WOOD & GRIEVE ENGINEERS

The Sandstone Precinct, Sydney

Acoustic Report
Development Application

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Project No. 29212-SYD-N
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Revision

REVISION	DATE	COMMENT	APPROVED BY
3	14/10/2016	JBA & Sagent Comments	**ORFG**
2	07/09/2016	Drawings Update	**ORFG**
1	30/08/2016	For comments	**ORFG**

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Contents

1. Introduction

As part of the DA documentation process, Wood & Grieve Engineers has been engaged by Pontiac Land Group to provide an acoustic assessment for the upcoming hotel-use development located at Lands and Education Building part of the Sandstone Precinct located on Bent Street, Sydney.

The proposed development consists of:

- 250 hotel guest rooms
- 2,300 m^2 commercial space over two floors
- 1,000 m^2 of meeting and events space
- Roof-top bar

This assessment discusses the likely noise impact of the development upon the potentially nearest most-affected residential receivers and also the potential noise intrusion upon the development.

This assessment has been prepared considering the following documents:

- City of Sydney Development Control Plan (DCP), 2012
- City of Sydney Standard Conditions of Development Consent, 2012
- NSW Environment Protection Authority (EPA) Industrial Noise Policy, 2000 (INP 2000)
- NSW Road Noise Policy, 2011 (RNP 2011)
- AS/NZS 2107:2000: "Acoustics – Recommended design sound levels and reverberation times for building interiors"
- AS 2021:2000: "Acoustics – Aircraft noise intrusion – Building siting and construction"
- NSW Environment Protection Authority (EPA) Interim Construction Noise Guideline (ICNG July 2009).
- Bureau of Meteorology, Daily rainfall report.
- The Clients Architecture & Interior Module

This report provides:

- A statement of compliance with the City of Sydney DCP 2012 criteria for the proposed residential-use development within the vicinity of the nearest potentially affected residential receivers.
- Recommendations for noise mitigation measures for the proposed development in order to meet Sydney DCP 2012 criteria when compliance is not achieved.

This report is based on our understanding of the proposed project, application of the relevant state guidelines and professional experience within the acoustic field. Therefore, this report shall not be relied upon as providing any warranties or guarantees.

2. Background Information

2.1 Information Sources

The following documentation has been used for the preparation of this report:

- Site drawings presenting the location of the proposed new residential building in relation to the nearest receivers.
- Noise data collected on site through the use of a noise logger and a hand held spectrum analyser.
- Development Application (DA) package drawings issued by Make Architects including:
    - SP-DA-G-2496, revision 1. Dated 06.10.2016
    - SP-DA-G-2497, revision 1. Dated 06.10.2016
    - SP-DA-G-2498, revision 1. Dated 06.10.2016
    - SP-DA-G-2499, revision 1. Dated 06.10.2016
    - SP-DA-G-2500, revision 1. Dated 06.10.2016
    - SP-DA-G-2501, revision 1. Dated 06.10.2016
    - SP-DA-G-2502, revision 1. Dated 06.10.2016
    - SP-DA-G-2503, revision 1. Dated 06.10.2016
    - SP-DA-G-2504, revision 1. Dated 06.10.2016
    - SP-DA-G-2505, revision 1. Dated 06.10.2016
    - SP-DA-G-2506, revision 1. Dated 06.10.2016
    - SP-DA-G-2507, revision 1. Dated 06.10.2016
    - SP-DA-G-2508, revision 1. Dated 06.10.2016
    - SP-DA-G-2509, revision 1. Dated 06.10.2016
    - SP-DA-G-2512, revision 1. Dated 06.10.2016
    - SP-DA-G-2112, revision 1. Dated 06.10.2016
    - SP-DA-G-3200, revision 1. Dated 06.10.2016
    - SP-DA-G-3201, revision 1. Dated 06.10.2016
    - SP-DA-G-3202, revision 1. Dated 06.10.2016
    - SP-DA-G-3203, revision 1. Dated 06.10.2016
    - SP-DA-G-3204, revision 1. Dated 06.10.2016
    - SP-DA-G-3205, revision 1. Dated 06.10.2016
    - SP-DA-G-3210, revision 1. Dated 06.10.2016
    - SP-DA-G-3501, revision 1. Dated 06.10.2016
    - SP-DA-G-3502, revision 1. Dated 06.10.2016

3. Project Overview

3.1 Site description

The proposed hotel-use development is to be located at Bent Street, Sydney. The site is bound by Macquarie Place Park and commercial properties to the north; a commercial properties block to the east; commercial properties to the south; and commercial properties to the west.

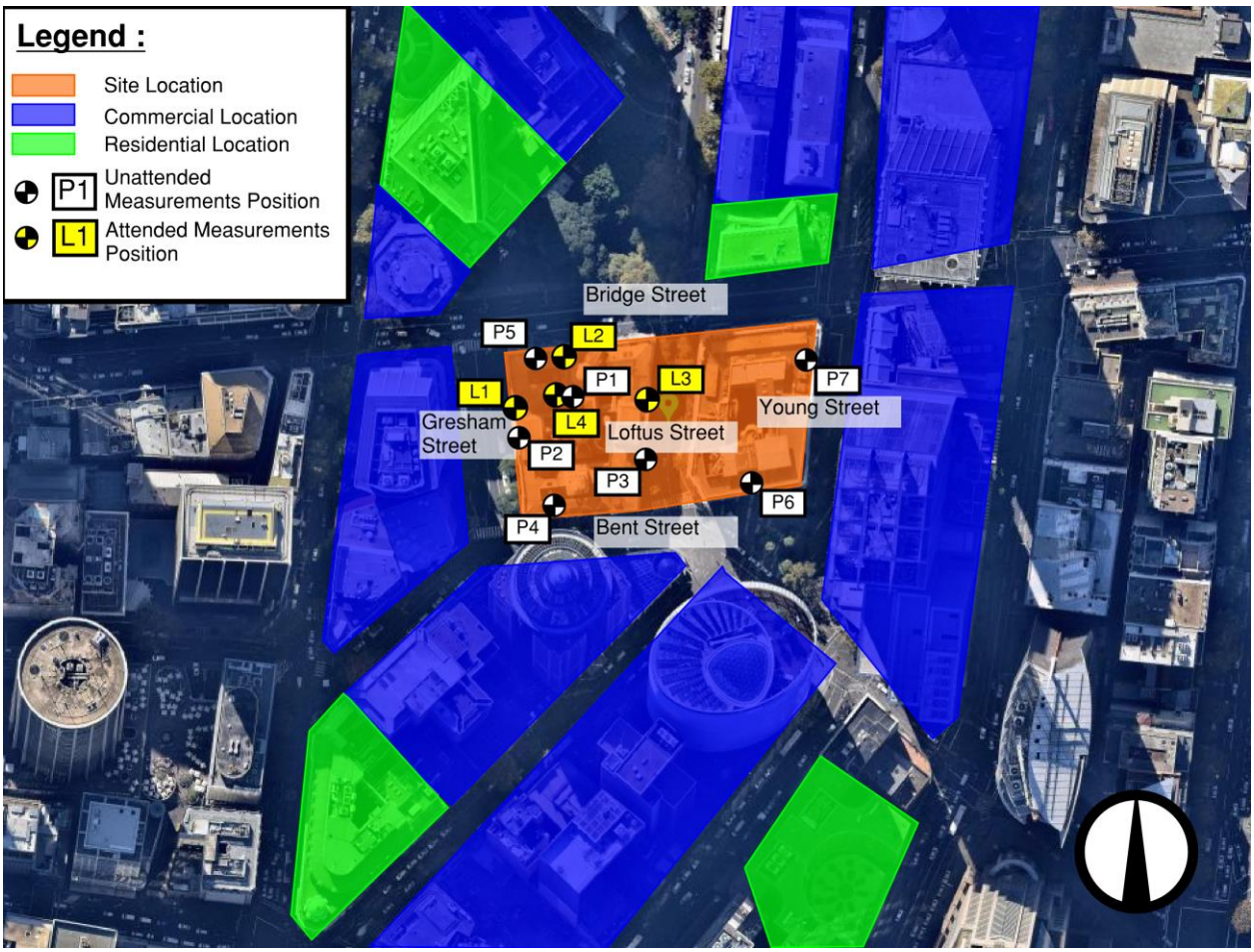
The acoustic issues relating to the development are as follows:

- Noise intrusion from vehicle movements on Bridge, Gresham, Loftus, Bent, and Young Street into the developments habitable areas.
- Noise emissions from mechanical plant from the development to the surrounding receivers.

The nearest potentially affected noise receivers (shown in Figure 1) have been identified as follows:

- Receiver North, Macquarie Place Park and residential apartment on 38 Bridge Street
- Receiver East, Commercial properties along Young Street
- Receiver West, Commercial properties along Gresham Street
- Receiver South, Commercial properties along Bent Street

Figure 1: Overview of the Site and Measurements Location



Source: nearmap.com

3.2 Existing Ambient Noise Level

3.2.1 Instrumentation

The equipment used for the noise survey was the following:

- Hand-held sound spectrum analyser Brüel & Kjær Type 2250, S/N 2709742
- ARL Environmental Noise Loggers ARL EL-215, S/N 194447
- ARL Environmental Noise Loggers ARL EL-215, S/N 194676
- ARL Environmental Noise Loggers ARL EL-215, S/N 194677
- ARL Environmental Noise Loggers ARL EL-215, S/N 194560
- Brüel & Kjær Sound Calibrator, S/N 2709826

All equipment was calibrated before and after the measurements and no significant drift was found. All equipment carries current traceable calibration certificates that can be provided upon request.

3.2.2 Attended Noise Survey Result

Attended noise measurements of 15-minute duration were conducted on site to characterise the acoustic environment for noise intrusion into the development and to determine any noise impact on the surrounding receivers. A summary of the attended noise measurements taken at the site are shown in Figure 1 refer to Table 1 for measurement locations.

Table 1: Attended Noise Measurements

Measurement Location	Measurement Time	$L_{Aeq, 15mins}$ dB(A)	L_{A90} dB(A)	L_{Amax} dB(A)	Comments
P1	10/06/2016 12:01	62.3	60.0	79.1	Background noise was taken from the roof of Lands Building
P2	23/03/2016 19:16	70.4	61.5	71.5	Background traffic noise was taken from the street level, Department of Lands
	09/06/2016 16:06	66.4	62.7	81.1	Background traffic noise was taken from the balcony at level 1, Department of Lands
	26/07/2016 16:57	71.7	63.5	90.1	Background traffic noise was taken from the street level, Department of Lands
P3	10/06/2016 11:37	66.3	62.5	81.0	Background traffic noise was taken from the balcony at level 1, Department of Lands
	26/07/2016 17:29	72.3	67.4	87.8	Background traffic noise was taken from the street level, Department of Lands
P4	26/07/2016	70.6	63.8	89.1	Background traffic noise was taken from the street level, Department of Lands
P5	23/03/2016 19:02	67.5	62.4	93.0	Background traffic noise was taken from the street level, Department of Lands
	10/06/2016 12:27	67.5	62.4	91.9	Background traffic noise was taken from the balcony at level 1, Department of Lands
	26/07/2016 17:45	70.4	62.3	94.5	Background traffic noise was taken from the street level, Department of Lands
P6	21/03/2016	69.5	68.0	-	Background traffic noise was taken from the street level, Farrer Place.
P7	21/03/2016	67	64.8	-	Background traffic noise was taken from the street level, Department of Education

3.2.3 Unattended Noise Survey Results

A noise logger was placed at position L1, L2, L3, and L4 as shown in Figure 1 to measure the ambient and background noise that is representative of the site and surrounding residential receivers. The loggers were installed from the 10th of June to the 24th of June 2016. The results of the unattended noise survey are shown in Table 2.

Background and Ambient Noise Monitoring

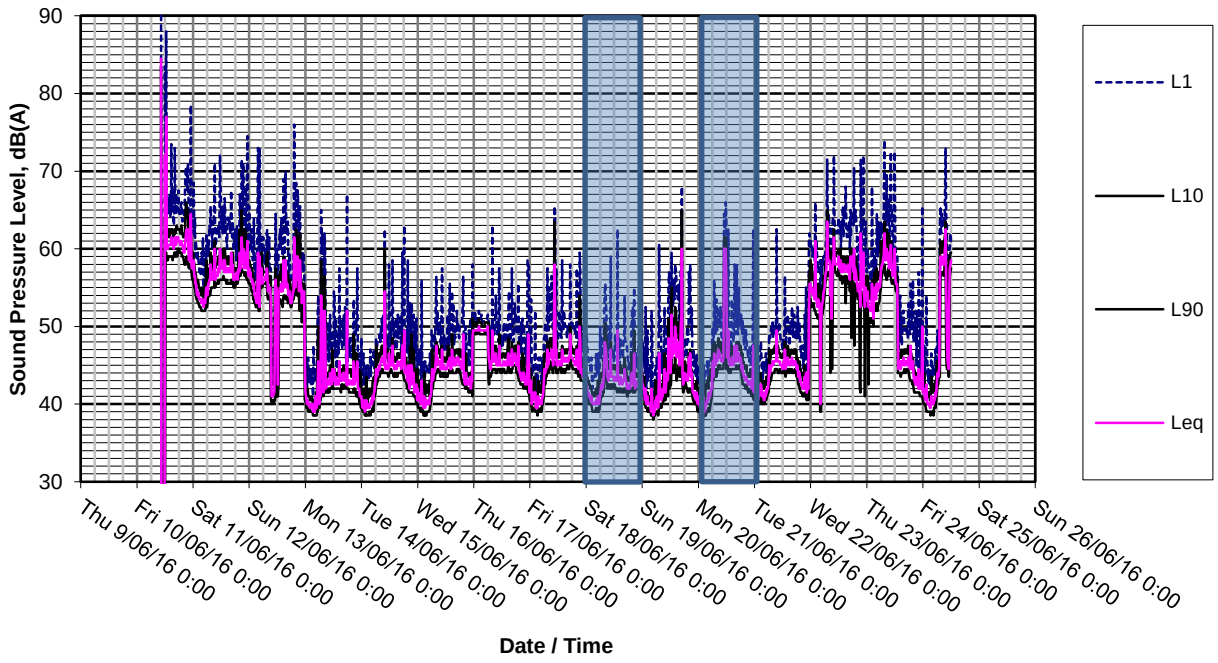
A noise logger was placed at position L4 as shown in Figure 1 to measure the background and ambient noise that is representative of the surrounding commercial receivers. Logger L4 was installed from the 10th to the 24th of June 2016. The results for the unattended background noise surveys are shown in Table 2 below (for the day, evening and night periods). Note that any rain affected data during the period of logging has been excluded from the calculations.

Table 2: Unattended noise measurements of L4

Location	Equivalent Continuous Noise Level $L_{Aeq,period}$ - dB(A)			Background Noise Level RBL - dB(A)		
	Day	Evening	Night	Day	Evening	Night
L4 – background noise	60	54	52	43.8	41.5	39.0

The local ambient noise environment is dominated by traffic noise throughout the majority of the day, evening and night periods. Refer to Figure 2 for the noise data.

Figure 2: Long term noise monitoring results at location L4-background noise measurement



: Data excluded due to rain. (Bureau of Meteorology, Daily Rainfall – June 2016)

Project Overview

The unattended background noise measurement was taken on the roof top of the Lands Building. This measurement was taken in absence of any industrial noise sources and is considered to representative of the background noise levels at nearest potentially most affected residential receivers.

Traffic Noise Monitoring

Noise monitors were installed in Positions L1, L2 and L3 as shown in Figure 1 to measure the traffic noise from Gresham, bridge, and Young Street respectively. Loggers L1, L2, and L3 were installed from the 10th to the 24th of June 2016. The results of the traffic noise survey from L1, L2 and L3 are shown in Figure 1 for the day and night time periods.

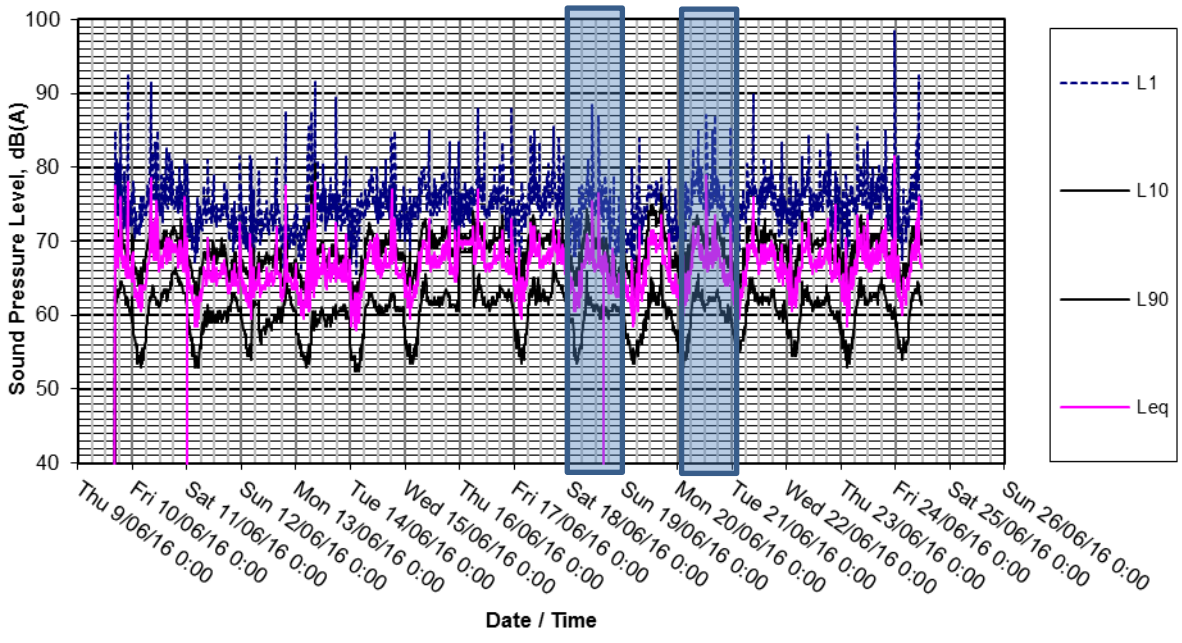
Table 3: Unattended noise measurements of L1, L2, and L3

Location	Average Noise Level $L_{Aeq, 15min}$ - dB(A)			Rated Background Level (RBL) $L_{A90, 15min}$ - dB(A)		
	Day (7.00am – 6.00pm)	Evening (6.00pm – 10.00pm)	Night (10.00pm – 7.00am)	Day (7.00am – 6.00pm)	Evening (6.00pm – 10.00pm)	Night (10.00pm – 7.00am)
L1 – traffic noise	68.0	67.0	65.0	59.0	60.0	53.9
L2 – traffic noise	68.0	68.0	66.0	59.0	60.5	53.5
L3 – traffic noise	67.0	66.0	64.0	61.5	59.0	52.5

The unattended traffic noise measurement for Gresham Street and Bridge Street was taken on the balcony of level 1 whilst the measurement for Loftus Street was taken on the balcony of level 2, Lands Building, Sydney.

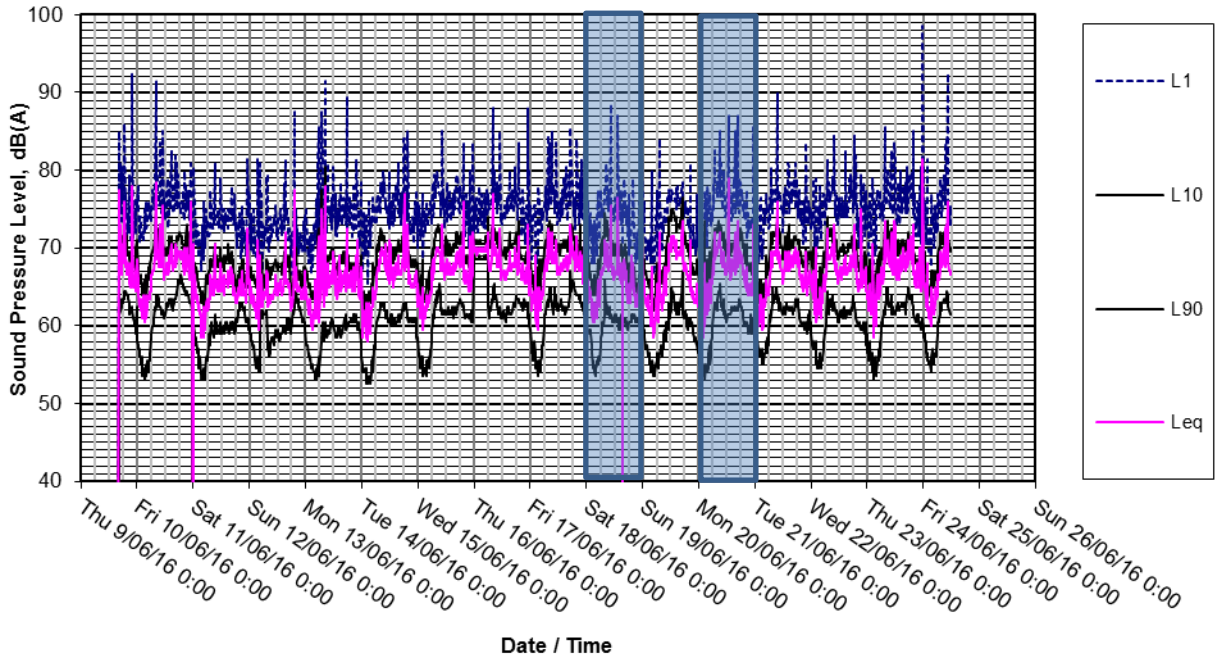
Refer to Figure 3 to Figure 5 for the noise data. The local noise environment is generally that of an urban area with vehicle movements being the dominant source of noise for the majority of the day and evening periods.

Figure 3: Long term noise monitoring results at location L1- traffic noise on Gresham Street



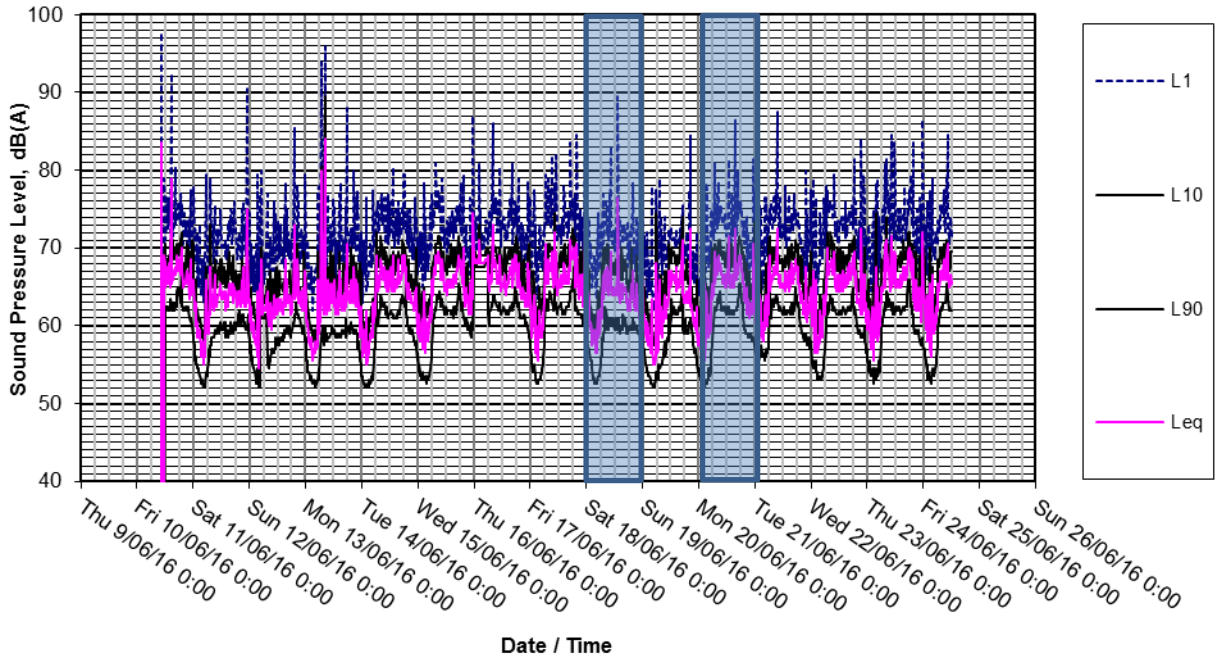
: Data excluded due to rain. (Bureau of Meteorology, Daily Rainfall – June 2016)

Figure 4: Long term noise monitoring results at Location L2 – traffic noise on Bridge Street



: Data excluded due to rain. (Bureau of Meteorology, Daily Rainfall – June 2016)

Figure 5: Long term noise monitoring results at Location L3 – traffic noise on Loftus Street



: Data excluded due to rain. (Bureau of Meteorology, Daily Rainfall – June 2016)

4. Project Criteria

4.1 City of Sydney DCP 2012 Internal Noise Level Criteria

Section 4.2.3.11 of the City of Sydney Council's DCP 2012 states the following:

The noise criteria outlined in the Standard Conditions of Development Consent 2012 are largely consistent with those of the City of Sydney DCP 2012 and the NSW Industrial Noise Policy. Additional criteria include the following:

"(62) (b) An LAeq, 15minute noise level emitted from the use must not exceed the LA90, 15minute noise level by more than 3dB in any Octave Band Centre Frequency (31.5 Hz to 8 kHz inclusive) when assessed inside any habitable room of any affected residence provided that:

(i) Where the LA90, 15minute noise level is below the threshold of hearing Tf at any Octave Band Centre Frequency as defined in Table 1 of International Standard ISO 226 – Normal Equal-Loudness Level Contours then the value of Tf corresponding to that Octave Band Centre Frequency shall be used instead.

(ii) The LAeq, 15minute noise level and the LA90, 15minute noise level shall both be measured with all external doors and windows of the affected residence closed;

(iii) The LA90, 15minute noise level shall be measured in the absence of noise emitted from the use but with the (excluding air-conditioning equipment) normally servicing the affected residence operating.

(7) The repeatable maximum L_{Aeq} (1 hour) for residential buildings and services apartments must not exceed the following levels:

(a) For closed windows and doors:

(i) 35 dB for bedrooms (10pm-7am); and

(ii) 45 dB for main living areas (24 hours).

(b) For open windows and doors:

(i) 45 dB for bedrooms (10pm-7am); and

(ii) 55 dB for main living areas (24 hours).

(8) Where natural ventilation of a room cannot be achieved, the repeatable maximum L_{Aeq} (1 hour) level in a dwelling when doors and windows are shut and air conditioning is operating must not exceed:

(a) 38 dB for bedrooms (10pm-7am); and

(b) 48 dB for main living areas (24 hours).

(9) These levels are to include the combined measured level of noise from both external sources and the ventilation system operating normally."

4.2 Client Internal Sound Insulation and Internal Noise Requirements

As specified in the clients Design/Construction Guidelines for Mock-up Guestroom, the aacoustic sound insulation requirements are summarised below in Table 4.

Table 4: Performance Requirements According to The Client Design/Construction Guidelines

Construction	Condition	Deemed-to-Satisfy Requirements
Walls	**Airborne Sound Insulation**	
	Guestroom masonry partitions	Minimum STC 55
	Guestroom gypsum on stud partitions	Minimum STC 55
	Between guestroom bathroom shaft and chase wall	Minimum STC 50
	Between guestroom to elevator shaft or other mechanical space	Minimum STC 56
	Between a guestroom to corridor	Minimum STC 52
Floors	**Airborne Sound Insulation**	
	Floor to ceiling in concrete	Minimum STC 50
	Floor to ceiling in wood frame system	Minimum STC 55
	Impact Sound Insulation	
	Between guestroom units	Minimum IIC 55
Doors	**Airborne Sound Insulation**	
	Main entrance to the guestrooms	Minimum double-slab 65mm

*__Note:__ STC is equivalent to R_w and IIC = 110-Ln,w.

As specified in the clients, Architecture & Interior Module, all the mechanical units such as air distribution system and air devices should not exceed NC 30 which is equivalent to L_{Aeq} of 39dB.

4.3 Project Specific Internal Noise Criteria

As a summary, there are three internal noise criteria specific to this project. The overall criteria for internal noise criterion were established using the values from the City of Sydney DCP 2012, Client Internal Sound Insulation and Internal Noise Criteria, and the City of Sydney Standard Condition of Development Consent 2012 – Internal Noise Level Criteria mentioned above. The internal project specific noise level adopted for the project is presented in Table 5.

Table 5: Project Specific Internal Noise Criteria

Type of occupancy / activity	Descriptor	Closed Window PSNL dB(A)	Open Window PSNL dB(A)
Sleeping areas	$L_{Aeq,\ 15min}$	35 (10pm-7am)	45 (10pm-7am)
Living areas	$L_{Aeq,\ 15min}$	45 (24 hours)	55 (24 hours)

4.4 NSW Industrial Noise Policy (INP) Criteria

The NSW Environment Protection Authority (EPA) sets out noise criteria in its Industrial Noise Policy (INP) to control the noise emission from industrial noise sources or continuous steady state noise. The external noise due to mechanical services from the proposed development is addressed following the guideline in the NSW EPA's INP.

The calculation is based on the results of the ambient and background noise unattended monitoring, addressing two components:

- Controlling intrusive noise into nearby residences (Intrusiveness Criteria)
- Maintaining noise level amenity for particular land uses (Amenity Criteria)

Intrusiveness Criteria

The NSW EPA INP states the following:

"The intrusiveness of an industrial noise source may generally be considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (represented by the L_{Aeq} descriptor), measured over a 15-minute period, does not exceed the background noise level measured in the absence of the source by more than 5 dB(A)."

The intrusiveness criterion can be summarised as follows:

$L_{Aeq,\ 15\ minute} \leq$ RBL background noise level plus 5 dB(A)

The intrusiveness criterion for the closest residential receivers is presented in Table 6 below. Note the values from L1 have been used in this assessment as they are the most relevant to define the background and ambient noise level of the residential receivers.

Table 6: EPA INP Intrusiveness Criteria

Period	Noise Descriptor – dB(A)	Noise Criteria – All residential receivers
Daytime 7am – 6pm	$L_{Aeq,15min} \leq L_{90,15min} + 5$	66.5
Evening 6pm – 10pm	$L_{Aeq,15min} \leq L_{90,15min} + 5$	65.5
Night 10pm – 7am	$L_{Aeq,15min} \leq L_{90,15min} + 5$	58.9

Amenity Criteria

The NSW INP states the following:

> *"To limit continuing increases in noise levels, the maximum ambient noise level within an area from industrial noise sources should not normally exceed the acceptable noise levels specified in Table 2.1 of the INP. Meeting the acceptable noise levels in table 2.1 will protect against noise impacts such as speech interference, community annoyance and to some extent sleep disturbance. These levels represent best practice for assessing industrial noise sources, based on research and a review of assessment practices used overseas and within Australia."*

Project Criteria

The applicable parts of Table 2.1: Recommended L_{Aeq} Noise Levels from Industrial Noise Sources - dB(A) which are relevant to the project are presented in Table 7.

Table 7: Amenity criteria for external noise levels

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended L_{Aeq} Noise Level, dB(A)		Adjusted Acceptable L_{Aeq} Levels
			Acceptable	Recommended Maximum	
55	All	Day	60	65	57
	All	Evening	50	55	58
	All	Night	45	50	54

Modifying Factor Adjustments

"Where a noise source contains certain characteristics, such as tonality, impulsiveness, intermittency, irregularity or dominant low-frequency content, there is evidence to suggest that it can cause greater annoyance than other noise at the same noise level."

In order to take into account, the potential annoying character of the noise an adjustment of 5 dB(A) for each annoying character aspect and cumulative of up to a total of 10 dB(A), is to be added to the measured value to penalise the noise for its potentially greater annoyance aspect.

Table 4.1 of Chapter 4 of the NSW INP (see Table 8) provides procedures for determining whether an adjustment should be applied for greater annoyance aspect.

Table 8: NSW INP – Modifying Factor Corrections (Table 4.1)

Factor	Assessment / Measurement	When to Apply	Correction[1]	Comments
Tonal Noise	One-third octave or narrow band analysis	Level of one-third octave band exceeds the level of the adjacent bands on both sides by: - **5 dB** or more if the centre frequency of the band containing the tone is above 400 Hz - **8 dB** or more if the centre frequency band containing the tone is 160 to 400 Hz inclusive - **15 dB** or more if the centre frequency of the band containing the tone is below 160 Hz	5 dB[2]	Narrow-band frequency analysis may be required to precisely detect occurrence.
Low Frequency Noise	Measurement of C-weighted and A-weighted level	Measure / assesses C- and A-weighted levels over same time period. Correction to be applied if the difference between the two levels is 15 dB or more	5 dB[2]	C-weighting is designed to be more responsive to low-frequency noise, especially at higher overall levels
Impulsive Noise	A-weighted fast response and impulsive response	If difference in A-weighted maximum noise levels between fast response and impulse response is greater than 2 dB	Apply difference in measured levels as the correction, up to a maximum of 5 dB.	Characterised by a short rise time of 35 milliseconds (ms) and decay time of 1.5 s.
Intermittent Noise	Subjectively assessed	Level varies by more than 5 dB	5 dB	Adjustment to be applied for **night-time only.**
Duration	Single-event noise duration may range from 1.5 min to 2.5 h	On event in any 24-hour period	0 to – 20 dB(A)	The acceptable noise level may be increased by an adjustment depending on duration of noise.
Maximum Adjustment	Refer to individual modifying factors	Where two or more modifying factors are indicated	Maximum correction of 10dB(A)[2] (excluding duration correction)	

Notes:

1. Corrections to be added to the measured or predicted levels.

2. Where a source emits tonal and low-frequency noise, only one 5 dB correction should be applied if the tone is in the low-frequency range.

3. At this point of the process noise emissions from the mechanical plants operations have not been determined. Therefore there is no particular consideration given to potential tonal or impulsive character for the emitted noise. Therefore no penalty has been applied to the noise sources associated with the proposed development.

4.5 Project Specific Noise Levels (PSNL)

As a summary, there are two criteria specific to this project. The overall criteria from all industrial plant noise sources were established using the lowest values from the DCP and the INP noise levels mentioned above. These are shown in Table 9 below.

Table 9: Project Specific Noise Levels LAeq from Industrial Noise Sources

Period	Descriptor	PSNL dB(A)
Commercial receivers		
Daytime 7am – 6pm	$L_{Aeq, 15min}$	57
Evening 6pm – 10pm	$L_{Aeq, 15min}$	58
Night 10pm – 7am	$L_{Aeq, 15min}$	54

4.6 Aircraft Noise

The site location is approximately 8.3km north-east of Sydney Airport's main runway and has been assessed for potential aircraft noise intrusion in accordance with AS2021-2000. The site location was found to fall outside the 20 ANEF contour and accordingly it is not expected that aircraft noise will be an intrusive noise source for the development.

4.7 Traffic Noise Criteria

The L_{Aeq} noise level or the "equivalent continuous noise level" correlates best with the human perception of annoyance associated with traffic noise. Road traffic noise impact is assessed in accordance with the NSW Road Noise Policy (RNP, Office of Environment and Heritage 2011). The criterion (Table 3 – Road Traffic Noise Assessment Criteria for Residential Land Uses) divides land use developments into different categories and lists the respective criteria for each case. The category that is relevant to the proposed use of the site is shown in Table 10.

Table 10: NSW Road Noise Policy – Traffic Noise Assessment Criteria

<table>
<tr><th rowspan="2">Road Category</th><th rowspan="2">Type of project/land use</th><th colspan="2">Assessment Criteria – dB(A)</th></tr>
<tr><th>Day
(7am – 10pm)</th><th>Night
(10pm – 7am)</th></tr>
<tr><td rowspan="3">Freeway/ arterial/ sub-arterial roads</td><td>1. Existing residences affected by noise from new freeway/arterial/sub-arterial road corridors</td><td>LAeq, (15 hour) 55</td><td>LAeq, (15 hour) 55</td></tr>
<tr><td>2. Existing residences affected by noise from redevelopment of existing freeway/arterial/subarterial roads</td><td rowspan="2">LAeq, (15 hour) 60</td><td rowspan="2">LAeq, (15 hour) 60</td></tr>
<tr><td>3. Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments</td></tr>
<tr><td>Local Roads</td><td>4. Existing residences affected by noise from new local road corridors</td><td>LAeq, (1 hour) 55</td><td>LAeq, (1 hour) 55</td></tr>
</table>

Project Criteria

Road Category	Type of project/land use	Assessment Criteria – dB(A)	
		Day (7am – 10pm)	Night (10pm – 7am)
	5. Existing residences affected by noise from redevelopment of existing local roads		
	6. Existing residences affected by additional traffic on existing local roads generated by land use developments		

In the event that the traffic noise at the site is already in excess of the criteria noted above, the NSW RNP states that the primary objective is to reduce the existing level through feasible and reasonable measures to meet the criteria above.

If this is not achievable, *Section 3.4.1 Process for applying the criteria – Step 4* states that for existing residences affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise should be limited to 2 dB above that of the corresponding 'no build option'.

Also, the inherent quality of noise from vehicles on public roads arriving to and departing from the site would be indistinguishable from other traffic noise on public roads.

5. Construction Noise and Vibration Criteria

5.1 Construction Noise Criteria

Noise criteria for construction sites are established in accordance with the Interim Construction Noise Guideline (ICNG July 2009) by the NSW Environment Protection Authority (EPA). It is important to note that the recommended criteria are for planning purposes only. Numerous other factors need to be considered when assessing potential noise impacts from construction works.

However, in undertaking the assessment of potential noise intrusion associated with the proposed construction activities, Chapter 4 of the NSW EPA ICNG (July 2009) were specifically referenced. The limits presented in Table 11 apply.

Table 11: NSW EPA ICNG Construction Noise Criteria

Time of Day	Management Level $L_{Aeq,15min}$ *	How to Apply
Recommended Standard Hours: Mon – Fri (7am – 6pm) Sat (8am – 1pm) No work on Sunday & Public Holidays	Noise Affected RBL + 10dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq,15min}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residences of the nature of works to be carried out, the expected noise levels and duration as well as contact details.
	Highly Noise Affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur in, taking into account: • Times identified by the community when they are less sensitive to noise (such as before and after school, for works near schools, or mid-morning or mid-afternoon for works near residences) • If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside Recommended Standard Hours	Noise Affected RBL + 5dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see section 7.2.2.

Note: Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30m of the residence. Noise levels may be higher at upper floors of the noise affected residence.
Source: Chapter 4 (Table 2 Sec 4.1.1) of NSW DECCW ICNG

5.2 Construction Vibration Criteria

The EPA has developed a document, "Assessing vibration: A technical Guideline" in February 2006 to assist in preventing people from excessive vibration levels within buildings. The guideline does not however address vibration induced damage to structures or structure-borne noise effects.
Vibration and its associated effects are usually classified as continuous, impulsive or intermittent.

5.2.1 Human Comfort – Continuous and Impulsive Vibration Criteria

Structural vibration in buildings can be detected by occupants and can affect them in many ways including reducing their quality of life and also their working efficiency. Complaint levels from occupants of buildings subject to vibration depend upon their use of the building and the time of the day.

Maximum allowable magnitudes of building vibration with respect to human response are shown in Table 12. It should be noted that the human comfort for vibration are more stringent than the building damage criteria.

Table 12: Preferred and maximum weighted RMS values for continuous and impulsive vibration acceleration (m/s2) 1-80Hz

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous vibration					
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and place of worship	Day or night time	0.020	0.014	0.040	0.028
Impulsive vibration					
Residences	Daytime	0.30	0.21	0.60	0.42
	Night time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and place of worship	Day or night time	0.64	0.46	1.28	0.92

5.2.2 Human Comfort – Intermittent Vibration Criteria

Disturbance caused by vibration will depend on its duration and its magnitude. This methodology of assessing intermittent vibration levels involves the calculation of a parameter called the Vibration Dose Value (VDV) which is used to evaluate the cumulative effects of intermittent vibration. Various studies support the fact that VDV assessment methods are far more accurate in assessing the level of disturbance than methods which is only based on the vibration magnitude.

Table 13: Acceptable Vibration Dose Values for Intermittent Vibration (m/s1.75)

Location	Daytime (7:00am to 10:00pm)		Night-time (10:00pm to 7:00am)	
	Preferred value	Maximum value	Preferred value	Maximum value
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and place of worship	0.40	0.80	0.40	0.80

5.2.3 Structural Damage – Vibration Criteria

Ground vibration criteria are defined in terms of levels of vibration emission from the construction activities which will avoid the risk of damaging surrounding buildings or structures. It should be noted that human comfort criteria are normally expressed in terms of acceleration whereas structural damage criteria are normally expressed in terms of velocity.

Most commonly specified structural vibration levels are defined to minimize the risk of cosmetic surface cracks and are set below the levels that have the potential to cause damage to the main structure. Structural damage criteria are presented in German Standard DIN4150-Part 3 “Structural vibration in buildings – Effects on structures” and British Standard BS7385-Part 2: 1993 “Evaluation and Measurement for Vibration in Buildings”. Table 5 indicates the vibration limits presented in DIN4150-Part 3 to ensure structural damage doesn’t occur.

5.2.4 Construction Vibration Objectives

Table 14 indicates the construction vibration criteria applicable to the residential and commercial properties located adjacent to the development site.

Table 14: Construction vibration criteria summary

Location	Period	Human Comfort Vibration Objectives			Building damage Objectives – Velocity (mm/s)
		Continuous mm/s^2 (RMS)		Intermittent $mm/s^{1.75}$ (VDV)	
		z-axis	x- and y-axis		
Residential	Day time	10 - 20	7 - 14	0.20 - 0.40	5
	Night time	7 - 14	5 - 10	0.13 - 0.26	5
Commercial	Day or night	20 - 40	14-28	0.40 - 0.80	20

Table 15: Guideline value of vibration velocity, vi, for evaluating the effects of short-term vibration

Line	Type of Structure	Vibration velocity, vi, in mm/s			
		Foundation			Plane of floor of uppermost full storey
		At a frequency of			
		Less than 10Hz	10 to 50Hz	50 to 100*Hz	All Frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that, because of their particular sensitivity to vibration, do not correspond to those listed in lines 1 and 2 and are of great intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8
*For frequencies above 100Hz, at least the values specified in this column shall be applied					

Table 16 presents guide values for building vibration, based on the lowest vibration levels above which cosmetic damage has been demonstrated as per BS7385-Part 2:1993.

Table 16: Transient vibration guide values for cosmetic damage

Type of Building	Peak Particle Velocity in frequency range of predominant pulse (PPV)	
Residential or light commercial type buildings	4 Hz to 15 Hz	15 Hz and above
Residential or light commercial type buildings	15mm/s at 4Hz increasing to 20mm/s at 15Hz	20mm/s at 15Hz increasing to 50mm/s at 40Hz and above

5.3 Retail Uses and Licensed/Un-licensed Premises

As the individual retail tenancies have not been defined yet and lease agreement with tenants have not been finalised, the noise criteria have not been defined for retail uses and licensed/un-licensed premises. For the purposes of this report we can assume the Level 3 tenancies of the Lands Building will consist of a Bar, a licensed Restaurant Dining area, and a Bistro Dining Area. We will assume the capacity of the entire floor to be no more than 200 persons. The noise emission criteria from the NSW Liquor Administration Board (LAB) shall be applied to any music/entertainment and patrons from the licensed premises. The applicable noise criteria associated with these premises includes the following:

Table 17: NSW Liquor Act 2007 Noise Criteria

Period	Octave Band Centred Frequencies (Hz)	Noise Descriptor dB(A)
7:00am – 12:00am	From 31.5Hz to 8000Hz	$L_{A10,\,Oct} \leq L_{A90,\,Oct} + 5$
12:00am – 7:00am	From 31.5Hz to 8000Hz	$L_{A10,\,Oct} \leq L_{A90,\,Oct} + 0$

Further to the criteria shown in Table 17 , the noise from the licensed premises shall not be audible within any habitable room in any residential premises between the hours of 12:00 midnight and 7:00am.

6. Noise Impact Assessment

The following sections detail the acoustic requirements for the proposed building glazing, and the noise impact assessment from external noise emissions to internal receivers.

6.1 External Glazing

In order to provide acoustic amenity to occupants for the future Hotel and comply with the City of Sydney DCP internal noise levels, the acoustic performance of the building facades was assessed.

The general limiting factor of the performance of a building façade in term of noise attenuation is the glazing. In this particular case of the proposed development, the traffic movements on Bridge Street will place the greatest acoustic demand on the development.

In order to achieve the recommended internal noise levels criterion as summarised on Table 5, the minimum recommended glazing system for the façades of the proposed development is presented in Table 18.

This assessment is based on the worst case scenario of external noise obtained from the attended and unattended noise measurements surrounding the sites. The glazing systems presented below should be considered as the minimum requirements to achieve appropriate acoustic performance. Greater glazing systems may be required for structural loading, wind loading, ESD, etc. Note that there was assumed to be no attenuation through external façade elements such as unsealed balustrades or landscaping elements.

Table 18: Recommended glazing thicknesses for Acoustics

Building	Façade Facing	Level	Type of Space	Internal noise level (Maximum) L_{Aeq} dB(A) based on PSINC	Glazing type – (Rw)
Lands	Bridge Street (North)	LG	Commercial	50	10.38mm Laminated Glass (Rw35)
		G	Guest Room	35	12.5mm VLam Hush (Rw40) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)
		1	Guest Room	35	12.5mm VLam Hush (Rw40) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)
		2	Guest Room	35	12.5mm VLam Hush (Rw40) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)
		3	Lounges	40	10.38mm Laminated Glass (Rw35)
	Gresham Street (West)	LG	Commercial	35	10.38mm Laminated Glass (Rw35)
		G	Guest Room	35	12.5mm VLam Hush (Rw40) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)
			Corridor	50	10.38mm Laminated Glass (Rw35)

		1	Guest Room	35	12.5mm VLam Hush (Rw40) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)
			Corridor	50	10.38mm Laminated Glass (Rw35)
		2	Guest Room	35	12.5mm VLam Hush (Rw40) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)
	Bent Street (South)	LG	Commercial	50	10.38mm Laminated Glass (Rw35) or VLam Hush/ 15mm cavity /6mm* glass (Rw43)
		G	Guest Room	35	12.5mm VLam Hush (Rw40) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)
			Lounges	50	12.38mm Laminated Glass (Rw37) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)
		1	Guest Room	35	12.5mm VLam Hush (Rw40) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)
		2	LB.L2.01 LB.L2.14	35	12.38mm Laminated Glass (Rw37) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)
			LB.L2.11 LB.L2.15 LB.L2.16	35	12.5mm VLam Hush (Rw40) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)
		3	Lounges	50	10.38mm Laminated Glass (Rw35)
	Loftus Street (East)	LG	Commercial	50	10.38mm Laminated Glass (Rw35)
		G	Guest Room	35	12.5mm VLam Hush (Rw40) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)
			Corridor	50	10.38mm Laminated Glass (Rw35)
		1	Guest Room	35	12.5mm VLam Hush (Rw40) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)
			Corridor	50	10.38mm Laminated Glass (Rw35)
		2	LB.L2.09 LB.L2.13	35	12.5mm VLam Hush (Rw40) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)
			LB.L2.10 LB.L2.11 LB.L2.L12 LB.L2.13B LB.L2.14	35	12.38mm Laminated Glass (Rw37) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)

	Light-well	All	Guest Room	35	10.38mm Laminated Glass (Rw35) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)
Education	**Bridge Street (North)**	LG	Function Room	40	12.5mm VLam Hush (Rw40) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)
		G	Function Room	40	12.38mm Laminated Glass (Rw37) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)
		1	EB.L1.05 EB.L1.07	35	6mm/1700mm cavity/6mm* glass (Rw48)
			Guest Room	35	12.5mm VLam Hush (Rw40) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)
		2-4	Guest Room	35	6mm/1700mm cavity/6mm* glass (Rw48)
			EB.L2.03 EB.L2.09	35	12.5mm VLam Hush (Rw40) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)
	Loftus Street (West)	LG	EB.LG.01 EB.LG.02	50	10.38mm Laminated Glass (Rw35) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)
			Bar	50	12.38mm Laminated Glass (Rw35) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)
		G	Function Room	40	12.38mm Laminated Glass (Rw37) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)
			Reception	50	10.38mm Laminated Glass (Rw35) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)
			Toilets/ Maintenance Area	55	10.38mm Laminated Glass (Rw35) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)
		1-5	Guest Room	35	6mm/1700mm cavity/6mm* glass (Rw48)
		6-above	Guest Room	35	10.38mm Laminated Glass (Rw35) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)
	Bent Street (South)	LG	Bar	40	10.38mm Laminated Glass (Rw35) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)
		G	Bar	50	10.38mm Laminated Glass (Rw35) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)

			Restaurant	45	10.38mm Laminated Glass (Rw35) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)
		1-5	Guest Room	35	6mm/1700mm cavity/6mm* glass (Rw48)
		6-above	Guest Room	35	12.38mm Laminated Glass (Rw37) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)
	Young Street (East)	LG	Function Room	40	12.5mm VLam Hush (Rw40) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)
			Maintenance Area	55	10.38mm Laminated Glass (Rw35)
		G	Restaurant/ Foyer	45	10.38mm Laminated Glass (Rw35)
			Function Room	40	12.38mm Laminated Glass (Rw37) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)
		1-5	Guest Room	35	6mm/1700mm cavity/6mm* glass (Rw48)
	Light-well	1-5	Guest Room	35	10.38mm Laminated Glass (Rw35) or 10.5mm VLam Hush/ 15mm cavity /6mm* glass (Rw43)

Notes:
The Required Acoustic Rating of Glazing Assembly refers to the acoustic performance of the glazing once installed on site (including the frame). It is the responsibility of the builder to ensure that the required acoustic performance of the glazing system is achieved.

The proposed glass systems are suggestions only. Alternative glass systems may be used as long as the Acoustic Rating specified is met.

*The 6mm glass is the glazing of the existing façade.

**The 12.5mm Vlam Hush recommended is equivalent in terms of acoustics performance to the Comfort Hush which will satisfy the project thermal performance requirements.

The glazing system proposed above is only for the Development Application purposes only. The acoustic performance of the glazing facade should be reviewed as the combined noise from external sources and mechanical services could result in internal noise level exceeding the recommended design sound level during the detailed design stage of the project.

6.2 Noise Emissions

The following noise sources are associated with the site operation, and details about expected noise levels from these sources are given in the ensuing sub-sections. Noise sources from general operations of the site typically include mechanical services noise from air-conditioning equipment and exhaust fans etc. servicing the guest rooms and auxiliary facilities. These noise sources have been used to predict in the worst case scenario the noise impact of the proposed development at the boundary of the nearest sensitive receivers.

The proposed redevelopment will include a combination of existing plant equipment and proposed new equipment.

Existing plant room relocation details are to be confirmed. Detailed assessment of the mechanical plant will be conducted at later stages during the detailed design phase. This will include specifying treatment for the equipment.

The main mechanical sources associated with the development will include:

- Level 8 cooling towers - Education Building
- Level 9 to rooftop mechanical exhausts such as garbage exhaust fan, kitchen exhaust and bathroom exhaust - Education Building
- Level 3 (rooftop) plant room – Lands Building

Activity associated with retail/commercial activities include:

- Patron Noise from the tenancy
- Music
- Potential noise from pool activities and change rooms

In order to assess the worst case scenario, it was assumed that the air conditioning units and exhausts and supply fans are running at any time throughout a 24hr period. With all, the night time is the most stringent period for the noise generated by the operation of mechanical plant and as such this criterion was used as the noise target at the boundary of the nearest sensitive receivers for the project.

Our most sensitive receivers are the commercial buildings on Young Street to the East, the commercial buildings across Bridge Street to the North, the commercial buildings on the Gresham Street to the West, and the commercial buildings on Bent Street to the South.

Using this approach, we can determine the combined Sound Power Level of all plant equipment can be a maximum of **98 dB(A)** from all mechanical plant when measured at its façade to the East.

6.2.1 Proposed Noise Levels

As presented on Appendix-3, there will be a plant room servicing Education Building that will be located on the Eastern corner of the building roof and a plant room servicing Lands Building that will be located on the South-West corner of the building.

Table 19: Proposed acoustic power for individual mechanical units

Item	Lw re 1pW								
	63 Hz	125 Hz	250 Hz	500 Hz	1 KHz	2 KHz	4 KHz	8 KHz	Overall dB(A)
Toilet Exhaust Fans	50	48	56	57	54	53	45	38	39
Kitchen Exhaust Fans	103	94	104	104	102	99	97	95	110
Cooling Towers	94	92	88	87	83	81	78	74	89
Stairs Pressurised Fans	95	99	97	98	101	100	96	93	107

Table 19 presents the proposed maximum sound power levels for individual mechanical units to achieve the noise criteria shown at the nearest sensitive receiver of the site. Typical mechanical unit spectrums have been used, and will need to be amended once specific units have been selected.

6.3 Noise Mitigation Measures

It is our opinion that the project specific noise levels at the boundaries of the surrounding receivers can be met by treating the rooftop plant equipment with standard acoustic treatment. This acoustic treatment might include the followings:

- Acoustic attenuators
- Acoustic louvers
- Internal lining of duct work

Note that this is a preliminary solution as the design is yet to be finalized. A detailed acoustic assessment will be required as more information becomes available regarding performance data of specific mechanical equipment or any further mechanical design information. Treatment will be proposed to ensure the Sydney City Council criteria for mechanical, electrical and hydraulic services noise at the site boundary is complied with.

6.4 Road Traffic Noise Impact Assessment

As there is no designated car-park allocated on the site, the traffic noise impact on the post-development generated traffic can be neglected. Therefore, the proposed development is expected comply with the requirements of the NSW RNP.

6.5 Retail/Commercial Noise Assessment

The future tenants of retail / commercial space within the development will hold the responsibility for achieving the applicable noise criteria for licensed/unlicensed premises (see Section 5.3). For the purposes of this Development Application we have assumed that Level 3 of Lands Building will consist of a designated Bar, a Licensed Restaurant with Dining Area, and a Bistro Dining space. The maximum capacity has been assumed to be 200 persons.

The NSW Liquor Act 2007 octave-band noise criteria for the premises based on the conducted measurements are shown below in Table 20.

Table 20: Licensed Premises noise criteria for Octave Band Frequencies

	Frequency (Hz)									Overall
	31.5	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**dB(A)**
Measured RBL 7:00am–12:00am $L_{A90,\ Oct}$ dB(A)	57	48	48	47	45	42	37	30	21	59
Criteria 7:00am–12:00am $L_{A10,\ Oct}$ dB(A)	62	53	53	52	50	47	42	35	26	64

7. Conclusion

An acoustic assessment for the proposed hotel development located on Bridge Street, Sydney has been conducted. This document forms part of the documentation package to be submitted to local authorities as part of the DA process.

This report has provided criteria, in-principle treatment and design requirements which aim to achieve the statutory criteria discussed in section 5. In terms of noise criteria, we have provided the following:

- Noise criteria for emissions from the development to receivers in accordance with the INP and City of Sydney DCP housing provided in section 4.1
- Noise criteria for internal noise levels according to AS/NZS2107:2000, provided in section 4.3
- Traffic noise criteria presented in section 4.7
- Construction noise criteria provided in section 5.1

Glazing acoustic performance requirements for the building has been provided to achieve internal noise levels in accordance with the requirements of AS/NZS2107:2000 and City of Sydney Development Control Plan (DCP). The initial glazing systems are presented in section 6.1.

The maximum sound power levels presented in this report show that the day, evening and night noise criteria is expected to be met. Should the plant sound power levels exceed the levels presented in this report noise mitigation measures will be required. These measures will be developed and implemented during the detailed design stages of the project.

As there is no designated car-park allocated on the site, the traffic noise impact on the post-development generated traffic will be negligible besides on street pick-ups/drop-offs. Therefore, the proposed development is expected comply with the requirements of the NSW RNP.

Even though no assessment can be considered as being thorough enough to preclude all potential environmental impacts, having given regard to the above listed conclusions, it is the finding of this assessment that the development application should not be refused on the grounds of excessive noise generation, as it can comply with all applicable regulations.

The information presented in this report shall be reviewed if any modifications to the features of the development specified in this report occur, including and not restricted to selection of air-conditioning units, layout of equipment, modifications to the building and introduction of any additional noise sources.

Appendix 1 - Glossary of Acoustic Terms

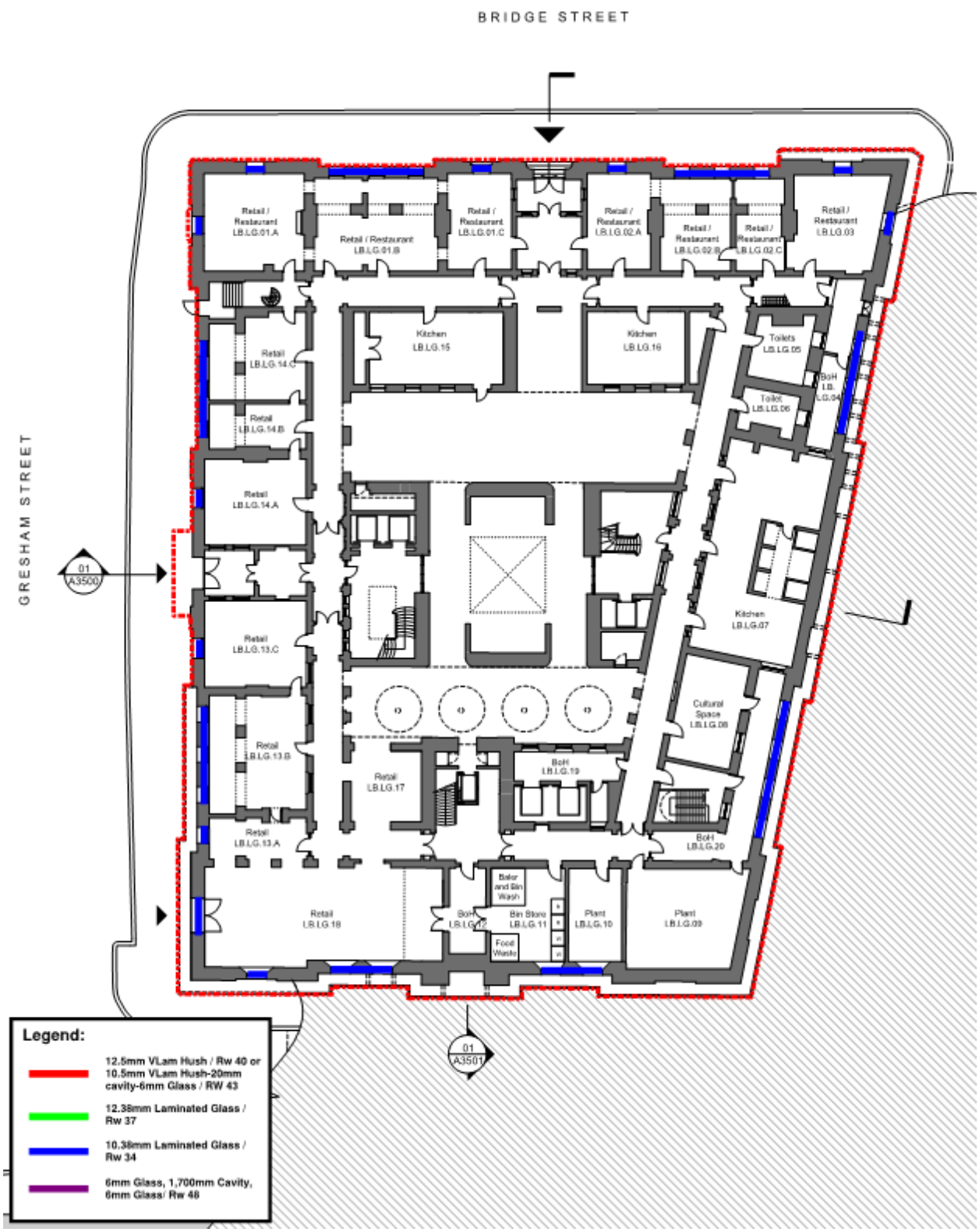
NOISE	
Acceptable Noise Level:	The acceptable LAeq noise level from industrial sources, recommended by the EPA (Table 2.1, INP). Note that this noise level refers to all industrial sources at the receiver location, and not only noise due to a specific project under consideration.
Adverse Weather:	Weather conditions that affect noise (wind and temperature inversions) that occur at a particular site for a significant period of time. The previous conditions are for wind occurring more than 30% of the time in any assessment period in any season and/or for temperature inversions occurring more than 30% of the nights in winter).
Acoustic Barrier:	Solid walls or partitions, solid fences, earth mounds, earth berms, buildings, etc. used to reduce noise.
Ambient Noise:	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment Period:	The period in a day over which assessments are made.
Assessment Location	The position at which noise measurements are undertaken or estimated.
Background Noise:	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level.
Decibel [dB]:	The units of sound pressure level.
dB(A):	A-weighted decibels. Noise measured using the A filter.
Extraneous Noise:	Noise resulting from activities that are not typical of the area. Atypical activities include construction, and traffic generated by holidays period and by special events such as concert or sporting events. Normal daily traffic is not considered to be extraneous.
Free Field:	An environment in which there are no acoustic reflective surfaces. Free field noise measurements are carried out outdoors at least 3.5m from any acoustic reflecting structures other than the ground
Frequency:	Frequency is synonymous to pitch. Frequency or pitch can be measured on a scale in units of Hertz (Hz).
Impulsive Noise:	Noise having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.

Appendix 1 - Glossary of Acoustic Terms

Intermittent Noise:	Level that drops to the background noise level several times during the period of observation.
LAmax	The maximum A-weighted sound pressure level measured over a period.
LAmin	The minimum A-weighted sound pressure level measured over a period.
LA1	The A-weighted sound pressure level that is exceeded for 1% of the time for which the sound is measured.
LA10	The A-weighted sound pressure level that is exceeded for 10% of the time for which the sound is measured.
LA90	The A-weighted level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
LAeq	The A-weighted "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
LAeqT	The constant A-weighted sound which has the same energy as the fluctuating sound of the traffic, averaged over time T.
Reflection:	Sound wave changed in direction of propagation due to a solid object met on its path.
R-w:	The Sound Insulation Rating R-w is a measure of the noise reduction performance of the partition.
SEL:	Sound Exposure Level is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound Absorption:	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound Level Meter:	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound Pressure Level:	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound Power Level:	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise:	Containing a prominent frequency and characterised by a definite pitch.

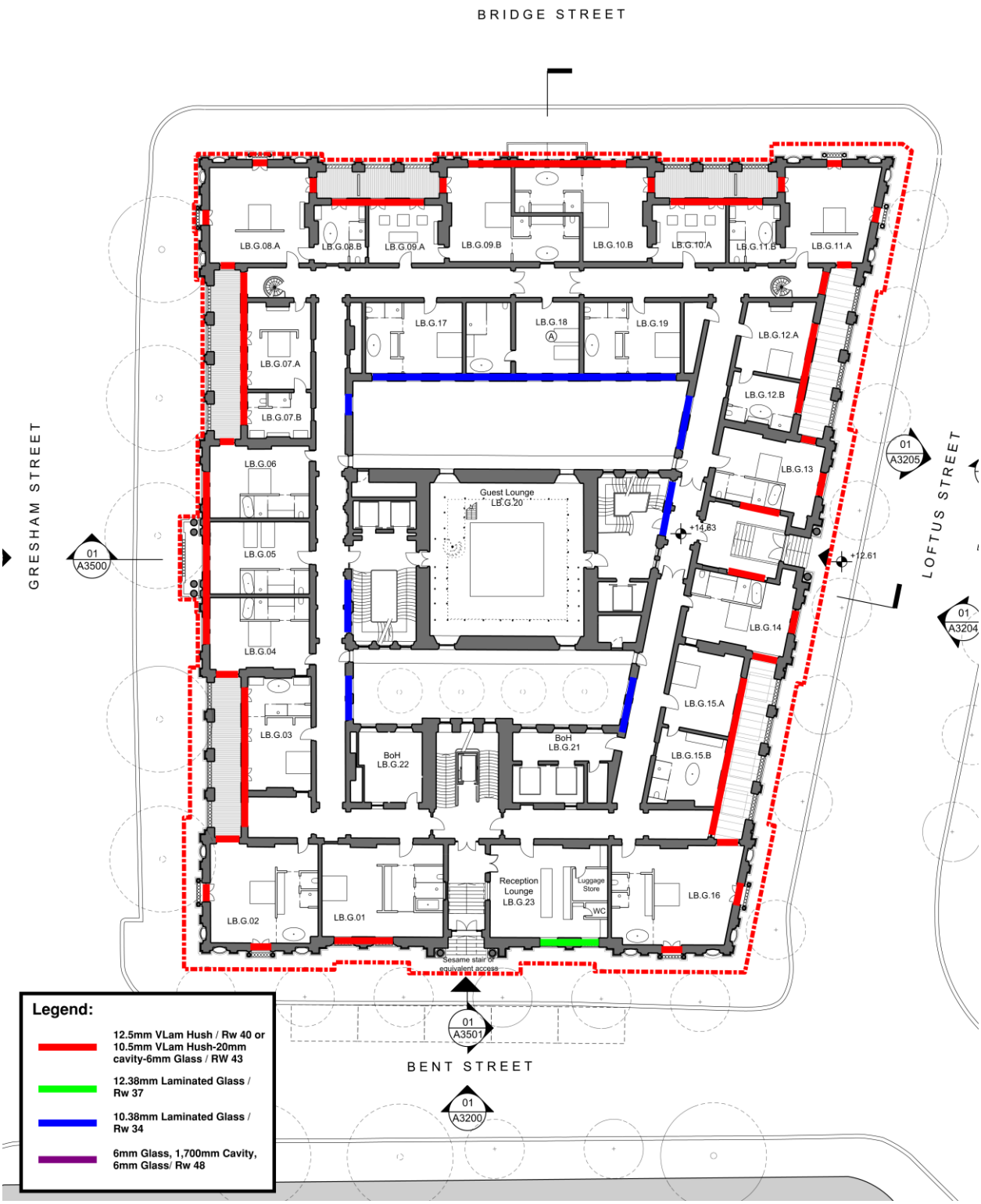
Appendix 2 – Glazing Assessment

Lower-Ground Level (Lands)



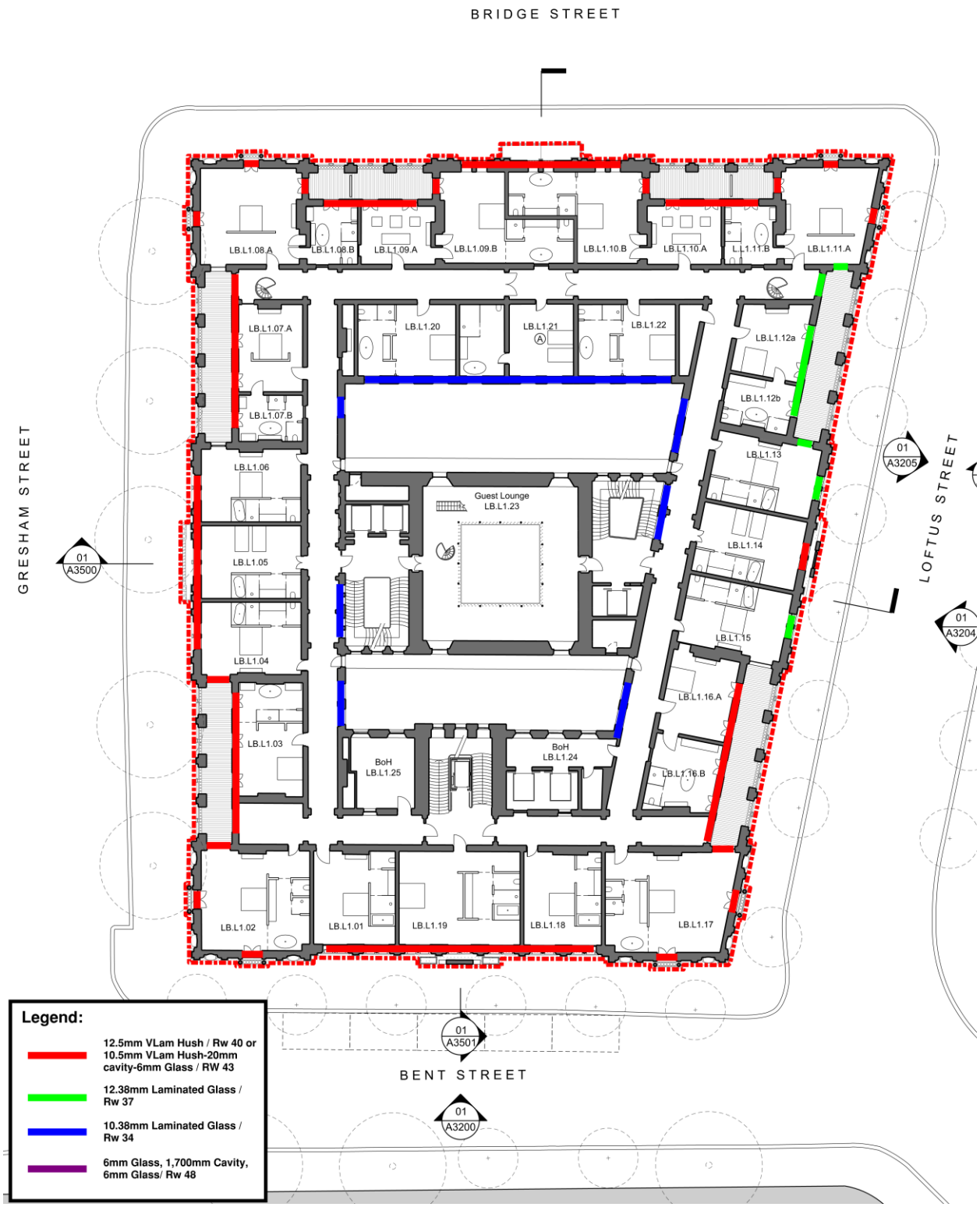
Appendix 2 – Glazing Assessment

Ground Level (Lands)



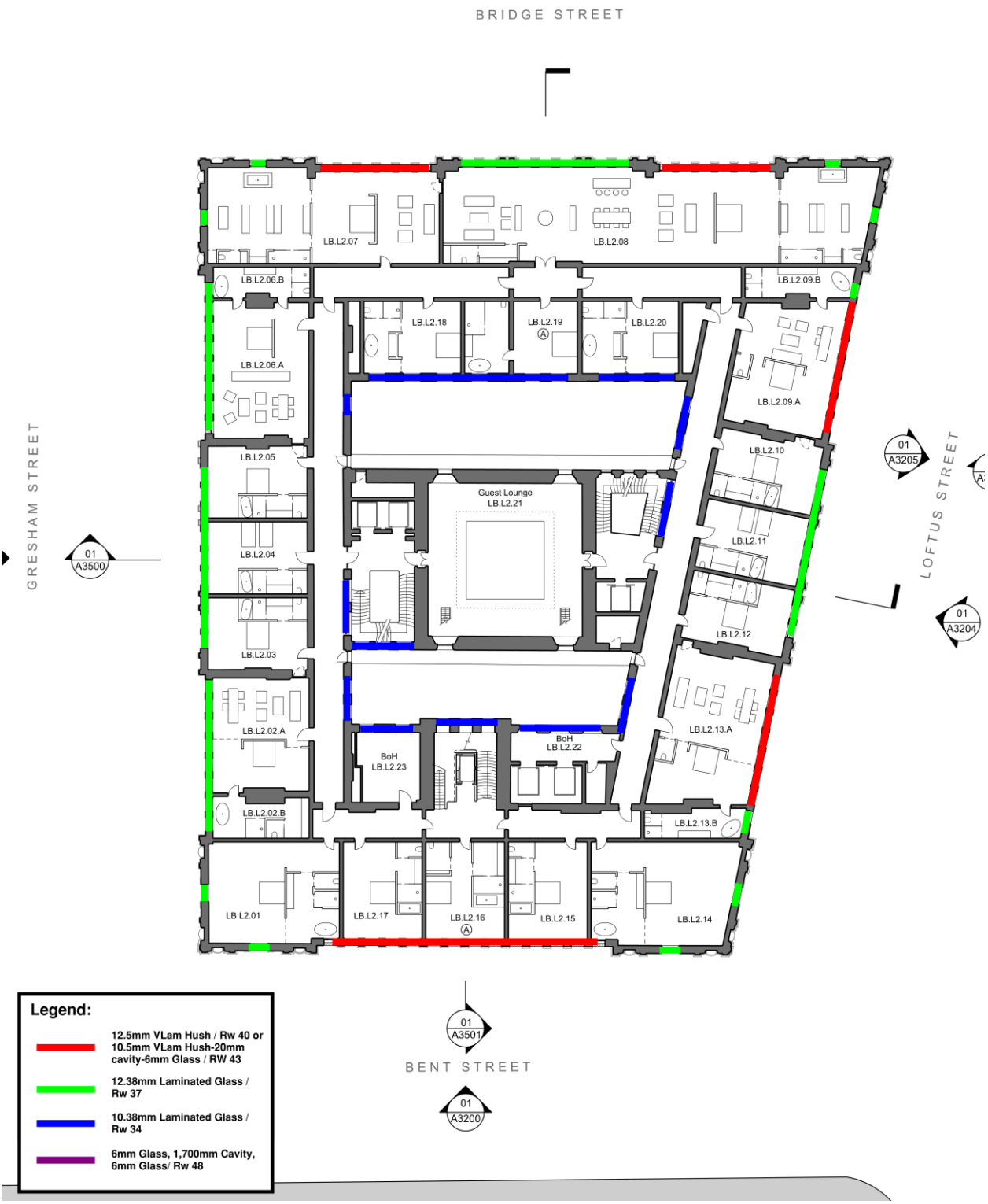
Appendix 2 – Glazing Assessment

Level 1 (Lands)



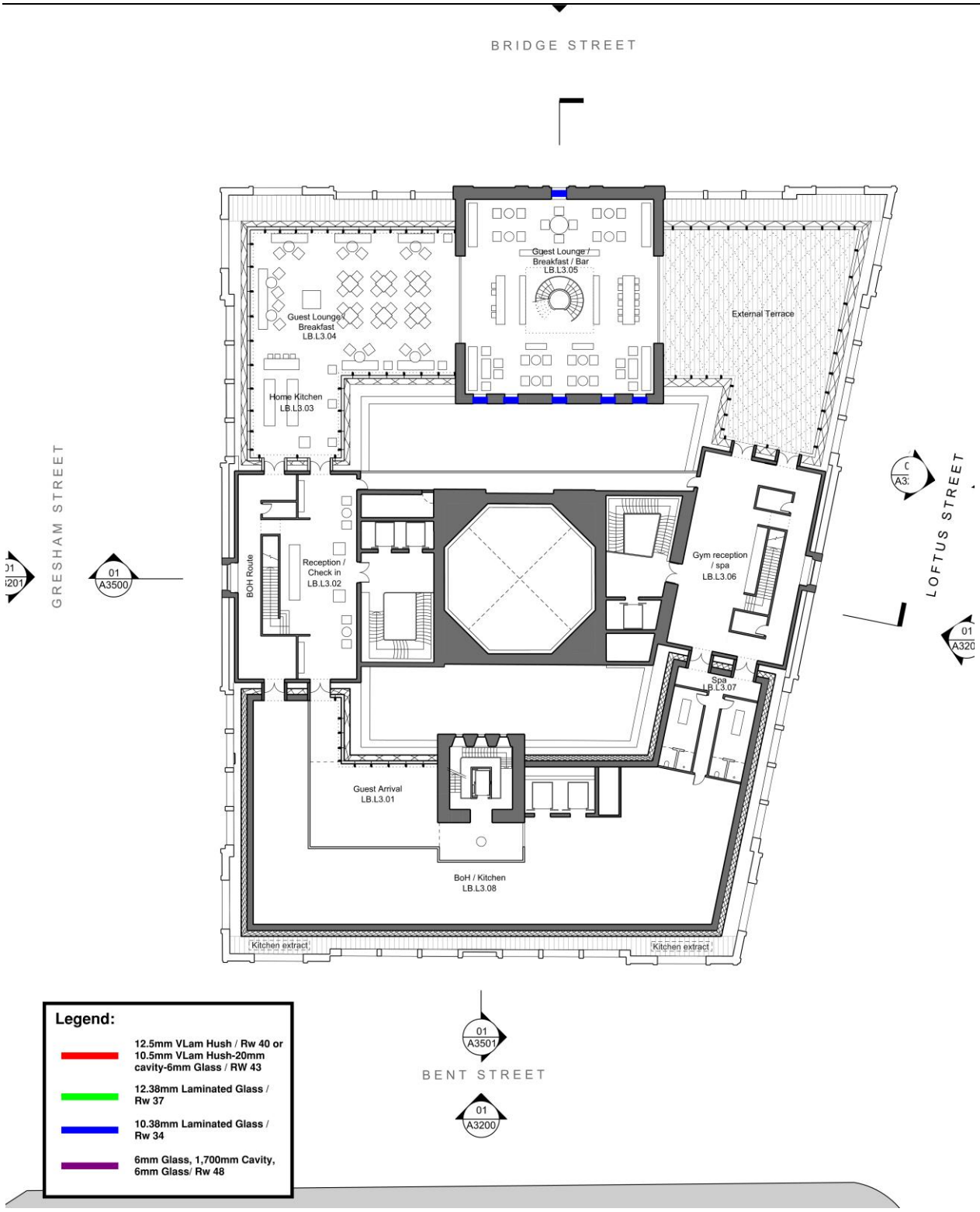
Appendix 2 – Glazing Assessment

Level 2 (Lands)



Appendix 2 – Glazing Assessment

Level 3 (Lands)

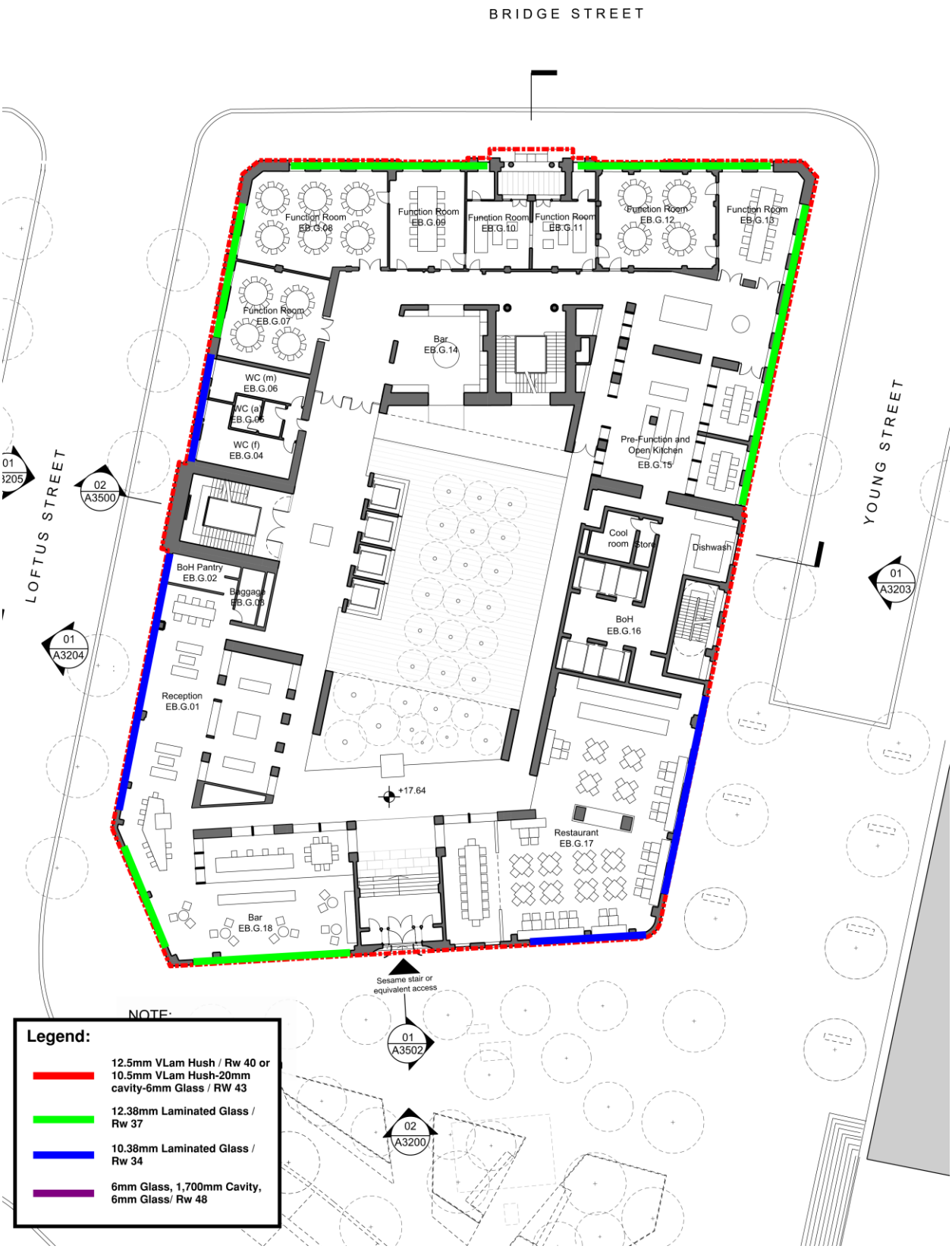


Appendix 2 – Glazing Assessment

Lower-Ground Level (Education)

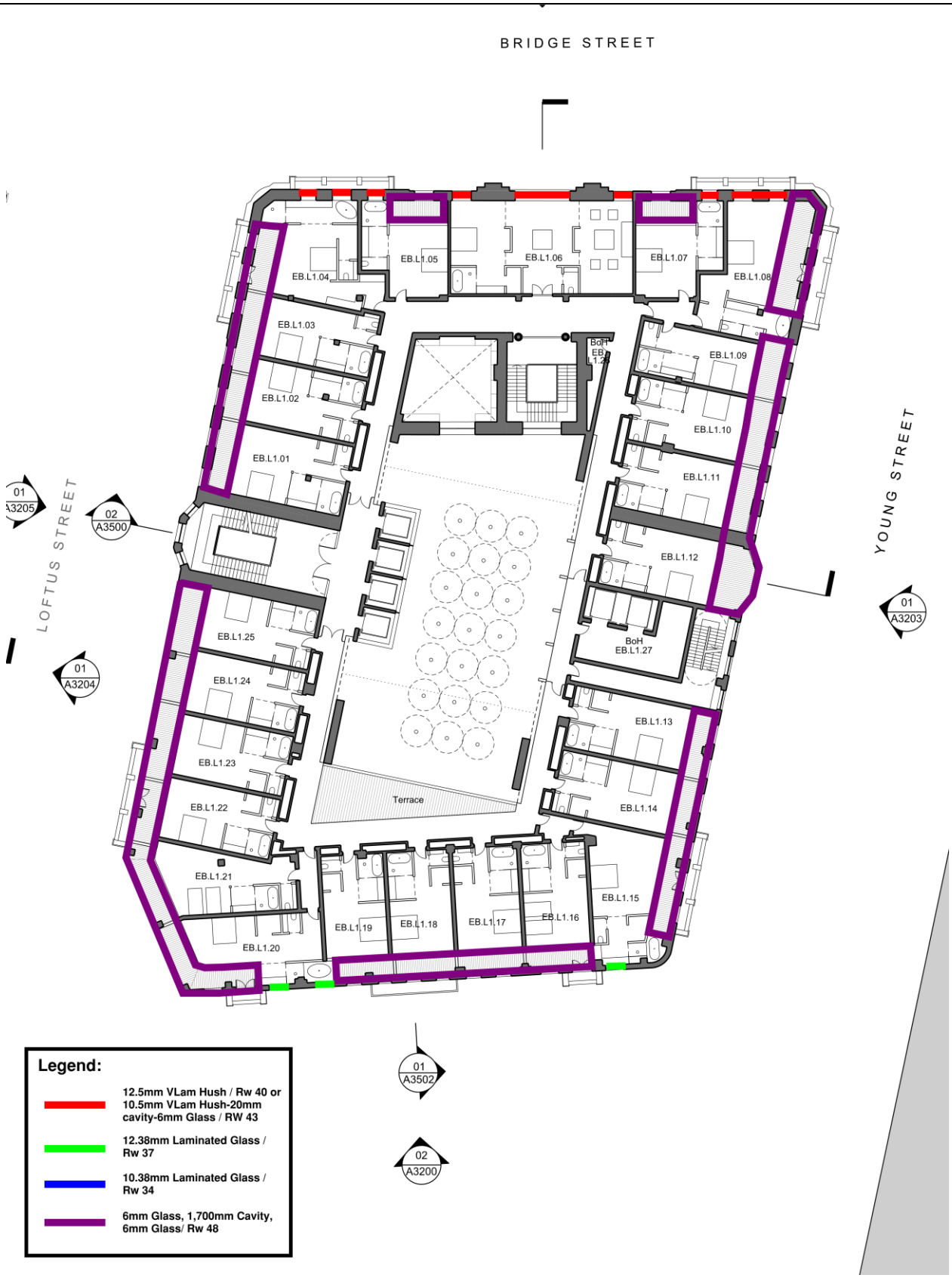
Appendix 2 – Glazing Assessment

Ground Level (Education)



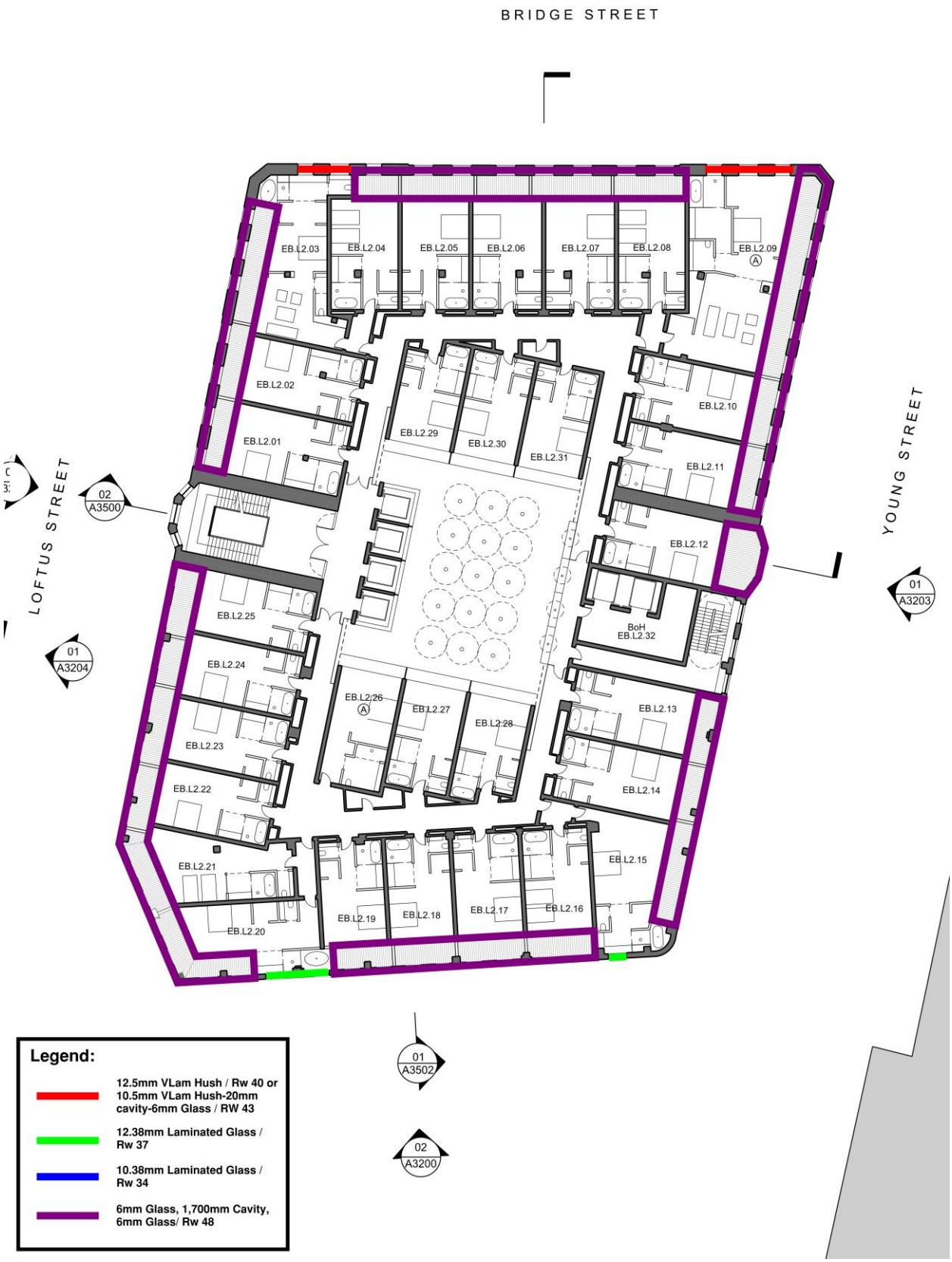
Appendix 2 – Glazing Assessment

Level 1 (Education)



Appendix 2 – Glazing Assessment

Level 2 (Education)



Appendix 2 – Glazing Assessment

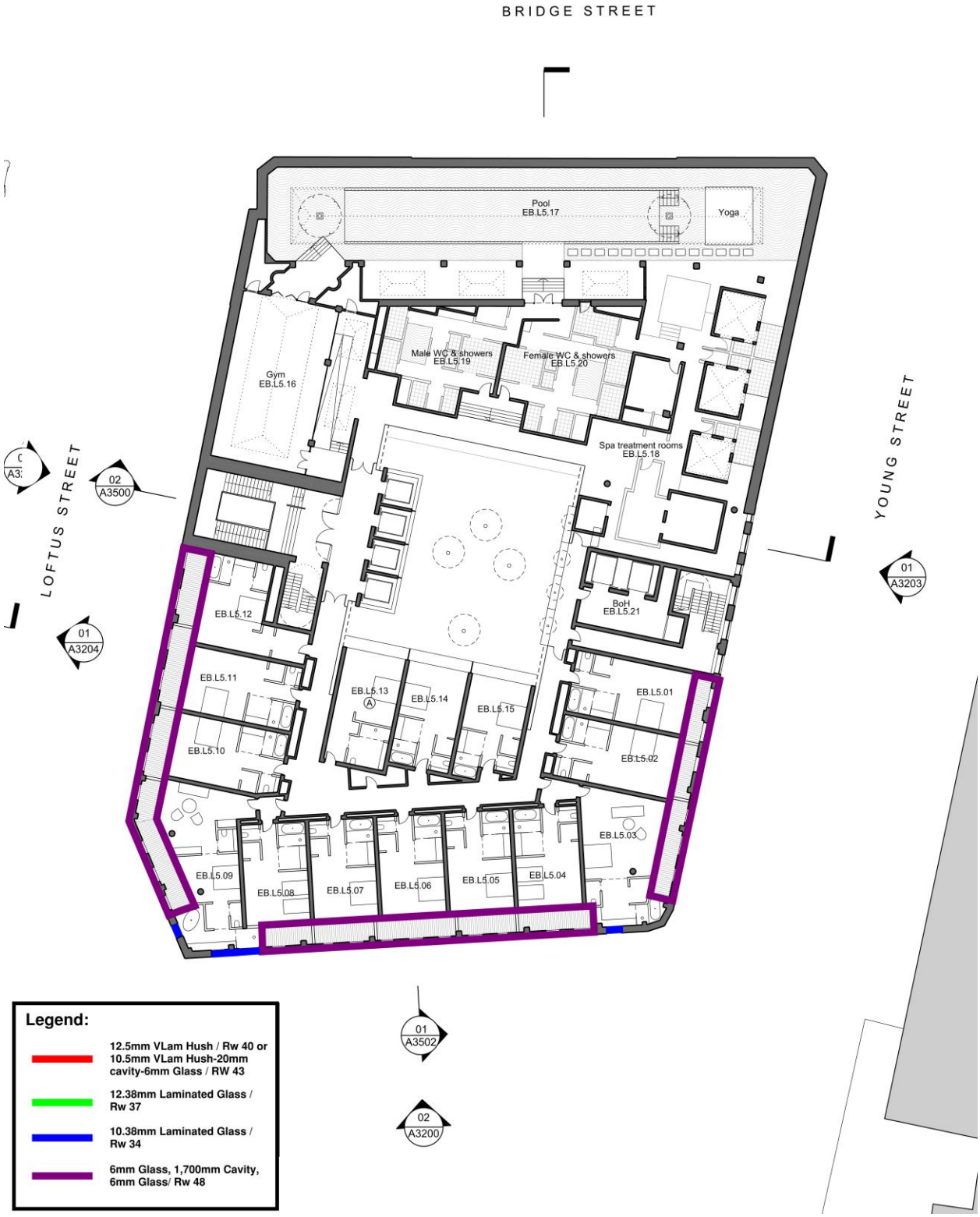
Level 3 (Education)

Appendix 2 – Glazing Assessment

Level 4 (Education)

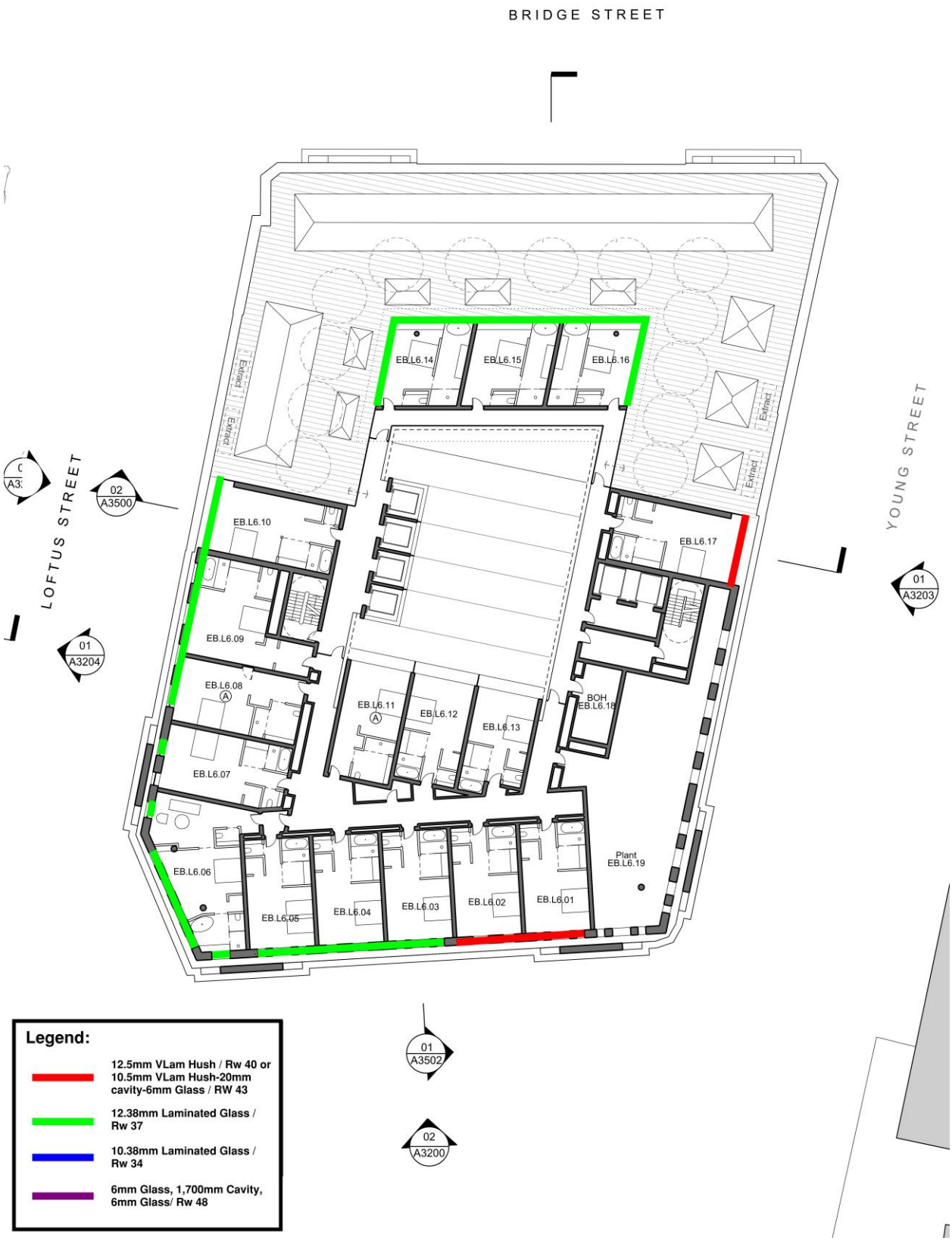
Appendix 2 – Glazing Assessment

Level 5 (Education)



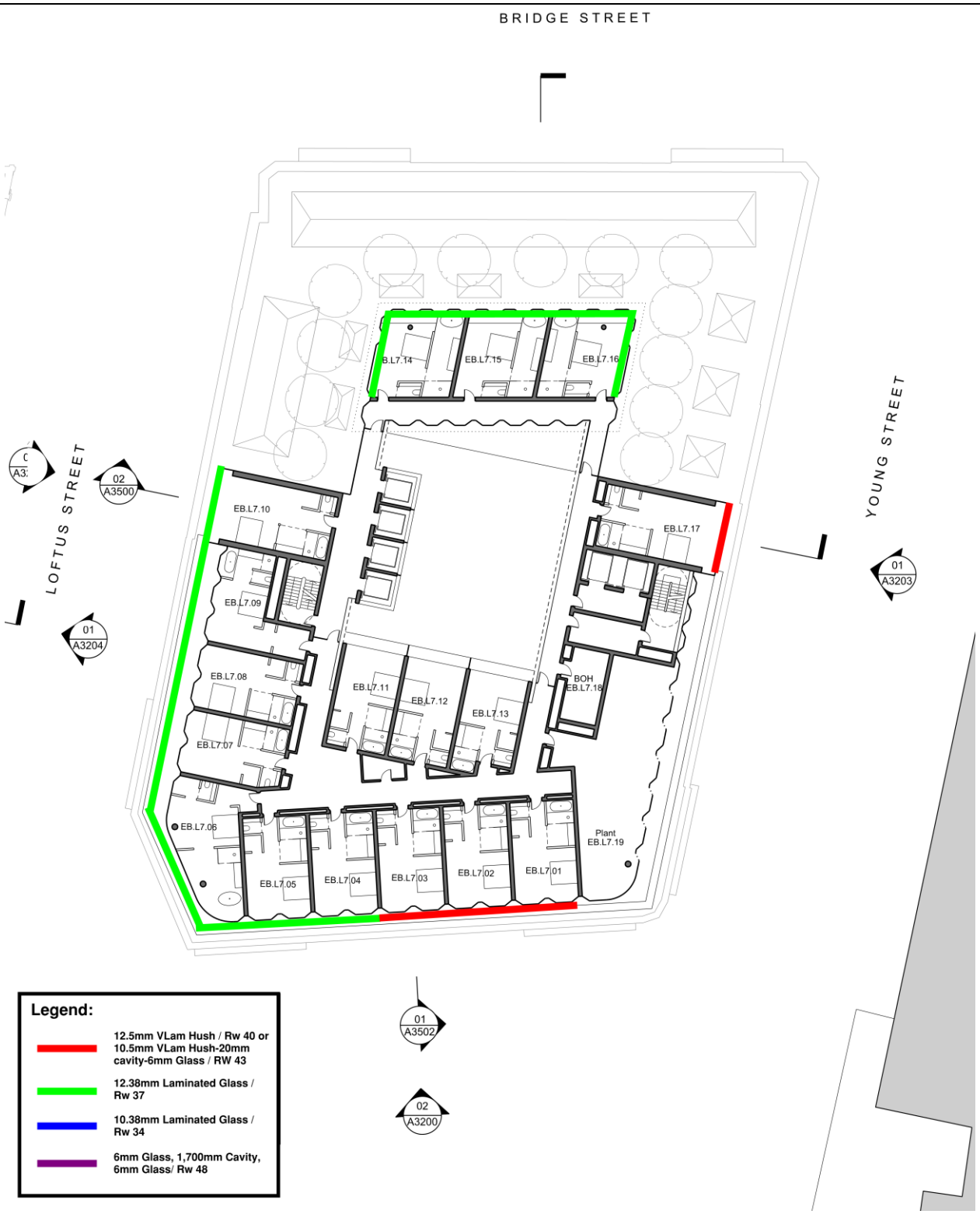
Appendix 2 – Glazing Assessment

Level 6 (Education)



Appendix 2 – Glazing Assessment

Level 7 (Education)

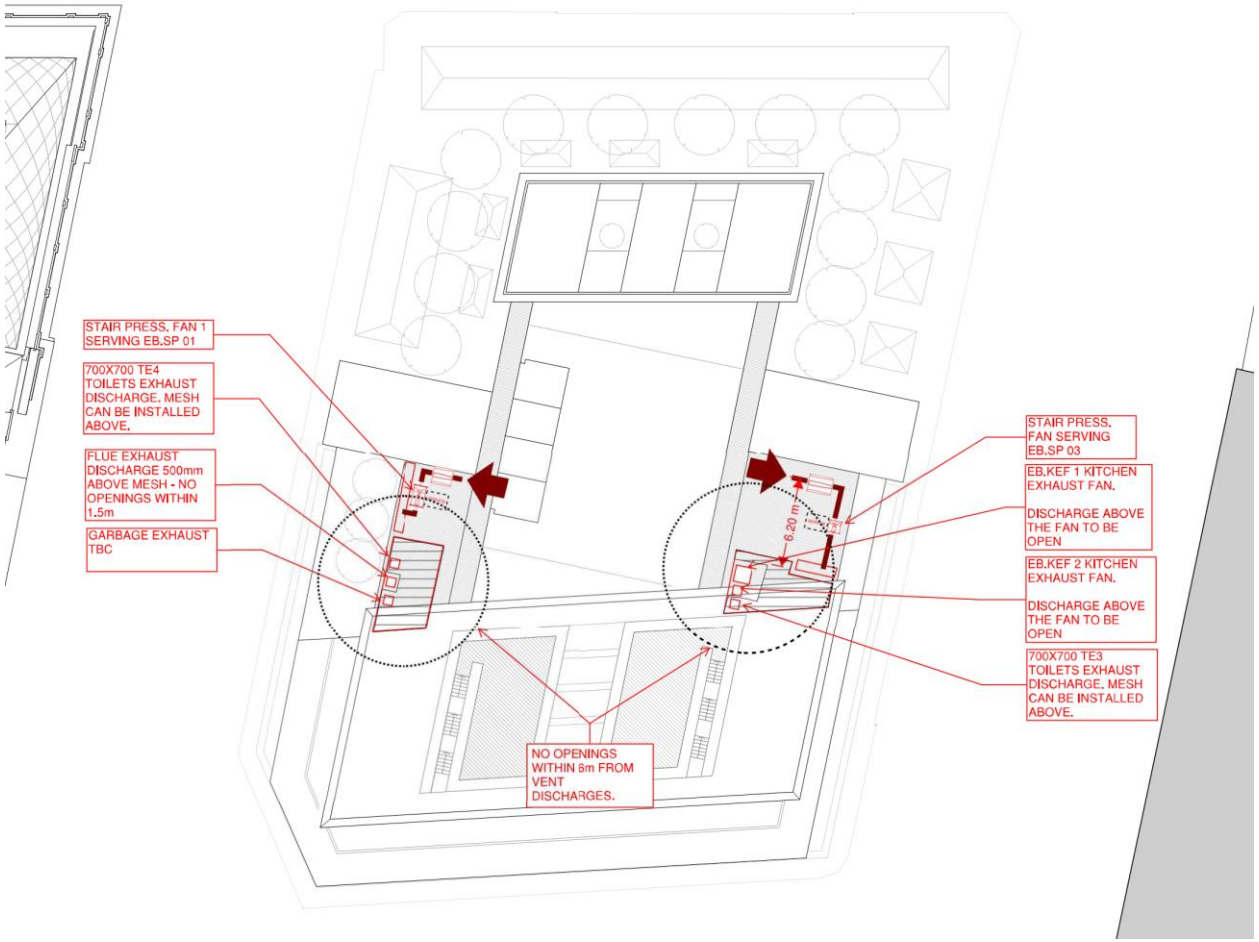


Appendix 2 – Glazing Assessment

Level 8 (Education)

Appendix 3 – Mechanical Plant Proposed Location

Rooftop (Education)



Appendix 3 – Mechanical Plant Proposed Location

Rooftop (Lands)