ENVIRONMENTAL IMPACT STATEMENT

RED HILL
MINING LEASE

Section 13
Noise and Vibration

Section 13 Noise and Vibration

13.1 Description of Environmental Values

A noise and vibration assessment was undertaken for the Red Hill Mining Lease (the project) and a detailed technical report was prepared (**Appendix M**). This section of the project's environmental impact statement (EIS) outlines the existing background noise levels in the EIS study area and at the surrounding receptors. It also outlines the potential construction and operational noise and vibration impacts that are associated with the project, including transport noise.

13.1.1 Local Setting and Project Overview

13.1.1.1 Existing Receptor Locations

The closest receptors to the project study area includes 14 residences and an existing mine site accommodation village (Eureka Village) that are all located within a distance of approximately 15 kilometres of the EIS study area boundary. Locations of receptors in relation to the EIS study area are shown in **Figure 13-1**.

These receptors comprise:

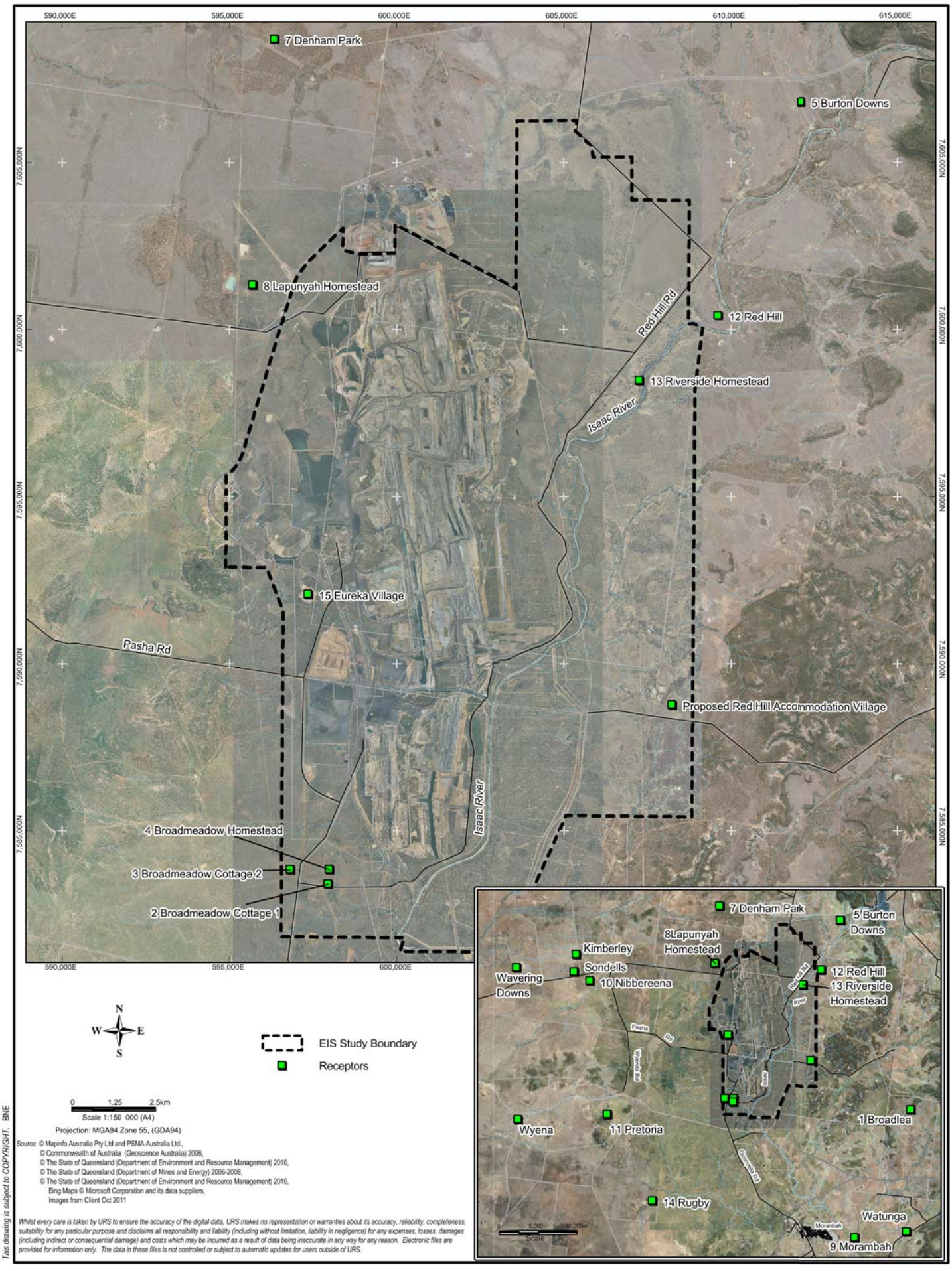
- Eureka Village, located within the EIS study area;
- seven residences located within a distance of approximately 5 kilometres of the EIS study area;
- two residences located within a distance of approximately 5 to 10 kilometres of the EIS study area; and
- five residences located within a distance of approximately 10 to 15 kilometres of the EIS study area. This includes the town of Moranbah which, for modelling purposes, has been represented by a single receptor located at the northern extents of the town.

Distances from each noise receptor to the EIS study area boundary and the proposed Red Hill coal handling and processing plant (CHPP) are given in **Table 13-1**.

A number of the nearest noise receptor properties are owned by BHP Billiton Mitsubishi Alliance (BMA) (Burton Downs and Red Hill Homesteads) or compensation is currently being negotiated, (Riverside and Broadmeadow Homestead and Cottages). This is an important consideration as BMA will determine who lives in these properties and can also readily apply noise control measures directly to the properties if required (for example, acoustically upgraded glazing).

The residential properties at Denham Park and Lapunyah are owned by BHP Billiton Mitsui Coal (BMC). If required, BMC can determine who lives in these properties and can apply noise control measures directly to the properties.

The Riverside Homestead is currently occupied by the current landowners, BMA will seek to put in place a compensation agreement whereby this receptor is vacated when existing or proposed project activities are proposed to impact on their continued occupancy.



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RED HILL MINING LEASE
ENVIRONMENTAL IMPACT STATEMENT

LOCATION OF NOISE RECEPTORS

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NOISE AND VIBRATION Figure: **13-1**

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Table 13-1 Proximity of Existing Noise Receptors to the EIS Study Area

Location Number	Noise Receptor – Property Reference	Distance to EIS Study Area (km)	Distance to Nearest MLA Boundary (km)	Distance to Red Hill CHPP (km)	Notes
1	Broadlea	12.5	13.3	25.5	
2	Broadmeadow Cottage 1	0 [1]	0 [1]	10.1	Privately owned – compensation agreement being negotiated
3	Broadmeadow Cottage 2	0 [1]	0 [1]	9.7	Privately owned – compensation agreement being negotiated
4	Broadmeadow Homestead	0 [1]	0 [1]	9.7	Privately owned – compensation agreement being negotiated
5	Burton Downs Homestead	4.2	4.2	19.1	Owned by BMA
6	Dabin	9.3	6.4	22.1	
7	Denham Park	5.8	6.3	15.1	Owned by BMC
8	Lapunyah Homestead	1.8	2.1	8.1	Owned by BMC
9	Moranbah Township	14.1	14.1	27.3	
10	Nibbereena	15.9	17.0	19.4	
11	Pretoria Homestead	16.9	17.8	19.9	
12	Red Hill	0.9	0.9	13.4	Owned by BMA
13	Riverside Homestead	0 [1]	0 [1]	10.5	Privately owned - compensation agreement under negotiation
14	Rugby	14.3	16.5	25	
15	Eureka Village	0 [1]	0 [1]	1.6	Owned by BMA

Note 1: Property currently lies within the boundary of the EIS study area or project mining lease and is therefore given a zero kilometre distance.

13.1.1.2 Proposed Development

The project includes the following components:

- The extension of BRM longwall panels 14, 15, and 16 into MLA70421. Key elements include:
  - No new mining infrastructure is proposed other than infrastructure required for drainage of incidental mine gas (IMG) to enable safe and efficient mining.
  - Management of waste and water produced from drainage of IMG will be integrated with the existing BRM waste and water management systems.
  - The mining of the BRM extension is to sustain existing production rates of the BRM mine and will extend the life of mine by approximately one year.
  - The existing BRM workforce will complete all work associated with the extensions.

- The incremental expansion of the GRM including:
  - underground mining associated with the Red Hill Mine (RHM) underground expansion option to target the Goonyella Middle Seam (GMS);
  - a new mine industrial area (MIA);
  - a CHPP adjacent to the Riverside MIA on MLA1764 and mining lease (ML) 1900 − the Red Hill CHPP will consist of up to three 1,200 tonne per hour (tph) modules;
  - construction of a drift for mine access;
  - a conveyor system linking RHM to the Red Hill CHPP;
  - associated coal handling infrastructure and stockpiles;
  - a new conveyor linking product coal stockpiles to a new rail load-out facility located on ML1900; and
  - means for providing flood protection to the mine access and MIA, potentially requiring a levee along the west bank of the Isaac River.
- A potential new Red Hill underground mine expansion option to the east of the Goonyella, Riverside and Broadmeadow (GRB) mine complex, to target the GMS on MLA70421. Key aspects include:
  - the proposed mine layout consists of a main drive extending approximately west to east with longwall panels ranging to the north and south;
  - a network of bores and associated surface infrastructure over the underground mine footprint for mine gas pre-drainage (IMG) and management of goaf methane drainage to enable the safe extraction of coal;
  - a ventilation system for the underground workings;
  - a bridge across the Isaac River for all-weather access. This will be located above the main headings, and will also provide a crossing point for other mine related infrastructure including water pipelines and power supply;
  - a new accommodation village (Red Hill accommodation village) for the up to 100 per cent remote construction and operational workforces with capacity for up to 3,000 workers; and
  - potential production capacity of 14 million tonnes per annum (mtpa) of high quality hard coking coal over a life of 20 to 25 years.

The project includes extension of the BRM footprint eastward. However, as this extension only includes underground mining, there are no expected noise impacts on the surface. Therefore, this extension to the BRM has not been included in the noise and vibration impact assessment. If incidental mine gas management is required for the Broadmeadow extension, surface infrastructure will be minimal and is unlikely to contribute to noise disturbance.

The assessment has been undertaken for the RHM underground expansion option and GRM incremental expansion which have the potential to produce up to 14 mtpa of product coking coal using thick seam longwall mining techniques. This production, together with the approved production rate of 18.5 mtpa at the GRB mine complex has the potential to result in a total production capacity for the combined mining operations of approximately 32.5 mtpa.

BMA is currently investigating three options for the use of IMG:

- use for mining under the ML including on site power generation;
- transport or storage within the area of the ML to allow it to be used beneficially for mining under the ML; and/or
- use or disposal for a purpose other than mining, including third-party gas off-take arrangements for use off-site, in accordance with applicable legislation.

If these options are not commercially or technically feasible, the gas will be flared. Gas may also be flared under the following circumstances:

- when the quantity or quality of gas being produced is inadequate for any beneficial reuse, either on or off the ML; or
- for safety reasons at any time during mining operations.

Figure 13-2 shows the proposed project including noise generating elements associated with the GRM incremental expansion and RHM underground expansion option.

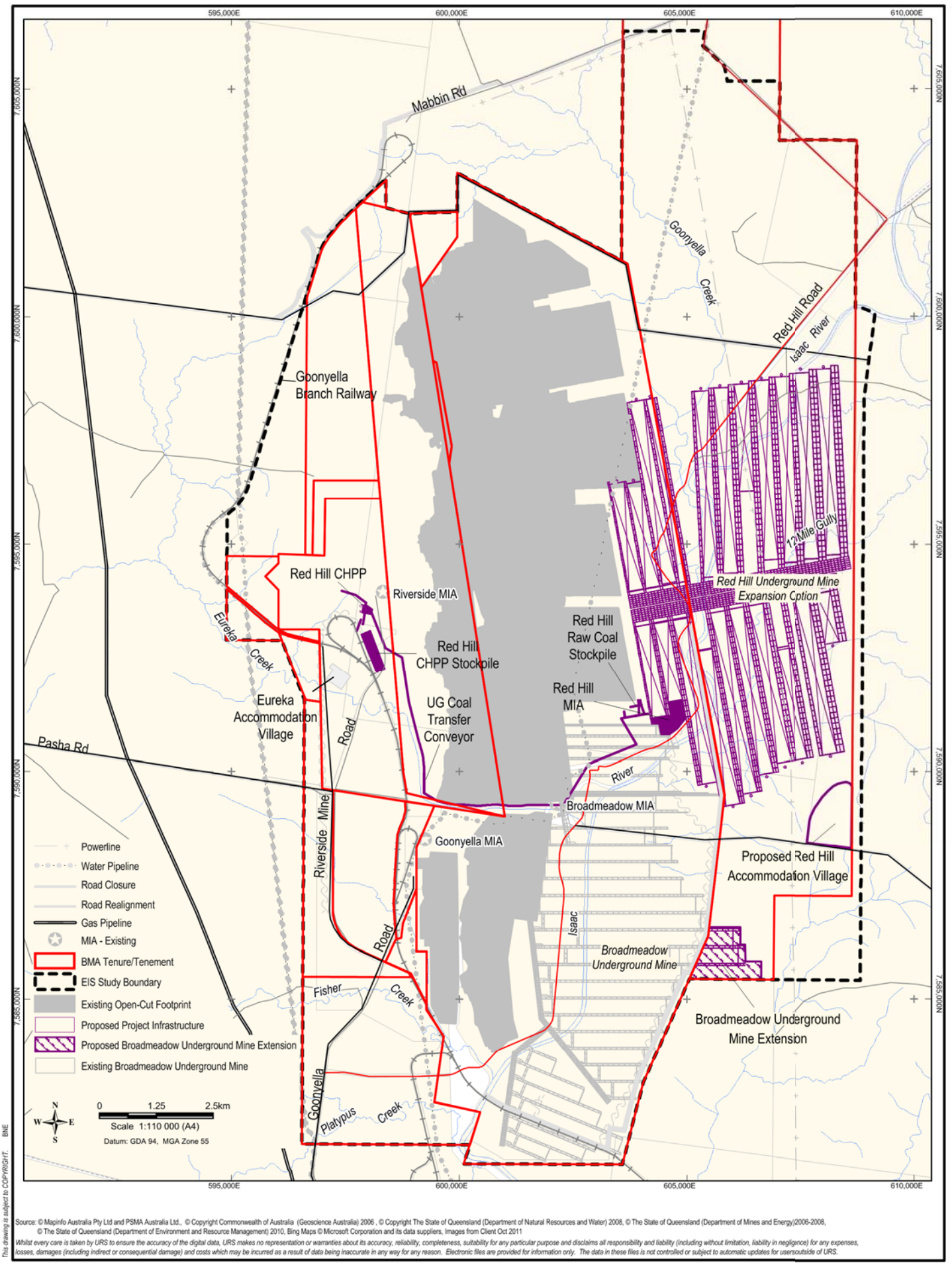
Noise impacts from underground mining operations are expected to be insignificant, as noise will be contained underground. However, the following above ground noise sources have the potential to impact on surrounding receptors:

- conveyor systems (including conveyor alarms);
- fixed plant such as motors, pumps, compressors and upcast ventilators;
- mobile plant; and
- fixed and mobile plant associated with the IMG and goaf gas drainage system.

There are no significant vibration sources associated with the GRM incremental expansion or the RHM underground expansion option as it is not proposed to undertake blasting. Due to the buffer distances between receptors and the vibration sources, no other discernible vibration levels are expected to reach nearby receptors. Therefore, further detailed assessment of vibration emissions is not required; however, the potential impact of existing blast vibration emissions at the proposed position of the new Red Hill accommodation village has been assessed.

The mine will operate on a 24 hour schedule, seven days a week during both construction and operational phases.

Further information on the project is provided in **Section 3**.



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RED HILL MINING LEASE
ENVIRONMENTAL IMPACT STATEMENT

PROPOSED UNDERGROUND MINE EXPANSION

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NOISE AND VIBRATION

Figure: **13-2**

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13.1.1.3 Red Hill Accommodation Village

As part of the RHM underground expansion option, BMA is proposing to establish an additional accommodation village to house new construction and increased operational workforces.

Potential noise impacts associated with the proposed Red Hill accommodation village include:

- noise impacts from construction of the accommodation village on existing residences;
- noise impacts from operational plant and vehicle movements at the accommodation village on existing residences and the accommodation village itself; and
- noise impacts from the mine construction and operation on the proposed Red Hill accommodation village (including existing GRB mine complex mine noise and noise and vibration from blasting).

The layout of the proposed Red Hill accommodation village will be finalised following the completion of environmental and engineering assessments during the detailed design phase. Consequently, a conceptual village layout based on BMA's Buffel Park accommodation village near Moranbah has been adopted as the villages are of similar scale and are considered to contain the same mix of noise sources and receptors.

The nearest existing receptors to the proposed Red Hill accommodation village, and the respective distances from the accommodation village are shown in **Table 13-2**.

Table 13-2 Proximity of Existing Noise Receptors to the Proposed Red Hill Accommodation Village

Existing Receptors	Distance to Red Hill Accommodation Village (km)
1 - Broadlea	14.0
2 - Broadmeadow Cottage 1	N/A
3 - Broadmeadow Cottage 2	N/A
4 - Broadmeadow Homestead	N/A
5 - Burton Downs Homestead	16.7
6 - Dabin	26.7
7 - Denham Park Homestead	22.3
8 - Lapunyah Homestead	17.1
9 - Moranbah Township	19.0
10 - Nibbereena	29.6
11 - Pretoria Homestead	27.4
12 - Red Hill	11.0
13 - Riverside Homestead	N/A
14 - Rugby	25.9
15 - Eureka Village	10.5

Note 1: BMA will seek to negotiate a compensation agreement with the owner of Riverside Homestead, Broadmeadow Homestead and Cottages 1 and 2 and where necessary, manage the occupancy of the dwellings.

13.1.2 Existing Acoustic Environment

Existing ambient noise levels at nearby receptors have been assessed in order to determine noise limits in accordance with the Queensland Department of Environment and Heritage Protection (EHP) (formerly Queensland Department of Environment and Resource Management (DERM) and Queensland Environmental Protection Agency (EPA)) noise guideline: *Planning for Noise Control* and the Queensland Coordinator-General's Terms of Reference (TOR).

13.1.2.1 Unattended Background Noise Surveys

Ambient noise logging was undertaken to establish baseline noise levels at Locations 4, 5 and 8 (listed in **Table 13-3**) between 13 May to 26 May 2009, and at Locations 7 and 13 from 26 May to 11 June, 2009. The monitoring locations are shown in **Figure 13-3**.

Ambient noise logging was also undertaken to establish baseline noise levels at Eureka Village between 31 March and 13 April 2011, as well as at the proposed Red Hill accommodation village between 20 May and 2 June 2011.

The results of the noise logging have been analysed to establish the noise limits at each of the noise sensitive locations, respectively.

As part of the analysis, periods with rainfall above 0.3 millimetres and/or wind above three metres per second have been excluded from the measurement results. The weather conditions during the remainder of the monitoring period were considered to be suitable for background noise measurements.

Table 13-3 Summary of (Unattended) Noise Logging Results

Locations	Description	Background Noise Levels min L_{A90} (dBA)[1]			Maximum Hourly Sound Pressure Level $L_{Aeq(1hour)}$ (dBA)		
		Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am
4 - Broadmeadow Homestead	Noise logger located in centre of yard between homestead and cottage/ dongers, ~15 m from homestead.	30	28 [2]	30	51	40 [2]	39 [2]
5 - Burton Downs Homestead	Noise logger located in centre of front yard ~100 m from homestead (between homestead and working shed, next to fruit garden).	25	24	24	50	33 [2]	32 [2]
7 - Denham Park Homestead	Noise logger located in south-eastern corner of front yard ~15 m from homestead.	28	25	25	49 [2]	35 [2]	36 [2]
8 - Lapunyah Homestead	Noise logger located in south-eastern corner of front yard ~20 m from homestead.	26	30 [2]	28	44 [2]	37 [2]	37 [2]

Locations	Description	Background Noise Levels min L_{A90} (dBA)[1]			Maximum Hourly Sound Pressure Level $L_{Aeq(1hour)}$ (dBA)		
		Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am
13 - Riverside Homestead	Noise logger located in north-east corner of tennis court ~40 m from homestead.	30	23	23	51	44 [2]	44 [2]
15 - Eureka Village	Noise logger located ~200 m from Eureka Creek and ~500 m from Mabbin Road.	36	39	36	46	48 [2]	47
Proposed Red Hill Accommodation Village	Noise logger located in southern end of proposed village.	25	25	25	43	28 [2]	28 [2]

Note 1: The L_{A90} represents the level exceeded for 90 per cent of the interval period and is referred to as the background noise level.
The L_{Aeq} is the equivalent continuous noise level defined as the level of noise equivalent to the energy average of noise levels occurring over a measurement period.
Note 2: Values have been adjusted downward to remove the (seasonal) influence of insect and bird noise.

The unattended ambient noise measurements were used to determine the rating background level (RBL) for daytime (7am to 6pm), evening (6pm to 10pm) and night-time (10pm to 7am) periods at each noise sensitive location. The RBLs are essentially the baseline noise levels and have been used to determine the operational noise criteria in accordance with the *Planning for Noise Control* guideline and the *Environmental Protection (Noise) Policy 2008* (EPP (Noise)).

A review of the data presented in **Table 13-3** at the five residential monitoring locations indicates that the RBLs ranged between 25 dBA to 30 dBA during the daytime, and 23 dBA to 30 dBA during both the evening and night-time periods.

Further, **Table 13-3** indicates that the RBLs at Eureka Village ranged between 36 dBA to 39 dBA during the daytime, evening and night time. The RBL at the proposed Red Hill accommodation village was 25 dBA for each of the daytime, evening and night time periods.

The maximum $L_{Aeq\ (1hour)}$ noise levels, which are representative of the average daily ambient noise environment at each location, are also shown in **Table 13-3**. The $L_{Aeq(1hour)}$ noise levels measured at each location have also been used for this assessment as required by the *Planning for Noise Control* guideline.

The measured background noise levels are typical of those of a rural environment with natural noise sources, such as birds, light wind in trees, insects, and some low level industrial noise contributions associated with the GRB mine complex and Peabody Energy's Eaglefield Mine (north of Goonyella Riverside Mine (GRM)) and Anglo American's Moranbah North Mine (south of GRM) (refer to **Section 3**, **Figure 3-1**).

13.1.2.2 Operator-attended Noise Surveys

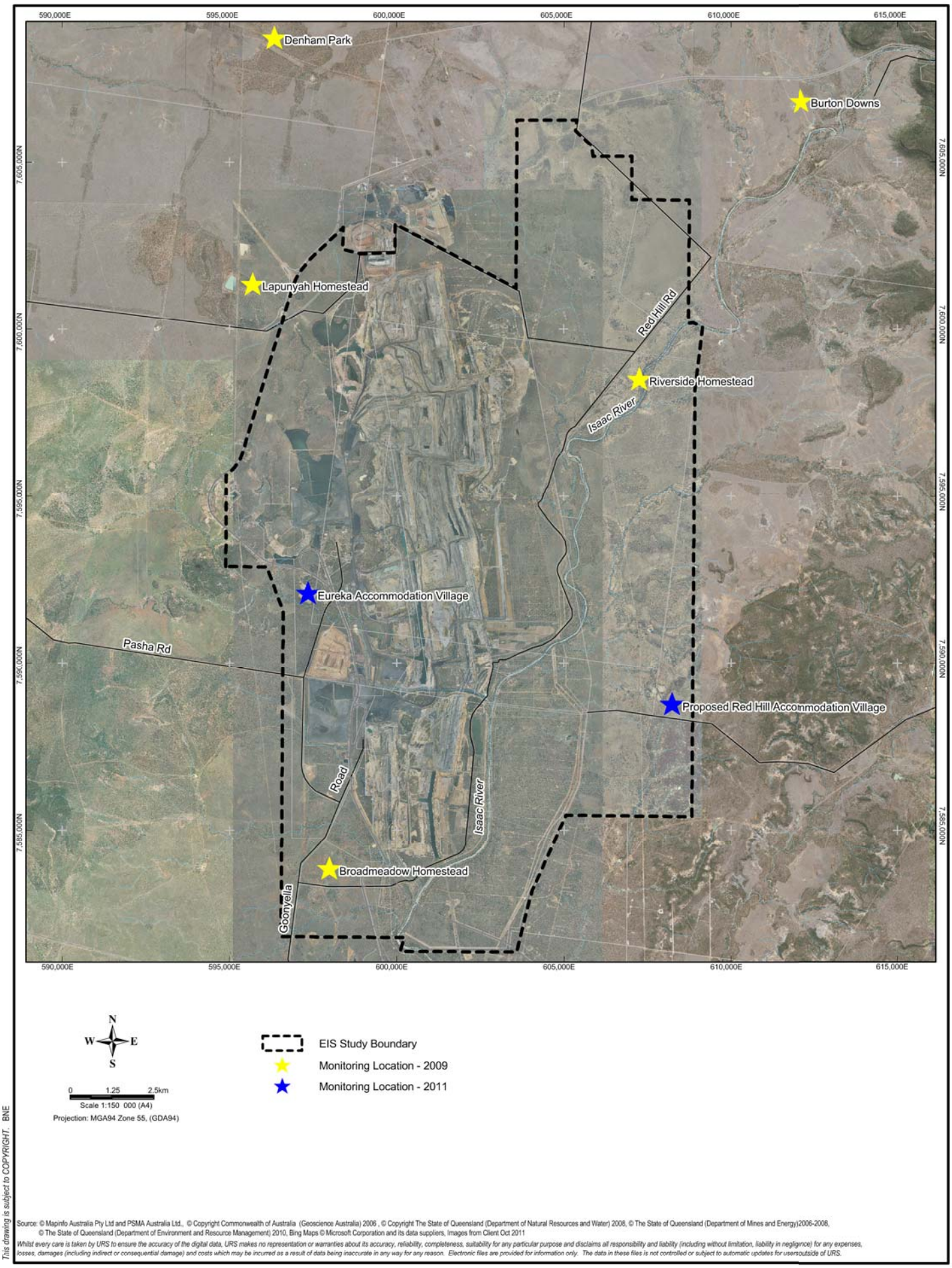
Operator attended noise surveys of 15 minutes duration were conducted at the noise logging locations during on site visits between 13 May and 27 May 2009 (for the residential locations), 31 March and 1 June 2011 (for the Eureka Village and the proposed Red Hill accommodation village).

The operator-attended noise measurements were conducted in order to qualify the results obtained with the unattended noise loggers. During the attended noise surveys, the operator identified the character and duration of acoustically significant ambient noise sources. Wherever possible, the operator quantified local traffic flows and made a qualitative assessment of the prevailing weather conditions.

A summary of the discernible noise sources, as observed during the operator-attended measurements, are detailed below:

- Lapunyah Homestead: insects and bird noise, GRB mine complex and Eaglefield mine noise audible (including engine drones, horn blasts, reverse alarms, track slaps), and tree movement in breeze;
- Denham Park Homestead: insects and bird noise, tree movement in breeze, and audible mine noise (GRB mine complex and Eaglefield mine);
- Burton Downs Homestead: insects and bird noise, tree movement in breeze, farm animal noise, and distant traffic noise;
- Riverside Homestead: insects and bird noise, tree movement in breeze, farm animal noise, and distant traffic noise;
- Broadmeadow Homestead: insects and bird noise, GRB mine complex noise audible (including dragline movement and CHPP), tree movement in breeze, and distant traffic noise;
- Eureka Village: insects and bird noise, GRB mine complex noise audible (including mobile plant and CHPP), tree movement in breeze, and traffic noise; and
- proposed Red Hill accommodation village: insects noise, tree movement in breeze, and GRB mine complex noise barely audible (mobile plant).

The operator-attended noise measurement results validated the results obtained from the unattended noise loggers and supported the use of the unattended long term measured noise levels as being representative of the background noise environment at the residences.



BHP Billiton Mitsubishi Alliance

RED HILL MINING LEASE
ENVIRONMENTAL IMPACT STATEMENT

NOISE AND VIBRATION MONITORING LOCATIONS

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NOISE AND VIBRATION Figure: **13-3**

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13.1.2.3 Vibration Survey

The GRM incremental expansion and the RHM underground expansion option are not predicted to cause any discernible vibration at nearby noise receptors. This is due to the distances between receptors and sources, and because no blasting is required.

Between 20 May and 18 June 2011, vibration measurements were carried out at the proposed Red Hill accommodation village. This was done to determine baseline vibration levels resulting from blasting at the existing GRB mine complex.

All measurements were taken directly on the ground in the vicinity of the chosen receptor location.

The summarised results of the vibration measurements are documented in **Table 13-4**, which represents the highest recorded peak component particle velocity and corresponding over pressure level measured.

Table 13-4 Summarised Vibration Measurements at the Proposed Red Hill Accommodation Village

Date-Time	Highest Peak Vector Component Ground Vibration (mm/s)	Peak Airblast (dBL)
12/06/11 17:45	0.52	<88.0

Note 1: Monitoring equipment was damaged by land clearing activities and no valid data was recorded.

A review of both the GRB mine complex blast schedule data (as provided by BMA) and the recorded vibration events during the blast monitoring at the proposed Red Hill accommodation village was completed. This identified ground vibration events that were potentially resulting from the scheduled blasts. These are summarised in **Table 13-5**.

Table 13-5 Potential Captured Blast Event Results

Location	Date-Time	Peak Vector Component Ground Vibration (mm/s)	Peak Airblast (dBL)	Blast Details
Red Hill Accommodation Village	22/05/11 12:50	0.18	- [1]	22/05/11 13:00 Ramp 8 North (unknown holes fired)
Red Hill Accommodation Village	29/05/11 16:46	0.16	- [1]	29/05/11 16:45 Ramp 10 North (1038 holes fired)
Red Hill Accommodation Village	10/06/11 16:00	0.21	< 88.0	10/06/11 16:05 Ramp 10 North (100 holes fired)

Note 1: Only ground vibrations were measured during this period.

The measured ground vibration levels and airblast overpressure (where measured) were very low, only marginally above the threshold of perception for a 'normal' person and well below the threshold at which structural damage might occur.

13.1.3 Construction Noise Criteria

13.1.3.1 Independently Owned Residential Properties

The EPP (Noise) does not include construction noise limits. Noise impacts are usually minimised by limiting the hours of operation and, in particular circumstances, scheduling the noisiest activities to occur at times when they would generate least disruption. For construction work occurring during normal daytime hours, provided all mechanical powered plant is fitted with mufflers as per manufacturer's specifications, specific noise limits are generally not warranted.

In accordance with the *Environmental Protection Act 1994* (EP Act), where construction noise may affect adjacent residential premises or other residential accommodation (including hotels, motels, serviced units or backpacker accommodation), it is recommended to limit the hours of construction activities to Monday to Saturday from 6.30am to 6.30pm.

For construction works outside these hours, particular noise limits may be required to prevent disturbances at independently owned residential properties.

The most important amenity issue for surrounding residents outside of 6.30am to 6.30pm Monday to Saturday is sleep preservation. The World Health Organisation (WHO) *Guidelines for Community Noise* (WHO 1999) recommends for quality sleep, maximum noise levels should not exceed 45 dBA.

Based on a conservative building façade noise reduction of 5 dBA through an open window, the following external criterion is proposed for sleep disturbance: L_{Amax} (external) 50 dBA.

This level is assessable at four metres from the building façade of any independently owned residential properties between 6.30pm and 6.30am Monday to Saturday and all day on Sunday.

13.1.3.2 BMA Owned Residential Properties

For BMA owned residential properties, including Eureka Village and the Red Hill accommodation village, it is important that conditions conducive to sleep are provided for all periods during the day, evening and night time. This is because shift workers utilising this accommodation may be required to sleep at any time.

Therefore, based on the WHO guidance, the following internal noise criterion is recommended for sleep disturbance measured inside the sleeping area of BMA owned residences and accommodation villages/sites during the day, evening or night time periods:

- L_{Amax} (internal) - 45 dBA.

The existing accommodation units at Eureka Village are air conditioned and the accommodation units at the proposed Red Hill accommodation village will also be air conditioned. Therefore, windows to all accommodation units can remain closed at all times. Assuming a conservative noise reduction from outside to inside of 20 dBA through the closed façade of the accommodation units, the external construction noise criterion for the proposed Red Hill accommodation village is therefore:

- L_{Amax} (external) - 65 dBA.

For BMA/BMC owned residential properties at Burton Downs, Denham Park, Lapunyah and Red Hill, air conditioning may not be provided. For these properties the following external construction noise criterion is proposed based on a five dBA façade reduction (i.e. assuming open windows) applicable at any time during the day, evening or night, given that the residents may be shift workers:

- L_{Amax} (external) - 50 dBA.

13.1.4 Operational Noise Criteria

13.1.4.1 Introduction

Acceptable noise criteria for mining operations are derived from:

- the EP Act, which recognises that noise can impact on amenity;
- the EPP (Noise) which provides the framework for determining noise levels required to protect amenity;
- guidelines issued by the EHP in relation to methodologies and techniques for determining appropriate noise levels in particular circumstances, as follows:
  - *Planning for Noise Control* (EPA 2004);
  - *Assessment of Low Frequency Noise* (EPA 2005); and
  - *Noise and Vibration from Blasting* (EPA 2006).

Criteria for the assessment of rail noise are also given in Queensland Rail's (QR) *Code of Practice – Railway Noise Management*.

In addition to this regulatory framework, the Australian Environmental Health Committee (enHealth) has published guidelines on *The health effects of environmental noise – other than hearing loss* (enHealth 2004). These guidelines consider the more holistic impacts of noise on individuals. Additional noise criteria are also provided in Australian Standard (AS) 2107:2000 *Acoustics – Recommended design sound levels and reverberation times for building interiors*.

Noise criteria are considered in two categories:

- those residences and other receptors that are occupied by members of the community and not directly under the control of BMA; and
- those residences and other receptors which are under the control of BMA, and thus occupation is determined by BMA.

Note that occupational health and safety noise is not considered in this assessment as there is a separate regulatory framework for determining occupational noise exposure and control.

Part of the underground mine footprint, accommodation village and gas drainage activities are proposed on a new mining lease for which a new environmental authority (EA) will be issued. The existing mining operations at GRM and BRM are subject to an existing EA (mining lease) EPML00853413 (formerly MIN100921609). Part of the underground mine footprint, infrastructure (including the MIA, CHPP and overland conveyor) will be located on the existing EA for GRM. Once implemented, these elements will be subject to the monitoring and compliance requirements contained within the existing GRM EA conditions.

Notwithstanding this requirement, it is necessary to assess noise emissions from the new infrastructure (ie MIA, CHPP and overland conveyor) together with the activities carried out on the new mining lease. To do this, it is considered appropriate at this stage to assess noise emissions against the noise criteria summarised in **Sections 13.1.4.2** to **13.1.4.4**.

13.1.4.2 Independently Owned Residential Properties

The appropriate assessment tools for the evaluation of environmental noise affecting the amenity of independently owned residences are the EPP (Noise) and EHP's *Planning for Noise Control* guideline.

The criteria derived from EPP (Noise) and the *Planning for Noise Control* guidelines are not directly applicable to residential properties owned by BMA/BMC because BMA/BMC can control who live in the properties, can apply acoustic treatments directly to the properties where required, and can consent to the properties' amenity being impacted.

However, for the purposes of the assessment, Lapunyah, Denham Park, Burton Downs and Riverside have been assessed in accordance with the *Planning for Noise Control* guideline and the EPP (Noise) to establish appropriate noise criteria for residential receptors further from the EIS study area.

EPP (Noise)

The EPP (Noise) assessment process has two main considerations:

- minimising background creep; and
- acoustic quality objectives (refer to Schedule 1 in EPP (Noise)).

The background creep criterion is intended to minimise the progressive increase in background noise levels in an area over time. The EPP (Noise) defines background creep criteria as follows:

- for noise that is continuous noise measured by $L_{A90,T}$ – more than nil dBA greater that the existing acoustic environment measured by $L_{A90,T}$; or
- for noise that varies over time measured by $L_{Aeq,T}$ – more than five dBA greater that the existing acoustic environment measured by $L_{A90,T}$.

Based on the most stringent RBL listed in **Table 13-3**, the following EPP (Noise) criteria are therefore applicable:

- 25 L_{A90}; and
- 30 L_{Aeq}.

The EPP (Noise) includes long term acoustic quality objectives. It is intended that the acoustic quality objectives be progressively achieved as part of achieving the purpose of the EPP (Noise) policy over the long term. **Table 13-6** summarises those acoustic quality objectives.

Table 13-6 Acoustic Quality Objectives

Receptor	Time of Day	Acoustic Quality Objectives (measured at the receptor) dBA			Environmental Value
		LAeq, adj, 1hr	LA10, adj, 1hr	LA1, adj, 1hr	
Dwelling (for outdoors)	Daytime and evening	50	55	65	Health and wellbeing
Dwelling (for indoors)	Daytime and evening	35	40	45	Health and wellbeing
	Night time	30	35	40	Health and wellbeing, in relation to the ability to sleep

On comparison of the two assessment processes contained within the EPP (Noise), it can be seen that in all cases the background creep criteria are equal to or more stringent than the acoustic quality objectives. Therefore, the EPP (Noise) background creep criteria will be applicable.

Planning for Noise Control Guideline

Noise Planning Levels

The *Planning for Noise Control* assessment process has four main considerations:

1. Control and prevention of background creep.
2. Determination of appropriate planning noise levels to protect amenity.
3. Containment of variable and short term noise emissions by setting specific (intrusive) noise levels.
4. Sleep disturbance.

The guideline recommends that the lower of the two levels derived from numbers (2) and (3) be used for assessment purposes as these levels are both based on the L_{Aeq} parameter.

The background creep criteria is calculated by comparing existing RBLs as measured at noise receptors with recommended RBLs given in the guideline.

Using the measured RBLs given in **Table 13-3**, the background creep criteria in **Table 13-7** were calculated in accordance with the *Planning for Noise Control* guideline.

Table 13-7 Background Creep Criteria

Location	Criteria minLA90, 1hour (dBA)		
	Day	Evening	Night
4 - Broadmeadow Homestead	33	25	25
5 - Burton Downs Homestead	30	29	25
7 - Denham Park Homestead	33	25	25
8 - Lapunyah Homestead	31	25	25
13 - Riverside Homestead	33	28	25

Note: The guideline sets a 'floor' on background creep criteria of 25 dBA.

The planning noise level (PNL) criteria is used to prevent, where possible, average ambient noise levels (defined as L_{Aeq}) from exceeding recommended ambient noise levels given in the *Planning for Noise Control* guideline. The PNL criteria is determined by comparing the existing maximum $L_{Aeq(1hour)}$ noise levels (as measured at noise receptors) with the recommended levels in the guideline. The PNL criteria have been calculated from the measured ambient noise levels shown in **Table 13-3**, and are shown in **Table 13-8**.

Table 13-8 Planning Noise Level Criteria

Location	Criteria $L_{Aeq, (1hour)}$ (PNL)		
	Day	Evening	Night
4 - Broadmeadow Homestead	41	30	29
5 - Burton Downs Homestead	40	31	28 [1]
7 - Denham Park Homestead	39	27	26
8 - Lapunyah Homestead	34	27	27
13 - Riverside Homestead	41	34	34

Note 1: Calculated PNL is less than 25 L_{Aeq} dB. As such, PNL has been recommended at 28 L_{Aeq} dB based on the below SNL (25 dBA + 3 dB).

The specific noise level (SNL) criteria are also used to control ambient noise levels (defined as L_{Aeq}). The SNL is calculated from the existing RBL by the simple relationship; SNL = RBL + 3 dBA. The SNL criteria have been calculated from the measured ambient noise levels in **Table 13-3** and are shown in **Table 13-9**.

Table 13-9 Specific (Intrusive) Noise Level Criteria

Location	Criteria $L_{Aeq, (1hour)}$ (SNL)		
	Day	Evening	Night
4 – Broadmeadow Homestead	33	31	33
5 - Burton Downs Homestead	28	28	28
7 - Denham Park Homestead	31	28	28
8 – Lapunyah Homestead	29	33	31
13 – Riverside Homestead	33	28	28

Note: The guideline sets a "'floor' on SNLs of 28 dBA (for example, background creep 'floor' of 25 dBA plus 3 dBA).

The PNL criteria would form the basis of the limiting L_{Aeq} criteria at all locations except Location 13 where the limiting L_{Aeq} criteria will be the SNL criteria.

To manage the L_{Aeq} criteria effectively for every noise receptor and not just the five noise monitoring locations, an overall L_{Aeq} criteria of 28 dBA has been set for all noise receptors within the EIS study area. This is based on the minimum SNL criteria of 28 dBA recommended in the *Planning for Noise Control* guideline.

On comparison of the criteria derived from the *Planning for Noise Control* guideline and the EPP (Noise), it can be seen that in all cases the *Planning for Noise Control* guideline criteria are equal to or more stringent than the EPP (Noise) criteria. Therefore, the *Planning for Noise Control* guideline criteria will be the defining criteria for assessment of the GRM incremental expansion and RHM underground expansion option.

Sleep Disturbance

The guideline recommends that in order to achieve a good night's sleep, internal noise levels should not exceed LAmax 45 dBA more than 10 to 15 times per night. Based on a conservative attenuation of five dBA through a façade with open windows, the following external criteria is recommended, assessable four metres from the façade and during the night-time period only: L_{Amax} (external) - 50 dBA.

enHealth's Health Effects of Environmental Noise

enHealth (2004) undertook a review of health effects of environmental noise. While limited qualitative information is available, possible health effects from environmental noise may include:

- noise-induced hearing impairment;
- interference with speech communication;
- disturbance of rest and sleep;
- psychophysiological, mental health and performance effects;
- effects on residential behaviour and annoyance; and
- interference with intended activities.

The enHealth report *The health effects of environmental noise – other than hearing loss* document contains four recommendations:

1. Recognise environmental noise as a potential health concern.
2. Promote measures to reduce environmental noise and its health impacts.
3. Address environmental noise in planning and development activities.
4. Foster research on the non-auditory health impacts of noise.

Following are responses to these four recommendations.

Recognise Environmental Noise as a Potential Health Concern

The guidelines suggest two actions in relation to recommendation 1:

- recognition and awareness of the need to address environmental health effects of noise in legislation and planning; and
- adoption of the WHO *Guidelines for Community Noise* (WHO 1999).

The WHO guidelines specify that the following noise levels should be achieved in residential premises:

- bedrooms (internal) - 30 dBA L_{Aeq} (steady noise);
- bedrooms (internal) - 45 dBA L_{Amax} (intermittent noise);
- living areas (internal) - 35 dBA L_{Aeq} (steady noise); and
- living areas (outdoor) - 50 dBA L_{Aeq} (steady noise).

The noise criteria determined using the *Planning for Noise Control* methodology are below the most stringent of the WHO noise levels, and are hence considered adequate to protect residents from adverse health effects.

The 30 dB L_{Aeq} guideline for bedrooms (internal) conservatively equates to conservatively 35 dB L_{Aeq} external assuming a conservative five dBA façade noise reduction. Given that the proposed *Planning for Noise Control* criteria is 28 dB L_{Aeq} and including 5 dBA as a conservative façade noise reduction (AS3671 recommends the use of 10 dBA and indeed the WHO guideline recommends the use of 15 dBA as a façade noise reduction), it is considered that *Planning for Noise Control* criteria will also ensure compliance with the WHO/enHealth guidelines.

Promote Measures to Reduce Environmental Noise and its Health Impacts

The enHealth document contains many 'high level' actions in this recommendation in relation to education programs, mitigation and licensing controls, relevant standards and product labelling. This recommendation does not contain any relevant recommendations in relation to this study.

Address Environmental Noise in Planning and Development Activities

The enHealth document contains many 'high level' actions in this recommendation in relation to integrating noise into planning processes and national consistency for limits that are not relevant to this study. The one relevant recommendation is that baseline environmental noise levels should be undertaken (where appropriate) to inform planning actions. This is a standard approach in Queensland and has been done for this study.

Foster Research on the Non-Auditory Health Impacts of Noise

The enHealth document recommends that research be undertaken in many areas of noise to further understand the non-auditory health effects of noise.

There is much ongoing work still to be done in this area; however, this work is outside of the scope of this assessment.

13.1.4.3 BMA/BMC Owned Residences

With respect to BMA/BMC owned residences, BMA/BMC can control who lives in these properties and can readily apply noise control measures directly to the properties. Also, BMA/BMC, as owners, can consent to the properties' amenity being impacted. Therefore, the EPP (Noise) background creep criteria and *Planning for Noise Control* background creep, PNL and SNL criteria, all of which are intended to minimise impacts on amenity, are not strictly applicable. The considerations for BMA/BMC owned residential properties, (including Eureka Village and the proposed Red Hill accommodation village) are based on sleep preservation and minimising the risk of adverse health effects.

As previously mentioned, the WHO recommends for quality sleep, maximum noise levels should not exceed 45 dB L_{Amax}. In addition, AS 2107:2000 *Acoustics – Recommended design sound levels and reverberation times for building interiors* recommends a satisfactory continuous noise level inside bedrooms of 30 dB L_{Aeq}. This is also in accordance with enHealth/WHO recommendations.

The existing accommodation units at Eureka Village are air conditioned and the accommodation units at the proposed Red Hill accommodation village will be air conditioned. Therefore, windows to all accommodation units can remain closed at all times. Assuming a conservative noise reduction from outside to inside of 20 dBA through the closed façade of the accommodation units, the external noise criteria for the proposed Red Hill accommodation village to achieve the WHO and AS 2107:2000 recommended external noise levels are therefore:

- 65 dB L_{Amax}; and
- 50 dB L_{Aeq}.

For BMA/BMC owned residential properties at Burton Downs, Denham Park, Lapunyah and Red Hill, air conditioning may not be provided. For these properties the following external noise criteria are recommended based on a 5 dBA façade reduction (i.e. assuming open windows):

- 50 dB L_{Amax}; and
- 35 dB L_{Aeq}.

It should be noted that if the above external criteria are achieved, the recommended satisfactory internal noise levels in AS 2107:2000 and the WHO guidelines for other habitable living areas would also be achieved.

13.1.4.4 Low Frequency Noise

Low frequency noise should be assessed where it has the potential to cause disturbance. Guidance on the assessment of low frequency noise impacts can be sought from EHP's *Assessment of Low Frequency Noise* guideline (EPA 2005). The intent of this guideline is to accurately assess annoyance and discomfort to persons at noise sensitive places from low frequency noise. The guideline assesses both infrasound – below 20 hertz (Part A), and low frequency noise – above 20 hertz (Part B).

The potential for low frequency noise to cause disturbance at nearby noise receptors has been assessed in accordance with the *Assessment of Low Frequency Noise* guideline.

The assessment procedure set out in the *Assessment of Low Frequency Noise* guideline involves the following initial screening test:

- sound pressure level within a sensitive residence should not exceed 50 dBL; and
- the difference between L_{Lineq} and L_{Aeq} should not be greater than 15 dB.

Should both screening tests be exceeded, further detailed 1/3rd octave band analysis of low frequency noise should be performed.

This initial screening test was undertaken with the following noted:

- The noise sources documented in **Table 13-15** (see **Section 13.2.2**) were used to predict A-weighted and linear noise levels at the 15 noise receptor locations as well as the proposed Red Hill accommodation village.
- The linear levels were compared to the 50 dBL (internal) initial screening tests outlined in the *Assessment of Low Frequency Noise* guideline. The only predicted exceedence was at Eureka Village. All other receptors are predicted to comply with the 50 dBL (internal) criteria.
- For Eureka Village, the A-weighted and linear noise levels were then compared against one another and for all instances, the difference was less than the 15 dBA trigger for further assessment given in the *Assessment of Low Frequency Noise* guideline.

Therefore, given that neither screening tests were exceeded for any receptor (residential or accommodation village or site), further assessment of low frequency noise was not necessary.

13.1.5 Transportation Noise Assessment Criteria

13.1.5.1 Rail

Rail noise from track and rail load out loops has been assessed as part of the operational mining noise and, as such, the criteria are derived from the *Planning for Noise Control* guideline. This has resulted in more stringent criteria than those typically applied to rail noise in Queensland as stipulated in the QR *Code of Practice – Railway Noise Management*:

- 87 dBA L_{Amax}; and
- 65 dBA $L_{Aeq\ (24hour)}$.

It should be noted that the noise assessment covers noise from possible train load out only, not from train movements between the mine and port.

13.1.5.2 Road

The effect of construction and operational road traffic on the noise emission from affected roadways has been assessed. In the absence of relevant legislation or guidance, this assessment has been performed by using the common method of assessing how traffic changes would alter the $L_{A10\ (18hour)}$ level of noise emission from roadways using the calculation of road traffic noise prediction algorithms.

For assessment purposes it is common to set the threshold of significance in relation to changes to the noise emission level from roads at 2 dBA. This threshold is adopted in this study.

13.1.6 Mine Noise Modelling Procedure

Noise modelling was used to predict construction noise, operational noise and noise from the proposed Red Hill accommodation village.

13.1.6.1 SoundPLAN

In order to predict the noise emission levels at the various noise receptor locations, a SoundPLAN (Version 7.0) environmental computer model was developed. SoundPLAN is a software package that enables compilation of a sophisticated computer model comprising a digitised ground map containing ground contours and buildings, the location and acoustic sound power levels of potentially critical noise sources on site and the location of receptors for assessment purposes.

The computer model can predict noise levels taking into account such factors as the source sound power levels and locations, distance attenuation, ground absorption, air absorption and shielding attenuation, as well as meteorological conditions, including wind effects.

13.1.6.2 Meteorological Conditions

Modelling of Meteorological Effects

As noise levels are very dependent on meteorological conditions, and in accordance with the *Planning for Noise Control* guideline, consideration has been given to the effects of prevailing and worst case meteorological conditions (wind, temperature, humidity and temperature inversions) on noise propagation.

SoundPLAN incorporates the CONCAWE prediction methodology which allows the influence of wind effects and the stability of the atmosphere to be incorporated into the model.

Noise levels have been calculated for neutral and worst case weather conditions based on weather analysis for the area. Assumptions incorporated into the model are set out below.

Wind Effects

In accordance with the *Planning for Noise Control* guideline, annual meteorological data was analysed for the following wind parameters:

- 30 per cent occurrence in any assessment period (day, evening or night) in any season;
- three metres per second or less source to receiver component; and
- 10 metre height for wind speed.

This analysis noted that there were no calculated periods of wind occurring at least 30 per cent of the time in any one season and assessment period, and speeds of up to three metres per second. Peak wind occurred during autumn nights, where wind from the east-southeast occurred 27 per cent of the time. Therefore, wind is not considered a feature of the area and has not been included in the worst case weather conditions in this assessment.

Temperature Inversion

In accordance with the *Planning for Noise Control* guideline, annual meteorological data was analysed for the following temperature inversion parameters (non-arid):

- 30 per cent occurrence for evening and night-time (6pm to 7am) period during winter (June, July, August); and
- moderate inversions (F-class stability category).

Analysis of temperature inversion data for the site noted that F-class stability category had an occurrence of 89 per cent. Therefore, temperature inversions are considered to be a characteristic of the surrounding area.

Modelled Meteorological Parameters

Based on the above analysis of available meteorological data, the weather conditions used to assess the effect of neutral and worst case meteorological conditions are shown in **Table 13-10**, below. The assessment for worst case weather is applied to all receptors due to the effects of the temperature inversion.

Table 13-10 Meteorological Conditions – Neutral and Worst Case

Parameter	Neutral Weather	Worst Case Weather
Temperature	10^{o}C	10^{0}C
Humidity	70%	90%
Pasqual Stability Class	D	F
Wind Speed	0 m/s	0 m/s

13.1.6.3 Modelling Scenarios

Seventeen general construction scenarios were developed and modelled for this assessment comprising concurrent activities. These 17 general construction scenarios were grouped in the following main construction activities:

- construction of the Red Hill CHPP, mine industrial area (MIA) and stockpiles;
- construction of the IMG drainage wells;
- construction of the IMG gathering pipeline system; and
- construction of the IMG power station.

For construction activities, the distances at which the nominated noise criteria of L_{Amax} 65 dB (for proposed Red Hill accommodation village) and L_{Amax} 50 dB (for all other residences) would be achieved for calm and worst case (enhanced propagation) have been calculated for the various construction scenarios. The distances can be considered to be minimum 'buffer' distances between the construction activities and the noise sensitive properties.

Twelve operational mining scenarios were also developed based on nominal production levels in three representative years (representing 'start of mine', 'mid-life of mine' and 'end of mine'). These were developed in combination with different options for management of IMG (flaring, on-site power station, transfer off-site via pipelines). Further, an 'overall' scenario was developed for each of the three mining operational stages incorporating the on-selling gas management scenario, mobile plant and rail. Operational scenarios were made up of the following components:

- Continuous or steady state noise sources (i.e. fixed plant items including gas management). This represents noise sources that are effectively continuous and the noise emissions from these sources have been compared with the nominated background creep criteria.
- Variable noise sources (i.e. mobile plant and rail). These sources are not operating on a continuous basis, and/or are operating at a range of locations. The noise emissions from these sources have been compared with the nominated average (i.e. L_{Aeq}) criteria.

All twelve operational mining scenarios developed were predicted under both neutral and worst case weather conditions, as detailed in **Table 13-10**.

Within the noise model, operations consisted of all plant items operating concurrently in order to simulate the overall maximum potential noise emissions. Model results can therefore be considered conservatively high.

Only above ground mobile plant was included in the model, which included plant at the Red Hill CHPP, MIA and stockpiles. Plant and equipment operating underground was excluded.

For operational activities, noise levels have been predicted at surrounding noise receptors (15 in total) as well as the proposed Red Hill accommodation village. All receivers have been positioned 1.5 metres above ground and four metres from the building under consideration. Predictions were also carried out to assess noise levels from noise sources within the proposed Red Hill accommodation village.

Further details of the modelling scenarios are given in **Appendix M**.

13.1.7 Transportation Noise Modelling Procedure

13.1.7.1 CoRTN Road Traffic Noise Prediction Method

The CoRTN method was developed by the UK Department of Transport in 1984 and was used to calculate the effect of road traffic increases due to the construction and operational phases. It allows calculation of the statistical noise level descriptors $L_{A10\ (1hour)}$ and $L_{A10\ (18hour)}$. These values are used to represent the highest traffic noise levels during a one hour period during the day and the overall traffic noise levels during the day respectively.

Existing and estimated future traffic patterns for Moranbah Access Road, Goonyella Road, Red Hill Road and Riverside Access Road are summarised in **Table 13-12** and have been assumed for the purpose of assessing the road traffic noise impact due to construction and operational activities.

13.1.7.2 Nordic Rail Traffic Noise Prediction Method

The Nordic Rail Traffic Noise Prediction Method (Kilde 130) dates from 1984. As this method reliably delivers accurate predictions (typically within two dBA), it has been commonly utilised in rail noise assessments across Queensland for over a decade. The method calculates emission noise levels based on the number of trains, train speed and train length, and predicts $L_{Aeq\ (24hour)}$ and pass-by maximum levels as required by QR's *Code of Practice*.

Rail noise levels from the section of rail associated with the project GRM incremental expansion and the RHM underground expansion option have been predicted at all receptor locations (see **Appendix M** for further details). The parameters used to calculate the future rail noise levels, summarised in **Table 13-11** were supplied by BMA and Aurizon, and have been confirmed by BMA.

Table 13-11 Train Movements for the Project

Parameter	Future (Riverside Loop)
Number of train movements per day (average)	6.2
Notch setting of train	Notch 1 / 2
Speed of train	4 – 6 km/h
Length of train	2,040 m
Number and type of locomotives	3 x E40AC-V2 (Siemens)

Note 1: Although train speeds have been stated as travelling at 4 to 6 km/h (i.e. walking pace) through the rail loops, the algorithm for rail calculations predicts accurately at speeds greater than 30 km/h. The rail noise model has therefore been configured with train speeds of 30 km/h (which will calculate conservatively high).

Rail noise emissions were represented by two noise sources:

- electric locomotives; and
- freight consist (coal wagons).

Rail noise levels were predicted by reference to the general rolling stock emissions used by QR and Aurizon for all Queensland rail noise assessments.

The rail noise emission levels calculated using the Nordic Rail Traffic Noise Prediction Method were incorporated into the SoundPLAN noise modelling predictions discussed in **Section 13.1.6.3**.

Table 13-12 Baseline Road Traffic Parameters

Road	Year 2009/10 Traffic Census		Year 2020 Projection		Year 2020 Projection with the Project (Construction Phase)		Year 2020 Projection		Year 2022 Projection with the Project (Operational Phase)		Year 2022 Projection		Year 2022 Projection with the Project (Operational Phase)	
	AADT [1]	% Heavy Vehicles	AADT [1]	% Heavy Vehicles	AADT [1]	% Heavy Vehicles	AADT [1]	% Heavy Vehicles	AADT [1]	% Heavy Vehicles	AADT [1]	% Heavy Vehicles	AADT [1]	% Heavy Vehicles
Moranbah Access Rd – Peak Downs Hwy to Mills Ave	4,691	10.5	6,177	10.5	6,337	11.2	6,393	10.5	6,481	11.0	9,018	10.5	9,106	10.9
Moranbah Access Rd – Mills Ave to Curtin St	4,297	9.5	5,658	9.5	6,118	9.7	5,856	9.5	6,244	9.5	8,261	9.5	8,649	9.5
Goonyella Rd – Curtin St to Red Hill Rd	3,263	18.4	4,152	18.4	4,612	17.8	4,296	18.3	4,684	17.6	6,061	18.4	6,449	17.8
Goonyella Rd – Red Hill Rd to Riverside Access Rd	2,391	18.9	3,042	18.9	3,082	18.6	3,148	18.9	3,188	18.6	4,441	18.9	4,481	18.7
Red Hill Rd	919	27.8	1,169	27.8	1,589	23.9	1,210	27.8	1,558	23.7	1,707	27.8	2,055	24.7
Riverside Access Rd	1,629	11.7	2,072	11.6	2,112	11.4	2,145	11.7	2,185	11.4	3,026	11.7	3,066	11.5

Note 1: AADT – annual average daily traffic

13.2 Potential Impacts

13.2.1 Noise Impact Assessment – Construction

The distances at which the nominated criteria of L_{Amax} 65 dB (for Eureka Village and the proposed Red Hill accommodation village) and L_{Amax} 50 dB (for all other residences) would be achieved under calm and worst case (enhanced propagation) weather conditions, and have been calculated using SoundPLAN. These off-set distances can be considered to be minimum 'buffer' distances between the construction activities and nearby noise sensitive uses for compliance with the nominated construction criteria.

Details of the model results are given in **Appendix M**. These results show that for all construction activities, the closest sensitive receiver is further away than the minimum off-set distance required to achieve the nominated construction noise criteria. No further noise mitigation options for construction noise are considered necessary.

13.2.2 Noise Impact Assessment – Operation

As previously mentioned in **Section 13.1.6.3**, noise impacts from operation are made up of the following components:

- Continuous or steady state noise from fixed plant items. This represents noise levels that are effectively continuous and this noise is assessed against the background creep criteria (L_{A90}).
- Variable noise from conveyor alarms, which has been assessed against sleep disturbance criteria. Conveyor alarms warn operators of conveyor start-ups and therefore represent an intermittent noise source.
- Other variable noise sources such as mobile plant and train loading. These sources are not operating on a continuous basis, and/or are operating at a range of locations. Noise from these sources has been assessed against the nominated average (L_{Aeq}) noise criteria.

13.2.2.1 Steady State Plant – Fixed Plant and Conveyors and Gas Drainage Options

Table 13-14 presents the results of the noise modelling predictions for steady-state (L_{A90}) noise levels from the fixed plant, conveyors, upcast vents, gas wells and the gas drainage options for neutral and worst case weather conditions. **Table 13-14** also shows the nominated noise criteria from **Section 13.1.4** for background creep as detailed in **Section 13.1.4**.

Noise from fixed plant is not expected to change significantly over the lifetime of the project activities and, therefore, the predicted levels in **Table 13-14** would be the same for 'start of mine', 'mid-life of mine' and 'end of mine'. Predicted exceedences of the background creep noise criteria for each of the receptors are indicated by bold text.

The nominated background creep criteria for steady-state noise sources are predicted to be achieved at all locations under neutral weather conditions. Under worst case weather conditions, the relevant steady-state operational noise criteria are predicted to be exceeded at Eureka Village.

13.2.2.2 Conveyor Alarms

Conveyor alarm noise has been assessed by predicting the minimum offset distance to achieve the external sleep disturbance criteria of L_{Amax} 65 dB at the proposed Red Hill accommodation village and Eureka Village, and L_{Amax} 50 dB for all other residences. The assessment has been carried out based on typical noise levels for standard conveyor alarm systems.

The predicted minimum offset distances are shown in **Table 13-13**. These distances will guide locations of conveyors in the detailed design stage.

Table 13-13 Predicted Minimum Offset Distances for Conveyor Alarm Noise

Noise Source	Predicted Minimum Off-Set Distance to achieve L_{Amax} 65 dB		Predicted Minimum Off-Set Distance to achieve L_{Amax} 50 dB	
	Neutral Weather Conditions	Worst Case Weather Conditions	Neutral Weather Conditions	Worst Case Weather Conditions
Conveyor Alarm	490 m	710 m	1,610 m	2,120 m

The assessment of conveyor alarms has indicated that the nominated external sleep disturbance criterion will be achieved at all receptors within the EIS study area. No further noise mitigation options for conveyor alarm noise are considered necessary.

13.2.2.3 Variable Noise Sources - Mobile Plant and Rail Operations

Table 13-15 presents the combined results of the noise modelling predictions for average (L_{Aeq}) noise levels from the mobile plant and rail movements associated with the three operational phases of the GRM incremental expansion and RHM underground expansion option (start, middle and end of mine life) and the predicted steady-state noise levels from **Table 13-14** for fixed plant, conveyors, upcast vents and gas wells. For the steady-state noise levels, the predicted levels, including potential on-selling of gas, has been used to represent the 'worst case' gas management option scenario. The results are presented for neutral and worst case weather conditions.

Table 13-15 also shows the nominated average noise (L_{Aeq}) criteria for overall noise sources as detailed in **Section 13.1.4**.

As a project wide initiative modelling assumed that 'self-adjusting volume' or 'broad-band buzzer' type reversing alarms should be utilised to avoid additional annoyance to neighbours. Should only traditional 'constant volume beeping' type reversing alarms be used, then the L_{Aeq} noise predictions presented in **Table 13-15** for mobile mechanical plant could be up to 5 dBA higher to allow for the noise associated with reversing alarms.

It can be seen from **Table 13-15** that operational noise levels were predicted to achieve the nominated noise criteria at all receptors other than at Eureka Village where 2 to 4 dBA exceedences of the nominated L_{Aeq} criterion are predicted during worst case weather conditions.

Fixed plant and conveyors generally dictate predicted noise levels at all nearby receptors. Noise contributions from mobile plant and rail movements are predicted to marginally increase overall noise levels at some receptor locations.

Table 13-14 Predicted Operational Noise Levels for Fixed Plant, Conveyors, Gas Wells and Gas Drainage Options

Location	Property Reference	LA90/LAeq Criteria (dBA)	Predicted Noise Level (dBA) for Fixed Plant, Conveyors, Gas Wells					
			+ Flaring		+ Power Generation		+ On-selling	
			Neutral Weather Conditions	Worst Case Weather Conditions	Neutral Weather Conditions	Worst Case Weather Conditions	Neutral Weather Conditions	Worst Case Weather Conditions
1	Broadlea	25	<10	12	<10	12	<10	14
2	Broadmeadow Cottage 1	N/A[1]	-	-	-	-	-	-
3	Broadmeadow Cottage 2	N/A[1]	-	-	-	-	-	-
4	Broadmeadow Homestead	N/A[1]	-	-	-	-	-	-
5	Burton Downs Homestead	35	<10	17	<10	17	11	18
6	Dabin	25	<10	<10	<10	<10	<10	<10
7	Denham Park Homestead	35	10	18	11	18	11	19
8	Lapunyah Homestead	35	17	25	17	25	18	25
9	Moranbah	25	<10	<10	<10	<10	<10	<10
10	Nibbereena	25	<10	14	<10	14	<10	14
11	Pretoria Homestead	25	<10	13	<10	13	<10	13
12	Red Hill	35	19	26	20	26	21	27
13	Riverside Homestead	N/A[1]	-	-	-	-	-	-
14	Rugby	25	<10	<10	<10	<10	<10	<10
15	Eureka Village	50	47	**52**	47	**52**	47	**52**
-	Proposed Red Hill accommodation village	50	32	37	32	38	33	38

Note: Levels in bold indicate an exceedence of the relevant noise criteria.
Note 1: BMA will negotiate a compensation agreement with the existing landowner and, if required, manage occupancy of the dwellings.

Table 13-15 Predicted Operational Noise Levels for Steady-State Noise Sources, Mobile Plant and Rail Movements

Location	Property Reference	LAeq Criteria (dBA)[1]	LAeq Predicted Noise Level (dBA)					
			FY2020		FY2030		FY2040	
			Neutral Weather Conditions	Worst Case Weather Conditions	Neutral Weather Conditions	Worst Case Weather Conditions	Neutral Weather Conditions	Worst Case Weather Conditions
1	Broadlea	28	<10	17	<10	17	<10	17
2	Broadmeadow Cottage 1	N/A[2]	-	-	-	-	-	-
3	Broadmeadow Cottage 2	N/A[2]	-	-	-	-	-	-
4	Broadmeadow Homestead	N/A[2]	-	-	-	-	-	-
5	Burton Downs Homestead	35	13	21	13	20	13	20
6	Dabin	28	<10	<10	<10	<10	<10	<10
7	Denham Park Homestead	35	14	21	13	21	13	21
8	Lapunyah Homestead	35	20	27	19	26	19	26
9	Moranbah	28	<10	<10	<10	<10	<10	<10
10	Nibbereena	28	<10	16	<10	16	<10	16
11	Pretoria Homestead	28	<10	16	<10	16	<10	16
12	Red Hill	35	21	28	21	28	21	28
13	Riverside Homestead	N/A[2]	-	-	-	-	-	-
14	Rugby	28	<10	<10	<10	<10	<10	<10
15	Eureka Village	50	48	**52**	49	**54**	49	**54**
-	Proposed Red Hill accommodation village	50	33	38	33	38	33	38

Note: Levels in bold indicates an exceedence of the relevant noise criteria.
Note 1: The LAeq 28 dBA criterion has been applied to independently owned receptor, in accordance with the Operational Criteria section.
Note 2: BMA will seek to negotiate a compensation agreement with the owner of Riverside Homestead, Broadmeadow Homestead and Cottages 1 and 2 and where necessary, manage the occupancy of the dwellings

Given the distances between operational sources and receptor locations, and that steady-state noise from fixed plant and conveyors generally dictates the noise levels at nearby receptors, L_{Amax} noise emissions are expected to be no greater than 5 dBA higher than the predicted L_{Aeq} levels. Therefore, the nominated sleep disturbance criteria of L_{Amax} 65 dBA and 50 dBA for the accommodation village and other residences, respectively, would be predicted to be achieved at all locations during neutral and worst case weather conditions.

13.2.3 Red Hill Accommodation Village

13.2.3.1 Noise Sources within the Proposed Red Hill Accommodation Village

Noise impact levels from sources within the conceptual accommodation village were calculated at the nearest accommodation unit(s) to the noise source. The calculated noise levels within the accommodation village are shown in **Table 13-16**.

Table 13-16 Noise Levels Based on Conceptual Accommodation Village Layout

Noise Source	Distance to Nearest Receptor (m) [1]	Predicted Noise Level (dBA)	Relevant Noise Criteria
Air conditioners (accommodation units)	5	**58 L_{Aeq}**	50 dB L_{Aeq}
750 kVA kitchen backup generator	60	**56 L_{Aeq}**	50 dB L_{Aeq}
Kitchen refrigeration	60	49 L_{Aeq}	50 dB L_{Aeq}
Refuse collection	70	60 L_{Amax}	65 dB L_{Amax}
Maintenance operations / wash booster pump	290	36 L_{Aeq}	50 dB L_{Aeq}
Water treatment plant	170	43 L_{Aeq}	50 dB L_{Aeq}
Sewage treatment plant	120	46 L_{Aeq}	50 dB L_{Aeq}
Sports fields (shouting)	70	**51 L_{Aeq}**	50 dB L_{Aeq}
Recreational facilities	120	38 L_{Aeq}	50 dB L_{Aeq}
Pool pump	15	46 L_{Aeq}	50 dB L_{Aeq}

Note 1: Receptor within the Red Hill accommodation village (i.e. unit).
Levels in bold indicate an exceedence of the relevant criteria.

Table 13-16 shows that L_{Amax} noise levels within the Red Hill accommodation village will achieve the external criterion of 65 dB L_{Amax}. It can be seen that a number of plant items have the potential to exceed the external L_{Aeq} criterion of 50 dBA, however this can be readily addressed during detailed design using the following approaches:

- selection of quieter mechanical plant;
- increasing the building façade noise reduction above the nominal 20 dB used in this assessment, for example, by double glazing or choice of wall materials;
- locating the plant such that it is shielded (for example behind buildings or on roof tops) from sensitive areas;
- increasing the distance between the plant and the nearest accommodation unit; and
- placing of noise barriers or plant enclosures around noisy items.

Since the assessment of noise impacts in **Table 13-16** is based on a conceptual village layout, it is proposed that a further acoustic assessment be undertaken during detailed design of the

accommodation village. Based on the mitigation measures listed above, it is expected that an acceptable noise environment can be achieved.

13.2.3.2 Red Hill Accommodation Village Noise at Receptor Locations

The total noise level from the village noise sources was also predicted at the nearest existing residences (i.e. off-site) for the proposed Red Hill accommodation village.

The results indicate that noise emissions from the accommodation village will be negligible at surrounding receptor locations.

13.2.3.3 Blasting Assessment

Based on a review of the measured vibration levels detailed in **Section 13.1.2.3,** the distances between the proposed Red Hill accommodation village, and the locations of blasting at GRB mine complex, blasting noise and vibration levels at the proposed Red Hill accommodation village is unlikely to cause unacceptable impacts and further assessment is not required.

13.2.4 Noise Impact Assessment – Transportation (Operation)

It can be seen from **Table 13-15** that overall noise levels including rail noise are below the *Planning for Noise Control* guideline as well as the 65 dBA $L_{Aeq(24hour)}$ criteria contained in QR's *Code of Practice* (which would be used to assess rail noise emissions elsewhere on the QR network). Therefore predicted average (i.e. L_{Aeq}) noise levels from the railway are considered to be acceptable.

In addition, based on the predicted overall average noise level (L_{Aeq}) and the offset distance between the railway and the receptors, maximum noise levels from rail movements would also readily achieve the 87 dBA L_{Amax} criteria contained in QR's *Code of Practice* at all surrounding receptor locations.

The predicted increase in road traffic noise levels associated with construction and operation activities were less than 2 dBA for all roads surrounding the site. As changes in environmental noise levels of less than or equal to 2 dBA are generally unnoticeable to the human ear, no adverse impact is anticipated due to road traffic.

13.2.5 Noise Impact Assessment on Fauna

The effect of noise from human activities on fauna is increasingly a subject of concern in the community when proposing developments such as new infrastructure, mines or industrial developments. The potential effects of noise on wildlife include physical damage to hearing, increased energy expenditure or physical injury while responding to noise, interference with normal animal activities and impaired communication. Ongoing impacts of these effects might include habitat loss through avoidance, reduced reproductive success and increased mortality.

While noise impacts on people are commonly regulated, there are no government policies or other widely accepted guidelines as to noise levels or thresholds that may have an adverse effect on wildlife. One reason for the lack of guidelines is that noise effects on most wildlife species are poorly understood (Larkin *et al.* 1996; Brown 2001; OSB 2003; summarised in AMEC 2005). The lack of understanding of noise effects on wildlife is understandable when the following points are considered:

- Response to noise disturbance cannot be generalised across species or among genera. Studies of one species cannot be extrapolated to other species.

- Hearing characteristics are species-specific. For example, noise impacts on humans are determined using a frequency weighting filter (A-weighting) which corresponds to human hearing characteristics, determined through laboratory testing. The frequency-dependent hearing characteristics of animals cannot be determined in this way.
- When studying of noise effects on animals it can be difficult to separate noise effects from other sensory disturbing effects (e.g. visual or olfactory cues).
- Experimental research in a laboratory is not always applicable in a natural setting.

It is clear that noise can have adverse effects on wildlife and domesticated mammals, with different species being more or less sensitive to noise. As with humans, extremely high noise levels can result in hearing damage or other physiological effects. At lower noise levels, it seems likely that animals avoid anthropogenic noise sources and prefer to occupy areas further from noise sources.

On the basis of the literature, and noting the difficulties inherent in assessing noise impacts on fauna, the following conclusions are drawn:

- Adverse impacts on fauna are highly unlikely at noise levels below 50 dBA L_{Aeq}, and unlikely at noise levels below 65 dBA L_{Aeq}.
- Long-term adverse impacts on fauna are unlikely to arise from short duration, high noise events. These events may, however, result in a short-term startle response.
- Very high maximum noise levels may result in hearing loss or other long-term physiological effects. The threshold of hearing damage is likely to be species and frequency dependent and, as with humans, damage may be cumulative over time.

It is considered that fauna (including domesticated mammals) exposed to less than 65 dBA L_{Aeq} are unlikely to experience adverse impacts.

On review of the noise contours contained within **Appendix M**, it is noted that noise levels of 65 dBA L_{Aeq} are predicted adjacent to the fixed plant, and centred on the Red Hill CHPP / stockpiles, the Red Hill MIA, and the gas management hub. Due to the extensive areas outside these three fixed plant locations which fauna can occupy, as well as the potential for increased startle cues within these three fixed plant locations, it is expected that fauna are unlikely to experience any adverse impacts.

13.3 Noise Mitigation Measures

13.3.1.1 Construction

Construction noise levels are predicted to achieve the nominated noise criteria at all receptors.

As construction noise levels are not expected to cause significant disturbance at any receptors, no specific noise mitigation measures are required for construction. In the event of complaints (from either independent residents or residents of BMA owned accommodation), an investigation of construction noise should occur and this investigation should include monitoring of noise levels and identification of mitigation measures to address identified construction noise issues.

Prior to commencement of construction, and at regular intervals during construction, existing BMA community liaison networks should be used to inform noise receptors of the proposed construction activities, and contact details in the event that construction noise related issues are experienced.

AS 2436-1981 *Guide to Noise Control on Construction, Maintenance and Demolition Sites* sets out numerous practical recommendations to assist in mitigating construction noise emissions. In the event that noise complaints or issues arise during construction activities, consideration will be given to the following noise control strategies:

- use of quieter plant and equipment if possible while still being able to undertake the work efficiently;
- increased maintenance of equipment in order to noise attenuation features in good working order;
- awareness raising among operators of construction equipment to identify potential noise problems and techniques to minimise noise emission such as turning equipment off when not in use; and
- relocation of noise sources away from receptors, if possible.

13.3.1.2 Operations

General

BMA will continue to maintain contact with local residents through its community consultation framework to inform local residents of potential noise impacts, and make available information on contacting BMA in the event that noise related disturbance occurs. Where noise complaints are received, BMA will investigate the complaint using its established complaint procedures and determine mitigation measures to address noise issues. The use of 'self-adjusting volume' or 'broad-band buzzer' type reversing alarms is available where noise issues arise.

Eureka Village

The following measures are available to mitigate operational noise at Eureka Village:

- Use of low noise idlers.
- Increased noise attenuation in accommodation units. The nominated operational noise criteria for Eureka Village is based on a conservative outside to inside noise reduction of 20 dBA for the accommodation units. It would be possible to achieve significantly higher outside to inside noise reductions using acoustically upgraded constructions for the accommodation units (for example thicker glazing, acoustic door seals and upgraded wall constructions). This would require further assessment at the detailed design stage (including on site measurements of the existing outside to inside noise reduction of the units), however, it is expected that an outside to inside noise reduction of 25 to 30 dBA would be readily achievable without the need for extensive modifications to the units (which would be sufficient to achieve the nominated internal noise criteria).
- Noise attenuation around the boundary of Eureka Village. Earth bunds and/or noise barriers may be constructed around the north and eastern edges of Eureka Village to reduce noise levels from sources located at the Red Hill and Riverside CHPPs and stockpile areas.

It is considered that acceptable operational noise levels could be achieved at Eureka Village using one or more of the above noise control options. This would be subject to assessment at the detailed design stage prior to the commencement of construction and operation of the CHPP and conveyor.

13.3.1.3 Noise Impacts from the Proposed Red Hill Accommodation Village

The results in **Section 13.2.3** indicate that noise emissions from the proposed Red Hill accommodation village will be negligible at surrounding receptor locations. No mitigation is required.

L_{Amax} noise levels within the proposed Red Hill accommodation village from noise sources associated with the village will achieve the external criterion of 65 dB L_{Amax}. A number of plant items have the potential to exceed the external L_{Aeq} criterion of 50 dBA. Options available for mitigating the predicted exceedences include:

- selection of quieter mechanical plant;
- increasing the building façade noise reduction above the nominal 20 dB used in this assessment, for example by double glazing or choice of wall materials;
- locating the plant such that it is shielded (for example behind buildings or on roof tops) from sensitive areas;
- increasing the distance between the plant and the nearest accommodation unit; and
- placing of noise barriers or plant enclosures around noise items.

Since the assessment of noise impacts in **Table 13-16** is based on a conceptual accommodation design, it is recommended that a further acoustic assessment be undertaken during detailed design of the proposed Red Hill accommodation village. Based on the mitigation measures listed above, it is fully expected that an acceptable noise environment can be achieved.

13.3.1.4 Monitoring

To allow BMA to confirm that noise levels are within acceptable levels, a permanent noise monitoring program within the surrounding community will be implemented. This will also provide historical data should a complaint be lodged.

13.3.1.5 Investigation of Complaints

In the event of a complaint, an investigation of operational noise will occur as follows:

- Noise monitoring will be carried out within a reasonable and practical timeframe to investigate the cause of the complaint.
- The noise monitoring results will be compared with the nominated operational noise limits given in **Section 13.1.4**.
- If the monitoring indicates exceedences of the nominated noise limits then further action will be taken as follows:
  - Noise mitigation measures will be implemented so that the nominated noise limits are achieved.
  - The complaint will be addressed through the use of appropriate dispute resolution.