Figure 7 Image from model showing predicted daytime L_{Aeq} sound levels across the proposed ground level external amenity areas

Balconies would also be exposed to higher levels of noise than the ideal. Where balconies are proposed to offer occupants breakout space, reductions in noise level could be achieved with mitigation measures such as, increased balustrade heights to provide a barrier to noise and the incorporation of acoustic absorption to the soffit of the balcony above.

There are also several rooftop terrace areas proposed across the scheme. Noise levels on roof terrace areas more heavily screened from the railway and road noise sources are not expected to exceed 55 dB.

Roof terrace areas overlooking the railway lines and Manor Road are expected to be exposed to higher levels of noise than ideal. These areas would benefit from additional screening in the form of increased parapets or balustrades heights to provide a barrier to noise.

BS 8233 advises that a level of 50-55 dB L_{Aeq} is desirable within external amenity areas, but recognises that these levels may not be achievable in all circumstances. It further advises that in higher noise areas, such as city centres and urban areas adjoining strategic transport networks, a compromise between elevated noise levels and other factors, such as the convenience of living in these locations, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited.

5.5 Noise impact on residential properties to the south of the site.

It is understood that concerns have been raised with regard to the effect of introducing buildings opposite the residential properties to the south of the site, on Manor Park, and the extent to which this may increase noise levels at the properties from the existing railway line due to additional reflected noise.

As part of the specialist acoustic modelling undertaken, a comparison has been made of the predicted noise levels incident on the properties on Manor Park, with the existing buildings on the site and with the proposed buildings associated with the development. Figure 8 shows the noise levels incident on the properties for both scenarios.

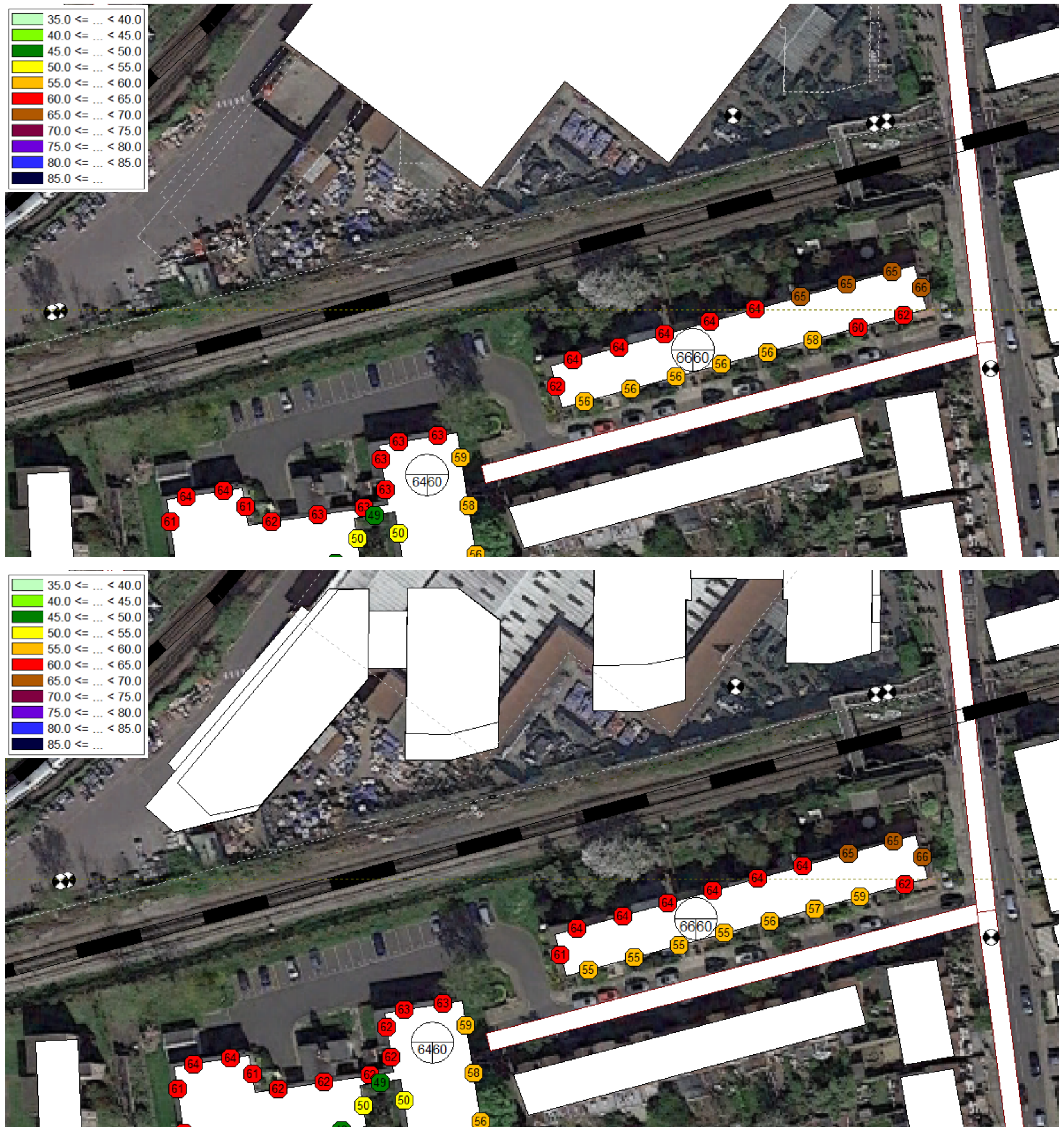


Figure 8 Comparison of noise levels incident on properties on Manor Park with existing buildings (top) and proposed buildings (bottom)

It can be seen that with the proposed buildings the noise levels incident on the properties on Manor Park remain the same for the majority of the properties, even slightly decreasing for some properties. This is due to the fact that the façades of the proposed buildings are actually set back further from the railway line than the existing Homebase building.

As part of the proposed mitigation strategy we are recommending a solid fence along the southern boundary of the site to help control noise from the railway line. The modelling considered a second scenario where a solid barrier of height 2.5m was introduced at the site boundary. As a result of reflections from this barrier, noise levels incident on the properties on Manor Park would potentially increase by a maximum of 1 dB. A difference of this magnitude would not normally be perceptible outside of laboratory conditions and can be considered a marginal effect.

6. Noise emissions of fixed plant.

Noise emissions from any equipment introduced in the area will need to be controlled to minimise the impact on the local sound environment as required by the local authority.

Noise levels due to building services associated with the proposed development are advised to meet the following noise level criteria (expressed as "free-field") shown below in Table 8. These noise limits are proposed at one metre from the nearest noise sensitive receptors as indicated in Figure 1.

The limits are based on the lowest background noise levels measured at position L1, which are deemed representative of the closest façade of the nearest noise sensitive receptor on Manor Park.

Table 8 Building services noise emission limits to properties on Ashby Street

Period	Typical prevailing background noise level $L_{A90,T}$ dB	Noise emission limit calculation $L_{Ar,Tr}$ dB
Daytime (07:00 – 23:00)	41	36
Night-time (07:00 – 23:00)	39	34

It should be noted that these are the combined operational noise levels of plant at the nearest noise sensitive façade. As such, the combined operational noise levels of all plant are required to achieve the noise limits defined within Table 8.

For plant noise that is tonal, contains a specific character or is intermittent, the limits of Table 8 above need to include a character correction as defined within BS 4142: 2014.

The plant emission limits proposed are not considered particularly onerous and should be readily achieved with appropriate mitigation measures.

7. Ground-borne vibration survey.

The site is bounded to the north by the London Overground and London Underground District lines and to the south by the South Western Railways line, which also carries freight trains. Due to this, the risk of ground-borne vibration to the site needs to be assessed.

7.1 Methodology

A vibration survey was undertaken on the 20th July 2018 with measurements of ground-borne vibration taken concurrently with the airborne sound measurements at locations P2 and P3 indicated in Figure 9.

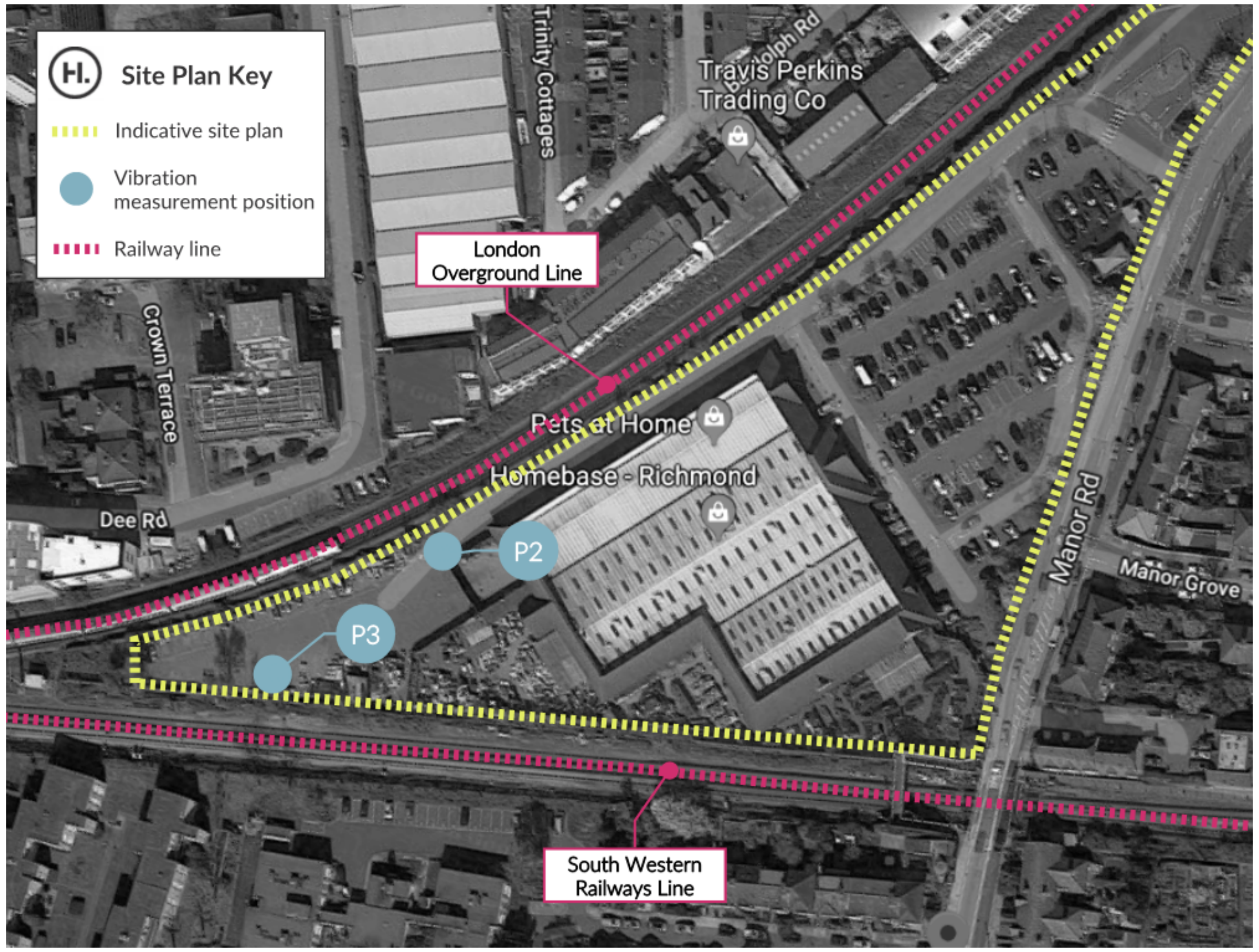


Figure 9 Vibration measurement positions

The survey was undertaken with the intent of quantifying the vibration levels generated from the various train movements. Vibration dose values (VDV) and rms-acceleration values were recorded at 30 seconds intervals, in the vertical direction only (Z-axis).

During the survey, the meter confirmed distinct 'vibration events', occurring at both positions. The vibration events were not perceptible to touch.

A more detailed description of the survey, including measurement times and instrumentation has been included in Appendix E. The measurement data has not been included in its entirety but is available on request.

7.2 Results

The results of the vibration measurements are summarised in Table 9.

The VDVs presented are the range off values measured from train pass events at each measurement position. Each train pass event varied in duration from approximately 10 – 30 seconds.

The different types of trains measured at the various measurement locations were as follows:

- P2 (along the north boundary of the site) - London Overground and London Underground District Line trains
- P3 (along the south boundary of the site) – South Western Railways and Freight trains

Table 9 Summary of vibration measurement results

Measurement Location	Measured vibration dose values, $m/s^{1.75}$ for train pass event
P2	0.004 – 0.008
P3	0.003 – 0.026

7.3 Vibration impact assessment

The average VDVs for day and night time periods have been calculated based on the London Overground, LU District Line, South Western Railways and Freight train timetable available online, and on the guidance provided in BS 6472-1:2008 *Guide to evaluation of human exposure to vibration in buildings, Part 1: vibration sources other than blasting*.

The rms-acceleration values measured have been used to calculate the regenerated noise levels due to ground-borne vibration transmission from the rail tracks that will likely be experienced by the proposed residences. The assessment assumes that residences will start on the ground floor of the building. The regenerated noise levels from train pass-bys were calculated in accordance with the methodology given in the Association of Noise Consultants' *Measurement and Assessment of Groundborne Noise & Vibration* dated 2012.

As the proposals for the building substructure are in their early stages of development, no corrections have been applied for the losses associated with the building foundations and can therefore be considered worst case. The predicted day time and night time VDVs and regenerated noise levels at positions P2 and P3 are reported in Table 10.

Table 10 Predicted vibration dose values and regenerated noise levels in the future level 1 residences

Measurement Location	Predicted vibration dose values, $m/s^{1.75}$		Predicted re-radiated noise level, L_{ASmax} (dB
	Daytime (07:00 – 23:00)	Night time (07:00 – 23:00)	Low amplification factor (such as expected for concrete framed buildings)
P2	0.04	0.03	< 31
P3	0.10	0.09	< 34

The predicted VDVs at both measurement locations given in Table 10 fall well below the BS 6472:2008 threshold of *low probability of adverse comment* and specialist mitigation measures would not normally be considered necessary.

There is potential for individual train events, particularly South Western Railway and Freight train passes on the nearside track of the southern railway line, to be perceptible by some people. These would, however, still be at a very low level and as the duration of the events are longer than one second they are less likely to cause disturbance.

The predicted levels of re-radiated noise at both measurement positions are below the Local Authorities required limit of 35 dB L_{ASmax} and as such are unlikely to cause disturbance. As such, specialist mitigation measures would not normally be considered necessary.

Impact of vibration on the development would not therefore be considered significant.

8. Summary and conclusion.

Environmental sound and vibration surveys have been undertaken to establish the existing conditions. The results have been used to assess the impact of sound and vibration on the proposed development. Comparisons have also been made with local authority policy to identify any limits or specialist measures that may be required.

The environmental sound survey indicates that the site is exposed to relatively high levels of environmental sound, primarily governed by road and railway traffic activity in the local area. The results indicate that the background sound levels do not vary significantly between day to night periods.

The results of the environmental sound survey were used to validate a specialist acoustic model of the existing site. This modelling has been used to predict the sound levels incident on the proposed buildings and across the proposed site.

The modelling has also been used to assess the impact of the proposed buildings on the neighbouring properties; particularly the residential properties to the south of the site on Manor Park. The modelling indicates that with the proposed buildings the noise levels incident on the properties on Manor Park will remain the same as existing for the majority of the properties, even slightly decreasing for some properties.

An assessment has been undertaken to understand the implications of the existing sound environment on the design of the facade and ventilation design. This has been summarised as follows:

- The sound reduction performance of the external façade will be controlled by the performance of the glazing. Preliminary calculations have been undertaken and these indicate that, facades overlooking the road and railway lines, will require high-performance double-glazed systems in the region of 45 dB R_w.
- Mechanical ventilation is likely to be required for the majority of the development, with openable windows for purge ventilation.

Exact selections for the building services plant equipment are not available at this early stage. Guideline plant emission limits have been derived in line with local authority requirements. The plant emission limits proposed are not considered particularly onerous and should be readily achieved with appropriate mitigation measures. The need to control noise to these limiting levels can be enforced by condition.

Vibration measurements were undertaken several ground floor locations, in-line with the proposed facades of building across the development. The results indicated that the levels of vibration measured on site from railway sources were below the threshold required by the Local Authority and the BS 6472:2008 threshold of *low probability of adverse comment*. As such, re-radiated sound from ground-borne vibration is not expected to require mitigation.

It is considered that any potentially significant environmental effects associated with the proposed development can be adequately controlled during the design stages, such that no significant effects would be likely.

Appendix A – Acoustic terminology.

Sound

Sound is produced by mechanical vibration of a surface, which sets up rapid pressure fluctuations in the surrounding air.

The Sound Pressure

The Sound Pressure is the force (N) of sound on a surface area (m^2) perpendicular to the direction of the sound. The SI-units for the Sound Pressure are Nm^{-2} or Pa (Pascal).

Sound is measured with microphones responding proportionally to the sound pressure – *p*. The power is proportional to the square of the sound pressure.

The Sound Pressure Level

The human ear has an approximately logarithmic response to sound pressure over a very large dynamic range. The lowest audible sound pressure approximately 2 x 10^{-5} Pa (2 ten billionths of an atmosphere) and the highest is approximately 100 Pa.

It is therefore convenient to express the sound pressure as a logarithmic decibel scale related to this lowest human audible sound, where:

$$L_p = 10\ log\left(\frac{p^2}{p_{ref}{}^2}\right) = 10\ log\left(\frac{p}{p_{ref}}\right)^2 = 20\ log\left(\frac{p}{p_{ref}}\right)$$

Where: L_p *= sound pressure level (dB)*

p = sound pressure (Pa)

p_{ref} *= 2 x* 10^{-5} *– reference sound pressure (Pa)*

In accordance with the logarithmic scale, doubling the sound pressure level gives an increase of 6 dB.

Decibel (dB)

The decibel is the unit used to quantify sound pressure levels as well as sound intensity and power levels.

In accordance with the logarithmic scale, an increase of 10 dB in sound pressure level is equivalent to an increase by a factor of 10 in the sound pressure level (measured in Pa). Subjectively, this increase would correspond to a doubling of the perceived loudness of the sound.

Sound Pressure Level of Some Common Sources

An indication of the range of sound levels commonly found in the environment is given in the following Table.

Source	Sound Pressure Level dB
Threshold of Hearing	0
Rustling Leaves	20
Quiet Whisper	30
Home	40
Quiet Street	50
Conversation	60
Inside a Car	70
Loud Singing	80
Motorcycle (10m)	90
Lawn Mower (1m)	100
Diesel Truck (1m)	110
Amplified Music (1m)	120
Jet Plane (1m)	130

Frequency

The rate at which the pressure fluctuations occur determines the pitch or frequency of the sound. The frequency is expressed in Hertz (Hz) or cycles per second.

Octave and Third Octave Bands

An octave is the interval between two points where the frequency at the second point is twice the frequency of the first.

There are many methods of describing the frequency content of a noise. The most common methods split the frequency range into defined bands, in which the mid-frequency is used as the band descriptor and in the case of octave bands is double that of the band lower. For example, two adjacent octave bands are 250 Hz and 500 Hz.

Third octave bands provided a fine resolution by dividing each octave band into three bands. For examples, third octave bands would be 160 Hz, 250 Hz and 315 Hz for the same 250 Hz octave band.

The human ear is sensitive to sound over a range of frequencies between approximately 20 Hz to 20 kHz and is generally more sensitive to medium and high frequency than to low frequencies within the range. This is the basis of the A-weighting.

A-Weighting

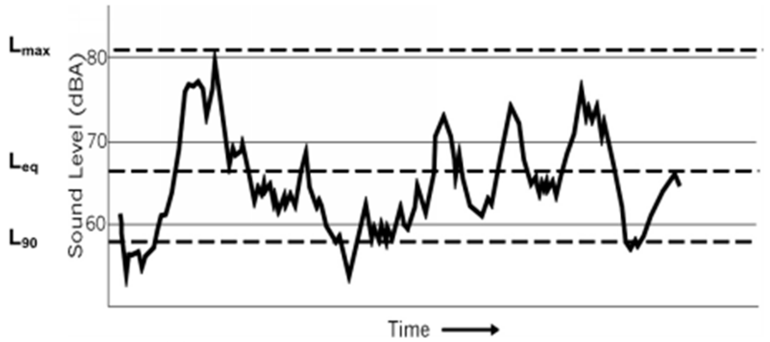
The A-weighting is a correction term applied to the frequency range in order to mimic the sensitivity of the human ear to noise. It is generally used to obtain an overall noise level from octave or third octave band frequencies.

An A weighted value would be written as dB(A), or including A within the parameter term.

Noise Units

In order to assess environmental noise, measurements are carried out by sampling over specific periods of time, such as five minutes, the statistically determined results being used to quantify various aspects of the noise.

The figure below shows an example of sound level varying with time. Because of this time variation the same period of noise can be described by several different levels. The most common of these are described below.



$L_{eq,T}$

The $L_{eq,T}$ is a parameter defined as the equivalent continuous sound pressure level over a defined time period 'T'. It is the sound pressure level equivalent to the acoustic energy of the fluctuating sound signal.

The $L_{eq,T}$ can be thought of as an 'average' sound pressure level over a given time period (although it is not an arithmetic average). Typically the $L_{eq,T}$ will be an A-weighted noise level in dB(A) and is commonly used to describe all types of environmental noise sources.

$L_{01,T}$

The $L_{01,T}$ is a parameter defined as the sound pressure level exceeded for 1% of the measurement period 'T'.

It is a statistical parameter and cannot be directly combined to other acoustic parameter.

$L_{10,T}$

The $L_{10,T}$ is a parameter defined as the sound pressure level exceeded for 10% of the measurement period 'T'.

It is a statistical parameter and cannot be directly combined to other acoustic parameter and is generally used to describe road traffic noise.

$L_{90,T}$

The $L_{90,T}$ is a parameter defined as the sound pressure level exceeded for 90% of the measurement period 'T'.

It is a statistical parameter and cannot be directly combined to other acoustic parameter and is generally used to describe the prevailing background noise level.

$L_{max,T}$

The $L_{max,T}$ is a parameter defined as the maximum noise level measured during the specified period 'T'.

Specific Noise Level, $L_{Aeq,Tr}$

This is the equivalent continuous A-weighted sound pressure level at the assessment position due to a specific noise source operating over a given time interval.

Free Field

A measurement taken in the free field is at least 3.5m from reflecting vertical surfaces and 1.2m from the ground.

Façade

A measurement is influenced by the reflection of sound from the façade of a building within 3.5m. A façade measurement is made 1m in front of the vertical building surface.

R_w

A single-number quantity which characterizes the airborne sound insulation of a material or building element in the laboratory. See BS EN ISO 717-1: 1997.

Appendix B – London Borough of Richmond upon Thames planning policy.

Internal design noise levels

Richmond Upon Thames Draft Supplementary Planning Document (SPD) *'Development Control for Noise Generating & Noise Sensitive Development'* sets out the following guidance for internal noise levels:

The Boroughs will normally seek to achieve the design noise levels contained in Table 4 of BS8233:2014 in all noise sensitive rooms. It should be noted that the acoustic integrity of the building envelope will be compromised in the event windows are opened for ventilation purposes, typically reducing the insulation to no more than 10 to 15 dB(A). The use of good acoustic design should aspire to achieve the internal design levels in noise sensitive rooms with windows partially open, although on certain sites the Boroughs may agree to assess the proposal assuming windows are closed. In many sites classified as NRC 0 then it should be possible to achieve the design noise levels with windows open.

Table 1: Internal Ambient Noise Levels for Dwellings

Situation	Location	07:00 – 23:00 hrs.	23:00 – 07:00 hrs.
Resting	Living room	35 dB LAeq,16 hour	-
Dining	Dining room/area	40 dB LAeq, 16 hour	-
Sleeping (daytime resting)	Bedroom	35 dB LAeq,16 hour	30 dB LAeq, 8 hour
Sleeping	Bedroom	-	45 dB LAMax (several times in any one hour)

(Source: BS8233:2014, page 24, Table 4 "Indoor Ambient Noise Levels")

Notes:

(i) The Table provides recommended levels for overall noise in the design of a building. These are the sum total of structure-borne and airborne noise sources. Groundborne noise is assessed separately and is not included as part of these targets, as human response to groundborne noise varies with many factors such as level, character, timing, occupant expectation and sensitivity.

(ii) The levels shown in the Table are based on the existing guidelines issued by the WHO and assume normal diurnal fluctuations in external noise. In cases where local conditions do not follow a typical diurnal pattern, for example on a road serving a logistic hub with high levels of traffic at certain times of the night, an appropriate alternative period, e.g. 1 hour, may be used, but the level should be selected to ensure consistency with the levels recommended in the Table.

(iii) These levels are based on annual average data and do not have to be achieved in all circumstances. For example, it is normal to exclude occasional events, such as fireworks night or New Year's Eve.

(iv) Regular individual noise events (for example, scheduled aircraft or passing trains) can cause sleep disturbance. A guideline value may be set in terms of SEL or LAmax,F, depending on the character and number of events per night. Sporadic noise events could require separate values.

(v) If relying on closed windows to meet the guide values, there needs to be appropriate alternative ventilation that does not compromise the façade insulation or the resulting noise level. If applicable, any room should have adequate ventilation (e.g. trickle ventilators should be open) during assessment.

(vi) Attention is drawn to the Building Regulations.

(vii) In certain circumstances where external noise levels above WHO guidelines, but development is considered necessary or desirable, the internal target levels may be relaxed by up to 5 dB and reasonable internal conditions still achieved.

With regard to noise from individual noise events, the Boroughs consider that for a reasonable standard in noise sensitive rooms at night (i.e. bedrooms) individual noise events measured with F time weighting should not normally exceed 45dB LAmax more than 10 times a night. This guideline is supported by advice contained in the WHO community Noise Guidelines (2000).

Design noise levels for external amenity spaces

Richmond Upon Thames Draft Supplementary Planning Document (SPD) *'Development Control for Noise Generating & Noise Sensitive Development'* sets out the following guidance for external amenity noise levels:

The acoustic environment of external amenity areas shall always be assessed and noise levels should ideally not be above the range 50 to 55dB LAeq,16hr. It may be necessary to carefully locate and design amenity areas and/or to provide acoustic screening in order to meet this goal.

Developers are encouraged to enter into pre application discussion where noise levels in proposed amenity spaces are likely to be above 55dB LAeq,16hr. In such cases, the availability of reasonable access to an outdoor recreational area away from but close to the development site, that meets the above target external levels will be taken into account in deciding whether the scheme is acceptable in noise terms. Soundscape management techniques, including psychological masking, may also help to provide a suitable outdoor acoustic environment in otherwise noisy locations. It is accepted that, in some circumstances it may be appropriate to vary, or not to apply, these goals in order to meet wider planning objectives.BS8233:2014 (Section 7.7.3.2 Design criteria for external noise) contains the following guidance:

"For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$, with an upper guideline value of 55 dB $L_{Aeq,T}$ which would be acceptable in noisier environments. However, it is also recognized that these guideline values are not achievable in all circumstances where development might be desirable. In higher noise areas, such as city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited.

Other locations, such as balconies, roof gardens and terraces, are also important in residential buildings where normal external amenity space might be limited or not available, i.e. in flats, apartment blocks, etc. In these locations, specification of noise limits is not necessarily appropriate. Small balconies may be included for uses such as drying washing or growing pot plants, and noise limits should not be necessary for these uses. However, the general guidance on noise in amenity space is still appropriate for larger balconies, roof gardens and terraces, which might be intended to be used for relaxation. In high-noise areas, consideration should be given to protecting these areas by screening or building design to achieve the lowest practicable levels. Achieving levels of 55 dB $L_{Aeq,T}$ or less might not be possible at the outer edge of these areas, but should be achievable in some areas of the space."

Appendix C – Environmental sound survey.

An environmental sound survey was undertaken by Hoare Lea between the 20th July and 25th July 2018. The survey comprised long term unattended monitoring on site and short-term attended measurements.

Weather conditions
The weather conditions on site during both survey periods were dry with approximately 50%-80% cloud cover. The wind speeds were lower than 5 ms^{-1} as recommended by the guidance.

Equipment details
The measurement equipment was calibrated before and after the survey. No significant drift has been observed. The equipment used for the survey has been summarised in Table C1. The instruments used for the survey were in calibration during the survey and their calibration certificate numbers have been included in the table for reference.

Table C1: Instrumentation details

Survey details	Instrumentation description	Manufacturer	Model	Serial Number	Date of Calibration	Certificate Number
Long term survey Position L1	Sound Level Meter	Rion	NL-52	00832187	10/11/2017	UCRT17/2011
	Microphone	Rion	UC-59	10815	10/11/2017	UCRT17/2011
	Pre-amp	Rion	NH-25	32215	10/11/2017	UCRT17/2011
	Acoustic Calibrator	Rion	NC-74	34557134	12/10/2017	UCRT17/1880
Short term measurements	Sound Level Meter	Rion	NA-28	01260200	29/08/2017	UCRT17/1731
	Microphone	Rion	UC-59	00280	29/08/2017	UCRT17/1731
	Pre-amp	Rion	NH-23	60103	29/08/2017	UCRT17/1731
	Acoustic Calibrator	Rion	NC-74	34172704	29/06/2017	UCRT17/1544

Long term unattended monitoring results
The results of the unattended measurements have been calculated into daytime ($L_{Aeq,16hr}$) and night-time ($L_{Aeq,8hr}$) equivalent levels, and are shown with the associated measured typical minimum background noise level ($L_{A90,15min}$) and maximum instantaneous measured noise level ($L_{Amax,T}$) in Table C2 below.

Table C2 Measured noise levels at Position L1

Measurement Position		Position L1					
		Daytime			Night-time		
Measurement Date	Time	$L_{Aeq,T}$ dB	Max $L_{Amax,T}$ dB	Min $L_{A90,15min}$ dB	$L_{Aeq,8hr}$ dB	Max $L_{Amax,T}$ dB	Min $L_{A90,15min}$ dB
Fri 20th Jul 2018	16:00 – 23:00	60	87	41	-	-	-
21st Jul 2018	23:00 – 07:00	-	-	-	60	83	39
Sat 21st Jul 2018	07:00 – 23:00	63	82	41	-	-	-
22nd Apr 2018	23:00 – 07:00	-	-	-	59	80	39
Sun 22nd Jul 2018	07:00 – 23:00	62	83	41	-	-	-
23rd Apr 2018	23:00 – 07:00	-	-	-	59	80	40
Mon 23rd Jul 2018	07:00 – 23:00	63	85	41	-	-	-
24th Apr 2018	23:00 – 07:00	-	-	-	58	79	39
Tues 24th Jul 2018	07:00 – 23:00	63	83	41	-	-	-
25th May 2018	23:00 – 07:00	-	-	-	58	80	39
Wed 25th Jul 2018	07:00 – 15:00	61	86	42	-	-	-

A time history of the L_{Aeq}, L_{A90} and L_{Amax} from the unattended measurements recorded is presented overleaf.

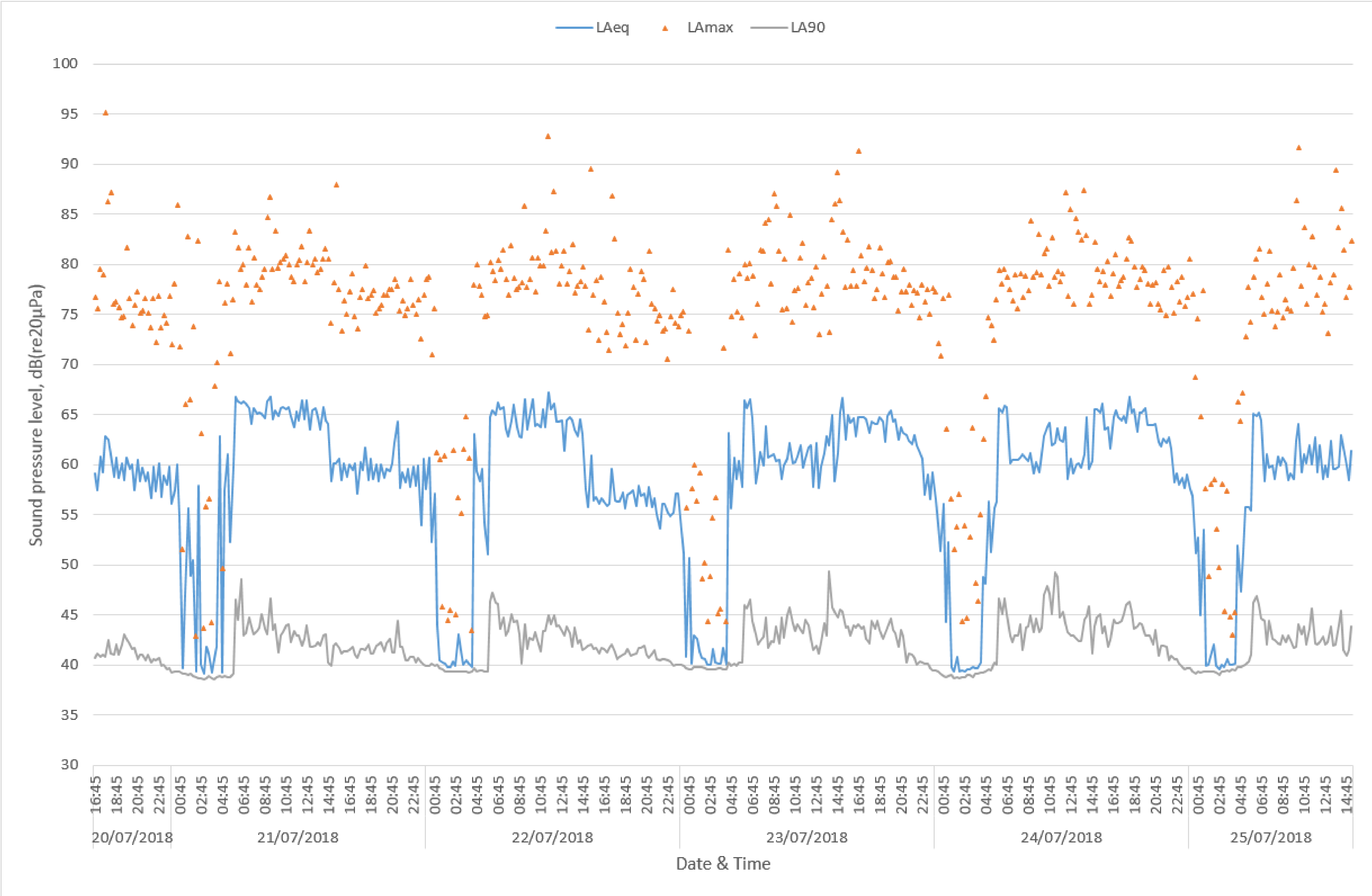


Figure C1 Time history results from unattended monitoring position L1

Short term attended monitoring

The results of the attended road traffic measurements taken at position P1, along Manor Road, are shown in terms of average ($L_{Aeq,T}$) noise levels measured with the associated maximum instantaneous noise level ($L_{Amax,T}$) and noise level exceeded for 10% of the measurement period (L_{A10}) in Table C3 below.

Table C3 Attended measurement results - Position P1 - Road traffic on Manor Road

Measurement date and time	Measurement period, T (hh:mm:ss)	Average ambient noise levels, dB $L_{Aeq,T}$	Maximum event level, dB L_{Afmax}	Level exceeded for 10% of time, dB (L_{A10})	Measurement Description
20/07/2018 11:45:00	01:00:00	64	90	69	Road traffic measurements
20/07/2018 12:45:00	01:00:00	65	87	69	
20/07/2018 13:45:00	01:00:00	65	83	69	
20/07/2018 14:45:00	01:00:00	66	90	69	

The results of the attended railway traffic measurements taken at position P2, P3 and P4 are shown in terms of average ($L_{Aeq,T}$) noise levels measured with the associated maximum instantaneous noise level ($L_{Amax,T}$) and sound exposure level (L_{AE}) in Table C4, C5 and C6 below.

Table C4 Attended measurement results - Position P2 - Railway traffic on London Overground line

Measurement date and time	Measurement period, T (hh:mm:ss)	Average ambient noise levels, dB $L_{Aeq,T}$	Maximum event level, dB L_{Afmax}	Sound exposure level, dB (L_{AE})	Measurement Description
20/07/2018 12:31	00:00:18	72	77	85	Near track, westbound
20/07/2018 12:35	00:00:17	71	76	83	Far track, eastbound
20/07/2018 12:40	00:00:15	72	76	84	Near track, westbound
20/07/2018 12:41	00:00:13	74	79	85	Far track, eastbound
20/07/2018 12:49	00:00:19	72	78	84	Near track, westbound
20/07/2018 12:55	00:00:14	72	76	84	Far track, eastbound
20/07/2018 12:58	00:00:31	70	77	85	2 trains - Both near & far tracks
20/07/2018 13:05	00:00:12	74	78	85	Far track, eastbound
20/07/2018 13:11	00:00:33	74	84	89	2 trains - Both near & far tracks
20/07/2018 13:23	00:00:21	68	72	81	Near track, westbound
20/07/2018 13:29	00:00:13	74	79	85	Far track, eastbound
20/07/2018 13:31	00:00:29	73	83	88	Near track, westbound

Table C5 Attended measurement results - Position P3 - Railway traffic on South Western Railway line

Measurement date and time	Measurement period, T (hh:mm:ss)	Average ambient noise levels, dB $L_{Aeq,T}$	Maximum event level, dB L_{Afmax}	Sound exposure level, dB (L_{AE})	Measurement Description
20/07/2018 13:50	00:00:16	70	74	82	Near track, eastbound
20/07/2018 13:58	00:00:15	76	85	87	Near track, eastbound
20/07/2018 14:00	00:00:17	68	72	80	Far track, westbound
20/07/2018 14:06	00:00:11	71	75	82	Far track, westbound
20/07/2018 14:11	00:00:22	66	71	80	Far track, westbound
20/07/2018 14:16	00:00:18	71	77	83	Far track, westbound
20/07/2018 14:17	00:00:28	66	71	81	Near track, eastbound. Train slowed down to halt just before site then sped up past the site
20/07/2018 14:21	00:00:39	69	75	85	2 trains - 1 overground westbound, 1 south westbound
20/07/2018 14:25	00:00:31	80	85	95	FREIGHT TRAIN - Far track, westbound
20/07/2018 14:28	00:00:15	64	68	76	Far track, westbound
20/07/2018 14:29	00:00:19	67	72	80	Near track, eastbound

Table C6 Attended measurement results - Position P4 - Railway traffic on pedestrian railway bridge

Measurement date and time	Measurement period, T (hh:mm:ss)	Average ambient noise levels, dB $L_{Aeq,T}$	Maximum event level, dB L_{Afmax}	Sound exposure level, dB (L_{AE})	Measurement Description
20/07/2018 15:16	00:00:20	76	81	89	Near track, eastbound
20/07/2018 15:19	00:00:12	80	84	91	Far track, westbound
20/07/2018 15:20	00:00:18	76	82	89	Near track, eastbound
20/07/2018 15:28	00:00:37	77	84	93	2 trains - 1 Near track, eastbound, 1 Far track, westbound
20/07/2018 15:35	00:00:26	72	79	86	Near track, eastbound
20/07/2018 15:38	00:00:16	78	82	90	Far track, westbound
20/07/2018 15:44	00:00:18	73	80	85	Far track, westbound
20/07/2018 15:45	00:00:19	78	84	91	Near track, eastbound
20/07/2018 15:47	00:00:14	81	85	93	Far track, westbound
20/07/2018 15:52	00:00:25	72	78	86	Near track, eastbound

The results of the attended measurements of bus movements taken at position P5, are shown in terms of average ($L_{Aeq,T}$) noise levels measured with the associated maximum instantaneous noise level ($L_{Amax,T}$) in Table C7 below.

Table C7 Attended measurement results - Position P1 - Road traffic on Manor Road

Measurement date and time	Measurement period, T (hh:mm:ss)	Average ambient noise levels, dB $L_{Aeq,T}$	Maximum event level, dB L_{Afmax}	Measurement Description
20/07/2018 12:05	00:00:13	80.4	67.6	Bus pulling in
20/07/2018 12:07	00:00:12	80.4	68.6	Bus pulling out
20/07/2018 12:14	00:00:13	79	75.0	Bus pulling out
25/07/2018 15:49	00:00:11	65	68.4	Bus pulling out
25/07/2018 15:50	00:00:05	82.5	69.8	Bus pulling in
25/07/2018 15:55	00:00:14	81.5	72.8	Bus pulling out

Appendix D – Predicted façade levels.

Figure D1 Predicted ground floor facade levels – Daytime L_{Aeq}

Figure D2 Predicted ground floor facade levels - Night-time L_{Aeq}

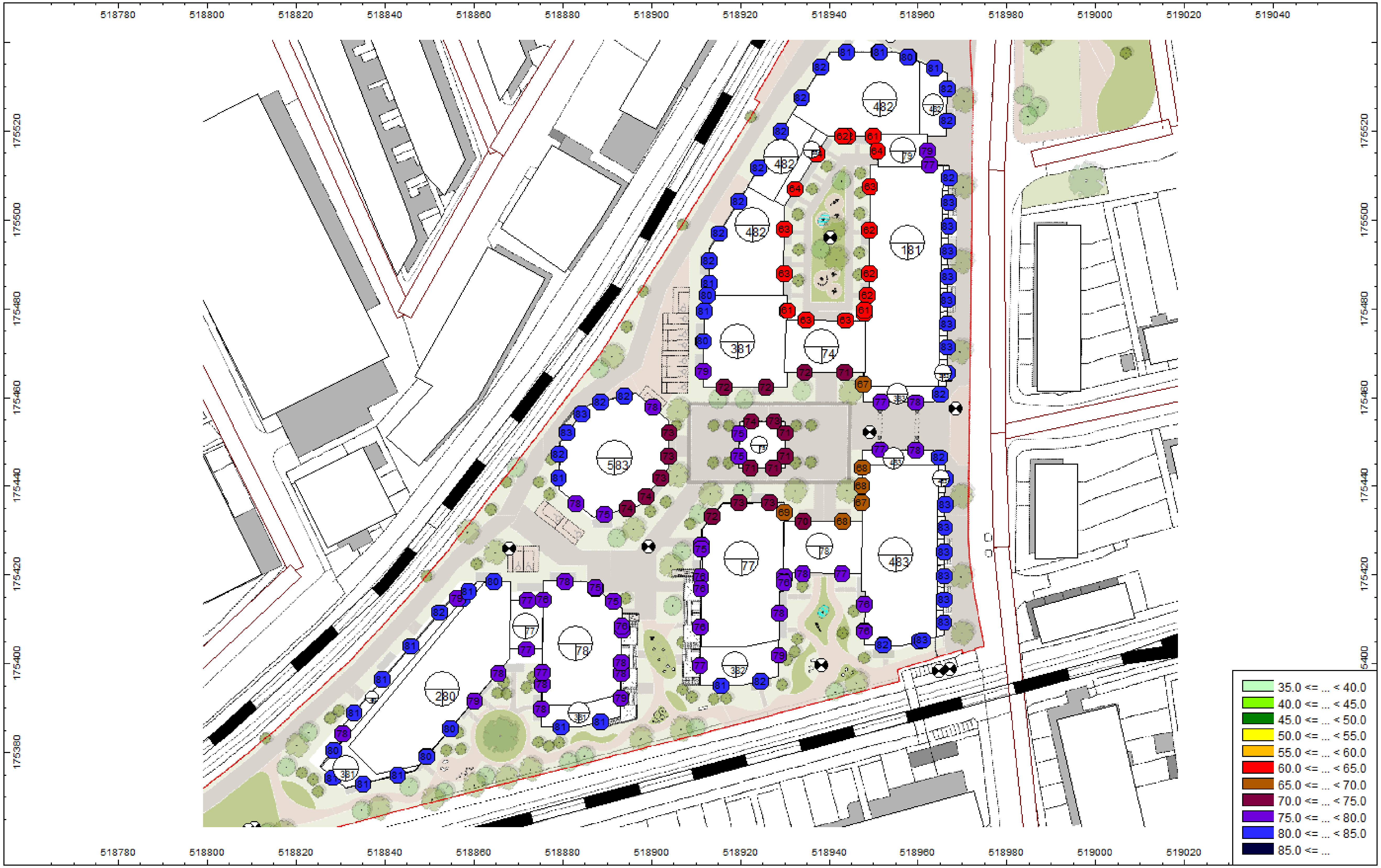


Figure D3 Predicted ground floor facade levels - Night-time L_{AFmax}

Appendix E – Environmental vibration survey.

A vibration survey was undertaken at two positions on the 20th July 2018 using a fixed vibration monitor in the vertical axis. The measurement positions, one to the north of the site and one to the south of the site, have been summarised in Section 7 of this report.

The first measurement was undertaken at the northern position between from 12:49 until 13:32 on the 20th July 2018. The Dytran 3191A1 accelerometer was attached to a steel mounting block, which was bonded to the existing floor. Distinct 'vibration events' were observed at this position but they were low in magnitude.

The second measurement was undertaken between 13:49 and 14:30 on the 20th July 2018. The Dytran 3191A1 accelerometer was again attached to a steel mounting block, which was bonded to the existing floor. Distinct 'vibration events' were observed at this position but they were low in magnitude.

The equipment used for the survey has been summarised in Table E1.

Table E1: Instrumentation details for Vibration survey

Survey details	Instrumentation description	Manufacturer	Model	Serial Number	Date of Calibration	Certificate Number
Vibration Survey	Vibration Meter	SVAN	959	00841830	23/01/2017	1701042
	Accelerometer	Dytran	3191A1	1906	23/01/2017	1701041
	Vibration Calibrator	APT	AT01	7001	20/01/2017	1701033

Full measurement results have not been included within this report but are available upon request.

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