16 VIBRATION

16.1 INTRODUCTION

This chapter examines potential sources of vibration associated with the development of the open cut mine and the gas pipeline from blasting and from mobile earthmoving and fixed plant. It also provides a summary of mitigation strategies and measures to address these impacts. A detailed vibration technical report is presented in TR 16-1-V1.5 Environmental Impacts from Blasting. Note that figures/documents with numbering ending in V1.5 refer to figures/documents contained in Volume 1, Book 5 of the EIS.

16.2 METHODOLOGY OF ASSESSMENT

The following tasks were undertaken as part of the blasting vibration assessment:

- sourcing site specific information provided by various specialists involved with the Wandoan Coal Project (the Project) specifically on geological conditions, the proposed mine plan and the location of sensitive receptors
- a site visit to inspect geological conditions from drill cores during the initial geotechnical drilling program and the existing sample pit
- modelling to predict ground vibration and airblast overpressure
- assessment of vibration and airblast overpressure against accepted criteria for human comfort.

Blasting is not expected when undertaking trenching activities for the gas supply pipeline. Hydraulic rock breaking will be used if required.

There are no established vibration criteria in Queensland for the assessment of vibration from earthmoving equipment during operational and construction phases. However, there are applicable criteria provided in other Australian states and international standards which can be used for assessment purposes. Assessment is broken down into evaluation of human exposure to vibration and the effects of vibration on structures. Human exposure to vibration has been assessed against NSW guideline, Assessing Vibration: a technical guideline, 2006, with effects of vibration on structures assessed against the German standard DIN 4150-3: 1999 Effects of vibration on structures.

16.2.1 BLASTING CRITERIA

The blasting criteria are drawn from the Environmental Protection Agency (EPA) Guideline: Noise and vibration from blasting (EPA, 2006) (the Blasting Guideline). These criteria are more restrictive than those defined in the Environmental Protection Regulation 1998. The EPA Guideline lists recommended human comfort criteria relating to:

- ground vibration peak particle velocity (PPV)
- airblast overpressure level
- times of blasting.

The quantitative criteria in the EPA Guideline are detailed below.

Vibration criteria

The Blasting Guideline recommends that ground-borne vibrations caused from blasting operations will not exceed:

- a PPV of 5 mm/s for nine out of any 10 consecutive blasts initiated, regardless of the interval between blasts
- a peak velocity of 10 mm/s for any blast.

Noise criteria

The Blasting Guideline recommends that airblast overpressure from blasting operations will not exceed:

- 115 dB (linear) peak for nine out of any 10 consecutive blasts initiated, regardless of the interval between blasts
- 120 dB (linear) peak for any blast.

Times of blasting

The Blasting Guideline recommends that blasting only occur during the hours of 9 am to 5 pm Monday to Friday, and from 9 am to 1 pm on Saturdays, with blasting not taking place on Sundays or public holidays.

Blasting outside these times should only be undertaken where:

- blasting during the preferred times is clearly impractical
- there is no likelihood of persons in a noise sensitive place being affected because of the remote location of the blast site.

These latter criteria have been adopted for this assessment so that blasting may be scheduled during daylight hours.

16.2.2 APPROACH TO VIBRATION ASSESSMENT

Vibration modelling was undertaken to predict the ground vibration and airblast overpressure levels potentially generated by blasting at the various mine pits.

The predictive formulae used for the vibration modelling was drawn from the Australian Standard 2187.2 Explosives — Storage and Use, Part 2: Use of explosives (2006). It provides adequate guidance as to the blasting practices required in order to meet the criteria recommended in the Blasting Guideline.

Field data from mines similar to the Project were used to derive values for the prediction parameters required for the formulae. The analyses provided likely estimates of the ground vibration and airblast overpressure levels that would potentially be generated by blasting. The predicted levels at sensitive receptors identified were then compared with the levels recommended in the Blasting Guideline. This approach assumes that the operations are undertaken to an appropriate standard of design and implementation and that there were no unusual ground conditions or adverse atmospheric effects that could exacerbate the resulting impacts.

Further details of the methodology and results are available in the technical report on blasting (refer TR 16-1-V1.5 Environmental Impacts from Blasting).

16.2.3 HUMAN EXPOSURE TO VIBRATION

Criteria for human exposure are defined in the NSW Department of Environment and Conservation document Assessing Vibration: a technical guideline, 2006, which is based on BS 6472 — 1992 Evaluation of human exposure to vibration in buildings. This guideline sets criteria (shown in Table 16-1) for evaluating the effects of human exposure to continuous and impulsive vibration. Adverse comments or complaints may be expected as the vibration levels approach the maximum guideline. Where activities are predicted that will generate values exceeding the maximum guideline, community consultation should be carried out.

Table 16-1: Human exposure vibration guidelines

Place	Peak particle velocity (mm/s)		
	Time	Preferred	Maximum
Continuous vibration			
Residences	Daytime	0.28	0.56
	Night-time	0.20	0.40
Workshops	Day or night-time	1.1	2.2
Impulsive vibration			
Residences	Daytime	8.6	17.0
	Night-time	2.8	5.6
Workshops	Day or night-time	18.0	36.0

16.2.4 EFFECTS OF VIBRATION ON STRUCTURES

The German standard, DIN 4150-3: 1999 Effects of vibration on structures, outlines guideline criteria for evaluating effects of short term vibration on structures (Table 16-2) as well as buried pipelines (Table 16-3). If the values outlined in the tables below are not exceeded, damage that reduces serviceability of the affected structure will not occur. If the measured PPV values are lower than the values below, then they are considered to satisfy this standard.

Table 16-2: Guideline values for evaluating vibration on structures

Type of structure	Guideline values for velocity v_i (mm/s)			
	Vibration at foundation			Vibration at highest floor (v_{xy})
	1–10 Hz	10–50 Hz	> 50 Hz	
Commercial and industrial buildings	20	20 – 40	40 – 50	40
Dwellings	5	5 – 15	15 – 20	15
Sensitive buildings	3	3 – 8	8 - 10	8

Note: vi refers to maximum vibration level in one axis only ie x, y or z direction. vxy refers to the sum of the vibration in the horizontal plane ie x and y directions.

Table 16-3: Guideline values for evaluating vibration on buried pipework

Pipe material	Guideline values for velocity v_i (mm/s) measured on pipe
Steel (including welded pipes)	100
Clay, concrete, reinforced concrete, prestressed concrete, metal (with or without flange)	80
Masonry, plastic	50

Note: v_i refers to maximum vibration level in one axis only ie x, y or z direction.

16.3 EXISTING ENVIRONMENT

16.3.1 SITE DESCRIPTION

Background vibration levels

The current level of ground or air-borne vibration in the vicinity of the Project location is negligible as no regular blasting operations are known to be carried out in the area. Vibration levels from traffic using the Leichhardt Highway are expected to be low except potentially in locations immediately adjacent to the highway. Baseline vibration measurements were therefore not considered necessary and accordingly, were not undertaken.

Geotechnical properties

Overburden in the Project area has a weak weathered surface zone between 8 and 25 m thick overlying medium strength, bedded but sparsely jointed siltstones and mudstones to the coal.

Minor high strength calcite cemented bands have been observed in some drill holes but are not expected to affect the overall blasting characteristics of the overburden. Coal and parting materials are also of modest strength, with interburdens marginally stronger than the fresh overburdens. Further details of the geotechnical properties of the site are provided in Chapter 9 Geology, Mineral Resources, Overburden and Soil.

Groundwater

Relatively dry conditions are expected to be encountered in most pits other than from water derived from direct rainfall. However, some mining pits may receive drainage from nearby saturated zones of alluvium leading to some groundwater being encountered in blast holes in isolated areas. Further details of the groundwater properties of the site are provided in Chapter 10 Groundwater.

16.3.2 SENSITIVE RECEPTORS

A number of sensitive receptors, using the Blasting Guideline definition, currently exist in the vicinity of the Project area. These sensitive receptors are:

- the Wandoan Township
- the Telstra communications tower
- the Wandoan cemetery

- local houses and farm buildings
- an abattoir
- services, including roads, power lines and pipelines
- groundwater bores.

Sensitive receptors from a blasting perspective are presented in Table 16-4. A plan showing the locations of these sensitive receptor groups is shown in Figure 16-1-V1.3.

Table 16-4: Sensitive receptors and their Lot location

Receptor	Lot	Plan	Receptor type
—	—	—	Wandoan Township
MLA-47	Lot 156	FT931	Telstra communications tower
MLA-705	Lot 113	FT617	Wandoan Cemetery
MLA-374 and MLA-367	Lot 111	FT487	a house and shed complex
MLA-595 and MLA-596	Lot 38	AB188	a house and shed complex
MLA-355	Lot 38	CP899702	a house
MLA-361	Lot 38	CP899702	a house
MLA-309, MLA-298, MLA-301 and MLA-303	Lot 45	FT497	a house and three shed complex
MLA-552 and MLA-551	Lot 16	FT1012	a house and shed complex
MLA531, MLA-541, MLA-548 and MLA-554	Lot 6	FT788	four sheds (feedlot)
MLA-505 and MLA-578	Lot 6	FT788	a house and shed complex
MLA-740 and MLA741	156 and 53	FT931	two shed complex (abattoir)

16.3.3 LEICHHARDT HIGHWAY

The Leichhardt Highway operates to the east of the mining lease application (MLA) 50230. The highway provides a connection for heavy transport to townships located to the north and south of Wandoan. The highway is suitable for heavy vehicles such as road trains and AB triples. These vehicles would generate various levels of vibration mainly in the road reserve areas.

16.4 DESCRIPTION OF PROPOSED DEVELOPMENT

16.4.1 MINING METHOD

Details of the mining methodology are provided in Chapter 6 Project Operations, but can be summarised as overburden removal by draglines or excavators and trucks, with coal being removed by excavator or front end loaders and trucks. Most overburden and thick interburdens will require blasting prior to excavation.

Blasting will be used to prepare the in-situ rock (overburden and interburden) for excavation. The rock has to be broken into fragments that are small enough for the dragline or excavator to load and handle efficiently. In addition, the resulting blasted overburden must be of sufficient looseness to allow the dragline or excavator bucket to

readily work through the blasted overburden to fill its bucket. The principle blasting objective will be to generate looseness in the overburden to avoid unnecessary damage to the underlying coal or adjacent pit wall.

The average depth of overburden, over the upper coal zone is between 15 m to 30 m over much of the coal within the Project area. Pits will therefore initially be quite shallow and will involve mining a thick coal and interburden zone. A number of pits will progress to a two seam operation that will involve overburden/interburden thicknesses in excess of 50 m.

The coal seams and thin partings within the coal zone area are not planned to be blasted.

16.4.2 BLASTING OPERATIONS

Overall, the Project overburden and interburden should require modest blasting intensity to achieve satisfactory excavation performance. Powder factors between approximately 0.3 kg/bank cubic metres (bcm) and 0.4 km/bcm are expected to provide adequate blast breakages and movement. In comparison, typical powder factors in the Bowen Basin are 0.4 kg/bcm to 0.6 km/bcm.

Cast blasting, as is often used in dragline strip mines, is not planned for the Wandoan operations.

16.4.3 BLAST DESIGNS

Overburden and interburden blasts

Table 16-5 summarises the nominal blast designs prepared for the Project overburden and interburden blasts. ANFO explosives were assumed for all blasts. The assumptions and factors considered in the blast design are provided in TR 16-1-V1.5.

Table 16-5: Nominal blast designs for Wandoan overburden and interburden

Bench height m	Hole diameter mm	hole angle deg	Stemming m	stand off m	Deck air m	Charge per hole kg	Burden m	Spacing n	Powder factor kg/bcm
3	127	90	2.0	0	0	10	2.8	3.2	0.38
5	127	90	2.5	0	0	26	3.5	4.0	0.37
7.5	165	90	3.5	0.5	0	61	4.5	5.2	0.35
10	165	90	3.5	1	0	95	5.0	5.8	0.33
15	229	70	5.0	2	0	295	7.0	8.7	0.32
20	229	70	6.5	2	0	422	7.5	9.0	0.31
30	270	70	8.0	2	0	1011	9.0	12.0	0.31
40	270	70	8.0	3	0	1455	10.0	12.0	0.30
50	270	70	8.0	3	3	1809	10.0	12.0	0.30

Coal and partings

The coal seams and minor partings within the coal zone are not expected to be blasted. Where excavating without blasting is not possible, a bulldozer will be used to rip and loosen the material for excavation.

Highwall control

Overburden and interburden blasts will need to be controlled to avoid damage to the new highwall formed by the excavation of the blasted material. It is common practice in Australian open pit dragline mines to initiate a pre-split blast on the alignment of the new highwall to create a fracture line to which the dragline can excavate.

Pre-split blasts are most effective in brittle, massive rock. While Wandoan rock is massive, it is also relatively soft and not particularly brittle. The overburdens are therefore unlikely to pre-split effectively, particularly where the weathered material is within the upper 10 m to 25 m of most pits. The shallow stable bench angles in the deeper walls prevent blast holes being drilled on the alignment of the wall, again making pre-splitting inappropriate.

The new highwall will therefore be formed by placing in-fill holes in the back of the blast and modifying the charge placement and initiation timing to control any damage to the new highwall. As pre-split blasts are often the greatest source of noise and vibration at a mine site, this proposed measure will reduce the potential for blasts to generate environmental nuisance from airblast overpressure or ground vibrations.

16.4.4 GAS PIPELINE

The delivery of a reliable source of suitable gas is required in the event that the Proponent decides that an on-site power generation option is the preferred source of power for the Project. CSM gas from the nearby Peat-Scotia lateral gas pipeline has been identified as the preferred fuel source for a proposed on-site gas fired power station.

The proposal involves the construction and operation of a 24 km high pressure gas supply pipeline which will connect into Santos' Scotia Plant (located on Lot 22 on RP847424). The pipeline will be co-located with and run parallel to the eastern edge of the proposed Surat Basin Rail easement for approximately 18 km before entering MLA 50230.

The proposed gas supply pipeline will generally be underground with approximately 0.5 to 1.2 m of cover and constructed via a section trench and backfill method.

16.5 POTENTIAL IMPACTS

16.5.1 CONSTRUCTION

Mine

No blasting is likely to be required for the construction phase. Construction activities with the potential to cause vibration are limited to those associated with development of infrastructure such as the rail spur, the gas pipeline and transport of heavy equipment. Ground vibration impacts are expected to be low as a result of these activities.

Gas supply pipeline

As detailed construction methods and earthworks schedules are not available at this stage, vibration levels have been predicted from typical construction activities associated with pipeline construction. The majority of the generated vibration will be from excavation and compacting activities.

Vibration levels from construction activities should not exceed the allowable levels due to large propagation distance between the source and receptor (minimum distance between receptor and pipeline route is 570 m). Typical vibration PPV levels from construction equipment are shown in Table 16-6 including a predicted vibration transmission at a distance of 100 m. The predicted values satisfy the criteria for allowable human vibration and effects of vibration of structures as outlined in Section 16.2.3.

In instances where the proposed pipeline is to traverse or intersect existing pipelines or other infrastructure easements, exact specifications of the infrastructure being affected will be acquired from the respective operator to identify if any potential vibration issue will arise. It is not expected that significant changes in the construction methodology will be required in those areas. However, lower vibration construction techniques will be implemented if required.

Table 16-6: Typical vibration levels from construction activities

Equipment	PPV (mm/s) at 10 m*	Predicted PPV (mm/s) at 100 m
Loader (breaking kerbs)	6 – 8	0.19 – 0.25
15t roller	7 – 8	0.22 – 0.25
7t compactor	5 – 7	0.16 – 0.22
Roller	5 – 6	0.16 – 0.19
Pavement breaker	4.5 – 6	0.14 – 0.19
Dozer	2.5 – 4	0.08 – 0.13
Backhoe	1	0.03
Jackhammer	0.5	0.02

* Source: *RTA Environmental Noise Management Manual 2001*

Road traffic

As discussed in Section 16.3, the Leichhardt Highway is a major transport route. Traffic levels will increase during the construction phase including some traffic related to heavy lifts. Heavy lifts will be undertaken intermittently, and almost exclusively during the construction phase. However, infrequent heavy lifts will occur during the operations phase. Accordingly, potential vibration impacts during the construction phase are considered to be low. Further information on the construction phase and transportation can be found in Chapter 5 Project Construction and Chapter 12 Transportation.

16.5.2 OPERATIONS

The main source of vibration generated during the operations phase will be from blasting. Other potential sources of vibration include coal trains and the coal handling and preparation plant (CHPP) operations and infrequent periods of heavy lifts.

Ground vibration

Blasts to be fired in the Wandoan mining operation will require a wide range of bench heights, blast hole diameters and charge weights. Blasts in shallow benches will inevitably be more confined than blasts in higher benches for the dragline, where the free face can be used to advantage. Table 16-7 summarises inputs to the estimation of ground vibration for a range of Wandoan blast designs. Also shown is the distance at which nine out of 10 blasts should generate 5 mm/s PPV or less.

Table 16-7: Summary of PPV calculations for distance to 5 mm/s

Bench height (m)	Charge per hole (kg)	Holes per delay	MIC (kg)	Distance to 5 mm/s (m)
3	10	6	60	231
5	26	6	156	372
7.5	61	5	305	448
10	95	5	475	540
15	295	4	1,180	754
20	422	4	1,688	861
30	1,011	4	4,044	1,131
40	1,455	4	5,820	1,357
50	1,809	4	7,236	1,513

As a guide, these distances can be plotted against bench height to enable a simple estimate of the distance to the limiting vibration value for a blast in any bench height as shown on Figure 16-2. The bumps in the curve result from the step changes in assumptions used for different blast designs.

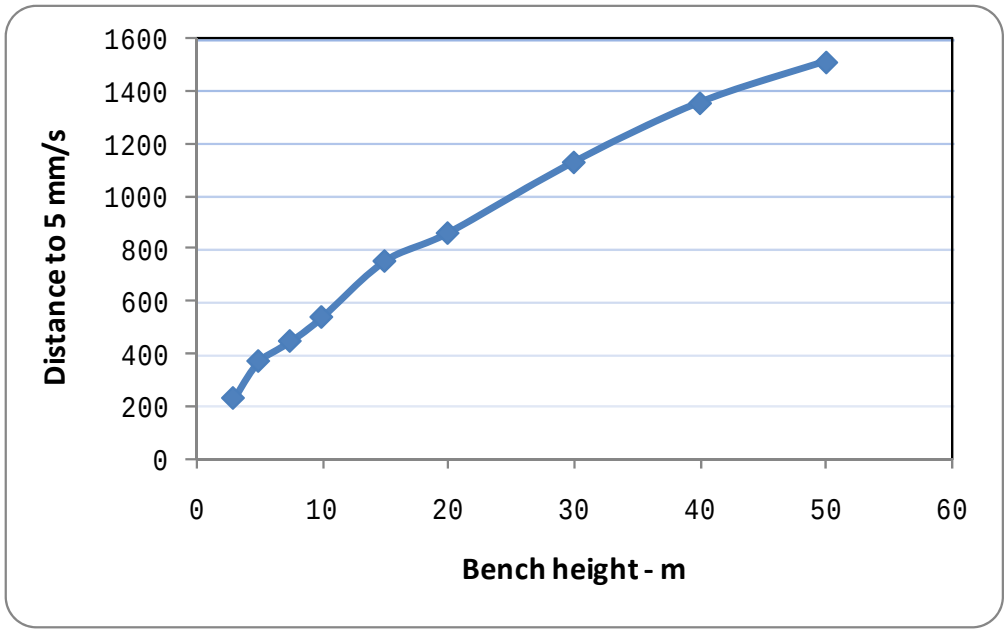

Figure 16-2: Relationship for simple estimation of distance to 5 mm/s PPV

Airblast overpressure

Table 16-8 summarises inputs to the estimation of airblast overpressure for a range of Wandoan blast designs. Also shown is the distance at which nine out of 10 blasts should generate no more than 115 dB (linear) and 120 dB (linear).

Table 16-8: Summary of airblast overpressure calculations

Bench height (m)	Charge per hole (kg)	Holes per delay	MIC (kg)	Distance to 115 dBl (m)	Distance to 120 dBl (m)
3	10	6	60	423	284
5	26	6	156	582	391
7.5	61	5	305	727	489
10	95	5	475	843	567
15	295	4	1,180	1,142	768
20	422	4	1,688	1,287	865
30	1,011	4	4,044	1,722	1,157
40	1,455	4	5,820	1,944	1,307
50	1,809	4	7,236	2,090	1,405

As a guide, these distances can be plotted against bench height to enable a simple estimate of the distance to the limiting airblast overpressure value for a blast in any bench height as shown on Figure 16-3. The bumps in the curve result from the step changes in assumptions used for different blast designs.

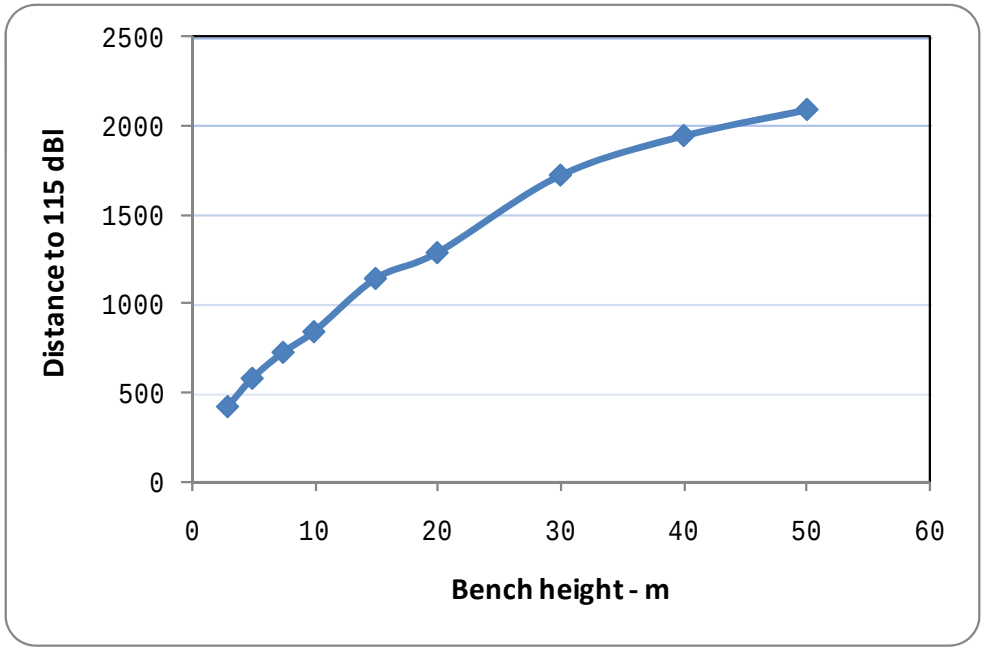

Figure 16-3: Relationship for simple estimation of distance to 115 dBl airblast overpressure

Blasting impacts

As shown in Table 16-7 and 16-8, the distance to the recommended airblast overpressure is greater than the distance to the recommended ground vibration limit. This means that if the airblast overpressure criteria are satisfied, then the ground vibration will also be within the requirements.

Unmitigated impacts from blasting are predicted to exceed the recommended EPA Guideline limits as discussed in Section 16.2.1 at a number of sites, as discussed in the following sections.

Leichhardt Highway and Wandoan Township

The Leichhardt Highway has been adopted as representing the boundary of Wandoan Township, which is regarded as a single sensitive receptor site. Based on the proposed mining plans, the limits for ground vibration and airblast overpressure both cross the highway adjacent to the central area of the Frank Creek Pit. Figure 16-1-V1.3 indicates that the airblast overpressure limit from dragline operations in Frank Creek Pit are likely to be exceeded in the western half of the Township in Year 5 of the Project. The use of truck and excavator operations in the north east portion of Frank Creek Pit reduce the airblast overpressure limit within Wandoan to within the EPA Guideline limits, as shown in Figure 16-4-V1.3.

Telstra communications tower

A Telstra regional communications tower is located approximately 300 m from the final highwall planned for the Frank Creek Pit. At this distance the tower could be exposed to ground vibrations of approximately 40 mm/s PPV at frequencies between 30 and 100 Hz

during the fifth year of the Project. However, the reduced bench height at Frank Creek Pit required to limit the airblast overpressure in the township will significantly reduce the vibration levels experienced by the Telstra Tower. The PPV should reduce to approximately 10 mm/s with frequencies likely to remain above 15 Hz. Monitoring prior to the commencement of mining in Frank Creek pit and discussions with Telstra will be undertaken to determine what mitigation or protection measures are required.

Wandoan Cemetery

The Wandoan Cemetery is about 1,200 m from the north end of the Leichhardt Pit and may receive airblast levels between 115 dB (linear) and 120 dB (linear) from the blasting operations in the northern area of the Leichhardt Pit. This area is scheduled to be mined during Years 13 to 18 of the Project schedule. Blasting will be scheduled not to interfere with the operations of funeral services.

Houses and associated infrastructure

Table 16-9 identifies eight sensitive receptor sites lying outside the Project's MLAs that are predicted to experience airblast overpressures greater than EPA (2006) limits. The receptors are shown in Figure 16-1-V1.3. Where the receptors consist of a house and sheds complex, only the house receptor number (the first number in each line of the table below) is shown on the figure.

Table 16-9: Sensitive receptors potentially affected by the Project blasting operations

Receptor number	Receptor type	Distance to closest Project blasting area (m)
MLA-374 and MLA-367	A house and shed complex	Approximately 1,000 m north of the Austinvale North Pit
MLA-595 and MLA-596	A house and shed complex	Approximately 900 m south west of the Turkey Hill Pit
MLA-355	A house	1,500 m south of the Mud Creek Pit
MLA-361	A house	2,000 m south of the Mud Creek Pit
MLA-309, MLA-298, MLA-301 and MLA-303	A house and 3 shed complex. Owned by WJV.	1,500 m west of the Woleebee Creek Pit
MLA-552 and MLA-551	A house and shed complex	1,900 m south west of the Woleebee Creek Pit
MLA-531, MLA-541, MLA-548 and MLA-554	Four sheds (feedlot)	900 m south west of the Woleebee South Pit
MLA-505 and MLA-578	A house and shed complex	500 m south east of the Woleebee South Pit

Mine Infrastructure Area, powerlines, pipelines, railway and bores

Circumstances will arise within the MLAs area and within the Mine Infrastructure Area (MIA) where the Project's facilities will be subjected to ground vibrations or airblast levels above those recommended by the EPA Guideline for disturbance caused by noise and vibration from blasting. These circumstances can be readily managed by the WJV but this may involve some temporary disruptions to normal production and business activities.

The mine's Blast Management Plan will need to ensure that mine electrical equipment is isolated and checked following near-by blasts.

The EPA criteria are based on nuisance to persons and not damage to structures or services. Richards and Moore (2002), Siskind *et al.* (1980) and many others have found that physical damage to common structures is highly unlikely for blast vibration levels below 50 mm/s. This is 10 times the EPA Guideline limit for 9 out of 10 mine blasts. Services such as powerlines, pipelines and water bores will not be damaged by mine blasts even though some may be within the distance required to meet the EPA Guideline recommendations to avoid nuisance to persons.

A search of international technical literature has found little reference to damage to groundwater bores from mine or construction blasting. Some structured studies were conducted by the U.S. Bureau of Mines adjacent to coal mines in the Appalachia Mountains in response to public concerns (Berger, P.R. 1980). Their detailed investigations and site test work found no clear evidence of any affect on the stability or performance of water wells or bores, but did identify a number of likely (non-blasting) factors that may have affected well performance. The successful use of dewatering bores in close proximity to many coal and metalliferous mines is a clear indication that they are not particularly vulnerable to damage from near-by blasting.

Loads imposed by vibrations from mine blasts on infrastructure elements such as railway lines, pipelines and power lines are found to be much lower than the loads they experience in normal use and hence pose no threat to their safety or functionality (Siskind, D. *et al.* 1994).

As such services such as power lines, pipe lines, groundwater bores, roads or railways outside the MLAs will not be at risk of damage from the Project's blasting operations.

Coal train impacts

Coal trains accessing and exiting the Project site along the spur line from the proposed Surat Basin Rail Project line may produce intermittent ground vibration impacts. The proposed route is close to Sensitive Receptors MLA-374 and MLA-367 (a house and shed complex). The WJV are already in negotiations with the landowner for the purchase of this property.

Fly rock

The recommended exclusion zone for persons around a mine blast is 600 m. The Leichhardt Highway is located approximately 500 m from Frank Creek Pit. Blasting will not be conducted within 600 m of the Leichhardt Highway as shown in Figure 16-4-V1.3.

Road traffic impacts

There will be additional traffic on the Leichhardt Highway during the operations phase of the Project. The traffic will essentially consist of light vehicles and delivery trucks. In addition, there will be intermittent heavy lifts using heavy vehicles.

Overall, given that the Leichhardt Highway is an ongoing source of heavy vehicles (such as road trains), and that the main contribution of vehicles will be light vehicles, the potential vibration impacts from road traffic during the operation of the mine are considered to be low.

Accordingly, vibration levels are not expected to significantly increase.

Dragline impacts

The Project will potentially operate multiple draglines across the site. There is very limited potential for draglines to produce vibration. Given that they will operate within mine pits (well away from sensitive receptors) and given the very low levels of vibration generated, draglines are not considered a significant source of vibration.

CHPP and conveyor impacts

The Project will operate a CHPP and conveyor system to move and wash product. Given the distance of these facilities from sensitive receptors and the relatively low level of vibration generated, it is considered unlikely that the CHPP or conveyor operations will impact on sensitive receptors.

Pipeline impacts

No vibration levels are expected to be associated with the operational phase of the pipeline.

16.6 MITIGATION MEASURES

16.6.1 CONSTRUCTION

No significant impacts associated with vibration are anticipated during the construction stage with either the mine or the gas pipeline. Accordingly, no specific mitigation measures are proposed.

16.6.2 OPERATIONS

Given the extent of this Project and the scattered distribution of receptors, a combined approach to vibration impact management has been adopted which will include management of impacts on site along with the use of site design and operational controls. Such a strategy will provide the most efficient method in mining areas close to residents while minimising impacts.

Triggers for management actions

As discussed in Section 16.5, the main potential source of vibration comes from blasting. The EPA Guideline establishes the criteria for acceptable levels of vibration and noise from blasting activities, as discussed in Section 16.2.1. Where monitoring indicates airblast overpressure levels are likely to exceed EPA limits, a trigger action response protocol (TARP) will be implemented, including a review of blasting procedures and other operational controls. If blasting impacts at a sensitive receptor cannot be mitigated to

comply with the Blasting Guideline, negotiation to purchase or relocation will be considered.

Ground vibration

The distance to the point where the ground vibration from a blast meets the Blasting Guideline recommendations always lies inside the distance required to meet the airblast overpressure requirements. Mitigation measures have therefore been focussed on meeting the airblast criteria, as this means that the ground vibration requirements will be readily achieved.

Airblast overpressure

Housing and associated infrastructure

Table 16-9 identifies eight sensitive receptor sites lying outside the Project's MLAs that are predicted to experience airblast overpressures greater than Blasting Guideline limits. The following actions are under consideration and will involve consultation with the relevant landowners with a view to achieving the following:

- negotiate an arrangement with the landowner regarding the abattoir (located on MLA-740 and MLA-741, three shed complex) prior to commencement of mining of Frank Creek Pit
- complete negotiation of an arrangement with landowners regarding purchase or relocation of MLA-374 and MLA-367 prior to commencement of mining in Austinvale North Pit
- sensitive receptors MLA-309, MLA-298, MLA-301 and MLA-303 (house and three shed complex) have already been purchased, so no additional actions required
- complete negotiation of an arrangement with landowners regarding purchase or relocation of MLA-552 and MLA-551 (house and shed complex) prior to the commencement of mining in Woleebee Creek Pit
- complete negotiation of an arrangement with landowners regarding purchase or relocation of MLA-355 and MLA-361 prior to commencement of mining in Mud Creek Pit
- reassess the potential impacts from blasting on MLA-595 and MLA-596 (house and shed complex) based on operational blasting experience gained prior to commencement of mining in Turkey Hill pit
- reassess the potential impacts from blasting on the feedlot (Receptors MLA-531, MLA-541, MLA-548 and MLA-554) and receptors MLA-505 and MLA-578 (house and shed complex) based on operational blasting experience, gained prior to the commencement of mining of Woleebee South Pit
- truck and excavator operations will be used for overburden removal in the north-eastern quarter of Frank Creek Pit. This may involve working benches as low as 7.5 m in height using 127 mm diameter blast holes to limited airblast overpressure to below 115 dB (linear) at the Leichhardt Highway. Drilling and blasting of overburden will be limited in the north eastern quarter.

The Cemetery

- airblast and vibration levels will be monitored as operations approach the Wandoan Cemetery
- blasting operations will be managed to ensure that the airblast overpressure and ground vibration levels do not exceed the allowable limits at the cemetery
- condition surveys of the cemetery structures will be undertaken prior to mining of Frank Creek West Pit, and three monthly during mining in the vicinity of the Cemetery to monitor any changes that might be identified
- the WJV will liaise with the managers of the Cemetery and seek community feedback via the Community Reference Group to manage the nuisance impact of blasts to those visiting the cemetery.

Telstra tower

- Discussions to date with Telstra and their engineering representatives have indicated that vibrations may have more of an impact on the equipment within the Telstra building at the base of the tower mast. Discussions will continue to be undertaken with Telstra and its representatives to determine whether the Telstra regional communication tower will be affected by the blasting operations and what mitigation or protection measures may be required.

Mine infrastructure

- Potential impacts and inconveniences from blasting to mine infrastructure and services within the MLAs will managed through the mine's operating protocols and Blast Management Plan. Similar services outside the MLAs area should not be at risk of damage from the mine's blasting operations.

Coal trains

- As no other significant vibration impacts related to coal trains operating on the rail spur are anticipated, no specific mitigation measures are proposed.

Road traffic

- As no significant vibration impacts related to road traffic associated with the Project operations are anticipated, no specific mitigation measures are proposed.

Draglines

- As no significant vibration impacts related to draglines operating on the site are anticipated, no specific mitigation measures are proposed.

CHPP and conveyors

- As no significant vibration impacts related to the CHPP and/or conveyors are anticipated, no specific mitigation measures are proposed.

Gas pipeline

- As no significant vibration impacts related to the gas pipeline operating on the site are anticipated, no specific mitigation measures are proposed.

Fly rock

- The recommended exclusion zone for persons around a mine blast is 600 m.
- Blasting will not be undertaken within 600 m of the Leichhardt Highway, as shown on Figure 16-4-V1.3.

Monitoring

Blast monitoring

- management will routinely monitor and report on the performance of blasting operations
- the locations and techniques selected for routine monitoring will be based on any community feed-back on performance and will comply with the requirements of AS 2187
- the data should be used to develop local predictive models of these impacts so that blast designs can be tuned to minimise their impacts and improve production performance
- the monitoring program, data analysis, reporting and modelling will form an integral part of the Blast Management Plan recommended under Australian Standard 2187.2
- the Blast Management Plan will include procedures that will avoid blasting in unfavourable weather conditions such as during heavy cloud or rain, adverse winds or during temperature inversions.

Complaints management

To manage any complaints, a site hot line will be established for residents who wish to report blasting related incidents associated with the operation of the Project. In addition the following commitments are made:

- all blasting related complaints will be investigated
- strategies and targets based on the regular review of blasting monitoring results and review of any blasting complaints will be undertaken as part of the site's Environmental Management System requirements.

Blast Management Plan

The Blast Management Plan will detail performance objectives, actions and procedures and be prepared prior to the Project's operations phase and incorporate the above measures. The Plan will incorporate the actions listed in Section 16.6.2. The Plan will be reviewed at least on a six monthly basis.

16.7 RESIDUAL IMPACTS

The mitigating measures described in Section 16.6 reduce the ground vibration and airblast overpressure levels experienced by each sensitive receptor outside the MLAs to within the EPA Guideline recommendations. The distance to the 115 dB (linear) airblast

level resulting from these measures is shown on Figure 16-4-V1.3. The Wandoan Township lies outside the affected area.

The distance to the limiting ground vibration level of 5 mm/s lies approximately 70% of the critical distance required to manage the airblast effects. The ground vibration levels experienced by any sensitive receptor will therefore meet the EPA Guideline requirements.

On this basis the blasting operations at Wandoan should meet all of the required environmental targets.

16.8 REFERENCES

Australian Standard 2187.2 – 2006, *Explosives – Storage and Use, Part 2: Use of explosives*, Standards Australia.

Barrett, S., Morphet, R., 2008, *Geotechnical Evaluation for Open Pit Mining – Wandoan Coal Project, Wandoan, Queensland,* Golder Associates.

Berger, P.R., 1980, Survey of blasting effects on ground water supplies in Appalachia, United States Department of Interior, Bureau of Mines, Philip R. Berger & Associates.

Environmental Protection Agency (EPA) 2006, *Guideline Noise and vibration from blasting*, Queensland Government, Brisbane.

Golder Associates, 2008, *Geotechnical evaluation report for open pit mining, Wandoan Coal Project*. Golder Associates Pty Ltd.

Richards, A.B., Moore, A.J., 2002, *Structure Response to Blast Vibration*, Australian Coal Association Research Program Project C9040, Terrock Consulting Engineers.

Siskind, D.E., Stag, M.S., Kopp, J.W., Dowding, C.H., 1980, *Structure response and damage produced by ground vibrations from surface blasting,* USBM RI 8507.

Siskind, D.E., Stochura, V.J., Stag, M.S., Kopp, J.W., 1980, Structure response and damage produced by airblast from surface blasting, USBM RI 8485.

Siskind, D. et al., 1994, *Surface mine blasting near pressurised transmission pipelines*, US Bureau of Mines Report of Investigation.