indoor ambient noise criteria (external noise sources)

A summary of proposed internal ambient noise criteria for the purposes of this assessment, as a result of external noise sources, within the Crescent House residential flats and associated reference noise guidance is given in Table 2-2 below.

Table 2-2. Summary of indoor ambient noise levels as a result of external noise sources

Location	Activity	Period		Criteria	Reference
Residential living room	Resting	Daytime	07:00-23:00	35 dB $L_{Aeq,16h}$	BS 8233:2014
	Dining room/area			40 dB $L_{Aeq,16h}$	
Residential bedroom	Resting	Daytime	07:00-23:00	35 dB $L_{Aeq,16h}$	
	Sleeping	Night-time	23:00-07:00	30 dB $L_{Aeq,8h}$	
				45 dB $L_{Amax,T}$*	ProPG

* Not to be exceeded more than 10 times per night under normal circumstances

3. Noise Survey

3.1 Noise Survey Methodology

The noise climate around Crescent House was established by undertaking a combination of long and short-term noise monitoring between Wednesday 11th May and Wednesday 18th May 2022.

A long-term (LT) unattended measurement was carried out at the external façade of Flat 347 from Wednesday 11th May to Wednesday 18th May. The long-term monitor was positioned outside the window of the studio flat facing Goswell Road. The monitor recorded noise levels continuously over the 7 days.

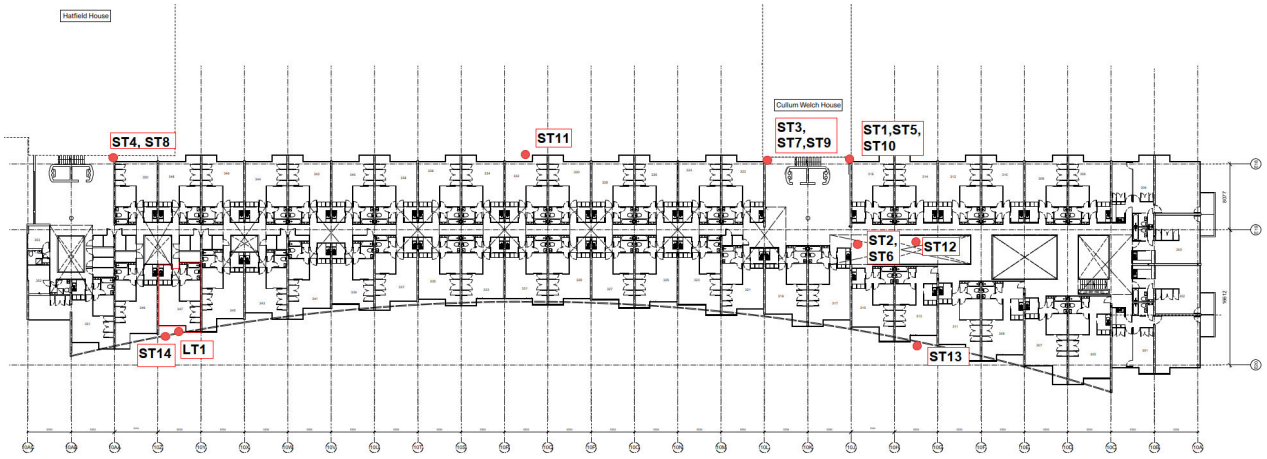
In addition to the long-term noise monitoring, a series of short-term (ST) attended noise measurements were carried out at locations around the building to capture external noise levels. These were carried out on the 11th May, but were repeated on the 18th May due to poor weather during the original measurements on the 11th May. Noise data from the 11th were excluded from the assessment.

Note that, due to the unavailability of other flats and the layout of Flat 347 which did not include a separate living area facing Goswell Road, it was not possible to carry out simultaneous external and internal noise measurements within the flat to establish current internal noise levels and estimate the acoustic performance of the existing façade. Nevertheless, since a secondary glazed element is not proposed in addition to the existing glazed frame but instead proposals include partial or complete replacement of the existing glazed elements. Consequently, data on the existing internal noise levels was not considered essential for the purposes of this assessment.

All noise measurements were carried out in accordance with BS 7445-1:2003 ‘Description and Measurement of Environmental Noise’.

Figure 3-1 presents the location of both long term and short-term noise measurements. This is also replicated for convenience in Appendix C.

Figure 3-1 Noise Monitoring Locations



3.2 Noise Monitoring Equipment

Details of the measurement equipment used are summarised in Table 3-1. Monitoring equipment was programmed to measure various sound level indicators, including $L_{eq,}$(dB), L_{90} (dB) and L_{max} (dB).

The sound level meters are calibrated every two years by a UKAS Accredited Calibration Laboratory to IEC 61672-3:2006. The sound level meters were checked with field calibrators immediately before and after the survey with no changes noted in the calibration level following the monitoring period. UKAS calibration certificates are available upon request.

Table 3-1. Noise Monitoring Equipment

Equipment	Manufacturer	Model	Serial Number	Location
Sound Level Meter	01dB	DUO	12039	All
Calibrator	B&K	4231	2642980	All

3.3 Weather Conditions

During the installation of the long-term monitoring kit and short-term measurements on 11th May, there was intermittent rainfall. The short-term measurements were repeated on the 18th May when there was no rainfall and wind speeds were below 5 m/s.

3.4 Noise Survey Results

3.4.1 Long-term (LT) Measurements

Long-term noise monitoring results for location LT1 are presented in Table 3-2. Detailed noise level time history for all long-term noise monitoring is given in Appendix B.

Measurement data are provided for overall ambient noise ($L_{Aeq,T}$), background noise ($L_{A90,T}$) and maximum noise ($L_{Amax,T}$ noise events).

Table 3-2. Long-term (LT) Measurement Results (non-free field)

Measurement Location	Date	Daytime (07:00 – 23:00)			Night-time (23:00 – 07:00)		
		$L_{Aeq,T}$ dB**	$L_{A90,T}$ dB	L_{AFmax} dB**	$L_{Aeq,T}$ dB**	$L_{A90,T}$ dB	L_{AFmax} dB**
	11/05/2022	71*	62*	95*	67	53	85

Measurement Location	Date	Daytime (07:00 – 23:00)			Night-time (23:00 – 07:00)		
		$L_{Aeq,T}$ dB**	$L_{A90,T}$ dB	L_{AFmax} dB**	$L_{Aeq,T}$ dB**	$L_{A90,T}$ dB	L_{AFmax} dB**
LT1 – Flat 347, Floor 3 (external, at façade)	12/05/2022	70	63	94	67	55	89
	13/05/2022	71	62	97	68	55	92
	14/05/2022	68	59	92	67	56	86
	15/05/2022	68	57	90	66	52	85
	16/05/2022	71	61	98	66	52	86
	17/05/2022	70	62	95	66	53	89
	18/05/2022	71*	63*	94*	-	-	-

** Incomplete monitoring period*

*** Logarithmic average of the ambient noise measurements*

*** The value presented is the 90th percentile of all values of $L_{Amax,15min}$ (the maximum noise level in each 15-minute period) over the day or night-time measurement period*

3.4.2 Short-term (ST) Measurements

Results of short-term noise monitoring within and outside flats are presented in Table 3-3.

Measurement data are provided for overall ambient noise ($L_{Aeq,T}$), background noise ($L_{A90,T}$) and maximum noise ($L_{Amax,T}$ noise events).

Table 3-3. Short-term (ST) Measurement Results

Location	Location Description	Start Time	Duration (min)	$L_{Aeq,T}$ dB	$L_{A90,T}$ dB	$L_{Amax,T}$ dB	Comments
ST1	Third Floor Balcony – Facing Courtyard	18/05/22 11:10	15	54	48	70	Traffic noise, some aircraft noise
ST2	Third Floor – Internal Courtyard	18/05/22 11:28	15	53	48	74	Traffic noise, some aircraft noise
ST3	Third Floor Balcony – Facing Tennis Court	18/05/22 11:44	15	57	50	80*	Traffic, noise from tennis court, reversing lorry alarm
ST4	Third Floor Balcony – Facing Courtyard (N)	18/05/22 12:01	15	53	50	72	Traffic noise, residents noise
ST5	Second Floor Balcony – Facing Courtyard	18/05/22 12:20	15	53	49	68	Traffic noise, some aircraft noise, residents noise
ST6	Second Floor -Internal Courtyard	18/05/22 12:45	15	59	52	80*	Traffic noise, residents noise
ST7	Second Floor Balcony – Facing Tennis Court	18/05/22 13:15	15	55	50	74	Noise from tennis court, traffic
ST8	Second Floor Balcony – Tennis Court (N)	18/05/22 13:35	15	54	49	70	Construction noise, traffic, noise from tennis court
ST9	First Floor Balcony –	18/05/22 13:52	15	53	49	80*	Residents noise, construction noise from tennis court, traffic noise

Location	Location Description	Start Time	Duration (min)	$L_{Aeq,T}$ dB	$L_{A90,T}$ dB	$L_{Amax,T}$ dB	Comments
	Facing Tennis Court						
ST10	First Floor Balcony – Facing Courtyard	18/05/22 14:10	15	58	48	77	Residents noise, traffic noise, construction noise
ST11	Ground Floor – Rear – Facing Tennis Court	18/05/22 14:31	15	55	52	75	Residents noise, traffic noise, construction noise
ST12	Ground Floor Atrium – Next to Shakespeare Pub	18/05/22 14:50	15	66	57	78	Traffic noise, residents noise, construction noise
ST13	Goswell Road – Next to Shakespeare Pub	18/05/22 15:10	15	68	59	79	Traffic and residents noise
ST14	Goswell Road – Ground Floor – Below Flat 347	18/05/22 15:27	15	69	60	81	Traffic noise

* Non-typical noise activities such as people shouting at the microphone, lorry revering alarm, angle grinder noise

4. Façade Assessment

Results of the noise monitoring on site indicated the prevailing ambient noise levels incident on the facades of Crescent House on Goswell Road and internal/rear courtyard areas.

A summary of external noise levels used as basis for the façade assessment is presented in Table 4-1.

Table 4-1. Representative external noise levels at Crescent House (dB)

Facade	Period	Description	External noise level (dB)
Goswell Road	Day-time (07:00 – 23:00)	$L_{Aeq,16hr}$	70
	Night time (23:00-07:00)	$L_{Aeq,8hr}$	67
		$L_{AFmax,T}$	84
Rear / Internal Courtyards	Day-time (07:00 – 23:00)	$L_{Aeq,16hr}$	58
	Night time (23:00-07:00)	$L_{Aeq,8hr}$	55*
		$L_{AFmax,T}$	74

* In the absence of night time noise data within the courtyard areas, a similar to the Goswell Road night time noise reduction of 3 dB has been assumed.

Based on the above external noise information and provided information on Crescent House flat layouts and elevations, calculations were carried out following the methodology given in BS 8233:2014 to predict the minimum sound insulation performance of façade elements to meet the internal ambient noise guideline values given in Table 2-2.

Table 4-2 presents the minimum required sound insulation performance for glazed and non-glazed elements of the facades.

Table 4-2 Minimum sound insulation performance requirements

Building Element		R / $D_{n,e}$ at octave band centre frequency (Hz)							R_w (-Ctr) (dB)
		63	125	250	500	1000	2000	4000	
External wall	All facades	35	41	45	45	54	55	55	52 (-)
Glazed elements	Goswell Road facades	33	36	36	44	47	49	58	47 (-4)
	Courtyard facades	16	18	24	33	44	48	48	36 (-6)

For guidance, Table 4-3 provides example glazing systems that would typically meet the acoustic performances set out in Table 4-2.

Table 4-3 Typical glazed systems

Building Element		
Glazed elements	Goswell Road facades	10 mm glass / 16 mm Argon / 6 mm glass / 16 mm Argon / 12.2 mm acoustic laminated glass
	Courtyard facades	4 mm float glass / 12 mm Argon / 4 mm float glass /12 mm Argon / 6.2 mm laminated glass

Due to the high levels of noise incident upon the Goswell Road façade (including facades that have direct line of sight to Goswell Road) and the large façade glazed areas, the sound insulation requirements for the glazed elements are particularly onerous.

The above performance (overall and per frequency) must be met by the entire glazing unit, i.e. glass, frames, seals, ventilators etc. Weak non-glass elements will require the use of higher performance glass units to maintain the required sound insulation. If ventilators are to be incorporated in the frames, these should not result in a reduction of the combined glazed element sound insulation performance per frequency given in Table 4-2 when in an open condition to allow air movement. There should be no gaps at the frame perimeter or anywhere else on the glazed system, e.g. where openable panes meet.

Test reports of a typical framed element performance must be submitted from independent test authorities.

Any non-glazed elements of the façade, e.g. existing external wall should meet (or be upgraded to meet) the minimum sound insulation performance values given in Table 4-2.

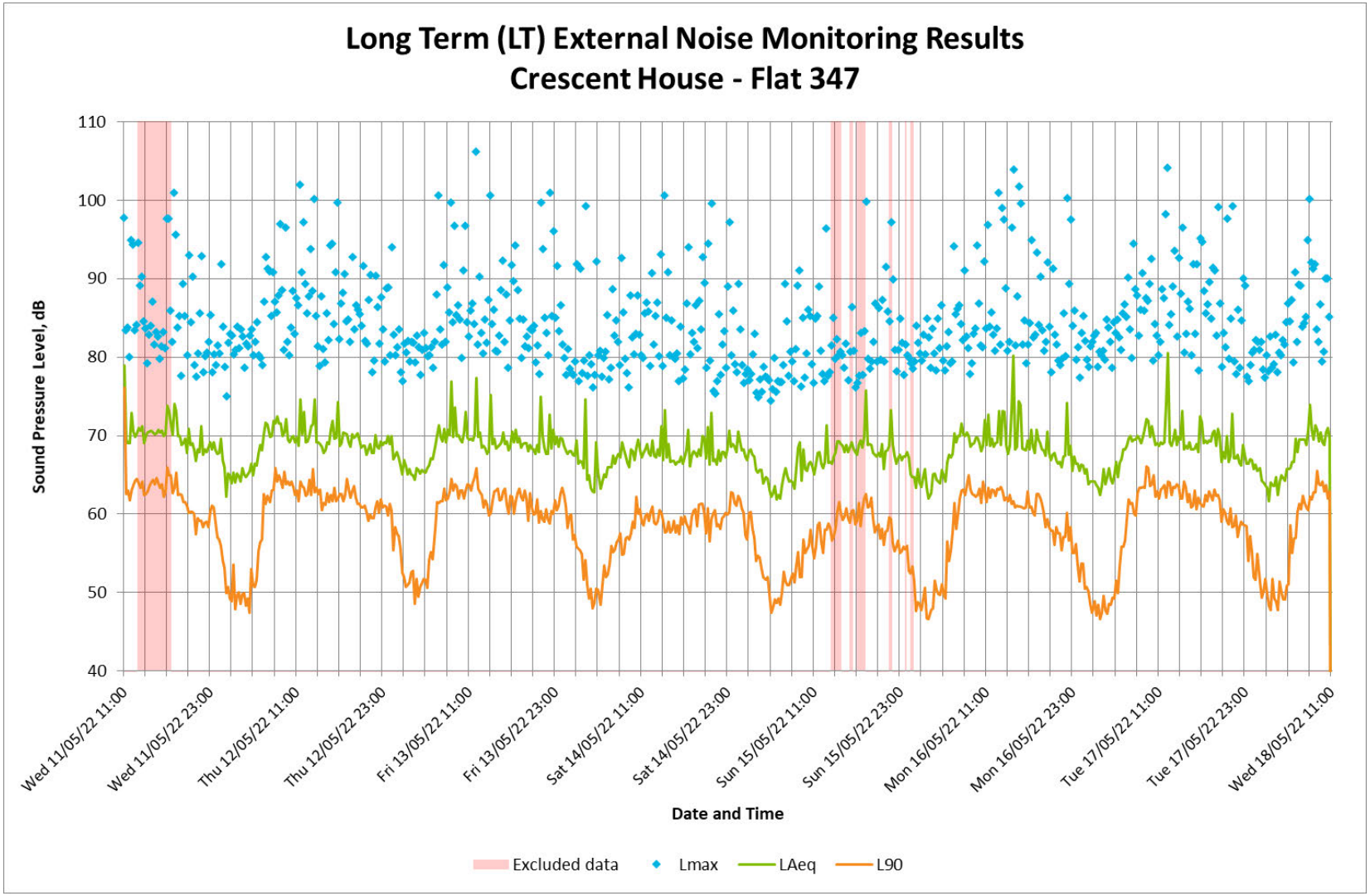
Note that in the case a decision is made to retain the existing timber frames and only replace the glazing, as the sound insulation performance of the existing frames is unknown and cannot be tested in isolation, it would not be possible to predict and confirm compliance with the BS 8233 guideline values. It is expected that the existing frame sound insulation performance would be significantly lower to that of the proposed glass and therefore would result in a sound insulation performance reduction of the overall system.

Appendix A Acoustic Glossary

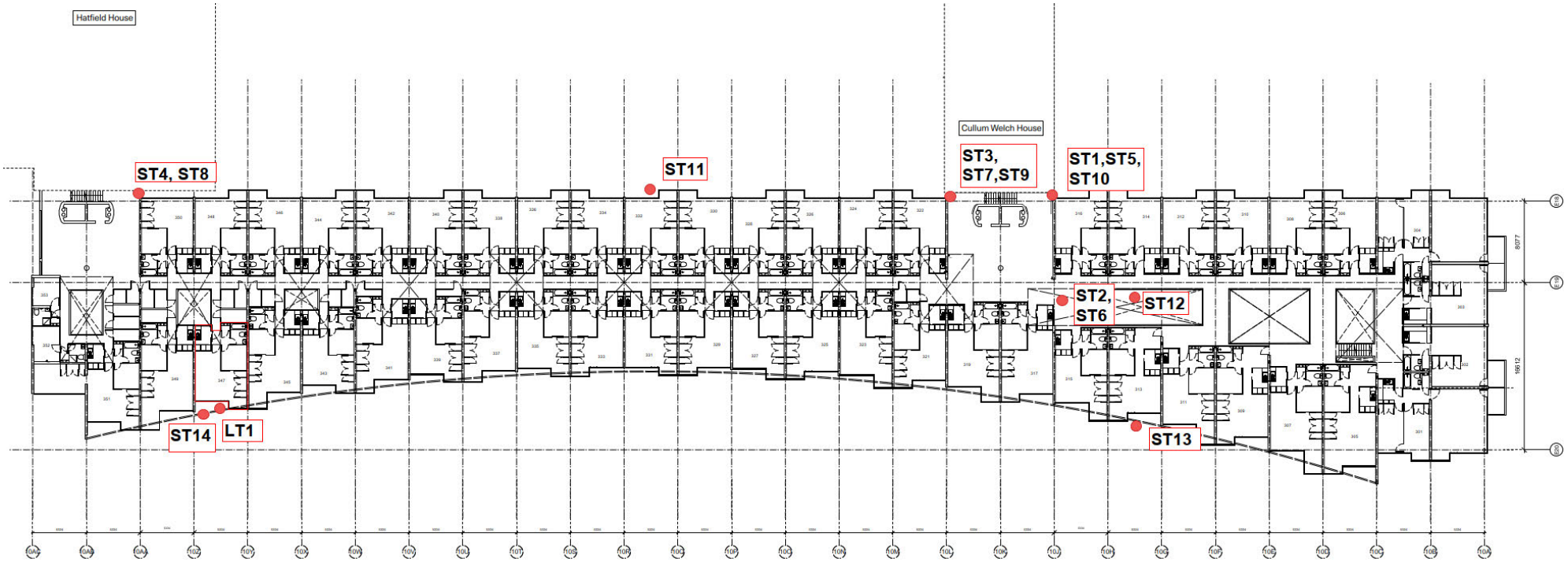
L_p	The instantaneous sound pressure level (L_p)
L_{pA} (or L_A)	The A-weighted instantaneous sound pressure level (L_{pAp} or L_A)
	This is the root mean square size of the pressure fluctuations in the air. This level can fluctuate wildly even for seemingly steady sounds. To make sound level meters easier to read the values on the display are smoothed or damped out. This is effectively done by taking a rolling average of the previous 0.125 s (FAST time constant) or the previous 1 s (SLOW time constant).
L_{AF}, L_{AS}	The letters F or S are added to the subscripts in the notation to indicate when the FAST or SLOW time constant has been used. These are often omitted but it is good practice to include them.
L_{max}	The maximum instantaneous sound pressure level (L_{max}),
L_{Amax}	The A-weighted maximum instantaneous sound pressure level (L_{Amax})
L_{AFmax}	The A-weighted maximum instantaneous sound pressure level with a FAST time constant (L_{AFmax}).
	This is the highest instantaneous sound pressure level reached during a measurement period.
	The opposite of the L_{max} is the minimum instantaneous sound pressure level or L_{min} etc.
L_{min} , L_{Fmin}	It is good practice to include the letter which identifies the time constant used as this can make a significant difference to the value.
$L_{N,T}$	The percentage exceedence sound pressure level ($L_{N,T}$),
$L_{AN,T}$ $L_{AFN,T}$	The A-weighted percentage exceedence sound pressure level ($L_{AN,T}$), the A-weighted percentage exceedence sound pressure level with a FAST time constant ($L_{AFN,T}$).
$_N$ = %age value, 0-100	This is the sound pressure level exceeded for N% of time period T. E.g. If an A-weighted level of x dB is exceeded for a total of 6 minutes within one hour, the level will have been above x dB for 10% of the measurement period. This is written as $L_{A10,1hr}$ = x dB.
$_T$ = measurement time	L_{A0} (the level exceeded for 0 % of the time) is equivalent to the L_{Amax} and L_{A100} (the level exceeded for 100 % of the time) is equivalent to the L_{Amin}.
e.g. L_{A90}, L_{A10}, $L_{AF90, 5\ min}$	It is good practice to include the letter which identifies the time constant used as this can make a significant difference to the value.
$L_{eq,T}$	The equivalent continuous sound pressure level over period T ($L_{eq,T}$),
$L_{Aeq,T}$	The A-weighted equivalent continuous sound pressure level over period T ($L_{Aeq,T}$).
$_T$ = measurement time	This is effectively the average sound pressure level over a given period. As the dec bel is a logarithmic quantity the L_{eq} is not a simple arithmetic mean value.
e.g. $L_{Aeq,5min}$	The L_{eq} is calculated from the raw sound pressure data. It is not appropriate to include a reference to the FAST and SLOW time constants in the notation
L_n	The normalised impact sound pressure level
(NB. different from L_N see above)	The value is a measure of the performance of a floor system and its ability to attenuate foot fall or impact noise under laboratory conditions. The L_n is the level of noise produced by a standard tapping machine measured in the room below the floor being tested. The lower the L_n the better the impact isolation achieved. L_n values are measured and quoted in third-octaves between 100 Hz and 3.15 kHz
L'_{nT}	The standardized impact sound pressure level
	The value is a measure of the performance of an in situ floor system and its ability to attenuate foot fall or impact noise. The value takes into account the quantity of acoustic absorption within the receiving room. The lower the L'_{nT} the better the impact isolation achieved. L_{nT} values are quoted in third-octaves between 100 Hz and 3.15 kHz
$L'_{nT,w}$	The normalised weighted impact sound pressure level
	A single value of the $L'_{n'T}$ derived from the third octave values using the method descr bed in BS EN ISO 717-2.
D	The level difference
	The difference between two measured sound pressure levels. In building acoustics this is usually the difference between the levels in tow adjacent rooms measured to determine the sound insulation performance of the partition between them. In this context D values are usually quoted in third-octave bands between 100 and 3150 Hz.
R	The sound reduction index
	This a measure of the sound insulation performance a material or construction measured under laboratory conditions in accordance with BS EN ISO 140-3. R differs from D in that it takes account of the area of the construction under test as well as the absorption in the receiving room, both of these factors influence the measured D. Taking into account these factors allows the R for different constructions to be compared on a like for like basis. R values are quoted in third-octaves between 100 Hz and 3150 Hz

R_w	The weighted sound reduction index A single value of the *R* derived from the third octave values of *R* using the method described in BS EN ISO 717-1. Partitioning and building board manufacturers commonly use this index to descr be the inherent sound insulation performance of their products.
D_{nT}	The standardised level difference There are occasions when neither *D* nor *R*' are the most appropriate descriptors for in situ measurements. An alternative is the D_{nT}, which is *D* corrected to allow for the reverberation time within the receiving room. Measurements are made in accordance with BS EN ISO 140-4.
D_{nTw}	The weighted standardised level difference A single value of the D_{nT} derived from the third octave values using the method described in BS EN ISO 717-1.
Absorption Coefficient α	The ratio of the sound absorbed by a surface to the sound incident upon it. A value of 0 means that no sound is absorbed and a value of 1 means that all sound is absorbed. The sound absorption of a surface is frequency dependent so it is usual to quote values of α in octave or third-octave bands
Reverberation Time *T* T_{60}, T_{30}, T_{20} RT	The length of time in seconds it takes for the sound pressure level to decay by 60 dB in an enclosed space after the source has stopped. It is not always poss ble to measure a full 60 dB sound decay, so reverberation time is often measured by multiplying the times taken to decay by 20 dB or 30 dB to give the equivalent of 60 dB decay time (these are often called T_{20} and T_{30} values). The longer the reverberation time the more reverberant the space. Different types of spaces have different ideal reverberation times.
T_{mf}	The reverberation time is frequency dependant and is usually presented in octave or third-octave bands. On some occasions it is useful average the level in several frequency bands. The mid frequency reverberation time is the arithmetical average of the T_{60} values in the 500, 1000 and 2000 Hz octave bands.

Appendix B Long Term Noise Monitoring Results



Appendix C Noise Monitoring Location Plan



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