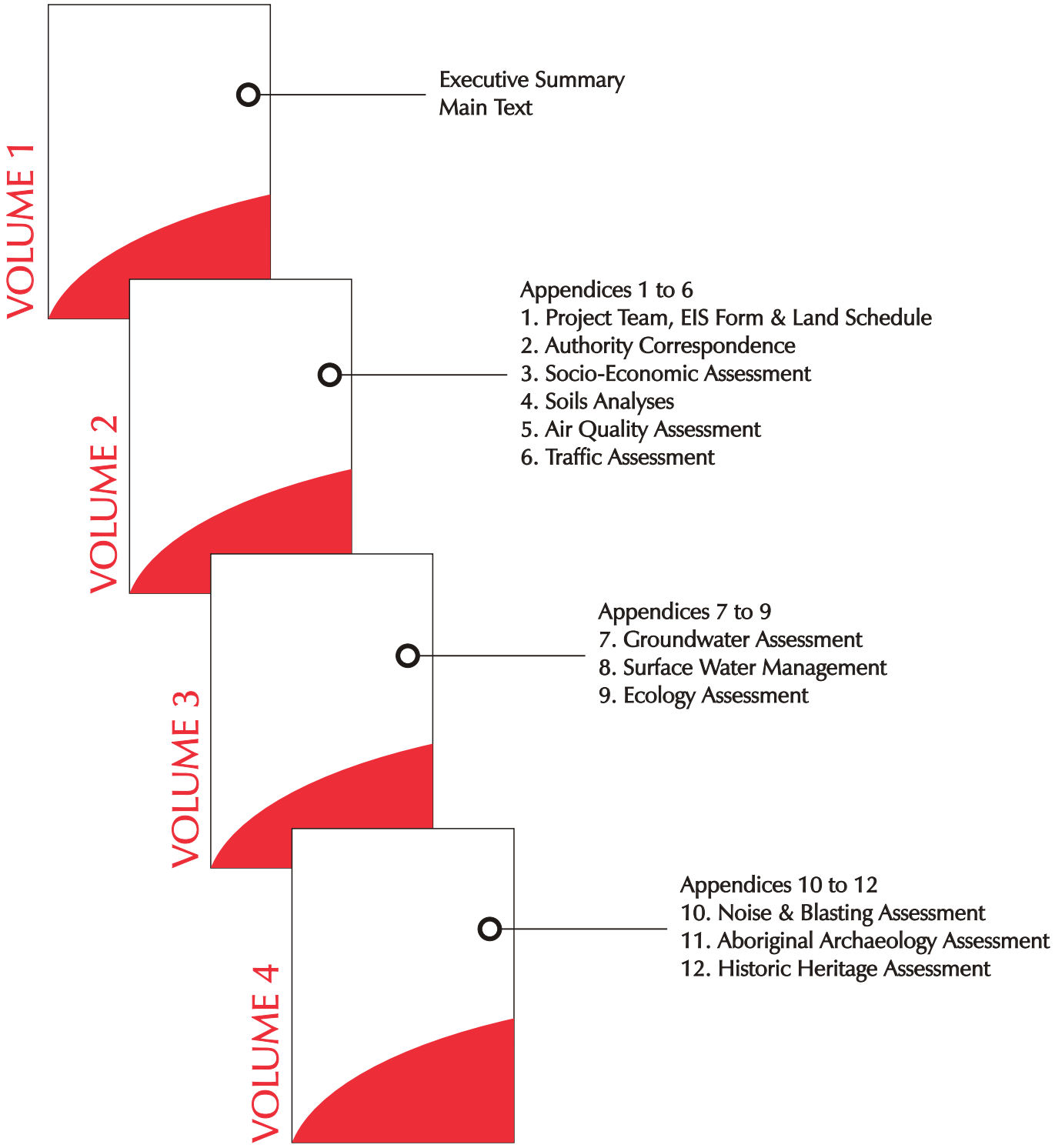
Environmental Impact Statement

Readymix Holdings Pty Ltd
Proposed Lynwood Quarry, Marulan

VOLUME 4
APPENDICES 10 TO 12

MAY 2005

Umwelt
Environmental Consultants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APPENDIX 10

Noise & Blasting Assessment

HEGGIES
AUSTRALIA

REPORT 10-3142-R1
Revision 0

Lynwood Quarry
Noise and Blasting Impact Assessment

PREPARED FOR

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12 MAY 2005

Lynwood Quarry

Noise and Blasting Impact Assessment

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10-3142-R1	Revision 0	12 May 2005	Jerremy Lofts	John Cotterill	John Cotterill

EXECUTIVE SUMMARY

Introduction

Heggies Australia (Heggies) has been commissioned to produce a noise and blasting impact assessment to be submitted as part of the Environmental Impact Statement (EIS) for the proposed Lynwood Quarry project to the west of Marulan in the Southern Tablelands region of NSW.

The proposed quarry will be located approximately 160 km southwest of Sydney and approximately 27 km northeast of Goulburn. The project area is located to the west of Marulan, NSW. The proposed quarry is intended to provide a long-term supply of high quality construction material into the Sydney, regional and local markets of approximately 5 million tonnes per annum (Mtpa).

Plant and Equipment

The sound power level of acoustically significant items of plant and equipment proposed to be used on the project area has been obtained from a Heggies noise source database. Sound power level information is contained in **Section 2.1** of this report, with detailed octave band spectra contained in **Appendix A**.

Operation

The proposed quarry is planned to produce approximately 5 Mtpa, operating on a 24 hour per day seven day per week basis. Operations have been scheduled to occur at times that would limit the potential for disturbance to neighbouring residences.

Transportation

The majority of the 5 Mtpa of product is expected to be transported from the project area by rail via a dedicated rail loop and loading facility. Product will be transported in trains with a capacity of approximately 3500 tonnes. Up to six (6) trains will be required per day.

The remainder of product from the quarry, amounting to approximately 1 Mtpa to 1.5 Mtpa, will be transported to local and regional markets via the Hume Highway.

Existing Acoustical and Meteorological Environment

In order to determine existing ambient noise levels at residential locations surrounding the project area, a background monitoring survey was undertaken at the seven (7) residential locations given in **Table 8** of this report.

The background noise monitoring consisted of continuous, unattended noise logging and operator attended noise surveys. The operator attended noise surveys help to define noise sources and the character of noise in the area and are, therefore, used to qualify unattended noise logging results.

In order to determine the prevailing conditions for the project area, weather data was obtained from the Wangi weather station located approximately eight (8) km to the south west of the proposed quarry. The data was analysed to determine the percentage occurrence of potentially noise enhancing wind and temperature lapse conditions in accordance with the NSW Department of Environment and Conservation (DEC) Industrial Noise Policy (INP) weather data analysis methodology.

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Project Specific Noise Criteria

Project specific noise criteria for both operation and construction of the quarry were determined from ambient noise monitoring data as per INP methodology. The resulting project specific noise criteria are contained in **Table 18** and **Table 19** respectively.

The noise criteria applicable to road traffic, including the major product haulage route and construction access roadways, are outlined in **Table 20** of this report.

The NSW Environmental Noise Control Manual (ENCM) 1994 Rail Traffic Noise Guidelines have been used to provide rail traffic noise criteria for residential receivers.

Assessment of Noise Impacts

Operational Noise Modelling

A computer model was used to predict the noise emissions from the project area using the Environmental Noise Model (ENM). Noise levels were predicted at 14 locations, 11 of which are existing residences, and the remaining three being possible future residential locations.

Six operational scenarios were chosen for the noise modelling. These include the following quarry plans:

- Year 1 quarry plan.
- Year 5 quarry plan.
- Year 10 quarry plan.
- Year 15 quarry plan.
- Year 20 quarry plan.
- Year 30 quarry plan.

Noise Mitigation and Management

Several mitigation methods have been investigated in order to minimise noise at the residences. Mitigation in the form of engineering or management controls, which have been adopted and included in the noise modelling process, are as follows:

Engineering controls

- All crushing and screening facilities are enclosed by buildings, except for the primary gyratory crusher, the scalps screen and spalls plant.
- The pug mills are enclosed by a building.
- Train and truck loading bins are lined on the base to reduce impact noise when bins are being loaded from empty.
- Trucks dumping the leading row of overburden on the eastern overburden emplacement area will have attenuation to a maximum sound power level of 111 dBA when dumping.
- The use of a rubber screen deck on the spalls plant.

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Management Controls

- The spalls plant will operate during the daytime only.
- The grader will operate during the daytime only.
- The overburden removal and emplacement fleet will operate during the daytime only.
- When operating on eastern overburden emplacement areas, the majority of operations occurring on the top of the emplacement areas will occur behind an earth mound created by the first row of dumping.
- The load and haul fleet will operate during the daytime and evening only.
- No dumping on the leading edge of either the eastern overburden emplacement area or the eastern excess product emplacement area will occur while the dozer is operating on the leading face of either the aforementioned emplacement areas.
- The number of finished product trucks at night shall be limited to 32 movements per hour.

Results of Operational Noise Modelling

Predicted noise levels for plant operations for both calm and prevailing weather conditions are shown in **Table 24** through to **Table 27**.

The noise modelling results indicate that the operation of the proposed Lynwood Quarry is predicted to meet all project specific noise criteria for operation during daytime, evening and night-time periods at all residential locations under both calm and prevailing weather conditions with the abovementioned noise controls in place.

Noise modelling was conducted for sleep disturbance using the L_{A1} noise level of a truck loading and train loading from each of the loading bins. Modelling was conducted for acoustically adverse weather conditions, including temperature inversion and relevant drainage flow winds. $L_{A1(1minute)}$ noise levels are predicted to be below project specific sleep disturbance goals for night-time operation of the quarry. This being the case, sleep disturbance is unlikely to occur at residential locations surrounding the proposed quarry.

Construction Noise Modelling

Earthworks and foundation work require the largest amount of plant and equipment to be used during the construction phase, and the noise assessment has concentrated on these construction activities. The worst case scenarios for both earthworks and foundation works have been modelled and are contained in **Table 31** and **Table 32**. Noise levels for earthworks and foundation construction are predicted to meet all construction noise goals at all residences.

Traffic Noise Impact

Modelling was conducted using traffic noise levels, measured during operator attended surveys, as input into the United States Federal Highways road traffic noise model (USFH) to compare existing and future traffic noise levels.

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Construction

It is envisaged that during the busiest 5 months of construction, traffic generated by the construction activity will number 270 vehicles per day (vpd) (135 in / 135 out). Heavy vehicles are expected to average 36 vehicle trips per day (18 in / 18 out). The construction route passes approximately 40 m from the closest residential receiver. The construction traffic noise is predicted to be below the Environmental Criteria for Road Traffic Noise (ECRTN) limit for traffic generated on a local road of $L_{Aeq(1hour)}$ 55 dBA.

Operation

It is envisaged that the quarry will despatch approximately 108 loads from the project area per day for sales of 1 Mtpa, increasing to approximately 162 loads per day for sales of 1.5 Mtpa.

Truck loading will be 7 days per week 24 hours per day. The increase in traffic noise on the Hume Highway due to the operation of the quarry is predicted to be between $L_{Aeq(15hour)}$ daytime 0.2 dBA and $L_{Aeq(9hour)}$ night-time 0.4 dBA, which is considered to be imperceptible to receivers along the roadway.

It should be noted that traffic on the access road from the project area to the Hume Highway was considered as an operational noise source and predictions were accordingly carried out at the nearest affected receivers to the access road. These traffic movements are subject to more stringent noise criteria than vehicle noise emanating from the Hume Highway.

Rail Noise Impact

Calculation of the 24 hour equivalent continuous noise level ($L_{Aeq(24hour)}$) and the maximum (L_{Amax}) passby levels have been conducted using a computer prediction model developed by Heggies.

Product will be transported in trains with a capacity of approximately 3500 tonnes with up to six (6) trains required per day. It is envisaged that rail loading and despatch would occur 24 hours per day 7 days per week.

The results presented in **Table 35** show that with six (6) trains per day the proposed quarry related rail movements will increase the $L_{Aeq(24hour)}$ noise level by approximately 0.9 dBA. The L_{Amax} noise level would remain unchanged. The contribution of the proposed quarry rail movements would meet the DEC's $L_{Aeq(24hour)}$ criterion of 60 dBA and the L_{Amax} criterion of 85 dBA at a distance of 25 m (and greater). The impact of the proposed quarry trains on the noise produced from total rail movements on the Main Southern Line would be negligible. The 0.9 dBA increase in noise would be imperceptible to residential receivers along the rail line.

Cumulative Impact Assessment

The only location where significant existing industrial noise is evident is noise monitoring Location N4. Noise from existing industrial sources (fertiliser handling facility) at this location was measured during the daytime at $L_{Aeq(15minute)}$ 51 dBA, with no contribution during the evening or night-time periods. The noise level from the project area at Location N4 is predicted to be less than $L_{Aeq(15minute)}$ 30 dBA during the daytime. This is more than 20 dBA below the existing L_{Aeq} industry noise, meaning it would not contribute to the cumulative industrial noise level of the area.

Blasting

Ground Vibration and Airblast Site Laws were determined following analysis of blast emission data obtained from Readymix for their nearby Johniefelds Quarry.

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The level of airblast and ground vibration has been predicted using the developed site laws for the project area. The blasting predictions reflect the worst case noise levels that would be experienced at each residential receiver for each stage of the development.

The predicted airblast and ground vibration levels comply with the ANZECC/DEC criteria at all surrounding residential receivers for each stage of development.

The predicted vibration level at the closest point of the proposed quarry to the natural gas pipeline is below level likely to cause impact, as is the predicted vibration level at the location of the proposed drinking water reservoir.

Control over MIC will be required when blasting at the closest point of the quarry pit to the Main Southern Railway to ensure that vibration levels are below the level likely to cause impact.

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1 INTRODUCTION

Heggies Australia (Heggies) has been commissioned to produce a noise impact assessment and blast impact assessment to be submitted as part of the Environmental Impact Statement (EIS) for the proposed Lynwood Quarry project. The quarry is proposed by Readymix Holdings Pty Ltd (Readymix) and planned to be located on land to the west of Marulan in the Southern Tablelands region of NSW.

The proposed quarry is intended to provide a long-term supply of high quality construction material into the Sydney, regional and local markets and will replace Readymix's current production from the Penrith Lakes Scheme which is likely to be exhausted around 2010. The proposed quarry is expected to produce approximately 5 million tonnes per annum (Mtpa).

Noise measurements and assessments conducted have been prepared in accordance with Australian Standard AS 1055-1997 "*Description and Measurement of Environmental Noise*" Part 1, 2 and 3 and with reference to the NSW Industrial Noise Policy (INP), Environmental Noise Control Manual (ENCM) and the EPA Road Traffic Noise Policy.

2 DESCRIPTION OF THE PROJECT

Readymix has a sound knowledge of the hard rock resource at the proposed quarry, due to both an extensive exploration drilling program and experience from operation of the existing Johniefelds Quarry, located on Brayton Road approximately 2 km north of the project area.

The quarrying process will involve the following broad steps:

- Clearing and topsoil stripping - likely equipment will include a dozer, excavator, loaders and dump trucks;
- Drill and blast - percussion drill drilling holes to a bench height of approximately 15 m. It is likely an average of one blast per week will be required in order to meet production requirements; and
- The resultant material from the blast will be loaded by front-end loaders into dump trucks and transported to the crushing and screening plant. Any pieces of rock that are too large to be transported or loaded into the primary crusher will be broken into smaller pieces by a hydraulic rock breaker.

Some of the material extracted as part of the quarrying process will not be suitable for sale and consequently out-of-pit emplacement areas will be required. Due to the depth of the resource and the number of years which will be required in order to reach a terminal face, in-pit dumping will not be possible until late in the quarry life.

During the construction phase, a portable crushing plant will be used to generate construction material for the project area. It is possible that sufficient material may be generated during this phase to produce saleable material.

Rehabilitation will include both rehabilitation of the out of pit emplacement areas and treatment of the upper batters of the quarry pit in order to reach a suitable final landform.

2.1 Plant and Equipment

The sound power level of acoustically significant items of plant and equipment proposed to be used on the project area has been obtained from a Heggies noise source database. The L_{Aeq} sound power levels of this plant and equipment are given in **Table 1** (fixed plant) and **Table 2** (mobile plant and equipment). The details of the octave band levels, including the spectral component (used to determine character of the noise) used in the noise modelling process are included in **Appendix A**.

Table 1 Fixed Plant Equipment List - Typical Noise Levels

Equipment Description	Number Required	Sound Power Level
Primary Gyratory Crusher	1	118 dBA
Primary Screen	1	117 dBA
Secondary Cone Crusher	1	113 dBA
Secondary Screen	4	115 dBA each
Tertiary Cone Crusher 1	7	113 dBA each
Surge Bin for Tertiary Crusher	7	107 dBA each
Product Screen	16	109 dBA each
Scalps Screen	1	109 dBA
Train Loading Bin - rubber lined base	2	100 dBA
Truck Loading Bin - rubber lined base	8	100 dBA
Stacker	1	99 dBA
Spalls Plant - rubber screen deck	1	106 dBA
Pre Coat Plant	1	99 dBA
Pug Mill	1	116 dBA

Table 2 Conceptual Mobile Plant Equipment List

Indicative Equipment Description (equipment listed or alternatives with similar sound power level will be used)		Number to be used	Sound Power Level
Drilling			
Tamrock Pantera 1100 Rock Drill		3	118 dBA
Load and Haul Fleet			
CAT 992 Loader		1	119 dBA
CAT 990 Loader		1	116 dBA
CAT 777 Dump	Hauling	6	111 dBA
	Dumping		118 dBA
Other Items			
CAT 773 Water Cart		2	116 dBA
CAT 345B Excavator with Hydraulic Hammer		1	118 dBA
CAT 140H Grader		1	113 dBA
Sales Fleet			
CAT 980G Sales Loader		2	110 dBA
CAT 773 Dump Truck		1	118 dBA
Miscellaneous Items			
Rough Terrain Forklift		1	110 dBA
Bobcat		1	101 dBA
Diesel Pump		3	83 dBA
Overburden Removal and Emplacement Fleet			
CAT 990 Loader		1	116 dBA
CAT 777 Dump Truck	Hauling	3	111 dBA
	Dumping		118 dBA
CAT D10 Bulldozer			109 dBA
Product Despatch			
Road Registered Trucks		As required	110 dBA
Road Registered Trucks Entering/Departing			107 dBA
Trains		As required	101 dBA

2.2 Hours of Operation

The proposed quarry is planned to produce approximately 5 Mtpa and to operate on a 24 hour per day seven day per week basis. To limit the potential for disturbance to neighbouring residences, operations have been scheduled to occur as follows in **Table 3**.

Table 3 Hours of Operation

Operation	Proposed Hours
Overburden removal and emplacement	7.00 am to 6.00 pm seven days per week
Drilling	7.00 am to 6.00 pm seven days per week
Extraction	7.00 am to 10.00 pm seven days per week
Sales and Transport Operations	24 hours per day, seven days per week
Processing Operations	24 hours per day, seven days per week

2.3 Transportation

The project area has ready access to key transport infrastructure. The Main Southern Railway bisects the project area and the Hume Highway adjoins Readymix's southern boundary.

The majority of the 5 Mtpa of product is expected to be transported from the project area by rail via a dedicated rail loop and loading facility. Product will be transported in trains with a capacity of approximately 3500 tonnes with up to six (6) trains required per day. The product will be railed to a Readymix distribution centre in Sydney, a distance of approximately 190 km.

Readymix currently delivers rail ballast from its Johniefelds quarry to a loading area in Marulan for use in rail line maintenance. This ballast loading operation is proposed to be transferred to the project area as part of this development.

The remainder of product from the quarry, amounting up to approximately 1.5 Mtpa, will be transported to local and regional markets by road. Trucks will be loaded at a truck loading facility located to the south of the rail balloon loop. The trucks will exit the project area via a dedicated access road which will have an intersection with the Hume Highway in the vicinity of the South Marulan Road intersection.

3 NOISE IMPACT ASSESSMENT PROCEDURES

3.1 General Objectives for Noise Impact at Residential Receivers - Operation

Residential Receiver

Responsibility for the control of noise emission in New South Wales is vested in Local Government and the DEC (formerly the EPA). DEC released the INP in December 1999. This policy provides a framework and process for deriving noise criteria for consents and licences that will enable the DEC to regulate premises that are scheduled under the Protection of the Environment Operations Act, 1997.

The specific policy objectives are:

- To establish noise criteria that would protect the community from excessive intrusive noise and preserve amenity for specific land uses.
- To use the criteria as the basis for deriving project specific noise levels.
- To promote uniform methods to estimate and measure noise impacts, including a procedure for evaluating meteorological effects.
- To outline a range of mitigation measures that could be used to minimise noise impacts
- To provide a formal process to guide the determination of feasible and reasonable noise limits for consents or licences that reconcile noise impacts with the economic, social and environmental considerations of industrial development.
- To carry out functions relating to the prevention, minimisation and control of noise from premises scheduled under the Act.

Assessing Intrusiveness

For assessing intrusiveness, the background noise needs to be measured. The intrusiveness criterion essentially means that the equivalent continuous noise level (L_{Aeq}) of the noise sources should not be more than 5 decibels above the measured background level (L_{A90}) when measured at the appropriate receiver location.

Assessing Amenity

The amenity assessment is based on noise criteria specific to land use and associated activities. The criteria relate only to industrial-type noise and do not include road, rail or community noise. The existing noise level from industry is measured. If it approaches the criterion value, then noise levels from new industries need to be designed so that the cumulative effect does not produce noise levels that would significantly exceed the criterion. For high-traffic areas there is a separate amenity criterion. The cumulative effect of noise from industrial sources needs to be considered in assessing impact.

Extracts from the INP that relate to the amenity criteria are given in **Table 4** and **Table 5**.

Table 4 Amenity Criteria - Recommended L_{Aeq} Noise Levels From Industrial Noise Sources

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

Notes: For Monday to Saturday, Daytime 7.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 7.00 am.
On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.
The L_{Aeq} index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period.

Table 5 Modification to Acceptable Noise Level (ANL)* to Account for Existing Levels of Industrial Noise

Total Existing L_{Aeq} noise level from Industrial Noise Sources	Maximum L_{Aeq} Noise Level for Noise from New Sources Alone, dBA
≥ Acceptable noise level plus 2 dBA	If existing noise level is *likely to decrease* in future acceptable noise level minus 10 dBA If existing noise level is *unlikely to decrease* in future existing noise level minus 10 dBA
Acceptable noise level plus 1 dBA	Acceptable noise level minus 8 dBA
Acceptable noise level	Acceptable noise level minus 8 dBA
Acceptable noise level minus 1 dBA	Acceptable noise level minus 6 dBA
Acceptable noise level minus 2 dBA	Acceptable noise level minus 4 dBA
Acceptable noise level minus 3 dBA	Acceptable noise level minus 3 dBA
Acceptable noise level minus 4 dBA	Acceptable noise level minus 2 dBA
Acceptable noise level minus 5 dBA	Acceptable noise level minus 2 dBA
Acceptable noise level minus 6 dBA	Acceptable noise level minus 1 dBA
< Acceptable noise level minus 6 dBA	Acceptable noise level

* ANL = recommended acceptable LAeq noise level for the specific receiver, area and time of day from **Table 4**.

Assessing Sleep Disturbance

DEC has acknowledged that the relationship between maximum noise levels and sleep disturbance is not currently well defined. Criteria for assessing sleep disturbance has not been defined under the INP but it is assumed that conformance with the INP would protect against the likelihood of awakening reactions. Not withstanding the preceding, sleep arousal has been assessed using the guidelines set out in the ENCM Section 19-3.

To avoid the likelihood sleep disturbance the ENCM recommends that the $L_{A1(1minute)}$ of the noise source under consideration should not exceed the background noise level (L_{A90}) by more than 15 dBA when measured outside the bedroom window of the receiver during the night-time hours (10.00 pm to 7.00 am).

Noise Management Procedure

The INP states that these criteria have been selected to protect at least 90% of the population living in the vicinity of industrial noise sources from the adverse effects of noise for at least 90% of the time. Provided the criteria in the INP are achieved, it is unlikely that most people would consider the resultant noise levels excessive.

In those cases where the INP project specific assessment criteria are not achieved, it does not automatically follow that all people exposed to the noise would find the noise unacceptable. In subjective terms, exceedances of the INP project specific assessment criteria can be generally described as follows:

- Negligible noise level increase <1 dBA
  (Not noticeable by all people)
- Marginal noise level increase 1 dBA to 2 dBA
  (Not noticeable by most people)
- Moderate noise level increase 3 dBA to 5 dBA
  (Not noticeable by some people but may be noticeable by others)
- Appreciable noise level increase >5 dBA
  (Noticeable by most people)

3.2 Construction Noise Assessment Criteria

The ENCM, Chapter 171, sets out noise criteria applicable to construction noise for the purpose of defining intrusive noise impacts. Based on this document the project specific noise limits outlined in **Table 6** will apply to the construction phase of the quarry.

Table 6 Construction Noise Criteria

Total Construction Period	Acceptable L_{A10} Noise Level[1]
4 weeks and under	Background L_{A90} plus 20 dBA
4 weeks to 26 weeks	Background L_{A90} plus 10 dBA
Greater Than 26 Weeks	Background L_{A90} plus 5 dBA

Note 1 Applicable between the hours of 7.00 am and 6.00 pm Monday to Friday, and 8.00 am to 1.00 pm Saturdays. For all other times construction noise must be inaudible at the receiver. No audible construction work is to take place on Sundays or Public Holidays.

3.3 Road Traffic Noise Assessment Criteria

DEC released the "Environmental Criteria for Road Traffic Noise" (ECRTN) in May 1999. The policy sets out noise criteria applicable to different road classifications for the purpose of defining traffic noise impacts.

The primary transport route will be via an internal access road to the Hume Highway. Access to the project area during construction will utilise the local road network. The noise criteria applicable to these roadways are outlined in **Table 7**.

Table 7 Environmental Criteria for Road Traffic Noise

Policy	Descriptor	Traffic Noise Goal
7. Land use developments with the potential to create additional traffic on existing freeways/arterials	$L_{Aeq(15hour)}$ daytime $L_{Aeq(9hour)}$ night-time	60 dBA* 55 dBA*
13. Land use developments with the potential to create additional traffic on local roads	$L_{Aeq(1hour)}$ daytime $L_{Aeq(1hour)}$ night-time	55 dBA* 50 dBA*

* In all cases (where criteria are already exceeded, or where existing noise levels are within 2 dBA of the criterion), traffic arising from the development should not lead to an increase in existing noise levels of more than 2 dBA.

While no well defined sleep disturbance criteria applicable to road traffic exists in NSW, the NSW RTA recognises that events likely to cause sleep arousal can occur, and are dependent upon both the maximum noise level of the source and the ambient background noise level at the residence. Where the L_{Amax} noise level is greater than 65 dBA and the L_{Amax} minus the L_{Aeq} noise level is greater than or equal to 15 dBA the event is recognised as a "significant" event, or an event likely to cause sleep disturbance at a residence.

3.4 Rail Traffic Assessment Criteria

The ENCM Rail Traffic Noise Guidelines form the basis of the assessment of cumulative train noise emissions on the Main Southern Railway.

The rail noise guideline provides criteria for residential receivers specified as both a 24 hour L_{Aeq} (equivalent continuous noise level) and as a maximum passby level, neither of which should be exceeded.

The guideline gives maximum levels of:

$L_{Aeq(24hour)}$ = 60 dBA (24 hour “noise exposure”); and

L_{Amax} = 85 dBA (maximum of any passby event)/

These guideline levels are normally evaluated at the most exposed property boundary.

The philosophy behind applying a 24 hour equivalent continuous noise level criterion is that it is sensitive to both the noise level of individual events and the number of noise events (whereas the L_{Amax} is not sensitive to the number of events).

4 EXISTING ACOUSTICAL AND METEOROLOGICAL ENVIRONMENT

In order to determine existing ambient noise levels at residential locations surrounding the project area, a background monitoring survey was undertaken at the seven (7) locations given in **Table 8**. These locations were chosen as they are representative of the nearest potentially affected existing and planned residential areas surrounding the site. These locations are also representative of varying acoustical environments surrounding the project area. The noise monitoring locations are identified on the Location Map contained in **Appendix B**.

Table 8 Background Noise Monitoring Locations

Noise Monitoring Location	Description
N1	North western boundary of project area
N2	North eastern boundary of project area
N3	60 Maclura Drive, Marulan
N4	30 Goulburn St, Marulan
N5	"Koorong Park" Wilson Drive East of the project area
N6	"Tangryang", Marulan South
N7	Residence to the south of the project area

The background noise monitoring consisted of continuous, unattended noise logging and operator attended noise surveys. The operator attended noise surveys help to define noise sources and the character of noise in the area and are, therefore, used to qualify unattended noise logging results.

Location N1 was located on the western boundary of the project area to the north of the Main Southern Railway.

Location N2 was located on the eastern boundary of the project area to the north of the Main Southern Railway and is on the boundary of a rural residential estate currently under development.

Location N3 was located at 60 Maclura Drive in a rural residential estate to the east of the project area to the north of the Main Southern Railway.

Location N4 was located in the township of Marulan, adjacent to the Main Southern Railway where there is a facility used for the loading of limestone.

Location N5 was located to the east of the project area, approximately 200 m west of the Hume Highway.

Location N6 was located to the south east of the project area, approximately 300 m to the east of the Hume Highway at a residence on South Marulan Road.

Location N7 was located on the south western boundary of the project area to the south of the Main Southern Railway.

4.1 Unattended Continuous Noise Monitoring

The objective of the background monitoring survey was to measure $L_{A90(15minute)}$ and $L_{Aeq(15minute)}$ noise levels at the nearest potentially affected receptors to determine the intrusiveness and amenity criteria for the project.

Background noise levels were monitored by Heggies at the previously defined residential locations from 31 May 2004 to 10 June 2004. Ambient background noise monitoring was conducted using ARL Type EL316 and Type EL215 environmental noise loggers. A temporary weather station was deployed on the project area during the noise monitoring to record weather conditions to be used for data exclusion as the nearest Bureau of Meteorology Automatic Weather Station (AWS) is at Goulburn, approximately 25 km to the south-west.

Noise data during periods of any rainfall and/or wind speeds in excess of 5 m/s (approximately 9 knots) were discarded in accordance with the INP weather affected data exclusion methodology.

A summary of the results of the unattended continuous noise monitoring are given in **Table 9**. The ambient noise levels from each monitoring location are presented in graphical format in **Appendix C**.

Table 9 Summary of Existing Ambient Background Noise Levels

Location	Description	Background Noise Level (L_{A90} dBA)	Measured Existing L_{Aeq} Noise Level (dBA)	Estimated Contribution from Existing Industrial Noise Sources ($L_{Aeq(period)}$ dBA)
		Rating Background Level		
N1	Daytime	30*	52	<35
	Evening	30*	45	<35
	Night	30*	49	<35
N2	Daytime	37	47	<35
	Evening	33	50	<35
	Night	33	51	<35
N3	Daytime	30*	49	<35
	Evening	32	45	<35
	Night	31	49	<35
N4	Daytime	40	58	51
	Evening	41	53	<35
	Night	40	51	<35
N5	Daytime	43	53	<35
	Evening	48	57	<35
	Night	41	56	<35
N6	Daytime	42	52	<35
	Evening	42	52	<35
	Night	38	50	<35
N7	Daytime	34	49	<35
	Evening	33	42	<35
	Night	32	42	<35

Notes
For Monday to Saturday, Daytime 7.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 7.00 am.
On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.
The L_{A90} represents the level exceeded for 90% of the interval period and is referred to as the average minimum or background noise level.
The L_{Aeq} index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period.
*RBL adjusted to 30 dBA where the measured RBL is less than30 dBA as per INP methodology.

4.2 Operator Attended Noise Monitoring

Operator-attended surveys were conducted at each of the noise monitoring locations to verify the unattended logging results and to determine the character and contribution of noise sources to the total ambient noise level.

Operator attended noise surveys were conducted during logger deployment on Monday 31 May 2004 and logger retrieval on Wednesday 9 June 2004. Results of these surveys are shown in **Table 10, Table 11** and **Table 12**. Ambient noise levels given in the tables include all noise sources such as traffic, insects, birds and local activities. The table provides the following information:

- Monitoring location.
- Date.
- Start time.
- Weather observations during survey.
- Typical maximum (L_{Amax}) and contributed noise levels.

Table 10 Operator Attended Noise Measurements - Daytime

Location	Date/ Start Time	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emission and Typical Maximum Levels LAmax (dBA)
		L_{Amax}	L_{A1}	L_{A10}	L_{A90}	L_{Aeq}	
N1	10/6/04 1230 W = 3 m/s SW Temp = 14 °C	50	48	45	39	41	Wind in trees 40-42 Birds 45-46
N2	1/6/04 1230 W = 3 m/s NW Temp = 15 °C	64	58	54	45	51	Wind in trees 45-48
N3	1/6/04 1150 W = 3 m/s NW Temp = 15 °C	81	66	53	40	55	Wind in trees to 54 Operator 80
N4	1/6/04 1230 W = 2 m/s NW Temp = 15 °C	77	67	55	50	56	Rail loading (lime) plant - 51, Car 65-67, Dog 75, Birds 51, Train horn 76, train ~70 Wind to 55
N5	1/6/04 1110 W = 1 m/s NW Temp = 14 °C	69	55	53	48	53	Highway 46-49, up to 51-52 with heavy traffic Wind in trees 45-46 Operator 68
N6	1/6/04 1050 W = 1 m/s NW Temp = 15 °C	64	62	53	46	51	Highway 46-48, up to 54 with heavy traffic Wind in trees ~42 Car 61-62
N7	10/6/04 1300 W = 3 m/s SW Temp = 14 °C	57	47	45	38	42	Highway 38-40 Wind in trees 42-44 Birds 45-46

Table 11 Operator Attended Noise Measurements - Evening

Location	Date/Start Time	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emission and Typical Maximum Levels LAmax (dBA)
		L_{Amax}	L_{A1}	L_{A10}	L_{A90}	L_{Aeq}	
N1	10/6/04 2000 W = Calm Temp = 10 °C	50	45	38	31	33	Train 45-47
N2	10/6/04 1900 W = Calm Temp = 12 °C	47	42	37	33	35	Highway 32-35
N3	10/6/04 1845 W = Calm Temp = 12 °C	69	62	53	34	50	Highway 32-35 Train 53-55, horn 67
N4	10/6/04 1915 W = Calm Temp = 12 °C	78	70	66	39	61	Highway 38-40, trucks to 43 Train 65-68, horn 67 Dogs barking to 66
N5	10/6/04 1830 W = Calm Temp = 14 °C	62	60	58	54	56	Highway 52-56, trucks to 59 Train ~48
N6	10/6/04 1800 W = Calm Temp = 15 °C	69	58	49	43	48	Highway 45-48 Dogs barking 58-60, 70 Lulls in traffic ~42
N7	10/6/04 2030 W = Calm Temp = 9 °C	56	48	45	36	41	Highway 40-41 Train 40-42

Table 12 Operator Attended Noise Measurements - Night time

Location	Date/ Start Time	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emission and Typical Maximum Levels LAmax (dBA)
		L_{Amax}	L_{A1}	L_{A10}	L_{A90}	L_{Aeq}	
N1	10/6/04 2200 W = Calm Temp = 8 °C	45	38	34	31	40	Highway barely audible
N2	31/5//04 2330 W = 1 m/s W Temp = 7 °C	64	57	51	39	47	Highway ~38 Wind in trees 37 Diesel train 40-42, to 53 up grade
N3	31/5//04 2350 W = 2 m/s W Temp = 6 °C	60	51	50	39	47	Highway 32-35 Train 53-55, horn 67
N4	31/5//04 2235 W = Calm Temp = 7 °C	63	48	43	40	42	Highway 38-39
N5	31/5//04 2220 W = Calm Temp = 7 °C	61	58	55	46	52	Highway 46-49, trucks to 58 Lulls in traffic ~42-44
N6	31/5//04 2200 W = Calm Temp = 8 °C	67	55	50	42	47	Highway 46-48, trucks to 56 Dogs barking 42-46 to 54 Lulls in traffic ~40-41
N7	31/5//04 2250 W = 1 m/s W Temp = 7 °C	66	43	40	34	39	Highway 32-36 Train 38-40 Birds ~34 Operator 66

4.3 INP Assessment of Prevailing Weather Conditions

Wind

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

Wind effects need to be considered when wind is a feature of the area being approved. Where wind blows from the source to the receiver at speeds up to 3 m/s for more than 30% of the time in any seasonal assessment period (ie day, evening or night), then wind is considered to be a feature of the area and noise level predictions must be made under these conditions.

In order to determine the prevailing conditions for the project area, weather data was obtained from the Wangi weather station (provided by Holmes Air Sciences) for the calendar year 2000. The Wangi weather station is located approximately eight (8) km to the south west of the proposed quarry site and Heggies consider that the data is representative of conditions at the proposed quarry.

This data was analysed to determine the frequency of occurrence of winds of speeds up to 3 m/s in each season during these periods. The results of the analysis showed that there are prevailing winds for the site as defined by the 30% threshold.

The results of the Wangi analysis for daytime, evening, and night-time winds are presented in **Table 13**, **Table 14** and **Table 15** respectively.

In each table, the wind directions and percentage occurrence are those dominant during each season.

Table 13 Seasonal Frequency of Occurrence Wind Speed Intervals - Daytime (0700-1800 Hours)

Period	Calm	Wind Direction	0.5 to 2 m/s	2 to 3 m/s	0.5 to 3 m/s
Summer	0.5%	WSW±45°	3.3%	6.8%	10.2%
Autumn	5.2%	NE±45°	8.6%	6.0%	14.6%
Winter	7.0%	WNW±45°	6.8%	5.7%	12.5%
Spring	0.6%	ENE±45°	3.0%	6.1%	9.1%

Table 14 Seasonal Frequency of Occurrence Wind Speed Intervals – Evening (1800-2200 Hours)

Period	Calm	Wind Direction	0.5 to 2 m/s	2 to 3 m/s	0.5 to 3 m/s
Summer	3.3%	W±45°	9.8%	14.8%	24.6%
Autumn	9.0%	W±45°	17.0%	13.5%	30.4%
Winter	9%	WNW±45°	23.8%	4.3%	28.1%
Spring	4.7%	NE±45°	10.9%	6.2%	17.0%

Table 15 Seasonal Frequency of Occurrence Wind Speed Intervals – Night-time (2200-0700 Hours)

Period	Calm	Wind Direction	0.5 to 2 m/s	2 to 3 m/s	0.5 to 3 m/s
Summer	12.8%	W±45°	22.6%	13.0%	35.6%
Autumn	18.2%	W±45°	22.2%	5.9%	28.1%
Winter	16.9%	W±45°	25.7%	5.5%	31.2%
Spring	9.0%	W±45°	12.0%	6.1%	18.1%

Seasonal wind records indicate that night-time winds of up to 3 m/s predominate in summer and winter from the western sector for up to 31.2% and 35.6% of the time respectively.

Seasonal wind records indicate that significant winds (of up to 3 m/s) predominate in autumn evenings for up to 30.4% of the time, and summer and winter nights from the western sector for up to 31% and 35.6% of the time respectively. Therefore, as the percentage occurrence of winds from this direction exceed the 30% threshold, an assessment of noise under prevailing wind conditions has been conducted as part of this assessment.

Holmes Air Sciences installed a weather station on the project area during June 2004. At the time of analysis 12 months worth of weather data (required for the noise assessment) was not available from this station and hence the Wangi station data was used. Data from the weather station located on the project area suggests that the dominant acoustically significant winds are from either the east or the west. Therefore, the analysis of the Wangi data, which gives a dominant westerly wind, is considered to provide a worst case scenario for noise assessment purposes.

Temperature Inversion

Temperature inversions, when they occur, have the ability to increase noise levels by focusing sound waves. Temperature inversions occur predominantly at night during the winter months. For a temperature inversion to be a significant characteristic of the area it needs to occur for approximately 30% of the total night-time during winter or about two nights per week.

The NSW INP states that temperature inversions need only be considered for the night-time noise assessment period (10.00 pm to 7.00 am). Analysis of temperature inversion data from Wangi shows that the occurrence of F Class temperature inversions is approximately 31% during winter nights. Hence an assessment of noise under temperature inversions has been conducted as part of this assessment. Furthermore, drainage flow wind have been accounted for where appropriate using INP methodology.

5 PROJECT SPECIFIC NOISE EMISSION CRITERIA

Seven (7) locations were chosen for the background noise monitoring. Noise levels have been predicted to 14 assessment locations, including locations at, or near the seven noise monitoring locations.

5.1 Operational Noise Design Criteria

Background noise monitoring and residential receiver Locations N1, N2, N3 and N7 are remote from any major roads or industry and exhibit an ambient noise climate typical of a rural area, whereas residential receiver locations in the vicinity of N4, N5 and N6 having constant traffic flows are best described by the suburban or urban category. For the purpose of this report residential receiver locations in the vicinity of N4, N5 and N6 have been defined as suburban.

The project specific operational noise criteria, set in accordance with the INP, are presented in **Table 16**.

Table 16 Project Specific Noise Emission Design Criteria for Noise Monitoring Locations

Location	Description	Measured Rating Background Level L_{A90} (dBA)	Intrusiveness Criterion $L_{Aeq(15minute)}$ (dBA)	Amenity Criterion $L_{Aeq(period)}$ (dBA)	Sleep Disturbance Criterion $L_{A1(1minute)}$ (dBA)
N1	Daytime	30	35	50	N/A
	Evening	30	35	45	N/A
	Night	30	35	40	45
N2	Daytime	37	42	50	N/A
	Evening	33	38	45	N/A
	Night	33	38	40	48
N3	Daytime	30	35	50	N/A
	Evening	32	37	45	N/A
	Night	31	36	40	46
N4	Daytime	40	45	53[1]	N/A
	Evening	41	46	45	N/A
	Night	40	45	41[2]	55
N5	Daytime	43	48	55	N/A
	Evening	48	53	47[2]	N/A
	Night	41	46	46[2]	56
N6	Daytime	42	47	55	N/A
	Evening	42	47	45	N/A
	Night	38	43	40	53
N7	Daytime	34	39	50	N/A
	Evening	33	38	45	N/A
	Night	32	37	40	47

Notes For Monday to Saturday, Daytime 7.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 7.00 am.
On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.
The L_{A90} represents the level exceeded for 90% of the interval period and is referred to as the average minimum or background noise level. The L_{Aeq} index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a 15 minute measurement period.
[1] Adjusted down by 2 dBA as per INP existing industrial noise methodology.
[2] Adjusted up to account for existing high traffic noise as per INP Methodology.

The amenity criteria noise levels are higher than the intrusiveness criteria noise levels in most cases. Exceptions include the evening period at noise monitoring Location N5, and the evening and night-time periods at noise monitoring Locations N4 and N6. Compliance with the intrusiveness criteria, therefore, will demonstrate compliance with the amenity criteria in most situations. For noise monitoring Locations N4, N5 and N6, the amenity criterion will be the limiting criteria. Accordingly, the following assessment is based on the controlling noise criteria being the lowest of the intrusiveness and the amenity criteria for noise monitoring Locations N4, N5 and N6. A conservative approach has been taken for this project, whereby amenity criteria that are below the intrusiveness criteria at noise monitoring Locations N4, N5 and N6 will be treated as if they were $L_{Aeq(15minute)}$ noise criteria. These criteria levels will be compared against $L_{Aeq(15minute)}$ noise predictions for operation of the quarry to determine compliance.

Noise modelling has been undertaken to 14 residential locations, so residences were grouped into locations exhibiting similar ambient acoustic properties. Based upon this methodology, **Table 17** shows the distribution of noise level criteria into residential groupings.

Table 17 Residential Groupings

Noise Monitoring Location	Noise Assessment Location	Acoustic classification
N1	1	Rural
N2	2, 3, 12,13	Rural
N3	4, 5, 6	Rural
N4	7, 8	Suburban
N5	9	Suburban
N6	10	Suburban
N7	11, 14	Rural

The project specific operational noise criteria, set in accordance with the INP, are presented in **Table 18**.

Table 18 Project Specific Operational Noise Criteria for Noise Assessment Locations

Location	Description	Criterion LAeq(15minute) dBA	Sleep Disturbance Criterion LA1(1 minute) dBA
Location 1	Daytime	35	N/A
	Evening	35	N/A
	Night	35	45
Location 2	Daytime	42	N/A
	Evening	38	N/A
	Night	38	48
Location 3	Daytime	42	N/A
	Evening	38	N/A
	Night	38	48
Location 4	Daytime	35	N/A
	Evening	37	N/A
	Night	36	46
Location 5	Daytime	35	N/A
	Evening	37	N/A
	Night	36	46
Location 6	Daytime	35	N/A
	Evening	37	N/A
	Night	36	46
Location 7	Daytime	45	N/A
	Evening	45*	N/A
	Night	41*	55
Location 8	Daytime	45	N/A
	Evening	45*	N/A
	Night	41*	55
Location 9	Daytime	48	N/A
	Evening	47*	N/A
	Night	46	56
Location 10	Daytime	47	N/A
	Evening	45*	N/A
	Night	40*	53
Location 11	Daytime	39	N/A
	Evening	38	N/A
	Night	37	47
Location 12	Daytime	42	N/A
	Evening	38	N/A
	Night	38	48
Location 13	Daytime	42	N/A
	Evening	38	N/A
	Night	38	48
Location 14	Daytime	39	N/A
	Evening	38	N/A
	Night	37	47

Note: * Derived from the amenity criteria.

5.2 Project Specific Construction Noise Design Goals

The construction noise emission design goals have been set with reference to the ENCM. **Table 19** contains the project specific construction noise design limits.

Table 19 Project Specific Construction Noise Goals

Location	Construction Period	Criterion LA10(15minute) dBA
Location 1	4 weeks and under	50
	4 weeks to 26 weeks	40
	Greater Than 26 Weeks	35
Location 2	4 weeks and under	57
	4 weeks to 26 weeks	47
	Greater Than 26 Weeks	42
Location 3	4 weeks and under	57
	4 weeks to 26 weeks	47
	Greater Than 26 Weeks	42
Location 4	4 weeks and under	50
	4 weeks to 26 weeks	40
	Greater Than 26 Weeks	35
Location 5	4 weeks and under	50
	4 weeks to 26 weeks	40
	Greater Than 26 Weeks	35
Location 6	4 weeks and under	50
	4 weeks to 26 weeks	40
	Greater Than 26 Weeks	35
Location 7	4 weeks and under	60
	4 weeks to 26 weeks	50
	Greater Than 26 Weeks	45
Location 8	4 weeks and under	60
	4 weeks to 26 weeks	50
	Greater Than 26 Weeks	45
Location 9	4 weeks and under	63
	4 weeks to 26 weeks	53
	Greater Than 26 Weeks	48
Location 10	4 weeks and under	62
	4 weeks to 26 weeks	52
	Greater Than 26 Weeks	47
Location 11	4 weeks and under	54
	4 weeks to 26 weeks	44
	Greater Than 26 Weeks	39
Location 12	4 weeks and under	57
	4 weeks to 26 weeks	47
	Greater Than 26 Weeks	42
Location 13	4 weeks and under	57
	4 weeks to 26 weeks	47
	Greater Than 26 Weeks	42
Location 14	4 weeks and under	54
	4 weeks to 26 weeks	44
	Greater Than 26 Weeks	39

Construction noise level goals are applicable between the hours of 7.00 am and 6.00 pm Monday to Friday, and 8.00 am to 1.00 pm Saturdays. For all other times construction noise must be inaudible at the receivers. No audible construction work is planned to take place on Sundays or Public Holidays.

5.3 Road Traffic Noise Goals

The noise criteria applicable to the major operational traffic route and construction access roadways are outlined in **Table 20**.

Table 20 Environmental Criteria for Road Traffic Noise

Policy	Descriptor	Traffic Noise Goal
7. Land use developments with the potential to create additional traffic on existing freeways/arterials	$L_{Aeq(15hour)}$ daytime	60 dBA*
	$L_{Aeq(9hour)}$ night-time	55 dBA*
13. Land use developments with the potential to create additional traffic on local roads	$L_{Aeq(1hour)}$ daytime	55 dBA*
	$L_{Aeq(1hour)}$ night-time	50 dBA*

* In all cases (where criteria are already exceeded, or where existing noise levels are within 2 dBA of the criterion), traffic arising from the development should not lead to an increase in existing noise levels of more than 2 dBA.

While no well defined sleep disturbance criteria applicable to road traffic exists in NSW, the NSW RTA recognises that events likely to cause sleep arousal can occur, and are dependent upon both the maximum noise level of the source and the ambient background noise level at the residence. Where the L_{Amax} noise level is greater than 65 dBA and the L_{Amax} minus the L_{Aeq} noise level is greater than or equal to 15 dBA the event is recognised as a "significant" event, or an event likely to cause sleep disturbance at a residence.

5.4 Rail Traffic Noise Goals

The DEC's ENCM 1994 Rail Traffic Noise Guidelines form the basis of the assessment of cumulative train noise emissions on the Main Southern Railway.

The rail noise guideline provides criteria for residential receivers specified as both a 24 hour L_{Aeq} (equivalent continuous noise level) and as a maximum passby level, neither of which should be exceeded. The guideline gives maximum levels of:

$L_{Aeq\ 24hour}$ = 60 dBA (24 hour "noise exposure") and

L_{Amax} = 85 dBA (maximum of any passby event)

These guideline levels are normally evaluated at the most exposed property boundary.

The philosophy behind applying a 24 hour equivalent continuous noise level criterion is that it is sensitive to both the noise level of individual events and the number of noise events (whereas the L_{Amax} is not sensitive to the numbers of events).

6 ASSESSMENT OF NOISE IMPACTS

6.1 Operational Noise Modelling

A computer model was used to predict the noise emissions from the project area using the Environmental Noise Model (ENM) software which was produced in conjunction with the DEC. A digital map giving all relevant topographic information was entered into the model. The model used this map, together with the noise source data, ground cover, shielding by barriers and/or adjacent buildings and atmospheric information to predict noise levels for both construction and operation of the proposed development. Noise levels were predicted at 11 residences and three (3) potential residential locations which represent the nearest, most potentially affected, residential receiver locations as shown in **Appendix B**. Noise levels under calm atmospheric conditions and prevailing weather conditions were modelled. All quarry plans and topographic data used in the ENM was supplied by Umwelt (Australia) Pty Limited.

Noise from all sources that contribute to the total noise at the site have been examined to identify characteristics that may cause greater annoyance (for example tonality, impulsiveness etc). The appropriate modifying factors, as outlined in the INP, have been applied where these characteristics are considered to be present. The noise model does not consider noise likely to emanate from reversing alarms, horns or other warning devices. In the event that these items are likely to pose a problem, consideration should be given to investigating alternative warning options as appropriate. Careful selection of alternatives is important so that safety is not compromised. Alternatives to reversing alarms may include warning lights, reversing sensors on vehicles, reversing cameras on vehicles, a combination of these, or diligent choice of the type and level of reversing alarms so that they only alert the immediate area around the vehicle.

Noise Modelling Parameters

The predicted noise emission levels for operation of the quarry at potentially affected receivers have been calculated with the meteorological parameters shown in **Table 21**.

Table 21 Noise Modelling Parameters

Assessment Condition	Temperature °C	Wind Speed Direction (m/s)	Relative Humidity (%)	Temperature Gradient °C/100m
Calm	20	Calm	65	0
Evening Prevailing Westerly Wind	10	2.5 m/s	80	0
Night Prevailing Westerly Wind	4	2.5 m/s	90	0
Temperature Inversion	4	Calm	90	-3
Temperature Inversion and Drainage Flow from the South East	4	2.0 m/s	90	-3
Temperature Inversion and Drainage Flow from the North West	4	2.0 m/s	90	-3

Under conditions of temperature inversion drainage flow was considered to occur from the project area either to the south-east or to the north-west as dictated by the surrounding topography.

Six operational scenarios were chosen for the noise modelling. These include the following quarry plans, which are also attached as maps in **Appendix B**:

- Year 1 quarry plan.
- Year 5 quarry plan.
- Year 10 quarry plan.
- Year 15 quarry plan.
- Year 20 quarry plan.
- Year 30 quarry plan.

6.2 Noise Mitigation and Management

Several mitigation methods have been investigated in order to minimise noise surrounding receiver locations. Mitigation in the form of engineering or management controls, which have been adopted and included in the noise modelling process, are as follows:

6.2.1 Engineering controls

- All crushing and screening facilities are enclosed by buildings, except for the primary gyratory crusher, and spalls plant.
- The pug mills are enclosed by a building.
- The scalps screen has a rubber screen deck.
- Train and truck loading bins are lined on the base to reduce impact noise when bins are being loaded from empty.
- Trucks dumping the leading row of overburden on the eastern overburden emplacement area will have attenuation to a maximum sound power level of 111 dBA when dumping.

6.2.2 Management Controls

- The spalls plant will operate during the daytime only.
- The grader will operate during the daytime only.
- The overburden removal and emplacement fleet will operate during the daytime only.
- When operating on the eastern emplacement areas, the majority of operations occurring on the top of the emplacement areas will occur behind an earth mound created by the first row of dumping.
- The load and haul fleet will operate during the daytime and evening only.
- No dumping will occur on the leading edge of either the eastern overburden emplacement area or the eastern excess product emplacement area will occur while the dozer is operating on the leading face of either the aforementioned emplacement areas.
- The number of finished product trucks at night shall be limited to 32 movements per hour.

6.3 Noise Modelling Results

Predicted noise levels for plant operations for both calm and prevailing weather conditions are shown in **Table 22** through to **Table 27**. Predicted noise levels shown in these tables under temperature inversion represent temperature inversion with drainage flow where appropriate. Noise contour plots have been produced for selected scenarios which relate to worst case situations for day, evening and night periods and are attached as **Appendix D**.

Table 22 Operational Noise Modelling Results for Year 1

Location	Period	Predicted Noise Level $L_{Aeq(15minute)}$ (dBA)			Project Specific Noise Criteria $L_{Aeq(15minute)}$ (dBA)
		Calm	Prevailing Wind	Temperature Inversion	
Location 1	Daytime	<30	N/A	N/A	35
	Evening	<30	<30	N/A	35
	Night	<30	<30	32	35
Location 2	Daytime	<30	N/A	N/A	42
	Evening	<30	<30	N/A	38
	Night	<30	<30	<30	38
Location 3	Daytime	<30	N/A	N/A	42
	Evening	<30	<30	N/A	38
	Night	<30	<30	<30	38
Location 4	Daytime	<30	N/A	N/A	35
	Evening	<30	32	N/A	37
	Night	<30	31	31	36
Location 5	Daytime	30	N/A	N/A	35
	Evening	<30	32	N/A	37
	Night	<30	32	32	36
Location 6	Daytime	35	N/A	N/A	35
	Evening	<30	36	N/A	37
	Night	<30	34	35	36
Location 7	Daytime	32	N/A	N/A	45
	Evening	<30	36	N/A	45
	Night	<30	32	33	41
Location 8	Daytime	33	N/A	N/A	45
	Evening	<30	35	N/A	45
	Night	<30	33	34	41
Location 9	Daytime	30	N/A	N/A	48
	Evening	<30	37	N/A	47
	Night	<30	33	35	46
Location 10	Daytime	38	N/A	N/A	47
	Evening	37	40	N/A	45
	Night	37	40	39	40
Location 11	Daytime	32	N/A	N/A	39
	Evening	<30	<30	N/A	38
	Night	<30	<30	32	37
Location 12	Daytime	<30	N/A	N/A	42
	Evening	<30	34	N/A	38
	Night	<30	34	31	38
Location 13	Daytime	34	N/A	N/A	42
	Evening	<30	36	N/A	38
	Night	<30	34	35	38
Location 14	Daytime	32	N/A	N/A	35
	Evening	<30	<30	N/A	37
	Night	<30	<30	33	36

Notes For Monday to Saturday, Daytime 7.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 7.00 am.
On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.

Table 23 Operational Noise Modelling Results for Year 5

Location	Period	Predicted Noise Level $L_{Aeq(15minute)}$ (dBA)			Project Specific Noise Criteria $L_{Aeq(15minute)}$ (dBA)
		Calm	Prevailing Wind	Temperature Inversion	
Location 1	Daytime	<30	N/A	N/A	35
	Evening	<30	<30	N/A	35
	Night	<30	<30	31	35
Location 2	Daytime	<30	N/A	N/A	42
	Evening	<30	<30	N/A	38
	Night	<30	<30	<30	38
Location 3	Daytime	<30	N/A	N/A	42
	Evening	<30	<30	N/A	38
	Night	<30	<30	<30	38
Location 4	Daytime	31	N/A	N/A	35
	Evening	<30	33	N/A	37
	Night	<30	31	31	36
Location 5	Daytime	35	N/A	N/A	35
	Evening	<30	31	N/A	37
	Night	<30	31	31	36
Location 6	Daytime	35	N/A	N/A	35
	Evening	<30	34	N/A	37
	Night	<30	34	34	36
Location 7	Daytime	35	N/A	N/A	45
	Evening	<30	33	N/A	45
	Night	<30	32	33	41
Location 8	Daytime	37	N/A	N/A	45
	Evening	<30	34	N/A	45
	Night	<30	33	34	41
Location 9	Daytime	32	N/A	N/A	48
	Evening	<30	33	N/A	47
	Night	<30	32	34	46
Location 10	Daytime	38	N/A	N/A	47
	Evening	37	40	N/A	45
	Night	37	40	39	40
Location 11	Daytime	31	N/A	N/A	39
	Evening	<30	<30	N/A	38
	Night	<30	<30	32	37
Location 12	Daytime	33	N/A	N/A	42
	Evening	<30	31	N/A	38
	Night	<30	<30	<30	38
Location 13	Daytime	38	N/A	N/A	42
	Evening	<30	35	N/A	38
	Night	<30	34	34	38
Location 14	Daytime	31	N/A	N/A	35
	Evening	<30	<30	N/A	37
	Night	<30	<30	32	36

Notes For Monday to Saturday, Daytime 7.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 7.00 am.
On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.

Table 24 Operational Noise Modelling Results for Year 10

Location	Period	Predicted Noise Level $L_{Aeq(15minute)}$ (dBA)			Project Specific Noise Criteria $L_{Aeq(15minute)}$ (dBA)
		Calm	Prevailing Wind	Temperature Inversion	
Location 1	Daytime	<30	N/A	N/A	35
	Evening	<30	<30	N/A	35
	Night	<30	<30	32	35
Location 2	Daytime	<30	N/A	N/A	42
	Evening	<30	<30	N/A	38
	Night	<30	<30	<30	38
Location 3	Daytime	<30	N/A	N/A	42
	Evening	<30	<30	N/A	38
	Night	<30	<30	<30	38
Location 4	Daytime	31	N/A	N/A	35
	Evening	<30	35	N/A	37
	Night	<30	31	31	36
Location 5	Daytime	33	N/A	N/A	35
	Evening	<30	32	N/A	37
	Night	<30	32	32	36
Location 6	Daytime	35	N/A	N/A	35
	Evening	<30	34	N/A	37
	Night	<30	34	34	36
Location 7	Daytime	32	N/A	N/A	45
	Evening	<30	35	N/A	45
	Night	<30	33	33	41
Location 8	Daytime	32	N/A	N/A	45
	Evening	<30	36	N/A	45
	Night	<30	33	34	41
Location 9	Daytime	31	N/A	N/A	48
	Evening	<30	35	N/A	47
	Night	<30	33	35	46
Location 10	Daytime	38	N/A	N/A	47
	Evening	37	40	N/A	45
	Night	37	40	39	40
Location 11	Daytime	31	N/A	N/A	39
	Evening	<30	<30	N/A	38
	Night	<30	<30	32	37
Location 12	Daytime	34	N/A	N/A	42
	Evening	<30	33	N/A	38
	Night	<30	<30	<30	38
Location 13	Daytime	36	N/A	N/A	42
	Evening	<30	37	N/A	38
	Night	<30	34	34	38
Location 14	Daytime	32	N/A	N/A	35
	Evening	<30	<30	N/A	37
	Night	<30	<30	32	36

Notes For Monday to Saturday, Daytime 7.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 7.00 am.
On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.

Table 25 Operational Noise Modelling Results for Year 15

Location	Period	Predicted Noise Level $L_{Aeq(15minute)}$ (dBA)			Project Specific Noise Criteria $L_{Aeq(15minute)}$ (dBA)
		Calm	Prevailing Wind	Temperature Inversion	
Location 1	Daytime	<30	N/A	N/A	35
	Evening	<30	<30	N/A	35
	Night	<30	<30	<30	35
Location 2	Daytime	<30	N/A	N/A	42
	Evening	<30	<30	N/A	38
	Night	<30	<30	<30	38
Location 3	Daytime	<30	N/A	N/A	42
	Evening	<30	<30	N/A	38
	Night	<30	<30	<30	38
Location 4	Daytime	<30	N/A	N/A	35
	Evening	<30	33	N/A	37
	Night	<30	30	30	36
Location 5	Daytime	<30	N/A	N/A	35
	Evening	<30	32	N/A	37
	Night	<30	32	32	36
Location 6	Daytime	<30	N/A	N/A	35
	Evening	<30	34	N/A	37
	Night	<30	34	34	36
Location 7	Daytime	<30	N/A	N/A	45
	Evening	<30	33	N/A	45
	Night	<30	32	33	41
Location 8	Daytime	<30	N/A	N/A	45
	Evening	<30	33	N/A	45
	Night	<30	33	34	41
Location 9	Daytime	<30	N/A	N/A	48
	Evening	<30	33	N/A	47
	Night	<30	33	35	46
Location 10	Daytime	38	N/A	N/A	47
	Evening	37	40	N/A	45
	Night	37	40	39	40
Location 11	Daytime	31	N/A	N/A	39
	Evening	<30	<30	N/A	38
	Night	<30	<30	32	37
Location 12	Daytime	<30	N/A	N/A	42
	Evening	<30	32	N/A	38
	Night	<30	<30	<30	38
Location 13	Daytime	<30	N/A	N/A	42
	Evening	<30	34	N/A	38
	Night	<30	34	34	38
Location 14	Daytime	31	N/A	N/A	35
	Evening	<30	<30	N/A	37
	Night	<30	<30	32	36

Notes For Monday to Saturday, Daytime 7.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 7.00 am.
On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.

Table 26 Operational Noise Modelling Results for Year 20

Location	Period	Predicted Noise Level $L_{Aeq(15minute)}$ (dBA)			Project Specific Noise Goal $L_{Aeq(15minute)}$ (dBA)
		Calm	Prevailing Wind	Temperature Inversion	
Location 1	Daytime	<30	N/A	N/A	35
	Evening	<30	<30	N/A	35
	Night	<30	<30	32	35
Location 2	Daytime	<30	N/A	N/A	42
	Evening	<30	<30	N/A	38
	Night	<30	<30	<30	38
Location 3	Daytime	<30	N/A	N/A	42
	Evening	<30	<30	N/A	38
	Night	<30	<30	<30	38
Location 4	Daytime	<30	N/A	N/A	35
	Evening	<30	37	N/A	37
	Night	<30	31	31	36
Location 5	Daytime	<30	N/A	N/A	35
	Evening	<30	33	N/A	37
	Night	<30	32	32	36
Location 6	Daytime	<30	N/A	N/A	35
	Evening	<30	35	N/A	37
	Night	<30	34	34	36
Location 7	Daytime	<30	N/A	N/A	45
	Evening	<30	36	N/A	45
	Night	<30	33	33	41
Location 8	Daytime	<30	N/A	N/A	45
	Evening	<30	36	N/A	45
	Night	<30	33	34	41
Location 9	Daytime	<30	N/A	N/A	48
	Evening	<30	35	N/A	47*
	Night	<30	32	34	46
Location 10	Daytime	37	N/A	N/A	47
	Evening	37	40	N/A	45
	Night	37	40	39	40
Location 11	Daytime	31	N/A	N/A	39
	Evening	<30	<30	N/A	38
	Night	<30	<30	32	37
Location 12	Daytime	<30	N/A	N/A	42
	Evening	<30	35	N/A	38
	Night	<30	<30	<30	38
Location 13	Daytime	<30	N/A	N/A	42
	Evening	<30	37	N/A	38
	Night	<30	34	34	38
Location 14	Daytime	32	N/A	N/A	35
	Evening	<30	<30	N/A	37
	Night	<30	<30	32	36

Notes For Monday to Saturday, Daytime 7.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 7.00 am.
On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.

Table 27 Operational Noise Modelling Results for Year 30

Location	Period	Predicted Noise Level $L_{Aeq(15minute)}$ dBA			Project Specific Noise Criteria $L_{Aeq(15minute)}$ dBA
		Calm	Prevailing Wind	Temperature Inversion	
Location 1	Daytime	<30	N/A	N/A	35
	Evening	<30	<30	N/A	35
	Night	<30	<30	32	35
Location 2	Daytime	<30	N/A	N/A	42
	Evening	<30	<30	N/A	38
	Night	<30	<30	<30	38
Location 3	Daytime	<30	N/A	N/A	42
	Evening	<30	<30	N/A	38
	Night	<30	<30	<30	38
Location 4	Daytime	<30	N/A	N/A	35
	Evening	<30	33	N/A	37
	Night	<30	31	31	36
Location 5	Daytime	<30	N/A	N/A	35
	Evening	<30	32	N/A	37
	Night	<30	32	32	36
Location 6	Daytime	<30	N/A	N/A	35
	Evening	<30	34	N/A	37
	Night	<30	34	34	36
Location 7	Daytime	<30	N/A	N/A	45
	Evening	<30	33	N/A	45
	Night	<30	33	33	41
Location 8	Daytime	<30	N/A	N/A	45
	Evening	<30	33	N/A	45
	Night	<30	33	34	41
Location 9	Daytime	<30	N/A	N/A	48
	Evening	<30	33	N/A	47*
	Night	<30	32	34	46
Location 10	Daytime	37	N/A	N/A	47
	Evening	37	40	N/A	45
	Night	37	40	39	40
Location 11	Daytime	30	N/A	N/A	39
	Evening	<30	<30	N/A	38
	Night	<30	<30	32	37
Location 12	Daytime	<30	N/A	N/A	42
	Evening	<30	34	N/A	38
	Night	<30	<30	<30	38
Location 13	Daytime	<30	N/A	N/A	42
	Evening	<30	35	N/A	38
	Night	<30	35	32	38
Location 14	Daytime	32	N/A	N/A	35
	Evening	<30	<30	N/A	37
	Night	<30	<30	32	36

Notes For Monday to Saturday, Daytime 7.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 7.00 am.
On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.

Noise modelling results indicate that the operation of the Lynwood Quarry is predicted to meet all project specific noise criteria for operation during daytime, evening and night-time at all residential locations under both calm and prevailing weather conditions with appropriate noise controls in place.

6.3.1 Sleep Disturbance

Noise modelling was conducted for sleep disturbance using an L_{A1} noise level of a truck loading and train loading from each of the loading bins. The loading of trucks and the rail bins was considered to have the most potential to cause sleep disturbance impacts. Modelling was conducted for acoustically adverse weather conditions, including temperature inversion and relevant drainage flow winds. Ground contours for the year one scenario, where no overburden emplacement areas have been constructed have been used in the noise model. This is considered to be the worst-case sleep disturbance situation. The highest of all predicted noise levels has been reported in **Table 28**.

Table 28 Sleep Disturbance Noise Modelling Results

Location	Period	Predicted Noise Level $L_{A1(1minute)}$ (dBA)	Project Specific Noise Goal $L_{A1(1minute)}$ (dBA)
Location 1	Night	39	45
Location 2	Night	<30	48
Location 3	Night	<30	48
Location 4	Night	40	46
Location 5	Night	42	46
Location 6	Night	45	46
Location 7	Night	42	55
Location 8	Night	44	55
Location 9	Night	45	56
Location 10	Night	44	53
Location 11	Night	44	47
Location 12	Night	42	48
Location 13	Night	44	48
Location14	Night	44	47

$L_{A1(1minute)}$ noise levels are predicted to be below project specific sleep disturbance goals for night-time operation of the quarry. This being the case, sleep disturbance is unlikely to occur at residential locations surrounding the proposed quarry.

6.4 Construction Noise Modelling

There will be ten (10) primary stages to the construction works. These include:

- Highway Intersection
- Bridge over Rail Line
- Earthworks
- Foundations
- Structures
- Building Fitout
- Mechanical Works
- Electrical Installation
- Plumbing Services
- Rail Track and Signalling

While the highway intersection forms part of the construction process, the construction activities take place predominantly on the highway road corridor. This being the case, the construction would be classed as a road upgrade under the jurisdiction of the document *Environmental Criteria for Road Traffic Noise* (ECRTN). This assessment is likely to occur during the detailed design stage, and may be undertaken by the roadworks contractor prior to construction activities commencing.

Earthworks and foundation work require the largest amount of plant and equipment to be used on the project area, and these two operations have been concentrated on for the construction noise assessment. Noise levels used in the construction noise model are contained in **Appendix A**.

The worst case scenario for earthworks has been modelled. This involves the equipment operating at the proposed location of the quarry processing plant and rail loop to level and prepare the project area for foundations.

Similarly, the worst case scenario for foundation work has also been modelled. This will occur when foundations are being created for the easternmost buildings.

Table 29 contains the results for earthworks, and **Table 30** contains the results for foundations.

Table 29 Predicted Construction Noise Levels - Earthworks

Location	Predicted Noise Level (LA10)	Construction Period	Criterion LA10(15minute) (dBA)
Location 1	<30	4 weeks and under	50
		4 weeks to 26 weeks	40
		Greater Than 26 Weeks	35
Location 2	<30	4 weeks and under	57
		4 weeks to 26 weeks	47
		Greater Than 26 Weeks	42
Location 3	<30	4 weeks and under	57
		4 weeks to 26 weeks	47
		Greater Than 26 Weeks	42
Location 4	<30	4 weeks and under	50
		4 weeks to 26 weeks	40
		Greater Than 26 Weeks	35
Location 5	34	4 weeks and under	50
		4 weeks to 26 weeks	40
		Greater Than 26 Weeks	35
Location 6	35	4 weeks and under	50
		4 weeks to 26 weeks	40
		Greater Than 26 Weeks	35
Location 7	31	4 weeks and under	60
		4 weeks to 26 weeks	50
		Greater Than 26 Weeks	45
Location 8	30	4 weeks and under	60
		4 weeks to 26 weeks	50
		Greater Than 26 Weeks	45
Location 9	<30	4 weeks and under	63
		4 weeks to 26 weeks	53
		Greater Than 26 Weeks	48
Location 10	<30	4 weeks and under	62
		4 weeks to 26 weeks	52
		Greater Than 26 Weeks	47
Location 11	39	4 weeks and under	54
		4 weeks to 26 weeks	44
		Greater Than 26 Weeks	39
Location 12	<30	4 weeks and under	57
		4 weeks to 26 weeks	47
		Greater Than 26 Weeks	42
Location 13	31	4 weeks and under	57
		4 weeks to 26 weeks	47
		Greater Than 26 Weeks	42
Location 14	39	4 weeks and under	54
		4 weeks to 26 weeks	44
		Greater Than 26 Weeks	39

Noise levels for earthworks construction are predicted to meet all construction noise goals at all residences.

Table 30 Predicted Construction Noise Levels - Foundation Works

Location	Predicted Noise Level (L_{A10})	Construction Period	Criterion $L_{A10(15minute)}$ (dBA)
Location 1	<30	4 weeks and under	50
		4 weeks to 26 weeks	40
		Greater Than 26 Weeks	35
Location 2	<30	4 weeks and under	52
		4 weeks to 26 weeks	47
		Greater Than 26 Weeks	42
Location 3	<30	4 weeks and under	52
		4 weeks to 26 weeks	47
		Greater Than 26 Weeks	42
Location 4	<30	4 weeks and under	50
		4 weeks to 26 weeks	40
		Greater Than 26 Weeks	35
Location 5	<30	4 weeks and under	50
		4 weeks to 26 weeks	40
		Greater Than 26 Weeks	35
Location 6	<30	4 weeks and under	50
		4 weeks to 26 weeks	40
		Greater Than 26 Weeks	35
Location 7	<30	4 weeks and under	60
		4 weeks to 26 weeks	50
		Greater Than 26 Weeks	45
Location 8	<30	4 weeks and under	60
		4 weeks to 26 weeks	50
		Greater Than 26 Weeks	45
Location 9	<30	4 weeks and under	63
		4 weeks to 26 weeks	53
		Greater Than 26 Weeks	48
Location 10	<30	4 weeks and under	62
		4 weeks to 26 weeks	52
		Greater Than 26 Weeks	47
Location 11	33	4 weeks and under	54
		4 weeks to 26 weeks	44
		Greater Than 26 Weeks	39
Location 12	<30	4 weeks and under	57
		4 weeks to 26 weeks	47
		Greater Than 26 Weeks	42
Location 13	<30	4 weeks and under	50
		4 weeks to 26 weeks	40
		Greater Than 26 Weeks	35
Location 14	33	4 weeks and under	54
		4 weeks to 26 weeks	44
		Greater Than 26 Weeks	39

Noise levels for foundation construction are predicted to meet all construction noise goals at all residences.

6.5 Traffic Noise Impact

6.5.1 Construction Traffic

Access to the project area during the construction period will be gained from Portland Avenue/Wilson Drive which currently provides access to the Marulan Waste Management Facility and to Orica Explosives who lease an area of land from Readymix adjacent to the waste management facility. Access to Wilson Drive will be via the at grade intersection with the Hume Highway (at Portland Avenue) and then via Portland Avenue. This route passes through the Marulan light industrial area. It is envisaged that during the busiest 5 months of construction traffic generated by the construction activity will number 270 vehicles per day (vpd) (135 in / 135 out). Heavy vehicles are expected to average 36 vehicle trips per day (18 in / 18 out). This construction route passes approximately 40 m from the closest residential receiver. Portland Avenue / Wilson Drive are Council roads and carry relatively low traffic volumes. Portland Avenue, west of George Street has an AADT volume of 421 vehicles (per day), of which 12% are heavy vehicles. The weekday (5 day) average volume is 453 vpd. Wilson Drive south of the industrial area has an AADT volume of 119 vehicles (per day) with 17% heavy vehicles. The weekday (5 day) average volume is 116 vpd.

During the early phases of construction prior to the completion of the rail overpass, limited access to the northern portion of the project area will also be gained via Stoney Creek Road which is currently and has historically been, the access point for the project area.

6.5.2 Operational Traffic

The majority of the finished product transported from the project area will be via rail. The remainder of product from the quarry, amounting up to 1.5 Mtpa will be transported to local and regional markets by road.

Existing Road Traffic

Measurements of existing traffic numbers were obtained from a traffic study conducted by Transport & Urban Planning (2005). The study measured traffic in terms of Average Annual Daily Traffic (AADT) which is defined as the total volume of traffic recorded taken over a calendar year and is divided by the number of days in that year. The study also provided classification of vehicle types and an indication of traffic flow in relation to time of day. The existing traffic volumes and the additional traffic flows from the project area are contained within **Table 31**.

Table 31 Existing and Proposed Traffic Volumes

Description	Traffic Movements
Existing traffic Flow Hume Highway (AADT 2003)	19,662 (22% heavy vehicles)
Proposed additional light vehicle movements	230
Proposed additional quarry daily heavy vehicle movements	340

Proposed Road Traffic

It is envisaged that the quarry will despatch approximately 108 loads from the project area per day for sales of 1Mtpa, increasing to approximately 162 loads per day for sales of 1.5 Mtpa.

Truck loading will be 7 days per week 24 hours per day. Trucks will be loaded at a truck loading facility located to the south of the balloon rail loop. The trucks will exit the project area via the site specific access road which will have an intersection with the Hume Highway in the vicinity of the South Marulan Road intersection. The intersection will be designed in accordance with the requirements of the RTA. Following the initial site establishment period, all traffic entering and leaving the project area including product transportation, goods delivery and personnel will use this road.

6.5.3 Prediction of Road Traffic Noise

Construction Traffic Noise

The predicted traffic noise level from the existing traffic flow with the additional vehicles accessing the project area during the peak of construction is contained within **Table 32**.

Table 32 Construction Traffic Noise Levels

Description	**Predicted Noise Level at 40 m $L_{Aeq(1hour)}$**
Light vehicles	48.8 dBA
Truck	50.9 dBA
Total	53 dBA

The construction traffic noise is predicted to be below the ECRTN limit for traffic generated on a local road of $L_{Aeq(1hour)}$ 55 dBA .

Operational Traffic Noise

Modelling was conducted using traffic noise levels, measured during operator attended surveys, as input into the United States Federal Highways road traffic noise model (USFH) to compare existing and future traffic noise levels. the USFH method for prediction of $L_{Aeq(period)}$ road traffic noise levels is an internationally accepted theoretical traffic noise prediction model which takes into account the L_{Amax} noise levels of vehicles, receiver offset distance, passby duration, vehicle speed, ground absorption (based on the ratio of soft ground and average height of propagation), number of hourly vehicle movements, receiver height, truck exhaust height and the height and location of any intervening barriers.

Given the AADT traffic data, and based on the traffic study that found the percentage of heavy vehicles on the Hume Highway would be 15% during the daytime and 54% at night, the predicted traffic noise comparisons are given in **Table 33**.

Table 33 Predicted Traffic Noise Levels

Description	Distance to Receiver					
	25 m		50 m		100 m	
	Day $L_{Aeq(15hour)}$	Night $L_{Aeq(9hour)}$	Day $L_{Aeq(15hour)}$	Night $L_{Aeq(9hour)}$	Day $L_{Aeq(15hour)}$	Night $L_{Aeq(9hour)}$
Existing Traffic Flow	67.9 dBA	65.2 dBA	64.1dBA	61.5 dBA	59.8 dBA	57.3 dBA
Total Traffic Movements with Proposed Quarry Vehicles	68.1 dBA	65.6 dBA	64.3 dBA	61.9 dBA	60.0 dBA	57.7 dBA
Predicted increase in noise levels	0.2 dBA	0.4 dBA	0.2 dBA	0.4 dBA	0.2 dBA	0.4 dBA

The increase in traffic noise on the Hume Highway due to the operation of the quarry is predicted to be between $L_{Aeq(15hour)}$ daytime 0.2 dBA and $L_{Aeq(9hour)}$ night time 0.4 dBA, which are considered to be imperceptible to receivers along the roadway. This increase is also within the 2 dBA increase in $L_{Aeq(period)}$ noise level allowable under the ECRTN.

The increase in traffic noise on the Hume Highway due to the operation of the quarry will be imperceptible to receivers along the roadway.

It should be noted that traffic on the access road from the project area to the Hume Highway was considered as an operational noise source and predictions were, accordingly, carried out at the nearest affected receivers to the access road. These traffic movements are subject to more stringent noise criteria than vehicles on the Hume Highway.

6.6 Rail Noise Impact

The majority of finished product produced at the quarry is proposed to be transported from the project area by rail via a dedicated rail loop and loading facility. The product will be railed to Readymix's proposed distribution centre in Sydney.

6.6.1 Existing Rail Traffic

The current daily numbers of freight and passenger train movements travelling on the Main Southern Railway are presented in **Table 34**.

Table 34 Existing Main Southern Railway Movements

Section of Line	Total Weekly Train Paths in Each Direction	Current allocation of train paths in each direction			
		Timetabled Freight Services	Other Freight Services	Countrylink Services	CityRail Services
Macarthur to Goulburn	166	87	20	28	31

6.6.2 Proposed Marulan Quarry Rail Movements

Product will be transported in trains with a capacity of approximately 3500 tonnes with up to six (6) trains required per day.

It is envisaged that rail loading and despatch would occur 24 hours per day 7 days per week.

6.6.3 Prediction of Rail Traffic Noise

Calculation of the 24 hour equivalent continuous noise level ($L_{Aeq(24hour)}$) and the maximum (L_{Amax}) passby levels have been conducted using a computer prediction model developed by Heggies.

The prediction model uses characteristic noise levels for the various sources (locomotive engine and exhaust noise as a function of throttle notch, wheel/rail noise as a function of train speed, and wagon type, etc.) at a fixed reference distance. The model then makes adjustments for the train length and the actual distance from the track. Parameters including the $L_{Aeq(24hour)}$ and maximum passby level (L_{Amax}) can then be determined by summing the effects of individual noise sources and by incorporating the number of daily train events.

Rail noise predictions were made for the existing rail traffic flow on the Main Southern Railway including six (6) typical rail movements from the project area. It should be noted that the loading and despatch of trains within the confines of the on-site rail loop has been considered and the noise impacts predicted as part of the operational noise modelling for the project area.

The noise from rail traffic has been predicted at 25 m, 50 m and 100 m distance from the rail line to account for possible closer residential receivers, than those in the vicinity of the proposed quarry, on the route to the distribution centre. The noise predictions for the rail movements are summarised in **Table 35**.

Table 35 Predicted Noise Levels from Main Southern Line Rail Movements

Description	Distance to Receiver					
	25 m		50 m		100 m	
	$L_{Aeq(24hour)}$	L_{Amax}	$L_{Aeq(24hour)}$	L_{Amax}	$L_{Aeq(24hour)}$	L_{Amax}
Existing Rail Movements	58.2 dBA	88.2 dBA	55.8 dBA	84.8 dBA	52.7 dBA	78.3 dBA
Proposed quarry Movements	49.8 dBA	80.2 dBA	47.2 dBA	76.4 dBA	44.7 dBA	72.7 dBA
Total Rail Movements with 6 proposed Quarry Trains	59.1 dBA	88.2 dBA	56.6 dBA	84.8 dBA	53.6 dBA	78.3 dBA
Predicted increase in noise levels	0.9 dBA	0	0.8 dBA	0	0.9 dBA	0

6.6.4 Rail Impact Assessment

The results presented in **Table 35** show that the proposed quarry related rail movements will increase the $L_{Aeq(24hour)}$ noise level by a maximum of 0.9 dBA. The L_{Amax} noise level will remain unchanged. The contribution of the quarry rail movements will meet DEC's $L_{Aeq(24hour)}$ criterion of 60 dBA and the L_{Amax} criterion of 85 dBA at a distance of 25 m (and greater).

The impact of the proposed quarry related trains on the noise produced from total rail movements on the Main Southern Line will be negligible. The maximum 0.9 dBA predicted increase in noise is unlikely to be perceived by residential receivers along the rail line.

6.7 Cumulative Impact Assessment

The INP prescribes detailed calculation routines for establishing "project specific" $L_{Aeq(15minute)}$ intrusive criteria and $L_{Aeq(Period)}$ amenity criteria at potentially affected receivers for a development (in isolation).

Potential cumulative noise impacts from existing and successive developments are embraced by the INP procedures by ensuring that the appropriate noise emission criteria (and consent limits) are established with a view to maintaining acceptable noise *amenity* levels for residences.

Therefore, the cumulative impact of the project area with existing industrial noise sources has been assessed in the determination of the amenity levels.

The only location where significant existing industrial noise is evident is noise monitoring Location N4. Noise from existing industrial sources (fertiliser handling facility) at this location was measured during the daytime at $L_{Aeq(15minute)}$ 51 dBA, with no contribution during the evening or night-time periods. The noise level from the project area at Location N4 is predicted to be less than $L_{Aeq(15minute)}$ 30 dBA during the daytime. This is more than 20 dBA below the existing L_{Aeq} industry noise, meaning it would not contribute to the cumulative industrial noise level of the area.

7 BLASTING

Explosives are used in quarrying in order to dislodge rock to enable the extraction of the resource. To achieve this end, holes are drilled in a designed pattern giving strict attention to their angle, depth and spacing. These holes are then filled with an explosive charge consisting of an emulsion type explosive. The charge is initiated with the aid of primers and detonators. The detonation of each hole is delayed in a pre-designed sequence to ensure that each hole is fired individually in close succession. This delayed firing technique improves the efficiency of the blast and also reduces its environmental impacts.

7.1 Blasting Practice

A summary of the indicative blast design for production blasting is presented in **Table 36**.

Table 36 Typical Blast Design Details

Blast Design Parameter	Typical Dimension
Number of holes/ rows	Up to 300
Hole diameter / Hole inclination	89 to 115mm / 10°
Bench height	15 m
Burden	2.8 m
Spacing	3.0 m
Subdrill	1.0 m
Stemming length	2.8 m
Delay timing	None (single hole per delay)
Column explosive	Emulsion
Maximum Instantaneous Charge (MIC)	100 kg to 160 kg

7.2 Blasting Emissions Criteria for Residential Receivers

DEC has set down guidelines for blasting based on human comfort levels. The guidelines have been adapted from the ANZECC Guidelines "*Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration"* and are as follows:

7.2.1 Airblast

The recommended maximum level for airblast is 115 dB Linear Peak.

The level of 115 dB may be exceeded on up to 5% of the total number of blasts over a period of 12 months. However, the level should not exceed 120 dB Linear Peak at any time.

7.2.2 Ground Vibration

The recommended maximum level for ground vibration is 5 mm/s (peak particle velocity, ppv). It is recommended that a level of 2 mm/s be considered as a long term regulatory goal.

The ppv level of 5 mm/s may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 10 mm/s at any time.

7.2.3 Times and Frequency of Blasting

Blasting should only generally be permitted during the hours of 9.00 am to 5.00 pm Monday to Saturday. Blasting should not take place on Sundays or Public Holidays. Blasting should generally take place no more than once per day.

7.3 Blast criteria for Infrastructure

7.3.1 Criteria for Structures and Buildings

The railway line (including bridges and culverts) and a proposed drinking water reservoir are located adjacent to the proposed quarry site. In order to assess the impact on these structures the British Standard 7385: Part 2-1993 "*Evaluation and measurement for vibration in buildings Part 2*" was deemed the most appropriate standard for use in this situation. This standard provides criteria against which the likelihood of building damage from ground vibration can be assessed. Sources of vibration which are considered in the standard include blasting (carried out during mineral extractions or construction excavation), demolition, piling, ground treatments (compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery. This British standard is used in favour of the Australian standard AS 2187.2 (1993) as it provides a more comprehensive treatment of vibration issues. The recommended limits applied in this case, however, would be similar in magnitude to that suggested in AS 2187.2.

The recommended limits (guide values) for transient vibration to ensure minimal risk of ***cosmetic*** damage to commercial and residential buildings are presented numerically in **Table 37**.

Table 37 Transient Vibration Guide Values - Minimal Risk of Cosmetic Damage

Line	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	15 Hz and Above
1	Reinforced or framed structures - Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures - Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz 20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above	

Note: Values referred to are at the base of the building being considered.

The standard states that the guide values in **Table 37** relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings. Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in **Table 37** may need to be reduced by up to 50%.

Allowing for the fact that the reservoir or rail infrastructure may experience resonance effects, a conservative level "minimal risk of cosmetic damage" criterion has been adopted here and is shown in **Table 38**.

Table 38 Construction Vibration Goals

Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
	4 Hz to 15 Hz	15 Hz and Above
Reinforced or framed structures - Industrial and heavy commercial buildings	25 mm/s at 4 Hz and above	

Note: Values referred to are at the base of the structure being considered.

7.3.2 Criteria for Vibration near Pipelines

A natural gas pipeline is located adjacent to the proposed quarry. Guideline vibration limits have been used for this pipeline with reference to German Standard DIN 4150-3 1999 *"Effect of Vibration on Structures".* A summary of these suggested values are contained within **Table 39**. There is no relevant Australian Standard for assessing vibration impacts on pipelines.

Table 39 Guideline Values for Vibration Velocity to be Used When Evaluating the Effects of Short Term Vibration on Buried Pipework (DIN 4150-3 1999)

Line	Pipe Material	Guideline Values for Velocity Measured on the Pipe in mm/s
1	Steel (including welded)	100
2	Clay, concrete, reinforced concrete, pre-stressed concrete, metal (with and without flange)	80
3	Masonry, plastic	50

7.4 Ground Vibration and Airblast Site Laws

Blast emission data was obtained from Readymix for their nearby Johniefelds Quarry to provide local background information to assist in the development of blasting site laws. Blast results between February 2000 and June 2004 were used in the analysis.

The data obtained was statistically analysed using the least squares method. Review of the data constituting the vibration and airblast graphs, and the resulting exceedance lines, revealed that the site law lines were generally flat in nature. This is most likely due to the limited range and variety of distances where monitoring has been conducted. To overcome this inconsistency in the data set, the Johniefelds statistical parameters were used but the slope of the line was modified to reflect that of the standard United States Bureau of Mines (USBM) formulas which are widely used to predict blasting impacts at greenfield sites.

The resulting site law plot, the lower of each pair of lines (labelled 50%) is based on the median of the measured data. However, the ground vibration and airblast criteria advocated by DEC and ANZECC, cater for the inherent variation in emission levels from a given blast design by allowing a five percent exceedance of a general criterion up to a (never to be exceeded) maximum. Correspondingly, the "5% exceedance" lines have also been included in the blast emission site laws.

The 5% site laws for ground vibration and airblast are:

Ground Vibration

PVS (mm/sec) (5%) = 3447 (SD) $^{-1.6}$

Airblast

SPL (dBL) (5%) = -25 log (SD) + 172

where PVS (5%) and SPL (5%) are the levels of ground vibration (Peak Vector Sum - mm/s) and airblast (dB Linear) respectively, above which 5% of the total population (of data points) will lie, assuming that the population has the same statistical distribution as the underlying measured sample.

SD_1 and SD_2 are the ground vibration and airblast scaled distances, where:

$$SD_1 = \frac{\text{Distance}}{\sqrt{\text{MIC}}} \quad (m.kg^{-0.5})$$

and,

$$SD_2 = \frac{\text{Distance}}{\sqrt[3]{\text{MIC}}} \quad (m.kg^{-0.33})$$

These site laws for ground vibration and airblast are presented graphically in **Figure 1** and **Figure 2** as follows:

Figure 1 The Proposed Quarry Ground Vibration Site Law

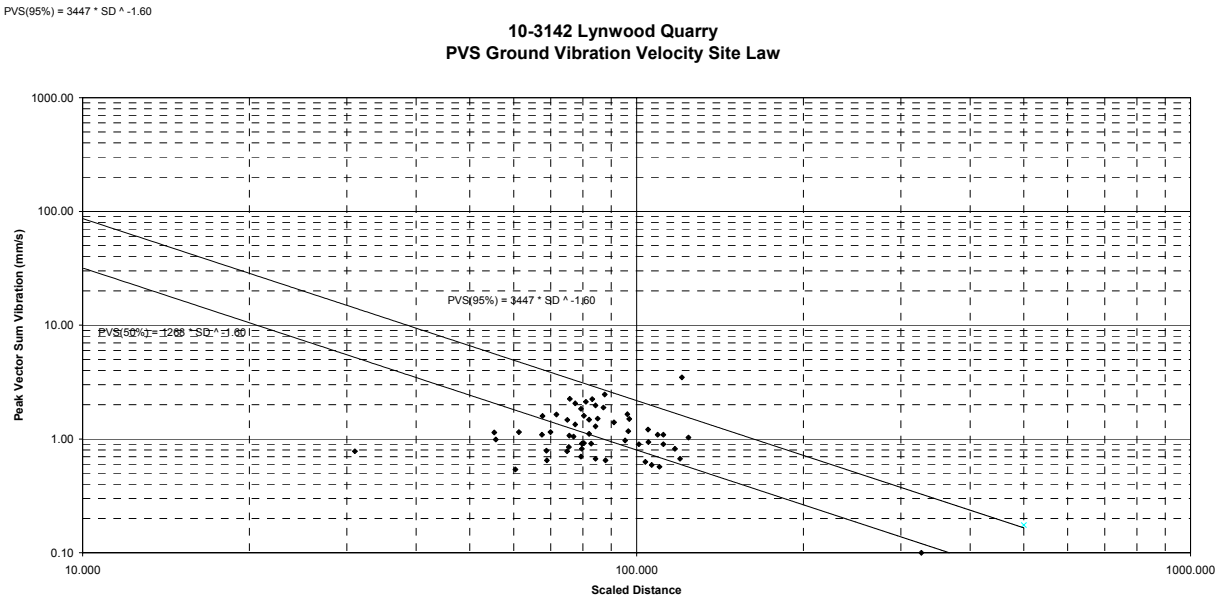
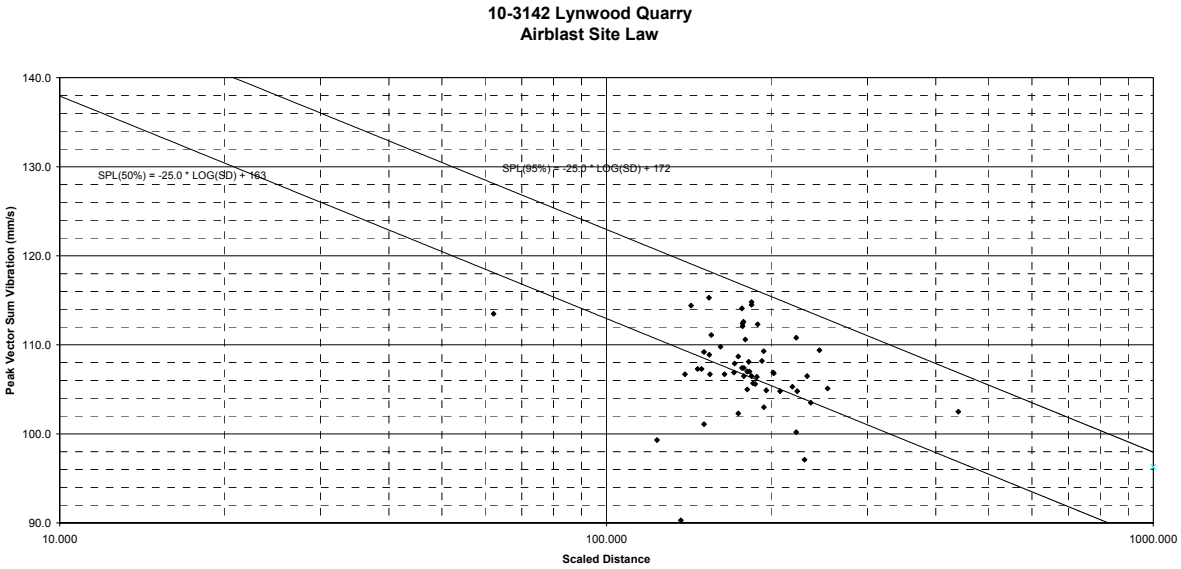


Figure 2 The Proposed Quarry Airblast Site Law



7.5 Predicted Levels of Blast Emission Residential Receivers

The level of airblast and ground vibration has been predicted using the developed site laws for the project area. A summary of the predicted levels for future blasting within the proposed quarry at residential receiver locations is contained within **Table 40**, **Table 41 Table 42**, **Table 43** and **Table 44**. The blasting predictions contained within the tables reflect the worst case airblast and vibration levels that would be experienced at each residential receiver for each stage of development.

Table 40 Predicted Blasting Levels Year 1

Blasting Location	MIC (kg)	Receiver Location	Predicted Blasting Level	
			Airblast (dB Linear)	Ground Vibration (mm/s)
Year 1	100	1	101.9	0.4
		2	106.3	0.2
		3	104.5	0.2
		4	105.3	0.7
		5	106.1	0.8
		6	106.7	0.9
		7	103.7	0.6
		8	104.2	0.6
		9	103.7	0.6
		10	102.2	0.5
		11	105.1	0.7
		12	109.1	1.3
		13	106.1	0.8
		14	105.6	0.8
		Criteria	**115**	**5**

Table 41 Predicted Blasting Levels Year 5

Blasting Location	MIC (kg)	Receiver Location	Predicted Blasting Level	
			Airblast (dB Linear)	Ground Vibration (mm/s)
Year 5	100	1	103.2	0.5
		2	107.2	0.3
		3	104.8	0.2
		4	106.1	0.8
		5	107.0	0.9
		6	107.7	1.1
		7	104.4	0.6
		8	105.0	0.7
		9	104.7	0.7
		10	103.1	0.5
		11	105.5	0.8
		12	109.9	1.5
		13	107.0	1.0
		14	105.7	0.8
		Criteria	**115**	**5**

Table 42 Predicted Blasting Levels Year 10

Blasting Location	MIC (kg)	Receiver Location	Predicted Blasting Level	
			Airblast (dB Linear)	Ground Vibration (mm/s)
Year 10	100	1	103.2	0.5
		2	109.7	0.4
		3	106.3	0.2
		4	106.6	0.9
		5	107.5	1.0
		6	108.0	1.1
		7	104.6	0.7
		8	105.0	0.7
		9	104.7	0.7
		10	103.1	0.5
		11	105.4	0.8
		12	111.3	1.8
		13	107.0	0.9
		14	105.7	0.8
		Criteria	**115**	**5**

Table 43 Predicted Blasting Levels Year 15

Blasting Location	MIC (kg)	Receiver Location	Predicted Blasting Level	
			Airblast (dB Linear)	Ground Vibration (mm/s)
Year 15	160	1	103.2	0.5
		2	111.3	0.5
		3	107.7	0.3
		4	107.6	1.0
		5	108.4	1.2
		6	108.8	1.2
		7	105.2	0.7
		8	105.4	0.8
		9	104.5	0.7
		10	103.0	0.5
		11	105.6	0.8
		12	113.1	2.3
		13	107.4	1.0
		14	105.9	0.8
		Criteria	**115**	**5**

Table 44 Predicted Blasting Levels Year 20 and 30

Blasting Location	MIC (kg)	Receiver Location	Predicted Blasting Level	
			Airblast (dB Linear)	Ground Vibration (mm/s)
Year 20 and 30	160	1	103.2	0.5
		2	111.3	0.5
		3	108.0	0.3
		4	107.9	1.1
		5	108.6	1.2
		6	108.8	1.2
		7	105.3	0.7
		8	105.4	0.7
		9	104.2	0.6
		10	102.8	0.5
		11	105.7	0.8
		12	114.0	2.6
		13	107.3	1.0
		14	106.1	0.8
		Criteria	**115**	**5**

The predicted airblast and ground vibration complies with the ANZECC/DEC criteria at all surrounding residential receivers for each stage of development.

7.6 Predicted Levels of Blast Vibration at Infrastructure Receivers

The level of airblast and ground vibration has been predicted using the developed site laws for the project area. A summary of the predicted levels for future blasting within the project area at the relevant adjacent infrastructure is contained within **Table 45**. The blasting predictions contained within the tables reflect the worst case vibration levels that would be experienced at each receiver for each stage of development

Table 45 Predicted Blasting Levels Infrastructure

Blasting Location	MIC (kg)	Receiver Location	Predicted Blasting Level	Criteria
			Ground Vibration (mm/s)	
Year 1	160	Reservoir	3.4	25 mm/s
	160	Pipeline	3.1	100 mm/s
	80	Railway	23.9	25 mm/s
Year 5	160	Reservoir	4.0	25 mm/s
	160	Pipeline	5.2	100 mm/s
	105	Railway	24.6	25 mm/s
Year 10	160	Reservoir	6.7	25 mm/s
	160	Pipeline	6.6	100 mm/s
	130	Railway	24.7	25 mm/s
Year 15	160	Reservoir	13.3	25 mm/s
	160	Pipeline	46.5	100 mm/s
	130	Railway	24.7	25 mm/s
Year 20	160	Reservoir	19.3	25 mm/s
	160	Pipeline	46.5	100 mm/s
	160	Railway	17.0	25 mm/s
Year 30	160	Reservoir	19.3	25 mm/s
	160	Pipeline	46.5	100 mm/s
	130	Railway	24.7	25 mm/s

The predicted vibration level at the closest point of the project area to the natural gas pipeline or the proposed reservoir is below level likely to cause impact on the structures.

Control over MIC will be required when blasting at the closest point of the quarry pit to the Main Southern Railway to ensure vibration levels are below the level likely to cause impact.

8 NOISE AND BLASTING MONITORING PROGRAMME

In order to evaluate the environmental noise and blasting performance of the project area over time a monitoring programme is proposed as follows.

8.1 Noise Monitoring Procedures

General Requirements

The noise measurement procedures employed throughout the monitoring programme should be guided by the requirements of AS 1055-1997 "*Acoustics - Description and Measurement of Environmental Noise*" and the NSW Industrial Noise Policy.

Monitoring Locations and Intervals

Operator-attended noise measurements should be conducted, as a minimum, for one 15 minute period one day per calendar quarter and at the commencement of any significant operational event at the monitoring locations identified in **Table 46** during periods when the quarry is operating.

Unattended continuous noise logging should be carried out at monitoring locations identified in **Table 46** on a quarterly basis for a minimum period of one week.

Table 46 Key Noise Monitoring Locations

Receiver Location	Description
1	Residence to the west of the project area
6	Maclura Drive, Marulan
11	Residence to the south of the project area
12	North eastern boundary of project area at Rural Residential Subdivision

Unattended Continuous Noise Logging

In order to supplement the operator-attended measurements, unattended continuous noise logging should be conducted at the key monitoring locations identified in **Table 46**. Unattended noise monitoring is used to quantify overall ambient noise amenity levels resulting from stripping, extraction, processing, sales activity and other environmental noise sources. Unattended monitoring will show whether existing ambient noise levels have increased or decreased, when compared to previous monitoring periods.

Operator-Attended Noise Surveys

Operator-attended noise measurements and recordings should be conducted to quantify the intrusive noise emissions from extraction, processing and sales activity as well as the overall level of ambient noise. Operator attended noise monitoring should be conducted at the four noise logger locations nominated in **Table 46**, and at any other location where noise monitoring is deemed necessary, such as locations from which noise associated complaints have been received.

The operator should quantify and characterise the maximum (L_{Amax}) and the energy equivalent (L_{Aeq}) intrusive noise level from extraction, processing and sales activity over a 15 minute measurement period. In addition, the operator should quantify and characterise the overall levels of ambient noise (ie L_{Amax}, L_{A1}, L_{A10}, L_{A50}, L_{A90}, L_{A99}, L_{Amin} and L_{Aeq}) over the 15 minute measurement interval.

Instrumentation and Measurement Parameters

All acoustic instrumentation employed throughout the monitoring programme should be designed to comply with the requirements of AS 1259.2-1990, "*Sound Level Meters*" and carry current NATA or manufacturer calibration certificates. All instrumentation should be programmed to record continuously statistical noise level indices in 15 minute intervals which may include the L_{Amax}, L_{A1}, L_{A5}, L_{A10}, L_{A50}, L_{A90}, L_{A99}, L_{Amin} and the L_{Aeq}.

The statistical noise exceedance levels (L_{AN}) are the levels exceeded for N% of the 15 minute interval. The L_{A90} represents the level exceeded for 90% of the interval period and is referred to as the average minimum or background noise level. The L_{Aeq} is the equivalent continuous sound pressure level and represents the steady sound level which is equal in energy to the fluctuating level over the interval period. The L_{Amax} is the maximum noise level recorded over the interval.

Instrument calibration should be checked before and after each measurement survey, with the variation in calibrated levels not exceeding ±0.5 dBA.

Weather Monitoring Instrumentation

All noise measurements should be accompanied by both qualitative description (including cloud cover) and quantitative measurements of prevailing local weather conditions throughout the survey period.

Meteorological measurements should be guided by the requirements of AS 2923-1987 "*Ambient Air-Guide for Measurements of Horizontal Wind for Air Quality Applications*" and the DEC. An automatic weather station located at the project area should be used to continuously record the meteorological parameters as shown in **Table 47**.

Table 47 Meteorological Measurement Parameters

Measured Parameter	Unit	Sample Interval
Mean wind speed	m/s	30 minute
Mean wind direction	Degrees	30 minute
Aggregate rainfall	mm	30 minute
Mean air temperature	°C	30 minute

Plant and Equipment Observations and Log

During the attended noise measurements, the operator should record any significant quarry generated noise sources (ie haul trucks, dozers, etc). In addition, the operator should obtain copies of the relevant fixed plant and mobile equipment quarrying operating shift logs and attach it to the report.

Data Presentation and Reporting

The measured $L_{Aeq(15minute)}$ noise level contributions from extraction, processing and sales activity, as well as the overall ambient noise levels, together with the weather and quarry operating conditions should be reported on a quarterly basis.

The unattended ambient noise logger data from each monitoring location, together with the weather and quarry operating conditions should be presented graphically on a daily basis.

It should be noted that the ambient noise levels do not necessarily reflect the contributed level of noise emissions from quarrying operations. The ambient noise level data quantifies the overall noise level at a given location independent of its source or character. Background noise monitoring, conducted as part of this assessment, has revealed existing ambient L_{Aeq} levels that are higher than the project specific noise criteria for the operation of the quarry. In these cases careful analysis of the monitoring results will be required to determine the noise contribution attributable to the project.

Prior to further analysis, the ambient noise level data from each monitoring location which correlates with periods of unstable weather (ie. rainfall greater than 0.5 mm or wind speed greater than 5 m/s) should be discarded. The remaining ambient noise level data should be processed using an acceptable statistical technique and reported.

8.2 Blast Monitoring Protocol

Monitoring Locations and Intervals

All blasting at the proposed quarry should be monitored. A reference location should be chosen for blast monitoring. Blasts should be monitored at the reference location for each blast and at the residential locations at least once per quarter.

8.2.1 Blast Emission Monitors

Blast monitoring instrumentation should be employed to meet the following primary specifications presented in **Table 48**. The instrumentation should be installed, operated and maintained by suitably qualified or trained personnel. The instruments should be externally calibrated at regular intervals throughout the life of the project.

Table 48 Blast Monitor Specifications

Specification	Seismic	Air Blast
Sample Rate	Minimum 1024 samples per second per channel	
Frequency Response	2 Hz to 250 Hz (3 dB points)	
Resolution	0.016 mm/s	0.1 dB
Range	0.1 mm/s to 254 mm/s	88 dB to 148 dB
Accuracy	3% at 15 Hz	0.2 dB at 30 Hz
Communications Link	Keyboard and Modem	
Recording Mode	Full Waveform Recording and archiving	

Vibration velocity geophones should be coupled to the ground via a “star stake” embedded in the consolidated surface approximately 25 m from the subject building or structure, with the microphone positioned in the free-field.

Weather Monitoring Equipment

Weather monitoring should be conducted as per the noise monitoring programme.

Blast Design Records and Predicted Emission Levels

Blast design records should be maintained for individual blast events. The purpose of the record is to assist in the design and optimisation of future events, planning and control of blasting emissions and to provide a traceable system of documentation in case of accident or complaint.

The blasting contractor should record the blast parameters for each blast event and include the location co-ordinates (East, North, RL) of the blast site and the maximum explosive mass (MIC) to be detonated in any 8 ms interval.

9 CONCLUSION

Heggies has conducted a noise and blasting impact assessment for both construction and operation of the proposed hard rock quarry, located to the west of Marulan in the Southern Tablelands region of NSW.

The ambient noise monitoring programme has found that the ambient noise environment of the area varies significantly with distance from the Hume Highway. The ambient noise environment at residences near the Hume Highway is dominated by significant road traffic noise. In areas significantly distanced from the highway, natural noise sources tend to dominate the ambient noise environment. Project specific noise criteria levels have been set accordingly.

To determine the contribution of the quarry, during both the construction phase, and the operational phase of the development to the existing ambient noise environment, noise modelling was undertaken for calm and prevailing weather conditions.

Construction

The noise modelling results indicate that the construction of Lynwood Quarry is predicted to meet all project specific construction noise level goals for a period of greater than 26 weeks at all residential locations.

Road traffic noise levels for the construction phase of the quarry are predicted to be below the ECRTN limit for traffic generated on a local road of $L_{Aeq(1hour)}$ 55 dBA.

Operation

The noise modelling results indicate that the operation of a hard rock quarry at the site is predicted to meet all project specific noise criteria for operation during daytime, evening and night-time at all residential locations under both calm and prevailing weather conditions with appropriate noise controls in place.

$L_{A1(1minute)}$ noise levels are predicted to be below project specific sleep disturbance goals for night-time operation of the quarry. This being the case, sleep disturbance is unlikely to occur at residential locations surrounding the proposed quarry.

The increase in traffic noise on the Hume Highway due to the operation of the quarry is predicted to be between $L_{Aeq(15hour)}$ daytime 0.2 dBA and $L_{Aeq(9hour)}$ night-time 0.4 dBA, which are considered to be imperceptible to receivers along the roadway. This increase is also within the 2 dBA increase in $L_{Aeq(period)}$ noise level allowable under the ECRTN.

The proposed Quarry rail movements will increase the $L_{Aeq(24hour)}$ noise level by approximately 0.9 dBA. The L_{Amax} noise level would remain unchanged. The contribution of the proposed quarry related rail movements would meet DEC's $L_{Aeq(24hour)}$ criterion of 60 dBA and the L_{Amax} criterion of 85 dBA at a distance of 25 m (and greater). The impact of the proposed quarry trains on the noise produced from total rail movements on the Main Southern Railway would be negligible. The maximum 0.9 dBA predicted increase in noise is unlikely to be perceived by residential receivers along the rail line.

The predicted airblast and ground vibration levels comply with the ANZECC/DEC criteria at all surrounding residential receivers for each stage of development.

The predicted vibration level at the closest point of the proposed quarry to the natural gas pipeline and proposed drinking water reservoir are below levels likely to cause impact on these structures.

Control over MIC will be required when blasting at the closest point of the project area to the Main Southern Railway to ensure the vibration level is below the level likely to cause impact.

Equipment Description	LA10 Octave Band Centre Frequency (Hz) - dBL re 1pW										dB Lin	dBA
	31.5	63	125	250	500	1k	2k	4k	8k	16K	Overall	Overall
Earthworks												
D9 Dozer 1	108	112	111	108	110	103	101	99	93		117	110
D9 Dozer 2	108	112	111	108	110	103	101	99	93		117	110
D9 Dozer 3	108	112	111	108	110	103	101	99	93		117	110
D9 Dozer 4	108	112	111	108	110	103	101	99	93		117	110
D9 Dozer 5	108	112	111	108	110	103	101	99	93		117	110
D9 Dozer 6	108	112	111	108	110	103	101	99	93		117	110
CAT140H Grader	100	103	112	107	111	112	109	106	106	106	118	116
CAT140H Grader	100	103	112	107	111	112	109	106	106	106	118	116
Bobcat 1	111	114	109	101	99	100	97	89	85	85	117	104
Bobcat 2	111	114	109	101	99	100	97	89	85	85	117	104
Excavator 1	106	107	110	106	107	102	97	89	79	79	115	107
Excavator 2	106	107	110	106	107	102	97	89	79	79	115	107
Back Hoe/Loader 1	85	94	93	92	97	94	88	101	95	84	105	104
Back Hoe/Loader 2	85	94	93	92	97	94	88	101	95	84	105	104
Scraper 1	111	116	115	109	107	106	104	97	92		120	111
Scraper 2	111	116	115	109	107	106	104	97	92		120	111
Scraper 3	111	116	115	109	107	106	104	97	92		120	111
Scraper 4	111	116	115	109	107	106	104	97	92		120	111
Scraper 5	111	116	115	109	107	106	104	97	92		120	111
Scraper 6	111	116	115	109	107	106	104	97	92		120	111
Scraper 7	111	116	115	109	107	106	104	97	92		120	111
Scraper 8	111	116	115	109	107	106	104	97	92		120	111
Scraper 9	111	116	115	109	107	106	104	97	92		120	111
Scraper 10	111	116	115	109	107	106	104	97	92		120	111
Articulated Truck 1	109	115	116	111	110	108	105	102	99		121	113
Articulated Truck 2	109	115	116	111	110	108	105	102	99		121	113
Articulated Truck 3	109	115	116	111	110	108	105	102	99		121	113
Articulated Truck 4	109	115	116	111	110	108	105	102	99		121	113
Articulated Truck 5	109	115	116	111	110	108	105	102	99		121	113
Articulated Truck 6	109	115	116	111	110	108	105	102	99		121	113
Articulated Truck 7	109	115	116	111	110	108	105	102	99		121	113
Articulated Truck 8	109	115	116	111	110	108	105	102	99		121	113
Articulated Truck 9	109	115	116	111	110	108	105	102	99		121	113
Articulated Truck 10	109	115	116	111	110	108	105	102	99		121	113
Vibrating Roller 1	99	104	109	112	107	105	102	96	90		116	110
Vibrating Roller 2	99	104	109	112	107	105	102	96	90		116	110
Vibrating Roller 3	99	104	109	112	107	105	102	96	90		116	110
Vibrating Roller 4	99	104	109	112	107	105	102	96	90		116	110
Foundations												
Vibrator 1	118	129	114	110	110	106	102	101	94	80	129	112
Vibrator 2	118	129	114	110	110	106	102	101	94	80	129	112
Vibrator 3	118	129	114	110	110	106	102	101	94	80	129	112
Vibrator 4	118	129	114	110	110	106	102	101	94	80	129	112
Vibrator 5	118	129	114	110	110	106	102	101	94	80	129	112
Transit mixer 1	103	108	108	105	106	107	105	99	94	86	115	111
Transit mixer 2	103	108	108	105	106	107	105	99	94	86	115	111
Transit mixer 3	103	108	108	105	106	107	105	99	94	86	115	111
Transit mixer 4	103	108	108	105	106	107	105	99	94	86	115	111
Front-end loader	90	97	110	106	108	108	107	101	94	84	115	113
Tipper	99	104	110	105	104	101	98	92	84	80	113	106
Cement Tanker	108	109	110	104	105	105	101	97	90	85	115	109
Ag. truck tipping	111	112	103	100	101	103	104	103	98	98	116	110
Split Drum	106	113	104	106	105	104	97	89	83	76	116	107
Crushing Plant	114	120	118	115	114	113	111	107	102		125	118
Crane	99	106	96	96	99	97	93	89	87	87	109	101

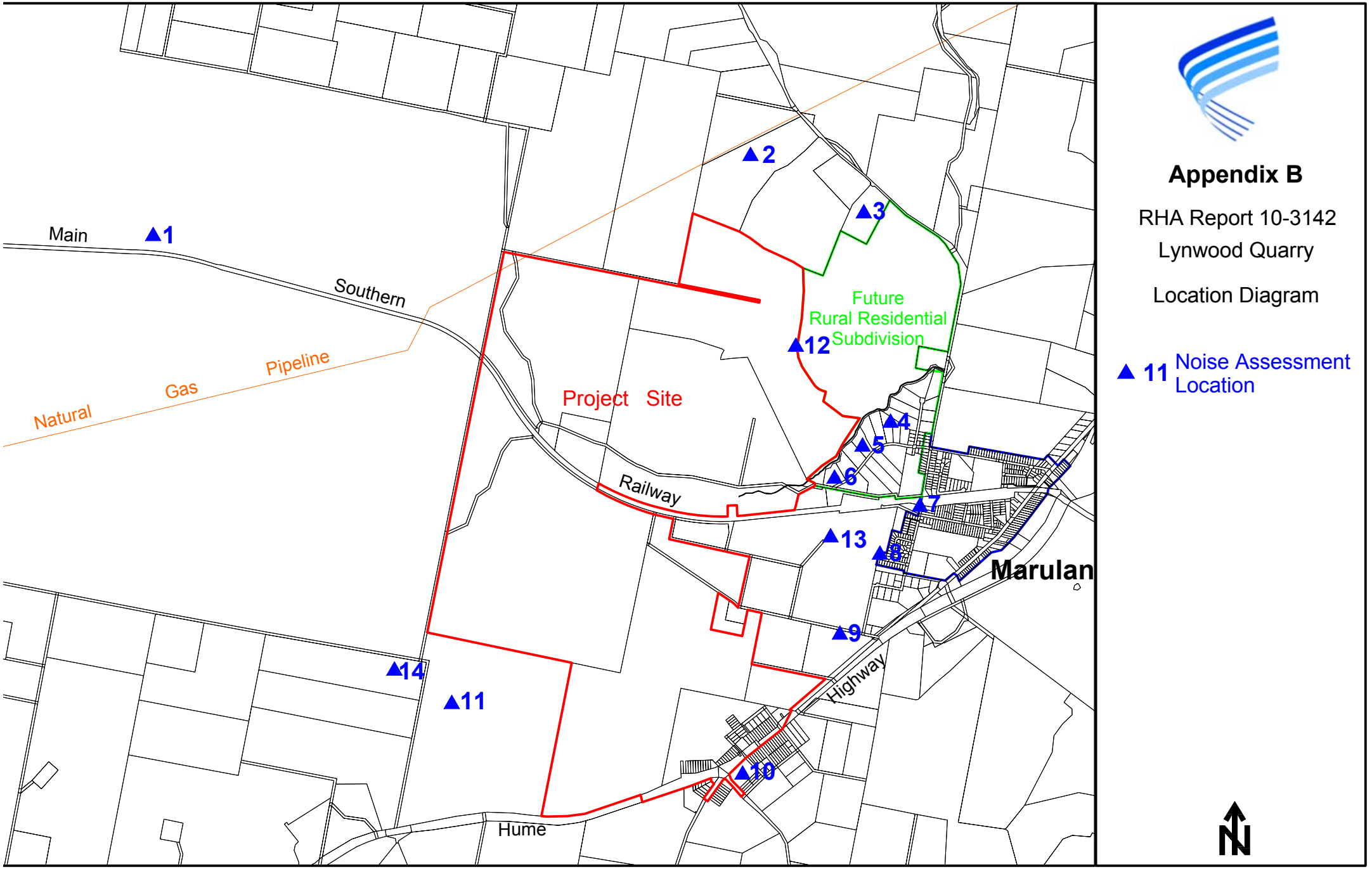
Equipment Description	LAeq Octave Band Centre Frequency (Hz) - dBL re 1pW										dB Lin	dBA
	31.5	63	125	250	500	1k	2k	4k	8k	16K	Overall	Overall
Fixed plant and equipment - operational during full project life												
Primary Gyratory Crusher	108	112	109	111	113	113	111	108	103	96	120	118
Primary Screen	103	102	103	105	110	111	112	107	100	92	117	117
Secondary Cone Crusher	106	111	112	110	110	109	106	99	89	80	118	113
Secondary Screen 1 x 2	108	105	106	106	109	112	114	108	101	89	119	118
Secondary Screen 2 x 2	108	105	106	106	109	112	114	108	101	89	119	118
Tertiary Cone Crusher 1	106	111	112	110	110	109	106	99	89	80	118	113
Tertiary Cone Crusher 2 x 4	112	117	118	116	116	115	112	105	95	86	124	119
Tertiary Cone Crusher 3	106	111	112	110	110	109	106	99	89	80	118	113
Tertiary Cone Crusher 4	106	111	112	110	110	109	106	99	89	80	118	113
Surge Bin for Tertiary Crusher 1	113	112	111	106	105	102	96	89	79	79	118	107
Surge Bin for Tertiary Crusher 2 x 4	119	118	117	112	111	108	102	95	85	85	124	113
Surge Bin for Tertiary Crusher 3	113	112	111	106	105	102	96	89	79	79	118	107
Surge Bin for Tertiary Crusher 4	113	112	111	106	105	102	96	89	79	79	118	107
Product Screen 1 x 4	111	110	107	104	105	107	110	108	101	81	117	115
Product Screen 2 x 6	113	112	109	106	107	109	112	110	103	83	119	117
Product Screen 3 x 2	108	107	104	101	102	104	107	105	98	78	114	112
Product Screen 4 x 2	108	107	104	101	102	104	107	105	98	78	114	112
Product Screen 5	105	104	101	98	99	101	104	102	95	75	111	109
Product Screen 6	105	104	101	98	99	101	104	102	95	75	111	109
Scalps? Screen 1	105	104	101	98	99	101	104	102	95	75	111	109
Lined Train Loading Bin	106	105	104	99	98	95	89	82	72	72	111	100
Stacker conveyor	111	111	110	98	97	92	86	77	72	72	115	99
Spalls Plant - rubber screen	98	95	96	99	102	104	98	91	79	79	108	106
Locomotives	114	115	105	96	95	95	94	86	80	80	118	100
Locomotives	114	115	105	96	95	95	94	86	80	80	118	100
Wagon Bunching	99	101	101	91	89	89	88	84	80	80	106	95
Wagon Bunching	99	101	101	91	89	89	88	84	80	80	106	95
Pre-coat plant	111	111	110	98	97	92	86	77	72	72	115	99
Pug Mill	113	119	117	107	111	112	108	103	98	98	123	115
Lined Truck loading bin being filled from empty	106	105	104	99	98	95	89	82	72	72	111	100
Truck loading at truck loadout (3/15)	100	114	105	104	100	102	105	103	100	100	116	110
Truck loading at pug mill (3/15)	100	114	105	104	100	102	105	103	100	100	116	110
Truck Loading at pre-coat plant (3/15)	100	114	105	104	100	102	105	103	100	100	116	110
Truck drive off at truck loadout	120	110	106	100	105	105	107	102	99	99	121	112
Truck drive off at pug mill	120	110	106	100	105	105	107	102	99	99	121	112
Truck drive off at pre-coat plant	120	110	106	100	105	105	107	102	99	99	121	112
Bobcat Plant Area	108	111	106	98	96	97	94	86	82	82	114	101
Product truck on haul road 1	113	115	104	100	102	104	101	93	85	85	118	107
Product truck on haul road 2	113	115	104	100	102	104	101	93	85	85	118	107
Product truck on haul road 3	113	115	104	100	102	104	101	93	85	85	118	107
Product truck on haul road 4	113	115	104	100	102	104	101	93	85	85	118	107
Product truck on haul road 5	113	115	104	100	102	104	101	93	85	85	118	107

Product truck on haul road 6	113	115	104	100	102	104	101	93	85	85	118	107
Rough terrain forklift plant area	104	105	116	110	108	104	101	93	87	87	118	110
Year 1												
CAT140H Grader	97	100	109	104	108	109	106	103	103	103	115	113
CAT345B with hammer	117	112	114	111	110	115	110	110	101	101	122	118
CAT773 dump truck at Plant area	107	109	116	112	109	105	104	96	92	92	119	111
CAT773 dump truck SRWP	117	120	121	116	117	112	110	102	98	98	126	118
CAT773 Watercart near rail	116	116	113	115	112	110	109	102	97	97	122	116
CAT777 dumping into crusher	117	120	121	116	117	112	110	102	98	98	126	118
CAT777 on haul road to crusher	107	109	116	112	109	105	104	96	92	92	119	111
CAT777 in pit	107	109	116	112	109	105	104	96	92	92	119	111
CAT777 stripping	107	109	116	112	109	105	104	96	92	92	119	111
CAT777 Near rail on surface	107	109	116	112	109	105	104	96	92	92	119	111
CAT777 dumping ROEA	117	120	121	116	117	112	110	102	98	98	126	118
CAT980G Stockpile east	114	112	108	106	103	103	103	104	100	89	118	110
CAT980G Stockpile west	114	112	108	106	103	103	103	104	100	89	118	110
CAT990 South Rail EPEA	112	109	114	112	105	114	104	109	95	95	120	116
CAT990 loader stripping	112	109	114	112	105	114	104	109	95	95	120	116
CAT992 Loader - in pit	115	112	117	115	108	117	107	112	98	98	123	119
CATD10 Contractor Dozer ROEA	114	115	114	101	105	104	102	94	88	88	120	109
Hydraulic Rock Drill Bench 1	107	117	106	101	107	109	111	113	110	110	121	118
Hydraulic Rock Drill Bench 4 N	107	117	106	101	107	109	111	113	110	110	121	118
Year 5												
CAT140H Grader	97	100	109	104	108	109	106	103	103	103	115	113
CAT345B with hammer	117	112	114	111	110	115	110	110	101	101	122	118
CAT773 dump truck dumping SRWP	117	120	121	116	117	112	110	102	98	98	126	118
CAT773 dump truck SRWP	117	120	121	116	117	112	110	102	98	98	126	118
CAT773 Watercart on haul road EOEA	116	116	113	115	112	110	109	102	97	97	122	116
CAT777 dumping into crusher	117	120	121	116	117	112	110	102	98	98	126	118
CAT777 in pit	107	109	116	112	109	105	104	96	92	92	119	111
CAT777	107	109	116	112	109	105	104	96	92	92	119	111
CAT777	107	109	116	112	109	105	104	96	92	92	119	111
CAT777 up ramp	107	109	116	112	109	105	104	96	92	92	119	111
CAT777 stripping being loaded	107	109	116	112	109	105	104	96	92	92	119	111
CAT777 haul road EOEA	107	109	116	112	109	105	104	96	92	92	119	111
CAT777 dumping EOEA	117	120	121	116	117	112	110	102	98	98	126	118
CAT980G Stockpile east	114	112	108	106	103	103	103	104	100	89	118	110
CAT980G Stockpile west	114	112	108	106	103	103	103	104	100	89	118	110
CAT990 loader In pit	112	109	114	112	105	114	104	109	95	95	120	116
CAT990 loader stripping	112	109	114	112	105	114	104	109	95	95	120	116
CAT992 Loader	115	112	117	115	108	117	107	112	98	98	123	119
CATD10 Contractor Dozer EOEA	114	115	114	101	105	104	102	94	88	88	120	109
Diesel Pump in pit	70	72	79	80	81	81	74	67	58	58	87	84

Diesel Pump near first conveyor	70	72	79	80	81	81	74	67	58	58	87	84
Diesel Pump near truck loading point	70	72	79	80	81	81	74	67	58	58	87	84
Hydraulic Rock Drill Bench 1	107	117	106	101	107	109	111	113	110	110	121	118
Hydraulic Rock Drill Bench 2	107	117	106	101	107	109	111	113	110	110	121	118
Hydraulic Rock Drill Bench 2	107	117	106	101	107	109	111	113	110	110	121	118
Year 10												
CAT140H Grader	97	100	109	104	108	109	106	103	103	103	115	113
CAT345B with hammer	117	112	114	111	110	115	110	110	101	101	122	118
CAT773 dump truck SRWP	117	120	121	116	117	112	110	102	98	98	126	118
CAT773 Watercart Inside rail loop	116	116	113	115	112	110	109	102	97	97	122	116
CAT773 Watercart EOEA Haul Road	116	116	113	115	112	110	109	102	97	97	122	116
CAT777 dumping into crusher	117	120	121	116	117	112	110	102	98	98	126	118
CAT777 bench 4	107	109	116	112	109	105	104	96	92	92	119	111
CAT777 exit ramp S	107	109	116	112	109	105	104	96	92	92	119	111
CAT777 In pit bench 5	107	109	116	112	109	105	104	96	92	92	119	111
CAT777 In Pit Lowest bench	107	109	116	112	109	105	104	96	92	92	119	111
CAT777 stripping being loaded	107	109	116	112	109	105	104	96	92	92	119	111
CAT777 EOEA Haul Road	107	109	116	112	109	105	104	96	92	92	119	111
CAT777 dumping EOEA	117	120	121	116	117	112	110	102	98	98	126	118
CAT980G Stockpile east	114	112	108	106	103	103	103	104	100	89	118	110
CAT980G Stockpile west	114	112	108	106	103	103	103	104	100	89	118	110
CAT990 loader In pit	112	109	114	112	105	114	104	109	95	95	120	116
CAT990 loader stripping	112	109	114	112	105	114	104	109	95	95	120	116
CAT992 Loader	115	112	117	115	108	117	107	112	98	98	123	119
CATD10 Contractor Dozer EOEA	114	115	114	101	105	104	102	94	88	88	120	109
Diesel Pump in pit	70	72	79	80	81	81	74	67	58	58	87	84
Diesel Pump near first conveyor	70	72	79	80	81	81	74	67	58	58	87	84
Diesel Pump near truck loading point	70	72	79	80	81	81	74	67	58	58	87	84
Hydraulic Rock Drill Bench 1	107	117	106	101	107	109	111	113	110	110	121	118
Hydraulic Rock Drill Bench 3	107	117	106	101	107	109	111	113	110	110	121	118
Hydraulic Rock Drill Bench 3	107	117	106	101	107	109	111	113	110	110	121	118
Year 15												
CAT140H Grader	97	100	109	104	108	109	106	103	103	103	115	113
CAT345B with hammer	117	112	114	111	110	115	110	110	101	101	122	118
CAT773 dump truck PWP	117	120	121	116	117	112	110	102	98	98	126	118
CAT773 Watercart In pit	116	116	113	115	112	110	109	102	97	97	122	116
CAT773 Watercart PWP	116	116	113	115	112	110	109	102	97	97	122	116
CAT777 dumping into crusher	117	120	121	116	117	112	110	102	98	98	126	118
CAT777 exit ramp N	107	109	116	112	109	105	104	96	92	92	119	111
CAT777 exit ramp S	107	109	116	112	109	105	104	96	92	92	119	111
CAT777 In pit bench 5	107	109	116	112	109	105	104	96	92	92	119	111

CAT777 In Pit Lowest bench	107	109	116	112	109	105	104	96	92	92	119	111
CAT777 stripping being loaded	107	109	116	112	109	105	104	96	92	92	119	111
CAT777 stripping passby	107	109	116	112	109	105	104	96	92	92	119	111
CAT777 dumping WOEA	117	120	121	116	117	112	110	102	98	98	126	118
CAT980G Stockpile east	114	112	108	106	103	103	103	104	100	89	118	110
CAT980G Stockpile west	114	112	108	106	103	103	103	104	100	89	118	110
CAT990 loader In pit	112	109	114	112	105	114	104	109	95	95	120	116
CAT990 loader stripping	112	109	114	112	105	114	104	109	95	95	120	116
CAT992 Loader	115	112	117	115	108	117	107	112	98	98	123	119
CATD10 Contractor Dozer PWP	114	115	114	101	105	104	102	94	88	88	120	109
Diesel Pump in pit	70	72	79	80	81	81	74	67	58	58	87	84
Diesel Pump near first conveyor	70	72	79	80	81	81	74	67	58	58	87	84
Diesel Pump near truck loading point	70	72	79	80	81	81	74	67	58	58	87	84
Hydraulic Rock Drill Bench 1	107	117	106	101	107	109	111	113	110	110	121	118
Hydraulic Rock Drill Bench 4 N	107	117	106	101	107	109	111	113	110	110	121	118
Hydraulic Rock Drill Bench 4 S	107	117	106	101	107	109	111	113	110	110	121	118
Year 20												
CAT140H Grader	97	100	109	104	108	109	106	103	103	103	115	113
CAT345B with hammer	117	112	114	111	110	115	110	110	101	101	122	118
CAT773 dump truck dumpint PWPEA	117	120	121	116	117	112	110	102	98	98	126	118
CAT773 Watercart In pit	116	116	113	115	112	110	109	102	97	97	122	116
CAT773 Watercart PWP	116	116	113	115	112	110	109	102	97	97	122	116
CAT777 dumping into crusher	117	120	121	116	117	112	110	102	98	98	126	118
CAT777 stripping passby	107	109	116	112	109	105	104	96	92	92	119	111
CAT777 exit ramp N	107	109	116	112	109	105	104	96	92	92	119	111
CAT777 exit ramp S	107	109	116	112	109	105	104	96	92	92	119	111
CAT777 In pit	107	109	116	112	109	105	104	96	92	92	119	111
CAT777 In Pit	107	109	116	112	109	105	104	96	92	92	119	111
CAT777 stripping being loaded	107	109	116	112	109	105	104	96	92	92	119	111
CAT777 in pit	107	109	116	112	109	105	104	96	92	92	119	111
CAT777 dumping WOEA	117	120	121	116	117	112	110	102	98	98	126	118
CAT980G Stockpile east	114	112	108	106	103	103	103	104	100	89	118	110
CAT980G Stockpile west	114	112	108	106	103	103	103	104	100	89	118	110
CAT990 loader In pit	112	109	114	112	105	114	104	109	95	95	120	116
CAT990 loader stripping	112	109	114	112	105	114	104	109	95	95	120	116
CAT992 Loader	115	112	117	115	108	117	107	112	98	98	123	119
CATD10 Contractor Dozer PWPEA	114	115	114	101	105	104	102	94	88	88	120	109
Diesel Pump in pit	70	72	79	80	81	81	74	67	58	58	87	84
Diesel Pump in pit	70	72	79	80	81	81	74	67	58	58	87	84
Diesel Pump in pit	70	72	79	80	81	81	74	67	58	58	87	84
Hydraulic Rock Drill Bench	107	117	106	101	107	109	111	113	110	110	121	118
Diesel Pump near first conveyor	70	72	79	80	81	81	74	67	58	58	87	84
Diesel Pump near truck loading point	70	72	79	80	81	81	74	67	58	58	87	84
Year 30												
CAT140H Grader	97	100	109	104	108	109	106	103	103	103	115	113
CAT345B with hammer	117	112	114	111	110	115	110	110	101	101	122	118

CAT773 dump truck Stockpiling	117	120	121	116	117	112	110	102	98	98	126	118
CAT773 Watercart In pit	116	116	113	115	112	110	109	102	97	97	122	116
CAT773 Watercart PWP	116	116	113	115	112	110	109	102	97	97	122	116
CAT777 dumping into crusher	117	120	121	116	117	112	110	102	98	98	126	118
CAT777 exit ramp N	107	109	116	112	109	105	104	96	92	92	119	111
CAT777 exit ramp E	107	109	116	112	109	105	104	96	92	92	119	111
CAT777 In pit	107	109	116	112	109	105	104	96	92	92	119	111
CAT777 In pit	107	109	116	112	109	105	104	96	92	92	119	111
CAT777 In pit	107	109	116	112	109	105	104	96	92	92	119	111
CAT980G Stockpile east	114	112	108	106	103	103	103	104	100	89	118	110
CAT980G Stockpile west	114	112	108	106	103	103	103	104	100	89	118	110
CAT990 loader In pit	112	109	114	112	105	114	104	109	95	95	120	116
CAT992 Loader	115	112	117	115	108	117	107	112	98	98	123	119
CATD10 Contractor Dozer PWP	114	115	114	101	105	104	102	94	88	88	120	109
Diesel Pump in pit	70	72	79	80	81	81	74	67	58	58	87	84
Diesel Pump near first conveyor	70	72	79	80	81	81	74	67	58	58	87	84
Diesel Pump near truck loading point	70	72	79	80	81	81	74	67	58	58	87	84
Hydraulic Rock Drill	107	117	106	101	107	109	111	113	110	110	121	118
Hydraulic Rock Drill	107	117	106	101	107	109	111	113	110	110	121	118
Hydraulic Rock Drill	107	117	106	101	107	109	111	113	110	110	121	118



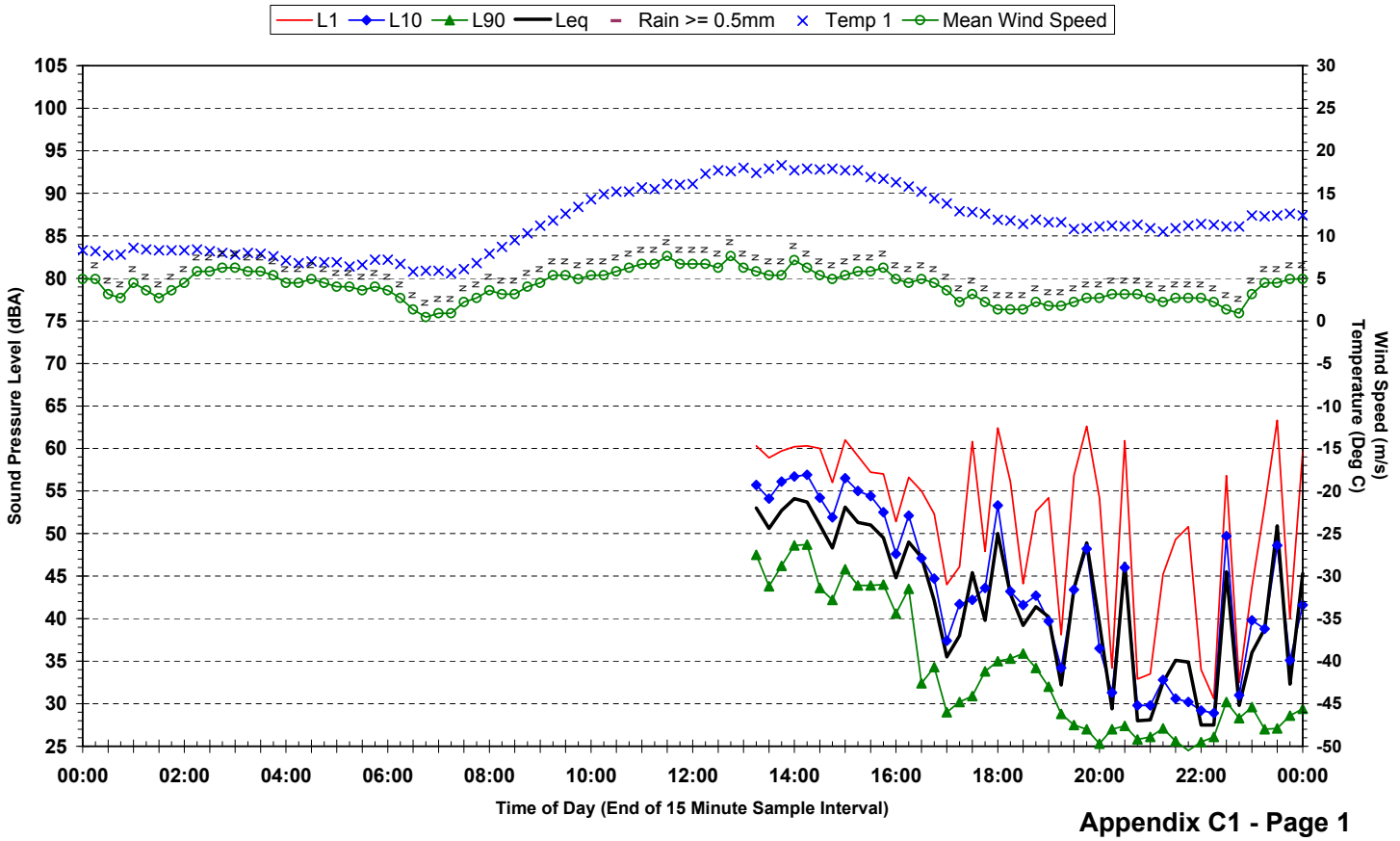
Appendix B

RHA Report 10-3142
Lynwood Quarry

Location Diagram

▲ 11 Noise Assessment Location

Statistical Ambient Noise Levels
Marulan N1 - North Western Boundary of Project Area - Tuesday 1 June 2004



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Ambient Conditions
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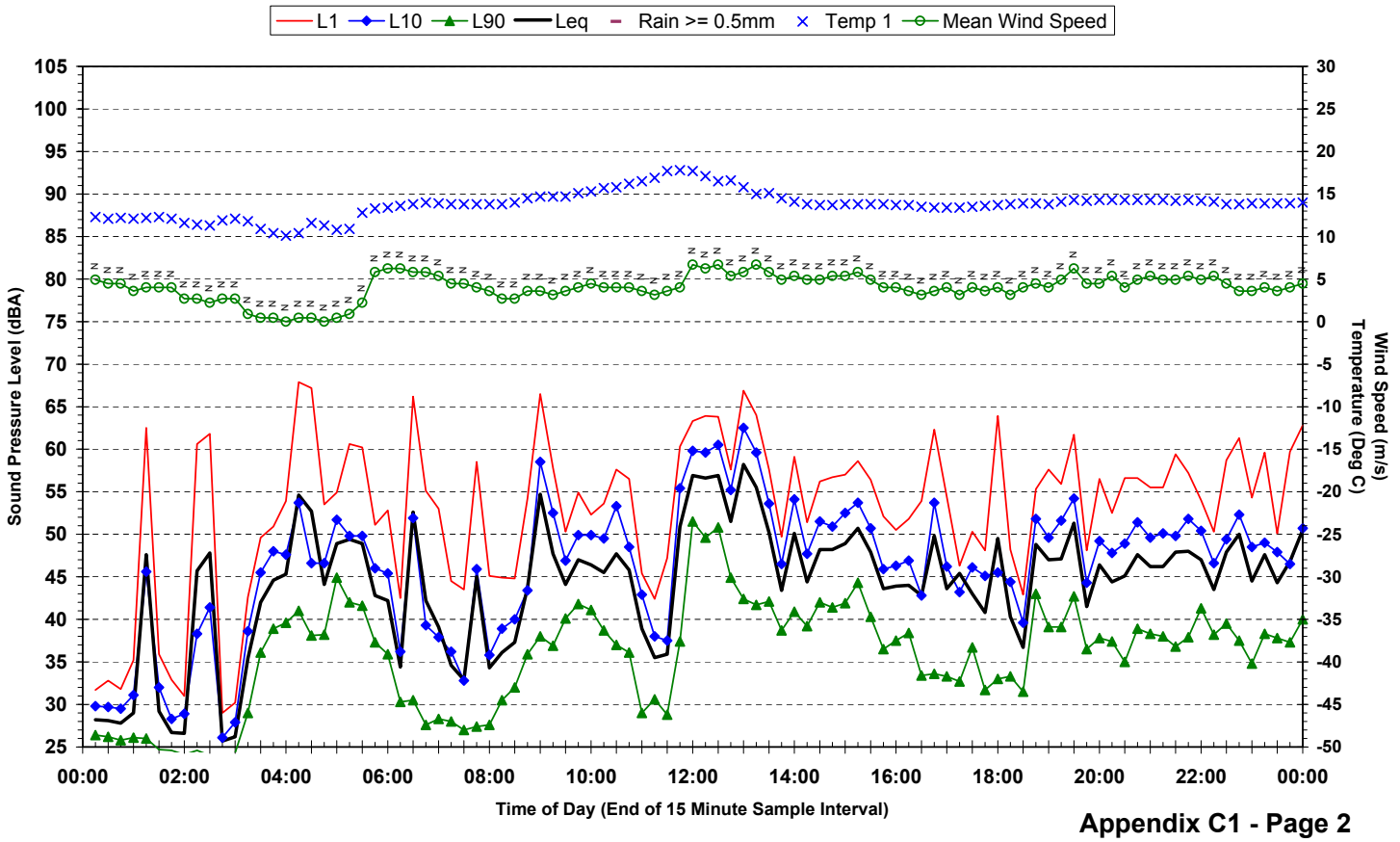
Statistical Ambient Noise Levels
Marulan N1 - North Western Boundary of Project Area - Wednesday 2 June 2004



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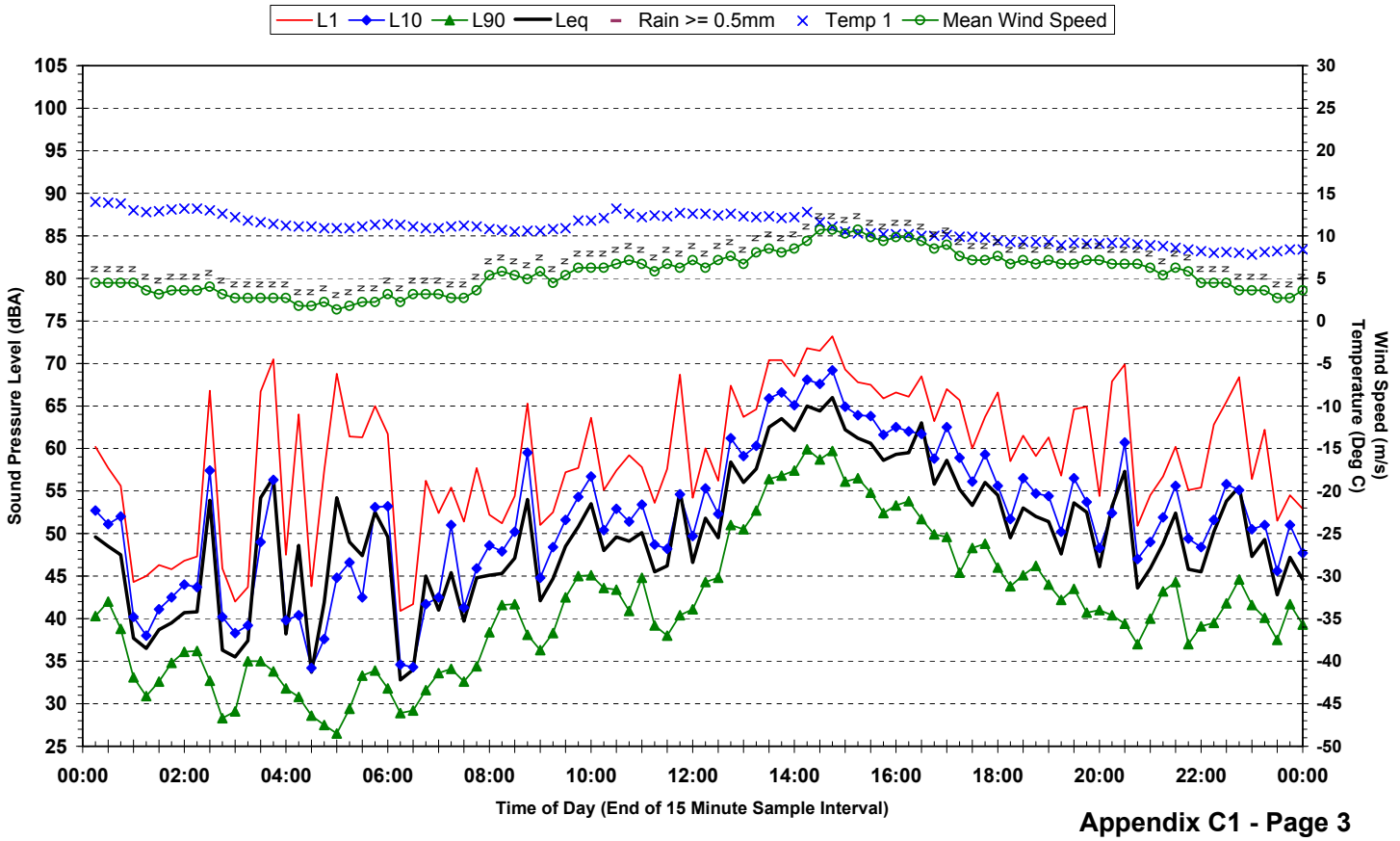
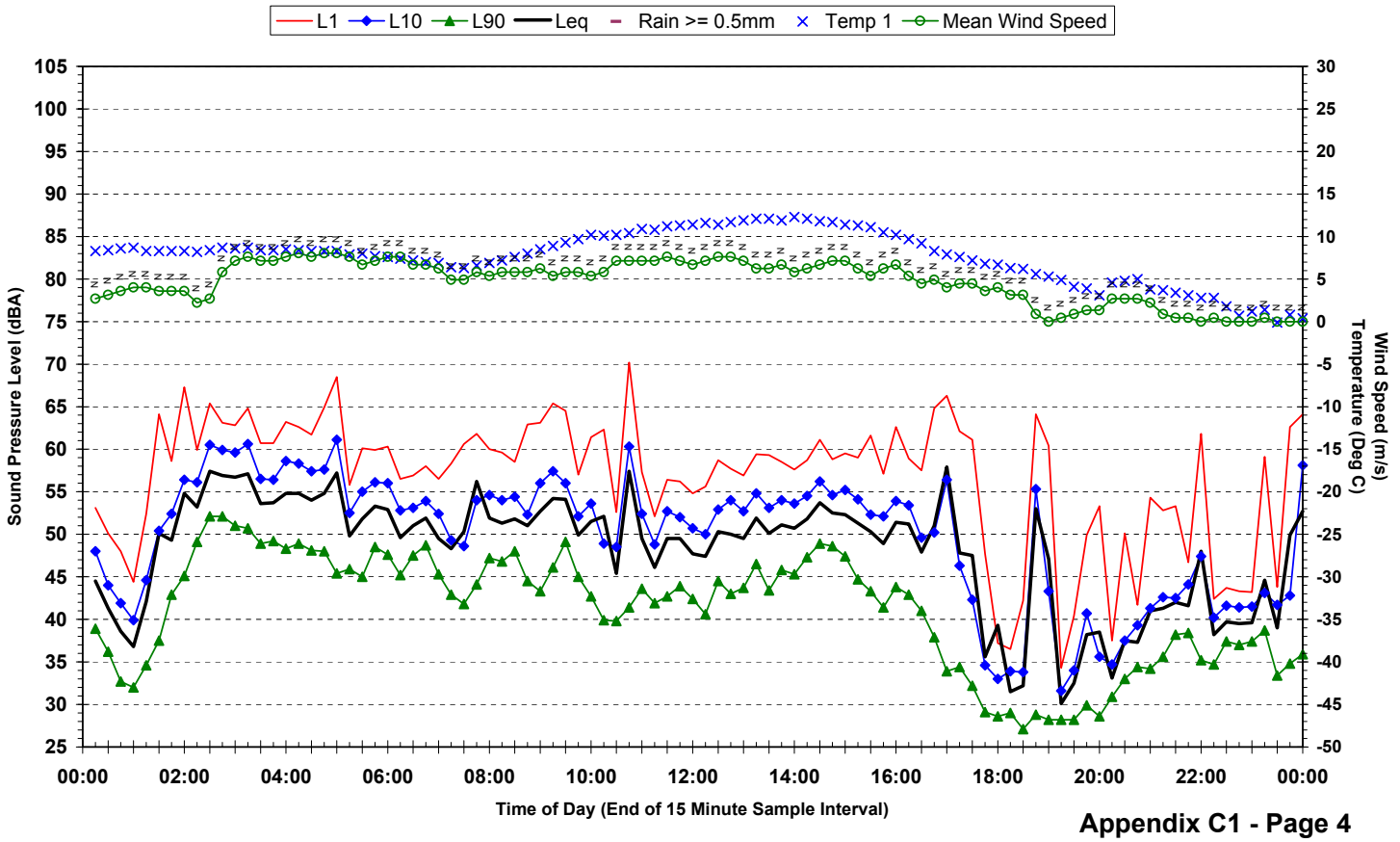
Ambient Conditions
RHA Report 10-3142

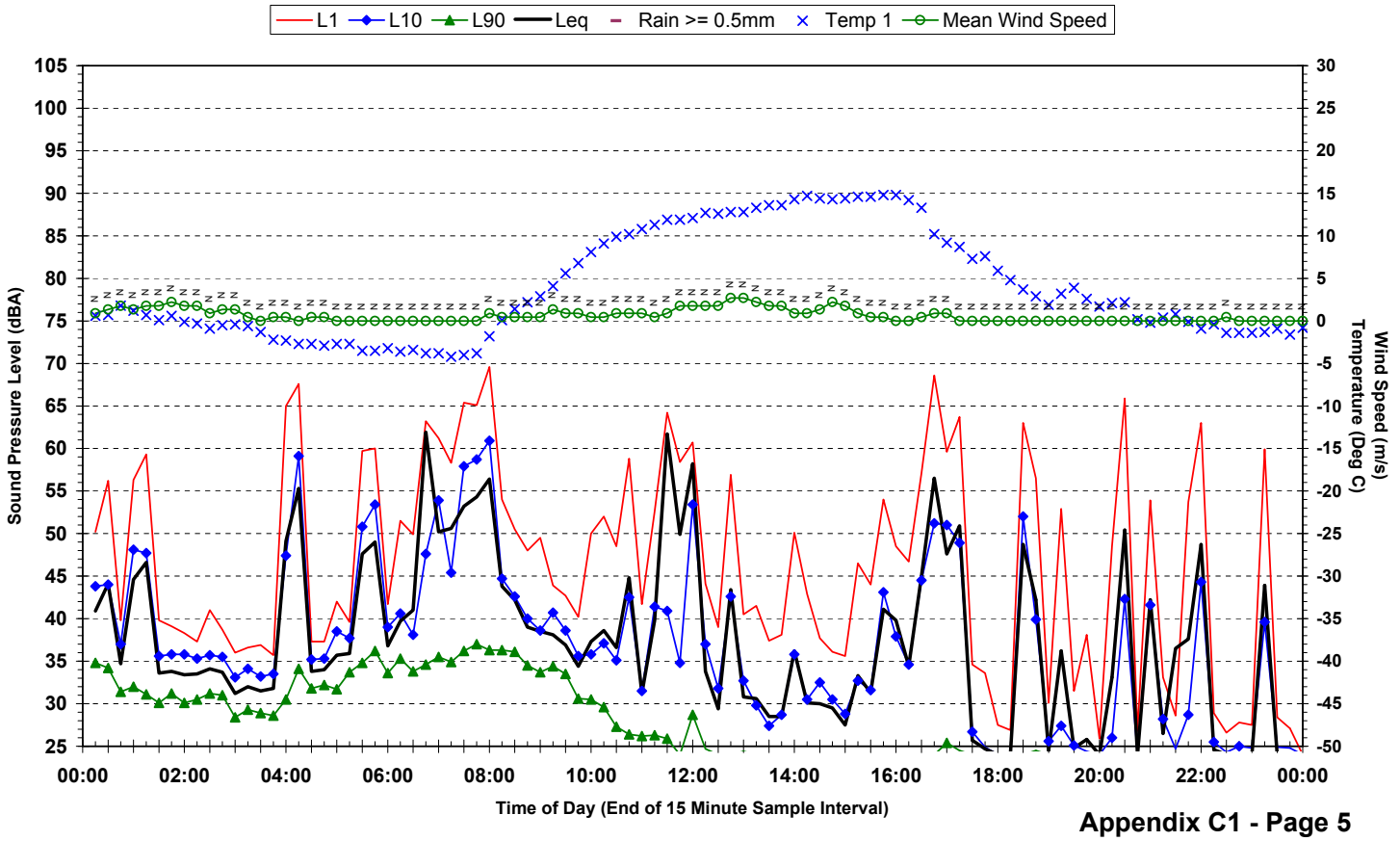
Statistical Ambient Noise Levels
Marulan N1 - North Western Boundary of Project Area - Thursday 3 June 2004



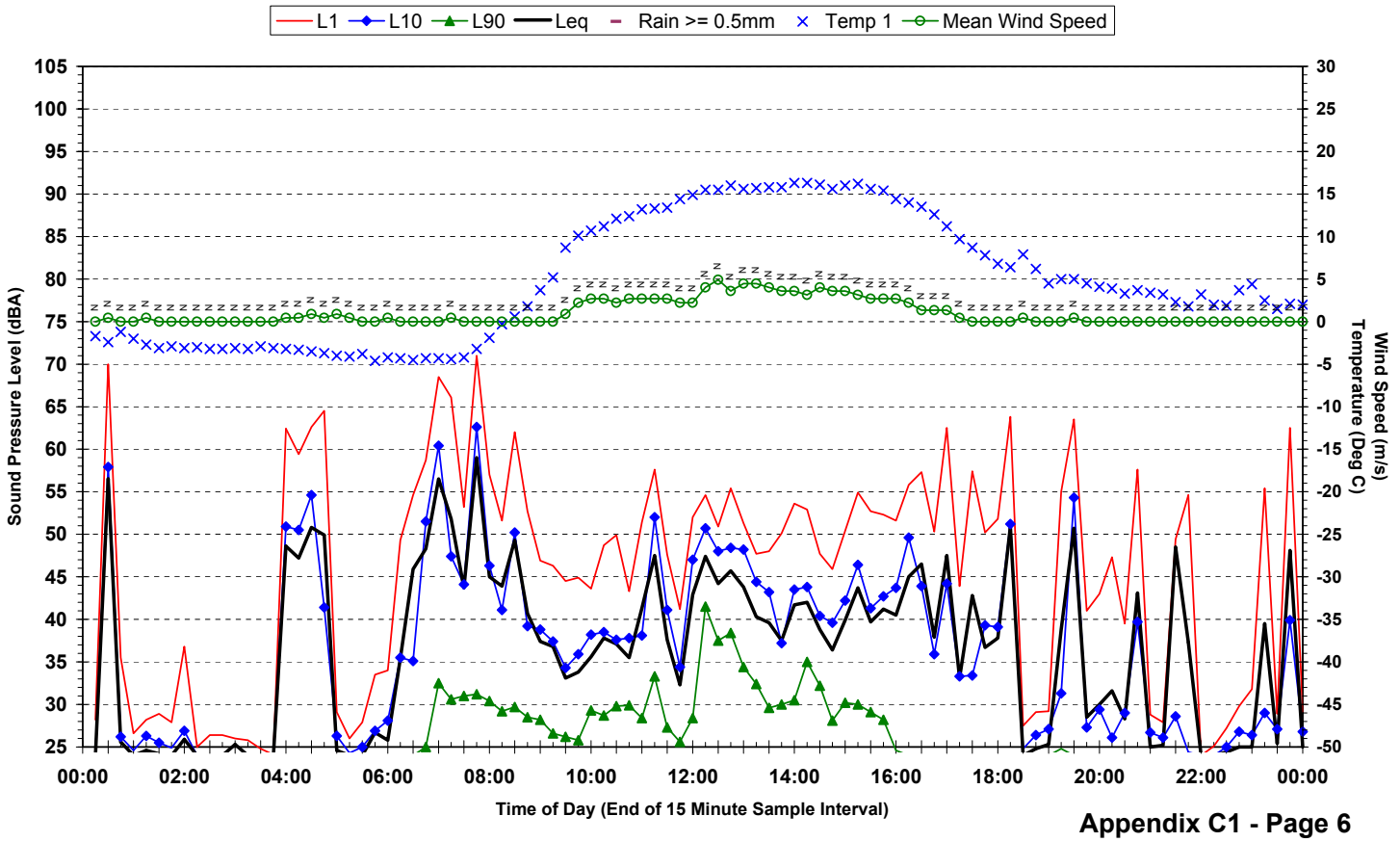
Statistical Ambient Noise Levels
Marulan N1 - North Western Boundary of Project Area - Friday 4 June 2004



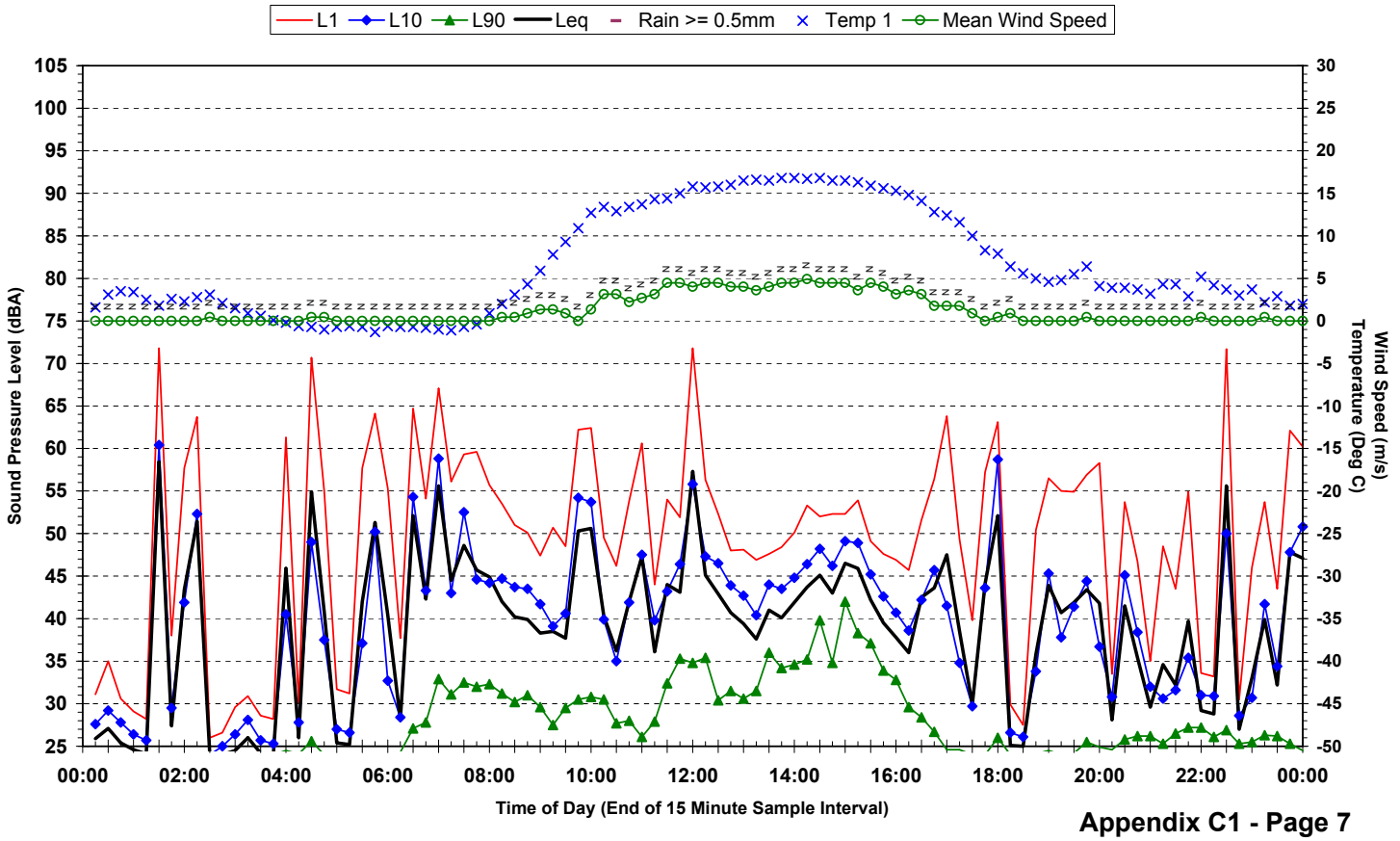
Statistical Ambient Noise Levels
Marulan N1 - North Western Boundary of Project Area - Saturday 5 June 2004



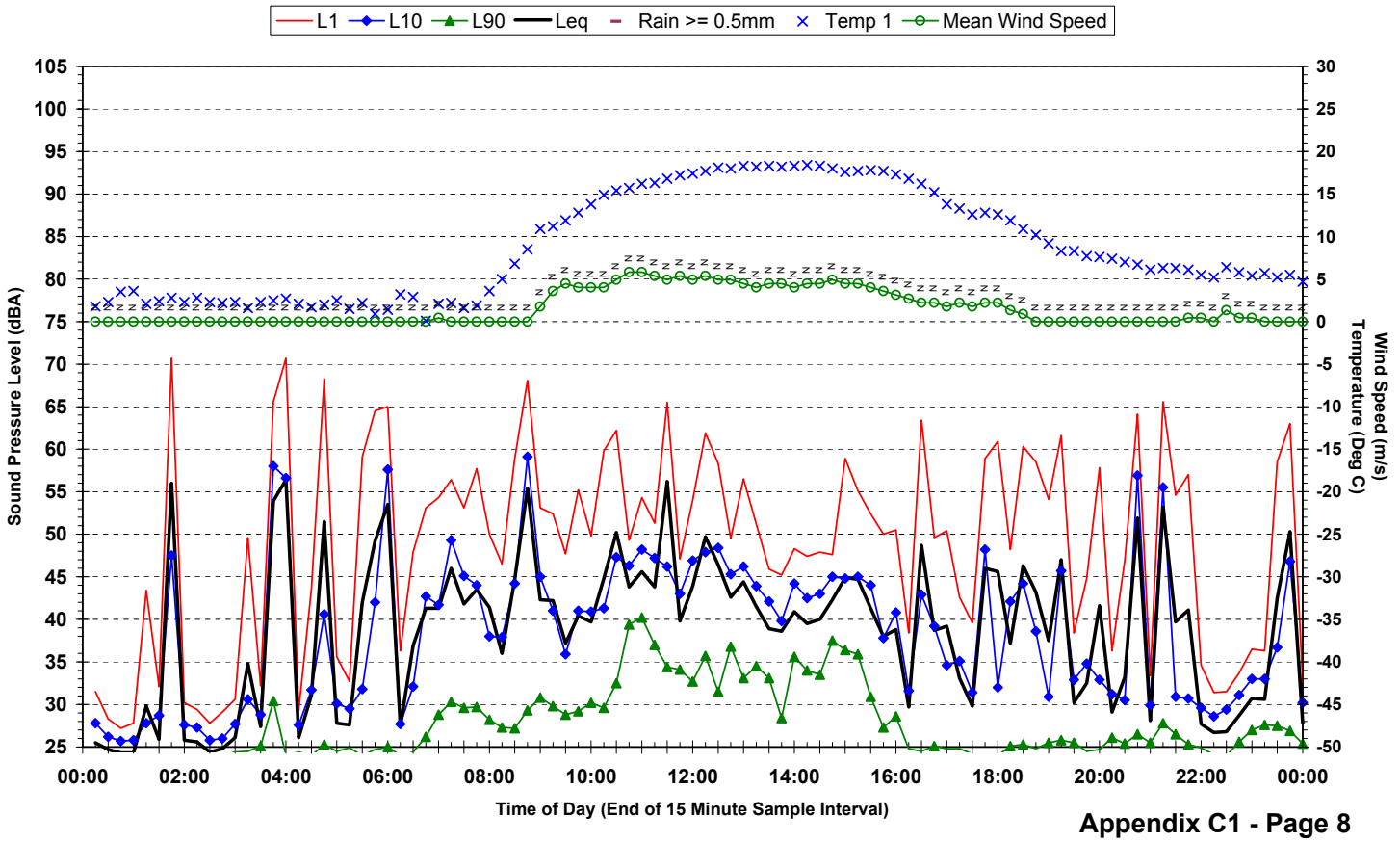
Statistical Ambient Noise Levels
Marulan N1 - North Western Boundary of Project Area - Sunday 6 June 2004



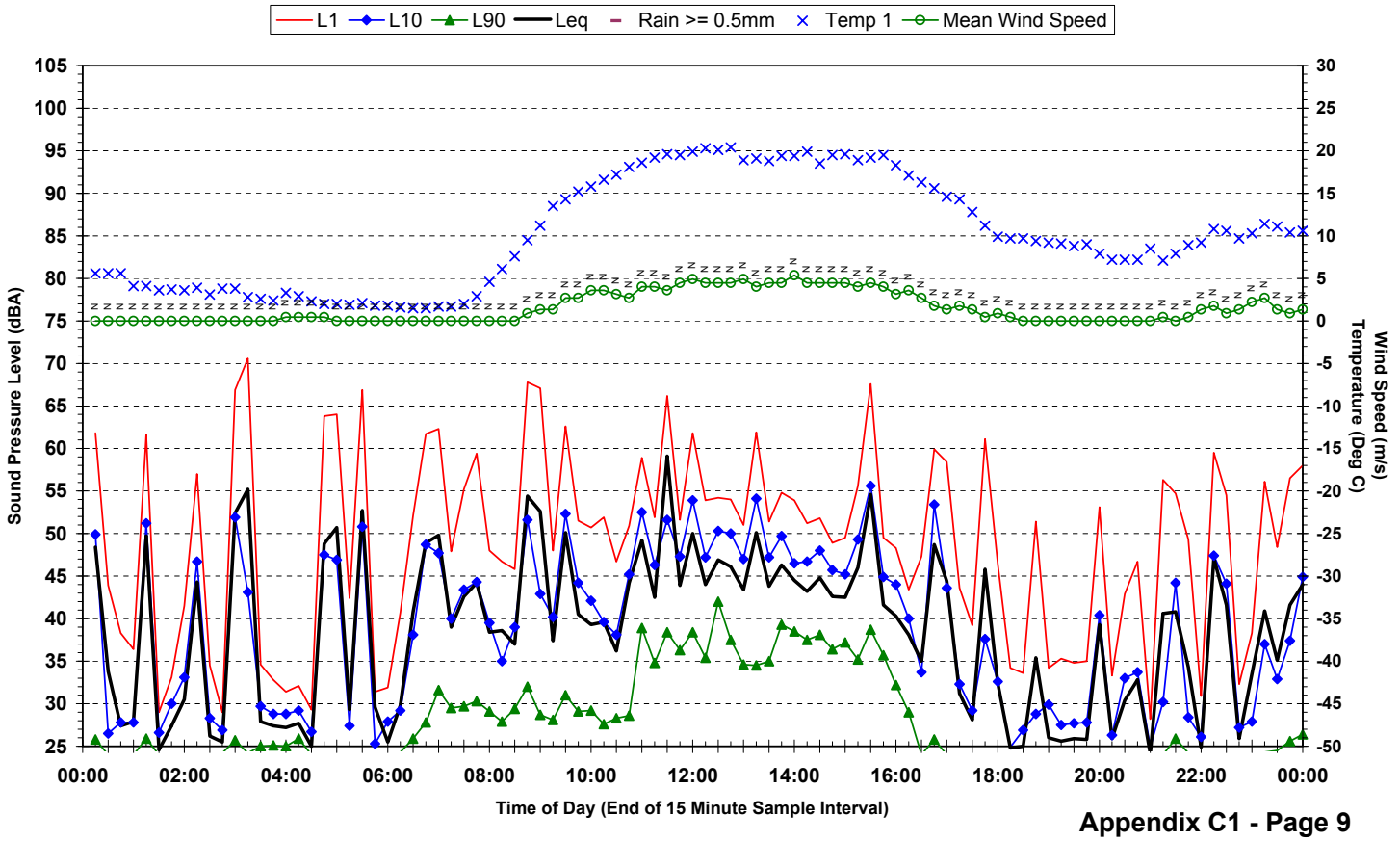
Statistical Ambient Noise Levels
Marulan N1 - North Western Boundary of Project Area - Monday 7 June 2004



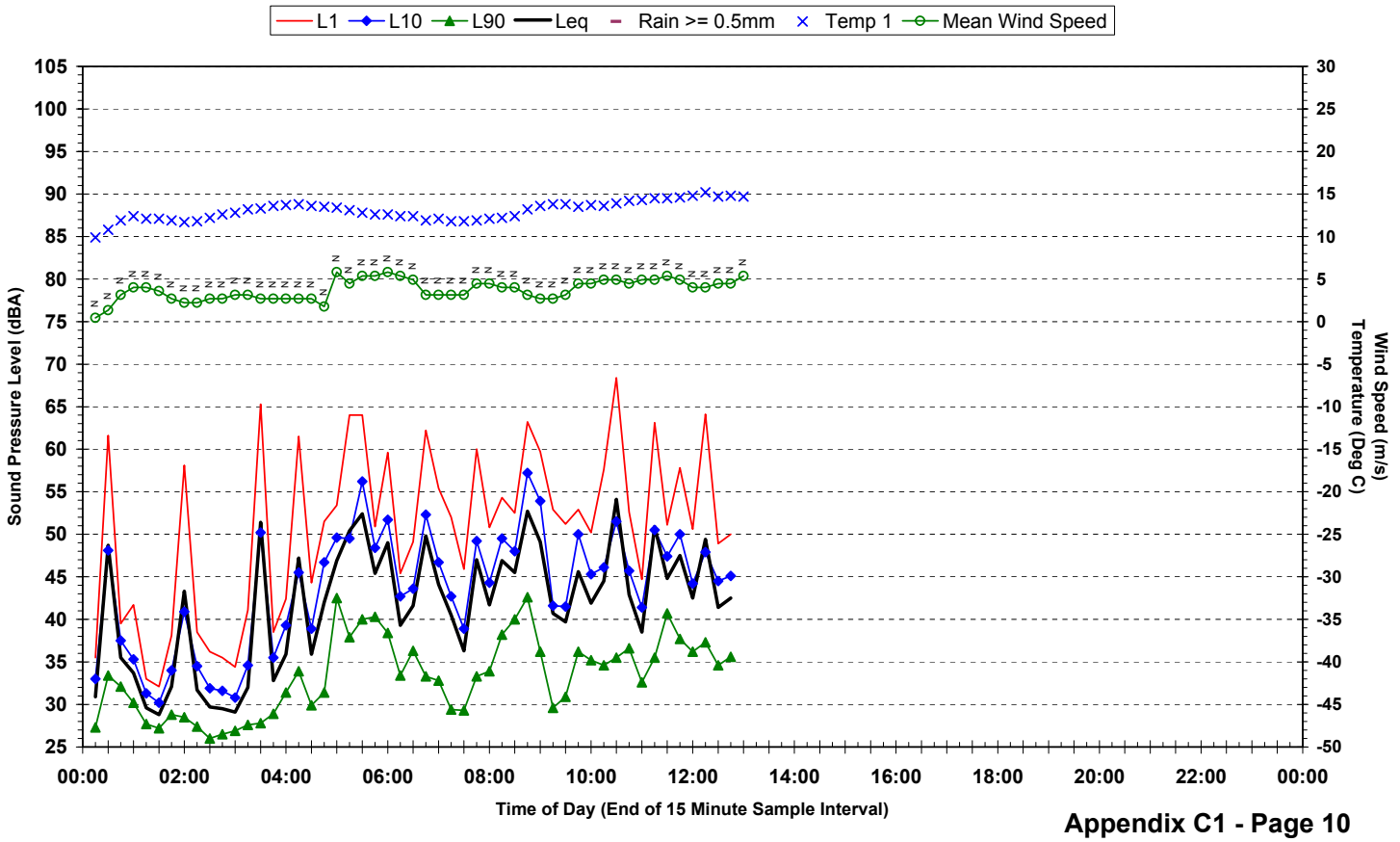
Statistical Ambient Noise Levels
Marulan N1 - North Western Boundary of Project Area - Tuesday 8 June 2004



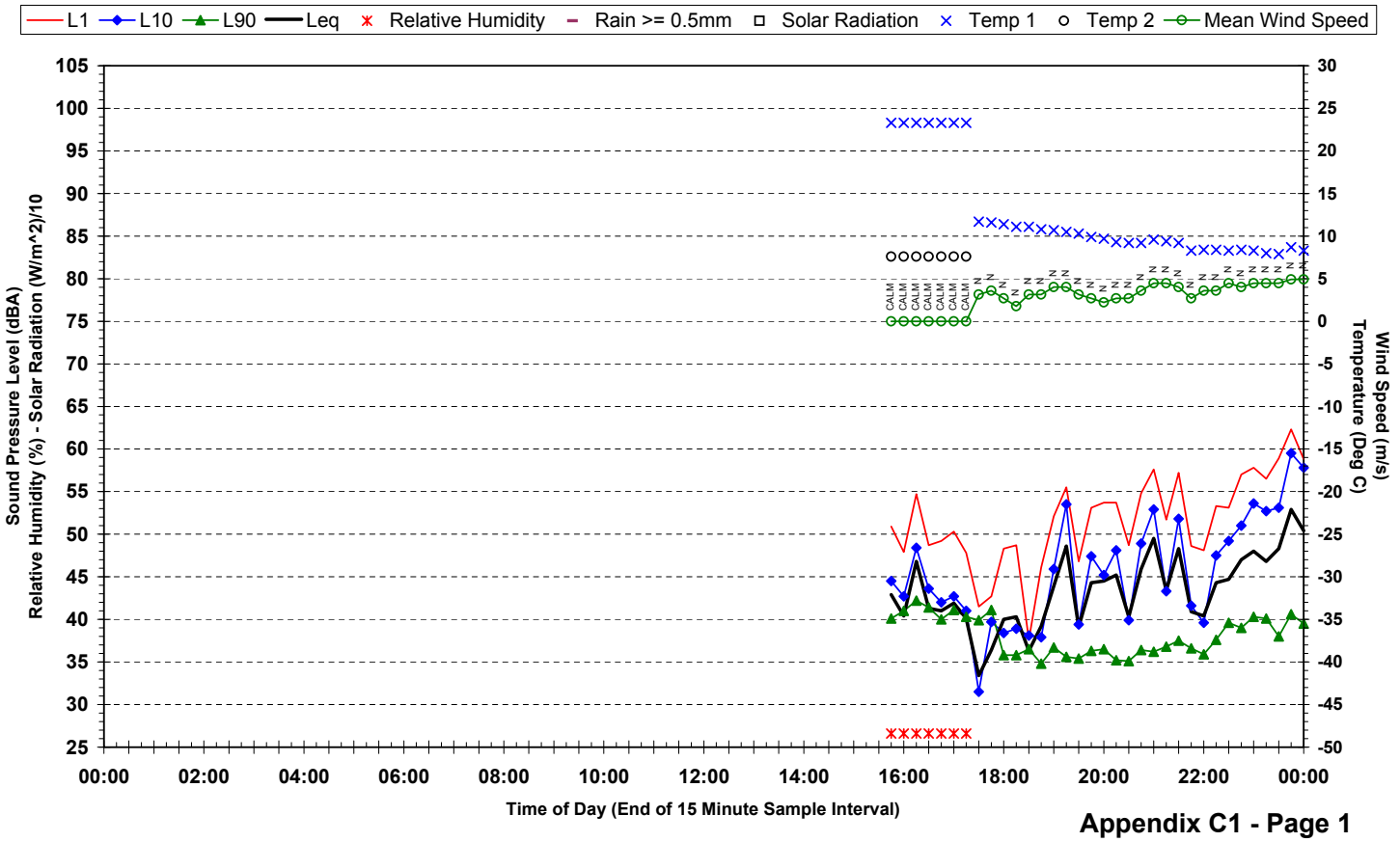
Statistical Ambient Noise Levels
Marulan N1 - North Western Boundary of Project Area - Wednesday 9 June 2004



Statistical Ambient Noise Levels
Marulan N1 - North Western Boundary of Project Area - Thursday 10 June 2004



Statistical Ambient Noise Levels
Marulan N2 North Eastern Boundary of Project Area - Monday 31 May 2004



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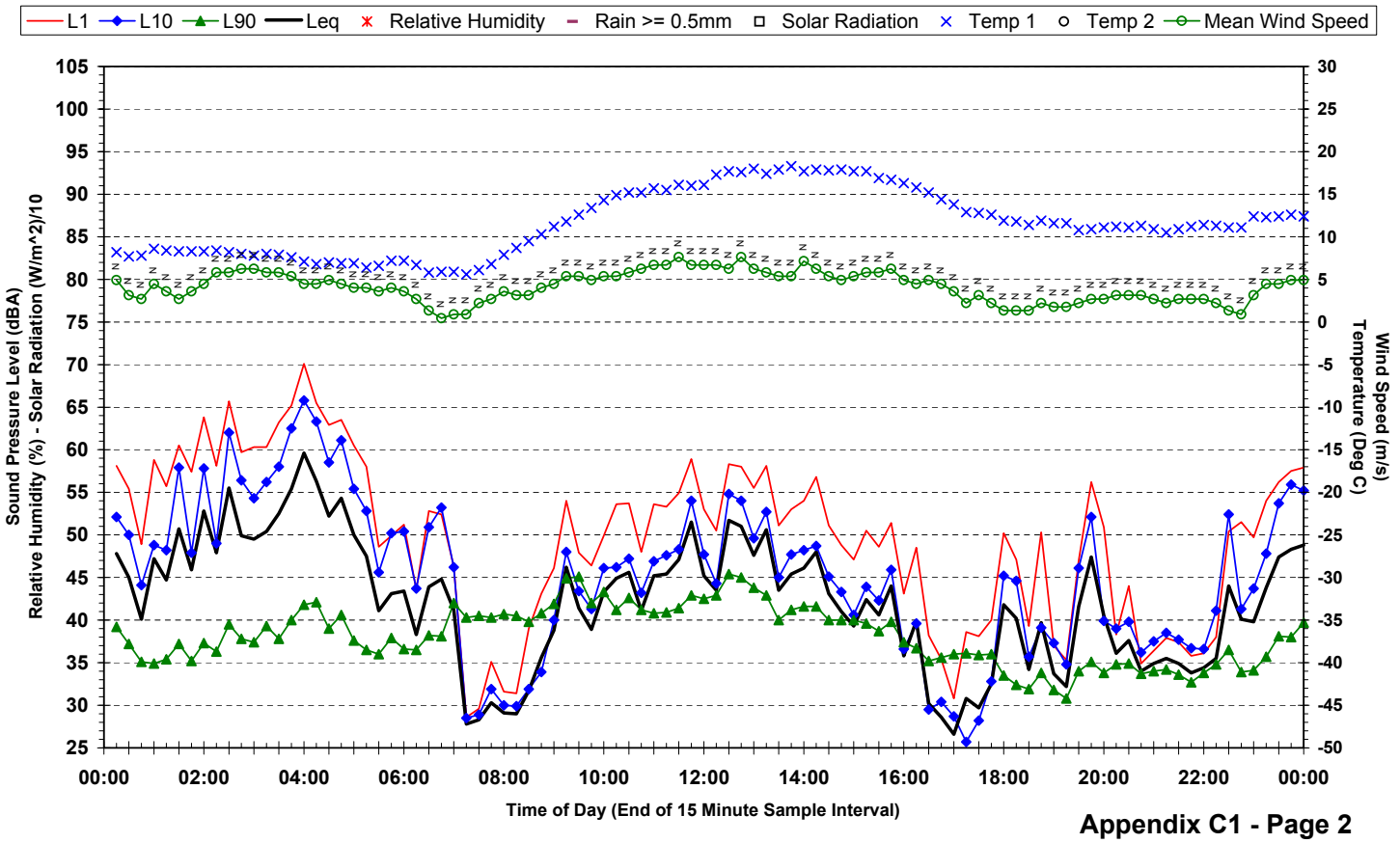
Ambient Conditions
RHA Report 10-3142

Statistical Ambient Noise Levels
Marulan N2 North Eastern Boundary of Project Area - Tuesday 1 June 2004



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Ambient Conditions
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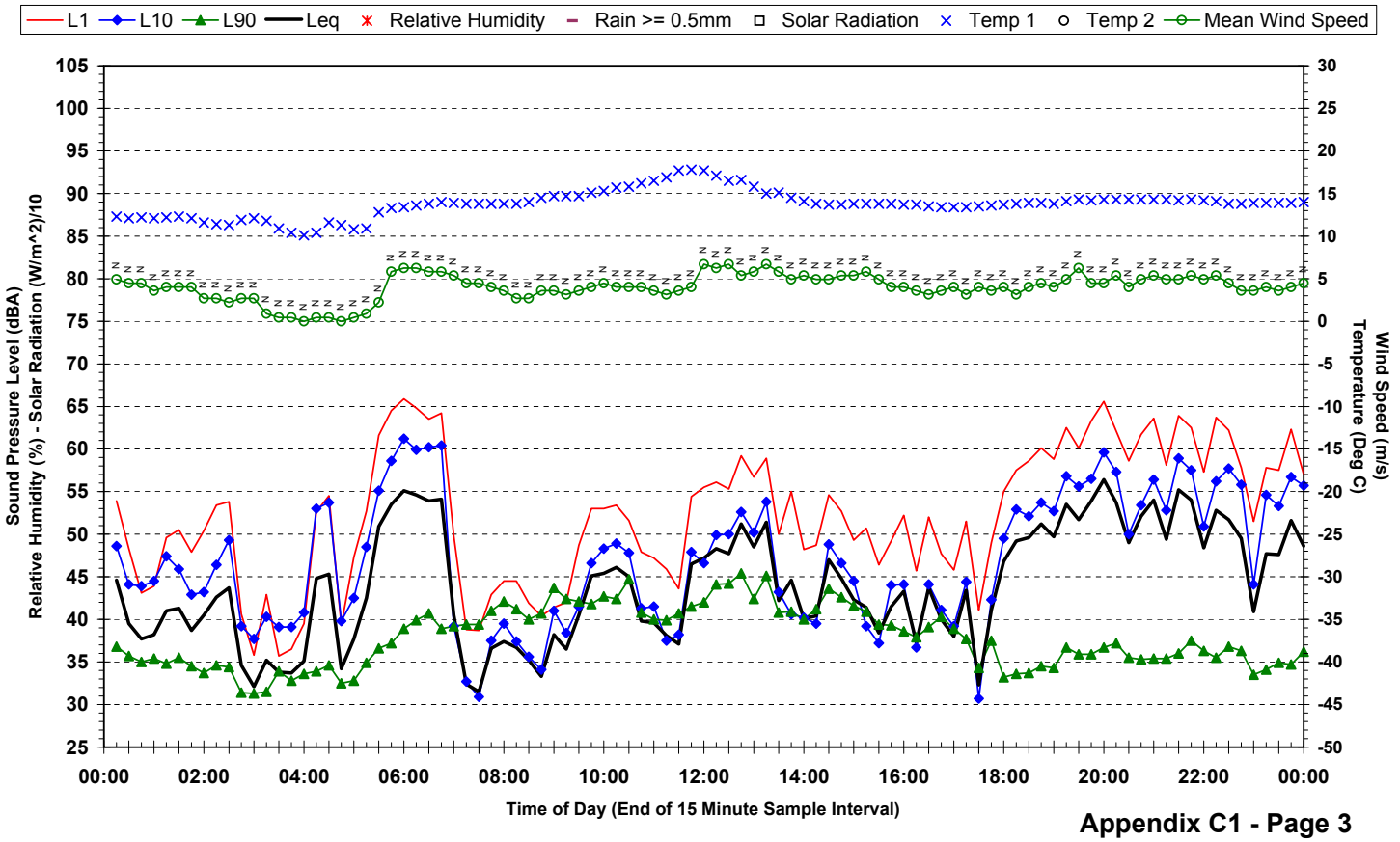
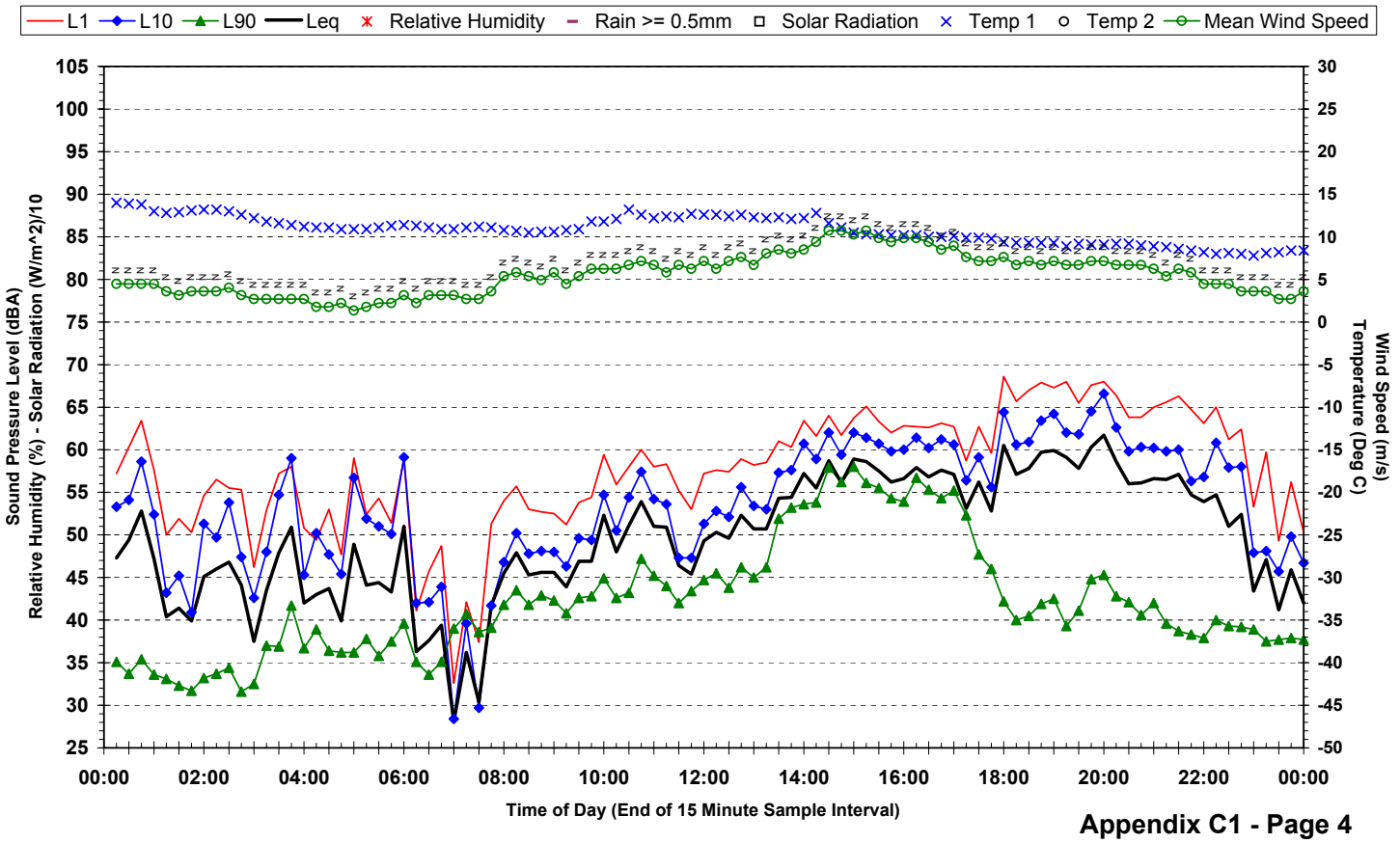
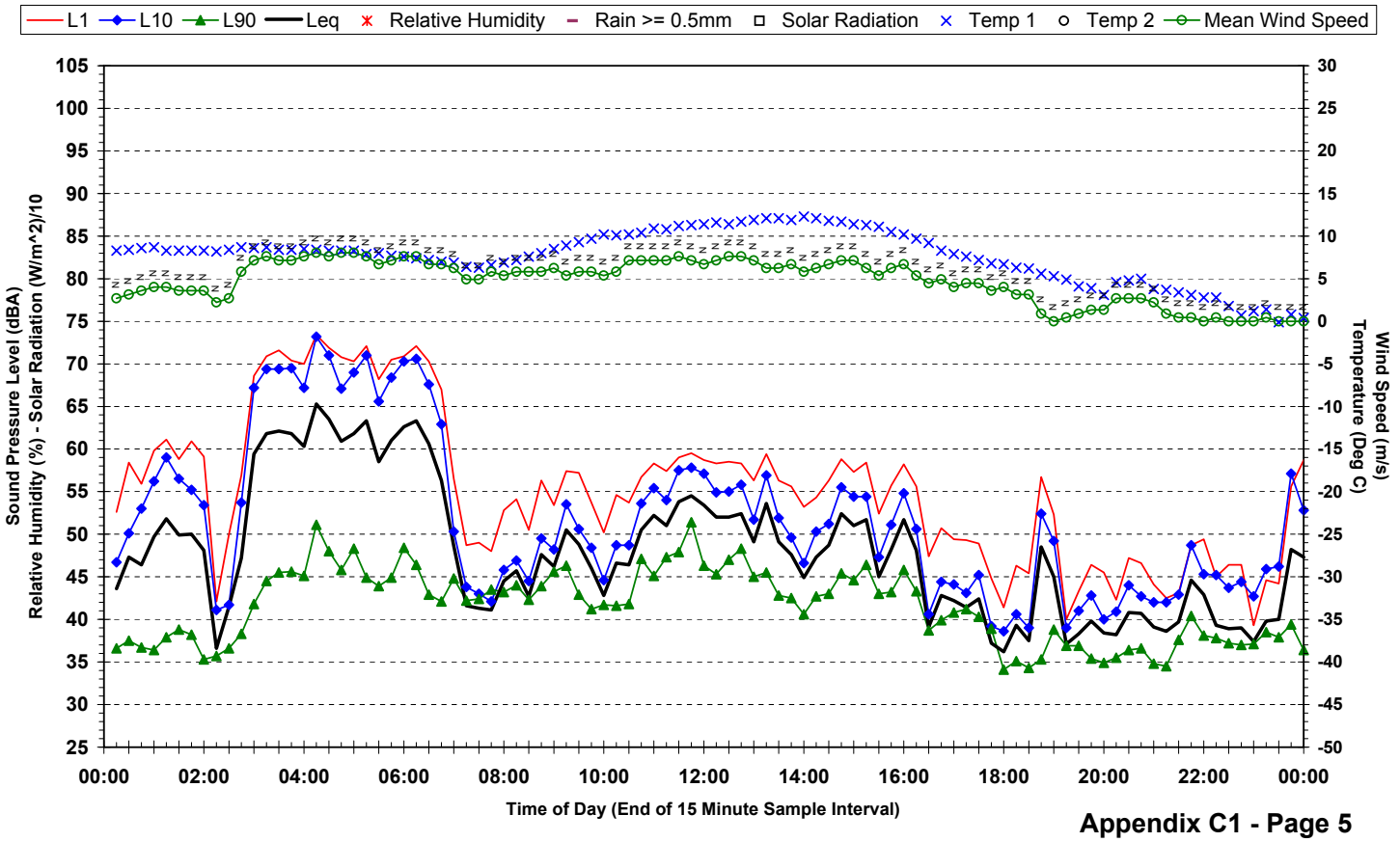
Statistical Ambient Noise Levels
Marulan N2 North Eastern Boundary of Project Area - Wednesday 2 June 2004



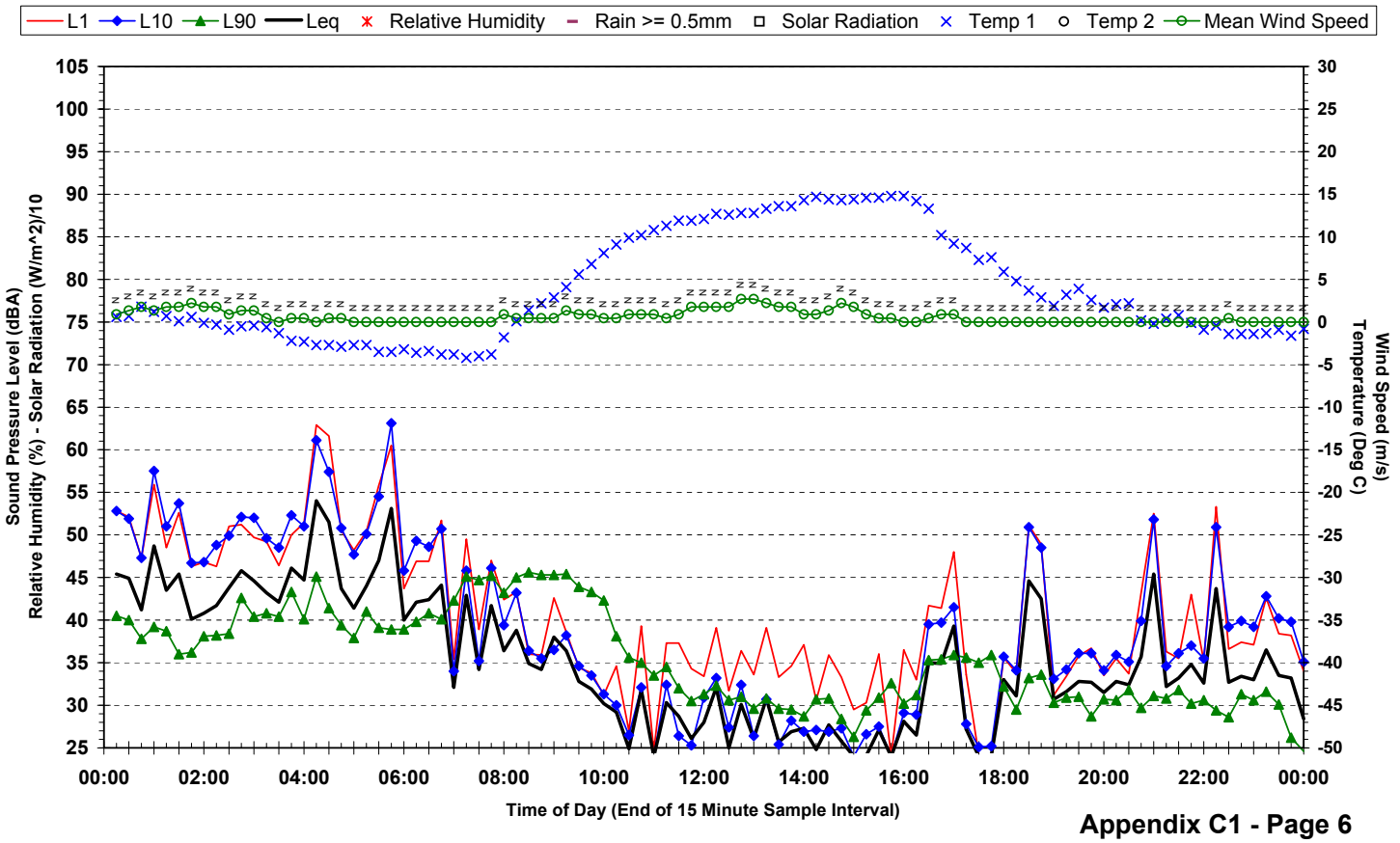
Statistical Ambient Noise Levels
Marulan N2 North Eastern Boundary of Project Area - Thursday 3 June 2004



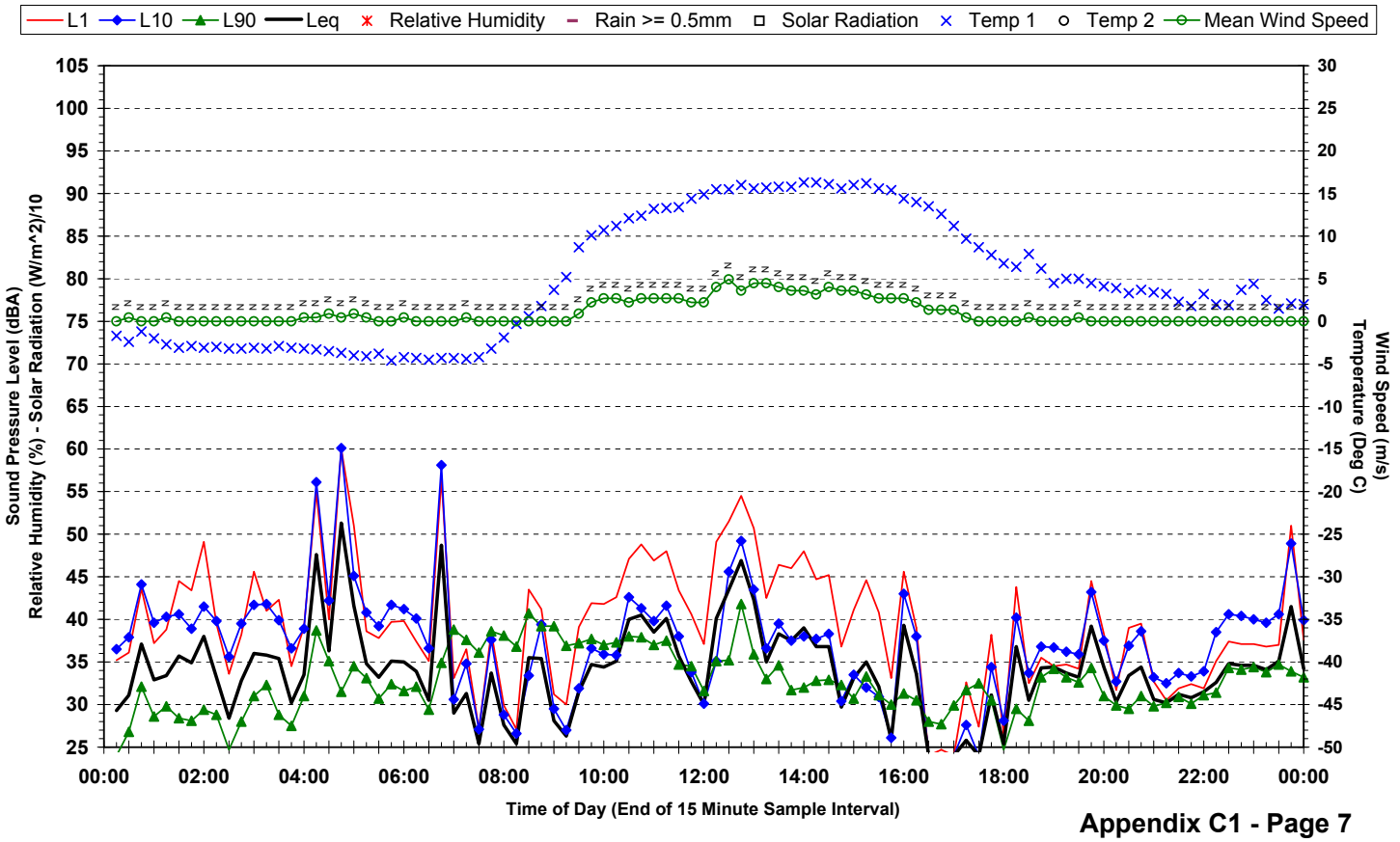
Statistical Ambient Noise Levels
Marulan N2 North Eastern Boundary of Project Area - Friday 4 June 2004



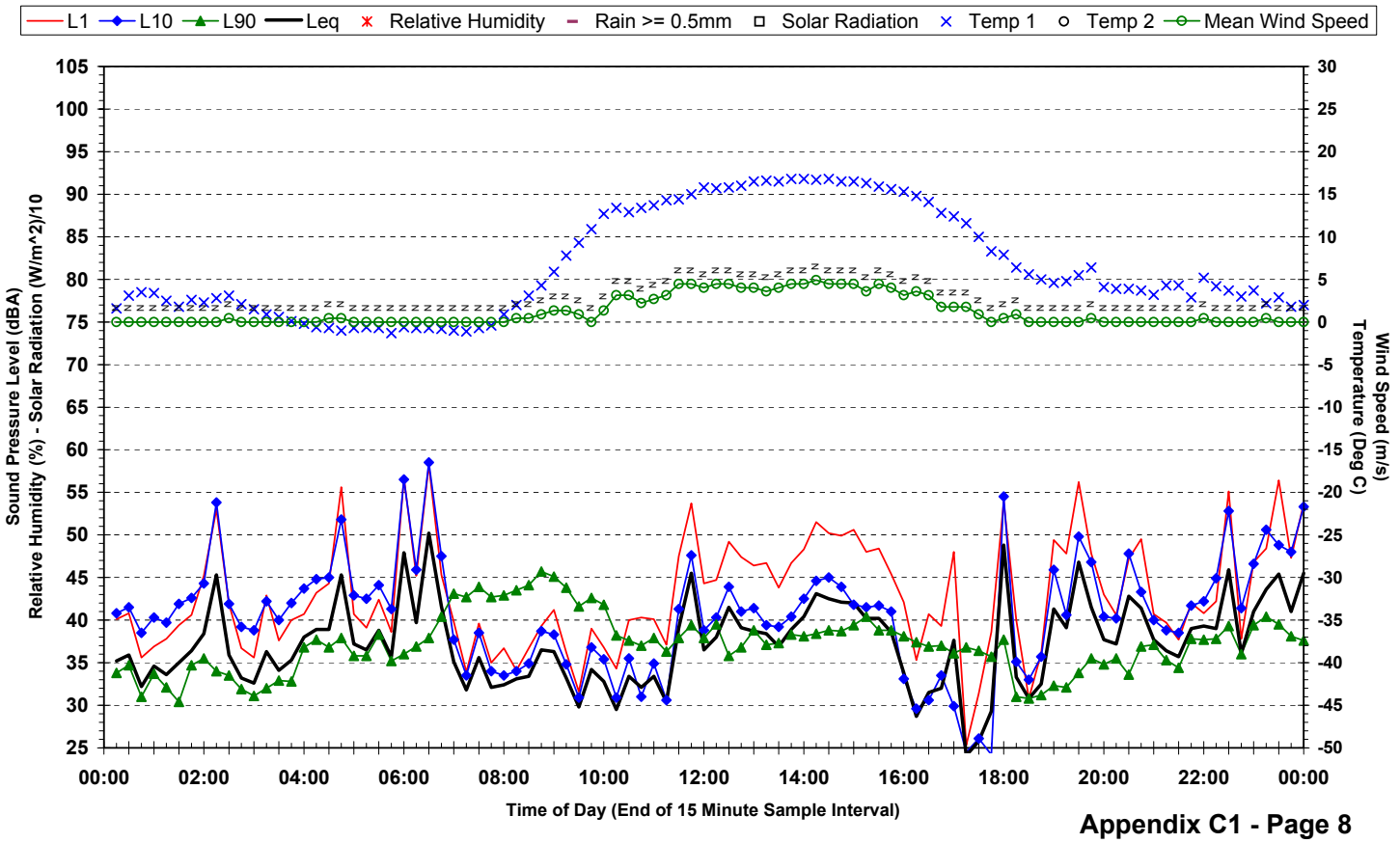
Statistical Ambient Noise Levels
Marulan N2 North Eastern Boundary of Project Area - Saturday 5 June 2004



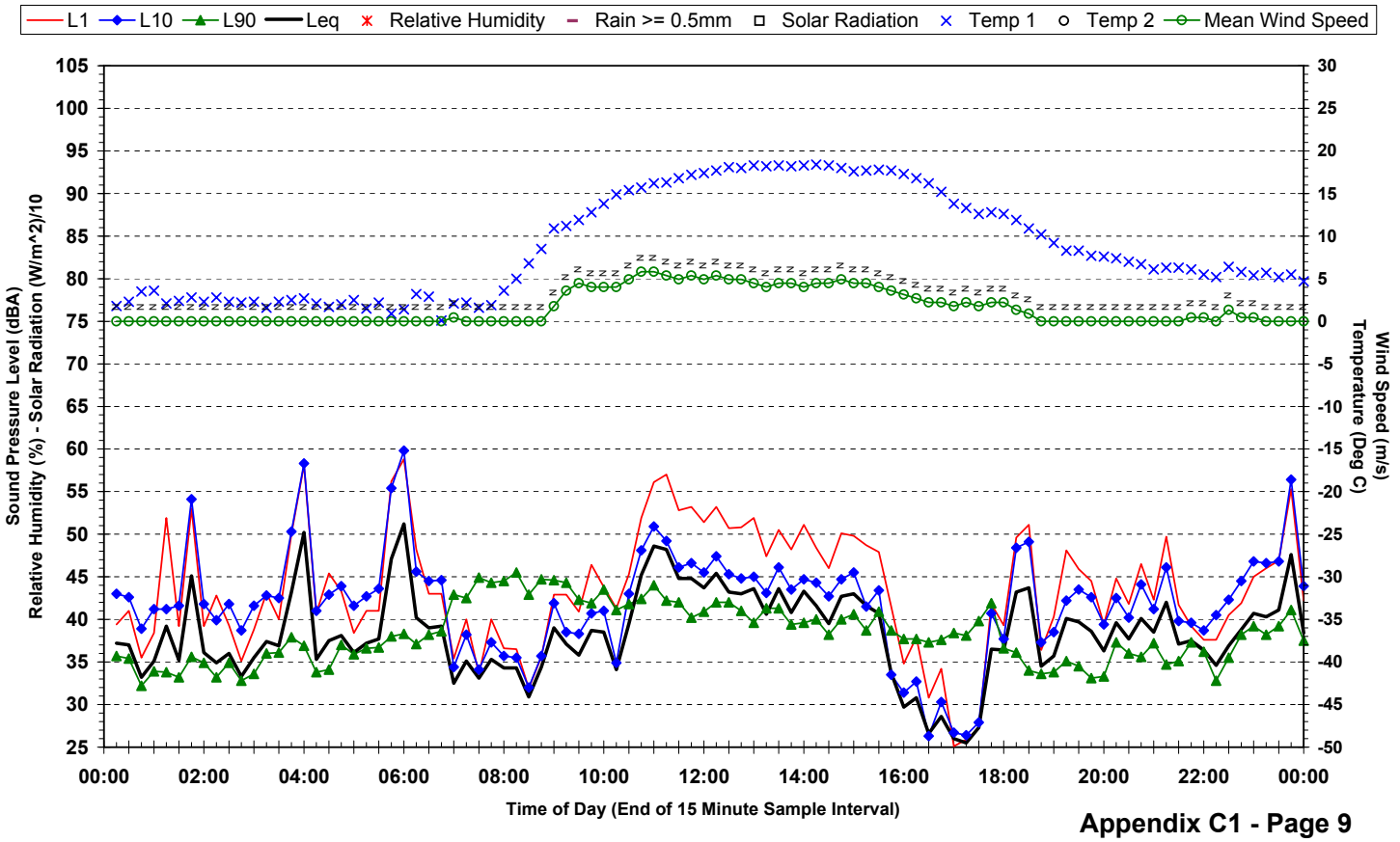
Statistical Ambient Noise Levels
Marulan N2 North Eastern Boundary of Project Area - Sunday 6 June 2004



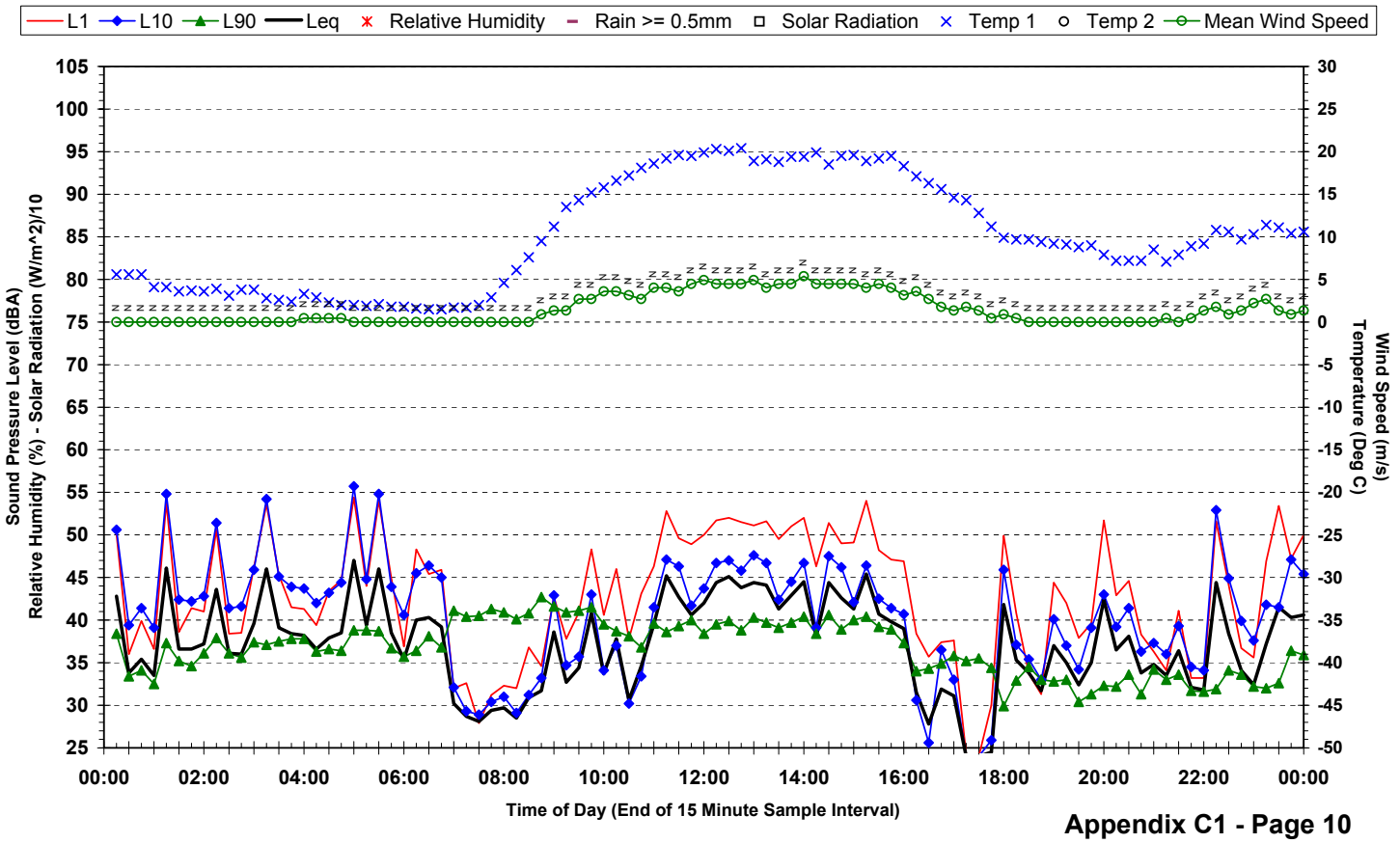
Statistical Ambient Noise Levels
Marulan N2 North Eastern Boundary of Project Area - Monday 7 June 2004



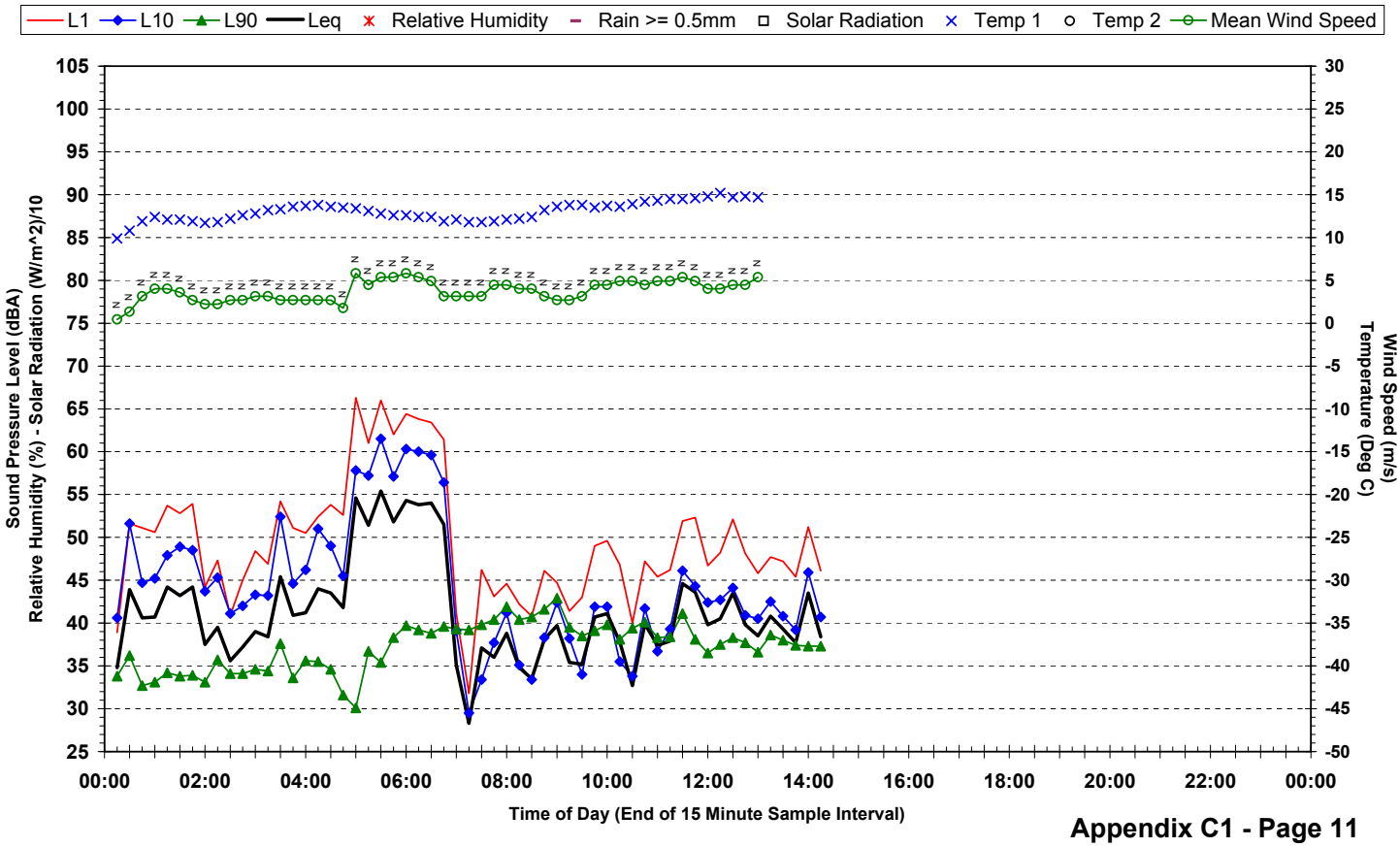
Statistical Ambient Noise Levels
Marulan N2 North Eastern Boundary of Project Area - Tuesday 8 June 2004



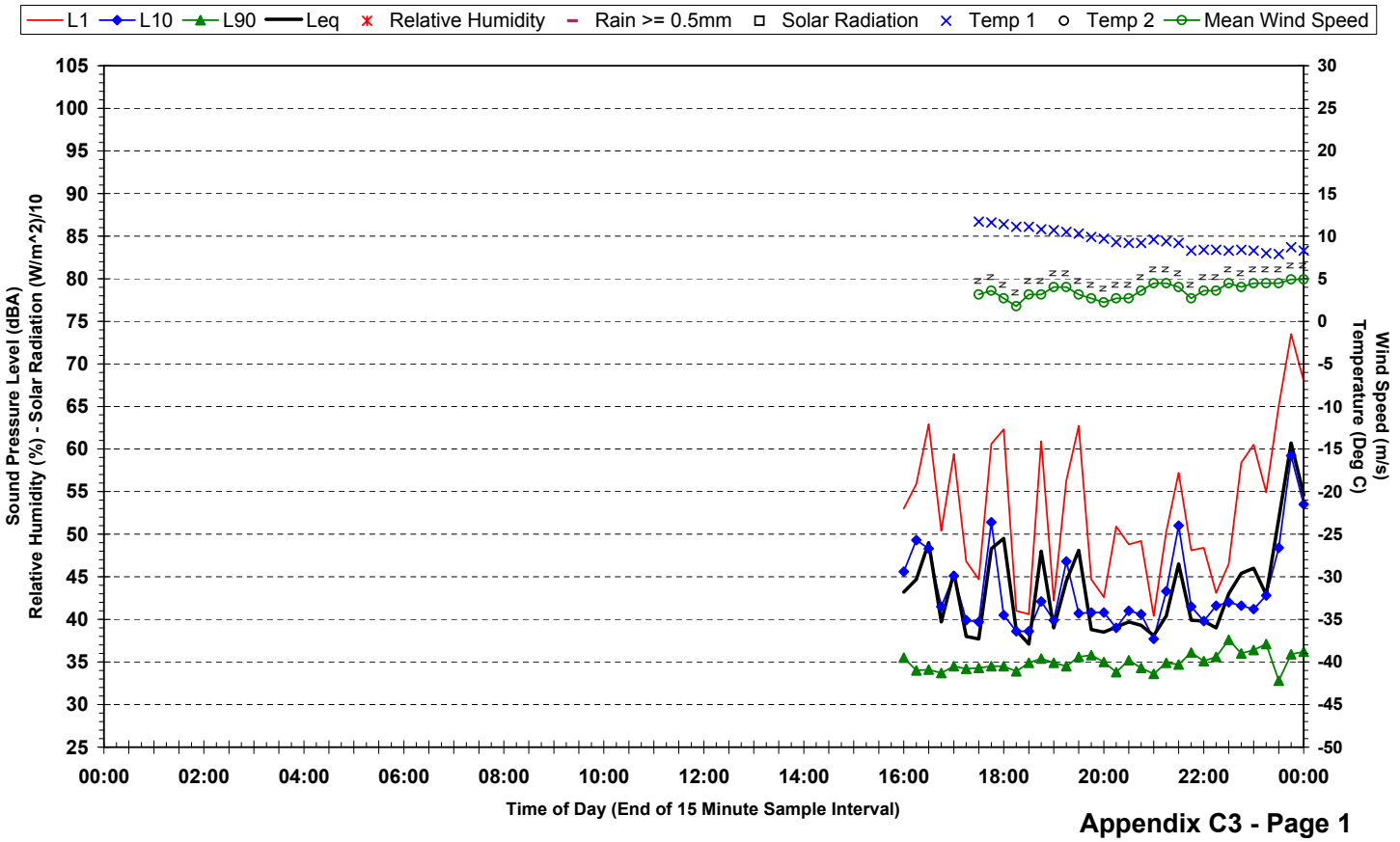
Statistical Ambient Noise Levels
Marulan N2 North Eastern Boundary of Project Area - Wednesday 9 June 2004



Statistical Ambient Noise Levels
Marulan N2 North Eastern Boundary of Project Area - Thursday 10 June 2004



Statistical Ambient Noise Levels
Marulan N3 60 Maclura Drive, Marulan - Monday 31 May 2004



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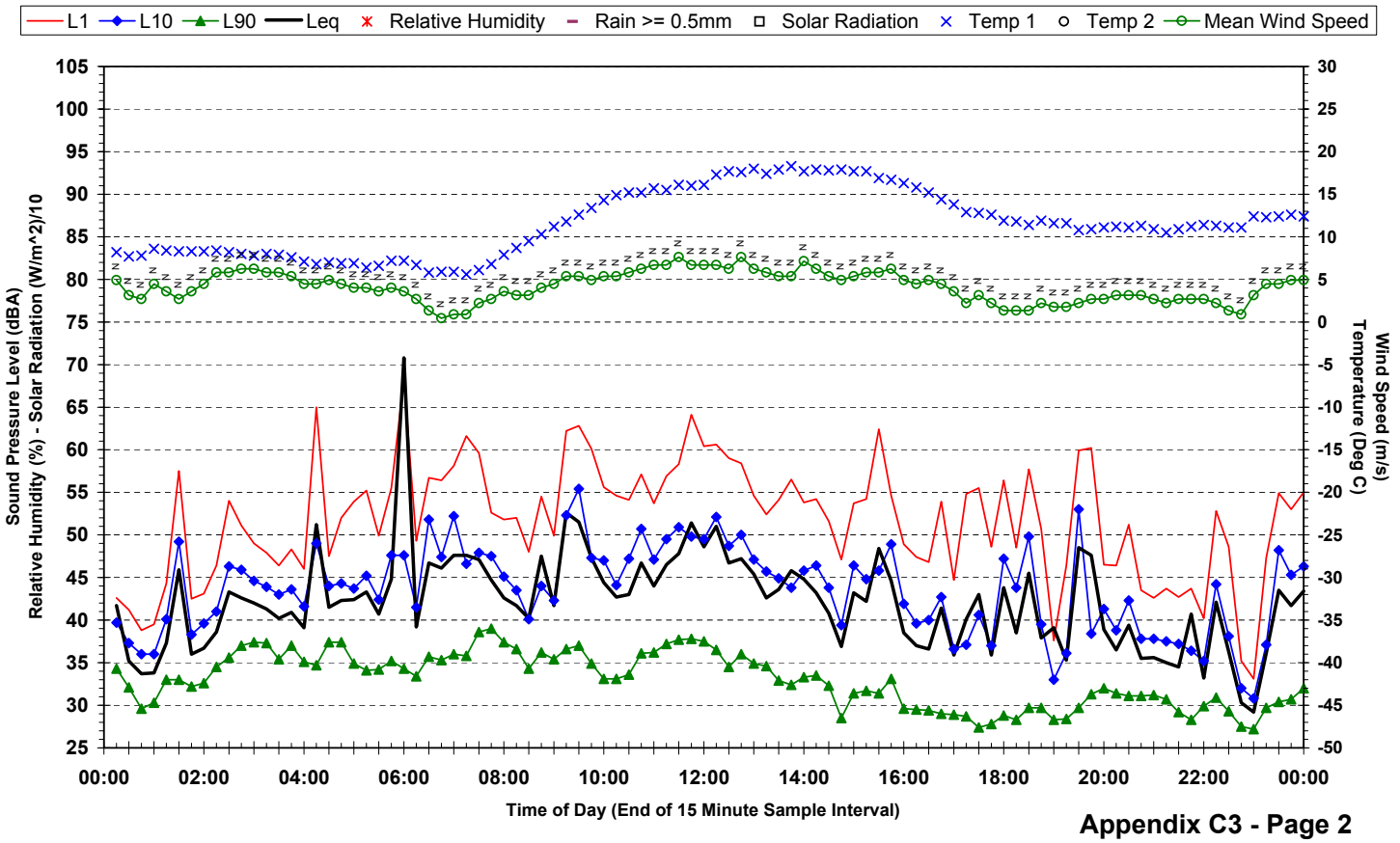
Ambient Conditions
RHA Report 10-3142

Statistical Ambient Noise Levels
Marulan N3 60 Maclura Drive, Marulan - Tuesday 1 June 2004



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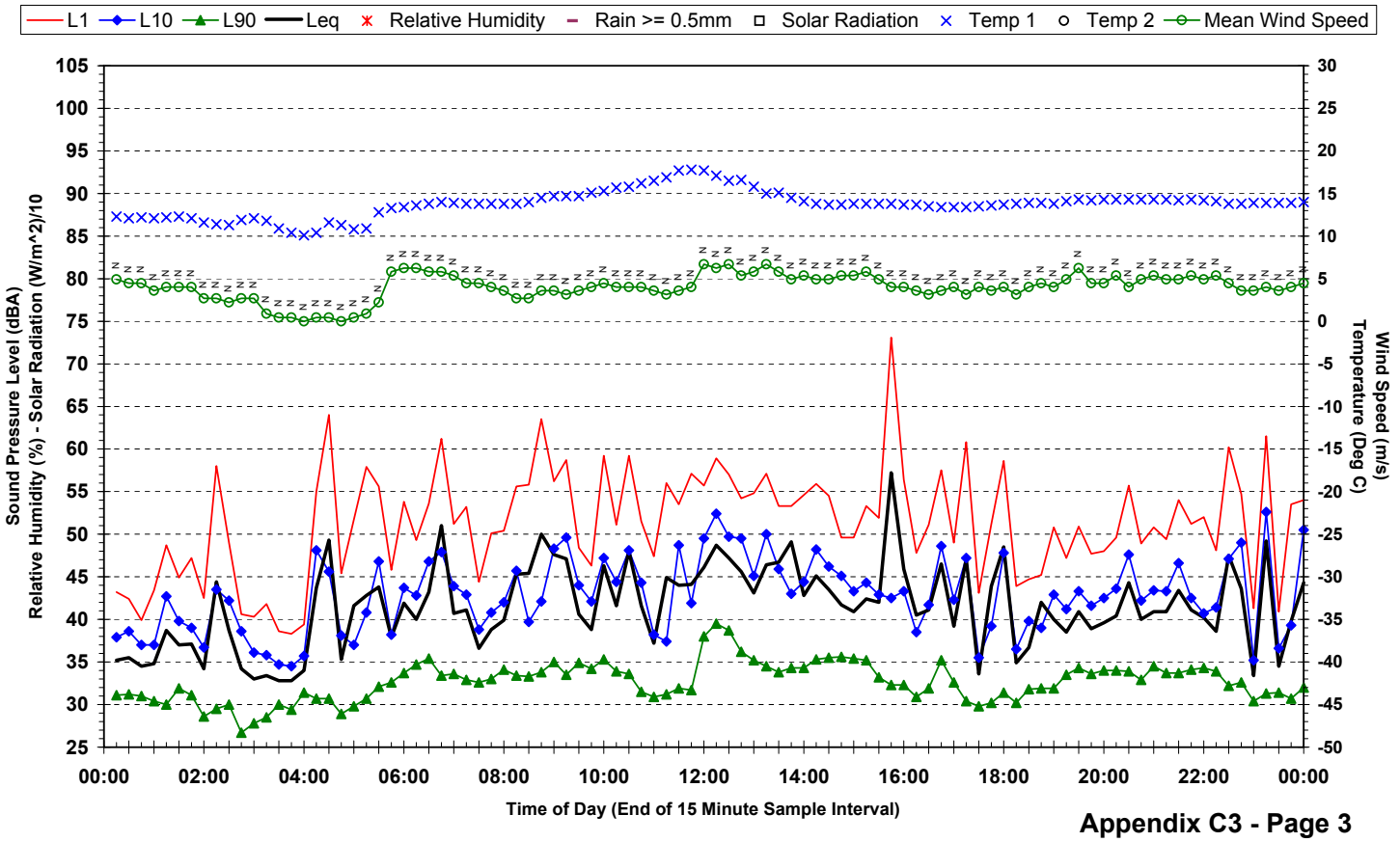
Ambient Conditions
RHA Report 10-3142

Statistical Ambient Noise Levels
Marulan N3 60 Maclura Drive, Marulan - Wednesday 2 June 2004



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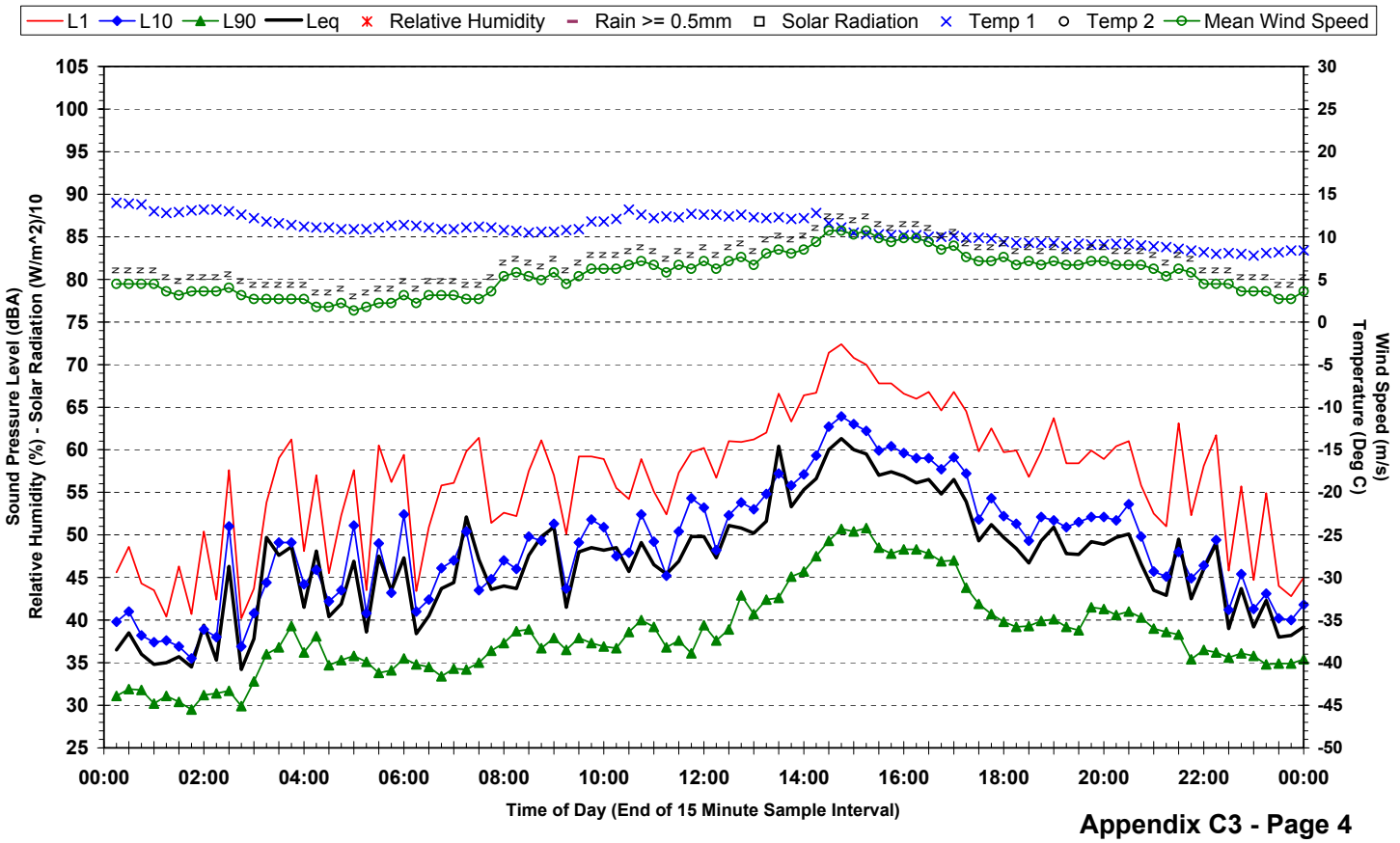
Ambient Conditions
RHA Report 10-3142

Statistical Ambient Noise Levels
Marulan N3 60 Maclura Drive, Marulan - Thursday 3 June 2004



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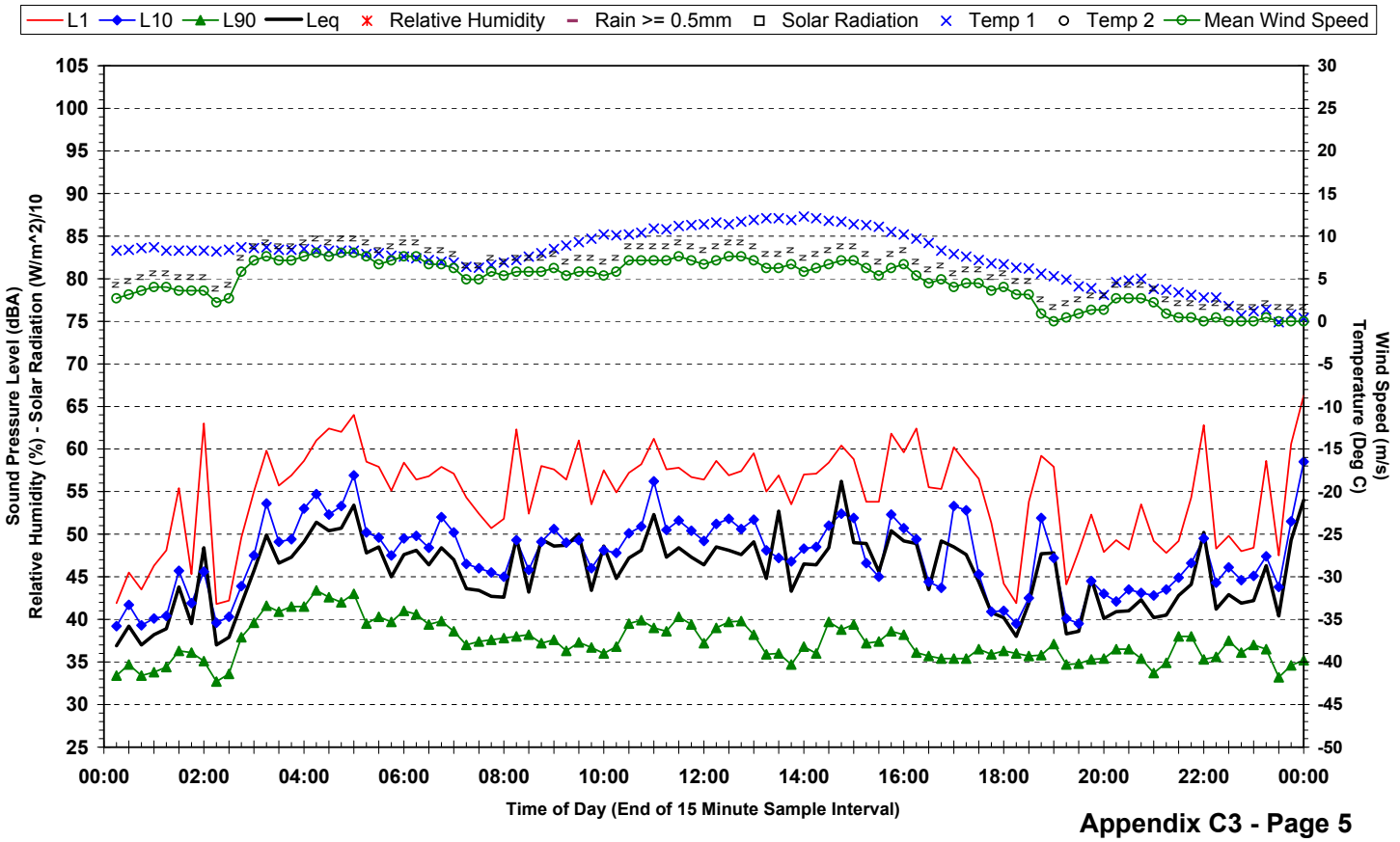
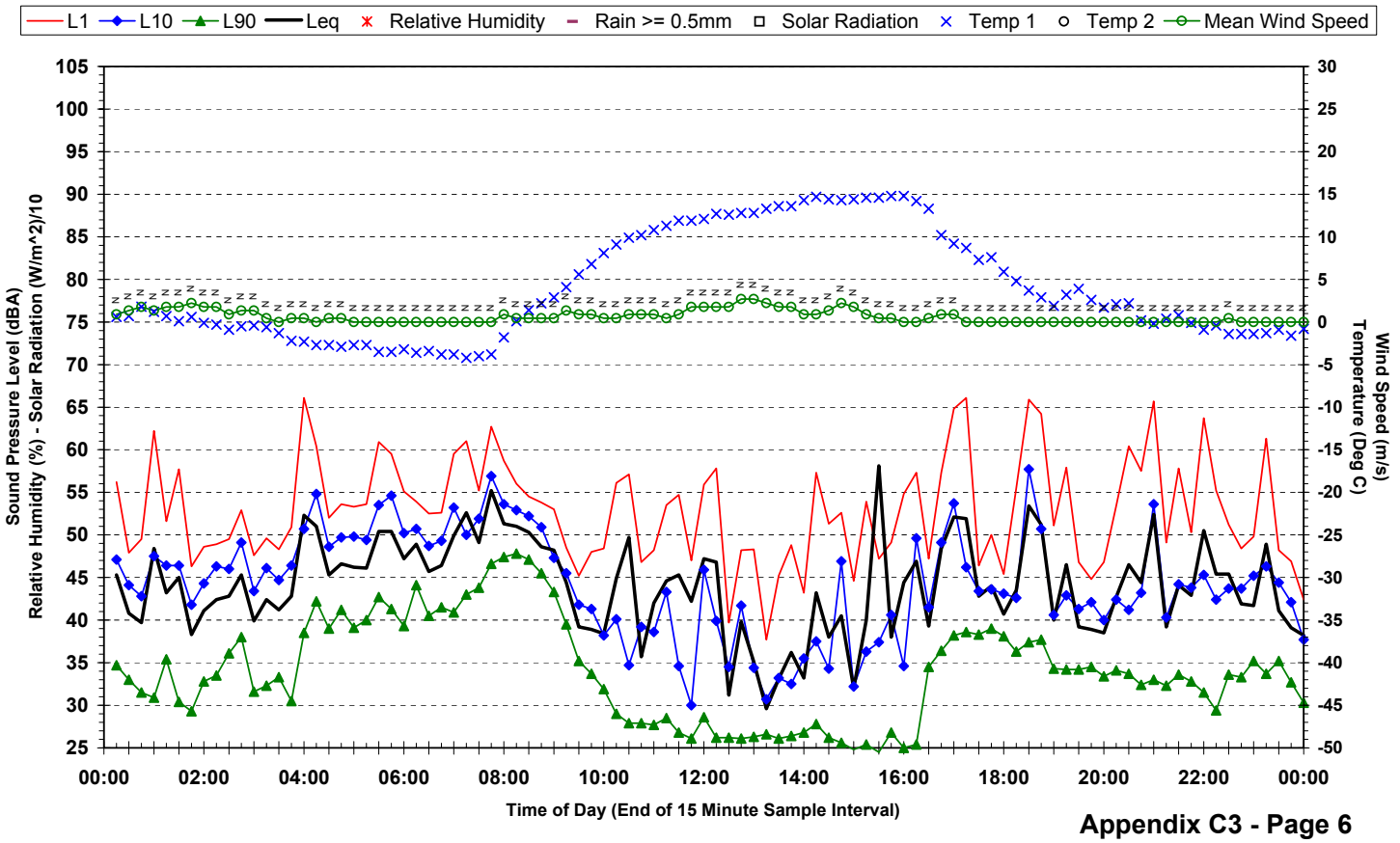
Ambient Conditions
RHA Report 10-3142

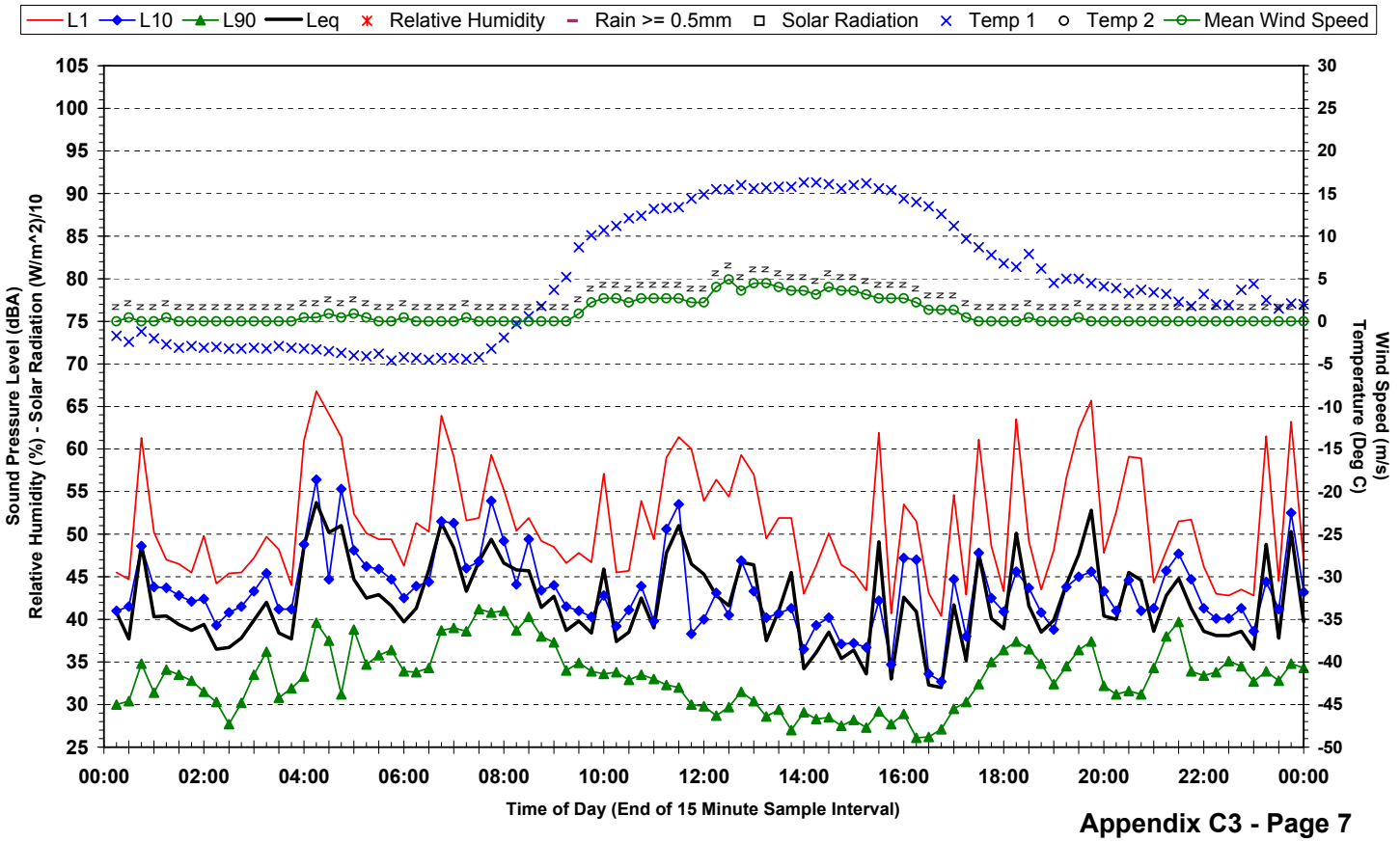
Statistical Ambient Noise Levels
Marulan N3 60 Maclura Drive, Marulan - Friday 4 June 2004



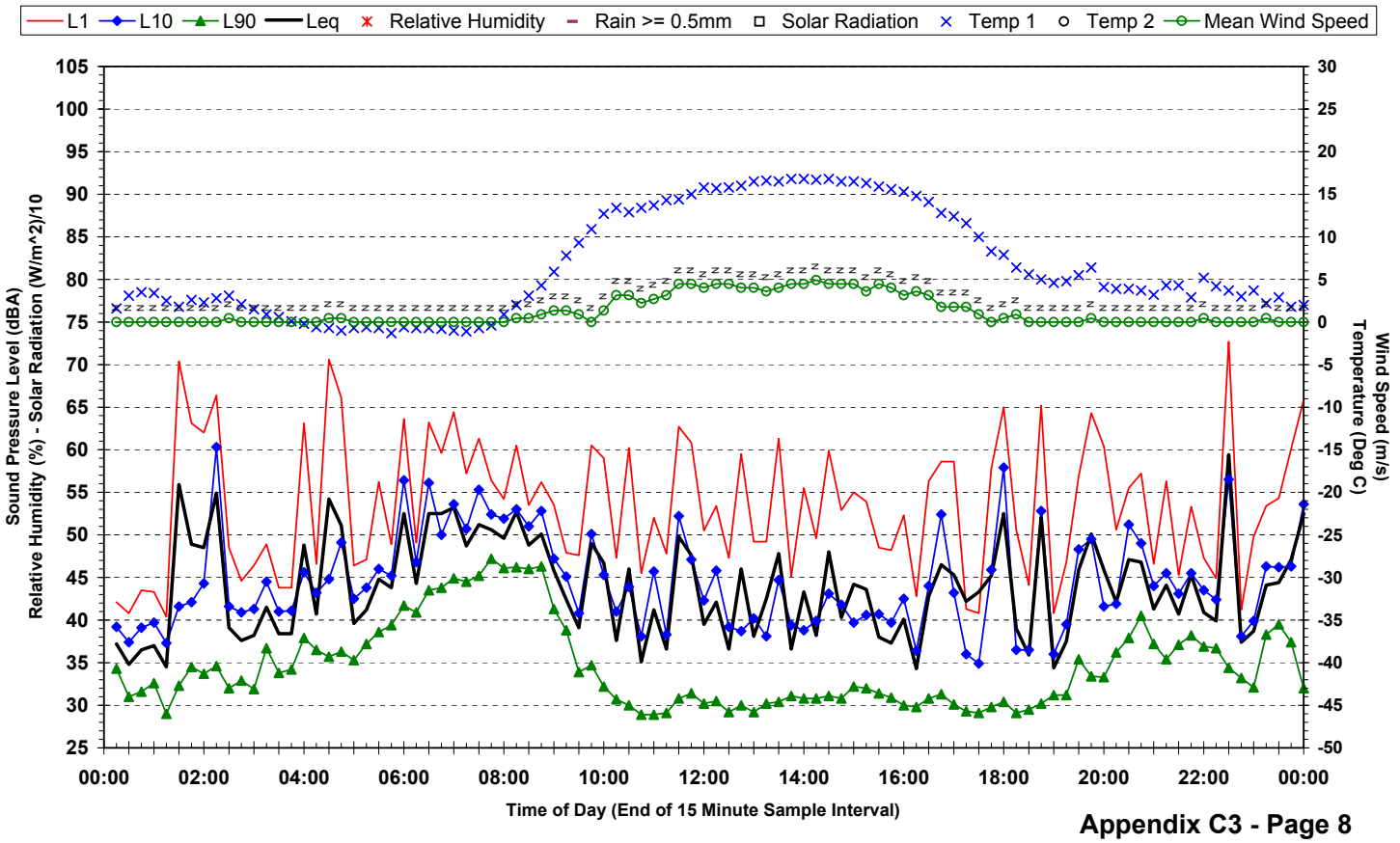
Statistical Ambient Noise Levels
Marulan N3 60 Maclura Drive, Marulan - Saturday 5 June 2004



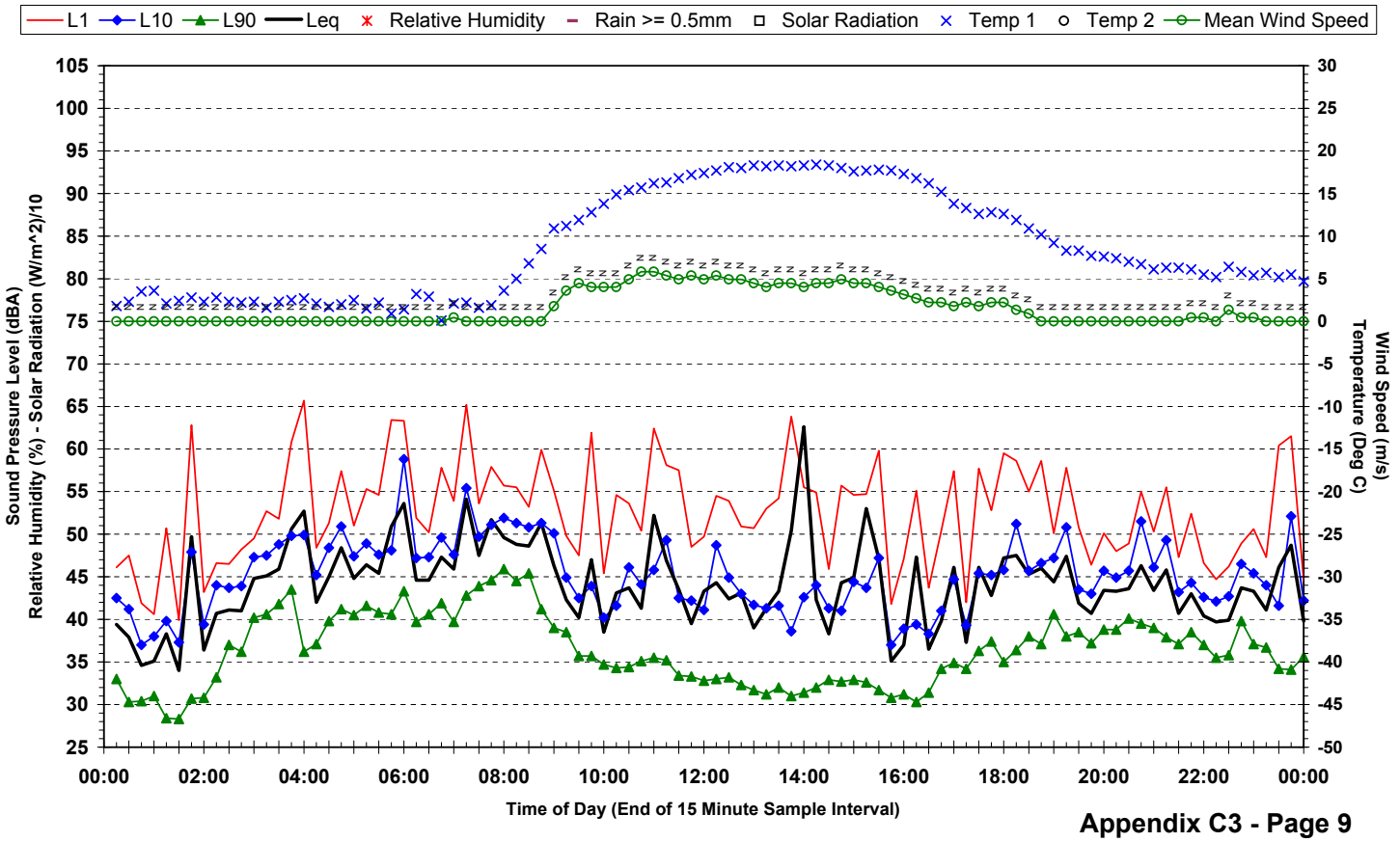
Statistical Ambient Noise Levels
Marulan N3 60 Maclura Drive, Marulan - Sunday 6 June 2004



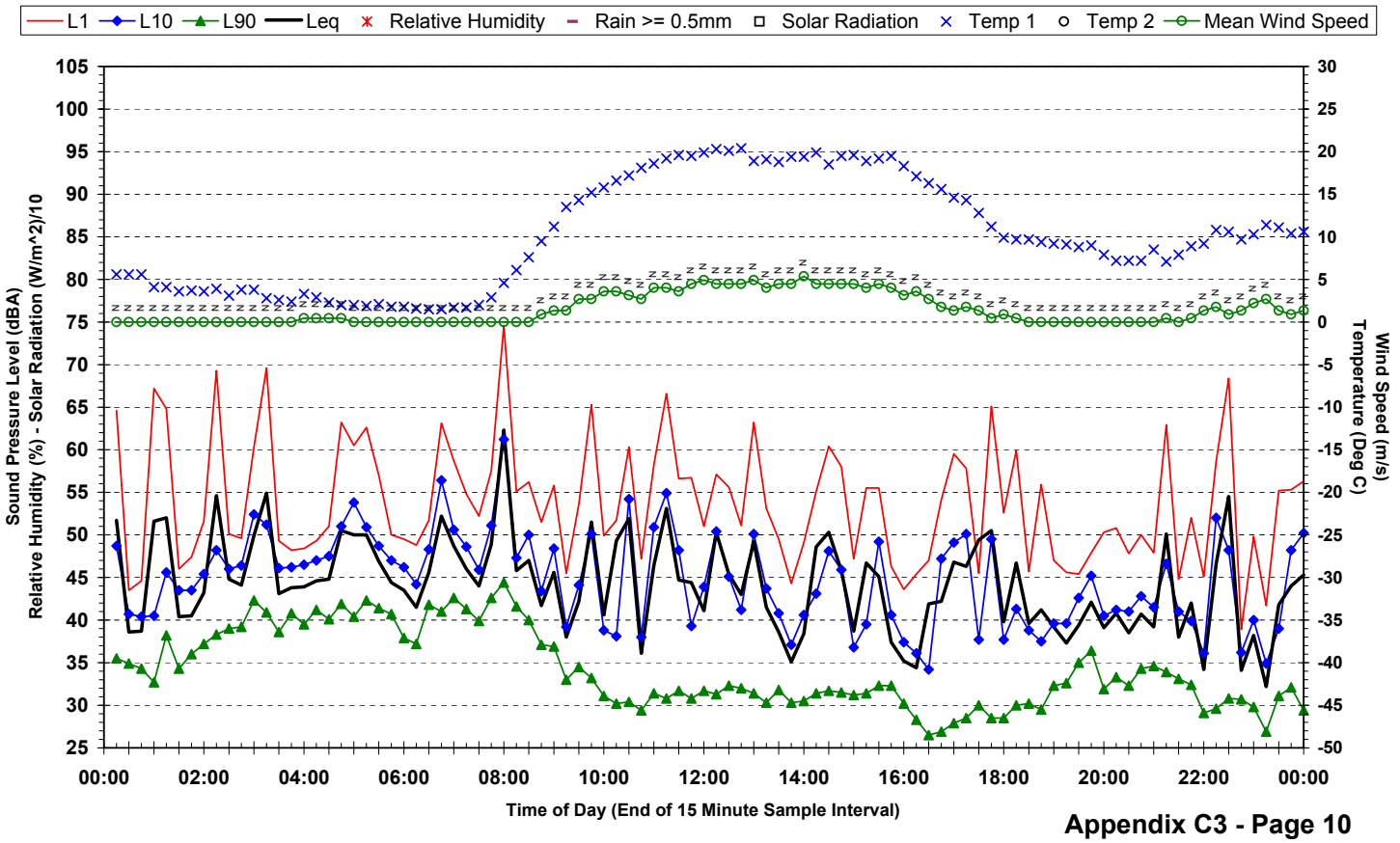
Statistical Ambient Noise Levels
Marulan N3 60 Maclura Drive, Marulan - Monday 7 June 2004



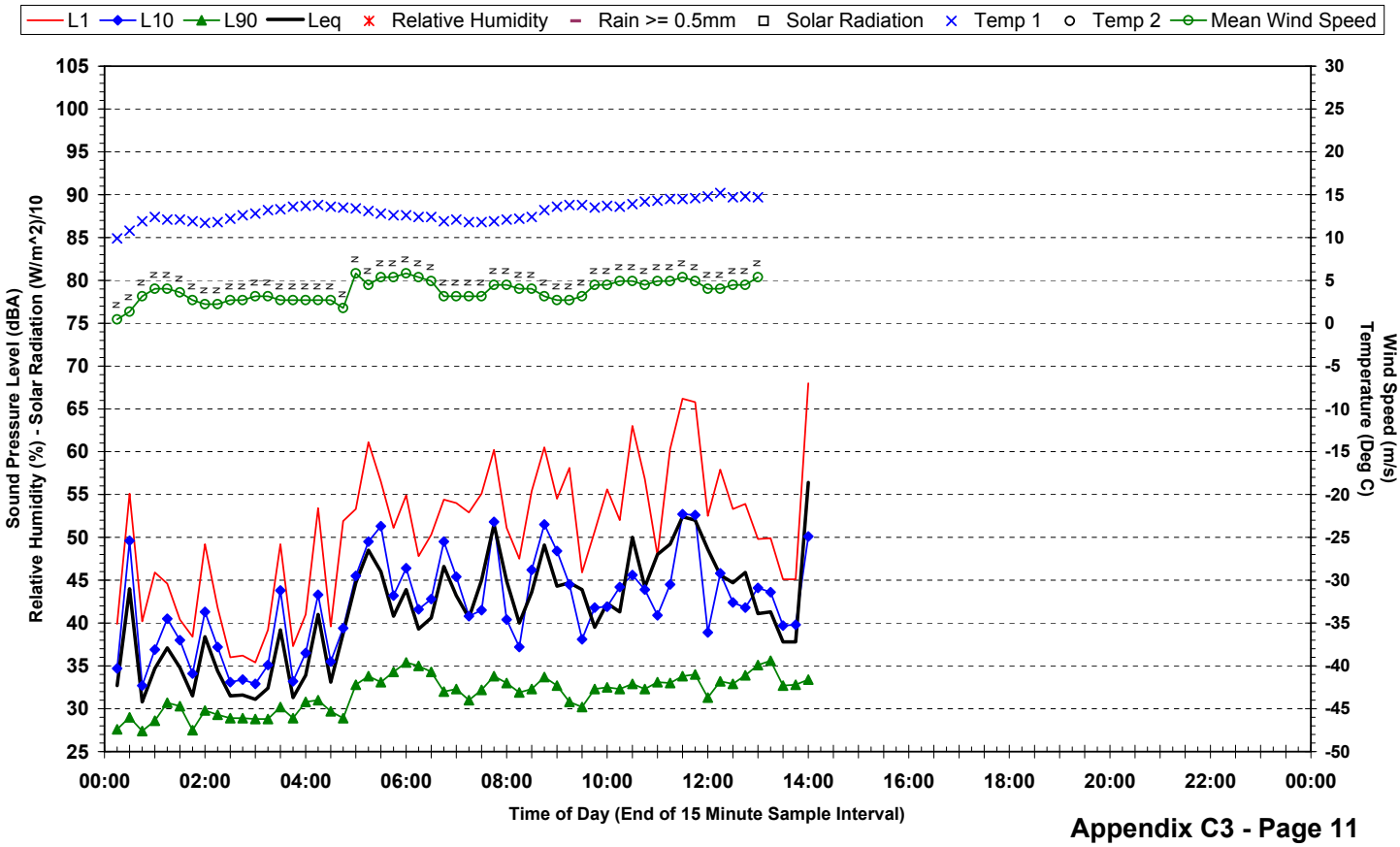
Statistical Ambient Noise Levels
Marulan N3 60 Maclura Drive, Marulan - Tuesday 8 June 2004



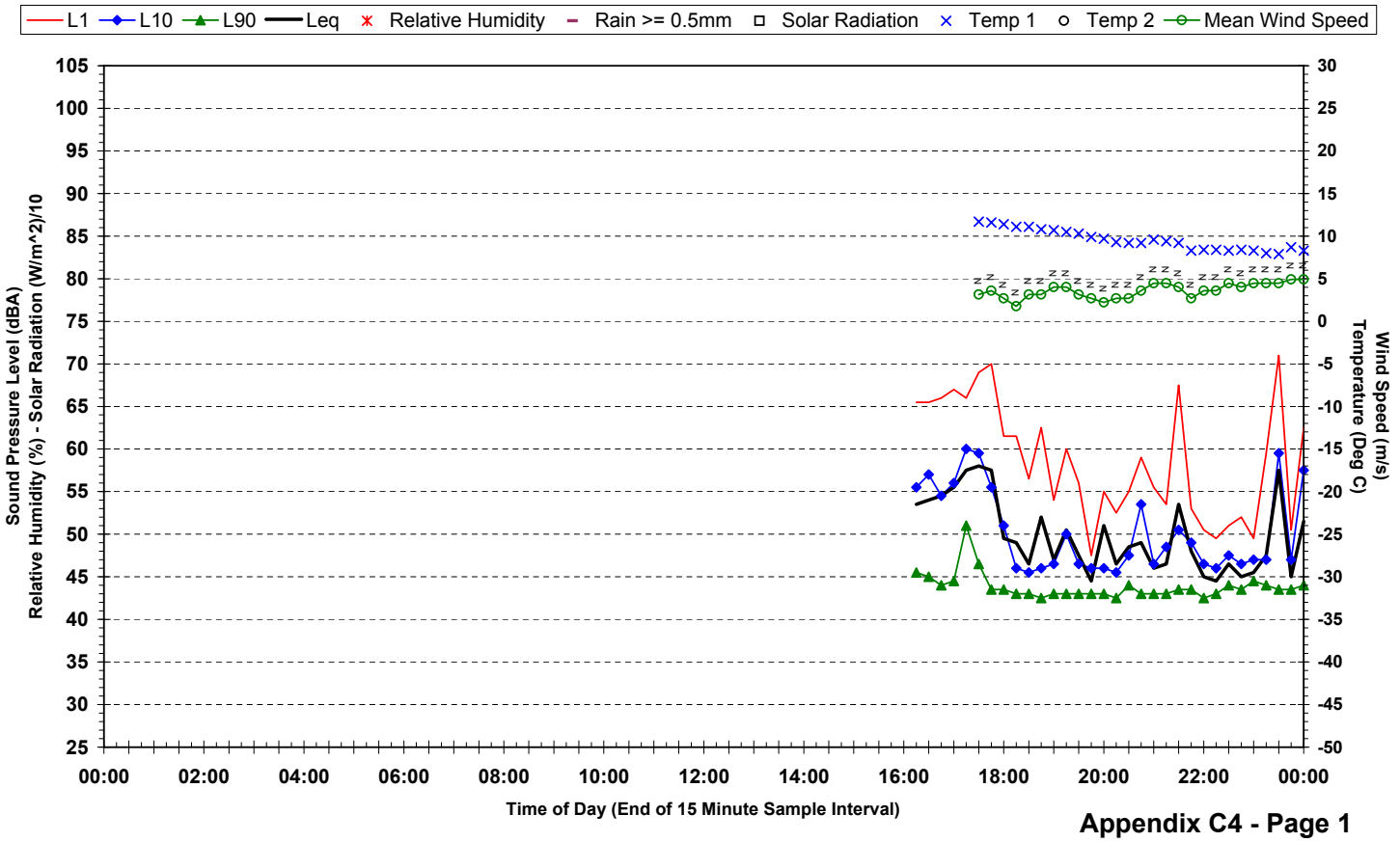
Statistical Ambient Noise Levels
Marulan N3 60 Maclura Drive, Marulan - Wednesday 9 June 2004



Statistical Ambient Noise Levels
Marulan N3 60 Maclura Drive, Marulan - Thursday 10 June 2004



Statistical Ambient Noise Levels
Marulan N4 30 Goulburn Street, Marulan - Monday 31 May 2004



Appendix C4 - Page 1
Ambient Conditions
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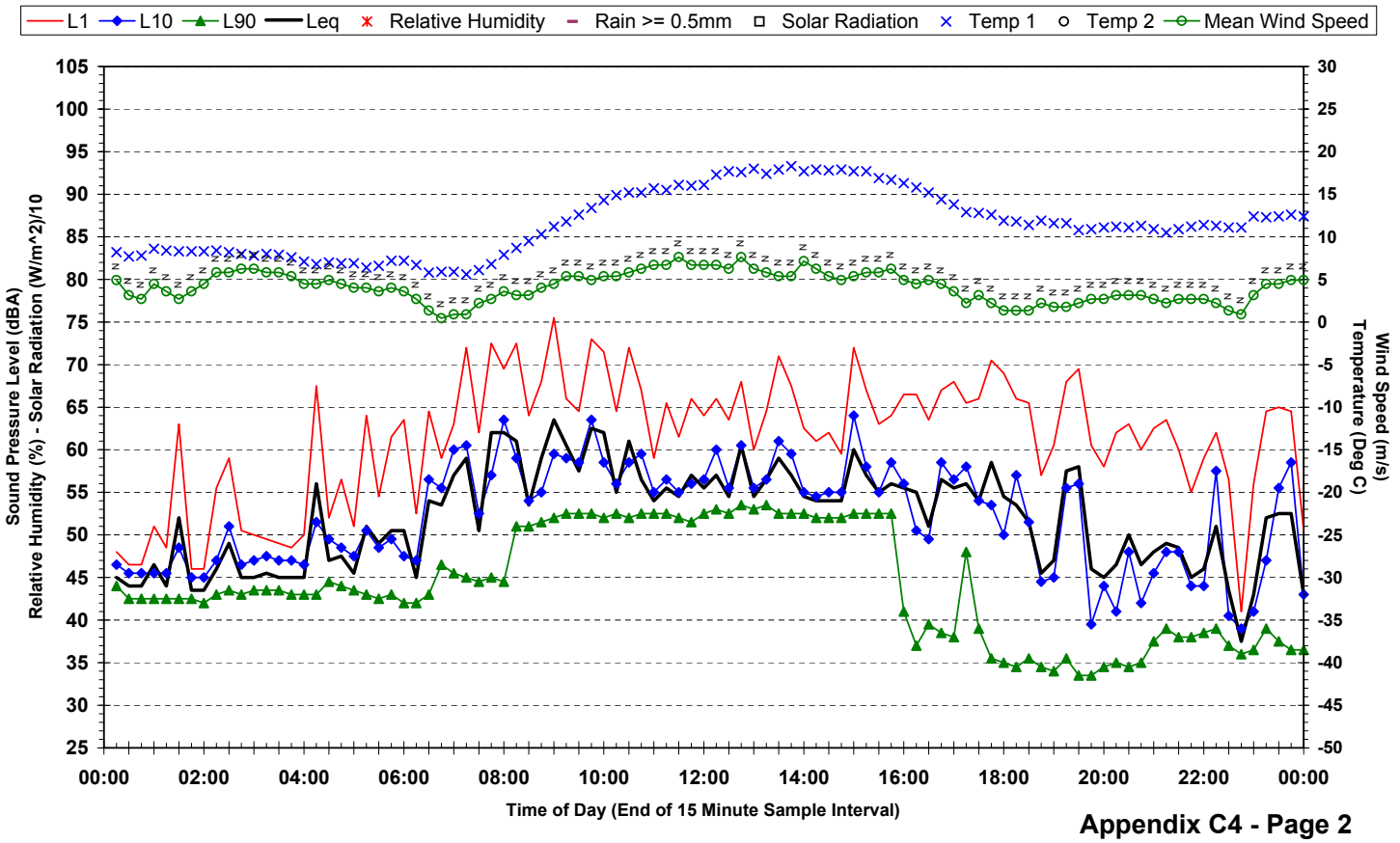
Statistical Ambient Noise Levels
Marulan N4 30 Goulburn Street, Marulan - Tuesday 1 June 2004



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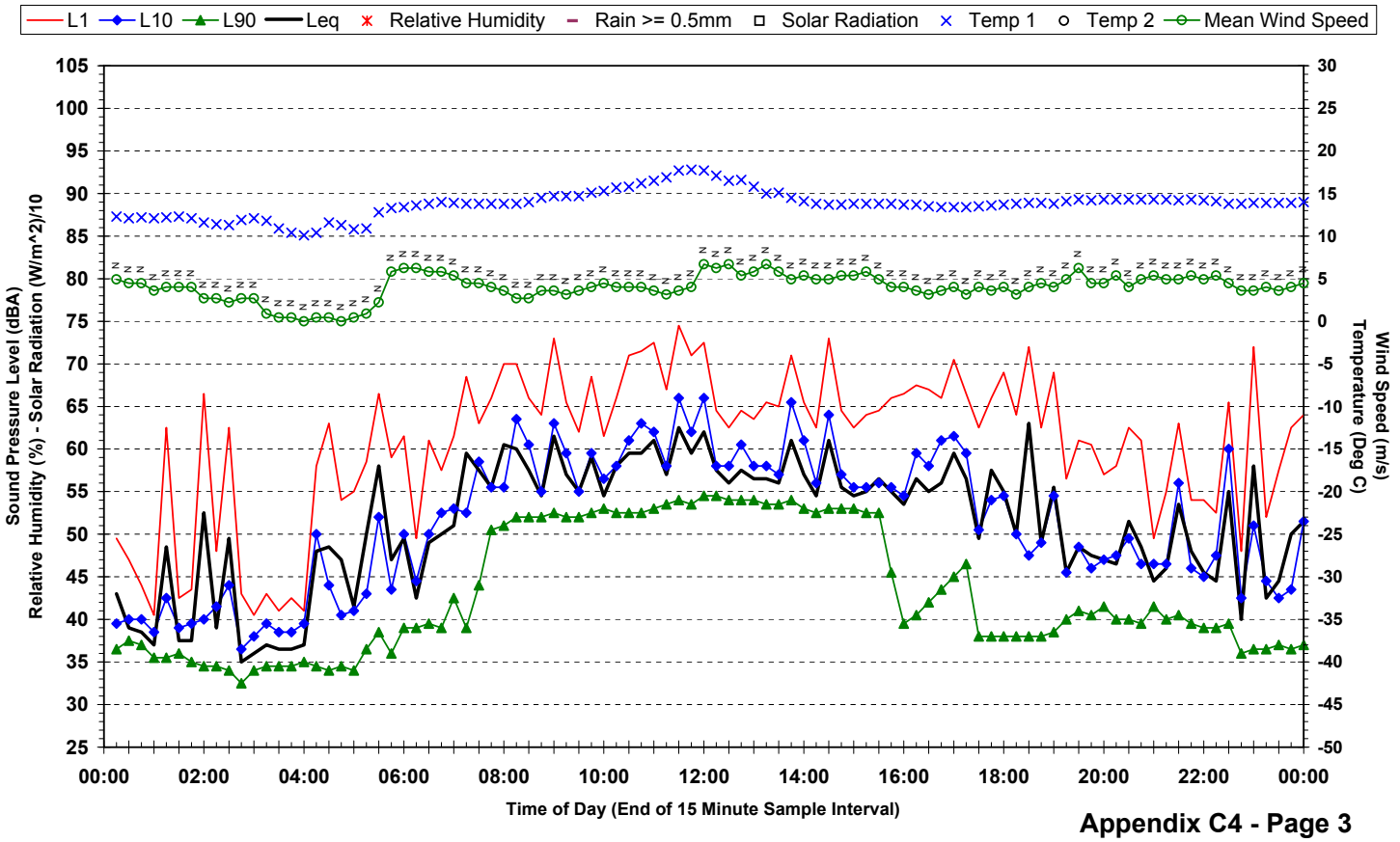
Ambient Conditions
RHA Report 10-3142

Statistical Ambient Noise Levels
Marulan N4 30 Goulburn Street, Marulan - Wednesday 2 June 2004



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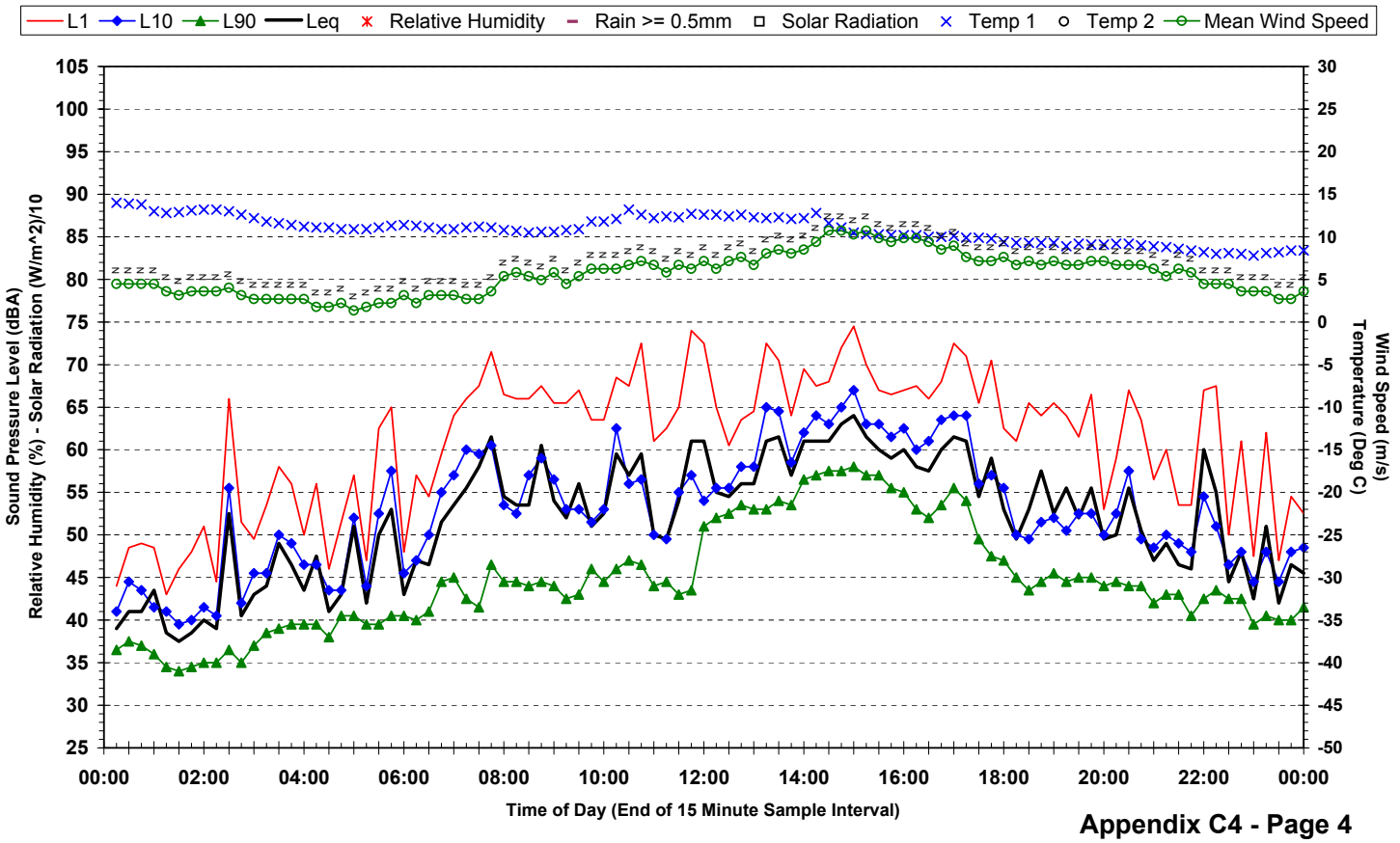
Ambient Conditions
RHA Report 10-3142

Statistical Ambient Noise Levels
Marulan N4 30 Goulburn Street, Marulan - Thursday 3 June 2004



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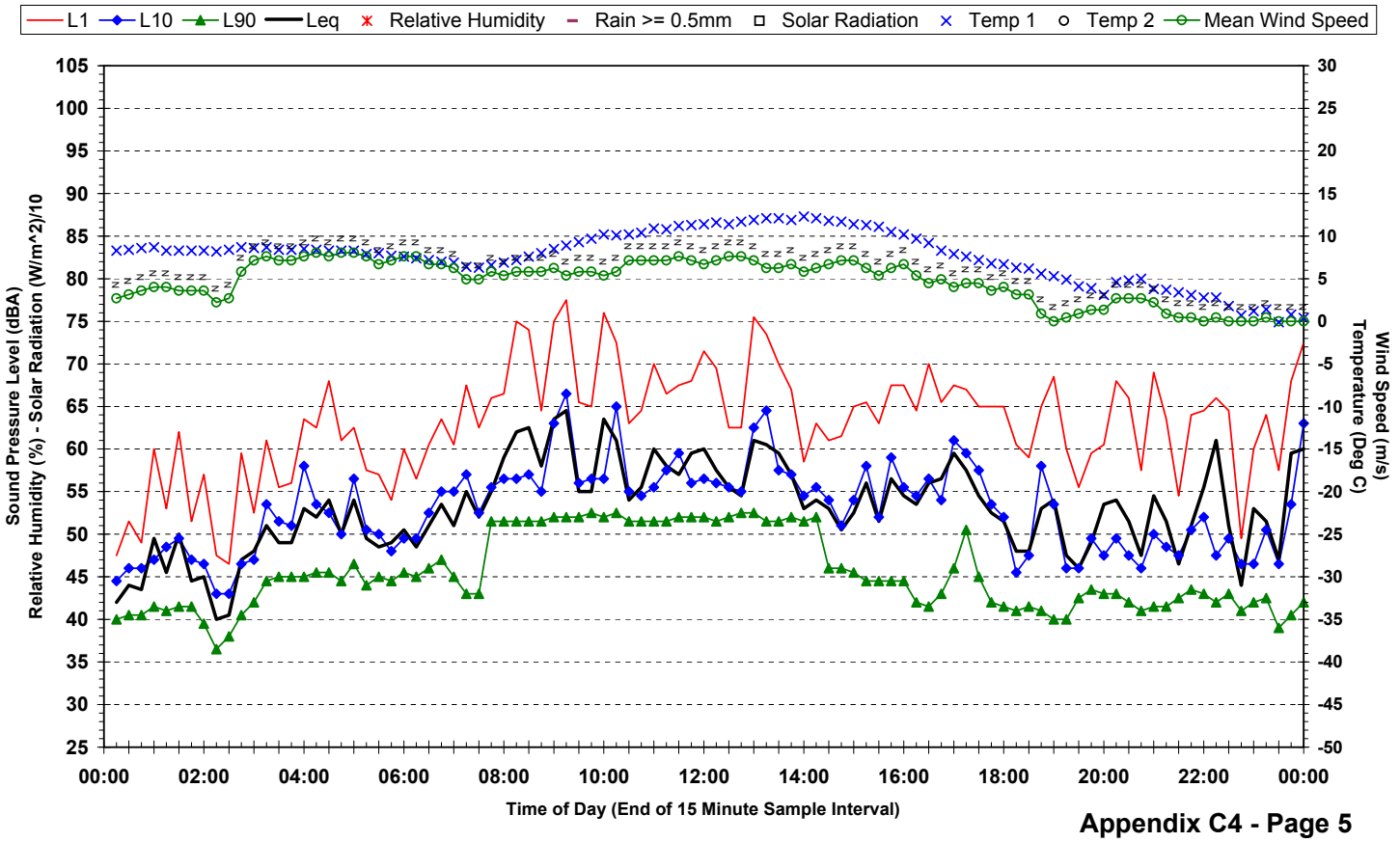
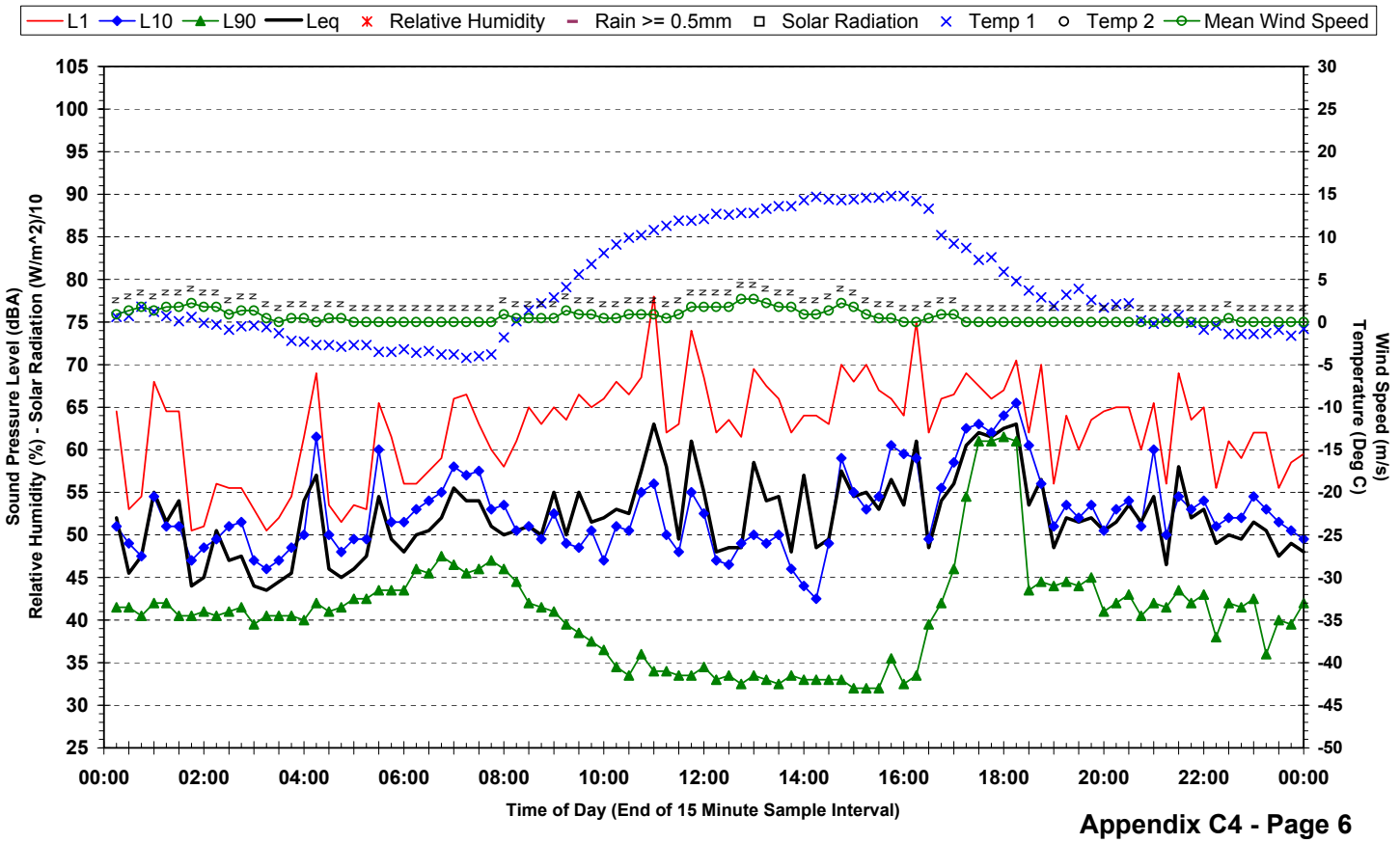
Ambient Conditions
RHA Report 10-3142

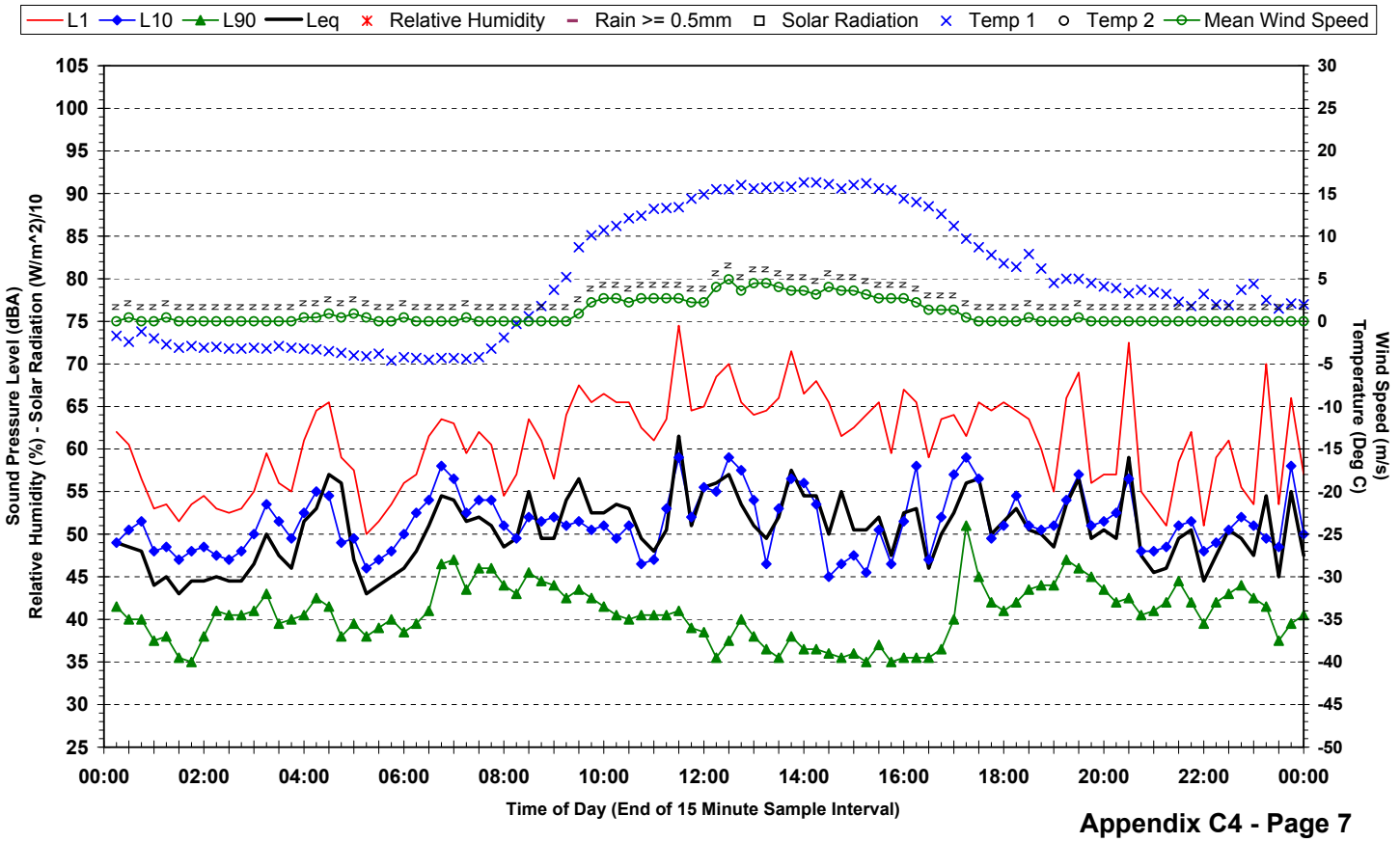
Statistical Ambient Noise Levels
Marulan N4 30 Goulburn Street, Marulan - Friday 4 June 2004



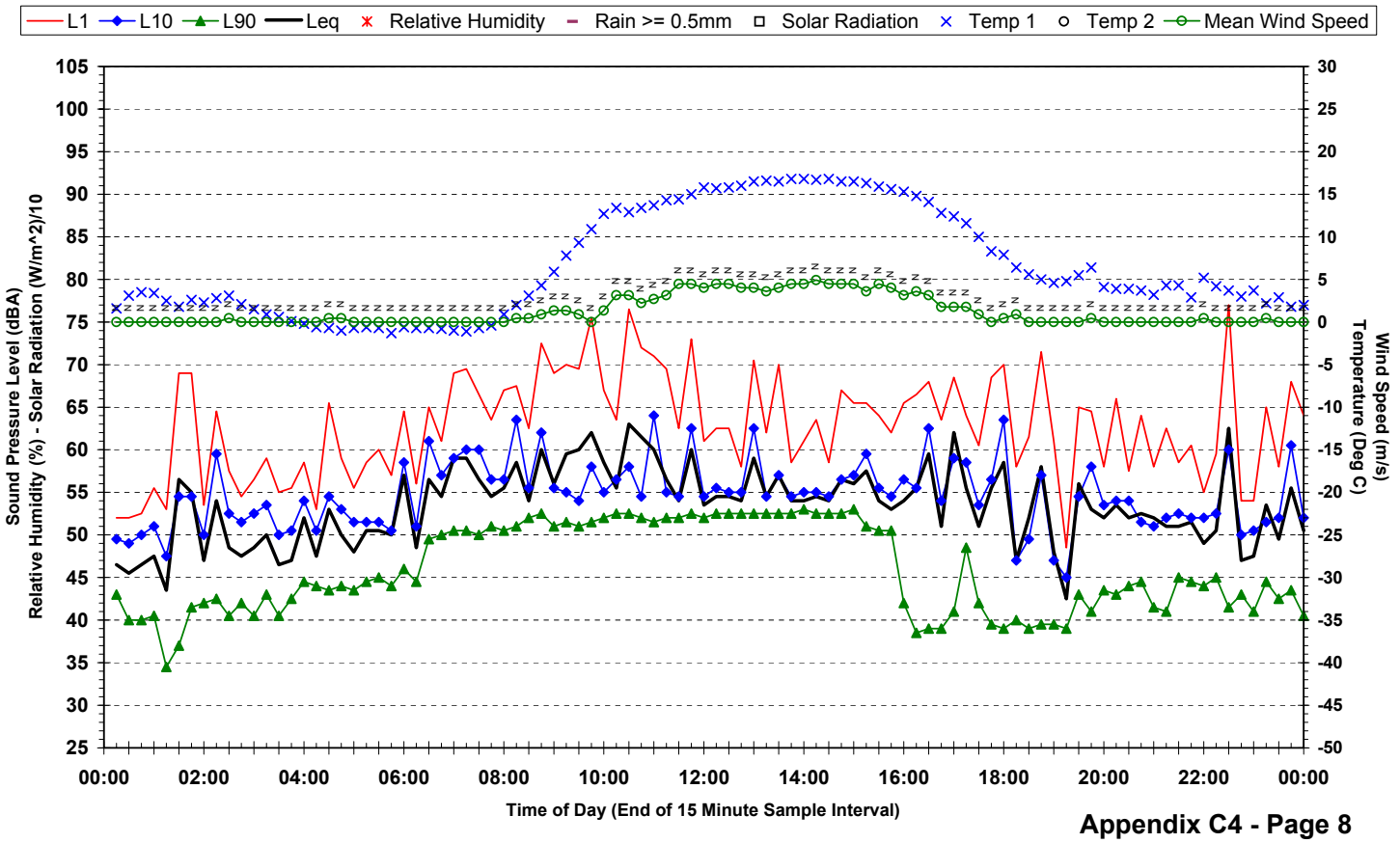
Statistical Ambient Noise Levels
Marulan N4 30 Goulburn Street, Marulan - Saturday 5 June 2004



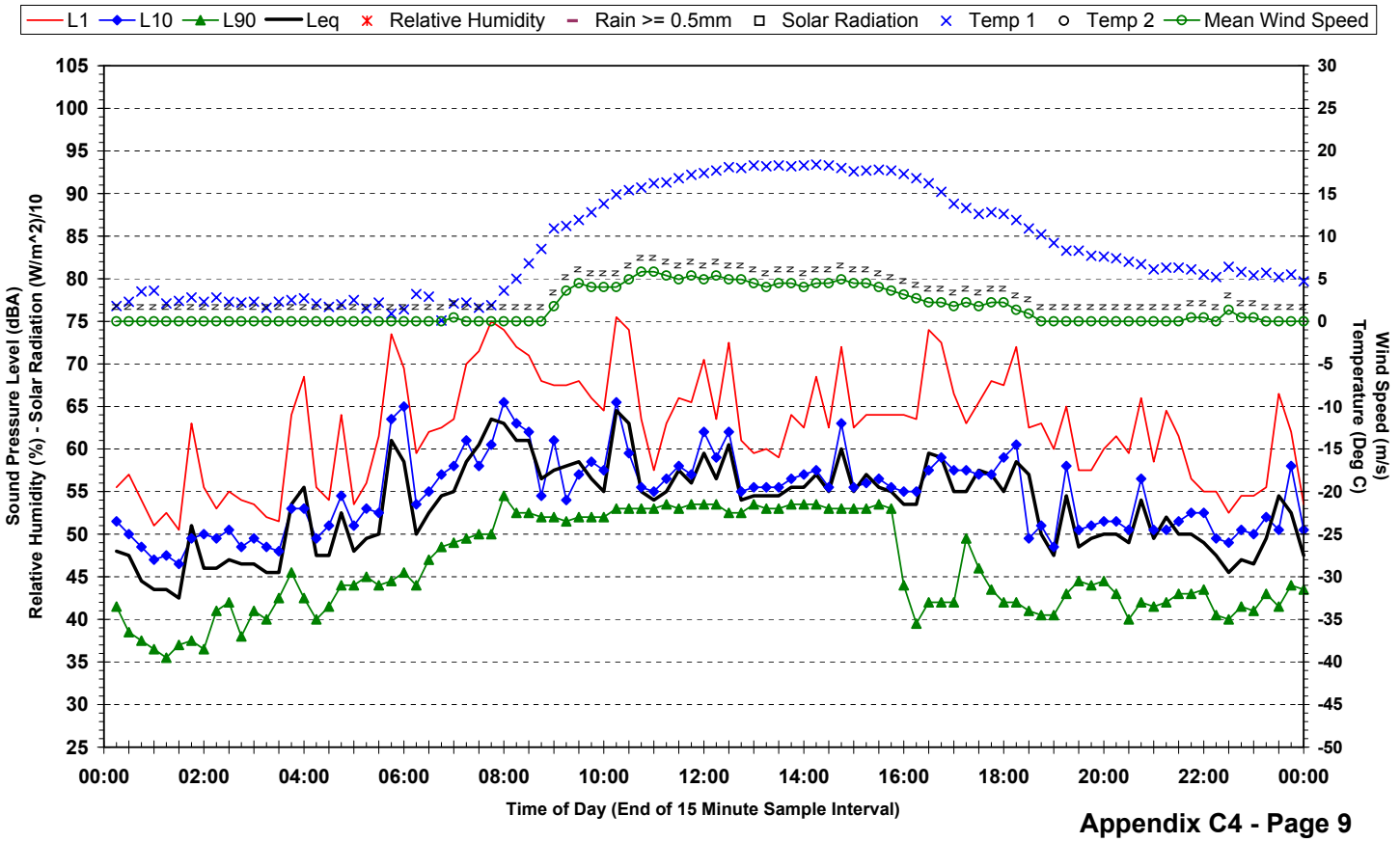
Statistical Ambient Noise Levels
Marulan N4 30 Goulburn Street, Marulan - Sunday 6 June 2004



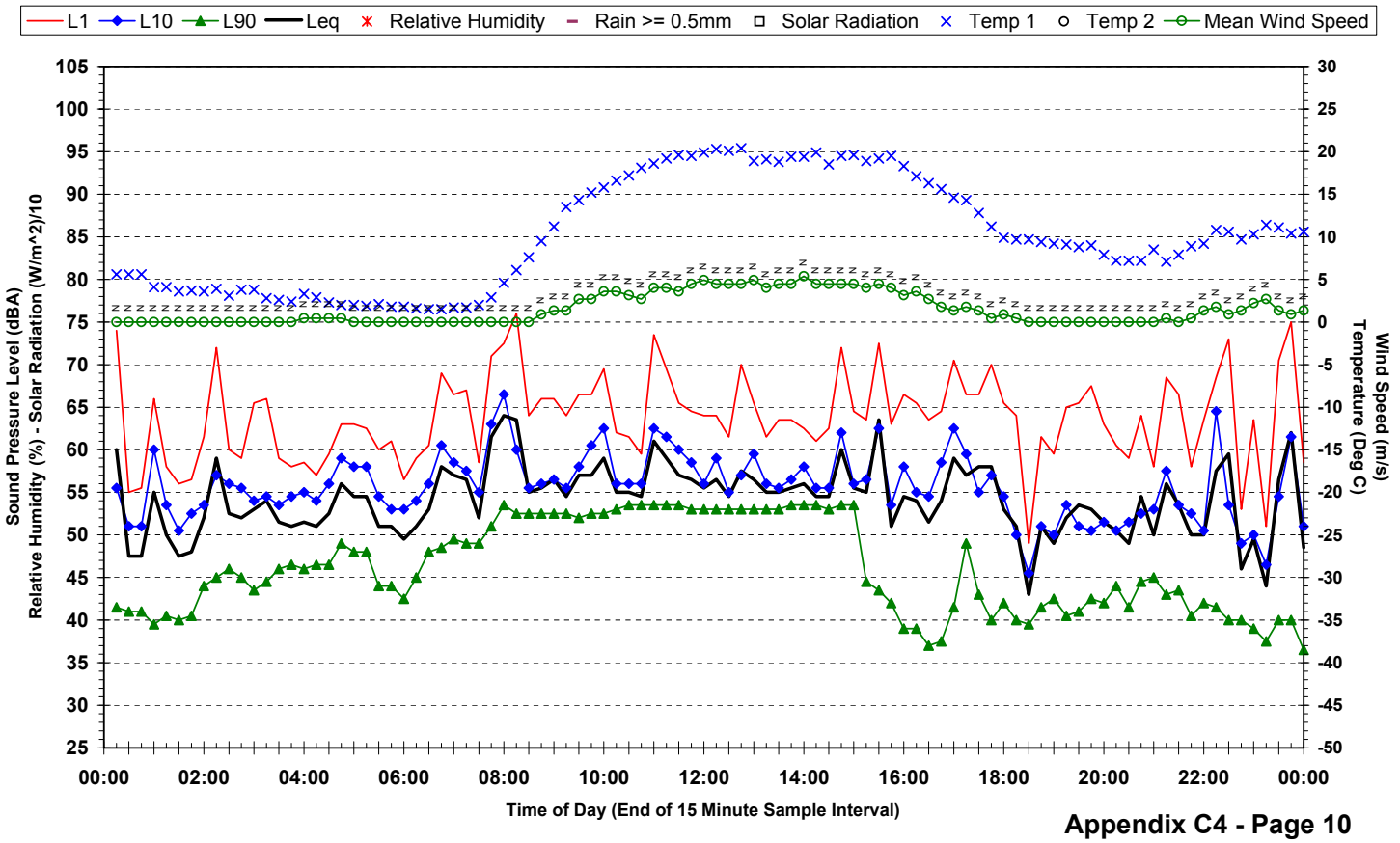
Statistical Ambient Noise Levels
Marulan N4 30 Goulburn Street, Marulan - Monday 7 June 2004



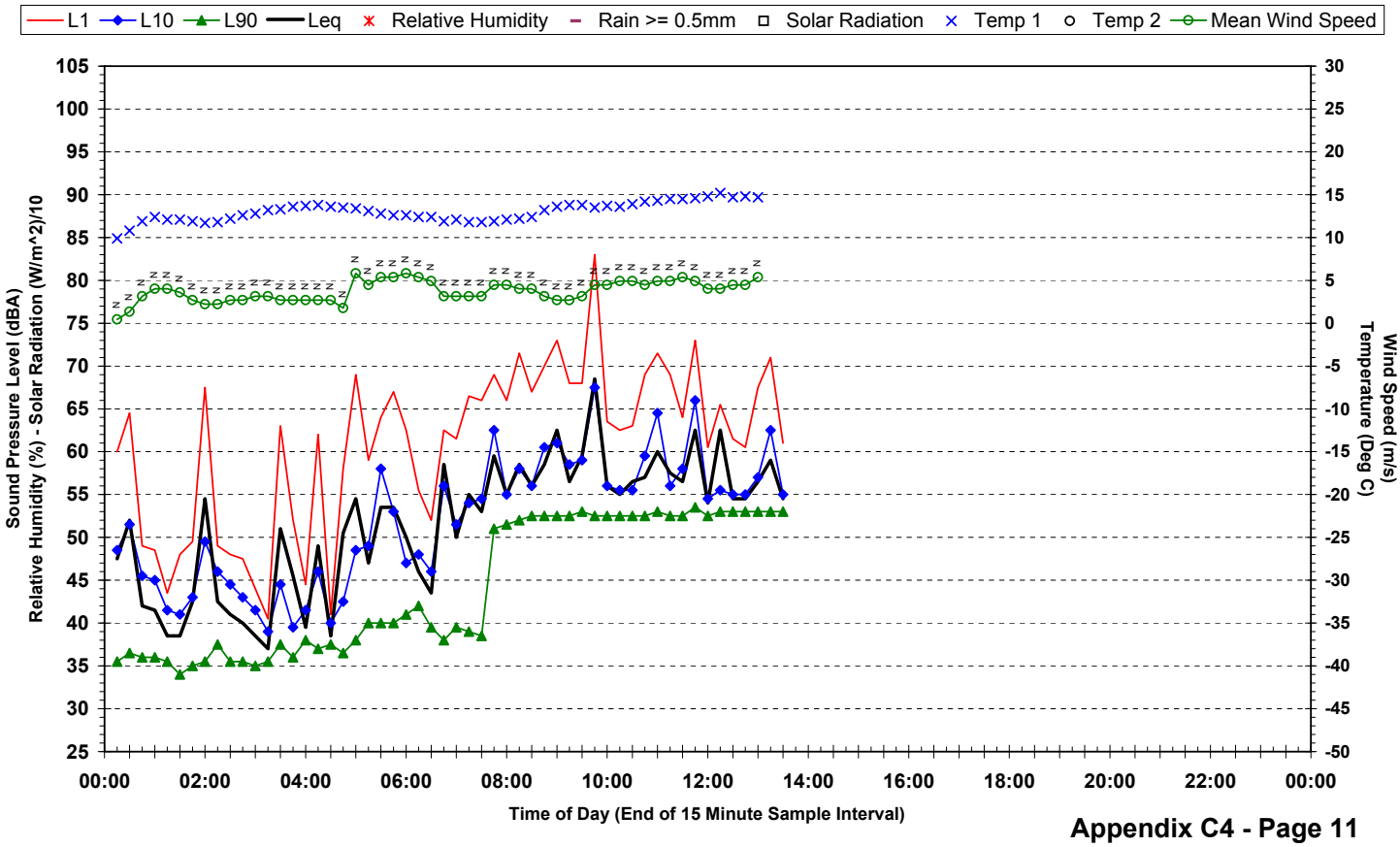
Statistical Ambient Noise Levels
Marulan N4 30 Goulburn Street, Marulan - Tuesday 8 June 2004



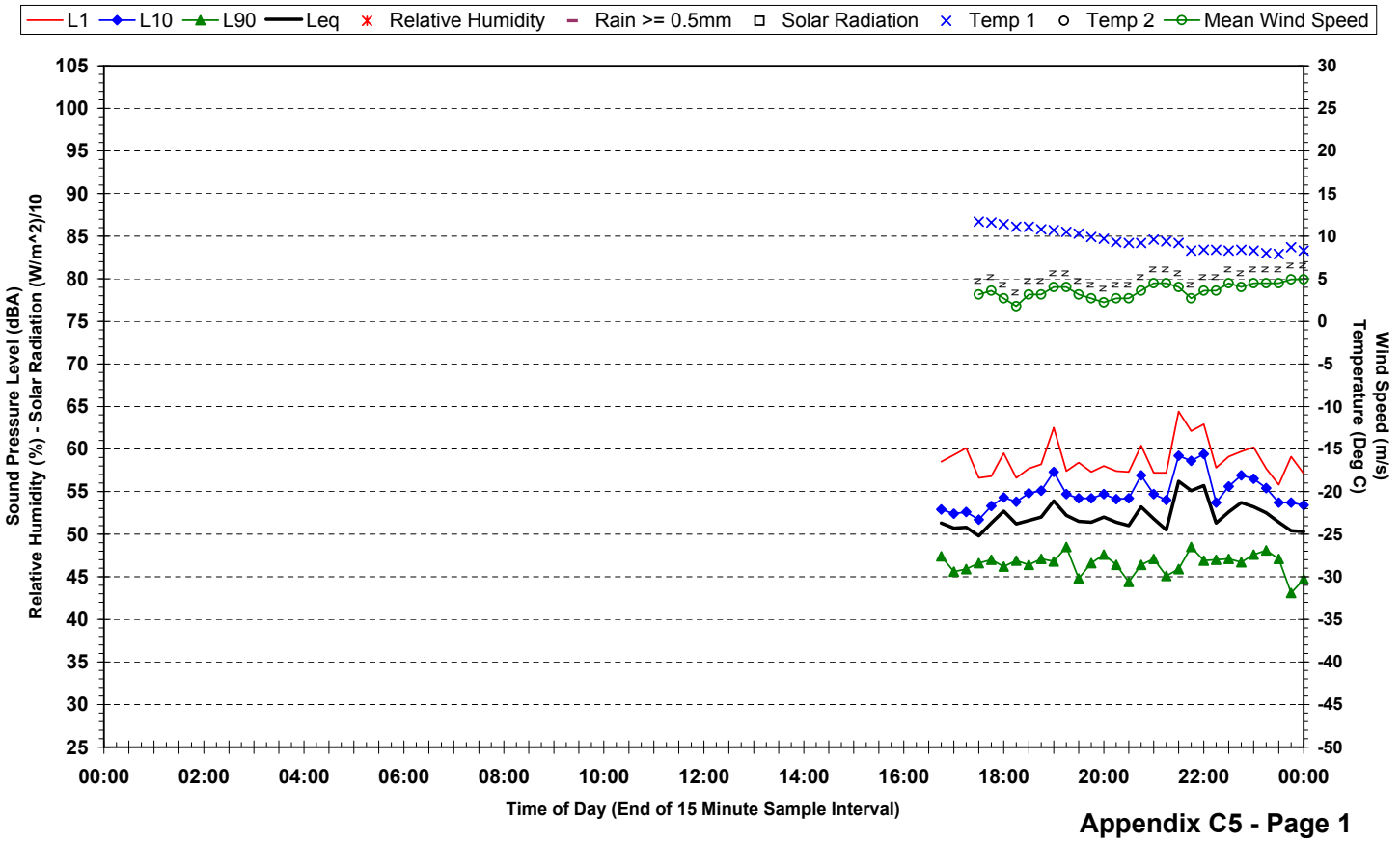
Statistical Ambient Noise Levels
Marulan N4 30 Goulburn Street, Marulan - Wednesday 9 June 2004



Statistical Ambient Noise Levels
Marulan N4 30 Goulburn Street, Marulan - Thursday 10 June 2004



Statistical Ambient Noise Levels
Marulan N5 'Koorong Park' - Monday 31 May 2004



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Ambient Conditions
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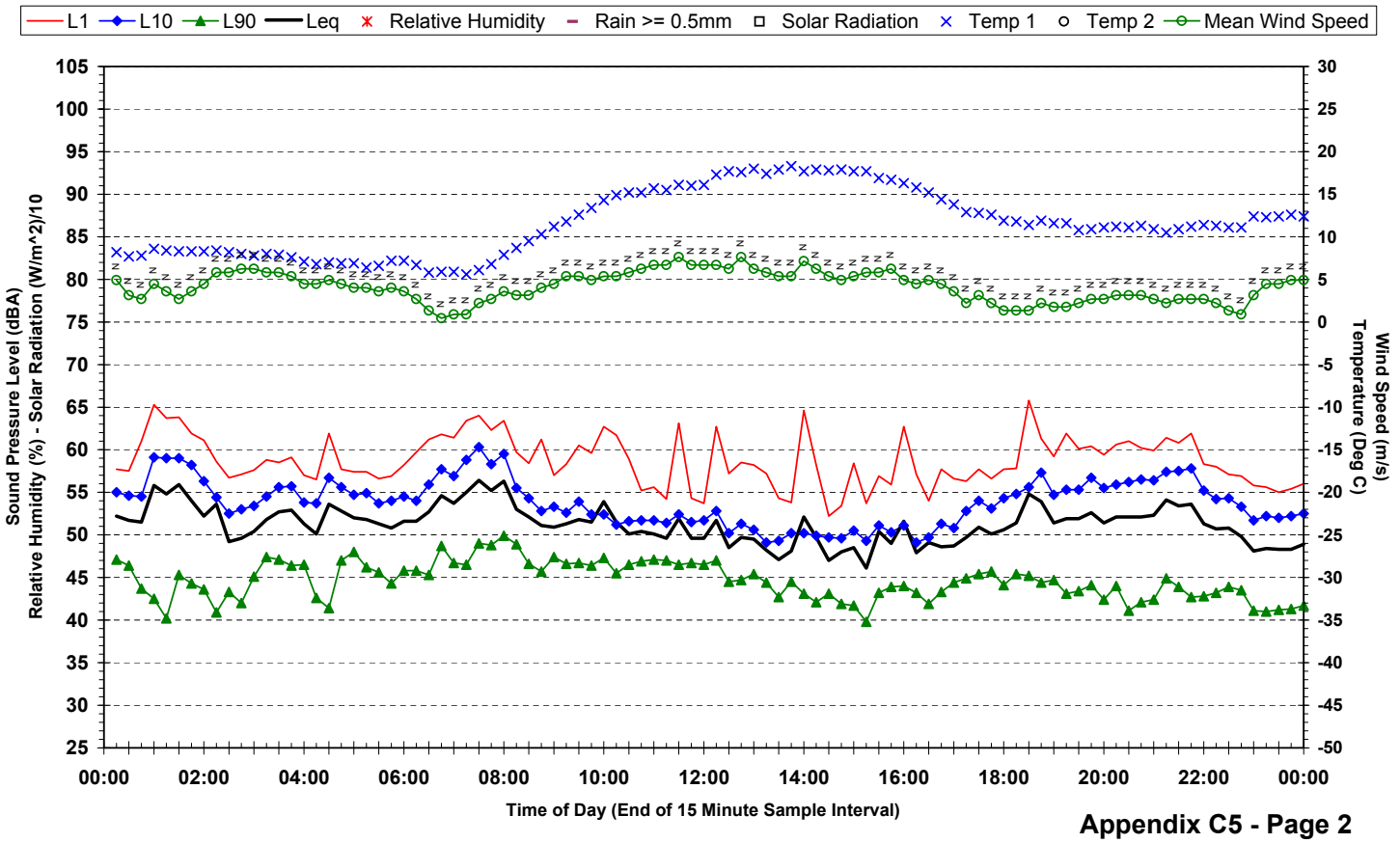
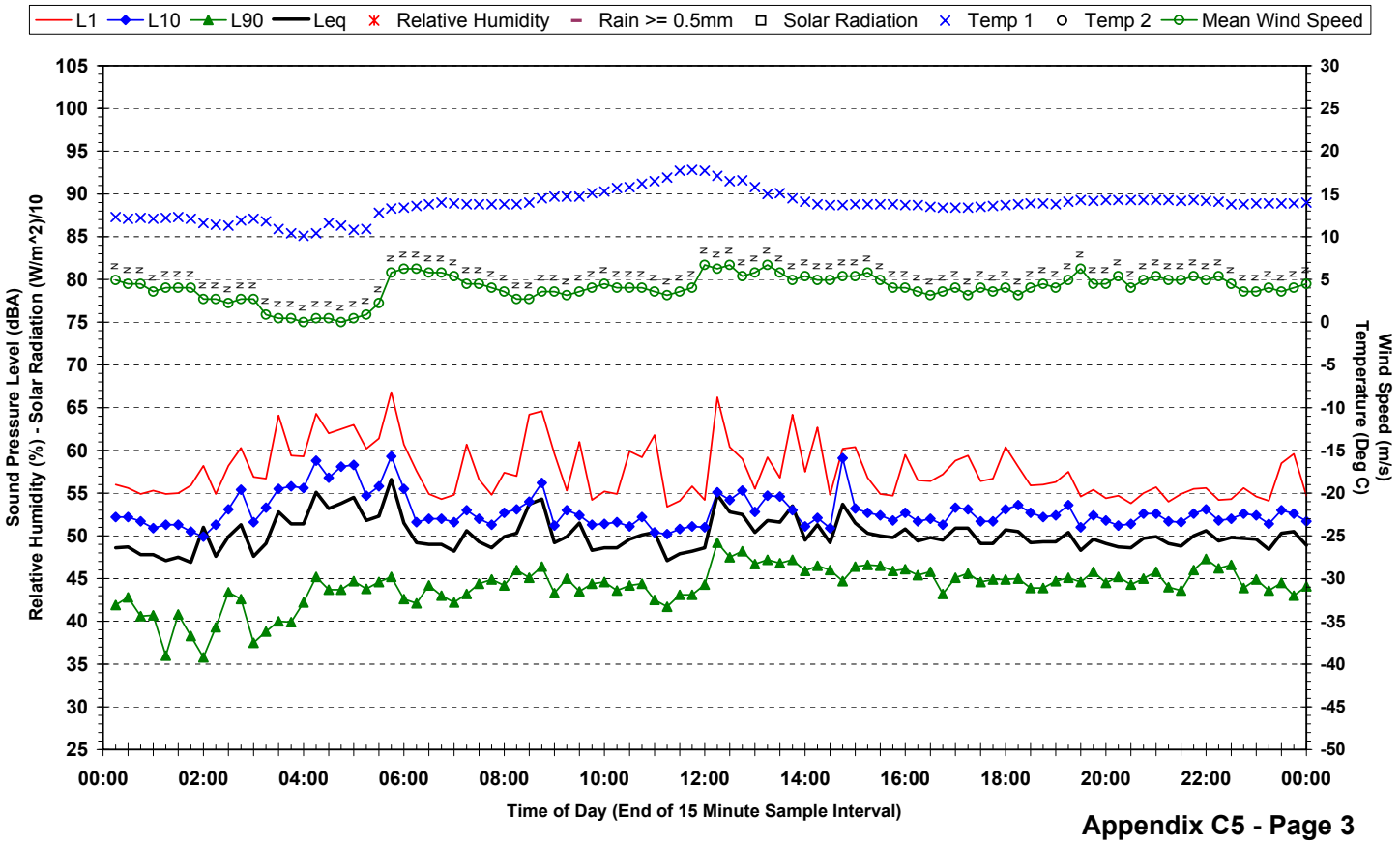
Statistical Ambient Noise Levels
Marulan N5 'Koorong Park' - Tuesday 1 June 2004



Appendix C5 - Page 2
Ambient Conditions
RHA Report 10-3142

Statistical Ambient Noise Levels
Marulan N5 'Koorong Park' - Wednesday 2 June 2004



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Ambient Conditions
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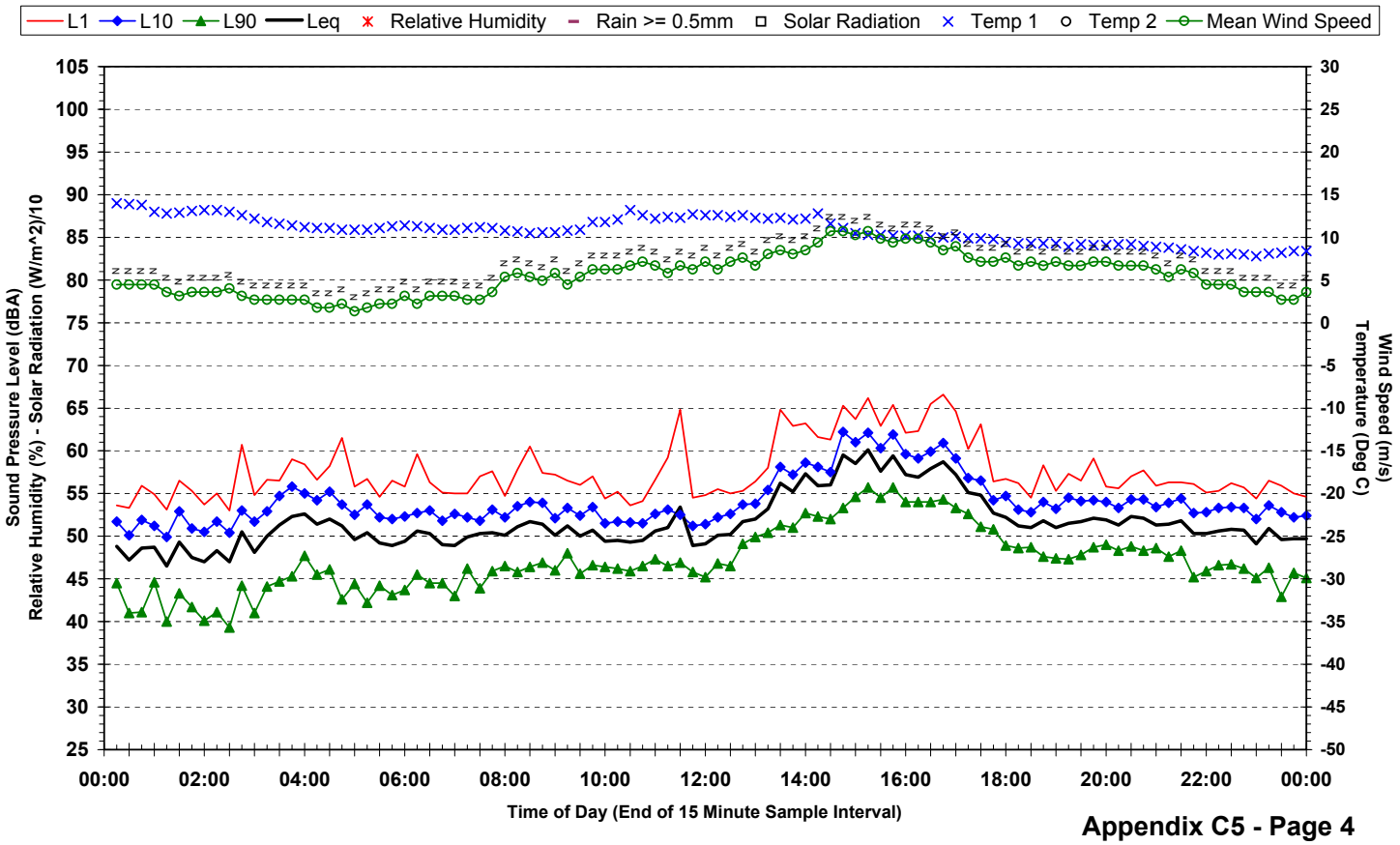
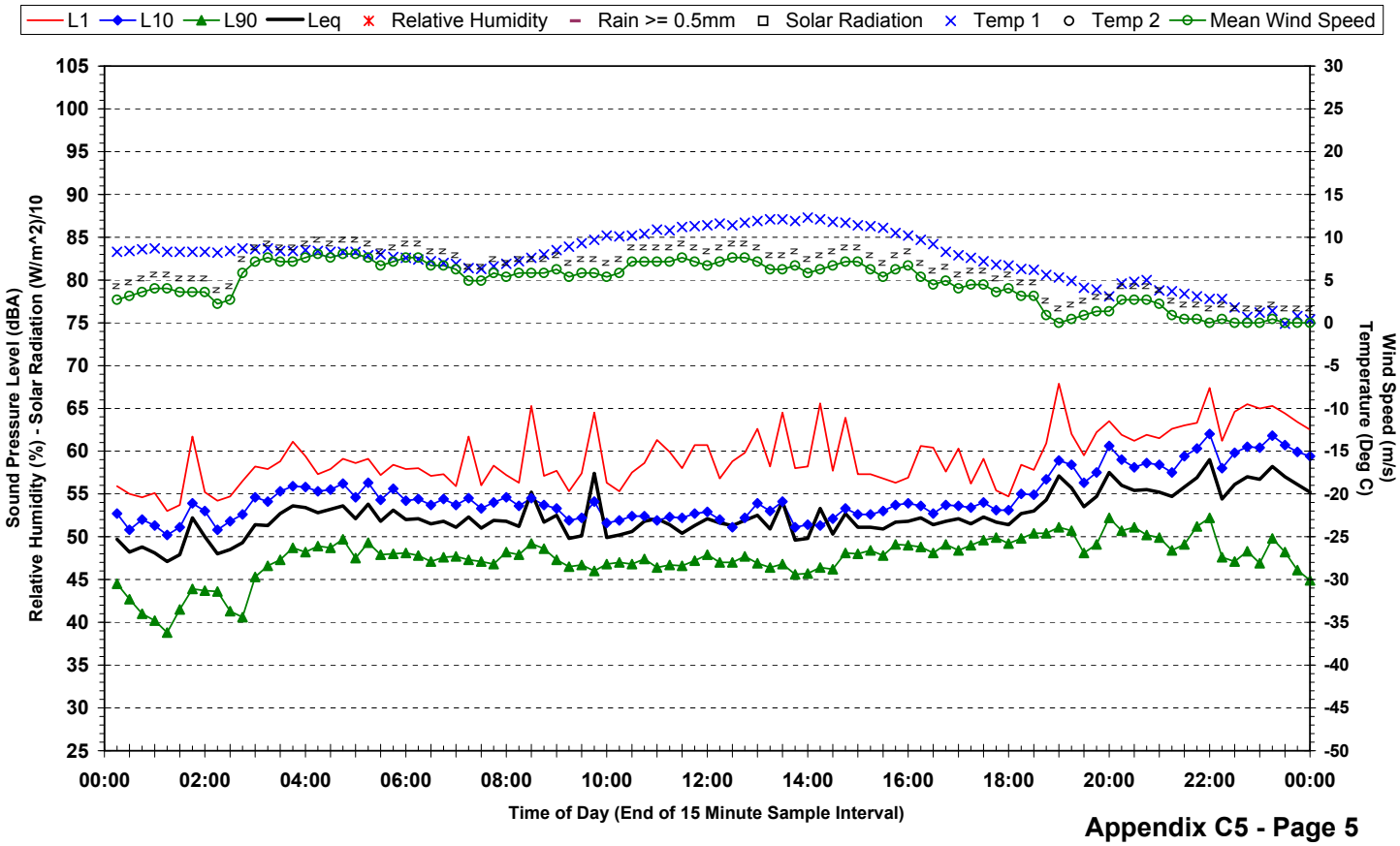
Statistical Ambient Noise Levels
Marulan N5 'Koorong Park' - Thursday 3 June 2004

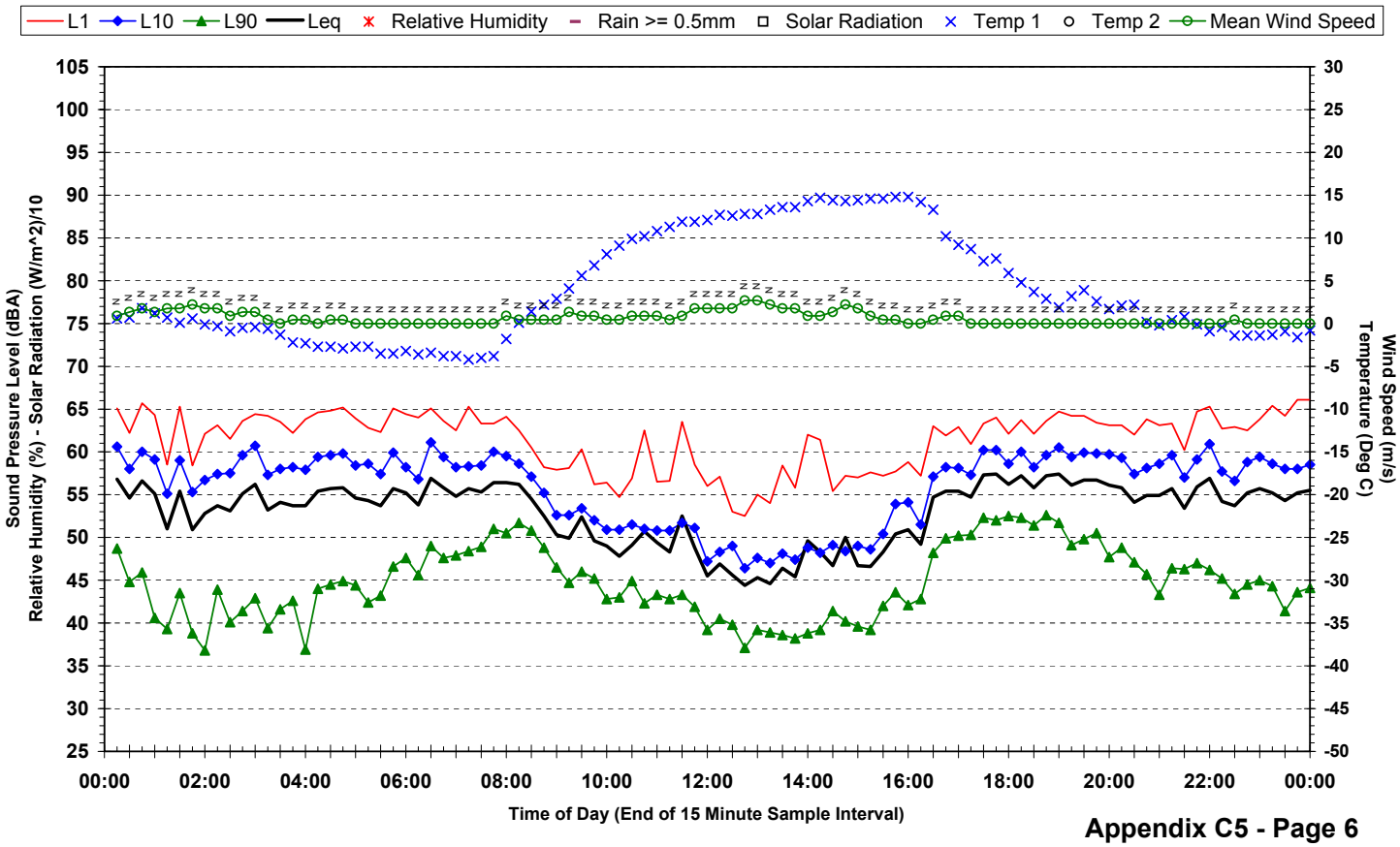


Appendix C5 - Page 4
Ambient Conditions
RHA Report 10-3142

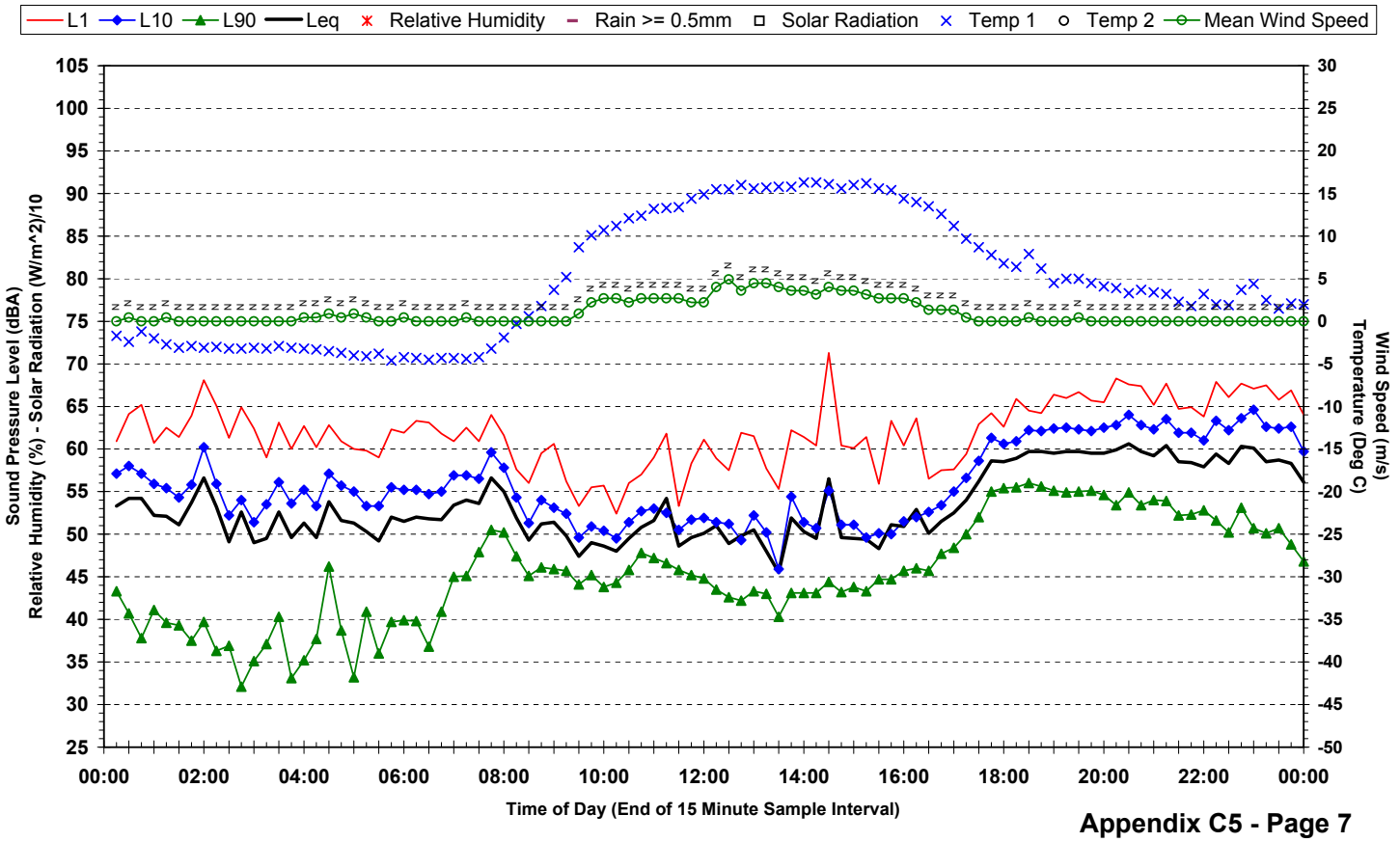
Statistical Ambient Noise Levels
Marulan N5 'Koorong Park' - Friday 4 June 2004



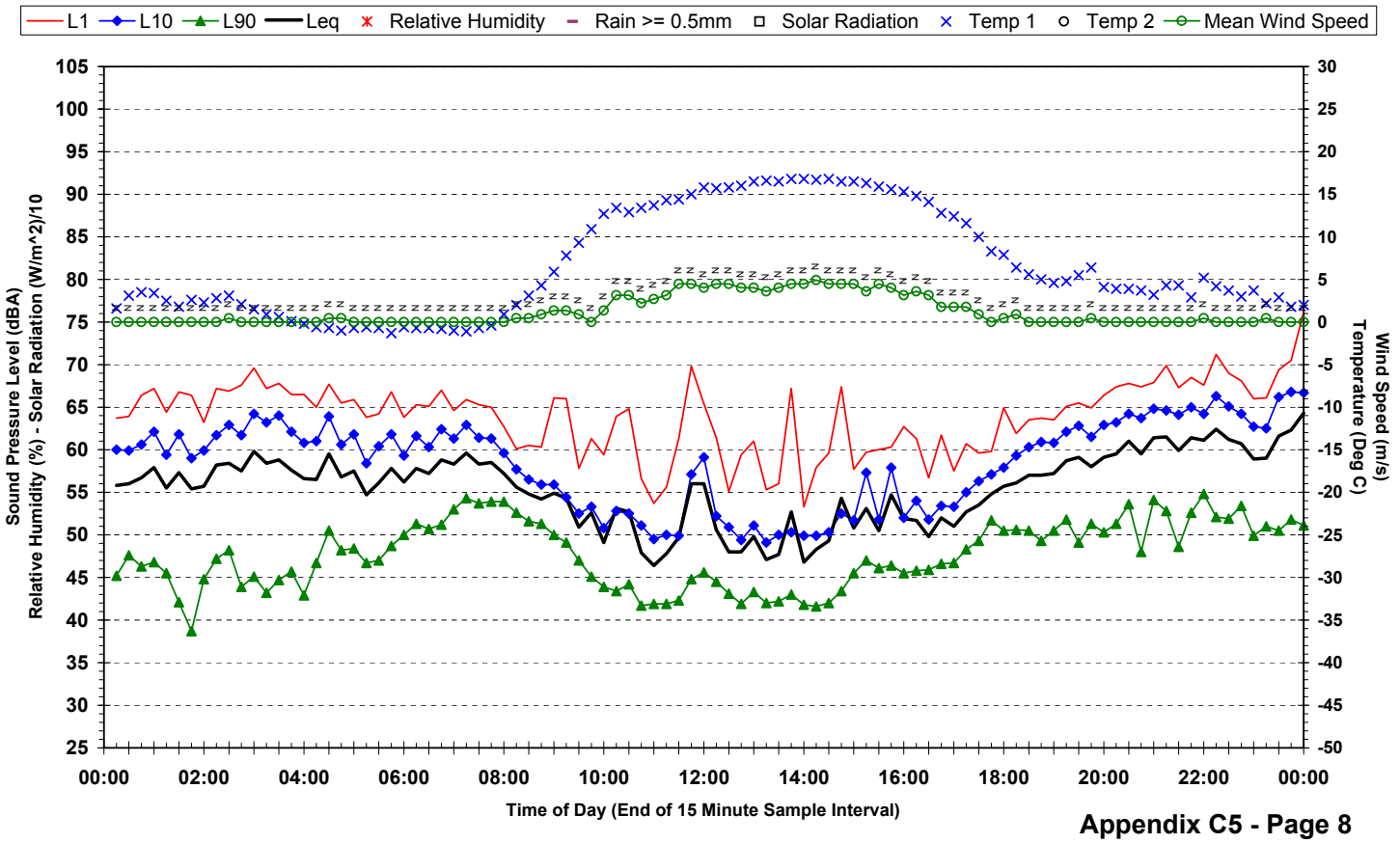
Statistical Ambient Noise Levels
Marulan N5 'Koorong Park' - Saturday 5 June 2004



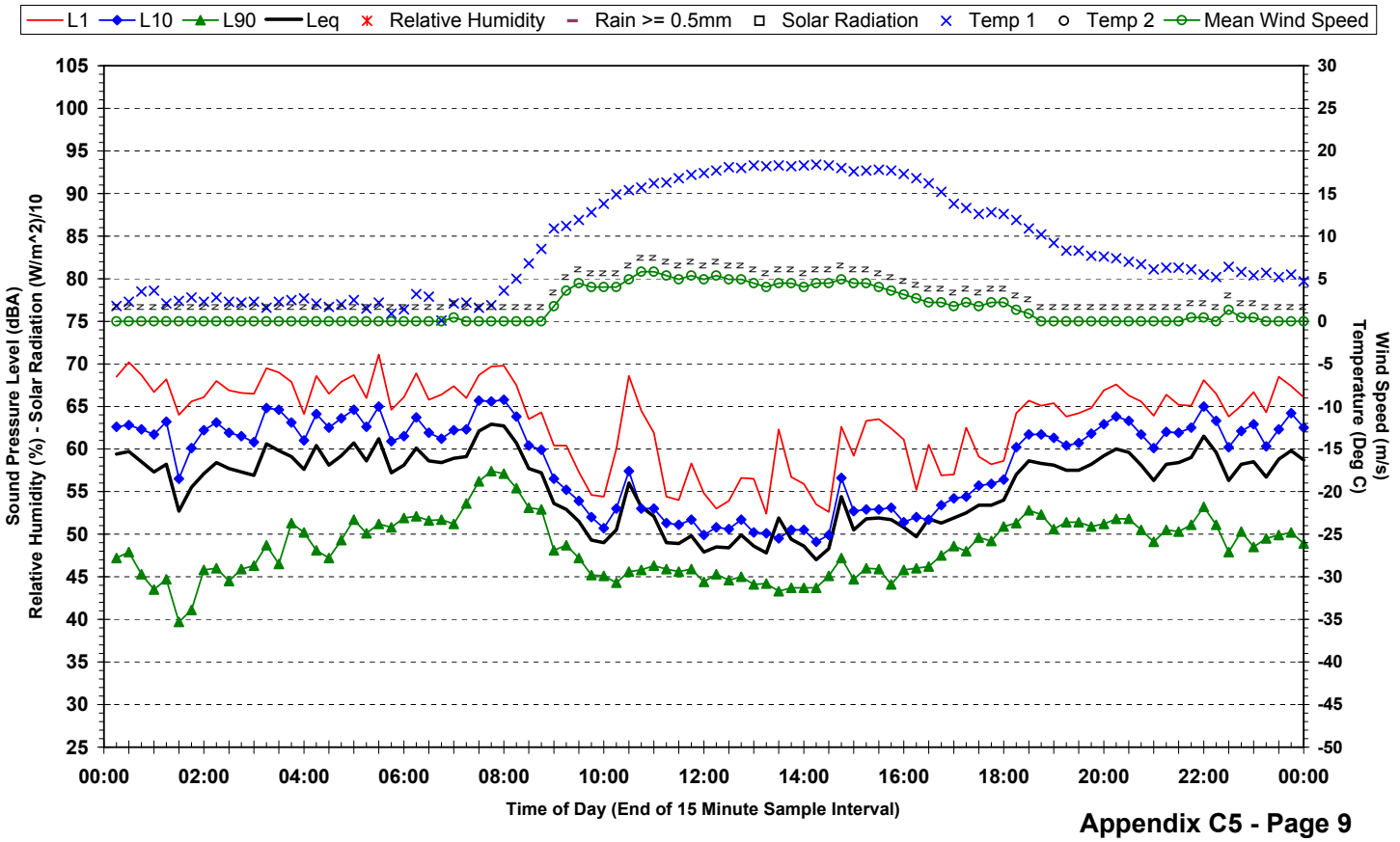
Statistical Ambient Noise Levels
Marulan N5 'Koorong Park' - Sunday 6 June 2004



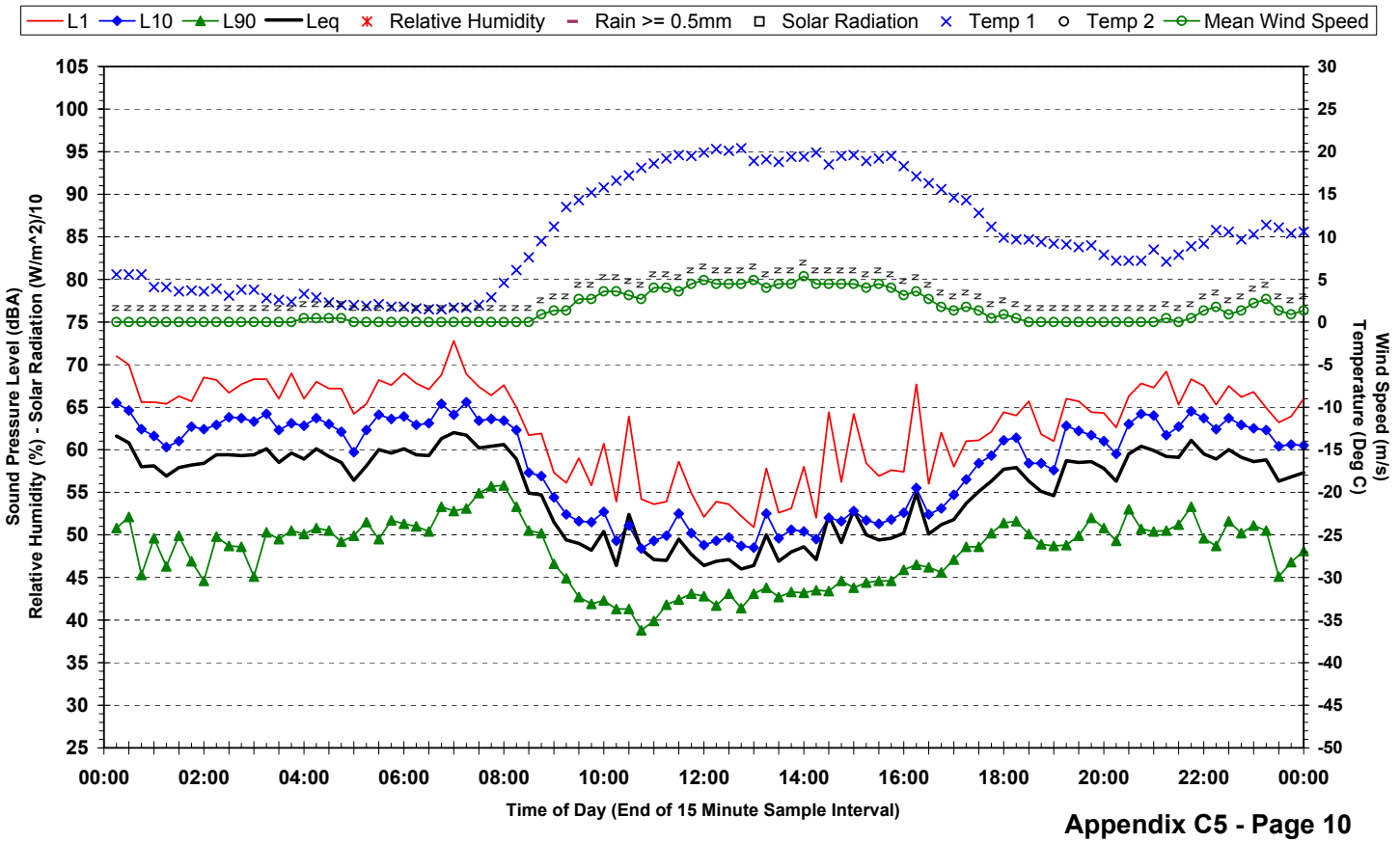
Statistical Ambient Noise Levels
Marulan N5 'Koorong Park' - Monday 7 June 2004



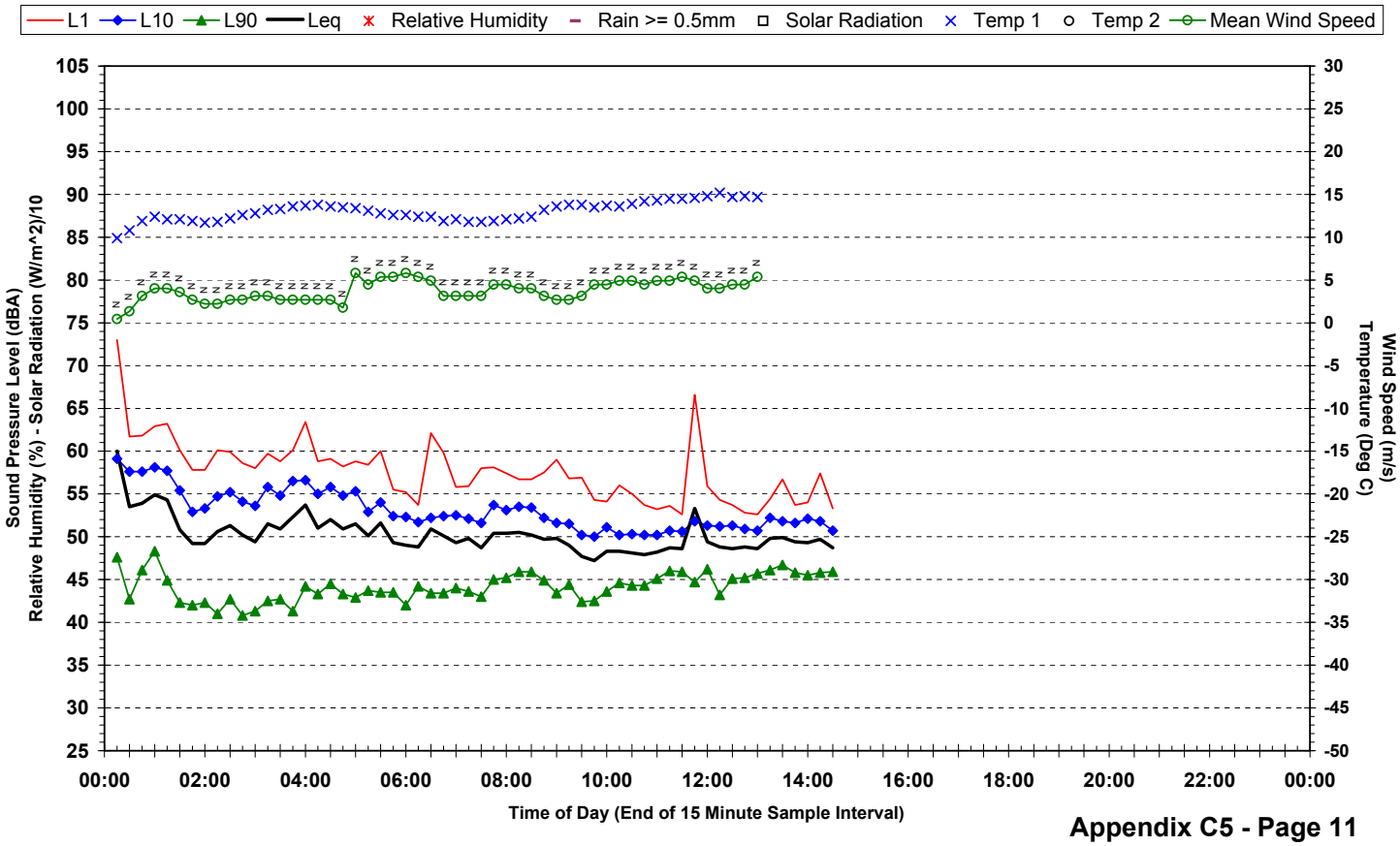
Statistical Ambient Noise Levels
Marulan N5 'Koorong Park' - Tuesday 8 June 2004



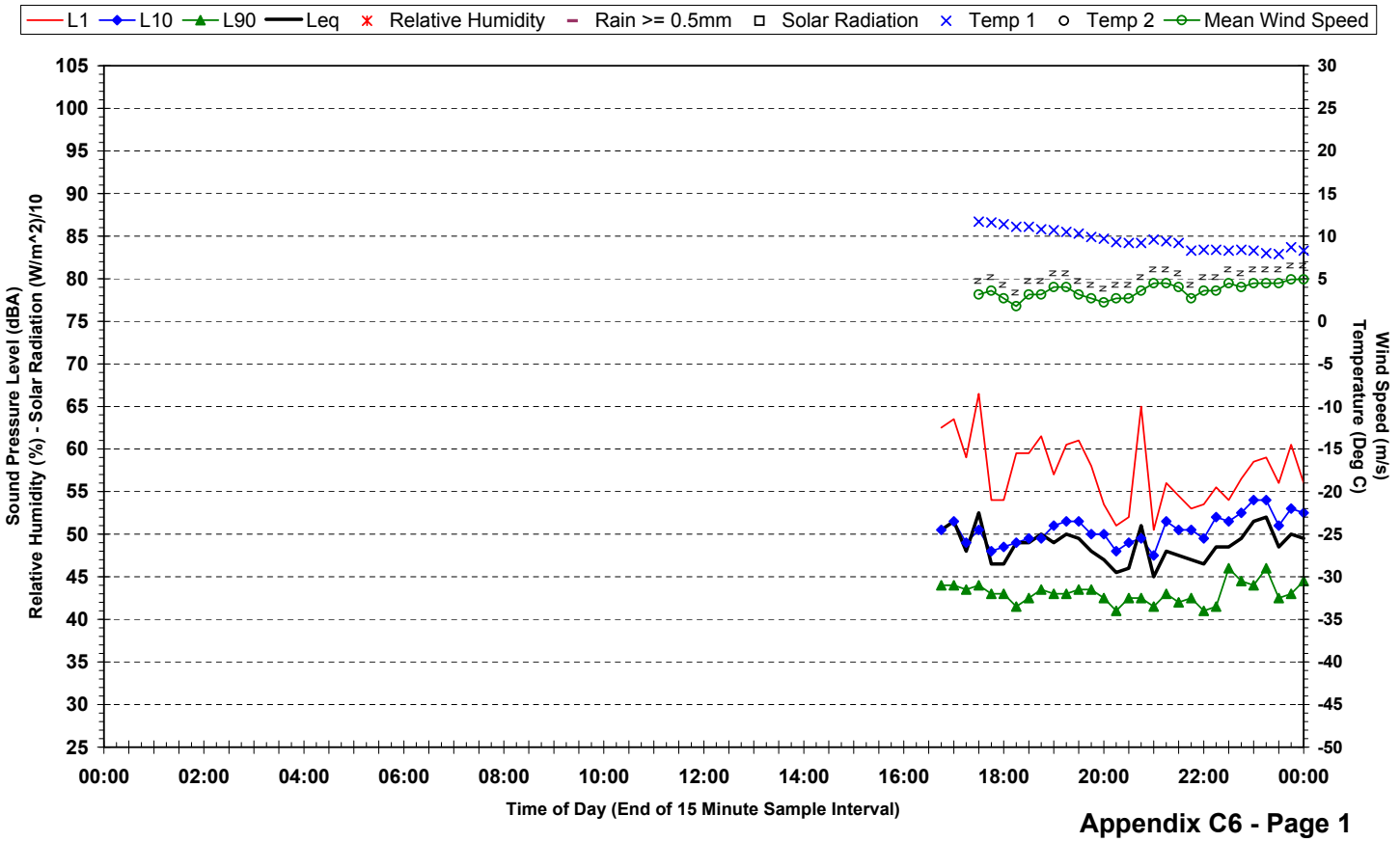
Statistical Ambient Noise Levels
Marulan N5 'Koorong Park' - Wednesday 9 June 2004



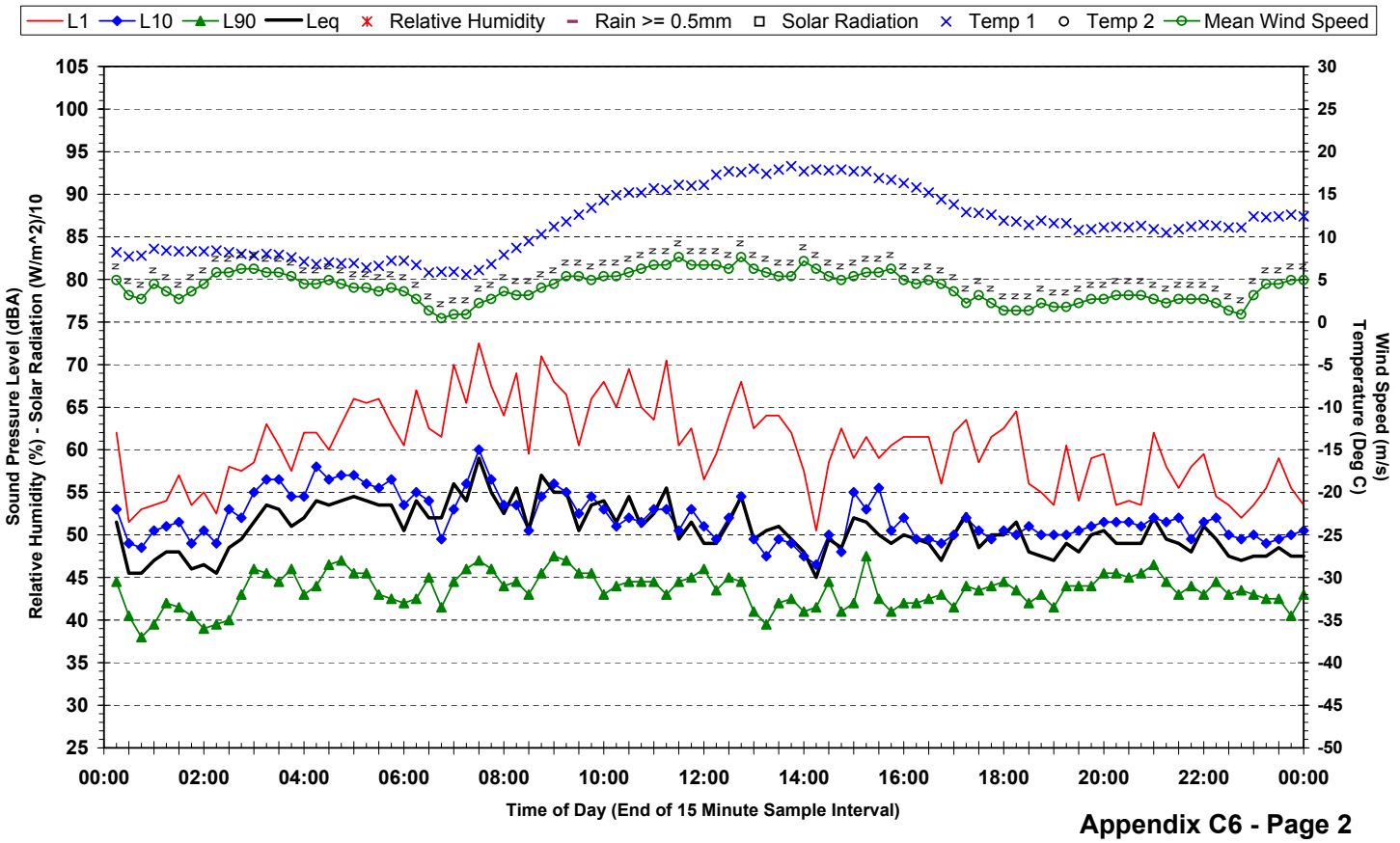
Statistical Ambient Noise Levels
Marulan N5 'Koorong Park' - Thursday 10 June 2004



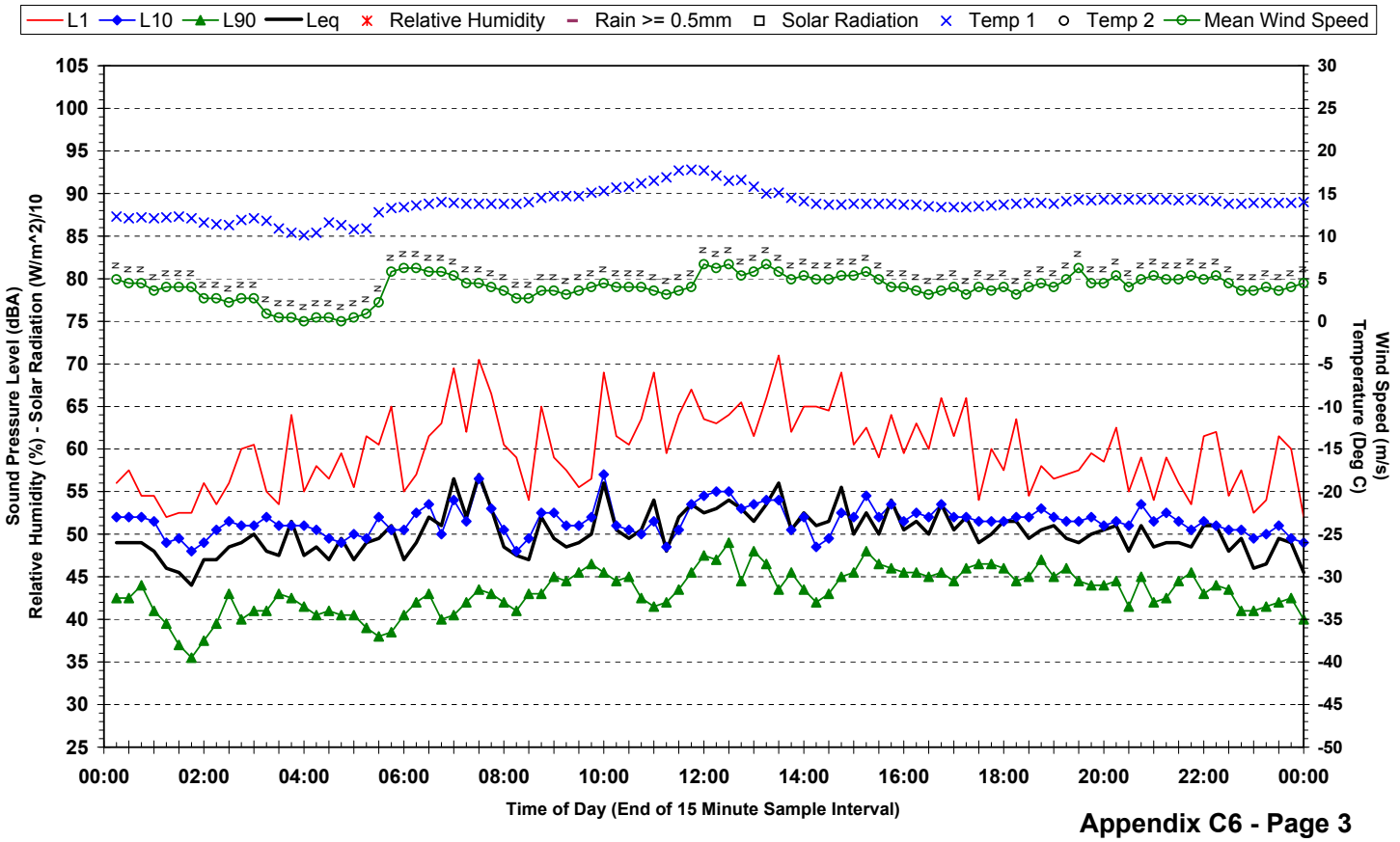
Statistical Ambient Noise Levels
Marulan N6 'Tangryang' Marulan South - Monday 31 May 2004



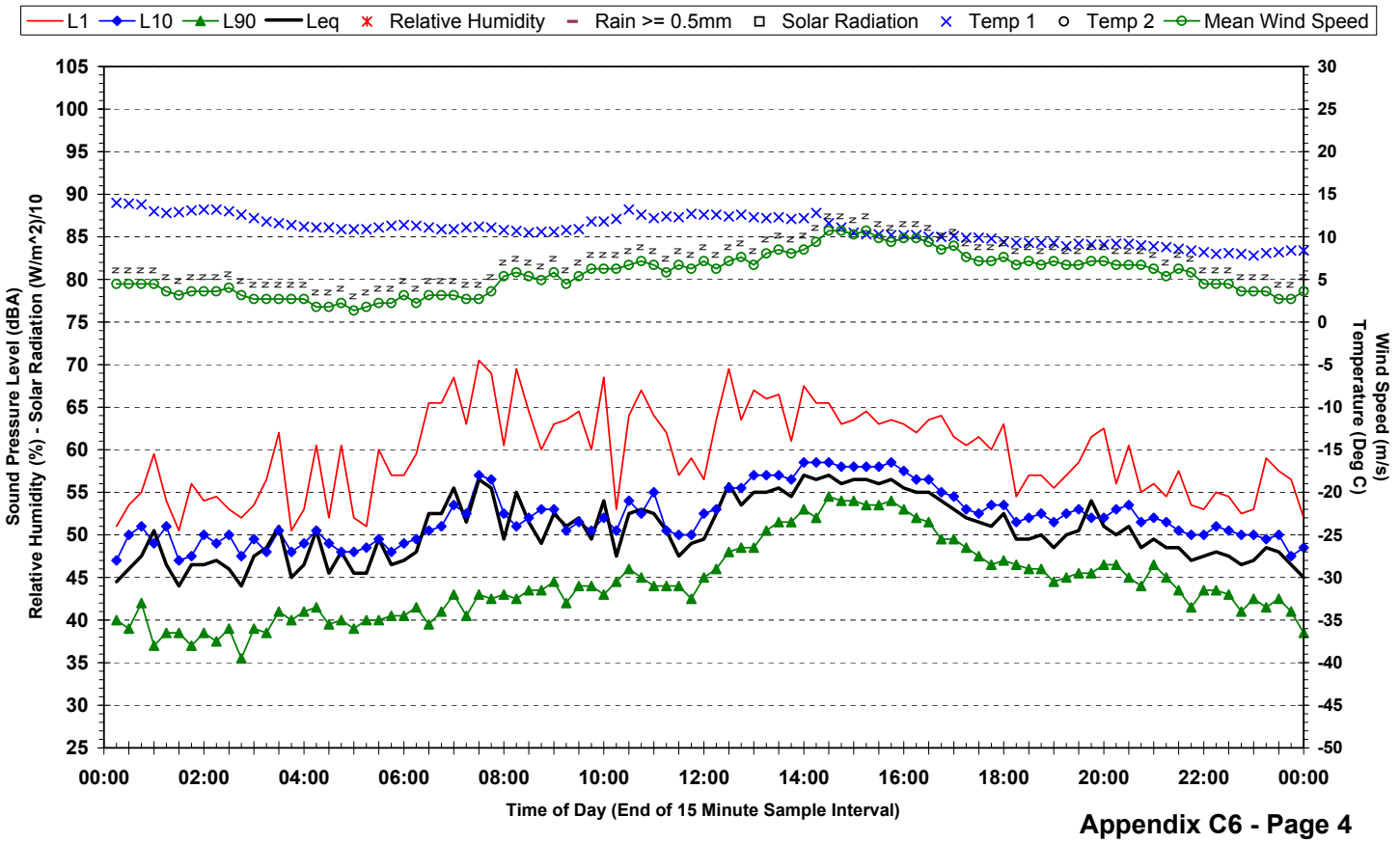
Statistical Ambient Noise Levels
Marulan N6 'Tangryang' Marulan South - Tuesday 1 June 2004



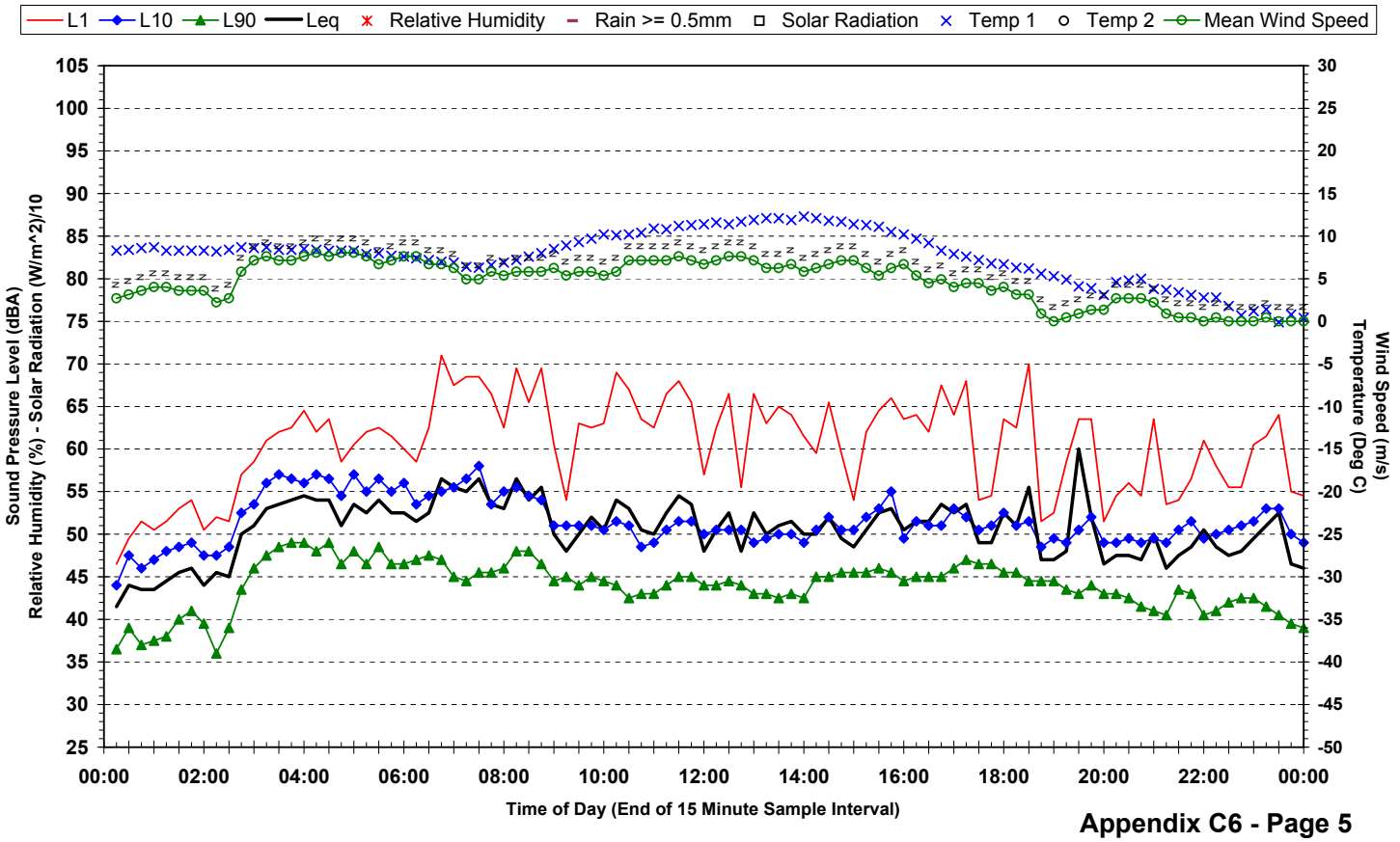
Statistical Ambient Noise Levels
Marulan N6 'Tangryang' Marulan South - Wednesday 2 June 2004



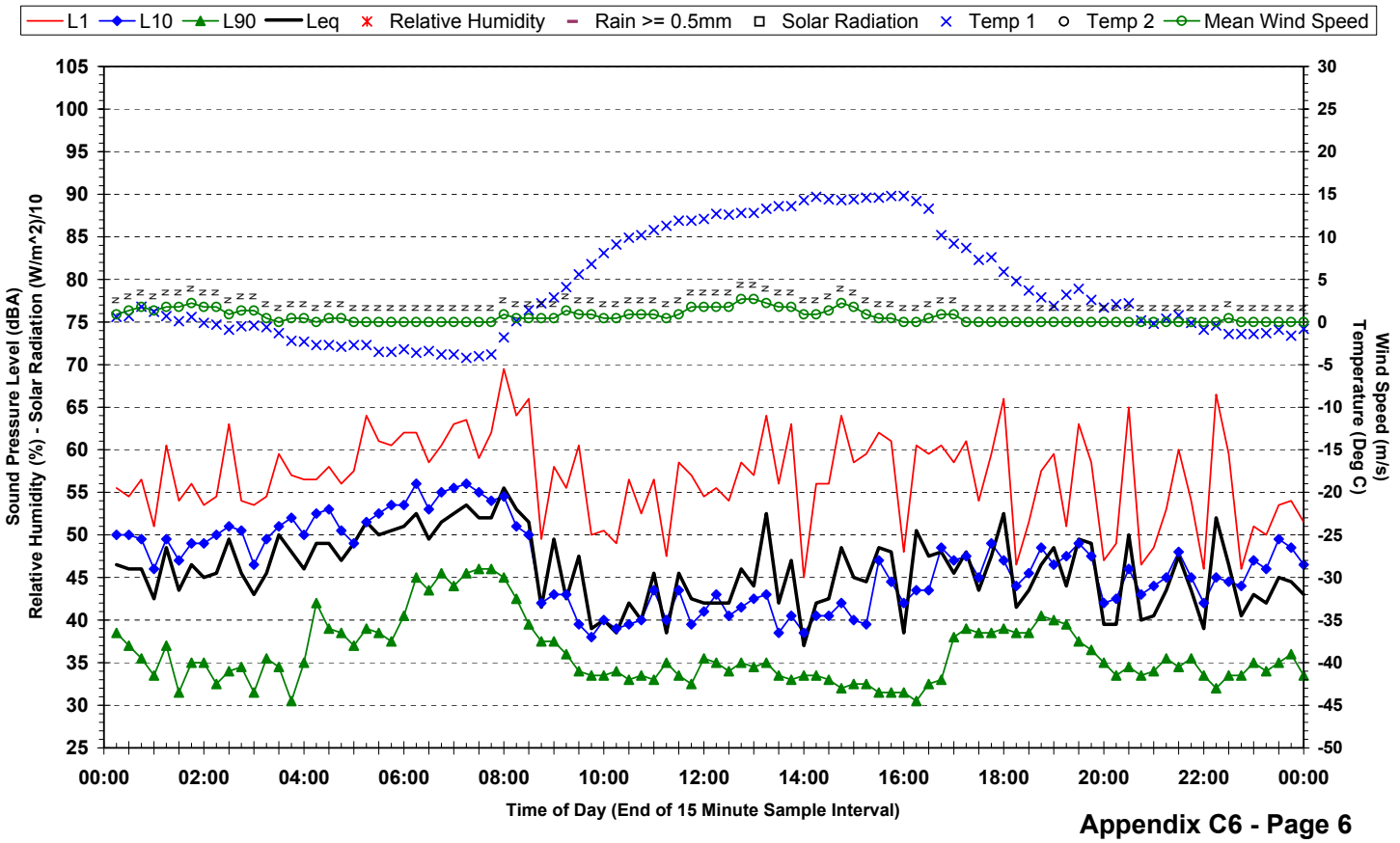
Statistical Ambient Noise Levels
Marulan N6 'Tangryang' Marulan South - Thursday 3 June 2004



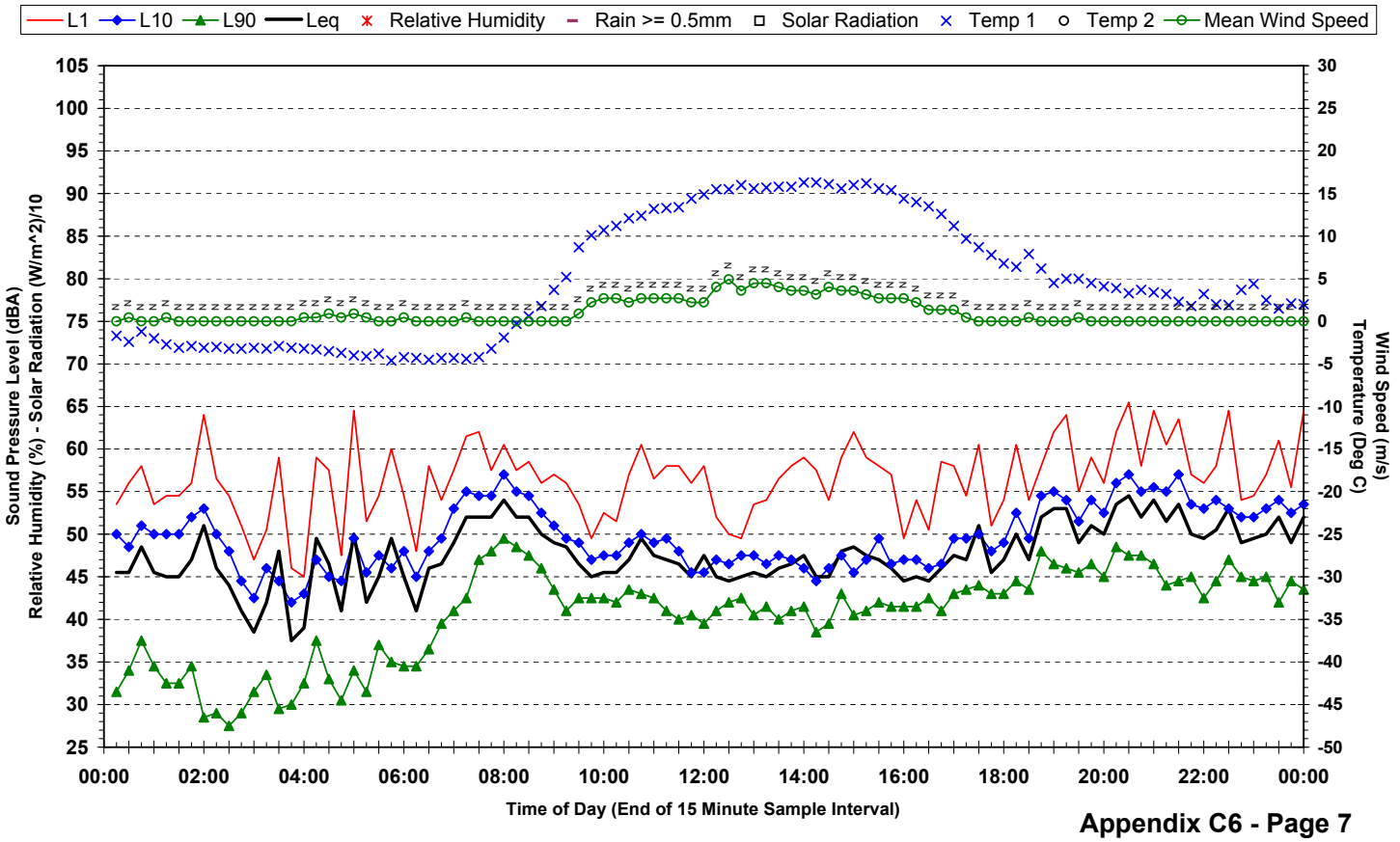
Statistical Ambient Noise Levels
Marulan N6 'Tangryang' Marulan South - Friday 4 June 2004



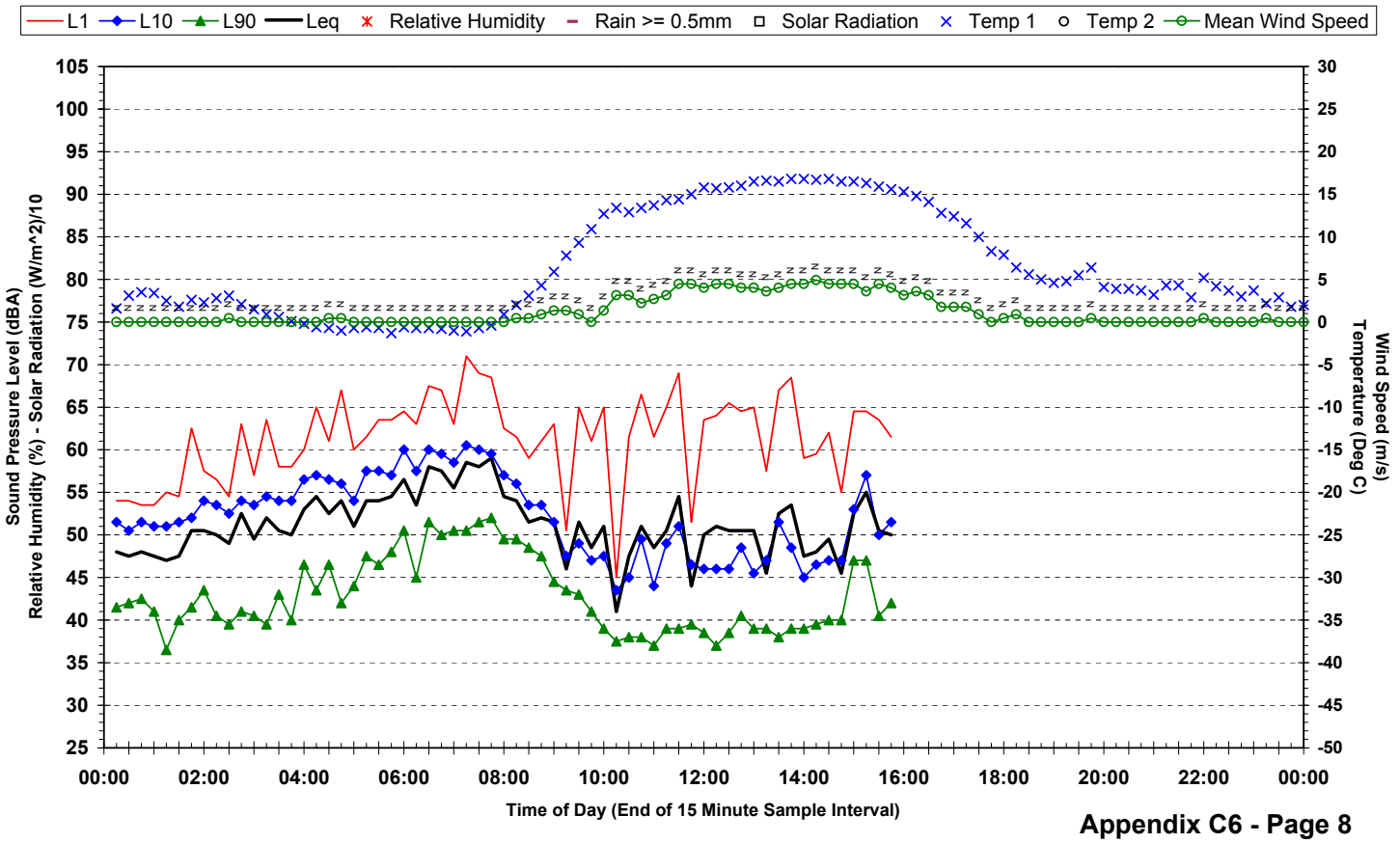
Statistical Ambient Noise Levels
Marulan N6 'Tangryang' Marulan South - Saturday 5 June 2004



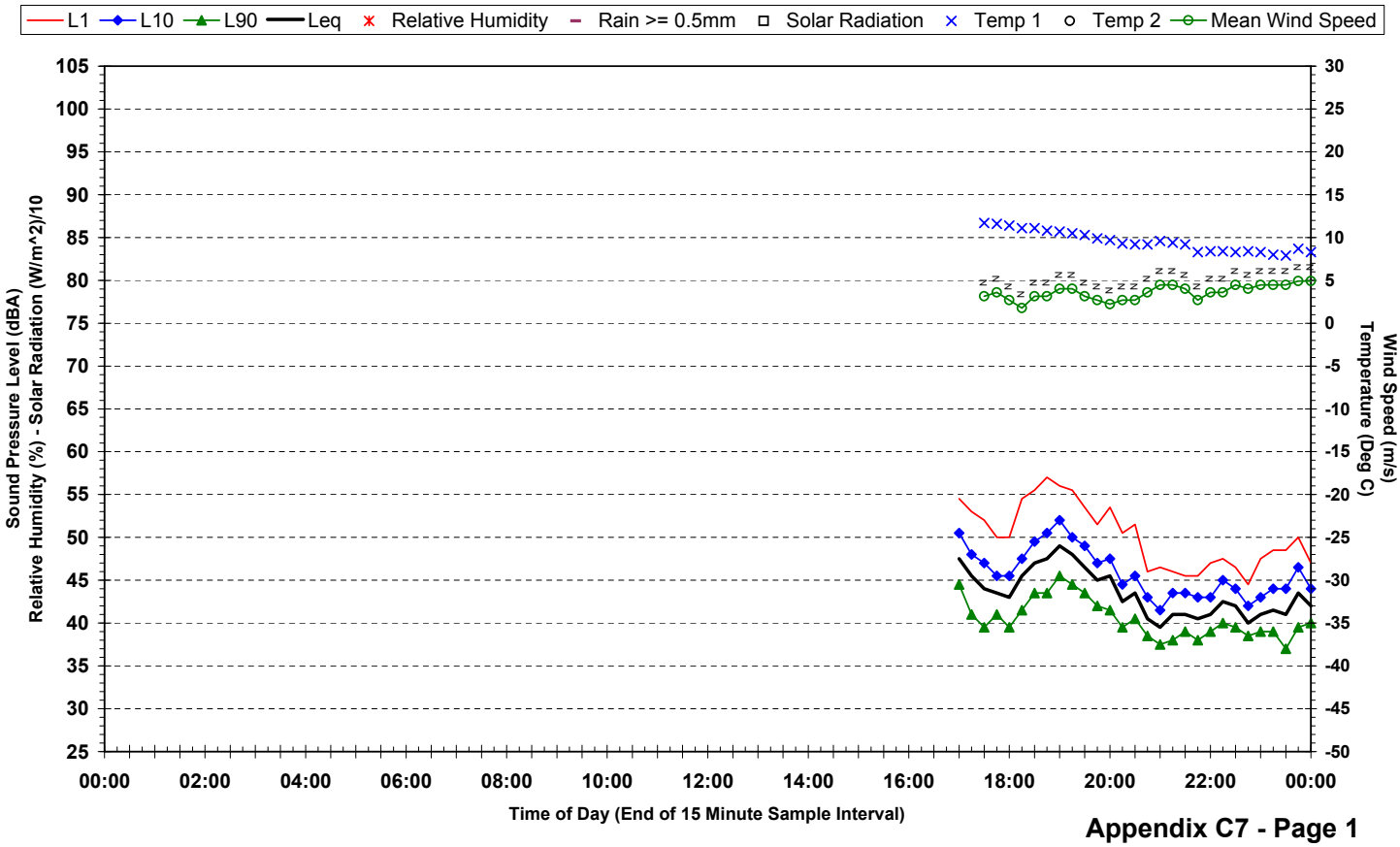
Statistical Ambient Noise Levels
Marulan N6 'Tangryang' Marulan South - Sunday 6 June 2004



Statistical Ambient Noise Levels
Marulan N6 'Tangryang' Marulan South - Monday 7 June 2004

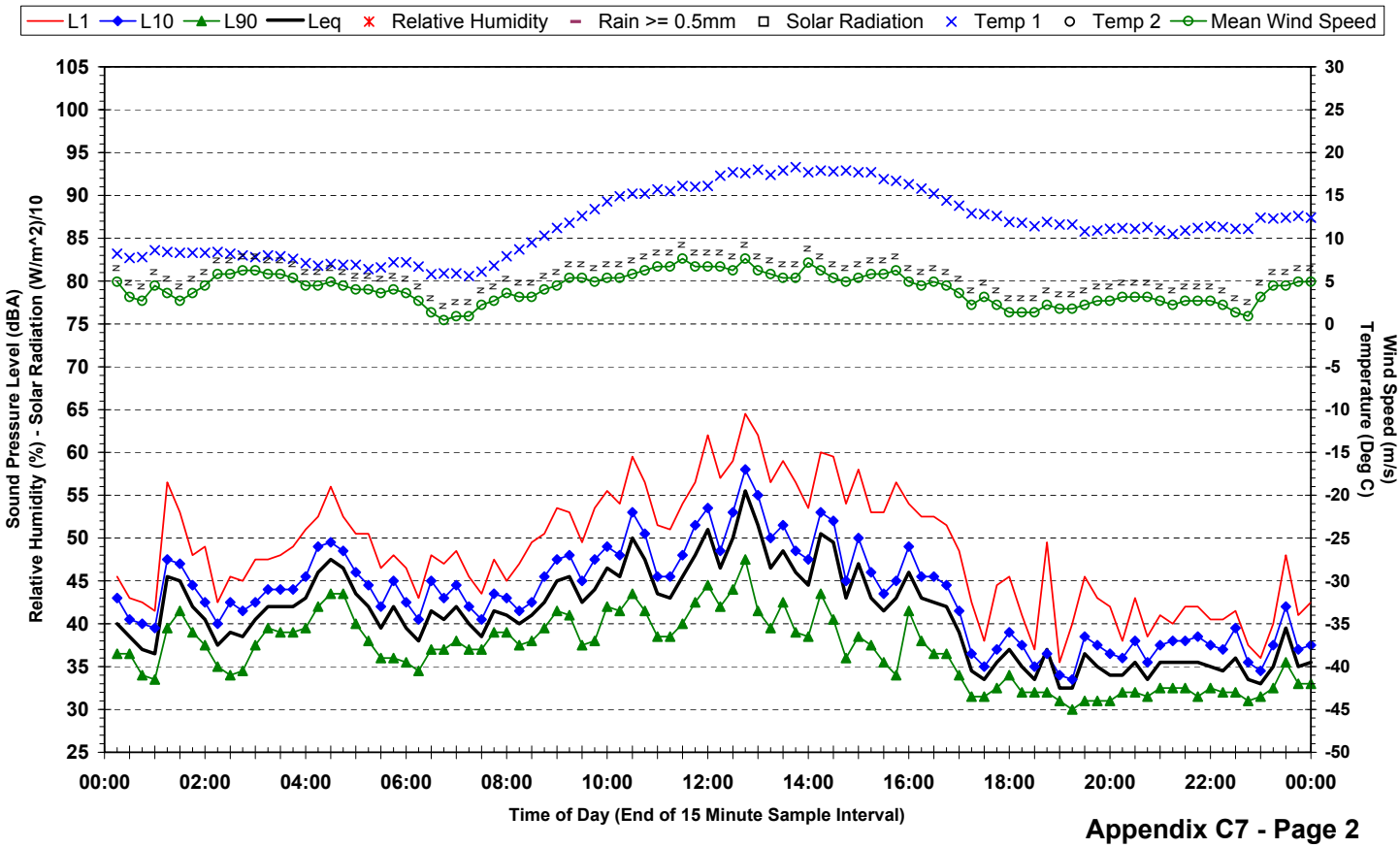


Statistical Ambient Noise Levels
Marulan N7 Residence South of the Project Area - Monday 31 May 2004



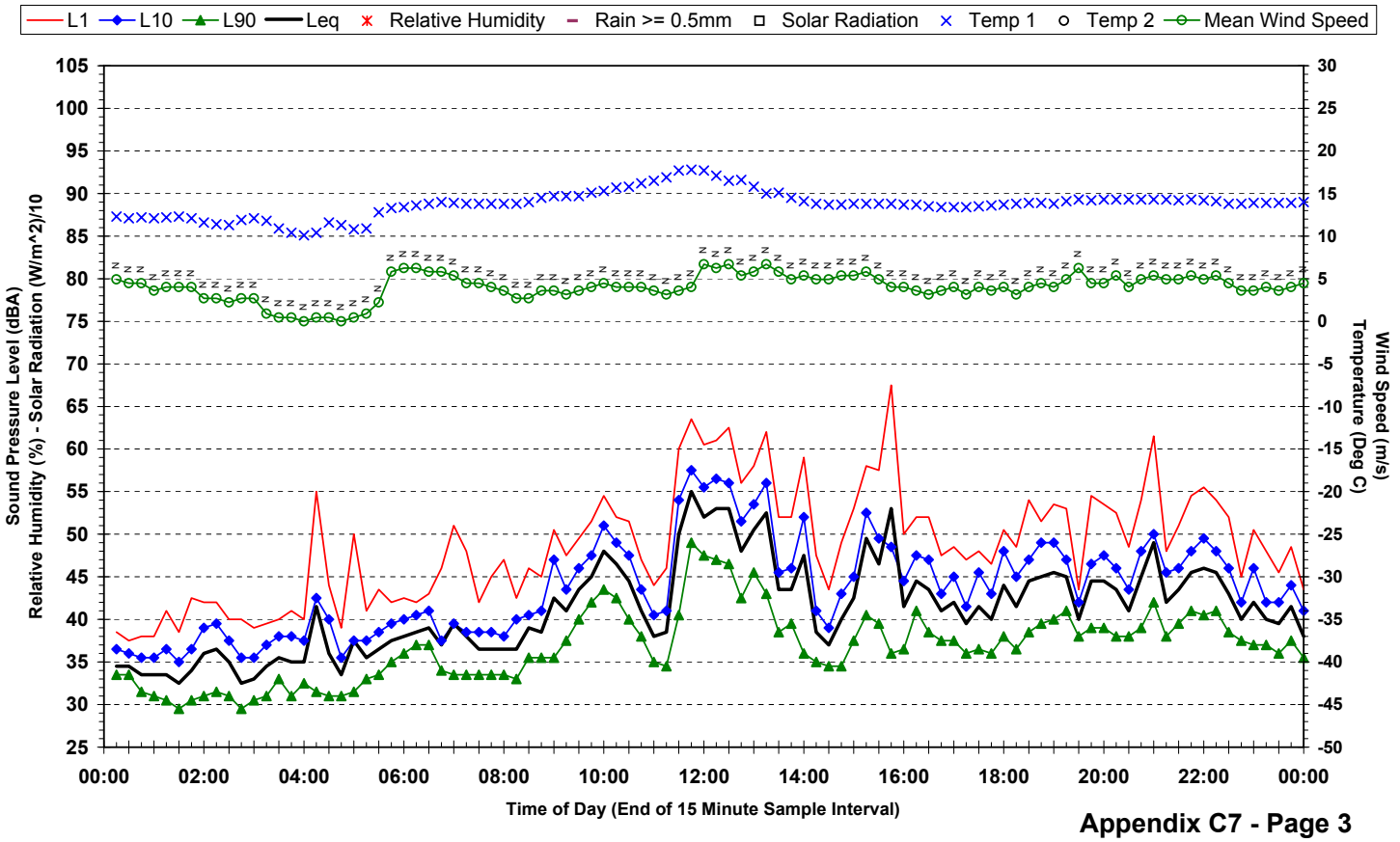
Appendix C7 - Page 1
Ambient Conditions
RHA Report 10-3142

Statistical Ambient Noise Levels
Marulan N7 Residence South of the Project Area - Tuesday 1 June 2004

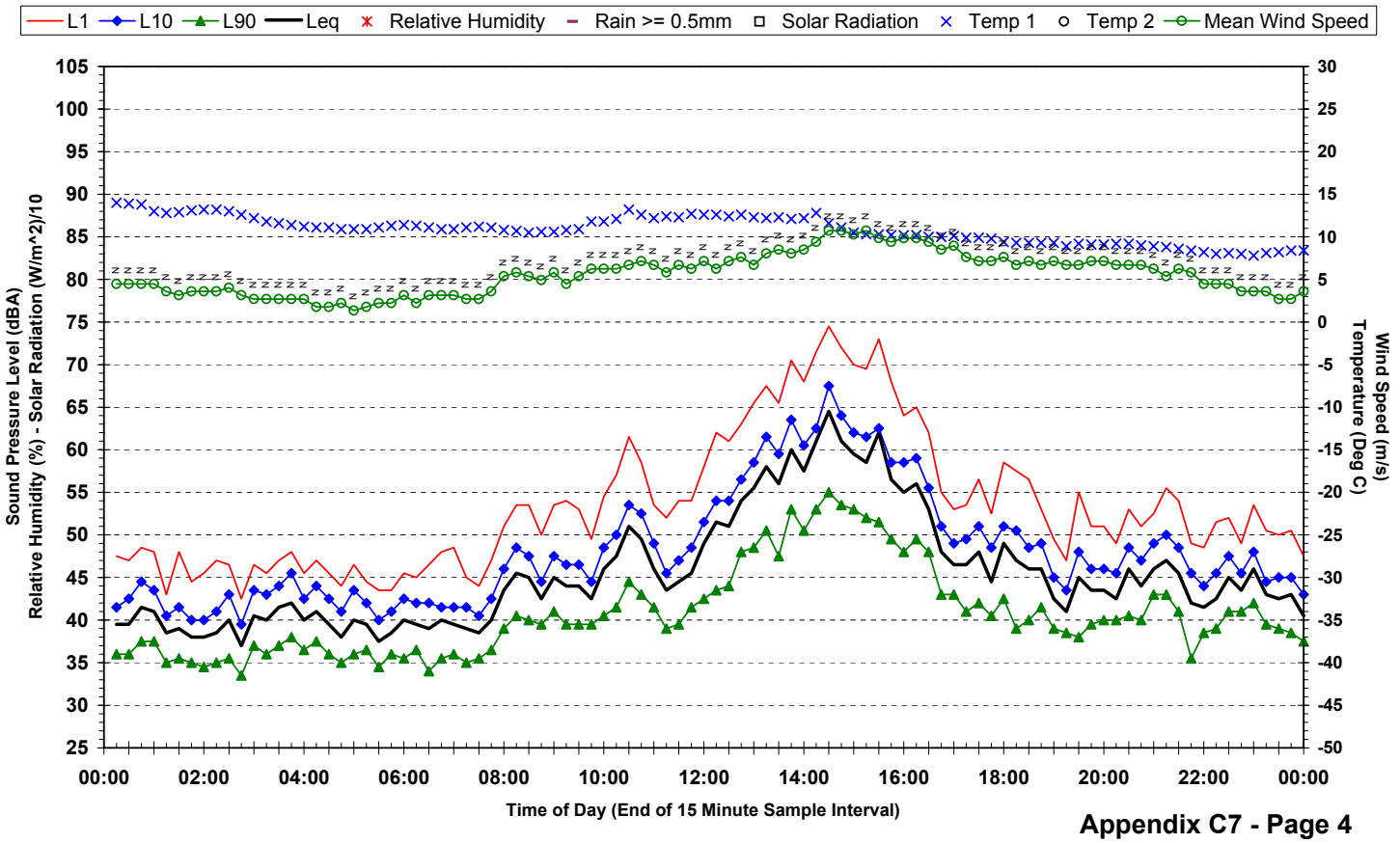


Appendix C7 - Page 2
Ambient Conditions
RHA Report 10-3142

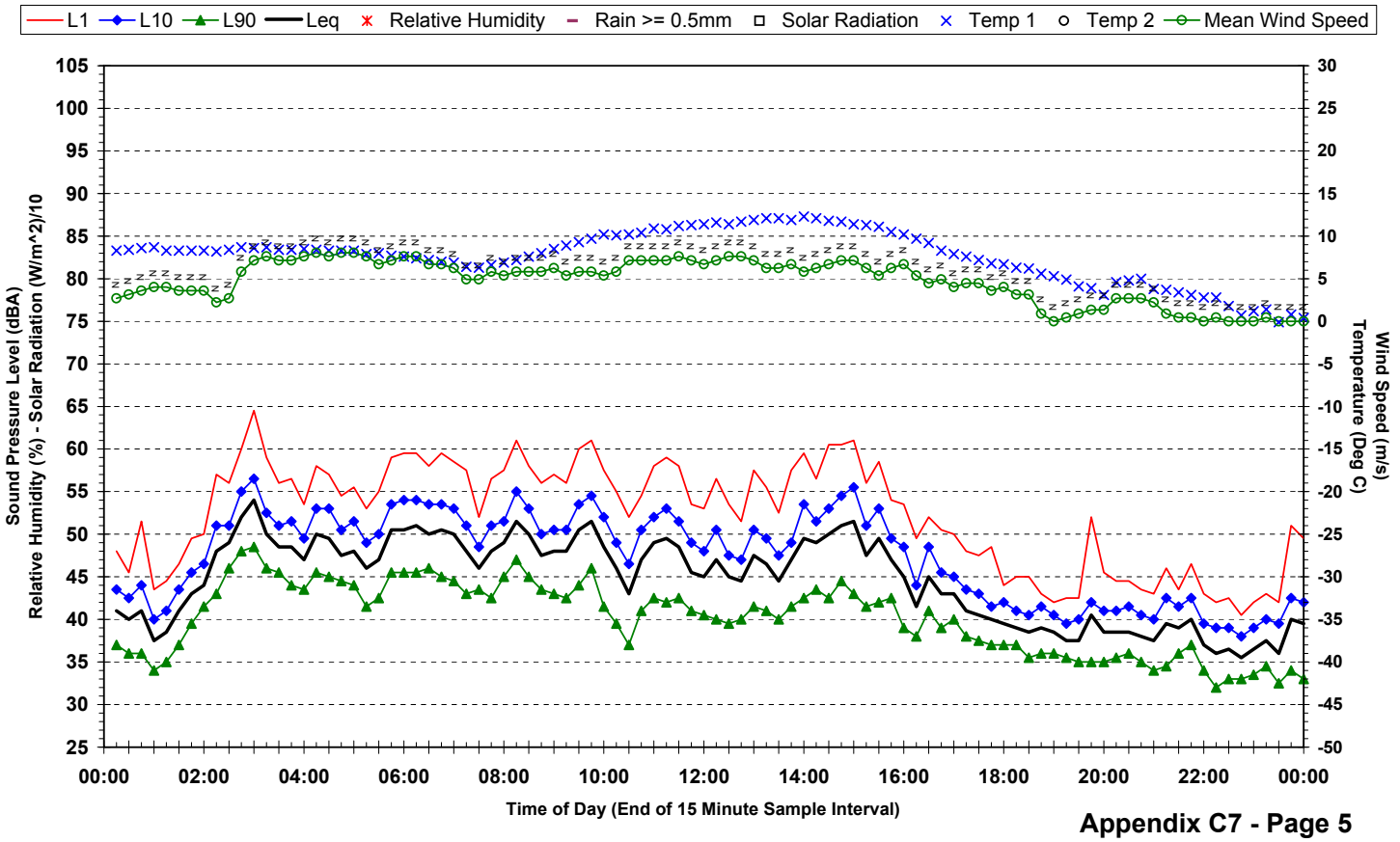
Statistical Ambient Noise Levels
Marulan N7 Residence South of the Project Area - Wednesday 2 June 2004



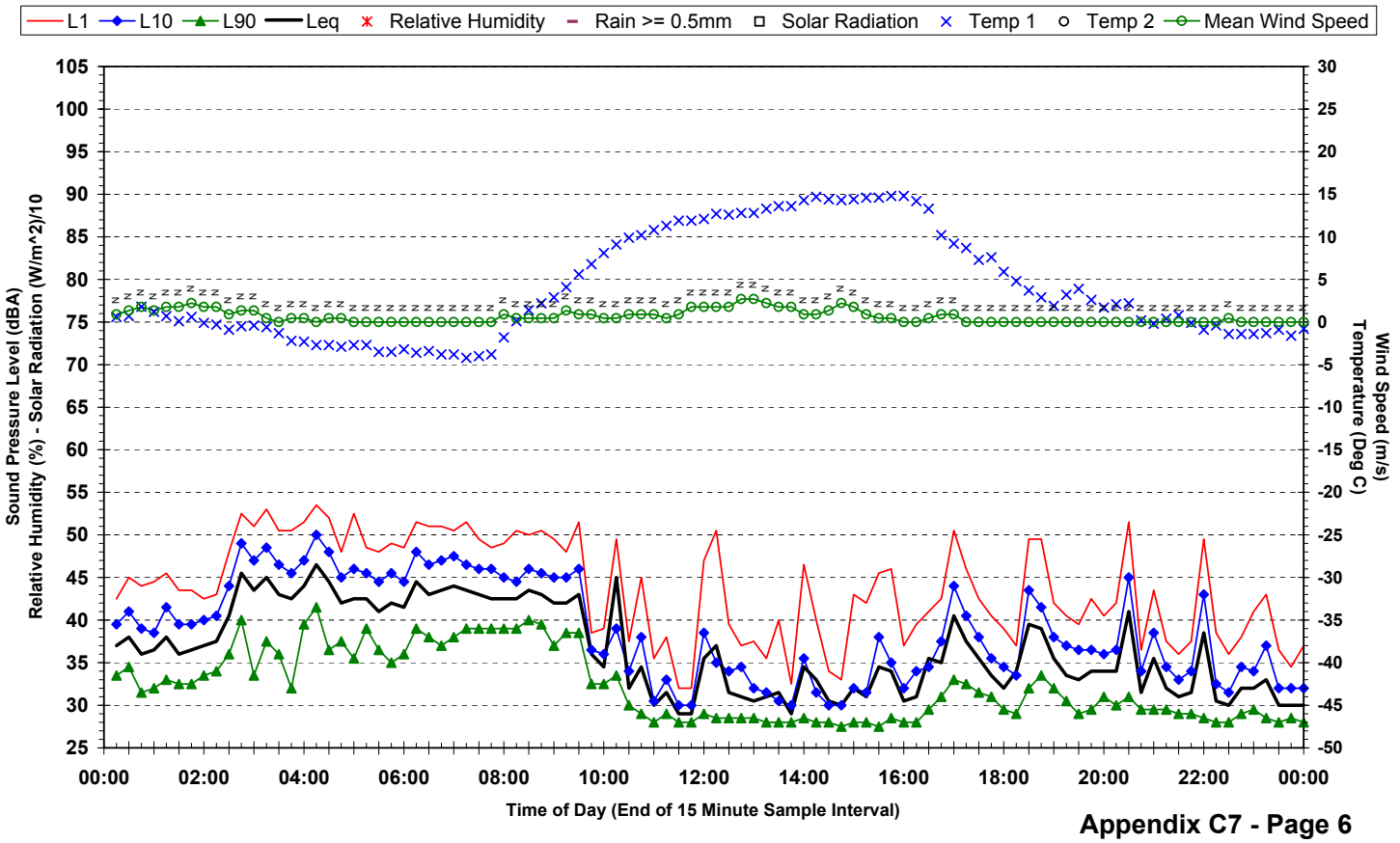
Statistical Ambient Noise Levels
Marulan N7 Residence South of the Project Area - Thursday 3 June 2004



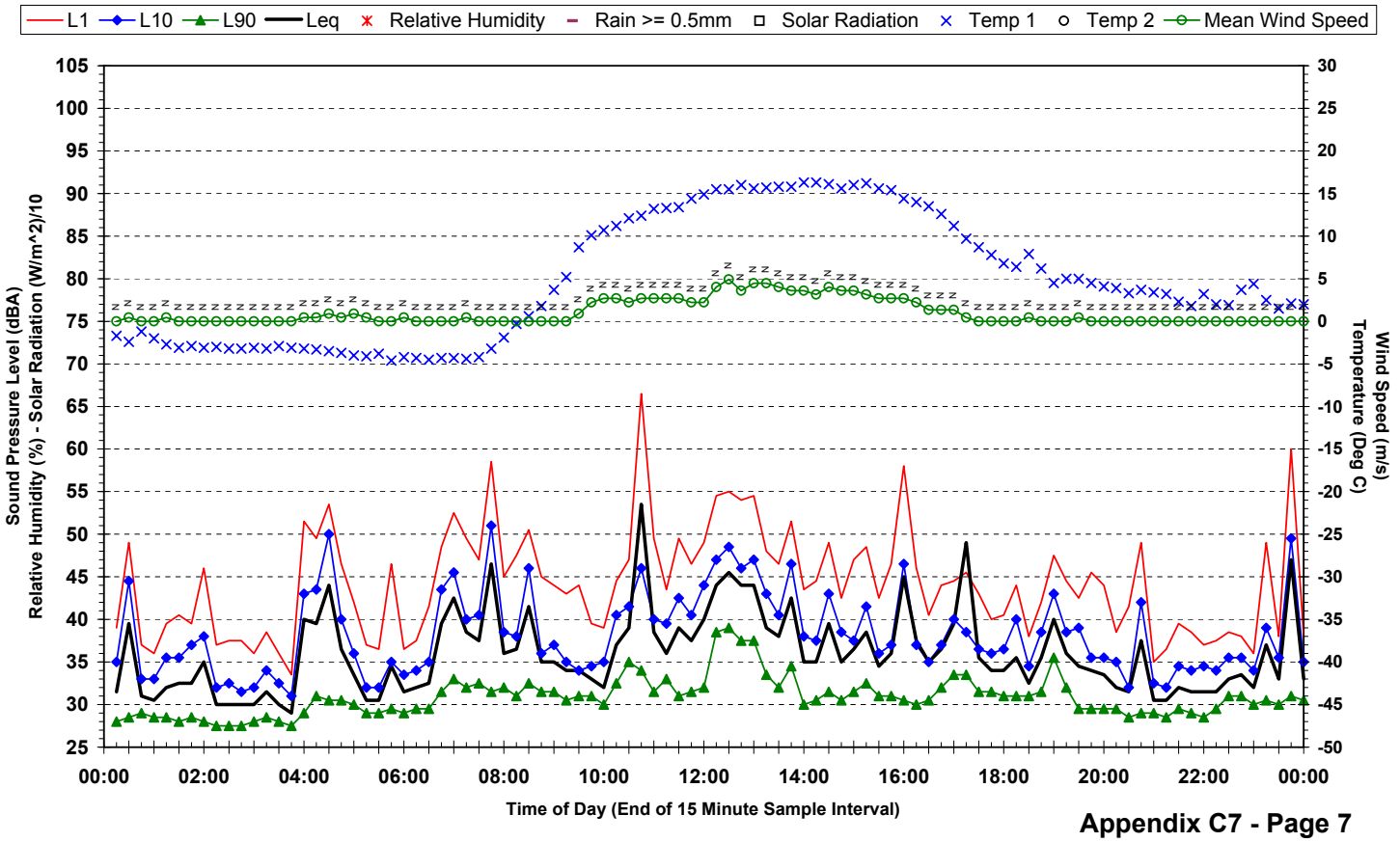
Statistical Ambient Noise Levels
Marulan N7 Residence South of the Project Area - Friday 4 June 2004



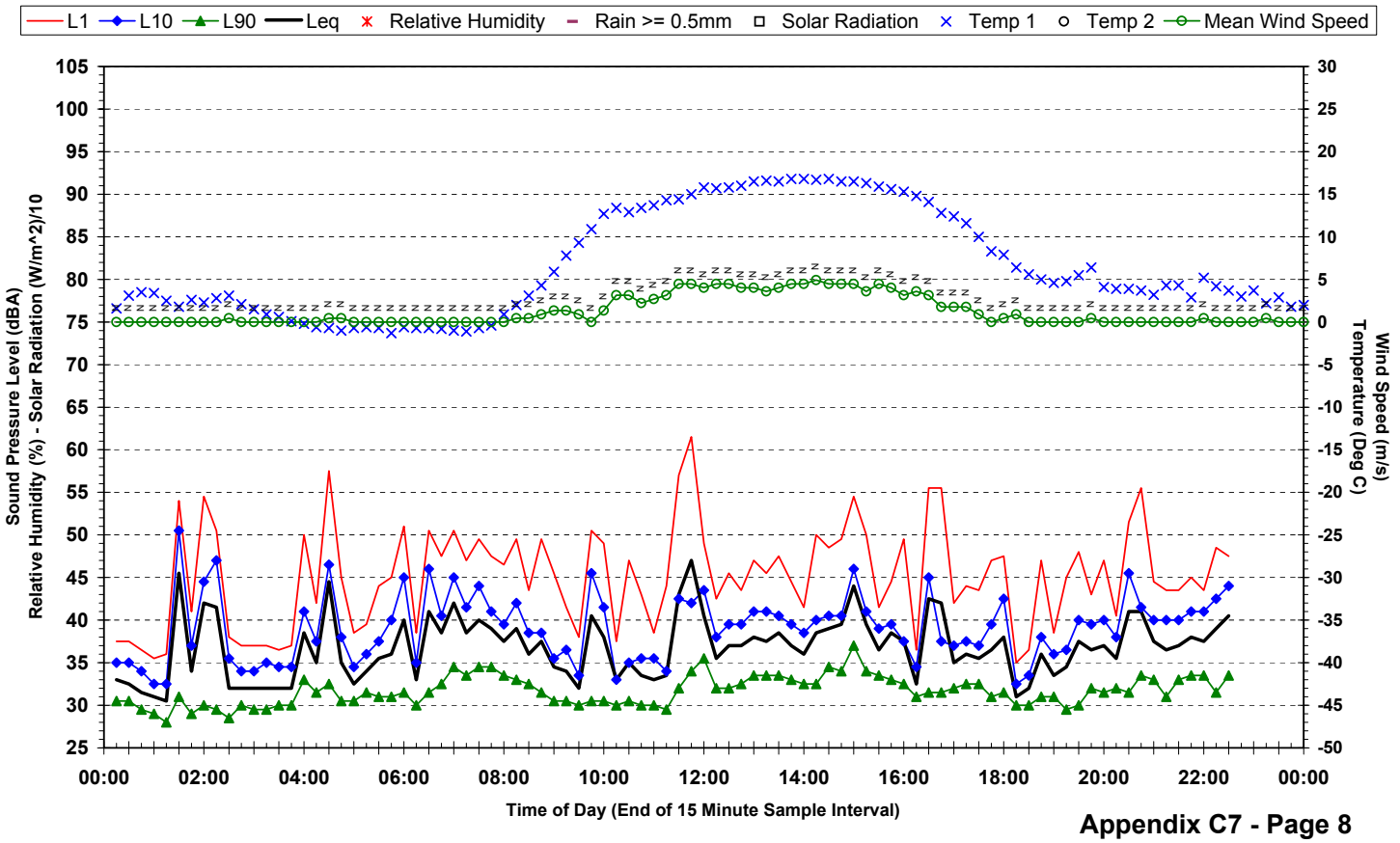
Statistical Ambient Noise Levels
Marulan N7 Residence South of the Project Area - Saturday 5 June 2004

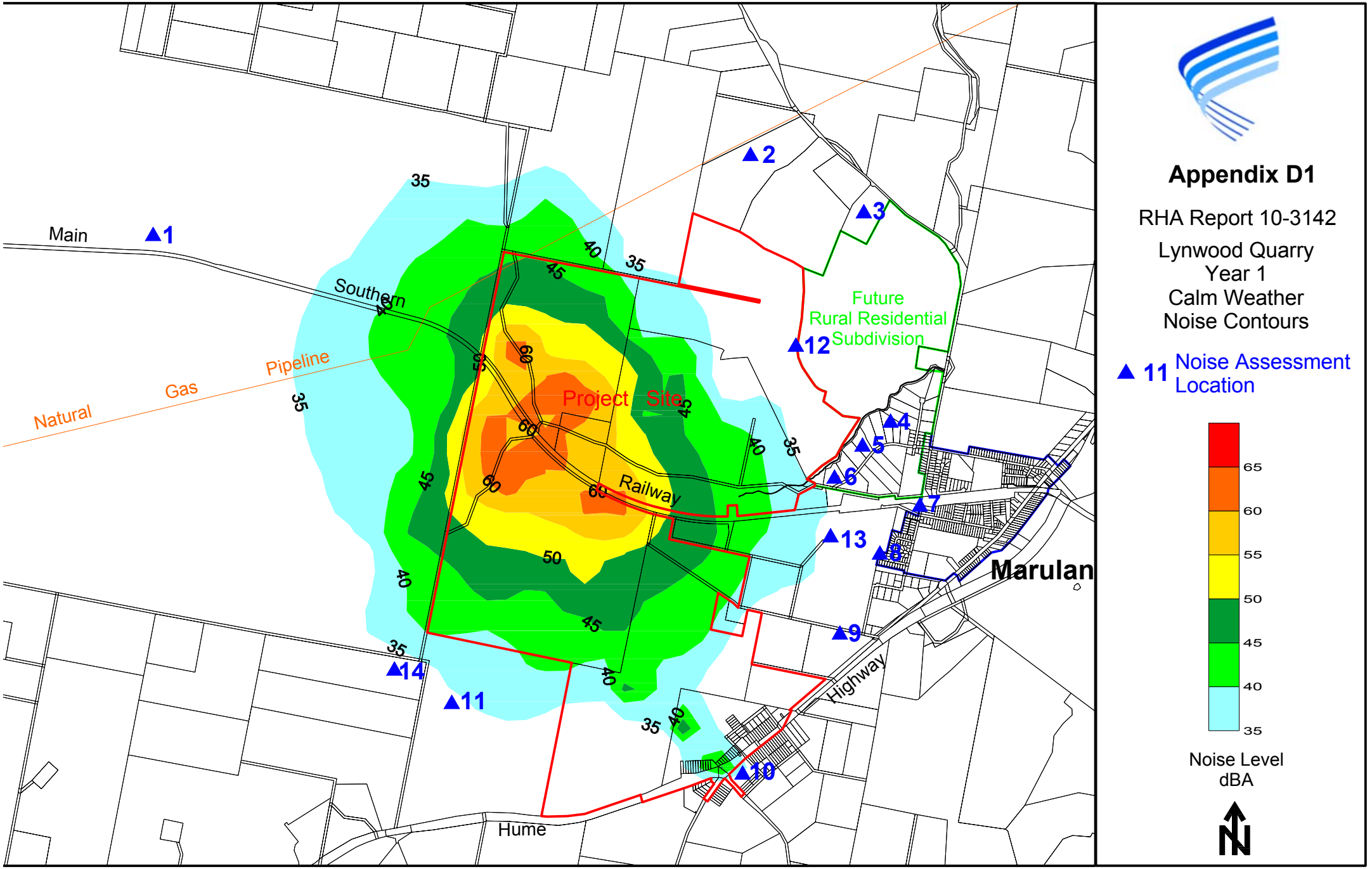


Statistical Ambient Noise Levels
Marulan N7 Residence South of the Project Area - Sunday 6 June 2004



Statistical Ambient Noise Levels
Marulan N7 Residence South of the Project Area - Monday 7 June 2004




Appendix D1
RHA Report 10-3142
Lynwood Quarry
Year 1
Calm Weather
Noise Contours
▲ 11 Noise Assessment Location
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Noise Level dBA
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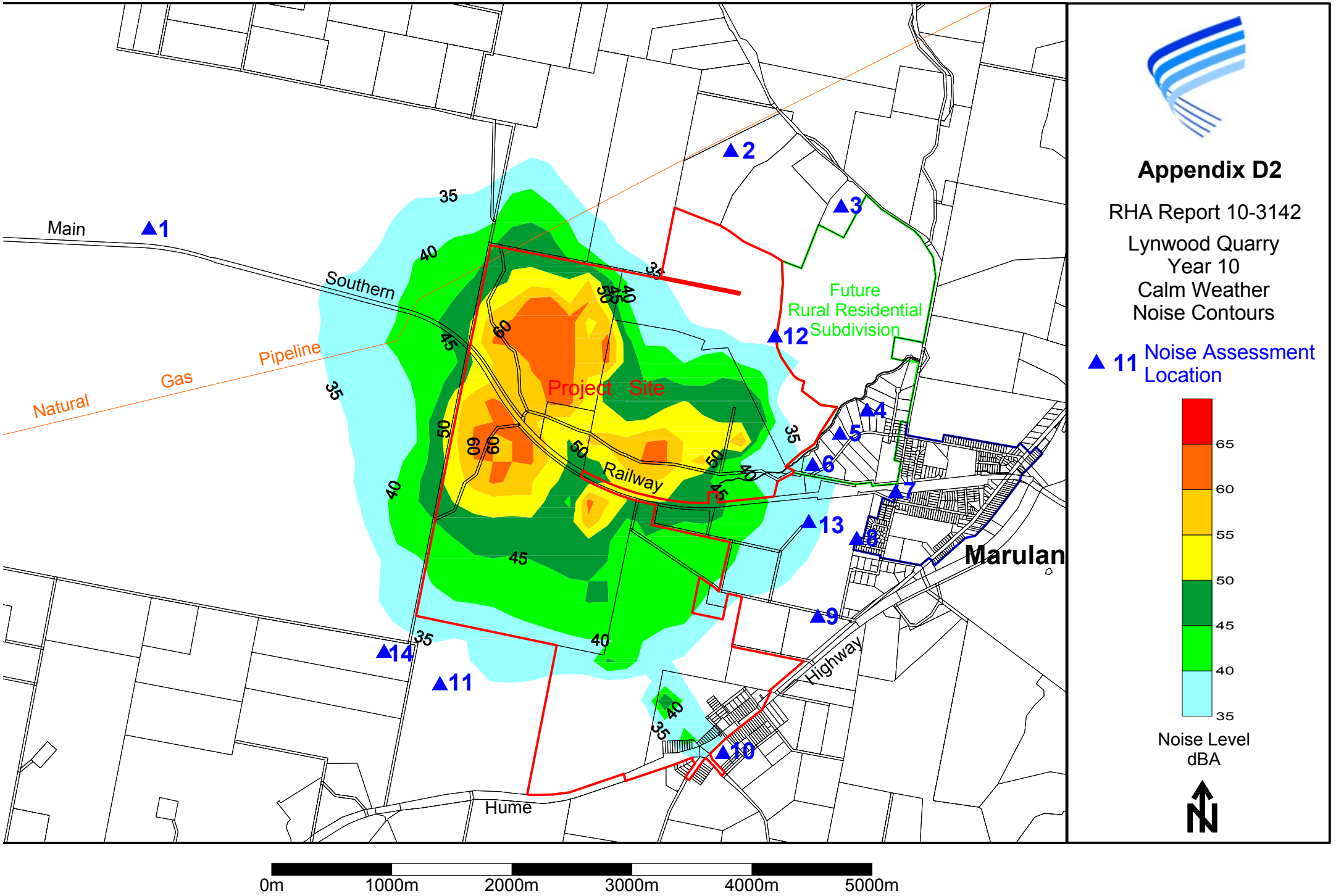
Appendix D2
RHA Report 10-3142
Lynwood Quarry
Year 10
Calm Weather
Noise Contours
▲ 11 Noise Assessment Location
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Noise Level dBA
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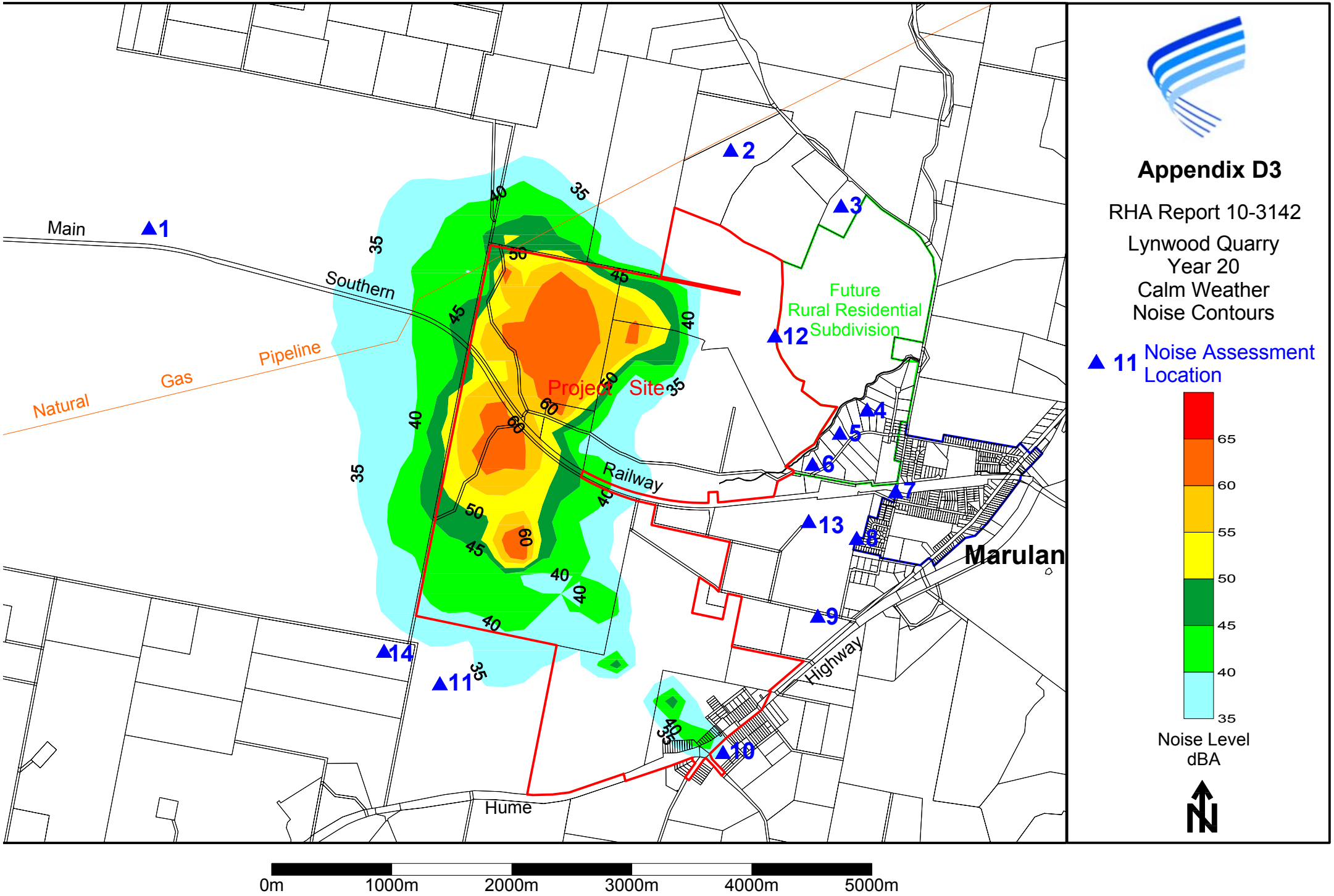
Appendix D3
RHA Report 10-3142
Lynwood Quarry
Year 20
Calm Weather
Noise Contours
▲ 11 Noise Assessment Location
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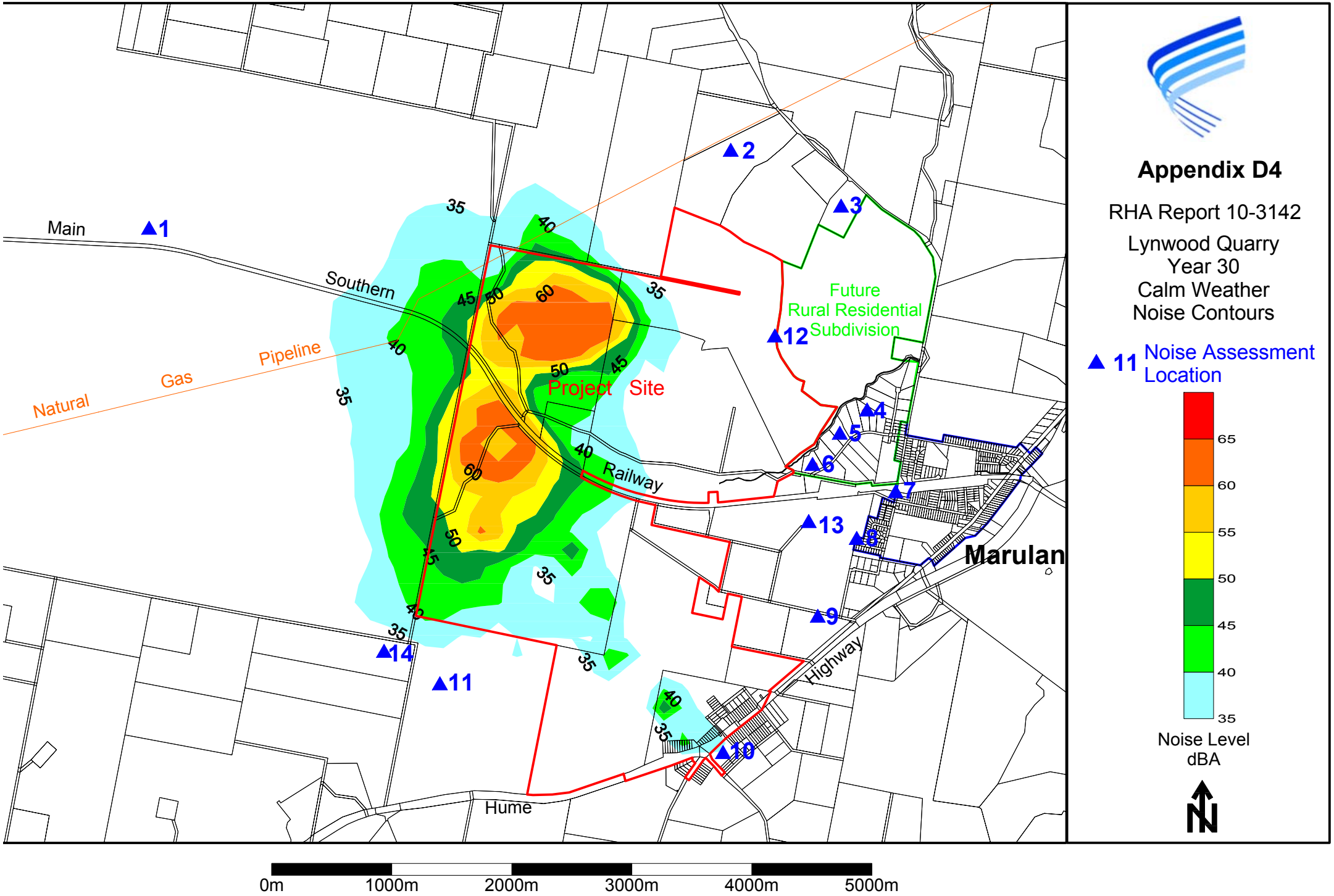
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Appendix D4
RHA Report 10-3142
Lynwood Quarry
Year 30
Calm Weather
Noise Contours
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Noise Level dBA
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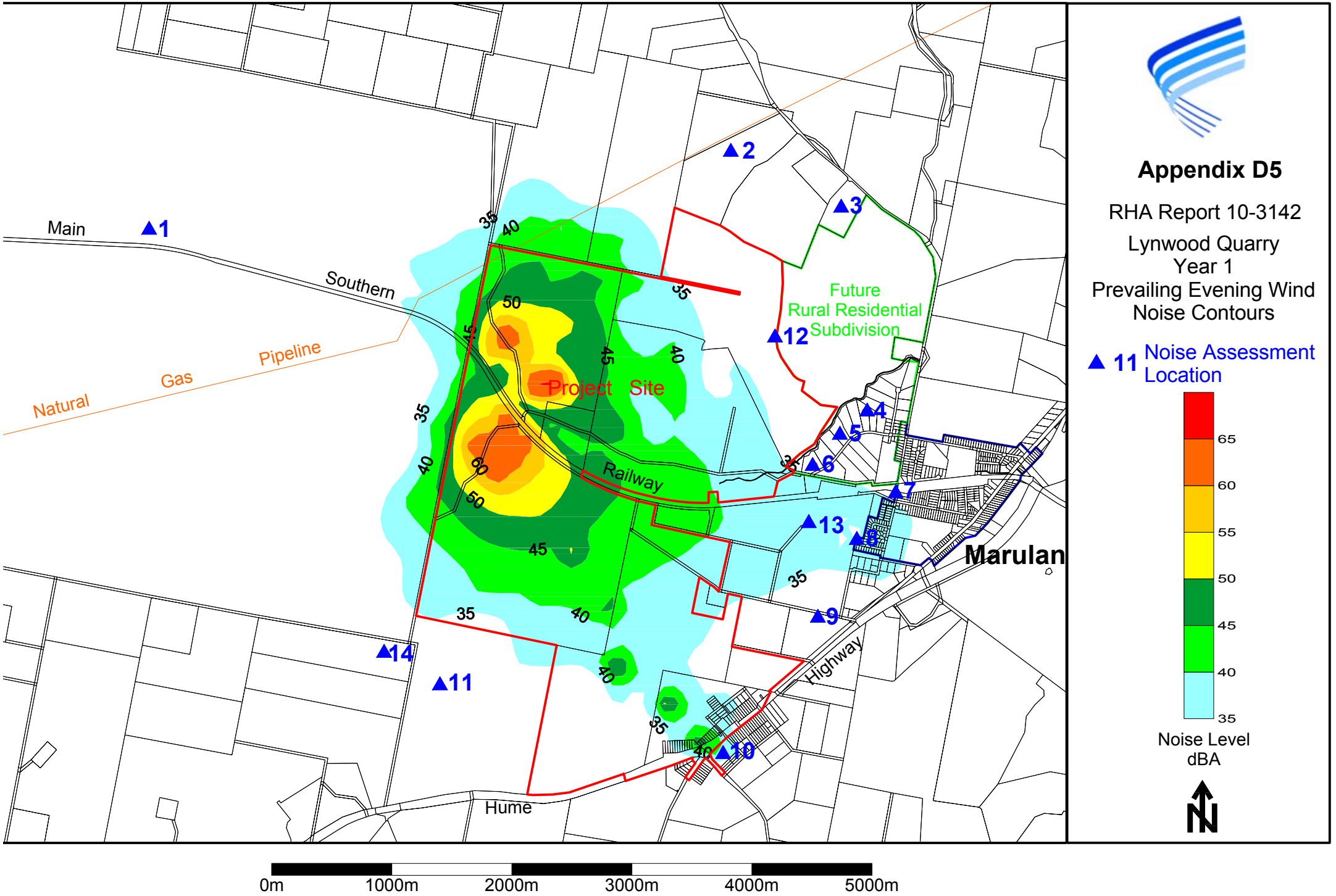
Appendix D5
RHA Report 10-3142
Lynwood Quarry
Year 1
Prevailing Evening Wind
Noise Contours
▲ 11 Noise Assessment Location
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Noise Level dBA
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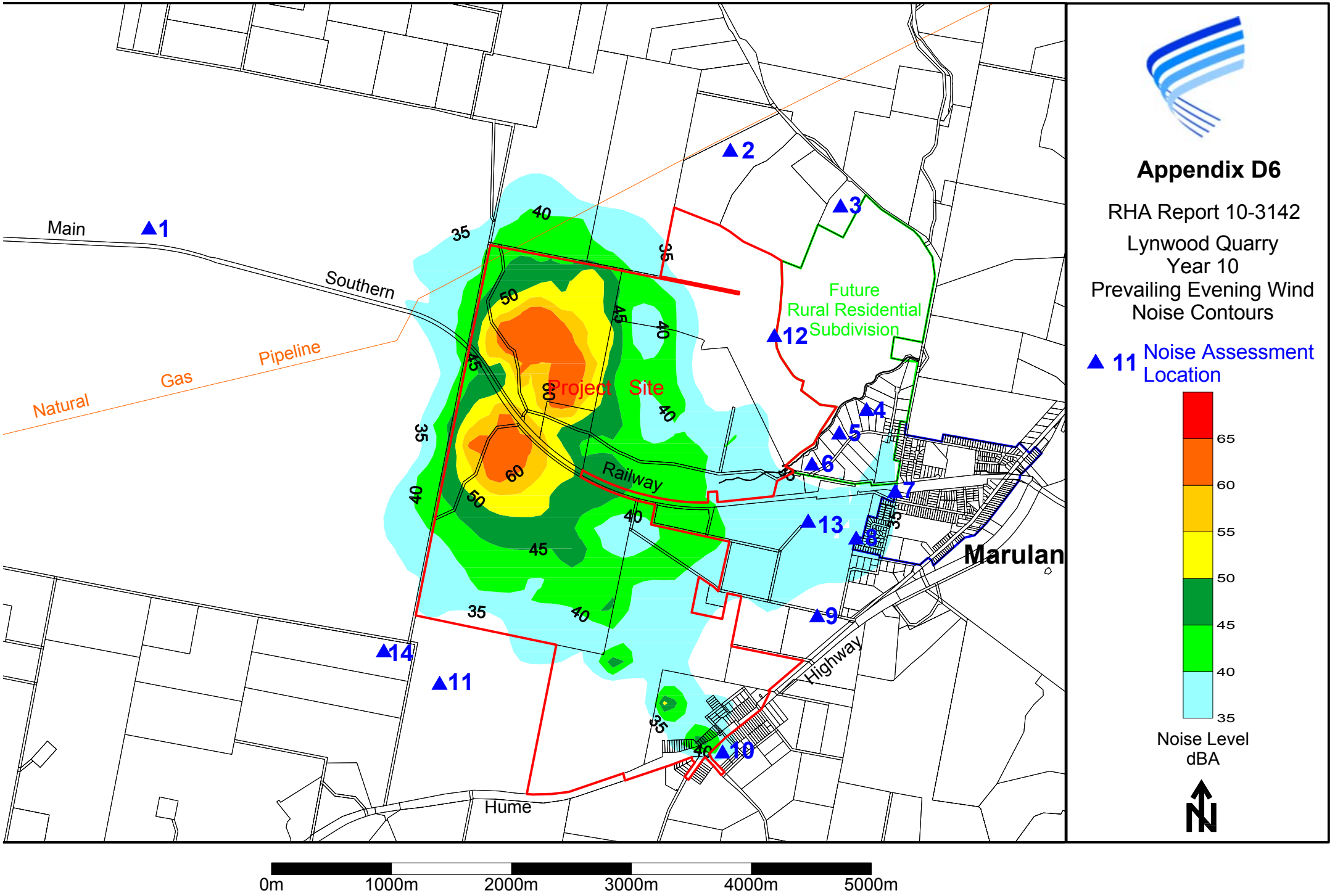
Appendix D6
RHA Report 10-3142
Lynwood Quarry
Year 10
Prevailing Evening Wind
Noise Contours
▲ 11 Noise Assessment Location
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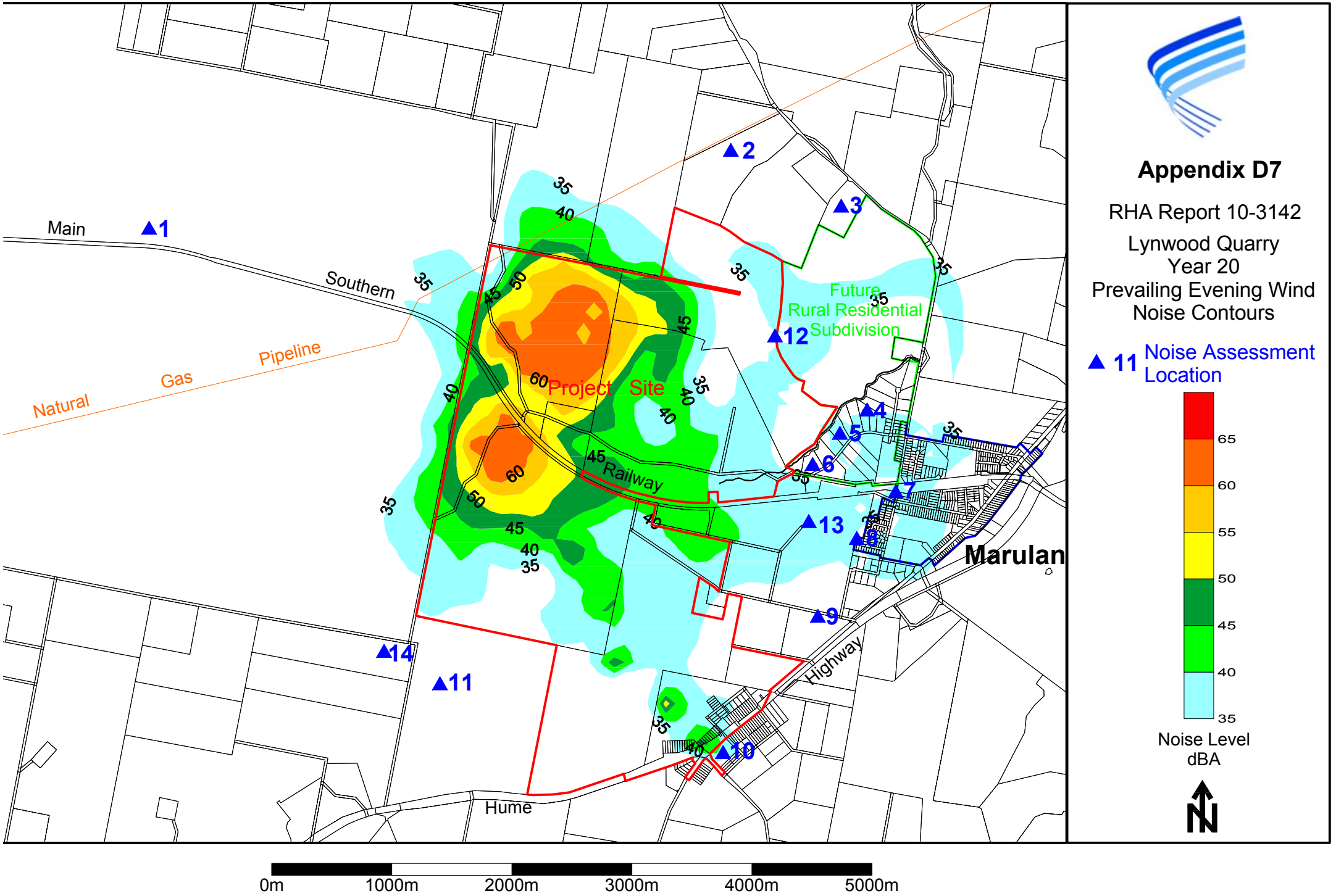
Appendix D7
RHA Report 10-3142
Lynwood Quarry
Year 20
Prevailing Evening Wind
Noise Contours
▲ 11 Noise Assessment Location
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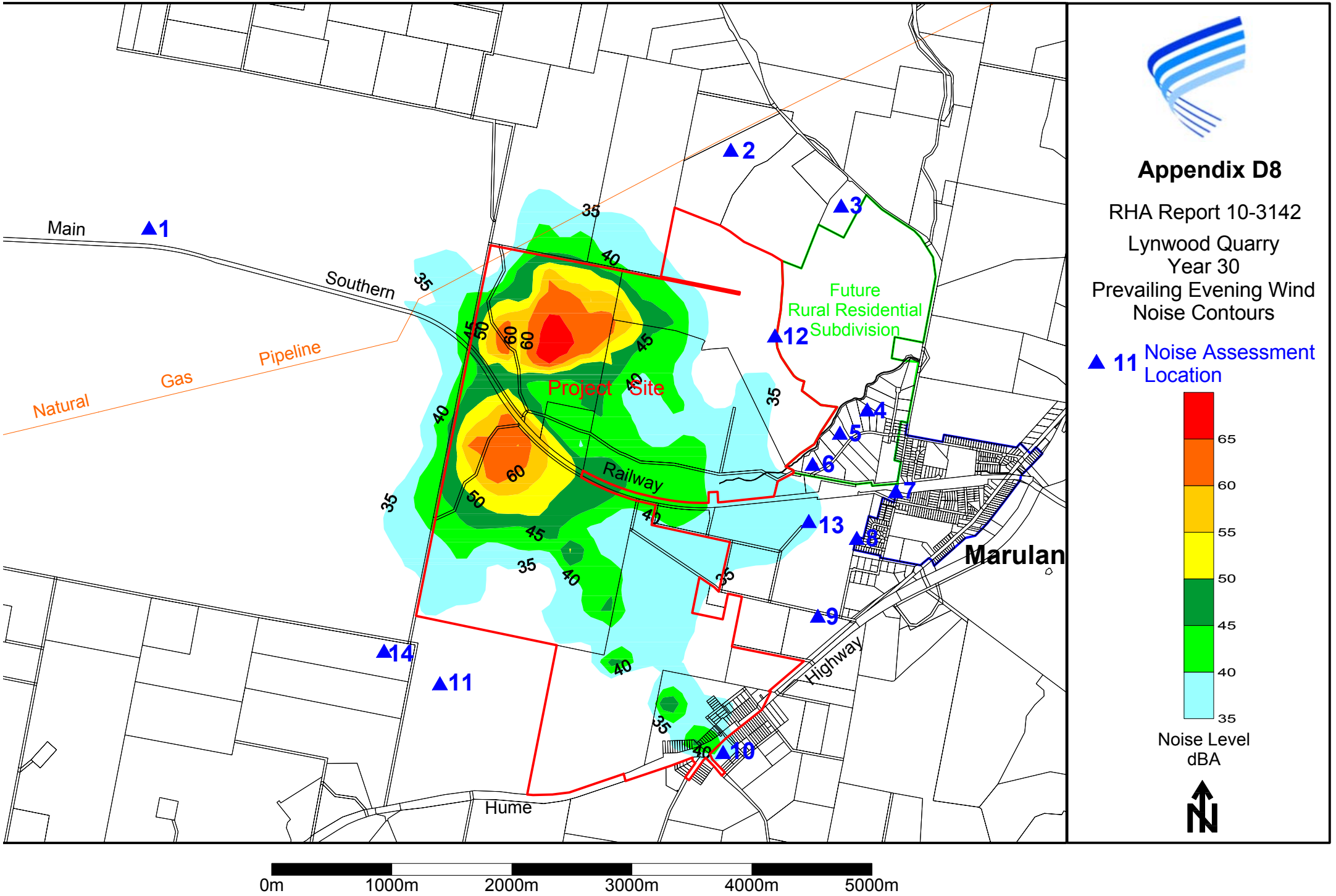
Appendix D8
RHA Report 10-3142
Lynwood Quarry
Year 30
Prevailing Evening Wind
Noise Contours
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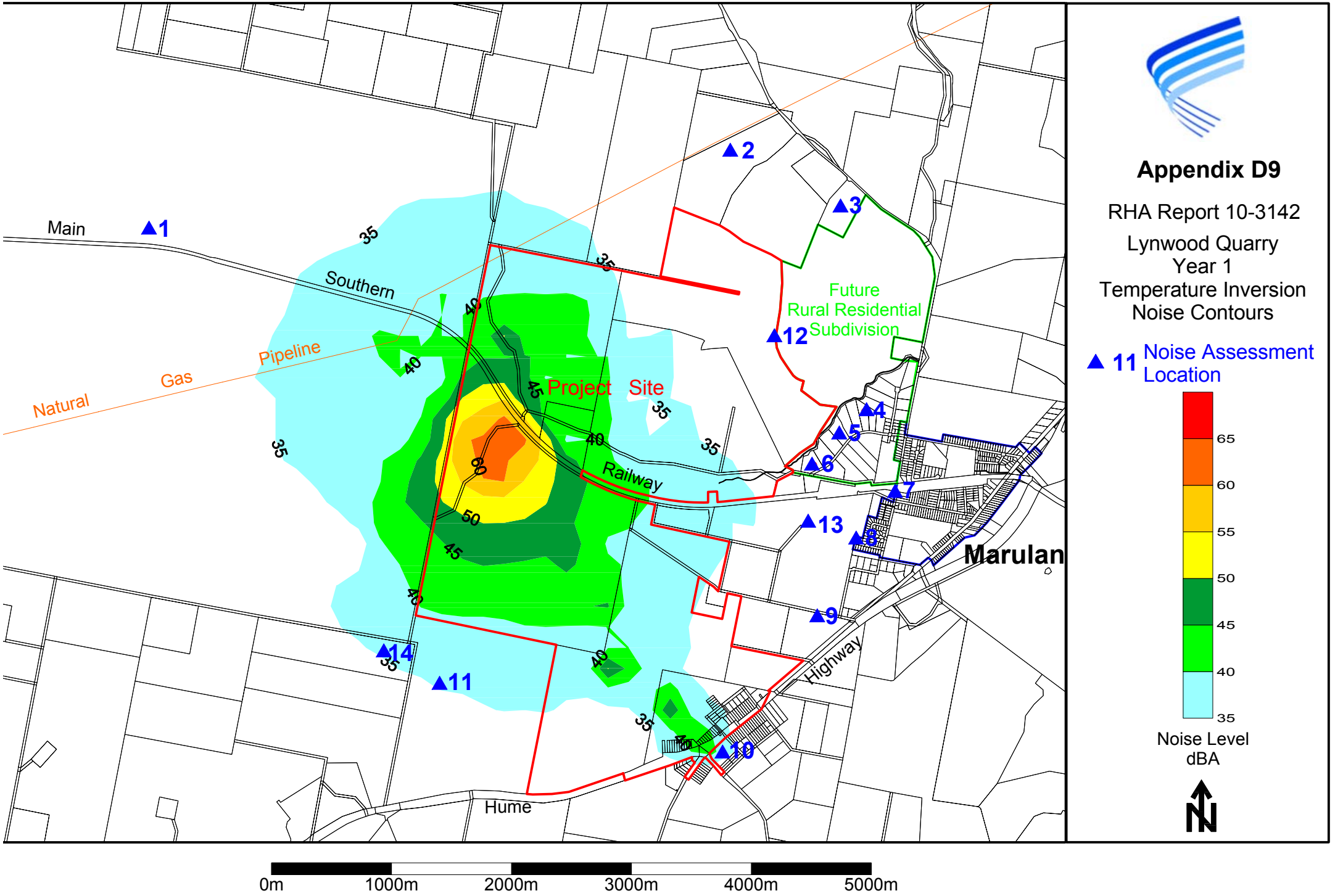
Appendix D9
RHA Report 10-3142
Lynwood Quarry
Year 1
Temperature Inversion
Noise Contours
▲ 11 Noise Assessment Location
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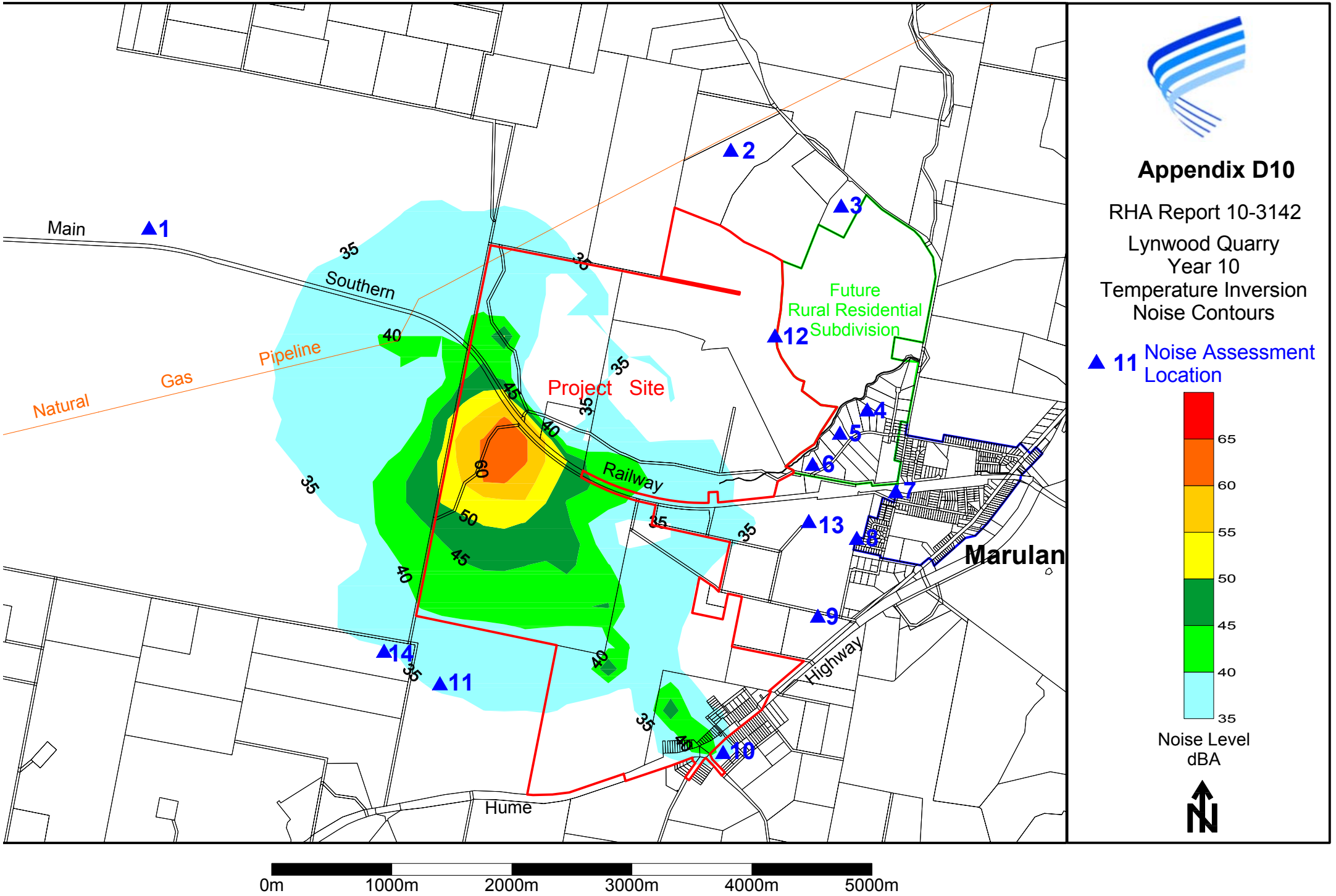
Appendix D10
RHA Report 10-3142
Lynwood Quarry
Year 10
Temperature Inversion
Noise Contours
▲ 11 Noise Assessment Location
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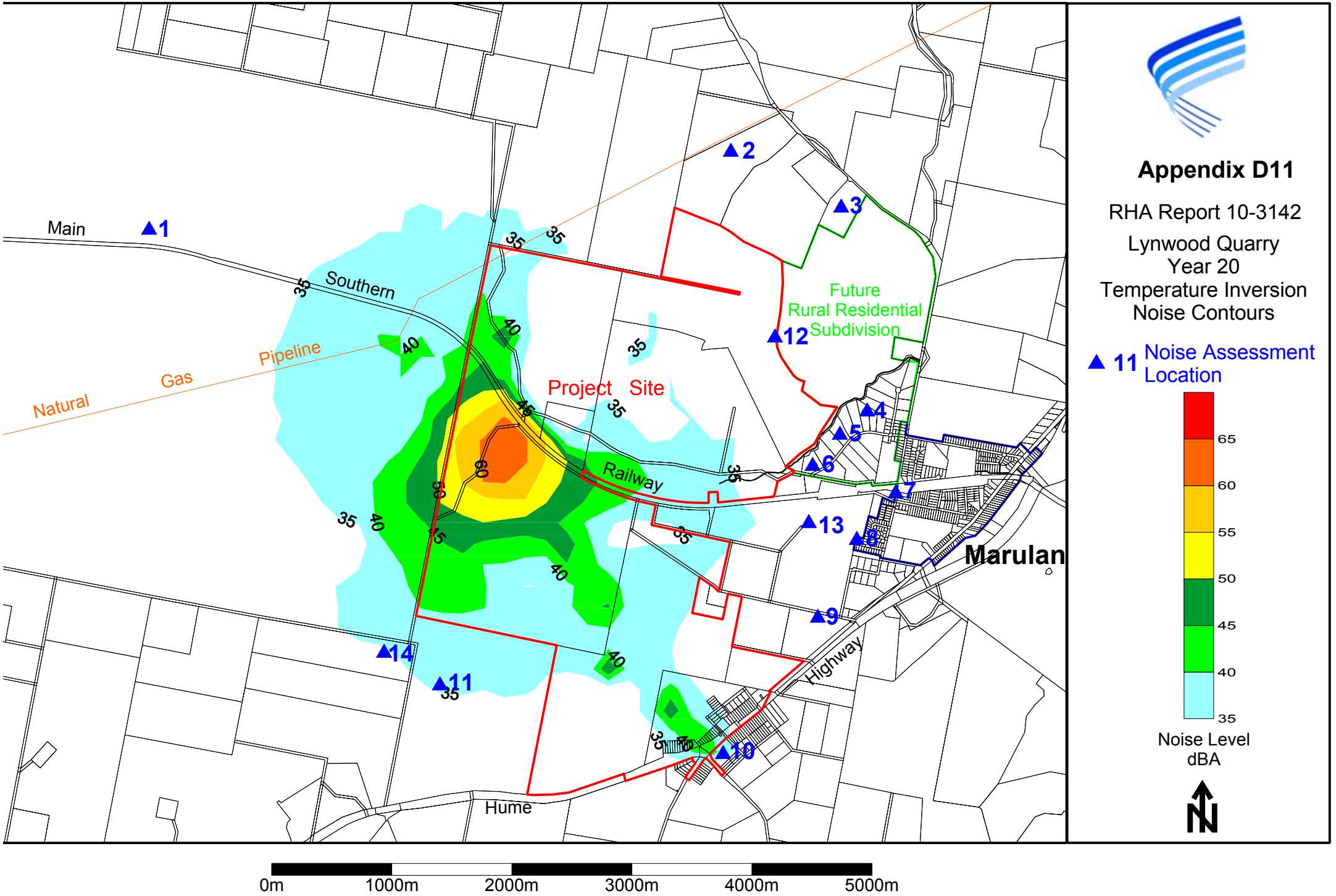
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Appendix D11
RHA Report 10-3142
Lynwood Quarry
Year 20
Temperature Inversion
Noise Contours
▲ 11 Noise Assessment Location
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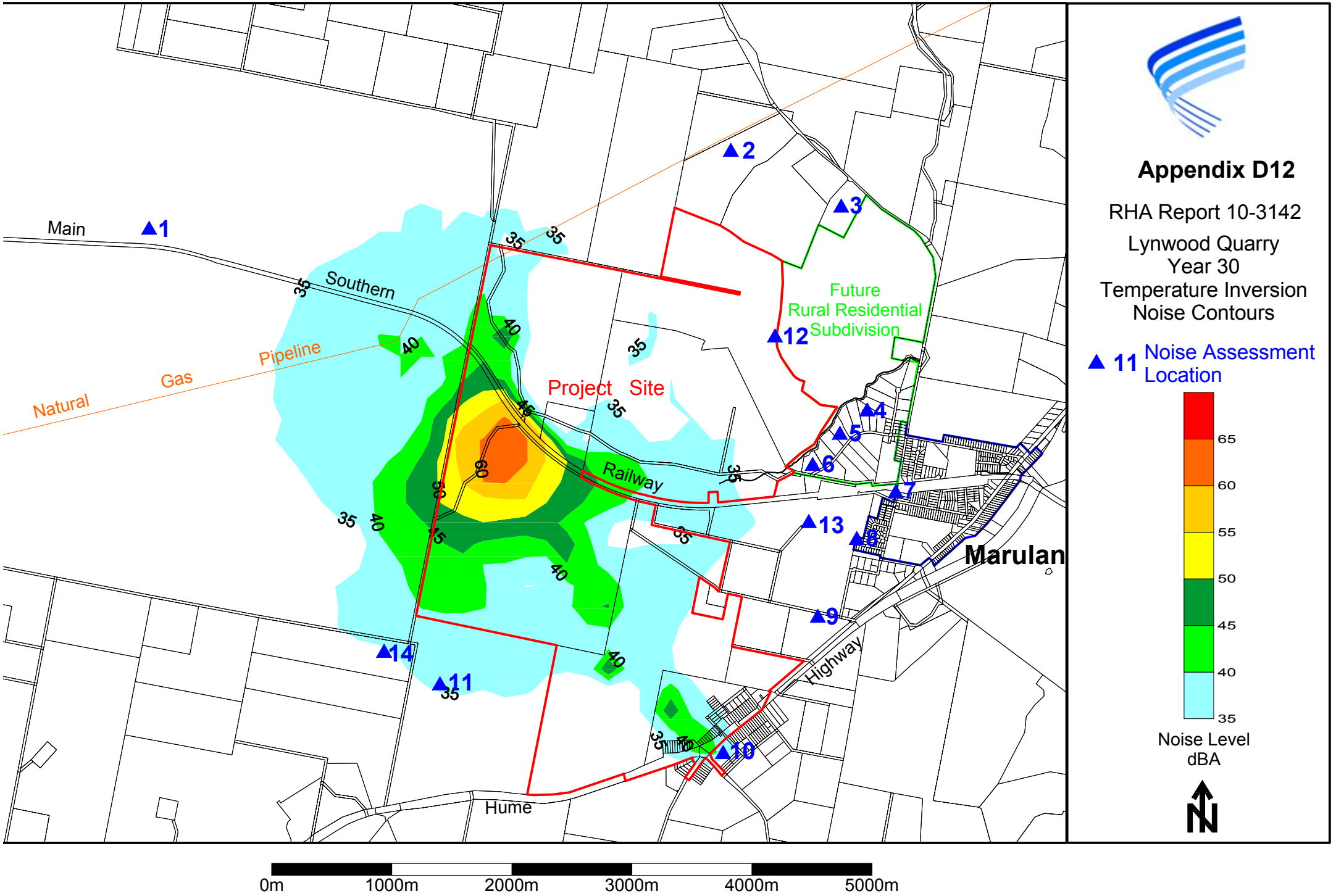
Appendix D12
RHA Report 10-3142
Lynwood Quarry
Year 30
Temperature Inversion
Noise Contours
▲ 11 Noise Assessment Location
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