7. HAZARDS AND RISKS TO HUMANS AND FACILITIES

The hazards and risks identified in this chapter consider those hazards and risks to humans and facilities that are considered to be possible, but unlikely to occur during the normal course of mining. Minemakers has adopted design, operating and control measures with the specific aim of preventing accidents associated with development and operation of the project. In addition, Minemakers will adopt the following general safeguards during the life of the project:

- Develop and implement emergency response plans (including spill response) and procedures for accidents and hazardous events.
- Develop and implement corporate and operational risk management plans.
- Conduct induction training and periodic refresher training for all employees and contractors on all aspects of safety and site-specific regulations concerning safety.
- Attend to government statutory compliance, notification and liaison requirements and procedures.

A hazard and risk assessment was conducted to identify and assess the key risks of each major component of the project to people (both project-related personnel and the general public), the mining operation, associated facilities and the environment. As part of the detailed design and initial site mobilisation phase, hazard and risk identification and hazard and risk operations workshops will be conducted to refine the assessment and incorporate further controls into final project design as necessary.

7.1 Hazard Identification

The hazard and risk assessment was based on experience gained by the project team in the development and operation of similar projects in similar environmental and social settings.

The assessment was conducted by examining the potential consequences (i.e., a measure of severity of the impact) and the likelihood that those impacts will occur. The assessment of ‘likelihood’ applied specifically to the resulting impact. Often a final impact results from a chain of events, each with an associated likelihood. These ‘conditional likelihoods’ were considered when determining the final likelihood of the impact occurring.

The risks were qualitatively evaluated, whereby a number of categories were used to describe the consequence of each impact and the likelihood of that impact occurring. As per the residual risk assessment in Chapter 6, a number of risk management assessment processes were evaluated (see Section 6.1) prior to determining the descriptors used for this assessment. The descriptors used in this assessment are a modification of those used in the Standards Australia’s HB 203:2006 (Standards Australia, 2006b) and the South Australian Guidelines for miners: preparation of a mining lease proposal or mining and rehabilitation program (MARP) in South Australia (PIRSA, 2009). These modified descriptors were chosen as they were considered to be most appropriate for the mining project (Table 7.1).

Table 7.1 Descriptors used to classify likelihood and qualitative measures of impact

Level	Descriptor	Detail of Description
Likelihood		
A	Almost certain	Is expected to occur in most circumstances, or is of a continuous nature, or likelihood is unknown.
B	Likely	Will probably occur during mine lifetime.
C	Possible	Could occur in most mines.
D	Unlikely	Could occur in some mines, but not expected to occur.
E	Rare	Occurs only in exceptional circumstances.
Consequence		
1	Catastrophic	Health – death or widespread health effects, or toxic release off-site with detrimental effect. Environmental – extreme permanent changes to the natural environment (not able to be practically or significantly rehabilitated or alleviated). Social – major public outrage. Financial – huge financial loss (greater than A$500 million). Or the consequences are unknown.
2	Major	Health – extensive injuries or significant staff numbers incapacitated resulting in a loss of production capability. Environmental – substantial and significant changes to the natural environment or only partially able to be rehabilitated or alleviated. Social – will attract public concern in wider community. Financial – major financial loss (A$100 to 500 million). Or changes will be substantial if cumulative effects are considered.
3	Moderate	Health – medical treatment required. Environmental – significant local changes, but can be rehabilitated or alleviated with difficulty at significant cost and with outside assistance. Social – will attract concern of adjoining community. Financial – high financial loss (A$10 to 100 million).
4	Minor	Health – first aid treatment required. Environmental – on-site release immediately contained very local consequence with no significant long-term changes or may be simply rehabilitated. Social – not of significant concern to wider community. Financial – medium financial loss (A$1 to 10 million).
5	Insignificant	Health – no injuries. Environmental – negligible environmental impact. Social – unlikely to be noticed by public. Financial – low financial loss (less than A$1 million)

The level of risk for each potential impact was then determined by combining consequences and likelihood using the risk matrix shown in Table 7.2.

Table 7.2 Qualitative risk analysis matrix

			Severity of Consequence				
			1	***2***	***3***	***4***	***5***
			Catastrophic	***Major***	***Moderate***	***Minor***	***Insignificant***
Likelihood of Consequence	***A***	***Almost Certain***	Extreme	Extreme	Extreme	High	High
	B	***Likely***	Extreme	Extreme	High	High	Moderate
	C	***Possible***	Extreme	Extreme	High	Moderate	Low
	D	***Unlikely***	Extreme	High	Moderate	Low	Low
	E	***Rare***	High	High	Moderate	Low	Low

The evaluation of residual risks was based on the findings from specific investigations carried out in support of the EIS, knowledge of the existing environment likely to be affected, experience at similar operations elsewhere, and professional judgement. It is expected that Minemakers will manage all residual risks to 'as low as reasonably practicable' (ALARP).

The hazard and risk assessment identified and evaluated 14 possible hazards to humans and facilities. Mitigation and prevention measures were developed for each identified hazard. Results of the assessment are shown in Table 7.3.

Two hazards were identified in the extreme-risk category. Eight hazards were identified in the high-risk category, one in the moderate-risk category and three in the low-risk category. The extreme risks identified fall into the extreme category as a result of their potential to cause fatalities. Management and mitigation measures will be implemented to reduce the likelihood of these events occurring to **unlikely**. However, because these events have occurred in other mines the likelihood cannot be reduced to **rare**. This in turn means that these risks are not unique to this operation and are common across all mining operations, and while they have been reduced to ALARP the likelihood and consequence still combine to generate an overall extreme risk.

The following sections discuss these risks in terms of whether they are existing risks at the site or new risks that are a direct result of the project.

7.2 Existing Risks

7.2.1 Uncontrolled Bushfire

Of the risks identified (see Table 7.3) only uncontrolled bushfire is an existing or pre-project risk to the site (Plates 7.1 and 7.2). It is possible that the project will increase the risk of uncontrolled bushfire because it will involve the storage and handling of flammable substances such as fuel that can lead to the generation of potentially explosive and/or flammable gas emissions. In addition, there is also a risk to the site from bushfires that may occur in the surrounding area. Potential environmental impacts from fire include fire-breakout into surrounding vegetation and release of significant quantities of emissions to air. Other potential impacts include injury and damage to property, potentially leading to shutdown of the crushing and screening plants, or cessation of mining activities.

Table 7.3 Hazard assessment

Hazard	Potential Consequence/ Impacts	Mitigation and Prevention Measures	Qualitative Risk Assessment		
			Likelihood	Consequence	Risk
Vehicle collision or roll-over.	Release of hydrocarbons or hazardous chemicals to the environment. Fire or explosion. Injury or fatality.	Comply with appropriate statutory standards for the transport of materials. Comply with project Traffic Management Plan. Adhere to speed limits and road rules. Develop emergency response plan (including spill response). Maintain all vehicles regularly.	Unlikely	Catastrophic	Extreme
Mobile mining equipment collision or roll-over.	Release of hydrocarbons. Injury or fatality.	Induct and train operators. Use flashing lights on equipment. Use night lighting.	Unlikely	Catastrophic	Extreme
Plane crash during fly in fly out operations.	Injury or fatality. Disruption to operations.	Comply with Civil Aviation Safety Authority requirements for airfields. Use a reputable operator.	Rare	Catastrophic	High
Uncontrolled bushfire.	Loss of native vegetation. Air emissions. Contaminated runoff from fire-fighting water enters watercourse. Injury. Damage to plant or machinery.	Comply with standards for the storage of flammable material. Maintain and test fire suppression equipment regularly. Train selected site personnel in use of fire suppression equipment. Develop and implement fire management plan and emergency response plan. Maintain appropriate fire breaks around fire-sensitive areas (e.g., fuel storage, accommodation, and infrastructure).	Unlikely	Major	High

Table 7.3 Hazard assessment

Hazard	Potential Consequence/ Impacts	Mitigation and Prevention Measures	Qualitative Risk Assessment		
			Likelihood	Consequence	Risk
Fuel spillage, fuel leakage or tank rupture.	Fire and explosion. Soil contamination. Surface water contamination. Groundwater contamination. Health hazard for humans and fauna.	Install storage tanks and bunding in accordance with relevant Australian Standards. Monitor fuel levels in tanks. Inspect tanks, pipes, connections and bunds regularly. Monitor soil and groundwater (if underground tanks). Conduct spill response training and locate and maintain spill response kits in appropriate areas. Develop waste management plan for contaminated materials. Develop emergency response plan (including spill response).	Likely	Moderate	High
Explosion.	Damage to plant or machinery. Release of emissions to air. Fire. Injury or fatality.	Comply with standards for the storage of explosives. Conduct regular audit and inspection of storage and handling procedures. Implement appropriate induction and training of staff required to handle explosives.	Rare	Catastrophic	High
Irrespirable atmosphere in confined spaces.	Crushing and screening plant shut-down. Injury or fatality.	Implement standard procedures for operating in confined spaces. Design crushing and screening plant to avoid confined spaces.	Rare	Catastrophic	High
Unauthorised site access.	Injury or fatality that could have been reasonably prevented.	Maintain secure site entrance. Install fencing where the pit is close to public roads.	Rare	Catastrophic	High

Table 7.3 Hazard assessment

Hazard	Potential Consequence/ Impacts	Mitigation and Prevention Measures	Qualitative Risk Assessment		
			Likelihood	Consequence	Risk
Incident involving Traditional Owners and mining operations as a result of sacred site access arrangements.	Injury or fatality.	Formal access arrangements. Education program to ensure Traditional Owners are aware of the dangers associated with mobile mining machinery and the operation in general.	Rare	Catastrophic	High
Pit wall failure due to seismic activity or geotechnical instability.	Disruption to operations. Injury.	Design pits slopes, bench heights and berms appropriately. Use artificial reinforcement of walls (e.g., rock bolts) where required. Implement stability monitoring, e.g., extensometer, ongoing geotechnical assessment.	Rare	Moderate	Moderate
Failure of waste rock storage.	Smothering of vegetation. Increase in sediment load to drainage lines and receiving waters. Injury. Potential damage to the Barkly Highway if failure occurs in the northern Main Zone area.	Appropriate design of storage. Locate storage in appropriate area. Use appropriate dumping practices. Manage surface water drainage. Develop recovery plan.	Rare	Minor	Low
Acid rock drainage (ARD) formation within the waste rock storages and pits.	Contaminated pit water injures wildlife. Contaminated pit water impacts groundwater aquifer.	Characterise geochemical conditions and manage accordingly. Analyse any accumulated pit water and if testing demonstrates ARD, conduct groundwater monitoring.	Rare	Minor	Low

Table 7.3 Hazard assessment

Hazard	Potential Consequence/ Impacts	Mitigation and Prevention Measures	Qualitative Risk Assessment		
			Likelihood	Consequence	Risk
Flooding as a result of extreme rainfall or flood event.	Disruption to operations. Flood water requiring disposal. Potentially contaminated pit water requires disposal. Potential for release of pit water into environment. Pit wall instability.	Monitor weather. Monitor pit water level. Ensure pumps are available in the event of major rainfall. Develop contingency plan for removal and disposal of large amounts of pit water.	Unlikely	Minor	Low
Reduced visibility for passing motorists due to airborne dust.	Vehicle collision. Injury or fatality.	Implement standard procedures for the minimisation of dust emissions and dust nuisance. Monitor dust emissions. Develop air quality environmental management plan.	Rare	Catastrophic	High

Detailed project design will address specific plant and infrastructure design criteria for fire prevention, detection, control and personnel safety requirements. Other measures to reduce this risk are detailed the project-specific Fire Management Plan and include:

- Appropriate induction and training of personnel.
- Procurement of fire fighting equipment adequate for the level of risk identified for the project and regularly maintained and tested to ensure good working order.
- Storage and handling of all substances, including waste, under conditions that minimise the risk of fire, explosion or toxic emissions.
- Implementation of specific procedures for high-risk tasks such as 'hot work' (e.g., welding) and use of chainsaws.
- Liaison regarding fire risk and management (e.g., Bushfires NT) and monitoring (e.g., fire danger ratings).

With the combination of project design and implementation of the Fire Management Plan, the likelihood of uncontrolled bushfire is **unlikely**. If uncontrolled bushfire were to occur, the potential environmental, social and health impacts could be **major**, giving an overall residual risk ranking of **high**.

7.3 New Risks

The remaining risks identified in Table 7.3, will be new risks as a consequence of mining operations beginning on-site. Each of these risks is discussed in greater detail below including control and mitigation measures to ensure risks are managed to be ALARP.

7.3.1 Vehicle Collision or Roll-over

Vehicles associated with the project may be involved in a road accident, potentially resulting in injury or fatality of drivers and other road users. There is potential for vehicles bringing fuel and other supplies to the site or carrying ore from the site to Tennant Creek to be involved in an accident. This could result in the release of hydrocarbons or other hazardous materials, with consequent adverse impacts on human health and the environment. The consequence of a vehicle collision or roll-over is therefore considered to be **catastrophic**, for the health criteria but considerably less for the other criteria as laid out in Table 7.1.

A project-specific Traffic Management Plan will be developed to set procedures targeted at limiting the potential for vehicle accidents. All vehicle operators will be trained and licensed appropriately for the vehicles they are operating, and will be inducted to ensure they are aware of the project-specific traffic management plan. Contractors will be required to comply with Minemakers' procedures and the relevant codes and standards for transport, storage and handling of hazardous materials, including emergency response. Contractors will be required to adhere to Northern Territory road rules at all times.

In addition to the above, any improvements to public roads or intersections used to transport ore to the multi-user hub will be engineered and constructed to ensure it meets all Northern Territory and Australian government design criteria. Appropriate signage will also be put in place to ensure

that other roads users are well aware of the potential for heavy vehicles to be entering and leaving the highway.

Fuel trucks will carry equipment necessary to respond to an accident that may result in a spill. Should fuel come into contact with surface drainage during the wet season, water quality will be monitored to ensure that the area is appropriately remediated, if necessary. In the event that ore is spilt during transport, the material will be recovered; given the geochemical and metallurgical properties of the ore it will not pose environmental risks should it be spilt, for further detail see Sections 5.3.3 and 5.3.4. The Minemakers Resident Manager and the relevant government authorities will be notified immediately of any spills during transport.

Through the implementation of the project-specific Traffic Management Plan and design and construction of road improvements, the likelihood of a vehicle collision or roll-over is **unlikely**. The overall residual risk ranking is therefore **extreme**.

Considering the inherent risk that all road users accept in day-to-day driving, the severity of the risk will most likely be lower than the allocated extreme residual risk rating. Additional management measures imposed by the project-specific Traffic Management Plan will support this further.

7.3.2 Mobile Mining Machinery Collision or Roll-over

During operations there is the potential that mobile mining equipment, such as excavators or haul trucks, could collide or rollover, possibly resulting in operator injury or fatality. In addition, hydrocarbons such as fuel or oil could be spilt on site. The consequence of a mobile mining machinery collision or rollover is therefore considered to be **catastrophic** for health criteria, but considerably less for other criteria as laid out in Table 7.1.

All mobile mining equipment will be fitted with appropriate warning equipment such as reversing alarms and night lighting. Light vehicles will also be fitted with flashing lights and hazard flags to warn larger vehicles of their presence. Speed limits and other procedures will be implemented to limit the potential for vehicle accidents. All vehicle operators will be trained and licensed appropriately for the machinery they are operating, and will be inducted to ensure they are aware of site traffic procedures. All site vehicles will be restricted to formed roads and access tracks; travel outside of these areas will only be allowed with prior clearance and the appropriate driver training. In addition, all site roads will be designed to provide appropriate site lines for vision and no sharp corners, where possible.

Site-specific inductions, training and safety requirements will result in the likelihood of a mobile mining machinery collision or rollover being **unlikely**. The overall residual risk ranking is therefore **extreme**.

7.3.3 Plane Crash During Fly-in Fly-out Operations

Employees will be flown to and from the project area during construction and operations. Therefore, there is potential for a plane crash and, depending on the severity of the incident, potential for death or injury. A crash or near miss would trigger investigations into the cause of the incident, possibly resulting in a hold on air travel and associated delay in operations. The consequence of a plane crash or near miss would be **catastrophic**.

The on-site aerodrome will be designed and constructed to comply with all Civil Aviation and Safety Authority standards. Only licensed and reputable operators will be engaged to fly employees in and out of the project area. Therefore the likelihood of a plane crash or near miss is considered to be **rare**. The overall residual risk ranking is therefore **high**.

7.3.4 Fuel Spillage, Fuel Leakage or Tank Rupture

Hydrocarbons for fuel and lubrication will be stored in significant quantities on site for use in the mining fleet, haulage fleet and generators. Therefore, the potential exists for spillage, leakage or tank rupture to result in the release of hydrocarbons to the environment.

To minimise the risk of hydrocarbon release, all fuel handling and refuelling operations will be undertaken only in appropriately bunded and contained designated refuelling areas, and in accordance with standard operating procedures (SOP) to ensure all reasonable steps are taken to reduce the risk of spillage. All storage tanks will be designed and bunded to Australian Standard 1940-2005 'The storage and handling of flammable and combustible liquids' (Standards Australia, 2004c) to limit the potential for failure and, in the event of failure, to prevent release. Regular monitoring and maintenance of tanks and equipment will ensure that potential leaks are detected and rectified quickly.

While the above health and safety procedures will reduce the potential for fuel spillage, leakage or tank rupture, it is considered **likely** that some fuel spillage or leakage will occur during the life of the project. The areas considered particularly susceptible to contamination from fuel spillage or leakage are areas where refuelling of machinery or vehicles occurs, as well as the workshop areas. Specific management measures (see Chapter 9) will be implemented on site to ensure the impact from such activities are appropriately managed and remediated. However, were a major fuel spill, leak or tank ruptures to occur the consequence will be **moderate**, giving an overall residual risk ranking of **high**.

7.3.5 Explosion

Storage of explosives and other flammables on site means that the potential for explosion does exist. However, all materials with explosive potential will be stored in accordance with appropriate Northern Territory and Australian standards and guidelines. Furthermore, all staff required to handle explosive material will be appropriately trained, and required to operate under SOPs to ensure all reasonable steps are taken to limit the risk of explosion.

Therefore, the likelihood of an accidental or unintentional explosion occurring is considered to be **rare**. However, given the potential for injury and death due to an uncontrolled explosion, the consequence is considered to be **catastrophic**. The residual risk ranking is therefore **high**.

7.3.6 Irrespirable Atmosphere in Confined Spaces

Work in confined spaces can be hazardous to the worker's health and safety. Confined spaces are defined as any space which, because of its location, contents and the activities performed within it, may be deficient or rich in oxygen or contain flammable or toxic vapours and gases. A confined space may therefore be of any size; however, will have limited openings for entry and exit and unfavourable natural ventilation (University of Queensland, 2007). Components of the project that may be defined as confined spaces include the crushing and screening plant, shallow pits and trenches. Such components will be designed to ensure that any potential risks are minimised, including provision of adequate ventilation in the crushing and screening plant. The

implementation of a SOP for working in a confined space will ensure that occupational health and safety requirements are met and the likelihood of illness or injury from working in a confined space is **rare**. If impacts were to occur, the potential for fatality however low, mean that the consequence is considered to be **catastrophic**, giving an overall residual risk ranking of **high**.

7.3.7 Unauthorised Site Access

There is a risk that unauthorised site access by members of the public could result in injury or fatality. This risk is limited by the fact that the site is in an isolated and sparsely populated area, and as such the potential for the general public to inadvertently enter the site is limited. Despite this, to minimise the risk Minemakers will fence any areas where the operation of mining machinery or other equipment poses a risk to the general public. Signage will also be posted at regular intervals around the site, and especially at likely entry points, to ensure anyone entering is fully aware they are prohibited from entering the area without prior authorisation. Finally, a security checkpoint will be installed at the main site access road, to discourage unauthorised access.

With implementation of these site management and safety measures, the likelihood of unauthorised site access leading to an injury or fatality that could have been reasonably prevented by Minemakers is **rare**. However, given the potential for fatality if the general public accesses the site without authorisation and the knowledge of the mine operator, the consequence is considered to be **catastrophic**. The overall risk ranking is therefore **high**.

7.3.8 Incident Involving Traditional Owners and Mining Operations as a Result of Sacred Site Access Arrangements

There is a risk that access arrangements allowing the Traditional Owners from the Wunara community to access cultural exclusion areas, could result in fatality or serious injury should an incident occur between the Traditional Owners and mobile mining machinery. As a result the consequence should this occur would be **catastrophic**.

As a result of this a Minemakers will develop formal access agreements with the Traditional Owners to ensure access does not occur without the prior agreement and knowledge of Minemakers. In addition, Minemakers will undertake to educate the community to ensure they are fully aware of the risks posed by mining machinery and operations. Therefore the likelihood of this hazard occurring is **rare**, and the overall risk is **high**.

7.3.9 Pit Wall Failure Due to Seismic Activity or Geotechnical Instability

Geotechnical instability or seismic activity has the potential to cause the pit wall to fail. Such a failure would disrupt mining operations and could result in injuries to personnel working in the pit at the time of the failure. Results of geotechnical investigations have been incorporated into the design of pits to ensure they are geotechnically stable it is therefore considered **rare** that a pit wall will fail. If the pit wall were to fail, the resultant environmental, financial and health consequences will potentially be **moderate**, giving an overall residual risk ranking of **moderate**.

7.3.10 Failure of Waste Rock Storage

The potential for the waste rock storages to fail is influenced by their design during mine planning and the placement of material in accordance with this design during operation. Waste rock will be designed to ensure stability, through waste rock storage shape and height i.e. they will have a low

hill profile and will have a height of approximately 20 m above natural ground level and final batter slopes of no more than 18°, so the effect of any failure will be minimal, and will be monitored throughout the life of the mine to ensure the placement of waste rock and operational storage design is as per the mine plan. It is therefore considered **rare** that the waste rock storages will fail. However, given the minor potential environmental, financial, and health and safety impacts associated with the failure of waste rock storages the consequence of such a failure is **minor**, giving a residual risk ranking for failure of waste rock storages as **low**.

7.3.11 Acid Rock Drainage Formation Within the Waste Rock Storages and Pits

If potentially acid forming material is not managed correctly or characterised properly ARD from the waste rock storages or pits may occur. However, as detailed in Section 5.3.3, waste rock and non-DSO material has been classified as non-acid forming, therefore ARD will not be a concern for the project. Therefore, the likelihood of ARD formation within either the waste rock storages or pits is **rare**.

ARD has the potential to have significant environmental, financial and social impacts; however, given the non-acid forming potential of all mined material the consequence of ARD on site has been assessed as being **minor**. The residual risk assessment for ARD formation within the waste rock storages and pits is therefore **low**.

7.3.12 Flooding as a Result of Extreme Rainfall or Flood Event

Flooding as a result of extreme rainfall or flood event does occur throughout the Barkly Tableland. As outlined in Chapter 4, the majority of rainfall occurs in the wet season (with 70 to 80% of rainfall occurring during the months from October to March) and as a result of tropical cyclones. Flood protection measures and site water management will be implemented (including flood protection levees and sedimentation basins) to ensure that mining operations are not disrupted and any excess site water is managed on site. Details on the designs of these measures are provided in Section 5.8.1. The likelihood of mining operations being disrupted or flood water requiring disposal is **unlikely**, given that a two week supply of product will be stockpiled at the multi-user hub to accommodate for any disruption to Barkly Highway. In addition, the only pit susceptible to flooding is the Arruwurra pit and this will have flood protection measures implemented. The potential environmental, financial, social and health impacts from flooding are **minor**, giving a residual risk ranking of **low**.

7.3.13 Reduced Visibility Due to Airborne Dust

During construction and operations, the presence of airborne dust represents a safety risk to traffic within the project area and on the Barkly Highway. Airborne dust has the potential to reduce visibility for motorists and therefore increase the risk of traffic accidents. The consequence of a traffic accident could result in injury or fatality and is therefore considered to be **catastrophic** for the health criteria but considerably less for the other criteria as laid out in Table 7.1. As outlined in Section 6.2.3 mitigation measures and monitoring procedures will be implemented to reduce the dust emissions generated within the Mineral Lease and therefore the likelihood of the event occurring is **rare.** The overall residual risk ranking is **high**.

Further air quality management and monitoring measures are outlined in the air quality environmental management plan (Attachment 5).

Plate 7.1
Post-fire woodland and access track at Wonarah

Plate 7.2
Post-fire woodland at Wonarah