NOISE CONSTRAINTS ASSESSMENT
LAND AT COVENTRY STADIUM, BRANDON

REC REFERENCE: AC103800-1R1

PREPARED FOR: FRAMPTONS

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National Consultancy, Locally Delivered

A CONCEPT LIFE SCIENCES COMPANY

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EXECUTIVE SUMMARY

Resource and Environmental Consultants Ltd were commissioned by Framptons to provide a Noise Constraints Assessment to support a planning application for the proposed residential development at Coventry Stadium, Brandon.

A Noise Survey has been undertaken in order to determine the existing levels of noise across the Site due to road traffic noise associated with Rugby Road / A428.

Noise modelling software has been used in order to predict the noise levels in external amenity areas and also incident upon the facades for the proposed residential development. As no masterplan was available at the time of the assessment, the provided red line boundary was used to inform two hypothetical scenarios to determine if suitable levels of amenity can be achieved on Site.

Scenario 1 has assumed the closest dwelling and associated garden are orientated at a 90 degree angle to Rugby Road. With the implementation of a 20m stand-off and 1.8m barrier, suitable levels of external amenity is achievable. Alternatively, scenario 2 features the closest dwelling at a 5m stand-off fronting Rugby Road, and with the garden area to the rear. With this orientation, no further mitigation is required to achieve suitable external amenity.

Internal Assessment has been based on a 5m stand-off from the redline boundary. It has been demonstrated that standard thermal double glazing is not sufficient for the worst-affected façade. Considering a partially open window, certain habitable rooms with line of sight to Rugby Road would be in exceedance of criteria. Depending on the orientation of habitable rooms, higher specification glazing and alternative ventilation may be required.

With appropriate site layout and mitigation measures, where required, the overall effect on the Site due to the surrounding sources is considered the NOAEL with noise being noticeable and not intrusive and with the following advice:

"Noise can be heard but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life."

The assessment has been based on robust and worst case assumptions. This assessment has shown that, in principle, there should be no adverse impact at the closest receptors as a result of the existing noise sources and that the Site is suitable for residential development.

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1. INTRODUCTION

Resource and Environmental Consultants (REC) Limited were commissioned by Framptons to undertake a Noise Constraints Assessment to support a planning application for a proposed residential development on land at Coventry Stadium, Brandon, to be referred to hereafter as '*the Site'*.

This assessment has been undertaken to identify key noise sources in the vicinity of the Site which may have the potential to impact upon the proposed sensitive residential development.

All acronyms used within this report are defined in the Glossary presented in Appendix II.

1.1 Site Location & Proposed Development

The site comprises a parcel of land located north east of the A428 Rugby Road. The Site is bound by existing residential dwellings and agricultural land.

Potentially impacting upon the site is road traffic originating from the A428 Rugby Road. The section of development most susceptible to noise impact is the south west section of the development south of Coombe Cottage, due to exposure to Rugby Road. However, the majority of plots are already offered protection due to the proposed stand-off distance and shielding from existing dwellings.

At this stage of the application, no layout is available and as such the Noise Constraints Assessment will be based on the concept plan in order to accompany the outline planning application and also to aid in the development of a masterplan:

- Coventry Stadium Concept Plan\27510\D9301\RA dated 11th May 2017;

1.2 Limitations

The limitations of this report are presented in Appendix I.

1.3 Confidentiality

REC has prepared this report solely for the use of the Client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed. Should any third party wish to use or rely upon the contents of the report, written approval must be sought from REC; a charge may be levied against such approval.

2. ASSESSMENT CRITERIA

2.1 Local National Planning Practice Guidance

Noise needs to be considered when new developments may create additional noise and when new developments would be sensitive to the prevailing acoustic environment. When preparing local or neighbourhood plans, or taking decisions about new development, there may also be opportunities to consider improvements to the acoustic environment.

Local planning authorities' plan-making and decision taking should take account of the acoustic environment and in doing so consider:

- Whether or not a significant adverse effect is occurring or likely to occur;
- Whether or not an adverse effect is occurring or likely to occur; and
- Whether or not a good standard of amenity can be achieved.

In line with the Explanatory Note of the Noise Policy Statement for England, this would include identifying whether the overall effect of the noise exposure (including the impact during the construction phase wherever applicable) is, or would be, above or below the significant observed adverse effect level and the lowest observed adverse effect level for the given situation.

The Observed Effect Levels are as follows:

- Significant observed adverse effect level: This is the level of noise exposure above which significant adverse effects on health and quality of life occur;
- Lowest observed adverse effect level: this is the level of noise exposure above which adverse effects on health and quality of life can be detected; and
- No observed effect level: this is the level of noise exposure below which no effect at all on health or quality of life can be detected.

Table 1 summarises the noise exposure hierarchy, based on the likely average response.

Table 1 Noise Exposure Hierarchy

Perception	Examples of Outcomes	Increasing Effect Level	Action
Not Noticeable	No Effect	No Observed Effect	No specific measures required
Noticeable and not intrusive	Noise can be heard but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.	No Observed Adverse Effect	No specific measures required
		Lowest Observed Adverse Effect Level	
Noticeable and intrusive	Noise can be heard and causes small changes in behaviour and/or attitude, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise.	Observed Adverse Effect	Mitigate and reduce to a minimum

	Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a perceived change in the quality of life.		
		Significant Observed Adverse Effect Level	
Noticeable and disruptive	The noise causes a material change in behaviour and/or attitude, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Effect	Avoid
Noticeable and very disruptive	Extensive and regular changes in behaviour and/or an inability to mitigate effect of noise leading to psychological stress or physiological effects, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory	Unacceptable Adverse Effect	Prevent

The subjective nature of noise means that there is not a simple relationship between noise levels and the impact on those affected. This will depend on how various factors combine in any particular situation.

These factors include:

- The source and absolute level of the noise together with the time of day it occurs. Some types and level of noise will cause a greater adverse effect at night than if they occurred during the day – this is because people tend to be more sensitive to noise at night as they are trying to sleep. The adverse effect can also be greater simply because there is less background noise at night;
- For non-continuous sources of noise, the number of noise events, and the frequency and pattern of occurrence of the noise; and
- The spectral content of the noise and the general character of the noise. The local topology and topography should also be taken into account along with the existing and, where appropriate, the planned character of the area.

More specific factors to consider when relevant:

- Where applicable, the cumulative impacts of more than one source should be taken into account along with the extent to which the source of noise is intermittent and of limited duration;
- Consideration should also be given to whether adverse internal effects can be completely removed by closing windows and, in the case of new residential development, if the proposed mitigation relies on windows being kept closed most of the time. In both cases a suitable alternative means of ventilation is likely to be necessary. Further information on ventilation can be found in the Building Regulations; and
- If external amenity spaces are an intrinsic part of the overall design, the acoustic environment of those spaces should be considered so that they can be enjoyed as intended.

2.2 Local Authority Guidance and Criteria – Rugby Borough Council

REC Ltd have contacted Gavin Smith, at Rugby Borough Council via email on Wednesday 14th June 2017 to agree the following methodology:

"REC have been appointed by a developer to complete a Noise Impact Assessment for a proposed residential development at Brandon Stadium off the A428 / Rugby Road in Coventry.

We would like to agree on the methodology and assessment criteria prior to commencement.

REC will complete a noise survey at the Site which will measure the impact of road traffic from A428 / Rugby Road to the south west, upon the development.

Road Noise: *The assessment will be completed with due regard to the internal target noise level criteria for bedrooms and living rooms as detailed in BS8233: 2014. Any proposed external amenity areas shall aim to achieve 55dB where possible, in line with the guidance given in BS8233: 2014.*

Where exceedances of criteria are found, REC will propose appropriate noise mitigation measures which may include for upgraded glazing, alternative ventilation and acoustic barriers where necessary.

I trust that the above is satisfactory and would be grateful if you could confirm acceptance to the above. Please do not hesitate to get in touch if you would like to discuss this further."

REC Ltd received a response from Gavin Smith on Friday 16th June 2017:

"The methodology for the assessment is fine."

Accordingly, the assessment has followed the methodology detailed above and in line with current guidance.

2.3 Calculation of Road Traffic Noise 1988

The Calculation of Road Traffic Noise (CRTN) memorandum, produced by the Department of Transport for the Welsh Office, describes the procedures for calculating noise from road traffic. Section III of this memorandum details the shortened measurement procedure whereby measurements of the L_{10} parameter are made over any three consecutive hours between 10:00 and 17:00. From the arithmetic average of the three 1-hour values, the $L_{10,18hr}$ noise levels are derived before derivation of the $L_{Aeq,16hr}$ value.

2.4 Transport Research Laboratory – Converting the UK traffic Noise Index $L_{A10,18hr}$ to EU Noise Indices for Noise Mapping

This document provides a method for converting the $L_{A10,18hr}$ level to the L_{night} level using the following formula, applicable to non-motorway roads;

$L_{night} = 0.90 \times L_{A10,18hr} - 3.77dB$

2.5 World Health Organisation's (WHO) 'Guidelines for Community Noise'

The WHO 'Guidelines for Community Noise' offers advice with regard to setting noise criteria applicable to sleep disturbance. Section 4.2.3 specifies:

'If the noise is not continuous, L_{Amax} or SEL are used to indicate the probability of noise-induced awakenings. Effects have been observed at individual L_{Amax} exposures of 45dB or less. Consequently, it is important to limit the number of noise events with a L_{Amax} exceeding 45dB.'

The guidelines go on to state:

'At night, sound pressure levels at the outside façades of the living spaces should not exceed 45 dB L_{Aeq} and 60dB L_{Amax}, so that people may sleep with bedroom windows open. These values have been obtained by assuming that the noise reduction from outside to inside with the window partly open is 15dB.'

The sound insulation performance value of 15dB for a façade containing a partially open window accords with the guidance offered in BS8233:2014.

The guidelines reference a study by Vallet & Vernet, 1991, which concluded that:

'For a good sleep, it is believed than indoor sound pressure levels should not exceed approximately 45 dB $L_{AF,max}$ more than 10-15 times per night.'

2.6 British Standard BS8233: 2014: 'Guidance on Sound Insulation and Noise Reduction for Buildings'

Noise Criteria Limits

The scope of this standard is the provision of recommendations for the control of noise in and around buildings. It suggests appropriate criteria and limits for different situations, which are primarily intended to guide the design of new buildings or refurbished buildings undergoing a change of use, rather than to assess the effect of changes in the external noise climate.

The standard suggests suitable internal noise levels within different types of buildings, including dwellings, as shown in Table 2.

Table 2 BS8233 Recommended Internal Noise Levels

Criterion	Typical Situation	Design $L_{Aeq,T}$ (dB)
Suitable resting / sleeping conditions	Living Room	35
	Bedroom	30
For a reasonable standard in bedrooms at night, individual noise events (measured with fast time weighting) should not normally exceed 45dB L_{Amax}		

BS8233 goes on to recommend noise levels for gardens. According to BS8233;

"It is desirable that the external noise level does not exceed 50dB $L_{Aeq,T}$, with an upper guideline value of 55dB $L_{Aeq,T}$ which would be acceptable in noisier environments. However, it is also recognised that these guideline values are not achievable in all circumstances where development might be desirable. In higher noise areas,

such as city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise levels and other factors might be warranted".

BS8233 goes on to say:

"In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited".

Ventilation Requirements

Where a partially open window cannot be relied upon to provide an adequate level of facade sound insulation performance, it is necessary to consider alternative ventilation for habitable rooms. Section 8.4.5.4 within BS8233 states:

"The Building Regulations' supporting documents on ventilation [48, 49, 50] recommend that habitable rooms in dwellings have background ventilation. Where openable windows cannot be relied upon for this ventilation, trickle ventilators can be used and sound attenuating types are available. However, windows may remain openable for rapid or purge ventilation, or at the occupant's choice.

Alternatively, acoustic ventilation units (see 7.7.2 below) are available for insertion in external walls. These can provide sound reduction comparable with double glazed windows. However, ducted systems with intakes on the quiet side of the building might be required in very noisy situations, or where appearance rules out through-the-wall fans."

Section 7.7.2 states:

"NOTE 5 If relying 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."

3. NOISE SURVEY

3.1 Road Traffic Noise Survey – A428 Rugby Road

REC has conducted a 3-hour road traffic noise measurement in accordance with the guidelines stated in CRTN. The survey was carried out over the following time periods:

- Wednesday 12th July 2017 between 13:24 and 16:24.

The following location was chosen for the survey:

- Noise Monitoring Position 1 (NMP1): Located 4m from the nearside kerbstone of the A428 Rugby Road which equates to 8m from the centre. The microphone was located at a height of 1.2m in free-field conditions. Noise sources at this locations were dominated by road traffic noise from the A428, birdsong was just perceptible.

A summary of the measured sound pressure levels are presented in Table 3.

Table 3 Summary of Measured Sound Pressure Level

Measurement Position	Measurement Period	Measured Sound Pressure Level, free-field (dB)			
		$L_{Aeq,T}$	$L_{Amax,fast1}$	$L_{A90,T}$	$L_{A10,T}$
NMP1	12/07/2017 13:24 – 14:24	68.1	82.9[1]	45.8	72.9
	12/07/2017 14:24 – 15:24	68.6		44.6	73.3
	12/07/2017 15:24 – 16:24	69.7		48.2	74.0
[1] 10th highest $L_{Amax,fast}$ measured during the entire 3-hour period					

The noise measurements were made using a class 1 sound level meter of which was calibrated on-site prior to and on completion of the noise survey. No drift in calibration was measured for either sound level meter. Calibration certificates of the noise monitoring equipment can be supplied upon request.

Table 4 details the noise equipment used for the surveys.

Table 4 Noise Measurement Equipment

Measurement Position	Equipment Description	Manufacturer & Type No.	Serial No.	Calibration Due Date
NMP1	Sound Level Meter	01dB-Metravib Black Solo	65771	19th October 2017
	Pre-amplifier	01dB-Metravib PRE 21 S	16539	
	Microphone	01dB Metravib MCE212	175280	
	Calibrator	01dB-Metravib CAL-21	34634218	6th October 2017

NOISE CONSTRAINTS ASSESSMENT

3.2 Road Traffic Noise

For the purposes of this assessment, REC have used noise modelling software, CadnaA 4.2, to determine the impact of road vehicles from the road upon the Site. A noise model has therefore been constructed in order to calculate façade noise levels and external noise levels due to the impact of road traffic noise.

The following inputs have been included in the model:

- Coventry Stadium Concept Plan\27510\D9301\RA dated 11th May 2017;
- Site elevations have been taken as existing;
- A reflection order of 2 has been used in all calculations;
- Road traffic noise input as a line source at a height of 0.5m; and
- Noise levels generated using ISO 9613-1 and ISO 9613-2 "Acoustics – Attenuation of sound during propagation outdoors" as incorporated into CadnaA software.

Table 5 details the calculated daytime and night-time noise levels for Rugby Road using the methods given in CRTN and the TRL Document.

Table 5 Rugby Road Predicted Noise Levels – 8m from Centre

Assessment Period	Measured and Predicted Sound Pressure Levels (dB)	
	$L_{Aeq,T}$	$L_{Amax,fast}$
Daytime (07:00- 23:00)	70.4	-
Night-time (23:00 – 07:00)	61.4	82.9

3.2.1 External Amenity Areas

The grid noise map has been used to predict the noise levels in the garden areas of the proposed development. Figure 2 of Appendix III details the grid noise map.

It can be seen that noise levels across the Site range between <40dB and up to 68dB in the worst affected areas of the site. It is considered desirable to achieve 50dB in garden areas with 55dB being acceptable in the areas closest to the road. However, considering the locality of the Site and the guidance, a compromise between elevated levels and other factors may be warranted for plots closest to Rugby Road, but this will be determined by the Local Planning Authority. Accordingly, 55dB will be considered the maximum level.

It had been predicted that the majority of potential gardens areas have a noise level of 55dB and below at the centre, with the majority below 50dB. The highest predicted noise level for the red line boundary immediately adjacent to Rugby Road is 68dB. However, given a stand-off distance from the boundary this is likely to be considerably lower. For example, at 10m from the boundary noise levels are predicted to be 64dB and at approximately 45m, noise levels achieve the 55dB criteria.

It should be noted that where gardens are shielded by dwellings, these noise levels will decrease significantly. As such, this will be expanded upon in Section 4 of this report.

The highest of these levels, without protection, are not considered acceptable, and, as such, consideration towards a suitable Site layout is required and mitigation measures will be required to ensure the lowest practicable levels in garden areas are achieved.

This is considered the 'Lowest Observed Adverse Effect Level' (LOAEL) with the following advice:

"Noise can be heard and causes small changes in behaviour and/or attitude, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a perceived change in the quality of life."

With the action being:

"*Mitigate and reduce to a minimum".*

3.2.2 Internal Habitable Rooms

In order to accurately determine the noise level within habitable rooms, it has been necessary to calculate the external noise level immediately outside any potential façade. At the time of the report, no detailed layout is available, however a proposed 5m standoff from the Site boundary has been used to inform a worst case scenario and to recommend mitigation measures.

With regards internal noise levels, BS8233:2014 suggest that a glazing unit with configuration 6mm glass/12mm air space/6mm glass affords sound insulation performance in the order of 33dB however this is for a pink noise spectrum. The same unit, weighted for road traffic noise using the '$+C_{tr}$' correction, has a sound insulation performance value of approximately 30dB and so this value has been used to calculate internal noise levels. It is also goes on to recommend that a partially open window provides approximately 15dB attenuation.

Figure 2 shows that the most exposed facades could be subject to levels of up to 69dB during the daytime. When considering standard thermal double glazing, there would be a predicted level of 39dB in living rooms facing Rugby Road. This exceeds the 35dB criteria. Therefore, standard thermal double glazing would be not be sufficient for dwellings overlooking Rugby Road. Considering a partially open window, noise levels are predicted at 54dB which exceeds criteria by +19dB. Consequently, alternative ventilation would be required.

Figure 3 shows that façades facing Rugby Road could be subjected to levels of up to 60dB during the night-time period. When considering standard thermal double glazing, there would be a predicted level of 30dB in bedrooms facing Rugby Road. This achieves the 30dB criteria for night-time. Considering a partially open window, the internal noise level equates to 45dB. Thus, opening windows should not be relied upon for the provision of adequate background ventilation.

With regards to maximum noise levels, the 10th highest level from road traffic (82.9dB) has been distance corrected to the closest proposed façades. A level of 33dB is assumed for the glazing as the maximum noise level does not include any frequency content and is non-descript. Accordingly, the resulting level at the receptors facing Rugby Road is 75dB. Therefore, standard thermal double

glazing is sufficient for bedrooms facing the road in order to achieve the WHO Guidelines 45dB $L_{Amax,fast}$ criteria. However, when considering a partially open window, the 45dB criteria for night-time maxima would not be achieved.

It is evident that for dwellings immediately adjacent to the road, alternative ventilation would be required for all habitable rooms with line of sight to the road.

Without mitigation in place, the LOAEL, without higher specification glazing and no alternative ventilation, and the following outcome is noted:

"Noise can be heard and causes small changes in behaviour and/or attitude, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a perceived change in the quality of life."

With the action being: "*Mitigate and reduce to a minimum".*

4. MITIGATION

4.1 Road Traffic Noise

4.1.1 External Amenity Areas

The grid noise map determined that predicted noise levels across the Site could range from <40dB up to 66dB without any mitigation in place due to the impact of road traffic noise. Figure 2 of Appendix III shows this grid noise map.

Accordingly, two scenarios have been run.

Figure 4 illustrates scenario 1. Scenario 1 assumes a minimum stand-off distance, 20m, for garden areas from the road with plots and gardens side on to the road. The model demonstrates that, at this distance, 1.8m high barriers would be required along the exposed edges of the gardens in order to achieve the criteria. As the distance to the road decreases, the height of the barrier increases. It is considered that a 1.8m high barrier would be acceptable but it may be that higher barriers can also be implemented. In that case, the stand-off distance may be reduced for exposed garden areas. Figure 4 demonstrates that with mitigation in place, the worst affected garden area will achieve the 55dB upper criteria at the centre.

Scenario 2, Figure 5, is based on the assumption that plots will front the road at a distance of 5m from the edge and garden areas would be shielded by the building envelope. Figure 5 predicts that garden areas to the rear of the property will achieve the 55dB criteria at the centre without further mitigation in place.

These are hypothetical scenario and are only used to determine whether suitable levels of noise can be achieved on Site. The actual layout will differ and will require reassessment in detail with a detailed masterplan but this assessment has shown that residential development is suitable and a reasonable level of amenity can be achieved for the majority of the Site.

Any barriers can be of wooden fence or brick wall construction, they must be close boarded, free from holes and sealed at the base.

In order to adequately protect garden areas, it is highly recommended that any gardens located close to the roads are orientated such that the dwelling acts as a barrier to the noise. In addition to this the provision of acoustic barriers around the remaining boundaries of the garden may be required to prevent noise ‘creep’ but the height of these will be much less than that required if gardens fronted the road.

Furthermore, gaps between dwellings fronting the roads should be kept to a minimum to avoid noise travelling easily through and, where possible, buildings should form around exposed corners to prevent the passage of noise into the gardens. Buffers along the boundaries of the road will be beneficial, which would increase the distance from the road, thus decrease the incident noise levels in the gardens and the facades.

4.1.2 Internal Habitable Rooms

Section 4.0 determined that standard thermal double glazing is not sufficient for the closest dwelling located by the south west boundary adjacent to Rugby Road considering a minimum stand-off of 5m from the red line boundary. For the worst-affected façade, a glazing specification of 34dB $R_w + C_{tr}$ would be recommended. However, exact glazing specification is dependent upon the eventual layout and orientation of the habitable rooms.

With a partially open window, the internal noise levels for the closest habitable rooms with line of sight to the road will exceed the internal target criteria. Accordingly it is recommended that an alternative system is installed that provides background ventilation without the need for opening windows but windows should be openable in order to provide purge ventilation. Ideally, any inlet for fresh air should be located away from the noise source to ensure the freshest air available is brought into the habitable rooms.

The exact requirement for alternative ventilation ultimately falls to the developer and, from an acoustics perspective, needs to ensure that fresh air flow can be achieved without the need for opening windows.

Wherever possible habitable rooms should be located away from the noise source with less noise-sensitive rooms facing the noise source.

5. CONCLUSION

Resource and Environmental Consultants Ltd were commissioned by Framptons to provide a Noise Constraints Assessment to support a planning application for the proposed residential development at Coventry Stadium, Brandon.

A Noise Survey has been completed in order to determine the existing levels of noise across the site due to road traffic noise associated with A428 Rugby Road.

Noise modelling software has been used in order to predict the noise levels in external amenity areas and also incident upon the facades for the proposed residential development. As no masterplan is currently available, the provided red line boundary has been used to inform the assessment.

The daytime grid noise map demonstrates external garden areas, if directly adjacent to the redline boundary, would be in exceedance of criteria without mitigation in place.

This Noise Constraints Assessment has modelled two example scenarios with mitigation strategies, which demonstrate that satisfactory levels of amenity are achieved within the garden areas. One method of attaining this is to shield garden areas from the road. Another situation was run in the model with garden areas orientated at a 90 degree angle to the road; a suitable level of amenity can be achieved by means of a 20m stand-off from the boundary and a 1.8m barrier.

Furthermore, depending on the orientation of habitable rooms, higher specification glazing and alternative ventilation may be required.

With appropriate site layout and mitigation measures, where required, the overall effect on the Site due to the surrounding sources is considered the NOAEL with noise being noticeable and not intrusive and with the following advice:

"Noise can be heard but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life."

The assessment has been based on robust and worst case assumptions. This assessment has shown that, in principle, there should be no adverse impact at the closest receptors as a result of the existing noise sources and that the Site is suitable for residential development.

APPENDIX I LIMITATIONS

1. This report and its findings should be considered in relation to the terms of reference and objectives agreed between REC Limited and the Client as indicated in Section 1.2.

2. The executive summary, conclusions and recommendations sections of the report provide an overview and guidance only and should not be specifically relied upon without considering the context of the report in full.

3. REC cannot be held responsible for any use of the report or its contents for any purpose other than that for which it was prepared. The copyright in this report and other plans and documents prepared by REC is owned by them and no such plans or documents may be reproduced, published or adapted without written consent. Complete copies of this may, however, be made and distributed by the client as is expected in dealing with matters related to its commission. Should the client pass copies of the report to other parties for information, the whole report should be copied, but no professional liability or warranties shall be extended to other parties by REC in this connection without their explicit written agreement there to by REC.

APPENDIX II GLOSSARY OF ACOUSTICAL TERMINOLOGY

Noise

Noise is defined as unwanted sound. Human ears are able to respond to sound in the frequency range 20 Hz (deep bass) to 20,000 Hz (high treble) and over the audible range of 0 dB (the threshold of perception) to 140 dB (the threshold of pain). The ear does not respond equally to different frequencies of the same magnitude, but is more responsive to mid-frequencies than to lower or higher frequencies. To quantify noise in a manner that approximates the response of the human ear, a weighting mechanism is used. This reduces the importance of lower and higher frequencies, in a similar manner to the human ear.

Furthermore, the perception of noise may be determined by a number of other factors, which may not necessarily be acoustic. In general, the impact of noise depends upon its level, the margin by which it exceeds the background level, its character and its variation over a given period of time. In some cases, the time of day and other acoustic features such as tonality or impulsiveness may be important, as may the disposition of the affected individual. Any assessment of noise should give due consideration to all of these factors when assessing the significance of a noise source.

The most widely used weighting mechanism that best corresponds to the response of the human ear is the 'A'-weighting scale. This is widely used for environmental noise measurement, and the levels are denoted as dB(A) or L_{Aeq}, L_{A90} etc., according to the parameter being measured.

The decibel scale is logarithmic rather than linear, and hence a 3 dB increase in sound level represents a doubling of the sound energy present. Judgement of sound is subjective, but as a general guide a 10 dB(A) increase can be taken to represent a doubling of loudness, whilst an increase in the order of 3 dB(A) is generally regarded as the minimum difference needed to perceive a change under normal listening conditions.

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

Table A1 Typical Sound Pressure Levels

Sound Pressure Level dB(A)	Location
0	Threshold of hearing
20 - 30	Quiet bedroom at night
30 - 40	Living room during the day
40 - 50	Typical office
50 - 60	Inside a car
60 - 70	Typical high street
70 - 90	Inside factory
100 - 110	Burglar alarm at 1m away
110 - 130	Jet aircraft on take off
140	Threshold of pain

Table A2 Terminology

Descriptor	Explanation
dB (decibel)	The scale on which sound pressure level is expressed. It is defined as 20 times the logarithm of the ratio between the root-mean-square pressure of the sound field and a reference pressure (2x10-5Pa).
dB(A)	A-weighted decibel. This is a measure of the overall level of sound across the audible spectrum with a frequency weighting (i.e. 'A' weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies.
$L_{Aeq, T}$	L_{Aeq} is defined as the notional steady sound level which, over a stated period of time (T), would contain the same amount of acoustical energy as the A - weighted fluctuating sound measured over that period.
L_{Amax}	L_{Amax} is the maximum A - weighted sound pressure level recorded over the period stated. L_{Amax} is sometimes used in assessing environmental noise where occasional loud noises occur, which may have little effect on the overall L_{eq} noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
L_{10} & L_{90}	If a non-steady noise is to be described it is necessary to know both its level and the degree of fluctuation. The Ln indices are used for this purpose, and the term refers to the level exceeded for n% of the time. Hence L_{10} is the level exceeded for 10% of the time and as such can be regarded as the 'average maximum level'. Similarly, L_{90} is the 'average minimum level' and is often used to describe the background noise. It is common practice to use the L_{10} index to describe traffic noise.
Free-field Level	A sound field determined at a point away from reflective surfaces other than the ground with no significant contributions due to sound from other reflective surfaces. Generally as measured outside and away from buildings.
Fast	A time weighting used in the root mean square section of a sound level meter with a 125millisecond time constant.
Slow	A time weighting used in the root mean square section of a sound level meter with a 1000millisecond time constant.

APPENDIX III FIGURES

Figure 1 - Framework Plan & Noise Measurement Positions

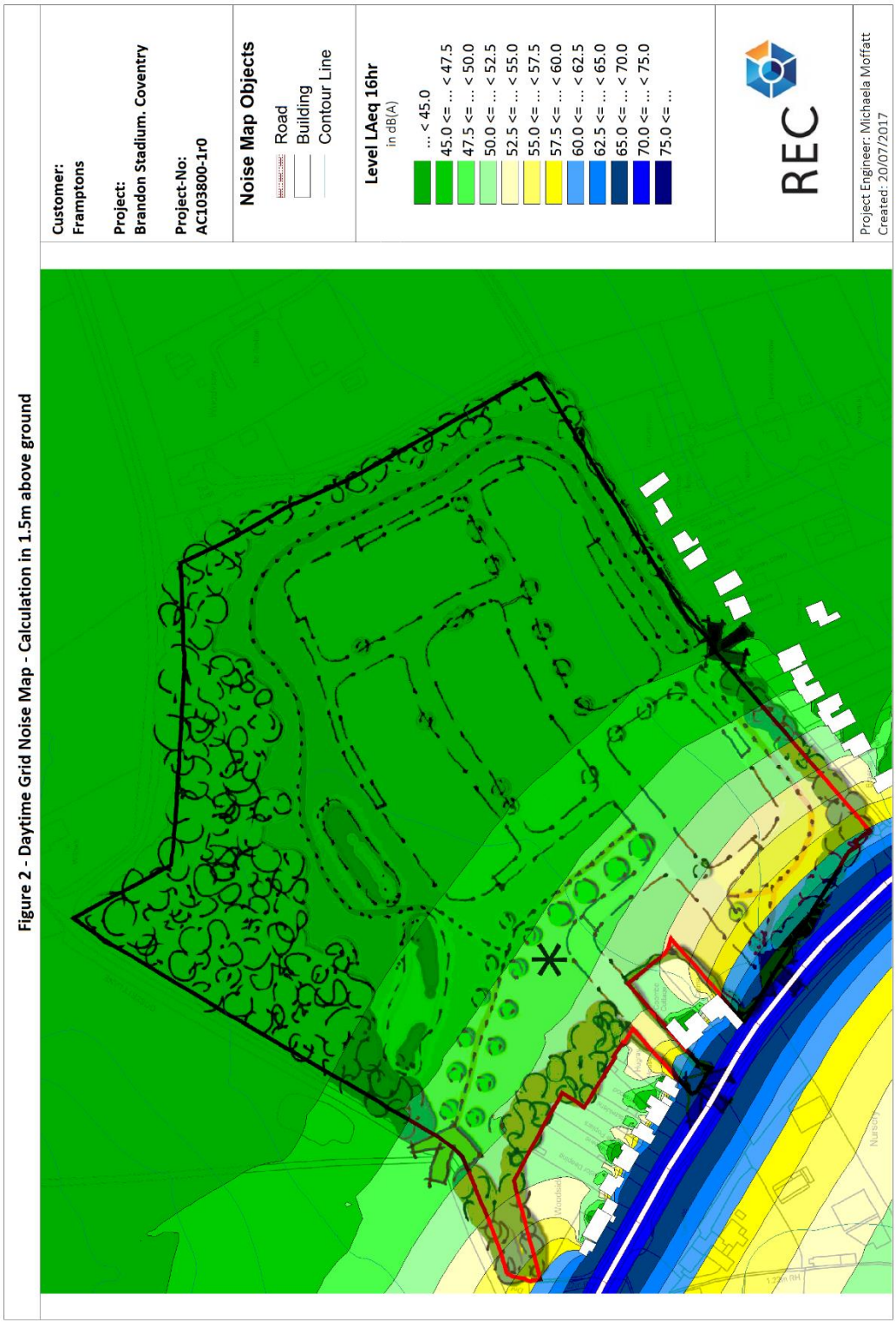

Figure 2 - Daytime Grid Noise Map - Calculation in 1.5m above ground

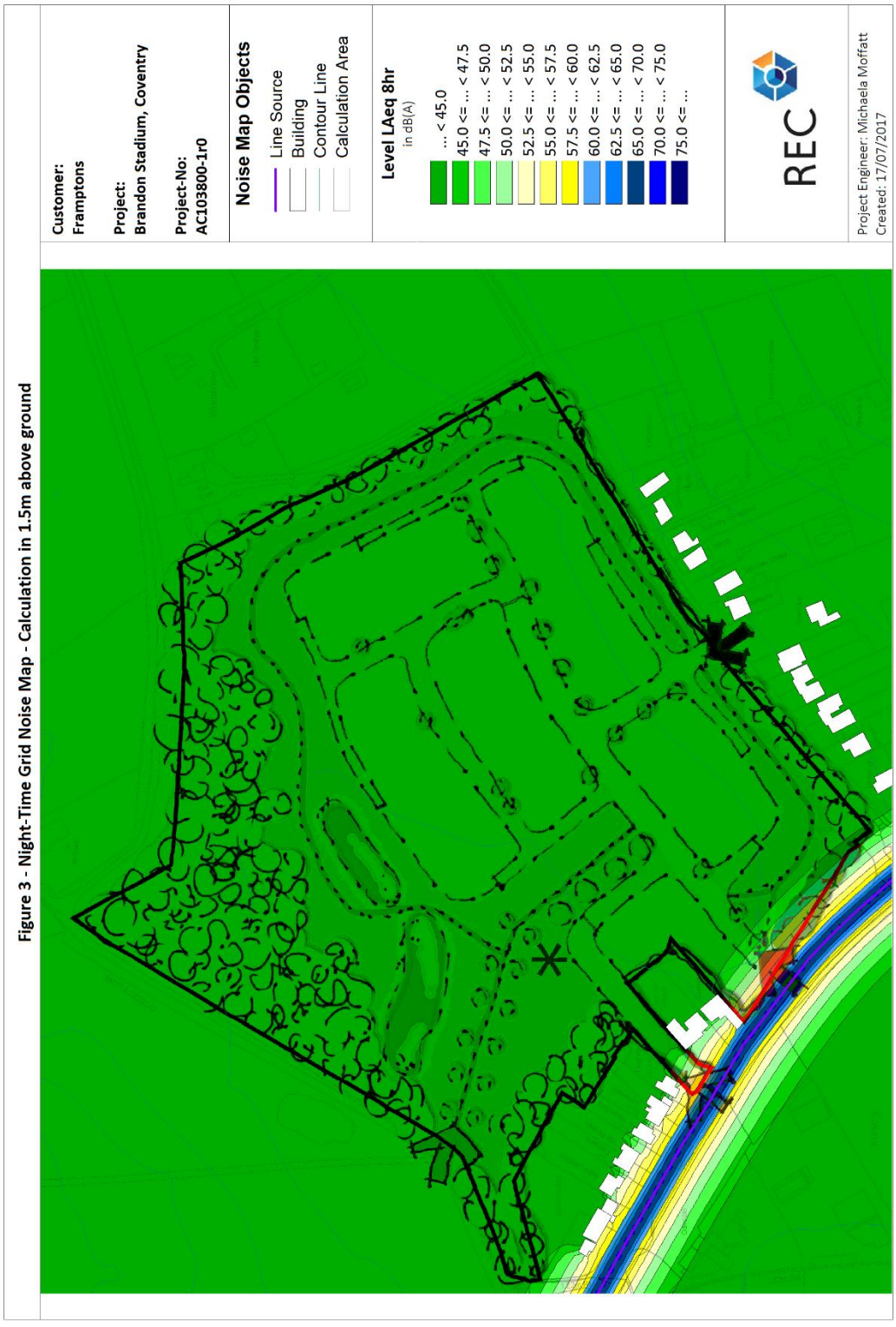

Figure 3 - Night-Time Grid Noise Map - Calculation in 1.5m above ground

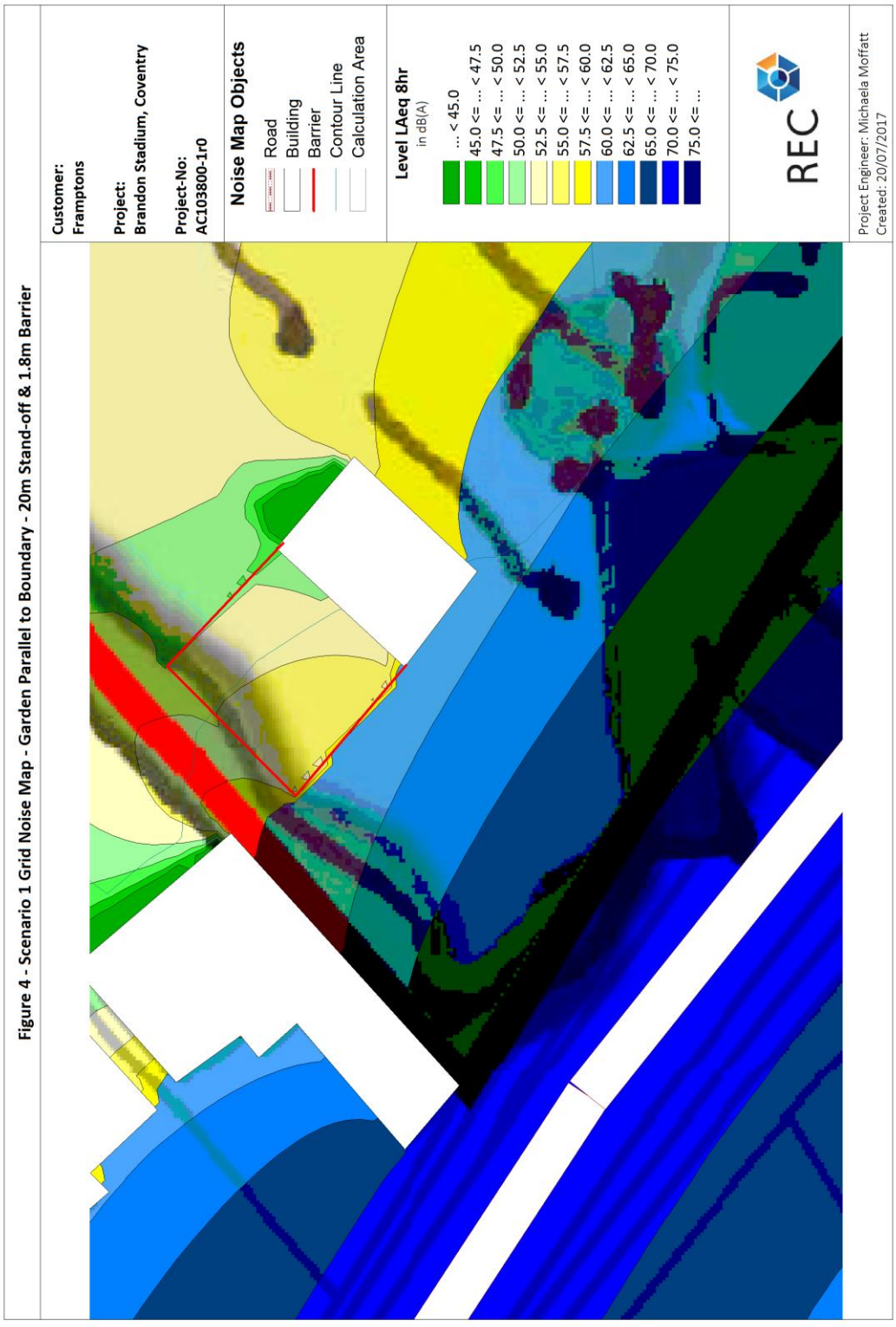

Figure 4 - Scenario 1 Grid Noise Map - Garden Parallel to Boundary - 20m Stand-off & 1.8m Barrier

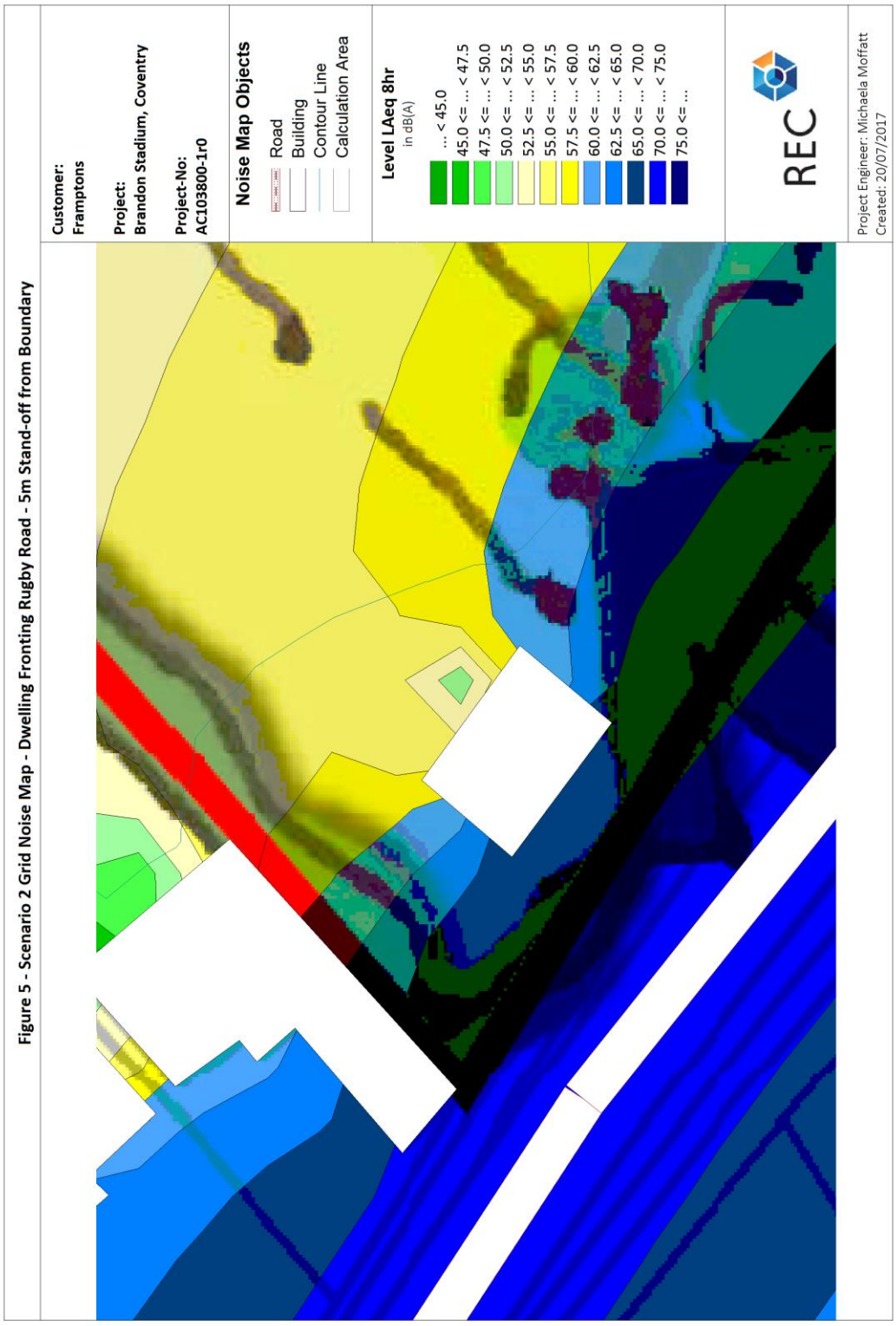

Figure 5 - Scenario 2 Grid Noise Map - Dwelling Fronting Rugby Road - 5m Stand-off from Boundary