Appendix C7

Noise & Blasting Assessment

MANGOOLA MINE MODIFICATIONS

NOISE & VIBRATION ASSESSMENT

ACOUSTICS AND AIR

REPORT NO. 08190-MO
VERSION C

WILKINSON MURRAY

MANGOOLA MINE MODIFICATIONS

NOISE & VIBRATION ASSESSMENT

REPORT NO. 08190-MO
VERSION C

DECEMBER 2010

PREPARED FOR

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1 INTRODUCTION

This report has been prepared by Wilkinson Murray (Sydney) Pty Limited for Umwelt (Australia) Pty Limited (Umwelt), who is acting on behalf of Xstrata Mangoola Pty Limited. The purpose of the report is to quantitatively assess the potential noise and vibration impacts of:

- proposed modifications to the Mine Plans of the Mangoola Coal Project (the Project); and
- proposed modification to rail operations.

The Mangoola Coal Project (formerly Anvil Hill Project) is located approximately 20 kilometres (km) to the west of Muswellbrook in the upper Hunter Valley. The mining operations were approved in 2007.

Xstrata Mangoola Pty Limited, trading as Mangoola Coal has since purchased the mine and is now seeking to streamline operations through altering the original mine plans and rail operations. Approval will be sought to modify the original project approval, under Section 75W of the *Environmental Planning and Assessment Act 1979*, and Xstrata Mangoola has engaged Umwelt to prepare an Environmental Assessment (EA).

The noise and vibration assessment upon which the previous approval was based was prepared by Wilkinson Murray and is described in the report "*Anvil Hill Mine Noise and Vibration Assessment Report number 03222 Version E dated August 2006*". The present report references the surrounding receivers, ambient noise measurements and weather conditions detailed in the previous noise and vibration assessment.

As a result of changes to the staged mine plans and altered rail operations, the noise emissions from the mine site and rail line during operation will change, and therefore additional assessment and review is required for:

- noise from mining and on site transport activities;
- overpressure and vibration from blasting activities; and
- noise from rail on the spur loop and main line.

Noise from mining and transport activities onsite has been assessed in accordance with the NSW Department of Environment, Climate Change and Water's (DECCW) *NSW Industrial Noise Policy (INP).*

It is not proposed to modify the construction activities through this modification application, and therefore noise and vibration from construction activities is not within the scope of this additional noise and vibration assessment.

2 PROJECT DESCRIPTION & CONTEXT

2.1 The Approved Project

The Mangoola Coal Project comprises the design, construction and operation of:

- an open cut coal mine;
- coal handling and crushing facilities, a preparation plant (washery) and stockpile areas;
- water management, supply and distribution infrastructure;
- handling and placement of overburden (rock);
- mine access road including a new intersection on Wybong Road, internal access roads and haul roads;
- infrastructure including offices, staff amenities, workshop, conveyors, and ancillary services; and
- a rail spur, rail loop and rail loading infrastructure for the transport of all product coal.

Mangoola Coal is approved to extract and process up to 10.5 million tonnes per annum (Mtpa) of Run-of-Mine (ROM) coal from the Mangoola site for a period of 21 years but is now seeking to streamline operations via various modifications to the original mine plan. One of the main modifications to the approved project will be the relocation of a 500 kV transmission line which currently bisects the approved project disturbance area. The relocation of this line will allow for a more efficient mine operation and mine layout.

As a result of the proposed relocation of the transmission line, revised mine plans have been developed which will reduce the operational life of the project to 15 years. Detailed mine and project planning has been undertaken to develop a conceptual mine plan, with indicative stages modelled at years 2, 5, 10 and 15.

Early works commenced at the site in January 2009 which include the development of the site access road, replacement of water lines, upgrades on Wybong Road East, establishment of site infrastructure for workers and the establishment of a borrow pit and internal roads. Xstrata Mangoola has completed its Early Works program and commenced full construction in November 2009.

Figure 2-1 shows the location of Mangoola Coal Project and surrounding residences, with numbering of residences as shown in the original Environmental Assessment for the project. A number of the properties shown in Figure 2-1 are now owned by Mangoola Coal.

Mining will be undertaken using conventional truck and shovel activities but with some changes to the number and type of equipment that will be used. Some changes to the mine infrastructure and layout are also proposed. Mining operations will continue to be conducted for up to 24 hours per day, seven days per week. Construction activities will be carried out during the daylight hours for up to seven days per week.

As for the original mine plan proposal, the activities will include:

- removal of vegetation and topsoil in advance of each mining strip;
- drill and blasting of overburden prior to excavation;
- strip mining using hydraulic excavators, assisted by dozers to uncover the coal seams;
- loading to rear dump trucks; and
- progressive rehabilitation of the overburden emplacements.

Four noise modelling scenarios have been developed for the years 2, 5, 10 and 15, which are consistent with the approach developed for the scenarios modelled in the original assessment. Table 2-1 shows the proposed overburden and coal production rates that were the subject of this assessment. These scenarios cover mining activities in various locations within the proposed disturbance boundary and for a range of material volumes and tonnages.

Table 2-1 Overburden and Coal Production Rates for Assessment Scenarios

Mining year	Total Waste Moved (Mbcm)	Total ROM Coal Mined (Mt)	Product Coal (Mt)
Year 2 (2012)	17.419	8.5	7.008
Year 5 (2015)	30.495	10.5	7.665
Year 10 (2020)	30.557	10.5	7.665
Year 15 (2025)	0.077	0.688	0.575

Mbcm = Million bank cubic metres, Mt = Million tonnes.

There will be concurrent operation of two (previously four) pits for most of the mine life, with rehabilitation commencing as soon as possible after disturbance from mining.

Figure 2-1 Mangoola Coal Site and Surrounding Residences

2.2 The Surrounding Area

The Mangoola Coal Project is located in the Upper Hunter Valley, on the margin of the valley floor. The approved project disturbance boundary covers an area of approximately

2283 hectares.

The approved project disturbance area has been extensively used for agriculture since the 1800s and is dominated by rolling grazing land with remnant and regrowth woodland. The locality immediately surrounding the project area consists of mostly smaller rural holdings, dominated by rural residential land use, but also includes more intensive agricultural land uses such as vineyards, irrigation for Lucerne and dairies.

The topography of the approved project disturbance area varies from lower slopes towards the Hunter River, through undulating and hilly lands to rocky outcrops. A notable topographical feature within this area is Anvil Hill itself which rises approximately 70m above the surrounding area at its highest point. It is located at the centre of the proposed mining area and consists of two hills connected by a saddle. Anvil Hill itself is not part of the approved mine plans. Construction for the Mangoola Coal Project has commenced in the lower sections of the approved project disturbance area. Until construction or mining work commences, these areas will continue to be used for pastoral grazing, with the existing 500kV TransGrid electricity transmission line crossing the site in a southeast / northwest direction. The relocation of the transmission line is part of a related project application to be lodged concurrently with the mine modifications. It is intended to relocate the transmission line to the south and west of its existing location, with the majority of the line to be inside the approved project disturbance boundary.

The area surrounding the approved project disturbance area is dominated by a row of hills to the west and south. The hills to the west are not named, although they are known locally as “Wallaby Rocks”. Wallaby Rocks rise to a height of 264m AHD, being approximately 100m above the surrounding area and contain a visually dominant escarpment along the western side. The rocky area to the south known as Limb of Addy Hill rises to a height of 302m AHD, which is also approximately 100m above the surrounding area.

There are several other mine sites within 20km of the Anvil Hill Project including Mount Arthur North, Bengalla, Drayton and the approved Mount Pleasant project. As such, to protect residential amenity, assessment of noise impacts from the Mangoola Coal Project needs to consider not only impacts from the project itself, but also the potential for cumulative impacts with other existing and approved operations.

2.3 Types of Noise & Vibration Impacts

A number of activities associated with the proposal have the potential to cause noise impacts at nearby surrounding residential receivers. These are of a similar nature to other operations in the area.

Operational noise levels would be dominated by the transportation of overburden and coal around the site. The majority of noise would result from the movement of haul trucks and, to a lesser extent, the operation of dozers on overburden emplacements. Adverse meteorological conditions would increase noise levels at receivers from equipment, particularly at night time, as temperature inversions are a common feature in the local area at night. Noise levels would often be higher in the surrounding area at night time than during the daytime as a result. Much of the other operational equipment is contained within pits, and this plant would not contribute as much to the overall noise environment, however it would still be perceivable at times.

Typically, noise from infrastructure and from rail loading and movement would be audible at residences close to these facilities but barely audible or inaudible at most residences surrounding the proposal.

2.4 Noise Controls

Several types of noise control measures are proposed as outlined below. Information on how these controls have been incorporated into the noise modelling procedures is discussed further in Section 6.2.5.

2.4.1 Restriction of Night Time Operations

Given that the greatest noise impacts are predicted to occur during the night time period, it is appropriate to consider methods of controlling operations at night, where feasible. Noise impacts are dominated by noise from the operation of haul trucks around the site, and hence maximum benefit would be obtained by restricting their operation.

Therefore, at night trucks would be restricted to operate below the maximum elevation of the overburden emplacement areas. This is considered both practical and economically viable and was found to have a more significant impact than construction of bunding on top of overburden emplacement areas (see below). Further, dozers involved in the distribution of overburden would also be restricted to the same working elevation.

2.4.2 Control of Noise from Infrastructure

The following measures have been established to mitigate potential noise impacts at residences.

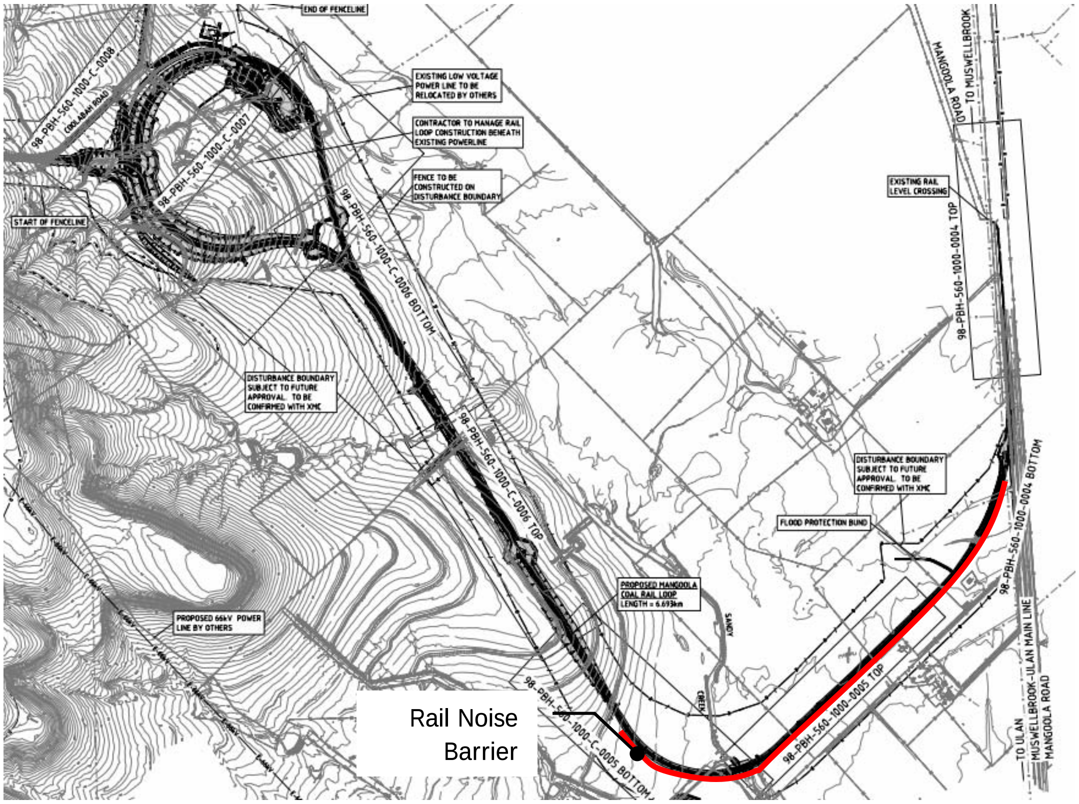
- All infrastructure and coal handling plant would be located in topographically shielded positions on the site, which are specifically located to reduce noise impacts to adjacent residences.
- The coal preparation plant rejects bin and crushing stations including the roof / ceiling, would be enclosed with cladding.
- All conveyors used in the plant would incorporate shielding close to the belt on the side closest to residential receivers.

2.4.3 Control of Noise from Rail Spur

The location of the rail loop requires part of the track to be positioned in a substantial degree of cutting as a result of the natural topography at the northern end of the loop. This in itself provides surrounding residences with a high degree of shielding from rail noise. As the track progresses south and out of the loop it is proposed to construct a barrier (referred to in the EA as a noise wall) to a height of 3.5 metres above the track on the eastern side. This barrier will continue to where the spur joins the main Muswellbrook to Ulan line.

The loop and barrier location is shown in Figure 2-2.

Figure 2-2 Rail Loop and Noise Barrier Location



2.4.4 Real-Time Noise Monitoring

It is proposed to monitor operational noise levels from the Mangoola Coal Project with a real-time monitoring system. The commitment to use such a system goes beyond normal DECCW monitoring requirements and has proved effective in assisting noise management at several other sites in NSW.

This real time system would not be utilised as a substitution for compliance monitoring which generally involves attended noise monitoring at various residential locations around the proposal.

2.4.5 Other Noise Control Measures

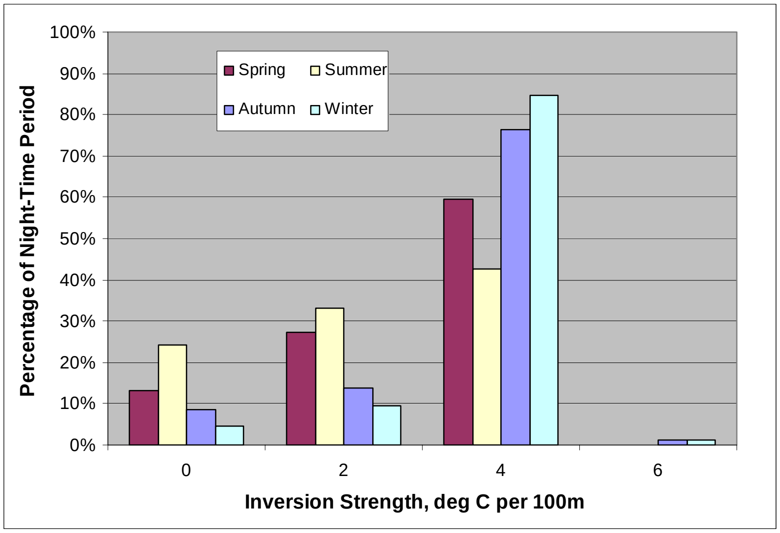
Several other noise control measures have been considered in the preparation of this assessment, but are not considered to be appropriate for the proposal. They include the following.

2.4.6 Restriction of Operations under Adverse Meteorological Conditions

Consideration was given to restricting or stopping operations at night under adverse meteorological conditions. Potential noise impacts are greatest under strong temperature inversions. However, investigation of the occurrence of temperature inversions at Mangoola Coal showed a very high frequency of such strong temperature inversions.

Figure 2-3 shows the occurrence as a percentage of the night time period for each season. It is noted that inversion strengths of 4°/100m are prevalent, with occurrences of between 42.8% of the time during summer nights and up to 84.8% of the time during winter nights. Xstrata Mangoola has advised that not operating for this amount of time would not be financially viable for the proposal.

Figure 2-3 Temperature Inversion Probabilities at Mangoola



2.4.7 Use of Trolley Assist System

Trolley assist systems allow haul trucks to use power from fixed overhead wiring, with the diesel engine operating at idle speed only. However such systems are only viable where there is a major haul route through the site. There is no scope for such a system for the Mangoola Coal Project.

2.4.8 Use of Bunding on overburden emplacement areas

Bunding at the top of the overburden emplacement areas was modelled under night time conditions. While the bunding would greatly reduce the noise levels at residences due to dozers operating at the top of the emplacements, there was negligible reduction in the noise level from haul trucks, and therefore the overall noise levels at residences were only marginally affected. It was found to be more effective to apply controls on the operating elevations of haul trucks and dozers at night as discussed in Section 2.4.1.

3 NOISE LEVEL CRITERIA

This section discusses the various noise and vibration criteria and guidelines set out by the NSW Government with regard to different types of activity associated with the proposal that have potential to impact on the surrounding area.

3.1 Operational Noise Criteria

The *NSW Industrial Noise Policy (INP)* sets out two forms of noise criteria. In assessing noise levels at residences, the criteria should be assessed at the most-affected point on or within the residential property boundary or, if this is more than 30m from the residence, at the most-affected point within 30m of the residence. The two criteria are described below.

3.1.1 Intrusiveness Criterion

The intrusiveness criterion specifies that the $L_{Aeq,15min}$ noise level from the proposed source should not exceed the RBL by more than 5dBA. The RBL is defined as the overall single-figure background noise level representing each measurement period (day, evening and night) over the whole monitoring period. The RBL is the level used for assessment purposes. Where the RBL is found to be less than 30dBA, it is to be set to 30dBA. As documented in Section 4, this is the case in all areas considered in this assessment.

In the present case, the application of modifying factors may be relevant for certain specific noise sources, notably an adjustment for tonality and an adjustment for impulsiveness. These sources are assessed separately below in terms of their potential to cause sleep disturbance. However, the overall noise at any residence due to all mining activities would be dominated by continuous or quasi-continuous sources such as haul trucks, and would be unlikely to attract such adjustments. Hence, the noise criteria are set equal to the RBL + 5dBA, for each of the relevant time periods.

These criteria should be assessed under specific meteorological conditions, which are detailed in the *INP.* Definition of appropriate meteorological conditions is discussed in detail in Chapter 5.

3.1.2 Amenity Criterion

The second type of criterion is an amenity criterion, and is intended to ensure that the total $L_{Aeq,Period}$ noise level from all industrial sources does not exceed specified levels. For rural residences, the relevant recommended “acceptable” levels are:

- Daytime (7.00am-6.00pm) 50dBA L_{Aeq}
- Evening (6.00pm-10.00pm) 45dBA L_{Aeq}
- Night Time (10.00pm-7.00am) 40dBA L_{Aeq}

(These time periods are as defined above for calculation of the RBL, with the exception that for the purpose of the amenity criterion only, the “night” period extends to 8.00am, rather than 7.00am, on Sundays and public holidays.)

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

Operator attended noise surveys have not identified any existing industrial noise at potentially affected residences, and hence the values above represent the applicable amenity criterion for noise from the project. There are no approved industrial developments that influence the criteria for this project.

3.1.3 Operational Noise Levels at Places of Worship

Two churches have been identified near the proposal, namely a Catholic Church on Wybong Road and an Anglican Church on Castlerock Road. There are no specific criteria in the *NSW Industrial Noise Policy (INP)* for places of worship; however, in respect of such premises, Australian Standard 2107:2000 *Acoustics – Recommended Design Sound Levels and Reverberation Times for Building Interiors* recommends a maximum internal level of L_{Aeq} 35dBA for places of worship without speech amplification systems. Internal noise levels are generally 10dBA below external noise levels with windows open to a normal extent. The above Australian Standard would therefore imply a recommended external noise level of L_{Aeq} 45dBA at the churches.

3.1.4 Summary of Operational Noise Criteria

The operational noise criteria for the Mangoola Coal Project are summarised in Table 3-1. All noise criteria apply under specific meteorological conditions which are described in detail in Section 5. These criteria are the same for each of the identified residences surrounding the proposal.

Table 3-1 Summary of Operational Site Specific Noise Criteria

Location	Period	RBL (dBA)	Noise Criteria (dBA)	
			Intrusiveness	Amenity
ALL	Day	30	35	50
	Evening	30	35	45
	Night	30	35	40

For the Mangoola Coal Project, the intrusiveness criterion is the more stringent criterion in all time periods, and is the adopted criterion for this assessment.

3.1.5 Exceedance of Criteria

In cases where the criteria set out in Section 3.1.4 are exceeded, the *INP* sets out a range of responses, including:

- application of “feasible and reasonable” mitigation measures to reduce noise levels;
- negotiation with relevant government bodies and/or the affected community to determine reasonable levels based on the extent of any residual impacts and other factors such as social and economic benefits derived from the noise source; and
- in extreme cases, acquisition of affected properties. Recent Department of Planning (DOP) approach for major projects would suggest acquisition of properties where the operational noise level, under meteorological conditions as defined in Section 5, exceeds the RBL by more than 10dBA.

In particular, the Policy indicates:

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

3.2 Blasting Assessment Criteria

3.2.1 Annoyance & Discomfort

For assessment of annoyance due to blasting, the DECCW (and most similar authorities in Australia) adopt guidelines produced by the Australian and New Zealand Environment and Conservation Council (ANZECC). The fundamental criteria are that at any residence or other sensitive location:

- the maximum overpressure due to blasting should not exceed 115dB for more than 5% of blasts in any year, and should not exceed 120dB for any blast; and
- the maximum peak particle ground velocity should not exceed 5mm/sec for more than 5% of blasts in any year, and should not exceed 10mm/sec for any blast.

3.2.2 Structural Damage

At sufficiently high levels, blast overpressure may in itself cause structural damage to some building elements such as windows. However, this occurs at peak overpressure levels of about 133 dB and above, well in excess of criteria for annoyance.

For assessment of damage due to ground vibration, Australian Standard *AS2187.2-1993 Explosives – Storage, Transport and Use* contains an appendix specifying recommended levels for peak particle vibration velocity to protect typical buildings from damage. These are:

- "Structures that may be particularly susceptible to ground vibration" – 5mm/sec
- "Houses and low-rise residential buildings; commercial buildings not included below" – 10mm/sec
- "Commercial and industrial buildings or structures of reinforced concrete or steel construction" – 25mm/sec

The Standard notes that there may be special cases including high-rise buildings, reservoirs and buildings housing sensitive equipment where alternative criteria may be appropriate. No such structure has been identified in the vicinity of the Mangoola Project.

A number of heritage sites have been identified surrounding the proposal. These sites have been inspected by a historic architect, and one was assessed as being susceptible to damage from vibration from blasting. At this site the 5mm/sec criterion has been adopted. Other heritage sites that are not particularly susceptible to damage from vibration adopt the 10mm/sec building damage criterion.

3.3 Low Frequency Noise Criteria

No criteria exist in NSW with regard to exposure to low frequency noise at residences. This topic has, however, been highlighted by a few local landholders as being of concern. A recent technical paper produced by the University of Salford, UK, proposes a criterion to assist in determining whether a low frequency disturbance exists.

A measurement of L_{Aeq}, L_{10} and L_{90} is taken in third octave bands between 10Hz and 160Hz. If the L_{Aeq} taken over a time when the noise is said to be present exceeds the reference curve in Table 3-2, it may indicate a source of low frequency noise that could cause disturbance. The character of the sound should be checked if possible by playing back an audio recording at an amplified level.

Table 3-2 Proposed Reference Curve - dB

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

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

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

The above parameters are evaluated in the third octave band which exceeds the reference curve by the greatest margin.

3.4 Project Approval Conditions

As this is a modification to an existing Project Approval, it is relevant to consider the existing project approval conditions.

Schedule 3, clause 3 of the project approval conditions (Project Approval 06-0014) specify noise impact assessment criteria for individual property numbers during the day, evening and night time. Provision is made in the project approval conditions for noise exceeding criteria in clause 3 that land acquisition is required upon receiving a written request from the landholder. Currently, the project approval conditions specify land acquisition if the $L_{Aeq\ (15\ minute)}$ exceeds 40dB in the day, evening or night.

The project approval conditions also contain cumulative noise criteria, and specify that this be measured in accordance with the *INP*.

The criteria for cumulative noise are presented below in Table 3-3.

Table 3-3 Cumulative Noise Criteria – Project Approval Conditions

	Day $L_{Aeq(11 hour)}$	Evening $L_{Aeq(4 hour)}$	Night $L_{Aeq(9 hour)}$
Amenity criteria	50	45	40
Acquisition criteria	53	48	43

Source: Project Approval Conditions 06-0014 Schedule 3, Clauses 5 and 6.

In addition, a number of properties are listed in Appendix 5 of the project approval conditions and Xstrata Mangoola as the proponent is obliged to undertaken 'Best Endeavours to Acquire' or enter a negotiated agreement with affected landholders. Landholders may be affected by noise, blasting or air quality impacts.

3.5 Rail Noise Criteria

Australian Rail Track Corporation (ARTC) operates the Gulgong - Sandy Hollow, Merriwa and Main Northern railways. Noise emissions from railways operated by the ARTC are regulated via ARTC's EPL 3142. The EPL Section L6 notes that:

> *"It is an objective of this licence to progressively reduce noise levels to the goals of 65 dB(A) (day time 7 am -10 pm) Leq, 60 dB(A) (night time from 10 pm – 7 am), 85 dB(A) (24 hr) max pass-by noise, at one metre from the facade of affected residential properties through the implementation of the Pollution Reduction Program."*

Based on the above guideline noise assessment goals, the following noise criteria have been adopted for the Mangoola Project:

- $L_{Aeq,9hr}$ = 60dBA
- $L_{Aeq,15hr}$ = 65dBA
- L_{Amax} = 85dBA

4 EXISTING NOISE ENVIRONMENT

The existing ambient noise environment around the proposal has been monitored on several occasions, both by means of unattended noise logging, and by operator attended measurements.

4.1 Unattended Noise Measurements

Four unattended noise surveys were carried out by HLA Envirosciences Pty Ltd in 2002 and 2003. The surveys involved establishing environmental noise loggers at eight representative residential locations surrounding the project application area. These residences N1 to N8 are listed in Table 4-1 and illustrated in Figure 4-1.

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

The noise logger enables the calculation of an Assessed Background Level (ABL), i.e. the single figure background level representing each assessment period (day, evening and night), for each day. The ABL is determined by calculating the 10th percentile (lowest 10th percent) background level (L_{A90}) for each period, as described in Appendix A. Over the whole measurement survey period the Rating Background Level (RBL), which is the median value of the ABL values for the period over all measurement days, is determined. The RBL value is the appropriate background noise level recommended to be used by the *INP*.

Results from the four surveys are shown in Figure 4-1 to Figure 4-3 for daytime (7.00am-6.00pm), evening (6.00-10.00pm) and night time (10.00pm-7.00am) assessment periods. Those periods in which wind speed at microphone level was greater than 5m/s or when it was raining were excluded from analysis in accordance with the *INP*.

Table 4-1 Unattended Noise Measurement Locations

Site No.	Property No.	Nearest Road	Measurement Location
N1	CH 0079	Mangoola Road	Inside house yard, near sheds
N2	CH 0255	Coolabah Road	Met station compound
N3	CH 0286	Mangoola Road	House yard in front of house
N4	CH 0276	Wybong Road	At dust gauge DG 10
N5	CH 0031	Wybong Post Office Road	At dust gauge DG 11
N6	CH 0304	Wybong Road	On fenceline, east of house
N7	CH 0123	Wybong Road	House yard, in front of pool
N8	CH 1358	Denman Road	Back of paddock, 200m from road

Figure 4-1 Measured Daytime Background Noise Levels

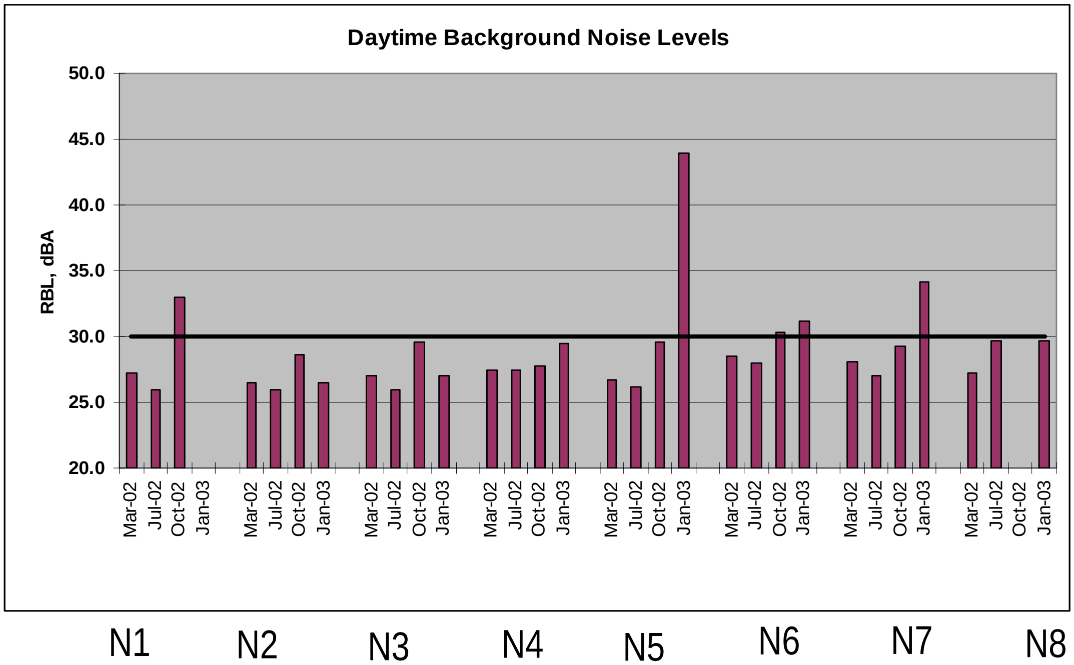


Figure 4-2 Measured Evening Background Noise Levels

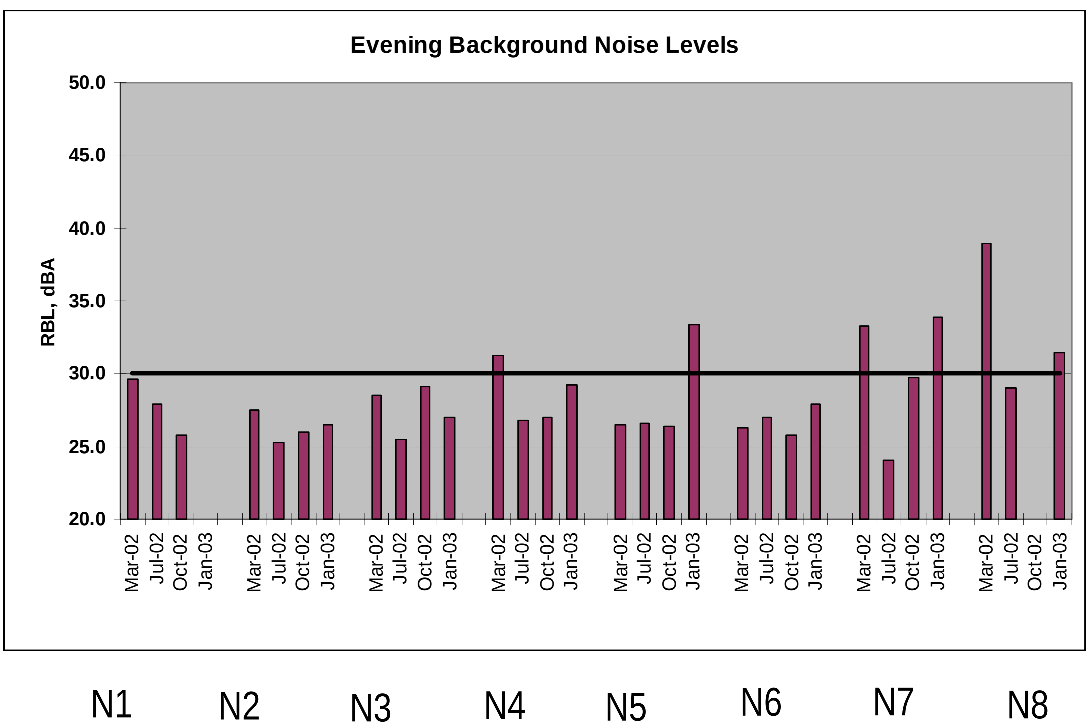
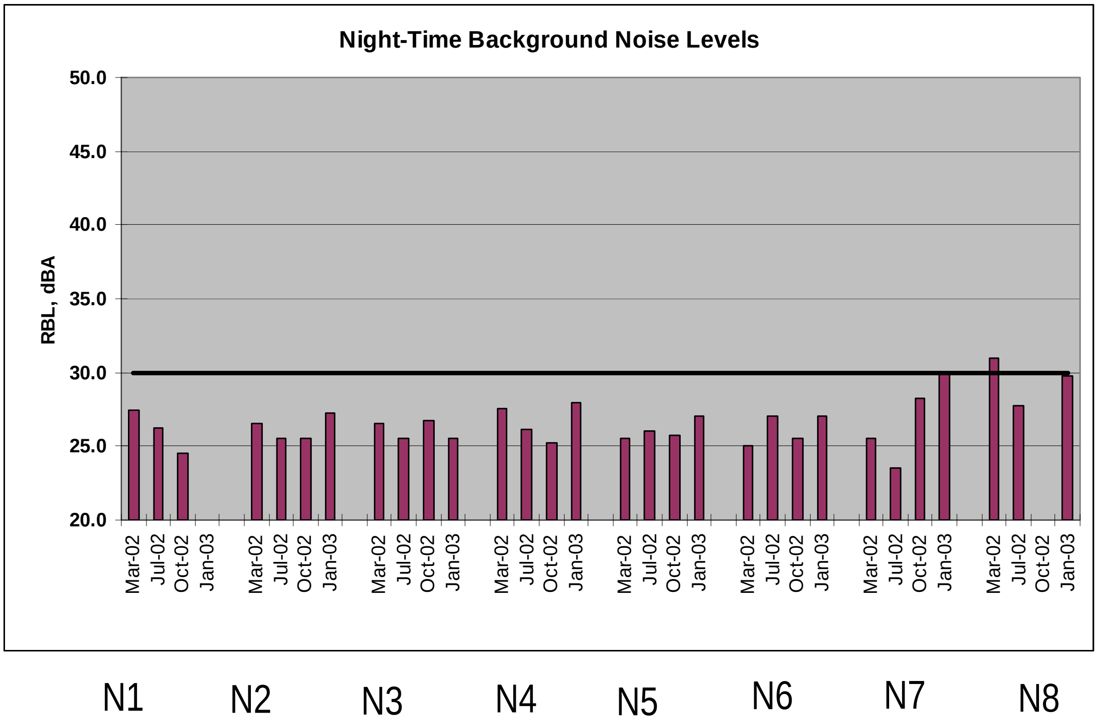


Figure 4-3 Measured Night Time Background Noise Levels



Although some sites have missing data due to logger failure, it is clear that the RBL background levels are generally below 30dBA for day, evening and night. There are some locations which show dramatic increases in RBL noise levels in the summer and autumn months, but this is most likely due to localised insect noise.

4.2 Attended Noise Measurements

Further attended noise measurements were conducted by Wilkinson Murray in December 2004. The purpose of these measurements was to establish whether there was any existing industrial noise in the area. Eight residences were chosen for short-term attended noise monitoring. Five of these residences were the same as those at which unattended monitoring was carried out. A full list of monitoring locations is shown in Table 4-2 . Monitoring was carried out at the roadside boundary of all residences.

Table 4-2 Attended Noise Measurement Locations

Site No.	Property No.	Nearest Road
N2	CH 0255	Coolabah Road
N3	CH 0286	Mangoola Road
N4	CH 0276	Wybong Road
N5	CH 0031	Wybong Post Office Road
N6	CH 0304	Wybong Road
N9	CH 0307	Mangoola Road
N10	CH 0310	Wybong Road
N11	CH 0151	Mangoola Road

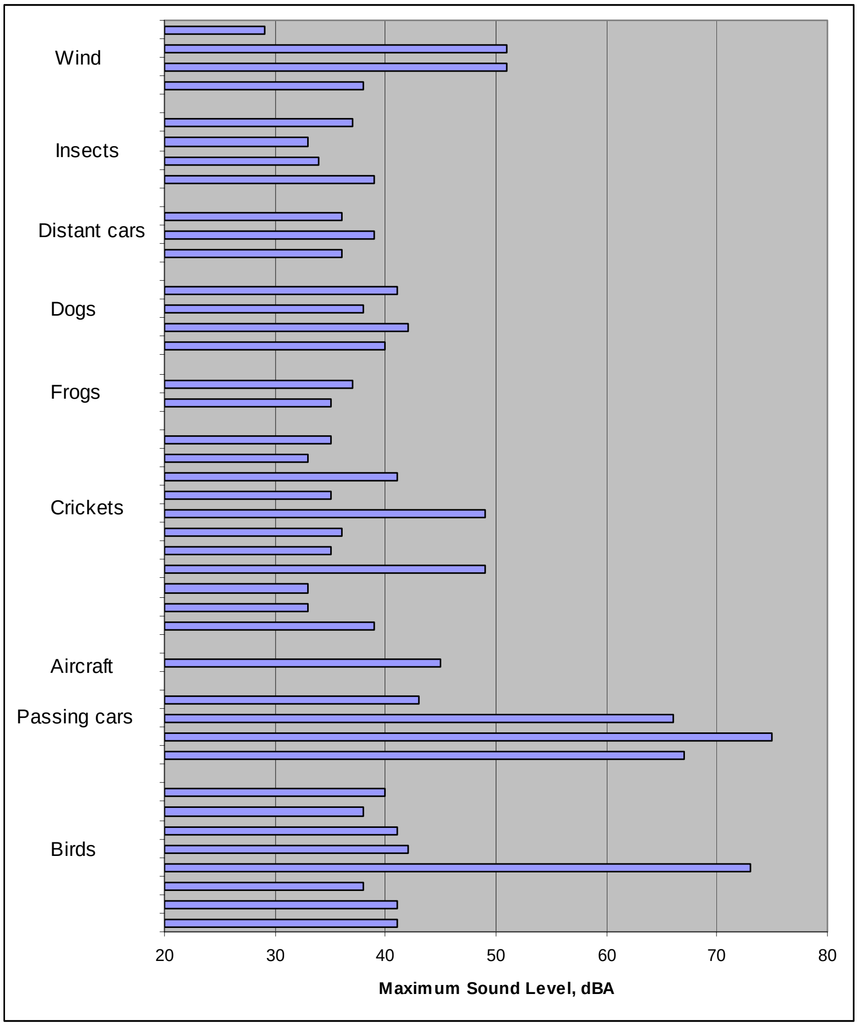
Attended measurements of ambient noise levels were taken at all residential locations on Wednesday, 1 December 2004 and again on Wednesday, 22 December 2004. Noise levels were measured with a CEL 593 Sound Level Meter. This Sound Level Meter conforms to Australian Standard 1259 "Acoustics – Sound Level Meters" as Type 1 Precision Sound Level Meter which has an accuracy suitable for laboratory use.

The A-Weighting filter of the meter was selected and the time weighting was set to "Fast". The meter was then field calibrated both before and after the measurements with a Sound Level Calibrator Type CEL 284/2. No significant system drift was noted. The CEL 593 and the CEL 284/2 have been laboratory calibrated within the previous two years in accordance with Wilkinson Murray Quality Assurance procedures.

Figure 4-4 illustrates typical maximum noise levels recorded at the eight receivers over the two monitoring periods.

During the measurement periods, no industrial noise sources were observed at any time.

Figure 4-4 Typical Maximum Noise Levels during Monitoring Surveys



5 METEOROLOGICAL FACTORS

5.1 Methodology

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

The *INP* identifies the Hunter Valley as a region where occurrence of temperature inversions is frequent and as such the effect of metrological conditions must be addressed in the prediction of noise levels from the proposal.

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

This alternative assessment procedure involves significantly greater computational complexity than the use of a single set of meteorological conditions, but provides a much more direct and comprehensible description of noise impacts at a receiver. This approach of using the 10^{th} percentile calculated noise level as a measure of noise impacts on residences has been considered acceptable by the DECCW for previous similar assessments. Due to the relatively large number of residences in the area surrounding the Mangoola Coal Project, this alternative procedure is considered appropriate and has been adopted.

5.2 Measured Meteorological Data

Three sets of meteorological data were available for this assessment.

- A weather station at Coolabah Road just within the southern section of the approved project disturbance boundary has recorded conditions from 2002-2010. This station provided data on wind speed and wind direction.

- A weather station at Wybong Road, a few hundred metres north of the approved project disturbance boundary, has recorded conditions from 2002-2010. This station provided data on wind speed and wind direction, and also data on standard deviation of wind direction (sigma-theta).

Given that the above stations do not have the capacity to measure temperature gradients, a methodology needs to be formulated to calculate temperature inversion strengths at the project site. A third data set was therefore incorporated in this analysis - data from a mast in the Bengalla mining lease area. This monitoring station provides direct, high-quality measurements of temperature gradient. The full methodology of calculation of temperature inversion strengths for the proposal can be found in Appendix B.

6 OPERATIONAL NOISE IMPACTS

This section outlines potential noise impacts at residences as a result of general operation of the proposal. This includes noise from mobile plant such as haul trucks, drills and dozers, and also potential impacts from infrastructure plant associated with the preparation of coal. Assessment of potential impacts from the proposed rail loadout facility and the impacts associated with the movement of trains on the proposed rail loop are also addressed in this section.

6.1 Noise Modelling Methodology

Operational noise levels at residences are calculated using the ENM noise prediction model. This model has been endorsed by the DECCW for environmental noise assessment. The ENM model takes account of noise attenuation due to geometric spreading, atmospheric absorption, shielding and the effect of acoustically soft ground. It can also be used to predict noise levels under various meteorological conditions, defined by a combination of temperature gradient, wind speed and wind direction.

Calculations were undertaken for four progressive operational scenarios, namely years 2, 5, 10, and 15 of the proposal. For each year a representative “worst-case” scenario was modelled. Where plant could be operating in more than one position around the proposal, noise levels were calculated at various positions relative to the surrounding residences, and the highest noise level used as the worst-case.

Because different operating procedures are proposed for daytime (7.00am-10.00pm) and night time (10.00pm-7.00am), two scenarios (day and night time) were modelled for each of the operating years.

Calculations were performed under a variety of meteorological conditions using the methodology outlined in Section 5. Noise levels were calculated under a total of 41 conditions for the 10 operational scenarios (day and night) at a total of 131 residences up to 8km surrounding the proposal. A summary of the inputs used in noise modelling is shown in Table 6-1. The following sections outline the calculation of noise levels in more detail.

Table 6-1 Noise Modelling Inputs

Modelling Inputs	
Residential receivers	From surveys undertaken locally and aerial photography
Topography	Disturbed contours for operational years in accordance with the Conceptual Mine Plan & local topography at residences provided by the NSW Lands Department & Aerial Digital Terrain DTM model from photogrammetry undertaken by Geospectrum
Noise Source Levels	From measurements of similar plant at other sites.
Meteorological data	From measurements at Wybong Road and Bengalla weather stations (see Section 5)

6.2 Noise Modelling Procedures

The following components have been combined to produce a final worst-case noise level for each residence. The derived resultant noise level is inherently conservative as it is unlikely that the items of plant above would all be in the worst-case position at the same time.

6.2.1 Source Sound Power Levels

Noise sources associated with mobile mine plant and infrastructure operating around the proposal, and their typical L_{Aeq} noise levels, are presented in Table 6-2. These levels are based on measurements conducted at a number of similar operations.

In regard to haul trucks, noise levels can vary considerably depending on the manufacturer and the degree of retrofitted noise attenuation measures. Typical trucks range from 111-117dBA in practice, with some older-style vehicles measured at up to 121dBA. As the manufacturer of trucks to operate at the Mangoola Coal project is not yet known, a figure of 114dBA has been adopted in the noise modelling. This figure is considered to be reliably achievable either with new trucks, or in some cases older trucks with some degree of noise attenuation.

The proponent has committed to use of haul trucks with an energy average sound power level not greater than 114dBA, unless it can be demonstrated that predicted noise levels can be achieved at nearest private residences with use of other noise control mechanisms that may become available in the future.

Table 6-2 Modelled Equipment Sound Power Levels

Equipment	Assumed L_{Aeq} Sound Power Level (dBA)	Comments
Haul Truck	114	
Drill	114	
Excavator	118	
Dozer	114	
Water cart	114	
Grader	109	
Lighting Rig	107	Night time operation only
Rehabilitation Dozer Front End Loader Dump Truck	 113 112 113	Day time operation only
Infrastructure Conveyers	79 per metre	shielded near belt
Conveyer Drive	97	
Coal Prep Plant	110	acoustic building design
Crushers	110	enclosed
Rail Loadout Bin	116	
Rail Class 92 Locomotives	79 per metre	Based on 3 locos at 10kph
Wagons	75 per metre	Based on 1500 m long train at 10kph

In the case of rail operations, as for the previous EA noise assessment, calculations are based on the worst-case scenario where two trains operate on the rail loop. However, the trains operating would differ from those assumed previously, as detailed in Table 6-3.

Table 6-3 Comparison between Approved and Proposed Rail Operations

Item	2006 EA	Current Proposal
Rail Locomotives	Two 81 Class Locomotives	Three 92 Class Locomotives
Wagons	1500 m long train	1500 m long train

The difference between 92 class and 81 class locomotives has been reviewed with respect to the Railcorp noise database. It has been determined that noise from a 92 class locomotive is 0.7dBA lower than an 81 class locomotive. However, as three 92 class locomotives are proposed rather than two 81 class locomotives the overall noise emitted from the proposed locomotive assembly will increase by 1.1dBA when compared to two 81 class locomotives.

Further it is noted that the spectral content of the two locomotives types varies significantly in low frequencies, the result being that barriers are more effective in shielding 92 class locomotive noise. The relative difference in spectral content is detailed in the Table 6-4 for the two locomotive types at a nominal speed of 60 km/hr at 10 metres distance.

Table 6-4 Comparison between Locomotive Noise Levels – Sound Exposure Level – dB

Locomotive Type*	Octave Band Centre Frequency - Hertz								A
	31.5	63	125	250	500	1000	2000	4000	
81 class	94.5	93.4	92.6	91.4	92	90.4	87.5	82.3	96.2
92 class	86.9	90.1	89.5	88.6	89.3	89.5	87.5	84.8	95.5

* Source Railcorp Noise Database

In modelling noise emitted from rail wagons, the same source noise levels are applied to a longer train.

6.2.2 Mine Plans

Scenarios were modelled to represent years 2, 5, 10 and 15, for daytime (7.00am-6.00pm), evening (6.00pm-10.00pm) and night time (10.00pm-7.00am) operations. For these three time periods, equipment usage is equivalent in terms of plant numbers with the following exceptions:

- rehabilitation plant operate during the day period only; and

lighting rigs operate only in the evening and night periods.

Table 6-6Table 6-5 details the maximum numbers of mobile plant that have been modelled for each of the years, as advised by Mangoola Coal. The table separates the equipment located in pit 3/1 (the northern pit) and its associated emplacement area, from that located in pit 4/2 (the southern pit) and its associated emplacement area.

Figures 6-1 to 6-4 illustrate the mine plans for each period.

6.2.3 Infrastructure

Included in noise modelling for each year, the infrastructure component of the overall noise environment will remain constant throughout the life of the proposal. It is composed of noise from all plant involved in the preparation of coal and subsequent movement to the rail loader.

The infrastructure location and type remain unchanged from the approved project.

6.2.4 Rail Spur

The spur loop has the capacity for two trains to move simultaneously, which in turn allows for three possible operational scenarios:

- one train arriving at coal loading bin as another departs;
- one train arriving at coal loading bin whilst another is being loaded; and
- one train departing coal loading bin whilst another is being loaded.

Each scenario is modelled and the worst-case noise level assigned to respective receivers. Calculations include noise barriers on the southern side of the line as illustrated in Figure 2-1.

Table 6-5 Equipment Modelled for Each Year of Noise Assessment

Staged Mine Plan	Equipment in Pit 3/1	Plant Split O=O/B,C=Coal	Equipment on/running to Dump 3/1	Equipment in Pit 4/2	Plant Split O=O/B,C=Coal	Equipment on/running to Dump 4/2	Equipment on/running to ROM	Comment
Yr 2	1 x EX5500 excavators	O	10 x Cat 793XQ trucks	1 x EX5500 excavators	O	10 x Cat 793XQ trucks	4 x Cat 789XQ trucks	1 x Cat 789XQ reject truck
-	1 x EX2500 excavators	C	1 x D11T dozer	1 x EX2500 excavators	C	1 x D11T dozer	Cat 994 FEL	runs between the dump & ROM
-	1 x SKS-W Reedrills	O&C	2 x Lighting plant (Bowers type)	2 x Cat 789XQ trucks	C	2 x Lighting plant (Bowers type)	1 x Cat 789XQ reject truck	
-	1 x D10T dozers	O&C	1 x 24M Grader	1 x SKS-W Reedrills	O&C	1 x 24M Grader	-	Note: Pit 4 = Northern Pit
-	1 x 16M grader	O&C	1 x Cat 777F W/cart	1 x D10T dozers	C	1 x Cat 777F W/cart	-	Pit 3 = Southern Pit
-	1 x Cat 854H RTD	O&C	1 x Cat 789XQ reject truck	1 x D11T dozer	O	1 x Cat 789XQ reject truck	-	Swap equipment splits between
-	1 x Cat 777F W/cart	O&C	-	1 x 16M grader	O&C	-	-	Pits
-	3 x Lighting plant (Bowers type)	1 x O, 2 x C	-	1 x Cat 854H RTD	O&C	-	-	2 Pits same Dump
-	-	-	-	1 x Cat 777F W/cart	O&C	-	-	-
-	nw pit	-	-	3 x Lighting plant (Bowers type)	1 x O, 2 x C	-	-	-
-	-	-	-	nw pit	-	-	-	-
Yr 5	2 x EX5500 excavators	As per Pit 4	9 x Cat 793XQ trucks	1 x EX5500 excavators	O	12 x Cat 793XQ trucks	7 x Cat 789XQ trucks	1 x Cat 789XQ reject truck
-	1 x EX2500 excavators	-	1 x D11T dozer	1 x EX2500 excavators	C	2 x D11T dozer	Cat 994 FEL	runs between the dump & ROM
-	2 x SKS-W Reedrills	-	1 x Lighting plant (Bowers type)	1 x SKS-W Reedrills	2 x O, 1 x C	2 x Lighting plant (Bowers type)	1 x Cat 789XQ reject truck	-
-	2 x D11T dozer	-	1 x 24M Grader	2 x D10T dozers	C	1 x 24M Grader	-	Note: Pit 4 = Northern Pit
-	1 x 16M grader	-	1 x Cat 777F W/cart	1 x 16M grader	O	1 x Cat 777F W/cart	-	Pit 3 = Southern Pit
-	1 x Cat 854H RTD	-	1 x Cat 789XQ reject truck	1 x Cat 854H RTD	O&C	1 x Cat 789XQ reject truck	-	Same Pit same Dump
-	1 x Cat 777F W/cart	-	-	1 x Cat 777F W/cart	O&C	-	-	-
-	5 x Lighting plant (Bowers type)	-	-	3 x Lighting plant (Bowers type)	O&C	-	-	-
-	nw pit	-	-	south pit	4 x O, 4 x C	-	-	-
-	-	-	-	-	-	-	-	-

Staged Mine Plan	Equipment in Pit 3/1	Plant Split O=O/B,C=Coal	Equipment on/running to Dump 3/1	Equipment in Pit 4/2	Plant Split O=O/B,C=Coal	Equipment on/running to Dump 4/2	Equipment on/running to ROM	Comment
Yr 10	2 x EX5500 excavators	O	9 x Cat 793XQ trucks	1 x EX5500 excavators	O	4 x Cat 793XQ trucks	7 x Cat 789XQ trucks	1 x Cat 789XQ reject truck
-	1 x EX2500 excavators	C	1 x D11T dozer	1 x EX2500 excavators	C	1 x D11T dozer	Cat 994 FEL	runs between the dump & ROM
-	2 x SKS-W Reedrills	1 x O, 1 x C	1 x Lighting plant (Bowers type)	1 x SKS-W Reedrills	O&C	1 x Lighting plant (Bowers type)	1 x Cat 789XQ reject truck	
-	2 x D11T dozer	1 x O, 1 x C	1 x 24M Grader	2 x D10T dozers	1 x O, 1 x C	1 x 24M Grader	-	Note: Swap equipment
-	1 x 16M grader	O&C	1 x Cat 777F W/cart	1 x 16M grader	O&C	1 x Cat 777F W/cart	-	splits & associated dump activity
-	1 x Cat 854H RTD	O&C	1 x Cat 789XQ reject truck	1 x Cat 854H RTD	O&C	1 x Cat 789XQ reject truck	-	between Pits
-	1 x Cat 777F W/cart	O&C	-	1 x Cat 777F W/cart	O&C	-	-	Pit 1 = Northern pit
-	5 x Lighting plant (Bowers type)	3 x O, 2 x C	-	3 x Lighting plant (Bowers type)	1 x O, 2 x C	-	--	Pit 2 = Southern pit
Yr 15	1 x EX5500 excavators	O	4 x Cat 793XQ trucks	Same Pit (as per Pit 1)	As per Pit 1	-	7 x Cat 789XQ trucks	1 x Cat 789XQ reject truck
-	2 x EX2500 excavators	C	1 x D11T dozer	-	-	-	Cat 994 FEL	runs between the dump & ROM
-	2 x SKS-W Reedrills	1 x O, 1 x C	1 x Lighting plant (Bowers type)	-	-	-	1 x Cat 789XQ reject truck	-
-	1 x D11T dozer	O	1 x 24M Grader	-	-	-	-	Note: Same Pit 2 Dumps
-	2 x D10T dozers	C	1 x Cat 777F W/cart	-	-	-	-	Pit 1 = Northern pit
-	1 x 16M grader	O&C	1 x Cat 789XQ reject truck	-	-	-	-	Pit 2 = Southern pit
-	1 x Cat 854H RTD	O&C	-	-	-	-	-	-
-	1 x Cat 777F W/cart	O&C	-	-	-	-	-	-
-	5 x Lighting plant (Bowers type)	2 x O, 3 x C	-	-	-	-	-	-

Figure 6-1 Mine Plan January 2012 – Year 2

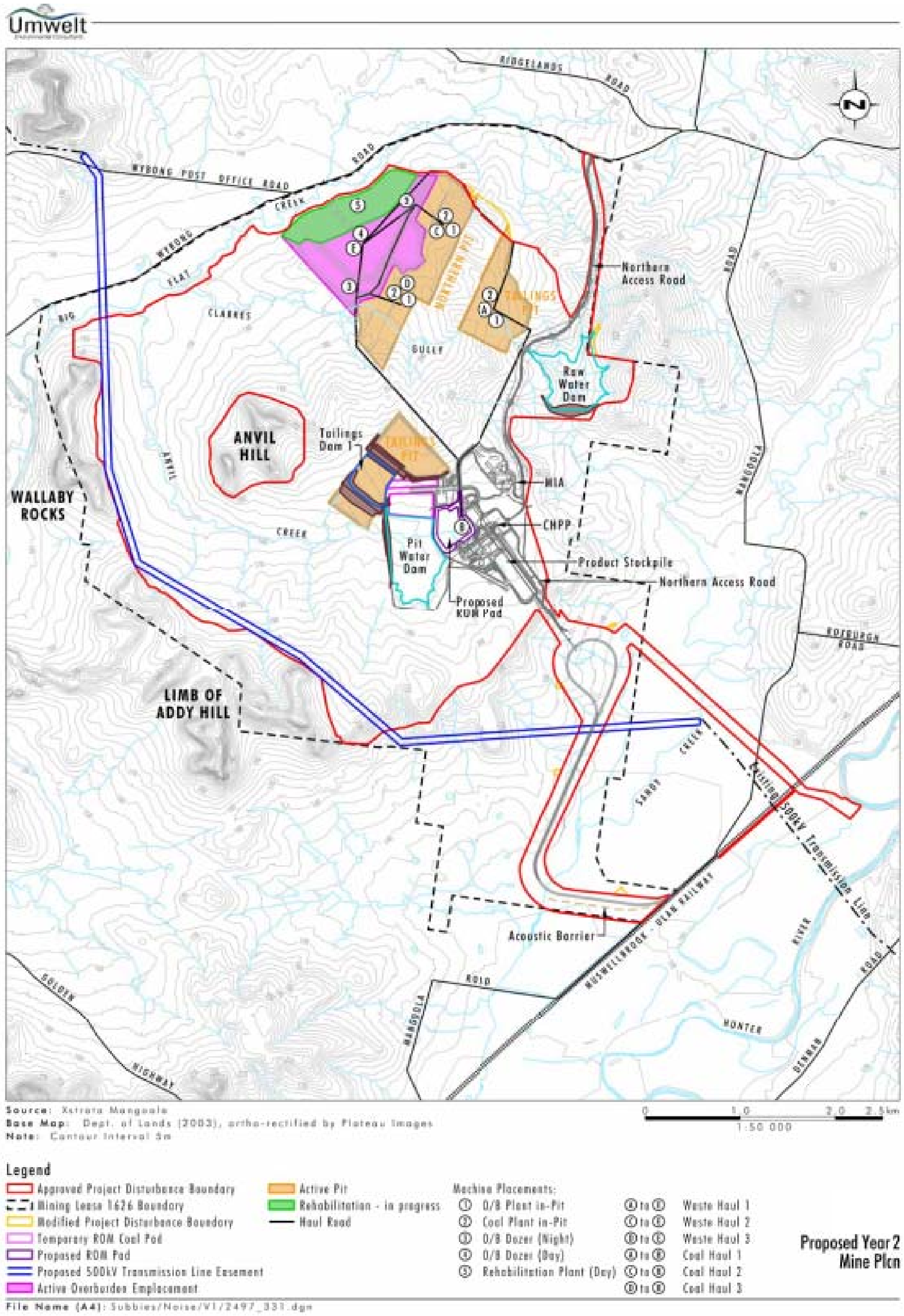


Figure 6-2 Mine Plan January 2015 – Year 5

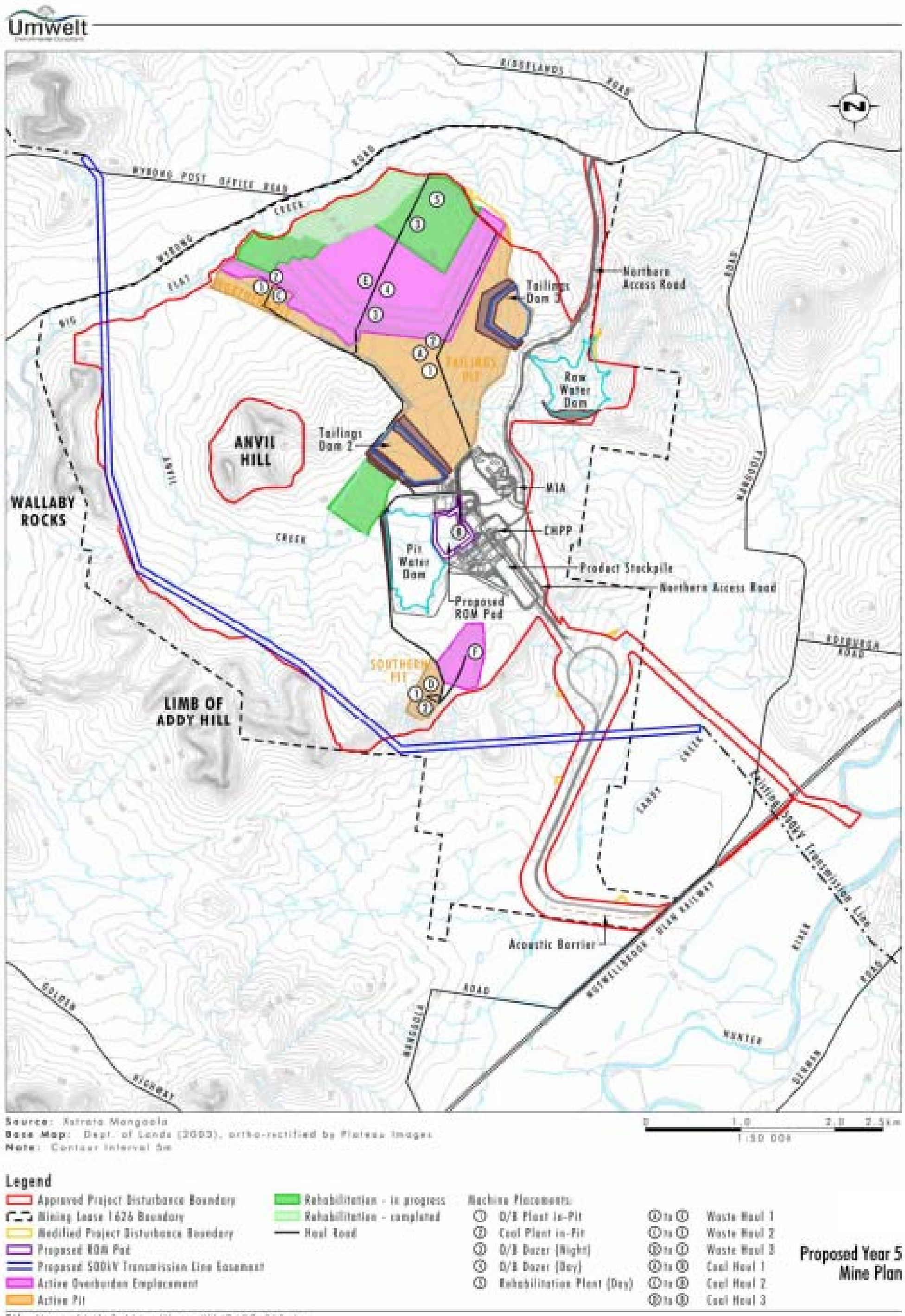


Figure 6-3 Mine Plan January 2020 – Year 10

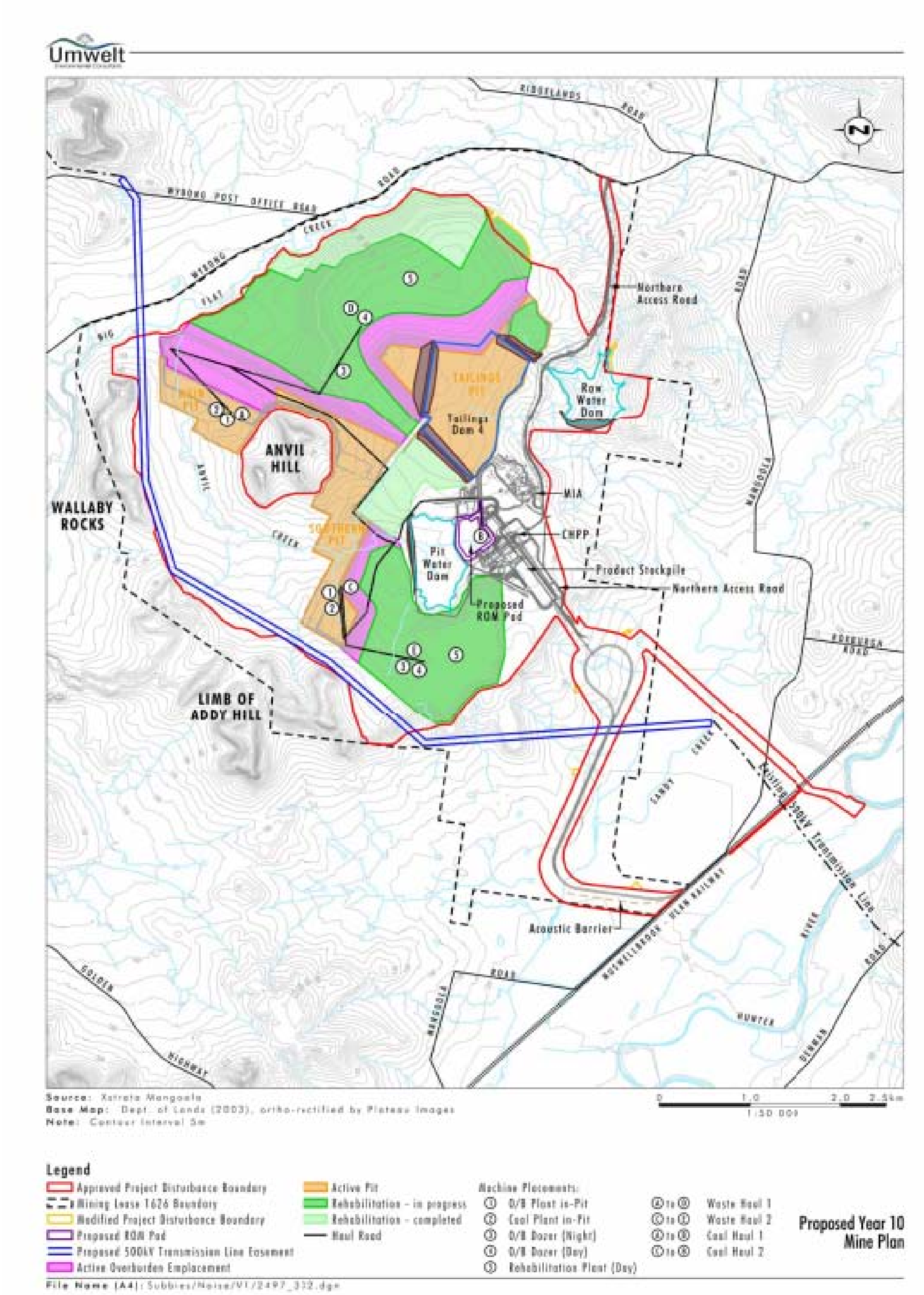
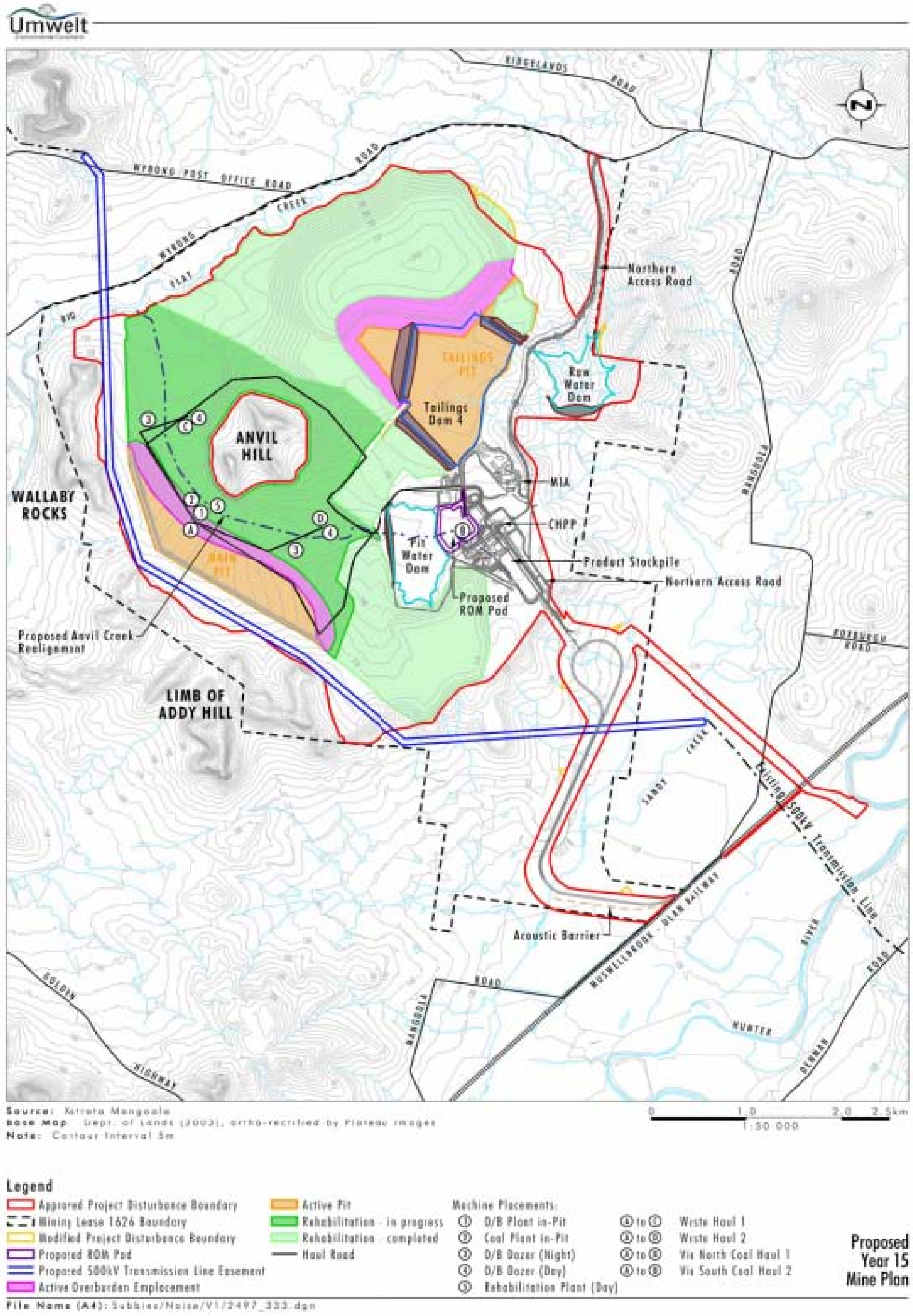


Figure 6-4 Mine Plan January 2025 – Year 15



6.2.5 Equipment Locations

The modelled operating locations for mobile plant and equipment differ between the day, evening and night scenarios. For daytime and evening operations, haul trucks would move overburden from pits to the tops of overburden dumps, with a dozer operating at the top of each dump. At night the haul trucks and dozers would be restricted to operating below the maximum elevation of the overburden emplacement areas. Both locations are shown in Figure 6-1, Figure 6-2, Figure 6-3 and Figure 6-4.

6.2.6 Noise Modelling Details

Plant that operates in the same vicinity for long periods, such as dozers and excavators, and all infrastructure items, were modelled as point sources. Items involved in transport of materials such as haul trucks, watercarts, graders, trains and conveyers were modelled with source points at 40-50m intervals along the routes.

The effective sound power level for each source point was assigned based on the number of items of plant using the route and the number of source points. The contributions of graders and watercarts were spread evenly over all coal and overburden routes for all scenarios.

Noise levels were calculated using the ENM model for each of the scenarios under a total of 41 meteorological conditions. A statistical data set representing the proportional occurrence of these conditions at the Wybong Road weather station over a year was then applied to the calculated noise levels. The noise level exceeded for 10% of the time during each of the day, evening and night time periods was then calculated.

For night time operations, 10th percentile exceedance noise levels were calculated using statistical meteorological data for the winter period only, as conditions in winter are more adverse than other seasons, with the greatest occurrence of strong temperature inversions. Data from all seasons was used to calculate 10th percentile exceedance levels during the daytime and evening periods. The particular season that generated the highest noise level at each of the respective residences was then used as a worst-case for each residence.

It should be noted that the calculations described above rely on predictions produced by the ENM model. This model is based on simple assumed vertical profiles of temperature and wind speed, and does not accurately model more complex situations. In particular, there are times when a combination of non-linear vertical temperature and wind speed profiles can result in “focussing” of noise in a small area. In these events, increases in noise level of 10-20dBA can occur over periods of minutes to hours. The frequency of these events, and the level of noise enhancement occurring, cannot be accurately predicted using ENM or any other known model. However, recent validation of measured noise levels from similar nearby operations has shown good correlation with predicted noise levels as a 10th percentile exceedance level.

6.2.7 Predicted Noise Levels at Residences

Five privately owned properties located to the south-west move in to the management zone, ten privately owned properties located to the north and south-east move out of the management zone, no new properties move into the acquisition zone and no additional vacant land is affected by the proposal. Worst-case 10th percentile noise levels for each of these residences were calculated for proposed typical day, evening and night time operations for years 2, 5, 10 and 15. The results are summarised in Table 6-6, in terms of the number of residences experiencing noise levels above the intrusiveness criterion of 35dBA, and the number experiencing levels more than 5dBA above that criterion. Calculated noise levels have been rounded to the nearest whole number.

Detailed results for each residence are shown in Appendix C. Figures 6-5 to 6-8 show noise contours for the night time period, being the period of greatest potential affectation.

Table 6-6 Summary of Operational Noise

Operational Year	No. of Private Residences with Predicted Noise Levels Exceeding Criteria	
	> 40dBA	>35-40dBA
Year 2		
Daytime	2	8
Evening	1	16
Night	3	23
Year 5		
Daytime	3	8
Evening	5	10
Night	7	35
Year 10		
Daytime	4	9
Evening	4	9
Night	7	21
Year 15		
Daytime	2	5
Evening	1	5
Night	2	10

Table 6-7 summarises impacts at private residences of the operational life of the proposal, showing numbers of residences predicted to have operational noise levels exceeding the criteria at any stage.

Table 6-7 Summary of Operational Noise Impacts over all years

All Years	No. of Private Residences with Predicted Noise Levels Exceeding Criteria	
	> 40dBA	>35-40dBA
	8	52

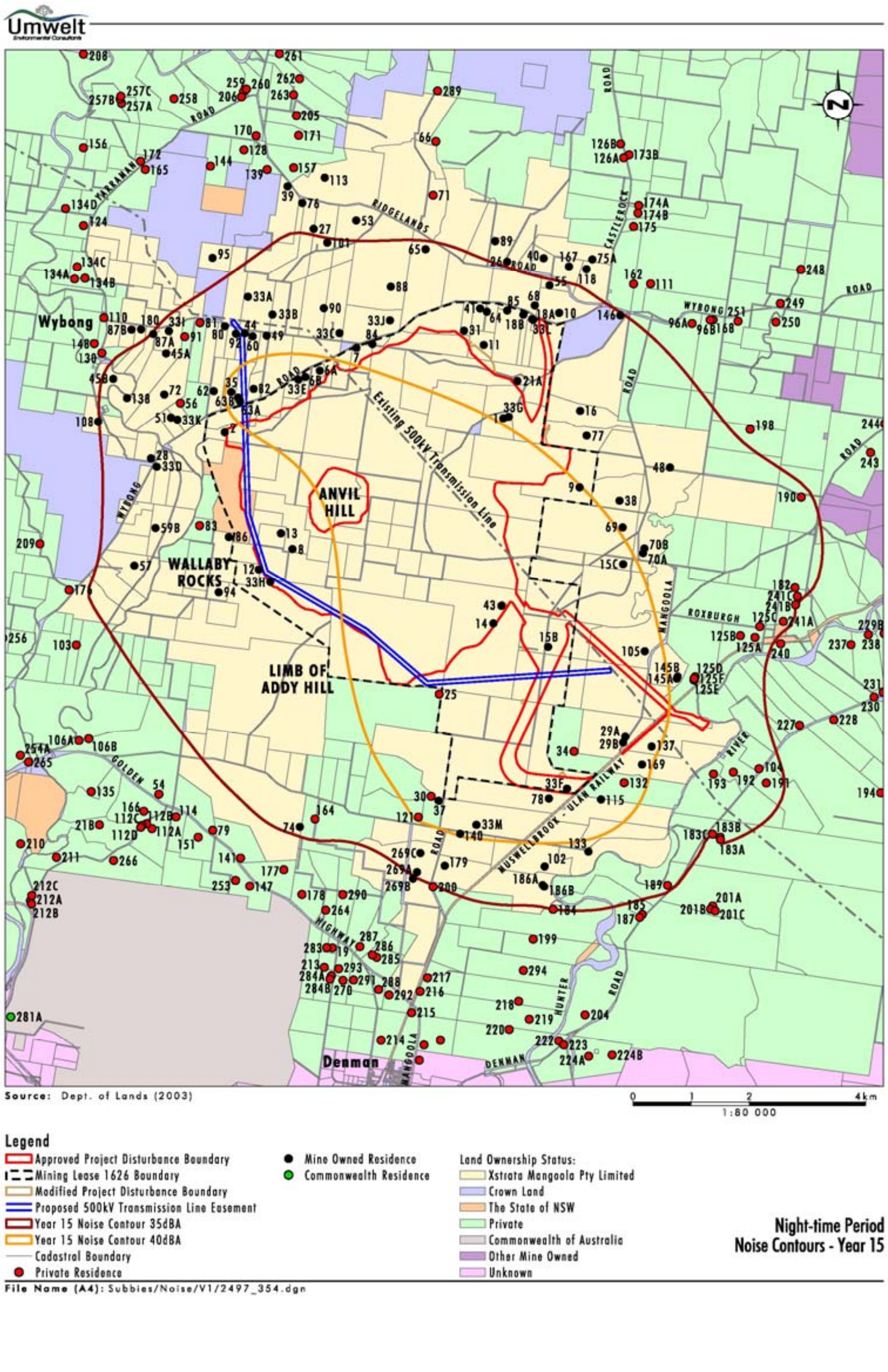
Appendix D also presents the overall maximum noise levels for day, evening and night periods compared to the 2006 EA predicted noise levels.

Figure 6-5 Year 2 Night Noise Contours

Figure 6-6 Year 5 Night Noise Contours

Figure 6-7 Year 10 Night Noise Contours

Figure 6-8 Year 15 Night Noise Contours



6.2.8 Potential for Sleep Disturbance

Short-term high noise level events have the potential to cause sleep disturbance if they emerge significantly above the background level. The *INP* does not specifically address sleep disturbance.

The most recent guidance in relation to sleep disturbance is contained in the DECCW's "Application Notes – *NSW Industrial Noise Policy*" issued in July 2006. The pertinent section of the DECCW's Application Notes states the following:

"*DEC reviewed research on sleep disturbance in the NSW Environmental Criteria for Road Traffic Noise (ECRTN) (EPA, 1999). This review concluded that the range of results is sufficiently diverse that it was not reasonable to issue new noise criteria for sleep disturbance.*

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

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

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

The $L_{A1,\ (1\ minute)}$ *descriptor is meant to represent a maximum noise level measured under 'fast' time response. DEC will accept analysis based on either* $LA_{1,(1\ minute)}$ *or* $L_{A,(Max)}$.

If an exceedance of the above is indicated then further review is recommended referencing the DECCW's *Environmental Criteria for Road Traffic Noise (ECRTN)* Appendix B which concludes:

"Considering all of the foregoing information the following conclusions can be drawn:

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

An internal objective of 50–55dBA equates to an external objective of 60-65dBA assuming an industry-accepted 10dB reduction in noise through an open window. Based on the adopted night time RBL for the proposal, the sleep disturbance criterion is shown in Table 6-8.

Table 6-8 Summary of Sleep Disturbance Criteria – L_{Amax}, dBA

Descriptor	Screening Criterion	*ECRTN* Goal
L_{Amax} or $L_{A1(1min)}$	45dBA	60-65

Note: 10dBA has been allowed for the attenuation of sound from outside to inside. This is an industry accepted adjustment.

The maximum instantaneous sound pressure level for typical plant around the proposal would be less than 5dBA above the sound power level used in noise modelling. On this basis, any properties with potential to experience noise levels above the L_{Amax} screening criterion will also experience noise levels above the 40dBA operational criterion.

6.3 Cumulative Noise Impacts

No existing industrial noise sources were identified at residences during attended measurements near the proposed disturbance boundary. However, it is possible that some of the residences considered in this study may be affected by noise from other mining operations, particularly those residences on the eastern boundary of the area considered.

Given the distance to the nearest mining operations (approximately 12km to the east), any residences affected by noise from other mines can be expected to have L_{Aeq} noise levels from Mangoola Coal which are significantly below the relevant amenity criterion of 40dBA. In this case, exceedance of the amenity criterion would require that noise from these other mines was the dominant noise source, and it is likely in that case that noise from the other mines would exceed their own relevant site specific noise criteria.

In most cases, no direct information is available on predicted noise levels from other mines at residences potentially affected by noise from Mangoola Coal. However, one receiver point to the extreme east of the proposal was found to also be included in the Mount Arthur North (MAN) Environmental Impact Statement. This residence, 273B, is referred to in the MAN EIS as "Denman Road West". The maximum calculated night time noise level at this residence due to the proposal is 30dBA, whereas the MAN EIS indicates a maximum level of approximately 36dBA. These noise levels are unlikely to occur simultaneously, but if they do the total noise level at this residence would be approximately 37dBA, which remains within the relevant amenity criterion.

The same residence is potentially affected by noise from other mines, notably Bengalla and Mount Pleasant. However, as noted in the MAN EIS, with these sources included the total noise level is unlikely to exceed 40dBA L_{Aeq}. In any case, the Mangoola Coal project, at 30dBA, would make a negligible contribution to the total industrial noise level at this location.

6.4 Low Frequency Noise Impacts

Potential sources of low frequency noise are unknown at this stage and experience suggests that such impacts have only occasionally been noted at similar operations. These impacts may be as a result of low frequency noise and/or vibration from processing equipment. It is not possible to predict such impacts at the planning stage, however if such noise is found to occur at levels similar to those referred to in Section 3.3, the Environmental Management Plan (EMP) for the proposal will specify methods of investigation to allow appropriate treatment methods to be devised. This may include specific structural monitoring and treatment.

7 OFF-SITE TRANSPORTATION NOISE IMPACTS

7.1 Road traffic Noise Impacts

7.1.1 Assessment Procedure

The potential noise impact associated with the change in projected traffic flows has been assessed as in the traffic noise assessment in the Anvil Hill EA. The changes in traffic volumes between the initial assessment and the currently-proposed mine operation and ETL relocation works are presented in the ETL traffic noise assessment prepared by Parsons Brinkenghoff (PB): "Mangoola Coal Project 500 kV Electricity Transmission Line Relocation Traffic Assessment", report number 2148084C-RPT-001B BH dated 12 April 2010.

Section 3.2.1 of the PB report indicates:

"Comparison of proposed project and approved project

The TPK and Associates Traffic Study (2006) reported:

- *a total AM peak hour traffic generation of 125 vehicles from 240 staff*
- *a total PM peak hour traffic volume of 106 vehicles from 240 staff.*

This compares to the following vehicle generation now forecast:

- *AM peak hour traffic of 156 vehicles from 300 mine operations staff and 26 vehicles for the construction of the ETL*
- *PM peak hour traffic of 135 vehicles from 300 mine operations staff and 29 vehicles for the construction of the ETL."*

The PB traffic report also indicates that that existing daily traffic on Wybong Road has been measured in 2009 to be 400 vpd. However as this will have included traffic associated with mine construction a more conservative the base case 2005 traffic flow of 300 vpd has been used in this assessment.

Based on the above information, the predicted traffic noise levels at residences in the Anvil Hill EA have been corrected to take into account three scenarios:

- Base – Existing Scenario as per the EA.
- Existing plus 2011 Mine Operation - AM and PM shift changes.
- Existing plus 2011 Mine Operation + ETL - AM shift change.

Maximum noise levels due to a vehicle passby will remain the same and therefore the findings of the EA with respect to maximum noise levels and sleep disturbance remain valid.

7.1.2 Traffic Volumes at Shift Changes

The following assumptions have been applied, consistent with the Anvil Hill EA, with regard to potential traffic flows during shift changeover.

- Administrative staff arrivals have been combined with shift-worker movements for 7.30am arrivals. They are likely to depart separately although it is reasonable that up to four may depart at the same time as shift workers (7.30pm). The potential impact of separate administrative staff departures at 5.00pm would be negligible and has not been assessed.

- Half of all visitor arrivals coincide with the 7.30am shift change. It is likely that visitor movements would be distributed evenly over the day.
- Shift workers are divided into four groups, with two active every day.
- Half of all heavy vehicle movement arrivals coincide with each shift change. It is likely that heavy vehicle movements would be distributed more evenly over the day.

A conservative level of car sharing has been adopted resulting in a high car usage rate of between 80% and 85%. This is consistent with similar operations in the area and has been applied to shift workers and administrative staff only.

Future peak predicted traffic movements for early morning and evening shift changes are shown in Table 7-1 and Table 7-2 respectively. As previously identified, over 90 % of traffic will use the Wybong Road / Bengalla Link Road route and assessment of potential noise impacts associated with traffic on this route has been conducted.

In addition, Table 7-3 details projected AM peak hour traffic when ETL construction occurs.

Table 7-1 Predicted Peak Operational Traffic Movements – AM shift change

Peak Project AM Movements (7.00-8.00am)						
Activity	Total Employees	No. on Site per Day	Sharing Adjustment	Movements in Worst-Case Hour		
				Arrivals	Departures	Total
Shift Employees	284	148	0.825	61	61	122
Day Employees	16	16	0.825	13	0	13
Visitors		20		15	0	15
Heavy Vehicles		10		5	1	6
Total	**300**	**194**		**94**	**62**	**156**

Table 7-2 Predicted Peak Operational Traffic Movements – PM shift change

Peak Project PM Movements (7.00-8.00pm)						
Activity	Total Employees	No. on Site per day	Sharing Adjustment	Movements in Worst-Case Hour		
				Arrivals	Departures	Total
Shift Employees	284	148	0.825	61	61	122
Day Employees	16	16	0.825	0	7	7
Visitors		20		0	3	3
Heavy Vehicles		10		1	2	3
Total	**300**	**194**		**50**	**56**	**135**

Table 7-3 Predicted Peak Operational Traffic Movements – AM shift change

Peak Project AM Movements plus ETL traffic (7.00-8.00Am)						
Activity	**Total Employees**	**No. on Site per day**	**Sharing Adjustment**	**Movements in Worst-Case Hour**		
				Arrivals	**Departures**	**Total**
Shift Employees	284	148	0.825	61	61	122
Day Employees	16	16	0.825	13	0	13
ETL				29		29
Visitors		20		15	0	15
Heavy Vehicles		10		5	1	6
Total	**300**	**194**		**94**	**62**	**185**

7.1.3 Traffic Noise Levels

Noise levels from both the existing and proposed traffic were calculated at individual residences using procedures based on the *CoRTN (Calculation of Road Traffic Noise* UK DoE Traffic Noise Prediction Method 1988) prediction algorithms. The standard prediction procedures were modified in the following ways.

- L_{Aeq} values were calculated from the L_{A10} values predicted by the *CoRTN* algorithms using the well-validated approximation $L_{Aeq,1hr} = L_{A10,1hr} - 3$.
- Noise source heights were set at 0.5m for cars and heavy vehicle tyres, 1.5m for heavy vehicle engines and 3.6m for heavy vehicle exhausts, representing typical values for Australian vehicles. Noise from a heavy vehicle exhaust was assessed as 8dBA lower than the noise from the engine.

The models were implemented using *ROADent* software, based on road points at 10m intervals along Wybong Road and Bengalla Link Road. Where there are no barriers present, ground was taken to be 50% soft. This has previously been found to give a good correlation with measured noise levels in similar situations. With barriers, hard ground is assumed, as required under the *CoRTN* procedures.

The existing road surface is modelled as chipseal with a *CoRTN* correction of 2.5dBA, with speeds of both light and heavy vehicles modelled at 100 kph which is consistent with the existing speed limit in the area. Speed limits on Bengalla Link Road are modelled at the likely limit of 80kph.

Tables 7-4 to 7-5 show the predicted existing and future noise levels for houses within 250m of either road between the proposed mine access road and the intersection with Denman Road. The calculated noise levels are then compared with the appropriate *ECRTN* criteria, as described in the Anvil Hill EA.

Table 7-4 Predicted Noise Levels – AM shift change

Residence	Nearest Road	Distance from Road (m)	$L_{Aeq, 1hr}$ Noise Level (dBA)			Criterion
			Existing	2011	2011 with ETL	
168	Wybong	80	49.5	57.0	57.5	55
246	Wybong	75	49.5	58.0	58.5	55
249	Wybong	80	49.5	58.0	58.5	55
250	Wybong	250	44	50.5	51.0	55
251	Wybong	120	46.5	54.0	54.5	55
96A	Wybong	200	46.5	52.5	53.0	55
96B	Wybong	90	49.5	56.0	56.5	55
203F	Bengalla Link	65	48	54.5	55.5	55
203G	Bengalla Link	50	50	57.0	58.0	55
203H	Bengalla Link	120	44.5	51.0	52.0	55
203I	Bengalla Link	220	42.5	49.0	49.0	55
203K	Bengalla Link	210	42	49.0	49.5	55

Table 7-5 Predicted Noise Levels – PM shift change

Residence	Nearest Road	Distance from Road (m)	$L_{Aeq, 1hr}$ Noise Level (dBA)		Criterion
			Existing	2011	
168	Wybong	80	50.7	57.5	55
246	Wybong	75	50.7	57.0	55
249	Wybong	80	50.7	56.5	55
250	Wybong	250	45.2	51.5	55
251	Wybong	120	47.7	54.0	55
96A	Wybong	200	47.7	54.0	55
96B	Wybong	90	50.7	57.0	55
203F	Bengalla Link	65	49.2	55.5	55
203G	Bengalla Link	50	51.2	57.5	55
203H	Bengalla Link	120	45.7	52.5	55
203I	Bengalla Link	220	43.7	50.0	55
203K	Bengalla Link	210	43.2	50.0	55

During the PM shift change, 7.00-8.00pm, half the assessed residences have calculated noise levels that meet the *ECRTN* criterion. These relatively minor exceedances of the ECRTN goals, of between 1 and 2.5dBA, are predicted at six residences that are additional to the findings of the Anvil Hill EA.

During the AM shift change, 7.00-8.00am, predicted exceedances of the *ECRTN* criteria are up to 3.5dBA. This represents a noticeable change in the acoustic environment for that hour, and monitoring of traffic noise levels at these residences should be conducted to ensure compliance with the appropriate criteria. It is noted that, when compared to the Anvil Hill EA assessment, only one additional residence exceeds the ECRTN criteria.

If measured noise levels are found to exceed *ECRTN* criteria, then appropriate noise mitigation measures would be offered to residents, consistent with current approval conditions. Potential noise mitigation measures include the provision of air conditioning or mechanical ventilation to allow windows to be kept closed.

7.2 Rail Noise Impacts – Muswellbrook to Ulan Line

Rail noise impacts considered in this section are from train movements associated with the transportation of coal on the Muswellbrook to Ulan line. Rail noise impacts from trains on the proposed Mangoola rail spur have been assessed as part of the overall operational noise impact and are assessed in Section 6 of this report.

The EA assessment of rail noise from Mangoola mine (formerly Anvil Hill) on the Muswellbrook to Ulan mine was based on train movements from the site along with trains from the following mines:

- Cobar Mine
- Ulan Mine
- Bengalla Mine
- Wilpinjong Coal Project
- Mount Pleasant Coal Mine

Table 7-6 displays the average existing and approved rail movements from trains on the line from Ulan to the Mount Pleasant rail spur, with parameters used in the EA train noise calculations. Where there are different train lengths for different operations the arithmetic mean length has been calculated. Predicted movements for facilities that are not included in this document have been sourced from the appropriate environmental documentation. The proposed rail movements from the Mangoola Project are shown, with the associated cumulative future average movements from all operations. It is conservatively assumed that maximum daily existing movements from the proposal are equal to the average daily value.

Table 7-6 Freight Train Movements and Configurations

Operation	Status	Number of Movements		Length (m)	Audible Wheel Defects	Speed (Kph)
		Daytime (7am-10pm)	Night Time (10pm-7am)			
Cobar Ore Freight	Existing	3	1	634	Medium	60
Ulan Coal	Existing	8	4	1319	Medium	60
Wilpinjong Coal Project	Existing	6	2	1500	Medium	60
Mt Pleasant Mine	Consented	4	2	1500	Medium	60
Bengalla Mine	Existing	4	2	1500	Medium	60
Mangoola Project (Peak)	Consented	5*	5*	1500	Medium	60
Cumulative Movements		31	15			

* The previous EA split train movements at Mangoola to 6 day and 4 night movements.

The following is noted.

- Maximum noise levels from the currently-proposed 92 class locomotives are 1 dBA lower than the previously-proposed 81 class locomotives.
- The noise level from each set of three 92 class locomotives at Mangoola will be in the order of 1.1dBA higher than noise levels used for the previously-assumed two 82 class locomotives.
- Mangoola rail movements represent up to 1/3 of night rail movements. Given the above estimated change in noise levels from Mangoola operations, the total change in L_{Aeq} noise level for receivers along the line is less than 0.4dBA.

Based on the above review it considered that the predicted total noise levels due to rail operations on the Muswellbrook to Ulan line will not change to any significant degree from previously-calculated values. Therefore the findings of the EA with respect to rail operations on the Muswellbrook to Ulan line are consistent with the revised rail operations at Mangoola.

Findings from the EA are summarised in Table 7-7.

Table 7-7 Exceedances of ARTC Criteria: Bengalla to Muswellbrook

Period	Criterion (dBA)	Existing Freight Movements		Proposed Freight Movements	
		Distance from Track (m)	Number of Residences Criterion Exceeded	Distance from Track (m)	Additional Residences Criterion Exceeded
Daytime (7am -10pm)	65	45	2	50	N/A
Night time (10pm-7am)	60	70	3	85	N/A
Maximum Passby Noise (24Hrs)	85	35	2	35	N/A

The maximum increase in distance from the track to meet the ARTC criteria as a result of proposed Mangoola freight movements on any part of the Muswellbrook to Ulan line is 5m for daytime peak operations and 20m for peak operations at night which is consistent with the approved project. For each section of track under consideration, the noise footprint for daytime $L_{Aeq,15\ hr}$ and maximum passby noise for proposed operations are wholly contained within the existing night time noise footprint. As such the only relevant time period for assessment of future additional exceedances is the night time period. The predicted noise levels associated with the proposed modifications do not affect any additional residences than those outlined in the Anvil Hill EA.

8 BLASTING IMPACTS

Whilst the proposed mine plans that are the subject of this assessment have changed as a result of the relocation of the TransGrid power line, the mine boundaries and the areas to be mined have not changed. Therefore the findings and recommendations with respect to blasting of the 2006 environmental assessment remain relevant.

Mining of the area currently occupied by the existing 500 kV transmission lines is remote from the mine boundaries and will not result in blasting occurring any closer to any residences or sensitive structures than that which was previously assessed. In the case of any relocated transmission lines the same precautions will need to be applied at these lines as previously identified.

The recommendations of the initial EA assessment are reiterated as follows:

"While there are no predicted exceedances of blast criteria at residential locations that are not already impacted by significant noise or dust impacts, one historical site, and several rock shelter sites and TransGrid pylon structures are predicted to have vibration levels in exceedance of their various criteria with the blasting parameters proposed.

The proponent has committed to design and undertake blasts to ensure the relevant vibration and blast overpressure criteria are met at the 500 kV power transmission line, Anvil Rock and rock shelters on Wallaby Rocks, Limb of Addy Hill and Western Rocks that are considered to be of highest Aboriginal cultural value. Remaining heritage structures that are predicted to exceed the vibration criteria will be inspected and recorded by appropriate experts prior to blasting. This will include assessing the structural status and identifying appropriate ameliorative measures, where relevant.

Techniques to minimise blast impacts will be employed as necessary to ensure compliance with relevant criteria. This may include blast initiation using electronic detonation techniques, limiting blast MIC, consideration of wind speed and direction prior to blasting, use of adequate stemming, implementing a delay detonation system, and careful drilling and hole loading to ensure that the required blast design is implemented.

The above recommendations have been included in the mine EMP.

9 CONCLUSION

Potential noise and vibration impacts associated with the proposed modified mine plans and rail operations at the Mangoola Coal Project have been assessed in accordance with appropriate environmental standards, notably the NSW Department of Environment, Climate Change and Water's *Industrial Noise Policy (INP)*. Impacts at relevant sensitive receivers have been quantified and where possible, measures have been proposed that would reduce these impacts. The major conclusions of this assessment are as follows.

- The existing noise environment around the proposal is typical of a quiet rural area, with little exposure from existing traffic noise and no significant exposure from any existing industrial noise.

- In keeping with its setting in the Hunter Valley, the Project and its surroundings are often affected by strong night time temperature inversion conditions, which tend to elevate night time noise levels at receivers. The assessment of the effect of meteorological conditions on noise levels as used in this report is effectively more conservative than the methodology outlined in the *INP*. Thus the calculated noise levels are higher than would have been predicted using standard *INP* conditions.

- Feasible noise control measures have been considered for the Mangoola Coal Project and a number are included in the proposal, where viable. However, a substantial number of residential dwellings are still predicted to have 10^{th} percentile noise levels that exceed the typical acquisition criterion of 40dBA. Real time noise monitoring would be undertaken at representative locations to manage potential noise impacts for residences that are predicted to have 10^{th} percentile noise levels above 35dBA.

- Vibration and overpressure levels that were predicted in the Anvil Hill Environmental Assessment noise and vibration assessment are still applicable to the Mangoola Coal mine plans. That assessment indicated an exceedance of the appropriate building damage and annoyance criteria for some private residences. However, these residences, many of which have been purchased by the mine, will also be impacted by significant noise and/or dust impacts. Recommendations initially noted for the existing TransGrid pylon structures and at some culturally significant rock shelters and heritage structures at some stages over the project life are still applicable even with the relocation of the 500 kV to the southern boundary of the site. Techniques to ensure compliance with appropriate criteria have been included in the site EMP and will be implemented at those sites.

- Off site noise generated by rail traffic is not expected to result in any acoustically significant change compared with that which was determined in the Anvil Hill Environmental Assessment. This conclusion is based the fact that in the case of rail operations the adoption of three 92 class locomotives in the context of other rail operations will result in little change in resultant rail noise levels at surrounding residences.

- Off site noise associated road traffic operations is expected to result in a small increase compared with that which was determined in the Anvil Hill Environmental Assessment. Monitoring of traffic noise levels at identified residences should be conducted to ensure compliance with the appropriate criteria.

  If measured noise levels are found to exceed *ECRTN* criteria, then appropriate noise mitigation measures would be offered to residents. Potential noise mitigation measures include the provision of air conditioning or mechanical ventilation to allow windows to be kept closed.

Note

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

Quality Assurance

We are committed to and have implemented AS/NZS ISO 9001:2008 “Quality Management Systems – Requirements”. This management system has been externally certified and Licence No. QEC 13457 has been issued.

AAAC

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

Version	Status	Date	Prepared by	Checked by
B	Draft	19 July 2010	Brian Clarke	Rob Bullen
C	Final	7 December 2010	Brian Clarke	Rob Bullen

APPENDIX A

GLOSSARY OF TERMS

GLOSSARY

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

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

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

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

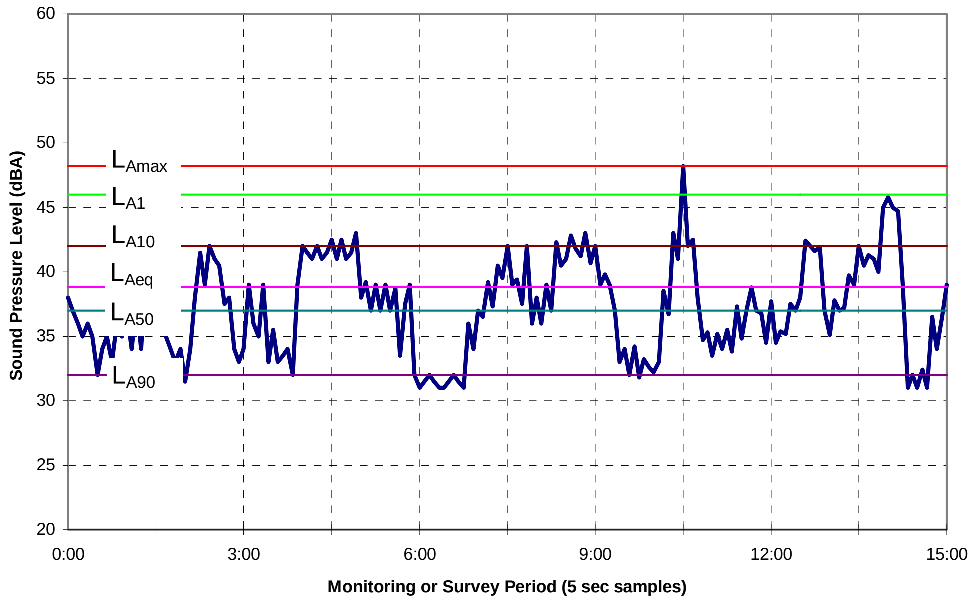
L_{Aeq} – The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise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

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

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

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

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


60
55
50
45
40
35
30
25
20
Sound Pressure Level (dBA)
L_{Amax}
L_{A1}
L_{A10}
L_{Aeq}
L_{A50}
L_{A90}
0:00
3:00
6:00
9:00
12:00
15:00
Monitoring or Survey Period (5 sec samples)

APPENDIX B

CALCULATION OF TEMPERATURE INVERSION STRENGTHS METHODOLOGY

A temperature inversion is said to occur when temperature increases with height above the ground. Inversions are typically found during the night and early morning periods, and are most common in winter. Under these conditions, noise which would otherwise propagate away from the ground can be refracted downwards, increasing the noise level as heard on the ground. This effect can dramatically reduce the effectiveness of barriers and shielding in controlling noise.

Temperature gradients may be determined either by direct measurement or by other indirect methods. The *INP* outlines several alternative methods of calculating temperature gradients where direct measured data is not available. These indirect methods allow the susceptibility of an area to inversions to be determined through the use of the relationship developed by the US Atomic Energy Commission between atmospheric stability categories and inversions. The relationship shown in Table B-1 outlines the range of temperature gradients that can be expected within each stability category. Hence, if a stability category is known, then the range of possible temperature gradients may be inferred.

Table B-1 Range of Temperature Gradients °C over 100m, By Stability Category (from US Atomic Energy Commission)

Stability Class	Range of Vertical Temperature Gradients (DT/DZ)
A	Temperature Gradient <-1.9
B	-1.9 < D Temperature Gradient < - 1.7
C	-1.7 < Temperature Gradient < - 1.5
D	-1.5 < Temperature Gradient < - 0.5
E	-0.5 < Temperature Gradient < 1.5
F	1.5 < Temperature Gradient < 4.0
G	4.0 < Temperature Gradient

One of the methods outlined in the *INP* for calculating stability category, and hence temperature inversion, in non-arid areas is the use of sigma-theta data. This measure of the standard deviation of the horizontal wind direction fluctuations can be related to atmospheric stability categories as shown in Table B-9-1.

Table B-9-1 Wind Fluctuation Criteria for Estimating Stability Categories

Stability Class	Range of Sigma-Theta Values (σ_A)
A	$\sigma_A >= 22.5°$
B	$17.5° <= \sigma_A < 22.5°$
C	$12.5° <= \sigma_A < 17.5°$
D	$7.5° <= \sigma_A < 12.5°$
E	$3.8° <= \sigma_A < 7.5°$
F	$2.1° <= \sigma_A < 3.8°$
G	$\sigma_A < 2.1°$

Using Table B- and Table B-9-1, and sigma-theta data from the Wybong Road weather station, it is possible to estimate the prevalence of temperature inversions of various strengths in the project area. However, utilizing data from the Bengalla mast allows a more accurate assessment by deriving a relationship between sigma theta and temperature inversion strength at the proposal.

It is possible to derive a relationship between stability category (based on sigma-theta levels), and temperature inversion strength at different wind speeds using the data from the Bengalla mast measured during winter 1999. This relationship is illustrated in Table B-9-2. The derived relationship between stability class and inversion strength at Bengalla is considered to be more appropriate than the US Atomic Energy Commission relationship from Table B- as it uses localised data and includes inversion strengths at different wind speeds.

Table B-9-2 Mean Measured Temperature Inversion Strengths at Bengalla under different Stability Categories during Winter Nights 1999, °C Per 100m

Wind Speed, m/sec	Stability Class						
	A	B	C	D	E	F	G
0	4	4	4	4	4	6	6
1	4	4	4	4	6	6	4
2	4	4	4	4	4	6	4
3	4	2	4	2	2	4	6
4	2	2	2	0	2	4	4
5	2	2	0	0	2	4	4
6	0	2	2	0	2	4	0
7	0	0	0	0	0	2	0
8	0	2	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0
12	0	0	0	2	0	0	0

Table B-9-2, in conjunction with wind speed and sigma-theta data from the Wybong Road weather station, was used to calculate the prevalence and strength of temperature inversions in the project area. This approach uses measured inversion strengths at Bengalla to estimate inversion strengths for the same wind speed and sigma-theta values in the project area. This is a more conservative approach than using Table B- for this purpose, as the overall estimated prevalence and strength of inversions is higher than would have been derived from Table B-.

APPENDIX C

CALCULATED 10TH PERCENTILE OPERATIONAL NOISE LEVELS

Residence numbers in this table refer to residences as shown in Figure 2-1 of the body of this report.

Residence	Y2			Y5			Y10			Y15			Worst-Case All Operational Years
	Day	Eve	Night	Day	Eve	Night	Day	Eve	Night	Day	Eve	Night	
30	36	37	40	39	42	44	36	36	41	36	36	40	**44**
34	48	45	50	48	45	51	48	44	50	48	44	50	**51**
56	38	39	40	40	41	42	45	45	46	38	37	39	**46**
81	37	37	38	39	39	41	40	41	43	36	36	37	**43**
83	31	30	34	32	31	34	32	32	35	33	31	35	**35**
91	37	36	38	39	39	40	41	42	43	36	36	37	**43**
121	36	36	39	38	41	43	36	37	40	35	35	39	**43**
132	41	39	43	42	40	44	41	38	43	41	39	43	**44**
25	37	34	41	42	44	46	37	32	41	37	30	40	**46**
66	38	39	40	34	34	36	33	32	34	29	29	31	**40**
104	33	32	35	34	35	36	33	32	35	33	32	35	**36**
110	33	32	34	34	34	36	37	37	39	33	32	34	**39**
111	35	39	39	34	37	37	33	35	35	31	31	33	**39**
128	32	32	33	29	27	29	25	23	25	18	18	20	**33**
130	33	33	34	34	34	35	37	37	38	34	33	34	**38**
139	34	34	35	32	32	33	31	32	33	25	22	24	**35**
144	32	32	34	29	29	31	30	31	33	26	23	25	**34**
148	34	34	35	34	34	35	37	38	39	33	33	34	**39**
162	36	40	39	34	37	37	33	34	35	31	31	33	**40**
164	33	33	36	36	38	39	33	35	37	32	33	36	**39**
168	34	37	37	33	35	36	32	33	34	31	31	33	**37**
171	31	32	34	28	28	30	29	30	31	22	19	20	**34**

Residence	Y2			Y5			Y10			Y15			Worst-Case All Operational Years
	Day	Eve	Night	Day	Eve	Night	Day	Eve	Night	Day	Eve	Night	
174B	34	38	38	33	35	35	31	32	33	29	30	31	**38**
175	35	38	38	33	35	35	31	32	33	29	30	31	**38**
178	31	31	33	33	34	36	31	33	35	30	31	33	**36**
182	33	32	35	34	34	36	33	33	35	33	33	35	**36**
184	32	32	35	34	34	37	33	32	35	32	32	35	**37**
185	32	32	34	33	33	36	32	32	34	32	31	34	**36**
187	32	32	34	33	34	36	32	32	34	32	31	33	**36**
189	33	33	35	34	34	36	33	32	35	33	32	35	**36**
190	34	34	36	34	35	36	34	33	35	33	33	35	**36**
191	33	33	35	34	34	36	33	32	35	33	32	34	**36**
192	35	34	37	36	36	38	35	34	36	34	33	36	**38**
193	35	34	37	36	36	38	34	33	36	34	33	36	**38**
198	33	34	36	34	35	36	33	33	35	32	33	34	**36**
199	31	31	33	33	34	36	31	31	34	30	30	33	**36**
200	32	32	35	35	36	38	32	32	35	31	31	34	**38**
201A	31	31	32	32	32	34	31	31	33	30	30	32	**34**
205	31	31	33	29	29	30	29	29	31	23	20	22	**33**
227	31	30	33	33	33	35	32	31	33	31	31	33	**35**
240	31	31	34	32	32	35	31	30	33	31	30	33	**35**
251	33	36	36	33	34	35	31	32	33	30	30	32	**36**
294	30	30	32	32	33	35	30	31	33	29	30	32	**35**
116A	32	33	33	32	33	34	36	35	37	32	31	32	**37**

Residence	Y2			Y5			Y10			Y15			Worst-Case All Operational Years
	Day	Eve	Night	Day	Eve	Night	Day	Eve	Night	Day	Eve	Night	
116B	32	33	33	33	33	34	36	35	37	31	31	32	37
125A	33	33	36	34	34	37	33	33	36	33	32	35	37
125B	31	32	35	32	33	36	31	31	34	30	31	34	36
125C	33	33	36	35	35	37	33	33	35	33	32	35	37
134A	32	32	33	33	33	34	34	34	36	31	31	32	36
134B	32	32	33	33	33	34	35	35	36	31	31	32	36
174A	34	37	38	32	35	35	30	32	32	29	29	31	38
183A	33	33	35	34	34	36	33	32	35	32	32	34	36
183B	33	33	35	34	34	36	33	32	35	33	32	35	36
183C	33	33	35	34	34	36	33	32	35	33	32	34	36
241A	33	32	35	34	34	36	33	32	35	32	32	34	36
241B	32	32	34	34	34	36	32	32	34	31	31	34	36
241C	33	32	35	34	34	36	33	33	35	32	31	34	36
116C	32	33	33	32	33	34	35	35	37	32	31	32	37
116D	32	33	33	32	33	34	35	35	37	31	31	32	37
116E	32	33	33	32	33	34	35	35	37	31	31	32	37
116F	32	33	33	32	33	34	35	35	37	31	31	32	37
116G	32	33	33	33	33	34	35	35	37	31	31	32	37
125E	34	32	37	35	34	38	34	32	37	34	31	37	38
201B	31	31	33	32	32	34	31	31	33	31	30	32	34
96A	34	37	37	33	36	36	32	33	35	31	31	33	37
96B	34	37	37	33	35	36	32	33	34	30	31	33	37

Residence	Y2			Y5			Y10			Y15			Worst-Case All Operational Years
	Day	Eve	Night	Day	Eve	Night	Day	Eve	Night	Day	Eve	Night	
54	29	30	32	32	33	34	30	32	34	29	30	32	**34**
79	30	31	32	33	34	36	31	33	35	30	31	32	**36**
103	31	32	33	32	33	34	34	36	36	31	33	33	**36**
114	31	32	33	32	33	34	34	36	36	31	33	33	**36**
124	23	20	21	21	18	19	29	29	30	24	19	19	**30**
135	27	28	30	29	30	31	28	30	31	26	26	28	**31**
141	30	31	33	34	35	36	31	33	35	30	31	33	**36**
147	30	30	32	33	34	35	30	32	34	29	29	32	**35**
151	30	31	32	33	34	35	31	33	34	30	30	32	**35**
156	29	29	30	29	28	29	29	28	30	25	23	25	**30**
157	19	19	20	19	20	21	29	31	33	24	20	21	**33**
165	25	24	26	25	25	27	25	25	26	23	23	26	**27**
166	29	30	31	31	32	33	30	32	33	29	30	32	**33**
170	29	30	31	29	30	31	28	30	31	23	19	21	**31**
172	27	26	28	27	26	28	26	26	27	24	24	26	**28**
176	31	32	33	32	33	34	34	36	37	33	34	34	**37**
177	30	31	33	32	33	35	30	32	35	29	30	33	**35**
206	23	24	25	25	26	27	27	28	29	21	19	20	**29**
209	25	26	28	27	27	29	27	26	29	26	25	28	**29**
210	14	15	16	16	17	17	15	15	16	14	14	16	**17**
211	24	26	28	25	27	28	27	28	30	23	24	26	**30**
213	28	28	30	29	30	32	27	29	32	26	28	30	**32**

Residence	Y2			Y5			Y10			Y15			Worst-Case All Operational Years
	Day	Eve	Night	Day	Eve	Night	Day	Eve	Night	Day	Eve	Night	
215	28	28	30	30	31	33	28	29	31	27	27	29	**33**
216	28	29	31	31	32	33	28	29	31	27	28	30	**33**
217	29	30	31	31	32	34	29	30	32	28	28	31	**34**
218	29	30	31	31	32	33	29	30	32	28	28	31	**33**
219	28	29	30	30	32	33	29	30	31	28	28	30	**33**
220	28	29	30	30	31	32	29	29	31	27	28	30	**32**
204	29	29	31	31	31	33	29	29	31	29	29	30	**33**
228	31	31	33	32	32	34	31	31	33	31	31	32	**34**
246	30	31	32	29	30	30	28	29	29	26	27	28	**32**
248	29	31	31	29	30	30	28	29	30	27	28	29	**31**
249	30	32	33	30	31	32	29	30	31	28	29	30	**33**
250	31	33	34	31	32	33	29	31	32	28	29	30	**34**
253	30	30	32	33	34	35	31	32	34	29	29	32	**35**
258	28	28	29	27	27	28	27	27	29	23	22	23	**29**
259	25	26	27	25	26	27	27	28	29	21	17	19	**29**
260	28	28	30	26	25	26	26	28	29	21	18	19	**30**
262	29	30	31	28	28	29	28	28	29	21	18	20	**31**
263	29	29	31	28	28	30	29	29	30	23	22	23	**31**
264	24	25	28	27	29	31	24	23	27	23	22	26	**31**
265	28	29	30	29	30	31	30	32	33	28	29	29	**33**
266	20	22	23	21	23	23	22	24	25	19	18	19	**25**
285	25	27	30	28	30	31	25	26	29	24	23	28	**31**

Residence	Y2			Y5			Y10			Y15			Worst-Case All Operational Years
	Day	Eve	Night	Day	Eve	Night	Day	Eve	Night	Day	Eve	Night	
287	26	27	30	28	30	32	25	25	29	25	24	29	**32**
286	26	28	30	28	30	32	25	26	29	24	24	28	**32**
288	25	28	29	28	29	31	25	26	29	24	25	28	**31**
289	31	32	33	27	26	27	28	28	29	21	19	20	**33**
290	19	19	26	23	27	31	19	19	26	18	18	26	**31**
291	29	29	31	30	31	33	28	29	31	28	28	30	**33**
292	27	28	30	28	30	32	26	27	30	26	27	29	**32**
293	27	28	30	29	30	32	28	30	32	27	28	30	**32**
106B	29	30	31	31	31	33	31	34	35	30	30	31	**35**
126B	27	31	31	25	26	28	24	25	27	21	22	25	**31**
134D	28	25	26	27	24	26	29	30	30	25	22	24	**30**
134C	28	26	27	27	25	26	28	28	29	25	22	23	**29**
173B	31	33	34	28	28	29	27	27	29	24	25	28	**34**
21B	17	20	20	17	19	20	16	18	19	15	14	16	**20**
254A	28	29	30	29	31	31	31	32	33	28	29	30	**33**
19	25	28	30	28	30	32	25	28	30	24	26	29	**32**
270	28	29	31	30	31	32	28	30	32	28	28	30	**32**
283	26	28	30	29	30	32	25	28	30	25	26	29	**32**
112B	29	30	31	31	32	34	31	32	33	29	30	31	**34**
212B	16	18	19	17	19	19	16	18	19	13	13	15	**19**
284B	26	26	28	27	28	30	26	25	28	25	25	27	**30**

APPENDIX D

CALCULATED 10TH PERCENTILE OPERATIONAL NOISE LEVELS VERSUS 2006 EA NOISE LEVELS

Residence	Day		Evening		Night	
	Maximum	2006 EA	Maximum	2006 EA	Maximum	2006 EA
30	39	42	42	42	44	46
34	48	44	45	44	51	48
56	45	48	45	48	46	44
81	40	43	41	44	43	44
83	33	35	32	35	35	34
91	41	43	42	44	43	42
121	38	40	41	40	43	45
132	42	41	40	41	44	46
25	42	54	44	54	46	57
66	38	40	39	40	40	40
104	34	36	35	36	36	38
110	37	38	37	38	39	36
111	35	35	39	34	39	39
128	32	37	32	37	33	36
130	37	39	37	39	38	37
139	34	38	34	39	35	38
144	32	37	32	37	34	36
148	37	39	38	39	39	37
162	36	35	40	34	39	39
164	36	36	38	37	39	39
168	34	34	37	34	37	38
171	31	37	32	37	34	37
174B	34	35	38	34	38	36
175	35	35	38	34	38	36
178	33	34	34	34	36	36
182	34	33	34	33	36	36
184	34	37	34	37	37	39
185	33	35	33	36	36	38
187	33	35	34	35	36	37
189	34	36	34	36	36	39
190	34	35	35	35	36	37
191	34	36	34	36	36	37
192	36	36	36	36	38	39
193	36	36	36	36	38	40
198	34	34	35	34	36	37
199	33	37	34	37	36	38
200	35	36	36	36	38	36
201A	32	34	32	34	34	36

Residence	Day		Evening		Night	
	Maximum	2006 EA	Maximum	2006 EA	Maximum	2006 EA
205	31	37	31	37	33	36
227	33	34	33	34	35	36
240	32	32	32	32	35	36
251	33	35	36	35	36	37
294	32	35	33	35	35	36
116A	36	36	35	36	37	35
116B	36	36	35	36	37	35
125A	34	36	34	35	37	38
125B	32	33	33	32	36	37
125C	35	35	35	34	37	38
134A	34	36	34	36	36	36
134B	35	36	35	36	36	35
174A	34	35	37	34	38	36
183A	34	35	34	35	36	38
183B	34	35	34	35	36	38
183C	34	36	34	36	36	38
241A	34	34	34	34	36	37
241B	34	35	34	34	36	37
241C	34	35	34	34	36	36
116C	35	36	35	36	37	35
116D	35	36	35	36	37	35
116E	35	36	35	36	37	35
116F	35	36	35	36	37	35
116G	35	36	35	36	37	35
125E	35	36	34	36	38	40
201B	32	34	32	34	34	36
96A	34	34	37	33	37	38
96B	34	34	37	34	37	38
54	32	33	33	33	34	34
79	33	34	34	34	36	35
103	34	35	36	35	36	35
114	34	34	36	34	36	34
124	29	32	29	32	30	30
135	29	32	30	31	31	31
141	34	34	35	34	36	35
147	33	34	34	34	35	35
151	33	33	34	34	35	34
156	29	34	29	34	30	33
157	29	33	31	33	33	32

Residence	Day		Evening		Night	
	Maximum	2006 EA	Maximum	2006 EA	Maximum	2006 EA
165	25	29	25	31	27	27
166	31	32	32	32	33	33
170	29	35	30	35	31	34
172	27	32	26	33	28	30
176	34	34	36	34	37	35
177	32	34	33	34	35	35
206	27	32	28	32	29	31
209	27	27	27	27	29	27
210	16	17	17	17	17	17
211	27	29	28	29	30	29
213	29	31	30	31	32	33
215	30	31	31	31	33	33
216	31	32	32	32	33	34
217	31	33	32	33	34	35
218	31	35	32	35	33	35
219	30	34	32	34	33	35
220	30	33	31	34	32	34
204	31	33	31	33	33	35
228	32	33	32	33	34	35
246	30	31	31	31	32	32
248	29	28	31	27	31	31
249	30	30	32	29	33	32
250	31	31	33	31	34	33
253	33	33	34	33	35	35
258	28	33	28	34	29	32
259	27	33	28	34	29	33
260	28	35	28	35	30	34
262	29	35	30	35	31	34
263	29	34	29	35	31	33
264	27	30	29	30	31	32
265	30	31	32	31	33	31
266	22	26	24	26	25	26
285	28	31	30	31	31	33
287	28	31	30	31	32	33
286	28	30	30	31	32	33
288	28	31	29	31	31	32
289	31	34	32	34	33	33
290	23	27	27	26	31	32
291	30	31	31	31	33	33

Residence	Day		Evening		Night	
	Maximum	**2006 EA**	**Maximum**	**2006 EA**	**Maximum**	**2006 EA**
292	**28**	31	**30**	31	**32**	32
293	**29**	31	**30**	31	**32**	33
106B	**31**	33	**34**	33	**35**	33
126B	**27**	29	**31**	28	**31**	32
134D	**29**	34	**30**	34	**30**	30
134C	**28**	32	**28**	32	**29**	31
173B	**31**	33	**33**	29	**34**	32
21B	**17**	23	**20**	23	**20**	28
254A	**31**	31	**32**	31	**33**	31
19	**28**	31	**30**	31	**32**	33
270	**30**	31	**31**	31	**32**	33
283	**29**	31	**30**	31	**32**	33
112B	**31**	33	**32**	33	**34**	33
212B	**17**	21	**19**	21	**19**	21
284B	**27**	29	**28**	29	**30**	31