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Burra Road Landfill Extension, Gundagai

Potential Blasting Impacts Assessment

Report Number 610.16431-R1

12 May 2016

PREPARED FOR:

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ON BEHALF OF:

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Potential Blasting Impacts Assessment

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1 INTRODUCTION

MH Earthmoving Pty Ltd is seeking approval to extend the current landfill operations located at 303 Burra Road, Gundagai NSW. Salvestro Planning, on behalf of MH Earthmoving Pty Ltd, has engaged SLR Consulting Australia Pty Ltd (SLR) to conduct a blasting impact assessment of the proposed construction activities associated with the landfill extension in order to determine the potential level of impact on the surrounding environment as well as on the existing landfill operations (specifically the landfill cell clay liners) in accordance with the requests from the NSW Environment Protection Authority (EPA).

Blasting Impacts Assessment Procedures

The NSW EPA has adopted the Australian and New Zealand Environment Conservation Council (ANZECC, now the Environment Protection and Heritage Council (EPHC))) "*Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration*" dated September 1990 for assessing potential human annoyance from blast emissions during daytime hours.

The assessment of blast emission impacts outside the hours advocated by the EPHC remains according to the NSW EPA's "*Environmental Noise Control Manual*", Chapter 154 Noise Control Guideline - Blasting.

British Standard BS 7385-2 1993 "*Evaluation and Measurement for Vibration in Buildings - Part 2: Guide to Damage Levels from Ground Borne Vibration*" (BS 7385), as called up in AS 2187-2 2006 "*Explosives - Storage and Use Part. Part 2: Use of Explosives*" (AS 2187), provides guideline criteria for evaluating the effects of vibration on structures.

German Standard DIN 4150-3 1999 "*Effects of Vibration on Structures*" provides more conservative "*Safe Limits*" for assessing the potential impacts of vibration on structures.

In the absence of any specific ground vibration criteria for the protection of the clay liners in the existing landfill cells at the subject site, an appropriate criterion has been derived from First Principles based on typical geotechnical properties of landfill clay liners and with reference to the methods outlined in the Australian Coal Association Research Program (ACARP) Report C14057 (ACARP Report) "*Effect of Blasting on Infrastructure*", 2008 (prepared by Terrock Consulting Engineers) as well as in "*Blast Vibration Monitoring and Control*", 1985 by Charles H. Dowding.

2 NSW EPA REQUESTS IN RELATION TO BLASTING

Following submission of the EIS for the subject Burra Road Landfill Extension (received by the EPA on 13 January 2016), the EPA reviewed the information provided in the EIS and requested additional information.

In Attachment B of the EPA's letter of 5 February 2016 (attached as **Appendix A**) to Gundagai Shire Council, it is stated that:

> *"In order for the EPA to assess the project we require the proponent to provide the following information:*
>
> 1. *Blasting overpressure and ground vibration at nearby residences should be assessed in accordance with the criteria in Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration (Australia and New Zealand Environment Council, 1990).*

2. *Based on the geology of the site, the EIS must also provide an estimate of the number of blasts and duration of blasting activity that may be required for all construction activity.*
3. *An assessment of the ground vibration impacts on the landfill liner from the blasting activity, and the proposed blast design, monitoring and review criteria that will be adopted to ensure that the existing liner will not be compromised by any blasting activity.*"

3 BLAST EMISSIONS ASSESSMENT CRITERA

3.1 Vibration Damage Criteria

Most commonly specified "safe" structural vibration limits are designed to minimise the risk of threshold or cosmetic surface cracks, and are set well below the levels that have potential to cause damage to the main structure.

3.1.1 Surface Structures

British Standard 7385: Part 2 - 1993

In terms of the most recent relevant vibration damage criteria, Australian Standard AS 2187: Part 2-2006 "*Explosives - Storage and Use - Part 2: Use of Explosives*" recommends the frequency dependent guideline values and assessment methods given in BS 7385 Part 2-1993 "*Evaluation and measurement for vibration in buildings Part 2" as they "are applicable to Australian conditions*".

The standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

Sources of vibration which are considered in the standard include blasting (carried out during mineral extraction or construction excavation), demolition, piling, ground treatments (eg compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery.

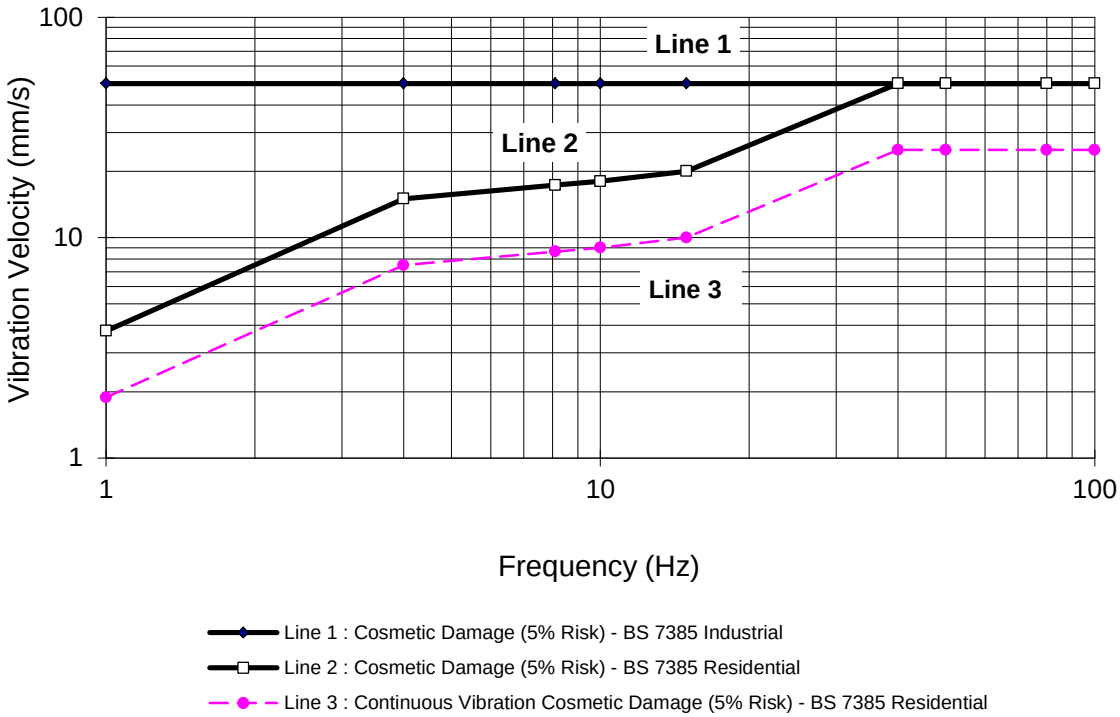
As the strain imposed on a building at the foundation level is proportional to the peak particle velocity, but is inversely proportional to the propagation velocity of the shear or compressional waves in the ground, this quantity (ie peak particle velocity) has been found to be the best single descriptor for correlating with case history data on the recurrence of vibration-induced damage.

The guide values from this standard for transient vibration judged to result in a minimal risk of cosmetic damage to residential buildings and industrial buildings are presented numerically in **Table 1** and graphically in **Figure 1**.

Table 1 Transient Vibration Guide Values for Cosmetic Damage

Line	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4Hz to 15Hz	15Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50mm/s at 4Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15mm/s at 4Hz increasing to 20mm/s at 15Hz	20mm/s at 15Hz increasing to 50mm/s at 40Hz and above

Figure 1 Graph of Transient Vibration Guide Values for Cosmetic Damage



In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for the building types corresponding to Line 2 are reduced. Below a frequency of 4Hz where a high displacement is associated with the relatively low peak component particle velocity value, a maximum displacement of 0.6mm (zero to peak) is recommended. This displacement is equivalent to a vibration velocity of 3.7mm/s at 1Hz.

The standard goes on to state that minor damage is possible at vibration magnitudes which are greater than twice those given in **Table 1** and major damage to a building structure may occur at values greater than four times the tabulated values.

Fatigue considerations are also addressed in the standard and it is concluded that unless calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials) then the guide values in **Table 1** should not be reduced for fatigue considerations.

It is noteworthy that extra to the guide values nominated in **Table 1**, the standard states that:

> *"Some data suggests that the probability of damage tends towards zero at 12.5mm/s peak component particle velocity. This is not inconsistent with an extensive review of the case history information available in the UK."*

Also that:

> *"A building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive."*

German Standard DIN 4150: Part 3-1999

For short-term vibration events (ie those unlikely to cause resonance or fatigue), DIN 4150 offers the criteria shown in **Table 2**. These are maximum levels measured in any direction at the foundation or in the horizontal axes in the plane of the uppermost floor.

Table 2 DIN 4150 Structural Damage - Safe Limits for Short-term Building Vibration

Group	Type of Structure	Peak Particle Velocity (mm/s)			
		At Foundation			Plane of Floor of Uppermost Storey
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz[1]	All Frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design20	20	20 at 10 Hz increasing to 40 at 50 Hz	40 at 50 Hz increasing to 50 at 100 Hz	40
2	Dwellings and buildings of similar design and/or use	5	5 at 10 Hz increasing to 15 at 50 Hz	15 at 50 Hz increasing to 20 at 100 Hz	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 ad have intrinsic value (eg buildings that are under a preservation order	3	3 at 10 Hz increasing to 8 at 50 Hz	8 at 50 Hz increasing to 10 at 100 Hz	8

Note 1: For frequencies above 100 Hz the upper value in this column should be used.

As opposed the "minimal risk of cosmetic damage" approach adopted in BS 7385 (95% probability of no effect), the "safe limits" given in DIN 4150 are the levels up to which no damage due to vibration effects has been observed for the particular class of building. "Damage" is defined by DIN 4150 to include even minor non-structural effects such as superficial cracking in cement render, the enlargement of cracks already present, and the separation of partitions or intermediate walls from load bearing walls.

3.2 Airblast - Structural Damage

Based largely on work carried out by the US Bureau of Mines, the US Office of Surface Mining has presented the following regulatory limits for airblast from blasting (depending on the low frequency limit of the measuring system):

Low Frequency Limit	Peak Airblast Level Limit
2Hz or lower	132 dBLinear
6Hz or lower	130 dBLinear

These levels are generally consistent with the level of 133 dBLinear nominated in AS 2187.2.

The US criteria are structural damage limits based on relationship between the level of airblast and the probability of window breakage and include a significant safety margin. It has been well documented that windows are the elements of residential buildings most at risk to damage from airblast from blasting.

While cracked plaster is the type of damage most frequently monitored in airblast complaints, research has shown that window panes fail before any other structural damage occurs (USBM, RI 8485-1980 "*Structure Response and Damage Produced by Airblast from Surface Mining*"). The probabilities of damage to windows exposed to a single airblast event are as shown in **Table 3**.

Table 3 Probability of Window Damage from Airblast

Airblast dB Linear	Level kPa	Probability of Damage	Effects and Comments
140	0.2	0.01%	"No damage" - windows rattle
150	0.6	0.5%	Very occasional failure
160	2.0	20%	Substantial failures
180	20.0	95%	Almost all fail

3.3 Human Comfort and Disturbance Considerations

The ground vibration and airblast levels which cause concern or discomfort to residents are significantly lower than the damage limits. Humans are far more sensitive to some types of vibration than is commonly realised. They can detect and even be annoyed at vibration levels which are well below those causing any risk of damage to a building or its contents.

The criteria recommended by the EPA for blasting in NSW, based on human comfort, are contained in the Environment Protection and Heritage Council (EPHC, previously the ANZECC) guidelines as well as in the Australian Standard 2187-2 2006 "*Explosives - Storage and use Part 2: Use of Explosive (AS 2187)*.

The EPHC criteria for the control of blasting impacts on people at noise sensitive site (eg residences, hospitals, schools, etc) are as follows:

- The recommended maximum level for airblast is 115 dBLinear.
- The level of 115 dB Linear may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 120 dBLinear at any time.
- The recommended maximum level for ground vibration is 5 mm/s (peak particle velocity (ppv)).
- The ppv level of 5 mm/s may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 10 mm/s at any time.
- Blasting should generally only be permitted during the hours of 0900 hours to 1700 hours Monday to Saturday. Blasting should not take place on Sundays and public holidays.

For occupied non-sensitive sites, such as factories and commercial premises, AS 2187 presents the following ground vibration and airblast limits for human comfort (as "*chosen by some regulatory authorities*"):

- 25 mm/s (Peak Particle Velocity, PPV) maximum ground vibration unless agreement is reached with the occupier that a higher limit may apply.
- 125 dBLinear maximum ariblast unless agreement is reached with the occupier that a higher limit may apply.

3.4 Landfill Cell Clay Liners

As discussed in **Section 1**, in the absence of any specific ground vibration criteria for the protection of the clay liners in the existing landfill cells (Cells 1 and 2), an appropriate criterion has been derived from First Principles using typical geotechnical properties of landfill clay liners.

Based on plane wave strain theory, the axial or stretching ground strain which develops through the compression/tension flexure parallel to the propagation of the vibration waves from the blast is given by:

$$\text{Ground Strain} = \frac{PPV}{Vp}$$

where,

PPV = Allowable Peak Particle Velocity (m/s)
Vp = Compressional wave velocity of the clay (m/s)

In turn, the strain is related to the Young's Modulus, the density and the tensile strength of the clay.

The following parameters for the clay liner were used in establishing an allowable blast vibration velocity damage limit.

Vp = 1,100 m/s;

Density = 1,800 kg/m^3;

Young's Modulus = 40 Mpa; and

Maximum allowable tensile strength = 50 kPa.

Based on the above parameters the maximum allowable level of vibration in the landfill cell clay liner for the prevention of damage is 1,375 mm/s. The calculation sheet used to derive the allowable vibration criterion is presented in **Appendix B**.

4 BLAST EMISSIONS IMPACT ASSESSMENT

4.1 Proposed Blasting Practices

The proposed method of material excavation for the creek diversion to create Cell 4 is by drill and blast techniques. A summary of indicative blast design details is presented in **Table 4**.

Table 4 Indicative Blast Design Details

Parameter	Free-Face
Borehole length	12 m (typically)
Sub-drill	1 m (approximately)
Stemming (using 14 mm aggregate)	3.2 m
Blasthole diameter	76 mm (or 89 mm)
Blasthole inclination (to vertical)	5^o
Blasthole spacing	2.5 m
Burden	2.5 m
Number of rows	18 to 20
Initiation	Non electric
Bulk explosive	Centra Gold Bulk Emulsion
Primer	Pentex H - Primer
Maximum Instantaneous Charge (MIC)	48 kg

4.2 Blast Emission Levels

By adopting the nominated indicative blast design, the level of blast vibration emissions can be predicted using the formula given in the AS 2187 and Orica Explosives Blasting Guide, applicable to blasting in average rock. Also given in the Standard (and Guide) is a formula in relation to the prediction of airblast emissions. Both methods of blast emission estimation are considered conservative and correspond to the mean blast emission level or the "50% likelihood of exceedance".

The relevant formulae are as follows:

$$PPV = 1{,}140\ (R/Q^{\wedge 0.5})^{\wedge -1.6}$$
$$dB = 164.2 - 24(\log_{10} R - 0.33 \log_{10} Q)$$

where,

PPV = Peak Particle Velocity ground vibration level (mm/s)
dB = Peak airblast level (dBLinear)
R = Distance between charge and receiver (m)
Q = Charge mass per delay (MIC - kg)

The ground vibration and airblast criteria for human comfort (noise sensitive receivers) advocated by the EPA and the EPHC cater for the inherent variation in emission levels from a given blast design by allowing a five percent exceedance of a general criterion up to a (never to be exceeded) maximum (refer to **Section 3.3**). Correspondingly, the "5% likelihood of exceedance" prediction formulae were generated for the above blast emission site laws.

The resulting 5% exceedance site laws for ground vibration and airblast are:

Ground Vibration

$$PPV\ (mm/s)\ (5\%) = 4{,}261\ (SD)^{-1.6}$$

Airblast

$$SPL\ (dBLinear)\ (5\%) = 175.7 - 24(\log_{10} R - 0.33 \log_{10} Q)$$

Where PPV (5%) and SPL (5%) are the levels of ground vibration (Peak Particle Velocity - mm/s) and airblast (dBLinear) respectively, above which 5% of the total population (of data points) will lie, assuming that the population has the same statistical distribution as the underlying measured sample.

In order to evaluate the appropriateness of using the ground vibration prediction formulae presented above for the subject assessment, reference was made to the blast monitoring results from a blast conducted at the Burra Road landfill site on 12 December 2013 (refer to Attachment A, Blast Monitoring Results, of Attachment 8, Clay Liner Report for Blasting in Part B of the EIS).

In this blast, the Maximum Instantaneous Charge (MIC) was 48 kg and the blast was estimated to be 610 m from the monitoring location at 305 Burra Road. The resulting measured level of ground vibration was 0.88 mm/s (a copy of the Blast Results sheet is presented in **Appendix C**).

Based on the parameters above, the (50% exceedance) blast vibration prediction formulae of:

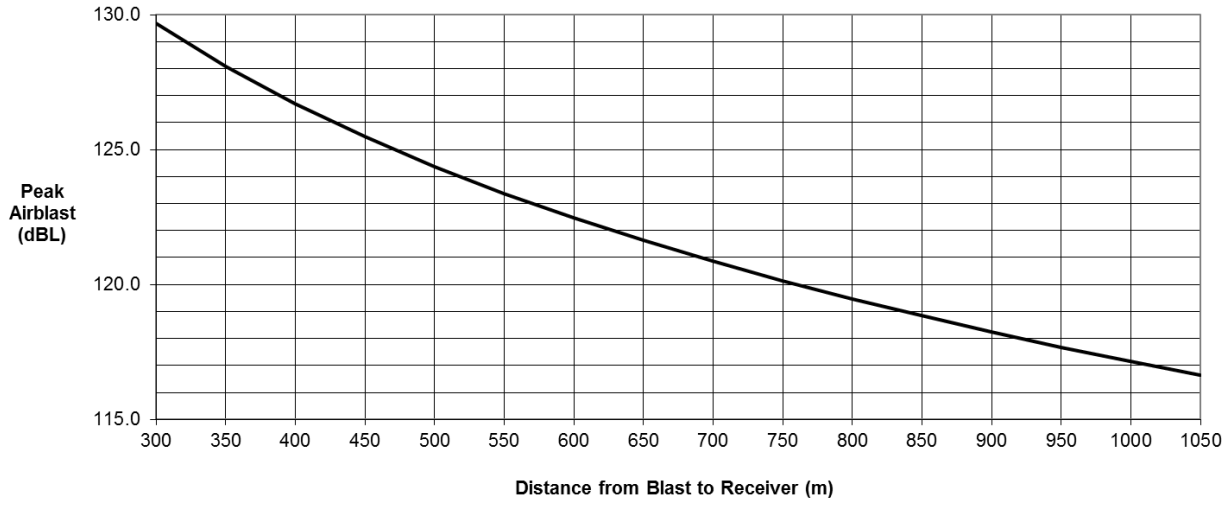
$$PVS = 1{,}140(R/Q^{\wedge 0.5})^{\wedge -1.6}$$

predicts exactly 0.88 mm/s at 610 m for an MIC of 48 kg. This formula and the corresponding 5% exceedance blast vibration prediction formulae were therefore used (unadjusted) for the subsequent blast emissions impact assessments.

The relationship between distance and the Peak Particle Velocity (PPV) ground vibration and peak airblast from the quarry blasting are presented in **Figure 2** and **Figure 3** respectively for an MIC of 48 kg.

Figure 2 Peak Particle Velocity Ground Vibration (5% Exceedance) for an MIC of 48 kg

Figure 3 Peak Airblast (5% Exceedance) for an MIC of 48 kg



The predicted level of blast emissions were subsequently determined considering the closest distances to the nearby residential and industrial buildings. The predicted levels of Peak Particle Velocity (PPV) ground vibration velocity and peak airblast at the nearest potentially affected residences and the Gundagai Bee Farms are presented in **Table 5**.

Figure 4 shows the closest buildings to the proposed blasting. The closest building to the blasting sites is Gundagai Bee Farms and the nearby residences are labelled R1 to R4.

Figure 4 Closest Buildings to the Proposed Blasting

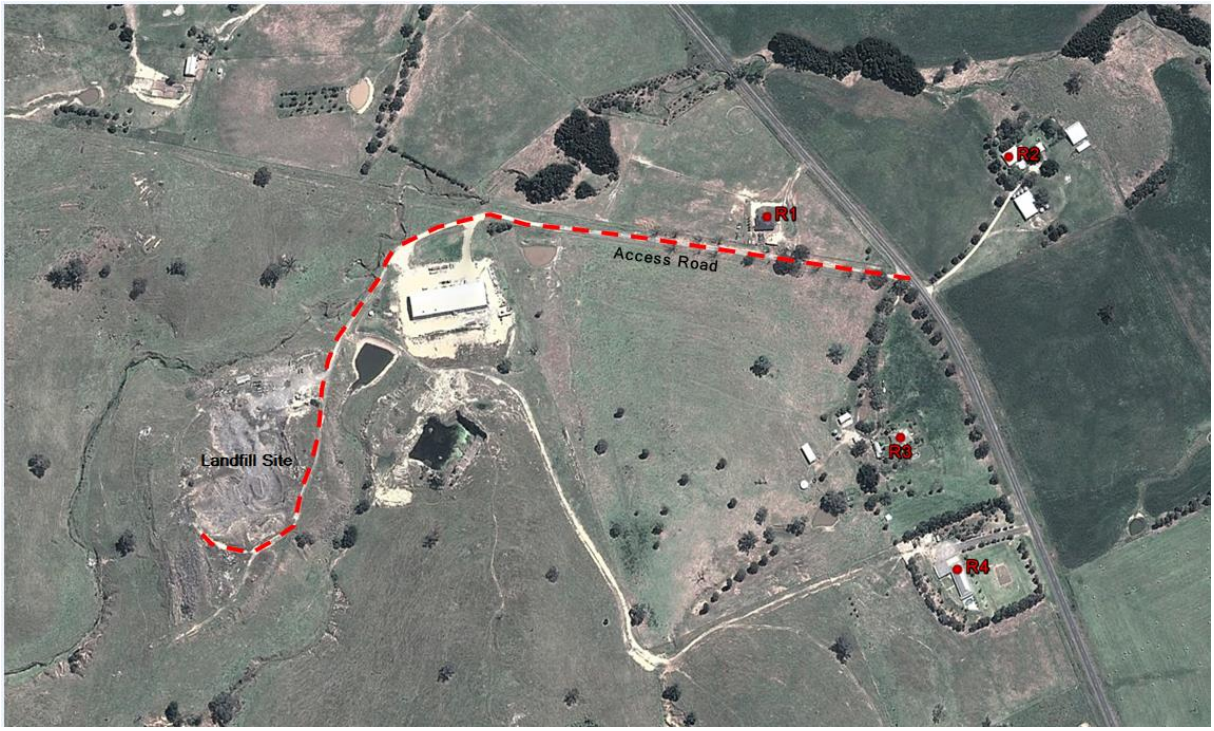


Table 5 Predicted Levels of Blast Emissions (5% Exceedance) for a 48 kg MIC

Residence	Closest Distance from Blasting	PVS Ground Vibration		Peak Airblast Prediction	
		Prediction	Criterion	Prediction	Criterion
Gundagai Bee Farms	320 m	9.3 mm/s	25 mm/s	129.0 dBLinear	125 dBLinear
R1	658 m	2.9 mm/s	5 mm/s	121.5 dBLinear	115 dBLinear
R2	927 m	1.7 mm/s	5 mm/s	117.9 dBLinear	115 dBLinear
R3	725 m	2.5 mm/s	5 mm/s	120.5 dBLinear	115 dBLinear
R4	737 m	2.4 mm/s	5 mm/s	120.3 dBLinear	115 dBLinear

The following information is derived from the predicted levels of blast emissions:

- The predicted level of ground vibration at the Gundagai Bee Farms (9.3 mm/s) complies with the human comfort criterion of (25 mm/s) for factories/commercial sites as well as the AS 2187 (BS 7385) structural damage criterion of 15 mm/s (at 4 Hz).
- The predicted levels of ground vibration at all nearby residences comply with the EPHC general human comfort criterion (of 5 mm/s) and consequently with the AS 2187 (BS 7385) structural damage criterion of 15 mm/s (at 4 Hz).
- For the residences, the maximum predicted ground vibration level of 2.9 mm/s occurs at Receiver R1 for an MIC of 48 kg.
- The predicted level of peak airblast at the Gundagai Bee Farms (129.0 dBLinear) exceeds the human comfort criterion (of 125 dBLinear) for factories/commercial sites by 4 dBLinear.

- The predicted levels of peak airblast at the nearby residences exceed the EPHC's maximum human comfort criterion of 120 dBLinear by between 0.3 dBLinear and 1.5 dBLinear, except at Receiver R2 where the criterion is met. The corresponding exceedances of the EPHC's general criterion of 115 dBLinear range from 2.9 dBLinear to 6.5 dBLinear.
- For the residences, the maximum predicted peak airblast level of 121.5 dBLinear occurs at Receiver R1 for an MIC of 48 kg.
- The predicted levels of peak airblast at all receivers are below the US Bureau of Mines damage limit of 132 dBLinear.
- In order to comply with the human comfort criterion for airblast at the Gundagai Bee Farms the nominal MIC of 48 kg would have to be reduced to 15 kg at the near point of blasting.
- In order to comply with the maximum human comfort criterion (of 120 dBLinear) at residences R1, R3 and R4 the nominal MIC of 48 kg would have to be reduced to 31 kg, 41 kg and 44 kg respectively.
- In order to comply with the general human comfort criterion (of 115 dBLinear) at Residences R1, R2, R3 and R4 the nominal MIC of 48 kg would have to be reduced to 7 kg, 21 kg, 10 kg and 10 kg respectively. At residence R2, the maximum human comfort criterion is met using an MIC of 48 kg.

5 LANDFILL CELL CLAY LINERS

The furthest distances from the proposed blasting in Cell 4 and for the Creek Diversion to the closest point of the existing clay liners are 89 m and 224 m respectively. The closest that the blasting will come to the clay liners is 5.5 m.

In order to assist in the design of the near-field blasts, based on the closest distance of blasting of 5.5 m and the clay liner damage criterion of 1,375 mm/s, **Table 6** presents the allowance MICs for a range of percentage "likelihoods of exceedance" in order to meet compliance.

Also presented in the table are the ground vibration prediction formulae for the respective percentage likelihoods of exceedance.

Table 6 Allowable MIC versus Percentage Likelihood Exceedance (Distance, R = 5.5 m)

Percentage Likelihood of Exceedance	Blast Vibration Prediction Formulae	Allowable MICs (Q)
1%	PPV = 7,379 $(R/Q^{\wedge 0.5})^{\wedge -1.6}$	3.7 kg
2.5%	PPV = 5,485 $(R/Q^{\wedge 0.5})^{\wedge -1.6}$	5.4 kg
5%	PPV = 4,261 $(R/Q^{\wedge 0.5})^{\wedge -1.6}$	7.4 kg
10%	PPV = 3,180 $(R/Q^{\wedge 0.5})^{\wedge -1.6}$	10.6 kg
15%	PPV = 2,624 $(R/Q^{\wedge 0.5})^{\wedge -1.6}$	13.5 kg
20%	PPV = 2,253 $(R/Q^{\wedge 0.5})^{\wedge -1.6}$	16.3 kg
50%	PPV = 1,140 $(R/Q^{\wedge 0.5})^{\wedge -1.6}$	38.2 kg

As an alternative approach to assist in the design of the near-field blasting, **Table 7** presents the range of offset distances from the blast for a range of percentage likelihoods of exceedance at which compliance with the clay liner damage criterion of 1,375 mm/s is predicted to be met for the nominal MIC of 48 kg.

Table 7 Required Offset Distance versus Percentage of Likelihood of Exceedance for an MIC of 48 kg (Q)

Percentage Likelihood of Exceedance	Blast Vibration Prediction Formulae	Required Offset Distance for Compliance (R)
1%	PPV = 7,379 (R/Q^0.5)^-1.6	19.8 m
2.5%	PPV = 5,485 (R/Q^0.5)^-1.6	16.5 m
5%	PPV = 4,261 (R/Q^0.5)^-1.6	14.1 m
10%	PPV = 3,180 (R/Q^0.5)^-1.6	11.8 m
15%	PPV = 2,624 (R/Q^0.5)^-1.6	10.4 m
20%	PPV = 2,253 (R/Q^0.5)^-1.6	9.5 m
50%	PPV = 1,140 (R/Q^0.5)^-1.6	6.2 m

Based on a review of the data contained in **Table 6** and **Table 7**, the initial blasts, which should commence at the far point of the Creek Diversion and the Cell 4 excavation blasting, can be designed with confidence to comply with the nominated clay liner damage criterion whilst project specific ground vibration "site laws" are progressively developed, as outlined in **Section 7**.

In relation to the nominated clay liner vibration damage criteria, it is strongly recommended that prior to the commencement of the proposed blasting operation that a sample of the material used for the existing linings in Cells 1 and 2 is tested in order to determine the specific values of the geotechnical parameters presented in **Appendix B** in order to check the values used and to update the resulting vibration criterion, if required.

6 BLAST EMISSION MONITORING

6.1 General Procedure

The Programme of Blast Monitoring will be developed with reference to the procedures described in AS 2187, "*Explosives - Storage, Transport and Use*" and with reference to the HEPC's "*Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration*", September 1990.

The blast emissions will be quantified for all blast events conducted at the project site for both the excavation of Cell 4 and the Creek Diversion. It is anticipated that there would be approximately 8 blasts over a 4 month period.

In the event that the blasting contractor's blast monitoring equipment is unavailable for service, due to installation or calibration requirement throughout the monitoring programme, then blast emissions will be monitored by alternative calibrated instrumentation.

6.2 Monitoring Locations

Blast vibration monitoring will be conducted in the ground adjacent to the closest point of the clay liner to the blast and both ground vibration and airblast will be monitored at the Gundagai Bee Farms as well as at the closest residential receivers to a given blast.

6.3 Instrumentation Requirements - Blast Emission Monitors

Blast monitoring instrumentation at the Gundagai Bee Farms and at the closest residences will be employed to meet the primary specifications presented in **Table 8**. The instrumentation will be installed, operated and maintained by suitably qualified or trained personnel. The instruments will be externally calibrated at regular intervals throughout the period of the blasting.

Table 8 Far-field Blast Monitor Specifications

Specification	Vibration	Airblast
Resolution	0.016 mm/s	0.1 dB
Range	0.1 mm/s to 254 mm/s	88 dB to 148 dB
Accuracy	3% at 15 Hz	0.2 dB at 30 Hz
Sample Rate	Minimum 1024 samples per second per channel	
Frequency Response	2 Hz to 250 Hz (3 dB points)	
Communications Link	Keyboard and Modem	
Recording Mode	Full Waveform Recording and archiving	

The near-field blast vibration monitoring adjacent to the clay liner will be conducted using the following 24-bit data acquisition system:

- Rion DA-21 4-channel data recorder

The data acquisition system will be used in conjunction with a PCB 356A01 triaxial shock accelerometer located in the ground immediately adjacent to the clay liner.

7 BLAST DESIGN RECORDS AND PREDICTED EMISSION LEVELS

Blast design records will be maintained for all the individual blast events. The purpose of the records is to assist in the design and optimisation of future events, planning and control of blasting emissions and to provide a traceable system of documentation.

The blasting contractor will provide a description of blast parameters prior to each blast event and include the distance from the blast to the blast monitors and the maximum explosive mass (MIC) to be detonated in any 8 ms interval. An example of a suitable format for recording the significant blast design parameters (from AS 2187) is attached as **Appendix D**.

The blasts will be monitored at the closest/potentially most affected residence and at the near-point of a clay liner in order to establish compliance with the nominated criteria and to develop, and subsequently to progressively update, blast emissions site laws (ground vibration and airblast) in order to optimise future blast designs, based on actual site conditions.

In the blast emission site law graphs, the median of the measured data will be plotted. Further, in accordance with the EPHC human comfort criteria, allowance of exceeding the general airblast and ground vibration criterion for 5% of the total number of blasts, the “5% exceedance lines” will also be plotted. Using the 5% exceedance site laws, calculations will subsequently be conducted to determine the allowable MICs for compliance with the nominated blast emission criteria at the nearby residential receivers. In this way, the site laws can be used to assist with the blast designs in order to ensure compliance with the nominate clay liner criterion as well as the EPHC criteria at the nearby residences.

An example of a site specific blast vibration site law is attached as **Appendix E**. This site law also shows the median (50% exceedance) and the 5% exceedance lines for the AS 2187/Orica “generic” prediction formulae presented in **Section 4.2**.

Where, based on the site specific clay liner damage criterion and the blast emissions site laws, the MIC has to be progressively reduced, decking of the blasthole may be required in order to maintain a practical blasthole length.

Deck loading ("decking") is a method of loading blastholes where the explosive charges in the same hole are separated by stemming or an air cushion. A graphical illustration of a typical decked blasthole is presented in **Appendix F**.

By adopting this "site law" approach, it is anticipated that the blast emissions criteria can be met without imposing any significant constraints on the blast designs throughout the proposed period of blasting.

EPA LETTER OF 5 FEBRUARY 2016

NSW EPA

Our reference: EF13/5103 DOC16/16236-04
Contact: Mark Enright 02 6022 0603

The General Manager
Gundagai Shire Council
PO Box 34
GUNDAGAI NSW 2722

Attention: Brent Livermore

Dear Mr McMurray

Re Development Application 136/2015 - Proposed Solid Waste Management Facility

I refer to the development application and accompanying Environmental Impact Statement (EIS) received by the Environment Protection Authority (EPA) on 13 January 2016 for the proposed extension to the existing waste management facility at 303 Burra Road, Gundagai.

The EPA has reviewed the information provided in the EIS and determined that at this point in time we are unable to complete our assessment of the proposed development as there is insufficient information in the EIS for the EPA to fully assess the potential environmental impacts of the proposal.

It should be noted that the EPA, in a letter dated 26 August 2015 to the Department of Planning and Environment, provided detailed requirements and reference to guidance material for the preparation of an EIS for the proposed expansion of the waste management facility. Based on the EPA's assessment of the EIS these information requirements have not been fully addressed.

The identified deficiencies with the project assessment are outlined at Attachment A.

As discussed with Andrew Brock from Gundagai Shire Council on 4 February 2016 and Rohan Johnston from Salvestro Planning on 5 February 2016, in order for the EPA to be undertake a full assessment of the potential environmental impacts of the proposal, we require the additional information as detailed at Attachment B. Please note the EPA is available to meet with Council, the proponent and consultants to discuss our comments and additional information requirements.

In light of our request for additional information, we understand that the deemed refusal clock will be stopped from the date of receipt of this letter until the information is provided to the EPA. Please forward the additional information by email to southwest.region@epa.nsw.gov.au once it has been received so that we can assess the submitted information in a timely manner.

PO Box 544 Albury NSW 2640
Second Floor, Government Offices
512 Dean Street Albury NSW 2640
Tel: (02) 6022 0600 Fax: (02) 6022 0610
ABN 30 841 387 271
www.environment.nsw.gov.au

If you have any further enquiries about this matter please contact Mark Enright by telephoning 02 6022 0603.

Yours sincerely

BRIAN WILD 5 February 2016
Head, Albury Unit
Environment Protection Authority

cc Mr Garry Salvestro
Salvestro Planning
PO Box 73
WAGGA WAGGA NSW 2650

ATTACHMENT A

MH Earthmoving Pty Ltd has submitted a proposal to expand the quantity for waste approved to be landfilled at 303 Burra Road Gundagai from the current 150,000 tonnes to 750,000 tonnes. With the proposed expansion there would also be a corresponding extension of anticipated operation from the current 3 years to 15 years of operation for the proposed development.

The EPA understands that the landfill will only receive waste described as dregs and grits, fly ash and paper machine rejects from the Visy Pulp and Paper Mill at a rate of approximately 40,000 tonnes per year. The increase in landfill capacity will be created by constructing two new cells. One cell will be formed by diverting an unnamed creek to the nearby Spring Creek and filling the valley of the unnamed creek, while the second cell will be formed by excavating a void adjacent to the southern extent of the existing landfill cell. This work will involve significant earthmoving work and possibly blasting.

The EPA's assessment has identified the following areas of concern with regard to both the assessment of potential environmental impacts and the implementation of appropriate mitigation measures.

Groundwater Impacts

The EIS presents only a simple assessment of the groundwater based primarily on data obtained from the existing monitoring bores. This assessment has not adequately assessed the risks and required mitigation measures arising from groundwater/ landfill interaction.

For example, at Bore 2 (the only monitoring location inside the proposed excavation area for cell 3) the standing water level is approximately 277 AHD, which is 2 metres higher that the designed base of the landfill of 275.0 AHD (Drawing 24, chainage 140m). At this location there would be potential for groundwater ingress during construction or operation of the new landfill cell.

In addition to the potential for groundwater ingress along the base of the proposed cell 3, the EIS has not considered the potential for groundwater ingress due to underground springs or shallow water table in the areas where there will be deep excavation to form the benches in landfill cell 3. We also note that some of the benches are more than 6 metres below natural ground level.

The EPA is of the view that these issues must be considered in more detail given that the near surface rock is identified as highly fractured, and cell 3 is to be located in a former watercourse, a location identified as an environmentally sensitive area in the EPA's *Environmental Guidelines: Solid waste landfills.*

Where groundwater water ingress is likely or possible then information should be provided in the EIS on proposed measures to manage that ingress (eg groundwater depressurisation).

Existing Groundwater Monitoring

The EIS states no negative impacts to groundwater based on consideration of the monitoring results for pH. However, for Bore 1, it is noted that some of the monitored parameters have increased since operations commenced. The EIS should include a thorough review of all relevant monitoring data including a trend analysis, identify any adverse trends, and provide details of any proposed actions to manage and mitigate environmental impacts.

Leachate collection, storage and disposal

The EIS has not undertaken an assessment of the volume of leachate likely to be generated by the proposed landfill expansion, and consequently there is no consideration of the possible need to

upgrade the leachate management system and storage capacity to deal with the leachate generated from the expanded landfill operation.

We also note that the proposed method of leachate disposal is removal by a licensed contractor for appropriate treatment and disposal at a licensed liquid waste facility, or by evaporation. The EPA requires additional information about the location of the licensed liquid waste treatment plant(s) and/or the management of leachate by storage and evaporation.

Surface water controls

The proposed development will involve a significant area of land disturbance, diversion of a creek into a new 260 metre long channel and construction of a landfill cell in a valley. The EIS has not assessed the potential for erosion and sediment runoff or provided details on the strategies that will be implemented to control and mitigate potential surface water impacts. In addition, the EIS must detail the management the entry of surface runoff into the landfill cells and the associated impact on leachate generation.

Odour impact assessment

The EIS has not assessed the likely odour impact from the proposed landfill operation or detailed mitigation strategies. The information and assessment of odour impacts in the main report is limited to a brief discussion of the odour assessment for the former initial development, and the inclusion of this report as an appendix. The original assessment has not been updated for the new proposal.

Dust impact assessment

The EIS has not assessed the likely dust impact from the construction and operation of the proposed landfill development. The assessment of dust emissions is based on the assessment report for the initial development, and the proposed mitigation is limited to general statements about measures that may be implemented to reduce off-site impacts. With the expanded area and volume of landfilled waste and the major earthworks required to construct the new cells and divert the unnamed creek, the EPA considers there is potential for a significant increase in the generation of dust emissions from the site. This has not been adequately considered in the EIS.

Noise impact assessment

The EIS has not assessed the likely noise impacts from the proposed construction activity and landfill operation. The assessment of noise impacts presented the EIS is limited to a brief discussion of the results of the previous noise assessment for the initial development and the inclusion of this report as an appendix. The noise mitigation proposed is limited to general statements about measures that may be taken to reduce off-site impacts. With the expanded operation and the significant construction work required to build the new cells and divert the unnamed creek, there is potential for an increase in the generation of noise emissions from the site, particularly related to construction. This has not been adequately considered in the EIS.

Road traffic noise

The EIS does not assess the periodic road traffic impacts arising from the importing to site the significant quantities of clay required for construction of the leachate liners and landfill caps, or the transport of leachate to offsite liquid waste treatment facilities.

Blasting impacts

The EIS incorrectly states blasting has been approved for the site. The approval for blasting was a modification to the original development consent to deal with a specific one-off situation, and was not a general approval.

The EIS has not assessed blasting impacts for the proposed development. If blasting is anticipated or planned as part of this proposal, then the EIS must provide an assessment in accordance with the blasting guidelines as per Attachment B. Given the need to use blasting for the establishment of the existing landfill cell, the EIS must identify if blasting will be required for deeper excavations associated with the proposed development. If blasting is anticipated then these impacts need to be assessed, and where required, mitigated.

Waste classification

The waste classification of the proposed waste streams presented in the EIS was from a single round of testing undertaken as part of the assessment for the original development in 2013. With the six fold expansion in volume and duration, the EPA considers additional analysis and results are required to confirm the classification of waste being received at the facility.

Landfill gas emissions

The EIS has not assessed the emission of landfill gases for the proposed development. Although the waste is classified as non-putrescible, it does contain organic matter (mainly paper) which will break down over time and generate landfill gas. With the sixfold increase in volume of waste the landfill gas emission should be estimated, and following this assessment the need or otherwise of landfill gas controls and monitoring can be determined. The previous assessment undertaken by Advitech Environmental (2013) for the original development has been referenced and included as an appendix, but has not been updated for the new proposal.

ATTACHMENT B

In order for the EPA to assess the project we require the proponent to provide following information.

Groundwater Impacts

1. Accurately determine the depth to groundwater relative to the base and benches for landfill cell 3 and the base of cell 4, and for this information to be used to update the long section drawing along the base of cell 3 and the cross section drawing of cell 3 and cell 4 to include groundwater levels.

2. Detail intended measures to manage any groundwater ingress during construction.

3. Detail the intended control measures to prevent damage to the leachate barrier system where high groundwater levels could affect the stability and performance of the leachate barrier.

4. Detail the intended mitigation measures in the event of failure of the landfill leachate barrier system.

Existing ground watering monitoring

Provide a thorough assessment of the groundwater monitoring from the existing premises for all monitored analytes. The assessment should include the identification of trends and any proposed mitigation measures.

Leachate collection, storage and disposal

1. Undertake a water balance calculation to determine the size of the leachate storage dam. This calculation must include the estimated contribution from all cells at the landfill, including capped cells, cells with intermediate cover, and the active cell. Adopted infiltration percentages should be based on proven landfill assessment tools such as *the Hydrological Evaluation of Landfill Performance* model or equivalent method.

2. Provide further details on the sustainable disposal of leachate. If offsite disposal options such as disposal to sewer are to be adopted, then evidence of an in principal agreement by the relevant authorities should also be included.

Surface Water Controls

Provide details of the proposed surface water management and controls in accordance with the guidance in *Managing Urban stormwater: Soils and Construction Volume 1* and *Volume 2B Waste Landfill.* Additional information must include details of measures to be installed to minimise erosion and sediment runoff impacts during the construction phase, prevent ingress of stormwater into to the leachate system, contamination of runoff by contact with waste, and prevent erosion and sediment impacts from exposed area such as new landfill cell caps. This information should include details of proposed sediment basins and how the collected runoff will be treated and disposed of.

Odour impacts

1. An odour impact assessment undertaken in accordance with *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (DECC, 2005)* and *Technical framework: Assessment and Management of Odour from Stationery Sources in NSW (DECC, 2006).* The assessment must include all potential sources of odour.
2. As previously advised, for the purposes of complying with this requirement the *Air Quality and Greenhouse Gas Impact Assessment* prepared by Advitech Environmental (20 March 2013) may be used as the basis of this assessment, provided it updated to include all aspects of the proposed development.

3. If odour impacts are predicted to occur, the additional information must detail the measures to will be implemented to ensure the proposed development will not cause off site odour impacts in excess of the EPA's criteria.

Dust Impacts

1. A dust impact assessment undertaken in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (DECC, 2005). The assessment must include all potential sources of dust, including dust emissions from the cartage, placement and compaction of waste material, and from all construction activity, including excavation, cartage, landscaping, material handling, crushing or processing of material on site, placement of clay liner and drainage layer, and wind erosion from exposed surfaces.
2. As previously advised, for the purposes of complying with this requirement the *Air Quality and Greenhouse Gas Impact Assessment* prepared by Advitech Environmental (20 March 2013) may be used as the basis of this assessment, provided it is updated to include all construction and operational aspects of the proposed development.
3. If dust impacts are predicted to occur, the additional information must describe the measures to will be implemented to ensure the proposed development will not cause off site odour impacts in excess of the EPA's criteria.

Noise impacts

1. Noise impact assessments for the proposed development undertaken in accordance with the following EPA guidelines as applicable:
   - Operational noise - NSW Industrial Noise Policy (EPA, 2000)
   - Construction noise - Interim Construction Noise Guideline (DECC 2009)
   - Road traffic noise - NSW Road Noise Policy (DECCW, 2011)

   The assessments should demonstrate that the proposal is unlikely to result in adverse noise and vibration effects in the surrounding community.

2. As previously advised, for the purposes of complying with this requirement the *Noise Impact Assessment* prepared by Advitech Environmental (14 March 2013) may be used in the assessment of operational, construction and road traffic noise , provided it is updated to include all aspects of the proposed development (both operational and construction).

3. If the predicted noise level exceeds the relevant noise criteria, then mitigation measures must be proposed that will enable the criteria to be met.

Blasting impacts

1. Blasting overpressure and ground vibration at nearby residences should be assessed in accordance with the criteria in *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* (Australia and New Zealand Environment Council, 1990).

2. Based on the geology of the site, the EIS must also provide an estimate of the number of blasts and duration of blasting activity that may be required for all construction activity.

3. An assessment of the ground vibration impacts on the landfill liner from the blasting activity, and the proposed blast design, monitoring and review criteria that will be adopted to ensure that the existing liner will not be compromised by any blasting activity.

Waste Classification

1. Provide a current classification of waste based upon analysis of adequate representative samples of all waste streams that have been tested and classified in accordance with the EPA guideline *Waste Classification Guidelines, Part 1: Classifying Waste* (EPA 2014).

2. Include in the EIS all relevant waste monitoring analysis undertaken by the waste generator.

Landfill Gas Emissions

1. Calculate the likely landfill gas emissions from waste material decomposition based on the percentage of organic content in the waste and the volume landfill.

2. Based on the predicted emissions, undertake a landfill gas risk assessment to determine the need or otherwise for landfill gas controls.

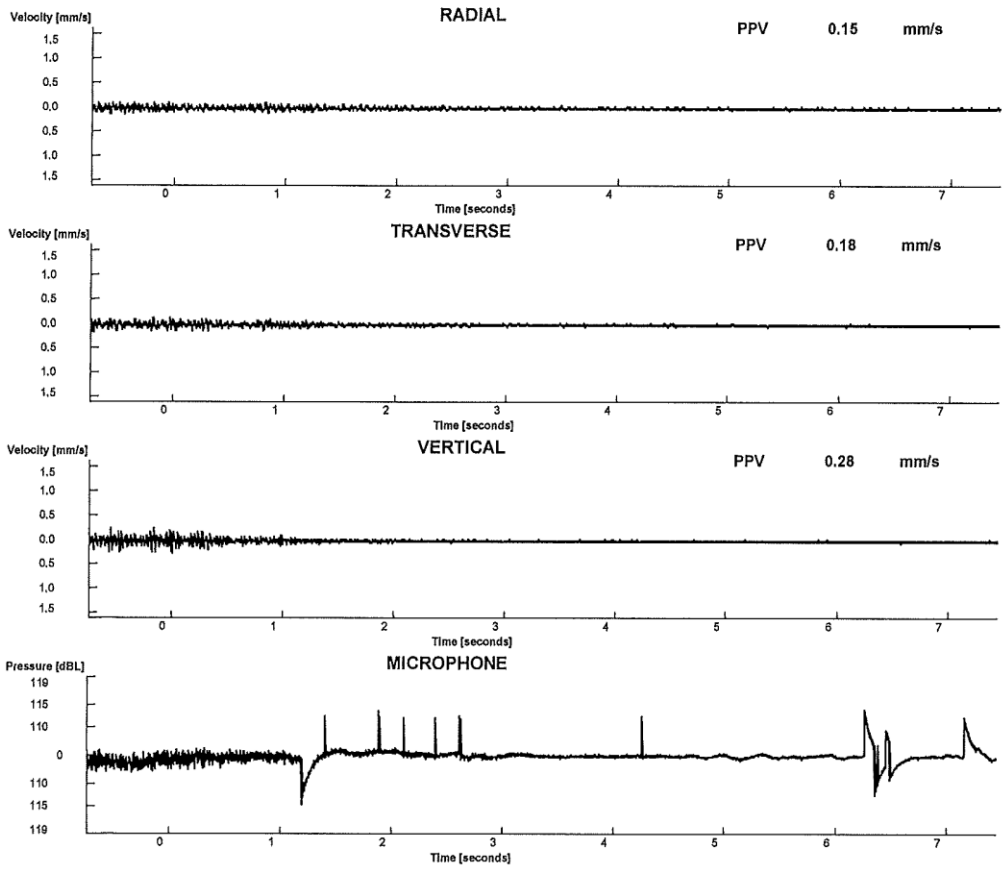
CLAY LINER VIBRATION DAMAGE CRITERION

Clay P-wave velocities:	**1100**	m/s	Range: 1100 to 2500 m/s saturated;Dowding (tables 2.3/3.3): 400 (heavily jointed) to 1700 (non-jointed) m/s
Density:	**1800**	kg/m^3	Other ref says 2000 to 2400 kg/m^3
Young's modulus:	40	MPa	Very soft: 0.5 to 5; medium 5-8; stiff to v stiff: 8-30; hard: 30-70 MPa
Maximum allowable strength; tensile strength:	**50**	kPa	
Corresponding strain:	0.00125	-	
Strain in %:	0.13%		
Allowable PPV resulting in the maximum strength:	**1375**	**mm/s**	**Dowding eq 2-10, ie PPV = strain * P-wave velocity**

BLAST RESULTS FROM 12 DECEMBER 2013

MHE Gundagai Recycle Pit

Location: 300 Burra Rd
Time: 11:10:54
Date: 12 Dec 2013



BLAST RESULTS

Peak Vector Sum Velocity	**:**	**0.28 mm/s**
Peak Overpressure	**:**	**113.7 dBL**

Monitoring conducted by: .....
(Southern explosive supplies:james micah)

Checked by: .....

TM Serial Number : 3013 **Last Calibration:** 24 Apr 2013

BLAST DESIGN RECORD SHEET

FORM B

GENERAL ..... DATE .....

QUARRY/MINE ..... BENCH LOCATION .....

WEATHER ..... WIND DIRECTION ..... STRENGTH .....
BLAST TYPE ..... BLAST SITE ..... TIME .....
ROCK TYPE ..... OTHER .....

BLAST DETAILS

Burden ..... m Spacing .....
Face height ..... m Stemming .....
Blast hole:
Diameter ..... Nos .....
Row 1 depth ..... m Subgrade ..... Vertical angle .....
Row 2 depth ..... m Water depth ..... m

Charge details ..... Total quantity ..... kg
Mass per hole ..... kg Mass per delay ..... kg
Initiation (sequence/time delays) .....

MONITORING DETAILS

Test by ..... Test site .....
Equipment .....
Settings .....
Blast distance ..... m
Scaled distance ..... m/kg
Measured ground vibration ..... mm/s
Airblast ..... dBL

SKETCH OF BLAST

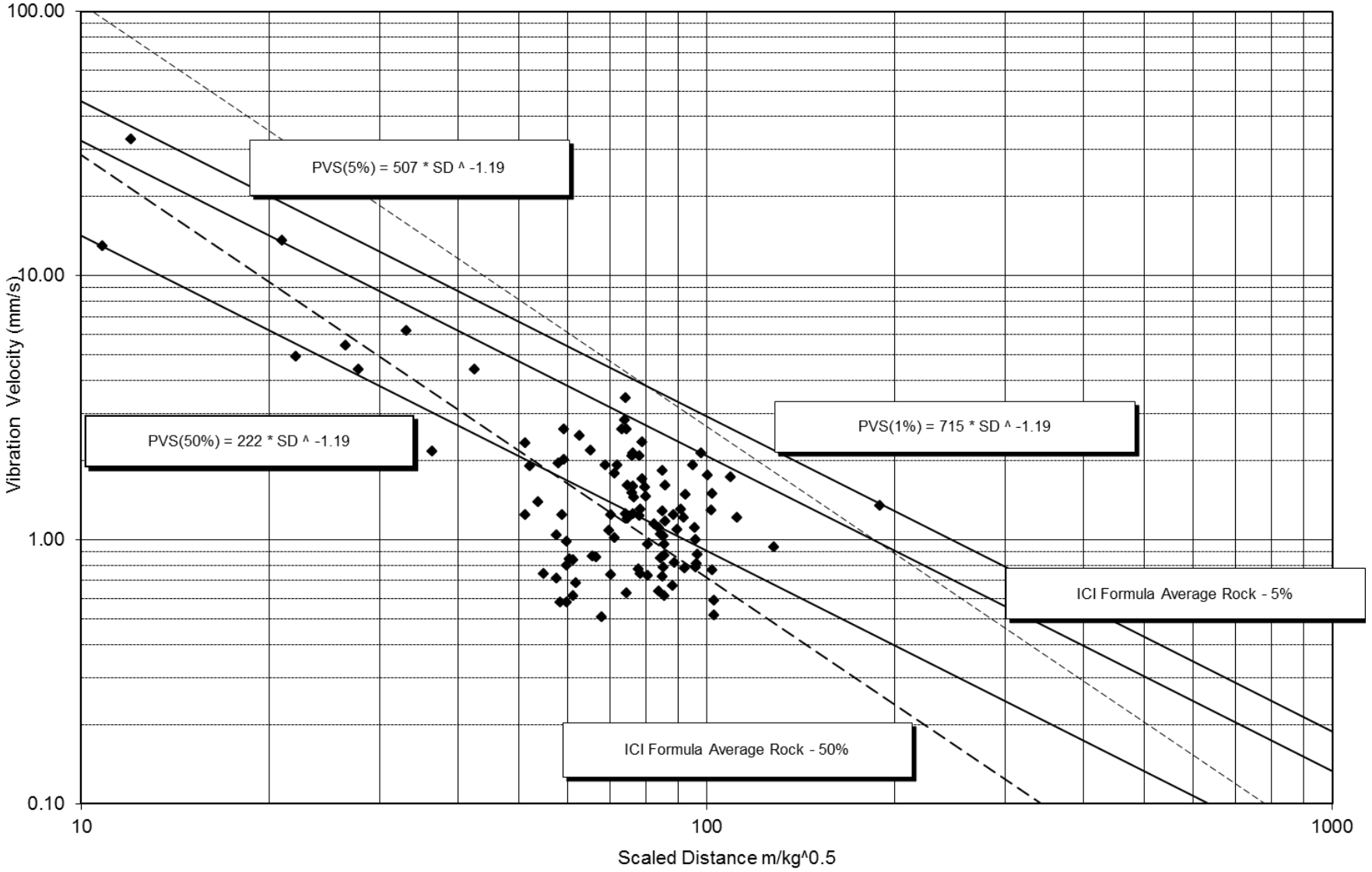
ADDITIONAL DETAILS AND POST-BLAST COMMENTS

.....

.....

SIGNATURE .....
SHOTFIRER

BLAST VIBRATION VELOCITY SITE LAW - 106 DATA POINTS



TYPICAL DECKED BLASTHOLE DESIGN