

PROPOSED WIND TUNNEL
MANCHESTER INSTITUTE OF HEALTH & PERFORMANCE

NOISE IMPACT ASSESSMENT

On behalf of:

Manchester Institute of Health & Performance operated by Nuffield Health

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On behalf of:
Manchester Institute of Health & Performance operated by Nuffield Health

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1.0 INTRODUCTION

- 1.1 Hepworth Acoustics Ltd was commissioned by Manchester Institute of Health & Performance operated by Nuffield Health to carry out a noise impact assessment in connection with a proposed wind tunnel to be installed within the existing building at Manchester Institute of Health & Performance (MIHP). The assessment was requested in connection with a planning application for the development.
- 1.2 The wind tunnel is to be installed in a large space to be formed by sub-dividing the existing large performance capture hall at the site. When in operation, the wind tunnel fan generates elevated levels of noise in the building and it is the potential break-out of this noise to nearby dwellings on Wilson Street that is the focus of this assessment
- 1.3 The noise assessment has included:
- i. An inspection of the site and surrounding area;
 - ii. A baseline noise survey at the MIHP suite to establish existing ambient and background noise levels;
 - iii. Source noise measurements of a similar wind tunnel in operation under worst-case conditions;
 - iv. Assessing the potential impact of wind tunnel operational noise outside the nearest dwellings taking into account the usual environmental noise control requirements of Manchester City Council; and
 - v. Recommendation of appropriate noise mitigation measures where necessary.
- 1.4 The various noise units and indices referred to in this report are described in Appendix I. All noise levels mentioned in the text have been rounded to the nearest decibel, as fractions of decibels are imperceptible.

2.0 SITE DESCRIPTION AND PROPOSALS

Site Description

- 2.1 Manchester Institute of Health & Performance, which is jointly founded by Manchester City Council, Sport England and City Football Group, and is operated by Nuffield Health, is a healthcare facility which provides world-class diagnostic services, sports medicine and education.
- 2.2 The existing building has a variety of different spaces and diagnostic facilities including a large performance capture hall including 3G sports pitch and 'tartan track' type running track. The existing ground floor layout of the building is shown in Figure 1.
- 2.3 The performance capture hall is approximately 40m long and is a triple height space (approximately 10m high). The external wall of the building envelope is formed of outer profiled steel cladding, mineral wool infill with inner steel lining, and with a further clear cavity and then a composite insulated panel internal lining. At low level (up to a height of around 4m) there is an additional lining of approximately 18mm thick plywood, with a band of lightweight acoustically absorbent panels above that. The roof is formed of single ply membrane over insulation which is laid on a profiled metal liner tray. Interior and exterior views of the performance capture hall are shown below:





- 2.4 The nearest dwellings are a row of terraced houses immediately opposite the MIHP on Wilson Street. These dwellings are approximately 33m from the Wilson Street elevation of the performance capture hall.

Proposals

- 2.5 Proposals are for the large performance capture hall to be split into two separate spaces with the running track and part of the 3G sports pitch retained on one side and a wind tunnel for sports performance testing to be installed in the new space, adjoining the performance car park on the Wilson Street elevation of the building as indicated in Figure 2. A new roller shutter door is also proposed at the eastern end of the Wilson Street elevation of the building.
- 2.6 The wind tunnel is essentially composed of a large bell-mouth air intake at one end of the room, with the test area in the middle and a large in line fan and air outlet located 'downstream' of the test area at the other end of the room. Air circulates back to the inlet from the outlet and so the wind tunnel room is a closed system with no need for any ventilation openings in the building envelope. The test area of the wind tunnel will be raised up off the floor at approximately first floor height.

- 2.7 The wind tunnel will operate at a variety of test air speeds up to a maximum of 21m/s. The faster the air speed, the higher the associated operating noise levels and so operation at 21 m/s is the worst-case in terms of potential noise impact. The wind tunnel will only be used during normal working hours. Furthermore the roller shutter door will remain closed at all times during wind tunnel operation as an open door would disrupt the required steady airflow.

3.0 NOISE CONTROL DESIGN CRITERION

- 3.1 Manchester City Council have a well-established noise design criterion for controlling the potential environmental impact of noise from fixed plant/equipment. The criterion is as follows:

Plante/equipment noise to be controlled so as to achieve a rating level of 5dB (L_{Aeq}) below the typical background (L_{A90}) level at the nearest noise sensitive location.

- 3.2 The 'rating' level noted in the criterion is a reference to British Standard 4142: 2014+A1:2019 'Methods for rating and assessing industrial and commercial sound'.
- 3.3 In line with the requirements of BS 4142, the 'rating' level is derived based on the 'specific' L_{Aeq} sound level attributable to the noise source with an 'acoustic feature' penalty added for any sound sources which give rise to characteristics that might result in the sound being more intrusive at the noise-sensitive location. Penalties can be applied for tonality (0 to +6dB), and/or impulsiveness (0 to +9dB), and/or intermittency (0 to +3dB), or 'other sound characteristics' (+3dB).

4.0 BACKGROUND NOISE SURVEY

- 4.1 A series of auto-logging noise measurements have been carried out at the site over a weekday period in order to quantify the existing ambient and background noise climate in the vicinity of the nearest dwellings during the proposed wind tunnel operational hours.
- 4.2 The noise measurements were taken at a location at the edge of the MIHP car park, immediately opposite the dwellings on Wilson Street as indicated in Figure 3. This location was chosen so as to be representative of the noise climate outside the dwellings on Wilson Street. The microphone was mounted onto a pole at approximately 2.5m above local ground level to ensure that the results were not significantly shielded by the car park boundary fence.
- 4.3 The noise measurements were taken in consecutive 15-minute periods, including octave band analysis, between 11:15 on Monday 26 April 2021 and 10:00 on Thursday 29 April 2021. It is noted that the noise survey was carried out during the on-going national COVID-19 lockdown. This will have had the possible effect of reducing the ambient noise climate of the area to below 'normal' levels. As such, the noise survey results are a very robust basis for the assessment.
- 4.4 The noise measurements were taken using a Rion NL52 'Class 1' sound analyser (serial no. 00242747) with environmental enclosure and microphone windshield. The equipment was field-calibrated before and after the measurements, with no variance observed.
- 4.5 The weather conditions during the survey were generally dry and calm (with wind speeds generally below 3-4 m/s) and overcast with periods of sun, although there was some very brief rain during the afternoon of 27 April. Temperatures were a minimum of around 1°C at night up to highs of 14°C in the daytime.
- 4.6 The full results of the noise measurements are shown in Appendix II.
- 4.7 On the basis that the wind tunnel will operate during normal office hours only, we have analysed the noise levels measured between 08:00 and 18:00 throughout the noise survey to establish the typical prevailing background noise level in terms of L_{A90} . The analysis is summarised as follows:

Table 1: Summary of analysis of background noise levels during wind tunnel operational hours

Description	dB $L_{A90,15min}$
Range	45 – 63
Mode	52
Arithmetic average	52

- 4.8 For the purposes of this assessment, the typical background noise level has been adopted as 52 dB L_{A90} .

5.0 WIND TUNNEL SOURCE NOISE MEASUREMENTS

- 5.1 Hepworth Acoustics visited an existing wind tunnel at Silverstone Sports Engineering Hub to carry out source noise measurements of the same type of wind tunnel in operation.
- 5.2 The visit was carried out on 12 May 2021.
- 5.3 Internal noise measurements were taken around the perimeter of the wind tunnel room (which was of a similar size/shape as that proposed at MIHP) to obtain data to allow the potential break-out of noise via the building envelope at the Manchester site to be calculated.
- 5.4 The noise measurements were carried out with one Rion NL52 sound analyser (s/n 00242747) and one Rion NA28 (s/n. 00960036). Calibration checks on each were carried out before and after the noise survey with no variance in levels observed. In both cases the sound analyser microphone was mounted onto a pole such that the noise measurement positions could be elevated in line with the centre of the wind tunnel test area and fan, etc. Large environmental windshields were fitted to the microphones during all noise measurements so as to minimise the undue influence of air movement on the measured noise levels. However, wind speed measurements during the testing using an anemometer indicated speeds in the wind tunnel room (i.e. outside the test area) up to 4 m/s which will have had no significant effect on the measured noise levels.
- 5.5 The wind tunnel produces steady noise when in operation and so the noise measurements were taken in terms of multiple short-term periods at various locations around 1m from the perimeter walls of the wind tunnel room. During all measurements, the wind tunnel was operating at a test air speed of 21 m/s which is the highest test air speed proposed at MIHP.
- 5.6 The character of the noise was found to be broadband in nature with no discernible tonal peaks. Whilst the noise levels were not found to vary significantly throughout the room, slightly higher noise levels were measured at the fan end of the wind tunnel compared to the intake end and this is attributed to the additional break-out of noise from the fan casing in this area. At the intake end of the room, the fan casing was well screened by the test area and control/prep room structure located across the centre of the room.
- 5.7 The measured noise levels can be summarised as follows:

Table 2: Wind tunnel operating noise levels in dB L_{eq}

Description	Octave band centre frequency (Hz)							A
	63	125	250	500	1k	2k	4k	
Room perimeter/side – fan end	80	84	88	87	82	77	71	88
Room perimeter/side – intake end	74	82	88	84	80	74	69	86

- 5.8 For the purposes of this assessment, we have adopted the slightly higher perimeter noise levels measured at the fan end of the wind tunnel.

6.0 ASSESSMENT

- 6.1 Calculations have been carried out to determine the likely level of wind tunnel operational noise break-out to the nearest dwellings on Wilson Street.
- 6.2 Because the performance capture hall is significantly taller than the dwellings with a shallow pitched roof obscured behind a parapet, noise break-out to the dwellings on Wilson Street via the roof is not expected to be significant. The calculations have therefore focussed on noise break-out via both the wall on the Wilson Street elevation and the gable end wall including the single fire escape door.
- 6.3 The calculations have been based upon the estimated airborne sound insulation of the performance capture hall external wall construction (both with and without the ply lining) predicted using the Insul 8 sound insulation software, with a 3 dB safety margin applied. The calculations also take into the surface area of the walls and fire escape doors located on the gable end elevation and the distance to the dwellings on Wilson Street. No angle of view correction has been applied for noise break-out via the gable end wall/fire escape doors and so the calculations represent a robust assessment of potential noise break-out. The calculation also assumes continuous operation of the wind tunnel at 21 m/s test air speed. In practice, the wind tunnel is only likely to be used for short periods and certainly for no more than 50% of any given hour-long assessment period.
- 6.4 The Insul wall sound insulation predictions and noise break-out calculation are shown in Appendix III and the result is summarised below:

Table 3: Calculated wind tunnel noise break-out to dwellings on Wilson Street in dB L_{eq}

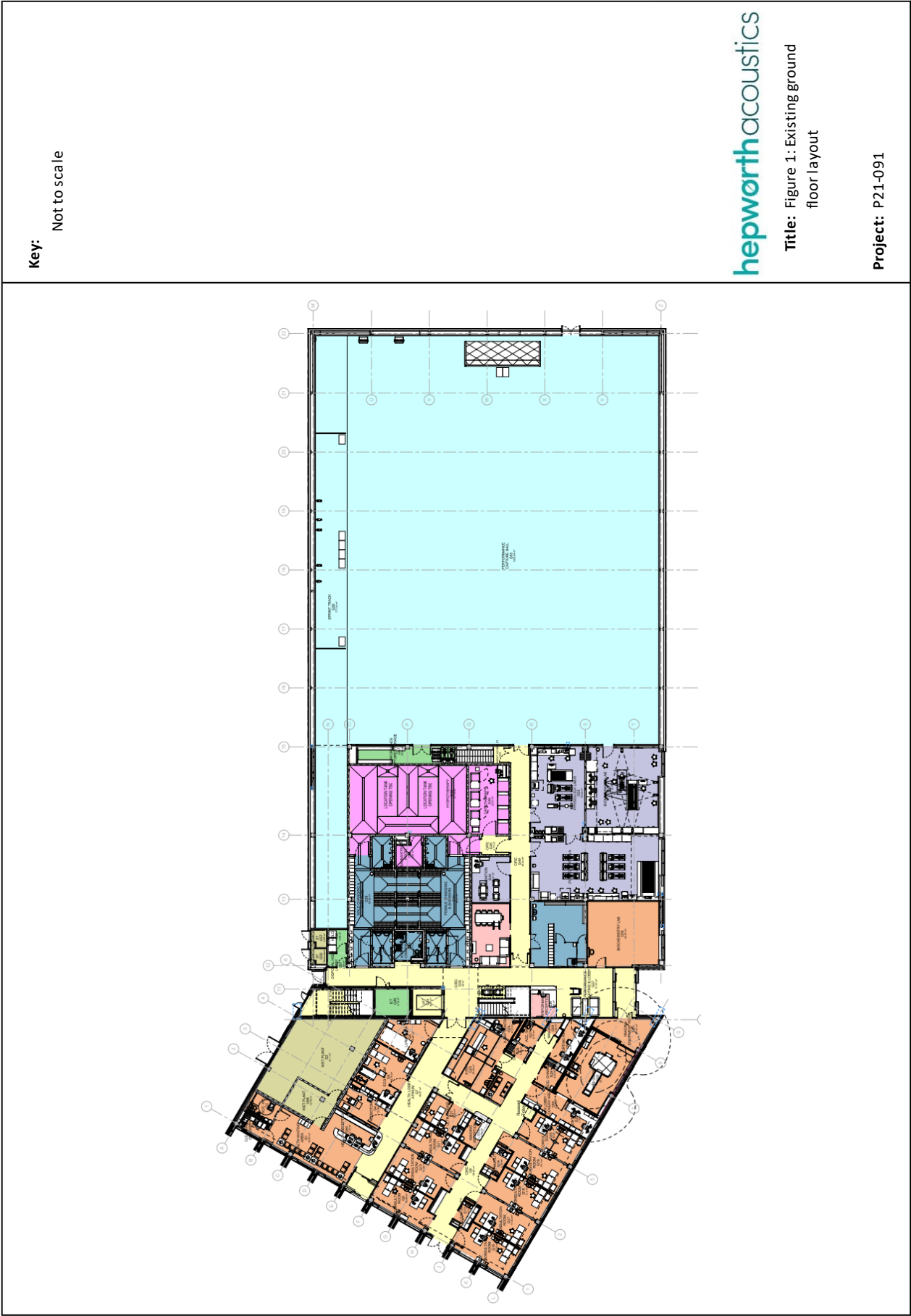
Description	Octave band centre frequency (Hz)							A
	63	125	250	500	1k	2k	4k	
Calculated wind tunnel noise outside dwellings on Wilson Street	53	54	50	37	28	27	21	44

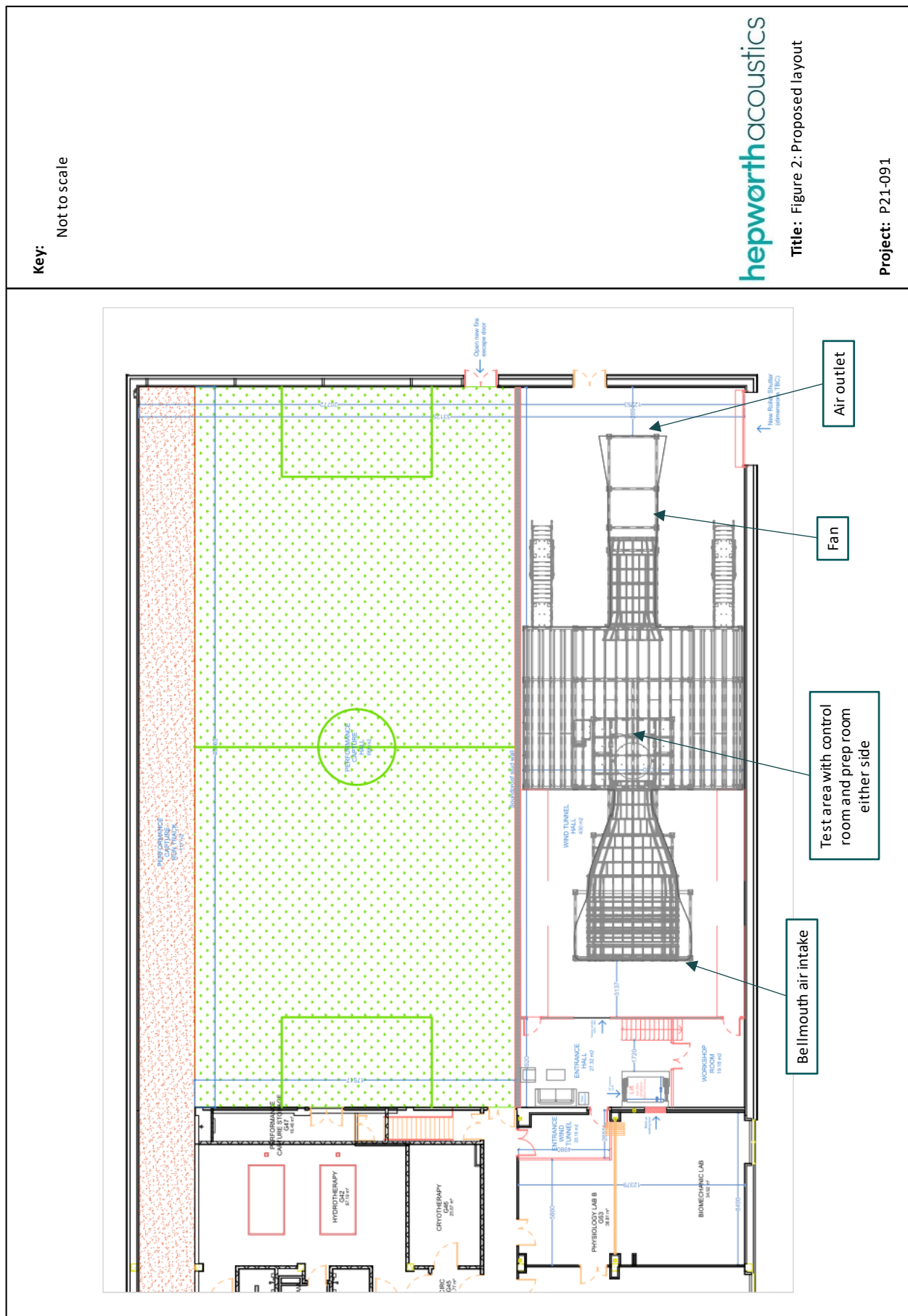
- 6.5 Table 3 shows that the calculated resulting wind tunnel operational noise outside the nearest dwellings on Wilson Street is 44 dB L_{Aeq} . This is 8 dB below the adopted 'typical' background noise levels and so will meet Manchester City Council's noise control requirements without any specific additional noise control measures.
- 6.6 We would however recommend that the proposed roller shutter door on the gable end elevation is built of a well-sealed composite construction with a minimum airborne sound insulation performance of 19 dB R_w and specified so as to minimise any wind-induced noise (i.e. from the wind tunnel) to

avoid any rattling noise that might otherwise be generated. We also recommend that the perimeter and threshold seals of the fire escape doors on the gable end elevation are checked and replaced if necessary to optimise their sound insulation performance.

7.0 SUMMARY AND CONCLUSION

- 7.1 Hepworth Acoustics Ltd was commissioned by Brookshaw Developments Ltd to carry out a noise impact assessment in connection with a planning application for a proposed wind tunnel to be installed within the existing building at Manchester Institute of Health & Performance (MIHP).
- 7.2 The assessment has involved an inspection of the existing MIHP site and a baseline noise survey to establish the existing ambient and background noise climate of the area.
- 7.3 Source noise measurements have been undertaken of the same type of wind tunnel operating under worst-case conditions and the results used in an assessment of the likely break-out of wind tunnel noise to nearby dwellings at the MIHP site.
- 7.4 The calculations demonstrate that wind tunnel noise outside the nearest dwellings will be 8 dB below the typical existing background noise and so will be within Manchester City Council's noise control requirements.
- 7.5 We therefore conclude that use of the proposed wind tunnel at MIHP will not result in any unacceptable noise impact at the nearest dwellings.







Appendix I: Noise Units & Indices

Sound and the decibel

A sound wave is a small fluctuation of atmospheric pressure. The human ear responds to these variations in pressure, producing the sensation of hearing. The ear can detect a very wide range of pressure variations. In order to cope with this wide range of pressure variations, a logarithmic scale is used to convert the values into manageable numbers. Although it might seem unusual to use a logarithmic scale to measure a physical phenomenon, it has been found that human hearing also responds to sound in an approximately logarithmic fashion. The dB (decibel) is the logarithmic unit used to describe sound (or noise) levels. The usual range of sound pressure levels is from 0 dB (threshold of hearing) to 120dB (threshold of pain).

Due to the logarithmic nature of decibels, when two noises of the same level are combined together, the total noise level is (under normal circumstances) 3 dB(A) higher than each of the individual noise levels e.g. 60 dB(A) plus 60 dB(A) = 63 dB(A). In terms of perceived 'loudness', a 3 dB(A) variation in noise level is a relatively small (but nevertheless just noticeable) change. An increase in noise level of 10 dB(A) generally corresponds to a doubling of perceived loudness. Likewise, a reduction in noise level of 10 dB(A) generally corresponds to a halving of perceived loudness.

The ear is not equally sensitive to sound at all frequencies. It is less sensitive to sound at low and very high frequencies, compared with the frequencies in between. Therefore, when measuring a sound made up of different frequencies, it is often useful to 'weight' each frequency appropriately, so that the measurement correlates better with what a person would actually hear. This is usually achieved by using an electronic filter called the 'A' weighting, which is built into sound level meters. Noise levels measured using the 'A' weighting are denoted dB(A) or dBA.

Frequency and Hertz (Hz)

As well as the loudness of a sound, the frequency content of a sound is also very important. Frequency is a measure of the rate of fluctuation of a sound wave. The unit used is cycles per second, or hertz (Hz). Sometimes large frequency values are written as kiloHertz (kHz), where 1 kHz = 1000 Hz.

Young people with normal hearing can hear frequencies in the range 20 Hz to 20 kHz. However, the upper frequency limit gradually reduces as a person gets older.

Glossary of Terms

When a noise level is constant and does not fluctuate, it can be described adequately by measuring the dB(A) level. However, when the noise level varies with time, the measured dB(A) level will vary as well. In this case it is therefore not possible to represent the noise climate with a simple dB(A) value. In order to describe noise where the level is continuously varying, a number of other indices can be used. The indices used in this report are described below.

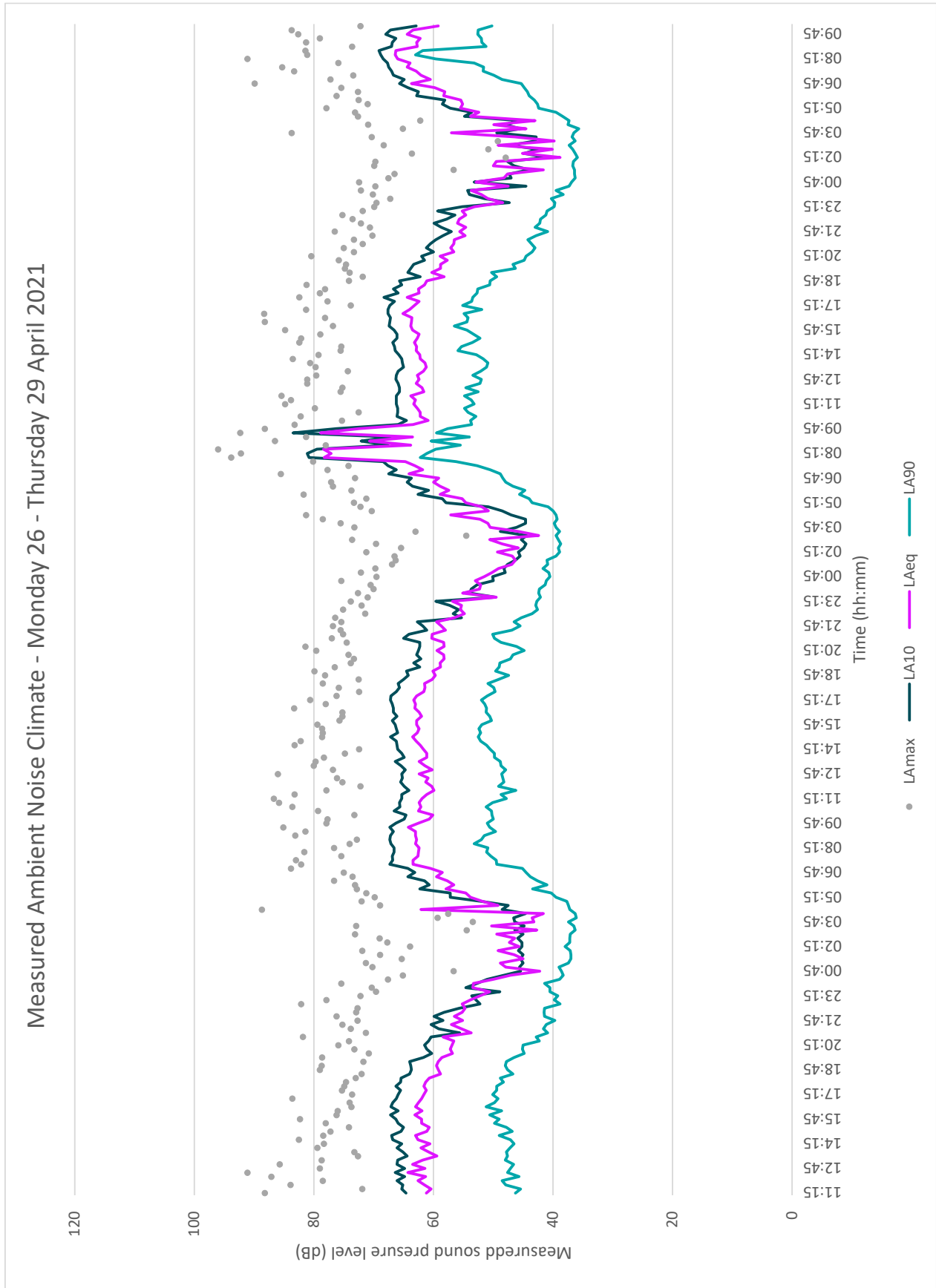
- L_{Aeq} This is the A-weighted 'equivalent continuous noise level' which is an average of the total sound energy measured over a specified time period. In other words, L_{Aeq} is the level of a continuous noise which has the same total (A-weighted) energy as the real fluctuating noise, measured over the same time period. It is increasingly being used as the preferred parameter for all forms of environmental noise.
- L_{A90} This is the A-weighted noise level exceeded for 90% of the time period. L_{A90} is used as a measure of background noise.
- R This is the 'Sound Reduction Index' as measured in a laboratory, and is a measure of the sound insulation properties of an building element in a stated frequency band.
- R_w This is the 'Weighted Sound Reduction Index' (R_w), and is a single figure quantity of R, the laboratory measured Sound Reduction Index.
- TL The Transmission loss is another name for Sound Reduction Index, (R , R')

Appendix II: Baseline Noise Survey Results

Date(s): Monday 26 – Thursday 29 April 2021

Equipment: Rion NL52 'Class 1' sound analyser (serial no. 00242747) with environmental
windshield, case, extension cable and pole and field-calibrator
calibrator

Results overleaf



Appendix III: Insul predictions and noise break-out calculation

Sound Insulation Prediction (v8.0.12)

Program copyright Marshall Day Acoustics 2015

- Key No. 0377

Margin of error is generally within $R_w \pm 3$ dB

Job Name: MIHP - proposed wind

Job No.: P21-091

Page No.:

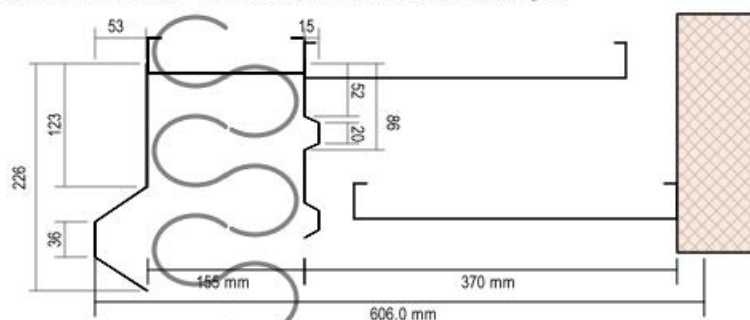
Date: 18 May 21

Initials: donald.quinn

File Name: P21-091 - MIHP wind tunnel - Insul of external cladding.ixl

Notes:

Estimation of overall external wall build-up
- without ply lining



R_w 43 dB

C -3 dB

C_{tr} -8 dB

D_{nTw} 45 dB

[V: 50m3]
[A: 11m2]

System description

Panel 1: 1 x 0.7 mm Roof Cladding Multispan (ρ :7800 kg/m³, E :2.1E02GPa, η :0.01, ρ_s :5.46 kg/m², f_c :1.786E4 Hz)

Cavity: Steel stud (1.0-1.6 mm): Stud spacing 600 mm, Infill Rockwool (33kg/m³) Thickness 140 mm (ρ :33 kg/m³, R_f :13400 Pa.s/m²)

Panel 2 + 1 x 0.4 mm Roof Cladding Dimondclad Rib 20 (ρ :7800 kg/m³, E :2.1E02GPa, η :0.01, ρ_s :3.12 kg/m², f_c :3.125E4 Hz)

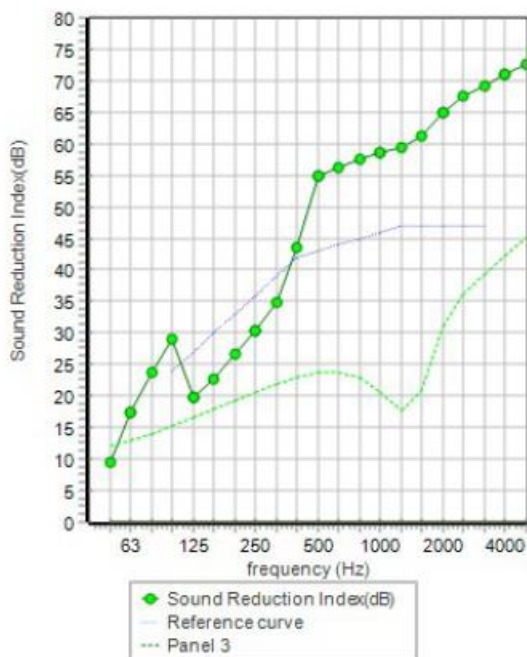
Cavity: Staggered Steel stud: Stud spacing 600 mm

Panel 3 + 1 x 79.9 mm Kingspan KS 1000AWP 70/80/100mm (ρ :7800 kg/m³, E :2.1E02GPa, η :0.12, ρ_s :3.9 kg/m², f_c :2.5E4 Hz)

Mass-air-mass resonant frequency =44 Hz, 111 Hz

Panel Size 2.7x4 m; Mass 26.3 kg/m²

frequency (Hz)	R(dB)	R(dB)
50	10	
63	18	14
80	24	
100	29	
125	20	22
160	23	
200	27	
250	30	29
315	35	
400	43	
500	55	48
630	56	
800	58	
1000	59	58
1250	59	
1600	61	
2000	65	64
2500	67	
3150	69	
4000	71	71
5000	73	



Sound Insulation Prediction (v8.0.12)

Program copyright Marshall Day Acoustics 2015

- Key No. 0377

Margin of error is generally within $R_w \pm 3$ dB

Job Name: MIHP - proposed wind

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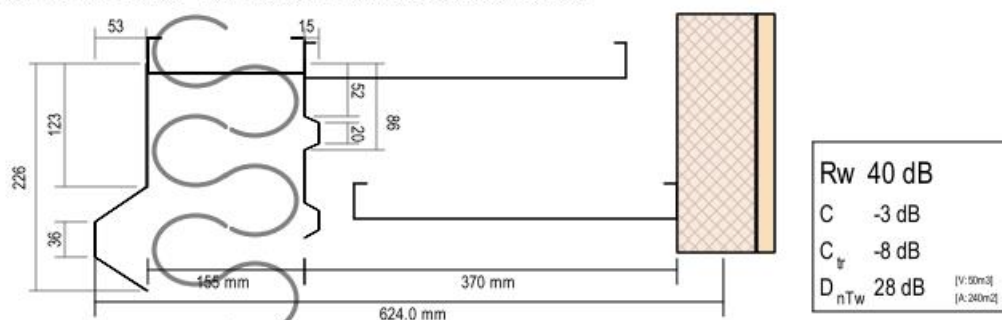
Date: 20 May 21

Initials: donald.quinn

File Name: P21-091 - MIHP wind tunnel - Insul of external wall overall.ixl

Notes:

Estimation of overall external wall build-up
- without ply lining



System description

Panel 1: 1 x 0.7 mm Roof Cladding Multispan (ρ :7800 kg/m³, E :2.1E02GPa, η :0.01, ρ_s :5.46 kg/m², f_c :1.786E4 Hz)

Cavity: Steel stud (1.0-1.6 mm): Stud spacing 600 mm, Infill Rockwool (33kg/m³) Thickness 140 mm (ρ :33 kg/m³, R_f :13400 Pa.s/m²)

Panel 2 + 1 x 0.4 mm Roof Cladding Dimondclad Rib 20 (ρ :7800 kg/m³, E :2.1E02GPa, η :0.01, ρ_s :3.12 kg/m², f_c :3.125E4 Hz)

Cavity: Staggered Steel stud: Stud spacing 600 mm

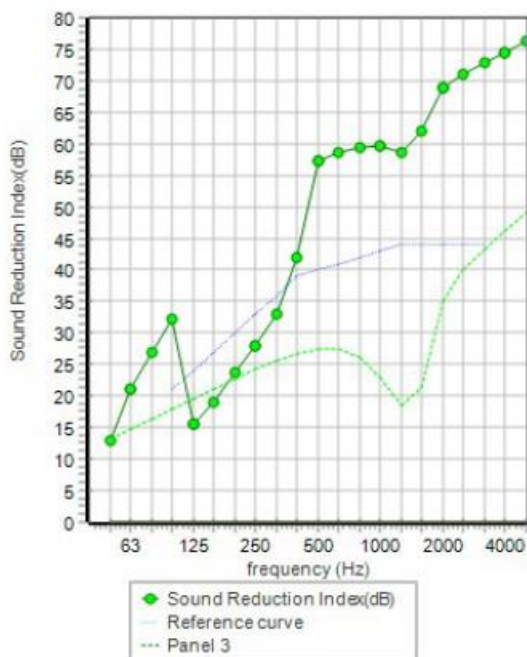
Panel 3 + 1 x 79.9 mm Kingspan KS 1000AWP 70/80/100mm

+ 1 x 18.0 mm Plywood

Mass-air-mass resonant frequency =39 Hz, 110 Hz

Panel Size 6x40 m; Mass 36.3 kg/m²

frequency (Hz)	R(dB)	R(dB)
50	13	
63	21	17
80	27	
100	32	
125	16	19
160	19	
200	24	
250	28	27
315	33	
400	42	
500	57	47
630	59	
800	59	
1000	60	59
1250	59	
1600	62	
2000	69	65
2500	71	
3150	73	
4000	75	74
5000	76	



Project Number	P21-091
Description	Proposed wind tunnel at MIHP - noise break-out to dwellings on Wilson Street

hepworthacoustics

Noise Break-out v6.0 February 2019

Source - Woods Practical Guide to Noise Control

	63	125	250	500	1k	2k	4k	A
SPL_{int}	80	84	88	87	82	77	71	88

Element 1 - External wall - low level with ply lining

SPL_{int}	80	84	88	87	82	77	71	88
Element SRI	17	19	27	47	59	65	72	
Area (S) =	296.0	25	25	25	25	25	25	
Distance (r) =	33.0	-30	-30	-30	-30	-30	-30	

MIHP - performance capture hall - external wall build-up with ply lining - Insul estimate with 3 dB safety

At receiver	43	45	41	20	4	-7	-21	34
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$= SPL_{int} - SRI + 10 \log S - 20 \log(r) - 14$

Element 2 - External wall - high level without ply lining

SPL_{int}	80	84	88	87	82	77	71	88
Element SRI	10	13	21	41	56	62	70	
Area (S) =	444.0	26	26	26	26	26	26	
Distance (r) =	33.0	-30	-30	-30	-30	-30	-30	

MIHP - performance capture hall - external wall build-up no ply lining - Insul estimate with 3dB safety

At receiver	52	53	49	28	8	-2	-17	42
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$= SPL_{int} - SRI + 10 \log S - 20 \log(r) - 14$

Element 3 - Fire Escape

Element 3 - Fire Escape				Is door lobbied?		No			
SPL_{int}	80	84	88	87	82	77	71	88	→
Element SRI	11	17	21	26	29	31	34		
Area (S) =	4.0	6	6	6	6	6	6		
Distance (r) =	42.0	-32	-32	-32	-32	-32	-32		
Lobby absorption (A) =	18								
At receiver	29	27	26	20	13	6	-4	22	

Solid core door, 40mm, with perimeter and threshold seals

No Lobby $= SPL_{int} - SRI + 10 \log S - 20 \log(r) - 14$

Lobby $= SPL_{int} - 2 \times SRI + 10 \log S - 20 \log(r) - 14 - 10 \log(A)$

Element 3 - Rollerdoor

Element 3 - Rollerdoor	Is door lobbied?				No			
SPL_{int}	80	84	88	87	82	77	71	35
Element SRI	1	7	13	18	21	17	17	→
Area (S) =	16.0	12	12	12	12	12	12	
Distance (r) =	33.0	-30	-30	-30	-30	-30	-30	
Lobby absorption (A) =	18							
At receiver	46	44	42	37	29	28	22	39

Clark Doors - Roller Shutter Door (0.7mm steel infilled with polystyrene foam & nylon end caps)

No Lobby $= SPL_{int} - SRI + 10 \log S - 20 \log(r) - 14$

Lobby $= SPL_{int} - 2 \times SRI + 10 \log S - 20 \log(r) - 14 - 10 \log(A)$

Note: External wall is approx. 40m long and 10m high - far-field boundary is at $2b/\pi = 25m$. Therefore Wilson St dwellings are in the far-field.

Overall Results

	63	125	250	500	1k	2k	4k	A
Resulting	54	54	50	38	29	28	22	44