

## **6. EXISTING ENVIRONMENT, POTENTIAL IMPACTS AND MANAGEMENT**

### **6.1 Framework**

This chapter presents the environmental and social aspects of the Wonarah Phosphate Project. For each aspect the following information is provided:

- Description of the environment and establishment of the baseline conditions prior to construction and operation of the project.
- Description of the potential, credible environmental and social impacts (or issues), both positive and negative, that may be associated with the project. Identification of the potential impacts is based on knowledge of the existing environment, experience with similar operations elsewhere and issues of concern to key stakeholders. This initial description of impacts does not take into consideration the measures that will be employed by Minemakers during all stages of project development to address these impacts.
- Avoidance, mitigation and/or management measures. These reflect Minemakers' commitment to good practice mining and environmental management, and are technically and economically feasible within the context of the project's setting.
- The level of residual risk associated with the various impacts, assuming the effective implementation of the proposed control measures.
- A monitoring program that will provide early warning that mitigation and/or management measures are ineffective or failing.

Further detail about the process for determining residual risk and appropriate monitoring measures is provided below.

#### **6.1.1 Residual Risk Assessment**

The residual risk assessment identifies the risk associated with the various impacts either known to occur as a result of the project or known to occur at similar mining operations. The residual risk assessment considers what the remaining risk is once the proposed mitigation and/or management measures have been effectively implemented.

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

As part of the risk assessment process, a number of risk management assessment processes were considered. These included the Australian/New Zealand Standard Risk Management standard (AS/NZS 4360:2004 (Standards Australia, 2004a)) and the associated guidelines (HB 436:2004 (Standards Australia, 2004b) and HB 158-2006 (Standards Australia, 2006a)),

Standards Australia's Environmental risk management – Principles and process (HB 203:2006 (Standards Australia, 2006b)) and the United States Environmental Protection Agency's Guidelines for Ecological Risk Assessment (US Environmental Protection Agency, 1998)).

The descriptors used in this assessment are based on 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 descriptors were chosen as they were considered to be most appropriate for the mining project (Table 6.1).

**Table 6.1 Descriptors used to classify likelihood and consequence measures of impact**

Descriptor	Definition
<b>Likelihood</b>	
Almost certain	Is expected to occur in most circumstances, or is of a continuous nature, or likelihood is unknown.
Likely	Will probably occur during mine lifetime.
Possible	Could occur in most mines.
Unlikely	Could occur in some mines, but not expected to occur.
Rare	Occurs only in exceptional circumstances.
<b>Consequence</b>	
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.
Major	Health – extensive injuries. 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.
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).
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).
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 is then determined by combining consequences and likelihood using the risk matrix shown in Table 6.2.

**Table 6.2 Qualitative risk analysis matrix**

		Severity of Consequence				
		<i>Catastrophic</i>	<i>Major</i>	<i>Moderate</i>	<i>Minor</i>	<i>Insignificant</i>
<b>Likelihood of Consequence</b>	<b><i>Almost Certain</i></b>	Extreme	Extreme	Extreme	High	High
	<b><i>Likely</i></b>	Extreme	Extreme	High	High	Moderate
	<b><i>Possible</i></b>	Extreme	Extreme	High	Moderate	Low
	<b><i>Unlikely</i></b>	Extreme	High	Moderate	Low	Low
	<b><i>Rare</i></b>	High	High	Moderate	Low	Low

The evaluation of residual risks is 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 all residual risks will be managed by Minemakers to ‘as low as reasonably practicable’ (ALARP).

### 6.1.2 Monitoring

Following the assessment of the residual risk of impacts, a monitoring program is outlined for each aspect. The monitoring program will enable early detection of any failure of management and mitigation measures. The monitoring program contains measurable performance indicators that can be used by Minemakers and others (such as external environmental auditors) to assess progress towards, or compliance with, the performance criteria. Where possible, the assessment criteria are based on standards, guidelines, monitoring results or similar that allows numerical comparison. However, this is not always feasible. Hence, other criteria have been developed that relate to the implementation of specific measures that require a simple yes/no assessment, use comparison with baseline or control site data, or use comparison with specific project features described in the baseline sections of this chapter.

## 6.2 Air Quality

Existing air quality conditions in the project area are described in Section 6.2.1. Potential, credible project-related impacts on air quality are described in Section 6.2.2. The proposed avoidance, mitigation and management measures that Minemakers will employ during all stages of project development are described in Section 6.2.3. The resulting residual air quality impacts are discussed in Section 6.2.4. The monitoring program is outlined in Section 6.2.5 and outcome and assessment criteria that will give early warning if management and mitigation measures are failing are identified in Section 6.2.6.

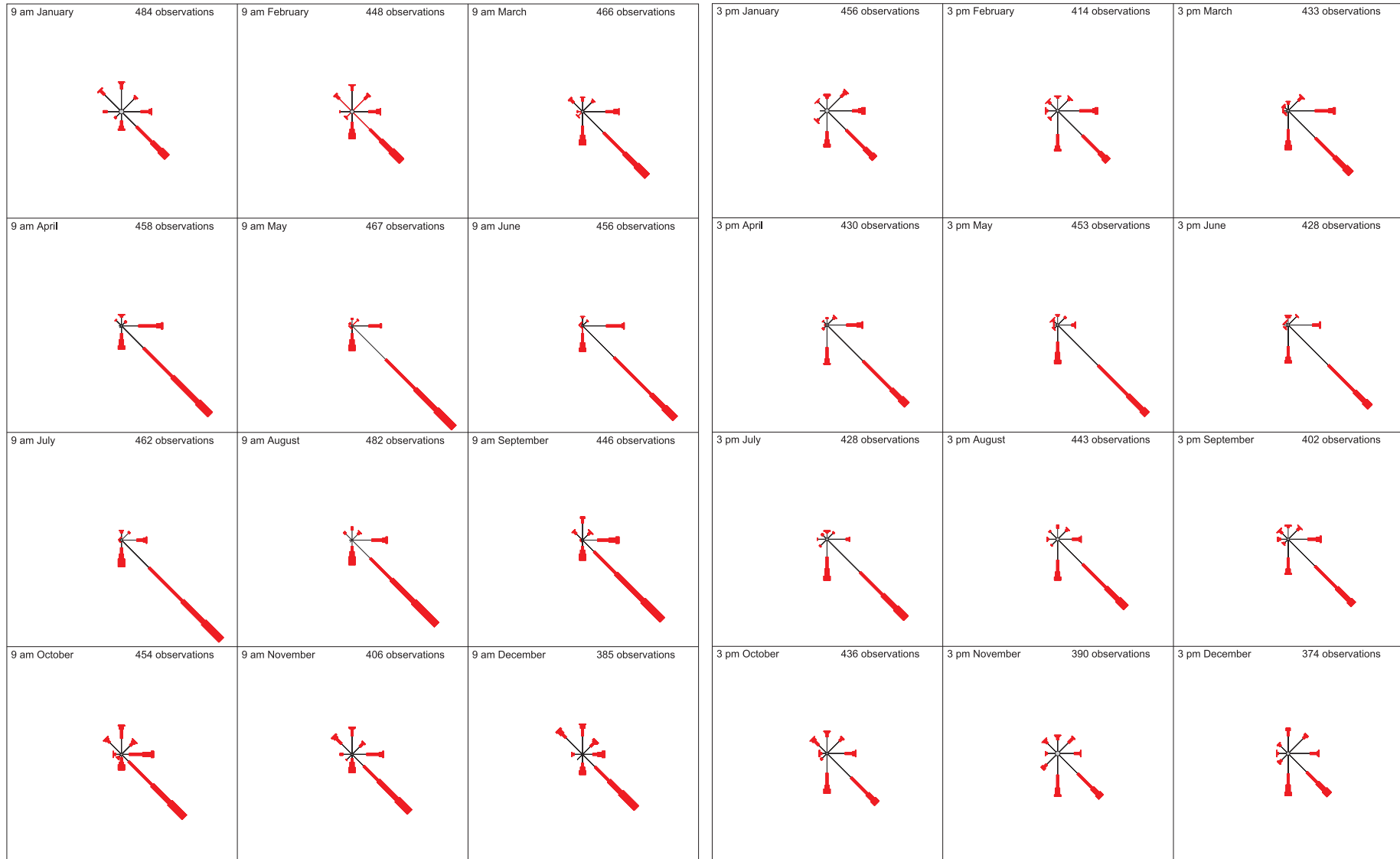
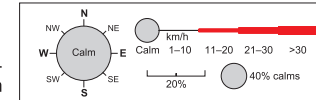
### 6.2.1 Baseline

The project area is remote from significant pollution sources such as industry. The existing air quality in the vicinity of the project area is relatively pollutant free and is typical of a remote, semi-arid rural environment. Dust generated by wind erosion of exposed surfaces is the main air pollutant present. Other pollutants sources are combustion emissions from bushfires and minor emissions from vehicles travelling along the Barkly Highway.

Wind conditions strongly influence dust generation and transport. In the project area the predominant wind direction is southeasterly and the strength of the wind is usually a fresh breeze (Figure 6.1) (Table 6.3).

# Wind Roses using data between Jan 1957 and Aug 1974 for Wonarah

Site Number 015034 • Locality: Ranken • Opened Apr 1946 • Closed 31 Dec 1974  
 Latitude 19°53'54"S • Longitude 136°20'09"E • Elevation 240m



Prepared by Climate Services Section in the WA Office of the Bureau of Meteorology. Contact us by phone on (08) 9263 2222, by fax on (08) 9263 2233, or by email on climate.wa@bom.gov.au  
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Morning and afternoon wind direction and speed recorded at the Wonarah BoM station 1957 to 1974

Figure No:  
6.1

In general, winds over the survey period (May 2008 to October 2009) were light breezes (the average was 10 km/h), which will cause rustling of leaves and can be felt on exposed skin. The highest average wind speed (14 km/h) was recorded in August 2008 and is a gentle breeze that results in constant motion of leaves and twigs. Winds gradually decrease to a light breeze over the wet season, with a low of 7 km/h in February 2009. Calm to light conditions (wind speed between 0 to 5 km/h) were recorded less than 10% of the time.

Wind data collected at the project area during the survey period reflected average data collected at both Brunette Downs and historical Wonarah data (see Figure 6.1). The average winds recorded at Brunette Downs and Wonarah is a gentle breeze (13.5 and 16.3 km/h respectively).

Wind speeds are generally higher in the morning than the afternoon (see Figure 6.1). The maximum peak gust recorded at the project area was 68 km/h; however, maximum gusts in excess of 100 km/h could be expected from October to January as experienced at the Tennant Creek Bureau of Meteorology (BoM) Station during cyclone-associated events.

**Table 6.3 Summary of seasonal wind conditions**

Season	Summary of Wind Condition
Dry season (April – July)	Predominantly calm to moderate southeasterly winds throughout the season.
Build-up to the wet season (September – November)	Predominantly strong southeasterly and moderate southerly winds throughout the season, with calm to mild winds varying in direction from east to northwest.
Wet season (December – March)	Predominantly calm to moderate southeasterly winds with calm winds varying in direction from east to northwest.

Background dust levels were measured by deposition gauges at eight locations within the project area and surrounds (Figure 6.2) over 11 sampling periods, from June 2008 to September 2009. The dust monitoring results indicate that the background dust fall ranges from around 0.7 to 7.0 g/m<sup>2</sup>/month, with an overall average of 2.6 g/m<sup>2</sup>/month. These results are similar to arid regions in general, historical studies of arid zones in Western Australia recorded dust deposition levels of 0.8 to 2.6 g/m<sup>2</sup>/month (Cattle et al., 2009).

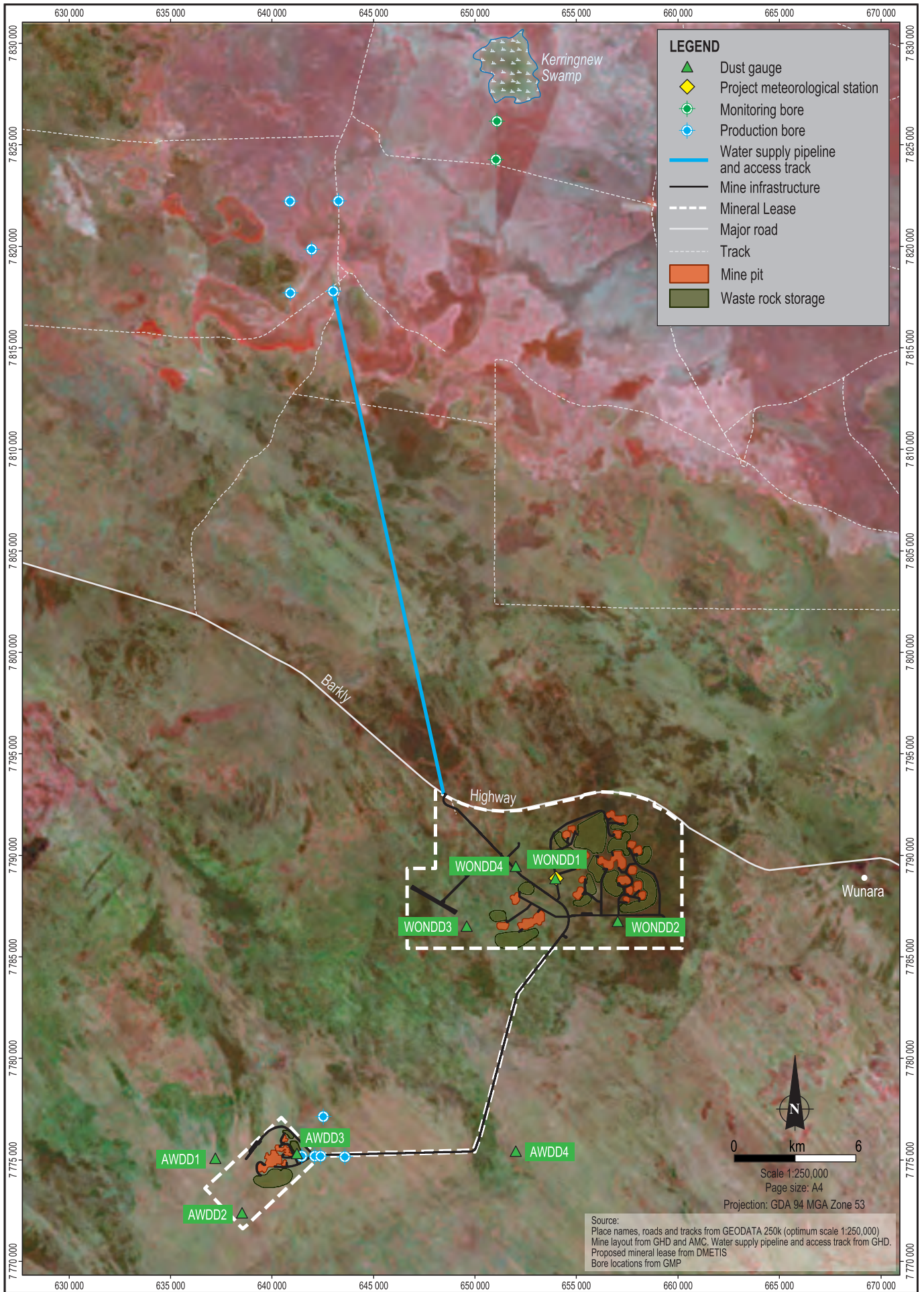
## 6.2.2 Potential Impacts

In this section, assessment and discussion of potential impacts to air quality as a result of the construction and operation of the project are from an anthropocentric perspective. Impacts on the natural values of the project area, e.g., flora and fauna, are addressed in their respective sections.

The potential impacts are discussed primarily as they relate to potential sensitive receptors. There are two main groups of potential sensitive receptors, those that could be affected by air emissions from the Mineral Lease and those that could be affected by air emissions from the product transport. These are treated separately within this section.

### **Decrease in Air Quality Due to Dust Emissions Generated within the Mineral Lease**

The main potential air quality issue that will result from construction and operation of the project will be the liberation of particulate matter, resulting in airborne dust. The main dust generating



activities are likely to be:

- Clearance of vegetation.
- Drilling and blasting waste rock.
- Loading waste rock to trucks.
- Hauling waste rock to the waste rock stockpiles.
- Drilling and blasting ore.
- Loading ore to trucks.
- Hauling ore to the run of mine (ROM) stockpile or crusher.
- Unloading ore at the ROM stockpile or directly to the crusher.
- Crushing and screening.
- General vehicle movements over unsealed roads.
- Wind erosion from exposed surfaces (e.g., soil, stockpiles and dumps).

Dust can be measured as:

- Total suspended particulate matter (TSP) generally less than 50  $\mu\text{m}$ .
- Particulate matter with an equivalent aerodynamic diameter of 10  $\mu\text{m}$  or less ( $\text{PM}_{10}$ ).
- Particulate matter with an equivalent aerodynamic diameter of 2.5  $\mu\text{m}$  or less ( $\text{PM}_{2.5}$ ).

Dust particles can be defined as large, medium and small. The larger the particle size, the faster dust settles or falls out of the atmosphere. Larger particles ( $>100 \mu\text{m}$ ) fall out quickly (terminal velocity of  $>0.5 \text{ m/s}$ ), medium sized particles (1 to 100  $\mu\text{m}$ ) will settle out slowly (terminal velocity of  $>0.2 \text{ m/s}$ ) and small particles ( $<1 \mu\text{m}$ ) tend to stay suspended longer and can be washed out of the atmosphere by rain (The Engineering Toolbox, 2009). For the project, 95 % of the phosphate product falls within the range of 4.75 mm to 10  $\mu\text{m}$  with 15% being smaller than 10  $\mu\text{m}$ .

The sensitive receptors that may be affected by dust emissions from the Mining Lease are the residents of the Wunara community and motorists of the Barkly Highway. The Wunara community has permanent residents and is located 10 km from the Mineral Lease boundary and may experience dust nuisance and amenity impacts. Motorists that travel on the section of the Barkly Highway that adjoins the Mineral Lease boundary are transient receptors, who would only have short-term exposure to any emissions from the Mineral Lease; however, they may experience temporary dust nuisance and amenity impacts such as reduced driving visibility.

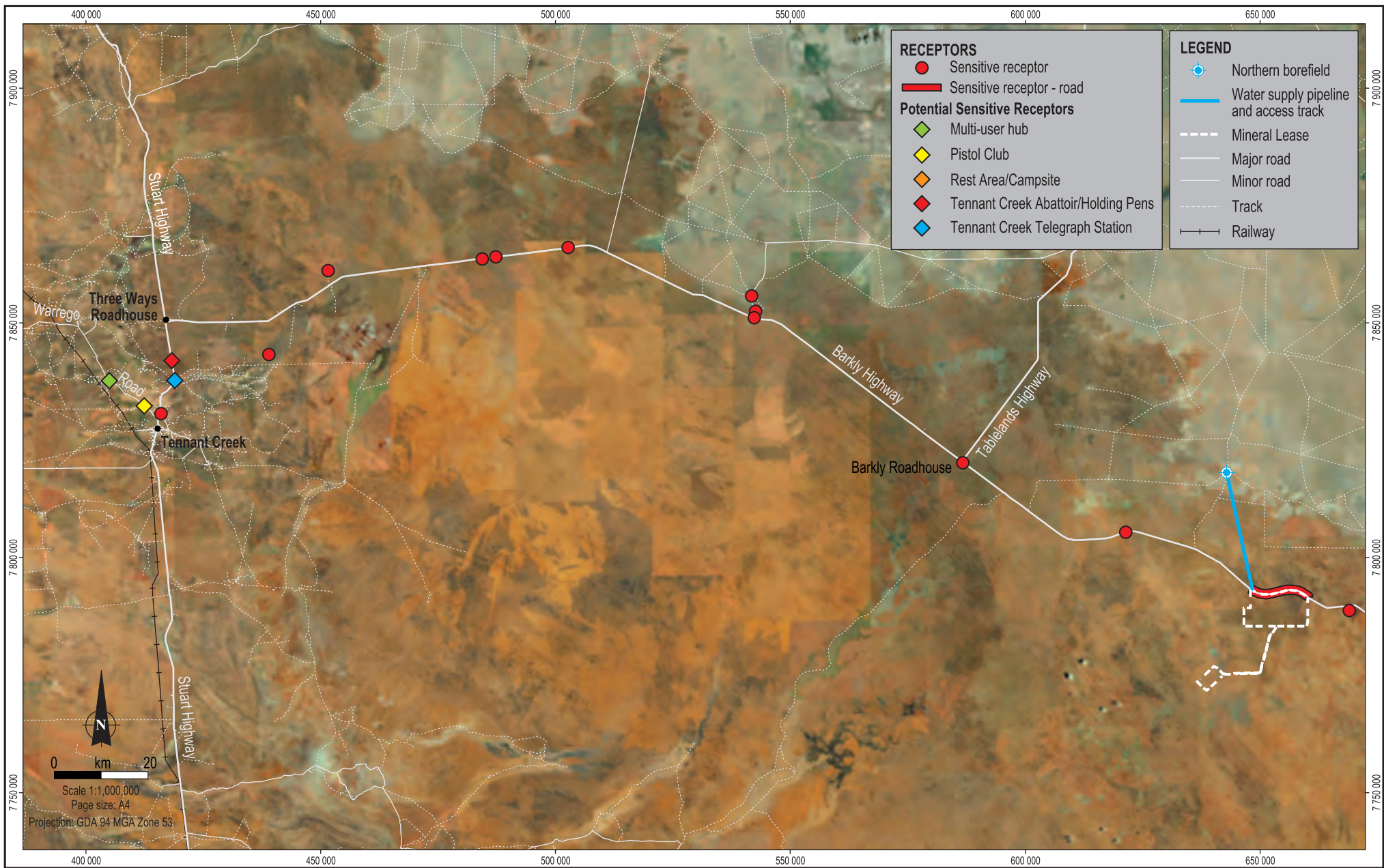
### **Decrease in Air Quality Due to Dust Emissions Generated from Project Related Heavy Vehicles along the Ore Transport Route**

During product transport dust may be generated from escape of product from the trailers or from the increased traffic mobilising particulate matter from roads and roadsides along the transport route. The potential sensitive receptors are the (Figure 6.3):

- Barkly Roadhouse.
- Five rest areas, including some with campsites for travellers on the Barkly Highway.
- Five houses between 0.5 and 7 km from the ore transport route.

These receptors may experience dust nuisance and amenity impacts.

Other potential sensitive receptors such as the Tennant Creek Abattoir/Holding Pens (possibly abandoned), Tennant Creek Telegraph Station and Tennant Creek Pistol Club were discounted, as they are not permanently occupied.



Source:  
 Place names, roads and tracks from GEODATA 250k (optimum scale 1:250,000)  
 Bore locations from GMP  
 Mine layout from GHD and Minemakers  
 Mineral lease from DMETIS



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Sensitive receptors along the ore transport route – air

Figure No: 6.3

## **Decrease in Air Quality Due to Combustion Emissions**

Project vehicles and equipment will run on hydrocarbon fuels (mostly diesel), which emit products such as carbon monoxide (CO), sulphur dioxide (SO<sub>2</sub>), nitrogen dioxide (NO<sub>2</sub>) and particulate matter from fuel combustion. These emissions have the potential to adversely impact local air quality and have the potential to cause nuisance or health impacts for the residents of the Wunara community. The impact of the project on greenhouse gases is addressed in Section 6.3.

## **Decrease in Air Quality Due to Odour**

Odour may be emitted from the sewage treatment plant and putrescible waste landfill, with a potential adverse impact on local air quality and has the potential to cause a nuisance impact for residents at the closest sensitive receptors (i.e., residents of the Wunara community). Some phosphate deposits also have the potential to generate odour, however, no odour has been observed during exploration drilling or laboratory analysis.

### **6.2.3 Avoidance, Mitigation and Management**

Minemakers will implement avoidance, mitigation and management measures to address the potential impacts on air quality. These measures will reflect current good practice at similar mines operating in similar environments and are described below.

## **Decrease in Air Quality Due to Dust Emissions Generated within the Mineral Lease**

To minimise dust emissions and dust nuisance Minemakers will:

- Consider the location of dust and odour generating activities and the prevailing meteorological conditions during the mine planning and design stage, e.g., locate accommodation sufficiently distant from the sewage treatment plant and mining operations, and locate waste rock storages as far as possible from the Mineral Lease boundary.
- Manage ground disturbance by:
  - Minimising the extent of vegetation cleared to reduce the amount of exposed areas susceptible to wind erosion.
  - Clearing vegetation progressively (i.e., as land is required) to reduce the amount of exposed areas susceptible to wind erosion.
  - Watering areas to be disturbed immediately prior to clearing during windy conditions.
  - Rehabilitating final surfaces progressively during the project to minimise the amount of exposed areas susceptible to wind erosion.
- Manage mine traffic, including such measures as:
  - Using signage, training and markings to ensure traffic is kept to formed site roads where dust suppression techniques are in use.
  - Prohibiting off road driving.
  - Restricting site access to necessary site vehicles only.
  - Limiting parking of vehicles to designated parking areas to minimise soil disturbance.
  - Speed limits will be imposed on roads used by mine traffic to reduce vehicle dust.

- Limiting load sizes of haul trucks on-site to ensure material is not above the level of the vehicle sidewalls.
- Manage waste rock, ore and topsoil storage, including such measures as:
  - Positioning the stockpiles lengthways to the predominant wind direction.
  - Minimising the slope of the upwind surfaces.
  - Stockpiling coarser material on the outer slopes of stored material to prevent wind blown dust and protecting with cleared vegetation.
  - Watering stockpiles to prevent wind losses when required (e.g., during dry windy weather, when stockpiles have been recently formed, and have surface dust).
  - Maintaining existing screening vegetation along the Mineral Lease boundary adjacent to the Barkly Highway to maximise particle capture on site and minimise dust movement off-site.
- Cease mining and clearing operations during severe meteorological conditions (wind speeds above around 40 km/h) causing extreme levels of dust.
- Spray water and/or the dust suppressant Dustbloc<sup>®</sup> (the specifications for Dustbloc<sup>®</sup> can be viewed in Attachment 4) on unsealed trafficked areas and other dust generating areas. Minemakers will keep daily records of the:
  - Operational hours of all water trucks.
  - Amount of water and dust suppressant used.
  - Numbers of water trucks in operation.
  - Time any mining operations are ceased due to severe meteorological conditions.

### **Decrease in Air Quality Due to Dust Emissions Generated from Project Related Heavy Vehicles along the Ore Transport Route**

Dust will be minimised during the transport of ore from the mine site to the East Arm Port by:

- Haulage contractors implementing management measures to prevent any product loss while transporting product from the mine site to the East Arm Port.
- Using covered haul trucks for the transport of ore from the mine site to the multi-user hub outside and to the north of Tennant Creek.
- Minimising double handling of product at the multi-user hub.
- Using covered rail wagons during the transport of ore from the multi-user hub to East Arm Port.
- Using purpose-designed and built ore storage and handling facility at East Arm Port (see Section 5.10 for details).

Further details about the management of dust during the operation of the multi-user hub and the facility at East Arm Port will be provided in the respective permitting documents for these projects.

To reduce the amount of dust carried on vehicles from site onto the Barkly Highway, Minemakers will:

- Compact the soil at ore loading and unloading sites.
- Seal the first 200 m of the access road from the Barkly Highway to the crushing and screening plant.
- Sweep tracked soil regularly from the site entrance.

### **Decrease in Air Quality Due to Combustion Emissions**

Project equipment, machinery and vehicles will meet exhaust air quality standards in the normal manner for all vehicles sold in Australia and will comply with all Northern Territory regulations. Vehicles and machinery will be fitted with the appropriate emission control equipment, and maintained and serviced frequently.

Minemakers will conduct regular general reviews of the mining operations to assess additional measures that can be implemented to minimise impacts on air quality due to combustion emissions. These reviews will incorporate findings from the monitoring program and consider any new technologies that may be available to reduce emissions.

### **Decrease in Air Quality Due to Odour**

The two potential sources of odour on-site are sewage treatment plant and the putrescible waste landfill. Location of the sewage treatment plant will comply with Northern Territory's Code of Practice for the small on-site sewage and sullage treatment systems and the disposal or reuse of sewage effluent (DHF, 1998) and the EPA guidelines that specify a minimum separation distance of 100 m for plants servicing less than 1,000 people.

The putrescible waste landfill has been designed with consideration of, and will be managed in accordance with, the Northern Territory Government's Guidelines for the Siting, Design and Management of Solid Waste Disposal Sites in the Northern Territory (EPA, 2003).

The sewage treatment plant to be used on-site will be a package membrane bio-reactor design. This type of treatment plant does not require any permanent standing wastewater ponds and will be covered to mitigate any potential entry by mosquitoes. Given the type of sewage treatment plant to be used and the implementation of effective management of the plant, there will be minimal generation of offensive odours.

No specific management measures have been designed to address potential odour issues, given the low potential for odour, distances from the nearest sensitive receptor and remoteness of the project area. The need for specific measures will be considered if complaints are received, taking into account frequency of occurrence, intensity, duration, offensiveness and location.

## **6.2.4 Residual Impact**

In the Northern Territory, the relevant guidelines for air quality is the National Environmental Protection Measure (NEPM) (NEPC, 1998; NEPC, 2003) that relates to air quality. Specific air quality criteria that are relevant to the project are shown in Table 6.4. These criteria apply to entire air sheds.

**Table 6.4 Environmental air quality objectives and goals**

Environmental Indicator	Averaging Period	Environmental Quality Objective	Goal within 10 years (of 1999) maximum allowable exceedances
PM <sub>10</sub>	1 day	50 µg/m <sup>3</sup>	5 days/a
PM <sub>2.5</sub>	1 day	25 µg/m <sup>3</sup>	
Carbon monoxide	8 hours	9.0 ppm	1 day/a
Sulfur dioxide	1 hour	0.20 ppm	1 day/a
	1 day	0.08 ppm	1 day/a
	1 year	0.02 ppm	none
Nitrogen dioxide	1 hour	0.12 ppm	1 day/a
	1 year	0.03 ppm	none

Source: NEPC (1998); NEPC (2003).

While the project must consider the assessment criteria in Table 6.4, the NEPM are goals established by the National Pollutant Inventory and are to assist in reducing the existing and potential impacts of emissions of substances and to assist government, industry and the community in achieving the desired environmental outcomes of the NEPM (Environment Protection and Heritage Council, 2009). These criteria do not apply to assessing the long-term effects of particulate matter or the effects of nuisance dust on humans, such as may happen as a result of the project.

The New South Wales Department of Environment and Conservation (DEC) (DEC, 2005) sets the following dust criteria applicable to assessing the long-term effects of particulate matter or the effects of nuisance dust:

- Annual average PM<sub>10</sub> concentration – 30 µg/m<sup>3</sup>.
- Annual average TSP concentration – 90 µg/m<sup>3</sup>.
- Annual average dust deposition – 2 g/m<sup>2</sup>/month (increment from the project) and 4 g/m<sup>2</sup>/month (total from all sources).

While the DEC criteria outlined are generally more relevant to rural or urban development and are not applicable to semi-arid environments, dust criteria for semi-arid environments in Australia have not been developed. Therefore, these criteria are not considered appropriate for use for this project; however, do provide guidance as to potentially acceptable increment increase from baseline conditions.

The South Australian Environmental Protection Agency (EPA) sets Guidelines for Separation Distances (EPA, 2007) to ensure developments are located to minimise impacts caused by noise, odour or polluting air emissions. The following separation distances apply to air pollution sources:

- Mineral works – minimum separation distance of 1 km.
- Treatment plant (crushing and grinding rocks, ore and minerals) greater than 1,000 t/a – minimum separation of 0.5 km.

Assessment of residual air quality impacts was based on the current baseline data for dust deposition and emission rates of similar operations in similar environments. Table 6.5 summarises the residual impacts of the project on air quality after implementation of the management and mitigation measures. These are discussed in more detail below.

**Table 6.5 Summary of residual impacts on air quality**

ID	Impact	Likelihood	Consequence	Residual Risk
I01	Decrease in air quality at the Wunara community due to dust emissions generated within the Mineral Lease.	Rare	Moderate	Moderate
I02	Decrease in air quality for motorists travelling along the section of the Barkly Highway adjoining the Mineral Lease due to dust emissions generated within the Mineral Lease.	Possible	Moderate	High
I03	Decrease in air quality due to dust emissions from project related heavy vehicles along the ore transport route.	Unlikely	Moderate	Moderate
I04	Significant increase in the amount of combustion emissions.	Unlikely	Insignificant	Low
I05	Decrease in air quality due to odour.	Rare	Insignificant	Low

### **Decrease in Air Quality at the Wunara Community Due to Dust Emissions Generated within the Mineral Lease**

Dust will be generated at the mine site and complete dust suppression in this type of operation and setting (which already experiences high levels of dust at times) is not feasible. Based on modelling of other semi-arid mining operations, most dust will be generated by the extraction of waste rock and ore from the open pits and the crushing and screening plant.

The potential for dust emissions to impact the nearest sensitive receptor with permanent residents (the Wunara community, located 10 km from the Mineral Lease boundary) is dependent on the level of dust generated, 'at source' management of the dust generating activities, the separation distance from activities to the receptor and the prevailing wind direction and strengths.

The mitigation and management measures outlined above will limit the dust emissions from the site. Potential impacts to the Wunara community are further limited by the large separation distance between the dust sources and the community (i.e., more than 10 km distance) and the prevailing wind direction, which is a southeasterly direction (i.e., the wind originates from the southeast and travels northwest) away from the community which is located east of the Mineral Lease.

The possibility of movement of dust off the mineral lease in the direction of, and distance to, the Wunara Community, such that it causes nuisance is therefore considered to be **rare**. Based on similar operations in similar environments the consequences of this dust generation in terms of the various assessment criteria if it were to impact the Wunara Community will be **moderate**, giving an overall residual risk ranking of **moderate**.

From an occupational health and safety perspective, air quality at the accommodation camp will only be affected by operational activities at the Main Zone, as the Arruwurra pit will be at least 20 km away and therefore highly unlikely to affect air quality at the accommodation. The accommodation camp is 2.0 km away from the closest activity with the potential to generate considerable dust (the crushing and screening plant). Air quality on site will be carefully managed and any significant residual risks are unlikely; however, air quality at the accommodation camp will be carefully monitored by Minemakers occupational, health and safety systems.

### **Decrease in Air Quality for Motorists Travelling Along the Section of the Barkly Highway Adjoining the Mineral Lease Due to Dust Emissions Generated within the Mineral Lease**

As outlined above, most dust generated by the extraction of waste rock and ore from the open pits and the crushing and screening plant. The Mineral Lease adjoins the Barkly Highway and dust generated from the open pits and crushing and screening plant has the potential to cause a nuisance to the amenity for drivers passing along this section of the highway.

Given the separation distance of 800 m from the closest open pit and associated stockpiles and the Barkly Highway, the movement of nuisance dust off the mineral lease is **possible**. The consequence of dust nuisance and amenity impacts for motorists is considered **moderate**, as this is an offsite impact and if visibility is reduced they will have to adjust their driving accordingly. The overall residual risk ranking is therefore **high**.

### **Decrease in Air Quality Due to Dust Emissions from Project Related Heavy Vehicles along the Ore Transport Route**

Dust generated through the transport of ore to the multi-user hub in Tennant Creek has the potential to cause a nuisance to persons occupying sensitive receptors and for vehicles travelling along the Barkly Highway past the mine site.

All public roads used for the transport of ore will be sealed roads which will reduce the potential to generate dust through liberation of particulate matter from the road surface and while in transport, the ore will be covered so loss of material and airborne dust will be minimal. While the closest sensitive receptors to the transport route are the rest areas and the Barkly Roadhouse (all located less than 100 m from the transport route), the transport route and method will minimise any potential dust generation. It is highly unlikely that air quality will be affected by dust generated through the transport of ore.

Management of air quality during storage of the product will be managed and permitted separately to this EIS. The multi-user hub at Tennant Creek will be developed and managed by Global Port Solutions. Potential environmental impacts (including air quality), mitigation and management measures and will be assessed as a part of the permitting for that development. Management of air quality at East Arm Port, Darwin, will be permitted and managed separately to the mine. As the separate permitting process for both the multi-user hub and the East Arm Port developments will include detailed assessment of their potential impacts to air quality, they are not included in this EIS.

Airborne dust generated through the transport of ore will be **unlikely**. As transport of ore occurs outside the Mineral Lease, off-site or outside Mineral Lease releases of dust are possible and the consequence is therefore **moderate**. An overall residual risk ranking is therefore **moderate**.

### **Significant Increase in the Amount of Combustion Emissions**

Even in large mines, the rate of emission of sulfur dioxide, nitrogen dioxide and carbon monoxide from vehicles and equipment are small compared with the emissions from traffic in an urban setting. For example, the traffic travelling on 3 km of arterial road carrying, for example, 60,000 vehicles per day and consuming 6,000 L of fuel per day would not normally cause exceedances of the ambient air quality criteria in Table 6.4. In practice, emissions of sulfur dioxide, nitrogen dioxide and carbon monoxide from open cut mines, which would span a similar

distance, are much too small and the equipment too widely dispersed for these to cause exceedances of the ambient air quality criteria in Table 6.4.

A significant increase in the amount of combustion emissions is **unlikely**. Further, impacts will be highly localised and the consequences will be **insignificant**, resulting in a **low** residual risk.

### **Decrease in Air Quality Due to Odour**

Emissions of odour from the sewage treatment plant are not expected to be detectable off-site or in the accommodation camp. Even if odorous emissions were to occur, which would be **rare**, they will be extremely localised and will have **insignificant** consequences. Therefore, the residual risk of odorous emissions is **low**.

This low residual risk rating is further supported by the separation distances to the nearest sensitive receptor (non-company residence) is 10 km from the closest odour generating activity. From an occupational health and safety perspective, the project accommodation camp is approximately 1 km from the closest odour generating activity. These separation distances suggest that air quality would not be affected at these locations.

### **6.2.5 Monitoring Program**

Monitoring of dust emissions will incorporate:

- Monthly monitoring of wind speed, wind direction, temperature, humidity and rainfall at Minemakers' Wonarah weather station located within the Mineral Lease.
- Monthly monitoring of total dust deposition at eight dust deposition gauges located within (or close to) the Mineral Lease and further dust deposition gauges located north of the Barkly Highway.
- Real time dust monitoring gauges will monitor dust deposition until a pattern of dust movement and seasonal variation is established, a 12 month monitoring period is expected. Monitoring will then occur as required.
- Recording the use of dust suppression techniques in log books in order for Minemakers to gauge the effectiveness of suppression techniques against monitoring data.

Any complaints concerning air quality will be recorded in the Complaints Register. This register will record the complaint and any actions taken to address the complaint and show that no reasonable complaint is unaddressed.

Monitoring of air quality with respect to the wellbeing of staff and contractors will be conducted where required as part of the project's occupational health and safety system.

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

No specific management measures have been designed to address potential odour issues, given the low potential for odour, distances from the nearest sensitive receptor and remoteness of the project area. The need for specific measures will be considered if complaints are received, taking into account frequency of occurrence, intensity, duration, offensiveness and location.

## 6.2.6 Outcome and Assessment Criteria

The outcome and assessment criteria for air quality are outlined in Table 6.6.

**Table 6.6 Outcome and assessment criteria – air quality**

ID	Impact	Outcome	Assessment Criteria	Summary of Management and Mitigation Measures
I01	Decrease in air quality at the Wunara community due to dust emissions generated within the Mineral Lease.	No decrease in air quality or visual amenity due to dust emissions outside of the Mineral Lease.	Compliance with annual average dust deposition rate does not exceed 2 g/m <sup>2</sup> /month above baseline dust deposition rate of 2.6 g/m <sup>2</sup> /month outside of the Mineral Lease.  Complaints register to show no reasonable complaint unaddressed.	Minimise area and progressively clear vegetation.  Cover ore during transport to market.  Rehabilitate final surfaces progressively during the project.  Traffic to be restricted to formed site roads.  Manage waste rock and ore storage to avoid dust generation.  Cease mining operations during severe meteorological conditions.  Spray water or dust suppressants on unsealed trafficked areas and other dust generating areas.  Keep daily records of dust suppression activities.  Limit vehicle speed on roads used by mine traffic.  Limit load sizes of haul trucks on-site.
I02	Decrease in air quality for motorists travelling along the section of the Barkly Highway adjoining the Mineral Lease due to dust emissions generated within the Mineral Lease.	No decrease in air quality or visual amenity due to dust emissions outside of the Mineral Lease.	Measurements of fugitive dust do not exceed levels that may affect visibility (5 g/m <sup>2</sup> /month) (CNI, undated). To be recorded by real time dust monitoring gauges) across the Barkly Highway.  Complaints register to show no reasonable complaint unaddressed.	Minimise area and progressively clear vegetation.  Cover ore during transport to market.  Rehabilitate final surfaces progressively during the project.  Traffic to be restricted to formed site roads.  Manage waste rock and ore storage to avoid dust generation.  Cease mining operations during severe meteorological conditions.  Spray water or dust suppressants on dust generating areas.  Keep daily records of dust suppression activities.  Limit vehicle speed on roads used by mine traffic.  Limit load sizes of haul trucks on site.

**Table 6.6 Outcome and assessment criteria – air quality**

<b>ID</b>	<b>Impact</b>	<b>Outcome</b>	<b>Assessment Criteria</b>	<b>Summary of Management and Mitigation Measures</b>
I03	Decrease in air quality due to dust emissions from project related heavy vehicles along the ore transport route.	No decrease in air quality due to dust emissions from project related heavy vehicles along the ore transport route.	Complaints register to show no reasonable complaint unaddressed.	Covered haul trucks for the transport of ore from the mine site to the multi-user hub at Tennant Creek.  Using covered rail wagons during the transport of ore from the multi-user hub to East Arm Port.  Using purpose-designed and built ore storage and handling facility at East Arm Port (see Section 5.10).
I04	Significant increase in the amount of combustion emissions.	No decrease in air quality due to combustion emissions outside of the Mineral Lease	Maintenance records show regular servicing of vehicles and plant.	Maintenance of vehicle exhaust systems.
I05	Decrease in air quality due to odour.	No decrease in air quality due to odour outside of the Mineral Lease.	Complaints register to show no reasonable complaint unaddressed.	Maintain complaints register.

## 6.3 Greenhouse Gas Emissions

Existing or baseline greenhouse gas emissions in the project area are described in Section 6.3.1. Potential, credible project-related impacts associated with greenhouse gas emissions are described in Section 6.3.2. The proposed avoidance, mitigation and management measures that Minemakers will implement during all stages of project development are described in Section 6.3.3. The resulting residual impacts of the project to greenhouse gasses are discussed in Section 6.3.4.

The assessment and management of greenhouse gas emissions has been guided by the:

- NT environmental assessment guide: greenhouse gas emissions and climate change (DNRETAS, 2009a).
- National greenhouse gas accounts (NGA) factors (DCC, 2009).
- National carbon accounting system (Richards et al, 2005).

### 6.3.1 Baseline

Baseline greenhouse gas emissions in the project area are limited to naturally occurring levels from biogenic sources, i.e., termites, soil, lightning and gut fermentation in animals. Activities which emit greenhouse gas within close vicinity to the project area are limited. The largest sources of anthropogenic greenhouse gas emissions in close vicinity to the project area are likely to be methane emitted from pastoral activities and carbon dioxide from vehicles travelling on the Barkly Highway.

### 6.3.2 Potential Impacts

The potential impact of the project on greenhouse gas emissions is an increase in the overall greenhouse gas emissions for the project area and the Northern Territory. Greenhouse gases are a known contributor to climate change and as identified in the NT Environmental Assessment Guide: Greenhouse Gas Emissions and Climate Change (DNRETAS, 2009a), climate change is expected to result in changes to sea temperatures and level, erratic and severe weather events and an overall increase in global mean temperatures.

Greenhouse gases identified under the Kyoto Protocol United Nations Framework Convention on Climate Change are:

- Carbon dioxide (CO<sub>2</sub>).
- Methane (CH<sub>4</sub>).
- Nitrous oxide (N<sub>2</sub>O).
- Hydrofluorocarbons (HFCs).
- Perfluorocarbons (PFCs).
- Sulfur hexafluoride (SF<sub>6</sub>).

Of these, CO<sub>2</sub> and N<sub>2</sub>O are the most significant for the project as they will be generated through combustion of hydrocarbon fuels (mainly diesel), electrical power use and vegetation clearance. Diesel will be used to fuel vehicles, machinery and generators to provide electricity during construction.

### 6.3.3 Avoidance, Mitigation and Management

Measures that incorporate best practices for greenhouse gas emission reduction will be employed during the construction and operations phases. These measures include:

- Develop and apply policies and procedures for efficient mine operation that will ensure fuel use is minimised.
- Minimise haul distances to minimise diesel use in vehicles and subsequent combustion emissions.
- Monitor energy consumption (e.g., diesel and electricity) and calculate greenhouse gas emissions. This data can then be used to identify and address any key opportunities to reduce greenhouse gas emissions.
- Identify and assess economically viable opportunities for reductions in emission rates, e.g., reducing areas of vegetation clearance and exploring opportunities to use more efficient fuel technology such as natural gas.
- Use renewable energy sources where available and viable (e.g. solar hotwater systems, monitoring systems powered by solar energy).
- Ensure that vehicles and equipment are mechanically sound, serviced regularly and fitted with appropriate emission control equipment.
- Use energy efficient lighting in all accommodation and office areas.
- Use 5-star appliances in accommodation and offices where available (e.g., refrigerators, air conditioners and cookers).

- Continue to pursue opportunities to reduce combustion emissions from ore transportation through development of a rail link between the mine and Tennant Creek.

Minemakers will consider offsets for greenhouse gas emissions as it relates to the emissions trading scheme commencing 1 July 2011 under the carbon pollution reduction scheme.

### 6.3.4 Residual Impact

The residual impact of the project on greenhouse gas emissions is outlined below.

All types of greenhouse gases are standardised by being expressed as a CO<sub>2</sub>-equivalent. This is achieved by multiplying the individual gas emission factor by the respective gas global warming potential (DCC, 2009). The estimated consumption of diesel fuel and expected annual emissions of CO<sub>2</sub>-equivalent during the project are shown in Table 6.7 and Table 6.8.

**Table 6.7 Estimated annual diesel fuel consumption and greenhouse gas emissions**

Description	Fuel (KL/a)	CO <sub>2</sub> (t/a)	CH <sub>4</sub> (t/a)	N <sub>2</sub> O (t/a)	CO <sub>2</sub> -equivalent <sup>1</sup> (t/a)
Average diesel consumption for electricity generation during construction (i.e., first 3 months).	3,000	8,013	1	69	8,084
Average diesel consumption associated with vehicle movement on site mining 1.5 Mt/a.	6,750	18,030	3	156	18,189
Average diesel consumption associated with vehicle movement on site mining 2.5 Mt/a.	10,350	27,646	4	240	27,890
Average diesel consumption associated with vehicle movement on site mining 3.0 Mt/a	13,500	36,060	5	313	36,378
Average diesel consumption for electricity generation during all operations.	1,800	4,808	1	42	4,850

1. Workings for emissions on gas by bas basis are shown in Appendix 7 and calculated according to the National greenhouse gas (NGA) factors (DCC, 2009).

**Table 6.8 Estimated annual greenhouse gas emissions CO<sub>2</sub>-equivalent (Mt/a)**

Year	Project Component				
	Vegetation Clearance	Diesel Consumption for Construction	Diesel Consumption for Electricity Generation	Diesel Consumption for Vehicle Movement	Total (Mt/a)
1	0.015	0.008	0.005	0.018	0.046
2	0.004	0.00	0.005	0.027	0.037
3	0.013	0.00	0.005	0.036	0.055
4	0.003	0.00	0.005	0.036	0.044
5	0.007	0.00	0.005	0.036	0.049
6	0.013	0.00	0.005	0.036	0.054
7	0.003	0.00	0.005	0.036	0.044
8	0.011	0.00	0.005	0.036	0.052
9	0.009	0.00	0.005	0.036	0.050
10	0.003	0.00	0.005	0.036	0.043

The project will involve clearance of an estimated 2,326 ha of vegetated land. Clearance of vegetation in the project area is expected to release in the order of 35 t CO<sub>2</sub>-equivalent per hectare after five years (if not revegetated) (Carmichael, pers. com., 2009). The total emissions, due to vegetation clearance over the life of the mine, are expected to be approximately 0.08 Mt CO<sub>2</sub>-equivalent, released over a period of time. However, all soil stockpiles (including waste rock storages when no longer required for mining) will be revegetated within a 6 to 12 month period, all pits to be backfilled will be revegetated within 12 months, and any remaining voids will be devoid of soil and so are not expected to release greenhouse gases. Therefore this value is expected to be an overestimation of the actual emissions.

In summary, when running at maximum capacity of 3.0 Mt/a the project is estimated to liberate 0.05 Mt/a of CO<sub>2</sub>-equivalent due to vegetation clearance, construction and operations, comprising:

- 0.04 Mt/a due to diesel consumption (vehicles).
- 0.005 Mt/a due to electricity generation.
- 0.008 Mt/a due to vegetation clearance

Transport of product to Tennant Creek represents approximately 15% (or 2.03 ML/a) of the average annual diesel fuel consumed. There will be additional emissions associated with the transport by rail and ship customers, but there is insufficient information to estimate these emissions at this stage of the project.

### Significant Increase in Greenhouse Gas Emissions

Table 6.9 summarises the residual risk of an increase in net greenhouse gas emissions within the Northern Territory and Australia as a result of the project.

**Table 6.9 Summary of impacts resulting from greenhouse gas emissions**

ID	Impact	Likelihood	Consequence	Residual Risk
I06	Significant increase in greenhouse gas emissions	Unlikely	Insignificant	Low

In 2005 the total estimated CO<sub>2</sub>-equivalent emissions for the Northern Territory was 13.5 Mt, for Australia were 597 Mt and in 2007 total emissions worldwide were 27,000 Mt (DCC, 2008; Solomon et al., 2007). When these are compared with the predicted emissions from construction and operation of the project (estimated at 0.05 Mt/a), the project will represent an increase in CO<sub>2</sub>-equivalent emissions of approximately 0.37% relative to the Northern Territory's total emissions, 0.008% relative to Australia's total emissions and less than 0.0001% relative to global emissions. A significant increase in emission of greenhouse gases in Australia due to project development is therefore **unlikely** to occur, the severity of consequence is **insignificant** and the residual risk is **low**.

### 6.3.5 Monitoring Program

The *National Greenhouse and Energy Reporting Act 2007* (NGER Act) establishes a mandatory corporate reporting system for greenhouse gas emissions, energy consumption and production that requires certain facilities and companies to monitor and report on these factors.

The project will trigger both of the NGER Act reporting thresholds for companies required to register and report on greenhouse gas emissions and energy production and consumption. Reporting thresholds are set annually, the 2008 to 2009 corporate reporting thresholds are:

- If facilities are owned that emit greater than 25 kt greenhouse emissions (expressed as CO<sub>2-e</sub>) or produce/consume greater than 100 TJ of energy per annum.
- If the corporate group emits greater than 125 kt of greenhouse emissions (expressed as CO<sub>2-e</sub>) or produce/consume greater than 500 TJ of energy per annum.

Minemakers will monitor, record and report under the NGER Act reporting guidelines:

- Energy production.
- Energy consumption.
- Greenhouse gas emissions.

No additional outcome and assessment criteria are proposed at this stage.

## **6.4 Noise and Vibration**

Existing noise conditions are outlined in Section 6.4.1. Potential, credible project-related impacts associated with noise and vibration are described in Section 6.4.2. The proposed avoidance, mitigation and management measures that will be implemented by Minemakers during all stages of project development are described in Section 6.4.3. The resulting residual noise impacts as a result of the project are discussed in Section 6.4.4. The monitoring program is outlined in Section 6.4.5 and outcome and assessment criteria that will give early warning if management and mitigation measures are failing are identified in Section 6.4.6.

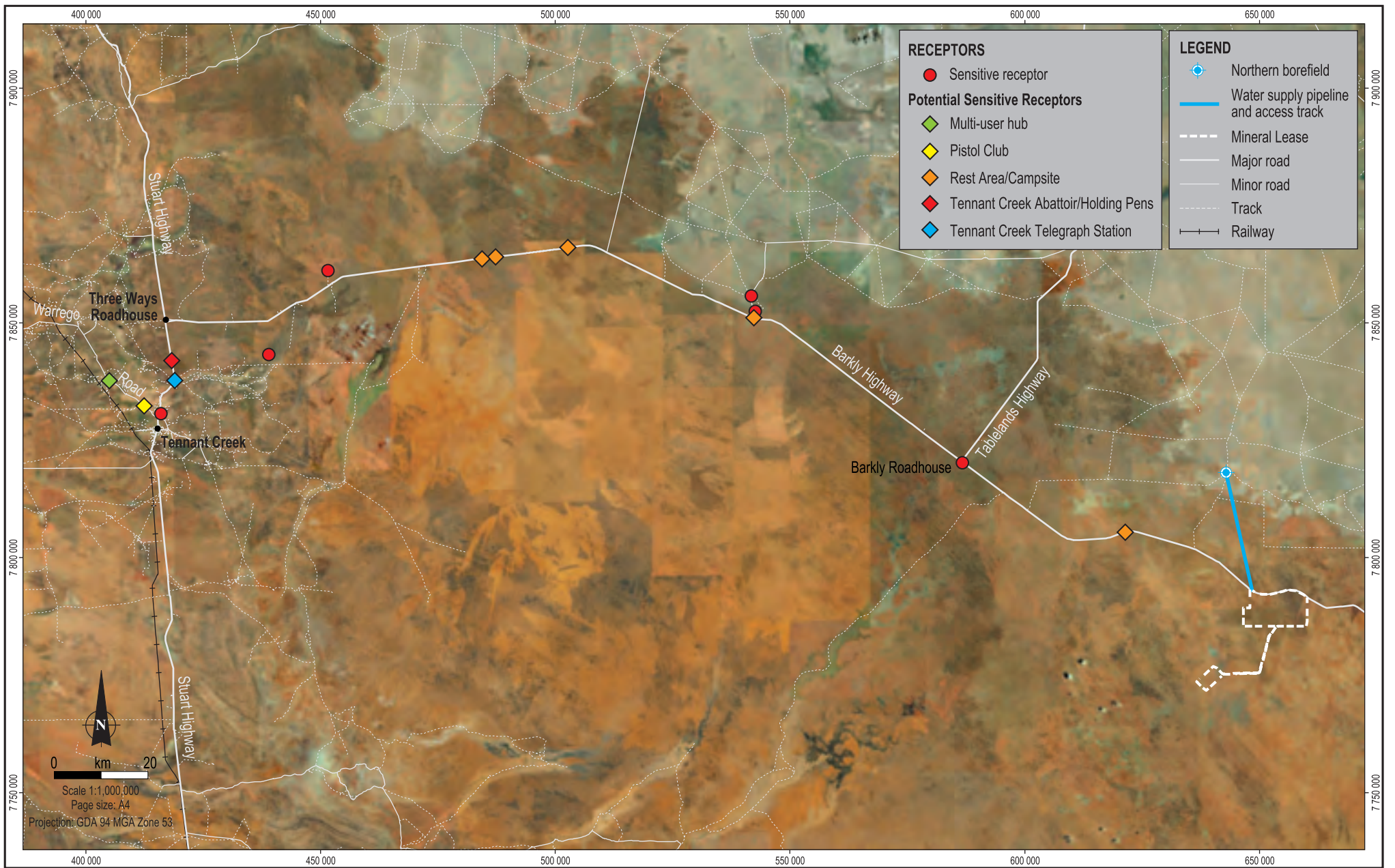
### **6.4.1 Existing Conditions**

No on site ambient noise data has been collected. However, no significant, permanent man-made noise sources are located at or near the project area, other than passing vehicles travelling on the Barkly Highway and noise when exploration activities are underway. The only ongoing noise present is caused by wind blowing over vegetation and noises from insects and birds. The background noise levels are therefore likely to be less than 32 dB(A) during the night and in non-windy periods during the day (MMA, undated).

The nearest sensitive receptors from the mine site, the residents of the Wunara community, are 10 km from the Mineral Lease boundary and approximately 11 km from the nearest source of constant mine-related noise (Figure 6.4). From an occupational health and safety perspective, the sensitive receptor within the Mineral Lease is the accommodation camp, which is located 6 km from the nearest source of constant mine-related noise (crushing and screening area).

Along the ore transport route there are a number of potential sensitive receptors to traffic-related noise, including:

- The Barkly Roadhouse.
- Five rest areas, including some with campsites for travellers on the Barkly Highway.
- Tennant Creek Abattoir/Holding Pens (possibly abandoned).
- Tennant Creek Telegraph Station.
- Tennant Creek Pistol Club.
- Five houses between 0.5 km and 7 km from the ore transport route.



Source:  
Place names, roads and tracks from GEODATA 250k (optimum scale 1:250,000)  
Bore locations from GMP  
Mine layout from GHD and Minemakers  
Mineral lease from DMETIS



Date: 06.11.2009  
MXID: Minemakers\_Wonarah\_GIS.mxd  
File Name: 9014\_07\_F06.4\_GIS\_GL

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Sensitive receptors along the ore transport route – noise

Figure No: 6.4

For the purposes of this impact assessment, sensitive receptors have been defined as permanent residences. Therefore, the five houses and the Barkly Roadhouse have been identified as sensitive receptors. The other potential sensitive receptors listed above were discounted as they are not permanent residences and persons occupying these areas are short-term or transient visitors and would only experience short-term exposure to noisy conditions. In addition, the Tennant Creek Abattoir/Holding Pens and the Tennant Creek Pistol Club were discounted for the above reason and the fact that a relatively high level of noise would be generated at these facilities. Finally, while it is recognised that the Tennant Creek Telegraph Station, within the Tennant Creek Telegraph Station Historical Reserve, is a tourist attraction and as such is sensitive to noise; however, it is not a residence and tourists are only there for a short period of time.

The ore transport route does not pass through the township of Tennant Creek as vehicles will turn off the Stuart Highway on to Warrego Road approximately 2 km north of the Tennant Creek township. Tennant Creek is therefore not considered to be a sensitive receptor for noise.

## **6.4.2 Potential Impacts**

In this section, assessment and discussion of potential impacts to noise and vibration as a result of the construction and operation of the project has an anthropogenic perspective. Impacts on the natural values of the project area as a result of noise and vibration, e.g., flora and fauna, are addressed in their respective sections.

### **Disturbance to Sensitive Receptors from Noise and Vibration Generated within the Mineral Lease**

The project has the potential to cause disturbance to the closest sensitive receptors (i.e., the residents of the Wunara community) from noise and vibration associated with mining activities.

Noise nuisance is generally determined by the noise increment above background noise levels. With noise attenuation by distance travelled over land, this increment above background does not usually extend more than 1 to 2 km from a mine.

The mine construction and operations will produce noise and vibration from both fixed and mobile sources, with the major sources being:

- Vehicles (including reversing alarms).
- Machinery (e.g., drills, loaders, haul trucks, excavators and other ancillary equipment).
- Crushing and screening plant.
- Blasting operations.
- Aircraft landing and taking off at the aerodrome.

### **Disturbance to Sensitive Receptors from Project Related Heavy Vehicle Noise Along the Ore Transport Route**

The movement of heavy vehicles along the ore transport route has the potential to cause disturbance to sensitive receptors (see Figure 6.4) from an increase in noise above existing levels. Table 6.10 shows the expected project-related traffic increase for the Barkly and Stuart highways during construction and operation of the project and the resulting estimated increase in noise levels above baseline.

**Table 6.10 Project-related traffic noise**

Project Stage	Current TPD*		Project-related TPD*	Traffic Increase (%)		Estimated Noise Increase# (dB(A))	
	Barkly Highway	Stuart Highway		Barkly Highway	Stuart Highway	Barkly Highway	Stuart Highway
Construction to 18 months (0 to 1.5 Mt/a)	44	41	64	145	156	4	4
18 months to closure (1.5 to 3 Mt/a)			192	436	468	6	7

\*TPD = Trucks per day (four axle articulated to triple road train as per AUSROADS Vehicle Classification System).

#Turnbull, pers. com., 2009.

### 6.4.3 Avoidance, Mitigation and Management

#### Disturbance to Sensitive Receptors from Noise and Vibration Generated within the Mineral Lease

There is no environmental noise legislation and criteria for mining in the Northern Territory. The South Australian Environmental Protection Agency (EPA) sets Guidelines for Separation Distances (EPA, 2007) to ensure developments are located to minimise impacts caused by noise. For blasting noise associated with mineral extraction greater than 100,000 t/a, the guidelines recommend a minimum separation distance of 0.5 km.

This minimum separation distance of 0.5 km has been adopted during the design of the layout of the project, for both sensitive receptors and the mine workforce. This design has provided separation distances of:

- 10 km from the boundary of the Mineral Lease to the Wunara community.
- 5.7 km from the crushing and screening plant to the workers' accommodation camp.
- 2 km from the closest pit to the workers' accommodation camp.
- 16 km from the closest Arruwurra pit to the workers' accommodation camp.
- 2 km from the aerodrome to the workers' accommodation camp.

Noise levels at the camp will be managed and monitored by Minemakers occupational health and safety systems.

Although the mine will be located too far from sensitive receptors to cause adverse impacts, Minemakers will implement measures to control noise and vibration to provide a safe working environment. To control noise Minemakers will:

- Service all plant, machinery and vehicles regularly.
- Install and maintain standard noise abatement devices (e.g., mufflers) on machinery and vehicles.
- Monitor noise impacts by complaint, developing additional mitigation measures if necessary.

To ensure there are no impacts from the effects of blasting Minemakers will:

- Strictly manage blasting procedures to ensure the comfort of employees and to protect mine infrastructure.
- Design each blast using a suitably qualified person, with initial blasts being conservatively designed.
- Monitor blasting impacts by complaint, developing additional mitigation measures if necessary.

#### **Disturbance to Sensitive Receptors from Project Related Heavy Vehicle Noise Along the Ore Transport Route**

Minemakers will implement the following measures to control noise generated by project related heavy vehicles:

- Service all vehicles regularly.
- Install and maintain standard noise abatement devices (e.g., mufflers) on vehicles.
- Impose speed limits on ore trucks.
- Monitor noise impacts by complaint, developing additional mitigation measures if necessary.

#### **6.4.4 Residual Impact**

Table 6.11 summarises the residual impacts of the project associated with noise and vibration after implementation of the management and mitigation measures.

**Table 6.11 Summary of noise and vibration impacts**

<b>ID</b>	<b>Impact</b>	<b>Likelihood</b>	<b>Consequence</b>	<b>Residual Risk</b>
I07	Disturbance to sensitive receptors from noise and vibration generated within the Mineral Lease.	Rare	Minor	Low
I08	Disturbance to sensitive receptors from project related heavy vehicle noise along the ore transport route.	Unlikely	Minor	Low

#### **Disturbance to Sensitive Receptors from Noise and Vibration Generated within the Mineral Lease**

The Australian and New Zealand Environment and Conservation Council (ANZECC) provides guidelines for blast overpressure and ground vibration for residential receivers (ANZECC, 1990) that protect against startling effects on people. Compliance with these guidelines is considered to also ensure protection of all but the most delicate physical structures. Given the isolation of the project site from populated areas, the potential to disturb residents at sensitive receivers is remote and the guidelines will therefore be met.

Given the separation distance to the nearest sensitive receptor (approximately 11 km from the nearest source of constant mine-related noise), there is virtually no prospect that noise levels at the closest sensitive receptors would be affected by noise emissions from the project.

In relation to occupational health and safety, no worker will be exposed to 8-hour time weighted average (TWA) noise levels of more than 85 dB(A) (as per Work Health (Occupational Health and

Safety Regulations). The project accommodation camp will be located at least 2 km from the closest pit within the Main Zone Deposit, which is the closest source of constant loud noise. Noise from aircraft at the airstrip will be intermittent and is not expected to be of concern to the workforce accommodated on site.

Generation of noise and vibration from this type of project is unavoidable. However, due to the distances to the nearest residence, any impacts on sensitive receptors are **rare**. Comparison with relevant criteria show that the consequences of noise and vibration will be **minor**, giving an overall residual risk ranking of **low**.

### **Disturbance to Sensitive Receptors from Project Related Heavy Vehicle Noise Along the Ore Transport Route**

Human response to noise is subjective and can vary greatly from person to person. Factors that can influence individual response include the loudness, frequency, time pattern, the amount of background noise present before an intruding noise and the nature of the activity (e.g., sleeping) that the noise affects (MMA, undated). However, it is generally considered that an increase of 3 dB(A) is just noticeable, 5 dB(A) is clearly noticeable and a 10 dB(A) increase is perceived as a doubling of noise (Turnbull, pers. com., 2009). Considering this, the noise increase as a result of project related heavy vehicle movements during the initial 18 months will be noticeable, but not significant. However, when operations increase to mining 3 Mt/a, the noise increase on both the Barkly and Stuart highways will be clearly noticeable, and is close to being perceived as doubling of the noise.

Sound levels decrease, or attenuate, over distance. Where topography is flat and vegetation is cleared, traffic related noise decreases by approximately 3 dB(A) each time the distance from the source is doubled (MMA, undated). In reality, other factors influence and can increase noise attenuation over distance. These other factors are:

- Existing structures.
- Topography.
- Foliage.
- Ground cover.
- Atmospheric conditions such as wind, temperature and relative humidity.

Under flat, cleared conditions, 75 m is a reasonable unit of distance from the noise source to use for a 3 dB(A) decrease in noise. Therefore, at 75 m noise would be reduced by 3 dB(A) from the source, at 150 m noise would be reduced by 6 dB(A), at 300 m noise would be reduced by 9 dB(A) and so on (Turner, pers. com., 2009). However, this would be under flat, cleared conditions and considering the factors mentioned above it is likely that attenuation of sound will in fact be greater than 3 dB(A) per 75 m. It should be noted that exceptions to this may occur, when atmospheric conditions result in temperature inversions that may focus or channel sounds.

Noise attenuation over distance will result in negligible increases above existing traffic noise at most sensitive receptors. However, given the distance of the Barkly Roadhouse to the transport route, complete noise attenuation over distance is not possible at this sensitive receptor.

The Barkly Roadhouse is approximately 70 m from the Barkly Highway and as such it is likely that an increase in noise will be experienced, particularly when the mine is operating at 3 Mt/a. However, it is the magnitude of this increase that is important; when operating at the maximum 3 Mt/a, the noise increase is estimated to be 6 dB(A) on the Barkly Highway. Given that 3 dB(A) is

just noticeable, and that some attenuation will occur over the 70 m between the Barkly Highway and the Barkly roadhouse and further dampening of noise will occur due to walls of buildings there will not be a significant disturbance to the roadhouse from project related heavy vehicle noise. Minemakers have discussed the potential increase in noise with the owners of the Barkly roadhouse and the owners believe the Barkly roadhouse will sufficiently dampen the noise from the trucks, particularly given that the short-term camping accommodation is located behind the roadhouse. Minemakers will take necessary mitigation measures to address any noise impacts at the Barkly roadhouse if the owners advise that the increased noise is an issue. Mitigation measures that may be implemented at the Barkly roadhouse, should noise become an issue, may include tree planting along the highway or construction of a bund or other noise screening.

The other sensitive receptor close to the transport route is a residence approximately 0.5 km from the Stuart Highway near the junction with Warrego Road. The maximum estimated noise increase as a result of project related heavy vehicles on the Stuart Highway is 7 dB(A). Therefore, given the noise attenuation over distance discussed above; it is extremely unlikely that the residents at the sensitive receptor will experience an increase above existing noise levels. In addition, the undulating nature of the local topography near the residence would further dampen any noise generated by traffic.

All other sensitive receptors lie at least 1.5 km from the transport route. It is therefore, it is extremely unlikely that the residents at these sensitive receptors will experience an increase above existing noise levels.

Generation of noise from project-related heavy vehicle traffic is inevitable; however, the isolated nature of the project and the distance of sensitive receptors from the transport route mean that the likelihood of disturbing sensitive receptors is **unlikely**. In addition, because the maximum estimated noise increase is 7 dB(A), and is likely to be attenuated to a level below 5 dB(A) (considered a clearly noticeable increase) within 75 m of the transport route and below 3 dB(A) (considered a just noticeable increase) within 150 m of the transport route, any consequences of increased noise are likely to be **minor**, giving an overall residual risk rating of **low**.

## 6.4.5 Monitoring Program

### Noise Monitoring

No noise monitoring will be conducted unless complaints arise. Minemakers will investigate and act upon any complaints regarding the noise levels of the operations outside of the mine site.

Monitoring of staff and contractor exposure to noise will be conducted as required as part of the project's health and safety system, to ensure that the workplace complies with occupational health and safety noise limits.

### Vibration Monitoring

No monitoring will be conducted unless complaints arise. If complaints indicate that agreed control measures are not adequate, Minemakers will assess whether additional mitigation measures are required.

## 6.4.6 Outcome and Assessment Criteria

The outcome and assessment criteria for noise and vibration are outlined in Table 6.12.

**Table 6.12 Outcome and assessment criteria – noise and vibration**

<b>ID</b>	<b>Impact</b>	<b>Outcome</b>	<b>Assessment Criteria</b>	<b>Summary of Management and Mitigation Measures</b>
I07	Disturbance to sensitive receptors from noise and vibration generated within the Mineral Lease.	No disturbance to sensitive receptors from noise and vibration at the mine	Complaints register to show no reasonable complaint unaddressed.	Maintain separation distance. Service all plant, machinery and vehicles regularly. Install and maintain standard noise abatement devices on machinery and vehicles. Design each blast using a suitably qualified person, with initial blasts being conservatively designed. Maintain complaints register.
I08	Disturbance to sensitive receptors from project related heavy vehicle noise along the ore transport route.	No significant increase in traffic related noise at sensitive receptors along the ore transport route.	Complaints register to show no reasonable complaint unaddressed.	Service all vehicles regularly. Install and maintain standard noise abatement devices on vehicles. Speed limiting ore trucks. Maintain complaints register.

## 6.5 Landform, Geology and Soils

Existing landform, geology and soils in the project area are described in Section 6.5.1. Potential, credible project-related impacts on landform, geology and soils are described in Section 6.5.2. The proposed avoidance, mitigation and management measures that Minemakers will employ during all stages of project development are described in Section 6.5.3. The resulting residual impacts are discussed in Section 6.5.4, the monitoring program is detailed in Section 6.5.5 and the outcome and assessment criteria in Section 6.5.6.

### 6.5.1 Baseline Description

This section describes the existing landform, geology and soils of the project area.

#### Landform

The project is located on the undulating plains of the Barkly Tableland. The landform of the project area has a general low relief, although small rocky outcrops are locally common (Plates 6.1 and 6.2). Across the Barkly Tableland there is generally only a very gentle relief, which varies less than 50 m in elevation from the highest to lowest point (Edgoose, 2003) (Figure 6.5).

#### Geology

The Barkly Tablelands consist of Tertiary clay deposits overlying calcareous Cambrian deposits. Detailed discussion on the regional geology for this project is discussed in Section 5.3, Geology and Resources.

The proposed mine site consists of two distinct phosphate deposits; the Arruwurra and the Main Zone. The geology of each deposit is discussed in detail in Section 5.3. Notwithstanding the



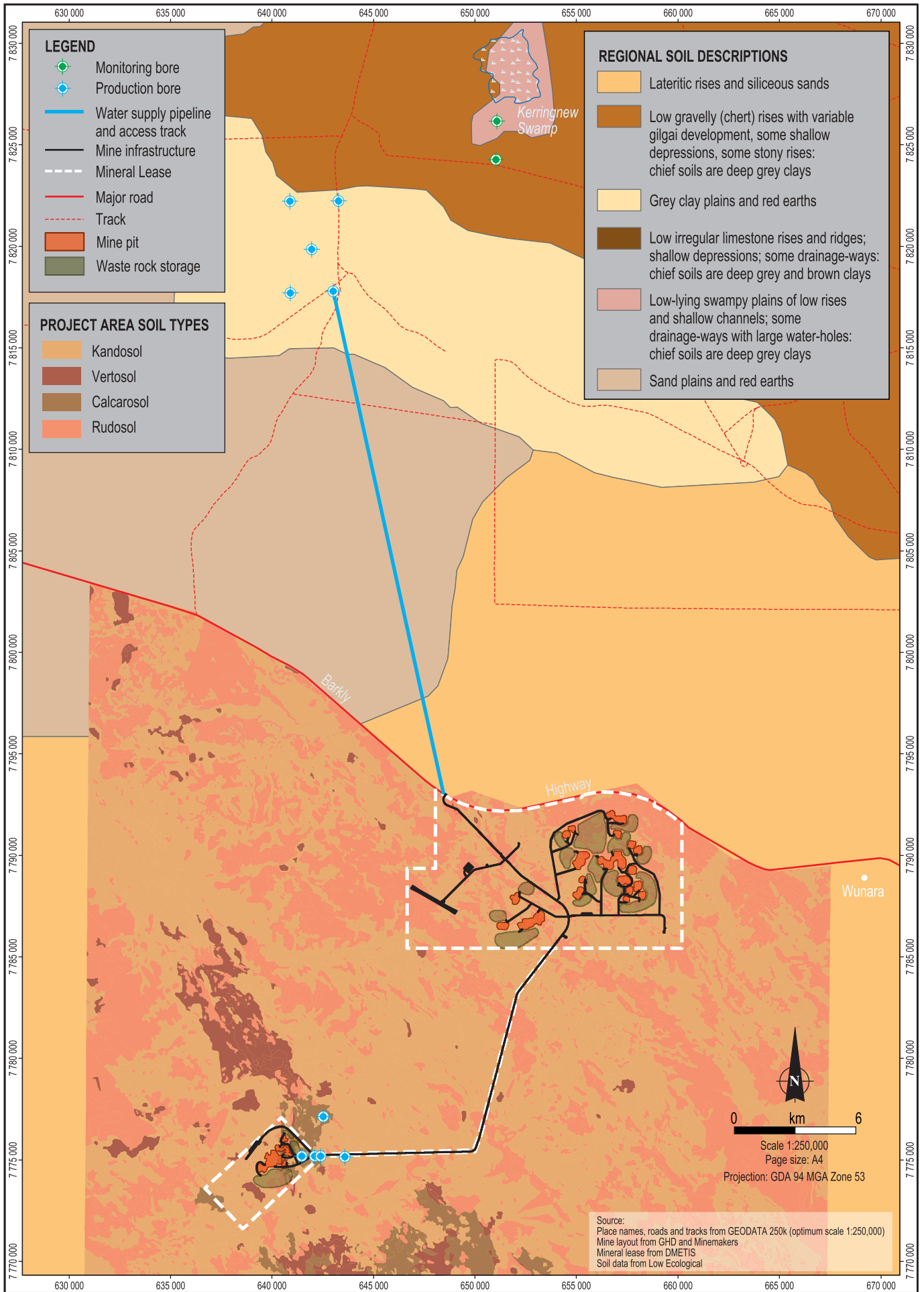
**Plate 6.1**  
Typical landform at Wonarah



**Plate 6.2**  
Typical rocky outcrop at Wonarah



**Plate 6.3**  
Tennant Creek police station



presence of the phosphate deposits, no significant geological formations or features are present within the project area.

## **Soils**

As defined by the Bureau of Rural Sciences (Appendix 8A), the soils of the project area fall into three soil classes, lateritic rises and siliceous sands (By4), sand plains and red earths (My80) and grey clays with red earths (CC61).

Lateritic rises and siliceous sands are described as encompassing undulating ridge and slope terrain on lateritic sediments with some rock outcrops. The predominant soils are shallow sands usually containing large amounts of mixed and variable gravels or ironstone gravels, and also soils with some gravels on ridges and upper slopes. Associated soils are shallow to deep varieties of soils on mid and lower slopes. Small areas of other soils are also likely to be found within the lateritic rises and siliceous sands unit. Sand plains and red earths are described as gently undulating plains slightly elevated above the adjoining cracking clay pans with some ridges and hills, and some shallow depressions. The most common soils on long gentle slopes and low rises are neutral red earths with a variable content and surface scatter of ironstone gravels. Associated soils are sands with red and yellow earthy subsoils on slopes and in depressions, loamy soils such as neutral red earths and acid yellow earths marginal to cracking clay plains, and some shallow gravelly and stony soils on ridges and hills.

Grey clays with red earths are described as flat to gently undulating plains of grey clays interspersed with low undulating rises of red earths. The northern borefield is identified in the broadscale Bureau of Rural Sciences mapping as having grey clays with red earths and while the area of the northern borefield was not ground truthed during field investigations, a desktop assessment using the Australian soil classification identified that this is likely to be made up of Epicalcareous Endohypersodic grey Sodosols, Vertosols and red Dermosols (Appendix 8A).

The broadscale mapping of the Bureau of Rural Sciences was ground-truthed for the Mineral Lease area during a field investigation conducted by Low Ecological Service Pty Ltd in March 2009 (Appendix 8A), using methods based on the Australian Soil and Land Survey Field Handbook (NCST, 2009). Based on the field investigation, soils within the project area were classified into four major soil classifications as per the Australian soil classification system: Kandosols, Vertosols, Calcarosols and Rudosols.

Kandosols and Rudosols dominate the sand plains within the project area, while Vertosols and Calcarosols are restricted to areas subject to inundation (e.g., ephemeral lakes) and two localities in the southern end of the project area, respectively (see Figure 6.5).

## **Soil Erosion**

Low Ecological Service Pty Ltd assessed the erodibility of soils in the project area during the field investigation in March 2009, with most soils assessed to have a low potential for erosion. Deep soils (mostly Rudosols with loose rock aggregations) on sloping terrains overlain by deep clayey sands, e.g., such as those found in the northeast corner of the Mineral Lease, were assessed as being susceptible to erosion. Minor gully erosion has occurred within the project area along existing exploration tracks.

## 6.5.2 Potential Impacts

Construction and operation of the project will involve the excavation and movement of large volumes of material within the project's proposed footprint. Specifically, activities that will involve the excavation and movement of soil on site will include removal and storage of topsoil and waste rock, construction of roads, and excavation of the phosphorite deposit. These activities could significantly affect the landform and quality of soil in the project area if not managed correctly.

Issues associated with rehabilitation of the project area as a result of mining are discussed in Chapter 8 and are only discussed here as they relate specifically to landform and soils. There are no credible impacts to geology as a result of the project (other than the removal of the resource, which is the intention of the mine) and as such geology is not discussed further in this chapter.

Potential impacts to landform and soils due to the project include:

- Unstable landforms.
- Significant reduction in soil quality.

These are discussed in more detail below. The potential impacts do not take into consideration the proposed avoidance, mitigation and management measures that will be implemented by Minemakers during all stages of project development and which will result in the residual impacts discussed in Section 6.5.4.

### Unstable Landforms

Approximately 161 Mm<sup>3</sup> of material will be excavated from the 23 mine pits during operation of the mine. Depending on the mining method used, waste rock will either be backfilled into voids as mining progresses (for strip mining method) or be stockpiled adjacent to the pits (for conventional open pit mining method). Where pits are not backfilled, a final void and waste rock stockpile will remain.

This change in landform, through the creation of waste rock storages and voids, will result in a change to the landform from pre-mining to post-mining. The stability of this post-mining landform will be dependent upon the landform design. Mass failure of the landform could result in substantial increases in sediment entering the surface water system. The potential impact of mass landform failure to humans is discussed in Chapter 7. Discussion of changes to the use of the land as a result of the change in landform is provided in Section 6.6.

### Significant Reduction in Soil Quality

Reduction in soil quality may be due to a number of factors, including an altered soil profile, compaction, contamination and erosion. A significant reduction in the quality of soil in the project area will present problems for the successful rehabilitation and revegetation of the site, and consequent compliance with agreed closure completion criteria, i.e., that the project area is returned to as close to pre-mining condition as possible. The potential causes and effects of this are discussed below.

**Due to altered profile**—as part of the construction and operation of the project, topsoil and subsoil will be removed and stockpiled. If this topsoil and subsoil is not stored in appropriately segregated areas (i.e., the topsoil and subsoil is allowed to mix), and not replaced in accordance with the profile in which it was removed, there will be a reduction in the quality of the soil in mined out areas to be rehabilitated.

**Due to compaction**—heavy machinery used during construction and operation of the project will compact the soil. This compaction will reduce the permeability of the soil, leading to increased surface runoff of water from disturbed areas and subsequent increased rates of erosion during and after rainfall, ultimately reducing the quality of soil in the project area. This soil may require treatment (e.g., ripping) before rehabilitation activities can take place.

**Due to contamination**—the soil in the project area may be contaminated during construction and operation activities due to seepage from putrescible waste and spills at chemical and fuel storage areas. Geochemical analysis classified the waste rock and non-DSO as non-acid forming and has low solubility (see Section 5.3); therefore, contamination from waste rock storages is not a concern for this project.

**Due to erosion**—all disturbed soils and stockpiled soils in the project area may be subject to erosion by wind and water. This erosion has the potential to remove soil from the project area, with consequent reduction in the quality of soil in the project area able to be used during rehabilitation. Analysis of the erodibility of soils present in the project area (Appendix 8A) determined that most soils had low potential for erosion, except for deep soils on slopes.

### **6.5.3 Avoidance, Mitigation and Management**

Minemakers will implement avoidance, mitigation and management measures to address the potential impacts on landform and soils. These measures will reflect current good practice at similar mines operating in similar environments.

#### **Unstable Landforms**

Successful rehabilitation of disturbed areas will increase the stability of post-mining land forms and minimise the potential for long term changes to the landform and landscape as a result of the project. Rehabilitation will be designed to achieve the agreed post-mining landform described in the mine closure and rehabilitation plan (see Chapter 8).

While rehabilitation and mine closure planning will continue to be refined during the life of the mine, generally the landform aspect of the project will be rehabilitated as follows:

- Open pits will be progressively backfilled with waste rock where practicable and economic during mining. The areas will be contoured, topsoil will be spread and they will be revegetated with native species. At the completion of mining some final voids may be left unfilled. Bunds will be formed around any of these final voids at a distance of at least 25 m to prevent accidental access to the edge of the void.
- Waste rock storages (including non-DSO stockpiles) will remain at completion of mining and these will be contoured to low hills not exceeding 20 m above the natural ground level, spread with topsoil (if necessary for successful rehabilitation) and revegetated with native species.
- No slopes of waste rock storages will exceed 18° to maximise the stability of these landforms.
- Other disturbed areas will be rehabilitated.

#### **Significant Reduction in Soil Quality**

To maximise the potential for successful rehabilitation of disturbed areas soil quality will be maintained as close to baseline levels as possible. To ensure the integrity of the soil quality, the following mitigation measures will be implemented during the mining process:

**Due to altered profile**—prior to development of any site infrastructure, including the pits, the topsoil layer will be stripped. Where possible stripped topsoil will be immediately reused elsewhere to preserve the seed store and nutrients. When immediate reuse is not possible, topsoil will be stored in stockpiles no higher than 2 m and adjacent to the area of clearance in readiness for reuse in rehabilitation. Where possible, stockpiles will be respread within three to six months of removal.

**Due to compaction**—to reduce the effects of compaction, all areas where the soil has been compacted during construction and operation (other than those with infrastructure to remain after closure) will be ripped, spread with topsoil and revegetated with native species.

**Due to contamination**—if mining works result in contamination of the soil, then the soil will be appropriately remediated and site contamination assessment will be carried out before Minemakers is released from its closure obligations.

Measures to manage waste and minimise the potential for contamination of soil due to spills are described in Attachment 5.

**Due to erosion**—sediment and erosion control measures will be incorporated in the erosion and sediment control management plan. These sediment and erosion control measures will be developed to control and mitigate the soil erosion that may occur. They will include general measures to maintain soil quality such as:

- Restricting clearing to essential areas and minimising the area of exposed cleared land.
- Watering unsealed roads and other dust sources during windy conditions.
- Minimising the period of time subsoil is exposed and topsoil is stored.
- Minimising disturbance to the ground layer by restricting machinery access from areas not required for project works, and through selection of equipment that will minimise disturbance (e.g., track type, weight, weight to track size ratio).
- Undertaking progressive rehabilitation and revegetation.

Many of these measures are common to the general rehabilitation and revegetation measures to minimise erosion. Details of these are provided in Chapter 8.

Measures specific to controlling sediment, and therefore maintaining the local quality of soil, include:

- Installing sediment traps downslope of stockpiles (including topsoil, subsoil, non-DSO and waste rock) to prevent eroded sediment entering drainage lines.
- Controlling drainage and diverting it away from infrastructure.
- Diverting clean water away from disturbed areas through diversion channels.
- Directing runoff from exposed subsoil to sedimentation ponds.

## 6.5.4 Residual Impact Assessment

The physical effects on land from excavation and mining will be evident. In the case of mining, the impact will involve some permanent landform changes, in the form of remnant waste rock storages and final pit voids.

Management measures will be adopted to stabilise disturbed areas and contain erosion, followed by rehabilitation, monitoring and remedial works as required. These measures are intended to confine impacts to the vicinity of active work areas and promote recovery from the short-term impacts of construction and operation.

Table 6.13 summarises the residual impacts of the project on the landform, geology and soils, considering the likelihood and consequence of the predicted impacts after the successful implementation of control and mitigation measures. The assessments of these are described in further detail below.

**Table 6.13 Summary of land resources impacts**

ID	Impact	Likelihood	Consequence	Residual Risk
I09	Unstable landforms	Unlikely	Minor	Low
	Significant reduction in soil quality			
I10	Due to altered profile	Unlikely	Minor	Low
I11	Due to compaction	Unlikely	Minor	Low
I12	Due to contamination	Unlikely	Minor	Low
I13	Due to erosion	Possible	Moderate	High

### Unstable Landforms

The setting of the mine and its associated infrastructure in the gently undulating plains of the Barkly Tablelands means that there will be a change to the landform as a result of the project. This will include final disturbance areas totalling approximately 1,385 ha, which will include final voids and waste rock storages. The waste rock storages and non-DSO stockpiles will also result in a change to the pre-mining landform by providing localised topographic highs in otherwise gentle relief areas. However, the design of the post-mining landform will be based on best practice and existing landform design used in similar mining operations and will provide for a stable landform. The likelihood of mass failure or unstable landforms is therefore **unlikely**.

This changed landform, be it pit voids or material stockpiles, will result in a change to the visual landscape of the project area. Successful rehabilitation of disturbed areas and compliance with agreed closure completion criteria will ensure that any long term visual impact is minimal.

The approximate area of portions of land subject to the Mineral Lease is 10,846 ha. Mining and associated infrastructure will disturb approximately 2,325 ha, with a residual disturbance area following rehabilitation post-mining of 1,385 ha. Therefore, the consequence of these changes to landform will be **minor**, as the area disturbed from mining activities will be contained to a small local area. The resulting residual risk is therefore **low**.

## Significant Reduction in Soil Quality

The successful rehabilitation of disturbed areas within the mining lease will be reliant on the resulting soil quality at the completion of mining. Failure to maintain soil quality may result in a diminished capacity to establish vegetation due a poor growth medium. The risk of this occurring is discussed below.

**Due to altered profile**—by following the management and mitigation measures to handle, store and replace excavated topsoil and subsoil described above, it is **unlikely** that the project will result in a significant long term reduction in soil quality due to an altered profile. Should it occur, the impacts of this altered profile will be **minor** as the re-handling of soil can occur prior to machinery being moved off-site at the completion of mining; the resulting in a residual risk is therefore **low**.

**Due to compaction**—soil will be compacted during construction and operation of the project. However, management and mitigation measures will be used to minimise the potential for this and to rehabilitate compacted soil. These measures are readily available and standard practice in earthworks activities. Therefore, it is **unlikely** that there will be a significant long term reduction in soil quality due to compaction. Should it occur, the consequence of this impact will be **minor**, as it will be relatively straightforward to rehabilitate. The residual risk is therefore **low**.

**Due to contamination**—soil may be locally contaminated by project activities (e.g., spill of fuel, discharge of hydraulic fluid); however, spill response measures will be followed to ensure that the impacts of the spill are minimised. With these measures in place, it is **unlikely** that this project will cause a significant long term reduction in soil quality due to contamination. The consequence of any reduction in soil quality due to contamination is **minor**, as widespread contamination from mining activity is unlikely (particularly given the geochemical characterisation of mine material, as discussed in Section 5.3). Given the unlikely possibility this will occur and its minor consequence, the residual risk is **low**.

**Due to erosion**—given the large volumes of ground to be disturbed during construction and operation of the project, erosion will affect the quality of soil in the project area. However, management and mitigation measures will be used to minimise the spatial and temporal extent of this erosion. These measures are common to the mining and earthworks industries and will be adapted as site conditions demand. Implementation of surface water management measures outlined in Section 6.10 will also assist in managing erosion due to water (e.g., direction of sediment-laden water to sediment ponds). However, it is **possible** that the project will result in a long term reduction in soil quality due to erosion. The consequence of a long term reduction in soil quality due to erosion, should it occur, will be **moderate**, as there may be direct or indirect environmental impacts as a result. The residual risk is therefore **high**.

### 6.5.5 Monitoring Program

#### Landform

The stability of the landform in the project area (e.g., pit walls, batters, waste rock storages) will be routinely monitored as part of construction and operation activities. Landform changes will be monitored through the mine closure and rehabilitation plan to ensure that progressive rehabilitation is meeting closure criteria.

Photo monitoring points will be established adjacent to proposed pit locations and photographic data will be collected on an annual basis once mining of the pit commences. Once rehabilitation commences, photographic data will be collected on a six monthly basis to ensure seasonal variation is captured.

## Soils

Monitoring of soils will be addressed through the Erosion and Sediment Control Management Plan (see Attachment 5), the monitoring programs for dust (see Section 6.2.5) and the treatment of waste should contaminated soil be disturbed (see Chapter 9).

### 6.5.6 Outcome and Assessment Criteria

The outcome and assessment criteria for soils and landform are outlined in Table 6.14.

**Table 6.14 Outcome and assessment criteria – landform and soils**

ID	Impact	Outcome	Assessment Criteria	Summary of Management and Mitigation Measures
I09	Unstable landforms.	Landform is stable.	Slopes within the Mineral Lease are stable with drainage patterns consistent with the pre-mine landform.  Slopes of waste rock storages and stockpiles do not exceed 18°.	Progressively backfill and contour open pits.  Contour waste rock storages and non-DSO stockpiles.  Progressively rehabilitate disturbed areas.  Refine final mine closure and rehabilitation measures based on results of progressive rehabilitation.
I10, I11, I12, I13	Significant reduction in soil quality due to altered profile, compaction, contamination and/or erosion.	No reduction in soil quality.	Verification testing of soils contaminated as a result of mining activities show remediation has been successful.  Compacted areas no longer required for mining activities have been ripped and revegetated.  No visible gully erosion.	Implement management measures for waste and hazardous materials (including spill response procedures).  Remediate contaminated soil.  Implement Erosion and Sediment Control Management Plan.

## 6.6 Land Use

This section identifies the land uses potentially affected by the project, with existing land uses in the project area described in Section 6.6.1. Potential, credible project-related impacts on land use are described in Section 6.6.2. The proposed avoidance, mitigation and management measures that Minemakers will employ during all stages of project development are described in Section 6.6.3. The resulting residual impacts are discussed in Section 6.6.4, the monitoring program is detailed in Section 6.6.5 and the outcome and assessment criteria in Section 6.6.6.

### **6.6.1 Baseline Description**

The Traditional Owners use the project area and surrounds for hunting and gathering and for accessing culturally significant sites. Broadscale land use mapping identifies the project area as having grazing, natural vegetation and traditional Indigenous use (Owen and Meakin, 2003). Surrounding pastoral properties are grazed with beef cattle and pastoral activities are currently only carried out in the northern borefield section of the project area. The project area and surrounds has also been used for mineral exploration, including drilling, periodically over the past 40 years.

There is little development in the area, with the closest populated area being the Wunara community, located approximately 10 km east of the northeast corner of the Mineral Lease boundary. The project area lies within the Arruwurra portions of Aboriginal Land.

### **6.6.2 Potential Impacts**

Potential, credible project-related impacts to land use are described below. These do not take into consideration the proposed avoidance, mitigation and management measures that will be implemented by Minemakers during all stages of project development and which will result in the residual impacts discussed in Section 6.6.4.

Potential impacts to land use as a result of the project include:

- Reduced availability of land for traditional hunting and gathering.
- Restriction of Traditional Owner access to sites of cultural significance.
- Significant reduction in land for potential pastoral use.

#### **Reduced Availability of Land for Traditional Hunting and Gathering**

The project area currently provides some value to the Traditional Owners as an area in which they practice traditional hunting and gathering. Project-related land clearance will result in a temporary reduction in the area available for hunting and gathering; Traditional Owners will also be restricted from entering the Mineral Lease during the life of the mine.

#### **Restriction of Traditional Owner Access to Sites of Cultural Significance**

Several culturally significant sites occur near, but outside, the Mineral Lease. The historical development of exploration tracks has provided easy access to these sites by Traditional Owners. Access to these sites via the exploration tracks to the east of the Mineral Lease will not be permitted during the life of the mine, as they either directly intercept the mine site or will be converted to haul roads. For the safety of the Traditional Owners and mine staff, the means of access to some culturally significant sites will therefore change and may require indirect routes.

#### **Significant Reduction in Land for Potential Pastoral Use**

Cattle grazing is the predominant land use of the Barkly Tablelands, with approximately 35% of the Northern Territory herd raised on the Barkly Tablelands (EnviroNorth, Undated). The project area to the north of the highway, that incorporates the northern borefield and water supply pipeline, is currently used for pastoral purposes; however, the mine site area, to the south of the highway, is not currently being used for this purpose but is suitable for cattle grazing.

There will be some loss of actual grazing land during the life of the mine at the northern borefield as the five proposed bores will be fenced to prevent access by grazing animals. There will also be a loss of potential grazing area in areas of the Mineral Lease to be used by the project.

### 6.6.3 Avoidance, Mitigation and Management

Minemakers will implement avoidance, mitigation and management measures to address the potential impacts on land use. These measures will reflect current good practice at similar mines operating in similar environments and are described below.

#### Reduced Availability of Land for Traditional Hunting and Gathering

The immediate loss of land for traditional hunting and gathering will be compensated for, as agreed during discussions and negotiations with the Traditional Owners and the Central Land Council (CLC) and Minemakers and will be formalised in a Mining Agreement between the parties. Rehabilitation and revegetation of the project area and the implementation of safety features (bunds) post mining will assist in the project area being suitable for hunting and gathering use after mining has finished.

#### Restriction of Traditional Owner Access to Sites of Cultural Significance

Prior to construction of the project Minemakers will develop alternative access routes to the sacred sites in consultation with the Traditional Owners and the CLC. These access routes will be designed to ensure safe access to the sites and the safe operation of the mine; it is likely that access routes will be restricted to the western side of the Mineral Lease boundary and not allow for unauthorised crossing of haul roads.

#### Significant Reduction in Land for Potential Pastoral Use

The rehabilitation measures described in Chapter 8, Mine Closure and Rehabilitation, will enable large areas of the mine site to be rehabilitated to a function similar to the surrounding land use and could therefore be used for grazing if desired; however, it is recognised that the mine site is not currently used for pastoral purposes and not part of a pastoral lease. The northern borefield and associated water supply pipeline is located on a pastoral lease. To minimise any permanent disturbance to the pastoral lease, the water supply pipeline will be buried and the borefield disturbance area restricted to the immediate area of the bore.

### 6.6.4 Residual Impact

Table 6.15 summarises the residual impacts of the project on land use, considering the likelihood and consequence of the predicted impacts after the successful implementation of control and mitigation measures. The assessments of these are described in further detail below.

**Table 6.15 Summary of land use impacts**

ID	Impact	Likelihood	Consequence	Residual Risk
I14	Reduced availability of land for traditional hunting and gathering.	Almost Certain	Insignificant	Low
I15	Restriction of Traditional Owner access to sites of cultural significance.	Rare	Minor	Low
I16	Significant reduction in land for potential pastoral use.	Unlikely	Insignificant	Low

### Reduced Availability of Land for Traditional Hunting and Gathering

It is **almost certain** that the amount of land available for traditional hunting and gathering by Traditional Owners will be reduced in the project area. However, the consequence of this will be **insignificant**. The loss of land available for hunting and gathering will be temporary, i.e., during the life of the mine, and comprise 32% of the lots subject to the Mineral Lease (refer Chapter 1). The total area that will not be available for traditional hunting and gathering as a result of mining is 0.4% of the total land owned by and available to the Arruwurra Aboriginal Corporation (approximately 611,051 ha). This provides a significant amount of similar land surrounding the project area that is available and suitable for hunting and gathering purposes. Minemakers will also consult with the Traditional Owners and the CLC to determine appropriate compensation prior to the project proceeding. The residual risk is therefore **low**.

### Restriction of Traditional Owners Access to Sites of Cultural Significance

It is almost certain that the Traditional Owners residing in, or accessing the culturally significant sites from, the Wunara Community will have a reduction in their ease of access to these sites as a result of the project; however, access to the sites will not be restricted as a result of the mining activities. Safe, alternative access routes will be developed in consultation with the Traditional Owners. As a result, the **rare** likelihood and **minor** consequence of the impact presents a **low** residual risk.

### Significant Reduction in Land for Potential Pastoral Use

The Barkly Tableland is approximately 100,000 km<sup>2</sup> in area (Edgoose, 2003) and is used predominantly for pastoral purposes. The disturbance area of the project is estimated to be 2,326 ha, with this disturbance area being reduced to approximately 1,385 ha once rehabilitation has been completed post-mining.

The approximate disturbance area that will be excluded from grazing in the bore field to the north of the highway amounts to approximately 6.0 ha. The likelihood of a significant reduction in land for potential pastoral use is therefore **unlikely**. Minemakers will revegetate disturbed areas, which will result in the project area being suitable for grazing in the future, should this be desired. The consequence is therefore **insignificant**, giving an overall risk ranking of **low**.

## 6.6.5 Monitoring Program

No formal monitoring of impacts on land use is proposed, except by complaint.

## 6.6.6 Outcome and Assessment Criteria

The outcome and assessment criteria for land use are outlined in Table 6.16.

**Table 6.16 Outcome and assessment criteria – land use**

ID	Impact	Outcome	Assessment Criteria	Summary of Management and Mitigation Measures
I14	Reduced availability of land for traditional hunting and gathering.	Minimal reduction in Arruwurra Aboriginal Corporation land available for traditional hunting and gathering.	Complaints register to show no reasonable complaint unaddressed.	Land access agreement in place.

**Table 6.16 Outcome and assessment criteria – land use**

<b>ID</b>	<b>Impact</b>	<b>Outcome</b>	<b>Assessment Criteria</b>	<b>Summary of Management and Mitigation Measures</b>
115	Restriction of Traditional Owner access to sites of cultural significance.	Alternative access routes to be agreed in consultation with Traditional Owners.	Complaints register to show no reasonable complaint unaddressed.	Land access agreement in place.
116	Significant reduction in land for potential pastoral use.	No significant reduction in land for potential and actual pastoral use.	Complaints register to show no reasonable complaint unaddressed.	Progressively backfill open pits. Progressively rehabilitate areas no longer required for mining.

## 6.7 Flora

Existing flora communities and species in the project area are described in Section 6.7.1. Potential, credible project-related impacts associated with flora communities and species are described in Section 6.7.2. The proposed avoidance, mitigation and management measures that Minemakers will implement during all stages of project development are described in Section 6.7.3. The resulting residual impacts of the project to flora communities and species are discussed in Section 6.7.4, the monitoring program is detailed in Section 6.7.5 and the outcome and assessment criteria in Section 6.7.6.

### 6.7.1 Baseline

The baseline characterisation of the composition, structure and diversity of flora species in the project area is based on database searches and vegetation surveys completed by Low Ecological Associates Pty Ltd (LOW) in March 2009 (Appendix 8A). This work builds upon previous similar work completed by Low Ecological Associates Pty Ltd in June 2008. The June 2008 survey followed a bushfire, which burnt much of the vegetation within the project area and reduced the possibility of species identification. The March 2009 survey followed favourable summer rains and regrowth was extensive with the area showing good signs of regeneration. A further desktop survey of the northern borefield and associated water supply pipeline route was carried out by LOW in October 2009 (Appendix 8B).

Site descriptions and flora surveys were based on the Northern Territory guidelines and field methods for vegetation survey and mapping (Brocklehurst et al., 2007), with some additional techniques tailored to suit the scope of works required for this project. Survey work was conducted under the Northern Territory's Department of Natural Resources, Environment, the Arts and Sport (DNRETAS) scientific permit number 28357.

Traditional Owners attended the March 2009 survey and were consulted regarding the identification of flora of Indigenous value.

Vegetation survey methods were the same for both surveys. Desktop studies identified six land units in the study area (see Appendix 8A for further description). Eight 200 m by 200 m quadrats

were established in the five accessible land units representative of the project area. For each land unit, six quadrats were located in the proposed impact zones and two were located in likely non-impact zones. The quadrats located in likely non-impact zones were chosen for suitability for future monitoring programs to assess impacts of the project on local biodiversity and significant species. At each quadrat detailed information was recorded to determine species presence, abundance and vegetation quality (where this considered distance to disturbance and presence of introduced species), including:

- Physical description (e.g., landform).
- Vegetation community.
- Plant species presence.
- Structural complexity.
- Degree of disturbance.

In addition to the Northern Territory survey guideline techniques, a 200 m transect was established in each quadrat for ongoing monitoring of vegetation abundance. Vegetation was recorded at 1 m intervals along transects, at incremental height classes. The amount and type of substrate was also recorded.

A search for significant species was carried out in all quadrats as part of the survey process and where significant plant species were identified they were classified at the:

- National level, i.e., listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- Territory level, i.e., listed under the *Territory Parks and Wildlife Conservation Act* (TPWC Act).
- Regional level, as outlined in White et al., (2000).
- Local level, as outlined in White et al., (2000), Traditional Owners and the CLC.

At each quadrat, dominant species at four strata (emergent tree layer, upper shrub layer, lower shrub layer and ground layer) were recorded as a total percent of vegetation cover. Vegetation communities were classified based on Wilson et al., (1990), but were modified to be more representative of the fine scale survey.

Plant voucher specimens were identified by a local botanist using reference from the Northern Territory herbarium.

Downstream impact assessment was carried out by Groundwater Resource Management (GRM), for discussion see Section 6.10.

## **Existing Conditions**

### **Summary**

At a broadscale the project area is dominated by the Yelverloft land system and characterised by skeletal soils and gravelly lateritic earth with *Eucalyptus brevifolia* or *E. dichromophlora* woodlands. The Arruwurra mine area and a section of the water supply pipeline is on the Wonarah land system and is characterised by gently undulating land with lateritic red earths with *Eucalyptus brevifolia* woodland or *Eucalyptus spp.* (low mallees) – *Acacia spp.* shrubland. Part of the northern borefield lies within the Wonarah/Barkly land system, described as gently undulating to nearly flat with *Astrebla pectinata* (Mitchell grass) plains.

At a finer scale the flora surveys identified that the Mineral Lease is dominated by: sand plains and the associated vegetation (*Acacia*, *Grevillea* and *Hakea* over *Aristida* and *Triodia*); open woodlands and the associated vegetation (*Acacia*, *Eucalyptus*, *Hakea*, and *Melaleuca* over *Triodia*); and rocky rises and the associated vegetation (*Acacia*, *Eucalyptus* over *Triodia*). The vegetation in the borefield is dominated by *Eucalyptus microtheca* low open-woodland with bluebush (*Chenopodium auricomum*) sparse shrubland understorey, and Mitchell grassland (*Astrebla* sp.) and a minor component of gidgee (*Acacia georginae*) low open woodland with Mitchell open grassland understorey. These vegetation communities are common and widespread throughout the Yelverloft land system.

Approximately 60% of the Mineral Lease had been burnt just prior to the June 2008 survey, which left 48% denuded in the affected areas. The March 2009 survey recorded bare ground of 19%, an indication of the degree of regeneration after the fire.

Searches of the NT Parks and Wildlife Flora Atlas (Appendices 8A and 8B) and field surveys identified no vegetation communities or flora species listed under the EPBC Act in the project area. No vegetation communities listed under the TPWC Act were recorded in the project area. However, thirteen species listed under the TPWC Act have been recorded in the region, with four species being recorded in the project area. Two near threatened species, *Bergia barklyana* and *Hibiscus brachychlaenus*, and two data deficient species, *Distichostem barklyanus* and *Heliotropium pulvinum*, listed under the TPWC Act were identified during the March 2009 survey.

No *Sporobolus latzi* specimens were identified during surveys in March 2009 specifically targeted to detect its presence.

Two environmental weed species, *Cenchrus ciliaris* (buffel grass) and *Aerva javanica* (kapok bush) were recorded during the March 2009 survey. While these species are not listed under the Northern Territory's *Weeds Management Act*, buffel grass has led to a degradation of native habitats along drainage systems in central Australia (Appendix 8A).

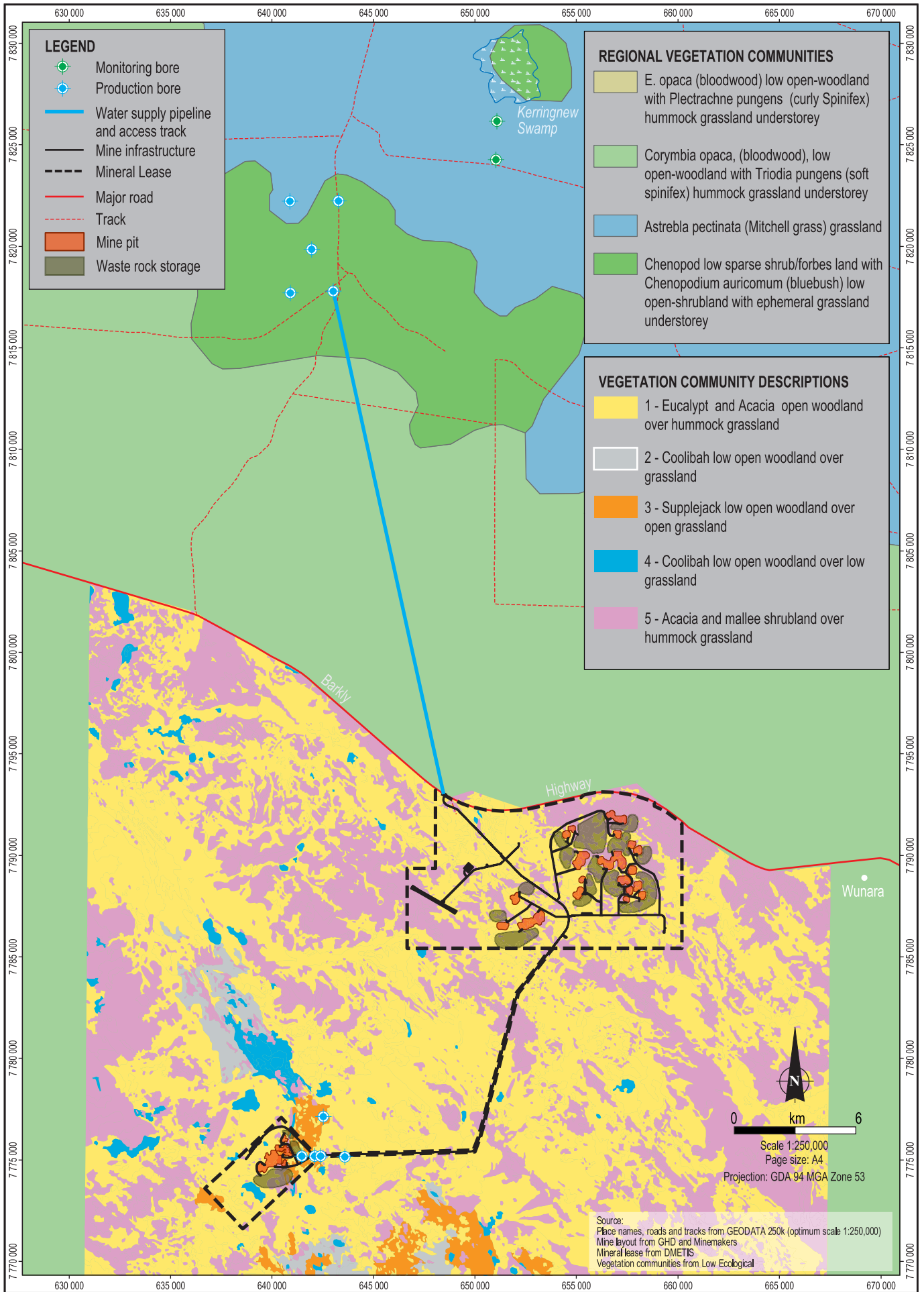
#### Vegetation Communities

The distribution and composition of vegetation is influenced by soil types. Field surveys identified five vegetation communities within the Mineral Lease (Figure 6.6):

1. Sand plains supporting *Eucalyptus* and *Acacia* open woodland over hummock grassland.
2. Black soil and clay pan supporting coolibah low open woodland over grassland.
3. Calcareous plains supporting supplejack low open woodland over open grassland.
4. Ephemeral lakes supporting coolibah low open woodland over grassland.
5. Rocky rises supporting *Acacia* and mallee shrubland over hummock grassland.

Three vegetation communities were identified by desktop review in the northern borefield and associated water supply pipeline:

6. Low open woodland supporting *Corymbia opaca*, (bloodwood) with *Triodia pungens* (soft spinifex) hummock grassland understorey.
7. Low open shrubland supporting Chenopod with *Chenopodium auricomum* (bluebush) with ephemeral grassland understorey.



8. *Astrebla pectinata* (Mitchell grass) grassland.

These vegetation communities are widespread and common across the Davenport Murchinson Ranges bioregion.

The dominant species at each field survey quadrat in the Mineral Lease for each of the vegetation communities is outlined in Table 6.17.

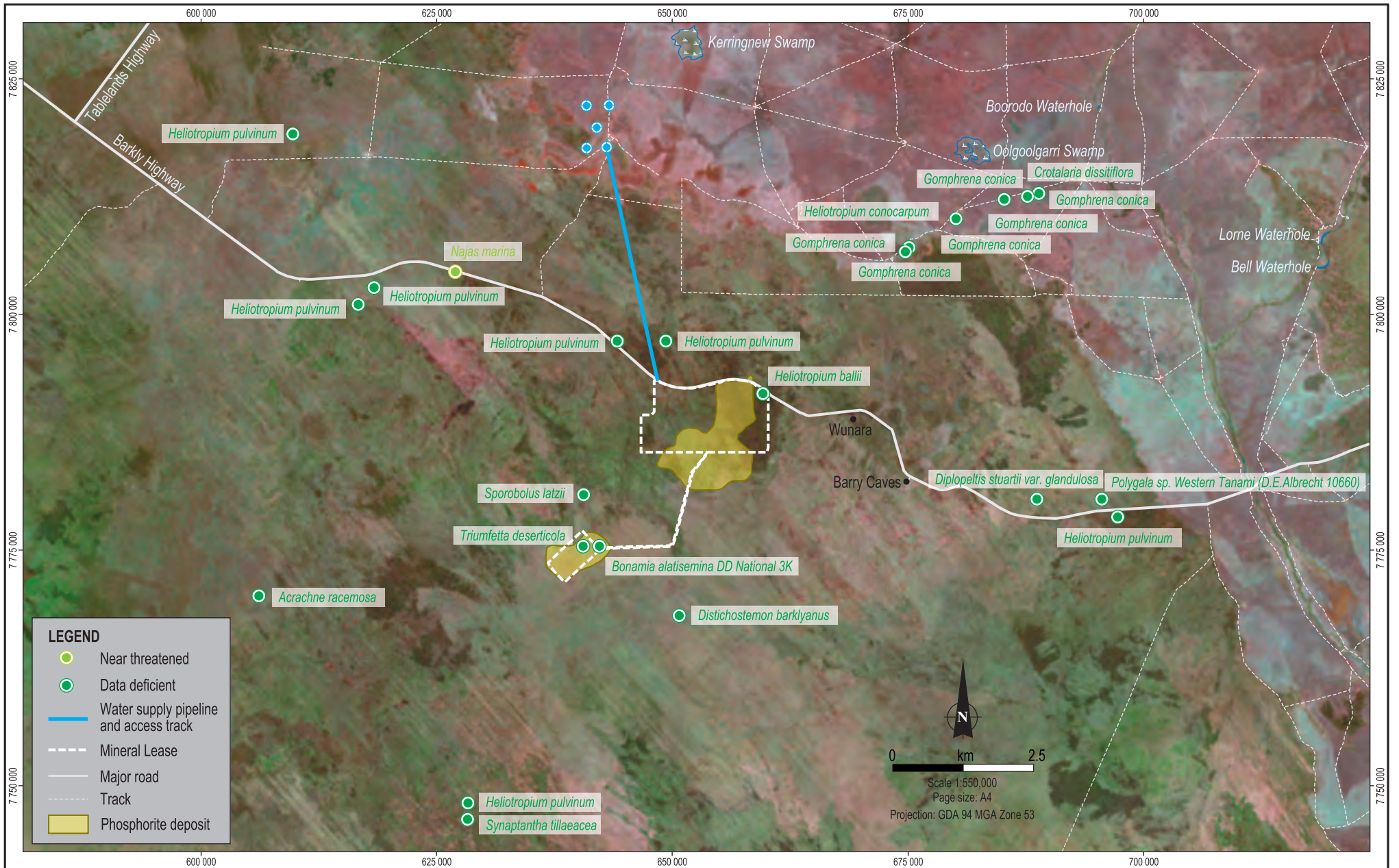
**Table 6.17 Dominant flora within the major vegetation communities for the Mineral Lease**

Vegetation community	Vegetation descriptions
1. Deep sand plains	Eucalypt (Coolibah, Mallee & Bloodwood) and Acacia (Dogwood) low open-woodland with <i>Senna</i> sp. low shrublands over hummock grassland.
2. Black soil and claypan	Coolibah low-open woodland with Silky browntop ( <i>Eulalia aurea</i> ) and <i>Aristida</i> sp. grasslands.
3. Calcareous plains	Supplejack low open woodland with open-grassland understorey.
4. Ephemeral lake	Coolibah low open woodland with open-grassland understorey.
5. Rocky rises	<i>Acacia</i> & mallee shrubland over hummock grassland.

***Plant Species of Conservation Significance***

No flora species of conservation significance listed under the EPBC Act were recorded in the project area, and none are considered likely to be present. A search of the NT Parks and Wildlife Flora Atlas (Appendices 8A and 8B) identified six species listed as data deficient under the TPWC Act in the project area. One data deficient species was recorded during the field surveys that has not previously been recorded in the area, with a further two near threatened species recorded (Figure 6.7). These were:

- *Bergia barklyana*. Listed as near threatened. *B. barklyana* plants were recorded at one survey site within low lying alluvial sand plain supporting open eucalypt woodland over hummock grassland. Dominant species were coolibah and bloodwood over spinifex. This area is within an Indigenous cultural exclusion zone.
- *Bonomia alatisemina*. Listed as data deficient. A single plant has been recorded in the NT Parks and Wildlife Flora Atlas within Arruwurra deposit. No specimens were recorded during site surveys.
- *Distichostemon barklyanus*. Listed as data deficient. A single specimen of *D. barklyanus* has been recorded 10 km southeast of the Arruwurra deposit prior to the current surveys. No specimens were recorded during site surveys.
- *Heliotropium ballii*. Listed as data deficient. A search of the NT Parks and Wildlife Flora Atlas identified one record of *H. ballii* just inside of the main zone deposit, alongside the Barkly Highway. No specimens were recorded during site surveys.
- *Heliotropium pulvinum*. Listed as data deficient. The NT Parks and Wildlife Flora Atlas records eight specimens of *H. pulvinum* in the project area surrounds. Records are scattered around



Source:  
 Place names, roads and tracks from GEODATA 250k (optimum scale 1:250,000)  
 Bore locations from GMP  
 Flora data from Low Ecological  
 Mine layout from GHD and Minemakers  
 Mineral lease from DMETIS



Date:  
 11.11.2009  
 MXD:  
 Minemakers\_Wonarah\_GIS.mxd  
 File Name:  
 9014\_07\_F06.07\_GIS\_HB

Minemakers Australia Pty Ltd  
 Wonarah Phosphate Project



Threatened flora in the project area and surrounds

Figure No:  
 6.7

the area with the closest record along the Barkly Highway. The March 2009 survey identified specimens within the Acacia shrubland.

- *Hibiscus brachychlaenus*. Listed as near threatened. The March 2009 survey identified *H. brachychleanus* plants within the Arruwurra deposit. Specimens were found within the Acacia shrubland vegetation community. This species has not been recorded in the area before.
- *Sporobolus latzii*. Listed as data deficient. One record of *S. latzii* is listed in the NT Parks and Wildlife Flora Atlas and this record is within an Indigenous cultural exclusion zone. This is the only known collection site of this species in Australia. Although targeted searches were performed as part of the surveys no specimens were identified.
- *Triumfetta deserticola*. Listed as data deficient. A single record of *T. deserticola* has been recorded within the proposed Arruwurra pit; however, no plants were recorded as part of the June 2008 or March 2009 surveys.

A further six data deficient and one near threatened species were identified by the NT Parks and Wildlife Flora Atlas as falling within a 50 km radius of the project area; however, these species were not recorded during site surveys. The species were:

- *Acrachne racemosa* (data deficient).
- *Crotalaria dissitiflora* (data deficient).
- *Diplopeltis stuartii* var. *glandulosa* (data deficient).
- *Gomphrena conica* (data deficient).
- *Heliotropium concarpum* (data deficient).
- *Najas marina* (near threatened).
- *Synaptantha tillaeacea* (data deficient).

Twenty-two species of regional or local significance were recorded during the site surveys (Table 6.18); however, all of these species are listed as of least concern under the TPWC Act.

**Table 6.18 Species of regional and local significance in the project area**

Species	Common Name	Conservation Significance
<i>Acacia hemignosta</i>	Club-leaf wattle	Southern range limit
<i>A. hilliana</i>	Flying-saucer bush	Southern range limit
<i>A. lysiphloia</i>	Turpentine bush	Disjunct and southern range limit
<i>A. monticola</i>	Hill turpentine	Southern range limit
<i>Capparis umbonata</i>	Northern wild orange	Southern range limit
<i>Croton aridus</i>		Southern range limit
<i>Cullen pallidum</i>	Woolly psoralea	Rare and disjunct
<i>Eremophila bignoniiflora</i>	Bignonia emu bush	Rare
<i>Eucalyptus gamphylla</i>	Blue mallee	Northern range limit
<i>E. odontocarpa</i>	Sturt Creek mallee	Southern range limit
<i>E. pachyphylla</i>	Red bud mallee	Northern range limit
<i>E. victrix</i>		Eastern range limit
<i>Fimbristylis ammobia</i>		Eastern range limit
<i>F. simulans</i>		Eastern range limit
<i>Hakea macrocarpa</i>	Flat leaved hakea	Southern range limit

**Table 6.18 Species of regional and local significance in the project area**

Species	Common Name	Conservation Significance
<i>Scaevola ovalifolia</i>	Bushy fan flower	Western range limit
<i>Setaria surgens</i>	Brown pigeon grass	Southern range limit
<i>Stretoglossa decurrens</i>		Disjunct
<i>Tephrosia lasiochlaena</i>	Green germander	Disjunct and western range limit
<i>Triodia intermedia</i>	Winged spinifex	Disjunct and range limit
<i>Triumfetta centralis</i>		Southern range limit
<i>Zornia albiflora</i>		Southern range limit

### **Plant Species of Indigenous Value**

Forty-four species of Indigenous utilitarian or cultural significance were recorded during the vegetation survey; a full list is provided in Appendix 8A. Mature trees, especially coolibah and bloodwood, are culturally significant. The CLC classifies trees with a trunk diameter of greater than 12.5 cm and a height at least 1.5 m as significant; removal of trees meeting these criteria requires Traditional Owner approval, which will be sought as part of the Mining Agreement currently being negotiated with the Traditional Owners, CLC and Minemakers.

### **Introduced Species**

Two environmental weed species were recorded in the project area, *Cenchrus ciliaris* (buffel grass) and *Aerva javanica* (kapok bush). A further three species listed as weeds of national significance; *Prosopis limensis* (mesquite), *Hymenachne amplexicaulis* (olive hymenachne) and *Parkinsonia aculeate* (parkinsonia); have been identified within a 50 km radius of the project area.

Buffel grass was recorded in four isolated patches along the exploration track between the Main Zone and Arruwurra deposits, which were all low lying areas within the sand plains. Buffel grass is commonly used for pasture grass and occurs extensively throughout the Barkly Tableland and along the Barkly highway.

An individual kapok bush was identified along the exploration track leading into the Arruwurra deposit in a shallow sand plain. Kapok bush is generally found in the red sand and gravelly soils along roadsides where soil has been disturbed. Kapok bush is not considered a significant pest species on the Barkly Tablelands (Baker, 2005).

## **6.7.2 Potential Impacts**

Vegetation will be cleared to accommodate project components such as access roads, aerodrome, crushing and screening plant, pits and administration facilities. Potential, credible project-related impacts to flora are described below. It should be noted that these do not take into consideration the proposed avoidance, mitigation and management measures that will be implemented by Minemakers during all stages of project development, and which will result in the residual impacts discussed in Section 6.7.4.

### **Reduced Species Abundance (Density and Diversity of Species)**

Species abundance can be measured by the density and diversity of species present (i.e., the number of individual plants in an area and the total number of species present in that area).

Vegetation clearing will remove individual plants from the broader population of plants in and around areas affected by the project. Grazing by animals attracted to increased levels of surface water and vegetation growth may also reduce the distribution and density of preferentially grazed plants in the project area. This may reduce the number of species present, and reduce the distribution, dispersal and genetic diversity of species, in the region. This may also fragment and reduce the area of habitat available for dependent fauna species (the potential impacts of this are discussed in Section 6.8.2).

### **Significant Impacts to Threatened Species**

Vegetation clearing may reduce the abundance of threatened species in the area of disturbance with consequent impacts to populations of threatened species at local, territory or national levels.

### **Reduced Conditions Favourable for Plant Growth**

Health and growth of flora communities and species may be reduced by deposition of dust generated during construction and operation of the project. Physical effects include blockage and damage to stomata, and shading or abrasion of the leaf surface or cuticle. Vegetation clearing will result in soil previously covered by vegetation being no longer bound by roots and protected by vegetative matter, and therefore more prone to wind (and water) erosion. Disturbance of areas that are not naturally vegetated can also lead to increased erosion, as the protective surface crust or stones will be removed. Vehicle movements and day-to-day operational activities will also generate dust. Increased erosion and dust generation has the potential to reduce conditions favourable for plant growth, with subsequent reduced plant health. Compaction of disturbed ground, minor contamination of soil and physical damage to vegetation in the project area may reduce the ability of plants to become established, and limit the potential for regeneration and revegetation of disturbed areas.

### **Increased Weed Density and Distribution**

Two environmental weed species have been identified in the project area along an exploration track and the Barkly Highway. Vegetation clearing and movement of project-related vehicles, machinery and equipment (especially earth-moving equipment) has the potential to increase weed density and distribution by creating conditions favourable for the establishment of weed species and exclusion of native species.

### **Introduction of New Weed Species**

Vegetation clearing and project-related vehicles, machinery and equipment (especially earth-moving equipment) have the potential to introduce and/or spread weed species within the project area, particularly via the import of seeds or vegetative matter from outside the project area. This may result in reduced flora species diversity and habitat in areas where weeds become established.

## **6.7.3 Avoidance, Mitigation and Management**

Minemakers will implement avoidance, mitigation and management measures to address the potential impacts on flora communities and species. These measures will reflect current good practice at similar mines operating in similar environments and are described below.

## **Reduced Species Abundance (Density and Diversity of Species)**

Land clearing is recognised as a principal cause of biodiversity loss (DNRETAS, 2009b). Land clearing will be required as a result of the project; however, during the design phase Minemakers has minimised, where practical, the area of vegetation required to be cleared. Further, design and layout of infrastructure and clearance techniques have been guided by the Draft Land Clearing Guidelines (DNRETAS, 2009b).

Disturbance of ecological communities can often promote diversity through the changes brought about by the removal of established species. As more water, light and nutrients become available other faster growing plants are able to take advantage of these resources and become established. In the past, fire patterns have been an important mechanism of these disturbance events. The progressive and staged rehabilitation of the disturbed areas by Minemakers will have a similar effect on flora communities, resulting in a diverse mosaic vegetation community, which also has benefits for local fauna (further discussed in Section 6.8). The proposed methods for progressive and final rehabilitation of the project area are described in Chapter 8.

Other measures to avoid, mitigate and manage the risks associated with reduced species abundance include:

- Minimising the area of direct land clearing, and only clearing areas immediately prior to their development.
- Minimising the area of direct land clearing in areas sensitive to disturbance, such as erosion-sensitive soils and drainage lines.
- Ensuring the development and implementation of relevant clearance protocols.
- Restricting clearing activities to existing disturbed areas, where possible.
- Progressively rehabilitating disturbed areas, including mine pits, and avoiding unnecessary future disturbance of these areas.
- Ensuring that all requirements of the Flora Management Plan are met.
- Ensuring vegetation debris (e.g., wood) on areas that do not require clearing is left in situ and not collected for firewood or other purposes.
- Consulting with the CLC for clearance approval of potentially culturally significant trees.
- Minimising the potential for water to pool in areas where it is applied as a dust suppressant (e.g., along unsealed access roads) to reduce the attraction of grazing animals.
- Carrying out regular inspections and maintenance of water containers and pipes to reduce the attraction of grazing animals to the project area from leaks and subsequent vegetation growth.

Minemakers will also consider developing a biodiversity offset plan for the project, this may involve a collaboration with Traditional Owners.

## **Significant Impacts to Threatened Species**

Along with measures to mitigate and manage the risks associated with reduced species abundance outlined above, measures specifically designed to avoid, minimise and manage significant impacts to threatened species include:

- Conducting walkovers of land to be cleared to identify plant species of conservation significance. If individuals are found, protocols in the Flora Management Plan (Attachment 5) will be followed to minimise the impacts to these plants.
- Continually monitoring low lying areas subject to inundated for the plant species *S. latzii*. If found, protocols in the Flora Management Plan (Attachment 5) will be followed to avoid and/or minimise the impacts to this species.
- Erecting flagging tape to mark 'no-go' zones to ensure areas to be protected are clearly defined, identified and avoided and that clearing and ground disturbance only occur within designated areas.
- Investigating the opportunities to use TWPC Act listed species known to occur in the region in rehabilitation.
- Avoiding the clearance of vegetation communities associated with ephemeral lakes, with such areas classified as 'no-go' areas and flagged accordingly.

### **Reduced Conditions Favourable for Plant Growth**

Measures designed to avoid, minimise and manage the risks associated with increased rates of erosion and dust generation are outlined in Sections 6.5.3 and 6.2.3, respectively.

### **Increased Weed Density and Distribution**

Measures designed to avoid, minimise and manage the risks associated with weed infestation as a result of the project include:

- Minimising the area of vegetation to be cleared.
- Using targeted weed control measures for any observed significant increase in the distribution or density of existing weeds, particularly buffel grass.
- Inspecting construction areas for weed outbreaks following rainfall events.
- Regularly monitoring areas with a high potential for, or susceptibility to, weed invasion, such as along roadsides and recently cleared areas.
- Controlling and/or preventing weed infestations in topsoil stockpiles to minimise the likelihood of weed introduction during respreading of topsoil.
- Instigating the ongoing rehabilitation of disturbed areas to reduce the potential for weed species to become established.
- Ensuring all requirements of the Flora Management Plan (Attachment 5) are met.
- Liaising with government agencies such as DNRETAS on appropriate measures to eradicate or control weed outbreaks, should they occur.

### **Introduction of New Weed Species**

Eradicating existing weeds along the Barkly Highway is not possible due to the well-established nature of these species. As a result, effort will concentrate on eradicating establishing populations of new weed species in the project area.

Along with the management measures to reduce the density and distribution of weed species outlined above, measures designed to avoid, minimise and manage the risks associated with the introduction of new weed species to the project area include:

- Ensuring that vehicles and project equipment arrive on site clean and free of vegetative matter, seeds and mud.
- Focussing on the control of declared weed species present in and around the project area, and preventing their spread during the life of the project.
- Using targeted weed control measures for new populations of weeds identified in previously uninfested areas.

### 6.7.4 Residual Impact

No vegetation communities listed under the EPBC Act or TWPC Act have been identified within the project area. As discussed above, during the design phase the project footprint has been minimised where practical to minimise the area of vegetation required to be cleared.

Table 6.19 summarises the residual impacts of the project to flora, considers the likelihood and consequences of the impacts (taking into account proposed management measures) and provides an overall risk rating for each potential impact. These are discussed in detail below.

**Table 6.19 Summary of impacts and risks to flora**

ID	Impact	Likelihood	Consequence	Residual risk
I17	Reduced species abundance.	Unlikely	Insignificant	Low
I18	Significant impacts to threatened species.	Unlikely	Moderate	Moderate
I19	Reduced conditions favourable for plant growth due to dust.	Likely	Insignificant	Moderate
I20	Reduced conditions favourable for plant growth due to disturbance.	Unlikely	Insignificant	Low
I21	Increased weed density and distribution.	Unlikely	Moderate	Moderate
I22	Introduction of new weed species.	Unlikely	Moderate	Moderate

### Reduced Species Abundance

Locating some project components in areas that are currently vegetated and must be cleared is unavoidable, with the area to be cleared totalling 2,325.6 ha (see Chapter 5, Section 5.4).

While the diversity of species may remain the same following vegetation clearing, the density of individual plants will reduce in the short term. However, progressive rehabilitation will enable Minemakers to identify and refine successful rehabilitation techniques throughout the life of the mine, making the likelihood of a long term reduction in species diversity **unlikely**.

The attraction of grazing animals to the project area will be prevented wherever possible and undertaken in accordance with the mitigation and management measures outlined above. The area will be actively managed to prevent overgrazing from native and introduced fauna (e.g., kangaroos or camels). Increased grazing impacts as a result of the project are therefore expected to be **unlikely**.

Vegetation from community 1 (*Eucalyptus* low open woodland), community 3 (supplejack low open woodland), community 4 (*Acacia* and mallee shrubland), community 5 (*Acacia* shrubland), community 6 (low open woodland supporting *Corymbia opaca*), community 7 (low open shrubland supporting Chenopod) and community 8 (Mitchell grassland) will be disturbed by the project. However, major clearances will only occur for community 1 and community 5, making up approximately 93% of the vegetation to be cleared. Clearance of community 3 and community 4 will be minimal (3% and 0.1% of total clearance will be in these vegetation communities respectively). Within the Northern Territory there are 12,307,800 ha of *Eucalyptus* woodlands available and 2,986,600 ha of *Acacia* shrublands. The clearance of these communities will result in a relative reduction of approximately only 0.008% of available *Eucalyptus* woodland and 0.01% of *Acacia* shrubland within the Northern Territory. Further, at a regional scale, there are 4,590,600 ha of *Eucalyptus* woodland and 310,100 ha of *Acacia* shrubland is held in reserves within the Davenport Murchison Ranges bioregion.

Long-term consequences of reduced species abundance in the project area are therefore **unlikely**; impacts will be relatively restricted, both spatially and temporally. The composition of flora species in these areas comprises species common across the region. Natural regeneration of vegetation, and progressive rehabilitation, will at least partially compensate for vegetation lost during clearing.

At a vegetation community level, vegetation clearing is expected to have an **insignificant** effect on the abundance, diversity, geographic distribution and productivity of flora in the region. No long-term changes in habitat are expected as a result of the project. The removal and/or fragmentation of vegetation communities associated with the ephemeral lakes (community 4) will be avoided. The vegetation groups and habitat present in the project area are widespread, and are known to be present in surrounding areas of the region with similar topography to that of the project area (Appendices 8A and 8B). The provision of environmental benefit measures outlined in the Flora Management Plan (Attachment 5) will provide compensation for the temporary reduced species abundance in the project area.

The residual risk is therefore **low**.

### **Significant Impacts to Threatened Species**

The 2,325.6 ha of land to be cleared to accommodate project components has been found to support near threatened species listed under the TPWC Act. The area may potentially contain further threatened species that have not yet been located; however, it is unlikely that, were these species found to be present, project-related disturbance will result in significant impacts at a local level. Any impacts that did result would be insignificant at a regional, territory and national scale.

No flora species of high conservation value have been identified in the project area and most plants and communities are widespread in the region. The near threatened (TPWC Act) *Hibiscus brachychaenus* was identified in the Arruwurra deposit, and *Bergia barklyana* in an Indigenous cultural exclusion zone (community 4). No vegetation from community 4 will be cleared for the project as it is located within an Indigenous cultural exclusion zone. All habitat types to be disturbed by the project are common in the region and any impact to threatened species will be limited, therefore the likelihood of significant impacts is **unlikely**.

One threatened species (*S. latzii*) could potentially be impacted by the project and is known to occur in a very specific habitat, which covers a small area adjoining the Mineral Lease. A single

record of *S. latzii* exists within an Indigenous cultural exclusion zone, although on-site surveys were unable to confirm its presence despite targeted searches for this species. All cultural exclusion areas are outside the project area and no project-related disturbance will occur within the Indigenous cultural exclusion areas. However, Minemakers will continue to monitor low lying inundated areas within the project area for the presence of *S. latzii* and follow procedures outlined in the Flora Management Plan (Attachment 5) for protecting *S. latzii* within the project area. As a result, there is little potential for the project to result in a significant change to the presence or abundance of this species.

Natural regeneration of vegetation, and progressive rehabilitation targeted to provide conditions favourable for the regeneration of threatened species, will compensate for any threatened species that may be inadvertently cleared.

Should it occur the consequence of significant impacts to threatened species is considered **moderate**. The provision of environmental benefits measures outlined in the Flora Management Plan (Attachment 5) will provide compensation for any reduced abundance of threatened species in the project area, and will further mitigate the likelihood of significant impacts to threatened species occurring.

Given this **moderate** consequence and **unlikely** likelihood, the residual risk is **moderate**.

### **Reduced Conditions Favourable for Plant Growth Due to Dust**

Dust suppression measures, such as water trucks, will be used throughout the life of the mine to minimise dust emissions (see Section 6.2). However, given the nature of construction and operations activities and the semi-arid environment, some dust generation is **likely**, which is likely to contribute to reduced conditions for plant growth. Studies on commercial crops and on vegetation in higher rainfall areas do not show any adverse effects on vegetation at dust deposition levels of the order of 4 g/m<sup>2</sup>/month, hence detectable effects on vegetation are only likely within a few tens of metres of actively mined areas. Given the high background dust levels (see Section 6.2) it is expected that local flora species will be tolerant of similarly high dust deposition levels.

The effect of reduced conditions favourable for plant growth is **insignificant**, although there is variation in the ability of different species to withstand dust deposition. Increased wind erosion and dust is not likely to lead to long term changes in flora composition, as impacts are likely to be localised in nature and able to be rehabilitated.

The residual risk is therefore **moderate**.

### **Reduced Conditions Favourable for Plant Growth Due to Disturbance**

Given the design of the project and the nature of construction and operations activities and management and mitigation measures, it is **unlikely** that disturbance will reduce conditions favourable for plant growth beyond the immediate footprint. The effect of reduced conditions favourable for plant growth is **insignificant**. Impacts will be localised in nature, and able to be rehabilitated both progressively and following project completion. The residual risk is therefore **low**.

### **Increased Weed Density and Distribution Due to Disturbance**

Weed management measures outlined in Section 6.7.3, such as minimising the area of vegetation disturbed, and regularly monitoring and promptly controlling any outbreaks of weed infestation, will reduce the likelihood for significant increases in the density and distribution of weeds. As a result, it is **unlikely** that the project will result in increased densities and distribution of weed species.

However, should it occur, the potential consequence of increased weed density and distribution as a result of the project is **moderate**. Weeds have the potential to change the composition and abundance of native vegetation communities, and rehabilitation of areas infested by weeds can be difficult. The residual risk is therefore **moderate**.

### **Introduction of New Weed Species**

Measures to prevent the introduction of new weed species, and limit their potential to become established if present, will ensure that it is **unlikely** that new weed species will present a threat to the native flora of the region. However, if new weed species do become established as a result of the project, then the potential consequence is **moderate**. The residual risk is therefore **moderate**.

## **6.7.5 Monitoring Program**

Ongoing vegetation monitoring will be conducted to allow identification of any impacts of mine construction and operations on flora. Monitoring will be conducted in vegetation communities identified during the baseline survey and any new areas as considered appropriate.

Monitoring sites will be visually inspected and photographed to allow assessment of:

- Changes in the abundance, composition or condition of vegetation communities, particularly threatened vegetation communities.
- Ongoing impacts to flora as a result of project-related activities.
- Increases in the density and distribution of known weed infestations.
- Introduction of new weed species.
- Accumulation of litter.

Transects will be used to allow the comparison of quantitative data on shrub numbers in the different vegetation communities, and between near-mine and control sites.

Vegetation monitoring will be timed as follows:

- Biennially during construction and operations. To ensure that the maximum number of species is recorded, vegetation monitoring will occur during both the wet and dry season.
- Post-closure of the operations until completion criteria are met (see Chapter 8 for further detail).

### **Weed Monitoring**

Minemakers will ensure that all vehicles and plant brought to the mine or transferred between properties are visually inspected to check they are free of mud, seeds and other plant material.

Areas with a high potential for, or susceptibility to, invasion by pest plants, such as along roadsides and recently cleared areas, will be monitored biannually (with a focus on after rain events) or after disturbance events such as clearing.

Monitoring for pest plants will include:

- Inspecting for pest plant outbreaks after the wet season and opportunistically after rain events and recording the size of infestations and the control treatment applied.
- Inspecting for pest plants after significant germination events and recording of level of pest plant invasion.

### Vegetation Clearance Monitoring

All areas to be cleared for project purposes will be documented recording the area and nature of the vegetation cleared. Each area cleared will be inspected to ensure that clearance is conducted in accordance with the conditions of the Mineral Lease and Mining Management Plan.

### 6.7.6 Outcome and Assessment Criteria

The outcome and assessment criteria for flora are outlined in Table 6.20.

**Table 6.20 Outcome and assessment criteria – flora**

ID	Impact	Outcome	Assessment Criteria	Summary of Management and Mitigation Measures
117, 118	Reduced species abundance or significant impacts to threatened species.	Disturbance to vegetation is restricted to areas permitted within the Mineral Lease conditions.	Annual audit of records show native vegetation clearance is in accordance with the Mineral Lease conditions.  Annual flora surveys (including photo monitoring) at all flora monitoring sites to show no unexpected change in abundance, composition or condition of flora species from baseline conditions.	Minimising the area of direct land clearing, and only clearing areas immediately prior to their development.  Ensuring the development and implementation of relevant clearance protocols.  Where possible restrict clearing activities to existing disturbed areas.  Progressively rehabilitating disturbed areas.  Ensuring that all requirements of the Flora Management Plan are met.  Continual monitoring of low-lying areas subject to inundated for the plant species <i>S latzii</i> .  Erecting flagging tape to mark 'no-go' zones.  Investigating the opportunities to use TWPC Act listed species known to occur in the region in rehabilitation.

**Table 6.20 Outcome and assessment criteria – flora**

<b>ID</b>	<b>Impact</b>	<b>Outcome</b>	<b>Assessment Criteria</b>	<b>Summary of Management and Mitigation Measures</b>
I19	Reduced conditions favourable for plant growth due to dust	The health of remaining vegetation does not alter significantly over the life of the project.	Annual flora surveys (including photo monitoring) at all flora monitoring sites in to show no unexpected change in abundance, composition or condition of flora species from baseline conditions. Compliance with annual average dust deposition rate does not exceed 2 g/m <sup>2</sup> /month above baseline dust deposition rate of 2.6 g/m <sup>2</sup> /month outside of the Mineral Lease.	Minimise the extent of vegetation cleared. Use progressive clearing techniques for areas that must be cleared. Rehabilitate final surfaces progressively during the project. Manage waste rock and ore storage to avoid dust generation. Spray water or dust suppressants on unsealed trafficked areas and other dust generating areas. Impose speed limits on mine traffic. Limit parking of vehicles to designated parking areas.
I20	Reduced conditions favourable for plant growth due to disturbance	The health of remaining vegetation does not alter significantly over the life of the project.	Annual flora surveys (including photo monitoring) at all flora monitoring sites in to show no unexpected change in abundance, composition or condition of flora species from baseline conditions.	Implement management measures for waste and hazardous materials (including spill response procedures). Remediate contaminated soil, if required. Implement Erosion and Sediment Control Management Plan.
I21, I22	Increased weed density and distribution or introduction of new weed species.	No weed species are encouraged or introduced due to the project construction and operations.	No increase in weed density/distribution and no new establishment of declared weeds, compared with control sites or baseline data.	Reducing the area of vegetation to be cleared. Targeted implementation of weed control measures. Regularly monitoring areas with a high potential for, or susceptibility to, weed invasion. Controlling and/or preventing weed infestations in topsoil stockpiles. Ensuring all requirements of the Flora Management Plan are met. Ensuring that vehicles and project equipment arrive on-site clean and free of vegetative matter. Focussing on the control of declared weed species present in the project area, and the prevention of their spread during the life of the project. Instigating the on-going rehabilitation of disturbed areas.

## 6.8 Fauna

Existing fauna species in the project area are described in Section 6.8.1. Potential, credible project-related impacts associated with fauna are described in Section 6.8.2. The proposed avoidance, mitigation and management measures that Minemakers will implement during all stages of project development are described in Section 6.8.3. The resulting residual impacts of the project to fauna are discussed in Section 6.8.4, the monitoring program is detailed in Section 6.8.5 and the outcome and assessment criteria in Section 6.8.6.

### 6.8.1 Baseline

The characterisation of fauna species and habitat types in the project area and surrounds is based on fauna surveys completed by Low Ecological Services Pty Ltd (LOW) in June 2008 and March 2009 (Appendix 8A). The site surveys build on a desktop survey completed before on-site visits. Records of previously observed fauna within a 20 km radius of the project area (hereafter referred to as the 'project surrounds') were obtained from a protected matters report generated from the Australian Government Department of the Environment, Water, Heritage and the Arts (DEWHA) website and the NT Parks and Wildlife Fauna Atlas. A further desktop survey of the northern borefield and associated water supply pipeline route was carried out by LOW in October 2009 (Appendix 8B).

Traditional Owners attended the March 2009 survey and were consulted regarding the identification of fauna of Indigenous value.

The fauna survey methods were based on biodiversity sampling guidelines established by the Northern Territory Government DNRETAS for central Australia. Surveys were carried out under:

- Charles Darwin University animal ethics permit – number A05020.
- Scientific permit to take wildlife for commercial purpose under the *Parks and Wildlife Conservation Act* – clearance number 28357.

Fauna survey quadrats were established in the flora survey sites (see Section 6.7.1 for further discussion), reflecting the various land units. Within each land unit eight quadrats were established (see Figure 6.6 for the location of these sites), six in areas that would be impacted by the project and two outside of the likely impact area. The locations of the sites are suitable for ongoing monitoring of the impacts of the project.

Surveys involved mammal and reptile trapping, tracking and bird and bat call surveys. However due to equipment failure bat surveys were not effective. A summary of the fauna survey methods and survey efforts for each survey at each site is given in Table 6.21.

Downstream impact assessment was carried out by Groundwater Resource Management (GRM), for discussion see Section 6.10.

**Table 6.21 Fauna survey method and effort at each site**

Type of Survey	Survey Method	Survey Effort	
		June 2008	March 2009
Mammal and reptile trapping	Pitfall trap line		Two pitfalls 100 m apart for three nights.
	Elliott trap line	25 traps 15 m apart for three nights.	25 traps 15 m apart for three nights.
Mammal and reptile tracking	Physical searches for tracks and/or scats	25 minute walkover survey of each quadrat. Opportunistic sightings.	25 minute walkover survey of each quadrat. Presence of tracks at 1 m intervals along a 200 m transect. Opportunistic sightings.
Bird survey	Physical searches for sightings or calls	25 minute in the morning and afternoon throughout project area.	25 minute in the morning and afternoon throughout project area.
Bat survey	Anabat <sup>1</sup>		One recorder at four sites for four hours.

<sup>1</sup>Anabat surveying allows for the identification of species of bat based on their echolocation signal.

## Existing Conditions

### Summary

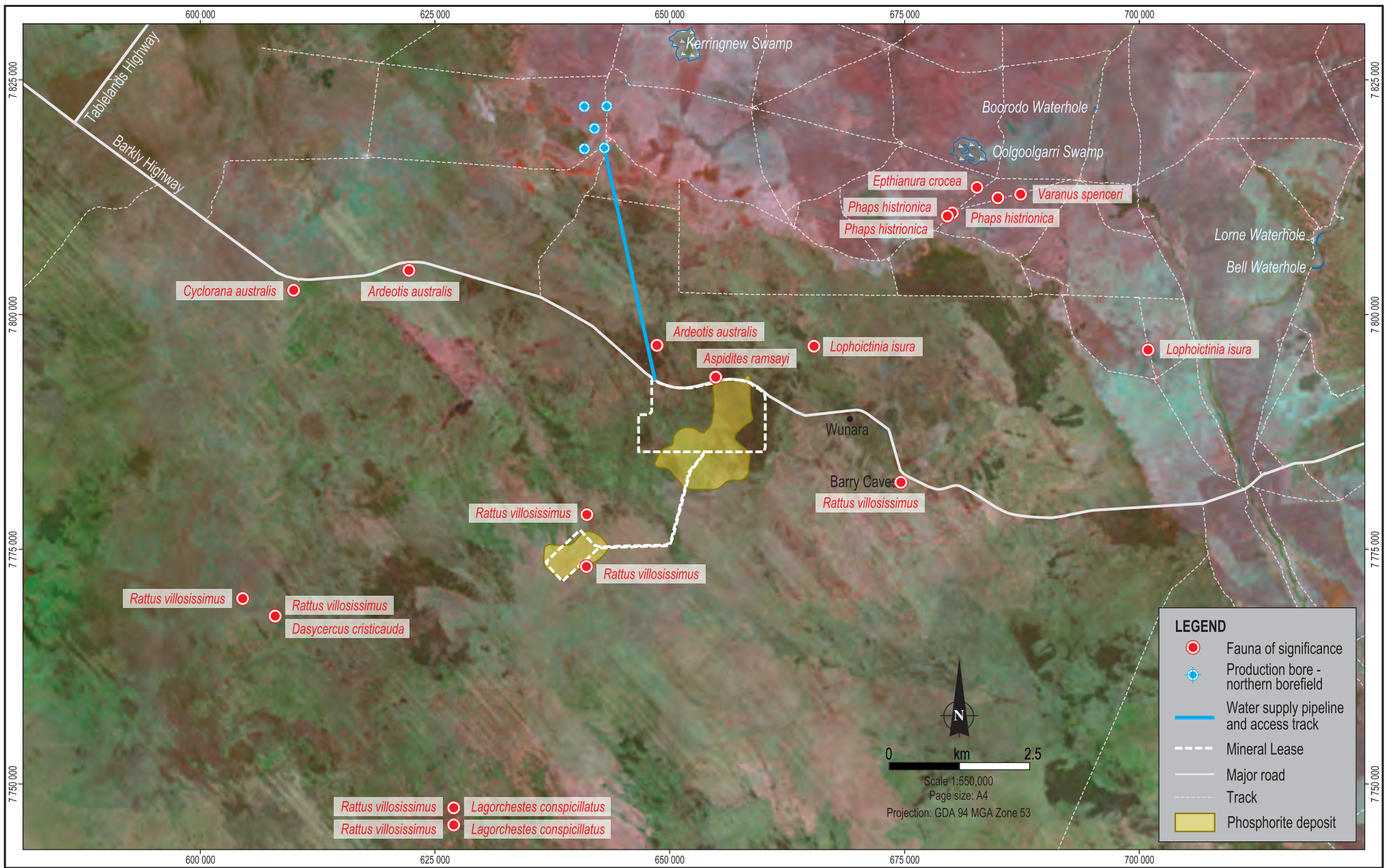
The protected matters report and search of the NT Parks and Wildlife Fauna Atlas identified 693 records of 163 species within the project surrounds. Twelve species were identified that are listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), including:

- *Rostratula australis* (painted snipe), listed as vulnerable.
- *Dasyercus cristicauda* (mulgara), listed as vulnerable.
- *Macrotis lagotis* (bilby), listed as vulnerable.
- *Epthianura crocea* (yellow chat), listed as vulnerable; however, it is the northern subspecies, *Epthianura crocea tunneyi*, which is listed. The inland species, *Epthianura crocea crocea*, recorded in the surrounding area, is not listed under the EPBC Act and is considered to be of least concern under the *Territory Parks and Wildlife Conservation Act* (TPWC Act).
- Eight migratory bird species that are potentially present.

None of these species were recorded during field surveys.

A further eight species listed under the TPWC Act have been recorded within the project surrounds; two species (both listed as near threatened) have been recorded in the project area, *Rattus villosissimus* (long haired rat) and *Aspidites ramsayi* (woma) (Figure 6.8).

Field surveys identified no habitats of ecological importance.



Source:  
 Place names, roads and tracks from GEODATA 250k (optimum scale 1:250,000)  
 Bore locations from GMP  
 Fauna data from Low Ecological  
 Mine layout from GHD and Minemakers  
 Mineral lease from DMETIS



Date: 11.11.2009  
 MXD: Minemakers\_Wonarah\_GIS.mxd  
 File Name: 9014\_07\_F06.08\_GIS\_HB

Minemakers Australia Pty Ltd  
 Wonarah Phosphate Project



Threatened fauna in the project area and surrounds

Figure No: 6.8

Two species of conservation significance were recorded during the field surveys, *Ardeotis Australia* (Australian bustard) (listed as vulnerable under the TPWC Act) and *Onychogalea unguifera* (northern nail-tailed wallaby) (listed as near threatened under the TPWC Act).

### **Birds**

A total of 31 bird species were identified during the field surveys (see Appendix 8A for a complete description). One species, *Ardeotis australis* (Australian bustard), listed as vulnerable under the TPWC Act, was recorded within the low lying sand plain characterised by low open woodland vegetation.

Ninety species have previously been recorded in the project surrounds and it is expected that these species would be present in the project area from time to time. The sand plain vegetation communities (see Figure 6.6, Section 6.7) are likely to support the highest avian diversity in the project area due to the diverse and dense nature of the habitat.

A protected matters search and search of the NT Parks and Wildlife Fauna Atlas identified nine bird species of conservation significance, including eight migratory species, which may be present in the area (Table 6.22).

**Table 6.22 Birds of conservation significance with the potential to occur in the project area**

Scientific name	Common name	Status under TPWC Act	Status under EPBC Act
<i>Ardeotis australis</i>	Australian bustard	Vulnerable	
<i>Rostratula australis</i>	Australian painted snipe	Vulnerable	Vulnerable Migratory wetland
<i>Merops ornatus</i>	Rainbow bee-eater	Vulnerable	Migratory marine Migratory terrestrial
<i>Ardea alba</i>	Great egret		Migratory wetland Migratory marine
<i>Ardea ibis</i>	Cattle egret		Migratory wetland Migratory marine
<i>Charadrius veredus</i>	Oriental plover		Migratory wetland Migratory marine
<i>Apus pacificus</i>	Fork-tailed swift		Migratory marine
<i>Glareola maldivarum</i>	Oriental pratincole		Migratory wetland
<i>Numenius minutus</i>	Little curlew		Migratory wetland

Tracks of *Ardeotis australis* (Australian bustard) were recorded in the Main Zone and Arruwurra deposits. This species has been previously recorded approximately 10 km to the northwest of the Main Zone and although widespread it is generally considered scarce in the Northern Territory (NRETAS, 2006). Within the Northern Territory, it is common in the Barkly Tableland, Daly River region, the Victoria River District and the Tanami Desert. Typical habitat of the Australian bustard includes grasslands, low shrublands and grassy woodlands. The Australian bustard has had a widespread decline in abundance which has been attributed to a combination of factors including

predation, altered fire regimes, hunting disturbance, habitat alteration, pesticides and grazing (NRETAS, 2006).

There is a single record of *Epthianura crocea* (yellow chat) approximately 40 km the northeast of the Main Zone deposit. However, this is likely to be the inland sub-species *E. crocea crocea* which is listed as least concern under the TPWC Act. It is the northern sub-species, *E. crocea tunneyi*, which is listed as endangered; this sub-species is restricted to 100 km<sup>2</sup> area in the northern part of Northern Territory approximately 900 km north of the project area. A further EPBC Act listed sub-species, *E. crocea macgregori*, is restricted to three populations on the Queensland coast (Houston and Melzer, 2008).

In general, ephemeral areas are likely to be important to migratory species listed under the EPBC Act during the wet season. An ephemeral swamp is located approximately 15 km to the northwest of the Arruwurra deposit, and may offer suitable habitat during periods of high rainfall. However, the lake is situated within a cultural exclusion zone and will not be disturbed during project operations. Another ephemeral swamp, Kerringnew Swamp, is located approximately 10 km northeast of the northern borefield. The habitat requirements of migratory species and lack of suitable ephemeral water bodies within the project area makes the ongoing presence of these migratory species unlikely. These species include:

- *Rostratula australis*. The Australian painted snipe is a wader of around 220 to 250 mm in length and occurs solitarily or in only small parties. The Australian painted snipe has been recorded at Tarrabool Lake on Eva Downs on the Barkly Tablelands and Lake Woods in 1993 (DEH, 2003) in the Northern Territory. The species occurs in shallow, vegetated, freshwater swamps, claypans or inundated grassland. The species is nomadic and can inhabit temporary wetlands. There is limited understanding of the population size and trend in the Northern Territory.
- *Merops ornatus*. The rainbow bee-eater is a medium-sized bird that is usually seen in pairs or small flocks. The species occurs mainly in open forests and woodlands, shrublands, and in cleared or semi-cleared areas such as farmland. It is usually located in close proximity to permanent water. The rainbow bee-eater is distributed across most arid regions of mainland Australia. In the Northern Territory it is known to occur in Kakadu National Park, Casuarina Coastal Reserve, Fogg Dam Conservation Reserve, Gregory National Park and Nitmiluk (Katherine Gorge) National Park. Suitable habitat may occur within the project area and the species may seasonally visit the site during significant wet seasons. However, due to a lack of permanent water, populations are likely to be ephemeral.
- *Ardea alba*. The great egret or white egret is found across most of the tropical regions of Australia. The species feeds in shallow water and breeds in colonies in trees close to large lakes with reed beds or other extensive wetlands. This species is unlikely to be in the project area due to lack of wetland habitats.
- *Ardea ibis*. The cattle egret has a distribution from Darwin down the east coast of Australia and across to southern Western Australia. The preferred habitat of the cattle egret is grasslands, woodlands and wetlands. It also uses pasture land. It is not common in arid areas. As there are no large drainage channels or drainage basins within the project area or immediate surrounds, the potential habitat for the cattle egret is unlikely. Ephemeral areas may be inhabited by these species in good wet seasons.
- *Charadrius veredus*. The Oriental Plover has been recorded throughout Australia. The species is generally found in open grasslands in arid and semi-arid zones. It can also be found in

estuarine or littoral environments, but is less common in these areas. The Oriental Plover may move to lightly-wooded grasslands with the onset of the wet season. Suitable habitat for the species may occur within the project area, and there is the potential for the species to be present within the project area.

- *Apus pacificus*. Fork tailed swifts are small insectivorous birds that spend the majority of their time in flight. They never voluntarily come to ground as they have small feet which they use to cling to vertical surfaces. This species has a large range, with an estimated global extent of occurrence of 10,000,000 km<sup>2</sup>, breeding from central Siberia eastwards through Asia. This species is migratory, spending winter in Australia and summer in the northern hemisphere. Although global populations have yet to be quantified, populations of the fork tailed swift are thought to be increasing (IUCN, 2008).
- *Glareola maldivarum*. Although classed as waders the oriental pratincole generally hunts their insect prey while in flight. In non-breeding grounds in Australia, the oriental pratincole usually inhabits open plains, floodplains or short grassland (including farmland or airstrips), often with extensive bare areas. They often occur near terrestrial wetlands, such as billabongs, lakes or creeks, and artificial wetlands such as reservoirs, saltworks and sewage farms, especially around the margins. It also occurs along the coast, inhabiting beaches, mudflats and islands, or around coastal lagoons. This species has a large range, with an estimated global extent of occurrence of 1,000,000 to 10,000,000 km<sup>2</sup>, extending through the warmer regions of south and east Asia, breeding in northern India and China and wintering in India, Australia and Indonesia (Birdlife International, 2009). The oriental pratincole has a large global population estimated to be 2.5 million individuals in 2004 and is not approaching the thresholds for the population decline (IUCN, 2008).
- *Numenius minutus*. The little curlew is widespread in the north of Australia and scattered elsewhere. It is an irregular visitor to New Zealand and Tasmania. The species may gather in large flocks on coastal and inland grasslands and black soil plains in northern Australia, where near swamps and flooded areas. Suitable habitat may occur within the project area. However, as there are no large drainage channels or drainage basins within the project area or immediate surrounds, the potential habitat is limited.

### **Reptiles and Amphibians**

No amphibian species were recorded during field surveys. One species, listed as data deficient under the TPWC Act, *Cyclorana australis* (northern snapping frog), has previously been recorded approximately 40 km northwest of the Main Zone deposit. A further two species, not of listed conservation significance; have been recorded in the project area.

A total of 11 reptile species were identified during the field surveys (see Appendix 8A for a complete description). No species of conservation significance listed under the EPBC Act or TPWC Act were recorded during the survey period; however, many tracks were unable to be identified to a species level. Within the surrounding region 50 species have previously been recorded and habitat within the project area is suitable for many, and their presence in the project area is possible.

A search of the NT Parks and Wildlife Fauna Atlas identified two reptile species of conservation significance within the project area and surrounds:

- *Aspidites ramsayi* (woma). Listed as near threatened under the TPWC Act. Previously recorded on the northern side of the Barkly Highway, just north of the Main Zone deposit. The

woma is large python which inhabits subtropical to temperate deserts, sand plains and dunefields and cracking clays in semi-arid environments. Habitat includes woodlands, shrublands and grasslands, feeding on lizards, snakes, birds and small mammals (DECC, 2008).

- *Varanus spenceri* (Spencers monitor). Listed as data deficient under the TPWC Act. Previously recorded 40 km northeast of the Main Zone deposit.

One amphibian species listed as data deficient, *Cyclorana australis* (northern snapping frog), has previously been recorded approximately 40 km northwest of the Main Zone deposit. This burrowing frog lives in coastal floodplains, woodlands and grasslands.

### **Mammals**

No bats were recorded as part of the surveys due to equipment failure. Microchiropteran bats were observed in flight at dusk during the survey; however, no species of conservation significance have been recorded in the project area or surrounds. One species of bat, *Saccolaimus flaviventris* (yellow bellied sheath tailed bat), has previously been recorded in the project surrounds.

A total of 10 native mammal species were recorded during the field surveys (see Appendix 8A for a complete description). One species, *Onycholagea unguifera* (northern nail-tailed wallaby), listed as near threatened under the TPWC Act, was recorded during the March 2009 survey. No species listed under the EPBC Act were recorded during the fauna surveys.

An additional seven mammal species were identified in the NT Parks and Wildlife Fauna Atlas as being previously recorded in the project surrounds:

- *Dasyercus cristicauda* (mulgara).
- *Largorchestes conspicillatus* (spectacled hare wallaby).
- *Leggadina forresti* (Forrest's mouse).
- *Macrotis lagotis* (bilby).
- *Planigale ingrami* (long-tailed planigale).
- *Sminthopsis macroura* (striped face dunnart).

All these species are classified as of least concern in the Northern Territory.

The TPWC Act listed species *Onycholalea unguifera* (northern nail-tailed wallaby) was recorded during the March 2009 survey. Listed as near threatened, the northern nail-tailed wallaby is generally scarce and patchily distributed over the northern Australian coast, extending several hundred kilometres. The preferred habitat of this species is open woodlands, grasslands, shrubby savannah and usually near water. It particularly favours the blacksoil plains with tussock grasslands such as those found in the Barkly Tablelands. Within central Northern Territory it is also found in coolibah open woodlands and tall shrublands. These habitats are widespread and common throughout the Barkly Tablelands.

Four species of conservation significance have been previously recorded in the project surrounds. Of these, two species, *Dasyercus cristicauda* (mulgara) and *Macrotis lagotis* (bilby) are listed as vulnerable under the EPBC Act. A further two species are listed as near threatened under the TPWC Act, *Largorchestes conspicillatus* (spectacled hair wallaby) and *Rattus villosissimus* (long-haired rat).

*Rattus villosissimus* was previously recorded a number of times in the project surrounds and there are two records within the project area, on the boundary of the Mineral Lease at the Arruwurra deposit, and within the ephemeral lake in the cultural exclusion zone.

Habitat for *Dasyercus cristicauda*, *Macrotis lagotis* and *Lagorchestes conspicillatus* exists within the project area:

- *Dasyercus cristicauda*. The mulgara is a carnivorous marsupial found within the Northern Territory, with most records of the mulgara from the Simpson Desert and the north of South Australia. The mulgara is primarily nocturnal and will burrow on sand dunes. The principle habitat for mulgara is hummock grasslands of spinifex, especially *Triodia basedowii* and *T. pungens*. They feed on invertebrates, reptiles and small mammals. Suitable habitat for this species is present within and surrounding the project area. Mulgaras have not been recorded in the project area and there is no evidence (i.e., burrows) of a population being present despite targeted searches for this species. Mulgara were recorded 40 km west-southwest of the project area in 1993.
- *Macrotis lagotis*. The greater bilby is found within the central and western parts of the Tanami bioregion, the southern Sturt Plateau bioregion and the northern Great Sandy Desert bioregion of the Northern Territory. The bilby previously occupied a large area of arid and semi-arid Australia; however, the distribution has declined significantly since European settlement and now occupies 20% of its former range. Habitat of the greater bilby in the Northern Territory is characterised by sandy soils dominated by hummock grasslands covered predominantly by three species of spinifex, *Triodia basedowii*, *T. pungens* and *T. schinzii*. An overstorey of low shrub cover dominated by *Acacia* and *Melaleuca* species grows over much of this country. Broad-scale surveys of bilbies in the Northern Territory in the 1990s indicated that laterite and drainage line land systems were occupied more frequently than sand plain and dune systems, which is the dominant system of the project area.
- *Lagorchestes conspicillatus*. Although considered widespread in the Northern Territory, the spectacled hare wallaby has disappeared from the southern part of its range, contracting 200 km northward. The species inhabits a variety of habitats including open forests and woodlands, tall shrublands, and hummock and tussock grasslands, these habitats are widespread throughout the Barkly Tablelands. Suspected threats to this species include introduced predators, grazing competition and changes in fire regimes (DEWHA, 2008).

### **Fauna of Indigenous Conservation Significance**

Traditional Owners identified local fauna of cultural significance for their utilitarian values. Larger fauna species such as kangaroo, Australian bustard, sand goanna and other large dragons are still hunted by the Traditional Owners. The ephemeral lakes within the cultural exclusion zones are considered as an important hunting ground as they provide seasonal refuge to larger species. The Traditional Owners consulted during the March 2009 survey identified no species of mythical significance.

### **Introduced Fauna**

Five introduced fauna were recorded within the project area during on-site surveys. Three herbivore species were recorded, *Camelus dromedarius* (camel), *Bos taurus* (cow), and *Equus asinus* (donkey). A few tracks were recorded clustered around waterholes, and were relatively old suggesting these animals most likely visited the area for water. The limited evidence of these species suggests that numbers are low and most likely are visits by individual animals seeking

water. Donkeys and camels are generally dispersive throughout Northern Territory, but tend to congregate around water sources such as dams, bores, natural waterholes and communities. Source populations for cattle would be surrounding pastoral properties.

Two carnivorous species were recorded in the project area, *Felis catus* (cat) and *Vulpes vulpes* (fox). Traces of cats and foxes were recorded along exploration tracks, and it is not uncommon for these species to use tracks for access into new areas. Numbers of records of this species were low, indicating they are in low abundance in the area.

## 6.8.2 Potential Impacts

Native bird, reptile and mammal species, including some species of conservation significance, may be affected by the project. Vegetation clearing and ground disturbance during construction has the potential to reduce areas of habitat and resources within the project area. Potential, credible project-related impacts to fauna are described below. It should be noted that these do not take into consideration the proposed avoidance, mitigation and management measures that will be implemented by Minemakers during all stages of project development, and which will result in the residual impacts discussed in Section 6.8.3.

### Reduced Species Abundance (Density and Diversity of Species)

Species abundance can be measured by the density and diversity of species present (i.e., the number of individual animals in an area and the total number of species present in that area). There is potential for species abundance to be reduced as a result of:

- *Vegetation clearing and ground disturbance.* Vegetation clearing and ground disturbance will remove fauna habitat, reduce resources for fauna species resident within the project area and increase inter- and intra-specific competition for food and habitat, with potential changes in the abundance of native fauna species in the fauna area.
- *Noise, light and vibration.* Project construction and operations will create noise, light and vibration emissions, typically generated by vehicle traffic, excavations, blasting and ore processing.
- *Surface water contamination.* Waterbodies established as part of the project (e.g., sediment ponds) may attract waterbirds to the area. There is the potential for adverse impacts to visiting waterbirds if these waterbodies are contaminated.

### Significant Impacts to Threatened Species

Ground disturbance (including mining) and vegetation clearing, in particular the clearing of particularly high quality habitat, may reduce the abundance of threatened animal species in the project area. This may result in significant impacts to resident threatened species at a local, regional, territory or national level, if there is a lack of other suitable habitat surrounding the project area or if the project area supports a significant population of a threatened species.

### Increased Abundance of Introduced Species

Project construction and operations have the potential to create conditions favourable for increased abundances of introduced species such as foxes, cats, camels, donkeys and camels that are currently present in low densities across the project area.

The construction of waterbodies and presence of domestic waste near the administration and accommodation facilities may provide food and shelter for these species. If not properly controlled, there is the potential for the populations of introduced species to increase as a result of these additional resources.

Increased abundance of introduced foxes and cats is likely to increase predation pressure on native bird, reptile and mammal species, leading to a reduction in their population size.

### **6.8.3 Avoidance, Mitigation and Management**

Minemakers will implement avoidance, mitigation and management measures to address the potential impacts on fauna. These measures will reflect current good practice at similar mines operating in similar environments and include site and species specific measures. These measures are described below.

#### **Reduced Species Abundance**

##### **Vegetation Clearing and Ground Disturbance**

During the design phase the project footprint has been minimised and located to avoid disturbance to significant habitats where practical. Other measures to avoid, mitigate and manage the risks associated with habitat removal or change include (see also Section 6.8.3):

- Minimising and consolidating areas of vegetation to be cleared for access tracks and infrastructure pathways so that large blocks of habitat, rather than small fragments, are preserved.
- Rehabilitating cleared land both progressively during the life of the project and following project completion (see Chapter 8).
- Regularly inspecting potential 'fauna traps' such as temporary trenches required during construction.
- Adhering to the measures outlined in the Flora Management Plan and Fauna Management Plan.

##### **Disturbance Due to Noise and Vibration**

Measures designed to avoid, mitigate and manage the risks associated with increased levels of noise and vibration are outlined in Section 6.4. Those measures specific to fauna include:

- Locating noisy and illuminated infrastructure (e.g., crushing and screening plant) close together to localise areas affected by noise and light from equipment.
- Where possible, locating vehicle and machinery access roads outside high-quality habitat to minimise the potential for disturbance to resident fauna.
- Limiting the number of roads constructed in the project area.
- Blasting during the day to minimise the potential for disturbance to nocturnal species such as the dunnarts which forage at night and bird and mammal species particularly active at dawn and dusk.

### **Potentially Contaminated Water**

Following significant rainfall, surface runoff may contain sediment and metal concentrations that have the potential to be toxic to wildlife. However, geochemical analysis has revealed high levels of metals or toxins in sedimentation is unlikely (Appendix 6). Surface water management measures are detailed in Section 6.10; however, management and mitigation measures specific to fauna include:

- Sediment release and erosion control measures to minimise the release of sediment to the receiving surface water environment.
- Rehabilitation of disturbed areas progressively once areas are no longer required for mining, where possible.
- Containment and reuse of all potentially contaminated waters in the project area (except during extreme rainfall events), thereby minimising the potential for discharge of contaminated water to surrounding surface water.

Other measures such as netting of the water storages or the use of passive deterrent devices will be considered if the water storages are shown to contain toxic levels of contaminants and are attracting fauna.

### **Threatened Species**

A fauna management plan, which incorporates mitigation measures such as relocation of resident species from areas to be disturbed, is provided in Attachment 5. To mitigate impacts to significant fauna the following techniques will be implemented:

- Undertaking a walk over survey of all areas to be disturbed prior to commencement of works to locate the presence of any significant species. Rescue and relocation protocols will be developed in consultation with NT National Parks and Wildlife Service and/or DNRETAS.
- Monitoring programs to establish the presence of any significant species and any impacts upon them.
- Training of key staff in the identification of significant species and any traces left by them.
- Managing pest species and native predators (i.e., dingo).

Minemakers will also consider developing a biodiversity offset plan for the project, this may involve a collaboration with Traditional Owners. Management protocols will be reviewed if any additional significant species or known locations are identified so that any impacts upon them can be assessed and minimised.

### **Increased Abundance of Introduced Species**

The presence of the introduced predators foxes and cats are a key threatening process to Australia's biodiversity. Both foxes and cats have been identified in the project area and Minemakers' flora and fauna management plan outlines actions to manage and reduce their presence. The benefits of controlling predator pests will not only be limited to the project area; if properly managed management procedures also have the potential to reduce fox and cat abundances in the surrounding areas.

Measures designed to manage and mitigate the risks associated with an increased abundance of introduced species include:

- Controlling existing feral animal populations outlined in the flora and fauna management plan.
- Targeting new populations, or significant increases in the current population, of foxes and/or feral cats.
- Ensuring that waste management procedures (see Attachment 5) are diligently followed to reduce potential resources for these species.
- Regularly monitoring areas with a high potential for, or susceptibility to, increases in abundance of introduced species (e.g., administration and plant facilities, waste storage areas and around water sources).

#### 6.8.4 Residual Impact

Table 6.23 summarises the residual impacts of the project to fauna, considers the likelihood and consequences of the impacts (taking into account proposed management measures), and provides an overall risk rating for each potential impact. These are discussed in detail below.

**Table 6.23 Summary of impacts to fauna**

ID	Impact	Likelihood	Consequence	Residual Risk
I23	Reduced species abundance in the long term.	Unlikely	Minor	Low
I24	Significant impacts to threatened species.	Unlikely	Minor	Low
I25	Increased abundance of introduced species.	Unlikely	Moderate	Moderate

#### Reduced Species Abundance

The project's footprint is approximately 2,326 ha, with some of the project components being unavoidably located in areas that currently provide habitat for a range of bird, reptile and mammal species. As a result of vegetation clearing, that habitat will be lost during the life of the project and fauna may be forced out of the area or die. Fauna may also move out of the immediate vicinity of the mine due to noise, light, dust and vibration emissions. Therefore, it is almost certain that the abundance of fauna species present in the project area and surrounds will be reduced for the life of the project. However, due to the abundance of similar flora communities and habitat surrounding the project area (see Section 6.7.4) and the progressive rehabilitation of some mining pits, these impacts are **unlikely** to impact on fauna communities in the long term.

Most of the vegetation to be removed is *Eucalyptus* woodland and *Acacia* shrubland of varying quality. These habitats support a range of native bird, reptile and mammal species present in the project area. However, apart from the threatened species discussed below, most species are relatively common in the region.

At a community level, the loss of habitat is expected to have a **minor** effect on the abundance, diversity, geographic distribution and viability of native fauna populations. All reptile and mammal species and the majority of bird species recorded during the surveys are relatively common in the Barkly Tableland. Animals able to relocate prior to clearing will not be significantly affected by

project activities, and none of the project infrastructure will encircle habitats and prevent fauna from moving between habitat areas.

The location of project infrastructure away from areas of high quality habitat will minimise the potential for impacts to fauna due to disturbance, although some disturbance is inevitable. Noise, vibration and dust due to vehicle traffic, blasting, excavations and ore crushing and screening in the project area are likely to disturb fauna. The louder and longer the duration of the noise and vibration, the greater the impact will be on species present. Species sensitive to disturbance by noise, vibration and light are likely to relocate to other suitable habitat in the project area or surrounds. There is the potential that in time, fauna in the project area may become tolerant to disturbance and re-colonise habitat previously vacated. This is likely to occur after construction of the project is complete. Should this occur, the residual risk to fauna may decrease.

The consequence of reduced species abundance in the project area is **minor**. Impacts are not expected to result in significant long-term changes to fauna composition in the region. Natural regeneration of vegetation, and ultimately rehabilitation, will at least partially compensate for habitat removed during clearing (see Chapter 8 for rehabilitation details). The environmental benefits for the project such as control of introduced species and increased habitat complexity will also assist in the mitigation of impacts associated with native vegetation clearing. The regeneration of habitat will allow for the re-colonisation of disturbed areas by native fauna species following project closure. It is expected that, if carefully managed over time, the rehabilitated areas will provide similar and/or better habitat to that present prior to clearing.

Given the **unlikely** likelihood that this impact will occur over the long term, and the **minor** consequence of such an impact, the residual risk is **low**.

## Significant Impacts to Threatened Species

### *Species Known to be Present*

The project is **unlikely** to significantly impact on the two TPWC Act listed species known to be present in the project area:

- Australian bustard (*Ardeotis australis*). The Australian bustard is widespread but is generally scarce in the Northern Territory (DNRETA, 2006). The Australian bustard has had a widespread decline in numbers which has been attributed to a combination of factors including predation, altered fire regimes, hunting disturbance, habitat alteration, pesticides and grazing (DNRETAS, 2006). While the species is relatively scarce in the Northern Territory it is known to occur within the project area. Numbers of the species are likely to fluctuate depending on seasons, and due to the highly mobile nature of the species and widespread availability of habitat, small, localised disturbance is not likely to affect its conservation status.
- Northern nail-tailed wallaby (*Onycholalea ungifera*). The northern nail-tailed wallaby has survived European settlement much better than other nail-tailed species. Within Northern Territory there has been little evidence of its decline in abundance and/or distribution (Appendix 8A) and it appears to be under little threat of population decline. This species is unlikely to be impacted by the project due to its ability to move into other suitable surrounding habitat.

### ***Species Potentially Present***

Ten EPBC Act listed species have the potential to exist in the project area; however, significant long-term impacts upon those species are **unlikely**.

#### *Mulgara (Dasycercus cristicauda)*

Suitable habitat for this species is present within and surrounding the project area; however, mulgara have not been recorded in the project area and there is no evidence (i.e., burrows) of a population being present. The mulgara may be present within suitable habitat in the project area, and could be disturbed during construction and operation activities. However, any impacts to this species, should they occur, are not predicted to be significant given:

- Critical habitat and populations of the mulgara are yet to be investigated but there is no evidence of the species being present within the project area, indicating that significant populations are unlikely to be present. As such it is unlikely that any mining activities will affect a significant habitat or significant population of this species.
- Any habitat disturbed during construction and operation of the project will be minor in the context of the extensive areas of similar suitable habitat across the Barkly Tablelands. Further, the proposed method of backfilling, where possible, lends itself to progressive rehabilitation of disturbed areas, minimising the period of time between ground disturbance and re-establishment of habitat.
- Predation of the mulgara by foxes and cats and competition pressure by introduced grazers are suspected of significantly impacting on mulgara populations. Foxes, cats and dingoes, rabbits and cattle have been recorded in the project area. This project is unlikely to see the introduction of any further pest species that could potentially impact on mulgara, if present. Conversely, control of feral animals in the project area and surrounds may reduce local hunting pressure on this species.

#### *Bilby (Macrotis lagotis)*

Broadscale surveys of bilbies in the Northern Territory in the 1990s indicated that laterite and drainage line land systems were occupied more frequently than sand plain and dune systems. It is unlikely that the project will have any significant impacts on the bilby because:

- Although no estimate is available for the size of the population of bilbies in the Northern Territory the range of the species is declining and contracting northwards. Bilby have not been recorded in the project area and no evidence of the species was identified during targeted field surveys. Although bilby have been collected west of the present Barkly Roadhouse on Dalmore Downs station, there are very few records in the Barkly Tableland region since 1970. The project area does not cover any critical habitat for the bilby identified in the Bilby Recovery Plan (Pavey, 2006) and it is unlikely that an important population falls within the project area. Although there is suitable habitat within the project area, the Bilby Recovery Plan considers the Tanami desert bioregion (west of the Stuart Highway) and the northern Great Sandy Desert bioregion as containing critical habitat and populations of the bilby. The project area does not encompass and will have no effect on these bioregions.
- It is unlikely that the project will in any way adversely affect the availability or quality of habitat to the extent that it will cause a further decline of the bilby. The habitat is not critical and the proposed method of backfilling pits, where possible, lends itself to progressive rehabilitation of

disturbed areas. This will enable rehabilitation and re-establishment of suitable habitat within reasonable timeframes.

- The project is unlikely to result in the introduction of invasive species. The major threats to the bilby across the Northern Territory are predation by foxes, cats and dingoes and competition with introduced grazers for food resources. All of these introduced pests are already present in the project area and this project will not introduce any new invasive species harmful to the bilby. All existing feral populations will be controlled through pest management measures.

#### *Australian painted snipe (Rostratula australis)*

The species occurs in shallow, vegetated, freshwater swamps, claypans or inundated grassland. The species is nomadic and can inhabit temporary wetlands. There is limited understanding of the population size and trend in the Northern Territory. The major threats to the species are drainage of wetlands and degradation of habitat by cattle. The lack of wetland habitat in the project area makes any impact on this species unlikely.

#### *Rainbow bee-eater (Merops ornatus)*

The major threat to the rainbow bee-eater is the introduced cane toad (*Bufo marinus*) as it feeds on the rainbow bee-eater eggs and nestlings and the cane toad will also occupy the nesting burrows. Suitable habitat may occur within the project area and the species may seasonally visit the site during significant wet seasons. However, due to a lack of permanent water, populations are likely to be ephemeral and not impacted by this project. The major threat to the rainbow bee-eater, the cane toad, is unlikely to be introduced to—or survive in—the project area because of the lack of available water.

#### *Great egret (Ardea alba)*

This species is unlikely to be in the project area due to lack of wetland habitats, and any impact on significant habitat or a population is therefore not likely.

#### *Cattle egret (Ardea ibis)*

As there are no large drainage channels or drainage basins within the project area or immediate surrounds, the potential habitat for the cattle egret is unlikely. Ephemeral areas may be inhabited by these species in good wet seasons; however, areas such as these that may be present in the project area are not classified as critical habitat, and any significant impacts on the populations are therefore unlikely.

#### *Oriental plover (Charadrius veredus)*

Suitable habitat for the species may occur within the project area, and there is the potential for the species to be present within the project area. However, there is no critical habitat for this species in the project area and breeding does not occur in Australia so significant impacts on this species are unlikely.

#### *Fork tailed swift (Apus pacificus)*

Although global populations have yet to be quantified, populations of the fork tailed swift are thought to be increasing (IUCN, 2008). Distributed over much of Australia, the project area encompasses only a minor part of available habitat for this species and the project is not expected to make an impact on populations and availability of habitat.

### *Oriental pratincole (Glareola maldivarum)*

The oriental pratincole has a large global population estimated to be 2.5 million individuals in 2004 and is not approaching the thresholds for the population decline (IUCN, 2008). Distributed over much of northern Australia the project is not likely to impact significantly on habitat suitable for this species.

### *Little curlew (Numenius minutus)*

Suitable habitat may occur within the project area. However, as there are no large drainage channels or drainage basins within the project area or immediate surrounds, the potential habitat is limited. The project is on the edge of the little curlew distribution and is not considered to be critical habitat or population. A significant impact on this species is therefore unlikely.

Given the ubiquitous nature of the habitat in the project area and surrounds, the likelihood of any significant impacts on fauna of conservation significance is **unlikely**. Due to the limited presence of fauna of conservation significance any impacts to populations (i.e., the removal of a few individuals) would be **minor**. The residual risk is therefore **low**.

## **Increased Abundance of Introduced Species**

Introduced species are already present in the project area in relatively low densities. The fox and cat are listed as key threatening processes under Section 3 of the EPBC Act, with the impact to bird, reptile and mammal species as a result of predation by foxes and cats being of particular concern. Management and mitigation measures outlined in Section 6.8.3 will provide for the control of introduced species and it is **unlikely** that the density and distribution of these species in the project area will increase as a result of project activities.

The consequence of an increased abundance of introduced species, and in particular foxes and cats, is **moderate** given numbers are currently low and both the fox and cat are considered to be a key threatening process to Australia's biodiversity. As a result of this, and the possible likelihood of it occurring, the residual risk is **moderate**.

The strict implementation of control measures outlined in Section 6.8.3 during construction and operation of the project may lower populations of introduced animals in the project area and surrounds.

## **6.8.5 Monitoring Program**

Fauna monitoring will be conducted to allow identification of potential impacts of mining operations to fauna. Fauna monitoring will involve fauna surveys and targeted counts for threatened species at selected sites to allow assessment of:

- Changes in the abundance, composition or condition of fauna species, particularly threatened species.
- Ongoing impacts to fauna as a result of project-related activities.
- Success of rehabilitation activities for threatened species.
- Increases in the density and distribution of pest animal infestations.
- Introduction of new pest animal species.

- Diversity and health of any waterbirds present in the project area.

Survey methods may include visual observations, spotlighting, bird census transects, trapping and active searching. Fauna monitoring will include:

- Preparing an inventory of fauna species for each of the surveyed habitat types.
- Conducting an annual survey after each wet season for the presence of species of conservation significance.
- Regularly inspecting potential 'fauna traps' such as temporary trenches required during construction.
- Inspecting water bodies located within the project area weekly for wetland bird species.
- Recording animal deaths that occur as a direct result of project activities.
- Monitoring the success of control techniques in reducing environmental impacts due to pest animals in the project area.

Monitoring will be conducted prior to, during and following disturbance. The number of sites to be sampled during monitoring will be calculated to allow for valid statistical comparisons between control and impact sites.

### 6.8.6 Outcome and Assessment Criteria

The outcome and assessment criteria for air quality are outlined in Table 6.24.

**Table 6.24 Outcome and assessment criteria – fauna**

ID	Impact	Outcome	Assessment Criteria	Summary of Management and Mitigation Measures
I23, I24	Reduced species abundance and significant impacts to threatened species.	Disturbance to vegetation is restricted to areas permitted within the Mineral Lease conditions.	Annual audit of records show native vegetation clearance is in accordance with the Mineral Lease conditions. Regular surveying (as per the monitoring program for fauna) indicates no changes in abundance, composition or condition of fauna species from baseline conditions.	Minimise the area of vegetation cleared and fragmentation of habitat. Rehabilitate cleared land progressively during the life of the mine and following project completion. Where possible, roads will be minimised and located outside high-quality habitat. Sediment release and erosion control measures to minimise the release of sediment to receiving surface water environment.  A walk over survey of all areas to be disturbed will be undertaken prior to commencement of works  Key staff trained in the identification of significant species and any traces left by them.

**Table 6.24 Outcome and assessment criteria – fauna**

<b>ID</b>	<b>Impact</b>	<b>Outcome</b>	<b>Assessment Criteria</b>	<b>Summary of Management and Mitigation Measures</b>
I25	Increased abundance of introduced species.	No introduced fauna species are encouraged or introduced due to the project construction and operations.	A reduction in abundance of pest (feral) species from baseline monitoring records.	Controlling existing feral animal populations. Targeting new populations, or significant increases in the current population of foxes and/or feral cats. Reducing potential resources for feral animals. Regularly monitoring areas with a high potential for, or susceptibility to, increases in abundance of introduced species.

## 6.9 Groundwater

Existing groundwater in the project area is described in Section 6.9.1. Potential, credible project-related impacts associated with groundwater are described in Section 6.9.2. The proposed avoidance, mitigation and management measures that Minemakers will implement during all stages of project development are described in Section 6.9.3. The resulting residual impacts of the project to groundwater are discussed in Section 6.9.4, the monitoring program is detailed in Section 6.9.5 and the outcome and assessment criteria in Section 6.9.6.

A water balance has been developed for the project to estimate the water demand during the construction and the operations phases of the project (see Chapter 5). Supply of water from groundwater bores is the only commercially viable means of providing the required amount of water to the project (see Chapter 3 for further detail).

### 6.9.1 Baseline

Hydrogeological and water supply investigations were carried out by Groundwater Resource Management (GRM) in October 2009 (Appendix 9), the objectives of the study were to:

- Estimate the water demand for the project.
- Characterise the existing groundwater environment to:
  - Identify the main aquifers.
  - Identify the main recharge and discharge zones.
- Identify and assess the ability of groundwater supply to meet the project demands, both in terms of quantity and quality.
- Assess the dewatering requirements in the planned pits.
- Assess the impact of the groundwater use during project construction and operations on the groundwater environment, including other users.

This section summarises the findings of these investigations; further detail can be found in Appendix 9.

The characterisation of the existing groundwater environment was based on field investigations, desktop survey and a search of the DNRETAS groundwater database for locations of other groundwater users within the project area (i.e., the Mineral Lease and northern borefield). The field investigations comprised three phases of drilling and a program of test pumping:

- Drilling Phase 1 was undertaken between 23 February and 12 April 2009 and comprised the drilling of 28 exploration holes.
- Drilling Phase 2 was undertaken between 19 April and 7 June 2009 and comprised the drilling of 40 exploration holes and the reaming and construction of two production bores.
- Drilling Phase 3 was undertaken between 20 August and 2 September 2009 and comprised the drilling of eight exploration holes, two of which were constructed as production bores and the remaining six constructed as monitoring bores.

The first two drilling phases were restricted to Exploration Lease tenements held by Minemakers to the south of the Barkly Highway and did not identify an adequate water supply for the project. The third drilling phase targeted an area north of Minemakers' tenements, which had been identified from the historical drilling record as being prospective in terms of groundwater supply. This drilling phase identified a suitable water supply for the project.

The location of bores to supply water for the project is shown in Figure 6.9.

## Hydrogeology

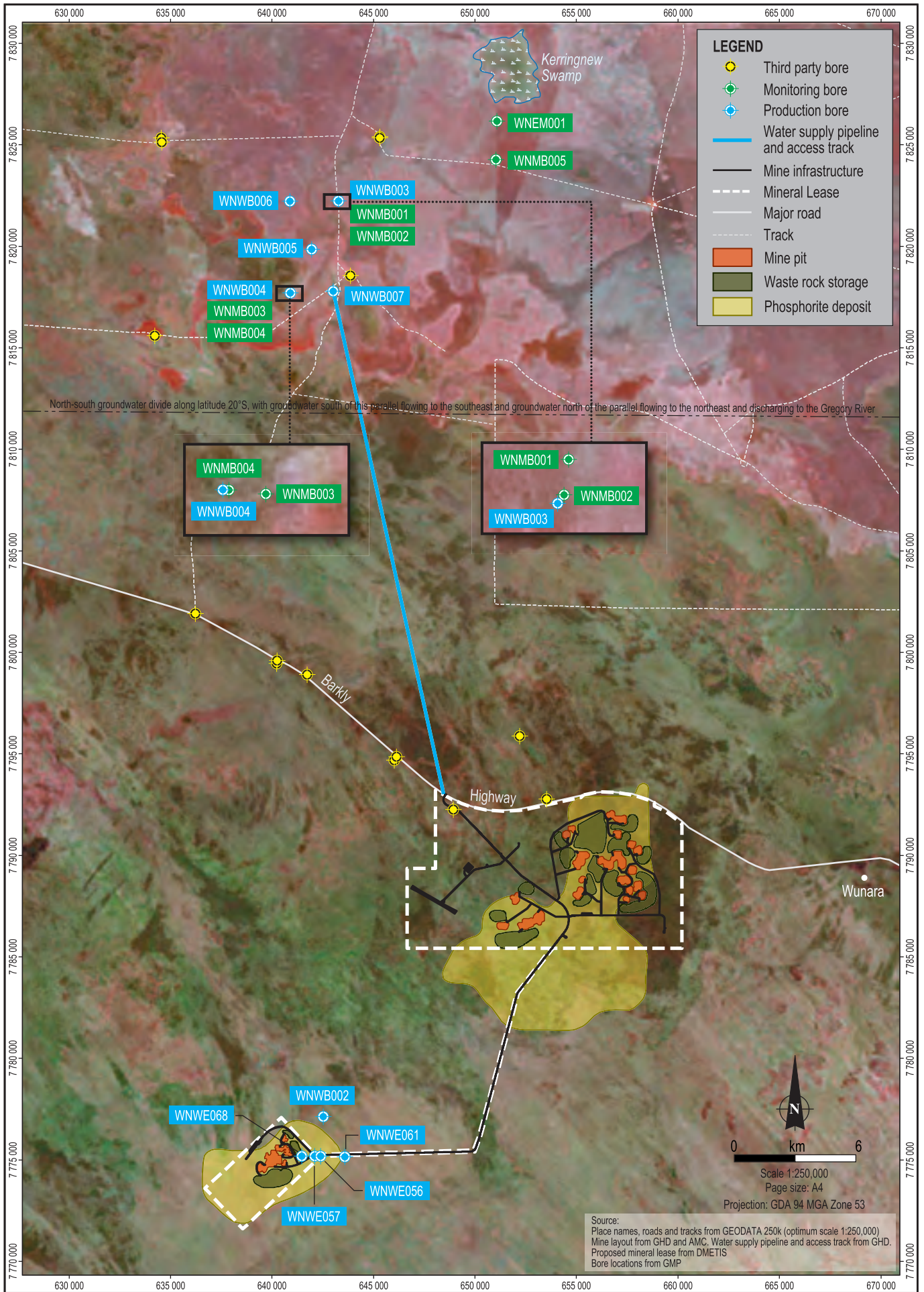
The main aquifers on the Barkly Tableland comprise cavernous zones that are commonly weathered and fractured, within calcareous units of the Wonarah Formation and Camooweal Dolomite. These aquifers have been used to provide domestic and stock water across the tableland for nearly a century. The majority of the existing bores have not been test pumped, preventing reliable estimates of aquifer yields. However, historical airlift testing suggests rates of over 5 L/s are common and in some instances rates over 100 L/s have been reported.

The volcanic rocks, which form the basement in the project area, have generally low permeability. Groundwater occurrence within the basement rocks is restricted to discrete fractures and zones of higher weathering. Maximum flow rates from the fractures are likely to be less than 5 L/s.

Groundwater recharge is predominantly from rainfall infiltration. Recharge from surface water will occur locally in the vicinity of the major rivers and, after rainfall events, from minor watercourses and marshy areas. Rainfall recharge rates have been estimated from water balance calculations at 4 mm/a and from chloride balance methods to be between 1.5 to 5 mm/a.

## Groundwater Levels

Groundwater levels in the region are extremely variable, ranging from about 25 to over 100 m below ground level (bgl). While the regional groundwater flow regime is poorly understood, it is thought that there may be a north-south groundwater divide along latitude 20°S, with groundwater south of this parallel flowing to the southeast and groundwater north of the parallel flowing to the northeast and discharging to the Gregory River (see Figure 6.9).



In the area north of the Mineral Lease groundwater levels are reasonably consistent, lying between 49 to 51 m bgl in the vicinity of production bores WNWB003 and WNWB004, and falling to about 65 m bgl at WNWB005. This consistency indicates the presence of a well-connected aquifer system within the cavernous and weathered dolomite.

Groundwater levels in the Mineral Lease are more variable and range from around 3 m to 103 m. This variability in groundwater level suggests a heterogeneous groundwater system, with poor hydraulic connections between aquifers. Watertable levels are below the base of the ore across the deposits, with the exception of a few isolated locations that show evidence of minor or perched waterbodies. Within the Main Zone, groundwater levels varied from about 3 to 63 m bgl. Two of the areas surveyed had groundwater levels above the average pit depth (50 m bgl), which were found to be blocked just below the measured water level. It is therefore almost certain the elevated levels in these holes are atypical and probably reflect a shallow, isolated and perched groundwater body. Similarly at Arruwurra, four holes where groundwater was encountered were blocked just below the recorded groundwater level. The depth of the ore zone in one of the remaining three wet holes was found to lie well below the measured water level. The reason for the anomalous levels is not known, but it is expected to be localised.

### **Groundwater Flow Rates**

Test pumping was carried out on three of the four production bores (WBWB002, WNWB003 and WNWB004); the exploration camp bore was not tested, because of its low yield and current use as the water supply bore for the Minemakers' camp (operational since May 2009). Results show:

- A modest aquifer transmissivity at the Arruwurra construction bore (WBWB002) of approximately 15 m<sup>2</sup>/d. The results are consistent with a moderately low yielding production bore.
- High to very high aquifer transmissivity at the northern borefield (WNWB003 and WNWB004) ranging from 350 to 500 m<sup>2</sup>/d and 700 to 900 m<sup>2</sup>/d, consistent with a short-term duty rate of between 15 and 20 L/s.

### **Groundwater Quality**

Groundwater quality over the Barkly Tableland is generally fresh to brackish, ranging from 500 to 4,000 mg/L total dissolved solids (TDS).

Groundwater samples were collected from the four test production bores at the end of the 48 hour constant rate tests. Results are provided in Table 6.25; in summary:

- The groundwater at the Main Zone exploration camp was fresh, while the other bores were slightly brackish.
- pH ranged from neutral to slightly alkaline.

**Table 6.25 Water quality analysis results**

Analyte	Units	Exploration Camp Bore	WNWB002	WNWB003	WNWB004	Australian Drinking Water Standards (Health)	ANZECC Stock Water Standards
Conductivity	µS/cm	ND	2,100	2,700	2,400	80-500 (good)	-
TDS	mg/L	780	1,300	1,800	1,500	a	4,000 - 5,000
pH		8	7.4	7.1	7	b	-
TSS	mg/L	ND	<5	10	8	-	-
Turbidity	NTU	ND	<1	2	7	b	-
Turbidity filtered 0.45µm	NTU	ND	<1	<1	<1	-	-
Colour	PCU	ND	<5	<5	<5	a	-
Total Hardness	mg/L CaCO <sub>3</sub>	170	ND	ND	ND	-	-
Calcium	mg/L	59	25	140	140	-	1,000
Magnesium	mg/L	6.5	34	97	88	-	-
Sodium	mg/L	ND	450	330	290	c	-
Potassium	mg/L	ND	29	53	46	-	-
Strontium	mg/L	ND	0.35	1.7	1.5	-	-
Barium	mg/L	0.065	<0.01	0.02	<0.01	0.7	-
Total Iron	mg/L	ND	<0.02	0.11	0.31	b	d
Manganese	mg/L	0.055	<0.005	0.51	0.059	0.5	d
Carbonate	mg/L CaCO <sub>3</sub>	ND	<1	<1	<1	-	-
Bicarbonate	mg/L CaCO <sub>3</sub>	ND	640	420	460	-	-
Sulphate	mg/L	ND	120	330	230	500	1,000
Chloride	mg/L	ND	310	550	450	c	-
Nitrate	mg/L	0.01	14	5.8	0.4	50	400
Fluoride	mg/L	1.2	1.4	1.2	1.1	1.5	2

**Table 6.25 Water quality analysis results**

Analyte	Units	Exploration Camp Bore	WNWB002	WNWB003	WNWB004	Australian Drinking Water Standards (Health)	ANZECC Stock Water Standards
Silica	mg/L	ND	46	17	19	-	-
Arsenic	mg/L	0.0026	ND	ND	ND	0.007	0.5
Cadmium	mg/L	<0.0001	ND	ND	ND	0.002	0.01
Lead	mg/L	<0.001	ND	ND	ND	0.01	0.1
Selenium	mg/L	0.0049	ND	ND	ND	0.01	0.02
Antimony	mg/L	<0.05	ND	ND	ND	0.003	-
Boron	mg/L	1.4	ND	ND	ND	4	5
Chromium	mg/L	<0.002	ND	ND	ND	0.05	1
Copper	mg/L	<0.002	ND	ND	ND	2	1
Molybdenum	mg/L	<0.01	ND	ND	ND	0.05	0.15
Nickel	mg/L	<0.005	ND	ND	ND	0.02	1
Total Mercury	mg/L	<0.001	ND	ND	ND	-	0.002
Total Cyanide	mg/L	<0.005	ND	ND	ND	0.08	-

Note: ND = Not determined.

Source: NHMRC, 2004 and ANZECC/ARMCANZ, 2000.

a = Not necessary.

b = Insufficient data to set a guideline value based on health considerations.

c = No health-based guideline considered necessary.

d = Not sufficiently toxic.

- Total suspended solids (TSS) and turbidity at the two northern bores were slightly elevated (these were constructed without filter pack); but below detection levels at the other bore which was constructed with a filter pack.
- The dominant ions in water from the Arruwurra bore (WBWB002) were sodium and bicarbonate/chloride, and in the northern bores sodium and chloride.
- Iron concentrations were elevated in the two northern bores (WNWB003, WNWB004).
- High silica values were measured in the Arruwurra bore and high to moderate values in the northern bores.

### Groundwater Users

Ten existing boreholes lie within the vicinity of the Mineral Lease, all located along the Barkly Highway. Seven of these boreholes were installed by the Northern Territory Government for construction and maintenance of the highway. An additional six existing boreholes lie within a 10 km radius of the northern borefield; these bores were installed by Dalmore Downs Station for stock watering purposes. Table 6.26 details all third party bores within or surrounding the project area. The bores closest to the project area are shown in Figure 6.9.

**Table 6.26 Third party bores in the project area**

Registered Bore Number (RN number)	Bore name	Location MGA Zn 53		Depth (m)	Date Installed	Status	Yield (L/s)
		(mE)	(mN)				
RN000031	4A-132 Barkly Highway	636,226	7,801,919	92.9	ND	ND	0.39
RN000301	3A-128 Mile Barkly Highway	641,726	7,798,919	60.9	ND	Not in use	ND
RN000302	2A-128 Mile Barkly Highway	641,726	7,798,919	ND	ND	Not in use	ND
RN000370	1A-124 Mile Barkly Highway	646,126	7,794,869	ND	ND	Not in use	ND
RN001237	No 2 Eagles Nest, Dalmore Downs Station	643,850	7,818,572	81.7	1950	ND	2.6
RN001238	No 3 Blue Bush, Dalmore Downs Station	634,207	7,815,614	88	1951	ND	2.6
RN001778	Wonarah repeater station, Barkly Highway	640,212	7,799,448	111.5	1958	ND	0.68
RN004087	No 11 Alroy Downs Station	634,526	7,825,369	71	1963	ND	2.86
RN006751	No 11 Dalmore Downs Station	634,571	7,825,132	94.5	1970	ND	3
RN020997	81/1 Barry Caves West, Dalmore Downs Station	648,937	7,792,271	ND	1981	ND	0.4

**Table 6.26 Third party bores in the project area**

Registered Bore Number (RN number)	Bore name	Location MGA Zn 53		Depth (m)	Date Installed	Status	Yield (L/s)
		(mE)	(mN)				
RN020998	81/2 Barry Caves West, Dalmore Downs Station	646,026	7,794,669	125	1981	ND	0.25
RN021238	81/3 Barkly Highway Barry Caves West	653,526	7,792,769	145	1981	ND	0.38
RN021239	81/4 Barkly Highway Barry Caves West	652,227	7,795,886	76	1981	Not in use	ND
RN021245	81/5 Barkly Highway Barry Caves West	640,230	7,799,600	134	1981	ND	1.9
RN025678	No 10A 88/37 Dalmore	645,306	7,825,367	140	1988	ND	5
RN025874	No 10 Dalmore Downs Station	645,320	7,825,391	135.6	1971	ND	1.4

Note: ND = Not determined

### Environmentally Sensitive Areas

There are two environmentally sensitive areas in the vicinity of the project area that have the potential to be impacted by the extraction of groundwater for the project; Kerringnew Swamp (see Figure 6.9) and Oolgoogarri Swamp. These areas have been identified as environmentally sensitive areas due to their potential to provide seasonal habitat for migratory bird species.

The Kerringnew Swamp is located 10 km northeast of the northern borefield. During the hydrogeological and water supply investigations the swamp was inspected, at that time there was no evidence of recent surface water, although the vegetation suggested inundation might occur after rainfall events. An environmental monitoring bore (WNEM001) was installed during the field program. The bore was dry to a completed depth of 18 m depth suggesting the swamp is an ephemeral surface water feature and not related to groundwater. It is therefore not expected to be influenced by changes in the underlying groundwater level.

The Oolgoogarri Swamp is located 37 km east of the northern borefield and is not expected to have a groundwater connection with the borefield.

### 6.9.2 Potential Impacts

Groundwater quality and quantity has the potential to be affected by the project. Potential, credible project-related groundwater impacts are described below. It should be noted that these do not take into consideration the proposed avoidance, mitigation and management measures that will be implemented by Minemakers during all stages of project development (see Section 6.9.3), and which will result in the residual impacts discussed in Section 6.9.4.

### **Decrease in the Availability of Groundwater for Third Party Users**

Groundwater naturally recharges or replenishes through infiltration of surface water. During groundwater extraction (for project water supply) there is potential for the extraction rate to exceed the recharge rate, causing a local cone of depression or drawdown of the groundwater table. This depression may affect the available water within the cone of depression, decreasing the availability of groundwater for existing third party users within the cone of depression.

Where the mine pit depth is equal to or below the depth of the groundwater, inundation of groundwater will occur. To enable mining of the ore, any groundwater inflow will be required to be intercepted before it enters the pit and/or removed from the pit, which can also reduce the availability of groundwater for third party users.

### **Reduced Groundwater Quality**

The continued and/or potential future use of groundwater by third parties may be dependent upon the quality of the groundwater. A reduction in the quality may result in a change or restriction in the use of this resource.

A reduction in groundwater quality due to contamination from mining operations is commonly associated with seepage from tailings storage facilities and acid rock drainage (ARD). However, the project will not produce tailings and geochemical analysis has indicated that the waste rock and non-DSO will not generate ARD (see Chapter 5 for further detail).

Potential impacts to groundwater quality may however result through:

- Increasing salinity due to reductions in dilution of salts in the aquifer system due to over-extraction of groundwater.
- Spillage or seepage of hazardous materials stored on-site such as chemicals or hydrocarbons.

### **Reduced Availability of Groundwater for Environmentally Sensitive Areas**

Groundwater dependent ecosystems are ecosystems that use groundwater as part of their survival and can include wetlands, vegetation and mound springs. The dependence of ecosystems will range from complete reliance to those that partially rely on groundwater, such as during droughts (Australian Government, 2009). Changes to the flow, level and quality of groundwater may affect the survival of groundwater dependent ecosystems.

If groundwater dependent ecosystems exist within the zone of influence of the borefield and mine pits ecological habitats may potentially be impacted. Two environmentally sensitive areas have been identified as potentially groundwater dependent, Kerringnew Swamp (10 km northeast of the borefield) and Oolgoogarri Swamp (37 km east of borefield). Groundwater modelling results indicate drawdown of less than 3 m at Kerringnew Swamp and 0.2 m at Oolgoogarri Swamp after 10 years of pumping, which is considered to be negligible considering the ambient groundwater depth of around 50 m. In addition, hydrogeological investigations of the Kerringnew Swamp indicate the swamp is fed through surface water flow and is not dependent on groundwater (see Section 6.9.1).

Potential impacts to the environmentally significant areas due to reduced groundwater availability are not considered to be credible impacts and are not assessed further in this report.

### 6.9.3 Avoidance, Mitigation and Management

Minemakers will implement avoidance, mitigation and management measures to address the potential impacts on groundwater. These measures will reflect current good practice at similar mines operating in similar environments and include site and species specific measures. These measures are described below.

#### Decrease in the Availability of Groundwater for Third Party Users

Minemakers groundwater monitoring program will monitor groundwater levels. Minemakers will deepen existing bores or provide a suitable alternative water supply for users of these third party bores if a reduction in water supply occurs as a result of Minemakers' extraction activities.

#### Reduced Groundwater Quality

Measures to avoid, mitigate and manage the risks associated with reduced groundwater quality include:

- Appropriately storing and managing hazardous substances on-site (see Chapter 9).
- Implementing the surface water management plan (see Section 6.10).
- Ensuring the extraction of groundwater does not exceed sustainable yield limits.

If a reduction in groundwater quality does occur, it will be detected by the groundwater monitoring program (see Section 6.9.5) and the necessary remedial measures will be put in place.

#### Reduced Availability of Groundwater for Environmentally Sensitive Areas

Impacts to groundwater dependent ecosystems have been avoided by locating the borefield in an area with no such ecosystems. Therefore, no specific measures are proposed to minimise or mitigate impacts to groundwater dependent ecosystems. However, to confirm that there is no linkage between the Kerringnew Swamp and the underlying groundwater table Minemakers will continue to monitor the environmental bore during construction and operation of the project. This will identify any fluctuations in groundwater level at this location and any unexpected linkage between it and the ecosystem. Should this monitoring detect linkage, ecological survey sites will be established at the swamp to determine the nature of impacts to the ecosystem as a result of drawdown due to the project.

### 6.9.4 Residual Impact

Table 6.27 summarises the residual impacts of the project to groundwater, considers the likelihood and consequences of the impacts (taking into account proposed management measures), and provides an overall risk rating for each potential impact. These are discussed in detail below.

**Table 6.27 Summary of impacts to groundwater**

ID	Impact	Likelihood	Consequence	Residual Risk
I26	Decrease in the availability of groundwater for third party users.	Unlikely	Minor	Low
I27	Unacceptable reduction in groundwater quality.	Unlikely	Minor	Low

### **Decrease in the Availability of Groundwater for Third Party Users**

Water during the construction phase will be required for road construction, dust suppression for the roads, construction water for the crushing and screening plant and village and potable water demand. The total water demand during construction is estimated to peak at 15 L/s during the final phase of construction.

Water during the operational phase of the project will be required for dust suppression for the roads and mining areas, water for the crushing and screening plant, accommodation areas and potable water demand. The peak water demand will be during the initial operational phase, while construction continues to be completed. This demand is estimated to be 67 L/s. Once construction is complete, operational water demand is expected to vary between 60 L/s during the dry season and 32 L/s in the wet season.

To meet the water requirements for the project a two-stage supply is planned. The first stage will provide approximately 10 to 15 L/s for the start of construction, using the exploration camp bore for potable water and lower yielding bores at Arruwurra for construction water requirements. During this initial construction period the second stage of water supply will be developed. This will involve constructing the northern borefield (see Figure 6.9). The estimated time to install the northern borefield and associated water supply pipeline is three months, at which point the Arruwurra and exploration camp bores will no longer be required.

Conceptual modelling was carried out to determine the sustainability of local aquifers to supply the project with the required water quantities (Appendix 9). Modelling has considered best and worst case scenarios and reflects a conservative condition with the exclusion of rainfall recharge and adoption of the lower range in hydraulic conductivity for the dolomite aquifer. The modelling results suggest a production rate of 75 L/s over the 10 year mine life is readily achievable. Modelling indicates the maximum drawdown at the northern borefield range from 14 to 17 m. Expected drawdown is shown in Figure 6.10.

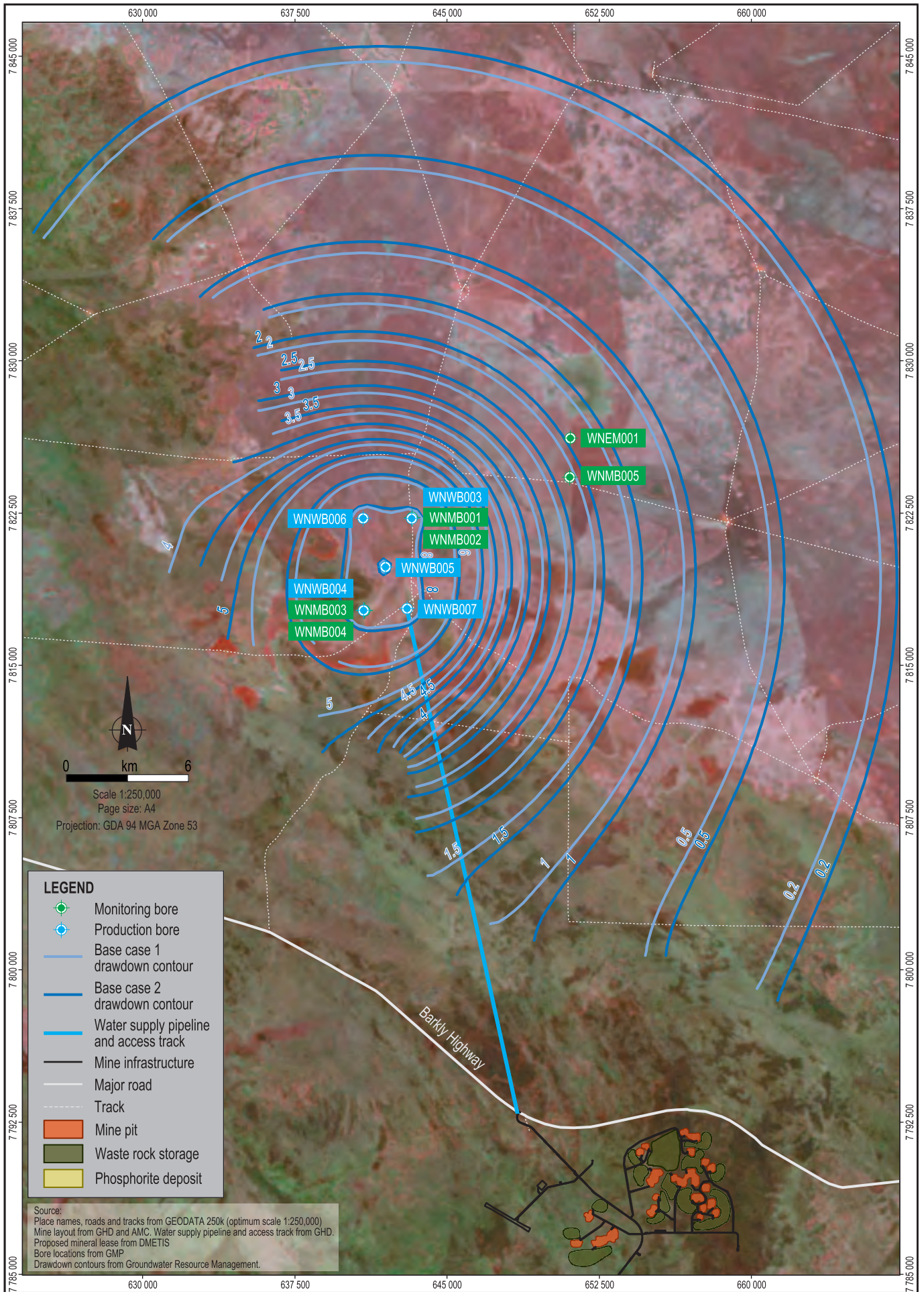
For the worst case scenario, modelling has identified the third party bores which may be adversely affected by the use of groundwater by the project. These users are located near the borefield and comprise:

- Six stock bores (RN025678, 025874, 004087, 006751, 001237 and 001238) that lie within the 5 m drawdown contour.
- One stock bore (RN001237) that lies within the 10 m drawdown contour for after 10 years.

No third party users have been identified surrounding the Arruwurra deposit.

The maximum drawdown of groundwater is estimated at about 17 m after 10 years using likely worst case values for hydraulic parameters and a combined pumping rate for the northern borefield of 75 L/s. This drawdown is considered negligible; given the available drawdown in the aquifer system is approximately 50 m.

The groundwater monitoring program will monitor drawdown extents in the regional bores and monitoring bore WNMB005. In addition, Minemakers will maintain existing third party user water supplies, where monitoring indicates pumping from the proposed northern borefield has reduced supply.



The likelihood of a decrease in the availability of groundwater for third party users it therefore **unlikely**. Due to Minemakers commitment to maintaining existing third party user supplies, the consequence is **minor**, resulting in a **low** residual risk.

### Unacceptable Reduction in Groundwater Quality

Regional groundwater quality data show groundwater salinities range from 500 to 4,000 mg/L TDS. The groundwater investigation has determined the extraction of groundwater for the project is sustainable and it is therefore unlikely the project's extraction will lower the quality of the groundwater. Groundwater across the Barkly Tableland is used extensively for stock watering purposes; acceptable salinity limits can be as high as 5,000 mg/L TDS (or 7,000 µS/cm EC) (ANZECC/ARMCANZ, 2000).

Hazardous materials and chemicals stored on site will be minimal, with notable items being fuel, and sundry lubricants and cleaning chemicals. All hazardous materials stored on site will be contained within bunded areas and will be managed to minimise spillage. The implementation of the spill management procedures in the waste management plan will also minimise any risk of contamination of groundwater aquifers as a result any spills.

With the planned groundwater quality monitoring program and the appropriate management of hazardous materials stored on-site is considered **unlikely** that there would be an unacceptable reduction in groundwater quality. The monitoring program will enable early detection of changes in groundwater quality and allow for mitigation measures to be implemented; the consequence is therefore **minor**, giving a risk rating of **low**.

### 6.9.5 Monitoring Program

Regular monitoring will be implemented for the potential groundwater impacts identified. The proposed groundwater monitoring schedule is presented in Table 6.28.

**Table 6.28 Groundwater monitoring schedule**

Monitoring Site	Parameter	Frequency
Arruwurra and camp area production bores	Groundwater level depth.	Monthly
	Cumulative pumping volume.	Monthly
	Electrical conductivity (EC), temperature and pH.	Monthly
Northern borefield - production bores	Groundwater level depth.	Monthly
	Cumulative pumping volume.	Monthly
	EC, temperature and pH.	Monthly
	Water quality (pH, TDS, EC, major ions, NO <sub>3</sub> and Fe).	Annual
Northern borefield - monitoring bores	Groundwater level depth	Monthly
Operational pits	Quantity of groundwater inflow removed from pits. Period of time during which pumps are operating to remove groundwater inflow.	As necessary
<b>Regional sites</b>		
Environmental monitoring bore (WNEM001)	Groundwater level depth.	Monthly
Nearby stock bores	Groundwater level depth.	Monthly

## 6.9.6 Outcome and Assessment Criteria

The outcome and assessment criteria for groundwater are outlined in Table 6.29

**Table 6.29 Outcome and assessment criteria – groundwater**

ID	Impact	Outcome	Assessment Criteria	Summary of Management and Mitigation Measures
I26	Decrease in the availability of groundwater for third party users.	Groundwater supply from third party bores identified Table 6.26 do not decrease due to the project's construction and operations.	Monitoring of nearby third party bores identified in Table 6.26 shows no decrease in groundwater level depth directly attributable to groundwater extraction for the project.	Monthly monitoring of status (i.e., active or inactive) and groundwater level depth of nearby third party bores.  Monthly monitoring of production bores.
I27	Unacceptable reduction in groundwater quality.	Groundwater quality is not reduced due to the Project construction or operations.	Monitoring of production bores reveal no change to groundwater quality.	Monthly in situ monitoring of EC, temperature and pH.  Annual laboratory analysis of water quality samples.  Appropriate storage and management of hazardous substances on site.  Implementation of surface water management plan.

## 6.10 Surface Water

Existing surface water conditions in the project area and surrounds are described in Section 6.10.1. Potential, credible project-related impacts associated with surface water are described in Section 6.10.2. The proposed avoidance, mitigation and management measures that Minemakers will implement during all stages of project development are described in Section 6.10.3. The resulting residual impacts of the project to surface water are discussed in Section 6.10.4, the monitoring program is detailed in Section 6.10.5 and the outcome and assessment criteria in Section 6.10.6.

### 6.10.1 Baseline

This section describes the existing surface water environment of the project area and surrounds, with a focus on:

- Beneficial uses (i.e., environmental values) of water.
- Catchment systems.
- Surface drainage patterns.
- Watercourses or other wetland habitat.
- Water quality.

This description is based on the surface water studies completed by Groundwater Resource Management Pty Ltd (GRM) (Appendices 10A and 10B) and flora and fauna surveys completed by Low Ecological Services Pty Ltd in June 2008 and March 2009 (Appendix 8A).

The Northern Territory's water resources are controlled under the *Water Act*, which recognises the beneficial uses (i.e., environmental values) of surface water as:

- Agriculture – to provide irrigation water for primary production including related research.
- Aquaculture – to provide water for commercial production of aquatic animals including related research.
- Culture – to provide water to meet aesthetic, recreational and cultural needs.
- Public water supply – to provide source water for drinking purposes delivered through community water supply systems.
- Environment – to provide water to maintain the health of aquatic ecosystems.
- Industry – to provide water for industry, including secondary industry and a mining or petroleum activity, and for other industry uses.
- Rural stock and domestic – to provide water for the purposes watering stock and for general household use.

The Northern Territory is divided into Surface Water Management Areas (SWMA), which are managed to protect the beneficial uses identified for that specific SWMA. The project is located in the Barkly SWMA. Under the Barkly SWMA management framework, there are no statutory water quality objectives to meet environmental and other public benefit outcomes.

From the project's perspective, the key environmental values relating to surface water are:

- Protection of downstream aquatic ecosystems.
- Provision of water for stock and domestic uses on neighbouring and downstream properties.
- Protection of culturally significant ephemeral lakes (see Section 6.12).

## **Meteorological Conditions**

### ***Rainfall***

As described in Chapter 4, the project is located in the central eastern section of the Davenport and Murchison Ranges Bioregion and rainfall in the region tends to be seasonal and although the mean annual rainfall values are relatively low (around 300 mm), high intensity rainfall events can be significant. Rainfall intensity data shows that short duration rainfall intensities in excess of 150 mm/hr have been recorded at the local BoM stations of Brunette Downs and Wonarah (see Figure 4.1, Chapter 4) and a 180 mm rainfall event was recorded at the project area in January 2009.

### ***Evaporation***

Mean daily evaporation rates are approximately 8 mm per day, ranging from a high of approximately 10 mm per day during October and November to a low of approximately 6 mm during June and July (see Figure 4.2, Chapter 4). Evaporation is highest during the build up to the wet season and the early wet season (October, November and December) with mean monthly evaporation in the range of 317 to 347 mm, reducing by half over the dry season (June to September) period. During the 2008 to 2009 survey period evaporation at Wonarah exceeded rainfall.

## **Cyclone Events**

The project area is located within a region that is occasionally subject to tropical cyclones (TC) and tropical depressions. Although infrequent, rainfall events associated with the cyclones could have an impact on the project area.

Cyclone swept path analysis reveals that 16 tropical cyclones entered the 4 degree band of influence (or approximately 400 km) of the project area during a 98-year period. This translates to a long-term regional average that one cyclone every six or seven years will occur within the four degree band of influence. However, regional cyclonic events can sometimes be more frequent, with two cyclones (TC Sam and TC Wylva) occurring within the 2000/2001 cyclone season.

Cyclone intensity is a factor that also requires consideration as a more intense cyclone passing further away may cause greater damage than a less intense cyclone in the immediate vicinity. This was evident when TC Steve occurred some 600 km north of the region, yet Annitowa (130 km south of the project area) received a resultant daily rainfall of 215 mm.

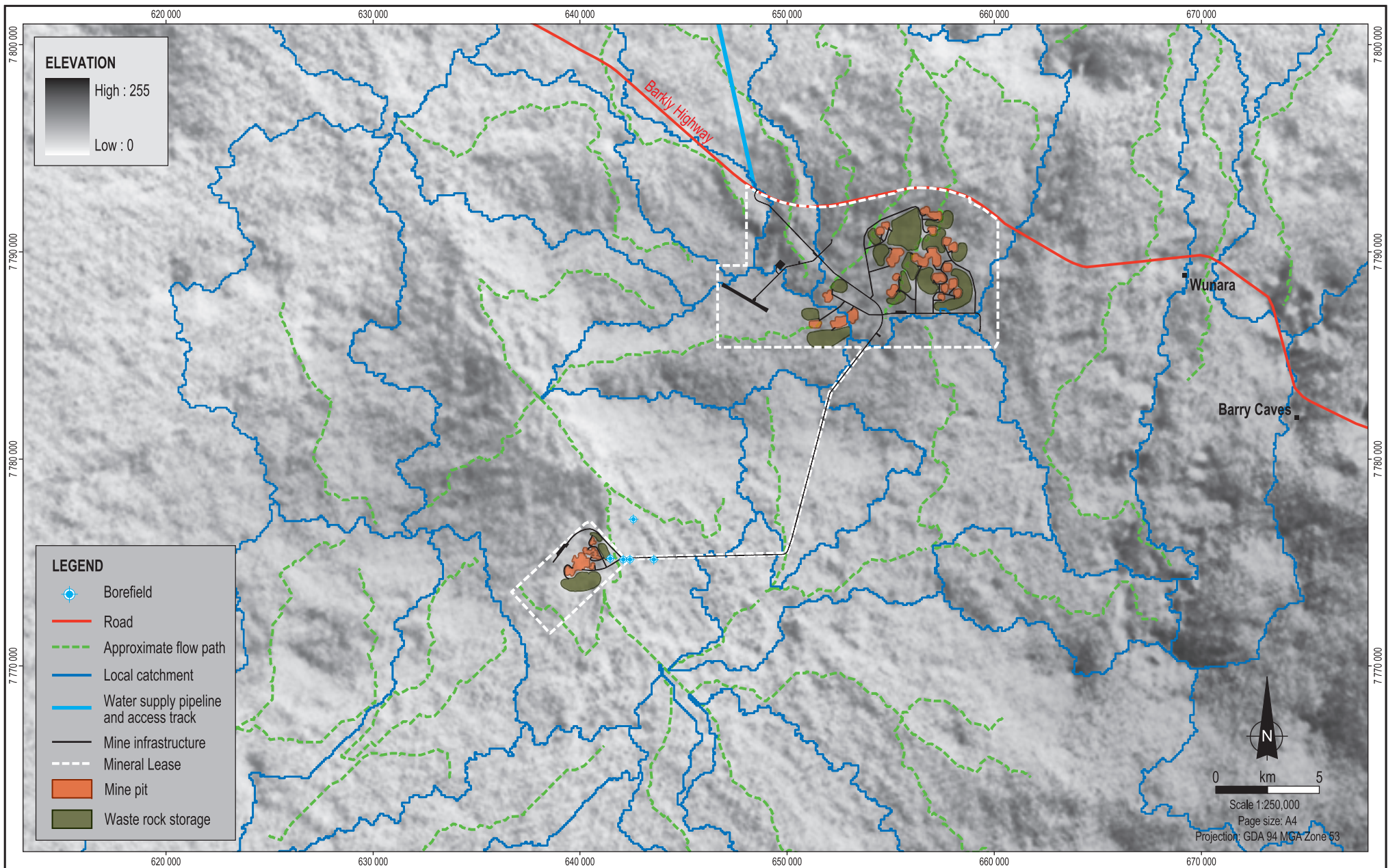
## **Catchment Areas, Surface Drainage and Flow Patterns**

The project area is located within the internally draining Barkly SWMA (see Figure 1, Appendix 10A), which covers an area of 123,000 km<sup>2</sup> and has an annual mean runoff volume of 600,000 ML/year. The project area incorporates nine local catchment areas. No discernible watercourse or drainage channels are located within the project area; and all of the watercourses and drainage lines in vicinity of the project area are relatively minor and ephemeral in nature and are likely to only carry runoff for short periods following significant rainfall events. Occasionally, flows will be significant enough to cause flooding.

The only notable surface water feature within close proximity to the project area is the seasonally flooded ephemeral swamps to the north of the Arruwurra section of the Mineral Lease and northeast of the northern borefield. These ephemeral lakes are not permanently inundated; however, some ephemeral lakes in the region are known to retain water for extended periods after rain (Edgoose, 2003).

The closest significant watercourses are the ephemeral Ranken River approximately 60 km to the east of the project area (in the Georgina River catchment) and the ephemeral Playford River (in the Playford River catchment) to the north (Figure 6.11; Chapter 1, Figure 1.1). Although there is no flow data for the Playford River, there is highly variable annual flow data for the Ranken and Georgina rivers, which are representative of the effects of climatic variations on surface water flows in the region. Maximum flow rates in these rivers can also be very high reflecting heavy rain periods. The data for these rivers are summarised in Table 6.30.

Although a lack of surface water flow data exists for the project area, modelling of surface water flows in the project area for a 100 year average recurrence interval (ARI) flood event was undertaken based on local meteorological and topographic conditions and catchment areas and using data from the Ranken and Georgina rivers and a potential flow rate of 480 m<sup>3</sup>/s. Under these modelled flood conditions the local drainage line of most concern to the project, which flows in a northwesterly direction towards Arruwurra deposit, floods an area greater than 1 km in width. Contributing factors to such extensive flooding include the large upstream catchment area of the watercourse and the lack of discernible channel.



Source:  
 Place names, roads and tracks from GEODATA 250k (optimum scale 1:250,000)  
 Mine plan from AMC & GHD.  
 Catchments and flow paths from Carrick Consulting.  
 DEM from Northern Territory Geological Survey.



Date:  
 13.11.2009  
 MXD:  
 Minemakers\_Wonarah\_GIS.mxd  
 File Name:  
 9014\_07\_F06.11\_GIS\_GL

Minemakers Australia Pty Ltd  
 Wonarah Phosphate Project



Catchments and estimated flow paths  
 in the project area

Figure No:  
 6.11

**Table 6.30 Regional flow data for rivers near the project area**

Parameters	Ranken River	Georgina River
Data record length (years)	~ 42	~ 21
Distance from site (km)	59 east	364 southeast
Catchment area (km <sup>2</sup> )	4,360	118,398
Maximum daily flow (m <sup>3</sup> /s)	1,720.9	3,612.7
Mean annual flow (GL)	172.1	1,042.3
Median annual flow (GL)	39.9	328.7
Minimum annual flow (GL)	0.6	9.9
Maximum annual flow (GL)	2,035.7	6,288.0

Groundwater recharge from surface water will occur locally (although at low rates) in the vicinity of the major rivers and, after rainfall events, from minor watercourses and swamp areas. Section 6.9 provides further detail about this.

Flow paths that intersect the planned location of the mine pits and other mine infrastructure are shown on Figure 6.11.

### Water Uses

There is no major water storage, diversion or supply infrastructure within the Barkly SWMA and the volume of surface water used is less than 0.1% of the mean annual runoff. There are no current surface water licences within the Barkly SWMA and any water use is for stock watering, with groundwater resources providing the main water source in the region (see Section 6.9).

Grazing of stock occurs to the north of the Barkly Highway, but relies predominantly on groundwater. Water (predominately groundwater) is sometimes used for maintenance of the Barkly Highway.

There are also ephemeral lakes adjoining the project area that are culturally significant sites and have been classified as exclusion zones by the Traditional Owners and CLC (see Section 6.12). Large ephemeral lakes, which act as seasonal refuges for populations of larger fauna, are important hunting grounds for Traditional Owners.

### Water Quality

Due to the ephemeral nature of drainage lines and watercourses in the project area, there is a lack of water quality data for the project area. Event-driven water quality sampling will be undertaken during the 2009 wet season. However, water quality data from other streams in the same region (and similar climatic and surrounding land use conditions) has been used to characterise the expected water quality of the project area. This data was sourced from the Queensland Government Department of Environment and Resource Management (DERM) and comprises extensive data sets (up to 139 sampling events over 40 years). These watercourses are listed below:

- Georgina River at Camooweal.
- Gunpowder Creek at Gunpowder.
- Leichardt River at Doughboy creek.
- Dugald River at Rail Crossing.

Discussions with relevant Northern Territory Government personnel indicate that no similar data is available from the Northern Territory Government.

Water quality data for these watercourses generally vary greatly, due largely to seasonal changes in flow. Generally:

- These watercourses are slightly alkaline (median pH between 7.6 to 7.9). However, overall the variation is large with pH values ranging from 5.4 to 9.6.
- Levels of total suspended solids and turbidity also generally vary greatly, with standard deviations often doubling the mean values. This is indicative of the high sediment loads during high flow periods following heavy rains. Therefore, in the project area it can be expected that variability in rainfall intensity will cause similar variability in sediment loads being delivered to waterbodies during inundation events. It is common for heavy rains to result in highly turbid flows and sediment-bound materials to be transported large distances (Smith, 2003). As semi-arid regions are characterised by a low density of vegetation – particularly sparse ground cover – soils are usually easily eroded and available for transport by stream flow (Smith et al., 2004).
- Salinity (as total dissolved solids) in these watercourses is largely varied. High salt concentrations are typical of watercourses that dry under high temperatures during summer.
- Nutrient levels (nitrate and total phosphorus) in these watercourses are highly varied and often exceed ANZECC/ARMCANZ trigger values for protection of 95% of species (for moderately-to-slightly-disturbed ecosystems). High nutrient levels are typical of streams where stock grazing land uses occur nearby and could be an indication of likely conditions in the water to the north of the Barkly Highway where stock grazing occurs.

It should be noted that application of guidelines to ephemeral waterbodies are often difficult due to the extreme variation in physical and chemical conditions and the associated logistical impedances of monitoring such water quality. However, it can be expected that physico-chemical conditions will be wide-ranging and depend on climatic conditions, physical conditions (e.g., flow rate, depth, temperature) and the phase of the water bodies (i.e., first flush, stream flow, flow cessation with remnant pools and final drying stages), which have very different influences on chemical and biological characteristics of the waterbody (Smith, 2003).

### **Wetland Habitat**

No wetland habitat has been identified within the project area. As previously discussed, ephemeral lakes that provide wetland habitat occur to the northeast of Arruwurra and northeast of the northern borefield.

Lake Sylvester, located approximately 100 km northeast of the project area, is regarded as one of the largest freshwater wetlands of the Australian inland.

Ephemeral lakes and watercourses are likely to be important habitats during wet seasons for many migratory species such as waterbirds. However, the likely species attracted to the ephemeral lakes in the vicinity of the project area are generally wide-ranging and not especially uncommon or rare in a regional sense (see Section 6.8). The habitat requirements of migratory species and lack of suitable ephemeral waterbodies within the project area makes the ongoing presence of these migratory species within the project area unlikely.

There are no large drainage channels or drainage basins within the project area or surrounding region so there is not a significant amount of habitat for species in the area, although surrounding ephemeral areas may be important in wet seasons. Drainage lines are usually environmentally sensitive, species-rich and provide important refuge areas for fauna through the dry season.

### **6.10.2 Potential Impacts**

Construction and operation of the project will involve the excavation and dumping of spoil and overburden, construction of roads, construction of the water supply pipeline and excavation of the phosphorite deposit. These activities could significantly affect the movement of surface waters in the project area and surrounding local environment if not managed correctly.

Given the nature of the project, i.e., relatively unreactive ores and no processing of ore on site, the key issues are limited, but relate to:

- Adverse effects on downstream ecosystems due to fugitive sediment.
- Adverse effects on downstream fauna and riparian vegetation due to altered flow regimes.
- Adverse effects on fauna and riparian vegetation and groundwater users due to surface water contamination.

These are discussed in further detail below. It should be noted that these do not take into consideration the proposed avoidance, mitigation and management measures that will be implemented by Minemakers during all stages of project development (see Section 6.10.3), and which will result in the residual impacts discussed in Section 6.10.4. Monitoring to ensure that impacts are not occurring or are within expected levels is proposed in Section 6.10.5.

#### **Adverse Effects on Downstream Ecosystems due to Fugitive Sediment**

As heavy seasonal rains are common in the Barkly SWMA, flows in the area are likely to carry high sediment loads regardless of the source (see Section 6.10.1). However, given the type of disturbance associated with the project (e.g., clearance of a large area of vegetation, excavation of soil and exposure of subsoil), storm water runoff from the project area may result in an increase in sediment delivery to downstream ecosystems.

Increases in sediment-laden storm water runoff could be associated with erosion and subsequent damage to downstream ecosystems. This could include physically altering watercourse habitat – through in-stream deposition and erosion effects – leading to unfavourable conditions for flora and fauna survival and changed ecosystem composition to species more tolerant of these conditions.

#### **Adverse Effects on Downstream Fauna and Riparian Vegetation Due to Altered Flow Regimes**

High intensity rainfall events can lead to flooding within the region. An analysis of the percentage probability for a range of different flood events occurring during the 10 year mine life of Stage 1 of the project is shown in Table 6.31.

**Table 6.31 Percentage probability of N-Year Average Recurrence Interval (ARI) flood event occurring**

ARI in Years*	5	10	20	50	100	200
Probability of occurrence	89%	65%	40%	18%	10%	5%

\*Flow intensity ranges from mild for 5 year to extreme for 200-year flood events.

Data has shown that local maximum rainfall records are generally associated with cyclone events and can result in flooding, road closures and operational interruptions. Construction of infrastructure for the mine and mining-related alteration of the landform will change the movement of surface flows in the project area. This could result in the development of new drainage channels or decrease or increase flows to existing watercourses, drainage lines and wetland habitats.

Depending on the relative changes in flow regimes related to these areas, riparian vegetation and aquatic fauna in these watercourses could be adversely impacted due to reduction of water supply or change in water quality conditions at downstream locations.

There are cultural exclusion zones in the vicinity of the project area, which include wetland areas of importance to the Traditional Owners. The exclusion zone to the northeast of the Arruwurra deposit also contains historical record of the plant *Sporobolus latzii* (see Section 6.7), which is recognised as significant at a national level (White et al., 2000); however, it is not listed for protection under the Commonwealth *Environment Protection, Biodiversity and Conservation Act 1999* (EPBC Act). If flow regimes were altered in these areas it could result in adverse impacts to these cultural sites and threaten the survival of *Sporobolus latzii* in this area.

The Arruwurra pits will be susceptible to flooding if appropriate measures are not put in place. This is due to the local watercourse that flows in a northwesterly direction towards the Arruwurra deposit. It is possible that flood water from this watercourse could report to some of the Arruwurra pits, thereby affecting flows to downstream environments. No such threat exists for the Main Zone deposit.

### **Adverse Effects on Fauna and Riparian Vegetation and Groundwater Users Due to Surface Water Contamination**

As the project will involve only dry crushing and screening of non-reactive ore on site, the main chemicals stored on-site that will be potential sources of contamination will be limited to fuels, lubricants and other liquid chemicals for machinery maintenance.

The potential exists for spillage of chemicals reporting to downstream surface watercourses (and possibly infiltrating groundwater sources) during flood events, resulting in a toxic effect to flora and fauna and impacts to users of groundwater in the region. Areas where such spillage could originate are:

- Arruwurra fuel storage and workshops.
- Central fuel storage and workshops.
- Aerodrome fuel storage.
- Vehicle washdown and tyre wash areas.

Waterbodies that are part of the project infrastructure (e.g., sediment ponds) may attract waterbirds to the area. These migratory birds could be harmed if these waterbodies are contaminated due to project activities.

### **6.10.3 Avoidance, Mitigation and Management**

Water quality management in Australia is based on the following approach (ANZECC/ARMCANZ, 2000):

- Identify the environmental values that are to be protected in a particular waterbody and the spatial designation of the environmental values (i.e., decide what values will apply where).
- Identify management goals and then select the relevant water quality guidelines, tailored to local environmental conditions, for measuring performance. Based on these guidelines, set water quality objectives to maintain the environmental values (taking account of social, cultural, political and economic concerns).
- Develop statistical performance criteria to evaluate the results of the monitoring program.
- Develop tactical monitoring programs focusing on the water quality objectives.
- Initiate appropriate management responses to attain (or maintain if already achieved) the water quality objectives.

However, ANZECC/ARMCANZ water quality guidelines often do not fully address the difficulties associated with their application to temporary (ephemeral) streams and lakes (Smith et al., 2004).

The management and protection of the Northern Territory's water resources is controlled under the *Water Act* and managed according to the National Water Quality Management Strategy (as described above).

Minemakers' surface water management objectives for the project include:

- Minimise the potential project impacts such as changes in the streamflow regime, alteration of habitat, pollution or increased erosion and sedimentation.
- Where feasible, maintain the shape and composition of the natural watercourse geometry, natural biological indicator conditions and flow conditions.
- Employ protection measures to prevent adverse hydrological and water quality impacts, for all recognised watercourses within the project area.
- Rehabilitate any watercourses that are unacceptably impacted as soon as practicable after detecting the impact.

The following high-level avoidance, mitigation and management measures have been developed to reduce the risk of the potential impacts to surface water in the project area described in Section 6.10.2:

- Site surface water management will be based on the principle of diverting clean surface water runoff away from disturbed areas and into existing natural watercourses and drainage lines, and intercepting runoff from disturbed areas and directing it through sediment control structures prior to discharge to the downstream environment.

- Mine infrastructure will be located to minimise deviation of natural surface water flow paths to avoid inundation of the open pits and to prevent erosion and siltation and adverse impacts on water quality downstream of the Mineral Lease.

### **Adverse Effects on Downstream Ecosystems due to Fugitive Sediment**

To minimise the risk of sediment runoff adversely affecting receiving water environments and downstream ecosystems, the following measures will be implemented:

- Sediment and erosion control plan for the project (Attachment 5).
- Disturbed areas will be rehabilitated progressively once areas are no longer required for mining, so that the potential for erosion and siltation of watercourses is minimised.
- Rain falling within the crushing and screening areas will be collected within bunded earthen slabs and, where practicable, returned to the crushing and screening plant for reuse in dust suppression.
- Small bunds and diversion drains will be constructed around the accommodation village to manage minor surface water runoff.
- Runoff from non-process areas (e.g., roads, roofs, yards, run of mine (ROM) area) will be captured in open drains. The drains will report to a sedimentation pond, before either being reused or, if suitable, released off-site.
- Non-process area drains reporting to a sedimentation pond will be sized for the peak of the 10 year ARI event as a minimum. Open drains will have a minimum freeboard of 500 mm and flow velocities along such drains will be limited to minimise erosion and the generation of sediment.
- To minimise runoff from pits, temporary stockpiled material will be processed following significant rainfall events. In-pit stage sumps will be used to settle out sediment from collected runoff prior to pumping to surface for re-use, if suitable, or discharge off-site.
- Runoff from the waste rock stockpiles is likely to generate sediment-laden stormwater. Bench widths will be minimised and inter-bench heights limited on stockpiles to limit sediment generation. Benches will also be back-graded to minimise potential overtopping and gully erosion establishing on slopes.
- The waste rock stockpiles will be bunded around their full perimeter to contain this water and to separate it from clean runoff from the surrounding catchment. The runoff from the stockpiles will be collected in diversion channels and directed through sediment ponds prior to discharging to the natural environment.
- The quality of water in sedimentation ponds will be routinely monitored. Water that is considered unsuitable for release to the environment, based on the potential for adverse impacts on environmental values of downstream watercourses, will be recycled for reuse on-site. Sediment accumulated in sedimentation traps will be removed periodically and disposed of to one of the active waste rock stockpiles.
- Sedimentation ponds will be constructed at the Main Zone, Arruwurra and crushing and screening plant to allow separate treatment of potentially high sediment runoff from ore and waste rock stockpiles.

Diversion drains and sedimentation ponds will be designed to manage runoff from the 10 year, 24-hour rainfall event (i.e., 128 mm rainfall) without discharge. Sedimentation ponds will have a minimum live settling depth of 1 m and an aspect ratio (length:width) of not less than 3:1 and preferably 5:1. Sufficient provision for sediment storage and freeboard will also be made.

Where active mining areas or other sensitive facilities require protection from runoff from undisturbed areas and flood flows, the 100 year ARI event will typically be used for the design of flood protection berms.

### **Adverse Effects on Downstream Fauna and Riparian Vegetation Due to Altered Flow Regimes**

Impacts to the local surface water flow regime will be managed by the placement of project components, where possible, to minimise changes to the flow regime. Runoff from undisturbed areas surrounding the project will be diverted around project facilities into existing natural watercourses or drainage lines by providing diversion drains typically sized for the 10 year ARI event with a minimum 500 mm freeboard. Flow velocities along all diversion drains will be limited to minimise erosion and the generation of sediment.

Flood diversion measures such as berms and flow diversion ditches will be used at the southeastern perimeter of the Arruwurra pits to minimise the risk of infiltration of these pits during stormwater runoff (and subsequent alteration of surface water flow in this vicinity) and will be designed to withstand a 100-year ARI event.

To avoid flooding of the Arruwurra pits and infrastructure near Main Zone (and subsequent alteration of surface flow regimes in these areas), two upstream catchment diversion ditches will be constructed at the following locations:

- Immediately upstream of the Arruwurra mine services area and waste rock stockpile, which will discharge to the north of the flood protection berm alignment.
- Two sections along the northeast side of the proposed aerodrome with both high points of the drains on either side of the airstrip terminal facility. The northern drain will divert runoff towards the northwestern corner of the airstrip, while the southern drain will drain to the southeastern corner of the airstrip.

The minimum height of all pit flood protection berms will be set at 2 m above existing ground level and will also be the height of the haul road where used in lieu of a flood protection berm. The proposed Arruwurra mine facilities area, including workshops, fuel storage and truck parking, will be situated at least 2 m above the watercourse average elevation of 255 mRL.

### **Adverse Effects on Fauna and Riparian Vegetation and Groundwater Users Due to Surface Water Contamination**

Measures to minimise downstream impacts due to contamination of surface water generally relate to the containment of potentially contaminated water and its subsequent controlled release.

Storage areas for chemicals, oils and hazardous material will be bunded in accordance with the relevant codes and standards (see Chapter 2). Water collected within the bunds will be assessed prior to release. If the water quality is suitable, the area will be drained to the closest non-process drain that reports to a sedimentation pond. Water that does not meet relevant water quality criteria will be returned to the process or disposed of appropriately.

To minimise the potential for oil leaks into watercourses during operation, oily water separators will be installed at four facilities as a minimum. These are:

- Arruwurra fuel storage and workshops.
- Central fuel storage and workshops.
- Airstrip fuel storage.
- Vehicle washdown and tyre wash areas.

A suitable ongoing water quality monitoring program will be adopted to identify any alterations to water quality as a result of project-related contamination (Section 6.10.5). This will include event-driven sampling to gain an understanding of water quality effects at different phases of flow as recommended by Batley et al., (2003). In the unlikely event that a release of contaminants was to occur, Minemakers will implement the spill response plan as per the waste management plan (Attachment 5) and emergency response management plan (Attachment 5).

#### 6.10.4 Residual Impact Assessment

Table 6.32 summarises the residual impacts of the project on surface waters, considering the likelihood and consequence of the predicted impacts after the successful implementation of management and mitigation measures. These assessments are described in further detail below and are considered with respect to the environmental value 'maintenance of aquatic ecosystems'.

**Table 6.32 Summary of surface water impacts**

ID	Impact	Likelihood	Consequence	Residual Risk
I28	Adverse effects on downstream ecosystems due to fugitive sediment.	Possible	Minor	Moderate
I29	Adverse effects on downstream fauna and riparian vegetation due to altered flow regimes.	Unlikely	Insignificant	Low
I30	Adverse effects on fauna and riparian vegetation and groundwater users due to surface water contamination.	Unlikely	Insignificant	Low

#### Adverse Effects on Downstream Ecosystems due to Fugitive Sediment

Release of fugitive sediment from the project area will be minimised by rehabilitation of the water supply pipeline from the northern borefield and implementation of on site sediment control measures within the Mineral Lease.

Construction of the northern borefield and the water supply pipeline will occur during the dry season and will take approximately three months. The water supply pipeline will be buried and a construction right of way (ROW) will be rehabilitated once construction is complete. The operational ROW will be the light vehicle access track adjoining the pipeline. This access track will be constructed to the same design standards as access tracks within the Mineral Lease.

Implementation of on site sediment control measures, which include diversion drains to separate clean and dirty water and appropriately designing sediment control structures will minimise the release of fugitive sediment off the Mineral Lease. High sediment loads are likely to occur only during high flow periods following long dry periods in semi-arid environments; therefore any sediment impacts in the overall context are likely to be minimal.

Notwithstanding the sediment control measures to be implemented, it is **possible** that some fugitive sediment will report to surface drainage lines in the vicinity of the project area due to project activities. However, the extent to which this occurs will depend to a large degree on the nature of rainfall events during project development. Drainage lines in the project area are dry unless significant rainfall events occur, and as noted earlier sediment loads in such semi-arid watercourses are naturally high. Fugitive sediment is therefore likely to be localised to the vicinity near the project area due to the infrequent nature of such rainfall events.

Downstream habitats are common and widespread, and likely to support organisms that are tolerant of episodic high sediment loads.

The consequence of fugitive sediment on the environmental values of regional downstream waterbodies is therefore considered to be **minor** over the longer term, and the risk is accordingly assessed to be **moderate**.

### **Adverse Effects on Downstream Fauna and Riparian Vegetation Due to Altered Flow Regimes**

As previously discussed, occasionally seasonal flows may cause flooding if appropriate measures are not in place. There are a number of local drainage lines that could adversely impact the proposed project facilities if not managed properly. These include (note the following nomenclature has been developed for use in this report only as these are currently unnamed features):

- Arruwurra Zone drainage line – draining an area of about 868 km<sup>2</sup> from the southeastern limit of Barkly SWMA and flows in a generally northwesterly direction towards the Arruwurra mining area.
- Main Zone drainage line 1 – draining an area of about 6.6 km<sup>2</sup> from the southwestern corner of the Main Zone mining area.
- Main Zone drainage line 2 – draining an area of about 15.7 km<sup>2</sup> from the northwest of the Main Zone mining area.
- Main Zone drainage line 3 – draining an area of about 16.3 km<sup>2</sup> area in the northeast of the Main Zone mining area.

While all of the above drainage lines will require some degree of management, it is assessed that the greatest flooding risk to the proposed project facilities relates to the Arruwurra Zone watercourse. Given its large upstream catchment area, poorly defined alignment and indiscernible channel geometry it is possible that floodwater from this watercourse could report to some of the proposed Arruwurra pits or could cause flooding over much of the proposed Arruwurra mining area.

The severity of the potential flooding at the Arruwurra Zone may be exacerbated due to its relatively flat, low-lying topography; typically 30 m lower than ground level over the Main Zone mining area. Consequently, the proposed Arruwurra mine facilities will require flood protection which will take the form of constructed berms and diversion ditches and strategically placed and armoured waste rock stockpiles and above-grade haul roads. These flood protection measures will be designed for the 100 year ARI runoff event. The probability of occurrence for this event during the envisaged 10 year Stage 1 operational life of the project is approximately 10%.

The wetland areas of importance to the Traditional Owners and the only known location of the *Sporobolus latzii* are located within cultural exclusion zones. These cultural exclusion zones contain buffers to minimise the risk of project works impacting on these environmental values and as such impacts in these areas are unlikely.

It is **unlikely** that flood flow regimes will be altered so runoff from the catchment upstream of the Arruwurra Zone mining area will be diverted around the infrastructure in this area. The establishment of flood protection measures (including flood protection berms, strategically placed and armoured waste rock storages and above-grade haulage routes) will divert the flood flows to the east. However, modelling shows flood flows from this watercourse could be well in excess of 1 km wide, therefore the consequence of the altered flood flow regimes for downstream habitats will be **insignificant** due to the large volumes of water that are likely to be received by downstream environments in such a rainfall event. The residual risk is therefore **low**.

### **Adverse Effects on Fauna and Riparian Vegetation and Groundwater Users Due to Surface Water Contamination**

With the combination of management measures, including bunding, oily water separators, measures to minimise the risk of flooding and the implementation emergency response management plan (Attachment 5), it is **unlikely** that fuels, oils and other chemicals will report to downstream environments.

In the event that this did occur the long-term consequences for aquatic fauna and downstream riparian vegetation and ecosystems will be **insignificant** since the sources and volumes of contamination associated with the project are limited and such a release will probably be associated with an intense rainfall event when dilution would be greatest. The residual risk is accordingly assessed to be **low**.

#### **6.10.5 Monitoring Program**

Ongoing surface water quality monitoring will be conducted to allow identification of any impacts of mine construction and operations on downstream ecosystems. All surface waters will be sampled for major anions and cations, total and dissolved metals and pH, total dissolved solids (TDS) and electrical conductivity (EC).

The integrity of flow diversion and bunding infrastructure will be inspected twice a year (before and after the wet season); and downstream environments (flora and fauna) will be monitored at regular intervals (see Sections 6.7 and 6.8 for further detail).

Ongoing monitoring will include:

- Event-driven water quality sampling and monitoring of project water storages (i.e., sedimentation ponds) and downstream ephemeral streams, with a focus on locally-defined water quality objectives.
- Inspection of flow diversion and flood protection infrastructure, with particular attention given to those protecting the susceptible Arruwurra mining area.

#### **6.10.6 Outcome and Assessment Criteria**

The outcome and assessment criteria for flora are outlined in Table 6.33.

**Table 6.33 Outcome and assessment criteria – surface water**

ID	Impact	Outcome	Assessment Criteria	Summary of Management and Mitigation Measures
I28	Adverse effects on downstream ecosystems due to fugitive sediment.	No adverse effects on downstream fauna and habitats due to the generation of fugitive sediment as a result of mining activities.	Annual flora surveys (including photo monitoring) at all flora monitoring sites (Section 6.7) to show no unexpected change in abundance, composition or condition of flora species from baseline conditions.	<p>Progressively rehabilitate disturbed areas.</p> <p>Appropriately bund disturbed areas to ensure separation of clean and dirty surface water flows.</p> <p>Install sedimentation ponds to collect sediment laden surface water.</p> <p>Install in-pit stage sumps.</p> <p>Benches and heights of waste rock storages designed to minimise erosion.</p> <p>Implement surface water management plan.</p> <p>Implement sediment and erosion control plan.</p>
I29	Adverse effects on downstream fauna and riparian vegetation due to altered flow regimes.	No adverse effects on downstream fauna and riparian vegetation due to altered flow regimes as a result of mining activities.	<p>Annual flora surveys (including photo monitoring) at all flora monitoring sites (Section 6.7) to show no unexpected change in abundance, composition or condition of flora species from baseline conditions.</p> <p>Fauna monitoring indicates no changes in abundance, composition or condition of fauna species from baseline conditions.</p>	<p>Project components located to minimise changes to the flow regime.</p> <p>Runoff from undisturbed areas surrounding the project will be diverted around project facilities into existing natural watercourses or drainage lines.</p> <p>Flood diversion measures will be used at the southeastern perimeter of the Arruwurra Zone mining area.</p> <p>Flood diversion measures will be used at the aerodrome.</p>
I30	Adverse effects on fauna and riparian vegetation and groundwater users due to surface water contamination.	No adverse effects on fauna, riparian vegetation and groundwater users due to surface water contamination as a result of mining activities.	Following rainfall events where there is runoff of water from the site, upstream and downstream monitoring to show no statistically significant impact of the project on surface water quality (including major anions and cations, total and dissolved metals and pH, TDS, EC and total petroleum hydrocarbons).	<p>Areas susceptible to hydrocarbon spillage will be designed to capture liquids in open drains that report to an oily water separator upstream of a sedimentation pond.</p> <p>Storage areas for chemicals, oils and hazardous material will be banded.</p> <p>Implement waste management plan</p>

## 6.11 Socio-economic

Existing socio-economic conditions in the project area are described in Section 6.11.1. Potential, credible project-related impacts associated with socio-economic conditions are described in Section 6.11.2. The proposed avoidance, mitigation and management measures that Minemakers will implement during all stages of project development are described in Section 6.11.3. The resulting socio-economic residual impacts of the project are discussed in Section 6.11.4, the monitoring program is detailed in Section 6.11.5 and the outcome and assessment criteria in Section 6.11.6.

### 6.11.1 Baseline

A socio-economic impact assessment was conducted by Coffey Natural Systems in October 2009 (Appendix 4); the objectives of the assessment were to:

- Provide a high-level characterisation of the existing socio-economic, demographic and economic conditions of the region.
- Describe the scope of local and regional employment and economic opportunities.
- Identify the project's stakeholders.
- Describe the potential impacts of the project on the socio-economic environment including lifestyle, employment and workforce impacts.
- Identify and define potential project issues requiring mitigation and management.

The project is located within the Barkly Shire Council area. The socio-economic impact assessment area incorporates this council area and focuses on the communities contained within it that are likely to be directly impacted by the project and includes the Wunara Community and Tennant Creek. Context on the socio-economic characteristics of Darwin and the Northern Territory in general, are also provided.

### Northern Territory

The Northern Territory is the most sparsely populated state or territory in Australia, with a population density of around 0.1 people per square kilometre. The remoteness and often harsh environmental conditions of the Northern Territory (from the tropics in the north with pronounced wet and dry seasons to the desert country in the south) give its residents, known as 'Territorians', a strong sense of identity built on independence, connection to the land or the 'outback' and a laid back attitude.

The Northern Territory's population is the youngest in Australia, having the largest proportion under 15 years of age and the smallest proportion aged 65 and over of all Australian states and territories. The median age of residents is 31 years, 6 years younger than the national median age. This is partly influenced by the significant Aboriginal population, which comprises a significant number of younger population and lesser older persons (due to a shorter expected lifespan for Indigenous people).

Almost 28% of the Northern Territory population is comprised of Indigenous persons (i.e., Aboriginal and Torres Strait Islander people), compared with 2.3% in the whole of Australia. In Darwin the Indigenous population is approximately 10% of the total population. Throughout the

territory there are many small Aboriginal communities, with nearly half of the land in the Northern Territory being owned by Aboriginal people or held in a tenure which provides Aboriginal people with secure rights of use (Strakosch *et al.*, 2006).

The Northern Territory's economy is based on tourism, largely for Kakadu National Park and Uluru (Ayers Rock), mining and defence. In 2008 the average weekly wages in the Northern Territory were slightly lower than the national average, with the percentage increase of average weekly wages also slightly lower than the national percentage increase. The Northern Territory recorded the largest percentage increase (4.8%) in the employment rate of anywhere in Australia between 2006 and 2007. In Darwin, employment was lower (3.5%) with government administration, school education and defence being the dominant employment industries. Unemployment in the Northern Territory at the 2006 census was 4.4%.

According to figures released by the Northern Territory Treasury, there are approximately 4,600 people employed in mining, oil and gas in the Territory (NT Government, 2006). This industry is recognised as the major employer in regional areas of the Northern Territory.

The mining industry also is a major contributor to the Northern Territory economy, with a total contribution of \$3,942 million in 2006/07, up 42% from the previous year (\$2,775 million). Taxes and mining royalties accounted for \$47 million of the Northern Territory Government revenue in 2007/08.

Access Economics has forecast the Northern Territory's average annual five-year growth to 2012-2013 to be 2.2%, slightly above the national growth of 2% (Northern Territory Treasury, 2009). The growth forecasts are driven by strong growth in exports from the mining and manufacturing industries.

### **Tennant Creek and the Barkly Tableland Profile**

The project is located on the Barkly Tableland region, which covers a large area of the central eastern part of the Northern Territory. The major service centre for the region is the town of Tennant Creek (population 2,920). The region is sparsely populated with the major sources of income for the region generated from grazing. Pastoral production within the Barkly Tableland region accounts for 39% of the Northern Territory cattle industry (DPI, 2006). Other sources of regional income include mining and tourism.

Indigenous people comprise 49% of the total population of Tennant Creek and 60% for the region. The region has a long history of occupation by Aboriginal people with many Aboriginal people maintaining a strong association with the land and water in the region. The Traditional Owners for Tennant Creek are the Warumungu people. Other Traditional Owners of the Barkly Tableland include the Kaiditch, Alyawarr and Arruwurra people. Three Aboriginal language groups exist; in the area covered by the project and ore road transport route, these are the Warumungu, Kaytej and Wakaya.

European settlement of Tennant Creek commenced with the development of the Overland Telegraph Line and local telegraph station, which was built in 1872. The town had a population boom in the 1930s due to a gold rush, with at least 100 small mines in operation by World War II. Tennant Creek's mining history continued after the gold rush and World War II with the discovery of copper in the 1950s. Gold mining once again became a prominent industry of Tennant Creek when the Nobles Nob Gold Mine reopened in 1967 and was the largest open-cut gold mine in

Australia until it closed in 1985 (Travel NT, 2009). Mining and exploration of copper and gold deposits continues in the region and a number of projects are planned for development.

The Barkly Tableland is renowned for its productive pastoral lands. The pastoral industry commenced on the Barkly Tablelands with cattle and sheep being driven from Queensland in 1868 (DNRETAS, 2007). However, it was not until the late 1870s when generous leasing arrangements on the Barkly Tableland became available that the settlement in the region began to develop. Today, some of Australia's largest and most historic pastoral stations are located on the Barkly Tableland. These include Newcastle Waters, Banka Banka and Brunette Downs.

Unemployment in Tennant Creek at the 2006 census was 7% and a similar unemployment rate exists throughout the non-urban areas of the Barkly Tablelands. Employment in Tennant Creek is predominantly in the areas of public administration, health care and social assistance, education, with training, retail trade (10%) and construction (6%) industries also contributing to employment. Mining accounts for 2% of employment in Tennant Creek.

Indigenous unemployment in Tennant Creek is 12% higher than the overall unemployment rate for the Northern Territory (4.4%). To reduce this disparity the Northern Territory Government is developing a range of initiatives and as part of the Northern Territory Employment Strategy (DBE, 2009) a new Regional Job Hub commenced operation in Tennant Creek in July 2009. The hub is a one-stop shop for information on training and employment. Regional staff coordinate and facilitate access to resources so that employees and training can be matched to real job opportunities in the region. The hub provides local knowledge to underpin strategy and program development, and ensure that locals are aware of, and matched to, the services available to assist them in gaining employment.

Tennant Creek residents earned a higher share of the region's average wages and salaries. The lower population and higher percentage of residents employed in agricultural activities may contribute to the lower regional earnings.

### ***Community Services and Infrastructure***

Tennant Creek is the major service centre for the region and has a range of social, commercial and professional services available. The town has a 20-bed hospital that employs 5 full-time medical officers and 23 nurses. It has a 24-hour accident and emergency department and an aerial medical service. The hospital offers a range of medical services provided by resident staff and visiting specialists.

Emergency services for the region are based in Tennant Creek and include police, fire, ambulance, emergency services and Royal Flying Doctor Service (RFDS) (Plates 6.3, 6.4 and 6.5). The Tennant Creek police station is staffed by aboriginal community police officers, auxiliaries and Criminal Investigation Branch (CIB) members. The Tennant Creek fire station has two permanent members and two volunteer fire and emergency response groups (based at Elliott and Borroloola) with a total of 24 members. The ambulance service is provided by St John Ambulance and has a permanent staff of five. The Northern Territory Emergency Service based in Tennant Creek has approximately 10 dedicated members. The RFDS has a general practice operating out of Tennant Creek and is the sole private general practice service in Tennant Creek.

Educational facilities include a childcare centre, pre-school, primary school (Plate 6.6) and high school. Charles Darwin University also has a campus based in Tennant Creek that offers courses in the trades and vocational education and training (VET) sectors. Along with the Regional Job

Hub discussed above, Tennant Creek also has Barkly Employment and Training (BEAT) a Commonwealth licensed job placement agency and the Julalikari Remote Employment Service. Julalikari focuses on providing opportunities for Indigenous persons and delivers accredited training in construction, horticulture, small business, office administration and community services.

The Tennant Creek airport is located approximately 1 km from the town centre but does not currently service commercial flights. It has two runways and is able to accommodate most commuter aircraft.

Other resources in Tennant Creek include two banks, a post office, supermarket, restaurants and take-away stores (Plate 6.7), as well as various sports facilities including ovals, synthetic-surface netball and tennis courts, and under-cover basketball courts.

Tennant Creek is generally well equipped with essential and non-essential services ensuring its residents are self-sufficient in the area. However, residents within the region may elect to travel to Darwin to access services, such as specialist medical services and some commercial and professional services that are not available in Tennant Creek.

### ***Accommodation and Housing***

According to Census Data from 2006 approximately 80% of the dwellings in Tennant Creek were occupied at the time of the census (ABS, 2008a) and within the remaining Barkly Tableland there are approximately 72% of the dwellings were occupied at the time of the census (ABS, 2008b). Typical dwellings in Tennant Creek are single level houses, constructed of either brick or weatherboard (Plate 6.8). The median house price (12 months to March 2009) is \$130,000. Long-term house rental is of limited availability and according to realestate.com.au in August 2009, no rentals were available in Tennant Creek or the surrounding area.

There are five hotels providing short-term accommodation within the Tennant Creek, with approximately 200 rooms available in total, 3 caravan parks also exist with another 66 rooms available in the form of cabins. Short-term accommodation is also available along the ore transport route at the Three Ways and Barkly Roadhouses and five roadside campsites along the Barkly Highway. Temporary accommodation demand and occupancy rates peak in the cooler months of the dry season when tourism to the regions is also at its peak.

### ***Community Wellbeing***

Alcohol and drug abuse is an existing issue in Tennant Creek and the surrounding Barkly Tableland region, and much of the Northern Territory. Northern Territory Government statistics (Department of Justice, 2007) show that 14.7 litres of pure alcohol was consumed per capita in the Barkly Region in 2005/2006, the Australian total for the same period was 9.8 litres. Alcohol related admissions to drug and alcohol treatment agencies in Tennant Creek had increased by over 200% from 2003/2004 to 2005/2006, with the 2005/2006 total of 154 admissions representing 5% of the population of Tennant Creek. This compares to the Territory total of 1,854 admissions, which represents less than 1% of the population.



**Plate 6.4**  
Tennant Creek fire station



**Plate 6.5**  
St John Ambulance Barkly Region



**Plate 6.6**  
Tennant Creek primary school



**Plate 6.7**  
Main street of Tennant Creek



**Plate 6.8**  
Typical weatherboard house  
in Tennant Creek



**Plate 6.9**  
BRADAAG Sobering Up Shelter

In addition to services provided by the Tennant Creek hospital, alcohol and other drug withdrawal services in Tennant Creek are provided by Anyinginyi Alcohol Aftercare, Alcohol and Other Drugs Services Central Australia (ADSCA) and Barkly Region Alcohol and Drug Abuse Advisory Group (BRADAAG). These organisations provide counselling, support and residential programs. BRADAAG also manage the Sobering Up Shelter (Plate 6.9).

Amendments to *Liquor Act* introduced in August 2008 limit the consumption of alcohol with a high percentage of alcohol in Tennant Creek and restricts the hours of trade and amount of alcohol that is permitted for sale. The legislation also prevents the drinking of alcohol in a public place within the town boundary (NT Government, 2008).

### ***Wunara Community***

Wunara is the closest populated area to the project and is a small Aboriginal settlement located approximately 10 km from the Mineral Lease boundary, adjacent to the Barkly Highway. The population residing in the community fluctuates from 2 to 30 people according to the season. Employment opportunities within the community are extremely limited; however, Minemakers has employed some Wunara residents to assist with exploration activities.

The community comprises four houses and associated buildings and communal areas (Plates 6.10 and 6.11). The community also has recreational and community infrastructure including a public telephone, bore and water storage infrastructure.

Members of the Wunara community are also the Traditional Owners of the land subject to the Mineral Lease and northern borefield.

### ***Similar Projects in the Region***

Bootu Creek Manganese Mine (OM Holdings Limited) is located 110 km north of Tennant Creek. The mine has been operational since June 2006 and is expected to extract manganese at a rate of approximately 500,000 t/a, with a minimum 10 year operational period. Over 200 employees and contractors are on-site, with the majority sourced from Darwin. Approximately 30 people are local residents of Tennant Creek.

Peko Rehabilitation Project Pty Ltd (Peko) is also due to commence operations in 2009. The Peko project is located 14 km southeast of Tennant Creek and involves a tailing reprocessing operation. Approximately 15 people are expected to be employed during its operational life of 6 to 7 years. This is likely to add pressure to the already limited accommodation in Tennant Creek.

### **Demographic and Economic Profile**

Table 6.34 summarises the key demographic and community indicators for the regions of Northern Territory, Darwin, the Barkly Shire Council region and the township of Tennant Creek, based on the 2006 Census Data.

**Plate 6.10**  
Houses within the  
Wunara community



**Plate 6.11**  
Communal area within the  
Wunara community



**Table 6.34 Community profile and demographic indicators**

Indicator	Tennant Creek	Barkly Shire	Darwin	NT
Total area (km <sup>2</sup> )	42	283,688	3,134	1,352,176
Population	2920	5,390	105,991	223,100
Population density (persons/km <sup>2</sup> )	69	0.02	33.8	0.1
Indigenous population (% of population)	49	60	10	28
Predominant country of birth (%) (Top 3)	Aust (76%) UK (2%) NZ (1%)	Aust (84%) UK (1%) NZ (1%)	Aust (71%) UK (4%) NZ (2%)	Aust (77%) UK (3%) NZ (2%)
Gender ratio (female:male)	1:1	0.9:1	0.9:1	0.9:1
Median age	31	28	32	31
Predominant age group	10 to 14 years	15 to 19 years	35 to 44 years	25 to 29 years
Unemployment rate (%)	7	6.3	3.5	4.4
Indigenous unemployment rate (%)	16.8	13.9	13.2	14.4
Industries of employment (Top 3)	Public administration and safety (23.3%) Health care and social assistance (16.5%) Education and training (11.9%)	Public administration and safety (24.1%) Agriculture, forestry and fishing (15.6%) Health care and social assistance (14.4%)	Public administration and safety (21.2%) Retail trade (9.7%) Education and training (8.4%)	Public administration and safety (6.6%) Health care and social assistance (9.8%) Retail trade (9.1%)
Median household income (\$/weekly)	997	855	1,282	1,192
Average household size	2.9	3.4	2.6	2.9
Family characteristics				
• Total families	603	1060	25,774	43,393
• Couples without children	190	295	9,156	14,123
• Couples with children	255	490	11,609	20,165
• One parent families	142	242	4,589	8,298
• Other families	16	33	420	807
Total number of dwellings	1,244	2,297	43,408	74,193
Number of rentals (median rent)	479 (\$100/wk)	921 (\$60/wk)	14,527 (\$200/wk)	28,283 (\$140/wk)
Environment	Arid, grassland	Semi-arid,	Tropical, savannah	Arid in the south to tropical in the north. Desert, grassland, savannah

Source: ABS Census, 2006 (ABS, 2008a,b,c,d).

### **6.11.2 Potential Impacts**

This section discusses the credible socio-economic impacts that could potentially occur if the project proceeds. Should the project not proceed, these potential positive impacts will be forfeited; however, the potential negative impacts will also be avoided.

The project has the potential to result in positive impacts such as:

- Economic benefits.
- Employment.
- Training.
- Education.

However, there is the potential for negative impacts, such as:

- Social disruption due to changes in population and demographics.
- Increased competition for skilled labour.
- Pressure on existing infrastructure and community services.
- Reduced availability and affordability of housing.
- Increased traffic on roads, with a consequent safety risk and reduced amenity for road users.
- Increased availability and affordability of drugs and alcohol, with consequent negative social impacts.

Potential, credible project-related positive and negative socio-economic impacts are described below. It should be noted that these do not take into consideration the proposed avoidance, mitigation and management measures that will be implemented by Minemakers during all stages of project development (see Section 6.11.3), and which will result in the residual impacts discussed in Section 6.11.4.

### **Demographic and Economic Profile**

Development of the project has the potential to boost the local economy of Tennant Creek and create employment opportunities and training incentives and through associated business creation, economic stimulus in the region. It may also change the demographic and economic profile within the region. This is discussed further below.

#### ***Population and Demographics***

Potential positive population impacts may be the increase in the number of people living in Tennant Creek, both through the addition of the road haulage workforce and migration to the area as local businesses develop and expand to service the requirements of the project. While an accommodation camp will be constructed close to the multi-user hub, it is anticipated that a small percentage of this workforce may choose to relocate to Tennant Creek with their families and seek private accommodation outside the village. Traditional owners may also return to Wunara community to work on the project.

A change in regional demographics may result an influx of mine workers who are typically male and in their 20s to 40s; this could contribute to social disruption in Tenant Creek and Wunara due

to increased law and order issues, tension between newcomers and existing residents and increases in drug and alcohol use.

The fly-in fly-out (FIFO) workforce will increase the temporary population of the Barkly Tableland region. Given the insular nature of FIFO operations, this population increase may not translate into population benefits for this region (i.e., disposable incomes of the mine workers is spent in their home localities and not within the region of their employment), but will have positive benefits for other communities (e.g., those hosting the FIFO employees).

### ***Employment***

The project will increase the number and variety of employment opportunities at the local, peripheral and Northern Territory level. Unemployment in the region is consistently above the Northern Territory average and employment as a result of the proposed mine may reduce the unemployment rate.

Local businesses and pastoralists sometimes have difficulty in finding suitable employees and this may be exacerbated if the mine is seen as an attractive place to work. Jobs within the mining industry may offer higher wages than other business or agricultural enterprises. They also provide a similar number of work hours as other industries; however, with mine rosters they will have two weeks off every four or six weeks. Therefore, there is potential for increased competition for skilled labour in Tennant Creek and across the Barkly Tableland.

However, the opportunity to source local labour will depend on the available skill base within Tennant Creek and Wunara. While Minemakers has a preference to employ from the local area, it is recognised that appropriately skilled personnel (particularly for highly skilled people with previous mining experience) may need to be sourced from the other areas and that this will not translate into a positive impacts on employment within Tennant Creek or Wunara.

### ***Local Economy***

A significant positive economic impact may be the economic boost to the territory and national economies due to the project, primarily from:

- Direct financial contributions through the payment of taxes and royalties.
- Increased gross state product (and gross domestic product) from sales revenue.
- Indirect financial contributions through the payment of taxes by people employed either directly or indirectly by the mine, and also by companies that service the project directly or indirectly.
- Decreased unemployment levels.

No potential negative impacts to the local economy have been identified.

### ***Community Services and Infrastructure***

Potential positive impacts to community services and infrastructure may be an increase in government funding and economies of scale for local service providers.

Potential negative impacts to community services and infrastructure include:

- Increased strain on health services by a major incident at the mine site or during the transport of ore to the multi-user hub requiring the attendance or assistance from local emergency services from Tennant Creek.
- Increased pressure on existing infrastructure and community services, particularly in terms of the capacity of local infrastructure to meet demands from the increased number of households, including health, waste, water, power, and education services.

## Housing and Accommodation

The nature, extent, quality and availability of housing and accommodation in the region are limited. While an accommodation village will be constructed for road haulage workforce and the FIFO mine workforce, there is likely to be an increase in demand for housing (particularly in Tennant Creek) for people employed by businesses associated with the mine (e.g., transport companies) and Traditional Owners attracted back to the Wunara community. The potential negative impacts of increased housing demand include:

- Increase in property prices in the town that may drive out existing residents from the property market or cause financial hardship for existing residents who may not be able to afford the 'mine prices' for accommodation. This has been evidenced in a number of mining towns such as Kalgoorlie in Western Australia and Emerald, Moranbah in Queensland. Inadequate housing may also cause issues with overcrowding and the establishment of sub-standard accommodation in the region (i.e., long-term caravan dwellers, shed dwellers).
- A lack of available housing in the Wunara community. The NT Planning Scheme identifies the Wunara community as an unzoned area. Therefore, development within the community is not subject to land use controls under the *Planning Act* or the NT Planning Scheme; development would be driven by the desire and financial capacity of the Traditional Owners.

Tennant Creek, however, is subject to the planning control provisions of the NT Planning Scheme and any development within Tennant Creek will require development approval. Development of land in Tennant Creek is currently constrained by the land available for development. Suitable parcels of land for future residential development exist within Tennant Creek; however, they are currently Crown land and require the Northern Territory government to release them for development.

## Roads and Traffic

Road traffic will increase along the ore transport route from the Mineral Lease to the multi-user hub in Tennant Creek. This includes the Barkly Highway, Stuart Highway and Warrego Road. Potential impacts associated with roads and traffic are addressed in Section 6.13, see also Section 6.4, which discusses the potential impacts of increased traffic to noise.

## Drug and Alcohol Issues

Minemakers has requested that the Wunara community and CLC give consideration to the operation of a wet mess (bar) within the accommodation village within the Mineral Lease solely for the purposes of the employees and contractors. The community has indicated a willingness to consider this proposal; however, Minemakers appreciates the concern of the Wunara community as to the potential for the development of drug and alcohol issues associated with the provision of a wet mess at the mine site. A similar facility is likely to be included in the accommodation village to be constructed at the multi-user hub north and outside of Tennant Creek.

Traditional Owners have raised concerns that this may increase the level of alcohol abuse among their people, and potentially result in employees losing their job due to problems with alcohol. There is also potential for an increase in drug and alcohol use in Tennant Creek due to the increased amount of money available in the community due to the economic flow on from the project.

### **6.11.3 Avoidance, Mitigation and Management**

Minemakers will implement avoidance, mitigation and management measures to address the potential socio-economic impacts. These measures will reflect current good practice at similar mines operating in similar environments and include site specific measures. These measures are described below.

#### **Demographic and Economic Profile**

##### ***Economy***

To optimise the socio-economic benefits of the project, Minemakers will:

- Develop and implement an Industry Participation Plan in accordance with the requirements of the Northern Territory Government for major projects. This plan that will be based on preferentially sourcing people, goods and services from within the Barkly Tableland region and the Northern Territory to build business, industry and community capability through capacity building, education and training.
- Aim to use local (Barkly Tableland region or Northern Territory) businesses to fill contract positions (e.g., catering, cleaning, fuel supply, light vehicle maintenance) provided the contractors are competitive and appropriately skilled.
- Consider how the contractors have considered or incorporated social and economic opportunities for the Traditional Owners when assessing and granting contracts.
- Develop the project as quickly as practicable, having regard for the necessary regulatory approvals and prevailing economic conditions.
- Seek premium prices for the sale of the ore.
- Continue to work with the Northern Territory government agencies, Barkly Shire Council and local businesses to build community capacity by working with schools and training providers to develop curricula and pathways to employment in the resource sector. Also establish relationships with other mining and exploration operators in the region to determine skill requirements and potential traineeship and apprenticeship programs.
- Place a high emphasis on stakeholder consultation to foster and maintain good relationships.
- Develop guiding principles for determining how the Company selects which causes to support. These principles will aim to ensure support is targeted and focuses on those causes that contribute to sustainable benefits for the community. Any support provided by Minemakers will be given through an open and transparent process.
- Where possible, assist in community-driven development initiatives, which may involve donation of people's time, skills and knowledge.

The Traditional Owners and the Wunara community will receive income in the form of royalties from the project. The Traditional Owners and the CLC are currently working together to establish a trust fund system where a percentage of royalties can be invested to establish a long-term, sustainable economic return from the project. Any profits from the trust fund can then be re-invested in to the community in the form of scholarships for Traditional Owners or infrastructure.

### ***Employment and Training***

Minemakers recognises the opportunity that accessing a workforce pool in Tennant Creek and the Wunara community represents. Minemakers will work with existing training providers to ensure that programs they deliver will give previously unskilled people the necessary skills to gain employment with the project. As part of the stakeholder consultation plan, Minemakers will also make the local community aware of the types of jobs that will be required and the skills and qualifications people will require to fill them, as well as when opportunities for tender will be available.

### ***Indigenous Employment and Training***

Minemakers does not intend to provide any specific training and employment programs prior to the commencement of mining. However, Minemakers will work with local training providers to ensure programs are focused on maximising skill development and employment opportunities for members of the Indigenous community. Minemakers, as member of the Northern Territory MCA, will also participate in the recently announced initiative to improve Indigenous employment opportunities in the mining industry.

Minemakers has had preliminary discussions with Julalikari Remote Employment Services regarding potential employment and training opportunities for Indigenous people. Minemakers is keen to support the development of business opportunities within the local Indigenous community to fill certain functions within the project such as light vehicle maintenance and rehabilitation management.

Minemakers' strategy for training local Indigenous community members prior to mining commencing will require ongoing communication with local training providers and government agencies. Ongoing communication with the local Indigenous community will also provide guidance in the types of employment and business opportunities available.

It is expected that civil, mining and logistics contractors will run programs to recruit and train members of the local Indigenous community.

### **Community Services and Infrastructure**

The project will be managed in accordance with Minemakers' workplace health and safety processes and procedures throughout all phases of the project. These processes and procedures ensure risks to the health and safety of both workers and the general public are minimised. Above and beyond these processes and procedures Minemakers will:

- Consult with local emergency services as part of the stakeholder consultation plan to ensure that any issues identified regarding additional strain on health services are identified and resolved.
- Provide first aid and facilities for emergency medical treatment at the minesite.

Minemakers will continue to liaise with the Barkly Shire Council and the Northern Territory Government to assist with future planning and development activities. Any necessary expansion or new facilities required to address increased demand will need to be built into town planning processes.

### Housing and Accommodation

The construction of accommodation villages at the multi-user hub and mine site will reduce the pressure on existing housing in Tennant Creek. Sufficient accommodation in the villages will be available to house the entire workforce.

Minemakers will have sufficient capacity within the accommodation villages to accommodate additional personnel, contractors or consultants as required. From time to time local temporary accommodation, such as the Barkly Roadhouse and Tennant Creek motels, may be required if the project's accommodation villages are full. Minemakers will work with providers of temporary accommodation to ensure that they can adequately meet this demand as required.

### Drug and Alcohol Management

Minemakers will develop and implement a drug and alcohol management plan for the project, which will apply to all employees and contractors and will induct people in the implementation of the management plan and their responsibilities under the plan. Minemakers will also implement substance abuse testing and management in all aspects of the operation. While a zero tolerance approach will be taken, the drug and alcohol management plan will also ensure details of relevant contacts and support services are provided for those people that have significant drug or alcohol problems.

#### 6.11.4 Residual Impact

Table 6.35 summarises the potential residual negative socio-economic impacts of the project, considers the likelihood and consequences of the impacts (taking into account proposed management measures), and provides an overall risk rating for each potential impact. These are discussed in detail below. The risks associated with the potential positive impacts have not been assessed using the risk matrix; they are also discussed in the relevant sections below.

**Table 6.35 Summary of socio-economic impacts**

ID	Impact	Likelihood	Consequence	Residual Risk
I31	Social disruption caused by population and demographics	Unlikely	Moderate	Moderate
I32	Increased competition for skilled labour, particularly for highly skilled people with previous mining experience	Possible	Minor	Moderate
I33	Significant pressure placed on existing emergency services	Unlikely	Minor	Low
I34	Inadequate existing infrastructure and community services	Unlikely	Moderate	Moderate
I35	Reduced availability and affordability of housing and accommodation in Tennant Creek	Unlikely	Moderate	Moderate
I36	Lack of accommodation for Traditional Owners in Wunara community	Possible	Minor	Moderate

**Table 6.35 Summary of socio-economic impacts**

<b>ID</b>	<b>Impact</b>	<b>Likelihood</b>	<b>Consequence</b>	<b>Residual Risk</b>
I37	Social problems due to drugs and alcohol	Unlikely	Moderate	Moderate

### **Population and Demographics**

It is **unlikely** that the project will result in social disruption due to an increased population in either the Wunara community or Tennant Creek due to changes in demography associated with the project. If impacts were to occur they would be of **moderate** consequence and the residual risk of this impact is therefore **moderate**.

### **Employment**

#### ***Workforce***

The construction phase of the project is expected to employ 50 to 100 people over a period of approximately eight months. During 3 Mt/a operations, the mine will accommodate a predominately fly-in-fly-out mine workforce of approximately 120 people, including project management, crushing and screening staff and contract mining workforce. A road haulage workforce of approximately 180 drivers and support staff are expected to be based at an accommodation village at the multi-user hub outside and north of Tennant Creek. It is expected that local people will be employed during the operation of the accommodation village in positions such as catering, cleaning and maintenance.

The Australian Bureau of Statistics estimates that the employment flow-on from mining operations is generally a multiple of 1.588 for each position directly related to the running of the operations (Madden, 1994). Considering Minemakers expects to directly employ a total of 300 people, then the flow on employment benefits would be in the order of 475 people locally and regionally.

#### ***Sources of Labour***

The workforce will be preferentially sourced from the local, regional, territory and then national level. Providing employment opportunities for the local community will be a priority and will be determined by the skills of people living in Wunara and Tennant Creek.

Sourcing labour from within the existing, local, labour market will increase local employment opportunities and may provide incentives for more skilled workers to move to the area and for skilled workers who have left the area to return to country. This type of structural adaptation in the workforce is common to the entry of any new industry into an area and is likely to create opportunities for both the existing and future workforce.

Minemakers will preferentially source labour from Wunara and Tennant Creek; the secondary sources will be Mount Isa and Darwin.

It is **possible** that the project will increase competition for skilled labour, particularly for highly skilled people with previous mining experience. The negative consequence of competition for skilled labour occurring is **minor**. Overall, the residual risk associated with the negative impact of increased competition for skilled labour is considered to be **moderate**.

### ***Training and Education***

Once employed, Minemakers' employees and contractors will receive job-related training and education. This will provide those trained with skills, experience and knowledge that should be able to be applied elsewhere after closure of the mine. Training opportunities offered directly by Minemakers will include occupational health and safety training and other associated on-site training and external accredited qualifications as required.

Minemakers is currently consulting with local training providers in Tennant Creek and Darwin about the training needs for the required workforce. It is anticipated that local training providers will tailor courses they offer to allow local residents seeking employment with the project to gain the required skills and qualifications prior to the project commencing.

### **Local Economy**

The project will result in increased revenue for local and Northern Territory economies. Minemakers predicts the following benefits when operating at full capacity (i.e., 3 Mt/a):

- Total capital investment (e.g., project expenditure and investment in additional infrastructure) of approximately \$107 million.
- Total, unescalated revenues of approximately \$500 million.
- Annual operating expenditure of approximately \$450 million.
- Annual government royalties of approximately \$7 million per annum.
- Annual salaries for Minemakers employees of approximately \$3.5 million per annum (excluding on-costs) and for contractors, approximately \$24.3 million.
- Increased incomes for people elsewhere in the region due to flow on impacts, including local and peripheral communities of approximately \$11.9 million per annum (using the total ABS income multiplier 0.428) (Madden, 1994).

The local community, i.e., the residents of Wunara located 10 km east of the project, will receive direct financial benefit from the project. There is the provision for the payment of royalties to the residents of Wunara (Traditional Owners of the project area) within the mining exploration agreement and the mining land use agreement. The payment of royalties has been negotiated with and through the CLC.

There will also be some indirect employment benefits to the Wunara community as part of clearance programs where Traditional Owners and the CLC are paid for their role in the land clearance procedures outlined in the mining land use agreement.

### **Peripheral Communities**

#### ***Tennant Creek***

Minemakers will preferentially employ local people. Further indirect benefits including the provision of goods and services and sponsorships are expected. The goods and services required for the operation of the workforce camps will be sourced locally where these are available at commercially competitive prices. The cost of these contracts is estimated to be approximately \$4 M per year when operating at 3 Mt/a.

Minemakers will contribute financially to local sporting communities and clubs, community based training providers and service groups in Tennant Creek.

### **Mount Isa**

Although Minemakers will preferentially source labour and goods from Tennant Creek and the Northern Territory, where this is not possible or the goods are not available in Tennant Creek, Mount Isa will be the secondary source as it is the next closest regional centre to the project. The Mount Isa economy is likely to consequently benefit from this.

### **Community Services and Infrastructure**

The provision of site-based emergency response teams and medical assistance, combined with the strong safety culture, operational and management systems implemented through all phases of operation, make it **unlikely** that significant pressure will be placed on existing emergency services. If externally provided emergency medical evacuation was required, the Royal Flying Doctor Service would be used. The expected infrequent reliance on external emergency and medical services results in this impact having a **minor** consequence. Minemakers will liaise with local emergency services to ensure they have capacity to deal with any credible mine-related emergencies that may occur. The residual risk is therefore **low**.

Employment of local people will not place additional strain on existing infrastructure services such as power, water and schooling as they are already using these services. The fly-in-fly-out workforce will be workers only (i.e., not families) and will not be located in Tennant Creek, so it should not place significant pressure on existing infrastructure services. Given this, it is **unlikely** that the project will result in existing infrastructure and community services being inadequate. The consequence of this, should it happen, consequence will be **moderate**. The residual risk is therefore **moderate**.

### **Housing and Accommodation**

The provision of accommodation villages at the multi-user hub and mine site make it **unlikely** that the project workforce will impact the availability and affordability of housing and accommodation. It is recognised that there may be pressure on housing associated with the flow-on effects of the mine (i.e., the increased business development in Tennant Creek); however, the direct project workforce will be accommodated within the villages. The consequence of this impact, should it occur, will be **moderate**, and is likely to require government planning to address. The residual risk is therefore **moderate**.

Traditional Owners who return to the area to work at the mine may wish to live in the community. With a total of four houses, the Wunara community does not have the housing to provide for a significant influx of such people, although it is not known how many people this is likely to be. Therefore, it is **possible** that there will be a lack of accommodation for Traditional Owners who return to country. This may require them to construct additional houses. However, Traditional Owners interviewed have highlighted the return to country of these people as a major potential positive benefit of the project. Accommodation for employed Traditional Owners will be available at the workers camp for these people until suitable additional housing can be constructed. Given this, the consequence of the current lack of accommodation for Traditional Owners is considered **minor**. The residual risk is therefore **moderate**.

## Drug and Alcohol Issues

Although Minemakers has proposed controlling access to the bar to only those people employed on site or legitimately visiting the site in connection with the operation, there is still the potential for alcohol to be taken onto site illegally. Minemakers believes that with responsible management and implementation of the drug and alcohol management plan, impacts to the residents of the Wunara Community will be prevented. The availability of self-testing facilities at both the multi-user hub and mine site accommodation villages will allow the opportunity to prevent a person from presenting for work in an unfit condition and thereby risk losing their employment.

The reality is that wherever there is money there is the potential for drugs to be brought into the community. Minemakers believes a zero tolerance approach to drugs, supported by a random testing regime, will deter most people from risking possessing or using drugs while on-site.

Through the strict management of the consumption and supply of alcohol in the accommodation villages, the likelihood of increased social problems due to drug and alcohol use as a result of the project is **unlikely**. Given the concern of the Traditional Owners, the consequence of inappropriate management of drugs and alcohol across the project, were it to occur, will be **moderate**. The residual risk therefore is **moderate**.

### 6.11.5 Monitoring Program

Ongoing monitoring will be conducted to allow identification of any impacts from the project on stakeholders and socio-economic conditions in the local and peripheral communities. This will involve monitoring of stakeholder and community sentiment and socio-economic impacts as part of Minemakers ongoing stakeholder consultation program.

Monitoring of stakeholder consultation will include ongoing monitoring of:

- Records of attendance at public events and community meetings to gauge the success of stakeholder consultation and to improve ongoing stakeholder consultation.
- Records of feedback including the person's name and contact details, method of consultation, information communicated, responses and outcomes of the consultation in the stakeholder database.
- Articles that appear in the media, particularly local newspapers in the peripheral communities.

Monitoring of the socio-economic impacts will include ongoing monitoring of the following indicators:

- Workforce statistics, including number of 'local' and Northern Territory people employed by the project.
- Number and nature of complaints documented in the Complaints Register, including the person's name and contact details, communication, action taken to resolve the complaint, outcomes and feedback from complainant.
- Service and goods supply statistics. These will include details regarding:
  - Type and quantity of goods/service.
  - Value.
  - Location of supplier.

- Contributions made by Minemakers to local communities, such as sponsorship of local events.

### 6.11.6 Outcome and Assessment Criteria

The outcome and assessment criteria for socio-economic matters are outlined in Table 6.36.

**Table 6.36 Outcome and assessment criteria – socio-economic**

ID	Impact	Outcome	Assessment Criteria	Summary of Management and Mitigation Measures
I31	Social disruption caused by population and demographics	No negative change in social cohesion in Wunara or Tennant Creek as a result of the project.	Annual audit of complaints register indicates no incidence of community complaint regarding changes in social cohesion due to project.	Accommodation of majority of workforce in purpose-built facilities. Strict enforcement of company policy regarding standards of behaviour. Maintenance of complaints register.
I32	Increased competition for skilled labour, particularly for highly skilled people with previous mining experience	Minimise adverse social impact due to increase in competition for skilled labour.	Consultation register shows liaison with existing training providers and local communities regarding training and employment.	Work with existing training providers to ensure that programs they deliver will provide appropriate training programs. Inform local community of the types of jobs that will be required and the skills and qualifications people will require to fill them. Use local businesses to fill contract positions where contractors are competitive and appropriately skilled. Support the development of business opportunities within the local Indigenous community. Implement stakeholder consultation plan.
I33	Significant pressure placed on existing emergency services	Project does not place additional pressure on existing emergency services.	Consultation register shows liaison with existing emergency services.	Implement workplace health and safety processes and procedures throughout all phases of the project. Provide on-site emergency response team and facilities. Consult with local emergency services.
I34	Inadequate existing infrastructure and community services	No unexpected demand placed on infrastructure or services as a result of the project.	Consultation register shows liaison with relevant stakeholders.	Liaise with the Barkly Shire Council and Northern Territory Government to assist future planning and development activities.

**Table 6.36 Outcome and assessment criteria – socio-economic**

<b>ID</b>	<b>Impact</b>	<b>Outcome</b>	<b>Assessment Criteria</b>	<b>Summary of Management and Mitigation Measures</b>
I35, I36	Decrease in availability and affordability of housing and accommodation in Tennant Creek and Wunara	Community awareness of project and its progress is maintained so potential impacts are taken into consideration for any planning.	Consultation register shows liaison with government, shire council and Traditional Owners.	Consultation with government, shire council and Traditional Owners.
I37	Social problems due to drugs and alcohol	Successful management of drugs and alcohol on mine site.	Annual audit of complaints register indicates no incidence of community complaint regarding drug or alcohol issues associated with the workforce.  Audit of drug and alcohol testing records demonstrate testing conducted and results acted on.	Implement a drug and alcohol management plan.  Implement substance abuse testing and management in all aspects of the operation.  Implement random drug and alcohol testing.  Zero tolerance approach for rules about drugs and alcohol.  Provide self-testing facilities at both the multi-user hub and mine site accommodation villages.
–	Positive benefits are realised	Positive socio-economic benefits are maximised.	Annual audit of procurement records show supply of goods and services have been sourced locally.  Workforce statistics indicate workforce composition includes local and Northern Territory people are employed at the project.	Preferentially source people, goods and services from locally.  Develop the project as quickly as practicable.  Seek premium prices for the sale of the ore.  Work with local and territory government and local businesses to build community capacity.  Maintain foster and maintain good stakeholder relationships.

## 6.12 Indigenous and Non-Indigenous Cultural Heritage

Indigenous and non-Indigenous cultural heritage in the project area are described in Section 6.12.1. Potential, credible project-related impacts associated with Indigenous and non-Indigenous cultural heritage are described in Section 6.12.2. The proposed avoidance, mitigation and management measures that Minemakers will implement during all stages of project development are described in Section 6.12.3. The resulting residual impacts of the project to cultural heritage are discussed in Section 6.12.4. The monitoring program is outlined in Section 6.12.5 and outcome and assessment criteria that will give early warning if management and mitigation measures are failing are identified in Section 6.12.6.

## 6.12.1 Baseline

### Indigenous Cultural Heritage

Minemakers worked with the CLC and Traditional Owners to ensure sites of cultural heritage significance were identified. In addition, Minemakers engaged the CLC to conduct an archaeological survey of the project area (Appendix 11); this section primarily summarises the findings of this work.

#### *Sacred Sites*

Through the CLC, consultation with Traditional Owners identified six sacred sites close to the project area. These sites have consequently been incorporated into cultural exclusion zones. No infrastructure or activities related to the project is to occur in these cultural exclusion zones. All of these cultural exclusion zones are located outside of the Mineral Lease.

A search of the Aboriginal Areas Protection Authority (AAPA) Heritage Database did not identify any sites within the northern borefield or associated water supply pipeline to the north of the Barkly Highway. The closest registered or recorded sites are approximately 40 km to the north west of the northern borefield.

#### *Archaeological Survey*

The archaeological survey of the project area, which was completed by Tim Hill in June 2009, developed an archaeological predictive model that identified two land units of varying archaeological sensitivity:

- Spinifex communities on sandplains and dunefields with low archaeological sensitivity.
- Spinifex communities on hills with moderate to high sensitivity, due to a high likelihood of silcrete quarries.

The survey used meandering pedestrian transects to focus survey effectiveness in areas with greater visibility. Archaeological materials were identified by definable characteristics, namely a prominent bulb of percussion, a point of force application, and distinct and/or retouched margins. A total of 13.5 km (7.7 km in spinifex communities on sandplains and dunefields and 5.8 km in spinifex communities on hills) was surveyed in eight transects (Table 6.37). Traditional Owners and representatives from the CLC were present during the site survey.

Six low density silcrete knapping areas were recorded across the Mineral Lease (Table 6.37 and Figure 6.12). These knapping areas were immediately associated with outcropping silcrete and the greatest densities of artefacts, in individual knapping areas, occurred within the immediate area of the source material. Artefact densities ranged from 0.2 to 1 per square metre. All artefacts were simple primary flakes with no signs of retouch, although several had signs of edge damage; and few artefacts showed signs of platform preparation.

When assessing the significance of the knapping areas it is important to note that they are directly associated with the stone (silcrete) and showed little evidence of efficient use of available material. This indicates that the use of these areas was task specific, with groups moving through the area only using as much of the silcrete as required for immediate or imminent tasks, and unlikely that the silcrete was knapped for trade or for the production of complicated tools. It is likely that all of the outcropping silcrete across the project area will have similar, associated archaeological evidence.

**Table 6.37 Summary of archaeological survey transects**

Transect	Land Unit	Distance Surveyed (m)	Visibility (%)	Sites
AW1	Spinifex communities on sandplains and dunefields.	6,518	50	AW1
AW2	Spinifex communities on sandplains and dunefields.	2,408	70	
AW3	Spinifex communities on sandplains and dunefields.	2,976	70	
AW4	Spinifex communities on hills.	180	60	AW2
AW5	Spinifex communities on hills.	65	80	AW3
AW6	Spinifex communities on hills.	195	70	AW4
AW7	Spinifex communities on hills.	34	70	AW5
AW8	Spinifex communities on hills.	10	80	AW6
	<b>Total</b>	<b>12,386</b>	<b>n/a</b>	<b>6</b>

The identified archaeological sites have potential cultural significance to the Traditional Owners as a tangible link to past geographies and use of the area. However, it should be noted that the archaeological sites were not recorded in the original sacred site survey, undertaken with the Traditional Owners. None of the sites of archaeological significance catalogued during the survey were identified by the Traditional Owners as sacred sites.

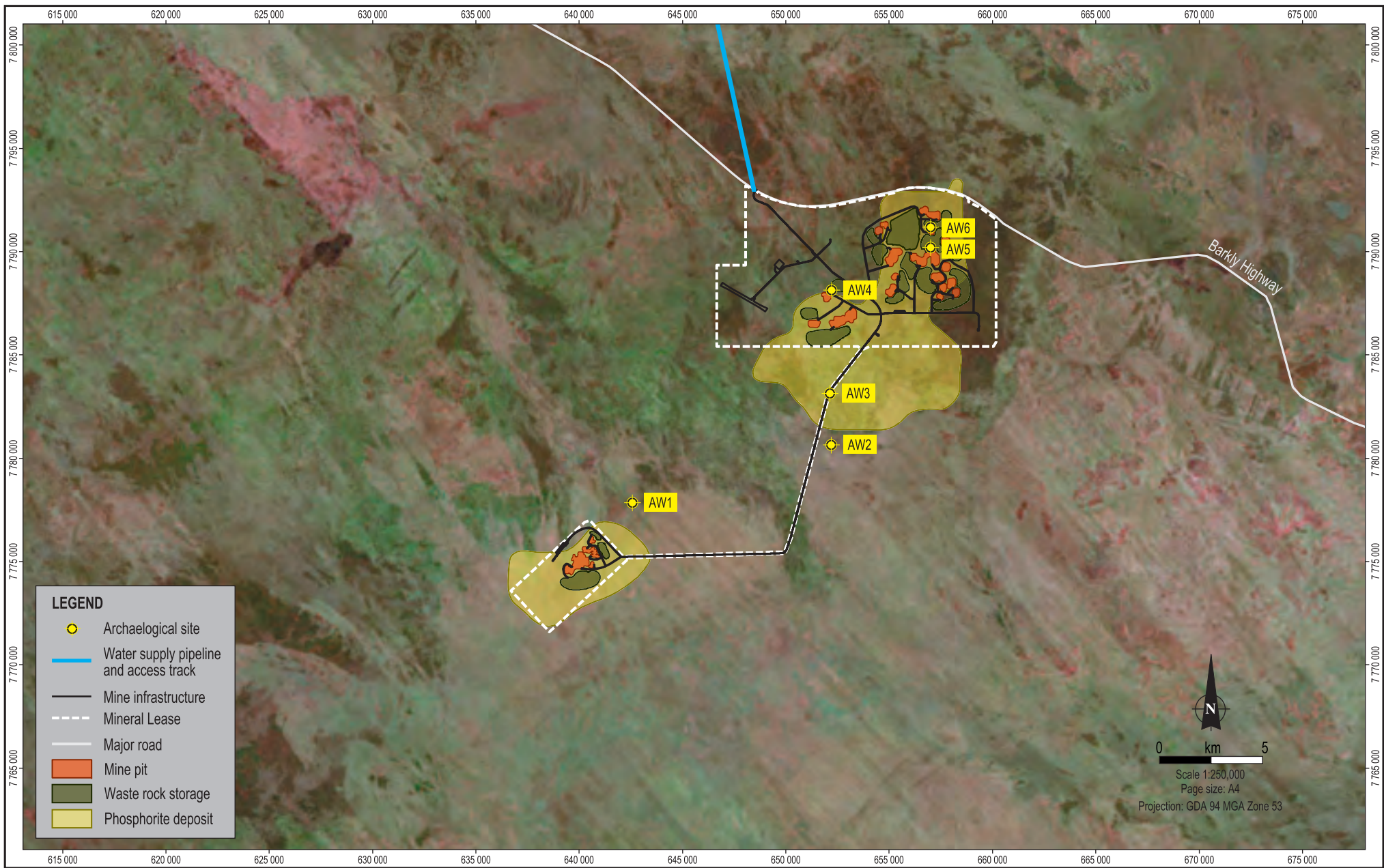
The following factors contribute to the scientific significance of the identified sites:

- Low artefact densities.
- The proximity of archaeological sites to sacred sites.
- Knowledge of sacred site's locations within the area, providing opportunities to understand the cultural context of stone knapping and site use.
- Probability and appearance that sites have been significantly impacted by previous land use or disturbance.

Consequently, Site AW1 has been determined as being of moderate scientific significance due to its capacity to inform the wider community from a cultural and scientific perspective; the significance of this site relates primarily to its association with a sacred site. The remaining sites AW2 to AW6 have been determined as being of low scientific significance. This is primarily due to the high likelihood that all silcrete outcrops in the area were utilised as a stone source; and that use appears to be of convenience rather than any other reason that may, potentially, have resulted in greater significance.

### **Non-Indigenous Cultural Heritage**

A search of the Australian Heritage Database and the NT Heritage Register identified no sites of non-Indigenous cultural heritage within the project area. In addition, there is no reason to suspect that non-Indigenous sites of cultural heritage significance are present within the project area. As such, non-Indigenous cultural heritage is not considered further in this impact assessment.



Source:  
 Place names, roads and tracks from GEODATA 250k (optimum scale 1:250,000)  
 Mine layout from AMC and Minemakers.  
 Archaeological sites from Coffey Natural Systems.  
 Mineral Lease from DMETIS.



Date:  
 12.11.2009  
 MXD:  
 Minemakers\_Wolarah\_GIS.mxd  
 File Name:  
 9014\_07\_F06.12\_GIS\_HB

Minemakers Australia Pty Ltd  
 Wolarah Phosphate Project



Archaeological sites in  
 the project area

Figure No:  
 6.12

### **6.12.2 Potential Impacts**

Construction and operation of the project will involve the excavation and movement of large volumes of material within the project's proposed footprint; specifically, removal and storage of topsoil, excavation and dumping of spoil, construction of roads, and excavation of the phosphorite deposit. These activities could significantly affect the sacred sites or sites of archaeological significance, by either disturbing or destroying them.

#### **Disturbance to Cultural Exclusion Zones**

There is potential for project related activities to disturb sacred sites contained within the cultural exclusion zones.

#### **Disturbance to Identified Archaeological Site of Moderate Significance**

There is potential for project related activities to disturb the archaeological site of moderate significance identified during the archaeological survey.

#### **Disturbance to, or Destruction of, Identified Archaeological Sites of Low Significance**

There is potential for project related activities to disturb and/or destroy archaeological sites of low significance identified during the archaeological survey, especially those within the footprint of project infrastructure or proposed pits.

#### **Disturbance to, or Destruction of, Unidentified Archaeological Sites of Significance**

Survey work suggests that sites of archaeological significance may exist within close proximity to all silcrete outcrops within the project area. However, the survey did not identify these sites and as such there is potential for the project to disturb sites that are as yet unidentified and unassessed in terms of significance.

### **6.12.3 Avoidance, Mitigation and Management**

Minemakers will implement avoidance, mitigation and management measures to address the potential impacts on archaeology and cultural heritage. These measures will reflect current good practice at similar mines operating in similar environments.

One of the primary measures implemented by Minemakers to avoid, mitigate and manage all potential impacts to cultural heritage will be to implement a cultural heritage management plan (Attachment 5) that will:

- Maintain an Indigenous sacred site and archaeological site inventory.
- Record all sacred and archaeological sites in the project's geographic information system (GIS) throughout construction and operations.
- Ensure regular monitoring of implementation of the cultural heritage management plan and relevant legislation.

- Induct and train all employees and contractors in the cultural heritage management plan to ensure that employees and contractors are aware of their obligations under the *Heritage Conservation Act* and the *Northern Territory Aboriginal Sacred Sites Act*.
- Ensure site inductions and training provides sufficient information that employees are well aware of the restriction to not enter or disturb the cultural exclusion zones.
- Establish procedures to be followed should probable archaeological sites be unearthed that are not associated with silcrete outcroppings during site development, i.e., cease work and contact the mine site environmental officer for further assessment.

### **Disturbance to Cultural Exclusion Zones**

Minemakers has applied to the AAPA for an Authority Certificate over the proposed Mineral Lease; this document will identify sacred sites and provide legal indemnity for work carried out in accordance with certificate conditions, one of which will be that sacred sites are not disturbed without prior approval or consent under the *Northern Territory Aboriginal Sacred Sites Act*. In addition, the CLC, in conjunction with the Traditional Owners, has identified sacred sites within Minemakers' Substitute Exploration Licence 26452. These sacred sites are incorporated into the cultural exclusion areas, which also include a buffer to ensure impacts do not occur. The cultural exclusion areas are outside the Mineral Lease and all activities and infrastructure planned will within the proposed Mineral Lease have been designed so that the cultural exclusion areas are not affected.

### **Disturbance to Identified Archaeological Site of Moderate Significance**

The identified site of moderate significance is outside the Mineral Lease and due to the proximity of the site of moderate significance to a cultural exclusion zone, the management and mitigation measures will be the same as those detailed above for disturbance to cultural exclusion zones.

### **Disturbance to, or Destruction of, Identified Archaeological Sites of Low Significance**

Physical disturbance of the land as a result of project activity will most likely result in the disturbance to or destruction of identified archaeological sites of low significance (AW2, AW3, AW4, AW5, and AW6). Minemakers proposes to apply to the DNRETAS, Heritage Branch, for consent to disturb the area of the proposed mineral lease under the *Heritage Conservation Act*. In this way removal of artefacts from these areas will be undertaken in accordance with *Heritage Conservation Act*.

### **Disturbance to, or Destruction of, Unidentified Archaeological Sites of Significance**

The archaeological survey undertaken for the project concluded that sites of low significance, similar to those described above, are likely to occur within 30 m of all silcrete outcrops. Therefore, Minemakers proposes to apply to the DNRETAS, Heritage Branch, for consent to disturb the area of the Mineral Lease under the *Heritage Conservation Act*. In this way removal of artefacts from these unidentified sites will be undertaken in accordance with *Heritage Conservation Act*.

In addition, the survey covered 12.4 km of the project area with greater than 50% ground visibility and discovered similar sites throughout, with the exception of one site (outside the Mineral Lease) given greater significance due to its proximity to a sacred site. In these circumstances, other

potential unknown sites close to sacred sites may be given higher significance. If this is the case Minemakers' development of cultural exclusion zones and designing the proposed Mineral Lease and project infrastructure to avoid these areas will ensure protection of potential unknown archaeological sites of higher significance in close proximity to sacred sites.

Minemakers' implementation of the cultural heritage management plan will also ensure that any sites uncovered, that are considered to be a potential site of archaeological significance, will be subject to some level of assessment by the mine site environmental officer, who will determine whether further, formal assessment of significance is required.

#### 6.12.4 Residual Impact

Physical disturbance of the land as result of project related activities is inevitable; however, active management measures will be adopted to identify and entirely avoid areas of Indigenous cultural heritage or archaeological significance, or to seek prior approval under the *Heritage Conservation Act* to disturb these sites if they cannot be avoided.

Table 6.38 summarises the residual impacts of the project on Indigenous cultural heritage and archaeological sites, considering the likelihood and consequence of the predicted impacts after the successful implementation of control and mitigation measures. The assessments of these are described in further detail below.

**Table 6.38 Summary of Indigenous cultural heritage impacts**

ID	Impact	Likelihood	Consequence	Residual Risk
I38	Disturbance to cultural exclusion zones	Rare	Major	High
I39	Disturbance to identified archaeological site of moderate significance	Rare	Moderate	Moderate
I40	Disturbance to identified archaeological sites of low significance	Likely	Insignificant	Moderate
I41	Disturbance to unidentified archaeological sites of significance	Possible	Insignificant	Low

#### Disturbance to Indigenous Cultural Exclusion Zones

Minemakers has consulted with the AAPA, CLC and Traditional Owners to identify sacred sites and have identified cultural exclusion zones. These cultural exclusion zones include a buffer area around the site of concern to provide further protection from any potential disturbance. The proposed Mineral Lease and project infrastructure have been designed to avoid these zones. All Minemakers' employees will be made aware of the location of these cultural exclusion zones through project inductions and access (and therefore disturbance) to these areas will be prohibited. Therefore, the likelihood is **rare** that the Indigenous cultural exclusion zones will be disturbed.

If the Indigenous cultural exclusion zones are disturbed, it is likely that the disturbance would attract the concern of the adjacent Wunara community and associated parties within the wider community, such as the CLC and AAPA; as such the consequence is **major**.

The overall risk is therefore **high**.

### **Disturbance to Identified Archaeological Site of Moderate Significance**

The identified site of moderate archaeological significance is close to a cultural exclusion zone and is not within the Mineral Lease and as such will not be disturbed by mining related activities. During project inductions, all Minemakers' employees will be made aware of the location of areas that have restrictions on access and this archaeological site will be included in these restricted areas. Therefore it is **rare** that the identified archaeological site of moderate significance will be disturbed.

Should the identified site of moderate significance be disturbed, Minemakers will have to notify the Minister responsible for the *Heritage Conservation Act* that an archaeological site had been disturbed without prior consent. The Traditional Owners will be notified and as such it is likely it will attract the concern of the adjacent Wunara community, CLC and the Heritage Branch of DNRETAS. Therefore, any consequence of disturbance will be **moderate**.

The overall risk is therefore **moderate**.

### **Disturbance to, or Destruction of, Identified Archaeological Sites of Low Significance**

Five identified sites of low significance occur within the Mineral Lease and infrastructure areas; as such it is **likely** that these will be disturbed during the mine life.

Minemakers proposes to apply to the DNRETAS, Heritage Branch, for consent to disturb the archaeological sites within the Mineral Lease under the *Heritage Conservation Act*. In this way removal of artefacts from these areas will be undertaken in accordance with *Heritage Conservation Act*. In addition, the archaeological survey suggested that sites similar to these five will occur at all silcrete outcroppings in the region. Due to the likelihood of their widespread occurrence across the region, the disturbance and/or destruction of these four sites of low significance will result in no loss of unique or rare archaeological artefacts. Therefore, the consequence of disturbance to these would be **insignificant**.

The overall risk is therefore **moderate**.

### **Disturbance to, or Destruction of, Unidentified Archaeological Sites of Significance**

During construction and operation of the project, some disturbance to unidentified sites of low significance associated with silcrete outcroppings could occur. However, if material is discovered away from silcrete outcroppings, it may be a site of greater significance than those catalogued during the survey; and as such stop work procedures will be implemented and the mine site environmental officer contacted to determine whether further, formal, assessment is required. Overall, it is **possible** that disturbance or destruction of unidentified archaeological sites of significance could occur.

Minemakers proposes to apply to the DNRETAS, Heritage Branch, for consent to disturb the area of the project area (Mineral Lease, northern borefield and water supply pipeline) under the *Heritage Conservation Act*. In this way removal of artefacts from these unidentified sites will be undertaken in accordance with *Heritage Conservation Act*. In addition, the archaeological survey suggests that similar sites occur at all silcrete outcroppings in the area, and due to the likelihood of their widespread occurrence across the area, the loss of these sites would result in no loss of

unique or rare archaeological artefacts. Therefore, the consequence of disturbance to these would be **insignificant**.

The overall risk is therefore **low**.

### 6.12.5 Monitoring Program

Monitoring of Indigenous cultural heritage and archaeological sites will primarily involve auditing of the cultural heritage management plan to ensure that all of the commitments therein are being met.

### 6.12.6 Outcome and Assessment Criteria

The outcome and assessment criteria for Indigenous cultural heritage are outlined in Table 6.39.

**Table 6.39 Outcome and assessment criteria – Indigenous cultural heritage**

ID	Impact	Outcome	Assessment Criteria	Summary of Management and Mitigation Measures
I38	Disturbance to Indigenous cultural exclusion zones	No disturbance to Indigenous cultural exclusion zones.	Audits show that all staff are inducted, and as such have been made aware of exclusion zones, commitments under relevant legislation and cultural heritage management plan.  Audits show no disturbance to Indigenous cultural exclusion zones.	AAPA authority certificate over mineral lease.  Consultation with Traditional Owners early on in project development to identify exclusion zones.  Designing mineral lease to avoid cultural exclusion zones.  Ensuring requirements of cultural heritage management plan are met.
I39	Disturbance to identified archaeological site of moderate significance	No disturbance to identified archaeological site of significance.	Audits show that all staff are inducted, and as such have been made aware of site locations, commitments under relevant legislation and cultural heritage management plan.  Audits show no disturbance to site.	Ensuring requirements of cultural heritage management plan are met.
I40	Disturbance to identified archaeological sites of low significance	Disturbance to identified sites of low significance is restricted to that permitted by granted consent to disturb under the <i>Heritage Conservation Act</i> , i.e., within mineral lease.	Audits show that all staff are inducted, and as such have been made aware of commitments under relevant legislation and cultural heritage management plan.  Audits show no unauthorised disturbance to sites.	Ensuring requirements of cultural heritage management plan are met.

**Table 6.39 Outcome and assessment criteria – Indigenous cultural heritage**

ID	Impact	Outcome	Assessment Criteria	Summary of Management and Mitigation Measures
I41	Disturbance to unidentified archaeological sites of significance	Disturbance to identified sites of archaeological significance is restricted to that permitted by granted consent to disturb under the <i>Heritage Conservation Act</i> , i.e., within mineral lease, and within 30 m of silcrete outcroppings.	Audits show that all staff are inducted, and as such have been made aware of commitments under relevant legislation and cultural heritage management plan.  Audits show no unauthorised disturbance to sites.	Ensuring requirements of cultural heritage management plan are met.  Archaeological survey of site has informed knowledge of likely distribution and significance of sites.

## 6.13 Traffic and Transport of Ore

### 6.13.1 Baseline

#### Road Transport

This description is based on the Wonarah Mine Road Scoping Requirements (Appendix 12A) completed by Worley Parsons in October 2009 and the Export Transport Logistics Study completed by Worley Parsons in August 2009 (Appendix 12B) and the Socio-economic Baseline and Impact Assessment (Appendix 4). The publicly available traffic and road information is limited to accident history, traffic counts and vehicle classifications for the Barkly and Stuart highways.

The existing road network that will be affected by the project, with a focus on those sections of public roads to be affected by mining operations, include:

- The Barkly Highway from the site entrance to its intersection with the Stuart Highway.
- The Stuart Highway from its intersection with the Barkly Highway to its intersection with Warrego Road.
- Warrego Road to the turn-off for the multi-user hub.

The Barkly Highway is the major transport link between Northern Territory and Queensland, and the Stuart Highway connects South Australia from the south to Darwin in the north. Tourists and freight transport frequently use both highways; an average of 240 vehicles use the Barkly Highway and 380 use the Stuart Highway south of Three Ways each day (Road Network Division, 2007). In the 12-month period from October 2007 to September 2008 there were four fatal crashes and 32 serious crashes in the Tennant Creek region (NT Transport Group, 2009). Data available between January 2007 and December 2008 on the Barkly Highway has recorded 14 accidents; the majority involving passenger cars or light vehicles overturning or running off the road.

All public roads along the ore transport route from the mine to the multi-user hub are sealed, dual carriage way. The speed limit within Tennant Creek is 50 km/hr. Outside of the built-up areas, the default speed limit is 100 km/hr; however, a speed limit of 130 km/hr applies on some parts of the

Barkly and Stuart highways. The turn-off for the Warrego Road is within the 80 km/h section of the Stuart Highway to the north of Tennant Creek.

According to the Northern Territory's Department of Planning and Infrastructure's (DPI) Annual Traffic Report-2008 (Appendix 12B), there were no unplanned road closures during the last two years on these sections of the highways.

Current road usage incorporates three groups; local traffic, tourist traffic and freight transport vehicle traffic. According to the 2006 census data, there are approximately 1,659 registered motor vehicles within the Tennant Creek region, consisting mostly of passenger vehicles (915) and light commercial vehicles (538) (ABS, 2008c). On average, the Barkly region receives 100,000 holiday makers each year (Travel NT, 2009).

The local primary school offers a bus service, which also caters to high school students. The bus has two runs in the morning leaving the school at 7 a.m. and returning from the final run at 7.50 a.m. The bus then departs again in the afternoon at 2.40 p.m. to return at 3.30 p.m. The service is predominantly around Tennant Creek with the most northern drop off at the United Service Station (Paterson St/Stuart Highway) on the northern outskirts of Tennant Creek (approximately 15 km southeast of the multi-user hub) and a drop off to the "east camp", Kargaru, and the Kalinjarri community. The ore transport route therefore does not correspond with the school bus service route.

There are two commercial bus routes operating along areas of the ore transport route (Alice Springs to Darwin and Mt Isa to Tennant Creek). The Alice Springs to Darwin bus route has a daily service in both directions and is travelling along the ore transport route between 1:30 a.m. to 3:40 a.m. and has scheduled stops at Tennant Creek and Three Ways. The Mt Isa to Tennant Creek bus route has five services a week and is travelling along the ore transport route between 10:00 p.m. and 2:50 a.m. and has scheduled stops at the Wunara community, Barkly Roadhouse, Three Ways and Tennant Creek.

## **Rail Transport**

The Adelaide-Darwin railway line runs through Tennant Creek and is a standard gauge, single-track, open access railway. Access to the Adelaide-Darwin railway is supplied by FreightLink Pty Ltd, the owner and operator of the infrastructure. The current weekly rail traffic on the line is made up of 34 trains consisting of:

- Intermodal freight.
- Bulk freight.
- Passenger trains.

Current bulk freight operations include:

- Bootu Creek to Port of Darwin – an 800 km haul of 0.6 Mt/a of manganese ore with four loaded trains and four empty return trains per week.
- Frances Creek to Port of Darwin – a 210 km haul of 1.5 Mt/a of iron ore with seven loaded trains and seven empty return trains per week.
- Prominent Hill to Port of Darwin – a 2,000 km haul of 0.25 Mt/a of copper-gold concentrate with five loaded trains using 'kibble containers' and five empty return trains per week.

### **6.13.2 Potential Impacts**

Construction and operation of the project will involve transport of up to 3 Mt/a of ore from the Wonarah Phosphate Project to the East Arm Port in Darwin. Transport will be a combination of road and rail. The transport of ore has the potential to increase the users of the existing road and rail infrastructure.

The key issues related to increased traffic and the transport of ore are:

- Adverse effects on safety due to increased road traffic.
- Decreasing road and rail capacity due to increased traffic.
- Adverse effects on air quality due to increased traffic related emissions (this is addressed in Section 6.2).
- Adverse effects on amenity due to increased traffic related noise (this is addressed in Section 6.4).

Potential impacts due to increased road and rail traffic are discussed in further detail below. It should be noted that these do not take into consideration the proposed avoidance, mitigation and management measures that will be implemented by Minemakers during all stages of project development (see Section 6.13.3), and which will result in the residual impacts discussed in Section 6.13.4.

#### **Increased Risk of Accident**

The increased number of vehicles on the road, largely heavy vehicles, may increase the likelihood of road accidents by:

- Reducing average headway between successive vehicles.
- Increasing the rate of road degradation through increased traffic, particularly heavy vehicles.

The degree to which the project increases road traffic levels will depend upon the annual ore production rate, i.e., there will be significantly less traffic associated with the project when it is operating at 1 Mt/a than when it is operating at 3 Mt/a.

#### **Decreasing Road and Rail Capacity Due to Increased Increment in Traffic**

Increases in road and rail traffic as a result of the project could adversely affect the available capacity of this infrastructure.

The 1 Mt/a production rate equates to 31 round trips by triple road trains per day and the 3 Mt/a production rate equates to 91 round trips by triple road trains per day. The current traffic counts for the Barkly Highway show it is not heavily trafficked and when the mine generated traffic is added, the additional traffic volumes do not unduly impact on the Barkly Highway road capacity. The Stuart Highway to the north of Tennant Creek carries more traffic than the Barkly Highway and again, this additional traffic does not severely impact the capacity of the Stuart Highway (see Appendix 12B).

The current road network has an existing capacity of 6,000 annualised average daily traffic (AADT). The peak transport demand projected for project is 400 AADT, less than 10% of the

available capacity. At no stage of the project do predicted volumes approach the lane capacity. Therefore, the proposed traffic increases on the road system are negligible in this regard.

While some upgrades will be required to the existing rail network (i.e., three new rail loops and the rail siding at the multi-user hub), Minemakers is consulting with FreightLink to ensure that upgrades to the existing rail infrastructure will be in place prior to the project commencing transport of ore. Therefore, the rail network will have the available capacity to accommodate Minemakers' ore transport.

A significant decrease in road and rail capacity is therefore not anticipated as a result of the project. This is therefore not considered to be an impact associated with the project and is not considered further in the residual risk assessment.

### **6.13.3 Avoidance, Mitigation and Management**

The haulage contractor will be required to prepare a project-specific traffic management plan to set procedures to limit the potential for vehicle accidents. Minemakers will have final approval of this plan. The traffic management plan will include such things as:

- All vehicle operators will be trained and licensed appropriately for the vehicles they are operating.
- A requirement for all vehicle operators to be inducted in the procedures of the plan.

The plan will also cover how to manage project-related road transport issues such as incident hotspots, river crossings, how spills will be handled (noting that the product is benign), as well as general aspects such as driver fatigue and covering loads. 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 (Attachment 5).

Contractors will be required to adhere to Northern Territory road rules at all times.

Vehicular accident data available between January 2007 and December 2008 for the Barkly Highway indicated that the majority of accidents occurred at two locations. Minemakers will review the road conditions at these two locations and the mine's road haulage records to determine whether further specific traffic management measures are required at these locations, and to confirm there are no issues with geometry or alignment that may be potential hazards to project related traffic.

Monitoring of traffic numbers and accidents will continue through Northern Territory Government data collection, to enable analysis of any mine related impacts.

Future road upgrades will be subject to government funding arrangements and Minemakers will contribute to the maintenance of roads through licence fees, fuel excise, taxes and royalties paid. The proposed traffic increases will conform to all Northern Territory registration controls and will contribute to taxes and other legislative requirements for road maintenance.

The impacts of traffic related to both 1 Mt/a and 3 Mt/a productions rates are considered to be negligible. As such, there will be no excessive changes in maintenance requirements outside the expected fair wear and tear of road usage.

FreightLink will be required to maintain the rail tracks to a safe standard at all times and complete any upgrades needed to meet that standard.

#### 6.13.4 Residual Impact Assessment

Table 6.40 summarises the residual impacts of the project on road and rail traffic, considering the likelihood and consequence of the predicted impacts after the successful implementation of management and mitigation measures.

**Table 6.40 Summary of traffic impacts**

ID	Impact	Likelihood	Consequence	Residual Risk
I42	Increased risk of accident due to reduced headway	Possible	Moderate	High
I43	Increased risk of accident due to increased rate of road degradation	Possible	Minor	Low

#### **Increased Risk of Accident due to Reduced Headway**

Operation of the project will involve the transport of ore by road and rail from the Wonarah mine site to the port facilities in Darwin. The road transport route from the Mineral Lease to the multi-user hub north of Tennant Creek will use (Figure 5.10, Chapter 5):

- An 8.5 km road from the Mine head to the Barkly Highway.
- The Barkly Highway, for 260 km, to its intersection with the Stuart Highway.
- The Stuart Highway, for 22 km, to its intersection with Warrego Road.
- Warrego Road, for 16 km, to the multi-user hub.

The phosphate ore will be transported utilising triple side tipper road trains. The total haul distance from Wonarah Phosphate Project to the multi-user hub is 306.5 km (one way). The operation will be carried out 24 hours/day for 365 days/year, however, an allowance for two weeks of road closures due to flooding or other reasons has been made when calculating the expected ore transport requirements.

#### ***Reducing Average Headway Between Successive Vehicles***

The 1 Mt/a production rate equates to 31 round trips by triple road trains per day. This results in an average headway time of 46 minutes between successive units in each direction (i.e., one truck travelling towards the multi-user hub every 46 minutes and one truck travelling to the mine site every 46 minutes). No additional allowances for mine traffic have been made as they are random in nature and overall will have a minimal impact on traffic volumes.

The 3 Mt/a production rate equates to 91 round trips by triple road trains per day. This results in an average headway time of 16 minutes between successive units in each direction. Again, no additional allowances for mine traffic have been made as they are random in nature and overall have a minimal impact on traffic volumes.

The haulage scenario has been overlaid on the existing traffic volumes to review changes in net headway effects. Table 6.41 shows the results of this.

**Table 6.41 Changes in net traffic headway for all vehicle classes**

Section	Inbound Time (Minutes)*			Outbound Time (Minutes)^		
	Current	Proposed		Current	Proposed	
		1 Mt/a	3 Mt/a		1 Mt/a	3 Mt/a
Barkly Highway	5.29	4.44	3.39	4.90	4.16	3.22
Stuart Highway	2.77	2.52	2.14	3.35	2.99	2.47

\* Inbound refers to loaded trucks travelling in a westerly direction on the Barkly Highway and in a southerly direction on the Stuart Highway.

^ Outbound refers to unloaded trucks travelling in an easterly direction on the Barkly Highway and a northerly direction on the Stuart Highway.

Given this, it is **possible** that there will be an increased risk of accident on a public road due to mine related traffic. The implementation of the traffic management plan will ensure that road transport of ore will be conducted in a responsible and legal manner with minimal disruption to other road users, particularly as the road trains hauling ore to the multi-user hub and back will not enter Tennant Creek. The consequence of an increased risk of accident is **moderate** as it will attract the concern of the community. The residual risk is therefore **high**. However, when the risk of traffic accidents is placed into context of normal day-to-day driving undertaken by the general public, the risk will most likely be lower.

### Increased Rate of Road Degradation

The AUSTRROADS vehicle classification system classifies the road trains that will transport ore as Class 12 vehicles. Table 6.42 shows the relative Class 12 vehicle increase due to road trains transporting phosphate from the mine site to the multi-user hub.

**Table 6.42 Class 12 vehicle increase related to ore transport throughput**

Section	Inbound			Outbound		
	Current	Proposed		Current	Proposed	
		1 Mt/a	3 Mt/a		1 Mt/a	3 Mt/a
Barkly Highway	15	46	105	12	44	103
Stuart Highway	12	43	103	13	43	104

It is **possible** the significant increase in heavy vehicles on the road due to project related activities may result in faster degradation of road infrastructure. Upgrades to roads will include upgrade of the intersection between the Stuart Highway and Warrego Road, the access to the multi-user hub on Warrego Road and the Barkly Highway at the mine site entrance; these will be completed prior to the transport of ore. Traffic investigations indicate that the design and condition of the roads to be used for the project (and particularly the route for the transport of ore from the mine site to multi-user hub) is suitable for the increased level of traffic that will result from the project. Maintenance for the road will be the responsibility of government and through royalties, taxes, licence fees and fuel excises Minemakers will make a financial contribution to this. The consequence of a reduced road condition, were it to occur, will be **minor** as road maintenance will return the road to its current condition. Therefore, the residual risk is **low**.

### 6.13.5 Outcome and Assessment Criteria

The outcome and assessment criteria for traffic and transport of ore are outlined in Table 6.43.

**Table 6.43 Outcome and assessment criteria – traffic and transport of ore**

<b>ID</b>	<b>Impact</b>	<b>Outcome</b>	<b>Assessment Criteria</b>	<b>Summary of Management and Mitigation Measures</b>
I42, I43	Increased risk of accident	No adverse effects on safety due to increased road traffic.	Complaints register shows all reasonable complaints are investigated.  Vehicular incident register shows no project-related incidents/near misses.	Carry out any road upgrades prior to the commencement of ore transportation.  Develop traffic management plan.  Adequate road maintenance by government.