GREATER BROCKMAN PROPOSAL NOISE AND VIBRATION IMPACT ASSESSMENT

RIO TINTO

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EXECUTIVE SUMMARY

Rio Tinto is evaluating the development of ore deposits within the Greater Brockman locality, in the Pilbara region of Western Australia. This proposal includes the potential development of new deposits as an extension to existing iron ore operations at Nammuldi-Silvergrass, Brockman 2 and Brockman 4.

Rio Tinto has engaged Wood to conduct a noise and vibration assessment of the construction and operation phases of the Greater Brockman Proposal to support an environmental approvals application under Part IV of the *Environmental Protection Act 1986* (EP Act).

There are several mine camps and mine villages proximate to the proposal area that were assessed under the Western Australia *Environmental Protection Regulations (Noise) 1997*. Additionally, it has been identified by Rio Tinto's ecology surveys that the area under consideration plays host to cave systems that could be habitat for bat species. A noise threshold of 70 dB(A) and a vibration threshold of 10 mm/s Peak Particle Velocity (PPV), is to be applied at cave system entrances (receivers) for the purposes of this noise and vibration assessment only (i.e. not for adoption in the management regime for the bat caves/populations), were derived from a review of relevant literature.

Modelling was undertaken to predict the noise levels at the noise sensitive receptors. Six scenarios representing maximum mining activities; and overburden removal during construction conditions was modelled.

The modelled noise levels indicate that noise levels will:

- Fall below the Assigned Noise Levels at all identified noise sensitive premises (camps and villages); and
- Fall below the noise threshold at 201 of the total 208 bat cave system entrances and exceed the threshold at the remaining 7 receivers listed in Table 4-1 of the report.

The modelling also indicates that activities undertaken within 1000 m of a cave system entrance could result in noise levels that exceed the 70 dB(A) threshold. However, implementation of appropriate noise management for activities undertaken within 1000 m of an identified significant cave system entrance should result in noise levels falling below the threshold or being as low as reasonably practicable.

Noise management can be achieved by considering the following elements:

1) Where possible, the site should be arranged to take advantage of potential barriers;
2) Choosing quieter plant and equipment based on the optimal power and size to most efficiently perform the required tasks;
3) Operating plant and equipment in the quietest and most efficient manner. This includes actions such as shutting down lighting plant that are not required and minimising vehicle movements;

4) Inspecting and maintaining plant and equipment to minimise noise increases and ensuring that all noise and vibration reduction devices are operating effectively;

5) Installing noise controls around fixed equipment; and

6) Noise monitoring at the entrances of cave systems that have identified bat populations.

Vibration due to blasting could exceed the 10 mm/s PPV threshold for blasts undertaken within 980 m of a significant cave system Implementation of appropriate vibration management for blasting undertaken within 980 m of a cave system should result in vibration falling below the threshold or being as low as reasonably practicable.

Vibration could be reduced by:

1) Adopting alternative mining methods such as use of low intensity or modified blasting, ‘dozing and ripping’;

2) Pre-splitting the ore;

3) Constructing additional separation measures such as bunds or deep trenches between the activity and the cave system; and

4) Use reducing charge size when undertaking blasting closer than 980 m to a sensitive receptor.

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1 INTRODUCTION

1.1 Background

Rio Tinto is evaluating the potential development of ore deposits within the Greater Brockman ("the Project") locality, in the Pilbara region of Western Australia. This proposal includes the potential development of new deposits and associated infrastructure as an extension to existing iron ore operations at Nammuldi-Silvergrass, Brockman 2 and Brockman 4.

The proposal comprises drill, blast, load and convey / haul from the following options of deposits:

- Brockman Syncline 2 pit 1-7 extension;
- Maybelline;
- Lens G;
- Diesel, Monkey, Sandleford;
- Brockman Syncline 3;
- Brockman Syncline 3 extension (Creekside, Lauriston, Brokenwood, MM-J); and
- Brockman Syncline 1.

Activities associated with the development could result in noise and vibration impacts on sensitive land uses and habitats.

Operation of heavy mobile equipment (e.g. dozers, haul trucks, excavators, drills) during construction; and heavy mobile equipment and fixed plant (e.g. crushers, conveyors, screens) during commissioning and operation could result in elevated noise at sensitive receivers. Additionally, drilling and blasting activities could result in elevated vibration.

Several mine camps and villages associated with Rio Tinto operations and several pastoral station homesteads are located in the surrounding area. Additionally, it has been identified by Rio Tinto's ecology surveys that the area under consideration plays host to numerous cave systems that could be habitat for bat species. Potential impacts caused by noise range from interruptions in feeding and resting behaviour, to complete abandonment of an area (Newport et al. 2014[1]). Constant levels of noise may also interfere with species communication, via acoustic

[1] Jenny Newport, David J. Shorthouse, Adrian D. Manning (2014) *The effects of light and noise from urban development on biodiversity: Implications for protected areas in Australia*, Ecological Management and Restoration

interference (Parris and Scheider 2009[2]). Species that may be especially at risk of disturbed communication are those that use calls to communicate or navigate.

1.2 Applicable Documents and Regulations

The following documents are applicable for this assessment:

- Western Australia *Environmental Protection Act 1986*;
- Western Australia *Environmental Protection (Noise) Regulations 1997* (ENPR); and
- *Significant Impact Guidelines 1.1 - Matters of National Environmental Significance, Australian Government Department of Agriculture, Water and the Environment 2009*.

1.3 Terms and Abbreviations

Term	Meaning
1/3 Octave bands	A 'constant percentage bandwidth' where each of the octave bands (defined below) is divided into 3 bands (ie each band is approximately 1/3 the 'width' of the octave bands), providing a more discreet analysis of the noises' frequency content.
dB	Decibel, a relative unit of measure for noise levels, using the threshold of human hearing as the reference point (for airborne sound pressure this is 20μPa). This scale is used to compress noise values into a numeric range that is more easily comprehensible.
dB(A)	The linear dB scale is usually modified by the A-weighting 'filter' to simulate the non-linear response of human hearing. The application of this filter is denoted by appending an 'A'; to the dB units. The unit may be presented as dB(A) or dBA.
DWER	Department of Water and Environmental Regulation
EIA	Environmental Impact Assessment
EPA	Environment Protection Authority
Hz	Hertz, the SI unit of frequency, meaning cycles per second.
L_{10}	The noise level that is exceeded for ten percent (10%) of the time. It is most commonly encountered in the assessment of environmental noise, as research has demonstrated that it can be proportionately linked to the level of annoyance (due to the noise) in the community
L_{A10}	The A-weighted L_{10}

[2] Kirsten M. Parris and Angela Schneider (2009) *Impacts of Traffic Noise and Traffic Volume on Birds of Roadside Habitats* Ecology and Society

Term	Meaning
L_{90}	The noise level that is exceeded for ninety percent (90%) of the time. The L_{90} is often used to define a 'background level' which is considered 'repeatable', and is used in many jurisdictions as the basis for setting environmental noise compliance limits
L_{A90}	The A-weighted L_{90}
L_{AF}	Sound pressure level with 'A-weighting', measured using the Fast response on the SLM.
L_{AS}	Sound pressure level with 'A-weighting', measured using the Slow response on the SLM.
$L_{eq,T}$	Equivalent Level - is the continuous sound level containing the same quantity of energy as the actual varying level over the same period. The 'T' component identifies the time averaging period (eg. $L_{eq,1h}$). Where the time averaging period is omitted, it is implied that the L_{eq} is representative of the long-term average of the noise source being discussed.
Octave Band	A 'constant percentage bandwidth' where each successive band centre frequency is double the previous one. International standards define nominal centre frequencies of 16 Hz, 31.5Hz, 63Hz, 125Hz, 250Hz, 500Hz, 1kHz, 2kHz, 4kHz, 8kHz, and 16kHz. Each octave band has a bandwidth which is proportional to the frequency so that there are no gaps or overlaps between bands. A separate noise level can be measured for each band, allowing definition of the frequency content of the noise.
SLM	Sound Level Meter
Sound Power	Describes the rate of sound energy output of a source. Under fixed operating conditions the sound power of a source is fixed, and it is independent of the environment in which it is operating. Sound power is often used to describe the noise emission of a machine and allows comparison of the 'source strength' of machines. Sound Power Levels can be calculated from measured sound pressure or sound intensity values. Sound power levels are usually denoted by L_W and the reference value for Sound Power Level in dB is 10^{-12} Watts.
SWL	Refer Sound Power
Tonality	A qualitative term used to identify when a noticeable tone or series of tones are detectable. In environmental noise this can be used to can be used describe noise that may be more annoying (due to its frequency content), than other noise of a similar overall level – when it is so used, the appropriate authority will usually define a quantitative means for determining when a noise demonstrates 'tonality'.
Wood	Wood PLC. A specialist noise team internal to Wood has prepared this study.
'Worst case' weather conditions	Refers to the "default meteorological conditions" as suggested by the *Draft Guideline on Environmental Noise for Prescribed Premises, Department of Environment Regulation, May 2016*, and incorporating worst-case (source to receiver) wind directions.

1.4 Greater Brockman Site Locality

Figure 1-1 below shows the Proposal development envelope and deposits.

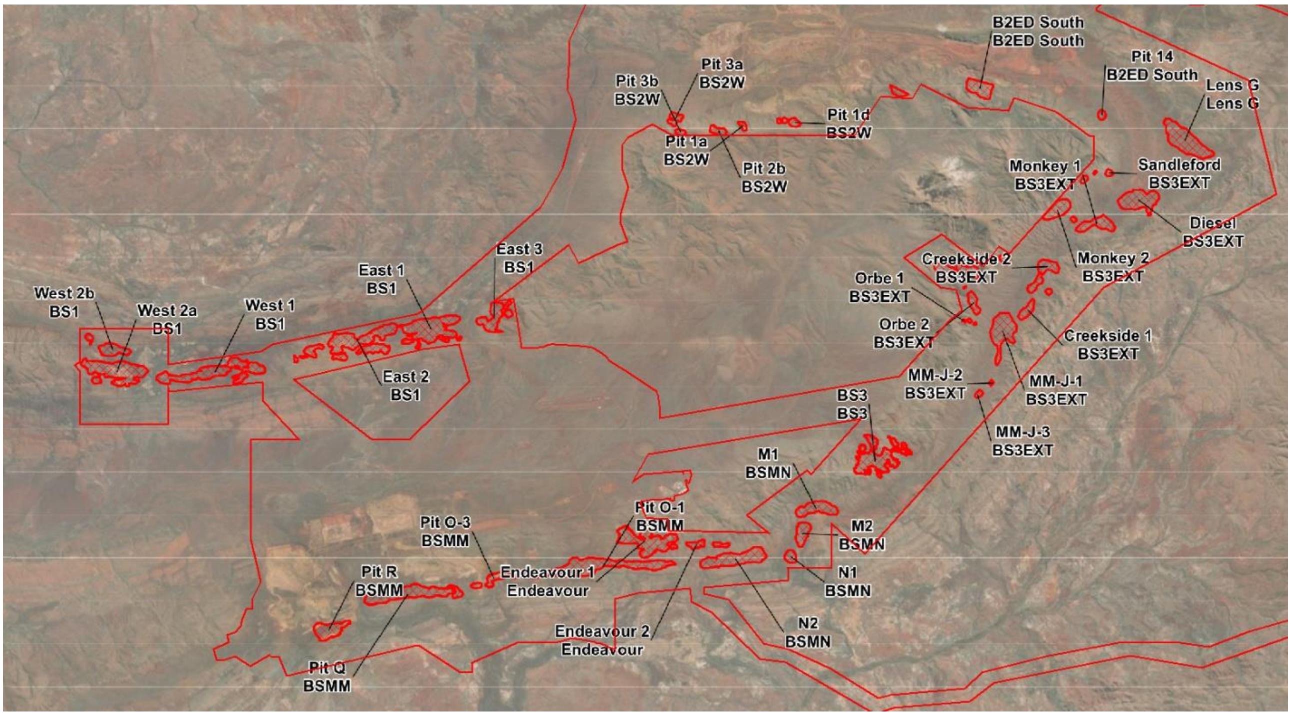


Figure 1-1 Proposed deposits within site locality

2 ASSESSMENT CRITERIA

2.1 Noise Criteria

The regulatory noise limits, referred to as 'Assigned Levels', that apply to the proposal are shown in Table 2-1 and are based on the *Environmental Protection (Noise) Regulations 1997.*

Additional noise thresholds for sensitive receiving locations that are not covered by the Regulation are shown in Table 2-2. The additional criteria are drawn from published literature on the impacts of noise on bat species.

The vibration threshold adopted for this study is shown in Table 2-3. The limit is drawn from published literature on the impacts of ground vibration on bat species. The vibration limit has been set based on the expectation that lower vibration levels will result inside significant caves. The attenuation of vibration propagating through the ground and cave structure is determined in part by the geotechnical properties, including the rock type of the cave and intervening ground, so data from geotechnical investigations can be used to inform acceptable vibration limits at specific cave entrances.

Table 2-1: Assigned Noise Levels

Location/Area	Assigned Noise Limits	Reference
Outdoor Noise at Residential Receivers	L_{AS10} 35 dB	Environmental Protection (Noise) Regulations 1997
Outdoor noise at camps and villages that form part of an industrial premises	L_{AS10} 65 dB	Environmental Protection (Noise) Regulations 1997

Table 2-2: Additional Noise Thresholds

Location/Area	Assigned Noise Limits	Reference
Sensitive Habitat (e.g. at the entrance of a cave system)	L_{Aeq} 70 dB [3]	DEWHA (2009) Matters of National Environmental Significance Significant Impact Guidelines. Bullen and Creese (2014).

[3] This limit is considered conservative (B. Bullen, pers. comm. May 2020)

Table 2-3: Vibration Threshold

Location/Area	Vibration Limit	Reference
Sensitive Habitat (e.g. at the entrance of a cave system)	10 mm/s [(4)]	Rio Tinto (2013)[5]

2.2 Sensitive Premises

The 35 dB(A) Assigned Level applies to noise sensitive premises, during the night-time period, for noise levels that occur for more than 10% of the time. The 65 dB(A) Assigned Level derived from the Noise Regulations applies to residences (camps or villages) that form part of an industrial premises, during all hours of the day, for noise levels that occur for more than 10% of the time.

The following noise sources are excluded from the Noise Regulations:

- rail noise;
- noise from traffic on public roads;
- aircraft noise; and
- noise from safety warning devices fitted to earth moving equipment.

2.3 Sensitive Habitat

There are no regulations applicable in Western Australia that specify noise or vibration limits for the habitat of protected fauna. However, the *Australian Department of Agriculture, Water and Environment 'Significant Impact Guidelines - Matters of National Environmental Significance (2009)'* specifies that activities should not 'disrupt the breeding cycle of an important population'. This could occur if bat roosts were exposed to noise or vibration that disrupted bat behaviour.

Bullen and Creese (2014) observed that sound levels up to 70 dB(A) generated by nearby drilling operations did not cause Pilbara Leaf Nose Bats or Ghost Bats to abandon a cave roost in the Pilbara region. Noise levels in the cave in the absence of drilling activity were in the range of 45 to 50 dB(A). Therefore, a conservative noise threshold of 70 dB(A) at a cave entrance was adopted for bat roosts.

[4] This limit is considered conservative (B. Bullen, pers. comm. May 2020)

[5] Rio Tinto 2013d. *Blasting adjacent to the Koodaideri bat adit: Results and recommendation from seismic field trials*.

Rio Tinto undertook a trial to document the behavioural response of the Pilbara Leaf-nosed bat to blasting and vibration disturbance in 2013[6]. The trial involved the use of explosive charges of incrementally increasing intensity and proximity to a cave system and related these to the behavioural responses of the resident bats during daylight hours. The trial adopted a nominal threshold vibration of 10 mm/s PPV, based on available standards for humans and limited data in the literature in relation to bat colonies.

The adopted threshold vibration of 10 mm/s PPV was exceeded at the roost by one of six trial blasts, conducted at 134 m, which produced vibration of 12.2 and 18.7 mm/s PPV at the nearest two monitoring sites. Very little evidence of any disturbance behaviour was detected associated with the trial blasts. Only three of the 51 calls recorded were concurrent with blast timing and on each occasion, calls were detected from only a single individual (a population of approximately 430 individuals was estimated to be present in the roost). The great majority of the colony was not disturbed even by the strongest and closest blast. There was no evidence that blasting significantly disturbed the colony, i.e. there was no blast that resulted in most, or all, bats taking flight within the cavern as a result of the blast.

Based on the results of the blasting trial, the adopted threshold vibration of 10 mm/s PPV was determined to be appropriate (although conservative) because of the lack of behavioural response of the bats to vibrations levels of 12.2 and 18.7 mms PPV at the two monitoring sites closest to the cavern.

[6] Rio Tinto 2013d. *Blasting adjacent to the Koodaideri bat adit: Results and recommendation from seismic field trials*.

3 METHODOLOGY

3.1 Description of Noise model

A numerical computer model has been developed using SoundPlan version 8.2. This program calculates sound pressure levels at nominated receiver locations or produces noise contours over a defined area of interest around the noise sources. SoundPlan can be used to model different types of noise, such as industrial noise, traffic noise and aircraft noise, and it is recognised internationally including in Australia. The inputs required in SoundPlan are noise source data, ground topographical data, meteorological data and receiver locations.

The noise model has been used to generate noise contours for the area surrounding the Project and predict noise levels at the noise sensitive locations.

The noise model does not include noise emissions from any source other than the proposed plant operations. Therefore, noise emissions from other neighbouring industrial sources, road traffic, aircraft noise, animals, domestic sources, etc are excluded from the modelling.

3.1.1 Algorithm

The CONCAWE algorithm[7] for industrial noise simulation has been used to predict the sound levels at each of the noise sensitive receivers. The algorithm has been approved by the Department of Water and Environmental Regulation (DWER).

3.1.2 Topography

Updated elevation data for the area was provided by Rio Tinto. The topographical data was also modified for pits and the surrounding dumps. The original topographical model was modified to incorporate these additional contours.

3.1.3 Ground Absorption

The acoustic properties of the ground surface influence the propagation of noise. SoundPlan allows for the input of ground absorption properties. A ground type corresponding to 'compacted dense ground' was selected in the model. Note that this is a 'conservative' estimate, because areas of more porous ground will result in lower predicted noise levels.

[7] C.J. Manning, (1981) *The propagation of noise from petroleum and petrochemical complexes to neighbouring communities*, CONCAWE Report no. 4/81

3.1.4 Source Sound Power Level

Noise sources used in the model were based upon Rio Tinto supplied equipment lists, plant layout drawings and mining plans as well as previous model plant layouts of Brockman 4.

The noise source sound power levels were based on Wood measurements of similar equipment at other Rio Tinto iron ore sites.

For the purposes of this assessment it has been assumed that all items of plant are operational 24 hours per day, 7 days a week. A full list of these sound power sources, and their associated spectra are shown in APPENDIX A.

3.1.5 Meteorological Conditions

SoundPlan calculates predicted noise levels for defined meteorological conditions. The following variables are included in the prediction algorithms and will affect the predicted noise level: temperature; Pasquill stability (temperature inversion); relative humidity; wind speed; and wind direction.

The "default meteorological conditions" as suggested by the *Draft Guideline on Environmental Noise for Prescribed Premises, Department of Environment Regulation, May 2016*, have been used to determine the 'worst-case' overall predicted noise levels at each selected noise sensitive receiving location as shown in Table 3-1.

Table 3-1 : Noise Model Meteorological Inputs for 'Worst-Case' Predictions

Time of Day	Temperature	Pasquill Stability	Wind speed	Wind Direction	Relative Humidity
Day and Evening	20 °C	Pasquill Stability E	4 m/s	Worst-case (source to receiver)	50%
Night	15 °C	Pasquill Stability F	3 m/s	Worst-case (source to receiver)	50%

3.2 Noise Sensitive Receivers

The noise sensitive receivers used in the model were based on information provided by Rio Tinto. The receivers included mine camps or villages as well as sensitive habitat (e.g. at the entrance of a cave system that may contain a bat roost).

Several mine camps and villages associated with Rio Tinto operations that are within a range at which noise due to the proposed development could exceed applicable noise limits (<10 km, refer noise contours in APPENDIX C). A list of these receivers is provided in APPENDIX B.

Noise levels were not modelled at the pastoral station homesteads because they are all located well beyond the range at which noise due to the proposed developed could exceed the Assigned Levels.

3.3 Mining Scenario Modelled

Wood has modelled a five scenarios representative of maximum mining operations and construction activities throughout the life of the Project and is based off the proposed mine plans as supplied by Rio Tinto.

The model included noise sources representing existing and proposed fixed and mobile equipment undertaking activities typical of removal of overburden during construction scenarios or typical mining activities during operations scenarios.

3.3.1 Scenario 1: Mine Year 2024

Scenario 1 represents construction and mining operations occurring within the Lens G, Diesel, Monkey & Sandleford pits for the 2024 period.

The mobile equipment fleet assumed is presented in Table 3-2 below.

Table 3-2 Scenario 1 Mobile Equipment

Mobile Equipment	Number	Make / Model
Haul Truck	31	Komatsu 930E
Loader	2	Hitachi EX8000
Loader	4	Hitachi EX5600
Loader	4	Hitachi EX3600
Loader	1	Hitachi EX2500
Loader	2	Komatsu L2350
Loader	1	Komatsu WA1200

3.3.2 Scenario 2: Mine Year 2028

Scenario 2 represents construction and mining operations occurring within the Brockman Syncline 1 pits for the 2028 period.

The mobile equipment fleet assumed is presented in Table 3-3 below.

Table 3-3 Scenario 2 Mobile Equipment

Mobile Equipment	Number	Make / Model
Haul Truck	37	Komatsu 930E
Loader	2	Hitachi EX3600
Loader	1	Hitachi EX2500
Loader	2	Komatsu L2350

3.3.3 Scenario 3: Mine Year 2029

Scenario 3 represents construction and mining operations occurring within the Brockman Syncline 3 pits for the 2029 period.

The mobile equipment fleet assumed is presented in Table 3-4 below.

Table 3-4 Scenario 3 Mobile Equipment

Mobile Equipment	Number	Make / Model
Haul Truck	30	Komatsu 930E
Haul Truck	2	Komatsu 730E
Loader	1	Hitachi EX8000
Loader	1	Hitachi EX5600
Loader	1	Hitachi EX3600
Loader	1	Hitachi EX2500
Loader	2	Komatsu L2350
Loader	1	Komatsu WA1200

3.3.4 Scenario 4: Mine Year 2034

Scenario 4 represents construction and mining operations occurring within the Brockman Syncline 2 (pit 1 – 7 extension and Maybelline) pits for the 2034 period.

The mobile equipment fleet assumed is presented in Table 3-5 below.

Table 3-5 Scenario 4 Mobile Equipment

Mobile Equipment	Number	Make / Model
Haul Truck	2	Komatsu 930E
Haul Truck	1	Komatsu 730E
Loader	2	Hitachi EX3600
Loader	2	Komatsu WA1200

3.3.5 Scenario 5: Mine Year 2035

Scenario 5 represents construction and mining operations occurring within the Brockman Syncline 3 extension (Creekside, Lauriston, Brokenwood & MM-J) pits for the 2035 period.

The mobile equipment fleet assumed is presented in Table 3-6 below.

Table 3-6 Scenario 5 Mobile Equipment

Mobile Equipment	Number	Make / Model
Haul Truck	5	Komatsu 930E
Loader	1	Hitachi EX2500
Loader	1	Komatsu L2350

3.3.6 Scenario 6: Mine Year 2037

Scenario 6 represents construction and mining operations occurring within the 'BS-MN' pits for the 2037 period.

The mobile equipment fleet assumed is presented in Table 3-7 below.

Table 3-7 Scenario 6 Mobile Equipment

Mobile Equipment	Number	Make / Model
Haul Truck	38	Komatsu 930E
Loader	2	Hitachi EX8000
Loader	2	Hitachi EX5600
Loader	1	Hitachi EX2500

Mobile Equipment	Number	Make / Model
Loader	2	Komatsu L2350

3.4 Vibration from Blasting

The peak particle velocity (V in mm/s PPV) due to blasting was modelled using the formula in *Australian Standard AS 2187.2-2006 (J7.3(1))* shown below:

$$V = k\ (R / Q^{0.5})^{-e}$$

Where:

- k is the 'site constant', representing the efficiency of vibration transmission through the ground;
- e is the 'site exponent', representing the decay of vibration level due to the spreading of vibration energy that occurs as distance from the source increases;
- R is the distance from the charge to the point of interest in metres; and
- Q is the maximum instantaneous charge mass in kilograms.

The variable 'k' is dependent on the rock or ground type. A value of 1140, which typically used for conservative estimates of blast vibration level in Australia, was adopted for this study.

The variable 'e' is dependent on the dominant wave type that develops in the ground, which may be shear, compression or Rayleigh (elliptical) types. The dominant wave type depends on the ground structure and can't be reliably predicted in advance. Therefore, a conservative[8] value of 1.6 was assumed.

A maximum instantaneous charge of 2580 kg (Q) has been assumed, consistent with other Rio Tinto sites, and a minimum radius (R) from the blast site that resulted in vibrations exceeding the nominated threshold was calculated.

[8] A. Richards, A. Moore *Blast Vibration Course* P13, Terrock Consulting Engineers

4 RESULTS

4.1 Noise due to Mine Operations

Modelled noise levels at camps, homesteads, and all identified entrances to cave systems are shown in APPENDIX B. All values are given as A-weighted noise levels in dB(A) and were modelled under the 'worst-case' conditions.

The modelled noise levels indicate that noise levels will:

- Fall below the Assigned Noise Levels at all identified noise sensitive premises (Rio Tinto mine camps and mine villages); and
- Fall below the noise threshold at 201 of the total 208 bat cave system entrances and exceed the threshold at the remaining 7 receivers listed in Table 4-1.

The modelled noise levels fall below the assigned levels at

Table 4-1: Sensitive habitat receivers exceeding Noise Threshold

Location/Area	Applicable Noise Limit, dB(A)	Receiver ID	Scenario Modelled	Modelled Noise Level, dB(A)
Noise at sensitive habitat (e.g. at the entrance of a cave system that may contain a bat roost)	70	CBRK-053	Scenario 2 - 2028	70.7
		CBRK-084	Scenario 4 - 2034	79.6
		CBRK-103	Scenario 3 - 2029	76.7
		CBRK-104	Scenario 3 - 2029	76.2
		CBRK-107	Scenario 3 - 2029	72.3
		CBRK-108	Scenario 3 - 2029	71.3
		CBRK-123	Scenario 6 - 2037	71.3

Noise Contours for the activities modelled are shown in APPENDIX C.

4.2 Vibration from Blasting

Vibration from blasting has been estimated for the noise sensitive receivers as per *Australian Standard AS 2187.2-2006 (J7.3(1))*. This is used to determine the minimum radius (in metres) from the blast that exceeds the vibration limit of 10 mm/s PPV, the result is shown in Table 4-2.

Table 4-2: Distance from blast that exceed vibration limit

Maximum instantaneous charge (kg)	Distance from blast where vibration falls below the limit
	10 mm/s
2580 kg	980 metres

The modelled maximum extent of the 10 mm/s PPV blast vibration level from each pit is shown as contours in APPENDIX C. Approximately 80 cave locations fall within the 10 mm/s contour.

5 DISCUSSION

5.1 Management of Noise Impacts

The results presented above show that noise levels due to the proposed development

Activities undertaken within 1000 m of a cave system could result in noise levels that exceed the 70 dB(A) threshold. Implementation of appropriate noise management should result in noise levels falling below the threshold or being as low as reasonably practicable.

Noise management should make use of existing noise barriers, constrain noise emissions from equipment and the intensity of operations and enable activities to be adapted based on monitored noise levels. This could be achieved by considering the following elements:

1) Where possible, the site should be arranged to take advantage of potential barriers;

2) Choosing quieter plant and equipment based on the optimal power and size to most efficiently perform the required tasks;

3) Operating plant and equipment in the quietest and most efficient manner. This includes actions such as shutting down lighting plant that are not required and minimising vehicle movements;

4) Inspecting and maintaining plant and equipment to minimise noise increases and ensuring that all noise and vibration reduction devices are operating effectively;

5) Installing noise controls around fixed equipment; and

6) Noise monitoring at the entrances of cave systems that have identified bat populations.

5.2 Management of Vibration Impacts

Blasting activities undertaken within 980 m of a cave system could result in vibrations that exceed the threshold for sensitive habitat. Implementation of appropriate vibration management should result in vibrations falling below the threshold or being as low as reasonably practicable.

Vibration could be reduced by:

1) Adopting alternative mining methods such as use of low intensity or modified blasting, ‘dozing and ripping’;

2) Pre-splitting the ore (described below);

3) Constructing additional separation measures such as bunds or deep trenches between the activity and the cave system and

4) Reducing blast size charges.

Pre-splitting of ore involves a blasting technique whereby cracks for the final contour (progressively nearer to the cave system) would be created by firing a single line of holes prior to the initiation of the remainder of the holes in the blast pattern.

Applying the pre-splitting approach, drill holes are placed slightly further apart as compared to normal line drilling and are loaded very lightly and fired before the main blast. The light explosive charges propagate a crack or cracks between the drill holes creating an artificial discontinuity along the final excavation line. The maximum depth for a single pre-split is normally limited by the accuracy of the drill holes and is usually about 15 m with depths generally between 6 m and 12 m. Pre-splitting can reduce ground vibrations by up to 30% of that produced from normal blasting[9].

[9] Rio Tinto 2013d. *Blasting adjacent to the Koodaideri bat adit: Results and recommendation from seismic field trials*.

6 CONCLUSIONS

The results of the noise modelling undertaken indicate that noise levels generated by activities associated with the Greater Brockman proposal should fall below the Assigned Levels and thus meet the Noise Regulations (1997).

The modelled noise levels indicate that noise levels will:

- Fall below the Assigned Noise Levels at all identified noise sensitive premises (Rio Tinto mine camps, mine villages and pastoral homesteads); and
- Fall below the noise threshold at 201 of the total 208 bat cave system and exceed the threshold at the remaining 7 receivers listed in Table 4-1 of the report.

The modelling also indicates that activities undertaken within 1000 m of a cave system entrance could result in noise levels that exceed the 70 dB(A) threshold. However, implementation of appropriate noise management for activities undertaken within 1000 m of an identified significant cave system entrance should result in noise levels falling below the threshold or being as low as reasonably practicable.

Vibration due to blasting could exceed the conservative threshold (10 mm/s PPV) for blasts undertaken within 980 m of a significant cave system. Implementation of appropriate vibration management for blasting undertaken within 980 m of a cave system should result in vibration falling below the threshold or being as low as reasonably practicable.

APPENDIX A NOISE SOURCES

Equipment	Octave Band Sound Power Levels in dB (A)									Overall level dB(A)
	31.5	63	125	250	500	1k	2k	4k	8k	
Conveyor CV510	64.5	78.6	92.3	101.5	105.2	105.2	103.8	96.5	87.3	110.4
Conveyor Drive CV510	63.3	82.0	91.8	102.1	102.8	106.8	102.9	94.6	84.8	93.1
Reclaimer Conveyor	49.5	68.3	79.0	86.6	91.3	88.0	84.2	77.0	70.8	94.6
Reclaimer Conveyor Drive	58.7	73.9	88.8	96.5	100.2	107.7	101.6	95.5	85.7	109.7
Stacker Conveyor	49.6	67.1	78.0	83.3	90.1	93.1	90.5	82.4	77.0	96.7
Crusher (primary)	121.1	121.3	116.8	115.6	109.7	105.4	96	95.9	82.4	111.9
Stacker Chute	54.9	75.8	89.4	93.2	99.1	98.1	94.7	87.2	79.7	103.3
Reclaimer Chute	58.6	68.8	81.4	89.3	95.2	99.7	96.3	93.1	85.4	103.1
SCB Feeder	70.7	95.0	99.9	103.6	101.9	101.7	100.6	97.3	86.9	70.7
Drive Bucket Reclaimer	57.0	72.2	87.1	94.8	98.5	106.1	99.9	93.8	84.0	108.0
Drive Conveyor Stacker	96.3	74.8	88.1	93.6	98.5	100.8	100.7	90.7	83.8	105.5
Crusher (secondary)	115.1	117.7	114	113.1	114.8	110.4	107.9	97.6	90.6	115.8
Haul Truck Komatsu 930E	-	113.8	118.6	121.1	121.9	119.9	119.8	114.3	111.7	125.6
Haul Truck Komatsu 730E	-	112.4	117.2	119.8	120.6	118.5	118.5	113.0	110.3	124.2
Loader Hitachi EX8000	76.3	89.0	108.3	112.9	115.3	115.4	114.1	106.1	96.9	119.7
Loader Hitachi EX5600	75.0	87.7	107.0	111.6	114.0	114.1	112.8	104.8	95.6	118.4
Loader Hitachi EX3600	73.3	86.0	105.3	109.9	112.3	112.4	111.1	103.1	93.9	116.7
Loader Hitachi EX2500	71.9	84.6	103.9	108.5	110.9	111.0	109.7	101.7	92.5	115.3

Equipment	Octave Band Sound Power Levels in dB (A)									Overall level dB(A)
	31.5	63	125	250	500	1k	2k	4k	8k	
Loader Komatsu L2350	99.1	108.9	121.1	116.2	113.2	110.4	108.4	101.3	94.3	116.1
Loader Komatsu WA1200	98.0	107.8	120.0	115.0	112.0	109.3	107.3	100.2	93.2	115.0
Loader CAT 992C	66.2	80.8	97.4	101.6	106.9	109.0	108.2	100.9	89.9	113.6
Dozer CAT D9L	62.2	80.8	100.4	102.6	106.9	108.0	103.2	99.9	89.9	112.4
Watercart CAT 621	-	81.6	96.0	103.1	105.2	107.8	110.6	103.5	93.0	114.1
Grader CAT 16G	62.6	75.1	93.2	94.1	98.4	100.4	99.2	93.3	86.4	105.2
Drill Rig	-	-	-	-	-	-	-	-	-	126
SCB Shuttle Level	78.3	89.9	93.9	98.1	98.4	99.6	99.2	95.1	88.8	78.3
SCB Screening	77.1	93.5	98.2	102.0	100.9	101.3	100.5	96.8	88.7	77.1
SCB Bins	75.4	93.3	96.9	100.1	103.0	102.8	99.7	97.1	89.2	75.4
TCB	85.2	102.3	106.8	110.4	110.4	110.5	109.5	105.7	97.5	85.2

APPENDIX B MODELLED NOISE LEVELS

B.1 Modelled noise levels at camps and villages

Receiver ID	Assigned Outdoor Noise Level, dB(A)	Modelled Noise Level, dB(A)					
		Scenario 1 – Mine Year 2024	Scenario 2 – Mine Year 2028	Scenario 3 – Mine Year 2029	Scenario 4 – Mine Year 2034	Scenario 5 – Mine Year 2035	Scenario 6 – Mine Year 2037
Brockman 2 Camp	65	23.4	Low*	12.5	24.4	Low*	Low*
Brockman 4 Village	65	27.3	28.1	29.2	27.2	27.4	30.7
Homestead Camp	65	Low*	Low*	Low*	Low*	Low*	Low*
Jerriwah Camp	65	23.5	Low*	4.7	27	Low*	Low*
Nammuldi Village	65	27.3	28.1	29.3	27.2	27.4	31.1
West Pilbara Village	65	27.6	28.4	29.2	27.6	27.8	30.6

Notes:

* "Low" denotes a predicted noise level that is below the threshold of hearing i.e. less than 0 dB(A).

B.2 Modelled noise levels at cave system entrances

Receiver ID	Assigned Noise Level, dB(A)	Modelled Noise Level, dB(A)					
		Scenario 1 - Mine Year 2024	Scenario 2 - Mine Year 2028	Scenario 3 - Mine Year 2029	Scenario 4 - Mine Year 2034	Scenario 5 - Mine Year 2035	Scenario 6 - Mine Year 2037
B4jul16-26-27	70	15.7	16.0	16.6	15.7	15.8	59.4
B4jun16-09	70	12.5	12.8	22.5	12.5	12.5	52.0
B4jun16-26	70	18.2	18.4	19.6	18.2	18.2	45.6
B4jun16-36	70	20.2	20.3	21.5	20.2	20.2	52.4
B4June16-26	70	18.0	18.2	19.5	18.0	18.0	45.8
BS4MM-Aug16-03	70	17.4	17.5	18.0	17.4	17.4	*Low
BS4MM-Aug16-04	70	12.8	13.2	15.5	12.8	12.8	30.7
BS4MM-Aug16-13	70	15.4	15.6	17.0	15.4	15.4	59.0
BS4MM-Aug16-15	70	24.5	24.5	24.8	24.5	24.5	50.6
BS4MM-Aug16-18	70	23.0	23.1	23.1	23.0	23.0	67.5
BS4MM-Aug16-19	70	24.4	24.4	24.5	24.4	24.4	67.2
BS4MMJul16-11	70	26.8	26.8	26.9	26.8	26.8	34.0
BS4MMJul16-13	70	26.3	26.4	26.6	26.3	26.3	35.6
BS4MMJul16-14	70	23.2	23.2	23.6	23.2	23.2	50.0
BS4MMJul16-15	70	24.5	24.5	24.8	24.5	24.5	43.7
BS4MMJul16-17	70	26.7	26.7	26.9	26.7	26.7	44.9

Receiver ID	Assigned Noise Level, dB(A)	Modelled Noise Level, dB(A)					
		Scenario 1 - Mine Year 2024	Scenario 2 - Mine Year 2028	Scenario 3 - Mine Year 2029	Scenario 4 - Mine Year 2034	Scenario 5 - Mine Year 2035	Scenario 6 - Mine Year 2037
BS4MMJ ul16-30	70	12.0	13.7	12.8	12.1	12.2	43.3
C3 (also CBRK-155)	70	*Low	*Low	*Low	1.9	*Low	45.3
C4 (also CBRK-155)	70	*Low	*Low	*Low	3.2	*Low	27.7
C5 (also CBRK-155)	70	*Low	*Low	*Low	*Low	*Low	*Low
C6	70	*Low	*Low	*Low	*Low	*Low	*Low
C7	70	*Low	*Low	*Low	6.7	*Low	*Low
C8	70	*Low	*Low	*Low	5.0	*Low	*Low
CBRK-000	70	12.5	43.1	12.5	12.5	12.5	*Low
CBRK-001	70	*Low	*Low	*Low	*Low	*Low	*Low
CBRK-002	70	40.3	40.4	40.3	40.3	40.3	12.7
CBRK-003	70	*Low	*Low	*Low	*Low	*Low	*Low
CBRK-004	70	40.6	40.6	40.6	40.6	40.6	40.3
CBRK-005	70	*Low	*Low	*Low	*Low	*Low	*Low
CBRK-006	70	16.7	18.2	16.7	16.7	16.7	40.6
CBRK-007	70	*Low	*Low	*Low	*Low	*Low	*Low
CBRK-008	70	26.2	26.6	26.2	26.2	26.2	17.1
CBRK-009	70	*Low	*Low	*Low	*Low	*Low	*Low
CBRK-010	70	26.3	26.8	26.3	26.3	26.3	26.3
CBRK-011	70	*Low	*Low	*Low	*Low	*Low	*Low

Receiver ID	Assigned Noise Level, dB(A)	Modelled Noise Level, dB(A)					
		Scenario 1 - Mine Year 2024	Scenario 2 - Mine Year 2028	Scenario 3 - Mine Year 2029	Scenario 4 - Mine Year 2034	Scenario 5 - Mine Year 2035	Scenario 6 - Mine Year 2037
CBRK-012	70	11.6	12.4	11.6	11.6	11.6	26.4
CBRK-013	70	*Low	*Low	*Low	*Low	*Low	*Low
CBRK-014	70	5.5	6.4	5.5	5.5	5.5	11.6
CBRK-015	70	*Low	*Low	*Low	*Low	*Low	*Low
CBRK-016	70	5.9	7.2	5.9	5.9	5.9	5.5
CBRK-017	70	*Low	*Low	*Low	*Low	*Low	*Low
CBRK-018	70	14.1	14.3	14.1	14.1	14.1	5.9
CBRK-019	70	*Low	*Low	*Low	*Low	*Low	*Low
CBRK-020	70	21.9	21.9	21.9	21.9	21.9	14.1
CBRK-021	70	*Low	*Low	*Low	*Low	*Low	*Low
CBRK-022	70	22.0	22.0	22.0	22.0	22.0	21.9
CBRK-023	70	*Low	*Low	*Low	*Low	*Low	*Low
CBRK-024	70	22.0	22.0	22.0	22.0	22.0	22.0
CBRK-025	70	*Low	*Low	*Low	*Low	*Low	*Low
CBRK-026	70	22.4	22.7	22.4	22.4	22.4	22
CBRK-027	70	*Low	*Low	*Low	*Low	*Low	*Low
CBRK-028	70	22.4	22.5	22.4	22.4	22.4	22.4
CBRK-029	70	*Low	*Low	*Low	*Low	*Low	*Low
CBRK-030	70	22.1	22.1	22.1	22.1	22.1	22.4

Receiver ID	Assigned Noise Level, dB(A)	Modelled Noise Level, dB(A)					
		Scenario 1 - Mine Year 2024	Scenario 2 - Mine Year 2028	Scenario 3 - Mine Year 2029	Scenario 4 - Mine Year 2034	Scenario 5 - Mine Year 2035	Scenario 6 - Mine Year 2037
CBRK-031	70	*Low	*Low	*Low	*Low	*Low	*Low
CBRK-032	70	22.1	22.1	22.1	22.1	22.1	22.1
CBRK-033	70	*Low	*Low	*Low	*Low	*Low	*Low
CBRK-034	70	22.2	22.3	22.2	22.2	22.2	22.1
CBRK-035	70	*Low	*Low	*Low	*Low	*Low	*Low
CBRK-036	70	18.8	18.8	18.8	18.8	18.8	22.2
CBRK-037	70	*Low	*Low	*Low	*Low	*Low	*Low
CBRK-038	70	9.9	10.6	9.9	9.9	9.9	18.8
CBRK-039	70	*Low	*Low	*Low	*Low	*Low	*Low
CBRK-040	70	8.6	9.3	8.6	8.6	8.6	9.9
CBRK-041	70	*Low	*Low	*Low	*Low	*Low	*Low
CBRK-042	70	5.7	6.7	5.7	5.7	5.7	8.6
CBRK-043	70	*Low	*Low	*Low	*Low	*Low	*Low
CBRK-044	70	6.4	7.2	6.4	6.4	6.4	5.7
CBRK-045	70	8.0	15.4	8.5	18.6	8.0	*Low
CBRK-046	70	6.2	7.1	6.2	6.2	6.2	6.4
CBRK-047	70	8.0	24.6	9.7	8.8	8.0	8.0
CBRK-048	70	5.8	7.1	5.8	5.8	5.8	6.2
CBRK-049	70	6.9	14.4	9	8.2	6.9	8.8

Receiver ID	Assigned Noise Level, dB(A)	Modelled Noise Level, dB(A)					
		Scenario 1 - Mine Year 2024	Scenario 2 - Mine Year 2028	Scenario 3 - Mine Year 2029	Scenario 4 - Mine Year 2034	Scenario 5 - Mine Year 2035	Scenario 6 - Mine Year 2037
CBRK-050	70	6.4	7.7	6.4	6.4	6.4	5.8
CBRK-051	70	21.5	26.9	21.7	21.7	21.5	7.9
CBRK-052	70	9.9	10.6	9.9	9.9	9.9	6.4
CBRK-053	70	20.2	**70.7**	20.2	20.2	20.2	21.5
CBRK-054	70	13.4	14.7	13.4	13.4	13.4	9.9
CBRK-055	70	41.8	*Low	6.2	2.3	9.7	20.2
CBRK-056	70	13.9	15.7	13.9	13.9	13.9	13.4
CBRK-057	70	41.5	*Low	6.2	0.2	8.7	*Low
CBRK-058	70	13.6	22.5	13.6	13.6	13.6	13.9
CBRK-059	70	29.7	*Low	4.9	*Low	9.0	*Low
CBRK-060	70	13.8	23.0	13.8	13.8	13.8	13.6
CBRK-061	70	46.1	*Low	17.4	7.4	22.7	*Low
CBRK-062	70	11.4	11.8	11.4	11.4	11.4	13.8
CBRK-063	70	47.1	*Low	17.6	10.2	22.7	*Low
CBRK-064	70	7.3	8.2	7.3	7.3	7.3	11.4
CBRK-065	70	47.3	*Low	17.4	10.1	22.8	*Low
CBRK-066	70	13.0	13.5	13.0	13	13.0	7.3
CBRK-067	70	58.6	*Low	17.3	6.7	23.1	*Low
CBRK-068	70	13.0	17.8	13.0	13.0	13.0	13.0

Receiver ID	Assigned Noise Level, dB(A)	Modelled Noise Level, dB(A)					
		Scenario 1 - Mine Year 2024	Scenario 2 - Mine Year 2028	Scenario 3 - Mine Year 2029	Scenario 4 - Mine Year 2034	Scenario 5 - Mine Year 2035	Scenario 6 - Mine Year 2037
CBRK-069	70	53.1	*Low	14.3	*Low	36.8	*Low
CBRK-070	70	23.4	23.6	23.4	23.4	23.4	13.0
CBRK-071	70	39.7	*Low	14.2	*Low	43.3	3.0
CBRK-072	70	23.4	24	23.4	23.4	23.4	23.4
CBRK-073	70	59.3	*Low	17.5	12.6	22.6	2.4
CBRK-074	70	12.1	*Low	2.7	20.5	*Low	23.4
CBRK-075	70	37.1	*Low	4.1	5.9	6.6	*Low
CBRK-076	70	37.3	*Low	6.9	15.9	20.3	*Low
CBRK-077	70	53.1	*Low	6.2	1.2	9.1	*Low
CBRK-078	70	*Low	*Low	*Low	8.3	*Low	*Low
CBRK-079	70	41.6	*Low	0.6	6.3	18.6	*Low
CBRK-080	70	*Low	*Low	*Low	4.4	*Low	*Low
CBRK-081	70	51.3	*Low	0.7	11.7	20.5	*Low
CBRK-082	70	*Low	*Low	*Low	1.5	*Low	*Low
CBRK-083	70	51.3	*Low	0.8	16	20.1	*Low
CBRK-084	70	9.6	7.3	5.8	**79.6**	4.0	*Low
CBRK-085	70	41.4	*Low	0.6	16.1	3.6	*Low
CBRK-086	70	4.3	6.9	5.9	65.0	4.0	4.7
CBRK-087	70	49.2	*Low	0.5	4.2	3.4	*Low

Receiver ID	Assigned Noise Level, dB(A)	Modelled Noise Level, dB(A)					
		Scenario 1 - Mine Year 2024	Scenario 2 - Mine Year 2028	Scenario 3 - Mine Year 2029	Scenario 4 - Mine Year 2034	Scenario 5 - Mine Year 2035	Scenario 6 - Mine Year 2037
CBRK-088	70	11.9	26.8	15	13.4	11.9	4.8
CBRK-089	70	54.8	*Low	11.1	*Low	20.6	*Low
CBRK-090	70	10.1	*Low	3.7	6.8	*Low	12.2
CBRK-091	70	55.6	*Low	17.3	15.8	21.1	1.3
CBRK-092	70	12.4	*Low	3.0	7.4	*Low	*Low
CBRK-093	70	55.3	*Low	7.8	*Low	11.6	*Low
CBRK-094	70	17.1	*Low	11.0	*Low	55.9	*Low
CBRK-095	70	49.2	*Low	7.5	*Low	10.2	*Low
CBRK-096	70	17.1	*Low	11.1	*Low	55.2	3.3
CBRK-097	70	60.3	*Low	16.7	*Low	21.5	*Low
CBRK-098	70	17.2	*Low	11	0.6	49.7	3.5
CBRK-099	70	60.5	*Low	16.7	8.9	21.6	*Low
CBRK-100	70	63.7	*Low	18.8	*Low	31.6	3.3
CBRK-101	70	63.1	*Low	17.6	*Low	22.9	*Low
CBRK-102	70	53.3	*Low	14.4	*Low	37.1	9.0
CBRK-103	70	7.9	6.0	**76.7**	7.1	8.0	*Low
CBRK-104	70	7.6	5.4	**76.2**	6.1	7.8	3.2
CBRK-105	70	43.4	*Low	17.5	0.6	22.2	22.8
CBRK-106	70	12.4	12.7	21.5	12.4	12.4	22.7

Receiver ID	Assigned Noise Level, dB(A)	Modelled Noise Level, dB(A)					
		Scenario 1 - Mine Year 2024	Scenario 2 - Mine Year 2028	Scenario 3 - Mine Year 2029	Scenario 4 - Mine Year 2034	Scenario 5 - Mine Year 2035	Scenario 6 - Mine Year 2037
CBRK-107	70	10.1	6.3	**72.3**	4.7	8.5	*Low
CBRK-108	70	8.5	5.1	**71.3**	4.3	7.4	50.9
CBRK-109	70	12.8	15.1	13.3	12.8	12.9	28.6
CBRK-110	70	18.0	18.3	19.6	18.1	18.1	31.6
CBRK-111	70	15.4	15.7	16.5	15.4	15.4	26.5
CBRK-113	70	31.0	*Low	4.7	*Low	6.0	46.0
CBRK-114	70	21.5	21.6	21.5	21.5	21.5	58.6
CBRK-115	70	6.0	7.0	6.0	6.0	6.0	*Low
CBRK-116	70	13.1	50.1	13.1	13.2	13.1	21.9
CBRK-119	70	13.2	53.2	13.2	13.2	13.2	6.0
CBRK-120	70	32.7	*Low	16.7	*Low	43	13.4
CBRK-121	70	18.3	17.7	35.1	17.6	18.2	13.6
CBRK-122	70	23.8	23.7	26.9	23.8	23.8	5.3
CBRK-123	70	14.3	14.2	26.8	13.9	14.4	**71.3**
CBRK-124	70	12.4	12.4	38.6	11.9	12.1	67.5
CBRK-125	70	8.0	7.4	26.0	6.7	7.9	46.5
CBRK-126	70	8.1	7.4	24.4	6.7	7.8	61.7
CBRK-136	70	18.1	60.9	18.1	18.1	18.1	60.9
CBRK-137	70	16.8	61.5	16.8	16.8	16.8	60.7

Receiver ID	Assigned Noise Level, dB(A)	Modelled Noise Level, dB(A)					
		Scenario 1 - Mine Year 2024	Scenario 2 - Mine Year 2028	Scenario 3 - Mine Year 2029	Scenario 4 - Mine Year 2034	Scenario 5 - Mine Year 2035	Scenario 6 - Mine Year 2037
CBRK-138	70	12.9	64.9	12.9	13	12.9	18.2
CBRK-139	70	22.3	59.6	22.3	22.3	22.3	16.9
CBRK-140	70	46.0	46.0	46.0	46.0	46.0	13.1
CBRK-141	70	47.2	*Low	9.4	*Low	14.6	22.3
CBRK-142	70	50.9	*Low	8.7	*Low	18.0	46.0
CBRK-143	70	13.3	45.1	13.3	13.3	13.3	3.1
CBRK-144	70	15.4	52.9	15.6	15.5	15.4	5.4
CBRK-145	70	14.7	66.8	14.9	14.7	14.7	13.5
CBRK-147	70	38.0	38.1	38.0	38.0	38.0	15.5
CBRK-148	70	35.3	*Low	0.4	16.2	2.3	14.8
CBRK-149	70	33	*Low	4.6	*Low	7.6	38.3
CBRK-150	70	48.7	*Low	0.4	9.7	2.4	*Low
CBRK-151	70	30.6	56.7	31	30.6	30.6	*Low
CBRK-152	70	35.1	35.2	35.1	35.1	35.1	*Low
CBRK-153	70	11.7	7.8	25.1	7.1	13.8	30.6
CBRK-154	70	11.4	7.6	25.7	6.9	8.3	35.5
CBRK-160	70	22.9	*Low	*Low	15.5	*Low	61.0
CBRK-161	70	7.8	*Low	*Low	6.8	*Low	61.7
CBRK-162	70	10.6	*Low	*Low	6.6	*Low	*Low

Receiver ID	Assigned Noise Level, dB(A)	Modelled Noise Level, dB(A)					
		Scenario 1 - Mine Year 2024	Scenario 2 - Mine Year 2028	Scenario 3 - Mine Year 2029	Scenario 4 - Mine Year 2034	Scenario 5 - Mine Year 2035	Scenario 6 - Mine Year 2037
CBRK-163	70	23.2	*Low	*Low	15.9	*Low	*Low
CBRK-164	70	23.2	*Low	*Low	15.6	*Low	*Low
CBRK-165	70	6.3	*Low	*Low	6.0	*Low	*Low
CBRK-166	70	3.4	*Low	*Low	2.8	*Low	*Low
CBRK-167	70	5.4	*Low	*Low	6.1	*Low	*Low
CBRK-168	70	8.1	*Low	*Low	2.6	*Low	*Low
CBRK-170	70	9.3	*Low	*Low	6.0	*Low	*Low
CBRK-171	70	15.8	*Low	*Low	8.6	*Low	*Low
CBRK-173	70	25.5	25.6	25.6	25.5	25.5	*Low
CBRK-174	70	23.0	23.1	23.1	23.0	23.0	*Low
CBRK-175	70	*Low	*Low	*Low	*Low	*Low	37.5
CBRK-176	70	*Low	*Low	*Low	*Low	*Low	34.8
CBRK-177	70	*Low	*Low	*Low	*Low	*Low	*Low
CBRK-199	70	47.5	*Low	18.2	*Low	33.4	*Low
GBS_CA_01	70	12.3	12.6	12.3	12.3	12.3	*Low
GBS_CA_02	70	21.4	21.7	21.4	21.4	21.4	14.4
GBS_CA_03	70	13.1	50.3	13.1	13.2	13.1	12.3
GBS_CA_04	70	21.7	64.6	21.7	21.7	21.7	21.4
GBS_CA_05	70	33.9	34.1	33.9	33.9	33.9	13.5

Receiver ID	Assigned Noise Level, dB(A)	Modelled Noise Level, dB(A)					
		Scenario 1 - Mine Year 2024	Scenario 2 - Mine Year 2028	Scenario 3 - Mine Year 2029	Scenario 4 - Mine Year 2034	Scenario 5 - Mine Year 2035	Scenario 6 - Mine Year 2037
GBS_CA_06	70	19.9	53.6	19.9	19.9	19.9	21.7
GBS_CA_07	70	24.7	26.3	24.7	24.7	24.7	34.0
GBS_CA_08	70	51.7	*Low	6.5	0.7	10.9	20.0
GBS_CA_09	70	42.8	*Low	2.5	*Low	3.5	24.7
GBS_CA_10	70	48.8	*Low	5.1	0.6	6.4	*Low
GBS_CA_11	70	46.2	*Low	17.4	15.6	21.5	*Low
GBS_CA_12	70	35.8	*Low	2.8	15.6	4.4	*Low
GBS_CA_13	70	15.7	16.2	15.7	15.7	15.7	*Low
GBS_CA_14	70	45.0	*Low	2.9	*Low	3.9	*Low
GBS_CA_15	70	58.7	*Low	14.7	*Low	17.8	15.7
GBS_CA_16	70	49.5	*Low	0.5	4.3	3.4	*Low
GBS_CA_17	70	40.5	*Low	8.2	15.9	20.3	*Low
GBS_CA_18	70	36.7	*Low	7.4	15.9	20.3	*Low
GBS_CA_19	70	22.1	22.2	22.1	22.1	22.1	*Low
GBS_CA_20	70	17.7	53.2	17.7	17.7	17.7	*Low
GBS_CA_21	70	16.1	59.8	16.1	16.2	16.1	22.1
GBS_CA_22	70	12.6	43.6	12.6	12.6	12.6	17.7
MAMbat 81-01	70	18.2	18	28.7	17.9	18.7	16.4
MAMBAT 93-01	70	12.4	11.7	29.5	11.5	12.3	12.6

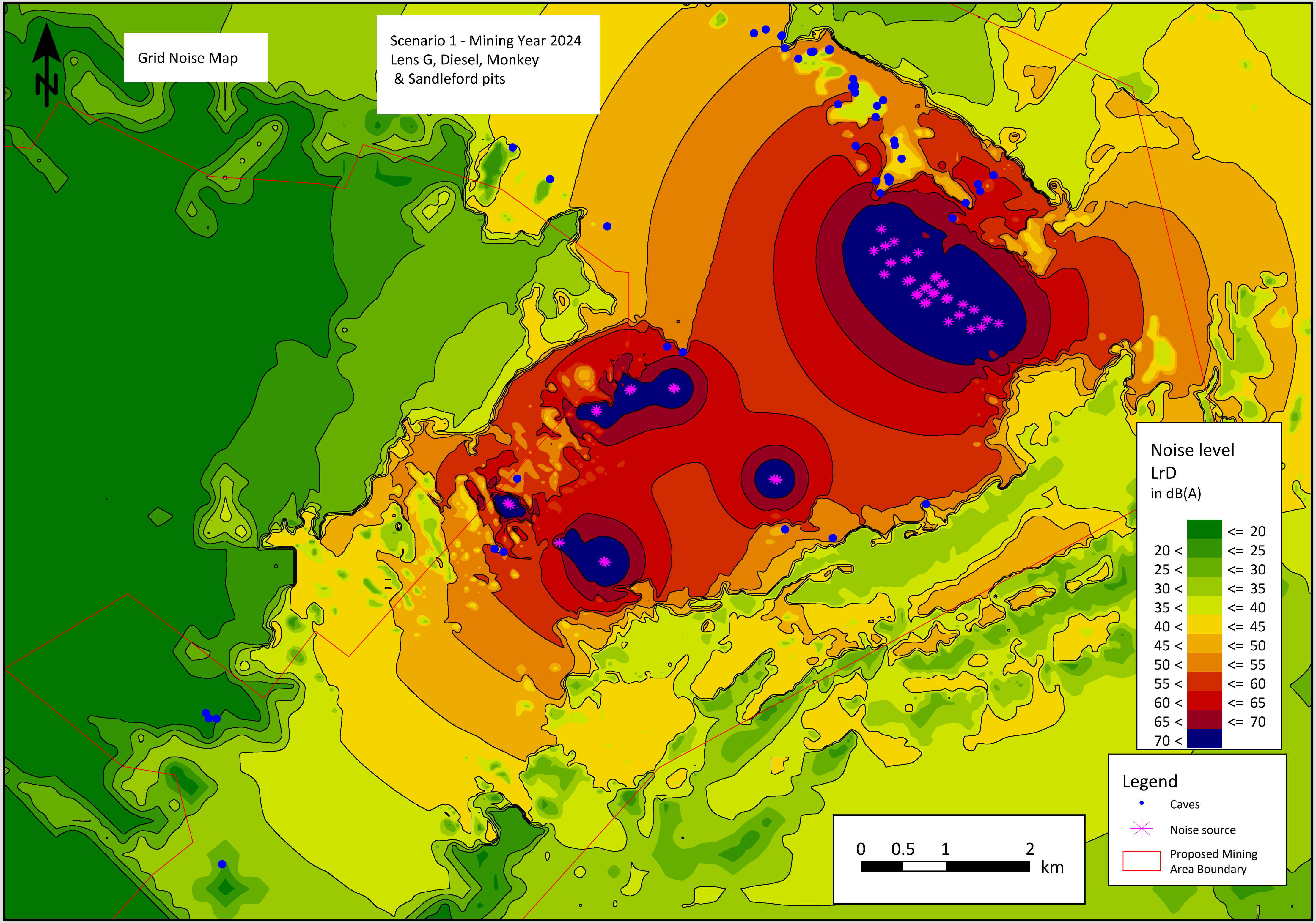
Receiver ID	Assigned Noise Level, dB(A)	Modelled Noise Level, dB(A)					
		Scenario 1 - Mine Year 2024	Scenario 2 - Mine Year 2028	Scenario 3 - Mine Year 2029	Scenario 4 - Mine Year 2034	Scenario 5 - Mine Year 2035	Scenario 6 - Mine Year 2037
SG1	70	*Low	*Low	*Low	0.4	*Low	*Low
Upper Beasley River PLNB Roost	70	10.8	18.6	17.3	10.2	10.4	*Low

Notes:

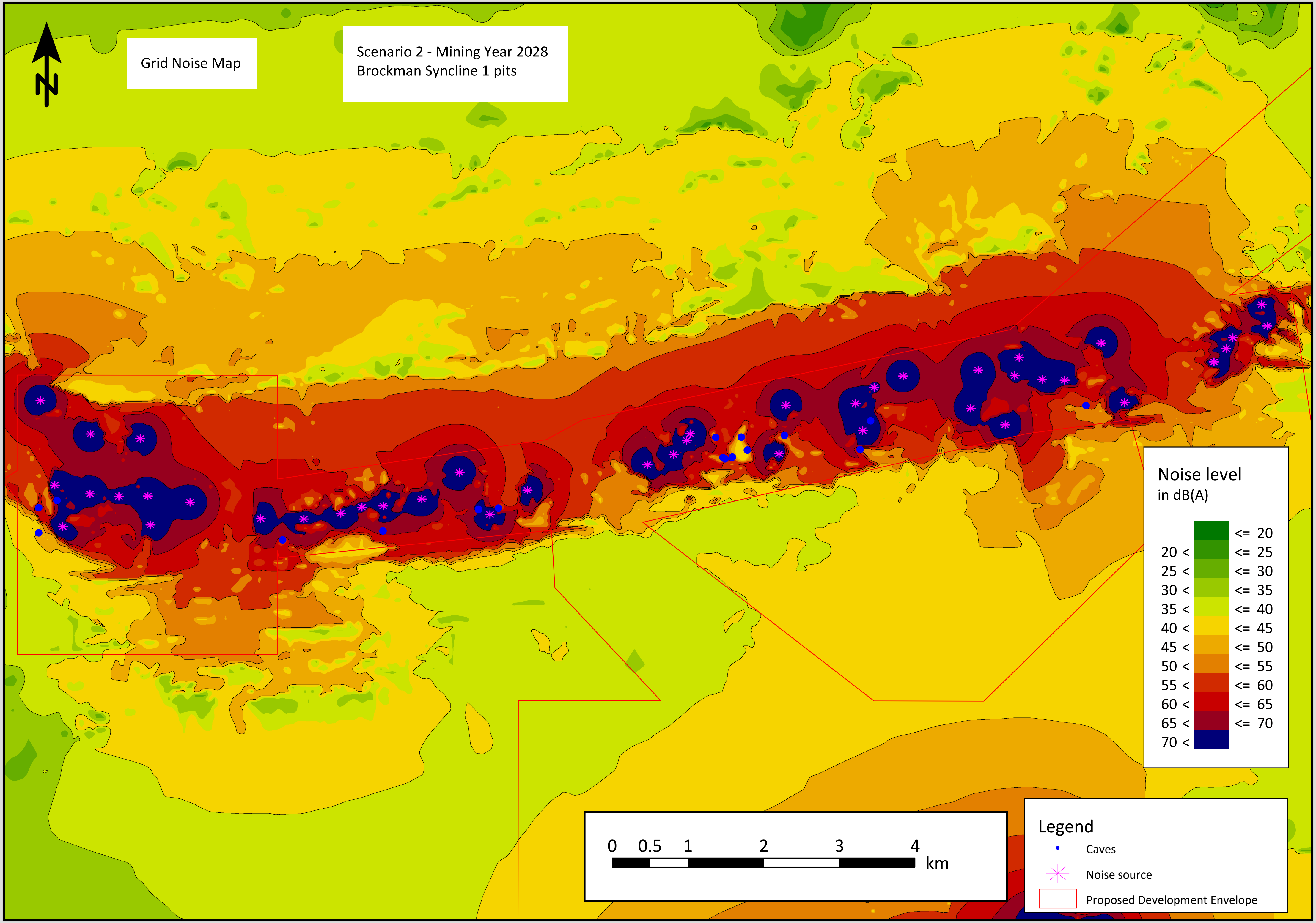
A red font indicates a predicted exceedance

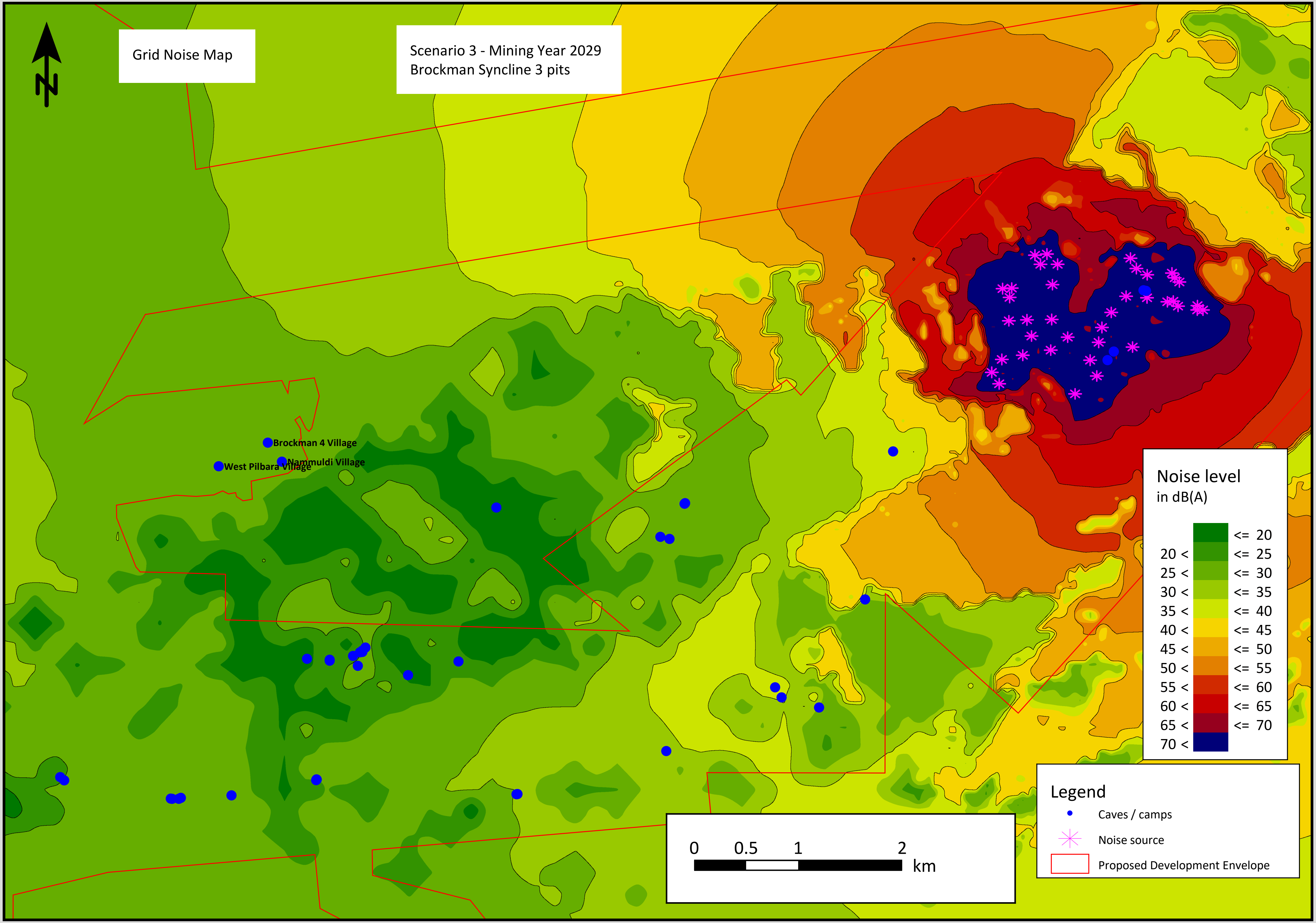
* "Low" denotes a predicted noise level that is below the threshold of hearing i.e. less than 0 dB(A).

APPENDIX C NOISE AND VIBRATION CONTOURS

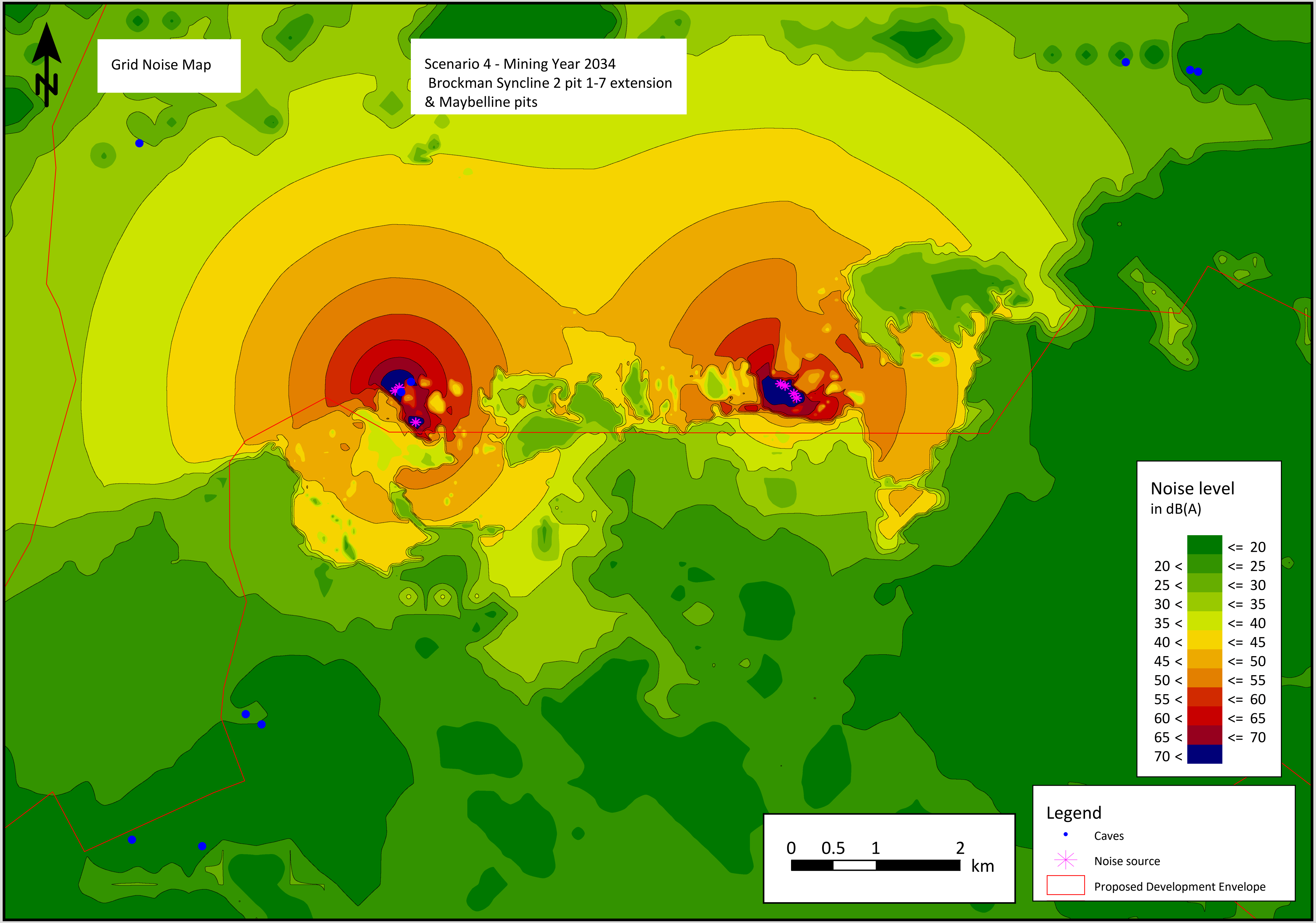


Grid Noise Map
Scenario 1 - Mining Year 2024
Lens G, Diesel, Monkey
& Sandleford pits
N
Noise level
LrD
in dB(A)
<= 20
20 < <= 25
25 < <= 30
30 < <= 35
35 < <= 40
40 < <= 45
45 < <= 50
50 < <= 55
55 < <= 60
60 < <= 65
65 < <= 70
70 <
Legend
Caves
Noise source
Proposed Mining Area Boundary
0 0.5 1 2 km

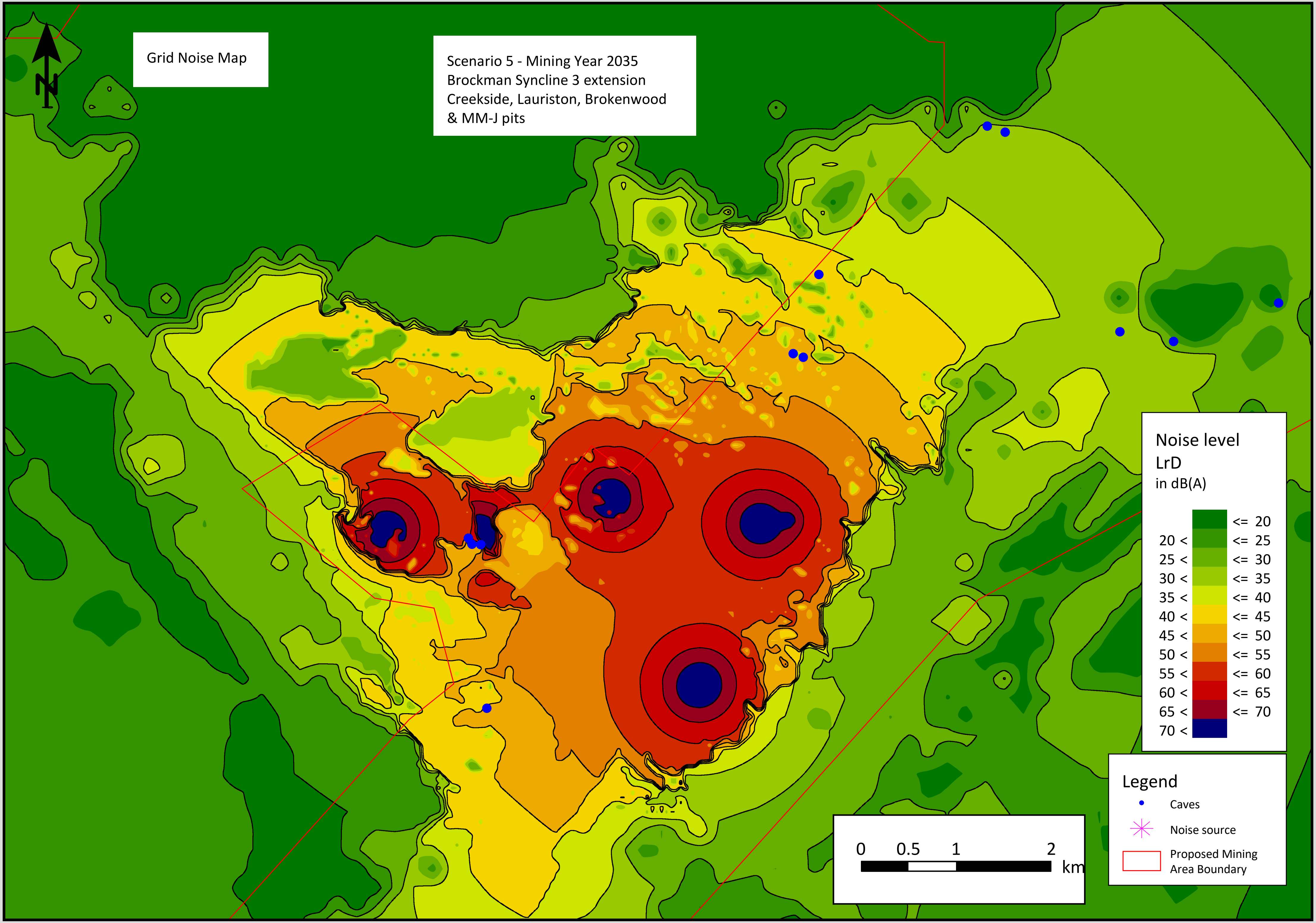

Grid Noise Map
Scenario 2 - Mining Year 2028
Brockman Syncline 1 pits
N
Noise level
in dB(A)
<= 20
20 < <= 25
25 < <= 30
30 < <= 35
35 < <= 40
40 < <= 45
45 < <= 50
50 < <= 55
55 < <= 60
60 < <= 65
65 < <= 70
70 <
0 0.5 1 2 3 4 km
Legend
Caves
Noise source
Proposed Development Envelope

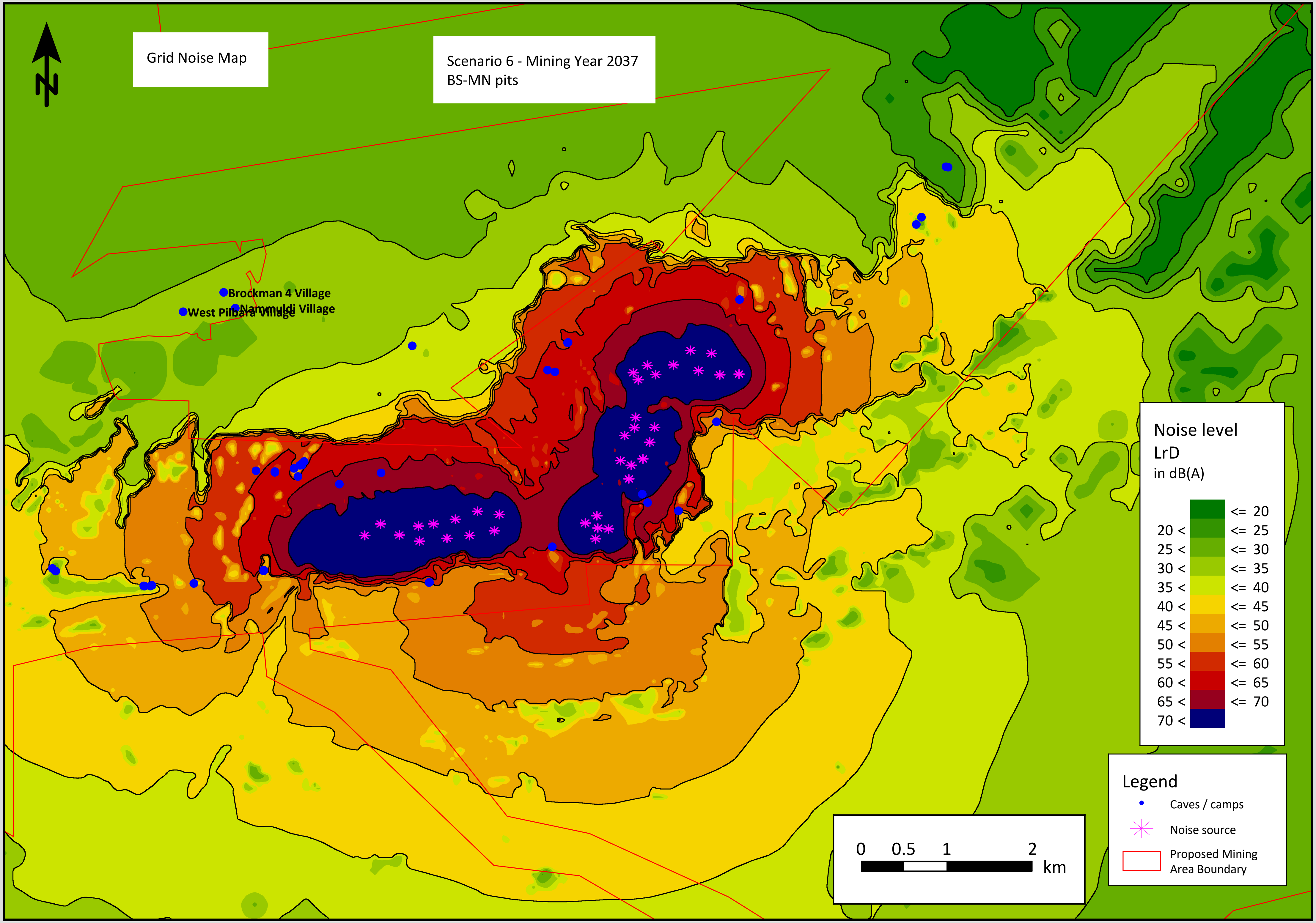


N
Grid Noise Map
Scenario 3 - Mining Year 2029
Brockman Syncline 3 pits
Brockman 4 Village
Nammuldi Village
West Pilbara Village
Noise level
in dB(A)
<= 20
20 < <= 25
25 < <= 30
30 < <= 35
35 < <= 40
40 < <= 45
45 < <= 50
50 < <= 55
55 < <= 60
60 < <= 65
65 < <= 70
70 <
0 0.5 1 2
km
Legend
Caves / camps
Noise source
Proposed Development Envelope

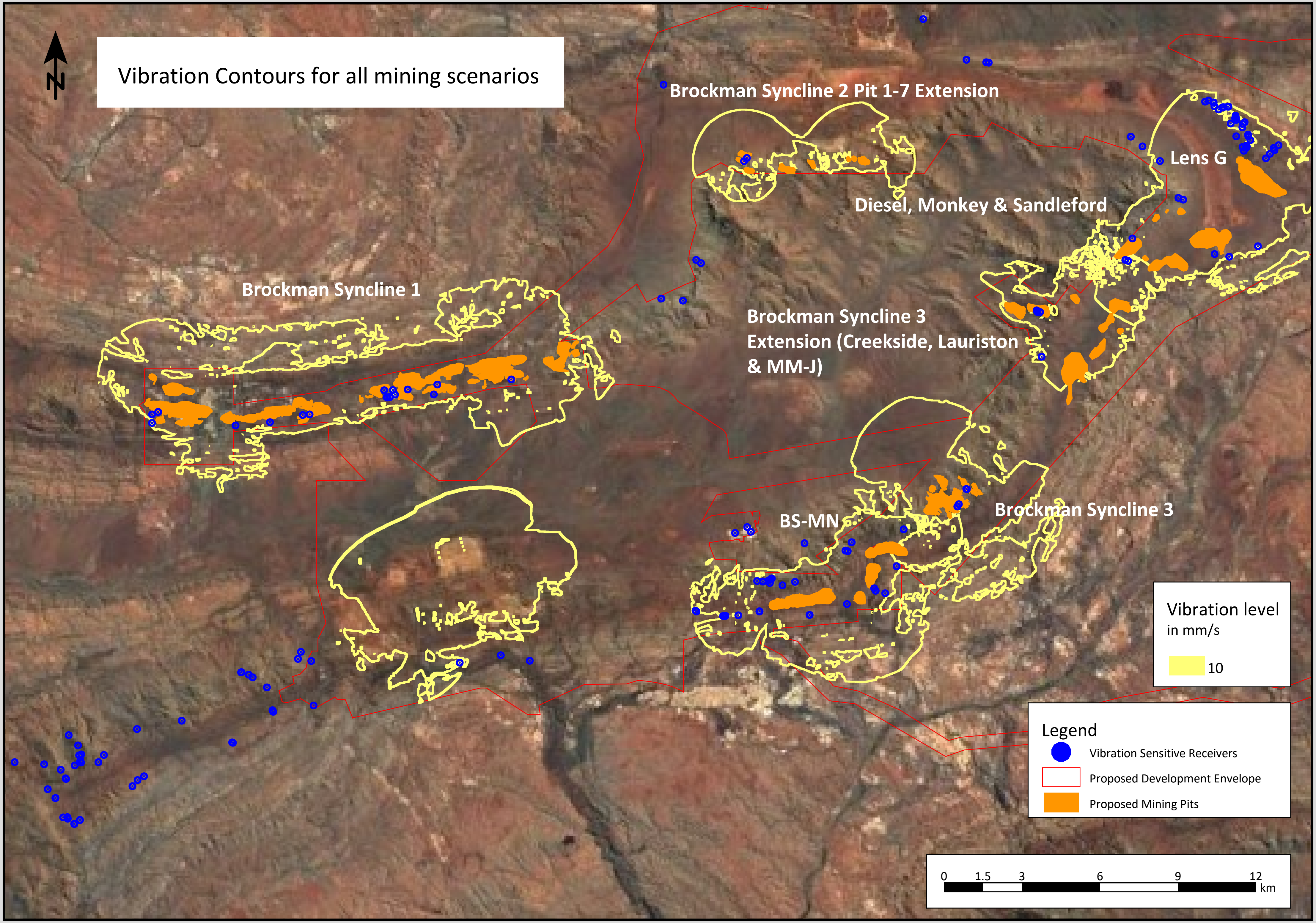


N
Grid Noise Map
Scenario 4 - Mining Year 2034
Brockman Syncline 2 pit 1-7 extension
& Maybelline pits
Noise level
in dB(A)
<= 20
20 < <= 25
25 < <= 30
30 < <= 35
35 < <= 40
40 < <= 45
45 < <= 50
50 < <= 55
55 < <= 60
60 < <= 65
65 < <= 70
70 <
0 0.5 1 2
km
Legend
Caves
Noise source
Proposed Development Envelope


Grid Noise Map
N
Scenario 5 - Mining Year 2035
Brockman Syncline 3 extension
Creekside, Lauriston, Brokenwood
& MM-J pits
Noise level
LrD
in dB(A)
<= 20
20 < <= 25
25 < <= 30
30 < <= 35
35 < <= 40
40 < <= 45
45 < <= 50
50 < <= 55
55 < <= 60
60 < <= 65
65 < <= 70
70 <
Legend
Caves
Noise source
Proposed Mining Area Boundary
0 0.5 1 2 km



Grid Noise Map
Scenario 6 - Mining Year 2037
BS-MN pits
N
Brockman 4 Village
West Pilbara Village
Nammuldi Village
Noise level
LrD
in dB(A)
<= 20
20 < <= 25
25 < <= 30
30 < <= 35
35 < <= 40
40 < <= 45
45 < <= 50
50 < <= 55
55 < <= 60
60 < <= 65
65 < <= 70
70 <
0 0.5 1 2
km
Legend
Caves / camps
Noise source
Proposed Mining Area Boundary


Vibration Contours for all mining scenarios
N
Brockman Syncline 2 Pit 1-7 Extension
Lens G
Diesel, Monkey & Sandleford
Brockman Syncline 1
Brockman Syncline 3
Extension (Creekside, Lauriston
& MM-J)
BS-MN
Brockman Syncline 3
Vibration level
in mm/s
10
Legend
Vibration Sensitive Receivers
Proposed Development Envelope
Proposed Mining Pits
0
1.5
3
6
9
12
km

APPENDIX D SUMMARY OF NOISE LEGISLATION

D.1 Environmental Protection (Noise) Regulations 1997

In Western Australia, noise emissions from industrial activities to other premises are regulated by the *Western Australia Environmental Protection (Noise) Regulations 1997* (ENPR).

To achieve compliance with this policy, noise levels at nearby sensitive receivers are not to exceed defined limits. These limits are determined from consideration of prevailing background noise levels and 'influencing factors' that take into account the level of commercial and industrial zoning in the locality.

The influencing factor (IF) takes into account zoning and road traffic around the nearest sensitive receiver of interest, within a 100 and 450 m radius. The below **Table D-1** presents the generic assigned noise levels as defined within EPNR for noise-sensitive receivers.

Table D-1 Table of Assigned Noise Levels

Type of premises receiving noise	Time of day	Assigned Levels dB(A)		
		$L_{A\ 10}$	$L_{A\ 1}$	$L_{A\ max}$
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 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
Noise sensitive premises: any area other than highly sensitive area	All hours	60	75	80
Industrial and utility premises other than those in the Kwinana Industrial Area	All hours	65	80	90

D.1.1 Table of Adjustments

If noise emitted from any premises when received at any other premises cannot reasonably be free of intrusive characteristics of tonality, modulation and impulsiveness, then a series of adjustments must be added to the emitted levels (measured or calculated) and the adjust level must comply with the Assigned Level. The adjustments are further defined in Regulation 9(1) of the Environmental Protection (Noise) Regulations 1997.

Tones are defined in Regulation 9(1) as being present where the difference between the A weighted sound pressure level in any one third octave band and the arithmetic average of the A weighted sound pressure levels in the two adjacent one third octave bands is greater than 3 dB in terms of $L_{Aeq,\ T}$ where the time period T is greater than 10% of the representative assessment period, or greater than 8 dB at any time when the sound pressure levels are determined as L_{ASlow} levels.

Modulation is defined as a variation in the emission of noise that:

- Is more than 3 dB L_{AFast} or is more than 3 dB L_{AFast} in any one third octave band;
- Is present for at least 10% of the representative assessment period; and
- Is regular, cyclic and audible.

Impulsiveness is defined as present where the difference between L_{Apeak} and L_{AmaxS} is more than 15 dB when determined for a single representative event.

If the noise is assessed as having any of these three characteristics, then the measured noise levels are adjusted by the amounts given in Table D-2. The adjusted noise levels must now comply with the assigned noise levels.

Table D-2: Table of Adjustments

Situation	Adjustment to Measured or Calculated Level
Where tonality is present	+5 dB
Where modulation is present	+5 dB
Where impulsiveness is present	+10 dB