CHAPTER 17
AIRBLAST AND VIBRATION

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Subject to that declaration:

(a) in writing this document, Iron Road Limited has relied on information provided by specialist consultants, government agencies, and other third parties. Iron Road Limited has reviewed all information to the best of its ability but does not take responsibility for the accuracy or completeness; and

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17 Airblast and Vibration

Members of the community living in the vicinity of the proposed mine enjoy a high level of amenity due to minimal noise and vibration sources. Road traffic, existing railway operations and agricultural machinery are expected to be the main sources of human-induced noise and vibration. The proposed mining operation will introduce new sources of noise and vibration to the project area, including airblast (pressure waves produced by blasting and transmitted through the air) and ground vibration from blasting as well as ground vibration caused by operation of plant and equipment.

The impact of noise due to construction, operation and closure of the proposed mine, other than blasting noise (i.e. airblast), is addressed in Chapter 16, as separate assessment methods and criteria apply to these noise sources compared with blasting noise.

This chapter describes how the introduction of blasting operations and other vibration sources would affect sensitive receiver locations. It provides a comparison of the predicted airblast and vibration levels against blasting and vibration criteria derived from Australian Standards and other relevant sources. The design measures and management strategies that have been incorporated into the project to minimise impacts from noise and vibration caused by blasting and other types of vibration, are described. Risks associated with project-related noise and vibration sources that could reasonably occur as a result of uncertainty in the impact assessment process during construction, operation and closure of the proposed mine site are also considered.

The Environmental Noise and Vibration Assessment technical report is provided in Appendix L.

17.1 Applicable Legislation and Standards

The following standards and guidelines provide criteria to be met regarding blasting and vibration:

- Australian Standard AS 2187.2-2006: Explosives – Storage and use Part 2: Use of explosives (AS 2187.2-2006)
- Assessing Vibration: a technical guideline (DEC 2006)

17.1.1 Blasting Criteria

Ground vibration and airblast are potential effects of blasting. Ground vibration from blasting is due to the movement of mechanical energy within the rock mass or soil. Airblast is the pressure wave produced by the blast and transmitted through the air. Studies and experience show that well-designed and controlled blasts are unlikely to create ground vibrations of a magnitude that cause damage to buildings or structures. Airblast is generally the cause of more complaints than ground vibration.

AS2187.2-2006 specifies requirements for the safe use of explosives, including the mixing, testing, initiation and firing of charges. It provides background information, guidelines for measurement and criteria for peak levels of ground vibration and airblast.

For the purposes of blasting works, the relevant ground vibration and airblast criteria from AS2187.2–2006 are the human comfort criteria for sensitive sites (e.g. houses), for blasting operations lasting longer than 12 months or more than 20 blasts, as is specified in Table 17-1. These criteria are more stringent than the criteria aimed at preventing damage to buildings, meaning that if these criteria are met, no damage to existing buildings or infrastructure would be expected.

Table 17-1 Ground Vibration and Airblast Criteria for Blasting

Category	Criteria
Ground vibration	Peak component particle velocity of 5 mm/s at sensitive receiver locations for 95% of blasts per year. Maximum of 10 mm/s unless agreement is reached with the occupier that a higher limit may apply.
Airblast	Peak sound pressure level of 115 dBL at sensitive receiver locations for 95% of blasts per year. Maximum of 120 dBL unless agreement is reached with the occupier that a higher limit may apply.

17.1.2 Ground Vibration Criteria

The effects of ground vibration are separated into two categories:

- Human response - Vibration that inconveniences or possibly disturbs the occupants or users of a building.
- Structural damage - Vibration that impacts on the structural integrity of a building, such as causes cracks in plaster walls and masonry.

The vibration criteria for human response are more stringent than the vibration criteria for structural damage for buildings. Cosmetic or structural damage to buildings would only occur due to extreme vibration levels relative to what humans would find tolerable. For this reason the vibration criteria for human response is considered applicable for this assessment.

The SA EPA does not have a policy or guideline for human response or structural damage effects due to vibration. A number of SA Government guidance documents refer to the Australian Standard AS2670.2- 1990: *Evaluation of human exposure to whole-body vibration*; however, this standard was withdrawn in April 2014. For human response criteria, the NSW Department of Environment and Conservation (DEC) guideline titled *Assessing Vibration: a technical guideline* (DEC 2006) presents preferred and maximum vibration values for use in assessing human responses to vibration, derived from a *British Standard, BS 6472-1992, Evaluation of human exposure to vibration in buildings (1–80 Hz)*. DEC 2006 advises that there is a low probability of adverse comment or disturbance to building occupants at vibration values below the preferred values, as listed in Table 17-2.

Table 17-2 Preferred and Maximum Vibration Values for Use in Assessing Human Responses to Vibration

Location	Assessment Period Day Time (7:00 am – 10:00 pm) Night Time (10:00 pm – 7:00 am)	Preferred and Maximum Weighted RMS Vibration Values (mm/s)	
		Preferred Value	Maximum Value
Continuous Vibration			
Critical Areas	Day or Night	0.10	0.20
Residences	Day time Night time	0.20 0.14	0.40 0.28
Office, schools, educational institutions and places of worship	Day or night time	0.40	0.80
Workshops	Day or night time	0.80	1.6
Impulsive Vibration			
Critical Areas	Day or Night	0.10	0.20
Residences	Day time Night time	6.0 2.0	12.0 4.0

Location	Assessment Period Day Time (7:00 am – 10:00 pm) Night Time (10:00 pm – 7:00 am)	Preferred and Maximum Weighted RMS Vibration Values (mm/s)	
		Preferred Value	Maximum Value
Office, schools, educational institutions and places of worship	Day or night time	13.0	26.0
Workshop	Day or night time	13.0	26.0

17.2 Assessment Method

An environmental noise and vibration assessment was completed for the proposed mine which included prediction calculations for ground vibration and airblast due to blasting and assessment of potential ground vibration due to plant and equipment operation.

The assessment of impacts from blasting was completed in accordance with the methodology in AS 2187.2-2006 and the *Imperial Chemical Industries (ICI) Explosives Blasting Guide* (ICI Technical Services 1995).

The assessment incorporated the following tasks:

- Identification of potential vibration sources from the proposed mine.
- Determination of relevant standards and criteria including review of national and state legislative requirements and standards.
- Identification of sensitive receivers that may be affected by construction and operation of the proposed mine.
- Establishment of existing vibration conditions in the vicinity of the proposed mine.
- Literature review and collation of inputs required for the prediction modelling.
- Prediction of ground vibration and airblast due to blasting.
- Assessment of potential ground vibration from sources other than blasting.
- Comparison of the predicted levels with the relevant criteria.
- Modification of design or development of management measures to reduce predicted levels, if required.

For a more detailed description of the impact assessment methodology, refer to the Environmental Noise and Vibration Assessment technical report provided in Appendix L.

17.3 Existing Environment

This section discusses the existing noise and vibration conditions and the location of sensitive receivers within the project area.

17.3.1 Existing Noise and Vibration Sources

The existing noise environment was described in Chapter 16.

Heavy vehicles on the surrounding highways and local roads, agricultural machinery and existing railway operations are likely to be the main sources of vibration in the vicinity of the proposed mine site. The lack of human-induced noise and vibration in the existing environment is of value to local landowners and community members.

17.3.2 Sensitive Receivers

Sensitive receivers include locations outside the proposed mining lease boundary where people live or work and may be affected by noise and vibration from the proposed mine. This includes dwellings, schools, hospitals, business premises or public recreational areas. Sensitive receivers may include derelict or uninhabitable dwellings or buildings as the site may have existing user rights which would allow re-development.

The locations of sensitive receivers have been primarily determined by desktop assessment of aerial imagery and are subject to field and community verification. As the sensitive receivers have been identified at different stages of the project development and assessment, they are not sequentially numbered; however, the same sensitive receiver numbers are used for the same sites throughout the MLP and in the technical reports.

The sensitive receivers closest to the proposed mine are individual dwellings on agricultural properties located intermittently around the proposed mine site boundary, as well as the small township of Warramboo located approximately 750 m west (refer to Figure 17-1).

Any residential buildings within the proposed mine site were not taken into account in the noise and vibration assessment as the intent is for Iron Road or a subsidiary company to own all of the land within the mine site boundary prior to commencing works.

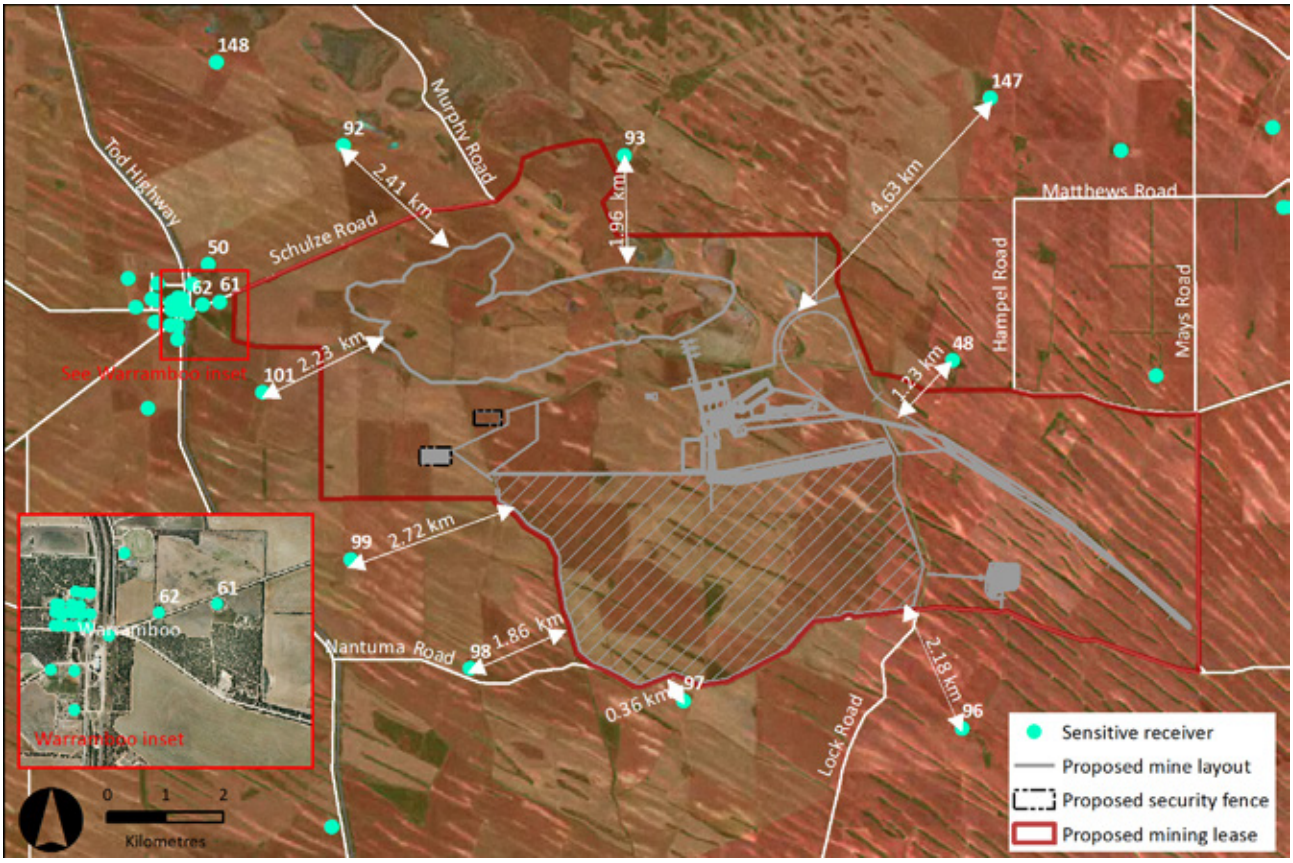

Figure 17-1 Distance from Sensitive Receivers to the Nearest Potential Noise and Vibration Source

17.3.3 Summary of Key Environmental Values

The proposed mine site is located in an area where sensitive receivers enjoy a high level of amenity due to minimal human-induced noise and vibration sources. Road traffic, existing railway operations and agricultural machinery are the main sources of human-induced noise and vibration. The quiet rural environment enjoyed by sensitive receivers is the key environmental value.

17.4 Context and Views of Affected Parties

The stakeholders relevant to airblast and vibration impacts include the local landowners and community, Wudinna DC, the EPA and DSD. Some members of the local community have raised concerns about the potential effects on rural amenity, quality of life and structural integrity of buildings as a result of the blasting operations and vibration from the 24 hour per day, 7 day a week operation of the proposed mine. Stakeholders are seeking the following outcomes in relation to airblast and vibration:

- No noise impacts from blasting (IM_17_04)
- No vibration impacts on buildings on land adjacent to the proposed mine site boundary (PIM_17_03)

All issues raised by stakeholders are presented in Chapter 5, Stakeholder Consultation and summarised in Table 5-8. Impacts and risks relevant to blasting and vibration and potential issues identified by stakeholders are discussed below and summarised in Table 17-5. All impact events are presented in the Impact and Risk Register in Appendix C.

17.5 Potentially Impacting Events

Considering the views and contexts of affected parties and the issues raised during technical studies, an assessment of Source, Pathway, Receptor (SPR) has been undertaken, as per the methodology outlined in Chapter 6, to determine which potential impact events are considered applicable to this project. Potential airblast and vibration impact events associated with the construction, operation and closure of the proposed mine that have a confirmed SPR linkage include:

- Vibration impacts from blasting operations on local residents (IM_17_01)
- Noise (airblast) impacts to local residents as a result of blasting operations (IM_17_04)

The impact and risk register presented in Appendix C provides confirmation of a source, pathway and receptor for each of the potential impact events (PIMs) and therefore follows each through as actual impact events (IMs) with a complete impact and risk assessment.

For airblast and vibration, a number of potential impact events (listed below) are not considered further as there is no confirmed linkage between source, pathway and receptor, as demonstrated in Appendix C. These include:

- Vibration impacts from construction and operational plant and equipment (excluding blasting) on local residents (IM_17_02).

  No SPR linkage was identified for vibration impacts on adjacent sensitive receivers from construction and operational plant and equipment used within the proposed mine site. Vibration caused by the type of plant and equipment proposed for use is known to be attenuated within short distances, therefore will be well below the ground vibration human response criteria and is unlikely to be perceptible outside the proposed mine site.

- Vibration impacts from blasting operations on structures located outside the proposed mine site (PIM_17_03).

  No SPR linkage was identified for vibration impacts from blasting on structures and buildings located outside the proposed mine site because the assessment found vibration levels from blasting will be well below the human comfort criteria for sensitive sites (e.g. houses), which is much more stringent than the structural damage criteria. Cosmetic or structural damage to buildings is only found to be due to extreme vibration levels, relative to what humans would find tolerable. As the human comfort blasting criteria will be met at all sensitive receiver locations, no damage to existing buildings or infrastructure would be expected.

17.6 Control Measures to Protect Environmental Components

This section identifies design measures and management or control strategies which will be implemented to mitigate the level of impact and risk associated with airblast and vibration.

17.6.1 Design Measures

The following design control measure has been incorporated to minimise the impacts and risks from blasting and vibration as a result of the construction, operation and closure of the proposed mine site:

- A reduced truck fleet is used with the proposed IPCC mining operation compared with conventional mining, thereby minimising noise and vibration from mobile equipment.

17.6.2 Management Strategies and Commitments

In order to minimise and mitigate impacts of airblast and vibration during construction, operation and closure activities, control and management strategies would be incorporated into the PEPR and implemented for relevant project phases. Key control and management strategies are outlined below in Table 17-3.

Table 17-3 Control and Management Strategies: Blasting and Vibration

Control and Management Strategies	Project Phase
Blasting procedures will be developed and implemented in accordance with AS2187.2-2006.	Operation
Initial noise and ground vibration monitoring will be performed to confirm compliance of the blasting operation with the airblast and ground vibration criteria.	Operation

17.7 Impact and Risk Assessment

This section identifies and assesses impacts and risks associated with airblast and vibration as a result of the blasting operations and heavy plant and equipment used during construction, operation and closure of the proposed mine. Impact events (confirmed by presence of a source, pathway and receptor) are those which are predicted to occur as a result of the development, whilst risk events would not be expected as part of the normal operation of the project, but could occur as a result of uncertainty in the impact assessment process. Although the risks may or may not eventuate, the purpose of the risk assessment process is to identify management and mitigation measures required to reduce the identified risks to a level that is as low as reasonably practicable (ALARP). This assessment has been undertaken in accordance with the methodology outlined in Chapter 6.

Impact and risk events were identified through technical studies and stakeholder consultation. Impact events can include multiple sources, pathways or receptors and where practical have been grouped together in discussions below to minimise duplication of information. Risks are events that would not be expected as part of the normal operation of the mine, but could occur as a result of either uncertainties with the impact assessment, or as a result of faults, failure of mitigation strategies or unplanned events. A summary of impact and risk events relating to airblast and vibration associated with blasting and heavy plant and equipment is presented in Table 17-5 at the end of this section (with Impact IDs). A complete register of all impact and risk events for the mine, considering source, pathway and receptor is provided in Appendix C.

Impacts and risks are assessed following the application of the design measures outlined in Section 17.6. Where required, management measures are proposed to reduce the impact to a level that is considered ALARP. Through the adoption of design modification or specific mitigation measures, all identified impacts and risks were categorised as low (or negligible) and considered ALARP. The key environmental risks would be monitored through the environmental management framework.

17.7.1 Ground Vibration and Airblast from Blasting

Ground vibration and airblast generated by blasting was predicted using the formula in *ICI Explosives Blasting Guide* (ICI Technical Services 1995).

The preliminary blasting plan for the proposed mining operation has estimated a maximum instantaneous charge (MIC) mass (that is the explosive charge mass of one blast hole only) of 983 kg per blast hole and 335 blast holes per detonation. Once all holes have been charged, they are connected together to explode in a certain sequence ('tied in'). Blasting is done on a hole-by-hole basis – no two holes are blasted at exactly the same time to ensure maximum efficiency in rock breakage, which in turn minimises vibration. It is proposed one blasting operation will be performed per day.

The prediction methodology of the airblast and ground vibration levels takes into account the MIC mass and distance between the blast site and sensitive receivers. The distance from the edge of the mine pit within which blasting will occur to the nearest sensitive receivers is approximately 1,950 m. Table 17-4 presents the ground vibration and airblast predictions based on a charge mass of 1000 kg (which represents a conservative estimate) as well as higher charge masses for comparison.

Table 17-4 Ground Vibration and Airblast for Blasting based on Various Blast Charges

Charge Mass (Kg)	Distance from Blast Site to Nearest Sensitive Receiver (m)	Predicted ground Vibration Level (mm/s) (Criteria is 5 mm/s)	Predicted Airblast Over Pressure (dBL) (Criteria is 115 dBL)
1000	1950	1.8	110
2000	1950	3.4	113
2500	1950	3.6	114
3000	1950	4.2	115

Table 17-4 demonstrates that the proposed blasting operation would comply with the relevant criteria, with blast charge mass volumes approximately one third of potentially compliant volumes.

Blasting procedures would be developed and implemented in accordance with AS 2187.2-2006 and ground vibration and airblast levels will not exceed the relevant criteria. Therefore it is considered that the impact of ground vibration and airblast due to blasting will be **low**.

There is a risk that the ground vibration and airblast levels due to blasting will be higher than predicted and exceed the blasting criteria due to incorrect procedures or faulty equipment during preparation, measurement or placing of the explosives. The consequence of incorrect procedures or faulty equipment is considered to be **minor** as it would result in a local and a minor exceedance of the blasting criteria. This is demonstrated by the predictions presented in Table 17-5 which indicate that the ground vibration and airblast criteria will still be met even if an error causes tripling of the MIC. It is considered **unlikely** that procedures or equipment would fail during a blasting operation as management of explosives is strictly regulated due to occupational health and safety risks of personnel. As the consequence is considered minor and likelihood is unlikely, the risk is considered to be **low**.

17.7.2 Summary of Impacts and Risk

With the implementation of design and management measures, all residual impacts have been categorised as low. Similarly, all risks have been reduced to a level of low that is considered to be ALARP and not warrant specific control measures, other than standard environmental management controls and measures previously outlined. A summary of each of the identified impacts and risks associated with vibration at the proposed mine site is presented in Table 17-5.

Table 17-5 Impact and Risk Summary: Vibration

Impact ID	Impact Event	Level of Impact[1]	Level of Risk[2]
IM _19_01	Vibration impacts from blasting operations on local residents	Low	Low
IM_17_04	Noise (airblast) impacts to local residents as a result of blasting operations	Low	Low

Notes:

1. Impact events are expected to occur are part of the project. Level of impact is assessed post control strategies, as per the impact assessment methodology provided in Chapter 6.

2. Level of risk reflects the risk that the assessment of impact is incorrect due to uncertainties in the assessment method, the control strategies, or in assumptions used. Risk is assessed post control strategies, as per the risk assessment methodology provided in Chapter 6.

17.7.3 Justification and Acceptance of Residual Impact and Risk

With the implementation of design and operational management measures, all impacts associated with blasting noise and vibration are considered to be low. Similarly, all risks have been reduced to a level of low. The impacts and risks are considered to be ALARP.

17.8 Proposed Outcome(s) and Criteria

In accordance with the methodology presented in Chapter 6, outcomes have been developed for all impact events with a confirmed linkage between source, pathway and receptor. Each outcome is supported by measureable assessment criteria that will be used to assess compliance against the proposed outcomes during the relevant phases (construction, operation, closure) of the mine. Proposed outcomes and measurement criteria have been developed for each of the impact events identified with a confirmed linkage and these are presented in Table 17-6 below. Outcomes for the entire project are presented in Appendix C.

Table 17-6 Outcomes and Assessment Criteria: Vibration

Proposed Outcome	Impact ID	Impact Event	Draft Outcome Measurement Criteria	Draft Leading Indicator Criteria
No adverse impact on public amenity from vibration or airblast caused by blasting.	IM _19_01	Vibrations from blasting operations impact on local residents.	Vibration levels as a result of blasting activities are less than 5 mm/s peak particle velocity at the nearest sensitive receiver for 95% of blasts per year, with a maximum of 10 mm/s peak particle velocity for any one blast, in accordance with AS2187.2-2006.	All complaints acknowledged in 48 hours and closed out within 14 days to the satisfaction of the complainant or as agreed with the Director of Mines.
	IM_18_04	Noise (airblast) impacts to local residents as a result of blasting operations.	Airblast levels as a result of blasting activities are less than 115 dBL sound pressure at the nearest sensitive receiver for 95% of blasts per year, with a maximum of 120 dBL for any one blast, in accordance with AS2187.2-2006.	All complaints acknowledged in 48 hours and closed out within 14 days to the satisfaction of the complainant or as agreed with the Director of Mines.

17.9 Findings and Conclusion

The assessment of airblast and vibration impacts due to the proposed blasting operation and plant and equipment-generated vibration has identified sensitive receivers potentially affected and determined predicted airblast and ground vibration levels at sensitive receiver locations. These have then been compared with relevant criteria.

The assessment of airblast and ground vibration impacts indicate that the relevant criteria would not be exceeded provided that blasting procedures are developed and implemented in accordance with AS2187.2-2006.

Proposed outcomes ensure that Iron Road will manage the impacts and risks of airblast and ground vibration to a level which is compliant with relevant standards and be as low as reasonably practicable.

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