Manchester Royal Infirmary – Observational Wards

Sound Impact Assessment

Engie

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1.0

Introduction

1.0 Introduction

Cundall has been commissioned by Engie to undertake a noise impact assessment relating to the installation of new rooftop chiller plant associated with the refurbishment works to the Observation Ward at Manchester Royal Infirmary (MRI) Hospital.

In order to establish the prevailing noise climate at the nearest non-hospital receptors, a noise survey has previously been undertaken by RPS between 17th June and 19th July 2014. All results and subjective findings from the RPS report[1] have been reproduced in this report where relevant.

The purpose of this assessment is to evaluate the findings of the RPS surveys and assess the level of noise impact associated with the proposed new external building services plant item at the nearest noise sensitive receivers in relation to current Manchester City Council (MCC) noise policy guidance.

In order to assist with the noise impact calculations, sound power level data for the proposed new plant item has been inputted into a 3D site model created using SoundPLAN version 7.4 acoustic software.

Note: Reproduction of RPS survey data has been authorised by Engie. Cundall cannot assume responsibility for the accuracy of third party survey information.

[1] Reference: B7477-ENV-P2 dated April 2nd 2015

2.0

Legislation and standards

2.0 Legislation and standards

The assessment methodology adopted in this report has been based on Cundall's extensive experience of similar developments and relevant British Standards.

2.1 British Standard 4142:2014 'Methods for rating and assessing industrial and commercial sound'

BS 4142: 2014 provides methods for rating and assessing sound of an industrial and/or commercial nature, which includes sound from fixed services plant.

BS 4142 utilises various descriptors to assess complaints, the impact of sound associated with proposed industrial / commercial activities on existing sound-sensitive receivers, or the impact and likely suitability of siting new sound-sensitive receivers in the vicinity of existing industrial / commercial sound sources.

The magnitude of impact is assessed by subtracting the measured background sound level at a location representative of the nearest sound-sensitive receiver from the 'rating level' (the specific sound source to be introduced into the locality, corrected for acoustically distinguishing characteristics which may make it more subjectively prominent).

Typically, the greater the difference between the background and rating level, the greater the magnitude of impact, although BS 4142 emphasises that this is highly context-specific.

As a guideline, BS 4142 states that:

- *A difference (between the background and rating level) of around +10 dB or more is likely to be indicative of significant adverse impact, depending on context*
- *A difference (between the background and rating level) of around +5 dB or more is likely to be indicative of adverse impact, depending on context*
- *The lower the rating level relative to the background level, the less likely it is that the specific sound will have an adverse impact*
- *Where the rating level does not exceed the background level, this in an indication that the specific sound will have a low impact, depending on context*

It should be noted that BS 4142 draws a clear distinction between the detailed and flexible assessment methods contained within, and the more limited versions contained in the previous (1997) edition.

Above all, BS 4142 requires qualified engineering consultants and technical planning professionals (e.g. Environmental Health Officers) to use a combination of quantitative assessment techniques and rational qualitative judgements to come to a sensible and reasonable conclusion.

2.1.1 Definitions

BS 4142 uses several specific terms to define the various levels used in assessments, as follows:

- Specific sound – the commercial / industrial sound source under consideration
- Residual sound – the sound level at the sound-sensitive receivers in the absence of the specific sound
- Ambient sound – the sound level at the sound-sensitive receivers in the presence of the specific sound (i.e. ambient = residual + specific)
- Background level - the sound pressure level which is exceeded by the residual sound for 90% of the measurement period
- Rating level – the specific sound, corrected for acoustically distinguishing characteristics

2.1.2 Background level

BS 4142 emphasises that the background level ($L_{A90,T}$) is in fact a range of levels, not one absolute value. Whilst stating that the measurements of background sound should be normally not less than 15 mins, the focus is on obtaining a level for use in assessment that is representative of typical conditions at the sound-sensitive receivers.

An example methodology by which this typical value may be obtained is given in the document. In this example, monitoring of $L_{A90,15mins}$ is undertaken during periods which represent when the specific sound will be operational. After obtaining a sequence of representative contiguous or disaggregated results, it is then proposed that the modal value is representative of the 'typical' background level.

2.1.3 Specific sound

BS 4142 requires that the specific sound ($L_{Aeq,Tr}$) is obtained over a reference period of 1 hour (daytime) and 15 mins (at night). Ideally, measurements would be taken of the ambient sound and residual sound at the assessment location, with these measurements used to accurately calculate the specific sound (ambient – residual = specific).

Where the source (specific sound) is not yet operational, it is permissible to measure the specific sound elsewhere (or to use known manufacturers' or library data) and then model the impact of this against the known background level.

2.1.4 Rating level

Once the specific sound level has been determined, this must be corrected in terms of the need to consider the subjective prominence of the impact of the sound at sound-sensitive receivers, and the extent to which acoustically distinctive characteristics will attract attention.

BS 4142 states that this is normally possible to carry out a subjective assessment of characteristics, based on the following correction guidelines:

- Tonality: +2 dB for a 'just perceptible' tone, +4 dB for 'clearly perceptible', and rising to +6 dB for 'highly perceptible' tones
- Impulsivity (rapidity of change and overall chance in level): +3 dB for 'just perceptible' impulsivity, +6 dB for 'clearly perceptible', rising to +9 dB for 'highly perceptible' impulsivity
- Intermittency: if the on/off-time of the specific sound is readily distinctive at the sound-sensitive receivers, +3 dB

It should be noted that where one feature is clearly perceived as dominant, it may be applicable to correct for that feature only. Where multiple features are likely to affect perception and response, each should be added arithmetically.

2.2 Manchester City Council noise policy guidance

Section 3.6.1.5.1 of the Planning & Noise Technical Guidance document issued by Manchester City Council (MCC) in December 2015 states the following:

"Any noise assessment needs to consider not only the overall level of noise emitted but also its particular characteristics. The noise assessment should be based on BS 4142: 2014 and any application for fixed plant, equipment or machinery must demonstrate that:

'Externally mounted ancillary plant, equipment and servicing shall be selected and/or acoustically treated in accordance with a scheme designed so as to achieve a rating level of 5dB (L_{Aeq}) below the typical background (L_{A90}) level at the nearest noise sensitive location'.

By designing the sound pressure level of any plant items to generate a noise impact of at least 5dB below the existing background level, any plant noise impact should be of a negligible level which should not give rise to complaints from users or occupiers of existing noise-sensitive usages."

In addition, the following condition related to noise is stated within Planning Permission ref. 117770/FO/2017:

"3) Before first occupation of the development the building, together with any externally mounted ancillary equipment, shall be acoustically insulated in accordance with a scheme submitted to and approved in writing by the City Council as local planning authority in order to secure a reduction in the level of noise emanating from the equipment.

Reason – To safeguard the amenities of the occupiers of nearby residential accommodation, pursuant to policies SP1 and DM1 of the Core Strategy."

3.0

Site context

3.0 Site context

3.1 Site

The Manchester Royal Infirmary (MRI) site is located to the south of Manchester City Centre and is bounded by Grafton Street to the north, Upper Brook Street (A34) to the east, Hathersage Road to the south and Oxford Road to the west.

Upper Brook Street and Oxford Road are main routes into Manchester City Centre and are heavily trafficked throughout the daytime period and moderately trafficked throughout the night-time. Oxford Road, in particular, has a high percentage of bus movements which continue throughout the night-time period.

Multi-storey car parks and entrances to pick-up / drop-off zones within the MRI are accessed via Grafton Street and Hathersage Road.

The area surrounding the MRI is of mixed use and comprises of residential, commercial, educational buildings and places of worship.

Further to correspondence between RPS and a representative of MCC, it is understood that the following sensitive receptors were identified as being closest to the boundary of the MRI campus, and therefore considered as being most exposed to potential sound impacts from the site:

- Nick Everton House (78 Grafton Street)
- The Grafton (60 Grafton Street)
- Wilmslow Park (211 Hathersage Road)
- Victoria Terrace (135-149 Hathersage Road)
- Victoria Hall (281 Upper Brook Street)
- Travelodge Manchester Upper Brook Street (227 Upper Brook Street)

An aerial photograph of the site showing the location of the nearest sound sensitive receptors and proposed locations for new rooftop plant is included in Appendix I of this report.

3.2 Observation wards

It is understood that a part of the main MRI building is being refurbished to form two new observation wards and that a new chiller unit will be required as part of the works.

An indicative rooftop layout plan showing the proposed location of new chiller plant is provided in Appendix II of this report.

The nearest existing noise sensitive receptor outside of the MRI campus boundary is considered to be the Travelodge Manchester Upper Brook Street hotel.

4.0

Background noise surveys

4.0 Background noise surveys

In order to assess the prevailing ambient noise climate across the site, attended daytime and night-time noise surveys were carried out by RPS between 17th June and 19th July 2014.

Weather conditions during all survey periods were reported as being typically dry (with the exception of 2 mm precipitation on 18th July) and with wind speeds < 5 ms/s.

4.1 Measurement locations

To assess the existing prevailing noise climate at the nearest sound sensitive receptors (as agreed with MCC), RPS measurements were undertaken at six different positions as detailed in Table 1 below.

Measurement position	Description
MP1	Situated at crossroads between Upper Brook Street and Grafton Street, capturing existing noise impact at residential apartments at 'Nick Everton House' (78 Grafton Street)
MP2	Situated at corner of Portsmouth Street and Grafton Street, capturing existing noise impact at residential apartments at 'The Grafton' (60 Grafton Street)
MP3	Situated along Hathersage Road, capturing existing noise impact at residential apartments at 'Wilmslow Park' (211 Hathersage Road)
MP4	Situated along Hathersage Road, capturing existing noise impact at residential apartments at 'Victoria Terrace' (135-149 Hathersage Road)
MP5	Situated at corner of Upper Brook Street and Blockstock Street, capturing existing noise impact at residential apartments at 'Victoria Hall' (281 Upper Brook Street)
MP6	Travelodge Manchester Upper Brook Street hotel. (227 Upper Brook Street)

Table 1 - Measurement locations

A site plan showing the approximate location of the RPS measurement positions can be found in Appendix I.

4.2 Summary of measurement results

A summary of the average daytime and night-time ambient noise levels recorded is detailed in Table 2. The values are the average L_{Aeq} and the lowest L_{A90} dB values measured during each daytime or night-time period. Values have been rounded to the nearest integer.

Measurement Position	Period	Start Date / Time	Finish Date / Time	Average $L_{Aeq,T}$ (dB)	Lowest $L_{A90,5min}$ (dB)
MP1	Day	Tue 17 Jun - 09:40	Tue 17 Jun - 12:40	64	55
	Night	Tue 08 Jul - 00:05	Tue 08 Jul - 03:00	54	43
MP2	Day	Tue 17 Jun - 12:45	Tue 17 Jun - 15:40	61	56
	Night	Wed 18 Jun - 00:00	Wed 18 Jun - 03:00	56	54
MP3	Day	Wed 18 Jun - 13:00	Wed 18 Jun - 16:00	63	53
	Night	Fri 04 Jul – 00:00	Fri 04 Jul – 03:00	55	46
MP4	Day	Wed 02 Jul - 12:05	Wed 02 Jul - 15:00	72	56
	Night	Wed 09 Jul - 00:05	Wed 09 Jul - 03:00	58	41
MP5	Day	Mon 07 Jul - 12:40	Mon 07 Jul - 15:40	67	56
	Night	Wed 09 Jul - 00:00	Wed 09 Jul - 03:00	54	41
MP6	Day	Mon 07 Jul - 12:30	Mon 07 Jul - 15:30	60	51
	Night	Tue 08 Jul - 00:00	Tue 08 Jul - 03:00	62	47

Table 2 - Summary of L_{Aeq} and L_{A90} noise monitoring results

Full single-figure results provided within the RPS report are reproduced in Appendix III.

Table 3 below gives the spectral values (octave band centre frequencies between 125Hz – 4kHz) for the lowest measured $L_{A90,5min}$ dB levels in each daytime and night time period and are reproduced from Table 4.3 of the RPS report.

Position	Period	Octave Band Centre Frequency							Broadband L_{A90} (dB)
		63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	
MP1	Day	64	55	51	50	51	47	38	55
	Night	53	48	43	42	38	33	23	43
MP2	Day	67	55	50	48	53	49	38	56
	Night	58	51	47	45	51	47	32	54
MP3	Day	62	54	52	50	48	45	37	53
	Night	55	50	48	44	40	36	28	46
MP4	Day	64	56	53	52	52	48	39	56
	Night	57	46	41	37	36	31	20	41
MP5	Day	66	58	54	51	52	48	39	56
	Night	56	48	42	38	36	32	24	41
MP6	Day	56	58	53	47	45	42	33	51
	Night	52	46	46	46	40	38	29	47

Table 3 - Summary of spectral data for lowest $L_{A90,5min}$ dB measurements

4.2.1 Discussion

The following table provides a summary of the subjective assessment of the prevailing noise climate as noted in the RPS report.

Position	Period	Comments
MP1	Day	Noise climate dominated by local road traffic
	Night	
MP2	Day	Noise climate dominated by local road traffic and existing building services noise
	Night	
MP3	Day	Noise climate dominated by local road traffic
	Night	
MP4	Day	
	Night	
MP5	Day	
	Night	
MP6	Day	
	Night	

Table 4 - Summary of noise contributions during surveys

5.0

Limiting plant noise levels

5.0 Limiting plant noise levels

To meet the requirements of the MCC Planning Policy, noise attributable to external services plant associated with the development should be designed to 5 dB below the existing ambient (L_{Aeq}) noise climate when measured at 1 m from the nearest sound sensitive receptors and should not contain tonal elements.

Table 5 details the highest permissible average noise levels from fixed services plant when measured at 1 m from the nearest sound sensitive properties. These are based on the measured prevailing background levels as detailed in Table 3.

Measurement Position	Period	Octave Band Centre Frequency							Broadband $L_{A90,5min}$ (dB)
		63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	
MP1	Day	59	50	46	45	46	42	33	50
	Night	48	43	38	37	33	28	18	38
MP2	Day	62	50	45	43	48	44	33	51
	Night	53	46	42	40	46	42	27	49
MP3	Day	57	49	47	45	43	40	32	48
	Night	50	45	43	39	35	31	23	41
MP4	Day	59	51	48	47	47	43	34	51
	Night	52	41	36	32	31	26	15	36
MP5	Day	61	53	49	46	47	43	34	51
	Night	51	43	37	33	31	27	19	36
MP6	Day	51	53	48	42	40	37	28	46
	Night	47	41	41	41	35	33	24	42

Table 5 - Limiting plant noise levels (5 dB below levels in Table 3)

It is considered that achieving compliance with the above limits should be sufficient to demonstrate compliance with Condition 3 of the approved Planning Permission Ref. 117770/FO/2017

6.0

Noise impact assessment

6.0 Noise impact assessment

In order to assess the specific sound level at the nearest residential receptors, a 3D sound model of the site has been created using SoundPLAN 7.4 software. This 3D sound model is capable of accurately determining sound propagation, by taking into account variations in topography, barrier attenuation provided by existing landscaping and buildings, and distance attenuation.

6.1 Proposed new plant item

The location of the plant noise source has been based on plans provided to Cundall by Engie. The noise data for the new chiller included within the SoundPLAN model has been reproduced in Table 6.

Plant Ref	Quantity	Item	Octave band centre frequency (Hz)							Sound Power Level L_w dBA
			63	125	250	500	1k	2k	4k	8k
ECGAM CGAM090 – Air-cooled chiller	1 no.	Chiller Unit	82	87	85	83	77	74	68	60	84

Table 6 - Manufacturer's sound power data

6.2 3D modelling results

The 3D façade noise map in Appendix IV of this report details the predicted level of noise impact at each location, relative to the lowest measured prevailing background levels. As the chiller unit is understood to potentially operate during the night-time period, background levels measured during the quietest night-time periods have been used as the basis for assessment.

Table 7 below details the calculated 'worst' case level of noise impact at each of the highlighted NSRs, with reference to the existing lowest measured levels as detailed in Table 2.

Location	Lowest Measured $L_{A90,5min}$ – dB(A)	Predicted Noise Impact L_{Aeq} - dB(A)	Difference predicted noise impact and lowest measured background - dB(A)
MP1 - Nick Everton House	43	< 28	More than 10 dB below
MP2 - The Grafton	54		
MP3 - Wilmslow Park	46		
MP4 - Victoria Terrace	41		
MP5 - Victoria Hall	41		
MP6 - Travelodge Manchester Upper Brook Street hotel	47		

Table 7 - Calculated noise impact at nearest residential receivers

6.2.1 Discussion

As can be seen from the 3D façade noise map in Appendix IV, and the results shown in Table 7 above, the level of noise impact due to new rooftop chiller plant associated with the Observation Wards is calculated to be more than 10 dBA below the existing lowest background noise level at all locations. This level of noise impact at each location would therefore be considered compliant with the MCC guidance.

In addition, as the level of predicted impact is anticipated to be at least ≈13 dBA below existing background levels, it can reasonably be surmised that noise emissions from new plant items should be inaudible at the nearest noise sensitive receivers. For this reason, no BS 4142:2014 feature corrections have been applied for acoustically distinguishing characteristics, and the MCC requirements regarding 'discernible tonal characteristics' should also be satisfied.

6.3 Noise impact considerations

In addition to the noise impact assessment detailed above, the following sub-sections detail other important factors that have been considered:

6.3.1 Cumulative levels from other new plant installations

Subsequent to the RPS background noise survey being undertaken in June / July 2014, other items of additional rooftop building services plant have also been installed at the MRI Surgical Ward and at the Clinical Science Building.

Whilst it is necessary to consider the cumulative impact from all items of building services plant, it can reasonably be determined that due to the very low level of impacts associated with proposed new chiller plant to the Observation Wards, the cumulative effects when operating simultaneously with other recently installed plant at MRI will be negligible.

7.0

Uncertainty

7.0 Uncertainty

BS 4142 requires that uncertainty is reported, and minimised wherever possible. The document acknowledges that all calculation-based modelling practices are ultimately an approximation. However, rather than ignore this fact or consider the results absolute, it is considered good practice to openly report factors which can affect the robustness of any assessment.

7.1 Source sound complexity & variability

In this assessment, the L_{Aeq} emission levels for proposed new building services during different times of the day may be variable and dependent on environmental factors such as temperate. It is considered that this variability has been robustly controlled by assuming the 'worst case' scenario that plant items will operate continuously 24 hours a day at typical maximum duty.

7.2 Background sound complexity & variability

The ambient sound climate at the assessment site is reasonably simple and the background sounds levels measured (which include busier and quieter periods) are considered to represent the typical range required.

There will inevitably be times when the background level at nearby sound-sensitive receivers is higher or lower than that used in assessment, however using the lowest measure L_{A90} level during each measurement period is considered to be representative of a 'worst case' assessment.

7.3 Distance & ground conditions

Ultimately, algorithms used to calculate distance attenuation are approximations. However, within all calculations, ground absorption and diffusion (which can be helpful in terms of attenuating sound with distance) have been set to appropriate levels.

In this way, a worst-case scenario can be modelled, increasing the robustness of the assessment.

8.0

Conclusions

8.0 Conclusions

An assessment of the potential noise impact due to proposed new external rooftop plant associated with the new Observation Wards at Manchester Royal Infirmary has been carried out.

This assessment involved the construction and interrogation of an acoustic model using SoundPLAN 7.4 software. Noise model inputs were based upon manufacturers' sound power level data for an indicative plant selection. All plant noise information has been supplied to Cundall by Engie.

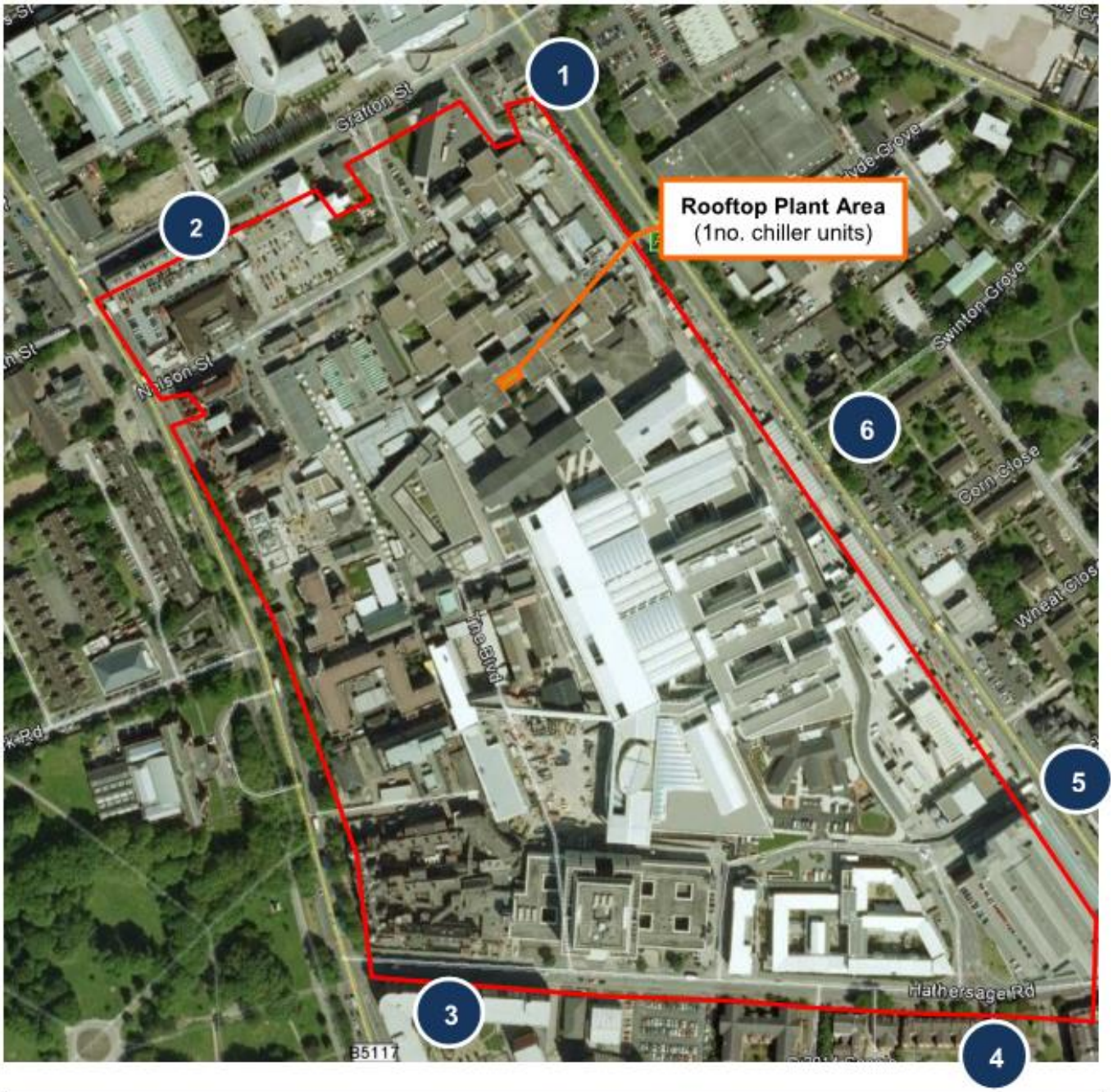
The results from the noise model were used in assessments carried out in accordance with Local Authority and National Planning Policy Guidance. Such assessments showed that the level of predicted noise impact at the 'worst case' affected receiver is likely to be at least 10 dB below the existing lowest background level as previously surveyed by RPS.

It is therefore considered that calculation results provide a positive indication that current proposals are compliant with the requirements of Manchester City Council local authority guidance, and that Condition 3 of Planning Permission Ref: 117770/FO/2017 can be discharged accordingly.

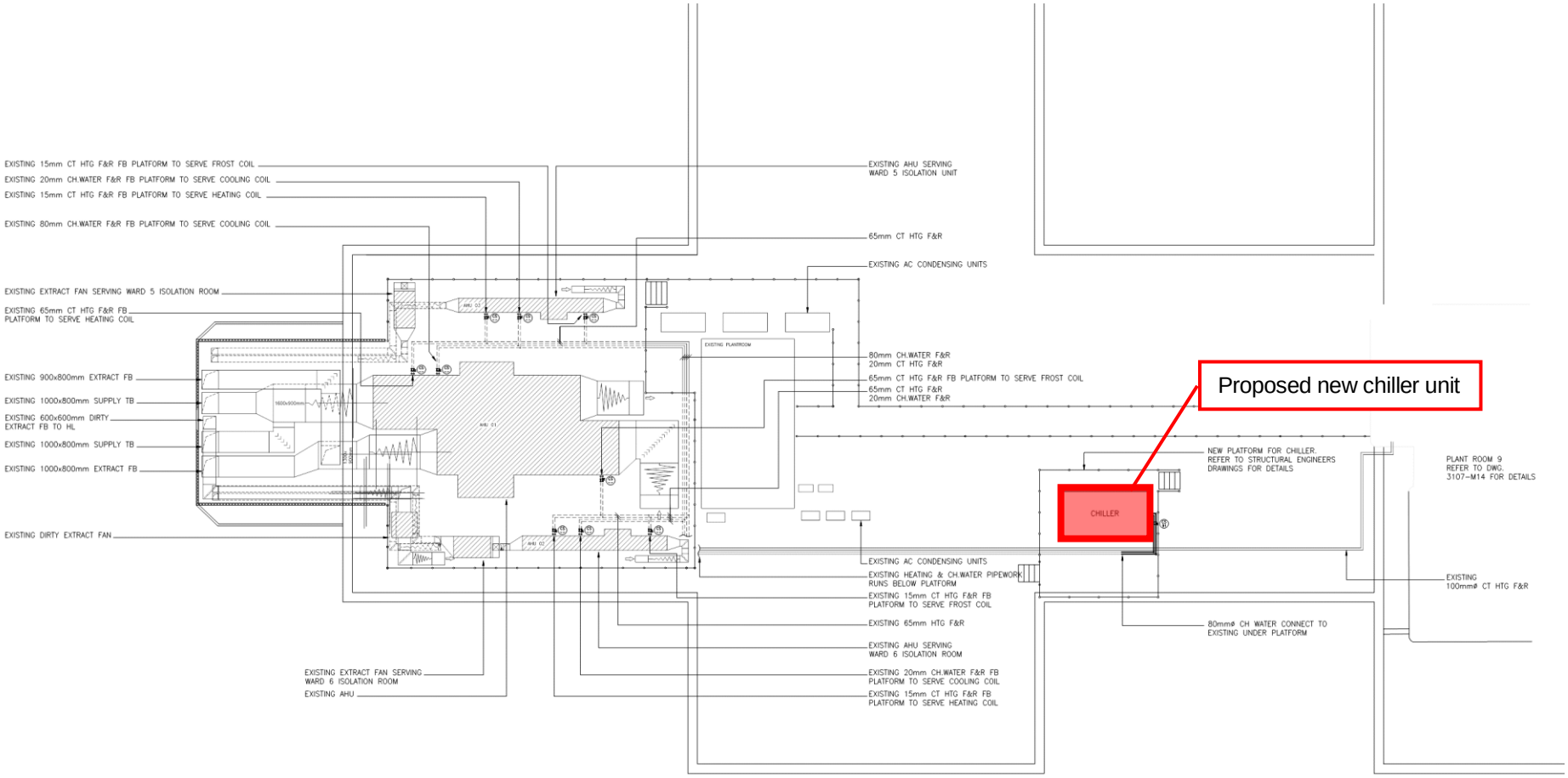
Appendices

Appendix I Aerial photograph and approximate measurement location

Note: Image reproduced from RPS report ref B7477-ENV-P2 dated 2nd April 2015



Appendix II Proposed rooftop plant layout



Appendix III RPS survey data

The tables below provide survey data from each measurement period, T (5 minutes). All survey results reproduced from RPS report ref B7477-ENV-P2 dated 2nd April 2015.

Measurement Position 1

Day: 17/06/2014			
Start Time	$L_{Aeq,5min}$	$L_{AF,max}$	$L_{A90,5min}$
09:40	62.3	70.5	57.6
09:45	62.5	69.1	57.5
09:50	64.1	75.8	57.3
09:55	62.5	69.3	57.8
10:00	62.2	70.4	56.8
10:05	65.3	77.4	59.4
10:10	64.9	79.6	58.3
10:15	67.1	84.8	56.6
10:20	61.9	68.1	55.7
10:25	71.9	89.7	55.9
10:30	62.1	69.3	55.5
10:35	61.4	69.2	55.6
10:40	62.4	69.4	56.4
10:45	62.9	73.8	57.1
10:50	61.6	68.4	55.8
10:55	63.3	78.3	56.8
11:00	60.9	70.7	55.2
11:05	62.1	69.0	56.8
11:10	62.8	69.5	55.7
11:15	62.4	68.4	57.9
11:20	62.4	70.9	56.5
11:25	62.9	72.0	56.5
11:30	62.2	69.6	54.9
11:35	62.4	71.9	56.4
11:40	61.8	70.2	55.7
11:45	61.6	72.3	55.0
11:50	62.0	71.1	56.6
11:55	61.1	67.0	55.7
12:00	61.5	68.3	55.6
12:05	62.1	70.2	55.7
12:10	62.4	70.6	55.5
12:15	61.6	69.5	54.5
12:20	61.8	68.7	55.4

Night: 08/07/2014			
Start Time	$L_{Aeq,5min}$	$L_{AF,max}$	$L_{A90,5min}$
00:05	54.1	64.1	48.1
00:10	54.4	63.7	46.2
00:15	54.4	62.7	47.9
00:20	56.7	63.7	49.0
00:25	54.6	63.7	46.8
00:30	52.1	64.3	46.4
00:35	52.5	61.2	46.2
00:40	54.1	61.8	48.0
00:45	53.4	63.2	45.6
00:50	54.9	70.3	46.9
00:55	57.7	75.5	47.0
01:00	52.6	65.4	45.9
01:05	63.4	83.1	46.3
01:10	52.3	60.3	45.2
01:15	51.8	62.2	44.5
01:20	53.5	63.7	45.7
01:25	52.9	62.2	45.5
01:30	53.1	63.2	44.9
01:35	50.2	61.2	44.5
01:40	52.0	63.0	45.9
01:45	50.3	63.7	44.7
01:50	52.2	60.3	45.3
01:55	49.9	58.6	43.8
02:00	52.7	63.1	45.3
02:05	51.0	61.6	44.5
02:10	53.3	65.8	44.4
02:15	50.7	62.1	43.6
02:20	51.2	60.5	44.3
02:25	52.5	62.5	43.5
02:30	49.9	63.4	43.2
02:35	51.0	61.9	43.7
02:40	51.0	61.4	44.5
02:45	49.0	61.3	43.2

Measurement Position 2

Day: 17/06/2014			
Start Time	$L_{Aeq,5min}$	$L_{AF,max}$	$L_{A90,5min}$
12:45	60.9	67.6	56.9
12:50	59.2	66.9	56.2
12:55	59.9	67.8	56.7
13:00	60.0	69.2	56.5
13:05	65.0	83.3	57.0
13:10	61.8	77.6	56.7
13:15	60.2	66.8	56.9
13:20	59.1	68.4	55.7
13:25	59.1	66.1	55.9
13:30	61.0	76.4	55.8
13:35	59.3	67.7	55.9
13:40	58.9	65.2	55.9
13:45	61.5	69.0	57.5
13:50	67.1	88.8	56.5
13:55	61.9	79.0	56.3
14:00	59.0	69.0	56.2
14:05	60.7	76.7	56.4
14:10	59.3	66.6	56.4
14:15	58.8	67.2	56.0
14:20	59.9	71.7	56.7
14:25	60.1	65.8	56.8
14:30	59.8	66.4	56.8
14:35	59.5	65.5	56.5
14:40	64.1	85.8	56.8
14:45	59.7	67.7	56.4
14:50	63.6	73.4	57.1
14:55	60.2	70.6	56.2
15:00	60.7	68.3	56.9
15:05	59.1	65.5	56.3
15:10	58.6	67.0	56.1
15:15	59.0	65.3	56.4
15:20	59.8	74.1	56.5
15:25	60.1	65.8	56.7
15:30	59.0	64.4	56.5
15:35	59.4	67.1	56.3

Night: 18/06/2014			
Start Time	$L_{Aeq,5min}$	$L_{AF,max}$	$L_{A90,5min}$
00:00	57.9	65.4	54.7
00:05	57.6	68.3	54.5
00:10	56.9	64.2	54.4
00:15	56.0	61.9	54.3
00:20	56.7	62.9	54.4
00:25	55.7	62.9	54.3
00:30	56.9	66.9	54.3
00:35	56.9	66.3	54.5
00:40	56.1	64.9	54.5
00:45	55.8	64.1	54.2
00:50	55.8	64.6	54.2
00:55	55.8	65.3	54.4
01:00	56.5	64.1	54.5
01:05	57.2	65.8	54.5
01:10	57.6	73.1	54.7
01:15	55.9	64.4	53.9
01:20	55.2	61.6	53.9
01:25	55.9	62.7	54.2
01:30	55.5	65.9	54.1
01:35	55.7	64.8	54.0
01:40	54.7	58.2	54.0
01:45	56.3	65.4	54.2
01:50	55.6	65.5	54.0
01:55	55.2	63.3	54.3
02:00	56.5	69.4	54.1
02:05	57.2	68.0	54.1
02:10	56.3	65.6	54.3
02:15	55.4	62.3	54.2
02:20	55.4	62.7	54.0
02:25	55.6	64.9	53.8
02:30	56.2	66.1	54.0
02:35	56.2	64.6	54.3
02:40	56.3	66.8	54.0
02:45	55.3	62.4	53.9
02:50	55.1	63.0	53.9
02:55	54.7	63.6	53.8

Measurement Position 3

Day: 18/06/2014			
Start Time	$L_{Aeq,5min}$	$L_{AF,max}$	$L_{A90,5min}$
13:00	63.4	72.7	57.4
13:05	60.7	71.2	52.8
13:10	59.5	64.2	54.8
13:15	60.0	66.3	54.9
13:20	59.6	70.2	54.3
13:25	64.5	79.3	54.5
13:30	59.7	69.3	55.0
13:35	59.2	64.3	55.3
13:40	62.9	77.1	57.7
13:45	68.4	84.0	57.5
13:50	61.9	70.3	56.8
13:55	63.3	74.4	57.5
14:00	59.3	66.2	55.5
14:05	64.9	85.7	54.2
14:10	59.7	68.6	54.7
14:15	59.4	66.8	55.6
14:20	61.8	76.9	55.8
14:25	59.3	67.0	55.4
14:30	59.0	63.3	54.5
14:35	60.5	77.7	56.1
14:40	61.7	73.5	56.9
14:45	59.7	68.5	54.0
14:50	59.2	66.3	53.5
14:55	60.6	72.4	53.6
15:00	66.5	86.2	55.0
15:05	70.9	90.7	56.0
15:10	64.7	78.5	58.7
15:15	62.1	76.5	58.1
15:20	60.3	71.2	55.8
15:25	61.1	73.2	56.4
15:30	61.9	75.6	56.6
15:35	60.3	68.6	55.8
15:40	61.4	73.9	56.1
15:45	59.6	66.8	55.1
15:50	62.5	73.5	56.5
15:55	63.6	72.4	57.5

Night: 04/07/2014			
Start Time	$L_{Aeq,5min}$	$L_{AF,max}$	$L_{A90,5min}$
00:00	57.4	65.6	49.4
00:05	56.2	66.9	48.6
00:10	56.9	69.1	48.4
00:15	55.9	63.6	49.2
00:20	55.5	65.3	48.2
00:25	55.1	66.2	47.6
00:30	53.8	61.0	47.7
00:35	57.0	71.8	47.6
00:40	55.1	63.6	48.4
00:45	57.1	75.8	47.6
00:50	64.2	83.0	47.8
00:55	53.9	64.9	47.6
01:00	52.3	66.8	47.0
01:05	54.8	63.3	47.6
01:10	55.0	65.8	47.7
01:15	54.3	61.4	47.8
01:20	53.1	61.8	47.1
01:25	53.5	64.7	46.9
01:30	52.5	63.0	46.9
01:35	54.4	65.2	46.9
01:40	54.6	64.2	46.7
01:45	54.1	65.7	46.3
01:50	53.8	67.0	46.4
01:55	50.6	58.8	45.9
02:00	52.4	61.5	46.9
02:05	54.3	63.4	46.6
02:10	53.9	64.5	46.4
02:15	52.0	61.2	46.1
02:20	51.7	63.9	46.1
02:25	52.4	61.7	46.3
02:30	52.6	69.0	45.8
02:35	52.0	64.0	45.8
02:40	52.7	64.4	46.0
02:45	52.2	62.2	46.4
02:50	54.0	66.1	46.1
02:55	58.3	75.9	46.9

Measurement Position 4

Day: 02/07/2014			
Start Time	$L_{Aeq,5min}$	$L_{AF,max}$	$L_{A90,5min}$
12:05	66.3	73.3	58.3
12:10	81.6	98.0	56.9
12:15	64.8	75.3	55.8
12:20	64.3	75.5	57.3
12:25	65.5	72.7	56.9
12:30	66.7	74.3	59.5
12:35	66.9	76.9	58.3
12:40	66.1	73.7	57.1
12:45	64.9	75.9	55.8
12:50	65.6	73.5	58.2
12:55	78.7	95.8	58.4
13:00	67.5	76.4	58.4
13:05	67.3	85.5	57.6
13:10	68.3	76.5	60.4
13:15	80.3	99.8	59.1
13:20	78.8	98.3	58.3
13:25	66.6	78.1	58.6
13:30	66.9	78.8	58.2
13:35	65.5	74.2	56.8
13:40	66.2	73.5	57.3
13:45	66.2	74.4	58.5
13:50	66.7	75.5	59.6
13:55	66.1	74.4	57.5
14:00	67.0	75.8	60.0
14:05	65.6	73.1	56.8
14:10	65.9	74.5	59.2
14:15	66.5	75.0	57.9
14:20	66.3	72.9	59.9
14:25	66.4	74.3	59.5
14:30	66.8	74.7	60.0
14:35	65.9	73.2	58.0
14:40	66.5	74.0	59.6
14:45	67.2	74.7	59.9
14:50	66.3	73.8	60.1
14:55	66.5	74.8	59.2

Night: 09/07/2014			
Start Time	$L_{Aeq,5min}$	$L_{AF,max}$	$L_{A90,5min}$
00:05	61.5	72.6	45.6
00:10	58.0	71.3	43.8
00:15	59.0	73.0	43.1
00:20	62.2	77.6	44.1
00:25	59.1	73.1	44.6
00:30	59.9	73.1	44.6
00:35	59.9	72.7	43.1
00:40	57.2	71.2	41.8
00:45	59.9	73.9	43.2
00:50	60.0	71.6	43.6
00:55	57.9	71.6	42.6
01:00	59.1	71.1	42.6
01:05	58.3	70.3	43.9
01:10	59.9	71.8	42.5
01:15	59.0	73.5	42.8
01:20	58.3	71.9	42.7
01:25	59.3	74.0	44.1
01:30	54.4	69.5	42.0
01:35	61.4	75.5	43.2
01:40	54.4	67.8	41.4
01:45	52.5	65.4	41.8
01:50	55.5	70.3	41.5
01:55	56.9	73.0	42.2
02:00	63.0	80.8	40.7
02:05	58.8	71.5	40.6
02:10	57.5	72.6	41.0
02:15	55.7	74.6	41.5
02:20	53.6	65.9	40.8
02:25	54.1	70.8	40.9
02:30	59.2	72.7	41.8
02:35	56.5	71.7	41.5
02:40	53.8	71.5	41.4
02:45	55.6	70.8	41.2
02:50	54.7	74.1	41.4
02:55	54.4	73.9	41.3

Measurement Position 5

Day: 07/07/2014			
Start Time	$L_{Aeq,5min}$	$L_{AF,max}$	$L_{A90,5min}$
12:40	66.0	74.4	56.9
12:45	66.2	83.3	58.7
12:50	63.5	69.7	58.6
12:55	63.3	70.1	57.4
13:00	73.3	90.7	56.1
13:05	64.5	71.3	58.6
13:10	66.0	75.2	61.3
13:15	65.7	77.4	60.0
13:20	64.6	74.4	59.4
13:25	64.9	79.1	59.6
13:30	64.1	69.5	59.6
13:35	63.7	71.1	59.5
13:40	63.4	71.8	58.8
13:45	62.6	68.1	58.2
13:50	66.1	82.1	58.9
13:55	64.0	72.1	59.4
14:00	65.9	75.2	60.6
14:05	64.4	74.5	59.7
14:10	62.1	67.4	58.4
14:15	62.5	69.0	58.3
14:20	62.2	70.7	58.2
14:25	62.5	68.8	58.4
14:30	76.6	95.7	58.8
14:35	63.1	73.9	57.5
14:40	63.0	69.0	59.5
14:45	62.8	75.3	58.5
14:50	63.2	75.3	58.5
14:55	63.2	72.4	59.0
15:00	73.0	93.1	58.3
15:05	64.7	73.7	58.9
15:10	64.2	71.6	59.4
15:15	64.1	73.3	57.8
15:20	65.3	74.3	57.9
15:25	64.1	69.4	58.8
15:30	63.6	71.8	57.7
15:35	73.0	88.9	57.6

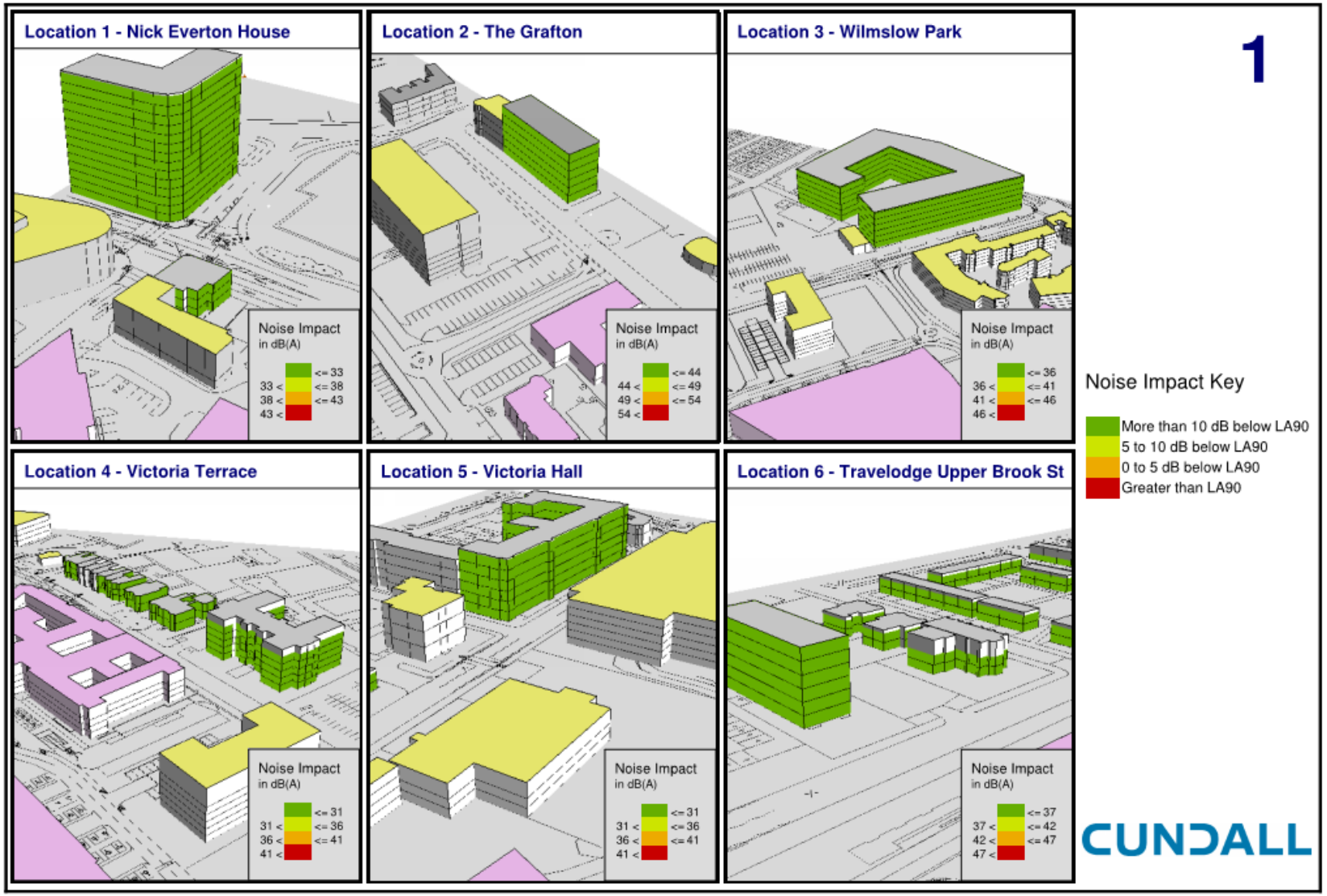
Night: 09/07/2014			
Start Time	$L_{Aeq,5min}$	$L_{AF,max}$	$L_{A90,5min}$
00:00	55.7	64.2	46.7
00:05	55.5	64.5	46.3
00:10	55.5	64.3	45.3
00:15	55.7	64.4	44.9
00:20	54.9	62.7	43.1
00:25	55.3	62.4	44.3
00:30	55.4	64.8	42.9
00:35	54.0	64.6	43.0
00:40	52.9	63.6	42.1
00:45	54.5	64.6	43.4
00:50	54.1	62.9	44.8
00:55	54.3	63.7	43.8
01:00	53.7	63.6	42.8
01:05	53.3	62.4	44.4
01:10	54.1	66.2	43.2
01:15	53.7	62.0	43.3
01:20	53.7	65.0	43.1
01:25	51.0	62.3	42.4
01:30	53.6	62.6	42.6
01:35	61.8	79.7	43.9
01:40	50.5	62.3	42.3
01:45	54.2	63.1	43.4
01:50	50.1	60.7	42.0
01:55	53.1	63.2	44.1
02:00	53.2	64.0	41.4
02:05	52.2	65.8	41.3
02:10	51.6	63.0	41.8
02:15	52.5	62.9	42.6
02:20	50.9	61.6	41.6
02:25	48.4	59.3	42.2
02:30	54.2	65.7	42.7
02:35	53.5	64.0	41.9
02:40	53.3	63.2	42.3
02:45	50.0	60.0	41.9
02:50	51.4	62.4	42.5
02:55	52.4	62.7	42.1

Measurement Position 6

Day: 17/06/2014			
Start Time	$L_{Aeq,5min}$	$L_{AF,max}$	$L_{A90,5min}$
12:30	56.0	64.6	51.1
12:35	56.2	64.2	51.2
12:40	56.9	65.5	51.1
12:45	55.7	60.7	51.3
12:50	62.9	78.8	50.8
12:55	56.3	62.5	50.9
13:00	59.4	76.2	51.0
13:05	62.1	81.5	51.6
13:10	65.9	77.2	52.4
13:15	58.8	72.3	52.8
13:20	69.9	78.9	54.3
13:25	57.3	64.8	53.4
13:30	57.4	63.5	53.7
13:35	58.2	63.0	54.5
13:40	57.1	62.9	53.5
13:45	58.0	70.3	53.5
13:50	56.9	63.5	53.2
13:55	55.9	63.7	52.9
14:00	56.4	64.7	52.8
14:05	56.3	62.9	52.7
14:10	57.2	63.9	52.8
14:15	56.2	61.2	52.6
14:20	57.2	64.3	53.5
14:25	56.3	62.0	53.0
14:30	58.0	70.9	53.0
14:35	55.9	61.1	52.9
14:40	57.0	64.7	53.0
14:45	56.4	62.6	53.0
14:50	55.9	61.8	52.7
14:55	56.7	63.0	53.5
15:00	59.9	76.3	53.4
15:05	56.9	65.9	53.2
15:10	56.9	62.8	53.7
15:15	57.5	64.1	53.3
15:20	59.4	66.8	53.4
15:25	58.1	66.5	53.8

Night: 08/07/2014			
Start Time	$L_{Aeq,5min}$	$L_{AF,max}$	$L_{A90,5min}$
00:00	62.1	77.3	49.4
00:05	64.1	80.2	48.1
00:10	65.1	82.4	48.1
00:15	65.5	84.5	48.1
00:20	63.6	75.4	48.8
00:25	62.8	73.5	48.4
00:30	63.1	76.4	48.1
00:35	61.9	77.6	47.5
00:40	63.5	74.0	48.9
00:45	61.5	73.7	47.5
00:50	64.4	76.4	49.1
00:55	62.6	76.8	47.8
01:00	61.2	75.3	47.6
01:05	61.0	74.4	47.3
01:10	60.3	75.4	47.4
01:15	62.1	75.0	48.1
01:20	62.1	76.8	49.0
01:25	61.7	73.2	47.9
01:30	61.9	75.4	47.4
01:35	60.8	73.8	47.3
01:40	61.6	76.3	47.5
01:45	58.3	73.4	47.4
01:50	62.8	75.3	46.9
01:55	55.9	73.7	47.1
02:00	62.4	80.9	47.7
02:05	60.6	73.5	46.9
02:10	58.1	73.4	47.0
02:15	56.2	73.5	46.9
02:20	61.2	79.7	47.0
02:25	61.2	76.3	46.9
02:30	59.4	76.8	46.5
02:35	57.8	75.1	46.9
02:40	60.4	74.2	47.8
02:45	57.2	71.3	46.7
02:50	60.7	74.0	46.9
02:55	58.6	73.8	47.2

Appendix IV SoundPLAN grid noise maps



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