CHAPTER 6 – Biodiversity

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6.1 Introduction

This chapter outlines the steps taken to assess the biodiversity values that may be impacted by the Twin Bonanza project (which includes MLA29822 and Section 19 (Figure 3-2, Chapter 3). A detailed risk assessment was undertaken to examine hazards, risk rankings and mitigations required to minimise risk to biodiversity values.

The project area is examined with regard to its contribution to local, regional, national and international biodiversity values, and overall conservation significance. The character and typical range of terrestrial species and ecosystems within the proposed development are summarised.

A particular focus has been placed on identifying threatened species and sensitive habitats, as these possess a high conservation value and require significant management and mitigation measures to reduce risk. Biodiversity values regarded as being at risk (and therefore priority for management) are examined in the biodiversity risk assessment in Section 6.7.

Mining development, by its nature, cannot proceed without some impacts on environmental values. ABM commits to minimising environmental impacts by well-informed mine layout decisions and proposing a variety of mitigations. Environmental impacts are to be accounted for through ABM's commitment to the proposed Biodiversity Offsets Program (refer to Chapter 16: Additional environmental offsets).

Several comprehensive reports and studies have been undertaken to complete the assessment of risk to biodiversity. The main document referenced is the latest flora and fauna report for Twin Bonanza (Appendix C), as this report includes a full account of desktop research, existing environment description, survey methodology, survey results, and significant species/habitat discussions associated with the project area. A Biodiversity Management Plan (BMP) has also been produced for this project which has been developed as a stand-alone document for management of biodiversity values that will be impacted by the mining operation (Appendix D).

6.2 Environmental objectives

ABM's environmental objective is to ensure their proposed operations have been developed in order to maintain the following broadly defined values through avoidance or management of adverse impacts:

- conservation status
- species diversity
- species geographic distribution
- productivity of flora and fauna at species and ecosystem levels.

6.3 Definitions

6.3.1 Biodiversity

Biodiversity is defined by Australia's Biodiversity Conservation Strategy 2010–2020, Consultation Draft (National Biodiversity Strategy Review Task Group 2009) as comprising three levels:

- Ecosystems – the variety of habitats, biotic communities and ecological processes
- Species – the variety of species
- Genetics – variation within a species (e.g. meta-population dynamics)

Conserving biodiversity is an essential part of safeguarding the biological life support systems on Earth. All living creatures, including humans, depend on these life support systems for the necessities of life.

This assessment examines biodiversity values and concerns for the Twin Bonanza gold project which are of local, regional, national and international significance. Issues of concern have been determined by focusing on significant species and sensitive habitat, as defined in the following section, as well as the status of ecological processes which influence the capacity of the landscape to maintain existing functionality and evolve and adapt over time.

Specifically, the Tanami Desert (where Twin Bonanza is located) is known as "one of the most important biological areas in Australia particularly as it provides a refuge for several of Australia's rare and endangered species" (Gibson 1986). Drawing on this theme, the area was highlighted in Morton et al. (1995) as a refuge for biological diversity in arid and semi-arid Australia. This diversity was initially thought to be related to the presence of palaeodrainage habitat which supports richer vegetation than the surrounding area. However, a more recent study suggested that diversity is high throughout the Tanami, and species richness is probably determined more by local seasonal factors (Paltridge & Southgate 2001).

6.3.2 Significant species

The majority of significant species are listed under Northern Territory and/or commonwealth legislation as threatened, migratory or marine species – or a combination of these. Some species lack sufficient data to accurately assess their status. The International Union for the Conservation of Nature (IUCN) nominates a set of criteria to define species risk of extinction. Categories of status species and habitat of cultural value as described in Figure 6-1.

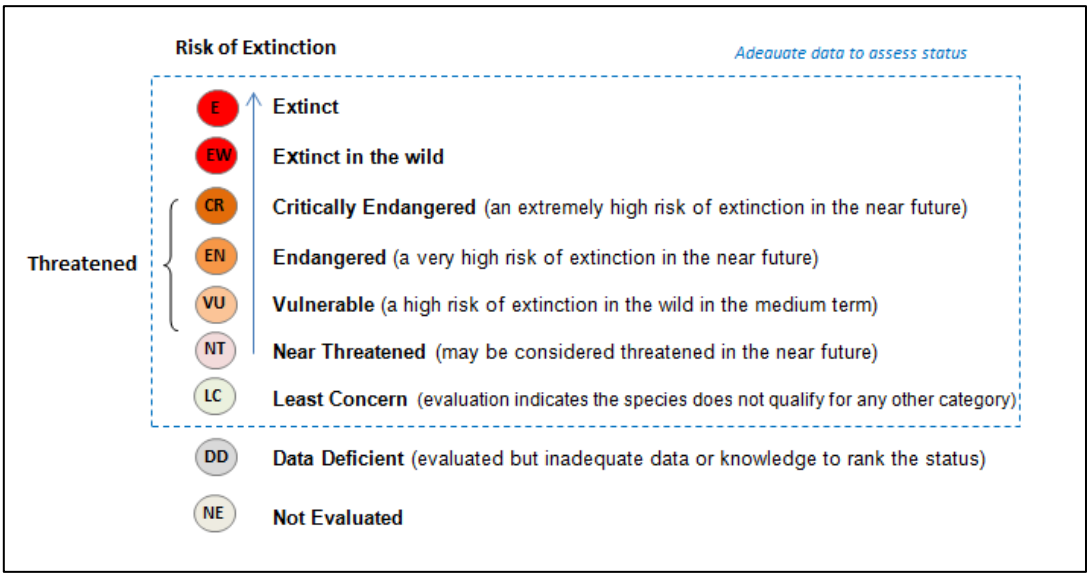

Figure 6-1. The IUCN red list categories of risk for threatened species

These criteria and categories are used by both the Northern Territory Government to identify threatened species and habitat which are listed under the *TPWC Act 2000*, and the Commonwealth Government to identify nationally threatened species under *EPBC Act 1999*. For the purpose of this assessment flora and fauna species are identified as significant if listed as:

- Threatened in accordance with either the EPBC Act or TPWC Act.
- Listed as either migratory or marine species under the EPBC Act.
- Species which are not listed either on a state or national basis as threatened but have experienced a significant reduction regionally, are naturally rare, endemic to the bioregion, have a restricted range or which are of value to the region. Some of these species may be listed as NT or DD under the TPWC Act.

6.3.3 Sensitive habitat

In terms of conserving catchment-based ecological resilience, a habitat or geographic place may be considered sensitive or significant because the area features any or a number of the following criteria:

- supports threatened taxa or communities
- serves important ecological or hydrological functions
- serves as an important corridor for the movement of individuals, range extension or genetic exchange between otherwise disjunct populations
- provides habitat during times of vulnerability or adverse conditions (e.g. drought)
- supports a concentration of a diverse range or abundance of species within a local area (i.e. a sub-catchment, breeding grounds for water birds)
- supports a disjunct population or degree of genetic diversity for a species that is not well represented elsewhere
- serves as a representation of habitat in sound condition which is more often in adverse condition in the catchment or bioregion.

Areas which are listed under the *EPBC Act* are also considered sensitive habitat.

6.3.4 Cultural values for biodiversity

The project areas fall within a broad region of value to Indigenous land owners and native title holders. Therefore this assessment of biodiversity values and concerns also considers species and habitat which may be of cultural significance to the regional population. These species and habitat are considered notable from a cultural perspective. With the project occurring in the Mt Frederick No. 2 Aboriginal Land Trust, consultation has occurred with the Traditional Owners of the region via the Central Land Council (CLC). Discussions have included the scope of the project and potential effects that mine disturbance may have on the ecosystem. Refer to Chapter 13: Social, economic risks, historic and cultural heritage for details on consultation approaches for this project.

6.4 Regional environmental context

A summary of the project areas environmental setting is provided below to help set the context for the risk assessment; however more detail is provided in Appendix C: Early dry season Flora and Fauna report 2013.

6.4.1 Bioregion description

The Twin Bonanza project falls within the Tanami Bioregion (Figure 6-2) (Baker et al. 2005). The terrain is mostly flat red sand plains with minor dunes and exposed rock occurring at hills and low lying ranges. The dominant vegetation is hummock grassland with paths of open Eucalyptus forests on a grassy understory. The habitat of the Tanami Palaeodrainage System and the relative absence of exotic animals and plants make this area a refuge to a high concentration of threatened species (Harrison et al. 2009).

Despite the arid climate, this bioregion is home to two nationally significant wetlands (all ephemeral): Lake Surprise (Yinapaka) and the Lake Gregory area, which are both over 100 km from the project area. Additionally, there are a range of smaller ephemeral wetlands over 20 km away. No permanent surface water is located in the region.

The majority of the bioregion appears in good condition with little major development. Development in the area is mostly associated with cattle production and mining. Current threats to the bioregion are changed fire regimes and the introduction of exotic plants and animals.

This bioregion has experienced some of highest extinction rates for native mammals, with thirteen species now classified as extinct.

6.4.2 Site of Conservation Significance

The project area falls outside of the South-west Tanami Site of Conservation Significance (SOCS); however it is likely that the project supports similar biodiversity values (Figure 6-2).

Due to the Tanami Palaeodrainage System and low numbers of exotic animals and plants, this area is known to have a high concentration of threatened species (Harrison et al. 2009). This broader area is recognised as being a stronghold for the greater bilby (*Macrotis lagotis*), brush-tailed mulgara (*Dasycercus blythi*), crest-tailed mulgara (*Dasycercus cristicauda*) and great desert skink (*Liopholis kintorei*) (Ward & Harrison 2009). It also supports several ephemeral wetlands and one plant species (*Marsilea latzii*) that is unique to the area.

Major vegetation communities within the site include soft spinifex (*Triodia pungens*) and feathertop spinifex (*T. schinzii*) hummock grassland with acacia tall sparse-shrubland overstorey between dunes; snappy gum (*Eucalyptus brevifolia*) low open-woodland with soft spinifex understorey; and neverfail (*Eragrostis xerophila*) open-grassland with scattered trees and shrubs (White et al. 2000).

Vegetation at some wetland areas located away from the project includes coolabah and bluebush at swamps, and bare pans of ephemeral lakes containing *Ruppia sp*. fringed by *Melaleuca glomerata*, or samphire and *Acacia maconochieana* fringing bare pans (Duguid 2005).

6.4.3 Indigenous protected areas

The Twin Bonanza project area does not occur within an Indigenous Protected Area (IPA); however it is close to the Southern and Northern IPAs (Figure 6-2). In the heartland of Warlpiri country, the Traditional Owners have nominated Australia's largest IPA at 10.16 million hectares. The southern Tanami IPA is populated by threatened species including the bilby, great desert skink and the brush-tailed mulgara. Also, over 70 bird species occur in

this area, including those of conservation significance such as the princess parrot. This area is also significant as when it rains, it attracts thousands of water birds to large inland lakes where they feed and breed. There are also around 100 reptile species that live in the area (STIPA 2012).

The Southern Tanami is declared under the IUCN Category Six, which ensures the conservation of natural and cultural values while enabling the sustainable use of natural resources (STIPA 2012).

The Northern Tanami Desert IPA covers around 40,000 km^2. Around two-thirds of the IPA is considered to be of high conservation value and have been identified in the Northern Territory Parks master plan as being a Biodiversity Conservation Hotspot. The land is a refuge for vulnerable species including the greater bilby and great desert Skink, and is a haven for the endangered Gouldian finch. The Northern IPA supports more than 30 threatened species of plants, and includes vast areas of hummock grassland which is otherwise poorly protected in the NT (NTIPA 2007).

6.4.4 Regional flora and fauna data

6.4.4.1 NT Atlas records

A review of existing flora and fauna records for the Tanami bioregion highlighted that survey effort has been concentrated around mining developments, CLC projects, and road-side records (see Appendix C: Early dry season flora and Fauna report for maps). Apart from the recent surveys for the Twin Bonanza project (of which data has not yet been submitted to the DLRM), very little survey effort has occurred within 20 km of the Twin Bonanza project area.

NT Fauna Atlas records indicate that 404 fauna species have been identified in the Tanami bioregion, including 12 amphibians, 106 reptiles, 224 birds, and 62 mammals.

- 14 are threatened under the TPWC Act
- 6 are threatened under the EPBC Act
- 11 species are extinct in the NT
- 9 introduced species

Nine migratory species are predicted to occur on the vicinity of the project area (EPBC search tool).

NT Flora Atlas records indicate that 1026 flora species have been identified in the Tanami bioregion.

- 1 species is threatened under the TPWC Act and the EPBC Act
- 6 declared weeds
- 46 environmental weeds (non-declared)

6.4.4.2 Threatened species

Twenty-one threatened species were identified by EPBC protected matters search tool report and DLRM databases as possibly occurring in the Twin Bonanza project area (see Appendix C). A review of the ecology, core habitat, known distribution, existing records of each species identified that two species are "*likely or known*" to occur within the project area, and one "*may*" occur within the project area (Table 6-1) (refer to Appendix C for details of the likelihood of occurrence assessment).

Table 6-1. Threatened species that are "known, likely or may" occur in the Twin Bonanza project area.

Scientific name	Common name	Status		Likelihood	Records in Tanami Bioregion	
		TPWC	EPBC		Pre 1970s	Post 1970s
REPTILE						
Liopholis kintorei	great desert skink	VUL	VUL	May	33	17
MAMMAL						
Macrotis lagotis	greater bilby	VUL	VUL	Known	26	501
Dasycercus blythi	brush-tailed mulgara	VUL	-	Known	10	220

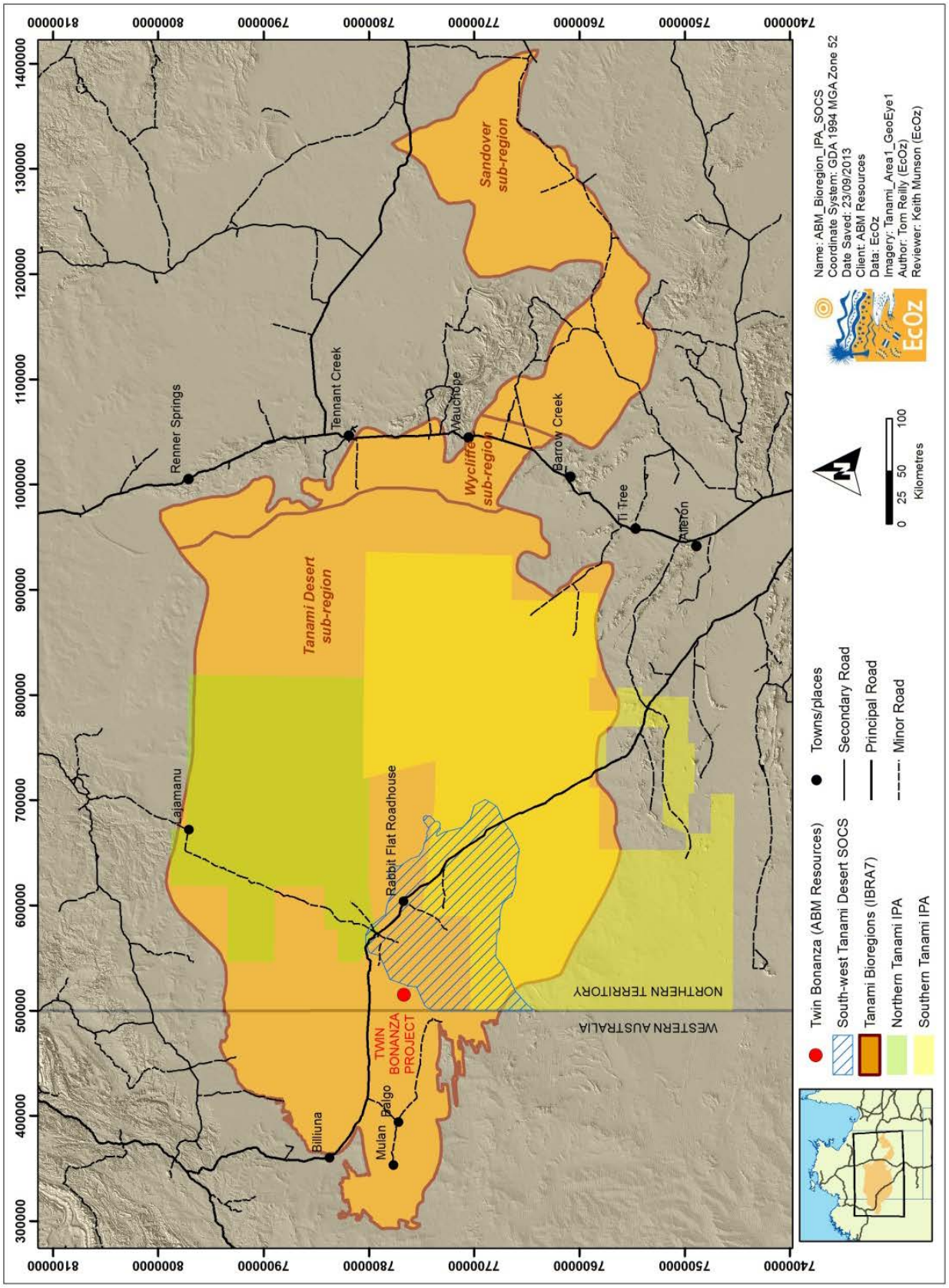

Figure 6-2. SOCS & IPAs within the Tanami Bioregion

6.4.4.3 Water birds and migratory species

Aerial water bird surveys supplemented by on-ground surveys were conducted in the Tanami Desert in early 2006 after exceptional flooding events (estimated at one in 910 year rainfall event, (GHD 2006)). These surveys concluded that 72 species of water birds occur in the Tanami Desert (Reid et al. 2006).

EPBC protected matters search tool results for a search area of 50 km from Wilsons Camp identified that nine listed migratory species may potentially occur in the region when ideal conditions persist.

6.4.4.4 Weeds

Weeds and invasive exotic plants are considered as a significant management concern in the Tanami region, with the main species of concern being Mossman river grass (Cenchrus echinatus) (category "B" weed), Buffel grass (Cenchrus ciliaris) and umbrella sedge (Cyperus involucratus) occur within the site (NRETAS 2012). Couch grass (Cynodon dactylon) is also likely to be present and spreading (NRETAS 2012).

N.T. Atlas records for the Tanami bioregion indicate that 6 declared weed species occur in the region, which includes one Weed of National Significance (WONS) (Table 6-2). The declared weeds are all listed as "B Class" under the *Weeds Management Act 2001* (NT), which means that growth and spread for these species are to be controlled by land managers if these weeds exist within their tenure.

Table 6-2. Weed records for the Tanami Bioregion (NT Atlas Records from DLRM)

Family	Scientific Name	Common Name	Listing Classification
FABACEAE	*Parkinsonia aculeata*	Parkinsonia	B Class; WONS
	Senna obtusifolia	Sicklepod	B Class
LAMIACEAE	*Hyptis suaveolens*	Hyptis	B Class
MALVACEAE	*Sida acuta*	Sida	B Class
POACEAE	*Cenchrus echinatus*	Mossman Grass	B Class
ZYGOPHYLLACEAE	*Tribulus terrestris*	Bindii	B Class

6.4.4.5 Feral Animals

A large range of introduced species have been previously recorded from this bioregion, including dog (*Canis lupus*), one-humped camel (*Camelus dromedaries*), feral donkey (*Equus*

asinus), feral horse (*Equus caballus*), feral cat (*Felis catus*), house mouse (*Mus musculus*), European rabbit (*Oryctolagus cuniculus*) and European red fox (*Vulpes vulpes*) (Baker et al. 2005). Of these species, the feral cat and one-humped camel are the most abundant in the bioregion. Hard-hoofed species (camels, donkeys and horses) create widespread erosion, damage native vegetation, introduce weeds and foul waterways. Exotic predators such as feral cats and foxes are efficient hunters that prey on a number of native species, particularly small to medium sized mammals. Environmental impacts from feral cat, European rabbit and European red fox are listed as Key Threatening Process under the *EPBC Act.*

6.4.5 Fire regime

Fire is a frequent and significant factor in the desert landscapes of this region, and strongly influences the structure and composition of the vegetation in the region (Latz 1995). The fire regime in the Tanami Desert now exhibits more frequent uncontrolled summer wildfires, which may be affecting threatened species such as the greater bilby (Pavey 2006a; Pavey 2006b) and the great desert skink (McAlpin 2001).

Fire scar mapping data (NAFI 2013) has identified that a large portion of the project area was burnt in 2011 and that areas in the south of lease have remained unburnt for between six and seven years. Areas to the north of the MLA29822 boundary also remained unburnt in the 2011 fire, with some patches remaining unburnt for a maximum of 11 years.

6.5 Vegetation survey – Twin Bonanza

The vegetation assessment was undertaken over two survey periods, one in April 2012 (GHD 2012) and the other in May 2013 (EcOz 2013). The purpose of the vegetation survey was to map vegetation communities to a scale of approximately 1:30K, identify any threatened or notable flora species, identify and describe any sensitive vegetation/habitat types, and map the extent of any existing weed infestations.

A detailed account of survey effort, methodology and results is provided in Appendix C: Early dry season Flora and Fauna Report.

6.5.1 Flora survey methods

The methods used in this vegetation mapping exercise followed Brocklehurst et al. (2007), with some exceptions to suit site conditions and survey logistics. A summary of methods used during the surveys is provided below. No targeted threatened flora species searches were required as desktop searches did not identify the potential for threatened flora species to be supported within the project area or possible “receiving” environs.

6.5.1.1 Vegetation mapping

Vegetation mapping was undertaken within the project area, which required a total of 32 survey sites (Figure 6-3). Sites were selected to both define the local habitat and map vegetation communities for the study area.

Prior to the field survey, boundaries of vegetation types were visually defined from high resolution aerial imagery (GeoEye 2m resolution) and mapping linework, which was undertaken in ArcGIS10 software. The resultant polygons were then allocated "proposed vegetation types" which were subsequently ground-truthed in the field. Amendments to proposed vegetation types occurred after final analysis of vegetation data.

Vegetation was mapped by selecting a suitable number of reference sites and check sites within the proposed vegetation types. In order to properly describe vegetation communities to a scale of 1:30K, reference sites were selected within each major vegetation community (with the exception of Vegetation Type 5 as this vegetation type has a low coverage within the project area). More sites were allocated to sites that covered larger areas to try to capture potential floristic variations within the community (common in desert environments that are highly influenced by fire). Check sites were used primarily as a mapping check tool, and include a more rapid field assessment that aims to determine the vegetation type.

6.5.1.2 Sensitive habitat surveys

One sensitive habitat type was identified at the proposed borrow pit and water bore areas – palaeochannel. Survey methodology required to collect adequate baseline data, on this habitat type, was included in the vegetation mapping exercise. Additionally, sites were selected within potential disturbance areas such as the water supply bores. Several fauna sites were also included in palaeochannels to ensure that a full characterisation of the ecological status was achieved.

6.5.1.3 Weed survey

Weed inspections were undertaken at each reference and check site associated with the vegetation mapping exercise. Additional weed inspections of existing exploration/access tracks, Wilsons camp, and water supply bores were also undertaken – as currently disturbed areas are more prone to weed infestations. All weed infestations were described and mapped as part of these surveys.

6.5.2 Vegetation communities

Geology, land form, and soils have a dominant influence in shaping the vegetation types present within the project area. Additionally, fire also strongly influences the structure and composition of the vegetation in the region (Latz 1995) which made some boundaries of vegetation types difficult to distinguish (from both aerial imagery and in the field).

The vegetation surveys identified and described five vegetation types within the Twin Bonanza project area (Table 6-3 and Figure 6-3). All vegetation types are widespread within the bioregion. Vegetation associated with the palaeochannel land unit has been considered as a sensitive vegetation type due to biodiversity values, and cultural importance (discussed below).

The most extensive vegetation type within the wider project area is vegetation type 3 (Table 6-3), which is associated with lateritic and loamy sand plains. There was a high floristic variation between flora sites within vegetation type 3, which was attributed to fire impact across the site. The proposed development largely falls within vegetation types 1 and 2, as these communities were associated with rocky hills land units that are associated with the target ore reserves.

6.5.3 Sensitive or notable vegetation communities

There are no threatened ecological communities or significant habitat types within the project area. However, the Tanami Desert is regarded as collectively being “significant habitat” for several threatened species and a diversity of native species (SEWPAC 2013).

Sensitive habitat types within this part of the Tanami Desert would include ephemeral wetlands, ephemeral salt lakes, and palaeochannels. These habitats are known for their importance in supporting a diversity of native species (including threatened species) and providing general refugia during dry periods. Additionally, these habitats are not widespread like sand plain habitats and also have the potential for fragmentation due to a relatively linear landform structure.

The project area does contain a palaeochannel (Figure 6-3). Palaeochannels (or palaeodrainage systems) are characterised by being the surface expressions of ancient river systems. There are two distinctive types described by Lundie-Jenkins (1989). Type 1 is the saline system associated with salt lakes, and soils affected by various salts including sodium chloride and gypsum and others. Type 2 is the drainage depressions which today appear not to be so affected by salinity, or where the salinity has been masked by overlying sediments such as aeolian or alluvial sands. Vegetation and habitat surveys of the palaeochannels located at the proposed borrow pit and water bore areas fit the description of Type 2 palaeochannel system.

When flood events occur, the palaeochannels flow in a southerly direction. The receiving salt lake environment is approximately 50 km from the project area and does not appear to be clearly linked along a distinct channel.

Table 6-3. Vegetation Types described within the Twin Bonanza Project Area.

Representative Photo	Description	Area (ha)
	Vegetation Type 1 Low *Eucalyptus brevifolia* isolated trees ± mid high *Acacia lysiphloia* or low *A. hilliana* isolated shrubs over *Triodia basedowii* open hummock grassland. Occurs on rocky outcropping.	Within MLA29822 534 ha Proposed for clearing 45
	Vegetation Type 2 *Triodia basedowii* and *T. intermedia* mid open hummock grassland with Acacia minutifolia and *A. adoxa var. adoxa* low open shrubland. Occurs on gravel flat to gentle relief.	Within MLA29822 264 Proposed for clearing 49
	Vegetation Type 3 Open *Triodia spp*. hummock grassland ± low *Eucalyptus brevifolia* or *Hakea lorea* isolated trees with tall ± *Grevillea wickhamii* or *Acacia spp.* open shrubland. Occurs in sand plains.	Within MLA29822 2251 Proposed for clearing 127.1
	Vegetation Type 4 Low *Corymbia opaca* or *Eucalyptus victrix ± Eucalyptus brevifolia* open woodland with tall *Acacia sericophylla* open shrubland over *Triodia pungens* open hummock grassland. Occurs in Palaeochannels and drainages.	Within MLA29822 183 Proposed for clearing 1.2
	Vegetation Type 5 *Acacia aneura* woodland over mixed tussock grass. Occurs within a variety of landform, present on heavy soils with high clay content.	Within MLA29822 1 Proposed for clearing 1

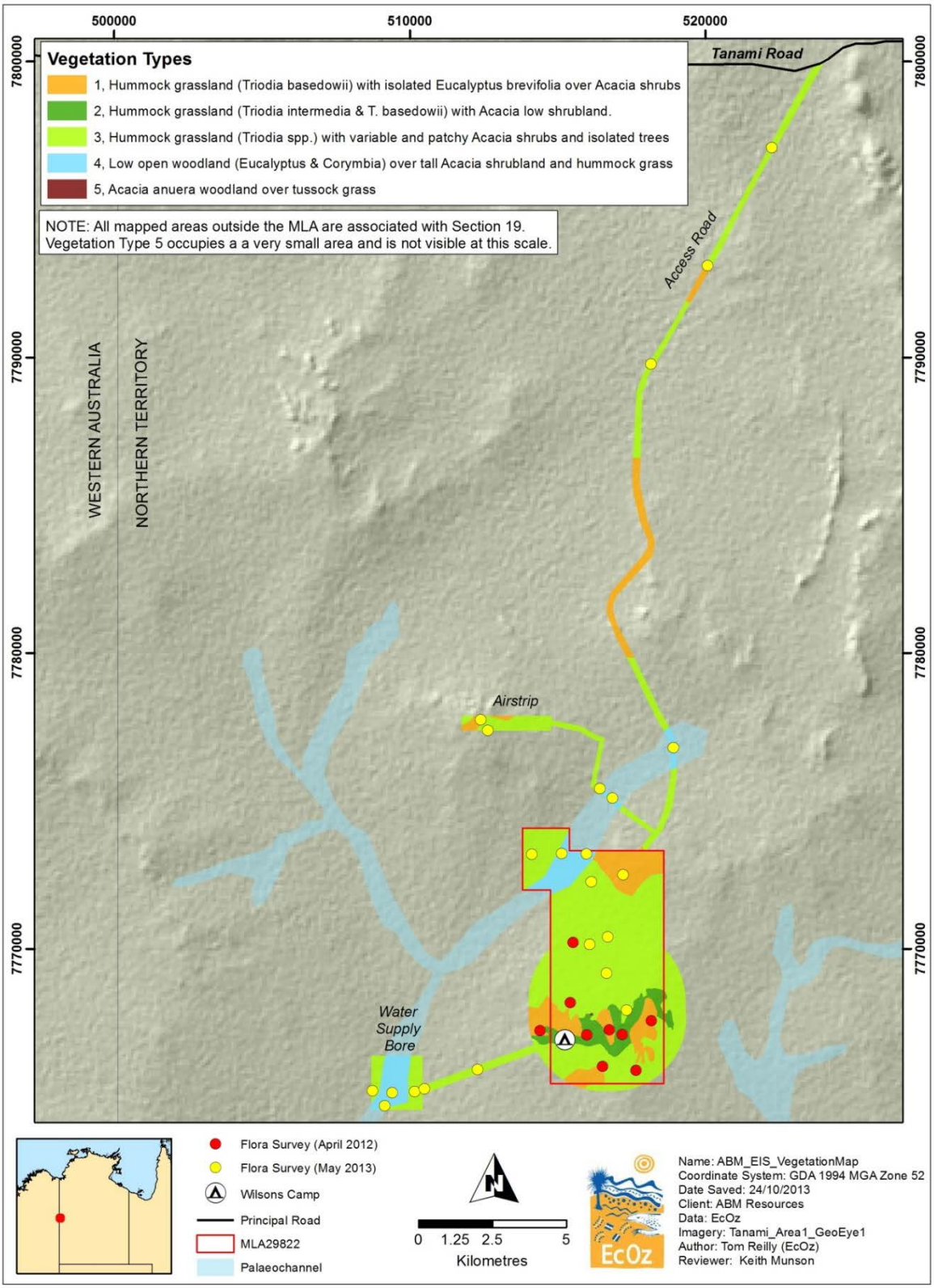

Figure 6-3. Vegetation communities of the Twin Bonanza project area.

6.5.4 Significant flora species

No threatened flora species were identified within the project area or were considered as possibly occurring within the project area (refer to Appendix C for rationale).

ABM have worked closely with Traditional Owners, elders and Indigenous groups (through the CLC) to better understand and minimise potential project impacts on cultural heritage. This information is not within the scope of this flora and fauna report.

The desert walnut (*Owenia reticulata*) was not identified during studies within the project area (this species is of cultural significance to the local indigenous people). Other larger trees (*Hakea* spp., *Grevillea* spp., *Eucalyptus* spp., and *Corymbia* spp.) may be significant to Traditional Owners and consultations will determine the level of significance and measures to protect them within the project area.

6.5.5 Weeds

The vegetation surveys identified three weed infestations, all related to Buffel grass (*Cenchrus ciliaris*) and previous land clearing practices (i.e. a legacy issue inherited by ABM). No declared weeds have been observed within the project area, despite there being database records of some significant (e.g. WONS) species in the bioregion.

Weed infestations were identified at following sites:

- Wilsons Camp. Several small Buffel grass patches located in disturbed areas across the camp area. Minor amount of purple-topped Rhodes grass. There is no evidence that weeds have spread outside of the camp area at this stage (see Appendix C for point locations).
- Wilsons Bore. Buffel grass infestation surrounding the cleared bore pad. Most likely spread by machinery used to clear the camp area.

Junction of Tanami Road and Wilson Camp access road. It occurs on each side of the access track, and also on the northern side of Tanami road. It is evident that earthworks associated with the establishment of Wilsons Camp access track are responsible for introduction of Buffel Grass at this site.

No weeds were identified along exploration tracks, drill pads, water bores, general roads, airstrip, or other areas within the Twin Bonanza project area. Purple-top Rhodes grass (*Chloris barbata*) is present in low densities at Wilsons Camp but is not generally regarded as a threat to native biodiversity (therefore has low priority of control).

Weed control (and management) will focus on Buffel grass, as this species is responsible for significantly changing the ecological function of landscapes in central Australia (such as changing fire regimes, displacement of native flora, and altering habitat availability for fauna) (CRC 2008). This species also poses a fire threat to camp infrastructure if infestations are not appropriately controlled. Subsequent to the weed surveys, the Buffel grass plants infesting Wilsons Camp and Wilsons Bore were manually removed followed by three rounds of spot spraying with a glyphosate based herbicide to kill Buffel grass seedlings (Figure 6-4).

Figure 6-4. Photograph on the left removing Buffel grass by hand. Photograph on the right bagged up Buffel grass for disposal at Twin Bonanza

6.6 Fauna survey – Twin Bonanza

The fauna assessment was undertaken over three surveys. The purpose of the fauna surveys was to describe fauna assemblages, provide an indication of abundances, identify any threatened or notable fauna species, identify and describe any notable habitat for migratory birds or water birds, and estimate existing feral animal populations through on-site observations.

A detailed account of survey effort, methodology and results is provided in Appendix C.

6.6.1 Fauna survey methods

6.6.1.1 Survey effort

Three comprehensive fauna surveys have been conducted for the Twin Bonanza EIS, which included at total of 35 'primary' (i.e. trapping plus active searches) fauna sites plus additional 'secondary' (i.e. active search only) sites and incidental searches across the project area (Figure 6-5). The survey periods were selected to cover the range of seasons in

the Tanami Desert, which provided a robust baseline dataset for ecological risk assessment of the proposed mining operations. The surveys timings were as follows:

- late wet season, April 2012 (GHD 2012)
- late dry season, September 2012 (EcOz 2012)
- early dry season, May 2013 (EcOz 2013)

A detailed account of fauna survey effort and methodology can be found in Appendix C, with a summary provided below.

6.6.1.2 Survey Protocol

Survey protocol was based on *Northern Territory survey methods for flora and fauna surveys used for standard biodiversity unit survey sites* (NRETAS 2008) and conducted under Parks and Wildlife permit and Animal Ethics Approval.

Sites were selected to represent the variation in habitat and vegetation types within the proposed development zones in MLA29822 and Section 19.

The layout of traps at each survey quadrat was based on the standard and accepted N.T. fauna survey guidelines for the southern bioregions of the N.T. (NRETAS 2008). Typically, each site included 20 Elliott traps, 4 pitfall traps, and 8 funnel traps. Traps were inspected for a 3 day period each evening and morning (noting that Elliott traps were shut during daytime). These traps were targeting amphibians, reptiles and mammals. Trapped animals were identified and released near the capture point. Total animal captures and confirmed sightings of reptiles and mammals were tallied to provide an activity estimate and relative abundance for the project area.

Birds were surveyed within each survey site each early morning and in the late afternoon. Incidental bird sightings were recorded and included in final dataset. Bird counts were not undertaken, as the purpose of this survey was to obtain a species list rather than numbers. General observation on bird abundances were noted and included in discussions if considered relevant (Appendix C).

Bat species present were assessed by using Song Meters (SM2+) and Anabat recorders (devices that record bat echolocation data). This method results in a species list rather than abundance.

Active searches were conducted three times at each fauna site including one morning, one afternoon, and one nocturnal. Opportunistic observations outside of survey sites were also recorded in an ‘incidentals’ list.

A habitat assessment was undertaken at each site as part of the vegetation mapping exercise.

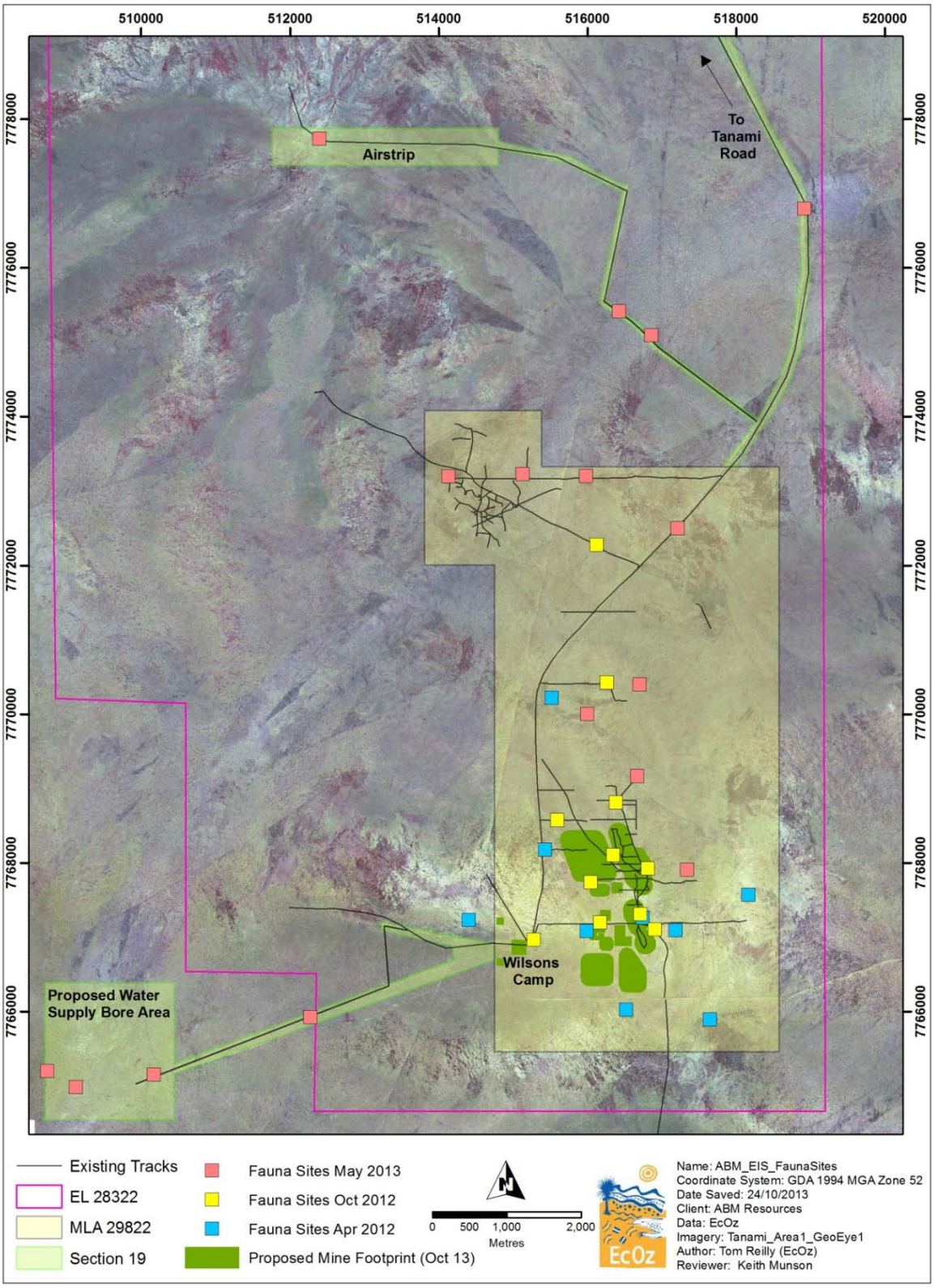

Figure 6-5. Fauna survey sites established for the Twin Bonanza project.

6.6.1.3 Targeted surveys

Desktop research of species present within the bioregion combined with habitat knowledge of the Twin Bonanza project area identified that three threatened species may persist within the project area (see section 6.4.4). Therefore, survey methodology was customised to provide the best chance of identification as standard methods may not detect these species. Methods selected for the fauna surveys at Twin Bonanza were based on relevant EPBC Threatened Species Guidelines (Sadlier et al. 2004; McElroy et al. 2004). Refer to Appendix C for a description of these methods.

6.6.2 Fauna survey Summary

The combined fauna survey results for the project area generated a total of 112 species (Appendix C), including 30 reptiles, 58 birds, and 24 mammals. No amphibians were recorded. Two threatened species and three introduced species were identified (discussed below).

6.6.2.1 Amphibians

No amphibians were recorded during the fauna surveys. However, this is a likely result of climatic conditions experienced during the surveys rather than assuming absence. Ideal timing for amphibian observations is after significant summer rainfall, as many of the species are burrowing frogs that are triggered by soil moisture content and temperature (Gibson, 1986). Amphibians in the Tanami Desert emerge sporadically and can be difficult to detect and capture. Habitat associated with the proposed mining operation is not expected to support high populations of amphibians.

6.6.2.2 Reptiles

A total of 30 species were recorded during the fauna surveys, including dragons, skinks, geckoes, monitors, legless lizards, and snakes (Appendix C). No threatened or introduced species were recorded.

Reptiles were abundant during all surveys when temperatures were high, with notably reduced activity during cold snaps and rainfall. The seasonal surveys were important at detecting different species as they emerged or became more active as climatic conditions changed. Additionally, species abundances varied greatly between seasons and high numbers of juveniles were observed in the September 2012 survey, which followed on from a high summer rainfall period when many species would have bred.

Some notable observations are listed below:

- Tanami Ctenotus (*Ctenotus tanamiensis*) occurs within the project area. This species is endemic to the Tanami Desert (Storr 1970). It is uncommon and prefers sand plain habitats with an understory of hummock grasses (Horner 1992). No captures occurred within proposed development zones.
- Military dragon (*Ctenophorus isolepis*), central netted dragon (*Ctenophorus nuchalis*) and leopard Ctenotus (*Ctenotus pantherinus*) were commonly sighted throughout the project area.
- High populations of spiny-tailed geckos (*Strophurus ciliaris*) were present across the project area, with the October 2012 survey period recording over 150 sightings.
- A lined earless dragon (*Tympanocryptis lineata*) was captured in September 2012 within existing disturbed exploration areas of associated with the Old Pirate deposit within the Twin Bonanza project area. This specimen was interesting as it displayed characters also associated with the centralian earless dragon (*Tympanocryptis centralis*). Further research found that this population of T. lineata could be an undescribed species, for which the name macra is available (Wilson & Swan 2010)

6.6.2.3 Birds

A total of 58 bird species were recorded during the fauna surveys (Appendix C). No threatened or introduced species were recorded.

Bird diversity was relatively low within the project area, reflecting the low variety of habitat structure. Habitat complexity is an important determinant of species richness in birds (Cousin & Phillips 2008). Vegetation cover throughout the project area is generally low, with large trees and shrubs sparsely scattered throughout. In most areas the upper and middle canopy is either very open or absent, which limits foraging and roosting options for birds. Bird communities of spinifex grasslands typically have few species and are low in abundance (Reid 1999), which is reflected in results across all surveys undertaken in the project area.

The most commonly reported species during the surveys were budgerigar (Melopsittacus undulatus), grey-headed honeyeater (Lichenostomus keartlandi), zebra finch (Taeniopygia guttata), black-faced woodswallow (Artamus cinereus), and diamond dove (Geopelia cuneata). Brown falcon (Falco berigora) was the most commonly observed bird of prey, while black-shouldered kite (Elanus axillaris) and nankeen kestrel (Falco cenchroides) were only observed following rainfall. These species likely migrated to the project area to exploit the increased availability of rodent and invertebrate prey.

Some notable observations are listed below.

- A black falcon (*Falco subniger*) was sighted during September 2012 and May 2013 preying on zebra finches (*Taeniopygia guttata*) drinking at a sprinkler at Wilson's Camp.
- Major Mitchell's cockatoo (*Lophochroa leadbeateri*) were sighted in May 2013. While this species is not listed as threatened, populations have declined due to land clearing and a reduction in the availability of nesting hollows (Birdlife Australia 2013).
- Rufous-crowned emu-wrens (*Stipiturus ruficeps*) were recorded in mature spinifex grasses during the May 2013 survey.
- Australian bustard (*Ardeotis australis*) were recorded during all surveys; these species are listed as near threatened under the *TPWC Act*.
- A striated grasswren (*Amytornis striatus*) was recorded in April 2012; these species are listed as near threatened under the *TPWC Act*.

6.6.2.4 Mammals

A total of 24 mammals were recorded during the fauna surveys, including two threatened species and three introduced species (Appendix C).

Small mammal activity appeared to be relatively high within the project area during all three surveys, which is likely a reflection of population "booms" after summer rainfall during the 2011/12 wet season. The most commonly trapped species were stipe-faced dunnart (Sminthopsis macrourus), spinifex hopping mouse (Notomys alexis), sandy inland mouse (Pseudomys hermannsburgensis), lesser hairy-footed dunnart (Sminthopsis youngsoni), and western chestnut mouse (Pseudomys nanus).

Notable results from the mammal survey included:

- Brush-tailed mulgara (*Dasycercus blythi*) were captured on several occasions during all three fauna survey periods. This included one female with multiple young during the September 2012 survey. This species is listed as vulnerable under the *TPWC Act*.
- Greater bilby (*Macrotis lagotis*) activity was recorded during all three survey periods, including nocturnal sightings, fresh diggings, fresh tracks at burrows, camera trap evidence (still and video footage). This species is listed as vulnerable under the *EPBC Act* and *TPWC Act*.
- Western chestnut mouse (*Pseudomys nanus*) was recorded during fauna surveys. This species is listed as near-threatened in the NT.

- Seven species of micro-chiropteran (insectivorous bats) were recorded during the surveys.
- Three introduced species were recorded during the surveys, including Ccamel (*Camelus dromedaries*), house mouse (*Mus musculus*), and feral cat (*Felis catus*).

6.6.3 Significant fauna species

Two threatened fauna species were recorded during surveys at Twin Bonanza, including:

- Brush-tailed mulgara (Dasycercus blythi) – vulnerable under the TPWC Act
- Greater bilby (Macrotis lagotis) – vulnerable under the TPWC Act and EPBC Act.

Evidence of these two species was recorded during the three surveys periods (GHD 2012; EcOz 2012; EcOz 2013). Transect surveys by ABM environmental staff has also detected several additional greater bilby burrows, which has revealed that there are specific focus-areas for bilby activity at the site (see Figure 6-6), which mostly occurred on lateritic sand plains in vegetation types 2 and 3. Brush-tailed mulgara activity appears to be less defined as it occurs across the surveyed area (see Figure 6-6). Targeted searches for the great desert skink (*Liopholis kintorei*) did not result in any evidence that the species occurs in the project area.

As greater bilby and brush-tailed mulgara have been detected within the Twin Bonanza project area, a specific management plan has been developed to ensure that impact to these species is minimised and appropriately monitored (see Appendix D – Biodiversity Management Plan).

A detailed account of survey evidence and the biology for the greater bilby and brush-tailed mulgara is provided in Appendix C: Flora and Fauna Report and Appendix D: Biodiversity Management Plan.

6.6.4 Feral animals

Three introduced fauna species were confirmed to be present within the project area, including the feral cat (Felis catus), one-humped camel (Camelus dromedaries), and house mouse (Mus musculus). These species are widespread and established in the region and are both regarded as a threatening process toward ecological biodiversity. There are several other introduced species that are likely to be present within the region (see Appendix C).

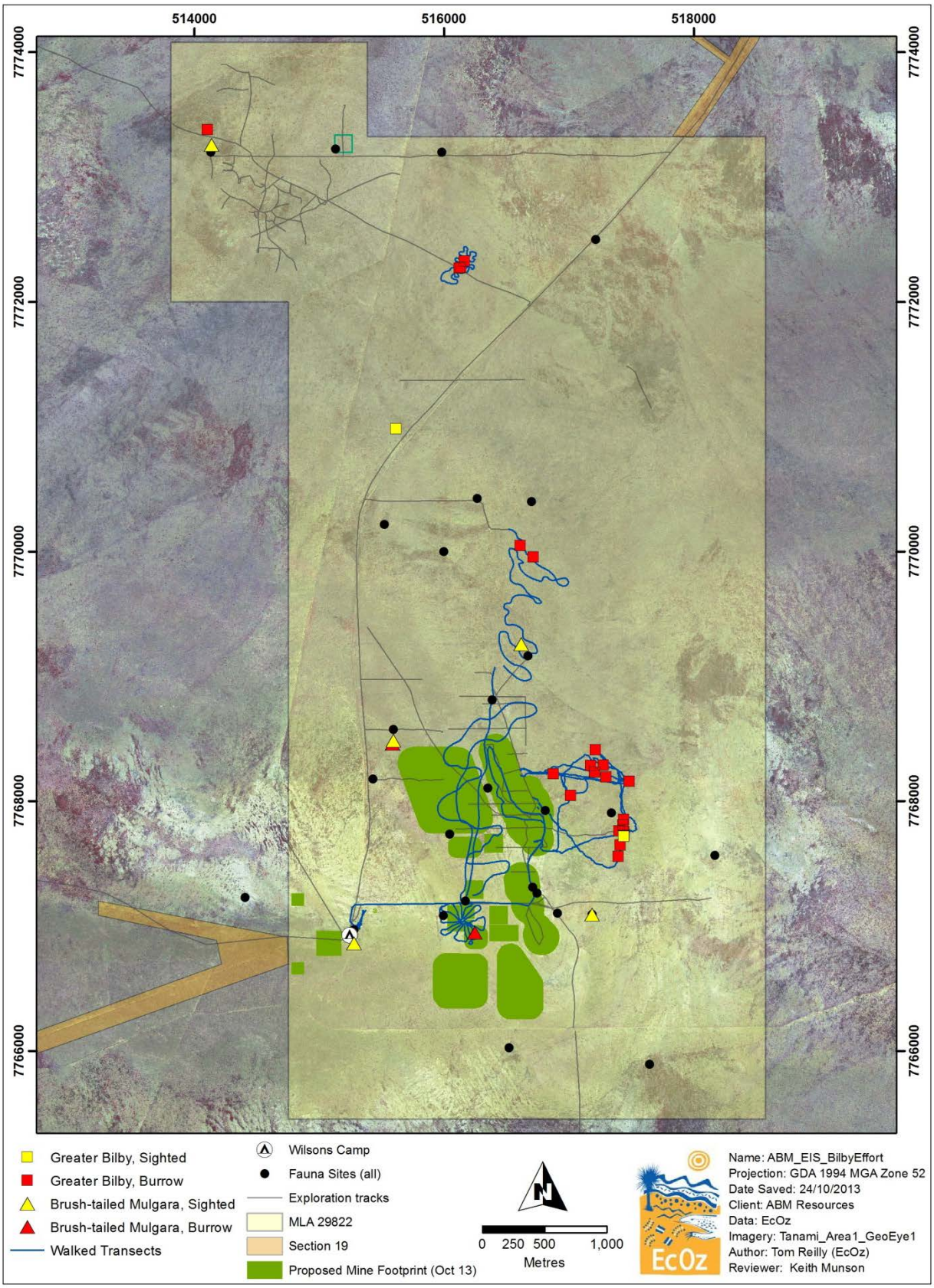

Figure 6-6. Threatened species distributions within the project area based on current survey effort.

6.7 Risk assessment – biodiversity

This section examines the potential impacts that this development will have on the biological values of the region and the local environment. This discussion is supported by literature review, as well as desktop and field surveys done specifically for this development. Risk assessment methodology is described in Chapter 5.

The region of the proposed development has substantial biodiversity conservation values. For example, two threatened species have been reported nearby and within the proposed project area (see Section 6.6.3). These values are reviewed, the associated risk determined and mitigation measures subsequently identified.

For the purposes of this section, biodiversity has been divided into the four main groups to clearly separate events, impacts, and mitigations associated with each of the main biodiversity components for the project area. These groups include:

- vegetation communities
- threatened species
- migratory species
- sensitive habitats

For each of the above groups, events associated with the mining proposal and their potential impacts are identified and assessed. Events selected for discussion in this section are considered to be specific to each group, and in most circumstances may also be further mitigated by standard minimal impact techniques that will be implemented by ABM during the construction and operations phase.

A summary of the risk assessment is provided in Tables 5-4 through to 5-9 (Chapter 5), which includes all environmental aspects of the mining operation.

6.7.1 Vegetation communities

This section identifies hazards that the mining operation may introduce to the project area and how they may impact vegetation communities and general habitat function.

Vegetation communities of the project area have been mapped to a scale of approximately 1:30 K (Section 6.5.2). No vegetation or ecological community of national or Northern Territory significance lies within the proposed clearing envelope and the existing vegetation communities are common throughout the region. Palaeochannels are considered as a sensitive habitat type (risk assessed separately in Section 6.7.2).

Important considerations for vegetation clearing include the type of vegetation being cleared (i.e. restricted or rare vegetation communities), the extent of the clearing (including

implications on connectivity), how it is cleared (including blade depth) and the stability of the soils of the cleared site (this has implications for erosion).

The mining hazards and associated impacts to vegetation communities are listed below and described in the following sections:

- EVENT – Vegetation clearing for general mining operations may lead to:
  - reduction in habitat availability for flora and fauna
  - fragmentation of habitat
  - increased erosion by wind and water.
- EVENT – Introduction and / or spread of weeds may lead to:
  - reduced habitat quality for native flora and fauna.
  - reduced biodiversity values.
  - increased fuel load, fire frequency, and fire intensity.
  - increased presence of out-competing weed species.

6.7.1.1 Vegetation clearing activities

Gross risk

The gross risk to vegetation communities (and associated habitat values) relates to inappropriate clearing in terms of clearing methodology and/or the extent of clearing. Without a proper clearing planning framework supported by relevant knowledge and information, it is likely that over-clearing and/or clearing of the wrong type of vegetation will result. This may also lead to habitat fragmentation in the palaeochannel environment, and accelerated soil erosion and soil loss. This also has implications for rehabilitation success.

If no mitigations are implemented, the risk that vegetation clearing will impact on vegetation communities is considered to have a gross risk rating of 17.

Mitigation measures

Mitigation measures proposed to reduce the gross risk of impacts on vegetation communities include:

- Progressive vegetation clearing, rather than clearing total area at start of project.
- Using existing Northern Territory Land Clearing Guidelines (NRETAS 2010) to inform clearing procedures and processes.
- Vegetation clearance planning that aims to clear the smallest possible area of vegetation.

- All approved clearing boundaries to be shown on maps and clearly marked on the ground when clearing actually takes place.
- Ensuring no unintended clearing occurs in sensitive vegetation communities.
- Closure planning incorporates good rehabilitation practices to return cleared areas to a sustainable landform similar to original (where possible) (see Chapter 11: Mine closure and rehabilitation).
- Ensuring that the above measures are incorporated into the MMP auditing process.

These mitigation measures will control the area cleared and also ensure that cleared areas will not result in a long term impact (i.e. after mine closure) on vegetation community and habitat function within the project area.

Approximately 215 hectares will be cleared for the proposed mining operations (see Table 6-3), including an existing 12.5 hectare of clearance from the bulk sample. Progressive clearing will be implemented to reduce surface disturbance at any one point in time (thereby reducing erosion/dust hazard, weed risk, and general disturbances to local habitat).

Net risk

If mitigation measures are implemented, the risk that vegetation clearing will impact on vegetation communities is considered to have a net risk rating score of 9. However, the risk of impacting sensitive vegetation communities is "low" (refer to Section 6.7.2).

6.7.1.2 Introduction or spread of weed species

Gross risk

Weeds are regarded as a priority management concern for the Tanami Desert region, as they reduce habitat quality. Weeds also adversely affect rehabilitation program success, leading to difficult and expensive mine closure operations. Therefore, weed invasion as a result of proposed mining operations is considered a high risk of affecting habitat quality at Twin Bonanza.

Although no declared weeds have been recorded within the project area, three Buffel grass (Cenchrus ciliaris) infestations were identified during baseline ecological surveys (see Section 6.5.5), which have subsequently undergone weed management.

The Twin Bonanza project may result in the spread of existing weeds, as well as facilitate the introduction of new weeds. The activities that could lead to this include clearing and disturbing vegetation for mining, upgrade of access tracks, installation of haul roads, and general vehicle/equipment movement.

If no mitigation measures are implemented, the risk that weeds will impact on vegetation communities is considered to have a gross risk rating score of 12.

Mitigation measures

Mitigation measures proposed to reduce the gross risk that weeds may impose on vegetation communities include:

- Progressive vegetation clearing rather than wide scale clearing at the start of the project.
- Implementation of the Weed Management Plan (forms part of the BMP – Appendix D), which includes the control and monitoring of existing Buffel grass infestations, enforcing weed hygiene protocols during construction and operation, and regular weed monitoring (especially after periods of rainfall when germination is most active).

Net risk

If mitigation measures are implemented, the risk that weeds will impact on vegetation communities is considered to have a net risk rating score of 5.

6.7.2 Sensitive habitats

This section identifies hazards that the mining operation may introduce to the project area and how they may impact sensitive habitats at the site.

Sensitive habitats include ecosystems that provide important ecological functions including riparian vegetation, protected area buffer zones, refugia, important habitat corridors, or geological features which may support unique ecosystems (escarpments, gorges, gullies etc.).

Section 6.5.3 discusses sensitive habitats of the Tanami bioregion, and concludes that palaeochannels are the only sensitive habitat that occurs within the Twin Bonanza project footprint and associated Section 19 leases. Baseline flora and fauna surveys were conducted to properly describe and map the extent of palaeochannels at Twin Bonanza. This concluded that palaeochannels within the project area can be described as Type 2 Palaeochannels, which are regarded as a drainage depression feature rather than a true palaeodrainage system (see Appendix C for more detailed description). However, ABM is conscious that this assessment may be debated and therefore have chosen to treat the palaeochannel as high priority and to limit disturbance to vegetation and avoid impacting trees that may rely on ground water reserves. Vegetation mapping was undertaken to determine extent and potential area of disturbance to palaeochannels.

The proposed mining operation may lead to impacts on palaeochannels within the project area. These hazards and impacts are listed below and described in the following sections:

- EVENT – Vegetation clearing for water bore pads and access tracks may lead to:
  - removal of deep-rooted species
  - fragmentation of habitat
- EVENT – Groundwater extraction may lead to:
  - decrease in water availability for deep-rooted trees
- EVENT – Habitat modifications (i.e. weeds, fire, noise etc.) may lead to:
  - reduced ecological function of local palaeochannel environment
  - increased fuel load, fire frequency, and fire intensity
  - poor management of supply water (i.e. water extracted from bore)

6.7.2.1 Vegetation clearing

Gross risk

Vegetation clearing for establishment of water supply bores and associated access tracks will result in disturbance of the palaeochannel environment (as the target aquifers occur in the palaeochannel). The mining proposal includes provision of water supply bores in the western palaeochannel. This involves a 900 m^2 drill pad (30 x 30 m) and an access track. Therefore the area of clearing is minimal and not likely to result in a significant habitat disturbance.

As palaeochannels are drainage features, it is possible that habitat fragmentation could result from developments that do not plan to avoid them. Components of the mine that may lead to fragmentation include access tracks that are not constructed and positioned appropriately, which may result in reduced ecological function of the local environment; especially during times of drought as the palaeochannel environment is regarded to have refuge values to biodiversity.

Uncontrolled land clearing for access tracks and drill pads may result in unnecessary removal of deep rooted trees and general habitat disturbance. This impact would have lasting effects on the local environment.

If no mitigation measures are implemented, the risk that vegetation clearing will impact on palaeochannels (i.e. sensitive habitat) is considered to have a gross risk score of 17.

Mitigation measures

Mitigation measures proposed to reduce the gross risk of vegetation clearing on palaeochannels include:

- Positioning water supply bores to limit disturbance and reduce fragmentation.
- Avoiding deep rooted trees where possible (i.e. all trees present within palaeochannel).
- Minimising size of drill pads.

Vegetation and land unit mapping studies were undertaken to determine palaeochannel boundaries at a scale of 1:30 K. This helped position proposed drill pads and tracks in locations that minimise palaeochannel disturbance (as sometimes these land units are difficult to discern on ground). This will be confirmed by on-ground inspections to determine final location in regards to minimising (ideally avoiding) removal of deep rooted tree species.

Net risk

If mitigation measures are implemented, the risk that vegetation clearing will adversely impact palaeochannels is considered to have a net risk score of 9.

6.7.2.2 Groundwater extraction

Gross risk

Extraction of groundwater for supply of the Twin Bonanza project (i.e. for processing, potable water etc.) may impact on deep rooted tree species by lowering of the groundwater aquifer, which can lead to reduced tree health and potential tree mortality due to water stress.

If no mitigation measures are implemented and uncontrolled and unmonitored water extraction occurs, the risk that groundwater extraction will impact on palaeochannels (i.e. specifically deep rooted trees) is considered to have a gross risk score of 17.

Mitigation measures

Mitigation measures proposed to reduce the gross risk of groundwater extraction on palaeochannels include:

- Strict groundwater monitoring schedule using monitoring bores (see Appendix D: BMP for detail on monitoring).
- Conduct tree health monitoring within water supply area, and also in control sites (see Appendix D: BMP for details on monitoring).
- If monitoring detects significant drawdown that cannot be rapidly replenished, water extraction will cease at that particular bore and rotate to another bore in a separate system Monitoring of the drawdown rate and recovery will occur and this information will be used for the ongoing management of the aquifer and to ensure the sustainable yield is not exceeded.

- Implementation of the Water Management Plan (see Appendix F)

Net risk

If mitigation measures are implemented, the risk that groundwater extraction will adversely impact palaeochannels is considered to have a net risk score of 9.

6.7.2.3 Habitat modifications

Gross risk

Habitat modifications associated with the development of a water supply bore in the palaeochannel, without mitigation, could have an effect on ecological processes and functionality. For the purposes of this assessment, habitat modifications include introduction of weeds, attraction of pests, erosion, increased noise, and changes to the fire regime.

Weeds may be transported to site on vehicles/machinery, soils/material, equipment, and personal clothing, which may be via ABM staff and/or their contractors. Typically, weeds initially establish on disturbed areas as there is limited competition with native species and soils are generally more suitable for germination. However, once these "pioneer" species have established and seeded, they can spread to adjacent undisturbed areas.

Weed infestations as a result of the establishment and operation of the water supply bore and access tracks is considered a high risk to maintaining habitat quality within the palaeochannel. Increased weed occurrence within the palaeochannel may change habitat qualities and increase fire frequency/intensities. In particular, protecting palaeochannels from weed incursion is a high priority, as they may transport seed during infrequent flood events. Currently, weed management and control (primarily Buffel grass) is a priority for the CLC in the Tanami Desert.

Landscape impacts from changes in fire regimes are implicated as one of the most important landscape-scale ecological threatening processes in the Tanami Desert. In the context of this mining proposal, ABM will protect environment, human safety, and property through fire-break installation, equipment maintenance, and onsite procedures. However, if mining practices introduce and spread weeds such as Buffel grass into the palaeochannels, this may result in a higher fuel load and more frequent/hotter fires in comparison to hummock grasses that naturally persist in this habitat.

Mitigation measures

Mitigation measures proposed to reduce the gross risk that habitat modifications may have on palaeochannels include:

- Implementation of the Weed Management Plan (see Appendix D).
- Implementation of the Fire Management Plan (see Appendix Z).
- Construction of access roads and pad to reduce chance of erosion development.

6.7.2.4 Poor management of supply water

Gross risk

Inappropriate release of bore water into palaeochannel areas could result in waterlogging of an area and/or soil contamination (if groundwater is saline), which may in turn impact on sensitive vegetation. If leaks and spills are consistent, this may also attract pest fauna.

If no mitigation measures are implemented, the risk that poor management of supply water will impact on palaeochannels is considered to have a gross risk score of 12.

Mitigation measures

Mitigation measures proposed to reduce the gross risk that discharge of bore supply water may have on palaeochannels include:

- Regular inspections of bore equipment.
- Follow BMP and Water Management Plan (refer appendices D and F).
- Monitoring of operations.

Net risk

If mitigation measures are implemented, the risk that habitat modifications will impact on palaeochannels is considered to have a net risk ranking score of 5.

6.7.3 Threatened fauna species

This section identifies hazards that the mining operation may introduce to the project area and how they may impact threatened fauna species.

To understand the regional assemblage of threatened fauna species at the Twin Bonanza project area, several studies were undertaken (described in Section 6.5 and 6.6). Collectively, these studies identify the threatened species of the development area, their ecology and the potential impacts that this development will have on them. This

information has been used to assess the risk profile and identify risk mitigation measures for these species.

The assessment concluded that three threatened species may be impacted by this development:

- Greater bilby (*Macrotis lagotis*) – has been located within project area.
- Brush-tailed mulgara (*Dasycercus blythi*) – has been located within project area.
- Great desert skink (*Liopholis kintorei*) – may occur within project area; has not been located in the area, but the project area is a potential habitat.

Surveys have indicated the greater bilby and brush-tailed mulgara are present in the area, while the great desert skink has not been recorded.

A discussion on the biology and habitat of each of these species is provided in Appendix C and Appendix D.

There are several hazards associated with the proposed mining operation that may lead to an adverse impact on threatened species that are present at the site. These hazards and impacts are listed below and described in the following sections:

- <u>EVENT - Vegetation clearing for mine construction and operations may lead to:</u>
  - accidental injury / mortality of threatened species that persist at the site
  - potential Impact - loss and degradation of threatened species habitat
- <u>EVENT – Introduction and / or spread of weeds may lead to:</u>
  - loss and degradation of threatened species habitat
  - decline in population dynamics from reduction
  - ncreased fuel load, fire frequency, and fire intensity
- <u>EVENT – Introduction and / or spread of pests may lead to:</u>
  - increased predation pressure on threatened species by creating suitable conditions for species such as dingos and feral cats
- <u>EVENT - Vehicle movements during construction and operations may lead to:</u>
  - accidental injury / mortality of individuals through collisions
  - damage to burrows due to off-road driving
- <u>EVENT – Increased noise and vibrations at the site may lead to:</u>
  - populations of threatened species leaving the local area
- <u>EVENT – Habitat modification:</u>
  - creating unsuitable fire regimes
  - food source availability
  - fauna death/ drowning

- failure to implement mitigation and management measures.
- vegetation smothering
- artificial habitat and food source dependency.

6.7.3.1 Vegetation clearing activities

Gross risk

Vegetation clearing will occur as part of this development. Vegetation clearing activities during construction and/or operation of the mine may result in a direct impact on threatened species at site, such as injury / mortality of individuals, and destruction of burrows. An additional potential impact of vegetation clearing is that suitable breeding and foraging habitat for threatened species may be lost or degraded.

For this project, if no mitigation measures were implemented, the likelihood of one of these impacts occurring is regarded as "likely" as field surveys have detected breeding populations of two threatened species within the project area (namely, greater bilby and brush-tailed mulgara). There is potential for a loss of species at a local level (due to the relatively high burrow density in close proximity to the proposed mine). The gross risk ranking score is 17.

Mitigation measures

There is several mitigation measures proposed to reduce the risk level that vegetation clearing imposes on threatened species, including:

- Siting of infrastructure in areas that will least impact threatened species.
- Pre-clearance fauna surveys for all developments that require removal of previously undisturbed native vegetation.
- Adhering to agreed clearing boundaries as part of the EIS approvals.
- Manage clearing in accordance with the BMP (Appendix D).
- Controlled burning of footprint areas prior to progressive cleared in association with traditional owners. This will diminish the food sources and/or modify the habitat in that area thus resulting in burrowing marsupials moving to new areas prior to infrastructure development.

To reduce the impact that vegetation clearing may impact on the greater bilby and brush-tailed mulgara, field surveys were conducted to identify "active zones" to determine if direct impact to these species could be avoided. Survey results identified that greater bilby burrows were concentrated in lateritic sand plains to the east of the proposed open cut pits (see Figure 6-6). Additional to field surveys, a habitat mapping exercise conducted by ABM geologists and mapping team used a selection of habitat layers and assumptions on bilby

biology to determine the most likely zones that bilbies will utilise within the project area (detailed in Appendix D). This mapping was used during the selection of proposed infrastructure locations, to aim to reduce disturbance of "potential" habitat. Brush-tailed mulgara appeared to occur in a wider variety of habitats within the project area (albeit in relatively low numbers) and are therefore difficult to confidently avoid. Therefore, risk mitigation for this project gave priority to reducing impact to greater bilby, as this species has a higher conservation status, is longer lived, and could more easily be avoided during the project design phase. As a result of these surveys, proposed mining infrastructure, such as waste rock dumps and tailing dams, have been located in areas where greater bilby burrows were not observed (see Figure 6-6).

While it is known that the great desert skink occurs in similar habitat within the Tanami, there are no known occurrences of the species along or nearby to the project area (closest records are from 95 km South West). Pre-clearance surveys will attempt to identify burrows of this species and contingencies will be applied if detection occurs.

A controlled burn will be undertaken prior to vegetation clearing to modify the habitat and discourage fauna from occurring the area, subsequently pre-clearance fauna surveys for threatened species will be conducted prior to vegetation clearing to advise ABM on presence of potential activity. If evidence of threatened species is recorded during the pre-clearance surveys, contingencies will be triggered and follow-up actions implemented where possible. These details are included in the BMP.

Furthermore, vegetation clearing practices will only occur within agreed final boundaries as a result of EIS process. A vegetation clearing plan will be summarised in the BMP, which will be based on the N.T. Land Clearing Guidelines and final EIS approvals.

Monitoring plans for greater bilby will occur throughout the mining operation as part of a research study on the species, and to also inform ABM of current activity in the local area (refer to Chapter 15: Environmental offsets).

Net risk

If mitigation measures are implemented, the risk that vegetation clearing activities will adversely impact threatened species is considered to have a "moderate" consequence and an "unlikely" likelihood, which results in a net risk score of 9. This means that specified management responsibility is required to ensure that risk levels are not increased.

6.7.3.2 Introduction or spread of weed species

Gross risk

The introduction of weed species to the site and spread of existing infestations have the potential to adversely impact threatened species populations that persist in the local area.

As discussed above, there are several mining-related activities that could lead to weed issues at the site.

Typically in the Tanami Desert, weed invasions that spread into undisturbed habitat are not common in this environment due to depleted soil nutrients, moisture, and also competition with native spinifex grasses. For threatened species associated with this development, a weed invasion would likely be small and restricted to disturbed zones.

In terms of specific weed impacts to greater bilby and mulgara, weeds may alter habitat qualities, increase fire frequency/intensities, and reduce available food resources.

Therefore, if weeds are not mitigated or managed appropriately, an impact on threatened species are considered to have a gross risk level score of 12.

Mitigations measures

Mitigation measures proposed to reduce the gross risk that weeds may impose on threatened species include:

- Minimise land clearing (thereby reducing soils that are susceptible for weed incursion).
- Progressive clearing of land, followed by progressive rehabilitation (thereby reducing soils that are susceptible for weed incursion).
- Implementation of the Weed Management Plan (forms part of the BMP – Appendix D), which includes:
    - control and monitoring of existing Buffel Grass infestations
    - enforcing weed hygiene protocols during construction and operation
    - transport/purchase of certified “weed free” material if extra soil-based material is required for construction purposes
    - regular weed monitoring (especially after periods of rainfall when germination is most active)

Net risk

If mitigation measures are implemented, the risk that weeds will impact on threatened species is considered to have a net risk score of 5.

6.7.3.3 Introduction or spread of pest species

Gross risk

Pest species have the potential to impose considerable impacts on populations of threatened species in the Twin Bonanza project area, the main impact being increased predation of threatened species populations. Dingos and feral cats are known to occur

within the project area, which indicates that a level of potential predation on threatened species already exists at the site. Both of these species are known to be key predators of the greater bilby and potentially the Brush-tailed Mulgara (Pavey 2006b).

Mine sites in the Tanami Desert are prone to attracting dingos and cats through a variety of activities such as poor management and disposal of putrescible waste, poor camp design (e.g. animals shelter under buildings), onsite personnel interacting with animals, providing water supply points, and creating habitat for dingo dens by leaving unattended soil stockpiles.

It is important that the mine does not actually increase unsustainable populations of any species, either native or introduced. This is because once the mine closes; it is likely that food, shelter, and water points will not be available for animals that may have become habituated to or increased in density as a result of human habitation.

If no mitigation measures are implemented, the risk that pest species will impact on threatened species is considered to have a gross risk score of 17. Therefore, a priority for ABM is to ensure that populations of pest species are not increased as a result of mining operations.

Mitigation measures

Mitigation measures proposed to reduce the Gross risk level that pest species may impose on threatened species include:

- Properly designed land fill area that includes barrier fencing
- Burning all putrescible waste on a daily basis to reduce attraction of scavenger species such as feral cats and dingos.
- Avoiding creation of artificial water points.
- Weekly inspections of land fill fencing to ensure that target species cannot enter the area.
- Monitoring of feral cats and dingos within the general area (see Appendix D: BMP).
- Minimising, where practical, the potential to create artificial habitat for pest species (e.g. loose stockpiles that could provide opportunity for Dingo dens).
- Designing the camp area to reduce chance of dingos and cats using structures for shelter (i.e. fencing under dongas etc.).

- Educating on-site personnel to make them aware not to feed or otherwise interact with animals on the site. This will be conducted via site inductions and ongoing tool box meetings.

Additionally, feral cats will be controlled, control measures will include shooting by professionals and/or Traditional owners supplemented by trapping programs. This program aims at reducing feral animals in the local area to firstly reduce chance of attraction to the camp area, and also to reduce impact to threatened species in the local area. This is discussed further in Chapter 15: Environmental offsets and Appendix D: BMP.

Net risk

If mitigation measures are implemented, the risk that pest predator species will impact on threatened species is considered to have a risk score of 9.

6.7.3.4 Vehicle movements

Gross risk

Irresponsible vehicle movements associated with the proposed mine may result in injury / mortality via road kill, burrow damage, and habitat damage of threatened species. Irresponsible vehicle movements include off road driving, speeding, and general disobedience of road rules (i.e. responding to signage).

The chance of road kill for all threatened species considered to persist within the project area is increased at night time, as these species are all nocturnal. The great desert skink is semi-diurnal, as it may emerge in the late afternoon to catch evening sun. Therefore, the risk of accidental road kill is highest at night time, when site traffic is anticipated to be at its lowest.

Several locations within the project area have relatively high concentrations of greater bilby burrows, and therefore off-road driving has the chance of burrow damage/destruction in these areas. Furthermore, brush-tailed mulgara burrows are widespread across the site (suspected low numbers from data collected in fauna surveys) and therefore will also be at risk of disturbance. Greater desert skinks are also a ground dwelling species that live in burrow systems that may be at risk of disturbance if off road driving is allowed; however there has been no evidence that this species persists on the site to date.

If no mitigation measures are implemented, the risk that vehicle movements will impact on threatened species is considered to have a gross risk score of 12.

Mitigation measures

Mitigation measures proposed to reduce the gross risk level that vehicle movements impose on threatened species include:

- Speed restrictions
- Night driving restrictions or awareness
- Signage along roads that remind drivers of threatened species presence within the project area
- Restrictions on off road driving with the focus on areas containing known Greater Bilby burrows and requirement to use existing roads.
- Education of employees (i.e. through inductions, tool box meetings etc.) to inform onsite personnel of the presence of threatened species within the project area.

Net risk

If mitigations are enforced, the risk that vehicle movements will impact on threatened species is considered to have a net risk score of 5.

6.7.3.5 Lights, noise and vibrations

Gross risk

The mine operation will introduce lights, noise and vibrations to the project area that may result in greater bilby and brush-tailed mulgara abandoning the local area. Therefore, the mine may displace some individuals which may put them at risk of predation and reduce suitable habitat available in the region to the species.

Mining activities may result in deterring individuals to their usual burrow locations, however there is evidence that species such as greater bilby and brush-tailed mulgara become "desensitised" to mine sites and can persist adjacent to infrastructure such airports, waste rock dumps, and haul roads. For example, brush-tailed mulgara have been captured within the kitchen and living quarters of ABM exploration camp (Appendix C). In the case of the greater bilby, it is well established that bilby burrows at the Coyote Mine site airstrip (located 45 km to the west of Twin Bonanza) remained active during airstrip operations over a period of several years (personal comment Jeremy Shepherdson, Principal Ecotec WA 2013).

Noise may have a deleterious effect on species that live or travel through or are situated nearby to the mine site and associated plant and haul road. It is likely that the noise impacts will be localised to the sites above and have no major effect to the wider region.

The greater bilby and brush-tailed mulgara have been recorded within the project area and may be affected by noise and vibration associated with mine establishment and operation. The consequence of the effect of noise on these species is unknown but it is expected to be minor due to the small footprint and expansive similar habitat in the local area. To further manage the effect of noise and vibration around the site a noise management plan has been formulated for the site (Appendix Y).

Lights and vehicle movements at night may also disturb greater bilby and brush-tailed mulgara as these species are nocturnal and are not familiar with this type of activity when foraging for food and breeding partners. The level of impact is difficult to estimate as limited information is available on this topic.

If no mitigations are enforced, the risk that noise, vibrations, and lights will impact on threatened species is considered to have a gross risk score of 16.

Mitigation measures

Mitigation measures proposed to reduce the gross risk level that lights, noise, and vibrations impose on threatened species include:

- Avoid areas currently inhabited by greater bilby.
- Ensure that machinery and equipment is installed with appropriate noise mufflers.
- Ensure that machinery and equipment is service regularly.
- Driving at night in known bilby areas will be minimised and staff will be informed of active zones during inductions, tool box meetings, and signage.
- Blasting for open cut pits cannot be avoided (i.e. blasting create extreme vibrations and noise), but will occur during shift change and is located 1 km from closest known Bilby burrow.

Net risk

If mitigations are enforced, the risk that lights, noise, and vibrations will impact on threatened species is considered to have a net risk (risk score 5).

6.7.4 Migratory species and water birds

This section identifies hazards that the mining operation may introduce to the project area and how they may impact migratory species (and other water birds) that may visit the site in preferred seasons.

Seventy-two species of water birds and migratory birds are known to visit the Tanami Desert after periods of high rainfall (Reid et al 2006). Nine migratory species are predicted to occur within the vicinity of the project area according to the EPBC matter search tool.

Typical natural habitat features in the Tanami Desert that attract water birds and migratory birds are salt lakes and palaeochannels (Type 1), as after significant rainfall these features provide plentiful food supplies of aquatic macro-invertebrates and suitable water qualities. Tailings dams and other man made water holding structures are also well known to attract a diversity of bird life, including migratory species.

The proposed mining operation has the potential to lead to adverse impact on migratory species visiting the site. These hazards and impacts are listed below and described in the following sections:

- <u>EVENT – Poor management of process water and sewerage dam may lead to:</u>
  - bird fatalities or illness

6.7.4.1 Poor management of process water in tailings facility

<u>Gross risk</u>

Migratory species and associated natural habitat features were not identified during Twin Bonanza field surveys; therefore the proposed mining will not have an impact on an existing migratory population or "stopover point". However, the proposal does include establishment of tailings and sewerage dams that have potential to attract migratory species on route to destinations in southern Australian and the Northern Hemisphere.

Typically, tailing facilities for gold mines have the potential to contain water qualities that can be detrimental to birds if consumed, and as these facilities are often contain "permanent" water they may end up being "constant" sites that are visited by a variety of water bird species over the life of the mine. The majority of tailings will be treated by gravity separation, with only a small quantity being leached with cyanide (cyanide being the issue in terms of impact to water birds) in a completely separate closed circuit with modules to remove and detoxify cyanide. ABM are installing two tailing dam cells to service the gravity concentrated waste, and one smaller concentrate residual dam to service leachate waste which will have the cyanide removed prior to deposition.

Other mines in the area that have these facilities have a history of migratory species attraction, therefore it is likely that migratory species will visit similar facilities built at Twin Bonanza.

If no mitigations are enforced, the risk that poor management of process and sewerage water will impact on threatened species is considered to have a gross risk score of 16.

Mitigation measures

Mitigation measures proposed to reduce the gross risk that migratory species are adversely impact by process water and sewerage water include:

- Properly design and operate the tailings dam to minimise the size of the decant pond.
- If required installation and implementation of bird deterrent items and activities, especially in the concentrate residual dam.
- Staff awareness training.
- Regular monitoring of tailings facility and sewerage dam to determine presence of waterbird/migratory species and if any illness or fatalities are occurring as a result of water quality.

Net risk

If mitigations are enforced, the risk that migratory species will be impacted by onsite water bodies is considered to have a net risk ranking score of 5.