Nabowla Quarries

Nabowla Quarry

Environmental noise, ground vibration and air blast overpressure assessment

Report No. 421295-01

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Table of Contents

1 Introduction......................................................................................................................... 4
2 Site description and measurement positions................................................................. 4
3 Environmental noise ........................................................................................................ 5
  3.1 Environmental noise measurements .......................................................................... 5
    3.1.1 Instrumentation ....................................................................................................... 6
    3.1.2 Measurement results ............................................................................................... 6
3.2 Environmental noise prediction .................................................................................... 9
  3.2.1 Sound power data ..................................................................................................... 9
  3.2.2 Predicted sound pressure levels ............................................................................. 10
3.3 Discussion ...................................................................................................................... 10
  3.3.1 Environmental noise measurements ....................................................................... 10
  3.3.2 Environmental noise prediction ........................................................................... 10
4 Ground vibration and air blast overpressure prediction .................................................. 11
  4.1 Ground vibration .......................................................................................................... 11
  4.2 Air blast overpressure ................................................................................................ 12
5 Conclusions ..................................................................................................................... 13

List of figures

Figure 1 – Aerial view with receiver locations marked......................................................... 5
Figure 2 – Position 1, 1/3-octave band spectrum................................................................. 7
Figure 3 – Position 1, narrow band spectrum 0 – 600 Hz. ................................................ 7
Figure 4 – Position 1, narrow band spectrum 0 – 1200 Hz. ............................................. 8
Figure 5 – Position 2, extended unobserved Ln-statistics................................................... 8

List of tables

Table 1 – Receiver locations. ............................................................................................... 5
Table 2 – Position 1, observed measurements. ................................................................... 6
Table 3 – Sound power levels. ............................................................................................. 9
Table 4 – Sound power level spectra. ................................................................................ 9
Table 5 – Predicted noise levels. ....................................................................................... 10
Table 6 – Predicted ground vibration. ............................................................................... 11
Table 7 – Predicted air blast overpressure. ...................................................................... 12

References

1 Introduction

VIPAC was commissioned by Nabowla Quarries to undertake an environmental noise, ground vibration and air blast overpressure assessment of operations at Nabowla Quarry. The assessment forms part of an Environmental Effects Report (EER) for a proposed production increase at the quarry. Guidelines for the EER were provided by the Tasmanian EPA with the section relevant to noise, ground vibration and air blast overpressure as follows:-

- Identify all possible sources of noise on site.
- Provide a map displaying all residences or other sensitive uses in other ownership within 1.5 kilometres of the quarry.
- Provide the results of a basic desktop assessment which demonstrates that the sound power output of the proposed activities to occur on site, compared to background noise levels, can meet current noise and blasting limits (issued as part of the Permit Conditions – Environmental No. 7495), being:
  - Noise emission limits:
    - 50 dB(A) between the hours of 0700 and 1900 (day time);
    - 40 dB(A) between the hours of 1900 and 2200 (evening); and
    - 35 dB(A) between the hours of 2200 and 0700 (night time).
  - Blasting – noise and vibration limits:
    - For 95% of blasts, air blast over pressure must not exceed 115 dB(Lin Peak);
    - Air blast over pressure must not exceed 120 dB;
    - For 95% of blasts ground vibration must not exceed 5mm/sec peak particle velocity; and
    - Ground vibration must not exceed 10mm/sec peak particle velocity.
  - Details about potential impacts of nuisance noise emissions should be provided, and proposed management measures described.

Following consultation with Nabowla Quarries it was decided that measurement of operational noise at the nearest residence would also be conducted in addition to the desktop environmental noise study.

Ground vibration and ABO prediction is typically conducted using site specific scaled regression equations developed from monitored data from multiple blasts measured at multiple locations. Such data is not available for Nabowla Quarry. Given this VIPAC has sourced regression equations developed by the Office of Surface Mining Reclamation and Enforcement (1) in the USA from their extensive data sets.

2 Site description and measurement positions

Nabowla Quarry is located on Fullbrooks Rd approx. 13 km west north-west of Scottsdale in north-eastern Tasmania.

Following blasting, material is dug, crushed, screened and stockpiled before being transported off site via truck.

The quarry is located in on elevated ground to the west of the Bridport Back Rd. The closest residence is located approx. 700 m to the south-east on Bridport Back Rd. A second residence is located approx. 730 m away to the south-west and is shielded from the quarry by topography.

Two positions were selected for the measurement of observed environmental noise data during operations and extended unobserved measurement of ambient environmental noise.

Table 1 below provides the location and coordinates for the measurement positions and the two residences. Figure 1 provides an aerial view of the quarry and surrounds with the measurement positions and residences marked.
### 3 Environmental noise

#### 3.1 Environmental noise measurements

All noise measurements were made in general accordance the *Tasmanian Noise Measurements Procedures Manual*.

A 10-minute time interval was selected for measurement of all statistical noise data.

Observed measurements were obtained over a 60-minute period at position 1 and the data is presented in table format with relevant observations also noted.

Spectral data was obtained during the observed measurement over a 1-minute period and is shown graphically in 3 data sets as follows:-

- 1/3-octave band spectra
- Narrow band 0 - 600 Hz (0.78 Hz resolution).
- Narrow band 0 - 1200 Hz (1.56 Hz resolution).

Where appropriate, significant tones have been marked in these spectra and potential sources noted.

---

Table 1 – Receiver locations.

<table>
<thead>
<tr>
<th>Position number</th>
<th>Coordinates (MGA)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>55 G 530464E / 5444730N</td>
<td>Representative of Bridport Back Rd Residence</td>
</tr>
<tr>
<td>2</td>
<td>55 G 530493E / 5445466N</td>
<td>Extended ambient monitoring</td>
</tr>
<tr>
<td>N/A</td>
<td>55 G 530441E / 5444490N</td>
<td>Residence (Bridport Back Rd) approx. 700 m</td>
</tr>
<tr>
<td>N/A</td>
<td>55 G 529076E / 5444658N</td>
<td>Residence (Knights Rd) approx. 730 m</td>
</tr>
</tbody>
</table>

---

Figure 1 – Aerial view with receiver locations marked.
Unobserved extended measurements were conducted at position 2 for approximately 11 days and a graph of selected 10-minute Ln statistical data is provided as follows:

- $L_{Aeq}$
- $L_{A10}$
- $L_{A90}$

For sake of clarity the other 5 data sets are not shown in these graphs. The data has been filtered for poor weather conditions and evening and night data has been removed. The evening and night periods are not considered here as VIPAC was informed by Nabowla Quarries that operations at the quarry don’t occur during these times.

### 3.1.1 Instrumentation

The following instrumentation was used during the survey:

- Spectrum analyser Larson Davis 2900 s/n 2900A0343
- Environmental noise analyser Larson Davis 870B s/n 1189
- Environmental noise analyser Larson Davis 824 s/n 824A1537
- Acoustic Calibrator CA250 s/n 2706

All instruments were field calibrated prior to use.

Wind socks were used at all times on microphones.

### 3.1.2 Measurement results

#### 3.1.2.1 Position 1

The equipment operating in the quarry during the observed measurement at position 1 was as follows:

- Crusher
- Excavator
- Front end loader
- Dozer
- Mobile conveyor
- Road truck (intermittent)

<table>
<thead>
<tr>
<th>Period</th>
<th>Time</th>
<th>$L_{Aeq}$</th>
<th>$L_{Amax}$</th>
<th>$L_{Amin}$</th>
<th>$L_{A10}$</th>
<th>$L_{A50}$</th>
<th>$L_{A90}$</th>
<th>$L_{A99}$</th>
<th>Weather</th>
<th>Audible sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td></td>
<td>57.1</td>
<td>83.1</td>
<td>31.0</td>
<td>69.8</td>
<td>45.7</td>
<td>38.0</td>
<td>34.1</td>
<td>32.2</td>
<td>Fine Light wind (1.5 m/s) E/SE</td>
</tr>
<tr>
<td>1010</td>
<td></td>
<td>42.6</td>
<td>66.5</td>
<td>34.9</td>
<td>48.2</td>
<td>44.7</td>
<td>40.9</td>
<td>38.1</td>
<td>36.1</td>
<td>Crusher (NQ), traffic (Bridport Back Rd), birds, insects, leaf rustle.</td>
</tr>
<tr>
<td>1020</td>
<td></td>
<td>51.1</td>
<td>76.3</td>
<td>37.0</td>
<td>56.5</td>
<td>49.9</td>
<td>45.8</td>
<td>41.9</td>
<td>39.4</td>
<td></td>
</tr>
<tr>
<td>1030</td>
<td></td>
<td>41.4</td>
<td>54.1</td>
<td>31.9</td>
<td>49.8</td>
<td>45.2</td>
<td>37.9</td>
<td>34.3</td>
<td>32.6</td>
<td></td>
</tr>
<tr>
<td>1040</td>
<td></td>
<td>38.7</td>
<td>53.2</td>
<td>32.0</td>
<td>45.2</td>
<td>41.3</td>
<td>37.4</td>
<td>34.7</td>
<td>33.2</td>
<td></td>
</tr>
<tr>
<td>1050</td>
<td></td>
<td>63.3</td>
<td>88.3</td>
<td>33.3</td>
<td>76.5</td>
<td>50.6</td>
<td>39.8</td>
<td>36.5</td>
<td>34.5</td>
<td></td>
</tr>
</tbody>
</table>

Table 2 – Position 1, observed measurements.
Figure 2 – Position 1, 1/3-octave band spectrum.

Figure 3 – Position 1, narrow band spectrum 0 – 600 Hz.
Figure 4 – Position 1, narrow band spectrum 0 – 1200 Hz.

3.1.2.2 Position 2

Figure 5 – Position 2, extended unobserved Ln-statistics.
3.2 Environmental noise prediction

3.2.1 Sound power data

The prediction of potential environmental noise emission levels from quarry operations were based on near field spectral measurements of equipment operating at Nabowla Quarry. These measurements were used to determine source sound power spectra. Where source were not available for measurements VIPAC library data has been used.

Table 3 provides the calculated sound power level for the equipment operating in the quarry and information in relation to the determination of the listed level. Table 4 provides the sound power level spectrum for each source.

<table>
<thead>
<tr>
<th>Area</th>
<th>SWL</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crusher</td>
<td>114.6</td>
<td>Pegson Premiertrak 1100 x 650 (measured at Nabowla Quarry)</td>
</tr>
<tr>
<td>Screen</td>
<td>107.0</td>
<td>Typical mobile screen (VIPCAC library). Screen normally used at the quarry was not on-site at time of measurements.</td>
</tr>
<tr>
<td>Front End Loader</td>
<td>103.8</td>
<td>CAT 950G (measured at Nabowla Quarry)</td>
</tr>
<tr>
<td>Excavator</td>
<td>104.1</td>
<td>CAT 345B (measured at Nabowla Quarry)</td>
</tr>
<tr>
<td>Dozer</td>
<td>106.8</td>
<td>CAT D7H (measured at Nabowla Quarry)</td>
</tr>
<tr>
<td>Road Truck</td>
<td>106.6</td>
<td>Typical road truck (VIPCAC library)</td>
</tr>
<tr>
<td>Drill</td>
<td>122.3</td>
<td>Roc F7 Atlas Copco (VIPCAC library). Engine, drilling and rattling noise combined. Drilling and rattling noise scaled for time of operation in a 10-minute period.</td>
</tr>
</tbody>
</table>

Table 3 – Sound power levels.

<table>
<thead>
<tr>
<th>Area</th>
<th>Frequency (Hz)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>31.5</td>
<td>63</td>
</tr>
<tr>
<td>Crusher</td>
<td>70.1</td>
<td>92.4</td>
</tr>
<tr>
<td>Screen</td>
<td>51.7</td>
<td>73.4</td>
</tr>
<tr>
<td>Front End Loader</td>
<td>58.2</td>
<td>72.8</td>
</tr>
<tr>
<td>Excavator</td>
<td>69.6</td>
<td>78.1</td>
</tr>
<tr>
<td>Dozer</td>
<td>65.4</td>
<td>82.5</td>
</tr>
<tr>
<td>Road Truck</td>
<td>70.1</td>
<td>81.6</td>
</tr>
<tr>
<td>Drill</td>
<td>69.2</td>
<td>93.9</td>
</tr>
</tbody>
</table>

Table 4 – Sound power level spectra.

**NB:** The mobile conveyor operating in the quarry was not considered as it produced low sound power level relative to the other equipment on-site.
### 3.2.2 Predicted sound pressure levels

Predicted noise levels at the four receiver locations were calculated with consideration of the following parameters:

- Distance attenuation
- Ground absorption.
- Atmospheric attenuation/amplification (worst case weather conditions were considered).
- Barrier effect from topography

Table 5 presented the predicted noise emission levels at two receiver locations (see figure 1 and table 1 for location details). The following scenarios were used for prediction:

- **Drill not operating**: All sources operating with the exception of the drill.
- **Drill operating**: All sources operating including the drill

**NB**: The contribution from the highest emitting source is also presented for each scenario. With the drill not operating the highest contributing source is the crusher and while the drill is operating it becomes the highest contributing source.

<table>
<thead>
<tr>
<th>Location</th>
<th>Drill not operating</th>
<th>Drill operating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Neutral</td>
<td>Crusher</td>
</tr>
<tr>
<td>Measurement position 1</td>
<td>41.9</td>
<td>39.8</td>
</tr>
<tr>
<td>Nearest residence (Bridport Back Rd)</td>
<td>39.5</td>
<td>37.4</td>
</tr>
</tbody>
</table>

- **NB**: Predictions were not made to the residence on Knights Rd (see figure 1). This location is further from the quarry and has greater topographic shielding than the residence on Bridport Back Rd.

### 3.3 Discussion

#### 3.3.1 Environmental noise measurements

- At position 1 the crusher was audible and controlled the $L_{A90}$ levels measured. With changes in wind conditions the $L_{A90}$ level varied by 7 dBA through the 60-minute measurement period. The highest level was 41.9 dBA measured during a lull in wind (see table 2).
- Narrow band tones from the crusher were audible and measureable (see figures 3 and 4).
- $L_{Aeq}$ levels were elevated by intermittent truck pass-bys on the Bridport Back Rd (see table 2).
- At position 2 the ambient noise levels ($L_{Aeq}$) typically varied between 35 and 45 in the absence of truck pass-bys on Fullbrooks Rd with occasional periods of less the 35, particularly during the early part of the day when weather conditions were likely to have been most stable (see figure 5).

#### 3.3.2 Environmental noise prediction

- The predicted noise emission level at position 1 under neutral weather and with no drill operating (see table 5) shows good correlation with the highest $L_{A90}$ level measured at position 1 of 41.9 dBA (see table 2).
- All predicted levels at the nearest residence are below the day limit of 50 dBA.
With all equipment operating in the quarry, including the drill, the predicted level at the nearest residence under worst case weather is 48.5 dBA, 1.5 dBA below the day limit of 50 dBA.

4 Ground vibration and air blast overpressure prediction

Ground vibration and air blast overpressure predictions are assessed here against limits provided in the PCE (see section 1 for details).

Prediction of ground vibration and air blast overpressure 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.

Predictions are made to the closest residence (Bridport Back Rd) to the quarry at a distance of approx. 700 m, residences at greater distance would have lower ground vibration and air blast overpressure predicted levels. A typical charge mass/delay of 60 kg (conservative estimate based on VIPAC experience at similar quarries) is assumed for the predictions.

4.1 Ground vibration

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

\[
PPV = k \left( \frac{\sqrt{mD}}{D} \right)^a
\]

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) used were developed by OSM from quarry production blast data are as follows:

- **Average**: k = 52, a = 1.38
- **Upper bound**: k = 138, a = 1.38

The equation above and the constants and exponent are for imperial data and as such all relevant data from the Nabowla Quarry was first converted to imperial before PPV predictions were made. The subsequent answers were then converted back to metric and are presented in table 5 below.

<table>
<thead>
<tr>
<th>Predicted ground vibration (mm/s)</th>
<th>quarry production blast</th>
<th>PPV (mm/s)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60 kg charge mass/delay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td>0.88</td>
<td>Under these regressions a charge mass/delay of up to 100 kg produces predicted PPV levels below the PCE limits</td>
</tr>
<tr>
<td>Upper bound</td>
<td></td>
<td>2.35</td>
<td></td>
</tr>
</tbody>
</table>

Table 6 – Predicted ground vibration.
4.2 Air blast overpressure

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

\[
PSI = k \left( \frac{\sqrt[3]{m}}{D} \right)^a
\]

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:

\[
dBL = 20 \log_{10} \left( \frac{PSI}{2.9 \times 10^{-9}} \right)
\]

These equations are for imperial input data and all relevant data from the Nabowla Quarry was converted to imperial prior to prediction being made.

The predicted level is calculated from the equations presented above with the OSM constant (k) and exponent (a) for highwall blasting.

\[
k = 0.162  
a = 0.794
\]

Table 6 presents the predicted air blast overpressure level with a charge mass/delay of 60 kg.

<table>
<thead>
<tr>
<th>Blast type</th>
<th>dB</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highwall</td>
<td>112.8</td>
<td>Under this regression a charge mass/delay of up to 100 kg produces predicted overpressure levels below the PCE limits.</td>
</tr>
</tbody>
</table>

Table 7 – Predicted air blast overpressure.

**NB**: The above prediction assumes adequate confinement of the charge mass. Where confinement is not adequate air blast overpressure levels would likely be considerably higher.
5 Conclusions

- Noise emissions from the quarry when measured at a location representative of the nearest residence (position 1) where below the day limit of 50 dBA by approx. 10 dBA. The crusher was audible and narrow band tones from this source were measured.
- There is good correlation between the predicted environmental noise and measured environmental noise.
- All predicted noise emission levels are below the day PCE noise emission limit of 50 dBA.
- The predicted noise levels with all equipment operating in the quarry, including the drill, is close to the day limit of 50 dBA under worst case weather conditions. The two dominant sources are the crusher and drill with both having the potential to produce intrusive noise characteristics such as tonality and impulsiveness. These characteristics have the potential to be perceived as annoying and would likely result in penalties being applied to measured noise levels in accordance with the Tasmanian Noise Measurement Procedures Manual. This in turn could lead exceedances and breaches of the day PCE noise emission limit. VIPAC recommends that the crusher and drill are not operated at the same time in the quarry. If both are to be operated at the same time then shrouding of the drill head may need to be considered.
- Prediction of ground vibration and air blast overpressure suggests blasting at the quarry is unlikely to generate levels above the PCE limits for a charge mass/delay of ≤ 100 kg. In relation to air blast overpressure this is predicated on the charge mass being adequately confined.

NB: Narrow band vehicle backing alarms were not considered in the prediction of sound pressure levels in this assessment. Should they become an issue with regard to noise nuisance then the installation of broadband backing alarms on all vehicles on site should be considered (see http://www.warningsystems.com.au/bbs.html for further details).