

Project:	Twickenham Rediscovered	Date:	16/11/2017
Client:	Slender Winter Partnership Ltd	Ref:	4008



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Report Title:	Environmental Noise Survey and Mechanical Plant Assessment		
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1.0 Introduction

It is proposed that a parcel of land be redeveloped to include a number of retail outlets, car parking spaces and residential accommodation. As part of the development a number of items of mechanical plant will be installed within the site demise.

Paragon Acoustic Consultants Ltd has been commissioned to conduct an environmental noise survey to obtain statistical noise data to characterise the existing local background and ambient noise climate at the site and to derive overall site noise limits to atmosphere based on Local Authority Noise Policy and other relevant guideline documents. Following receipt of the drawing giving the proposed number of commercial units, the overall site noise limits have been apportioned to provide limits for the landlords plant, each of the commercial unit plant and plant associated with future residential space of the development.

Following receipt of the proposed landlords plant an exercise has been undertaken to establish if the proposed new mechanical plant selections will meet with the derived noise limits for landlord's plant, and noise mitigation measures considered necessary.

2.0 Existing Site Description

2.1 Existing Site Description

The site under consideration is a plot of land in Twickenham bordered to the east by Water Lane and the south by The Embankment, within the London Borough of Richmond upon Thames. Existing buildings of the site include offices and commercial with their frontage on King Street and a number of derelict (building windows Boarded up) buildings that lie in the southern part of the plot under consideration.

To the north west of the site lies King Street, being a two way trafficked highway. To the north of King Street lie 3 / 4 storey properties, generally comprising retail outlets at ground floor level with commercial / residential above. Certain of these properties, such as numbers 6-8, 10, 16 and 18 lie directly to the north of the proposed development and include residential accommodation.

To the north of the site lies the road junction of King Street, Water Lane / Church Street. Church Street includes residential accommodation in properties such as Numbers 31 and 28, both to the north of the site.

To the east of the site lies Water Lane. Properties lie on the east side of Water Lane with their frontage facing Water Lane, most of which contain residential use accommodation. Most of these properties are two storeys in height, however, Velux type windows and dormer windows in roof areas were noted on certain properties indicating that these may be three stores in height.

To the south of the site lies The Embankment, beyond which lies the River Thames. To the south of the River Thames lies Eel Pie Island on which lie numerous residential properties.

Diamond Jubilee Gardens lie to the south west of the site. Generally to the west of the site lie the properties with their frontage on the south side of King Street. Certain of these properties do contain residential accommodation such as numbers 3, 7 and 9 that are in close proximity to the proposed site.

The site is illustrated by plan in Appendix A. together with the current proposed site plan.

3.0 Existing Noise Climate

3.1 Road Traffic

Noise emanating from vehicular road traffic was deemed to provide a significant contribution to the ambient noise climate proximal to the nearest affected residential premises. The overall

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noise comprises both individual “event” type emissions from vehicles passing along local roads, and also continuous low frequency “rumble” due to middle distance traffic flows.

3.2 Rail Traffic

Rail traffic was not observed during the manned period at the start and end of the survey.

3.3 Aircraft

Aircraft over flights were observed at the site during manned survey periods. Due to the relatively close proximity of Heathrow airport, estimated at 7km, aircraft are still at a low altitude and hence noise levels associated with the aircraft can be significant in terms of the ambient noise climate. Aircraft over flight noise contribution to the background noise climate will have been included within the measurements taken.

3.4 Mechanical Noise Sources

Numerous items of mechanical plant items were observed that were associated with third party properties. At MP4 (Back of properties with their frontage on King Street) a greater amount of mechanical plant was noted, with numerous plant at the rear of premises with their frontage on King Street. In addition, a low frequency “hum” associated with a transformer located in the vicinity was noted. It could not be established whether all of the items of plant were operating, however, it is assumed that their contribution to the overall noise climate will have been included within the readings measured. It is taken that all mechanical plant associated with third party premises is operating within legal noise limits and has planning permission.

3.5 Other Noise Sources

Noise associated with the speech of pedestrians is evident during the day time. Birds, including geese, pigeons, and rooks etc, all produce noise that is very noticeable during the day in the proximity of the southern end of Water Lane / Embankment, as people were observed feeding the birds on numerous occasions. During the daytime noise survey speech noise associated with the general public using the amenity areas along the embankment was audible.

4.0 Environmental Noise Surveys

4.1 Un-manned Noise Measurements

The noise monitoring took place between the following dates / times:

- Start : 12th July 2017 at 10:06 hours
- End : 14th July 2017 at 09:51 hours

The noise monitoring was generally un-manned and was undertaken at the location as described below.

- **MP1:** In the roof of 1C King Street on the King Street Elevation

The measurement location is illustrated on the site layout drawing in Appendix A.

The weather conditions at the start of the manned period of the survey were dry and ward with a slight breeze. At the end of the survey the weather conditions were similar.

Various statistical broad-band and spectral sound pressure level measurements were obtained during the survey. A measurement time interval $T_m = 15$ minutes was used for sampling. Measurements of the percentile level $L_{A90,T}$ were made using time weighting F as per clause 3.4 of BS 4142:2014.

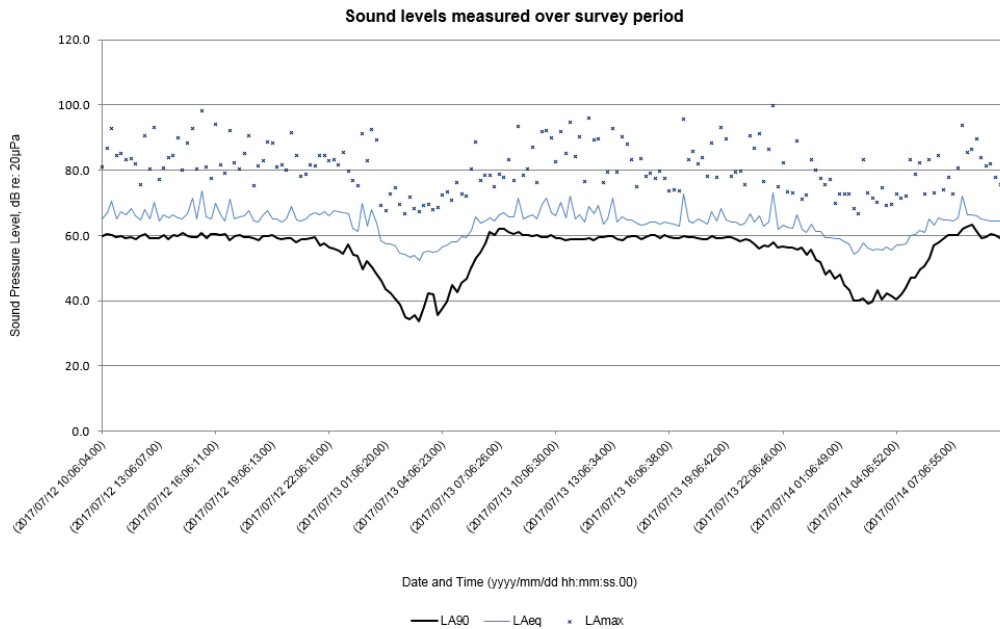
The quantities recorded included:

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- **L_{Aeq}**: the equivalent continuous A-weighted sound pressure level over the measurement period
- **L_{Amax}**: the maximum A-weighted sound pressure level for the measurement period
- **L_{A10}**: the A-weighted sound pressure level exceeded for 10% of the measurement period
- **L_{A90}**: the A-weighted sound pressure level exceeded for 90% of the measurement period

The recorded survey data is shown within Appendix B. Broadband sound pressure level data over the survey period (L_{A90} background levels, L_{Aeq} and L_{Amax} measurements) are shown graphically below:

Figure 1: Graphical Survey Data



The lowest representative daytime and night-time background sound levels obtained are summarised below:

Table 1: Lowest representative background sound levels

Measurement Position	Daytime 07:00-23:00 L_{A90,(15 min)}	Night-time 23:00-07:00 L_{A90,(15 min)}
MP1 measurement position	54 dB	34 dB

Note: It is recognised that due to the methodology given in BS4142:2014 the objective is not necessarily to ascertain a lowest measured background sound level, but rather to quantify what is typical during particular time periods. However, critical period discontinuous background noise surveys do not allow a reasonable statistical review and as such, it is considered robust to use the lowest value in this instance.

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4.2 Manned Noise Measurements – Night

Due to the lack of a secure location to allow un-manned noise monitoring to the south of the site it was considered reasonable to undertake critical period discontinuous noise readings at manned monitoring positions as follows:

- MP2: South end residential on of Water Lane
- MP3: Eel Pie Island
- MP4: Back of properties with their frontage on King Street
- MP5: Outside Number 15 Water Lane

Measurements took place in the early hours of 14th July 2017. Readings were undertaken for 10 minute samples during each hour at each position between 00:00 and 03:00 hours.

Various statistical broad-band and spectral sound pressure level measurements were obtained during the survey. Measurements were obtained at 1.5m above ground level. A measurement time interval $T_m = 10$ minutes was used for sampling. Measurements of the percentile level $LA_{90,T}$ were made using the sound level meter fast time constant (125ms).

The weather conditions for the survey were dry and warm with a slight breeze.

The results are summarised as follows:

Table 2: Manned Noise Measurements -Night

	LAeq	LAFmax	LAF,10	LAF,90
Monitoring at position MP2 (South end res on of Water Lane) within period 00:00-01:00	43	63	45	39
Monitoring at position MP2 (South end res on of Water Lane) within period 01:00-02:00	41	58	44	35
Monitoring at position MP2 (South end res on of Water Lane) within period 02:00-03:00	40	60	42	34
Monitoring at position MP3 (Eel Pie Island) within period 00:00-01:00	40	51	43	36
Monitoring at position MP3 (Eel Pie Island) within period 01:00-02:00	38	53	40	33
Monitoring at position MP3 (Eel Pie Island) within period 02:00-03:00	36	49	37	33
Monitoring at position MP4 (Back of properties with their frontage on King Street) within period 00:00-01:00	45	56	46	40
Monitoring at position MP4 (Back of properties with their frontage on King Street) within period 01:00-02:00	44	57	46	39
Monitoring at position MP4 (Back of properties with their frontage on King Street) within period 02:00-03:00	44	55	47	36
Monitoring at position MP5 (Outside Number 15 Water Lane) within period 00:00-01:00	53	68	55	42
Monitoring at position MP5 (Outside Number 15 Water Lane) within period 01:00-02:00	48	60	51	40
Monitoring at position MP5 (Outside Number 15 Water Lane) within period 02:00-03:00	45	59	48	34

It will be seen that generally the lowest background noise levels are each location were in the order 33-34 dB LA_{90} . MP4 (Back of properties with their frontage on King Street) is higher, as expected, as mechanical plant at the rear of premises was audible, as was the “hum” of a transformer located in the vicinity.

4.3 Manned Noise Measurements – Daytime

Again, due to the lack of a secure location to allow un-manned noise monitoring to the south of the critical period discontinuous noise readings at manned monitoring positions was undertaken as follows:

- MP2: South end res on of Water Lane
- MP3: Eel Pie Island
- MP4: Back of properties with their frontage on King Street
- MP5: Outside Number 15 Water Lane

Measurements took place on 17th July 2017. Readings were undertaken for 10 minute samples during each hour at each position between 20:00 and 23:00 hours.

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Various statistical broad-band and spectral sound pressure level measurements were obtained during the survey. Measurements were obtained at 1.5m above ground level. A measurement time interval $T_m = 10$ minutes was used for sampling. Measurements of the percentile level LA90,T were made using the sound level meter fast time constant (125ms)

The results are summarised as follows:

Table 3: Manned Noise Measurements -Day

	LAeq	LAFmax	LAF,10	LAF,90
Monitoring at position MP2 (South end res on of Water Lane) within period 20:00-21:00	56	71	59	46
Monitoring at position MP2 (South end res on of Water Lane) within period 21:00-22:00	58	75	61	43
Monitoring at position MP2 (South end res on of Water Lane) within period 22:00-23:00	50	61	54	45
Monitoring at position MP3 (Eel Pie Island) within period 20:00-21:00	53	79	55	42
Monitoring at position MP3 (Eel Pie Island) within period 21:00-22:00	48	66	50	39
Monitoring at position MP3 (Eel Pie Island) within period 22:00-23:00	62	76	64	33
Monitoring at position MP4 (Back of properties with their frontage on Kind Street) within period 20:00-21:00	56	73	59	49
Monitoring at position MP4 (Back of properties with their frontage on Kind Street) within period 21:00-22:00	59	72	62	48
Monitoring at position MP4 (Back of properties with their frontage on Kind Street) within period 22:00-23:00	67	78	74	48
Monitoring at position MP5 (Outside Number 15 Water Lane) within period 20:00-21:00	61	75	65	48
Monitoring at position MP5 (Outside Number 15 Water Lane) within period 21:00-22:00	63	74	69	46
Monitoring at position MP5 (Outside Number 15 Water Lane) within period 22:00-23:00	50	69	53	47

The weather conditions for the survey were dry and warm and still. It will be seen that generally the lowest background noise levels at each location varied. MP4 (Back of properties with their frontage on King Street) is potentially dominated by existing mechanical plant in the vicinity.

4.4 Instrumentation

4.4.1 Un-manned Noise Measurements

Sound pressure level measurements were obtained using the following instrumentation complying with the Type 1 specification of BS EN 60804, BS EN 60651, BS EN 60942, BS EN 61260, and BS EN 61672-1:

- Norsonic Type 118 Sound level analyser, serial number 31663
- Norsonic Type 1225 ½" microphone

Additionally, the following equipment was used:

- Weather protection kit
- NOR 1212 microphone outdoor protection kit
- Tripod

Calibration checks were made prior to and after completion of measurements using a Norsonic Type 1251 acoustical calibrator complying with Class 1 of BS EN 60942, calibration level 114.0 dB \pm 0.3 dB, @ 1.0 kHz. All instrumentation carries a current manufacturer's certificate of conformance a copy of which is available upon request.

4.4.2 Manned Noise Measurements – Daytime and Night time

Sound pressure level measurements were obtained using the following instrumentation complying with the Type 1 specification of BS EN 60804, BS EN 60651, BS EN 60942, BS EN 61260, and BS EN 61672-1:

- Norsonic Type 118 Sound level analyser, serial number 31990
- Norsonic Type 1225 ½" microphone

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Calibration checks were made prior to and after completion of measurements using a Norsonic Type 1251 acoustical calibrator complying with Class 1 of BS EN 60942, calibration level 114.0 dB \pm 0.3 dB, @ 1.0 kHz. All instrumentation carries a current manufacturer's certificate of conformance a copy of which is available upon request.

5.0 Evaluation of External Noise Criteria

The local vicinity contains mixed commercial and residential premises, both of which must be given due consideration in terms of acceptable levels of noise exposure from the new plant.

5.1 Residential Properties

It is necessary to consider the requirements of the Local Authority. The site is in the London Borough of Richmond upon Thames. This practice contacted the Local Authority to discuss their noise policy for mechanical plant and spoke to Mr Chris Hurst (Principal Environmental Health Officer (EHO) at LBRuT). Mr Hurst provided details of their draft SPD, the final version of which will be out shortly. The details are confirmed in italicised text as follows:

NEW NOISE GENERATING INDUSTRIAL AND COMMERCIAL DEVELOPMENT

The Borough recognises the contribution of industrial and commercial developments in helping to achieve wider sustainable development goals. However, there are many kinds of industrial and commercial developments that have the potential to generate noise. In the Boroughs some of the most commonly occurring noise issues with commercial developments are associated with building services plant, usually air-conditioning equipment or kitchen extraction systems. In addition to plant noise, noise associated with deliveries or collections and an increase in traffic noise levels may also impact on local residents.

An assessment of the impact of noise from these types of development will be required. Applicants should be aware that the Borough will always seek to encourage good acoustic design and will prevent development where unacceptable acoustic conditions are anticipated nearby noise sensitive premises as a result of noise from new industrial or commercial development.

NOISE STANDARDS FOR NEW INDUSTRIAL AND COMMERCIAL DEVELOPMENT

All industrial and commercial development with the potential to generate noise will be assessed and, where relevant, controlled by planning conditions in order to protect residential amenity. Conditions may be used, for example, to restrict noise levels and to control hours of operation. The most relevant standard for assessing new industrial and commercial development is BS4142:2014.

BS4142:2014 METHODS FOR RATING AND ASSESSING INDUSTRIAL AND COMMERCIAL SOUND

The standard describes methods for rating and assessing sound of an industrial and/or commercial nature. The methods described use outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident.

The standard is applicable to the determination of the following:

- *rating levels for sources of sound of an industrial and/or commercial nature;*
- *ambient, background and residual sound levels, for the purposes of:*

(i) assessing sound from proposed, new, modified or additional source(s) of sound of an industrial and/or commercial nature;

(ii) assessing sound at proposed new dwellings or premises used for residential purposes.

The significance of sound of an industrial and/or commercial nature depends upon both the margin by which the rating level of the specific sound source exceeds the background sound

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level and the context in which the sound occurs. The greater this difference, the greater the magnitude of the impact.

A difference of around +10 dB or more is likely to be an indication of a significant adverse impact	Depending on the context.
A difference of around +5 dB is likely to be an indication of an adverse impact	Depending on the context.
The lower the rating level is relative to the measured background sound level	The less likely it is that the specific sound source will have an adverse impact or a significant adverse impact.

As a general rule, the Boroughs will seek to achieve the external noise standards detailed in Table 2 below (Paragon Note: Table is headed "Table 1")

Table 1: New Industrial and Commercial Development

Noise Significance Risk	BS4142 Outcome	Planning Advice
Minimal	$L_{A,Ti} - L_{A90,T} \leq -5$	Where the rating level of noise is below the background noise level by at least 5dB, this indicates that the proposed NGD is likely to be acceptable from a noise perspective. The Borough will seek this level of compliance in most noise sensitive areas and/or where there is a requirement to mitigate creeping background effects.
Low	$L_{A,Ti} - L_{A90,T} \leq 0$	Where the rating level of noise is equal to, or below the background noise level by up to 5dB, this indicates that the proposed NGD may be acceptable from a noise perspective but will be more context dependent, i.e. extent and effect on noise sensitive receivers (externally and internally). Compliance within this range is more applicable to less sensitive sites or where there is no requirement to mitigate creeping background effects.
Medium	$L_{A,Ti} - L_{A90,T} \leq +5$	Where the rating level of noise is equal to, or above the background noise level by up to 5dB, this indicates that the proposed NGD is less likely to be acceptable from a noise perspective and will be context dependent, i.e. extent and effect on noise sensitive receivers (externally and internally). Compliance within this range is typically only applicable to non-sensitive sites or where there are overriding other reasons why development should be considered. It will typically be necessary for the applicant to confirm how adverse impacts from the NGD will be mitigated and minimised. It is less likely that planning consent will be granted.
High	$L_{A,Ti} - L_{A90,T} > +5$	Where the rating level of noise is above the background noise level by more than 5dB, this indicates that the proposed NGD is unlikely to be acceptable from a noise perspective and planning consent is likely to be refused on noise grounds.

Note: All terms as defined in BS4142

The Boroughs will not impose unreasonable restrictions on businesses but applicants should be aware that it is usually simpler and less expensive to design in noise management and noise control measures at the planning stage rather than wait for complaints to arise.

INTERNAL NOISE LEVELS IN NEARBY DWELLINGS

In addition to an assessment of external noise, in some cases it will also be necessary to predict internal noise levels at the closest and/or worse affected noise sensitive premises and to demonstrate the means of achieving suitable internal noise levels within noise sensitive rooms (with windows partially open for ventilation where this is the norm for the building likely to be affected).

In some cases, e.g. for steady continuous noise without a specific character, the guidance on suitable internal noise levels found in Table 4 of BS8233 may be relevant. The application should demonstrate that these levels can be complied with. In other cases, it may be necessary to seek to achieve better standards in nearby dwellings, for example where the proposed industrial or commercial development may emit noise with a tonal, impulsive or other discrete characteristics the Borough may consider it appropriate to apply a character correction penalty for internal noise standards.

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The assessment of noise associated with future retail / commercial outlet deliveries /collections / an increase in traffic noise levels are outside the scope of this assessment.

Based on the above details, this practice will propose limits to the mechanical plant such that the Rating Level (L_{Ar,Tr}) is at least 5 dB(A) below the Background Level LA90 , that is “*Likely to be acceptable from a noise perspective*”. In addition, commercial property noise limits shall be considered as follows:

5.2 Commercial Properties

In order to maintain the amenity of the occupants of any affected commercial properties, it is considered acceptable to assess noise emissions in line with the guidelines provided in BS 8233:2014

Figure 2: BS8233:2014 table of typical noise levels in non-domestic buildings

Activity	Location	Design range dB L _{Aeq,T}
Speech or telephone communications	Department store Cafeteria, canteen, kitchen	50 – 55
	Concourse Corridor, circulation space	45 – 55
Study and work requiring concentration	Library, gallery, museum	40 – 50
	Staff/meeting room, training room	35 – 45
Listening	Executive office	35 – 40
	Place of worship, counselling, meditation, relaxation	30 – 35

Figure 3: BS8233:2014 table of indoor ambient noise levels

Objective	Typical situations	Design range L _{Aeq,T} dB
Typical noise levels for acoustic privacy in shared spaces	Restaurant	40 – 55
	Open plan office	45 – 50
	Night club, public house	40 – 45
	Ballroom, banqueting hall	35 – 40
	Living room	35 – 40

NOTE See Noise control in building services [28] and BS EN ISO 3382.

In view of the details presented above it is considered reasonable to adopt a noise criterion of 40 dB L_{Aeq,T} for commercial office space in the proximity of the site.

It is also reasonable to consider a noise criterion external to commercial property windows that takes account of the internal design range, plus the loss expected through an openable window. In a research study conducted for DEFRA NANR116: “Open/Closed Window Research”, numerous references are provided which quantify losses through open and partially open windows:

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Figure 4: DEFRA NANR16 Summary of findings

Information Source	Summary of Findings
PPG 24 (1994) [2]	A reduction of 13 dB(A) from the facade level is assumed for an open window
WHO (1999) [4]	A reduction of 15 dB from the facade level is assumed for a partially open window. (no reference)
BS 8233 (1999) [5]	Windows providing rapid ventilation and summer cooling are assumed to provide 10 - 15 dB attenuation (no specific reference)
BRE Digest 338 (1988) [6]	A partly open window has an averaged level difference, $D_{1m,av,100-3150}$ of 15 dB
DoE Design Bulletin 26 (1972) [7]	A reduction of 5 dB(A) with a window wide open
Nelson - Transportation Noise (1987) [8]	Sound insulation of an open single window is 5 – 15 dB. (theoretical)
Mackenzie & Williamson DoE Report (1972–73) [9],[10]	A vertical sliding sash window open 0.027 m ² (summer night-time ventilation) and 0.36 m ² (daytime summer ventilation) provided a sound level reduction of 16 and 11 dB(A) respectively. (Lab Study)
Kerry and Ford (1973 – 74) [11], [12]	A horizontal sliding sash window open 25 mm and 200 mm provided averaged sound reduction indices, R_{av} of 14 and 9 dB respectively. (Field Study)
Lawrence and Burgess (1982 – 83) [13],[14]	A vertical sliding sash open 9% of the total façade provided a sound reduction index R_w 10 dB. (Field study)
Hopkins (2004) [15]	Road traffic noise reductions through window openings resulted in reductions of between $D_{2m,n,T}$ 8 and 14 dB. (Field Study)

Table 1.1 Summary of open-window acoustic transmission literature

The findings of the study are referenced in this report to substantiate the use of a 13dBA loss through a partially open window.

5.3 Amenity Spaces

BS 8233:2014 Guidance on sound insulation and noise reduction for buildings, Section 7.7.3.2 deals with design criteria for external noise.

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 LAeq,T, with an upper guideline value of 55 dB LAeq,T which would be acceptable in noisier environments.

It is therefore recommended that the Diamond Jubilee Gardens be given a noise limit of 50 dB LAeq,T.

5.4 External Noise Criteria

The Paragon report ref 4008_ENS_0 dated 18th July 2017 gave the limiting noise levels for the complete development when considering all plant. These are reproduced below:

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Table 4: Limiting Noise Criteria applicable at the affected premises for operational noise associated with the completed development from mechanical plant

Plant Location	Receptor	Daytime 07:00- 23:00	Night- time 23:00- 07:00
Any Location on the development site	Windows of the apartments of the new proposed development facing King Street at 1.0m from the façade	49 dB L _{A,r,Tr}	29 dB L _{A,r,Tr}
	Windows of the apartments of the new proposed development facing all other directions at 1.0m from the façade	38 dB L _{A,r,Tr}	29 dB L _{A,r,Tr}
	Residential property frontages facing King Street including those in King Street and Church Street at 1.0m from the façade.	49 dB L _{A,r,Tr}	29 dB L _{A,r,Tr}
	Residential properties in Water Lane at 1.0m from the façade	38 dB L _{A,r,Tr}	29 dB L _{A,r,Tr}
	Residential properties on Eel Pie Island at 1.0m from the façade.	28 dB L _{A,r,Tr}	28 dB L _{A,r,Tr}
	Side / rear elevations of residential properties with their frontage on the south side of King Street	38 dB L _{A,r,Tr}	29 dB L _{A,r,Tr}
	Diamond Jubilee Gardens	50 dB L _{Aeq, T}	
	All Commercial properties at 1.0m from the façade.	53 dB L _{Aeq}	

L_{A,r,Tr}: For residential receivers, the L_{A,r,Tr} shall be as described in BS4142: 2014

The Paragon report ref 4008_ENS_0 dated 18th July 2017 advised that:

“It will be appreciated that there are potentially noise sources associated with the residential and retail outlets of the site. A separate limiting noise specification shall be issued for individual retail tenants when the details of numbers of retail units etc. are known”.

The number of retail outlets has now been advised. There are 5 retail units indicated on the drawings. This practice has been requested to consider the landlords plant comprising commercial unit condensers, extract fans to units 3 and 5, and car park ventilation systems, each retail unit may potentially incorporate mechanical plant items that would emit noise to atmosphere. It is also necessary to set limiting noise levels for the incoming tenants of the 5 retail outlets proposed.

As such the noise limits established for the complete development shall be split down into limits for the landlord plant, each of the commercial unit plant and plant associated with future residential space of the development. Whilst 6/7 groups of plant are proposed, it is considered unlikely that all 6/7 groups of plant will contribute to the noise at any particular receiver position. The limits allow for four groups of plant noise levels, giving a reduction of 6 dB to the overall site noise limits for each group of noise sources.

As such, the noise limits have been specified for Landlords plant, the incoming tenant of each unit and plant associated with future residential space of the development. **Due to the possibility of cumulative effect of plant noise each of the tenants of the 5 retail outlets and plant associated with future residential space of the development, each group shall be encumbered with the limiting noise levels given in the applicable Tables in Appendix C.**

In addition, the landlords plant considered by this practice and detailed herein shall be subject to the following noise limits:

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Table 4: Limiting Noise Criteria to be maintained by all mechanical plant noise emissions associated with Landlord plant

Plant Location	Receptor	Daytime 07:00- 23:00	Night- time 23:00- 07:00
Any Location on the development site	Windows of the apartments of the new proposed development facing King Street at 1.0m from the façade	43 dB $L_{Ar,Tr}$	23 dB $L_{Ar,Tr}$
	Windows of the apartments of the new proposed development facing all other directions at 1.0m from the façade	32 dB $L_{Ar,Tr}$	23 dB $L_{Ar,Tr}$
	Residential property frontages facing King Street including those in King Street and Church Street at 1.0m from the façade.	43 dB $L_{Ar,Tr}$	23 dB $L_{Ar,Tr}$
	Residential properties in Water Lane at 1.0m from the façade	32 dB $L_{Ar,Tr}$	23 dB $L_{Ar,Tr}$
	Residential properties on Eel Pie Island at 1.0m from the façade.	22 dB $L_{Ar,Tr}$	22 dB $L_{Ar,Tr}$
	Side / rear elevations of residential properties with their frontage on the south side of King Street	32 dB $L_{Ar,Tr}$	23 dB $L_{Ar,Tr}$
	Diamond Jubilee Gardens	44 dB $L_{Aeq, T}$	
	All Commercial properties at 1.0m from the façade.	47 dB L_{Aeq}	

$L_{Ar,Tr}$: For residential receivers, the $L_{Ar,Tr}$ shall be as described in BS4142: 2014

Compliance with the above limiting noise levels and the incoming commercial unit tenants limits given in Appendix will allow the overall site limiting noise levels to be achieved as given in the Paragon report 4008_ENS_0 dated 18th July 2017.

6.0 Review of Proposed Mechanical Plant

6.1 Operational Times

The acoustic assessment has been based on the operational times for landlord's plant as follows:

Roof mounted condensers associated with the commercial units and kitchen extract systems:

Monday to Friday:	08:00-23:00
Sat:	08:00-23:00
Sun:	10:00-23:00

It is taken that the car park extract fans can operate continuously 7 days / week.

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6.2 General

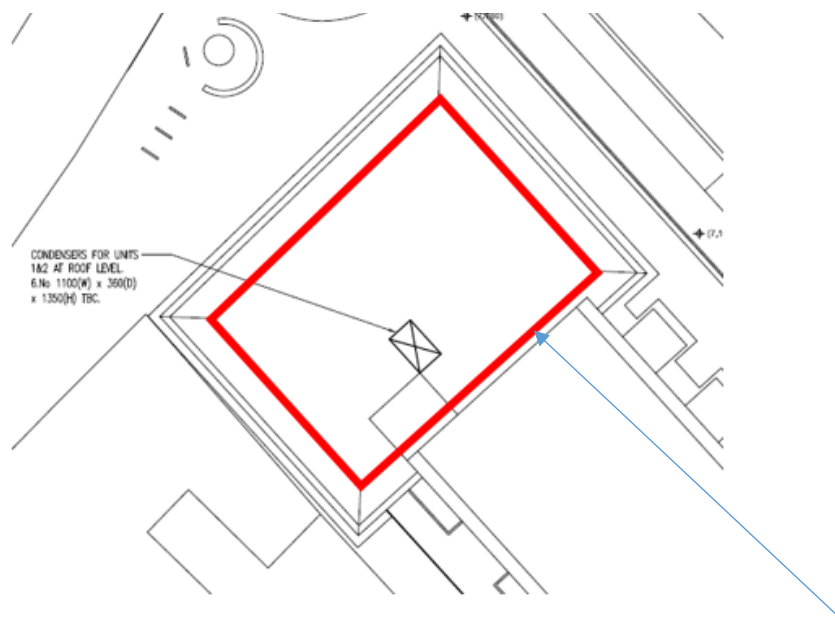
Detailed calculations have been carried out in order to determine the likely level of airborne noise transmission outside the identified assessment locations due to the operation of the proposed new landlord's plant to include the following:

- 1 number extract fan – to be located in the commercial unit 5 plantroom at ground floor level and ducted to the roof to discharge air at roof level
- 1 number extract fan – to be located in the commercial unit 3 plantroom at ground floor level and ducted to the roof to discharge air at roof level
- Commercial units 1 and 2: 6 number external condensers located on the building roof
- Commercial unit 4: 1 number external condenser located on the building roof
- Commercial unit 3: 3 number external condensers located on the building roof
- Commercial unit 5: 3 number external condensers located on the building roof
- 2 main car park extract fans to be located within the basement car park
- 4 “Jet” fans to be located within the basement car park

Please note: It is taken that the basement car park openings to atmosphere will be limited to the car park ramp entrance allowing air in / out and the ventilated opening for exhaust air of the car park extract. It is understood that the car park extract fans exhaust in a south east direction at the southern extremity of the site and are exhausting from louvres in a vertical wall such that there is no direct line of sight from the louvres to the proposed new properties.

If other openings are designed into the car park, then it may be necessary to enhance attenuation measures to plant and / or openings to atmosphere.

It is taken that the 6 number condensers located on the northern most block at roof level will benefit from a low mansard type roof to partially screen noise levels. It is taken that the mansard roof will be 0.6m higher than the roof top on which the condensers are situated and that the mansard roof will be located on all 4 sides of the northern block roof as follows:



Red line indicating top of mansard roof taken as part of the noise assessment.

Detailed calculations have been carried out in order to determine the likely level of airborne noise transmission outside the identified assessment locations due to the operation of the

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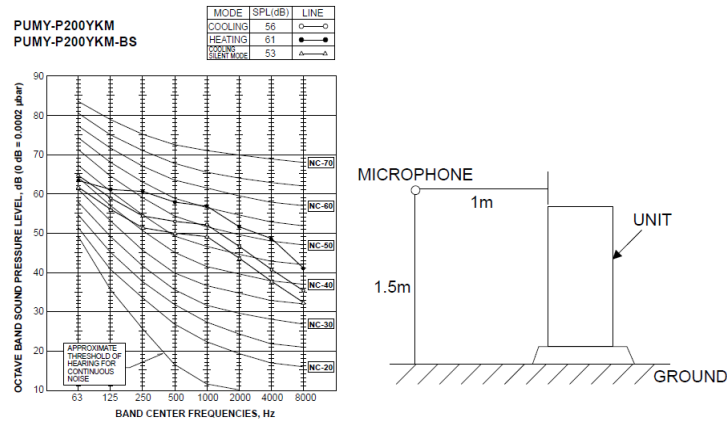
proposed new plant to be installed in the positions discussed herein. The following sections provide a record of the proposed new plant, the operational sound levels used as the basis for this assessment, and a specification for noise mitigation treatments.

6.3 Condenser Noise Levels

The Mechanical Services Consultant has advised that the proposed condensers will all be of the same size, these being type Mitsubishi PUMY200 models.

The manufacturers published operational noise levels for the condenser plant are reproduced as follows:

4-5. NOISE CRITERION CURVES

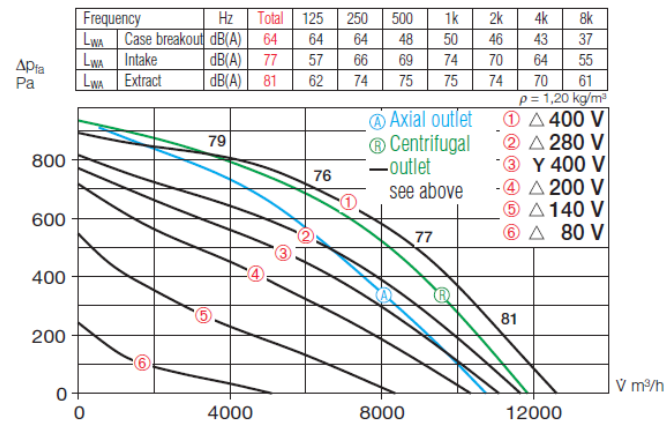


6.4 Fan unit noise levels

6.4.1 Kitchen extract fans

Kitchen extract fans associated with commercial units 3 and 5 are reproduced as follows:

GBD 560/4/4



6.4.2 Car Park Extract Fans

It has been advised that the car park units are two speed. The acoustic assessment considers the noise levels at lower speed (10951 m³/hour (3m³/sec)) when the fans are operating at normal operation mode. The acoustic assessment has not been undertaken for emergency conditions when the noise levels will be significantly higher.

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The noise data for the Main car park ventilation fans by Systemair GmbH are reproduced below:

It is taken that the top set of figures are noise levels under smoke extract conditions and will operate in an emergency only

Acoustic data										
Sound power level		63	125	250	500	1k	2k	4k	8k	Tot
Sound power Lw6	dB(A)	75	85	93	98	98	95	91	84	103
Sound power Lw4	dB(A)	76	86	95	99	100	97	93	85	104
Sound pressure Lp	dB(A)	57	67	76	80	81	78	74	66	86

Sound power level		63	125	250	500	1k	2k	4k	8k	Tot
Sound power Lw6	dB(A)	60	70	78	83	83	80	76	69	88
Sound power Lw4	dB(A)	61	71	80	84	84	82	77	70	89
Sound pressure Lp	dB(A)	42	52	61	65	66	63	59	51	70

Lw6: free-outlet conditions, Lw4: in-duct conditions, Lp: free field conditions | Sound pressure level (Lp) distance: 3 m

It is taken that the lower set of noise levels are for normal operation and have been considered in the acoustic assessment

6.4.3 Car park Jet Fans

The supplier has advised that they do not have a full noise spectrum for the jet fans, and are only able to advise that the fan noise emissions are of 60 dB(A) at full speed and 45 dB(A) at low speed, both at 3 metres free field.

6.5 Plant Noise Level Assessment to Atmosphere

Calculations have been undertaken using known prediction techniques, and utilising CadnaA software to predict the resultant sound pressure levels due to airborne transmitted noise outside the nearest exposed noise assessment positions.

Where not advised by this practice others shall select roomside attenuators to ensure reasonable roomside noise levels are maintained. At this stage, the assessment of mechanical plant noise transmission to internal occupied areas of the clients building via the building envelope is not in the scope of works by this practice. It is recommended that the client employ acoustic consultants to assess this aspect at the appropriate stage of the project.

The assessments show that the proposed plant will not maintain the derived noise limits for the landlord plant given in Table 4. It is unlikely that significantly quieter equipment is available for equipment of similar capacity and it is understood that other locations are not available for the plant, therefore, it is considered appropriate to propose noise mitigation measures to the plant as detailed in the following Sections:

7.0 Noise mitigation measures

It will be necessary to introduce noise mitigation measure to the proposed plant. The following Sections detail the noise mitigation measures proposed.

7.1 6 number Condensers for Units 1&2 Located at Roof Level.

Either a single acoustic enclosure to each condensing unit or an enclosure to house all condensing units shall be used. A specialist supplier shall provide fit for purpose acoustic enclosure/s to provide the following minimum acoustic performance:

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Table 5: Minimum insertion loss requirements for enclosure/s

Quantity	1/1 octave band centre frequency, Hz							
	63	125	250	500	1000	2000	4000	8000
Minimum insertion loss (dB)	7	8	12	16	20	25	20	15

The insertion loss is hereby defined as the difference in sound pressure level with and without the enclosure in place.

In order for this potential reduction in acoustic performance to be evaluated the enclosure supplier shall submit their product acoustic test data to Paragon Acoustic Consultants Limited prior to procurement / manufacture. Test data shall be provided for all of the proposed hardware products used in the construction of the enclosure and shall be obtained from an independent UKAS accredited test laboratory to provide proof that the foregoing acoustic performance will be maintained.

The dimensions of the enclosure are to be determined by the noise mitigation hardware supplier and agreed with the client.

Paragon Acoustic Consultants has considered the acoustic performance of the enclosure. The introduction of this type of structure has implications in other areas of design. As such, the client shall employ the services of other specialists to take responsibility for other areas of design associated with the introduction of such a structure. The following list is provided as an example of other areas to be considered as a minimum:

Airflow to and from condensing units: The installation of an enclosure will restrict the airflow around the condensing units. This will potential give rise to two adverse effects as follows:

- The resistance to airflow will increase
- Heated discharge air from the condenser coils may re-circulate back into the condenser coils

The supplier of close fitting enclosure and the mechanical services consultant shall guarantee that their enclosures shall not adversely affect the performance of condensing units.

Structural: A suitably qualified consultant shall assess all structural loading as necessary.

Aesthetics: The visual appearance of the enclosures is to be agreed by the client's architect. The architect shall also consider all necessary statutory approvals and address design issues not covered by the relevant specialist consultant.

Alteration to existing services: The installation of each enclosure may require alteration to certain of the existing mechanical and electrical services in the vicinity of the proposed enclosure. In addition, the condensing units may require to be moved into close fitting enclosures. The client shall co-ordinate any such works.

Delivery and installation access: The enclosure supplier shall make appropriate arrangements for the delivery and installation of enclosures, including equipment such as cranes and scaffolding requirements.

Guarantees: The client shall obtain the necessary guarantees that the enclosure will meet the minimum insertion loss requirements as specified by this practice in the foregoing section. In addition, the client shall obtain all other guarantees as required.

Maintenance / repair / replacement: The enclosures shall allow maintenance / repair / replacement of the condensing unit equipment enclosed.

Warrantees: The client shall ensure that the warrantees provided by the condensing unit supplier/manufacture are not invalidated by the introduction of the noise mitigation works.

Submission of final enclosure designs: The final design of the enclosures shall be submitted to Paragon Acoustic Consultants for comment prior to manufacture.

7.2 Kitchen Extract Fans and Car Park Main Ventilation Fans

Attenuation is proposed to the atmosphere side of the kitchen extract fans for units 3 and 5. Others shall select roomside attenuators.

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Attenuation is proposed to the exhaust (atmosphere side) and intake (roomside) of the car park extract fans. It is important to attenuate both sides of the fan, as the car park is open to atmosphere and intake noise from the fan can be transferred to the atmosphere via the ramp opening. The Car Park intake attenuators will reduce noise to the car park to approximately NR55 at 2m from the fans.

The following attenuators shall be installed to the fans:

Table 6: Attenuator Specification

Ref	Description	Duty		Approximate Size (mm)			Minimum Insertion Losses							
							Octave Band Centre Frequency							
		Vol (m ³ /s)	Max res (Pa)	Width	Height	Length	63	125	250	500	1k	2k	4k	8k
A1	Main Car Park Extract fan exhaust to atmosphere	tba	50	tba	tba	tba	17	31	49	50	50	50	50	47
A2	Main Car Park Extract fan intake from car park	tba	50	tba	tba	tba	5	11	21	37	39	29	19	15
A3	Main Car Park Extract fan exhaust to atmosphere	tba	50	tba	tba	tba	17	31	49	50	50	50	50	47
A4	Main Car Park Extract fan intake from car park	tba	50	tba	tba	tba	5	11	21	37	39	29	19	15
A5	Unit 3 kitchen extract fan exhaust to atmosphere	tba	50	tba	tba	tba	7	17	30	47	50	50	36	23
A6	Unit 3 kitchen extract fan exhaust to atmosphere	tba	50	tba	tba	tba	7	17	30	47	50	50	36	23

The attenuator construction shall be suitable for the application.

Special attention needs to be given to the construction of attenuators associated with the main far park extract fans to ensure that they are suitable for the temperatures involved and any fire rating standards that may be applicable.

The attenuator supplier shall ensure that the car park extract attenuators are suitable for the higher air volumes expected under smoke extract conditions.

For the kitchen extract attenuators, where it is predicted or known that the airstream will contain a grease laden atmosphere or high moisture atmosphere the mineral wool shall be bagged within Melinex and retained behind the 30% minimum free area perforated steel.

The elements shall incorporate aerodynamically shaped leading edges and be secured within the casing using suitable mechanical fixings. Side elements shall be provided to reduce noise breakout

Note: Dimensions are not stated in the above Table. Attenuator suppliers may have their own preferred standard sizes. The insertion loss requirements and maximum pressure drops stated in the Table shall be maintained

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7.3 Main Car Park Ventilation Fans – Enclosure

With regards the main car park fan casings, ducted sections to attenuators and flexible connections, these shall be acoustically enclosed. The enclosure may be by means of a builders work enclosure or proprietary enclosures by an acoustic hardware supplier.

The design of a builderswork enclosure / enclosure by an acoustic hardware supplier shall ensure that noise emissions from the fan casing, flexible connections and duct transformations to attenuators do not exceed NR45 at 2m from the fan casing under installed conditions within the car park space.

7.4 Car Park ‘Jet’ Fans

Car park Jet fan noise levels are limited, with only broadband noise levels being available. As such, a thorough noise assessment is not possible. However, the assessment does indicate that the noise levels of the “Jet” fans will potentially undermine the noise limits established at site due to noise leakage from the open ramp that allows vehicle access to the basement car park. At the present time the provisional assessment shows that the figures of 60 dB(A) at full speed and 45 dB(A) at low speed, both at 3 metres free field, will undermine the noise limits established. It is recommended that these fans will need to be reduced to 40 dB(A) at 3 metres free field in order to maintain the noise limits detailed herein. If fans operate at a noise levels of greater than 40 dBA at 3m free field, the noise limits established are likely to be exceeded.

7.5 Other Roof Mounted Condensers

The following condensers are located on the roof areas of the two blocks to the south of the proposed development:

- Commercial unit 4: 1 number external condenser located on the building roof
- Commercial unit 3: 3 number external condensers located on the building roof
- Commercial unit 5: 3 number external condensers located on the building roof

All condensers shall be enclosed. Either a single acoustic enclosure to each condensing unit or enclosures to house each group of condensing units shall be used. A specialist supplier shall provide fit for purpose acoustic enclosure/s to provide the following minimum acoustic performance:

Table 7: Minimum insertion loss requirements for enclosure/s

Quantity	1/1 octave band centre frequency, Hz							
	63	125	250	500	1000	2000	4000	8000
Minimum insertion loss (dB)	11	13	19	28	22	30	32	28

The insertion loss is hereby defined as the difference in sound pressure level with and without the enclosure in place.

In order for this potential reduction in acoustic performance to be evaluated the enclosure supplier shall submit their product acoustic test data to Paragon Acoustic Consultants Limited prior to procurement / manufacture. Test data shall be provided for all of the proposed hardware products used in the construction of the enclosure and shall be obtained from an independent UKAS accredited test laboratory to provide proof that the foregoing acoustic performance will be maintained.

The dimensions of the enclosure are to be determined by the noise mitigation hardware supplier and agreed with the client.

Paragon Acoustic Consultants has considered the acoustic performance of the enclosure. The introduction of this type of structure has implications in other areas of design. As such, the client shall employ the services of other specialists to take responsibility for other areas of design

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associated with the introduction of such a structure. The following list is provided as an example of other areas to be considered as a minimum:

Airflow to and from condensing units: The installation of an enclosure will restrict the airflow around the condensing units. This will potential give rise to two adverse effects as follows:

- The resistance to airflow will increase
- Heated discharge air from the condenser coils may re-circulate back into the condenser coils

The supplier of close fitting enclosure and the mechanical services consultant shall guarantee that their enclosures shall not adversely affect the performance of condensing units.

Structural: A suitably qualified consultant shall assess all structural loading as necessary.

Aesthetics: The visual appearance of the enclosures is to be agreed by the client's architect. The architect shall also consider all necessary statutory approvals and address design issues not covered by the relevant specialist consultant.

Alteration to existing services: The installation of each enclosure may require alteration to certain of the existing mechanical and electrical services in the vicinity of the proposed enclosure. In addition, the condensing units may require to be moved into close fitting enclosures. The client shall co-ordinate any such works.

Delivery and installation access: The enclosure supplier shall make appropriate arrangements for the delivery and installation of enclosures, including equipment such as cranes and scaffolding requirements.

Guarantees: The client shall obtain the necessary guarantees that the enclosure will meet the minimum insertion loss requirements as specified by this practice in the foregoing section. In addition, the client shall obtain all other guarantees as required.

Maintenance / repair / replacement: The enclosures shall allow maintenance / repair / replacement of the condensing unit equipment enclosed.

Warrantees: The client shall ensure that the warrantees provided by the condensing unit supplier/manufacture are not invalidated by the introduction of the noise mitigation works.

Submission of final enclosure designs: The final design of the enclosures shall be submitted to Paragon Acoustic Consultants for comment prior to manufacture.

7.6 Vibration – Mechanical Plant

It is recommended that the client provisions for appropriate vibration isolation mountings for the proposed mechanical plant items. It is recommended that the plant be installed on vibration isolation mounts providing a minimum of 98% isolation efficiency at all forcing frequencies using an isolation mount system approved by the plant supplier. In addition, all pipework should be suitably isolated from the building structure.

7.7 Predicted Plant Noise Levels Following Noise Mitigation

Calculations have been carried out to determine the predicted noise levels at the most exposed receiver location based on the noise mitigation measures proposed herein. The predicted results summarised in the following Tables:

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Table 8: Predicted Noise Levels @ Nearest Exposed Residential Dwellings following noise mitigation - Daytime

Plant under consideration	Assessment location	Predicted Lp at receiver	Derived noise limit ^[x] Daytime
All plant	Properties on north side of King St	Up to 24 dB	43 dB L _{Ar,Tr}
	Properties on east side of Water Lane	Up to 28 dB	32 dB L _{Ar,Tr}
	Properties of the first, second and third (where applicable) floors of the proposed development	Up to 31 dB	32 dB L _{Ar,Tr}
	Properties on Eel Pie Island	Up to 18 dB	22 dB L _{Ar,Tr}
	Side / rear elevations of residential properties with their frontage on the south side of King Street	Up to 27 dB	32 dB L _{Ar,Tr}
	Diamond Jubilee Gardens	Up to 22 dB	47 dB L _{Aeq}

[x]: Note that this derived noise limit is based on the limits for the landlord's plant only.

Table 9: Predicted Noise Levels @ Nearest Exposed Residential Dwellings following noise mitigation - Night time

Plant under consideration	Assessment location	Predicted Lp at receiver	Derived noise limit ^[x] Night time
All plant	Properties on north side of King St	<10 dB	23 dB L _{Ar,Tr}
	Properties on east side of Water Lane	13 dB	23 dB L _{Ar,Tr}
	Properties of the first, second and third (where applicable) floors of the proposed development	Up to 23 dB	23 dB L _{Ar,Tr}
	Properties on Eel Pie Island	Up to 17 dB	22 dB L _{Ar,Tr}
	Side / rear elevations of residential properties with their frontage on the south side of King Street	<10 dB	23 dB L _{Ar,Tr}
	Diamond Jubilee Gardens	Up to 14 dB	47 dB L _{Aeq}

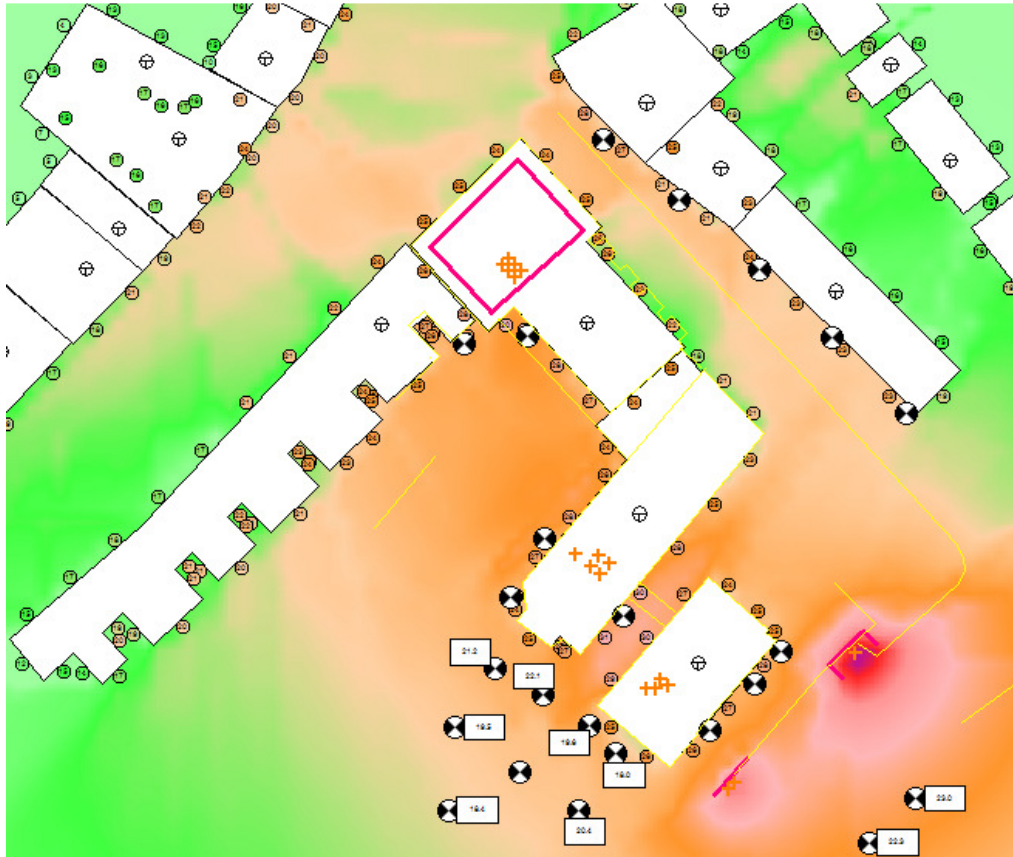
[x]: Note that this derived noise limit is based on the limits for the landlord's plant only.

It can be seen from the results indicated in Table 8 and 9 that the proposed plant together with the noise mitigation measures details herein **will maintain** the derived noise limits given for the Landlords plant in Table 4

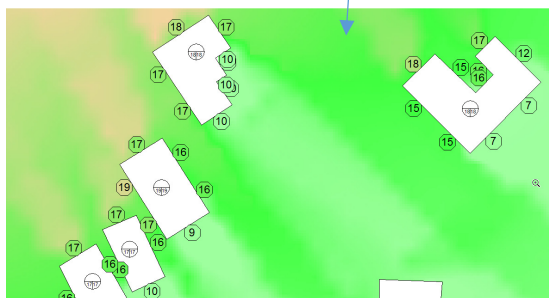
Project:	Twickenham Rediscovered	Date:	16/11/2017
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Screenshots of the CadnaA model are reproduced as follows:

Figure 5: Plan view of area local to the proposed plant including noise mitigation measures – daytime - predicted noise levels given in octagonal markers

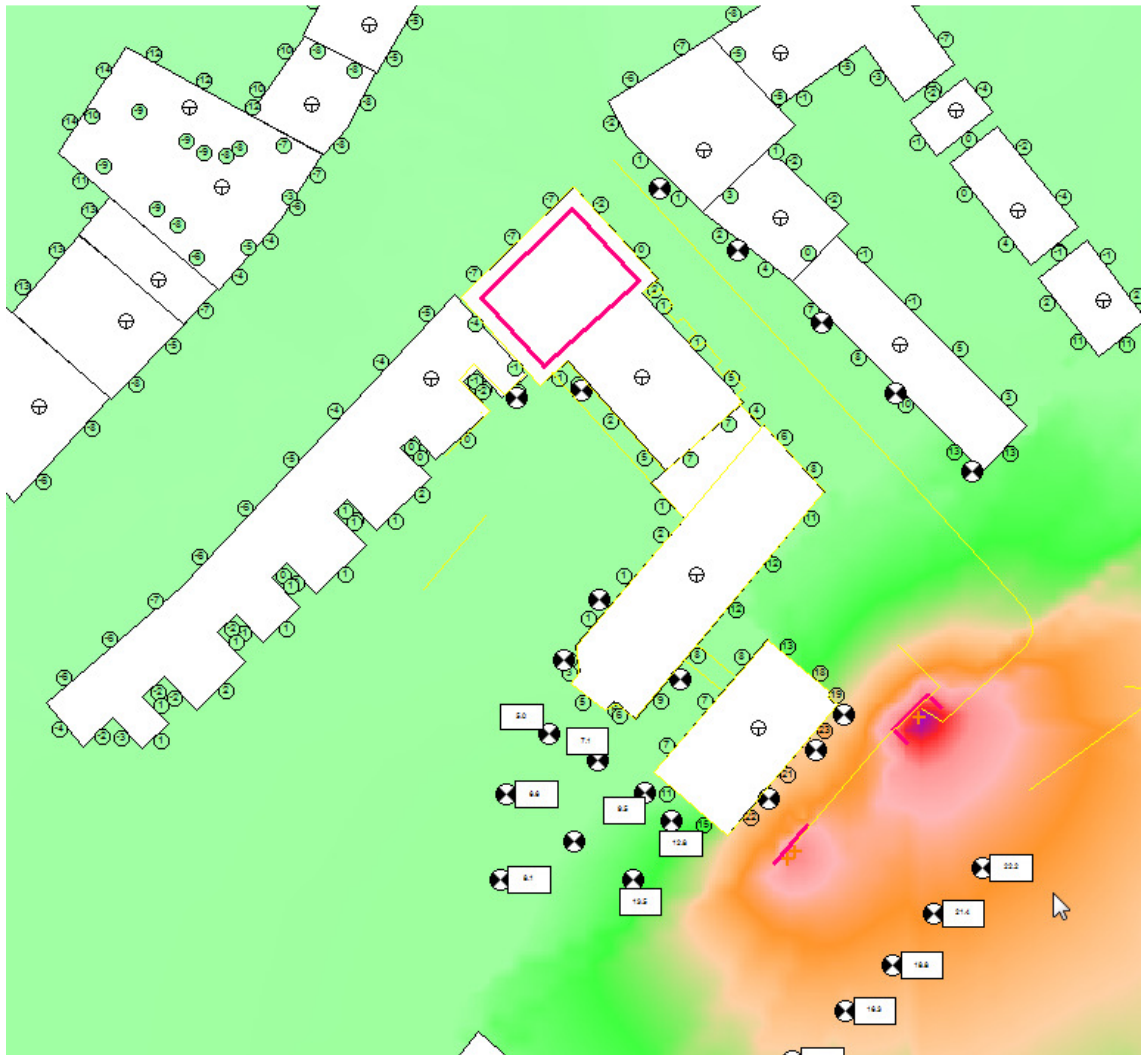


Eel Pie Island – properties nearest the River Thames and the site

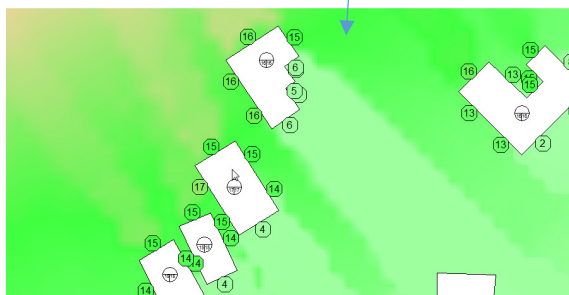


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Figure 6: plan view of area local to the proposed plant including noise mitigation measures – Night time - predicted noise levels given in octagonal markers



Eel Pie Island – properties nearest the River Thames and the site



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8.0 Conclusions

Background noise surveys have been undertaken to determine the noise climate likely to exist in the vicinity of the site where the positioning of new mechanical plant is proposed.

Appropriate external noise criteria have been identified on the basis of Local Authority noise policy, and other industry standards, codes of practice and references and the potential for future plant to be installed within the commercial units.

Predictions of noise emission from the proposed plant indicate that the noise mitigation measures will be required to the landlord's plant in order to meet with the derived noise limits and as such specification for the noise mitigation measures has been provided herein.

The incoming tenants of the commercial units and designers of any plant associated with the residential units (other than that addressed herein) shall be encumbered with achieving the limiting noise levels appropriate to their unit as given in Appendix C.

Following implementation and achievement of the noise mitigation recommended to the proposed landlords plant and achievement by incoming tenants to maintain the limiting noise levels given in Appendix C it is predicted that the overall site noise limits will be maintained. On this basis, reservations are not expected from the planning authority on the grounds of noise.

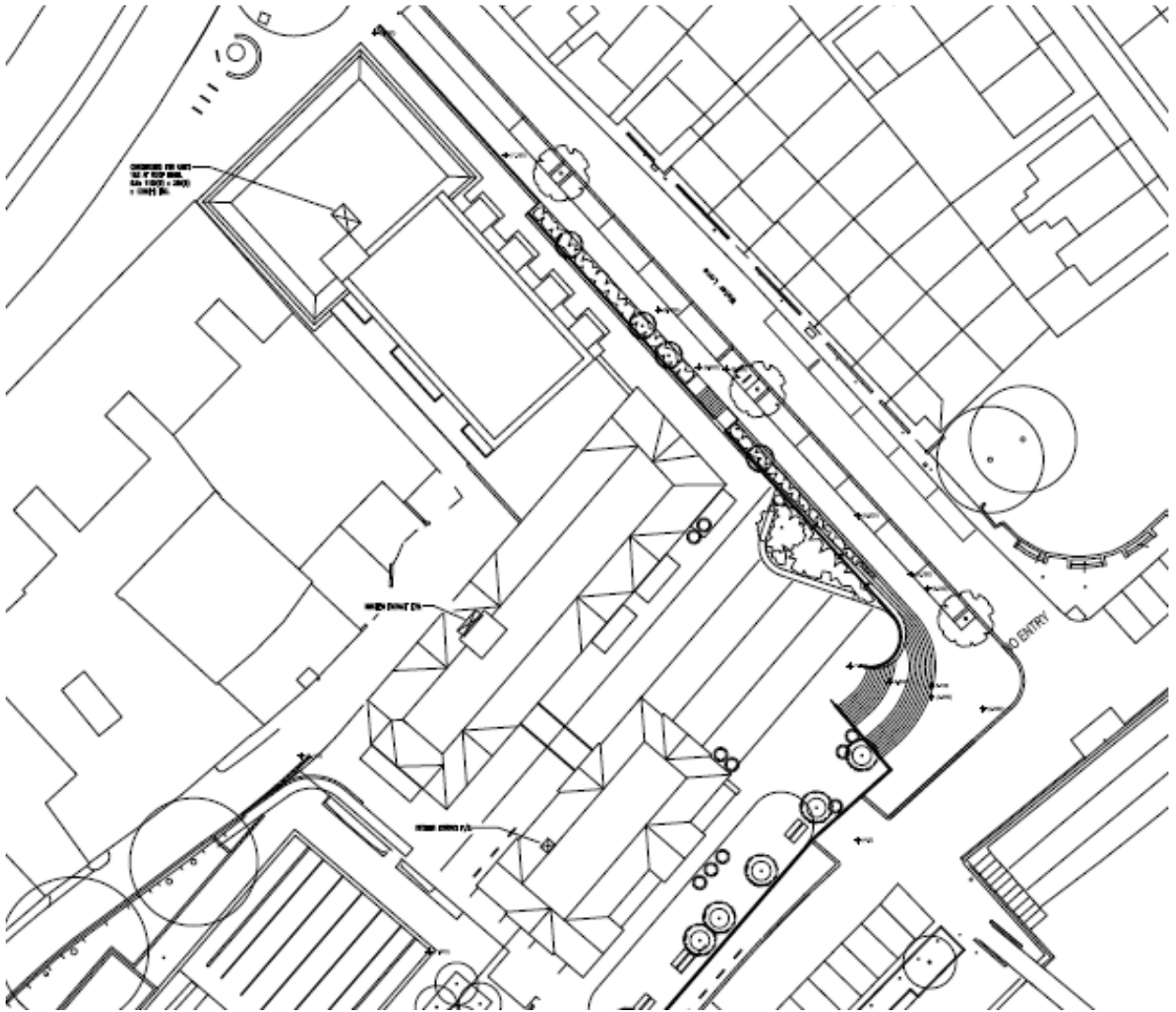
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Appendix A: Site Plan



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Proposed site plan



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Appendix C: Noise Limits for Each Commercial Unit Plant and Future Pant Associated With The Residential Areas Of The Development

Table 10: Limiting Noise Criteria to be maintained by all mechanical plant noise emissions associated with unit 1

Plant Location	Receptor	Daytime 07:00- 23:00	Night- time 23:00- 07:00
Any Location on the development site	Windows of the apartments of the new proposed development facing King Street at 1.0m from the façade	43 dB $L_{Ar,Tr}$	23 dB $L_{Ar,Tr}$
	Windows of the apartments of the new proposed development facing all other directions at 1.0m from the façade	32 dB $L_{Ar,Tr}$	23 dB $L_{Ar,Tr}$
	Residential property frontages facing King Street including those in King Street and Church Street at 1.0m from the façade.	43 dB $L_{Ar,Tr}$	23 dB $L_{Ar,Tr}$
	Residential properties in Water Lane at 1.0m from the façade	32 dB $L_{Ar,Tr}$	23 dB $L_{Ar,Tr}$
	Residential properties on Eel Pie Island at 1.0m from the façade.	22 dB $L_{Ar,Tr}$	22 dB $L_{Ar,Tr}$
	Side / rear elevations of residential properties with their frontage on the south side of King Street	32 dB $L_{Ar,Tr}$	23 dB $L_{Ar,Tr}$
	Diamond Jubilee Gardens	44 dB $L_{Aeq, T}$	
	All Commercial properties at 1.0m from the façade.	47 dB L_{Aeq}	

$L_{Ar,Tr}$: For residential receivers, the $L_{Ar,Tr}$ shall be as described in BS4142: 2014

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Table 11: Limiting Noise Criteria to be maintained by all mechanical plant noise emissions associated with unit 2

Plant Location	Receptor	Daytime 07:00- 23:00	Night- time 23:00- 07:00
Any Location on the development site	Windows of the apartments of the new proposed development facing King Street at 1.0m from the façade	43 dB L _{Ar,Tr}	23 dB L _{Ar,Tr}
	Windows of the apartments of the new proposed development facing all other directions at 1.0m from the façade	32 dB L _{Ar,Tr}	23 dB L _{Ar,Tr}
	Residential property frontages facing King Street including those in King Street and Church Street at 1.0m from the façade.	43 dB L _{Ar,Tr}	23 dB L _{Ar,Tr}
	Residential properties in Water Lane at 1.0m from the façade	32 dB L _{Ar,Tr}	23 dB L _{Ar,Tr}
	Residential properties on Eel Pie Island at 1.0m from the façade.	22 dB L _{Ar,Tr}	22 dB L _{Ar,Tr}
	Side / rear elevations of residential properties with their frontage on the south side of King Street	32 dB L _{Ar,Tr}	23 dB L _{Ar,Tr}
	Diamond Jubilee Gardens	44 dB L _{Aeq, T}	
	All Commercial properties at 1.0m from the façade.	47 dB L _{Aeq}	

L_{Ar,Tr}: For residential receivers, the L_{Ar,Tr} shall be as described in BS4142: 2014

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Table 12: Limiting Noise Criteria to be maintained by all mechanical plant noise emissions associated with unit 3

Plant Location	Receptor	Daytime 07:00- 23:00	Night- time 23:00- 07:00
Any Location on the development site	Windows of the apartments of the new proposed development facing King Street at 1.0m from the façade	43 dB $L_{Ar,Tr}$	23 dB $L_{Ar,Tr}$
	Windows of the apartments of the new proposed development facing all other directions at 1.0m from the façade	32 dB $L_{Ar,Tr}$	23 dB $L_{Ar,Tr}$
	Residential property frontages facing King Street including those in King Street and Church Street at 1.0m from the façade.	43 dB $L_{Ar,Tr}$	23 dB $L_{Ar,Tr}$
	Residential properties in Water Lane at 1.0m from the façade	32 dB $L_{Ar,Tr}$	23 dB $L_{Ar,Tr}$
	Residential properties on Eel Pie Island at 1.0m from the façade.	22 dB $L_{Ar,Tr}$	22 dB $L_{Ar,Tr}$
	Side / rear elevations of residential properties with their frontage on the south side of King Street	32 dB $L_{Ar,Tr}$	23 dB $L_{Ar,Tr}$
	Diamond Jubilee Gardens	44 dB $L_{Aeq, T}$	
	All Commercial properties at 1.0m from the façade.	47 dB L_{Aeq}	

$L_{Ar,Tr}$: For residential receivers, the $L_{Ar,Tr}$ shall be as described in BS4142: 2014

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Table 13: Limiting Noise Criteria to be maintained by all mechanical plant noise emissions associated with unit 4

Plant Location	Receptor	Daytime 07:00- 23:00	Night- time 23:00- 07:00
Any Location on the development site	Windows of the apartments of the new proposed development facing King Street at 1.0m from the façade	43 dB $L_{Ar,Tr}$	23 dB $L_{Ar,Tr}$
	Windows of the apartments of the new proposed development facing all other directions at 1.0m from the façade	32 dB $L_{Ar,Tr}$	23 dB $L_{Ar,Tr}$
	Residential property frontages facing King Street including those in King Street and Church Street at 1.0m from the façade.	43 dB $L_{Ar,Tr}$	23 dB $L_{Ar,Tr}$
	Residential properties in Water Lane at 1.0m from the façade	32 dB $L_{Ar,Tr}$	23 dB $L_{Ar,Tr}$
	Residential properties on Eel Pie Island at 1.0m from the façade.	22 dB $L_{Ar,Tr}$	22 dB $L_{Ar,Tr}$
	Side / rear elevations of residential properties with their frontage on the south side of King Street	32 dB $L_{Ar,Tr}$	23 dB $L_{Ar,Tr}$
	Diamond Jubilee Gardens	44 dB $L_{Aeq, T}$	
	All Commercial properties at 1.0m from the façade.	47 dB L_{Aeq}	

$L_{Ar,Tr}$: For residential receivers, the $L_{Ar,Tr}$ shall be as described in BS4142: 2014

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Table 14: Limiting Noise Criteria to be maintained by all mechanical plant noise emissions associated with unit 5

Plant Location	Receptor	Daytime 07:00- 23:00	Night- time 23:00- 07:00
Any Location on the development site	Windows of the apartments of the new proposed development facing King Street at 1.0m from the façade	43 dB $L_{Ar,Tr}$	23 dB $L_{Ar,Tr}$
	Windows of the apartments of the new proposed development facing all other directions at 1.0m from the façade	32 dB $L_{Ar,Tr}$	23 dB $L_{Ar,Tr}$
	Residential property frontages facing King Street including those in King Street and Church Street at 1.0m from the façade.	43 dB $L_{Ar,Tr}$	23 dB $L_{Ar,Tr}$
	Residential properties in Water Lane at 1.0m from the façade	32 dB $L_{Ar,Tr}$	23 dB $L_{Ar,Tr}$
	Residential properties on Eel Pie Island at 1.0m from the façade.	22 dB $L_{Ar,Tr}$	22 dB $L_{Ar,Tr}$
	Side / rear elevations of residential properties with their frontage on the south side of King Street	32 dB $L_{Ar,Tr}$	23 dB $L_{Ar,Tr}$
	Diamond Jubilee Gardens	44 dB $L_{Aeq, T}$	
	All Commercial properties at 1.0m from the façade.	47 dB L_{Aeq}	

$L_{Ar,Tr}$: For residential receivers, the $L_{Ar,Tr}$ shall be as described in BS4142: 2014

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Table 15: Limiting Noise Criteria to be maintained by all mechanical plant noise emissions associated with the proposed residential areas of the development.

Plant Location	Receptor	Daytime 07:00- 23:00	Night- time 23:00- 07:00
Any Location on the development site	Windows of the apartments of the new proposed development facing King Street at 1.0m from the façade	43 dB L _{Ar,Tr}	23 dB L _{Ar,Tr}
	Windows of the apartments of the new proposed development facing all other directions at 1.0m from the façade	32 dB L _{Ar,Tr}	23 dB L _{Ar,Tr}
	Residential property frontages facing King Street including those in King Street and Church Street at 1.0m from the façade.	43 dB L _{Ar,Tr}	23 dB L _{Ar,Tr}
	Residential properties in Water Lane at 1.0m from the façade	32 dB L _{Ar,Tr}	23 dB L _{Ar,Tr}
	Residential properties on Eel Pie Island at 1.0m from the façade.	22 dB L _{Ar,Tr}	22 dB L _{Ar,Tr}
	Side / rear elevations of residential properties with their frontage on the south side of King Street	32 dB L _{Ar,Tr}	23 dB L _{Ar,Tr}
	Diamond Jubilee Gardens	44 dB L _{Aeq, T}	
	All Commercial properties at 1.0m from the façade.	47 dB L _{Aeq}	

L_{Ar,Tr}: For residential receivers, the L_{Ar,Tr} shall be as described in BS4142: 2014