Annex L

Lismore to Mullumbimby Electricity Network Upgrade - Acoustic Assessment
(ERM, 2008)

FINAL REPORT

Country Energy

Lismore to Mullumbimby Electricity Network Upgrade
Noise Impact Assessment

October 2008

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FINAL REPORT

Country Energy

Lismore to Mullumbimby Electricity Network Upgrade *Noise Impact Assessment*

October 2008

Reference: 0051706noise rp3

For and on behalf of:
Environmental Resources Management Australia

Approved by: Murray Curtis

Signed: 

Position: Partner

Date: 21 October 2008

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1 INTRODUCTION

1.1 BACKGROUND

Environmental Resources Management Australia Pty Ltd (ERM) was engaged to undertake a noise impact assessment for the proposed Lismore to Mullumbimby Electricity Network Upgrade (see *Figure 1.1*). The upgrade includes construction activities and network operation along the transmission line routes and at the following existing substations:

- Lismore;
- Lismore South;
- Ballina;
- Lennox Head;
- Ewingsdale; and
- Mullumbimby.

The noise impact assessment (NIA) was conducted as a stand alone report to identify potential acoustic impacts associated with construction and operational activities and has been conducted with reference to:

- *Industrial Noise Policy* (INP), Department of Environment and Climate Change (DECC) 2000;
- *Environmental Noise Control Manual* (ENCM), NSW EPA 1994; and
- AS 1055-1997 *Description and Measurement of Environmental Noise* Part 1, 2 and 3.

The assessment has also been undertaken in accordance with the Director Generals Requirements issued pursuant to Section 75F of the Environmental Planning and Assessment Act 1979 for the preparation of an Environmental Assessment.

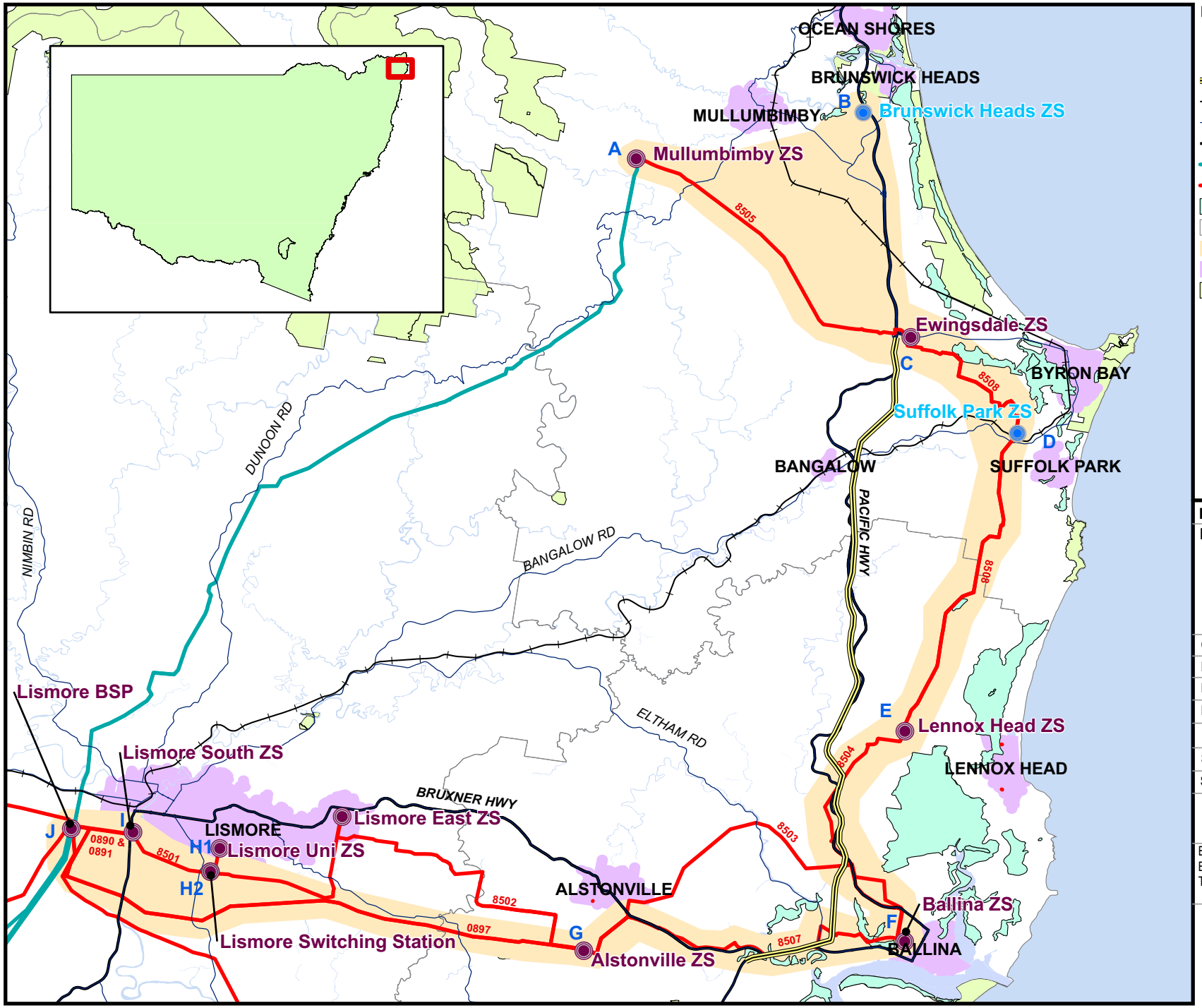

Figure 1.1
Project Area

Client:	Country Energy		
Project:	Lismore to Mullumbimby Upgrade		
Drawing No:	0051706_01	Suffix No:	A0
Date:	29/07/08	Drawing size:	A4
Drawn by:	TH	Reviewed by:	WW
Source:	Department of Lands		
Scale:	Refer Scale Bar		

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Acoustic Glossary

Environmental noise levels are commonly expressed in decibels (dB(A)). The A-weighting scale follows the average human hearing response and enables comparison of the intensity of noise with different frequency characteristics. Noise from environmental sources such as vehicles often varies with time. For this reason, noise emission from such sources is often described in terms of statistical noise descriptors. The following descriptors are commonly used to assess noise.

- dB(A) Noise level measurement units are decibels (dB). The "A" weighting indicates that a filter has been applied to the measured results to mimic the human response to noise.

- L_{max} - The absolute maximum noise level in a noise sample.

- L_{10} - The noise level which is exceeded for 10 per cent of the time and is approximately the average of the maximum noise levels.

- L_{90} - The noise level exceeded for 90 per cent of the time and is approximately the average of the minimum noise levels. The L_{90} level is often referred to as the "background" noise level and is commonly used as a basis for determining noise criteria for assessment purposes.

- L_{eq} - This level represents the "equivalent" or average noise energy during a measurement period. The $L_{eq\ (24\ hour)}$ noise descriptor simply refers to the Leq noise level calculated over a 24 hour period. Indeed, any of the above noise descriptors may be defined in this way, with an accompanying time period (e.g. L_{10} (15 minute)) as required.

- Sound Power Level Lw or SWL - 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.

The following concepts offer qualitative guidance in respect of the average response to changes in noise levels.

- differences in noise level of less than approximately 2 dB are generally imperceptible in practice.

- differences in noise level of around 5 dB are considered to be significant.

- a difference in noise level of around 10 dB is generally perceived to be a doubling (or halving) of the loudness of the noise.

2 NOISE IMPACT ASSESSMENT METHODOLOGY

2.1 NOISE CRITERIA

2.1.1 Operational Noise Criteria

The DECC, in its INP, gives guidelines for assessing industrial facilities. Assessment criteria depend on the existing amenity of areas potentially affected by a proposed development as outlined below.

Assessment criteria for sensitive receivers near industry are based on the following objectives:

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

To meet these objectives, two separate criteria are prescribed by the DECC, namely the intrusiveness criteria and the amenity criteria. A fundamental difference between the intrusiveness and the amenity criteria is that the former is applicable over 15 minutes in any period, while the latter covers the entire assessment period (day, evening and night).

Assessing for Intrusiveness

The intrusiveness criterion requires that $L_{Aeq,15min}$ noise levels from a newly introduced source during the day, evening and night do not exceed the existing Rating Background Levels (RBL) by more than 5dB. This is expressed as:

$$L_{Aeq,15min} \leq RBL + 5 - K$$

where $L_{Aeq,15min}$ is the L_{eq} noise level from the source, measured over a 15 minute period and K is a series of adjustments for various noise characteristics. Where the RBL is less than 30 dB(A), a value of 30 dB(A) is used.

Assessing for Amenity

The EPA's amenity criterion requires industrial noise to be within an acceptable level for the particular locality and land use. Where ambient noise is already high, the acoustic environment should not be deteriorated significantly. The strategy behind the amenity criterion is a holistic approach to noise, where all industrial noise (existing and future) received at a given receptor does not exceed the recommended goals.

Private residences potentially affected by the proposal are covered by the EPA's varying amenity categories as presented in Table 2.1 of the Industrial Noise Policy and reproduced below in *Table 2.1*.

Table 2.1 Amenity Criteria - Recommended LAeq Levels from Industrial Noise Sources

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended LAeq(Period) Noise Level (dB(A))	
			Acceptable	Recommended Maximum
Residence	Rural	Day	50	55
		Evening	45	50
		Night	40	45
	Suburban	Day	55	60
		Evening	45	50
		Night	40	45
	Urban	Day	60	65
		Evening	50	55
		Night	45	50
	Urban/Industrial Interface (for existing situations only)	Day	65	70
		Evening	55	60
		Night	50	55
School classrooms - internal	All	Noisiest 1 hour period when in use	35	40
Hospital wards - internal - external	All	Noisiest 1 hour period	35 50	40 55
Place of worship - internal	All	When in use	40	45
Area specifically reserved for passive recreation (e.g. National Park)	All	When in use	50	55
Active recreation area (e.g. school playground, golf course)	All	When in use	55	60
Commercial premises	All	When in use	65	70
Industrial premises	All	When in use	70	75

Note: Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am. On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.

Project Specific Noise Criteria

The proposed substation noise emission criteria have been set in accordance with the INP. Given that noise generated by substations is generally constant over 24 hours the critical time period for noise emissions to meet relevant criteria is during the night time. For those substations identified as being located in areas experiencing low night time acoustic amenity, background noise levels were not measured and therefore assessment criteria has been set based on the INP minimum background level of 30dB(A). The PSNC for these substations is given in *Table 2.2*.

Table 2.2 Project Specific Noise Criteria

Location	Description	Intrusiveness Criteria LAeq(15minute)
All Receivers	Night	35dB(A)

Due to likely elevated background noise levels from highway traffic, Project Specific Noise Criteria for Lismore South, Ballina and Ewingsdale substations were derived from long-term noise measurements logged at representative sensitive receptor locations near these substations. Details of noise measurements and derived PSNC for these substations are provided in the specific assessments in the relevant sections of this report.

2.1.2 Construction Noise Criteria

The DECC's current guidelines for construction (Environmental Noise Control Manual NSW EPA 1994) are described as follows:

Working Hours

Proposed construction working hours are based on guidance in Environmental NOSE Control Manual (NSW EPA 1994) and include:

- Monday to Friday - 0700 hours to 1800 hours
- Saturday - 0800 hours to 1300 hours
- No work on Sundays or Public Holidays

Work outside these hours would be permitted if the work is inaudible at sensitive receptors.

The DECC's construction noise guidelines sets out methods for determining construction criteria associated with proposed developments. *Table 2.3* reproduces the construction noise correction above the rating background noise level (RBL) based on duration that applies to nearest sensitive receivers.

Table 2.3 Construction Noise Goals

Construction Period	Acceptable LA10 Noise Level[1]
4 weeks and under	Background LA90 plus 20 dBA
4 weeks to 26 weeks	Background LA90 plus 10 dBA

Construction Period	Acceptable LA10 Noise Level[1]
Greater than 26 weeks	Background LA90 plus 5 dBA

For a cumulative period of exposure to noise from construction activity of up to four (4) weeks in duration, the LA10(15minute) noise level emitted by the works, when measured at a residential receiver, should not exceed the LA90(15minute) RBL by more than 20 dBA.

For a cumulative period of exposure to noise from construction activity of between 4 weeks and 26 weeks duration, the LA10(15minute) noise level emitted by the works, when measured at a residential receiver, should not exceed the LA90(15minute) RBL more than 10 dBA.

For a cumulative period of exposure to noise from construction activity in excess of 26 weeks duration, the LA10(15minute) noise level emitted by the works, when measured at a residential receiver, should not exceed the LA90(15minute) RBL by more than 5 dBA.

Derived Construction Noise Criteria

For transmission line construction and at those substations where background noise measurements were not recorded a conservative daytime background noise level of 5dB(A) above the adopted night time background level was assumed (i.e. 35dB(A)). The substation construction phase of this project is expected to occur near individual sensitive receptors over a period of between 4 weeks to 26 weeks in duration, whilst due to the rate of installation, the transmission line construction phase will be of a short-term (less than four weeks) duration in any particular location. Therefore the construction noise goals in these instances are set to background plus 10 dBA (LA90 + 10dBA) and plus 20dBA (LA90 + 20dBA) respectively as given in *Table 2.4*.

Table 2.4 Construction Noise Goals (between 4 weeks to 26 weeks construction period)

Location	Project Specific Noise Criteria LA10(15minute)
Substations - all receivers	45 dBA
Transmission line – all receivers	55 dBA
Note: Construction that is audible at sensitive receivers may only occur between the hours of 7.00 am and 6.00 pm Monday to Friday, and 8.00 am to 1.00 pm Saturdays. For all other times construction noise should be inaudible at the receiver.	

2.1.3 Sleep Disturbance

Substation noise is constant and free from impulsive sounds; therefore night time sleep disturbance is expected to be met if the typical night operating scenario is met. Sleep disturbance has not been considered further in this assessment.

2.2 EQUIPMENT SOUND POWER LEVELS

Dominant noise sources associated with operational substations include the following:

- transformers; and
- capacitor banks.

The sound power levels of this substation plant vary depending on capacity and manufacturer specifications. Sound power levels of modelled noise sources are detailed in each substation noise assessment below and are based on guidance in Australian Standard AS 1274.6 *Power Transformers Part 6: Determination of Transformer and Reactor Sound Levels* or from noise specifications provided by Country Energy.

"Modifying Factor" Adjustments

In accordance with *Section 4 'Modifying Factor Adjustments'* of the INP, sources that contain certain characteristics, such as tonality, low frequency noise or intermittency may result in a greater annoyance to the community. To account for this, the INP provides modifying factor corrections to be applied to such noise sources. Transformers and capacitor banks exhibit tonal characteristics at 50Hz and 100Hz that may meet guideline levels for tonality at sensitive receivers. Therefore, to provide a conservative assessment a modifying factor of 5dB(A) has been applied to the assessed noise levels for all assessed receivers at each substation.

2.3 METEOROLOGICAL ANALYSIS

Noise propagation over long distances can be significantly affected by the meteorological conditions. Of most interest are source to receiver winds and the presence of temperature inversions that can enhance received noise levels. To account for meteorological enhancement, the DECC's INP, specify weather analysis procedures to determine the prevalent weather conditions that enhance noise propagation with a view to determining whether they can be described as a feature of the project area.

The prevailing wind directions have been determined in accordance with the INP which requires that winds below 3m/s with an occurrence greater than 30 per cent be assessed. A multiple of wind directions were determined as prevailing when analysis of the Bureau of Meteorology data was undertaken.

Therefore, rather than assessing all prevailing conditions, only those condition that enhance noise emissions (source to receivers winds) were modelled in this assessment.

2.3.1 Lismore and Lismore South Substations

Wind roses created from 1 January 2004 to 30 December 2004 from the Bureau of Meteorology station at Casino, NSW have been analysed (approximately 24 kilometres from the substation sites), the results of this analysis are presented in more detail and form the wind roses presented in *Annex B* of this report. Generally, the resultant meteorological conditions to be modelled as a result of the analysis are presented in *Table 2.5.*

Table 2.5 Relevant Site Specific Meteorological Parameters for Lismore and Lismore South Zone Substations

Assessment Condition	Temperature	Wind Speed / Direction	Relative Humidity	Temperature Gradient
Daytime - Calm	20^0C	n/a	65%	n/a
Evening - Calm	15^0C	n/a	80%	n/a
Evening - Prevailing	15^0C	3m/s to receiver	80%	n/a
Night time - Calm	10^0C	n/a	85%	n/a
Night time - Prevailing	10^0C	3m/s to receiver	85%	n/a

Assessment Condition	Temperature	Wind Speed / Direction	Relative Humidity	Temperature Gradient
Temperature Inversion	10^0C	n/a	85%	3^0C/100 m

The potential for drainage flows to occur around the substation sites have been analysed and are not relevant as substation noise sources are at a similar or lower elevation than nearby receivers, or there is intervening topography present between the substation and nearby receivers.

2.3.2 Ballina, Lennox Head, Ewingsdale and Mullumbimby Zone Substations

Wind roses created from 1 November 2006 to 12 December 2007 from the Bureau of Meteorology station at Cape Byron have been analysed (approximately 12 to 24 kilometres from the substation sites), the results of this analysis are presented in more detail and form the wind roses presented in *Annex C* of this report. Generally, the resultant meteorological conditions to be modelled as a result of the analysis are presented in *Table 2.6.*

Table 2.6 Relevant Site Specific Meteorological Parameters

Assessment Condition	Temperature	Wind Speed / Direction	Relative Humidity	Temperature Gradient
Daytime - Calm	20^0C	n/a	65%	n/a
Evening - Calm	15^0C	n/a	80%	n/a
Night time - Calm	10^0C	n/a	80%	n/a
Temperature Inversion	10^0C	n/a	80%	3^0C/100 m

2.4 NOISE IMPACT ASSESSMENT

2.4.1 Calculation Procedures

ENM noise modelling software was used to assess potential noise impacts associated with the proposed substation. ENM is a DECC accepted software package and takes into account distance, ground effect, atmospheric absorption and topographic detail.

The model incorporated three-dimensional digitised ground contours for the facility, as derived from proposed site plans, and the surrounding land base topography, superimposed on each other. Substation plant was modelled at various locations and heights, representative of realistic operating conditions (for one-third octave sound power data see *Annex A*).

2.4.2 Operational Noise Modelling

A modifying factor of 5 dBA for low frequency/tonal content has been applied to substation noise emissions in this assessment in accordance with Section 4 if the INP. The operational scenario was modelled to determine the potential acoustic impact of the substation on the surrounding community during typical operation.

2.4.3 Construction Noise Modelling

Construction works at the substations are expected to last for between 4 weeks to 26 weeks. The construction noise impact assessment has adopted the simultaneous operation items of equipment presented in *Table 2.7* to represent likely construction noise levels. The sound power levels provided were obtained from ERM's database.

Table 2.7 Construction Plant

Plant and Equipment	Sound Power Level (LA10)
Compressor	91 dBA
Agitator	107 dBA
Franna Crane / Hooklift Truck	105 dBA
Road Trucks	103 dBA
Paver/Wacker	108 dBA
Rollers	113 dBA
Excavator Komatsu PC300	103 dBA
Hand tools (including grinding, hammering etc.)	106 dBA

3 LISMORE BULK SUPPLY POINT SUBSTATION

3.1 PROJECT DESCRIPTION

The Lismore substation is a bulk supply substation linked to Transgrid's Lismore substation. The project involves the installation of a new 132kV line bay for the proposed new 132kV feeder to Ballina. No changes to transformers and capacitor banks are proposed. Dominant noise sources currently associated with the substation include the following:

- 3 x 132/66kV 120MVA transformers;
- 2 x 66kV 6MVA capacitor banks; and
- 1 x 132kV 12MVA capacitor bank.

Table 3.1 presents the sound power levels of modelled sources in this assessment.

Table 3.1 Equipment Sound Power Levels

Equipment	Sound Power Level dB(A)
132/66kV MVA Transformers	78
66kV 6MVA Capacitor Banks	81
132kV 12 MVA Capacitor Bank	81

3.2 RESIDENTIAL RECEIVERS

Sensitive receivers surrounding the proposed substation are west and east in Three Chain Road and north west on Ruane Road, south east off Caniaba Road and south west off Nimoola Road, Lismore, NSW. The locality map presented in *Figure 3.1* identifies the nearest residential dwellings adjacent to the proposed substation.

3.3 NOISE IMPACT ASSESSMENT

3.3.1 Operational Noise Modelling Results and Discussion

A summary of predicted noise levels at assessed representative residences adjacent to the proposed substation are provided in *Table 3.2* to for calm, prevailing and inversion conditions.

Legend

Substation Site

R1 Receptor Location

Figure 3.1

Lismore Substation Locality Plan

Client:	Country Energy		
Project:	Proposed 132kV Substation upgrade, Lismore - Noise Impact Assessment		
Drawing No:	0051706hv_lismore_01		
Date:	29/09/08	Drawing size:	A4
Drawn by:	SP	Reviewed by:	MC
Source:	Google Maps		
Scale:	Refer to Scale Bar		

N

0 100 200 300m

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Table 3.2 Noise Modelling Summary – Proposed Substation, Lismore

Locality	Period / Meteorological Condition	Project Specific Noise Criteria LAeq dB(A)	LAeq dB(A)
Residence 1	Day – Calm	35	<30
	Evening – Calm	35	<30
	Evening – Prevailing	35	<30
	Night - Calm	35	<30
	Night - Prevailing	35	<30
	Night - Inversion	35	<30
Residence 2	Day – Calm	35	<30
	Evening – Calm	35	<30
	Evening – Prevailing	35	<30
	Night - Calm	35	<30
	Night - Prevailing	35	<30
	Night - Inversion	35	<30
Residence 3	Day – Calm	35	<30
	Evening – Calm	35	<30
	Evening – Prevailing	35	<30
	Night - Calm	35	<30
	Night - Prevailing	35	<30
	Night - Inversion	35	<30
Residence 4	Day – Calm	35	<30
	Evening – Calm	35	<30
	Evening – Prevailing	35	<30
	Night - Calm	35	<30
	Night - Prevailing	35	<30
	Night - Inversion	35	<30
Residence 5	Day – Calm	35	<30
	Evening – Calm	35	<30
	Evening – Prevailing	35	<30
	Night - Calm	35	<30
	Night - Prevailing	35	<30
	Night - Inversion	35	<30
Residence 6	Day – Calm	35	<30
	Evening – Calm	35	<30
	Evening – Prevailing	35	<30
	Night - Calm	35	<30
	Night - Prevailing	35	<30
	Night - Inversion	35	<30
Residence 7	Day – Calm	35	<30
	Evening – Calm	35	<30
	Evening – Prevailing	35	<30
	Night - Calm	35	<30
	Night - Prevailing	35	<30
	Night - Inversion	35	<30

Note : Where predicted noise levels were below 30 dBA, <30 dBA level has been reported.

Modelled noise levels for the Lismore substation upgrade are expected to comply with the PSNC at all nearest residences to the proposed upgraded substation site.

3.3.2 Construction Noise Modelling Results and Discussion

Model results for the construction works at the substation site are presented in *Table 3.3*.

Table 3.3 Construction Emissions Summary

Locality	Project Specific Noise Criteria LAeq dB(A)	LAeq dB(A)
Residence 1	45	41
Residence 2		<30
Residence 3		<30
Residence 4		<30
Residence 5		<30
Residence 6		<30
Residence 7		<30

Calculations of noise emissions associated with the construction and upgrade of the proposed Lismore substation would not exceed the construction noise criteria.

4 LISMORE SOUTH SUBSTATION

4.1 PROJECT DESCRIPTION

The Lismore South substation is located on the Bruxner Highway in an area dominated by industrial land use. The project involves the long-term redesign of the substation resulting in the relocation of transformer bays and capacitor banks.

Dominant noise sources associated with the upgraded substation include the following:

- 3 x 66/11kV 30MVA transformers; and
- 1 x 11kV 7.5MVA capacitor bank.

Table 4.1 presents the sound power levels of modelled sources.

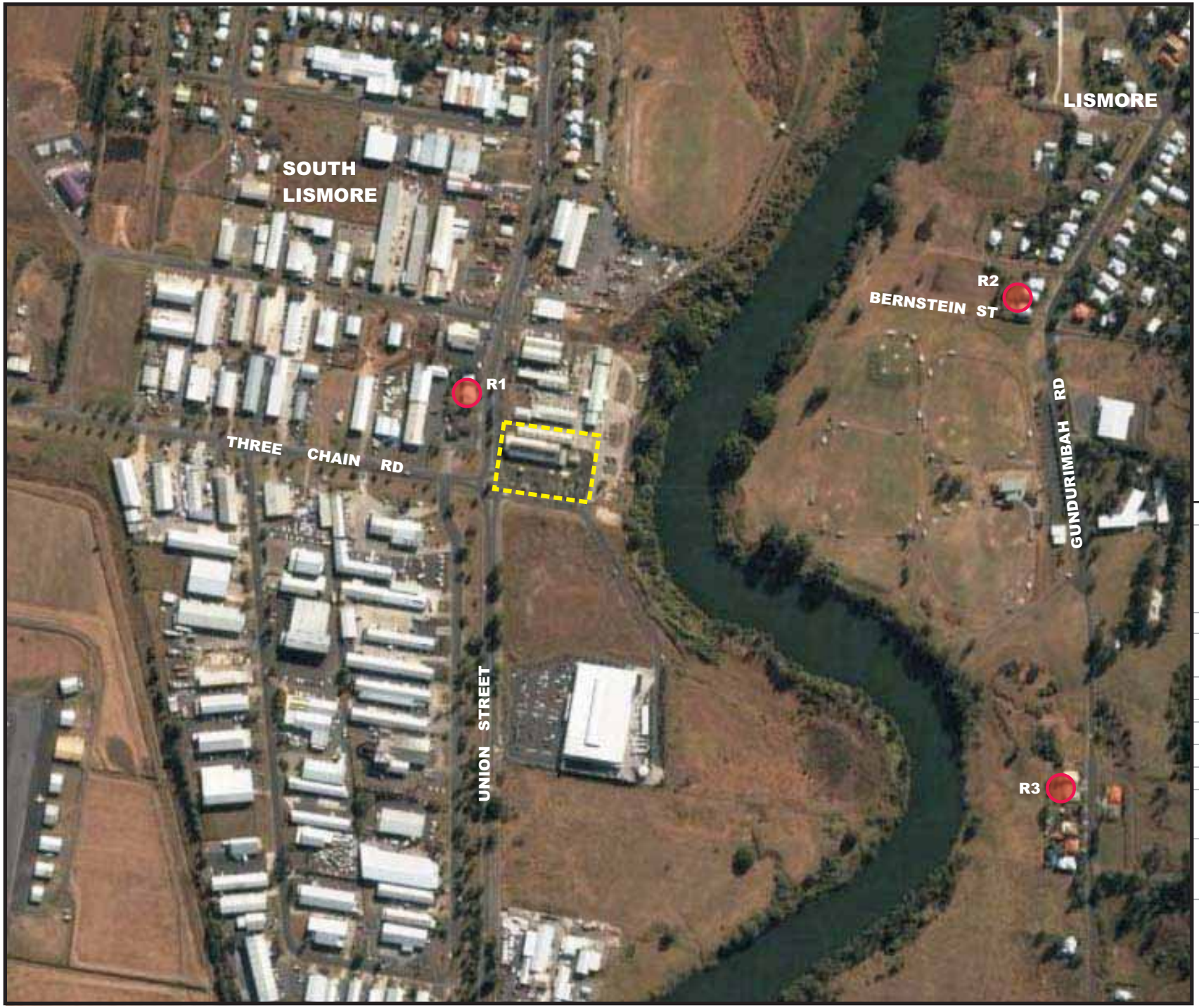
Table 4.1 Equipment Sound Power Levels

Equipment	Sound Power Level dB(A)
66/11kV 30MVA Transformers	77
11kV 7.5 MVA Capacitor Bank	81

4.2 SENSITIVE RECEPTORS

Closest receivers to the proposed substation are generally to the north in Union Street, north east and south east in Gundurimba Road, South Lismore, NSW.

The locality map presented in *Figure 4.1* identifies the receptors assessed in this report.



Legend

Substation Site

R1 Receptor Location

Figure 4.1

Lismore South Substation Locality Plan

Client:	Country Energy		
Project:	Proposed 132kV Substation upgrade, South Lismore - Noise Impact Assessment		
Drawing No:	0051706hv_sth_lis_01		
Date:	29/09/08	Drawing size:	A4
Drawn by:	SP	Reviewed by:	MC
Source:	Google Maps		
Scale:	Refer to Scale Bar		

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4.3 NOISE CRITERIA

4.3.1 Unattended Noise Monitoring

Unattended continuous noise monitoring was conducted from 5 December 2007 to 18 December 2007 inclusive at the nearest residential receivers situated in Gundurimba Road, South Lismore using an ARL Type EL215 environmental noise logger.

A summary of the results of the background surveys, within the proposed hours of operation of the development, are given in *Table 4.2*. *Annex D* presents the noise logging charts for the unattended noise assessment.

Table 4.2 Summary of Background and Ambient Noise Levels

Location	Rating Background Level, dB(A)			Ambiant Noise Level, dB(A)$L_{eq,period}$		
	Day	Evening[3]	Night	Day	Evening	Night
Gundurimba Road	39	40 (39)	38	53	60	51

1. Day is from 7am to 6pm; Evening is from 6pm to 10pm; and Night is from 10pm to 7am (INP).
2. Noise data during periods of any rainfall and/or wind speeds above 10m/s were discarded. This is based on AS1170 wind speed data height corrections for data recorded at an elevation of 10m.
3 Adjustments are to be made to the Project Specific Noise Criteria to account for evening noise levels being 1 dBA higher than daytime, in accordance with the DECC's Application Notes for the INP.

4.3.2 Attended Noise Monitoring

To gain an understanding of the existing noise environment ERM conducted attended noise monitoring during calm clear weather conditions to ascertain dominate ambient noise sources and to quantify existing industrial noise contributions. Attended monitoring was undertaken at Union Street and at Gundurimba Road on 18 December 2007 during logger deployment. The findings of the survey are presented in *Table 4.3.*

Table 4.3 Summary of Attended Noise Measurements

Location	Time/Date	Duration (min)	Total Measured Noise Levels, dB(A)		Noise Sources dBA
			L_{eq}	L_{90}	
Gundurimba Road	14:45	15:00	50	44	Low level distant traffic noise 40-42 Local traffic 42-47 Some industrial noise contribution from west of river 38 – 44 Substation inaudible.
Union Street	13:30	15:00	56	47	Dominated by traffic noise. Substation inaudible.

4.3.3 Project Specific Noise Criteria

Operational Noise Criteria

The PSNC have been set in accordance with the INP. The intrusiveness and amenity design criteria have been set from logging measurements conducted at the nearest representative receiver to the substation site.

The background noise levels for setting the intrusiveness criterion have been determined in the absence of any noise from the proposed or existing development.

The existing LAeq in the area where unattended noise monitoring was undertaken to the east of the substation near Gundurimba Street is dominated by traffic noise, some industrial noise from the area around Union Street and from residential noise sources. The acoustical environment in this area is typical of a *suburban* environment as it is dominated by traffic noise during peak times including the evenings. The resulting design goals are given in *Table 4.4*.

Table 4.4 Project Specific Noise Criteria

Location	Description	Intrusiveness Criteria LAeq(15minute)	Amenity Criteria LAeq(Period)
North East and South East Receivers	Day	**44 dBA**	55 dBA
	Evening	**44 dBA**	45 dBA
	Night	43 dBA	**40 dBA**

1. Weekdays and Saturdays – Daytime 7:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night 10:00 pm – 07:00 am.
2. Applicable project specific noise criteria are in bold. Adjustments have been made to the PSNC to account for daytime noise levels being quieter than evening and night periods in accordance with the DECC Application Notes of the INP.
3. The INP states that these criteria have been selected to protect at least 90% of the population living in the vicinity of industrial noise sources from the adverse effects of noise for at least 90% of the time. Provided the criteria in the INP are achieved, it is unlikely that most people would consider the resultant noise levels excessive.

The attended monitoring at Union Street indicates that this area experiences higher noise levels due to traffic and other nearby industrial land uses. The acoustical environment in this area around the substation is typical of an *urban* environment as it is dominated by industrial noise sources and has through traffic with characteristically heavy and continuous traffic flows during peak periods. Given no long-term background noise monitoring was undertaken it can be reasonably expected that the critical noise criteria for this area (night time) would be between an intrusiveness criteria of 43dB(A) (based on the criteria identified for eastern receivers in *Table 4.4* and 45dB(A) being the night time amenity criteria for urban areas (refer

Table 2.1).

Construction Noise Criteria

Noise criteria for the construction phase of this project is expected to occur for a period of between 4 to 26 weeks in duration, therefore the construction noise goals are set to background plus 10 dBA (LA90 + 5dBA), therefore the following noise criteria for construction apply :

Table 4.5 Construction Noise Goals (Between 4 and 26 week construction period)

Location	Project Specific Noise Criteria LA10(15minute)
North East and South East Receivers	49 dBA
Union Street	57dB(A)
Note: Construction audible at sensitive receivers may only occur between the hours of 7.00 am and 6.00 pm Monday to Friday, and 8.00 am to 1.00 pm Saturdays. For all other times construction noise must be inaudible at the receiver.	

4.4 NOISE IMPACT ASSESSMENT

4.4.1 Operational Noise Modelling Results and Discussion

A summary of predicted noise levels at assessed representative residences adjacent to the proposed substation are provided in *Table 4.6* to for calm, prevailing (source to receiver winds) and inversion conditions.

Table 4.6 Noise Modelling Summary – Proposed Substation, South Lismore

Locality	Project Specific Noise Criteria LAeq	Calm LAeq	Prevailing LAeq	Inversion LAeq
Union Street	Night[1] – 43-45 dBA	43 dBA	44 dBA	43 dBA
Gundurimba Street (north)	Day[2] - 44 dBA	<30 dBA	<30 dBA	<30 dBA
	Evening[2] - 44 dBA *			
	Night[3] - 40 dBA			
Gundurimba Street (south)	Day[2] - 44 dBA	<30 dBA	<30 dBA	<30 dBA
	Evening[2] - 44 dBA *			
	Night[3] - 40 dBA			

1. Estimate, see Section 4.3.
2. Intrusive Criteria Applicable - LAeq(15minute).
3. Amenity Criteria Applicable - LAeq(Period).

Modelled noise levels for each period (day, evening and night) were within 1 dBA of each other. Where the PSNC day is quieter than that of evening or night, the day PSNC has been adopted.

Modelled noise levels of the proposed Lismore South substation upgrade are expected to meet the relevant PSNC for all sensitive receivers during applicable meteorological conditions.

4.4.2 Construction Noise Modelling Results and Discussion

Model results for the construction works at the substation site are presented in *Table 4.7*

Table 4.7 Construction Emissions Summary

Locality	Project Specific Noise Criteria LAeq	Calm LAeq
Union Street	Day - 57 dBA	62 dBA
Gundurimba Street (north)	Day - 49 dBA	30 dBA
Gundurimba Street (south)		36 dBA

Calculations of noise emissions associated with the construction of the proposed Lismore South substation upgrade would exceed the construction noise criteria at the nearby receiver in Union Street. However, it is noted that this assessment did not consider intervening barriers such as the existing buildings within the substation site. Further, the residence is located adjacent to the Bruxner Highway within an area dominated by industrial activity. Therefore, this assessment is conservative and it is considered that the potential for construction noise to impact on this residence is less likely. Nevertheless to minimise the potential acoustic impacts of construction activities on nearby residences, it is recommended that management and mitigation activities detailed in *Section 10* be implemented as part of the construction process.

5 BALLINA SUBSTATION

5.1 PROJECT DESCRIPTION

The project involves upgrading the 66/11kV Ballina substation to a 132/66/11kV zone substation and includes the installation of new 132kV and 66kV line bays and a new 132/66/11kV transformer. The existing 66/11kV infrastructure will be retained including transformers and capacitor banks.

Dominant noise sources associated with the upgraded substation include the following:

- 2 x 66/11kV 30MVA transformers (only one to operate at any one time);
- 1 x 132/66/11kV 75MVA transformer; and
- 1 x 11kV 7.5MVA capacitor bank.

Table 5.1 presents the sound power levels of modelled sources in this assessment.

Table 5.1 Equipment Sound Power Levels

Equipment	Sound Power Level dB(A)
132/66/11kV 75MVA Transformer	85
66/11kV 30MVA Transformer	78
11kV 7.5MVA Capacitor Bank	81

5.2 RESIDENTIAL RECEIVERS

Sensitive receivers surrounding the proposed substation are north in Vera Street, east in Temple Street and to the south in Canal Road.

The locality map presented in *Figure 5.1* identifies the nearest residential dwellings adjacent to the proposed substation.

Legend

Substation Site

R1 Receptor Location

Figure 5.1

Ballina Substation Locality Plan

Client:	Country Energy		
Project:	Proposed 132kV Substation upgrade, Ballina - Noise Impact Assessment		
Drawing No:	0051706hv_ballina__01		
Date:	29/09/08	Drawing size:	A4
Drawn by:	SP	Reviewed by:	MC
Source:	Google Maps		
Scale:	Refer to Scale Bar		

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5.3 NOISE CRITERIA

5.3.1 Unattended Noise Monitoring

Unattended continuous noise monitoring was conducted from 8 August 2008 to 19 August 2008 inclusive at 49 Temple Street, Ballina to the east of the substation site using an ARL Type EL215 environmental noise logger.

A summary of the results of the background surveys, within the proposed hours of operation of the development, are given in *Table 5.2*. *Annex E* presents the noise logging charts for the unattended noise assessment.

Table 5.2 Summary of Background and Ambient Noise Levels

Location	Rating Background Level, dB(A)			Ambiant Noise Level, dB(A)$L_{eq,period}$		
	Day	Evening[3]	Night	Day	Evening	Night
49 Temple Street	33	38	33	48	44	45

1. Day is from 7am to 6pm; Evening is from 6pm to 10pm; and Night is from 10pm to 7am (INP).

5.3.2 Attended Noise Monitoring

To gain an understanding of the existing noise environment ERM conducted attended noise monitoring during calm clear weather conditions to ascertain dominate ambient noise sources and to quantify existing industrial noise contributions. Attended monitoring was undertaken at 49 Temple Street on 8 August 2008 during logger deployment. The findings of the survey are presented in *Table 5.3.*

Table 5.3 Summary of Attended Noise Measurements

Location	Time/Date	Duration (min)	Total Measured Noise Levels, dB(A)		Noise Sources dBA
			L_{eq}	L_{90}	
49 Temple Street	10:10	15:00	43	39	Distant traffic noise from Pacific Highway 42-44 Some construction noise in local area 44 – 47 Substation inaudible.

5.3.3 Project Specific Noise Criteria

Operational Noise Criteria

The PSNC have been set in accordance with the INP. The intrusiveness and amenity design criteria have been set from logging measurements conducted at the nearest representative receiver to the substation site.

The background noise levels for setting the intrusiveness criterion have been determined in the absence of any noise from the proposed or existing development.

The existing LAeq in the area where unattended noise monitoring was undertaken to the east of the substation in Temple Street is dominated by traffic noise and from residential noise sources. The acoustical environment in this area is typical of a *suburban* environment as it is dominated by traffic noise during peak times including the evenings. The resulting design goals are given in *Table 5.4*.

Table 5.4 Project Specific Noise Criteria

Location	Description	Intrusiveness Criteria LAeq(15minute)	Amenity Criteria LAeq(Period)
All Receivers	Day	**38 dBA**	55 dBA
	Evening	**43 dBA**	45 dBA
	Night	**38 dBA**	40 dBA

1. Weekdays and Saturdays – Daytime 7:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night 10:00 pm – 07:00 am.
2. Applicable project specific noise criteria are in bold.
3. The INP states that these criteria have been selected to protect at least 90% of the population living in the vicinity of industrial noise sources from the adverse effects of noise for at least 90% of the time. Provided the criteria in the INP are achieved, it is unlikely that most people would consider the resultant noise levels excessive.

Construction Noise Criteria

Noise criteria for the construction phase of this project is expected to occur for a period of between 4 to 26 weeks in duration, therefore the construction noise goals are set to background plus 10 dBA (LA90 + 5dBA), therefore the following noise criteria for construction apply :

Table 5.5 Construction Noise Goals (Between 4 and 26 week construction period)

Location	Project Specific Noise Criteria LA10(15minute)
All Receivers	43 dBA

Note: Construction audible at sensitive receivers may only occur between the hours of 7.00 am and 6.00 pm Monday to Friday, and 8.00 am to 1.00 pm Saturdays. For all other times construction noise must be inaudible at the receiver.

5.4 NOISE IMPACT ASSESSMENT

5.4.1 Operational Noise Modelling Results and Discussion

A summary of predicted noise levels at assessed representative residences adjacent to the proposed substation are provided in *Table 5.6* to for calm and inversion conditions.

Table 5.6 Noise Modelling Summary – Proposed Substation, Ballina - No Mitigation

Locality	Period / Meteorological Condition	Project Specific Noise Criteria LAeq dB(A)	LAeq dB(A)
Residence 1	Day – Calm	38	51
	Evening – Calm		51
	Night - Calm		51
	Night - Inversion		52
Residence 2	Day – Calm		44
	Evening – Calm		44
	Night - Calm		44
	Night - Inversion		45
Residence 3	Day – Calm		40
	Evening – Calm		40
	Night - Calm		40
	Night - Inversion		41
Residence 4	Day – Calm		37
	Evening – Calm		37
	Night - Calm		37
	Night - Inversion		38
Residence 5	Day – Calm		43
	Evening – Calm		43
	Night - Calm		43
	Night - Inversion		44

The modelled noise levels for the proposed substation upgrade are expected to be above the adopted project specific noise criteria at several residences therefore noise mitigation was incorporated into the noise model. The mitigation adopted included:

- 3.8 metre barrier along the northern and eastern boundary of the substation compound; and
- installation of a Stage 1 attenuation kit on the capacitor bank (10dB reduction).

Levels following the implementation of the above mitigation measures resulted in noise levels within 3 dBA of the noise criteria as summarised in *Table 5.7*.

Table 5.7 Noise Modelling Summary – Proposed Substation, Ballina – Limited Mitigation

Locality	Period / Meteorological Condition	Project Specific Noise Criteria LAeq dB(A)	LAeq dB(A)
Residence 1	Day – Calm	38	38
	Evening – Calm		38
	Night - Calm		38
	Night - Inversion		39
Residence 2	Day – Calm		36
	Evening – Calm		36
	Night - Calm		36
	Night - Inversion		40
Residence 3	Day – Calm		39
	Evening – Calm		39
	Night - Calm		39
	Night - Inversion		41
Residence 4	Day – Calm		36
	Evening – Calm		36
	Night - Calm		36
	Night - Inversion		38
Residence 5	Day – Calm		36
	Evening – Calm		36
	Night - Calm		36
	Night - Inversion		37

Project Sound Power Level

The results in *Table 5.7* indicate only minor exceedences with the only exceedences above 1dB predicted to occur at residences located to the east and south east during night time inversion events. These events are likely to be relatively limited within such a coastal location. Country Energy has advised that alternate options for mitigation could include one or a combination of the following:

- installation of a Stage 2 attenuation kit on the capacitor bank (additional 6dB reduction);
- installation of partial or full enclosure around the 132/66/11kV 75MVA power transformer;
- installation of partial or full enclosure around the 66/11kV 30MVA power transformers;
- construction of alternate barrier wall heights and locations (e.g. along the eastern portion of the southern compound boundary); and
- redesign of the substation placing plant with highest noise emissions further from sensitive receptors.

Given the large potential permutations of available mitigation options it is proposed that the most feasible and economic mitigation option be developed with the goal of achieving an overall sound power level for the substation site meeting the PNSC.

5.4.2 Construction Noise Modelling Results and Discussion

Model results for the construction works at the substation site are presented in *Table 5.8*.

Table 5.8 Construction Emissions Summary

Locality	Project Specific Noise Criteria LAeq dB(A)	LAeq dB(A)
Residence 1	43	62
Residence 2		56
Residence 3		53
Residence 4		51
Residence 5		56

Calculations of noise emissions associated with the construction and upgrade of the proposed Ballina substation would exceed the construction noise criteria. To minimise the potential acoustic impacts of construction activities on nearby residences, it is recommended that management and mitigation activities detailed in the recommendation section of this report be implemented as part of the construction process.

6 LENNOX HEAD SUBSTATION

6.1 PROJECT DESCRIPTION

The Lennox Head substation was recently constructed to accept 132kV though has to date only energised to 66kV. The project involves the replacement of existing 66/11kV transformers with 132/11kV transformers to allow energisation to 132kV.

Dominant noise sources associated with the upgraded substation include the following:

- 2 x 132/11kV 30MVA transformers; and
- 1 x 11kV 7.5MVA capacitor bank.

Table 6.1 presents the sound power levels of modelled sources.

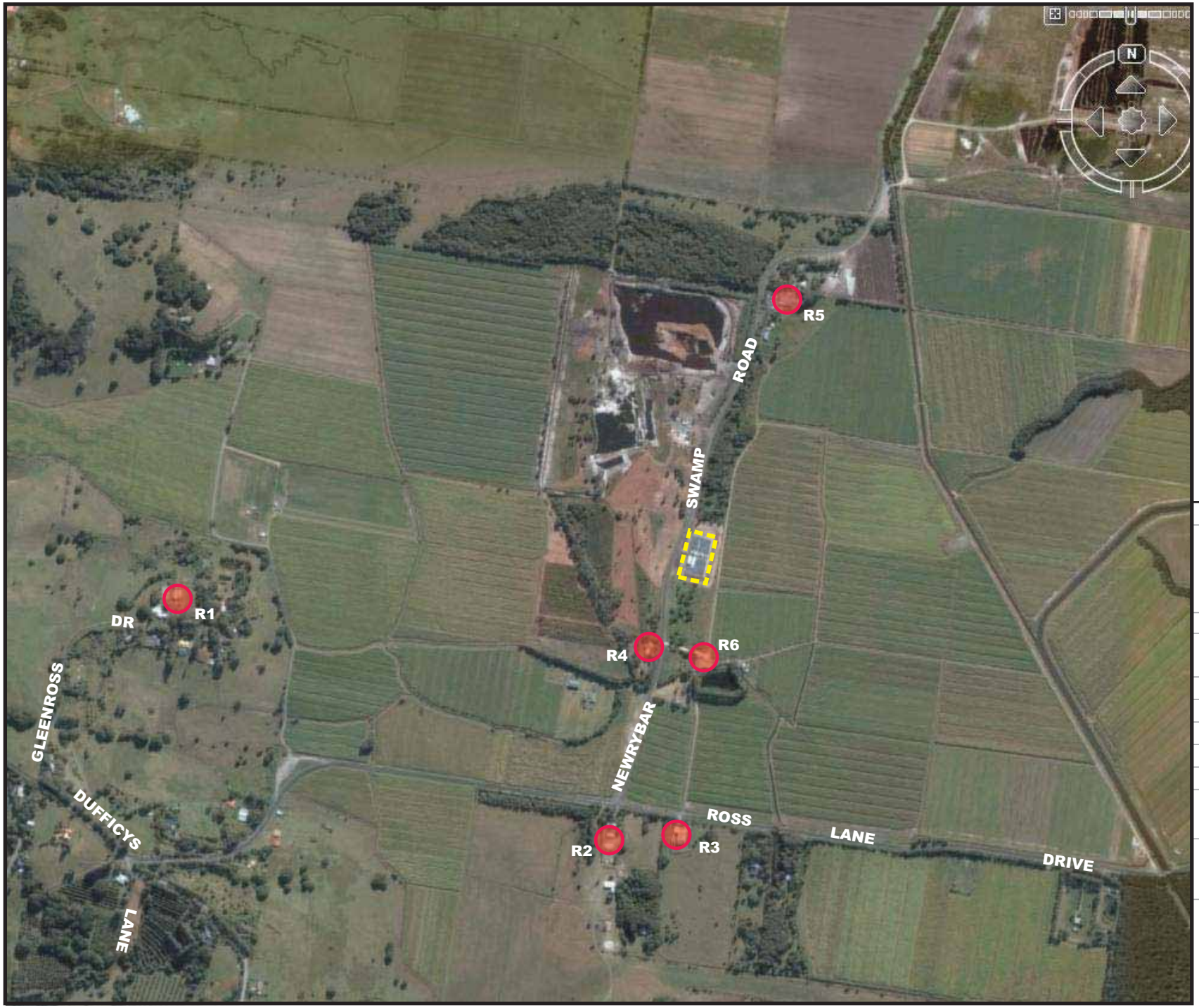
Table 6.1 Equipment Sound Power Levels

Equipment	Sound Power Level dB(A)
132/11kV 30MVA Transformers	71
11kV 7.5 MVA Capacitor Bank	81

6.2 RESIDENTIAL RECEIVERS

Sensitive receivers surrounding the proposed substation are north and south in Newrybar Swamp Road, further south in Ross Lane and west in Glennross Drive.

The locality map presented in *Figure 6.1* identifies the nearest residential dwellings within the vicinity of the substation site.



Legend

Substation Site

R1 Receptor Location

Figure 6.1

Lennox Head Substation Locality Plan

Client:	Country Energy		
Project:	Proposed 132kV Substation upgrade, Lennox Head - Noise Impact Assessment		
Drawing No:	0051706hv_lennox_01		
Date:	29/09/08	Drawing size:	A4
Drawn by:	SP	Reviewed by:	MC
Source:	Google Maps		
Scale:	Refer to Scale Bar		

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6.3 NOISE IMPACT ASSESSMENT

6.3.1 Operational Noise Modelling Results and Discussion

A summary of predicted noise levels at assessed representative residences adjacent to the proposed substation are provided in *Table 6.2* to for calm and inversion conditions.

Table 6.2 Noise Modelling Summary

Locality	Period / Meteorological Condition	Project Specific Noise Criteria LAeq dB(A)	LAeq dB(A)
Residence 1	Day – Calm	35	<30
	Evening – Calm		
	Night - Calm		
	Night - Inversion		
Residence 2	Day – Calm		
	Evening – Calm		
	Night - Calm		
	Night - Inversion		
Residence 3	Day – Calm		
	Evening – Calm		
	Night - Calm		
	Night - Inversion		
Residence 4	Day – Calm		
	Evening – Calm		
	Night - Calm		
	Night - Inversion		
Residence 5	Day – Calm		
	Evening – Calm		
	Night - Calm		
	Night - Inversion		
Residence 6	Day – Calm		
	Evening – Calm		
	Night - Calm		
	Night - Inversion		

Modelled noise levels for the proposed Lennox Head substation upgrade are expected to comply with the PSNC at all residences surrounding the proposed upgraded substation.

6.3.2 Construction Noise Modelling Results and Discussion

Model results for the construction works at the substation site are presented in *Table 6.3*.

Table 6.3 Construction Emissions Summary

Locality	Project Specific Noise Criteria LAeq dB(A)	LAeq dB(A)
Residence 1	45	32
Residence 2		38
Residence 3		39
Residence 4		51
Residence 5		41
Residence 6		51

Calculations of noise emissions associated with the construction of the proposed Lennox Head substation indicates noise levels will comply at all adjacent residences with the exception of Residence 4 and Residence 6. To minimise the potential acoustic impacts of construction activities on nearby residences, it is recommended that management and mitigation activities detailed in the recommendation section of this report be implemented as part of the construction process.

7 EWINGSDALE SUBSTATION

7.1 PROJECT DESCRIPTION

The Ewingsdale substation was recently constructed to accept 132kV though has to date only energised to 66kV. The project involves the replacement of existing 66/11kV transformers with 132/11kV transformers to allow energisation to 132kV.

Dominant noise sources associated with the upgraded substation include the following:

- 2 x 132/11kV 30MVA transformers; and
- 1 x 11kV 7.5MVA capacitor bank.

Table 7.1 presents the sound power levels of modelled sources.

Table 7.1 Equipment Sound Power Levels

Equipment	Sound Power Level dB(A)
132/11kV 30MVA Transformers	71
11kV 7.5 MVA Capacitor Bank	81

7.2 RESIDENTIAL RECEIVERS

Closest receivers to the proposed substation are a single residence to the north on Ewingsdale Road and residences to the south east and south in Parkway Drive, Ewingsdale.

The locality map presented in *Figure 7.1* identifies the receptors assessed in this report.

Legend

Substation Site

R1 Receptor Location

Figure 7.1

Ewingsdale Substation Locality Plan

Client:	Country Energy		
Project:	Proposed 132kV Substation upgrade, Ewingsdale - Noise Impact Assessment		
Drawing No:	0051706hv_ewingsdale__01		
Date:	29/09/08	Drawing size:	A4
Drawn by:	SP	Reviewed by:	MC
Source:	Google Maps		
Scale:	Refer to Scale Bar		

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7.3 NOISE CRITERIA

7.3.1 Background Noise Monitoring

Unattended Noise Monitoring

Unattended continuous monitoring was conducted from 23 November 2007 to 5 December 2007 inclusive at the residential receivers situated in Avocado Crescent, Ewingsdale using an ARL Type EL215 environmental noise logger.

A summary of the results of the background surveys, within the proposed hours of operation of the development, are given in *Table 7.2*. *Annex F* presents the noise logging charts for the unattended noise assessment.

Table 7.2 Summary of Background and Ambient Noise Levels

Location	Rating Background Level, dB(A)			Ambiant Noise Level, dB(A)$L_{eq,period}$		
	Day[1]	Evening[1]	Night[1]	Day[1]	Evening[1]	Night[1]
Avocado Crescent	37	40	40	46	49	51

1. Day is from 7am to 6pm; Evening is from 6pm to 10pm; and Night is from 10pm to 7am (INP).
2. Noise data during periods of any rainfall and/or wind speeds above 8m/s were discarded. This is based on AS1170 wind speed data height corrections.

Attended Noise Monitoring

To gain an understanding of the existing noise environment ERM conducted attended noise monitoring during calm clear weather conditions to ascertain dominate ambient noise sources and to quantify existing industrial noise contributions. Attended monitoring was undertaken at Avocado Crescent on 23 November 2007 during logger deployment. The findings of the survey are presented in *Table 7.3.*

Table 7.3 Summary of Attended Noise Measurements

Location	Time/Date	Duration (min)	Total Measured Noise Levels, dB(A)		Industrial Noise Contribution dB(A)	Noise Sources
			L_{eq}	L_{90}		
30 Avocado Crescent	11:45	15:00	45	41	< 35	Low level distant traffic noise 40-42 Birds – 42-47 No industrial noise contribution

7.3.2 Project Specific Noise Criteria

Operational Noise Criteria

The proposed facilities noise emission criteria have been set in accordance with the INP. The intrusiveness and amenity design criteria have been set from logging measurements conducted at a representative receiver near the substation site.

The background noise levels for setting the intrusiveness criterion have been determined in the absence of any noise from the substation.

The existing LAeq in the area surrounding the proposed substation is dominated by traffic and residential noise sources. The acoustical environment surrounding the proposed substation is typical of a suburban environment as it is dominated by through traffic from Ewingsdale Road and the Pacific Highway, in particular during peak times including the evenings, where noise levels are elevated from traffic.

Assessment of transport noise in accordance with Section 2.2.3 of the INP has been undertaken and it has been identified that corrections for high traffic noise is applicable to night noise levels. Furthermore, there is no existing industrial noise contribution at representative receivers, the recommended acceptable amenity levels from Table 2.1 of the INP has been adopted as the Amenity Criteria.

The resulting design goals are given in *Table 7.4*.

Table 7.4 Project Specific Noise Criteria

Location	Description	Intrusiveness Criteria LAeq(15minute)	Amenity Criteria LAeq(Period)
South East and South Receivers	Day	**42 dBA**	55 dBA
	Evening	**45 dBA**	45 dBA
	Night	45 dBA	**41 dBA**

1. Weekdays and Saturdays - Daytime 7:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night 10:00 pm - 07:00 am.
2. Applicable project specific design criteria are in bold. Adjustments have been made to the PSNC to account for daytime noise levels being quieter than evening and night periods in accordance with the DECC Application Notes of the INP.
3. The INP states that these criteria have been selected to protect at least 90% of the population living in the vicinity of industrial noise sources from the adverse effects of noise for at least 90% of the time. Provided the criteria in the INP are achieved, it is unlikely that most people would consider the resultant noise levels excessive.
4. Ambient noise levels were controlled by traffic noise. An assessment of noise for high traffic areas (in accordance with Section2.2.3 of the INP) has been undertaken and a correction to the night Ambient Noise Level will be undertaken as this level is 10 dB above the recommended acceptable amenity levels.

Construction Noise Criteria

Noise criteria for the construction phase of this project is expected to occur for a period of between 4 to 26 weeks in duration, therefore the construction noise goals are set to background plus 10 dBA (LA90 + 5dBA), therefore the following noise criteria for construction apply:

Table 7.5 Construction Noise Goals (Between 4 and 26 week construction period)

Location	Project Specific Noise Criteria LA10(15minute)
South East and South Receivers	47 dBA

Note: Construction audible at sensitive receivers may only occur between the hours of 7.00 am and 6.00 pm Monday to Friday, and 8.00 am to 1.00 pm Saturdays. For all other times construction noise must be inaudible at the receiver.

7.4 NOISE IMPACT ASSESSMENT

7.4.1 Operational Noise Modelling Results and Discussion

A summary of predicted noise levels at assessed representative residences adjacent to the proposed substation are provided in *Table 7.6* to for calm and inversion conditions.

Table 7.6 Noise Modelling Summary – Proposed Substation, Ewingsdale

Locality	Project Specific Noise Criteria LAeq	Calm LAeq	Inversion LAeq
Ewingsdale Road	Day[1] - 42 dBA	31 dBA	31 dBA
	Evening[1] - 45 dBA *		
	Night[2] - 41 dBA		
Parkway Drive	Day[1] - 42 dBA	31 dBA	32 dBA
	Evening[1] – 45 dBA *		
	Night[2] - 41 dBA		
Avocado Crescent	Day[1] - 42 dBA	31 dBA	32 dBA
	Evening[1] - 45 dBA *		
	Night[2] - 41 dBA		

1. Intrusive Criteria Applicable - LAeq(15minute).
2. Amenity Criteria Applicable - LAeq(Period).

Modelled noise levels for the upgrade of the proposed substation are expected to meet the relevant PSNC for all sensitive receivers during applicable meteorological conditions.

7.4.2 Construction Noise Modelling Results and Discussion

Model results for the construction works at the substation site are presented in *Table 7.7*.

Table 7.7 Construction Emissions Summary

Locality	Project Specific Noise Criteria LAeq	Calm LAeq
Ewingsdale Road	Day - 47 dBA	55 dBA
Parkway Drive		55 dBA
Avocado Crescent		50 dBA

Calculations of noise emissions associated with the construction of the proposed Ewingsdale substation upgrade would exceed the construction noise criteria. To minimise the potential acoustic impacts of construction activities on nearby residences, it is recommended that management and mitigation activities detailed in the recommendation section of this report be implemented as part of the construction process.

8 MULLUMBIMBY SUBSTATION

8.1 PROJECT DESCRIPTION

The Mullumbimby substation is located adjacent to Australia Pipeline Trust's AC/DC converter station and receives 132kV from Country Energy's Lismore bulk supply point substation. Mullumbimby zone substation currently includes a 132/66/11kV 75MVA and a 132/66/11kV 40MVA power transformers and an 11kV earthing transformer. The earthing transformer is not a significant noise source and the 40MVA power transformer is a spare and would only operate in the case of the 75MVA transformer being down for repairs or maintenance. The project involves the installation of a new 132kV line bay for the proposed 132kV feeder to Ewingsdale via Brunswick Heads and the replacement of the two 132/66/11kV transformers with a 132/11kV transformer.

Dominant noise sources associated with the substation upgrade include the following:

- 1 x 132/11kV 30MVA transformer.

Table 8.1 presents the sound power levels of modelled sources.

Table 8.1 Equipment Sound Power Levels

Equipment	Sound Power Level dB(A)
132/11kV 30MVA Transformers	71

8.2 RESIDENTIAL RECEIVERS

Sensitive receivers surrounding the proposed substation are north west, west and north east in Alidenes Road, east and south in Wilsons Creek Road.

The locality map presented in *Figure 8.1* identifies the nearest residential dwellings adjacent to the proposed substation.

Legend

Substation Site

R1 Receptor Location

Figure 8.1

Mullumbimby Substation Locality Plan

Client:	Country Energy		
Project:	Proposed 132kV Substation upgrade, Mullumbimby - Noise Impact Assessment		
Drawing No:	0051706hv_mull_01		
Date:	29/09/08	Drawing size:	A4
Drawn by:	SP	Reviewed by:	MC
Source:	Google Maps		
Scale:	Refer to Scale Bar		

N

0 50 100 150m

Environmental Resources Management Australia Pty Ltd
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ERM

8.3 NOISE IMPACT ASSESSMENT

8.3.1 Operational Noise Modelling Results and Discussion

The operational scenario was modelled to determine the potential acoustic impact of the substation on the surrounding community during typical operation.

A summary of predicted noise levels at assessed representative residences adjacent to the proposed substation are provided in *Table 8.2* to for calm and inversion conditions.

Table 8.2 Noise Modelling Summary – Proposed Substation, Mullumbimby

Locality	Period / Meteorological Condition	Project Specific Noise Criteria LAeq dB(A)	LAeq dB(A)
Residence 1	Day – Calm	35	<30
	Evening – Calm		<30
	Night - Calm		<30
	Night - Inversion		<30
Residence 2	Day – Calm		<30
	Evening – Calm		<30
	Night - Calm		<30
	Night - Inversion		<30
Residence 3	Day – Calm		<30
	Evening – Calm		<30
	Night - Calm		<30
	Night - Inversion		<30
Residence 4	Day – Calm		<30
	Evening – Calm		<30
	Night - Calm		<30
	Night - Inversion		<30
Residence 5	Day – Calm		<30
	Evening – Calm		<30
	Night - Calm		<30
	Night - Inversion		<30
Residence 6	Day – Calm		<30
	Evening – Calm		<30
	Night - Calm		<30
	Night - Inversion		<30

Modelled noise levels for the proposed substation upgrade are expected to comply with the PSNC at all residences adjacent to the substation site.

8.3.2 Construction Noise Modelling Results and Discussion

Model results for the construction works at the substation site are presented in *Table 8.3*.

Table 8.3 Construction Emissions Summary

Locality	Project Specific Noise Criteria LAeq dB(A)	LAeq dB(A)
Residence 1	45	50
Residence 2		52
Residence 3		46
Residence 4		42
Residence 5		27
Residence 6		37

Calculations of noise emissions associated with the construction and upgrade of the proposed Mullumbimby substation upgrade would exceed the construction noise criteria at Residences 1, 2 and 3. To minimise the potential acoustic impacts of construction activities on nearby residences, it is recommended that the management and mitigation activities detailed in the recommendation section of this report be implemented as part of the construction process.

9 TRANSMISSION LINE ROUTE

9.1 CONSTRUCTION ACTIVITIES

Construction work will include as a number of activities including:

- existing conductor and pole removal;
- excavation of hole and installation of new pole;
- access by vehicles and machinery; and
- easement restoration and rehabilitation as the work proceeds.

These works will be undertaken with relevant plant progressively moving along the transmission line route. Due to the rate of installation, any noise impacts from the work will be of a short-term (less than four weeks) duration in any particular location.

An assessment of construction activities associated with the transmission line route has been undertaken results are outlined for various distances are outlined below.

9.2 TRANSMISSION LINE CONSTRUCTION IMPACTS

Transmission line construction has the potential to occur are varying distances from sensitive receivers. Several distances have been assessed to quantify the potential impacts of transmission line construction with the inclusion of bored piling and trucking activities for representative distances presented in *Table 9.1*

Table 9.1 Power Line Construction Emissions Summary

Distance (m)	Construction Noise Criteria L10 dB(A)	L10 dB(A)
25	55	69
50		63
80		59
150		53
200		51
500		43
1000		37

Note: Adopting a construction period of less than four weeks duration.

Taking into consideration that overhead transmission line and cable installation is progressive and that not all equipment can operate at the same location, it is reasonable to assume that not all pieces of equipment would operate together at the closest location to a residence, therefore noise levels presented in *Table 9.1* should be considered as a worst case. Given this staggered construction method, low population density along the route and generally great distances to nearest residences, exceedances of noise criteria are considered unlikely in most locations.

However, where distances to residences are less than 100 metres, mitigation measures provided in the mitigation section of this report should be considered.

9.2.1 Pole Blasting

While Country Energy does not routinely use blasting to create excavations for new poles, if required a specialist contractor would be employed to undertake such work. Blasting times and frequency would be assessed on a case-by-case basis, with particular regard to any nearby residences and safety requirements.

9.3 TRANSMISSION LINE OPERATION

During operation key noise generators would be due to maintenance and repair crews working on the transmission line. General maintenance crews would generally use lighter plant and equipment than during construction. Major repairs and pole replacements etc would use similar plant and equipment as for transmission line construction and would exceed short-term construction criteria in only a few instances where works would be closer than about 100m to a residence. Typically these instances would be where the transmission line follows road alignments and hence background noise from traffic would be higher than at more rural locations. Considering the essential nature of this infrastructure and the short time frames maintenance and repairs are undertaken at anyone location, noise impacts are likely to be minimal.

9.3.1 The Corona Effect

In addition to general operational noise, some additional noise may also occur intermittently during operation of the line; however, this is unlikely to be discernible above background levels. During rain, light drizzle, heavy fog, mist or following rainfall, a mild “fizzing” sound (known as corona) may be generated and continue until the conductors dry. The noise produced is similar to the sound of light rainfall, with people often mistaking the two.

Corona noise generated during fine weather is rare, and is dependent on the surface condition of conductors. A slight crackling noise may be heard following a long dry spell, as dust or other pollutants build up on conductors and insulators. This crackling noise ceases following a rain shower as the transmission lines are washed clean of dust and foreign particles. Exposure of the conductors to the climatic elements generally reduces noise levels over time.

Corona noise emissions at substation sites were not considered in this assessment although it is expected that they will be minimal compared to the overall transformer noise, notwithstanding this, conductor size should be chosen to minimise the potential for corona noise.

9.3.2 Aeolian Noise

Wind noise may occur when wind blows over conductors and insulators, or through lattice towers or hollow components like ‘arcing horns’. It is therefore independent of the line being energised or not.

The noise caused by wind blowing over conductors results from the shedding of air vortices. It may become troublesome at wind speeds higher than 10 m/s, and may

under exceptional circumstances reach very high dB(A) values. However, it is often mistaken for the noise of the rain or wind.

9.3.3 Conclusion

During transmission line operation there would be the emission of noise due to maintenance and repair works that may be audible at nearby sensitive receivers. This noise would be short-term in nature and forms part of maintaining an efficient and reliable essential service.

In addition, there is potential for some emission of noise due to the corona effect and wind noise. However, typically when conditions do exist which might result in audible noise due to these effects, background noise levels would also generally increase. This would result in the masking of the generated noise, minimising potential impacts on sensitive receivers.

Corona and aeolian induced noise is not, therefore, expected to be a source of impact from the proposal.

No specific monitoring or mitigation measures are considered necessary.

10 CONCLUSIONS AND RECOMMENDATIONS

10.1 CONCLUSIONS

This report presents results of the assessment of potential impacts of noise generated by the construction and operation of the Lismore to Mullumbimby Electricity Network Upgrade in accordance with relevant DECC guidelines . The report considers impacts at the six substation sites proposed for upgrade works as well as along the transmission line corridor.

Based on background noise level monitoring or the adoption of DECC's minimum background noise levels project specific noise criteria for each substation site and construction noise criteria for all works where established.

The assessment concludes that noise emissions from the upgraded substations would meet the relevant criteria at the nearest residential receivers to each substation site. However, it was identified that noise mitigation measures would be required at the Ballina substation; with specific options modeled to indicate that compliance was attainable. The assessment also concluded that the operation of the upgraded transmission line is unlikely to result in a degradation of the existing ambient noise environment.

Construction noise at the substation sites and along the transmission line has the potential to impact on nearby sensitive receivers. These impacts though short-term can be reduced in many cases by the implementation of mitigation measures as detailed in *Section 10.2*.

10.2 RECOMMENDATIONS

10.2.1 Ballina Substation

To minimise impacts from the upgraded Ballina substation the following measures will be implemented:

- The final noise mitigation options included in the detailed design phase will be modelled by a suitably qualified acoustical consultant to confirm the substation once operational is predicted to meet relevant DECC noise criteria.

- Post construction noise monitoring will be undertaken by a suitably qualified acoustic consultant confirming noise levels actually generated by the upgraded substation. The consultants report will recommend any necessary additional amelioration measures to be carried out.

- Once commissioned a noise compliance monitoring report will be prepared by a suitably qualified acoustic consultant confirming noise levels generated by the upgraded substation comply with DECC's *Industrial Noise Policy* (2000).

10.2.2 Construction Impacts

To minimise the impacts of construction noise emissions on nearby residences during construction of the proposed Lismore to Mullumbimby electricity network upgrade it is recommended the following mitigation and management procedures be implemented:

- residents potentially affected by construction noise to be informed in advance that work to take place and is likely to generate some noise, with residents being kept informed of progress at regular intervals;

- consultation be undertaken with residents where works may be audible within particular residences;

- all construction activities will be restricted to the hours of 7:00am and 6:00pm Monday to Friday, 8:00am to 1:00pm Saturdays and at no time on Sundays or Public Holidays except:

    - any works which do not cause emissions to be audible at any nearby residential property;

    - the delivery of materials which is required outside these hours as requested by police or other authorities for safety reasons;

    - emergency work to avoid the loss of lives, property and/or to prevent environmental harm; and

    - any other work as agreed through negotiations between Country Energy and potentially affected noise receivers.

- construction in close proximity to residences be completed in as short a time frame as possible;

- where practical, pushing topsoil or fill to form earth mounds between the construction site and residences;

- where possible barriers should be placed nearest to plant equipment to maximise barrier attenuation;

- maximise the offset distance between noisy plant items and nearby noise sensitive receivers;

- avoiding any coincidence of noisy plant working together in close proximity simultaneously adjacent to sensitive receivers;

- minimising the occurrence of consecutive or ongoing out of hours works in the same locality;

- orienting noisy plant or equipment away from sensitive areas;

- carrying out loading and unloading away from noise sensitive areas, if loading near sensitive receiver's acoustic enclosures or barriers of a suitable height is constructed to minimise the noise impacts;

- should blasting be required, specific assessment should be undertaken regarding impacts to any nearby residences

- monitor construction noise levels throughout the varying stages of the project to quantify potential impact at most sensitive residences; and

- the contractor must take reasonable steps to manage and control noise from all plant and equipment. Examples of appropriate noise management and control may include installation of acoustic silencers, low noise mufflers and alternatives to reversing alarms.

REFERENCES

NSW Environment Protection Authority (1994) **Environmental Noise Control Manual** (ENCM).

NSW Environment Protection Authority (January 2000) **Industrial Noise Policy**.

Standards Australia (1994) **AS 2374.6-6 Australian Standard Power Transformers part 6: Determination of transformer and reactor sound levels**.

Annex A

Sound Power Spectral Data

Table A.1 Sound Power Level Spectrum for ENM

Frequency	Source dB Linear	
	132 kV Transformer	Capacitor Bank
25Hz	63.2	55.1
31.5Hz	55.3	53.6
40Hz	59.7	53.6
50Hz	58.9	55.5
63Hz	56.8	53.8
80Hz	58.4	54.9
100Hz	78.7	66.8
125Hz	56.8	52.6
160Hz	52.6	51.6
200Hz	74.1	50.3
250Hz	54.2	46.7
315Hz	64.7	51.6
400Hz	60.5	52.9
500Hz	53.7	46.3
630Hz	54.2	64.2
800Hz	50.3	60.9
1kHz	49.5	51.9
1.25kHz	47	45.6
1.6kHz	45.5	47.2
2kHz	43.9	42.2
2.5kHz	43.6	42.1
3.15kHz	42.6	39.5
4kHz	40.8	38
5kHz	38.6	35.2
6.3kHz	37.1	31.3
8kHz	33.6	27.2
10kHz	31	22.2
12.5kHz	26.8	19.2
16kHz	26.8	19.2
20kHz	26.8	19.2
Overall 'A' (SWL)	**67**	**65**

Table A.2 Sound Power Spectral Data – Construction and Power Pole Installation

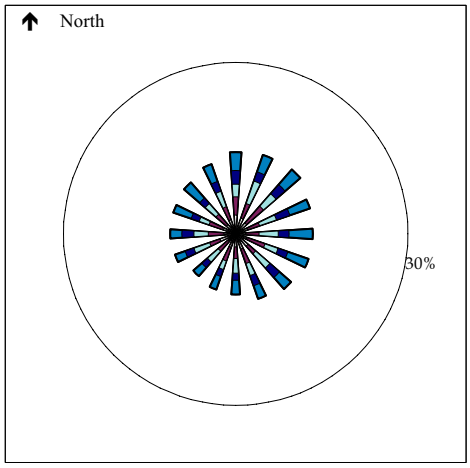
Sound Power Level Spectrum for ENM									
Noise Source	**Linear Frequency (Hz)**								**Total**
	63	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**dB(A)**
Air Compressor	86	81	82	87	84	85	83	77	**91**
Komatsu Excavator/Loader PC300	105	109	104	102	98	92	82	71	**103**
Hand tools (including grinding, hammering etc.)	107	87	93	90	95	98	102	101	**106**
Wacker Packer	103	108	108	105	106	107	105	99	**111**
Excavator	109	105	109	104	102	98	92	82	**103**
Road Trucks	63	86	89	89	93	99	98	93	**103**
Agitator	40	74	90	94	103	102	101	100	**107**
Bored Piling	108	100	99	95	94	93	87	80	**99**

Annex B

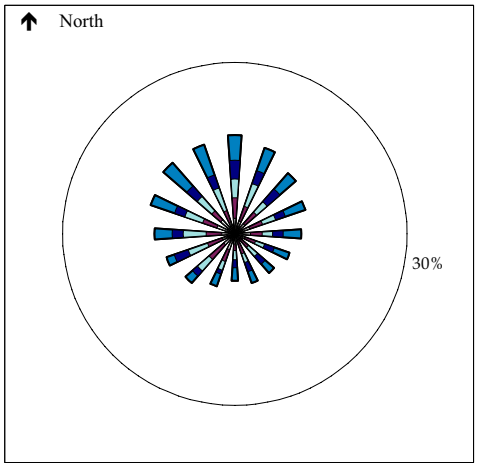
Casino Vector Wind Roses
Annual Hourly Wind Analysis

Day

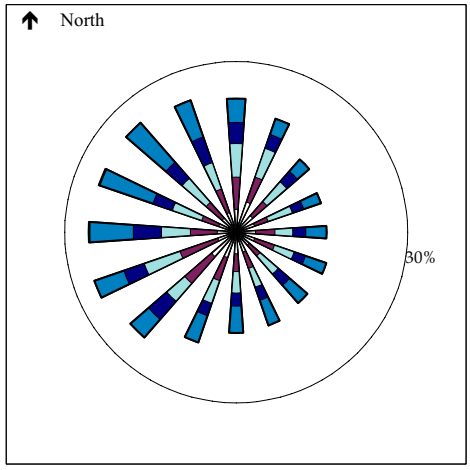
Summer



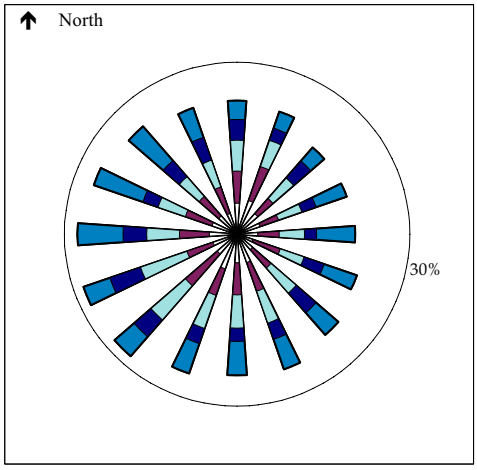
Spring

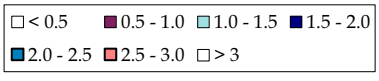


Winter



Autumn

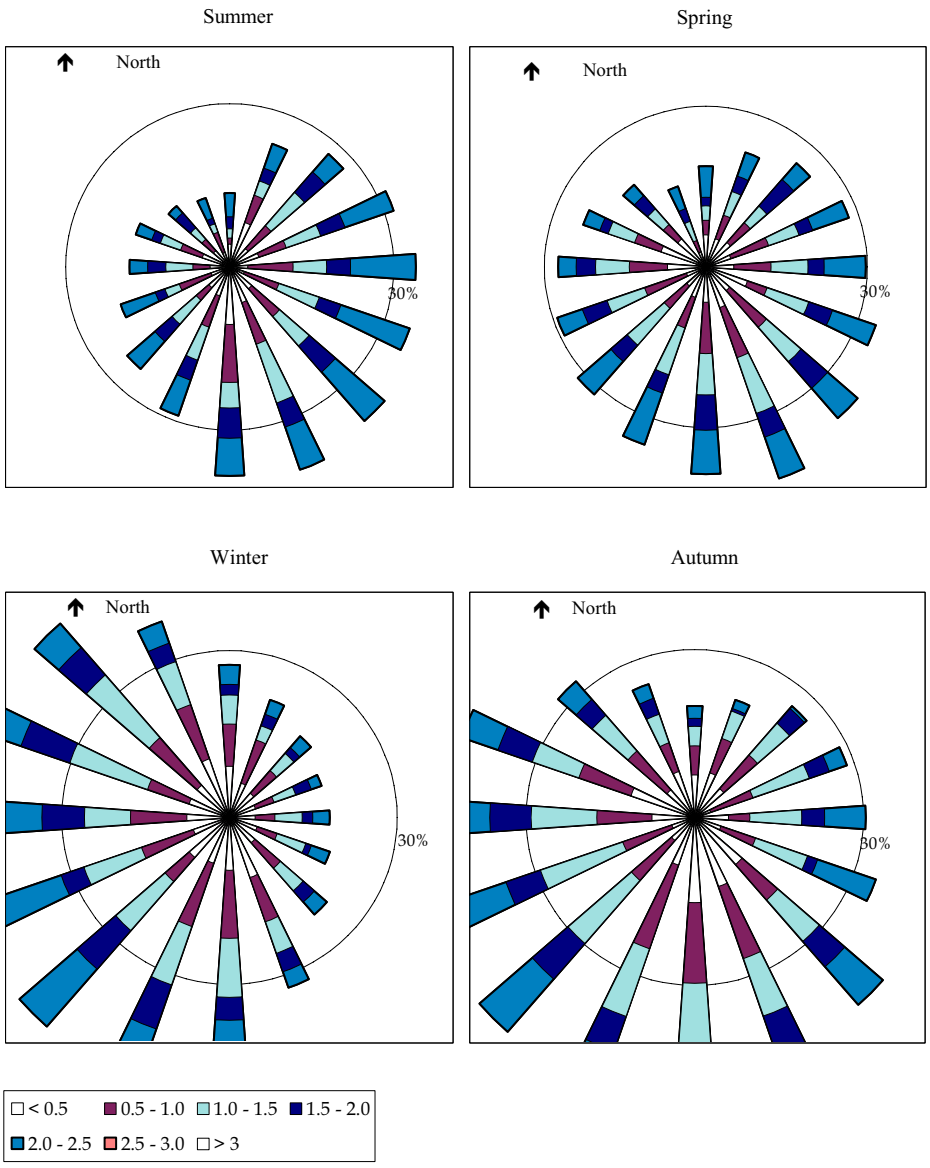




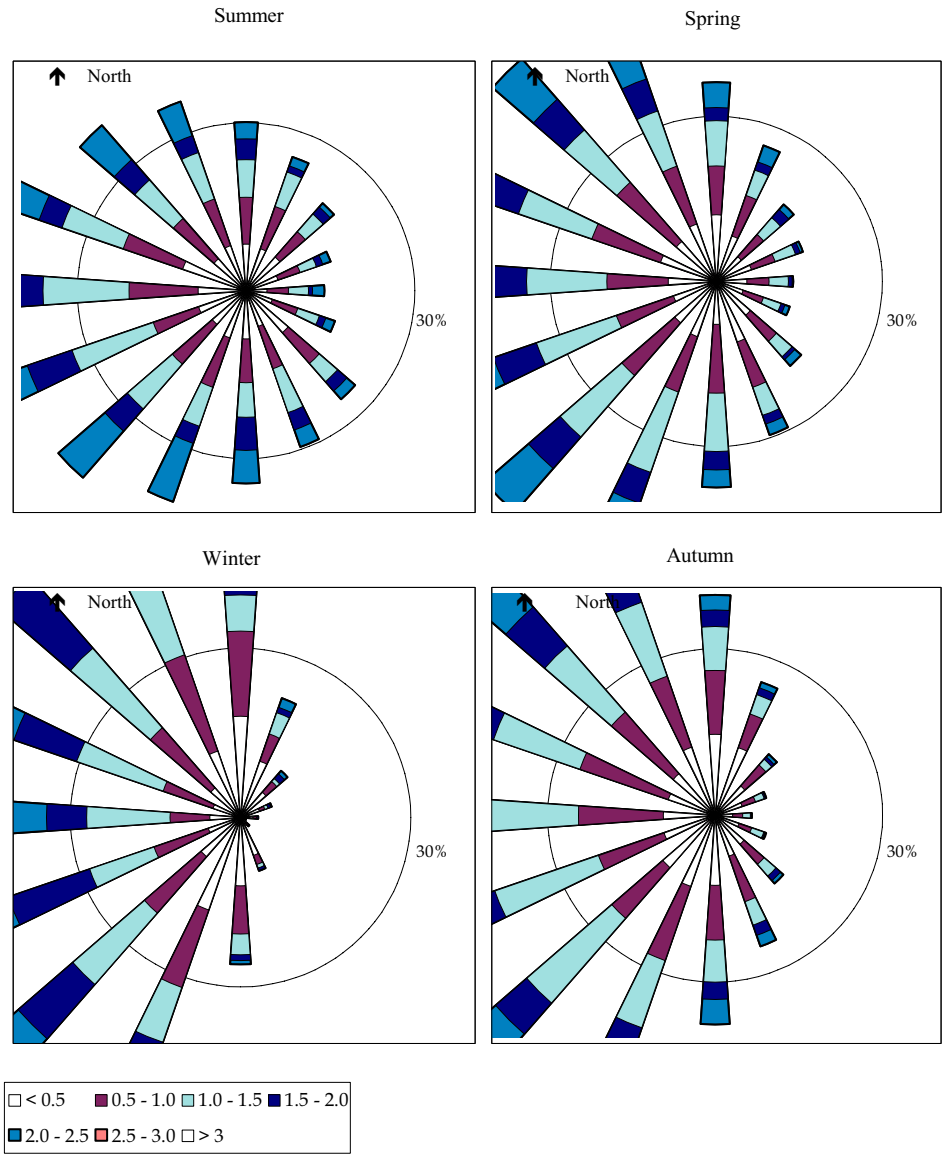
Data Source: BOM Casino Met Station
Data Range: 60 min, 01-01-04 to 30-12-04
Data in m/s

The segments of each arm represent the six valid wind speed classes, with increasing windspeed from the centre outwards. The length of each arm represents the vector components (for each direction) of wind speeds 3m/s or below as a proportion of the total time for the period .
The circle represents the 30% occurrence threshold.

Evening


Summer
North
30%
Spring
North
30%
Winter
North
30%
Autumn
North
30%
< 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
2.0 - 2.5
2.5 - 3.0
> 3

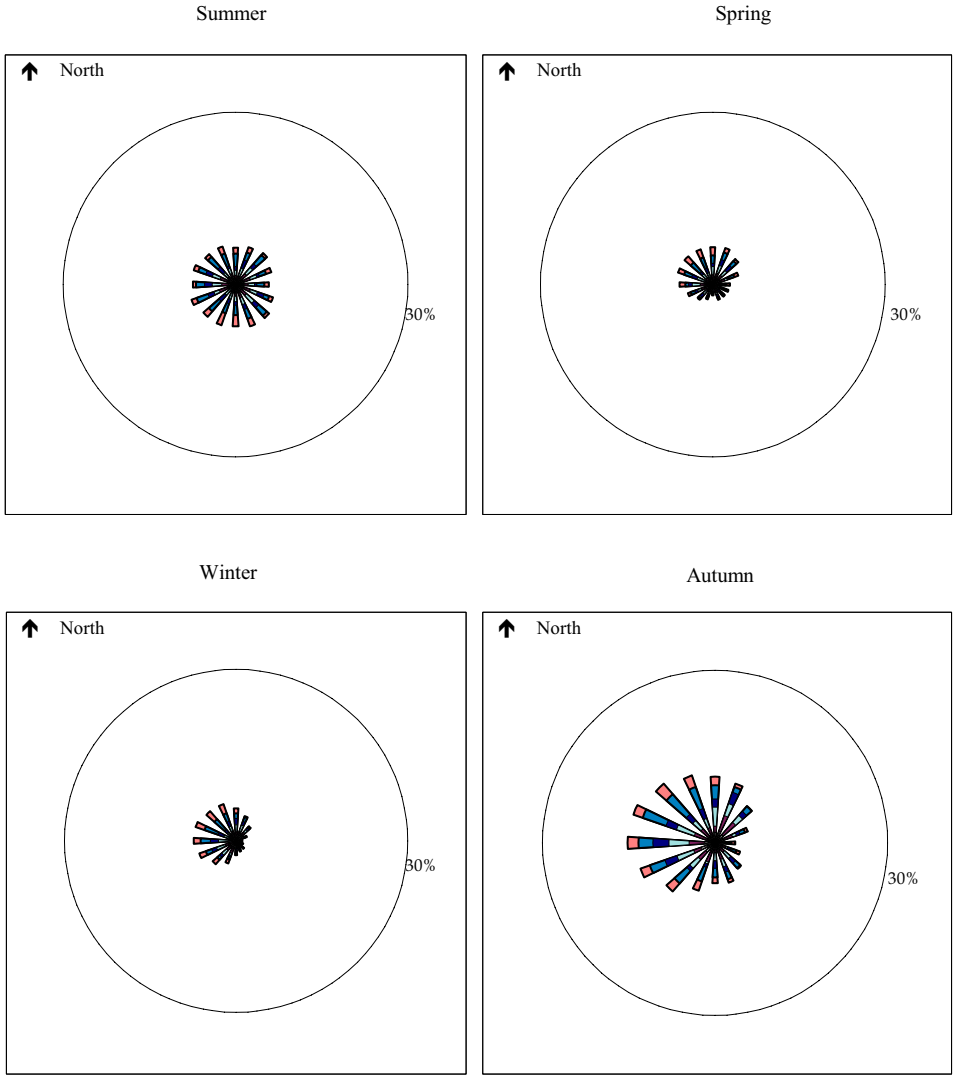
Night


Summer
Spring
North
North
30%
30%
Winter
Autumn
North
North
30%
30%
< 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
2.0 - 2.5
2.5 - 3.0
> 3

Annex C

Cape Byron Vector Wind Roses
Annual Hourly Wind Analysis

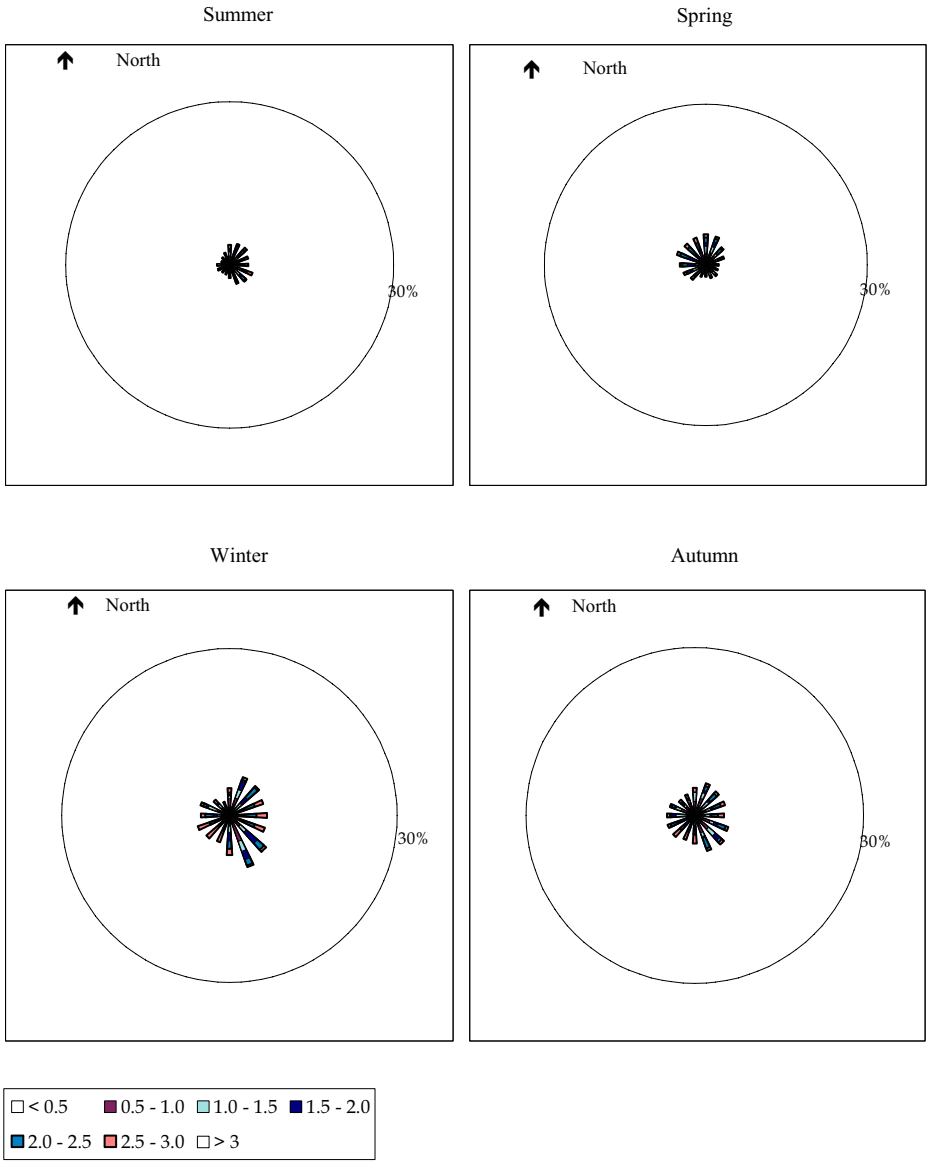
Day



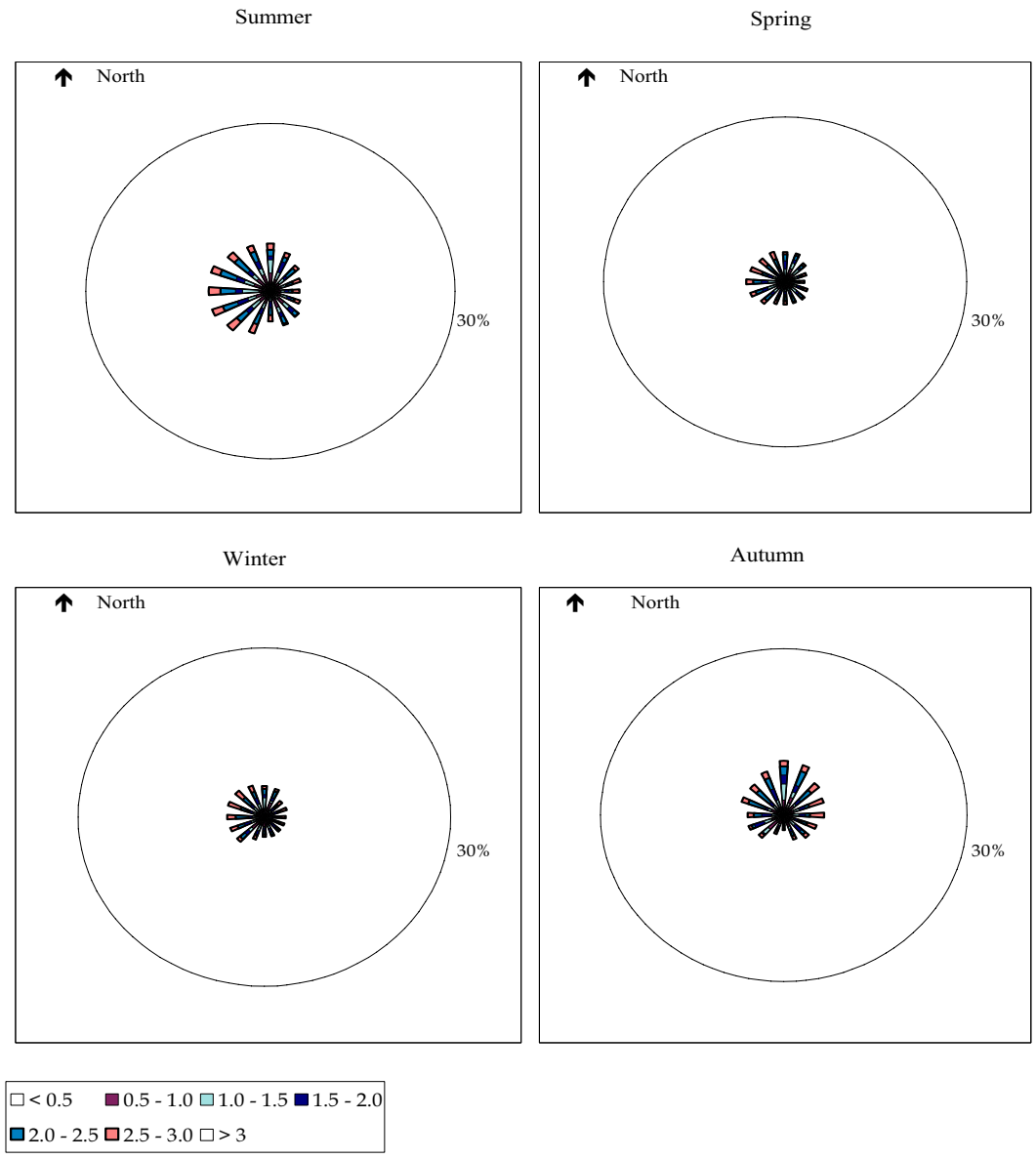
Data Source: BOM Cape Byron, NSW
Data Range: 60 min, 01-11-06 to 12-12-07

The segments of each arm represent the six valid wind speed classes, with increasing windspeed from the centre outwards. The length of each arm represents the vector components (for each direction) of wind speeds 3m/s or below as a proportion of the total time for the period .
The circle represents the 30% occurrence threshold.

Evening


Summer
North
30%
Spring
North
30%
Winter
North
30%
Autumn
North
30%
< 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
2.0 - 2.5
2.5 - 3.0
> 3

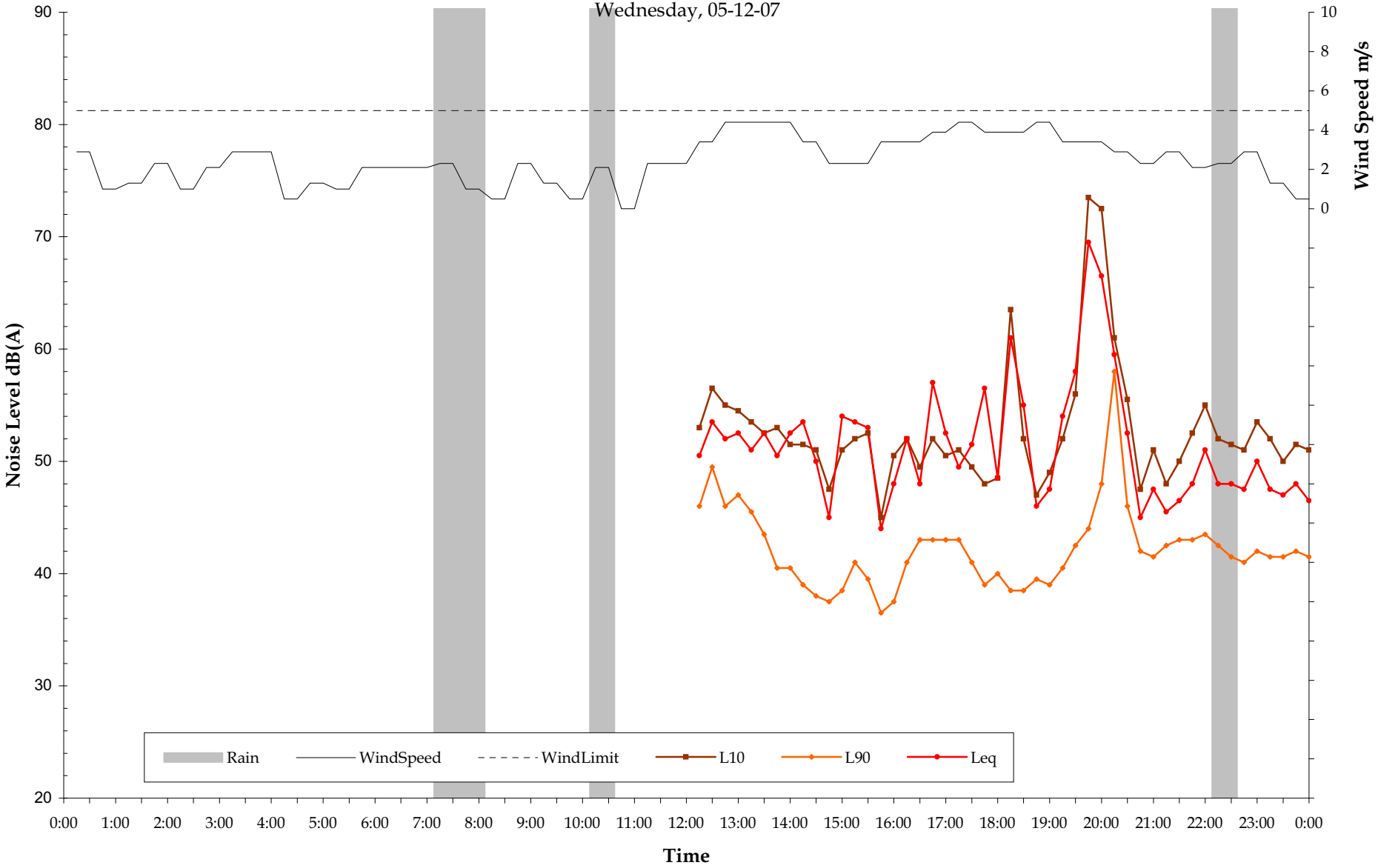
Night


Summer
North
30%
Spring
North
30%
Winter
North
30%
Autumn
North
30%
< 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
2.0 - 2.5
2.5 - 3.0
> 3

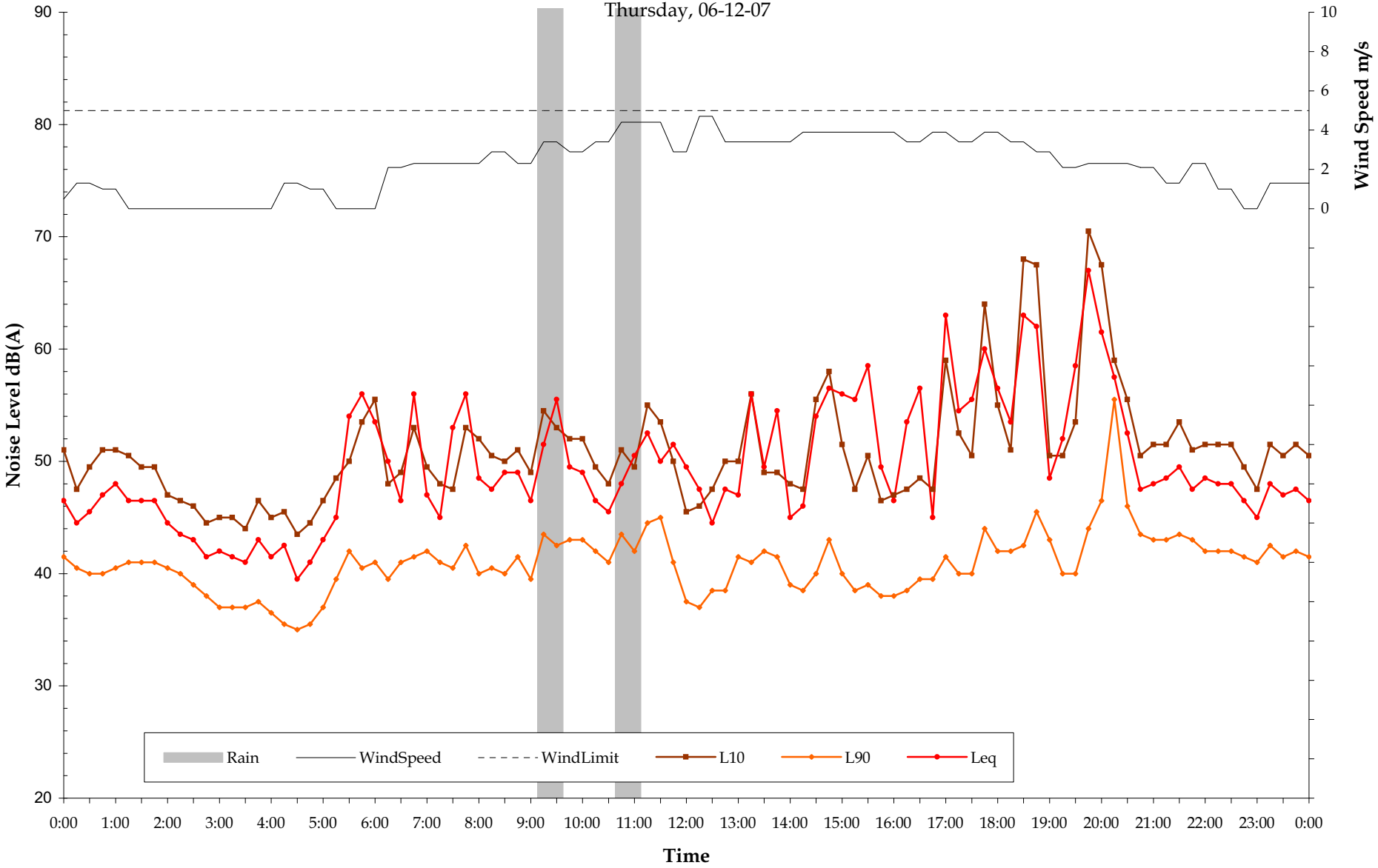
Annex D

Noise Logger Graphs - Lismore South

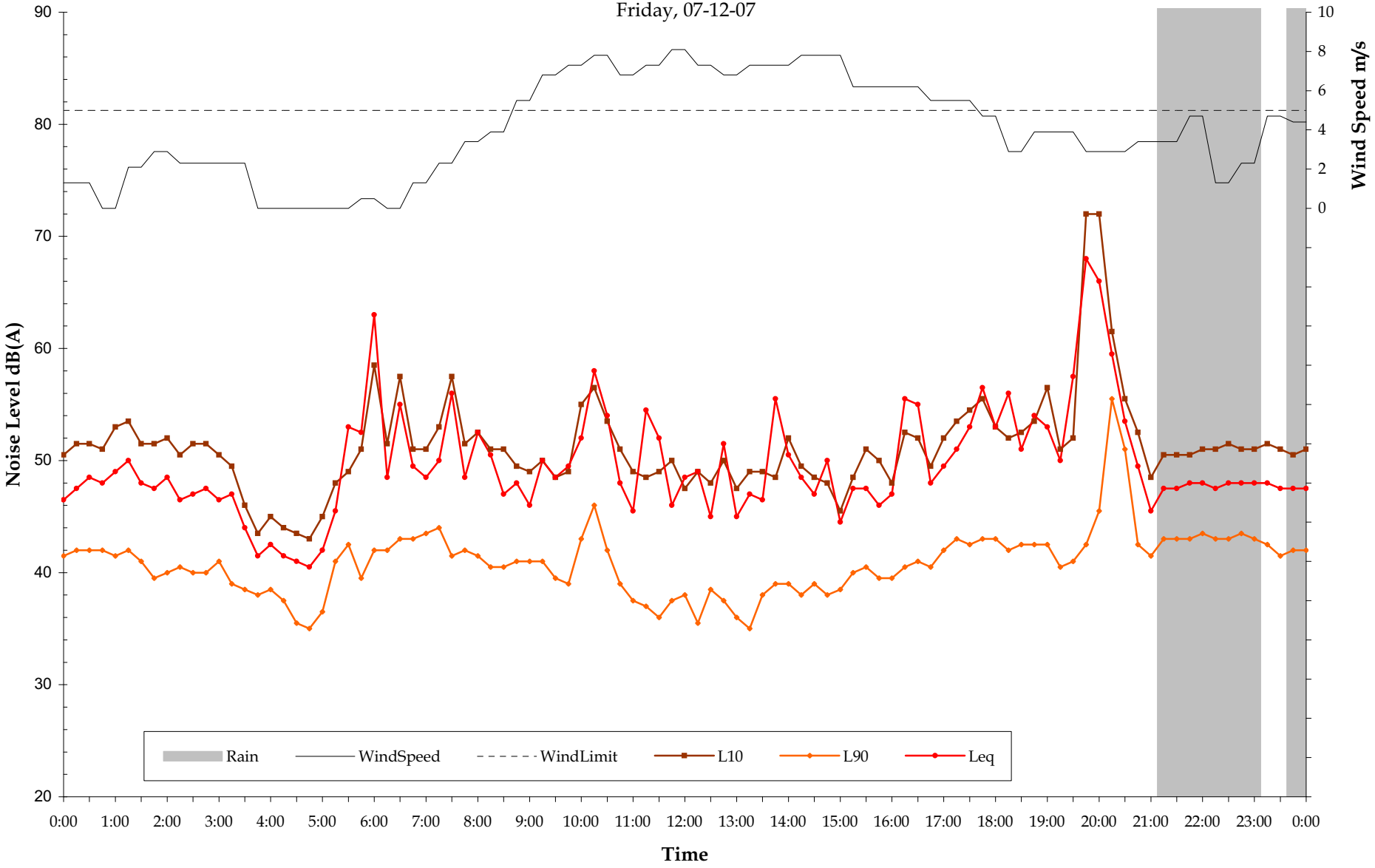
Measured Ambient Noise Levels - Lismore South
Noise Logger Charts
Wednesday, 05-12-07



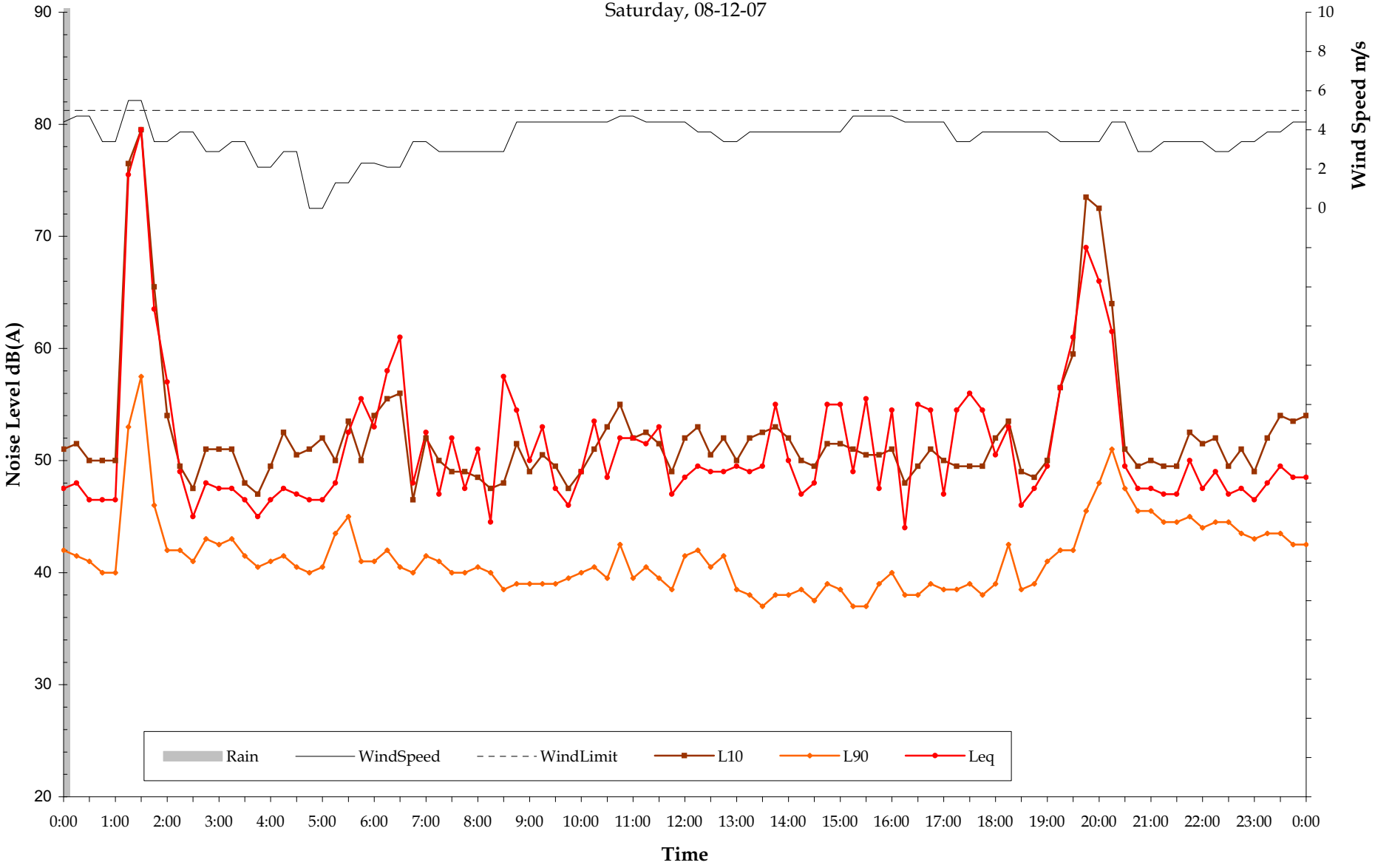
Measured Ambient Noise Levels - Lismore South
Noise Logger Charts
Thursday, 06-12-07

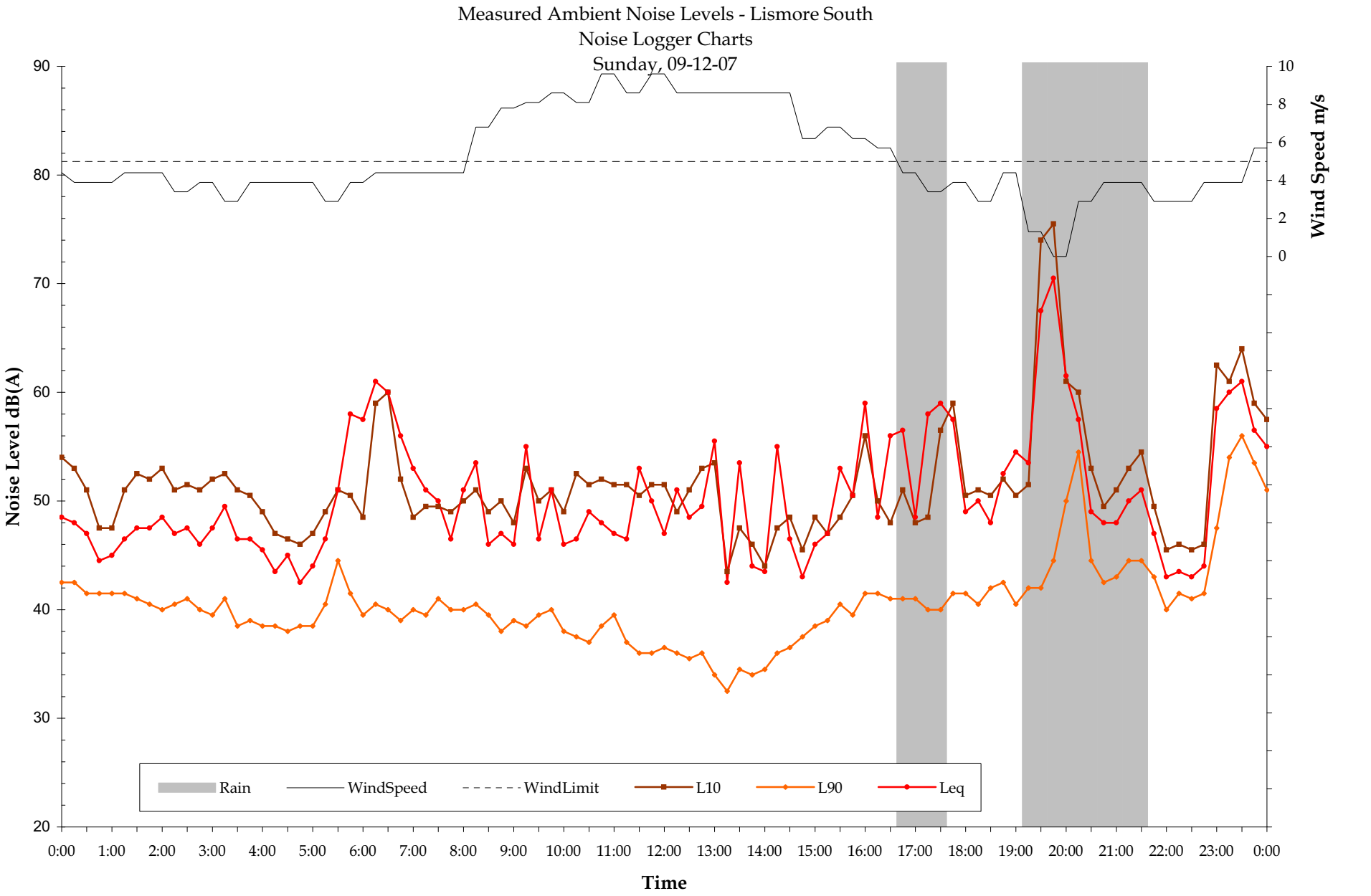


Measured Ambient Noise Levels - Lismore South
Noise Logger Charts
Friday, 07-12-07

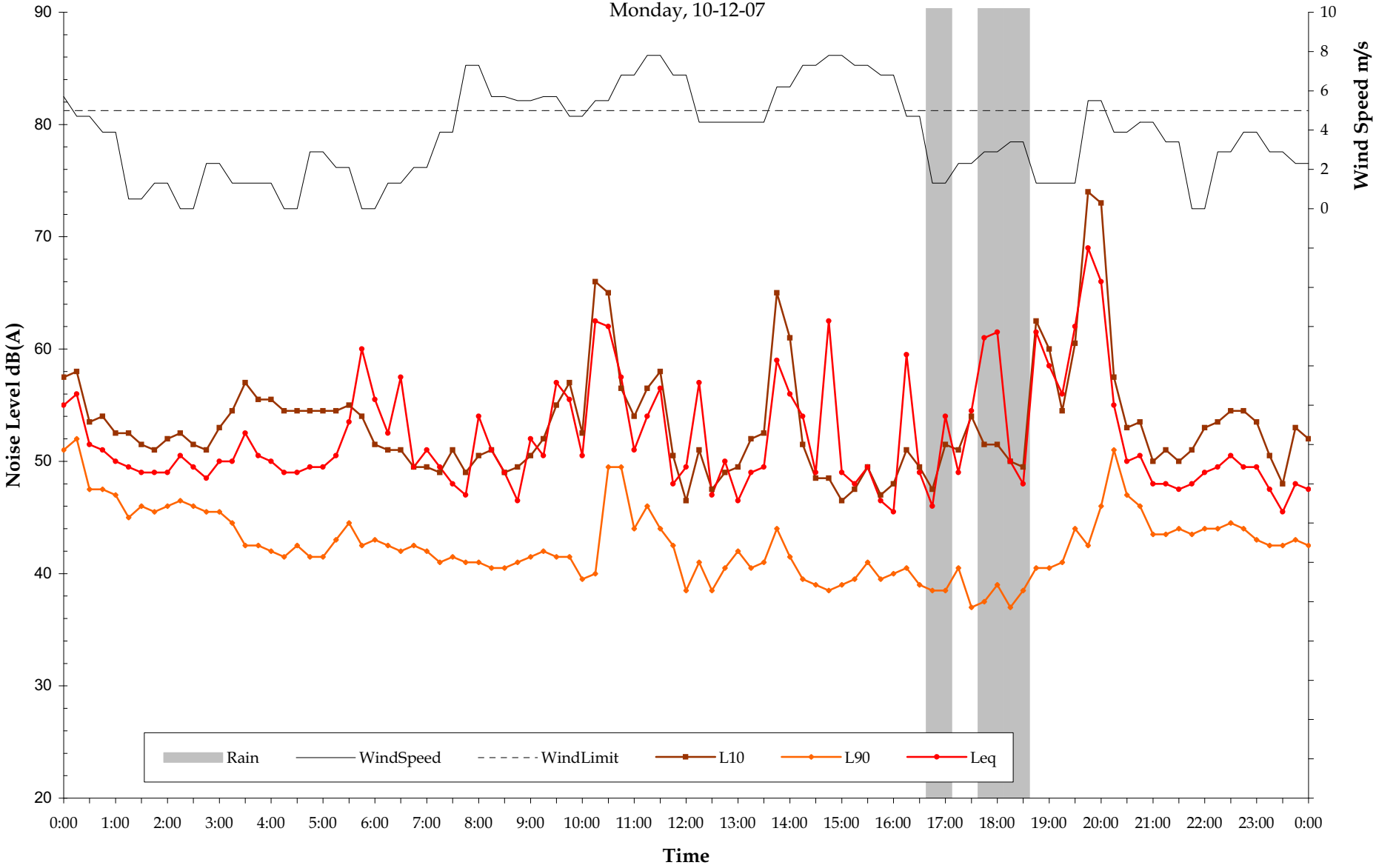


Measured Ambient Noise Levels - Lismore South
Noise Logger Charts
Saturday, 08-12-07

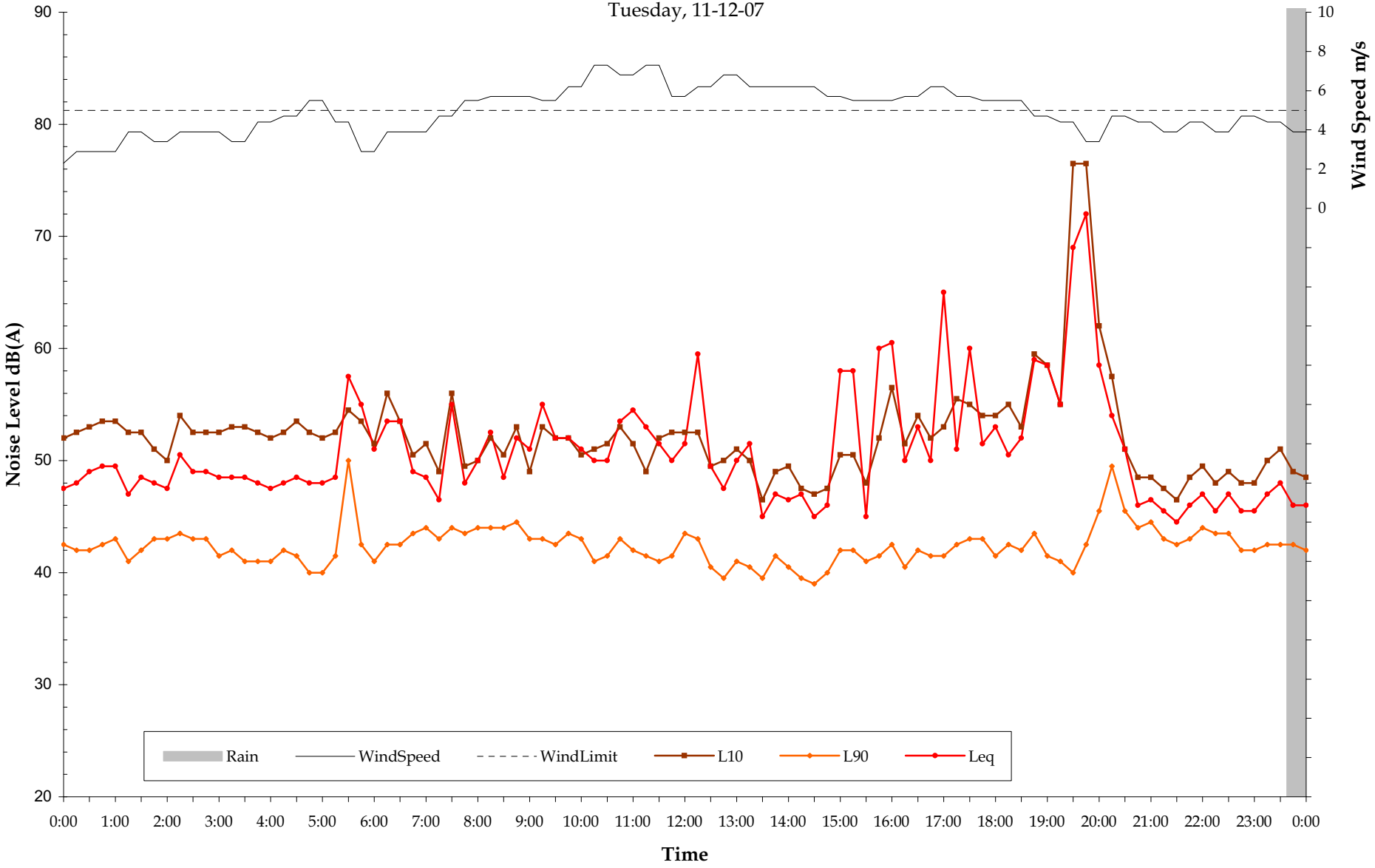



Measured Ambient Noise Levels - Lismore South
Noise Logger Charts
Sunday, 09-12-07
Noise Level dB(A)
Wind Speed m/s
Time
Rain
WindSpeed
WindLimit
L10
L90
Leq
90
80
70
60
50
40
30
20
10
8
6
4
2
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00

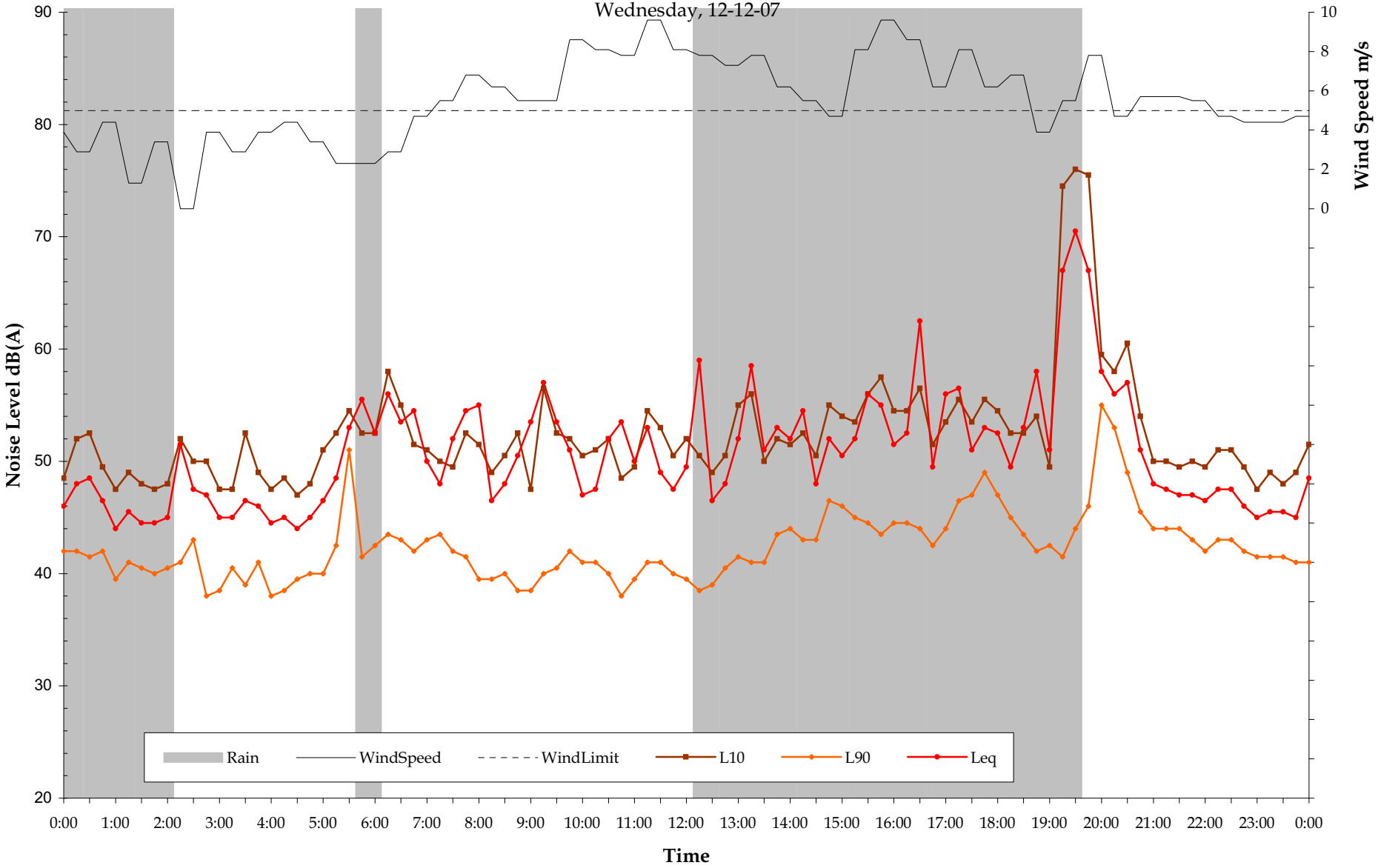
Measured Ambient Noise Levels - Lismore South
Noise Logger Charts
Monday, 10-12-07

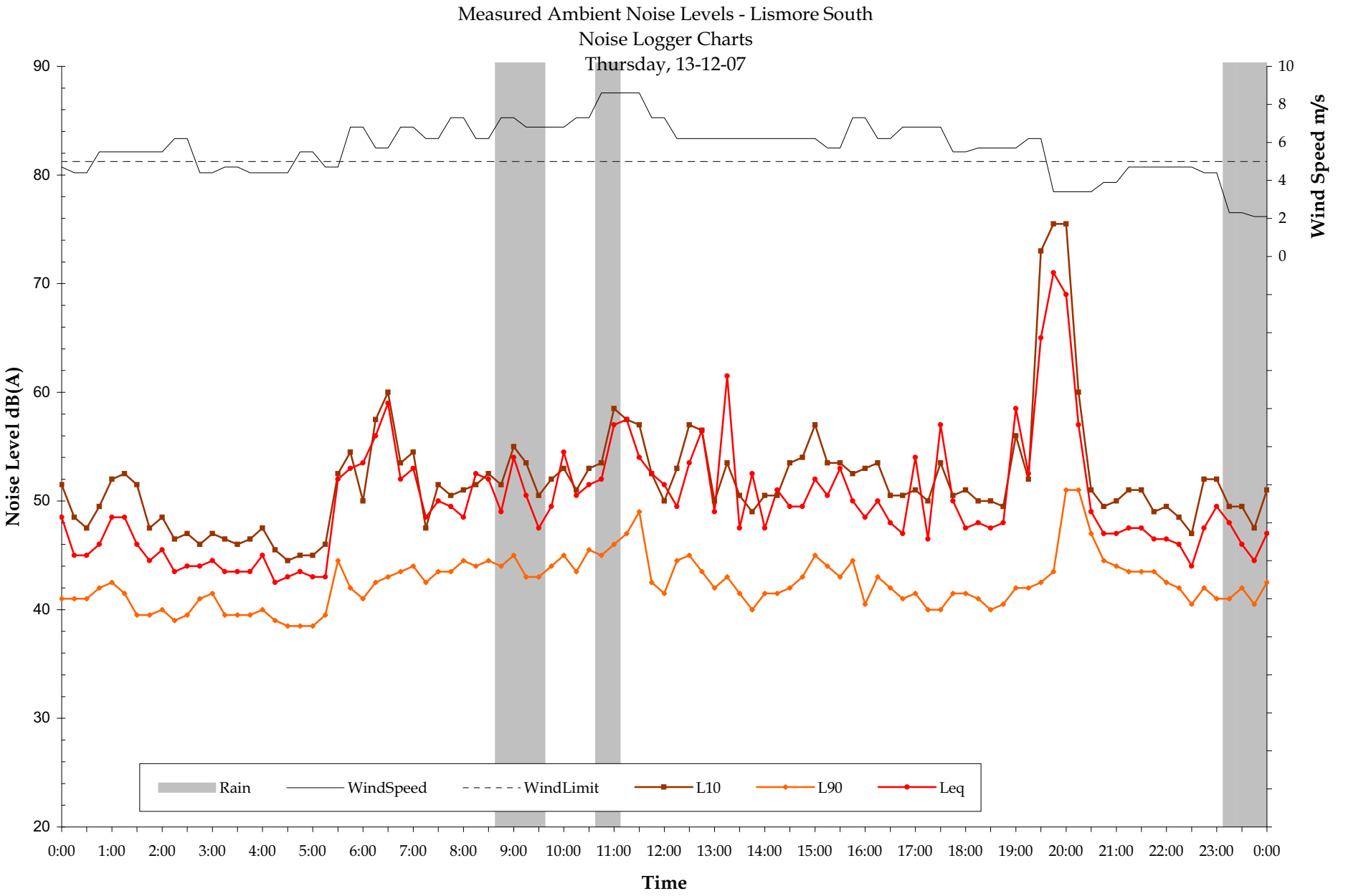


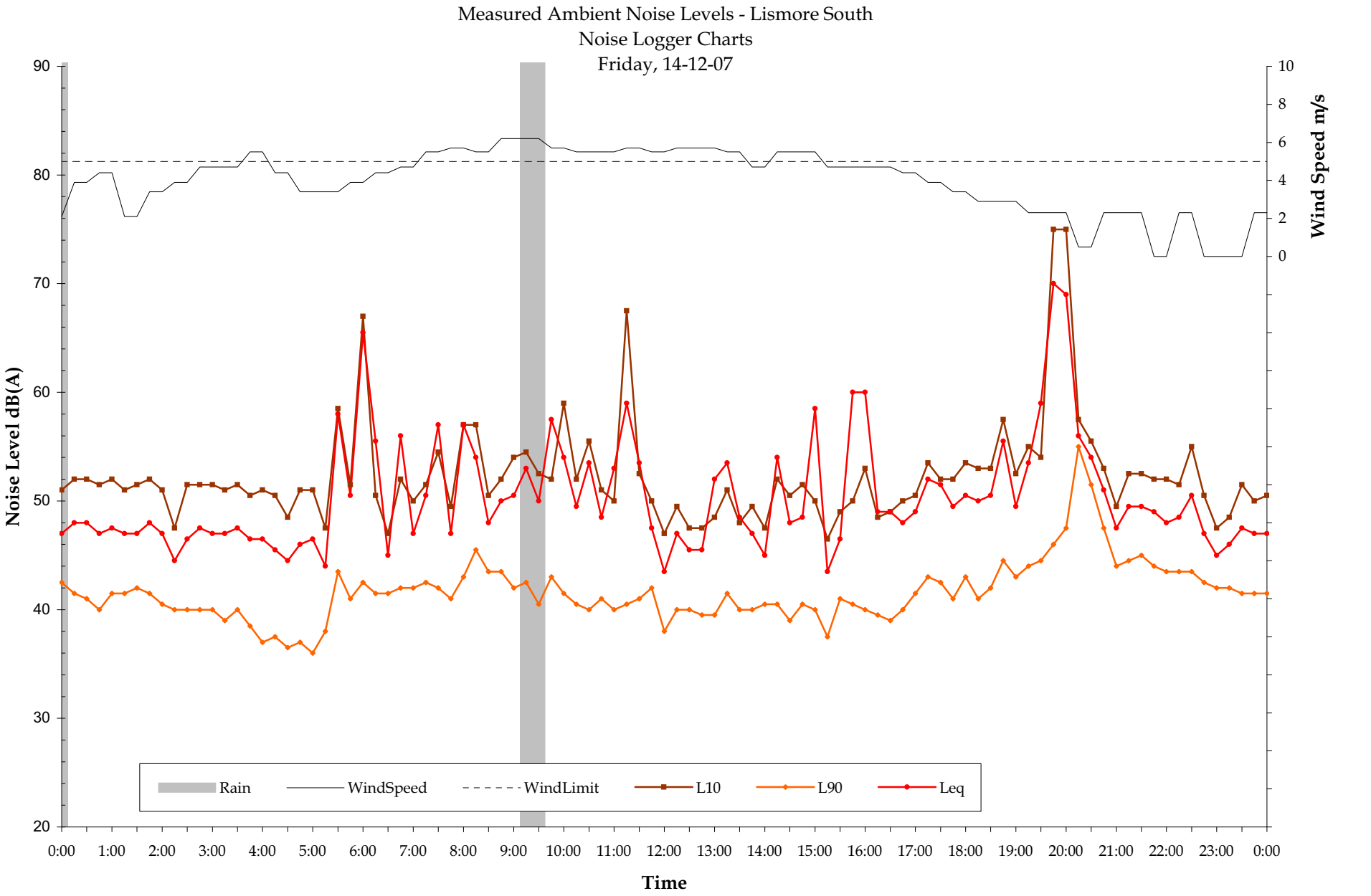
Measured Ambient Noise Levels - Lismore South
Noise Logger Charts
Tuesday, 11-12-07



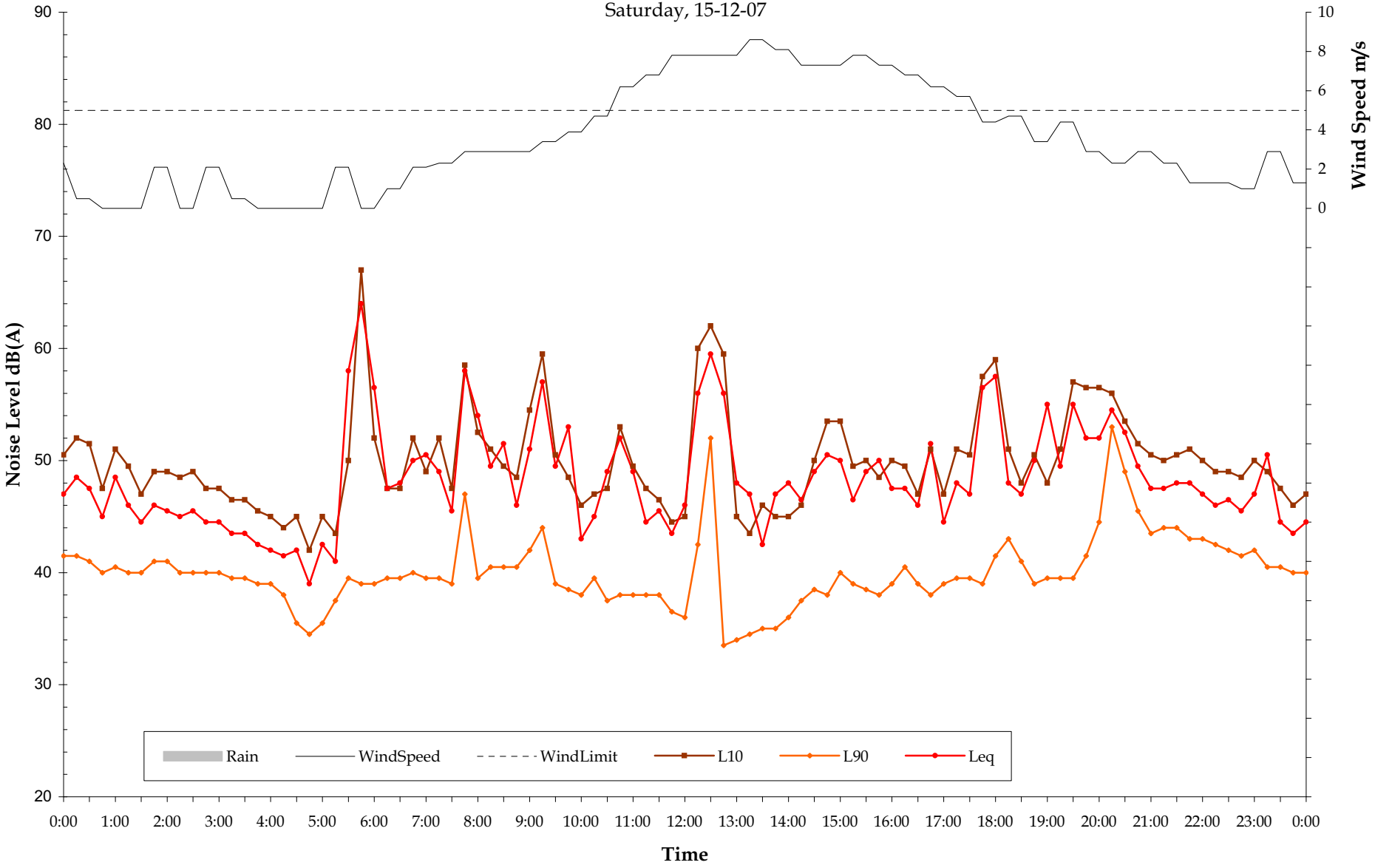
Measured Ambient Noise Levels - Lismore South
Noise Logger Charts
Wednesday, 12-12-07

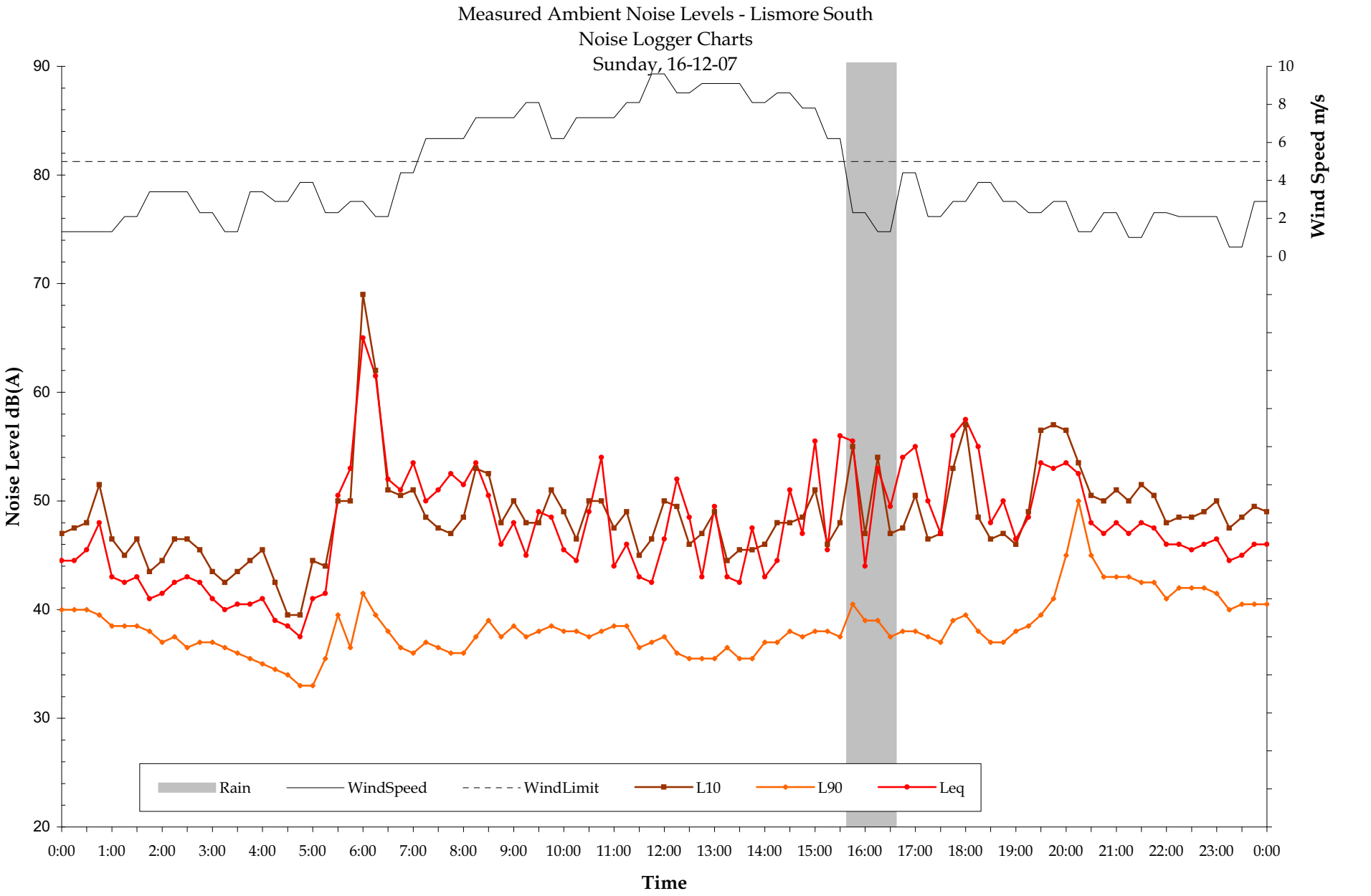



Measured Ambient Noise Levels - Lismore South
Noise Logger Charts
Thursday, 13-12-07
Noise Level dB(A)
Wind Speed m/s
Time
Rain
WindSpeed
WindLimit
L10
L90
Leq
90
80
70
60
50
40
30
20
10
8
6
4
2
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00

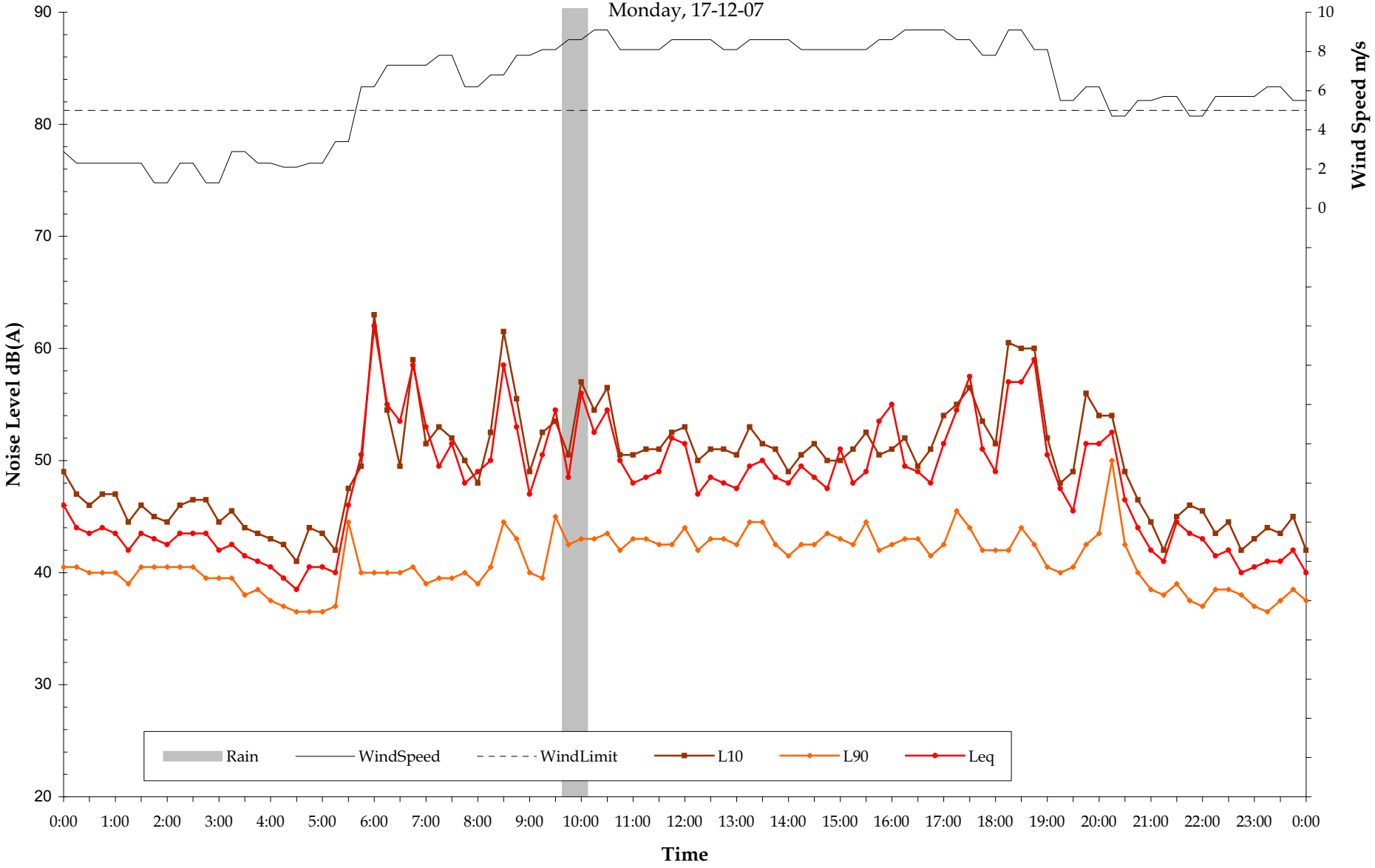

Measured Ambient Noise Levels - Lismore South
Noise Logger Charts
Friday, 14-12-07
Noise Level dB(A)
Wind Speed m/s
Time
Rain
WindSpeed
WindLimit
L10
L90
Leq
90
80
70
60
50
40
30
20
10
8
6
4
2
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00

Measured Ambient Noise Levels - Lismore South
Noise Logger Charts
Saturday, 15-12-07

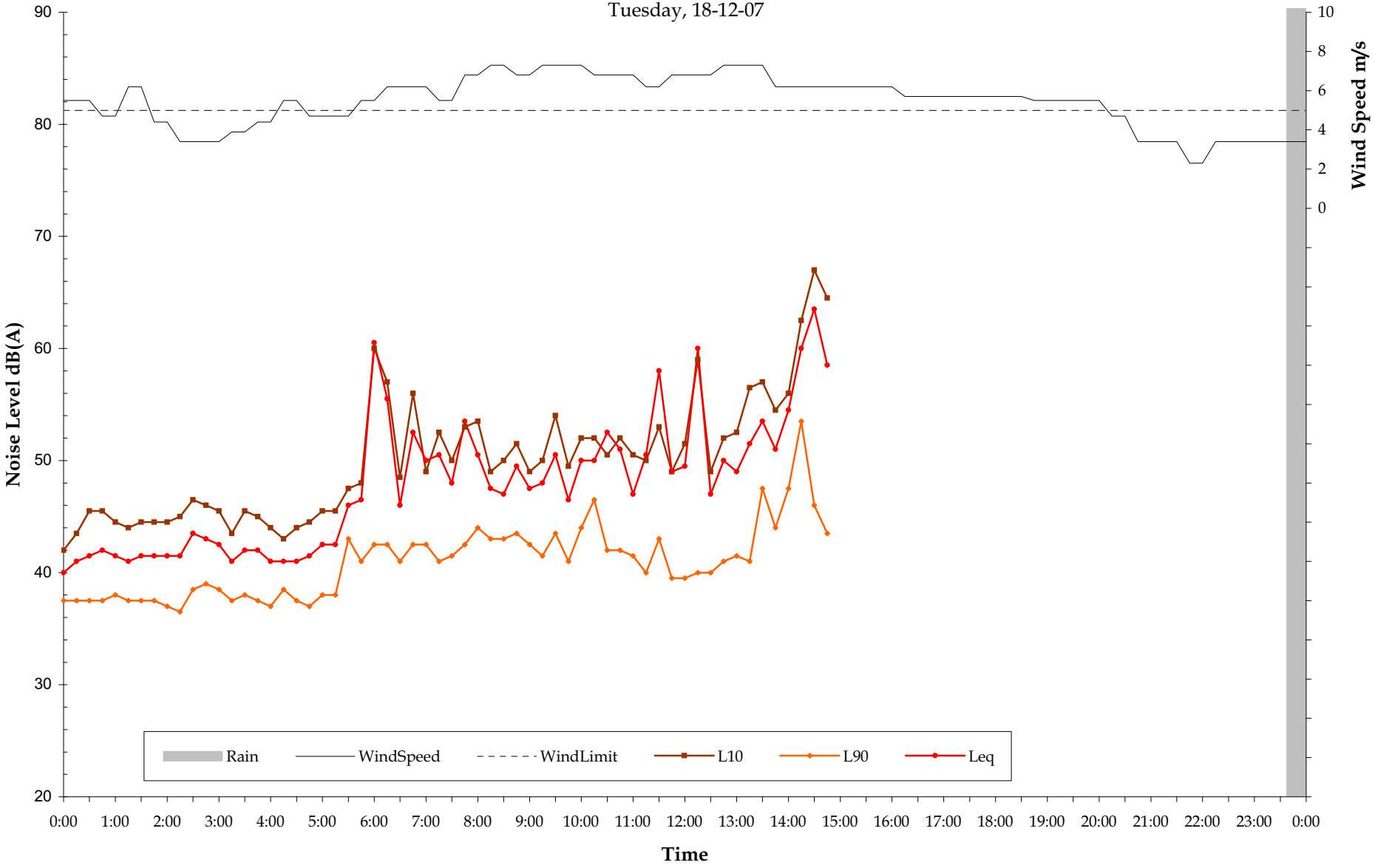



Measured Ambient Noise Levels - Lismore South
Noise Logger Charts
Sunday, 16-12-07
Noise Level dB(A)
Wind Speed m/s
Time
90
80
70
60
50
40
30
20
10
8
6
4
2
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Rain
WindSpeed
WindLimit
L10
L90
Leq

Measured Ambient Noise Levels - Lismore South
Noise Logger Charts
Monday, 17-12-07

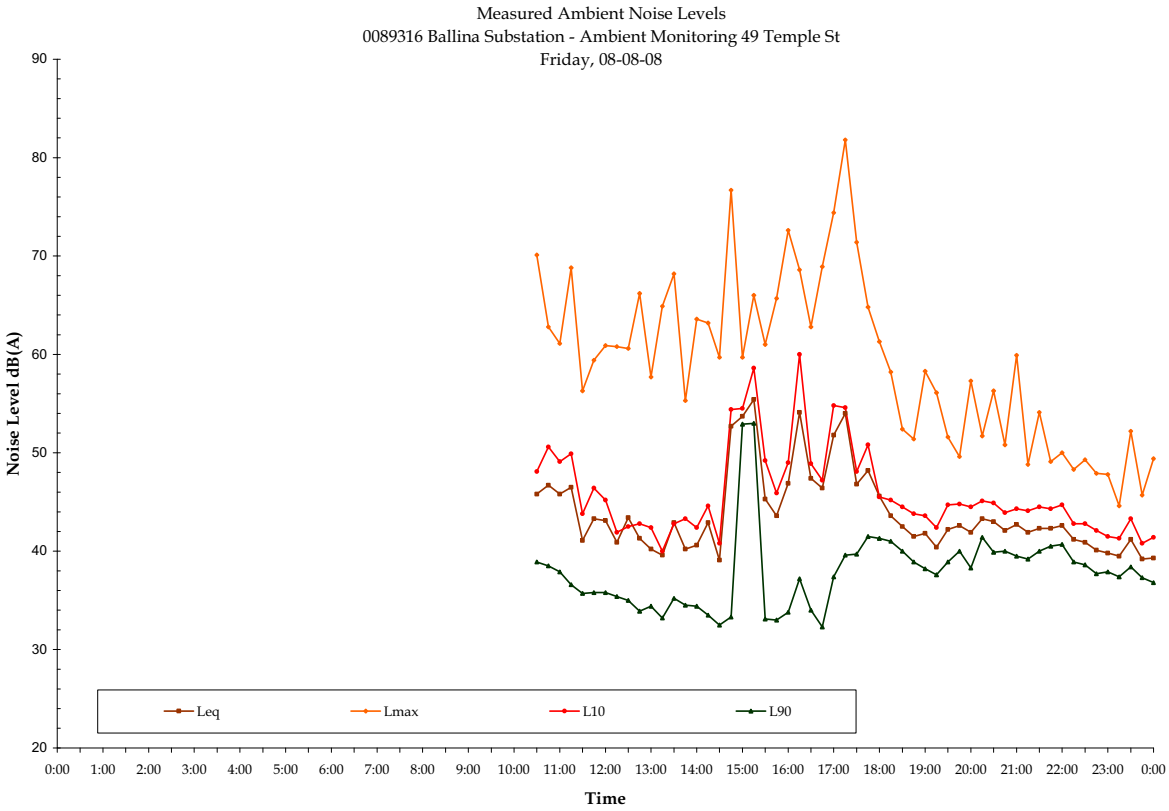


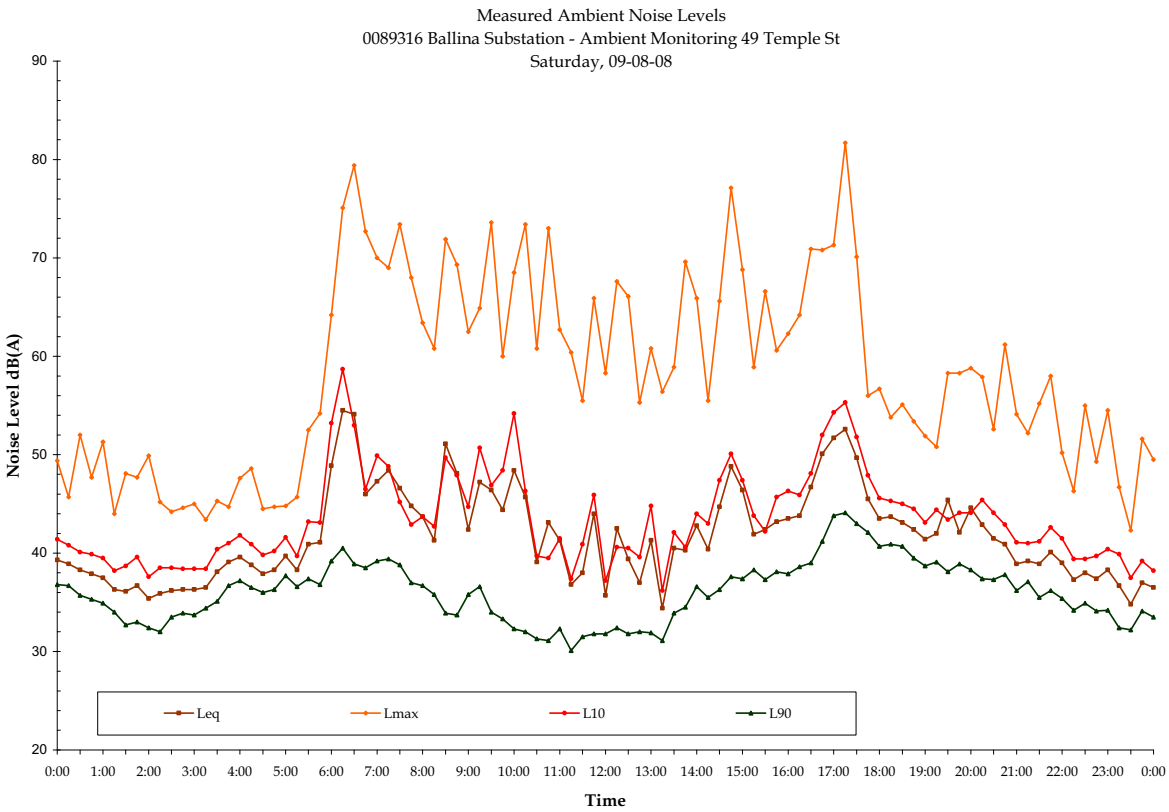
Measured Ambient Noise Levels - Lismore South
Noise Logger Charts
Tuesday, 18-12-07

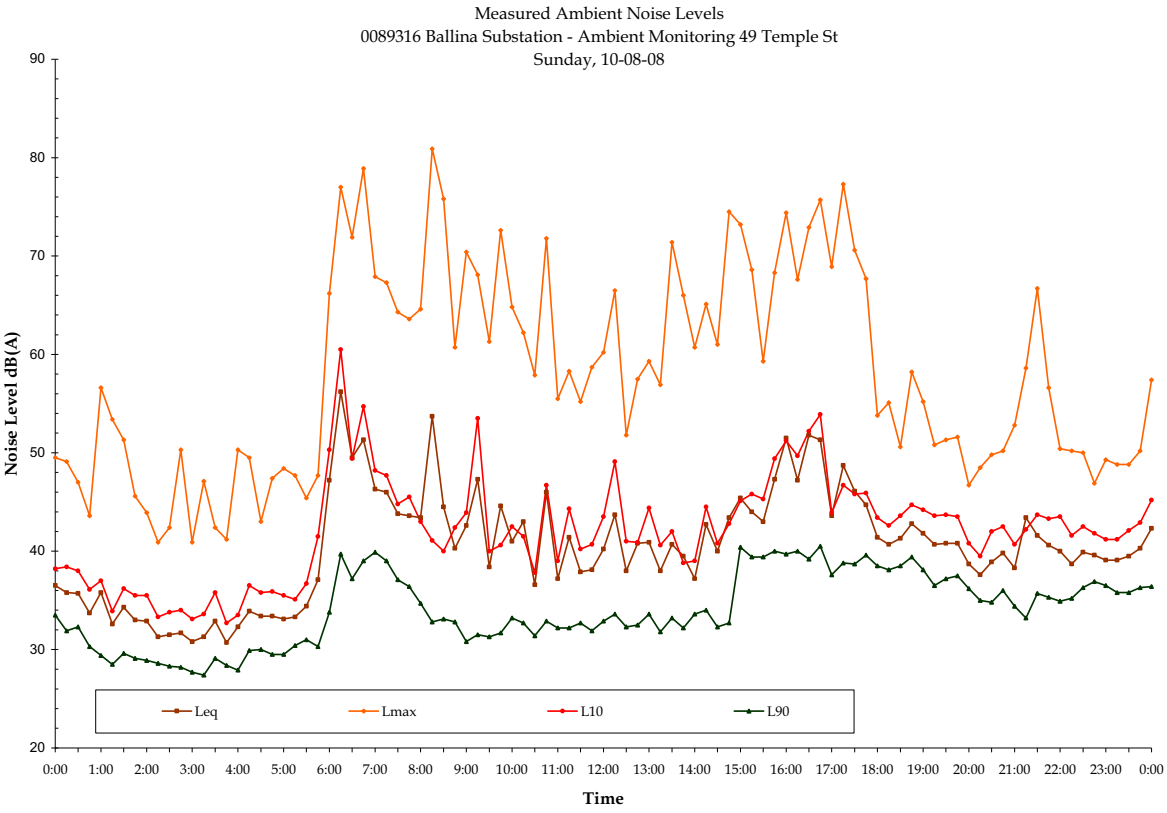


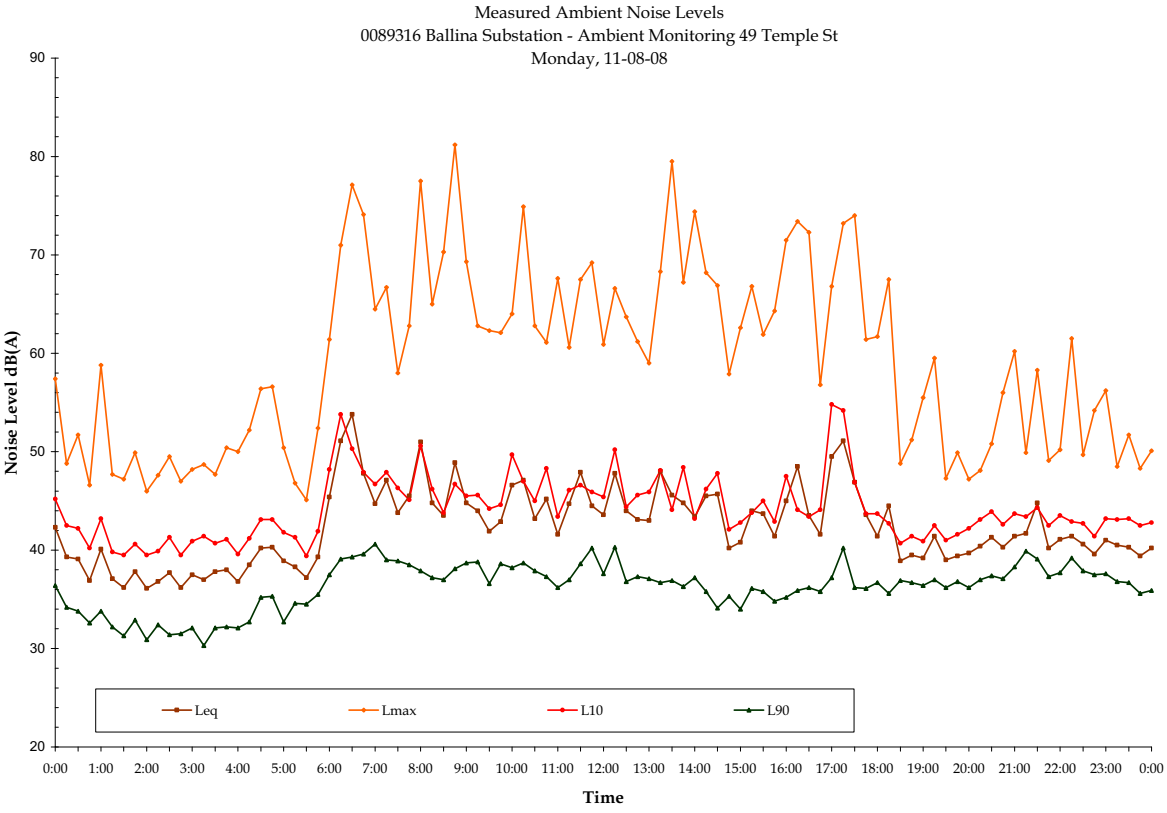
Annex E

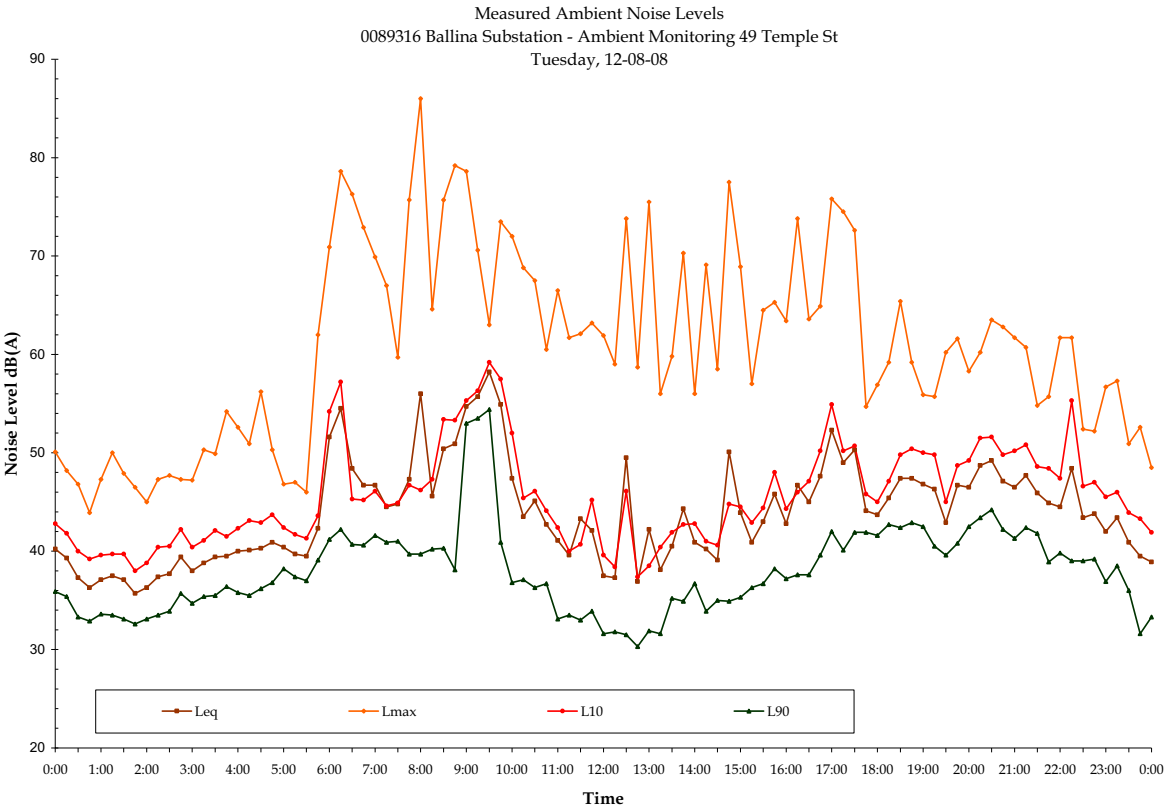
Noise Logger Graphs - Ballina

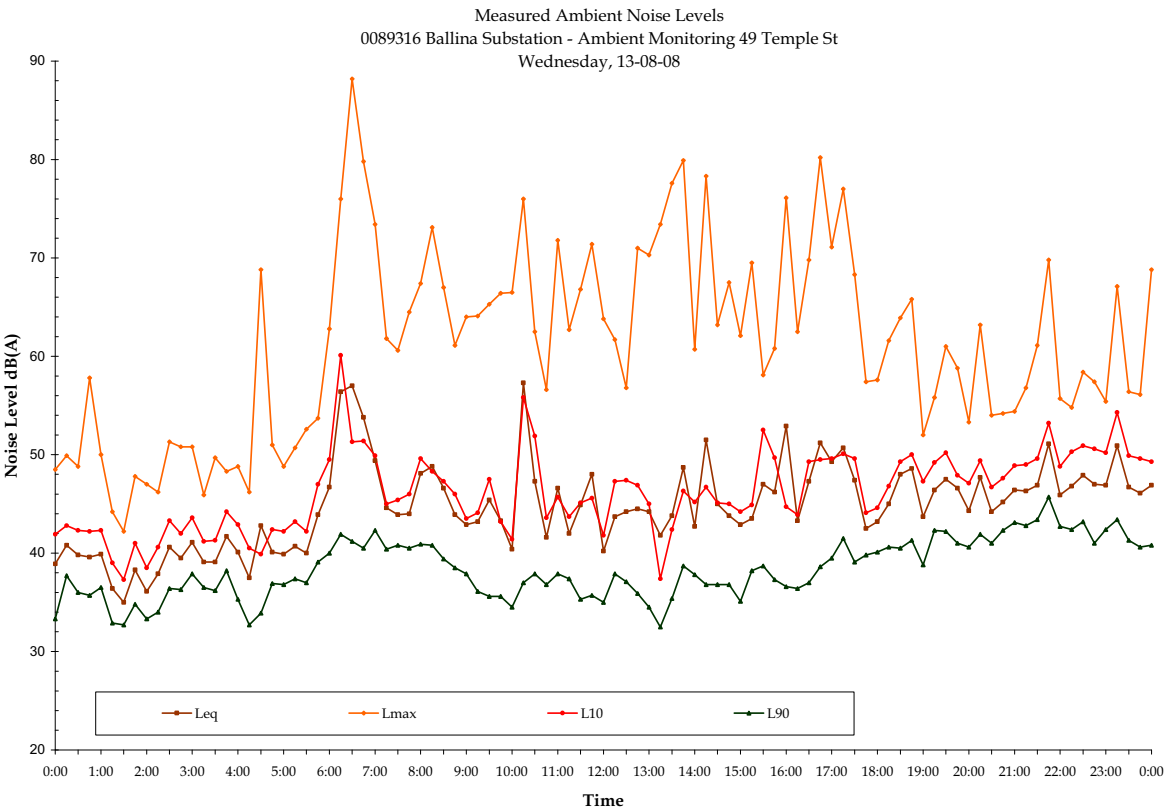

Measured Ambient Noise Levels
0089316 Ballina Substation - Ambient Monitoring 49 Temple St
Friday, 08-08-08
Noise Level dB(A)
90
80
70
60
50
40
30
20
Leq
Lmax
L10
L90
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 0:00
Time

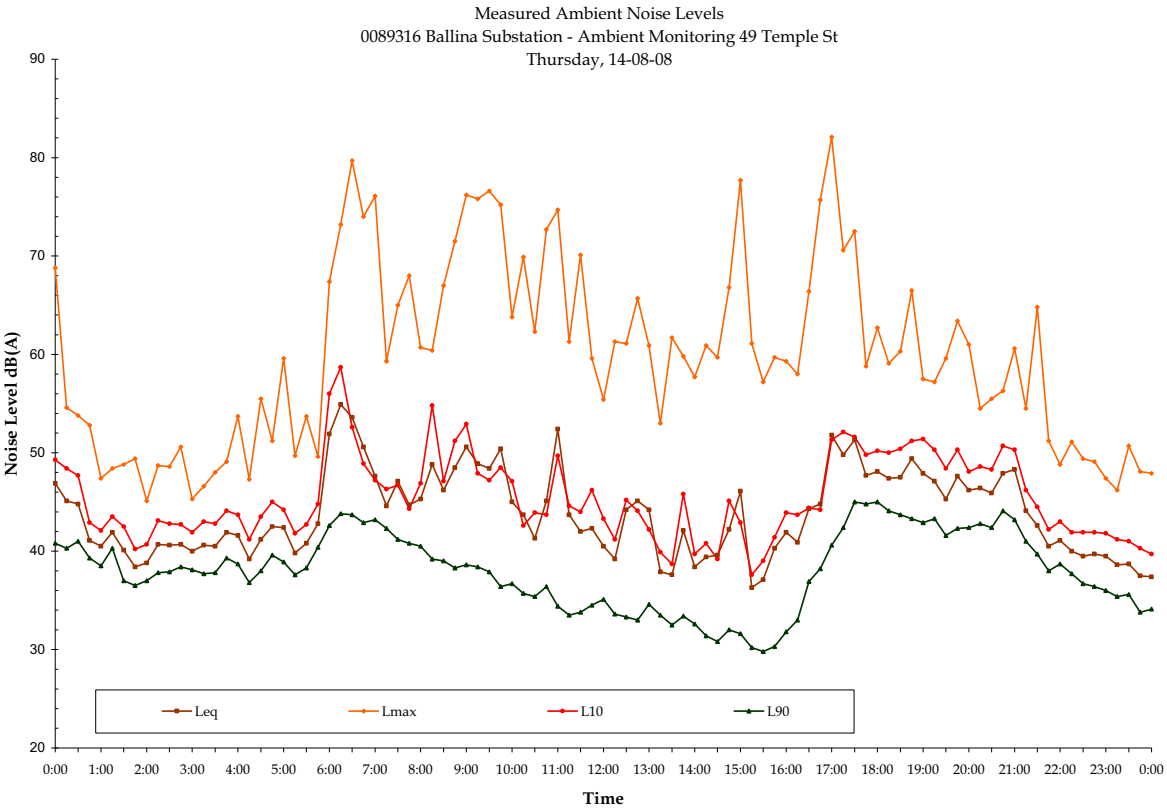

Measured Ambient Noise Levels
0089316 Ballina Substation - Ambient Monitoring 49 Temple St
Saturday, 09-08-08
Noise Level dB(A)
90
80
70
60
50
40
30
20
Leq
Lmax
L10
L90
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 0:00
Time

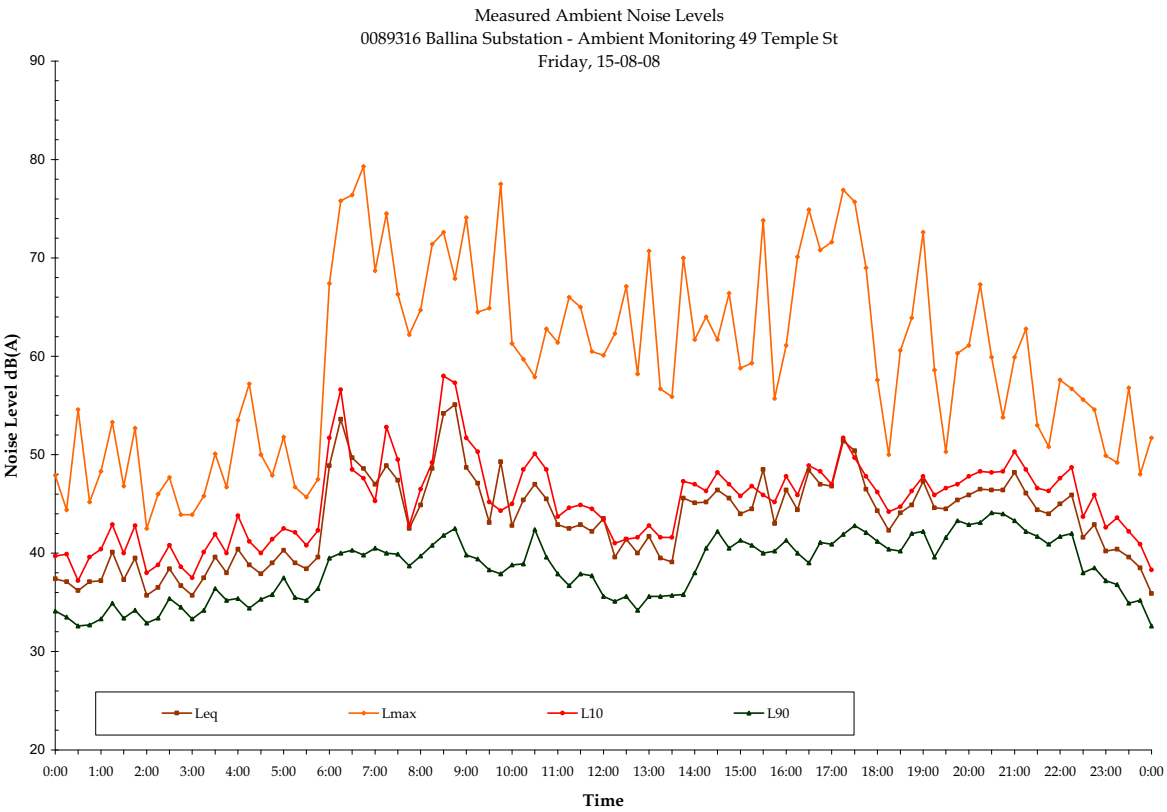

Measured Ambient Noise Levels
0089316 Ballina Substation - Ambient Monitoring 49 Temple St
Sunday, 10-08-08
Noise Level dB(A)
90
80
70
60
50
40
30
20
Leq
Lmax
L10
L90
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 0:00
Time

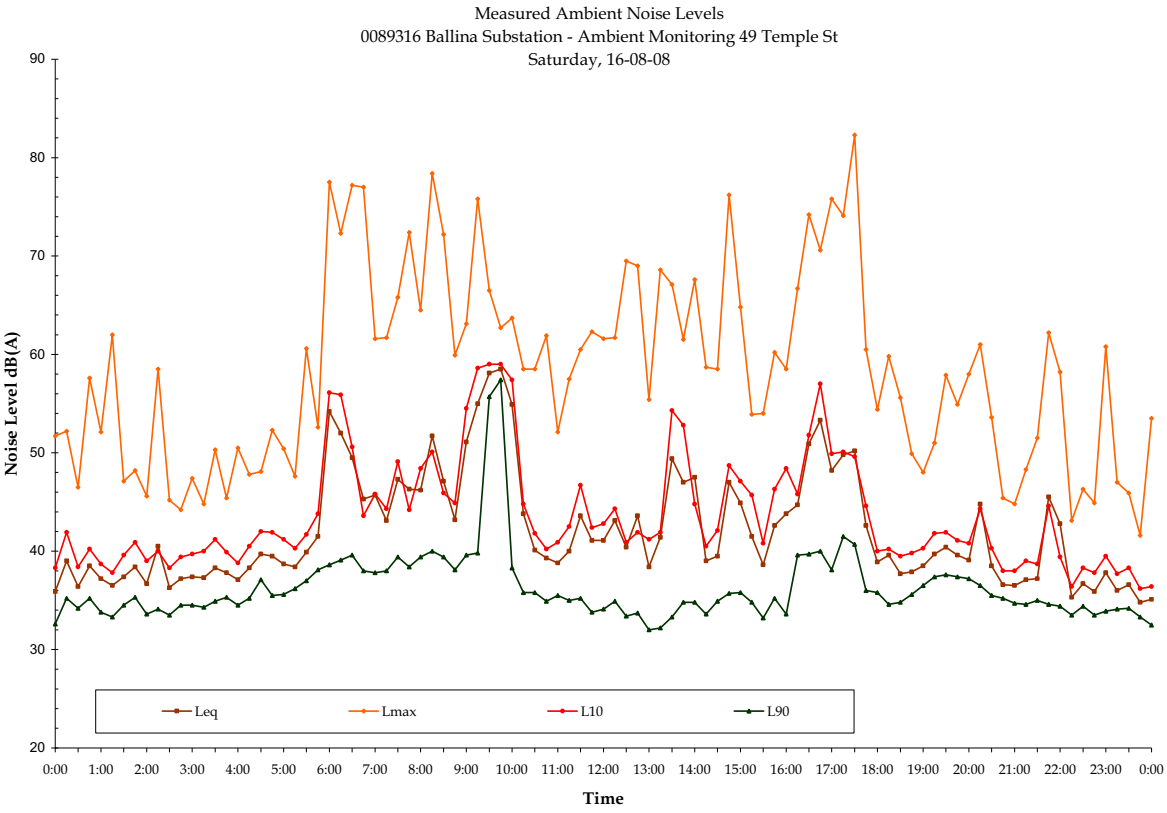

Measured Ambient Noise Levels
0089316 Ballina Substation - Ambient Monitoring 49 Temple St
Monday, 11-08-08
Noise Level dB(A)
90
80
70
60
50
40
30
20
Leq
Lmax
L10
L90
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 0:00
Time

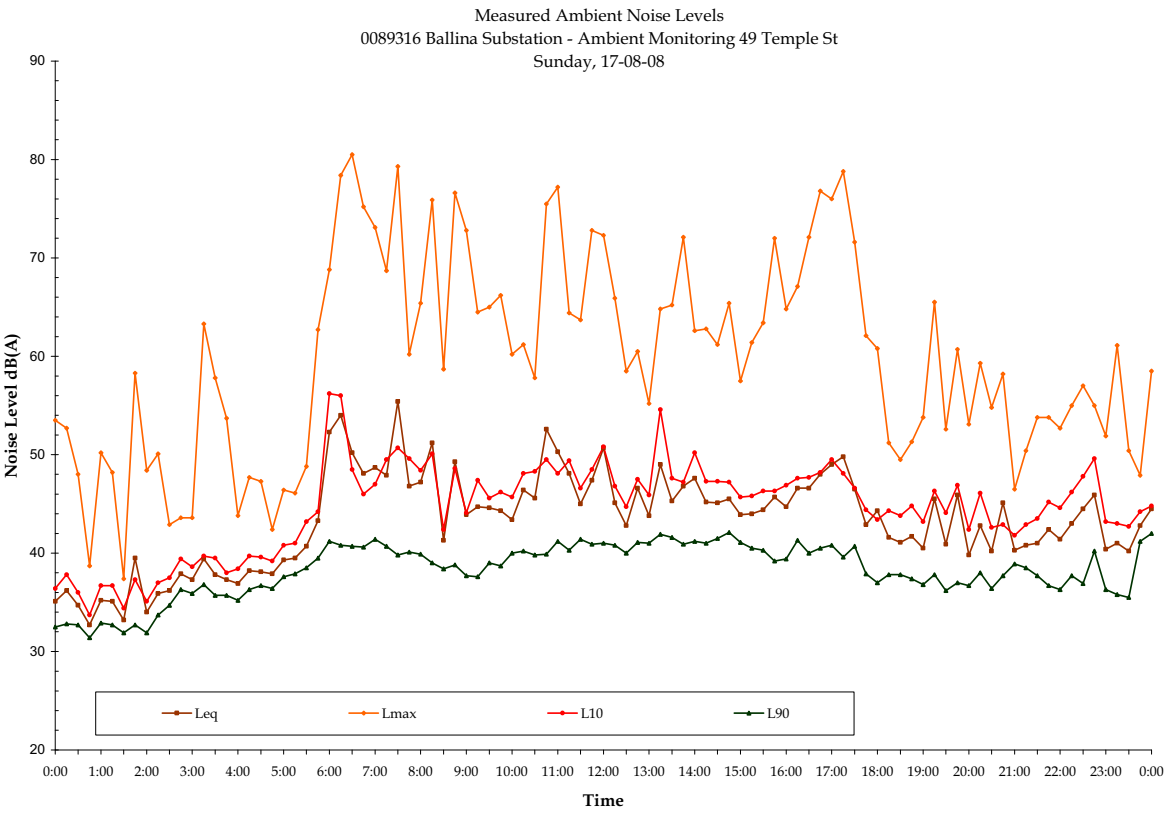

Measured Ambient Noise Levels
0089316 Ballina Substation - Ambient Monitoring 49 Temple St
Tuesday, 12-08-08
Noise Level dB(A)
90
80
70
60
50
40
30
20
Leq
Lmax
L10
L90
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 0:00
Time

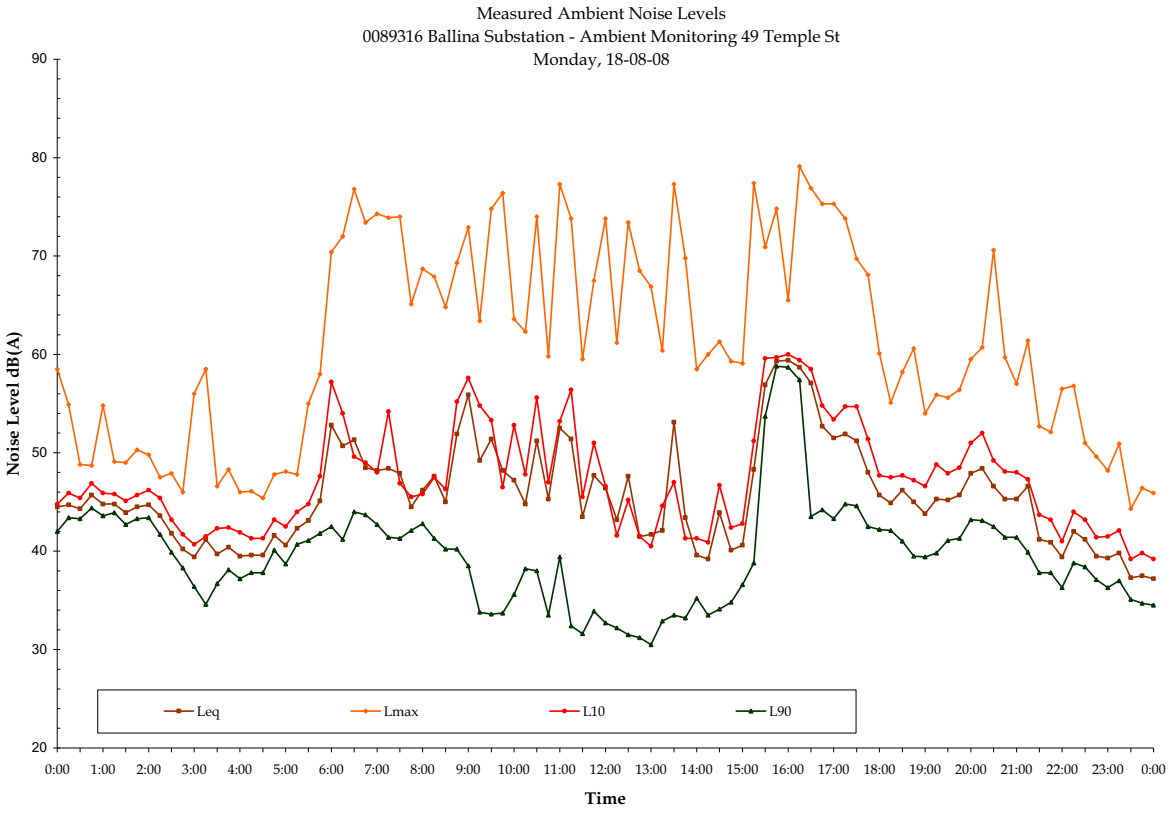

Measured Ambient Noise Levels
0089316 Ballina Substation - Ambient Monitoring 49 Temple St
Wednesday, 13-08-08
Noise Level dB(A)
90
80
70
60
50
40
30
20
Leq
Lmax
L10
L90
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 0:00
Time

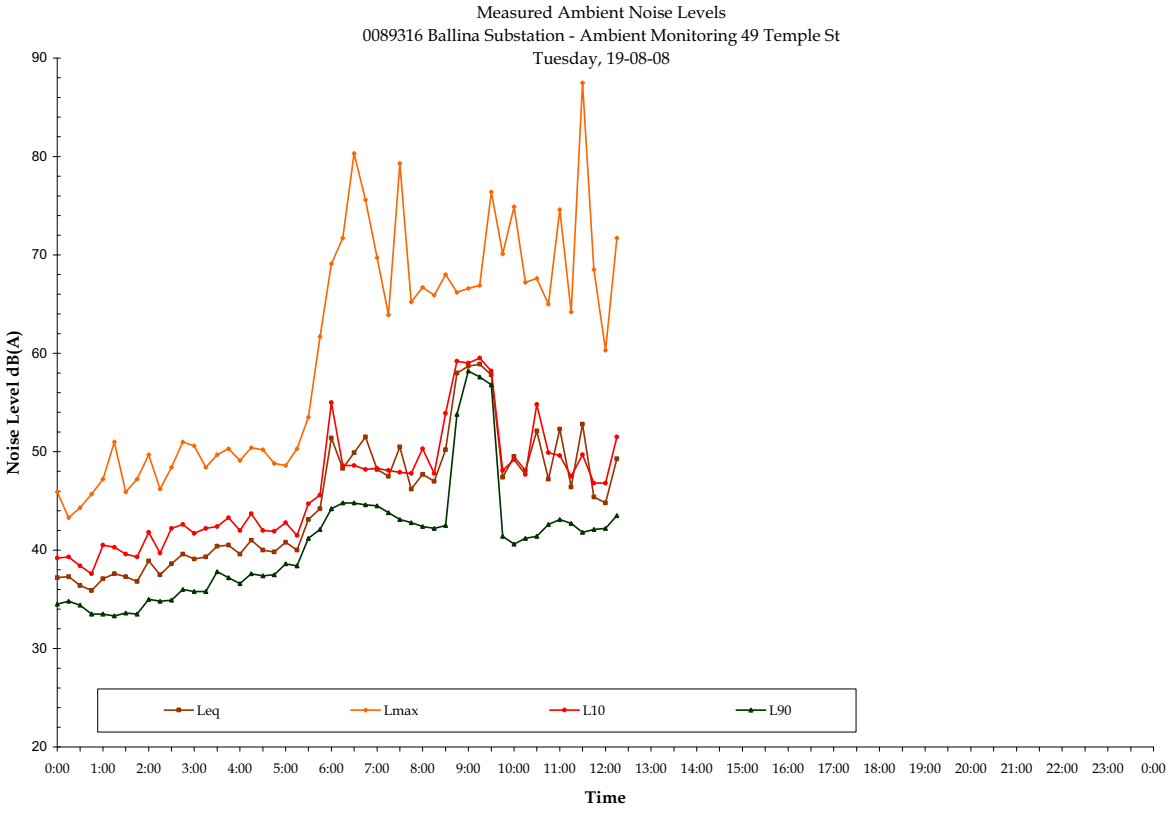

Measured Ambient Noise Levels
0089316 Ballina Substation - Ambient Monitoring 49 Temple St
Thursday, 14-08-08
Noise Level dB(A)
90
80
70
60
50
40
30
20
Leq
Lmax
L10
L90
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 0:00
Time


Measured Ambient Noise Levels
0089316 Ballina Substation - Ambient Monitoring 49 Temple St
Friday, 15-08-08
Noise Level dB(A)
90
80
70
60
50
40
30
20
Leq
Lmax
L10
L90
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 0:00
Time


Measured Ambient Noise Levels
0089316 Ballina Substation - Ambient Monitoring 49 Temple St
Saturday, 16-08-08
Noise Level dB(A)
90
80
70
60
50
40
30
20
Leq
Lmax
L10
L90
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 0:00
Time

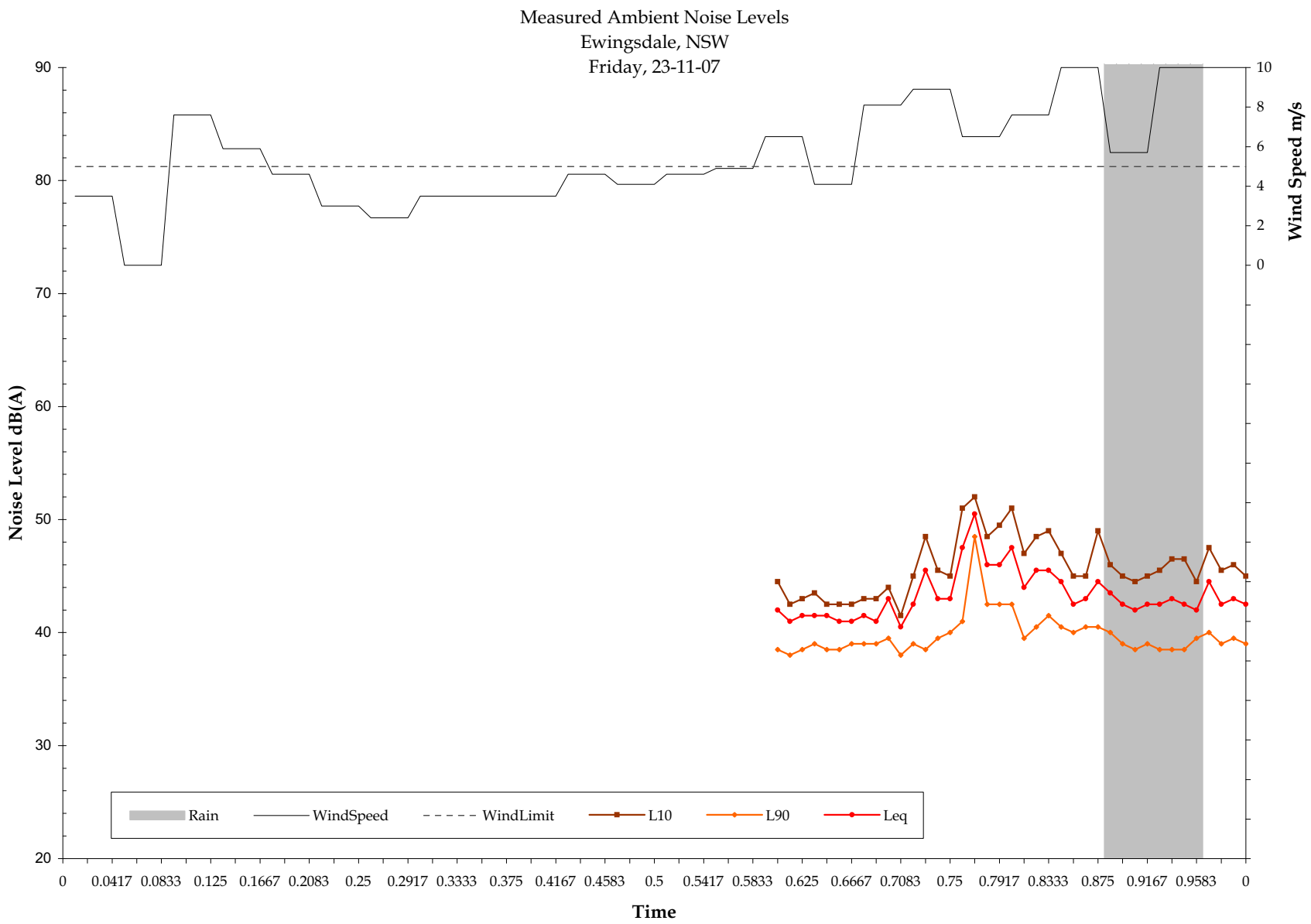

Measured Ambient Noise Levels
0089316 Ballina Substation - Ambient Monitoring 49 Temple St
Sunday, 17-08-08
Noise Level dB(A)
90
80
70
60
50
40
30
20
Leq
Lmax
L10
L90
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 0:00
Time

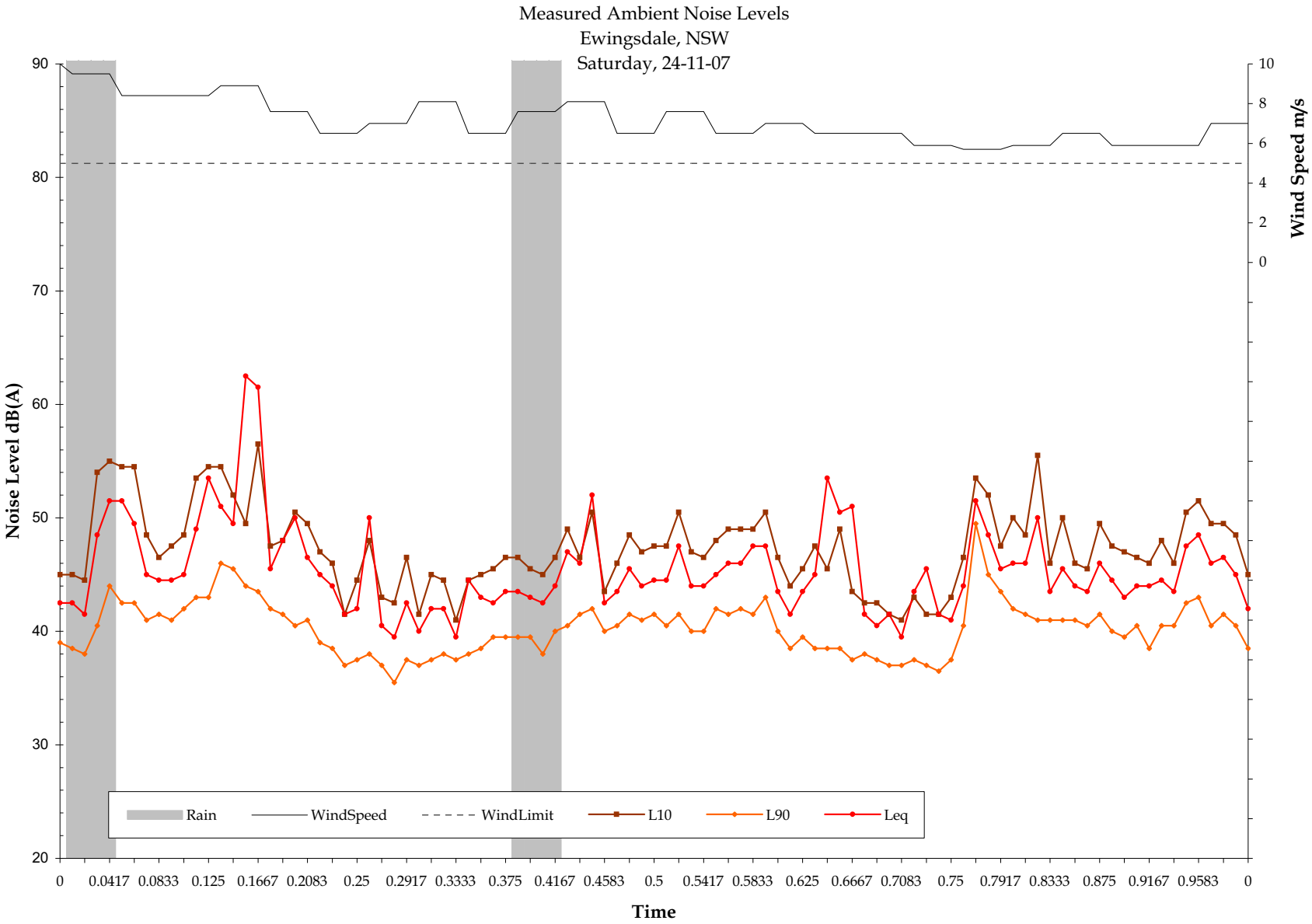

Measured Ambient Noise Levels
0089316 Ballina Substation - Ambient Monitoring 49 Temple St
Monday, 18-08-08
Noise Level dB(A)
90
80
70
60
50
40
30
20
Leq
Lmax
L10
L90
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 0:00
Time

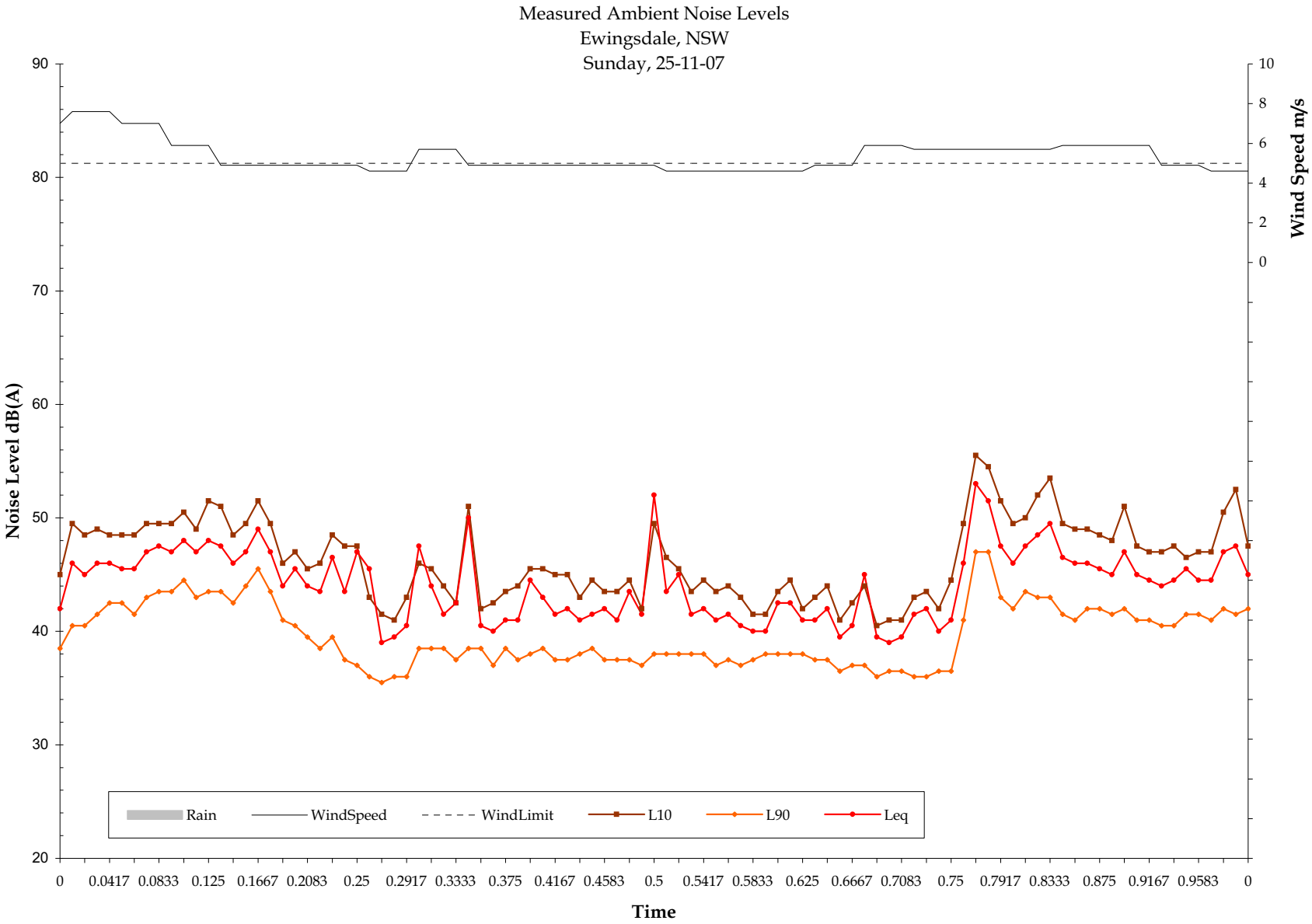

Measured Ambient Noise Levels
0089316 Ballina Substation - Ambient Monitoring 49 Temple St
Tuesday, 19-08-08
Noise Level dB(A)
90
80
70
60
50
40
30
20
Leq
Lmax
L10
L90
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 0:00
Time

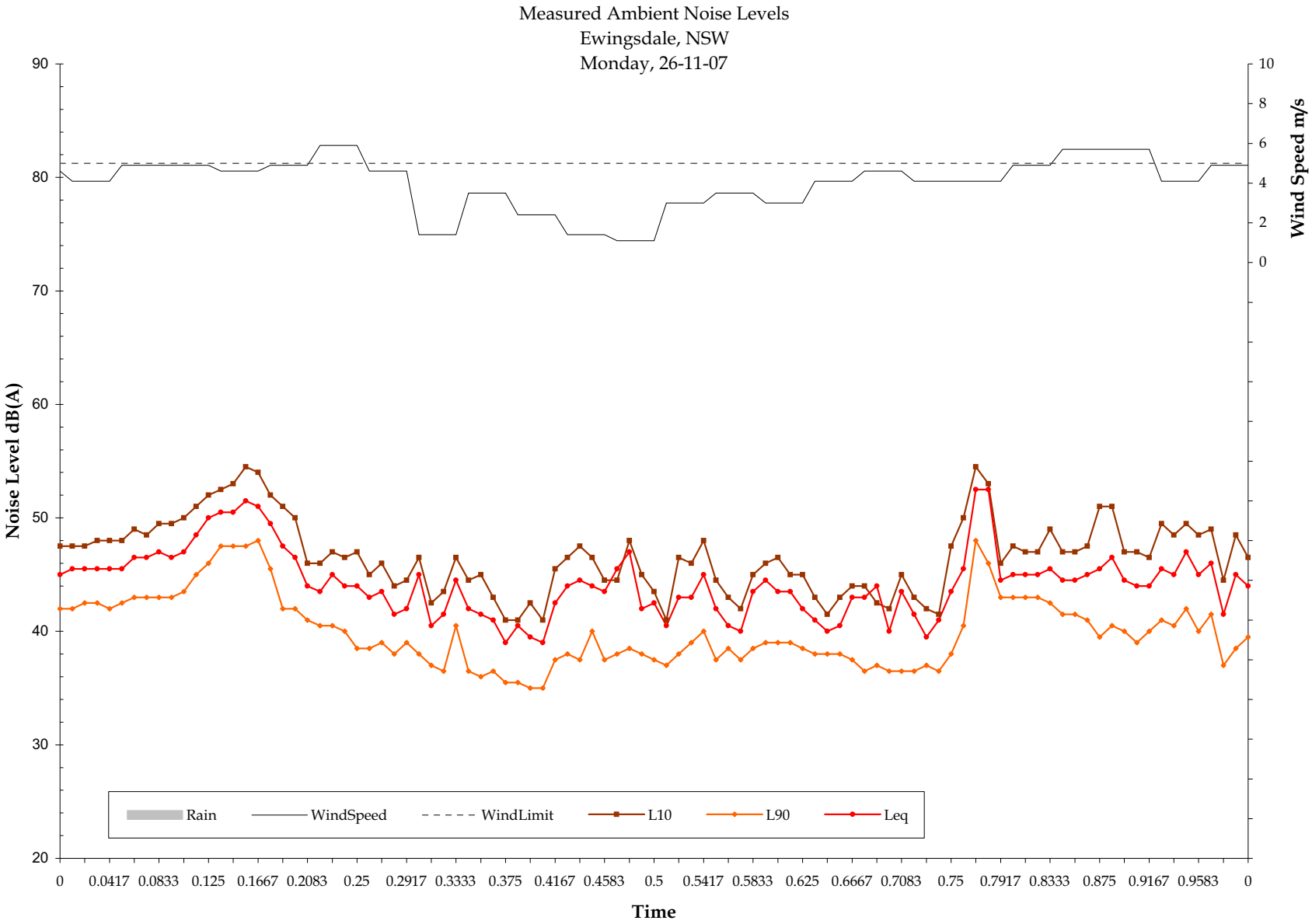
Annex F

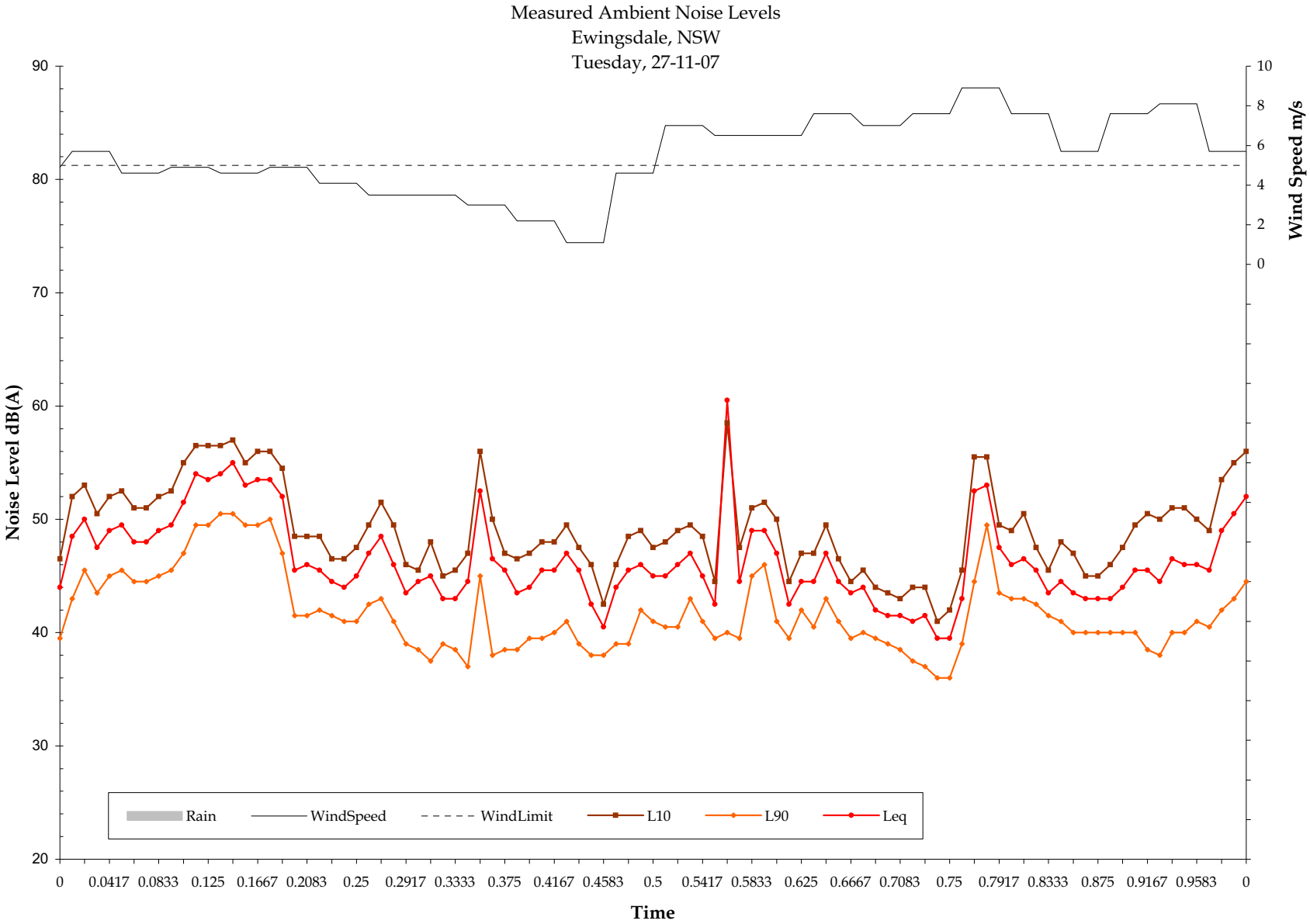
Noise Logger Graphs - Ewingsdale

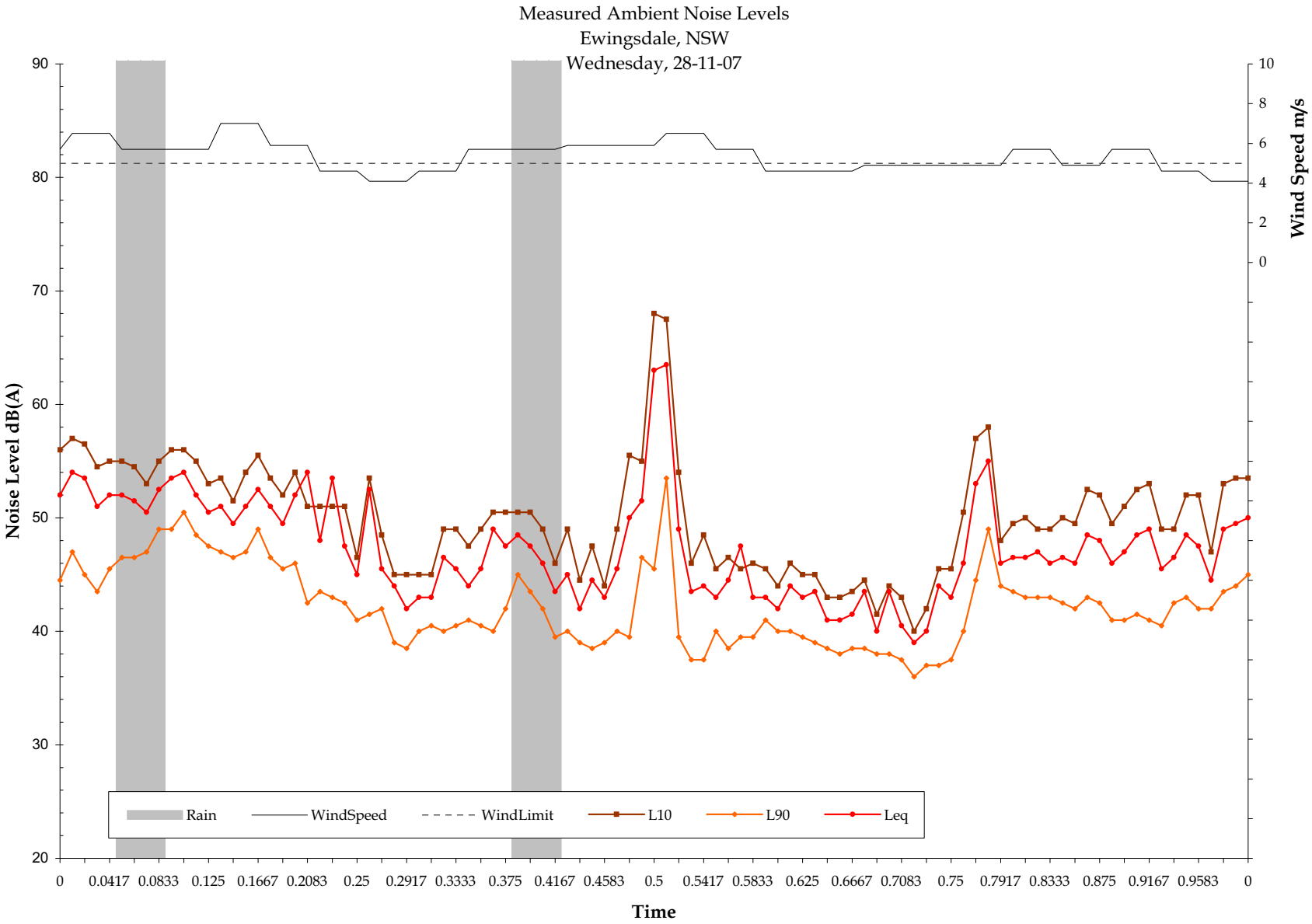

Measured Ambient Noise Levels
Ewingsdale, NSW
Friday, 23-11-07
Noise Level dB(A)
Wind Speed m/s
Time
90
80
70
60
50
40
30
20
10
8
6
4
2
0
0
0.0417
0.0833
0.125
0.1667
0.2083
0.25
0.2917
0.3333
0.375
0.4167
0.4583
0.5
0.5417
0.5833
0.625
0.6667
0.7083
0.75
0.7917
0.8333
0.875
0.9167
0.9583
0
Rain
WindSpeed
WindLimit
L10
L90
Leq

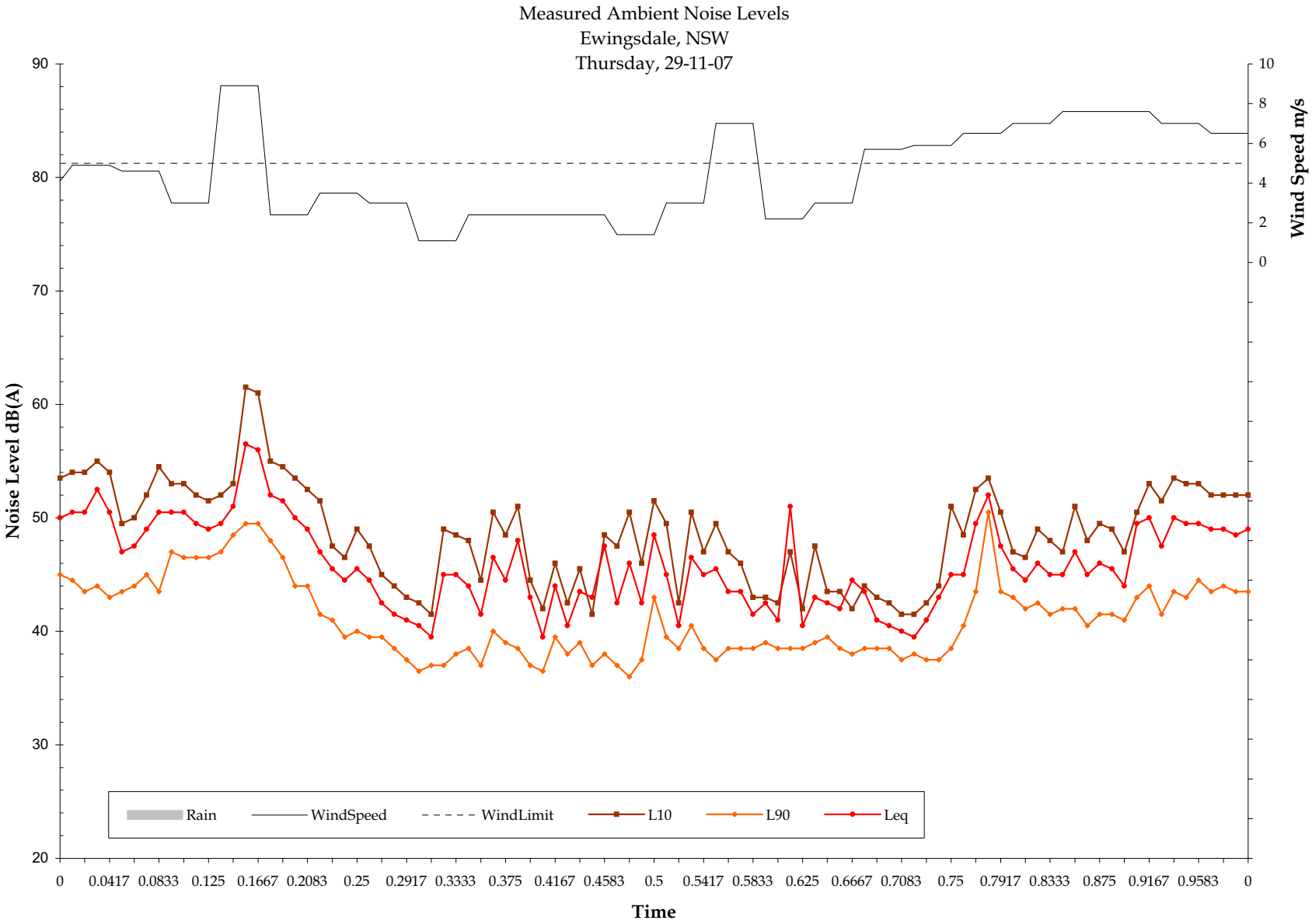

Measured Ambient Noise Levels
Ewingsdale, NSW
Saturday, 24-11-07
Noise Level dB(A)
Wind Speed m/s
Time
Rain
WindSpeed
WindLimit
L10
L90
Leq
90
80
70
60
50
40
30
20
10
8
6
4
2
0
0
0.0417
0.0833
0.125
0.1667
0.2083
0.25
0.2917
0.3333
0.375
0.4167
0.4583
0.5
0.5417
0.5833
0.625
0.6667
0.7083
0.75
0.7917
0.8333
0.875
0.9167
0.9583
0

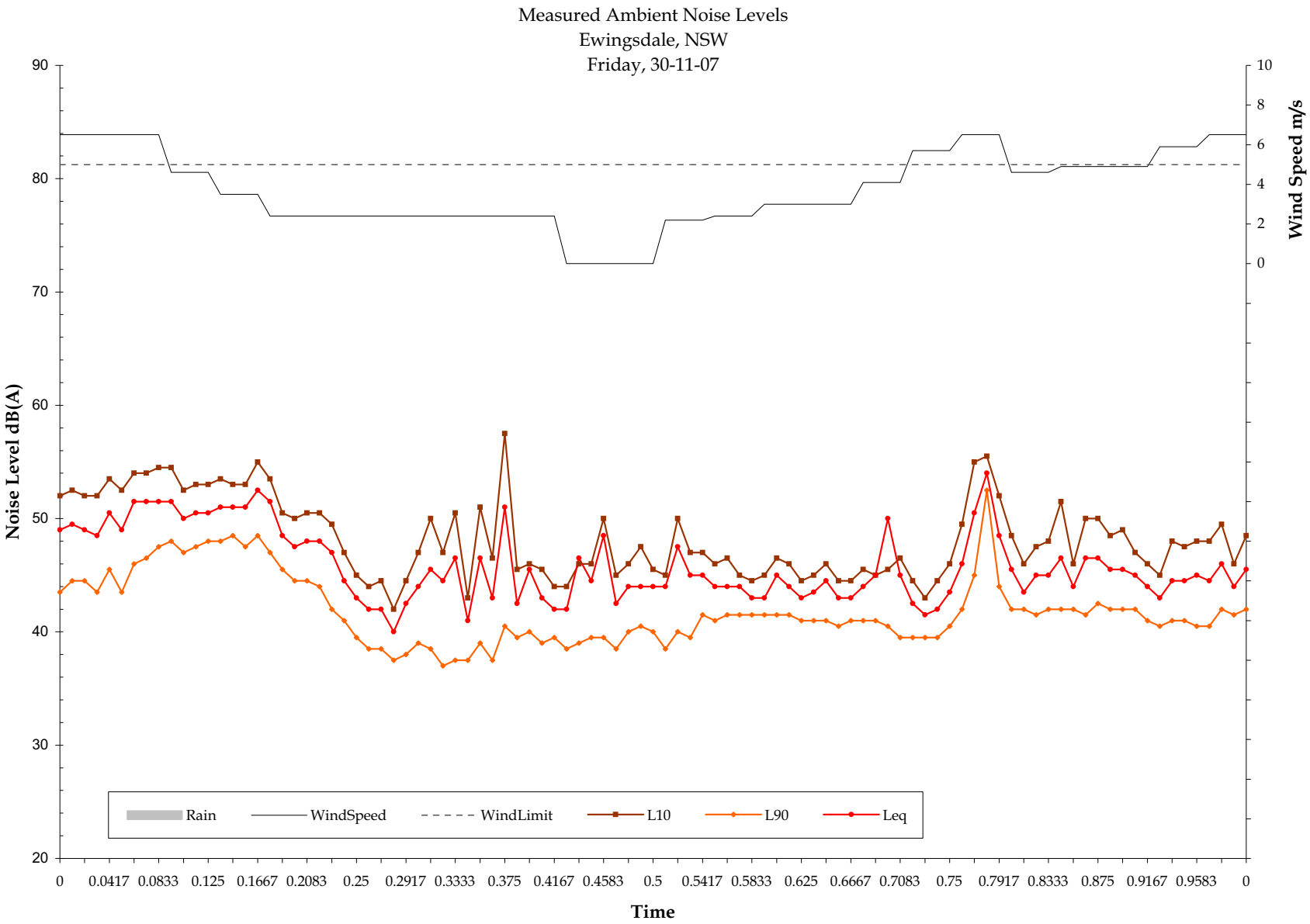

Measured Ambient Noise Levels
Ewingsdale, NSW
Sunday, 25-11-07
Noise Level dB(A)
Wind Speed m/s
Time
90
80
70
60
50
40
30
20
10
8
6
4
2
0
0
0.0417
0.0833
0.125
0.1667
0.2083
0.25
0.2917
0.3333
0.375
0.4167
0.4583
0.5
0.5417
0.5833
0.625
0.6667
0.7083
0.75
0.7917
0.8333
0.875
0.9167
0.9583
0
Rain
WindSpeed
WindLimit
L10
L90
Leq


Measured Ambient Noise Levels
Ewingsdale, NSW
Monday, 26-11-07
Noise Level dB(A)
Wind Speed m/s
Time
90
80
70
60
50
40
30
20
10
8
6
4
2
0
0
0.0417
0.0833
0.125
0.1667
0.2083
0.25
0.2917
0.3333
0.375
0.4167
0.4583
0.5
0.5417
0.5833
0.625
0.6667
0.7083
0.75
0.7917
0.8333
0.875
0.9167
0.9583
0
Rain
WindSpeed
WindLimit
L10
L90
Leq


Measured Ambient Noise Levels
Ewingsdale, NSW
Tuesday, 27-11-07
Noise Level dB(A)
Wind Speed m/s
Time
90
80
70
60
50
40
30
20
10
8
6
4
2
0
0
0.0417
0.0833
0.125
0.1667
0.2083
0.25
0.2917
0.3333
0.375
0.4167
0.4583
0.5
0.5417
0.5833
0.625
0.6667
0.7083
0.75
0.7917
0.8333
0.875
0.9167
0.9583
0
Rain
WindSpeed
WindLimit
L10
L90
Leq


Measured Ambient Noise Levels
Ewingsdale, NSW
Wednesday, 28-11-07
Noise Level dB(A)
Wind Speed m/s
Time
Rain
WindSpeed
WindLimit
L10
L90
Leq
90
80
70
60
50
40
30
20
10
8
6
4
2
0
0
0.0417
0.0833
0.125
0.1667
0.2083
0.25
0.2917
0.3333
0.375
0.4167
0.4583
0.5
0.5417
0.5833
0.625
0.6667
0.7083
0.75
0.7917
0.8333
0.875
0.9167
0.9583
0


Measured Ambient Noise Levels
Ewingsdale, NSW
Thursday, 29-11-07
Noise Level dB(A)
Wind Speed m/s
Time
90
80
70
60
50
40
30
20
10
8
6
4
2
0
0
0.0417
0.0833
0.125
0.1667
0.2083
0.25
0.2917
0.3333
0.375
0.4167
0.4583
0.5
0.5417
0.5833
0.625
0.6667
0.7083
0.75
0.7917
0.8333
0.875
0.9167
0.9583
0
Rain
WindSpeed
WindLimit
L10
L90
Leq


Measured Ambient Noise Levels
Ewingsdale, NSW
Friday, 30-11-07
Noise Level dB(A)
Wind Speed m/s
Time
Rain
WindSpeed
WindLimit
L10
L90
Leq
90
80
70
60
50
40
30
20
10
8
6
4
2
0
0
0.0417
0.0833
0.125
0.1667
0.2083
0.25
0.2917
0.3333
0.375
0.4167
0.4583
0.5
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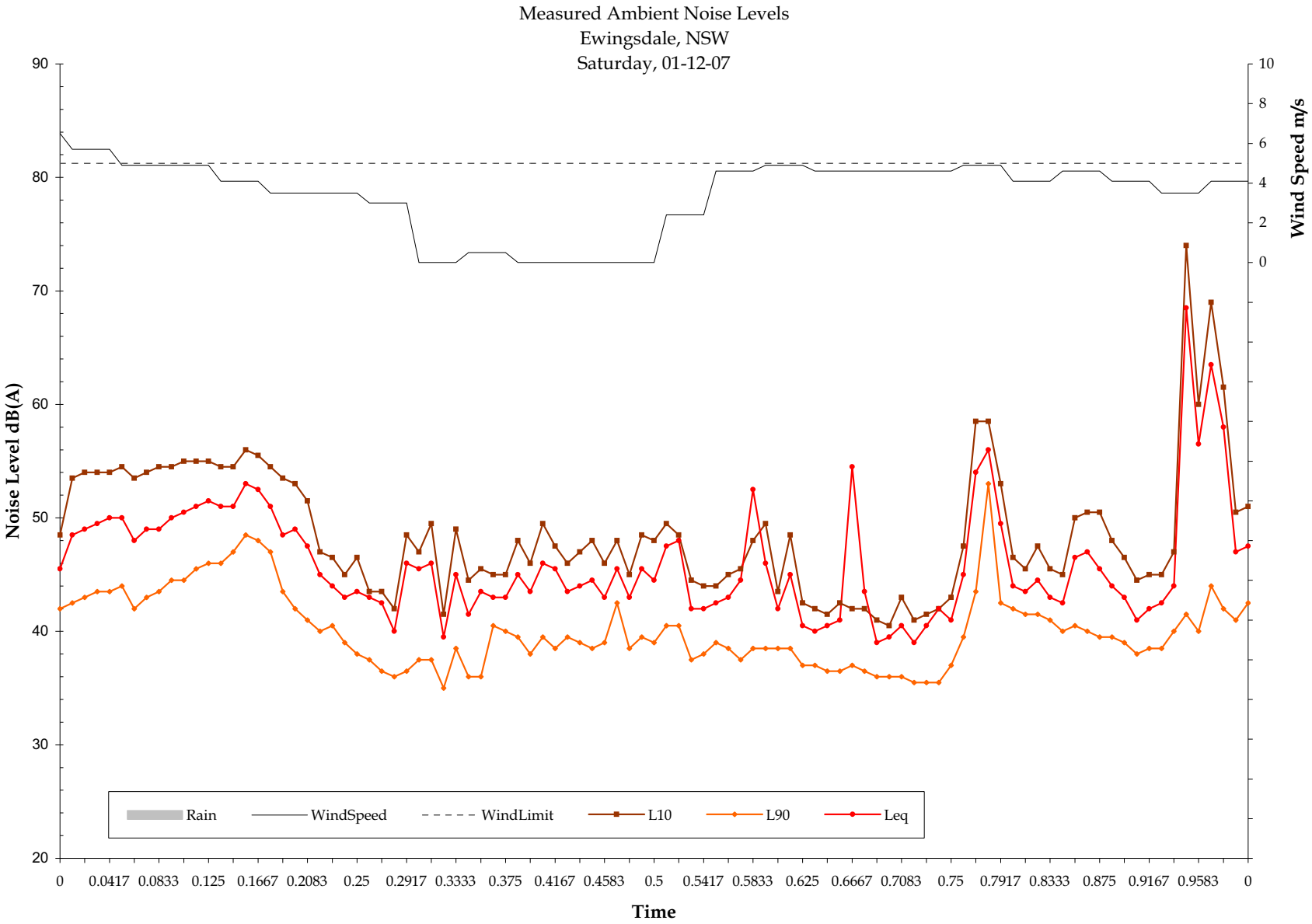
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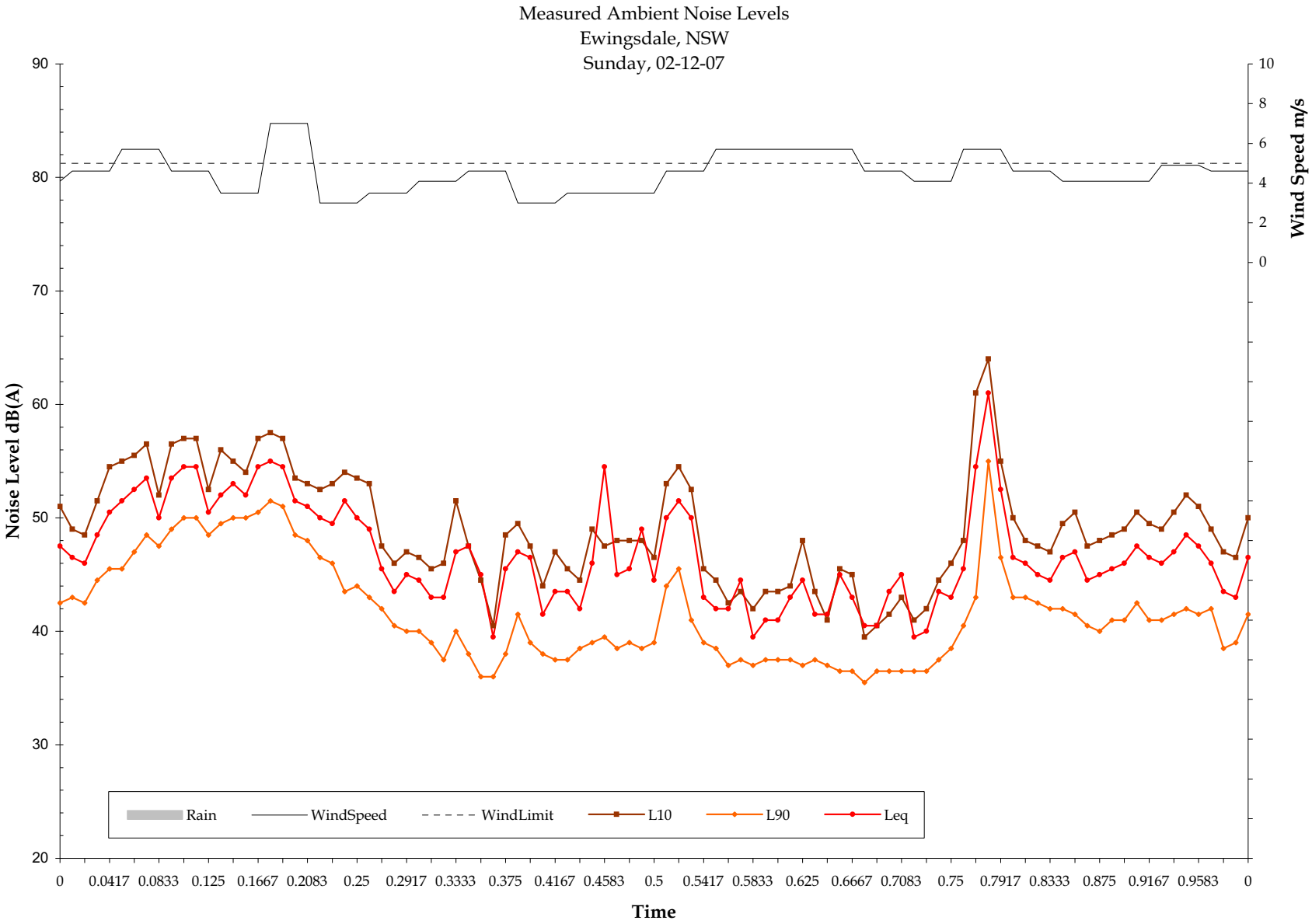
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Ewingsdale, NSW
Sunday, 02-12-07
Noise Level dB(A)
Wind Speed m/s
Time
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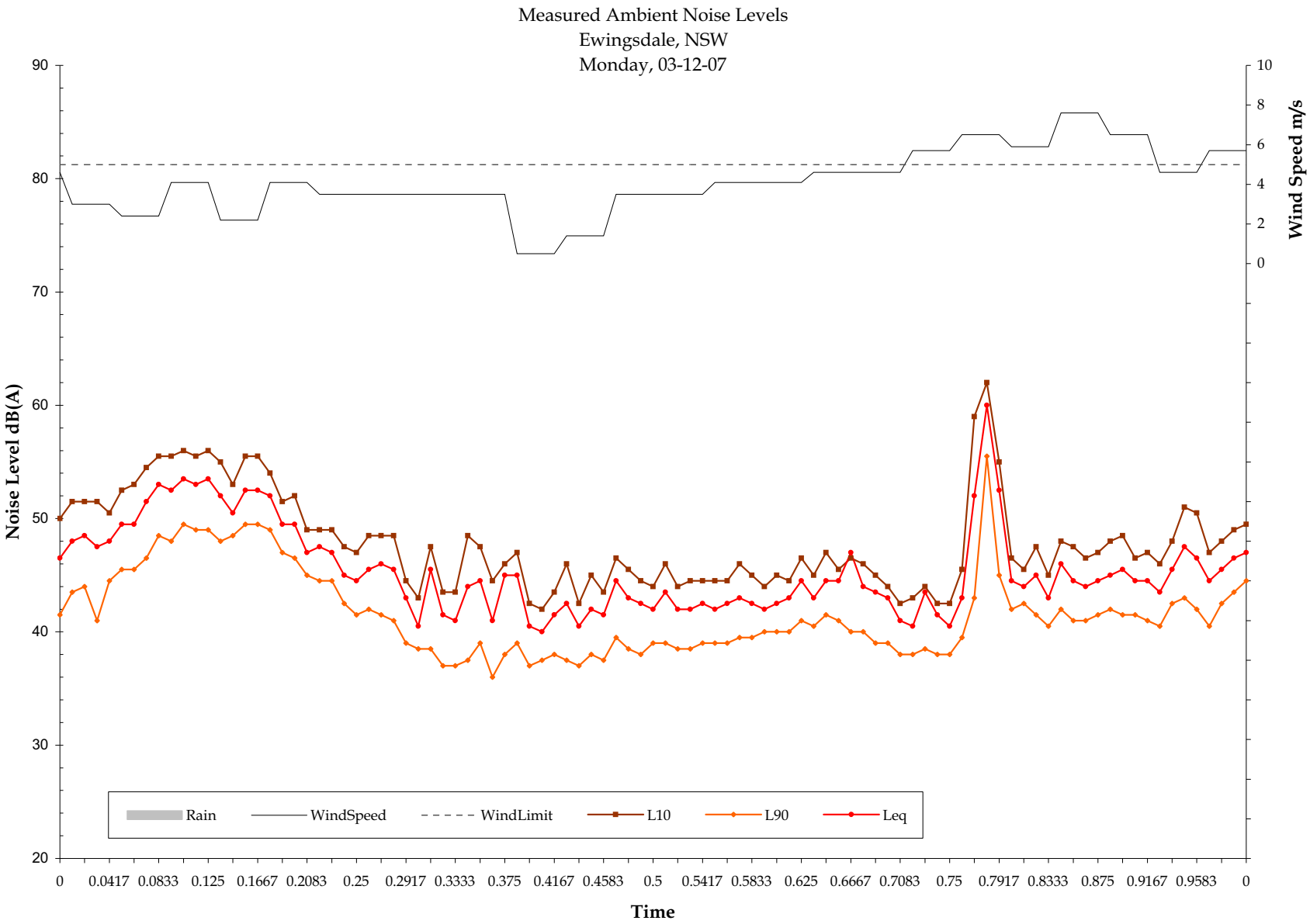
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Ewingsdale, NSW
Monday, 03-12-07
Noise Level dB(A)
Wind Speed m/s
Time
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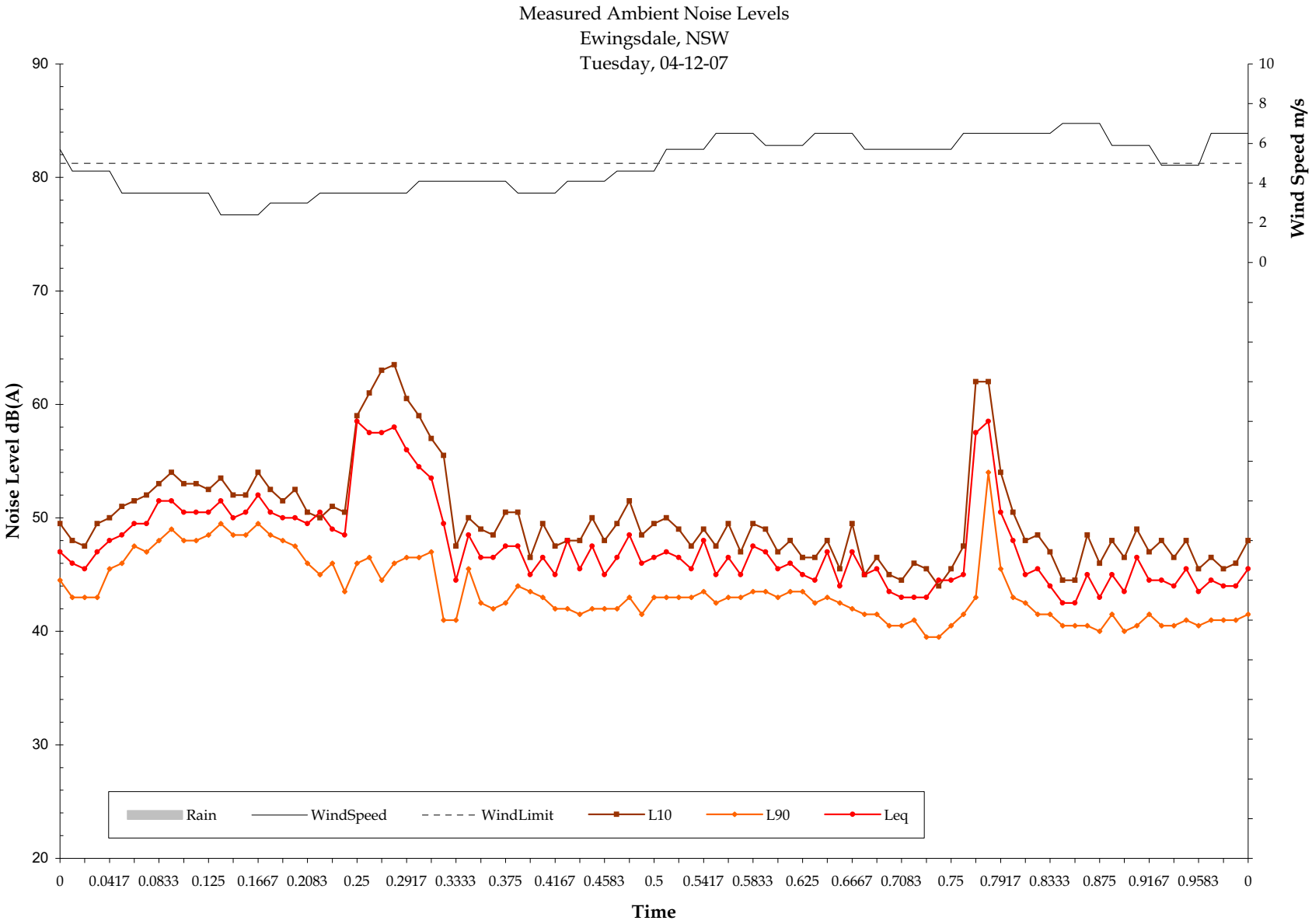
Measured Ambient Noise Levels
Ewingsdale, NSW
Tuesday, 04-12-07
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Wind Speed m/s
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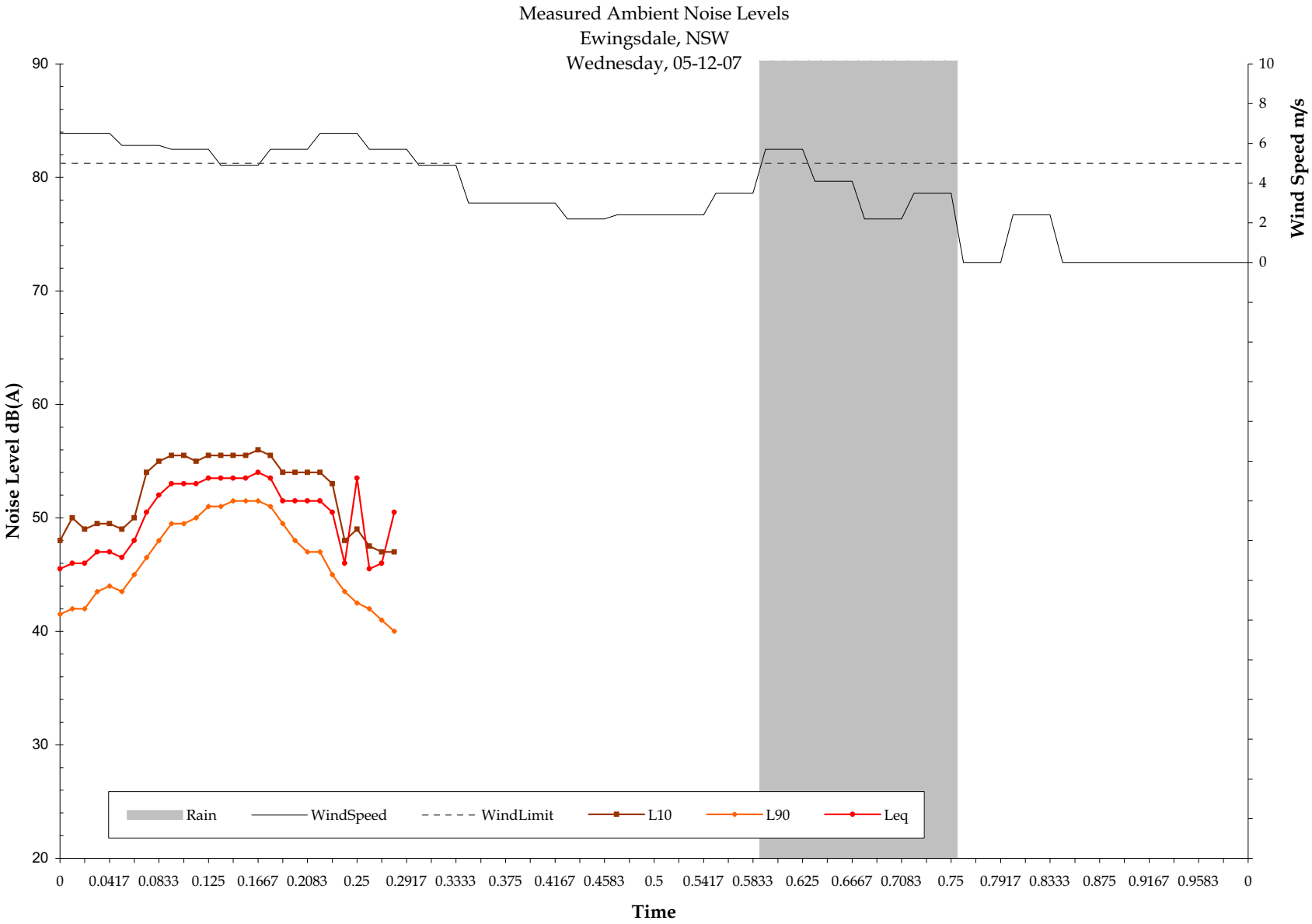
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Wednesday, 05-12-07
Noise Level dB(A)
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Time
Rain
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Annex M

Lismore to Mullumbimby Electricity Network Upgrade - Visual Impact Assessment
(ERM, 2008)

FINAL REPORT

Lismore to Mullumbimby Electricity Network Upgrade Project

Visual Assessment Report

For
Country Energy

21 October 2008

Environmental Resources Management Australia
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FINAL REPORT

Lismore to Mullumbimby Electricity Network Upgrade Project
Visual Assessment Report

For
Country Energy

21 October 2008

Reference: 0051706 RPT3

For and on behalf of
Environmental Resources Management Australia

Approved by: Murray Curtis

Signed:

Position: Managing Partner

Date: 21 October 2008

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ANNEX A ***PARAMETERS OF HUMAN VISION***
ANNEX B ***PHOTOGRAPHIC MONTAGES***

1 INTRODUCTION

Country Energy has identified the need for augmentation of its electricity supply network in the Lismore, Ballina, Ewingsdale and Mullumbimby areas on the NSW Mid North Coast to cater for long-term electricity supply demands.

The Project will involve a combination of infrastructure upgrades to the existing 66kV transmission line and associated infrastructure to 132kV infrastructure. This will involve the construction of new 66kV and 132kV transmission lines and construction of new zone substations and upgrade of existing zone substations.

2 METHODOLOGY

This section outlines the methodology adopted for assessing the Landscape & Visual Impact Assessment of the proposed Lismore to Mullumbimby Electricity Network Upgrade (the Project), under the Environmental Assessment Requirements under Part 3A of the Environmental Planning and Assessment Act 1979.

The methodology used within this visual assessment of the electricity network upgrade includes the following steps.

The Visual Components

We have described the visual components of the transmission line upgrade. These include, but are not limited to, transmission lines and zone substations.

The Viewshed

We have defined the viewshed of the transmission line upgrade, which has been based upon the parameters of human vision. The rationale behind the definition of the viewshed is appended to this report (Refer *Annex A*) which describes the parameters of human vision, and assists in defining the viewshed.

Landscape Units and Sensitivity

We have defined Landscape Units for all potentially affected areas. Landscape Units are based on the physical characteristics of the area within the viewshed. The characteristics that assist in defining Landscape Units include geology, vegetation, topography and drainage patterns as well as the extent of human-modifications and urban development.

The sensitivity of Landscape Units is primarily an assessment of the extent to which they can accept further change. Generally, the greater the extent of human-made modifications, the lesser will be the sensitivity.

Assessment of Publicly Accessible Viewpoints

An assessment of the visual impact from indicative viewpoints within the public domain is partly based on photomontages that show views of the landscape and the possible alteration to these views as a result of the upgrade and its associated infrastructure. These photomontages assist in the analysis of the overall visual impact.

The visual impact of a development is affected by:

- The distance of the viewer from the development;
- The nature of the surrounding landscape (including the Landscape Units represented and their sensitivity); and
- The number of viewers able to see the development.

Accordingly, the overall effect of the transmission line upgrade on each viewpoint has been assessed by evaluating the value of each of the above criteria, ranking them as being either low, medium, or high and, subsequently, making an assessment as to the overall effect by balancing each of the criteria.

Scale of Effects

The overall visual impacts of the transmission line upgrade's built components from indicative publicly accessible viewpoints have been assessed using the following scale:

- Negligible – minute level of effect that is barely discernable over ordinary day to day effects.
- Low Adverse Effect – adverse effects that are noticeable but that will not cause any significant adverse impacts.
- Moderate Adverse Effect – significant effects that may be able to be mitigated /remedied.
- High or Unacceptable Adverse Effect – extensive adverse effects that cannot be avoided, remedied or mitigated.

These are explained as follows:

Negligible Adverse Effect: The assessment of a "*negligible*" level of impact is usually based on distance. That is, the transmission line upgrade is at such a distance that, when visible in good weather, it would be a minute element in the view across a human-modified landscape. However sometimes the screening afforded by vegetation can lead to a similar level of assessment.

Low Adverse Effect: The assessment of a "*low*" level of impact can be derived if the rating of any one three factors, (that is, distance, viewer numbers and landscape sensitivity), is assessed as low. The reasoning for this "*minor*" assessment is as follows:

- If the distance to the transmission line upgrade is great (i.e. towards the edge of the viewshed) then even if the viewer numbers and the landscape sensitivity were high, the overall visual impact would be minor because the upgrade would be only just visible in the landscape.

- If viewer numbers were low (i.e. few people can see the transmission line upgrade from the nominated publicly accessible viewpoint), then even if the transmission line is close to the viewpoint and the landscape sensitivity is high, the overall visual impact would be minor because the change to the landscape is not seen by many viewers. In a visual assessment it is important to differentiate between a "visual impact" and a "landscape impact". Viewer numbers are important in the assessment of a visual impact, because if no one sees a particular development then the visual impact is nil, even though there may be a significant change to the landscape and, hence, a large landscape impact.

- If landscape sensitivity is low (i.e. within a highly human-modified landscape) then even if the transmission line upgrade is in close proximity to the viewpoint and it is visible to a large number of viewers, the overall visual impact would be low because the viewpoint is not in a landscape of such sensitivity that further change would be unacceptable.

Moderate Adverse Effect: The assessment of a "*more than minor effect*" will depend upon all three assessment criteria (distance, viewer numbers, and landscape sensitivity) being assessed as higher than "low"

High or Unacceptable Adverse Effect: The assessment of a "*high*" or "*unacceptable adverse effect*" from a publicly accessible viewpoint usually requires the assessment of all these three elements to be high. For example a highly sensitive landscape, viewed by many people with the development in close proximity would lead to an assessment of an unacceptable adverse effect. This assessment is also usually based on the assumption that such a view cannot be mitigated. An example may be a well frequented viewpoint in a National Park, with the upgrade located in close proximity to a viewpoint that currently overlooks what appears to be a natural, pristine, un-modified landscape. Landscape treatment can screen this view and even though it would mitigate the view to the upgrade such treatment would be unacceptable as it would also block the view from the lookout.

Mitigation Measures for Publicly Accessible Viewpoints

Mitigation measures are considered when they may be appropriate in reducing the visual impact from a publicly accessible viewpoint. For example, now roadside planting along a section of highway may significantly reduce the visual impact of the upgrade.

Recommendations

Recommendations for the transmission line upgrade are based on the findings of this landscape and visual impact assessment.

2.1 PHOTOMONTAGE PREPARATION

Photomontages are used within this report to illustrate the potential visual impact of the transmission line upgrade from selected locations and assist in the assessment of those visual impacts.

The transmission infrastructure modelled during the preparation of the photomontages contained in this report is based on the technical information provided by Country Energy. In order to provide an indication of the 'worst case' scenario for the assessment, the maximum dimensions have been used, that is, maximum height and maximum width. It should be noted that the exact design and model of the concrete poles shown in the upgrade and the photomontages may differ from those selected for installation.

Generally the field of view for photomontages is approximately 60^{O} horizontal and 15^{O} vertical. The rationale behind this field of view is set out in *Annex A*.

It is stressed that the small images used within the report are only for referencing comments made within the text. While technically correct, they do not accurately

portray a perceptually accurate image to assess the visual impact. For this reason larger (A3) images are appended to this report. However, while these images are a more accurate portrayal, a proper assessment of the visual impact can only be made when the images are produced at A1 or AO sizes and held at arm's length.

2.2 STUDY LIMITATIONS

This report has been prepared in accordance with project objectives with reference to the Environmental Assessment Requirements as provided by the NSW Department of Planning for the proposed Lismore to Mullumbimby Electricity Network Upgrade.

3 PROJECT DESCRIPTION

Upgrading of the Lismore to Mullumbimby Electricity Network from 66kV to 132kV infrastructure will involve a combination of works as follows:

Transmission lines

- construction of new transmission lines (66k and 132kV, dual and single circuit);
- replacement of existing 66kV transmission line infrastructure with 132kV; and
- construction of new 66kV and 132kV underground transmission lines.

Substations

- construction of two new 132kV / 11 kV zone substations; and
- upgrading of existing substations and bulk supply points.

3.2 TRANSMISSION LINES

There are a range of transmission line infrastructure upgrades proposed for the Lismore to Mullumbimby Electricity Network Upgrade.

The majority of these works will be confined to within close proximity of the existing transmission line easement.

Where possible, the existing timber poles will be retained and the head gear or insulators will be replaced.

There are several possible transmission line configurations that may be used along the transmission line corridor. Visually, there are three common configurations, Staggered, Vertical and Horizontal. These configurations can be seen in *Figure 3.1.*

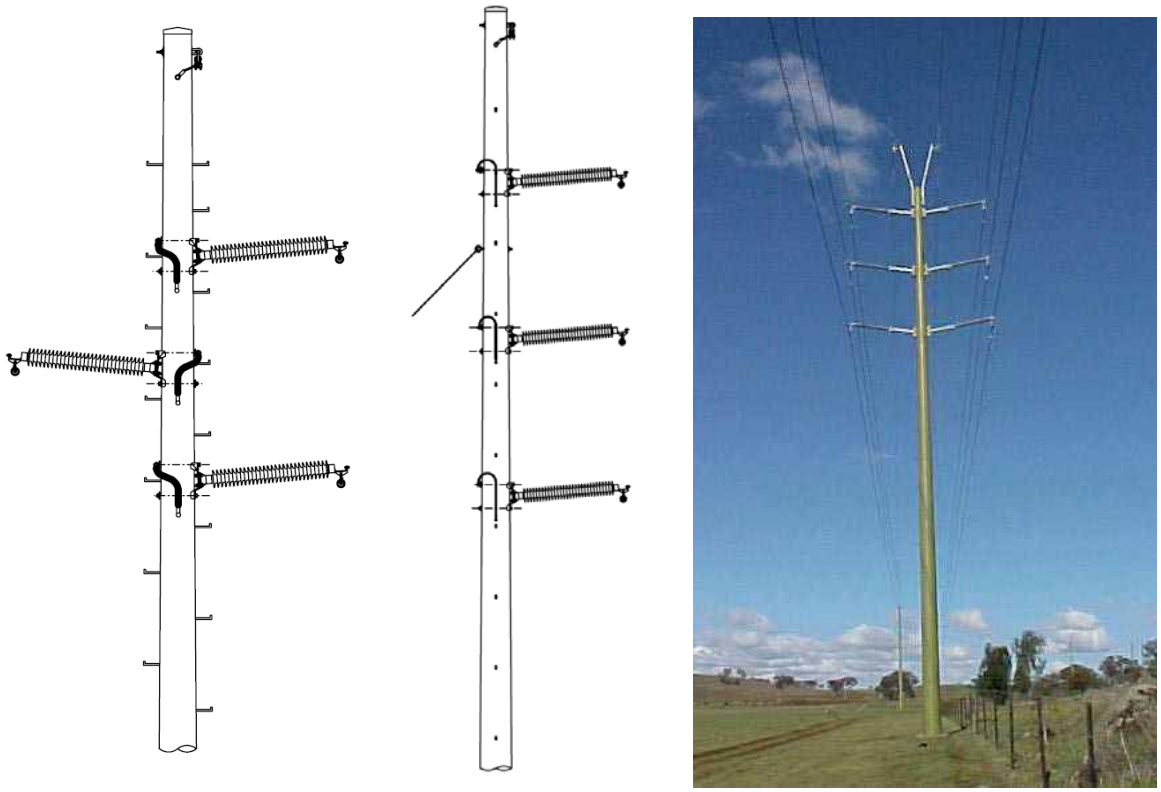

Figure 3.1 Transmission line configurations, staggered (left), vertical (middle) dual circuit (right), (Images Courtesy of Country Energy)

There may be subtle and technical variations to those the configurations shown in *Figure 3.1*, such as earth wire location and insulator length however, visually these will not be discernable to the untrained eye.

Other transmission line works include the construction of new underground transmission lines as well as undergrounding sections of existing over head transmission lines. Where overhead to underground infrastructure is installed the infrastructure at these locations can be visually bulky. ***Figure 3.2*** shows an example of this infrastructure.

Figure 3.2 Example of Overhead to Underground Transition Infrastructure

3.3 SUBSTATIONS

The Lismore to Mullumbimby Electricity Network Upgrade begins at the Lismore bulk supply point substation to the west of Lismore and terminates at Mullumbimby zone substation located on the Wilsons Creek Road west of Mullumbimby. These substations can be seen in *Figure 3.3 and Figure 3.4.*

Figure 3.3 Existing Mullumbimby Substation.

Figure 3.4 Existing Lismore Bulk Supply Point

There are five existing substations located along the existing transmission line corridor that will form part of the proposed transmission line corridor upgrade. These are:

- Ewingsdale;
- Lennox Head substation;
- Ballina Substation;
- Alstonville Substation;
- Lismore South Substation.

All of the existing substations are located behind a secure, visually permeable fence. They have visible electricity infrastructure entering and exiting site as well as behind the secure fencing.

Some of these substations may see some visual change associated with the Lismore to Mullumbimby Electricity Upgrade. The following is a summary of the proposed substation works.

Mullumbimby Substation

- installation of a new 132kV line bay for the proposed 132kV feeder to Ewingsdale via Brunswick Heads;
- replacement of the 132/66/11kV 75MVA power transformer with a 132/11kV 30 MVA transformer and removal of the 132/66/11kV 40MVA power transformer;
- installation of new 132kV feeder poles and lines; and
- installation of a new microwave communications tower.

Ewingsdale Substation

- replacement of the two existing 66/11kV power transformers with two 132/11kV power transformers to allow energisation to 132kV;
- replacement of the two existing 66kV voltage transformers with two 132kV voltage transformers; and
- replacement of the existing 66kV surge arrestors with 132kV surge arrestors.

Lennox Head Substation

- replacement of existing 66/11kV transformers with 132/11kV transformers to allow energisation of to 132kV;
- replacement of the two existing 66kV voltage transformers with two 132kV voltage transformers; and
- replacement of the existing 66kV surge arrestors with 132kV surge arrestors.

Ballina Substation

- installation of two new 132kV line bays;
- installation of one new 132kV transformer bay;
- installation of one new 66kV transformer bay; and
- installation of a new 132/66/11kV 75MVA transformer.
- This substation may also be expanded to the east, closer to the Temple Street frontage.

Alstonville Substation

The proposed works at the Alstonville substation are limited to the removal of the existing 66kV transmission line (line 8507) from entering the substation. Rearrangement of 66kV and 11kV overhead lines will be undertaken to avoid cross-overs and lessen the visual impact in the vicinity of the substation. This may involve undergrounding of some 11 kV feeders. Options for the final arrangement are still under investigation. No new infrastructure is proposed to be installed at the substation as part of the Project.

Lismore South Substation;

This substation is to be reconfigured to relocate the bus and line bays, transformers and capacitor banks.

This may involve possible decommissioning of the existing power station building.

Options for the final arrangement are still under investigation.

Lismore Bulk Supply Substation

- installation of a new 132kV line bay for the proposed new line from Alstonville;
- installation of two new 66kV line bays for the proposed 66kV underground transmission lines to Lismore South substation; and
- installation of a new microwave communications tower.

There are two proposed new substations, one will be located near Brunswick Heads; and one located at Suffolk Park.

The assessment of the proposed substations located at Brunswick Heads and Suffolk is being under taken by others.

Figure 3.5 shows the location of the proposed new Zone Substation located near Yagers Lane.

Figure 3.5 View from Yagers Lane looking south

The proposed substation will be located in the cleared area adjoining the eastern boundary of the existing piggery that can be seen in the image. There is existing electricity infrastructure in this location.

3.3.1 Communications Towers

It is proposed to install new communication towers at the Mullumbimby zone substation and the Lismore BSP involving the installation of an approximately 30m slimline concrete monopole supporting two antenna dishes. An example of the proposed tower construction is provided in *Figure* 3.6. A green pole will be used at Mullumbimby to minimise the visual impact against the surrounding hills and vegetated landscape.

(source: Brewster Murray)

Figure 3.6 Example of slimline communications pole with dish antenna

3.4 TRANSMISSION LINE CORRIDOR

This section provides a description of the proposed transmission line corridor for the Lismore to Mullumbimby Electricity Network Upgrade.

The Line Route Selection report prepared by ERM (2007) discusses the project in six sections, these are as follows:

- **Section 1 –** Mullumbimby to Ewingsdale (including additional 132kV feeder out to Brunswick Heads)
- **Section 2** – Ewingsdale to Suffolk Park
- **Section 3** – Suffolk Park to Lennox Head
- **Section 4** – Lenox Head to near Alstonville via Ballina
- **Section 5** – Alstonville to near Lismore

- **Section 6** – East Lismore to Lismore bulk supply point (and additional 66kV feeder from Lismore South to Lismore Switching Station)

This assessment has been based on the Project Description outlined in Chapter 3 of this report and subsequent line route revisions following negotiations held between Country Energy and relevant landowners.

3.4.1 Section 1 – Mullumbimby to Ewingsdale

This section runs from the existing substation location on the Wilsons Creek Road, Mullumbimby to the existing substation near Ewingsdale.

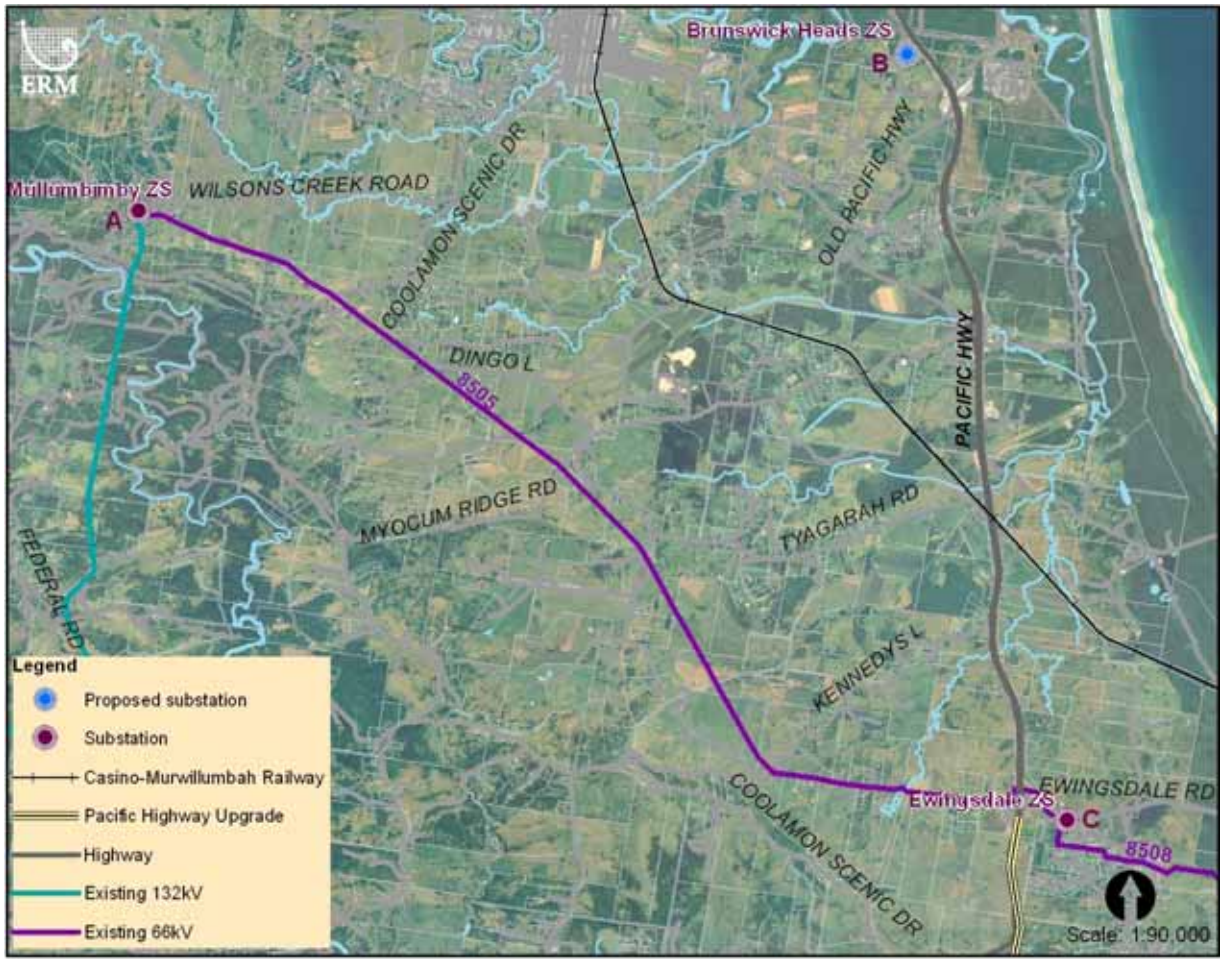

Figure 3.7 Section One

The existing single circuit 66kV transmission line will be upgraded to a single circuit 132kV transmission line.

This will involve upgrading the existing infrastructure within the existing alignment.

The existing pole infrastructure will be retained where possible; however, some timber poles may be replaced with new concrete transmission poles where required.

Where the existing transmission line is currently underground (i.e. within Ewingsdale) the upgraded line will be also be installed underground.

Where there are environmentally sensitive locations along the transmission line route, there may also be deviations. These known deviations are as follows:

- The existing underground line from the Ewingsdale substation will be deviated to the west and south of the existing Country Energy Ewingsdale Field Service Centre, to enter the new Ewingsdale substation from the south.

The line route for 132kV feeders to the proposed new Brunswick Heads substation have not been considered in this visual assessment report.

3.4.2 Section 2 – Ewingsdale to Suffolk Park

This section runs from the existing Ewingsdale substation to a new substation located at the southern end of Yagers Lane, Suffolk Park.

Figure 3.8 Section Two

The existing single circuit 66kV transmission line will mainly be upgraded to a single circuit 132kV transmission line between Ewingsdale and the proposed new zone substation at Suffolk Park as seen in *Figure 3.8.*

This will involve upgrading the existing infrastructure within the existing alignment. The existing pole infrastructure will be retained where possible; however, some timber poles may be replaced with new concrete transmission poles where required.

Where the existing transmission line is currently underground (i.e. within Ewingsdale) the upgraded line will be also be installed underground.

Where there are environmentally sensitive locations along the transmission line route, there may also be deviations.

The existing overhead 66kV transmission line that runs through Ewingsdale will be replaced by a new underground 132kV within the road reserves of Parkway Drive, McGettigans Lane and Citriodora Drive.

There will also be a new substation constructed near the southern end of Yagers Lane, Suffolk Park, which will have an underground cable component. The extent of this underground section of the 132kV transmission line is still under investigation.

3.4.3 Section 3 – Suffolk Park to Lennox Head

Section 3 runs from a proposed new substation located near the southern end of Yagers Lane, to the west of Suffolk Park, to the existing substation located Newrybar Swamp Road, west of Lennox Head.

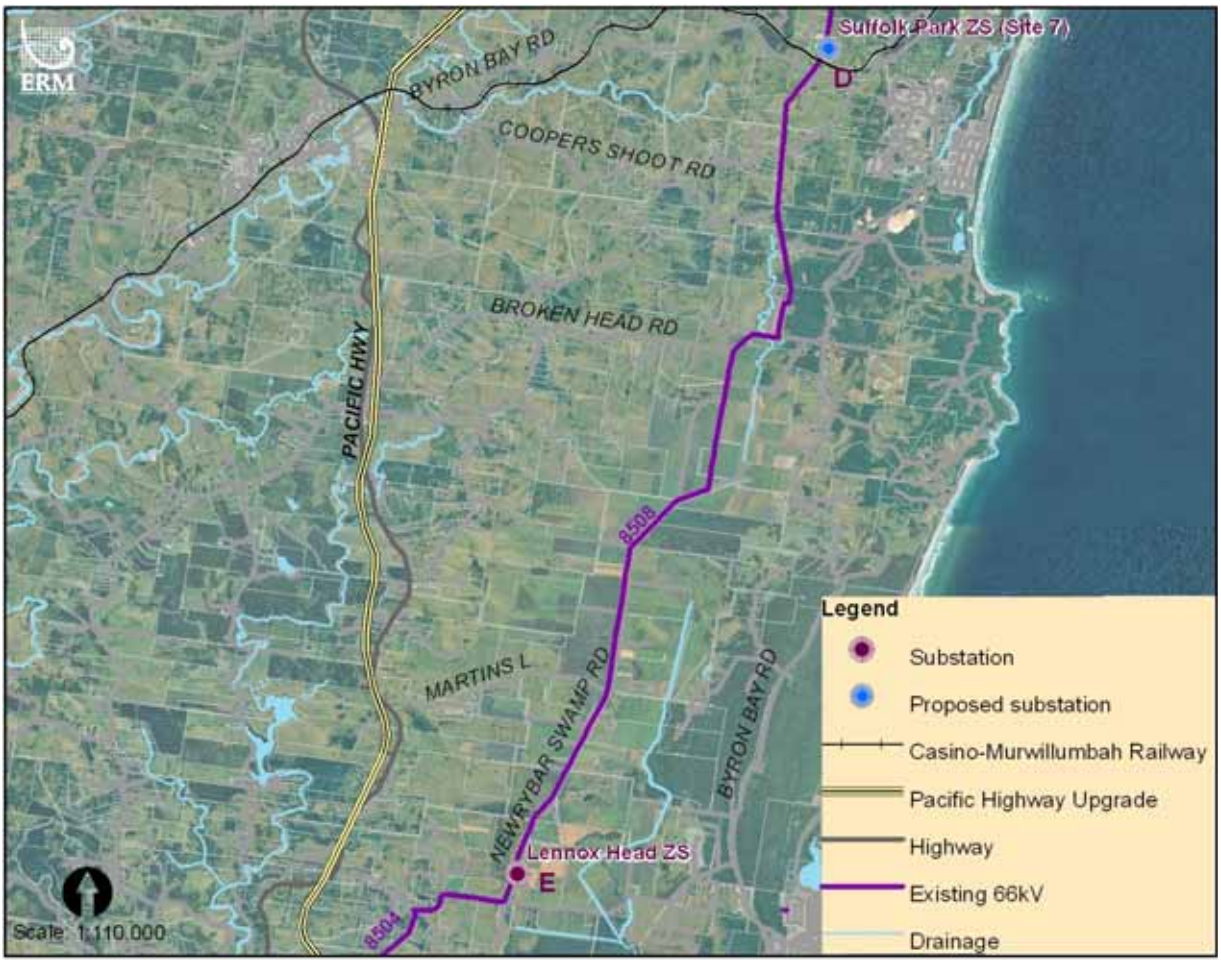

Figure 3.9 Section Three

The existing single circuit 66kV transmission line will be upgraded to a single circuit 132kV transmission line between the proposed new substation located at the end of Yagers Lane, to the west of Suffolk Park, to the existing substation located Newrybar Swamp Road, west of Lennox Head.

This will involve upgrading the existing infrastructure within the existing alignment. The existing pole infrastructure will be retained where possible; however, some timber poles may be replaced with new concrete transmission poles where required.

3.4.4 Section 4 – Lennox Head to near Alstonville via Ballina

Section four runs from the existing substation located on Newrybar Swamp Road west of Lennox Head, via the existing substation located in the west of Ballina, to an existing substation located Wardell Road south of Alstonville.

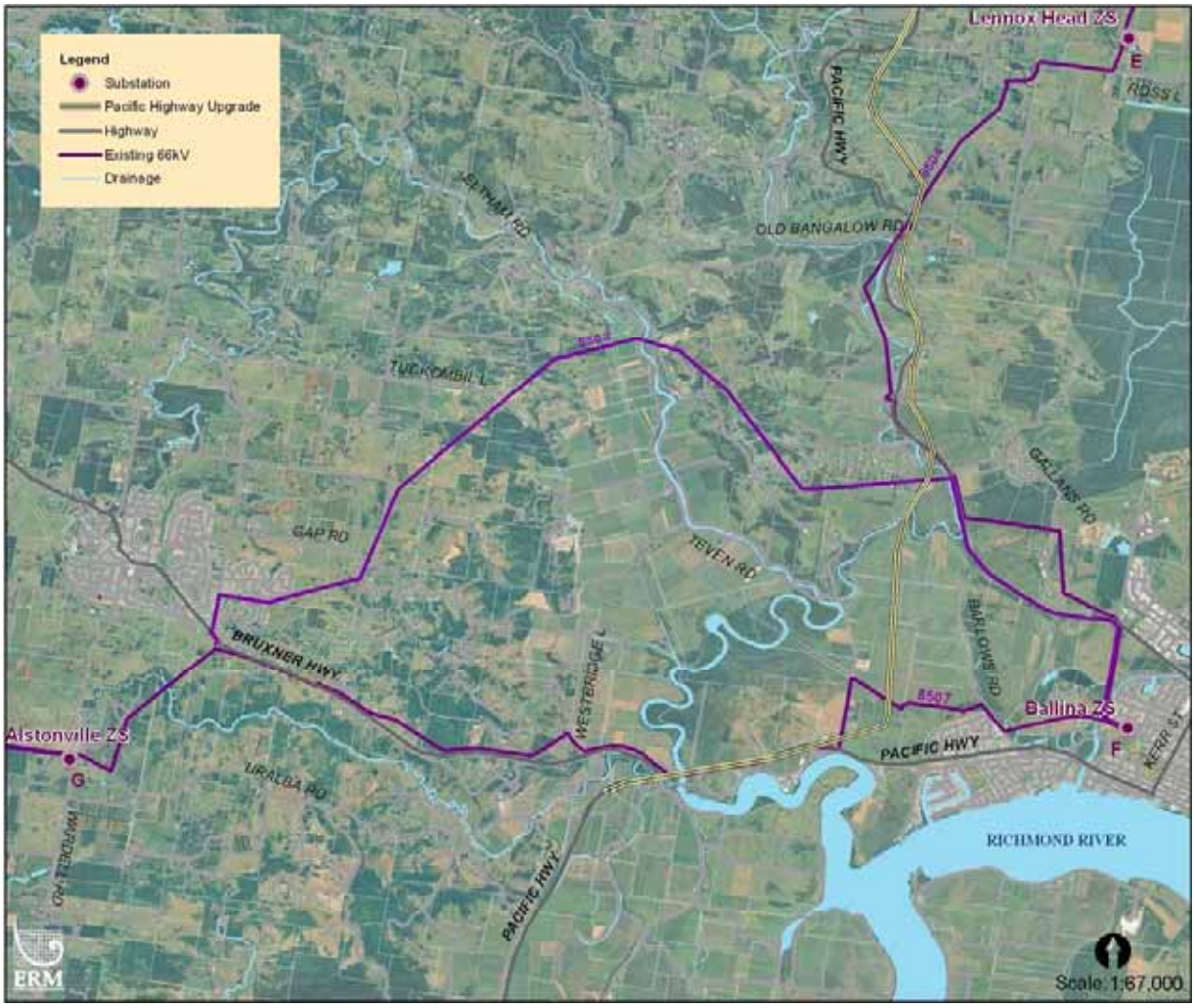

Figure 3.10 Section Four

The existing single circuit 66kV transmission line will be upgraded to a single circuit 132kV transmission line between the existing substation located Newrybar Swamp Road, west of Lennox Head

This will involve upgrading the existing infrastructure within the existing alignment. The existing pole infrastructure will be retained where possible; however, some timber poles may be replaced with new concrete transmission poles where required.

Where there are environmentally sensitive locations along the transmission line route, there may also be deviations. Known deviations from the current transmission line corridor are as follows:

- A short section of the existing overhead transmission line that runs along Barlow's Road in west Ballina will be relocated from the western road reserve, to the east further away from existing dwellings located along Barlow's Road.

- The existing transmission line that runs along the Bruxner Highway near the eastern entrance of Alstonville will be relocated to the south and away from three existing residences.

- The existing dual circuit section that runs from the Bruxner Highway to Alstonville ZS will be temporarily relocated to within the existing transmission line easement. This is to allow upgrading of the existing dual circuit section to be constructed without removing the lines from service.

The Ballina substation will also be expanded as part of these works. A detailed landscape plan will be prepared upon finalisation of the proposed substation design.

3.4.5 Section 5 – Alstonville to near Lismore

Section 5 runs from the runs from existing substation located on Wardell Road south of Alstonville to the existing substation/ bulk supply point located at the end of Three Chain Road to the west of Lismore.

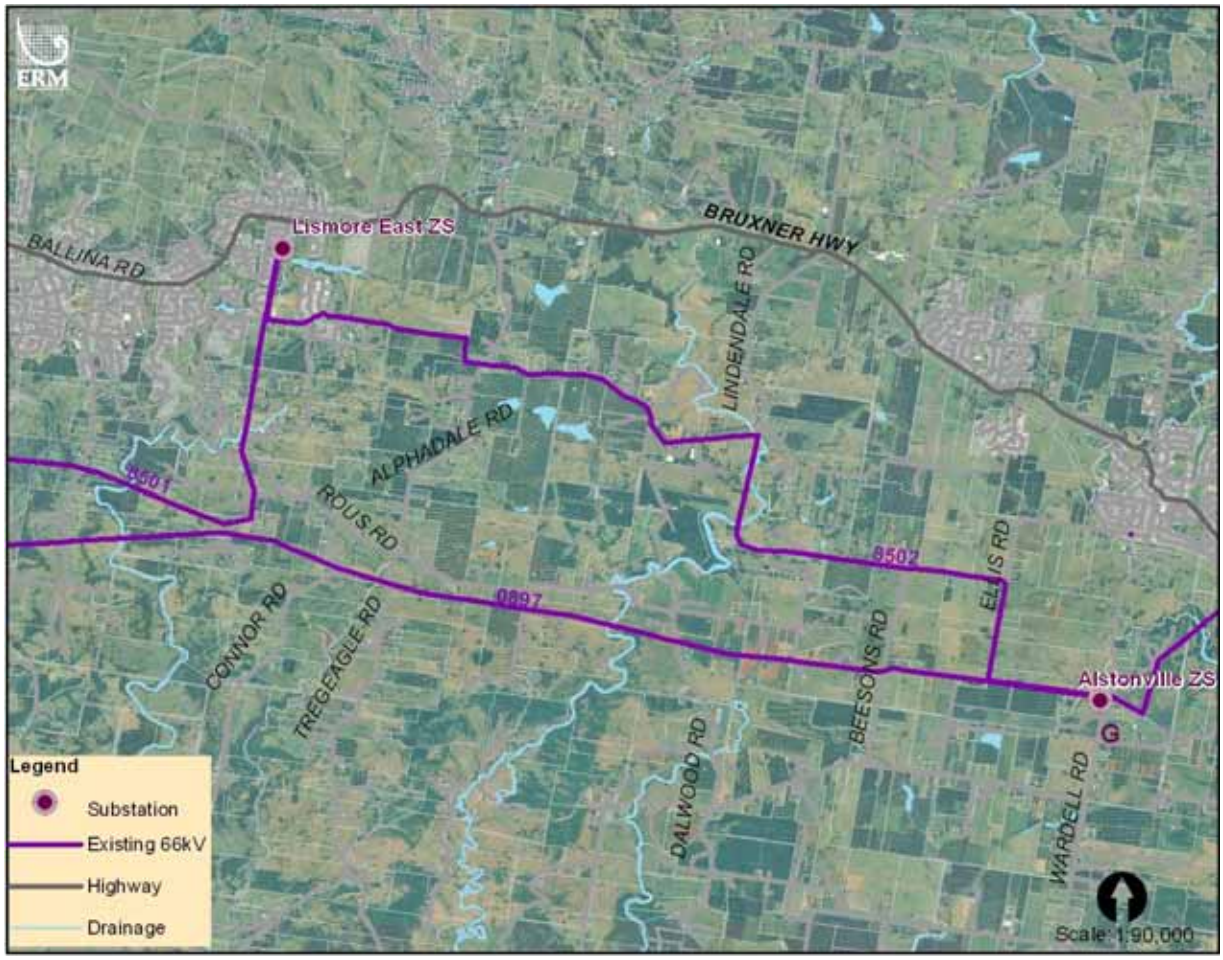

Figure 3.11 Section Five

The majority of the existing transmission line from Ballina to Alstonville is a single circuit 66kV transmission line. The majority of the existing single circuit 66kV transmission line will be upgraded to a dual circuit 66kV/132kV between Alstonville and Lismore and along the existing 66kV alignment.

There is also a section of dual circuit 66kV transmission line between the Alstonville substation to where it meets the Bruxner Highway in Alstonville. This section of line will be upgraded to dual circuit 66kV//132kV transmission line. This will involve upgrading the existing infrastructure within the existing alignment. The existing pole infrastructure will be retained where possible; however, some timber poles may be replaced with new concrete transmission poles where required.

Where there are environmentally sensitive locations along the transmission line route, there may also be deviations. Known deviations from the current transmission line corridor are as follows:

- Construction of a new 132kV line continuing west from Norton Road,
- Deviation of the existing line near Caniaba Road, Lismore to avoid a number of houses in the vicinity of Caniaba Road and prior to entering the Lismore substation; and
- Removal of redundant 66kV line.

3.4.6 Section 6 – East Lismore to Lismore Bulk Supply Point

This section is a continuation of section 5 and runs from the existing substation located Wardell Road south of Alstonville, to the existing substation/ bulk supply point located at the end of Three Chain Road to the west of Lismore.

Figure 3.12 Section Six

The proposed upgrade includes the continuation of the dual circuit 132kV/66kV circuit from near Alstonville into Lismore BSP, with possible rationalisation of the transmission lines with other in the area approaching the Lismore BSP. This section also includes the construction of two new underground 66kV transmission lines within the road reserve along Three Chain Road between Lismore BSP and the existing Lismore South substation, and a 66kV feeder from the Lismore South zone substation to the Lismore Switching Station located on Skyline Road.

A 66kV sub-transmission line exists between the existing Lismore BSP and a junction in the line located near Alstonville. This line will be upgraded to a 132/66kV dual circuit.

There are currently two options under investigation for the alignment of the new 66kV line between Lismore South zone substation and the Lismore Switching Station including:

- to install it south from near the Lismore South substation, across Wilsons River, south east along East Gundurimba Road before heading east towards Wyrallah Road, avoiding the Lismore Landfill and Sewerage Treatment facilities; and

- An alternative route further north of this option, however, this is subject to further investigation.

Two new 66kV underground lines will be installed within the Three Chain Road reserve. These will connect to the existing Lismore South zone substation located near the corner of the Bruxner Highway and Three Chain Road.

The existing 66kV overhead lines will be retained in this location to continue to supply the Lismore switching station.

3.5 DESCRIPTION OF THE MAIN VISUAL ELEMENTS DURING CONSTRUCTION, OPERATION & MAINTENANCE

There are a number of visual elements that will occur during the construction, operation and ongoing maintenance of the transmission line upgrade. These would include:

- trench for excavation for 66kV and 132kV underground cables;
- access tracks; and
- construction machinery and temporary storage compounds.

3.5.1 Trench for Excavation for 66kV and 132kV Underground Cables

66kV and 132kV underground cables will require excavation and trenching works, as shown in *Figure 3.13.* Underground cables would be installed in conduits with a minimum of 900 mm coverage.

Figure 3.13 Indicative Photograph of the Installation of Underground Conduits

Excavation of trenches for laying cables would be done using standard excavation techniques. Sand or stabilised sand would be delivered to the site from local suppliers or supplied from an on-site batching plant and installed into trenches via a cement truck. The trenches would be re-instated and compacted with a front end loader and excess spoil would be disposed on-site which would generally be spread around during trench reinstatement.

In all but the most vegetated areas, such a trench will only be visible during construction. Once filled, underground cable trenches are not discernible in the landscape, especially when located in farmland.

3.5.2 Access tracks

All weather access will be required during construction for cranes, pre-mixed concrete trucks and other vehicles.

Where possible, construction vehicles will use existing tracks. These tracks would be upgraded as required. When necessary, new tracks will be established. The location of these new tracks will be determined by the prevailing land conditions and land uses.

3.5.3 Construction Machinery

Construction activities to construct access tracks, the 132kV transmission lines and substation will require the use of earth-moving equipment, trucks, mobile cranes, and transport vehicles.

3.5.4 Construction Timing

Construction will occur over several years, by which time all works, including any landscaping or grassing, will be completed.

4 STUDY AREA DEFINITION BASED ON THE VIEWSHED

This section provides a definition of the study area by identifying those areas that can potentially be visually affected by the proposed upgrade. This area is called the viewshed.

A viewshed extends to a distance where any built elements would be considered visually insignificant, even though they may still be visible. The extent of a viewshed may be roughly determined by an analysis based upon human vision parameters. For readers not familiar with the parameters of human vision these are set out in *Annex A*, as are the calculations upon which the extent of the viewshed has been based.

The viewshed of the proposed upgrade is based on the highest visual element which would be the 132kV transmission lines. To ensure that this assessment is conservative, the viewshed has been based on a scenario of transmission poles of between 17 m and 23 m in height.

Distance ranges are used as a guide to determine zones of visual impact. It is recognised that built form visibility does not dramatically change at each defined zone boundary. For example, visibility does not dramatically change when a viewer moves from 1.3 km to 1.6 km from the nearest transmission line pole, even though these locations are within different zones that, for the purposes of this analysis, show differing levels of impact. It must also be recognised that climatic factors such as rainfall, sea haze, cloudy skies and sun angle will also affect the visibility of and development.

The viewshed and the zones of visual influence within the viewshed that will be used within this assessment are set out in *Table 4.1*.

Table 4.1 Zones of Visual Influence within the Viewshed

Distance from an observer to the 88kV and 132kV transmission lines	Zones of Visual Influence
>7 km	*Visually insignificant – outside the viewshed.* A very small element which is difficult to discern. Transmission poles will be invisible in certain lighting or weather conditions.
1.4-7 km	*Potentially noticeable, but will not dominate the landscape.* The degree of visual intrusion from this distance range will depend on the landscape sensitivity and the sensitivity of the viewer. However, transmission poles do not dominate the landscape.
0.7 - 1.4 km	*Potentially noticeable and can dominate the landscape.* The degree of visual intrusion, from this distance range will depend on the landscape sensitivity and the sensitivity of the viewer.
<0.7 km	*Highly visible and will usually dominate the landscape.* The degree of visual intrusion from this distance range will depend on the transmission pole placement within the landscape and factors such as foreground screening.

Note: 66kV and 132kV transmission line infrastructure may be visible at distances greater than 7 km. However, within landscapes that are disturbed, the ability for the casual observer to identify these at such distances is small.

The Lismore to Mullumbimby Electricity Network Upgrade proposes to upgrade the existing electricity infrastructure within and existing transmission line corridor to support 132kV electricity infrastructure. There may be some route deviations along the length of the existing transmission line as well as pole location adjustments where new poles are installed within the existing corridor.

Other visible change will be the installation of upgraded transmission line supporting infrastructure.

Although there may be a noticeable visual change, the transmission line infrastructure is already part of the existing landscape in many areas. To most viewers, the level of visual change associated with the modification to the existing transmission line corridor will be negligible.

5 LANDSCAPE UNITS

Landscape Units are based on areas with similar visual characteristics in terms of their ability to absorb visual change. Often the units relate to areas with similar environmental, geological and land use features. These Landscape Units will inform the landscape and visual impact assessment of the proposed upgrade.

There are 7 defined Landscape Units that have been identified within the viewshed for the proposed upgrade. These are as follows:

- Landscape Unit 1 – "Flat to Gently Undulating Cleared Farmland";
- Landscape Unit 2 – "Moderate to Steeply Undulating Cleared Farmland";
- Landscape Unit 3 – "Forested Hills";
- Landscape Unit 4 – "Riverine";
- Landscape Unit 5 – "Wetlands";
- Landscape Unit 6 – "Orchards"; and
- Landscape Unit 7 – "Townships".

Each of these Landscape Units is described in the following sections, including the conditions in the viewshed.

5.1 LANDSCAPE UNIT 1 – "FLAT TO GENTLY UNDULATING CLEARED FARMLAND"

Landscape Unit 1 – "Flat to Gently Undulating Cleared Farmland" describes those areas of cleared farmland that are gentle in grade or slope.

These areas are generally cleared with only occasional remnant or planted tree lines. There are also many instances of man-made modifications within this landscape type including road and rail network, farm buildings and fences.

Figure 5.1 Flat to Gently Undulating Cleared Farmland

The topography is undulating with slopes averaging around 1:50 to 1:100 with flatter areas occurring on the ridgelines.

5.2 LANDSCAPE UNIT 2 – "MODERATE TO STEEPLY UNDULATING CLEARED FARMLAND"

Landscape Unit 2 – "Moderate to Steeply Undulating Cleared Farmland" describes those areas of cleared farmland that are steep in grade or slope.

These areas are also generally cleared with only occasional remnant or planted tree lines. There are also many instances of man-made modifications within this landscape type including road and rail network, farm buildings and fences.

Figure 5.2 Moderate to Steeply Undulating, Cleared Farmland

The topography is undulating with slopes averaging around 1:10 to 1:50 with flatter areas occurring on the ridgelines.

5.3 LANDSCAPE UNIT 3 – "FORESTED HILLS"

Landscape Unit 3 – "Forested Hills" occur primarily in State Forests, State Parks, Regional Parks and local reserves.

Figure 5.3 Forested Hills Landscapes

There are no State or National Parks within the viewshed of the Lismore to Mullumbimby Electricity Network Upgrade.

5.4 LANDSCAPE UNIT 4 – "RIVERINE"

Landscape Unit 4 – "Riverine" is a narrow band that follows the alignment of water courses. The major water courses that are near to the Lismore to Mullumbimby Electricity Network Upgrade are:

- Wilson's River, Lismore;
- Richmond River to the South of Ballina; and.
- North Creek Canal, Ballina.

Figure 5.4 Riverine

5.5 LANDSCAPE UNIT 5 – "WETLANDS"

Landscape Unit 5 – "Wetlands" are natural flood prone areas located along Landscape Unit 4 – "Riverine" and sometimes adjacent to Landscape Unit 1 – "Flat to Gently Undulating Cleared Farmland". Landscape unit 7 "Townships" are also located near to this landscape unit.

Figure 5.5 Wetlands

Existing 66kV transmission poles can be seen at centre and in the background of the above Figure prior to spanning the wetlands.

5.6 LANDSCAPE UNIT 6 – "ORCHARDS"

Landscape Unit 6 – "Orchards" occur on some farms within the study area. These farms are characterised by extensive formal rows of macadamia nut or fruit trees that dominate the landscape.

Figure 5.6 Orchards

The macadamia trees are evergreen and are subject to the seasonal variations of blossom and fruiting then new growth.

Visibility is confined to the immediate area in these landscapes.

5.7 LANDSCAPE UNIT 7 – "TOWNSHIPS"

Landscape Unit 7 – "Townships" describes the urban areas within the study area. There are several townships within the visual catchment of the proposed upgrade. These include the townships of Lismore, Alstonville, Ballina and Ewingsdale.

Figure 5.7 Ballina West Residential Area

Housing and the landscape associated with residential areas generally tends to screen views to the surrounding rural areas. It is only on the periphery of townships that views across the adjacent rural areas are possible.

5.8 LANDSCAPE SENSITIVITY

Landscape sensitivity can be defined as the ability of a landscape to absorb visual change, and its visual influence thereof on the viewers. While change is an integral part of any landscape, development and infrastructure are significantly different to the natural processes that occur in a landscape. The sensitivity of viewers to change in the previously described Landscape Units will depend upon a number of factors, such as:

Location. The sensitivity of a potential viewer varies according to location. For example, visitors to a National or State Park where the landscape appears untouched or pristine will be more sensitive to the imposition of new or artificial elements within that landscape. The same viewer travelling along a rural highway, which contains examples of modifications and artificial elements, will be less sensitive to the presence of new elements. Modifications or artificial elements are not confined to vertical structures or built form. They also include the removal of native vegetation, visibility of roads, tracks, fences and other rural infrastructure - all of which decrease the sensitivity of a landscape to further change.

The rarity of a particular landscape. Landscapes that are considered rare or threatened are valued more highly by a particular community with an attachment to the particular landscape.

The scenic qualities of a particular landscape. Landscapes can be considered scenic because of dramatic topographical changes or the presence of water and coastlines. Viewers have greater sensitivity to alterations within these scenic landscapes. However, as discussed above, the presence of modifications or artificial elements (including built form, roads, tracks, fences, silos and rail) as well as farming practices (including land clearing, cropping and burning), all decrease the sensitivity of a landscape's scenic qualities.

The pre-European landscape of the study area associated with the proposed upgrade has been heavily modified through agricultural practices that have included the clearing of native vegetation for cropping and grazing. The resultant cleared landscape is interspersed with agricultural buildings farmhouses, outbuildings, sheds, stockyards, access roads, silos and road networks. Associated with these structures are plantings along roadsides or as shelter belts.

The Landscape Units through on which the proposed upgrade is to be located are not rare, nor are they high in scenic quality and for these reasons the landscape sensitivity is considered to be low. However, it must be recognised that some people value the appearance of cleared farmland with minimal signs of built form such as houses and farm sheds. For these viewers, the presence of the proposed upgrade may be perceived as a high visual impact due to the presence of larger transmission lines in a rural landscape.

Servicing the rural areas are settlements that in the larger townships, also include commercial and public buildings and recreational areas. These rural townships are not uncommon nor are the scenic qualities particularly high as they often contain many forms of infrastructure and development. However, given the concentration of housing which is a sensitive land use, these have been given a medium sensitivity rating.

Table 5.1 summarises the landscape sensitivity of each of the Landscape Units for the assessment of the landscape and visual impacts of the proposed upgrade.

Table 5.1 Landscape Sensitivity

Landscape Unit	Sensitivity	Comments
Landscape Unit 1 – "Flat to Gently Undulating Farmland"	LOW to MODERATE	This unit is obviously man-modified, contains other infrastructure, is not topographically dramatic and does not usually contain areas of water. It is a common landscape type in this area of New South Wales.
Landscape Unit 2 – "Moderate to Steeply Undulating Cleared Farmland "	LOW to MODERATE	The rolling hills of the hinterland are an attractive landscape type. They offer varying views back to the coast as well as views into Landscape Unit 1 – "Flat to Gently Undulating Farmland". They are also man-modified and contain other infrastructure.
Landscape Unit 3 – "Forested Hills"	MODERATE to HIGH	This unit is topographically varied and contains areas that appear natural. Forested hills occur primarily in State Forests, State Parks, Regional Parks and local reserves.
Landscape Unit 4 – "Riverine"	LOW to HIGH	Where the water courses are inland they are usually deeply incised into the landscape and difficult to access. In some areas, the watercourses are degraded – and little more than a drain. However, as the rivers, creeks and canals approach the coast, the riverine banks are shallower and become more accessible for recreation purposes.
Landscape Unit 5 – "Wetlands"	LOW to HIGH	Wetland landscape occur in flat low lying areas, and are often surrounded by stands of large melaleuca scrub.
Landscape Unit 6 – "Orchards"	LOW	This unit is topographically varied and is often highly modified. These areas often occur in hilly landscapes.
Landscape Unit 7 – "Townships"	MODERATE	Views from residential townships are always important so there is an increased sensitivity. However, urban areas are also able to accommodate change as that is a regular occurrence within this Landscape Unit.

5.9 THE IMPACT OF TOPOGRAPHY AND VEGETATION ON VISIBILITY

Vertical structures may not be apparent within flat landscapes if foreground vegetation screens views as shown in *Figure 5.8.*

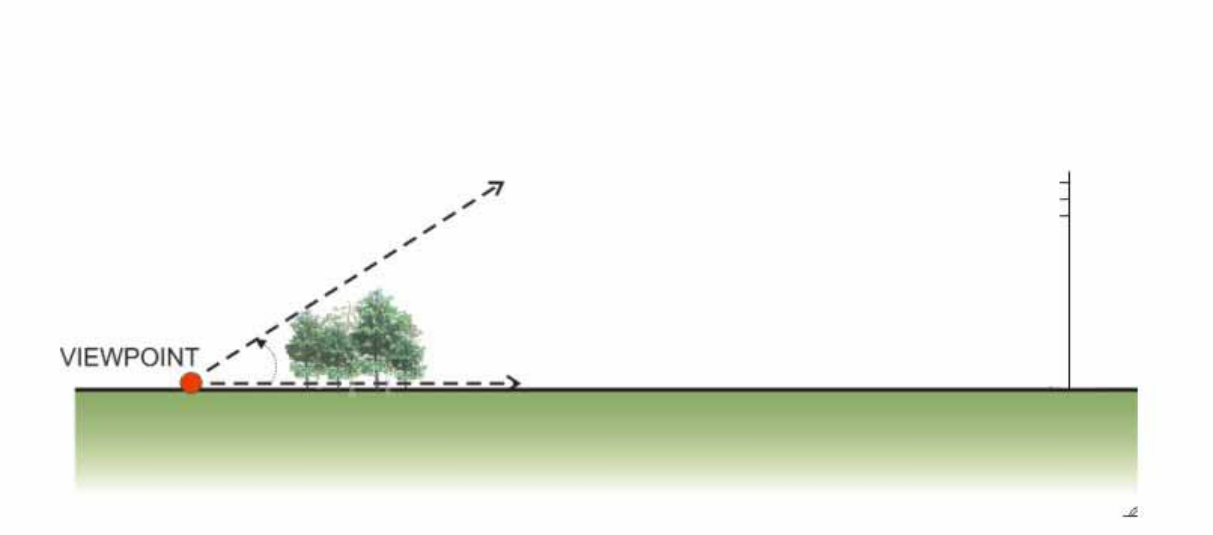

Figure 5.8 Transmission lines in a Flat Landscape

If views are not screened by vegetation, vertical development above the scale of the surrounding landscape is apparent.

Landscapes with topographical variations have greater capacity to partially screen views to transmission lines. However, this is largely dependent on the viewing location. At lower elevations topography may help to screen foreground views whereas at higher elevations views may be exposed.

This relationship becomes more critical when topographical changes are small, such as within dune systems and gently undulating landscapes. In these areas, vertical development is difficult to screen without foreground screening measures.

In steeper areas the potential for screening varies according to the elevation of the viewpoint and the location of the poles. At lower levels, views may be screened by foreground obstructions. However, at higher elevations views become more expansive.

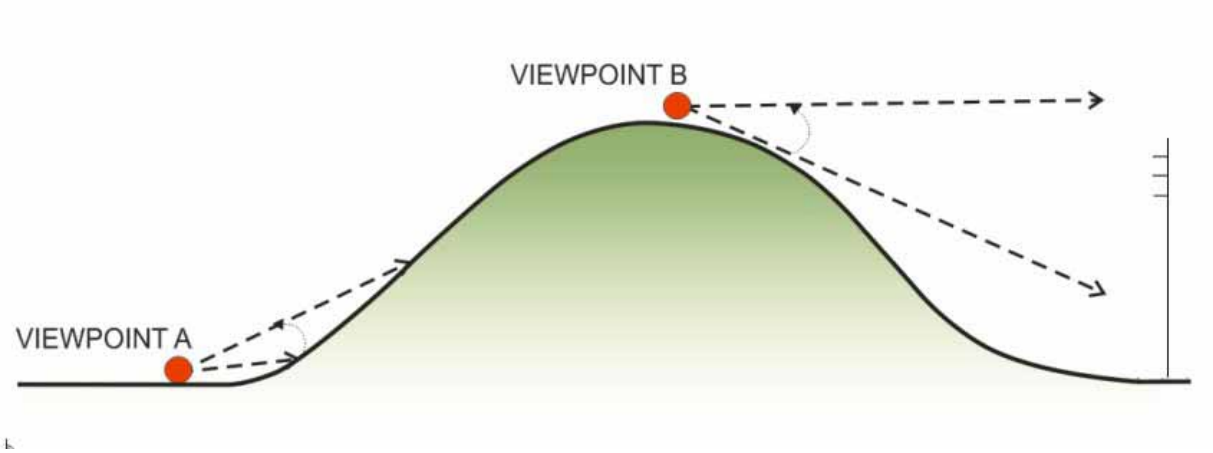

Figure 5.9 The visibility of transmission lines also depends upon the elevation of the viewpoint

Within a valley, transmission lines are more likely to be absorbed against a backdrop of vegetation rather than silhouetted against the sky.

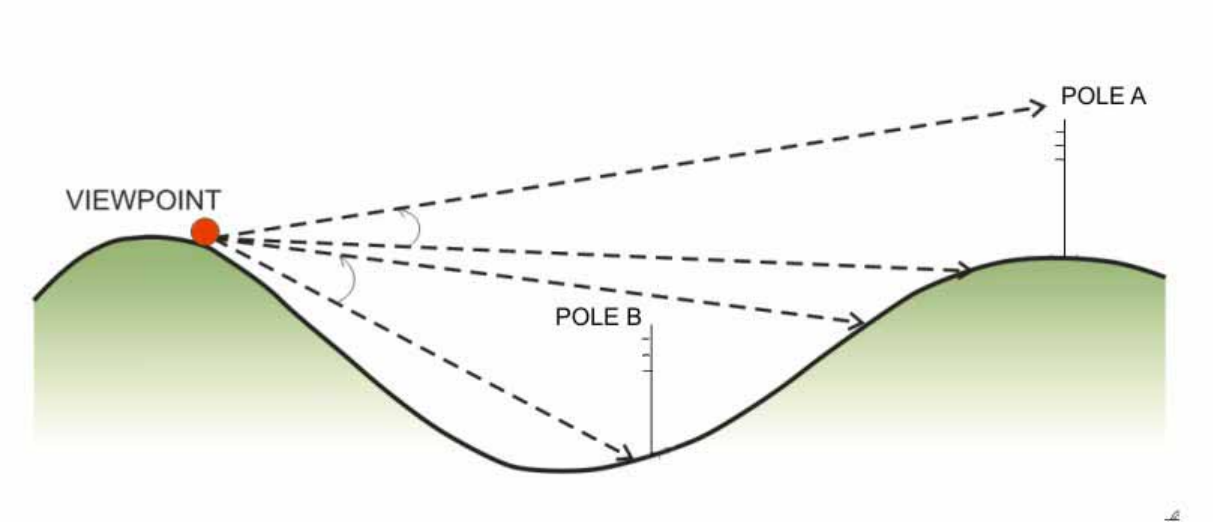

Figure 5.10 The visibility of transmission lines may depend on the elevation of the poles

Topography can also influence visual impacts on a local level. Viewpoints located within cut batters often have views blocked in the uphill direction. In these instances, the visual orientation is towards the downhill side or valley. This may enable opportunities for siting of development above viewpoints such as roads and houses without the risk of associated visual impacts.

6 ASSESSMENT OF THE VISUAL IMPACT OF THE TRANSMISSION LINE UPGRADE FROM PUBLICLY ACCESSIBLE LOCATIONS

The selection of publicly accessible viewpoints discussed in this section provides representative views for each of the Landscape Units discussed in Section 5 of this report. These viewpoints represent the range of likely landscape and visual impacts from publicly accessible locations within the viewshed. As such they provide a reasonable range of views on which to evaluate the likely visual impact of the current transmission line corridor on publicly accessible areas within the view shed.

People view the landscape from publicly accessible locations. These include roads, tourist destinations as well as from public recreation areas (such as ovals and sporting grounds).

The visual impact of the 132kV transmission line on motorists will vary according to alignments, distances and surrounding landscape character. A 132kV transmission line crossing a road is seen for only a short period in the context of a journey and the visual impact is far less than a 132kV transmission line that runs parallel to a road for a considerable distance.

Where a 132kV transmission line crosses a road, the preferred alignment to minimise visual impact is at right angles to the road. Views to the surrounding landscape (and transmission line corridors) can be filtered by the use of vegetation to limit the impact of a transmission pole to the immediate foreground.

In other open landscapes where the 132kV transmission line runs close to and parallel to the road, the proximity of the larger transmission poles can create a new scale on the landscape, thereby potentially causing a visual change.

Generally, views most valued by motorists are unique or picturesque settings. Views that are repetitive or uniform within the landscape are less valued. For these reasons, assessment of the current alignment on roads has been considered as follows:

- Where views by motorists capture a “unique” or picturesque setting within the context of the surrounding landscape;
- Where the current alignment will impact upon a recognised scenic or tourist destination; and/or
- Where the current alignment runs parallel to, or crosses the road.

This section of the report provides an assessment of the likely range of visual impacts of the current alignment from publicly accessible viewpoints within the view shed.

Viewpoints have been selected as representative and indicative of views from publicly accessible locations.

The indicative viewpoint locations from which an assessment will be undertaken are:

Section One

- Viewpoint 1– Wilson’s Creek Road
- Viewpoint 2– Coolamon Scenic Drive
- Viewpoint 3– Myocum Road
- Viewpoint 4– Ewingsdale

Section Two

- Viewpoint 5- Skinners Shoot Road
- Viewpoint 6– Corner of Bangalow Road and Coopers Shoot Road

Section Three

- Viewpoint 7– Newrybar Swamp Road
- Viewpoint 8– Newrybar Swamp Road #2

Section Four

- Viewpoint 9- Pacific Highway North of Ballina
- Viewpoint 10– Pacific Highway
- Viewpoint 11– Canal Road
- Viewpoint 12– Temple Street
- Viewpoint 13– Jamie Place
- Viewpoint 14– Bruxner Highway Alstonville
- Viewpoint 15– Ellis Road

Section 5

- Viewpoint 16– Wardell Road / Grays Lane
- Viewpoint 17– Tregeagle Road - Tregeagle Hall
- Viewpoint 18– Tregeagle Road
- Viewpoint 19– Three Chain Road

Section 6

- Viewpoint 20– Three Chain Road
- Viewpoint 21– Corner Three Chains Road and Bruxner Highway
- Viewpoint 12– Bruxner Highway east of Alstonville
- Viewpoint 23– Gundurimba Road

These viewpoints form the basis of the assessment of the visual impacts of the Lismore to Mullumbimby Electricity Network Upgrade.

6.1 VIEWPOINT 1– WILSON'S CREEK ROAD

Viewpoint 1 is located on the Wilson's Creek Road west of Mullumbimby.

Wilson's Creek Road is a minor sealed road that meanders through the local hills.

The most visible Landscape Unit in this location is Landscape Unit 2 – "Moderate to Steeply Undulating Cleared Farmland".

Figure 6.1 shows the view looking west towards the existing Mullumbimby Substation.

VP1 Locality Plan (GPS N 054 44536, E 683 9401, Elevation 81AHD)

The existing substation will see some minor visual alterations associated with the installation of 132kV infrastructure. There will also be new 132kV transmission lines entering the site. *Figure 6.1* Shows the existing substation looking west from Wilson's Creek Road.

Figure 6.1 Wilson's Creek Road, looking West

The existing substation is set well below the road level and is surrounded by an extensive tree canopy. There are limited views available of the existing Mullumbimby substation from the surrounding landscape.

Visually the proposed changes to this location will appear as routine maintenance to the existing infrastructure. This combined with the limited visibility will mean that the visual impact to this location will be low.

Table 6.1 ***Summary of Visual Impact from Viewpoint 1***

ITEM	DESCRIPTION	VISUAL IMPACT
Landscape sensitivity	Landscape Unit 2 – "Moderate to Steeply Undulating Cleared Farmland"	Low
Viewer numbers		Low
Distance to transmission line	0.2 km	High - Moderate
Overall visual impact		Low

6.2 VIEWPOINT 2– COOLAMON SCENIC DRIVE

Viewpoint 2 is located on the Coolamon Scenic Drive south west of Mullumbimby.

Coolamon Scenic Drive is a minor sealed road that meanders through the local hills.

The most visible Landscape Unit in this location is Landscape Unit 2 – "Moderate to Steeply Undulating Cleared Farmland".

Figure 6.2 shows the view looking west towards the existing 66kV transmission line from this location.

VP2 Locality Plan (GPS N 054 6336, E 6838435 Elevation 81AHD)

The existing 66kV transmission line in this area will be upgraded to a 132kV transmission line. The existing 66kV transmission line runs perpendicular to the Coolamon Scenic Drive in this location.

Figure 6.2 Coolamon Scenic Drive, looking West (Existing)

Figure 6.2 also shows the undulating rural landscape is punctuated by existing and remnant vegetation.

Figure 6.3 shows the existing photograph with the proposed 132kV transmission lines superimposed into the view.

Figure 6.3 Coolamon Scenic Drive, looking West (Photomontage)

There is little discernable difference between the proposed 132kV transmission lines and the existing 66kV transmission lines shown in *Figure 6.2*.

Visually the proposed changes to this location will appear as routine maintenance to the existing infrastructure. The visual impact of the proposed new poles and transmission lines will be low.

Table 6.2 ***Summary of Visual Impact from Viewpoint 2***

ITEM	DESCRIPTION	VISUAL IMPACT
Landscape sensitivity	Landscape Unit 2 – "Moderate to Steeply Undulating Cleared Farmland"	Low
Viewer numbers		Low
Distance to transmission line	0.2 km	High - Moderate
Overall visual impact		Low

6.3 VIEWPOINT 3– MYOCUM ROAD

Viewpoint 3 is located on Myocum Road approximately 5.8 km south of Mullumbimby.

Myocum Road is a minor sealed road that traverses flat farmland.

The most visible Landscape Unit in this location is Landscape Unit 1 – "Flat to Gently Undulating Cleared Farmland".

Figure 6.4 shows the view looking south towards the existing 66kV transmission line from this location.

VP3 Locality Plan (GPS N 054 748, E 683 7163, Elevation 18AHD)

The existing 66kV transmission line in this location will be upgraded to a 132kV transmission line.

Figure 6.4 shows the view looking south from Myocum Road. There are extensive areas of remnant and planted vegetation located along boundaries, fence lines and near to existing rural dwellings.

Figure 6.4 Myocum Road looking West (existing)

The existing vegetation that can be seen in the surrounding landscape assists to confine views to the existing transmission line corridor.

Figure 6.5 shows the view from this location with the proposed 132kV transmission line super imposed into the view.

Figure 6.5 Myocum Road looking West (Photomontage)

Figure 6.5 shows that there will be little discernable difference from the upgrading of the excising 66kV transmission line to a 132kV transmission line from this location.

There is an existing transmission line in this location already.

Visually the proposed changes to this location will appear as routine maintenance to the existing infrastructure. This visual impact resulting from the proposed upgrading from 66kV to a 132kV transmission line will be low.

Table 6.3 Summary of Visual Impact from Viewpoint 3

ITEM	DESCRIPTION	VISUAL IMPACT
Landscape sensitivity	Landscape Unit 1 – "Flat to Gently Undulating Cleared Farmland".	Low
Viewer numbers		Low
Distance to transmission line	0.2 km	High - Moderate
Overall visual impact		Low

6.4 VIEWPOINT 4–RESIDENTIAL ESTATE, EWINGSDALE

Viewpoint 4 is located at the intersection of Cape Vista Drive and Ivory Curl Court within the Ewingsdale residential subdivision.

Cape Vista Drive and Ivory Curl Court are sealed residential roads.

The most visible Landscape Unit in this location is Landscape Unit 7 – "Townships".

Figure 6.6 shows the view looking east towards the existing 66kV transmission line from this location.

VP4 Locality Plan. (GPS N 055 5070, E 683 1276, Elevation 24AHD)

Viewpoint 4 is taken from the rear of residential dwellings to the east of Ewingsdale, looking east.

The existing 66kV transmission line in this area will be upgraded to a 132kV transmission line across the plain seen in *Figure 6.6*.

Figure 6.6 Ewingsdale looking east

There are approximately six residential properties in this location that share this view.

Figure 6.6 shows that even from this low angle, the transmission poles do not break the horizon line established by the existing vegetation seen in the background of the photograph.

Figure 6.7 shows the eastern edge of a residential dwelling that has a view over the existing 66kV transmission line.

Figure 6.7 Existing Residences looking east

The majority of the existing residences in this location are located at a higher elevation than the landscape shown in *Figure 6.6.*

Figure 6.8 shows the existing transmission line that runs through the Ewingsdale residential subdivision.

Figure 6.8 Existing Transmission line

The existing 66kV transmission line seen in this location is proposed to be under grounded and will therefore not be visible.

The existing transmission line is already part of the visual landscape when viewed from this location looking east across the plain. The visual impact in upgrading the existing 66kV infrastructure to 132kV infrastructure will be low to negligible.

The existing transmission line runs through the residential areas will be located underground.

The visual impact to this location resulting from the under grounding of the existing cables will be positive.

Table 6.4 Summary of Visual Impact from Viewpoint 4

ITEM	DESCRIPTION	VISUAL IMPACT
Landscape sensitivity	Landscape Unit 7 – "Townships".	High
Viewer numbers		High
Distance to transmission line	0.2 km	High - Moderate
Overall visual impact		Low - Positive

6.5 Viewpoint 5– Skinners Shoot

Viewpoint 4 is located on Skinners Shoot Road.

Skinners Shoot Road is a gravel road that meanders through the local hills.

The most visible Landscape Unit in this location is Landscape Unit 2 – "Moderate to Steeply Undulating Cleared Farmland".

Figure 6.9 shows the view looking south along Skinners Shoot Road. An existing 66kV transmission line is visible from this location.

VP5 Locality Plan (GPS N 055 7824, E 682 7574, Elevation 93AHD)

The existing 66kV transmission line seen in *Figure 6.9* will be upgraded to a 132kV transmission line.

Figure 6.9 Skinners Shoot Road

Skinners Shoot Road is a partially sealed gravel access road for most of its length. There is dense vegetation located in both the road reserve and within private lots on both sides of the road. The existing 66kV transmission line is located within the Skinners Shoot Road however, it cannot be seen in its entirety due to the existing vegetation.

There are residential properties located on either side of Skinners Shoot Road. The majority of these residential properties are oriented to views across the surrounding landscape and away from Skinners Shoot Road.

Views to the existing 66kV transmission line are restricted due to existing vegetation located within the road reserve and within private allotments. Some vegetation clearing will be required for the proposed 132kV transmission line upgrade.

Upgrading the existing 66kV transmission line to a 132kV transmission line in this location may be visually noticeable however to the untrained eye the proposed visual changes this location will appear as routine maintenance to the existing infrastructure. However, as the transmission line is already part of the landscape character of the surrounding area the visual impact will be low.

Table 6.5 Summary of Visual Impact from Viewpoint 5

ITEM	DESCRIPTION	VISUAL IMPACT
Landscape sensitivity	Landscape Unit 2 – "Moderate to Steeply Undulating Cleared Farmland"	Low
Viewer numbers		Low
Distance to transmission line	0.1 km	High - Moderate
Overall visual impact		Low

6.6 Viewpoint 6– Corner of Bangalow Road and Coopers Shoot Road

Viewpoint 6 is located on the Corner of Bangalow Road and Coopers Shoot Road.

Coopers Shoot Road is a minor sealed road that meanders through the local hills in this location.

The most visible Landscape Unit in this location is Landscape Unit 2 – "Moderate to Steeply Undulating Cleared Farmland".

Figure 6.10 shows the view looking north from Coopers Shoot Road.

VP6 Locality Plan (GPS N 055 7914, E 682 7762, Elevation 111AHD)

There is an existing piggery in the area which can be seen in the bottom of *Figure 6.10.* This location also takes in panoramic view to the coastline located to the north and east.

There is a new zone substation proposed in the cleared area immediately to the east of a former piggery. The existing 66kV transmission line seen in *Figure 6.10* will be upgraded to a 132kV transmission line over the hills and across the plains.

Figure 6.10 Corner of Bangalow Road and Coopers Shoot Road Looking North

Figure 6.11 shows the view looking south from Yagers Lane towards the former piggery (sheds in foreground) and Bangalow Road beyond. Coopers Shoot Road is located below the hill in the background of this figure. The piggery is no longer in use and ERM understands that the site has development approval to be developed into a plant nursery.

Figure 6.11 View from Yagers Lane looking south

The view already contains many signs of visual modification including the clearing of vegetation, existing transmission lines and poles, residential dwellings and other large sheds and buildings.

The areas of cleared farmland are located in the foreground of the view and within close proximity to the former piggery.

The distant views to the north and east of this location are over areas of existing and intact vegetation towards the bay. These are the most dominant views from this location.

The proposed substation will be located within an area of cleared vegetation adjacent to the former piggery. This proposed location will be in the background of the view and adjacent to existing large sheds and other infrastructure. The dominant views to the coastal areas and large areas of remnant vegetation will not be compromised through the installation of a substation in this location.

The visual impact to this location will be low – moderate.

Table 6.6 Summary of Visual Impact from Viewpoint 6

ITEM	DESCRIPTION	VISUAL IMPACT
Landscape sensitivity	Landscape Unit 2 – "Moderate to Steeply Undulating Cleared Farmland".	Moderate
Viewer numbers		Low
Distance to substation	0.6 km	Low
Overall visual impact		Low - Moderate

6.7 VIEWPOINT 7– NEWRYBAR SWAMP ROAD

Viewpoint 7 is located on Newrybar Swamp Road.

Newrybar Swamp Road is a two-way road that runs between Ballina and Lismore.

The most visible Landscape Unit in this location is Landscape Unit 1 – "Flat to Gently Undulating Cleared Farmland".

Figure 6.12 shows the view looking south-west along the alignment of the existing 66kV transmission line from this location.

VP7 Locality Plan (GPS N 055 5712, E 682 1106, Elevation 81AHD)

The existing transmission line in this location is proposed to be upgraded from a 66kV line to a 132kV line.

Figure 6.12 Newrybar Swamp Road looking South-West (existing)

There are also areas of retained melaleuca scrub in this section. The existing vegetation that can be seen in the surrounding landscape assists to confine views to the existing transmission line corridor.

Figure 6.13 shows the view from this location with the proposed 132kV transmission line super imposed into the view.

Figure 6.13 ***Newrybar Swamp Road looking South-West (photomontage)***

Figure 6.13 shows that there will be little discernable difference from the upgrading of the excising 66kV transmission line to a 132kV transmission line from this location.

Visually the proposed changes to this location will appear as routine maintenance to the existing infrastructure. This visual impact resulting from the proposed upgrading from 66kV to a 132kV transmission line will be low.

Table 6.7 ***Summary of Visual Impact from Viewpoint 7***

ITEM	DESCRIPTION	VISUAL IMPACT
Landscape sensitivity	Landscape Unit 1 – "Flat to Gently Undulating Cleared Farmland".	Moderate
Viewer numbers		Low
Distance to transmission line	0.0 km	High
Overall visual impact		Low

6.8 VIEWPOINT 8– NEWRYBAR SWAMP ROAD #2

Viewpoint 8 is located on Newrybar Swamp Road.

Newrybar Swamp Road is a two-way sealed road that runs between Ballina and Lismore.

The most visible Landscape Unit in this location is Landscape Unit 1 – "Flat to Gently Undulating Cleared Farmland".

Figure 6.14 shows the view looking north towards the existing 66kV transmission line from this location.

VP8 Locality Plan (GPS N 055 3827, E 686 1042, Elevation 81AHD)

The existing substation in this location is proposed to be upgraded from a 66kV substation to a 132kV substation.

The existing 66kV transmission lines feeding the substation will also be upgraded to 132kV power infrastructure.

Figure 6.14 Existing Substation looking north

Visually the proposed changes to this location will appear as routine maintenance to the existing infrastructure. The visual impact to this location will be low.

Table 6.8 Summary of Visual Impact from Viewpoint 8

ITEM	DESCRIPTION	VISUAL IMPACT
Landscape sensitivity	Landscape Unit 1 – "Flat to Gently Undulating Cleared Farmland".	Moderate
Viewer numbers		Low
Distance to substation	0.0 km	High
Overall visual impact		Low

6.9 VIEWPOINT 9– PACIFIC HIGHWAY, NORTH-WEST OF BALLINA

Viewpoint 9 is located on the Pacific Highway north-west of Ballina.

The Pacific Highway is a two-way sealed road that runs inland between Ballina and Tweed Heads.

The most visible Landscape Unit in this location is Landscape Unit 1 – "Flat Cleared Farmland".

Figure 6.15 shows the view looking west towards the existing 66kV transmission line from this location.

VP9 Locality Plan (GPS N 055 2102, E 680 9563, Elevation 45AHD)

The existing transmission line shares a short section (approximately 3km) of the Pacific Highway leading into Ballina from the north.

The existing 66kV transmission line seen in *Figure 6.15* will be upgraded to a 132kV transmission line.

Figure 6.15 Pacific Highway looking west

The existing transmission line is already part of the visual landscape in this location.

Visually the proposed changes to this location will appear as routine maintenance to the existing infrastructure.

Table 6.9 Summary of Visual Impact from Viewpoint 9

ITEM	DESCRIPTION	VISUAL IMPACT
Landscape sensitivity	Landscape Unit 1 – "Flat Cleared Farmland"	Moderate
Viewer numbers		Moderate
Distance to transmission line	0.0 km	High - Moderate
Overall visual impact		Low

6.10 VIEWPOINT 10– PACIFIC HIGHWAY

Viewpoint 10 is located on the Pacific Highway, on the western edge of Ballina.

The Pacific Highway is a two way sealed road that runs between Ballina and Lismore.

The most visible Landscape Unit in this location is Landscape Unit 1 – "Flat Cleared Farmland".

Figure 6.16 shows the view looking north towards the existing 66kV transmission line from this location.

VP10 Locality Plan (GPS N 055 1043, E 680 6908, Elevation 2AHD)

The existing 66kV transmission line seen in *Figure 6.16* will be upgraded to a 132kV transmission line.

Figure 6.16 View looking North from Pacific Highway

Figure 6.17 shows the view looking east along the Pacific Highway towards Ballina.

Figure 6.17 View looking East toward Ballina along the Pacific Highway

The Sunmaid Village Caravan Park is also located to the south of this location.

There is also an existing transmission line that parallels the southern side of the Pacific Highway in this location.

The existing transmission line that is located on the southern side of the Pacific Highway is a visually dominant feature in the landscape of the Pacific Highway.

The existing 66kV transmission line that is proposed to be upgraded to a 132kV transmission line is set back from the Pacific Highway.

There are several transmission line corridors that are already visible from this location. The upgrading of the existing 66kV transmission line to a 132kV transmission line is set back from the Pacific Highway.

Visually the proposed changes to this location will appear as routine maintenance to the existing infrastructure. This visual impact resulting from the proposed upgrading from 66kV to a 132kV transmission line will be low.

Table 6.10 Summary of Visual Impact from Viewpoint 10

ITEM	DESCRIPTION	VISUAL IMPACT
Landscape sensitivity	Landscape Unit 1 – "Flat to Gently Undulating Cleared Farmland".	Moderate
Viewer numbers		High
Distance to transmission line	0.7 km	Moderate
Overall visual impact		Low

6.11 VIEWPOINT 11 – CANAL ROAD

Viewpoint 11 is located on Canal Road in the township of Ballina, looking north-east.

Canal Road is a residential street.

The most visible Landscape Unit in this location is Landscape Unit 7 – "Townships".

Figure 6.18 shows the view looking west towards the existing 66kV transmission line from this location.

VP11 Locality Plan (GPS N 055 3731, E 680 7122, Elevation 11AHD)

The existing substation seen in *Figure 6.18* will be upgraded and expanded to the east (right of figure).

Figure 6.18 View looking North across Reserve towards Existing Substation

This viewing location is located within an existing residential area to the west of Ballina that has views to the existing substation.

Figure 6.19 shows the view looking south towards existing residential dwellings on the southern side of Canal Road.

Figure 6.19 View looking South towards Canal Road

The view already contains many signs of visual modification including the clearing of vegetation, existing transmission lines and poles, residential dwellings and other large sheds and buildings.

The proposed substation expansion will be to the eastern edge of the existing substation. Views to the existing substation are also filtered by the perimeter planting against the substations southern boundary as well the existing trees in the Canal Road, road reserve and sports reserve margins.

The visual impact to this location will be low - moderate.

Table 6.11 Summary of Visual Impact from Viewpoint 11

ITEM	DESCRIPTION	VISUAL IMPACT
Landscape sensitivity	Landscape Unit 7 – "Townships".	High
Viewer numbers		High
Distance to transmission line	0.2 km	High
Overall visual impact		Low - Moderate

6.12 VIEWPOINT 12– TEMPLE STREET

Viewpoint 12 is located on Temple Street in the township of Ballina, looking west.

Temple Street is a residential street.

The most visible Landscape Unit in this location is Landscape Unit 7 – "Townships".

Figure 6.20 shows the view looking west towards the existing 66kV substation from this location.

VP12 Locality Plan (GPS N 055 3987, E 680 7301, Elevation 12AHD)

The existing substation seen in *Figure 6.20* will be upgraded and expanded to the east (centre of figure).

Figure 6.20 View looking West towards Existing Substation from Temple Street

The existing vegetation between this location and the existing substation is patchy and allows views in to the substation.

This location is located within an existing residential area to the west of Ballina that has views to the existing substation.

The view already contains many signs of visual modification including the clearing of vegetation, the existing substation, existing transmission lines and poles, residential dwellings and other large sheds and buildings.

There will be new landscape works associated with the proposed expansion of the substation. This planting will assist to filter views to the substation.

The visual impact to this location will be low to moderate. When the landscape works become established, the visual impact to this location could be a positive visual outcome.

Table 6.12 Summary of Visual Impact from Viewpoint 12

ITEM	DESCRIPTION	VISUAL IMPACT
Landscape sensitivity	Landscape Unit 7 – "Townships".	High
Viewer numbers		High
Distance to substation	0.05 km	High
Overall visual impact		Moderate – Positive (long-term)

6.13 VIEWPOINT 13– JAMIE PLACE

Viewpoint 13 is located on Jamie Place in the township of Ballina, looking west.

Jamie Place is a residential court.

The most visible Landscape Unit in this location is Landscape Unit 7 – "Townships".

Figure 6.21 shows the view looking south-west towards the existing transmission line from this location.

VP13 Locality Plan (GPS N 055 3923, E 680 7442, Elevation 10AHD)

The existing substation seen in *Figure 6.18* will be upgraded and expanded to the east (to the left of *Figure 6.21*).

Figure 6.21 View looking South towards Existing Substation from Jamie Place

This viewing location is located within an existing residential area to the west of Ballina. There are views to the existing substation.

Figure 6.21 shows the view looking south-west from Jaimie Place.

The view already contains many signs of visual modification including the clearing of vegetation, existing transmission lines and poles, residential dwellings and other large sheds and buildings.

The proposed substation expansion will be the eastern edge of the existing substation.

The visual impact to this location will be low.

Table 6.13 Summary of Visual Impact from Viewpoint 13

ITEM	DESCRIPTION	VISUAL IMPACT
Landscape sensitivity	Landscape Unit 7 – "Townships".	High
Viewer numbers		Medium
Distance to transmission line	0.2 km	High - Moderate
Overall visual impact		Low

6.14 VIEWPOINT 14 – BRUXNER HIGHWAY ALSTONVILLE

Viewpoint 14 is located on the Bruxner Highway near Alstonville.

Bruxner Highway is a two way major road that runs between Ballina and Alstonville.

The most visible Landscape Units in this location is Landscape Unit 1 – "Flat to Gently Undulating Cleared Farmland" and Landscape Unit 7 "Townships".

Figure 6.22 shows the view looking west towards the existing 66kV transmission line from this location.

VP14 Locality Plan (GPS N 054 3931, E 680 8375, Elevation 161AHD)

The existing 66kV transmission line seen in *Figure 6.22* and *Figure 6.23* will be upgraded to a 132kV transmission line.

Figure 6.22 Bruxner Highway looking east

The existing 66kV transmission line parallels the Bruxner Highway for the majority of its length between the Pacific Highway intersection (near Ballina) to Alstonville.

Figure 6.23 shows the view looking roughly west towards Alstonville from this location.

Figure 6.23 Bruxner Highway looking North-West

Figure 6.22 and *Figure 6.23* shows the extensive areas of existing vegetation that is found along the same length of the Bruxner Highway.

This vegetation assists to create limited or intermittent viewing opportunities of the existing transmission line from the Bruxner Highway.

There is an option to relocate this section of the transmission line further to the south of this location and away from existing residential dwellings.

Upgrading the existing 66kV transmission line to a 132kV transmission line in this location may be visually noticeable. However, as the transmission line is already part of the landscape character of the surrounding area. Visually the proposed changes to this location will appear as routine maintenance to the existing infrastructure. The visual impact will be low.

If the transmission line was relocated to the south of its current location it would not be visible from this section of the Bruxner Highway. This would be a positive visual outcome.

Table 6.14 Summary of Visual Impact from Viewpoint 14

ITEM	DESCRIPTION	VISUAL IMPACT
Landscape sensitivity	Landscape Unit 1 – "Flat to Gently Undulating Cleared Farmland".	Moderate
Viewer numbers		High
Distance to transmission line	0.0 km	High
Overall visual impact		Low Positive

6.15 VIEWPOINT 15– ELLIS ROAD

Viewpoint 15 is located on Ellis Road.

Ellis Road is a minor sealed road that meanders through the local hills.

The most visible Landscape Unit in this location is Landscape Unit 2 – "Moderate to Steeply Undulating Cleared Farmland".

Figure 6.24 shows the view looking west along the existing 66kV transmission line from this location.

VP15 Locality Plan (GPS N 054 1074, E 680 7209, Elevation 81AHD)

The existing 66kV transmission lines seen in *Figure 6.24* will be upgraded to a dual circuit 132kV/66kV transmission line. The southern (left) transmission line will be upgraded in this location.

Figure 6.24 Ellis Road looking west

There are extensive area of remnant and planted trees both in road reserves and within orchards in this location. This vegetation in combination with the undulating landscape in this location assists to filter views to the existing transmission line.

Figure 6.25 shows looking east from Ellis Road along the existing 66kV transmission line. The southern (right) transmission line will be upgraded in this direction.

Figure 6.25 Ellis Road looking east

Upgrading the existing 66kV transmission line to a dual circuit 132kV/66kV transmission line in this location may be visually noticeable. Because the transmission line is already part of the landscape character of the surrounding area, visually the proposed changes to this location will appear as routine maintenance to the existing infrastructure.

The visual impact will be low.

Table 6.15 Summary of Visual Impact from Viewpoint 15

ITEM	DESCRIPTION	VISUAL IMPACT
Landscape sensitivity	Landscape Unit 2 – "Steep to Moderate Undulating Cleared Farmland".	Moderate
Viewer numbers		Medium
Distance to transmission line	0.0 km	High - Moderate
Overall visual impact		Low

6.16 VIEWPOINT 16– WARDELL ROAD / GRAYS LANE

Viewpoint 16 is located on Wardell Road immediately north of its intersection with Gray's Lane.

Wardell Road is a minor sealed road that meanders through the local hills.

The most visible Landscape Unit in this location is Landscape Unit 4 – "Moderate to Steeply Undulating Cleared Farmland".

Figure 6.26 shows the view looking west towards the existing 66kV substation from this location.

VP16 Locality Plan (GPS N 054 2423, E 680 7114, Elevation 60AHD)

Figure 6.27 shows a view to the front entrance to the "*House with no steps*" looking away from the existing substation.

The existing substation in this location is not proposed to be upgraded 66kV to 132kV from as part of this project.

The existing 66kV transmission line that bypasses the substation will be upgraded to a 132kV transmission line. From here the existing transmission line will continue towards Lismore a dual circuit 132kV/66kV transmission line.

Figure 6.26 Entrance to Alstonville Substation looking South-West

Figure 6.27 View "House with no steps" looking North-East

The upgrade will involve the proposed 132kV transmission line running past the Alstonville substation.

The view already contains an existing substation that includes clearing of vegetation, existing transmission lines and poles, sheds and buildings.

Visually, there will be no discernable difference as a result of upgrading the existing 66kV infrastructure to 132kV and 132/66kV infrastructure in this location. Visually the proposed changes to this location will appear as routine maintenance to the existing infrastructure.

The visual impact to this location will be low.

Table 6.16 Summary of Visual Impact from Viewpoint 16

ITEM	DESCRIPTION	VISUAL IMPACT
Landscape sensitivity	Landscape Unit 2 – "Moderate to Steeply Undulating Cleared Farmland".	Moderate
Viewer numbers		Low
Distance to transmission line	0.2 km	High - Moderate
Overall visual impact		Low

6.17 VIEWPOINT 17– TREGEAGLE ROAD - TREGEAGLE HALL

Viewpoint 17 is located on the Tregeagle Road, Tregeagle.

Tregeagle Road is a minor sealed road that meanders through the local hills.

The most visible Landscape Unit in this location is Landscape Unit 2 – "Moderate to Steeply Undulating Cleared Farmland".

Figure 6.28 shows the view looking north west and *Figure 6.29* shows the view looking north east towards the existing 66kV transmission line from this location.

VP17 Locality Plan (GPS N 053 4653, E 680 8255, Elevation 84AHD)

The existing 66kV transmission line in this location will be upgraded to a dual circuit 132kV/66kV transmission line.

Figure 6.28 shows the view looking north-west from the Tregeagle Hall. There are extensive areas of exiting tall vegetation both native and exotic in this location.

Figure 6.28 Tregeagle Road looking North-West

Figure 6.29 shows the view looking north-east from the Tregeagle Hall and recreation reserve.

Figure 6.29 Tregeagle Road looking North-East

This vegetation assists to filter views to the surrounding landscape, and in some cases will also screen infrastructure from view. This can also be seen in *Figure 6.28* and *Figure 6.29*

Upgrading the existing 66kV transmission line to a dual circuit 132kV/66kV transmission line in this location may be visually noticeable. The existing vegetation in this area screens most views to the existing transmission line. The transmission line is already part of the landscape character of the surrounding area. Visually the proposed changes to this location will appear as routine maintenance to the existing infrastructure. The visual impact to this location will be low.

Table 6.17 Summary of Visual Impact from Viewpoint 17

ITEM	DESCRIPTION	VISUAL IMPACT
Landscape sensitivity	Landscape Unit 2 – "Moderate to Steeply Undulating Cleared Farmland".	Moderate
Viewer numbers		Medium
Distance to transmission line	0.3 km	High - Moderate
Overall visual impact		Low

6.18 VIEWPOINT 18– TREGEAGLE ROAD

Viewpoint 18 is located on Tregeagle Road, Tregeagle.

Tregeagle Road is a minor sealed road that meanders through the local hills.

The most visible Landscape Unit in this location is Landscape Unit 2 – "Moderate to Steeply Undulating Cleared Farmland".

Figure 6.30 shows the view looking west along the existing 66kV transmission line from this location.

VP18 Locality Plan (GPS N 053 4679, E 680 8410, Elevation 81AHD)

The existing 66kV transmission line seen in *Figure 6.30* will be upgraded to a dual circuit 132kV/66kV transmission line.

Figure 6.30 Tregeagle Road looking West (Existing View)

The existing vegetation that can be seen in the surrounding landscape assists to confine views to the existing transmission line. This will also screen views to the proposed poles. Vegetation around properties does vary. Other rural properties have less perimeter vegetation than this property.

Figure 6.31 Tregeagle Road looking West (Photomontage)

Figure 6.31 shows that there will be little discernable difference from the upgrading of the existing 66kV transmission line to a dual circuit 132kV/66kV transmission line from this location.

This vegetation assists to filter views to the surrounding landscape, and in some cases will also screen infrastructure from view.

Upgrading the existing 66kV transmission line to a dual circuit 132kV/66kV transmission line in this location may be visually noticeable.

The existing vegetation in this area screens most views to the existing transmission line. The transmission line is already part of the landscape character of the surrounding area. Visually the proposed changes to this location will appear as routine maintenance to the existing infrastructure. The visual impact to this location will be low.

Table 6.18 Summary of Visual Impact from Viewpoint 18

ITEM	DESCRIPTION	VISUAL IMPACT
Landscape sensitivity	Landscape Unit 2 – "Moderate to Steeply Undulating Cleared Farmland".	Moderate
Viewer numbers		Medium
Distance to transmission line	0.0 km	High - Moderate
Overall visual impact		Low

6.19 VIEWPOINT 19– THREE CHAIN ROAD

Viewpoint 19 is located on Three Chain Road near to the Lismore Substation.

Three Chain Road is a minor sealed road that provides access to the Ballina Aerodrome, Ballina Substation and several residential properties.

The most visible Landscape Unit in this location is Landscape Unit 1 – "Flat to Gently Undulating Cleared Farmland".

Figure 6.32 shows the view looking east towards the existing Lismore Bulk Supply Point from this location.

VP19 Locality Plan (GPS N 052 03336, E 681 2065, Elevation 21AHD)

This viewing location is located within a farming and industrial area to the west of Ballina.

Figure 6.32 Lismore Bulk Supply Point

The view already contains many signs of visual modification including the clearing of vegetation, existing transmission lines and poles, residential dwellings and other large sheds and buildings.

The proposed substation upgrade works will occur within the existing substation site.

Visually the proposed changes to this location will appear as routine maintenance to the existing infrastructure.

The visual impact to this location will be low.

Table 6.19 Summary of Visual Impact from Viewpoint 19

ITEM	DESCRIPTION	VISUAL IMPACT
Landscape sensitivity	Landscape Unit 1 – "Flat to Gently Undulating Cleared Farmland".	Moderate
Viewer numbers		Low
Distance to transmission line	0.2 km	High - Moderate
Overall visual impact		Low

6.20 VIEWPOINT 20– THREE CHAIN ROAD

Viewpoint 20 is located on the Three Chain Road near the Lismore Substation.

Three Chain Road is a minor sealed road that provides access to the Ballina Aerodrome, Ballina Substation and several residential properties.

The most visible Landscape Unit in this location is Landscape Unit 1 – "Flat to Steeply gently Undulating Cleared Farmland".

Figure 6.33 shows the view looking east towards the existing 66kV substation from this location.

VP20 Locality Plan (GPS N 052 5238, E 681 1917, Elevation 22AHD)

In this location, it is proposed that new underground 66kV transmission lines feeding the substation will also installed along Three Chain Road.

Figure 6.33 Three Chain Road looking west

Figure 6.34 Three Chain Road looking east

This location is located at the northern end of the Lismore Airfield and within a farming and industrial area to the west of Lismore.

The view also contains many signs of visual modification including the clearing of vegetation, existing transmission lines and poles, residential dwellings and other large sheds and buildings.

The works in this location will involve this installation of new 66 kV underground cables along the existing road reserve and below the existing over head transmission lines.

Because the new cable will be buried, the visual impact to this location will be low.

Table 6.20 Summary of Visual Impact from Viewpoint 20

ITEM	DESCRIPTION	VISUAL IMPACT
Landscape sensitivity	Landscape Unit 1 – "Flat to Gently Undulating Cleared Farmland".	Moderate
Viewer numbers		Low
Distance to transmission line	0.0 km	High - Moderate
Overall visual impact		Low

6.21 VIEWPOINT 21– CORNER THREE CHAIN ROAD AND BRUXNER HIGHWAY

Viewpoint 21 is located near the intersection of Three Chains Road and the Bruxner Highway.

Three Chains Road is a minor sealed road. The Bruxner Highway runs between Lismore and Casino.

The most visible Landscape Unit in this location is "Landscape Unit 7 – Townships".

Figure 6.35 shows the view looking east towards the existing substation from this location.

VP21 Locality Plan (GPS N 052 5813, E 681 1813, Elevation 19AHD)

Figure 6.35 Corner Three Chain Road and Bruxner Highway looking east

This viewpoint is located within industrial areas to the west of Lismore that has views to the existing substation.

The proposed substation upgrade will involve new 66kV transmission lines entering and exiting the existing substation.

The view already contains an existing substation which includes clearing of vegetation, existing transmission lines and poles, sheds and buildings.

The proposed changes to the existing substation and transmission lines in this location will appear as routine maintenance.

The visual impact to this location will be low.

Table 6.21 Summary of Visual Impact from Viewpoint 21

ITEM	DESCRIPTION	VISUAL IMPACT
Landscape sensitivity	Landscape Unit 7 – "Townships".	Moderate
Viewer numbers		Low
Distance to transmission line	0.1 km	High - Moderate
Overall visual impact		Low

6.22 VIEWPOINT 22– BRUXNER HIGHWAY, WEST OF LISMORE

Viewpoint 22 is located on the Bruxner Highway in Lismore.

The Bruxner Highway is a two-way sealed road. The Bruxner Highway runs between Lismore and Casino.

The most visible Landscape Unit in this location is Landscape Unit 7 – "Townships".

Figure 6.36 shows the view looking north along the Bruxner Highway towards Three Chain Road and Lismore line from this location.

VP22 Locality Plan (GPS N 052 5868, E 681 1726, Elevation 21AHD)

Figure 6.36 Entrance to Lismore looking North

This vegetation seen in *Figure 6.36* assists to create limited or intermittent viewing opportunities of the existing transmission line from the Bruxner Highway.

The proposed transmission line works in this area are to the east of this location and parallel to the Bruxner Highway. *Figure 6.37* shows the view looking east from this location towards the existing 66kV transmission line.

Figure 6.37 View looking East from Bruxner Highway

The existing 66kV transmission line seen in *Figure 6.37* will be upgraded to a two single circuit 66kV transmission lines or to a dual circuit 66kV/66kV transmission line in this location

Upgrading the existing 66kV transmission line to two single circuit 66kV transmission lines or to a dual circuit 66kV/66kV transmission line in this location may be visually noticeable.

Visually the proposed changes to this location will appear as routine maintenance to the existing infrastructure. The transmission line is already part of the landscape character of the surrounding area the visual impact will be low.

Table 6.22 Summary of Visual Impact from Viewpoint 22

ITEM	DESCRIPTION	VISUAL IMPACT
Landscape sensitivity	Landscape Unit 7 – "Townships".	Moderate
Viewer numbers		Low
Distance to transmission line	0.1 km	High - Moderate
Overall visual impact		Low

6.23 VIEWPOINT 23– GUNDURIMBA ROAD

Viewpoint 23 is located on Gundurimba Road.

Gundurimba Road is a minor sealed road that meanders through the local hills.

The most visible Landscape Unit in this location is Landscape Unit 1 – "Flat to Undulating Cleared Farmland".

Figure 6.38 shows the view looking north along the existing 66kV transmission line from this location.

VP23 Locality Plan (GPS N 052 6445, E 681 1015, Elevation 21AHD)

The existing 66kV transmission line seen in the background of *Figure 6.38* will be upgraded to a dual 66kV transmission line.

Figure 6.38 View from Gundurimba Road looking east

Figure 6.39 shows the existing 66kV transmission line heading west prior to crossing the Wilson River.

Figure 6.39 Existing View looking west from Gundurimba Road

The existing vegetation also assists to screen views to the existing transmission line infrastructure beyond the immediate location.

Upgrading the existing 66kV transmission line to a dual 66kV transmission line in this location may be noticeable. Visually the proposed changes to this location will appear

as routine maintenance to the existing infrastructure because the transmission line is already part of the landscape in this area.

The visual impact will be low.

Table 6.23 Summary of Visual Impact from Viewpoint 23

ITEM	DESCRIPTION	VISUAL IMPACT
Landscape sensitivity	Landscape Unit 1 – "Flat to Gently Undulating Cleared Farmland".	Moderate
Viewer numbers		Medium
Distance to transmission line	0.0 km	High
Overall visual impact		Low

6.24 SUMMARY OF THE VISUAL IMPACT FROM PUBLICLY ACCESSIBLE VIEWPOINTS

Table 6.24 provides a summary of the visual impact assessment ratings of all publicly accessible viewpoints as discussed in this section.

Table 6.24 Summary assessment of publicly accessible viewpoints

VP	Visual Component	Location	Distance from viewpoint	Overall visual impact
VP 1	Substation	Wilson's Creek Road	0.2 km	Low
VP 2	132kV	Coolamon Scenic Drive	0.2 km	Low
VP 3	132kV	Myocum Road	0.2 km	Low
VP 4	132kV	Residential Estate, Ewingsdale	0.1 km	Low - Positive
VP 5	132kV	Skinner Shoot	0.1 km	Low
VP 6	132kV and New Substation	Cnr. Bangalow Road and Coopers Shoot Road	0.6 km	Low - Moderate
VP 7	132kV	Newrybar Swamp Road	0.1 km	Low
VP 8	Substation	Newrybar Swamp Road	0.1 km	Low
VP 9	132kV	Pacific Highway north-west of Ballina	0.1 km	Low
VP 10	132kV	Pacific Highway, on the western edge of Ballina	0.7 km	Low
VP 11	Substation	Canal Road in Ballina	0.3 km	Low- Moderate
VP 12	Substation	Temple Street in Ballina	0.2 km	Moderate – Positive (Long-term)
VP 13	Substation	Jamie Place in Ballina	0.2 km	Low
VP 14	132kV/66 kV	Bruxner Highway near Alstonville	0.0 km	Low - Positive
VP 15	132kV/66kV	Ellis Road	0.0 km	Low
VP 16	Substation	Wardell Road / Gray's Lane	0.2 km	Low
VP 17	132kV/66kV	Tregeagle Road – Tregeagle Hall	0.3 km	Low
VP 18	132kV/66kV	Ellis Road	0.0 km	Low
VP 19	Substation	Three Chain Road	0.2 km	Low
VP 20	66kV Underground	Three Chain Road	0.1 km	Low
VP 21	66kV Underground/ Substation	Three Chains Road and the Bruxner Highway	0.1 km	Low
VP 22	66kV	Bruxner Highway west of Lismore	0.1 km	Low
VP 23	66kV	Gundurimba Road	0.0 km	Low

This summary shows that that there are two viewpoints that are considered as having a Low-moderate visual impact from publicly accessible locations.

All of the remaining viewpoints assessed have a Low visual impact.

This visual assessment provided for in this section of the report is by no means exhaustive. The viewing locations have been selected to provide discussion of the range of visual impacts likely to be encountered for the proposed Lismore to Mullumbimby Electricity Network Upgrade.

Given that the transmission line is an existing part of the surround landscape for the most part of the proposed route alignment, the visual impact of the proposed upgrade is likely to be low in most if not all areas.

There are also few houses in the proposed route corridor with the exception of entries to larger towns such as Ballina. The route also shares only short sections of local roads and highways.

7 VISUAL IMPACT MINIMISATION STRATEGIES

This section provides an overview of landscape mitigation strategies suitable for the mitigation of the landscape and visual impact of the Lismore to Mullumbimby Electricity Network Upgrade.

7.1 LANDSCAPE MITIGATION FOR RESIDENTIAL PROPERTIES

Landscaping is a mitigation option that is useful for affected residential properties. As the viewing location is relatively fixed, planting may be designed to either screen the current alignment from view, or significantly reduce the visual dominance through filtering.

The effectiveness of landscape as a mitigation measure varies in accordance with landowner objectives and the residence's orientation in relation to the visible components of the Lismore to Mullumbimby Electricity Network Upgrade, particularly areas near to new substations.

Typically for most developments, properties that lie to the north of a development are easily screened. Screening vegetation on the southern boundaries will protect these properties from southern winds and will not affect solar access. However properties may wish to retain views to the south, say to the coastline or nearby hills. Therefore it must be recognised that a landholder may not wish to establish boundary planting on southern boundaries.

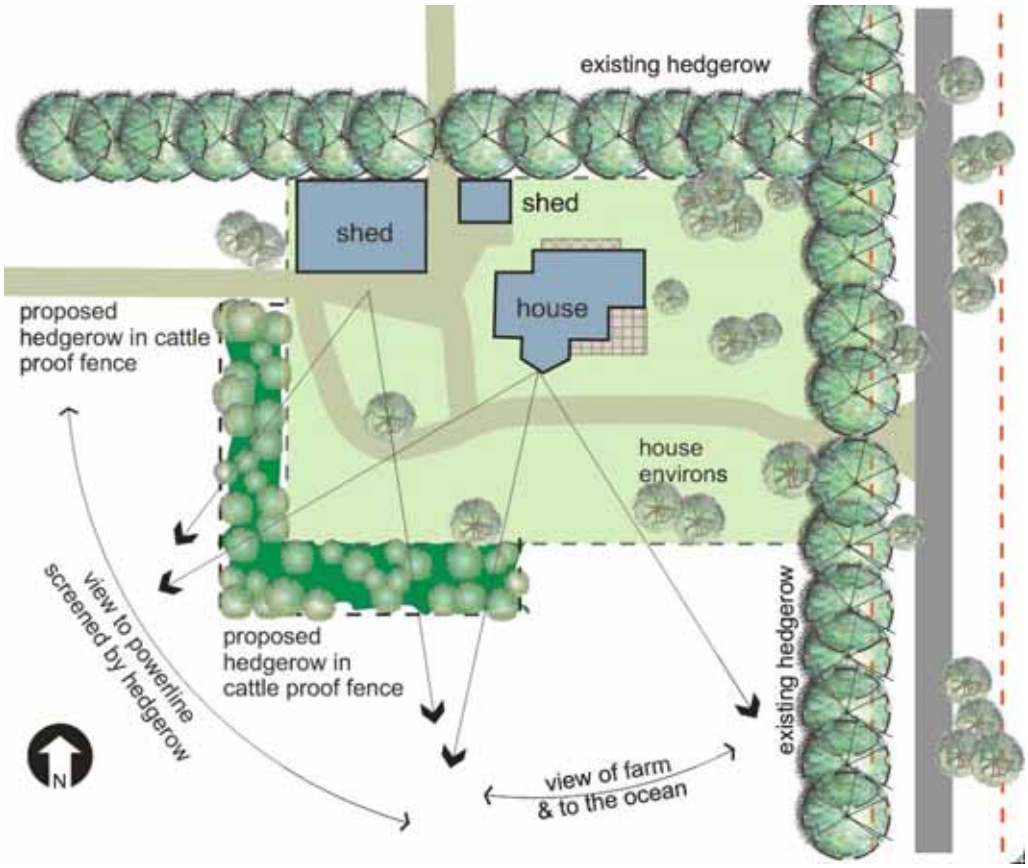

Figure 7.1 Panorama from the rear of a 'hypothetical' property

Figure 7.1 shows a potential mitigation plan for a hypothetical property that retains some views across the rural landscape and to the ocean to the south, while fully or partly screening views to a transmission line located towards the south west.

Landscape can also have the potential to reduce visual impact of overhead transmission lines.

A number of options are illustrated below which may be appropriate at different instances along the current alignment.

In designing a proposed transmission line there are a number of strategies that can minimise the visual impact on communities. These include:

- strategic siting;
- undergrounding;
- the design of above-ground structures;
- micro siting the location of proposed poles to minimise visual impact; and
- landscape mitigation measures.

Each of these strategies will be discussed in further detail below.

7.2 STRATEGIC SITING

Strategic siting refers to a method of selecting a route which would lead to the least visual impact.

For example to minimise the visual impact of a new transmission line route there are two options that can be considered. The first option for a new route is to locate the transmission line away from residential areas and roads in forested areas where there may be little visual impact; however the ecological implications may be greater.

The second option for a new route is to locate the route in rural areas that are optimally comprised of large holdings with few rural residential residences. Country Energy and ERM has provided several routes options that propose alternatives to the existing alignment. For these options there will be a much greater visual impact on the landscape as the change will be from no transmission line to a landscape with transmission lines.

Locating the proposed transmission line upgrade and associated infrastructure in an existing corridor has obvious advantages. The existing line is part of the local landscape character and most people would have selected their residences on the basis that a transmission line is located nearby.

Therefore upgrading the existing infrastructure or adding a second line, while it does change the landscape, is not nearly as great a change as the installation of a new line.

In terms of minimising visual impact by strategically siting the route, the utilisation of an existing corridor which already contains a transmission line is a much preferable option.

7.3 UNDERGROUNDING

Undergrounding a route also reduces visual impact. However the visual advantages of undergrounding have to be balanced against the additional cost to be borne by the community and maintenance issues which include inherent delays in re-establishing service after a fault.

At these locations where lines change from over head to underground infrastructure, the transmission line infrastructure can be visually bulky. An example of this infrastructure can be seen in ***Figure 7.2***.

Figure 7.2 Example of Overhead to Underground Transition Infrastructure

The point at which the transmission line connects to aboveground infrastructure requires a heavier in appearance set-up at the top of the pole than the remainder of the poles.

7.4 THE DESIGN OF ABOVE-GROUND STRUCTURES

Lattice transmission towers are sometimes highly visible and in these situations are generally considered a visual intrusion into the landscape. Pole type support structures are less visually disturbing and are considered less of a visual intrusion into the landscape.

In this case the proposed transmission line will be mounted on poles.

7.5 MICRO-SITING THE LOCATION OF PROPOSED POLES

Micro siting refers to the ability of the proponent to site the proposed poles in situations where they will minimise visual impact.

This may be on flatter areas and where line duplication occurs. In this situation if the poles were moved out of sync between the two transmission lines the visual impact would be increased through the additional visual clutter in the landscape.

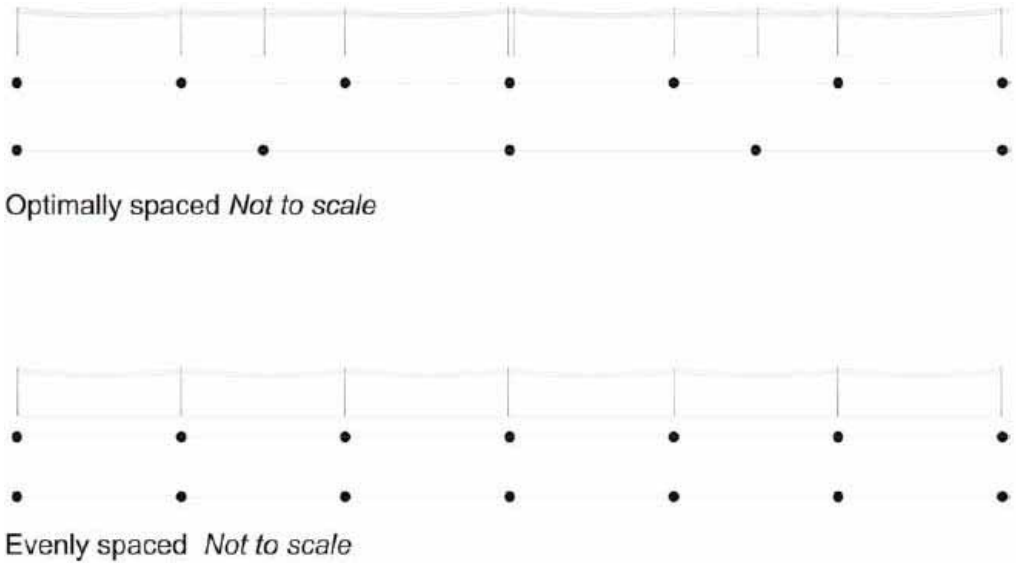

Figure 7.3 Pole Spacing Diagram

Where the transmission line passes through or nearby sensitive areas such as residential areas or wetlands, the poles may able to be spaced to minimise impact to these areas. This may be achieved by siting poles at property boundaries in residential areas, or behind existing vegetation in recreational/environmental areas.

Once the final route location is determined, micro siting of poles will be most beneficial where there are nearby residential areas or the transmission line is being duplicated or in residential areas.

This analysis is simplistic as the existing transmission lines may not be located at even centres and the landscape that they traverse is not flat, however the previous figures illustrate the possibility of utilising micro-siting options to reduce the visual impact from a nearby residence.

It is also not necessary or desirable for co-location to be mandatory along the entire route. In some places co-locating the towers and poles may make it difficult for the rural land holder to manage the land as these may create pinch points that restrict vehicular/stock movement or irrigation practices.

In some cases along the route such siting may reduce the visual impact from a residence, in other locations land owners may much prefer a reduced number of poles and therefore increased spans are desirable.

7.6 LANDSCAPE MITIGATION MEASURES

Landscape can also have the potential to reduce visual impact of overhead transmission lines.

A number of options are illustrated below which may be appropriate at different instances along the proposed transmission line route.

7.7 VEGETATION IN FRONT OF THE LINE

In this area of New South Wales, the native vegetation often reaches heights comparable to that of the proposed poles.

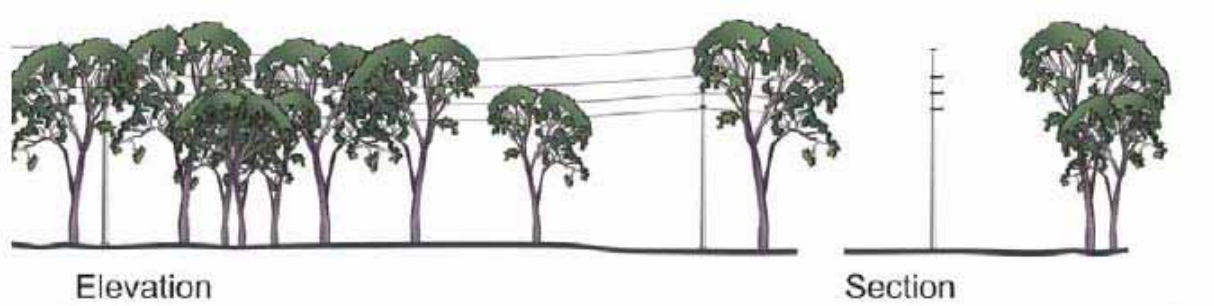

Figure 7.4 Vegetation in Front

In *Figure 7.4* vegetation between the proposed transmission lines and the viewer shows the potential to filter views of the poles and interconnecting wires.

7.8 TREE PLANTING BEHIND THE LINE

Vegetation behind the transmission line, while it does not screen the line from view as in *Figure 7.4* does prevent the poles and lines becoming silhouetted on the horizon and is an effective visual mitigation measure, see *Figure 7.5*.

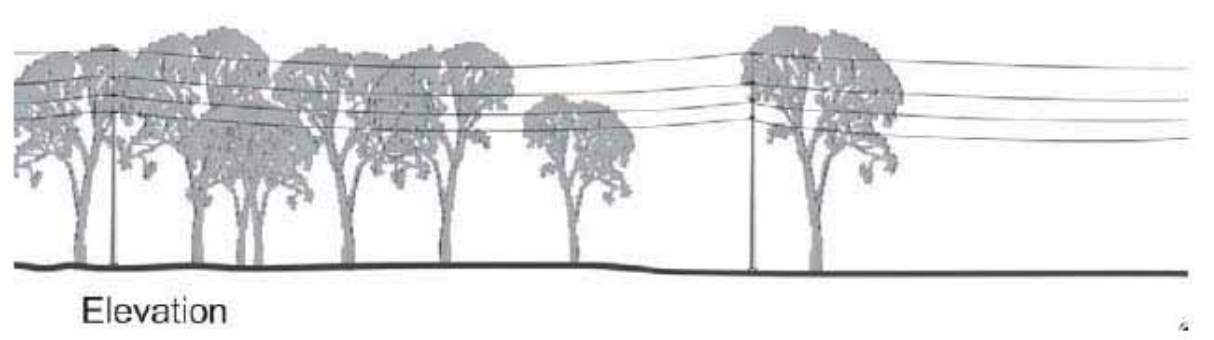

Figure 7.5 Vegetation Behind

This will be most effective in areas where there is existing mature vegetation or where there is sufficient room within the corridor to plant trees and other tall vegetation.

7.9 SMALLER PLANTING NEAR A VIEWER

When planted near the transmission poles, trees need to reach almost the height of the poles to screen them from view. However if planting is located closer to an observer it needs to reach only 2 – 3 m before it forms an effective screen as shown in *Figure 7.6*.

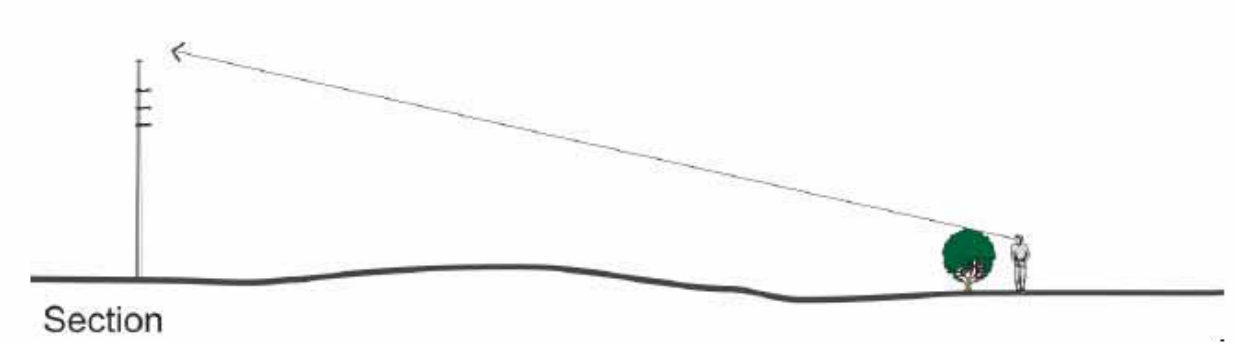

Figure 7.6 Vegetation near Viewer

This example is particularly appropriate immediately adjacent to residential viewpoints where the land owner does not like large trees or where there is insufficient space for their establishment.

7.9.1 Planting of Deciduous Trees

Deciduous trees can also be used to minimise the visual impact of towers and / or poles and lines. These deciduous trees may be more appropriate in some situations than the evergreen trees discussed previously as they allow greater winter sun penetration to adjacent areas in winter. Because these trees also reach greater heights than the shrubs illustrated in Figure 7.6, their ability to minimise the visual impact extends for a greater distance than the previous shrub example.

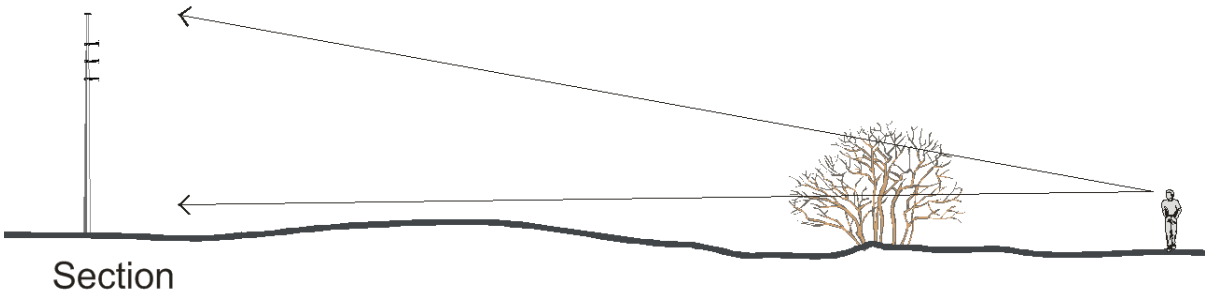

Figure 7.7 Planting of deciduous trees

In this example deciduous trees allow solar access while filtering views out to some distance from the trees.

7.9.2 Timing

Obviously, the establishment time for this type of tree planting will vary from site to site depending on climate, soil quality, rainfall and a range of other horticultural parameters. Therefore this report allows for between 5 and 20 years for the successful establishment of tree planting of this kind.

8 CONCLUSION

The Lismore to Mullumbimby Electricity Network Upgrade proposes to upgrade the existing electricity infrastructure within and existing transmission line corridor to support 132kV electricity infrastructure. There may be some route deviations along the length of the existing transmission line as well as pole location adjustments where new poles are installed within the existing corridor.

The landscape surrounding the proposed transmission line corridor contains many signs and types of electricity infrastructure including 11kV, 66kV and 132kV transmission lines. In many areas there are also street lights and other poles.

Many of the existing substations along the route will see some level of visual change, however to the untrained eye this work will appear as routine maintenance of the infrastructure.

The proposed location of the new Suffolk Park substation is located in a low lying cleared area that is already highly modified and contains many large sheds and transmission line infrastructure.

There are few residential properties that are oriented towards the new substation location. The majority of the existing residential dwellings in this location are surrounded by extensive tree canopy cover. If the visual impact of the proposed new substation in this location was considered to be of a high level of visual impact, then screening to the perimeter of the substation and within the affected residential lots will reduce the level of visual impact.

A detailed landscape plan is to be developed for the Ballina substation site following the completion of the substation design.

Although there may be a noticeable visual change, the transmission line infrastructure is already part of the existing landscape in many areas. To most viewers, the level of visual change associated with the modification to the existing transmission line corridor will be negligible.

Where a new or alternate transmission line is selected the visual impact to the surrounding area is likely to be higher to the introduction of a new change to the landscape. There are few locations where this will occur.

The majority of the work proposed as part of the Lismore to Mullumbimby Electricity Network Upgrade and outlined in this report will not be visually discernable to the untrained eye. Because the majority of the work is proposed within and along an existing transmission line corridor and the infrastructure is visually similar, the majority of the works outlined in this report will appear as routine maintenance of the existing infrastructure.

The overall visual impact will not represent an unacceptable level of visual change to the landscape surrounding the Lismore to Mullumbimby Electricity Network Upgrade.

Annex A

Parameters of Human Vision

PARAMETERS OF HUMAN VISION

The visual impact of a development can be quantified by reference to the degree of influence on a person's field of vision. The diagrams on the following pages illustrate the typical parameters of human vision. These provide a basis for assessing and interpreting the impact of a development by comparing the extent to which the development would intrude into the central field of vision (both horizontally and vertically).

Horizontal Cone of View

The central field of vision for most people covers an angle of between 50^O to 60^O. Within this angle, both eyes observe an object simultaneously. This creates a central field of greater magnitude than that possible by each eye separately.

This central field of vision is termed the 'binocular field' and within this field images are sharp, depth perception occurs and colour discrimination is possible.

These physical parameters are illustrated in the figure opposite.

The visual impact of a development will vary according to the proportion in which a development impacts on the central field of vision. Developments, which take up less that 5% of the central binocular field, are usually insignificant in most landscapes (5% of $50^O = 2.5^O$).

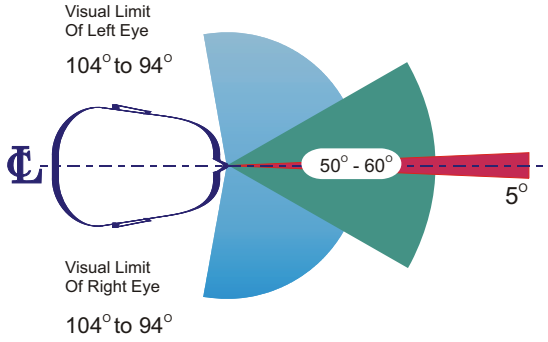

Figure A.1 Horizontal Field Of View

These calculations mean that a power pole approximately 5 m wide would reduce to insignificance at 115 m; a 10 m wide tower would be insignificant at 230 m as the power poles would form less than 5% or 2.5^O of the horizontal field of view.

It is obvious that power poles are still very apparent at this distance and that their height, rather than their width gives a better, and more conservative, measurement on which to base the viewshed.

Vertical Field of View

A similar analysis can be undertaken based upon the vertical line of sight for human vision.

The typical line of sight is considered to be horizontal or 0^O. A person's natural or normal line of sight is normally a 10^O cone of view below the horizontal and, if sitting, approximately 15^O.

Objects, which take up 5% of this cone of view (5% of $10^O = 0.5^O$) would only take up a small proportion of the vertical field of view, and are only visible when one focuses on them directly. However, they

are not dominant, nor do they create a significant change to the environment when such short objects are placed within a disturbed or man-modified landscape.

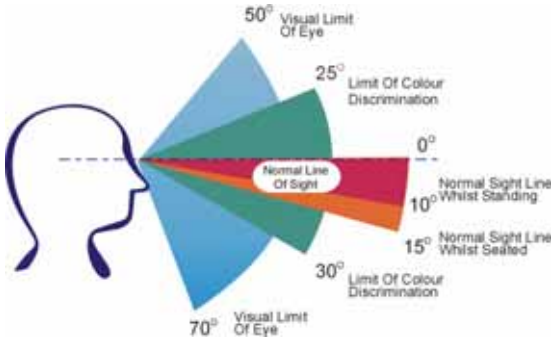

Figure A.2 Vertical Field Of View

The table below shows the relationship between impact and the proportion that the development occupies within the vertical line of sight.

Table A.2 Visual Impact based on the Vertical Field of View

Vertical Line of Sight	Impact	Distance from an observer to a 30 m high built form
< 0.5O of vertical angle	*Insignificant* A thin line in the landscape.	>3500 m
0.5O – 2.5O of vertical angle	*Potentially noticeable* The degree of visual intrusion will depend on the development's ability to blend in with the surroundings.	700 -3500 m
> 2.5O of vertical angle	*Visually evident* Usually visible, however the degree of visual intrusion will depend of the width of the object and its placement within the landscape.	< 700 m

These calculations suggest distances at which the magnitude of visual impact of the power poles is reduced with distance. At distances greater than 3.5 km, a fully visible 30 m high power pole would be an insignificant element within the landscape. At distances less than 1.4 km the power poles would be potentially noticeable and could dominate the landscape. To make this assessment more conservative a greater weighting has been given to power poles that are within 0.7 km of the towers

The zones of visual influence that have been used within this assessment are shown on T*able A3*.

Table A.3 Viewshed and zones of visual influence

Distance from an observer to the Power Poles	Zones of visual influence
>3.5 km	*Visually insignificant – outside the viewshed* A very small element which are difficult to discern and power poles will be invisible in some lighting or weather conditions.
0.7-3.5 km	*Potentially noticeable, but will not dominate the landscape.* The degree of visual intrusion will depend on the landscape sensitivity and the sensitivity of the viewer; however power poles do not dominate the landscape.
0.2 – 0.7 km	*Potentially noticeable and can dominate the landscape.* The degree of visual intrusion will depend on the landscape sensitivity and the sensitivity of the viewer
<0.2 km	*Highly visible and will usually dominate the landscape* The degree of visual intrusion will depend on the power poles placement within the landscape and factors such as foreground screening.

Annex B

Photographic Montages

EXISTING 66KV TRANSMISSION LINES

PROPOSED 132KV TRANSMISSION LINES

NOTES

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ERM

Environmental Resources Management Australia

VIEWPOINTS - North of Lennox Heads Looking South

VIEWPOINTS
LISMORE TO MULLUMBIMBY VIA BALLINA 132KV RING TRANSMISSION LINE UPGRADE

Project No:	0051706	Drawing No:	VP
Date:	11/08/08	Drawing size:	A1
Drawn by:	DC	Reviewed by:	HB

LISMORE RING

PREPARED FOR:
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EXISTING 66KV TRANSMISSION LINES

PROPOSED 132KV TRANSMISSION LINES

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VIEWPOINTS

VIEWPOINTS
LISMORE TO MULLUMBIMBY VIA BALLINA 132KV RING TRANSMISSION LINE UPGRADE

Project No:	0051706	Drawing No:	VP
Date:	11/08/08	Drawing size:	A1
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VIEWPOINTS - Tregeagle Road

VIEWPOINTS
LISMORE TO MULLUMBIMBY VIA BALLINA 132KV RING TRANSMISSION LINE UPGRADE

Project No:	0051706	Drawing No:	VP
Date:	11/08/08	Drawing size:	A1
Drawn by:	DC	Reviewed by:	HB

LISMORE RING

PREPARED FOR:
COUNTRY ENERGY

Annex N

Lismore to Mullumbimby Electricity Network Upgrade: Generic Assessment of Transmission Line Electric and Magnetic Fields

(Connell and Wagner 9 September 2008)

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Lismore to Mullumbimby Electricity Network Upgrade: Generic Assessment of Transmission Line Electric and Magnetic Fields

Country Energy

9 September 2008
Reference 36034
Revision 1

Document Control

Rev No	Date	Revision Details	Typist	Author	Verifier	Approver
0	25 Aug 08	Initial Draft Issue	PF	PF	DVB	LK
1	9 Sep 08	Initial Issue	DVB	PF	DVB	CV

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1. Introduction

1.1 Background

In order to meet both existing and future electricity demand in the Lismore/Ballina/Byron region on the New South Wales upper north coast, Country Energy is undertaking a major upgrade of its network in the area.

As part of Country Energy's overall assessment process in relation to the project, Connell Wagner has been engaged to assess the electric and magnetic fields (EMF) likely to be associated with the proposed 132,000 Volt (132kV) transmission lines. The purpose of this report is to address the general issues pertaining to transmission line EMFs, and to document site-specific assessments undertaken at five sites nominated by Country Energy.

The study area for the project is shown in Figure 1 below.

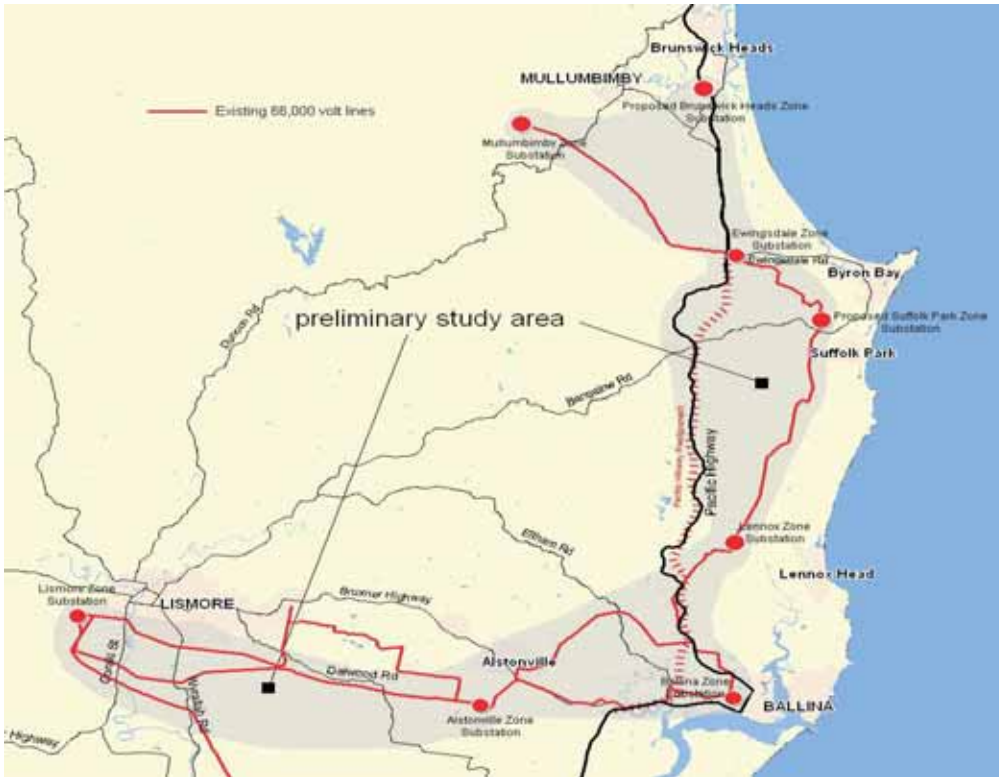

Figure 1: Area of assessment for proposed 132kV upgrade

1.2 Project description

The (April 2008) Line Route Options report for the project, prepared by ERM, indicates that the preferred option for the transmission lines component of the network upgrade is the replacement of a number of existing 66kV transmission lines with 132 kV lines and replacing a 66kV line between Alstonville and Lismore with a double circuit 66kV/132kV line.

Country Energy has advised that the proposed overhead lines will be of modern compact design, using single pole structures with line post insulators and that a short section of line in the Ewingsdale area will be of underground construction.

Typical examples of the proposed overhead and underground construction are shown in Figure 1.2. The calculations described later in this report are based on these construction types.

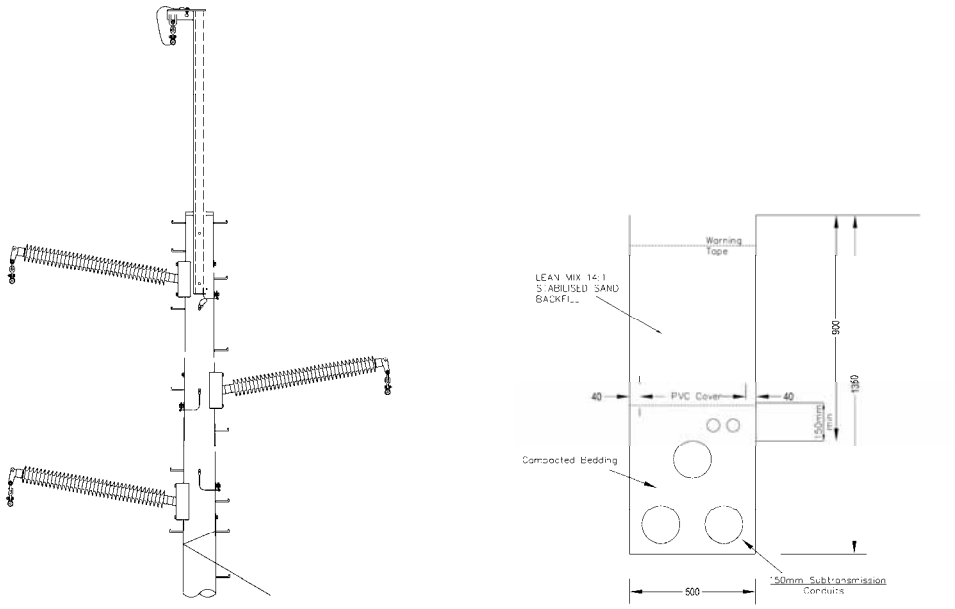

Figure 1.2 Proposed Overhead and Underground Construction (Typical)

1.3 Structure of Report

Section 2 provides background information on the EMF/Health issue and Section 3 discusses line loadings and documents relevant information supplied by Country Energy. The results of generic field calculations for the various lines are contained in Section 4, while Section 5 contains a review of specific sites. Section 6 addresses the matter of "prudent avoidance" and its application to the project and brief conclusions are presented in Section 7.

2. Overview of Electric and Magnetic Fields

An **electric field** is a region where electric charges experience an invisible force. The strength of this force is related to the voltage, or pressure, which forces electricity along wires.

Electric fields are strongest close to their source, and their strength diminishes rapidly with distance from the source, in much the same way as the warmth of a fire decreases with distance. Many common materials - such as brickwork or metal - block electric fields, so they are readily shielded and, for all practical purposes, do not penetrate buildings. They are also shielded by human skin, such that the electric field inside a human body will be at least 100,000 times less than the external field.

Being related to voltage, the electric fields associated with overhead lines remain relatively constant over time.

A **magnetic field** is a region where magnetic materials experience an invisible force produced by the flow of electricity or the current (amps). Because magnetic fields are related to the current rather than the voltage, high voltage equipment is not the only source of magnetic fields encountered in everyday life. In fact, modern life involves frequent contact with magnetic fields from a variety of sources such as appliances and electrical machinery.

The strength of a magnetic field depends on the size of the current (measured in amps), and decreases with distance from the source. While electric fields are blocked by many common materials, this is not the case with magnetic fields. This is one reason why power lines may contribute to the overall magnetic fields in the environment and why burying power lines will not necessarily eliminate these fields.

The magnetic field strength resulting from an electrical installation varies continually with time and is affected by a number of factors including:

- The total electrical load
- The size and nature of the equipment
- The design of the equipment
- The layout and electrical configuration of the equipment and its interaction with other equipment.

For an overhead line, the current flowing, the geometric configuration of the overhead wires, the ground clearance and, where there are other circuits nearby, the “phasing” of the circuits in relation to one another determine the magnetic field. In the case of an underground cable installation, the layout of the individual cables within the trench, the “phasing” of the individual circuits and the depth of burial can have a significant effect on the external magnetic fields.

2.1 The EMF Health Issue

Over the past 40 years, concerns have been expressed that the EMFs associated with electrical equipment might have adverse health effects. The issue has been the subject of extensive research throughout the world. To date, adverse health effects have not been established but the possibility that they may exist has not been ruled out.

The first studies into possible health effects from EMFs, in the late 1960s, were directed towards *electric fields* and, overall, gave generally reassuring results. In 1979, an epidemiological study of childhood cancers in Denver, Colorado first raised the possibility that there could be a relationship between *magnetic fields* and cancer. Although this study was relatively unsophisticated by today’s epidemiological standards, it created interest in the scientific and broader community and, over the following ten years, led to the redirection of research efforts towards magnetic fields.

Since the 1979 study, many thousands of papers have been published on EMFs and human health. However, answering the question "*do EMFs cause illness?"* is not a simple task. Research into EMFs and health is a complex area involving many scientific disciplines - from biology, physics and chemistry to medicine, biophysics and epidemiology. Also, the situation is further complicated by the fact that many of the health issues of interest to researchers are quite rare.

It is well accepted by scientists that no study considered in isolation will provide a meaningful answer to the question of whether or not EMFs can contribute to adverse health effects. In order to make an informed conclusion from all of the research, it is necessary to consider the science in its totality. Over the years, governments and regulatory agencies around the world have commissioned independent scientific review panels to provide such overall assessments.

The most recent scientific reviews by authoritative bodies are reassuring for most potential health issues. However, statistical associations between prolonged exposure to elevated magnetic fields and childhood leukaemia have persisted. This led the International Agency for Research on Cancer (IARC) (Ref 1) in 2001 to classify magnetic fields as a "possible carcinogen".[1]

In noting the association between exposure to elevated magnetic field levels and childhood leukaemia, it is important to recognise that a statistical association does not necessarily reflect a cause and effect relationship.

The fact that, despite over 25 years' laboratory research, no mechanism for an effect has been identified, lends weight to the possibility that the observed associations reflect some factor other than a causal relationship. This point is made in the 2001 report of the UK National Radiological Protection Board's (NRPB) Advisory Group, chaired by eminent epidemiologist, the late Sir Richard Doll (Ref 2).

> *"in the absence of clear evidence of a carcinogenic effect in adults, or of a plausible explanation from experiments on animals or isolated cells, the evidence is currently not strong enough to justify a firm conclusion that such fields cause leukaemia in children"* (page 164).

The bulk of the electric and magnetic fields/health interest and research over the past 20 years has been directed towards magnetic rather than electric fields. For this reason, the focus of this assessment is also on magnetic fields.

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[1] *IARC publishes authoritative independent assessment by international experts of the carcinogenic risks posed to humans by a variety of agents, mixtures and exposures. These agents, mixtures and exposures are categorised into 5 groups, namely:*

- ***Group 1** -the agent is carcinogenic to humans-88 agents are included in the group, including asbestos, tobacco and gamma radiation;*
- ***Group 2A** - the agent is probably carcinogenic - 64 agents have been included in this group, including diesel engine exhaust, UV radiation and formaldehyde;*
- ***Group 2B** - the agent is possibly carcinogenic to humans - 236 agents have been included in this group, including coffee, gasoline, lead, nickel, engine exhaust and extremely low frequency magnetic fields;*
- ***Group 3** - the agent is not classifiable as to carcinogenicity - 496 agents have been included in this group;*
- ***Group 4** - the agent is probably not carcinogenic to humans - only 1 agent has been included in this group.*

2.2 Health Standards

The relevant Australian health standard has been the document called 'Interim Guidelines on Exposure to 50/60 Hz Electric and Magnetic Fields' (1989) (Ref 3). The document was issued by the National Health and Medical Research Council (NHMRC) and was based on guidelines developed by the International Non-ionising Radiation Committee of the International Radiation Protection Association (IRPA) (Ref 4). IRPA has since been replaced by the International Commission on Non-ionising Radiation Protection (ICNIRP). While the authors of the above guidelines considered the then epidemiological and laboratory studies regarding electric and magnetic fields and cancer, they considered that the available data did not provide any basis for health risk assessment useful for the development of exposure limits. The exposure limits in the guidelines are based primarily on established or predicted effects related to the flow of electric current within the body. They are not intended to define safe limits for possible health effects, should these exist, from fields at strengths normally found in the vicinity of electrical equipment.

In the case of magnetic fields, the guidelines stipulate a limit of 1000 milligauss for general public exposure for up to 24 hours per day. The corresponding limit for electric fields is 5000 Volts/metre (5kV/metre).

Because the NHMRC has not updated its guidelines since their original issue, they have lapsed and the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) is currently reviewing them. The ICNIRP guidelines, upon which the NHMRC guidelines are based, have been reviewed twice (1993 and 1999) and the 24-hour exposure limits for the general public remain unchanged (1000 milligauss and 5000 Volts/metre).

In December, 2006, ARPANSA issued a Draft Standard on "Exposure Limits for Electric and Magnetic Fields (0Hz to 3kHz) for public comment. The Draft Standard proposes a 24-hour exposure limit (Reference Level) for the general public of 1000 milligauss - i.e identical to both the previous (Australian) NHMRC Guidelines and the current (International) ICNIRP Guidelines.

In the Foreword to the ARPANSA Draft, the CEO of ARPANSA, Dr John Loy notes that *"the incorporation of arbitrary additional safety factors beyond the limits of the Standard is not supported"*.

2.3 Prudent Avoidance

With regard to the potential health effects from magnetic fields, while compliance with the relevant guideline is important, it does not imply a level of 'safety'. The possibility of health effects has been comprehensively studied over several decades worldwide but, to this day, there is no clear understanding of whether or not electric or magnetic fields pose a threat to human health.

Since the late 1980s, many reviews of the scientific literature have been published by authoritative bodies. There have also been a number of 'Inquiries' such as those by Sir Harry Gibbs in NSW (Ref 5) and Professor Hedley Peach in Victoria (Ref 6). These reviews and inquiries have consistently found that:

- Adverse health effects have not been established.
- The possibility cannot be ruled out.
- If there is a risk, it is more likely to be associated with the magnetic field than the electric field.

Both Sir Harry Gibbs and Professor Peach recommended a policy of prudence or prudent avoidance, which Sir Harry Gibbs defined as doing what can be done at modest cost and without undue inconvenience to avoid a possible risk.

More recently (1999) the (US) National Institute of Environmental and Health Sciences (Ref 7) found:

> *In summary, the NIEHS believes that there is weak evidence for possible health effects from ELF-EMF exposures, and until stronger evidence changes this opinion, inexpensive and safe reductions in exposure should be encouraged. (page 38)*

The practice of 'prudent avoidance' has been adopted by the Energy Supply Association of Australia (ESAA) and most Australian power utilities, including Country Energy.

Given the inconclusive nature of the science and the ongoing possibility of adverse health effects, it is considered that a prudent avoidance approach continues to be the most appropriate response in the circumstances. Under this approach, subject to modest cost and reasonable convenience, power utilities should design their facilities to reduce the intensity of the fields they generate, and locate them to minimise the fields that people, especially children, encounter over prolonged periods. While these measures are prudent, it cannot be said that they are essential or that they will result in any benefit.

In the Australian context, the Draft ARPANSA Standard addresses the mater of prudent avoidance in an Annex entitled *"A Public Health Precautionary Approach to ELF Fields".* The Annex states:

> *[Prudent avoidance] "does not imply setting exposure limits at an arbitrarily low level, and requiring that they be achieved regardless of cost, but rather adopting measures to reduce public exposure to ELF fields at modest cost."*

Section 5.7 of the Draft addresses "Protection of the General Public" and relevantly stipulates:

> *"Measures for the protection of the general public who may be exposed to ELF and/or static fields due to their proximity to high ELF and/or static sources must include the following: …… Minimising, as appropriate, ELF and/or static electric and magnetic field exposure, provided this can be readily achieved without undue inconvenience and at reasonable expense. Any such precautionary measures should follow good engineering and risk minimisation practice. ……The incorporation of arbitrary additional prescriptive safety factors beyond the exposure limits of this Standard is not supported."*.

Internationally, the World Health Organisation has also addressed the notion of prudence or precaution and this work has been taken into account by ARPANSA in framing its Draft Standard.

Commentary on the application of prudent avoidance to the current project is contained in Section 6 below.

3. Line Loadings and Input Information

3.1 Dependence on Load

During a typical day, the amount of load current in a transmission line will vary substantially between a daily minimum, generally in the early hours of the morning and a daily maximum at times of peak demand. Loadings also vary seasonally during the year, generally reaching a peak in summer. Loads also tend to grow slowly over time, due to population growth and other factors. It is these various actual loadings which are relevant in the health context, rather than the maximum capacity of the line, which may only be required for very short periods, under emergency conditions, a few times over its service life.

3.2 Line Loadings Used for Modelling

The magnetic fields from the proposed lines will vary over time, and also spatially, depending on the loadings, both on the proposed lines and on nearby circuits, at the particular time.

Accordingly, in characterising the magnetic fields, it is necessary to make practical assumptions regarding the above factors.

Given that the epidemiological associations which underpin concerns regarding EMF tend to relate to elevated "***average***" magnetic fields, of the various hypothetical conditions one could select for magnetic field characterisation, the most meaningful is to take the long term average load and link this to conservative assumptions regarding other factors. The magnetic fields derived under these conditions are the most appropriate for consideration in the context of the magnetic field/health literature. This approach has been followed, as noted below:

3.3 Information Provided by Country Energy

To establish the line loadings to be used for the study, the Country Energy Network Planning Department provided information on:

- Forecast yearly peak loadings on the lines;
- Annual load profiles; and
- The way in which the lines will be configured and operated.

This, and other relevant information supplied by Country Energy, served as the basis for the EMF assessment. Salient points are set out below:

- The lines will be constructed predominantly using single pole structures as shown in Figure 1.2.
- The poles will typically be 21 metres in length;
- The existing 66kV line between Lismore and Alstonville will be reconstructed as a double circuit 132kV line, with one circuit operating at 66kV and one circuit operating at 132kV;
- It is expected that a short section of line will be of underground construction;
- Where installed, the underground cables will be in PVC ducts with a minimum depth of cover of 900mm;
- Overhead conductors will be designed to achieve the following minimum ground clearances at their design maximum operating temperature:
  - Over normal ground: 7.3 metres;
  - Over roadways: 8 metres;
  - Over cane fields 10 metres;
  - Over cane loading areas: 15 metres.
- The anticipated peak (system normal) loading in the lines prior to the introduction of 132kV, following commissioning at 132kV and in the longer term (2027) are set out in Table 3.1.

- Under abnormal emergency conditions, the line loadings could be approximately two to three times those shown in Table 3.1.
- The 85th percentile load, i.e. the load which will be exceeded for not more than 15% of the time is expected to be some 69% of the annual peak;

Line	2011/12 (66kV)	2011/12 (132kV except 0897 & 8507)	2015 (All 132kV except 0897)	2027 (All 132kV except 0897)
8505 Mullumbimby - Ewingsdale	318	241	142	221
8508 Ewingsdale – Suffolk Park	138	163	45	70
8504 Lennox Head - Ballina	44	52	85	124
8507 Ballina - Alstonville	160	65	-	-
0897 (remains 66kV) Lismore - Alstonville	255	172	121	181
98507 (132kV) Lismore - Ballina	-	-	168	224

Table 3.1: Predicted 66kV & 132kV Peak Line Loadings Advised by Country Energy (Amps)

In some places, local 11kV distribution lines are co-located on the structures which carry the 66kV lines.

The relevant 11kV lines and their predicted loadings, as advised by Country Energy are set out in Table 3.2 below.

11kV Line	2011/12	2011/12 after 132kV Commissioned	2027 (132kV)
ED 3B5 Bangalow	210	210	300
ED 3B10 Broken Head	312	10	30
Bal 3B2 CBD West	152	152	300

Table 3.2: Predicted 11kV Peak Line Loadings Advised by Country Energy (Amps)

4. Field Characterisation

4.1 Approach Taken for this Generic Assessment

In undertaking this generic assessment, we have modelled the EMF likely to be associated with the proposed infrastructure and compared it with the existing EMF environment due to the existing infrastructure along the various sections of line route. As the staging of the work will take place over several years, we have used 2012, immediately prior to the commissioning of the first 132kV circuits, as a baseline and then modelled the 132kV lines on a short term basis (2012 or 2015 as appropriate) and in the long term (2027). As some of the lines will be progressively cut and turned in to new substations, in undertaking the modelling, we have selected a representative sample of the more heavily loaded line sections as the basis of our assessment.

The sections of line route studied are listed below, together with descriptions of their present construction types:

- 8505: Mullumbimby – Ewingsdale (predominantly wishbone construction)
- 8508: Ewingsdale – Suffolk Park (predominantly offset line post construction)
- 8504: Lennox Head – Ballina (partly wishbone and partly offset line post construction
- 8507: Ballina – Alstonville (predominantly offset line post construction)
- 0897: Lismore – Alstonville (predominantly wishbone construction)
- 98507: Lismore – Alstonville 132kV (to be constructed as a double circuit 66/132kV between Lismore and Alstonville, on the route of the existing 0897 Lismore – Alstonville 66kV line and, as a single circuit replacing the 8507 Ballina- Alstonville 66kV line, from Alstonville to Ballina.)

4.2 Magnetic Fields Under Normal Operating Conditions

Based on the available design and loading information, provided by Country Energy, a series of typical field profiles have been calculated to provide an understanding of the magnetic fields likely to be associated with the proposed lines, as noted above.

The modelling has been carried out using established engineering techniques, which are used internationally, have been validated by field measurements and are known to produce accurate results provided that the underlying assumptions (as discussed above) are valid. In all cases, fields have been calculated at a height of 1 metre above ground in accordance with the international practice.

As noted in 4.1 above, the scenarios modelled were:

a) In 2012 with the existing 66kV lines in operation;
b) In 2012/2015 as applicable, following commissioning at 132kV;
c) In the long term, around 2027.

The results of the modelling are shown graphically in Figures 4.1 to 4.5 for each of the five line sections modelled. For each section of line, separate curves are shown for each of scenarios a to c and, where appropriate, a curve showing the fields associated with the underground section under the 2012 scenario is also included.

4.2.1 8505 route between Mullumbimby and Ewingsdale

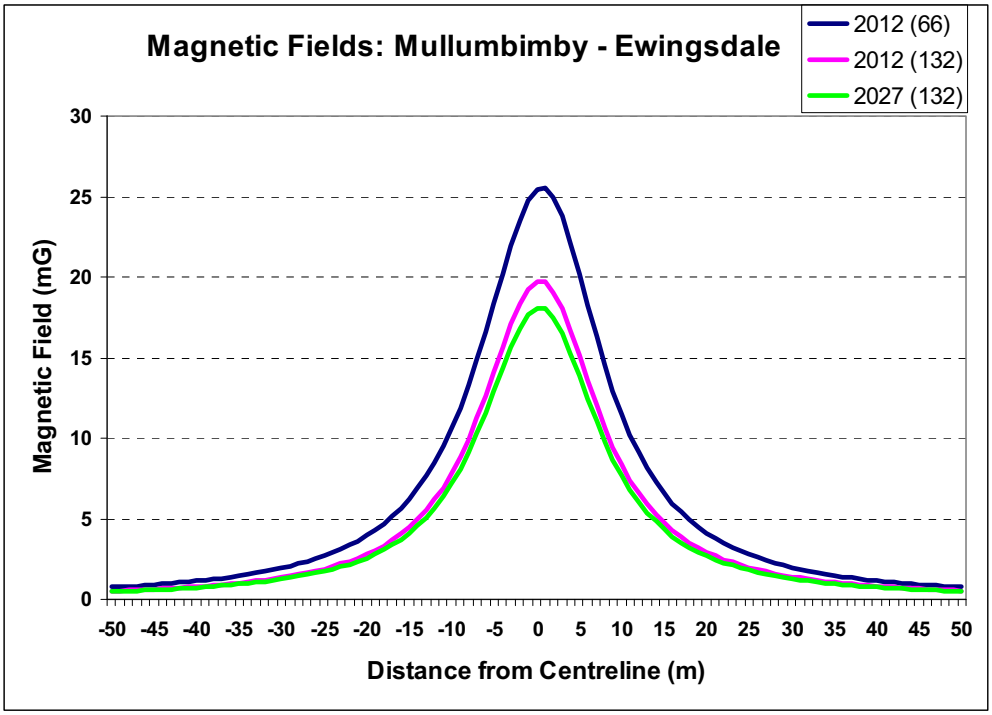

Figure 4.1: 8505 route between Mullumbimby and Ewingsdale

The following observations are made in respect of the results shown in Figure 4.1:

- In 2012, with the system still operating at 66kV, the magnetic field directly under the line will be approximately 25 milligauss. Following commissioning of the 132kV, the field directly under the line will decrease to approximately 20 milligauss, decreasing to less than 5 milligauss at 15 metres and 2 mG at 25 metres;
- Between 2012 and 2027 the magnetic fields will decrease by a further 10% due to a similar decrease in the load carried by the line.

4.2.2 8508 route between Ewingsdale and Suffolk Park

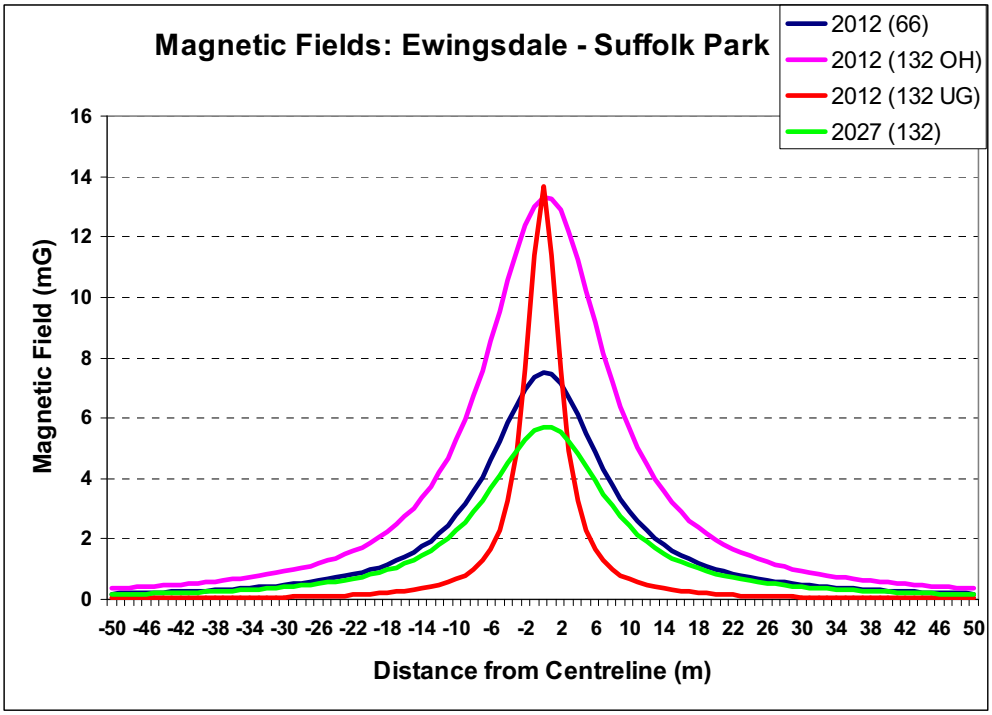

Figure 4.2: 8508 route between Ewingsdale and Suffolk Park

The following observations are made in respect of the results shown in Figure 4.2:

- In 2012, with the system still operating at 66kV, the magnetic field directly under the line will be 7.5 milligauss. Following commissioning of the 132kV, the field directly under the line will increase to approximately 14 milligauss, decreasing to 3 milligauss at 16 metres and 2 mG at 20 metres;
- In 2027 the magnetic fields will be less than 50% of those in 2012, due to a decrease in the load carried by the line. (Although not evident from the curves, in 2015, the magnetic field levels will actually decrease by approximately 70% due to the completion of the 132kV ring, but subsequently, as a result of progressive load growth, will gradually increase to the 2027 figure shown on the curve.);
- Because part of the new line route will be of underground construction, a profile of the magnetic field produced by a 132kV underground cable carrying the 2012 load has also been included in Figure 4.2. It can be seen that the magnetic field directly above the cable is very similar to that directly below the 132kV overhead line, but it drops off more rapidly as one moves away from the cable, decreasing to less than 1 mG within 8 metres.

4.2.3 8504 route between Lennox Head and Ballina

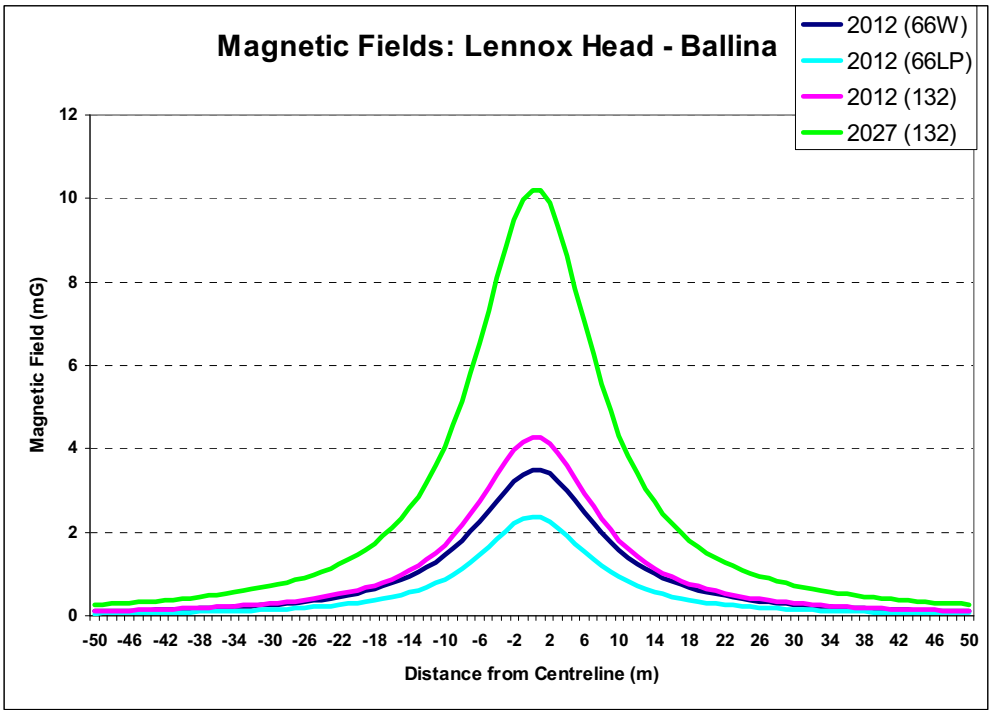

Figure 4.3: 8504 route between Lennox Head and Ballina

The following observations are made in respect of the results shown in Figure 4.3:

- Because the existing 66kV line comprises a mixture of construction types, we have modelled both a "wishbone" construction and a more modern construction using line post insulators. The magnetic fields associated with both construction types are shown in Figure 4.3 and it is readily apparent that the fields produced by the more compact "line post" construction are some 30% lower than those associated with the "wishbone" construction.
- In 2012, with the system still operating at 66kV, the magnetic field directly under the line will be 3.5 milligauss in the vicinity of 66kV "wishbone" construction and 2.4 mG where 66kV line post construction has been used. Following commissioning of the 132kV line, which will use modern line post construction throughout, the field directly under the line will increase to 4.3 milligauss but, within 16 metres, will drop off to be less than 1 mG;
- Between 2012 and 2027 the magnetic fields will more than double, due to a similar increase in the load carried by the line.

4.2.4 8507 Route between Ballina and Alstonville

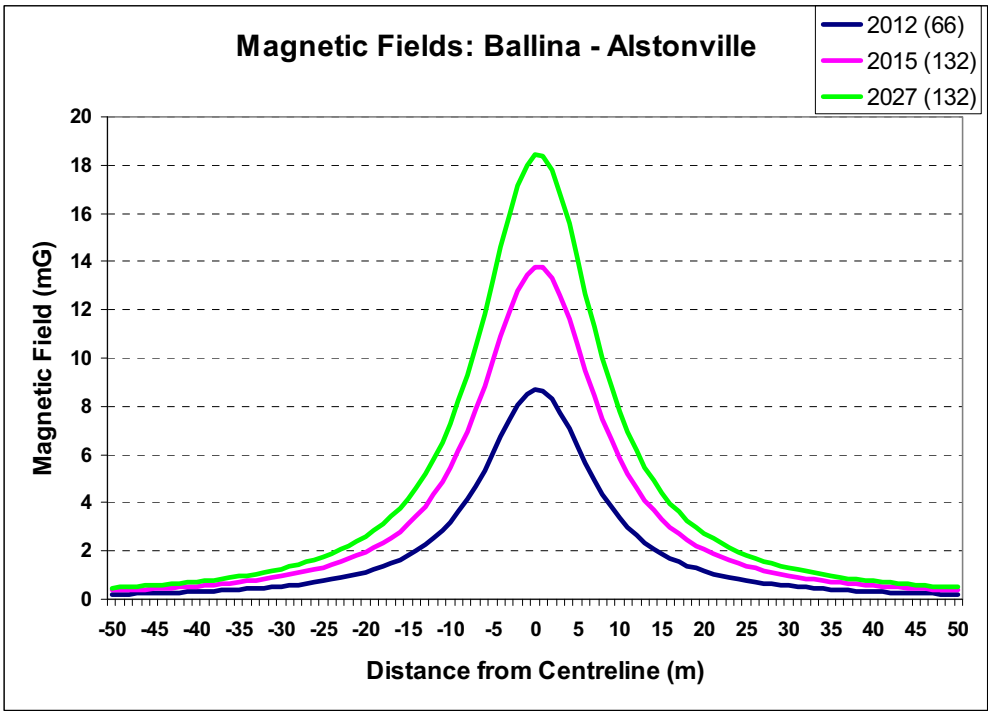

Figure 4.4: 8507 Route between Ballina and Alstonville

The following observations are made in respect of the results shown in Figure 4.4:

- In 2012, with the system still operating at 66kV, the magnetic field directly under the line will be 8.7 milligauss. Following commissioning of the 132kV in 2015, the field directly under the line will increase to approximately 14 milligauss, decreasing to 3 milligauss at 16 metres and 2 mG at 20 metres;
- Between 2012 and 2027 the magnetic fields will increase by approximately 33% due to a similar increase in the load carried by the line.

4.2.5 98507 66/132kV Double Circuit between Lismore and Alstonville

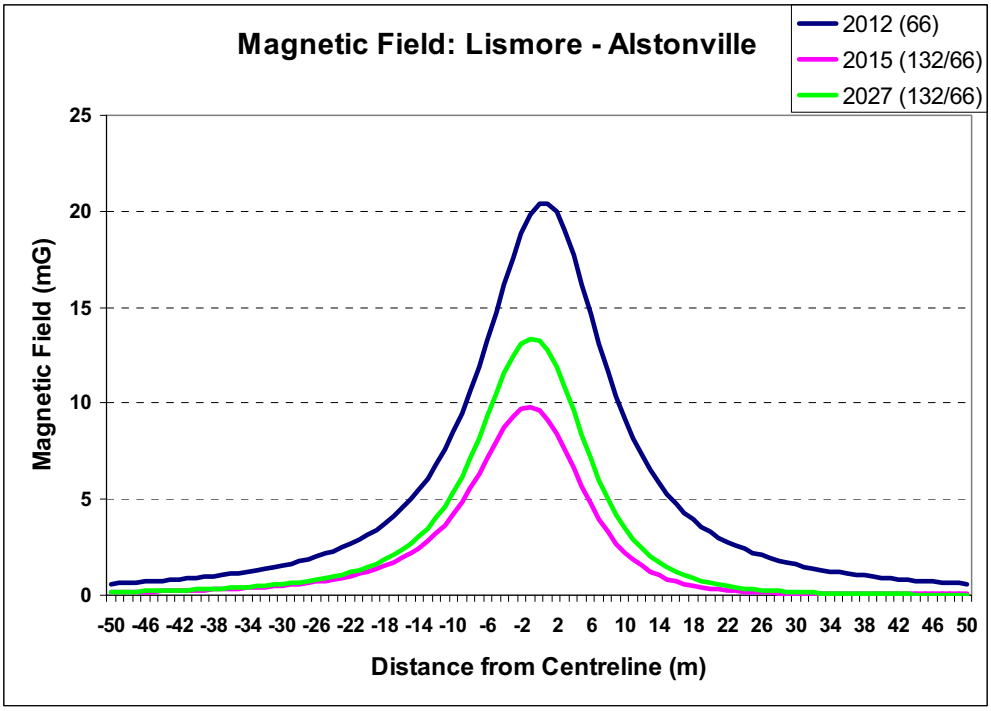

Figure 4.5: 98507 66/132kV Double Circuit between Lismore and Alstonville

The following observations are made in respect of the results shown in Figure 4.5:

- In 2012, with the system still operating at 66kV, the magnetic field directly under the line will be approximately 20 milligauss. Following commissioning of the double circuit 132/66kV line in 2015, the field directly under the line will decrease to approximately 10 milligauss, decreasing to 2 milligauss at 16 metres and 1.2 mG at 20 metres;
- Between 2012 and 2027 the magnetic fields will increase by approximately 35% due to load growth;
- Due to the current in the 132kV circuit being higher than that in the 66kV circuit, the magnetic fields will tend to be higher on the 132kV side of the line than the 66kV side.

4.3 Magnetic Fields Experienced Intermittently

While the field levels presented in Section 4.2 are the most relevant in the health context, in the broader context of an environmental assessment, it also appropriate to recognise the possibility that, for the single circuit sections, fields two to three times the level of those modelled could be experienced in some places for short periods over the life of the lines. Such situations would rarely arise over the life of the lines and would not be expected to be of prolonged duration.

In considering both this matter and the fact that the fields directly underneath the overhead lines are quite localised, it is important to recognise that life in the modern world involves moving from one source of magnetic fields to another. The intermittent fields, which may be experienced for short

periods of time in the vicinity of an overhead line, are analogous to those we experience in everyday life. To put this into perspective, the Energy Networks Association (ENA) (Ref 8) has published a series of typical magnetic field levels associated with particular appliances at normal user distance. These are set out in Table 4.1 below:

	Typical Measurement (mG)	Range of Measurements (mG)
Stove	6	2-30
Computer	5	2-20
TV	1	0.2-2
Electric Blanket	20	5-30
Hair Dryer	25	10-70
Refrigerator	2	2-5
Toaster	3	2-10
Kettle	3	2-10
Fan	1	0.2-2

Table 4.1: Magnetic Field Levels Associated with Appliances

From the above range of fields, it can be seen that the magnetic field exposures likely to be experienced intermittently as a result of the proposed lines are consistent with the range encountered in everyday life.

4.4 Electric Fields

The electric field under the proposed 132kV lines will be less than 1kV/metre, reducing to 300 volts/metre within 15 metres. These levels are, respectively, 20% and 6% of the relevant guideline levels and, in practice, are likely to be even lower, due to the effects of shielding. Accordingly, electric fields are not addressed further in this report.

5. Review of Specific Sites

5.1 General

As well as undertaking a generic assessment, we have been asked to direct our attention to five specific sites as follows:

- Residential Subdivision and Proposed Hospital, Ewingsdale;
- Skinners Shoot Road/Yagers Lane;
- Barlows Road, Ballina;
- House with no Steps, 253 Wardell Road Alstonville; and
- Rural Property, Muller Road, Alstonville

Our reviews of the five nominated sites are set out in the following sections.

5.2 Residential Subdivision and Proposed Hospital, Ewingsdale

This is a residential subdivision site located between Ewingsdale and Suffolk Park and is crossed by the existing 8508 66kV line. The route is also adjacent to the site of a proposed hospital. In developing the 132kV project, it is understood that Country Energy proposes to replace the 66kV overhead line with a 1.6 km section of underground cable, located on private property for part of its length, with the remainder in the road reserve.

We are advised that, at its nearest approach, the 132kV underground cable route will be 40 metres from the nearest proposed hospital building.

We are also advised that the existing 66kV overhead line is 6, 7 & 8.7 metres from the nearest 3 residences and that the proposed 132kV underground cable will be 14 metres from the nearest residence.

Although the magnetic field profiles contained in Figure 4.2 are broadly representative of this site, there are also 11kV circuits in the vicinity. Accordingly, these have also been considered in the modelling upon which the following assessment has been based. The magnetic fields at the hospital and the nearest residence before and after commissioning of the 132kV line are shown in Table 5.1.

Location	2011/12 (66kV)	2011/12 (Following Commissioning of 132kV Cables)	2027
Nearest proposed hospital building	Less than 1 mG	Less than 0.1 mG	Less than 0.1 mG
Nearest residence	14 mG	Less than 1 mG	Less than 1 mG

Table 5.1: Subdivision at Ewingsdale

In respect of the hospital, it can be seen that the field at the nearest proposed building is negligible and will be more so following commissioning of the 132kV cables.

In respect of the nearest residence(s), the 2012 magnetic field due to the existing infrastructure will be 14 mG, but this will decrease to a negligible level following commissioning of the 132kV cables.

5.3 Skinners Shoot Road/Yagers Lane

This area is located between Ewingsdale and Suffolk Park, adjacent to the existing 8508 66kV line and has been selected for specific assessment because it is an example of the line route passing through an area of scattered rural residential properties.

We are advised that the existing 66kV overhead line is 25 metres from the nearest residence and have based our assessment on the assumption that the proposed 132kV line will follow the same route.

Although the magnetic field profiles contained in Figure 4.2 are broadly representative of this site, there is also an "underbuilt" 11kV circuit on the existing 66kV structures. It is understood that this 11kV circuit will continue to be "underbuilt" on the proposed 132kV line. Accordingly, its influence has also been considered in the modelling upon which the following assessment has been based. The magnetic fields at the nearest residence before and after commissioning of the 132kV line are shown in Table 5.2.

Location	2011/12 (66kV)	2011/12 (Following Commissioning of 132kV)	2027
Nearest residence	1.7 mG	1.3 mG	Less than 1 mG

Table 5.2: Skinners Shoot Road/Yagers Lane Site

It can be seen that the magnetic fields at this residence are already low and will be even lower following commissioning of the 132kV line.

5.4 Barlows Road, Ballina

This area is located between Alstonville and Ballina adjacent to the existing 8507 66kV line and has been selected for specific assessment because it contains a mixture of residential, commercial and light industrial premises. The existing line runs along the western side of Barlows Road, some 5-10 metres outside several residential back yards and also passes over the corner of a concrete batching plant. Country Energy proposes to relocate the 132kV line to be clear of the concrete batching plant, with its associated heavy vehicle manoeuvring areas. The 132kV line will also be moved to a low lying area on the opposite side of Barlows Road from the existing route to increase its separation from the residential premises.

We are advised that the existing 66kV overhead line is 7 metres from the nearest residence and that the proposed 132kV line will be approximately 20 metres away.

Although the magnetic field profiles contained in Figure 4.4 are broadly representative of this site, there is also an "underbuilt" 11kV circuit on the existing 66kV structures. It is understood that this 11kV circuit will continue to be "underbuilt" on the proposed 132kV line. Accordingly, its influence also been considered in the modelling upon which the following assessment has been based. The magnetic fields at the nearest residence before and after commissioning of the 132kV line are shown in Table 5.3.

Location	2011/12 (66kV)	2011/12 (Following Commissioning of 132kV)	2027
Nearest residence	6.4 mG	1.3 mG	1.6 mG

Table 5.3: Barlows Road, Ballina

It can be seen that, largely as a result of the line's relocation to the opposite side of Barlows Road, there will be a five-fold decrease in the magnetic field at the nearest residence following commissioning of the 132kV line. By 2027, this will have increased by 25% due to load growth but will still be very low and only 25% of the level immediately prior to commissioning of the 132kV.

5.5 House with no Steps, 253 Wardell Road Alstonville

This area is located between Alstonville and Ballina adjacent to the existing 8507/8503 dual circuit 66kV line and has been selected for specific assessment because, being a workshop for people who are intellectually or physically challenged, it is considered to be of special interest to the wider community. The existing dual circuit 66kV line will be replaced with a dual circuit line constructed to 132kV standards. The upgraded 8507 circuit will be energised at 132kV while the 8503 circuit will continue to operate at 66kV.

We are advised that the existing double circuit 66kV line is 58 metres from the nearest processing building on the property (de-husking shed) and that the proposed 132kV line will follow the same route.

Site specific calculations performed for this location indicate that, due to the 58 metre separation, the existing magnetic fields would be negligible. Following commissioning of the 132kV, they will increase somewhat but, even in 2027, will be less than 0.5 milligauss, which is still considered negligible.

5.6 Rural Property, Muller Road, Alstonville

This property, which is located between Alstonville and Lismore, contains a dwelling which is located between two of the existing 66kV lines (0897 and 8501).

We are advised that the distance from the nearest part of the dwelling to the 0897 line is approximately 50 metres while the 8501 line is approximately 35 metres away. The 0897 line is to be reconstructed as a double circuit 132/66kV line.

It is understood that Country Energy has recently undertaken magnetic field measurements on the property. While these measurements are useful, it should be noted that they represent a snapshot in time and, in the absence of other EMF sources, such as household wiring or appliances, are likely to be lower than the predicted fields because the latter make conservative assumptions regarding line loadings. Accordingly, some caution should be exercised in comparing them with predictions.

This site has been reviewed by reference to Figure 4.5. The predicted magnetic fields at the corners of the house nearest to the 0897 and 8501 feeders respectively, before and after commissioning of the 132kV line, are shown in Table 5.6, along with the results of the recent measurements.

Location	Recent Measurements	2011/12 (66kV)	2011/12 (Following Commissioning of 132kV)	2027
Corner of house nearest 0897	1 mG	Less than 1 mG	Less than 1 mG	Less than 1 mG
Corner of house nearest 8501/1	1 mG	Less than 1 mG	Less than 1 mG	Less than 1 mG

Table 5.5: Rural Property, Muller Road, Alstonville

It can be seen that, due to the extent of the separation between the subject residence and both of the lines crossing the property, the existing and future magnetic fields are expected to be less than 1 mG, which is considered negligible.

6. Prudent Avoidance

Given the inconclusive nature of the science and the ongoing possibility of adverse health effects, it is considered that a prudent avoidance approach continues to be the most appropriate response in the circumstances. Under this approach, subject to modest cost and reasonable convenience, power utilities should configure their facilities to reduce the intensity of the fields they generate and locate them to minimise the fields that people, especially children, experience over prolonged periods. While these measures are prudent, it cannot be said that they are essential or that they will result in any benefit.

The available information regarding the proposed lines has been reviewed against criteria which can be regarded as good practice in the application of prudent avoidance, recognising that, at this stage, design details are preliminary. It is noted that Country Energy has taken the following steps:

- Selected a reasonably compact geometry for the proposed 132kV lines, thereby reducing the magnetic fields they will produce;
- Selected a trefoil configuration for the proposed underground section, thereby reducing the magnetic fields;
- Indicated its intention to locate the proposed 98507 132kV line on the opposite side of Barlows Road, Ballina to the existing 8507 line thereby increasing the separation from residential premises.
- Consistent with Country Energy's policy of prudent avoidance, where the proposed 132 line between Lismore and Alstonville will share double circuit construction with the existing 66kV line, it is understood that the phasing of the two circuits will be arranged as far as practicable to achieve reduced magnetic fields.
- Indicated its intention to share information openly regarding the EMF/health issue and the proposed line.

Each of these measures is consistent with the notion of prudent avoidance.

7. Conclusions

The transmission line magnetic fields likely to be associated with the proposed Mullumbimby 132kV Ring Project have been assessed on the basis of the information currently available. The findings of the assessment are:

- Even directly underneath the lines, the magnetic fields will normally be less than 2% of the relevant health guideline.
- The magnetic fields will decrease quite rapidly as one moves away from the lines.
- Although there is some variability from circuit to circuit, overall, the magnetic fields associated with the proposed 132kV lines will be of similar magnitude to those associated with the existing 66kV lines.
- The electric fields associated with the lines will be less than 20% of the relevant health guideline, decreasing to 6% within 15 metres.
- The actual electric fields are likely to be further reduced due to the effects of shielding by vegetation etc.
- The fields at the nearest residences in the residential subdivision at Ewingsdale and in Barlows Road, Ballina, will be reduced significantly as a result of the proposed works.
- The fields at the other sites nominated for detailed study are already negligible, and will continue to be so following the proposed works.

8. References

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4. International Commission on Non-Ionising Radiation Protection (1998): Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300GHz): Health Physics, April 1999, Volume 74, Number 4; pp 4494-5528.

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