Adani Mining Pty Ltd

NORTH GALILEE BASIN RAIL PROJECT

Environmental Impact Statement

Chapter 12 Noise and vibration

November 2013

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12. Noise and vibration

12.1 Purpose of chapter

This chapter documents the noise and vibration assessment of the North Galilee Basin Rail Project (NGBR Project). The scope of the noise and vibration assessment was defined by the following tasks:

- Description of noise and vibration related environmental values
- Modelling of NGBR Project noise and vibration
- Identification of appropriate environmental noise and vibration criteria
- Assessment of NGBR Project noise and vibration against relevant criteria at sensitive receptors.

Background noise and vibration and propagation modelling is documented in detail in Volume 2 Appendix J Noise and vibration, and presented in summary in this chapter.

This noise and vibration chapter was prepared in accordance with the Terms of Reference (TOR) for the NGBR Project. A table that cross-references the contents of this chapter and the TOR is included as Volume 2 Appendix A Terms of Reference cross-reference.

All mitigation and management measures identified within this chapter are included within Volume 2 Appendix P Environmental management plan framework.

The potential impacts of noise and vibration on fauna behaviour are provided in Volume 1 Chapter 6 Nature conservation. Potential impacts of noise and vibration on cultural heritage values are provided in Volume 1 Chapter 15 Cultural heritage.

12.2 Methodology

12.2.1 Study area

The study area for this noise and vibration assessment included the NGBR Project final rail corridor (nominally 100 m wide) and nearest potential sensitive receptors. These potential sensitive receptors were identified within approximately six kilometres of the preliminary investigation corridor (nominally 1,000 m wide). Potential quarry areas were also considered as noise sources, however impacts were only considered at the identified sensitive receptors within the study area.

12.2.2 Data sources

This noise and vibration chapter relied on the following data sources:

- North Galilee Basin Rail Concept Design Report (Aarvee Associates 2013)
- Noise source data for modelling input (refer to Volume 2 Appendix J Noise and vibration).

Details regarding the sensitive receptors are provided in the following chapters:

- Volume 1 Chapter 3 Land use and tenure
- Volume 1 Chapter 4 Scenic amenity and lighting.

12.2.3 Legislation and guidelines

Legislation and guidelines relevant to this noise and vibration chapter are as follows.

- *Environmental Protection Act 1994* (Qld)
- *Environmental Protection (Noise) Policy 2008* (Qld).

An explanation of the *Environmental Protection Act 1994* and *Environmental Protection (Noise) Policy 2008* is provided in Volume 1 Chapter 20 Legislation and approvals.

In addition to the *Environmental Protection Act 1994*, a number of guidelines published by the Queensland Environmental Protection Agency (EPA), the New South Wales Environmental Protection Authority (NSW EPA), Queensland Rail (QR) and British and Australian Standards, were referred to in the development of noise and vibration assessment criteria, as listed below:

- Australian Standard AS 1055.1-1997 Acoustics – Description and Measurement of Environmental Noise General Procedures
- Australian Standard AS 2187.2 – 2006 Explosives – Storage and use Part 2: Use of explosives
- British Standard BS 5228-2:2009 Code of practice for noise and vibration on construction and open sites – Part 2: Vibration
- British Standard BS 6472-1:2008 Guide to evaluation of human exposure to vibration in buildings Part 1: Vibration sources other than blasting
- Queensland EPA Noise Measurement Manual
- Queensland EPA Noise and vibration from blasting guideline
- Queensland EPA Planning for Noise Control guideline
- QR Code of Practice for Railway Noise Management
- NSW EPA Interim Construction Noise Guideline (ICNG)
- NSW EPA Rail Infrastructure Noise Guideline (RING).

The noise and vibration criteria derived from these guidelines are listed in Table 12-2. Further detail on the selection of guidelines and the development of noise and vibration assessment criteria is provided in Volume 2 Appendix J Noise and vibration.

12.2.4 Site assessment

Attended and unattended monitoring was undertaken in the vicinity of sensitive receptors with the potential to be most affected by noise and vibration from the NGBR Project (refer Table 12-1 and Figure 12-1). Unattended monitoring was undertaken to establish existing background noise levels, whereas attended monitoring was undertaken to identify noise sources. Background vibration monitoring coincided with attended noise monitoring.

Monitoring was undertaken with consideration to the Noise Measurement Manual (Environmental Protection Agency 2000) and AS 1055.1-1997 Acoustics - Description and Measurement of Environmental Noise General Procedures.

Table 12-1 Monitoring locations

Description	Distance (km)[1]	Monitoring period
Location A, in the vicinity of final rail corridor	0.08	9 May – 29 May 2013
Location B, in the vicinity of Homestead 1	1.6	8 May – 25 May 2013
Location C, in the vicinity of Homestead 17	2.7	9 May – 30 May 2013
Location D, in the vicinity of homestead 22	1.0	29 May – 12 June 2013

[1] Measured to edge of 100 m final rail corridor

12.2.5 Desktop assessment

The desktop assessment involved the following tasks:

- Collation and review of background noise and vibration monitoring (refer Section 12.2.4)
- Identification of nearest sensitive receptors within approximately six kilometres of the preliminary investigation corridor (refer Section 12.3.3)
- Identification and characterisation of NGBR Project noise and vibration sources in the North Galilee Basin Rail Concept Design Report (Aarvee Associates 2013)
- Identification of appropriate assessment criteria and objectives
- Prediction of noise and vibration levels at sensitive receptors
- Assessment of predicted noise and vibration levels against assessment criteria.

The construction of the NGBR Project was considered to consist of the following stages, for the purpose of the noise and vibration assessment:

- Clearing and grubbing
- Cut and fill earthworks
- Drainage construction
- Capping layer application
- Bridge construction
- Haul road and access road maintenance
- Track laying.

Additional assessment was undertaken for noise and vibration impacts relating to potential quarrying sites employed during construction which are located outside of the NGBR Project footprint (final rail corridor and ancillary infrastructure.

Operation of the NGBR Project was considered at maximum capacity (100 mtpa), comprising 28 total train movements per 24 hour period. For the purposes of assessment in relation to the selected day (7 am to 10 pm) and night (10 pm to 7 am) criteria, the following breakdown was implemented in the operational rail modelling scenario:

- 9 loaded trains per day (7 am to 10 pm)
- 9 unloaded trains per night (10 pm to 7 am)
- 5 loaded trains per day (7 am to 10 pm)
- 5 unloaded trains per night (10 pm to 7 am).

Further information on the construction and operation of the NGBR Project is provided in Volume 1 Chapter 2 Project description.

Construction noise

An indicative list of equipment used during the construction of the NGBR Project was used to determine the combined noise level of construction activities, with reference to BS 5228-1:2009 Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 1: Noise and AS 2436:2010 Guide to Noise Control on Construction, Maintenance and Demolition Sites. Construction noise propagation was modelled with Computer Aided Noise Abatement (CadnaA). The combined noise level was modelled from the 100 m final rail corridor and ancillary infrastructure sites. Technical information on the model parameters is provided in Volume 2 Appendix J Noise and vibration.

A number of model parameters were assumed to present a 'worst case' scenario for noise impacts from operation, including:

- Equipment operating at full power for 75 per cent of the modelled operational time
- Equipment operating at the point on the 100 m final rail corridor with the greatest potential for impact to a given sensitive receptor
- Existing surface topography.

For context, equipment would likely operate at full power for a briefer period than 75 per cent of the duration of construction. Noise propagation was based on natural surface topography, which discounts the mitigating effect of cuttings on noise levels. It was not expected that fills would significantly affect noise propagation in comparison to noise at natural surface level.

It is also noted that although construction noise was assessed against standard working hours defined in the ICNG, broader general building work hours defined under the *Environmental Protection Act 1994* are accepted in Queensland.

The time restrictions are designed to strike a balance between protecting noise amenity and the need to start construction activities early in the morning.

Noise from traffic during construction was also estimated at the key road intersections. These intersections were selected based on the predicted increased vehicle movements as a result of the NGBR Project. Further details on vehicle movements including a figure identifying these intersections has been included within Volume 1 Chapter 14 Transport.

The QLD EPA's Ecoaccess Planning for Noise Control (PNC) guideline for industrial activities, planning purposes and industrial developments.

Operation noise

Rail traffic noise was modelled using the Nordic Rail Traffic Noise Prediction Method. Operation noise propagation was modelled with CadnaA.

A number of model parameters were assumed to present a 'worst case' scenario for noise impacts from operation, including:

- A ground absorption coefficient of 0.5
- Atmospheric conditions of 10°C and 70% humidity – given
- Existing surface topography.

For context, a ground absorption coefficient of 1.0 represents highly absorptive ground covers (e.g. grass, porous soil) and 0.0 represents highly reflective surfaces (e.g. concrete). Therefore a coefficient of 0.5, applied uniformly across the study area, was considered conservative.

Atmospheric conditions were selected from a finite range of noise model configurations, close to the mean minima at Collinsville Post Office BOM, representing a 'worst case' scenario for noise propagation.

Noise propagation was based on existing surface topography, which discounts the mitigating effect of cuttings on noise levels. It was not expected that fills would significantly affect noise propagation in comparison to noise at natural surface level.

Construction and operation vibration

Typical vibration levels for construction equipment were estimated with reference to the NSW Roads and Maritime Service Environmental Noise Management Manual. Vibration from construction was estimated at sensitive receptors using a distance relationship calculation. Vibration from operation was assessed by a review of in situ vibration testing.

Blasting

Airblast overpressure and ground vibration were estimated at sensitive receptors using a distance relationship calculation, with reference to AS 2187.2 – 2006 Explosives – Storage and use Part 2: Use of explosives. A maximum instantaneous charge (MIC) of 50 kg was considered likely to be appropriate during construction and was therefore the modelled value.

Site constants and ground constants for airblast overpressure and ground vibration respectively were selected with due consideration to AS 2187.2 – 2006 Explosives – Storage and use Part 2: Use of explosives. The standard recommends a site constant in the range of 10 to 100 for the purpose of assessing airblast overpressure – both ends of the range were applied. For ground vibration, the standard recommends a ground constant in the range of 240 to 4,400. A range of 800 to 1,600 was considered appropriate for the NGBR Project – both ends of this range were applied. Range estimates for the site constant and ground constant were conservative.

To present a 'worst case' scenario for noise impacts from blasting, blasting was considered to occur at the closest point on the 100 m final rail corridor to a given sensitive receptor.

Construction will generally take place during daytime working hours (6 am to 7 pm). Night-time construction works may include those activities that would be inhibited during daytime working hours, such as:

- Embankment moisture conditioning
- Work within an operational rail corridor
- Road works where required to avoid peak traffic

- Materials delivery by oversize vehicles.

Other night-time construction works may be undertaken where they can be conducted safely and have limited noise and light impacts on sensitive receptors, such as:

- Welding to support track construction
- Concrete casting
- Utilities adjustment
- Investigations or testing.

The duration of night-works required during construction of the NGBR Project is currently unknown and will be investigated further during detailed design.

12.2.6 Impact assessment

A summary of the relevant noise and vibration criteria applied at sensitive receptors to assess the impacts of the NGBR Project is shown in Table 12-2.

Table 12-2 Noise and vibration criteria summary at sensitive receptors

Phase	Emission	Timeframe	Criteria
Construction	Noise[1]	Standard working hours[2]	< 40 dB(A) $L_{Aeq(15min)}$
		Outside standard working hours	< 35 dB(A) $L_{Aeq(15min)}$
	Vibration[3]	24 hours	< 0.3 mm/s
	Overpressure (blasting)[4]	Monday to Friday 9 am to 3 pm	<115 dB(lin) peak for nine out of 10 blasts
		Saturday 9 am to 1 pm	120 dB(lin) maximum for any blast
	Vibration (blasting)[4]	Monday to Friday 9 am to 3 pm	<5 mm/s PPV for nine out of 10 blasts[5]
		Saturday 9 am to 1 pm	10 mm/s maximum for any blast[5]
Operation	Noise[5]	Monday to Sunday 7 am to 10 pm	60 dB $L_{Aeq,15\ hour}$ or 80 dB L_{AFmax}
		Monday to Sunday 10 pm to 7 am	55 dB $L_{Aeq,\ 9\ hour}$ or 80 dB L_{AFmax}
	Vibration[6]	Monday to Sunday 7 am to 11 pm	Low probability for adverse comment: 0.2 to 0.4 $m/s^{1.75}$
		Monday to Sunday 11 pm to 7 am	Low probability for adverse comment: 0.1 to 0.2 $m/s^{1.75}$

[1] Defined in ICNG

[2] Defined in ICNG as Monday to Friday 7 am to 6 pm, Saturday 8 am to 1 pm

[3] Defined in BS 5228-2:2009

[4] Defined in *Environmental Protection Act 1994*

[5] Defined in RING

[6] Defined in BS 6472-1:2008

Construction noise criteria under the ICNG represent noise levels at which there may be some community reaction to noise. The criterion during standard working hours is the rating background level (RBL) plus 10 dB(A), whereas the criterion outside of standard working hours is the RBL plus five dB(A). Construction noise criteria for the NGBR Project were calculated based on a RBL of 30 dB(A), defined as the minimum RBL in NSW Industrial Noise Policy (NSW EPA 2000).

The RING criteria were adopted in favour of the QR Code of Practice for Railway Noise Management criteria (65 dB $L_{Aeq,24\ hr}$ and 87 dB L_{Amax}) as the RING criteria provide a more complete assessment including night time impacts. A comparison of the NSW EPA RING

criteria and the QR criteria is demonstrated in Volume 2 Appendix J Noise and vibration. Further, the ICNG standard working hours (Monday to Friday 7 am to 6 pm, Saturday 8 am to 1 pm) were adopted over the broader general building work hours (Monday to Saturday, 6:30 am to 6:30 pm) defined in the *Environmental Protection Act 1994.*

Additional blasting criteria are referred to in Noise and Vibration from Blasting (EPA 2006). The guideline recommends that blasting should generally only be permitted during the hours of:

- Monday to Friday, 9 am to 3 pm
- Saturday, 9 am to 1 pm
- No blasting on Sundays or public holidays.

Blasting outside these recommended times should be undertaken only where:

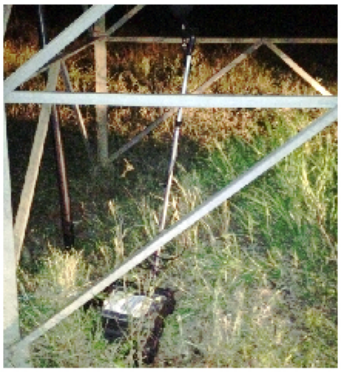
- Blasting during the preferred times is clearly impracticable (in such situations blasts should be limited in number and stricter airblast overpressure and ground vibration limits should apply)
- There is no likelihood of persons in a noise-sensitive place being affected because of the remote location of the blast site.

The Planning for Noise Control guideline includes noise criteria that are designed to protect receivers from industrial noise significantly louder than the background level, and limit the total noise level from all sources near a receiver. In the absence of existing industrial noise, noise from continuous sources should be limited to three dB(A) above the background noise level where noise is non-impulsive or tonal. The PNC criteria were considered applicable to the rolling stock maintenance facility during the operation of the NGBR Project.

12.2.7 Limitations

Construction noise has been modelled based on the construction methodology and indicative plant and equipment described in the North Galilee Basin Rail Concept Design Report (Aarvee Associates 2013), as outline in Volume 1 Chapter 2 Project description.

Blasting is non-linear in nature and variability in ground type and meteorological conditions makes it difficult to accurately predict ground vibration and airblast overpressure without site specific measurement data - therefore the blasting predictions are provided here as a guide.



480,000 520,000 560,000 600,000 640,000

7,800,000 7,760,000 7,720,000 7,680,000 7,640,000 7,600,000

Flinders Highway
Bruce Highway
Port Of Abbot Point
A
BOWEN
MERINDA
Strathalbyn Road
Burdekin Falls
Normanby Road
B
Blue Valley Road
Myuna Road
COLLINSVILLE
C
Rutherford Road
GLENDEN
Bowen Developmental Road
Stratford Road
Suttor Developmental Road
Collinsville Elphinstone Road
D
Gregory Developmental Road
Kilcummin-Diamond Downs Road

LEGEND

- Population Centres
- Major Port
- Monitoring Location
- Railway
- Highway
- Main Road
- Carmichael Mine Project Rail
- North Galilee Basin Rail 1000m Corridor
- North Galilee Basin Rail 100m Corridor

1:1,100,000 Paper Size A4

0 10 20 40

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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GHD adani

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North Galilee Basin Rail Project

Job Number	41-26457
Revision	B
Date	28 Aug 2013

Monitoring locations

Figure 12-1

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145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: GA: Populated Places, Railway, Watercourse, Lakes/2007; Adani: NGBR Corridor 06/06/2013, NGBR Corridor 13/05/2013, Camichael Project Rail/2013; DNRM: Roads/2010; GHD: Monitoring Locations/2013.

12.3 Existing environment

12.3.1 Background noise

Unattended monitoring

Unattended monitoring was undertaken at four monitoring locations (refer Section 12.2.4). The results of unattended monitoring are in Table 12-3. Results are presented as a RBL, a single-figure representation of background noise during a given assessment period (day, evening or night). For a given monitoring location, RBL is calculated as follows:

- The median value of measurements between 7 am to 6 pm (day)
- The median value of measurements between 6 pm to 10 pm (evening)
- The median value of measurements between 10 pm to 7 am (night).

Unattended monitoring results presented graphically and as daily overall values at each monitoring site, for each assessment period, throughout the entire monitoring program, are provided in Volume 2 Appendix J Noise and vibration.

Table 12-3 Summary of unattended noise monitoring

Location	Background L_{A90} dB(A)			Ambient L_{Aeq} dB(A)		
	Day	Evening	Night	Day	Evening	Night
A	26	40	31	46	56	48
B	21	35	19	52	48	46
C	21	30	20	49	40	39
D	24	24	20	51	41	42

Attended monitoring

Attended monitoring was undertaken at four monitoring locations (refer Section 12.2.4). The results of attended monitoring are in Table 12-4. Levels recorded during attended noise monitoring were consistent with those recorded during unattended monitoring. Attended noise monitoring identified the following noise sources.

Table 12-4 Summary of attended noise monitoring

Location	Dominant noise sources
A	Day – wind through vegetation, trains, highway traffic
	Evening – birds, insects
	Night – birds, insects
B	Day – birds, insects, wind through vegetation
	Evening – insects, frogs
	Night – insects, frogs
C	Day – birds, insects, wind through vegetation, cows, vehicles (cattle truck, 4WD)
	Evening – insects, wind through vegetation, creaking windmill
	Night – insects, wind through vegetation, creaking windmill
D[1]	Day – insects, frogs, wind through vegetation, dogs, horses

[1] Evening and night attended monitoring did not occur

12.3.2 Background vibration

Attended vibration monitoring was undertaken at four monitoring locations considered representative of the NGBR Project study area (refer Section 12.2.4). The results of monitoring are in Table 12-4. There was no perceptible ground vibration at any of the monitoring locations, which conformed with the recorded levels.

Table 12-5 Summary of vibration monitoring

Location	Time (hrs)	Sum (mm/s)	Observations
A	18:29-18:50	0.102	No perceptible ground vibration
B	10:43-11:09	0.237	No perceptible ground vibration
C	14:14-14:35	0.093	No perceptible ground vibration
D	18:59-19:28	0.093	No perceptible ground vibration

12.3.3 Sensitive receptors

Sensitive receptors for this chapter are defined as locations with a high sensitivity to changes in background noise and vibration levels. This may consist of residential dwellings (homesteads) and non-residential premises including schools, shops, offices, churches and structured recreational areas in accordance with the Queensland *Environmental Protection (Noise) Policy 2008.* Industrial premises were excluded as a sensitive receptor as they typically are more tolerant to noise or vibration changes.

Due to the nature and scale of the predicted noise and vibration emissions likely to be generated during the construction and operation of the NGBR Project, only nearest sensitive receptors within approximately six kilometres of the preliminary investigation corridor were

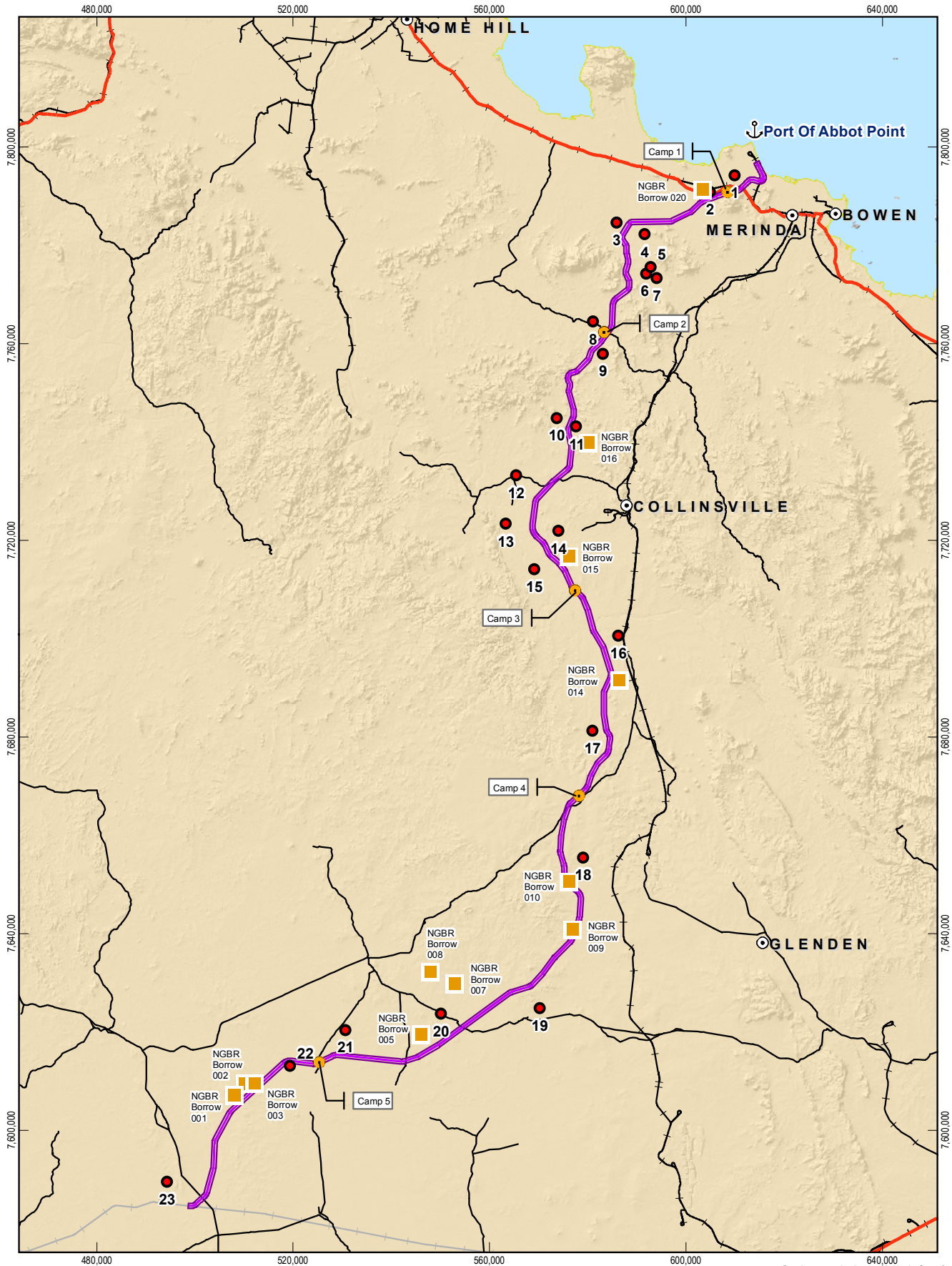
considered (refer Section 12.2.1). No non-residential premises were located within the study area.

All homesteads identified within the study area and included within this assessment are listed in Table 12-6 and depicted in Figure 12-1. The nearest identified sensitive receptor was approximately 1.1 km from the centreline of the NGBR Project final rail corridor.

Five temporary construction camps will be established on sites adjacent to the final rail corridor to meet estimated workforce accommodation demands. For the purposes of this assessment, temporary construction camps were not considered as sensitive receptors however they are locations which will trigger the implementation of mitigation measures to protect the general health and safety of occupants. Temporary construction camps have therefore been included in the discussion on potential impacts and mitigation Section 12.4.1. Further details regarding the location, size and layout of the temporary construction camps has been included within Volume 1 Chapter 2 Project description.

Table 12-6 Sensitive receptors

Receptor	Easting	Northing	Distance to centreline of final rail corridor (m)
Homestead 1	609916	7794255	2,740
Homestead 2	604874	7790877	1,202
Homestead 3	585906	7784622	2,248
Homestead 4	591656	7782269	2,631
Homestead 5	592845	7775614	4,730
Homestead 6	591975	7774322	3,826
Homestead 7	594112	7773398	5,724
Homestead 8	581086	7764508	3,622
Homestead 9	583141	7758004	2,121
Homestead 10	573776	7744903	2,927
Homestead 11	577907	7743136	1,564
Homestead 12	565463	7733205	6,208
Homestead 13	563357	7723411	5,366
Homestead 14	574094	7721935	3,913
Homestead 15	569153	7714138	4,313
Homestead 16	586276	7700615	3,869
Homestead 17	580954	7681237	2,822
Homestead 18	579067	7655503	4,170
Homestead 19	570319	7624819	4,981
Homestead 20	550182	7623709	4,744
Homestead 21	530696	7620414	5,209
Homestead 22	519416	7613045	1,109
Homestead 23	494429	7589483	6,634



LEGEND

- Potential Quarry
- Population Centres
- Major Port
- Homestead Sensitive Receptor
- Potential Camp Sensitive Receptor
- Highway
- Main Road
- Railway
- Carmichael Mine Project Rail
- North Galilee Basin Rail 1000m Corridor
- North Galilee Basin Rail 100m Corridor

1:1,100,000 Paper Size A4

0 10 20 40

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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Adani Mining Pty Ltd
North Galilee Basin Rail Project

Job Number 41-26457
Revision B
Date 28 Aug 2013

Sensitive receptors and emissions sources

Figure 12-2

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145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: GA: Populated Places, Railway, Watercourse, Lakes/2007; Adani: NGBR Corridor 06/06/2013, NGBR Corridor 13/05/2013, Camichael Project Rail/2013, Construction Camps/2013,Quarry Locations/2013; DNRM: Roads/2010; GHD/Adani: Potential Sensitive Receptors/2013.

12.4 Potential impacts and mitigation measures

The construction and operation of the NGBR Project has the potential to generate noise and vibration emissions that have an impact at sensitive receptors, including potential for nuisance or harm to human health and wellbeing. An assessment of impacts on locations with a high sensitivity to changes in background noise and vibration levels is detailed in the following sections.

12.4.1 Construction

Impact of construction noise

The results of CadnaA noise modelling for construction related impacts are provided in Table 12-7. The ICNG noise affected criterion for work occurring outside standard working hours (40 dB $L_{Aeq(15min)}$) was predicted to be exceeded during earthworks at 11 homesteads. If earthworks were to take place only during standard working hours (40 dB $L_{Aeq(15min)}$), the total reduces to five homesteads. Neither criterion was predicted to be exceeded during other construction activities, noting that blasting is assessed separately.

The result presented here is the product of a number of 'worst case' assumptions (refer Section 12.2.5). Actual noise experienced at a sensitive receptor is likely to be lower than predicted and short term, given that:

- Equipment would not operate at full power for the entire time
- Certain types of equipment for a given activity will be present for brief periods of time
- Equipment would be moving around the final rail corridor
- Noise emissions from equipment working in cuttings may be reduced.

Despite the conservatism of the impact assessment presented here, a number of standard mitigation measures are proposed to further mitigate impacts occurring. These mitigation measures will form the Noise and Vibration Management Plan, which will be incorporated into the Environmental Management Plan for the NGBR Project (refer Volume 2 Appendix P Environmental management plan framework). The mitigation measures to be included in the plan are listed in Section 12.4.3.

Table 12-7 Estimated construction noise dB(A) L_{Aeq}

Receptor	Earthworks	Drainage	Capping	Structures	Haul roads	Track work
Homestead 1	**39.8**[2]	20.8	20.9	22.4	21.9	22.7
Homestead 2	**50.5**[1]	31.0	31.5	32.5	32.7	34.9
Homestead 3	**41.1**[1]	21.9	22.2	23.5	23.1	24.1
Homestead 4	**37.2**[2]	16.7	18.2	17.9	19.5	20.1
Homestead 5	31.3	14.3	13.8	16.0	14.6	14.2
Homestead 6	34.3	16.4	16.1	18.0	17.0	17.0
Homestead 7	27.0	11.7	10.9	13.4	11.6	10.9
Homestead 8	**35.4**[2]	17.2	17.0	18.8	17.9	18.0
Homestead 9	**43.4**[1]	24.0	24.4	25.6	25.4	26.7
Homestead 10	**35.7**[2]	15.1	16.5	16.3	17.9	18.3
Homestead 11	**43.9**[1]	23.9	25.1	25.2	26.6	28.0
Homestead 12	23.2	4.0	4.5	5.6	6.1	5.5
Homestead 13	25.9	6.9	6.9	8.7	8.4	7.9
Homestead 14	31.3	13.4	12.8	15.1	13.6	13.4
Homestead 15	32.9	15.4	15.0	17.1	15.8	15.6
Homestead 16	31.7	14.6	14.1	16.2	14.9	14.5
Homestead 17	**38.1**[2]	19.3	19.3	20.9	20.2	20.8
Homestead 18	30.3	10.8	11.1	12.5	12.5	12.3
Homestead 19	27.3	7.2	8.2	8.6	9.7	9.2
Homestead 20	31.3	14.3	13.8	16.0	14.6	14.2
Homestead 21	26.5	10.7	9.8	12.4	10.5	9.7
Homestead 22	**51.6**[1]	32.2	32.7	33.7	33.9	**36.3**[2]

[1] Greater than or equal to ICNG noise management level for work within standard working hours (40 dB $L_{Aeq(15min)}$)

[2] Greater than or equal to ICNG noise management level for work outside standard working hours (35 dB $L_{Aeq(15min)}$)

Five temporary construction camps will be established on sites adjacent to the final rail corridor and are likely to be constructed within 500 m of emission sources. The construction camp facilities will be positioned to minimise external impacts from the final rail corridor or associated construction laydown or turning areas, as well as any internal emission sources such as generators or parking areas. Construction camp designs will meet the construction noise criteria (refer Section 12.2.6) by incorporating enclosed meals, living and sleeping quarters which will be mechanically ventilated and insulated to protect residents. Given that the construction camps will predominantly be occupied outside of general building hours, when emission sources will be minimal, in addition to the transient or fleeting nature of construction activities in sections of the

final rail corridor adjacent to the construction camps, the potential impacts to camp residents from noise will be insignificant.

Impact of construction traffic noise

Key intersections with potential increases in construction traffic are provided in Table 12-8.

Noise from traffic during construction was also estimated at the following key road sections:

- Intersection A, Bruce Highway/New Access Road (near chainage 14 km)
- Intersection B, Glenore Road/New Access Road (near chainage 34 km)
- Intersection C, Strathalbyn Road/New Access Road (near chainage 62 km)
- Intersection D, Bowen Developmental Road/New Access Road (near chainage 120 km)
- Intersection E, Bowen Developmental Road/New Access Road (near chainage 170 km)
- Intersection F, Suttor Developmental Road/Stratford Road (near chainage 230 km)
- Intersection G, Stratford Road/New Access Road (near chainage 262 km)
- Intersection H, Gregory Developmental Road/New Access Road (near chainage 305 km).

Further detail on background annual average daily traffic (AADT) at key road sections is provided in Volume 1 Chapter 14 Transport.

Table 12-8 Key intersections and nearest receptors

Road section	Background (AADT)	Increase (AADT)	Approximate noise increase (dB)	Nearest homestead
Intersection A	3592	79	0.1	Homestead 1 (2.5 km)
Intersection B	29	764	14.2	Homestead 4 (three kilometres)
Intersection C	1216	89	0.1	Homestead 6 (2.5 km)
Intersection D	1386	80	0.2	Homestead 18 (10.5 km)
Intersection E	335	459	3.5	Homestead 15 (6.9 km)
Intersection F	29	81	5.4	Homestead 22 (5.2 km)
Intersection G	29	81	5.4	Homestead 20 (5.1 km)
Intersection H	710	56	2.1	Homestead 23 (eight kilometres)

The predicted change to anticipated background traffic (year 2015) as a result of the construction traffic from the NGBR Project indicates that intersections B, F and G were considered to have the highest potential increase in traffic noise of up to 14 dB(A).

However due to low existing traffic, road traffic noise due to the NGBR Project is not expected to exceed 40 dB(A) at sensitive receptors. As such, no mitigation measures relating specifically to traffic noise are proposed.

Vibration

The peak particle velocity at distances from construction vibration sources are in Table 12-9. The results indicate that at a distance of 300 m from the NGBR Project, vibration from activities excluding piling are unlikely to be perceptible in residential environments (refer Section 12.2.6). Given that the nearest sensitive receptor is more than one kilometre from the final rail corridor, it is expected that received vibration from vibratory piling will be less than 0.75 mm/s. At this level the activity may be perceptible, however is unlikely to impact the amenity of residences as the disturbance will be periodic and temporary in nature, should they occur at all in proximity to residences.

Given that the construction camps will predominantly be occupied outside of general building hours, when vibration sources will be minimal, in addition to the transient or fleeting nature of construction activities in sections of the final rail corridor adjacent to the construction camps, the potential impacts to camp residents from vibration will be insignificant.

Vibration from blasting is considered separately in the following subsection.

Table 12-9 Estimate construction vibration

Source	Peak particle velocity (mm/s) at distance							
	5 m	10 m	20 m	50 m	100 m	150 m	200 m	300 m
Piling (vibratory)	52.2	30.0	17.2	8.3	4.8	3.4	2.7	2.0
15 tonne roller	13.9	8.0	4.6	2.2	1.3	0.9	0.7	0.5
15 tonne compactor	13.9	8.0	4.6	2.2	1.3	0.9	0.7	0.5
7 tonne compactor	10.4	6.0	3.4	1.7	1.0	0.7	0.5	0.4
Dozer	7.0	4.0	2.3	1.1	0.6	0.5	0.4	0.3
Excavator	4.4	2.5	1.4	0.7	0.4	0.3	0.2	0.2
Grader	4.4	2.5	1.4	0.7	0.4	0.3	0.2	0.2
Backhoe	1.7	1.0	0.6	0.3	0.2	0.1	0.1	0.1
Piling (Boring)	1.4	0.8	0.5	0.2	0.1	0.1	0.1	0.1

Blasting

Blasting is anticipated to be used during construction within the final rail corridor and also at quarries and borrows outside the final rail corridor.

The result of distance relationship calculations for airblast overpressure and ground vibration from blasting are presented in Table 12-10 for blasting in the final rail corridor and Table 12-11 for blasting from potential quarry locations.

For blasting along the final rail corridor the results indicate that airblast overpressure levels have the potential to exceed the blasting criteria at Homestead 2, Homestead 11 and Homestead 22 should blasting occur within the final rail corridor near these sensitive receptors. A review of the cut and fill areas in the vicinity of these homesteads indicate it is unlikely that blasting would be required at these locations, therefore blast related impacts are not expected at the assessed sensitive receptors. Although blasting related impacts are not anticipated, standard mitigation measures have been provided below to assist with preventing noise and vibration impacts from blasting.

Quarries are at sufficient distance (greater than two kilometres) from sensitive receptors such that received airblast overpressure due to blasting at quarries is predicted to be significantly less than the criteria (115 dB(lin)).

It was not predicted that ground vibration would exceed the blasting criteria at any of the identified sensitive receptors for blasting in the final rail corridor or at quarries (greater than 260 m from sensitive receptors to meet five mm/s criteria).

It is noted that airblast overpressure was estimated under the 'worst case' assumption that blasting would occur at the closest point on the 100 m final rail corridor to a given sensitive receptor. For quarries, the blast was propagated from the listed locations. All other parameters were conservatively assumed (refer Section 12.2.5).

A number of standard mitigation measures are proposed to prevent impacts from blasting occurring. These mitigation measures will be incorporated into the Environmental Management Plan for the NGBR Project (refer Volume 2 Appendix P Environmental management plan framework). The mitigation measures to be included in the plan are listed in Section 12.4.3.

In addition to the above, the following will be undertaken to confirm the result of the impact assessment and inform blast design to prevent airblast overpressure or ground vibration impacts at sensitive receptors.

- Undertake airblast overpressure monitoring during initial blasts to assist with the optimisation of blast parameters and confirmation of predictions
- Modify blast design as necessary to prevent impact, including
  - Reduce maximum instantaneous charge using delays, reduced hole diameter, or deck-loading
  - Changing the burden and spacing by altering the drilling pattern and/or delay layout, or altering the hole inclination
  - Spacing and orientation of blast drill holes
  - Use minimum practicable sub-drilling which gives satisfactory toe conditions.
  - Investigate alternative rock-breaking techniques
  - Establish times of blasting to suit local conditions
  - Direction of detonator initiation away from nearby residences.

Given that blasting will only occur during acceptable hours under the *Environmental Protection Act 1994* (refer Section 12.2.6), where construction camps will be predominately unoccupied, it is unlikely that impacts from blasting will occur. All blasting will be undertaken with consideration to the health and safety of the NGBR Project workforce.

Table 12-10 Estimated airblast overpressure and ground vibration from blasting within the final rail corridor (based on 50 kg MIC)

Receptor	Airblast overpressure dB(linear)		Ground vibration (mm/s)	
	Ka 10[1]	Ka 100[1]	Kg 800[2]	Kg 1600[2]
Homestead 1	90.9	110.9	0.1	0.1
Homestead 2	101.6	**121.6**[3]	0.2	0.5
Homestead 3	93.5	113.5	0.1	0.2
Homestead 4	91.5	111.5	0.1	0.1
Homestead 5	84.0	104.0	0.0	0.0
Homestead 6	86.7	106.7	0.0	0.1
Homestead 7	81.5	101.5	0.0	0.0
Homestead 8	87.4	107.4	0.0	0.1
Homestead 9	94.2	114.2	0.1	0.2
Homestead 10	90.1	110.1	0.1	0.1
Homestead 11	98.2	**118.2**[3]	0.1	0.3
Homestead 12	80.5	100.5	0.0	0.0
Homestead 13	82.4	102.4	0.0	0.0
Homestead 14	86.4	106.4	0.0	0.1
Homestead 15	85.1	105.1	0.0	0.1
Homestead 16	86.5	106.5	0.0	0.1
Homestead 17	90.6	110.6	0.1	0.1
Homestead 18	85.6	105.6	0.0	0.1
Homestead 19	83.3	103.3	0.0	0.0
Homestead 20	83.9	103.9	0.0	0.0
Homestead 21	82.7	102.7	0.0	0.0
Homestead 22	102.7	**122.7**[3]	0.3	0.5
Homestead 23	79.7	99.7	0.0	0.0

1 Site constant, refer Section 12-5

2 Ground constant, refer Section 12-5

3 Greater than or equal to the *Environmental Protection Act 1994* criterion

Table 12-11 Estimated airblast overpressure and ground vibration from quarries (50 kg MIC)

Quarry name	Homestead number	Distance (km)	Airblast		Vibration	
			Ka 10	Ka 100	Kg 800	Kg 1600
NGBR Borrow 001\NGBR Borrow 001a	22	13	71.1	91.1	0.0	0.0
NGBR Borrow 002	22	10	74.4	94.4	0.0	0.0
NGBR Borrow 003	22	8	77.2	97.2	0.0	0.0
NGBR Borrow 005	20	6	80.8	100.8	0.0	0.0
NGBR Borrow 007	20	7	78.9	98.9	0.0	0.0
NGBR Borrow 008	20	9	75.7	95.7	0.0	0.0
NGBR Borrow 009	18	15	69.3	89.3	0.0	0.0
NGBR Borrow 010	18	6	80.8	100.8	0.0	0.0
NGBR Borrow 014	16	9	75.7	95.7	0.0	0.0
NGBR Borrow 015	14	6	80.8	100.8	0.0	0.0
NGBR Borrow 016	11	4	85.9	105.9	0.0	0.1
Mount Carew, Walmington Station (NGBR Borrow 020)	2	2	94.7	114.7	0.1	0.2

Night-works

Any works required outside daytime working hours (i.e. 7 pm to 6 am) would be minimised where possible. Potentially affected sensitive receptors will be notified at least five days in advance of night works occurring in a particular location. Impact pile driving and blasting would not be undertaken outside of daytime working hours.

Any noise complaints regarding night-time works will be investigated immediately and measures will be developed in consultation with the affected sensitive receptor to minimise any confirmed impacts. Measures for consideration may include provision of alternate temporary accommodation, use of alternate construction equipment or techniques and rescheduling of works to daytime working hours.

12.4.2 Operation

Impact of operation noise

The results of CadnaA noise modelling for operation are provided in Table 12-12. The relevant RING day criterion and maximum criterion were not predicted to be exceeded. The RING night criterion of 55dB $_{LAeq,9h}$ was predicted to be exceeded at Homestead 2 and Homestead 22.

It is noted that the less stringent QR criteria would not be exceeded at any sensitive receptor (refer Section 12.2.6).

Table 12-12 Estimated operation noise

Receptor	Day (dB $L_{Aeq, 15h}$)	Night (dB $L_{Aeq,9h}$)	Maximum (dB L_{AFmax})
Homestead 1	49.3	49	60.0
Homestead 2	56	**55.7**[1]	69.3
Homestead 3	49.4	49.1	62.3
Homestead 4	49.6	49.3	60.4
Homestead 5	40.5	40.2	50.7
Homestead 6	43.3	43	54.3
Homestead 7	36.1	35.8	46.9
Homestead 8	45.1	44.8	55.5
Homestead 9	50.7	50.3	63.2
Homestead 10	46.6	46.3	58.5
Homestead 11	54.1	53.8	66.7
Homestead 12	35.3	34.9	45.8
Homestead 13	37.4	37.1	48.5
Homestead 14	43.1	42.7	53.9
Homestead 15	41.8	41.5	52.3
Homestead 16	42.9	42.5	54.4
Homestead 17	46.4	46	58.7
Homestead 18	42.3	42	53.0
Homestead 19	38.4	38.1	49.3
Homestead 20	40.4	40	51.0
Homestead 21	38.1	37.8	49.4
Homestead 22	57.5	**57.2**[1]	70.9
Homestead 23	32.1	31.7	43.4

[1] Exceeds RING night criterion

The result presented here is the product of a number of 'worst case' assumptions (refer Section 12.2.5). Actual noise experienced at a sensitive receptor is expected to be lower than predicted, given that:

- Conservative ground absorption and atmospheric conditions were used
- Noise emissions from trains within cuttings may be reduced.

Despite the conservatism of the impact assessment presented here, a number of standard mitigation measures are proposed to further prevent impacts occurring. These mitigation measures will form the Noise and Vibration Management Plan, which will be incorporated into the Environmental Management Plan for the NGBR Project (refer Volume 2 Appendix P

Environmental management plan framework). The mitigation measures to be included in the plan are listed in Section 12.4.3.

In addition to the above, the following will be undertaken to confirm the result of operational noise modelling and mitigate potential impacts, as necessary.

- Undertake operational noise monitoring to validate noise predictions
- Where operational noise monitoring identifies noise impact occurring at a sensitive receptor, employ additional mitigation, such as
  - Construction of screening and barriers or bunds
  - Noise mitigating building works at sensitive receptors, such as double glazing.

Based on previous noise assessments (refer Volume 2 Appendix J Noise and vibration), noise emissions were predicted to be within the Planning for Noise Control criteria at one kilometre from the rolling stock maintenance facility. Given the nearest sensitive receptor to the rolling stock maintenance facility was 2.5 km distant, no impacts were expected with regard to these criteria.

Impact of operation vibration

Recent vibration monitoring was undertaken for coal trains on the Australian Rail Track Corporation rail network in the Hunter Valley (Hunter8 Alliance 2010). Monitored trains included those operated by Pacific National and Aurizon. The monitoring indicated a low probability of human comfort or structural vibration criteria (refer Section 12.2.6) being reached more than 40 m from the rail line.

Additional rail vibration assessments of the same network (Hunter8 Alliance 2010) for trains similar to those used for the NGBR Project resulted in similar findings, with negligible vibration levels at distances greater than approximately 50 m from the rail line. Vibration levels from the operation of the NGBR Project were expected to be consistent with the above findings.

Given the nearest sensitive receive is over one kilometre from the NGBR Project, no operational vibration impact is predicted.

12.4.3 Summary of mitigation and management measures

A summary of mitigation measures relevant to the NGBR Project are provided in Table 12-13.

Table 12-13 Summary of mitigation measures

Timing	Mitigation measure
Detailed design	Factor distance to nearest sensitive locations into initial blasting design to ensure that impacts are avoided.
Detailed design	Locate noise generating ancillary infrastructure (construction depot, concrete batch plant, laydown areas) as far as practicable from sensitive receptors
Pre-construction	Consider noise performance in the procurement of construction equipment
Construction and operation	Fit equipment with noise suppression equipment
Construction and operation	Adhere to a maintenance schedule for equipment, ensuring that all equipment is maintained as per the specifications of the manufacturer
Construction and operation	Adhere to maintenance schedule for equipment, ensuring that all equipment maintenance is as per the specifications of the manufacturer
Construction and operation	During construction and operation, actual noise and vibration levels will be monitored to validate the predictions in this chapter. Blasting in particular will be monitored to ensure that blast design is appropriate to site conditions and considers any potential sensitive receptors.
Construction and operation	Any mechanical issues relating to excessive noise generation from plant or equipment will be immediately rectified.
Construction and operation	Equipment found to be producing excessive noise (i.e. which exceeds noise emissions standards for vehicles) will be taken out of use and repaired or removed from site.
Construction and operation	Monitor complaints relating to noise and vibration. Respond to complaints in accordance with complaints management procedures. Implement mitigation measures, where required.
Construction	As far as practicable, confine construction activities which are likely to generate major noise emissions (use of large machines etc.) within two kilometres of a sensitive receptor to general building work hours.
Construction	If planned construction activities within two kilometres of a sensitive receptor will not be confined to general building work hours, provide the following information to the relevant landholders at least two days prior to the activity occurring:

Timing	Mitigation measure
	• Nature of the activity • Justification for the activity to be outside general building work hours • Proposed date and timing of the activity • Access routes for workers and equipment.
Construction	As far as practicable, confine loading and unloading activities to general building work hours
Construction	Confine impact pile driving to general building work hours
Construction	Confine blasting to general building work hours
Construction	Potentially affected sensitive receivers will be notified at least five days in advance of night works occurring in a particular location.
Construction	Any noise complaints regarding night-time works will be investigated immediately and measures will be developed to minimise any identified impacts in consultation with the affected sensitive receptor. Measures for consideration may include provision of alternate temporary accommodation, use of alternate construction equipment or techniques and rescheduling of works to daytime working hours
Construction	Adhere to general protocols for construction including: • As far as practicable, situate mobile plant (e.g. compressors, generators) away from sensitive receptors • As far as practicable, direct principal noise sources (e.g. exhausts) away from sensitive receptors • Minimise use of warning devices, within operational health and safety constraints.
Construction	Modify blast design as necessary to prevent impact, including: • Reduce maximum instantaneous charge using delays, reduced hole diameter, or deck-loading • Changing the burden and spacing by altering the drilling pattern and/or delay layout, or altering the hole inclination • Spacing and orientation of blast drill holes • Use minimum practicable sub-drilling which gives satisfactory toe conditions • Investigate alternative rock-breaking techniques • Establish times of blasting to suit local conditions

Timing	Mitigation measure
	• Direction of detonator initiation away from near residences.
Construction	Undertake airblast overpressure monitoring during initial blasts to assist with the optimisation of blast parameters and confirmation of predictions.
Operation	Minimise use of horns and warning devices, within operational health and safety constraints.
Operation	Adhere to a maintenance schedule for rolling stock and maintenance equipment, ensuring that all equipment is maintenance as per the specifications of the manufacturer.
Operation	Site specific work practices for the rolling stock maintenance yard, such as • Minimisation of dropping materials from heights • Minimisation of operating equipment at full power • Training and induction for work practices to minimise noise and vibration • Direction of noise sources away from sensitive receptors • Service and maintain all plant and equipment according to service schedules.
Operation	Undertake operational noise monitoring to validate noise predictions. Where operational noise monitoring identifies noise impact occurring at a sensitive receptor, employ additional mitigation, such as: • Construction of screening and barriers or bunds • Noise mitigating building works at sensitive receptors, such as double glazing.

12.5 Conclusion

This chapter describes the potential noise and vibration impacts of the NGBR Project, and provides associated mitigation measures. Noise and vibration levels provided in this chapter have been developed based on the construction methodology and proposed operations described in the North Galilee Basin Rail Concept Design Report (Aarvee Associates 2013). They have also been based on conservative or 'worst case' assumptions as necessary.

During construction and operation, actual noise and vibration levels will be monitored to validate the predictions in this chapter. Blasting in particular will be monitored to ensure that blast design is appropriate to site conditions and considers any potential sensitive receptors. A monitoring program will also be developed for operational noise and provide corrective actions where required.

It is expected that noise and vibration caused by the construction and operation of the NGBR Project will be appropriately managed through the implementation of the mitigation and management measures identified within this chapter. Residual impacts after the implementation of the above mitigation and management measures are expected to be insignificant.