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CANAL QUARTER REGENERATION PROJECT, STRATFORD-UPON-AVON

NOISE ASSESSMENT

On behalf of:

Stratford-on-Avon District Council

Report No P17-095-R01v3
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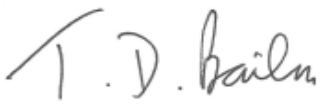
CANAL QUARTER REGENERATION PROJECT, STRATFORD-UPON-AVON

NOISE ASSESSMENT

Report prepared by:
Hepworth Acoustics Ltd
Hamilton House
Mabledon Place
London
WC1H 9BB

On behalf of:
Stratford-on-Avon District Council

Report prepared by: Thomas Bailess MEng MIOA – Principal Consultant	
Report checked by: Graham Bowland BSc MIOA – Technical Director	

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1.0 INTRODUCTION

1.1 Hepworth Acoustics Ltd was commissioned by Stratford on Avon District Council to carry out a noise assessment of the Canal Quarter. The proposed site is shown in Figure 1.

1.2 The assessment has been commissioned in connection with the proposal to regenerate the area, including introduction of a residential neighbourhood

1.3 The aims of this report are:

i) To assess the existing noise levels across the site.

ii) To determine whether those noise levels are conducive to residential development.

iii) To make recommendations to mitigate noise impact where deemed necessary.

1.4 Following our meeting with the council on 28th April 2017, we understand that preference will be given to mitigation techniques that do not require specialist acoustics products for the residences such as laminated glazing. Consideration must also be given to the noise levels in outdoor amenity areas used by residents.

1.5 The various noise units and indices referred to in this report are described in Appendix I. All noise levels mentioned in the text have been rounded to the nearest decibel, as fractions of decibels are imperceptible.

2.0 SITE DESCRIPTION AND PROPOSALS

Site Description

2.1 The site is bounded by Masons Road to the south, with Stratford Upon Avon fire station bordering the site on the southern tip. The boundary then follows Masons Road and crosses the canal at Timothy's Bridge Road, where it continues up to the office block at 20 Timothy's Bridge Road, before turning north to the railway line. The north and east of the site is bounded by the railway line, along with Morrison's supermarket in the south-east corner. The canal runs through the central part of the site. To the south of the site is a residential housing estate. To the west are further commercial and industrial premises. To the north are residences, and the Avenue Farm Industrial Estate with light industry and commercial units. A site plan is shown in Figure 1.

2.2 Currently the area is for industrial and commercial uses with a range of manufacturing, storage, and distribution companies.

2.3 We understand that the aspiration is that most, if not all, of the existing companies can be relocated in order to make way for residential development. This is with the exception of the Tappex and Pressavon site, which, it is to be assumed for these purposes, will remain.

Proposals

2.4 We understand that approximately 600 dwellings could be provided on the part of the Canal Quarter covered by this assessment. This will be complemented with appropriate retail, office, and commercial spaces. There was also be private outdoor amenity areas and public spaces for the benefit of the residents.

2.5 The buildings are expected to include a mix of townhouses and apartment blocks, typically between 2 and 4 storeys high.

2.6 We had a meeting with Tappex/Pressavon on 9th June 2017 for them to inform us of their current operations and their future proposals. Currently the Tappex/Pressavon manufacturing facility operates on weekdays from 07:00 to 21:30, with a warm-up period from 06:00. Pressavon (on the same site) operates on weekdays from 07:00 to 17:00, again with a warm-up period from 06:00. This is not anticipated to change in the foreseeable future. The warm-up period is when the machinery is switched on but before the manufacturing processes start. The Tappex facility conducts machining operations to create threaded inserts and similar components. The Pressavon facility conducts stamping and pressing operations.

3.0 ACOUSTIC DESIGN CRITERIA

National Planning Policy Framework

3.1 The *National Planning Policy Framework* (NPPF) 2012 states in Paragraph 17 that planning should always seek to secure high quality design and a good standard of amenity for all existing and future occupants of land and buildings. In addition, the NPPF provides some general guidance to local authorities on taking noise in to account in planning policies and decisions. This includes guidance (in Paragraph 123) that local authorities should 'aim to avoid noise from giving rise to significant adverse impacts on health and quality of life as a result of new development' and 'recognise that development will often create some noise and existing businesses wanting to develop in continuance of their business should not have unreasonable restrictions put on them because of changes in nearby land uses since they were established'.

3.2 The *Noise Policy Statement for England* (NPSE) 2010, which is referred to in the NPPF, includes three aims:

i. Avoid significant adverse impacts on health and quality of life from environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.

i. Mitigate and minimise adverse impacts on health and quality of life from environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.

ii. Where possible, contribute to the improvement of health and quality of life through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.

3.3 There is as yet no specific guidance on numerical acoustic assessment/design criteria for proposed new developments provided in the NPPF, accompanying Technical Guidance document, National Planning Practice Guidance 'Noise', nor the NPSE.

3.4 The Explanatory Note (EN) issued alongside the NPSE has introduced three observed effect level (OEL) definitions to the assessment of noise in England, in order to identify and rate noise impact on the community from any proposed development:

- NOEL – No Observed Effect Level. This is the level below which no effect can be detected and below which there is no detectable effect on health and quality of life due to noise.

- LOAEL – Lowest Observable Adverse Effect Level. This is the level above which adverse effects on health and quality of life can be detected.

- SOAEL – Significant Observed Adverse Effect Level. This is the level above which significant adverse effects on health and quality of life occur.

3.5 The EN does not define the OELs numerically, and for the SOAEL the NPSE makes it clear that the noise level is likely to vary depending upon the noise source, the receptor, and the time of day/day of the week, etc.

3.6 Therefore, it is necessary to refer to established national guidance such as the acoustic design goals for residential development that are set out in BS8233: 2014, *Guidance on sound insulation and noise reduction for buildings*, which carries the full weight of an adopted British Standard. The design criteria recommended in BS8233 for daytime periods (07:00 – 23:00 hours) and night-time periods (23:00 – 07:00 hours) are summarised in Table 1:

Table 1: BS8233 recommended acoustic design criteria

Activity	Location	07:00 – 23:00	23:00 – 07:00
Resting	Living room	35 dB $L_{Aeq,16hr}$	-
Dining	Dining room/area	40 dB $L_{Aeq,16hr}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16hr}$	30 dB $L_{Aeq,8hr}$

3.7 BS 8233 also states that, "where development is considered necessary or desirable … the internal target levels [i.e. those in Table 1] may be relaxed by up to 5dB and reasonable internal conditions still achieved".

3.8 These BS 8233 levels are based on annual average data and do not have to be achieved in all circumstances.

3.9 BS 8233 clarifies that the above guidance relates only to noise without specific character (e.g. such as that which has a distinguishable, discrete and continuous tone, is irregular enough to attract attention, or has strong low-frequency content) and that where such characteristics are present, lower noise limits might be appropriate.

3.10 BS 8233 states that if there is a reliance on closed windows to meet the guide values, "*there needs to be an appropriate alternative ventilation that does not compromise the façade insulation or the resulting noise level*". Further, it is stated that assessments should be based on a room with "*adequate ventilation provided (e.g. trickle ventilators should be open)*".

3.11 BS8233 also recognises that regular individual noise events at night can cause sleep disturbance. Peaks of noise from individual events are usually described in terms of L_{Amax} values and these can be highly variable and unpredictable such that for design purposes it is usual to take into account the findings of research described in WHO *Community Noise Guidelines* that states, 'for a good sleep, it is believed that indoor sound pressure levels should not exceed approximately 45 dB L_{Amax} more than 10-15 times per night'.

3.12 For outdoor amenity spaces such as private gardens and patios, BS8233 states that 'it is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$ with an upper guideline value of 55 dB $L_{Aeq,T}$ which would be acceptable in noisier environments'. However, the standard also recognises that these guideline values are not achievable in all circumstances where development might be desirable.

BS 4142: 2014

3.13 BS 4142: 2014 '*Methods for rating and assessing industrial and commercial sound'* provides methods for rating and assessing sound of an industrial and/or commercial nature.

3.14 BS 4142 requires the 'rating' noise level for the operation to be compared with the L_{A90} background noise level in the absence of the operational noise.

3.15 The 'rating' level is derived based on the 'specific' L_{Aeq} noise level attributable to the operation with an 'acoustic feature' penalty added for any noise sources which give rise to tonal, impulsive, intermittent, or other characteristics readily distinctive against the residual acoustic environment.

3.16 BS 4142 stipulates that noise impacts should be assessed over a reference time interval of 1-hour during the daytime (07:00-23:00 hours) and 15-minutes during the night-time (23:00-07:00 hours).

3.17 An initial estimate of the impact of the operation is determined by subtracting the background level from the rating level. BS 4142 states that:

- Typically, 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 level, the less likely it is that the operation will have an adverse impact or a significant adverse impact. Where the rating level

does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context.

3.18 Where the initial estimate of the impact needs to be modified due to the context, all pertinent factors should be taken into account, including:

- The absolute level of sound
- The character and level of the residual sound
- The sensitivity of the receptor and whether dwellings … will already incorporate design measures that secure good internal and/or outdoor acoustic conditions, such as: i) façade insulation treatment, ii) ventilation and/or cooling, and iii) acoustic screening.

3.19 When assessing whether a penalty for tonality is applicable, in this report we have used the objective one-third octave method for assessing the audibility of tones in sound described in Annex C of BS4142: 2014. This states that the level differences between adjacent one-third-octave bands that identify a tone are:

- 15 dB in the low-frequency one-third-octave bands (25 Hz to 125 Hz);
- 8 dB in the middle-frequency one-third-octave bands (160 Hz to 400 Hz); and,
- 5 dB in the high-frequency one-third-octave bands (500 Hz to 10 000 Hz).

3.20 For impulsivity, BS4142: 2014 states that a correction of up to +9 dB can be applied for sound that is highly impulsive, considering both the rapidity of the change in sound level and the overall change in sound level. Subjectively, this can be converted to a penalty of 3 dB for impulsivity which is just perceptible at the noise receptor, 6 dB where it is clearly perceptible, and 9 dB where it is highly perceptible.

3.21 For intermittency, BS4142: 2014 notes in Section 9.2 of the standard that if the intermittency is readily distinctive against the residual acoustic environment, a penalty of +3 dB can be applied.

4.0 NOISE SURVEY

Environmental Noise Survey

4.1 Environmental noise measurements were carried out at nine locations around the site. The dates and times of the measurements are shown in Appendix II. The measurement locations are indicated in Figure 1 and are described below:

- Location 1: North of Tappex/Pressavon, with a view to the doors to the machining area.
- Location 2: South east corner of the site, adjacent Morrison's supermarket.
- Location 3: Mason's Road, adjacent to RS Masons.
- Location 4: Between the railway line and the Western Road Industrial Estate.
- Location 5: Timothy's Bridge Road, adjacent to McVeigh Construction.
- Location 6: Timothy's Bridge Road, adjacent to Sitel UK Ltd.
- Location 7: Beside the canal, adjacent to Sitel UK Ltd.
- Location 8: North of the railway line on Orian Close.
- Location 9: On the flat roof to the rear of 18 Drayton Avenue, CV37 9PF.

4.2 Locations 1 to 8 were selected to measure the noise at critical positions around the site to cover the main noise sources. Location 9 was specifically requested by Stratford on Avon District Council to be representative of the prevailing ambient noise levels in the residential area adjacent to the Canal Quarter.

4.3 The noise measurements were taken in 'free-field' conditions. At Locations 1 to 8, the microphone was at approximately 1.5 metres above ground level. At Location 9 (rear of 18 Drayton Avenue), the microphone was on a 1.5 metre high tripod on top of a 4 metre high flat roof.

4.4 At Locations 1 – 3 and 9, continuous measurements were taken in sequential 5-minute samples throughout the survey, with attendance to cover critical periods of the day and night. At Locations 4 – 8, samples were 15-minutes duration in the day and 5-minutes duration at night, with attendance at all times.

4.5 The weather conditions throughout the noise survey were mostly dry with some brief showers on Thursday 18th May. Conditions were mostly overcast, with some sunny periods. Temperatures were between a minimum of 14^0C at night and up to 27^0C during the day. These were considered suitable conditions for the survey.

4.6 The overall noise levels for Locations 1 to 9 are summarised in Table 2 for daytime and Table 3 for night-time. The overall $L_{Aeq,16hr}$ and $L_{Aeq,8hr}$ noise levels at Locations 1 to 9, for individual daytime (07:00 to 23:00) and night-time (23:00 to 07:00) periods respectively as specified in BS 8233:2014, have been determined on the basis of the logarithmic average of all measured $L_{Aeq,T}$ noise levels over each of those periods. To provide a robust interpretation of WHO guidelines relating to L_{Amax}, the overall night-time L_{Amax} noise level at each location has been determined, for assessment purposes, as the measured $L_{Amax,f}$ noise level exceeded during no more than 10 measurement periods over the night-time survey periods where continuous monitoring was used (i.e. Locations 1 – 3 and 9). Where non-continuous monitoring was used (i.e. Locations 4 to 8), the highest of the measured L_{Amax} values has been used. Average $L_{A90,T}$ is expressed as the arithmetic average of the measured $L_{A90,T}$ over respective daytime and night-time periods, where T refers to the measurement duration of the samples.

Table 2: Overall daytime (07:00 to 23:00) noise levels at Locations 1 to 9 (dBA)

Measurement Location	dB $L_{Aeq,16hour}$		dB $L_{A90,T}$	
	Range	Log Average	Range	Mean
1. North of Tappex	34 – 62	58	32 – 61	48
2. SE corner, near Morrison's	33 – 69	48	30 – 63	43
3. Mason's Road	48 – 63	55	45 – 53	50
4. East of railway	50 – 51	51	36 – 47	45
5. Timothy's Bridge Road (E)	54 – 56	54	48 – 50	49
6. Timothy's Bridge Road (W)	54 – 57	56	49 – 54	51
7. Beside canal	50 – 51	51	46 – 50	47
8. North of railway	50 – 51	50	44 – 49	46
9. Drayton Avenue	46 – 52	50	40 – 52	48

Table 3: Overall night-time (23:00 to 07:00) noise levels at Locations 1 to 9 (dBA)

Measurement Location	dB $L_{Aeq,8hour}$		dB $L_{A90,T}$		dB $L_{Amax,f}$	
	Range	Log Average	Range	Mean	Range	Overall
1. North of Tappex	32 – 56	40	29 – 54	37	38 – 77	59
2. SE corner, near Morrison's	31 – 55	38	29 – 48	35	36 – 79	59
3. Mason's Road	32 – 61	43	30 – 41	39	40 – 72	67
4. East of railway	39 – 42	40	35 – 36	36	55 – 58	58
5. Timothy's Bridge Rd (E)	41 – 43	42	37 – 39	37	53 – 62	62
6. Timothy's Bridge Rd (W)	40 – 44	43	36 – 39	38	52 – 59	59
7. Beside canal	38 – 40	37	32 – 38	34	46 – 52	52
8. North of railway	39 – 40	40	32 – 37	34	50 – 56	56
9. Drayton Avenue	44 – 51	49	40 – 54	47	42 – 74	66

4.7 The mean daytime $L_{Aeq,1hour}$ and night-time $L_{Aeq,15mins}$ (BS4142 reference time intervals) for Locations 1 to 3, as requested by the Client, are presented in Table 4:

Table 4: Mean daytime $L_{Aeq,1hr}$ and night-time $L_{Aeq,15mins}$ at Locations 1 to 9 (dBA)

Measurement Location	Daytime (07:00 to 23:00) dB $L_{Aeq,1hour}$	Night-time (23:00 to 07:00) dB $L_{Aeq,15mins}$
1. North of Tappex	59	40
2. SE corner, near Morrison's	48	38
3. Mason's Road	55	44

4.8 The full results of the noise survey are shown in Appendix II.

Noise Sources

4.9 At Location 1, the dominant noise source during the daytime on weekdays was Tappex's machining operations. There was a direct line of sight into the main machine room. The noise was intermittent and impulsive, but not tonal, using the assessment criteria noted in Paragraphs 3.19 to 3.21. There was also some noise from vehicle movements to and around Lister's car park as a minor source, as well as occasional HGVs carrying out deliveries to Tappex/Pressavon. During the night, there was no noise from Tappex until 06:00 when machine warm-up started. The warm-up period involves the machinery being switched on sequentially before the manufacturing processes start. The leads to a steady increase in the noise generated, but at a lower level and with a more continuous quality compared to

the rhythmical impulses that occur once the manufacturing processes are underway. At night, the main noise source was from distant road traffic. Noise from the railway was slightly audible as a minor source. There was no noise from Tappex at weekends. The L_{AMax} levels were primarily caused by the manufacturing activities, with some contribution from vehicle movement and loading.

4.10 At Location 2, the noise in the daytime on weekdays was from Tappex/Pressavon and from the activities at Precision Business Centre to the south. The noise was intermittent and impulsive, but not tonal, using the assessment criteria noted in Paragraphs 3.19 to 3.21. Noise from Precision Business Centre stopped at 19:00 and started from around 06:00 on weekdays. There was no industrial noise at weekends. Noise from distant road traffic was audible during the day, and became the dominant noise source at night and at weekends. Noise from the railway was slightly audible as a minor source. Noise from the rooftop plant at Morrison's supermarket was not audible during the daytime, and was slightly audible at night during lulls in traffic noise. The L_{AMax} levels were primarily caused by the manufacturing activities, with some contribution from vehicle movement and loading.

4.11 At Location 3, the dominant noise source was road traffic on Mason's Road. There was no noticeable industrial noise. The L_{AMax} levels were primarily caused by louder vehicles, such as motorbikes and HGVs.

4.12 At Location 4, the noise was a mix of road traffic noise with occasional passing trains. There was no noticeable industrial noise.

4.13 At Location 5, the dominant noise source was road traffic on Timothy's Bridge Road. Passing trains were audible as a minor source. There was no noticeable industrial noise.

4.14 Location 6 had a similar noise environment to Location 5.

4.15 At Location 7, the noise was primarily distant road traffic. There was some noise audible as a minor source during the daytime on weekdays from vehicle movements at the commercial sites on the opposite side of the canal. The noise had no features readily distinctive against the residual acoustic environment.

4.16 At Location 8, the noise was a mix of road traffic noise with occasional passing trains. There was no noticeable industrial noise.

4.17 At Location 9 (i.e. inside the existing residential estate south of the Canal Quarter), the main noise source when we were in attendance was distant road traffic. There was occasional dog barking and some distant construction noise observed as minor sources. The background L_{A90} noise levels at night

were unexpectedly high at this location during the night time periods when we were not in attendance, from 21st to 25th May. This could warrant some further investigation. The characteristics of the noise suggest some type of continuous mechanical noise, such as a generator or fan. Note that this noise was not picked up at Locations 1 to 3, the nearest locations to Location 9 within the proposed development area, so this noise would not constrain the proposed residential development.

Sound Level Meter Details

4.18 The equipment used for the noise surveys was as follows:

- Location 1 – Norsonic 140 Type 1 sound level meter (serial no. 1402924)
- Location 2 – Brüel & Kjær 2250 Type 1 sound level meter (serial no. 2488353)
- Location 3 – Rion NL-31 Type 1 sound level meter (serial no. 01120844)
- Locations 4 to 8 – Brüel & Kjær 2260 Type 1 sound level meter (serial no. 2413555)
- Location 9 – Norsonic 116 Type 1 sound level meter (serial no. 22697).

4.19 The calibration level of the meters was checked before and after the surveys with a Brüel & Kjær Type 4203 sound calibrator (serial no. 2412667). No significant calibration deviation occurred.

5.0 NOISE MAPPING

5.1 A noise map showing the predicted noise contours across the site has been produced using CadnaA noise modelling software. This uses the guidance in ISO9613 as well as other relevant standards documents. The results are shown in Figures 2 to 5. These show the predicted noise levels across the site at 1.5 metres height with the existing industrial buildings removed, with the exception of the Tappex/Pressavon buildings.

5.2 Figures 2 and 3 show the daytime $L_{Aeq,16hr}$ and night-time $L_{Aeq,8hr}$ noise levels respectively. This has been calibrated based on the measurements made on site of the key noise sources, and then extrapolated across the site with the existing industrial buildings removed (except Tappex/Pressavon) to show the worst-case scenario without the shielding effect of buildings.

5.3 Figures 4 and 5 show the same scenario, but with an additional +6 dB penalty factor added to the noise emissions from the Tappex/Pressavon site. This is to take into account the character of the noise associated with the noise from these manufacturing activities. Based on our observations on site while attending the noise measurements, an impulsive '*acoustic feature*' penalty of +3 dB is considered applicable based on BS4142's guidance as the impulsivity is "just perceptible at the noise receptor" to use the terminology stated in Section 9.2 of BS4142: 2014. A further penalty of +3 dB has been applied to reflect the intermittent character of activities at the site, as the intermittency is "readily distinctive against the residual acoustic environment", again to use the terminology stated in Section 9.2 of BS4142: 2014. The noise was not tonal when assessed using the objective one-third octave method for assessing the audibility of tones in sound described in Annex C of BS4142: 2014, so no penalty factor for tonality is considered necessary. This makes a +6 dB penalty in total for these noise sources.

6.0 ASSESSMENT

6.1 Taking the $L_{A90,T}$ results from Location 1 for the hour before and after Tappex/Pressavon's operating hours (06:00 to 21:30) provides the background noise level at this location in the absence of the industrial noise. This shows a background level of 42 dB L_{A90} during the day and 39 dB L_{A90} at night. The worst-case specific sound level attributable to Tappex/Pressavon's operations at this position is 61 dB $L_{Aeq,1hr}$ during the daytime, and 54 dB $L_{Aeq,15mins}$ during the night-time (i.e. from 06:00 to 07:00 as the plant does not operate at other times during the night). Applying the relevant 'acoustic feature' penalty of +6 dB for intermittent and impulsive noise (as discussed in Paragraph 5.3 of this report) for the daytime results in a rating level of 67 dB $L_{Ar,1hr}$ in the worst-case. These characteristics are not readily apparent for the night-time noise but applying the same +6 dB penalty at night to take a cautious approach results in a rating level of 61 dB $L_{Ar,15mins}$. Comparison of these rating levels and the background noise level measured yields a difference of +25 dB during the day, and +15 dB at night.

6.2 An initial estimate in line with BS 4142 therefore indicates that noise from Tappex/Presavon, based on the current situation with no noise mitigation measures in place, is likely to be of a significant adverse impact for any proposed residences in the immediate vicinity, depending on the context, therefore noise mitigation measures will be required for this part of the Canal Quarter.

6.3 Where the initial estimate of the impact needs to be modified due to the context, BS 4142 states that all pertinent factors should be taken into account. This includes the absolute level of the sound, and also whether dwellings will incorporate design measures that secure good internal and/or outdoor acoustic conditions, such as façade insulation treatment, ventilation and/or cooling, and acoustic screening.

6.4 In this situation, it is therefore of particular relevance that there is sufficient level of scope to incorporate design measures to secure good internal and outdoor acoustic conditions for future residential areas.

6.5 It is noted that the relevant BS 8233 criteria described in Section 3, including the internal design criteria set out in Table 1 (of this report), relates only to noise without specific character, and that where these characteristics are present, lower noise limits might be appropriate.

6.6 Given the characteristics of the Tappex/Pressavon site noise, it is therefore appropriate to adopt lower noise limits, and it is recommended that noise attributable to the Tappex/Pressavon site should be at least 6 dB below the standard BS 8233 criteria.

6.7 When considering noise mitigation, it has been requested by Stratford on Avon District Council to use a sound reduction of 13 dB(A) for open windows. This means that to achieve the BS8233 limits shown in Table 1 using open windows for ventilation, the noise outside bedrooms should not be above 48 $L_{Aeq,16hr}$ during the daytime or 43 $L_{Aeq,8hr}$ (and 56 dB $L_{Amax,f}$) during the night. If trickle ventilators are used, standard (non-acoustic) ventilators in combination with thermal double glazing can typically achieve a reduction of at least 25 dB(A). This will allow noise levels outside bedrooms of up to 60 dB $L_{Aeq,16hr}$ during the day and 55 dB $L_{Aeq,8hour}$ and 70 dB $L_{Amax,f}$ during the night. These limits apply after corrections for the character of the noise are applied.

6.8 For outdoor amenity areas, we understand that Stratford on Avon District Council prefers to apply an upper limit of 50 dB $L_{Aeq,T}$ during the day.

6.9 As can be seen from the predicted noise levels in Figures 4 and 5, the majority of that part of the Canal Quarter area covered by this study (as described in paragraph 2.4) will be able to accommodate residences compliant with the BS8233 internal noise limits using standard thermal double glazing and non-acoustic trickle vents, with no additional noise mitigation measures needed.

6.10 The exception to this is the area in the vicinity of Tappex/Pressavon, where in the daytime 60 dB is predicted to be exceeded up to 30 metres north, 60 metres west, and 75 metres east of the Tappex/Pressavon site boundary, excluding the effect of any new buildings. This is including the +6 dB penalty factor referred to above.

6.11 This means that noise mitigation measures will be required for residences within this zone. Our proposed solutions are summarised as follows, which are expanded on in the following paragraphs:

a) Solid noise barriers

b) Earth bunds.

c) Closing Tappex/Pressavon loading doors.

d) Design and layout of the proposed residences to create a noise barrier.

e) Acoustic glazing and ventilation systems to the proposed residences (not preferred).

<u>a) Noise Barriers</u>

Noise barriers installed along the Tappex/Pressavon site boundary would reduce noise breakout to the adjacent areas. This barrier must be imperforate (i.e. solid, with no gaps, and sealed at base) and have a surface density of at least 12 kg/m^2. To be effective, the barrier would need to block direct lines of sight between Tappex/Pressavon and any noise-sensitive windows or outdoor amenity areas. The

height of the barrier would therefore depend on where proposed windows will be, but it's likely to be at least 4 metres high.

b) Earth Bund

An earth mound or bund could be constructed between the Tappex/Pressavon site and any proposed residences or outdoor amenity areas. This would fulfil the same function as a noise barrier and may incorporate landscaping features to soften the visual impact. It would be wider than a barrier so it would require additional area. Again, the mound would need be sufficiently high to block direct line of sight between Tappex/Pressavon and any noise-sensitive windows or outdoor amenity areas. The mound could have a noise barrier on top to increase the height, if building a high enough mound was not practical.

c) Closing Tappex/Pressavon Doors

Currently Tappex/Pressavon leaves the main entry doors to the machining and pressing operation rooms open for ventilation. This is to prevent over-heating on warm days, however it also allows a significant amount of noise egress. The doors were open for the duration of the measurements during our survey. If the doors can be closed, this is predicted to reduce noise levels at the perimeter by 10 – 15 dB(A) (taking into account other noise sources such as road traffic). This would though require mechanical ventilation or other climate control system to be installed in the factory. This would involve a capital cost for installation, plus ongoing costs for power consumption and maintenance, for which Tappex/Pressavon may expect compensation.

d) Design of Residences

The proposed residences within the high-noise zones could be designed to function as noise barriers by locating noise-sensitive windows and outdoor amenity areas on sides of the buildings facing away Tappex/Pressavon. This takes advantage of the shielding effect that would be provided by the new buildings. The disadvantage is that this puts constraints on the design of the new residences in the immediate vicinity of Tappex/Pressavon, putting restrictions on the location of noise-sensitive windows and outdoor amenity areas.

e) Acoustic Glazing and Ventilation Systems

If necessary, an option will be to consider using enhanced acoustic glazing and ventilation systems. We understand this is not the preferred solution by the council so this would only be considered if the other solutions proposed are not viable. This would involve installing laminated or secondary glazing

to noise-sensitive windows overlooking Tappex/Pressavon, and including attenuated ventilation systems to the affected rooms. The exact specification of the glazing and ventilation systems would depend on the distance and orientation relative to Tappex/Pressavon. Outdoor amenity areas would still need to be positioned on the sides of the building facing away from Tappex/Pressavon, or have their own screening in the form of walls or barriers.

6.12 For outdoor amenity areas, the results show that the areas directly adjacent to Mason's Road, Timothy's Bridge Road, and the Tappex/Pressavon site exceed 50 dB $L_{Aeq,T}$ during the day. This means that residences directly adjacent to these locations should either have the amenity areas moved to the rear of the building to benefit from the shielding effect of the building itself, or should have a barrier such as a solid wall or fence to provide shielding from the noise source. This should be imperforate (i.e. solid, with no gaps, and sealed at base), and have a surface density of at least 12 kg/m^2. For gardens and terraces at ground level next to these areas, this barrier should be at least 2 metres high. For balconies, a wall of height 1.2 metres is usually enough to provide sufficient shielding from the adjacent road taking into account the elevation above ground level but this would need to be reviewed for each case. Balconies overlooking the Tappex/Pressavon site are not recommended.

7.0 SUMMARY AND CONCLUSION

7.1 The impact of noise has been assessed for the Canal Quarter Regeneration Project.

7.2 Noise surveys have been undertaken at the site and daytime and night-time noise levels across the site have been determined. Noise modelling software has been used to predict the noise contours across the site with the existing buildings removed, and taking into account industrial noise penalty factors.

7.3 The impact of industrial noise based on guidance in BS4142: 2014 has been determined.

7.4 Appropriate external intrusive noise mitigation measures have been recommended, which will allow internal and external noise levels to meet the recommended acoustic criteria based on the guidelines set out in BS 8233: 2014.

7.5 By following the recommendations in this report, we conclude that the development can comply with the requirements of current British Standards and planning guidelines with regards to noise impact.

Figure 1 – Site Map

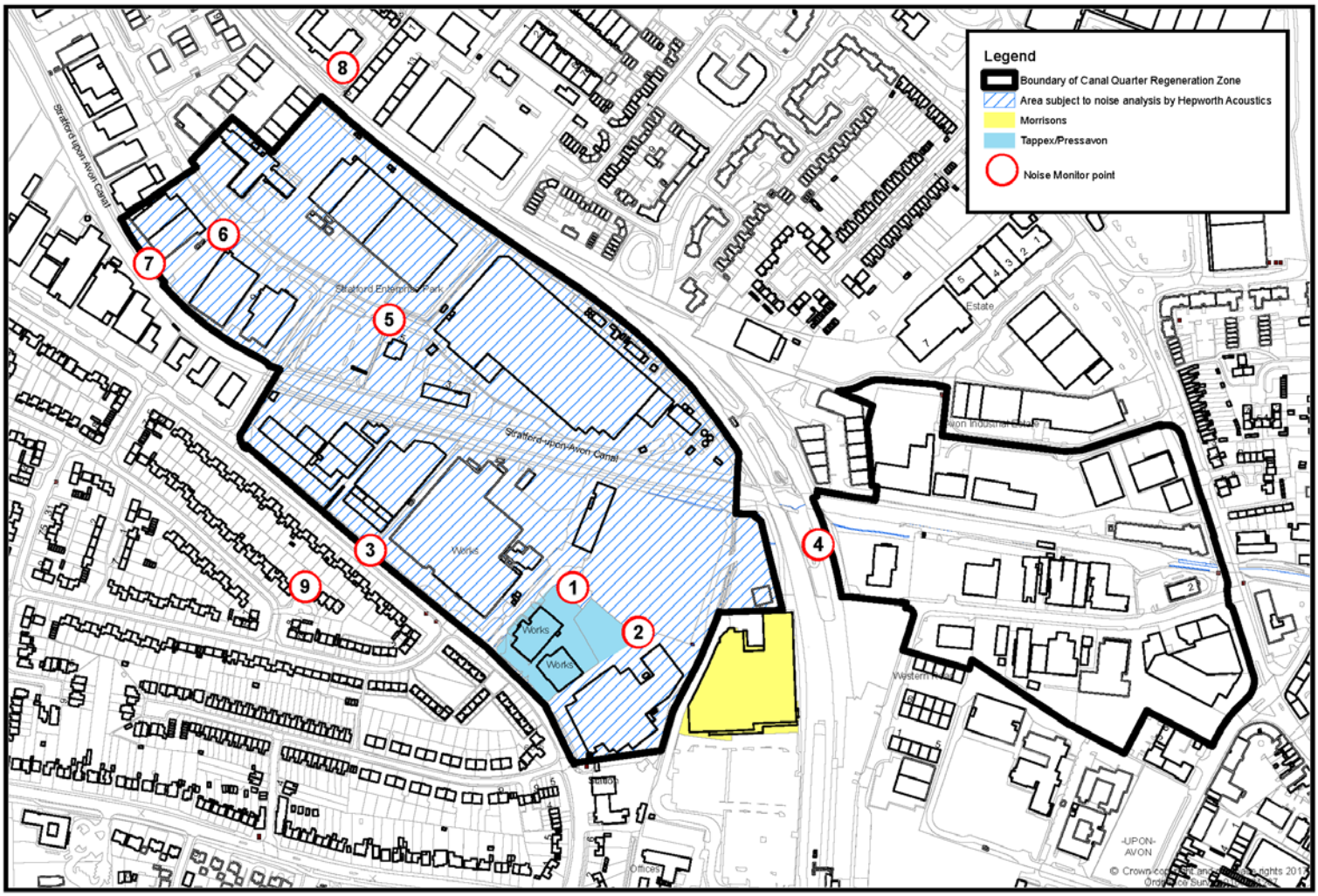


Figure 2 – Predicted $L_{Aeq,16hr}$ Noise Contours, Daytime, No Penalty Factors

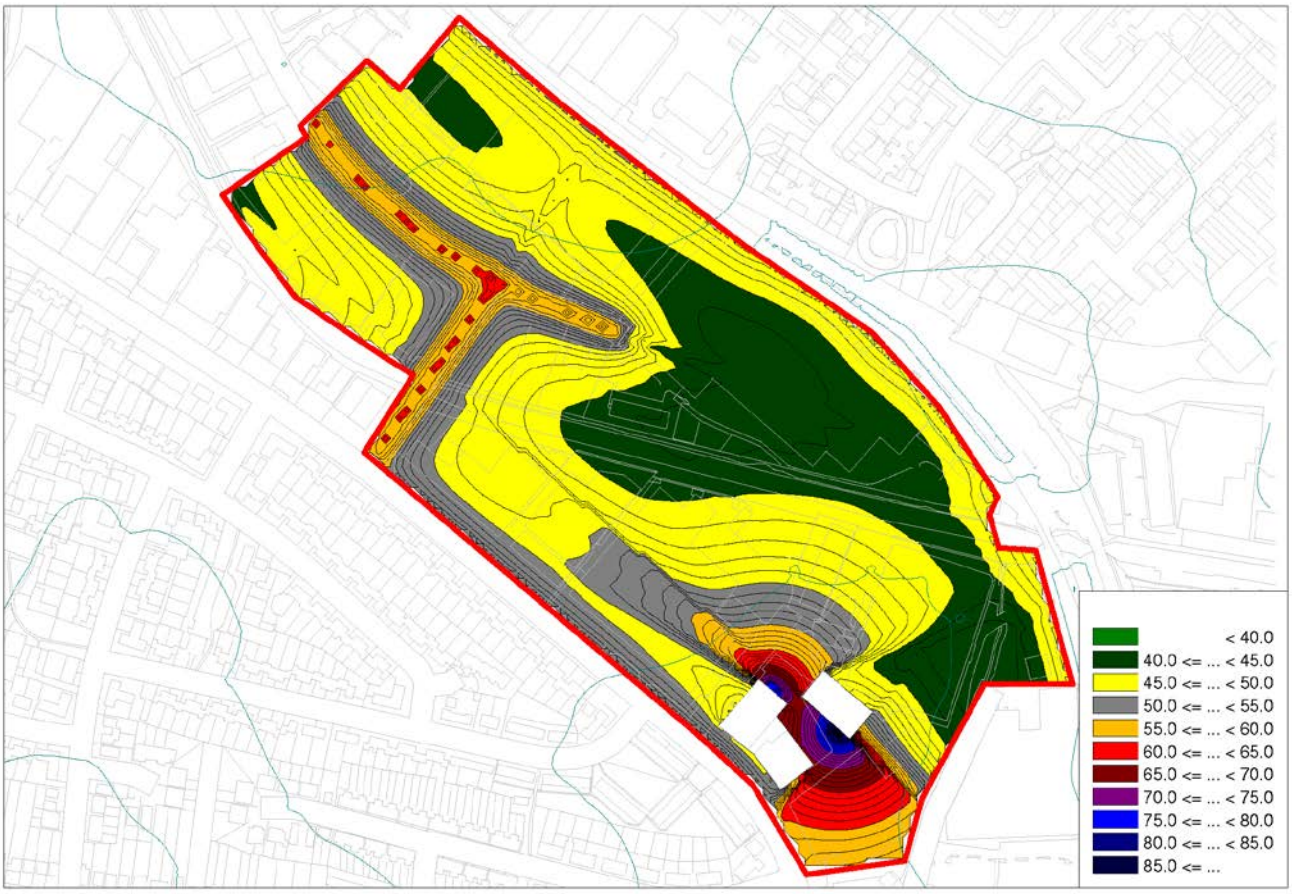


Figure 3 – Predicted $L_{Aeq,8hr}$ Noise Contours, Night, No Penalty Factors

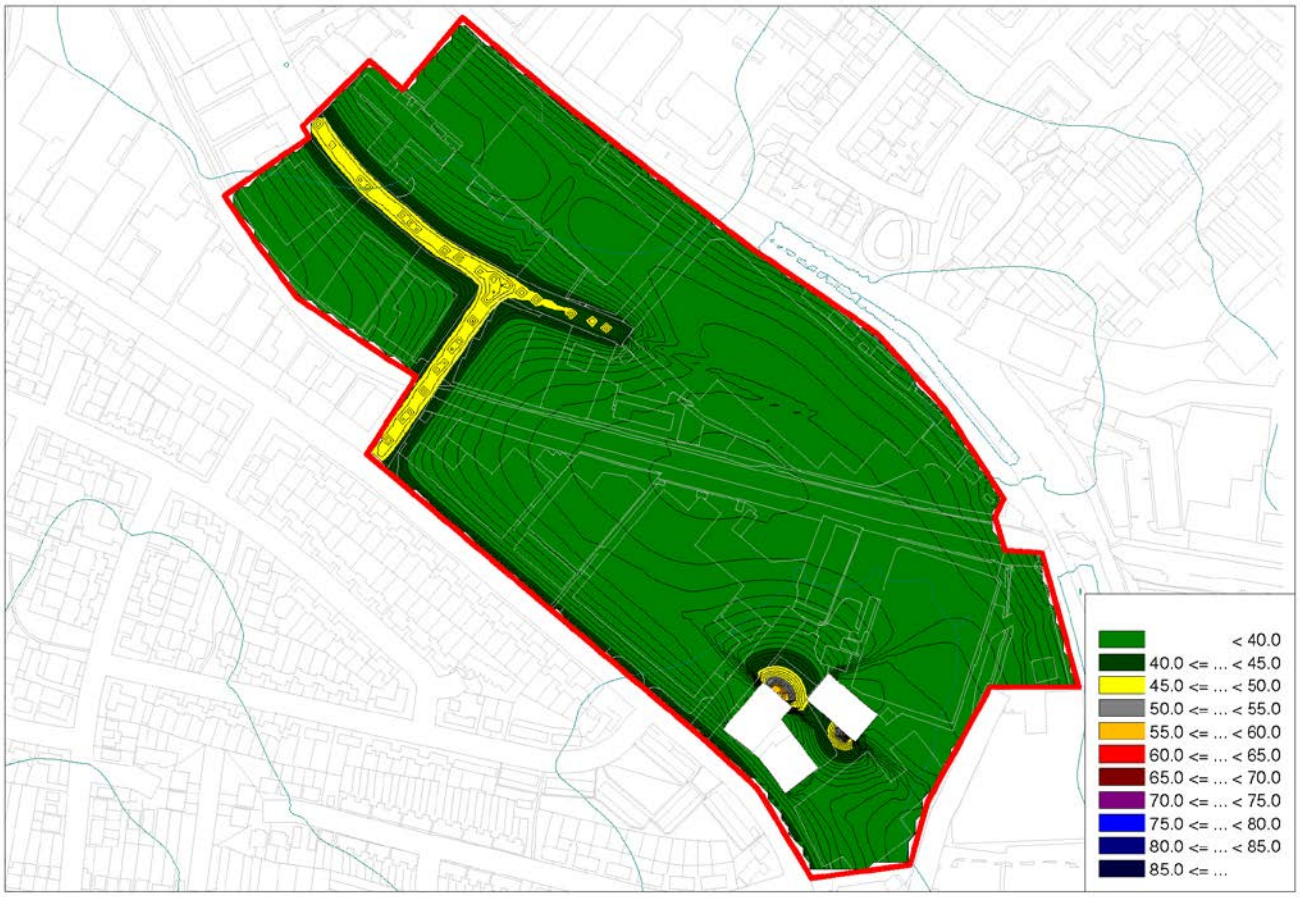


Figure 4 – Predicted $L_{Aeq,16hr}$ Noise Contours, Day, With Penalty Factors

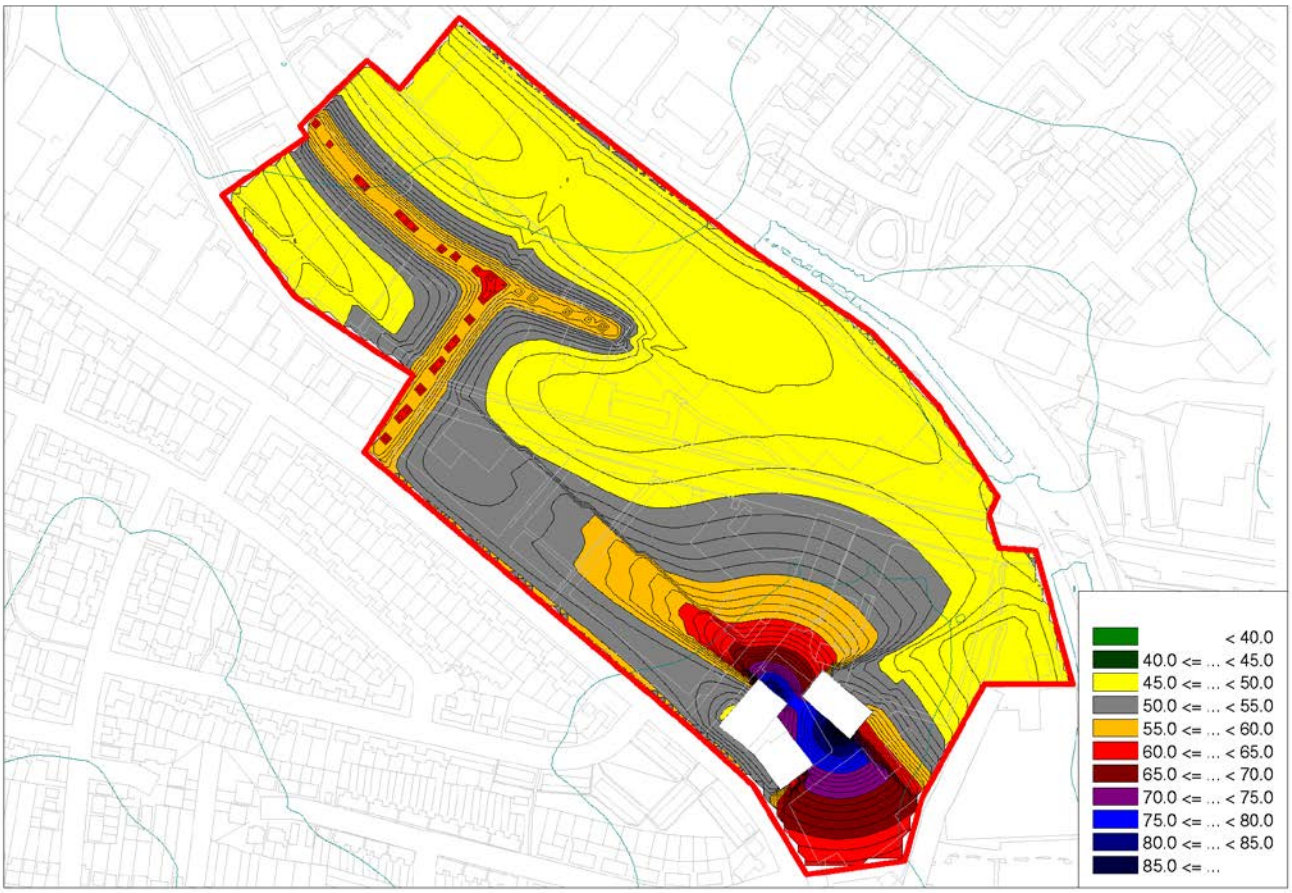
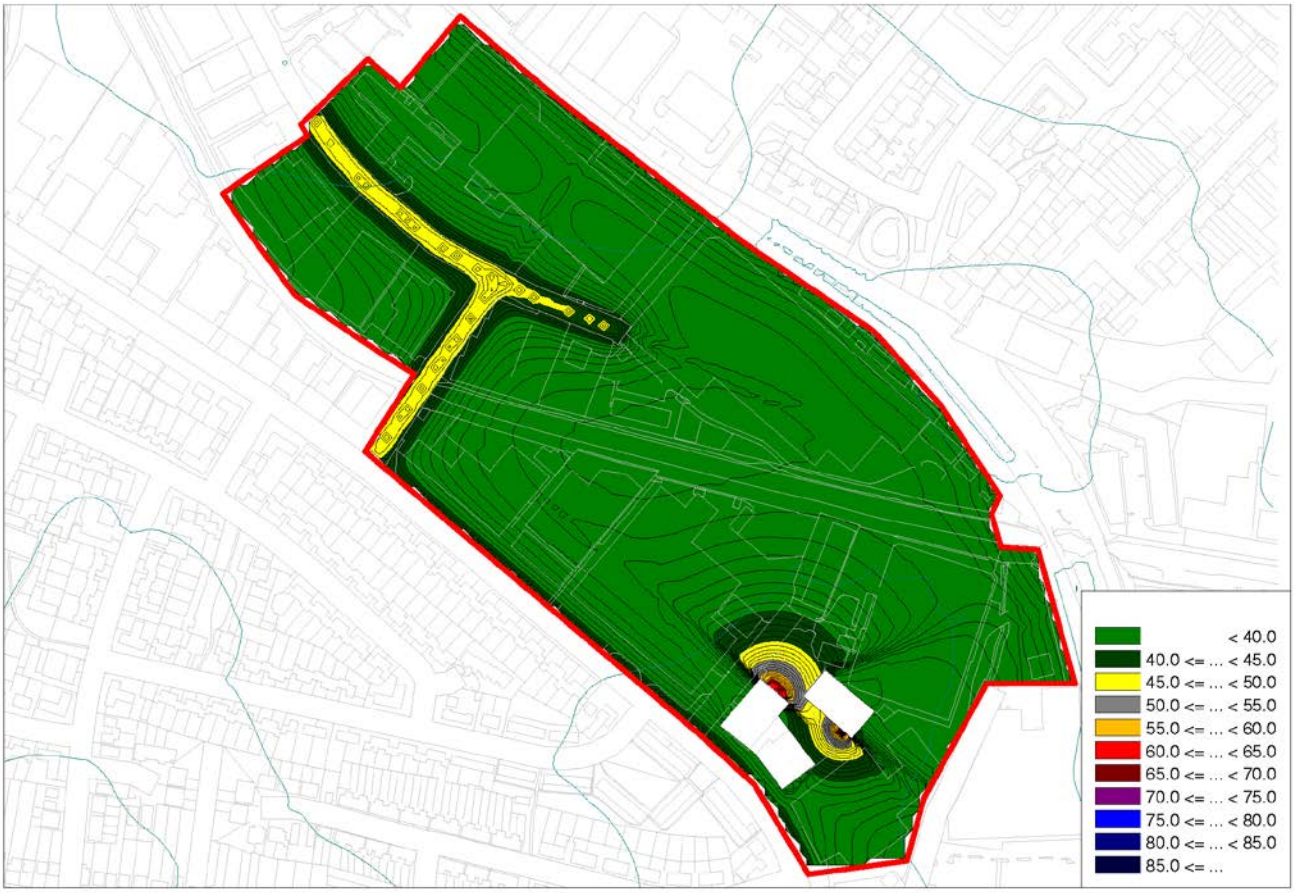


Figure 5 – Predicted $L_{Aeq,8hr}$ Noise Contours, Night, With Penalty Factors



Appendix I: Noise Units & Indices

Sound and the decibel

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

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

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

Frequency and Hertz (Hz)

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

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

Glossary of Terms

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

$L_{Aeq,T}$ This is the A–weighted 'equivalent continuous noise level' which is an average of the total sound energy measured over a specified time period, T. In other words, L_{Aeq} is the level of a continuous noise which has the same total (A–weighted) energy as the real fluctuating noise, measured over the same time period. It is increasingly being used as the preferred parameter for all forms of environmental noise.

$L_{Amax,f}$ This is the maximum A–weighted noise level that was recorded during a measurement sample period, with the sound level meter on the ‘fast’ setting.

$L_{A90,T}$ This is the A–weighted noise level exceeded for 90% of the time period, T. L_{A90} is used as a measure of background noise.

Appendix II: Noise Survey Results

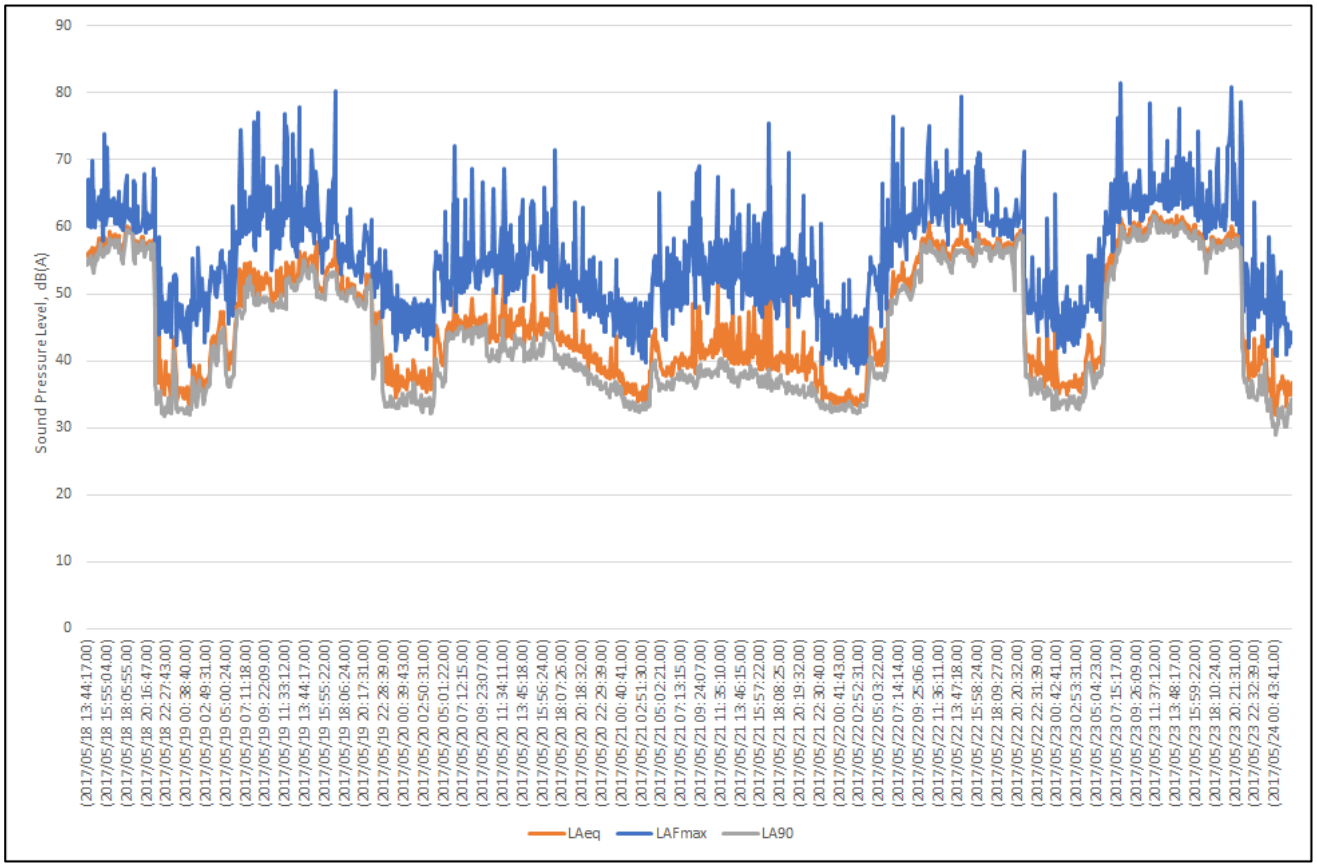
Location 1: North of Tappex/Pressavon

Date(s): Between 13:39 on Thursday 18th May and 02:39 on Wednesday 24th May 2017

Equipment: Norsonic 140 Type 1 sound level meter (serial no. 1402924) with tripod and windshield.

Weather: Mostly dry, wind speed below 5 m/s

All levels in dB(A)



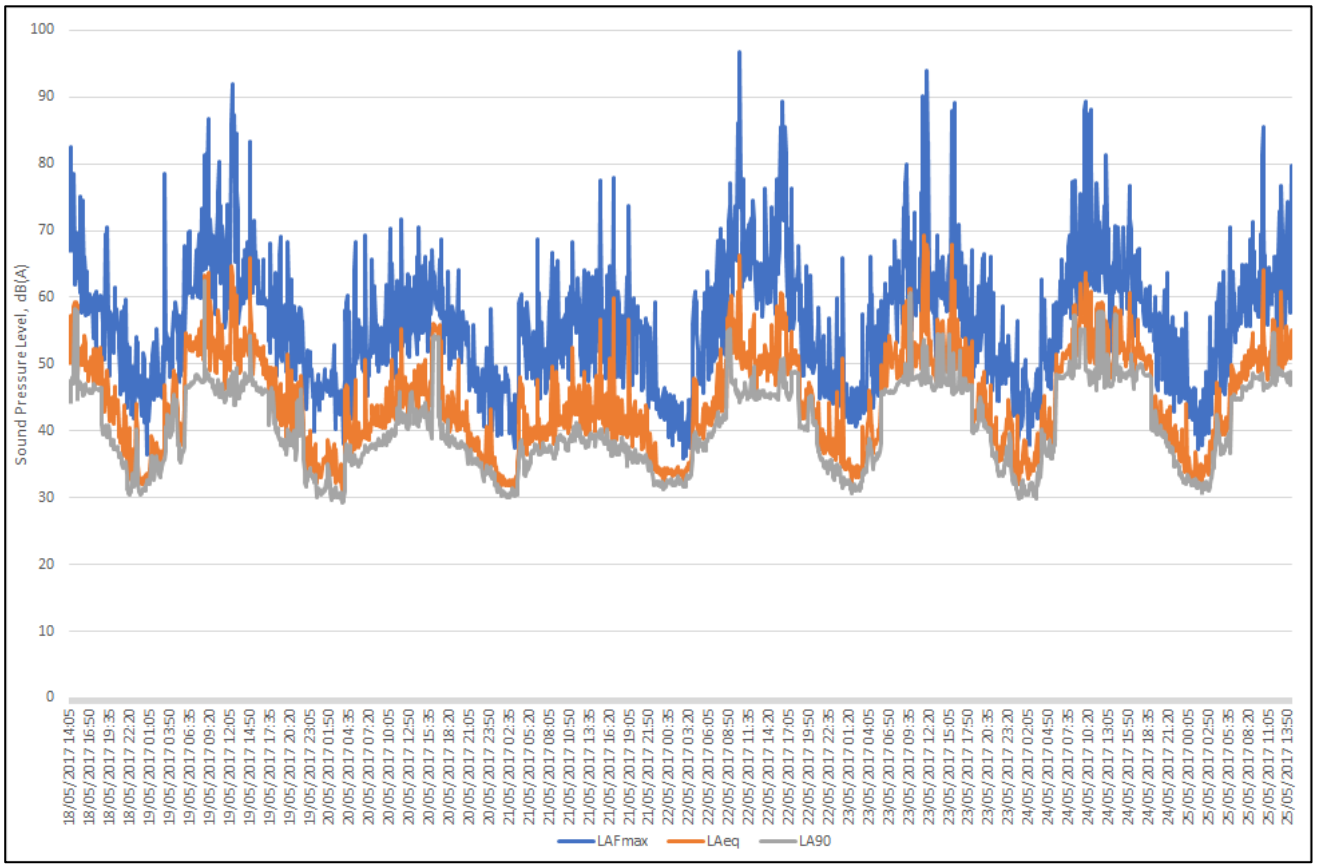
Location 2: South East Corner, Adjacent to Morrison's Supermarket

Date(s): Between 14:05 on Thursday 18th May and 14:20 on Thursday 25th May 2017

Equipment: Brüel & Kjær 2250 Type 1 sound level meter (serial no. 2488353) with tripod and windshield.

Weather: Mostly dry, wind speed below 5 m/s

All levels in dB(A)



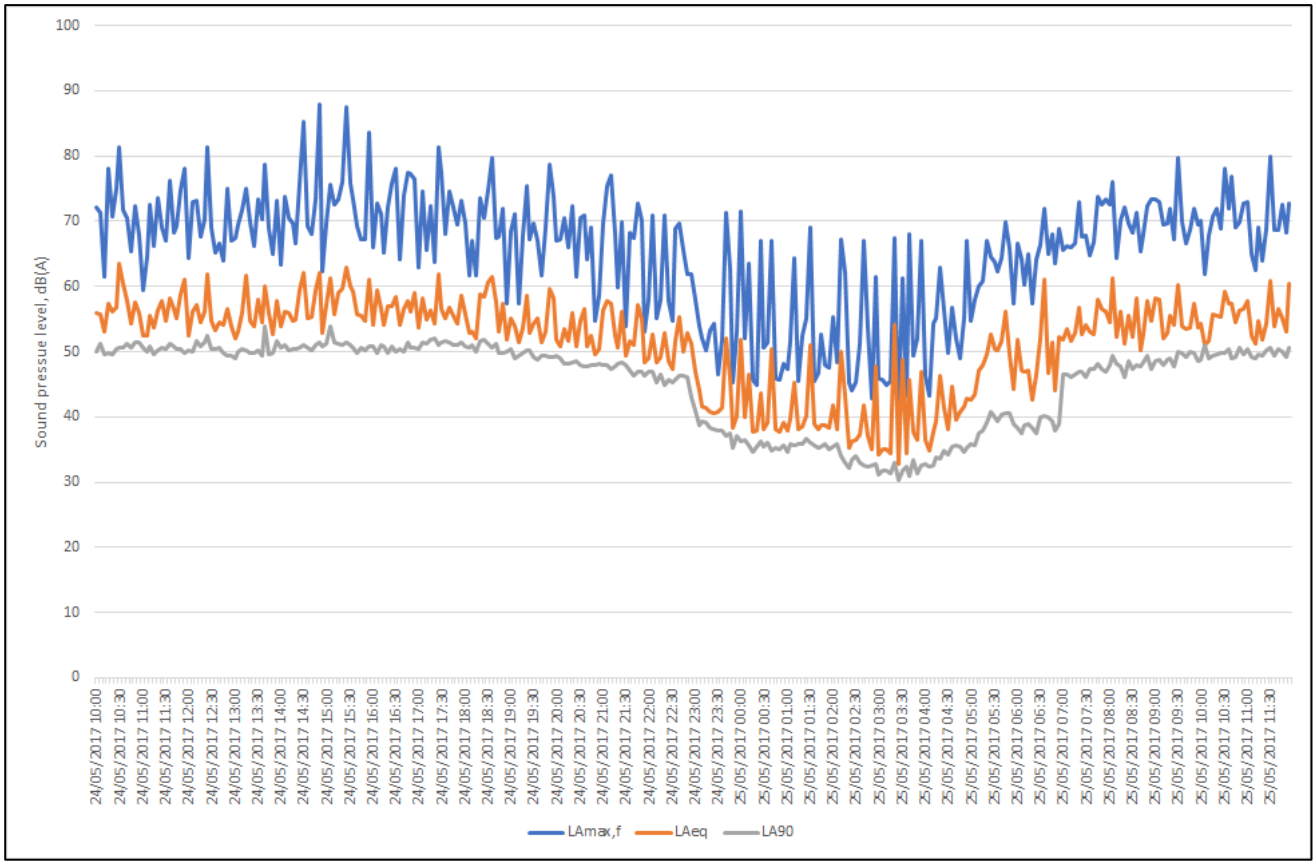
Location 3: Mason's Road

Date(s): Between 10:00 on Wednesday 24th May and 12:00 on Thursday 25th May 2017

Equipment: Rion NL-31 'Type 1' sound level meter (serial no. 01120844) with tripod and windshield.

Weather: Dry, wind speed below 5 m/s

All levels in dB(A)



Location 4: East of railway line

Equipment: Brüel & Kjær 2260 'Type 1' sound analyser (serial no. 2413555) with tripod and windshield.

Weather: Dry, wind speed below 5 m/s

All levels in dB(A)

Date	Start Time	Duration (mm:ss)	Measured Noise Levels (dB)		
			L_{Aeq}	L_{Amax}	L_{A90}
17/05/2017	08:00	15:00	50	67	44
17/05/2017	08:15	15:00	51	65	45
17/05/2017	08:30	15:00	49	59	46
17/05/2017	08:45	15:00	48	62	45
17/05/2017	09:00	15:00	51	73	46
17/05/2017	09:15	15:00	50	63	46
17/05/2017	09:30	15:00	50	66	47
17/05/2017	09:45	15:00	50	70	47
17/05/2017	10:00	15:00	50	66	47
24/05/2017	20:01	15:00	50	70	47
24/05/2017	20:16	15:00	49	62	47
24/05/2017	20:31	15:00	50	64	46
24/05/2017	20:46	15:00	53	80	45
24/05/2017	21:01	15:00	48	61	44
24/05/2017	21:16	15:00	48	62	45
24/05/2017	21:31	15:00	48	66	44
24/05/2017	21:46	15:00	48	61	44
25/05/2017	00:03	5:00	42	55	36
25/05/2017	00:08	5:00	41	54	36
25/05/2017	00:13	5:00	43	54	36
25/05/2017	00:18	5:00	41	56	35
25/05/2017	00:23	5:00	39	55	35
25/05/2017	00:28	5:00	37	56	35
25/05/2017	00:33	5:00	38	56	37
25/05/2017	00:38	5:00	39	54	35

25/05/2017	00:43	5:00	40	56	34
25/05/2017	00:48	5:00	40	58	37
25/05/2017	00:48	5:00	41	54	35
25/05/2017	00:48	5:00	43	58	36
25/05/2017	15:00	15:00	46	64	42
25/05/2017	15:15	15:00	59	82	46
25/05/2017	15:30	15:00	52	75	46
25/05/2017	15:45	15:00	49	61	46

Location 5: Timothy's Bridge Road (East)

Equipment: Brüel & Kjær 2260 'Type 1' sound analyser (serial no. 2413555) with tripod and windshield.

Weather: Dry, wind speed below 5 m/s

All levels in dB(A)

Date	Start Time	Duration (mm:ss)	Measured Noise Levels (dB)		
			L_{Aeq}	L_{Amax}	L_{A90}
17/05/2017	11:03	15:00	53	63	50
17/05/2017	11:18	15:00	54	73	49
17/05/2017	11:33	15:00	56	78	49
17/05/2017	11:48	15:00	52	67	48
17/05/2017	12:03	15:00	58	80	49
17/05/2017	12:18	15:00	53	72	49
17/05/2017	12:33	15:00	54	72	50
17/05/2017	12:48	15:00	60	78	49
18/05/2017	00:02	5:00	43	56	39
18/05/2017	00:07	5:00	45	56	42
18/05/2017	00:12	5:00	41	52	37
18/05/2017	00:17	5:00	43	57	38
18/05/2017	00:22	5:00	42	56	35
18/05/2017	00:27	5:00	43	57	41
18/05/2017	00:32	5:00	43	53	37
18/05/2017	00:37	5:00	41	53	37
18/05/2017	00:42	5:00	45	51	38
18/05/2017	00:47	5:00	42	62	37
18/05/2017	00:52	5:00	41	57	35
18/05/2017	00:57	5:00	43	62	39
24/05/2017	17:00	15:00	52	66	48
24/05/2017	17:15	15:00	53	78	48
24/05/2017	17:30	15:00	53	68	48
24/05/2017	17:45	15:00	57	78	50

24/05/2017	18:00	15:00	53	64	49
24/05/2017	18:15	15:00	53	70	48
24/05/2017	18:30	15:00	55	78	48
24/05/2017	18:45	15:00	52	71	48
25/05/2017	01:23	5:00	41	54	39
25/05/2017	01:28	5:00	40	52	37
25/05/2017	01:33	5:00	41	54	36
25/05/2017	01:38	5:00	42	55	37
25/05/2017	01:43	5:00	41	53	36
25/05/2017	01:48	5:00	43	54	37

Location 6: Timothy's Bridge Road (West)

Equipment: Brüel & Kjær 2260 'Type 1' sound analyser (serial no. 2413555) with tripod and windshield.

Weather: Dry, wind speed below 5 m/s

All levels in dB(A)

Date	Start Time	Duration (mm:ss)	Measured Noise Levels (dB)		
			L_{Aeq}	L_{Amax}	L_{A90}
17/05/2017	14:04	15:00	55	83	51
17/05/2017	14:19	15:00	64	76	54
17/05/2017	14:34	15:00	54	67	51
17/05/2017	14:49	15:00	55	67	51
17/05/2017	15:04	15:00	64	87	51
17/05/2017	15:19	15:00	57	80	51
17/05/2017	15:34	15:00	54	66	51
18/05/2017	01:18	5:00	43	59	40
18/05/2017	01:23	5:00	42	56	36
18/05/2017	01:28	5:00	43	59	38
18/05/2017	01:33	5:00	40	55	38
18/05/2017	01:38	5:00	42	52	37
18/05/2017	01:43	5:00	44	55	39
24/05/2017	11:00	15:00	54	64	51
24/05/2017	11:15	15:00	55	74	50
24/05/2017	11:30	15:00	57	79	50
24/05/2017	11:45	15:00	53	68	49
24/05/2017	12:00	15:00	59	81	50
24/05/2017	12:15	15:00	54	73	50
24/05/2017	12:30	15:00	55	73	51
24/05/2017	12:45	15:00	61	79	50
25/05/2017	19:08	15:00	55	67	52
25/05/2017	19:23	15:00	54	66	51

Location 7: Canalside by Sitel UK

Equipment: Brüel & Kjær 2260 'Type 1' sound analyser (serial no. 2413555) with tripod and windshield.

Weather: Dry, wind speed below 5 m/s

All levels in dB(A)

Date	Start Time	Duration (mm:ss)	Measured Noise Levels (dB)		
			L_{Aeq}	L_{Amax}	L_{A90}
17/05/2017	17:00	15:00	52	77	47
17/05/2017	17:15	15:00	52	67	47
17/05/2017	17:30	15:00	56	77	49
17/05/2017	17:45	15:00	52	63	48
17/05/2017	18:00	15:00	52	69	47
17/05/2017	18:15	15:00	54	77	47
17/05/2017	18:30	15:00	51	70	47
17/05/2017	18:45	15:00	52	66	48
18/05/2017	01:58	5:00	40	52	36
18/05/2017	02:03	5:00	41	52	38
18/05/2017	02:08	5:00	40	50	34
18/05/2017	02:13	5:00	40	49	33
18/05/2017	02:18	5:00	38	48	32
18/05/2017	02:23	5:00	39	49	33
18/05/2017	02:28	5:00	38	49	32
18/05/2017	02:33	5:00	36	46	32
18/05/2017	02:38	5:00	40	49	33
24/05/2017	14:01	15:00	53	60	50
24/05/2017	14:16	15:00	52	68	49
24/05/2017	14:31	15:00	55	81	48
24/05/2017	14:46	15:00	52	65	47
24/05/2017	15:01	15:00	52	67	48
24/05/2017	15:16	15:00	51	62	47
24/05/2017	15:31	15:00	51	64	48

24/05/2017	15:46	15:00	51	67	47
25/05/2017	21:00	15:00	51	62	46
25/05/2017	21:15	15:00	51	59	46
25/05/2017	21:30	15:00	53	68	48
25/05/2017	21:45	15:00	50	63	46

Location 8: North of railway

Equipment: Brüel & Kjær 2260 'Type 1' sound analyser (serial no. 2413555) with tripod and windshield.

Weather: Dry, wind speed below 5 m/s

All levels in dB(A)

Date	Start Time	Duration (mm:ss)	Measured Noise Levels (dB)		
			L_{Aeq}	L_{Amax}	L_{A90}
17/05/2017	20:07	15:00	52	69	47
17/05/2017	20:22	15:00	52	66	47
17/05/2017	20:37	15:00	51	62	47
17/05/2017	20:52	15:00	52	68	48
17/05/2017	21:07	15:00	53	75	49
17/05/2017	21:22	15:00	52	64	48
17/05/2017	21:37	15:00	52	63	47
17/05/2017	21:52	15:00	52	66	48
24/05/2017	08:00	15:00	48	60	44
24/05/2017	08:15	15:00	49	65	45
24/05/2017	08:30	15:00	49	61	45
24/05/2017	08:45	15:00	49	73	45
24/05/2017	09:00	15:00	53	69	45
24/05/2017	09:15	15:00	49	66	45
24/05/2017	09:30	15:00	49	63	45
24/05/2017	09:45	15:00	50	59	45
25/05/2017	02:04	5:00	40	54	37
25/05/2017	02:09	5:00	39	52	33
25/05/2017	02:14	5:00	40	54	35
25/05/2017	02:19	5:00	43	56	36
25/05/2017	02:24	5:00	40	52	32
25/05/2017	02:29	5:00	37	56	34
25/05/2017	02:34	5:00	41	53	35
25/05/2017	02:39	5:00	40	53	34

25/05/2017	02:44	5:00	39	52	33
25/05/2017	02:49	5:00	40	51	34
25/05/2017	02:54	5:00	38	50	32
25/05/2017	17:02	15:00	52	67	47
25/05/2017	17:17	15:00	52	69	48
25/05/2017	17:32	15:00	52	68	48
25/05/2017	17:47	15:00	52	66	48

Location 9: Rear of 18 Drayton Avenue

Date(s): Between 13:13 on Thursday 18th May and 13:35 on Wednesday 24th May 2017

Equipment: Norsonic 116 Type 1 sound level meter (serial no. 22697) with tripod and windshield.

Weather: Dry, wind speed below 5 m/s

All levels in dB(A)