

Environmental Noise
Impact Assessment
Uranquinty Gas-Fired Power Station
Wambo Power Ventures

REPORT ON: Environmental Noise Emission
PROJECT: Uranquinty Gas-Fired Power Station
CLIENT: Wambo Power Ventures
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REPORT ON
ENVIRONMENTAL NOISE EMISSION

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PROJECT
Uranquinty Gas-Fired Power Station

CLIENT
**Environmental and Licensing
Professionals**

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1. EXECUTIVE SUMMARY

A gas-fired power station is proposed for a site at Uranquinty near Wagga Wagga, New South Wales. Bassett Acoustics has conducted an assessment of the potential environmental noise emission from the site into surrounding areas.

The area is a primarily rural area. The closest residences to the site are the settlements of 'Pine Grove', 'The Wardrobe', 'Wallace', 'Metcalfe' and 'Pearce'. Background noise measurements were conducted at two representative locations and processed in accordance with the specifications of the "NSW Industrial Noise Policy". The rating background level in the area was found to be 30 dB(A) for both day and night time periods. The intrusiveness criterion based on this rating background level is 35 dB(A).

Two 150MW gas turbines are proposed initially for the site, with provisions for two additional units to be added in the future. These turbines will be the primary source of environmental noise emission from the plant. Noise is emitted from the turbines through the inlet, through the exhaust stack and through casing breakout noise. The maximum permissible sound pressure level has been determined for each of the turbines.

Meteorological conditions exist at the site that can unfavourably promote noise propagation from the proposed power plant towards the nearest residential receivers. Computer noise modelling was used to assess the noise emission with all four turbines operating. A number of different meteorological conditions were modelled.

The maximum noise levels were found to result from the combination of a Pasquill Stability Class F meteorological condition and a 3m/s Westerly wind, evaluated to be weather category 6, the most adverse weather category for noise propagation defined by the CONCAWE algorithms. Under these conditions, the 35 dB(A) noise emission limit is met at the two closest receivers, 'Pine Grove' and 'The Wardrobe' where the overall noise emission from each turbine is limited to 56 dB(A) at 100 m.

Noise emission from the construction works associated with the power plant has also been assessed. The early stage of construction requires earthworks operations for which excavators, loaders and/or dozers may be required. The noise emission objective for construction works was 35dB(A) as outlined in the NSW DEC 'Environmental Noise Control Manual'.

The maximum noise levels were produced when a 3m/s wind from the west was evident. Noise levels of 46dB(A) are predicted at the nearest receivers when two dozers or excavators are operating at the site. This level exceeds the 35dB(A) objective by 11 dB(A).. The maximum permissible noise emission from each item of plant has been scheduled in this report to enable the construction noise emission criteria to be met. Treatments are recommended to control noise emission from construction plant as much as practicable. . Noise generated by traffic movements to and from the site has also been addressed. The forecast noise increase due to traffic movements during normal plant operation was found to be within Department of Environment and Conservation guidelines.

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2. INTRODUCTION

Bassett Acoustics has been commissioned by Environment and Licensing Professionals to assess the environmental noise emission from the planned Uranquinty gas-fired power station at Uranquinty, New South Wales.

The proposed site will consist of upto four 150MW gas turbines, with two installed initially and a further two at a later date. The turbines have the potential to generate environmental noise that will require treatment or mitigation to meet the criteria outlined in this report.

The site is located in a primarily rural area, with nearest residences approximately 650 m from the site. Long-term background noise measurements have been taken in the area to characterise the ambient noise environment and to determine the maximum permissible noise emission levels from the power station.

Noise modelling has been performed using the computer package SoundPLAN 6.0 to determine the impact of the affect of topography and meteorological conditions on the noise levels experienced at nearby residences. Noise emission from construction works associated with the power plant has also been assessed.

Appropriate noise limits have been recommended to control noise from both the operation of the plant and the construction activities at the site.

3. DESCRIPTION OF SITE AND OPERATIONS

The proposed site will be located near Wagga Wagga in Southern New South Wales. The site is approximately 3km from the township of Uranquinty and is in a primarily rural area. The closest residences are summarised in Table 3-1 below. The distances are based on aerial photos of the area supplied by ELP.

Table 3-1 – Summary of most affected noise sensitive areas around the Uranquinty power station

Description	Direction to resident	Distance from the site
'Pine Grove'	South	650 m
'The Wardrobe'	South-East	850 m
'Wallace'	East	980 m
'Metcalfe'	North-West	1300 m
'Pearce'	West	1400 m
'The Pines'	North-East	1500 m
'Churchill Square'	South	1700 m
'Wyrilla'	North-West	2000 m
'Weemont'	East	2100 m
'Tandara'	East	2000 m
Uranquinty Township	South- East	2400 m

The location of these residences and others in the area is shown on the site map in Appendix B. Access to the site will be via the Uranquinty Cross Road, which runs past the southern end of the site.

A total of four 150MW gas turbine generators are proposed for the site. Initially only two will be built. This report has assessed the overall noise impact from all four units.

It is expected that the plant will typically operate between the hours of 6.30 am and 7:00 pm. Operation outside these hours is rare but it is assumed that this occurs for the purpose of this assessment.

3.1 POWER PLANT NOISE EMISSION

The turbine generators outlined in Section 3.1.1 below are the most significant noise source at the power station. Noise from transformers and switchgear can also be significant. Other potential noise sources are described below in Sections 3.1.1 to 3.1.5. The environmental noise emission from these sources are insignificant in relation to the potential noise emission from the turbines

3.1.1 Turbines

Gas turbines are made up of three main parts: the compressor, the combustion chamber and the turbine. Air is drawn into the inlet by the compressor and compressed to a high pressure, then forced through the combustion area where the gas is burnt to produce a high-pressure, high velocity air mixture. The high-speed rush of this hot air rotates the turbine. The hot air is then vented through an exhaust stack. Noise is created through the action of the compressor and through the movement of high velocity air. This noise is emitted from the turbines through the air intake, the exhaust stack and from breakout noise through the oil cooler casing.

The specific plant to be used at the Uranquinty site has not yet been determined. The assessment is based on typical noise emission levels and noise spectra associated with gas turbines, as outlined in Appendix C.

3.1.2 Transformers and Switchgear

Each turbine will have a generator transformer, a unit (auxiliary) transformer, a low voltage transformer and fin fan coolers associated with its operation. The generator transformer and fin fan coolers in particular can produce significant levels of noise. However housing the transformers in an enclosure of suitable construction can easily control this noise. The turbines and transformers can be supplied as a package, and housed together in a noise-suppression building. Refer to Section 10.1 for the published noise data

The exhaust and inlet noise from the turbines would therefore be the dominant noise source.

3.1.3 Diesel Generator

The plant has a small diesel generator for use in emergencies. It is proposed to operate the generator for typically 15-30 minutes every 2-3 months as part of its regular maintenance procedures. The generator is in an enclosed room and is a much smaller source of noise than the turbines.

Due to its small size, location in an enclosed room and infrequent operation, compliance with the noise emission criteria for the area is considered straightforward.

3.1.4 Maintenance Activities

Maintenance activities are infrequent, being scheduled for every 4000 hours of plant operation. In general maintenance activities will not require the use of noisy power tools and are not expected to generate significant environmental noise.

3.1.5 Pump House

Operation of the site involves the use of a variety of pumps. The five major types of pumps are:

- Raw water transfer pumps – 2 pumps, 25kW power rating, centrifugal
- Dematerialised water pumps – 3 pumps, 15 kW power rating, centrifugal
- Fire water pumps – 2 pumps, 125 kW power rating, centrifugal
- Fuel unloading pumps – 2 pumps, 22 kW power rating,
- Fuel transfer pumps – 2 pumps, 30 kW power rating

The pumps are located in an enclosed pump house and have sound power levels more than 20 dB(A) below that of each turbine. They are a secondary source of noise and any potential noise exceedance can be easily controlled.

3.1.6 Demineralisation Plant

The demineralisation plant for the site will consist of a few low noise pumps. The pumps will be encased in concrete and will have sound power levels more than 20dB(A) below that of each turbine. They are a secondary source of noise and any potential noise exceedance is controlled with the enclosure. Refer to Section 10.1 for the published noise data

3.2 TRAFFIC NOISE

The power plant is autonomous and does not require heavy vehicles to transport material to and from the site during normal operation.

Normal operation of the plant requires a maximum of 4-5 people to be at the site each day. Some maintenance activities may require an extra 2 people on site. The forecast number of vehicle movements on Uranquinty Cross road is 7 light vehicle trips per day in each direction.

Occasionally chemicals or other equipment will be trucked to the site as needed, typically once every 2-3 months. Rubbish from the site is scheduled to be collected on a weekly basis, with recyclables collected fortnightly

3.3 CONSTRUCTION ACTIVITIES

Construction of the power plant will involve the following stages:

1. Clearing of vegetation and removal and stockpiling of topsoil
2. Bulk earthworks including site grading and excavation work
3. Establishing and preparing concrete foundations for major plant and buildings
4. Construction of buildings and installation of equipment.
5. Pipe line route excavation and construction

The estimated length of each construction stage is shown in Table 3-2 below, along with the equipment required and the number of personnel required on a daily basis during each stage of construction. This was based on information received from Environment and Licensing Professionals..

Table 3-2 – Construction Stages

Stage	Length	Manpower	Equipment
1. Site Preparation & Earthworks	1 month	10	Bulldozer, loaders, scrapers, excavators, graders, rollers, water trucks, crusher and separator
2. Foundations	2 months	40-70	Crane, compactor, concrete truck,
3. Equipment Installation and . Building Construction	5 months	90-110	Crane, power tools, compressor
4. Pipeline construction	1 week	30	Crane, power tools, compressor

Construction activities will be limited to daytime hours on weekdays and Saturday mornings. Construction will not be undertaken on Sundays or Public Holidays.

The hours of operation for construction activities are:

- 7am to 6pm Monday – Friday
- 7am to 1 pm Saturday

If the project requires construction work outside of these hours, regulatory authorities and affected stakeholders should be consulted and negotiations undertaken to enable suitable activities to take place.

4. EXISTING NOISE ENVIRONMENT

4.1 NOISE MONITORING

The residences at 'Wyrilla' (Site 1) and 'Pine Grove' (Site 2) were identified as representative of the potentially most-affected receiver locations. These residences are located in opposite directions from the proposed power station site (shown on the site plan in Appendix B) and were chosen to give an accurate reflection of the noise environment typical to the Uranquinty area.

A noise monitor was set up between Thursday 11 September and Thursday 18 September 2003 at each location. Noise levels were sampled at a rate of 10 samples/second. L_{Aeq} , L_{A90} and L_{A10} noise level descriptors were processed for each 15-minute time interval over the seven-day period. Typical daily traces for Site 1 and Site 2 are attached in Appendix C.

The noise measuring instrumentation used for the project is summarised below in Table 4-1.

Table 4-1 - Sound Level Instrumentation

TYPE OF MEASUREMENT	INSTRUMENT	SERIAL NUMBER	CALIBRATION DATE
Attended	Rion NA-29 Sound Level Meter	00690619	8 th January 2003
Attended & Automated	Rion NC-73 Sound level Calibrator	10302481	8 th January 2003
Automated	ARL EL315 Noise Logger	15-299-453	22 nd November 2002
Automated	ARL EL315 Noise Logger	15-199-414	17 th September 2002

4.2 ATTENDED NOISE MEASUREMENTS

Attended noise measurements were taken at 'Wyrilla' and 'Pine Grove', and also at the proposed power station site on the 11 September 2003. The noise levels measured over 15 minutes are shown in Table 4-2 below. The associated spectra are attached in Appendix E

Table 4-2 – Attended Noise Measurements

Measure	Sound Pressure Level (dB(A))			
	Wyrilla (10:00am)	Pine Grove (11:00am)	Power Station Site (11:30am)	Pearce (12:00pm)
L _{eq}	39	37	49	40
L _{max}	67	63	76	62
L ₁₀	44	39	27	42
L ₉₀	33	29	24	31

Noise from traffic is generally considered to be represented by the L_{eq} descriptor. The site of the proposed power station was the only one of the attended noise measurement locations where passing traffic was audible, resulting in an L_{eq} of 49dB(A) from the four car pass-bys during a 15 minute measurement period.

4.3 PROCESSING MEASURED AMBIENT NOISE DATA

The raw L_{90} measured data was processed in accordance with the requirements of the NSW Department of Environment and Conservation in their "NSW Industrial Noise Policy". This document sets out a method of determining a 'rating background level' (RBL) on which to base intrusiveness criteria. The method accounts for the variation of background noise levels by nominating a reference level that is exceeded for at least 90% of a measured time period.

In this method, an 'assessment background level' (ABL) is determined from the tenth percentile L_{90} result for each identified period (day, evening or night), for each day of measurement. This corresponds to the 15 minute L_{90} result that was exceeded by 90% of the measured L_{90} levels in each period. The 'rating background level' of each day, evening or night period is the median result of the assessment background levels over all measurement days. The results from the noise logging at Pine Grove and Wyrilla are presented in Table 4-3 below. The Industrial Noise Policy states that where the median ABL is less than 30 dB(A), the RBL is taken to be 30 dB(A).

Table 4-3 – SUMMARY OF MEASURED NOISE DATA

NSW DEC Industrial Noise Policy Calculation Method						
	ABL - 10th percentile L_{90}					
	'Wyrilla'			'Pine Grove'		
	Day	Evening	Night	Day	Evening	Night
	7am-6pm	6pm-10pm	10pm-7am	7am-6pm	6pm-10pm	10pm-7am
Day 1	24.8	29.5	25.0	26.4	27.9	26.7
Day 2	26.7	24.7	24.2	29.7	27.9	26.0
Day 3	25.7	33.8	26.1	29.5	28.6	25.7
Day 4	36.9	27.2	30.2	34.0	28.0	26.4
Day 5	37.0	24.5	30.2	39.0	27.3	29.7
Day 6	32.0	31.2	27.9	35.2	30.1	29.3
Day 7	29.0	25.4	25.4	32.3	28.3	26.1
Day 8	27.6			29.3		
Median ABL	28.3	27.2	27.0	31.0	28.0	26.4
RBL	30.0	30.0	30.0	31.0	30.0	30.0

The ABL of ambient noise was below 30 dB(A) on numerous occasions at the two sites. The corresponding RBL at both sites is 30 dB(A) during the evening and night. The daytime RBL was 30 and 31 dB(A) respectively at the two sites

Pine Grove and Wyrilla can be assumed to have background levels typical of other residences in the Uranquinty area. The minimum RBL Rating Background Level of 30 dB(A) applied by the Environment Protection Authority, and its use at the other receivers represents a justifiable but conservative approach.

Accordingly, an RBL of 30 dB(A) has been applied throughout the area surrounding the site.

5. ENVIRONMENTAL NOISE EMISSION CRITERIA

5.1 INDUSTRIAL NOISE

The New South Wales DEC sets out guidelines for controlling industrial noise in the "NSW Industrial Noise Policy" (2000). According to the policy, the intrusiveness of an industrial source is generally considered acceptable if the continuous level of noise from the source does not exceed the background noise level by more than 5 dB(A). The level of noise emission from the source is assessed from the equivalent continuous A-weighted noise level (represented by the L_{Aeq} descriptor) measured over a 15-minute period. To account for the variation of background noise levels, a 'rating background level' is used (as defined in Section 4 above), from data measured in the absence of the source. This intrusiveness criterion is summarised as follows:

$$L_{Aeq\ 15\ minute} \leq \text{rating background level plus 5}$$

Where ambient noise levels in an environment are already quite high, the Industrial Noise Policy defines maximum L_{Aeq} noise levels for various receiver types in Table 2.1 on page 16 of the INP. The relevant parts of this table are reproduced in Table 5-1 below.

Table 5-1 – Amenity Criteria

Type of Receiver	Indicative Noise Amenity Area	Time of Day	L_{Aeq} noise level dB(A)	
			Acceptable	Maximum
Residence	Rural	Day	50	55
		Evening	45	50
		Night	40	45
	Suburban	Day	55	60
		Evening	45	50
		Night	40	45
School Classroom – internal		(a)	35	40
Hospital Ward	Internal		35	40
	External		50	55
Passive Recreation Area (National Park)		(b)	50	55
Active Recreation Area eg playground,		(b)	55	60
Commercial Premises		(b)	65	70

(a) Noisiest one-hour period when in use

(b) When in use

As the background noise levels in the Uranquinty area are low, the maximum noise levels set out above will not affect the intrusiveness criteria. Table 5-2 below summarises the intrusiveness criterion for the site, based on the NSW Industrial Noise Guidelines and the measured background levels.

Table 5-2 – Intrusiveness Criterion

Period	Time	Rating Background Level (RBL) (dB(A))		Criterion (RBL + 5)
		Wyrilla	Pine Grove	
Day	7am – 6pm	30	31	35
Evening	6pm – 10pm	30	30	35
Night	10pm – 7am	30	30	35

The 35 dB(A) intrusiveness criterion can be assumed to apply at all identified sensitive receivers.

5.1.1 Modifying Factor Adjustments

Where a noise source contains certain characteristics, such as tonality, impulsiveness, intermittency, irregularity or dominant low-frequency content it can cause greater annoyance than another noise of the same noise level. Section 4 of the Industrial Noise Policy discusses the 'Modifying factor' adjustments that should be applied to the intrusiveness criterion in these circumstances.

Low frequency noise is defined as noise containing major components within the low frequency range (20Hz – 250Hz) of the frequency spectrum. As turbine noise is generally characterised mostly by mid-frequency noise, an adjustment for low frequency noise will not be required.

Impulsive noise is defined as noise having a high peak of short duration or a sequence of such peaks. *Intermittent noise* is defined as noise where the level suddenly drops to that of the background noise several times during the assessment period, with a noticeable change in the noise levels of at least 5dB(A). The turbines are expected to run continuously with a steady noise output. Noise emission from the turbines is not characterised by large modulations in sound power output. The noise emission can therefore be classified as continuous noise.

Tonal noise is defined as noise containing a prominent frequency and characterised by a definite pitch. Tonality is not generally characteristic of turbine operation. However, tonality can be demonstrated in noise emission from some turbine casings or exhaust/intake stacks due to blade-pass frequencies. In this case, the following modifying factor corrections should be made:

Table 5-3 Modifying Factor Corrections

Factor	Assessment/ measurement	When to apply	Correction	Comments
Tonal Noise	One-third octave or narrow band analysis	Level of one-third octave band exceeds the level of adjacent bands on both sides by: -5 dB or more if the centre frequency of the band containing the tone is above 400Hz -8 dB or more if the centre frequency of the band containing the tone is 160 to 400Hz inclusive -15 dB or more if the centre frequency of the band containing the tone is below 160Hz	5 dB	Narrow-band frequency analysis may be required to precisely detect occurrence.

The intrusiveness criterion for noise emission from the power plant where tonality is demonstrated would therefore be reduced from 35 dB(A) in Section 5.1 above to 30dB(A).

5.2 SLEEP DISTURBANCE

In the event that the operating hours of the power plant are extended into the night time period there could potentially be sleep disturbance reactions at nearby residences. The following sections summarise the relevant criteria:

5.2.1 NSW DEC Industrial Noise Policy

Section 2.2 of the Industrial Noise Policy states that "Meeting the acceptable noise levels in Table 2.1 will protect against noise impacts such as speech interference, community annoyance and, to some extent, sleep disturbance."

Table 2.1 defines the acceptable external L_{Aeq} noise level for rural areas of 40 dB(A) at night.

5.2.2 World Health Organisation

The World Health Organisation (WHO) has summarised research on sleep disturbance associated with road traffic, rail and aircraft pass-by noise. They conclude that

If negative effects on sleep are to be avoided the equivalent sound pressure level should not exceed 30 dB(A) indoors for continuous noise. If the noise is not continuous, sleep disturbance correlates best with L_{Amax} and effects have been observed at 45dB(A) or less

An indoor L_{eq} noise level of 30 dB(A) is equivalent to an external noise level of 40 dB(A) assuming an outdoor to indoor noise reduction of 10 dB(A). This is equivalent to the NSW DEC criterion of 40 dB(A) in Section 5.2.1 above.

5.2.3 Griefahn

Griefahn [Acoustics Australia vol 20 No 2 August 1992 pp43-47] investigated sleep disturbance and awakenings due to transportation noise.

For continuous noises, Griefahn reviewed research observed alterations in sleep in quiet rooms and during continuous noises. Various studies found that sleep alterations occurred at equivalent sound pressure levels of between 36 and 45 dB(A). This was classified as the critical range for sleep disturbance

For intermittent noise, her research reviewed previous experimental studies on sleep disturbance mainly from aircraft with a small number of studies on truck noise and impulsive noise. The number of intermittent events was examined in conjunction with the L_{max} levels and the number of awakenings occurring. The reported results were compiled along with her own experimental studies and used to develop a noise dose vs. response curves.

The study showed that generally people are more disturbed by intermittent than continuous noises. Griefahn found that equivalent sound pressure levels are not generally suitable for the prediction of sleep disturbances from intermittent events, and that upper limits should be determined for the different acoustic situations separately. She defines the limit between continuous and intermittent noises by a modulation depth of 10dB(A).

5.2.4 Summary

The noise associated with turbine noise is not characterised by large modulations in sound power output, and can therefore be considered continuous noise.

The nominated external L_{eq} noise criterion of 40 dB(A) is greater than the daytime and night-time intrusiveness criterion of 35dB(A) as defined in Section 5.1 above for continuous noise emission from the plant. Accordingly, where the intrusiveness criterion is met at nearby residences, the sleep disturbance criteria would also be met and does not require additional noise control measures from the power plant.

5.3 CONSTRUCTION SITE NOISE

The "NSW Industrial Noise Policy" (2000) does not specify particular noise emission criteria for noise made during construction activities. However, this document superseded an earlier NSW Department of Environment and Conservation document entitled "Environmental Noise Control Manual" (ENCM) (1993). The ENCM contained a number of noise control guidelines that were not updated nor revised in the Industrial Noise Policy. Chapter 171 of the ENCM covered the acceptable noise emission objectives from a construction site. The following objectives are recommended:

CHAPTER 171: NOISE CONTROL GUIDELINE – CONSTRUCTION SITE NOISE

Level Restrictions

(i) Construction period of 4 weeks and under:

The L_{10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 20 dB(A) .

(ii) Construction period greater than 4 weeks and not exceeding 26 weeks

The L_{10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 10 dB(A) .

Time Restrictions

- Monday to Friday. 7am to 6pm
- Saturday, 7am to 1pm if audible on residential premises, otherwise 8am to 1pm
- No construction work to take place on a Sunday or Public Holiday.

Silencing

All possible steps should be taken to silence construction site equipment. It is particularly important that silenced equipment be used on road or rail works where 24 hour operation is necessary.

These objectives apply particularly to non-scheduled premises such as commercial buildings, where a long construction time is not likely. The construction of Uranquinty power station is scheduled over distinct two phases, the initial two turbines will be constructed in Phase 1 and the final two are due to be constructed in Phase 2. The duration of construction of either phase is not considered "long" and accordingly the criteria outlined above are applicable. The objective for construction activities which take longer than 6 months are to be covered by a background + 5 dB(A) noise objective.

The loudest stages of construction are the site preparation and earth works , which are likely to involve the use of dozers, loaders, and excavators etc to clear and prepare the site. Site preparation and earthworks should take less than one month. The overall length of the construction period will be greater than 26 weeks, and as such the objective for noise emission from construction will be background + 5 dB(A), or 35dB(A).

It is not feasible or reasonable to meet a 35 dB(A) construction noise objective using either earth moving equipment or some construction activities such as hammering or some hand-held power tools. Where this objective cannot be met, all reasonable and feasible measures to reduce noise emission from the construction site will be employed.

5.4 TRAFFIC NOISE

5.4.1 Noise Annoyance

The New South Wales Department of Environment and Conservation has published a document entitled “Environmental criteria for road traffic noise” (ECRTN) which sets out guidelines for assessing the noise impact created by increased traffic for a proposed development.

Roads are classified in a number of functional categories:

- *arterial roads (including freeways)* which carry predominantly through-traffic from one region to another, forming principal avenues of communication for urban traffic movements
- *sub-arterial roads*, which connect the arterial roads to areas of development and carry traffic from one part of a region to another. They may also relieve traffic on arterial roads in some circumstances
- *collector roads*, which connect the sub-arterial roads to the local road system in developed areas..
- *local roads*, which are the sub-divisional road with a particular developed area. These are used solely as local access roads.

The Uranquinty Cross Road runs past the proposed power station site and will provide the main access to the plant. This road could be considered as either a collector road or a local road. The road traffic noise criteria for proposed road or residential land use developments are set out in Table 1 of the ECRTN. The sections relevant to the Uranquinty Cross Road are summarised below in Table 5-4.

Table 5-4 – Road Traffic Noise Criteria for residential land use developments

Type of Development	Criteria (dB(A))		
	Day (7am-10pm)	Night (10pm – 7am)	Additional
8. Land use developments with potential to create additional traffic on collector road.	$L_{Aeq(1hr)}$ 60	$L_{Aeq(1hr)}$ 55	Traffic arising from the development should not lead to an increase in existing noise levels of more than 2 dB
13. Land use developments with the potential to create additional traffic on local roads	$L_{Aeq(1hr)}$ 55	$L_{Aeq(1hr)}$ 50	

5.4.2 Sleep Disturbance

Appendix B of ECRTN discusses the results of recent research into sleep disturbance due to traffic noise, and concludes the following:

- *Maximum internal noise levels below 50-55dB(A) are unlikely to cause awakening reactions*
- *One or two noise events per night, with maximum internal noise levels of 65-70dB(A) are not likely to affect health and wellbeing significantly.*

Given that the number of staff required for normal plant operation is 4 – 5 people, no more than 1 to 2 vehicle passbys can generate internal maximum noise levels of 65-70 dB(A)

within nearby affected dwellings. This is equivalent to external noise levels of 75-80 dB(A) assuming an outdoor to indoor noise reduction of 10 dB(A).

6. METEOROLOGY CONDITIONS AT WAGGA WAGGA

Katestone Environmental Pty Ltd have gathered and reported on the meteorological data from Wagga Wagga Airport in their report dated 10 September 2003. They have processed this data and used it as input data in the TAPM atmospheric modelling to determine the predominant meteorological conditions at the site.

There are six distinct atmospheric classes typically used to represent atmospheric stability. These are called Pasquill Stability Classes and vary between Class A and Class F. Each of these Classes represent a differing ability of sound to propagate across terrain.

- Class F is characterised by a temperature inversion of eg 3°C/100m and wind speeds of less than 3 m/s. It assists the propagation of noise and can increase the noise impact at a site. Class F typically occurs at night when the ground is cooler than the surrounding air.
- Class D involves little or no wind and no temperature inversion. It is considered neutral to the transmission of sound.
- Classes A & B are characterised by wind blowing from receiver to source and/or a temperature lapse (ie "inverted" temperature inversion) which reduces the impact of noise emissions. This generally occurs during the day.

The typical worst-case noise emission is represented by either a moderate wind blowing from source to receiver and/or by a Pasquill Stability Class F. The percentage occurrence of the different Pasquill Stability Classes forecast by Katestone Environmental at the site is summarised in Table 6-1 below.

Table 6-1: Percentage of stability classes calculated for Wagga Wagga Airport for the period from 1 January 1998 to 31 December 1998.

Season	Time of day	Percentage of each stability class (%)					
		A	B	C	D	E	F
Summer	Midnight to 6 am	0.0	0.0	0.0	35.6	39.8	24.6
	6 am to midday	19.1	30.9	30.4	19.6	0.0	0.0
	Midday to 6 pm	12.0	23.3	40.4	24.3	0.0	0.0
	6 pm to midnight	0.0	0.0	0.0	36.9	32.0	31.1
Autumn	Midnight to 6 am	0.0	0.0	0.0	19.9	46.6	33.5
	6 am to midday	16.1	24.3	23.6	33.9	0.7	1.4
	Midday to 6 pm	12.9	19.4	24.6	40.0	1.4	1.6
	6 pm to midnight	0.0	0.0	0.0	19.7	32.2	48.0
Winter	Midnight to 6 am	0.0	0.0	0.0	35.9	43.3	20.8
	6 am to midday	4.5	17.8	21.7	50.4	4.0	2.2
	Midday to 6 pm	2.2	16.35	18.3	55.1	3.4	4.5
	6 pm to midnight	0.0	0.0	0.0	33.3	35.3	31.3
Spring	Midnight to 6 am	0.0	0.0	0.0	31.0	46.7	22.3
	6 am to midday	16.8	24.7	31.5	26.9	0.0	0.0
	Midday to 6 pm	9.2	16.8	27.5	46.5	0.0	0.0
	6 pm to midnight	0.0	0.0	0.0	34.4	30.4	35.2

Wind conditions for the site were assessed using the Katestone supplied wind roses in Appendix F. A moderate wind will increase the level of noise impact from a noise source in the downwind direction. However at higher wind speeds, the wind and its effect on vegetation will also increase the background noise level.

The worst-case noise intrusion scenario is defined by the NSW DEC as involving a wind speed of approx 3 m/s, blowing from the noise source towards the receiver/s. Above that speed, the ambient noise generated by the wind itself starts to mask any increase in intrusive noise from the nearby industry etc.

The meteorological data demonstrated that wind, when present, blew primarily from East to West and from West to East at the Wagga Wagga site. Winds from both directions were well represented at different times of the day and in all four seasons. As the nearest and potentially most affected receivers are located both to the East and to the West of the site, both of these scenarios have been modelled to determine the daytime power station noise impact.

Appendix E also demonstrates that both Easterly and Westerly winds can occur during the night hours of 6pm to 6am, when Class F temperature inversions may exist. The combination of a Stability Class F with a light wind towards a receiver assists the propagation of sound and increases the resultant noise level experienced at the receiver. This has been modelled for night-time noise propagation.

In order to assess the worst-case noise level experienced at each receiver the modelled meteorological conditions are summarised below:

- Neutral weather conditions (Class D)
- Pasquill Stability Class D and Easterly Wind, 3m/s
- Pasquill Stability Class D and Westerly Wind, 3m/s
- Pasquill Stability Class F and 3m/s Easterly wind
- Pasquill Stability Class F and 3m/s Westerly wind.

7. NOISE MODELLING

7.1 NOISE EMISSION

7.1.1 Power Station Noise Emission

The gas-fired power station plant for Uranquinty is to be supplied as a complete package. The preferred supplier is Siemens and would incorporate V94.2 gas turbines, related transformers and other auxiliary equipment. Siemens are capable of incorporating noise guarantees for their equipment and can design their plant to meet set noise limits.

Siemens have supplied spectral Sound Power data for an unsilenced V94.2 turbine. They have no spectral data available for silenced plant. For this assessment gas turbine data for both silenced and unsilenced plant has been used from another supplier; Solar Turbines. Their Mars plant is rated at 11 MW which is smaller than the 150 MW required for this project. Nevertheless the overall noise level and spectral data for the unsilenced Mars units are equivalent to the Siemens unsilenced data (refer to the spectral comparison in Appendix C).

The incorporation of attenuators will alter the noise spectrum of both the Mars and Siemens units in a similar and predictable way. These data are presented in Table C-2 in Appendix C and have been used in this assessment. Using these spectra and overall levels enabled the appropriate noise limits to be determined at the boundary of the site. These criteria will be used by the power unit supplier in-house to select appropriate attenuators and treatments for the power generation plant..

Noise emitted through the casing was modelled as a point source 7m above the ground. The spectrum used was typical of a Mars 100 enclosed turbine.

The inlet noise was modelled as a point source located 7m above the ground. A 2-D directivity typical of an opening was applied in the horizontal plane (shown in Appendix C). The noise spectrum assumed that silencing had been applied.

It has been assumed that the exhaust stack is 30m high. Noise emission through the exhaust stack was modelled as a point source 30m above the ground, with a spectrum typical of the Mars 100 turbine exhaust outlet with a silencer included. The predicted noise emission from the equipment is summarised below in Table 7-1. Full spectral data is provided in Appendix C.

Table 7-1 – Sound Power Noise emission spectra for Uranquinty Power Plant

Source	Overall dB(A)	Octave Band Centre Frequency (Hz)							
		63	125	250	500	1000	2000	4000	8000
Turbine inlet noise	115	121	115	110	93	78	76	115	115
Turbine casing breakout	105	110	105	109	103	98	94	97	83
Turbine exhaust stack	102	122	116	104	94	86	78	59	59

7.1.2 Construction Site Noise Emission

Construction of the site will take less than a year and will consist of a number of different stages:

1. Clearing of vegetation, removal and stockpiling of topsoil and bulk earthworks
2. Establishing and preparing concrete foundations for major plant and buildings
3. Construction of buildings
4. Pipe line route excavation and construction

Construction will involve the use of dozers, loaders and excavators at different times to clear, level and prepare the site for further works. The use of this equipment generates moderate levels of noise, which has the potential to cause annoyance at nearby residences. The site preparation and earthworks activities are expected to produce the most noise emission. Noise emission from this stage of construction was modelled by assuming a maximum of two dozers, or a dozer, loader and excavator all operating at once. The noise emission from two Caterpillar D8 Dozers measured previously by Bassett Acoustics was used, for a total sound power emission of 122 dB(A). This spectrum is shown in Table 7-2 below.

Table 7-2: Sound Power Emission from Caterpillar D8 Dozer

Source	Overall dB(A)	Octave Band Centre Frequency (Hz)								
		31.5	63	125	250	500	1000	2000	4000	8000
Caterpillar D8 Dozer	119	79	87	95	111	114	114	110	100	95

Construction is proposed between 7am and 6pm, and as such Pasquill Stability Class F meteorological conditions are not present during this noise emission. The following conditions were therefore modelled for construction site noise emission:

- Neutral weather conditions - Pasquill Stability Class D
- Pasquill Stability Class D and Easterly Wind, 3m/s
- Pasquill Stability Class D and Westerly Wind, 3m/s

7.2 MODELLING METHODOLOGY

In order to determine the extent of noise emission from the site a 3D computer noise model has been developed. This model was developed using SoundPLAN 6.0 in conjunction with topographic information provided by Environmental and Licensing Professionals. SoundPLAN is a modelling package that is accepted and endorsed by numerous agencies Australia-wide, including the NSW Environment Protection Authority. The model is also widely accepted worldwide.

The modelling can account for the following site conditions:

- Ground topography and the extent of ground absorption from different surfaces.
- The prevailing meteorological conditions, including the presence of temperature inversions and adverse winds.
- The noise emission of each source as well as its location, elevation, orientation, shape and size.
- The location and elevation above local ground level of all sensitive receptors.
- Screening from any enclosures, barriers, earth berms, buildings or hills.
- Attenuation due to distance and atmospheric absorption.
- The increase in noise level due to reflections from nearby façades and reflective objects.

The output of the modelling can be presented in either graphical format or tabular format.

For the noise assessment of the planned Uranquinty power station, sound power data from Section 3 was used, assuming the worst-case scenario of all four turbines operating at full capacity. Noise emission during construction of the plant was assessed by modelling two Caterpillar D8 Dozers working to clear and level the land. The sound power data from Section 3 was used.

Noise level contours were determined for typically adverse weather conditions at the site for each stage as described in Section 5.4. The results of the modelling are shown in Section 8.

8. PREDICTED NOISE EMISSIONS

Noise levels in the area surrounding the site have been predicted using SoundPLAN 6.0 as described in Section 7.2 above. This model is used throughout Australia and is well recognised and accepted for its accuracy and validity. Noise levels experienced at various residences in the area vary according to the terrain between the plant and the receiver, the distance from the plant to the receiver and the meteorological conditions modelled.

8.1 PLANT OPERATION

The predicted noise levels at each residence, based on the modelled data outlined in Section 7.1 are summarised in Table 8-1 below and in Figure 8-1 to Figure 8-3.

The noise modelling used a noise emission level of 67 dB(A) at 100m per turbine and associated packaged plant or 73 dB(A) at 100 m from all four plant .. The emitted level exceeded the criterion under certain conditions as shown in **Bold** in the Table. Given that the maximum exceedance was 5 dB(A) (ie 40 dB(A) noise level at Pine Grove under westerly 3m/s wind) then a noise emission level of 62 dB(A) from each turbine at 100 m is required to meet the nominated acoustical criteria.

The following scenarios have been presented as they demonstrate maximum noise impact during typically adverse weather conditions.

- Normal Plant Operation - Pasquill Stability Class F & 3m/s Easterly wind (Figure 8-1)
- Normal Plant Operation - Pasquill Stability Class F & 3m/s Westerly wind (Figure 8-2)
- Normal Plant Operation – 3 m/s Westerly wind (Figure 8-3)

Table 8-1 – Noise Levels at Residences during Plant Operation using a Source Level of 67 dB(A) at 100m from each Turbine

Receiver	Plant Operation L_{eq} noise emission –dB(A)			
	Criterion – dB(A)	Weather Condition		
		Class D W 3m/s	Class F E 3m/s	Class F W 3m/s
Churchill Square	35	27	33	30
Metcalfe	35	32	38	33
Pearce	35	31	37	32
Pine Grove	35	41	38	41
The Pines	35	33	30	33
Tandara	35	31	25	31
Uranquinty	35	27	21	27
Wallace	35	39	35	39
The Wardrobe	35	39	36	39
Weemont	35	29	24	29
Wyrilla	35	26	32	27

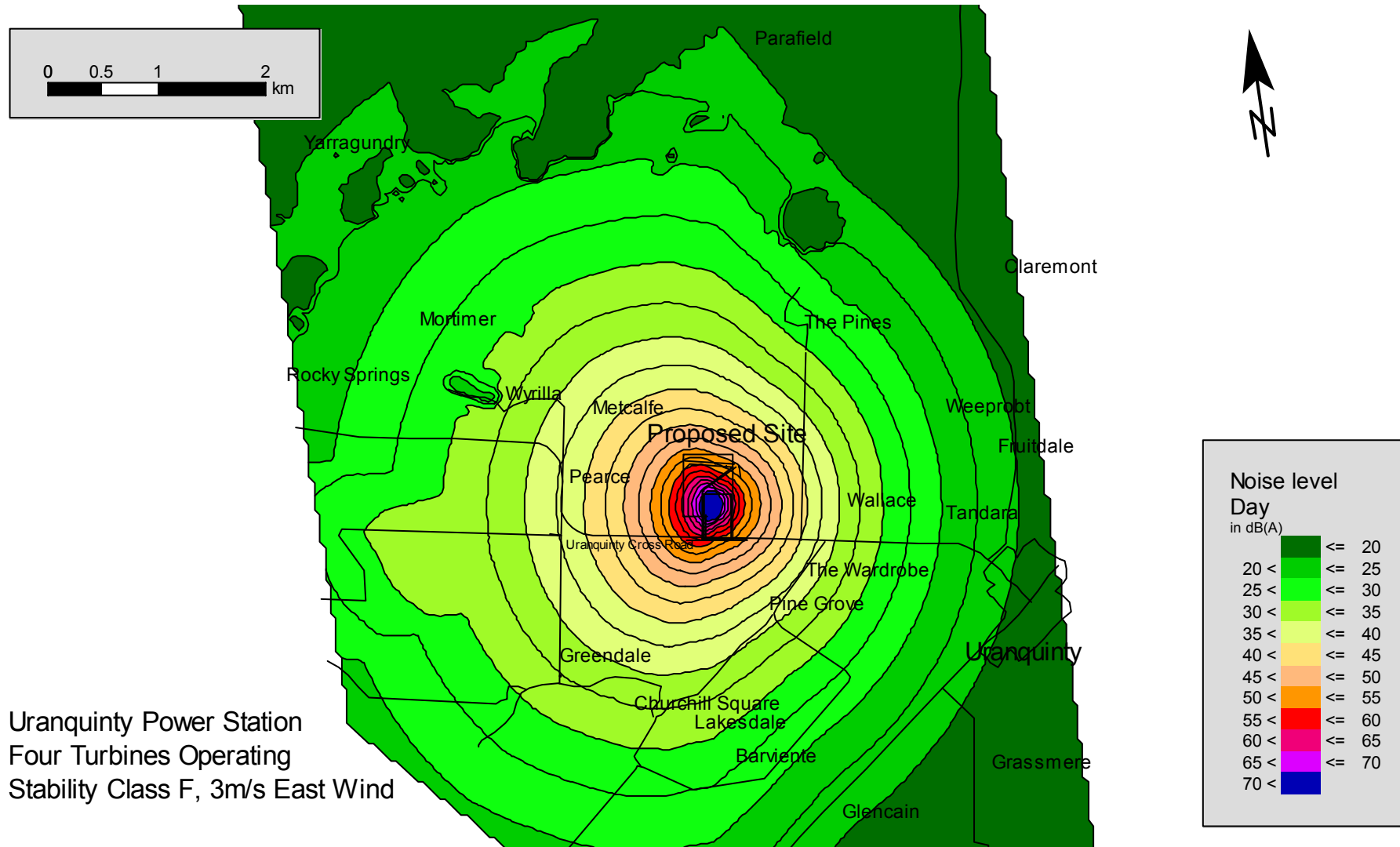


Figure 8-1: Four Turbines operating with Pasquill Stability Class F conditions and 3m/s wind from the East.

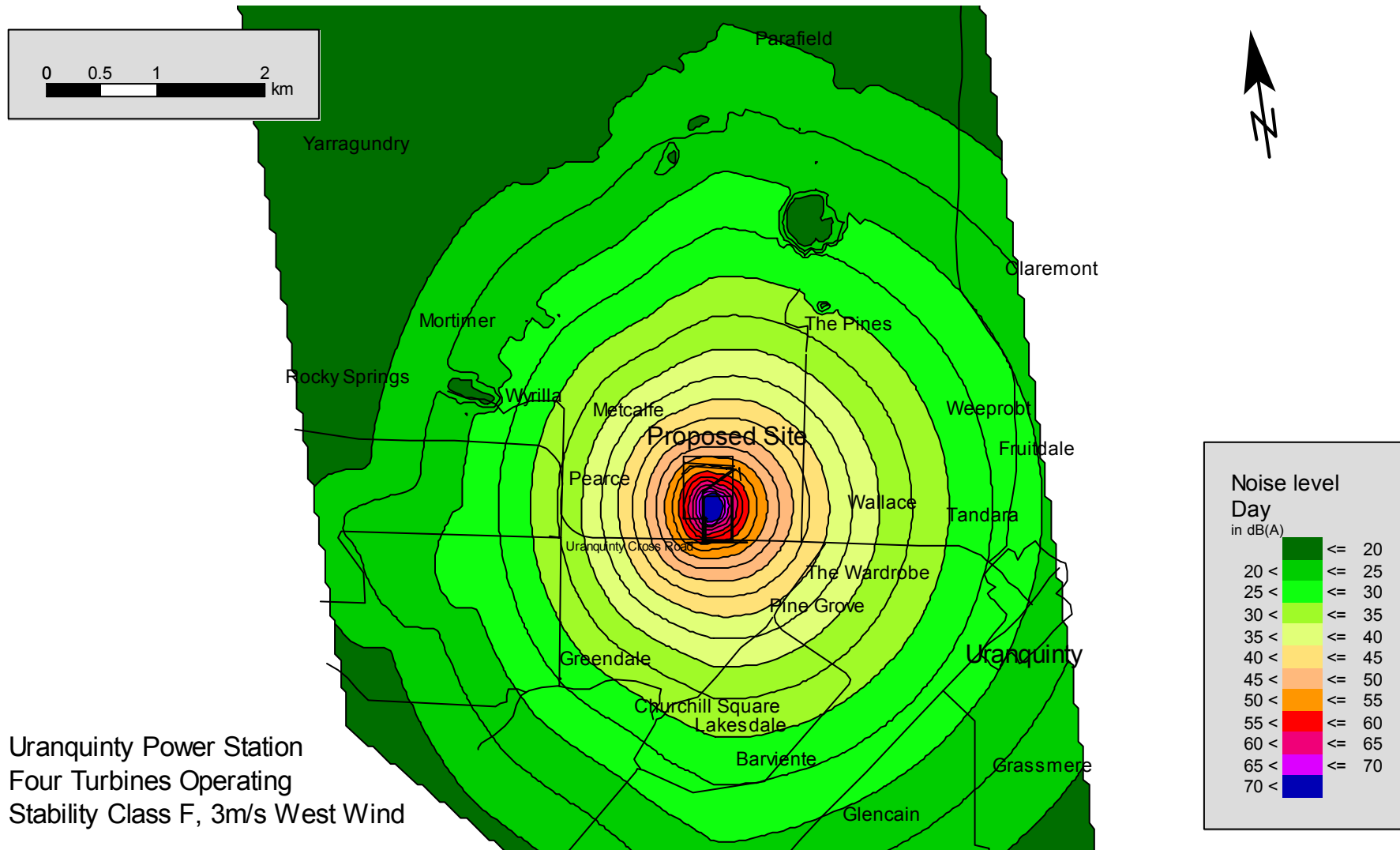


Figure 8-2: Four Turbines operating with Pasquill Stability Class F conditions and 3m/s wind from the West

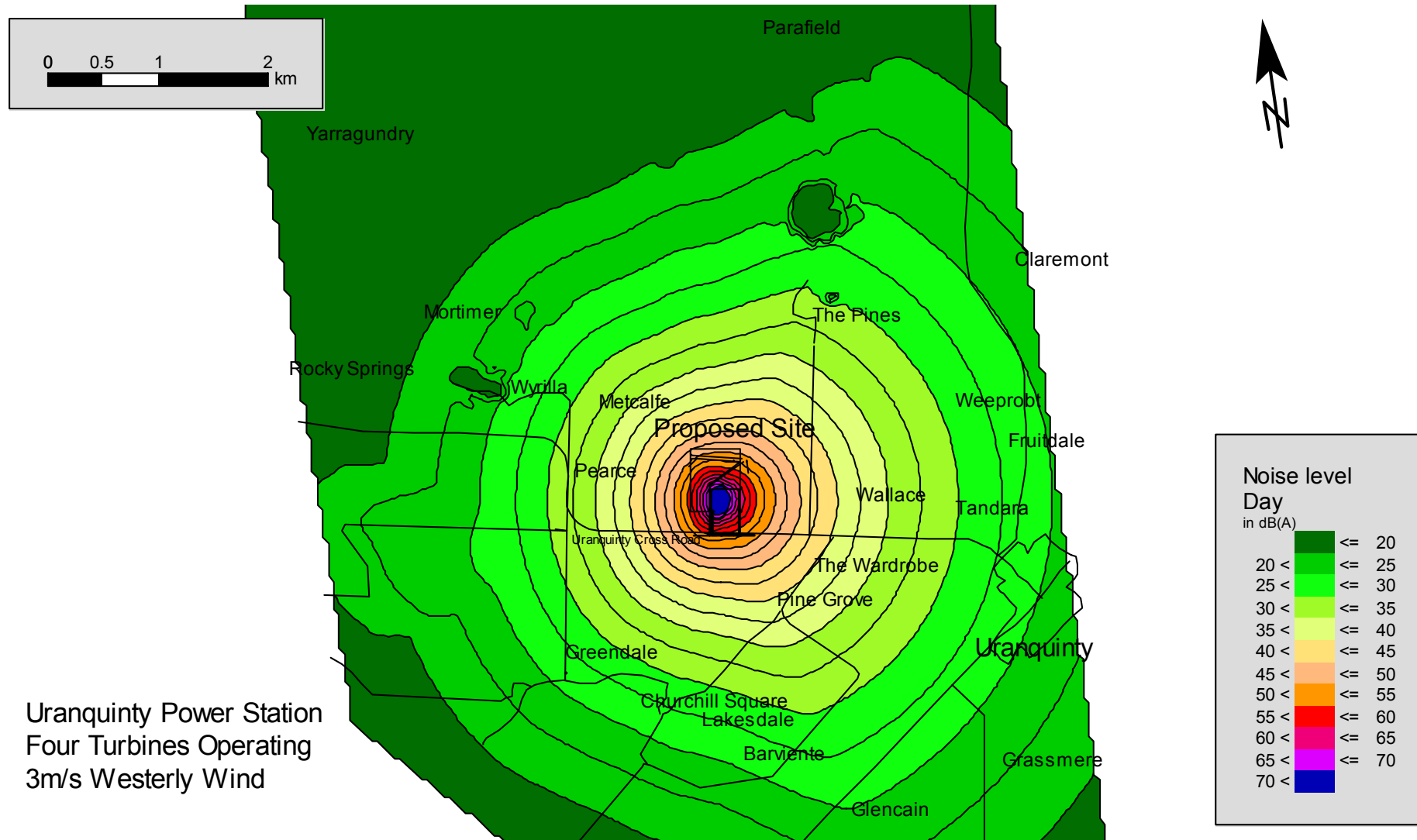


Figure 8-3: Four Turbines operating, 3m/s wind from the West

8.2 CONSTRUCTION NOISE

The predicted noise levels at each residence, based on the modelled data outlined in Section 7.1 are summarised in Table 8-1 below. The predicted noise emission levels are also presented graphically in Figure 8-4 to Figure 8-5

The noise modelling was based on two Caterpillar dozers with a combined sound power level of 122dB(A). The emitted level exceeded the 35dB(A) objective under certain conditions as shown in **Bold** in the Table. Given that the maximum exceedance was 11 dB(A) (ie 46 dB(A) noise level at Pine Grove under westerly 3m/s wind) then a sound power level of 111 dB(A) from all construction activities would be required to meet the nominated acoustical objective..

The following scenarios have been presented as they demonstrate maximum noise impact during typically adverse weather conditions.

- Construction Stage – Neutral Daytime conditions (Figure 8-4)
- Construction Stage – Daytime conditions and 3m/s Westerly wind (Figure 8-5)

Table 8-2 – Noise Levels at Residences during Plant Construction

Receiver	Construction Stage Leq Noise Emission – dB(A)		
	Objective dB(A)	Weather Condition	
		Neutral No wind	Class D W 3m/s
Churchill Square	35	33	29
Metcalfe	35	38	31
Pearce	35	37	30
Pine Grove	35	42	46
The Pines	35	35	40
Tandara	35	32	38
Uranquinty	35	28	34
Wallace	35	39	45
The Wardrobe	35	40	45
Weemont	35	31	37
Wyrilla	35	32	25

Noise from other construction activities such as hand-held power tools is predicted to be approximately 4-11 dB(A) quieter at the nearest receivers than the plant outlined above. Refer to Table 10-3 for equipment noise levels.

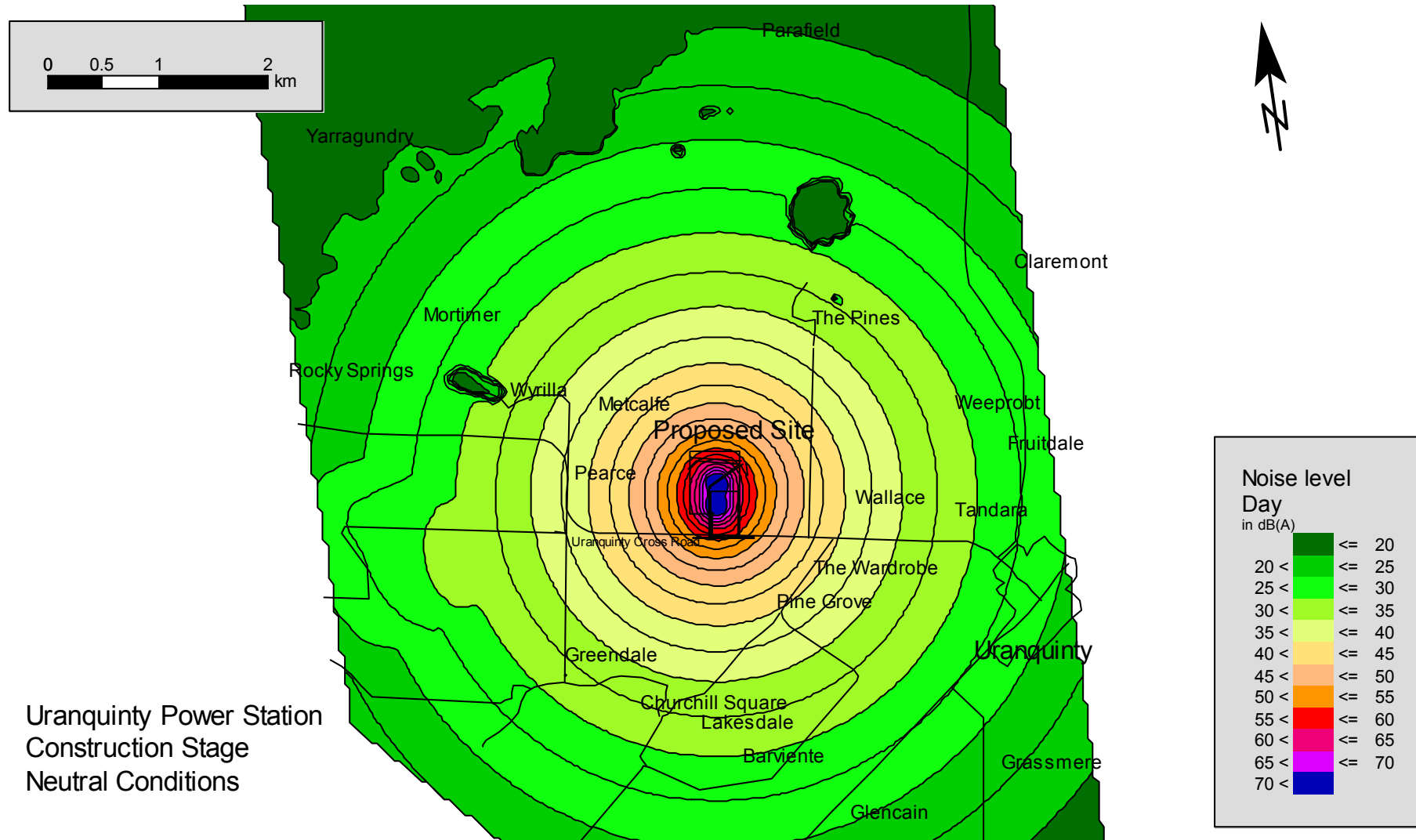
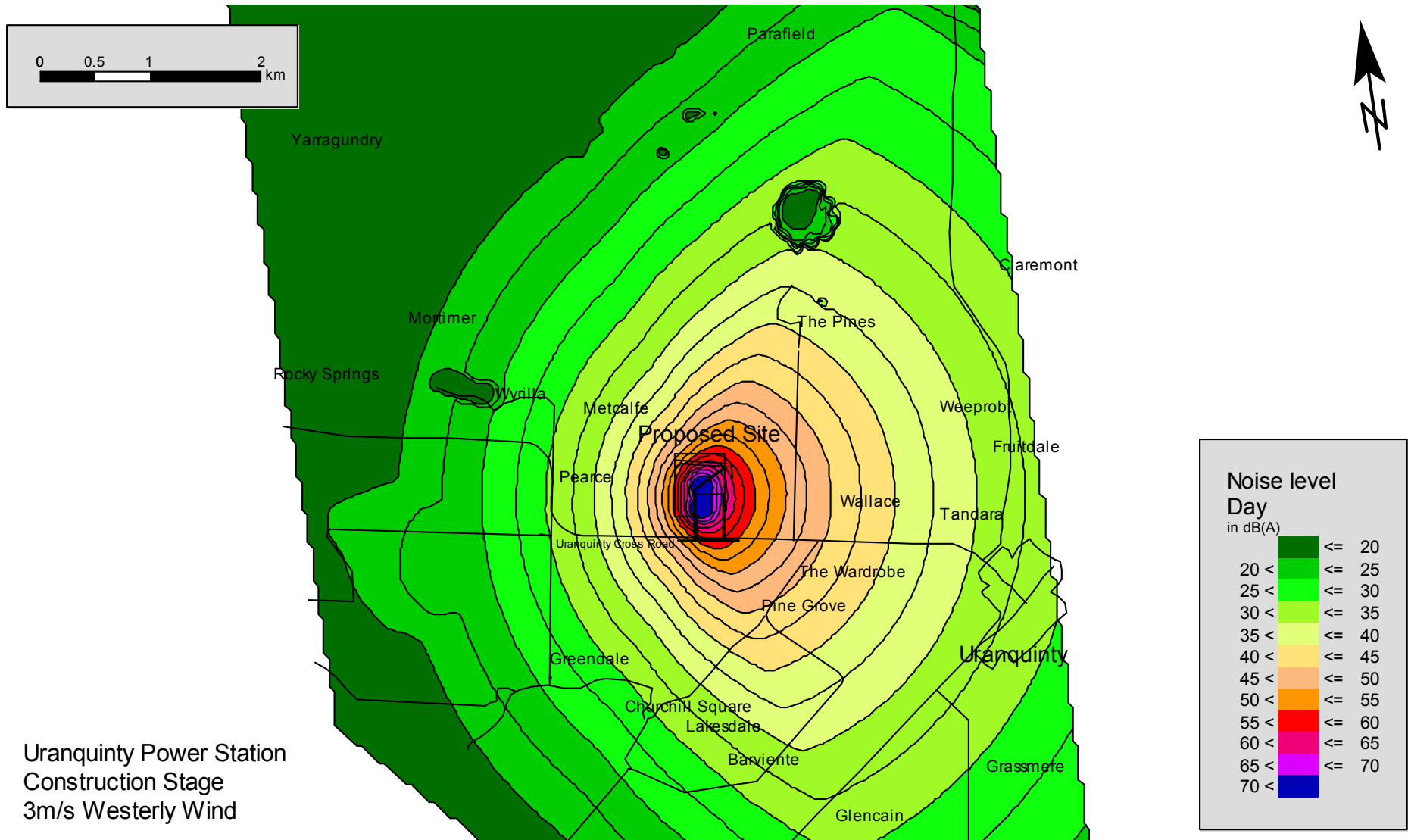


Figure 8-4: Construction Stage - Neutral Weather Conditions

Figure 8-5: Construction Stage – 3m/s wind from the West



8.3 TRAFFIC NOISE

8.3.1 Operation

Data received from the Wagga Wagga council indicates that currently around 100 vehicles per day pass along the Uranquinty Cross Road, with approximately 2% of these heavy vehicles. It is typically assumed that 10% of the total daily traffic flow occurs each hour of the peak morning and afternoon periods. Where the daily traffic flow is only 100 vehicles per day, this translates to 10 vehicles per hour. There is no information available whether this assumption is an over or underestimate of the peak hourly traffic movements. Nevertheless, 10 vehicles per hour, and 100 vehicles per day are both considered to be negligible volumes of traffic flow. ,

Noise measurements were taken 20m from the road at the power station site. The noise level from four car pass-bys in a 15 minute period was $L_{eq, 15\text{minute}}$ 49dB(A). This is equivalent to a 1 hour L_{eq} of 49 dB(A) where $(4 \times 4 =)$ 16 vehicles per hour pass. Based on this measurement, the predicted $L_{eq1\text{ hour}}$ for 10 vehicles per hour passing the site is 47 dB(A).

Heavy vehicles make up two percent of the traffic on the Uranquinty Cross Road, corresponding to two heavy vehicle trips per day. A typical truck passing by the site would result in an increased L_{eq} noise level of 65-70dB(A) for around 10 seconds. It could be assumed that one of the heavy vehicle trips occurs during the peak traffic period. If the ambient L_{eq} level for the remaining time is 47dB(A), the ambient L_{eq} for the peak period including a single heavy vehicle trip would not be greater than 49 dB(A).

The measured daytime ambient L_{eq} consistently reached over 50 dB(A) at both the long-term noise survey locations of Pine Grove and Wyrilla. These residences are significantly further (500 m & 300m respectively) from the road and accordingly the overall traffic noise L_{eq} at these sites would be lower than the predicted 49 dB(A) at 20 m from the road, ie 35 dB(A) and 37 dB(A) respectively,. Nevertheless the 50+ dB(A) L_{eq} ambient levels indicate that other noises in the area control the ambient L_{eq} levels rather than the traffic in the area.

The Pearce residence is the nearest receiver to the road and potentially most affected by traffic noise. It is approximately 20m from the roadside kerb. The ambient $L_{eq, 15\text{minute}}$ noise measurement at this residence was 40dB(A) with no car pass-bys. The predicted ambient $L_{eq1\text{ hour}}$ with ten vehicles passing the site would be (49 dB(A).

We have assumed a worst-case scenario where all 7 vehicles associated with the power station arrived within a 1 hour peak morning or afternoon period and from the same direction. Regardless that this volume of traffic flow is considered negligible, the resulting $L_{eq1\text{ hour}}$ contribution from these car pass-bys at the Pearce residence would be 45dB(A). The total $L_{eq1\text{ hour}}$ level at the residence would then be $(49 + 45=)$ 50 dB(A).

The resulting $L_{eq1\text{ hour}}$ noise contribution from these seven car pass-bys at other residences such as Pine Grove would be less than 30 dB(A) from these movements.

It is intended that the power plant generally operate from 6.30am to 7:00pm. The morning peak hour period may therefore occur during the 'night-time' hours of 10pm to 7am. However, the ambient noise traces show that noise levels in the Uranquinty area begin to rise dramatically at 6am, which could suggest a basis to alter the period considered 'night' as a shoulder period in accordance with Section 2 of the ECRTN. Nevertheless, the total traffic noise contribution level at the nearest residence meets the ECRTN Section 2 night-time criterion of 50 dB(A). This level translates to an internal noise level of 40-45dB(A), which also meets the ECRTN criteria for sleep disturbance. The traffic noise will increase by less than 1dB(A) at the most affected site, which complies with the DEC criterion in Table 1 of Section 2

of the ECRTN. The other residences are further away from the Uranquinty Cross Road and are less likely to be affected by traffic noise. Accordingly, the increase in traffic noise due to the operation of the plant is unlikely to adversely affect nearby residents.

8.3.2 Construction

During building construction there will be up to 110 people on site who must travel along the Uranquinty Cross Road to reach the site. Some will come from Uranquinty township to the East and others from Olympic Way to the West. We have assumed that a maximum of 80 % of these people will travel to the site in any 1 hour period from the same direction. Where 88 vehicles pass by the Pearce residence west of the site during a peak one-hour period, the 1-hour L_{eq} at Pearce would increase to 56dB(A) based on the L_{eq} levels outlined above.

There are currently no criteria for noise from traffic associated with construction. Noise from light vehicle traffic will be minimised as much as practicable by limiting the construction hours to 7am to 6pm, and by application of the Australian Design Rules, which apply to road registered vehicles. The movement of heavy vehicles to and around the site will also be restricted to the daytime period where necessary

9. DISCUSSION OF RESULTS

The modelling results show that the maximum noise levels at residential receivers will vary considerably depending on the intervening topography and the meteorological conditions. The residential receivers closest to the proposed plant site were identified as 'Pine Grove' to the South,- 'The Wardrobe' to the South East, Wallace to the East, Metcalfe to the North West and Pearce to the West.'

9.1 POWER PLANT NOISE EMISSION

Operation of the four turbines at the plant was modelled using data for a Mars 100 turbine, such that the Sound Pressure Level at 100m was 73 dB(A) for four turbines. Modelling showed that two residences would routinely experience noise levels in excess of the NSW Department of Environment and Conservation criterion of 35 dB(A). The maximum noise levels resulted when a Pasquill Stability Class F temperature inversion occurred along with a 3m/s wind from the West. Under these conditions, 'Pine Grove' would experience levels of up to 41 dB(A) while 'The Wardrobe' and 'Wallace' would experience levels of up to 39dB(A). The 41 dB(A) exceeds the nominated noise criterion by upto 6 dB(A) during the most adverse weather conditions.

To reduce the overall noise emission to acceptable levels the level of noise emission from the packaged plant is to be limited as follows

- Single Turbine Plant 61 dB(A) @ 100 m
- Two Turbine Plant 66 dB(A) @ 100 m,
- Four turbine Plant 67 dB(A) @ 100 m

The maximum noise levels at residences to the West of the plant occurred with weather category 6, when a Pasquill Stability Class F temperature inversion occurred along with 3m/s wind from the East. Under these conditions, 'Metcalfe' and 'Pearce' would experience levels of 37-38dB(A) , while 'Pine Grove' would experience levels of up to 38 dB(A) and 'The Wardrobe' up to 36dB(A).

The maximum exceedance of the 35 dB(A) criterion is 3 dB(A). Accordingly, application of the noise emission limits specified above will be sufficient to reduce the power station noise at these receivers to acceptable levels.

The noise levels at all other residences, including 'Wyrilla' and 'The Pines' were less than the specified 35 dB(A) noise criterion under all modelled meteorological conditions. These residences will not be unduly affected by noise emission from the proposed power plant operation.

9.2 CONSTRUCTION SITE NOISE EMISSION

It was determined that the noisiest stage of construction was the site preparation and earthworks stage which will involve the use of dozers, loaders and excavators at different times to clear, level and prepare the site for future works. Noise emission from this stage was modelled using the spectrum of two Caterpillar D8 Dozers operating simultaneously to produce a total sound power of 122dB(A). The maximum noise levels resulted during weather category 5 when a 3m/s wind blew from the West. Under these conditions, 'Pine Grove' would experience levels of up to 46 dB(A) while 'Wallace' and 'The Wardrobe' would experience levels of up to 45 dB(A) This exceeded the nominated objective of 35dB(A) by 11 dB(A).. It was determined that the total sound power of construction activities would have to be limited to 111dB(A) to meet the objective of 35dB(A). Where this level cannot be met, the strategies outlined below in Section 10.2 will be implemented. .

10. RECOMMENDED MAXIMUM PLANT NOISE LEVELS

10.1 POWER PLANT

The total noise emission from the turbine plant must not exceed the limits outlined in Table 10-1 below. Note that these noise emission levels apply to broadband noise without any annoying characteristics such as tonality or impulsiveness. Where tonality is a characteristic of the noise emission a 5 dB(A) penalty should be subtracted from the noise emission criteria in Table 10-1.

Table 10-1 – Maximum Broadband Noise Emission Levels at 100m for Turbine Plant

Condition	Maximum Sound Pressure Level at 100m
Single turbine plant	61 dB(A)
Two turbine plant	66 dB(A)
4 turbine plant	67 dB(A)

It is intended that the plant for the gas-fired power station at Uranquinty will be supplied as a complete package including turbines, generators, transformers, pump, switch gear, demineralisation plant and all other items for a complete operating power station. The preferred supplier is Siemens. Siemens advise that their packaged plant will incorporate the V94.2 gas turbines, related transformers and the other auxiliary equipment as noted above. Siemens can provide a noise guarantee that their equipment can meet a criterion of 55 dB(A) at 100 m. Accordingly whether or not there are residual tonal characteristics they can meet a 61 dB(A) @ 100m broad-band noise or a 56 dB(A) at 100m tonal noise criterion.

The approximate noise levels associated with the basic plant are presented in Table 10-2 below.

Table 10-2 – Basic equipment noise limits

Component	Surface SPL / SWL per unit	No Units	Total SWL
Gas Turbine Casing (v94.2)	90	4	96
Generator Casing (TLRi 115/36)	93	1	93
UBF GT Generator Transformer	105	4	121
UBE Auxiliary Transformer	88	4	94
UBD Low Voltage Transformer	75	4	81
Compressor Air Intake Duct (incl. Inflow casing, silencer casing, elbow casing, air flap casing vertical intake duct)	98	4	104
Filterhouse (Casing and Air Inlet)	105	4	111
Diffuser Extension Duct - Standard	114	4	120
Diffuser Extension Duct – Sound Barrier Walls	109	4	115
Exhaust Stack (lower part, silencer casing, outlet), total	110	4	116
MPR Fin Fan Cooler per cell	98	4 units with 16 fans	116
MPV Fin Fan Cooler per cell	98	4 units with 4 fans	110
Ventilation and AC Systems, total	98	1	98

The air intake opening can be further silenced to 92dB(A), and the air exhaust to 91dB(A) if required. The turbine can be housed in a noise suppression building designed to meet any required noise level.

10.2 CONSTRUCTION SITE NOISE CONTROL

The primary sources of noise emission from the site, during the construction stage, are the dozers, scrapers and excavators used to level and clear the site. Noise emission from two D8 dozers with a combined sound power level of 122dB(A) was predicted to be 46dB(A). This is 11dB(A) greater than the DEC criterion of 35dB(A).DEC. On this basis the maximum noise emission from construction needs to be limited to 111dB(A).

Table 10-3 below outlines typical maximum sound power of equipment used during each stage of construction, based on previous measurements taken by Bassett Acoustics and information supplied in Australian Standard AS 2436 – 'Guide to Noise Control on Construction, Maintenance and Demolition Sites'.

Table 10-3 – Construction Stages –maximum noise emission from plant

Stage	Length	Equipment	Typical Quantity at site	Maximum Sound Power from each unit
1. Site Preparation & Earthworks	1 month	Bulldozer,	1	119
		Loaders	1	112-115
		Excavators,	1	108-112
		Compressor	1	93-107
		Graders	1	114-118
		Rollers	1	108-111
		Dump truck	3	102-107
Maximum Noise Emission		(2 dozers, loaders & excavators)		123 dB(A)
2. Foundations	2 months	Cranes	2	98-115
		Compactor	1	113-115
		Concrete truck	1	107-115
		Concrete mixer	1	107-112
Maximum Noise Emission		(Compactor, truck & mixer or crane)		116 dB(A)
3. Building Construction	5 months	Crane,	1	104-108
		Pneumatic Breaker	2	108-111
		Circular Saw	5	96-111
		Welding Converter	5	96
		Electric Drill	5	94
		Electric Grinder	3	101-106
		Petrol Breaker	5	100-103
		Screw Driver	10	76-95
		Chipping hammer	5	101-111
Maximum Noise Emission		See note below		111 dB(A)
4. Pipeline construction	1 week	Crane,	1	104-108
		Pneumatic Hammer	1	113
		Welding Converter	2	96
		Electric Drill	5	94
		Electric Grinder	3	101-106
		Petrol Breaker	5	100-103
		Screw Driver	10	76-95

		Chipping hammer	5	101-111
Maximum Noise Emission		See note below		111 dB(A)

During building construction and equipment installation there are 110 people on site, it is assumed that approximately 50 of these will work for trades that use noisy power tools. Of these, around 25 will be inside buildings or behind acoustic screens and of those, 10-15 will be operating their tools at any one time. The resultant likely noise emission from building construction and equipment installation is likely to be around 111 dB(A) and hence will meet the background + 5dB(A) objective at the receivers. Where possible, equipment should be fitted with silencers or mufflers and damped, or work should be conducted behind acoustic screens to further limit noise emission.

However, Table 10-3 demonstrates that the noise level during Foundation and Earthworks may exceed the 111dB(A) sound power objective. Accordingly the following Best Management Practices should be adopted

Site preparation and earthworks are forecast to take one month and should involve bulldozers, loaders, excavators, graders and rollers, which could all potentially produce noise levels greater than 35dB(A) at nearby residences. In order to reduce the noise level to meet the criteria, the earthmoving machinery would have to be replaced by hand shovels, which is not considered best practice. Instead, the following reasonable measures should be implemented to limit the noise and reduce the annoyance at neighbouring properties:

- Inform contractors and sub-contractors that noise is to be kept to a minimum
- Fit residential grade mufflers and silencers to machines
- Use rubber tyred machinery rather than metal tracked dozers etc where possible.
- Limit operation of earthmoving machinery to between 9am and 4pm when residences are less sensitive to noise and ambient levels are greatest.
- Keep neighbours informed when noisy equipment is introduced to site and the likely duration of its use.
- Ensure a site contact number is circulated to neighbouring residences to allow a swift response to complaints
- Introduce a management strategy to monitor noise emission, assess and record noise complaints and track performance in limiting and managing noise.

Laying the foundations for the plant will take two months and will involve cranes, compactors, concrete trucks and concrete mixers, which could potentially produce noise levels above 111dB(A). The following measures will be implemented to reduce the noise emission from this stage of construction and limit the impact of any exceedance:

- Inform contractors and sub-contractors that noise is to be kept to a minimum
- Fit residential grade mufflers and silencers to machines
- Enclose or shield engines of concrete mixers where practical
- Limiting the drop height of concrete aggregate where possible
- Do not hammer drums or other containers when emptying the vessels
- Locate mixing plant as far as possible from sensitive receivers
- Limit operation of noisiest machinery to between 9am and 4pm.
- Keep neighbours informed when noisy equipment is introduced to site and the likely duration of its use
- Ensure a site contact number is circulated to neighbouring residences to allow a swift response to complaints

Introduce a management strategy to monitor noise emission, assess and record noise complaints and track performance in limiting and managing noise.

11. CONCLUSIONS

Bassett Acoustics has conducted an assessment of the environmental noise emission from the proposed Uranquinty gas turbine power station at Uranquinty, NSW.

The ambient noise level in the area has been measured and corresponding noise emission criteria have been established.

The overall noise emission from the site has been modelled. The closest residences to the site are 'Pine Grove', 'The Wardrobe', 'Wallace', 'Metcalf' and 'Pearce' and these control the maximum level of noise emission permitted by the power station.

It is proposed to operate up to four 150MW gas turbines at the site. The level of environmental noise emission may exceed the DEC nominated criteria unless treatments are implemented to control noise emission.

The maximum permissible noise emission from each item of plant is outlined in Table 10-1.

Noise emission from the construction of the power plant has also been assessed. The level of environmental noise emission can exceed the DEC nominated criteria unless treatments are implemented to control noise emission. The maximum permissible noise emission from each item of equipment is outlined in Table 10-2.

The power station has the potential to generate traffic on nearby roads. Modelling indicates that the maximum noise emission from nearby roads will comply with the DEC nominated criteria.

This assessment has indicated that provided the maximum noise emission from each source is controlled, the overall noise emission from the construction and operation of the proposed Uranquinty Gas Turbine Power Station will comply with the nominated DEC noise criteria and produce acceptable levels of noise emission.

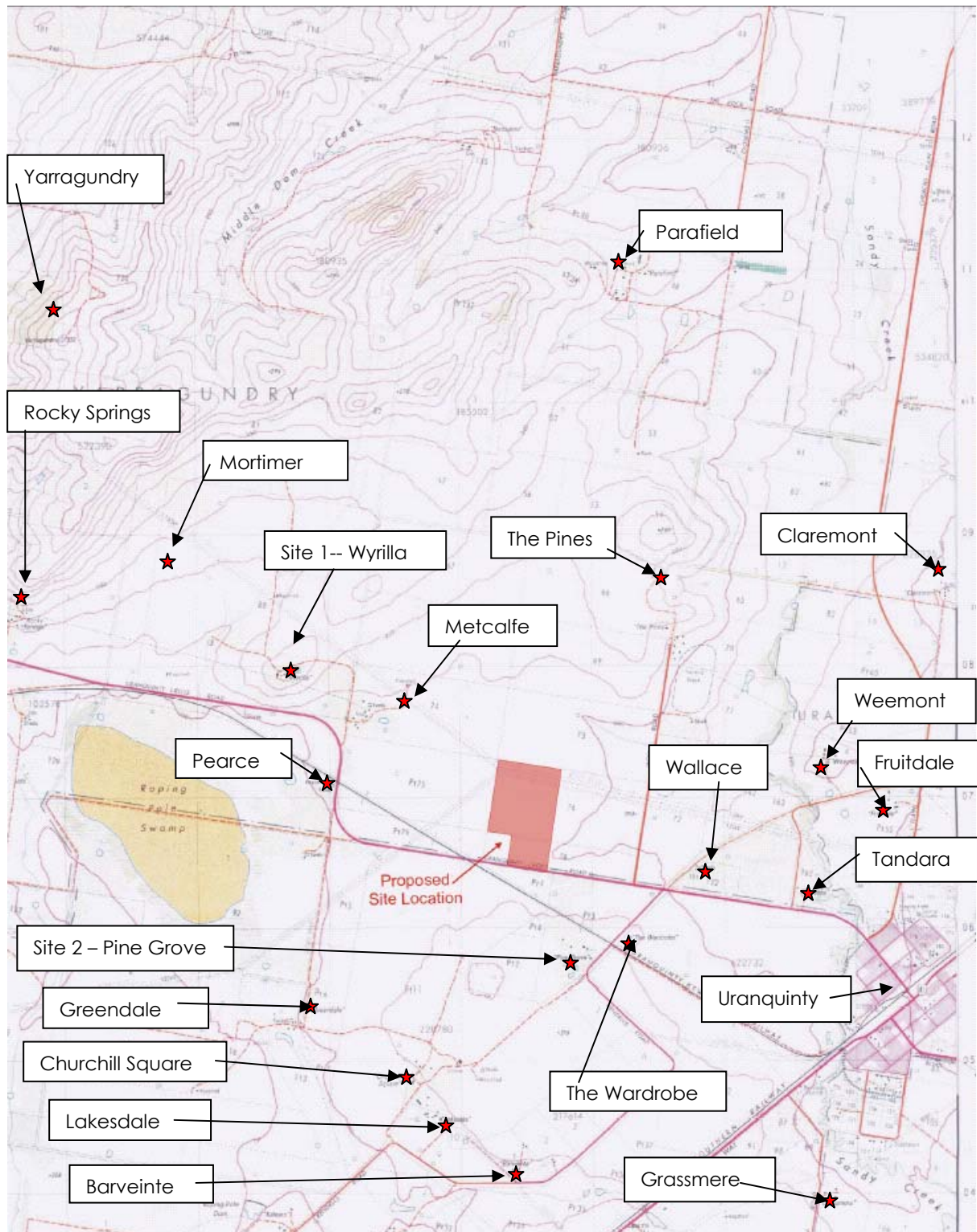
12. LIST OF REFERENCES

- Environmental Protection Authority 1993, *Environmental Noise Control Manual*, Environmental Protection Authority, Sydney.
- Environmental Protection Authority 1999, *Environmental Criteria for Road Traffic Noise*, Environmental Protection Authority, Sydney.
- Environmental Protection Authority 2000, *NSW Industrial Noise Policy*, Environmental Protection Authority, Sydney.
- Katestone Environmental Pty Ltd 2003, *Stability Information*, report prepared by Natalie Leishman, Katestone Environmental, Bardon QLD.
- Solar Turbines, 1998 *Noise Prediction Guidelines for Industrial Gas Turbines*, Caterpillar, USA.
- Standards Association of Australia 1981 *Guide to Noise Control on Construction, Maintenance and Demolition Sites*, Standards Association of Australia.

Appendix A - Nomenclature

L _{bg}	Background noise level, also known as L ₉₀ . Refer also to L ₉₀ below.
L _{eq} -	Energy averaged noise level over the measurement period. This measure is commonly used when comparing noise levels for occupational noise
L _{eq,8h} -	L _{eq} level for an eight hour period.
L ₉₀ -	Noise level exceeded 90% of the measurement period. This represents the background noise level when the source of polluting noise is off . Where background noise levels are referenced in this report the L ₉₀ level is inferred.
L ₁₀ -	Noise level exceeded for 10% of the measurement period. This represents the upper intrusive noise level. This measure is commonly used when assessing noise emission levels of developments and of roads
L _w	Sound Power. A measure of the inherent sound energy of a noise source
dB(A)	'A' Weighted overall sound pressure level re 2 x 10 ⁻⁵ Pa.
L _{eq} -	Energy averaged noise level over the measurement period. This measure is commonly used when assessing noise from steady sources
L _{max} -	Maximum instantaneous noise level during measured period

Appendix B – Site Map & Nearest Residences



Appendix C – Turbine Noise Emission

Table C-1 – Comparison of Unsilenced Sound Power Data for Gas Turbines in dB re 10⁻¹²W

	Octave Band Centre Frequencies								Overall dB(A)
	63	125	250	500	1000	2000	4000	8000	
Mars 100 Inlet	125	125	125	125	127	131	161	152	162
Siemens V94.2 Inlet	118	119	121	128	141	148	141	132	151
Mars 100 Exhaust	124	123	122	123	120	114	106	90	124
Siemens V94.2 Exhaust	144	139	136	140	144	149	146	140	153
Mars 100 Cooler	110	105	109	103	98	94	97	83	105
Siemens V94.2 Cooler	112	113	112	105	105	104	104	100	112

Figure C-1– Comparison of Unsilenced Sound Power of Mars100 and Siemens V94.2 Turbines

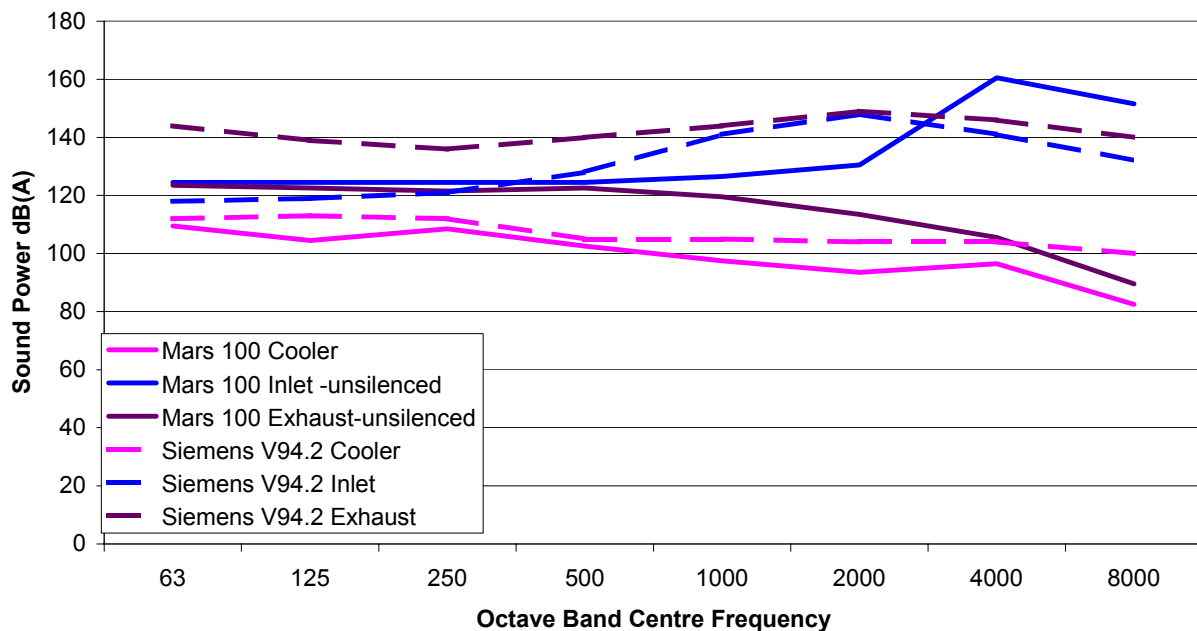


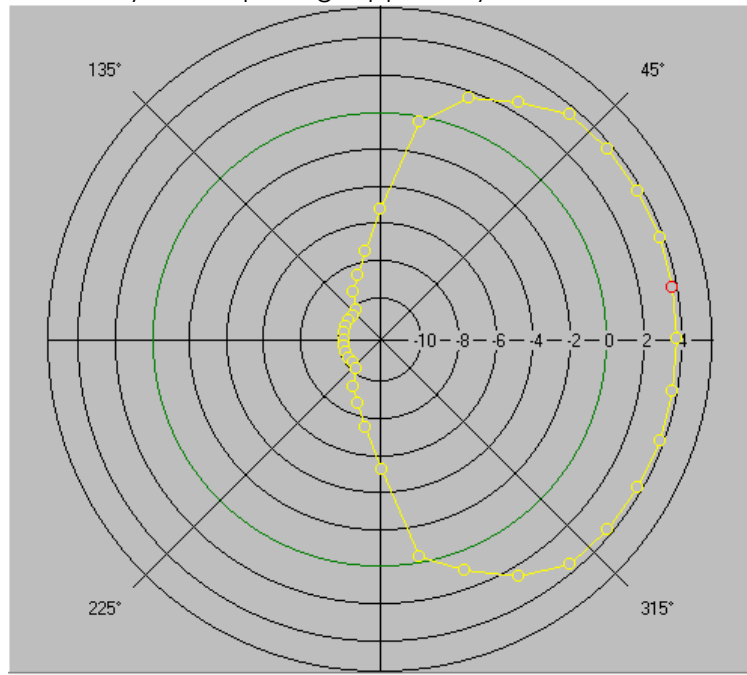
Table C-2 – Sound Power Emission for Gas Turbine in dB re 10⁻¹²W

	Octave Band Centre Frequencies									Overall dB(A)
	31.5	63	125	250	500	1000	2000	4000	8000	
Sound Power - Inlet	121.5	120.5	114.5	109.5	92.5	77.5	75.5	114.5	114.5	114.7
Sound Power - Exhaust	122.5	121.5	115.5	103.5	93.5	85.5	77.5	58.5	58.5	102.2
Sound Power - Cooler	117	110	105	109	103	98	94	97	83	105.2
Each Turbine	76.4	74.9	68.9	64.4	55.2	49.7	45.6	58.9	66.5	67.3
Total for all Turbines	79.4	77.9	71.9	67.4	58.2	52.7	48.7	61.9	69.5	70.3

Based on Mars 100 turbine manufactured by Solar Turbines

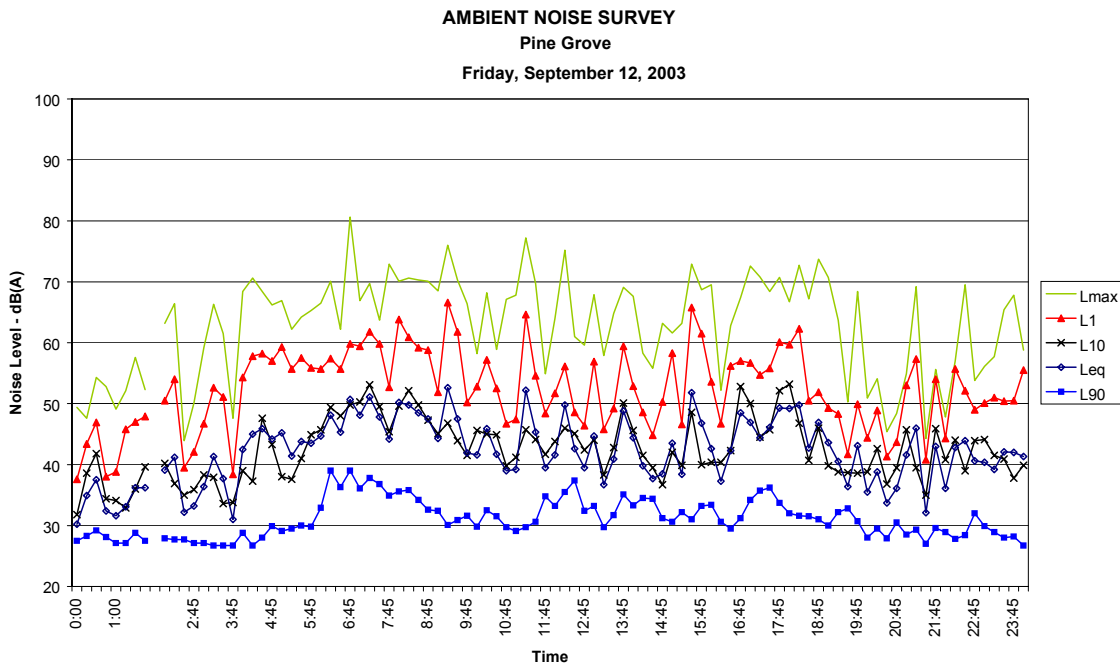
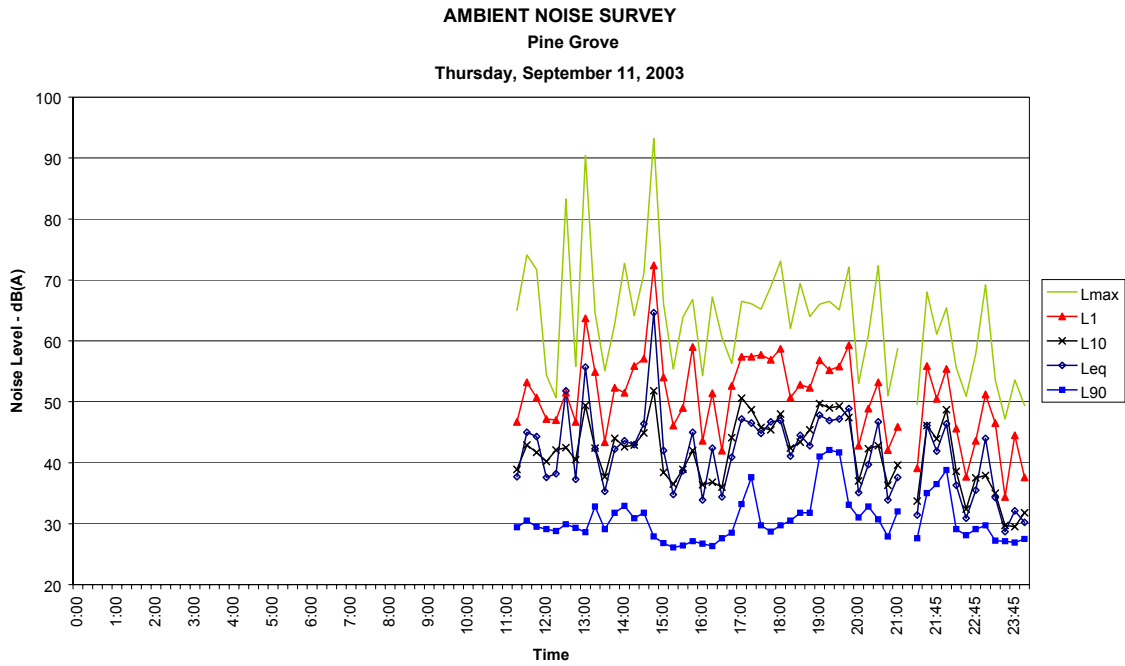
Figure C-2– Inlet Noise Emission: 2-D Horizontal Directivity

Based on the 2D directivity of an opening supplied by SoundPLAN 6

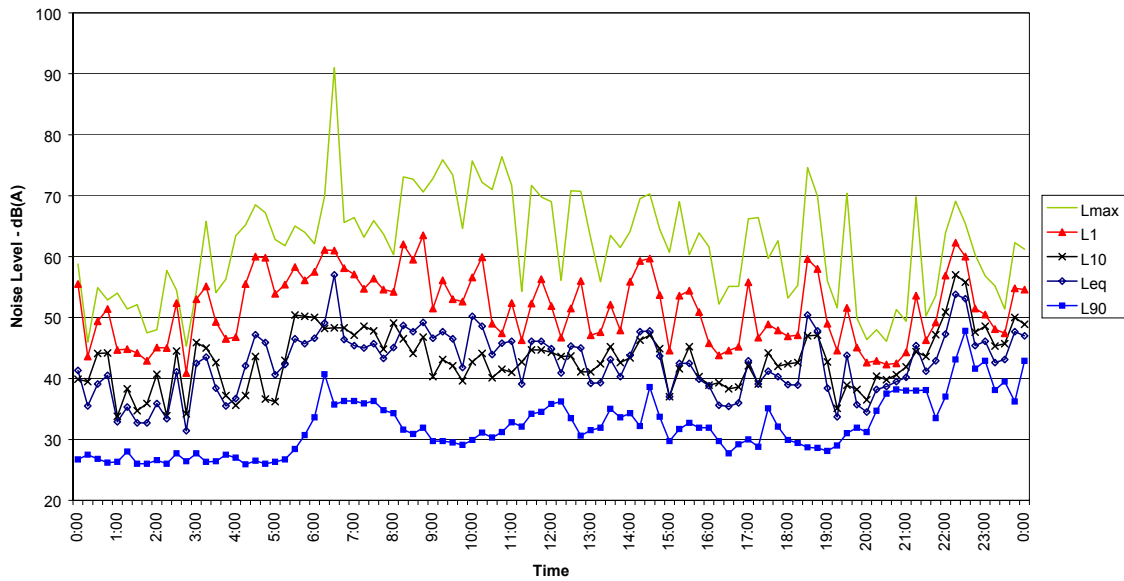


Appendix D – Ambient Noise Survey

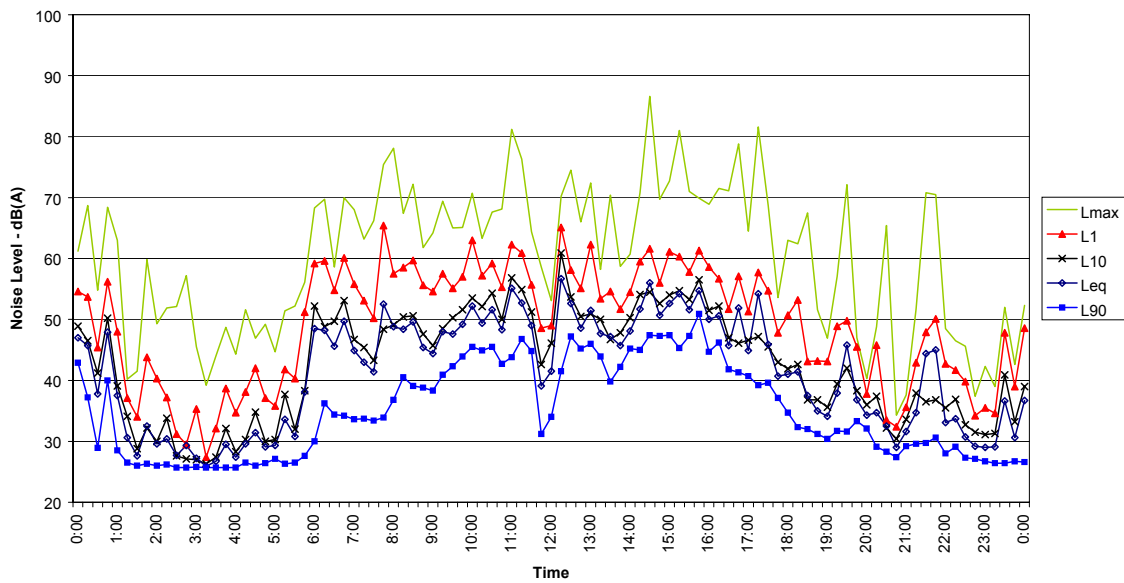
D-1: Ambient Noise Survey - Pine Grove



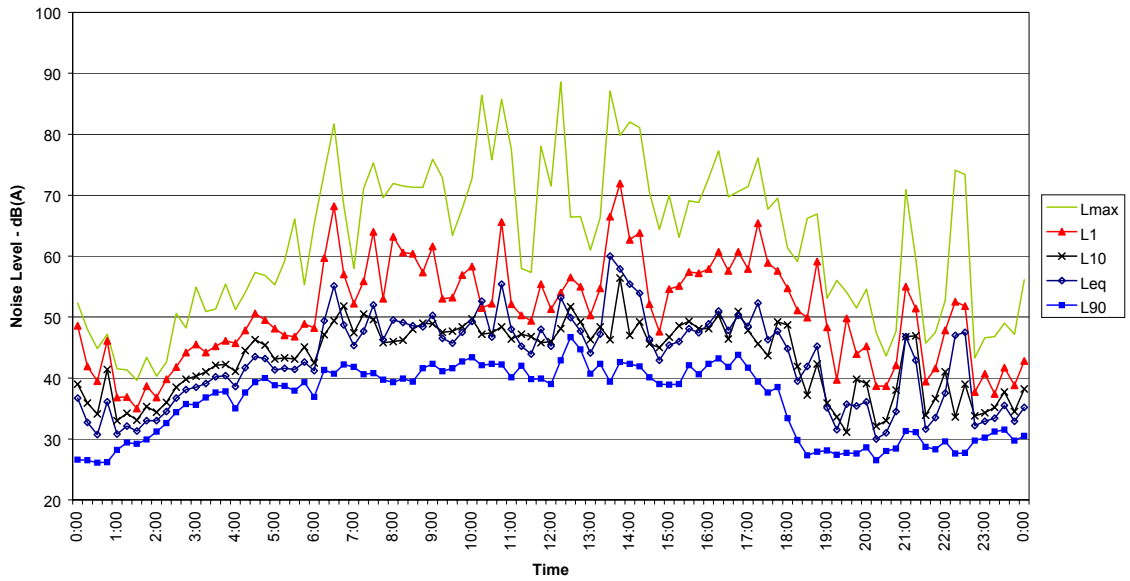
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Pine Grove
Saturday, September 13,



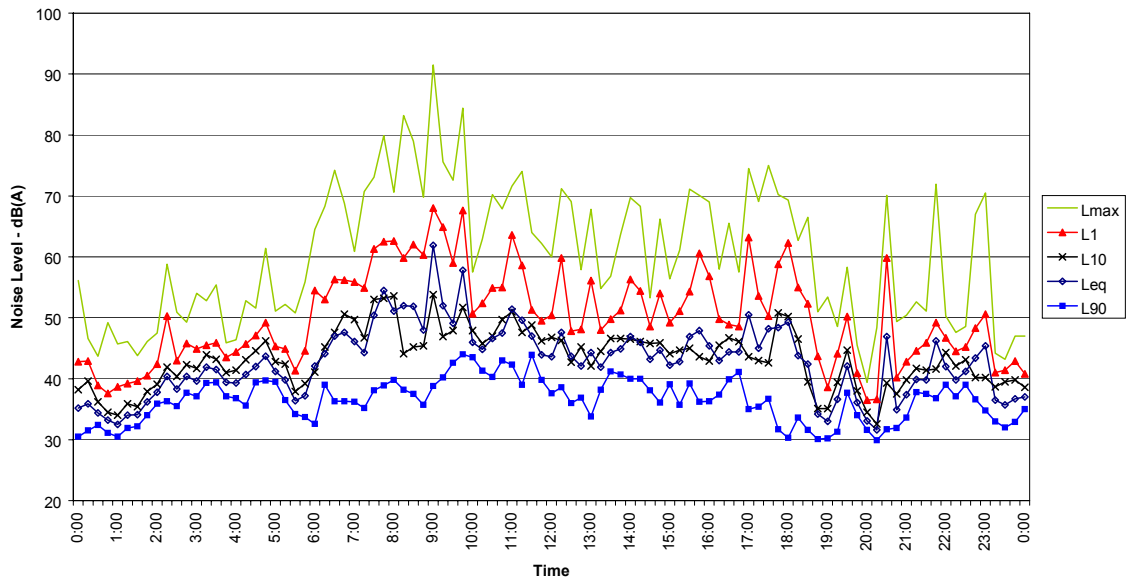
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Pine Grove
Sunday, September 14, 2003



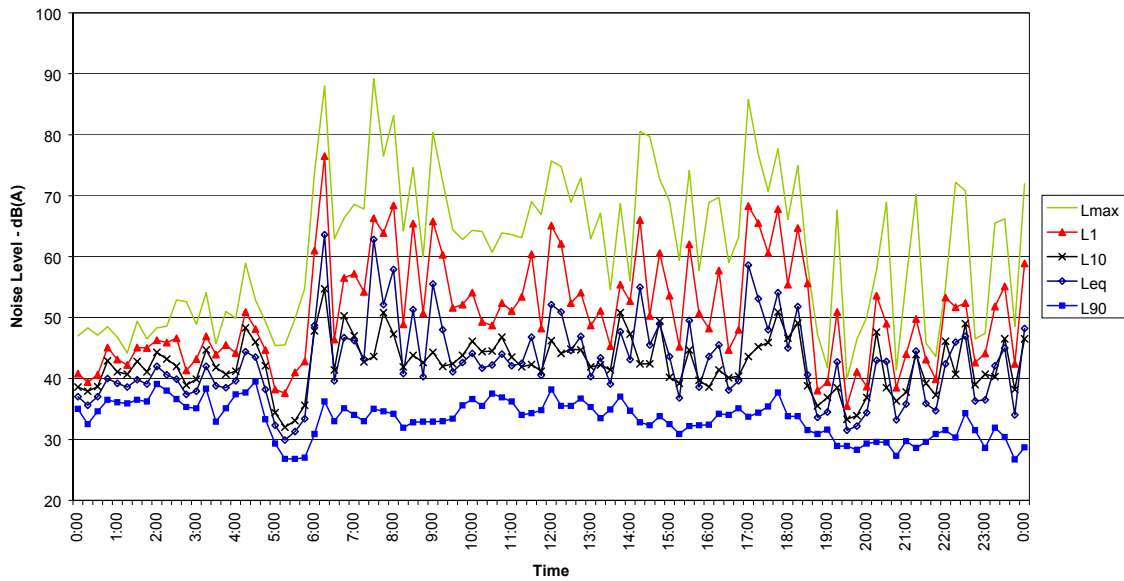
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 Pine Grove
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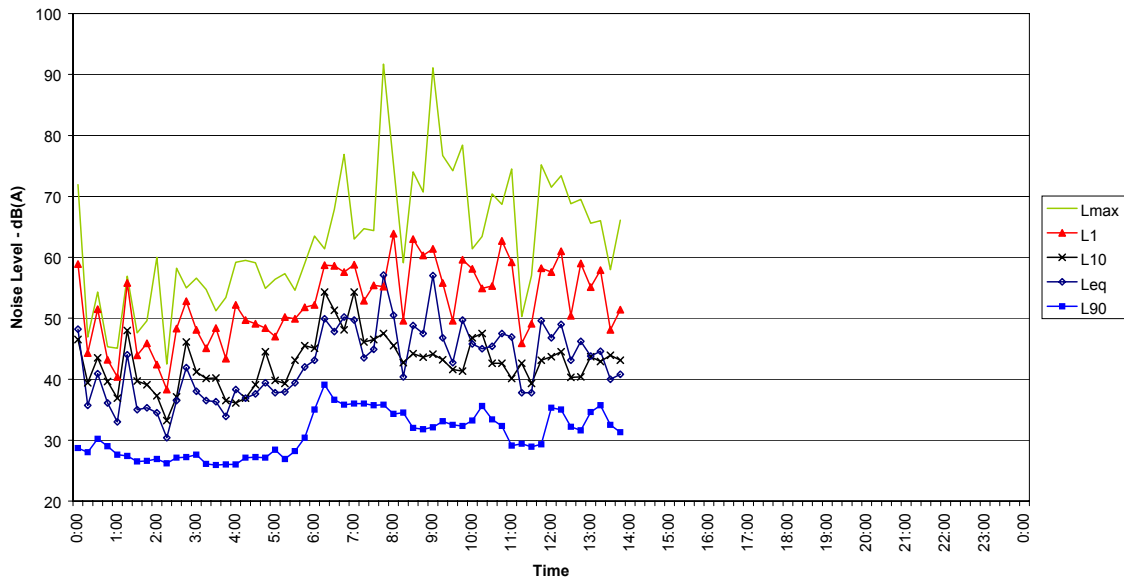
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 Pine Grove
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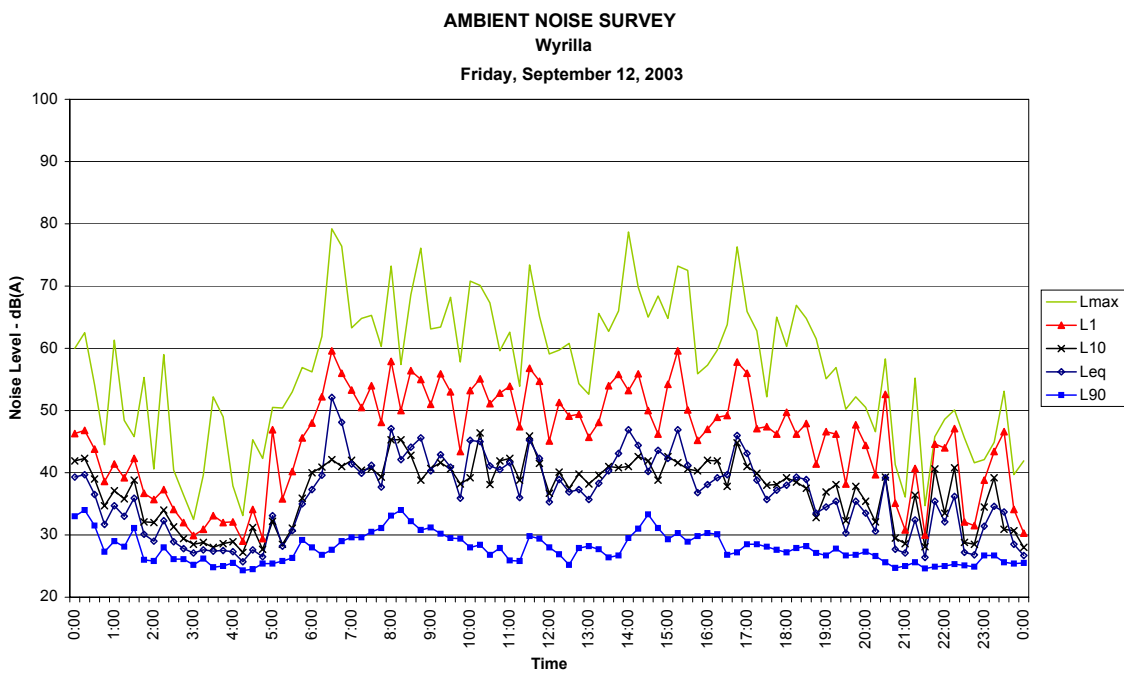
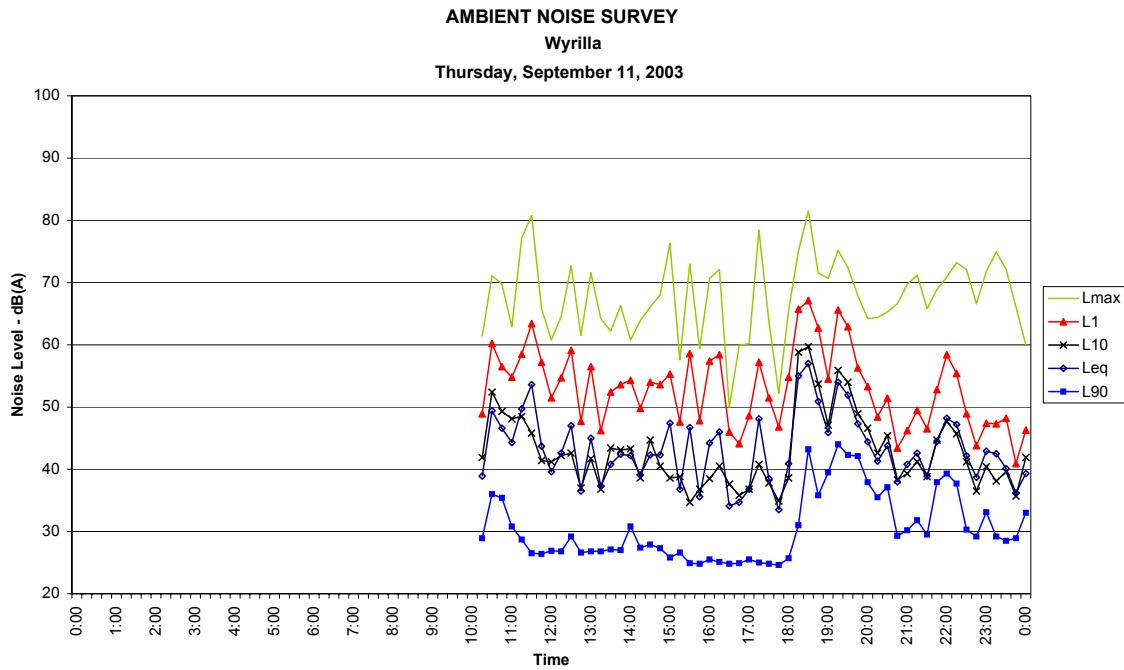
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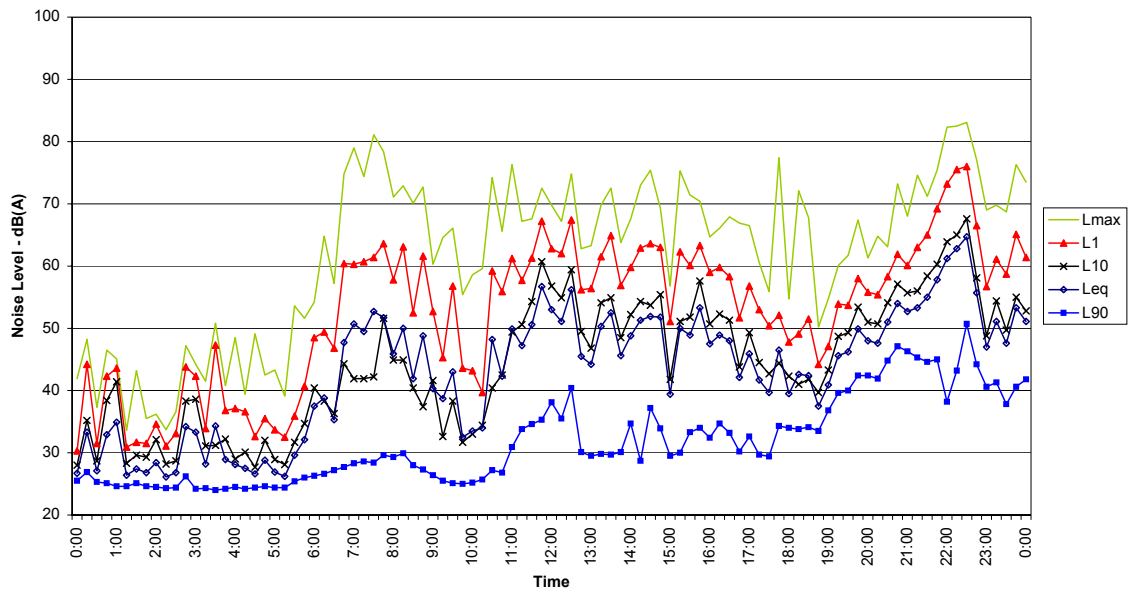
AMBIENT NOISE SURVEY
 Pine Grove
 Thursday, September 18, 2003



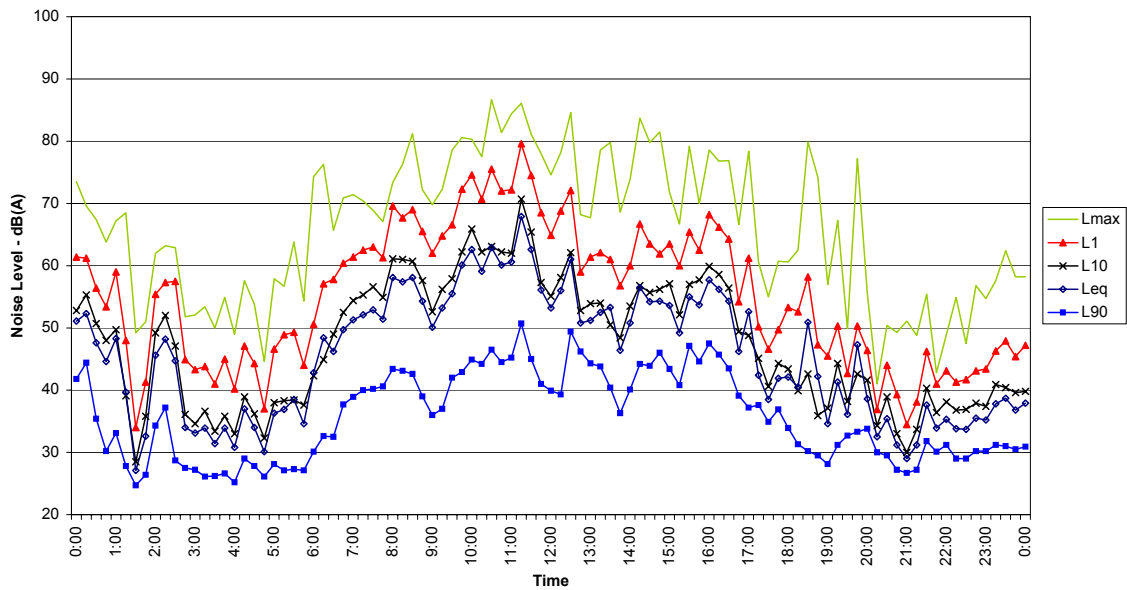
D-2: Ambient Noise Survey – Wyrilla



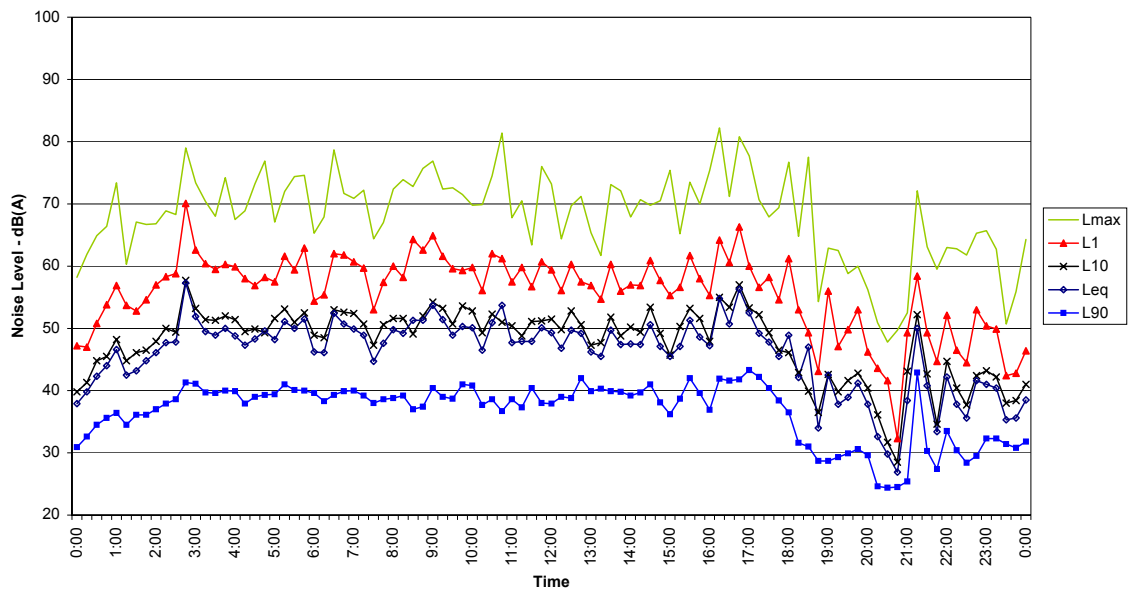
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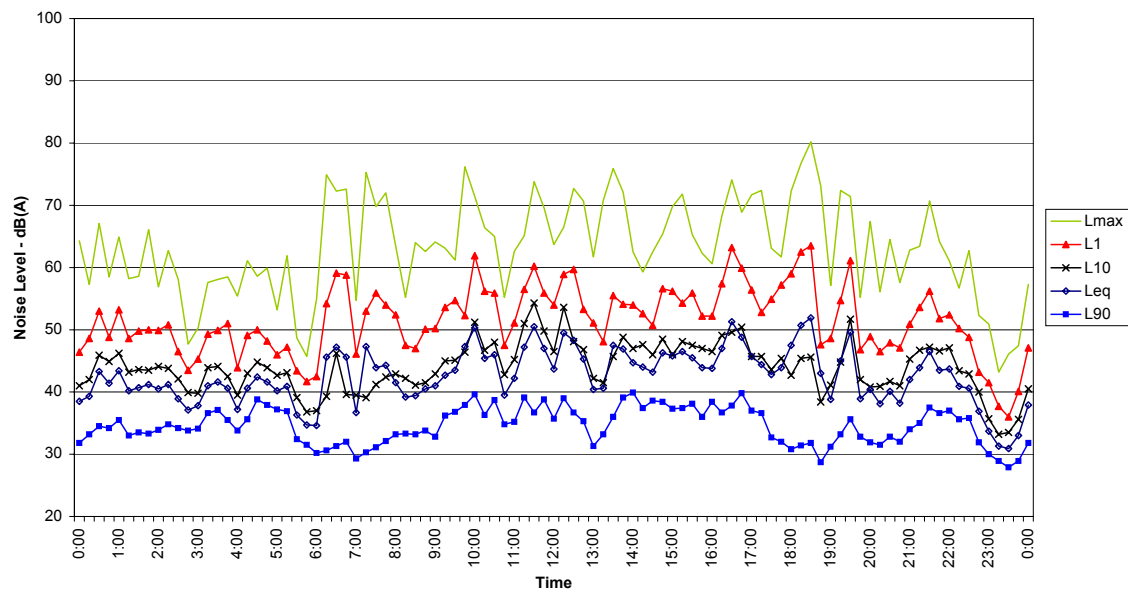
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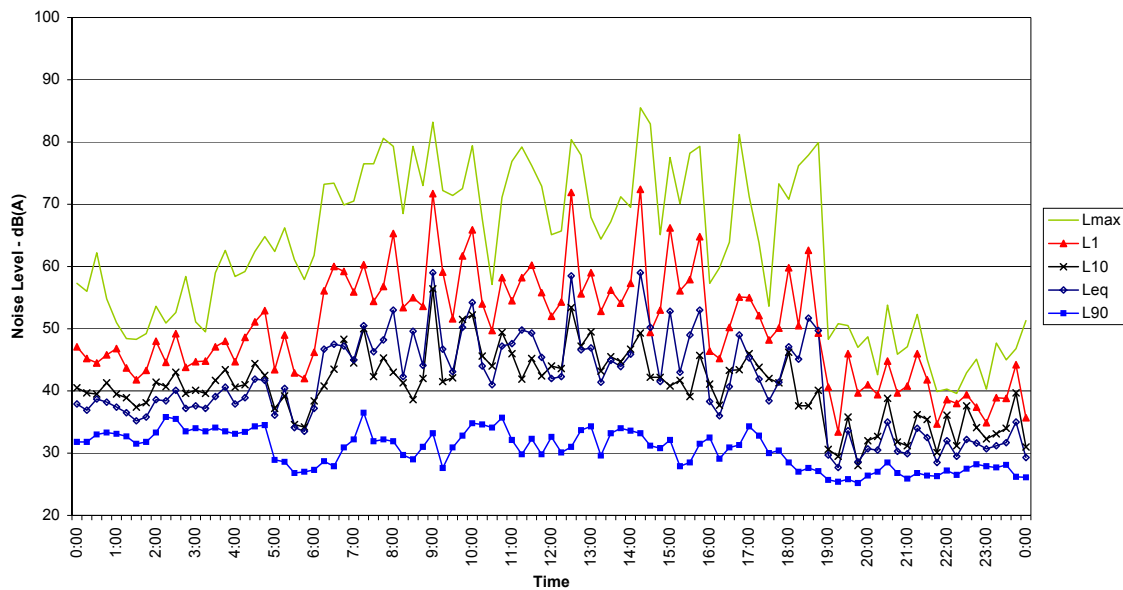
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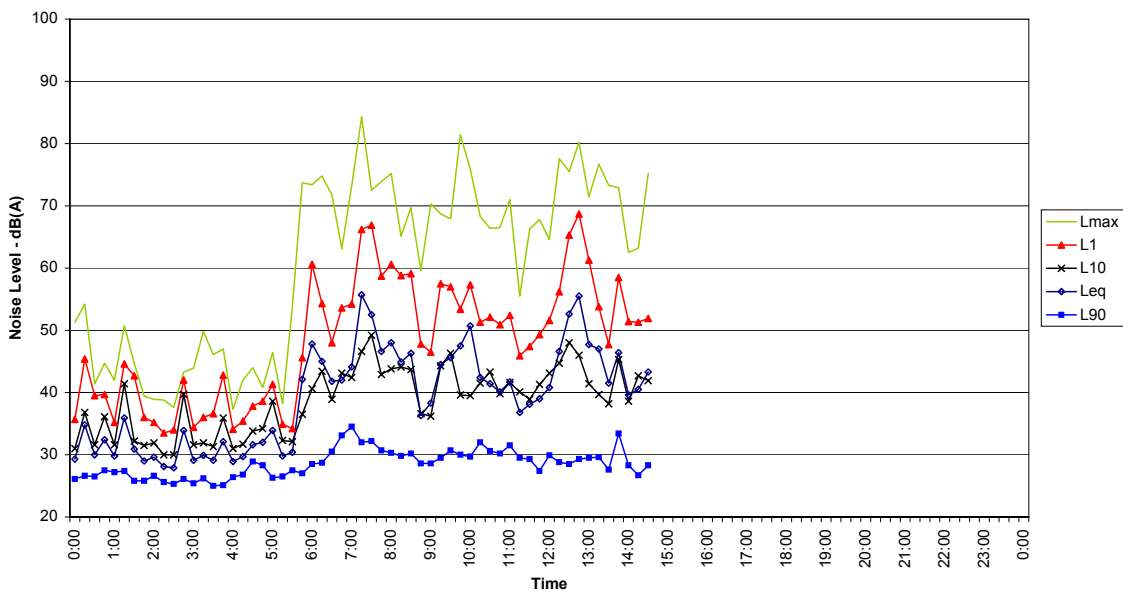
AMBIENT NOISE SURVEY
Wyrilla
Tuesday, September 16, 2003



AMBIENT NOISE SURVEY
Wyrilla
Wednesday, September 17, 2003



AMBIENT NOISE SURVEY
Wyrilla
Thursday, September 18, 2003



Appendix E - Attended Noise Measurements

Start Calibration 94.0 dB
 End Calibration 93.8 dB

WYRILLA

Time: 10.00 am
 Temperature 15-17°C
 Wind Speed Low to Moderate
 Sky Clear
 Background Noise Birds, cows, wind moving through trees

Measurement	Octave Band Centre Frequency (Hz)									Overall Value	
	31.5	63	125	250	500	1000	2000	4000	8000	dB	dB(A)
L _{eq}	23	26	29	30	32	33	33	33	25	40	39
L _{max}	51	54	57	59	59	62	62	60	47	68	67
L ₁₀	25	28	31	32	35	39	38	35	27	44	44
L ₉₀	21	23	29	29	30	29	25	25	18	36	33

PINE GROVE

Time: 11.00 am
 Temperature 17-19°C
 Wind Speed Low
 Sky Clear
 Background Noise Birds, cows, wind moving through trees.

Measurement	Octave Band Centre Frequency (Hz)									Overall Value	
	31.5	63	125	250	500	1000	2000	4000	8000	dB	dB(A)
L _{eq}	13	19	21	24	26	25	28	35	23	37	37
L _{max}	42	48	51	55	57	54	53	60	50	64	63
L ₁₀	13	20	21	24	27	27	30	36	25	39	39
L ₉₀	12	16	20	23	23	21	21	25	17	31	29

POWER STATION SITE

Time: 11.30 am
 Temperature 19-20°C
 Wind Speed Low
 Sky Clear
 Background Noise Birds, sheep, and very light traffic (four cars in 15 minute interval).

Measurement	Octave Band Centre Frequency (Hz)									Overall Value	
	31.5	63	125	250	500	1000	2000	4000	8000	dB	dB(A)
L _{eq}	15	25	30	37	42	47	41	35	25	50	49
L _{max}	46	49	57	65	70	75	67	60	55	77	76
L ₁₀	11	17	18	17	23	21	21	19	17	29	27
L ₉₀	10	14	16	15	14	14	17	18	17	25	24

PEARCE RESIDENCE

Time: 12.00 am
 Temperature 19-20°C
 Wind Speed Low
 Sky Clear
 Background Noise Birds, sheep, no light traffic (no cars in 15 minute interval).

Measurement	Octave Band Centre Frequency (Hz)									Overall Value	
	31.5	63	125	250	500	1000	2000	4000	8000	dB	dB(A)
L _{eq}	11	19	21	24	20	23	32	37	30	39	40
L _{max}	31	41	42	40	41	42	57	58	51	61	62
L ₁₀	11	20	21	25	21	26	34	39	32	41	42
L ₉₀	10	17	20	23	18	20	24	27	22	32	31

Appendix F - Wind Roses

Figure F-1: Wind roses for Wagga Wagga for Summer during the period from 1st January 1998 to 31st December 1998 for (a) midnight to 6 am, (b) 6 am to midday, (c) midday to 6 pm and (d) 6 pm to midnight

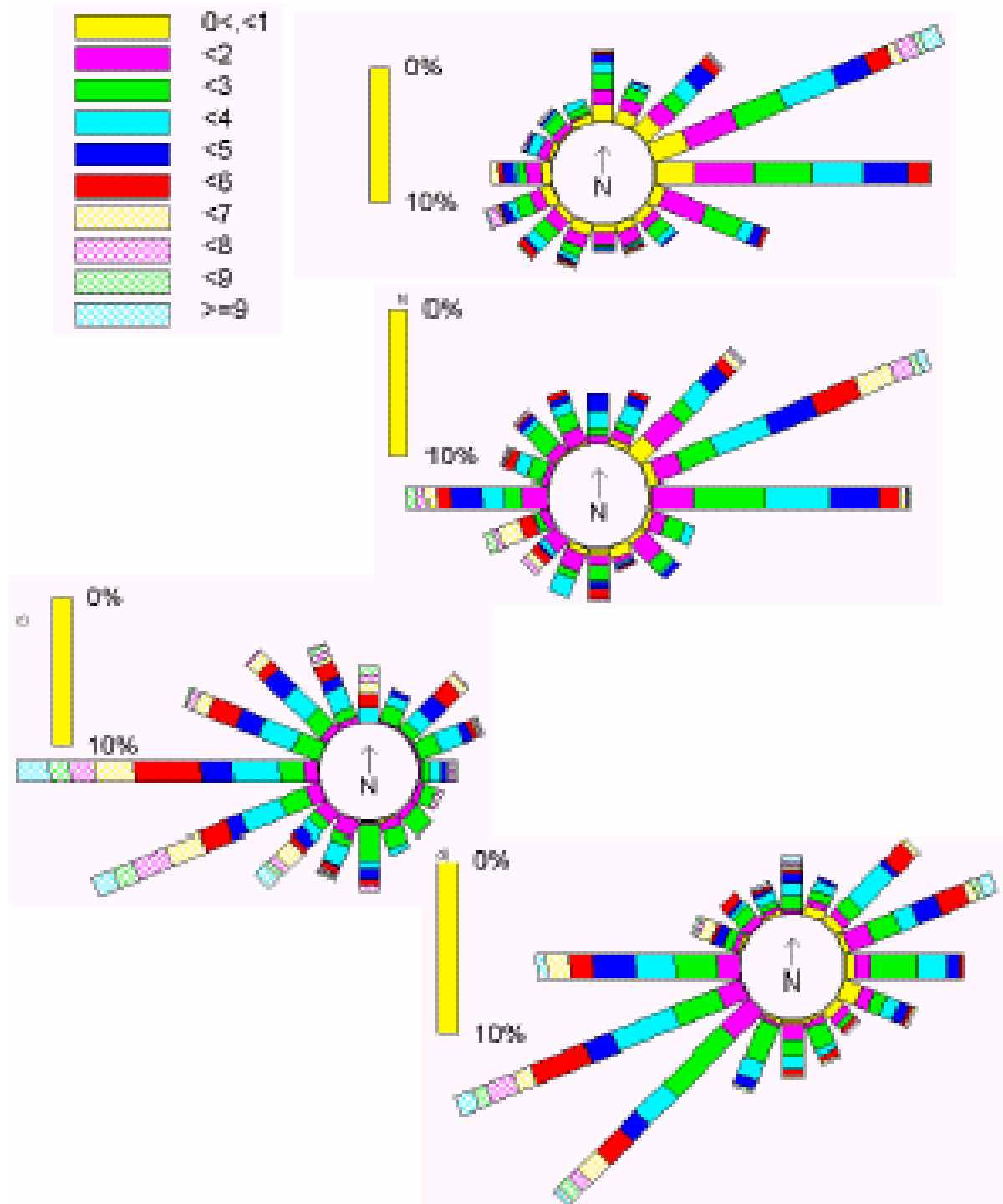
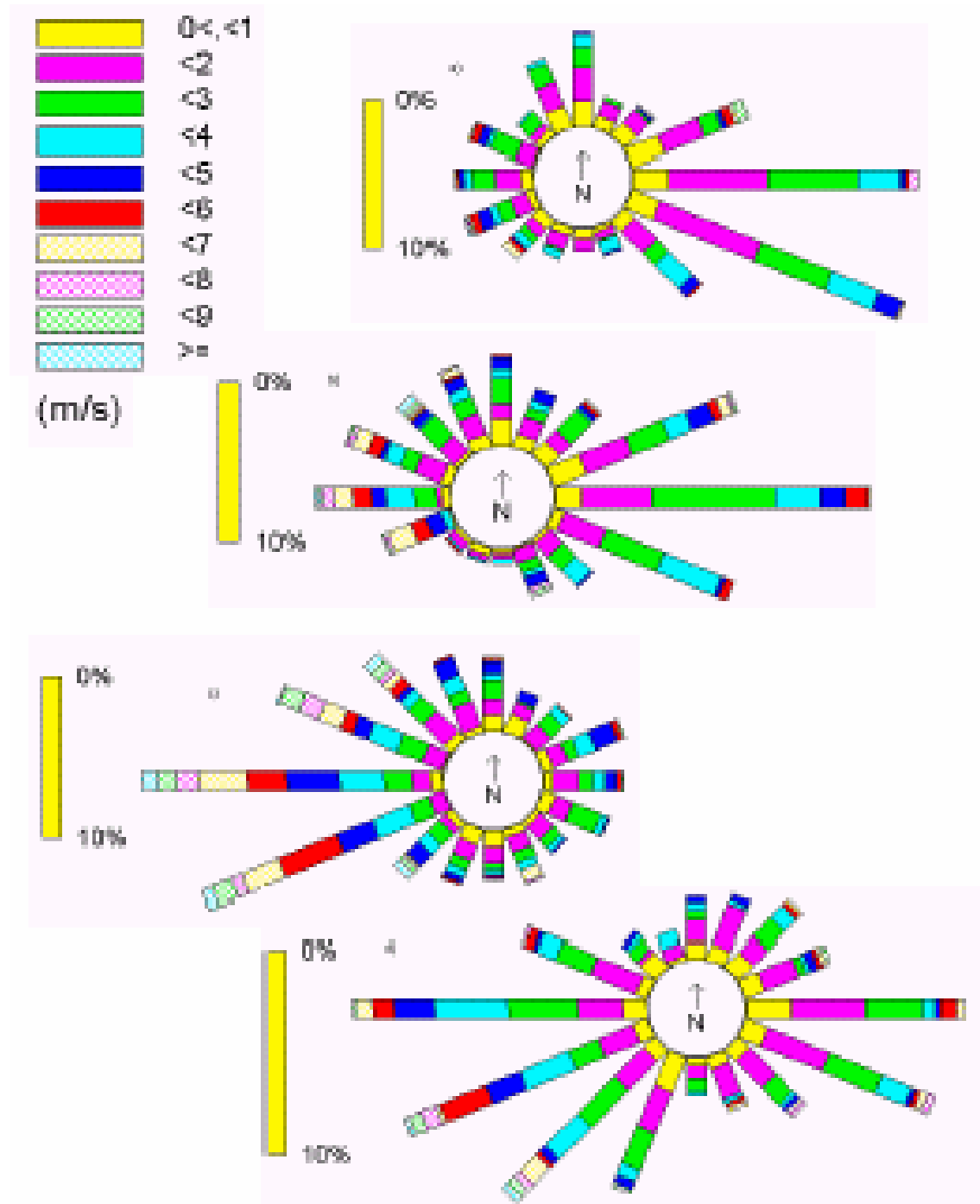
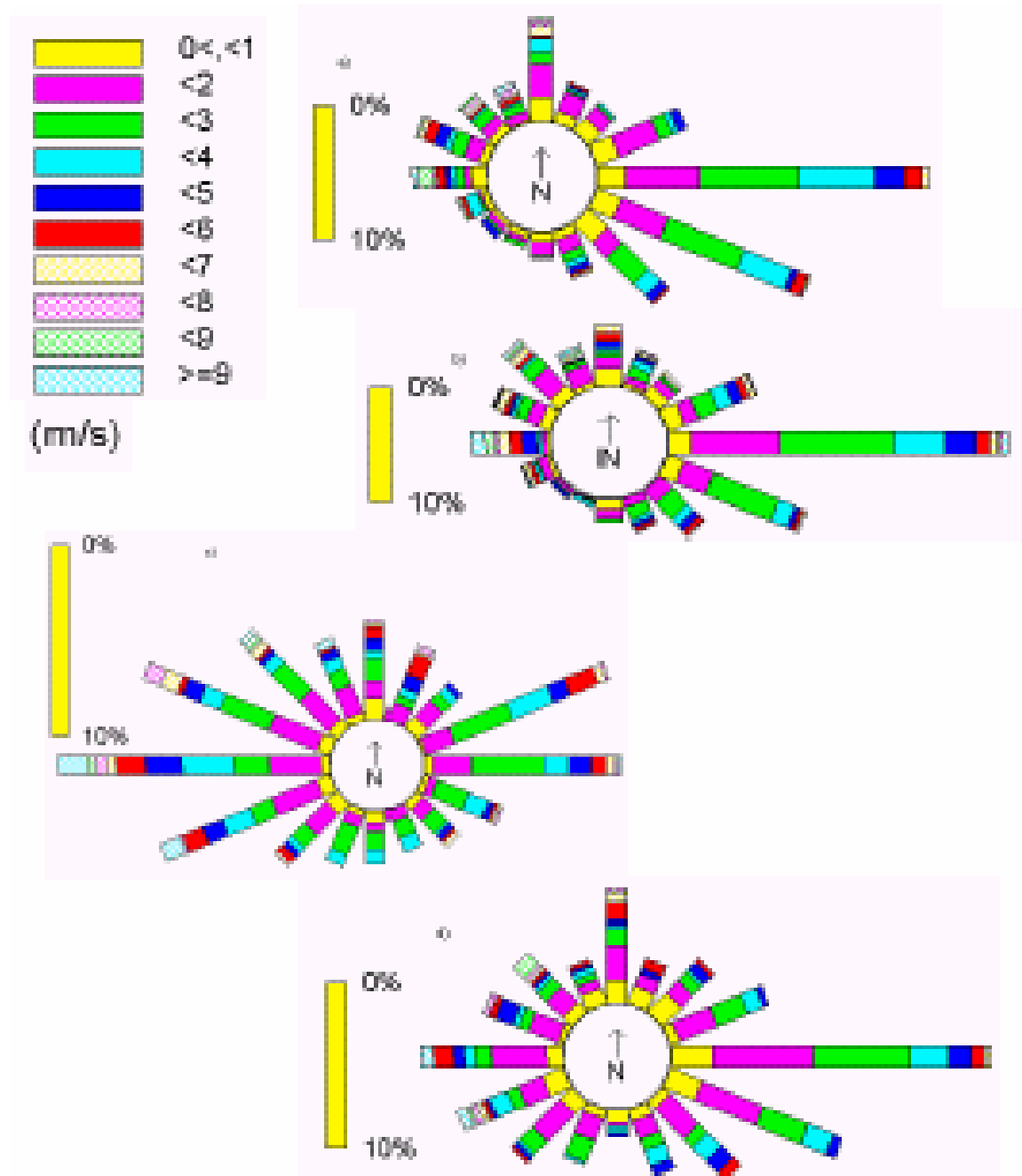


Figure F-2: Wind roses for Wagga Wagga Airport for Autumn during the period from 1st January 1998 to 31st December 1998 for (a) midnight to 6 am, (b) 6 am to midday, (c) midday to 6 pm and (d) 6 pm to midnight



Environmental Noise Impact of Uranquinty Gas-Fired Power Station

Figure F-3: Wind roses for Wagga Wagga Airport for Winter during the period from 1st January 1998 to 31st December 1998 for (a) midnight to 6 am, (b) 6 am to midday, (c) midday to 6 pm and (d) 6 pm to midnight



Environmental Noise Impact of Uranquinty Gas-Fired Power Station

Figure F-4: Wind roses for Wagga Wagga Airport for Spring during the period from 1st January 1998 to 31st December 1998 for (a) midnight to 6 am, (b) 6 am to midday, (c) midday to 6 pm and (d) 6 pm to midnight

