Noise and Vibration Assessment
Muswellbrook Coal Company
No. 1 Open Cut Extension

Prepared for

Muswellbrook Coal Company Limited

HLA-Envirosciences Project No U888/2

by

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12 June 2002

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EXECUTIVE SUMMARY

A Noise and Vibration Assessment has been conducted for the Muswellbrook Coal Company Limited's No. 1 Open Cut Extension proposal. The study addressed the following noise and vibration issues:

- Noise emissions during operational phases;
- Noise impacts from road transport of coal; and
- Overpressure and vibration from blasting.

Potential impacts from noise and vibration have been assessed against current NSW EPA policy. Noise modelling was conducted using RTA Technology's Environmental Noise Model (ENM) software. This software is well known to the EPA and PlanningNSW. Site-specific equations for blast overpressure and vibration levels have been developed from standard equations with corrections determined from MCC blast data.

Findings and recommendations arising from the assessment are summarised as follows:

Operational Noise

In Year 1 of the proposal (the worst-case year for nearby Muswellbrook residences) noise levels will satisfy the EPA noise criteria, with the exception of potential minor (1-2 dB(A)) exceedances under adverse night-time atmospheric conditions at Locations 12 (Madden) and 13 (McMaster).

It is recommended that a noise monitoring program be carried out at the commencement of operations in the extension area to determine the degree of noise impact. If the measured noise levels are above the noise goals and are also unacceptable to residents, excavation works at ground level should be limited to daytime hours only while the relevant noise-enhancing atmospheric conditions persist, or an engineering solution to reduce noise levels should be sought.

The above recommendation also holds for Year 5, when residences to the south on Muscle Creek Road may experience a similar degree of impact.

As a minimum, it is recommended that residences 10, 13, 14, 15, 17 and 20 should be included in the monitoring program.

Road Traffic Noise

Even considering an unrealistic case in which truck movements double as a result of the Proposal, the night-time traffic noise criterion was found to be met at all residences more than 12m from the haul route. All residences are considerably further from the road than this, so no further assessment of road traffic noise from the proposed No. 1 Open Cut Extension was considered necessary.

Sleep Arousal

The only predicted exceedance of the sleep arousal criterion occurred at Location 20 (Gordon). The level of exceedance is only 1 dB(A) and is caused by rock impacts during excavation works at ground level producing a sound power level of 128 dB(A).

While the likelihood of sleep disturbance is small, excavator/shovel operators should take particular care when loading large rocks onto the back of dump trucks. The noise monitoring program should include measurement of Lmax levels, as well as the Leq levels required to determine compliance with operational noise goals.

Worst-case impact noise levels will reduce by at least 5 dB(A) when the excavator (or shovel) had dug down one bench height, as the source will be immediately behind a wall of earth at least 10 m high.

Blasting

Site-specific attenuation curves developed from historical blast data suggest that EPA overpressure and vibration limits will be easily met by typical blasts with MIC of 200-400kg. Charge weights should not exceed 600kg to ensure compliance with the overpressure limits at the closest residence in Queen Street, Muswellbrook.

We conclude that EPA noise and vibration criteria for the No 1 Open Cut Extension can be achieved if the recommendations given in this report are adopted.

1.0 INTRODUCTION

1.1 The Proposal

Muswellbrook Coal Company (MCC) is seeking to extend operations in the existing No. 1 Open Cut within its currently held mining lease (CCL 713).

The proposal is classified as designated, local development pursuant to Section 76A(4) of the *Environmental Planning and Assessment Act* and as such Muswellbrook Shire Council is the consent authority for the subject Development Application. This Noise and Vibration Assessment has been conducted as required under the Environment Protection Authority (EPA) *NSW Industrial Noise Policy* (INP, 2000).

1.2 Study Area

MCC's No. 1 Open Cut is located on Coal Road, approximately 1.6 km to the east of the nearest residential areas of North Muswellbrook. Muswellbrook is a major regional centre approximately 130 km west of Newcastle.

1.3 Existing Operations

The current MCC mining activities have operated under a succession of mining titles issued under the relevant legislation since operations commenced in 1907.

The existing open cut coal mine produces thermal coal for both export and domestic markets. Coal is hauled by highway trucks along the private haul road to Muscle Creek Road to the Ravensworth Coal Terminal and is then transported by rail to the Port of Newcastle for export. Coal with a higher ash content is hauled from the site to local power stations.

1.4 Proposed Operations

The mine plan allows for the No. 1 Open Cut Extension A (Extension A) to progress in an easterly direction for four or five years. No. 1 Open Cut Extension B (Extension B) envisages operations commencing at the north easterly limit of the identified resource and continue operations in a south westerly direction for five years.

The proposal, when combined with the No. 2 Open Cut operations has the potential to allow mining to continue for up to 10 years at a production rate of up to 1.5 Mtpa. Extension A will intercept underground workings which may provide an alternate entry into the approved Sandy Creek Colliery. The layout of the existing No. 1 Open Cut and Extensions A and B is shown in **Figure 1**.

2.0 DESCRIPTION OF TERMS

This section of the report aims to convey an understanding of several commonly used acoustical terms. Various terms are explained in clear language and the effects of certain atmospheric phenomena on noise propagation are discussed. Noise level percentiles are explained with the aid of a diagram of a hypothetical noise signal.

The descriptions in this section are not formal definitions of the terms. Formal definitions may be found in AS1633-1985 "Acoustics – Glossary of terms and related symbols".

2.1 General Terms

Sound Power Level

The amount of acoustic energy (per second) emitted by a noise source. Usually written as "Lw" or "SWL", the Sound Power Level is expressed in decibels (dB) and cannot be directly measured. Lw is usually calculated from a measured sound pressure level.

Sound pressure Level

The "noise level", in decibels (dB), heard by our ears and/or measured with a sound level meter. Written as "SPL", the sound pressure level generally decreases with increasing distance from a source. Noise levels are often written as dB(A) rather than dB. The "A-weighting" is a correction applied to the measured noise signal to account for the ear's ability to hear sound differently at different frequencies. For example, 40 dB at 500 Hz (speech frequency) is clearly audible but 40 dB at 50 Hz (very low bass) would be far less audible. The A-weighted sound pressure level therefore represents the measured (or predicted) noise level as it would be heard by the typical human ear.

Temperature Inversion

An atmospheric state in which the air temperature increases with altitude. Sound travels faster in warmer air than in cold air, so that during an inversion the top of a "sound wave" will move faster than the bottom. This bends (refracts) sound back towards the ground just as light bends upon entering and exiting a glass prism. The result is a "trapping" of sound energy near the ground and an increase in noise levels.

Wind Shear

A moving air mass will experience a "friction drag" at the ground in much the same way as a lava flow will flow quickly on top and "roll over" the lava beneath which must drag along the ground. This increasing wind speed with altitude is called "wind shear".

For a sound wave travelling down wind, the top of the wave moves faster than the bottom and the wave bends towards the ground. However, for a wave travelling into the wind the top of the wave is slowed down more than the bottom is and the wave bends upwards. **Figure 2** shows several examples of how atmospheric effects can bend sound waves.

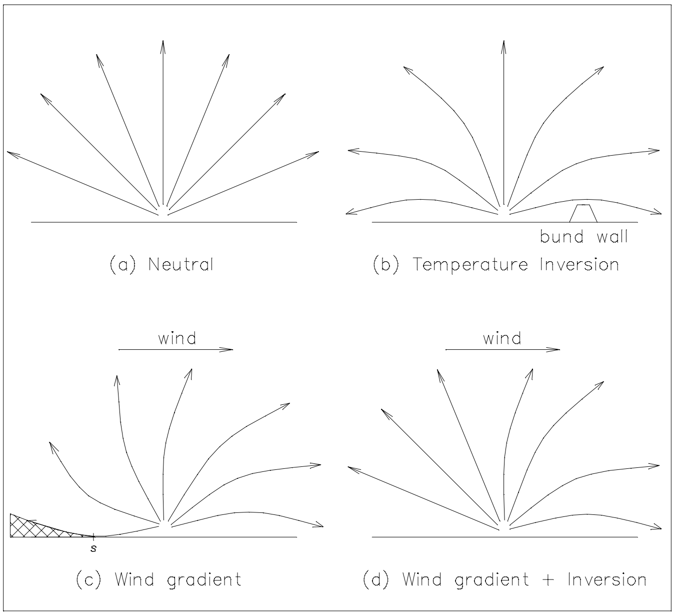


Figure 1. Sound refraction phenomena

Figure 2 shows that sound rays can be refracted over a barrier (usually a bund wall or small hill) during a temperature inversion, greatly increasing noise levels in the 'shadow zone'.

Neutral Atmospheric Conditions

An atmosphere that is at a temperature of approximately 23^0C from ground level to an altitude of 200 m or more. There are no fluctuations in density or humidity and no wind. Such conditions rarely occur, as temperature will usually vary with altitude and there is always movement in various directions in different layers of the atmosphere.

Prevailing Atmospheric Conditions

Atmospheric conditions (with regards to potential effects on noise propagation) which are characteristic of the study area. These will typically include seasonal wind directions and velocities. Temperature inversions will be included as prevailing if they occur, on average, for more than two nights per week in winter.

Adverse Atmospheric Conditions

Adverse conditions will include simultaneous winds and temperature inversions, even if the inversions occur for less than two nights per week in winter. This represents the worst case scenario for potential noise enhancement due to atmospheric effects.

2.2 Noise Level Percentiles

A noise level percentile (Ln) is the noise level (SPL) in decibels which is exceeded for "n" % of a given monitoring period. Several important Ln percentiles will be explained by considering the hypothetical time signal in **Figure 3**.

Figure 3. Hypothetical time signal to illustrate Ln percentiles.

The signal in **Figure 3** has a duration of 2.5 minutes (ie 150 seconds) with noises occurring as follows:

- The person holding the instrument is standing beside a road and hears crickets in nearby grass at a level of around 60 dB (A);
- At about the 30 second mark a motorcycle passes on the road, followed by a car;
- At 60 seconds a truck passes;
- After the truck passes it sounds its air horn at the 73 second mark;
- The crickets are frightened into silence and the truck fades into the distance;
- All is quiet until 105 seconds when the crickets slowly start to make noise, reaching full pitch by 120 seconds;
- The measurement stops at 150 seconds, just when an approaching car starts to become audible.

L1 Noise Level

Near the top of Figure 3, there is a dashed line at 92 dB(A). A small spike of 1.5 sec duration extends above this line at around 73 seconds. As 1.5 sec is 1% of the signal duration (150 seconds) we say that the L1 noise level of this sample is 92 dB(A). The L1 percentile is often called the *average peak noise level* and is used by the NSW EPA as a measure of potential disturbance to sleep.

L10 Noise Level

The dashed line at 82 dB(A) is exceeded for four periods of duration 2.5 sec, 2 sec, 8 sec and 2.5 sec, respectively. The total of these is 15 sec, which is 10% of the total sample period. Therefore, the L10 noise level of this sample is 82 dB(A). The L10 percentile is called the *average maximum noise level* and has been widely used as an indicator of annoyance caused by noise.

L90 Noise Level

In similar fashion to L1 and L10, Figure 3 shows that the noise level of 41 dB(A) is exceeded for 135 seconds (90 + 45 =135). As this is 90% of the total sample period, the L90 noise level of this sample is 41 dB(A). The L90 percentile is called the *background noise level*.

Leq Noise Level

Equivalent continuous noise level. As the name suggests, the Leq of a fluctuating signal is the continuous noise level which, if occurring for the duration of the signal, would deliver equivalent acoustic energy to the actual signal. Leq can be thought of as a kind of ‘average’ noise level. Recent research suggests that Leq is the best indicator of annoyance caused by industrial noise and the EPA *Industrial Noise Policy* takes this into consideration.

Lmax and Lmin Noise Levels

These are the maximum and minimum SPL values occurring during the sample. Reference to **Figure 3** shows these values to be 97 dB(A) and 35 dB(A), respectively.

3.0 THE EXISTING ENVIRONMENT

The existing meteorological and acoustic environments have been studied as part of this EIS. The acoustical climate has been quantified at specific residential locations, whereas the meteorological data are assumed to be consistent over the entire study area.

3.1 Meteorology

The atmospheric conditions most relevant to noise assessments are temperature inversions, gentle winds (indicative of possible wind shear) and relative humidity. From long-term weather monitoring data, the existing environment at this location is well classified. These data are discussed in detail in the EIS document. The following data are the most significant with respect to noise propagation:

- Extremes of relative humidity (RH) are rarely experienced. For modelling purposes, a value of 70% RH was adopted;

- Mild temperature inversions are likely to occur on greater than 25% of mornings and evenings in winter. The EPA default value of +3^{o}C/100 m vertical temperature gradient was adopted in the noise model; and

- Winds are predominantly southeasterly in summer and northwesterly in winter. A wind speed of 3 m/s was modelled to determine the noise impact under 'prevailing' conditions.

3.2 Ambient Noise Levels

Ambient noise monitoring was conducted at five representative residential locations for various time periods between 11 December 2001 and 19 February 2002 in order to obtain at least seven days of valid data normally required under the INP. Noise levels were continuously monitored at 15-minute statistical intervals using Acoustic Research Laboratories EL-215 environmental noise loggers in accordance with relevant EPA guidelines and AS1055-1997 "Acoustics - Description and measurement of environmental noise". Receiver locations around the MCC site are shown in **Figure 4** and described in **Table 1**, where the noise measurement locations are indicated as *N1* to *N5*.

Note that R11 is currently non-residential and R19 is owned by MCC. These locations will therefore not be considered in the following assessment of noise and vibration impacts.

TABLE 1 NOISE RECEIVER LOCATIONS	
Location	Residents
R1	K. Watts
R2	J. French
R3	Reg J. Watts
R4	Reynolds
R5	McKean
R6	V. M. French
R7 (*N1*)	R. G. & G. A. Watts
R8	Aird
R9	Neilsen
R10	R. G. & G. A. Watts
R11	St Heliers Correctional Facility
R12	J. Madden
R13	McMaster
R14	F. Madden
R15 (*N2*)	Collins
R16 (*N3*)	Tuckey
R17 (*N4*)	Colvin
R18	Shephard
R19	Lower Gyarran Cottage (owned by MCC)
R20 (*N5*)	Gordon
R21	Ardee Holdings P/L
R22	M. Bowman
R23	N. Bowman

Table 2 presents a summary of the background noise monitoring results (LA_{90} Assessment Background Levels (ABL) and existing LA_{eq}) recorded at the monitoring locations. Shaded cells represent spuriously high noise levels with no obvious explanation. These data have not been included in the totals to allow for the setting of conservatively low noise goals.

The Rating Background Level (RBL) is the median of the daily ABL's in each assessment period (day/evening/night), over all valid days in the monitoring period. The existing LA_{eq} in each assessment period (day/evening/night) is the logarithmic average of data measured during the relevant period, defined as follows:

Day:	7* am – 6 pm	(*8 am on Sundays and Public Holidays)
Evening:	6 pm – 10 pm	
Night:	10 pm – 7* am	(*8 am on Sundays and Public Holidays)

Graphs of ambient noise data are shown in **Appendix A**.

TABLE 2
MEASURED AMBIENT NOISE LEVELS, dB(A) – DECEMBER 2001 TO FEBRUARY 2002

Watts Residence (*N1*)						
Date	Leq(day)	Leq(eve)	Leq(night)	L90(day)	L90(eve)	L90(night)
11-Dec-01	56.2	52.7	46.7	35.4	34.5	32.5
12-Dec-01	52.9	56.7	42.6	35.0	35.5	34.5
13-Dec-01	43.4	42.5	43.3	30.7	32.8	34.0
14-Dec-01	53.6	47.4	46.8	31.2	33.8	32.0
15-Dec-01	45.4	44.4	39.4	31.5	31.3	31.8
16-Dec-01	49.6	50.4	45.6	31.2	33.5	32.0
17-Dec-01	55.2	50.9	46.4	33.0	36.0	32.8
Log Average	**53**	**52**	**45**	**--**	**--**	**--**
Median (RBL)	**--**	**--**	**--**	**32**	**34**	**33**

Collins Residence (*N2*)						
Date	Leq(day)	Leq(eve)	Leq(night)	L90(day)	L90(eve)	L90(night)
11-Dec-01	47.0	48.5	41.3	36.8	38.8	30.5
12-Dec-01	49.6	57.2	43.4	33.5	31.8	29.0
13-Dec-01	54.0	52.9	44.7	31.0	33.3	30.0
14-Dec-01	58.9	55.1	47.9	30.2	45.8	33.0
15-Dec-01	53.0	57.4	52.0	30.5	48.3	29.8
16-Dec-01	47.1	51.7	45.1	31.7	35.3	30.3
17-Dec-01	48.0	51.6	44.9	31.5	36.5	31.3
Log Average	**51**	**54**	**43**	**--**	**--**	**--**
Median (RBL)	**--**	**--**	**--**	**31**	**34**	**30**

Tuckey Residence (*N3*)						
Date	Leq(day)	Leq(eve)	Leq(night)	L90(day)	L90(eve)	L90(night)
13-Feb-02	44.5	51.6	39.7	33.0	38.0	28.0
14-Feb-02	40.9	47.7	42.4	31.0	36.5	28.5
15-Feb-02	46.9	50.1	39.4	31.0	35.3	28.3
16-Feb-02	49.1	42.4	54.9	32.5	35.5	33.8
17-Feb-02	50.1	49.3	55.1	32.7	37.3	30.5
Log Average	**47**	**49**	**51**	**--**	**--**	**--**
Median (RBL)	**--**	**--**	**--**	**32**	**37**	**29**

No data were recorded for 18 and 19 February at the Tuckey residence (*N3*) due to a flat logger battery, so there are only five days of data instead of the seven days normally required under the INP. However, with the night-time noise goal being the governing criterion, the measured background noise level of 29 dB(A) will result in the lowest noise goal that can be derived with the INP and the acquisition of additional data is not considered necessary.

TABLE 2 (Cont'd)
MEASURED AMBIENT NOISE LEVELS, dB(A) – DECEMBER 2001 TO FEBRUARY 2002

Colvin Residence (*N4*)						
Date	Leq(day)	Leq(eve)	Leq(night)	L90(day)	L90(eve)	L90(night)
12-Dec-01	50.1	52.6	46.4	37.5	41.0	35.0
13-Dec-01	44.8	48.2	45.5	36.2	39.5	37.0
14-Dec-01	56.7	64.8	58.7	37.0	41.8	37.0
15-Dec-01	47.7	54.8	46.1	35.7	38.5	35.0
16-Dec-01	47.2	52.1	45.7	34.5	38.8	35.3
17-Dec-01	47.6	49.8	47.4	37.5	38.0	38.0
18-Dec-01	50.1	48.8	45.9	36.0	41.8	38.8
Log Average	**47**	**49**	**45**	**--**	**--**	**--**
Median (RBL)	**--**	**--**	**--**	**36**	**40**	**37**

Gordon Residence (*N5*)						
Date	Leq(day)	Leq(eve)	Leq(night)	L90(day)	L90(eve)	L90(night)
13-Feb-02	55.7	55.9	54.1	42.5	32.5	31.8
14-Feb-02	56.3	57.5	54.7	39.5	33.8	31.0
15-Feb-02	55.7	55.5	53.2	36.7	33.3	32.5
16-Feb-02	55.2	55.2	53.6	37.2	33.8	33.5
17-Feb-02	54.6	51.8	49.4	41.5	31.3	30.5
18-Feb-02	53.1	49.7	50.2	38.5	36.8	36.5
19-Feb-02	55.5	52.6	50.5	43.5	39.0	37.5
Log Average	**55**	**55**	**53**	**--**	**--**	**--**
Median (RBL)	**--**	**--**	**--**	**40**	**33**	**32**

The above results suggest that the background noise levels at the Colvin residence were elevated by a local influence not present at the Tuckey and Collins residences. No obvious source was identified during installation or retrieval of the noise logger, so it cannot be determined whether the above results are an accurate representation of the ambient noise at this location.

While it is not required under the INP, the background levels at R15 (Collins) will be adopted for R17 (Colvin) for the purposes of setting noise criteria, to account for the possibility of extraneous influences on the measured levels at Colvin.

Also, Section 3.1.2 of the INP states that an RBL of 30 dB(A) is adopted wherever the measured level is less than 30 dB(A). This adjustment applies only to the night-time RBL at residence R16 (Tuckey).

4.0 NOISE AND VIBRATION CRITERIA

4.1 Operational Noise Goals

The INP specifies two noise criteria: an *intrusiveness criterion* which limits Leq noise levels from the industrial source to a value of 'background plus 5dB' and an *amenity criterion* which aims to protect against excessive noise levels where an area is becoming increasingly developed. EPA acceptable industrial noise levels (ANL, as presented in Table 2.1 of the INP) are summarised in **Table 3** below. These values, and the measured existing industrial noise levels, are used to establish the amenity criteria by applying modifications to the ANL's. The modifications are shown in **Table 4** (reproduced from Table 2.2 of the INP).

TABLE 3
EPA RECOMMENDED Leq NOISE LEVELS FROM INDUSTRIAL SOURCES

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended Leq Noise Level, dB(A)	
			Acceptable (ANL)	Recommended Maximum
Residence	Rural	Day	50	55
		Evening	45	50
		Night	40	45
Residence	Suburban	Day	55	60
		Evening	45	50
		Night	40	45
Residence	Urban	Day	60	65
		Evening	50	55
		Night	45	50

Section 2.2.1 of the INP contains guidelines for the selection of noise amenity categories for various land use zones. When considering the proximity of built-up areas and roads, residences 14-17 are in a "suburban" noise amenity area, while the remaining residences are categorised as "rural".

TABLE 4 MODIFICATIONS TO ACCOUNT FOR EXISTING INDUSTRIAL NOISE LEVEL	
Total existing Leq noise level from industrial sources, dB(A)	Maximum Leq noise level for noise from new sources alone, dB(A)
≥ ANL +2	If existing noise level is *likely to decrease* in the future: ANL – 10 If existing noise level is un*likely to decrease* in the future: Existing level – 10
ANL + 1	ANL - 8
ANL	ANL - 8
ANL - 1	ANL - 6
ANL - 2	ANL - 4
ANL - 3	ANL - 3
ANL - 4	ANL - 2
ANL - 5	ANL - 2
ANL - 6	ANL - 1
< ANL - 6	ANL

Operational noise goals calculated in accordance with the INP are shown in **Table 5**. Due to the general absence of significant industrial noise at the receiver locations, existing industrial noise levels will be at least 6 dB(A) below the relevant ANL's and the amenity criteria will be equal to the ANL.

TABLE 5 EPA CRITERIA FOR OPERATIONAL NOISE LEVELS				
Location	Criterion	Day	Evening	Night
R1	Intrusiveness – dB(A),Leq(15 min)	37	39	38
	Amenity – dB(A),Leq(period)	50	45	40
	Project Specific Noise Goal	**37**	**39**	**38**
R2	Intrusiveness – dB(A),Leq(15 min)	37	39	38
	Amenity – dB(A),Leq(period)	50	45	40
	Project Specific Noise Goal	**37**	**39**	**38**
R3	Intrusiveness – dB(A),Leq(15 min)	37	39	38
	Amenity – dB(A),Leq(period)	50	45	40
	Project Specific Noise Goal	**37**	**39**	**38**
R4	Intrusiveness – dB(A),Leq(15 min)	37	39	38
	Amenity – dB(A),Leq(period)	50	45	40
	Project Specific Noise Goal	**37**	**39**	**38**
R5	Intrusiveness – dB(A),Leq(15 min)	37	39	38
	Amenity – dB(A),Leq(period)	50	45	40
	Project Specific Noise Goal	**37**	**39**	**38**

TABLE 5
EPA CRITERIA FOR OPERATIONAL NOISE LEVELS

Location	Criterion	Day	Evening	Night
R6	Intrusiveness – dB(A),Leq(15 min)	37	39	38
	Amenity – dB(A),Leq(period)	50	45	40
	Project Specific Noise Goal	**37**	**39**	**38**
R7 (*N1*)	Intrusiveness – dB(A),Leq(15 min)	37	39	38
	Amenity – dB(A),Leq(period)	50	45	40
	Project Specific Noise Goal	**37**	**39**	**38**
R8	Intrusiveness – dB(A),Leq(15 min)	37	39	38
	Amenity – dB(A),Leq(period)	50	45	40
	Project Specific Noise Goal	**37**	**39**	**38**
R9	Intrusiveness – dB(A),Leq(15 min)	37	39	38
	Amenity – dB(A),Leq(period)	50	45	40
	Project Specific Noise Goal	**37**	**39**	**38**
R10	Intrusiveness – dB(A),Leq(15 min)	37	39	38
	Amenity – dB(A),Leq(period)	50	45	40
	Project Specific Noise Goal	**37**	**39**	**38**
R11	Intrusiveness - dB(A),Leq(15 min)	37	39	38
	Amenity - dB(A),Leq(period)	50	45	40
	Project Specific Noise Goal	**37**	**39**	**38**
R12	Intrusiveness - dB(A),Leq(15 min)	37	39	38
	Amenity - dB(A),Leq(period)	50	45	40
	Project Specific Noise Goal	**37**	**39**	**38**
R13	Intrusiveness - dB(A),Leq(15 min)	37	39	38
	Amenity - dB(A),Leq(period)	50	45	40
	Project Specific Noise Goal	**37**	**39**	**38**
R14	Intrusiveness - dB(A),Leq(15 min)	42	40	40
	Amenity - dB(A),Leq(period)	55	45	40
	Project Specific Noise Goal	**42**	**40**	**40**
R15 (N2)	Intrusiveness - dB(A),Leq(15 min)	37	42	35
	Amenity - dB(A),Leq(period)	55	45	40
	Project Specific Noise Goal	**37**	**42**	**35**
R16 (N3)	Intrusiveness - dB(A),Leq(15 min)	37	42	35
	Amenity - dB(A),Leq(period)	55	45	40
	Project Specific Noise Goal	**37**	**42**	**35**
R17 (N4)	Intrusiveness - dB(A),Leq(15 min)	37	42	35
	Amenity - dB(A),Leq(period)	55	45	40
	Project Specific Noise Goal	**37**	**42**	**35**

TABLE 5
EPA CRITERIA FOR OPERATIONAL NOISE LEVELS

Location	Criterion	Day	Evening	Night
R18	Intrusiveness - dB(A),Leq(15 min)	45	38	37
	Amenity - dB(A),Leq(period)	50	45	40
	Project Specific Noise Goal	**45**	**38**	**37**
R19	Intrusiveness - dB(A),Leq(15 min)	45	38	37
	Amenity - dB(A),Leq(period)	50	45	40
	Project Specific Noise Goal	**45**	**38**	**37**
R20 (N5)	Intrusiveness - dB(A),Leq(15 min)	45	38	37
	Amenity - dB(A),Leq(period)	50	45	40
	Project Specific Noise Goal	**45**	**38**	**37**
R21	Intrusiveness - dB(A),Leq(15 min)	45	38	37
	Amenity - dB(A),Leq(period)	50	45	40
	Project Specific Noise Goal	**45**	**38**	**37**
R22	Intrusiveness - dB(A),Leq(15 min)	45	38	37
	Amenity - dB(A),Leq(period)	50	45	40
	Project Specific Noise Goal	**45**	**38**	**37**
R23	Intrusiveness - dB(A),Leq(15 min)	45	38	37
	Amenity - dB(A),Leq(period)	50	45	40
	Project Specific Noise Goal	**45**	**38**	**37**

The above noise goals are to be satisfied during prevailing conditions of winds and mild temperature inversions. Chapter 4 of the INP also lists several "modifying factor" adjustments to be added to predicted (or measured) noise levels if the noise contains annoyance characteristics such as tones and low frequency content, or if the noise is intermittent in nature. A scanned copy of INP Table 4.1 describing these modifying factors is shown below.

Table 4.1. Modifying factor corrections

(See definitions in *Section 4.2*)

Factor	Assessment/ measurement	When to apply	Correction[1]	Comments
Tonal noise	One-third octave or narrow band analysis	Level of one-third octave band exceeds the level of the adjacent bands on both sides by: —5 dB or more if the centre frequency of the band containing the tone is above 400 Hz —8 dB or more if the centre frequency of the band containing the tone is 160 to 400 Hz inclusive —15 dB or more if the centre frequency of the band containing the tone is below 160 Hz	5 dB[2]	Narrow-band frequency analysis may be required to precisely detect occurrence
Low frequency noise	Measurement of C-weighted and A-weighted level	Measure/assess C- and A-weighted levels over same time period. Correction to be applied if the difference between the two levels is 15 dB or more	5 dB[2]	C-weighting is designed to be more responsive to low-frequency noise
Impulsive noise	A-weighted fast response and impulse response	If difference in A-weighted maximum noise levels between fast response and impulse response is greater than 2 dB	Apply difference in measured levels as the correction, up to a maximum of 5 dB.	Characterised by a short rise time of 35 milliseconds (ms) and decay time of 1.5 s
Intermittent noise	Subjectively assessed	Level varies by more than 5 dB	5 dB	Adjustment to be applied for **night-time only.**
Duration	Single-event noise duration may range from 1.5 min to 2.5 h	One event in any 24-hour period	0 to –20 dB(A)	The acceptable noise level may be increased by an adjustment depending on duration of noise. (See *Table 4.2*)
Maximum adjustment	Refer to individual modifying factors	Where two or more modifying factors are indicated	Maximum correction of 10 dB(A)[2] (excluding duration correction)	

Notes:
1. *Corrections to be added to the measured or predicted levels.*
2. *Where a source emits tonal and low-frequency noise, only one 5-dB correction should be applied if the tone is in the low-frequency range.*

4.2 Sleep Arousal

To help protect against people waking from their sleep, the EPA recommends that 1-minute L1 noise levels (effectively, the Lmax noise level from impacts, etc) should not exceed the background level by more than 15dB(A). The sleep arousal criterion at each receiver location is equal to the intrusiveness criteria presented in Table 11 plus 10dB(A), and applies to Lmax noise emissions.

4.3 Road Traffic Noise

Additional road traffic generated by the proposal, and travelling on public roads, has the potential to increase traffic noise levels at residences along the affected road. Base traffic noise goals given in the EPA *Environmental Criteria for Road Traffic Noise* (ECRTN) are 55 dB(A),Leq(day) and 50 dB(A),Leq(night).

Measured noise levels near the Gordon residence (*N5*, see Table 2) were 55 dB(A) and 53 dB(A) for day and night, respectively. The logger was placed approximately 3m from the edge of Muscle Creek Road, which forms part of the MCC coal haul route. Trucking was observed to be active during deployment and retrieval of the logger and, due to the relative consistency of the Leq noise levels, is likely to have been the source of Leq levels during the monitoring period.

The day and night ECRTN criteria will therefore be met at 3 m and 6 m from the road, respectively, based on the same number of truck movements. Even considering an unrealistic case in which truck movements double as a result of the proposed No. 1 Open Cut Extension, the night-time traffic noise criterion will be met at all residences more than 12m from the haul route. All residences are further from the road than this, so no further assessment of road traffic noise from the Proposal is considered necessary.

4.4 Blasting

4.4.1 Annoyance Criteria

Noise and vibration levels from blasting are assessable against criteria proposed by the Australian and New Zealand Environment and Conservation Council (ANZECC) in their publication *"Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration – September 1990"*. These criteria are summarised as follows:

- The recommended maximum overpressure level for blasting is 115 dB;
- The level of 115 dB may be exceeded for up to 5% of the total number of blasts over a 12-month period, but should not exceed 120 dB at any time;
- The recommended maximum Peak Particle Velocity (PPV) for blasting is 5 mm/s; and

- The PPV level of 5 mm/s may be exceeded for up to 5% of the total number of blasts over a 12-month period, but should not exceed 10 mm/s at any time.

4.4.2 Building Damage Criteria

Building damage assessment criteria are nominated in AS 2187.2-1993 *"Explosives – Storage, Transport and Use. Part 2: Use of Explosives"* and summarised in **Table 6**.

TABLE 6
BLASTING CRITERIA TO LIMIT DAMAGE TO BUILDINGS (AS 2187)

Building Type	Vibration Level (mm/s)	Airblast Level (dB re 20 μPa)
Sensitive (and Heritage)	5	133
Residential	10	133
Commercial/Industrial	25	133

The annoyance (ANZECC) criteria are more stringent than the building damage criteria (Table 6) and will be taken as the governing criteria.

5.0 METHODOLOGY

5.1 Operational Noise

Sound power levels of all significant sources associated with the proposed No. 1 Open Cut Extension were measured in full operation on the site during January 2002. Measurements were taken with a Bruel & Kjaer 2260C Investigator sound level meter in general accordance with the sound pressure method detailed in AS2017. Sound power spectra of major noise sources are shown in **Appendix B**.

Assessment of operational noise was conducted using RTA Technology's Environmental Noise Model (ENM) v3.06. The noise sources were modelled at their known (for stationary sources such as the existing crusher) or most exposed (for mobile sources such as trucks, dumps and excavators) positions and noise contours and/or point calculations were generated for the surrounding area. As discussed in **Section 3.1**, modelling was conducted for the following prevailing atmospheric conditions:

- *Inversion* – 10^0C, 70% R.H., $+3^o$C/100m vertical temperature gradient; and

- *Prevailing wind* – 20^0C, 70% R.H., 3m/s wind from NW (winter) and SE (summer).

Scenario A. Year 1: Hydraulic excavator operating in the far north-western corner of the No. 1 Open-Cut Extension, behind a mining face at 10 m below ground. Overburden dumping in No. 1 Open-Cut void. Coal handling/crushing/stockpiling as per existing operations.

No. 2 Open Cut as per existing operations with excavation by hydraulic excavator and shovels, and ripping coal with dozer. No activity on No. 2 Open Cut overburden dump.

Scenario B. As above (Scenario A) except excavator in No. 1 Open Cut Extension operating at ground level above existing highwall.

Scenario C. As above (Scenario B) except excavator operating 20 m below ground level.

Scenario D. Year 5: Mining at ground level in the centre of the extension area (near existing offices). No operations in No. 2 Open-Cut.

Scenarios A to C are potentially the worst case for receivers to the north and west, while scenario D represents the worst case for receivers to the south.

A schematic drawing showing the proposed No. 1 Open Cut Extension boundaries and source locations as used in the noise modelling is shown in **Figure 5**. The sketch shows all sources used in the modelling, and are not all contained in a single scenario. For example different Year 1 scenarios include either Excavator #1 or Excavator #2, whereas Excavator #3 is included in the Year 5 scenario.

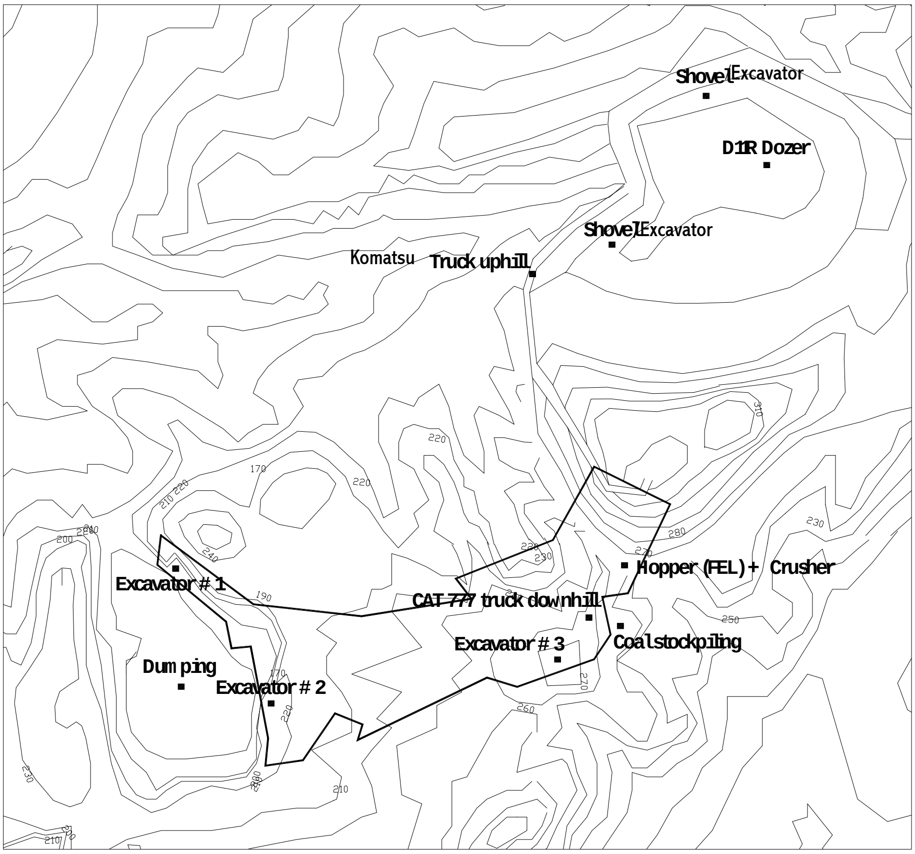


Figure 5. Noise source locations.

5.2 Sleep Arousal

An assessment of Lmax noise impacts from all sources, including reverse beepers, has been conducted. Typical reverse beepers with sound power of 115 dB(A) at 500-1000 Hz were added to the measured Lmax sound pressure level of each source and modelled at the relevant locations. Lmax sound power levels are shown in **Appendix B**. Since all noise measurements were taken with the mobile equipment in full operation, the Lmax levels typically represent such things as rock impacts from an excavator loading a dump truck and various impacts during a dumping cycle.

5.3 Blasting

The following sections provide standard equations for predicting blast overpressure and ground vibration levels, sourced from the United States Bureau of Mines. Blast data from the permanent monitor at Residence 7 (Watts) were analysed to determine suitable correction factors that would align the equations with actual measured results. The modified equations were then used to predict blast overpressure and vibration levels from the proposed No. 1 Open Cut Extension.

5.3.1 Blast Overpressure Levels

Unweighted airblast overpressure levels, OP, are usually predicted from **Equation 1** below.

$$\text{OP} = 165 - 24(\log_{10}(D) - 0.3\log_{10}(Q)),\ \text{dB} \qquad (1)$$

where D is distance from the blast to the assessment point (m) and
Q is the weight of explosive per delay (kg).

Measured overpressure levels from 175 blasts in the No. 2 Open Cut measured after December 2000 reveal a 95th percentile exceedance level of 109.5 dB. Based on a typical charge weight per delay of 200kg ANFO, and average distance of 1700m, Equation 1 gives a value of only 105.7dB. Therefore, a correction factor of +3.8dB was applied to the results of Equation 1 to estimate 95th percentile blast overpressure levels from the Proposal.

5.3.2 Blast Vibration Levels

The basic equations for calculation of peak particle vibration (PPV) levels from blasting are as follows:

$$\text{PPV} = 1140\left(\frac{D}{Q^{0.5}}\right)^{-1.6},\ \text{mm/s} \qquad \text{(average ground type)} \qquad (2)$$

$$\text{PPV} = 500\left(\frac{D}{Q^{0.5}}\right)^{-1.6},\ \text{mm/s} \qquad \text{(Hard rock)} \qquad (3)$$

where D and Q are defined as in Equation 1.

Vibration data from the No. 2 Open Cut blasts reveal a 95th percentile exceedance level of approximately 0.87 mm/s PPV. Equation 2 reproduces this value with the coefficient set to 2550 rather than 1140, suggesting that the ground between the No. 2 Open Cut and the Watts residence (R7) is quite 'elastic' and supports the propagation of ground vibrations. A coefficient of 2550 was used in Equation 2 for predictions of blast vibration levels.

6.0 RESULTS AND DISCUSSION

6.1 Operational Noise Impact

Predicted noise levels for the various operational scenarios and atmospheric conditions are summarised in **Tables 7 to 10**. EPA noise goal exceedances in all Tables in this Section of the report are highlighted in bold type.

Noise contour plots are shown in **Figures 6 to 16**, presented at the end of this report.

It has been assumed that operational noise levels may occur at any time during the day, evening or night so the night-time project specific noise goals in Table 5 have been taken as the governing criteria.

TABLE 7
PREDICTED NIGHT-TIME OPERATIONAL NOISE LEVELS – dB(A),Leq(15-minute)
COAL HANDLING + No 2 OPEN-CUT + **YEAR 1** IN NO. 1 OPEN CUT EXTENSION
EXCAVATOR IN FAR NORTH-WESTERN AREA (Scenario A)

Location	Predicted level			Criterion	Exceedance		
	NW Wind	Inversion	SE Wind		NW Wind	Inversion	SE Wind
(1) K Watts	<25	25	26	38	0	0	0
(2) J French	<25	25	26	38	0	0	0
(3) Reg J Watts	<25	25	26	38	0	0	0
(4) Reynolds	<25	25	27	38	0	0	0
(5) McKean	<25	30	33	38	0	0	0
(6) V M French	<25	34	35	38	0	0	0
(7) R G & G A Watts	<25	34	36	38	0	0	0
(8) Aird	<25	35	37	38	0	0	0
(9) Neilsen	<25	34	36	38	0	0	0
(10) R G & G A Watts	<25	34	36	38	0	0	0
(12) J Madden	<25	36	38	38	0	0	0
(13) McMaster	25	37	39	38	0	0	**1**
(14) F Madden	26	35	39	35	0	0	0
(15) Collins	<25	34	33	35	0	0	0

(16) Tuckey	<25	33	31	35	0	0	0
(17) Colvin	<25	32	25	35	0	0	0
(18) Shephard	25	25	<25	37	0	0	0
(20) Gordon	31	30	<25	37	0	0	0
(21) Ardee Holdings P/L	34	31	<25	37	0	0	0
(22) M Bowman	34	32	<25	37	0	0	0
(23) N Bowman	34	32	<25	37	0	0	0

These results show no noise goal exceedances, with the exception of a 1 dB(A) exceedance at Location 13 under south-east wind conditions.

TABLE 8
PREDICTED NIGHT-TIME OPERATIONAL NOISE LEVELS – dB(A),Leq(15-minute)
COAL HANDLING + No 2 OPEN-CUT + **YEAR 1** IN NO. 1 OPEN CUT EXTENSION
EXCAVATOR OPERATING AT GROUND LEVEL (Scenario B)

Location	Predicted level			Criterion	Exceedance		
	NW Wind	Inversion	SE Wind		NW Wind	Inversion	SE Wind
(1) K Watts	<25	27	28	38	0	0	0
(2) J French	<25	27	28	38	0	0	0
(3) Reg Watts	<25	27	28	38	0	0	0
(4) Reynolds	<25	26	28	38	0	0	0
(5) McKean	<25	32	32	38	0	0	0
(6) V M French	<25	34	35	38	0	0	0
(7) R G & G A Watts	<25	34	36	38	0	0	0
(8) Aird	<25	35	37	38	0	0	0
(9) Neilsen	<25	34	36	38	0	0	0
(10) R G & G A Watts	<25	34	36	38	0	0	0
(12) J Madden	<25	38	39	38	0	0	**1**
(13) McMaster	25	39	40	38	0	**1**	**2**
(14) F Madden	25	36	40	40	0	0	0
(15) Collins	<25	35	35	35	0	0	0
(16) Tuckey	<25	35	34	35	0	0	0
(17) Colvin	<25	34	29	35	0	0	0
(18) Shephard	25	25	<25	37	0	0	0
(20) Gordon	34	30	<25	37	0	0	0
(21) Ardee Holdings P/L	36	31	<25	37	0	0	0
(22) M Bowman	34	32	<25	37	0	0	0
(23) N Bowman	34	32	<25	37	0	0	0

These results suggest that minor noise goals exceedances may be experienced at Locations 12 and 13 during adverse weather conditions.

Table 9 shows predicted noise levels for a few weeks after the above scenario, when the excavator has dug down one bench height (approximately 10 m). Only results for inversions and south-east winds are shown, as these were the atmospheric conditions that produced the minor exceedances shown in **Table 8**.

TABLE 9
PREDICTED NIGHT-TIME OPERATIONAL NOISE LEVELS – dB(A),Leq(15-minute)
COAL HANDLING + No 2 OPEN-CUT + **YEAR 1** IN NO. 1 OPEN CUT EXTENSION
EXCAVATOR OPERATING 10m BELOW GROUND LEVEL (Scenario C)

Location	Predicted level		Criterion	Exceedance	
	Inversion	SE Wind		Inversion	SE Wind
(1) K Watts	27	28	38	0	0
(2) J French	27	28	38	0	0
(3) Reg Watts	27	28	38	0	0
(4) Reynolds	26	28	38	0	0
(5) McKean	32	32	38	0	0
(6) V M French	34	35	38	0	0
(7) R G & G A Watts	34	36	38	0	0
(8) Aird	35	37	38	0	0
(9) Neilsen	34	36	38	0	0
(10) R G & G A Watts	34	36	38	0	0
(12) J Madden	36	38	38	0	0
(13) McMaster	38	39	38	0	**1**
(14) F Madden	34	26	40	0	0
(15) Collins	34	33	35	0	0
(16) Tuckey	33	31	35	0	0
(17) Colvin	32	26	35	0	0
(18) Shephard	25	<25	37	0	0
(20) Gordon	30	<25	37	0	0
(21) Ardee Holdings	31	<25	37	0	0
(22) M Bowman	32	<25	37	0	0
(23) N Bowman	32	<25	37	0	0

These results suggest that a minor 1 dB(A) exceedance may be experienced at Location 13 at night-time during south-easterly winds, once the excavator above the No. 1 Open Cut highwall has dug down one bench height.

TABLE 10
PREDICTED NIGHT-TIME OPERATIONAL NOISE LEVELS – dB(A),Leq(15-minute)
COAL HANDLING + **YEAR 5** IN NO. 1 OPEN CUT EXTENSION
EXCAVATOR OPERATING AT GROUND LEVEL (Scenario D)

Location	Predicted level			Criterion	Exceedance		
	NW Wind	Inversion	SE Wind		NW Wind	Inversion	SE Wind
(1) K Watts	<25	<25	<25	38	0	0	0
(2) J French	<25	<25	<25	38	0	0	0
(3) Reg Watts	<25	<25	<25	38	0	0	0
(4) Reynolds	<25	<25	<25	38	0	0	0
(5) McKean	<25	26	26	38	0	0	0
(6) V M French	<25	27	27	38	0	0	0
(7) R G & G A Watts	<25	29	29	38	0	0	0
(8) Aird	<25	30	30	38	0	0	0
(9) Neilsen	<25	29	29	38	0	0	0
(10) R G & G A Watts	<25	30	30	38	0	0	0
(12) J Madden	<25	35	38	38	0	0	0
(13) McMaster	25	38	39	38	0	0	**1**
(14) F Madden	28	35	36	40	0	0	0
(15) Collins	25	35	35	35	0	0	0
(16) Tuckey	29	35	33	35	0	0	0
(17) Colvin	31	33	28	35	0	0	0
(18) Shephard	31	25	<25	37	0	0	0
(20) Gordon	38	34	<25	37	**1**	0	0
(21) Ardee Holdings P/L	39	35	25	37	**2**	0	0
(22) M Bowman	39	34	<25	37	**2**	0	0
(23) N Bowman	39	34	<25	37	**2**	0	0

The ENM calculations summarised in the above Tables were conducted at octave-band centre frequencies and analysed manually in a spreadsheet to determine the C-weighted minus A-weighted noise levels. This allowed an assessment of the low frequency content of the received noise (see Section 4.1 and INP Table 4.1 on Page 13). Typical C-A levels were in the range 5-10 dB under the noise-enhancing atmospheric scenarios, and up to 12 dB under neutral condition.

The higher C-A levels under neutral conditions reflects the fact that barriers and ground surfaces absorb most efficiently in the mid to high frequency range, thereby increasing the proportion of low frequency noise content. Under noise-enhancing conditions, the effect of barriers and the ground surface is reduced, increasing overall noise levels but decreasing the proportion of low frequency noise.

6.2 Sleep Arousal

Table 11 shows predicted Lmax noise levels at five representative locations, compared with the sleep arousal criteria of 'night-time background level + 15 dB(A)'. In each case the two loudest individual noise sources over *all* modelled scenarios are listed with Lmax in brackets. Predicted criterion exceedances are shown in bold type.

TABLE 11
PREDICTED NIGHT-TIME MAXIMUM NOISE LEVELS – dB(A),Lmax
COAL HANDLING, No 2 OPEN-CUT (NO DUMPING) AND
YEAR 1 IN NO. 1 OPEN CUT EXTENSION
EXCAVATOR(S) AT HIGHEST LEVEL

Location	Criterion	Atmospheric Condition	Sources*
(7) Watts	48	NW Wind	Excavator #2 (27), Truck from No 2 O/C (25)
		Inversion	Excavator #2 (38), Stockpiling coal (35)
		SE Wind	Truck from No 2 O/C (36), Excavator #2 (35)
(14) Madden	50	NW Wind	Excavator #1 (42), Excavator #2 (41)
		Inversion	Excavator #2 (48), Excavator #1 (45)
		SE Wind	Excavator #2 (49), Excavator #1 (47)
(15) Collins	45	NW Wind	Excavator #2 (28), Excavator #1 (28)
		Inversion	Excavator #2 (34), Excavator #1 (32)
		SE Wind	Excavator #2 (36), Excavator #1 (31)
(17) Colvin	50	NW Wind	Excavator #2 (36), Excavator #1 (32)
		Inversion	Excavator #2 (39), Excavator #1 (34)
		SE Wind	Excavator #2 (37), Excavator #1 (28)
(20) Gordon	47	NW Wind	**Excavator #3 (48)**, Coal stockpiling (43)
		Inversion	Excavator #3 (42), Coal stockpiling (39)
		SE Wind	Coal stockpiling (29), Hopper (22)

* *Excavator #1 = Excavator in NW tongue of No 1 Open Cut Extension*
Excavator #2 = Excavator above highwall in No 1 Open Cut Extension
Excavator #3 = Excavator at ground level in Year 5 of No. 1 Open Cut Extension

6.3 Blasting

Site-specific blast overpressure and vibration curves for varying charge weights are shown in **Figures 17 and 18**.

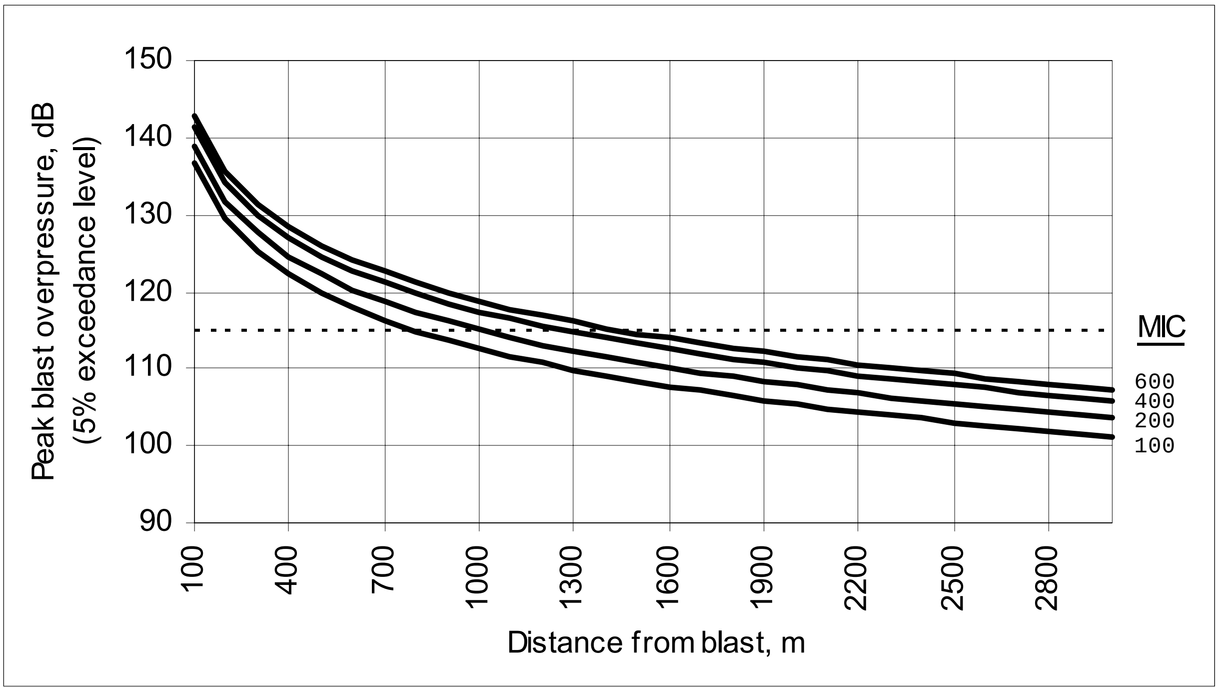


Figure 17. Site-specific blast overpressure curves.

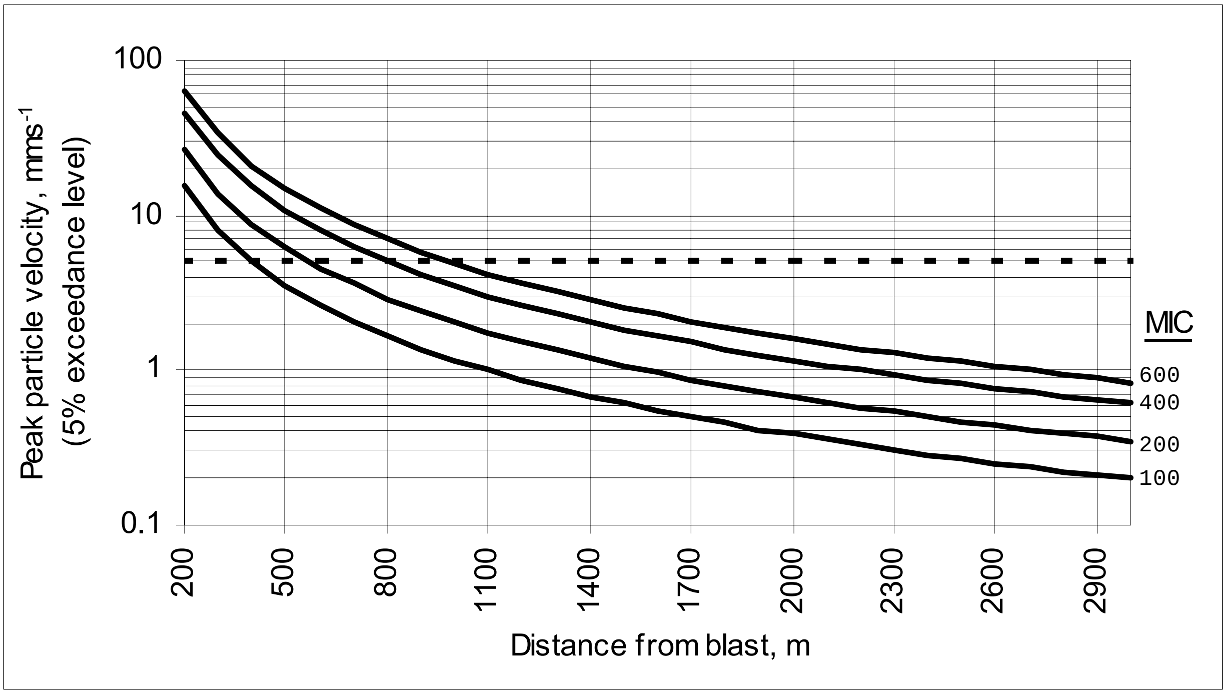


Figure 18. Site-specific blast vibration (PPV) curves.

Table 12 shows predicted 95th percentile blast overpressure and ground vibration levels at several residential locations based on the site-specific curves above for a large blast (maximum instantaneous charge weight of 600 kg). Quoted distances are to the nearest point on the boundary of the proposed extension area, with the exception that no blasting will take place in the north-western tongue of the Year 1 operations.

TABLE 12
PREDICTED IMPACTS FROM BLASTING (95th PERCENTILE*)

Location	Distance, m	Overpressure, dB	PPV, mm/s
R10 – R.G. & G.A. Watts	2800	109	0.95
R13 – McMaster	1900	112	1.7
R14 – Madden	2000	111	1.6
R15 – Collins	1600	114	2.2
R17 – Colvin	1900	112	1.7
R20 – Gordon	3000	108	0.85

* 95th Percentile means 5% of blasts may exceed the values in the table.

6.4 Cumulative Noise Impacts

Results in Section 5 have shown that worst-case noise impacts at Muswellbrook residences will be during winds generally from the southeastern quadrant. Other operating or approved mines nearest to these residences include Bengalla, Mount Pleasant and Dartbrook, which are all further west/north-west. Therefore, under southeasterly winds, these mines will have their lowest noise impact on Muswellbrook residences when MCC is having its greatest impact.

Conversely, nearby mines will have their maximum noise impact on Muswellbrook residences when winds are from the west to north-west. Under these conditions, this study has shown that the noise level contribution from MCC will drop to well below 25 dB(A).

The above considerations suggest that the proposed MCC No 1 Open Cut Extension will not give rise to cumulative noise impacts at Muswellbrook residences.

6.5 Low Frequency Noise/Vibration

The issue of low frequency noise/vibration impact has developed as a real concern with Muswellbrook residents in recent years, with some quite significant cases having been discovered. In all cases, the offending source has been identified as reciprocating machinery (breakers and screens) operating inside coal washing plants. Noise generated in the 16Hz and 31.5Hz third-octave bands has been known to be felt in the ears and body, rather than heard, giving rise to the perception of vibration, rather than noise.

This proposal will result in no changes to the current coal handling operations at MCC, so that any potential for low frequency noise/vibration impact has been present for many years. The phenomenon is usually so intrusive that strong complaints are generated, and the absence of such complaints in relation to MCC's operations suggests that this problem will not emerge as a result of the No 1 Open Cut Extension project.

7.0 RECOMMENDATIONS

7.1 Operational Noise

In Year 1 of the proposal (the worst-case year for nearby Muswellbrook residences) noise levels will satisfy the EPA noise criteria, with the exception of potential minor (1-2 dB(A)) exceedances under adverse night-time atmospheric conditions at Locations 12 (Madden) and 13 (McMaster).

The predicted exceedances are due almost entirely to excavators at ground level working the far western extent of the No. 1 Open Cut Extension. It must be noted here that when the noise measurements were taken, the excavator was handling material with several very large (i.e., greater than 1 m across) rocks and dumping these onto the haul trucks, with maximum noise levels up to 128 dB(A). This contributed to the resulting Leq noise level of 119 dB(A), which was at least 3 dB(A) higher than had previously been measured for a similarly sized excavator.

If such large rocks are not encountered during surface excavations at the western end of the expansion area, the Leq level of an excavator will be a more typical 116 dB(A), and noise goal exceedances are unlikely to occur.

Even allowing for the rocky material and a sound power level of 119 dB(A) as used in the modelling, initial mining operations at the surface may be conducted during daytime hours only, when air temperatures are higher than at night, relative humidity is lower and the atmosphere exhibits a temperature lapse of 1-1.5 ^{0}C/100m altitude. These factors will lower received noise levels by approximately 4-6 dB(A) relative to the predicted night-time levels.

It is recommended that a noise monitoring program be carried out at the commencement of operations in the No. 1 Open Cut Extension area to determine the degree of noise impact. If the measured noise levels are above the noise goals and are also unacceptable to residents, excavation works at ground level should be limited to daytime hours only while the relevant noise-enhancing atmospheric conditions persist, or an engineering solution to reduce noise levels should be sought.

The above recommendation also holds for Year 5, when residences to the south on Muscle Creek Road may experience a similar degree of impact.
As a minimum, it is recommended that residences 10, 13, 14, 15, 17 and 20 should be included in the monitoring program.

7.2 Sleep Arousal

The only predicted exceedances of the sleep arousal criterion occurs at Location 20 (Gordon). The level of exceedances is only 1 dB(A) and is caused by rock impacts during excavation works at ground level producing a sound power level of 128 dB(A). These impact noises are predicted to be only 1-2 dB(A) under the criterion at Location 14 (Madden).

While the likelihood of sleep disturbance is small, excavator/shovel operators should take particular care when loading large rocks onto the back of dump trucks. The noise monitoring program should include measurement of Lmax levels, as well as the Leq levels required to determine compliance with operational noise goals.

Worst-case impact noise levels will reduce by at least 5 dB(A) by the time the excavator (or shovel) has dug down one bench height, as the source will be immediately behind a wall of earth at least 10 m high.

7.3 Blasting

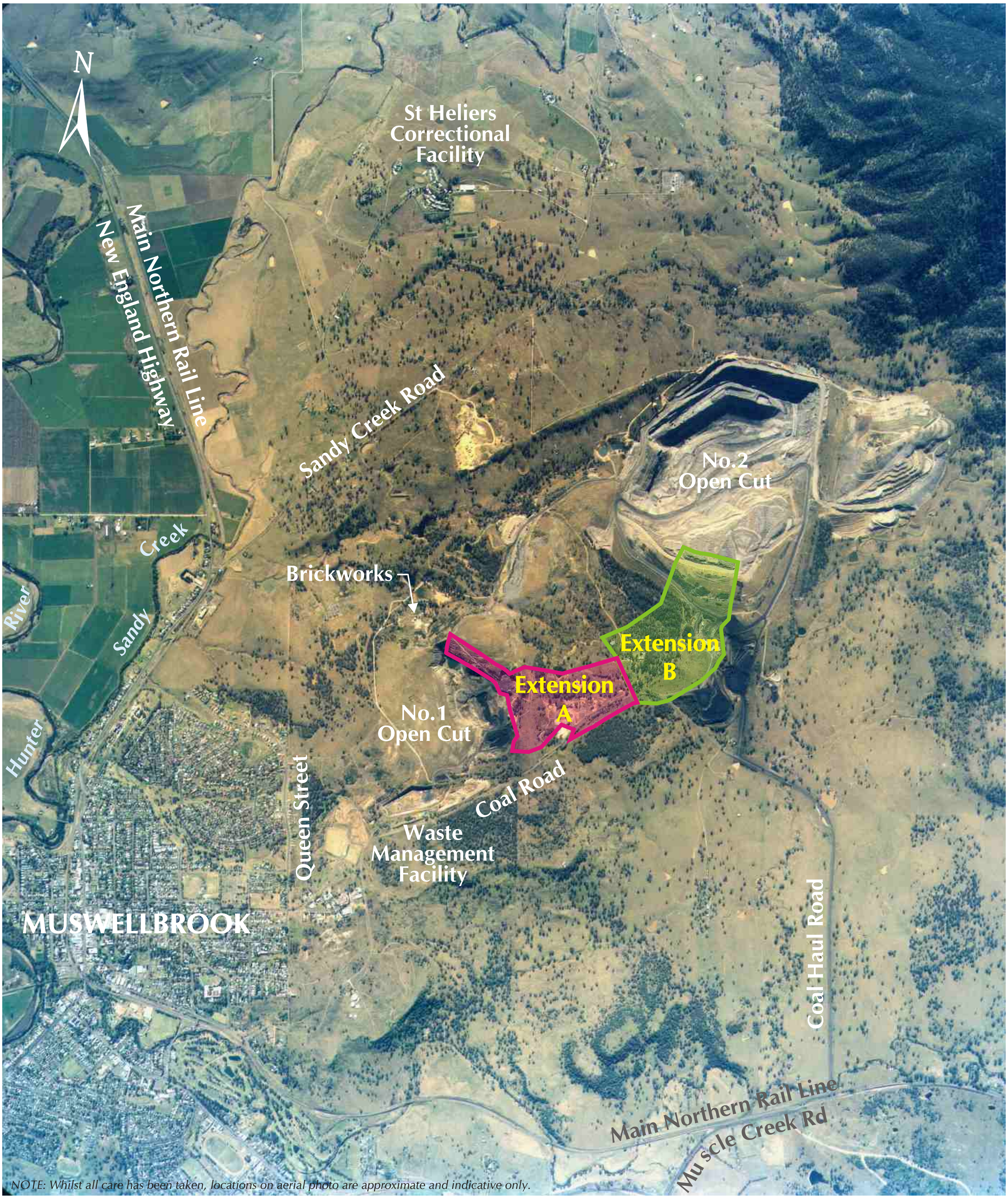
The predicted results in **Table 11** suggest that overpressure and vibration limits will be easily met by typical blasts with MIC of 200-400 kg. Charge weights should not exceed 600 kg to ensure compliance with the overpressure limit of 115 dB(A) at the closest residence (Collins).

8.0 CONCLUSION

An assessment has been conducted to determine the noise and vibration impact of the proposed Muswellbrook Coal Company No. 1 Open Cut Extension project. Modelling results show minor exceedances of night-time noise goals at various residential locations under noise-enhancing atmospheric conditions.

Recommendations have been made with regard to mitigating the predicted noise exceedances. These include regular compliance monitoring and management of noise emissions under adverse weather conditions. Recommendations have also been given regarding noise and vibration compliance monitoring procedures.

We conclude that the proposal can operate without adversely impacting upon the acoustical amenity of any non-mine owned residential receiver.



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MUSWELLBROOK COAL COMPANY LIMITED

Layout of Mining Operations and the No.1 Open Cut Extension

FIGURE 1

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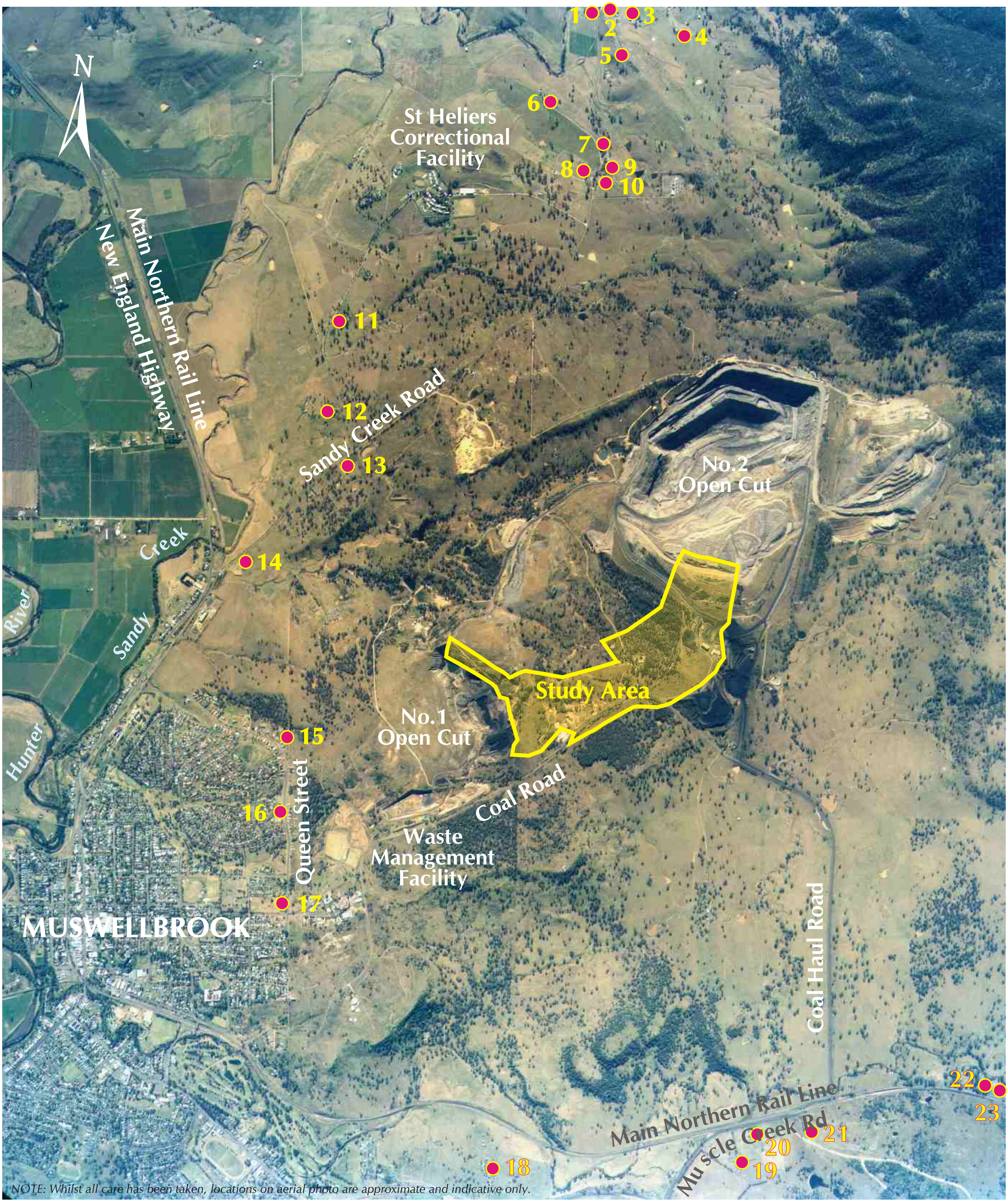
Search

Appendices



LEGEND

8 ● Denotes Residence

SCALE

0 1 2

Kilometres

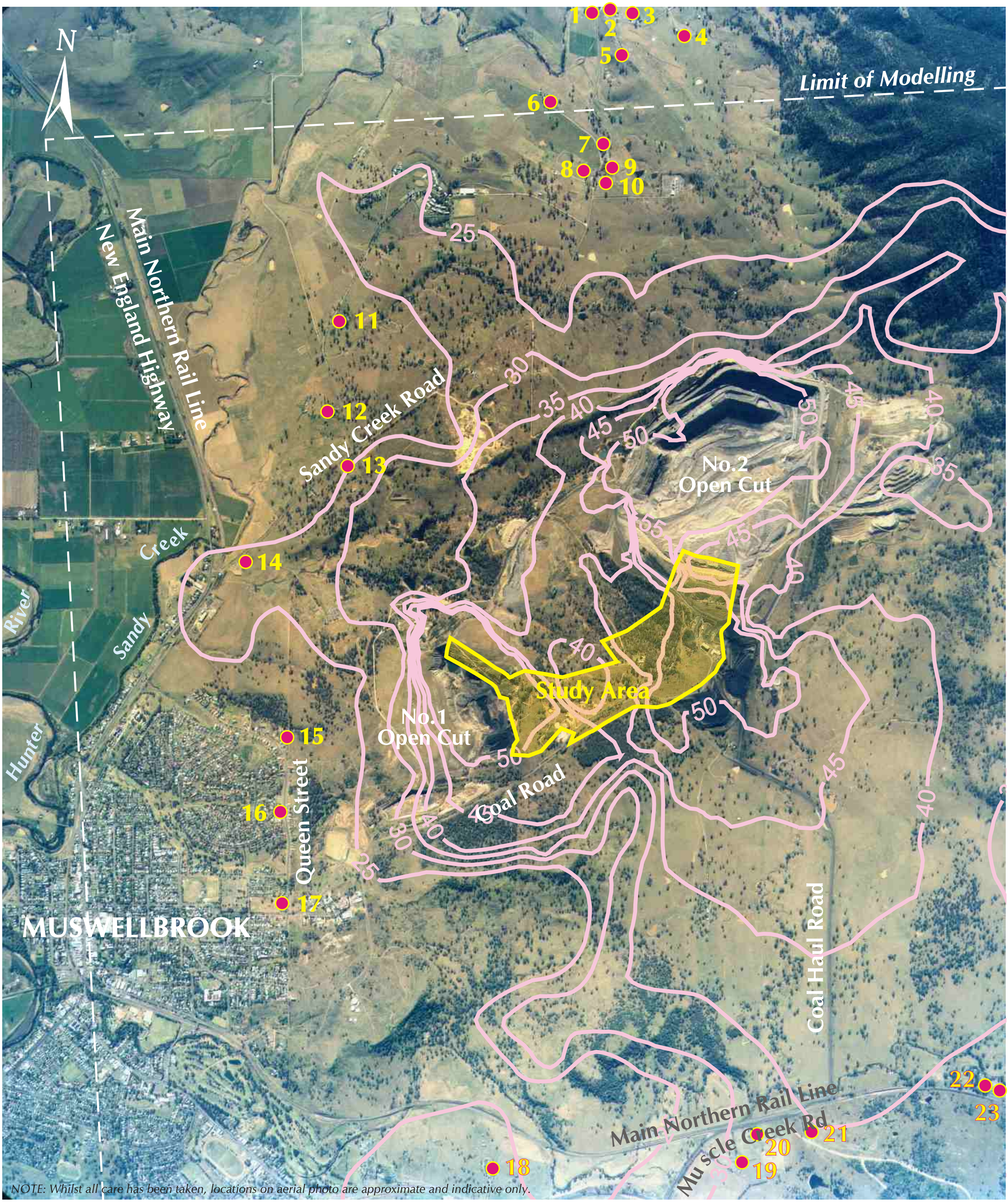
MUSWELLBROOK COAL COMPANY LIMITED

Residences

FIGURE 4

File Name: RESIDENCES.CDR

Start Screen | Search | Appendices



LEGEND

8 ● Denotes Residence

Noise Contour dB(A), L_{eq}

SCALE

0 1 2

Kilometres

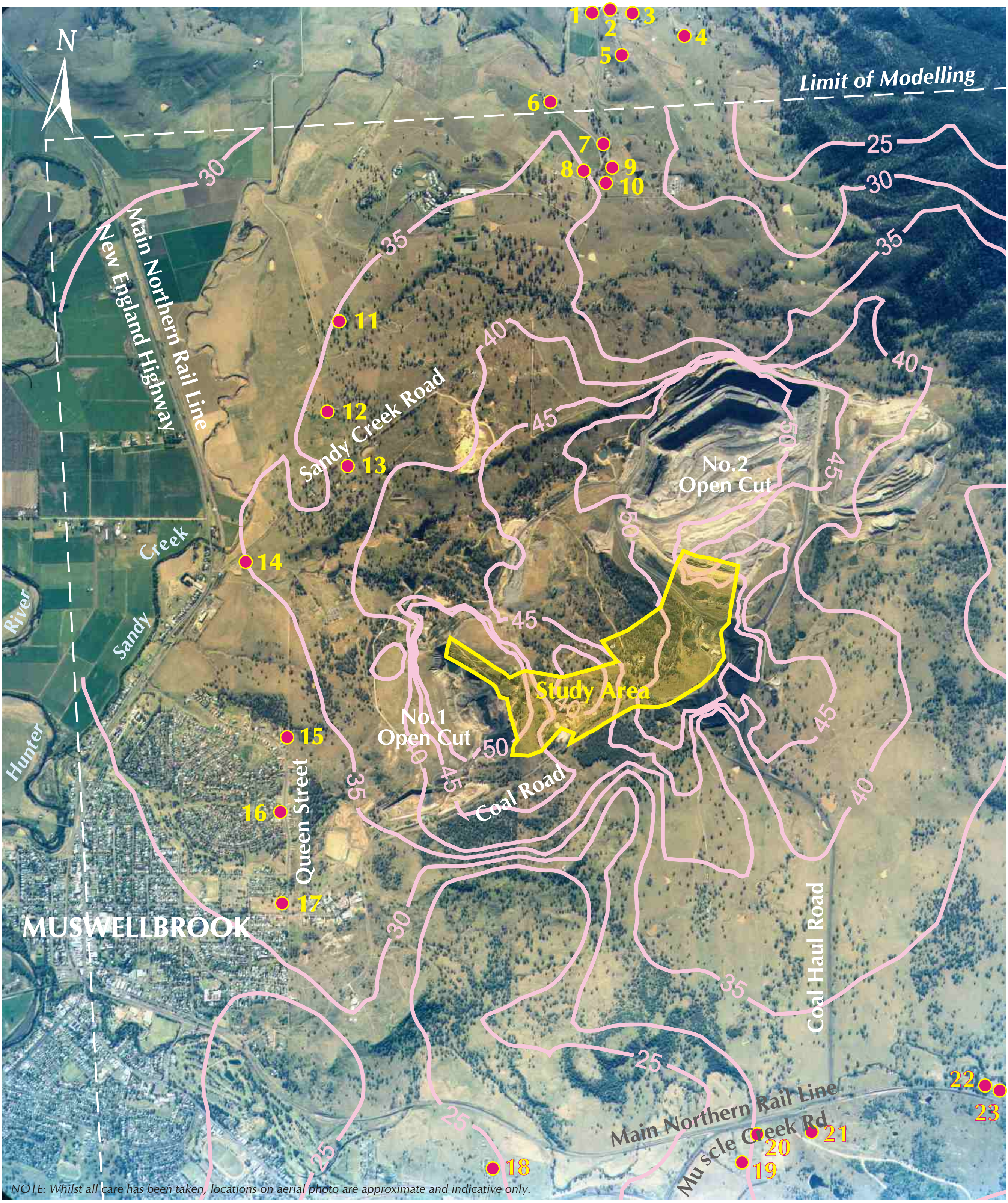
File Name: Y1DLEQNW.CDR

MUSWELLBROOK COAL COMPANY LIMITED

Noise Contours: Year 1 - Excavator in NW Tongue 10m Below Ground

NW Wind

FIGURE 6



LEGEND

8 ● Denotes Residence

Noise Contour dB(A), L_{eq}

SCALE

0 1 2

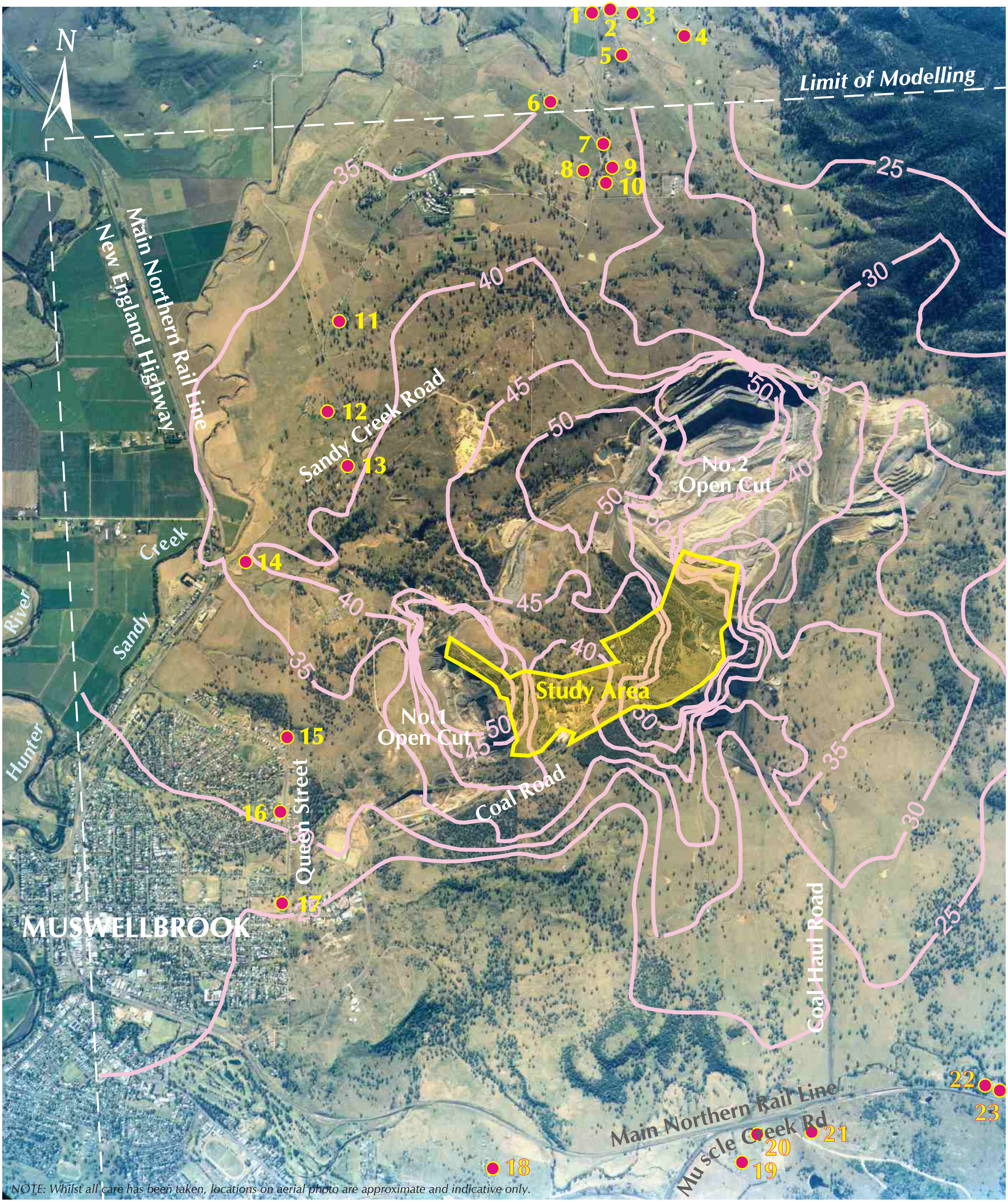
Kilometres

File Name: Y1DLEQIN.CDR

MUSWELLBROOK COAL COMPANY LIMITED

Noise Contours: Year 1 - Excavator in NW Tongue 10m Below Ground Inversion

FIGURE 7



LEGEND

8 ● Denotes Residence

Noise Contour dB(A), L_{eq}

SCALE

0 1 2

Kilometres

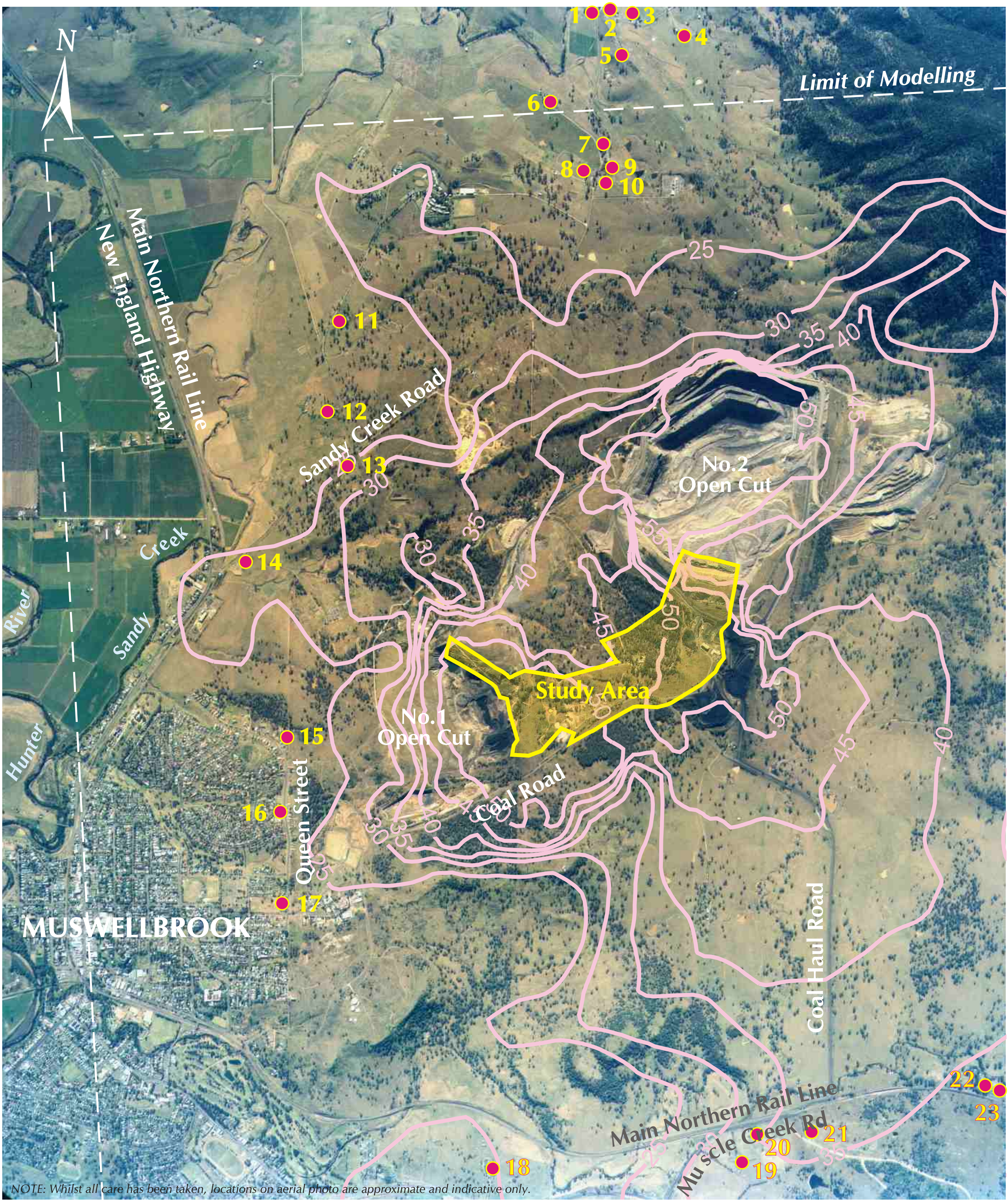
MUSWELLBROOK COAL COMPANY LIMITED

Noise Contours: Year 1 - Excavator in NW Tongue 10m Below Ground SE Wind

FIGURE 8

File Name: Y1DLEQSE.CDR

Start Screen | Search | Appendices



LEGEND

8 ● Denotes Residence

Noise Contour dB(A), L_{eq}

SCALE

0 1 2

Kilometres

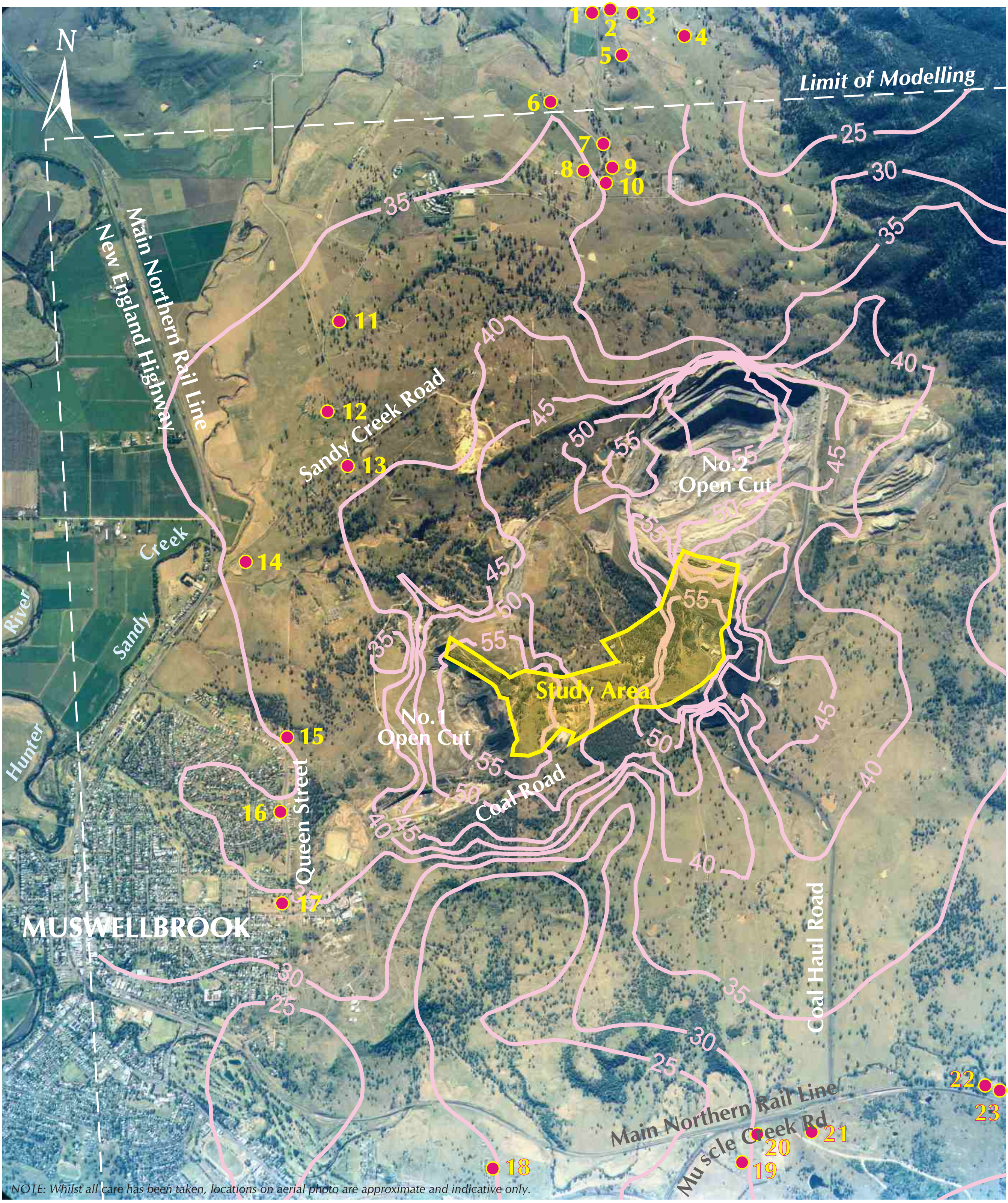
File Name: Y1CLEQNW.CDR

MUSWELLBROOK COAL COMPANY LIMITED

Noise Contours: Year 1 - Excavator at Ground Level Above No.1 Open Cut Highwall NW Wind

FIGURE 9

Start Screen | Search | Appendices



LEGEND

8 ● Denotes Residence

Noise Contour dB(A), L_{eq}

SCALE

0 1 2

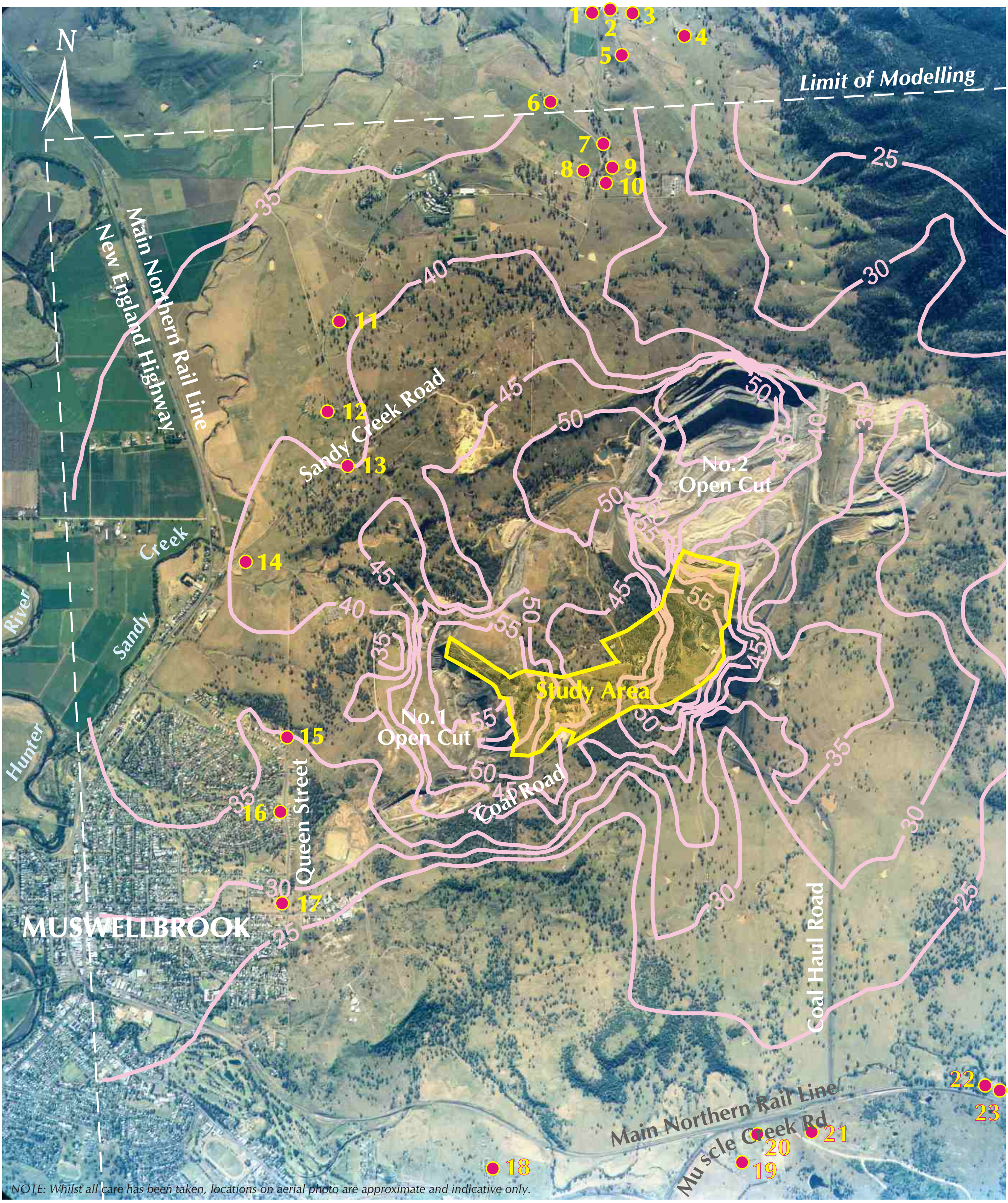
Kilometres

MUSWELLBROOK COAL COMPANY LIMITED

Noise Contours: Year 1 - Excavator at Ground Level Above No.1 Open Cut Highwall Inversion

FIGURE 10

File Name: Y1CLEQIN.CDR



LEGEND

8 ● Denotes Residence

Noise Contour dB(A), L_{eq}

SCALE

0 1 2

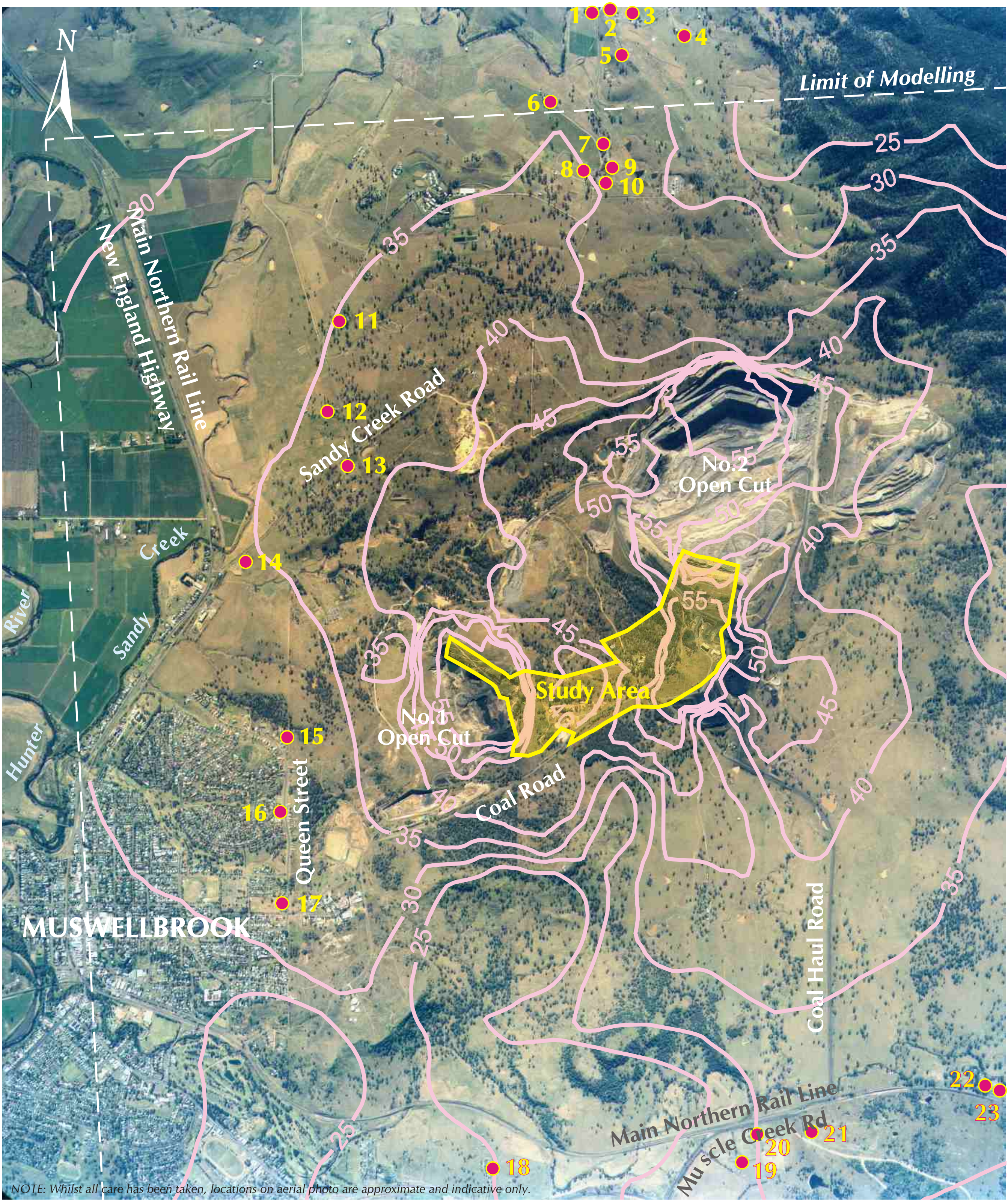
Kilometres

MUSWELLBROOK COAL COMPANY LIMITED

Noise Contours: Year 1 - Excavator at Ground Level Above No.1 Open Cut Highwall SE Wind

FIGURE 11

File Name: Y1CLEQSE.CDR



LEGEND

8 ● Denotes Residence

Noise Contour dB(A), L_{eq}

SCALE

0 1 2

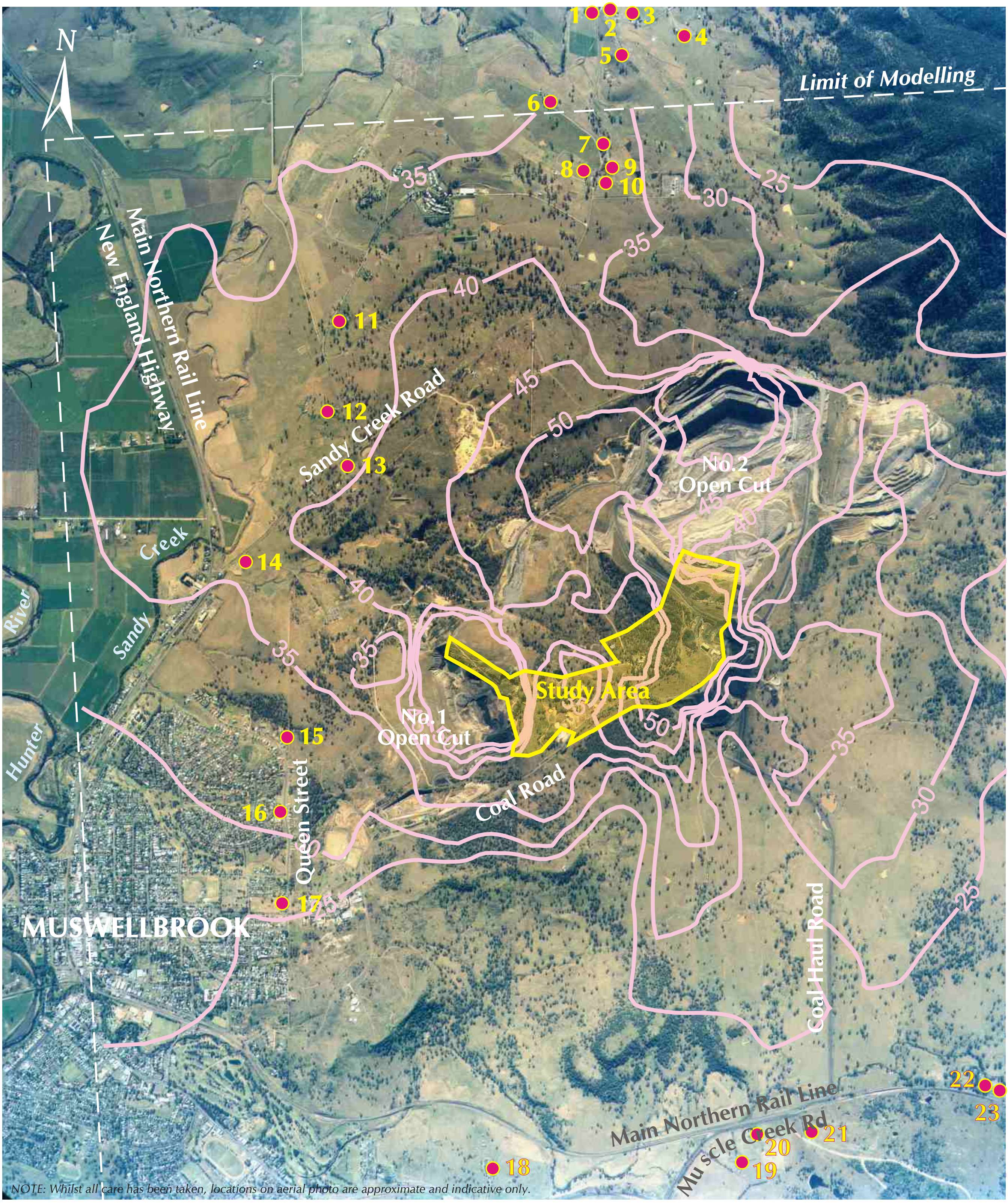
Kilometres

MUSWELLBROOK COAL COMPANY LIMITED

Noise Contours: Year 1 - Excavator Above No.1 Open Cut Highwall (20m Below Ground Level) Inversion

FIGURE 12

File Name: Y1CLEQIN2.CDR



LEGEND

8 ● Denotes Residence

Noise Contour dB(A), L_{eq}

SCALE

0 1 2

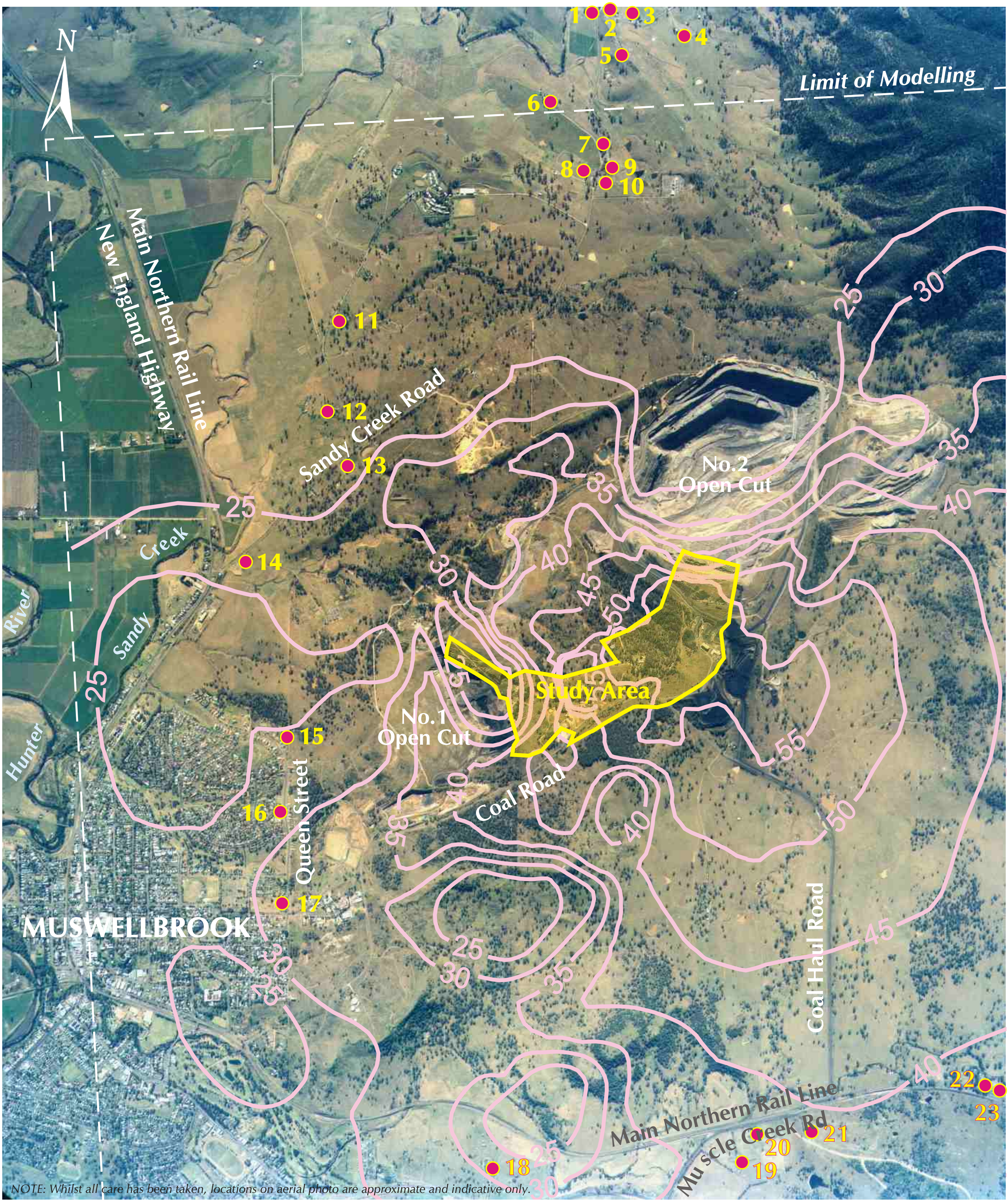
Kilometres

File Name: Y1CLEQSE2.CDR

MUSWELLBROOK COAL COMPANY LIMITED

Noise Contours: Year 1 - Excavator Above No.1 Open Cut Highwall (20m Below Ground Level) SE Wind

FIGURE 13



LEGEND

8 ● Denotes Residence

Noise Contour dB(A), L_{eq}

SCALE

0 1 2

Kilometres

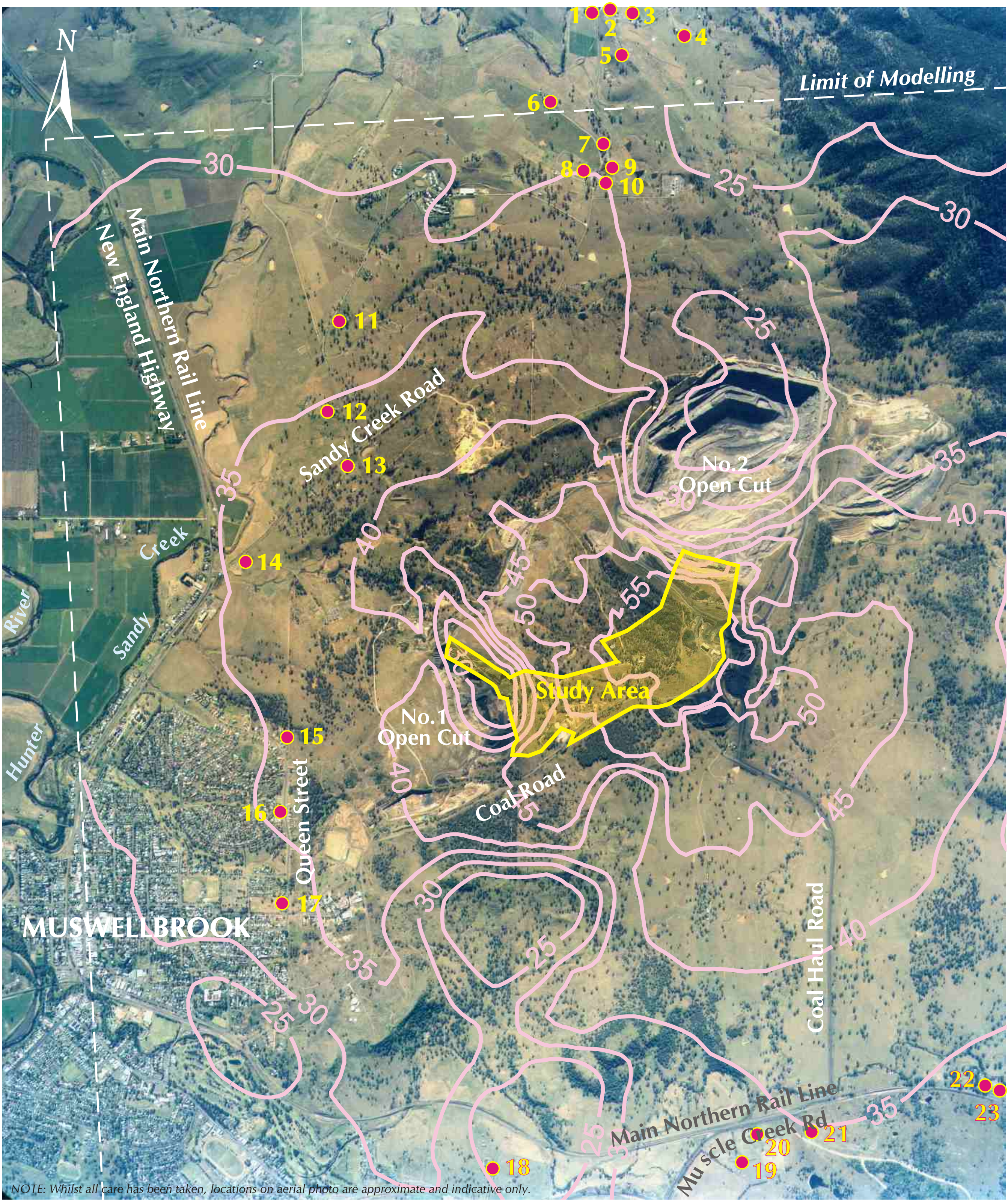
File Name: Y5CLEQNW.CDR

MUSWELLBROOK COAL COMPANY LIMITED

Noise Contours: Year 5 - Excavator at Ground Level Highest Point in Study Area NW Wind

FIGURE 14

Start Screen | Search | Appendices



LEGEND

8 ● Denotes Residence

Noise Contour dB(A), L_{eq}

SCALE

0 1 2

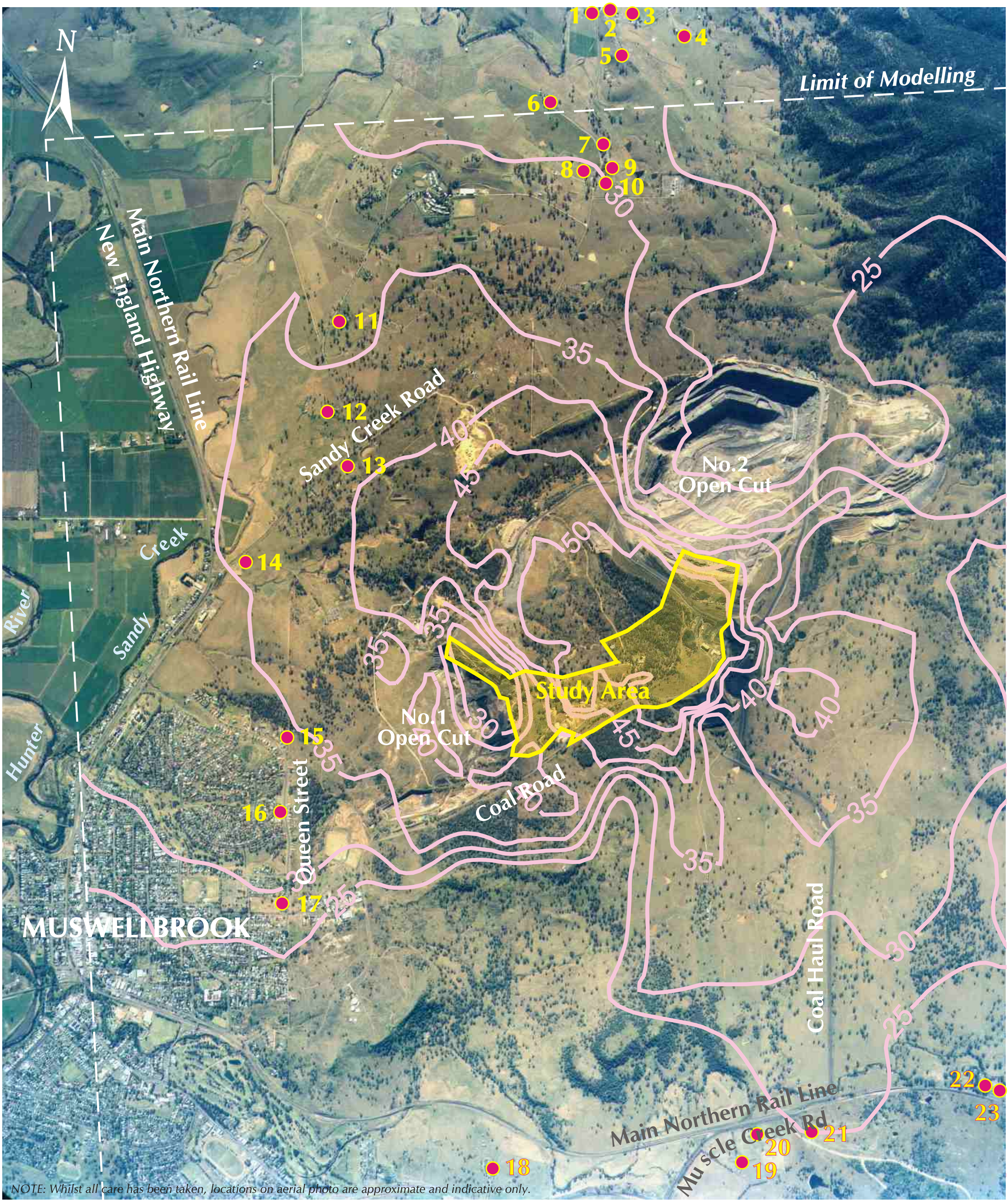
Kilometres

File Name: Y5CLEQIN.CDR

MUSWELLBROOK COAL COMPANY LIMITED

Noise Contours: Year 5 - Excavator at Ground Level Highest Point in Study Area Inversion

FIGURE 15



LEGEND

8 ● Denotes Residence

Noise Contour dB(A), L_{eq}

SCALE

0 1 2

Kilometres

File Name: Y5CLEQSE.CDR

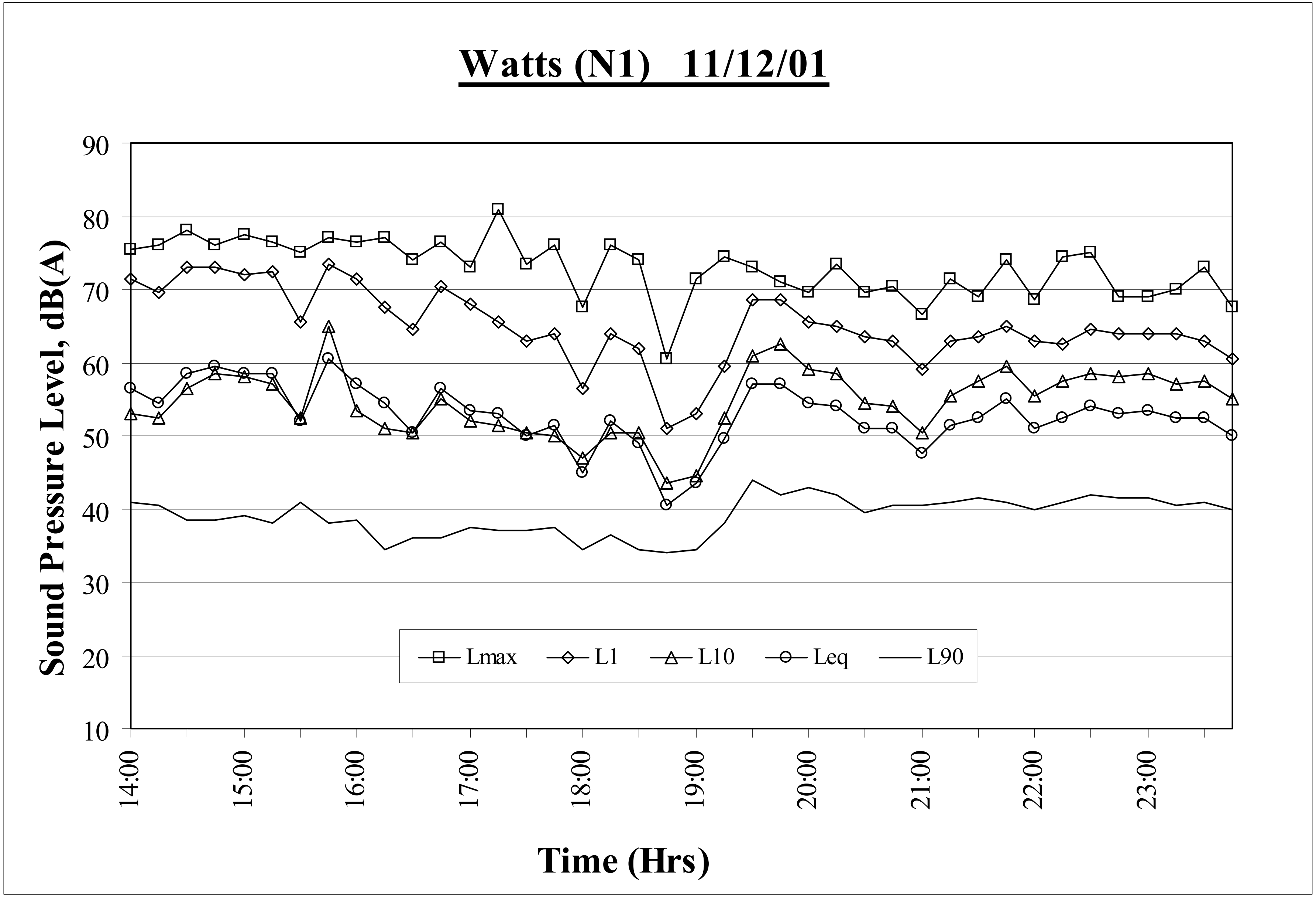
MUSWELLBROOK COAL COMPANY LIMITED

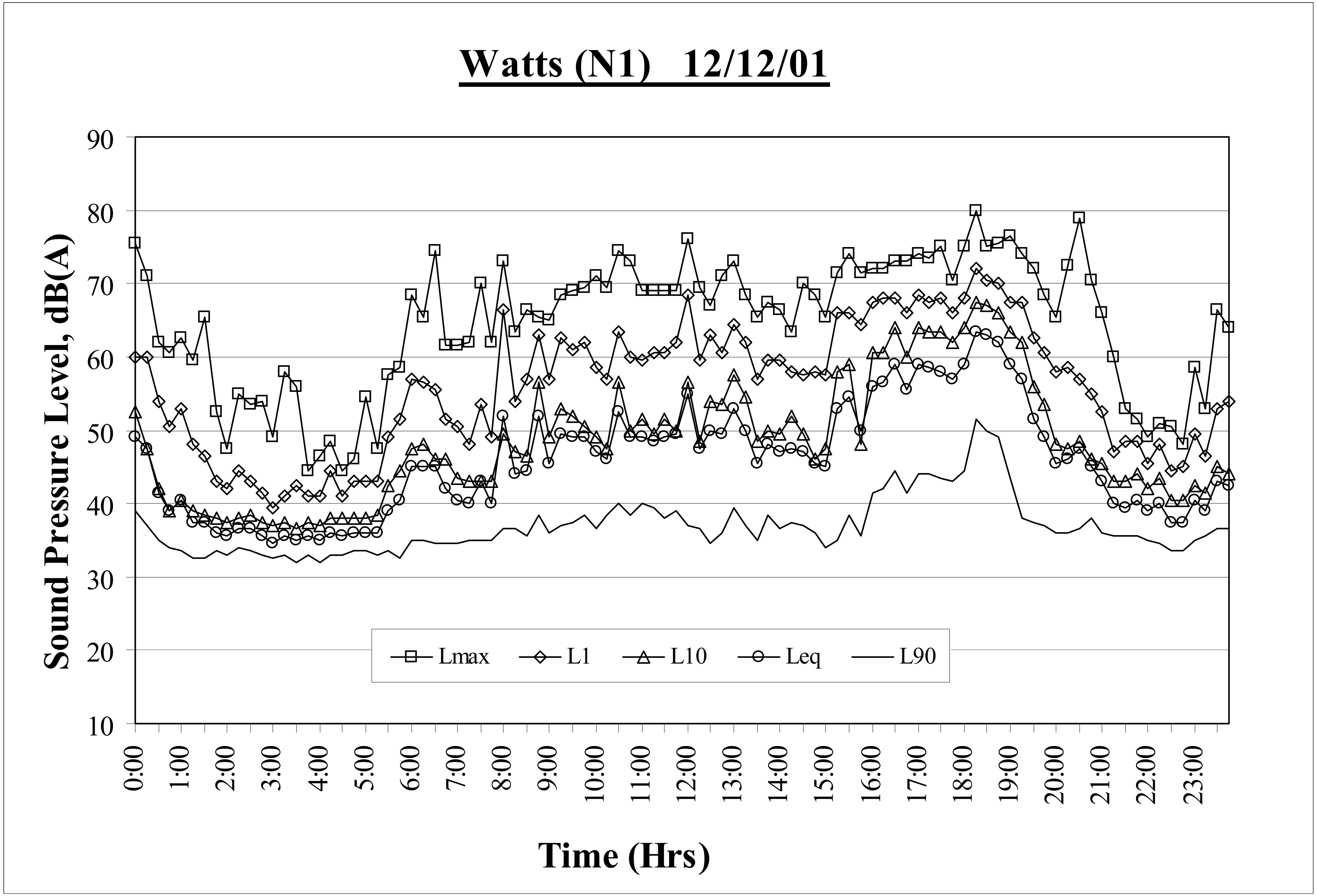
Noise Contours: Year 5 - Excavator at Ground Level Highest Point in Study Area SE Wind

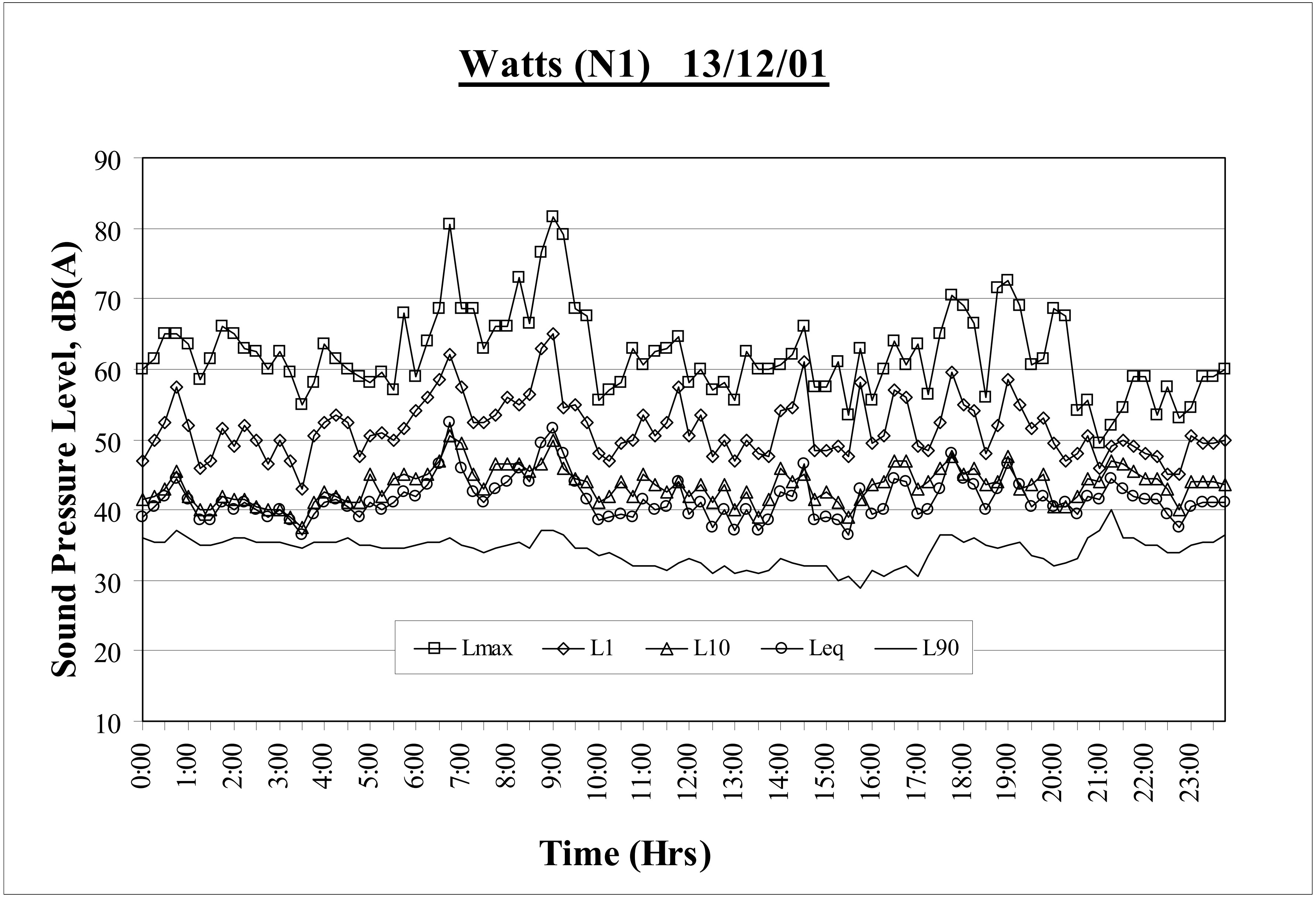
FIGURE 16

APPENDIX A

Ambient Noise Logger Data


Watts (N1) 11/12/01
Sound Pressure Level, dB(A)
90
80
70
60
50
40
30
20
10
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time (Hrs)
Lmax
L1
L10
Leq
L90


Watts (N1) 12/12/01
Sound Pressure Level, dB(A)
90
80
70
60
50
40
30
20
10
Lmax
L1
L10
Leq
L90
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time (Hrs)


Watts (N1) 13/12/01
Sound Pressure Level, dB(A)
90
80
70
60
50
40
30
20
10
Lmax
L1
L10
Leq
L90
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
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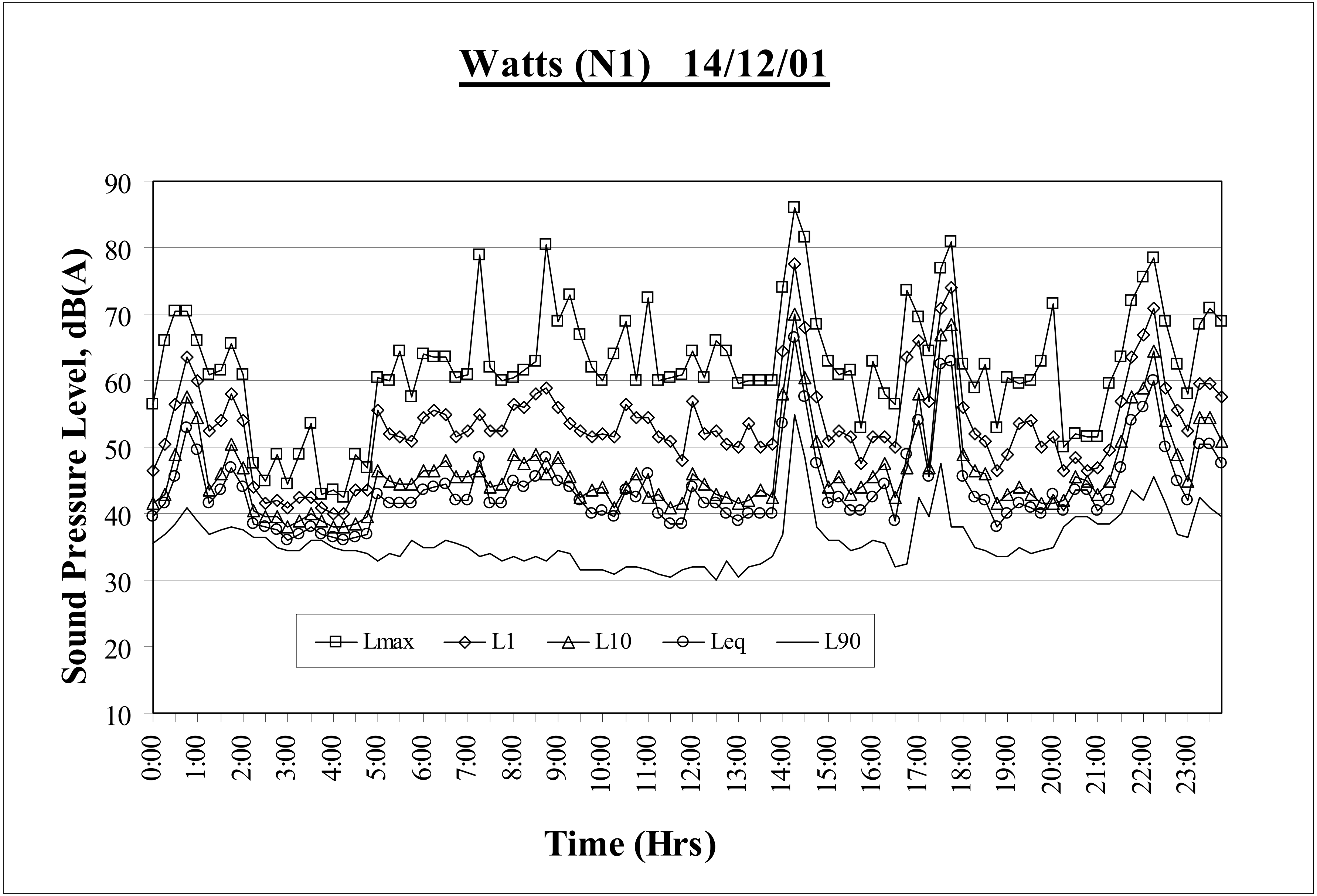
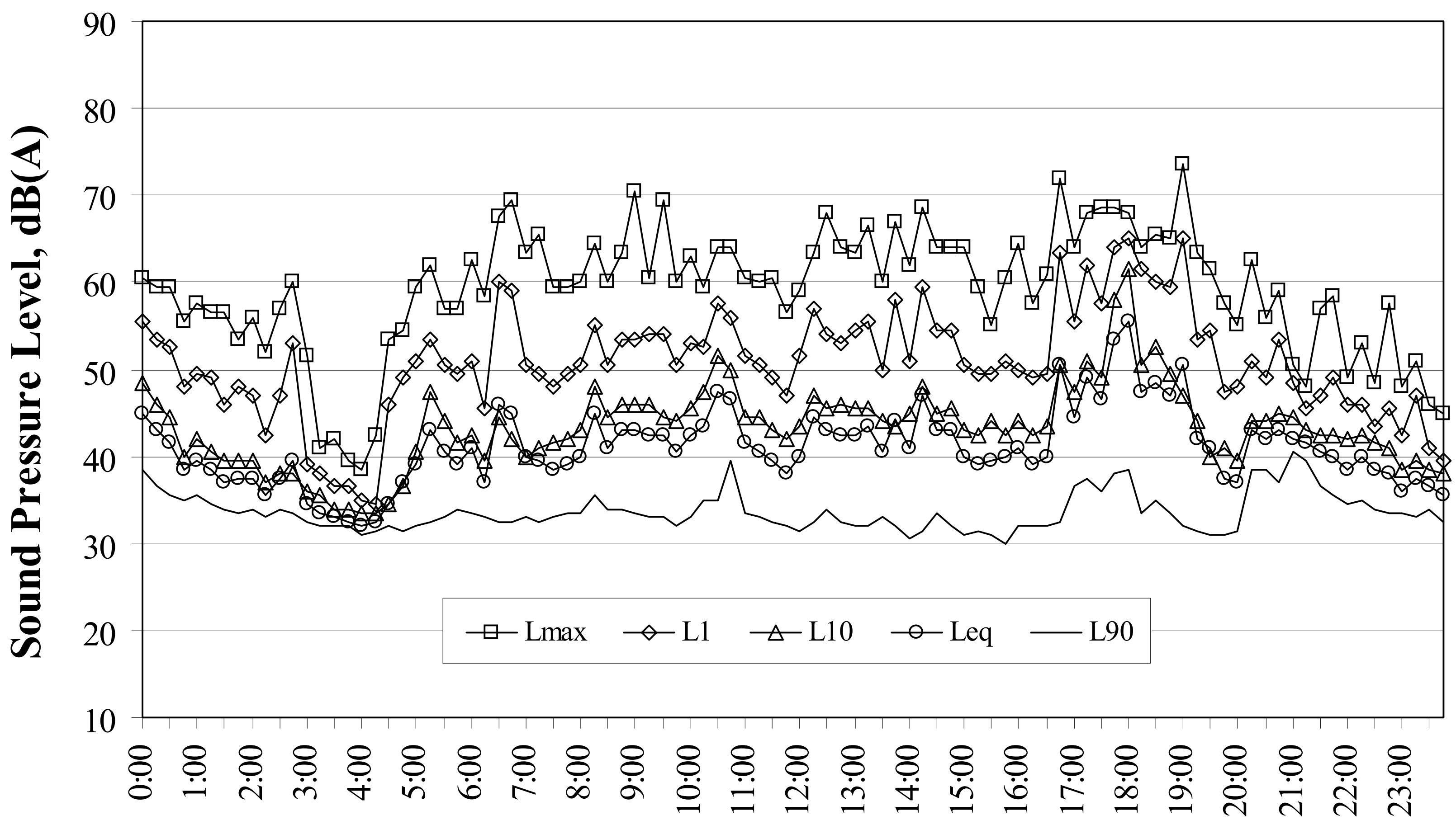
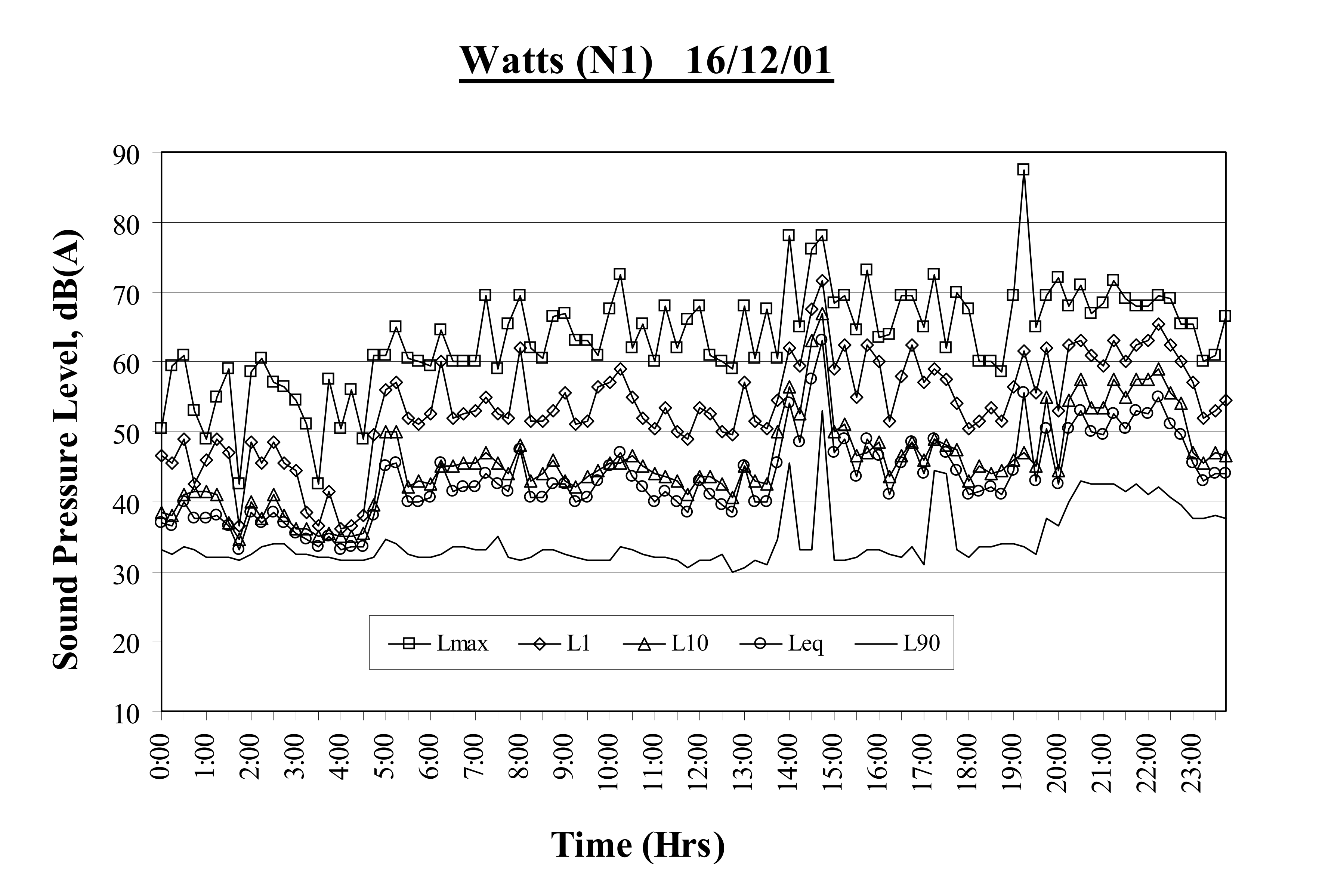
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time (Hrs)


Watts (N1) 14/12/01
Sound Pressure Level, dB(A)
90
80
70
60
50
40
30
20
10
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time (Hrs)
Lmax
L1
L10
Leq
L90

Watts (N1) 15/12/01




Watts (N1) 16/12/01
Sound Pressure Level, dB(A)
90
80
70
60
50
40
30
20
10
Lmax
L1
L10
Leq
L90
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
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11:00
12:00
13:00
14:00
15:00
16:00
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19:00
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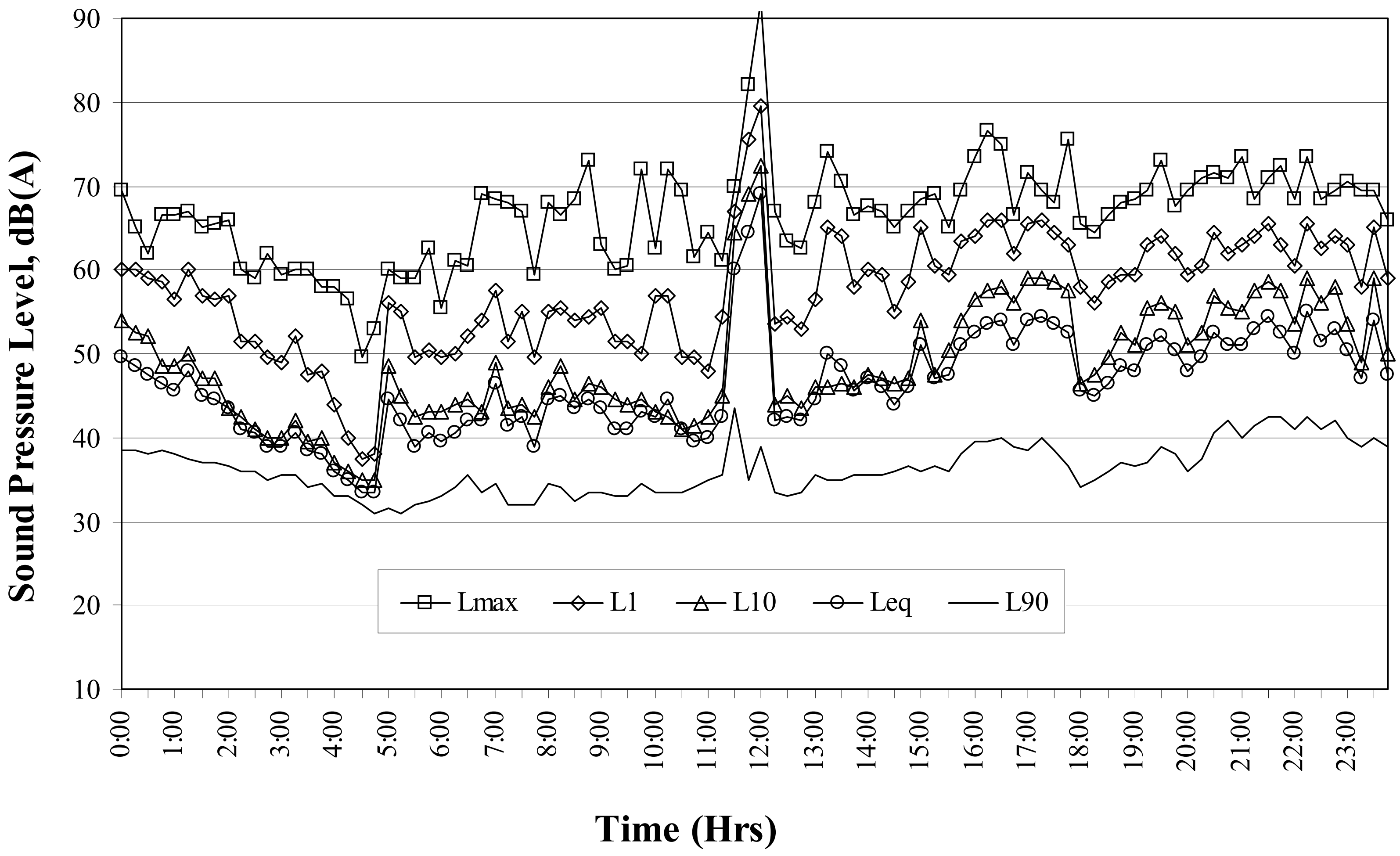
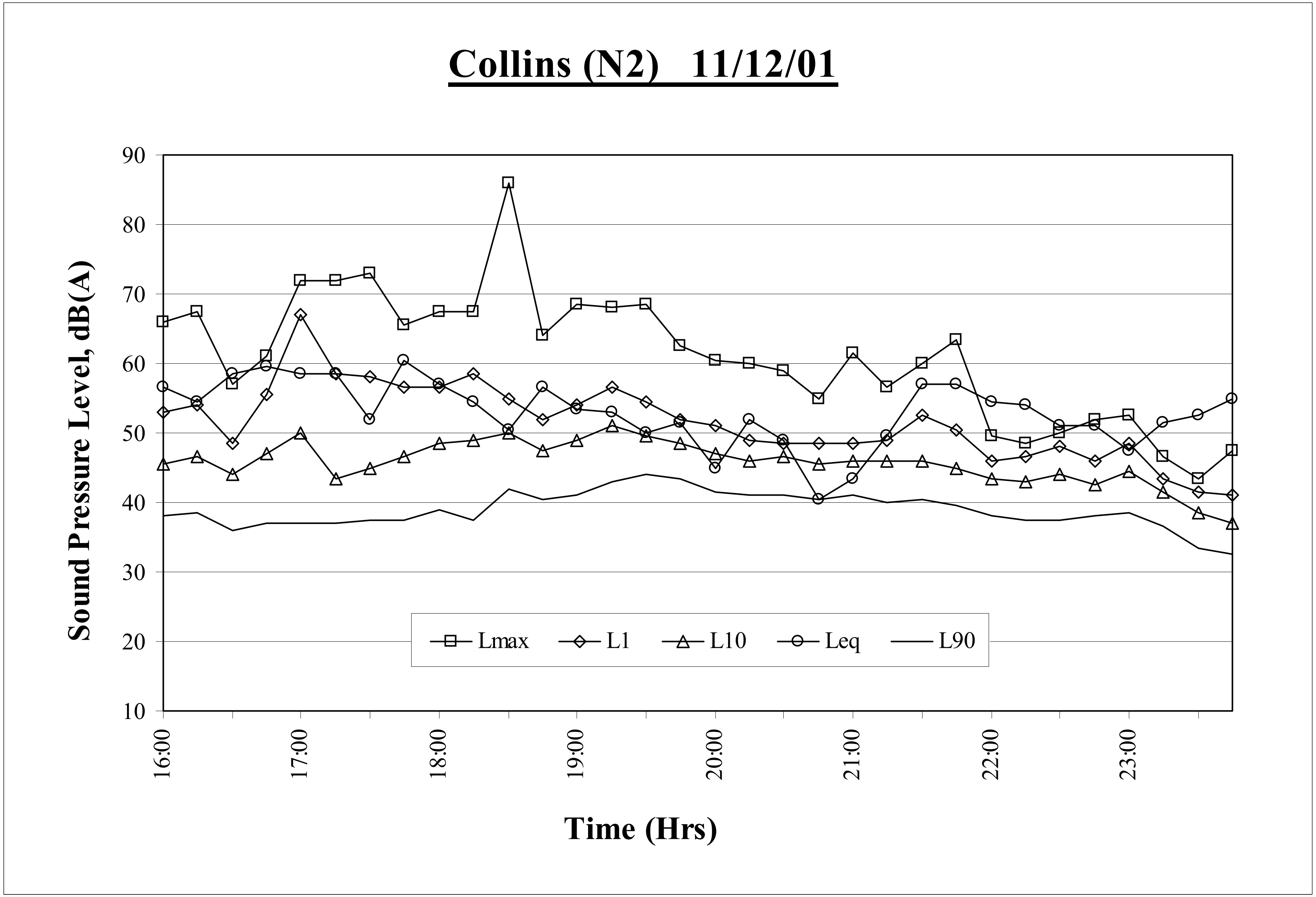
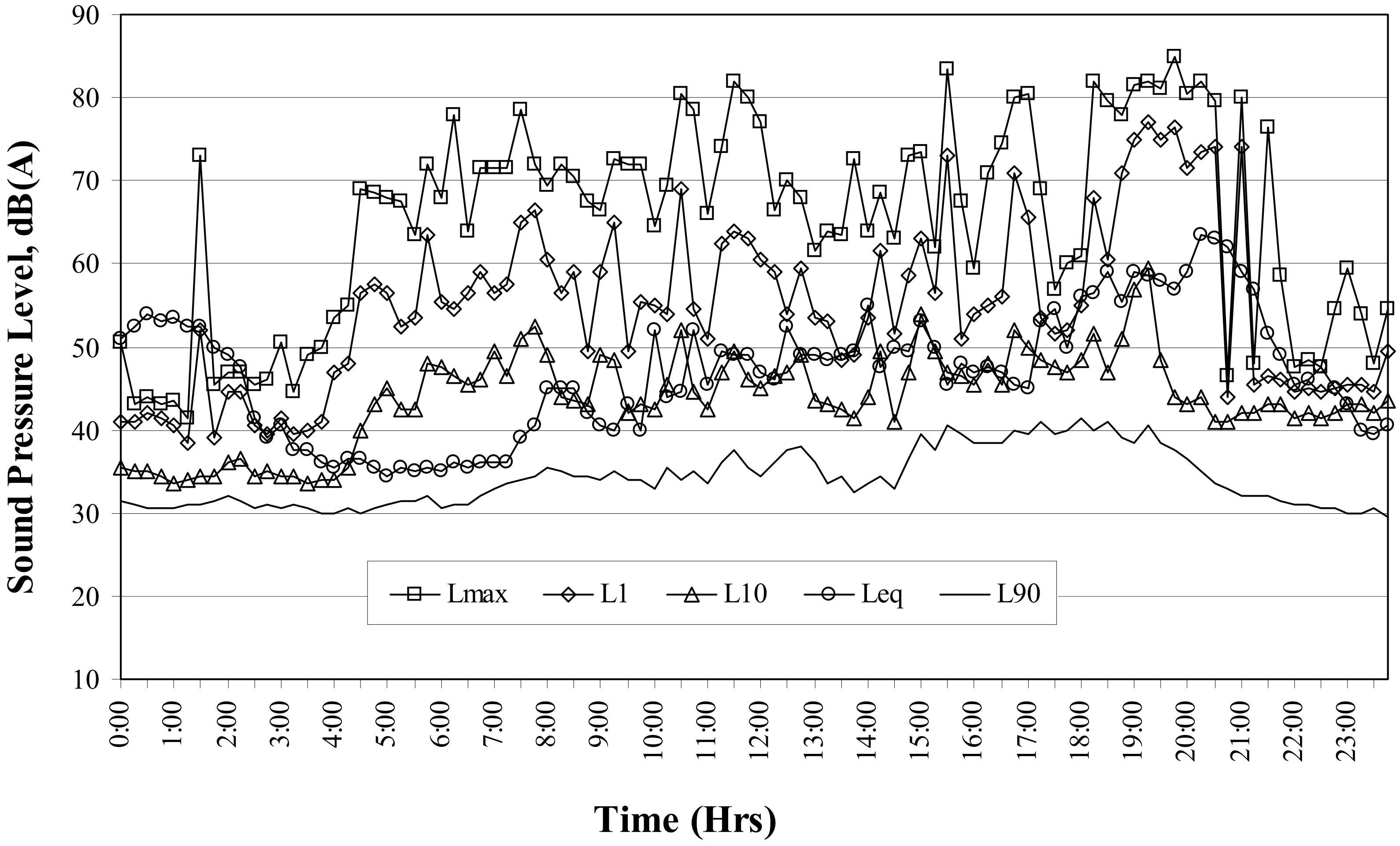
21:00
22:00
23:00
Time (Hrs)

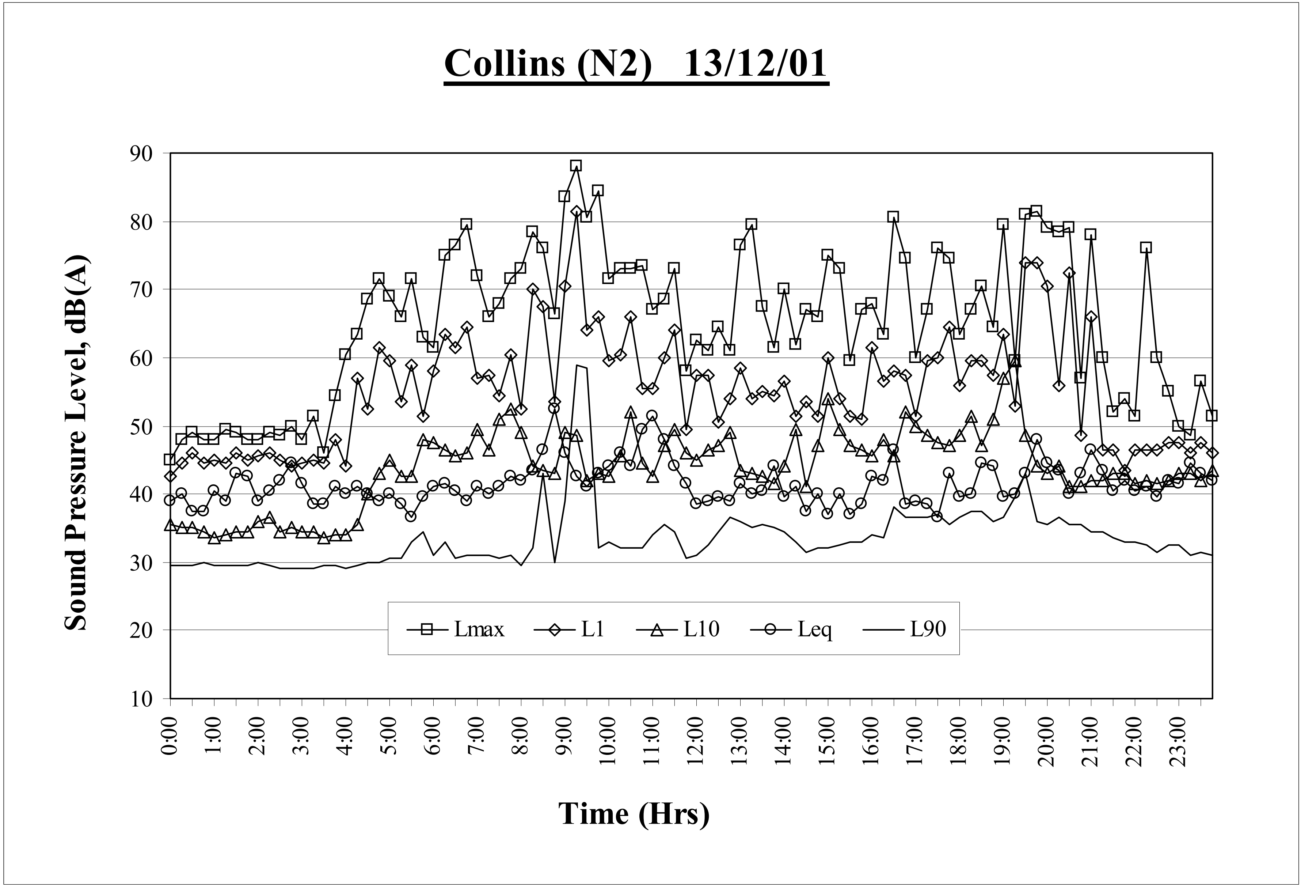
Watts (N1)   17/12/01




Collins (N2) 11/12/01
Sound Pressure Level, dB(A)
90
80
70
60
50
40
30
20
10
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time (Hrs)
Lmax
L1
L10
Leq
L90

Collins (N2) 12/12/01




Collins (N2) 13/12/01
Sound Pressure Level, dB(A)
90
80
70
60
50
40
30
20
10
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
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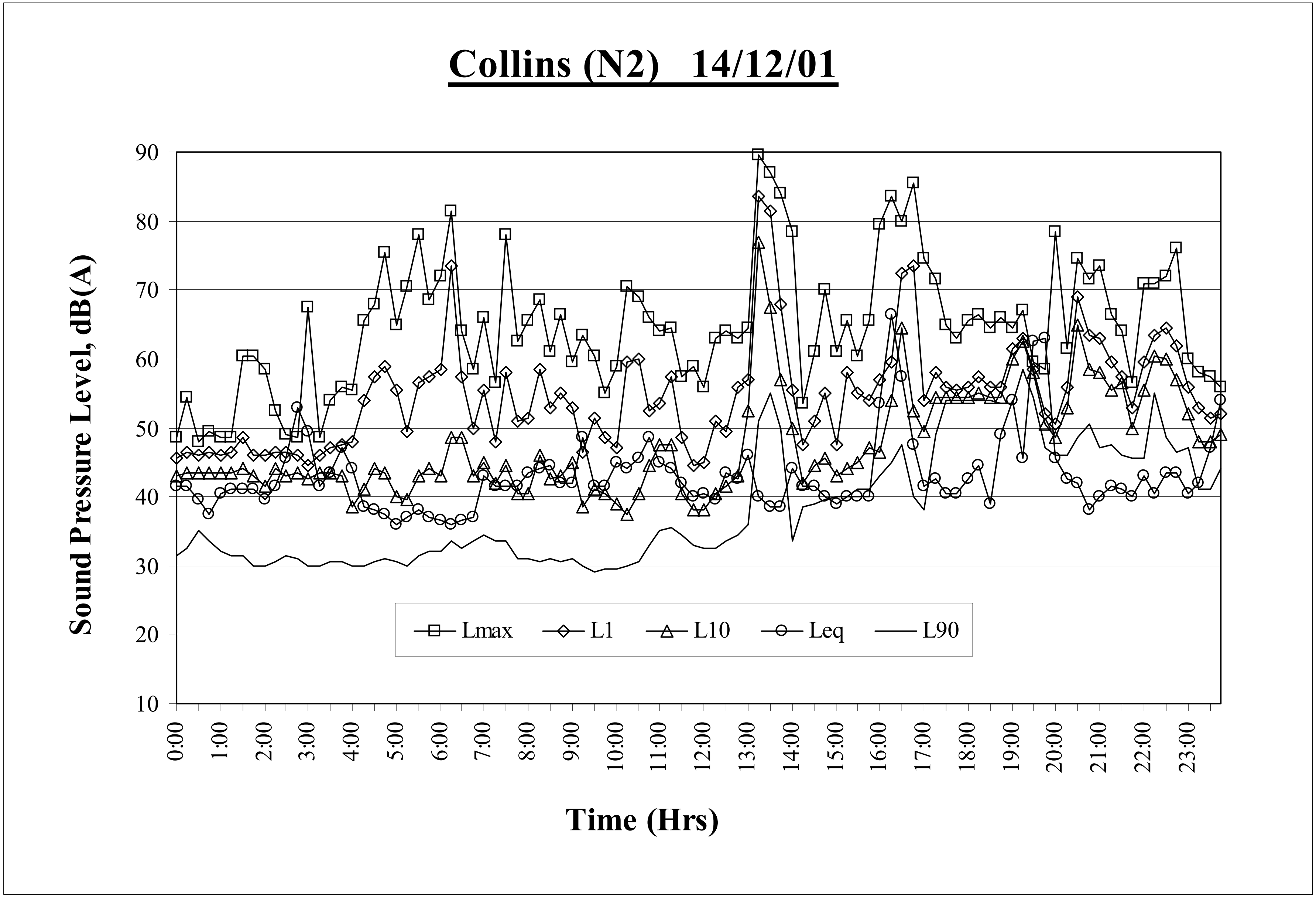
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time (Hrs)
Lmax
L1
L10
Leq
L90


Collins (N2) 14/12/01
Sound Pressure Level, dB(A)
Time (Hrs)
Lmax
L1
L10
Leq
L90
90
80
70
60
50
40
30
20
10
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
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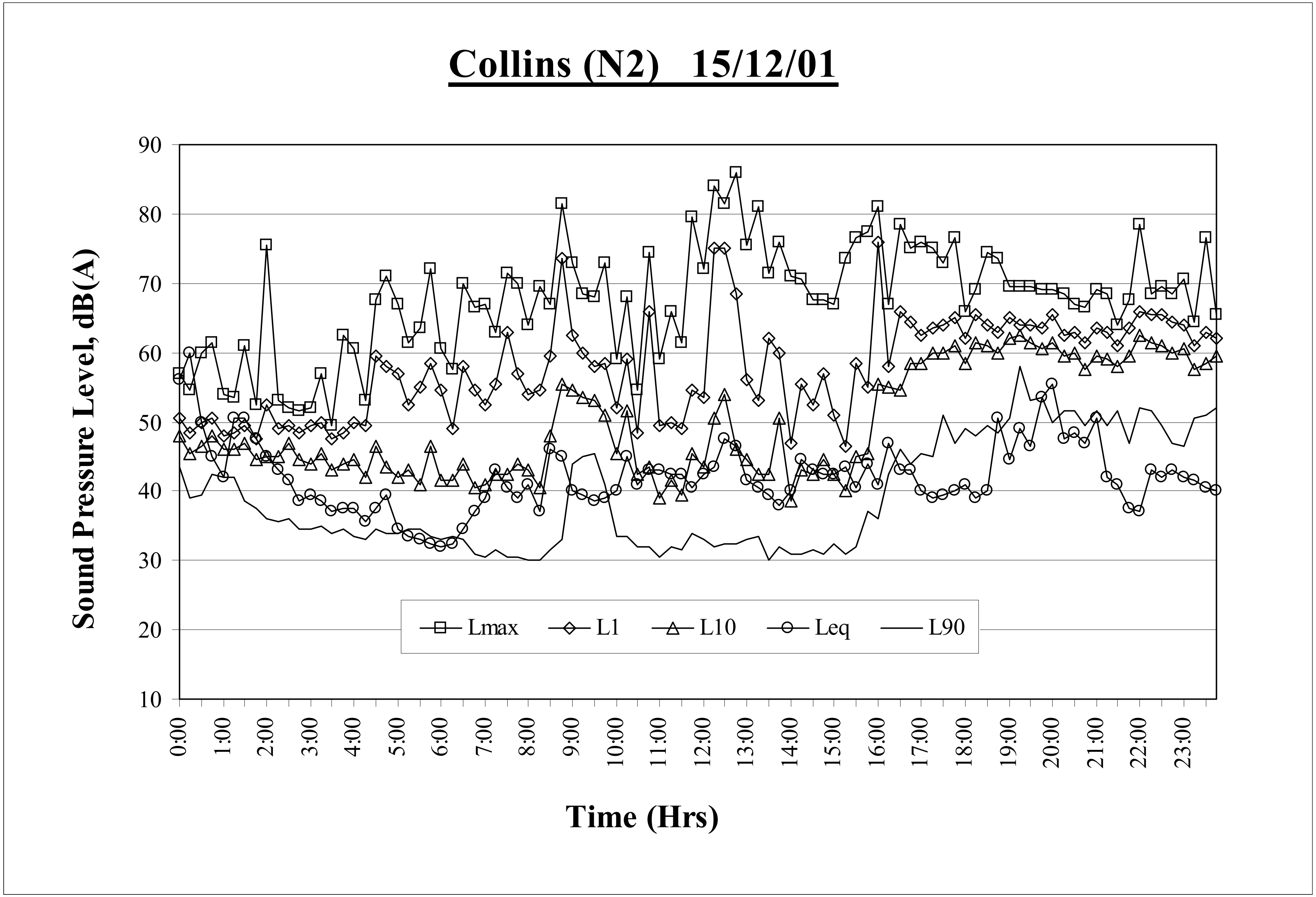
17:00
18:00
19:00
20:00
21:00
22:00
23:00


Collins (N2) 15/12/01
Sound Pressure Level, dB(A)
90
80
70
60
50
40
30
20
10
Lmax
L1
L10
Leq
L90
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1:00
2:00
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9:00
10:00
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12:00
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14:00
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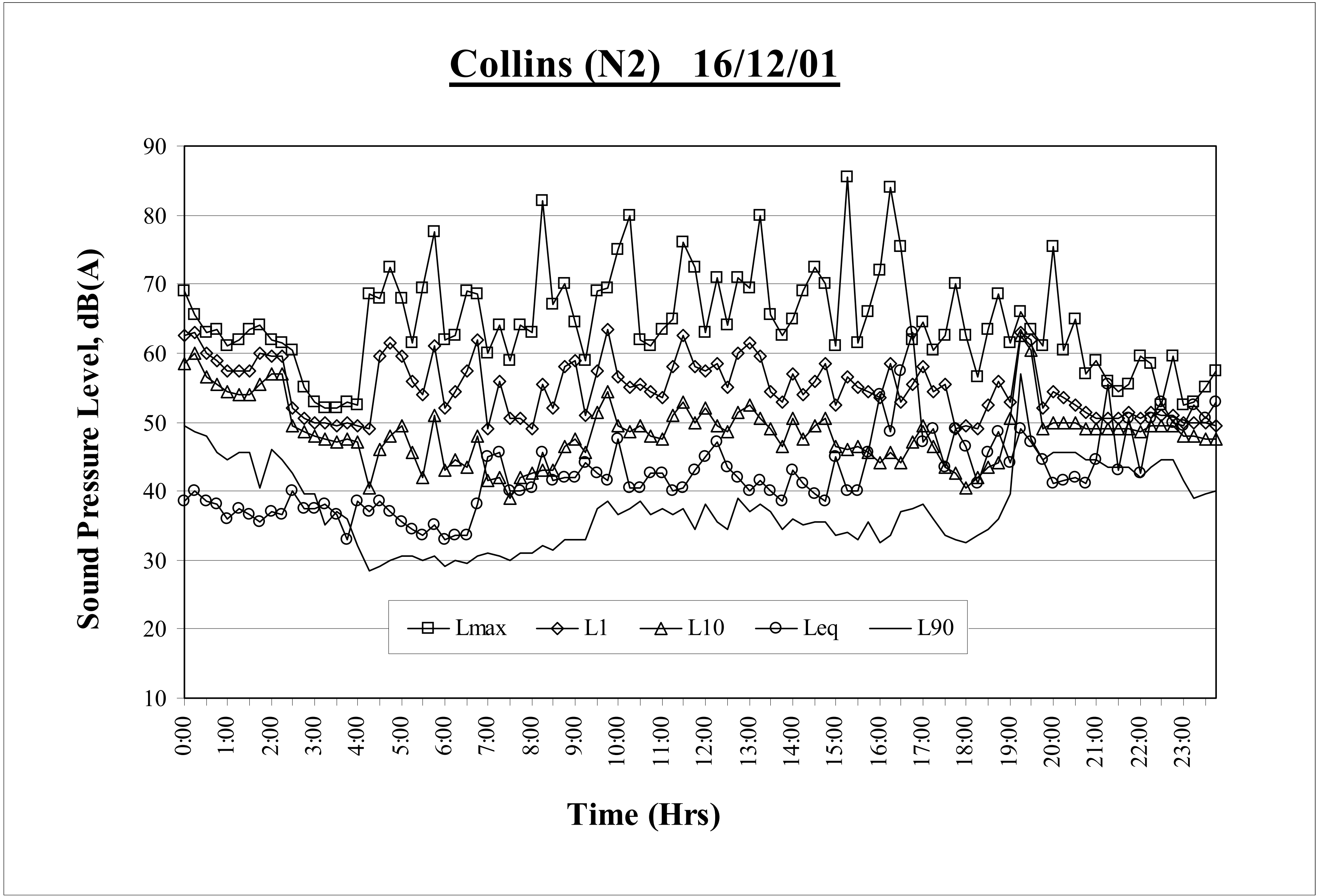
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time (Hrs)


Collins (N2) 16/12/01
Sound Pressure Level, dB(A)
90
80
70
60
50
40
30
20
10
Lmax
L1
L10
Leq
L90
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1:00
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12:00
13:00
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15:00
16:00
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19:00
20:00
21:00
22:00
23:00
Time (Hrs)

Start Screen

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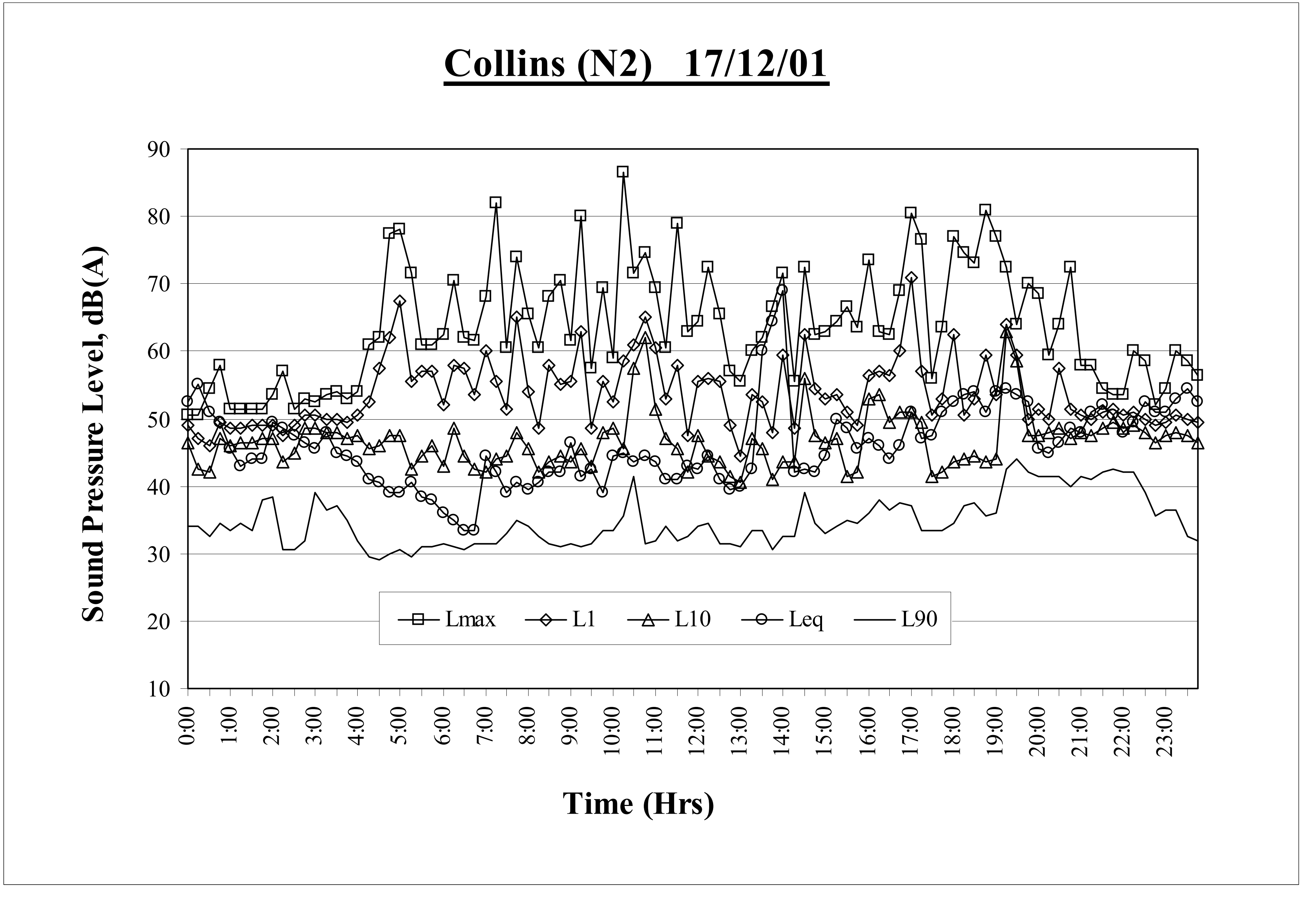

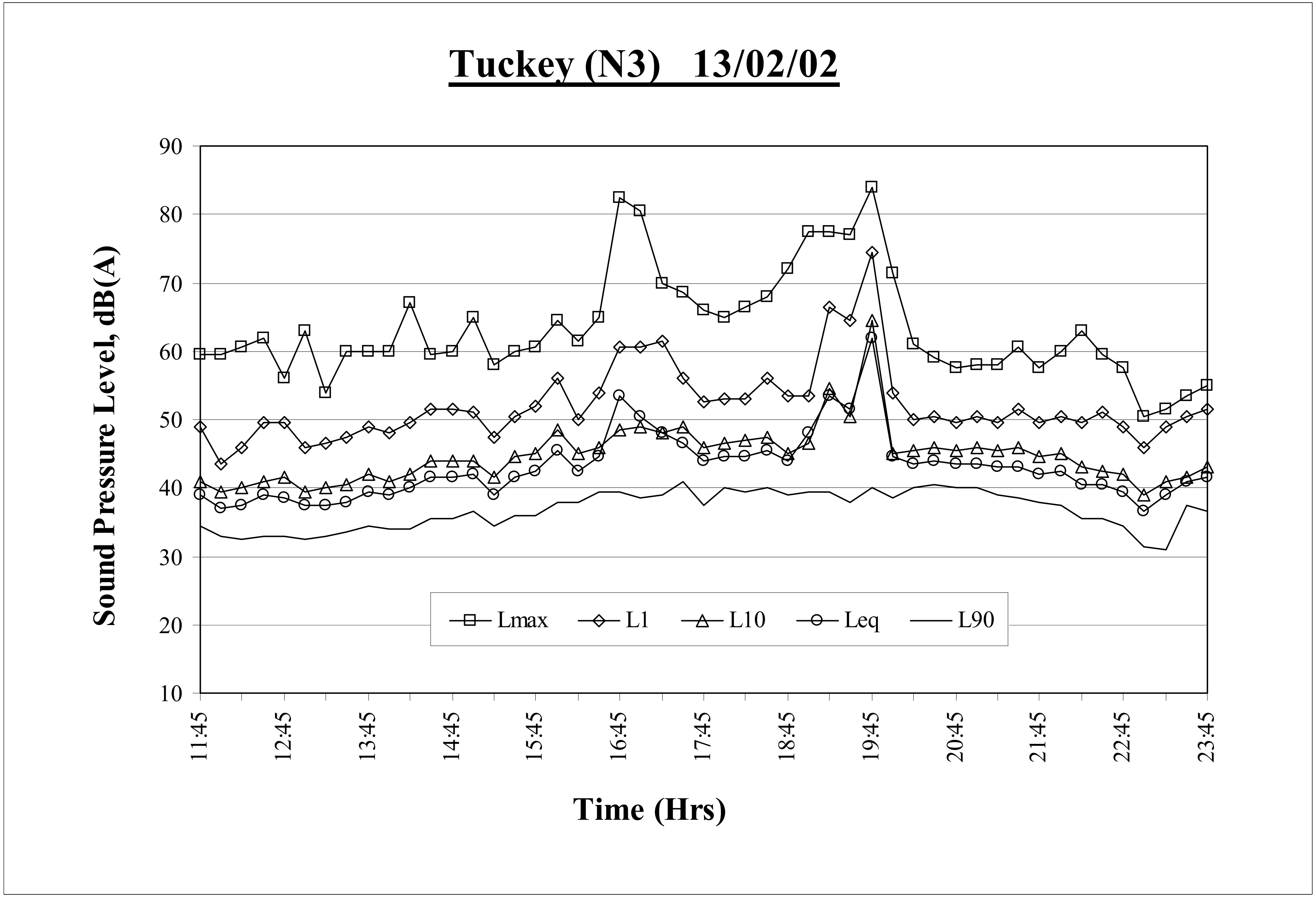
Tuckey (N3) 13/02/02
Sound Pressure Level, dB(A)
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80
70
60
50
40
30
20
10
11:45
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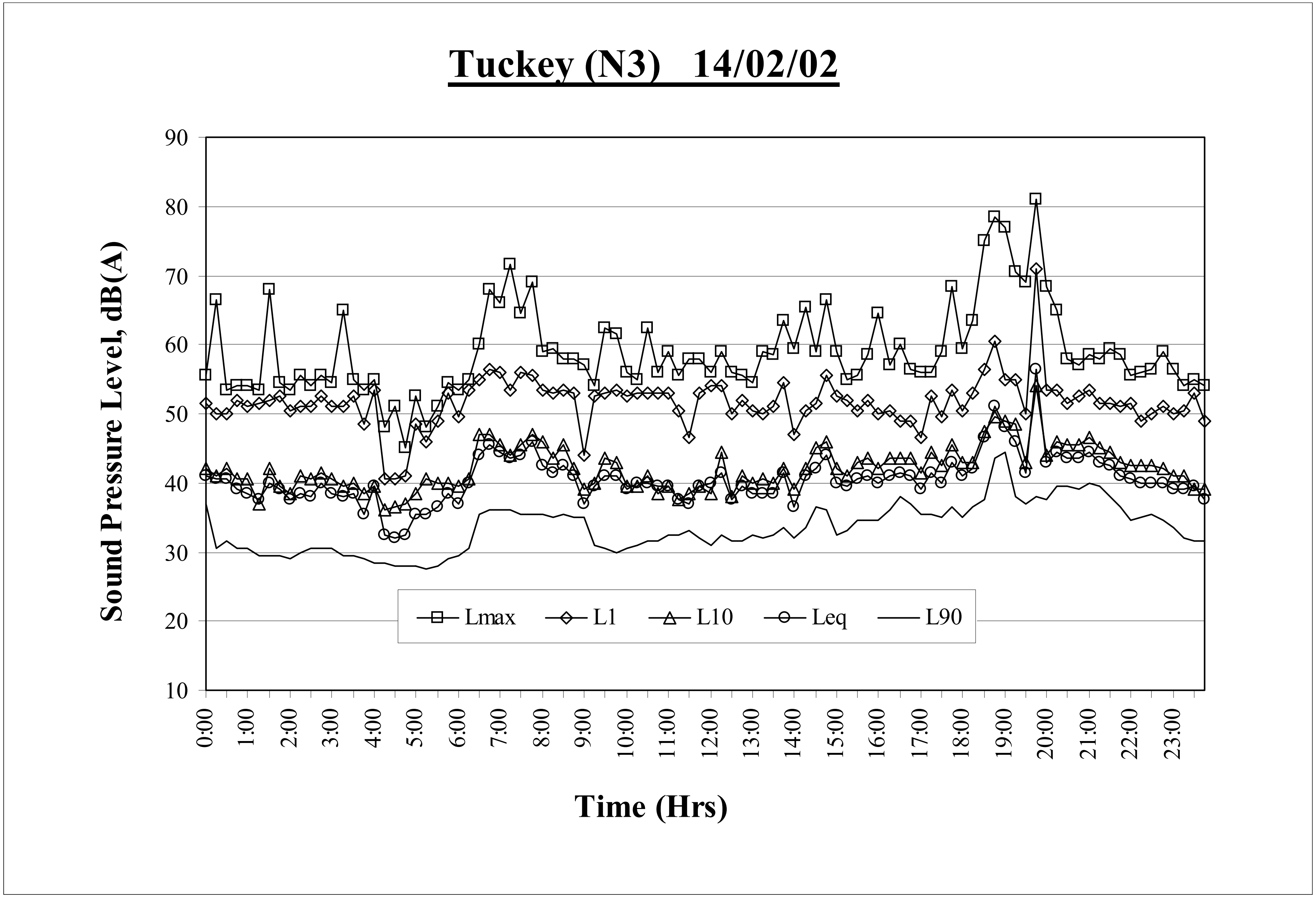
13:45
14:45
15:45
16:45
17:45
18:45
19:45
20:45
21:45
22:45
23:45
Time (Hrs)
Lmax
L1
L10
Leq
L90


Tuckey (N3) 14/02/02
Sound Pressure Level, dB(A)
Time (Hrs)
Lmax
L1
L10
Leq
L90
90
80
70
60
50
40
30
20
10
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
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11:00
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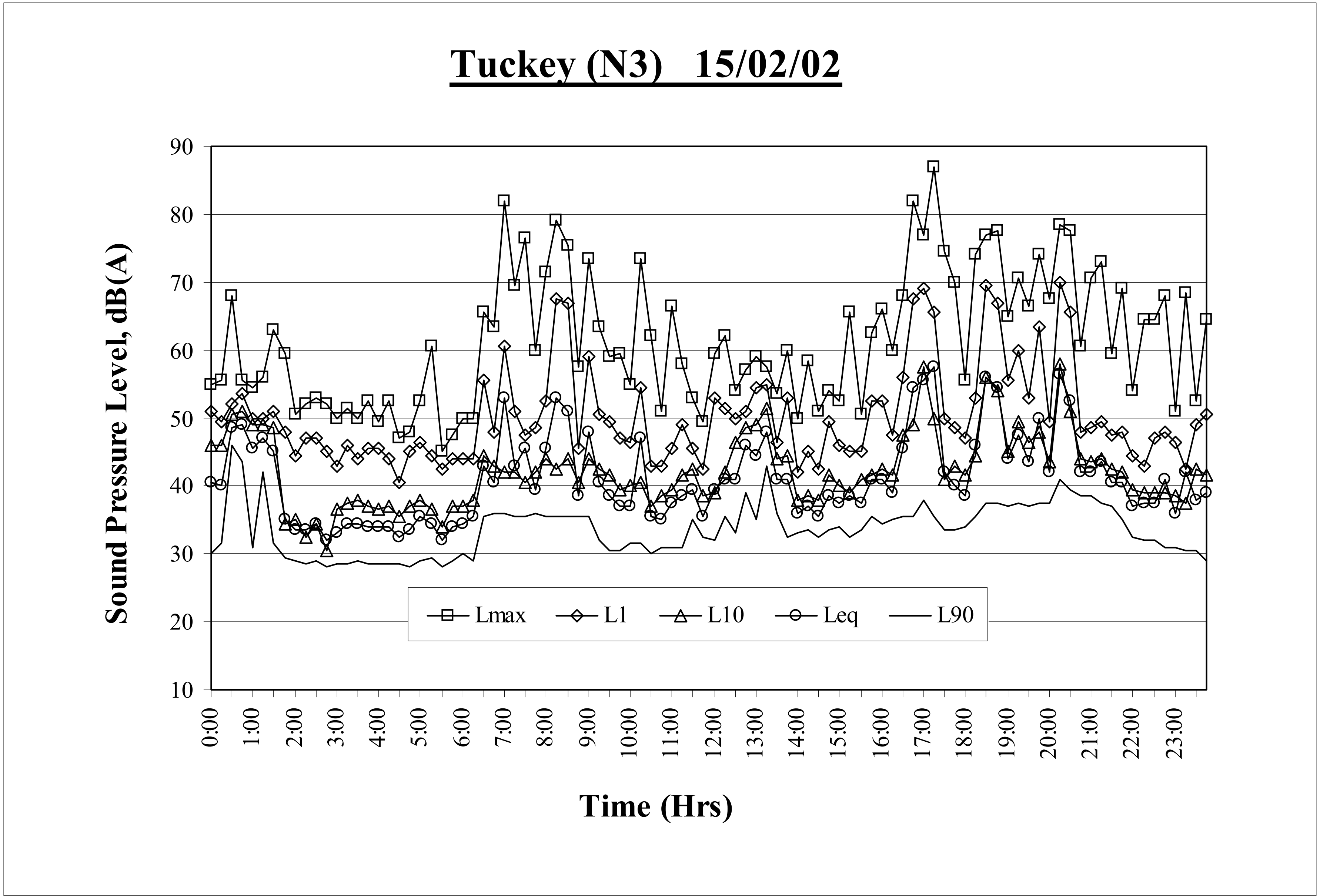
22:00
23:00


Tuckey (N3) 15/02/02
Sound Pressure Level, dB(A)
90
80
70
60
50
40
30
20
10
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
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9:00
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12:00
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14:00
15:00
16:00
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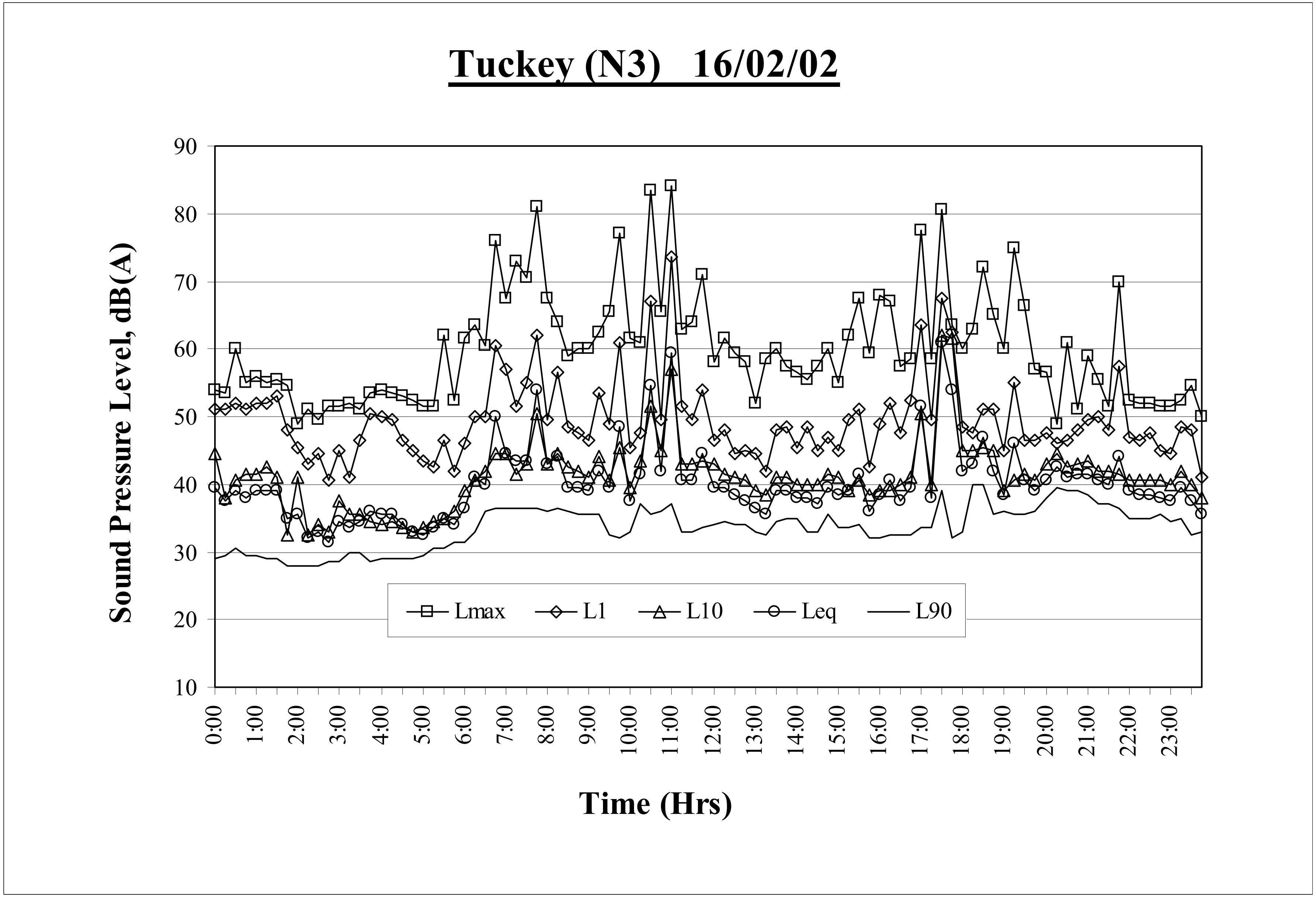
22:00
23:00
Time (Hrs)
Lmax
L1
L10
Leq
L90


Tuckey (N3) 16/02/02
Sound Pressure Level, dB(A)
90
80
70
60
50
40
30
20
10
Lmax
L1
L10
Leq
L90
0:00
1:00
2:00
3:00
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7:00
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12:00
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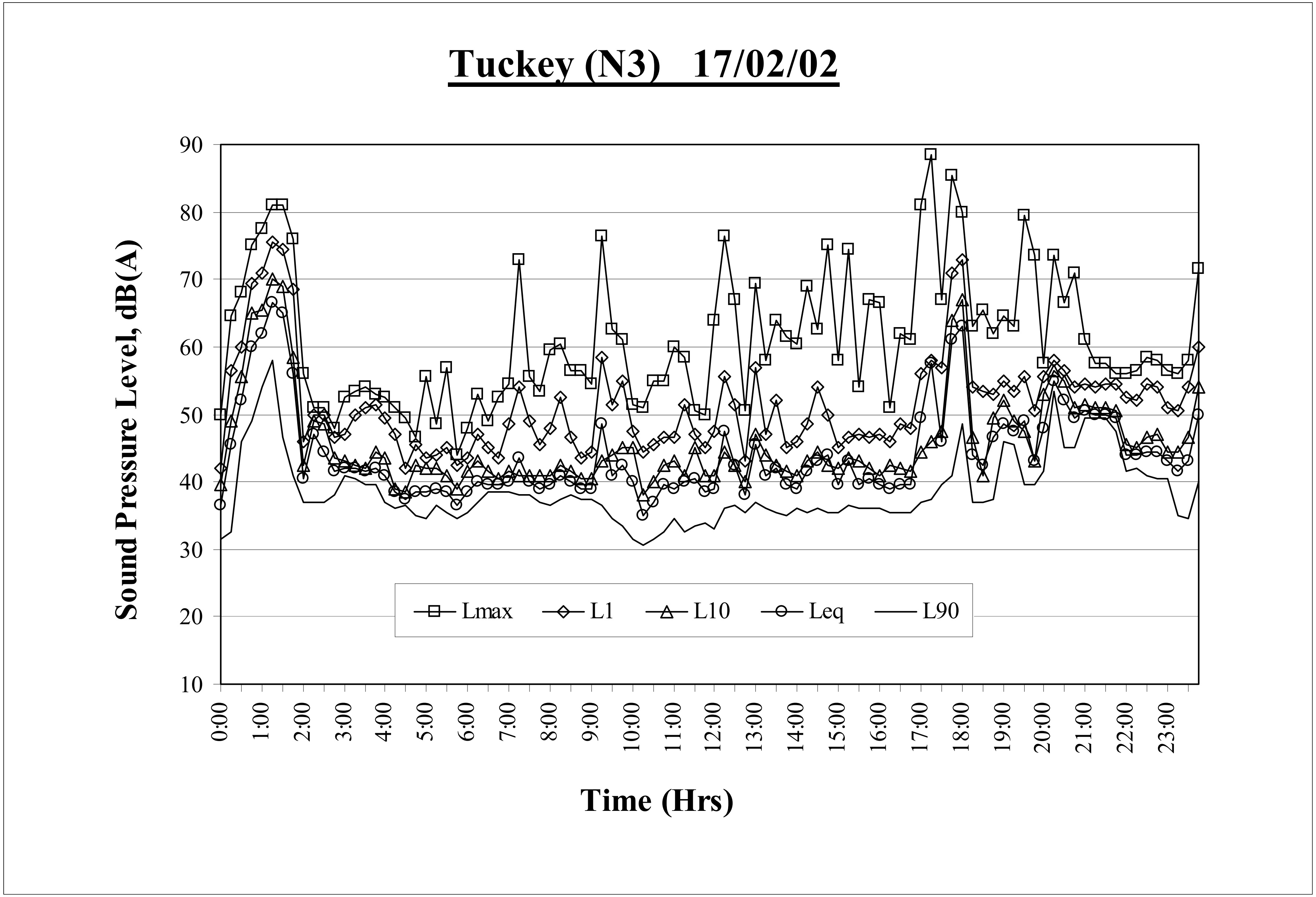
22:00
23:00
Time (Hrs)


Tuckey (N3) 17/02/02
Sound Pressure Level, dB(A)
90
80
70
60
50
40
30
20
10
Lmax
L1
L10
Leq
L90
0:00
1:00
2:00
3:00
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10:00
11:00
12:00
13:00
14:00
15:00
16:00
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21:00
22:00
23:00
Time (Hrs)

Start Screen

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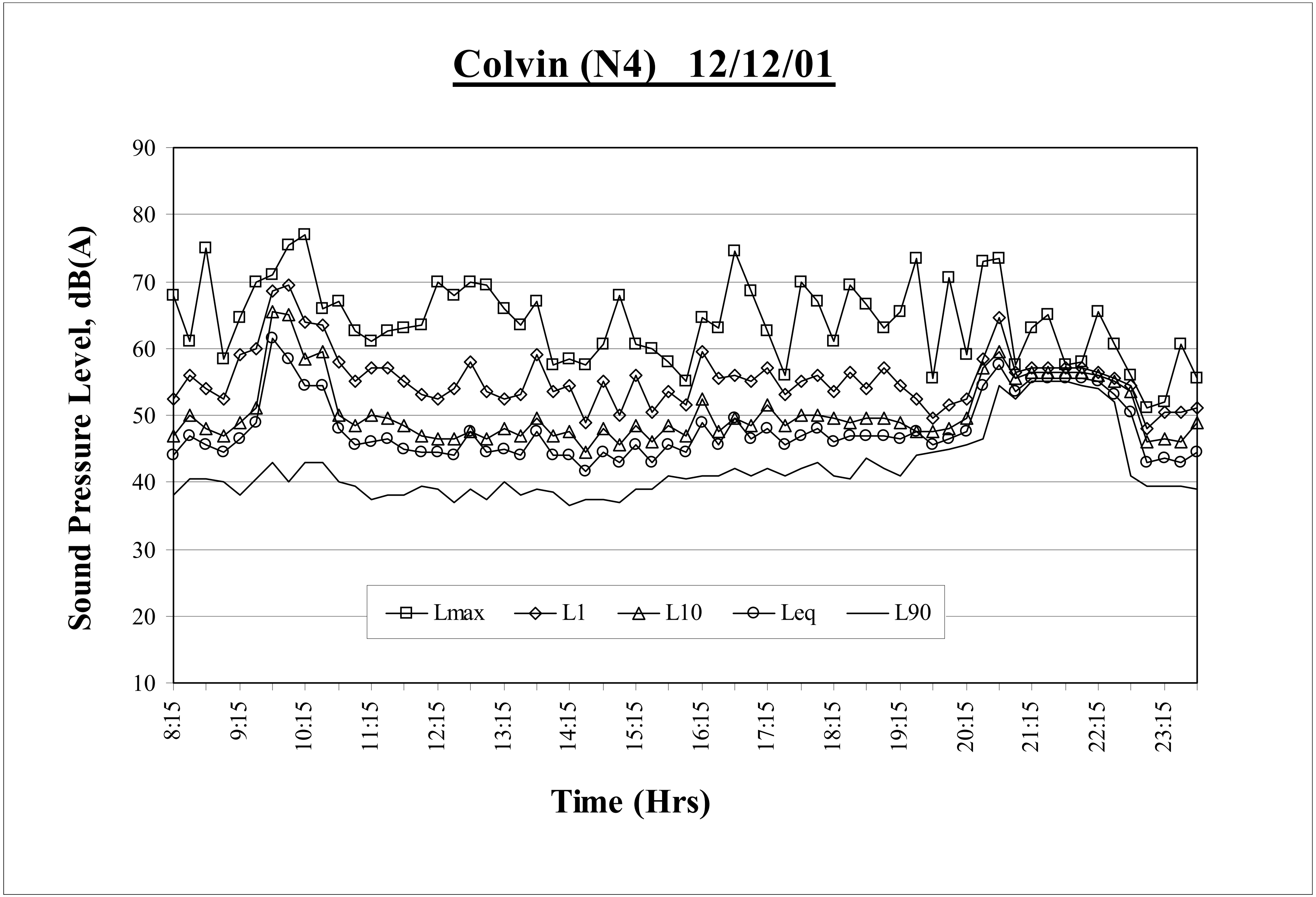

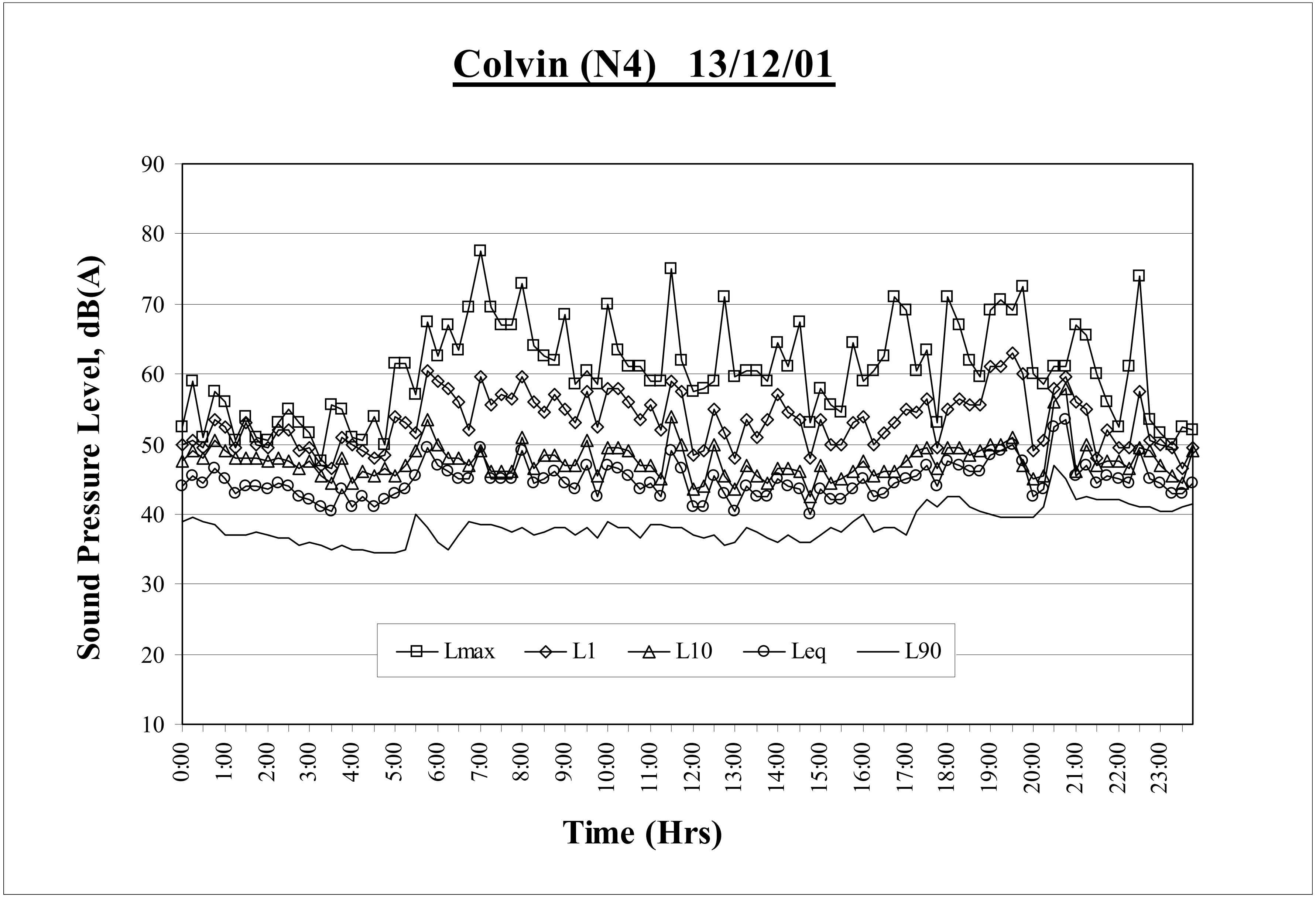
Colvin (N4) 13/12/01
Sound Pressure Level, dB(A)
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80
70
60
50
40
30
20
10
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
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14:00
15:00
16:00
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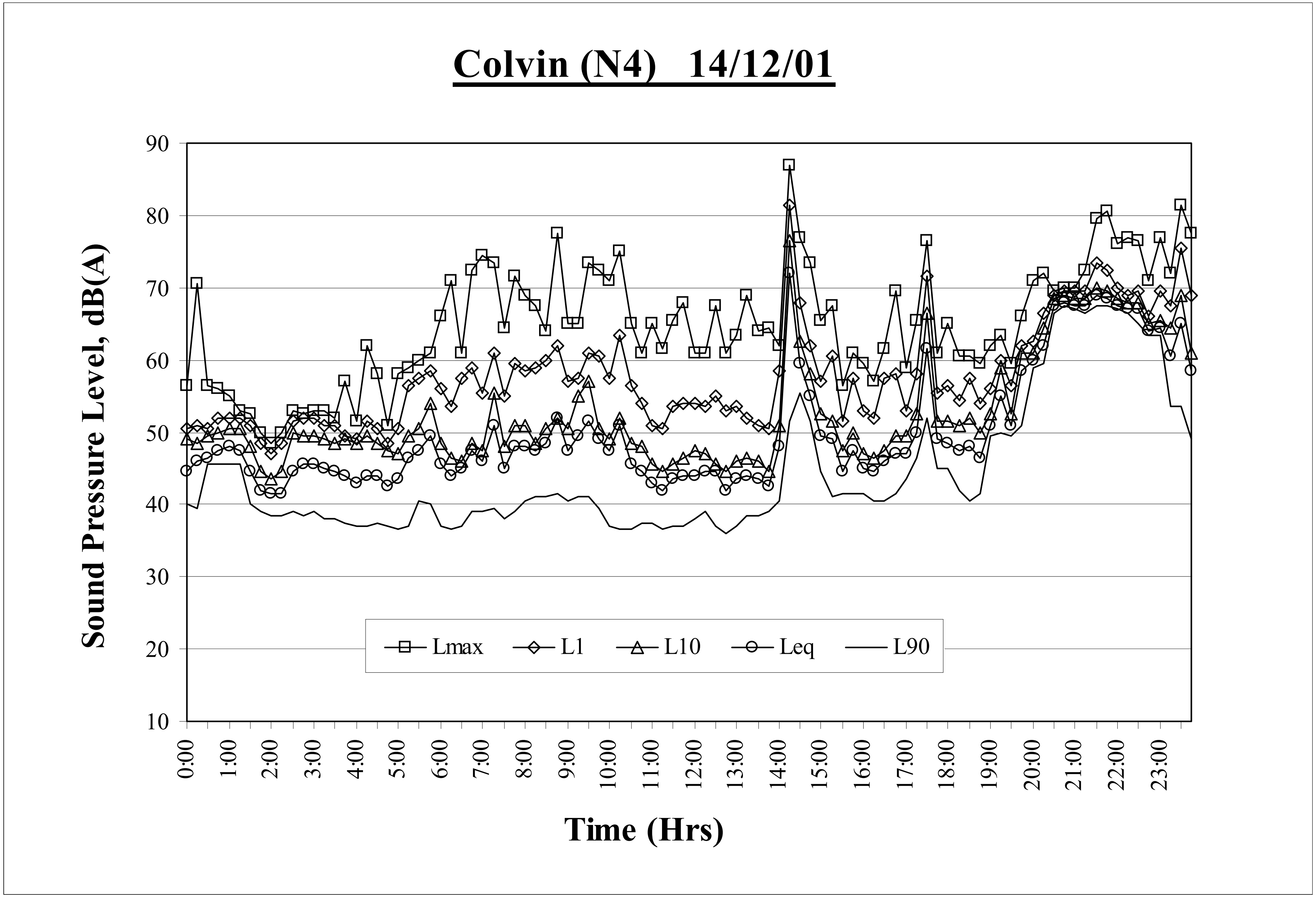
23:00
Time (Hrs)
Lmax
L1
L10
Leq
L90


Colvin (N4) 14/12/01
Sound Pressure Level, dB(A)
Time (Hrs)
Lmax
L1
L10
Leq
L90
10
20
30
40
50
60
70
80
90
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
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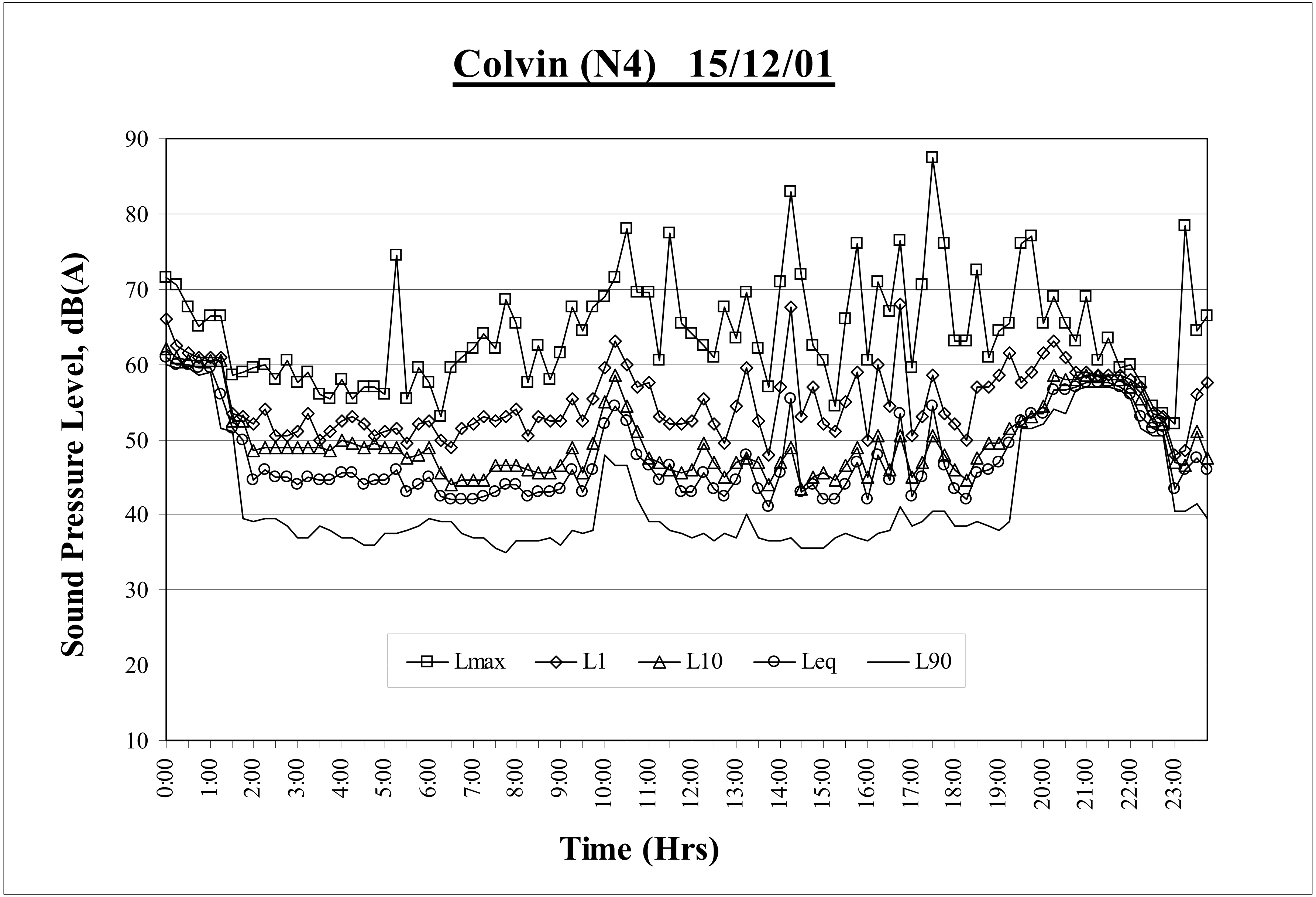
Colvin (N4) 15/12/01
Sound Pressure Level, dB(A)
90
80
70
60
50
40
30
20
10
Lmax
L1
L10
Leq
L90
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1:00
2:00
3:00
4:00
5:00
6:00
7:00
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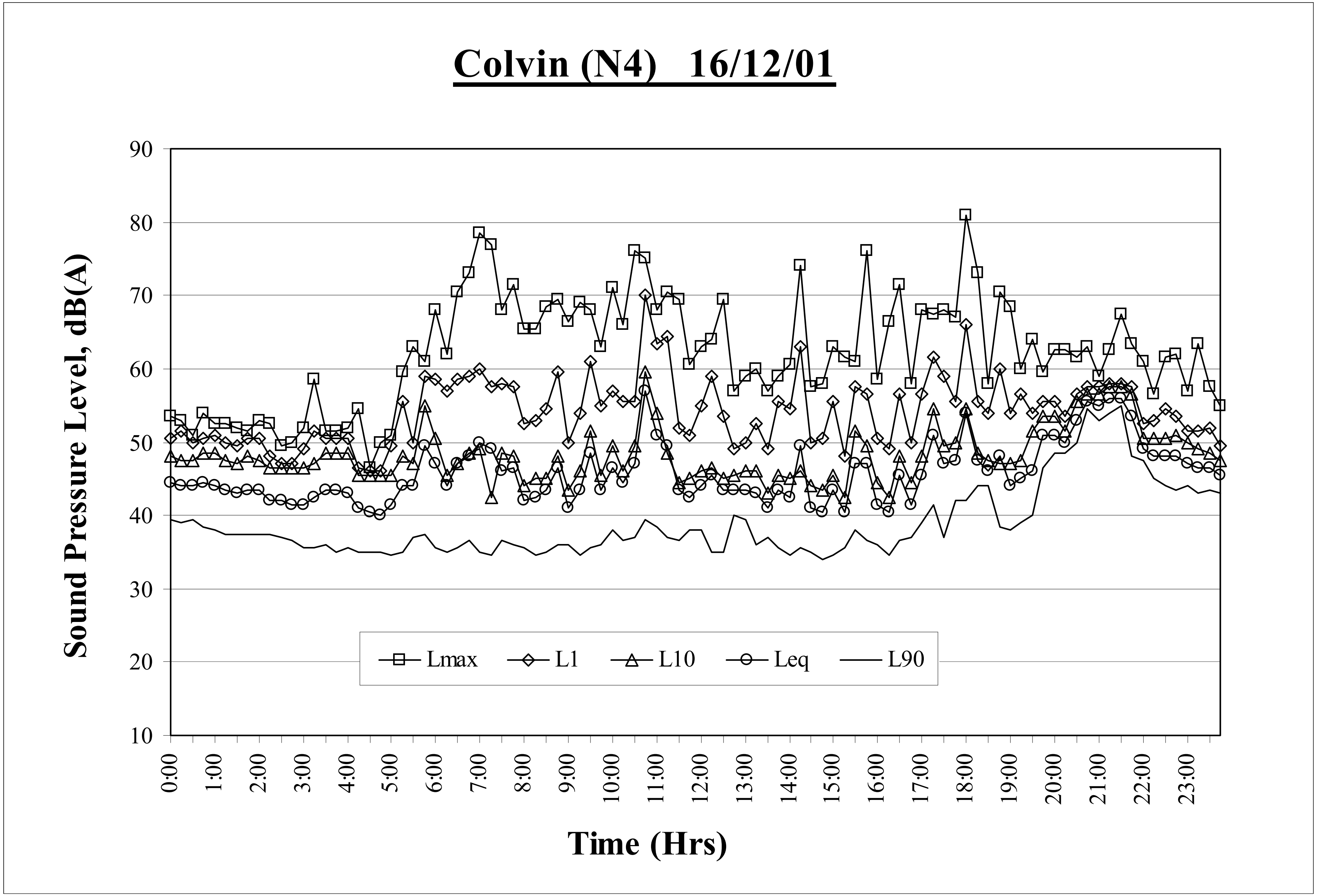
23:00
Time (Hrs)


Colvin (N4) 16/12/01
Sound Pressure Level, dB(A)
90
80
70
60
50
40
30
20
10
Lmax
L1
L10
Leq
L90
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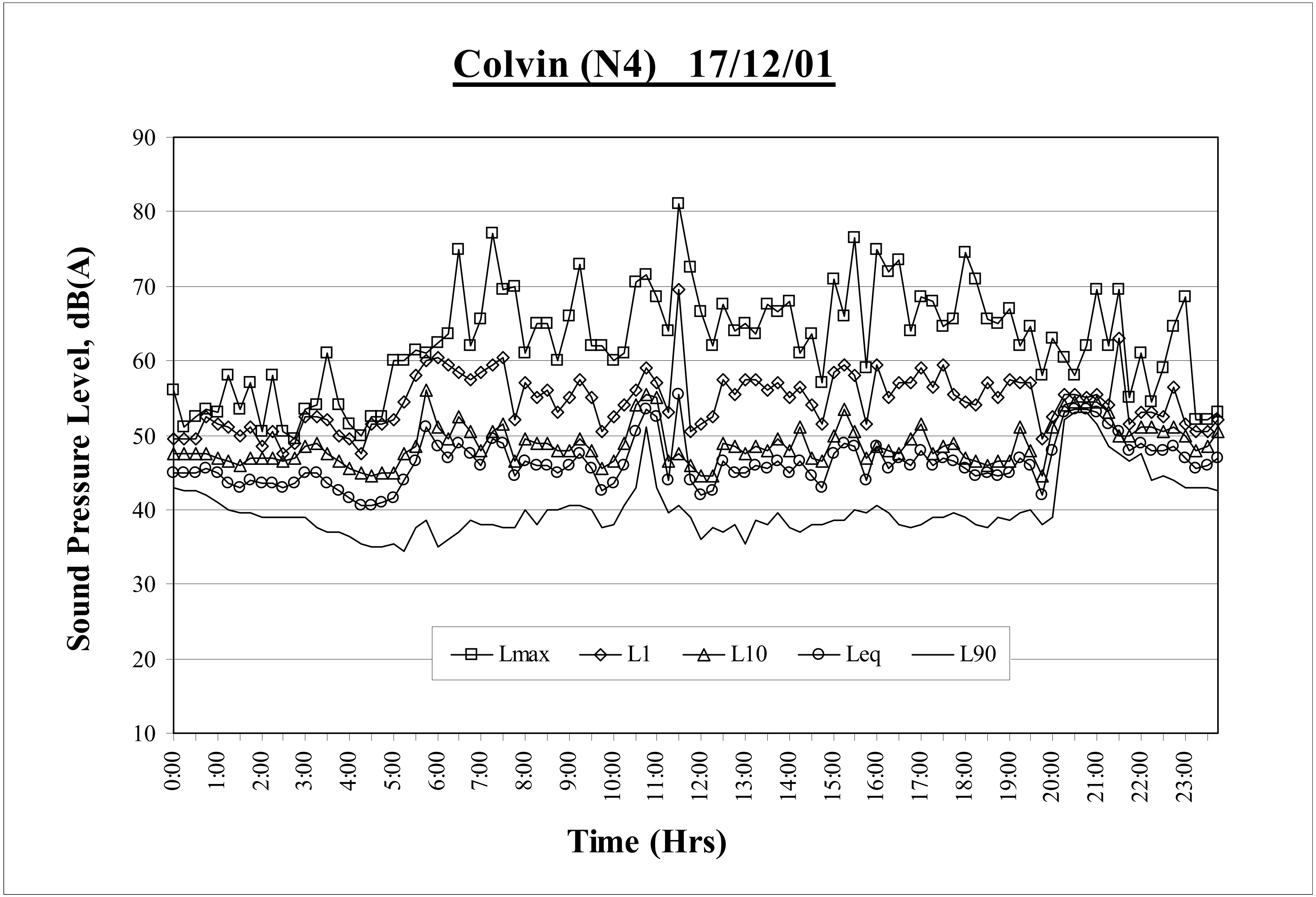
22:00
23:00
Time (Hrs)


Colvin (N4) 17/12/01
Sound Pressure Level, dB(A)
90
80
70
60
50
40
30
20
10
Lmax
L1
L10
Leq
L90
0:00
1:00
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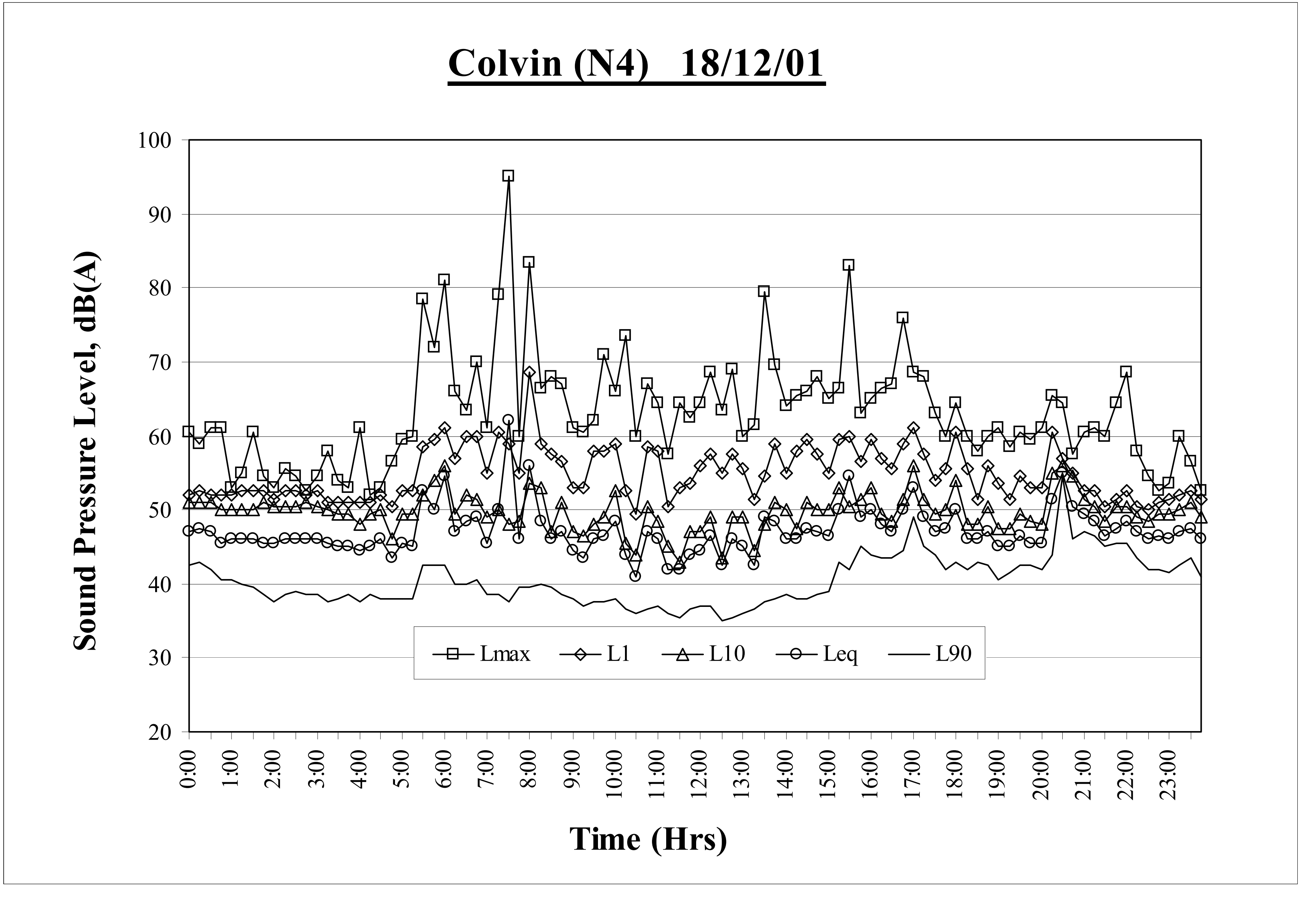
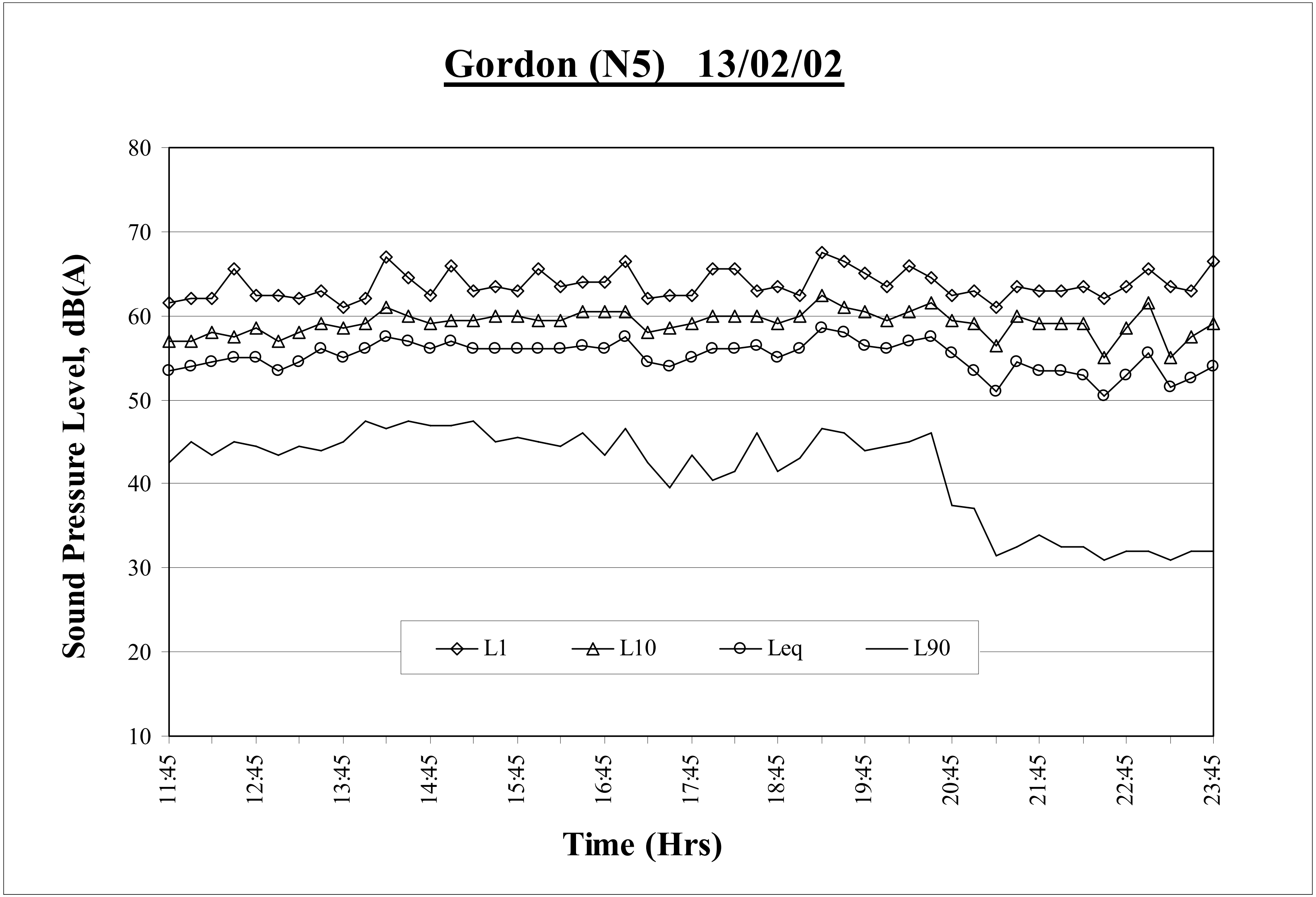
21:00
22:00
23:00
Time (Hrs)

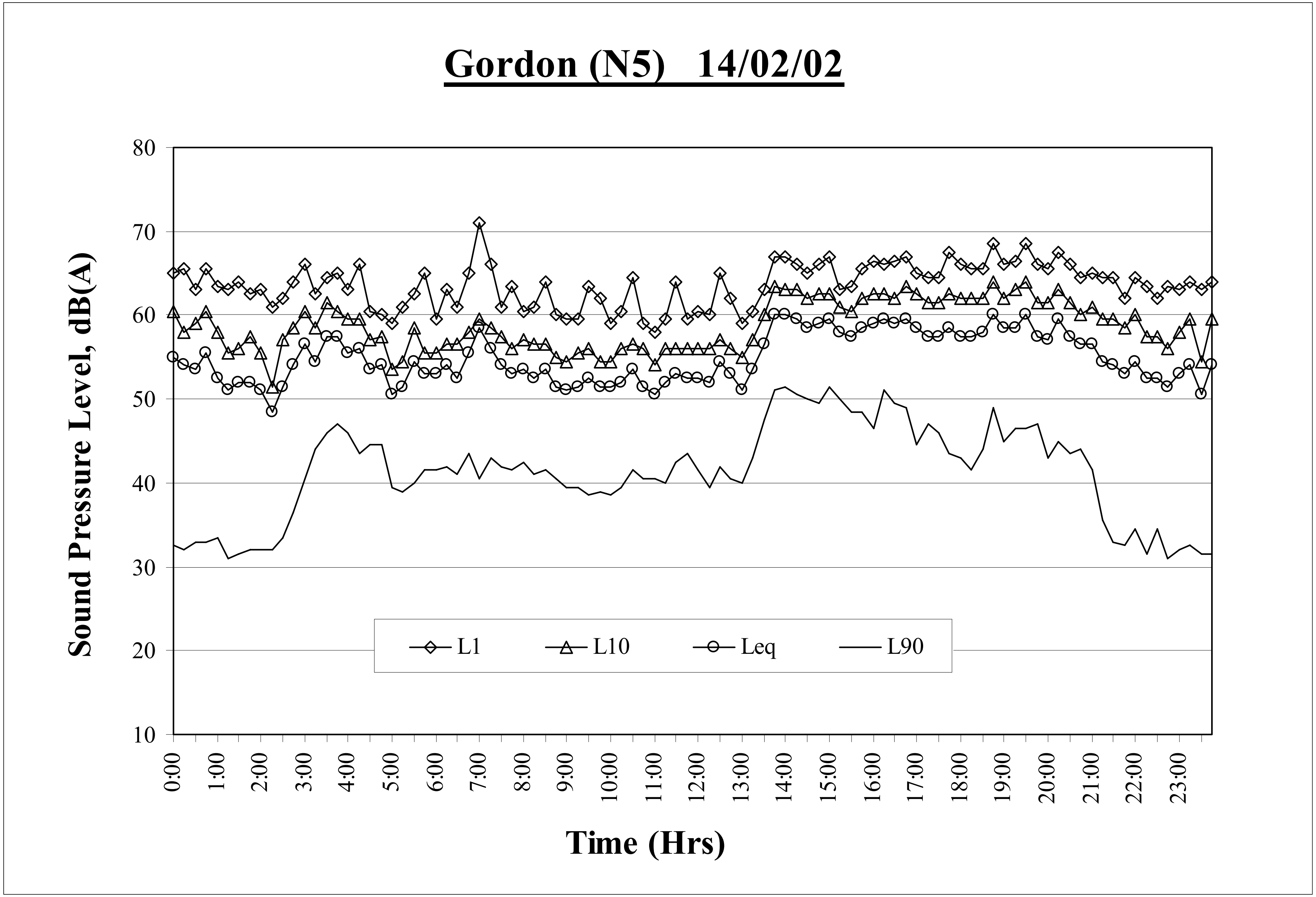
Start Screen

Search

Appendices




Gordon (N5) 13/02/02
Sound Pressure Level, dB(A)
80
70
60
50
40
30
20
10
11:45
12:45
13:45
14:45
15:45
16:45
17:45
18:45
19:45
20:45
21:45
22:45
23:45
Time (Hrs)
L1
L10
Leq
L90


Gordon (N5) 14/02/02
Sound Pressure Level, dB(A)
80
70
60
50
40
30
20
10
L1
L10
Leq
L90
0:00
1:00
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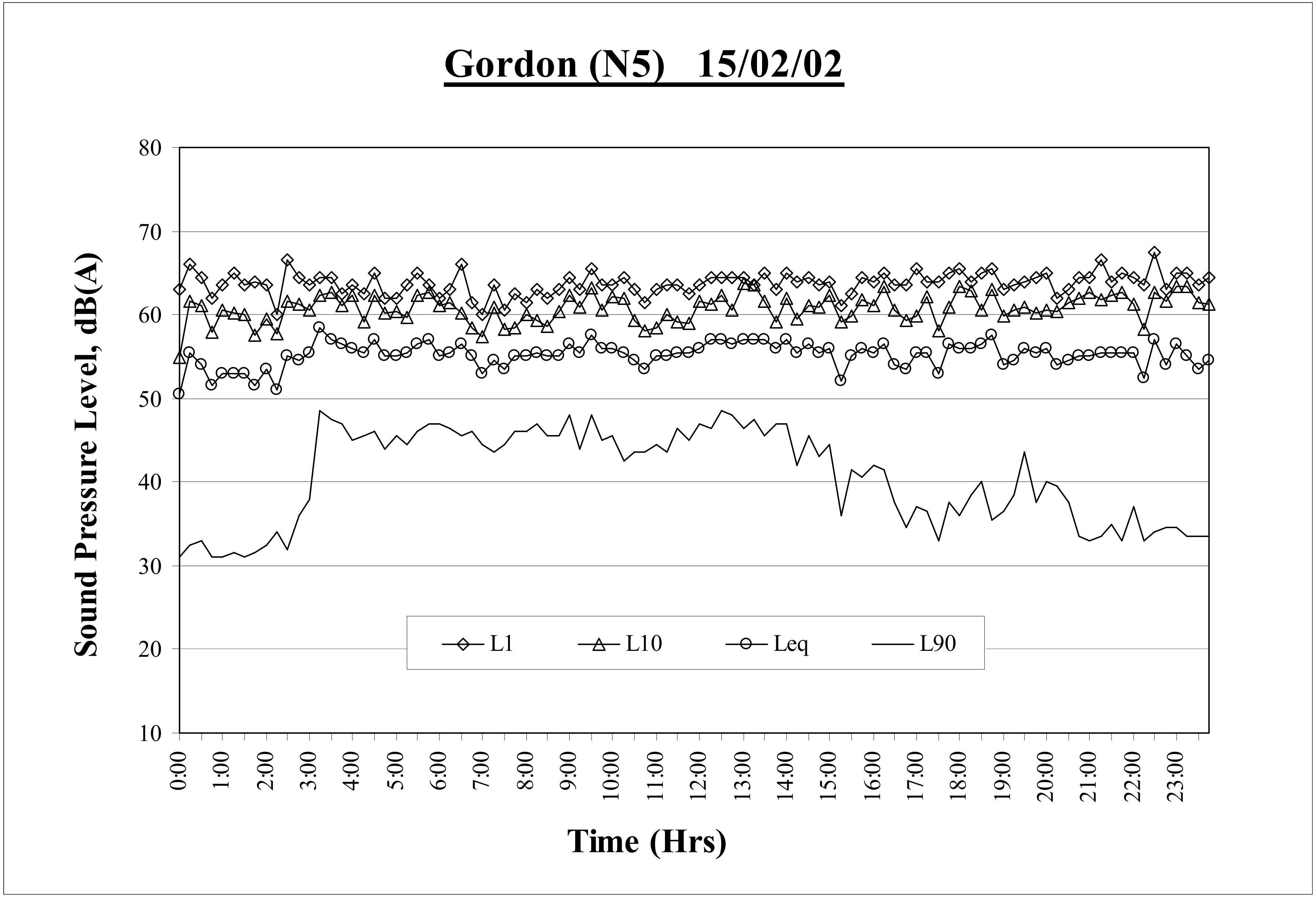
Time (Hrs)


Gordon (N5) 15/02/02
Sound Pressure Level, dB(A)
80
70
60
50
40
30
20
10
0:00
1:00
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3:00
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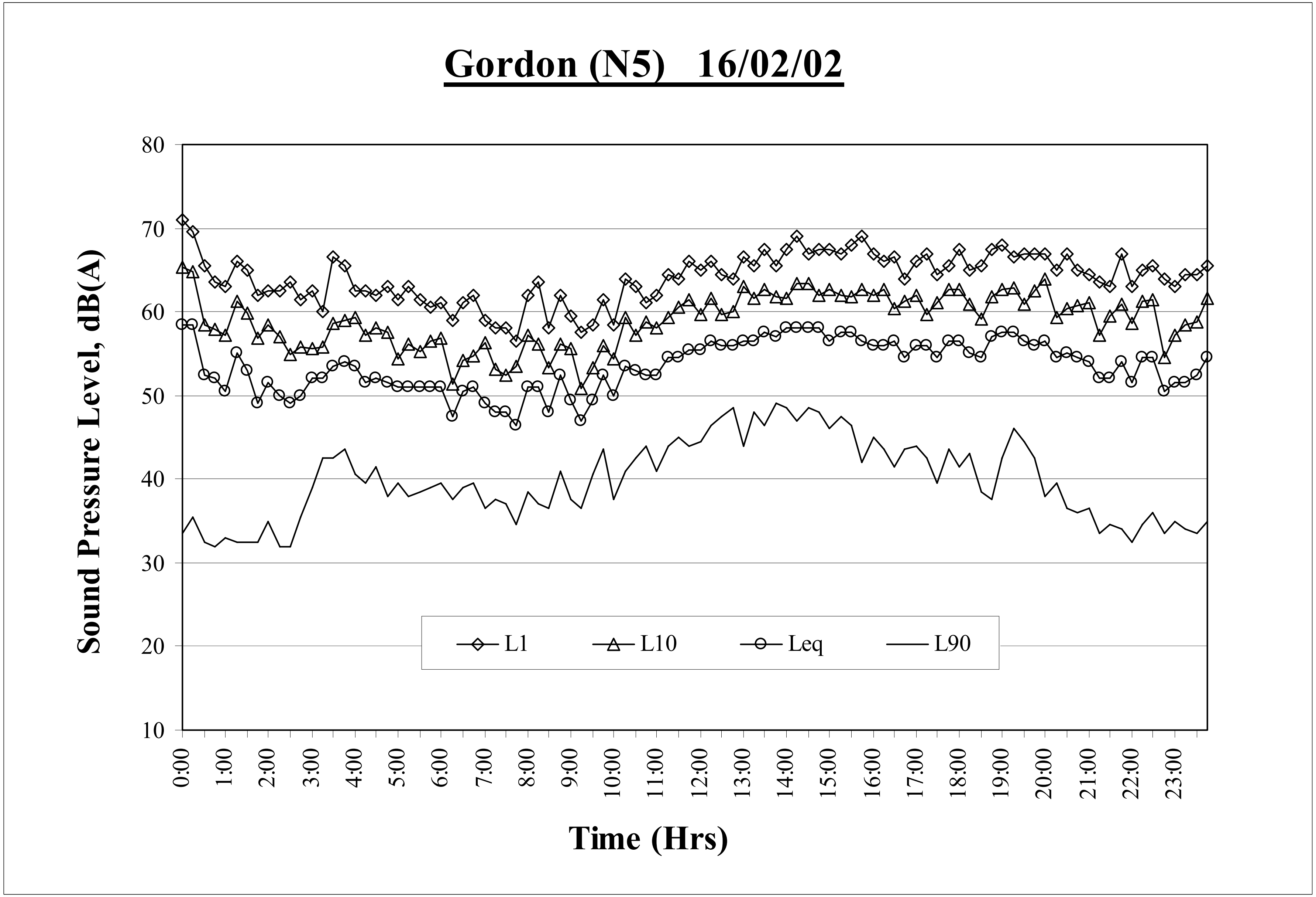
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time (Hrs)
L1
L10
Leq
L90


Gordon (N5) 16/02/02
Sound Pressure Level, dB(A)
Time (Hrs)
L1
L10
Leq
L90
80
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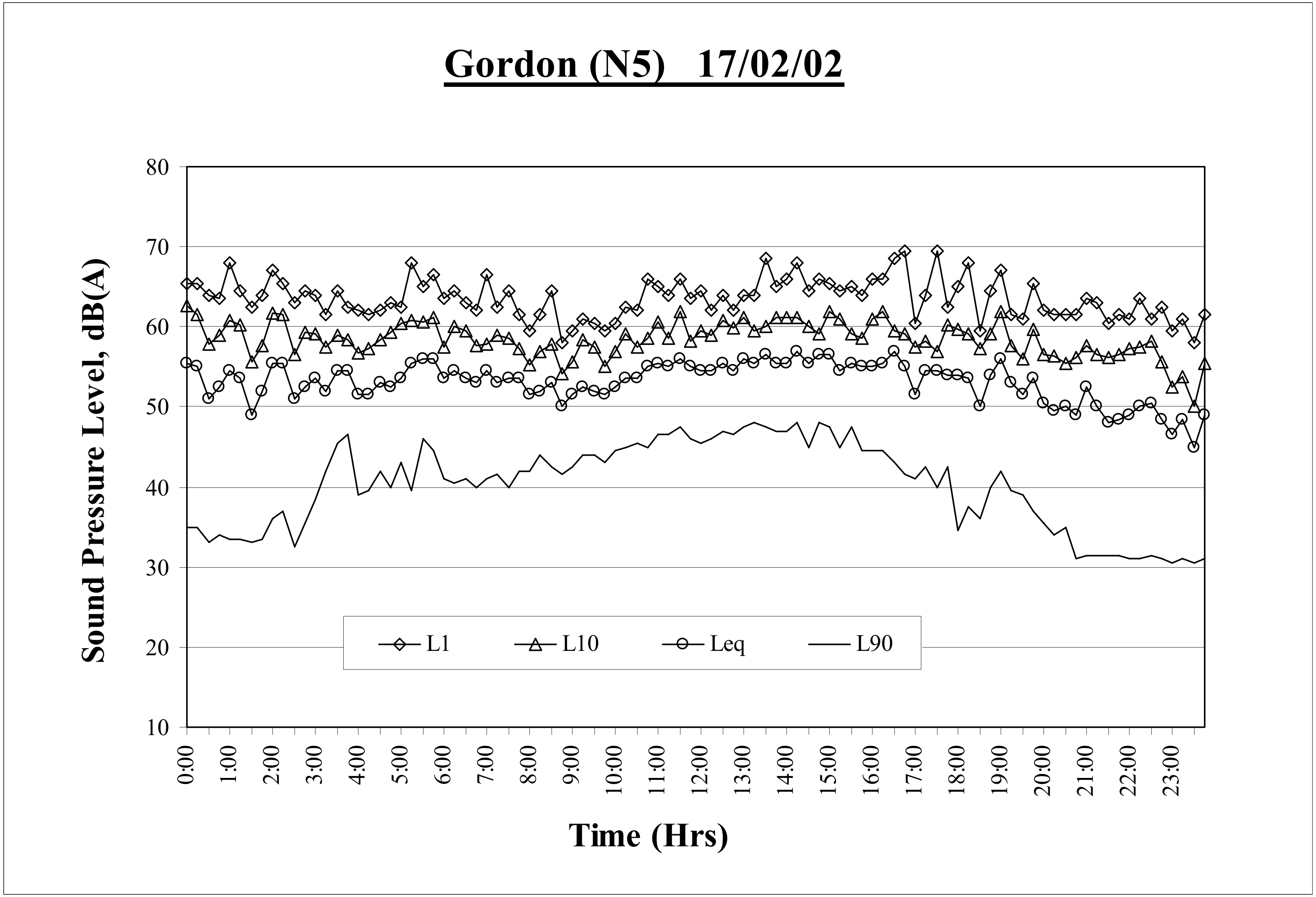
Gordon (N5) 17/02/02
Sound Pressure Level, dB(A)
80
70
60
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40
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2:00
3:00
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16:00
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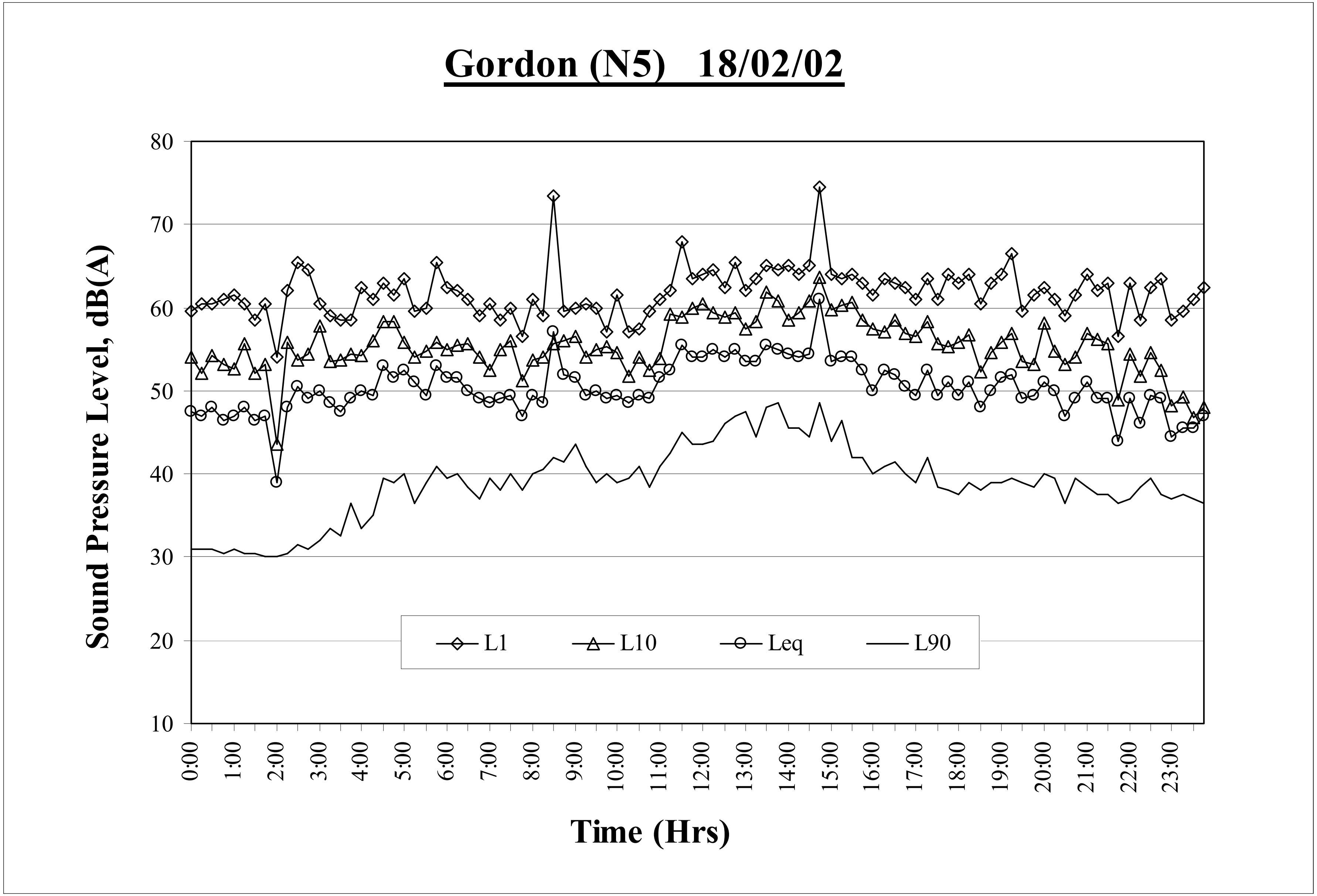
18:00
19:00
20:00
21:00
22:00
23:00
Time (Hrs)
L1
L10
Leq
L90


Gordon (N5) 18/02/02
Sound Pressure Level, dB(A)
80
70
60
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2:00
3:00
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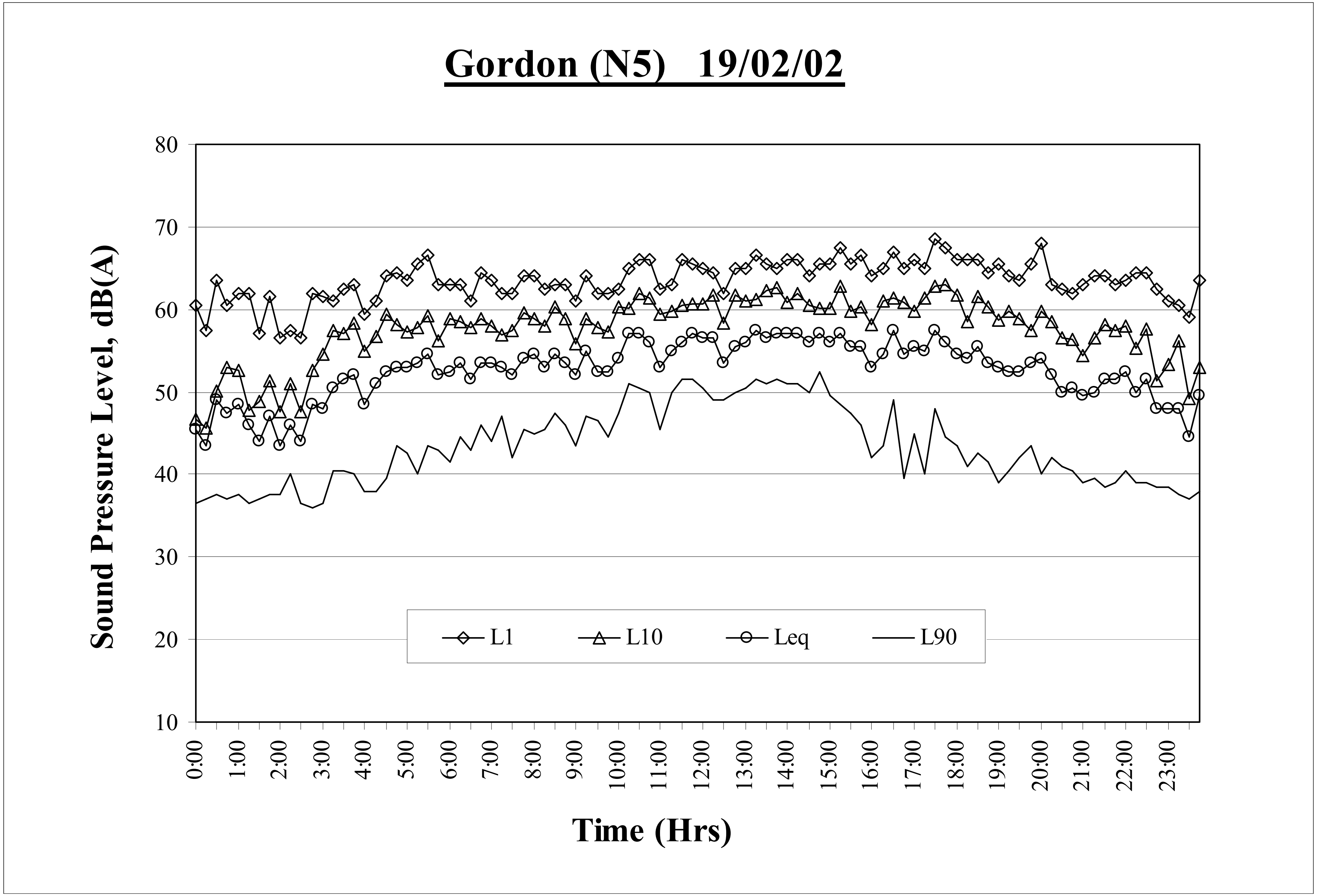
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time (Hrs)
L1
L10
Leq
L90


Gordon (N5) 19/02/02
Sound Pressure Level, dB(A)
80
70
60
50
40
30
20
10
L1
L10
Leq
L90
0:00
1:00
2:00
3:00
4:00
5:00
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Time (Hrs)

APPENDIX B

Noise Source Sound Power Levels

Source Sound Power Levels, dB											
SOURCES	Ln	dB(A)	Octave band centre frequency, Hz								
			31.5	63	125	250	500	1000	2000	4000	8000
Hydraulic excavator / Shovel	Leq	119	114	118	119	115	117	113	111	109	105
Loading 730E trucks	Lmax	128	126	129	129	127	128	119	117	116	114
CAT 992C FEL filling coal	Leq	115	109	115	114	111	113	109	108	101	96
hopper plus crusher	Lmax	127	118	126	127	122	124	121	121	112	110
D11R dozer stockpiling at base	Leq	106	107	114	110	102	103	102	98	91	84
Of No 2 Open Cut	Lmax	116	115	121	116	107	110	112	108	102	94
Komatsu 730E dump truck	Leq	117	115	121	111	119	117	111	109	102	97
Loaded – going uphill	Lmax	119	115	123	112	121	119	112	110	103	98
CAT 777 truck	Leq	112	115	118	113	111	109	106	106	99	92
Coal stockpiling	Lmax	125	125	129	126	121	120	114	121	112	108
CAT 777 truck	Leq	110	114	114	109	110	107	105	104	92	84
Empty – going downhill	Lmax	111	113	114	110	113	109	104	102	93	86

DISTRIBUTION

Noise and Vibration Assessment
Muswellbrook Coal Company
Muswellbrook NSW 2333

12 June 2002

3 copies	**Muswellbrook Coal Company**
Original	Project File

Quality Control Reviewer

Colin Phillips
Manager, Planning and Environment