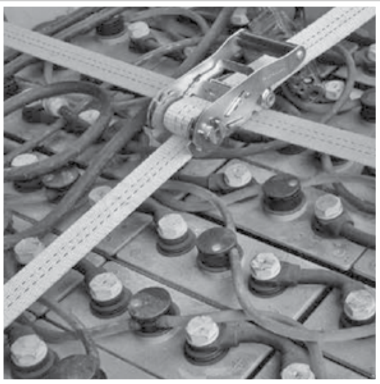
Noise and Vibration Assessment

Appendix H



Appendix H — Noise and Vibration Assessment

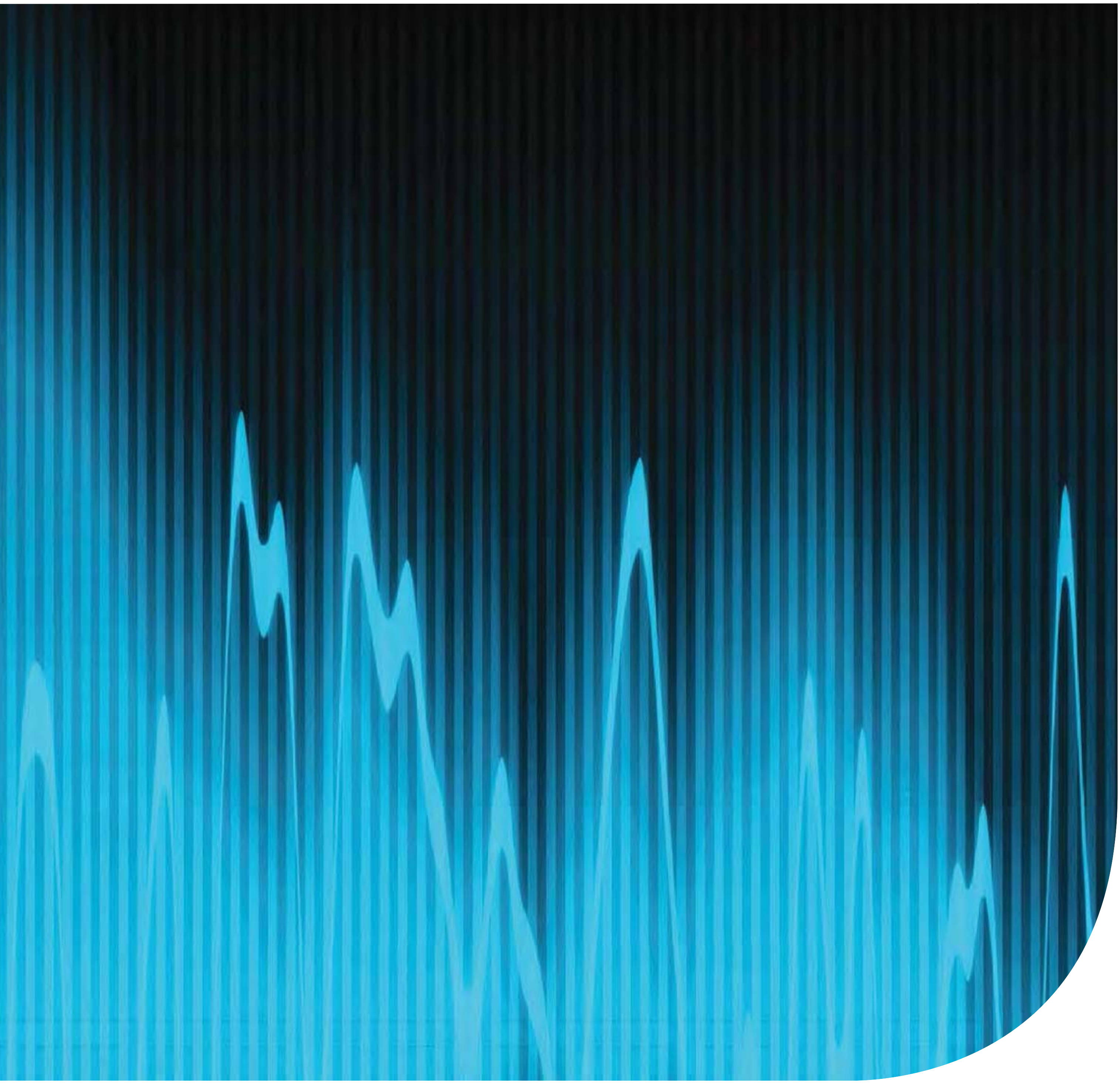
H

Noise and Vibration Assessment

Battery Recycling Facility

129 Mitchell Avenue, Kurri Kurri

Prepared for Pymore Recyclers Pty Ltd | 24 October 2016



Noise and Vibration Assessment

Battery Recycling Facility

129 Mitchell Avenue, Kurri Kurri

Prepared for Pymore Recyclers International Pty Ltd | 24 October 2016

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Noise and Vibration Assessment

Final

Report J15156RP1 | Prepared for Pymore Recyclers International Pty Ltd | 24 October 2016

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Executive Summary

EMM has completed a construction and operation noise and vibration assessment for a proposed battery recycling facility (the project) located at 129 Mitchell Avenue, Kurri Kurri (the site). The project would recycle approximately 60,000 tonnes per annum (tpa) of used lead-acid batteries.

Operational noise levels have been assessed for the daytime, evening and night-time periods during calm and prevailing weather conditions. 'Worst-case' predictions assumed that all fixed plant is operating simultaneously for the proposed operations. The assessment found that operating noise from the facility is predicted to satisfy Industrial noise Policy intrusive noise criteria for day, evening and night periods at all assessment locations. Notwithstanding, recommendations regarding operational noise management is provided in Section 11.2.

Sleep disturbance from operation of the project during the night period has been assessed. Internal maximum noise levels are predicted to be below those likely to wake residents. On this basis, sleep disturbance impacts during the night period are unlikely; however, the proponent will actively manage noise during this period to avoid maximum noise level events.

An assessment of cumulative industrial noise from the project together with other industrial noise sources in the vicinity was also conducted. The project is not predicted to increase industrial noise levels above the relevant amenity criteria.

A quantitative approach has been taken regarding assessment of construction noise from the project. Construction noise levels are predicted to satisfy the Interim Construction Noise Guideline noise management levels (or noise criteria) at all assessment locations. The proponent will manage construction noise from the project by adopting universal noise management and mitigation measures.

The project will result in additional traffic movements. This increase is minor in comparison to existing traffic volumes and the overall increase in road traffic noise at residents will be negligible. Therefore, the impact of road traffic noise associated with the project is predicted to be negligible and within the 2 dB allowable increase for land use developments as described in the Road Noise Policy (DECCW 2011).

The assessment has also considered potential construction vibration impacts. The nearest building to the site is the Weston Aluminium industrial building positioned directly west on the property boundary. It is, therefore, envisaged that cosmetic damage to nearby structures (rather than human response) would be the most likely impact. Given the unknowns, it is not possible to provide precise predictions of vibration at this stage that may occur at nearby structures and, therefore, in the first instance the guide values presented in this report should be followed. Further construction vibration management measures are presented in this report. Operational vibration impacts from the project are considered unlikely.

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Appendices

Tables

Figures

1 Introduction

1.1 Background

This noise and vibration assessment has been prepared by EMM Consulting Pty Ltd for Pymore Recyclers International Pty Ltd's (Pymore) proposed used lead-acid battery (ULAB) recycling facility (the project) at 129 Mitchell Avenue, Kurri Kurri (the site).

The project would recycle approximately 60,000 tonnes per annum (tpa) of ULABs. The ULAB recycling plant would have four main processes – crushing, screening and separation; desulphurisation; crystallisation; and lead recovery. The entire process converts a ULAB into materials which are recycled for use in new products. Lead and plastics recovered are used in the production of new batteries. Sodium sulphate crystals, a by-product of ULAB recycling, can be readily used in other industries.

The project is State significant development (SSD) which requires development consent under Part 4, Division 4.1 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). A development application (DA) for SSD is required to be accompanied by an environmental impact statement (EIS). This noise and vibration assessment will be appended to the EIS for the project.

1.2 Assessment requirements

Secretary's Environmental Assessment Requirements (SEARs) were issued by the Department of Planning and Environment (DP&E) in March 2016 for the project. The NSW Environment Protection Authority (EPA) has also provided details of key issues requiring assessment for the project. Table 1.1 provides the relevant assessment requirements and the section of the report relevant to the specific requirement.

Table 1.1 Noise and vibration assessment requirements

Relevant authority and assessment requirement	Section of report where addressed
DP&E	
The EIS must include an assessment of all potential impacts of the proposed development on the existing environment (including cumulative impacts if necessary) and develop appropriate measures to avoid, minimise, mitigate and/or manage these potential impacts. As part of the EIS assessment, the following matters must also be addressed.	Refer entire report
Noise and vibration – including	
- a description of all potential noise and vibration sources during construction and operation, including road traffic noise;	Chapter 3
- a noise and vibration assessment in accordance with the relevant Environment Protection Authority guidelines; and	Refer entire report
- a description and appraisal of noise and vibration mitigation and monitoring measures.	Chapter 11
EPA	
Describe baseline conditions	
Determine the existing background (LA90) and ambient (LAeq) noise levels in accordance with the *NSW Industrial Noise Policy*.	Section 4.2
Determine the existing road traffic noise levels in accordance with the *NSW Environmental Criteria for Road Traffic Noise*, where road traffic noise impacts may occur.	Chapter 9
The noise impact assessment report should provide details of all monitoring of existing ambient noise levels.	Section 4.2

Table 1.1 Noise and vibration assessment requirements

Relevant authority and assessment requirement	Section of report where addressed
Assess impacts	
Determine the project specific noise levels for the site.	Chapter 5
Determine the noise levels likely to be received at the most sensitive locations (these may vary for different activities at each phase of the development). Potential impacts should be determined for any identified significant adverse meteorological conditions. Predicted noise levels under calm conditions may also aid in quantifying the extent of impact where this is not the most adverse condition.	Chapters 7, 8, 9, 10
The noise impact assessment report should include details of any mitigation proposed including the attenuation that will be achieved and the revised noise impact predictions following mitigation.	Chapters 7, 8, 11
Discuss the findings from the predictive modelling and, where relevant noise criteria have not been met, recommend additional mitigation measures.	Chapters 7, 8, 11
The noise impact assessment report should include details of any mitigation proposed including the attenuation that will be achieved and the revised noise impact predictions following mitigation.	Chapter 11
Where relevant noise/vibration criteria cannot be met after application of all feasible and cost effective mitigation measures the residual level of noise impact needs to be quantified	Chapters 7, 8, 9, 10
For the assessment of existing and future traffic noise, details of data for the road should be included such as assumed traffic volume; percentage heavy vehicles by time of day; and details of the calculation process. These details should be consistent with any traffic study carried out in the EIS.	Chapter 9
Describe management and mitigation measures	
Determine the most appropriate noise mitigation measures and expected noise reduction including both noise controls and management of impacts for both construction and operational noise.	Chapter 11
For traffic noise impacts, provide a description of the ameliorative measures considered (if required), reasons for inclusion or exclusion, and procedures for calculation of noise levels including ameliorative measures. Also include, where necessary, a discussion of any potential problems associated with the proposed ameliorative measures, such as overshadowing effects from barriers.	Chapter 9

1.3 Assessment guidelines

The noise and vibration assessment has been completed with reference to the following guidelines and policies:

- the *NSW Industrial Noise Policy* (EPA 2000) (INP);
- the *Road Noise Policy* (EPA 2011) (RNP);
- the *Interim Construction Noise Guideline* (EPA 2009) (ICNG);
- *Environmental Noise Management – Assessing Vibration: a technical guideline* (DEC 2006); and
- BS 7385 Part 2-1993 *Evaluation and measurement for vibration in buildings Part 2 (BSI 1993).*

2 Glossary of acoustic terms

A number of technical terms are required for the discussion of noise and vibration. These are explained in Table 2.1.

Table 2.1 Glossary of acoustic terms

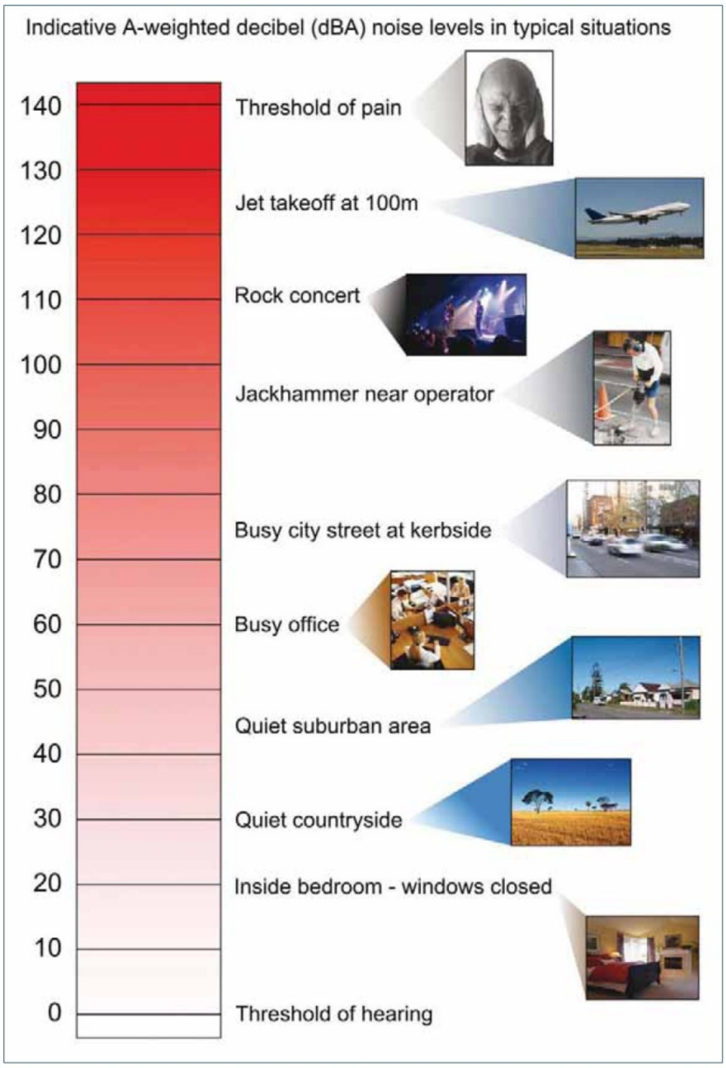
Term	Description
dB	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
L_{A1}	The A-weighted noise level exceeded for 1% of a measurement period.
L_{A10}	The A-weighted noise level which is exceeded 10% of the time. It is approximately equivalent to the average of maximum noise levels.
L_{A90}	Commonly referred to as the background noise, this is the A-weighted noise level exceeded 90% of the time.
L_{Aeq}	It is the energy average noise from a source, and is the equivalent continuous A-weighted sound pressure level over a given period. The $L_{Aeq,15min}$ descriptor refers to an L_{Aeq} noise level measured over a 15 minute period.
L_{Amax}	The maximum root mean squared A-weighted sound pressure level received at the microphone during a measuring interval.
RBL	The Rating Background Level (RBL) is an overall single value background level representing each assessment period over the whole monitoring period.
Sound power level	This is a measure of the total power radiated by a source. The sound power of a source is a fundamental property of the source and is independent of the surrounding environment.
Temperature inversion	A positive temperature gradient. A meteorological condition where atmospheric temperature increases with altitude.

It is useful to have an appreciation of decibels, the unit of noise measurement. Table 2.2 gives an indication as to what an average person perceives about changes in noise levels.

Table 2.2 Perceived change in noise

Change in sound level (dB)	Perceived change in noise
1–2	typically indiscernible
3	just perceptible
5	noticeable difference
10	twice (or half) as loud
15	large change
20	four times (or quarter) as loud

Examples of common noise levels are provided in Figure 2.1.



Source: Road Noise Policy (Department of Environment, Climate Change and Water (DECCW) 2011)

Figure 2.1 Common noise levels

3 Project and site description

3.1 Site operations and equipment

The project intends to reuse components recovered from the ULABs for use in the manufacture of new lead-acid batteries. The technology used for the project will be supplied by Engitec Technologies S.p.A (Engitec). Engitec has developed the CX Integrated System, which uses a combination of hydrometallurgical and pyrometallurgical process for the recovery of lead and associated by-products.

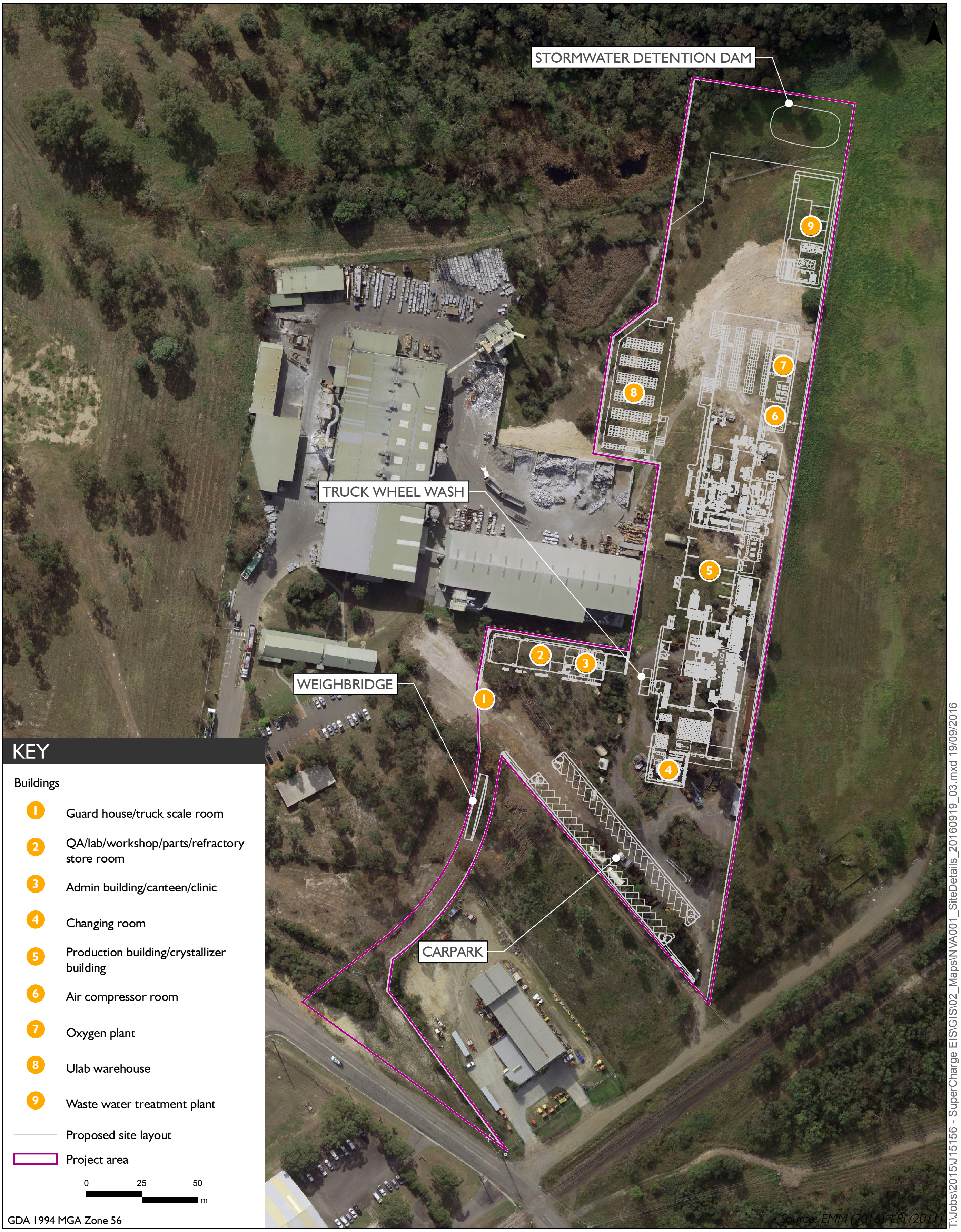
The ULAB recycling plant would have four main processes – crushing, screening and separation; desulphurisation; crystallisation; and lead recovery. The entire recycling process converts a ULAB into materials which are recycled for use in new products. Lead and plastics recovered are used in the production of new batteries. Sodium sulphate crystals are a by-product of ULAB recycling which are readily used in other industries.

The proposed project site layout is shown in Figure 3.1. The site will include the following components:

- a production/crystallizer building which would contain the majority of processing activities and stockpiles;
- a ULAB storage warehouse;
- a workshop/store room incorporating a quality assurance laboratory;
- a three storey administration building incorporating a canteen;
- a waste water treatment plant;
- amenities including a guard house, truck scale, compressor room, oxygen plant, changing rooms, diesel, water and septic tanks;
- a 46 space car parking area; and
- general use areas, including internal roads.

The majority of the site would be sealed (asphalt or concrete) with a perimeter curb.

The site is accessible from Mitchell Avenue via Government Road and Hart Road and also from Mitchell Avenue via Lang Road. Mitchell Avenue is predominantly located within the IN3 Heavy Industrial zone within the Cessnock Local Environmental Plan 2011 (Cessnock LEP) and is suitable for heavy vehicles.



Proposed site layout

Kurri Kurri Battery Recycling Facility
Noise and vibration impact assessment

Figure 3.1

Indicative noise generating equipment to be utilised by the project is listed in Table 3.1 and have been considered a part of this assessment.

Table 3.1 Indicative equipment and activities

Plant	Quantity	Typical activities
Front end loaders	2	Battery loading/charge preparation
Forklift	2	Ingot and crucible handling
Hammer mill	1	Breaking ULABs
Vibrating feeder	1	Conveying materials
Agitators	4	Stirring
Scrubber fan	1	Discharging fumes
Crystallizer	1	Crystallisation and drying
Rotary furnace	2	Lead recovery
Technofer	1	Recycling plastic
Outdoor fans	3	Providing ventilation
Cooling tower pump	1	Pumping water
Oxygen plant	1	Supplying oxygen to furnaces

3.2 Workforce and hours of operation

The project is expected to operate 24 hours per day, 7 days a week. It would generally accept deliveries and dispatch materials between the hours of 6:00 am and 6:00 pm on weekdays.

The project is expected to be operated by a total site workforce of 73 persons (including contractors).

3.3 Construction activities

The site surface would largely be sealed with concrete or asphalt and water management measures installed. These would include the perimeter kerb and a water collection pit.

Project construction would then require:

- installing gates and fencing;
- construction and fit out of the ULAB facility;
- construction of office building, canteen and other amenities including a guard house, diesel and water tanks;
- marking traffic circulation and parking bays; and
- landscaping.

Reticulated water and sewer are available to the site as well as electricity and telecommunications. Construction is expected to take 18 months.

3.4 Site location and surroundings

The site is undulating and slopes slightly downhill to the north (approximately 15-20 metres (m) Australian Height Datum (AHD)). It currently comprises undeveloped land largely used for the storage of unused industrial equipment for the neighbouring aluminium recycling plant.

Surrounding land uses are primarily industrial including the neighbouring aluminium recycling plant to the west, a neighbouring industrial coatings business to the south and a waste water treatment facility 750 m to the east. The residential areas of Kurri Kurri and Weston are approximately 650 m to the south-east and 1 km to the west of the site, respectively. The Hunter Expressway is approximately 550 m to the north-east. Swamp Creek is approximately 70 m to the north. A private rail line exists 25 m to the east.

3.5 Key noise and vibration issues

The broad potential noise and vibration issues for the project are as follows:

- noise and vibration from project construction activity;
- noise associated with the main operations;
- noise associated with the increased traffic to/from the site during construction and operation; and
- cumulative noise from all existing and proposed industrial operations as part of the larger development precinct.

The noise and vibration assessment has considered these potential issues. The noise assessment methodology included noise measurements, derivation of suitable criteria in accordance with the EPA's *NSW Industrial Noise Policy* (INP) and comparison of predicted noise emission levels to appropriate noise criteria. The vibration assessment methodology included derivation of relevant criteria and provision of recommendations regarding appropriate safe-working distances.

4 Existing environment

4.1 Noise assessment locations

Representative assessment locations considered in the noise assessment are listed in Table 4.1 and are shown in Figure 4.1. The nearest residential assessment locations are located on Mitchell Avenue, approximately 200 m south of the site.

Table 4.1 Assessment locations

ID	Receptor Type	Address
R1	Residential	4 Horton Road, Loxford
R2	Residential	7 McLeod Road, Loxford
R3	Residential	20 James Street, Kurri Kurri
R4	Classroom	Cnr Deakin and Standford Streets, Kurri Kurri
R5	Active recreation	Heddon Street, Kurri Kurri
R6	Residential	66 Northcote Street, Kurri Kurri
R7	Classroom	107 Lang Street, Kurri Kurri
R8	Place of worship	134 Maitland Street, Kurri Kurri
R9	Commercial	312 Lang Street, Kurri Kurri
R10	Active recreation	Northcote Street, Kurri Kurri
R11	Residential	122 Mitchell Avenue, Kurri Kurri
R12	Hospital	Hospital Road, Kurri Kurri
R13	Industrial	125 Mitchell Avenue, Kurri Kurri
R14	Industrial	Cnr Johnson Street and Mitchell Avenue, Kurri Kurri
R15	Active recreation	Boundary St, Kurri Kurri
R16	Hospital	Hospital Road, Kurri Kurri
R17	Active recreation	Government Road, Weston
R18	Industrial	130 Mitchell
R19	Classroom	20-34 Sixth Street, Weston
R20	Residential	62 Government Road, Weston
R21	Industrial	142 Mitchell Avenue, Kurri Kurri
R22	Residential	86 Government Road, Weston
R23	Residential	65 Government Road, Loxford
R24	Industrial	129 Mitchell Avenue, Kurri Kurri
R25	Residential	72 Hart Road, Loxford

The assessment locations represent those most likely to be affected by the project. Adherence with noise criteria at these locations would indicate that noise criteria will be met at other surrounding noise-sensitive locations.

4.2 Existing acoustic environment

A key element in assessing environmental noise impact from industry is to quantify the existing ambient acoustic environment, including any existing industrial noise where present. The locations of ambient noise monitoring used in this assessment are provided in Figure 4.1.

The existing acoustic environment (ie ambient noise) was characterised by long-term unattended and short-term attended noise monitoring undertaken in February 2016 at the locations shown in Figure 4.1.

4.2.1 Unattended noise monitoring

Unattended noise monitoring was undertaken at three locations in Kurri Kurri from 11 to 24 February 2016 as described in Table 4.2. The monitoring was completed using an ARL EL 316 Type 1 environmental noise logger (s/n 16-306-036) and two ARL Rion NL-42EX environmental loggers (s/n 00-521-657 and 00-810-713).

The noise loggers were programmed to record statistical noise level indices continuously in 15 minute intervals, including the L_{Amax}, L_{A1}, L_{A10}, L_{A50}, L_{A90}, L_{A99}, L_{Amin} and the L_{Aeq}. Calibration of all instrumentation was checked prior to and following measurements. Drift in calibration did not exceed ±0.5 dB. All equipment carried appropriate and current NATA (or manufacturer) calibration certificates.

Table 4.2 EMM noise logging details

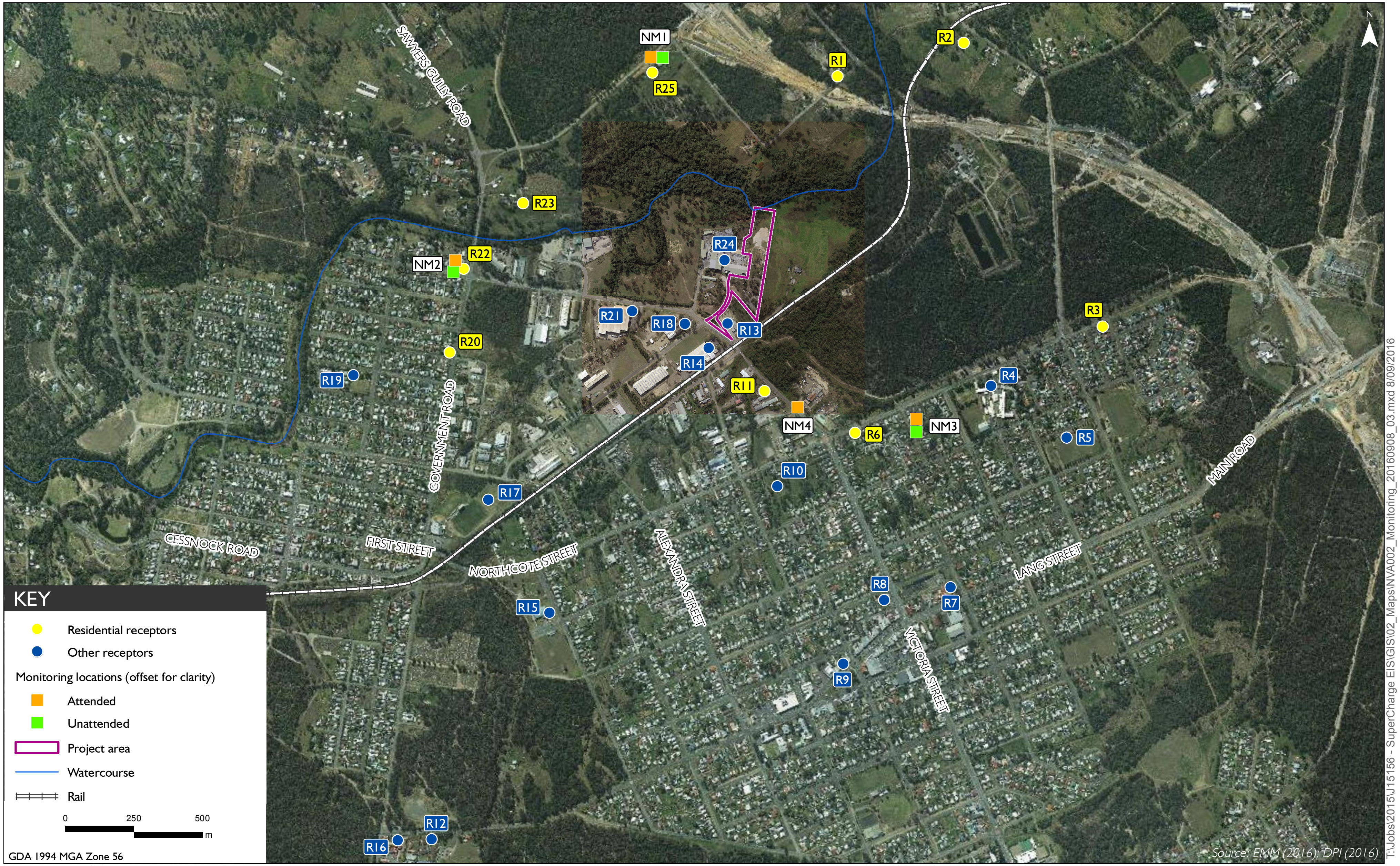
Location	Approximate position with respect to the site
NM1 - Hart Road	650 m to the north-west
NM2 - Tenth Street	1,000 m to the west
NM3 - Burns Street	750 m to the south-east

The Rating Background Levels (RBL) and ambient $L_{Aeq,period}$ noise levels derived from unattended noise monitoring are summarised in Table 4.3. The daily noise data and charts from noise logging are provided in Appendix A. The logging data was analysed in accordance with the INP, whereby data was excluded where rainfall and/or winds of greater than 5 metres per second (m/s) were recorded. This analysis was completed using weather data from the Bureau of Meteorology's (BoM) automatic weather station (AWS) at Cessnock Airport located approximately 13 km west of the site. This approach is consistent with recommendations of the INP.

Table 4.3 Unattended noise monitoring summary

Location	RBL, dB(A)			Ambient (L_{Aeq}) noise level, dB		
	Day	Evening	Night	Day	Evening	Night
NM1 - Hart Road	44	43	41	55	60	53
NM2 - Tenth Street	42	36	28	56	49	42
NM3 - Burns Street	41	39	35	59	57	48

Note: 1. Day: 7 am to 6 pm Monday to Saturday; 8 am to 6 pm Sundays and public holidays; evening: 6 pm to 10 pm; night is the remaining periods.



Noise monitoring and assessment locations

Kurri Kurri Battery Recycling Facility

Noise and vibration impact assessment

Figure 4.1

4.2.2 Attended noise monitoring

Attended noise measurements of 15 minutes duration were completed at four locations, including the three unattended monitoring locations. The attended noise surveys were conducted using a Brüel and Kjær Type 2250 one-third octave hand-held analyser (s/n 2759405). Field calibration of the instrument was undertaken using a Brüel and Kjær type 4230 calibrator (s/n 1442144). Attended measurements were conducted in accordance with Australian Standard (AS) 1055-1997 *Description and Measurement of Environmental Noise,* Parts 1, 2 and 3.

Meteorological conditions throughout each survey period were generally calm and clear with no winds above 5 m/s at microphone height or rain events.

Table 4.4 presents the results of the attended noise measurements, description of the ambient noise environment and quantification of existing noise levels at nearby residences.

Several industrial developments currently operate in the area surrounding the site. Levels of existing industrial noise at each location have been quantified where possible.

Table 4.4 Attended noise monitoring summary

Location	Date	Start time	L_{eq}	L_{90}	L_{max}	Comments and typical levels (dB)
NM1 - Hart Road	11/2/16	13:00	55	45	85	Traffic on Hunter Expressway dominant. Insects consistent. Traffic on Hart Road. Birds, horses, residents audible.
NM2 - Tenth Street	11/2/16	13:45	51	46	69	Traffic on Government Road. Insects consistently audible. Industrial noise from east (42 dB) Birds, dogs barking, chainsaw and wind in trees audible.
NM3 - Burns Street	11/2/16	15:00	51	48	63	Insects and birds dominant. Idling truck, model plane, wind in trees and car passbys audible.
NM4 - Mitchell Avenue	11/2/16	15:30	66	55	80	Insects dominant. Car passbys consistent. Industrial noise.
NM3 - Burns Street	19/2/16	01:15	37	33	51	Traffic on Hunter expressway, insects and birds consistent. Industrial hum from north consistent (≤30 dB). Occasional local traffic. Push bike and residents audible
NM4 - Mitchell Avenue	19/2/16	01:45	44	36	69	Traffic on Hunter expressway, insects and birds consistent. Occasional local traffic. Industrial hum from south-west barely audible. Livestock and people audible
NM2 - Tenth Street	19/2/16	02:15	42	40	58	Traffic on Hunter expressway consistent. Industrial hum from east, consistent (39 dB). Traffic on Government Road frequent.

Table 4.4 Attended noise monitoring summary

Location	Date	Start time	L_{eq}	L_{90}	L_{max}	Comments and typical levels (dB)
NM1 - Hart Road	19/2/16	02:45	47	40	70	Insects consistent. Traffic on Hunter Expressway very frequent. Industrial noise, consistent (42 dB). Occasional local traffic.

Results of operator-attended noise surveys at nearby locations to the site indicate that road traffic and, to a lesser extent, existing industrial operations are the main contributors to ambient noise levels in the vicinity of the site.

4.3 Meteorology

Noise propagation over distance can be significantly affected by the prevailing weather conditions. Of most interest are source to receiver winds, the presence of temperature inversions and drainage flow effects, as these conditions can enhance received noise levels. To account for these phenomena, the INP specifies meteorological analysis procedures to determine the prevalent weather conditions that enhance noise propagation in a particular area, with a view to determining whether they can be described as a feature of the site.

4.3.1 Wind

Wind has the potential to increase noise impacts at a receiver when it is light and stable, and blows from the direction of the noise source. As the wind strength increases, the noise produced by the wind usually obscures noise from most industrial and transport sources.

The prevailing wind directions in the area have been determined in accordance with Section 5 of the INP. The INP requires that winds of speeds up to 3 m/s with an occurrence greater than 30% of the time during any period (day, evening or night) in any season be assessed.

4.3.2 Analysis of prevailing winds

The INP recommends consideration of wind effects if they are a “feature” of the area. The INP defines feature as the presence of source-to-receiver wind speed (measured at 10 m above ground level) of 3 m/s or less, occurring for 30% of the time in any assessment period and season.

This is further clarified by defining source-to-receiver wind direction as being the directional component of wind. The INP states that where wind is identified to be a feature of the area then assessment of noise impacts should consider the highest wind speed at or below 3 m/s, which is considered to prevail for at least 30% of the time.

Detailed analysis of winds was undertaken using weather data from the BoMs AWS at Cessnock Airport (station number 061260), located approximately 13 km west of the site.

The prevailing winds analysis was undertaken in accordance with INP methodologies and considered weather data over a two year period (January 2014 to January 2016). The analysis identified that winds during the evening and night-time periods are a feature of the area, as per the INP, from the east-south-east (112.5^{o}) through to the west-north-west (292.5^{o}). A detailed summary of the wind analysis is presented in Appendix B.

4.3.3 Temperature inversions

Temperature inversions, when they occur, have the ability to increase noise levels by focusing sound waves. Temperature inversions generally occur during the night-time and early morning periods during winter months. A temperature inversion needs to occur for approximately 30% of the total night-time period during winter, or approximately two nights per week, for it to be a significant characteristic of the area and require consideration in accordance with the INP (EPA 2000).

F class temperature inversions have been found to occur for greater than 30% of the evening and night-time periods in this part of the Hunter Valley area and, therefore, have been considered in the prediction and assessment of noise emissions from the project.

4.3.4 Drainage winds

The INP states that a default wind drainage value should be applied where sources are at a higher altitude than the assessment location with no intervening topography. All assessment locations are at a similar or higher elevation than the site. Therefore, drainage winds have not been considered as part of this assessment.

4.3.5 Modelled meteorological conditions

The relevant site specific meteorological conditions adopted in this noise assessment based on the meteorological data analysis detailed above are presented in Table 4.5.

Table 4.5 Weather conditions considered in noise modelling

Assessment period	Meteorological condition	Air temperature	Relative humidity	Wind speed[1]	Wind direction[2]	Stability class
Day	Calm	20°C	70%	0 m/s	N/A	D
Evening	Calm	20°C	70%	0 m/s	N/A	D
	Wind	20°C	70%	2.6 m/s	135°-292.5°	D
Night	Calm	10°C	90%	0 m/s	N/A	D
	Wind	10°C	90%	2.4 m/s	112.5°-247.5°	D
	Temperature inversion	10°C	90%	0 m/s	N/A	F

Notes: *1. Based on the 10th percentile wind speed of all winds present for 30% of the time during the relevant period.*

2. Wind directions considered are at 22.5° intervals from north (0°) based on data from the Cessnock Airport AWS.

N/A = Not applicable.

5 Noise criteria

5.1 Operational noise

Industrial sites in NSW, including recycling facilities, are regulated by the local council, DP&E and/or the EPA and usually have a licence and/or approval conditions stipulating noise limits. These limits are normally derived from operational noise criteria applied at assessment locations. They are based on INP guidelines or noise levels that can be achieved at a specific site following the application of all reasonable and feasible noise mitigation.

The INP guidelines for assessing industrial facilities have been used for this assessment. With respect to the criteria, the guidelines state:

> They are not mandatory, and an application for a noise producing development is not determined purely on the basis of compliance or otherwise with the noise criteria. Numerous other factors need to be taken into account in the determination. These factors include economic consequences, other environmental effects and the social worth of the development.

Assessment criteria depend on the existing amenity of areas potentially affected by a proposed development. Noise assessment criteria for industry are based on the following objectives:

- protection of the community from excessive intrusive noise; and
- preservation of amenity for specific land uses.

To ensure these objectives are met, the EPA provides two separate noise criteria: intrusiveness criteria and amenity criteria. A fundamental difference between the intrusiveness and the amenity criteria is the period they relate to:

- intrusiveness criteria — apply over 15 minutes in any period (day, evening or night); and
- amenity criteria — apply to the entire assessment period (day, evening or night).

5.1.1 Intrusiveness

The intrusiveness criteria require that $L_{eq,15min}$ noise levels from a project during the relevant operational periods (ie day, evening and night) do not exceed the RBL by more than 5 dB. The RBL and the intrusiveness criteria for the project are detailed in Table 5.1.

Table 5.1 Intrusive noise criteria

Assessment location	Adopted RBL, dB			Intrusiveness criteria, $L_{Aeq,15min}$, dB		
	Day	Evening	Night	Day	Evening	Night
R1, R2, R25	44	43	41	49	48	46
R3, R6, R11	41	39	35	46	44	40
R20, R22, R23	42	36	30[1]	47	41	35

Notes: Day: 7 am to 6 pm Monday to Saturday; 8am to 6pm Sundays and public holidays; Evening: 6 pm to 10 pm; Night: all remaining periods.

1. This RBL has been adjusted to the minimum value as per the INP.

5.1.2 Amenity

The assessment of amenity is based on noise criteria specific to the land use. The criteria relate only to industrial noise and exclude road or rail noise. Where the measured existing industrial noise approaches recommended amenity criteria, it needs to be demonstrated that noise levels from new industry will not contribute to existing industrial noise.

Residential assessment locations potentially affected by the project have been categorised in the INP 'Urban' amenity category. The corresponding recommended amenity criteria for the project are given in Table 5.2.

Table 5.2 Amenity criteria

Assessment location	Indicative area	Time period	Recommended noise level dB(A), $L_{eq,period}$	
			Acceptable	Maximum
All residential areas	Urban	Day	60	65
		Evening	50	55
		Night	45	50
Industrial premises	All	When in use	70	75
School classroom (internal)	All	When in use	35	40
Place of worship (internal)	All	When in use	40	45
Hospital ward	All	When in use	35 (Internal) 50 (External)	40 (Internal) 55 (External)
Active recreation area (playground, golf course, etc.)	All	When in use	55	60

If existing industrial noise approaches the acceptable noise level (ANL), the criteria is to be adjusted to ensure the total industrial level with a project does not exceed the expectable amenity criteria. This is achieved by applying modification factors to the recommended criteria which are reproduced from Table 2.2 of the INP in Table 5.3 below.

Table 5.3 Modification to acceptable noise level to account for existing levels of industrial noise

Total existing L_{Aeq} noise level from industrial noise sources	Maximum L_{Aeq} noise level for noise from new sources alone, dB
≥ ANL plus 2 dB	If existing noise level is likely to decrease in future, ANL minus 10 dB
	If existing noise level is unlikely to decrease in future, existing noise level minus 10 dB
ANL plus 1 dB	ANL minus 8 dB
ANL	ANL minus 8 dB
ANL minus 1 dB	ANL minus 6 dB
ANL minus 2 dB	ANL minus 4 dB
ANL minus 3 dB	ANL minus 3 dB
ANL minus 4 dB	ANL minus 2 dB
ANL minus 5 dB	ANL minus 2 dB
ANL minus 6 dB	ANL minus 1 dB
< ANL minus 6 dB	ANL

Notes: ANL = recommended acceptable L_{Aeq} noise level for the specific receiver, area and time of day from Table 5.2

Existing industrial noise contributions and adjusted amenity criteria for the project are provided in Table 5.4. The amenity criteria have been adjusted using INP methods reproduced in Table 5.3 and the existing measured industrial noise contribution.

Table 5.4 Project specific amenity criteria

Assessment location	Existing Industrial noise, dB			Amenity criteria dB, $L_{Aeq,period}$		
	Day	Evening	Night	Day	Evening	Night
R1	<54	<44	42	60	50	42 [1]
R2	<54	<44	42	60	50	42 [1]
R3	<54	<44	42	60	50	45
R4	<54	<44	<30	35	35	35
R5	<54	<44	<30	55	55	55
R6	<54	<44	<30	60	50	45
R7	<54	<44	<30	35	35	35
R8	<54	<44	<30	40	40	40
R9	<54	<44	<30	65	65	65
R10	<54	<44	<30	55	55	55
R11	<54	<44	<30	60	50	45
R12	<54	<44	39	35	35	35
R13	<54	<44	39	70	70	70
R14	<54	<44	39	70	70	70
R15	<54	<44	39	55	55	55
R16	<54	<44	39	35	35	35
R17	<54	<44	39	55	55	55
R18	<54	<44	39	70	70	70
R19	<54	<44	39	35	35	35
R20	<54	<44	39	60	50	44 [1]
R21	<54	<44	39	70	70	70
R22	<54	<44	39	60	50	44 [1]
R23	<54	<44	39	60	50	44 [1]
R24	<54	<44	39	70	70	70
R25	<54	<44	42	60	50	42 [1]

Notes: Day: 7 am to 6 pm Monday to Saturday; 8 am to 6 pm Sundays and public holidays; evening: 6 pm to 10 pm; night is the remaining periods.

1. The amenity criteria have been adjusted using INP methods reproduced in Table 5.3 and the existing measured industrial noise contribution.

5.1.3 Project specific noise level

The project-specific noise level (PSNL) is the lower of the calculated intrusive or amenity criteria. The PSNL for the daytime, evening and night periods are indicated in Table 5.5.

Table 5.5 Project specific noise levels

Assessment location	PSNL, dB		
	Day	Evening	Night
R1	49	48	46 $L_{Aeq,15min}$/42 $L_{Aeq,period}$
R2	49	45	46 $L_{Aeq,15min}$ /42 $L_{Aeq,period}$
R3	46	44	40 $L_{Aeq,15min}$ /45 $L_{Aeq,period}$
R4	35	35	35
R5	55	55	55
R6	46	44	40 $L_{Aeq,15min}$ /45 $L_{Aeq,period}$
R7	35	35	35
R8	40	40	40
R9	65	65	65
R10	55	55	55
R11	46	44	40 $L_{Aeq,15min}$ /45 $L_{Aeq,period}$
R12	35	35	35
R13	70	70	70
R14	70	70	70
R15	55	55	55
R16	35	35	35
R17	55	55	55
R18	70	70	70
R19	35	35	35
R20	47	41	35 $L_{Aeq,15min}$ /44 $L_{Aeq,period}$
R21	70	70	70
R22	47	41	35 $L_{Aeq,15min}$ /44 $L_{Aeq,period}$
R23	47	41	35 $L_{Aeq,15min}$ /44 $L_{Aeq,period}$
R24	70	70	70
R25	49	45	46 $L_{Aeq,15min}$ /42 $L_{Aeq,period}$

Notes: Day: 7 am to 6 pm Monday to Saturday; 8 am to 6 pm Sundays and public holidays; evening: 6 pm to 10 pm; night is the remaining periods.

5.2 Construction noise criteria

The ICNG provides guidelines for the assessment and management of noise from construction works.

The ICNG suggests the following time restriction for construction activities where the noise is audible at residential premises:

- Monday to Friday 7.00 am–6.00 pm;
- Saturday 8.00 am–1.00 pm; and
- No construction work is to take place on Sundays or public holidays.

Table 5.6 is an extract from the ICNG and provides noise management levels for residential receivers for both recommended standard construction hours and outside of these periods. These time restrictions are the primary management tool of the ICNG.

Table 5.6 ICNG residential criteria

Time of day	Management level $L_{eq, 15min}$	How to apply
Recommended standard hours: Monday to Friday 7:00 am to 6:00 pm Saturday 8:00 am to 1:00 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq, 15min}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: i) times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences; and if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

In summary, the ICNG noise level goals for activities during standard construction hours are 10 dB above the existing background levels. Table 5.7 is an extract from the ICNG and provides noise management levels for other land uses.

Table 5.7 ICNG noise levels at other land uses

Land use	Management level, $L_{Aeq,15min}$
Industrial premises	External noise level 75 dB (when in use)
Offices, retail outlets	External noise level 70 dB (when in use)
Classrooms at schools and other educational institutions	Internal noise level 45 dB (when in use)
Hospital wards and operating theatres	Internal noise level 45 dB (when in use)
Places of worship	Internal noise level 45 dB (when in use)
Active recreation areas	External noise level 65 dB (when in use)
Passive recreation areas	External noise level 60 dB (when in use)

Source: ICNG (DECC, 2009).

The construction noise management levels (NMLs) for this assessment presented in Table 5.8 have been developed using the noise monitoring data provided in Section 4 and in accordance with the ICNG.

Table 5.8 Construction noise management levels

Receiver	Period	Representative RBL, dB(A)	NML[1], $L_{Aeq,15min}$, dB
R1, R2, R25	Recommended standard hours	44	54
R3, R6, R11	Recommended standard hours	41	51
R20, R22, R23	Recommended standard hours	42	52
Offices, retail outlets	When in use	N/A	70
Neighbouring industrial premises	When in use	N/A	75
Classrooms	When in use	N/A	45 (Internal)/55 (External)
Hospital wards and operating theatres	When in use	N/A	45 (Internal)/55 (External)
Places of worship	When in use	N/A	45 (Internal)/55 (External)
Active recreation areas	When in use	N/A	65
Passive recreation areas	When in use	N/A	60

Notes: N/A = not applicable.
1. External noise levels

5.3 Sleep disturbance criteria

The project will operate during the night-time period from 10.00 pm to 7.00 am. Therefore, assessment of sleep disturbance is required in accordance with the INP and associated application notes.

The operational criteria described in Section 5.1, which consider the average noise emission of a source over 15 minutes, are appropriate for assessing noise from steady-state sources, such as engine noise from mobile plant and processing equipment. However, noise impacts from sources such as a front end loader (FEL) is intermittent (rather than continuous) and needs to be assessed using the L_{A1} or L_{Amax} noise metrics.

The INP application notes (last updated June 2013) recognise that the current sleep disturbance criteria is not ideal. The assessment of potential sleep disturbance is complex and poorly understood and the EPA believes that there is insufficient information to determine a suitable alternative criteria.

In the interim, the INP guideline suggests that the $L_{A1,1min}$ (or L_{Amax}) level of 15 dB above the RBL is a suitable screening criteria for sleep disturbance for the night-time period. Guidance regarding potential for sleep disturbance is also provided in the RNP. The RNP references a number of studies that have been conducted into the effect of maximum noise levels on sleep. The RNP acknowledges that, at the current level of understanding, it is not possible to establish absolute noise level criteria that would correlate to an acceptable level of sleep disturbance. However, the RNP provides the following conclusions from the research on sleep disturbance:

- maximum internal noise levels below 50 to 55 dBA are unlikely to awaken people from sleep; and
- one or two noise events per night, with maximum internal noise levels of 65 to 70 dBA, are not likely to affect health and wellbeing significantly.

It is commonly accepted by acoustic practitioners and regulatory bodies that a facade including a partially open window will reduce external noise levels by 10 dB. Therefore, with reference to the RNP, external noise levels in the order of 60–65 dB calculated at the facade of a residence are unlikely to awaken people.

If noise levels over the screening criteria were identified, then additional analysis would consider factors such as:

- how often the events would occur;
- the time the events would occur (between 10.00 pm and 7.00 am); and
- whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods).

Table 5.9 provides the sleep disturbance screening criteria for the residential assessment locations potentially impacted by the project.

Table 5.9 Sleep disturbance screening criteria – residential assessment locations

Assessment location	Adopted RBL, dB(A)[1]	Sleep disturbance screening criteria dB, L_{Amax} Night-time period (10 pm to 7 am)
R1, R2, R25	41	56
R3, R6, R11	35	50
R20, R22, R23	30	45

Notes: 1.Night-time RBLs adopted.

5.4 Road traffic noise criteria

The principle guidance for assessing the impact of road traffic noise is RNP. Table 5.10 presents the road noise assessment criteria reproduced from Table 3 of the RNP.

Table 5.10 Road traffic noise assessment criteria for residential land uses

Road category	Type of project/development	Assessment criteria, dB	
		Day (7 am to 10 pm)	Night (10 pm to 7 am)
Freeway/arterial/sub-arterial roads	Existing residences affected by additional traffic on existing freeway/arterial/sub-arterial roads generated by land use developments.	$L_{Aeq(15\text{-}hr)}$ 60 (external)	$L_{Aeq(9\text{-}hr)}$ 55 (external)

Source: EPA (2011).

The RNP states that where existing road traffic noise criteria are already exceeded, any additional increase in total traffic noise level should be limited to 2 dB.

5.4.1 Relative increase criteria

In addition to meeting the assessment criteria, any significant increase in total traffic noise at assessment locations must be considered. Table 5.11 presents the relative increase assessment criteria reproduced from Table 6 of the RNP. Assessment locations experiencing increases in total traffic noise levels above those outlined in Table 5.11 should be considered for mitigation.

Table 5.11 Relative increase criteria for residential land uses

Road category	Type of project/development	Total traffic noise level increase, dB	
		Day (7 am to 10 pm)	Night (10 pm to 7 am)
Freeway/arterial/sub-arterial roads and transitways	New road corridor/redevelopment of existing road/land use development with the potential to generate additional traffic on existing road.	Existing traffic $L_{Aeq(15\text{-}hr)}$+12 dB (external)	Existing traffic $L_{Aeq(9\text{-}hr)}$+ 12 dB (external)

Road traffic generated by the project will be relatively minor compared to existing traffic volumes on the proposed transport route. The potential for the relative increase criteria to be exceeded is, therefore, highly unlikely and has not been considered further.

6 Vibration criteria

Environmental Noise Management – Assessing Vibration: a technical guideline (the ENM, DEC 2006) is based on guidelines contained in British Standard *BS 6472 – 2008, Evaluation of human exposure to vibration in buildings (1-80Hz).* The ENM presents preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques. At vibration values below the preferred values, there is a low probability of adverse comment or disturbance to building occupants. Where all feasible and reasonable mitigation measures have been applied and vibration values are still beyond the maximum value, it is recommended the operator negotiate directly with the affected community.

The ENM defines three vibration types and provides direction for assessing and evaluating the applicable criteria. Table 2.1 of the ENM provides examples of the three vibration types and has been reproduced in Table 6.1.

Table 6.1 Examples of types of vibration (from Table 2.1 of the ENM)

Continuous vibration	Impulsive vibration	Intermittent vibration
Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading. Blasting is assessed using ANZECC (1990).	Trains, intermittent nearby construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer these would be assessed against impulsive vibration criteria.

6.1 Continuous vibration

Appendix C of the ENM outlines acceptable criteria for human exposure to continuous vibration (1-80Hz). The criteria are dependent on both the time of activity (usually daytime or night-time) and the occupied place being assessed. Table 6.2 reproduces the preferred and maximum criteria relating to measured peak velocity.

Table 6.2 Criteria for exposure to continuous vibration

Place	Time	Peak velocity	
		Preferred	Maximum
Critical working areas (eg hospital operating theatres, precision laboratories)	Day or night-time	0.14	0.28
Residences	Daytime	0.28	0.56
	Night-time	0.20	0.40
Offices	Day or night-time	0.56	1.1
Workshops	Day or night-time	1.1	2.2

Notes: Root mean square velocity (mm/s) and vibration velocity value (dB re 10^{-9} mm/s).
Values given for most critical frequency >8 Hz assuming sinusoidal motion.

6.2 Intermittent vibration

Intermittent vibration (as defined in Section 2.1 of the ENM) is assessed using the vibration dose concept which relates to vibration magnitude and exposure time. Intermittent vibration is representative of activities such as impact hammering, rolling or general excavation work (such as an excavator tracking).

Section 2.4 of the ENM provides acceptable values for intermittent vibration in terms of vibration dose values (VDV) which requires the measurement of the overall weighted RMS (root mean square) acceleration levels over the frequency range 1 Hz to 80 Hz. To calculate VDV the following formula (refer section 2.4.1 of the ENM) was used:

$$VDV = \left[\int_0^T a^4(t)dt \right]^{0.25}$$

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

The acceptable VDV for intermittent vibration are reproduced in Table 6.3

Table 6.3 Acceptable VDV for intermittent vibration ($m/s^{1.75}$)

Location	Daytime		Night-time	
	Preferred value, $m/s^{1.75}$	Maximum value, $m/s^{1.75}$	Preferred value, $m/s^{1.75}$	Maximum value, $m/s^{1.75}$
Critical areas	0.10	0.20	0.10	0.20
Residences	0.20	0.4	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Notes: *Daytime is 7 am to 10 pm and night-time is 10 pm to 7 am.*

These criteria are indicative only, and there may be a need to assess intermittent values against continuous or impulsive criteria for critical areas.

There is a 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. The ENM states that activities should be designed to meet the preferred values where an area is not already exposed to vibration.

6.3 Structural vibration

Most commonly specified "safe" structural vibration limits are designed to minimise the risk of threshold or cosmetic surface cracks, and are set well below the levels that have potential to cause damage to the main structure.

In terms of the most recent relevant vibration damage criteria, Australian Standard AS 2187.2 - 2006 "*Explosives* - Storage *and Use - Use of Explosives*" recommends the frequency dependent guideline values and assessment methods given in British Standard BS 7385 Part 2-1993 *Evaluation and measurement for vibration in buildings Part 2* be used as they are "applicable to Australian conditions".

British Standard BS 7385-2 sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

Sources of vibration that are considered in British Standard BS 7385-2 include demolition, blasting (carried out during mineral extraction or construction excavation), piling, ground treatments (eg compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery.

British Standard BS 7385-2 provides recommended limits (guide values) for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in Table 6.4 and graphically in Figure 6.1.

Table 6.4 Transient vibration guide values - minimal risk of cosmetic damage

Line	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	**15 Hz and above**
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

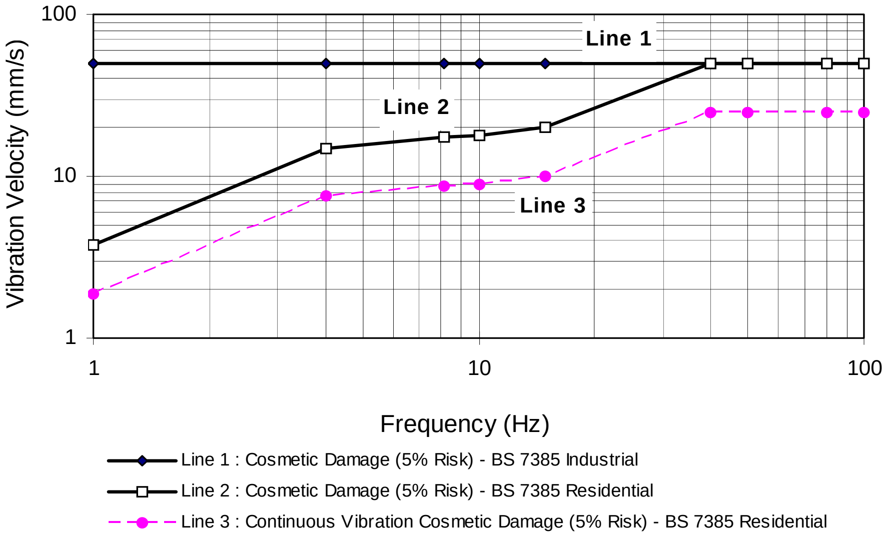


Figure 6.1 Graph of transient vibration guide vales for cosmetic damage

British Standard BS 7385-2 states that the guide values in Table 6.4 relate predominantly to transient vibration which does not give rise to resonant responses in structures and low-rise buildings.

Where the dynamic loading caused by continuous vibration may give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in Table 6.4 may need to be reduced by up to 50%. Sheet piling activities (for example) are considered to have the potential to cause dynamic loading in some structures (eg residences) and it may, therefore, be appropriate to reduce the transient values by 50%.

In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for building types corresponding to Line 2 are reduced. Below a frequency of 4 hertz (Hz) where a high displacement is associated with the relatively low peak component particle velocity value, a maximum displacement of 0.6 millimetres (mm) (zero to peak) is recommended. This displacement is equivalent to a vibration velocity of 3.7 mm/s at 1 Hz.

British Standard BS 7385-2 goes on to state that minor damage is possible at vibration magnitudes which are greater than twice those given in Table 6.4, and major damage to a building structure may occur at values greater than four times the tabulated values.

Fatigue considerations are also addressed in British Standard BS 7385-2 and it is concluded that unless calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials) then the guide values in Table 6.4 should not be reduced for fatigue considerations.

In order to assess the likelihood of cosmetic damage due to vibration, AS2187 specifies that vibration measurements should be undertaken at the base of the building and the highest of the orthogonal vibration components (transverse, longitudinal and vertical directions) should be compared with the criteria curves presented in Table 6.4.

It is noteworthy that extra to the guide values nominated in Table 6.4, British Standard BS 7385-2 states that:

> Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity. This is not inconsistent with an extensive review of the case history information available in the UK.

Also that:

> A building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive.

6.4 Ground-borne vibration (safe working distances)

As a guide, safe working distances for typical items of vibration intensive plant are listed in Table 6.5. The safe working distances are quoted for both “Cosmetic Damage” (refer British Standard BS 7385) and “Human Comfort” (refer British Standard BS 6472-1).

Table 6.5 Recommended safe working distances for vibration intensive plant

Plant Item	Rating/Description	Safe working distance	
		Cosmetic damage (BS 7385)	Human response (BS 6472)
Vibratory Roller	<50kN (Typically 1-2 tonnes)	5 m	15 to 20 m
	<100kN (Typically 2-4 tonnes)	6 m	20 m
	<200kN (Typically 4-6 tonnes)	12 m	40 m
	<300kN (Typically 7-13 tonnes)	15 m	100 m
	>300kN (Typically 13-18 tonnes)	20 m	100 m
	>300kN (>18 tonnes)	25 m	100 m
Small hydraulic hammer	(300 kg - 5 to 12t excavator)	2 m	7 m
Medium hydraulic hammer	(900 kg - 12 to 18t excavator)	7 m	23 m
Large hydraulic hammer	(1600 kg - 18 to 34t excavator)	22 m	73 m
Vibratory pile driver	Sheet piles	2 m to 20 m	20 m
Pile boring	≤ 800 mm	2 m (nominal)	N/A
Jackhammer	Hand held	1 m (nominal)	Avoid contact with structure

Source: Transport Infrastructure Development Corporation Construction's Construction Noise Strategy (Rail Projects), November 2007.

The safe working distances presented in Table 6.5 are indicative and will vary depending on the particular item of plant and local geotechnical conditions. They apply to cosmetic damage of typical buildings under typical geotechnical conditions.

In relation to human comfort (response), the safe working distances in Table 6.5 relate to continuous vibration and apply to residential receivers. For most construction activities, vibration emissions are intermittent in nature and, for this reason, higher vibration levels occurring over shorter periods are allowed, as discussed in BS 6472-1.

6.5 Ground-borne noise

Ground-borne noise is noise generated by vibration transmitted through the ground into a structure. The ICNG provides guidance on the assessment of ground-borne noise and relevant internal noise levels for the evening and night-time periods above which management actions should be implemented.

It is understood that vibration-generating events, such as vibratory rolling and compacting during construction, would occur for the project during the daytime only. Therefore, ground-borne noise impacts have not been considered as part of this assessment.

7 Operational noise assessment

7.1 Noise modelling method

This section presents the methods and assumptions used to model noise emissions from operation of the project.

Noise modelling was based on three-dimensional digitised ground contours of the surrounding land. Noise predictions were carried out using Brüel and Kjær Predictor Version 11.00 (Predictor) noise prediction software. It calculates total noise levels at assessment locations from the concurrent operation of multiple noise sources. Predictor considers factors such as:

- the lateral and vertical location of plant;
- source to assessment location distances;
- ground effects;
- atmospheric absorption;
- topography of the site and surrounding area; and
- applicable meteorological conditions (refer to Section 4.3).

Plant and equipment was modelled at locations and heights representing activities during operation of the project using representative equipment sound power levels and quantities provided in Table 7.1. The sound power levels adopted have been taken from EMM's database of similar equipment and information provided by the proponent. Noise modelling has conservatively assumed that all fixed plant and equipment operates simultaneously. The use of mobile plant will generally be intermittent during operations.

Table 7.1 Operational plant and equipment sound power levels

Plant and equipment	Typical activities	Location	Quantity operating			Lw, dB
			Day	Evening	Night	
Front end loaders	Battery loading/charge prep.	CX area/foundry	2	2	2	105
Forklift	Ingot and crucible handling	CX area/foundry/refinery	2	2	2	105
Hammer mill	Breaking ULABs	CX area	1	1	1	110
Vibrating feeder	Conveying materials	CX area	1	1	1	91
Agitators	Stirring	CX area/crystallizer	4	4	4	93
Scrubber fan	Discharging fumes	CX area	1	1	1	80
Crystallizer	Crystallisation and drying	Crystallizer building	1	1	1	91
Rotary furnace	Lead recovery	Foundry	2	2	2	94
Technofer	Recycling plastic	CX area	1	1	1	93
Oxygen plant	Supplying oxygen	Oxygen plant building	1	1	1	90
Outdoor fans	Providing ventilation	Crystallizer/baghouse area	3	3	3	80
Cooling tower pump	Pumping water	CX area	1	1	1	91
Delivery trucks	Delivering/dispatching	Delivery/dispatch route	2	1	1	104

Table 7.1 Operational plant and equipment sound power levels

Plant and equipment	Typical activities	Location	Quantity operating			Lw, dB
			Day	Evening	Night	
	Idling	Delivery/dispatch areas	1	1	1	90

Noise modelling was completed for daytime, evening and night-time periods for the meteorological scenarios presented in Table 4.5.

7.2 Noise modelling results and discussion

The modelling results for noise emissions from the project at assessment locations are provided in Table 7.2 and Table 7.3 for day/evening and night-time periods, respectively.

Based on experience with similar industrial sites, site contributed $L_{Aeq,period}$ noise levels can typically be up to 5 dB below the site contributed $L_{Aeq,15min}$ noise levels due to the transient nature of noise events. For this site, it has been conservatively assumed that $L_{Aeq,period}$ noise levels are 3 dB below the $L_{Aeq,15min}$ noise level.

Table 7.2 Operational noise modelling results – daytime/evening

Assessment locations	Predicted operational noise level, $L_{Aeq,15min}$,dB		PSNL, dB			
			Day		Evening	
	Calm	Wind	$L_{Aeq,15min}$	$L_{Aeq,period}$	$L_{Aeq,15min}$	$L_{Aeq,period}$
R1	<30	<30	49	60	48	50
R2	<30	<30	49	60	48	50
R3	<30	<30	46	60	44	50
R4	<30	<30	N/A	35	N/A	35
R5	<30	<30	N/A	55	N/A	55
R6	32	35	46	60	44	50
R7	<30	<30	N/A	35	N/A	35
R8	<30	<30	N/A	40	N/A	40
R9	<30	<30	N/A	65	N/A	65
R10	31	34	N/A	55	N/A	55
R11	38	40	46	60	44	50
R12	<30	<30	N/A	55	N/A	55
R13	52	52	N/A	70	N/A	70
R14	42	42	N/A	70	N/A	70
R15	<30	<30	N/A	55	N/A	55
R16	<30	<30	N/A	55	N/A	55
R17	<30	<30	N/A	55	N/A	55
R18	44	45	N/A	70	N/A	70
R19	<30	<30	N/A	35	N/A	35
R20	<30	<30	47	60	41	50
R21	37	39	N/A	70	N/A	70
R22	<30	<30	47	60	41	50
R23	<30	31	47	60	41	50

Table 7.2 Operational noise modelling results – daytime/evening

Assessment locations	Predicted operational noise level, $L_{Aeq,15min}$,dB		PSNL, dB			
			Day		Evening	
	Calm	Wind	$L_{Aeq,15min}$	$L_{Aeq,period}$	$L_{Aeq,15min}$	$L_{Aeq,period}$
R24	45	45	N/A	70	N/A	70
R25	<30	<30	49	60	48	50

Notes: 1. N/A = Not applicable

Table 7.3 Operational noise modelling results – night-time

Assessment locations	Predicted operational noise level, $L_{Aeq,15min}$,dB			PSNL, dB	
	Calm	Wind	Inversion	$L_{Aeq,15min}$	$L_{Aeq,period}$
R1	<30	31	<30	46	42
R2	<30	<30	<30	46	42
R3	<30	<30	<30	40	45
R4	<30	30	30	N/A	35
R5	<30	<30	<30	N/A	55
R6	33	36	36	40	45
R7	<30	<30	<30	N/A	35
R8	<30	<30	<30	N/A	40
R9	<30	<30	<30	N/A	65
R10	32	34	35	N/A	55
R11	38	40	40	40	45
R12	<30	<30	<30	N/A	55
R13	52	52	52	N/A	70
R14	42	42	43	N/A	70
R15	<30	<30	<30	N/A	55
R16	<30	<30	<30	N/A	55
R17	<30	<30	<30	N/A	55
R18	44	45	45	N/A	70
R19	<30	<30	<30	N/A	35
R20	<30	<30	<30	35	44
R21	37	39	39	N/A	70
R22	<30	30	30	35	44
R23	<30	32	32	35	44
R24	45	45	45	N/A	70
R25	<30	31	30	46	42

Notes: 1. N/A = Not applicable

Operational noise emission levels are predicted to meet the relevant PSNLs at all assessment locations for calm and prevailing weather conditions during all assessment periods. Therefore, it is unlikely that project noise emissions would cause adverse impacts at any assessment locations, according to the INP.

7.3 Sleep disturbance assessment

The predicted L_{Amax} noise levels from the site at the nearest residential assessment locations are presented in Table 7.4 for prevailing meteorological conditions. The predictions are for the night period only (10.00 pm–7.00 am) coinciding with the typical sleep period and in accordance with the INP.

Typical maximum noise level events are likely to be from the front end loaders scraping the ground and loading/unloading trucks. A maximum sound power level of L_{Amax} 126 dB has been assumed for this activity and represents the likely highest maximum noise level event from the site during the entire night-time period.

Table 7.4 Predicted maximum noise levels at residential assessment locations

Assessment locations	Predicted L_{Amax} noise level, dB			L_{Amax} screening criteria, dB
	Calm	Wind	Inversion	
R1	38	41	41	56
R2	41	44	44	56
R3	31	34	34	50
R6	46	49	49	50
R11	52	54	54	50
R20	39	42	42	45
R22	40	43	43	45
R23	38	41	41	45
R25	42	45	45	56

Noise modelling predicts that the INP sleep disturbance screening criteria will be met during calm and prevailing meteorological conditions at most assessment locations. The exception is R11 where an L_{Amax} 54 dB is predicted (4 dB above the screening criteria). However, the RNP provides the following conclusion from the research on sleep disturbance:

> maximum internal noise levels below 50 to 55 dB(A) are unlikely to awaken people from sleep

It is commonly accepted by acoustic practitioners and regulatory bodies that a facade including a partially open window will reduce external noise levels by 10 dB. Therefore, external noise levels in the order of 60 to 65 dB calculated at the facade of a residence are unlikely to cause awakening reactions. The highest predicted external maximum noise level from site is 54 dB under adverse weather conditions.

Assessment location R11 is situated in an existing industrial area, with a number of surrounding industries operating throughout the night period. Further to this, existing measured L_{Amax} levels during the night period were in the range of 65 to 70 dB surrounding the site. These levels were attributed to local traffic and car passbys and are more than 10 dB above the predicted L_{Amax} levels from the project.

Hence, it is unlikely that night-time operations from the project will awaken people at any of the assessment locations. Nonetheless, work practices during the night period will be appropriately managed to minimise the impact and number of potential events. Recommendations in this regard are provided in Chapter 11.

7.4 Cumulative noise assessment

Potential cumulative noise impacts from existing and successive developments are considered by the INP procedures by ensuring that the appropriate noise criteria are established with a view to maintaining acceptable noise amenity levels. Therefore, the cumulative impact of the project with *existing* industrial noise sources has been assessed in the determination of the acceptable amenity levels at the assessment locations.

Based on experience with similar industrial sites, amenity noise levels can typically be up to 5 dB below the intrusive noise levels of the site due to the transient nature of noise events. For this site, it has been conservatively assumed that amenity noise levels are 3 dB below the intrusive noise level. On this basis, the highest predicted amenity noise level at any residential assessment location is $L_{Aeq,period}$ 37 dB for the night-time period. This is 8 dB below the acceptable amenity level for an urban receiver type and thus is predicted to have a negligible effect on increasing industrial noise above the relevant criteria.

Further, the predicted amenity noise level from the project is greater than 10 dB below the measured existing ambient $L_{Aeq,day}$ of 59 dB and $L_{Aeq,night}$ of 48 dB which are primarily due to distant traffic on the Hunter Expressway and, to a lesser extent, existing industrial noise.

It is of note that Weston aluminium currently has an EIS on exhibition for the construction and operation of a thermal waste processing plant on the neighbouring Weston Aluminium site. *Noise Impact Assessment – Weston Aluminium Thermal Waste Processing Project* (AECOM 2016) indicates that existing Weston Aluminium site noise levels will increase by up to 1 dB with the addition of the thermal waste processing plant. Thus, the combined impact of this project is predicted to have a negligible impact on the existing ambient amenity of the area.

An EIS for the demolition and remediation of the former Hydro Aluminium smelter at Loxford is also currently on exhibition. It is of note that the proposed works are classified as a construction activity and, therefore, less stringent noise criteria are applicable due to the temporary nature of the works. Further, it is difficult to quantify the impacts of construction works on the amenity of surrounding areas due to the temporary and indefinite nature of works and the amenability of noise control measures. Work practices, equipment/activity siting and substitution are proposed to be implemented where applicable to minimise construction noise impacts from the site. *Noise and Vibration Impact Assessment – Demolition and Remediation* (Vipac 2016) indicates that site noise emissions will comply with relevant ICNG criteria at the nearest residential assessment locations during standard construction hours. For works that may fall outside standard construction hours, a reduced fleet of equipment is proposed in order to keep site emissions below relevant criteria.

On this basis, the project is predicted to have a negligible impact on the existing ambient acoustic amenity and is not predicted to increase industrial noise levels above the relevant amenity criteria.

8 Construction noise assessment

Noise from proposed construction activities associated with the project has been predicted at the assessment locations shown in Figure 4.1.

Simultaneous operation of the equipment listed in Table 8.1 was used to represent typical construction activity and are considered to represent an acoustically worst-case 15-minute period during ICNG standard construction hours. Representative sound power levels associated with these equipment used in the noise modelling are also summarised in Table 8.1.

Table 8.1 Representative equipment sound power levels

Equipment	Quantity	$L_{Aeq,15min}$ sound power level, dB
Delivery truck	2	103
Concrete truck	2	113
Scraper	1	104
Excavator (30 tonne)	1	99
Crane	1	106

It has been assumed that construction activities for the project would generally take place during the ICNG standard construction hours (see Section 5.2). Activities outside standard construction hours may be permitted where work needs to be undertaken for a safety requirement or where it can be demonstrated through attended noise monitoring that construction activity will not cause noise impact at nearby residences.

The project's predicted construction noise levels at assessment locations are provided in Table 8.2.

Table 8.2 Predicted construction noise levels

Assessment locations	Indicative construction noise level $L_{Aeq,15min}$, dB	Construction noise management level, $L_{Aeq15min}$, dB
	Standard construction hours	Standard construction hours
R1	37	54
R2	39	54
R3	30	51
R4	35	55
R5	<30	65
R6	41	51
R7	<30	55
R8	35	55
R9	<30	70
R10	39	65
R11	45	51
R12	<30	55
R13	51	75
R14	46	75
R15	<30	65

Table 8.2 Predicted construction noise levels

Assessment locations	Indicative construction noise level $L_{Aeq,15min}$, dB	Construction noise management level, $L_{Aeq15min}$, dB
	Standard construction hours	Standard construction hours
R16	<30	55
R17	30	65
R18	48	75
R19	<30	55
R20	31	52
R21	44	75
R22	37	52
R23	40	52
R24	39	75
R25	38	54

Note: All construction noise management levels have been adjusted to external levels.

Predictions in Table 8.2 indicate that construction noise levels for the project are likely to be below the construction noise management level. Given that the predictions assume equipment operating simultaneously it is likely that actual construction noise levels would be less than those predicted for the majority of the time. Notwithstanding, recommendations are provided in Section 11.1 with the aim of minimising construction noise impacts from the project.

9 Road traffic noise assessment

The nearest residences potentially affected by an increase in road traffic volumes as a result of the project are located on Mitchell Avenue, to the south-east of the site and on Government Road, to the west of the site. Mitchell Avenue and Government Road are approved B-Double routes and suitable for heavy vehicles.

The traffic assessment for the project (EMM 2016) states that the predicted total traffic volume increase on Mitchell Avenue east of the site will be +1.7% with an associated increase in heavy vehicles of +3.7%. The predicted traffic volume increase during construction of the project on Mitchell Avenue east is +1.7% with an associated increase in heavy vehicles of 5.6%. The predicted total traffic volume increase on Government Road to the west of the site will be +0.9% with an associated increase in heavy vehicles of +13.7%. The predicted traffic volume increase during construction of the project on Government Road is +1.1% with an associated increase in heavy vehicles of 20.5%.

Traffic generated by the project during construction and operation is not expected to generate any noticeable increase in road traffic noise levels at the nearest residential locations. This increase in traffic volume would lead to a negligible increase (<0.5 dB) in road traffic noise. Therefore, the impact of road traffic noise associated with the project is predicted to be negligible and within the 2 dB allowable increase for land use developments as described in the RNP.

10 Vibration assessment

10.1 Construction

The nearest building to the site is the Weston Aluminium industrial building positioned directly west on the property boundary. It is, therefore, envisaged that cosmetic damage to nearby structures (rather than human response) would be the most likely impact. It is difficult at this stage to predict the level of vibration that may occur at nearby structures during construction of the project. This is due to a number of variables including construction activities, plant location, operator behaviour and local geotechnical conditions. Therefore, in the first instance the guide values presented in Table 6.5 should be followed. Additional construction vibration management measures are presented in Section 11.1.

10.2 Operation

The most significant sources of vibration associated with the project would be the hammer mill and heavy vehicle movements.

The hammer mill would be designed to reduce the amount of vibration transferred through the ground. This will be achieved by incorporating vibration absorbing rubber pads between the hammer mill supporting steel structure and the concrete foundation of the building.

Heavy vehicle movements on site would be classified as an intermittent source of vibration as trucks arrive and depart over the course of a day. Therefore, the vibration criteria in Table 6.3 would apply.

There is low risk in heavy vehicle movements within the boundaries of the site generating an adverse reaction to vibration. The US Federal Transport Authority (FTA) document *Transit Noise and Vibration Impact Assessment* (May 2006) suggests that transport projects involving rubber tyred vehicles are unlikely to cause vibration impacts unless in unusual situations. Unusual situations could be where there are vibration sensitive buildings (eg theatres, research facilities) in proximity to the site. It is understood that no such facilities are in proximity to the site.

The RNP provides limited guidance on vibration assessment for heavy vehicle movements, but states that vehicles operating on a roadway are unlikely to cause a perceptible level of vibration, particularly if the receiver is more than 20 m from the road. This is the case for all residential locations surrounding the site which would be most sensitive to vibration.

Furthermore, as the human comfort criteria are more stringent than the building damage criteria, it is expected that there is even less risk of cosmetic damage criteria being exceeded. On this basis operational vibration impacts from the project are considered unlikely.

11 Management and mitigation

11.1 Construction

Construction noise levels from the project are predicted to satisfy the NMLs at all assessment locations. Construction vibration impacts are also predicted to be minor. Nonetheless, the proponent will manage construction noise and vibration from the site by adopting universal work practices during construction. These practices will be documented in the Construction Management Plan for the project and will include consideration of the following:

- construction activities during ICNG standard hours only (where practical);
- regular reinforcement (such as at toolbox talks) of the need to minimise noise and vibration;
- regular identification of noisy activities and adoption of improvement techniques;
- avoid the use of portable radios, public address systems or other methods of site communication that may unnecessarily impact upon nearby residents except where required for safety reasons;
- develop routes within the site for the delivery of materials and parking of vehicles to minimise noise;
- where possible, avoid the use of equipment that generates impulsive noise;
- minimise the need for vehicle reversing; for example, by arranging for one-way site traffic routes;
- minimise use of broadband audible reverse alarms on vehicles and elevated work platforms used on site;
- minimise the unnecessary movement of materials and plant; and
- schedule intensive works outside of respite periods.

11.2 Operations

Operational noise predictions indicate that operational noise emission levels will not be above the relevant PSNLs. Notwithstanding, there are mitigation measures that may be employed to further reduce noise impacts. These include:

- design traffic management to minimise the need for reversing especially during the night-time and early morning period;
- regular maintenance and servicing of plant and equipment;
- the use of broadband reversing alarms (growlers) on site equipment;
- plant and equipment to be switched off when not in use; and
- minimise material drop heights and dragging materials along the ground.

12 Conclusion

EMM has prepared a noise and vibration assessment to accompany an EIS for the proposed ULAB recycling facility at Kurri Kurri, NSW. This assessment considered the potential for noise and vibration impacts during operation and construction and has been prepared in accordance with the methodology outlined in the INP and associated Application Notes, as well as other relevant guidelines and standards.

PSNLs (noise criteria) have been established based on the results of ambient noise monitoring and methodology provided in the INP.

Findings of the assessment are summarised below.

- Operational noise levels were assessed for the daytime, evening and night-time periods during calm and prevailing weather conditions. The assessment found that noise from operation of the project is predicted to satisfy INP noise criteria for day, evening and night periods at all assessment locations.

- The potential for sleep disturbance from operation of the project during the night period has been assessed. Internal maximum noise levels from the operations are predicted to be below those likely to wake residents. On this basis, sleep disturbance impacts during the night period are unlikely; however, the proponent will manage noise during this period to avoid maximum noise level events.

- An assessment of cumulative industrial noise from the project with other industrial noise sources in the vicinity was conducted. The project is not predicted to increase industrial noise levels above the relevant amenity criteria.

- A quantitative assessment of construction noise from the project was undertaken. Noise levels from construction of the facility are predicted to satisfy the ICNG noise management levels (or noise criteria) at all assessment locations. The project will result in additional traffic movements. This increase is minor in comparison to existing traffic volumes and the overall increase in road traffic noise at residences will be negligible. Therefore, the impact of road traffic noise associated with the project is predicted to be negligible and within the 2 dB allowable increase for land use developments as described in the RNP.

- The assessment considered potential construction vibration impacts from the project. Operational and construction vibration impacts from the project are considered unlikely. Notwithstanding, recommendations have been provided with regard to safe operating distances for typical construction equipment.

Notwithstanding the above, recommended management measures and work practices have been provided to further reduce noise impacts from operation and construction of the project.

References

AECOM 2016, *Noise Impact Assessment – Weston Aluminium Thermal Waste Processing Project.*

Australian Standard AS 1055-1997, *Acoustics - Description and Measurement of Environmental Noise*.

Australian Standard AS 2436-2010, *Guide to Noise Control on Construction, Maintenance and Demolition Sites.*

British Standard BS 7385 Part 2-1993, *Evaluation and measurement for vibration in buildings Part 2.* NSW Department of Environment and Climate Change 2009, *Interim Construction Noise Guideline.*

NSW Department of Environment and Conservation 2006, *Assessing Vibration: A Technical Guideline.*

NSW Department of Environment, Climate Change and Water 2011, *Road Noise Policy*.

NSW Environment Protection Authority 2000, *Industrial Noise Policy.*

NSW Environment Protection Authority 2009, *Interim Construction Noise Guideline.*

Vipac 2016, *Noise and Vibration Impact Assessment – Demolition and Remediation.*

Appendix A

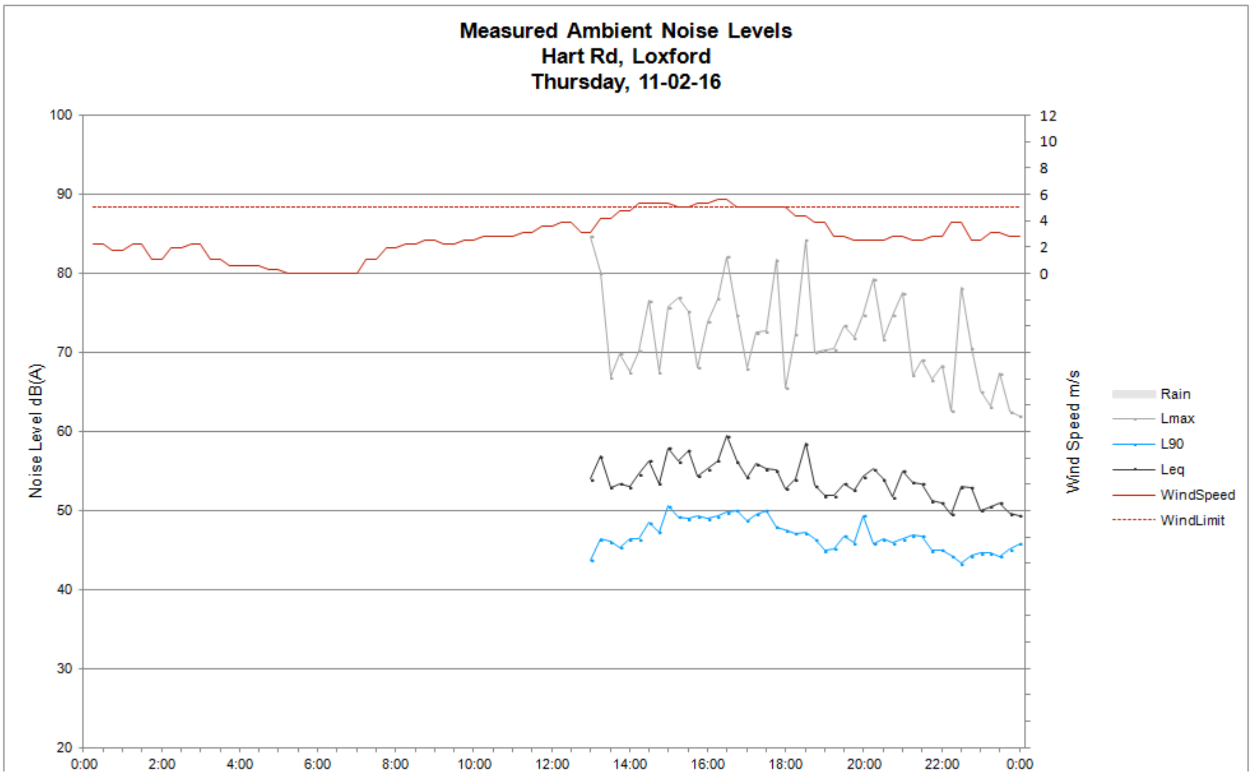
Daily unattended noise monitoring

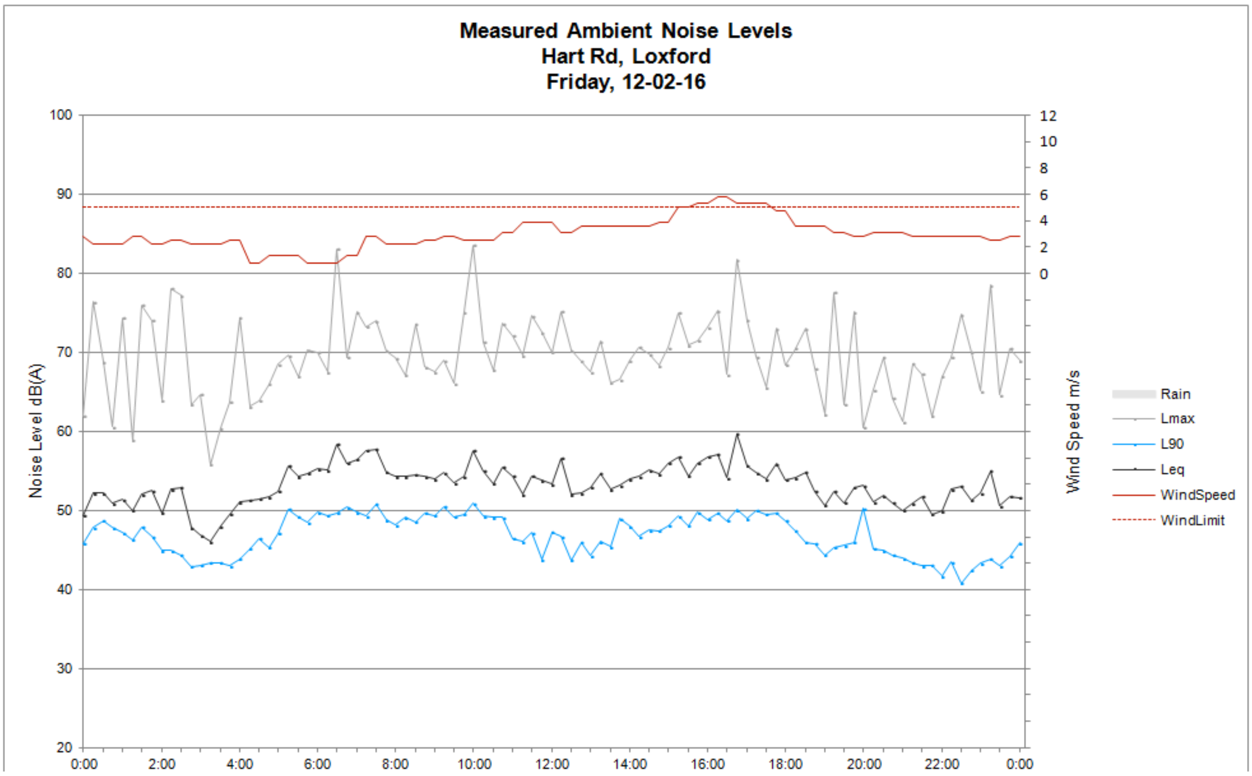
Table A.1 Ambient noise monitoring summary – NM1 (Hart Rd, Kurri Kurri)

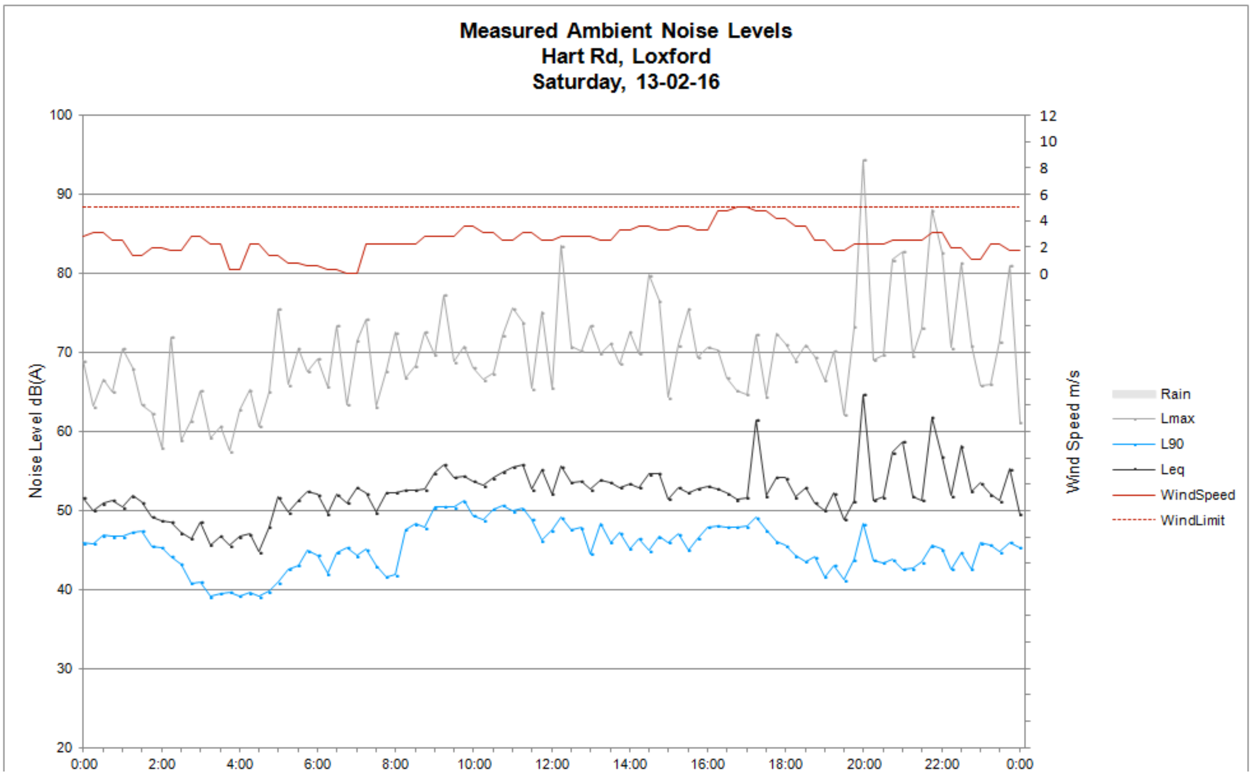
Date	ABL Day	ABL Evening	ABL Night	L_{eq} 11hr Day	L_{eq} 4hr Evening	L_{eq} 9hr Night
Thursday, 11-02-16	0	45	43	0	54	53
Friday, 12-02-16	46	43	40	55	52	51
Saturday, 13-02-16	45	42	38	54	57	51
Sunday, 14-02-16	38	41	40	53	53	58
Monday, 15-02-16	0	42	42	0	69	51
Tuesday, 16-02-16	44	44	39	55	52	52
Wednesday, 17-02-16	43	45	41	54	56	51
Thursday, 18-02-16	44	43	41	55	55	54
Friday, 19-02-16	46	44	39	56	57	56
Saturday, 20-02-16	41	41	36	54	60	53
Sunday, 21-02-16	38	44	41	58	55	52
Monday, 22-02-16	45	42	41	55	52	53
Tuesday, 23-02-16	44	43	41	56	54	53
Wednesday, 24-02-16	0	0	0	0	0	0
Summary Values						
RBL	44	43	41	-	-	-
Average Leq	-	-	-	55	60	53

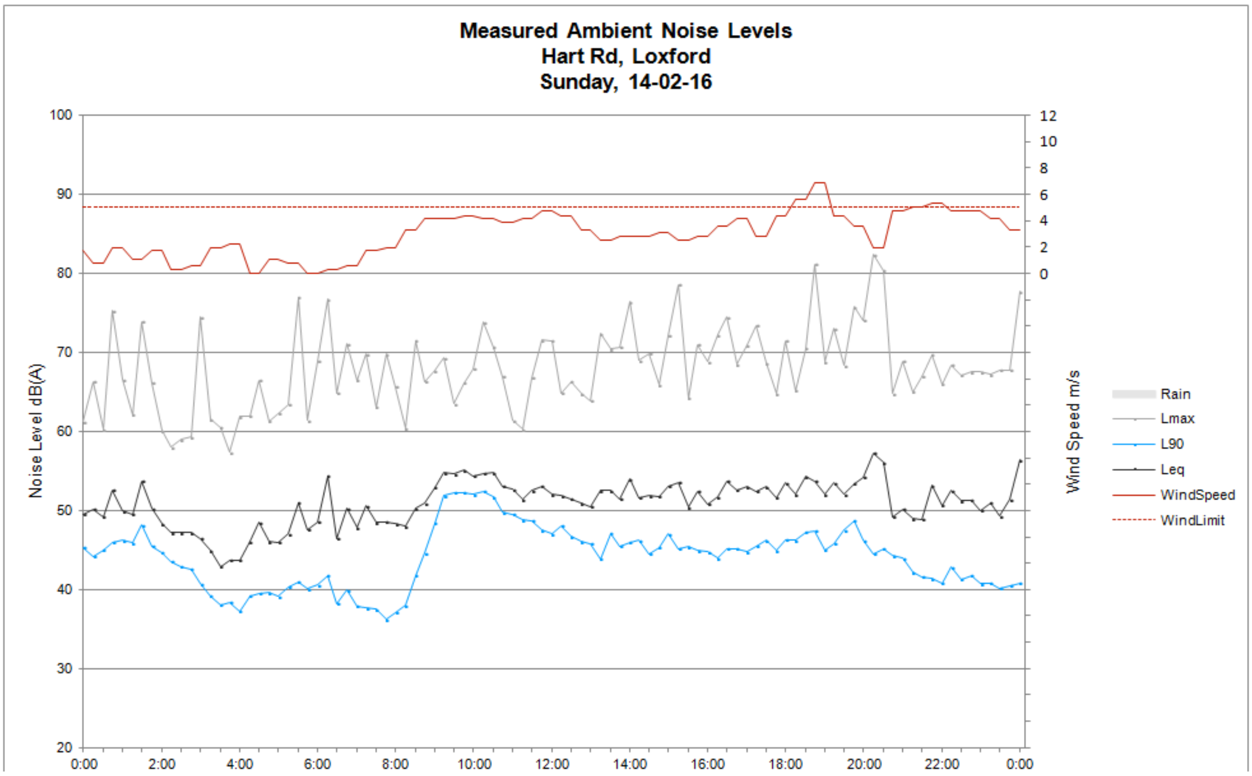
Notes: *0 = indicates periods with too few valid samples due to weather or logger operation.*

ABL: Assessment Background Level (as defined in the INP)


Measured Ambient Noise Levels
Hart Rd, Loxford
Thursday, 11-02-16
Noise Level dB(A)
Wind Speed m/s
Rain
Lmax
L90
Leq
WindSpeed
WindLimit


Measured Ambient Noise Levels
Hart Rd, Loxford
Friday, 12-02-16
Noise Level dB(A)
Wind Speed m/s
Rain
Lmax
L90
Leq
WindSpeed
WindLimit


Measured Ambient Noise Levels
Hart Rd, Loxford
Saturday, 13-02-16
Noise Level dB(A)
Wind Speed m/s
100
90
80
70
60
50
40
30
20
12
10
8
6
4
2
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Rain
Lmax
L90
Leq
WindSpeed
WindLimit


Measured Ambient Noise Levels
Hart Rd, Loxford
Sunday, 14-02-16
Noise Level dB(A)
Wind Speed m/s
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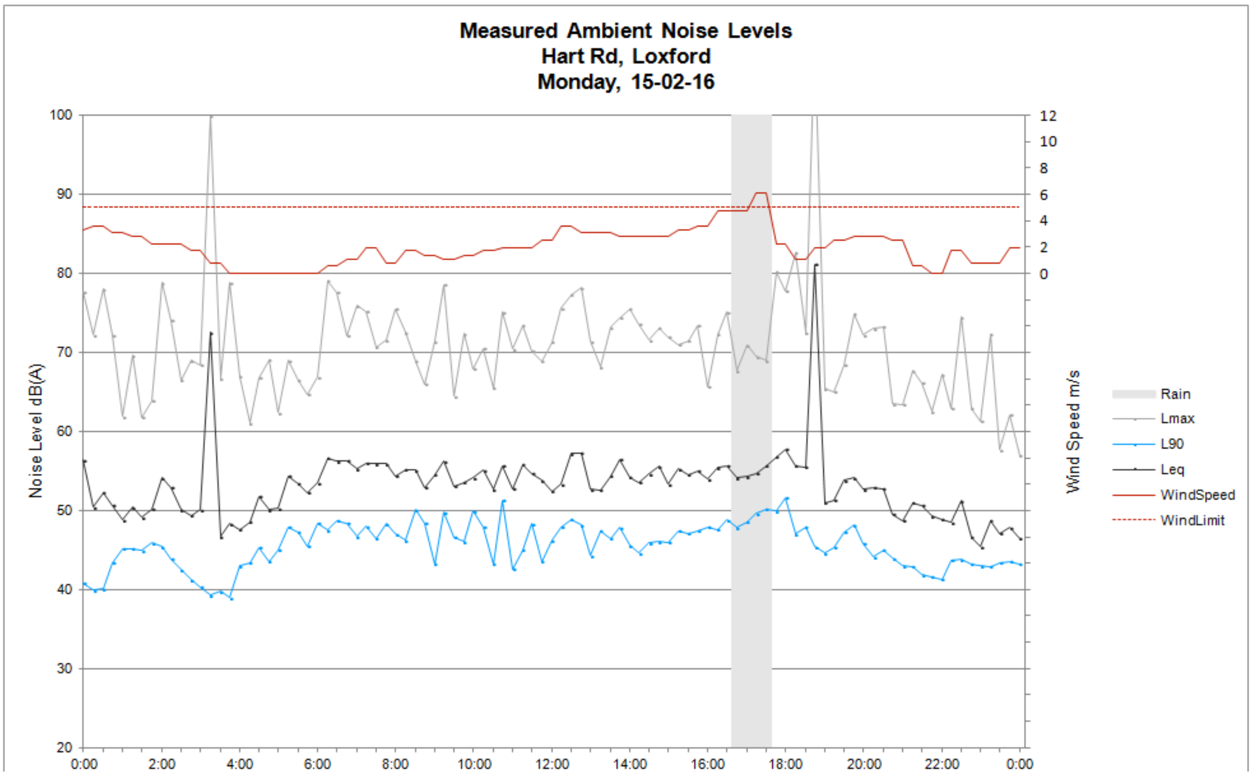
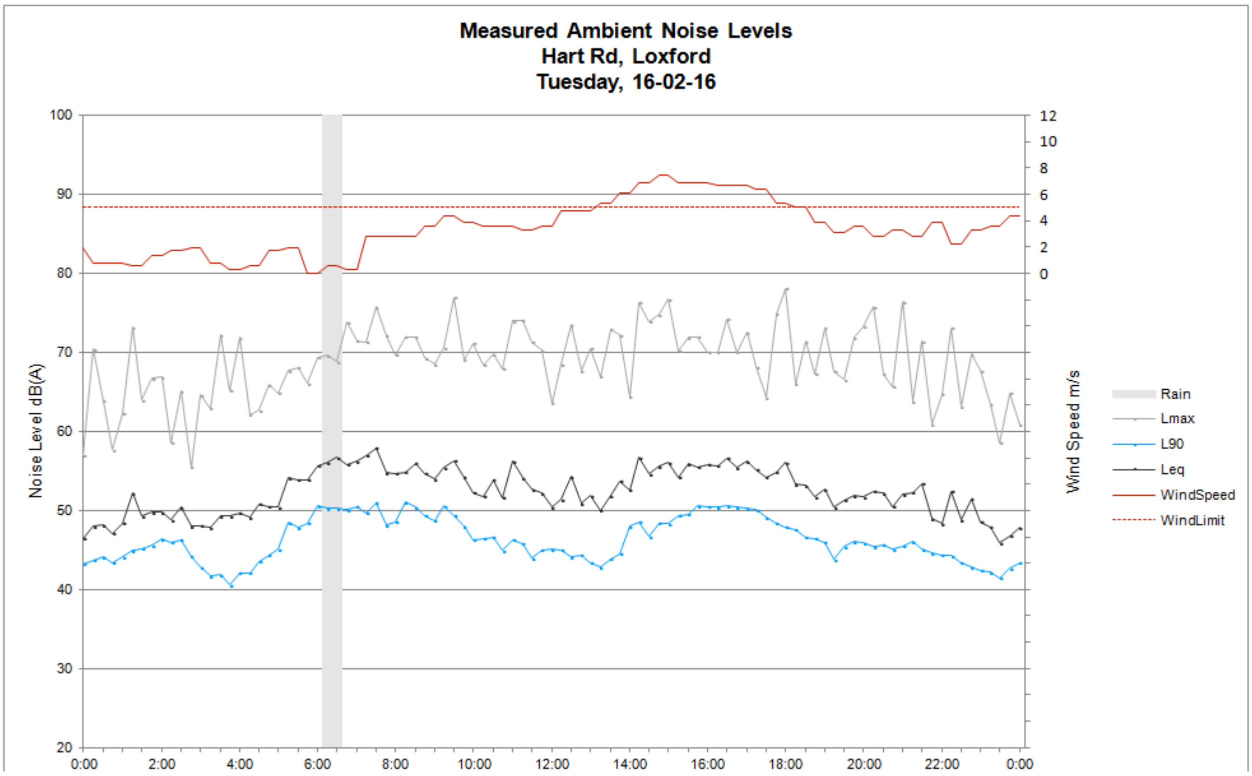
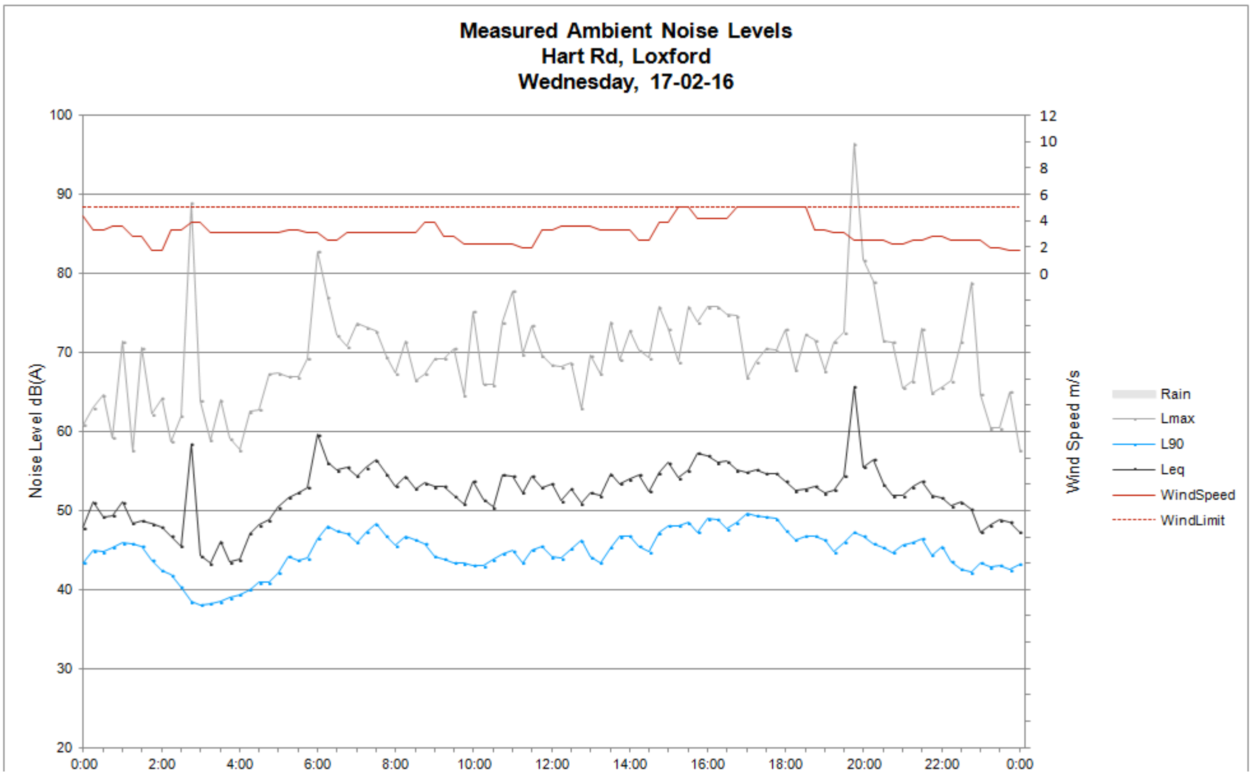
80
70
60
50
40
30
20
12
10
8
6
4
2
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Rain
Lmax
L90
Leq
WindSpeed
WindLimit


Measured Ambient Noise Levels
Hart Rd, Loxford
Monday, 15-02-16
Noise Level dB(A)
Wind Speed m/s
Rain
Lmax
L90
Leq
WindSpeed
WindLimit


Measured Ambient Noise Levels
Hart Rd, Loxford
Tuesday, 16-02-16
Noise Level dB(A)
Wind Speed m/s
Rain
Lmax
L90
Leq
WindSpeed
WindLimit


Measured Ambient Noise Levels
Hart Rd, Loxford
Wednesday, 17-02-16
Noise Level dB(A)
Wind Speed m/s
100
90
80
70
60
50
40
30
20
12
10
8
6
4
2
0
0:00
2:00
4:00
6:00
8:00
10:00
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22:00
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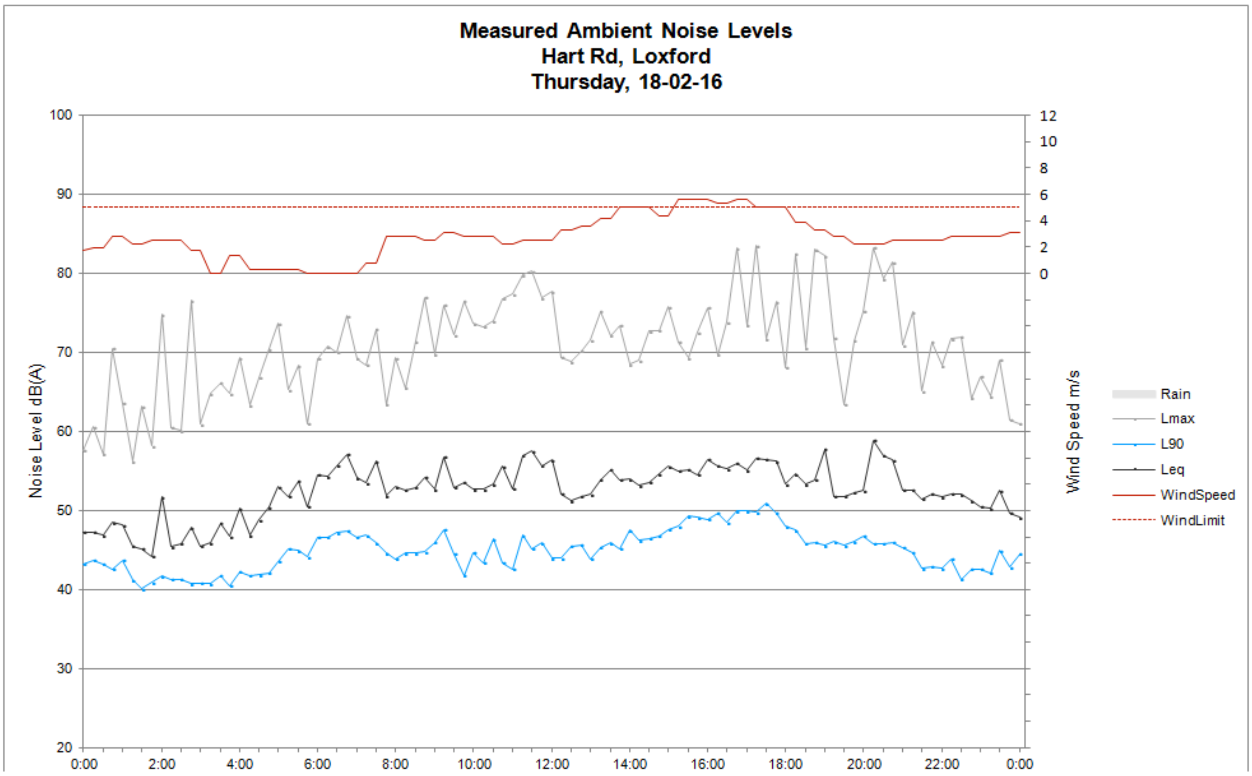
L90
Leq
WindSpeed
WindLimit


Measured Ambient Noise Levels
Hart Rd, Loxford
Thursday, 18-02-16
Noise Level dB(A)
Wind Speed m/s
100
90
80
70
60
50
40
30
20
12
10
8
6
4
2
0
0:00
2:00
4:00
6:00
8:00
10:00
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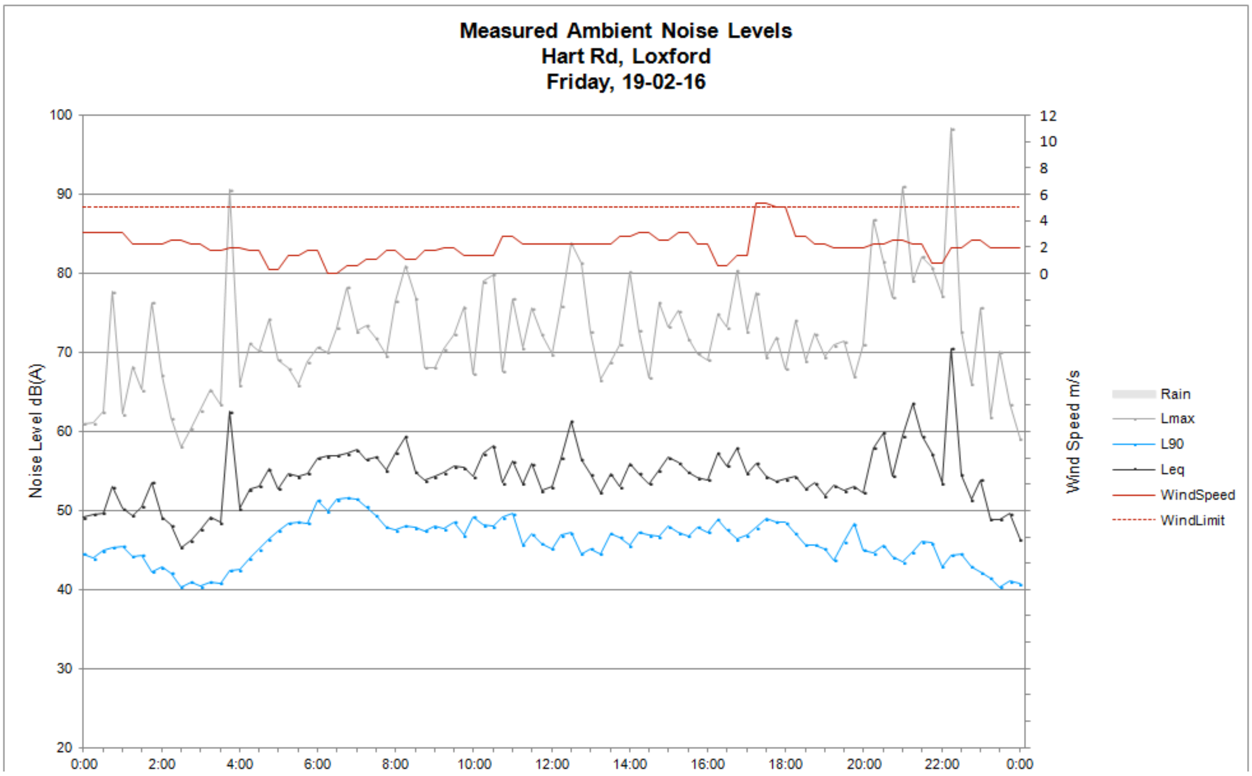
L90
Leq
WindSpeed
WindLimit


Measured Ambient Noise Levels
Hart Rd, Loxford
Friday, 19-02-16
Noise Level dB(A)
Wind Speed m/s
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
100
90
80
70
60
50
40
30
20
12
10
8
6
4
2
0
0:00
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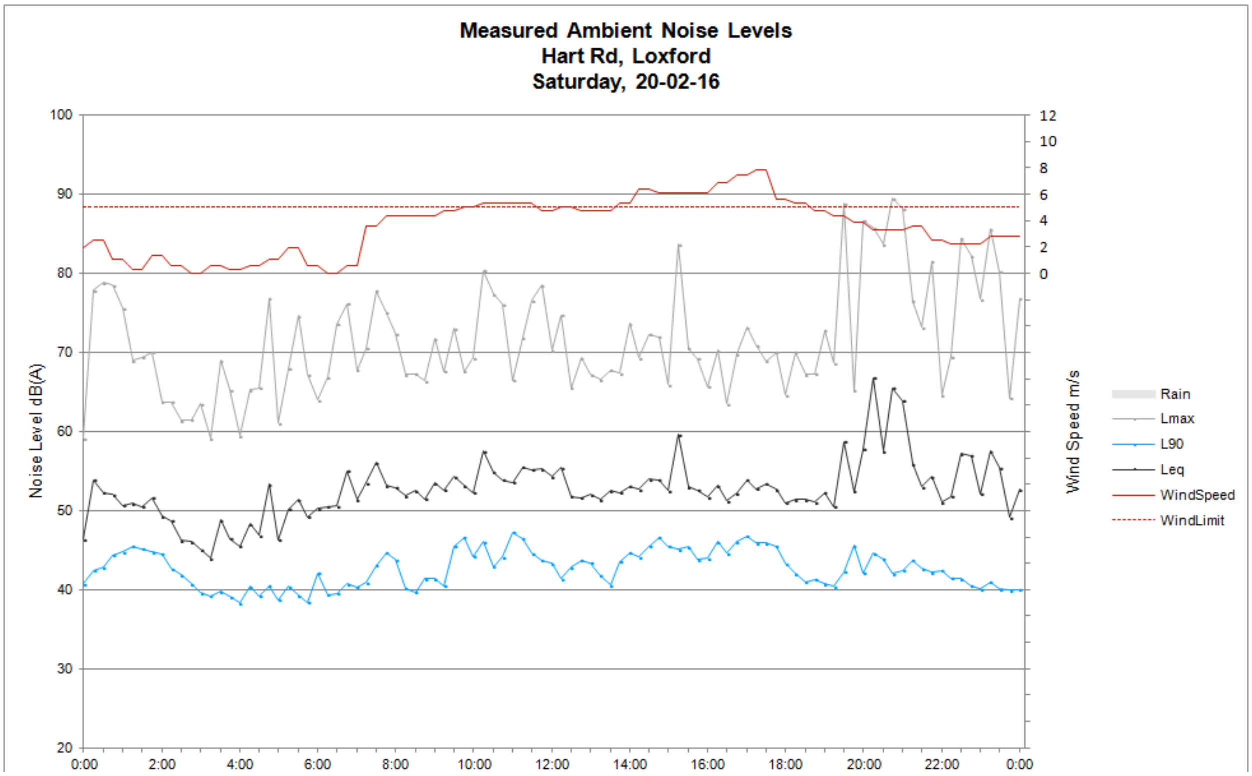
0:00


Measured Ambient Noise Levels
Hart Rd, Loxford
Saturday, 20-02-16
Noise Level dB(A)
Wind Speed m/s
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
100
90
80
70
60
50
40
30
20
12
10
8
6
4
2
0
0:00
2:00
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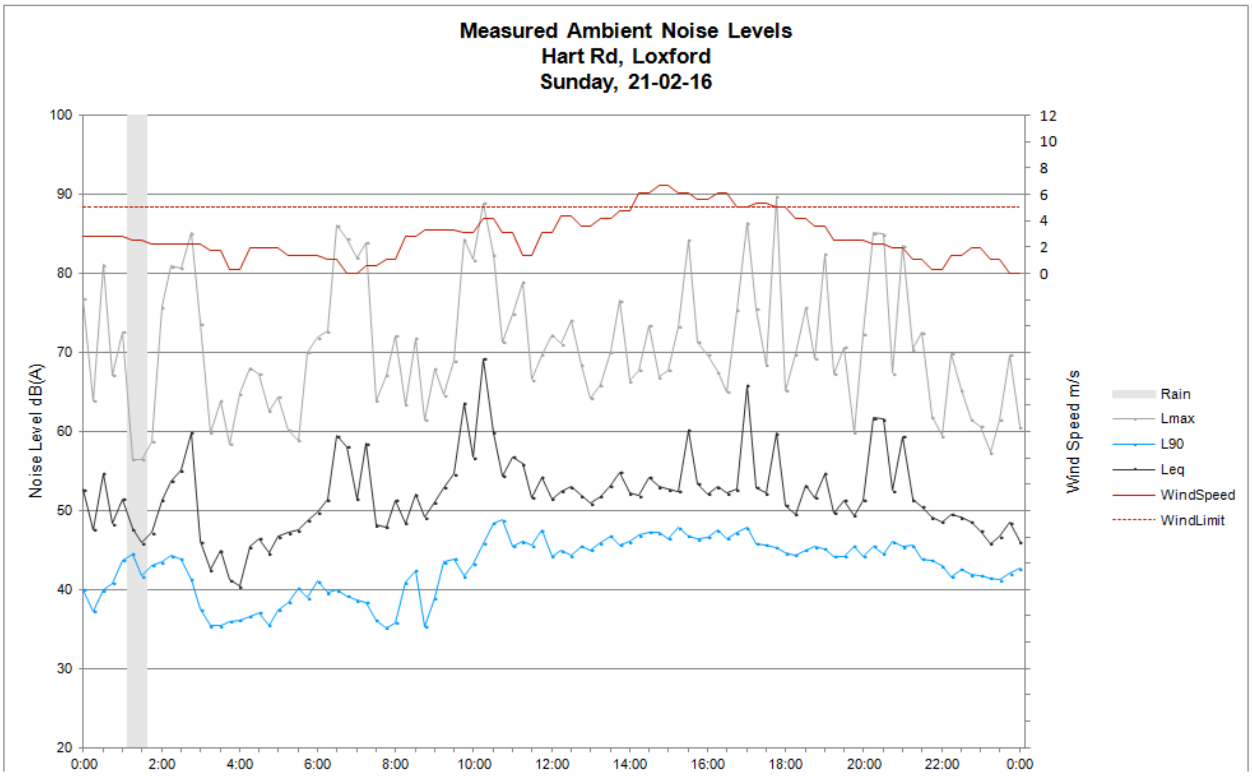
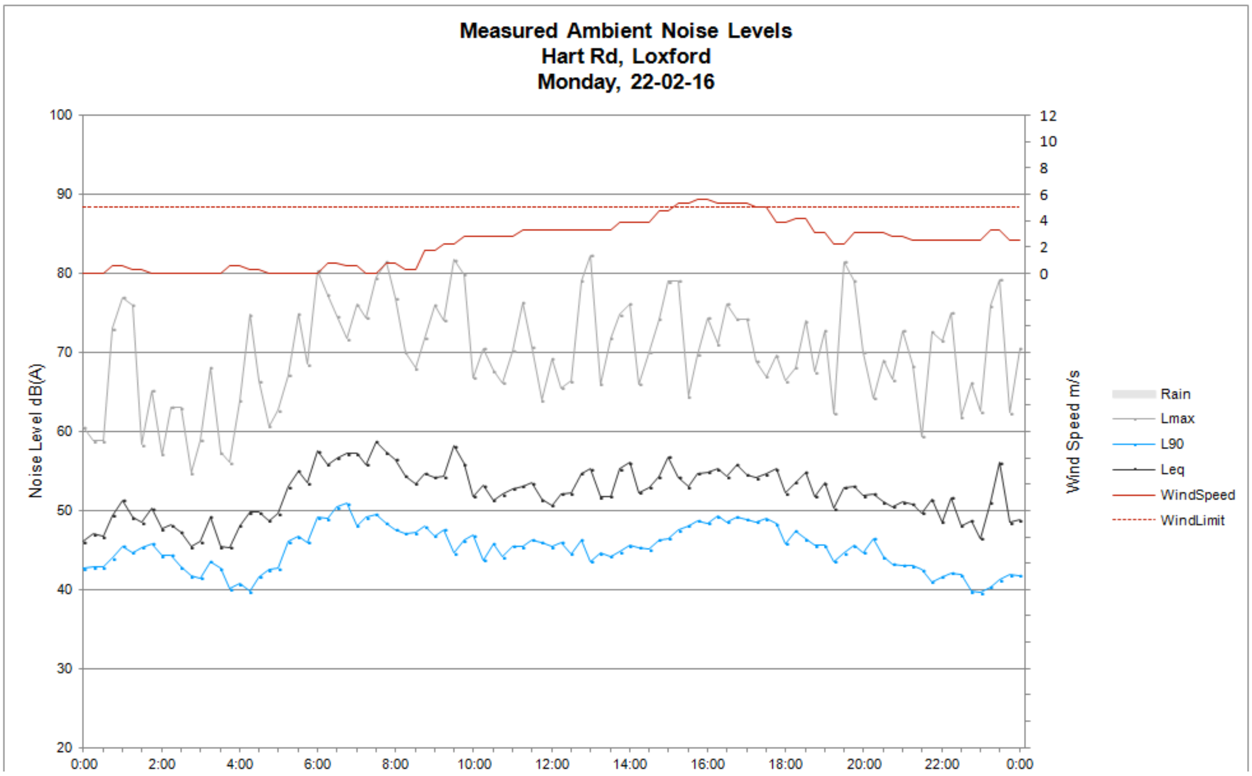
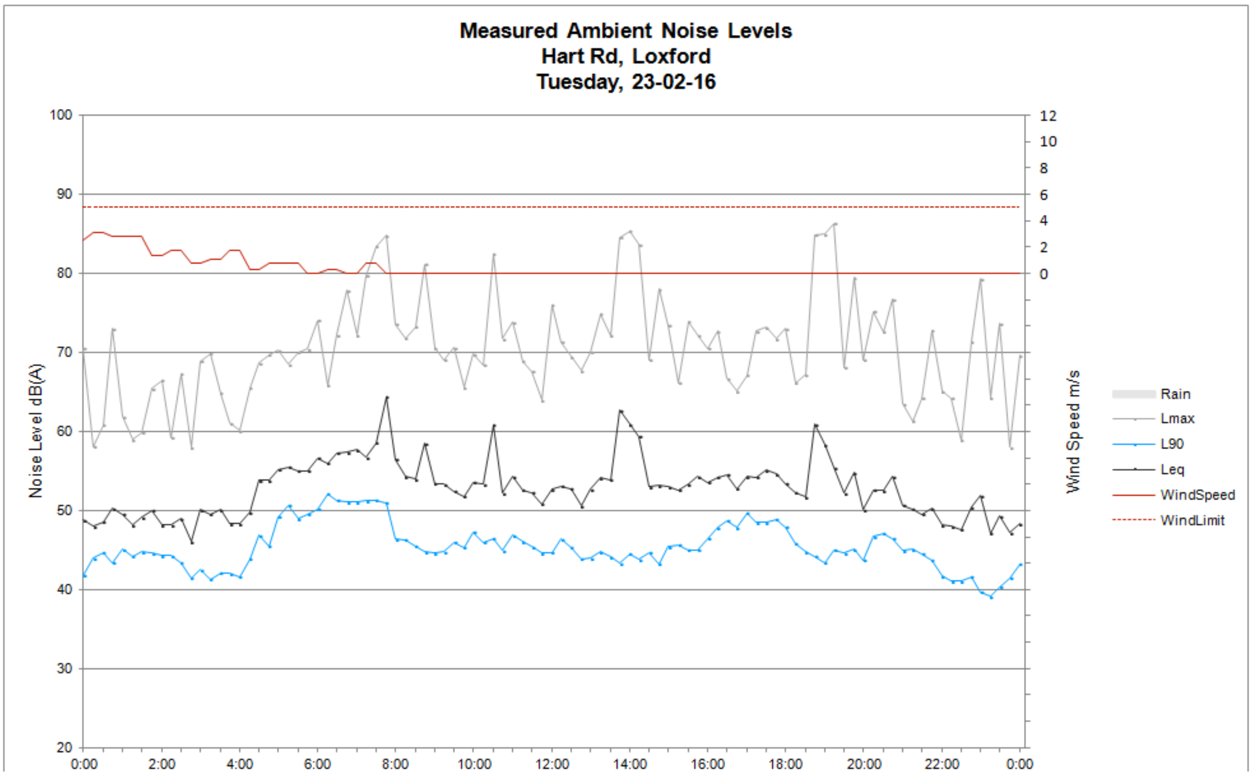


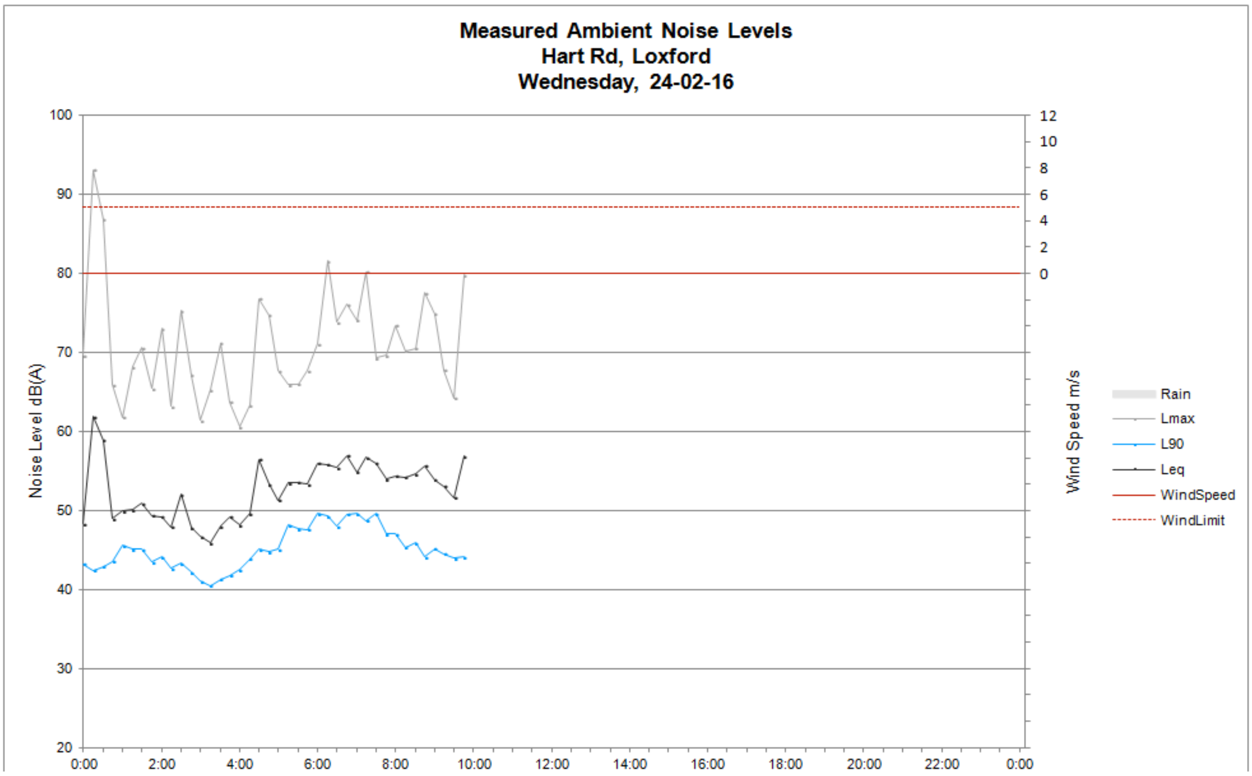
Measured Ambient Noise Levels
Hart Rd, Loxford
Sunday, 21-02-16
Noise Level dB(A)
Wind Speed m/s
Rain
Lmax
L90
Leq
WindSpeed
WindLimit



Measured Ambient Noise Levels
Hart Rd, Loxford
Monday, 22-02-16
Noise Level dB(A)
Wind Speed m/s
Rain
Lmax
L90
Leq
WindSpeed
WindLimit



Measured Ambient Noise Levels
Hart Rd, Loxford
Tuesday, 23-02-16
Noise Level dB(A)
Wind Speed m/s
Rain
Lmax
L90
Leq
WindSpeed
WindLimit



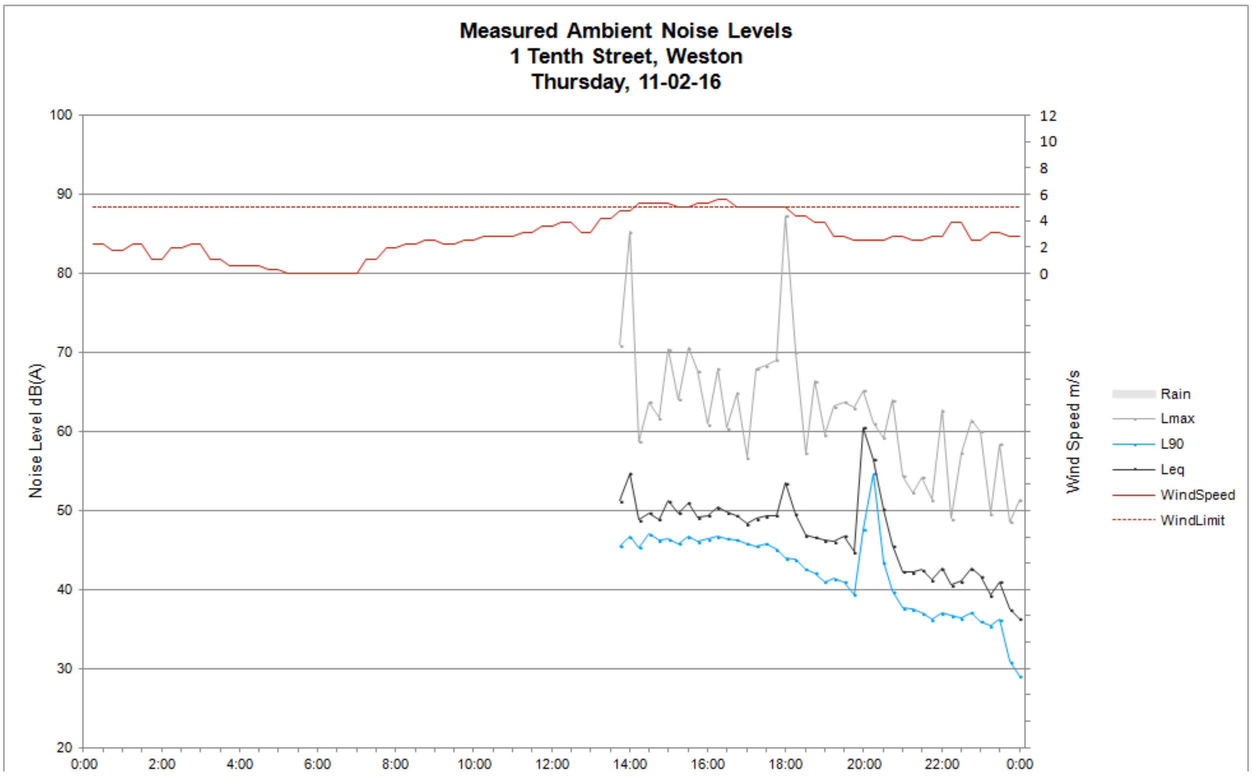
Measured Ambient Noise Levels
Hart Rd, Loxford
Wednesday, 24-02-16
Noise Level dB(A)
Wind Speed m/s
Rain
Lmax
L90
Leq
WindSpeed
WindLimit

Table A.2 Ambient noise monitoring summary – NM2 (1 Tenth Street, Weston)

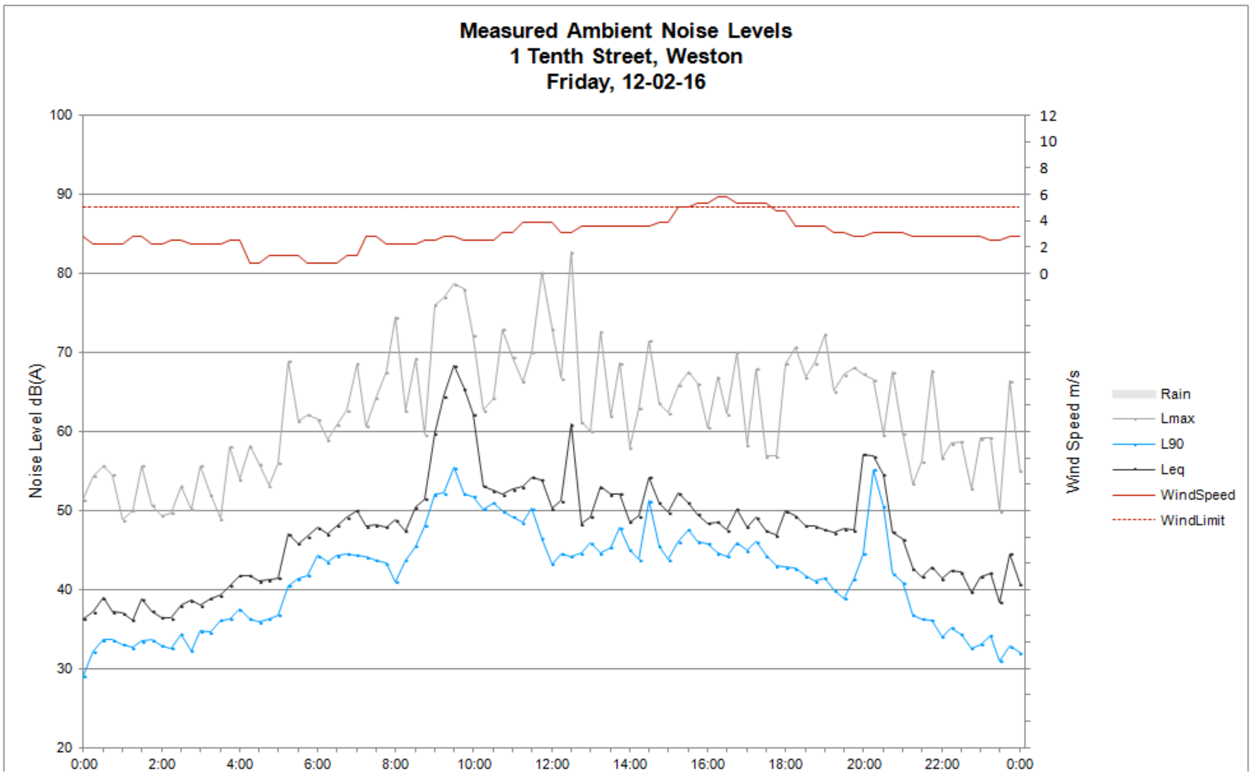
Date	ABL Day	ABL Evening	ABL Night	L_{eq} 11hr Day	L_{eq} 4hr Evening	L_{eq} 9hr Night
Thursday, 11-02-16	0	37	32	0	51	43
Friday, 12-02-16	43	36	28	57	51	41
Saturday, 13-02-16	39	36	27	64	48	40
Sunday, 14-02-16	37	38	29	52	52	42
Monday, 15-02-16	0	35	29	0	50	41
Tuesday, 16-02-16	45	34	26	52	48	43
Wednesday, 17-02-16	42	36	28	51	48	41
Thursday, 18-02-16	40	37	35	51	50	44
Friday, 19-02-16	44	38	27	50	50	40
Saturday, 20-02-16	40	36	25	52	50	40
Sunday, 21-02-16	38	37	27	48	48	42
Monday, 22-02-16	42	37	32	49	44	43
Tuesday, 23-02-16	43	36	33	50	45	43
Wednesday, 24-02-16	0	0	0	0	0	0
Summary Values						
RBL	42	36	28	-	-	-
Average Leq	-	-	-	56	49	42

Notes: 0 = indicates periods with too few valid samples due to weather or logger operation.

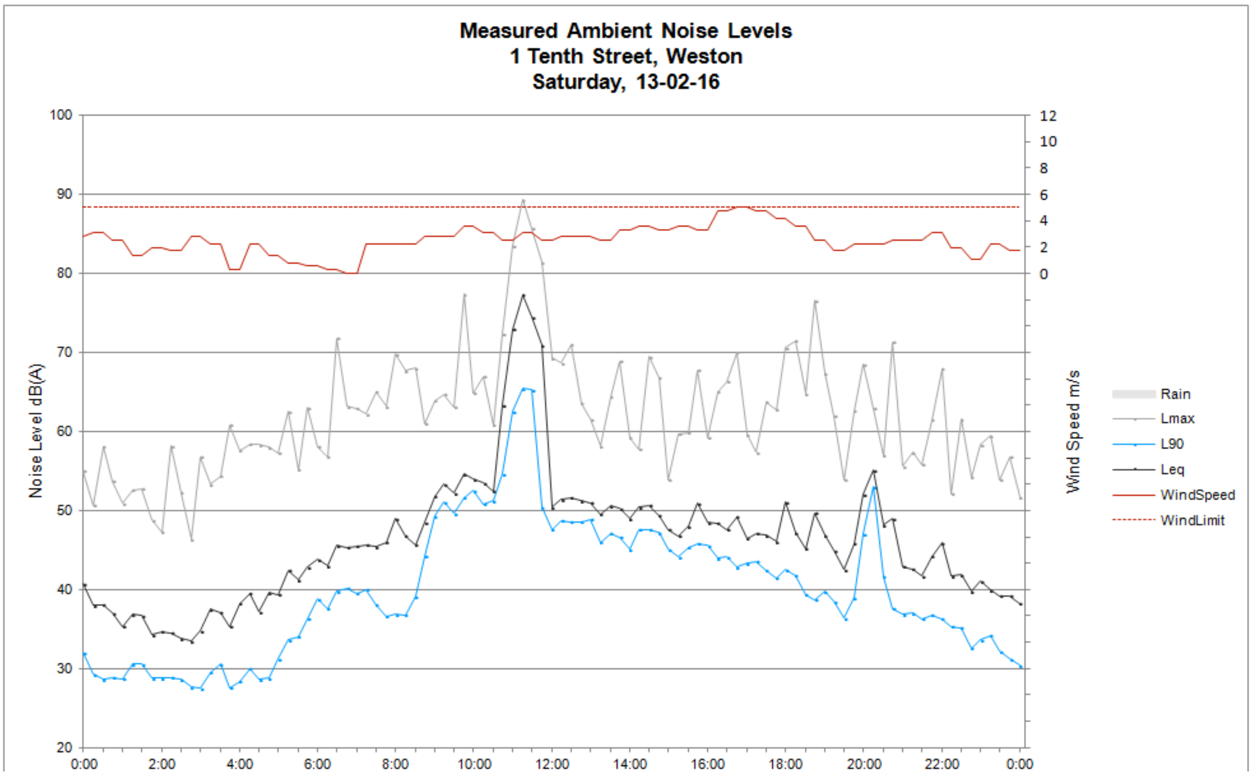
ABL: Assessment Background Level (as defined in the INP).

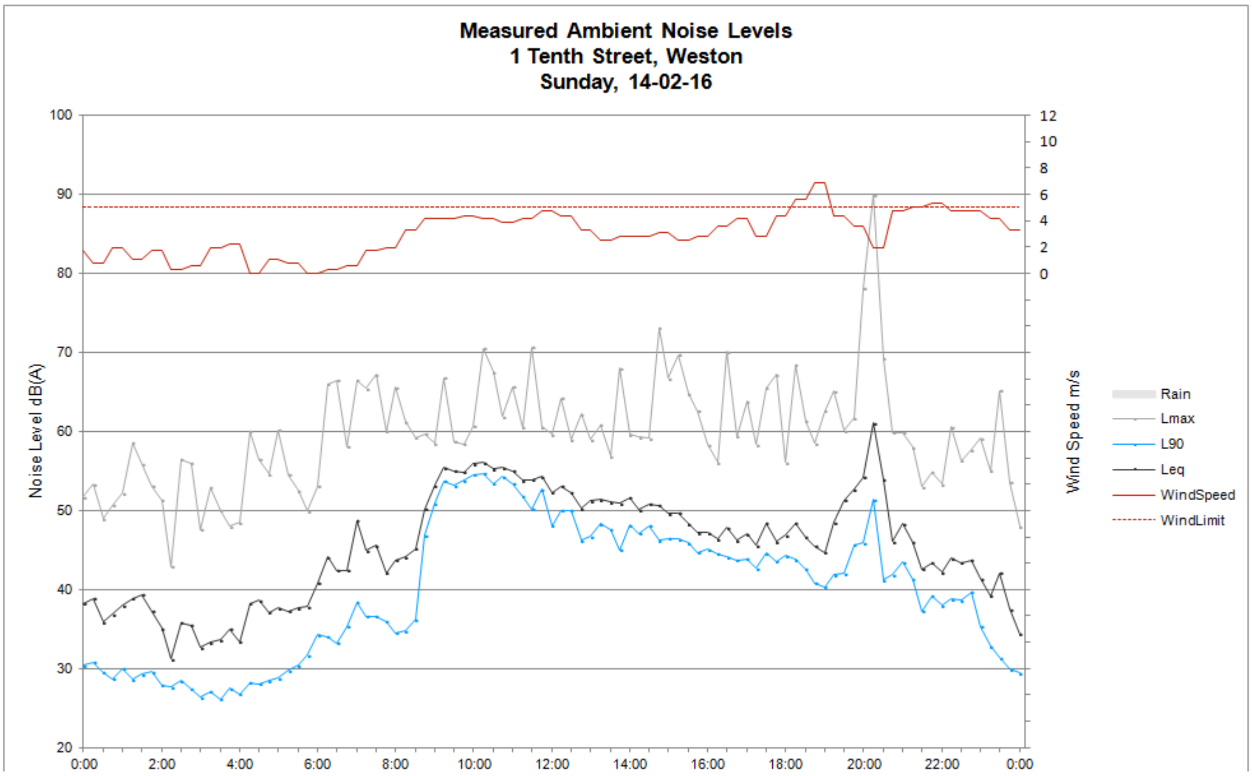


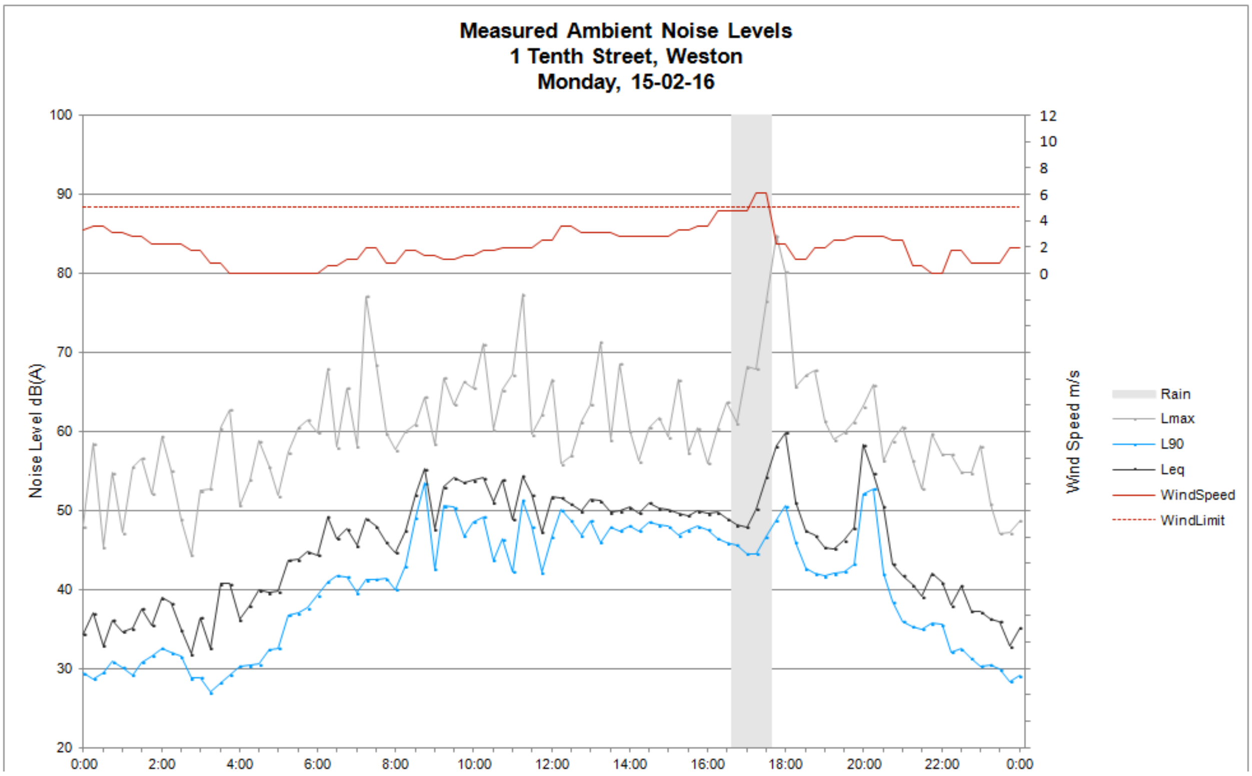
Measured Ambient Noise Levels
1 Tenth Street, Weston
Thursday, 11-02-16
Noise Level dB(A)
Wind Speed m/s
100
90
80
70
60
50
40
30
20
12
10
8
6
4
2
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Rain
Lmax
L90
Leq
WindSpeed
WindLimit

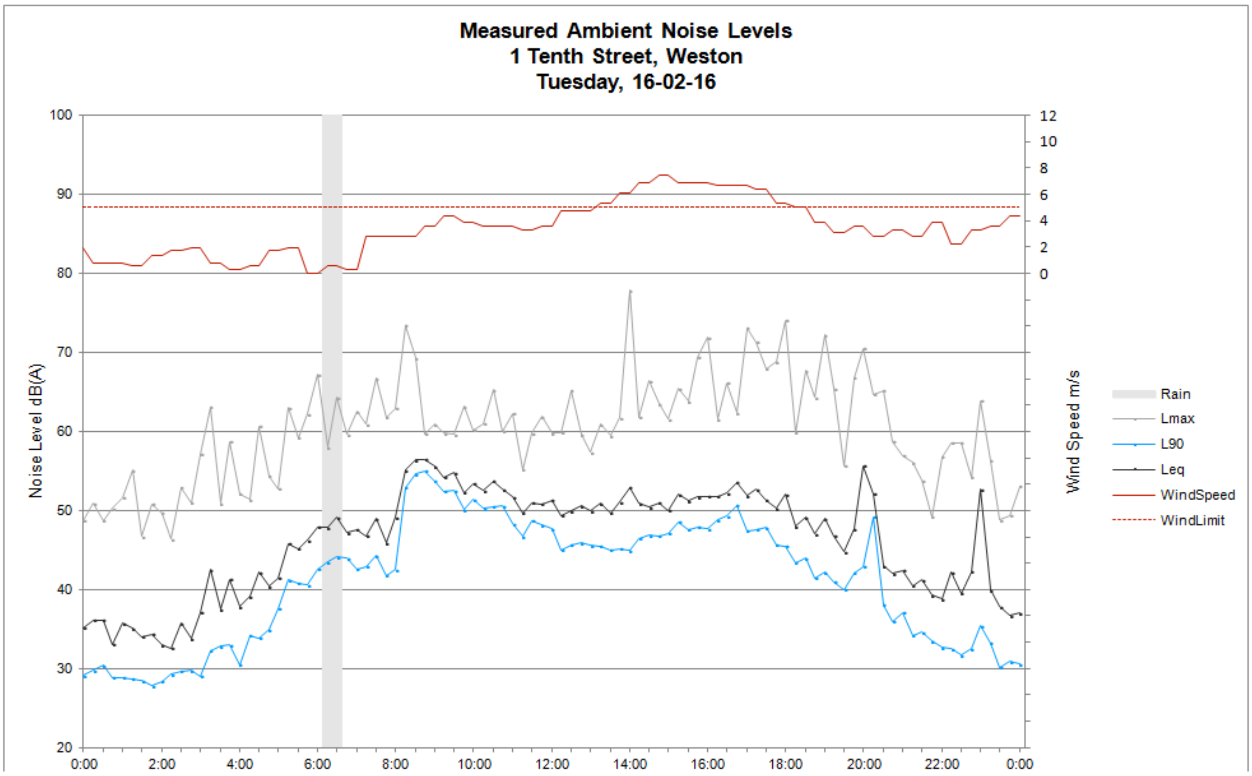


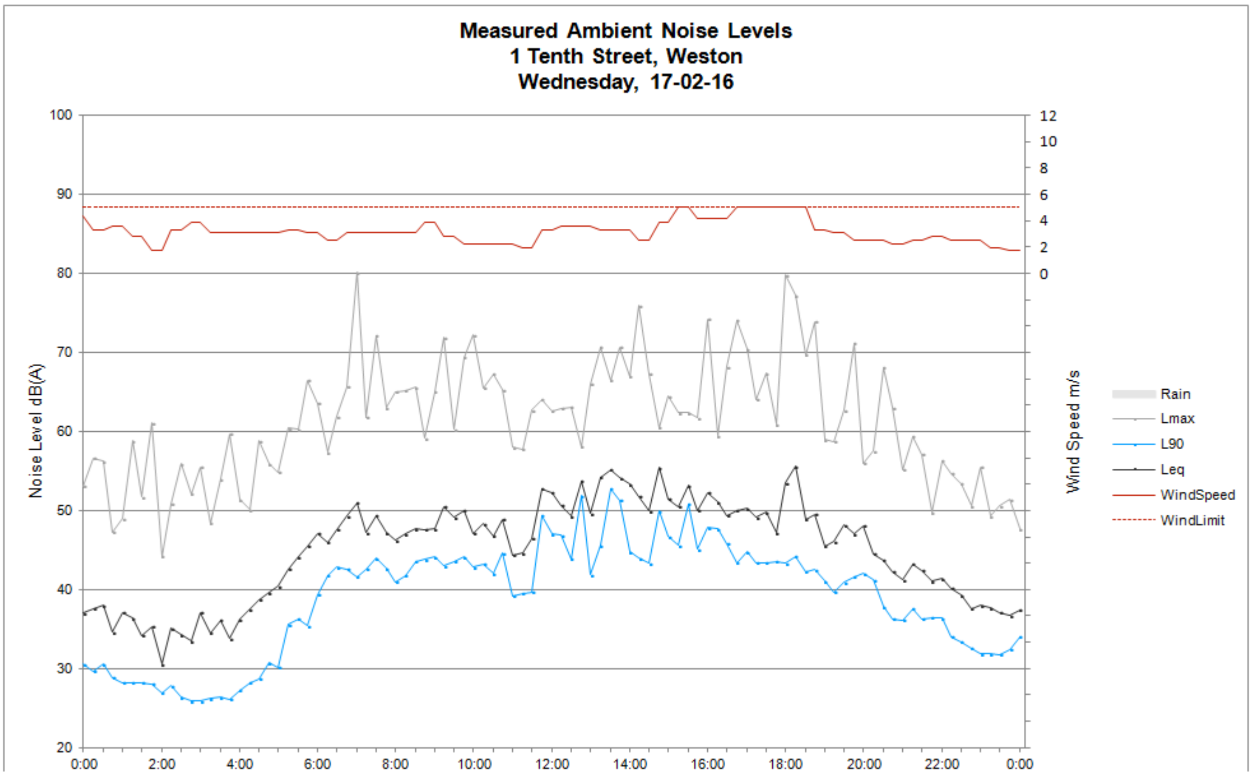
Measured Ambient Noise Levels
1 Tenth Street, Weston
Friday, 12-02-16
Noise Level dB(A)
Wind Speed m/s
100
90
80
70
60
50
40
30
20
12
10
8
6
4
2
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Rain
Lmax
L90
Leq
WindSpeed
WindLimit

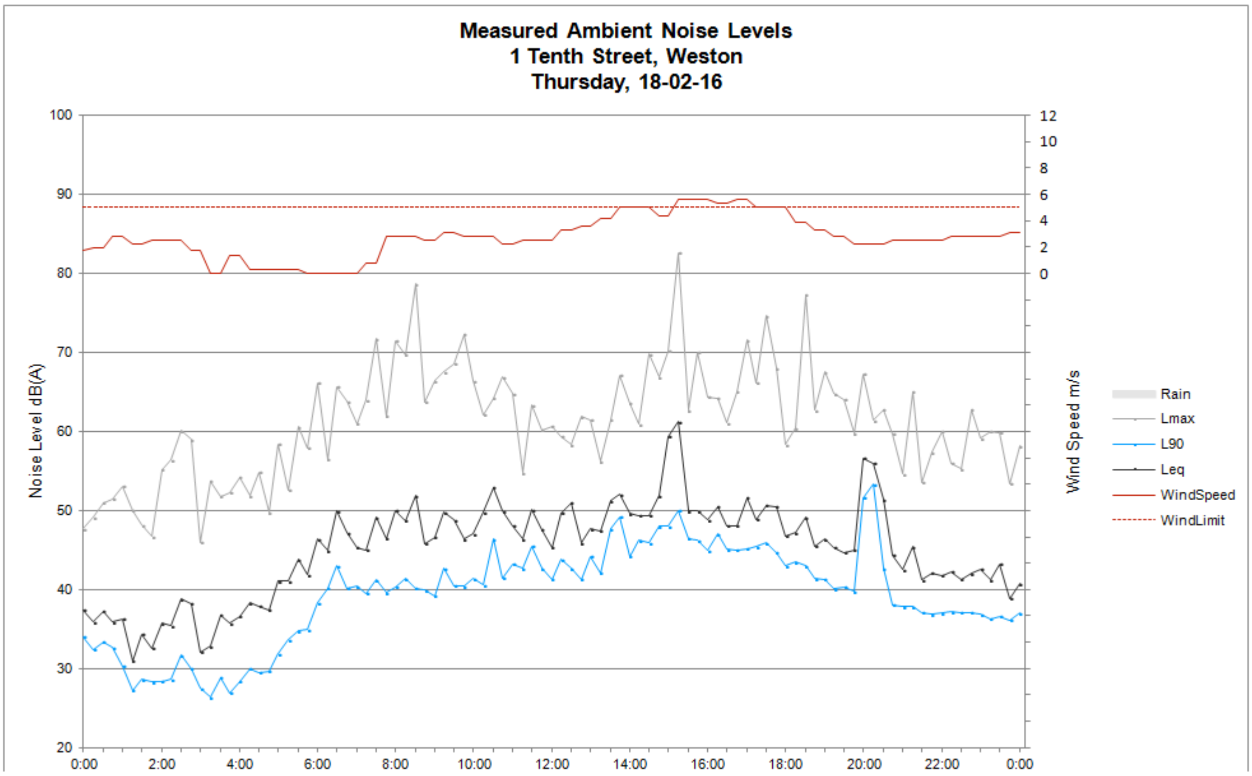

Measured Ambient Noise Levels
1 Tenth Street, Weston
Saturday, 13-02-16
Noise Level dB(A)
Wind Speed m/s
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
100
90
80
70
60
50
40
30
20
12
10
8
6
4
2
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00

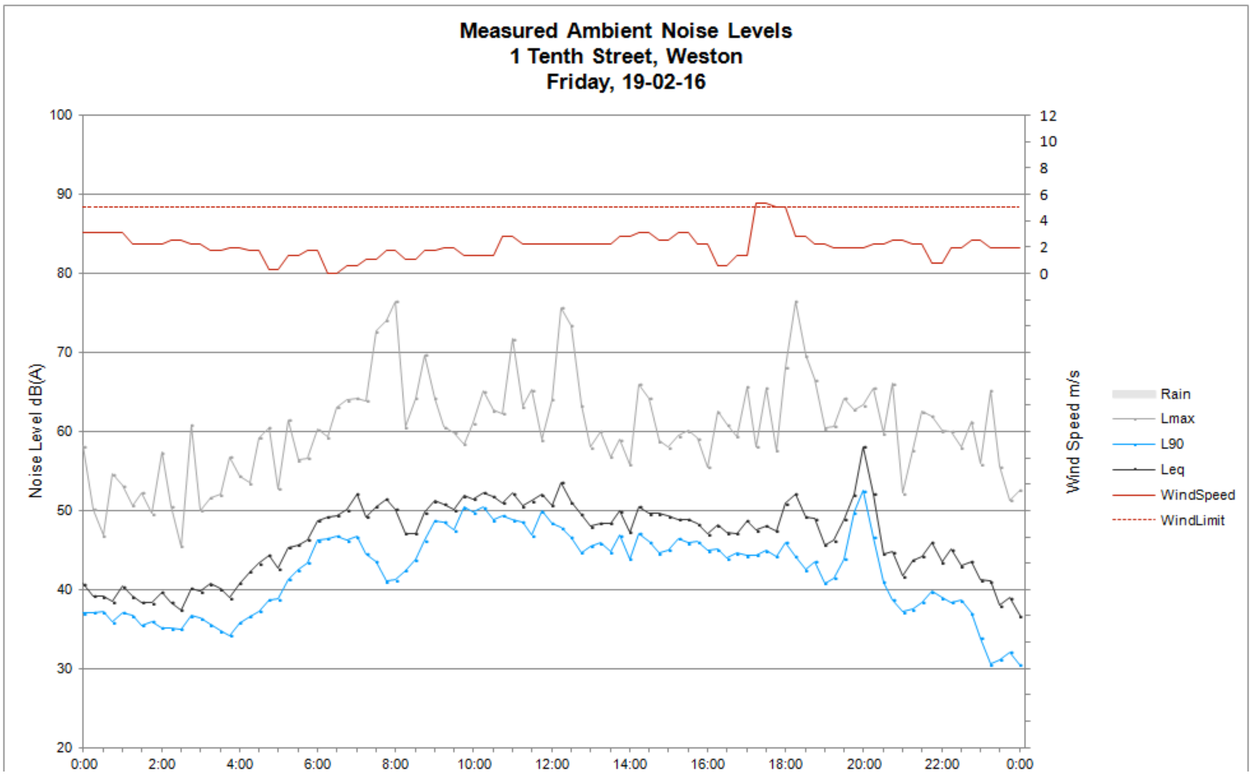

Measured Ambient Noise Levels
1 Tenth Street, Weston
Sunday, 14-02-16
Noise Level dB(A)
Wind Speed m/s
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
100
90
80
70
60
50
40
30
20
12
10
8
6
4
2
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00


Measured Ambient Noise Levels
1 Tenth Street, Weston
Monday, 15-02-16
Noise Level dB(A)
Wind Speed m/s
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
100
90
80
70
60
50
40
30
20
12
10
8
6
4
2
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00

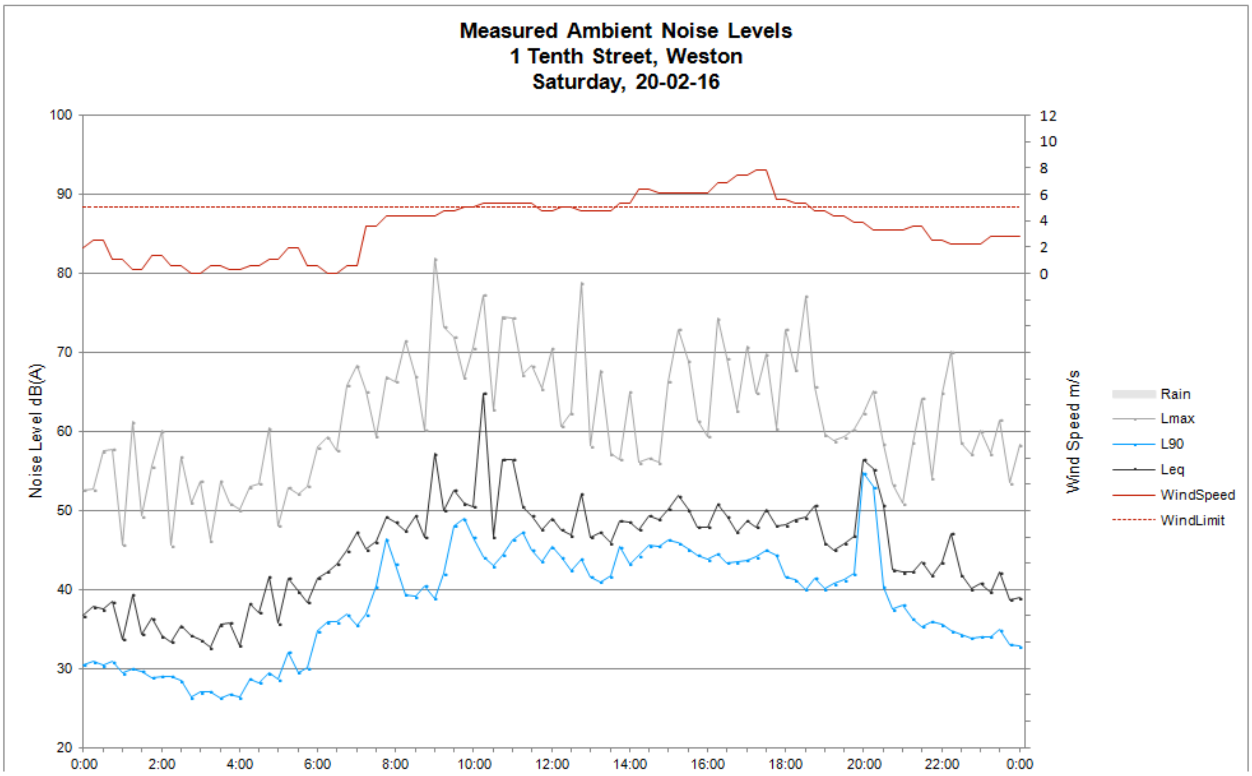

Measured Ambient Noise Levels
1 Tenth Street, Weston
Tuesday, 16-02-16
Noise Level dB(A)
Wind Speed m/s
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
100
90
80
70
60
50
40
30
20
12
10
8
6
4
2
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00


Measured Ambient Noise Levels
1 Tenth Street, Weston
Wednesday, 17-02-16
Noise Level dB(A)
Wind Speed m/s
100
90
80
70
60
50
40
30
20
12
10
8
6
4
2
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Rain
Lmax
L90
Leq
WindSpeed
WindLimit

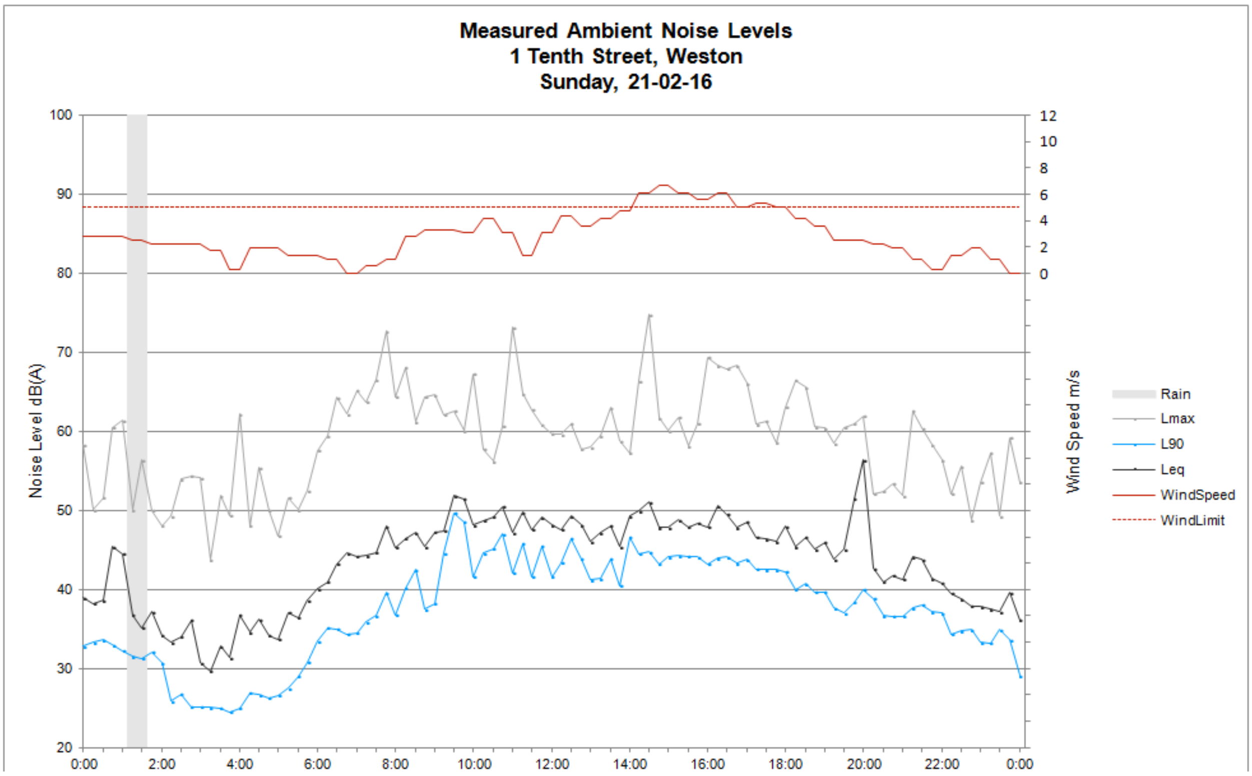

Measured Ambient Noise Levels
1 Tenth Street, Weston
Thursday, 18-02-16
Noise Level dB(A)
Wind Speed m/s
100
90
80
70
60
50
40
30
20
12
10
8
6
4
2
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Rain
Lmax
L90
Leq
WindSpeed
WindLimit

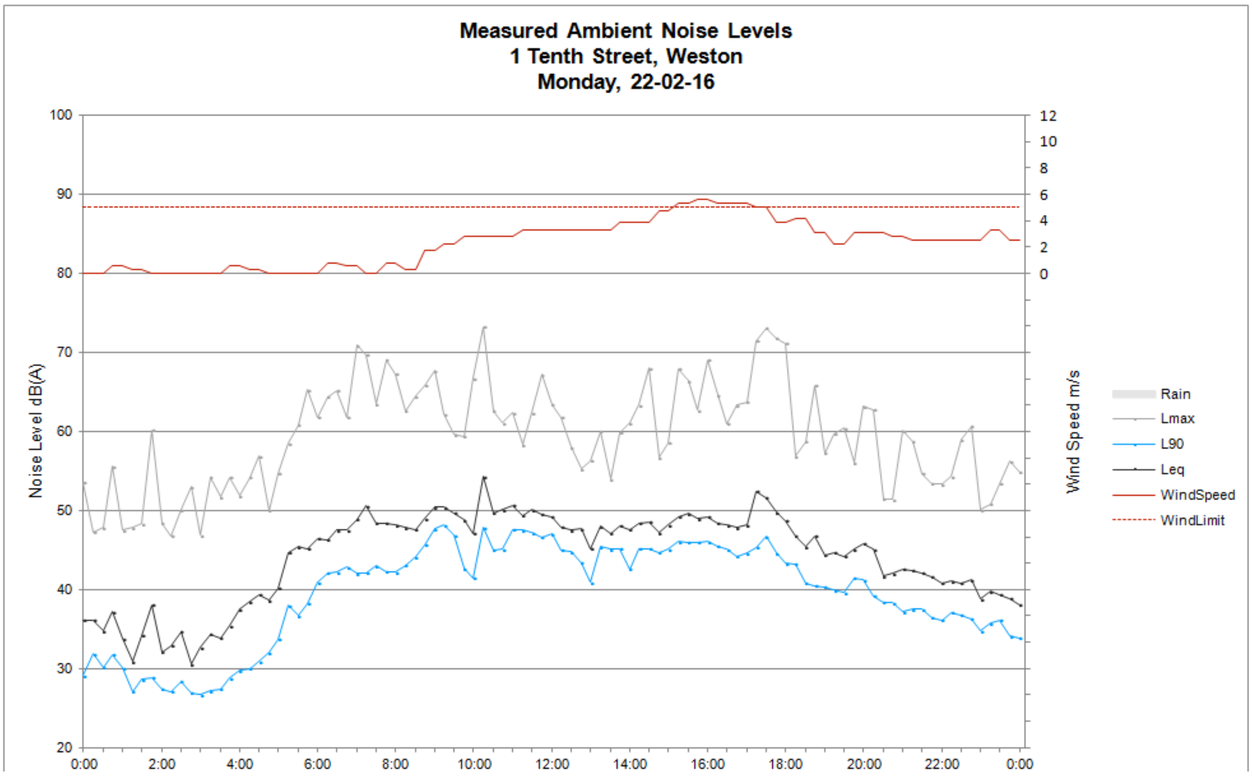


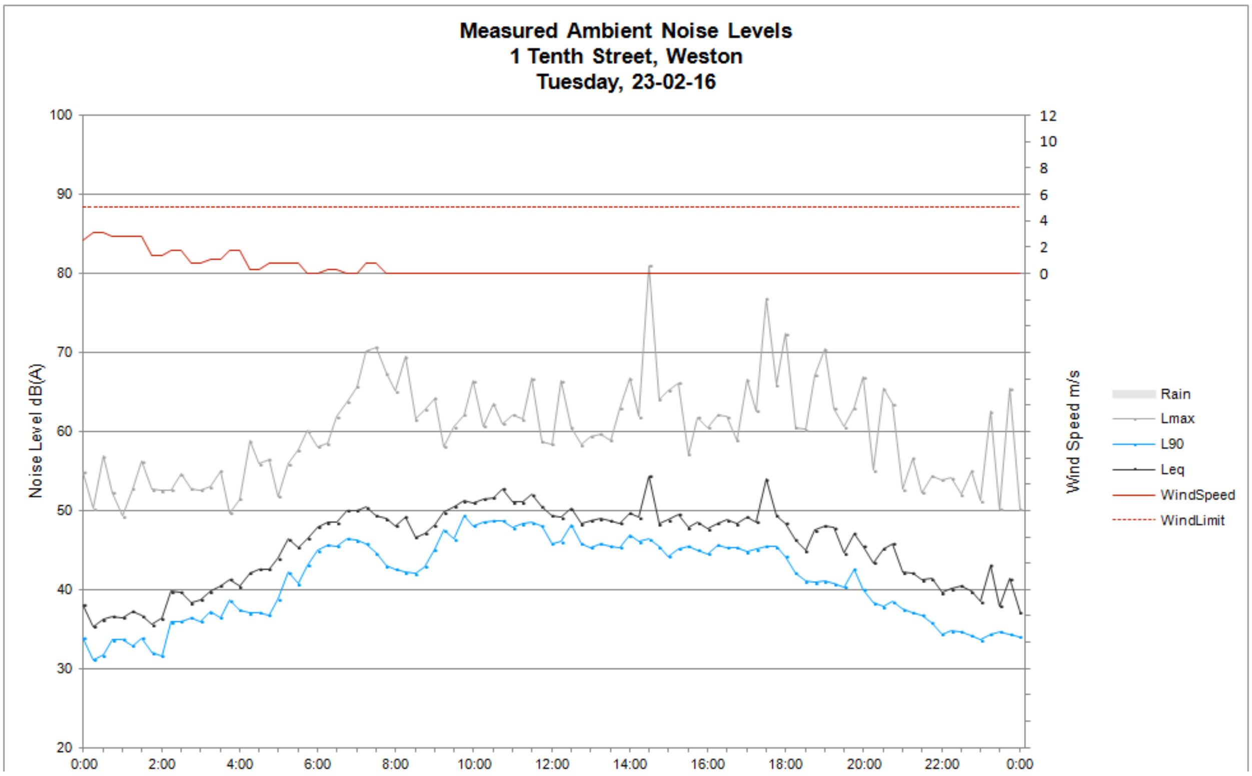
Measured Ambient Noise Levels
1 Tenth Street, Weston
Friday, 19-02-16
Noise Level dB(A)
Wind Speed m/s
Rain
Lmax
L90
Leq
WindSpeed
WindLimit



Measured Ambient Noise Levels
1 Tenth Street, Weston
Saturday, 20-02-16
Noise Level dB(A)
Wind Speed m/s
Rain
Lmax
L90
Leq
WindSpeed
WindLimit


Measured Ambient Noise Levels
1 Tenth Street, Weston
Sunday, 21-02-16
Noise Level dB(A)
Wind Speed m/s
100
90
80
70
60
50
40
30
20
12
10
8
6
4
2
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Rain
Lmax
L90
Leq
WindSpeed
WindLimit


Measured Ambient Noise Levels
1 Tenth Street, Weston
Monday, 22-02-16
Noise Level dB(A)
Wind Speed m/s
100
90
80
70
60
50
40
30
20
12
10
8
6
4
2
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Rain
Lmax
L90
Leq
WindSpeed
WindLimit


Measured Ambient Noise Levels
1 Tenth Street, Weston
Tuesday, 23-02-16
Noise Level dB(A)
Wind Speed m/s
Rain
Lmax
L90
Leq
WindSpeed
WindLimit

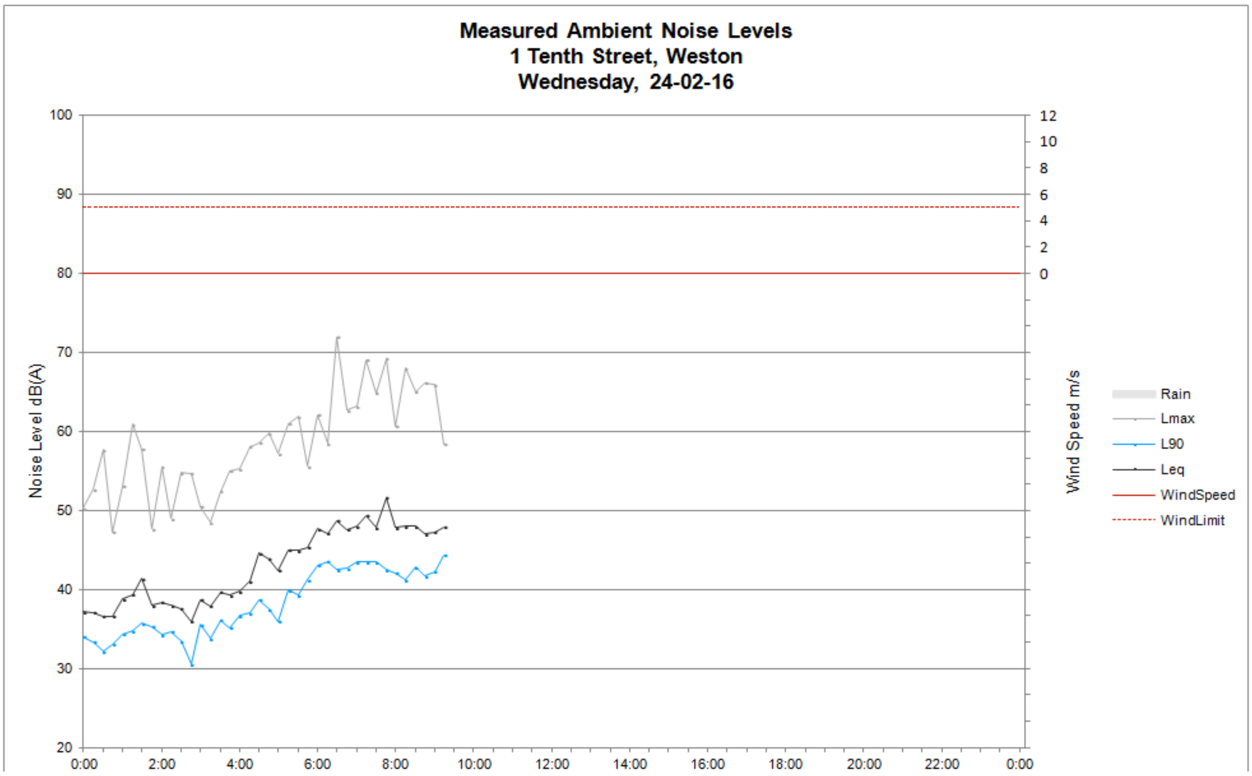
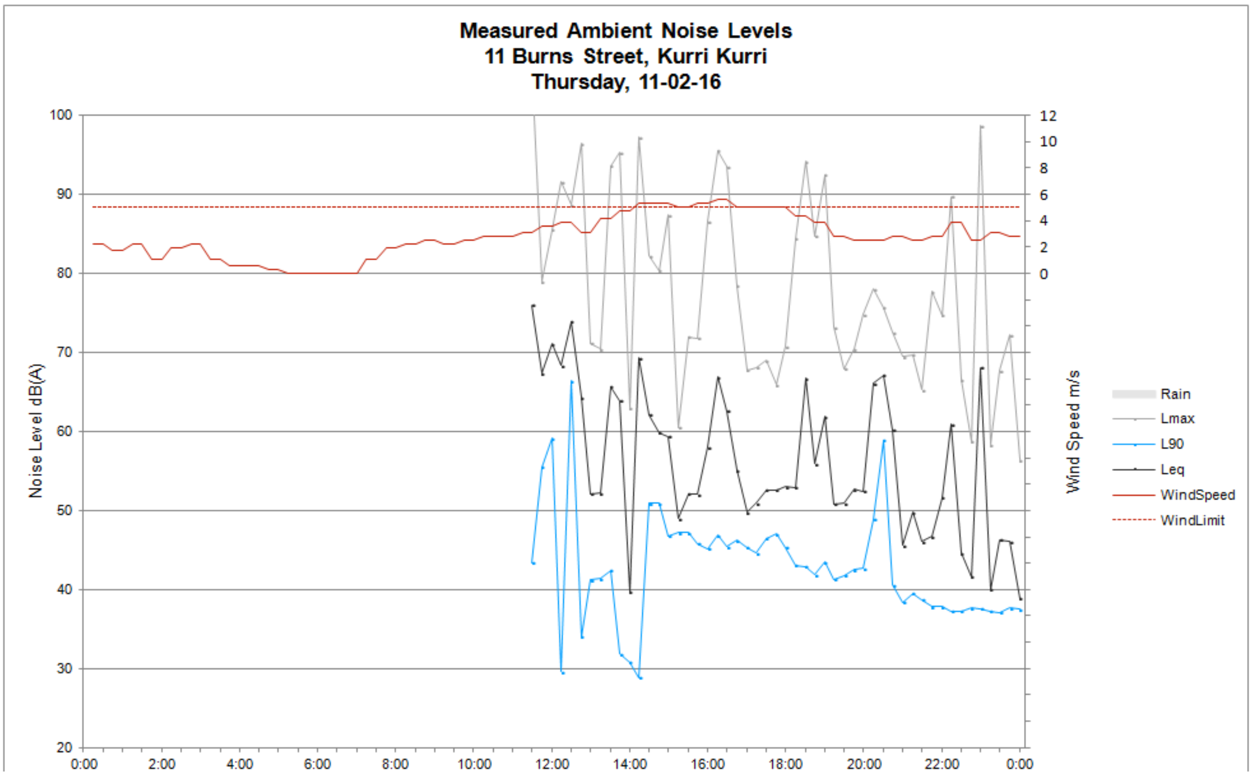

Measured Ambient Noise Levels
1 Tenth Street, Weston
Wednesday, 24-02-16
Noise Level dB(A)
Wind Speed m/s
Rain
Lmax
L90
Leq
WindSpeed
WindLimit

Table A.3 Ambient noise monitoring summary – NM3 (11 Burns Street, Kurri Kurri)

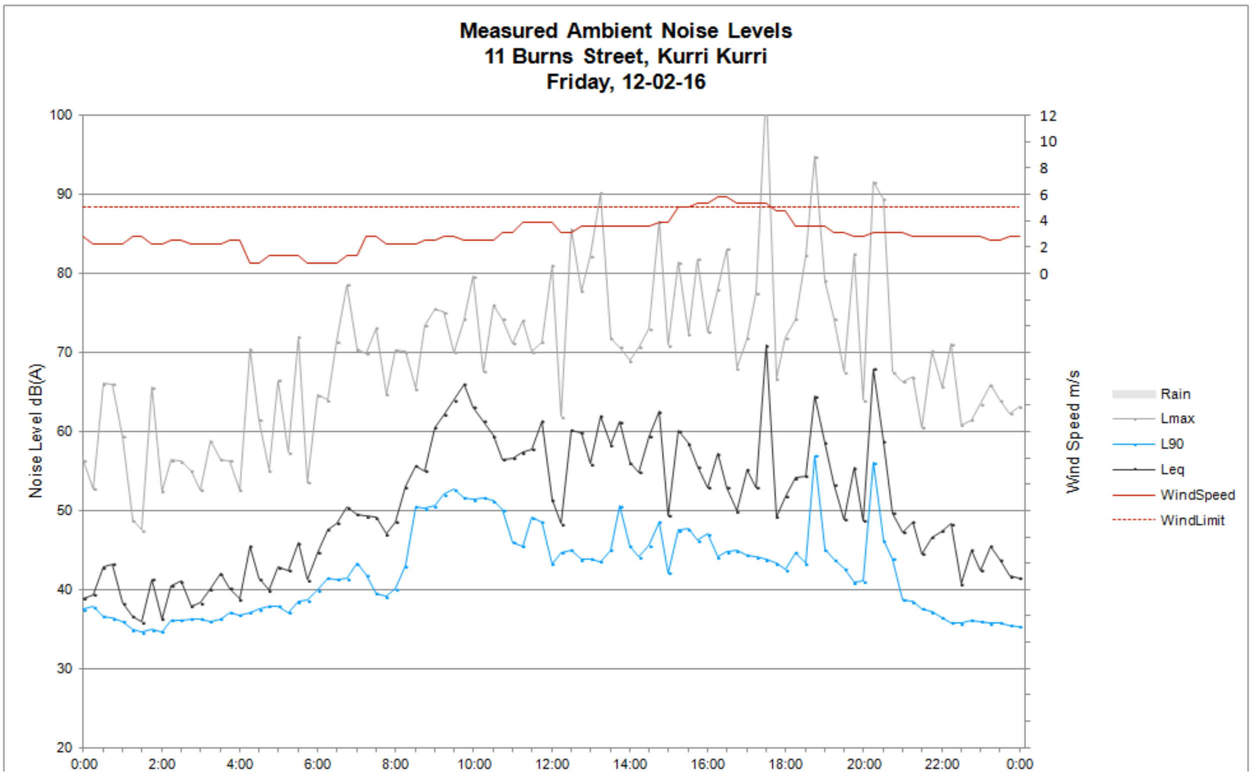
Date	ABL Day	ABL Evening	ABL Night	L_{eq} 11hr Day	L_{eq} 4hr Evening	L_{eq} 9hr Night
Thursday, 11-02-16	0	38	35	0	61	54
Friday, 12-02-16	42	37	32	60	59	46
Saturday, 13-02-16	41	38	34	65	58	48
Sunday, 14-02-16	38	40	36	58	62	46
Monday, 15-02-16	0	41	37	0	53	51
Tuesday, 16-02-16	44	38	34	58	51	43
Wednesday, 17-02-16	40	41	33	58	52	45
Thursday, 18-02-16	39	39	35	58	54	47
Friday, 19-02-16	43	39	37	56	55	44
Saturday, 20-02-16	42	39	35	58	56	44
Sunday, 21-02-16	34	38	37	58	55	46
Monday, 22-02-16	40	39	36	56	56	47
Tuesday, 23-02-16	41	39	34	56	50	45
Wednesday, 24-02-16	0	0	0	0	0	0
Summary Values						
RBL	41	39	35	-	-	-
Average L_{eq}	-	-	-	59	57	48

Notes: *0 = indicates periods with too few valid samples due to weather or logger operation.*

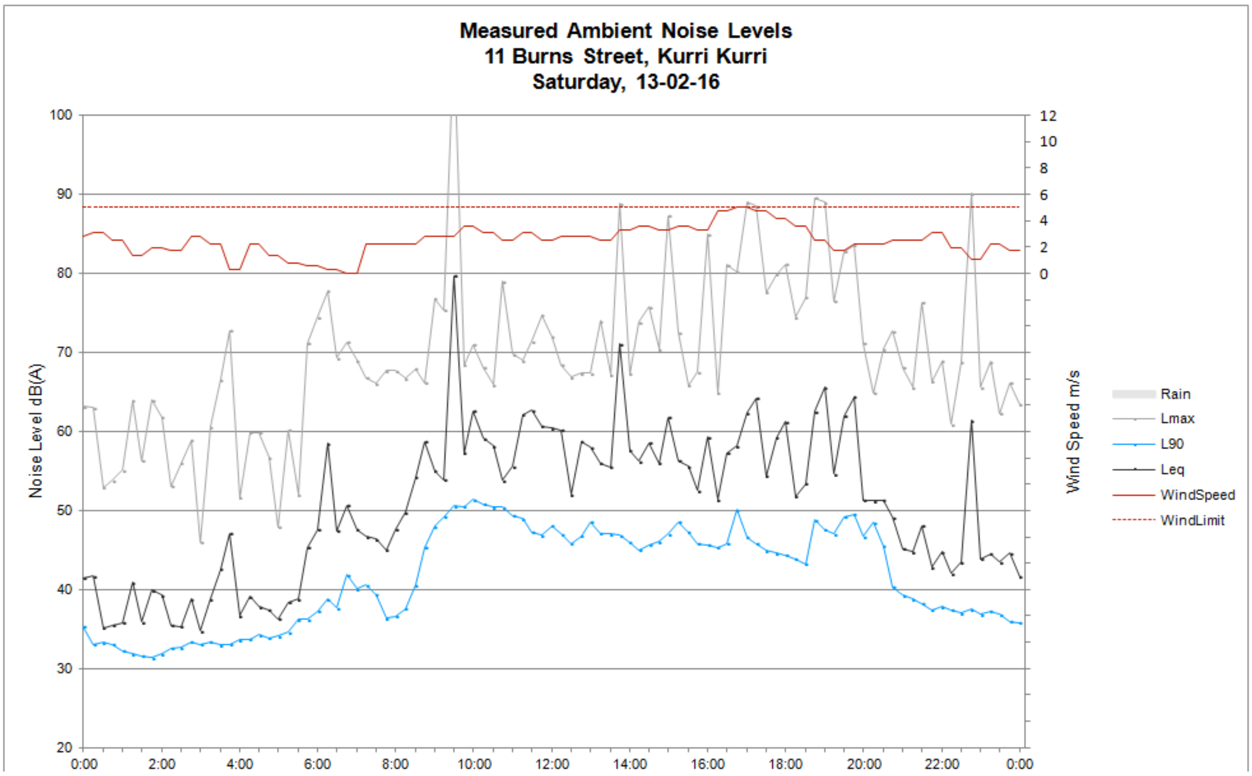
ABL: Assessment Background Level (as defined in the INP).

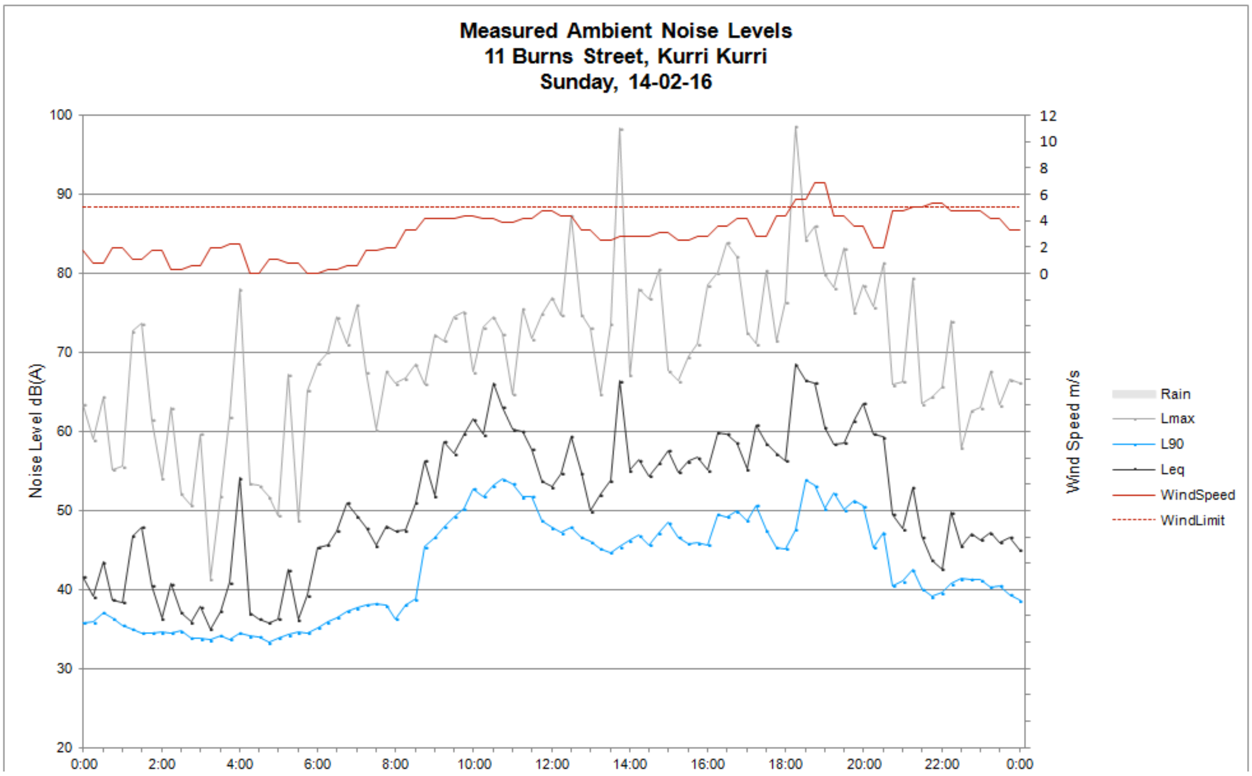


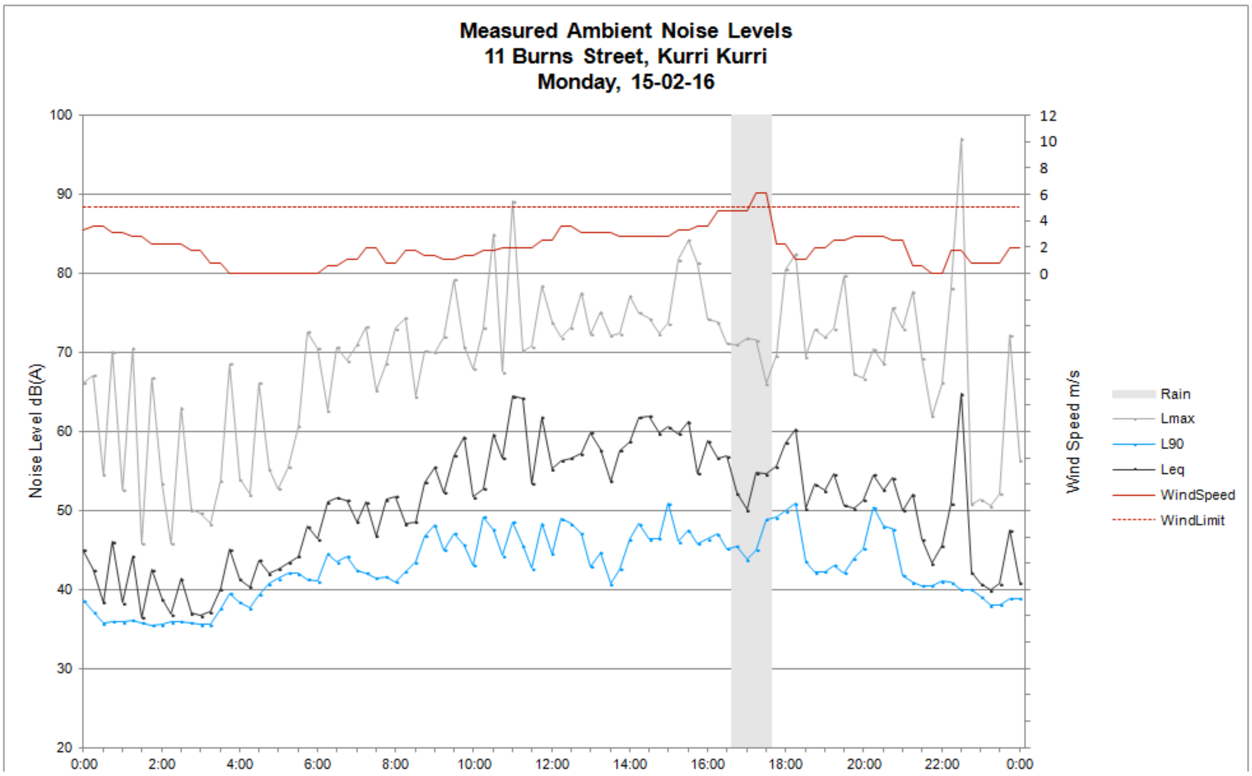
Measured Ambient Noise Levels
11 Burns Street, Kurri Kurri
Thursday, 11-02-16
Noise Level dB(A)
Wind Speed m/s
100
90
80
70
60
50
40
30
20
12
10
8
6
4
2
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Rain
Lmax
L90
Leq
WindSpeed
WindLimit



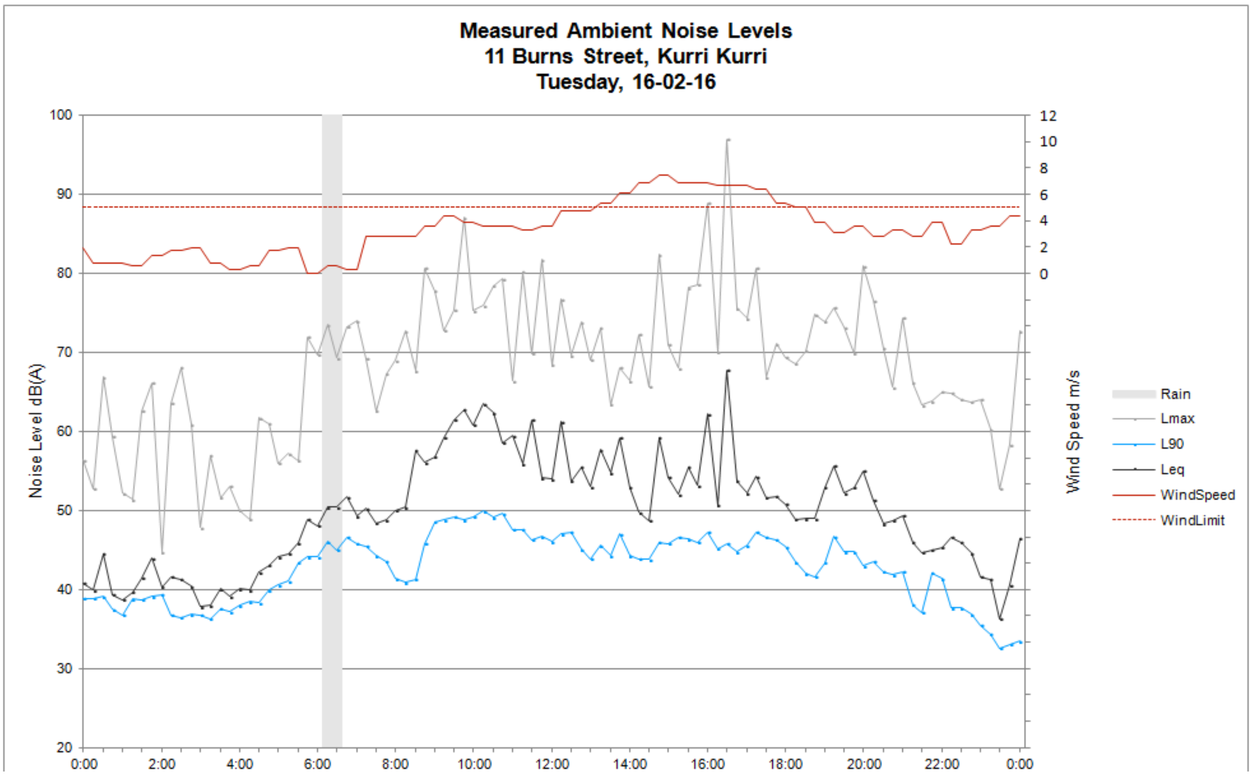
Measured Ambient Noise Levels
11 Burns Street, Kurri Kurri
Friday, 12-02-16
Noise Level dB(A)
Wind Speed m/s
100
90
80
70
60
50
40
30
20
12
10
8
6
4
2
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Rain
Lmax
L90
Leq
WindSpeed
WindLimit


Measured Ambient Noise Levels
11 Burns Street, Kurri Kurri
Saturday, 13-02-16
Noise Level dB(A)
Wind Speed m/s
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
100
90
80
70
60
50
40
30
20
12
10
8
6
4
2
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00

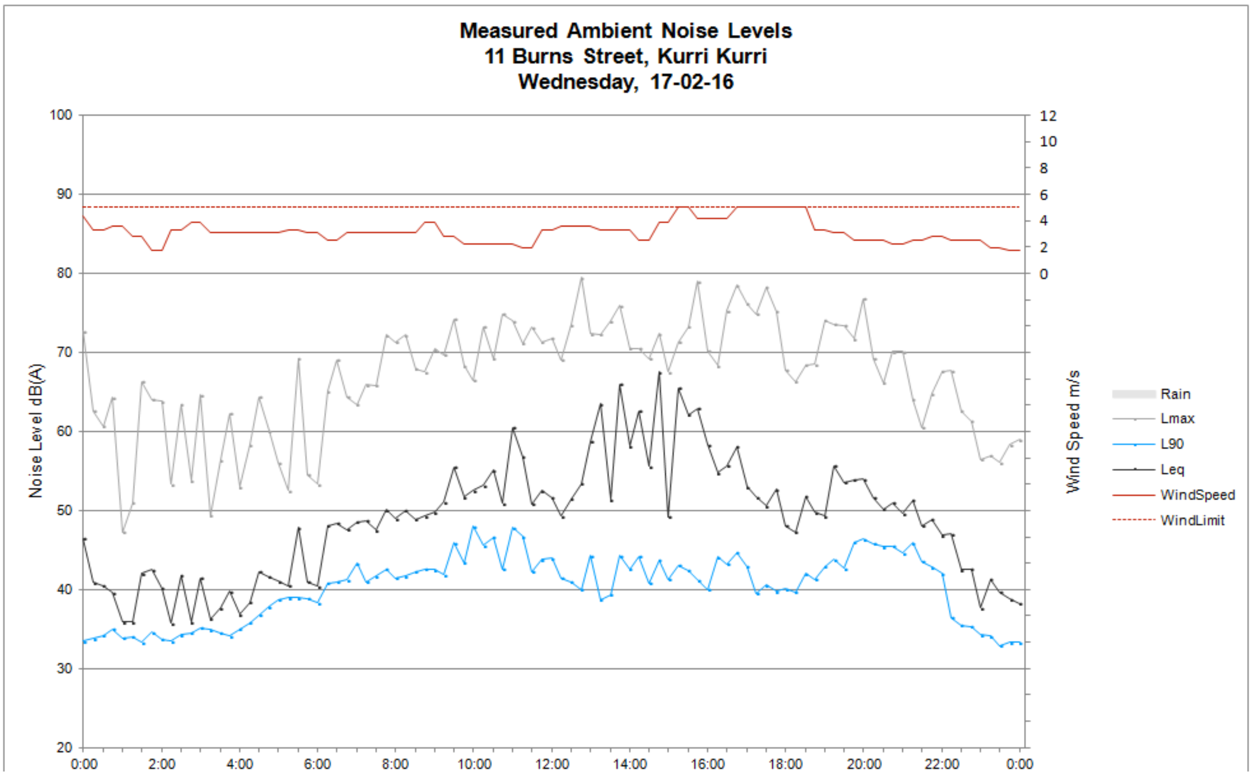

Measured Ambient Noise Levels
11 Burns Street, Kurri Kurri
Sunday, 14-02-16
Noise Level dB(A)
Wind Speed m/s
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
100
90
80
70
60
50
40
30
20
12
10
8
6
4
2
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00



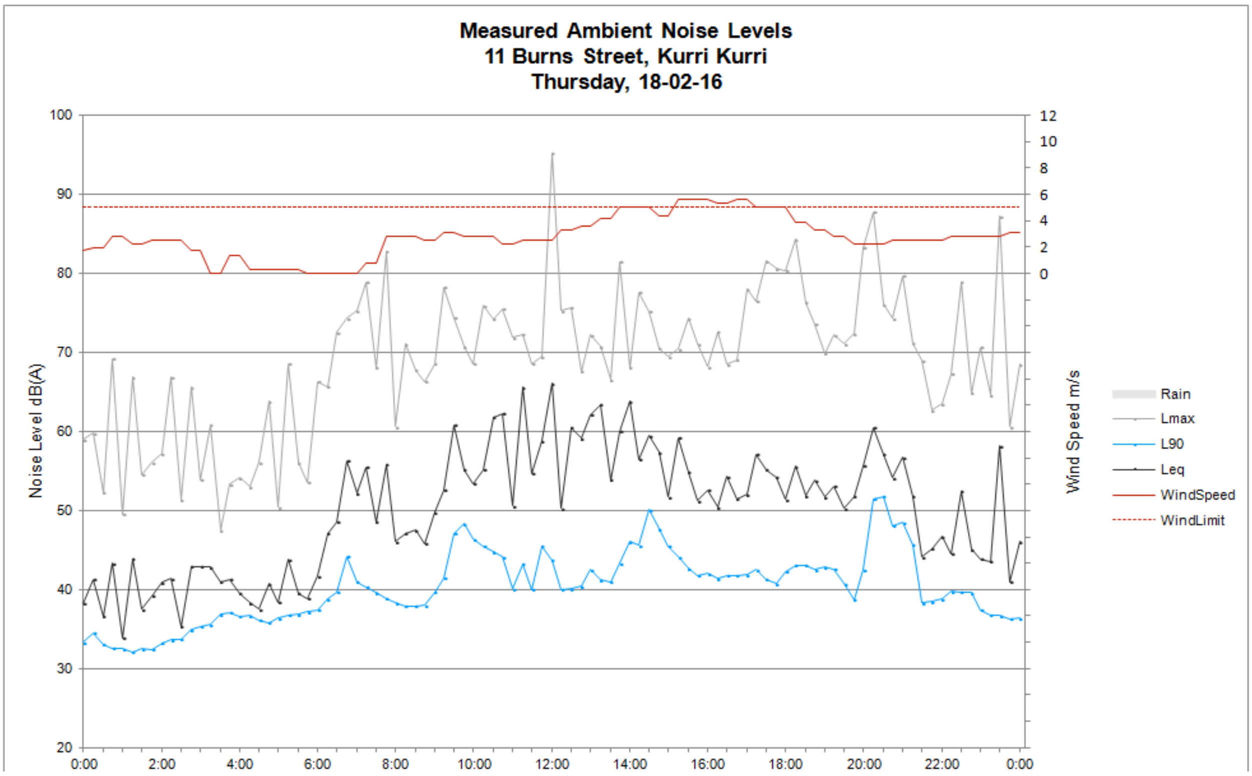
Measured Ambient Noise Levels
11 Burns Street, Kurri Kurri
Monday, 15-02-16
Noise Level dB(A)
Wind Speed m/s
100
90
80
70
60
50
40
30
20
12
10
8
6
4
2
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Rain
Lmax
L90
Leq
WindSpeed
WindLimit



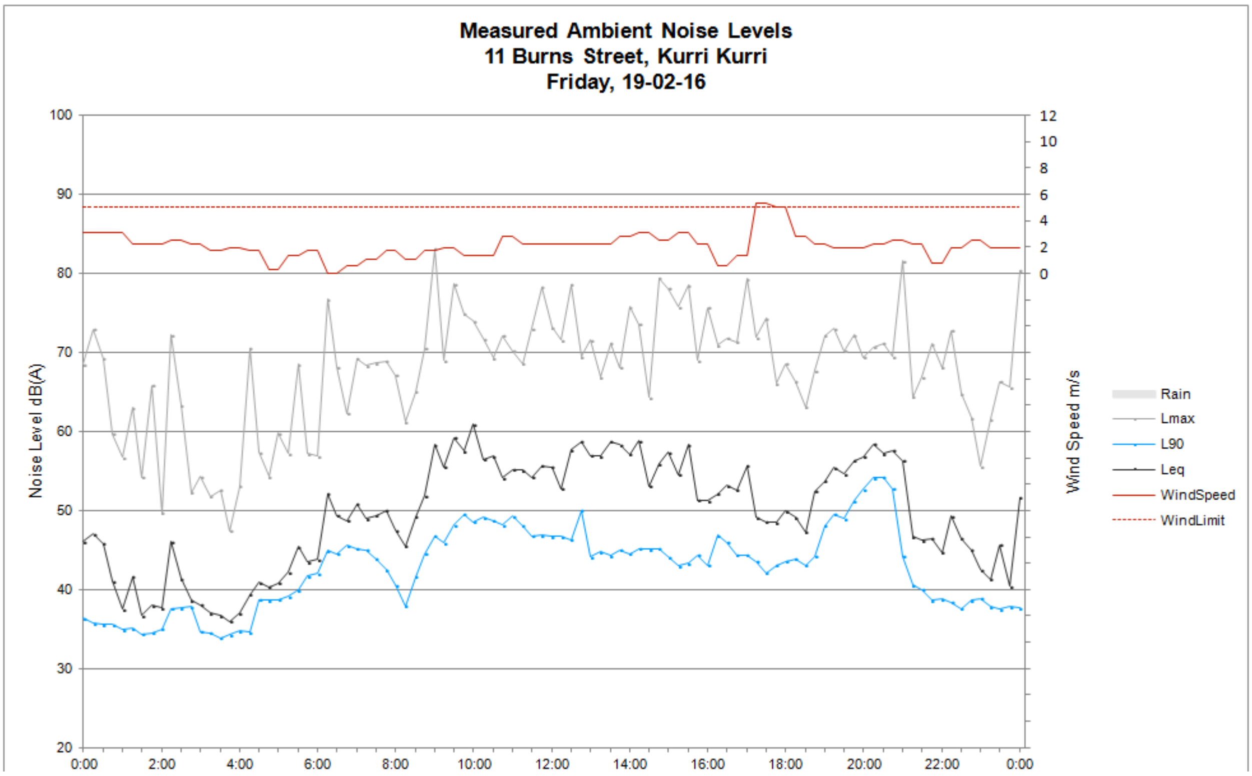
Measured Ambient Noise Levels
11 Burns Street, Kurri Kurri
Tuesday, 16-02-16
Noise Level dB(A)
Wind Speed m/s
100
90
80
70
60
50
40
30
20
12
10
8
6
4
2
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Rain
Lmax
L90
Leq
WindSpeed
WindLimit



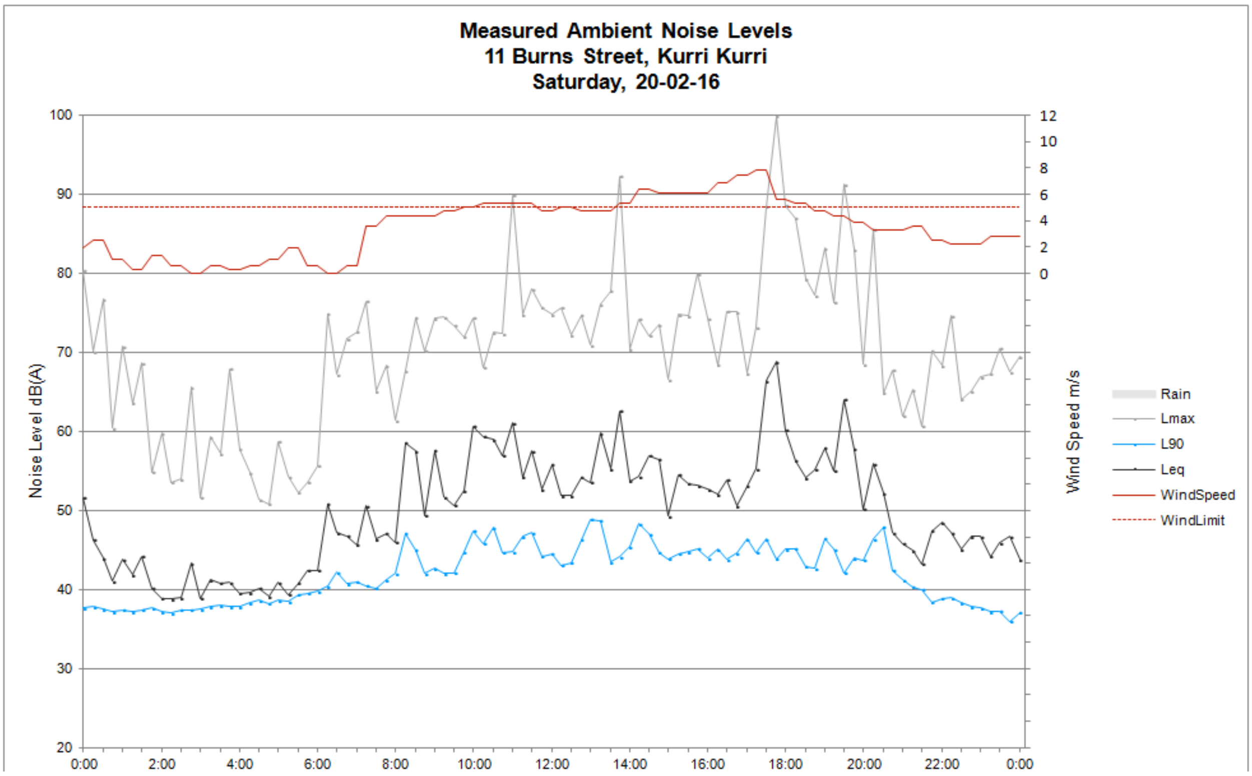
Measured Ambient Noise Levels
11 Burns Street, Kurri Kurri
Wednesday, 17-02-16
Noise Level dB(A)
Wind Speed m/s
100
90
80
70
60
50
40
30
20
12
10
8
6
4
2
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Rain
Lmax
L90
Leq
WindSpeed
WindLimit



Measured Ambient Noise Levels
11 Burns Street, Kurri Kurri
Thursday, 18-02-16
Noise Level dB(A)
Wind Speed m/s
100
90
80
70
60
50
40
30
20
12
10
8
6
4
2
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Rain
Lmax
L90
Leq
WindSpeed
WindLimit



Measured Ambient Noise Levels
11 Burns Street, Kurri Kurri
Friday, 19-02-16
Noise Level dB(A)
Wind Speed m/s
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00



Measured Ambient Noise Levels
11 Burns Street, Kurri Kurri
Saturday, 20-02-16
Noise Level dB(A)
Wind Speed m/s
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
0:00
2:00
4:00
6:00
8:00
10:00
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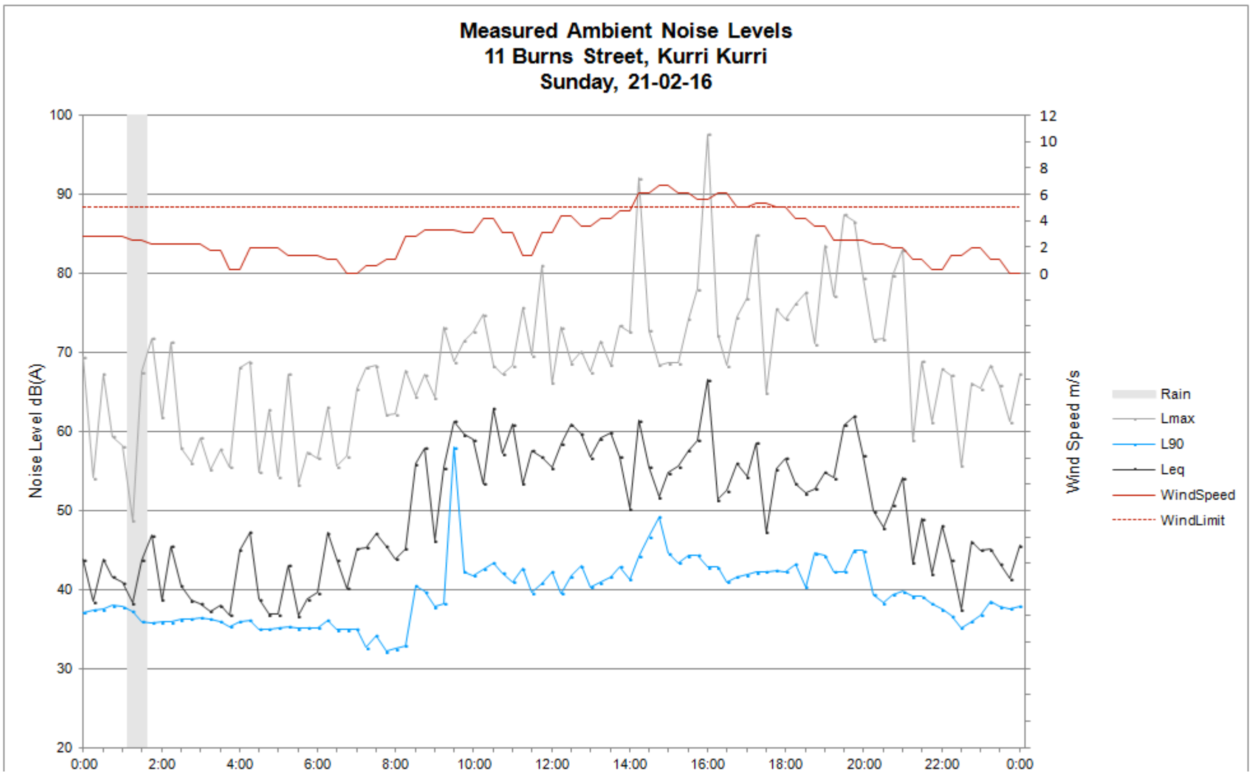
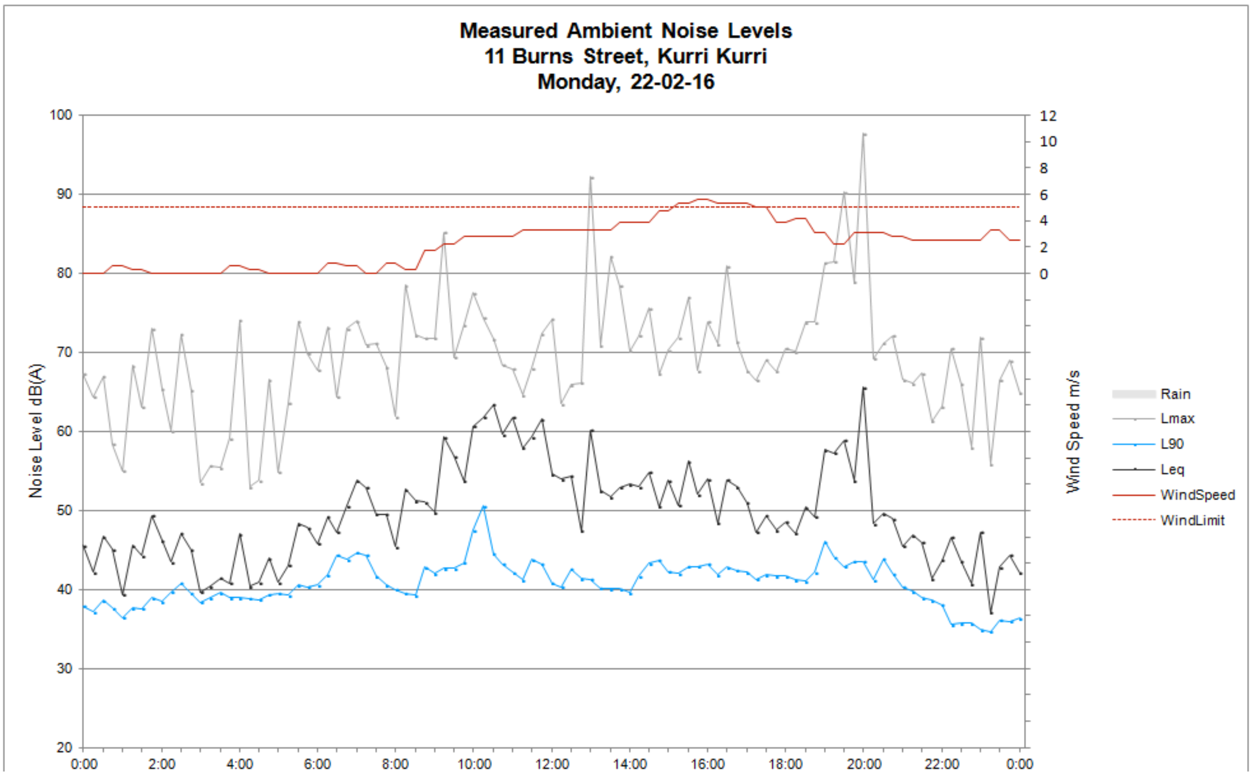
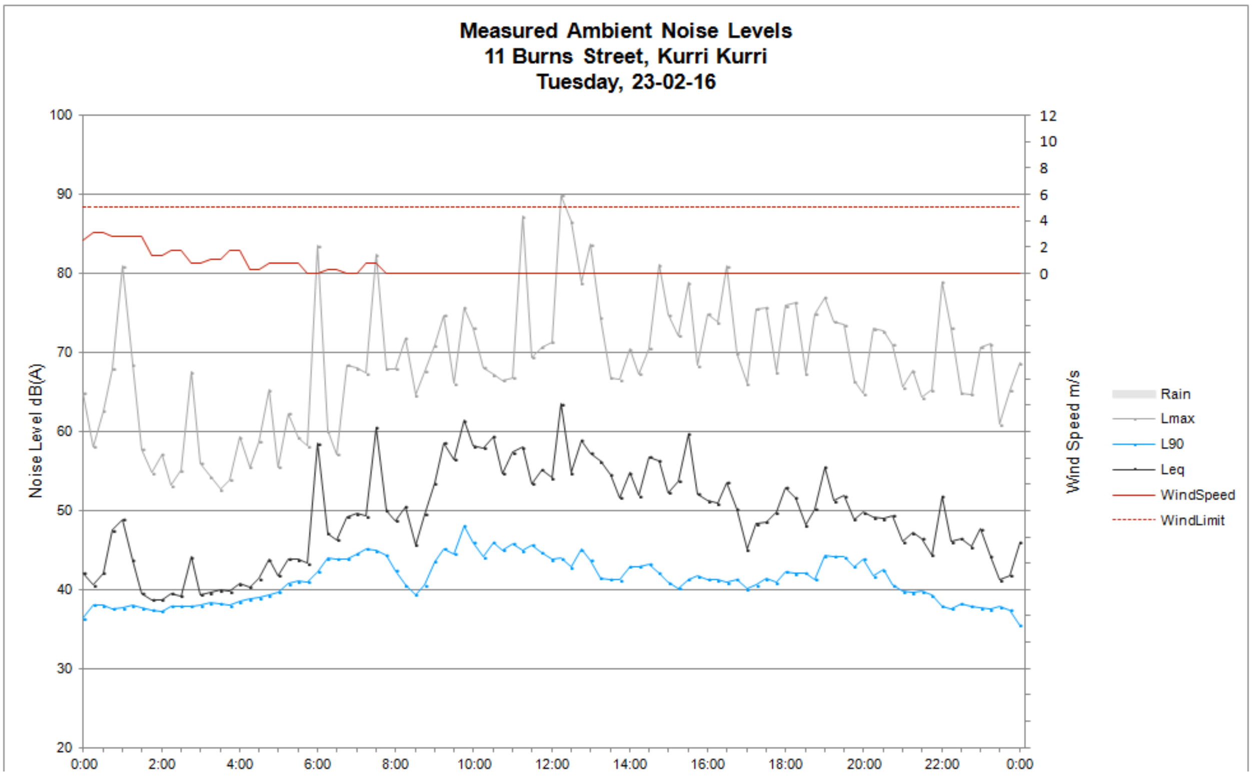
20:00
22:00
0:00

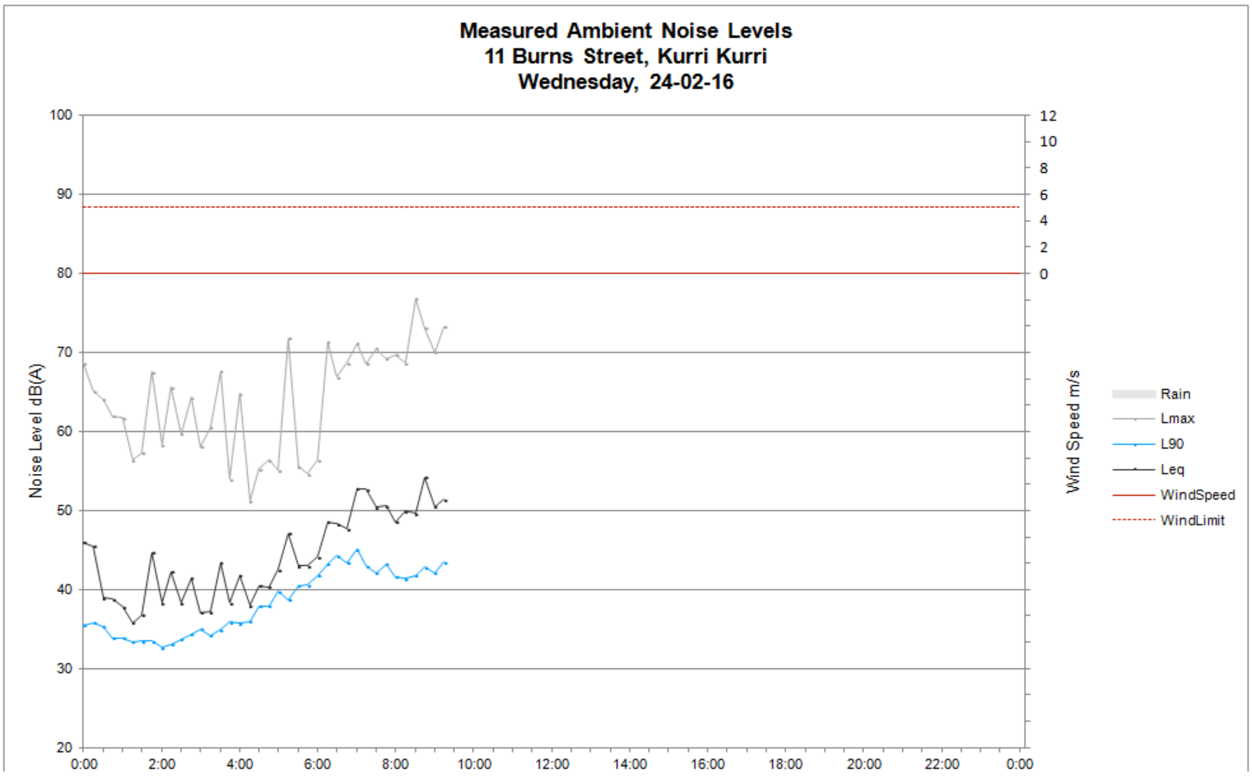


Measured Ambient Noise Levels
11 Burns Street, Kurri Kurri
Sunday, 21-02-16
Noise Level dB(A)
Wind Speed m/s
100
90
80
70
60
50
40
30
20
12
10
8
6
4
2
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Rain
Lmax
L90
Leq
WindSpeed
WindLimit



Measured Ambient Noise Levels
11 Burns Street, Kurri Kurri
Monday, 22-02-16
Noise Level dB(A)
Wind Speed m/s
100
90
80
70
60
50
40
30
20
12
10
8
6
4
2
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Rain
Lmax
L90
Leq
WindSpeed
WindLimit


Measured Ambient Noise Levels
11 Burns Street, Kurri Kurri
Tuesday, 23-02-16
Noise Level dB(A)
Wind Speed m/s
100
90
80
70
60
50
40
30
20
12
10
8
6
4
2
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Rain
Lmax
L90
Leq
WindSpeed
WindLimit


Measured Ambient Noise Levels
11 Burns Street, Kurri Kurri
Wednesday, 24-02-16
Noise Level dB(A)
Wind Speed m/s
100
90
80
70
60
50
40
30
20
12
10
8
6
4
2
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Rain
Lmax
L90
Leq
WindSpeed
WindLimit

Appendix B

Prevailing winds analysis

Table B.1 INP prevailing winds analysis

Period	Season	Direction	Wind Speed (m/s)
		2014	
Evening	Autumn	157.5-270	2.3
Evening	Winter	180-292.5	2.3
Evening	Spring	135-225	2.5
Night	Summer	135-247.5	2.3
Night	Autumn	180-247.5	2.3
Night	Spring	157.5-247.5	2.3
		2015	
Evening	Summer	135-202.5	2.6
Evening	Autumn	157.5-270	2.3
Evening	Winter	180-292.5	2.3
Evening	Spring	112.5-247.5	2.4
Night	Summer	135-247.5	2.4
Night	Spring	157.5-247.5	2.2

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