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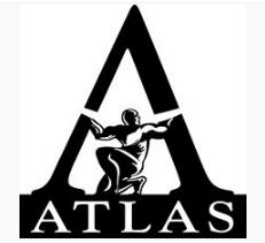
Miralga Creek Project

Environmental Noise and Vibration Impact Assessment



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Executive Summary

This report summarises an environmental Noise and Vibration Impact Assessment undertaken for Atlas Iron's proposed Miralga Creek Project, located 40km Northwest of Marble Bar, Western Australia.

Based on the outcomes of the noise modelling and analysis, the following has been concluded:

- **Mining Noise (Section 4)** – Received noise levels from Miralga Creek's proposed mining operations are predicted to comply with the Environmental Protection (Noise) Regulations [2] at the Abydos Camp for all proposed mining locations including Sandtrax, Miralga West and Miralga Creek at all times of day.
- **Blast Noise (Section 5.2)** – Received noise from blasting is predicted to comply with the Regulations.
- **Ground Borne Vibration from Blasting (Section 5.3)** – Ground borne vibration impacts are predicted to comply with AS2187.2 for building integrity and human comfort.
- **Bat Caves and Heritage Areas (Section 6)** – Noise and ground borne vibration levels have been calculated at various distances, for reference should a sensitive bat cave or heritage area be identified.

This study has concluded that proposed operations for the Miralga Creek Project comply with the relevant Regulations [2], and as such, no mitigation actions are required or proposed for the project.

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1 Introduction

This report summarises an environmental noise and vibration impact assessment undertaken for Atlas Iron's proposed Miralga Creek Project, located 40km Northwest of Marble Bar, Western Australia.

1.1 Aim

The aim of the assessment is to determine environmental noise and vibration levels (and impacts where applicable) of the proposed Miralga Project.

1.2 Scope

The scope of this report includes the following:

- A noise impact assessment of Miralga Creek's mining noise on the Abydos Camp.
- Predictions of received blast noise and vibration levels at surrounding bat caves and heritage areas.

1.3 Applicable Documents

[1] Environmental Protection Act 1986.
[2] Environmental Protection (Noise) Regulations 1997.
[3] Draft Guidance Note 8 Guideline on Environmental Noise for Prescribed Premises.
[4] Australian Standard AS2187 "Explosives – Storage, Transport and Use".

1.4 Project - Overview

The proposed Miralga Creek Project will involve mining three deposits; Miralga Creek, Miralga West and Sandtrax ore bodies over the life of mine (see Figure 1-1).

Abydos Camp (see Figure 1-2) is located at distances ranging from 10km to 40km from the three deposits. The camp, shown in Figure 1-2, is located ≈10km West of Sandtrax the nearest ore body.

There are also a number of bat caves and heritage areas that surround the project.

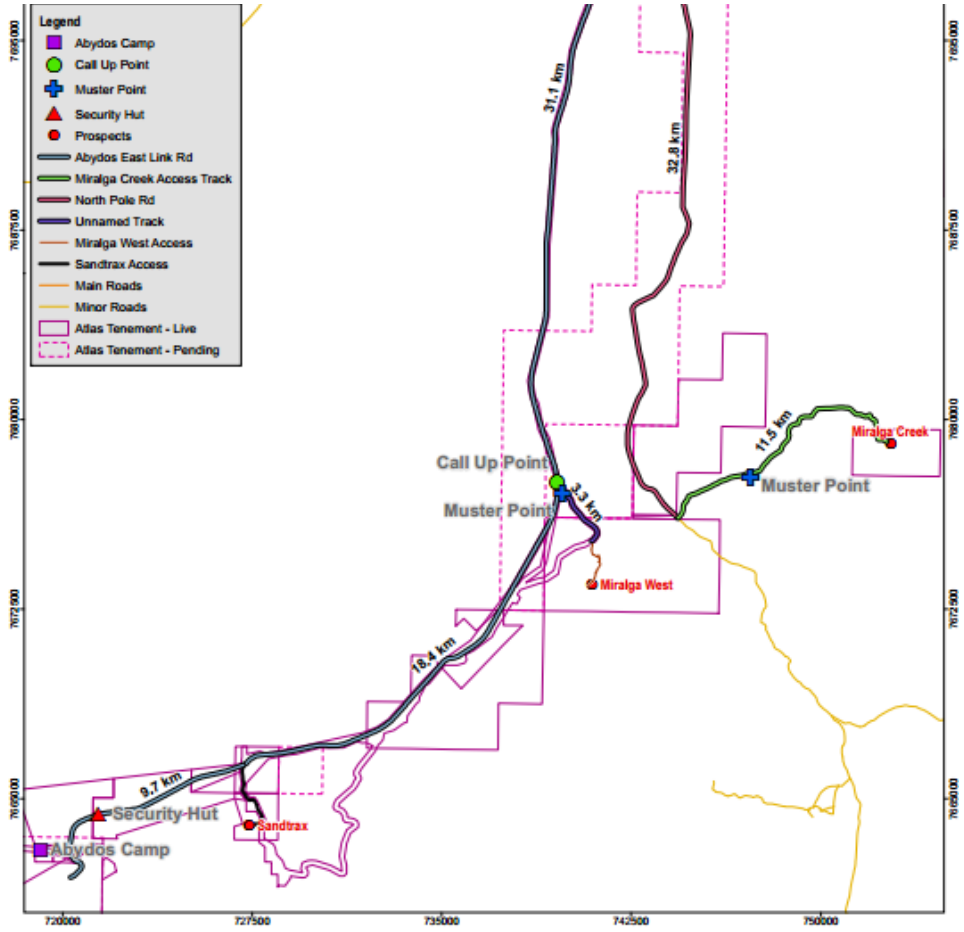

Figure 1-1 Location of proposed Miralga Creek Project and Abydos Camp

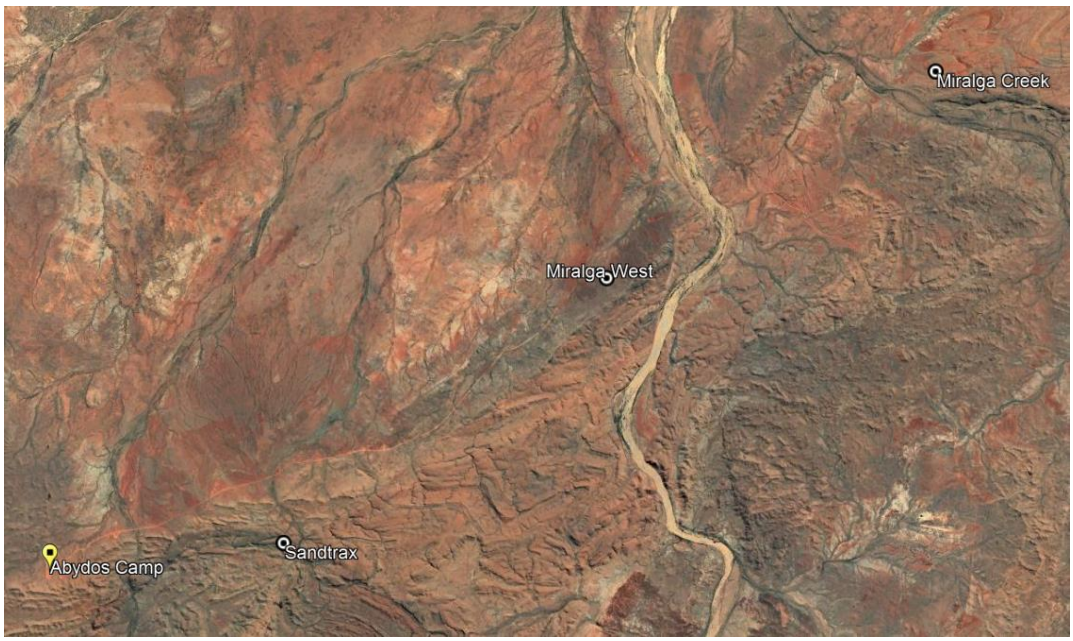

Figure 1-2 - Location of proposed ore bodies and Abydos camp receiver (Source: Google Earth)

2 Assessment Criteria

The applicable assessment criteria for this study can be divided into the following two components:

- Operations Noise **(Section 2.1).**
- Blasting Noise and Vibration (**Section 2.2)**

2.1 Environmental Protection (Noise) Regulations

Received noise has been assessed against the Regulations [2]. The Regulations define maximum allowable noise levels which apply to noise received at sensitive premises, such as residential areas. These are determined by a combination of a base noise level plus an Influencing Factor (IF). The result is termed the "assigned level".

The assigned noise levels include L_{A1}, L_{A10} and L_{AMAX} noise parameters, defined as;

- L_{ASMAX} means an assigned level which is not to be exceeded at any time;
- L_{AS1} means an assigned level which is not to be exceeded for more than 1% of time;
- L_{AS10} means an assigned level which is not to be exceeded for more than 10% of time.

For noise sensitive premises, the time of day also affects the assigned levels. As the proposed operations will occur 24 hours a day, 7 days a week, the noise emissions have been assessed against the most stringent night-time assigned levels (10pm-7am).

2.1.1 Assigned Noise Levels

Table 2-1 presents the L_{A10} assigned noise levels for noise sensitive receivers, which will be used to assess received noise levels at the Abydos mining camp.

Table 2-1 : Assigned Noise Levels as defined in the Environmental Protection (Noise) Regulations

Sensitive Receiver	Time of day	Assigned Levels (dB)		
		L_{A10}	L_{A1}	L_{Amax}
Noise Sensitive Premises	0700 to 1900 hours Monday to Saturday	45 + influencing factor	55 + influencing factor	65 + influencing factor
	0900 to 1900 hours Sundays and public holidays	40 + influencing factor	50 + influencing factor	65 + influencing factor
	1900 to 2200 hours all days	40 + influencing factor	50 + influencing factor	55 + influencing factor
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays	35 + influencing factor	45 + influencing factor	55 + influencing factor

2.1.2 Influencing Factor

The Influencing Factor (IF) is based on the surrounding land use adjacent to the noise sensitive receiver including the amount (%) of industrial and commercial premises and the number and proximity of major and secondary roads. Due to its location, the Abydos Camp has no influencing factor.

2.1.3 Applicable Assigned Level

As shown in Table 2-2 the applicable night time assigned L_{AS10} at Abydos Camp (R1) is **35** dB(A).

Table 2-2 Assigned Noise Levels (night-time 2200-0700)

Receiver	Applicable Assigned Noise Level		
	L_{AS10}	L_{AS1}	L_{ASMAX}
Abydos Camp (R1)	35	45	55

2.1.4 Adjustments for intrusive or dominant characteristics

Received noise levels are subject to adjustments if the noise exhibits intrusive or dominant characteristics i.e. if the noise is impulsive, tonal or modulating. These adjustments, shown in Table 2-3, are cumulative up to a maximum of 15 dB.

Section 9 of the Regulations sets out objective tests to assess whether the received noise is free of these characteristics. A definition of tonality, impulsiveness and modulation as defined by Regulation 9 is presented in Appendix A1.

Table 2-3 : Adjustments For Intrusive Or Dominant Characteristics (Cumulative To Maximum 15 dB)

Tonality	Modulation	Impulsiveness
+ 5dB	+5 dB	+10 dB

As the distance from the Miralga Creek Project to the receiver is greater than 10km, it is unlikely that at this distance that the received mining noise will have any measurable tonal, impulsive or modulating characteristics. As a result no adjustments have been applied.

2.2 Blasting

Blasting is an irregular mining activity that creates high instantaneous noise and vibration levels at the source. Due to the nature of blasting, the Regulations define different noise criteria for this activity.

2.2.1 Noise Limits

Table 2-4 outlines the blast noise limits defined in the Regulations [2]. Blasting will be carried out during day-time hours, thus the most applicable limit is 125 dB (Monday – Saturday) and 120 dB (Sundays and Public holidays).

Table 2-4 Blasting Noise Limits

Time Period	Noise Limit dB Peak (Lin)	Applicable to
Day-time (7 am to 6 pm), except Sundays or public holidays	125	Any blast
Day-time (7 am to 6 pm), except Sundays or public holidays	120	9 in 10 consecutive blasts
Sundays & Public Holidays (7 am to 6 pm)	120	Any blast
Sundays & Public Holidays (7 am to 6 pm)	115	9 in 10 consecutive blasts
Night-time (6 pm to 7 am) on any day	90	Any blast

2.2.2 Ground-Borne Vibration Limits

Ground borne vibration impacts from blasting have been assessed using acceptable levels defined in Australian Standard AS2187.2 and German Standard DIN4150. The types of impacts associated with this ground borne vibration have been categorised as follows:

- Structural damage of buildings.
- Disturbance (i.e. the potential for ground borne vibration from blasting to disturb people sleeping).

The levels recommended in these standards could also potentially be used to estimate the likelihood of structural damage to heritage sites and bat caves as well disturbance at meeting grounds and inside bat caves.

2.2.2.1 Structural Damage

The accepted vibration parameter for blasting is ground borne particle velocity at the receiver (in mm/s). Table 2-5 presents the vibration levels defined in Appendix J of AS 2187.2.

Table 2-5 Vibration Limits – Building Structural Integrity

Type of Building Structure	Peak Particle Velocity (mm/s)
Houses and low-rise residential buildings and commercial buildings	10

2.2.2.2 Disturbance

Ground-borne vibration from blasting has the potential to cause sleep disturbance which can result in fatigue. It is therefore considered a safety concern. Blasting is limited to day-time hours and therefore its impacts are expected to be limited to shift workers sleeping during day-time hours.

Human comfort vibration levels available in literature are shown in Table 2-6. These were used when considering vibration levels at which sleep disturbance could occur.

Table 2-6 Blasting Vibration Limits – Human Discomfort

Literature	Description	Peak Particle Velocity (mm/s)
AS2187.2 2006	95th percentile for human comfort	5
German Standard DIN4150	Vibration is Noticeable	1
	Vibration is Easily Noticeable	2.2
	Vibration is Strongly Noticeable	6

3 Noise Modelling Overview

3.1 Noise Model Software

A desktop environmental noise model was created to simulate the proposed project using the SoundPlan v8 software program. This software package calculates sound pressure levels at nominated receiver locations and produces noise contours over a defined area of interest. SoundPlan can be used to model different types of noises, such as industrial noise, traffic noise and aircraft noise.

The inputs required by the SoundPlan modelling software are noise sources, ground topographical and absorption data, meteorological data and sensitive receiver point locations. SoundPlan utilises ISO9613 for calculating the attenuation of sound during outside propagation in combination with CONCAWE[1,2].

3.2 Noise Model Inputs

3.2.1 Noise Sensitive Receiver

Table 3-1 presents the location of noise sensitive receiver used in this assessment to predict noise levels within the community, which were previously shown in Figure 1-2.

Table 3-1 : Noise Sensitive Receivers

Reference	Description	GPS Location (UTM, MGA94)	
		Northings	Eastings
R1	Abydos Camp	7662987	719170

3.2.2 Topography

Ground topography provided by Atlas Iron has been imported into the model and used to create a Digital Ground Map (DGM).

3.2.3 Ground Absorption

The acoustic properties of the ground surface can have a considerable effect on the propagation of noise. Flat non-porous surfaces such as concrete, asphalt and water are highly reflective whereas soft, porous surfaces such as foliage and grass are highly absorptive. A CONCAWE ground factor of G=0.8 was applied to the model.

[1] CONCAWE (Conservation of Clean Air and Water in Europe) was established in 1963 by a group of oil companies to carry out research on environmental issues relevant to the oil industry.

[2] The propagation of noise from petroleum and petrochemical complexes to neighbouring communities, CONCAWE Report 4/81, 1981.

3.2.4 Meteorological Conditions

SoundPlan calculates noise levels for defined meteorological conditions. In particular, temperature, relative humidity, wind speed and direction data are required as input to the model.

Table 3-2 presents the worst case meteorological conditions applied to the model, which are defined in the DWER "*Draft Guideline on Environmental Noise for Prescribed Premises*".

Table 3-2 : Worst-Case Meteorological Conditions for Noise Propagation

Time of day	Temperature	Relative Humidity	Wind Speed	Wind Direction	Pasquil Stability Category (PSC)
Night (19:00 - 07:00)	15° Celsius	50%	3 m/s	worst case	F

3.2.5 Noise Sources

A list of fixed and mobile mining equipment was provided by Atlas. This list was used to determine Sound Power Levels (SWLs) from equivalent equipment measured on other iron ore mine sites (see Table 3-3 and Appendix B for a list of equipment source levels and third octave frequency band levels).

The entire fleet listed in Table 3-3 was placed in the model scenario for each area (Miralga Creek, Miralga West and Sandtrax). It is unlikely that 100% utilisation would be achieved in-situ and therefore this is considered conservative.

Table 3-3 : Equipment Noise Sources Included

Equipment Details	Quantity	Sound Power Level per item, in dB(A)
Haul Trucks	3	117.1
Dozer	1	113.7
Excavator	1	109.9
Front End Loader	1	113.8
Grader	1	111.8
Service Vehicle	1	111.0
	Total	**123.8**

3.3 Noise Model Scenario

Three scenarios were modelled to represent operations in ore bodies at Miralga Creek, Miralga West and Sandtrax. A worst case approach has been adopted, whereby assuming that all mining equipment listed in Table 3-3 will operate simultaneously in each scenario.

As the operations are greater than 10km from Abydos Camp, the noise source levels for all equipment items have been calculated and combined into a point source which has been modelled in each area (Miralga Creek, Miralga West and Sandtrax).

4 Noise Model Results

Table 4-1 presents the predicted received noise levels at the Abydos Camp for mining occurring in each of the three ore bodies, and a comparison against the assigned noise levels.

Table 4-1 : Noise Modelling Results

Scenario No.	Description	Assigned LA10 Level Night-time (10pm to 7am)	Received LA10 Noise Level at Abydos Camp	Exceedence in dB
1	Mining at Sandtrax	35	24.7	Nil
2	Mining at Miralga West		7.1	Nil
3	Mining at Miralga Creek		1.5	Nil

Figure 4-1 shows a noise contour map for the worst case modelled scenario, which includes mining at Sandtrax (scenario 1), the nearest operations to the Abydos Camp.

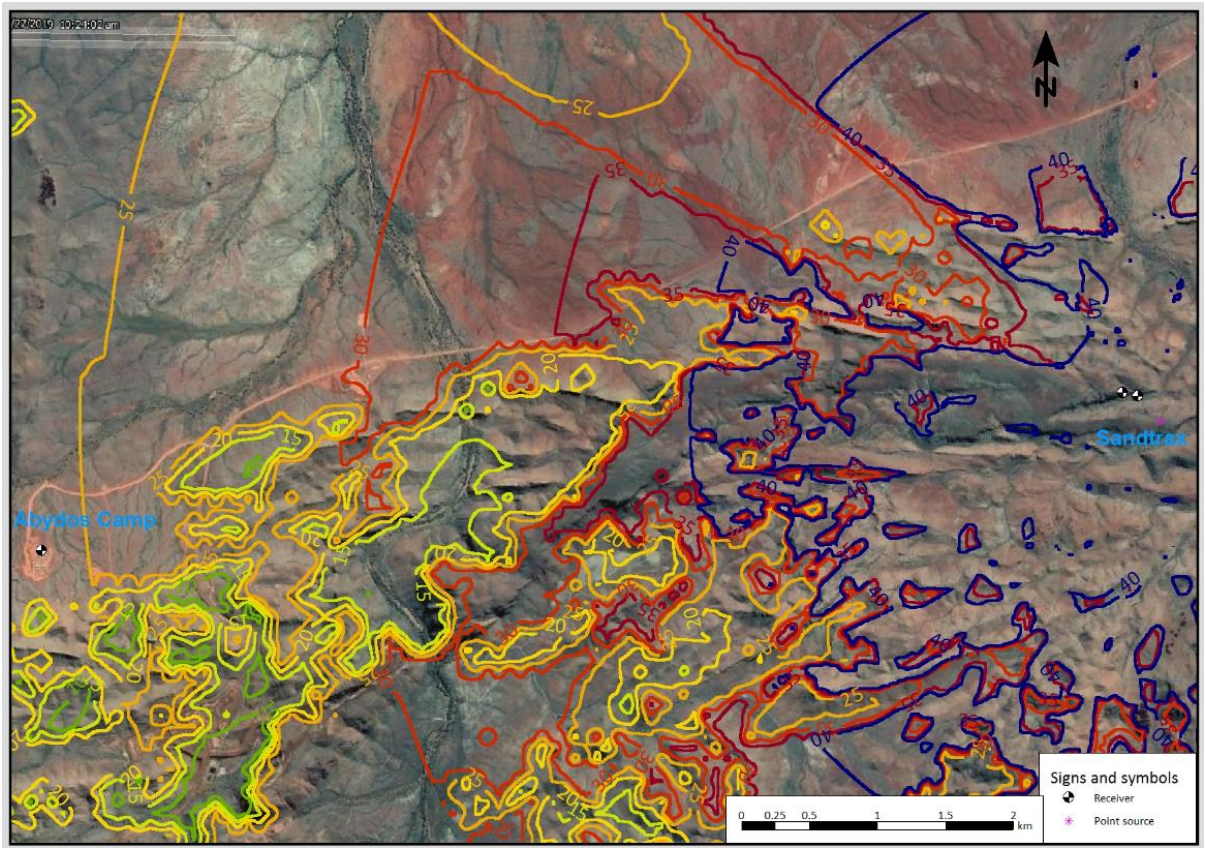

Figure 4-1 Noise Contour Map - Sandtrax

4.1 Results Discussion

As can be seen from the results, the predicted received noise levels at the Abydos Camp comply with the assigned noise levels at all times. As a result, no mitigation is required.

5 Blasting

A desktop assessment has been undertaken to predict the potential noise and vibration levels from Blasting at Sandtrax, on the Abydos Camp.

5.1 Blast Parameters

Table 5-1 presents the blast parameters used to undertake the blasting noise and vibration assessment, which have been provided by Atlas.

The most significant parameter for blast noise and vibration emissions is weight of explosives per hole. The assessment assumes a maximum instantaneous charge of 1 hole at 30kg of explosives per hole for 5m benches, with a detonation delay of ≥ 1 ms.

Table 5-1 Typical Blasting Parameters

Parameter	Typical Blast Parameters
Explosive per hole	30 kg
Instantaneous detonation	1 hole
Depth	5 m
Hole Diameter	115 mm
Emulsion	ANFO

5.2 Blast Noise Assessment

The peak noise level from blasting has been predicted using the following empirical formula Defined in AppendixJ7.2 of Australian Standard AS2187.2 Explosives – Storage and Use;

$$P = K(\frac{R}{Q^{1/3}})^{a}$$

where;

- **P** is pressure, in kilopascals
- **Q** is the explosives charge mass, in kilograms
- **R** is the distance from charge, in metres
- **K** is the site constant (A site constant of 55 has been used for this assessment)
- **a** is the site exponent (A site exponent of -1.45 is used for this assessment)

Table 5-2 provides calculated peak instantaneous noise levels ($dB_{Lin,\ peak}$), which are based on a maximum instantaneous charge of 30kg.

Table 5-2 Blasting Results

Receiver	Blast Location	Noise Limit single blast (dBlin, peak)	Calculated Level (dBlin, peak)
Abydos Camp	Sandtrax	125	89.8

5.3 Ground Borne Vibration Assessment

Ground borne vibration levels have been estimated using blast parameters provided by Atlas (see Table 5-1) and the vibration prediction formula defined in AS2187.2[3], which is as follows;

$$V = K(\frac{R}{Q^{0.5}})^{-B}$$

Where:

- **V** is the ground vibration peak particle velocity in mm/s.
- **R** is the distance between the detonation and the receiver.
- **Q** is the maximum instantaneous charge in kg.
- **K** and **B** are empirical constants related to site and rock properties. Where 'K' refers to the site confinement conditions (i.e. free face, quarry, heavily confined blasting) and 'B' refers to expected rock types.

The values used for the calculation include a peak detonation of 30 kg/hole and site and rock properties for 'average' free field conditions defined in AS2187 of K=1140, B=1.6.

5.3.1 Results

For the Sandtrax area, the calculated ground borne vibration levels (mm/s) from blasting is very small at 0.01 mm/s.

Blasting is predicted to comply with AS2187.2 vibration criteria for building damage and human comfort, and therefore no mitigation is required.

[3] Square Root scaling of charge per delay. Nichols et al 1971 (Nichols, H.R., Johnson, C.F., and Dewall, 1971 "Blasting Vibrations and their effects on structures, Bureau of Mines bulletin 656").

6 Bat Caves and Heritage areas

There are a number of bat caves and heritage areas surrounding the Miralga Creek Project. Noise and ground borne vibration levels from mining and blasting have been predicted at various distances so they can be used to determine potential received levels at bat caves and heritage areas.

As the hearing bandwidths of the bats is not known all results in the following sections have been presented as **Linear**[4] (unweighted) overall and third octave band levels so that they can be used to determine applicable bat weighted received levels once the hearing bandwidths for bats is established.

6.1 Noise

Table 6-1 and Figure 6-1 present predicted received noise levels for operations (dB Lin) and blasting (dB Lin Peak) at various distances within which bat caves and heritage areas may be identified.

Table 6-1 Predicted Received Noise Levels with distance

Distance (m)	Operations Noise[5] (Table 3-3), in dBLin	Blast Noise, in dBLin Peak
100	75	145
200	70	136
300	66	131
400	63	128
500	61	125
600	59	123
700	58	121
800	56	119
900	55	117
1000	54	116

[4] Bats hear different noise levels in different frequency bands to humans and therefore dB Lin (unweighted) noise levels have been provided.

[5] For operational noise impacts on bat caves, an excavator and dozer are both operating simultaneously, as this is a representative operational scenario within a pit.

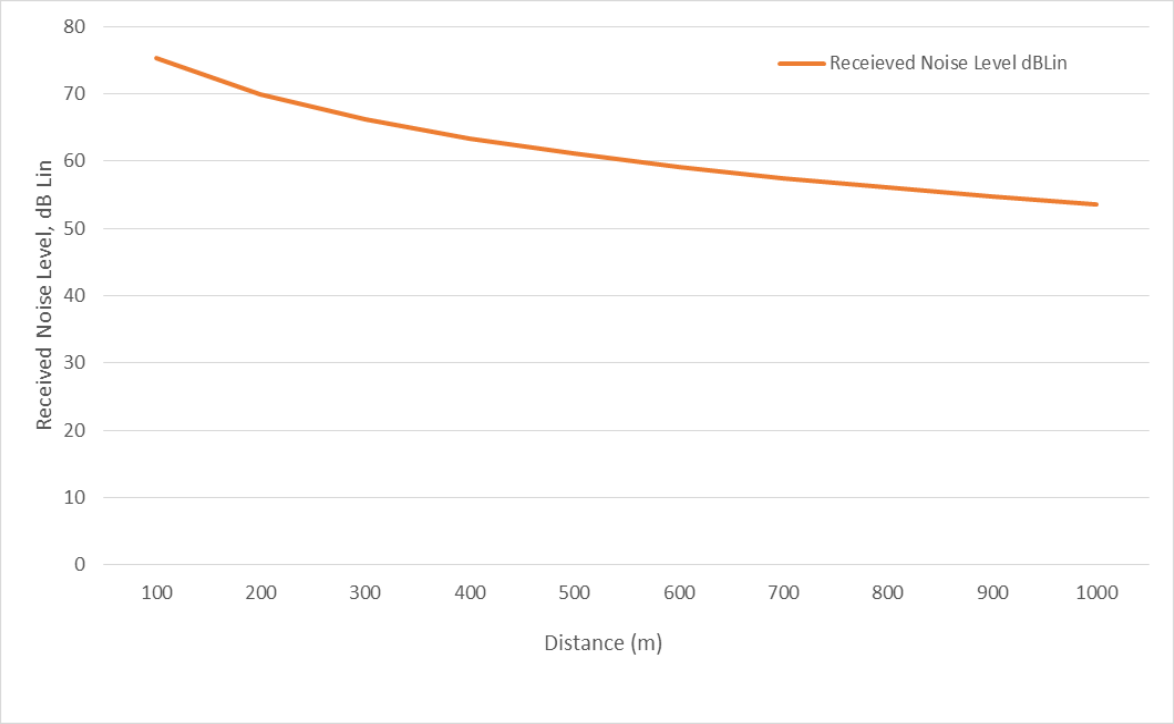

Figure 6-1 OPERATIONS - Predicted Received Noise Levels with distance (db Lin)

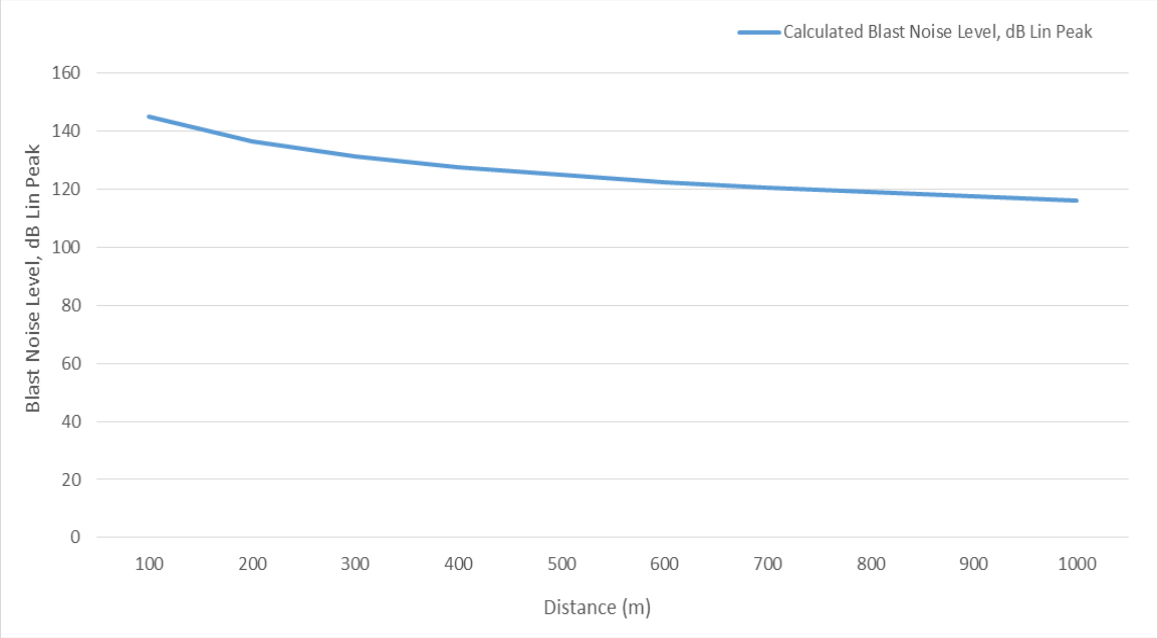

Figure 6-1 BLASTING - Predicted Received Noise Levels with distance (db Lin Peak)

6.2 Blasting – Vibration

Table 6-2 and Figure 6-2 presents the calculated received ground borne vibration levels for blasting at various distances from the blast.

Table 6-2 Predicted received vibration levels with distance

Distance (m)	Calculated received vibration, in mm/s
100	10.9
200	3.6
300	1.9
400	1.2
500	0.8
600	0.6
700	0.5
800	0.4
900	0.3
1000	0.3
2000	0.1

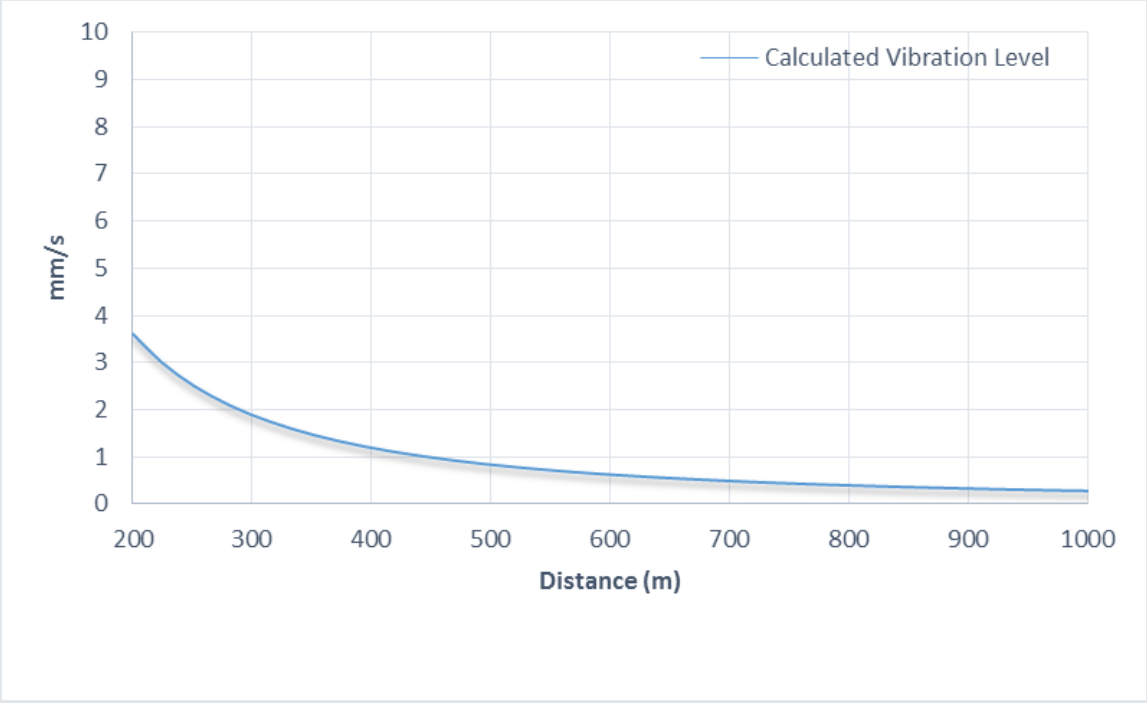

Figure 6-2 Calculated received vibration levels with distance

7 Conclusions and Recommendations

Based on the outcomes of the noise modelling and analysis, the following has been concluded:

- **Mining Noise (Section 4)** – Received noise levels from Miralga Creek Project are predicted to comply with the Regulations at the Abydos Camp for all proposed mining locations including Sandtrax, Miralga West and Miralga Creek at all times of day.
- **Blast Noise (Section 5.2)** – Received noise from blasting is predicted to comply with the Regulations.
- **Ground Borne Vibration from blasting (Section 5.3)** – Ground borne vibration impacts are predicted to comply with AS2187.2 for building integrity and human comfort.
- **Bat Caves and Heritage Areas (Section 6)** – Noise and ground borne vibration levels have been calculated at various distances, for reference should a sensitive bat cave or heritage area be identified.

This study has concluded that the Miralga Creek Project complies with the Regulations, and as such, no mitigation actions are required or proposed for the project.

Appendix A Noise Legislation

Noise management in Western Australia is implemented through the Environmental Protection (Noise) Regulations 1997 (the Regulations), which operate under the Environmental Protection Act 1986. The Regulations specify maximum noise levels (assigned noise levels) which are the highest noise levels that can be received at noise-sensitive (residential), commercial and industrial premises.

Assigned noise levels are defined differently for noise sensitive premises, commercial premises, and industrial premises. For noise sensitive premises, an Influencing Factor (IF) is included in the assigned noise levels. The IF depends on the presence of major/minor roads and commercial/industrial land use zonings within circles of 100 metres and 450 metres radius from the noise receiver.

For noise sensitive residences, the time of day also affects the assigned levels. The regulations define three types of assigned noise level:

- L_{ASMAX} means an assigned level that is not to be exceeded at any time;
- L_{AS1} means an assigned level that is not to be exceeded for more than 1% of time;
- L_{AS10} means an assigned level that is not to be exceeded for more than 10% of time.

Table A1 : Assigned Noise Levels for Noise Sensitive Receivers

Type of premises receiving noise	Time of day	Assigned Levels (dB)		
		L_{A10}	L_{A1}	L_{Amax}
Noise sensitive premises: highly sensitive area	0700 to 1900 hours Monday to Saturday	45 + influencing factor	55 + influencing factor	65 + influencing factor
	0900 to 1900 hours Sunday and public holidays	40 + influencing factor	50 + influencing factor	65 + influencing factor
	1900 to 2200 hours all days	40 + influencing factor	50 + influencing factor	55 + influencing factor
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays	35 + influencing factor	45 + influencing factor	55 + influencing factor
Noise sensitive premises: any area other than highly sensitive area	All hours	60	75	80
Commercial premises	All hours	60	75	80
Industrial and utility premises other than those in the Kwinana Industrial Area	All hours	65	80	90
Industrial and utility premises in the Kwinana Industrial Area	All hours	75	85	90

Environmental Protection (Noise) Regulations 1997

Appendix B Equipment Noise Source Levels (SWLs)

Table B 1 - Modelled Equipment, Sound Power Levels (SWLs)

Equipment Item	Overall SWL, dB(A)	Octave Band Levels, Hz in dB(A)																								
		25	*31*	*40*	*50*	*63*	*80*	*100*	*125*	*160*	*200*	*250*	*315*	*400*	*500*	*630*	*800*	*1k*	*1.25k*	*1.6k*	*2k*	*2.5k*	*3.15k*	*4k*	*5k*	*6.3k*	*8k*
Haul Truck	**117.1**	60	65	70	75	80	86	93	99	100	101	101	103	104	106	106	107	107	107	107	107	106	104	103	99	96	92
Dozer	**113.7**	57	78	68	76	77	77	83	98	93	98	102	101	104	105	105	104	103	102	101	100	100	97	93	92	88	82
Excavator	**109.9**	59	64	69	74	78	82	92	95	98	95	98	100	99	100	101	98	99	99	96	96	96	88	88	87	80	79
Front End Loader	**113.8**	52	49	55	63	65	76	79	90	107	95	96	104	99	97	96	102	104	103	101	100	104	103	97	93	90	87
Grader	**111.8**	41	53	59	64	65	74	87	84	92	96	96	94	99	99	101	102	103	103	103	101	100	95	91	88	87	81
Service Vehicle	**111.0**	55	61	67	72	83	84	84	88	94	94	95	101	101	100	101	100	100	101	101	100	100	95	92	91	89	85

Appendix C Received Noise Levels with distance in third octaves (dB Lin)

Table C1 Calculated received third octave noise levels over distance, in dBLin

Distance (m)	Overall, dB(Lin)	Octave Band Levels, Hz in dB(Lin)																									
		25	31	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1k	1.2 5k	1.6 k	2k	2.5 k	3.1 5k	4k	5k	6.3k	8k
100m	75	58	70	58	61	59	58	65	69	66	61	63	60	57	57	56	56	54	53	53	52	52	47	43	40	33	25
200m	70	54	65	54	57	55	54	58	62	59	54	56	54	52	52	51	51	49	48	47	46	45	41	35	31	21	8
300m	66	50	62	50	53	51	50	54	58	55	50	52	50	50	49	48	48	46	45	43	41	40	35	28	22	9	-7
400m	63	48	59	48	50	49	48	51	55	52	48	49	47	47	47	46	45	43	42	40	38	36	31	22	14	-2	-23
500m	61	45	57	45	48	46	45	49	52	49	45	47	44	46	45	44	43	41	39	37	34	32	26	17	7	-12	-37
600m	59	43	55	44	46	45	43	47	50	47	43	45	42	44	43	42	41	39	37	34	32	28	22	12	0	-22	-52
700m	58	42	53	42	45	43	42	45	49	45	42	43	41	43	42	41	39	37	35	32	29	25	19	7	-7	-32	-66
800m	56	40	52	40	43	41	40	43	47	44	40	42	39	42	41	40	38	36	34	30	26	22	15	2	-14	-42	-80
900m	55	39	51	39	42	40	39	42	46	42	39	40	38	41	40	39	36	34	32	28	24	20	11	-3	-21	-51	-94
1000m	54	38	49	38	40	39	37	41	45	41	38	39	37	40	39	38	35	33	31	26	22	17	8	-8	-27	-61	-99