Environmental noise, ground vibration and air blast overpressure impact assessment

Gundagai Quarry, May 2010

Report No. 421057-01

Vipac Engineers & Scientists Ltd
PO Box 506
Kings Meadows TAS 7249
May 2010
# Noise, ground vibration and air blast overpressure impact assessment

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## GUNDAGAI QUARRY

**ENVIRONMENTAL NOISE, GROUND VIBRATION AND BLAST OVERPRESSURE IMPACT ASSESSMENT**  
**MAY 2010**

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**Report No.**  
421057 - 01

**Prepared for**  
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**Date:**  
10 August 2010

**Approved by**

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1 Introduction

Vipac was commissioned by Trawmana Environmental Consultants (TEC) to conduct an impact assessment of environmental noise; ground vibration; and air blast overpressure emissions from operations at Gundagai Quarry, north-west of Lilydale in the north-east of Tasmania. This impact assessment is part of a Development Proposal and Environmental Management Plan (DPEMP) for the expansion of the quarry’s operations.

Under TEC’s “Request for Quote” the following information was requested:-

- Noise modelling to determine the 30, 35, 40 and 45 dBA noise contours.
- Prediction to determine the 110, 115 and 120 dB (Linear Peak) air blast overpressure contours.
- Prediction to determine the 2.5, 5, 7.5 and 10 mm/s peak particle velocity contours.

Data is presented from a single establishment blast with air blast overpressure (ABO) and peak particle velocity (PPV) measured at a residence on Rawnsleys Rd. ABO was also measured at a second location close to a group of residences on the north-eastern side of the quarry. Prediction of PPV and ABO was conducted using scaled regression equations developed by the Office of Surface Mining Reclamation and Enforcement[1] (OSM), a bureau of the United States Department of the Interior.

Full acoustic modelling of the quarry’s operations, using SoundPLAN[2] acoustic modelling software, was carried out to provide the noise contour information requested by TEC.

This report presents the results of the environmental noise modelling and measurement and prediction of ABO and PPV carried out by Vipac. An assessment of the impact of these environmental emissions is also presented with recommendations for mitigation where appropriate.

2 Site description

Gundagai Quarry is located at Tunnel, approximately 7 km north-west of the township of Lilydale in north-eastern Tasmania. The quarry is on a north-west to south-east trending ridgeline of Ordovician to Devonian rock above river valleys of Quaternary alluvium.

The residence on Rawnsleys Rd at which ground vibration and blast overpressure measurements were conducted is approximately 460 m to the east of the quarry (530 m from the measured establishment blast). The topography between the quarry and this residence is relatively level and lightly wooded. A group of three residences also exist near the corner of Rawnsleys Rd and Gundagai Rd. These residences are approximately 550 m from the quarry (630 m from the measured establishment blast). Line of site to the quarry lip is blocked by the local topography.

Figure 1 shows and aerial view of the quarry and its surrounds with the location of residences marked.
3 Ground vibration and air blast overpressure

3.1 Measurement
Ground vibration (PPV) and ABO measurements were conducted during an establishment blast at Gundagai Quarry on 22 March 2010 at 1310 hrs (see table 1 for details). All measured data is assessed against Australian and New Zealand Environment Council (ANZEC) guidelines on the minimisation of annoyance due to blast overpressure and ground vibration[3]. The blast details are presented in Table 1.

<table>
<thead>
<tr>
<th>Blast details</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of holes</td>
<td>130</td>
</tr>
<tr>
<td>Hole depth</td>
<td>7.9 m</td>
</tr>
<tr>
<td>Burdon</td>
<td>2.5 m</td>
</tr>
<tr>
<td>Spacing</td>
<td>3.0 m</td>
</tr>
<tr>
<td>Stemming</td>
<td>2.5 m</td>
</tr>
<tr>
<td>Charge length</td>
<td>5.9 m</td>
</tr>
<tr>
<td>ANFO / hole</td>
<td>N/A</td>
</tr>
<tr>
<td>Emulsion / hole</td>
<td>46 kg (0.78 kg/m³)</td>
</tr>
</tbody>
</table>

Table 1 – Establishment blast details.

Two measurement locations were selected and the following data recorded at each as follows:-

- **Location A – Residence B**: A small concrete pad was cast and levelled at a location adjacent to the residence. An Instantel Minimate Plus ground vibration and ABO meter was used to monitor the blast at this location.
- **Location B – Cnr Rawnsleys Rd & Gundagai Rd**: An integrating sound level meter (Larson Davis 870B) was used to monitor the linear peak ABO from the blast at this location.

Figure 2 and 3 show measurement locations A and B respectively. Table 2 presents the measured PPV and linear peak ABO levels along with the recommended limits under the ANZEC guidelines[1]. The measured data is also presented on an aerial view of the quarry and its surrounds in figure 4.
Figure 2 – Measurement location A.

Figure 3 – Measurement location B.
Ground vibration and air blast overpressure

<table>
<thead>
<tr>
<th>Location</th>
<th>Ground vibration</th>
<th>Air blast overpressure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vector sum peak particle velocity (mm/s)</td>
<td>Maximum wave peak particle velocity (mm/s)</td>
</tr>
<tr>
<td>Location A</td>
<td>1.95</td>
<td>1.94 (Longitudinal)</td>
</tr>
<tr>
<td>Location B</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*Level must not be exceeded for 95% of blasts over a 12 month period. 10 mm/s must never be exceeded.

**Level must not be exceeded for 95% of blasts over a 12 month period. 120 dB must never be exceeded.

\[ \text{Longitudinal – line between quarry and residence.}\]

Table 2 – Ground vibration and ABO data.

From the above Vipac notes the following:-

- All measured data is below the recommended limits under the ANZEC guidelines.
- The linear peak ABO measured at location A was within 0.2 dB of the recommended limit under the ANZEC guidelines.
- Under the ANZEC guidelines a PPV of 2 mm/s is recommended as a long term regulatory goal for the control of ground vibration. The measured peak particle velocity level at location A was below 2 mm/s.
3.2 Prediction

Ground vibration and ABO prediction is typically conducted using site specific scaled regression equations developed from monitored data from multiple blasts at multiple locations. Such data is not available for Gundagai Quarry. The only monitored data for the site is from the establishment blast monitored by Vipac on 22 March 2010. Given this Vipac has sourced regression equations developed by OSM from their extensive data sets.

Table 3 presents the details of the establishment blast measured on 22 March 2010 and future face blasts at Gundagai Quarry. The latter was obtained following discussions with the blast contractor. For the purposes of prediction the details of the establishment blast measured by Vipac will be considered typical of future establishment blasts.

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Measured establishment blast</th>
<th>Future face blast</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of holes</td>
<td>130</td>
<td>-</td>
</tr>
<tr>
<td>Hole depth</td>
<td>7.9 m</td>
<td>10.5 m</td>
</tr>
<tr>
<td>Burdon</td>
<td>2.5 m</td>
<td>3.0 m</td>
</tr>
<tr>
<td>Spacing</td>
<td>3.0 m</td>
<td>3.0 m</td>
</tr>
<tr>
<td>Stemming</td>
<td>2.5 m</td>
<td>3.0 m</td>
</tr>
<tr>
<td>Charge length</td>
<td>5.9 m</td>
<td>-</td>
</tr>
<tr>
<td>ANFO / hole (delay)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Emulsion / hole (delay)</td>
<td>46 kg (0.78 kg/m$^3$)</td>
<td>57 kg (0.65 kg/m$^3$)</td>
</tr>
<tr>
<td>Distance to Location A</td>
<td>530 m</td>
<td>-</td>
</tr>
<tr>
<td>Distance to Location B</td>
<td>630 m</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 3 – Details of the measured establishment blast and proposed future face blasts.

3.2.1 Ground vibration prediction

Prediction of ground vibration was conducted using the following regression equation from OSM with a square root scaled distance:

$$PPV = k \left( \frac{\sqrt{m}}{D} \right)^a$$

PPV = peak particle velocity (in/s)

k = constant

m = charge mass / delay (lb)

D = distance to receiver (ft)

a = exponent

The constant (k) and exponent (a) were developed by OSM from quarry production blast data. A constant of 52 is given as the average for quarry production blasts with 138 an upper bound. The exponent for quarry production blasts is given as 1.38. The equation above and the constants and exponent are for imperial data and as such all relevant data from Gundagai Quarry was first converted to metric and are presented in tables below.

Table 4 presents predicted PPV levels for an establishment blast and face blast at location A (residence B) under average and upper bound OSM constants for quarry production blasts.

<table>
<thead>
<tr>
<th>Location</th>
<th>OSM constant (quarry production blasts)</th>
<th>Predicted PPV (mm/s)</th>
<th>Measured PPV (mm/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establishment Blast</td>
<td>Upper bound 138</td>
<td>2.87</td>
<td>1.94</td>
</tr>
<tr>
<td></td>
<td>Average 52</td>
<td>1.08</td>
<td></td>
</tr>
<tr>
<td>Face Blast</td>
<td>Upper bound 138</td>
<td>3.32</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Average 52</td>
<td>1.25</td>
<td></td>
</tr>
</tbody>
</table>

Table 4 – Predicted and measured PPV levels at location A.
The upper bound constant of 138 given by OSM for quarry production blasts provides a conservative estimate of PPV at location A (residence B). Prediction of critical PPV contours was conducted using the 138 constant. Table 5 presents the predicted distances to critical PPV levels for an establishment blast and a face blast and figures 5 and 6 present these distances graphically as contours.

### Distances (m) to critical PPV levels

<table>
<thead>
<tr>
<th>PPV (mm/s)</th>
<th>Establishment blast</th>
<th>Face blast</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5</td>
<td>585</td>
<td>651</td>
</tr>
<tr>
<td>5</td>
<td>354</td>
<td>394</td>
</tr>
<tr>
<td>7.5</td>
<td>264</td>
<td>294</td>
</tr>
<tr>
<td>10</td>
<td>214</td>
<td>239</td>
</tr>
</tbody>
</table>

Table 5 – Predicted distances to critical PPV levels.

Figure 5 – Predicted critical PPV contours for an establishment blast (base map supplied by TEC).
Noise, ground vibration and air blast overpressure impact assessment

Figure 6 – Predicted critical PPV contours for a face blast (base map supplied by TEC).

From the above Vipac notes the following:-
- PPV levels predicted levels give a conservative estimate of ground vibrations levels generated by blasting at Gundagai quarry.
- Predicted PPV contours suggest that blasting operations at Gundagai Quarry are highly unlikely to generate PPV levels at or above the ANZEC recommended maximum of 5 mm/s at any residence near the quarry. The highest predicted PPV level at the nearest residence (residence B) was 3.3 mm/s for a face blast.

3.2.2 Air blast overpressure prediction

Air blast overpressure prediction was conducted using the following regression equation from OSM with a cube root scaled distance:-

\[
\text{PSI} = k \left(\frac{t}{m} \right)^{\frac{a}{D}}
\]

PSI = pounds per square inch
k = constant
m = charge mass / delay (lb)
D = distance to receiver (ft)
a = exponent

Subsequent predictions of PSI are converted to dBL via the following equation:-

\[
\text{dBL} = 20 \log_{10} \left( \frac{\text{PSI}}{2.9 \times 10^{-5}} \right)
\]

These equations are for imperial data and all relevant data from Gundagai Quarry was converted to imperial format prior to predictions being made.
Cube root scaled distances based on data from the measured establishment blast to location A and B (locations where ABO was measured) were plotted on OSM’s Airblast Plotter of comparison with OSM data (see figure 7). The Airblast Plotter presents the scaled distance in relation to pressure (PSI) and decibels (dB). The scaled distances from the establishment blast at Gundagai Quarry show reasonable correlation with highwall blasting in coal mines. This is also considered by OSM to be typical of quarry blasting.

Figure 7 – Cube root scaled distances for the Gundagai Quarry establishment blast plotted on the OSM Airblast Plotter.

Table 6 presents predicted and measured ABO levels at locations A and B for an establishment blast and face blast. Predicted levels are calculated from the equations presented above with the OSM constant (k=0.162) and exponent (a=0.794) for highwall blasting.

<table>
<thead>
<tr>
<th>Location</th>
<th>Blast type</th>
<th>Predicted overpressure</th>
<th>Measured overpressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (Residence B)</td>
<td>Establishment</td>
<td>114.1</td>
<td>114.8</td>
</tr>
<tr>
<td></td>
<td>Face</td>
<td>114.6</td>
<td>-</td>
</tr>
<tr>
<td>B (Cnr Rawnsley Rd and Gundagai Rd)</td>
<td>Establishment</td>
<td>112.9</td>
<td>108.8</td>
</tr>
<tr>
<td></td>
<td>Face</td>
<td>113.4</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 6 – Predicted and measured ABO at locations A and B.
Table 7 presents the predicted distances to critical dBL levels for an establishment blast and a face blast at Gundagai Quarry. Figures 8 and 9 present these distances graphically in the form of contours.

<table>
<thead>
<tr>
<th>Distances (m) to critical dBL levels</th>
<th>Establishment blast</th>
<th>Face blasts</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABO (dBL)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>110</td>
<td>960</td>
<td>1036</td>
</tr>
<tr>
<td>115</td>
<td>463</td>
<td>500</td>
</tr>
<tr>
<td>120</td>
<td>226</td>
<td>241</td>
</tr>
</tbody>
</table>

Table 7 – Predicted distances to critical ABO levels.

Figure 8 – Predicted critical ABO contours for an establishment blast (base map supplied by TEC).
From the above Vipac notes the following:-

- The OSM cube root scaled regression used to predict ABO slightly under predicts the level at location A measured during an establishment blast on 22 March 2010. The level at location B is over predicted by 4 dB and is likely to be due to topographic shielding from a low rise between the quarry and location B resulting in a lower measured than predicted level.
- The increased charge mass proposed for a face blasts results in a predicted ABO 0.5 dB greater than was predicted for an establishment blast. In turn the distance to critical ABO levels is also greater.

3.3 Recommendations

- Predicted ground vibration levels are below the critical 5 mm/s ANZEC recommended limit by ≥ 1.7 mm/s at residences surrounding Gundagai Quarry. Given this and the conservative nature of the predictions Vipac has no recommendations for mitigation of ground vibration. However, Vipac recommends that all future blasts are monitored for PPV at multiple locations, including location A, surrounding the quarry. This would provide further verification that predicted PPV levels are suitably conservative and also data for the development of a site specific square root scaled regression equation for more accurate prediction of PPV. Additionally, Vipac recommends that should the charge mass/delay used for blasting at the quarry be increased in the future that prediction of the resulting PPV levels surrounding the quarry be undertaken.
The measured ABO level at the nearest residence (residence B) was within 0.2 dB of the ANZEC recommended limit of 115 dBL. Given this and the slight under prediction of ABO to the same location Vipac recommends the following mitigation measures:-

- Vipac recommends that the charge mass/delay used at the quarry be capped at the amount used for an establishment blast, i.e. 46 kg, and not be increased to 57 kg for face blasts. A reduction in charge mass below 46 kg doesn’t provide a significant reduction in ABO levels without a considerable decrease in charge mass, so much so that blasting would become ineffective. This is exemplified by the insensitive nature of the cube root scaling employed in the prediction of ABO to changes in charge mass.

- Stemming height for both establishment and face blasts should be a minimum of 3 m, while the burden employed for face blasts should also be a minimum of 3 m.

- All future blasts should be monitored for ABO at residence B to determine that the above measures are controlling ABO emissions to levels below 115 dBL. Should future monitoring demonstrate that ABO levels are significantly below 115 dBL then an increase in charge mass/delay could be considered following predictive studies. ABO should also be monitored at other locations surrounding the quarry. The measurement of ABO at multiple locations would provide data for the development of a site specific cube root scaled regression equation for more accurate prediction of ABO in the future.

- Should emissions exceed 115 dBL then further mitigation measures such as deck loading the front row of holes for face blasts and backfill covering of the blast area for both establishment and face blasts may need to be explored.

- Blasting should be avoided when atmospheric inversions are present and when the prevailing wind direction is from the west. These atmospheric conditions have the potential to increase ABO levels at residences surrounding the quarry.

4 Environmental noise

A noise emission limit has not been set for the Gundagai Quarry at present. A noise emission limit specified by the EPA for daytime activity when measured at any noise sensitive premises in other ownership is likely to be as follows under the *Tasmanian Quarry Code of Practice*:\[4\]:-

- 10 dBA above normal daytime ambient noise levels.
  (0700 to 1800 hrs weekdays)
  (0800 to 1600 hrs Saturdays).

On two occasions Vipac logged 10-minute noise statistics at the closest residence to the quarry (residence B). The lowest ambient noise level (L_{Aeq,10min}) measured in the absence of noise emissions from the quarry was 36 dBA. This results in a potential limit of 46 dBA under the *Tasmanian Quarry Code of Practice*. All noise emission predictions in this report are based on L_{Aeq,10min} levels and will be assessed against a potential emission limit of 46 dBA at any noise sensitive premises.

4.1 Environmental noise model

SoundPLAN[@\textsuperscript{2}] software was used for carrying out detailed noise emission spectra and contour modelling of the quarry operations. This program allows the use of the CONCAWE[@\textsuperscript{5}] calculation method for modelling atmospheric attenuation of noise. Parameters influencing sound propagation and attenuation include:

- Source type (point, line, plane).
- Relative source and receiver height.
- Topography and barriers.
- Industrial buildings as sources and/or barriers.
- Ground absorption.
- Distance attenuation.
- Atmospheric conditions including pasquil stability, temperature, humidity and vector wind speed.
- Reflecting surfaces.
- Source directivity.
As all propagation and attenuation parameters are frequency dependent, all input source data has been based on 1/3-octave band sound power spectra.

Geodata for the area surrounding the quarry was obtained from TASMAP 1:25000 “Lilydale 5043”. This provided contours at 10-metre intervals; residential locations; road layouts; and river and stream courses for the area.

Spatial maps of the quarry’s projected development were provided by Trawmana Environmental Consultants and were used as a guide in the construction of digital ground models.

All source data is referenced to the Map Grid of Australia (MGA) reference coordinate system.

### 4.2 Model input data

Sound power spectra for the equipment used during the quarry’s operations were calculated from measurements taken during site testing conducted on 18 & 30 March 2010. Where measurement of equipment was not possible Vipac library data was utilised. The overall sound power level for each source is summarised in table 8 below.

<table>
<thead>
<tr>
<th>Source Type</th>
<th>Source Type</th>
<th>PWLₐ</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drill Rig (Roc F7 Atlas Copco) - engine noise</td>
<td>Point</td>
<td>111.8</td>
<td>Measured data</td>
</tr>
<tr>
<td>&quot; - drilling</td>
<td>Point</td>
<td>124.1</td>
<td>&quot;</td>
</tr>
<tr>
<td>&quot; - rattling drill rods</td>
<td>Point</td>
<td>109.6</td>
<td>&quot;</td>
</tr>
<tr>
<td>Crusher (Gara-Pagos BR 380 JG)</td>
<td>Point</td>
<td>117.2</td>
<td>&quot;</td>
</tr>
<tr>
<td>Impactor</td>
<td>Point</td>
<td>109.8</td>
<td>&quot;</td>
</tr>
<tr>
<td>Impactor screen</td>
<td>Point</td>
<td>115.3</td>
<td>&quot;</td>
</tr>
<tr>
<td>Sizing screen</td>
<td>Point</td>
<td>109.0</td>
<td>&quot;</td>
</tr>
<tr>
<td>Generator - enclosure</td>
<td>Point</td>
<td>99.6</td>
<td>&quot;</td>
</tr>
<tr>
<td>&quot; - exhaust</td>
<td>Point</td>
<td>106.1</td>
<td>&quot;</td>
</tr>
<tr>
<td>Excavator (Komatsu PC300-5)</td>
<td>Point</td>
<td>103.2</td>
<td>Vipac library data</td>
</tr>
<tr>
<td>Front End Loader (Komatsu WA300)</td>
<td>Point</td>
<td>108.0</td>
<td>Measured data</td>
</tr>
<tr>
<td>Road truck</td>
<td>Line</td>
<td>90.6</td>
<td>Vipac library data</td>
</tr>
</tbody>
</table>

Table 8 – Sound power levels for quarry equipment.

All sound power data has been scaled to represent the typical operation of each piece of equipment within a 10-minute period.

### 4.3 Modelled operating scenario

Scenarios were modelled based on projected quarry development and mapping of the current quarry topography. Three operational modes were modelled to represent the following:-
- drilling for blast preparation (Sources: drill rig)
- crushing and screening of material (Sources: excavator; crusher; impactor; impactor screen; sizing screen; and generator)
- loading screened material for transport (Sources: front end loader and road truck).

The quarry development stages modelled for each operational scenario are as follows:-

#### Stage 1 - Current depth (at measured locations on 18 & 30 March 2010)
- drilling;
- crushing and screening;
- truck loading.

#### Stage 2 - Expansion of current depth (expansion of 230 m a.s.l area)
- drilling (on upper bench western end);
- crushing and screening.
Stage 3 - Projected Year 2 to 4
- drilling;
- crushing and screening.

Stage 4 - Projected Year 3 to 11
- drilling;
- crushing and screening

Stage 5 - Projected Year 4 to 20
- crushing and screening.

For each development stage, all noise sources were modelled at the western end of the quarry, as these represented worst-case positions for propagation of noise to the residential receiver locations.

4.4 Modelled weather
Both neutral and worst-case weather conditions were modelled for each scenario.

Situations where the atmospheric conditions are considered to be neutral occur with a Pasquil stability class D and no wind. These conditions can typically occur in the hour before and after sunrise and sunset; as well as during calm, cloudy conditions.

Worst case weather propagation considers all receiver points to be downwind of all sources with a Pasquil stability class F and a vector wind speed of 2 m/s. Under these conditions the highest predicted noise levels are generated.

4.5 Wire frame model
To aid in the visualization of the modelled scenarios, a series of plan view and wire frame images are presented in figures 10 to 19 below. The height (m a.s.l) at the maximum depth of the quarry is also noted on the plan view for each stage of development. These heights may not correspond to heights presented elsewhere in the DPEMP as they are only relative to the 10-metre contour geodata used in the model.

4.5.1 Stage 1 – Current depth

Figure 10 – Plan view of quarry at current depth.
4.5.2 Stage 2 – Expansion of current depth

Figure 11 – Wire frame view of quarry at current depth, view to north-east.

Figure 12 - Plan view of quarry following expansion of current depth.
4.5.3 Stage 3 – Year 2 to 4

Figure 13 – Wire frame view of quarry following expansion of current depth, view to north-east.

Figure 14 – Plan view of quarry at projected 2 to 4 year depth.
4.5.4 Stage 4 – Year 3 to 11

Figure 15 – Wire frame view of quarry at projected 2 to 4 year depth, view to north-east.

Figure 16 – Plan view of quarry at projected 3 to 11 year depth.

Figure 17 – Wire frame view of quarry at projected 3 to 11 year depth, view to north-east.
4.5.5 Stage 5 – Year 4 to 20

Figure 18 – Plan view of quarry at projected 4 to 20 year depth.

Figure 19 – Wire frame view of quarry at projected 4 to 20 year depth, view to north-east.

4.6 Noise sensitive receivers

Four receiver locations were selected for modelling as follows:-

- **Model calibration**
  - Quarry Lip (eastern lip of the quarry).
  - Gundagai Rd.
- **Noise sensitive locations**
  - Residence B.
  - Cnr of Rawnsleys Rd and Gundagai Rd.

Figure 20 shows the receiver locations in relation to Gundagai Quarry.
4.7 Model calibration
A series of measurements were taken at receiver locations to the east of the quarry during testing on 18 & 30 March 2010 to verify the predicted noise emission levels from the model.

At receiver positions 1 and 2 (see figure 20 above), where noise emissions from the quarry were dominant, short duration $L_{Aeq}$ measurements were taken.

At receiver position 3 (see figure 20 above) a logging sound level meter (Larson Davis 870B) was used to record 10-minute Ln statistics during current quarry operations. Local noise sources were a dominant feature of immissions at receiver 3. Given this, and the fact that noise sources within the quarry largely operated on a constant basis, measured $L_{A_{90,10min}}$ levels are presented for comparison at this location.

Table 9 presents measured and predicted noise levels at receivers 1, 2 and 3 for the calibration runs of the existing operations (Stage 1 – current depth).
Noise, ground vibration and air blast overpressure impact assessment

Calibration measurements

<table>
<thead>
<tr>
<th>Current depth</th>
<th>Calibration receivers (neutral weather)</th>
<th>Noise sensitive receivers (neutral and worst case weather)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Receiver 1</td>
<td>Receiver 2</td>
</tr>
<tr>
<td></td>
<td>Measured  $(L_{Aeq})$</td>
<td>Predicted  $(L_{Aeq,10min})$</td>
</tr>
<tr>
<td>Drilling</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Crushing &amp; screening</td>
<td>73.5</td>
<td>74.4</td>
</tr>
</tbody>
</table>

Table 9 – Measured and predicted noise levels at calibration receivers (1 & 2) and receiver 3.

The predicted noise levels at receivers 1 and 2 are within 1 dBA of the measured levels under neutral atmospheric conditions. At receiver 3 under neutral weather conditions predicted levels are 2 to 3 dBA lower than measured $L_{A90,10min}$ levels while worst case weather predicted noise levels are 2 dBA greater. These results demonstrate a good correlation between measured and predicted levels and therefore no offset in predicted levels has been applied.

4.8 Summary of environmental noise modelling results
4.8.1 Predicted noise contours
Using the environmental noise model, a series of noise contour maps have been generated as follows:

**Stage 1 – Current depth**
- Drilling at measured location with worst-case weather.
- Crushing & screening at measured location with worst-case weather.
- Truck loading at measured location with worst-case weather.

**Stage 2 – Expansion of current depth**
- Drilling on upper bench at western end of quarry with worst-case weather.
- Crushing & screening at western end of quarry with worst-case weather.

**Stage 3 – Year 2 to 4**
- Drilling at western end of quarry with worst-case weather.
- Crushing & screening at western end of quarry with worst-case weather.

**Stage 4 – Year 3 to 11**
- Drilling at western end of quarry with worst-case weather.
- Crushing & screening at western end of quarry with worst-case weather.

**Stage 5 – Year 4 to 20**
- Crushing & screening at western end of quarry with worst-case weather.
Stage 1 – Current depth

Figure 21 – Drilling at measured location with worst-case weather

Figure 22 – Crushing & screening at measured location with worst-case weather.
Noise, ground vibration and air blast overpressure impact assessment

Figure 23 – Truck loading at measured location with worst-case weather.

Stage 2 – Expansion of current depth

Figure 24 – Drilling on bench at western end of quarry with worst-case weather.
Figure 25 – Crushing & screening at western end of quarry with worst-case weather.

Stage 3 – Year 2 to 4

Figure 26 – Drilling at western end of quarry with worst-case weather.
Figure 27 – Crushing & screening at western end of quarry with worst-case weather.

Stage 4 – Year 3 to 11

Figure 28 – Drilling at western end of quarry with worst case weather.
Figure 29 – Crushing & screening at western end of quarry with worst case weather.

Stage 5 – Year 4 to 20

Figure 30 – Crushing & screening at western end of quarry with worst case weather.
## 4.8.2 Received levels

Predicted received levels at the four receiver location under worst case weather for each of the modelled scenarios are presented in table 4 below.

<table>
<thead>
<tr>
<th>Model scenario</th>
<th>Model calibration receivers</th>
<th>Noise sensitive receivers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stage 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Current depth</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(measured location)</td>
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</tr>
<tr>
<td></td>
<td>drilling</td>
<td>77.6</td>
</tr>
<tr>
<td></td>
<td>crushing &amp; screening</td>
<td>75.7</td>
</tr>
<tr>
<td></td>
<td>truck loading</td>
<td>64.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stage 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Expansion of current depth</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>drilling</td>
<td>75.4</td>
</tr>
<tr>
<td></td>
<td>crushing &amp; screening</td>
<td>72.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stage 3</td>
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<td></td>
<td>Year 2 to 4</td>
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</tr>
<tr>
<td></td>
<td>(projected depth)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>drilling</td>
<td>75.0</td>
</tr>
<tr>
<td></td>
<td>crushing &amp; screening</td>
<td>71.5</td>
</tr>
<tr>
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</tr>
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<td>Stage 4</td>
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<td>Year 3 to 11</td>
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</tr>
<tr>
<td></td>
<td>(projected depth)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>drilling</td>
<td>73.5</td>
</tr>
<tr>
<td></td>
<td>crushing &amp; screening</td>
<td>70.2</td>
</tr>
<tr>
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<td></td>
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</tr>
<tr>
<td></td>
<td>Stage 5</td>
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</tr>
<tr>
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<td>Year 4 to 20</td>
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<td></td>
<td>(projected depth)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>crushing &amp; screening</td>
<td>70.0</td>
</tr>
</tbody>
</table>

Received level greater than 46 dBA at noise sensitive receiver.

Table 10 – Received levels for all modelled scenario under worst-case weather conditions.

From the above Vipac notes the following:-

- Predicted noise levels at the noise sensitive receivers are well below the potential noise emission limit of 46 dBA under all scenarios with the exception of Stage 2 (expansion of current depth) - drilling on the upper bench at the western end of the quarry.
- During drilling on the upper bench at the western end of the quarry noise immissions at receiver 3 are predicted to exceed 46 dBA by 8 dBA under worst-case weather conditions. The high noise levels predicted from this phase of the operations are due to lack of shielding from the eastern face of the quarry.
- While truck loading activity would continue through the quarry’s life, this activity has only been modelled for Stage 1. Stage 1 represents the worst case operational conditions where shielding from the eastern quarry face is at its minimum. Stage 1 modelling shows that truck loading is well below the 46 dBA potential limit.

### 4.9 Recommendations

- During drilling on the upper western bench (current quarry level), noise emissions are likely to exceed any specified emission limit. A minimum of 8 dBA reduction in predicted noise emissions from the drill rig would be required to meet a noise limit of 46 dBA. Such a reduction is possible by shrouding the drill head. Shrouded drill rigs are currently available and such a unit should be sort for this phase of the quarry’s development. If this is not practicable then shrouding of an existing rig used at the site would need to be explored. This may be achieved using a product such as Flexshield Sound Stop, a flexible PVC curtain, that can provide between 10 to 15 dB transmission loss.
5 Summary

- An impact assessment of environmental noise, ground vibration and air blast overpressure emissions from operations at Gundagai Quarry has been carried out as part of a DPEMP for the expansion of the quarry’s operations.
- Ground vibration and air blast overpressure measurements at Residence B are within recommended maximum limits under ANZEC guidelines.
- The air blast overpressure level measured at Residence B (location A) was 0.2 dB below the recommended limit under ANZEC guidelines.
- Conservative predictions of PPV levels from an establishment blast and face blast are below 5 mm/s at residential locations surrounding the quarry.
- Predictions of ABO slightly under predict the measured level at residence B. Predicted levels for an establishment blast and face blast are below 115 dBL. An increase in charge mass results in an increase in ABO.
- With the exception of drilling on the current bench at the western end of the quarry, predicted environmental noise modelling has demonstrated that noise emissions from quarry operations, both current and proposed, are highly unlikely to exceed a 46 dBA $L_{Aeq,10min}$ limit.
- Vipac makes the following recommendation in relation to environmental noise, ground vibration and air blast overpressure emissions from operations at Gundagai Quarry:-
  - Independent monitoring of ground vibration and air blast overpressure should be carried out for all quarry blasting at multiple locations including at location A (residence B). This would allow for the development of site specific scaled regression equations for more accurate prediction of ground vibration and ABO.
  - Charge mass/delay should be capped at 46 kg. Stemming height should be no less than 3 m and burden for face blasts no less than 3 m.
  - Blasting should be avoided when atmospheric inversions are present and when the prevailing wind direction is from the west.
  - Further PPV and ABO prediction should be undertaken if any significant change to blasting design is proposed.
  - Environmental noise emissions should be monitored on a quarterly basis for the first year following approval of the quarry’s expansion and annually thereafter. This is to verify the predicted noise levels presented in this report and demonstrate compliance with noise emissions limits.
  - Any significant changes to the quarry’s operations should be modelled to allow prediction of likely noise emissions resulting from the change.
  - A shrouded drill rig should be sourced for the drilling on the upper western bench of the quarry. If this is not practicable then shrouding of an existing rig used at the site would need to be explored.

6 References