



NOISE IMPACT ASSESSMENT 3G SYNTHETIC PITCH, HAVANT RFC

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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 Rugby Football Union to provide a Noise Impact Assessment for the proposed construction of a new synthetic turf rugby pitch at Havant RFC.

A Noise Survey has been completed at the location of the AGP in order to quantify the existing levels of noise at the closest receptors as well as to measure source noise levels from a rugby training session.

The Noise Impact Assessment has determined that during a training match at the most sensitive periods, i.e. between 21:00 and 22:00, the change in ambient noise levels is predicted to be +2.4dB, resulting in a negligible impact.

Furthermore, the results of the rugby training assessment pass Test 1 in the Sport England Guidance (Existing $L_{Aeq,1hr} + AGP L_{Aeq,1hr} \leq 3dB$) and Test 2 ($AGP Noise \leq 50dB L_{Aeq,1hr}$) given in the Sport England Guidance.

Accordingly, no mitigation measures are required. Furthermore, when considering internal levels in living rooms, with a partially open window, the predicted level whilst training is taking place will be 31dB, 4dB below the criteria. Accordingly, no adverse impact during the more sensitive periods is likely to take place.

The Noise Impact Assessment has determined that the NOAEL will be achieved with noise being noticeable but 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.





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1. INTRODUCTION

Resource and Environmental Consultants (REC) Limited have been commissioned by Rugby Football Union (RFU) to undertake a Noise Impact Assessment for the proposed construction of a new synthetic turf rugby pitch at Havant RFC on Hooks Lane in Havant, to be referred to hereafter as '*the Artificial Grass Pitch (AGP)*'.

This assessment has been undertaken to identify key noise sources associated with the AGP which may have the potential to impact upon the existing residential receptors in the vicinity of the AGP.

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

1.1 Site Location and Proposed Development

Havant RFC is located on Hooks Lane, Fraser Road, Havant, Hampshire PO9 3EJ. The club is predominantly surrounded by residential properties and schools, community buildings, and a St John's ambulance station. Havant Town Centre and retail park is located approximately 1km to the south east, and the village centre of Bedhampton, approximately 0.7km to the south. The main source of noise at the boundaries of the site is distant road traffic, birdsong and local sound sources.

Proposals include for the construction of a synthetic pitch which will allow the intensification of use. The site is currently restricted due to the weather and drainage of the pitches. Proposals include for the use of the AGP between 09:00 – 22:00 Monday to Friday, 09:00 – 20:00 Saturdays and Sundays.

The key noise sources associated with the intensified AGP use will be from rugby training sessions and rugby matches, in line with the operational hours of the facility outlined above.

This assessment has been undertaken with due regard to the supplied masterplan shown on the following planning drawing:

- ▶ Proposed Location Plan (drawing number MUK1853 07 Rev F) dated 21st November 2017 and produced by SIS Pitches.

The Location Plan is shown in Figure 1 of Appendix III.

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 METHODOLOGY

2.1 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.
- ▶ 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			





Perception	Examples of Outcomes	Increasing Effect Level	Action
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. 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.	Observed Adverse Effect	Mitigate and reduce to a minimum
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;
- ▶ 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.



- ▶ 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 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 exceed 45dB L_{max}		

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”.

2.3 Institute of Environmental Management & Assessment ‘Guideline for Environmental Noise Impact Assessment’, October 2014

The guidelines address the key principles of noise impact assessment and are applicable to all development proposals where noise effects are likely to occur. The guidelines provide specific support on how noise impact assessment fits within the Environmental Impact Assessment (EIA) process. They cover:

- ▶ How to scope a Noise Assessment;
- ▶ Issues to be considered when defining the baseline noise environment;





- ▶ Prediction of changes in noise levels as a result of implementing development proposals; and,
- ▶ Definition and evaluation of the significance of the effect of changes in noise levels (for use only where the assessment is undertaken within an EIA).

Although the guidance states that it is only applicable for use in an Environmental Impact Assessment (EIA), in the absence of any other relevant guidance for assessing changes in ambient noise levels, it is the most appropriate document for establishing significance of effect.

Table 3 categorises the change in noise level for a noise sensitive receptor.

Table 3 Effect Descriptors

Effect	Change in Ambient Noise Level
Major	>10dB
Moderate	5.0dB – 10.0dB
Minor	3.0dB – 5.0dB
Negligible	1.0 – 3.0dB
None/not significant	0 – 1.0dB

2.4 Artificial Grass Pitch Acoustics – Design Guidance Note

The Design Guidance Note Artificial Grass Pitch (AGP) Acoustics, released in August 2015, provides details of acoustic implications associated with such facilities and follows on from an acoustic research programme involving detailed analysis of relevant noise guidance documents and site testing in a range of locations. It proposes appropriate noise criteria and assessment methods and outlines practical measures that can be applied to reduce noise in particular sensitive areas. There is no previous guidance or assessment methodology specifically relating to noise from AGPs and this guidance considers the issues from first principles.

With no specific noise criteria for an AGP, the following documents are considered the most relevant and the most commonly applied for the assessment of AGP noise:

- ▶ World Health Organisation 'Guidelines for Community Noise'; and,
- ▶ IOA / IEMA Working Party Consultation Draft 2002.

The World Health Organisation's (WHO) Document provides guidance for outdoor living areas stating that to avoid 'moderate annoyance' during the daytime and evening the noise level should not exceed 50dB $L_{Aeq,16hr}$. However, for an AGP, a 16-hour assessment period may not truly reflect the noise impact as it takes into account time of use and non-use. It is suggested that an appropriate assessment time period is for one 1-hour as this is typically the time period for a community sports session on an AGP. In some circumstances, an alternative assessment methodology may be appropriate such as where there are changes to an existing natural turf or AGP pitch. The IOA / IEMA Working Party Consultation Draft 2002 categorises the significance of a change in noise level. A 'slight' impact is considered for an increase of less than 3dB which is generally accepted as being the minimum perceptible change to a





human ear. The noise levels are to be measured using the L_{Aeq} parameter over the same time period, T (taken as being 1-hour).

Table 4 summarises the noise level criteria relative to the development scenario.

Table 4 Noise Level Criteria

Noise Criteria, by Scenario	
Proposed Noise-sensitive Development close to Existing AGP	Proposed AGP close to Existing Noise-sensitive Development
50dB $L_{Aeq,1hr}$	Test 1: Existing $L_{Aeq,1hr}$ + AGP $L_{Aeq,1hr} \leq 3dB$ and; Test 2: AGP Noise $\leq 50dB$ $L_{Aeq,1hr}$

The Design Guidance Note goes on to state that a typical free-field noise level of 58dB $L_{Aeq,1hr}$ at a distance of 10m from the side-line halfway marking has been determined as being representative of noise from an AGP. By virtue that AGP's do vary in size and sport type, REC suggest that wherever possible, noise measurements should be taken of a similar AGP under the same sport type conditions.





3. NOISE SURVEYS

3.1 Ambient Sound Survey

REC has conducted an attended ambient sound survey immediately prior to current rugby training and immediately after in order to establish the existing levels of sound at closest existing receptors on Hooks Lane. The survey was carried out over the following time period:

- ▶ Tuesday 17th April between 18:00 and 19:00 and 21:00 and 22:00.

The following noise measurement position was chosen for the Ambient Sound Survey:

- ▶ Noise Measurement Position 1 (NMP1): Located on the south eastern Site boundary of the Site immediately adjacent the receptors on Hooks Lane. The microphone of the sound level meter was located at a height of 1.5m above the ground in free-field conditions. Noise sources at this location consisted predominately of distant road traffic noise on the local road network and intermittent birdsong.

A summary of the measured sound pressure levels from the sound survey are presented in Table 5.

Table 5 Measured Sound Levels at NMP1

Measurement Start Time	Measured Sound Pressure Level, $L_{Aeq,15mins}$ (dB)
18:00	54.6
18:15	54.0
18:30	59.8
18:45	52.8
21:00	52.3
21:15	50.5
21:30	49.0
21:45	47.6

The weather conditions during the Noise Surveys were conducive towards the measurement of environmental noise, being fine and dry with wind speeds of less than 5.0m/s.

3.2 Rugby Training Source Noise Measurements

REC have conducted a Source Noise Measurement of a typical Rugby Training session at Havant RFC. The survey was carried out between the following periods:

- ▶ Tuesday 17th April 2018 between 19:00 and 21:00.

The following noise measurement position was chosen for the Source Noise Measurements:





- Noise Measurement Position 2 (NMP2): The noise measurement position was located adjacent to the centre approximately 39m from the centre of the pitch. The microphone was located in free-field conditions at a height of 1.5m above ground level.

A summary of the measured sound pressure levels from the Source Noise Survey are presented in Table 6. The results below reflect the hourly blocks of measurements.

Table 6 Source Noise Measurement Results from Rugby Training

Activity	Measured Noise Level (dB)	Sources
Training	56.6	Players running and training general
Training Match	58.9	Practice Rugby Match

The following equipment was used for the Noise Surveys. Calibration dates relate to those at the time of the surveys.

Table 7 Noise Measurement Equipment

Measurement Position	Equipment Description	Manufacturer & Type No.	Serial No.	Calibration Due Date
NMP1 and NMP2	Sound Level Meter	01dB-Metravib Black Solo	65211	30 th March 2019
	Pre-amplifier	01dB-Metravib PRE 21 S	16831	
	Microphone	01dB Metravib MCE212	142644	
	Calibrator	01dB-Metravib CAL-21	34113643	25 th October 2018

The sound level meter was field-calibrated on Site prior to and after noise measurements were taken. No significant drift was witnessed. Calibration certificates are available upon request.





4. NOISE IMPACT ASSESSMENT

4.1 AGP Usage Noise Impact Assessment

When assessing the noise from the use of the AGP it is important to consider the different uses and activities during a typical day. Therefore, this assessment will look at rugby training during the most sensitive periods, 21:00 – 22:00.

In order to accurately assess the impact, a change in ambient noise level assessment will be undertaken where a change of less than 2.9dB is considered negligible as a change of less than 3dB is not perceptible to the human ear.

The measured noise levels from the centre have been taken as the equivalent 1-hour noise level ($L_{Aeq,1hr}$), where applicable. The noise levels have been distance corrected to the closest receptors using the following formula:

$$L_{Aeq,1hr} = 20 \times \log (D_2/D_1)$$

Where D_1 = Measurement Distance; and
 D_2 = Distance to Receptor.

Tables 8 and 9 calculate the resulting noise level at the closest existing receptors to the AGP due to rugby training for the daytime period. Distance correction has been applied where applicable. The worst case measured existing ambient sound level was 47.6dB at 21:45. Given that the existing gardens either have a garden fence or are located behind dwellings, a correction of -5dB to account for partial line of sight removal has been applied. The assessment is based on the level change during the daytime which would only be perceptible outside. Any living rooms facing the AGP will benefit from -15dB for a partially open window.

Table 8 Calculation of Noise Level at Receptors – Rugby Training

Receptor	Measured Noise Level of Rugby Training, $L_{Aeq,1hr}$ (dB)	Measurement Distance to centre of Pitch (m)	Distance to Centre of Garden (m)	Sound Pressure Level at the Receptor, $L_{Aeq,1hr}$ (dB)
Hooks Lane	58.6	39	89	46.4

Table 9 Predicted Change in Ambient Noise Level – Rugby Training

Receptor	Sound Pressure Level at the Receptor, $L_{Aeq,1hr}$ (dB)	Existing Ambient Sound Level, $L_{Aeq,1hr}$ (dB)	Combined Noise Level (dB)	Difference +/- (dB)
Hooks Lane	46.4	47.6	50.1	+2.5

Table 9 indicates that the ambient noise level at the closest residential receptors will increase during rugby training. Table 10 compares this change in noise level to the appropriate criteria.





Table 10 **Categorisation of Change in Ambient Noise Level – Rugby Training**

Receptor	Predicted Change in Noise Level (dB)	Applicable Category
Hooks Lane	+2.4	None/Not Significant

Table 10 indicates that during rugby training, the predicted change in ambient noise level results in a none/not significant or negligible impact. This would result in the NOAEL 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.”

Furthermore, the results of the rugby training assessment pass Test 1 (Existing $L_{Aeq,1hr} + AGP L_{Aeq,1hr} \leq 3dB$) and Test 2 ($AGP Noise \leq 50dB L_{Aeq,1hr}$) given in the Sport England Guidance.

Accordingly, no mitigation measures are required. Furthermore, when considering internal levels in living rooms, with a partially open window, the predicted level whilst training is taking place will be 31dB, 4dB below the criteria. Accordingly, no adverse impact during the more sensitive periods is likely to take place.





5. CONCLUSION

REC Ltd were commissioned by Rugby Football Union to provide a Noise Impact Assessment for the proposed construction of a new synthetic turf rugby pitch at Havant RFC.

A Noise Survey has been completed at the location of the AGP in order to quantify the existing levels of noise at the closest receptors as well as to measure source noise levels from a rugby training session.

The Noise Impact Assessment has determined that during a training match at the most sensitive periods, i.e. between 21:00 and 22:00, the change in ambient noise levels I predicted to be +2.4dB, resulting in a negligible impact.

Furthermore, the results of the rugby training assessment pass Test 1 in the Sport England Guidance (Existing $L_{Aeq,1hr} + AGP L_{Aeq,1hr} \leq 3dB$) and Test 2 ($AGP Noise \leq 50dB L_{Aeq,1hr}$) given in the Sport England Guidance.

Accordingly, no mitigation measures are required. Furthermore, when considering internal levels in living rooms, with a partially open window, the predicted level whilst training is taking place will be 31dB, 4dB below the criteria. Accordingly, no adverse impact during the more sensitive periods is likely to take place.

The Noise Impact Assessment has determined that the NOAEL will be achieved with noise being noticeable but 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.





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 ACOUSTIC 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	Location/Example
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





Acoustic Terminology

Table A2 Terminology

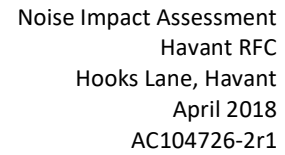
Descriptor	Explanation
dB (decibel)	The scale on which sound pressure level is expressed. It is defined as 20 times the logarithm of the ratio between the root-mean-square pressure of the sound field and a reference pressure (2x10 ⁻⁵ Pa).
dB(A)	A-weighted decibel. This is a measure of the overall level 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 Leq 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



[illegible]