NORTH EVELEIGH REDEVELOPMENT

PRELIMINARY ACOUSTIC REPORT – RAIL TRAFFIC NOISE AND VIBRATION
ACOUSTIC DESIGN CONSIDERATIONS - MARCH 2007

Prepared for:

Redfern-Waterloo Authority
Attention: Ms Kerrie Symonds
Project Manager
Redfern-Waterloo Authority
Level 11, Tower 2
1 Lawson Square
(PO Box 3332)
REDFERN NSW 2016

Email: Kerrie.Symonds@rwa.nsw.gov.au
Phone: 02 9202 9126
Fax: 02 9292 9111

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acoustic dynamics

ACOUSTIC DYNAMICS PTY LTD
SOUND AND VIBRATION - MEASUREMENT, EFFECTS AND ASSESSMENT
MEMBER - ASSOCIATION OF AUSTRALIAN ACOUSTICAL CONSULTANTS
SUITE 12 / 38-46 ALBANY STREET ST LEONARDS NSW 2065 (PO BOX 270 NEUTRAL BAY NSW 2089)
ABN 36 105 797 715 ACN 105 797 715 FAX +61 2 9908 1271 PHONE +61 2 9908 1270
www.acousticdynamics.com.au acoustics@acousticdynamics.com.au

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EXECUTIVE SUMMARY

Acoustic Dynamics has been engaged by the Redfern-Waterloo Authority (RWA) to provide a preliminary assessment and advice of potential noise and vibration impact at the proposed North Eveleigh development site, resulting from the proximity of the site to the adjacent railway corridor.

This report examines the proposed Concept Plan and addresses, in accordance with the Director-General's Requirement's issued under Section 75F of the *Environmental Planning and Assessment Act 1979*, noise and vibration impacts from adjacent rail activities, including mitigation and monitoring measures where appropriate. This is undertaken consistent with guidelines published by RailCorp including:

- *Interim Guidelines for Applicants – Consideration of Rail Noise and Vibration in the Planning Process; and*
- *Interim Guidelines for Councils – Consideration of Rail Noise and Vibration in the Planning Process.*

The State Environmental Planning Policy (Infrastructure) 2007 is also addressed, as it relates to noise and vibration. Monitoring and measurement results from surveys conducted at the site during September 2007 are analysed.

Further to our comparison of the data obtained from site noise and vibration surveys with the RailCorp guidelines and SEPP (Infrastructure), the following conclusions are drawn:

- **The facade setbacks proposed for the concept design and detailed within Table 1.3.1 are considered acceptable with regard to noise and vibration intrusion;**

- **The site layout proposed for the concept design allows for the provision of some "acoustically" shielded outdoor areas for recreational and other uses;**

- **The site layout proposed for the concept design provides some buildings and facades with "acoustic" shielding from direct line-of-site to the adjacent railway corridor;**

- **Based on the above information, the concept design facade setback information detailed in Table 1.3.1 and subsequent to the inclusion of adequate acoustic design measures, the proposed development of the North Eveleigh site <u>can</u> be constructed to comply with the various applicable criteria, standards and guidelines for rail related vibration intrusion; and**

- **Conduct further investigations into various acoustic design aspects, during the detailed design stages of the project, as detailed within section 8.2 of this report.**

1 INTRODUCTION

1.1 General

Acoustic Dynamics has been engaged by the Redfern-Waterloo Authority (RWA) to provide a review of relevant documentation and a preliminary assessment and advice of potential noise and vibration impact at the proposed North Eveleigh development site, resulting from the proximity of the site to the adjacent railway corridor.

In this report, Acoustic Dynamics outlines and provides detail of relevant noise and vibration criteria included in RailCorp guidelines and the SEPP (Infrastructure) 2007,. This report also presents measurement results, findings and recommendations following noise and vibration measurements carried out at the North Eveleigh site during September 2007.

This report is to be reviewed and consulted by both RWA and the project architect and further investigations undertaken during the design and development phase of the North Eveleigh site to ensure relevant design considerations relating to potential rail noise and vibration impact are incorporated into the project.

This report has been prepared in accordance with the requirements and principles of Acoustic Dynamics' Quality Control System.

1.2 Report Structure

Further to the background information provided within section 1 of this report, the structure of this report is as follows:

- Section 2 - Relevant acoustic design guidelines and policy required to be assessed by the Director-General;
- Section 3 - Detail of instrumentation used for measurements and relevant measurement standards;
- Section 4 - Results of noise measurements and monitoring;
- Section 5 - Results of vibration measurements and monitoring;
- Section 6 - A discussion of noise measurements and impact;
- Section 7 - A discussion of vibration measurement results and impact; and
- Section 8 - Conclusions and areas for further investigation.

1.3 Background

The subject North Eveleigh site, within the Redfern Waterloo precinct, bounded by the main western railway corridor, Iverys Lane to the west, Wilson Street to the north and residential properties fronting Little Eveleigh Street, was formerly used by RailCorp and its predecessors as railway work yards and workshops.

At the North Eveleigh site, there are numerous buildings, including some presently in use, and others presently unused, some buildings with historical (heritage) significance, others without such significance, rail turnout facilities, two railway workshop traversers and various other buildings and structures.

The largest building at the site, formerly the carriage workshop, now known as "CarriageWorks", was recently refurbished by the NSW State Government in conjunction with Arts NSW, and has been transformed into a bold new centre committed to the nurturing, development and presentation of contemporary arts. The building retains its original heritage external form, however the inside has been transformed to contain two large flexible theatre spaces and a smaller space. This building and its facilities demonstrate that a functional world class performance space can be developed directly adjacent to a railway corridor provided appropriate mitigation measures are incorporated into the design.

The Redfern-Waterloo Authority (RWA) is currently investigating re-development of this and the remainder of the site and its buildings and is considering plans for various uses of different areas, which may include the following:

- A market area;
- Various retail areas;
- Commercial buildings;
- Residential buildings;
- Mixed use buildings (commercial/residential); and
- Various parking facilities.

Based on the concept design information provided to Acoustic Dynamics, Table 1.3.1 presents approximate facade setback distances to the nearest railway track in use, from the nearest facades of buildings proposed within the North Eveleigh re-development.

Table 1.3.1 Proposed Setback Distances to Nearest Railway Track from Nearest Facade

Building	Number of Storeys	Type	Approximate Facade Setback [m]
A1	4	Residential	120
A2	4	Residential	120
A3	4	Residential	120
B1	6	Residential	50
C1	12	Residential	20
C2	8	Residential	20
C3	5	Residential	20
C4	2	Existing Heritage – Adaptive Re-use	75
D1	8	Residential	20
D2	12	Residential	20
D3	5	Residential	20
D4	5 / 6	Residential	85
E1	4	Residential	120
E2	4	Residential	120
E3	4	Residential	120
F1	4	Residential	85
G1	5	Residential	90
G2	5	Residential	90
H1	1	Existing Heritage – Adaptive Re-use	25
H2	4	Residential	15
H3	4	Residential	15
H4	4	Residential	15
J1	5	Office / Retail	20
K1	8	Office / Retail	10
K2	8	Office / Retail	12
L1	8	Office / Retail	15
L2	8	Office / Retail	20
M1	8	Office / Retail	20
M2	8	Office / Retail	25
N1	2	Existing Heritage – Adaptive Re-use	80
N2	2	Existing Heritage – Adaptive Re-use	90
P1	16	Residential	30
Q1	1	Existing Heritage – Adaptive Re-use	20
R1	1	Existing Heritage – Adaptive Re-use	120
S1	1	Existing Heritage – Adaptive Re-use	120

2 RELEVANT ACOUSTIC DESIGN STANDARDS CRITERIA AND GUIDELINES

2.1 Director General's Requirements

In accordance with the requirements of Part 3A of the *Environmental Planning and Assessment Act 1979* the Director-General of the Department of Planning is to prepare environmental assessment requirements (DGRs).

These requirements relating directly to noise and vibration are reproduced below:

> *"Address noise and vibration impacts from adjacent rail activities, including mitigation and monitoring measures where appropriate, consistent with guidelines published by RailCorp including "Interim Guidelines for Applicants - Consideration of Rail Noise and Vibration in the Planning Process" and "Interim Guidelines for Councils - Consideration of Rail Noise and Vibration in the Planning Process".*

In addition the DGRs require that the Environmental Assessment address the SEPP (Infrastructure) 2007.

Acoustic Dynamics has conducted a review of the above guidelines and policy. A summary of these is presented within the following sections.

2.2 RailCorp's "Interim Guidelines for Councils – Consideration of Rail Noise and Vibration in the Planning Process"

These guidelines have been prepared by Rail Infrastructure Corporation (RIC) and State Rail Authority (SRA) to assist local government and the regulatory authorities in assessing and considering rail noise and vibration as part of their strategic planning and development control functions. By implementing the *"Guidelines for Councils"*, it is anticipated that an appropriate acoustic amenity can be achieved for future development, in particular, residential development near the railway corridor.

To assist Councils in assessing and determining development applications, the guideline recommends that all multi-unit residential and other noise-sensitive proposals located within 60 m of an operational railway line, be subject to an acoustic assessment.

The guideline recommends that new residential buildings be designed and constructed to comply with the design noise criteria presented within Table 2.2.1, in habitable rooms, with external windows and doors closed. If noise levels with Windows or doors open exceed these criteria by more than 10 dB(A), the design of the ventilation for these rooms should be such that the occupants can leave windows closed, if they so desire.

Table 2.2.1 Recommended Design Criteria for Habitable Rooms with Windows & Doors Closed

Internal Space	Time Period	Railway Noise L_{Aeq} (1 hr) Level
Living and sleeping areas	Day (7am to 10pm)	40 dB(A)
	Night (10pm to 7am)	35 dB(A)

Where residential buildings are constructed adjacent to railway tunnels, ground-borne noise may be present without the masking effects of normal airborne railway noise. In such cases, residential buildings should be designed and constructed to comply with an L_{Amax} ground-borne noise limit of 40 dB(A). For some residential buildings, the proponents may wish to apply more stringent design goals in response to market demand for higher quality living environment. Such design goals are discussed within the AAAC's star rating guide.

Floor vibration levels in habitable room should comply with the criteria in British Standard BS 6472:1992 "*Evaluation of Human Exposure to Vibration and Buildings (1 Hz to 80 Hz)"*. This is the vibration standard recommended by DIPNR and the DECC. It is similar to AS 2670.2-1990 "*Evaluation of human exposure to whole-body vibration – Part 2: Continuous and Shock-induced vibration in buildings (1 to 80 Hz)"* but includes additional guidance in relation to intermittent vibration such as that emitted by trains.

The British Standard contains significant additional guidance, and has been updated to take account of developments in vibration evaluation and assessment (particularly in relation. to complex patterns of vibration and 'vibration dose' concepts).

BS 6472:1992 includes information on the evaluation of intermittent vibration by introducing a 'vibration dose' concept. This approach can be used for the evaluation and assessment of vibration from trains and other vibration sources which are not continuous.

BS 6472:1992 also includes improved guidance on the degrees of community response associated with various values of vibration and better illustrative examples of applications of the standard's procedures. The following information is derived from Acoustic Dynamics' review of BS 6472:1992.

Ground vibrations may cause reactions in affected occupants ranging from *'just perceptible',* to *'concern',* to *'alarm'* and then to *'discomfort'.* The subjective response varies widely and is a function of situation, information, time of day and duration.

British Standard BS 6472:1992 *"Guide to evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)"* gives base curves of vibration for minimal adverse comment, and also vibration dose values (VDVs) at which complaints are probable. VDVs may be used to assess the severity of impulsive and intermittent vibration, such as experienced from blasting at quarries or from rail traffic, and steady vibration such as from a busy road or fixed plant.

The adoption of the VDV parameter is based on social studies undertaken in the 1980s and early 1990s into human response to vibration. BS 6472 requires that the VDV be determined separately for the 16-hour daytime (07.00-23.00) and 8-hour night-time (23.00-07.00) periods.

The VDV is given by the fourth root of the integral of the fourth power of the acceleration after it has been frequency-weighted:

$$VDV = ({}^{\circ}{}_{0}{}^{T}a^{4}(t)dt)^{0.25}$$

where VDV is the vibration dose value (in $ms^{-1.75}$), a(*t*) is the frequency-weighted acceleration (ms^{-2}) and T is the total period of the day (in seconds) during which vibration may occur.

The VDV is measured in each of the three whole-body orthogonal axes and the maximum from the three axes used. Where the vibration conditions are constant or regularly repeated only one representative period need be measured (or predicted) and the 16-hour daytime (or 8-hour night-time) overall VDV level may be calculated from the shortened data.

Where measurement of similar installations is not possible and predictions of VDV are necessary the following formula may be used to predict the estimated vibration dose value, eVDV, knowing the likely frequency weighted rms acceleration level of the source, a, (or estimating this from the known or measured peak particle velocity) and the duration of exposure, t, in seconds:

$$eVDV = 1.4(a)(t^{0.25})$$

The predicted or measured VDV may then be compared to Table 7 in the Appendix of BS 6472, (reproduced below as Table 2.2.2), to identify the likelihood of complaint.

Table 2.2.2 Vibration Dose Values ($ms^{-1.75}$) Above which Various Degrees of Adverse Comment may be Expected in Residential Buildings (taken from BS 6472:1992)

Location	**VDV, $ms^{-1.75}$**		
	Low probability of adverse comment	**Adverse comment possible**	**Adverse comment probable**
Residential buildings, 16h day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings, 8h night	0.13	0.26	0.54

For example, between 0.4 and 0.8ms$^{-1.75}$ adverse comment regarding daytime vibration levels becomes possible, or when the VDV increases above 0.54ms$^{-1.75}$ at night adverse comment becomes probable. For office and commercial buildings the suggested daytime limits above are relaxed by a factor of up to two (Table 5 of BS 6472:1992) as shown in Table 2.2.3 below.

Table 2.2.3 Vibration Dose Values (ms$^{-1.75}$) Above which Various Degrees of Adverse Comment may be Expected in Commercial Buildings (based on Table 2.2.2, taken from BS 6472:1992)

Location	**VDV, ms$^{-1.75}$**		
	Low probability of adverse comment	**Adverse comment possible**	**Adverse comment probable**
Commercial buildings, daytime	0.4 to 0.8	0.8 to 1.6	1.6 to 3.2

Data included in BS 6472:1992 may therefore be used to assess the likelihood of adverse comment arising at residential or commercial property from temporary or permanent vibration sources to be introduced into a residential area (demolition, construction, new industrial premises etc.), or from occupiers of future residential or commercial property proposed for a site subject to existing vibration (proposed residential site adjacent to railway lines, for example).

The NSW DECC's document *"Assessing Vibration: A Technical Guideline"* presents preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations of the measurement and evaluation techniques.

The criteria presented are non-mandatory goals that should be sought to be achieved through the application of all feasible and reasonable mitigation measures. Where all feasible and reasonable measures have been applied and vibration values are still beyond the maximum value, the operator would need to seek specialist advice for mitigation measures and negotiate directly with the affected community. Sources of vibration, covered in this guideline include construction and excavation equipment, rail and road traffic, and industrial machinery.

Individuals can detect building vibration values that are well below those that can cause any risk of damage to the building or its contents. The level of vibration that affects amenity is lower than that associated with building damage.

The guideline is designed to be used in evaluating and assessing the effects on amenity of vibration emissions from industry, transportation and machinery. It also has a useful role in assisting planning decisions for proposed developments (e.g. setting conditions of consent). It is directed towards officers of the DECC and to proponents (and their consultants) of developments. Local councils and other regulatory authorities, planners, and others who are responsible for the evaluation or control of vibration emissions and their effects on the community will be guided by the guideline.

The guideline states that it is a useful reference:

- *"During the land-use planning stage to reduce conflicts that vibration can cause, such as the determination of railway corridors and the design of building footings".*

Vibration may be continuous (with magnitudes varying or remaining constant with time), impulsive (such as in shocks) or intermittent (with the magnitude of each event being either constant or varying with time).

Vibration resulting from railway traffic is characterised by the guideline as intermittent vibration. Intermittent vibration is defined by the guideline as interrupted periods of continuous or repeated periods of impulsive vibration, or continuous vibration that vary significantly in magnitude. It may originate from impulse sources or repetitive sources, or sources which operate intermittently, but which would provide continuous vibration if operated continuously (for example, intermittent machinery, railway trains and traffic passing by).

Indoor vibration values caused by an external source can be measured externally (in the ground) and translated to indoor values or measured internally and then compared to the relevant criteria. In some situations, where resonance of the building occurs, indoor values may be greater than the external ground vibration values, produced by the same source. For a detailed assessment users of this guideline may choose to perform indoor measurements or refer to relevant texts and literature, in order to translate ground vibration values to indoor values. Such an investigation is likely to form part of the detailed acoustic design of the project, rather than being included within the preliminary advice presented within this document.

When assessing intermittent vibration, the vibration dose value (VDV) is used. The VDV uses a fourth power acceleration method, making it more sensitive to peaks in the acceleration waveform. The VDV accumulates, the vibration energy received over the daytime and night-time periods. The vibration dose is fully described within British Standard BS 6472-1992. Alternatively, vibration velocity can be used to broadly estimate of the VDVs, however, where possible acceleration should be used when determining VDV.

Acceptable VDVs for intermittent vibration are set out within Table 2.2.4 below.

Table 2.2.4 Acceptable Vibration Dose Values for Intermittent Vibration (m/s$^{1.75}$)

Location	Daytime[1]		Night-time[1]	
	Preferred value	Maximum value	Preferred value	Maximum value
Critical areas[2]	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Officers, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Note: 1) Daytime is 7.00am to 10.00pm and night-time is 10.00pm to 7:00am.

2) Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulse of criteria critical areas.

There is low probability of adverse comment or disturbance to building occupants at vibration values below the preferred values. Adverse comment or complaints may be expected if vibration values approach the maximum values. Activities should be designed to meet the preferred values where an area is not already exposed vibration. Where all feasible and reasonable measures have been applied, values up to the maximum range may be used if they can be justified. For values beyond the maximum value, the operator should negotiate directly with the affected community.

The guideline discusses mitigation of sources of vibration. Controlling vibration at the source is discussed, and for railways, the guideline suggests:

> *"…jointed rail could be replaced by continuous welded rail in rail lines passing new sensitive premises. Rail vibration isolation systems include resilient rail fastenings, ballast mats and floating slabs. Rolling stock controls include keeping wheels regularly maintained."*

Although controlling vibration at the source would be ideal, in this investigation, note is made that mitigation of vibration via controls at the receiver, is the most appropriate means of mitigating railway vibration at the North Eveleigh redevelopment site.

With regard to controlling the transmission of railway vibration, the guideline states:

> *"Distance is one of the most effective mitigation measures against noise and vibration, although geological make-up, and terrain also have an effect. For example, some studies have shown that annoyance from railway vibration is easy inversely proportional to distance from railway tracks, with a rapid decrease in vibration disturbance as distance increases from 25 to 150 metres and a slower rate of reduction over 200 metres, until no vibration disturbance is detected at 500 metres (DUAP, 1997)."*

With regard to controlling vibration at the receiver, the guideline states:

> *"Land-use planning is a critical component in managing vibration impacts. Planning decisions can create or avoid vibration impacts. Decisions that do not consider vibration impacts (where they are present) will almost certainly create land-use conflict. At the initial planning stage it may be feasible to reduce or avoid vibration impacts by locating less vibration-sensitive land users (e.g. active recreation, industry) in the intervening land between the existing vibration-causing development and sensitive receivers. Alternatively, at the building stage, special building methods could be used to modify ground-borne vibration being transmitted into the building structure (e.g. isolation of foundation and footings using resilient elements such as rubber pads, all springs)."*

RailCorp's "Interim Guidelines for Councils – Consideration of Rail Noise and Vibration in the Planning Process" encourages Councils and proponents to involve an acoustic consultant early in the design process to provide advice relating to the location and orientation of buildings and their internal layout, all of which can affect the exposure of sensitive spaces to railway noise. The potential benefit of noise barriers and acoustic shielding from other structures should also be considered as part of the overall detailed design. This was undertaken for the concept plan.

The guideline indicates that an acoustic consultant would normally need to carry out noise and/or vibration measurements and then calculate the resultant internal noise and vibration levels, taking into account the particular features and intended use of the proposed development. At this stage, as the internal building layouts and uses have not been deterined, a detailed study should be undertaken during the development of the detailed design, using the measurement results presented within this report.

2.3 RailCorp's "Interim Guidelines for Applicants – Consideration of Rail Noise and Vibration in the Planning Process"

Further to the "Interim Guidelines for Councils" discussed above, "Interim Guidelines for Applicants" have also been prepared by Rail Infrastructure Corporation (RIC) and State Rail Authority (SRA) to assist those involved in the planning and design of developments that are potentially affected by rail noise and vibration.

The guideline suggests that relevant provisions of Council planning instruments, including local environmental plans, development control plans and master plans should be checked to verify whether there are any specific statutory provisions relating to rail noise and vibration. In addition, the guideline indicates the following State Government policy documents should also be reviewed:

- State Environmental Planning Policy (SEPP) No 65 – *"Design quality of residential flat buildings"*;

- *The Residential flat design code* (2002);

- *Integrating land use and transport* – a policy package for state government agencies, councils and developers. This includes *"Draft State Environmental Planning Policy No 66 – Integration of land use and transport"*

The criteria presented within this guideline do not differ from those summarised within section 2.2 above, however in addition to criteria presented for residential noise intrusion, floor vibration levels and structure-borne noise, the guideline discusses non-residential development. With regard to non-residential development, the guideline indicates that appropriate noise and vibration criteria should be determined for the various occupancies proposed within the subject development.

With regard to commercial occupancies, the guideline states:

> *"Commercial buildings should also be assessed, although in many cases, special measures are not required."*

The guideline indicates that an Australian Standard for railway noise is under development, and suggests the following Australian Standards be reviewed to determine appropriate criteria:

- AS 2107:2000 Acoustics – Recommended Design Sound Levels and Reverberation Times for Building Interiors;

- AS 2021:2000 Acoustics – Aircraft Noise Intrusion – Building Siting and Construction;

- AS 3671:1989 Acoustics – Road Traffic Noise Intrusion – Building Siting and Construction;

- BS 6472:1992 Evaluation of Human Response to Vibration in Buildings (1 Hz to 80 Hz).

As indicated within section 2.2 above, although some further investigation of this guideline is provided within this document, a detailed study should be prepared in conjunction with the development of the detailed design.

2.4 The NSW SEPP (Infrastructure) 2007

Acoustic Dynamics advises that the State Environmental Planning Policy (SEPP) (Infrastructure) 2007 was gazetted on 21 December 2007.

Although this policy states that it is intended to assist in the effective delivery of public infrastructure throughout the State, and hence specifically relates to public infrastructure

projects, the following relevant reference is made to developments adjacent to railway corridors:

> **"*87 Impact of rail noise or vibration on non-rail development***
>
> *(1) This clause applies to development for any of the following purposes that is on land in or adjacent to a rail corridor and that the consent authority considers is likely to be adversely affected by rail noise or vibration:*
> *(a) a building for residential use,*
> *(b) a place of public worship,*
> *(c) a hospital,*
> *(d) an educational establishment or child care centre.*
>
> *(2) Before determining a development application for development to which this clause applies, the consent authority must take into consideration any guidelines that are issued by the Director-General for the purposes of this clause and published in the Gazette.*
>
> *(3) If the development is for the purposes of a building for residential use, the consent authority must not grant consent to the development unless it is satisfied that appropriate measures will be taken to ensure that the following LAeq levels are not exceeded:*
> *(a) in any bedroom in the building—35 dB(A) at any time between 10.00 pm and 7.00 am,*
> *(b) anywhere else in the building (other than a garage, kitchen, bathroom or hallway)—40 dB(A) at any time."*

Acoustic Dynamics advises that the above criteria relate to noise intrusion and are consistent with other acoustic criteria outlined within sections 2.2 and 2.3 of this document.

3 MEASUREMENT PROCEDURES AND INSTRUMENTATION

3.1 General

During September 2007, Acoustic Dynamics undertook both operator-attended and unattended monitoring in order to investigate ambient noise and vibration levels received at the North Eveleigh site.

The procedures for all noise and vibration measurements and monitoring were in accordance with the relevant ISO and Australian Standards.

Sound pressure measurements and monitoring were carried out using a precision sound level meters conforming to the requirements of AS 1259-1990 "Sound Level Meters". Vibration measurements and monitoring were carried out with equipment conforming to the requirements of AS 2670.1 “Vibration – General Requirements” and AS 2670.2 “Vibration & Shock – Buildings”.

The survey instrumentation used for this investigation is set out in **Table 3.1**.

Table 3.1 Noise Survey Instrumentation

Type	Serial Number	Instrument Description
B&K 2260	2413547	Brüel & Kjær Modular Precision Sound Level Meter
4189	2395414	Brüel & Kjær 12.5 mm Prepolarised Condenser Microphone
4231	2412578	Brüel & Kjær Calibrator
B&K 2231	1588075	Brüel & Kjær Sound Level Meter
4155	1594002	Brüel & Kjær 12.5 mm Prepolarised Condenser Microphone
RTA-01	AD-RTA-01	RTA Type 1 Noise Logger
EL-315	15-203-510	ARL Type 1 Noise Logger
EL-316	16-203-502	ARL Type 1 Noise Logger
EL-315	15-203-504	ARL Type 1 Noise Logger
716A0406	BE9117	Instantel Minimate Plus 8 Channel Vibration Monitor
714A9701	BG8200	Instantel Standard Triaxial Geophone
714A8302	BQ8234	Instantel Low Level Triaxial Geophone

4 NOISE MEASUREMENT RESULTS AND NOISE ENVIRONMENT

4.1 General

Acoustic Dynamics deployed four (4) unattended noise loggers at various locations around the North Eveleigh redevelopment site to quantify the existing ambient noise environment between Wednesday 29 August and Thursday 6 September 2007.

During our site visit on 6 September 2007, Acoustic Dynamics conducted operator-attended noise measurements at representative locations to determine received noise levels resulting from rail traffic movements within the adjacent railway corridor.

The results obtained from the unattended noise loggers were processed to determine daytime and night-time L_{Aeq} noise levels, along with maximum (L_{Amax}) noise levels. These levels were subsequently compared to the relevant noise criteria identified and established within section 2 of this document.

A Measurement and Monitoring Location Plan is attached within **Appendix A** showing the noise monitoring and measurement locations.

4.2 Unattended Noise Monitoring Results

The noise data obtained at the four (4) unattended noise monitoring locations were processed to determine the existing ambient noise environment at each of the four (4) locations. The results are presented within Table 4.2.1 below.

Table 4.2.1 Unattended Noise Monitoring Results – Existing Ambient Noise Environment

Noise Monitoring Location	Measured Daytime $L_{Aeq(1hr)}$ Noise Level [dB(A)]	Recom'd Daytime Design Sound Level (L_{Aeq}) [dB(A)]	Measured Night-time $L_{Aeq(1hr)}$ Noise Level [dB(A)]	Recom'd Night-time Design Sound Level (L_{Aeq}) [dB(A)]	Maximum Measured Night-time L_{A1} Noise Level [dB(A)]	Sleep Disturbance Criterion[1] (L_{A1}) [dB(A)]
BG1	62	40	58	35	79	57
BG2	56		53		76	54
BG3	68		65		84	58
BG4	56		53		76	58

Note: 1) Sleep Disturbance criteria have been determined for each monitoring location.

Based on the information provided within Table 4.2.1 above, the following **indicative** maximum noise reductions would be required:

- Maximum noise reduction required from facade for daytime ~ 28 dB(A);
- Maximum noise reduction required from facade for night-time ~ 30 dB(A); and
- Maximum noise reduction required from facade for sleep disturbance ~ 36 dB(A).

Note should be made that the required facade noise reduction for the sleep disturbance criterion has been adjusted by 10 dB(A) to allow a correction for outdoor to indoor noise levels.

4.3 Operator-Attended Noise Measurements Results

During our site visit on 6 September 2007, Acoustic Dynamics conducted operator-attended noise measurements at two representative locations to determine noise levels resulting from rail traffic movements within the adjacent railway corridor.

During the detailed design stages of the project, the results obtained from the attended noise monitoring can be extrapolated to the building facades of the proposed North Eveleigh redevelopment and used to determine appropriate facade treatments to adequately reduce rail noise intrusion.

The results of the operator-attended noise monitoring are presented within Table 4.3.1 below.

Table 4.3.1 Operator Attended Noise Monitoring Results

Meas't Loc	Measurement Description	Approximate Distance from Measurement Loc to Train [m]	Measured L_{Aeq} of Train Passing By [dB(A)]	Measured L_{AE} of Train Passing By [dB(A)]	Measured L_{A1} of Train Horn [dB(A)]
A0	Train(s) Passing By	-	62	78	-
A0	Train(s) Passing By	-	72	85	-
A0	Train(s) Passing By	-	72	85	-
A0	Train(s) Passing By	24	72	87	-
A0	Train(s) Passing By	53	66	76	-
A0	Train(s) Passing By	24	70	81	-
A0	Train(s) Passing By	24	67	78	-
A0	Train(s) Passing By	34	70	83	-
A0	Train Horn	Unknown	-	-	85
A0	Train Horn	Unknown	-	-	81
A0	Train Horn	Unknown	-	-	81
B0	Train(s) Passing By	20	65	79	-
B0	Train(s) Passing By	20	69	82	-
B0	Train(s) Passing By	31	65	79	-
B0	Train(s) Passing By	-	67	80	-
B0	Train(s) Passing By	-	73	85	-
B0	Train(s) Passing By	27	70	83	-
B0	Train(s) Passing By	27	66	78	-
B0	Train(s) Passing By	31	64	77	-
B0	Train(s) Passing By	23	71	84	-
B0	Train(s) Passing By	23	66	78	-
B0	Train(s) Passing By	31	67	77	-
B0	Train(s) Passing By	41	62	75	-
B0	Train(s) Passing By	16	78	89	-
B0	Train(s) Passing By	12	75	87	-
B0	Train(s) Passing By	20	67	80	-
B0	Train(s) Passing By	23	69	84	-
B0	Train(s) Passing By	35	62	73	-
B0	Train(s) Passing By	12	82	92	-
B0	Train Horn	Unknown	-	-	86
B0	Train Horn	Unknown	-	-	78
B0	Train Horn	Unknown	-	-	85
B0	Train Horn	Unknown	-	-	87
B0	Train Horn	Unknown	-	-	75

5 VIBRATION MEASUREMENT RESULTS AND ENVIRONMENT

5.1 General

During our site visit on 6 September 2007, Acoustic Dynamics conducted operator-attended vibration measurements at a number of locations to determine levels of vibration at these locations resulting from rail traffic movements within the adjacent railway corridor.

The results obtained from the vibration measurements were processed in accordance with the relevant standards to determine vibration dose values (VDVs) and subsequently compared to the relevant vibration criteria identified and established within section 2 of this document.

A Measurement Location Plan is attached within **Appendix A** showing the vibration measurement locations.

5.2 Vibration Measurement Results

Table 5.2.1 to Table 5.2.6 present the processed results of the operator-attended vibration measurements at the various monitoring locations.

Table 5.2.1 Vibration Dose Values (VDVs) – Locations A0 and A10

Meas't No.	Time	Measurement Description	Meas't Loc 1	Meas't Loc 2	Overall VDV Loc 1 [mm/s$^{1.75}$]	Overall VDV Loc 2 [mm/s$^{1.75}$]	Acceptable Daytime VDV (Resid'l) [mm/s$^{1.75}$]	Acceptable Night-time VDV (Resid'l) [mm/s$^{1.75}$]
0003	11:37:05	Train(s) Passing By	A0	A10	2.7	3.0		
0004	11:37:49	Train(s) Passing By	A0	A10	2.2	2.3		
0005	11:39:58	Background (No Trains)	A0	A10	0.9	0.2		
0006	11:43:01	Train(s) Passing By	A0	A10	2.4	2.4		
0007	11:45:44	Train(s) Passing By	A0	A10	2.8	2.8	200	130
0008	11:46:56	Train(s) Passing By	A0	A10	4.1	4.1	(0.2m/s$^{1.75}$)	(0.13m/s$^{1.75}$)
0009	11:51:31	Train(s) Passing By	A0	A10	4.0	3.8		
0010	11:56:25	Train(s) Passing By	A0	A10	5.5	6.1		
0011	12:00:02	Train(s) Passing By	A0	A10	7.0	7.2		
0012	12:04:29	Train(s) Passing By	A0	A10	3.9	4.3		
				Overall	**8.1**	**8.4**	**200**	**130**

Table 5.2.2 Vibration Dose Values (VDVs) – Locations A0 and A20

Meas't No.	Time	Measurement Description	Meas't Loc 1	Meas't Loc 2	Overall VDV Loc 1 [mm/s$^{1.75}$]	Overall VDV Loc 2 [mm/s$^{1.75}$]	Acceptable Daytime VDV (Resid'l) [mm/s$^{1.75}$]	Acceptable Night-time VDV (Resid'l) [mm/s$^{1.75}$]
0013	12:10:52	Background (No Trains)	A0	A20	0.9	0.4	200 (0.2m/s$^{1.75}$)	130 (0.13m/s$^{1.75}$)
0014	12:12:12	Train(s) Passing By	A0	A20	4.4	2.6		
0015	12:21:47	Train(s) Passing By	A0	A20	3.7	2.2		
0016	12:22:38	Train(s) Passing By	A0	A20	3.0	2.0		
0017	12:23:59	Train(s) Passing By	A0	A20	4.3	3.3		
0018	12:26:24	Train(s) Passing By	A0	A20	4.3	2.9		
0019	12:27:20	Background (No Trains)	A0	A20	2.0	1.6		
0020	12:28:35	Train(s) Passing By	A0	A20	2.5	1.8		
0021	12:29:52	Train(s) Passing By	A0	A20	4.8	3.3		
0022	12:32:40	Train(s) Passing By	A0	A20	2.2	1.9		
0023	12:37:58	Background (No Trains)	A0	A20	1.6	0.8		
				Overall	**6.6**	**4.6**	**200**	**130**

Table 5.2.3 Vibration Dose Values (VDVs) – Locations A0 and A40

Meas't No.	Time	Measurement Description	Meas't Loc 1	Meas't Loc 2	Overall VDV Loc 1 [mm/s$^{1.75}$]	Overall VDV Loc 2 [mm/s$^{1.75}$]	Acceptable Daytime VDV (Resid'l) [mm/s$^{1.75}$]	Acceptable Night-time VDV (Resid'l) [mm/s$^{1.75}$]
0024	12:46:01	Train(s) Passing By	A0	A40	6.7	3.1	200 (0.2m/s$^{1.75}$)	130 (0.13m/s$^{1.75}$)
0025	12:48:06	Train(s) Passing By	A0	A40	3.5	1.4		
0026	12:52:40	Train(s) Passing By	A0	A40	2.5	1.5		
0027	12:59:37	Train(s) Passing By	A0	A40	5.9	2.9		
0028	13:03:52	Train(s) Passing By	A0	A40	4.7	2.5		
				Overall	**7.9**	**3.8**	**200**	**130**

Table 5.2.4 Vibration Dose Values (VDVs) – Locations B0 and B10

Meas't No.	Time	Measurement Description	Meas't Loc 1	Meas't Loc 2	Overall VDV Loc 1 [mm/s$^{1.75}$]	Overall VDV Loc 2 [mm/s$^{1.75}$]	Acceptable Daytime VDV (Resid'l) [mm/s$^{1.75}$]	Acceptable Night-time VDV (Resid'l) [mm/s$^{1.75}$]
0031	13:52:20	Train(s) Passing By	B0	B10	6.9	5.4	200 (0.2m/s$^{1.75}$)	130 (0.13m/s$^{1.75}$)
0032	13:54:46	Background (No Trains)	B0	B10	0.9	0.5		
0033	13:55:54	Train(s) Passing By	B0	B10	6.5	4.8		
0034	13:58:38	Train(s) Passing By	B0	B10	3.5	2.3		
0035	14:00:00	Train(s) Passing By	B0	B10	9.2	6.0		
0036	14:03:22	Train(s) Passing By	B0	B10	6.2	4.3		
0037	14:04:04	Train(s) Passing By	B0	B10	8.4	6.3		
0038	14:05:23	Train(s) Passing By	B0	B10	9.1	5.5		
0039	14:10:10	Background (No Trains)	B0	B10	0.9	0.5		
0040	14:11:54	Train(s) Passing By	B0	B10	5.9	3.7		
0041	14:14:19	Train(s) Passing By	B0	B10	4.0	1.8		
0042	14:15:09	Train(s) Passing By	B0	B10	9.7	6.8		
0043	14:16:04	Train(s) Passing By	B0	B10	6.0	4.0		
				Overall	**13.8**	**9.5**	**200**	**130**

Table 5.2.5 Vibration Dose Values (VDVs) – Locations B0 and B20

Meas't No.	Time	Measurement Description	Meas't Loc 1	Meas't Loc 2	Overall VDV Loc 1 [mm/s$^{1.75}$]	Overall VDV Loc 2 [mm/s$^{1.75}$]	Acceptable Daytime VDV (Resid'l) [mm/s$^{1.75}$]	Acceptable Night-time VDV (Resid'l) [mm/s$^{1.75}$]
0044	14:19:04	Train(s) Passing By	B0	B20	5.7	4.1	200 (0.2m/s$^{1.75}$)	130 (0.13m/s$^{1.75}$)
0045	14:19:59	Train(s) Passing By	B0	B20	8.8	4.6		
0046	14:21:23	Train(s) Passing By	B0	B20	4.1	2.3		
0047	14:22:18	Train(s) Passing By	B0	B20	10.7	5.6		
0048	14:23:33	Train(s) Passing By	B0	B20	5.1	2.9		
0049	14:26:07	Train(s) Passing By	B0	B20	6.0	3.3		
0050	14:27:57	Train(s) Passing By	B0	B20	6.1	4.5		
				Overall	**12.5**	**6.9**	**200**	**130**

Table 5.2.6 Vibration Dose Values (VDVs) – Locations B0 and B40

Meas't No.	Time	Measurement Description	Meas't Loc 1	Meas't Loc 2	Overall VDV Loc 1 [mm/s$^{1.75}$]	Overall VDV Loc 2 [mm/s$^{1.75}$]	Acceptable Daytime VDV (Resid'l) [mm/s$^{1.75}$]	Acceptable Night-time VDV (Resid'l) [mm/s$^{1.75}$]
0051	14:32:37	Train(s) Passing By	B0	B40	2.9	1.3	200 (0.2m/s$^{1.75}$)	130 (0.13m/s$^{1.75}$)
0052	14:33:59	Train(s) Passing By	B0	B40	7.7	3.4		
0053	14:37:05	Train(s) Passing By	B0	B40	5.3	2.3		
				Overall	**8.1**	**3.6**	**200**	**130**

5.3 Summary of Vibration Measurement Results

Table 5.3.1 presents a summary of the processed operator-attended vibration measurements results presented in Table 5.2.1 to Table 5.2.6 for the various monitoring locations.

Table 5.3.1 Summary of Vibration Dose Values (VDVs) – All Measurement Locations

Measurement Loc 1	Measurement Loc 2	Overall VDV Loc 1 [mm/s$^{1.75}$]	Overall VDV Loc 2 [mm/s$^{1.75}$]	Acceptable Daytime VDV (Residential) [mm/s$^{1.75}$]	Acceptable Night-time VDV (Residential) [mm/s$^{1.75}$]
A0	A10	8.1	8.4	200 (0.2m/s$^{1.75}$)	130 (0.13m/s$^{1.75}$)
A0	A20	6.6	4.6		
A0	A40	7.9	3.8		
B0	B10	13.8	9.5		
B0	B20	12.5	6.9		
B0	B40	8.1	3.6		

6 DISCUSSION AND RECOMMENDATIONS – NOISE IMPACT

6.1 Documentation Review

Acoustic Dynamics has conducted a review of documentation relating to rail traffic noise intrusion for the proposed North Eveleigh redevelopment required to be addressed by the Director-General for the purpose of the Environmental Assessment.

In section 2 of this report, detail of the relevant noise criteria, standards and guidelines applicable for the assessment of rail noise are provided. Unattended noise monitoring and operator-attended noise measurement results are presented within section 4 of this document, following surveys carried out at the North Eveleigh site during September 2007.

As indicated above, this engagement is specifically to investigate potential noise and vibration impact resulting from rail traffic and the proximity of the site to the adjacent railway corridor. Consideration of other acoustic design aspects for the proposed development has not been included within this report, however these aspects should be considered in further detail during the detailed design stages of the project.

6.2 Discussion of Noise Measurement Results

Acoustic Dynamics' noise measurement results, presented within section 4 of this document, indicate the noise environment at the North Eveleigh site varies across the site, however high noise levels, resulting from rail traffic within the adjacent rail corridor, contribute significantly to the measured noise environment at each of the noise monitoring locations used by Acoustic Dynamics in this investigation.

The following noise sources, associated with rail traffic movements within the adjacent rail corridor, were identified during Acoustic Dynamics' noise surveys:

- rail traffic movements (rolling noise);
- rail traffic wheel squeal;
- rail traffic passing over track joints and turnouts;
- rail traffic brake noise; and
- rail traffic horns.

Measured noise emission levels associated with rail traffic movements within the adjacent rail corridor were similar to measurements taken by Acoustic Dynamics at other locations adjacent to rail corridors, however adjacent rail traffic movements were more frequent at the North Eveleigh site. This high rail traffic volume results as the railway tracks adjacent to the North Eveleigh site carry all rail traffic travelling between Central Railway Station and the western, south-western and southern railway routes to and from Sydney.

The relevant noise criteria for the assessment of rail traffic noise intrusion into such a development are detailed within section 2 of this report. Noise criteria are presented for

office buildings and residential buildings. Note should be made that relevant noise criteria for open areas, recreational areas and other areas have not been provided for the purpose of this investigation, however these should be considered during the detailed design stages of the project.

Based on Acoustic Dynamics' review of the relevant acoustic criteria for rail traffic noise intrusion into a residential or office development and the measurement results from our surveys, we provide the following information:

- Unattended measured background RBL (L_{A90}) noise levels at the site were high, ranging between 39 dB(A) (the lowest measured night-time RBL) and 48 dB(A) (the highest measured daytime RBL);

- Unattended measured L_{Aeq} noise levels at the site were high, ranging between 53 dB(A) (the lowest measured night-time $L_{Aeq(1hr)}$) and 65 dB(A) (the highest measured daytime $L_{Aeq(1hr)}$);

- Unattended measured night-time L_{A1} noise levels were high, ranging between 76 dB(A) and 84 dB(A) across the four (4) measurement locations;

- Based on the information provided above and within Table 4.2.1, the following indicative maximum facade noise reductions would be required for facades at the same offset distances as the four (4) unattended monitoring locations:
    - Maximum facade noise reduction required for daytime ~ 28 dB(A);
    - Maximum facade noise reduction required for night-time ~ 30 dB(A); and
    - Maximum facade noise reduction required for sleep disturbance ~ 36 dB(A).

- Operator-attended measured L_{Aeq} noise levels resulting from adjacent rail traffic movements ranged between 62 dB(A) and 82 dB(A) at measurement location A0 and B0;

- Operator-attended measured L_{AE} noise levels resulting from adjacent rail traffic movements ranged between 73 dB(A) and 92 dB(A) at measurement locations A0 and B0;

- Operator-attended measured L_{A1} noise levels resulting from adjacent rail traffic horns ranged between 75 dB(A) and 87 dB(A) at measurement location A0 and B0;

- Based on the information provided above and within Table 4.3.1, the following indicative maximum facade noise reductions would be required for facades at the same offset distances as monitoring locations A0 and B0:
    - Maximum facade noise reduction required for daytime/night-time ~ 47 dB(A);
    - Maximum facade noise reduction required for sleep disturbance ~ 40 dB(A).

- Comparison of the unattended and operator-attended measured noise levels indicates that the offset (or setback) distances to the facades of the proposed development from the rail corridor will have a significant influence on the noise reduction required from the facade;

- Acoustic Dynamics advises that well constructed building facades can provide noise reductions from 28 dB(A) up to 47 dB(A). (Note is made that a noise reduction of 47 dB(A) would be required for a sleeping area within a dwelling with an offset (or setback) distance equivalent to the monitoring locations A0 and B0. Such a situation would not be anticipated);

- Although Acoustic Dynamics does not anticipate the development will include residential dwellings with sleeping areas at offsets equivalent to the monitoring locations A0 and B0, to provide noise reductions as high as 47 dB(A), the size, position and type of windows used would be critical;

- Based on our surveys and assessment, Acoustic Dynamics advises that typical residential facade noise reductions of between 28 dB(A) and 36 dB(A) are likely to be required for the North Eveleigh redevelopment site;

- Residential facade noise reductions of between 28 dB(A) and 36 dB(A) are likely to be achieved by typical constructions without a requirement for significant or special noise mitigation treatments;

- Glazing requirements will require careful consideration during the detailed design stages of the project;

- The layout and positioning of outdoor areas, including balconies and recreation areas will require careful consideration during the detailed design stages of the project.

The above information leads to the following conclusions:

- **The facade setbacks proposed for the concept design and detailed within Table 1.3.1 are considered acceptable with regard to noise intrusion; and**

- **Based on the above information, the concept design facade setback information detailed in Table 1.3.1 and subsequent to the inclusion of adequate acoustic design measures (such as facade design possibly with glazing that is reduced in size, non-operable or double-glazed or internal layout, with sensitive areas including sleeping areas located away from exposed facades), the proposed development of the North Eveleigh site <u>can</u> be constructed to comply with the various applicable criteria, standards and guidelines for rail related noise intrusion.**

In addition to the above information, Acoustic Dynamics has indicated further areas for investigation and consideration with regard to noise intrusion within section 8 of this document.

7 DISCUSSION AND RECOMMENDATIONS – VIBRATION IMPACT

7.1 Documentation Review

In section 2 of this document, detail of the relevant vibration criteria, standards and guidelines applicable for the assessment of rail vibration are provided. Operator-attended vibration measurement results are presented within section 5 of this document, following surveys carried out at the North Eveleigh site during September 2007.

As indicated above, this engagement is specifically to investigate potential noise and vibration impact resulting from rail traffic and the proximity of the site to the adjacent railway corridor. Consideration of other acoustic design aspects for the proposed development has not been included within this report, however such aspects should be considered in further detail during the detailed design stages of the project.

7.2 Discussion of Vibration Measurement Results

Acoustic Dynamics' vibration measurement results, presented within section 5 of this document, indicate that received vibration levels at the North Eveleigh site, resulting from rail traffic within the adjacent rail corridor, vary across the site.

At locations adjacent to rail corridors, vibration is received which is associated with rail traffic movements within the adjacent rail corridor occurs as a result of a combination of any of the following:

- rail traffic movements (rolling vibration);
- railway traffic rolling stock travelling on uneven tracks or undulating tracks;
- railway traffic rolling stock with wheel flats;
- railway traffic rolling stock with varying weights and varying suspension systems;
- rail traffic passing over track joints and turnouts; and
- various other factors.

Measured vibration levels adjacent to vibration sources can vary significantly depending on the nature of the subject vibration source and the transmission path between the source and the receiving location.

The relevant noise criteria for the assessment of rail traffic vibration intrusion into such a development are detailed within section 2 of this report. Vibration criteria are presented for office buildings and residential buildings.

Although rail traffic movements are more frequent at the North Eveleigh site than other sites adjacent to railway corridors, the overall received vibration dose value (VDV) at any measurement location is significantly controlled by the highest recorded vibration event during the measurement period.

Based on Acoustic Dynamics' review of the relevant criteria for received levels of vibration resulting from rail traffic movements at a residential or office building and the operator-attended vibration measurement results from our surveys, we provide the following information:

- Operator-attended vibration measurement were undertaken at various offset (setback) distances from the nearest railway track at two principal locations, A and B. The respective measurement location offsets to the nearest railway tracks were:
  - A0 and B0 – 10m to the nearest track;
  - A10 and B10 – 20m to the nearest track;
  - A20 and B20 – 30m to the nearest track; and
  - A40 and B40 – 50m to the nearest track;

- As detailed in Table 5.2.1 to Table 5.2.6 and Table 5.3.1, the vibration dose values (VDVs) obtained following the processing of the measured vibration data for the respective measurement locations were as follows:
  - VDV at A0 – 6.6 to 8.1 $mm/s^{1.75}$;
  - VDV at A10 – 8.4 $mm/s^{1.75}$;
  - VDV at A20 – 4.6 $mm/s^{1.75}$;
  - VDV at A40 – 3.8 $mm/s^{1.75}$;
  - VDV at B0 – 8.1 to 13.8 $mm/s^{1.75}$;
  - VDV at B10 – 9.5 $mm/s^{1.75}$;
  - VDV at B20 – 6.9 $mm/s^{1.75}$;
  - VDV at B40 – 3.6 $mm/s^{1.75}$;

- The results obtained at monitoring locations B0 to B40 are likely to more accurately represent the vibration levels experienced nearer to BG1 and BG2 than the results obtained at monitoring locations A0 to A40 as a railway tunnel is present within the railway corridor, adjacent to locations A0 to A40;

- These calculated VDVs are significantly below the vibration dose criteria for residential building and office buildings of 200 $mm/s^{1.75}$ ($0.2m/s^{1.75}$) and 130 $mm/s^{1.75}$ ($0.13m/s^{1.75}$) respectively;

- Additionally, the measured and calculated vibration dose values are external ground vibration levels and are likely to be lower than the translated (or resulting) indoor vibration dose values following the completion of the North Eveleigh redevelopment;

- Despite the above comment, review of the proposed design is required to ensure that resonance of the proposed building will not occur at or near to the natural frequencies (or natural modes) of the building;

- Acoustic Dynamics' review of relevant documentation along with vibration measurements and analysis has been carried out on a preliminary basis, to

determine the feasibility of development at the North Eveleigh redevelopment site with regard to vibration intrusion and impact and to determine whether the incorporation of significant vibration mitigation measures into the building design is likely to be required;

- Based on the above information and the results of our vibration measurements and analyses, it is likely that normal construction methods and techniques are likely to ensure that acceptable levels of vibration are received within the completed development;

- Acoustic Dynamics' vibration measurements and analysis have not considered regenerated noise resulting from adjacent railway traffic. (Regenerated (or structure-borne) noise travels through significant building elements, such as floor slabs and building columns, enabling a rumbling noise to be identified within a space as rail traffic passes a subject location);

- As detail of the proposed North Eveleigh redevelopment is currently unknown, detailed investigation of such regenerated noise can not be carried out. As such, Acoustic Dynamics recommends a detailed analysis of regenerated noise be undertaken as part of the detailed design stages of the project;

- Comparison of the results of Acoustic Dynamics' vibration measurements and analysis with the respective vibration dose criteria indicates that no minimum offset (or setback) distance to the facades of the proposed development from the rail corridor is required to ensure acceptable levels of vibration are received within the completed development;

- The site layout proposed for the concept design allows for provision of "acoustically" shielded outdoor areas for recreational and other uses; and

- The site layout proposed for the concept design provides some buildings and facades with "acoustic" shielding from direct line-of-site to the adjacent railway corridor.

The above information leads to the following conclusions:

- **The facade setbacks proposed for the concept design and detailed within Table 1.3.1 are considered acceptable with regard to vibration intrusion; and**

- **Based on the above information, the concept design facade setback information detailed in Table 1.3.1 and subsequent to the inclusion of adequate acoustic design measures (where necessary), the proposed development of the North Eveleigh site <u>can</u> be constructed to comply with the various applicable criteria, standards and guidelines for rail related vibration intrusion.**

In addition to the above information, Acoustic Dynamics has indicated further areas for investigation and consideration with regard to vibration intrusion and regenerated noise within section 8 of this document.

8 CONCLUSIONS AND FURTHER INVESTIGATIONS

8.1 Conclusions

Acoustic Dynamics' review of relevant documentation, noise and vibration monitoring, measurements and analyses have led to the following conclusions:

General

- The documentation **relating to noise and vibration intrusion** into a development from an adjacent railway corridor is extensive and should be considered in detail when developing the detailed design for the redevelopment of the North Eveleigh site;

- The documentation, not necessarily discussed within this report, **relating to other aspects of acoustics** for a development is extensive and should be considered in detail when developing the detailed design for the redevelopment of the North Eveleigh site;

Noise

- Although high noise levels are present at the site resulting from rail traffic related activities within the adjacent railway corridor, it is feasible that a development can be constructed that can adequately mitigate rail traffic related noise intrusion as well as other external noise, such as road traffic, aircraft, and nearby industrial noise;

- The magnitudes of noise reduction likely to be required from the facades (and glazing) of the development are feasible and are unlikely to require incorporation of mitigation measures that would be prohibitively expensive;

- The planners and architects/designers of the proposed North Eveleigh redevelopment should continue to work with an appropriately qualified acoustical consultant throughout the detailed design stages of the development to ensure a high quality development is constructed meeting the various applicable acoustic standards and criteria;

- Provision of specific detail with regard to facades, glazing and other acoustic treatments cannot be provided at this preliminary investigation stage. Such acoustical design advice can be provided by an acoustical consultant once the following have been determined:
    - proposed internal building layouts;
    - proposed construction detail for the development.

- Sufficient information and data has been obtained and determined during this preliminary investigation to enable appropriate specific acoustic advice to be provided in relation to the proposed development; and

- Recommendations for further investigations during the detailed design stages of the project are made within section 8.2 below.

Vibration

- Measured vibration levels resulting from rail traffic related activities within the adjacent railway corridor and vibration dose values (VDVs) determined, indicate that it is feasible to construct a development that can adequately mitigate rail traffic related vibration intrusion;

- The magnitudes of vibration measured were significantly lower than the relevant criteria indicating proposed buildings at the North Eveleigh redevelopment site are unlikely to require incorporation of significant vibration mitigation measures, if at all;

- Acoustic Dynamics has not undertaken a review of regenerated noise resulting from adjacent railway traffic. As detail of the proposed North Eveleigh redevelopment is currently unknown, detailed investigation of such regenerated noise can not be carried out. As such, Acoustic Dynamics recommends a detailed analysis of regenerated noise be undertaken as part of the detailed design stages of the project. (Such an investigation may (or may not) indicate that vibration control measures are required to reduce regenerated noise);

- The planners and architects/designers of the proposed North Eveleigh redevelopment should continue to work with an appropriately qualified acoustical consultant throughout the detailed design stages of the development to ensure a high quality development is constructed meeting the various applicable acoustic and vibration standards and criteria;

- Sufficient information and data has been obtained and determined during this preliminary investigation to enable appropriate specific vibration related advice to be provided during the detailed design stages of the project; and

- Recommendations for further investigations during the detailed design stages of the project are made within section 8.2 below.

8.2 Further Investigations

Further to this preliminary investigation, which indicates the feasibility of the proposed North Eveleigh redevelopment with regard to rail related noise and vibration intrusion and impact, Acoustic Dynamics advises that the following investigations should be carried out during the detailed design stages of the project:

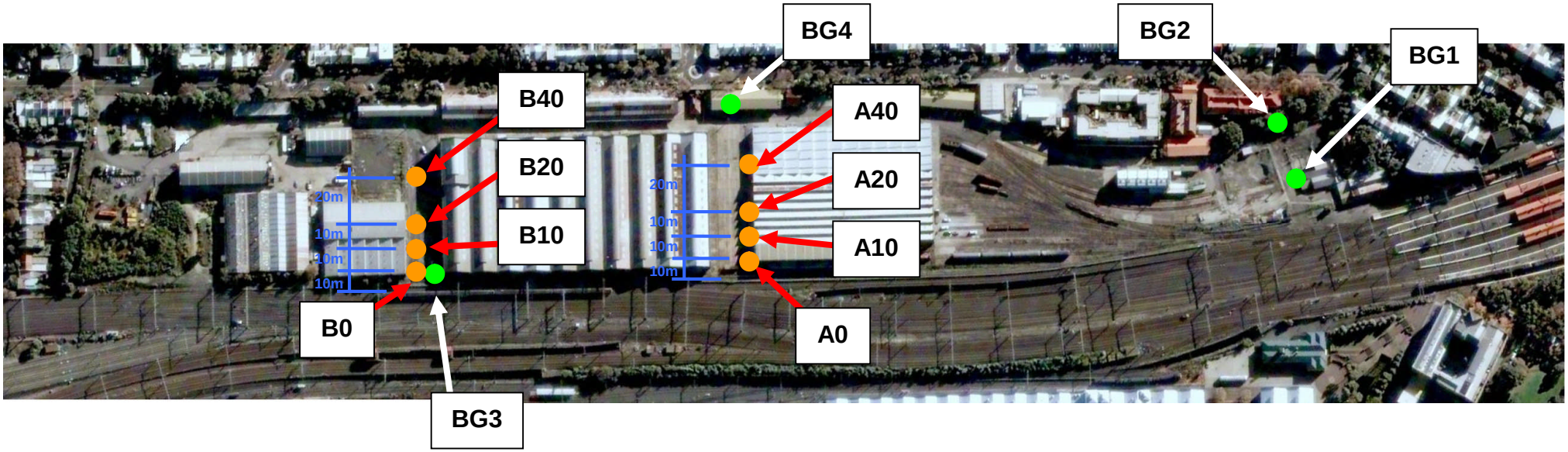
- An investigation of and provision of detailed acoustic design advice for external building envelope component sound transmission requirements to adequately mitigate external noise to internal areas of occupancy within the proposed development. (This would include facade and roof construction along with external glazing and door sound transmission requirements and a review of internal building layouts);

- An investigation and provision of detailed acoustic design advice for mitigation of external noise to, and acoustical privacy of the proposed development's external and open areas.;

- A review and provision of detailed acoustic design advice for mechanical and other external noise emission from the proposed development;

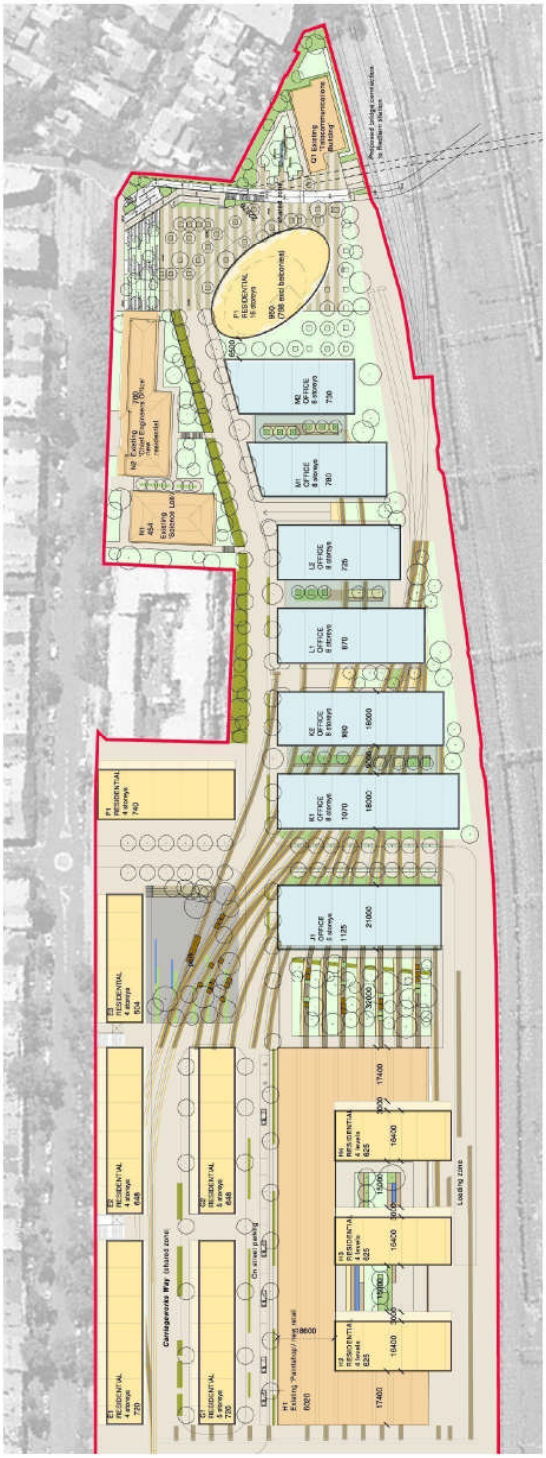
- A review and provision of detailed acoustic design advice for appropriate vibration isolation for both human comfort and reduction of regenerated noise. (Note is made that this preliminary investigation indicates received vibration dose values are likely to be of a magnitude that does not require addition vibration mitigation to be incorporated, however regenerated noise must be considered and assessed);

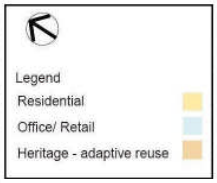
Appendix A
Monitoring & Measurement Location Plan and Site Plan

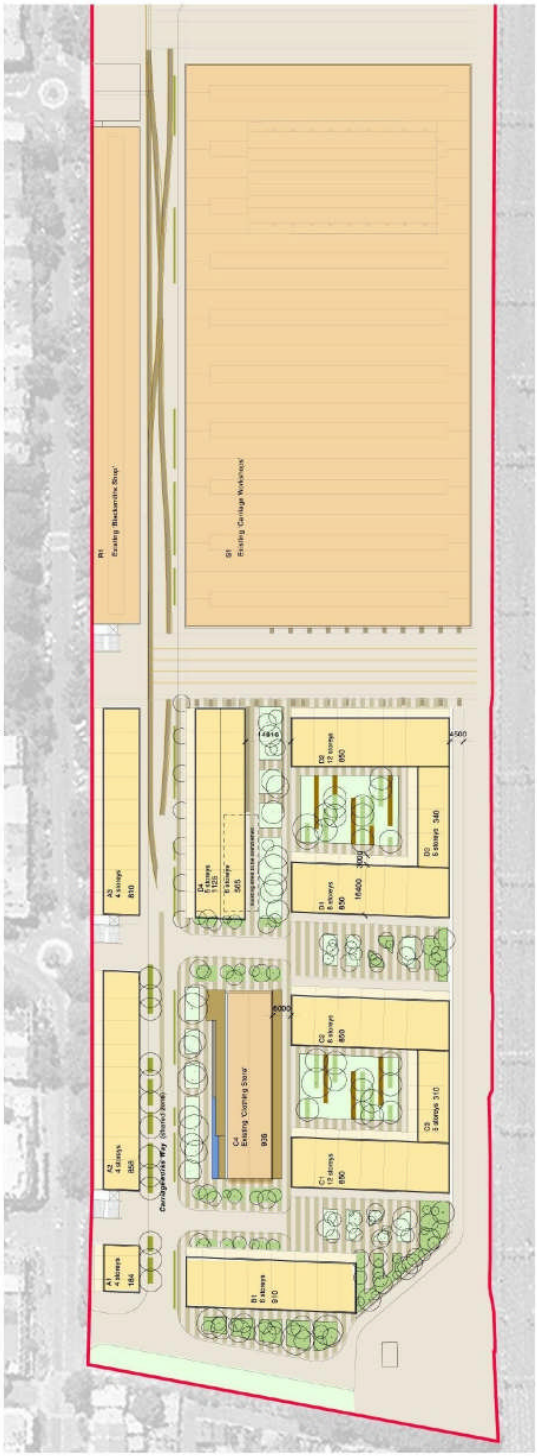


Noise and Vibration Monitoring and Measurement Location Plan

Appendix A
Monitoring & Measurement Location Plan and Site Plan



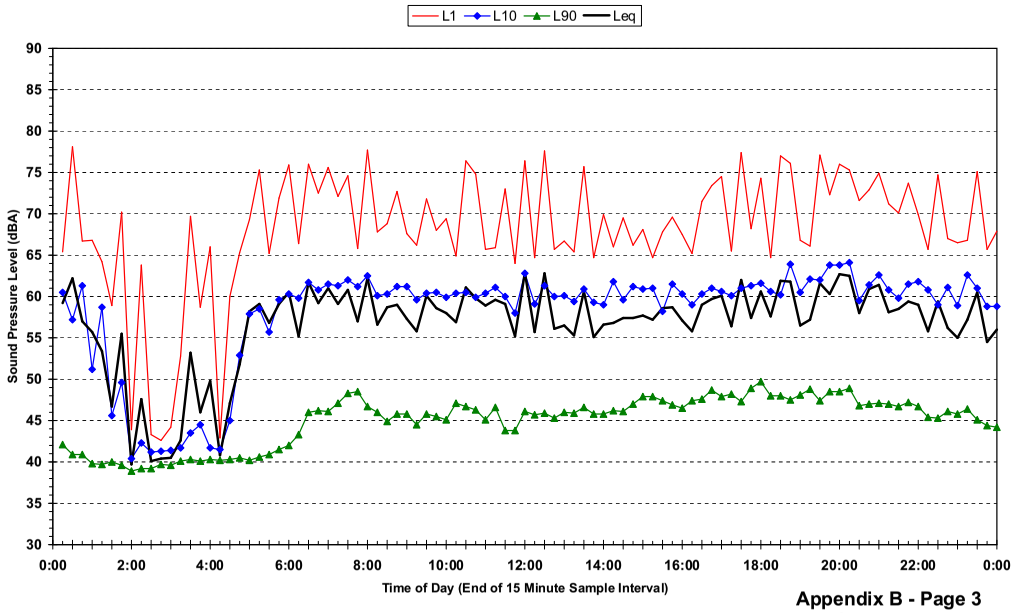




Site Layout Pan (East)

Site Layout Pan (West)

Statistical Ambient Noise Levels
North Eveleigh - BG1 - Sunday 2 September 2007



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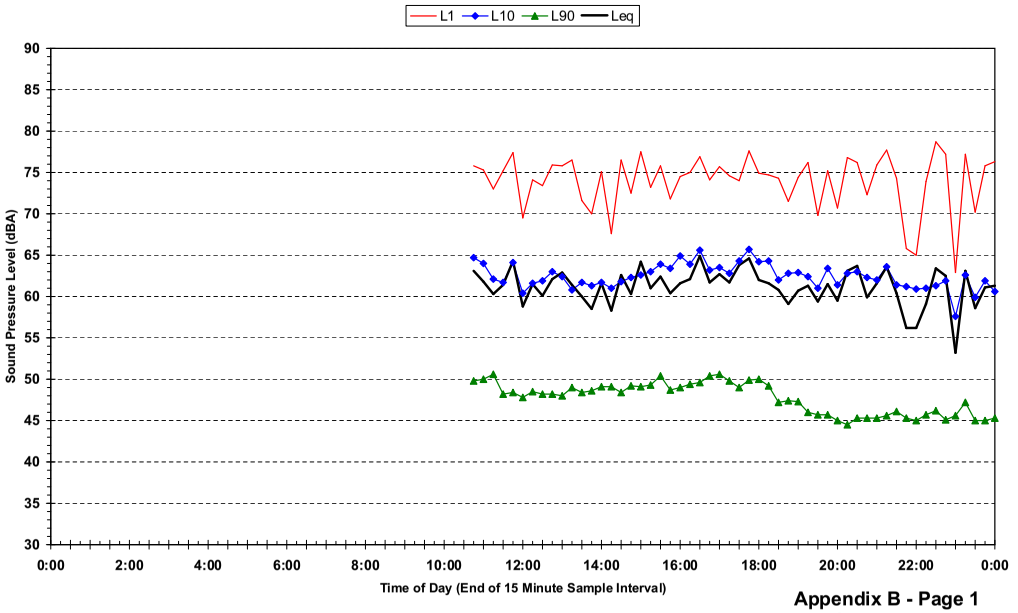
Statistical Noise Levels
AD Report 2590

Statistical Ambient Noise Levels
North Eveleigh - BG1 - Friday 31 August 2007



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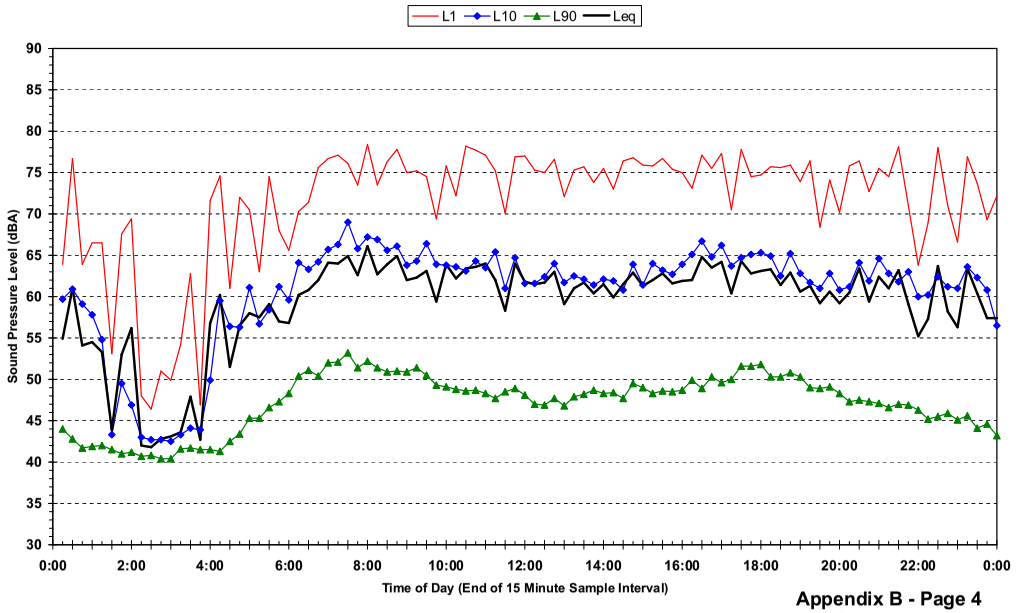
Statistical Noise Levels
AD Report 2590

Statistical Ambient Noise Levels
North Eveleigh - BG1 - Monday 3 September 2007



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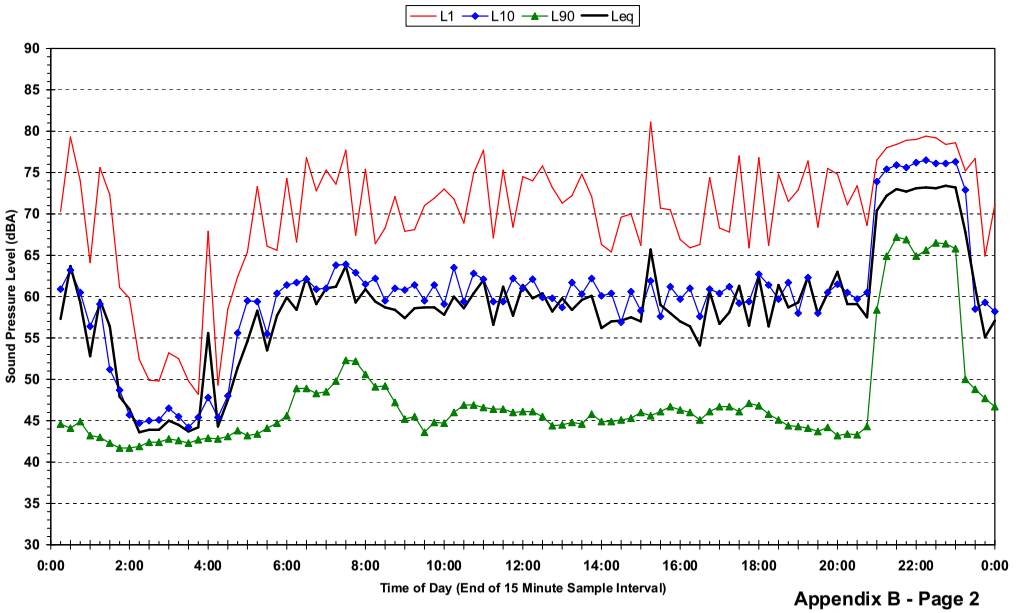
Statistical Noise Levels
AD Report 2590

Statistical Ambient Noise Levels
North Eveleigh - BG1 - Saturday 1 September 2007



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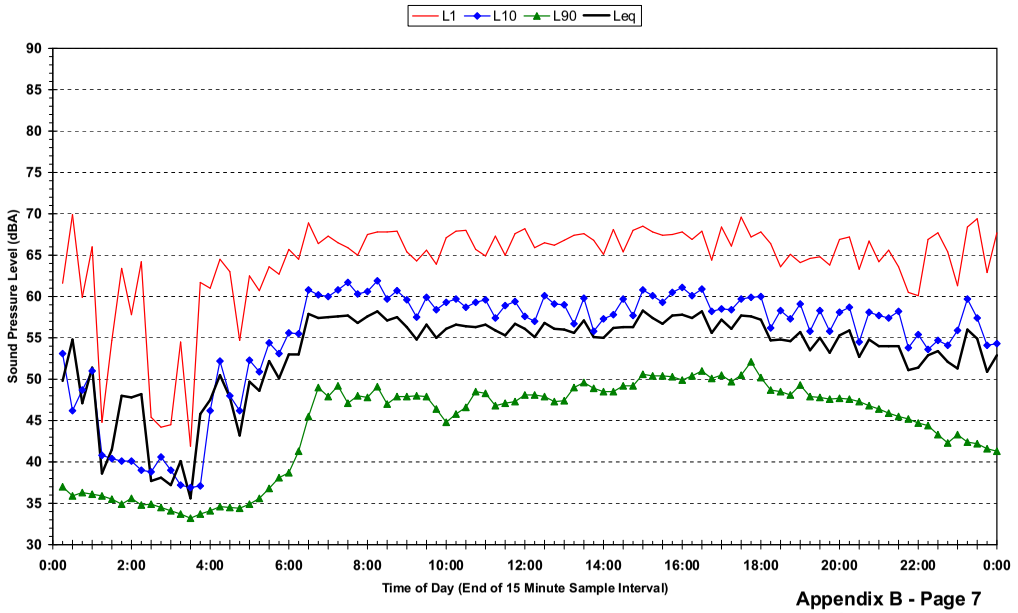
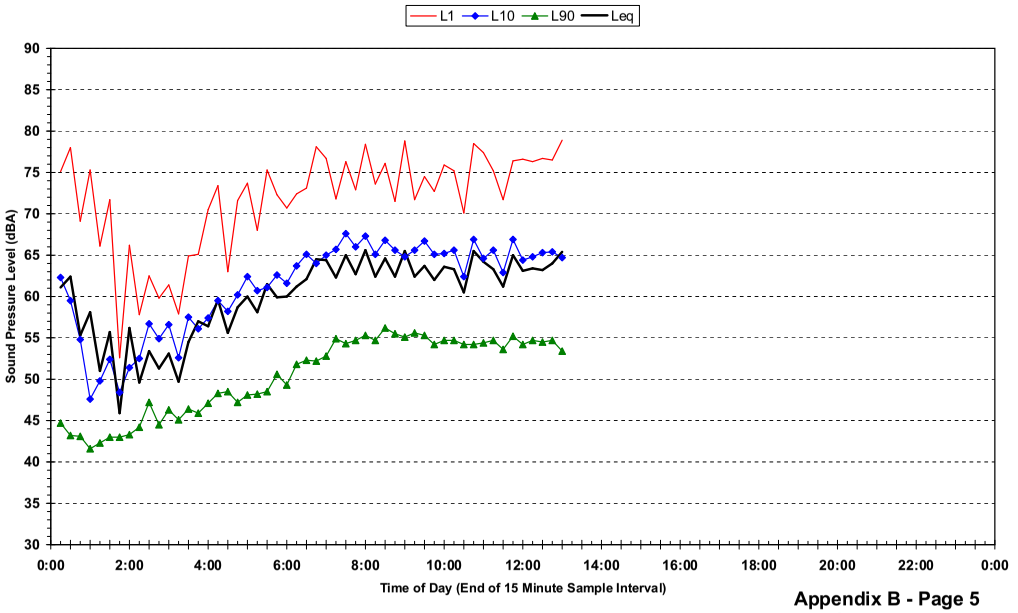
Statistical Noise Levels
AD Report 2590

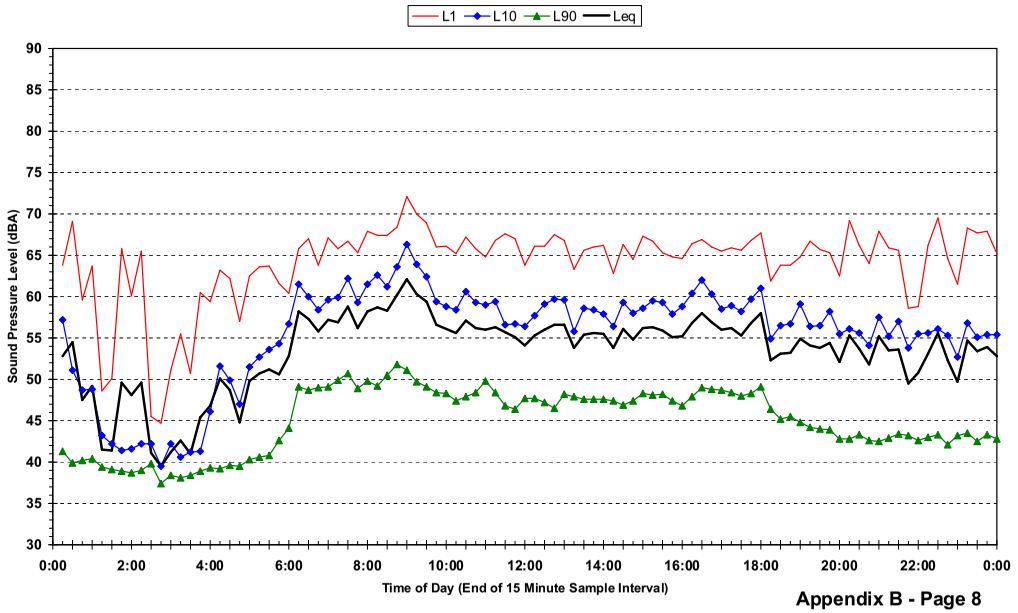
Statistical Ambient Noise Levels
North Eveleigh - BG2 - Thursday 30 August 2007



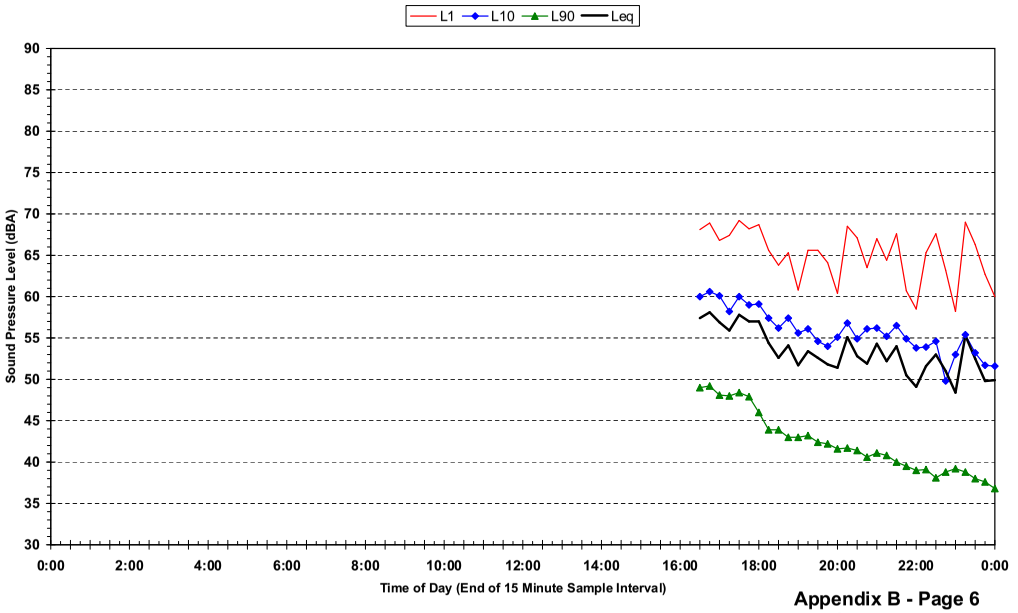
Statistical Ambient Noise Levels
North Eveleigh - BG1 - Tuesday 4 September 2007



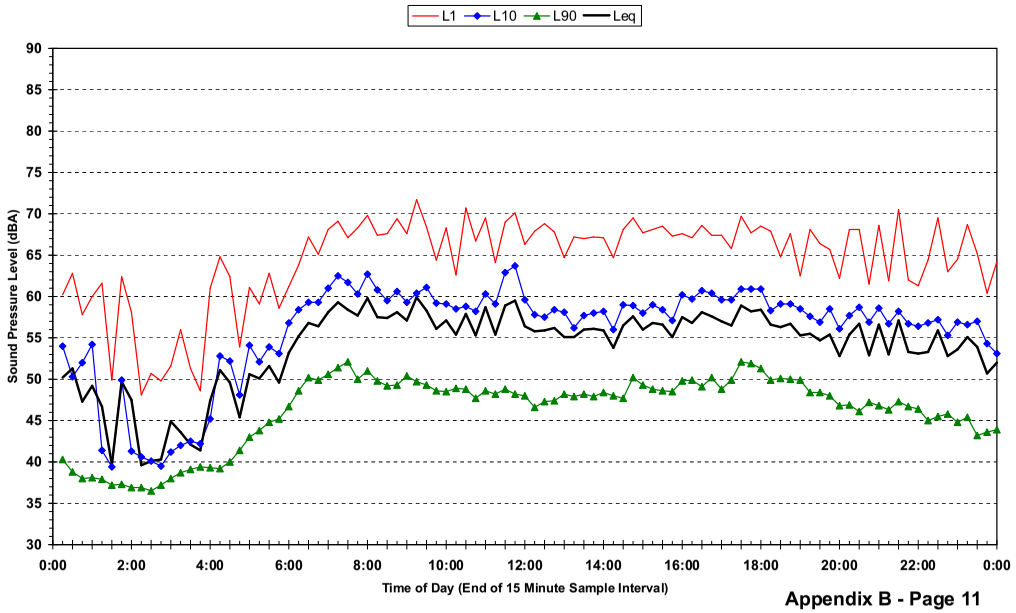
Statistical Ambient Noise Levels
North Eveleigh - BG2 - Friday 31 August 2007



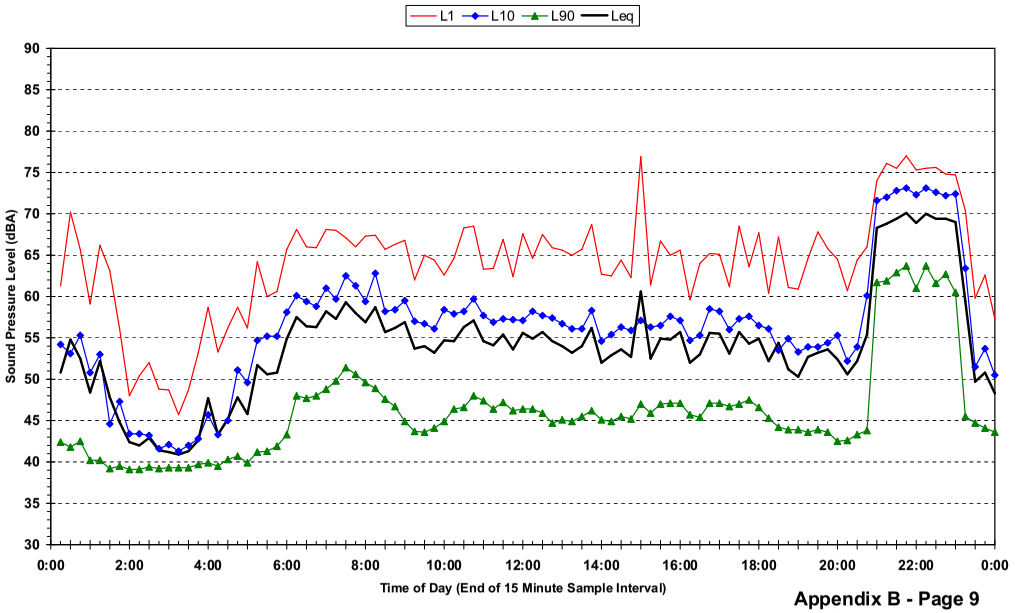
Statistical Ambient Noise Levels
North Eveleigh - BG2 - Wednesday 29 August 2007



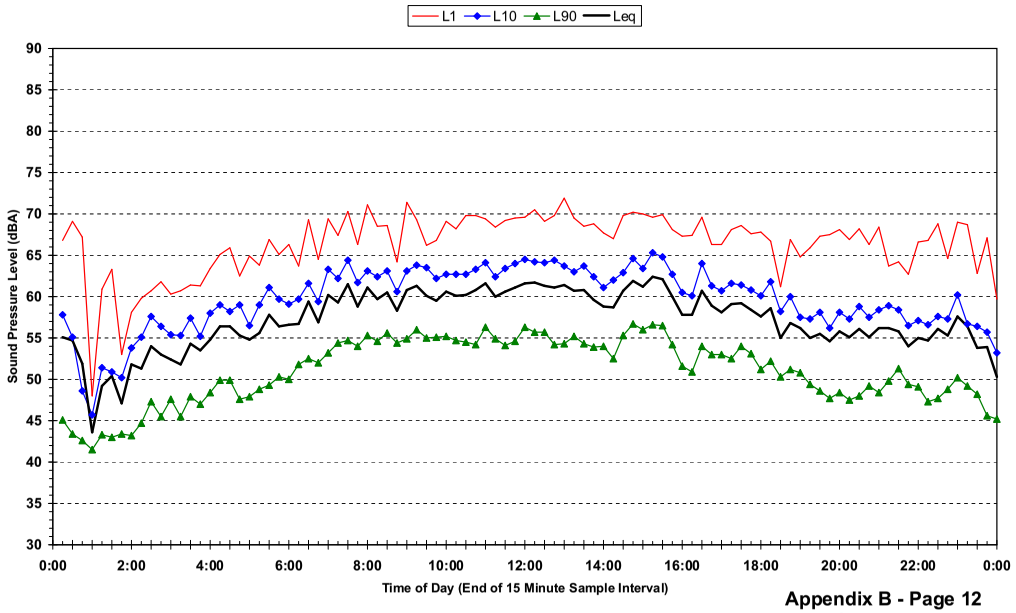
Statistical Ambient Noise Levels
North Eveleigh - BG2 - Monday 3 September 2007



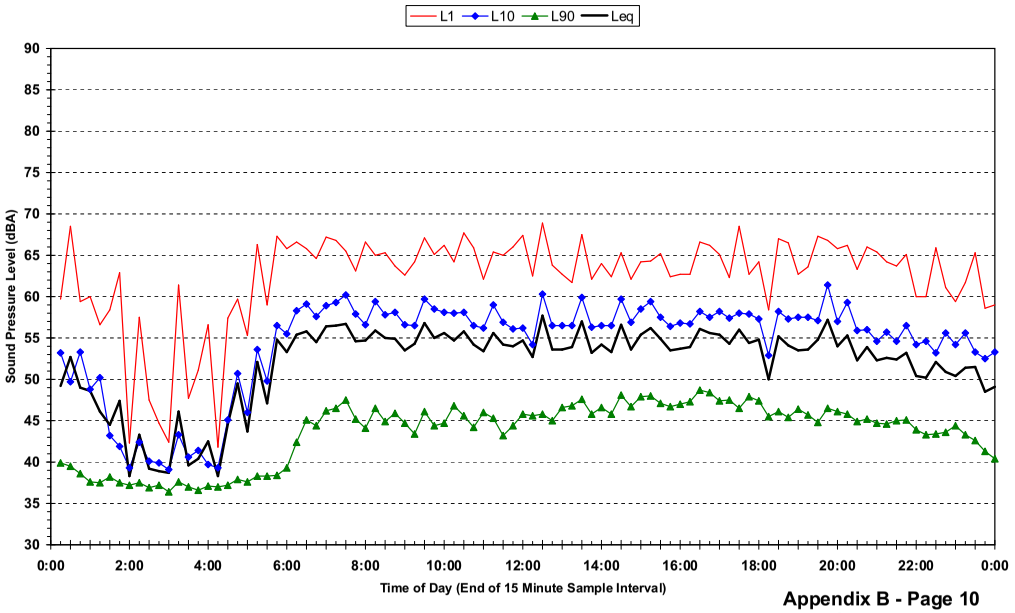
Statistical Ambient Noise Levels
North Eveleigh - BG2 - Saturday 1 September 2007



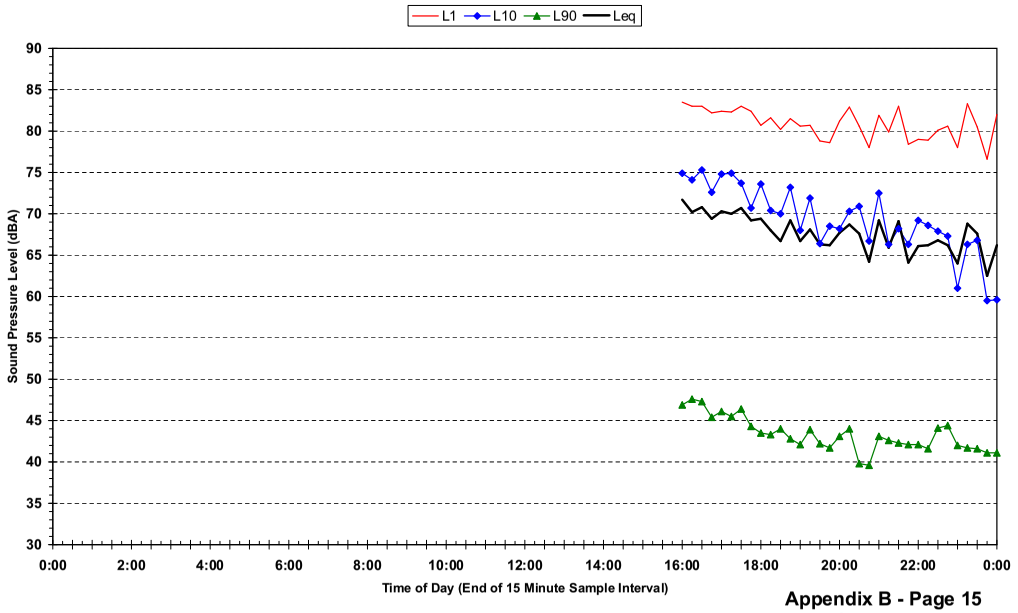
Statistical Ambient Noise Levels
North Eveleigh - BG2 - Tuesday 4 September 2007



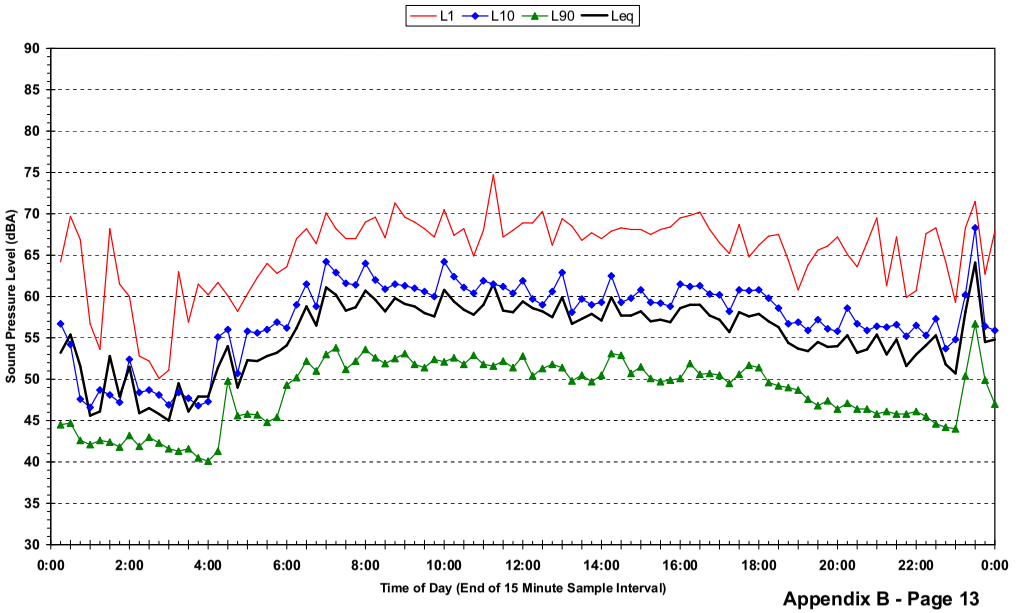
Statistical Ambient Noise Levels
North Eveleigh - BG2 - Sunday 2 September 2007



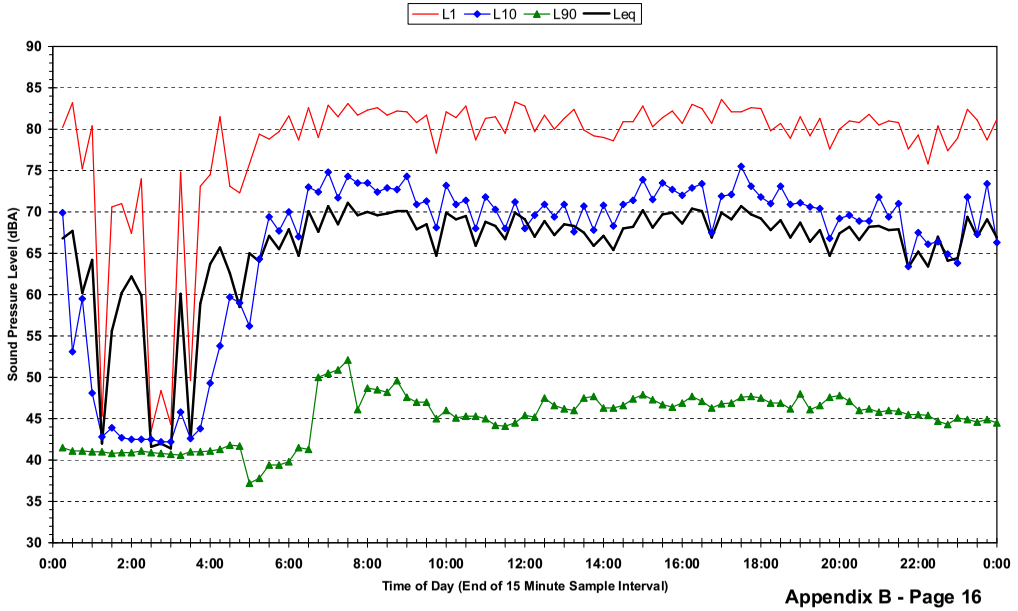
Statistical Ambient Noise Levels
North Eveleigh - BG3 - Wednesday 29 August 2007



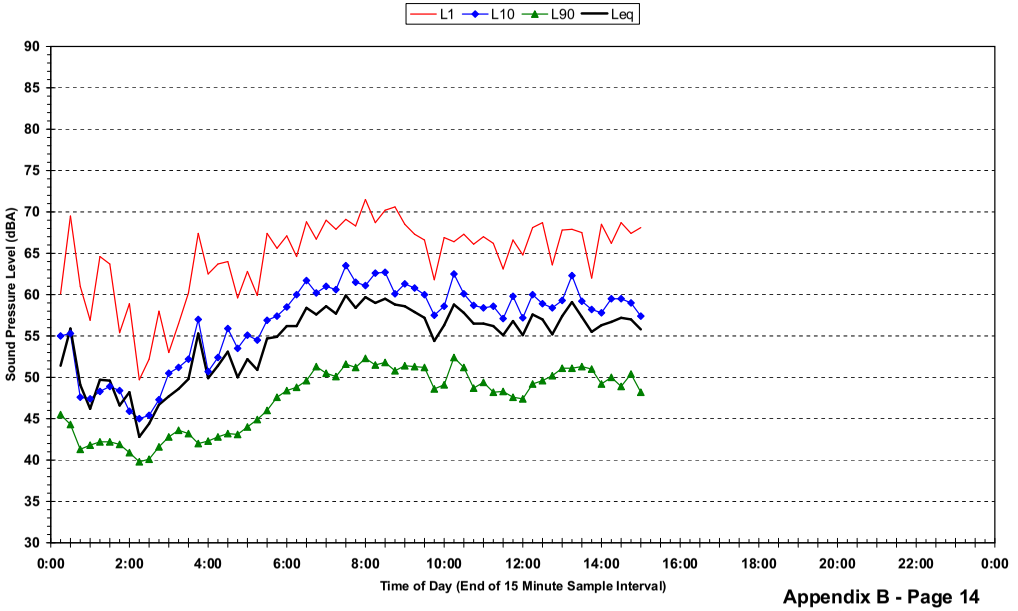
Statistical Ambient Noise Levels
North Eveleigh - BG2 - Wednesday 5 September 2007



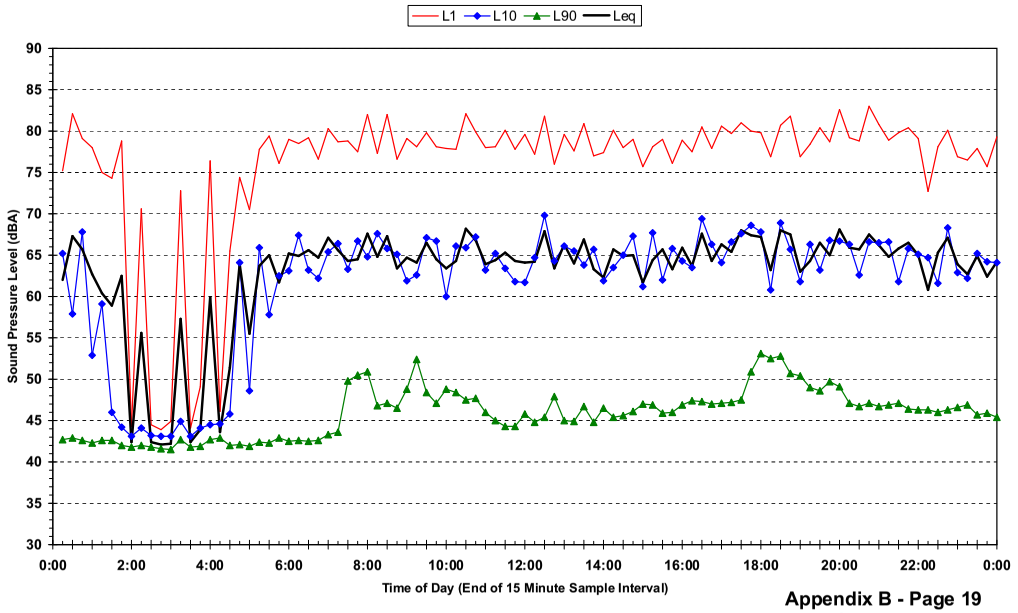
Statistical Ambient Noise Levels
North Eveleigh - BG3 - Thursday 30 August 2007



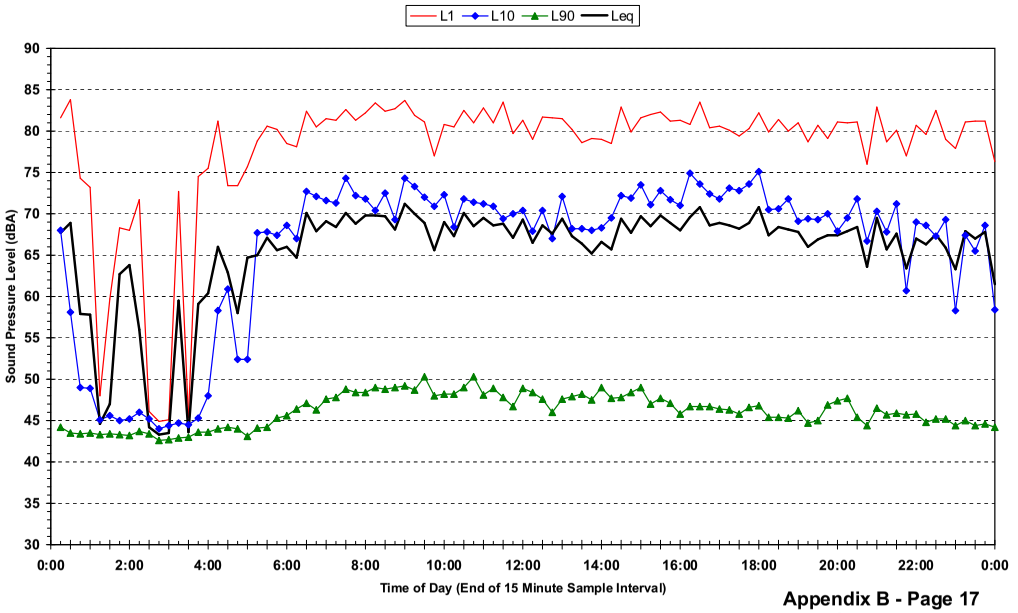
Statistical Ambient Noise Levels
North Eveleigh - BG2 - Thursday 6 September 2007



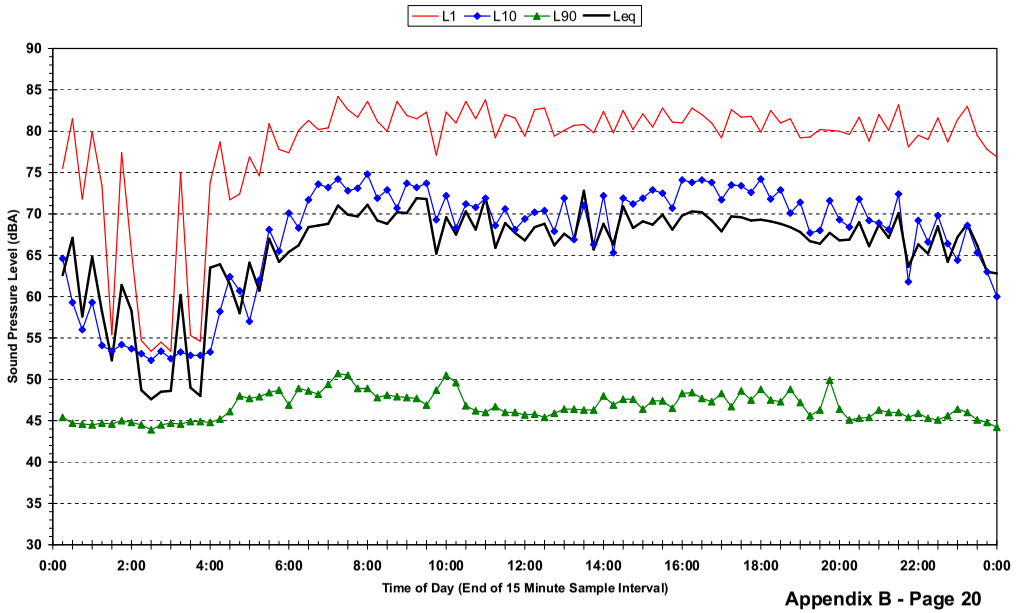
Statistical Ambient Noise Levels
North Eveleigh - BG3 - Sunday 2 September 2007



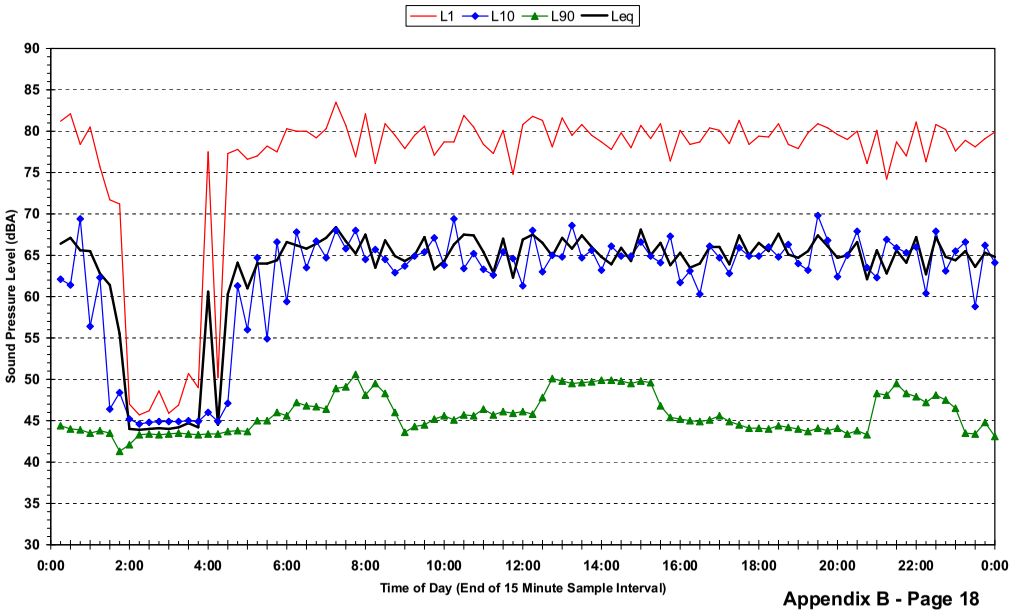
Statistical Ambient Noise Levels
North Eveleigh - BG3 - Friday 31 August 2007



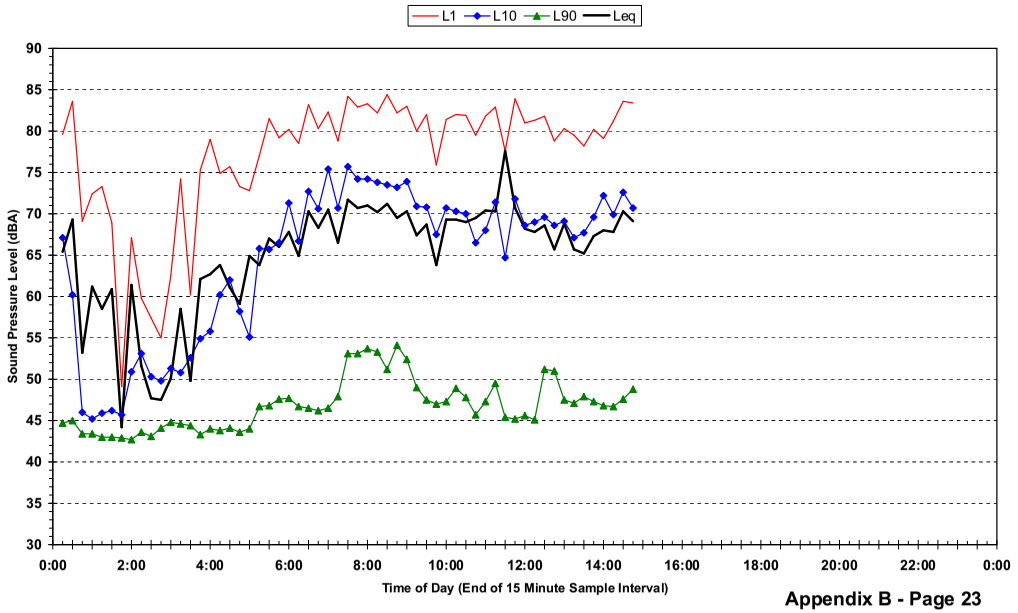
Statistical Ambient Noise Levels
North Eveleigh - BG3 - Monday 3 September 2007



Statistical Ambient Noise Levels
North Eveleigh - BG3 - Saturday 1 September 2007



Statistical Ambient Noise Levels
North Eveleigh - BG3 - Thursday 6 September 2007



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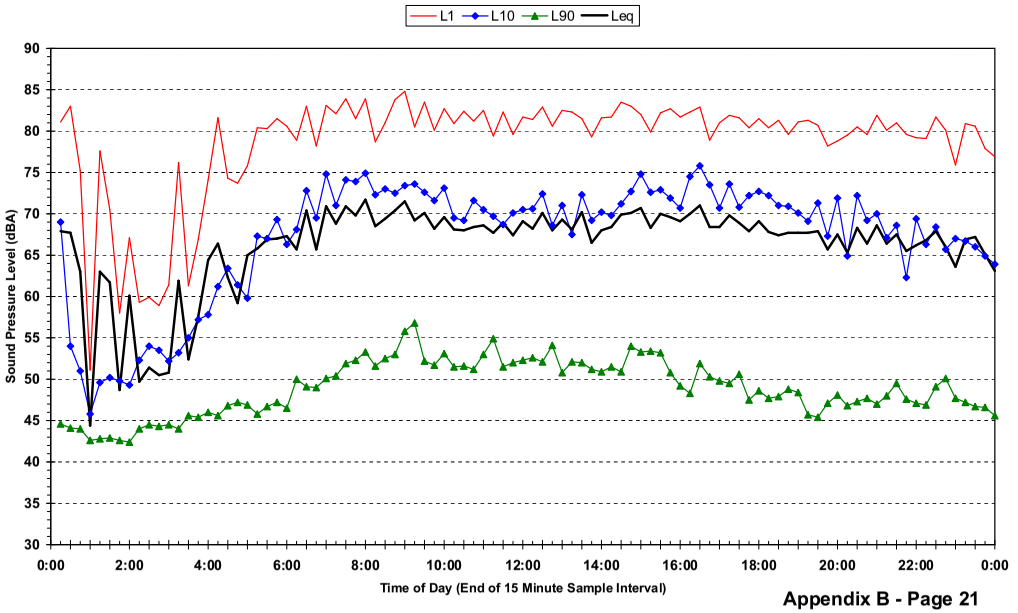
Statistical Noise Levels
AD Report 2590

Statistical Ambient Noise Levels
North Eveleigh - BG3 - Tuesday 4 September 2007



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Statistical Noise Levels
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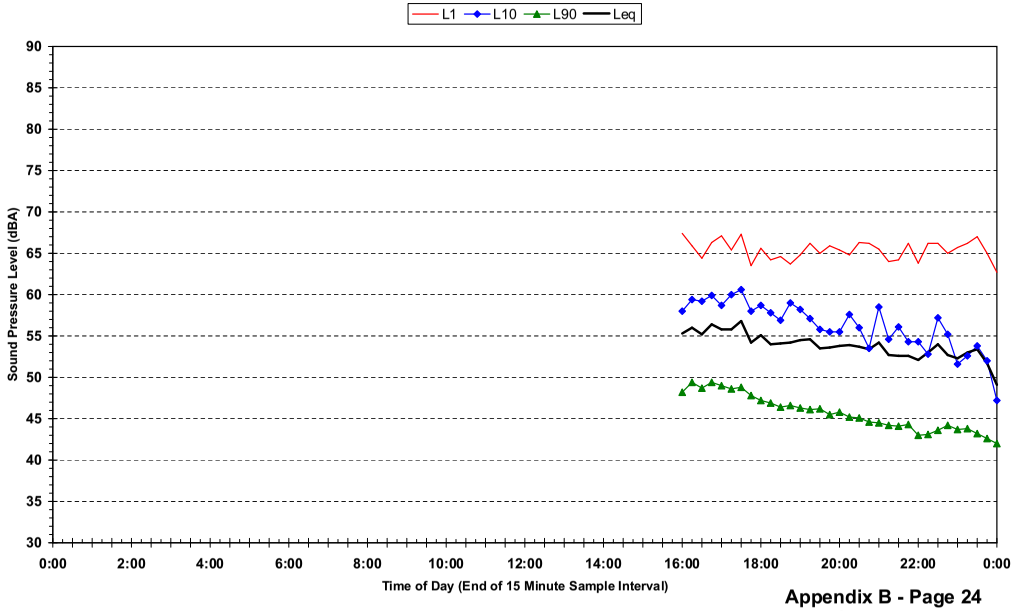
Statistical Ambient Noise Levels
North Eveleigh - BG4 - Wednesday 29 August 2007



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Statistical Noise Levels
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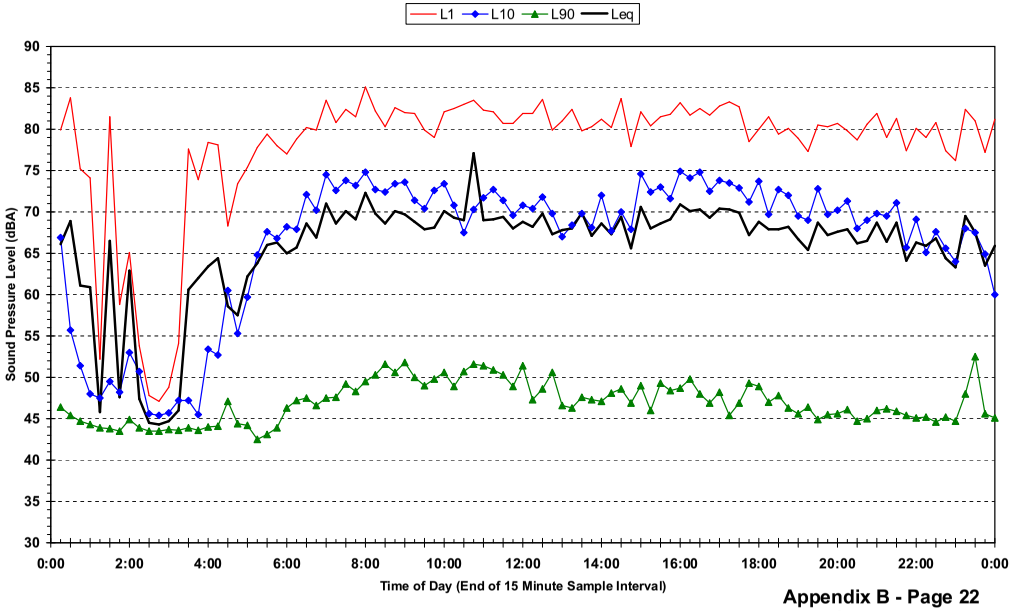
Statistical Ambient Noise Levels
North Eveleigh - BG3 - Wednesday 5 September 2007



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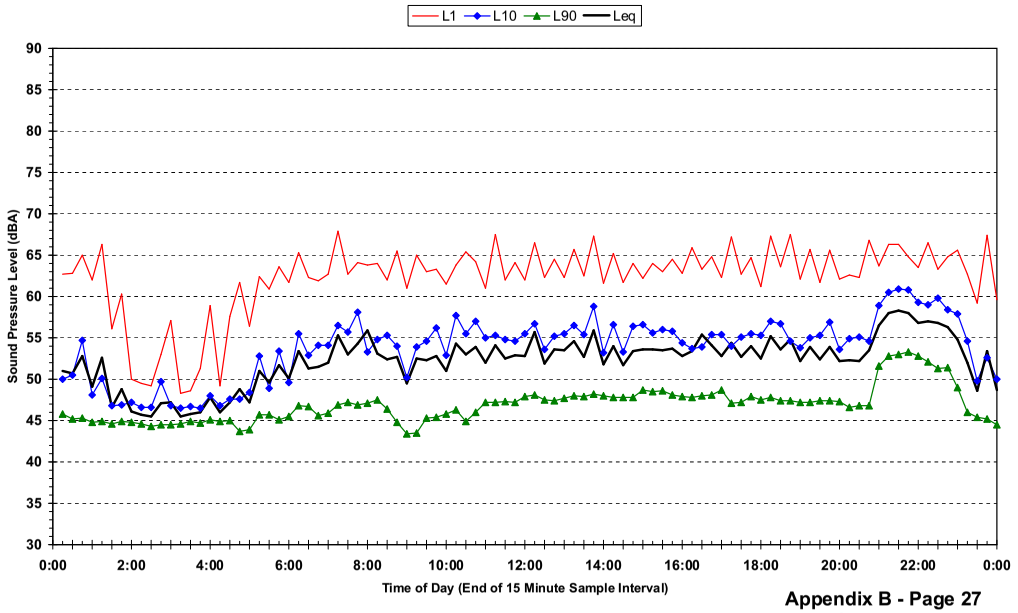
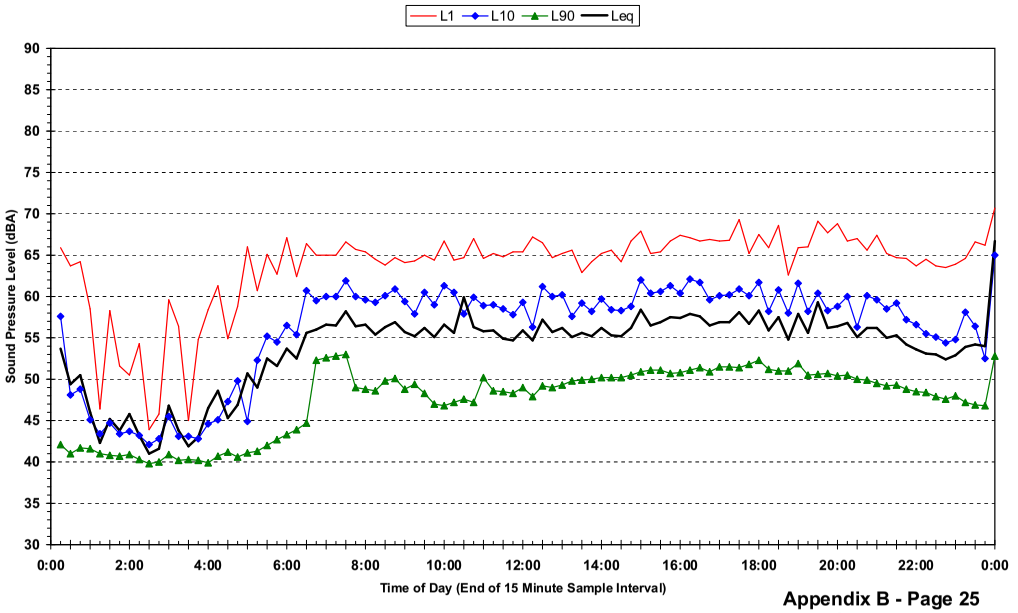
Statistical Noise Levels
AD Report 2590

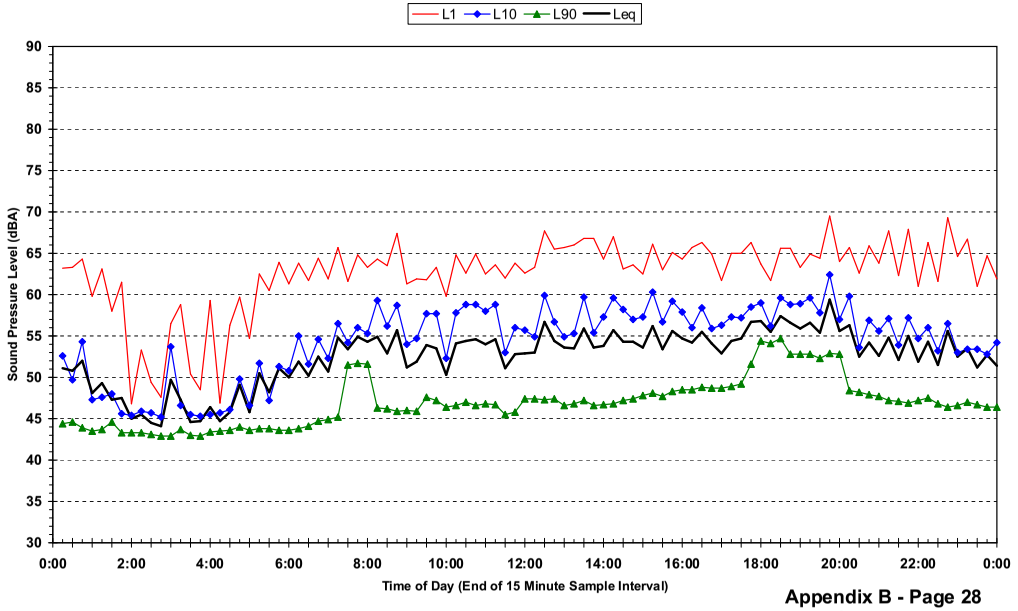
Statistical Ambient Noise Levels
North Eveleigh - BG4 - Saturday 1 September 2007



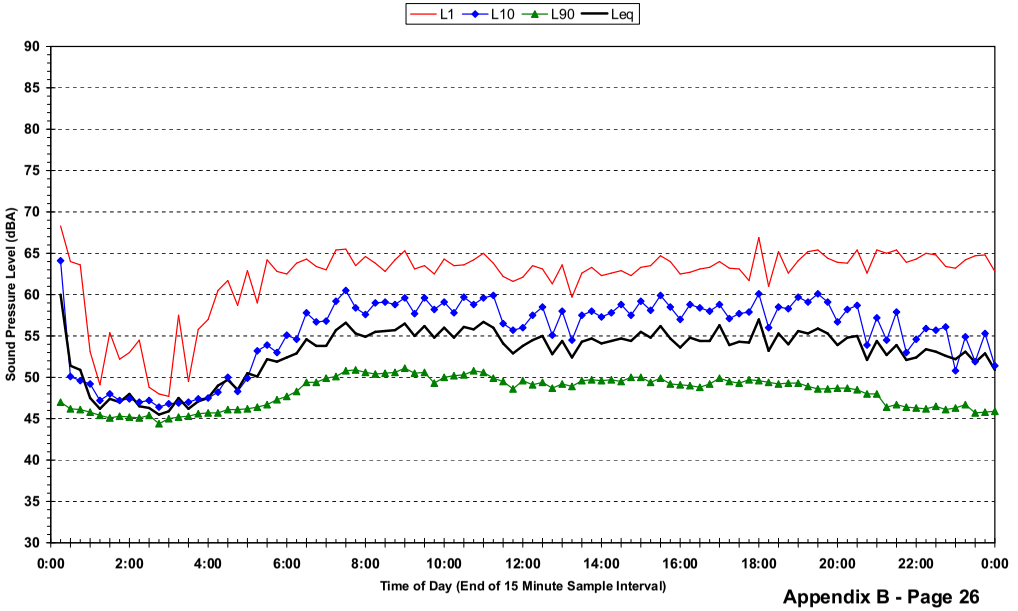
Statistical Ambient Noise Levels
North Eveleigh - BG4 - Thursday 30 August 2007



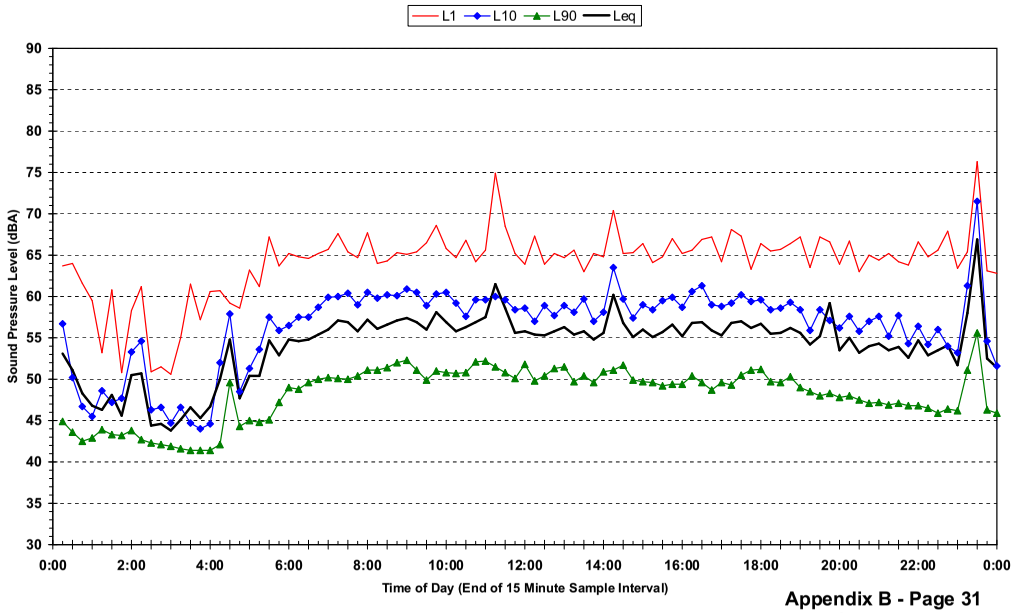
Statistical Ambient Noise Levels
North Eveleigh - BG4 - Sunday 2 September 2007



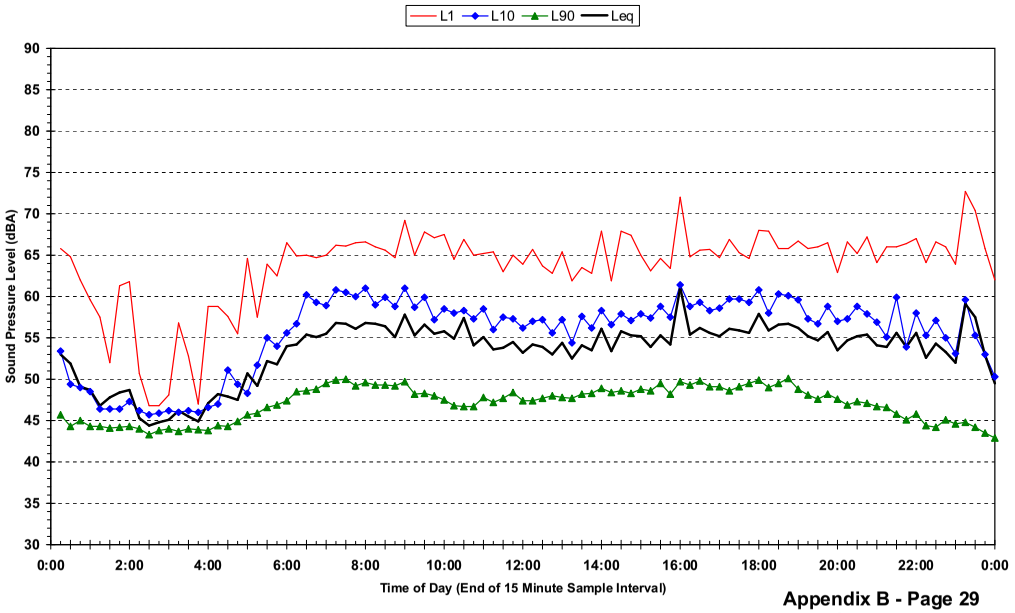
Statistical Ambient Noise Levels
North Eveleigh - BG4 - Friday 31 August 2007



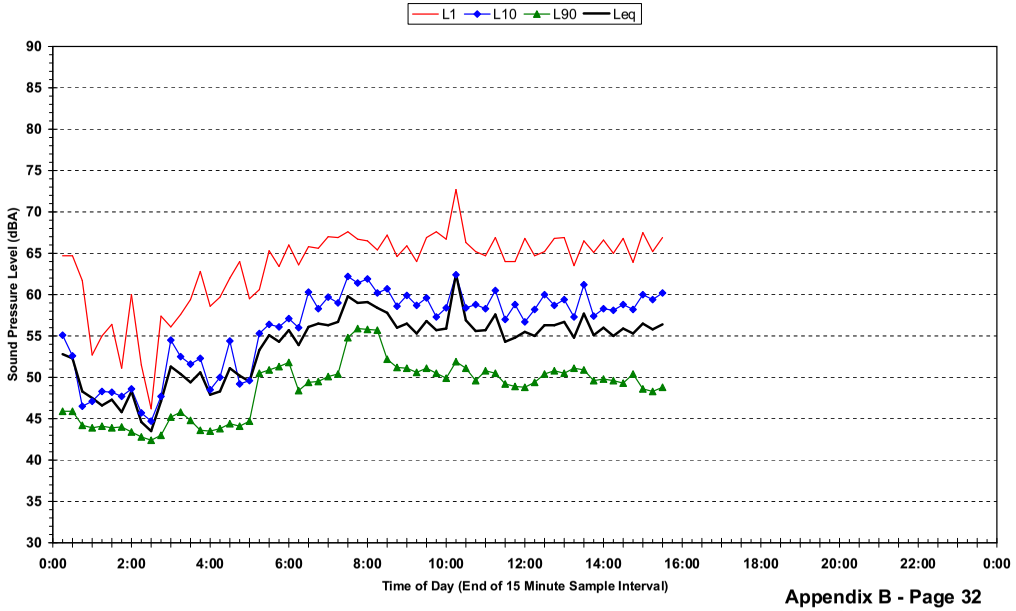
Statistical Ambient Noise Levels
North Eveleigh - BG4 - Wednesday 5 September 2007



Statistical Ambient Noise Levels
North Eveleigh - BG4 - Monday 3 September 2007



Statistical Ambient Noise Levels
North Eveleigh - BG4 - Thursday 6 September 2007



Statistical Ambient Noise Levels
North Eveleigh - BG4 - Tuesday 4 September 2007