# LIDDELL COAL OPERATIONS

APPENDIX **M**

## Environmental Noise and Blasting Assessment
(Global Acoustics, 2013)

## APPENDICES

Global Acoustics

Noise and Vibration Analysis and Solutions

6 September 2013

GSS Environmental
PO Box 907
Hamilton NSW 2303
Attention: Nicole Armit

Dear Nicole,

**Regarding:** Liddell Coal – Conveyor Construction Noise

## 1 INTRODUCTION

This letter is in response to issues raised by the EPA during an adequacy review of our noise impact assessment report for the proposed modification to Liddell Coal Operations (LCO) development consent (DA 305/11/01), and reiterates an opinion on the likelihood of noise impact at off-site receptor locations from the construction of a conveyor at LCO as stated in our report 11068_R08.

## 2 FACTS

With respect to conveyor construction the following facts are known:

- It is only planned to occur during the day period;
- It is at the far end of the mine site with respect to noise sensitive receptors (the mine is intervening); and
- There is always topographical shielding between it and noise sensitive receptors.

The construction equipment sound powers are unknown. However, from our experience we consider it reasonable to assume sound powers in the order of $L_{WA}$ 105 to 115 dB.

LCO operate in the order of 30 rear dump trucks, 6 excavators and 15 dozers, all large machines (much larger than any construction equipment), and some are used in exposed locations.

Given the above the following can be said about conveyor construction plant:

- It has lower sound power to other items on site;
- It operates in a more shielded position than many other items on site; and

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- It only operates during the period when noise propagation enhancements are least likely.

## 3 OPINION

Based on the above it is my opinion that noise emissions from the conveyor construction would be insignificant in context of entire site operations, and, also occurs only in a low risk noise period, such that the risk of it constituting an off-site noise impact is very low.

I trust this information meets your requirements. If you have any questions or need further details please contact me.

Regards,

Tony Welbourne
Acoustics Engineer

# *Liddell Coal Operations*

## *Modification 5 to Development Consent DA 305-11-01*

## *Environmental Noise and Blasting Assessment*

*Prepared for*

*GSS Environmental*

Global Acoustics

Noise and Vibration Analysis and Solutions

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# *Liddell Coal Operations*

## *Modification 5 to Development Consent DA 305-11-01*

## *Environmental Noise and Blasting Assessment*

Reference: 11068_R08.doc

Report date: 3 September 2013

### *Prepared for*

GSS Environmental
PO Box 907
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### *Prepared by*

Global Acoustics Pty Ltd
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Prepared: Amanda Borserio, Environmental Scientist

QA Review: Jeremy Welbourne, Civil Engineer - Acoustics

*Global Acoustics Pty Ltd ~ Environmental noise modelling and impact assessment ~ Sound power testing ~ Noise control advice ~ Noise and vibration monitoring ~ OHS noise monitoring and advice ~ Expert evidence in Land and Environment and Compensation Courts ~ Architectural acoustics ~ Blasting assessments and monitoring ~ Noise management plans (NMP) ~ Sound level meter and noise logger sales and hire*

# EXECUTIVE SUMMARY

Liddell Coal Operations (LCO) is an established open-cut mining operation located at Ravensworth, in the Upper Hunter Valley of New South Wales. LCO is operated and managed by Liddell Coal Operations Pty Limited, the applicant for the proposed modification, on behalf of the Liddell Joint Venture (LJV). The LJV ownership comprises Enex Liddell Pty Limited holding 35 per cent; Gabume Pty Limited holding 32.5 per cent; and Mitsui Matsushima Pty Limited holding 32.5 per cent. Gabume Pty Limited is wholly owned by Enex Liddell Pty Limited, which is wholly owned by Xstrata Coal Pty Limited (XC). XC is ultimately controlled by GlencoreXstrata plc.

LCO currently has approval to conduct mining operations until the end of 2023 within the approved mining footprint illustrated in **Figure 1**. Open cut mining activities will however reach this approved boundary in 2014. Coal reserves have been identified outside of this footprint, within the development consent boundary, and LCO therefore propose to extend the existing open cut mining operations outside the approved mining area to enable continuity of mining and maximise recovery of coal resources within the existing development consent boundary.

LCO are therefore seeking approval to modify DA 305-11-01 to allow for this extension of mining activities, with the primary objectives of the proposed modification to:

- Develop the on-going open cut mining operations with a focus on maximising resource recovery within the existing development consent and mining lease boundaries;
- Maintain continuity of coal production, and subsequently secure on-going employment opportunities and socio-economic flow-on benefits; and
- Continue to conduct mining at Liddell in an environmentally responsible manner to ensure the potential for adverse impact is minimised.

The proposed works lie wholly within both the existing development consent boundary and the mining lease ML 1597 boundary. No changes are proposed to the approved operating hours, mining method, or mining equipment, which will remain as approved under DA 305-11-01, as modified.

Noise impact assessment criteria outlined in Table 1 of DA 301-11-01 were adopted as project specific noise criteria for assessment of operational noise impact. The Project Specific Noise Criterion was $L_{Aeq,15\ minute}$ 35 dB for all receptors, for all time periods.

Three operational scenarios representing worst case operating conditions with regard to potential noise impacts were assessed for the proposed modification. The scenarios represent mining operations during Year 2 (approximately February 2015), Year 4 (approximately November 2017) and Year 5 (approximately June 2018). Meteorological enhancement effects

were assessed using the prevailing method as outlined in the NSW Environment Protection Authority's Industrial Noise Policy (2000).

Model results for neutral atmospheric conditions were significantly less than the Project Specific Noise Criterion at all receptor locations for all three scenarios. As such, no impact under neutral atmospheric conditions is predicted.

Model results for enhancing meteorological conditions at privately owned residences indicate:

- Noise levels are predicted to be within the Project Specific Noise Criterion at ten of the thirteen assessed receptors at all times for all scenarios; and
- Three receptors are predicted to experience minor exceedances of the Project Specific Noise Criterion in Scenario 3.

With regard to the two residences owned by Macquarie Generation:

- Receptor R13 (the Liddell Recreation Area) has minor to moderate exceedances of the Project Specific Noise Criterion predicted. Given that the Liddell Recreation Area is owned by Macquarie Coal Generation and is therefore not a privately owned residence, land acquisition criteria do not apply.
- No exceedances of the Project Specific Noise Criterion are predicted at Receptor R15.

There are no predicted exceedances of the sleep disturbance criterion for any of the three assessed operational scenarios.

No road traffic noise impacts are predicted due to the proposed LCO modification.

No rail noise impacts are predicted due to the proposed LCO modification.

No construction noise impacts are predicted due to the proposed LCO modification.

No cumulative noise impacts are predicted due to the proposed LCO modification.

Continued management of blasting activities at LCO should see continued compliance with vibration and overpressure criteria.

There are no predicted exceedances of the Broner (2010) desirable low frequency noise criterion due to the proposed LCO modification.

**Global Acoustics Pty Ltd**

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# 1 INTRODUCTION

## 1.1 The Applicant

Liddell Coal Operations (LCO) is operated and managed by Liddell Coal Operations Pty Limited, the applicant for the proposed modification, on behalf of the Liddell Joint Venture (LJV). The LJV ownership comprises Enex Liddell Pty Limited holding 35 per cent; Gabume Pty Limited holding 32.5 per cent; and Mitsui Matsushima Pty Limited holding 32.5 per cent. Gabume Pty Limited is wholly owned by Enex Liddell Pty Limited, which is wholly owned by Xstrata Coal Pty Limited (XC). XC is ultimately controlled by GlencoreXstrata plc.

## 1.2 Overview of the Project

LCO currently has approval to conduct mining operations until the end of 2023 within the approved mining footprint illustrated in **Figure 1**. Open cut mining activities will however reach this approved boundary in 2014. Coal reserves have been identified outside of this footprint, within the development consent boundary, and LCO therefore propose to extend the existing open cut mining operations outside the approved mining area to enable continuity of mining and maximise recovery of coal resources within the existing development consent boundary.

LCO are therefore seeking approval to modify DA 305-11-01 to allow for this extension of mining activities, with the primary objectives of the Project to:

- Develop the on-going open cut mining operations with a focus on maximising resource recovery within the existing development consent and mining lease boundaries;
- Maintain continuity of coal production, and subsequently secure on-going employment opportunities and socio-economic flow-on benefits; and
- Continue to conduct mining at Liddell in an environmentally responsible manner to ensure the potential for adverse impact is minimised.

The key components of the Project, as illustrated in **Figure 1**, include the following:

- **Expansion of the open cut mining and dump footprint -** Extension of the South and Entrance Pits to the south east, and, upon completion of mining in these pits, the mining of coal resources under the Mine Infrastructure Area (MIA). LCO currently has approval to conduct open cut mining operations within a number of pit areas, totaling 1374 ha. The proposed modification involves an expansion of the approved mining and dump footprint by 171 ha, equating to a 12% increase in this footprint. The extension will enable the recovery of an additional 38 Mt of coal.

- **Extension to the Life of Mine** – The extension of open cut mining activities will lead to an associated extension of the life of mine at LCO from 2023 to 2028.

- **Additional Tailings Emplacement Areas** – A tailings emplacement area will be constructed within the final void of the South Pit to dispose of the additional tailings associated with the extension of open cut mining activities.

- **Coal Processing** – Coal will continue to be processed at the LCO Coal Handling and Preparation Plant (CHPP) at the approved rate of up to 8 Million tonnes per annum (Mtpa). Coal will however no longer be received from, or sent to, the Cumnock CHPP for processing as currently approved under DA 305-11-01, as this CHPP has been demolished following the cessation of mining operations at Cumnock No. 1 Colliery. LCO seek to maintain a contingency for coal processing by delivery of up to 1.5 Mtpa of ROM coal to Ravensworth Central Coal Processing (RCCP) facility for washing via a new connection to the existing overland conveyor or by road transport route to RCCP. In addition, up to 2 Mtpa may be received from Mt Owen for processing via the same existing overland conveyor.

**Minor additional infrastructure**:

- Construction and commissioning of a transfer point and conveyor connected to the existing Mt Owen/Glendell/Macquarie Generation conveyor is proposed, enabling LCO to send or receive material to and from Mt Owen via the existing conveyor system. The new conveyor will deliver/take ROM coal to/from a new 50,000 tonne stockpile; and

- Infrastructure and auxiliary surface disturbance to support the new mining areas will be required, including but not limited to, powerlines, water management infrastructure and haul roads.

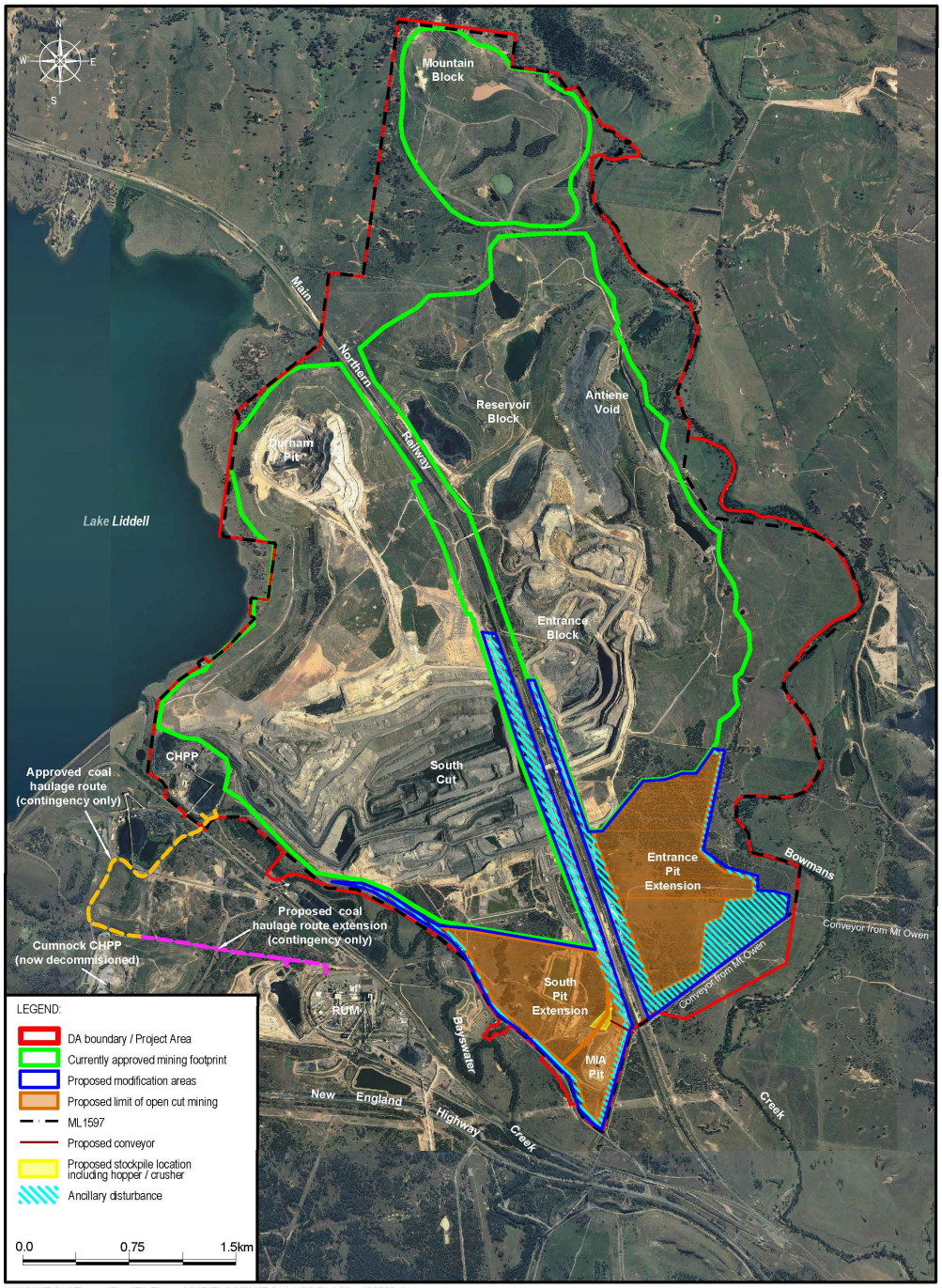
The proposed works lie wholly within both the existing development consent boundary and the mining lease ML 1597 boundary. No changes are proposed to the approved operating hours, mining method, or mining equipment, which will remain as approved under DA 305-11-01, as modified.

### *1.2.1 Mine Workforce and Hours of Operation*

LCO will continue to operate with approximately 360 full time employees, and approximately 100 contractors.

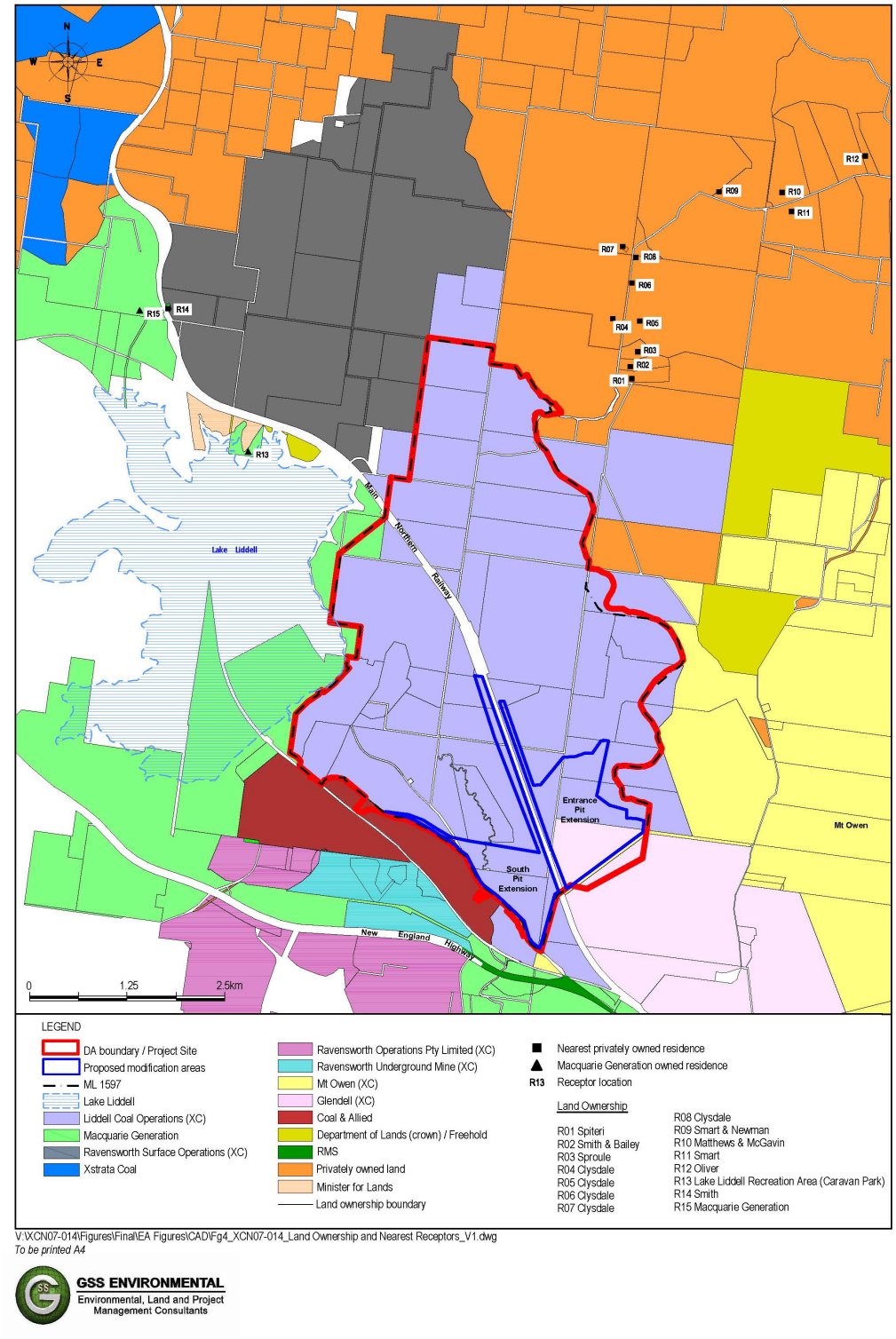
Potential traffic related impacts are discussed separately in the Traffic Impact Assessment of the proposed modification (PB, 2013).

Mining operations will continue to operate 24 hours per day, seven days per week.




*Source: GSS Environmental, 2013*

**Figure 1 Project Area – Liddell Coal Operations**




*Source: GSS Environmental, 2013*

**Figure 2 Land Ownership and Receptor Locations**

## 1.3 Director General's Requirements

Table 1.1 outlines the Director General's requirements for the noise assessment and the sections of the report in which these requirements are addressed.

*Table 1.1 DIRECTOR GENERAL REQUIREMENTS FOR NOISE AND BLASTING IMPACTS AND RELATED SECTIONS OF THIS REPORT*

| Director General's Requirements | Report Sections |
|---|---|
| A quantitative assessment of the potential construction and operational noise impacts, in conjunction with the cumulative noise impacts from other sources, including the surrounding mines and other operations at the mine; | 2.6, 3.6, 8.6 |
| Noise modelling based on applicable meteorological and stability category temperature inversion conditions to be developed in consultation with OEH; and | 3.1, 3.2, 3.3, 3.4, 3.5, 3.7, 3.9, 4.1, 4.1.2, 1.1, 5.1, 5.2, 5.3, 8.1, 0, 8.5, 8.8 |
| Potential blasting impacts of the project on people, livestock, property and roads. | 2.7, 3.8, 5.4, 8.7 |

## 1.4 Terminology

Some definitions of acoustic terminology are as follows:

- $L_A$, the A-weighted root mean squared (RMS) noise level at any instant;
- $L_{A1}$, the noise level which is exceeded for 1 per cent of the time;
- $L_{A1,1\ minute}$, corresponds to the highest noise level generated for 0.6 second during one minute. In practical terms, this represents the maximum measured level, and is often used to assess sleep disturbance;
- $L_{A10}$, the noise level which is exceeded for 10 per cent of the time, which is approximately the average of the maximum noise levels;
- $L_{A90}$, the level exceeded for 90 per cent of the time, which is approximately the average of the minimum noise levels. The $L_{A90}$ level is often referred to as the "background" noise level and is commonly used to determine noise criteria for assessment purposes;
- $L_{Aeq}$, the average noise energy during a measurement period;
- $L_{pk}$, the unweighted peak noise level at any instant;
- dB(A), noise level measurement units are decibels (dB). The "A" weighting scale is used to describe human response to noise;
- sound power level ($L_W$ denotes linear, $L_{WA}$ denotes A-weighted), 10 times the logarithm of energy radiated from a source (as noise) divided by a reference power, the reference power being 1 picowatt;
- sound pressure level ($L_p$), fluctuations in pressure measured as 10 times a logarithmic scale, the reference pressure being 20 micropascals;
- sound exposure level (SEL), the A-weighted noise energy during a measurement period normalised to one second.;
- Hertz (Hz), cycles per second, the frequency of fluctuations in pressure, sound is usually a combination of many frequencies together;
- ABL, the 10th percentile background noise level for a single period (day, evening or night) of a 24 hour monitoring period;
- RBL, the background noise level for a period (day, evening or night) determined from ABL data;
- PPV or peak particle velocity, a measure of vibration, typically in units of millimetres per second. This descriptor is commonly used to quantify blast vibration measured in the ground as it has been found to correlate best to structural damage; and
- Overpressure is a transient pressure wave generated by blasting. It is measured on the decibel scale as an un-weighted peak.

## 1.5 Historical attended noise monitoring data from Liddell Coal Operations

Global Acoustics has undertaken attended compliance monitoring for LCO at four locations on Hebden Road and also at the Liddell Recreation Area on a quarterly basis since quarter 4, 2010.

The Liddell Recreation Area is owned by Macquarie Coal Generation so is not a privately owned residence and as such, LCO land acquisition criteria do not apply. This discussion of monitoring results will focus on data collected in the vicinity of the privately owned Hebden Road residences.

Of the 100 attended measurements taken by Global Acoustics on Hebden Road:

- LCO was inaudible on 37 occasions;
- LCO was audible but not measurable (due to low levels) on 8 occasions;
- LCO $L_{Aeq}$ results were less than 20 dB on 7 occasions;
- LCO $L_{Aeq}$ results were between 20 dB and 30 dB (inclusive) during 30 measurements;
- LCO $L_{Aeq}$ results were between 31 dB and 35 dB (inclusive) during 17 measurements; and
- One LCO $L_{Aeq}$ result exceeded the night- period criterion of $L_{Aeq,15\ minute}$ 35 dB by one decibel. This measurement occurred during wind speeds exceeding 3 metres per second so the measurement was not a reportable exceedance, as the criterion did not apply.

Monitoring results over the past two years at LCO therefore indicate that noise levels associated with the current operation are within the Project Specific Noise Criterion (PSNC) of $L_{Aeq,15\ minute}$ 35 dB as set out in DA 305-11-01. PSNC is discussed further below in section 2.2.

The proposed modification will see LCO continuing to dump in similar locations to the operations of the last two years and will be moving further to the south, away from receivers. Similar or lower noise levels could reasonably be expected as a result of the modification.

# 2 CRITERIA

LCO operate under DA 305-11-01. DA 305-11-01 has been modified on four occasions, the most recent of which was approved in October 2009. Noise criteria in this assessment are based on the specific environmental conditions detailed in Sections 1 to 4 in Schedule 3 of DA 305-11-01. Blast vibration and overpressure criteria are based on the specific environmental conditions detailed in Sections 6 to 8 of Schedule 3 of DA 305-11-01.

## 2.1 Receptor Locations

All private residence locations in the area, shown on Figure 2, were considered in the assessment. GSS Environmental provided details of receptors to be assessed, including coordinates and ownership details. Details of each receptor are shown in Table 2.1.

*Table 2.1 RECEPTOR IDENTIFICATION NUMBERS AND NAMES*

| Receptor ID | Receptor Name |
|---|---|
| R01 | Spiteri |
| R02 | Smith and Bailey |
| R03 | Sproule |
| R04 | Clydsdale |
| R05 | Clydsdale |
| R06 | Clydsdale |
| R07 | Clydsdale |
| R08 | Clydsdale |
| R09 | Smart & Newman |
| R10 | Matthews & McGavin |
| R11 | Smart & Smart |
| R12 | Oliver |
| R13 | Lake Liddell Recreation Area (Caravan Park) |
| R14 | Smith |
| R15 | Macquarie Generation |

For the remainder of the report, receptor locations are referred to by receptor ID only.

## 2.2 Operational Noise Criteria

### 2.2.1 Project Specific Noise Criteria

Noise impact assessment criteria outlined in Table 1 of DA 301-11-01 have been adopted as PSNC for assessment of operational noise impact. A PSNC of $L_{Aeq,15\ minute}$ 35 dB applies for all receptors, for all time periods.

Table 1 of DA 301-11-01 is reproduced below.

1. The Applicant shall ensure that the noise generated by the development does not exceed the noise impact assessment criteria in Table 1 at any residence on, or on more than 25 percent of, any privately owned land.

*Table 1: Noise impact assessment criteria dB(A)*

| Assigned residential location number | Noise criteria $LA_{eq(15\ minute)}$ | Sleep disturbance Noise Criteria $LA_{(1\ min)}$ |
|---|---|---|
| 1,2,4,5,6,7,8,9,10,11,12,13,14 | 35dB(A) Day | |
| | 35dB(A) Evening | |
| | 35dB(A) Night | 45dB(A) Night |

*Notes:*

- *To determine compliance with the $L_{Aeq(15\ minute)}$ noise limits, noise from the development is to be measured at the most affected point within the residential boundary, or at the most affected point within 30 metres of a dwelling (rural situations) where the dwelling is more than 30 metres from the boundary. Where it can be demonstrated that direct measurement of noise from the development is impractical, the DECC may accept alternative means of determining compliance (see Chapter 11 of the NSW Industrial Noise Policy). The modification factors in Section 4 of the NSW Industrial Noise Policy shall also be applied to the measured noise levels where applicable.*
- *To determine compliance with the $L_{A1(1\ minute)}$ noise limits, noise from the development is to be measured at 1 metre from the dwelling façade. Where it can be demonstrated that direct measurement of noise from the development is impractical, the DECC may accept alternative means of determining compliance (see Chapter 11 of the NSW Industrial Noise Policy).*
- *The noise emission limits identified in the above table apply under meteorological conditions of:*
  - *wind speeds of up to 3 m/s at 10 metres above ground level; or*
  - *temperature inversion conditions of up to 3ºC/100m, and wind speeds of up to 2 m/s at 10 metres above ground level.*

Table 1 of DA 305-11-01 (reproduced above) also contains an $L_{A1,1\ minute}$ criterion of 45 dB for all privately owned land. This criterion has been adopted as the sleep disturbance criterion for all residences included in this assessment.

### 2.2.2 Land Acquisition Criteria

Land acquisition criteria are outlined in Table 2 of DA 305-11-01 (reproduced below). In essence, privately owned land where the noise level is predicted to be greater than $L_{Aeq,15\ minute}$ 40 dB would be within the acquisition area.

2. If the noise generated by the development exceeds the criteria in Table 2, the Applicant shall, upon receiving a written request for acquisition from the landowner, acquire the land in accordance with the procedures in conditions 10-12 of Schedule 4.

*Table 2: Land acquisition criteria dB(A)*

| Day/Evening/Night $LA_{eq(15\ minute)}$ | Land |
|---|---|
| 40 | Any residence on, or on more than 25 percent of, any privately owned land. |

*Note: Noise generated by the development is to be measured in accordance with the notes to Table 1.*

## 2.3 Road Traffic Noise Criteria

Minor construction of a transfer point and conveyor is proposed to connect to the existing Mt Owen / Glendell / Macquarie Generation conveyor for the proposed modification. This is not expected to significantly increase traffic volumes or road traffic noise in the long term.

There will be no change to the existing workforce at LCO as a result of the proposed modification. The modification to DA 305-11-01 is however seeking to regularise the current workforce numbers. As such, there is not likely to be any increase to road traffic volumes or road traffic noise as a result of the proposed modification.

Road traffic noise is not discussed further in this assessment.

## 2.4 Rail Noise Criteria

With regards to coal transport, the original 2001 EIS (Umwelt, 2001) stated that LCO would load trains on up to 127 days per year. In 2006, LCO sought approval to modify the development consent to increase the number of train loading days from 127 to a maximum of 220. Train loading is now scheduled by the Hunter Valley Coal Chain, and is scheduled to occur concurrently with other generators on the loop to maximise the capacity of the system. To provide for maximum flexibility to support the efficient use of the system, LCO proposes train loading to occur on all days of the year as part of the proposed modification.

There is no proposed change to the currently approved production rate of 8 Mtpa, or product coal to be transported by rail for export (in the order of 6 Mtpa). Therefore, whilst LCO is seeking increased flexibility in the number of allowable train loading days, there will be no overall increase to rail movements or rail noise associated with the proposed modification.

Rail noise is not discussed further in this assessment.

## 2.5 Construction Noise Criteria

Whilst no significant construction is proposed in association with the proposed modification, should construction noise occur, it would generally be expected to comply with DA 301-11-01 criteria outlined above in Section 2.1.

Only minor additional infrastructure is proposed as part of the modification, as described above in Section 1.2, and would primarily include the construction and commissioning of a transfer point and conveyor connected to the existing Mt Owen/Glendell/Macquarie Generation conveyor, as well as minor ancillary infrastructure to support the new mining areas such as powerlines and water management infrastructure.

Any construction would therefore be minor, would be located in close proximity to mining operations, and would occur during the day period only. As such, it is considered highly unlikely that construction noise would be audible over and above the noise generated by the open cut mining operation. Construction noise is not discussed further in this assessment.

## 2.6 Cumulative Noise Criteria

Section 3 and 4 of Schedule 3 of DA 305-11-01 outlines cumulative noise criteria. Details are reproduced below.

**Cumulative Noise Criteria**

3. The Applicant shall take all reasonable and feasible measures to ensure that the noise generated by the development combined with the noise generated by other mines does not exceed the following amenity criteria at any residence on, or on more than 25 percent of, any privately owned land:
   - $L_{Aeq(11\ hour)}$ 50 dB(A) – Day;
   - $L_{Aeq(4\ hour)}$ 45 dB(A) – Evening; and
   - $L_{Aeq(9\ hour)}$ 40 dB(A) – Night.

4. If the noise generated by the development when combined with the noise generated by other mines exceeds the following amenity criteria at any residence on, or on more than 25 percent of, any privately owned land, then upon receiving a written request from the landowner, the Applicant shall acquire the land on as equitable basis as possible with the relevant mines, based on each mine's relative noise contribution to the cumulative noise, in accordance with the procedures in conditions 10-12 of Schedule 5:
   - $L_{Aeq(11\ hour)}$ 53 dB(A) – Day;
   - $L_{Aeq(4\ hour)}$ 48 dB(A) – Evening; and
   - $L_{Aeq(9\ hour)}$ 43 dB(A) – Night.

These criteria have been adopted as cumulative noise criteria for all residences included in this assessment.

## 2.7 Blast Overpressure and Vibration

Sections 6 to 15 of the DA 305-11-01 and condition L4 of LCO's Environmental Protection Licence (EPL) pertain to blast overpressure and vibration criteria, which are consistent with criteria presented in the Australia and New Zealand Environment and Conservation Council publication titled *Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration* (ANZECC 1990). Condition L4 of the EPL is reproduced below.

**L4 Blasting**

L4.1 Blasting in or on the premises must only be carried out between 0900 hours and 1700 hours, Monday to Saturday. Blasting in or on the premises must not take place on Sundays or Public Holidays without the prior approval of the EPA.

L4.2 The airblast overpressure level from blasting operations in or on the premises must not exceed:

a) 115 dB (Lin Peak) for more than 5% of the total number of blasts during each reporting period; and
b) 120 dB (Lin Peak) at any time.

At any residence or noise sensitive location (eg school/hospital) that is not owned by the licensee or subject of a private agreement between the owner of the residence or noise sensitive location and the licensee as to an alternative overpressure level.

L4.3 The ground vibration peak particle velocity from blasting operations carried out in or on the premises must not exceed:

a) 5mm/s for more than 5% of the total number of blasts carried out on the premises during each reporting period; and
b) 10 mm/s at any time.

At any residence or noise sensitive location (eg school/hospital) that is not owned by the licensee or subject of a private agreement between the owner of the residence or noise sensitive location and the licensee as to an alternative ground vibration level.

## 2.8 Low Frequency Noise Criteria

Two methodologies have been adopted for assessment of low frequency noise (LFN):

- Evaluation of LFN through comparison of C-weighted and A-weighted predicted total noise levels at receptors, as per *NSW Industrial Noise Policy* (EPA, 2000) (INP) guidelines. In this method, the difference between C–weighted and A-weighted levels at receptor locations is calculated, and if the difference is greater than or equal to 15 dB, a 5 dB penalty (modifying factor) is added to predicted levels; and
- Evaluation of LFN through comparison of total predicted C-weighted levels at receptor locations with an upper limit criterion. This method is in accordance with recommendations published in *A Simple Method for Low Frequency Noise Emission Assessment* (Broner, 2010), published in the Journal of Low Frequency Noise, Vibration and Active Control, Volume 29 Number 1 2010. The author of the document recommends outdoor criteria for LFN assessment; the following extract from the document presents recommended criteria. If the total predicted C– weighted noise level at a receptor exceeds the relevant criterion a 5 dB penalty (modifying factor) is added to predicted levels. In this assessment, the desirable limit for residential receptors of $L_{Ceq}$ 60 dB has been adopted.

**Criteria for Assessment of LFN**

| | Sensitive Receiver | Range | Criteria Leq (dBC) |
|---|---|---|---|
| Residential | Night time or plant operation 24/7 | Desirable | 60 |
| | | Maximum | 65 |
| | Daytime or Intermittent (1 – 2 hours) | Desirable | 65 |
| | | Maximum | 70 |
| Commercial/ Office/ Industrial | Night time or plant operation 24/7 | Desirable | 70 |
| | | Maximum | 75 |
| | Daytime or Intermittent (1 – 2 hours) | Desirable | 75 |
| | | Maximum | 80 |

*Source: A Simple Method for Low Frequency Noise Emission Assessment by N. Broner*

# 3 METHODOLOGY

## 3.1 Input from the EPA

As requested by the DGRs, LCO sought comment from the NSW Office of Environment and Heritage (OEH) in April 2012 on the proposed methodology for the noise impact assessment. A response was received from the NSW Environment Protection Authority (EPA) on 16 May 2012.

In their letter, the EPA commented on how temperature inversion conditions are to be considered in the assessment. The EPA stated that despite the default inversion condition in the NSW INP for noise modelling being an inversion rate of 3degC/100m, the EPA would prefer that noise modelling be undertaken for F Stability Class conditions. Using RTA Technology's Environmental Noise Model (ENM), this could be achieved by modelling for 4 degC/100m, as has been undertaken in the noise modelling for this noise impact assessment, as described in section 4.1.2 below.

## 3.2 Modelled scenarios

Three operational noise scenarios were modelled representing worst case operating conditions for the proposed progression of the mine with equipment operating at exposed, elevated levels. These scenarios, known as Scenario 1, Scenario 2 and Scenario 3 represent mining in years 2 (approximately early 2015), 4 (approximately late 2017) and 5 (approximately mid-2018) of the modification respectively. Further detail regarding the operating scenarios is provided in Section.4.1.2.

## 3.3 Model Inputs

Data used in the model was sourced as follows:

- Topography surrounding the active mining area and haul route data was supplied by GSS Environmental;
- Sound power of plant was sourced from Global Acoustics' technical database. Our database included direct measurements of the equipment onsite at LCO and from other similar items in use on other coal mine sites in the Hunter Valley;
- Meteorological data (discussed further in Section 4.1) was sourced from a Mount Owen meteorological station on Hebden Road. Data was used from the period from September 2008 to February 2011; and
- Receptor locations were supplied by GSS Environmental.

## 3.4 Operational Noise Modelling Assessment

Noise levels were predicted using RTA Technology's ENM, a computer based environmental noise model, to determine the acoustic impact of mining operations. The model takes into account geometric spreading, atmospheric absorption, and, barrier and ground attenuation.

Model results were calculated using prevailing meteorological conditions as per the INP method. A discussion of meteorological data analysis is included in the following section.

ENM Terrain Category 2, representing a rural land environment, was adopted for model input.

## 3.5 INP Modifying Factors

Section 4 of the INP requires consideration of modifying factors. These are characteristics of noise received at receptor locations that could result in more annoyance than would normally occur from that level. The modifying factors are tonal noise, LFN, impulsive noise, intermittent noise and duration (if single event).

Years of environmental noise monitoring of open cut mining has shown that these factors are rarely if ever applicable. The only factor that has at times been considered as a possible issue is LFN.

Evaluation of LFN in this assessment is through comparison of total predicted C-weighted levels at receptor locations with an upper limit criterion as described above.

## 3.6 Cumulative Noise Assessment

### 3.6.1 Mining Noise Sources

Other mining and industrial noise sources in the general vicinity of LCO include:

- Bayswater Power Station (5 kilometres to the west of LCO);
- Liddell Power Station (3 kilometres to the northwest of LCO);
- Mount Owen Complex (3 kilometres to the east of LCO);
- Drayton Coal Mine (8 kilometres to the northwest of LCO);
- Ravensworth Surface Operations (7 kilometres to the south of LCO);
- Hunter Valley Operations (6 kilometres to the south west of LCO);
- Integra (15 kilometres to the south east of LCO); and
- Ashton (10 kilometres to the south east of LCO).

As specified in LCO's development consent, cumulative noise criteria apply to the noise generated by the development combined with the noise generated by other mines, therefore the noise impact of the local power stations need not be considered in the cumulative noise assessment.

Mount Owen Complex is comprised of three mines, Mount Owen, Glendell and Ravensworth East mines. Mining noise from Mount Owen Complex and Drayton Coal Mine has the potential to impact some of the receivers included in this assessment. However, these mines are considered to be geographically located at sufficient distance from LCO, and directionally different to the noise enhancing prevailing conditions modelled in this report, that cumulative noise is not considered to be likely.

Ravensworth Underground Mine, Hunter Valley Operations, Integra and Ashton are located at sufficient distance to the LCO that they are not expected to contribute to cumulative noise at the receptors.

Cumulative noise has not been considered further in this report.

## 3.7 Sleep Disturbance

Sleep disturbance has been considered by predicting levels from plant items known to generate noise levels that stand out above the general mining continuum. Excavator bucket noise and dozer track noise are recognised as sources which can generate high, short term noise levels that may cause sleep disturbance, although with experienced operators, these occurrences will be rare.

Excavator buckets impacting hard ground material, or rocks impacting the bottom of empty haul truck trays are often responsible for measured maximum off site noise emissions. A

maximum sound power of $L_{wA}$ 125 dB has been used in this assessment to determine sleep disturbance impacts from the excavator buckets.

Most dozers at LCO are fitted with track attenuation packages that significantly reduce track slap noise. To assess potential sleep disturbance impact from dozer track noise, each dozer in the model was allocated a sound power 5 dB higher than the sound power input for operational noise, as measurements have shown this to be, typically, the maximum operating noise level for this equipment.

All LCO owned haul trucks are partially or fully attenuated, and have been modelled at full power; therefore, there would generally be little difference between maximum and average sound power levels. On this basis, haul trucks were not included in the assessment of sleep disturbance.

Assessment of sleep disturbance for each model scenario involved modelling each of the excavators and dozers at the maximum sound power levels mentioned above. The result for each plant item was combined with results for the remainder of operational plant to obtain an estimate of possible short-term maximum noise emissions.

## 3.8 Blast Vibration and Overpressure

Blasting at LCO has been occurring since the early 1990s. Blasting is a controllable process. Rather than estimate future blast vibration and overpressure levels, it is relevant to review monitoring results of blasts to date for the following reasons:

- LCO have demonstrated a history of managing blasting at Liddell;
- LCO have an established blasting site law developed over many years of blasting, enabling accurate blast design and vibration and overpressure prediction; and
- Blasting associated with the proposed modification will not be significantly closer to residences than for current operations.

Comparison of measured blast results and criteria provide an indication of the likelihood of achieving ongoing compliance. Results are presented in Section 5.4.

LCO has developed and implemented procedures to govern all blasting activities. Blast design is undertaken prior to every blast to predict likely ground vibration and air blast overpressure levels through restriction of Maximum Instantaneous Charge (MIC) weights. LCO have an established blasting site law developed over many years of blasting. The application of this site law to blast design will not change for the proposed modification.

## 3.9 Low Frequency Noise

The Broner method is Global Acoustics' preferred method for assessing the low frequency impact of mining noise; it is expected this method will be adopted by the regulatory authorities in the near future. The current INP method involving the subtraction of total A-weighted levels from total C-weighted levels does indicate the possibility of a low frequency noise problem, however, it has two major failings. One is that it can be influenced by the presence (or absence) of other noise sources in the environment when measured at receivers for compliance. The major problem is though, that at increasing distances from mining noise sources, predicted A-weighted levels will decrease faster than predicted C-weighted levels, skewing the C minus A relationship such that a low frequency noise issue will be identified, when in fact absolute low frequency levels will be lower than nearer locations to the source that have not been identified as having a low frequency issue. This can be seen in the INP low frequency results presented in this assessment. The Broner method predicts that low frequency noise levels will decrease with increased distance from the mining noise source, which follows basic distance loss theory in noise prediction.

# 4 NOISE MODEL PARAMETERS

## 4.1 Meteorology

Under various wind and temperature gradient conditions, noise may be increased or decreased compared with still-isothermal conditions - that is, no wind or temperature gradient. Atmospheric conditions that most affect noise propagation are temperature and wind velocity gradients. They can both enhance or reduce noise propagation from source to receiver due to refraction of sound propagating through the atmosphere, brought about by a change in sound speed with height.

Noise levels are increased when the wind blows from source to receiver or under temperature inversion conditions (both of which are sometimes referred to as adverse weather conditions), and decreased when the wind blows from receiver to the source or under temperature lapse conditions.

One full year's meteorological data (2007) from the LCO weather station was initially analysed for this project. There were 52,510 15 minute records out of a possible 52,560 in the data set, representing 99.9 percent data capture. This meteorological data was inconsistent with other Hunter Valley meteorological data; therefore, this data set was disregarded. An analysis of this meteorological data showed that east-south-easterly to southerly winds were present for over 30% of summer nights, but that no other prevailing (present for greater than 30%) conditions occurred.

Data from a nearby Mount Owen meteorological station on Hebden Road was then analysed. There were 84,857 15 minute records out of a possible 87,456 between September 2008 to February 2011, representing 97 percent data capture. Analysis of this data revealed prevailing conditions typical of the Hunter Valley including east to south easterly winds in summer and autumn and west-north-west and north-westerly winds in winter.

On this basis, data from the Mount Owen meteorological station was used in lieu of the Liddell meteorological station data. This data set was used to calculate the frequency occurrence of meteorological conditions, which were used to determine the prevailing meteorological conditions for assessment, in accordance with INP guidelines.

### 4.1.1 Neutral Meteorological Conditions

All three scenarios were modelled under neutral meteorological conditions, as shown in Table 4.1. Modeling results under neutral meteorological conditions are presented in Section 5.1.1 of this report.

*Table 4.1 METEOROLOGICAL CONDITIONS INCLUDED IN ASSESSMENT AS NEUTRAL CONDITIONS*

| Temperature Deg C | Humidity % | Wind Speed m/s | Wind Direction | VTG Deg C/100m |
|---|---|---|---|---|
| 10 | 80 | 0 | - | -0.5 |

### 4.1.2 Prevailing Meteorological Conditions

Section 5 of the INP provides procedures for considering meteorological effects. The effects of gradient winds, drainage flow winds and temperature inversions need to be considered.

Wind effects need to be assessed when wind is considered to be a feature of the area. Wind is considered a feature of the area when source-to-receiver wind speeds (at 10m height) of 3 m/s or less occur for more than 30 percent of the time in any time period, in any season.

Temperature inversions need to be assessed when there is more than a 30 percent occurrence during winter nights (June, July, August). The time period used for this assessment is 18:00 to 07:00 as per INP guidelines. Default values are provided for temperature inversion and drainage flow wind speed for use when required. Alternatively, actual measured values may be used (INP, 2000).

The effects of temperature inversion enhancement are to be considered if the percentage occurrence of positive inversions is greater than 30 percent of winter night periods. In a letter to LCO dated 16 May 2012, the EPA requested that a value of 4 degrees/100m be used to assess stability class F for the night period, rather than the default INP value of 3 degrees/100m. The night period for determining temperature inversion frequency is from 1 hour before sunset until 1 hour after sunrise (6pm to 7am).

When assessing temperature inversion effects, calm wind conditions have been used in conjunction with vertical temperature gradients of 3 (default INP value for Stability Class F) and 4 (EPA requested value for Stability Class F) degrees/100m.

The INP defines drainage flow wind as the localised drainage of cold air under the influence of local topography and travels in one direction only (direction of decreasing altitude).

Inspection of the topography of the Hebden Valley reveals that cold air drainage would be expected to flow from the north to the south, or from the receptors to the source. As such drainage flow winds have not been included in this assessment.

A comprehensive assessment of meteorological data has been conducted in accordance with INP guidelines. Based on the analysis of meteorological data, the conditions listed in Table 4.2 are included in this assessment as prevailing meteorological conditions. A detailed description of the assessment is included in Appendix A.

*Table 4.2 METEOROLOGICAL CONDITIONS INCLUDED IN ASSESSMENT AS PREVAILING CONDITIONS*

| Temperature Deg C | Humidity % | Wind Speed m/s | Wind Direction Degrees | VTG Deg C/100m |
|---|---|---|---|---|
| 10 | 80 | 0 | 0 | 3 |
| 10 | 80 | 0 | 0 | 4 |
| 10 | 80 | 3 | 90 | -0.5 |
| 10 | 80 | 3 | 112.5 | -0.5 |
| 10 | 80 | 3 | 135 | -0.5 |
| 10 | 80 | 3 | 292.5 | -0.5 |
| 10 | 80 | 3 | 315 | -0.5 |

Modelling results for prevailing meteorological conditions are presented in Section 5.1.2 of this report.

## 4.2 Model Scenarios

Three scenarios were modelled representing worst case operating conditions for the proposed modification. All known major noise sources for LCO, including the open cut and CHPP plant and equipment, were included in all scenarios. All plant is modelled at maximum sound power, and assuming all plant operates continuously and simultaneously. In reality, this rarely occurs; as such, modelled results are considered conservative.

Table 4.3 lists representative typical plant quantities included in each model scenario.

*Table 4.3 OPEN CUT PLANT ITEMS INCLUDED IN MODELS*

| | Plant Quantities | | |
|---|---|---|---|
| **Description** | **Scenario 1 Year 4** | **Scenario 2 Year 2** | **Scenario 3 Year 5** |
| Hitachi EX8000 excavator | 1 | 1 | 1 |
| Liebherr R996 excavator | 2 | 2 | 2 |
| Liebherr 9400 excavator | 3 | 3 | 3 |
| Hitachi EH5000 trucks[1] | 16 | 16 | 16 |
| Caterpillar 789C trucks | 12 | 12 | 12 |
| Caterpillar D10T dozer | 9 | 9 | 9 |
| Caterpillar D11R dozer | 1 | 1 | 1 |
| Caterpillar 854K rubber tyre dozer | 1 | 1 | 1 |
| Caterpillar 16M grader | 2 | 2 | 2 |
| Caterpillar 16G grader | 1 | 1 | 1 |
| Caterpillar 24M grader | 1 | 1 | 1 |
| Caterpillar 775 service cart | 2 | 2 | 2 |
| Volvo service cart | 1 | 1 | 1 |
| Caterpillar 777 water truck | 4 | 4 | 4 |
| Bucyrus SKF drill | 3 | 3 | 3 |

*Note: 1. Although the LCO fleet has 18 Hitachi EH5000 trucks, maintenance scheduling results in only 16 being operational at any time.*

The currently approved CHPP infrastructure and associated mobile plant is scheduled to operate concurrently with the proposed modification and has been included in all operating scenarios. The conveyors associated with the transfer point to the south of the site are also included in all three operating scenarios.

Typical quantities of these noise sources are outlined in Table 4.4.

*Table 4.4 CHPP PLANT ITEMS, MOBILE EQUIPMENT AND OTHER CONVEYORS INCLUDED IN ALL THREE SCENARIOS*

| Description | Quantity |
|---|---|
| CHPP building | 1 |
| Raw coal conveyor | 1 |
| Raw coal conveyor drive | 1 |
| Product conveyor | 1 |
| Product conveyor drive | 1 |
| Reject conveyor | 1 |
| Reject conveyor drive | 1 |
| Caterpillar D11 dozer | 3 |
| Caterpillar 992 loader | 1 |
| Thickener pumps | 2 |
| ROM crusher | 1 |
| Mobile crusher (day models only) | 1 |
| Conveyors near new stockpile and transfer point | 2 |

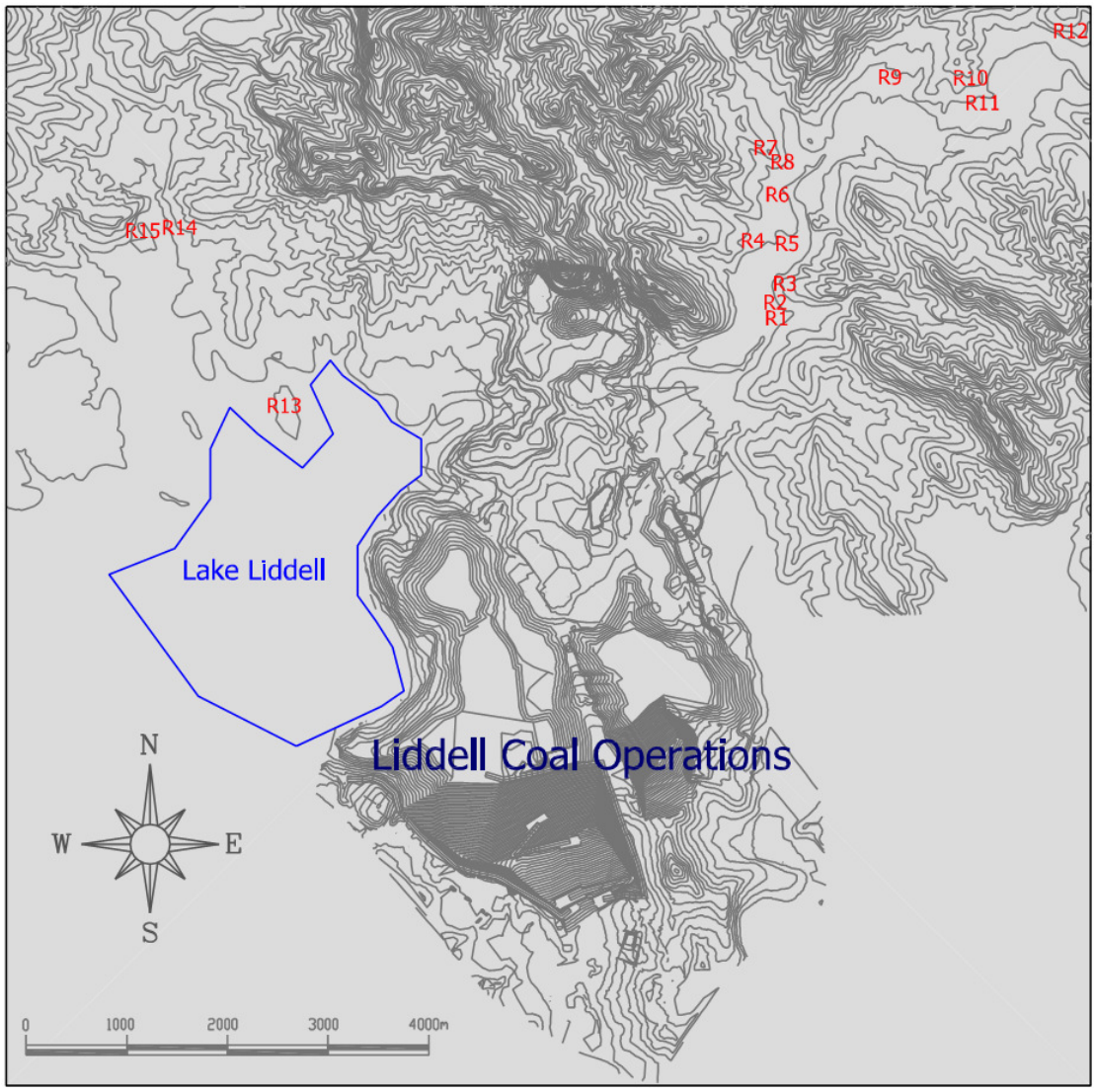
Details below show the mobile equipment modelled for each scenario.

**Environmental Modelling Scenarios for DA Modification 2014**

Assume three CHPP D11 dozers and the CAT 992 Loader are working full time at the CHPP
Assume two CAT 775 and one Volvo Service Carts are working 25% of the time

| Scenario | Haul Code | Date | Digger | Material | Location | Dump | Hitachi EH5000 trucks | CAT 789C trucks | D10 dozers on digger floor | D10 dump dozers | D11 dump dozers | RTD (DZ481) | 16M Graders | 16G Grader | 24M Grader | Water Cart | Drills |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | Feb-15 | EX101 | WASTE | STH/S19/01/WEA | STH/S16/RL190 | 6 | | 1 | | | 1 | | | 1 | 1 | 1 |
| | 2 | | EX112 | WASTE | STH/S18/01/LEMF | STH/S16/RL150 | 5 | | 1 | | 1 | | 1 | | | 1 | 1 |
| | 3 | | EX113 | WASTE | STH/S17/01/HEB | STH/S16/RL0 | 5 | | 1 | 1 | | | | 1 | | | 1 |
| | 4 | | EX134 | WASTE | STH/S18/01/LEMF | STH/S16/RL180 | | 3 | 1 | 1 | | | | | | 1 | |
| | 5 | | EX135 | COAL | STH/S18/01/LEMG | ROM | | 6 | 2 | 1 | | | 1 | | | 1 | |
| | 6 | | EX136 | WASTE | STH/S18/01/LEMF | STH/S16/RL180 | | 3 | | | | | | | | | |
| 2 | 7 | Nov-17 | EX101 | WASTE | ENT/E05/01/WEA | ENT/E05/RL190 | 5 | | 1 | | | 1 | | | 1 | 1 | 1 |
| | 8 | | EX112 | WASTE | STH/S20/01/LB1 | STH/S18/RL180 | 6 | | 1 | | 1 | | 1 | | | 1 | 1 |
| | 9 | | EX113 | WASTE | STH/S21/01/LEMB | STH/S18/RL180 | 5 | 1 | 1 | 1 | | | | 1 | | 1 | 1 |
| | 10 | | EX134 | WASTE | STH/S21/01/LEMB | STH/S18/RL180 | | 3 | 1 | 1 | | | | | | | |
| | 11 | | EX135 | COAL | STH/S20/01/LB2U | ROM | | 5 | 2 | 1 | | | 1 | | | 1 | |
| | 12 | | EX136 | WASTE | STH/S21/01/LEMB | STH/S18/RL180 | | 3 | | | | | | | | | |
| 3 | 13 | Jun-18 | EX101 | WASTE | ENT/E06/01/WEA | STH/S19/RL120 | 6 | | 1 | | | 1 | | | 1 | 1 | 1 |
| | 14 | | EX112 | WASTE | ENT/E05/01/LEMD | STH/S19/RL90 | 5 | | 1 | | 1 | | 1 | | | 1 | 1 |
| | 15 | | EX113 | WASTE | STH/S21/01/MPG | STH/S19/RL90 | 5 | | 1 | 1 | | | | 1 | | | 1 |
| | 16 | | EX134 | COAL | ENT/E05/01/LEMG | ROM | | 6 | 2 | 1 | | | 1 | | | 1 | |
| | 17 | | EX135 | WASTE | STH/S21/01/MPG | STH/S19/RL90 | | 3 | 1 | 1 | | | | | | 1 | |
| | 18 | | EX136 | WASTE | STH/S21/01/MPG | STH/S19/RL90 | | 3 | | | | | | | | | |

Figure 3 shows the contours and position of receivers used in all models. The receivers are indicated in red text, the general topography and mine contours are shown in dark grey, Lake Liddell is shown in blue and the position of LCO is shown in dark blue text.

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Noise and Vibration Analysis and Solutions

Figure 3 – Contours and Receptors

**Figure 3 Overview of contours and location of receptors**

Figure 4 shows the noise sources at the CHPP area, which were used in all models. Some source locations have been altered slightly for graphical purposes.

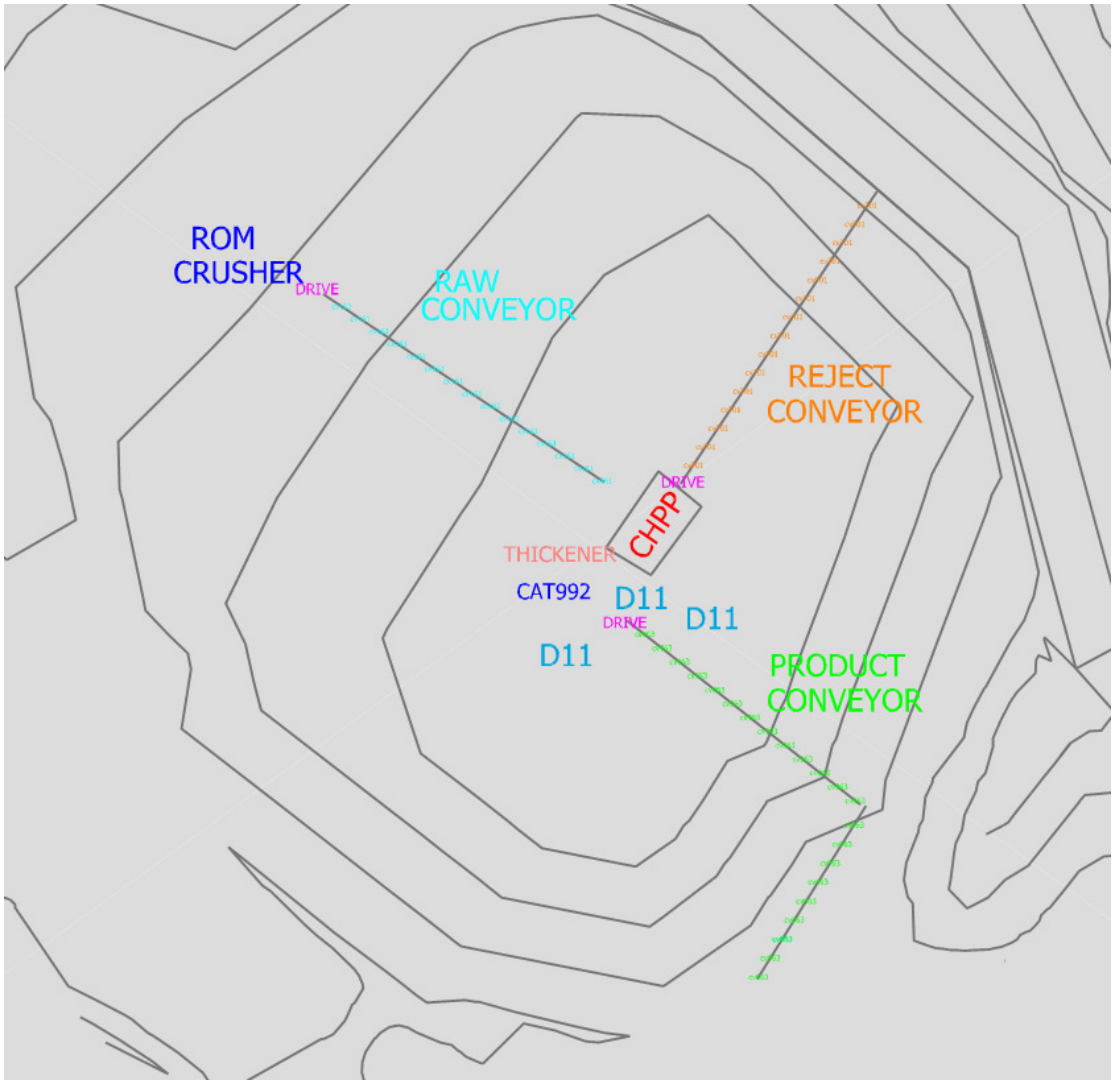


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Figure 4 – Coal Handling and Preparation Plant Area

**Figure 4 Coal Handling and Preparation Plant Area**

Figure 5 to Figure 7 show the three modelled operational scenarios. Receptors shown in Figure 3 and noise sources shown in Table 4.3 and Table 4.4 were included in the scenarios. Transfer conveyors in the south of the site are also included in all models.

Some source locations have been altered slightly for graphical purposes.

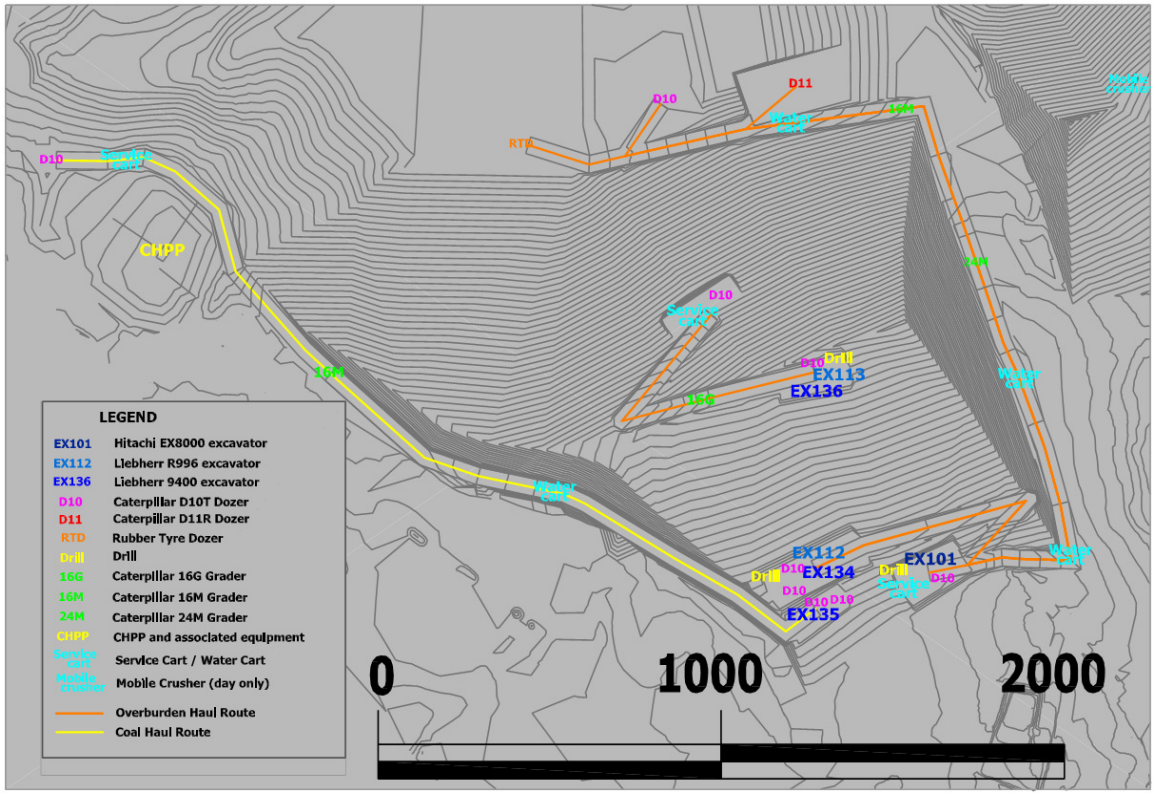


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Figure 5 – Scenario 1, February 2015

**Figure 5 Scenario 1, February 2015, noise sources**

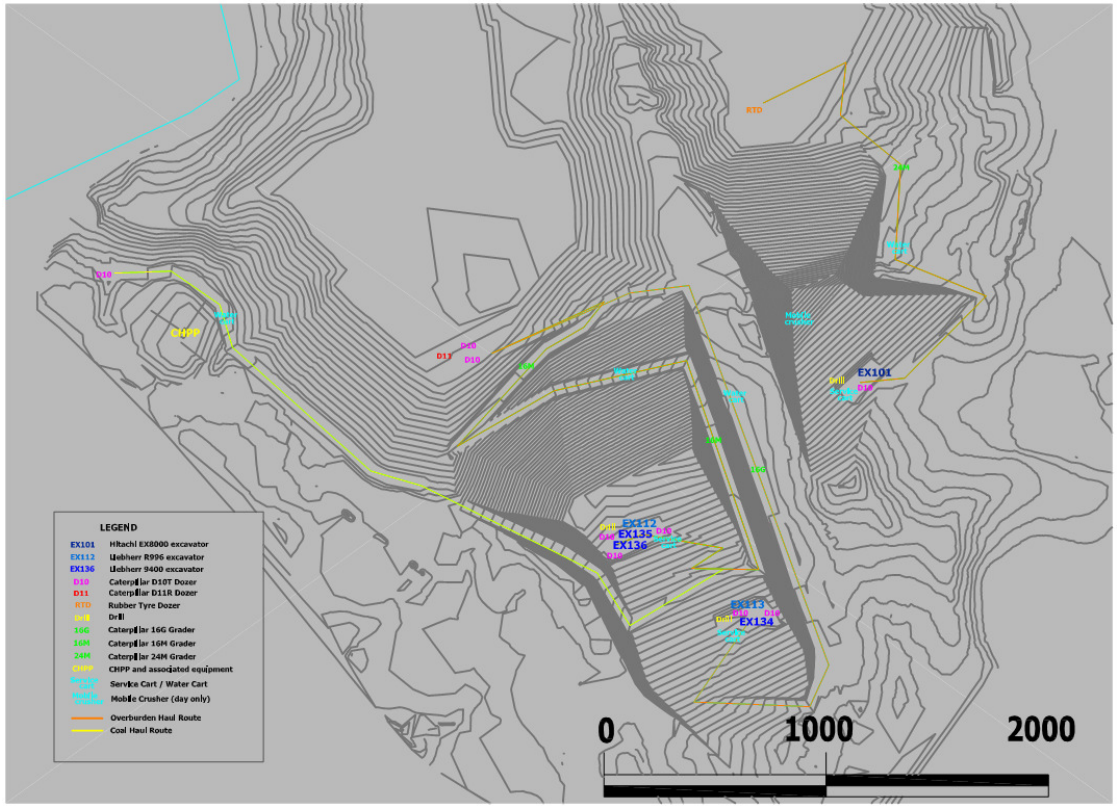


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Figure 6 – Scenario 2, November 2015

**Figure 6 Scenario 2, November 2017, noise sources**

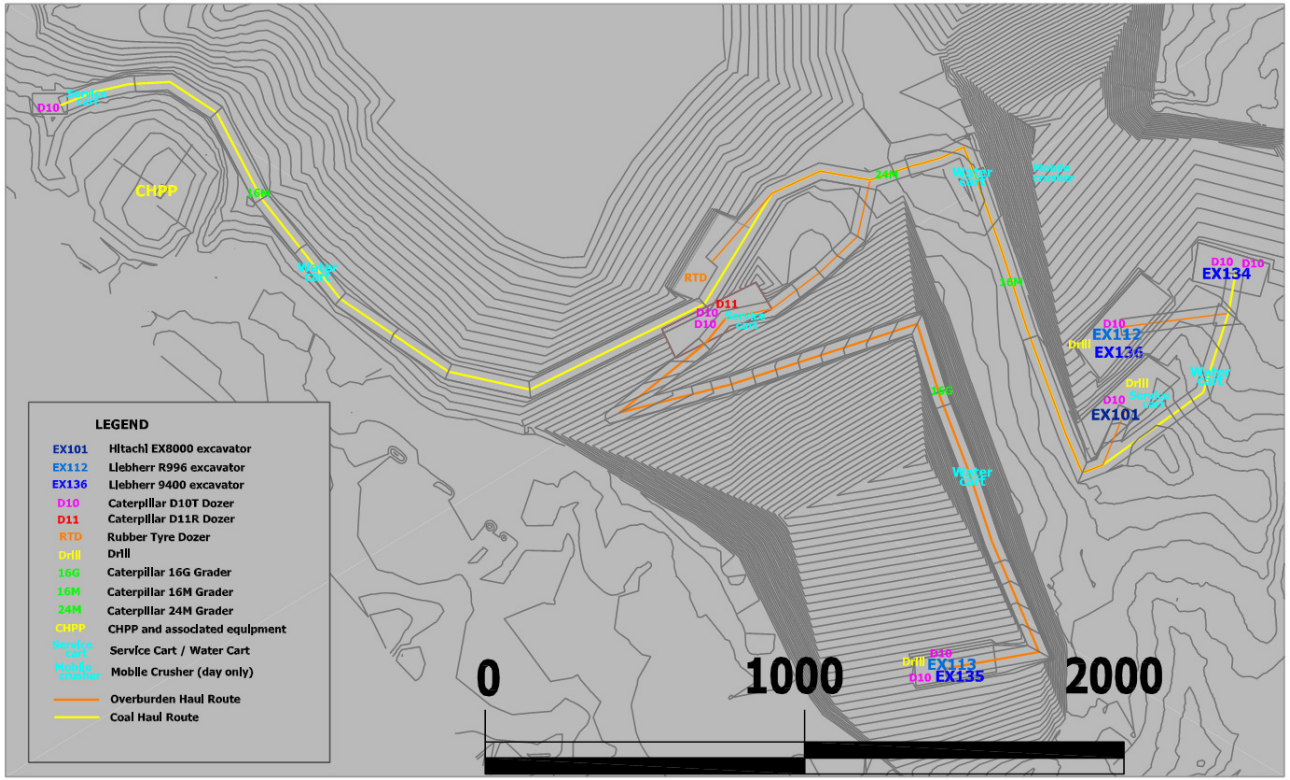


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Figure 7 – Scenario 3, June 2018

**Figure 7 Scenario 3, June 2018, noise sources**

## 4.3 Plant Sound Power

$L_{Aeq,15minute}$ sound power data was used for model inputs for all sources other than haul trucks, graders and water carts. For these items, the acoustic energy was averaged over the length of their operating route by creating a string of points to represent their path around the site. Details of this process are included below.

All acoustically significant noise sources on site have been included in the models. Global Acoustics undertake regular sound power testing of plant at LCO, therefore, sound powers used in modelling, provided in Table 4.5, were primarily based on measured in-service levels. Where test data was not available sound power levels for similar plant items in use in the Hunter Valley were adopted.

Sound power levels adopted for the CHPP, conveyors, thickeners and crusher were sourced from *Liddell Coal Operations, CHPP Sound Power Survey, November 2010* (Global Acoustics, 2010).

Haul truck, grader and watercart sound powers were incorporated into haul routes by creating haul route strings along the length of each haul route. This method distributes the acoustic energy of the vehicles along the length of each haul route.

Routes comprised a string of segments of fixed length, each segment having a sound power determined by the following:

- Sound power for type of trucks on route. Trucks travelling down ramps greater than 5% grade were allocated a reduced sound power;
- Number of each truck type on route in 15-minute period, based on loading unit load capacity;
- Speed of truck on segment grade toward dump/ROM; and
- Speed of truck on segment grade from dump/ROM.

Truck speeds are relative to grade in direction of travel and were allocated in accordance with truck speed data collected from mine sites in the Hunter Valley. Speed determined the duration required to traverse each segment, an important variable when calculating $L_{Aeq}$ for a specific time period.

Haul truck sound powers shown in Table 4.5 are uphill loaded, full power levels.

*Table 4.5 SOUND POWER DATA*

| | Octave Band Sound Power Spectrum, $L_{eq}$ dB | | | | | | | | Total Leq dB | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Description** | **63** | **125** | **250** | **500** | **1k** | **2k** | **4k** | **8k** | **Lin** | **A wt** |
| **Liddell Coal Operations Plant Sound Power** | | | | | | | | | | |
| Hitachi EX8000 excavator | 122 | 123 | 121 | 112 | 113 | 110 | 102 | 90 | 127 | 118 |
| Liebherr R996 excavator | 113 | 116 | 124 | 122 | 120 | 117 | 112 | 104 | 128 | 125 |
| Liebherr 9400 excavator | 112 | 119 | 118 | 117 | 113 | 110 | 105 | 98 | 124 | 119 |
| Hitachi EH5000 trucks | 123 | 118 | 114 | 111 | 110 | 108 | 105 | 104 | 125 | 116 |
| Caterpillar 789C trucks | 110 | 117 | 114 | 113 | 109 | 107 | 100 | 92 | 121 | 115 |
| Caterpillar D10T dozer | 116 | 121 | 111 | 109 | 109 | 104 | 96 | 89 | 123 | 113 |
| Caterpillar D11R dozer | 110 | 114 | 113 | 112 | 112 | 105 | 98 | 92 | 120 | 115 |
| Caterpillar 854K rubber tyre dozer | 106 | 113 | 109 | 106 | 106 | 102 | 95 | 89 | 117 | 110 |
| Caterpillar 16M grader | 99 | 108 | 109 | 106 | 106 | 102 | 95 | 89 | 114 | 110 |
| Caterpillar 16G grader | 102 | 112 | 105 | 102 | 102 | 101 | 96 | 88 | 114 | 107 |
| Caterpillar 24M grader | 108 | 110 | 109 | 104 | 101 | 98 | 90 | 83 | 115 | 107 |
| Caterpillar 775 service cart | 102 | 117 | 114 | 109 | 109 | 107 | 98 | 91 | 120 | 114 |
| Volvo service cart | 102 | 117 | 114 | 109 | 109 | 107 | 98 | 91 | 120 | 114 |
| Caterpillar 777F water truck | 116 | 117 | 116 | 113 | 112 | 111 | 106 | 98 | 123 | 118 |
| Bucyrus SKF drill | 106 | 115 | 111 | 109 | 107 | 105 | 98 | 94 | 118 | 112 |
| CHPP building – North facade | 115 | 110 | 112 | 112 | 108 | 105 | 100 | 93 | 123 | 113 |
| CHPP building – South facade | 115 | 112 | 113 | 112 | 109 | 106 | 101 | 95 | 125 | 114 |
| CHPP building – East facade | 114 | 112 | 113 | 112 | 111 | 108 | 103 | 96 | 124 | 115 |

*Table 4.5 SOUND POWER DATA*

| | Octave Band Sound Power Spectrum, $L_{eq}$ dB | | | | | | | | Total Leq dB | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Description** | **63** | **125** | **250** | **500** | **1k** | **2k** | **4k** | **8k** | **Lin** | **A wt** |
| CHPP building – West facade | 114 | 112 | 113 | 112 | 109 | 106 | 101 | 94 | 123 | 114 |
| Raw coal conveyor (per metre) | 84 | 85 | 79 | 81 | 76 | 68 | 53 | 44 | 89 | 91 |
| Raw coal conveyor drive | 95 | 97 | 95 | 93 | 93 | 90 | 83 | 77 | 102 | 97 |
| Product conveyor (per metre) | 89 | 92 | 88 | 87 | 83 | 78 | 71 | 63 | 96 | 88 |
| Product conveyor drive | 103 | 109 | 110 | 106 | 103 | 98 | 87 | 78 | 114 | 108 |
| Reject conveyor (per metre) | 80 | 78 | 77 | 80 | 76 | 69 | 61 | 51 | 86 | 80 |
| Reject conveyor drive | 96 | 93 | 93 | 95 | 94 | 91 | 85 | 78 | 102 | 98 |
| Caterpillar 992G loader | 106 | 110 | 109 | 109 | 106 | 103 | 96 | 91 | 116 | 111 |
| Mobile crusher (day models only) | 116 | 117 | 113 | 115 | 113 | 111 | 108 | 0 | 123 | 118 |
| Thickener pumps | 98 | 101 | 99 | 97 | 98 | 93 | 90 | 93 | 108 | 102 |
| ROM crusher | 116 | 114 | 111 | 109 | 105 | 101 | 94 | 86 | 120 | 111 |
| Conveyors near new stockpile and transfer point (per 100 metre) | 103 | 105 | 100 | 101 | 97 | 93 | 85 | 79 | 109 | 102 |

# 5 RESULTS

## 5.1 Operational Noise Results

The following sections present the results of the noise models for each scenario for neutral and enhancing meteorological conditions.

Where relevant, discussions of results for receptors have been grouped into the following exceedance categories:

- **Minor** – Predicted $L_{Aeq,15minute}$ level exceeds PSNC by 1 to 2 dB;
- **Moderate** – Predicted $L_{Aeq,15minute}$ level exceeds PSNC by 3 to 5 dB; and
- **Significant –** Predicted $L_{Aeq,15minute}$ level exceeds PSNC by more than 5 dB.

The model scenarios consider worst-case equipment configurations, with all plant modelled at maximum sound power, and all equipment assumed to operate simultaneously.

### 5.1.1 Neutral Meteorological Conditions

Table 5.1 presents the model results for each scenario for neutral meteorological conditions.

*Table 5.1 OPERATIONAL NOISE LEVELS $L_{Aeq,\ 15\ minute}$ dB – NEUTRAL CONDITIONS FOR PRIVATELY OWNED RESIDENCES*

| Receptor ID | Criteria D/E/N [1] | Predicted Results [3] | | | Predicted Exceedances | | |
|---|---|---|---|---|---|---|---|
| | | Scenario 1 2015 | Scenario 2 2017 | Scenario 3 2018 | Scenario 1 2015 | Scenario 2 2017 | Scenario 3 2018 |
| R01 | 35/35/35 | 20 | 23 | 20 | Nil | Nil | Nil |
| R02 | 35/35/35 | 19 | 23 | 19 | Nil | Nil | Nil |
| R03 | 35/35/35 | 19 | 24 | 19 | Nil | Nil | Nil |
| R04 | 35/35/35 | 17 | 22 | 18 | Nil | Nil | Nil |
| R05 | 35/35/35 | 18 | 22 | 19 | Nil | Nil | Nil |
| R06 | 35/35/35 | 16 | 21 | 17 | Nil | Nil | Nil |
| R07 | 35/35/35 | 15 | 20 | 17 | Nil | Nil | Nil |
| R08 | 35/35/35 | 16 | 20 | 17 | Nil | Nil | Nil |
| R09 | 35/35/35 | 16 | 19 | 15 | Nil | Nil | Nil |
| R10 | 35/35/35 | 15 | 16 | 15 | Nil | Nil | Nil |
| R11 | 35/35/35 | 14 | 15 | 13 | Nil | Nil | Nil |
| R12 | 35/35/35 | 13 | 14 | 12 | Nil | Nil | Nil |
| R14 | 35/35/35 | 17 | 19 | 16 | Nil | Nil | Nil |

*Note: 1. "D/E/N" denotes day/evening/night criteria; and*

*2. Bolded results denote predicted result exceeds relevant period criterion (if applicable).*

Model results for private residences under neutral meteorological conditions are less than the PSNC ($L_{Aeq,15\ minute}$ 35 dB) at all receptor locations for all three scenarios. As such, no impact under neutral conditions is predicted at these receivers.

*Table 5.2 OPERATIONAL NOISE LEVELS $L_{Aeq,\ 15\ minute}$ dB – NEUTRAL CONDITIONS FOR MACQUARIE GENERATION OWNED RESIDENCES*

| Receptor ID | Criteria D/E/N [1] | Predicted Results [3] | | | Predicted Exceedances | | |
|---|---|---|---|---|---|---|---|
| | | Scenario 1 2015 | Scenario 2 2017 | Scenario 3 2018 | Scenario 1 2015 | Scenario 2 2017 | Scenario 3 2018 |
| R13 | 35/35/35 | 21 | 22 | 20 | Nil | Nil | Nil |
| R15 | 35/35/35 | 17 | 18 | 17 | Nil | Nil | Nil |

*Note: 1. "D/E/N" denotes day/evening/night criteria; and*

*2. Bolded results denote predicted result exceeds relevant period criterion (if applicable).*

Model results for Macquarie Generation owned residences under neutral meteorological conditions are equal to or less than the PSNC ($L_{Aeq,15\ minute}$ 35 dB) at both receptor locations for all three scenarios.

### 5.1.2 Prevailing Method Results

Table 5.3 and Table 5.4 present the operational noise results for each operating scenario for prevailing meteorological conditions. Results presented are the highest predictions for each of the prevailing meteorological conditions considered for each receptor.

Model results for enhancing meteorological conditions at privately owned residences indicate:

- Noise levels are predicted to be within the PSNC at ten of the thirteen assessed receptors at all time periods for all scenarios; and
- Three receptors are predicted to experience minor exceedances of the PSNC in Scenario 3.

With regard to the two residences owned by Macquarie Generation:

- Receptor R13 (the Liddell Recreation Area) has minor to moderate exceedances of the PSNC predicted. Given that the Liddell Recreation Area is owned by Macquarie Coal Generation and is therefore not a privately owned residence, land acquisition criteria do not apply.
- No exceedances of the PSNC are predicted at Receptor R15.

These results are discussed further below.

#### 5.1.2.1 PRIVATELY OWNED RESIDENCES - SCENARIO 3

Minor exceedances of the PSNC are predicted at R03 and R04 during the day and night periods. A minor exceedance of the PSNC is predicted at R02 during the night period.

#### 5.1.2.2 MACQUARIE GENERATION RESIDENCES – SCENARIO 1

Moderate exceedances of the PSNC are predicted at R13 during the day, evening and night periods.

#### 5.1.2.3 MACQUARIE GENERATION RESIDENCES – SCENARIO 2

A minor exceedance of the PSNC is predicted at R13 during the evening period. Moderate exceedances of the PSNC are predicted at R13 during the day and night periods.

#### 5.1.2.4 MACQUARIE GENERATION RESIDENCES – SCENARIO 3

Moderate exceedances of the PSNC are predicted at R13 during the day, evening and night periods.

*Table 5.3 OPERATIONAL NOISE LEVELS $L_{Aeq, 15\ minute}$ dB – RESULTS FOR PREVAILING METEOROLOGICAL CONDITIONS FOR PRIVATELY OWNED RECEPTORS*

| Receptor ID | Criteria | Predicted Scenario 1-2015 Results | | | Predicted Scenario 2-2017 Results | | | Predicted Scenario 3-2018 Results | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Day/Evening/Night | Day | Evening | Night | Day | Evening | Night | Day | Evening | Night |
| R01 | 35/35/35 | 33 | 19 | 35 | 30 | 24 | 33 | 32 | 22 | 34 |
| R02 | 35/35/35 | 34 | 19 | 35 | 31 | 25 | 34 | 34 | 23 | **36** |
| R03 | 35/35/35 | 33 | 19 | 35 | 31 | 25 | 34 | **36** | 28 | **37** |
| R04 | 35/35/35 | 33 | 21 | 33 | 33 | 29 | 33 | **36** | 31 | **36** |
| R05 | 35/35/35 | 33 | 18 | 35 | 31 | 24 | 33 | 32 | 22 | 34 |
| R06 | 35/35/35 | 32 | 19 | 33 | 32 | 26 | 33 | 35 | 30 | 35 |
| R07 | 35/35/35 | 31 | 21 | 32 | 31 | 27 | 32 | 33 | 31 | 33 |
| R08 | 35/35/35 | 31 | 19 | 32 | 31 | 26 | 32 | 34 | 30 | 34 |
| R09 | 35/35/35 | 28 | 16 | 30 | 26 | 19 | 29 | 27 | 17 | 30 |
| R10 | 35/35/35 | 18 | 14 | 22 | 24 | 16 | 26 | 27 | 15 | 30 |
| R11 | 35/35/35 | 17 | 13 | 21 | 23 | 14 | 25 | 27 | 13 | 28 |
| R12 | 35/35/35 | 18 | 12 | 23 | 22 | 13 | 25 | 25 | 12 | 29 |
| R14 | 35/35/35 | 33 | 32 | 33 | 34 | 33 | 34 | 35 | 34 | 35 |

*Note: 1. Bolded results denote predicted result exceeds relevant period criterion.*

*Table 5.4 OPERATIONAL NOISE LEVELS $L_{Aeq,\ 15\ minute}$ dB – RESULTS FOR PREVAILING METEOROLOGICAL CONDITIONS FOR MACQUARIE GENERATION OWNED RECEPTORS*

| Receptor ID | Criteria | Predicted Scenario 1 Results | | | Predicted Scenario 2 Results | | | Predicted Scenario 3 Results | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Day/Evening/Night | Day | Evening | Night | Day | Evening | Night | Day | Evening | Night |
| R13 | 35/35/35 | **40** | **38** | **40** | **40** | **37** | **40** | **40** | **38** | **40** |
| R15 | 35/35/35 | 35 | 34 | 35 | 35 | 34 | 35 | 35 | 34 | 35 |

*Note: 1. Bolded results denote predicted result exceeds relevant period criterion.*

## 5.2 Sleep Disturbance Results

Table 5.5 presents the results of the sleep disturbance models. The maximum predicted result from the dozers and excavators included in the sleep disturbance models was added to the operational noise level for each scenario to produce these results for each receiver.

*Table 5.5 OPERATIONAL NOISE LEVELS $L_{A1,\,1\,minute}$ dB – SLEEP DISTURBANCE RESULTS FOR PRIVATELY OWNED RESIDENCES*

| Receptor ID | Scenario 1 2015 | Scenario 2 2017 | Scenario 3 2018 |
|---|---|---|---|
| R01 | 38 | 32 | 38 |
| R02 | 38 | 33 | 39 |
| R03 | 39 | 34 | 40 |
| R04 | 38 | 35 | 40 |
| R05 | 37 | 32 | 37 |
| R06 | 37 | 34 | 39 |
| R07 | 36 | 35 | 37 |
| R08 | 36 | 34 | 38 |
| R09 | 33 | 28 | 33 |
| R10 | 28 | 24 | 34 |
| R11 | 28 | 23 | 33 |
| R12 | 28 | 23 | 33 |
| R14 | 37 | 38 | 38 |

*Table 5.6 OPERATIONAL NOISE LEVELS $L_{A1,\,1\,minute}$ dB – SLEEP DISTURBANCE RESULTS FOR MACQUARIE GENERATION OWNED RESIDENCES*

| Receptor ID | Scenario 1 2015 | Scenario 2 2017 | Scenario 3 2018 |
|---|---|---|---|
| R13 | 43 | 42 | 43 |
| R15 | 38 | 38 | 38 |

Results of the sleep disturbance models are less than the $L_{A1,\,1\,minute}$ criterion of 45 dB at all receptor locations. As such, there is no sleep disturbance impact predicted.

## 5.3 Low Frequency Noise Assessment Results

### 5.3.1 Preferred Broner Method

Table 5.7 presents LFN results for operational noise. Results are the maximum results from each of the modelled scenarios using prevailing meteorological conditions, and considering all time periods.

*Table 5.7 OPERATIONAL LOW FREQUENCY NOISE RESULTS FOR PRIVATELY OWNED RESIDENCES $L_{Ceq,\ 15\ minute}$ dB*

| Receptor ID | LFN Criterion | Scenario 1 2015 | Scenario 2 2017 | Scenario 3 2018 |
|---|---|---|---|---|
| R01 | 60 | 49 | 46 | 48 |
| R02 | 60 | 50 | 47 | 50 |
| R03 | 60 | 50 | 48 | 50 |
| R04 | 60 | 49 | 48 | 50 |
| R05 | 60 | 49 | 47 | 48 |
| R06 | 60 | 48 | 47 | 49 |
| R07 | 60 | 48 | 47 | 48 |
| R08 | 60 | 48 | 47 | 49 |
| R09 | 60 | 45 | 44 | 45 |
| R10 | 60 | 40 | 42 | 45 |
| R11 | 60 | 38 | 41 | 45 |
| R12 | 60 | 41 | 43 | 45 |
| R14 | 60 | 50 | 50 | 50 |

*Table 5.8 OPERATIONAL LOW FREQUENCY NOISE RESULTS FOR MACQUARIE GENERATION OWNED RESIDENCES $L_{Ceq,\ 15\ minute}$ dB*

| Receptor ID | LFN Criterion | Scenario 1 2015 | Scenario 2 2017 | Scenario 3 2018 |
|---|---|---|---|---|
| R13 | 60 | 54 | 54 | 53 |
| R15 | 60 | 51 | 51 | 50 |

All predicted results are within the Broner criterion (as set out above in Section 2.8).

### 5.3.2 INP Low Frequency Method

Table 5.9 and Table 5.10 present the results of the low frequency noise assessment using the INP LFN method for each scenario. Results shown are the maximum $L_{Ceq,15\ minute}$ result minus the maximum $L_{Aeq,15\ minute}$ model result (C minus A) using prevailing meteorological conditions, and considering all time periods.

Scenario 1 results show that all receptors except R01, R05 and R13 have a C minus A result greater than or equal to 15 dB.

Scenario 2 results show that receptors R07 to R14, and R15 have a C minus A result greater than or equal to 15 dB.

Scenario 3 results show that receptors R07 to R14, and R15 have a C minus A result greater than or equal to 15 dB.

As discussed in Section 3.9, Global Acoustics' opinion is the INP LFN method falsely identifies potential LFN impact. Results in Table 5.9 and Table 5.10 show that increasing C minus A differentials typically correspond to decreasing absolute predictions. Generally, the receptors with the lowest C minus A differential are actually predicted to receive the highest C weighted levels. In all cases, total C-weighted levels are well below the lowest desirable LFN limit nominated by Broner for the night period of $L_{Ceq,\ 15\ minute}$ 60 dB. On this basis, operational LFN is not considered likely to cause impact under any of the scenarios assessed; LFN modifying factor penalties have not been applied.

*Table 5.9 OPERATIONAL LOW FREQUENCY NOISE RESULTS FOR PRIVATELY OWNED RESIDENCES INP METHOD – dB*

| Receptor ID | LFN Criterion | Scenario 1 | | | Scenario 2 | | | Scenario 3 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | C-weighted Total | A-weighted Total | C - A | C-weighted Total | A-weighted Total | C - A | C-weighted Total | A-weighted Total | C - A |
| R01 | 60 | 49 | 35 | 14 | 46 | 33 | 13 | 48 | 34 | 14 |
| R02 | 60 | 50 | 35 | **15** | 47 | 34 | 13 | 50 | 36 | 14 |
| R03 | 60 | 50 | 35 | **15** | 48 | 34 | 14 | 50 | 37 | 13 |
| R04 | 60 | 49 | 33 | **16** | 48 | 33 | 15 | 50 | 36 | 14 |
| R05 | 60 | 49 | 35 | 14 | 47 | 33 | 14 | 48 | 34 | 14 |
| R06 | 60 | 48 | 33 | **15** | 47 | 33 | 14 | 49 | 35 | 14 |
| R07 | 60 | 48 | 32 | **16** | 47 | 32 | **15** | 48 | 33 | **15** |
| R08 | 60 | 48 | 32 | **16** | 47 | 32 | **15** | 49 | 34 | **15** |
| R09 | 60 | 45 | 30 | **15** | 44 | 29 | **15** | 45 | 30 | **15** |
| R10 | 60 | 40 | 22 | **18** | 42 | 26 | **16** | 45 | 30 | **15** |
| R11 | 60 | 38 | 21 | **17** | 41 | 25 | **16** | 45 | 28 | **17** |
| R12 | 60 | 41 | 23 | **18** | 43 | 25 | **18** | 45 | 29 | **16** |
| R14 | 60 | 50 | 33 | **17** | 50 | 34 | **16** | 50 | 35 | **15** |

*Note: 1. Bolded results denote predicted result exceeds the INP method low frequency criterion.*

*Table 5.10 OPERATIONAL LOW FREQUENCY NOISE RESULTS FOR MACQUARIE GENERATION OWNED RESIDENCES INP METHOD – dB*

| Receptor ID | LFN Criterion | Scenario 1 | | | Scenario 2 | | | Scenario 3 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | C-weighted Total | A-weighted Total | C - A | C-weighted Total | A-weighted Total | C - A | C-weighted Total | A-weighted Total | C - A |
| R13 | 60 | 54 | 40 | 14 | 54 | 40 | 14 | 53 | 40 | 13 |
| R15 | 60 | 51 | 35 | **16** | 51 | 35 | **16** | 50 | 35 | **15** |

*Note: 1. Bolded results denote predicted result exceeds the INP method low frequency criterion.*

## 5.4 Blast Vibration and Overpressure

LCO has provided monitoring results for 537 overburden and coal blasts over the period October 2008 to December 2012 inclusive. A summary of blast monitoring results is presented in Table 5.11.

Potential impacts and management measures relating to Chain of Ponds for blast and vibration is discussed in detail in the Historic Heritage Assessment of the proposed modification by OzArk Environmental & Heritage Management P/L.

As indicated in Section 2.7, private residences have two criteria for vibration and overpressure. The lower criterion may be exceeded for 5% of blasts in a 12-month period. The higher criterion is the upper limit, and should not be exceeded.

*Table 5.11 BLAST MONITORING SUMMARY – BURLING AND SCRIVENS LOCATIONS*

| Year | Total Number of Blasts | Vibration mm/sec | | | Overpressure dB | | |
|---|---|---|---|---|---|---|---|
| | | Criteria [1] | Number of Exceedances [2] | Percentage of Total [3] | Criteria [1] | Number of Exceedances [2] | Percentage of Total [3] |
| 2008 | 29 | 5/10 | 0/0 | 0% | 115/120 | 1/0 | 3.4% |
| 2009 | 133 | 5/10 | 0/0 | 0% | 115/120 | 4/1 | 3% |
| 2010 | 119 | 5/10 | 0/0 | 0% | 115/120 | 4/2 | 3.4% |
| 2011 | 106 | 5/10 | 0/0 | 0% | 115/120 | 2/1[4] | 1.9% |
| 2012 | 150 | 5/10 | 0/0 | 0% | 115/120 | 0/0 | 0% |

*Note:* 1. *Lower criterion may be exceeded up to 5% of blasts in 12-month period. Higher criterion is upper limit;*

2. *Exceedance of lower criterion/exceedance of higher criterion;*

3. *Percentage of total blasts lower criterion was exceeded in the calendar year of data; and*

4. *This result was wind affected.*

The above results show that neither the upper nor the lower vibration criteria have been exceeded in the last five years.

The lower overpressure criterion has not been exceeded more than the allowable 5% in a 12-month period during the last five years. The upper limit criterion has been exceeded four times in the last five years, with the trend declining due to improved blasting techniques and knowledge of strata. Continued management of blasting activities should see this trend continue.

# 6 ONGOING NOISE MANAGEMENT

LCO intends to meet the current consent conditions outlined in Project Approval 305-11-01 through implementation of the following management strategies.

- A continued program of regular sound power screening testing that will assist in managing sound power levels, and identify plant items requiring maintenance to noise attenuation packages, including new attenuation technologies as methods develop with time;

- A continued program of attended monitoring as outlined in the *Liddell Colliery Noise Monitoring Program* (Liddell Coal Operations, 2013) will assist in demonstrating compliance with approved noise criteria;

- The use of a real time noise monitoring system in proximity to the nearest receptors to provide alerts if mining noise levels are close to the criterion. Alerts will prompt adaptive management techniques to allow mining operations to be altered as necessary for noise levels to remain within PSNC. Audio files may allow the source of the potential exceedance to be identified. Techniques to address potential exceedances may include, but are not limited to:

  - The review of digging and dumping activities likely to have resulted in a noise exceedance, taking into consideration wind direction and height / proximity to the continuous noise monitor;

  - The relocation of equipment closest to receivers to lower risk areas;

  - The temporary reduction in height of operations;

  - The shutting down of mining equipment, as deemed necessary to meet criteria;

- Continued management of blast vibration and overpressure through blast design utilising the established blast site law and monitoring of real time meteorological data;

- Continued monitoring of blast vibration and overpressure in accordance with the *Liddell Coal Operations Meteorological Assessment, Blast Monitoring and Reporting Procedure;* and

- If hire equipment is to be used at the LCO it will be required to meet the linear total sound power levels listed in Table 4.5. An environmental noise assessment will be undertaken by a suitably qualified acoustic consultant prior to operating hire equipment on site.

# 7 DISCUSSION OF ASSESSMENT RESULTS

It should be noted that the results shown in this report are modeled results and that historical attended monitoring results show that exceedances of the nature predicted do not typically occur.

Additionally, LCO mining operations will in general move further to the south, increasing distances to receptors, which would be expected to reduce noise levels over time.

The proposed use of real time monitoring systems will allow potential exceedances to be identified promptly and mining operations to be altered as necessary.

A change in noise level of 2 dB is generally not detectable by the human ear for steady state noise sources, with a change of 3 dB considered to be just detectable. Minor exceedances are predicted for one scenario for receptors R02, R03 and R04. The maximum exceedance predicted is 2 dB at R03, with only 1 dB exceedance predicted for the other receptors. The largest difference between the highest and next highest result predicted for these receptors is 3 dB for R04. Given this is a gradual change over time it is highly unlikely any resident would be able to perceive the difference between the compliant and non-compliant levels. If these predicted results were to eventuate, the residual impact as calculated is insignificant.

It is considered that no additional noise control measures (above those outlined in the previous section) are warranted to manage potential noise impacts from LCO.

# 8 SUMMARY

## 8.1 Operational Noise

Model results for neutral atmospheric conditions were significantly less than the PSNC at all receptor locations for all three scenarios. As such, no impact under neutral atmospheric conditions is predicted.

Model results for enhancing meteorological conditions at privately owned residences indicate:

- Noise levels are predicted to be within the PSNC at ten of the thirteen assessed receptor at all times for all scenarios; and
- Three receptors are predicted to experience minor exceedances of the PSNC in Scenario 3.

With regard to the two residences owned by Macquarie Generation:

- Receiver R13 (the Liddell Recreation Area) has minor to moderate exceedances of the PSNC predicted. Given that the Liddell Recreation Area is owned by Macquarie Coal Generation and is therefore not a privately owned residence, land acquisition criteria do not apply.
- No exceedances of the PSNC are predicted at Receptor R15.

## 8.2 Sleep Disturbance

There are no predicted exceedances of the sleep disturbance criterion for any of the three proposed scenarios of the LCO modification.

## 8.3 Road Noise

No road traffic noise impacts are predicted due to the proposed LCO modification.

## 8.4 Rail Noise

No rail noise impacts are predicted due to the proposed LCO modification.

## 8.5 Construction Noise

No construction noise impacts are predicted due to the proposed LCO modification.

## 8.6 Cumulative Noise

No cumulative noise impacts are predicted due to the proposed LCO modification.

## 8.7 Blasting

Continued management of blasting activities at LCO should see continued compliance with vibration and overpressure criteria.

## 8.8 Low Frequency Noise

There are no predicted exceedances of the Broner (2010) desirable low frequency noise criterion due to the proposed LCO modification.

**Global Acoustics Pty Ltd**

# 9 REFERENCES


Australian and New Zealand Environment Conservation Council (ANZECC), 1990. *Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration*.

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NSW Environment Protection Authority, 2000. *NSW Industrial Noise Policy.* Sydney: NSW Environment Protection Authority.

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APPENDIX

# A. ANALYSIS OF METEOROLOGICAL DATA

## A.1 METEOROLOGY

Noise levels were calculated using ENM, an environmental noise model, to determine the acoustic impact of mining at nominated noise sensitive receptor locations. The model takes into account geometric spreading, atmospheric absorption, and, barrier and ground attenuation.

Under various wind and temperature gradient conditions, noise may be increased or decreased compared with still-isothermal conditions - that is, no wind or temperature gradient. Atmospheric conditions that most affect noise propagation are temperature and wind velocity gradients. They can both enhance or reduce noise propagation from source to receiver due to refraction of sound propagating through the atmosphere, brought about by a change in sound speed with height.

Noise levels are increased when the wind blows from source to receiver or under temperature inversion conditions (both of which are sometimes referred to as adverse weather conditions), and decreased when the wind blows from receiver to the source or under temperature lapse conditions.

Prevailing meteorological conditions were derived in accordance with the EPA *Wind Enhancement Analysis Program* (NEWA) and *Procedures to estimate the frequency of wind conditions that enhance noise levels* (DECCW, 2009). The procedure recommends that when calculating the percentage occurrence of wind directions from source to receiver, the percentage can be restricted to a range of wind directions around the primary source to receiver direction, which is usually taken to be +/- 45 degrees either side. Prevailing meteorological conditions for this assessment were determined in accordance with the latest EPA procedure recommendations.

Meteorological data from the Liddell weather station was analysed to determine prevailing meteorological conditions. There were 52,510 15 minute records out of a possible 52,560 in the met data set, representing 99.9 percent data capture. One full year's data (2007) was analysed but no conditions occurred more than 30% of the time.

Data from a nearby Mount Owen meteorological station on Hebden Road was then analysed and prevailing conditions were determined. There were 84857 15 minute records out of a possible 87456 between September 2008 to February 2011, representing 97% per cent data capture. An analysis of this data revealed prevailing conditions typical of the Hunter Valley.

### A.1.1 Prevailing Meteorological Conditions

Section 5 of the INP provides procedures for considering meteorological effects. The effects of gradient winds, drainage flow winds and temperature inversions need to be considered.

Wind effects need to be assessed when wind is considered to be a feature of the area. Wind is considered a feature of the area when source-to-receiver wind speeds (at 10m height) of 3 m/s or less occur for more than 30 percent of the time in any time period, in any season.

Temperature inversions need to be assessed when there is more than a 30 percent occurrence during winter (June, July, August) nights. The time period used for this assessment is 6pm to 7am. Default values are provided for temperature inversion and drainage flow wind speed for use when required. Alternatively, actual measured values may be used.

### A.1.2 Gradient Wind

The INP states that when the occurrence of wind up to 3 m/s (source-to-receptor component) is greater than 30 percent, wind should be included as a model parameter for any given receptor. The INP proposes a wind speed of 3 m/s be used as a default wind speed, however, in the case where the occurrence of wind up to 3 m/s (source-to-receptor component) is greater than 30 percent; use the highest wind speed (below 3 m/s) instead of the default.

When the occurrence of wind up to 3 m/s (source-to-receptor component) is less than 30 percent, wind need not be included as a model parameter.

A detailed analysis of meteorological data from the Mount Owen weather station on Hebden Road has been undertaken to determine prevailing gradient wind conditions to include as model parameters. The analysis included the following steps:

- All wind speed data greater than 5 m/s was discarded, as higher wind speeds cause extraneous noise and, tend to drown out industrial noise;
- All wind speed data less than 0.5 m/s was discarded, as these conditions are considered calm, or neutral;
- Remaining data was sorted into data sets representing each time period (day, evening and night), and each season;
- For each time period, and for each season, the percentage occurrence of the vector component of each of the sixteen standard compass directions was determined for wind speed ranges of 0.5 to 3 m/s and 0.5 to 2.25 m/s. Vector components with a resulting direction component more than 45 degrees from each compass direction were excluded.

The results of this analysis are included in Table B.1. Bolded results exceed 30 percent.

*Table B.1 Percentage occurrence of wind direction with vector component 0.5 to 3.0 m/s*

| Wind Direction | Summer | Autumn | Winter | Spring |
|---|---|---|---|---|
| **Night Period** | | | | |
| 0 | 8% | 9% | 15% | 13% |
| 22.5 | 10% | 8% | 5% | 9% |
| 45 | 16% | 12% | 6% | 13% |
| 67.5 | 29% | 20% | 10% | 22% |
| 90 | **35%** | 28% | 13% | 28% |
| 112.5 | **36%** | **31%** | 13% | **30%** |
| 135.0 | **33%** | 28% | 12% | 27% |
| 157.5 | 24% | 23% | 10% | 22% |
| 180.0 | 14% | 15% | 8% | 14% |
| 202.5 | 9% | 11% | 9% | 11% |
| 225.0 | 7% | 10% | 10% | 10% |
| 247.5 | 7% | 10% | 16% | 11% |
| 270.0 | 7% | 12% | 28% | 14% |
| 292.5 | 9% | 15% | **36%** | 18% |
| 315.0 | 8% | 12% | **33%** | 17% |
| 337.5 | 7% | 10% | 28% | 15% |
| **Evening Period** | | | | |
| 0 | 7% | 7% | 15% | 11% |
| 22.5 | 8% | 9% | 8% | 9% |
| 45 | 14% | 17% | 10% | 13% |
| 67.5 | 21% | 28% | 15% | 23% |
| 90 | 22% | **35%** | 17% | 29% |
| 112.5 | 20% | **33%** | 18% | 28% |
| 135.0 | 19% | 28% | 16% | 26% |
| 157.5 | 14% | 22% | 14% | 20% |
| 180.0 | 9% | 12% | 11% | 12% |
| 202.5 | 7% | 8% | 10% | 9% |
| 225.0 | 6% | 6% | 10% | 9% |
| 247.5 | 6% | 5% | 13% | 9% |
| 270.0 | 7% | 7% | 22% | 10% |
| 292.5 | 8% | 8% | 26% | 14% |
| 315.0 | 6% | 7% | 24% | 13% |
| 337.5 | 6% | 7% | 22% | 11% |

*Table B.1 Percentage occurrence of wind direction with vector component 0.5 to 3.0 m/s*

| Wind Direction | Summer | Autumn | Winter | Spring |
|---|---|---|---|---|
| | | **Day Period** | | |
| 0 | 2% | 3% | 6% | 3% |
| 22.5 | 7% | 6% | 4% | 5% |
| 45 | 15% | 12% | 6% | 12% |
| 67.5 | 22% | 23% | 11% | 19% |
| 90 | 28% | **30%** | 16% | 24% |
| 112.5 | **30%** | **33%** | 20% | 25% |
| 135.0 | 26% | **31%** | 20% | 24% |
| 157.5 | 21% | 25% | 19% | 21% |
| 180.0 | 14% | 17% | 15% | 15% |
| 202.5 | 10% | 13% | 14% | 13% |
| 225.0 | 7% | 10% | 15% | 11% |
| 247.5 | 6% | 9% | 19% | 10% |
| 270.0 | 4% | 8% | 22% | 11% |
| 292.5 | 3% | 7% | 20% | 9% |
| 315.0 | 2% | 5% | 16% | 7% |
| 337.5 | 1% | 4% | 11% | 5% |

*Notes: 1. Vector component percentages are for the range +/- 45 degrees from each standard wind direction.*

**Night period**

East to south easterly winds are considered prevailing during summer. East-south-easterly winds are prevailing during autumn. North-westerly and west-north-westerly winds are considered prevailing in winter. A wind speed of 3 m/s has been adopted for these wind directions.

**Evening period**

East to south easterly winds are considered prevailing during autumn. A wind speed of 3 m/s has been adopted for these wind directions.

**Day period**

East to South easterly wind is considered prevailing during autumn. A wind speed of 3 m/s has been adopted for this wind direction.

### *A.1.3 Drainage Flow Wind*

The INP defines drainage flow wind as the localised drainage of cold air under the influence of local topography and travels in one direction only (direction of decreasing altitude).

Inspection of the topography of the Hebden Valley reveals that cold air drainage would be expected to flow from the north to the south, or from the receptors to the source.

As such drainage flow winds have not been included in this assessment.

### *A.1.4 Vertical Temperature Gradient*

The effects of temperature inversion enhancement are to be considered if the percentage occurrence of positive inversions is greater than 30 percent of winter night periods. In a letter to LCO dated 16 May 2012, the EPA requested that a value of 4 degrees/100m be used to assess stability class F for the night period, rather than the default INP value of 3 degrees/100m. The night period for determining temperature inversion frequency is from 1 hour before sunset until 1 hour after sunrise (6pm to 7am).

When assessing temperature inversion effects, calm wind conditions have been used in conjunction with vertical temperature gradients of 3 (default INP value for Stability Class F) and 4 (EPA requested value for Stability Class F) degrees/100m.

### A.1.5 Summary of Prevailing Meteorological Conditions

Based on the analysis of meteorological data described above, the conditions listed in Table C.2 are included in this assessment as prevailing meteorological conditions.

*Table C.2 Meteorological conditions included in assessment as prevailing conditions*

| Temperature $^{O}$C | Humidity % | Wind Speed m/s | Wind Direction | VTG $^{O}$/100m |
|---|---|---|---|---|
| **Night Period** | | | | |
| 10 | 80 | 0 | - | 3 |
| 10 | 80 | 0 | - | 4 |
| 10 | 80 | 3 | 90 | -0.5 |
| 10 | 80 | 3 | 112.5 | -0.5 |
| 10 | 80 | 3 | 135 | -0.5 |
| 10 | 80 | 3 | 292.5 | -0.5 |
| 10 | 80 | 3 | 315 | -0.5 |
| **Evening Period** | | | | |
| 10 | 80 | 3 | 90 | -0.5 |
| 10 | 80 | 3 | 112.5 | -0.5 |
| **Day Period** | | | | |
| 10 | 80 | 3 | 90 | -0.5 |
| 10 | 80 | 3 | 112.5 | -0.5 |
| 10 | 80 | 3 | 135 | -0.5 |
| **Neutral Conditions** | | | | |
| 10 | 80 | 0 | - | -0.5 |