Delta electricity

Appendix E
Noise & Vibration Assessment

Marulan Gas Turbine Facility

Environmental Assessment

PROJECT APPLICATION

VOLUME 2	APPENDICES	August 2008

URS

DELTA ELECTRICITY
GAS TURBINE FACILITY AT MARULAN

NOISE AND VIBRATION ASSESSMENT

ACOUSTICS AND AIR

REPORT NO. 05255
VERSION G

WILKINSON MURRAY

DELTA ELECTRICITY
GAS TURBINE FACILITY AT MARULAN

NOISE AND VIBRATION ASSESSMENT

REPORT NO. 05255
VERSION G

JULY 2008

PREPARED FOR

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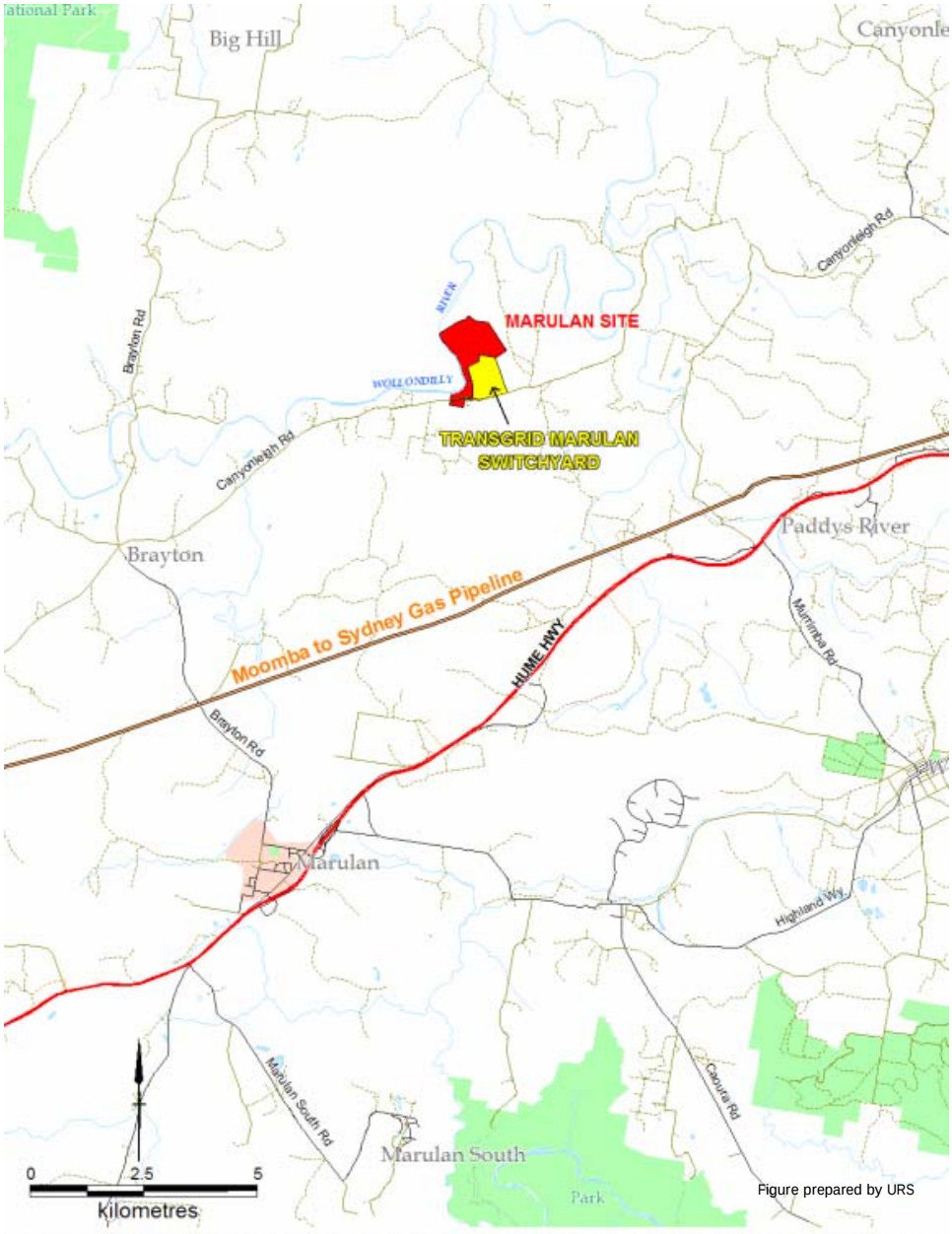
1 INTRODUCTION

This is a noise assessment to support the Environmental Assessment Report for a project application prepared under the provisions of Part 3A of the Environmental Planning and Assessment Act 1979 (EP&A Act)for the development by Delta Electricity of a gas turbine facility at the 'Marulan Site' (approximately 12 km northwest of Marulan). The location of the site is shown in Figure 1-1 below.

Figure 1-1 Locality Map



Wilkinson Murray has been engaged by URS to conduct a noise and vibration assessment forming part of a project application. This assessment covers the environmental noise and vibration aspects relating to the construction (post earthworks) and operation of the facility. A cumulative noise assessment is included in this assessment considering other potential industrial facilities in the area.

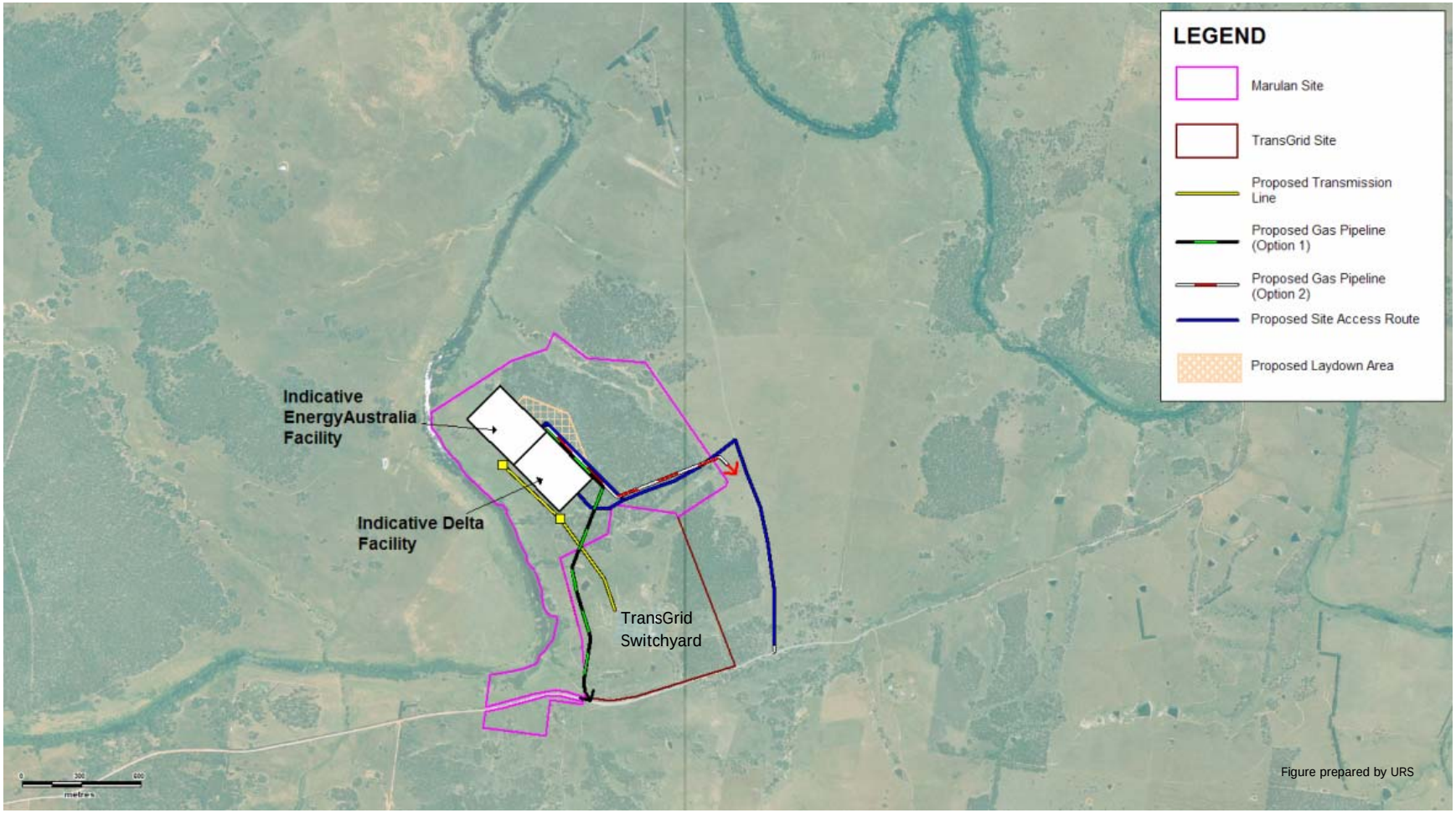
2 DESCRIPTION OF SITE, PROPOSED FACILITY & SURROUNDINGS

2.1 Introduction

The 'Marulan Site' lies approximately 12 km north of Marulan, which is 25 km east of Goulburn. Marulan is historically a primarily rural farming area. In recent years the area has experienced increasing levels of rural residential development and more recently proposed quarrying operations. The topography varies from flat valley areas which have typically been cleared for grazing to steeper ridges where vegetation has been retained.

The location of the 'Marulan Site' is presented in Figure 2-1.

Figure 2-1 Locality Map.



2.2 Site Description

The 'Marulan Site' is located on Canyonleigh Road, Brayton, approximately 12km northeast of the village of Marulan. The site is 19.6km from the Marulan Highway turnoff and 10km from the Canyonleigh-Brayton Road turnoff (refer to Figure 1-1). The Marulan Site is currently jointly owned by Delta Electricity and EnergyAustralia.

The site comprises approximately 116ha of pasture land and dry eucalypt forest. The proposed plant locations lies within a partially cleared area bordering a tree covered area which continues on the higher ground east of the Wollondilly River. It is situated on a bench approximately 20m above the river's edge at an assumed elevation of approximately 605m AHD. Overall the site slopes gently west towards the river. The Site is located in the Upper Lachlan Shire Council local government area.

2.3 Proposed Facility

The implementation of the proposed Delta Electricity gas turbine facility at the Marulan Site would be carried out in two stages:

Stage 1 Two open cycle gas turbines (OCGT) with a total capacity in the range of 250 to 350 MW. Each turbine could have a capacity in the order of 125 to 175 MW depending on final equipment selected.

Stage 2: Conversion to combined cycle Gas Turbine (CCGT) facility to generate electricity for intermediate/base load electricity demand. The proposed capacity of the Stage 2 combined cycle plant is in the range of 400 to 450 MW

The main components of the power plant facility would be:

2.3.1 Stage 1

- Gas turbine and auxiliaries; Two gas turbines comprising compressor, combustion and turbine stages (including low NOx burners) and exhaust stack (approx. 40m height) each. Turbines will be connected to air cooled generators. The turbines would be converted to combined cycle during Stage 2;
- Generator transformers;
- Process control and monitoring systems; and
- Administration, amenities and control building (approximately 10m height).

2.3.2 Stage 2 – Additional plant

- Heat recovery steam generator (HRSG) and auxiliaries;
- Steam turbine and auxiliaries;
- Air Cooled Condenser;
- Chillers;

- Water treatment plant; and
- Sewerage treatment plant.

The site layout for Delta Electricity Facility Stage 2 is presented in Figure 2-2.

Figure 2-2 Indicative site layout for Delta Electricity Facility Stage 2.

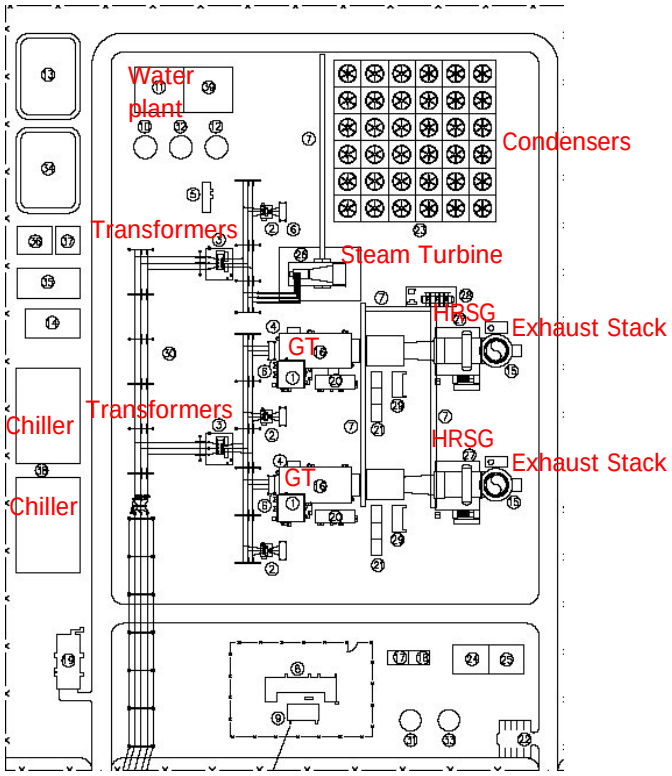


Figure prepared by URS

Figure 2-3 shows the assumed location of the proposed Delta Electricity Facility relative to the closest residential receivers.

2.4 Future Facilities

In addition to the Delta Electricity Facility, EnergyAustralia are also proposing to develop a power generation facility consisting of two open cycle gas turbines with a total capacity in the range of 250 to 320 MW similar to that proposed by Delta Electricity in their Stage 1 at the 'Marulan Site'. The timing of the construction and operation of the EnergyAustralia Facility is similar to that of the Delta Electricity Facility.

A separate project application for the EnergyAustralia Facility has been prepared under the provisions of Part 3A of the *EP&A Act* independent of the Delta Electricity application. To take account for the potential noise impacts from both the Delta Electricity Facility and the EA Facility this report contains a cumulative noise impact assessment in addition to the noise impact assessment for the Delta Electricity Facility.

Figure 2-3 shows the assumed location of the proposed EnergyAustralia Facility relative to the closest residential receivers.

Figure 2-3 Assumed location of Facilities within the footprint.

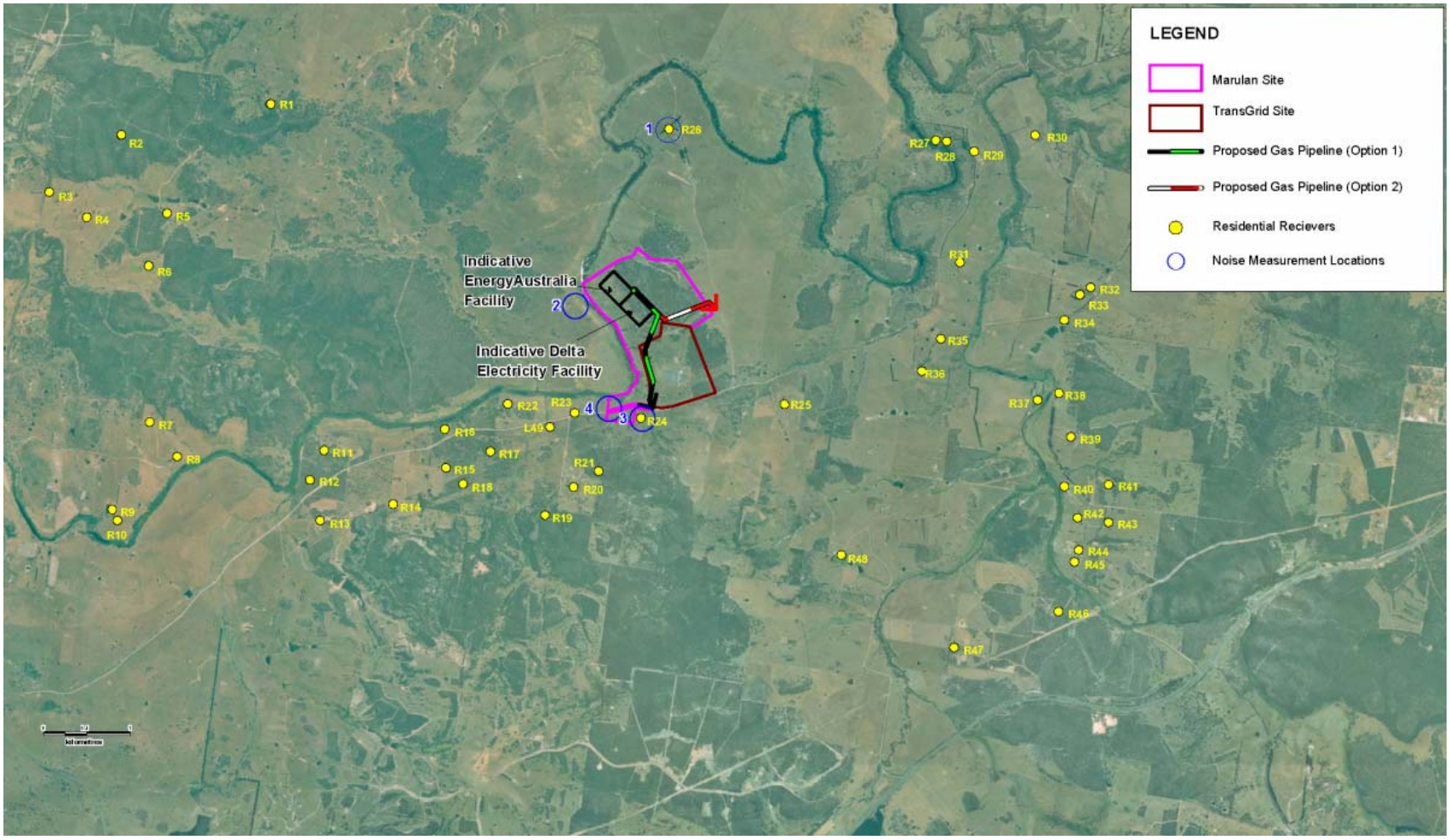


Figure prepared by URS

2.5 Surrounding

Adjoining the site are rural lands that include residences. Table 2-1 summarises the residential receiver locations surrounding the Marulan Site within an approximate 3 km radius of the proposed Delta Electricity Facility. The noise assessment will concentrate on residential receivers within the 3 km radius of the facility.

A number of structures near the Marulan Site were assessed to confirm potential receivers. Council has advised that a property to the south of the Marulan Site had a development application approved for a dwelling on 29 March 1994, however no evidence of physical commencement of work has been presented to Council, and as such, the Development Consent may have lapsed. There is currently a shed on the property to the south of the Marulan Site that does not appear to be a habitable dwelling and accordingly, is not considered a receiver.

Another structure to the north of the Marulan Site is not considered a receiver as it is shearers' quarters used by students of the University of Sydney for approximately one week every two months, these quarters are not permanently occupied.

Table 2-1 Summary of Residential Receiver Locations Identified.

Receiver Location	Building Type
R15	Rural Residence
R16	Rural Residence
R17	Rural Residence
R18	Rural Residence
R19	Rural Residence
R20	Rural Residence
R21	Rural Residence
R22	Rural Residence
R23	Rural Residence
R24	Rural Residence
R25	Rural Residence
R26	Rural Residence

3 EXISTING ACOUSTIC ENVIRONMENT

Four noise loggers were placed at various locations on site from Sunday, 7 May 2006 to Thursday, 18 May 2006. The detailed measurement results are presented in graphical format in Appendix B. Figure 2-3 shows the location of noise monitoring locations relative to the residential receivers and the development site.

The noise loggers were set to an A-weighting, fast response and to continuously monitor over 15-minute sampling periods. This equipment is capable of remotely monitoring and storing noise level descriptors for later detailed analysis. The equipment calibration was checked before and after the survey and no significant drift was noted.

The loggers determine a variety of noise descriptors, including L_{A90} and L_{Aeq} levels (see Appendix A for definitions) of the existing noise environment. From the background noise levels (L_{A90}) the Rating Background Levels (RBLs) were determined using methodology as recommended by the NSW Department of Environment & Climate Change (DECC) document, the *NSW Industrial Noise Policy (INP)*. The DECC considers the RBL to represent the background noise level.

Table 3-1 presents a summary of the RBL levels from the unattended noise measurements.

Table 3-1 Summary of RBL Levels from Unattended Noise Measurements

Measurement Location	Relevant Proposed Receivers	Rating Background Level RBL (dBA)		
		Day	Evening	Night
1	R26	28[2]	30	31[1]
2	MS Site	27[2]	29[2]	29[2]
3	R24, R25	29	42[1]	31[1]
4	R15, R16, R17, R18, R19, R20, R21, R22, R23	27[2]	29[2]	29[2]

1. Extraneous noise influence and will not be used as part of this assessment. Lowest permissible RBL, as listed in *INP*, of 30dBA will be used instead.

2. Where the measured RBL is less than 30 dBA, the lowest permissible RBL, as listed in *INP*, of 30dBA will be used instead.

As required by the *INP*, extraneous noise and any effects due to adverse meteorological conditions (rain and wind speed greater than 5m/s at a height of 1.5m) have been excluded using the weather data from the Bureau of Meteorology Goulburn Airport Meteorological Station Number 070330.

4 NOISE CRITERIA

With respect to noise criteria, the NSW Department of Planning has provided the environmental assessment requirements under Part 3A of the *EP&A Act* to be compliant with the NSW Industrial Noise Policy (INP) and Chapter 171 of the Environmental Noise Control Manual (ENCM). Similarly, the Department of Environment & Climate Change (DECC) requires that impacts of noise and vibration be assessed in accordance with the INP.

4.1 Industrial Noise Policy Criteria

The INP is designed to assess industrial noise using the more stringent of the following two approaches:

- Intrusive noise impacts in the short term for residences; and
- Amenity for particular land uses such as residences.

The *INP's* intrusive goal is set 5dBA above the Rating Background Level (RBL) for each time period (daytime (7am to 6pm), evening (6pm to 10pm) or night time (10pm to 7am) of interest as defined by DECC. The RBLs are derived from the measured L_{A90} noise levels as per the DECC guidelines.

The amenity goal sets an upper limit to the total noise level (L_{Aeq}) in an area from all industrial noise (existing and future). The criterion depends on the time of day, area classifications and the relationship of the total measured L_{Aeq} (and contribution from existing industrial noise) to determine the Acceptable Noise Level (ANL) for the development.

The potentially affected area is classified as Rural by the INP. Given this, the acceptable amenity levels (L_{Aeq}) which apply over the whole day, evening or night period are as follows and are applicable as there are no other industrial noise sources:

- Daytime 50dBA
- Evening 45dBA
- Night time 40dBA

Table 4-1 presents a summary of the INP noise criteria for the project. The intrusiveness noise criteria for the existing residential receivers is the most stringent criteria and is therefore adopted as the project specific noise level for the project and will be used to judge the potential noise impacts from the Delta Electricity Facility.

The project specific noise level of 35dBA $L_{Aeq,15minutes}$ based on a 5dBA above the lowest permissible RBL of 30dBA as recommended within the *INP* is adopted for all residential receivers. This criterion is the most stringent criterion that can be developed by the procedures in the INP. As the residential receivers are rural, the criterion applies within 30m of the existing residence.

Table 4-1 Operational Noise Criteria

Location	Intrusiveness $L_{Aeq,15min}$ (dBA)			Amenity $L_{Aeq,period}$ (dBA)		
	Day	Evening	Night	Day	Evening	Night
R15	35	35	35	50	45	40
R16	35	35	35	50	45	40
R17	35	35	35	50	45	40
R18	35	35	35	50	45	40
R19	35	35	35	50	45	40
R20	35	35	35	50	45	40
R21	35	35	35	50	45	40
R22	35	35	35	50	45	40
R23	35	35	35	50	45	40
R24	35	35	35	50	45	40
R25	35	35	35	50	45	40
R26	35	35	35	50	45	40

The INP requires where noise sources contain certain characteristics, such as tonality, impulsiveness, intermittency or dominate low frequency content a modifying factor of +5dBA be added to the noise levels because this type of noise typically causes greater annoyance to the community.

Gas turbine facilities can potentially have low frequency noise and therefore low frequency noise is considered later in this noise assessment. The INP recommends for low frequency noise that an assessment be conducted for the difference between C and A weighting levels and if greater than 15 dB difference exits, a correction of +5 dB be applied.

4.2 Cumulative Impacts

The amenity criterion represents the cumulative impact of all existing and potential industrial noise sources affecting a location, and the appropriate criterion for a new source depends on the existing and future noise levels from other industrial sources. The Policy specifies explicitly how the above criterion levels should be reduced if the existing noise level from other industrial sources is known.

In this case the potentially affected residences that could be impacted from the Delta Electricity Facility could also be impacted by the EnergyAustralia Facility. As both these facilities could operate at the same time, the cumulative noise criterion should be the same as the intrusive noise criterion (ie 35 dBA). All reasonable and feasible noise mitigation is to be considered in order to achieve the intrusive noise criterion. The night time amenity criterion of 40 $L_{Aeq,period,}$ typically used for cumulative noise assessments, could however be considered as an upper noise limit not to be exceeded.

4.3 Exceedance of Criteria

In cases where the criteria set out in Section 4.1 and 4.2 are exceeded, the INP sets out a range of responses, including:

- Application of "feasible and reasonable" mitigation measures to reduce noise levels. For example, controlling noise at the source, controlling the transmission of noise and controlling noise at the receiver;
- Negotiation with relevant government bodies and/or the affected community to determine reasonable levels based on the extent of any residual impacts and other factors such as social and economic benefits derived from the noise source; and
- In extreme cases, acquisition of affected properties. Recent Department of Planning (DoP) approach for major projects would suggest acquisition of properties where the operational noise level, under adverse under meteorological conditions, exceeds the RBL by more than 10dBA (40dBA for this Project).

In particular, the INP indicates:

> *The industrial noise source criteria … are best regarded as planning tools. They are not mandatory, and an application for a noise-producing development is not determined purely on the basis of compliance or otherwise with the noise criteria. Numerous other factors need to be taken into account in the determination. These factors include economic consequences, other environmental effects and the social worth of the development. The criteria help to determine consent/licence conditions because they provide information on the likely effect of any environmental noise associated with the development.*

4.4 Sleep Arousal Criteria

Peak noise level events, such as reversing beepers, noise from heavy items being dropped or other high noise level events, have the potential to cause sleep disturbance. The potential for high noise level events at night and effects on sleep should be addressed in noise assessments for both the construction and operational phases of a development. The INP does not specifically address sleep disturbance from high noise level events.

DECC reviewed research on sleep disturbance in the NSW Environmental Criteria for Road Traffic Noise (ECRTN). This review concluded that the range of results is sufficiently diverse that it was not reasonable to issue new noise criteria for sleep disturbance.

From the research, DECC recognised that current sleep disturbance criterion of an $L_{A1,1\ minute}$ not exceeding the $L_{A90,15\ minutes}$ by more than 15 dB(A) is not ideal. Nevertheless, as there is insufficient evidence to determine what should replace it, DECC will continue to use it as a guide to identify the likelihood of sleep disturbance. This means that where the criterion is met, sleep disturbance is not likely, but where it is not met, a more detailed analysis is required.

The detailed analysis should cover the maximum noise level or $L_{A1, (1\ minute)}$, that is, the extent to which the maximum noise level exceeds the background level and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the appendices to the ECRTN. Other factors that may be important in assessing the extent of impacts on sleep include:

- how often high noise events will occur;
- time of day (normally between 10pm and 7am); and
- whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods).

The primary sleep arousal criteria adopted for this project is 45dBA $L_{A1,1\ minute}$ (based on the lowest permissible RBL of 30dBA+15dBA) during the hours 10.00pm-7.00am assessed external to a bedroom window.

4.5 Construction Noise Criteria

With respect to construction noise, the requirements outlined in Chapter 171 of the *ENCM* are usually applied and this approach is reproduced below.

Level Restrictions

(i) Construction period of 4 weeks and under.
The L_{A10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 20 dB(A).

(ii) Construction period greater than 4 weeks and not exceeding 26 weeks.
The L_{A10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 10 dB(A).

Time Restrictions

Monday to Friday	*7am–6pm*
Saturday	*7am–1pm (if inaudible at residential premises)*
	8am–1pm (if audible at residential premises)

No construction work to take place on Sundays or Public Holidays

Silencing

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

There is no suggested criterion for projects that occur for greater than 26 weeks. However, the following criterion is typically used and appropriate:

The L_{A10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 5 dB(A).

It is anticipated that construction will most likely take place from 7.00am to possibly up to 6.00pm during weekdays and 8.00am-1.00pm on Saturdays.

The proposed construction for Delta Electricity Facility Stage 1 has been estimated to be approximately 18 months and Stage 2 is estimated to be approximately 12 months.

The daytime construction criterion adopted for all residential receivers for this project is 35dBA L_{A10} (based on the lowest permissible RBL of 30dBA+5dBA) as the construction is greater than 26 weeks duration.

5 NOISE PREDICTIONS

5.1 Introduction

For this assessment, noise predictions were made using the ENM noise modelling software. This model has been endorsed by the DECC for environmental noise assessment. This is a point-to-point noise model that takes into account attenuation factors including; distance, ground absorption, air absorption and the effects of adverse meteorological conditions.

Intervening topography attenuates noise before it reaches receivers. Additionally, noise propagation over distances of at least several hundred metres is influenced by meteorological factors such as wind speed, wind direction and the presence of temperature inversions. In addition to increasing noise levels, these meteorological conditions significantly reduce the attenuating effect of intervening topography (and bunds) since the sound waves follow a curved path that can go over such barriers.

5.2 Meteorological Conditions

Noise levels experienced by a receiver at relatively large distances from a source can vary considerably under different meteorological conditions, particularly in the evening and at night. Prevailing wind and air temperature gradients will change over the course of the night time period, and hence noise levels at receivers will change, even when the noise source level is constant.

The southern highlands region is an area where occurrence of temperature inversions is frequent and as such the effect of metrological conditions must be addressed in the prediction of noise levels from the proposal.

The *INP* generally directs the use of a single set of adverse meteorological data to use in the assessment of noise impacts; however Wilkinson Murray has adopted a more rigorous approach in past assessments where noise levels at residences are calculated under a varied set of existing meteorological conditions. Measured statistical occurrences of these conditions over a period of at least one year, split into seasons, are then applied to the results, and a 10^{th} percentile exceedance noise level calculated, which is then compared with relevant criteria. This approach is generally more conservative than one using a single set of meteorological data as it accounts for the directional distribution of prevailing winds for each residence surrounding the proposal.

This alternative assessment procedure involves significantly greater computational complexity than the use of a single set of meteorological conditions, but provides a much more direct and comprehensible description of noise impacts at a receiver. This approach of using the 10^{th} percentile calculated noise level as a measure of noise impacts on residences has been considered acceptable by the DECC for previous similar assessments. This alternative procedure is considered appropriate for this project.

Hourly data for an entire year (2006) was processed for the site by URS using CALMET and TAPM using two meteorological stations in the area. This data included the stability class ratings for inversions (Class A to G), which is relevant in determining the inversion class of the area. Please refer to the Delta Electricity - Marulan Gas Turbine Facility - Air Quality Assessment (URS 2008) for detailed information and justification of meteorological data and summary of stability class frequencies.

The weather data has been analysed for a total of approximately 80 weather conditions for each season and the probability of occurrence for all the conditions have been calculated. The conditions that have been considered are presented in Appendix C.

5.3 Topography

For the Marulan site, URS has supplied a detailed 3D digital terrain map in 0.5m contours for the Arthursleigh property and 10m contours for the surrounding area. The assumed location of the Delta Electricity Facility is presented Figure 2-3 relative to the closest residential receivers.

5.4 Sound Power Levels

The assumed sound power levels for the Delta Electricity Facility are based on an 'E Class' turbine OCGT plant and generic data for the CCGT. Table 5-1 presents the A-weight sound power levels used for the noise modelling.

According to the plant designers, OCGT facility (Stage 1) would not have any peak noise events that could result in sleep disturbance impacts. Peak noise events that could result in sleep disturbance impacts may only occur as a result of emergency steam valves being released. This would only occur very rarely for Stage 2 (CCGT) operations. The sound power levels of such occurrences are presented in Table 5-1.

Table 5-1 Assumed Sound Power Levels for the Proposed Delta Electricity Gas Turbine Facility.

Plant Item (Individual Unit)		Sound Power Level (dBA) $L_{Aeq, 15min}$
Stage 1 Open Cycle Gas Turbine Power Plant (OCGT)	Flue gas system – Stack	110[1]
	Flue gas system – Stack body	97
	Air Intake	106[2]
	Air Intake - Duct	106
	Turbine and Generator Enclosure	102
	Flue gas system - Diffuser	102
	Flue gas system – exhaust duct elbow	109
	GT Coolers	101
	Generator Transformer	102
Stage 2 Conversion of Open Cycle to Combined Cycle gas Turbine (CCGT)	Steam Turbine	110
	Air Cooled Condenser (Total)	110
	HRSG	105
	Chiller[3]	100
	Water Treatment Plant	80
	Sewerage Treatment Plant	80
Emergency Operation	HRSG safety Valves operation	115 L_{max}

1 Direction – vertical. Includes some mitigation in the form of a silencer. Model assumed 90 degree directivity from the top of the stack to the residences.

2 Directional - to the north east. Includes some mitigation in the form of a silencer.

3 Optional Equipment – Included in the assessment to represent the worst case scenario.

The noise calculations assume the following:

- a height of 40 metres for the Delta Electricity Facility stacks; and
- a site RL of 605m.

The larger and potentially noisier plant / equipment items have been assessed. Any small or localised noise sources, such as pipe-work could be treated individually with screens/enclosures or lagging and the like. Correct vibration isolation will be necessary.

6 ASSESSMENT OF OPERATIONAL NOISE

6.1 Noise Prediction – Delta Electricity Facility Stage 1 and Stage 2

Calculated $L_{Aeq,15min}$ 10^{th} percentile exceedance noise levels (typically referred to as "calculated noise levels under adverse meteorological conditions") were undertaken for the two operational stages for daytime, evening, night time, refer to Tables 6-1 and 6-2.

Noise contours based on 10^{th} percentile levels have been calculated for Delta Electricity Facility Stage 1 and 2 considering the worst case season and worst case time period. The contours are presented in Appendix D. It should be noted that noise contours are indicative only, the point to point calculations should be considered more accurate than the noise contours.

The following observations as a result of the noise predictions are presented:

- during Stage 1 the noise predictions indicate that there is minor 2-3 dB exceedance of the criteria at R24 under adverse weather conditions.
- during Stage 2 the noise predictions indicate that there is an exceedance of the criteria at R23, R24 and R26 for adverse weather conditions.

The exceedances of the criteria indicate that noise mitigation would need to be considered for the project.

Table 6-1 Summary of Calculated Noise Levels to Existing Residences – Delta Electricity Facility Stage 1.

Residence No.	Time Period	Calculated $L_{Aeq,15min}$ Noise Level (dBA) Adverse Meteorological Condition (Worst case season)	Noise Criteria $L_{Aeq,15min}$(dBA)
R15	Day	26	35
	Evening	28	
	Night	27	
R16	Day	28	35
	Evening	30	
	Night	29	
R17	Day	28	35
	Evening	30	
	Night	30	
R18	Day	26	35
	Evening	28	
	Night	27	
R19	Day	27	35
	Evening	28	
	Night	28	
R20	Day	29	35
	Evening	31	
	Night	31	
R21	Day	29	35
	Evening	31	
	Night	31	
R22	Day	27	35
	Evening	31	
	Night	29	
R23	Day	33	35
	Evening	35	
	Night	35	
R24	Day	36	35
	Evening	38	
	Night	38	
R25	Day	23	35
	Evening	32	
	Night	30	
R26	Day	32	35
	Evening	33	
	Night	33	

Table 6-1 Summary of Calculated Noise Levels to Existing Residences – Delta Electricity Facility Stage 2.

Residence No.	Time Period	Calculated $L_{Aeq,15min}$ Noise Level (dBA) Adverse Meteorological Condition (Worst case season)	Noise Criteria $L_{Aeq,15min}$(dBA)
R15	Day	30	35
	Evening	32	
	Night	31	
R16	Day	31	35
	Evening	33	
	Night	32	
R17	Day	31	35
	Evening	34	
	Night	32	
R18	Day	30	35
	Evening	32	
	Night	31	
R19	Day	31	35
	Evening	32	
	Night	32	
R20	Day	33	35
	Evening	35	
	Night	34	
R21	Day	33	35
	Evening	35	
	Night	34	
R22	Day	29	35
	Evening	35	
	Night	33	
R23	Day	38	35
	Evening	40	
	Night	40	
R24	Day	39	35
	Evening	41	
	Night	41	
25	Day	26	35
	Evening	35	
	Night	32	
26	Day	35	35
	Evening	36	
	Night	36	

6.2 Reasonable and Feasible Noise Mitigation

Essentially there are three main physical noise mitigation strategies for noise control, namely:

1. **Controlling noise at the source.** There are two approaches that need to be considered: Best Management Practices (BMP) where particular operational procedures that minimise noise while retaining productive efficiency and Best Available Technology Economically Achievable (BATEA) where equipment, plant and machinery is used that incorporates the most advantaged and affordable technology to minimise noise output.

2. **Controlling the transmission of noise.** Barriers are one of the most effective methods to reduce noise levels by controlling the transmission path. Barriers are more effective if they are near the source or the receiver.

3. **Controlling noise at the receiver.** This typically includes the provision of good glazing systems (ie laminated glass or double glazing) and the provision of ventilation to allow fresh air into rooms which require glazing to be closes.

A turbine manufacturer has advised that 'E Class' turbines for the OCGT facilities have inherent noise mitigation measures incorporated such as:

- Air intake silencers;
- Generator transformer walls on 3 sides; and
- Exhaust air silencers.

Therefore, the manufacturer considers that 'E class' OCGT plant proposed is BATEA and as such noise levels can not be reduced any further.

For Delta Electricity Facility Stage 2 however, there may be opportunities in the detail design phase to incorporate additional mitigation measures for example:

- the sound power level of the HRSG to be reduced to 100 dBA.

- the use of low noise condenser fans and the potential incorporation of barriers and silencers. A total SWL of 105 dB(A) has been assumed for the condensing fans.

Every effort was made to place the Facilities in a topographically shielded position on the site, however, with the height of the stack and supporting structures barrier noise reduction at adjacent residences was found to be limited.

Controlling noise at the receiver (ie architectural treatments) would be considered for residential receivers where all reasonable and feasible source noise controls have been incorporated and marginal residual impacts still remain. Tables 6-3 presents a summary of the noise levels resulting from the inclusion of the noise mitigation indicated above in Delta Electricity Facility Stage 2.

Noise contours (10^{th} percentile levels) have been calculated for Delta Electricity Facility Stage 2 with the proposed mitigation for the worst case season and worst case time period and are presented in Appendix D. As mentioned previously, the point to point calculations should be considered more accurate than the noise contours

Table 6-3 Summary of Calculated Noise Levels to Existing Residences – Delta Electricity Facility Stage 2 with mitigation.

Residence No.	Time Period	Calculated $L_{Aeq,15min}$ Noise Level (dBA) Adverse Meteorological Condition (Worst case season)	Noise Criteria $L_{Aeq,15min}$(dBA)
R15	Day	29	35
	Evening	31	
	Night	30	
R16	Day	30	35
	Evening	32	
	Night	31	
R17	Day	30	35
	Evening	33	
	Night	31	
R18	Day	29	35
	Evening	31	
	Night	30	
R19	Day	29	35
	Evening	31	
	Night	31	
R20	Day	31	35
	Evening	33	
	Night	33	
R21	Day	31	35
	Evening	33	
	Night	33	
R22	Day	29	35
	Evening	33	
	Night	31	
R23	Day	37	35
	Evening	39	
	Night	39	
R24	Day	38	35
	Evening	41	
	Night	40	
25	Day	25	35
	Evening	34	
	Night	31	
26	Day	34	35
	Evening	35	
	Night	35	

The noise predictions indicate that the intrusive noise criterion from the Delta Electricity Facility can not be achieved at all residential receivers for both Stages 1 and 2. During Delta Electricity Facility Stage 1 the noise predictions indicate that there is marginal 1-3 dB exceedance of the criteria at R24 under adverse weather conditions and during Delta Electricity Facility Stage 2 the noise predictions (with mitigation) indicate that there are significant exceedances of up to 6 dB at R24 and R23 for adverse weather conditions.

6.3 Low Frequency Noise Assessment

The INP recommends for low frequency noise that an assessment be conducted of the difference between C and A weighting levels and if a 15 dB difference exits, a correction of 5 dB is applied.

From current information it would appear to be possible for a gas turbine plant to exceed the allowable (dBC-dBA) difference. At the most affected receiver (R24) a difference between C and A weighting levels of 17 dB was calculated. The noise predictions are based on best available octave band data between 63 Hz and 8000 Hz. As such, the calculation of the difference between C and A weighting levels was dominated by two octave bands being 63 and 125 Hz which would provide some uncertainty in the calculations.

Recent international research has shown that the use of this difference approach is not suitable when the noise levels are low, since the low frequencies may then be below threshold of hearing levels (A review of Published Research on Low Frequency Noise and its Effects, Report for Department for Environment, Food and Rural Affairs (UK) by Dr Geoff Leventhall, 2003). Current research suggests that (dBC-dBA) difference should not be used as an annoyance predictor, but as a simple indicator of whether further investigation may be necessary (Low Frequency Noise and Annoyance, Noise & Health 2004, 6:23, 59-72).

Recently the UK Department for Environment, Food and Rural Affairs (DEFRA) has developed a new procedure to assess low frequency noise.

A measurement of L_{Aeq}, L_{10} and L_{90} is taken in third octave bands between 10Hz and 160Hz. If the L_{Aeq} taken over a time when the noise is said to be present exceeds the reference curve in Table 6-4, it may indicate a source of low frequency noise that could cause disturbance. The character of the sound should be checked if possible by playing back an audio recording at an amplified level.

Table 6-4 Proposed Reference Curve

Hz	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160
dB, L_{eq}	92	87	83	74	64	56	49	43	42	40	38	36	34

If the noise occurs only during the day then a 5dB relaxation may be applied to all third octave bands. If the noise is steady then a 5dB relaxation may be applied to all third octave bands. A noise is considered steady if either of the conditions below is met:

- $L_{10} - L_{90} < 5$dB
- The rate of change of sound pressure level (fast time weighting) is less than 10dB per second.

The above parameters are evaluated and the assessment process is a comparison with the with the reference cure. An exceedance of the reference curve requires the reduction of the low frequency noise level. The Delta Electricity Facility would be likely to be able to meet this

criterion outside the most affected residential receiver let alone within a room with no additional noise mitigation on the plant. It should be noted that room resonances could enhance low frequency noise however this can not be estimated at an environmental assessment stage of a project.

Low frequency noise issues for the project during detailed design would be addressed consistent with the most recent low frequency noise assessment process that have been developed overseas in lieu of the INP, namely:

- Proposed criteria for the assessment of low frequency noise disturbance, 2005, Prepared for Defra by Dr. Andy Moorhouse, Dr. David Waddington, Dr. Mags Adams; and
- Procedure for the assessment of low frequency noise complaints 2005, Prepared for Defra by Dr. Andy Moorhouse, Dr. David Waddington, Dr. Mags Adams.

6.4 Assessment of the Potential for Sleep Arousal

The potential for sleep disturbance within the residences will likely be greatest during the early morning hours (notionally, 2.00am-4.00am) when background noise levels are at their lowest.

The maximum anticipated noise levels during abnormal (emergency) operating conditions that could result in sleep disturbance impacts are summarised Table 6-5.

Table 6-5 Calculated Maximum Levels at Residential Receivers.

Locations	Calculated Noise Level $L_{A1,1min}$ (dBA)	Noise Criteria $L_{A1,1min}$ (dBA)
R15	33	45
R16	33	45
R17	35	45
R18	33	45
R19	33	45
R20	34	45
R21	34	45
R22	32	45
R23	41	45
R24	39	45
R25	30	45
R26	36	45

From the predictions presented in Table 6-5, the potential for sleep disturbance from the operation of the development were found to be negligible.

6.5 Cumulative Noise Assessment

As there is potential for residences to be impacted by both the Delta Electricity Facility and the EnergyAustralia Facility it is considered important to investigate the potential cumulative noise impacts of both Facilities.

Calculated cumulative $L_{Aeq,15min}$ 10^{th} percentile exceedance noise levels were undertaken for the EnergyAustralia Facility and the two Delta Electricity operational stages for daytime, evening, night time, refer to Tables 6-6 and 6-7.

The noise assessment conducted in support of the EnergyAustralia Facility project approval presents all noise modelling assumptions for the EnergyAustralia Facility.

Table 6-6 Summary of Calculated Cumulative Noise Levels to Existing Residences for the Delta Electricity Facility Stage 1 and EnergyAustralia Facility.

Residence No.	Time Period	Calculated 10% $L_{Aeq,15min}$ Noise Level (dBA)			Noise Criteria $L_{Aeq,15min}$(dBA)
		EnergyAustralia Facility	Delta Electricity Facility	Total	
R15	Day	21	26	27	35
	Evening	23	28	29	
	Night	22	27	28	
R16	Day	24	28	29	35
	Evening	25	30	31	
	Night	25	29	30	
R17	Day	23	28	29	35
	Evening	26	30	31	
	Night	25	30	31	
R18	Day	21	26	27	35
	Evening	23	28	29	
	Night	22	27	28	
R19	Day	26	27	30	35
	Evening	26	28	30	
	Night	26	28	30	
R20	Day	29	29	32	35
	Evening	31	31	34	
	Night	31	31	34	
R21	Day	29	29	32	35
	Evening	31	31	34	
	Night	31	31	34	
R22	Day	22	27	28	35
	Evening	25	31	32	
	Night	24	29	30	
R23	Day	34	33	37	35
	Evening	36	35	39	
	Night	35	35	38	
R24	Day	36	36	39	35
	Evening	38	38	41	
	Night	38	38	41	
R25	Day	23	23	26	35
	Evening	31	32	35	
	Night	30	30	33	
R26	Day	33	32	36	35
	Evening	34	33	37	
	Night	34	33	37	

Table 6-7 Summary of Calculated Cumulative Noise Levels to Existing Residences for the EnergyAustralia Facility and Delta Electricity Facility Stage 2 (with mitigation).

Residence No.	Time Period	Calculated 10% $L_{Aeq,15min}$ Noise Level (dBA)			Noise Criteria $L_{Aeq,15min}$(dBA)
		EnergyAustralia Facility	Delta Electricity Facility	Total	
R15	Day	21	29	30	35
	Evening	23	31	32	
	Night	22	30	31	
R16	Day	24	30	31	35
	Evening	25	32	33	
	Night	25	31	32	
R17	Day	23	30	31	35
	Evening	26	33	34	
	Night	25	31	32	
R18	Day	21	29	30	35
	Evening	23	31	32	
	Night	22	30	31	
R19	Day	26	29	31	35
	Evening	26	31	32	
	Night	26	31	32	
R20	Day	29	31	33	35
	Evening	31	33	35	
	Night	31	33	35	
R21	Day	29	31	33	35
	Evening	31	33	35	
	Night	31	33	35	
R22	Day	22	29	30	35
	Evening	25	33	34	
	Night	24	31	32	
R23	Day	34	37	39	35
	Evening	36	39	41	
	Night	35	39	40	
R24	Day	36	38	40	35
	Evening	38	41	43	
	Night	38	40	42	
R25	Day	23	25	27	35
	Evening	31	34	36	
	Night	30	31	34	
R26	Day	33	34	37	35
	Evening	34	35	38	
	Night	34	35	38	

Noise contours (10^{th} percentile) have been calculated for Delta Electricity Facility Stage 2 with the proposed mitigation for the worst case season and worst case time period. The contours are presented in Appendix F. It should be noted that noise contours are indicative only, the point to point calculations should be considered more accurate than the noise contours.

Generally receivers that experience noise levels that exceed the noise criteria can be separated into three noise exceedance categories, namely:

- 0-2dB(A): minor exceedances;
- 2-5dB(A): marginal exceedances; and
- >5dB(A): significant exceedances

The following observations as a result of the cumulative noise predictions are presented:

- meteorological conditions that contribute to the exceedances are temperature inversions (3 degrees per 100 metre) and or light winds from the north western to north eastern sectors (refer to Appendix C).

- for Delta Electricity Facility Stage 1 and the EnergyAustralia Facility operating the cumulative noise predictions indicate that there is marginal 1-4 dB exceedance of the criteria at R23 and R26 under adverse weather conditions.

- for Delta Electricity Facility Stage 1 and the EnergyAustralia Facility operating the cumulative noise predictions indicate that there is significant exceedance of 6dB above the criteria at R24 under adverse weather conditions. The noise level at R24 also exceeds the INP recommended night time amenity criteria of 40 dBA.

- for Delta Electricity Facility Stage 2 and the EnergyAustralia Facility operating the cumulative noise predictions indicate that there is marginal 1-4 dB exceedance of the criteria at R26 under adverse weather conditions.

- for Delta Electricity Facility Stage 2 and the EnergyAustralia Facility operating the cumulative noise predictions indicate that there is minor 1 dB exceedance of the criteria at R25 under adverse weather conditions.

- for Delta Electricity Facility Stage 2 and the EnergyAustralia Facility operating the cumulative noise predictions indicate that there is significant exceedance of greater than 5 dB above the criteria at R23 and R24 under adverse weather conditions. The noise levels at R23 and R24 also exceed the INP recommended night time amenity criteria of 40 dBA.

The exceedances of the criteria indicate that noise mitigation in addition to the BATEA plant and equipment is required for the project. The noise exceedance categories trigger the implementation of appropriate noise management and/or mitigation strategies. That is, ‘minor’ and ‘marginal’ exceedances would generally trigger implementation of an appropriate noise management action like architectural treatments, while ‘significant’ noise exceedances could trigger a negotiated agreement or in an extreme case property acquisition.

For existing buildings architectural treatments are generally limited to acoustic treatment of the building elements and the installation of acoustic screens close to dwellings. Building element treatments are more effective when they are applied to masonry structures than light timber frame structures. The acoustic treatments provided are typically limited to:

- Fresh air ventilation systems (possibly air conditioning) that meet Building Code of Australia requirements with the windows and doors shut;
- Upgraded windows and glazing and solid core doors on the exposed facades of masonry structures only (these techniques would be unlikely to produce any noticeable benefit for light frame structures with no acoustic insulation in the walls);
- Upgrading window and door seals;
- The sealing of wall vents, eaves, roofs; and
- The installation of external screen walls.

7 TRAFFIC NOISE ASSESSMENT

This section assesses the impact of increased noise potentially impacting residential receivers due to additional road traffic generated by the development.

With respect to access to the power station sites, all road traffic movements (construction and operation) will travel along Canyonleigh Road. The functional category of this road is considered to be "sub-arterial" (RTA Road Design Guide 1996) and using the DECC document, the *Environmental Criteria for Road Traffic Noise*, the applicable noise criteria refer to a day time (7.00am-10.00pm) $L_{Aeq,15hr}$ 60dBA level and a night time (10.00pm-7.00am) $L_{Aeq,9hr}$ 55dBA level. Traffic generating developments are allowed an increase above these limits of 2dB, once all reasonable and feasible mitigation is considered. Analysing the traffic data and the estimated vehicle movements during the construction phase as supplied by URS, and given the fact that this is the only access, the 2dB limit applies.

There will be minor increases in road noise during the peak construction activities however, there is minimal risk of exceeding the 2dB limit. During the operational stage, there would be minor, light vehicle activity as required and as such negligible impact expected. Given the low risk of exceeding the 2dB limit, a further detailed assessment is not deemed necessary.

8 VIBRATION ASSESSMENT

This section provides a qualitative appreciation of the effect of vibration from the operation of the facility and its construction.

In terms of vibration sources identified during the construction stage, likely plant would include rollers, dozers and like. Given that the nearest existing residential receivers will be at least 1,000m away from the closest area of works, the vibration levels would not be perceptible and therefore would not impact on the residences.

Given the low risk associated with vibration impacts (both annoyance and structural damage) a detailed vibration assessment is not deemed necessary.

9 CONSTRUCTION NOISE ASSESSMENT

This section of the report is a preliminary assessment of the potential impact of noise during construction. This assessment covers the post earthworks construction as earthworks were dealt with in the Concept Approval stage of the project.

The construction works assessed are:

- Construction of the slab;
- Construction of the building, and fit out;
- Landscaping; and
- Commissioning.

It would require approximately 18 months to complete Delta Electricity Facility Stage 1 works and 12 months to complete Stage 2.

9.1 Construction Activities Involving Fixed & Mobile Plant

To predict the typical worst case noise levels at typical construction stages over the duration of the project, the following typical scenarios have been considered.

Scenario 1

A worst case month where activities, including construction of the slab.

Scenario 2

A worst case month where activities including, construction of the building, fitout and landscaping is anticipated to occur simultaneously.

Scenario 3

This represents the activities occurring towards the end associated with commissioning. This essentially is the noise that will be experienced during operation and as such is not assessed.

9.2 Plant Items & Assigned Sound Power Levels

URS have supplied indicative information and activities of the likely plant to be used to construct the Delta Electricity Facility. The sound power level (SWL) of these plant items has been sourced from Wilkinson Murray's extensive database. Table 9-1 summarises the proposed plant to be used during each construction scenario together with its respective SWL and number of items.

Table 9-1 Equipment Numbers & Sound Power Levels

Plant / Equipment Item	Maximum Sound Power Level (dBA)	Number of Items Modelled	
		Scenario 1	**Scenario 2**
Crane	103	0	1
Concrete/Brick/Tile Saw	105	0	1
Concrete/Haul Truck	112	4	2
Concrete Pump	108	1	0
Compressor	103	0	1
General Power Tools	95	0	1
Jack Hammer	90	0	0
Portable Generator	110	0	1

All equipment listed in Table 9-1 would not be working at the maximum power levels simultaneously. Experience indicates that these maximum noise levels occur only rarely, and the L_{A10} noise levels will be at least 7 dBA below the maximum levels. For this reason, 7 dBA was subtracted from the calculated "worst case" maximum noise levels to give an estimate of the typical L_{A10} noise level from the site. Using the assumed plant items and their associated maximum sound power levels (with consideration given to the operational changes, intermittent processes and changes in distance of mobile plant), the combined L_{A10} sound power levels for each scenario is:

- Scenario 1 111dBA
- Scenario 2 109dBA

9.3 Calculated Noise Levels

Table 9-2 summarises the calculated daytime noise levels under adverse meteorological conditions (10^{th} percentile exceedance noise levels) without noise mitigation at the existing residences.

Table 9-2 Calculated Construction Noise Levels at Existing Receivers

Locations	Scenario 1 Calculated Noise Level $L_{Aeq,15min}$ (dBA)	Scenario2 Calculated Noise Level $L_{Aeq,15min}$ (dBA)	Noise Criteria $L_{A1,1min}$ (dBA)
R15	27	25	35
R16	27	25	35
R17	30	28	35
R18	27	25	35
R19	27	25	35
R20	29	27	35
R21	29	27	35
R22	27	25	35
R23	36	34	35
R24	34	32	35
R25	25	23	35
R26	31	29	35

Table 9-2 shows marginal exceedances of the construction noise criteria of 1 dBA at R23.

Once the contractor is selected, the plant, processes and duration will be better known and a Construction Noise Management Plan is to be developed so that our assumptions confirmed and reasonable and feasible noise mitigation measures can be investigated if necessary. In brief, these may include:

- Positioning of plant / processes; and
- Limiting the “clustering” of plant / processes.

10 CONCLUSION

Noise and vibration impacts from the proposed Delta Electricity Gas Turbine Facility have been assessed in accordance with appropriate environmental standards, notably the DECC's Industrial Noise Policy (*INP*). Impacts at relevant sensitive receivers such as residential dwellings have been quantified and where possible, measures have been proposed that would reduce these impacts. The major conclusions of this assessment are as follows.

- The existing noise environment around the proposal is typical of a quiet rural area, with little exposure from existing traffic noise and no exposure from any existing industrial noise.
- In keeping with its setting in the Southern Highlands area, the Project and its surroundings are often affected by noise enhancing meteorological conditions, which tend to elevate night time noise levels at receivers. The area around the proposal has a high frequency of strong night time temperature inversions, which could elevate night time operational noise levels. The assessment of the effect of meteorological conditions on noise levels as used in this report is effectively more conservative than the methodology outlined in the *INP*.
- Feasible and reasonable noise control measures have been considered for the Delta Electricity Facility and are included in the proposal. The OCGT facilities have intrinsic noise mitigation measures incorporated such as: Air intake silencers; Generator transformer walls on 3 sides; and Exhaust air silencers. The CCGT facility would incorporate mitigation measures as necessary for example quiet HRSG and/or quiet condenser fans.
- Two residential dwellings are predicted to have 10^{th} percentile noise levels that exceed 40dBA which would trigger negotiated agreements or in the most extreme cases acquisition. One residential dwelling is predicted to have a marginal exceedance where it would be appropriate to negotiate an agreement or possibly provide architectural treatments to the dwelling. One residential dwelling is predicted to have a minor exceedance of 1 dB.
- On completion of commissioning the plant noise monitoring would be undertaken at representative locations to ensure compliance with predicted 10^{th} percentile noise levels.
- The potential for sleep disturbance from the operation of the development were found to be negligible for the Marulan site.
- Noise impacts due to extra traffic for the Marulan sites along Canyonleigh Road (both during construction and operation) were found to be negligible.
- A preliminary assessment of noise during the construction phase shows general compliance with the construction noise criteria. These levels are to be confirmed prior to commencement with the Contractor. A Construction Noise Management Plan should be developed to ensure a suitable program and that these levels are met.
- An assessment of low frequency noise identified that the Delta Electricity Facility has the potential for low frequency noise, however using a more detailed assessment it was found that it would be unlikely that low frequency noise impacts from the Delta Electricity Facility would cause annoyance at the closest residential receivers.
- No vibration impacts are envisaged to occur at the residential receivers.

Note

All materials specified by Wilkinson Murray Pty Limited have been selected solely on the basis of acoustic performance. Any other properties of these materials, such as fire rating, chemical properties etc. should be checked with the suppliers or other specialised bodies for fitness for a given purpose.

Quality Assurance

We are committed to and have implemented AS/NZS ISO 9001:2000 "Quality Management Systems – Requirements". This management system has been externally certified and Licence No. QEC 13457 has been issued.

AAAC

This firm is a member firm of the Association of Australian Acoustical Consultants and the work here reported has been carried out in accordance with the terms of that membership.

Version	Status	Date	Prepared by	Checked by
A	Draft	10-9-2006	John Wassermann	Sam Demasi
B	Draft	25-9-2006	John Wassermann	Sam Demasi
C	Final	14-11-2006	John Wassermann	Sam Demasi
D	Final	1-12-2006	John Wassermann	Sam Demasi
E	Draft	1-6-2007	John Wassermann	Sam Demasi
F	Draft	19-7-2007	John Wassermann	Sam Demasi
G	Draft	18-2-2008	John Wassermann	Sam Demasi
G	Final	1-4-2008	John Wassermann	Sam Demasi
G	Final	7-5-2008	John Wassermann	Sam Demasi
G	Final	11-7-2008	John Wassermann	-
G	Final	29-7-2008	John Wassermann	-

APPENDIX A

GLOSSARY OF TERMS

GLOSSARY

Most environments are affected by environmental noise which continuously varies, largely as a result of road traffic. To describe the overall noise environment, a number of noise descriptors have been developed and these involve statistical and other analysis of the varying noise over sampling periods, typically taken as 15 minutes. These descriptors, which are demonstrated in the graph overleaf, are here defined.

Maximum Noise Level (L_{Amax}) – The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.

L_{A1} – The L_{A1} level is the noise level which is exceeded for 1% of the sample period. During the sample period, the noise level is below the L_{A1} level for 99% of the time.

L_{A10} – The L_{A10} level is the noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the L_{A10} level for 90% of the time. The L_{A10} is a common noise descriptor for environmental noise and road traffic noise.

L_{Aeq} – The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and road traffic noise.

$L_{Aeq,(1hr)}$ – The L_{Aeq} noise level for a one hour period.

$L_{Aeq,(15hr)}$ – The L_{Aeq} noise level for the period 7am to 10pm.

$L_{Aeq,(9hr)}$ – The L_{Aeq} noise level for the period 10pm to 7am.

L_{A50} – The L_{A50} level is the noise level which is exceeded for 50% of the sample period. During the sample period, the noise level is below the L_{A50} level for 50% of the time.

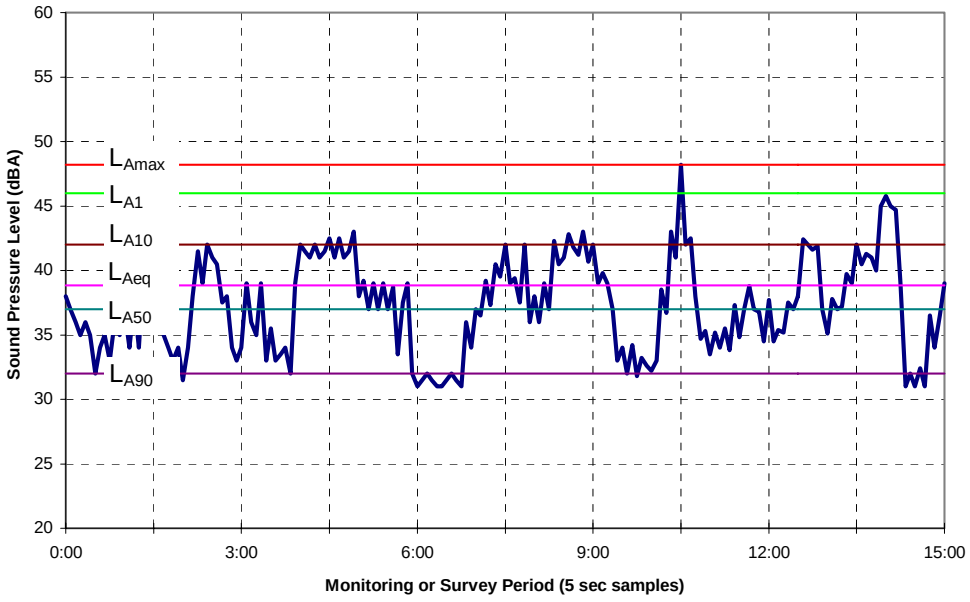
L_{A90} – The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.

ABL – The Assessment Background Level is the single figure background level representing each assessment period (daytime, evening and night time) for each day. It is determined by calculating the 10^{th} percentile (lowest 10^{th} percent) background level (L_{A90}) for each period.

RBL – The Rating Background Level for each period is the median value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period – daytime, evening and night time.

dBA – The A-weighting has a frequency response corresponding approximately to that of human hearing. People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4000 Hz), and less sensitive at lower and higher frequencies. Thus, the level of a sound in dBA is a good measure of the "loudness" of that sound. Different sources having the same dBA level generally sound about equally as loud, although the perceived loudness can also be affected by the character of the sound (eg the loudness of human speech and a distant motorbike may be perceived differently, although they are of the same dBA level).

dBC – The C-Weighting has a relatively flat response. C-Weighting is used in evaluating annoying community noises such as low frequency sound.

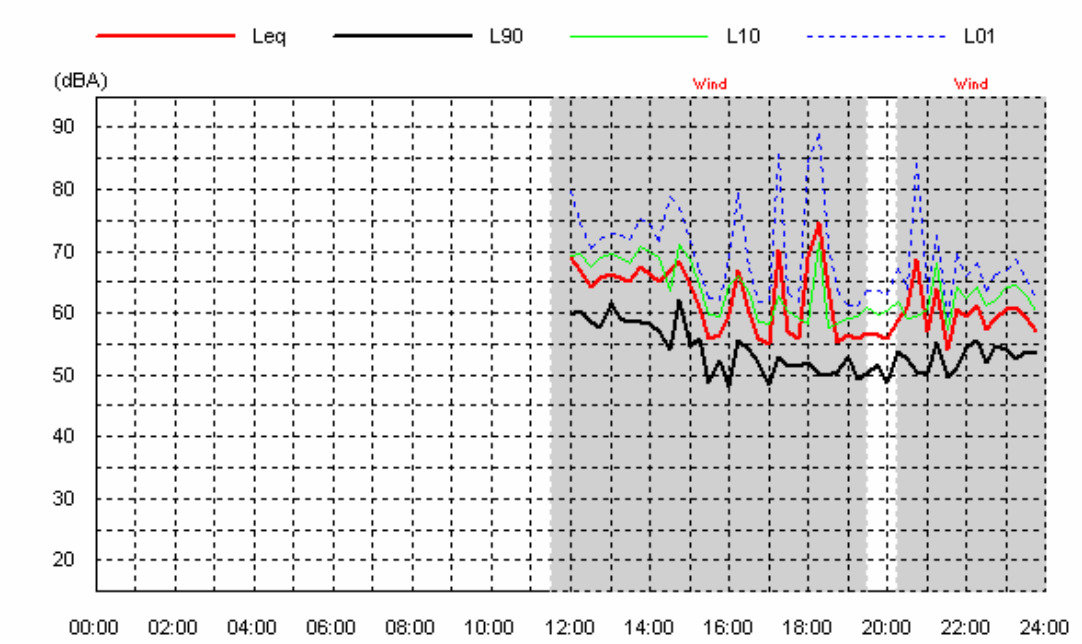


APPENDIX B

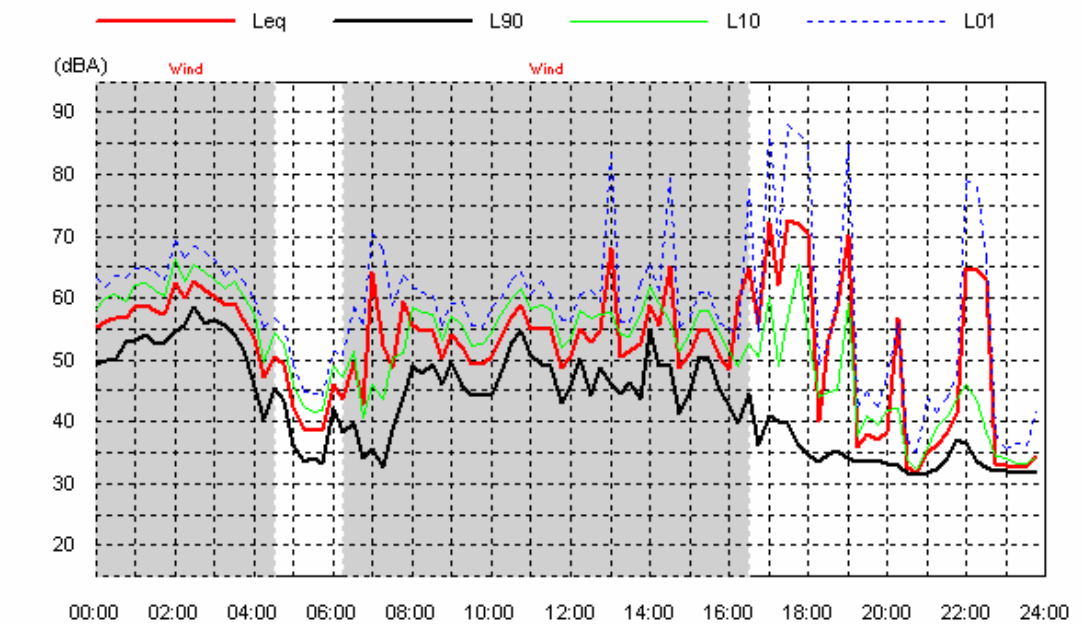
NOISE MEASUREMENT RESULTS

Location: Marulan site – Location 1 (RTA Noise Logger Version 1 - 25)
Data shaded: Wind

Sun 07 May 06

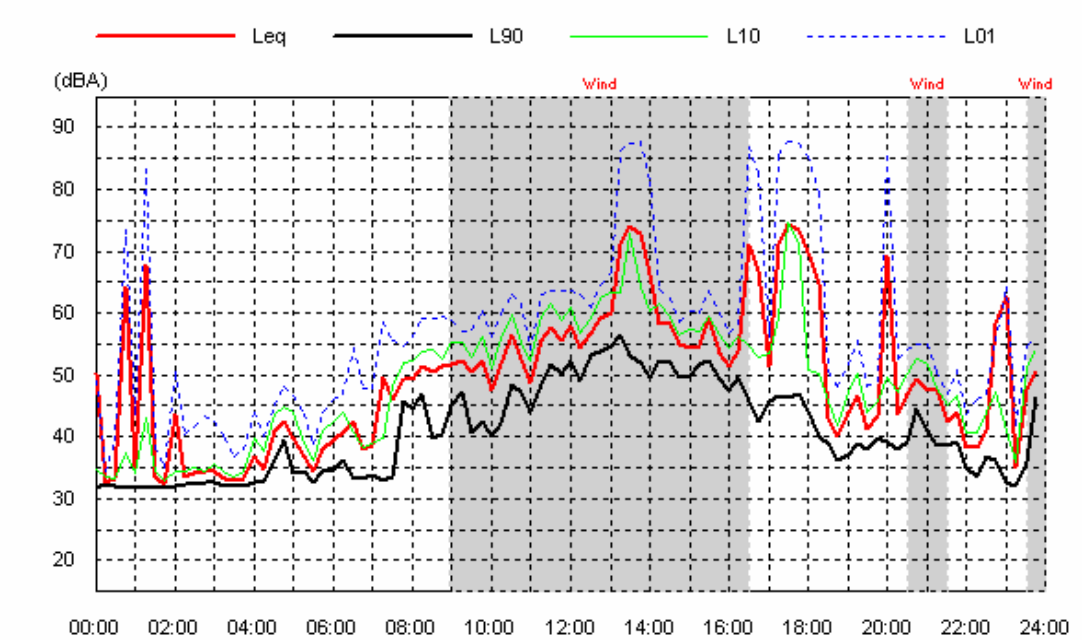


Mon 08 May 06

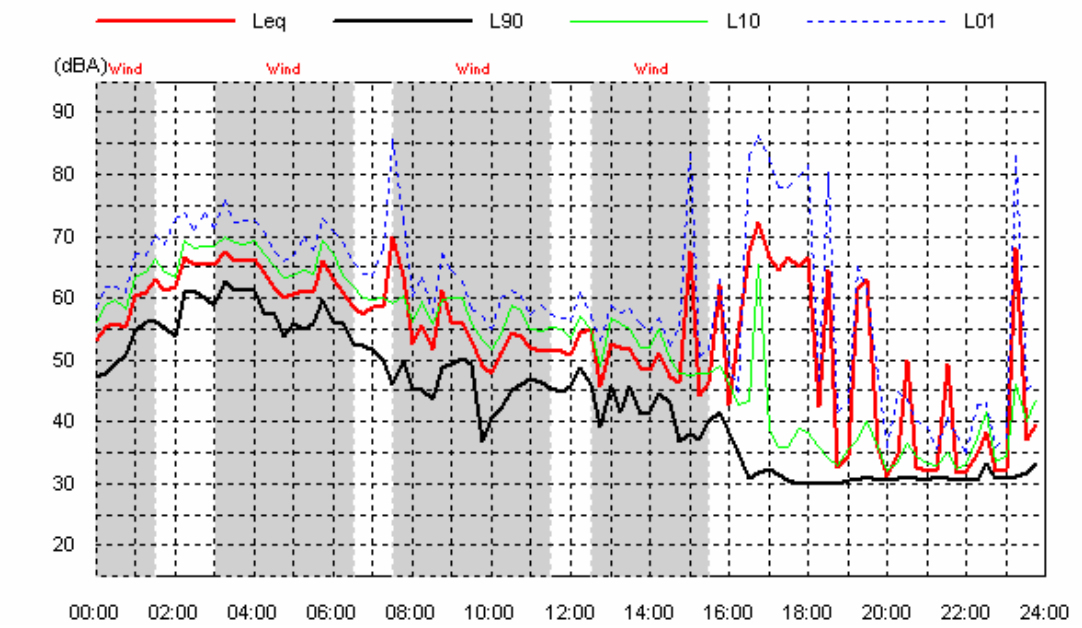


Location: Marulan site – Location 1 (RTA Noise Logger Version 1 - 25)
Data shaded: Wind

Tue 09 May 06

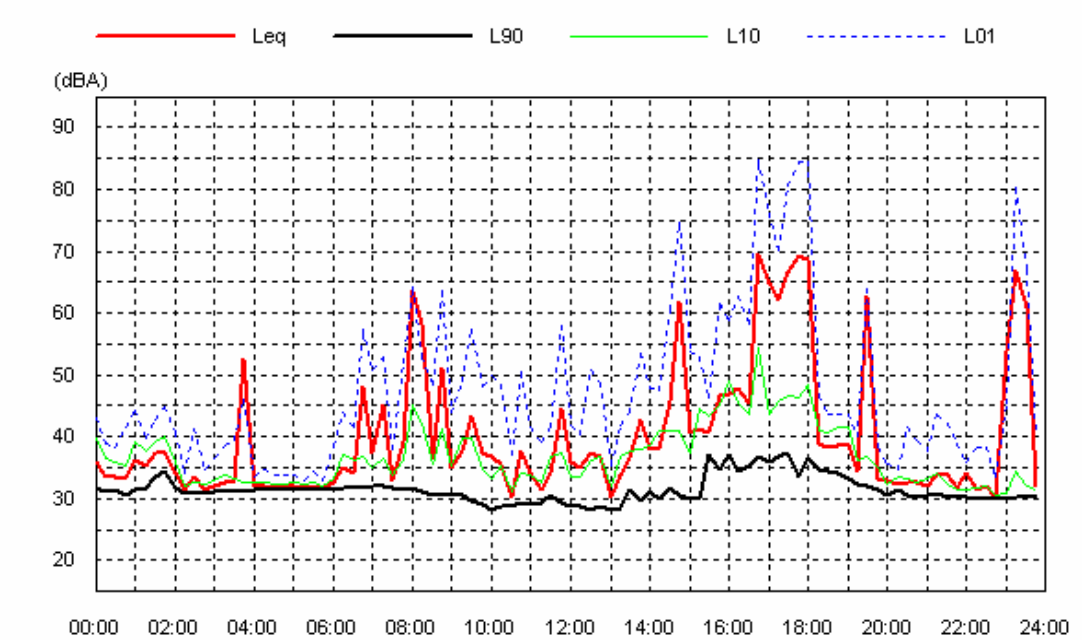


Wed 10 May 06

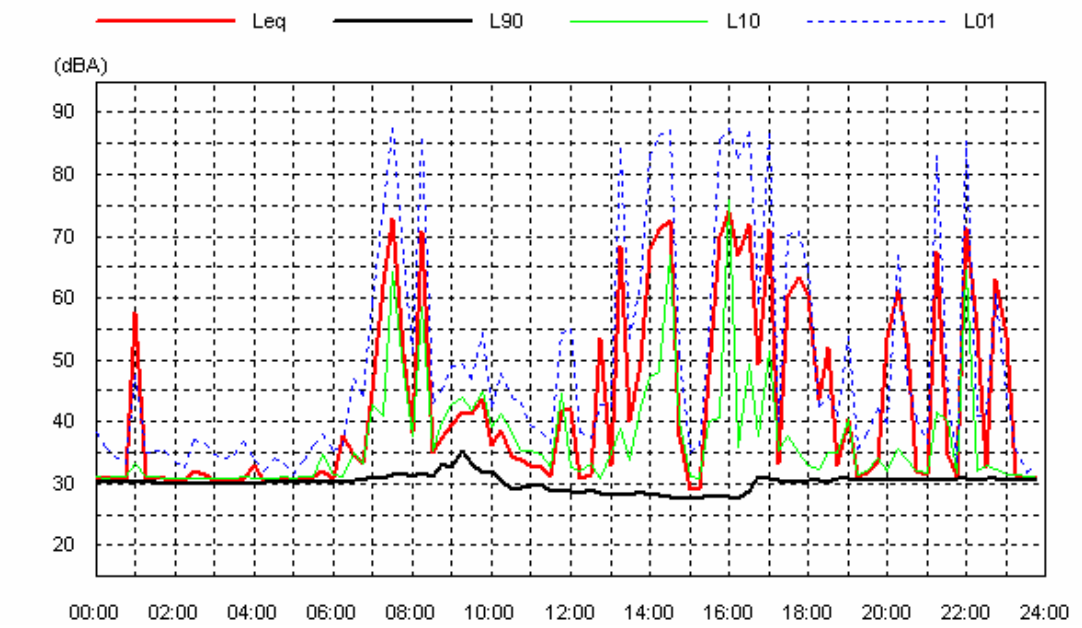


Location: Marulan site – Location 1 (RTA Noise Logger Version 1 - 25)
Data shaded: Wind

Thu 11 May 06

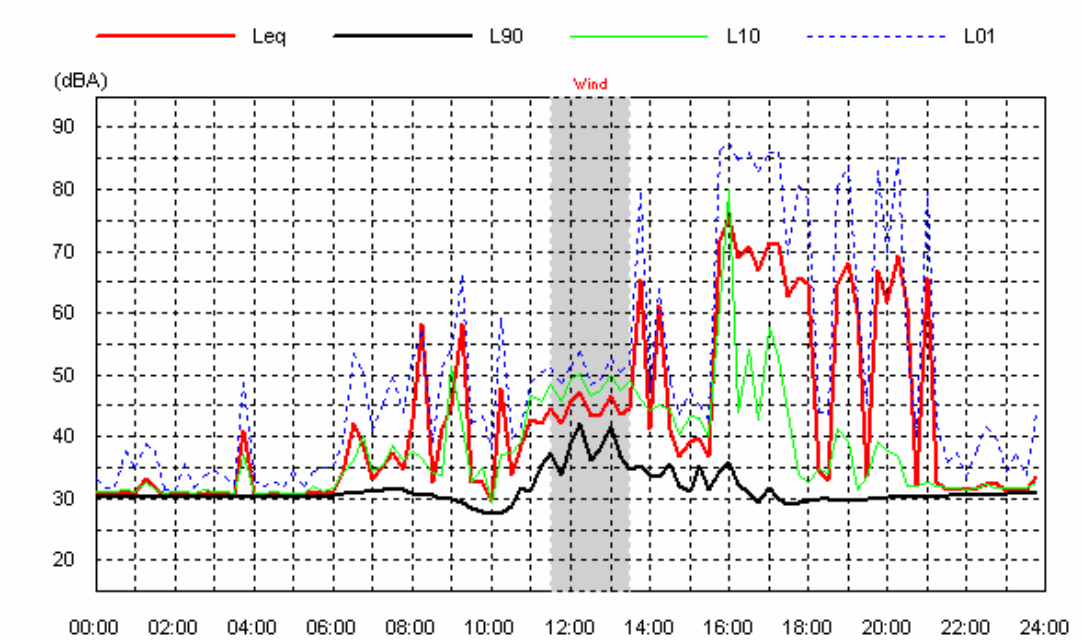


Fri 12 May 06

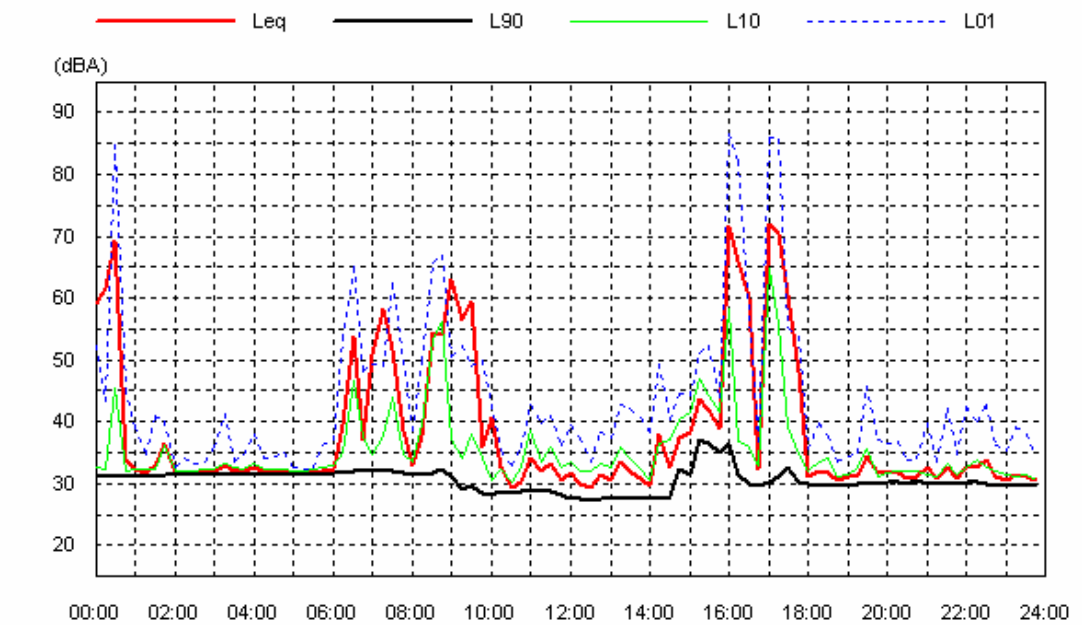


Location: Marulan site – Location 1 (RTA Noise Logger Version 1 - 25)
Data shaded: Wind

Sat 13 May 06

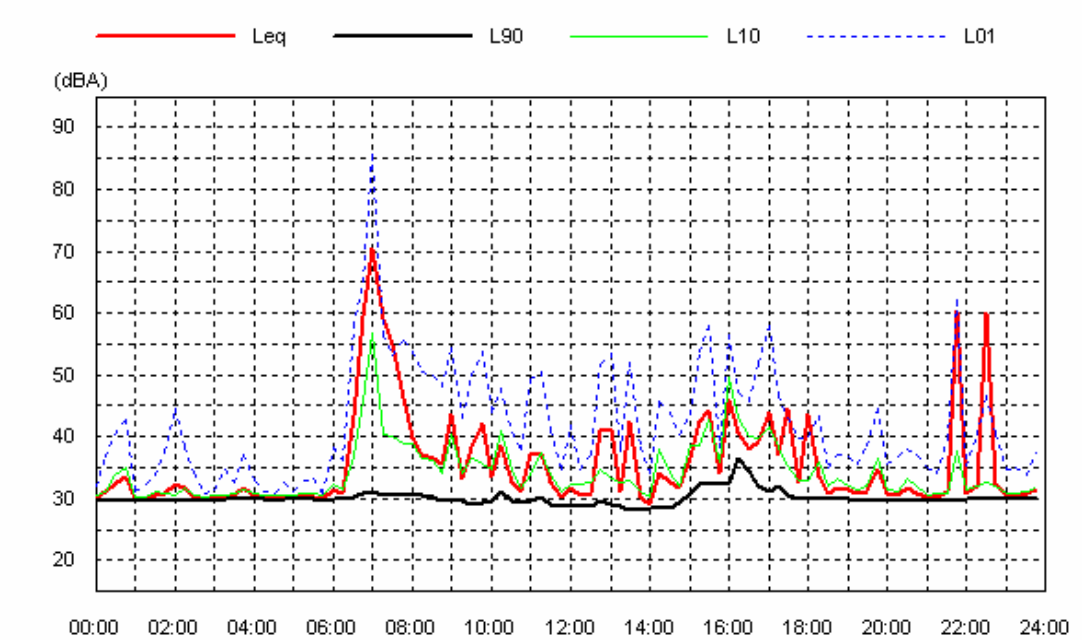


Sun 14 May 06

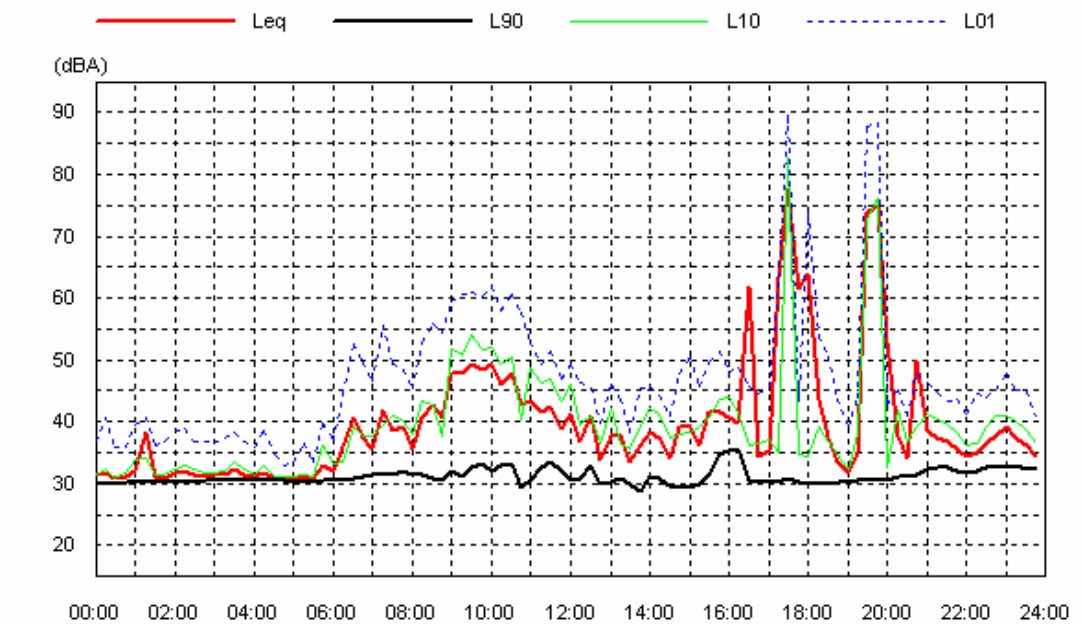


Location: Marulan site – Location 1 (RTA Noise Logger Version 1 - 25)
Data shaded: Wind

Mon 15 May 06

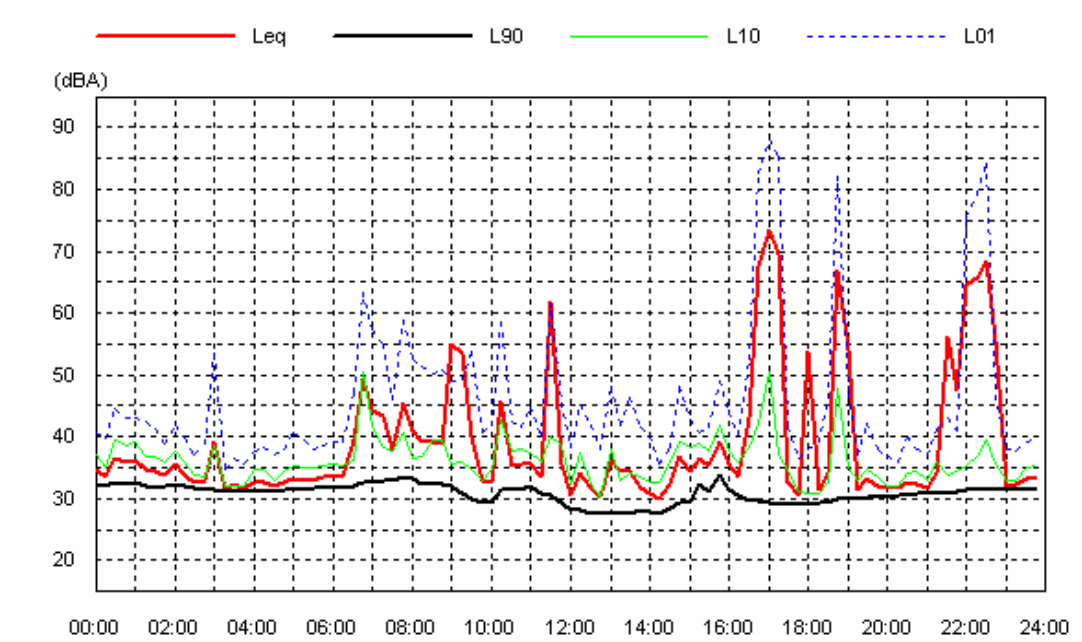


Tue 16 May 06

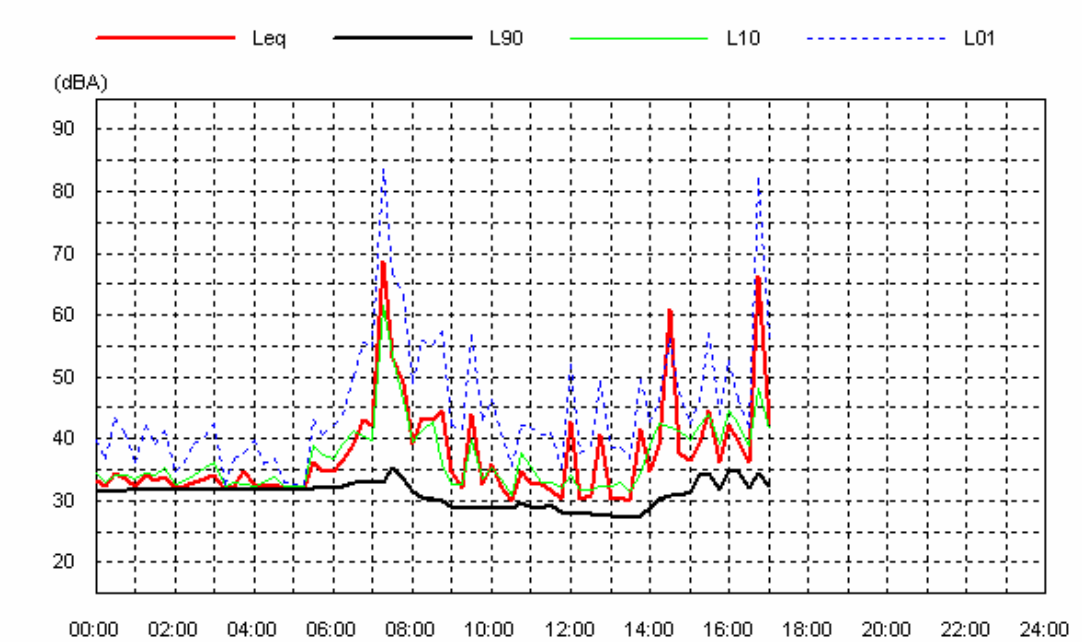


Location: Marulan site – Location 1 (RTA Noise Logger Version 1 - 25)
Data shaded: Wind

Wed 17 May 06

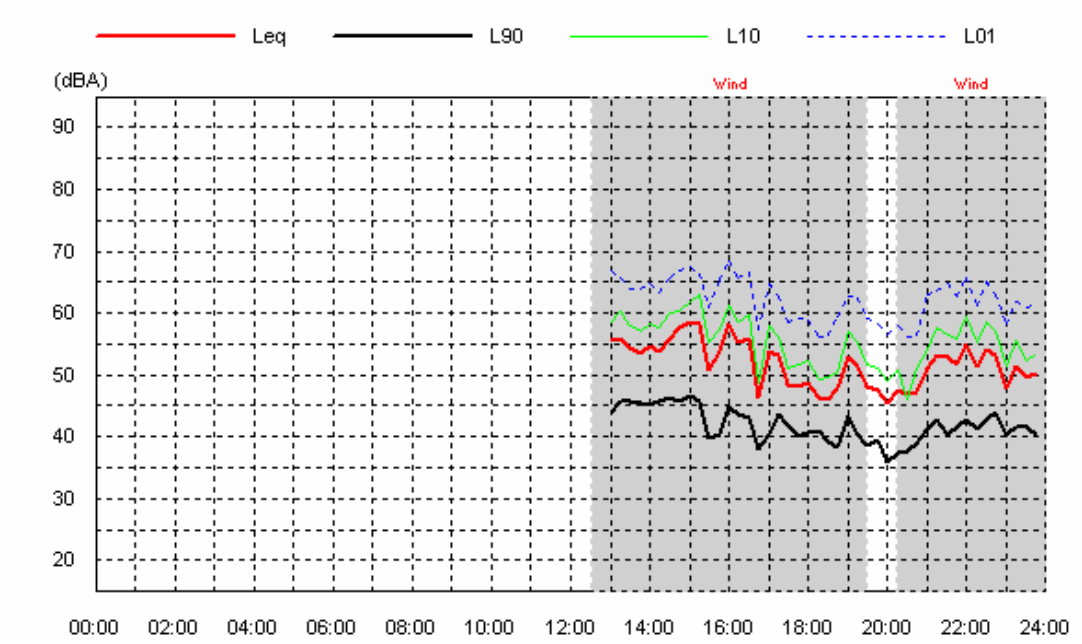


Thu 18 May 06

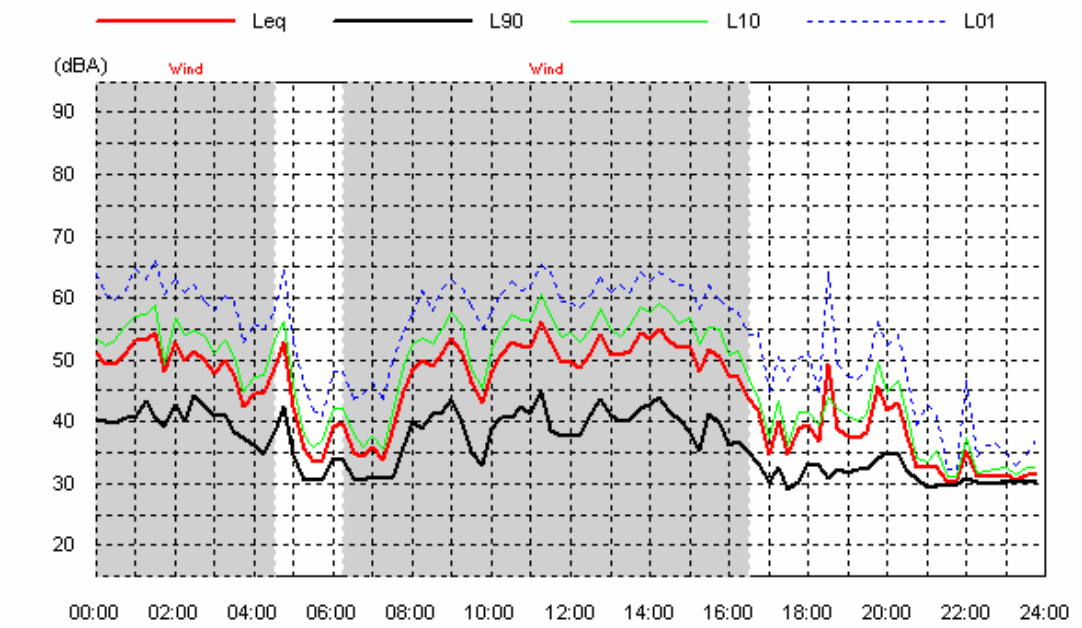


Location: Marulan site – Location 2 (RTA Noise Logger Version 1 - 13)
Data shaded: Wind

Sun 07 May 06

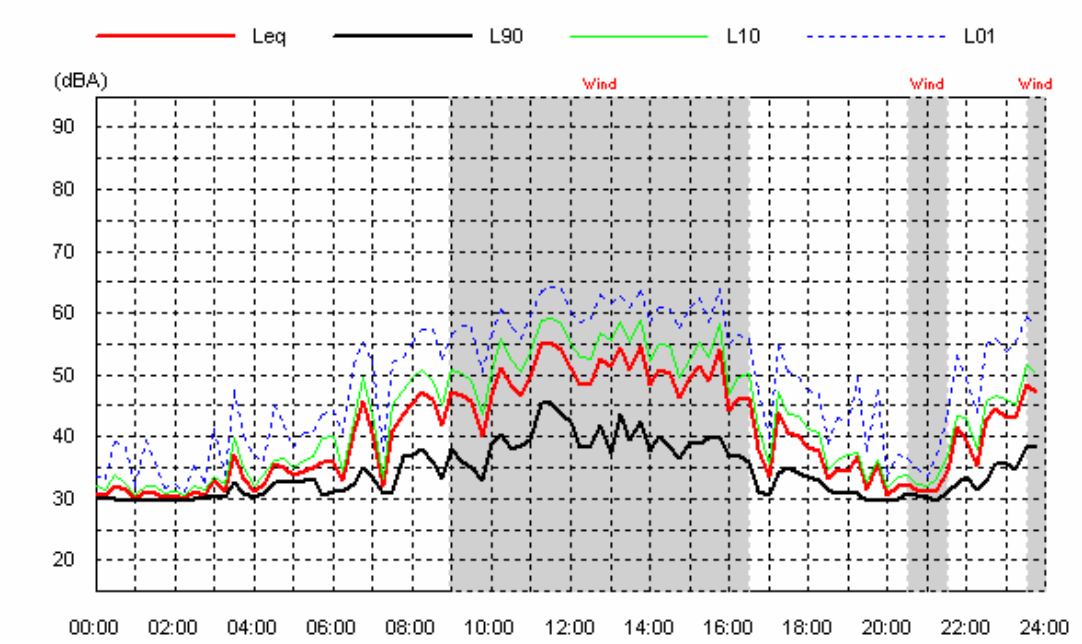


Mon 08 May 06

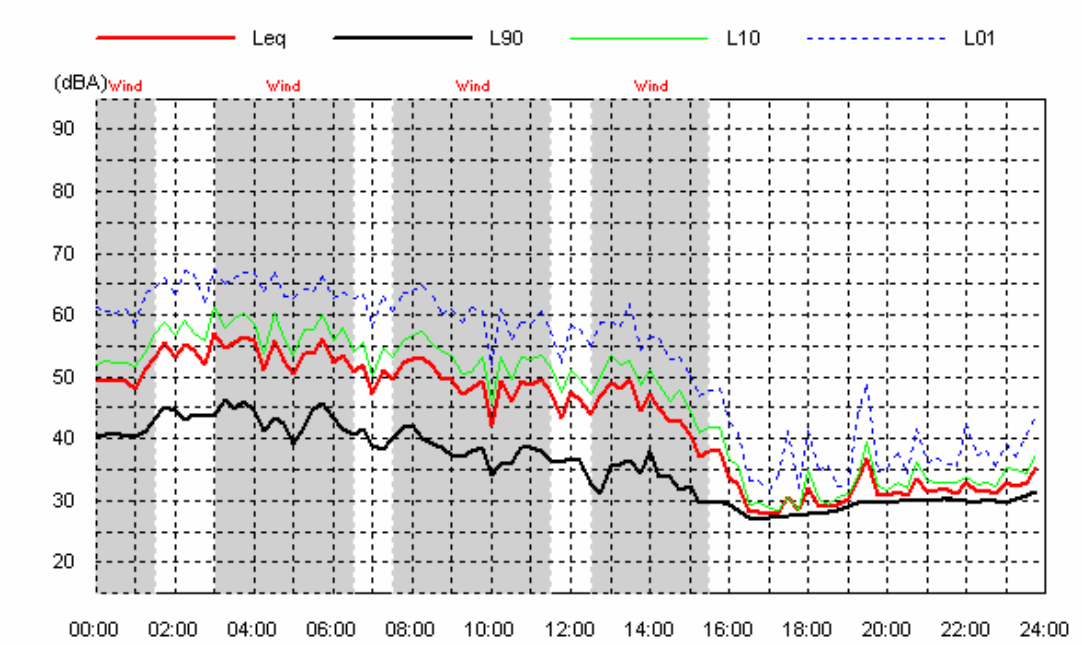


Location: Marulan site – Location 2 (RTA Noise Logger Version 1 - 13)
Data shaded: Wind

Tue 09 May 06

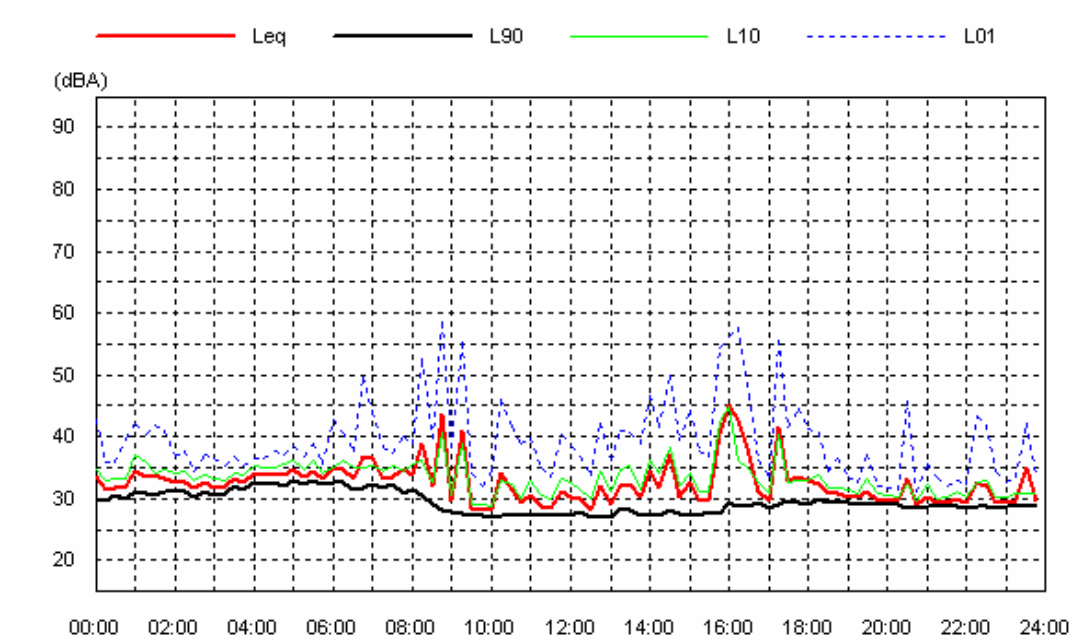


Wed 10 May 06

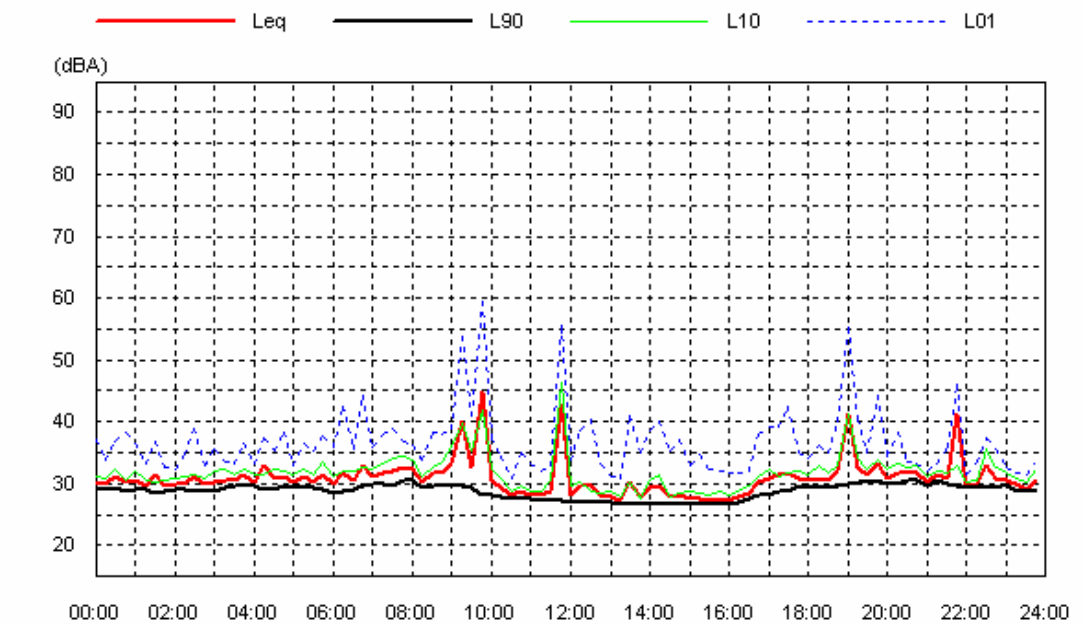


Location: Marulan site – Location 2 (RTA Noise Logger Version 1 - 13)
Data shaded: Wind

Thu 11 May 06

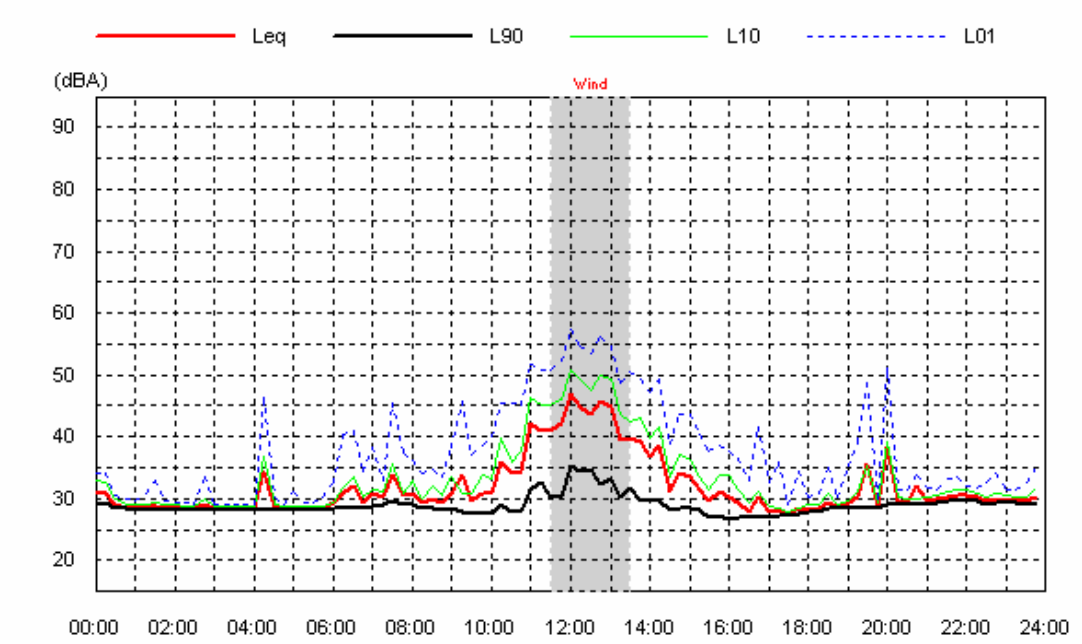


Fri 12 May 06

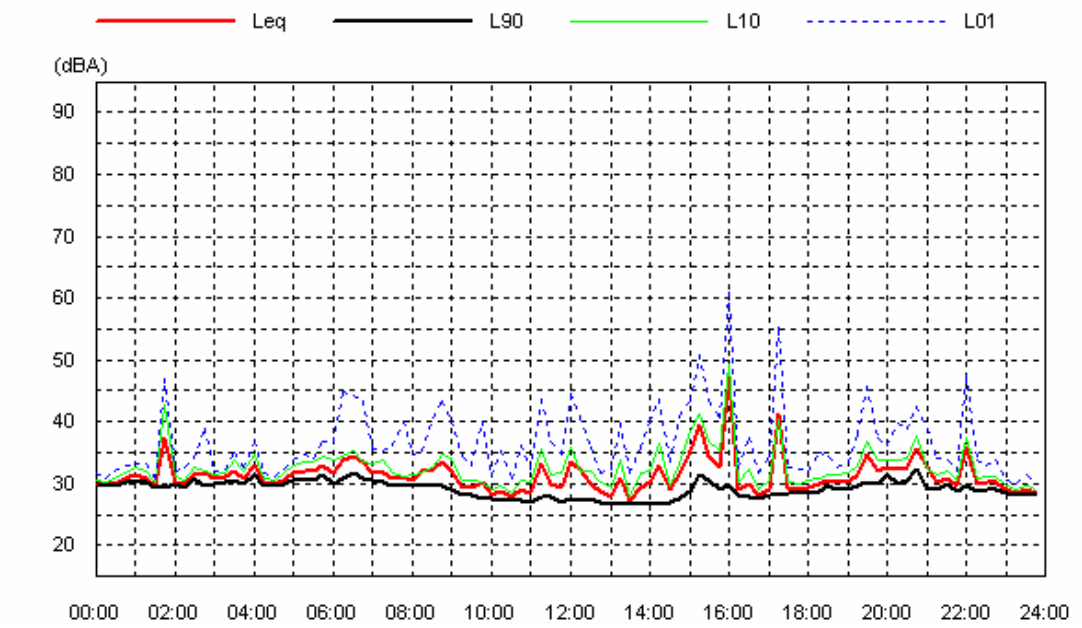


Location: Marulan site – Location 2 (RTA Noise Logger Version 1 - 13)
Data shaded: Wind

Sat 13 May 06

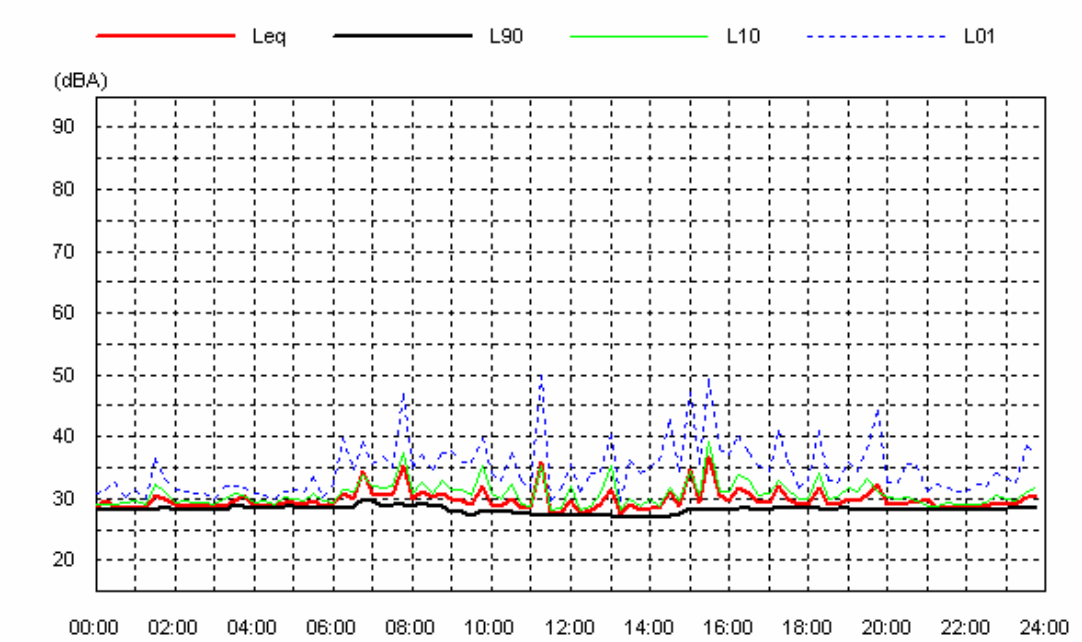


Sun 14 May 06

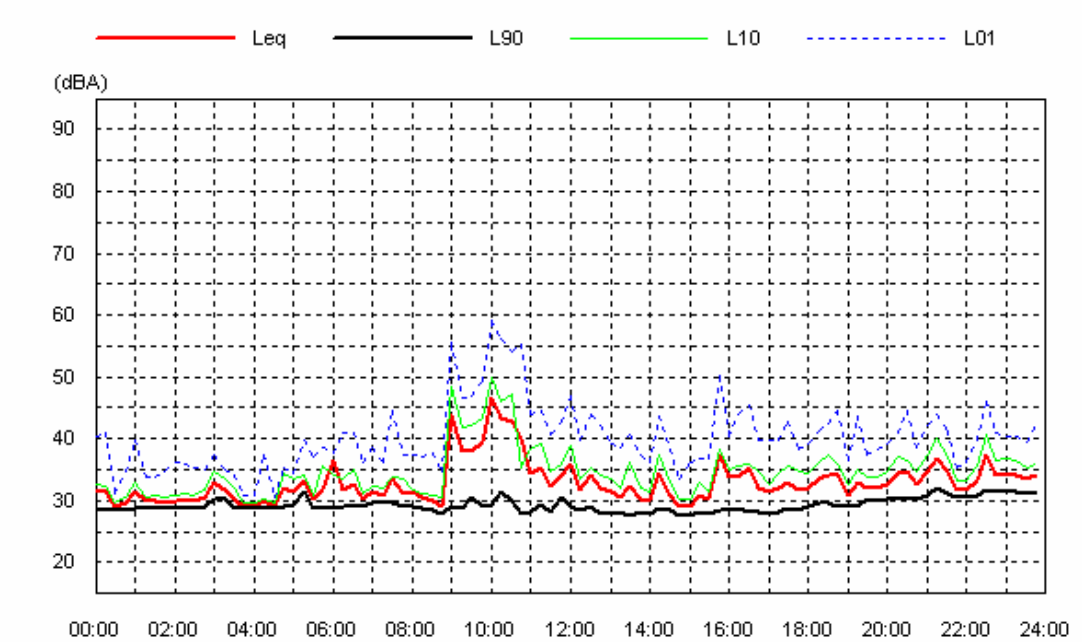


Location: Marulan site – Location 2 (RTA Noise Logger Version 1 - 13)
Data shaded: Wind

Mon 15 May 06

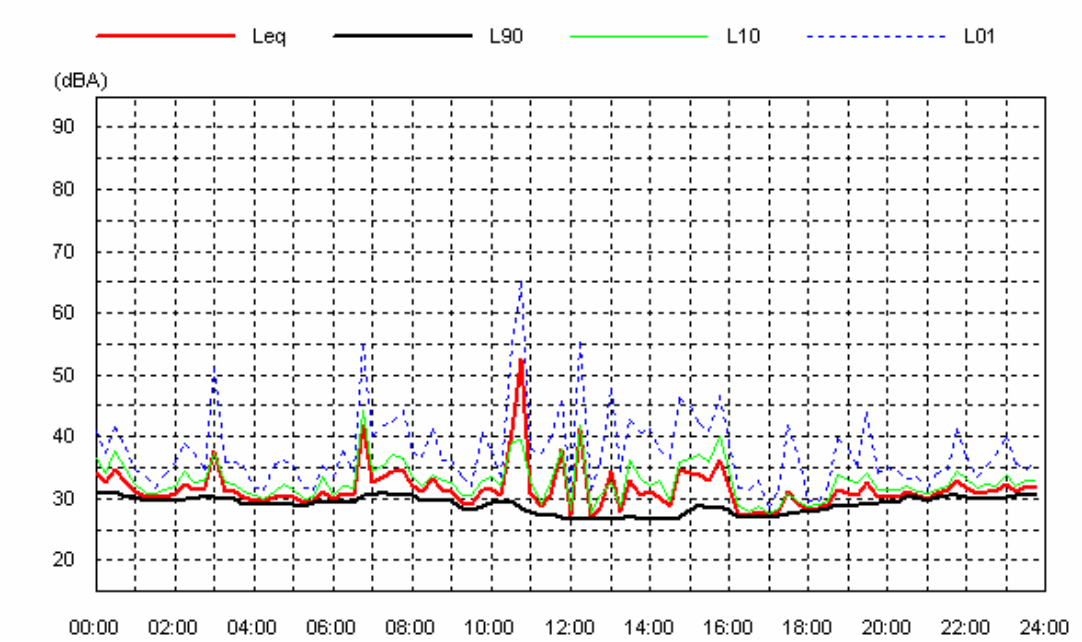


Tue 16 May 06

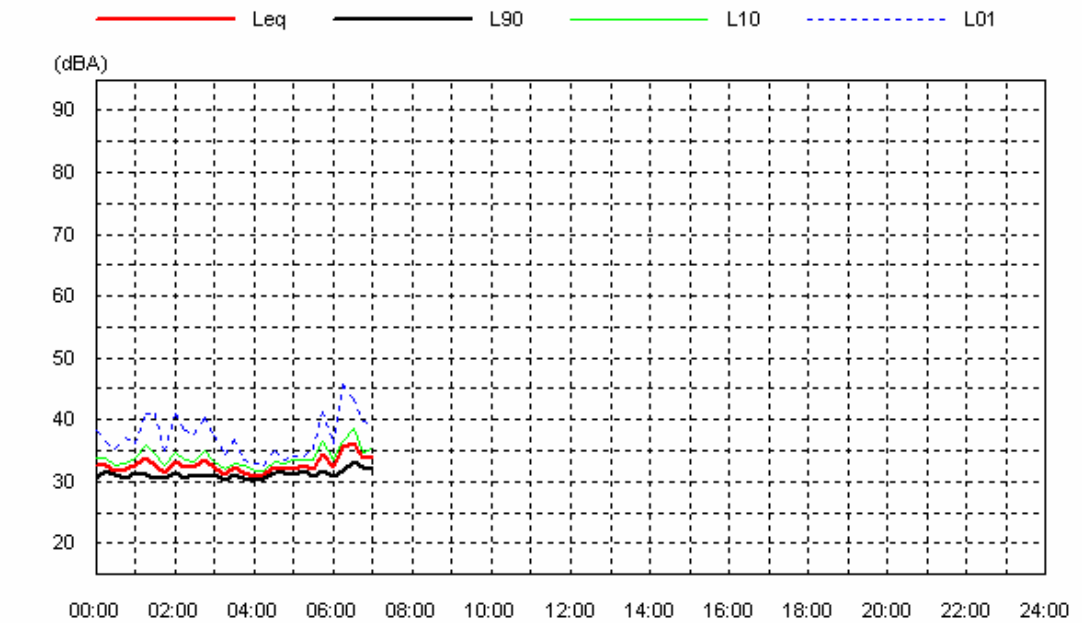


Location: Marulan site – Location 2 (RTA Noise Logger Version 1 - 13)
Data shaded: Wind

Wed 17 May 06

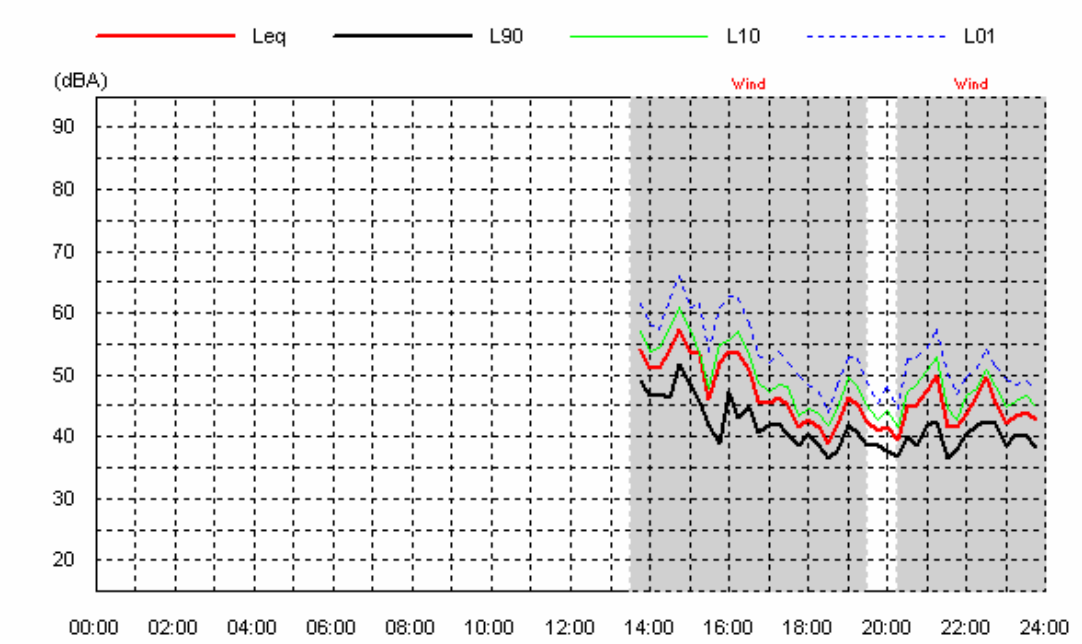


Thu 18 May 06

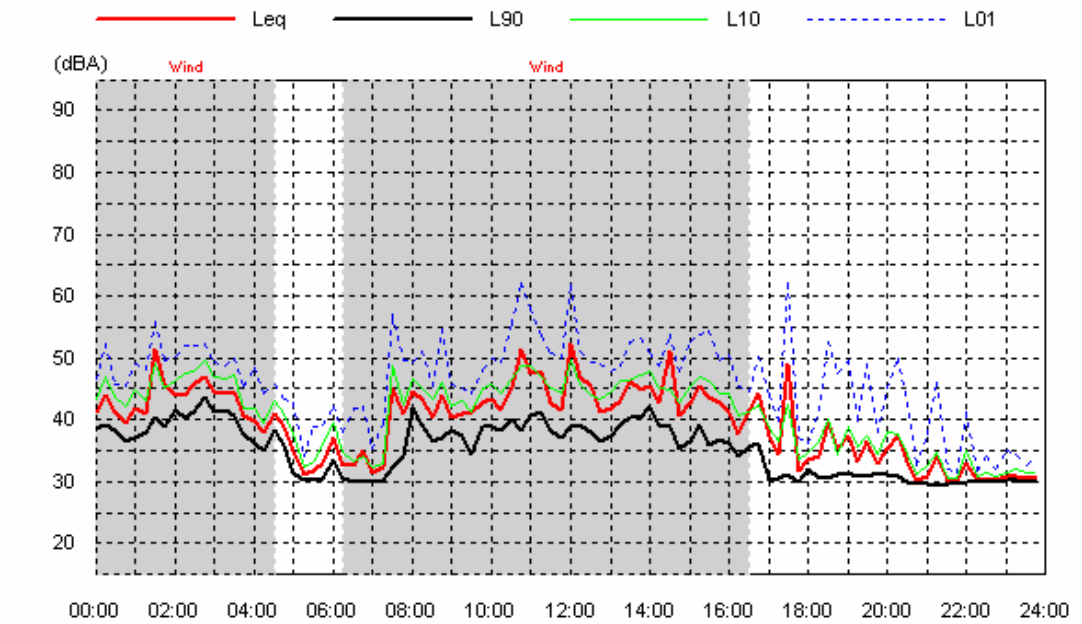


Location: Marulan site – Location 3 (RTA Noise Logger Version 1 - 12)
Data shaded: Wind

Sun 07 May 06

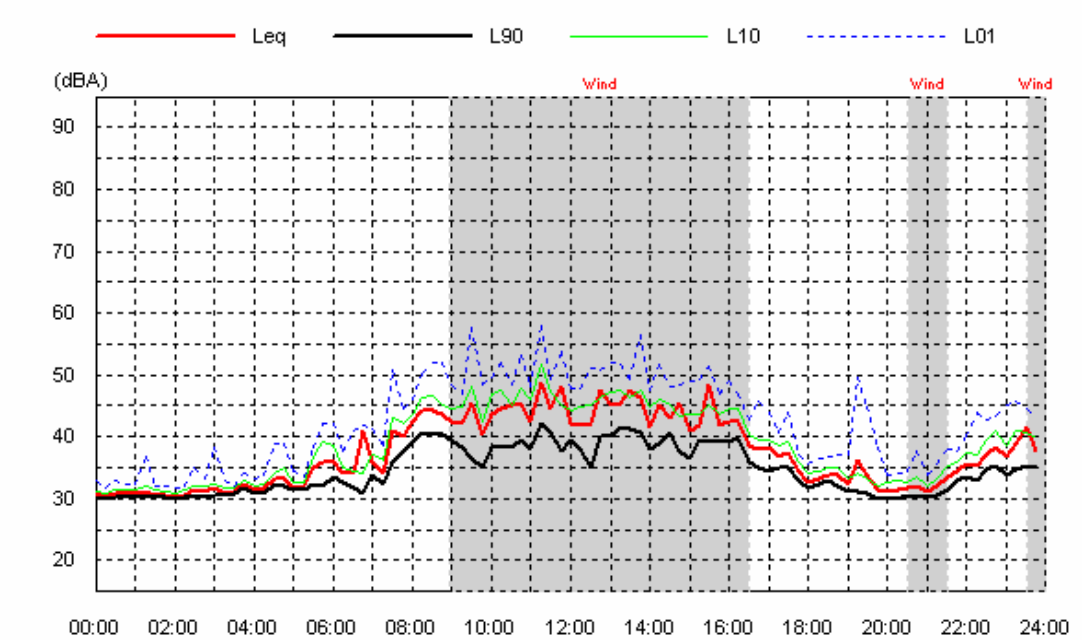


Mon 08 May 06

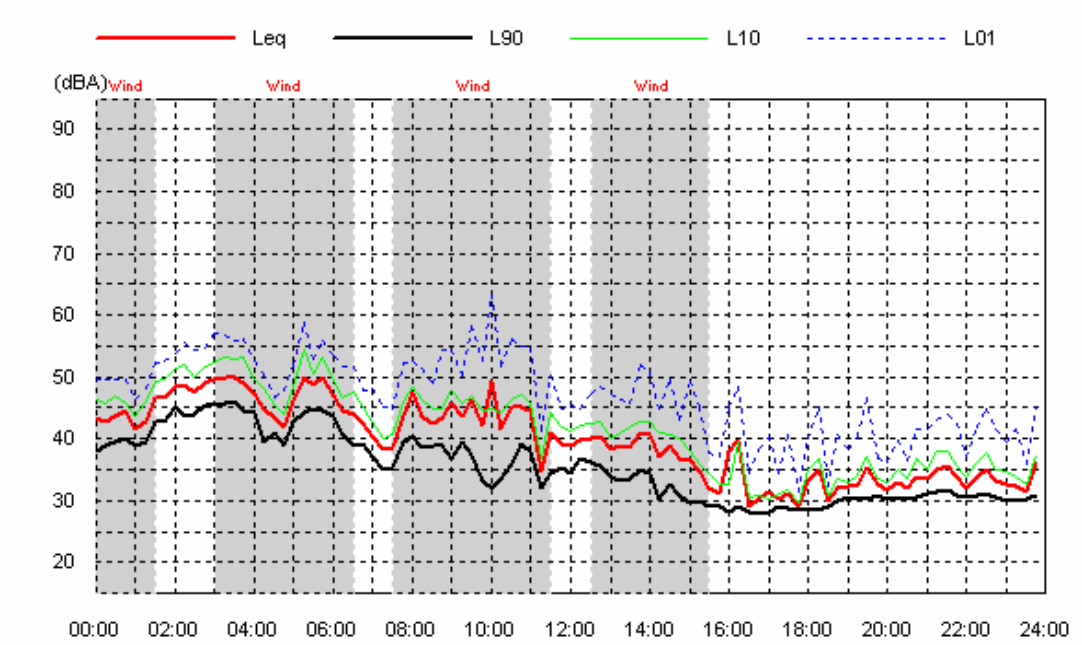


Location: Marulan site – Location 3 (RTA Noise Logger Version 1 - 12)
Data shaded: Wind

Tue 09 May 06

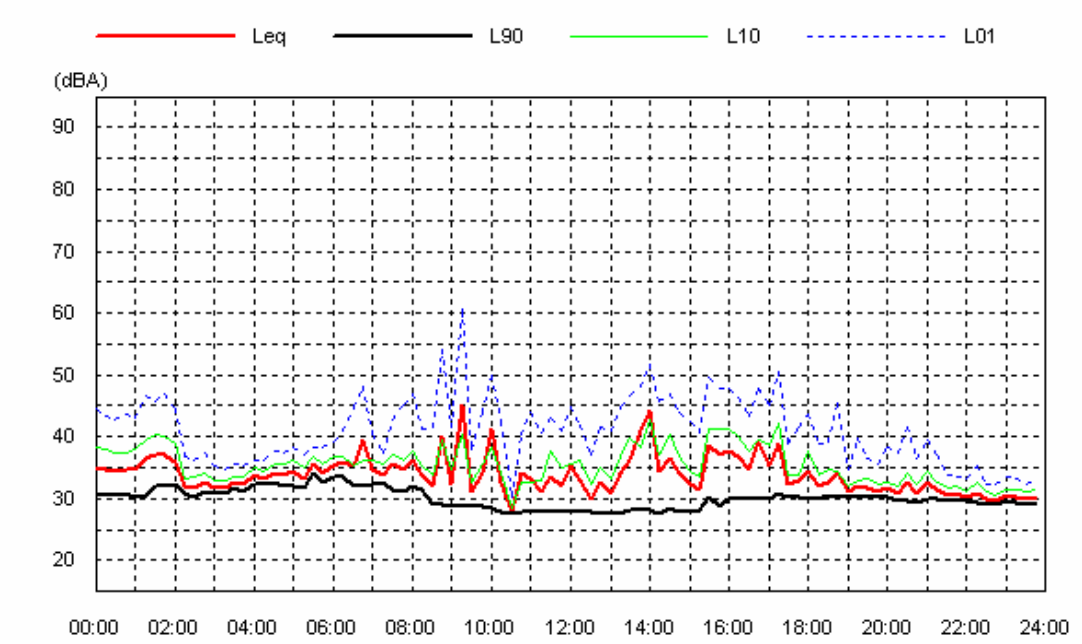


Wed 10 May 06

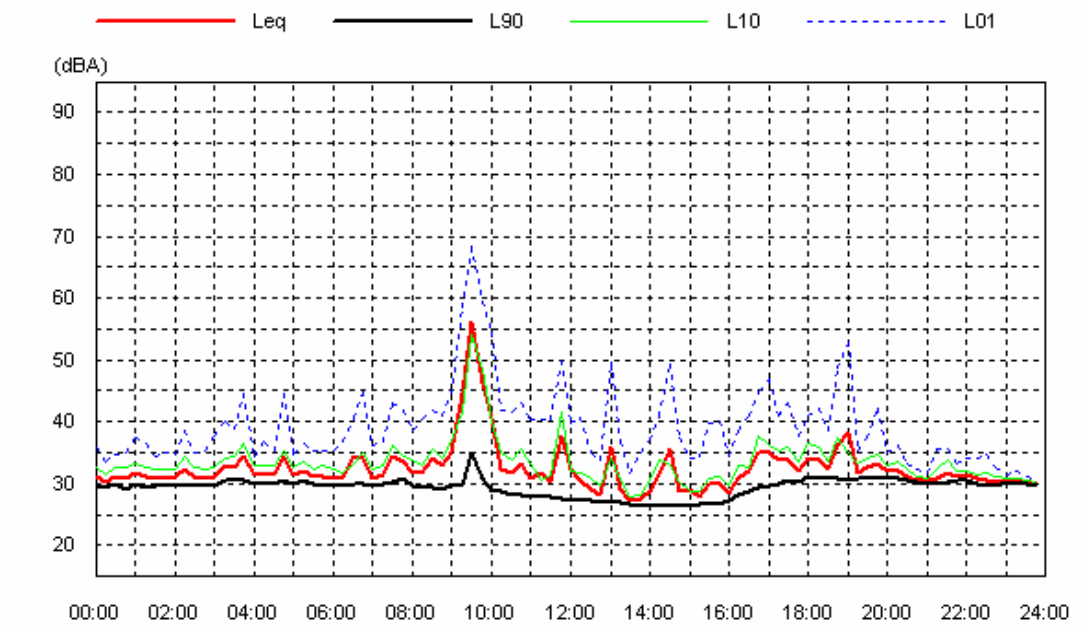


Location: Marulan site – Location 3 (RTA Noise Logger Version 1 - 12)
Data shaded: Wind

Thu 11 May 06

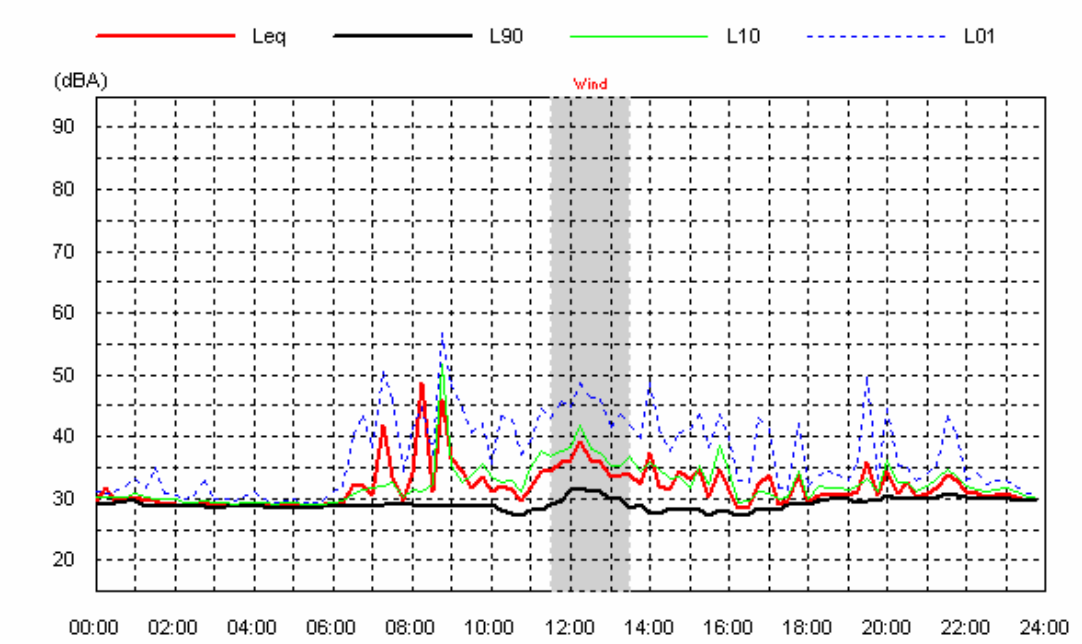


Fri 12 May 06

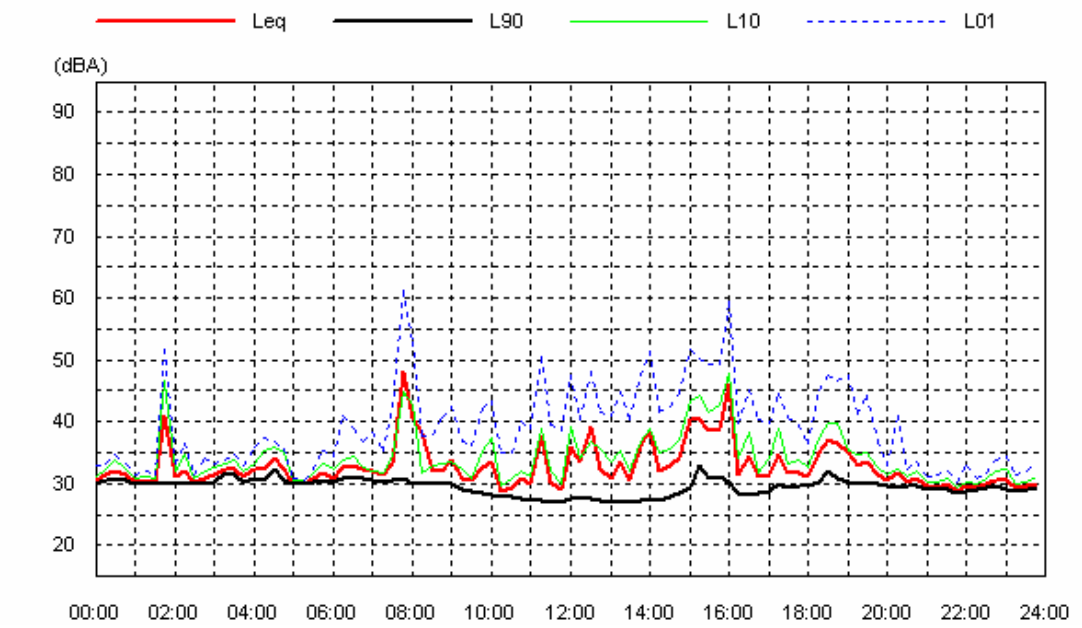


Location: Marulan site – Location 3 (RTA Noise Logger Version 1 - 12)
Data shaded: Wind

Sat 13 May 06

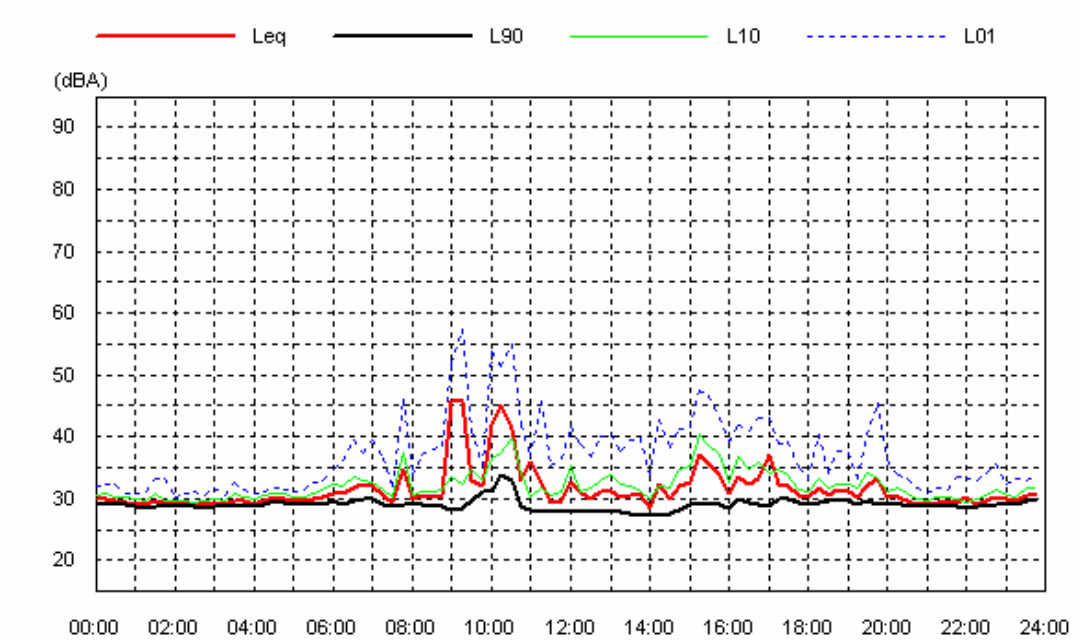


Sun 14 May 06

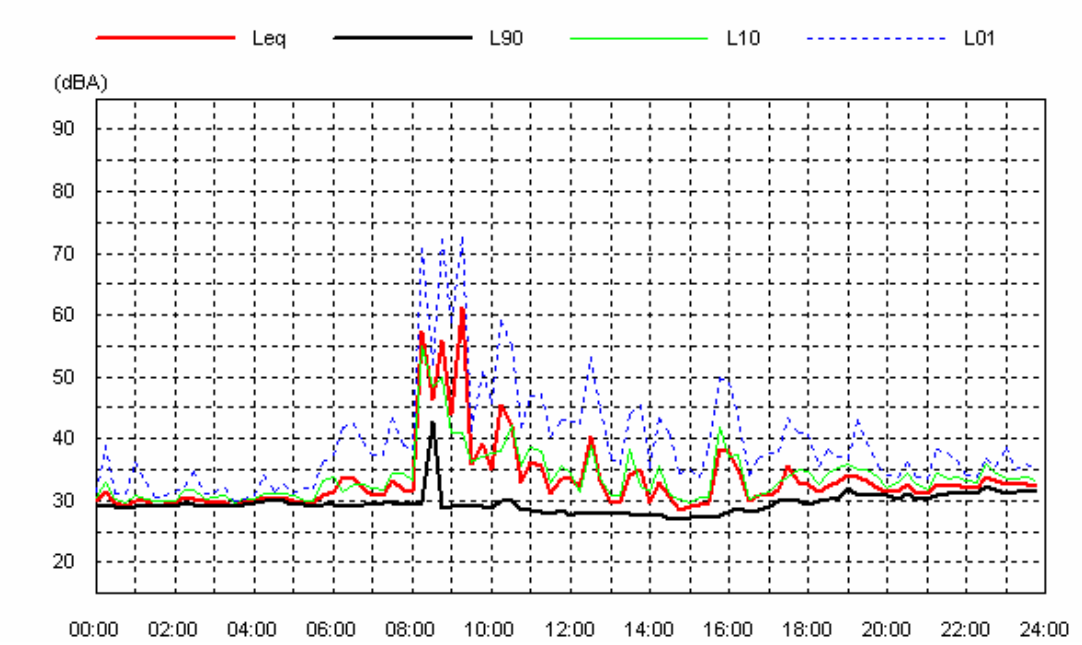


Location: Marulan site – Location 3 (RTA Noise Logger Version 1 - 12)
Data shaded: Wind

Mon 15 May 06

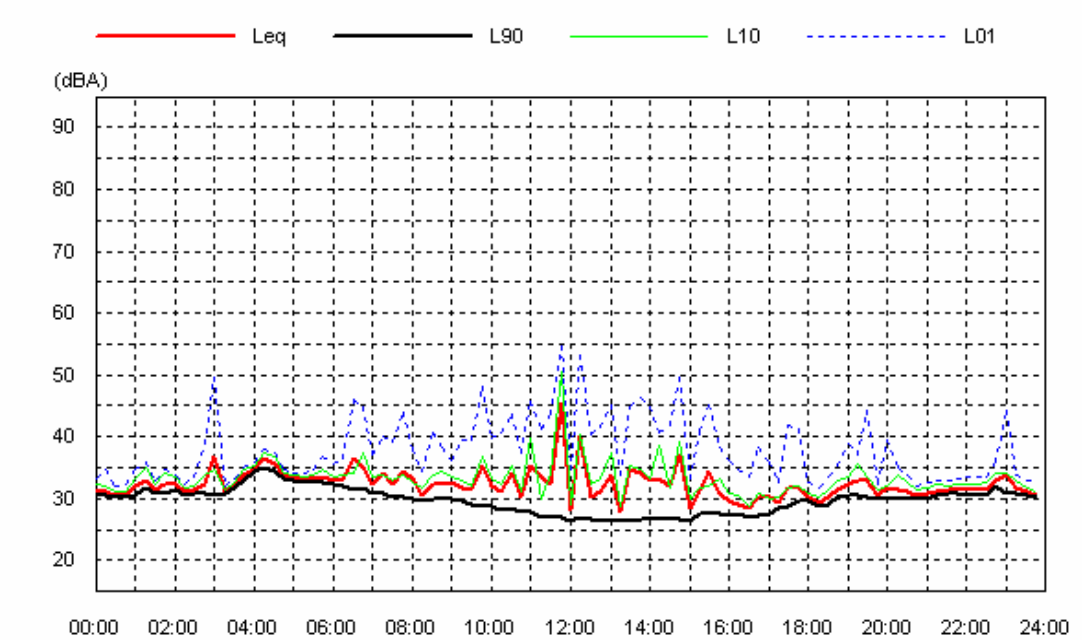


Tue 16 May 06

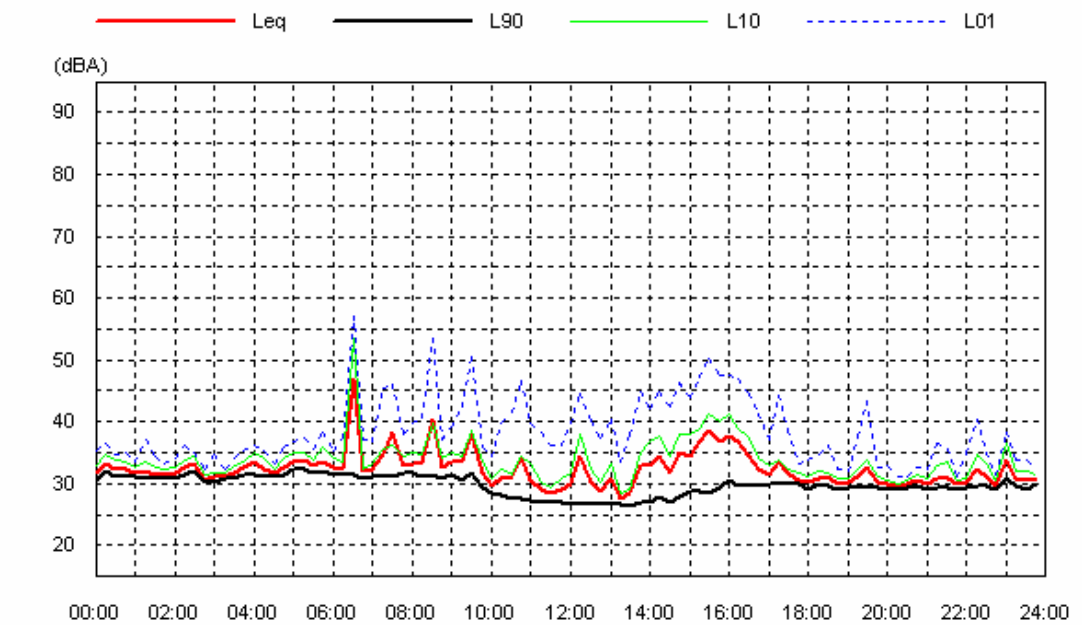


Location: Marulan site – Location 3 (RTA Noise Logger Version 1 - 12)
Data shaded: Wind

Wed 17 May 06

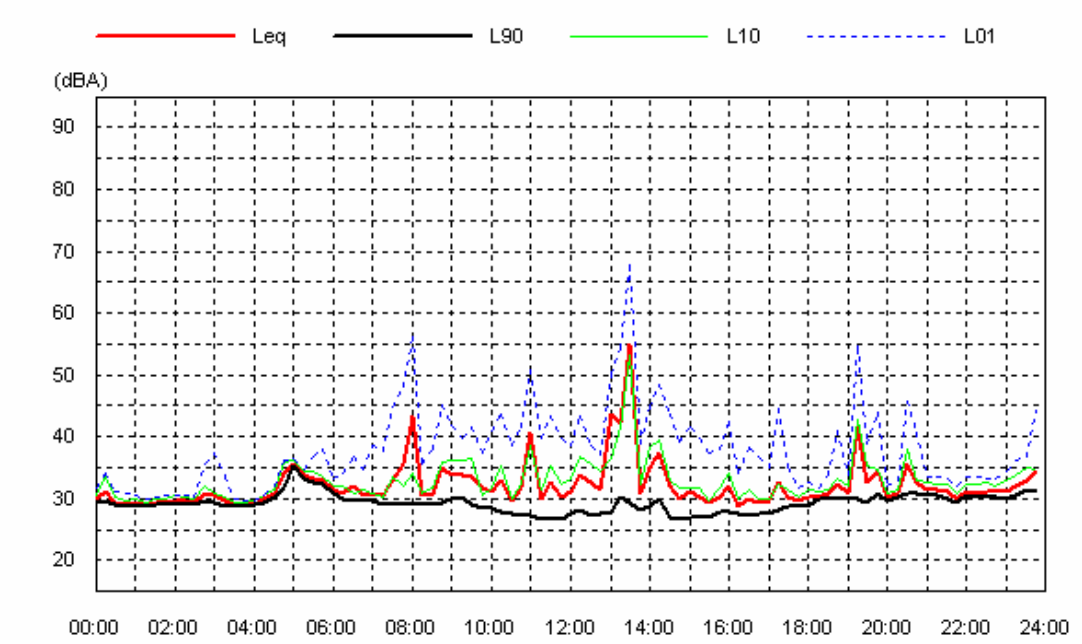


Thu 18 May 06

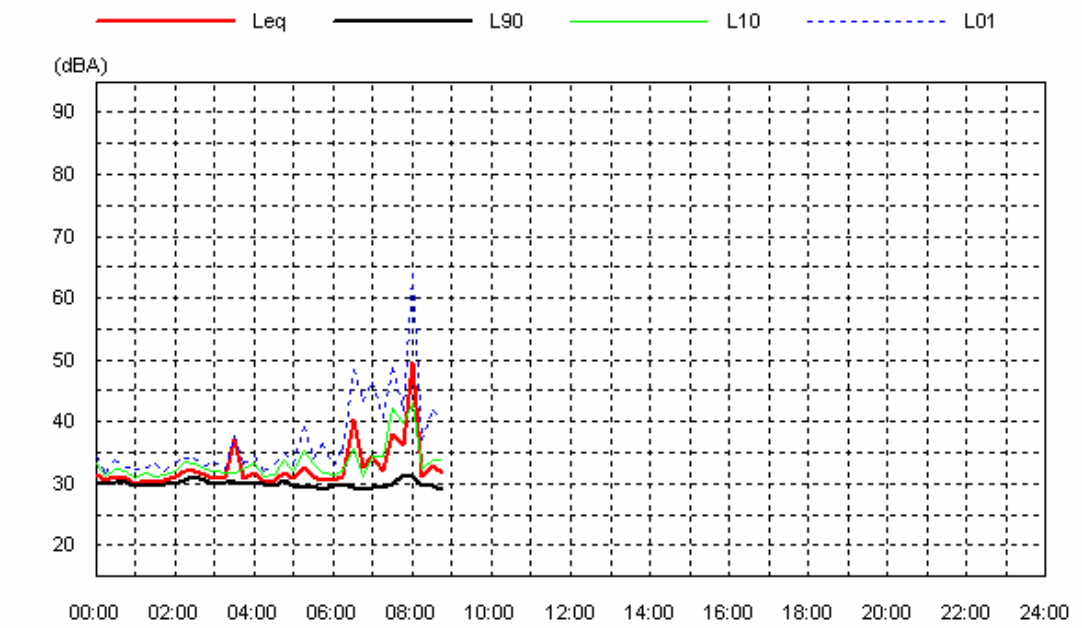


Location: Marulan site – Location 3 (RTA Noise Logger Version 1 - 12)
Data shaded: Wind

Fri 19 May 06

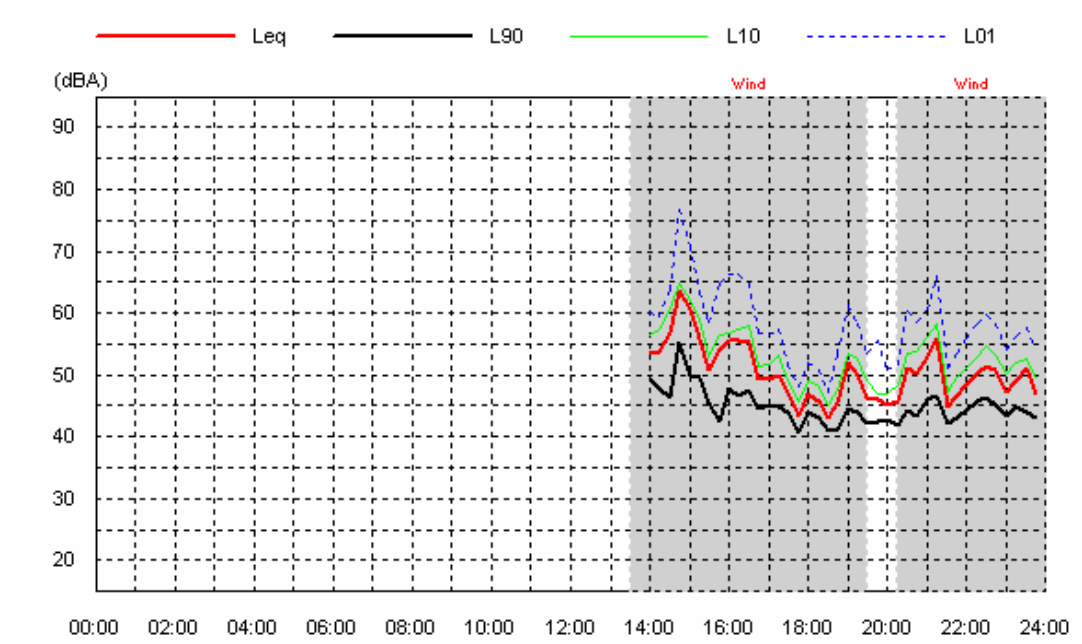


Sat 20 May 06

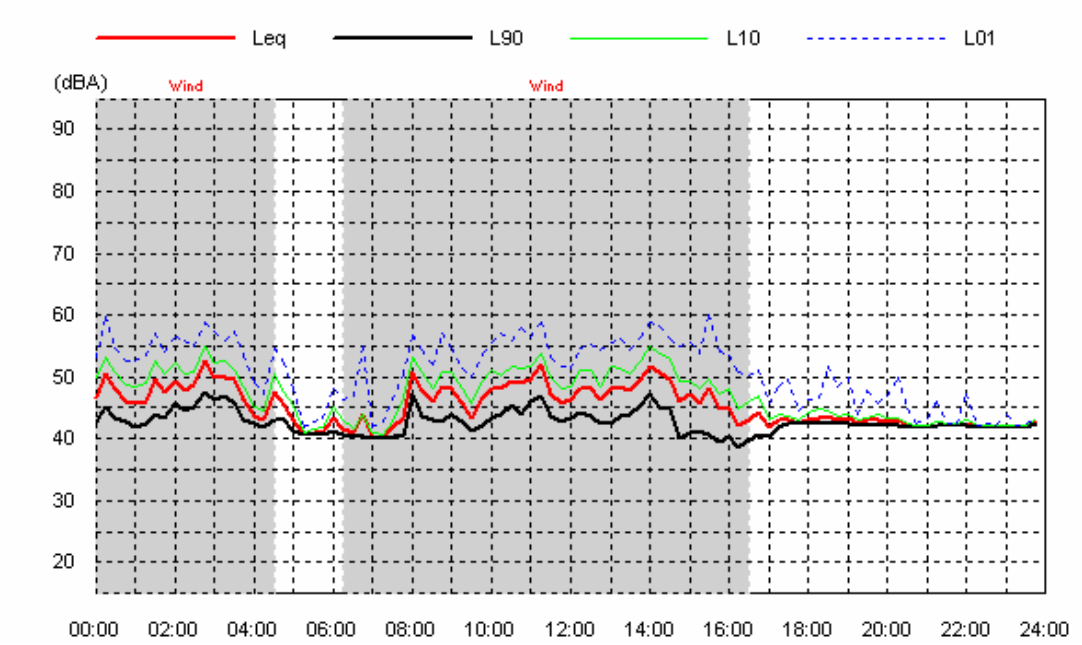


Location: Marulan site – Location 4 (RTA Noise Logger Version 1 - 26)
Data shaded: Wind

Sun 07 May 06

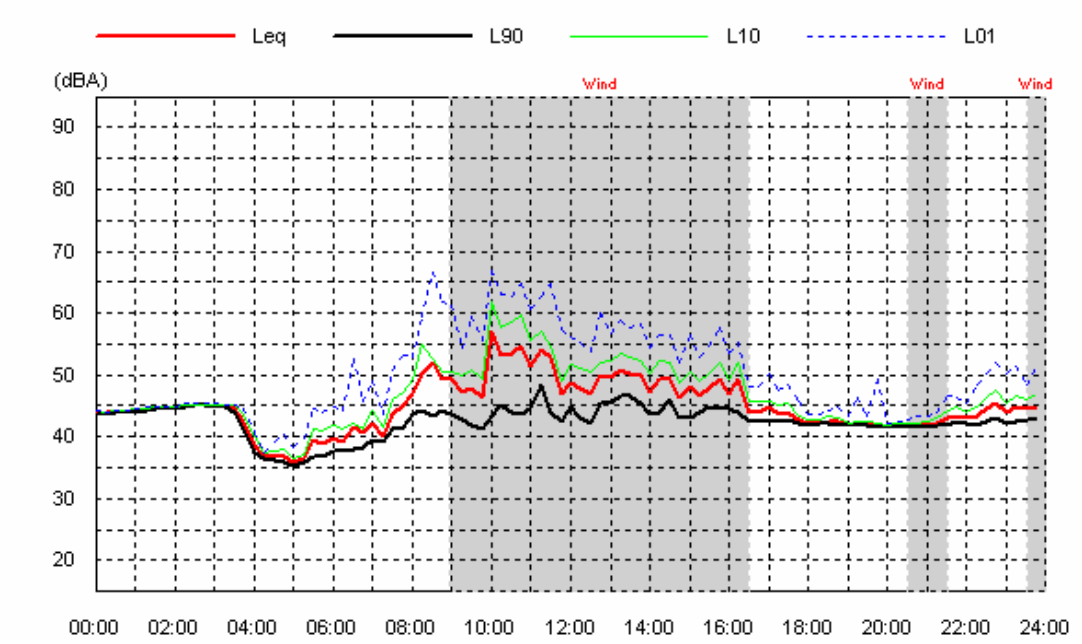


Mon 08 May 06

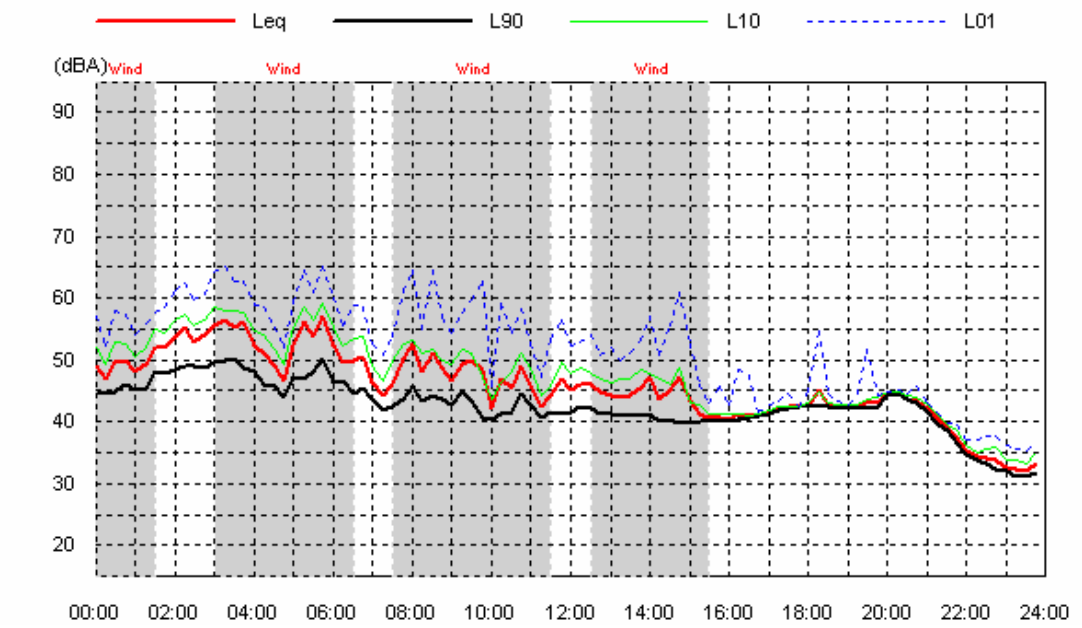


Location: Marulan site – Location 4 (RTA Noise Logger Version 1 - 26)
Data shaded: Wind

Tue 09 May 06

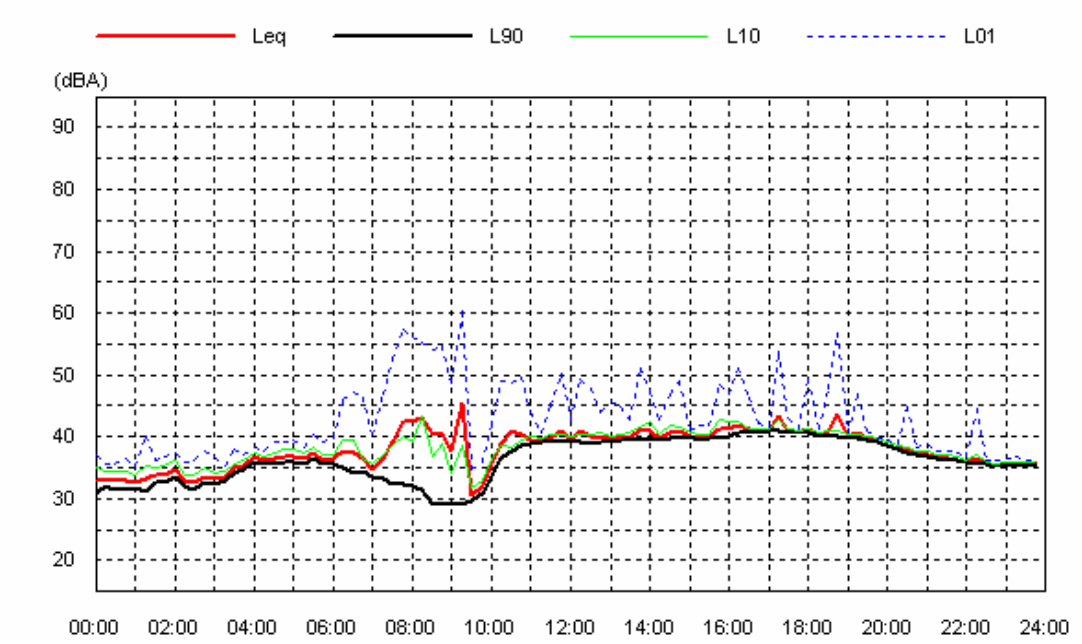


Wed 10 May 06

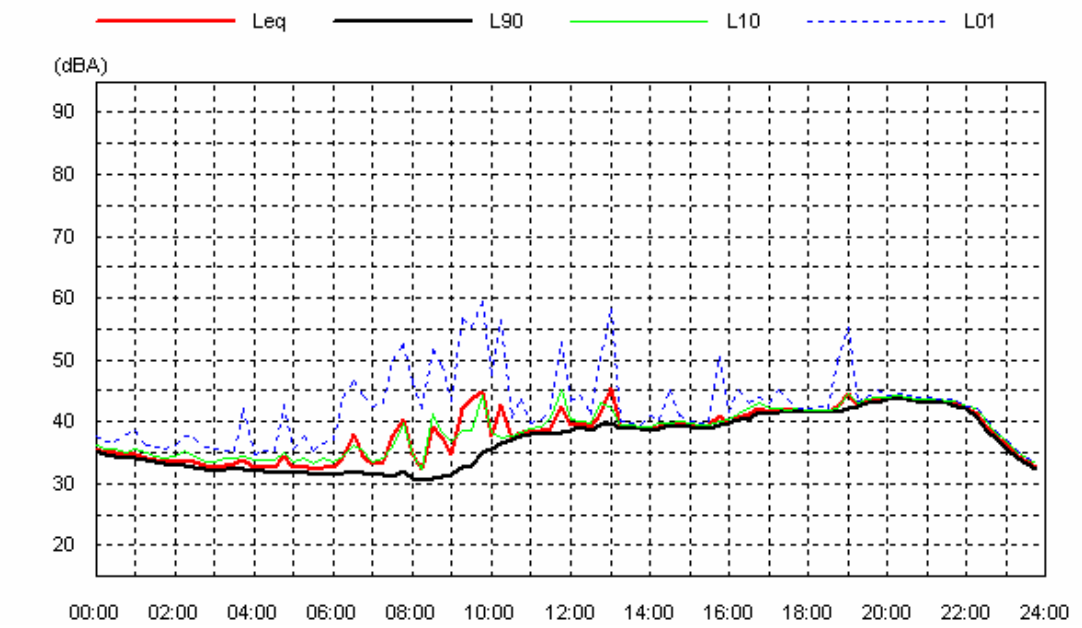


Location: Marulan site – Location 4 (RTA Noise Logger Version 1 - 26)
Data shaded: Wind

Thu 11 May 06

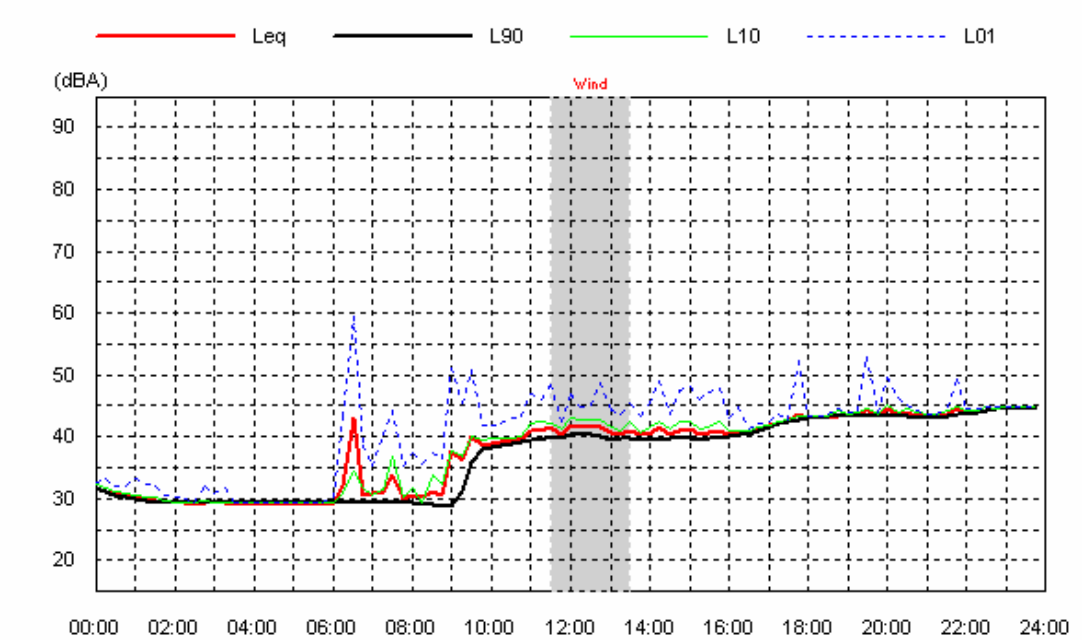


Fri 12 May 06

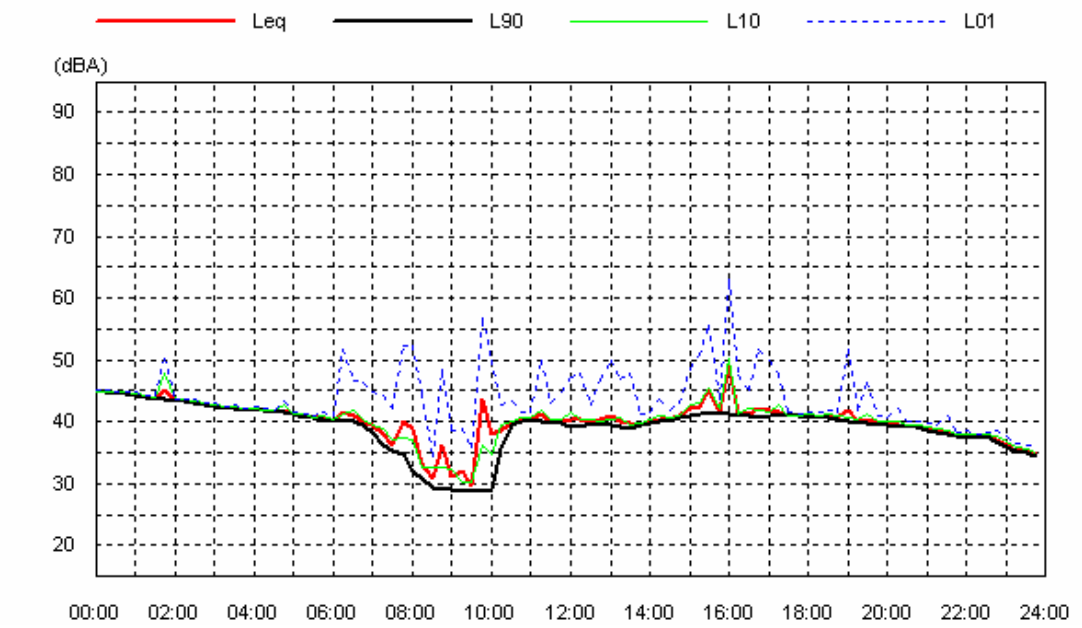


Location: Marulan site – Location 4 (RTA Noise Logger Version 1 - 26)
Data shaded: Wind

Sat 13 May 06

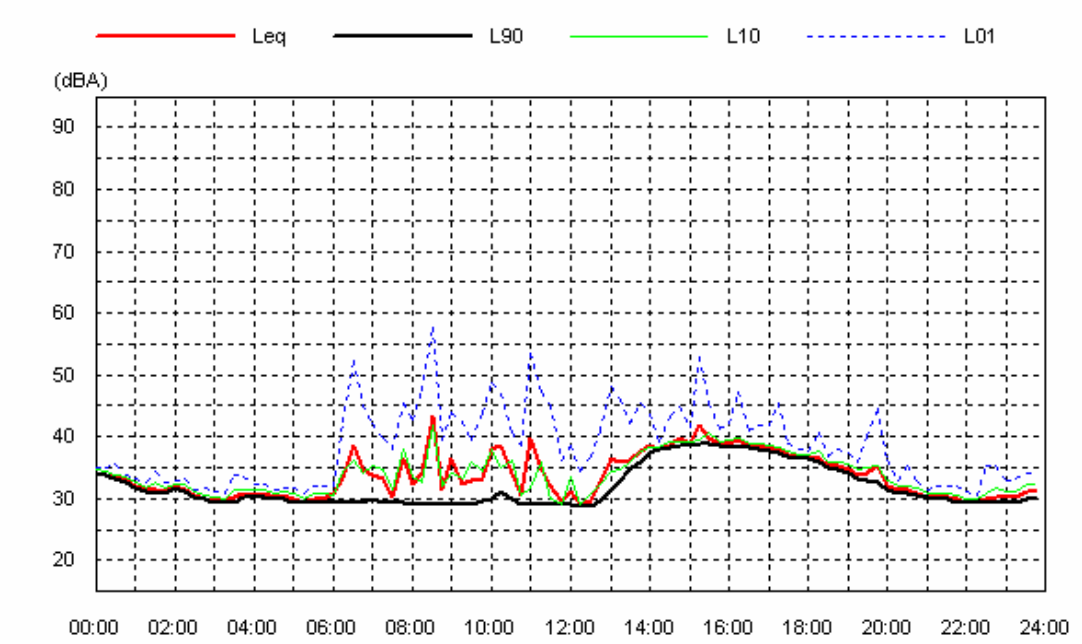


Sun 14 May 06

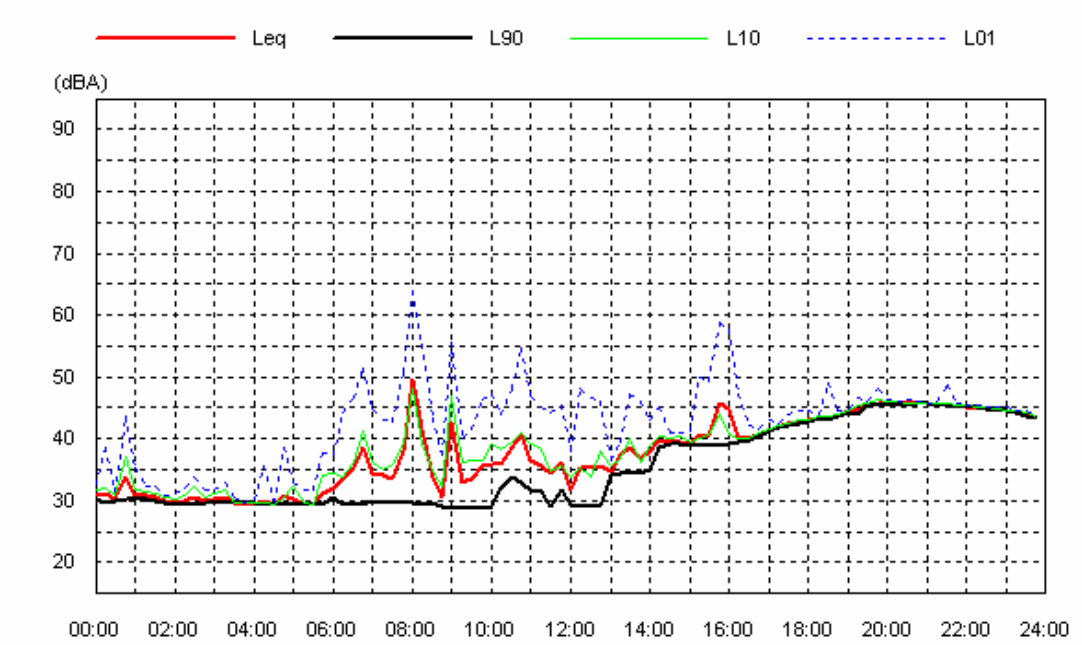


Location: Marulan site – Location 4 (RTA Noise Logger Version 1 - 26)
Data shaded: Wind

Mon 15 May 06

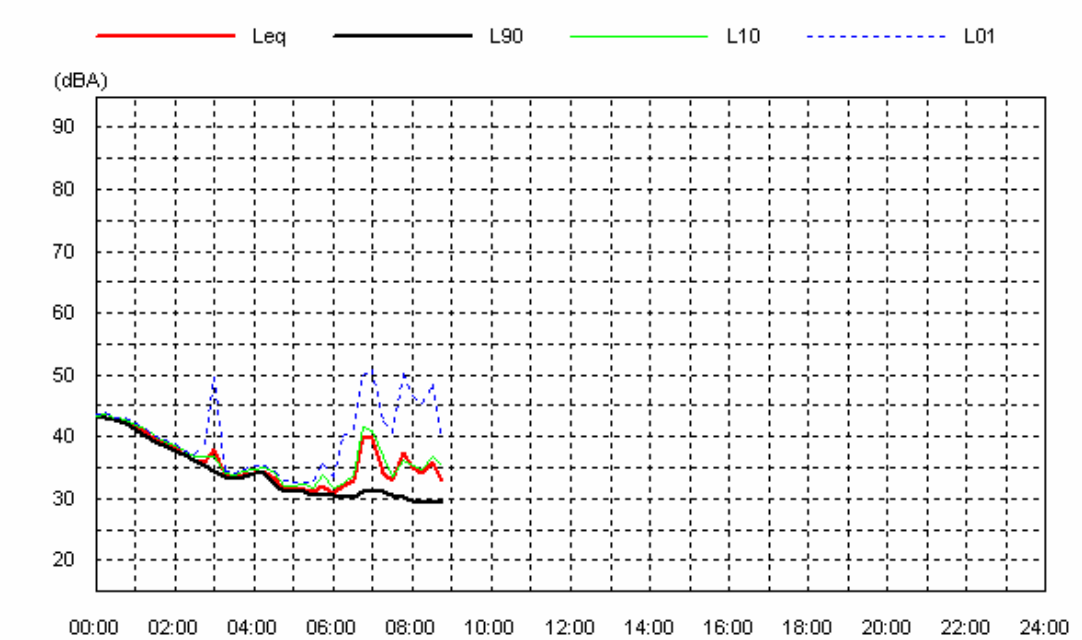


Tue 16 May 06



Location: Marulan site – Location 4 (RTA Noise Logger Version 1 - 26)
Data shaded: Wind

Wed 17 May 06



APPENDIX C

SUMMARY OF METEOROLOGICAL CONDITIONS MODELLED

Met Data - Marulan_2006_2 All MetProbs					
Season	Period	Wind Dir	Wind Speed	Inv Strength	Weighting
Autumn	Day	0	0	0	57.51
Autumn	Day	45	0.75	0	0.20
Autumn	Day	90	0.75	0	0.49
Autumn	Day	135	0.75	0	0.49
Autumn	Day	180	0.75	0	0.59
Autumn	Day	225	0.75	0	0.30
Autumn	Day	270	0.75	0	0.40
Autumn	Day	315	0.75	0	0.10
Autumn	Day	0	1.25	0	0.40
Autumn	Day	45	1.25	0	1.09
Autumn	Day	90	1.25	0	0.89
Autumn	Day	135	1.25	0	0.79
Autumn	Day	180	1.25	0	0.10
Autumn	Day	225	1.25	0	0.40
Autumn	Day	270	1.25	0	0.89
Autumn	Day	315	1.25	0	0.30
Autumn	Day	0	1.75	0	0.89
Autumn	Day	45	1.75	0	0.89
Autumn	Day	90	1.75	0	1.88
Autumn	Day	135	1.75	0	1.38
Autumn	Day	180	1.75	0	0.59
Autumn	Day	225	1.75	0	0.69
Autumn	Day	270	1.75	0	1.68
Autumn	Day	315	1.75	0	0.40
Autumn	Day	0	2.25	0	0.89
Autumn	Day	45	2.25	0	0.99
Autumn	Day	90	2.25	0	1.48
Autumn	Day	135	2.25	0	0.99
Autumn	Day	180	2.25	0	0.89
Autumn	Day	225	2.25	0	1.09
Autumn	Day	270	2.25	0	3.36
Autumn	Day	315	2.25	0	0.30
Autumn	Day	0	2.75	0	0.40
Autumn	Day	45	2.75	0	0.59
Autumn	Day	90	2.75	0	0.99
Autumn	Day	135	2.75	0	1.19
Autumn	Day	180	2.75	0	0.49
Autumn	Day	225	2.75	0	1.19
Autumn	Day	270	2.75	0	2.67
Autumn	Day	315	2.75	0	0.30
Autumn	Day	0	0	3	1.88
Autumn	Day	0	0.75	3	0.10
Autumn	Day	45	0.75	3	0.30
Autumn	Day	90	0.75	3	0.10
Autumn	Day	225	0.75	3	0.40
Autumn	Day	270	0.75	3	0.10
Autumn	Day	0	1.25	3	0.10
Autumn	Day	45	1.25	3	0.10
Autumn	Day	90	1.25	3	0.49
Autumn	Day	180	1.25	3	0.10
Autumn	Day	225	1.25	3	0.49
Autumn	Day	270	1.25	3	0.20
Autumn	Day	315	1.25	3	0.10
Autumn	Day	0	1.75	3	0.20
Autumn	Day	45	1.75	3	0.20
Autumn	Day	90	1.75	3	0.79
Autumn	Day	135	1.75	3	0.10

Met Data - Marulan_2006_2 All MetProbs					
Season	Period	Wind Dir	Wind Speed	Inv Strength	Weighting
Autumn	Day	180	1.75	3	0.10
Autumn	Day	225	1.75	3	0.10
Autumn	Day	270	1.75	3	0.30
Autumn	Day	315	1.75	3	0.20
Autumn	Day	90	2.25	3	0.59
Autumn	Day	180	2.25	3	0.20
Autumn	Day	270	2.25	3	0.10
Autumn	Day	315	2.25	3	0.30
Autumn	Day	90	2.75	3	0.79
Autumn	Day	225	2.75	3	0.10
Autumn	Day	270	2.75	3	0.40
Total					100.00

Met Data - Marulan_2006_2 All MetProbs					
Season	Period	Wind Dir	Wind Speed	Inv Strength	Weighting
Autumn	Evening	0	0	0	20.65
Autumn	Evening	270	0.75	0	0.27
Autumn	Evening	90	2.25	0	0.27
Autumn	Evening	270	2.25	0	0.27
Autumn	Evening	90	2.75	0	1.09
Autumn	Evening	135	2.75	0	0.54
Autumn	Evening	0	0	3	31.52
Autumn	Evening	0	0.75	3	1.63
Autumn	Evening	45	0.75	3	5.16
Autumn	Evening	90	0.75	3	3.80
Autumn	Evening	135	0.75	3	0.27
Autumn	Evening	180	0.75	3	0.82
Autumn	Evening	225	0.75	3	2.17
Autumn	Evening	315	0.75	3	0.54
Autumn	Evening	0	1.25	3	1.90
Autumn	Evening	45	1.25	3	1.63
Autumn	Evening	90	1.25	3	3.26
Autumn	Evening	135	1.25	3	0.27
Autumn	Evening	225	1.25	3	1.36
Autumn	Evening	315	1.25	3	0.27
Autumn	Evening	0	1.75	3	1.09
Autumn	Evening	90	1.75	3	2.17
Autumn	Evening	135	1.75	3	0.27
Autumn	Evening	225	1.75	3	0.54
Autumn	Evening	270	1.75	3	0.54
Autumn	Evening	315	1.75	3	1.63
Autumn	Evening	0	2.25	3	1.63
Autumn	Evening	45	2.25	3	0.54
Autumn	Evening	90	2.25	3	3.26
Autumn	Evening	180	2.25	3	0.54
Autumn	Evening	225	2.25	3	0.27
Autumn	Evening	270	2.25	3	2.17
Autumn	Evening	315	2.25	3	0.54
Autumn	Evening	0	2.75	3	0.27
Autumn	Evening	45	2.75	3	0.82
Autumn	Evening	90	2.75	3	2.72
Autumn	Evening	270	2.75	3	3.26
Total					100

Met Data - Marulan_2006_2 All MetProbs					
Season	Period	Wind Dir	Wind Speed	Inv Strength	Weighting
Autumn	Night	0	0	0	23.79
Autumn	Night	45	0.75	0	0.12
Autumn	Night	90	0.75	0	0.24
Autumn	Night	135	0.75	0	0.24
Autumn	Night	225	0.75	0	0.97
Autumn	Night	270	0.75	0	0.12
Autumn	Night	0	1.25	0	0.12
Autumn	Night	45	1.25	0	0.24
Autumn	Night	90	1.25	0	0.85
Autumn	Night	135	1.25	0	0.60
Autumn	Night	180	1.25	0	0.12
Autumn	Night	225	1.25	0	0.36
Autumn	Night	315	1.25	0	0.24
Autumn	Night	0	1.75	0	0.24
Autumn	Night	45	1.75	0	0.60
Autumn	Night	90	1.75	0	1.09
Autumn	Night	135	1.75	0	0.36
Autumn	Night	270	1.75	0	0.48
Autumn	Night	0	2.25	0	0.24
Autumn	Night	45	2.25	0	0.48
Autumn	Night	90	2.25	0	1.21
Autumn	Night	135	2.25	0	0.12
Autumn	Night	225	2.25	0	0.12
Autumn	Night	270	2.25	0	1.33
Autumn	Night	315	2.25	0	0.12
Autumn	Night	45	2.75	0	0.12
Autumn	Night	90	2.75	0	0.36
Autumn	Night	135	2.75	0	0.24
Autumn	Night	225	2.75	0	0.12
Autumn	Night	270	2.75	0	0.97
Autumn	Night	0	0	3	31.16
Autumn	Night	0	0.75	3	2.17
Autumn	Night	45	0.75	3	0.97
Autumn	Night	90	0.75	3	1.93
Autumn	Night	135	0.75	3	0.97
Autumn	Night	180	0.75	3	0.72
Autumn	Night	225	0.75	3	3.50
Autumn	Night	270	0.75	3	0.12
Autumn	Night	315	0.75	3	0.85
Autumn	Night	0	1.25	3	1.21
Autumn	Night	45	1.25	3	0.72
Autumn	Night	90	1.25	3	1.45
Autumn	Night	135	1.25	3	0.48
Autumn	Night	180	1.25	3	0.24
Autumn	Night	225	1.25	3	1.33
Autumn	Night	270	1.25	3	0.24
Autumn	Night	315	1.25	3	0.60
Autumn	Night	0	1.75	3	0.85
Autumn	Night	45	1.75	3	0.48
Autumn	Night	90	1.75	3	1.57
Autumn	Night	135	1.75	3	0.48
Autumn	Night	225	1.75	3	1.09
Autumn	Night	270	1.75	3	1.93
Autumn	Night	315	1.75	3	1.09
Autumn	Night	0	2.25	3	0.24
Autumn	Night	90	2.25	3	0.85

Met Data - Marulan_2006_2 All MetProbs					
Season	Period	Wind Dir	Wind Speed	Inv Strength	Weighting
Autumn	Night	135	2.25	3	0.12
Autumn	Night	270	2.25	3	1.57
Autumn	Night	315	2.25	3	0.48
Autumn	Night	0	2.75	3	0.48
Autumn	Night	90	2.75	3	0.72
Autumn	Night	225	2.75	3	0.24
Autumn	Night	270	2.75	3	2.29
Autumn	Night	315	2.75	3	0.60
Total					100

Met Data - Marulan_2006_2 All MetProbs					
Season	Period	Wind Dir	Wind Speed	Inv Strength	Weighting
Spring	Day	0	0	0	68.43
Spring	Day	0	0.75	0	0.20
Spring	Day	45	0.75	0	0.10
Spring	Day	90	0.75	0	0.20
Spring	Day	135	0.75	0	0.20
Spring	Day	180	0.75	0	0.20
Spring	Day	225	0.75	0	0.10
Spring	Day	270	0.75	0	0.20
Spring	Day	315	0.75	0	0.20
Spring	Day	0	1.25	0	0.10
Spring	Day	45	1.25	0	1.40
Spring	Day	90	1.25	0	1.40
Spring	Day	135	1.25	0	0.30
Spring	Day	180	1.25	0	0.50
Spring	Day	225	1.25	0	0.50
Spring	Day	270	1.25	0	0.60
Spring	Day	315	1.25	0	0.60
Spring	Day	0	1.75	0	0.80
Spring	Day	45	1.75	0	0.90
Spring	Day	90	1.75	0	0.80
Spring	Day	135	1.75	0	0.90
Spring	Day	180	1.75	0	0.20
Spring	Day	270	1.75	0	1.30
Spring	Day	315	1.75	0	0.50
Spring	Day	0	2.25	0	0.70
Spring	Day	45	2.25	0	0.50
Spring	Day	90	2.25	0	1.70
Spring	Day	135	2.25	0	1.90
Spring	Day	180	2.25	0	0.50
Spring	Day	225	2.25	0	0.20
Spring	Day	270	2.25	0	1.30
Spring	Day	315	2.25	0	1.00
Spring	Day	0	2.75	0	0.90
Spring	Day	45	2.75	0	0.50
Spring	Day	90	2.75	0	2.20
Spring	Day	135	2.75	0	0.80
Spring	Day	180	2.75	0	0.40
Spring	Day	225	2.75	0	0.30
Spring	Day	270	2.75	0	1.80
Spring	Day	315	2.75	0	0.40
Spring	Day	0	0	3	1.00
Spring	Day	0	0.75	3	0.10
Spring	Day	225	0.75	3	0.20
Spring	Day	315	0.75	3	0.10
Spring	Day	0	1.25	3	0.10
Spring	Day	45	1.25	3	0.20
Spring	Day	90	1.25	3	0.30
Spring	Day	225	1.25	3	0.10
Spring	Day	270	1.25	3	0.10
Spring	Day	315	1.25	3	0.10
Spring	Day	90	1.75	3	0.20
Spring	Day	270	1.75	3	0.10
Spring	Day	315	1.75	3	0.20
Spring	Day	45	2.25	3	0.10
Spring	Day	90	2.25	3	0.40
Spring	Day	135	2.25	3	0.10

Met Data - Marulan_2006_2 All MetProbs					
Season	Period	Wind Dir	Wind Speed	Inv Strength	Weighting
Spring	Day	270	2.25	3	0.10
Spring	Day	315	2.25	3	0.10
Spring	Day	45	2.75	3	0.30
Spring	Day	90	2.75	3	0.30
Spring	Day	315	2.75	3	0.10
Total					100

Met Data - Marulan_2006_2 All MetProbs					
Season	Period	Wind Dir	Wind Speed	Inv Strength	Weighting
Spring	Evening	0	0	0	22.80
Spring	Evening	180	0.75	0	0.82
Spring	Evening	90	1.75	0	0.55
Spring	Evening	45	2.25	0	0.27
Spring	Evening	90	2.25	0	1.10
Spring	Evening	135	2.25	0	1.10
Spring	Evening	135	2.75	0	1.10
Spring	Evening	0	0	3	20.88
Spring	Evening	0	0.75	3	2.47
Spring	Evening	45	0.75	3	4.67
Spring	Evening	90	0.75	3	0.82
Spring	Evening	180	0.75	3	0.27
Spring	Evening	225	0.75	3	2.20
Spring	Evening	315	0.75	3	0.27
Spring	Evening	0	1.25	3	4.95
Spring	Evening	45	1.25	3	1.92
Spring	Evening	90	1.25	3	4.40
Spring	Evening	135	1.25	3	0.27
Spring	Evening	225	1.25	3	0.27
Spring	Evening	270	1.25	3	0.27
Spring	Evening	315	1.25	3	0.82
Spring	Evening	0	1.75	3	3.57
Spring	Evening	45	1.75	3	1.92
Spring	Evening	90	1.75	3	1.92
Spring	Evening	225	1.75	3	1.65
Spring	Evening	270	1.75	3	0.55
Spring	Evening	315	1.75	3	0.27
Spring	Evening	0	2.25	3	1.37
Spring	Evening	45	2.25	3	2.20
Spring	Evening	90	2.25	3	3.30
Spring	Evening	135	2.25	3	0.27
Spring	Evening	180	2.25	3	0.27
Spring	Evening	225	2.25	3	0.27
Spring	Evening	270	2.25	3	1.10
Spring	Evening	315	2.25	3	0.27
Spring	Evening	0	2.75	3	0.82
Spring	Evening	45	2.75	3	2.47
Spring	Evening	90	2.75	3	3.02
Spring	Evening	135	2.75	3	0.82
Spring	Evening	180	2.75	3	0.27
Spring	Evening	225	2.75	3	0.55
Spring	Evening	270	2.75	3	0.55
Spring	Evening	315	2.75	3	0.27
Total					100

Met Data - Marulan_2006_2 All MetProbs					
Season	Period	Wind Dir	Wind Speed	Inv Strength	Weighting
Spring	Night	0	0	0	28.69
Spring	Night	0	0.75	0	0.49
Spring	Night	45	0.75	0	0.61
Spring	Night	90	0.75	0	0.49
Spring	Night	135	0.75	0	0.12
Spring	Night	180	0.75	0	0.24
Spring	Night	225	0.75	0	1.10
Spring	Night	270	0.75	0	0.24
Spring	Night	315	0.75	0	0.24
Spring	Night	0	1.25	0	1.34
Spring	Night	45	1.25	0	0.12
Spring	Night	90	1.25	0	0.61
Spring	Night	135	1.25	0	0.73
Spring	Night	180	1.25	0	0.61
Spring	Night	225	1.25	0	0.49
Spring	Night	270	1.25	0	0.61
Spring	Night	315	1.25	0	0.49
Spring	Night	0	1.75	0	0.61
Spring	Night	45	1.75	0	0.49
Spring	Night	90	1.75	0	0.24
Spring	Night	135	1.75	0	1.10
Spring	Night	180	1.75	0	0.61
Spring	Night	225	1.75	0	0.12
Spring	Night	270	1.75	0	0.37
Spring	Night	315	1.75	0	0.37
Spring	Night	0	2.25	0	0.24
Spring	Night	45	2.25	0	0.37
Spring	Night	90	2.25	0	0.24
Spring	Night	135	2.25	0	1.34
Spring	Night	180	2.25	0	0.73
Spring	Night	225	2.25	0	0.12
Spring	Night	270	2.25	0	0.98
Spring	Night	315	2.25	0	0.12
Spring	Night	0	2.75	0	0.24
Spring	Night	45	2.75	0	0.49
Spring	Night	90	2.75	0	0.24
Spring	Night	135	2.75	0	0.73
Spring	Night	180	2.75	0	0.24
Spring	Night	225	2.75	0	0.24
Spring	Night	270	2.75	0	0.12
Spring	Night	315	2.75	0	0.12
Spring	Night	0	0	3	24.30
Spring	Night	0	0.75	3	3.42
Spring	Night	45	0.75	3	0.73
Spring	Night	90	0.75	3	1.34
Spring	Night	225	0.75	3	3.42
Spring	Night	270	0.75	3	0.12
Spring	Night	315	0.75	3	0.49
Spring	Night	0	1.25	3	4.40
Spring	Night	45	1.25	3	0.61
Spring	Night	90	1.25	3	0.61
Spring	Night	135	1.25	3	0.37
Spring	Night	180	1.25	3	0.12
Spring	Night	225	1.25	3	0.73
Spring	Night	315	1.25	3	0.49
Spring	Night	0	1.75	3	2.20

Met Data - Marulan_2006_2 All MetProbs					
Season	Period	Wind Dir	Wind Speed	Inv Strength	Weighting
Spring	Night	45	1.75	3	0.49
Spring	Night	90	1.75	3	1.47
Spring	Night	135	1.75	3	0.37
Spring	Night	225	1.75	3	0.49
Spring	Night	270	1.75	3	0.24
Spring	Night	315	1.75	3	0.49
Spring	Night	0	2.25	3	0.73
Spring	Night	45	2.25	3	0.49
Spring	Night	90	2.25	3	0.37
Spring	Night	135	2.25	3	0.12
Spring	Night	180	2.25	3	0.12
Spring	Night	225	2.25	3	0.24
Spring	Night	270	2.25	3	0.37
Spring	Night	315	2.25	3	0.49
Spring	Night	0	2.75	3	0.85
Spring	Night	45	2.75	3	0.12
Spring	Night	90	2.75	3	0.73
Spring	Night	135	2.75	3	0.12
Spring	Night	270	2.75	3	0.49
Spring	Night	315	2.75	3	0.12
Total					100

Met Data - Marulan_2006_2 All MetProbs					
Season	Period	Wind Dir	Wind Speed	Inv Strength	Weighting
Summer	Day	0	0	0	70.30
Summer	Day	0	0.75	0	0.40
Summer	Day	45	0.75	0	0.20
Summer	Day	90	0.75	0	0.10
Summer	Day	135	0.75	0	0.10
Summer	Day	225	0.75	0	0.20
Summer	Day	270	0.75	0	0.20
Summer	Day	315	0.75	0	0.40
Summer	Day	0	1.25	0	0.40
Summer	Day	45	1.25	0	0.40
Summer	Day	90	1.25	0	0.20
Summer	Day	135	1.25	0	0.20
Summer	Day	180	1.25	0	0.10
Summer	Day	225	1.25	0	0.51
Summer	Day	270	1.25	0	0.30
Summer	Day	0	1.75	0	0.71
Summer	Day	45	1.75	0	1.92
Summer	Day	90	1.75	0	1.21
Summer	Day	135	1.75	0	0.51
Summer	Day	225	1.75	0	0.61
Summer	Day	270	1.75	0	0.81
Summer	Day	315	1.75	0	0.20
Summer	Day	0	2.25	0	1.52
Summer	Day	45	2.25	0	2.63
Summer	Day	90	2.25	0	2.22
Summer	Day	135	2.25	0	0.81
Summer	Day	225	2.25	0	0.51
Summer	Day	270	2.25	0	0.40
Summer	Day	315	2.25	0	0.30
Summer	Day	0	2.75	0	1.31
Summer	Day	45	2.75	0	2.93
Summer	Day	90	2.75	0	4.65
Summer	Day	135	2.75	0	0.51
Summer	Day	180	2.75	0	0.10
Summer	Day	225	2.75	0	0.61
Summer	Day	270	2.75	0	1.21
Summer	Day	315	2.75	0	0.30
Total					100

Met Data - Marulan_2006_2 All MetProbs					
Season	Period	Wind Dir	Wind Speed	Inv Strength	Weighting
Summer	Evening	0	0	0	36.67
Summer	Evening	45	1.25	0	0.28
Summer	Evening	45	1.75	0	0.28
Summer	Evening	90	1.75	0	1.39
Summer	Evening	135	1.75	0	0.28
Summer	Evening	45	2.25	0	0.56
Summer	Evening	90	2.25	0	1.67
Summer	Evening	45	2.75	0	0.56
Summer	Evening	90	2.75	0	1.67
Summer	Evening	135	2.75	0	0.56
Summer	Evening	0	0	3	11.39
Summer	Evening	0	0.75	3	1.67
Summer	Evening	45	0.75	3	1.39
Summer	Evening	90	0.75	3	1.39
Summer	Evening	180	0.75	3	0.28
Summer	Evening	225	0.75	3	0.28
Summer	Evening	0	1.25	3	0.83
Summer	Evening	45	1.25	3	4.17
Summer	Evening	90	1.25	3	2.50
Summer	Evening	0	1.75	3	0.56
Summer	Evening	45	1.75	3	2.50
Summer	Evening	90	1.75	3	5.83
Summer	Evening	135	1.75	3	0.83
Summer	Evening	0	2.25	3	1.67
Summer	Evening	45	2.25	3	2.78
Summer	Evening	90	2.25	3	4.17
Summer	Evening	135	2.25	3	0.56
Summer	Evening	225	2.25	3	0.28
Summer	Evening	270	2.25	3	0.56
Summer	Evening	315	2.25	3	0.28
Summer	Evening	0	2.75	3	1.39
Summer	Evening	45	2.75	3	3.06
Summer	Evening	90	2.75	3	5.83
Summer	Evening	135	2.75	3	0.56
Summer	Evening	225	2.75	3	0.28
Summer	Evening	270	2.75	3	0.56
Summer	Evening	315	2.75	3	0.56
Total					100

Met Data - Marulan_2006_2 All MetProbs					
Season	Period	Wind Dir	Wind Speed	Inv Strength	Weighting
Summer	Night	0	0	0	23.33
Summer	Night	0	0.75	0	0.49
Summer	Night	45	0.75	0	0.62
Summer	Night	90	0.75	0	0.86
Summer	Night	135	0.75	0	0.37
Summer	Night	225	0.75	0	0.25
Summer	Night	270	0.75	0	0.12
Summer	Night	315	0.75	0	0.25
Summer	Night	0	1.25	0	0.86
Summer	Night	45	1.25	0	1.36
Summer	Night	90	1.25	0	2.10
Summer	Night	135	1.25	0	0.62
Summer	Night	225	1.25	0	0.12
Summer	Night	270	1.25	0	0.12
Summer	Night	315	1.25	0	0.37
Summer	Night	0	1.75	0	0.37
Summer	Night	45	1.75	0	1.23
Summer	Night	90	1.75	0	3.21
Summer	Night	135	1.75	0	0.25
Summer	Night	180	1.75	0	0.12
Summer	Night	270	1.75	0	0.49
Summer	Night	315	1.75	0	0.49
Summer	Night	0	2.25	0	1.48
Summer	Night	45	2.25	0	2.10
Summer	Night	90	2.25	0	4.57
Summer	Night	135	2.25	0	0.74
Summer	Night	270	2.25	0	0.12
Summer	Night	315	2.25	0	0.37
Summer	Night	0	2.75	0	0.99
Summer	Night	45	2.75	0	1.98
Summer	Night	90	2.75	0	3.21
Summer	Night	135	2.75	0	1.36
Summer	Night	270	2.75	0	0.37
Summer	Night	315	2.75	0	0.12
Summer	Night	0	0	3	13.33
Summer	Night	0	0.75	3	2.47
Summer	Night	45	0.75	3	2.59
Summer	Night	90	0.75	3	0.99
Summer	Night	225	0.75	3	1.11
Summer	Night	0	1.25	3	3.21
Summer	Night	45	1.25	3	2.84
Summer	Night	90	1.25	3	2.72
Summer	Night	135	1.25	3	0.12
Summer	Night	225	1.25	3	0.49
Summer	Night	270	1.25	3	0.12
Summer	Night	315	1.25	3	0.12
Summer	Night	0	1.75	3	3.09
Summer	Night	45	1.75	3	1.11
Summer	Night	90	1.75	3	2.35
Summer	Night	135	1.75	3	0.12
Summer	Night	0	2.25	3	0.99
Summer	Night	45	2.25	3	1.11
Summer	Night	90	2.25	3	1.48
Summer	Night	135	2.25	3	0.12
Summer	Night	225	2.25	3	0.25
Summer	Night	270	2.25	3	0.25

Met Data - Marulan_2006_2 All MetProbs					
Season	Period	Wind Dir	Wind Speed	Inv Strength	Weighting
Summer	Night	315	2.25	3	0.12
Summer	Night	0	2.75	3	0.49
Summer	Night	45	2.75	3	0.62
Summer	Night	90	2.75	3	1.48
Summer	Night	135	2.75	3	0.12
Summer	Night	270	2.75	3	0.37
Summer	Night	315	2.75	3	0.37
Total					100

Met Data - Marulan_2006_2 All MetProbs					
Season	Period	Wind Dir	Wind Speed	Inv Strength	Weighting
Winter	Day	0	0	0	48.02
Winter	Day	0	0.75	0	0.49
Winter	Day	45	0.75	0	0.30
Winter	Day	90	0.75	0	0.99
Winter	Day	135	0.75	0	0.89
Winter	Day	180	0.75	0	0.30
Winter	Day	225	0.75	0	1.09
Winter	Day	270	0.75	0	0.89
Winter	Day	315	0.75	0	0.30
Winter	Day	0	1.25	0	0.69
Winter	Day	45	1.25	0	0.89
Winter	Day	90	1.25	0	1.19
Winter	Day	135	1.25	0	1.09
Winter	Day	180	1.25	0	0.20
Winter	Day	225	1.25	0	0.79
Winter	Day	270	1.25	0	2.67
Winter	Day	315	1.25	0	0.10
Winter	Day	0	1.75	0	0.30
Winter	Day	45	1.75	0	0.10
Winter	Day	90	1.75	0	1.68
Winter	Day	135	1.75	0	2.57
Winter	Day	180	1.75	0	1.28
Winter	Day	225	1.75	0	0.49
Winter	Day	270	1.75	0	1.88
Winter	Day	315	1.75	0	0.49
Winter	Day	0	2.25	0	0.89
Winter	Day	45	2.25	0	0.30
Winter	Day	90	2.25	0	1.58
Winter	Day	135	2.25	0	2.17
Winter	Day	180	2.25	0	1.58
Winter	Day	225	2.25	0	0.59
Winter	Day	270	2.25	0	2.67
Winter	Day	315	2.25	0	0.20
Winter	Day	0	2.75	0	1.09
Winter	Day	45	2.75	0	0.10
Winter	Day	90	2.75	0	1.38
Winter	Day	135	2.75	0	2.17
Winter	Day	180	2.75	0	1.19
Winter	Day	225	2.75	0	1.09
Winter	Day	270	2.75	0	1.28
Winter	Day	315	2.75	0	0.69
Winter	Day	0	0	3	3.46
Winter	Day	0	0.75	3	0.10
Winter	Day	45	0.75	3	0.69
Winter	Day	90	0.75	3	0.59
Winter	Day	180	0.75	3	0.40
Winter	Day	225	0.75	3	0.30
Winter	Day	315	0.75	3	0.10
Winter	Day	0	1.25	3	0.30
Winter	Day	45	1.25	3	0.20
Winter	Day	90	1.25	3	1.19
Winter	Day	180	1.25	3	0.10
Winter	Day	225	1.25	3	0.49
Winter	Day	270	1.25	3	0.30
Winter	Day	315	1.25	3	0.20

Met Data - Marulan_2006_2 All MetProbs					
Season	Period	Wind Dir	Wind Speed	Inv Strength	Weighting
Winter	Day	0	1.75	3	0.20
Winter	Day	45	1.75	3	0.10
Winter	Day	90	1.75	3	0.49
Winter	Day	135	1.75	3	0.10
Winter	Day	180	1.75	3	0.20
Winter	Day	270	1.75	3	0.20
Winter	Day	315	1.75	3	0.10
Winter	Day	135	2.25	3	0.10
Winter	Day	225	2.25	3	0.30
Winter	Day	270	2.25	3	0.49
Winter	Day	315	2.25	3	0.10
Winter	Day	90	2.75	3	0.10
Winter	Day	270	2.75	3	0.49
Total					100

Met Data - Marulan_2006_2 All MetProbs					
Season	Period	Wind Dir	Wind Speed	Inv Strength	Weighting
Winter	Evening	0	0	0	23.37
Winter	Evening	135	0.75	0	0.27
Winter	Evening	180	0.75	0	1.09
Winter	Evening	90	1.25	0	0.27
Winter	Evening	225	1.25	0	0.27
Winter	Evening	45	1.75	0	0.27
Winter	Evening	90	1.75	0	0.82
Winter	Evening	135	1.75	0	0.27
Winter	Evening	180	1.75	0	1.09
Winter	Evening	225	1.75	0	0.27
Winter	Evening	135	2.25	0	0.54
Winter	Evening	180	2.25	0	0.54
Winter	Evening	225	2.25	0	0.27
Winter	Evening	0	2.75	0	0.27
Winter	Evening	135	2.75	0	0.54
Winter	Evening	180	2.75	0	0.27
Winter	Evening	225	2.75	0	0.27
Winter	Evening	270	2.75	0	0.27
Winter	Evening	0	0	3	32.88
Winter	Evening	0	0.75	3	1.09
Winter	Evening	45	0.75	3	1.90
Winter	Evening	90	0.75	3	1.63
Winter	Evening	180	0.75	3	1.36
Winter	Evening	225	0.75	3	3.53
Winter	Evening	270	0.75	3	0.27
Winter	Evening	315	0.75	3	0.27
Winter	Evening	0	1.25	3	0.82
Winter	Evening	45	1.25	3	0.82
Winter	Evening	90	1.25	3	1.90
Winter	Evening	135	1.25	3	0.54
Winter	Evening	180	1.25	3	0.54
Winter	Evening	225	1.25	3	1.63
Winter	Evening	270	1.25	3	0.82
Winter	Evening	315	1.25	3	1.09
Winter	Evening	0	1.75	3	0.82
Winter	Evening	45	1.75	3	0.27
Winter	Evening	90	1.75	3	0.82
Winter	Evening	135	1.75	3	0.27
Winter	Evening	180	1.75	3	0.82
Winter	Evening	225	1.75	3	1.09
Winter	Evening	270	1.75	3	0.82
Winter	Evening	315	1.75	3	1.09
Winter	Evening	0	2.25	3	1.36
Winter	Evening	180	2.25	3	0.27
Winter	Evening	225	2.25	3	1.09
Winter	Evening	270	2.25	3	2.72
Winter	Evening	315	2.25	3	0.27
Winter	Evening	225	2.75	3	1.09
Winter	Evening	270	2.75	3	4.35
Winter	Evening	315	2.75	3	0.82
Total					100

Met Data - Marulan_2006_2 All MetProbs					
Season	Period	Wind Dir	Wind Speed	Inv Strength	Weighting
Winter	Night	0	0	0	22.58
Winter	Night	45	0.75	0	0.24
Winter	Night	90	0.75	0	0.24
Winter	Night	135	0.75	0	0.12
Winter	Night	180	0.75	0	0.48
Winter	Night	225	0.75	0	1.09
Winter	Night	270	0.75	0	0.12
Winter	Night	90	1.25	0	0.12
Winter	Night	135	1.25	0	0.12
Winter	Night	180	1.25	0	0.97
Winter	Night	225	1.25	0	0.60
Winter	Night	270	1.25	0	0.60
Winter	Night	0	1.75	0	0.12
Winter	Night	45	1.75	0	0.12
Winter	Night	90	1.75	0	0.12
Winter	Night	135	1.75	0	0.48
Winter	Night	180	1.75	0	2.66
Winter	Night	225	1.75	0	1.45
Winter	Night	270	1.75	0	0.36
Winter	Night	45	2.25	0	0.24
Winter	Night	180	2.25	0	1.09
Winter	Night	225	2.25	0	1.09
Winter	Night	270	2.25	0	1.33
Winter	Night	45	2.75	0	0.24
Winter	Night	135	2.75	0	0.12
Winter	Night	180	2.75	0	0.60
Winter	Night	225	2.75	0	0.24
Winter	Night	270	2.75	0	0.48
Winter	Night	0	0	3	33.45
Winter	Night	0	0.75	3	1.33
Winter	Night	45	0.75	3	0.24
Winter	Night	90	0.75	3	0.24
Winter	Night	135	0.75	3	0.24
Winter	Night	180	0.75	3	0.72
Winter	Night	225	0.75	3	6.40
Winter	Night	315	0.75	3	0.72
Winter	Night	0	1.25	3	0.72
Winter	Night	45	1.25	3	0.48
Winter	Night	90	1.25	3	0.72
Winter	Night	135	1.25	3	0.36
Winter	Night	180	1.25	3	0.36
Winter	Night	225	1.25	3	3.14
Winter	Night	270	1.25	3	0.97
Winter	Night	315	1.25	3	0.85
Winter	Night	0	1.75	3	0.36
Winter	Night	45	1.75	3	0.36
Winter	Night	90	1.75	3	0.12
Winter	Night	180	1.75	3	0.24
Winter	Night	225	1.75	3	2.42
Winter	Night	270	1.75	3	0.97
Winter	Night	315	1.75	3	0.36
Winter	Night	0	2.25	3	0.12
Winter	Night	225	2.25	3	0.24
Winter	Night	270	2.25	3	2.05
Winter	Night	315	2.25	3	0.60
Winter	Night	0	2.75	3	0.24

Met Data - Marulan_2006_2 All MetProbs					
Season	Period	Wind Dir	Wind Speed	Inv Strength	Weighting
Winter	Night	225	2.75	3	0.12
Winter	Night	270	2.75	3	2.66
Winter	Night	315	2.75	3	0.12
Total					100

APPENDIX D

DELTA ELECTRICITY FACILITY WORST CASE NOISE CONTOURS

Note: **Please note these noise contours are indicative only, the point to point calculations should be considered more accurate than the noise contours.**

Figure D-1 Delta Electricity Facility - Stage 1 OCGT.

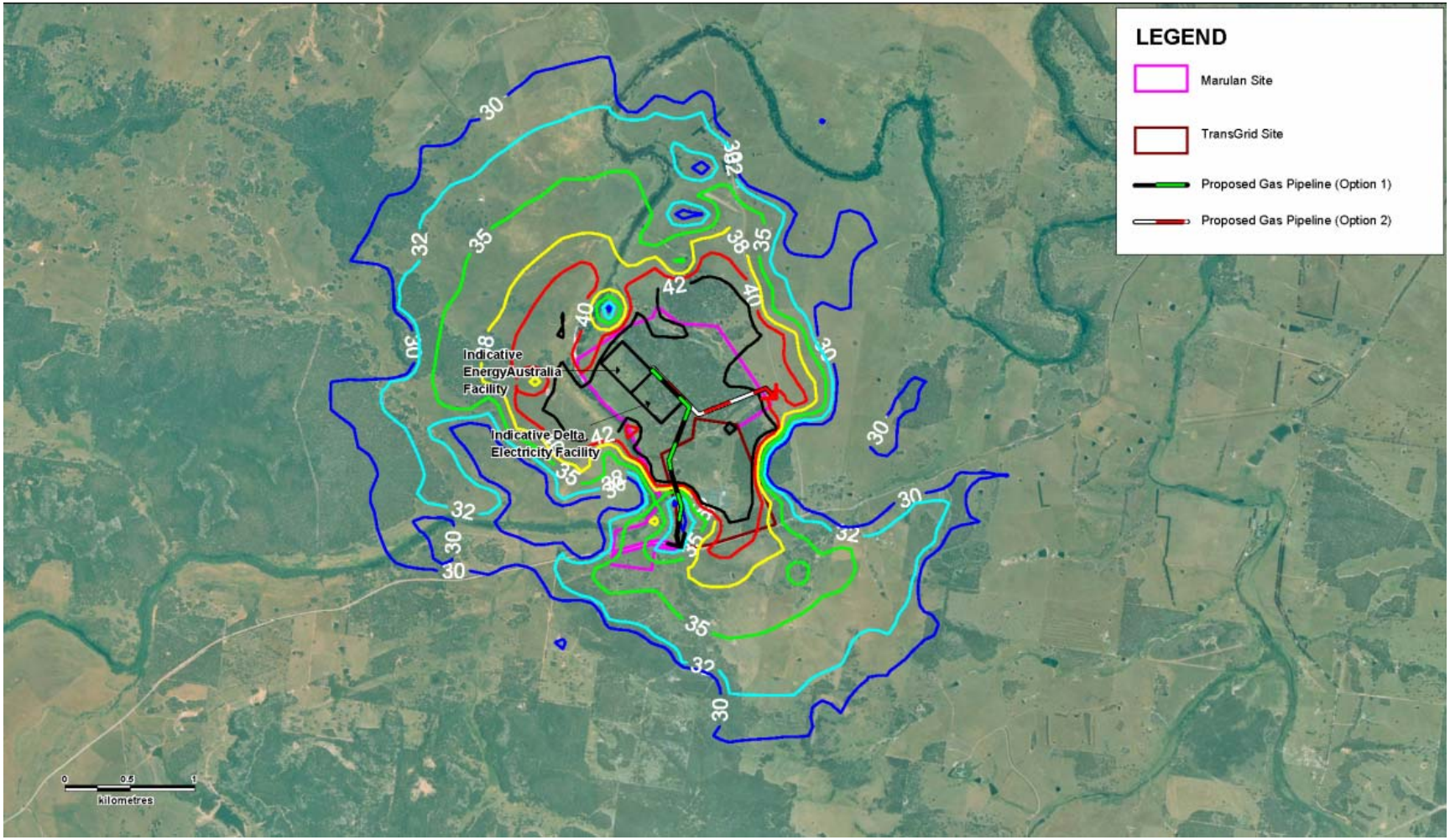
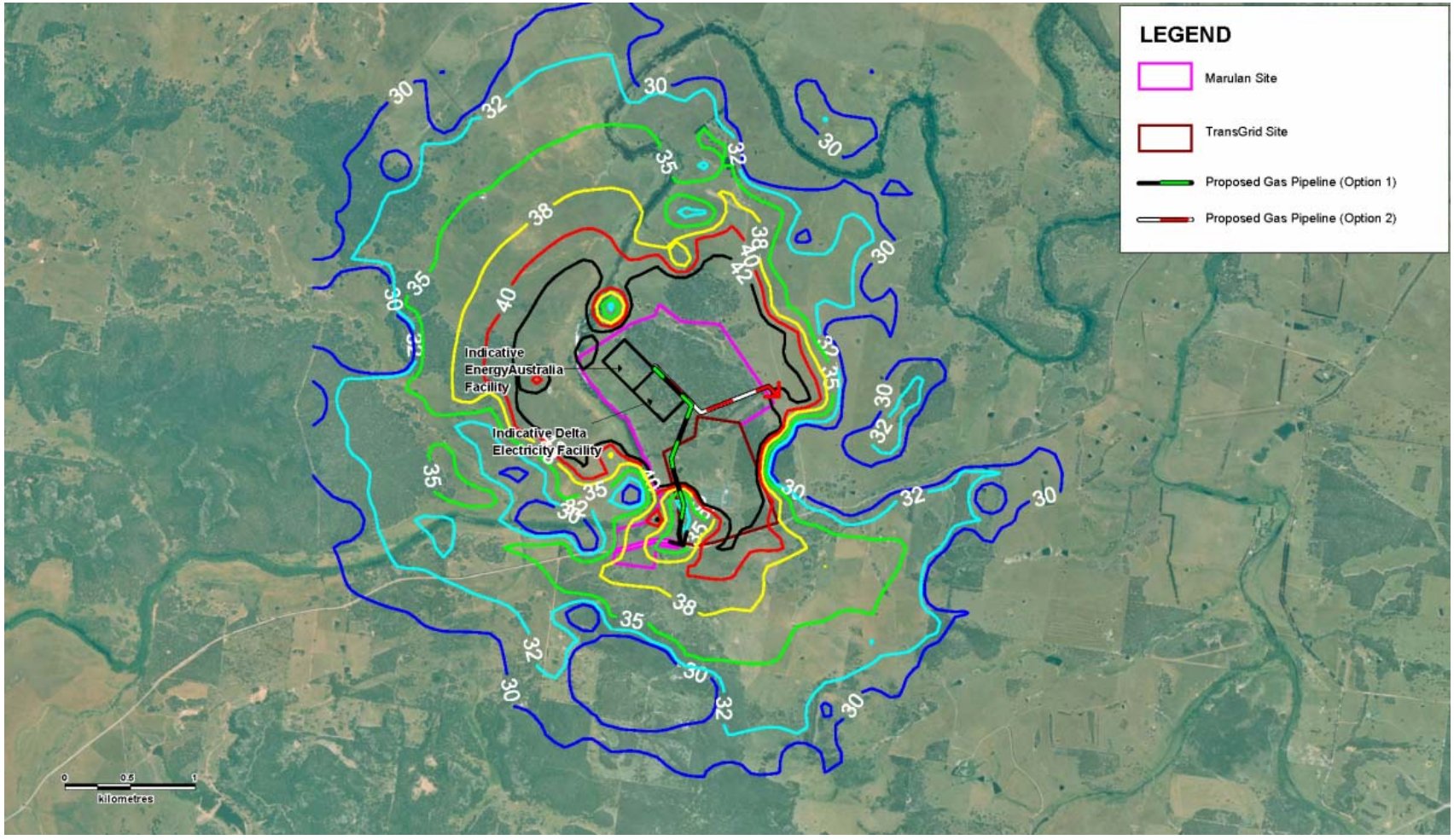


Figure D-2 Delta Electricity Facility - Stage 2 CCGT (noise mitigation being applied to Stage 2).



APPENDIX E

STACK DIRECTIVITY

	Octave Band Levels (dBLin)							
	63Hz	**125Hz**	**250Hz**	**500Hz**	**1KHz**	**2KHz**	**4KHz**	**8KHz**
90 degree Stack Directivity	-3	-4	-6	-8	-10	-12	-14	-16

Refer to “Cooling Tower Source Prediction, Modelling, Specification and Noise Control, Mark C Derrick, HFP Acoustical Consultants Ltd” for comparison, of 90 degree directivity from stacks, website, http://www.hfpacoustical.com.

APPENDIX F

CUMULATIVE NOISE ASSESSMENT - WORST CASE NOISE CONTOURS

Note: **Please note these noise contours are indicative only, the point to point calculations should be considered more accurate than the noise contours.**

Figure F-1 Delta Electricity Facility Stage 1 OCGT and Energy Australia OCGT.

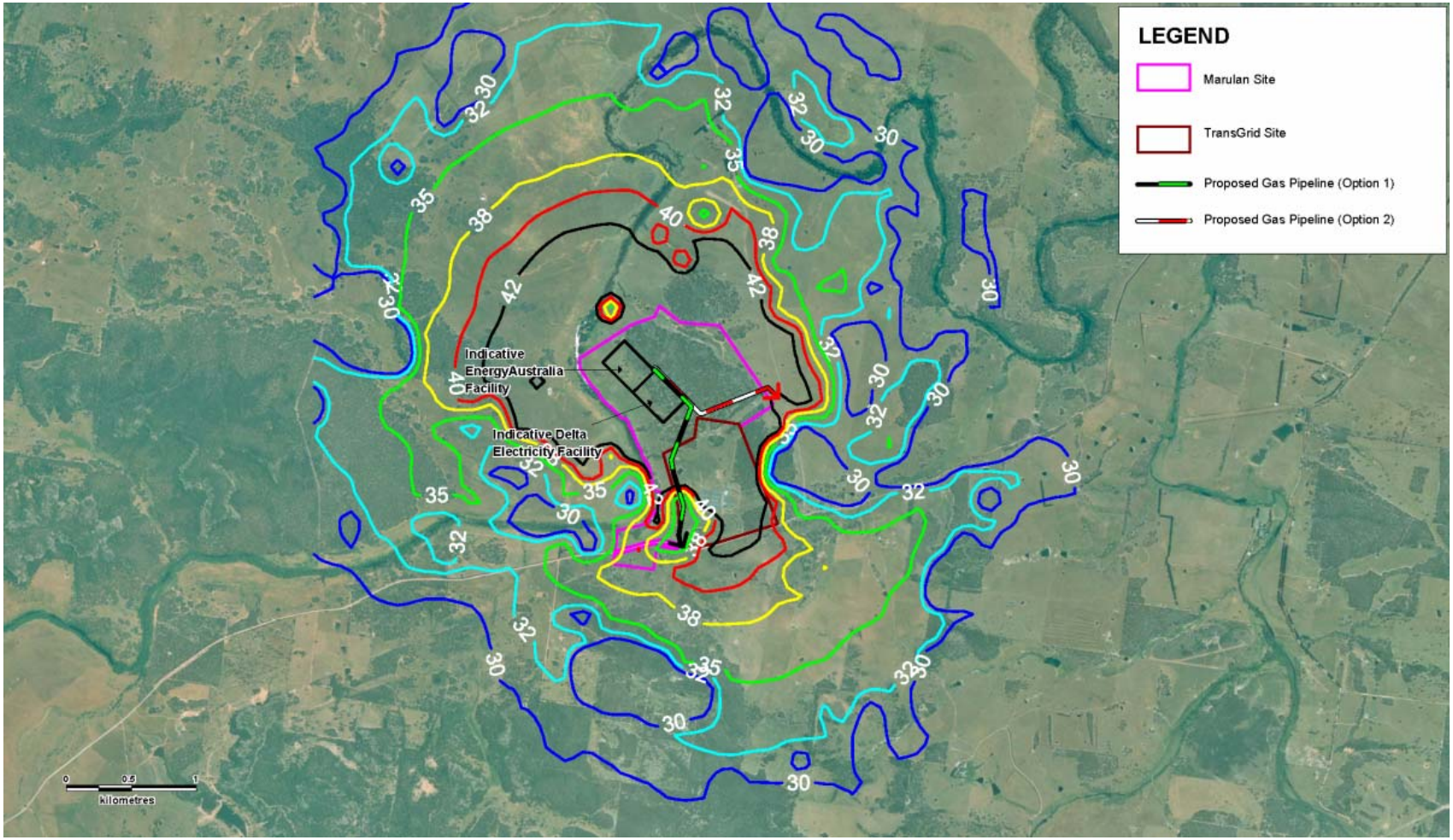


Figure F-2 – Delta Electricity Facility Stage 2 CCGT (noise mitigation being applied to Stage 2) and EnergyAustralia Facility OCGT.